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3.9.2 Compliance with the UL and CSA standards

3.9.2 Compliance with the EU Directives

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4.1.2 The inverter equipped with magnetic contactor on primary side (with FR-BU2 type brake unit) (common)

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4.2 Remote operation (common)

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4.2.2 Automatic operation using 4 to 20mADC current signal (common)

4.3 Motor equipped with brake (common)

4.4 Parallel motor operation (common)

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4.4.2 Inverters and motors are in pairs (common)

4.4.3 Using pulse VO (A700)

4.4.4 Soft starter is used to soft-start/soft-stop two motors at the same time (common)

4.5 Inverter - commercial power supply switch-over operation (common)

4.5.1 Star-Delta connection start (common)

4.5.2 Bypass inverter switch-over operation (common)

4.5.3 Bypass-inverter switch-over operation [when bypass/inverter switch-over sequence is used] (common)

4.6 Automatic restart after instantaneous power failure circuit (common)

4.7 Automatic operation of fan, pump or the like using speed setter (common)

4.8 Positioning operation (common)

4.9 Vertical, winding lifter (A700, E700)

4.9.1 Use of relay output option (A700, E700)

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4.10 Inverter fault output display and failure reset (A700, F700)

4.11 Multi-speed operation application example (A700, F700, E700)

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4.13 Operation using the second acceleration/deceleration time (common)

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## 1.1 Specification list

### 1.1.1 Rating

#### (1) FR-A700

- **Type**: FR-A700-10

| Applicable motor capacity (kW) | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
|-------------------------------|-----|------|-----|-----|-----|-----|-----|----|----|-------|----|----|----|----|----|----|----|----|
| FR-A720-10 | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |
| FR-A740-10 | 0.4 | 0.75 | 1.5 | 2.2 | 3.7 | 5.5 | 7.5 | 11 | 15 | 18.5 | 22 | 30 | 37 | 45 | 55 | 75 | 90 |

- **Voltage**: Three-phase 200 to 240V

#### (2) FR-A740-10

<table>
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<th>Applicable motor capacity (kW)</th>
<th>0.4</th>
<th>0.75</th>
<th>1.5</th>
<th>2.2</th>
<th>3.7</th>
<th>5.5</th>
<th>7.5</th>
<th>11</th>
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<td>7.5</td>
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<td>15</td>
<td>18.5</td>
<td>22</td>
<td>30</td>
<td>37</td>
<td>45</td>
<td>55</td>
</tr>
</tbody>
</table>

- **Voltage**: Three-phase 380 to 480V

### 1.1.2 Protective structure (JEM 1030)

- Enclosed type (IP20)*8
- Open type (IP00)

### 1.1.3 Power supply system capacity (kVA)*7

- Without DC reactor
  - FR-A720-10: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
  - FR-A740-10: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100

- With DC reactor
  - FR-A720-10: 0.9, 1.4, 2.9, 3.8, 5.7, 8.5, 11, 14, 20, 25.5, 31, 41, 51, 62, 75, 110, 132
  - FR-A740-10: 0.9, 1.4, 2.9, 3.8, 5.7, 8.5, 11, 14, 20, 25.5, 31, 41, 51, 62, 75, 110, 132

- With DC reactor
  - FR-A720-10: 0.9, 1.4, 2.9, 3.8, 5.7, 8.5, 11, 14, 20, 25.5, 31, 41, 51, 62, 75, 110, 132
  - FR-A740-10: 0.9, 1.4, 2.9, 3.8, 5.7, 8.5, 11, 14, 20, 25.5, 31, 41, 51, 62, 75, 110, 132

### 1.1.4 Approximate mass (kg)

- FR-A720-10: 1.9, 2.3, 3.5, 3.8, 3.8, 7.1, 7.1, 7.5, 13, 13, 14, 23, 35, 35, 58, 70, 70
- FR-A740-10: 3.8, 3.8, 3.8, 3.8, 3.8, 7.1, 7.1, 7.5, 13, 13, 23, 35, 35, 37, 37

### Specifications

- **Type**: Three-phase 200V class
- **Applicable motor capacity (kW)**: 0.4, 0.75, 1.5, 2.2, 3.7, 5.5, 7.5, 11, 15, 18.5, 22, 30, 37, 45, 55, 75, 90
- **Rated capacity (kVA)**: 1.1, 1.9, 3.7, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Rated current (A)**: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Overload current rating*4**: 150% 60s, 200% 3s (inverse-time characteristics)
- **Voltage*5**: Three-phase 200 to 240V
- **Rated capacity (kVA)*2**: 1.1, 1.9, 3.7, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Rated current (A)*3**: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Rated capacity (kVA)*7**: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Rated current (A)*7**: 1.5, 2.5, 4.5, 5.5, 9, 12, 17, 20, 28, 34, 41, 52, 66, 89, 100
- **Protective structure (JEM 1030)*9**: Enclosed type (IP20)*8
- **Approximate mass (kg)**: 1.9, 2.3, 3.5, 3.8, 3.8, 7.1, 7.1, 7.5, 13, 13, 14, 23, 35, 35, 58, 70, 70

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*1: FR-A700
*2: FR-A740
*3: FR-A700
*4: FR-A740
*5: FR-A700
*6: FR-A700
*7: FR-A700
*8: FR-A700
*9: FR-A700
### Specifications

1. The applied motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.

2. The rated output capacity indicated assumes that the output voltage is 220V for 200V class and 440V for 400V class.

3. When operating the inverter of 75K or more with a value larger than 2kHz set in Pr. 72 PWM frequency selection, the rated output current is lower than the figures in the table. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

4. The % value of the overload current rating indicated is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

5. The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the pulse voltage value of the inverter output side voltage remains unchanged at about 1.2 times the power supply voltage.

6. 200V: When FR-ABR (option) is connected, 15% torque 10% ED for 0.4K and 0.75K, 100% torque 10% ED for 1.5K to 7.5K, 100% torque 6% ED for 11K to 22K.

   400V: When FR-ABR-H (option) is connected, 15% torque 10% ED for 0.4K to 7.5K, 100% torque 6% ED for 11K to 22K.

7. The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).

8. When the hook of the inverter front cover is cut off for installation of the plug-in option, protective structure of the inverter changes to an open type (IP00).

9. FR-DU07: IP40 (except for the PU connector)

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<th>132</th>
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## SPECIFICATIONS

### (2) FR-F700

#### Three-phase 200V class

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#### Three-phase 400V class

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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissible frequency fluctuation</td>
<td>±5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply system capacity (kVA)*6</td>
<td>Without DC reactor</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
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<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>With DC reactor</td>
<td>110</td>
<td>137</td>
<td>165</td>
<td>198</td>
<td>247</td>
<td>275</td>
<td>325</td>
<td>366</td>
<td>416</td>
<td>464</td>
<td>520</td>
<td>586</td>
<td>659</td>
<td>733</td>
<td>833</td>
</tr>
<tr>
<td>Protective structure (JEM 1030)*8</td>
<td>Open type (IP00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling system</td>
<td>Forced air cooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate mass (kg)</td>
<td>37</td>
<td>50</td>
<td>57</td>
<td>72</td>
<td>72</td>
<td>110</td>
<td>110</td>
<td>175</td>
<td>175</td>
<td>260</td>
<td>260</td>
<td>370</td>
<td>370</td>
<td>370</td>
<td></td>
</tr>
</tbody>
</table>

*1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.
*2 The rated output capacity indicated assumes that the output voltage is 220V for 200V class and 440V for 400V class.
*3 When operating the inverter with the carrier frequency set to 3kHz or more, the carrier frequency will automatically decrease if the output current of the inverter exceeds the value in parenthesis of the rated current. This may cause the motor noise to increase.
*4 The % value of the overload current rating indicated is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.
*5 The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the pulse voltage value of the inverter output side voltage remains unchanged at about d) of the power supply.
*6 The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).
*7 When the hook of the inverter front cover is cut off for installation of the plug-in option, the inverter changes to an open type (IP00).
*8 FR-DU07 : IP40 (except for the PU connector)
### SPECIFICATIONS

#### (3) FR-E700

**Three-phase 200V power supply**

<table>
<thead>
<tr>
<th>Type FR-E720 (K/-C)</th>
<th>0.1</th>
<th>0.2</th>
<th>0.4</th>
<th>0.75</th>
<th>1.5</th>
<th>2.2</th>
<th>3.7</th>
<th>5.5</th>
<th>7.5</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated output (kVA)</td>
<td>0.3</td>
<td>0.8</td>
<td>1.7</td>
<td>4.4</td>
<td>7.0</td>
<td>9.5</td>
<td>13.1</td>
<td>18.7</td>
<td>23.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current (A)</td>
<td>0.8</td>
<td>1.5</td>
<td>3</td>
<td>8</td>
<td>11</td>
<td>17.5</td>
<td>24</td>
<td>33</td>
<td>47</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Overload current</td>
<td>105% 60% 200% 3x (inverse-time characteristics)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Voltage**:  Three-phase 200 to 240V
- **Rated input**: Three-phase 200 to 240V 50Hz/60Hz (283 to 339VDC)
- **Permissible AC voltage fluctuation**: ±5%
- **Power supply capacity (kVA)**: 0.4 0.8 1.5 2.5 4.4 7.0 9.5 12 17 20 28

**Protective structure (JEM1030)**: Enclosed type (IP20). IP40 for totally enclosed structure series.

**Cooling system**
- Self-cooling
- Forced air cooling

**Approximate mass (kg)**
- 0.5 0.5 0.7 1.0 1.4 1.7 2.3 4.3 5.9 9.9 9.9

*1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.

*2 The rated output capacity indicated assumes that the output voltage is 230V for three-phase 200V class and 440V for three-phase 400V class.

*3 The % value of the overload current rating indicated is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

*4 The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the pulse voltage value of the inverter output side voltage remains unchanged at about 70% that of the power supply.

*5 The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).

*6 Setting 2kHz or more in Pr. 72 PWM frequency selection to perform low acoustic noise operation in the surrounding air temperature exceeding 40°C (totally-enclosed structure is 30°C), the rated output current is the value in parenthesis.

*7 Connect DC power supply to terminal P/+ and N/-. Connect the plus side of the power supply to terminal P/+ and minus side to terminal N/-. Since the voltage between P/+ and N/- may increase due to the regeneration energy from the motor and exceeds 415V temporarily, select the DC power supply which can withstand the voltage/energy during regeneration. If using the power supply which cannot withstand voltage/energy during regeneration, insert diodes in series for reverse current prevention.

• Since the power supply capacity depends on the output impedance of the power, select the power supply capacity which has enough allowance according to the AC power supply system capacity.

#### Three-phase 400V power supply

<table>
<thead>
<tr>
<th>Type FR-E740 (K/-C)</th>
<th>0.4</th>
<th>0.75</th>
<th>1.5</th>
<th>2.2</th>
<th>3.7</th>
<th>5.5</th>
<th>7.5</th>
<th>11</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated output (kVA)</td>
<td>1.2</td>
<td>2</td>
<td>3.0</td>
<td>4.8</td>
<td>7.2</td>
<td>9.1</td>
<td>13.0</td>
<td>17.5</td>
<td>23.0</td>
</tr>
<tr>
<td>Current (A)</td>
<td>1.8</td>
<td>2.8</td>
<td>4.0</td>
<td>6.0</td>
<td>9.5</td>
<td>12</td>
<td>17</td>
<td>23</td>
<td>30</td>
</tr>
<tr>
<td>Overload current</td>
<td>105% 60% 200% 3x (inverse-time characteristics)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Voltage**: Three-phase 380 to 480V
- **Rated input voltage/frequency**: Three-phase 380 to 528V 50Hz/60Hz
- **Permissible AC voltage fluctuation**: ±5%
- **Power supply capacity (kVA)**: 1.5 2.5 4.5 5.5 9.5 12 17 20 28

**Protective structure (JEM1030)**: Enclosed type (IP20). IP40 for totally enclosed structure series.

**Cooling system**
- Self-cooling
- Forced air cooling

**Approximate mass (kg)**
- 1.4 1.4 1.9 1.9 1.9 2.2 2.2 3.9 5.9

---

*1 The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.

*2 The rated output capacity indicated assumes that the output voltage is 200V for three-phase 200V class and 440V for three-phase 400V class.

*3 The % value of the overload current rating indicated is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.

*4 The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the pulse voltage value of the inverter output side voltage remains unchanged at about 70% that of the power supply.

*5 The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).

*6 Setting 2kHz or more in Pr. 72 PWM frequency selection to perform low acoustic noise operation in the surrounding air temperature exceeding 40°C (totally-enclosed structure is 30°C), the rated output current is the value in parenthesis.

*7 Connect DC power supply to terminal P/+ and N/-. Connect the plus side of the power supply to terminal P/+ and minus side to terminal N/-. Since the voltage between P/+ and N/- may increase due to the regeneration energy from the motor and exceeds 415V temporarily, select the DC power supply which can withstand the voltage/energy during regeneration. If using the power supply which cannot withstand voltage/energy during regeneration, insert diodes in series for reverse current prevention.

• Although the FR-E700 series has the built-in inrush current limit circuit, select the DC power supply considering the inrush current at powering ON as the inrush current four times of the rated inverter flows at powering ON.

• Since the power supply capacity depends on the output impedance of the power, select the power supply capacity which has enough allowance according to the AC power supply system capacity.
### FR-D700

#### Three-phase 400V power supply

<table>
<thead>
<tr>
<th>Model FR-D740-K(-C)</th>
<th>0.4</th>
<th>0.75</th>
<th>1.5</th>
<th>2.2</th>
<th>3.7</th>
<th>5.5</th>
<th>7.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applicable motor capacity (kW)</td>
<td>0.4</td>
<td>0.75</td>
<td>1.5</td>
<td>2.2</td>
<td>3.7</td>
<td>5.5</td>
<td>7.5</td>
</tr>
<tr>
<td>Rated capacity (kVA)</td>
<td>0.9</td>
<td>1.7</td>
<td>2.7</td>
<td>3.8</td>
<td>6.1</td>
<td>9.1</td>
<td>12.2</td>
</tr>
<tr>
<td>Rated current (A)</td>
<td>1.2</td>
<td>2.2</td>
<td>3.6</td>
<td>5.0</td>
<td>8.0</td>
<td>12.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Overload current rating</td>
<td>150% 60s, 200% 0.5s (inverse-time characteristics)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>Three-phase 380 to 480V</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rated input AC voltage/frequency</td>
<td>Three-phase 380 to 480V 50Hz/60Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Permissible AC voltage fluctuation</td>
<td>30% to 50% 50Hz/60Hz</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Permissible frequency fluctuation</td>
<td>±5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power supply capacity (kVA)</td>
<td>1.5</td>
<td>2.5</td>
<td>4.5</td>
<td>5.5</td>
<td>9.5</td>
<td>12.0</td>
<td>17.0</td>
</tr>
<tr>
<td>Protective structure (JEM1030)</td>
<td>Enclosed type (IP20), IP40 for totally enclosed structure series</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling system</td>
<td>Self-cooling, Forced air cooling</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approximate mass (kg)</td>
<td>1.3</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>3.3</td>
<td>3.3</td>
<td></td>
</tr>
</tbody>
</table>

1. The applicable motor capacity indicated is the maximum capacity applicable for use of the Mitsubishi 4-pole standard motor.
2. The rated output capacity indicated assumes that the output voltage is 440V.
3. The % value of the overload current rating indicated is the ratio of the overload current to the inverter's rated output current. For repeated duty, allow time for the inverter and motor to return to or below the temperatures under 100% load.
4. The maximum output voltage does not exceed the power supply voltage. The maximum output voltage can be changed within the setting range. However, the pulse voltage value of the inverter output side voltage remains unchanged at about 2/3 that of the power supply.
5. The power supply capacity varies with the value of the power supply side inverter impedance (including those of the input reactor and cables).
6. Totally enclosed structure series ends with -C.
1.1.2 Common specifications

**Operation specifications**
- Base frequency can be set from 0 to 400Hz, constant torque/variable torque pattern or adjustable 5 points V/F can be selected.
- Digital input 0 to 10V, 0 to 5V, 4 to 20mA (0 to 20mA) can be selected
- Analog input Within ±0.2% of the max. output frequency

**Control specifications**
- Frequency resolution setting
- Control method Soft-PWM control/high carrier frequency PWM control (selectable from among V/F control, Advanced magnetic flux vector control, Real sensorless vector control, and vector control

**Operational functions**
- Base frequency can be set from 0 to 400Hz, constant torque/variable torque pattern or adjustable 5 points V/F can be selected
- Digital input 0 to 10V, 0 to 5V, 4 to 20mA (0 to 20mA) can be selected
- Analog input Within ±0.2% of the max. output frequency
### SPECIFICATIONS

<table>
<thead>
<tr>
<th><strong>Operating status</strong></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input frequency, motor current (steady or peak value), output voltage, frequency setting, running speed, motor torque, overload, converter output voltage (steady or peak value), electronic thermal relay function load factor, output power, output power, load meter, motor acceleration current, cumulative energization time, actual operation time, motor load factor, cumulative power, power saving effect, cumulative saving power, regenerative brake duty, PID set point, PID measured value, PID deviation, inverter I/O terminal monitor, input terminal option monitor, output terminal option monitor, option fitting status, terminal assignment status, torque command, torque current command, feed back pulse, motor output</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Alarm description</strong></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can be displayed only on the operation panel (FR-DU07). Can be displayed only on the parameter unit (FR-PU07/FR-PU04). Temperature applicable for a short period in transit, etc. 2.9m/s² or less for the 160K or more. This protective function does not function in the initial status.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Protective/Warning function</strong></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overcurrent during acceleration, overcurrent during deceleration, overvoltage during acceleration, overvoltage during deceleration, inverter protection thermal operation, converter protection thermal operation, heat sink overheating, instantaneous power failure occurrence, undervoltage, input phase failure, motor overload, output side earth (ground) fault occurrence, output short circuit, main circuit element overheat, output phase loss, external thermal relay operation, PTC thermistor operation, option alarm, parameter error, PU disconnection, net current excessive, CPU alarm.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Environment</strong></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrounding air temperature</td>
<td>-10 to +50°C (non-freezing)</td>
</tr>
<tr>
<td>Ambient humidity</td>
<td>90% RH maximum (non-condensing)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 to +65°C</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Indoor (without corrosive gas, flammable gas, oil mist, dust and lint etc.)</td>
</tr>
<tr>
<td>Pollution Degree</td>
<td>Maximum 330 according to IEC 60439-2, 3.5m/s or less at 10 to 50Hz (directions of X, Y, Z axes)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Notes</strong></th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Available only when the option (FR-A7AP/FR-A7AL) is mounted.</td>
</tr>
<tr>
<td>2</td>
<td>Can be displayed only on the operation panel (FR-DU07).</td>
</tr>
<tr>
<td>3</td>
<td>Can be displayed only on the parameter unit (FR-PDJ/F-PU04).</td>
</tr>
<tr>
<td>4</td>
<td>Temperature applicable for a short period in transit, etc.</td>
</tr>
<tr>
<td>5</td>
<td>2.9m/s² or less for the 160K or more.</td>
</tr>
<tr>
<td>6</td>
<td>This protective function does not function in the initial status.</td>
</tr>
</tbody>
</table>
## FR-F700

<table>
<thead>
<tr>
<th>Specification</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control method</td>
<td>SVPWM control/high frequency PWM control (VP control, Optimum excitation control, Simple mag-</td>
</tr>
<tr>
<td>Frequency range</td>
<td>0 Hz to 400 Hz</td>
</tr>
<tr>
<td>Frequency setting resolution</td>
<td>0.1 Hz to 100 Hz</td>
</tr>
<tr>
<td>Frequency accuracy</td>
<td>0.01 Hz to 0.05 Hz</td>
</tr>
<tr>
<td>Voltage/frequency characteristic</td>
<td>Max Frequency can be set 0.1Hz to 100Hz.</td>
</tr>
<tr>
<td>温饱感</td>
<td>指定方法: SVPWM control/high frequency PWM control (VP control, Optimum excitation control, Simple mag-</td>
</tr>
<tr>
<td>频率范围</td>
<td>0 Hz to 400 Hz</td>
</tr>
<tr>
<td>频率设定精度</td>
<td>0.1 Hz to 100 Hz</td>
</tr>
<tr>
<td>频率精度</td>
<td>0.01 Hz to 0.05 Hz</td>
</tr>
<tr>
<td>电压/频率特性</td>
<td>最大频率可以设置0.1Hz到100Hz。</td>
</tr>
</tbody>
</table>

### Operational functions

- **Start signal**: Forward and reverse rotation or start signal automatic self-holding input (3-wire input) can be selected.
- **Setting signal**: Frequency, Stagnation prevention operation level, Operation current level can be set (0 to 150% adjustable), whether to use the function or not can be selected.
- **DC injection brake**: Operation frequency (0 to 120Hz), operation time (0 to 10s), operation voltage (0 to 30%) variable.
- **Acceleration/deceleration time setting**: 0.01s to 3600s (acceleration and deceleration can be set individually), linear or S-pattern acceleration/deceleration mode can be selected.
- **Starting torque**: 120% at 3Hz when set to simple magnetic flux vector control and slip compensation.
- **Voltage/frequency characteristics**: Base frequency can be set from 0 to 400Hz. Constant torque/variable torque pattern or adjustable 5 points V/F can be selected.

### Input signal

- **Operational status**: You can select any twelve signals using Pr. 190 to Pr. 196 (open collector output) and Pr. 197 to Pr. 199 (closed collector output) from among multi-speed selection, second function selection, emergency stop selection, JOG operation selection, JOG operation signal selection, selection of automatic reset after instantaneous power failure, external relay operation signal, HVCD connection (inverter operation enable signal), HC connection (inverter operation enable signal), and PID stop/start signal. You can select any four signals using Pr. 150, Pr. 151, Pr. 152, Pr. 153 (open collector output) from among multi-speed selection, second function selection, emergency stop selection, JOG operation selection, JOG operation signal selection, selection of automatic reset after instantaneous power failure, external relay operation signal, HVCD connection (inverter operation enable signal), HC connection (inverter operation enable signal), and PID stop/start signal.
- **PID process value**: You can select any seven signals using Pr. 150, Pr. 151, Pr. 152, Pr. 153 (open collector output) from among PID upper limit, PID lower limit, PID forward/rotation reverse rotation output, electronic bypass MC1, electronic bypass MC2, electronic bypass MC3, alarm output, heater overheating pre-alarm, inverter running/stop command, deactivation at an instantaneous power failure, PID control activated, during retry, PID output interruption, life alarm, fault output 1 (power-off signal), power savings average value update timing, current average monitor, fault output 2, maintenance timer alarm, remote output, alarm output, fault output. Open collector output (5 points), relay output (2 points) and alarm code of the inverter can be output (4 bit) from the output coil.
- **Operation enable signal**: You can select any twelve signals using Pr. 190 to Pr. 196 (open collector output) and Pr. 197 to Pr. 199 (closed collector output) from among multi-speed selection, second function selection, emergency stop selection, JOG operation selection, JOG operation signal selection, selection of automatic reset after instantaneous power failure, external relay operation signal, HVCD connection (inverter operation enable signal), HC connection (inverter operation enable signal), and PID stop/start signal.

### Terminal detail

- **When used with the FR-A7AX, FR-A7AT option**: In addition to the details above, you can also select any three signals using Pr. 160, Pr. 161, Pr. 162 (open collector output) from among multi-speed selection, second function selection, emergency stop selection, JOG operation selection, JOG operation signal selection, selection of automatic reset after instantaneous power failure, external relay operation signal, HVCD connection (inverter operation enable signal), HC connection (inverter operation enable signal), and PID stop/start signal.
- **GU terminal function**: You can select any seven signals using Pr. 150, Pr. 151, Pr. 152, Pr. 153 (open collector output) from among PID upper limit, PID lower limit, PID forward/rotation reverse rotation output, electronic bypass MC1, electronic bypass MC2, electronic bypass MC3, alarm output, heater overheating pre-alarm, inverter running/stop command, deactivation at an instantaneous power failure, PID control activated, during retry, PID output interruption, life alarm, fault output 1 (power-off signal), power savings average value update timing, current average monitor, fault output 2, maintenance timer alarm, remote output, alarm output, fault output. Open collector output (5 points), relay output (2 points) and alarm code of the inverter can be output (4 bit) from the output coil.
- **PU terminal function**: You can select any twelve signals using Pr. 150, Pr. 151, Pr. 152, Pr. 153 (open collector output) from among PID upper limit, PID lower limit, PID forward/rotation reverse rotation output, electronic bypass MC1, electronic bypass MC2, electronic bypass MC3, alarm output, heater overheating pre-alarm, inverter running/stop command, deactivation at an instantaneous power failure, PID control activated, during retry, PID output interruption, life alarm, fault output 1 (power-off signal), power savings average value update timing, current average monitor, fault output 2, maintenance timer alarm, remote output, alarm output, fault output. Open collector output (5 points), relay output (2 points) and alarm code of the inverter can be output (4 bit) from the output coil.
- **Output terminal function selection**: You can select any twelve signals using Pr. 158 to Pr. 169 (open collector output) from among inverter running, up-speed, instantaneous power failure alarm/guarding, overload warning, output frequency detection, second output frequency detection, regenerative brake pre-arming, electronic thermal relay function pre-arming, PU operation mode, inverter operation ready, output current detection, zero current detection, PID low limit, PID upper limit, PID forward rotation reverse rotation output, electronic bypass MC1, electronic bypass MC2, electronic bypass MC3, alarm output, heater overheating pre-alarm, inverter running/stop command, deactivation at an instantaneous power failure, PID control activated, during retry, PID output interruption, life alarm, fault output 1 (power-off signal), power savings average value update timing, current average monitor, fault output 2, maintenance timer alarm, remote output, alarm output, fault output. Open collector output (5 points), relay output (2 points) and alarm code of the inverter can be output (4 bit) from the output coil.
SPECIFICATIONS

Protective/warning function
- Overcurrent during acceleration, overcurrent during constant speed, overcurrent during deceleration,
- Overvoltage during acceleration, overvoltage during constant speed, overvoltage during deceleration,
- Inverter protection, thermal operation, motor protection, thermal operation, overload, instantaneous power failure,
- Overcurrent, input phase loss, motor overload, output side earth (ground) fault, overcurrent,
- Output phase loss, external thermal relay operation, PTC, thermistor operation, option fault, parameter error,
- PU disconnection, retry count, excess, CPU fault, operation panel power supply short circuit, 24VDC power
- Output short circuit, output current, output voltage, excess, inrush current, line circuit fault, communication fault
- (inverter), analog input fault, internal circuit fault (12V power supply), fan alarm, overcurrent stall prevention,
- Overvoltage stall prevention, regenerative brake pressure alarm, electronic thermal relay function alarm,
- Overload, maintenance timer alarm, brake transistor alarm detection, parameter write error, copy operation error,
- Operation panel lock, parameter copy

Environment
- Surrounding air temperature: -10°C to +50°C (non-freezing)
- Storage temperature: -20°C to +65°C
- Atmosphere: Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)
- Altitude/ambient temperature: Maximum 1000m above sea level, 5.9m/s² or less at 10 to 55Hz (directions of X, Y, Z axes)

*1 Can be displayed only on the operation panel (FR-DU07).
*2 Can be displayed only on the parameter unit (FR-PU07/FR-PU04).
*3 Temperature applicable for a short period in transit, etc.
*4 Functions for 75K or more.
*5 2.9m/s² or less for the 185K or more.
*6 This protective function does not function in the initial status.
## FR-E700

### SPECIFICATIONS

<table>
<thead>
<tr>
<th>Control method</th>
<th>Analog input (parameter unit)</th>
<th>DC injection brake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input</td>
<td>Within 0.01% of the set output frequency</td>
<td>Operation frequency (0 to 120Hz), operation time (0 to 10s), operation voltage (0 to 30%) variable</td>
</tr>
<tr>
<td>Frequency setting resolution</td>
<td>Output signal</td>
<td>Digital input</td>
</tr>
<tr>
<td>4 to 20mA</td>
<td>Output signal</td>
<td>Two points</td>
</tr>
<tr>
<td>0.01Hz</td>
<td>Output signal</td>
<td>0.01 to 360s, 0.1 to 3600s (acceleration and deceleration can be set individually), linear or S-pattern acceleration/deceleration mode can be selected.</td>
</tr>
<tr>
<td>Output frequency range</td>
<td>Pulse output</td>
<td>For motor</td>
</tr>
<tr>
<td>2.2K or more</td>
<td>Pulse output</td>
<td>You can select from among output frequency, motor current (steady), output voltage, frequency setting, motor torque, converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, reference voltage output, motor load factor, PID set point, PID measured value, output power.</td>
</tr>
<tr>
<td>Frequency accuracy</td>
<td>Specification</td>
<td>Two points</td>
</tr>
<tr>
<td>±0.5% of the max. output frequency (25°C±10°C)</td>
<td>Specification</td>
<td>You can select from among multi-speed operation, remote setting, stop-on contact control, second function control, maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, operation external interlock, external-NET operation switchover, command source switchover, inverter operation enable signal, and PU-External operation switchover.</td>
</tr>
<tr>
<td>Frequency setting</td>
<td>Operating status</td>
<td>You can select from among multi-speed selection, remote setting, stop-on contact selection, second function, maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, operation external interlock, external-NET operation switchover, command source switchover, inverter operation enable signal, and PU-External operation switchover.</td>
</tr>
<tr>
<td>0.12Hz/60Hz (terminal2, 4: 0 to 5V/9bit)</td>
<td>Operating status</td>
<td>You can select from among multi-speed selection, remote setting, stop-on contact selection, second function, maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, operation external interlock, external-NET operation switchover, command source switchover, inverter operation enable signal, and PU-External operation switchover.</td>
</tr>
<tr>
<td>0.06Hz/60Hz (terminal2, 4: 0 to 10V/10bit)</td>
<td>Operating status</td>
<td>You can select from among multi-speed selection, remote setting, stop-on contact selection, second function, maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, operation external interlock, external-NET operation switchover, command source switchover, inverter operation enable signal, and PU-External operation switchover.</td>
</tr>
<tr>
<td>0.06Hz/60Hz (terminal2, 4: 0 to 20mA/10bit)</td>
<td>Operating status</td>
<td>You can select from among multi-speed selection, remote setting, stop-on contact selection, second function, maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, operation external interlock, external-NET operation switchover, command source switchover, inverter operation enable signal, and PU-External operation switchover.</td>
</tr>
</tbody>
</table>

### Operational functions

- Operation method: Frequency setting, pulse output, retarder relay output, inverter operation enable signal, PID control, computer link operation (RS-485)...
- You can select from among output frequency, motor current (steady), output voltage, frequency setting, motor torque, converter output voltage, regenerative brake duty, electronic thermal relay function load factor, output current peak value, converter output voltage peak value, reference voltage output, motor load factor, PID set point, PID measured value, output power.
## SPECIFICATIONS

<table>
<thead>
<tr>
<th>Protective/Warning Function</th>
<th>Protective Functions</th>
<th>Warning Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overcurrent during acceleration, overcurrent during constant speed, overcurrent during deceleration, overvoltage during acceleration, overvoltage during constant speed, overvoltage during deceleration, inverter protection thermal operation, motor protection thermal operation, heatsink overheated, input phase failure, output side earth (ground) fault overcurrent at start, output phase failure, external thermal relay operation, option fault, parameter error, PU disconnection, retry count excess, CPU fault, brake transistor alarm, inrush resistance overheat, communication error, analog input error, USB communication error, brake sequence error 4 to 7</td>
<td></td>
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</tr>
<tr>
<td>Fan alarm, overcurrent stall prevention, overvoltage stall prevention, parameter write error, regenerative brake prealarm, electronic thermal relay function prealarm, maintenance output, undervoltage</td>
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<tr>
<td>-10°C to +50°C (non-freezing) (-10°C to +40°C for totally-enclosed structure feature)</td>
<td>-20°C to +65°C</td>
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<tr>
<td>Indoors (without corrosive gas, flammable gas, oil mist, dust and dirt etc.)</td>
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<tr>
<td>Maximum 1000m above sea level, 5.9m/s² or less at 10 to 55Hz (directions of X, Y, Z axes)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 The braking torque indicated is a short-duration average torque (which varies with motor loss) when the motor alone is decelerated from 60Hz in the shortest time and is not a continuous regenerative torque. When the motor is decelerated from the frequency higher than the base frequency, the average deceleration torque will reduce. Since the inverter does not contain a brake resistor, use the optional brake resistor when regenerative energy is large. (Not available for 0.1K and 0.2K.) A brake unit (FR-BU2) may also be used.

*2 Temperatures applicable for a short time, e.g. in transit.

*3 As the 0.75K or less are not provided with the cooling fan, this alarm does not function.

*4 When using the inverters at the surrounding air temperature of 40°C or less, the inverters can be installed closely attached (0cm clearance).

*5 This protective function does not function in the initial status.
## FR-D700

### Specifications

#### Control specifications

- **Control method**: Soft-PWM control/high carrier frequency PWM control (V/F control, General-purpose magnetic flux vector control. Optimum excitation control can be selected)
- **Output frequency range**: 0.2 to 400Hz
- **Frequency setting resolution**: Analog input
  - 0.06Hz/60Hz (terminal 2, 4: 0 to 10V/10bit)
  - 0.12Hz/60Hz (terminal 2, 4: 0 to 5V/9bit)
  - 0.06Hz/60Hz (terminal 4: 0 to 20mA/10bit)
- **Digital input**: 0.01Hz

#### Frequency accuracy

- **Analog input**: Within ±1% of the max. output frequency (25°C ±10°C)
- **Digital input**: Within 0.01% of the set output frequency

#### Voltage/frequency characteristics

- Base frequency can be set from 0 to 400Hz. Constant-torque/variable torque pattern can be selected

#### Starting torque

- 150% or more (at 1Hz)...when General-purpose magnetic flux vector control and slip compensation is set

#### Torque boost

- Manual torque boost

#### Acceleration/deceleration time setting

- 0.1 to 3600s (acceleration and deceleration can be set individually), linear or S-pattern acceleration/deceleration mode can be selected.

#### Braking torque

- Regenerative
  - 0.1K, 0.2K ... 150%, 0.4K, 0.75K ... 100%, 1.5K ... 50%, 2.2K or more ... 20%

#### DC injection brake

- Operation frequency (0 to 120Hz), operation time (0 to 10s), operation voltage (0 to 30%) variable

#### Stall prevention operation level

- Operation current level can be set (0 to 200% adjustable), whether to use the function or not can be selected

#### Frequency setting signal

- **Input signal** (Five terminals)
  - Multi-speed selection, remote setting, second function selection, terminal 4 input selection, JOG operation selection, PID control valid terminal, computer link operation (RS-485), Optimum excitation control, power failure stop, speed smoothing control, Modbus RTU

#### Operational functions

- Maximum/minimum frequency setting, frequency jump operation, external thermal relay input selection, automatic restart after instantaneous power failure operation, forward/reverse rotation prevention, remote setting, second function, multi-speed operation, regeneration avoidance, slip compensation, operation mode selection, offline auto-tuning function, PID control, computer link operation (RS-485), Optimum excitation control, power failure stop, speed smoothing control, Modbus RTU

#### Output signal

- **Open collector output** One terminal
- **Relay output** One terminal

#### Output point for meter

- Pulse output MAX 2.4kHz: one point
- Pulse train output (MAX 2.4kHz: one terminal)

#### Parameter unit (FR-PU07)

- Operating status
  - Output frequency, output current (steady), output voltage, frequency setting, cumulative energization time, actual operation time, converter output voltage, converter output voltage peak value, reference voltage output, motor load factor, PID set point, PID measured value, output power, PID deviation, motor thermal load factor, and inverter thermal load factor
- Fault definition
  - Fault definition is displayed when the fault occurs and the past 8 fault definitions (output voltage/current/frequency/cumulative energization time right before the fault occurs) are stored
## SPECIFICATIONS

### Protective/warning functions

| Overcurrent during acceleration, overcurrent during constant speed, overcurrent during deceleration, overvoltage during acceleration, overvoltage during constant speed, overvoltage during deceleration, inverter protection thermal operation, motor protection thermal operation, heatsink overheated, input phase loss, output phase loss, external thermal relay operation, PTC thermistor operation, parameter error, PU disconnection, retry count excess, CPU fault, brake transistor alarm, stall prevention operation, output current detection value exceeded, safety circuit fault, output side earth (ground) fault, overcurrent at start, output phase loss, external thermal relay operation, output phase loss, parameter error, PU disconnection, retry count excess, CPU fault, brake transistor alarm, stall prevention operation, analog input error, stall prevention operation, output current detection value exceeded, safety circuit fault. |

### Warning functions

| Fan alarm, overcurrent stall prevention, overvoltage stall prevention, regenerative brake prealarm, electronic thermal relay function prealarm, maintenance output, undervoltage, operation panel lock, password locked, inverter reset, safety stop. |

### Environment

<table>
<thead>
<tr>
<th>Surrounding air temperature</th>
<th>-10°C to +50°C maximum (non-freezing) (-10°C to +40°C for totally-enclosed structure feature)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient humidity</td>
<td>90%RH or less (non-condensing)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20°C to +65°C</td>
</tr>
</tbody>
</table>

### Notes:

- *1 The braking torque indicated is a short-duration average torque which varies with motor body when the motor alone is decelerated from 60Hz in the shortest time and is not a continuous regenerative torque. When the motor is decelerated from the frequency higher than the base frequency, the average deceleration torque will reduce. Since the inverter does not contain a brake resistor, use the optional brake resistor when regenerative energy is large. A brake unit (FR-BU2) may also be used.
- *2 Temperatures applicable for a short time, e.g. in transit.
- *3 As the 0.75K or less are not provided with the cooling fan, this alarm does not function.
- *4 When using the inverters at the surrounding air temperature of 40°C or less, the inverters can be installed closely attached (0cm clearance).
- *5 This protective function does not function in the initial status.
### 1.2.1 Specification comparison list

<table>
<thead>
<tr>
<th>Item</th>
<th>FR-A700</th>
<th>FR-A500</th>
<th>FR-V500</th>
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</thead>
<tbody>
<tr>
<td>Attachment (option)</td>
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<tr>
<td>Compatibility by the outline</td>
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<tr>
<td>Standard (intercompatibility)</td>
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<tr>
<td>0.4K to 22K</td>
<td>0.4K to 7.5K</td>
<td>0.4K to 15K</td>
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<td>0.4K to 7.5K</td>
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<tr>
<td>1.5K to 5.5K</td>
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<tr>
<td>0.4K to 1.5K</td>
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<tr>
<td>Braking capability</td>
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<td>Overload current rating</td>
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<td>Current limit</td>
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<tr>
<td>Motor noise</td>
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<tr>
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<td>Capacity range</td>
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## SPECIFICATIONS

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### Performance
- **Soft-PWM control**
  - FR-F500: High carrier frequency PWM control
  - FR-F500L: Sine wave PWM control

- **Flux Control**
  - FR-F500: V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, Optimum excitation control
  - FR-F500L: V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, Optimum excitation control

### Additional Features
- **Ultra-low noise**
  - FR-F500: Ultra-low noise
  - FR-F500L: Ultra-low noise

### Capacitor Regeneration
- **75% (capacitor regeneration)**
  - FR-F500: 0.4K to 15K (9 models)
  - FR-F500L: 0.4K to 15K (9 models)

- **25% (capacitor regeneration)**
  - FR-F500: 2.2K or more (20% capacitor regeneration)
  - FR-F500L: 2.2K or more (20% capacitor regeneration)

### Compatibility
- Compatible with E500 series
- Compatible with 5S00 series
### SPECIFICATIONS

<table>
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<tr>
<th>Item</th>
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<th>FR-A500 (L)</th>
<th>FR-V500 (L)</th>
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*FR-A700, FR-A500 (L), FR-V500 (L), FR-F700, FR-F500 (L), FRL-E700*
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**Notes:**

- FR-E700, FR-E500, FR-F500J are not available for FR-F500 (L) and FR-D700.
- FR-D700 and FR-S500 are not available for FR-F500 (L).
- FR-S500 and FR-F500J are not available for FR-D700.
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FR-DU07 is equipped as a standard.
FR-PU07 is equipped as a plug-in option.
FR-DU04 is equipped as a standard.
FR-DU04-1 is equipped as a plug-in option.
FR-PU04 is equipped as a standard.
FR-PU04V is equipped as a plug-in option.
One port as standard and another as plug-in option.
Two ports as standard.

Item

Swedish, Finnish
Spanish, Italian,
German, French,
(Japanese, English,
languages
display
FR-DU04 : no language
FR-DU04-1 : no language
FR-PU04 : eight languages
FR-PU04V : eight languages
FR-DU07 : no language
FR-PU01 : —
FR-PU03/FR-ARW03 : —
FR-PU04 : —

Password lock
—
Copy function
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Item

Swedish, Finnish
Spanish, Italian,
German, French,
(Japanese, English,
languages

Pr.
initial value setting (available by using
registration
Pr.
Pr.
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<td>Built-in operation panel: no language display</td>
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**Specifications**

- **Language:**
  - FR-DU04: no language display
  - FR-PU04: eight languages (Japanese, English, German, French, Spanish, Italian, Swedish, Finnish)
  - PA02: no language display

- **Copied:**
  - (Plug-in option) can be copied
  - (Plug-in option) can not be copied
  - (Plug-in option) can not be copied

- **Standard:**
  - One port as standard
  - One port as standard

- **Options:**
  - Only for FR-F500E CH-M4R
## SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>FR-A700</th>
<th>FR-A500 (L)</th>
<th>FR-V500 (L)</th>
<th>FR-F700</th>
<th>FR-F500 (L)</th>
<th>FRL-E700</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency setting signal</strong></td>
<td>0 to 400Hz, 0 to 100Hz</td>
<td>0 to 400Hz, 0 to 100Hz</td>
<td>0 to 400Hz, 0 to 100Hz</td>
<td>0 to 400Hz, 0 to 100Hz</td>
<td>0 to 400Hz, 0 to 100Hz</td>
<td>0 to 400Hz, 0 to 100Hz</td>
</tr>
<tr>
<td><strong>Control circuit terminal</strong></td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
</tr>
<tr>
<td><strong>Main circuit terminal</strong></td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
<td>Screw type terminal (using ring tongue terminal)</td>
</tr>
<tr>
<td><strong>Cooling fan (cassette changing method)</strong></td>
<td>10 years</td>
<td>10 years</td>
<td>10 years</td>
<td>10 years</td>
<td>10 years</td>
<td>10 years</td>
</tr>
<tr>
<td><strong>Built-in EMC filter</strong></td>
<td>(2nd Environment)</td>
<td>—</td>
<td>(2nd Environment)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Plug-in option</strong></td>
<td>Up to three single-function options may be plugged in</td>
<td>Up to three single-function options may be plugged in</td>
<td>Up to three single-function options may be plugged in</td>
<td>Up to three single-function options may be plugged in</td>
<td>Up to three single-function options may be plugged in</td>
<td>A single-function option can be plugged in</td>
</tr>
<tr>
<td><strong>AC reactor</strong></td>
<td>0 (option)</td>
<td>0 (option)</td>
<td>0 (option)</td>
<td>0 (option)</td>
<td>0 (option)</td>
<td>0 (option)</td>
</tr>
<tr>
<td><strong>DC reactor</strong></td>
<td>option, provided for 75K or more</td>
<td>option, provided for 75K or more</td>
<td>option, provided for 75K or more</td>
<td>option, provided for 75K or more</td>
<td>option, provided for 75K or more</td>
<td>option, provided for 75K or more</td>
</tr>
<tr>
<td><strong>Cooling fan</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td><strong>Built-in filter</strong></td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

**Notices:**
- Items marked with "—" are not available.
- Specifications subject to change without notice.
- For detailed specifications, refer to the FR Configurator manual.
<table>
<thead>
<tr>
<th></th>
<th>FR-F500 (L)</th>
<th>FR-E700</th>
<th>FR-E500</th>
<th>FR-M700</th>
<th>FR-S500</th>
<th>FR-F500J</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminals</td>
<td>Available in 7 terminals</td>
<td>Available in 6 terminals</td>
<td>Available in 4 terminals</td>
<td>Available in 5 terminals</td>
<td>Available in 4 terminals</td>
<td>Available in 6 terminals</td>
</tr>
<tr>
<td>Terminals</td>
<td>Available in 5 terminals</td>
<td>Available in 2 terminals</td>
<td>Available in 2 terminals</td>
<td>Available in 1 terminal</td>
<td>Available in 1 terminal</td>
<td>Available in 1 terminal</td>
</tr>
<tr>
<td>Terminals</td>
<td>Available in 1 terminal (ABC)</td>
<td>Available in 1 terminal (ABC)</td>
<td>Available in 1 terminal (ABC)</td>
<td>Available in 1 terminal (ABC)</td>
<td>Available in 1 terminal (ABC)</td>
<td>Available in 1 terminal (ABC)</td>
</tr>
<tr>
<td>Terminals</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>0V to 19Vdc (0 to 30mA)</th>
<th>0 to 10V</th>
<th>0 to 5VDC, 0 to 10V</th>
<th>0 to 5VDC, 0 to 10V</th>
<th>0 to 5VDC, 0 to 10V</th>
<th>0 to 5VDC, 0 to 10V</th>
</tr>
</thead>
<tbody>
<tr>
<td>Screw type terminal</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Screw type terminal</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Screw type terminal</td>
<td>○</td>
<td>○</td>
<td>○</td>
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<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>10 years</th>
<th>10 years</th>
<th>5 years</th>
<th>10 years</th>
<th>5 years</th>
<th>10 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-F500 (L)</td>
<td>A single-function option can be plugged in.</td>
<td>A single-function option can be plugged in.</td>
<td>A single-function option can be plugged in.</td>
<td>A single-function option can be plugged in.</td>
<td>A single-function option can be plugged in.</td>
<td>A single-function option can be plugged in.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-F500 (L)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>(option)</th>
<th>(option)</th>
<th>(option)</th>
<th>(option)</th>
<th>(option)</th>
<th>(option)</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th></th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
<th>FR Configuration (FR_S03-SETUP-LU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-F500 (L)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
<td>(option)</td>
</tr>
</tbody>
</table>

|                     | (option)                          | (option)                          | (option)                          | (option)                          | (option)                          | (option)                          |
**1.3 Standard connection diagram and terminal specifications**

**1.3.1 Internal block diagram**

(1) FR-A700

---

*1 A common mode choke is provided for the 55K or less.

*2 For the 75K or more, a jumper across terminal P1-P/+ is not provided. Always connect a DC reactor provided. When a DC reactor is connected to the 55K or less, remove the jumper across P1-P/+.

*3 A relay is used for the 200V class 11K and 30K to 90K and 400V class 11K, 15K and 110K to 500K.

*4 The 200V class 0.4K and 0.75K are not provided with the EMC filter ON/OFF connector.

*5 To supply power to the control circuit separately, remove the jumper across R/L1-R1/L11 and S/L2-S1/L21.

*6 Terminal function can be changed using [Pr. 178 to Pr. 189 Input terminal selection].

*7 Terminal input specifications can be changed by analog input specifications switchover ([Pr. 73, Pr. 267]). Note that the current at terminal 2 and 4 is always 4 to 20mA when the voltage/current input switch is set to ON.

Terminal 2 : Initial value 0 to 5VDC (can be changed to 0 to 10VDC, 4 to 20mADC)
Terminal 4 : Initial value 4 to 20mADC (can be changed to 0 to 5VDC, 0 to 10VDC)
Terminal 1 : Initial value 0 to 10VDC (can be changed to 0 to 5VDC)

*8 It is recommended to use 2W1k resistor when the frequency setting signal is changed frequently.

*9 Remove the jumper across terminal PR-PX when connecting a brake resistor (0.4K to 7.5K).

*10 The built-in brake resistor is provided for the 7.5K or less. A brake transistor is provided for the 22K or less.

*11 A CN8 connector is provided for the 75K or more.

*12 Terminal function can be changed using [Pr. 190 to Pr. 196 Output terminal selection].

*13 It is not necessary when calibrating the meter from the operation panel.
**SPECIFICATIONS**

**FR-F700**

| *1| A common mode choke is provided for the 55K or less. |
| *2| For the 75K or more, a jumper across terminal P1-P/+ is not provided. Always connect a DC reactor provided. When a DC reactor is connected to the 55K or less, remove the jumper across P1-P/+.
| *3| A relay is used for the 200V class 15K and 37K to 110K and 400V class 15K, 18.5K and 132K to 560K. |
| *4| The 200V class 0.75K and 1.5K are not provided with the EMC filter ON/OFF connector.
| *5| To supply power to the control circuit separately, remove the jumper across R/L1-R1/L1 and S/L2-S1/L21. |
| *6| Terminal function can be changed using [Pr. 178 to Pr. 189 Input terminal selection]. |
| *7| Terminal input specifications can be changed by analog input specifications switchover ([Pr. 73, Pr. 267]). Note that the current at terminal 2 and 4 is always 4 to 20mA when the voltage/current input switch is set to ON. |
| *8| It is recommended to use 2W1k  when the frequency setting signal is changed frequently. |
| *9| Do not use PR and PX terminals. Please do not remove the jumper connected to terminal PR and PX. |
| *10| A CN8 connector is provided for the 75K or more. |
| *11| Terminal function can be changed using [Pr. 190 to Pr. 196 Output terminal selection]. |
| *12| It is not necessary when calibrating the meter from the operation panel. |
(3) FR-E700

- Three-phase 200V, 400V class

---

1. Thyristor is used for three-phase 200V class 11K/15K.
2. Brake resistor is unavailable for 0.1K and 0.2K as these inverters do not have brake transistor plugged-in.
3. Operation panel is not removable from the inverter.
4. Terminal function can be changed using \[ \text{Pr. 178 to Pr. 184 Input terminal selection} \].
5. Take caution not to short across terminals PC and SD when using between those terminals as 24VDC power supply.
6. It is recommended to use 2W1k \( \Omega \) when the frequency setting signal is changed frequently.
7. Can be changed by switching analog input specification (\[ \text{Pr.73} \]).
8. Can be changed by switching analog input specification (\[ \text{Pr.267} \]).
9. Terminal function can be changed using \[ \text{Pr. 190 to Pr. 192 Output terminal selection} \].
10. It is not necessary when calibrating the meter from the operation panel.

---

To input voltage, set the voltage/current input switch to "V". To input current, set the voltage/current input switch to "I" (initial setting).

---

26
(4) FR-D700
*Three-phase 400V class

1. Operation panel is not removable from the inverter.
2. Terminal function can be changed using [Pr. 178 to Pr. 182 Input terminal selection].
3. Take caution not to short across terminals PC and SD when using between those terminals as 24VDC power supply.
4. It is recommended to use 2W1kΩ when the frequency setting signal is changed frequently.
5. Can be changed by switching analog input specification ([Pr.73]). Terminal 10 and 2 can be used as PTC input terminals ([Pr.561]).
6. Can be changed by switching analog input specification ([Pr.267]).
To input voltage, set the voltage/current input switch to “V”. To input current, set the voltage/current input switch to “I” (initial setting).
7. Terminal function can be changed using [Pr. 190 and Pr. 192 Output terminal selection].
8. It is not necessary when calibrating the meter from the operation panel.
9. Common terminal for terminal SO is terminal SC (Terminal SC is connected to terminal SD inside of the inverter.)
### 1.3.2 Explanation of I/O terminal specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Availability</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1, S1, L1, T1, L3</td>
<td>AC power input terminal</td>
<td>Three-phase 200V to 230V 50Hz, 200 to 240V 60Hz</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>U, V, W</td>
<td>Inverter output terminal</td>
<td>Connected to a three-phase inverter motor.</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>R1L11, S1L21</td>
<td>Power supply for control circuit</td>
<td>Same rating as the AC power input terminal R1, S1, L1, T1, L3</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Pr, Pr</td>
<td>Brake resistor connection terminal (22k or less)</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Pr, N</td>
<td>Brake unit connection terminal</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Pr, Pt</td>
<td>DC reactor connection terminal</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Pr, Px</td>
<td>Built-in brake circuit connection terminal</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Earth terminal</td>
<td>—</td>
<td>Terminals for earthing (grounding) the inverter chassis. Must be earthed grounded.</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
## Specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>STF *1</td>
<td>Forward rotation start signal terminal</td>
<td>Input resistance: 4.7kΩ</td>
<td>Turning ON STF signal gives forward command and off gives stop command; Turning ON STR signal gives reverse command and off gives stop command.</td>
</tr>
<tr>
<td>1.2</td>
<td>STR *1</td>
<td>Reverse rotation start signal terminal</td>
<td>Input resistance: 4.7kΩ</td>
<td>Turning ON STF signal gives forward command and off gives stop command; Turning ON STR signal gives reverse command and off gives stop command.</td>
</tr>
<tr>
<td>1.3</td>
<td>STOP *1</td>
<td>Start self-holding selection terminal</td>
<td>Input resistance: 4.7kΩ</td>
<td>Turning ON STOP signal selects the self-holding start method. If the start signal STF (STR) is once turned ON, it will stay on until OFF. If the start signal is held off, the motor will stop.</td>
</tr>
<tr>
<td>2.1</td>
<td>RH, RM, RL *1</td>
<td>Three speeds selection</td>
<td>Input resistance: 4.7kΩ</td>
<td>For multi-speed selection, setting multi-speed frequencies in [Pr. 24 to Pr. 27, Pr. 232 to Pr. 239] allows up to 15 speeds to be selected by the combinations of RH, RM, RL, REX signal. Allocate REX signal to any of the terminals using input terminal function selection.</td>
</tr>
<tr>
<td>3.1</td>
<td>JOG *1</td>
<td>Jog mode selection terminal</td>
<td>Input resistance: 4.7kΩ</td>
<td>When second function such as [Pr. 44, Pr. 45, Pr. 46] is set, turning ON RT signal selects the second function.</td>
</tr>
<tr>
<td>4.1</td>
<td>RT *1</td>
<td>Second function selection terminal</td>
<td>Input resistance: 4.7kΩ</td>
<td>When second function such as [Pr. 44, Pr. 45, Pr. 46] is set, turning ON RT signal selects the second function.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Available Inverters</th>
<th>A700</th>
<th>F700</th>
<th>E700</th>
<th>D700</th>
</tr>
</thead>
<tbody>
<tr>
<td>A700</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>F700</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>E700</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>D700</td>
<td>o</td>
<td>o</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>

### Application Explanation
- **STF (STR) Signal**: Triggers forward (reverse) rotation when activated. OFF signal stops the motor.
- **STOP Signal**: Selects self-holding start method. Once activated, the start signal is retained even after power failure.
- **RH, RM, RL Signals**: Enable multi-speed operation.
- **JOG Signal**: Used for jog mode when STF (STR) is ON.
- **RT Signal**: Selects second function when Pr. 44, 45, 46 is set.
### SPECIFICATIONS

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
<th>Available Inverters</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRS</td>
<td>Inverter output stop terminal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE5</td>
<td>Reset terminal</td>
<td>Input resistance: 4.7 kΩ</td>
<td>21 to 27 VDC</td>
<td>Voltage when contacts are open</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voltage when contacts are short circuited: 4 to 6 mADC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RES</td>
<td></td>
<td>Isolated by photocoupler</td>
<td></td>
<td>Controls by open collector output or no voltage contact signal</td>
<td>O O — 56</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Designed to reset the inverter trip by the protective circuit operated when a fault occurs. Immediately sets each portion of the control circuit to the initial state and shuts off the inverter output at the same time. To provide this reset input, turn RES signal ON for 0.1 s or longer, then turn OFF. Inverter recovers about 1 s after reset is cancelled.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Terminal is overridden by the multi-speed terminal.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AU</td>
<td>Input selection terminal (current input selection)</td>
<td>Input resistance: 4.7 kΩ</td>
<td>21 to 27 VDC</td>
<td>Voltage when contacts are open</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Voltage when contacts are short circuited: 4 to 6 mADC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolated by photocoupler</td>
<td></td>
<td>Controls by open collector output or no voltage contact signal</td>
<td>O O — 43</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Terminal AU is used as PTC input terminal (thermal protection of the motor). When using it as PTC input terminal, set the AU/PTC switch to PTC.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Only when AU signal is turned ON, the 4 to 20 mA DC frequency setting signal input to across terminals 4-5 (voltage input) is invalid.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>The terminal is overridden by the multi-speed terminal.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specification of PTC-thermistor resistance: Normal: 0 to 500 Ω Boundary: 500 Ω to 4 kΩ Overload: 4 kΩ or higher</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Terminal AU is used as PTC input terminal (thermal protection of the motor). When using it as PTC input terminal, set the AU/PTC switch to PTC.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Turn ON CS signal to enable automatic reset control when power is restored from an instantaneous power failure. Note that reset setting is necessary for this operation. In the initial setting, a reset is disabled.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Common terminal for contact input terminal (sink logic) and terminal FM. Isolated from terminals 5 and SE.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Common output terminal for 24 VDC 0.1 A power supply (PC terminal). Isolated from terminals 5 and SE.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>When connecting the transistor output (open collector output), such as a programmable controller, when source logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Type**

- **Terminal Symbol**: MRS, RE5, RES, AU, CS, SD, EX, SW
- **Available Inverters**: A700, F700, E700, D700
- **Refer to Page**: 56, 57, 43, 50, 58, 80
## SPECIFICATIONS

### Contact input common terminal (source)

**Application Explanation**
- When connecting the transistor output (open collector output), such as a programmable controller, when sink logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.

### Power supply voltage range:
- 19.2 to 28.8VDC
- 22 to 26.5VDC

### Permissible load current:
- 100mA

### External transistor common terminal (initial setting)
- Can be used as 24VDC 0.1A power supply.

### Frequency setting input range:

<table>
<thead>
<tr>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PC 10E</td>
<td>Power supply voltage range: 19.2 to 28.8VDC</td>
<td>When connecting the transistor output (open collector output), such as a programmable controller, when sink logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.</td>
</tr>
<tr>
<td>PC 10E</td>
<td>Common terminal for contact input terminal (source logic).</td>
<td></td>
</tr>
<tr>
<td>PC 10E</td>
<td>24VDC power supply</td>
<td>Can be used as 24VDC 0.1A power supply.</td>
</tr>
<tr>
<td>PC 10E</td>
<td>Frequency setting signal terminal (voltage signal)</td>
<td>Input values: 0 to 5VDC (or 0 to 10V, 0 to 20mA) provide the maximum output frequency at 5V (10V, 20mA) and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input). Use [Pr. 73] to switch from among input 0 to 5VDC, 0 to 10VDC, and 0 to 20mA.</td>
</tr>
<tr>
<td>PC 10E</td>
<td>Overheat detection resistance: 500 to 30kΩ</td>
<td>Connect a PTC thermistor between terminal 10 and 2. Setting PTC thermistor active ([Pr. 561 ≠ 9999]) disables the frequency setting in terminal 2.</td>
</tr>
<tr>
<td>PC 10E</td>
<td>Terminal functions</td>
<td>Use [Pr. 267] to switch from among input 4 to 20mA (initial setting), 0 to 5VDC and 0 to 10VDC. Use [Pr. 858] to switch terminal functions.</td>
</tr>
<tr>
<td>PC 10E</td>
<td>Common terminal for frequency setting signal (terminal 2, 1 or 4) and analog output terminal AM.</td>
<td>Connected from terminals SD and SE. Do not earth (ground).</td>
</tr>
</tbody>
</table>

### Available Inverters:
- A700
- F700
- E700
- D700

### Refer to Page:
- 85
- 43
- 50
- 43
- 43

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Contact input common terminal (source)</td>
<td>Power supply voltage range: 19.2 to 28.8VDC</td>
<td>When connecting the transistor output (open collector output), such as a programmable controller, when sink logic is selected, connect the external power supply common for transistor output to this terminal to prevent a malfunction caused by undesirable currents.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>External transistor common terminal (initial setting)</td>
<td>Common terminal for contact input terminal (source logic).</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Power supply voltage range: 19.2 to 28.8VDC</td>
<td>Can be used as 24VDC 0.1A power supply.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Frequency setting signal terminal (voltage signal)</td>
<td>Input values: 0 to 5VDC (or 0 to 10V, 0 to 20mA) provide the maximum output frequency at 5V (10V, 20mA) and makes input and output proportional. This input signal is valid only when the AU signal is ON (terminal 2 input). Use [Pr. 73] to switch from among input 0 to 5VDC, 0 to 10VDC, and 0 to 20mA. For [Pr. 700 &lt; 2], set the voltage/current input switch in the ON position to select current input (0 to 20mA). Use [Pr. 267] to switch from among input 4 to 20mA (initial setting), 0 to 5VDC and 0 to 10VDC. Use [Pr. 858] to switch terminal functions.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Overheat detection resistance: 500 to 30kΩ</td>
<td>Connect a PTC thermistor between terminal 10 and 2. Setting PTC thermistor active ([Pr. 561 ≠ 9999]) disables the frequency setting in terminal 2.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Terminal functions</td>
<td>Use [Pr. 267] to switch from among input 4 to 20mA (initial setting), 0 to 5VDC and 0 to 10VDC. Use [Pr. 858] to switch terminal functions.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Specifications

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
<th>Available Inverters</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A1, B1, C1, A2, B2, C2</td>
<td>Relay output terminal 1 (Fault output terminal)</td>
<td>Contact capacity: 230VAC 0.3A (power factor 0.4)</td>
<td>Switched low when the inverter output frequency is equal to or higher than the starting frequency (initial value 0.2Hz). Switched high during stop or DC injection brake operation.</td>
<td>A700, F700, E700, D700</td>
<td>65</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Relay output terminal 2</td>
<td>Contact capacity: 30VDC 0.3A</td>
<td>1 channel output contact indicates that the inverter fault occurs. When a fault occurs, terminals B-C are open (A-C are closed). In the normal state, B-C are closed (A-C are open). When this signal is output, the motor coasts.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter running terminal</td>
<td></td>
<td>switched low when the inverter output frequency is equal to or higher than the starting frequency (initial value 0.2Hz). Switched high during stop or DC injection brake operation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open collector output terminal</td>
<td></td>
<td>Switched low when the output frequency reaches within the range of ±10% (initial value) of the set frequency. Switched high during acceleration/deceleration and at a start.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overload alarm terminal</td>
<td></td>
<td>Switched low when stall prevention is activated by the stall prevention function. Switched high when stall prevention is cancelled.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instantaneous power failure terminal</td>
<td></td>
<td>Switched low when the protective circuit is activated due to an instantaneous power failure and under voltage.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency detection terminal</td>
<td></td>
<td>The open collector output is switched low when the output frequency reaches or exceeds the detection frequency set in [Pr. 42] (initial value 6Hz) and [Pr. 43] (initial value 9999 (same as the [Pr. 42] setting)) and is high when it is less than the detection frequency.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Open collector output common terminal</td>
<td></td>
<td>Common terminal for terminals RUN, SU, OL, IPF, and FU. Isolated from terminals SD and 5. Do not earth (ground).</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolated by photocoupler</td>
<td></td>
<td>Switched low when the frequency reaches within the range of ±10% (initial value) of the set frequency. Switched high during acceleration/deceleration and at a start.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Non-isolated signal output terminal</td>
<td></td>
<td>Factory-set to provide 10VDC at full-scale value, which is proportional to the monitor value. When the frequency is as set in [Pr. 11] (initial value is 60Hz), the output voltage is 10VDC.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analog signal output terminal</td>
<td></td>
<td>Confirmed standard: IEC-485 (RS-485). Transmission form: Multidrop link. Communication speed: 460bps to 38400bps. Overall extension: 500m. With the PU connector, communication can be made through RS-485. (1:1 connection only)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>No.</th>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Application Explanation</th>
<th>Available Inverters</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>USB</td>
<td>USB connector</td>
<td>Interface - conforms to USB1.1</td>
<td></td>
<td>RR Configurator can be operated by connecting the inverter to the personal computer through USB.</td>
<td>---</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>USB mini B connector (mini B receptacle)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>Inverter output</td>
<td>Inverter output is shut/off depending on shorting/opening between S1 and SC, or between S2 and SC. At initial state, terminal S1 and S2 are shorted to terminal SC with a shorting wire.</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>Inverter output</td>
<td>Inverter output is shut/off depending on shorting/opening between S1 and SC, or between S2 and SC. At initial state, terminal S1 and S2 are shorted to terminal SC with a shorting wire.</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SO</td>
<td>Safety monitor</td>
<td>Switched low when inverter output is shut/off by safety stop function, and high during other state.</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>output</td>
<td>Safety monitor output (open collector output)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SC</td>
<td>Output shut/off</td>
<td>Common terminal for terminals S1, S2 and SO. Connected to terminal SD inside of the inverter.</td>
<td>---</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Terminal function can be changed using [Pr. 178 to Pr. 189 Input terminal assignment].
2. Terminal function can be changed using [Pr. 190 to Pr. 196 Output terminal assignment].
3. The description at a fault occurrence can be output by 4 bit digital signal using [Pr. 76 Fault code output selection].
4. Low indicates that the open collector output transistor is ON (conducts). High indicates that the transistor is OFF (does not conduct).
5. Monitor to be output to terminal FM can be changed using [Pr. 54 FM terminal function selection].
6. Monitor to be output to terminal AM can be changed using [Pr. 158 AM terminal function selection].
1.4 Information on use of external terminals

1.4.1 Switching the inverter power ON/OFF (R/L1, S/L2, T/L3) (common)

1) No-fuse breaker and magnetic contactor on the inverter power supply side

   1) Install a specified moulded case circuit breaker (MCCB) on the power receiving side to protect the wiring to the inverter. An MCCB of greater capacity may be required as compared to commercial power operation because of the low power factor of the power supply resulting from the distorted input current in the inverter input power supply side. Refer to page 526.

   2) It is recommended to install a magnetic contactor on the inverter power supply side to ensure safety at fault occurrence. (See the circuit in the lower right.) The circuit should be made up to protect the inverter from any accident etc. that may be caused by automatic restart when the power is restored without magnetic contactor after power failure.

   3) Start and stop the motor by switching ON/OFF the STF or STR signal. If the MC is used to stop the motor, the motor coasts to a stop because regenerative braking inherent in the inverter is not applied. If the MC is used to start the motor during coasting when, for example, load inertia is extremely large, the protective circuit (overvoltage E.OV1 to E.OV3) may be activated to shut off the inverter output.

   When performing Jog operation, the MC must not be used to start and stop the motor. Otherwise, slow response will result because of a start delay due to the initial reset time (approximately 1s) after power ON.

   4) In case of the forced cooling, the cooling fan starts rotating as soon as the power is switched ON. However, cooling fan operation selection [Pr. 244 Cooling fan operation selection] may also be used to exercise cooling fan ON-OFF control.

* When the power supply is 400V class, install a step-down transformer.

The MC in the inverter power supply side can be used to start and stop the motor. However, the MC must not be used frequently to start and stop the motor as repeated inrush current generated at power ON will shorten the life of the converter section of the inverter.
(2) Inverter power ON/OFF timing chart

*1 The inverter output is shut off immediately (between more than 15ms and less than 100ms) after the power is switched OFF. If more than 100ms has elapsed after the power is switched OFF, the inverter protective circuit is automatically reset by powering ON again.

*2 Inverter output immediately shuts off if bus voltage of inverter drops to the specified value or lower for more than 10ms after power OFF.

(3) Inverter instantaneous power failure timing chart

*1 For \([\text{IFC}]\), instantaneous power failure IPF activates when the power is restored within 15 to 100ms. Note that automatic restart after instantaneous power failure is activated and fault output signal is not switched ON when 0 or any of 0.1 to 5s is set in \([\text{Pr.13}]\). For the 75K or more, 0 or any of 0.1 to 30s is set.

When power is restored after inverter output shut off in \([\text{ETD}]\), the inverter does not output fault and re-starts from the starting frequency. However, automatic restart after instantaneous power failure becomes active when the automatic restart after instantaneous power failure function \([\text{Pr.13}]\) is set to "0" or "0.1 to 5s".

*2 An instantaneous power failure of longer than 100ms is identical to a long-time power failure. (Refer to (2) inverter power ON/OFF timing chart.) If the start signal is ON, the inverter is restarted when the power is restored.
### 1.4.2 Connecting external power supply to the control circuit (R1/L11, S1/L21)

**A700** *(F700)*

If any of the protective functions (other than fan alarm, stall prevention, and current limit functions) are activated, the alarm indicator lamp is lit and the corresponding fault signal is output. If the MC etc. in the inverter power supply is switched OFF by the fault signal at this time, the control power is lost and the fault output cannot be kept ON. To keep this fault output ON, use the other power supply with the control circuit (power supply with the same voltage as the one used with the main circuit).

**Connection**

Never connect the power cable to the terminals in the wrong stand. Doing so will damage the inverter. The other power supply connection terminal block on the printed circuit board is a two-step type terminal block and jumpers are connected across the upper and lower terminals before shipment from the factory. After loosening (and removing) the screws and removing the jumpers as shown below, connect an external power supply in the procedure shown below.

1. Loosen the upper screws.
2. Remove the lower screws.
3. Remove the jumpers.
4. Connect the separate power supply cable for the control circuit to the lower terminals (R1/L11, S1/L21).

**FR-A720-0.4K to 3.7K, FR-A740-0.4K to 3.7K, FR-F720-0.75K to 5.5K, FR-F740-0.75K to 5.5K**

1. Loosen the upper screws.
2. Remove the lower screws.
3. Remove the jumpers.
4. Connect the separate power supply cable for the control circuit to the upper terminals (R1/L11, S1/L21).

**FR-A720-5.5K, 7.5K, FR-A740-5.5K, 7.5K**

1. Remove the upper screws.
2. Remove the lower screws.
3. Remove the jumpers.
4. Connect the separate power supply cable for the control circuit to the lower terminals (R1/L11, S1/L21).

**FR-F720-5.5K to 5.5K, FR-F740-0.75K to 5.5K**

1. Remove the upper screws.
2. Remove the lower screws.
3. Remove the jumpers.
4. Connect the separate power supply cable for the control circuit to the upper terminals (R1/L11, S1/L21).

(1) Do not turn OFF the control power (terminal R1/L11, S1/L21) with the main circuit power (terminal R/L1, S/L2, T/L3) ON. When the main circuit power supply is ON, a DC voltage exists in the converter output area and the voltage is being applied to the transistors. If a signal enters the transistor gate circuit due to noise etc., the transistors conduct and the terminals P/+ and N( ) are connected, which may damage the transistor modules. When the control power supply is ON, an inverse bias voltage is applied to the gate circuit to prevent the transistors from conducting.

The circuit should be configured so that the main circuit power is also turned OFF when the control power is OFF.

(2) If the MC of the main circuit power supply is switched OFF (for more than 0.1s), then ON, the inverter is reset. Hence, the method may be used to perform fault-on reset.

(3) If the MC for the main circuit power is switched OFF once (for more than 0.1s), then ON during the inverter output (operation), the inverter is initial-reset and the motor is restarted in the coasting state. If the MC is switched OFF, the undervoltage (E.UVT) protection is not activated.
SPECIFICATIONS

1.4.3 Switching the inverter output MC ON/OFF (U, V, W) (common)
Switch the magnetic contactor between the inverter and motor only when both the inverter and motor are at a stop. When the magnetic contactor is turned ON while the inverter is operating, overcurrent protection of the inverter and such will activate. When an MC is provided to switch to a commercial power supply, for example, it is recommended to use bypass-inverter switchover function [Pr. 135 to Pr. 139] (refer to page 416).

1.4.4 Input signal (STF, STR, RL, RM, RH, RT, AU, JOG, CS, MRS, STOP, RES) (common)

(1) When inverter output MC switch-ON

<table>
<thead>
<tr>
<th>Inverter State</th>
<th>Motor State before Power on</th>
<th>Motor Running (Coasting)</th>
<th>Motor at Stop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter operating</td>
<td>Motor may not be switched ON</td>
<td>Motor may not be switched ON</td>
<td>Motor may not be switched ON</td>
</tr>
</tbody>
</table>

*1 MC switch-ON might become available by selecting an appropriate inverter capacity. (For example, select an inverter capacity considering the start current of the motor. Refer to page 476.)

*2 Because overcurrent protection and electronic thermal protection may occur at an inverter start, use of automatic restart after instantaneous power failure/flying start (refer to page 367) is recommended.

(2) When inverter output MC switch-OFF

Motor State before Power on
Motor Running
Motor Running (Coasting)
Motor at Stop

Inverter operating
Motor may be switched OFF
The motor coasts to a stop
Motor may be switched OFF
Motor may be switched OFF

Use these parameters to select/change the input terminal functions.

1) 2) 3)

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>178</td>
<td>STF terminal function selection</td>
<td>60</td>
</tr>
<tr>
<td>179</td>
<td>STR terminal function selection</td>
<td>61</td>
</tr>
<tr>
<td>180</td>
<td>RL terminal function selection</td>
<td>0</td>
</tr>
<tr>
<td>181</td>
<td>RM terminal function selection</td>
<td>1</td>
</tr>
<tr>
<td>182</td>
<td>RH terminal function selection</td>
<td>2</td>
</tr>
<tr>
<td>183</td>
<td>RT terminal function selection</td>
<td>3</td>
</tr>
<tr>
<td>184</td>
<td>AU terminal function selection</td>
<td>4</td>
</tr>
<tr>
<td>185</td>
<td>JOG terminal function selection</td>
<td>5</td>
</tr>
<tr>
<td>186</td>
<td>CS terminal function selection</td>
<td>6</td>
</tr>
<tr>
<td>187</td>
<td>MRS terminal function selection</td>
<td>24</td>
</tr>
<tr>
<td>188</td>
<td>STOP terminal function selection</td>
<td>25</td>
</tr>
<tr>
<td>189</td>
<td>RES terminal function selection</td>
<td>62</td>
</tr>
</tbody>
</table>

1. Capacity (VA) of separate power supply
The following power capacity is necessary when separate power is supplied from R15.11 and S15.21.
- FR-A720-1K or less, FR-A740-1.5K or less...60VA or more
- FR-A720-1.5K or more, FR-A740-18.5K or more...80VA or more
- FR-F720-15K or less, FR-F740-18.5K or less...60VA or more
- FR-F720-18.5K or more, FR-F740-22K or more...80VA or more

*3 MC switch-ON might become available by selecting an appropriate inverter capacity. (For example, select an inverter capacity considering the start current of the motor. Refer to page 476.)

*4 Because overcurrent protection and electronic thermal protection may occur at an inverter start, use of automatic restart after instantaneous power failure/flying start (refer to page 367) is recommended.

(3) When inverter output MC switch-OFF
Using [Pr. 179 to Pr. 189], set the functions of the input terminals.
Refer to the following table and set the parameters:

<table>
<thead>
<tr>
<th>Setting</th>
<th>Signal</th>
<th>Functions</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>RL</td>
<td>Low-speed operation command</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote setting (setting clear)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>1</td>
<td>RM</td>
<td>Middle-speed operation command</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote setting (acceleration)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>2</td>
<td>RH</td>
<td>High-speed operation command</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Remote setting (acceleration)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>3</td>
<td>RT</td>
<td>Stop-on contact selection 0</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Stop-on contact selection 1</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>4</td>
<td>AU</td>
<td>Terminal 4 input selection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>5</td>
<td>JSOG</td>
<td>Jog operation selection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>6</td>
<td>CS</td>
<td>Selection of automatic reset after instantaneous power failure, flying start</td>
<td>○ ○ —</td>
</tr>
<tr>
<td>7</td>
<td>CN1</td>
<td>Commercial power supply-inverter switchover function</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>8</td>
<td>REX</td>
<td>Commercial power supply-inverter switchover function</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>9</td>
<td>X9</td>
<td>Third function selection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>10</td>
<td>X10</td>
<td>Inverter run enabled signal (FR-HL, MT-HC/PF, CV connection)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>11</td>
<td>X11</td>
<td>PWM, BR, BRDC, BRDC, instantaneoous power failure detection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>12</td>
<td>X12</td>
<td>PU operation external interlock</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>13</td>
<td>X13</td>
<td>External DC injection brake operation start</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>14</td>
<td>X14</td>
<td>PID control valid terminal</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>15</td>
<td>X15</td>
<td>Brake opening completion signal</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>16</td>
<td>X16</td>
<td>PU external operation switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>17</td>
<td>X17</td>
<td>Load pattern selection forward/rotation reverse rotation boost</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>18</td>
<td>X18</td>
<td>V/F switcher (V/F control is exercised when X18 is ON)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>19</td>
<td>X19</td>
<td>Load torque high-speed frequency</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>20</td>
<td>X20</td>
<td>S-pattern acceleration/deceleration C switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>21</td>
<td>X21</td>
<td>Orientation command 1, 2</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>22</td>
<td>X22</td>
<td>Pre-rotation on</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>23</td>
<td>LK1</td>
<td>Output stop</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>24</td>
<td>LK2</td>
<td>Commercial power supply-inverter switchover function</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>25</td>
<td>ST10</td>
<td>Start self-holding selection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>26</td>
<td>M1</td>
<td>Motor control switch</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>27</td>
<td>TL</td>
<td>Torque limit selection</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>28</td>
<td>X28</td>
<td>Start-time tuning start external input</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>29</td>
<td>X29</td>
<td>Torque limit selection 1</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>30</td>
<td>X30</td>
<td>Torque limit selection 2</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>31</td>
<td>X31</td>
<td>P/PI control switch</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>32</td>
<td>X32</td>
<td>Forward rotation (assigned to STR terminal [Pr. 173] only)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>33</td>
<td>X33</td>
<td>Reverse rotation (assigned to STR terminal [Pr. 174] only)</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>34</td>
<td>X34</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>35</td>
<td>X35</td>
<td>External FE operation switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>36</td>
<td>X36</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>37</td>
<td>X37</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>38</td>
<td>X38</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>39</td>
<td>X39</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>40</td>
<td>X40</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
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<tr>
<td>41</td>
<td>X41</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>42</td>
<td>X42</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>43</td>
<td>X43</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>44</td>
<td>X44</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
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<tr>
<td>45</td>
<td>X45</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>46</td>
<td>X46</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>47</td>
<td>X47</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>48</td>
<td>X48</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>49</td>
<td>X49</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
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<tr>
<td>50</td>
<td>X50</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>51</td>
<td>X51</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>52</td>
<td>X52</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>53</td>
<td>X53</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>54</td>
<td>X54</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>55</td>
<td>X55</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>56</td>
<td>X56</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>57</td>
<td>X57</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>58</td>
<td>X58</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>59</td>
<td>X59</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>60</td>
<td>X60</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>61</td>
<td>X61</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>62</td>
<td>X62</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>63</td>
<td>X63</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>64</td>
<td>X64</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>65</td>
<td>X65</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>66</td>
<td>X66</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>67</td>
<td>X67</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>68</td>
<td>X68</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>69</td>
<td>X69</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>70</td>
<td>X70</td>
<td>Command source switcher</td>
<td>○ ○ ○</td>
</tr>
</tbody>
</table>

**A700**  
**F700**  
**E700**  
**D700**
**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Signal</th>
<th>Functions</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>X71</td>
<td>DC feeding cancel</td>
<td></td>
</tr>
<tr>
<td>74</td>
<td>X74</td>
<td>Magnetic flux decay output shutdown signal</td>
<td></td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>No function</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Available Inverters</th>
<th>A700</th>
<th>F700</th>
<th>E700</th>
<th>D700</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>○</td>
<td>○</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*1 When [Pr. 59 Remote function selection ≠ 0], the functions of the RL, RM and RH signals change as listed above.
*2 When [Pr. 270 Stop-on contact, load torque high-speed frequency control selection = 2 or 3], the functions of the RL and RT signals change as listed above.
*3 The ON signal turns ON when the relay contact "opens".
*4 The FR-A7AX (16-bit digital input) is needed to externally input a stop position under orientation control.
*5 Serve ON is valid during position control under vector control operation.
*6 This parameter is valid when the FR-A7AP or FR-A7AL (option) is mounted.
*7 Changing the terminal assignment using [Pr. 178 to Pr. 189 Input terminal function selection] may affect the other functions. Please make setting after confirming the function of each terminal.
*8 Same function can be assigned to two or more terminals. In this case, the logic of terminal input is OR.
*9 The priorities of the speed commands are in order of jog, multi-speed setting (RH, RM, RL, REX) and PID (X14).
*10 When the X10 signal (FR-HC, MT-HT, FR-CV connection - inverter operation enable signal) is not set or the PU operation external interlock (X12) signal is not assigned at [Pr. 79 Operation mode selection = 7], the MRS signal shares this function.
*11 Use common terminals to assign multi-speeds (7 speeds) and remote setting. These cannot be set individually. (Common terminals are used since these functions are designed for speed setting and need not be set at the same time.
*12 When V/F switching (X18) signal and load pattern selection forward rotation reverse rotation boost (X17) signal are not assigned in [Pr. 81 Number of motor poles = 12, 14, 16, 18, 20], the RT signal shares this function. (Pr. 81 Operation mode selection = 7). In this case, V/F control is valid in the second function.
(2) Response time of each signal
The response time of the X10 signal is within 2ms. However, when the X10 signal is not assigned at the [Pr. 30 Regenerative function selection = 2] (FR-HC, MT-HC, FR-CV connection), the response time of the MRS signal is within 2ms in [A700 (F700)] and [Pr. 17 MRS signal assignment] is invalid.

<table>
<thead>
<tr>
<th>Setting</th>
<th>MRS Assignment</th>
<th>X10 Assignment</th>
<th>Response Time</th>
<th>X10 Assignment</th>
<th>Response Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>Within 2ms</td>
<td>0</td>
<td>0</td>
<td>Within 2ms</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>Within 2ms</td>
<td>0</td>
<td>0</td>
<td>Within 2ms</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
<tr>
<td>Other</td>
<td>0</td>
<td>Within 2ms</td>
<td>0</td>
<td>0</td>
<td>Within 2ms</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>—</td>
</tr>
</tbody>
</table>

Response time of X10 signal and MRS signal is within 2ms.

(3) Changing the control logic
The input signals are set to sink logic (SINK) when shipped from the factory.
In sink logic, a signal switches ON when a current flows from the corresponding signal input terminal.
Terminal SD is common to the contact input signals.
In source logic, a signal switches ON when a current flows into the corresponding signal input terminal.
Terminal PC is common to the contact input signals.

1) Changing the control logic for [A700 (F700)]
To change the control logic, the jumper connector on the back of the control circuit terminal block must be moved to the other position. (The output signals may be used in either the sink or source logic independently of the jumper connector position.)
(a) Loosen the two installation screws in both ends of the control circuit terminal block. (These screws cannot be removed.)
Pull down the terminal block from behind the control circuit terminals.
(b) Change the jumper connector set to the sink logic (SINK) on the rear panel of the control circuit terminal block to source logic (SOURCE).
(c) Using care not to bend the pins of the drive unit’s control circuit connector, reinstall the control circuit terminal block and fix it with the mounting screws.

2) Changing the control logic for [E700 (D700)]
To change the control logic, the jumper connector above the control terminal must be moved to the other position.
Change the jumper connector in the sink logic (SINK) position to source logic (SOURCE) position using tweezers, a pair of long-nose pliers etc.
Change the jumper connector position before switching power ON.

*1 Make sure that the control circuit connector is fitted correctly.
*2 While power is ON, never disconnect the control circuit terminal block.

For FR-E700
For FR-D700
1.4.5 Run and stop (STF, STR, STOP)

To start and stop the motor, first switch ON the input power of the inverter (turn ON the MC at the operation-ready when there is an MC on the input side). Then start the motor with the forward or reverse rotation start signal.

(1) Two-wire type (STF, STR) (common)
A two-wire type connection is shown below.
1) Forward/reverse rotation signal is used as both the start and stop signals. Turn ON either of the forward and reverse rotation signals to start the motor in the corresponding direction. Switching ON or OFF both the start signals during operation will decelerate the inverter to a stop.
2) The speed setting signals may either be given by entering 0 to 5VDC across the frequency setting input terminal 2-5, by setting three speed [Pr. 4 to Pr. 6] (high, middle, low speeds), etc. (For multi-speed operation, refer to page 48.)
3) After the start signal has been input, the inverter starts operating when the frequency setting signal reaches or exceeds the [Pr. 13 Starting frequency].
   If the motor load torque is large or the [Pr. 6 Torque limit] setting is small, operation may not be started due to insufficient torque until the inverter output frequency reaches about 3 to 6Hz.
   If the [Pr. 2 Minimum frequency] is set to 6Hz, for example, merely entering the start signal causes the running frequency to reach the minimum frequency of 6Hz according to the [Pr. 7 Acceleration time].
4) To stop the motor, operate the DC injection brake for the period of time set in [Pr. 11 DC injection brake operation time] at not more than the DC injection brake operation frequency or at not more than 0.5Hz.
   To disable the DC injection brake function, set 0 in [Pr. 12 DC injection brake operation frequency] or [Pr. 0 Torque limit].
   In this case, the motor is coasted to a stop at not more than the frequency set in [Pr. 10 DC injection brake operation frequency] or at not more than 0.5Hz (when the DC injection brake is not operated).
5) If the reverse rotation signal is input during forward rotation or the forward rotation signal is input during reverse rotation, output characteristics change without going through the stop mode.

(2) Three-wire type connection (STF, STR, STOP) (common)
A three-wire type connection is shown below.
1) Turn ON the STOP signal to enable the start self-holding function. In this case, the forward/reverse rotation signal functions only as a start signal.
2) If the start signals STF (STR) are turned ON once, then OFF, the start signals are kept ON and starts the inverter. When changing the direction of rotation, turn STR (STF) signal ON once and then OFF.
3) The inverter is decelerated to a stop by turning OFF the STOP signal once. For the frequency setting signal and the operation of DC injection brake at a stop time, refer to paragraphs 2) to 4) in (1) Two-wire type connection.
4) When the signal JOG is turned ON, terminal STOP signal is invalid and JOG operation has precedence.
5) If MRS signal is turned ON, the self-holding function is not deactivated.

(3) Start signal selection

<table>
<thead>
<tr>
<th>STF</th>
<th>STR</th>
<th>Setting Inverter State</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>Stop</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>Reverse rotation</td>
</tr>
<tr>
<td>ON</td>
<td>OFF</td>
<td>Forward rotation</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>Stop</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reverse rotation</td>
</tr>
</tbody>
</table>

Example
- Two wire-type connection [Pr. 218 = 9999]
- Three wire-type connection [Pr. 218 = 0000]

Example
- Two wire-type connection [Pr. 218 = 9999]
- Three wire-type connection [Pr. 218 = 0000]
**SPECIFICATIONS**

**DC Injection Brake and Coasting to Stop**

- **Start/Stop Timing Chart (for two-wire type)**
- **Operation Mode**
  - **External Operation or Combined Operation**
    - When [Pr. 79 = 0, 2, 3]
      - DC injection brake enabled
        - DC injection brake operation frequency
          - 0.5Hz or less
        - Coasting to stop
          - DC injection brake operation frequency
        - DC injection brake enabled
        - DC injection brake operation frequency
          - 0.5Hz or less
        - Coasting to stop
          - DC injection brake operation frequency
    - When [Pr. 79 = 0, 1, 4]
      - DC injection brake enabled
        - DC injection brake operation frequency
          - 0.5Hz or less
        - Coasting to stop
          - DC injection brake operation frequency

- **PU Operation or Combined Operation**
  - When [Pr. 79 = 0, 1, 4]
    - DC injection brake enabled
      - DC injection brake operation frequency
        - 0.5Hz or less
      - Coasting to stop
        - DC injection brake operation frequency

- **Operation**
  - **Mode**
    - External Operation or Combined Operation
      - When [Pr. 79 = 0, 2, 3]
        - DC injection brake
          - Terminals STF (STR) turn OFF *1
        - Terminals STF (STR) turn ON *2 and 0V across terminals 2-5
        - STOP key
        - Set frequency changed to 0Hz
      - DC injection brake enabled
        - DC injection brake operation frequency
          - 0.5Hz or less
        - Coasting to stop
          - DC injection brake operation frequency
      - DC injection brake disabled
        - Coasting to stop
          - DC injection brake operation frequency
  - **For multi-speed operation, the same operation is performed when RH, RM, RL signals are OFF.**

- **DC injection brake**
  - Without DC injection brake
    - [Pr. 10 DC injection brake operation frequency] *4
  - With DC injection brake
    - [Pr. 11 DC injection brake operation time] *3

- **Output frequency**
  - [Pr. 13 Starting frequency] (initial value 0.5Hz) may be set between 0 and 60Hz.
  - [Pr. 11 DC injection brake operation time] (initial value 0.5s) may be set between 0 and 10s.
  - The frequency at which the motor is coasted to a stop is not more than [Pr. 10 DC injection brake operation frequency] (initial value is 3Hz; may be set between 0 and 120Hz) or not more than 0.5Hz.

- **Settings**
  - The [Pr. 13 Starting frequency], [Pr. 11 DC injection brake operation time], and [Pr. 10 DC injection brake operation frequency] are the initial values.

- **Timing Chart**
  - **Start/Stop Timing Chart (for two-wire type)**
  - **Forward-Reverse Rotation Switch-Over Timing Chart**

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*1 Also stopped by the STOP key. (Refer to page 382.)
*2 For multi-speed operation, the same operation is performed when RH, RM, RL signals are OFF.
1.4.6 Relationships between frequency setting input signals and output frequencies

(10, 10E*, 2, 5, 1*, 6*, 4, AU) (common)

The analog frequency setting input signals that may be entered are voltage and current signals. For the relationships between the frequency setting input voltages (currents) and output frequencies, refer to the following diagram. The frequency setting input signals are proportional to the output frequencies. Note that when the input signal is less than the starting frequency, the output frequency of the inverter is 0Hz.

If the input signal of 5VDC (or 10V, 20mA) or higher is entered, the output frequency does not exceed the maximum output frequency.

(1) Voltage input (10, 10E*, 2, 6*, 4, 5)

Enter the frequency setting input signal of 0 to 5VDC (or 0 to 10VDC) across terminals 2 (or 4)-5. The maximum output frequency is reached when 5V (10V) is input across terminals 2 (or 4)-5. When using A700 with FR-A7AZ, terminal 6 is available for frequency setting input. The power supply used may either be the inverter's built-in power supply or an external power supply. The internal power supply outputs 5VDC across terminals 10-5, or 10V across terminals 10E-5.

For operation at 0 to 5VDC, set [Pr. 125(903)] to 0 to 5VDC input. Use terminal 10 for the built-in power supply.

For operation at 0 to 10VDC, set [Pr. 126(905)] to 0 to 10VDC input. Use terminal 10E for the built-in power supply.

(2) Current input selection (2*, 4, 5, AU)

To automatically perform operation under constant pressure or temperature control using a fan, pump etc., enter the controller output signal of 4 to 20mADC across terminals 4 (or 2)-5. AU signal must be turned ON to use terminal 4. When the multi-speed signal is input, the current input is ignored.

*Current input with terminal 2 is not available for (10, 10E*, 4) do not have terminal 10E nor terminal 1."

(1) Voltage input (10, 10E*, 2, 5, 1*, 6*, 4, 5) (common)

*Terminal 6 is available only in the (10E) with FR-A7AZ.

(1) Voltage input (10, 10E*, 2, 5, 1*, 6*, 4, 5) (common)

*Terminal 6 is available only in the (10E) with FR-A7AZ.

Enter the frequency setting input signal of 0 to 5VDC (or 0 to 10VDC) across terminals 2 (or 4)-5. The maximum output frequency is reached when 5V (10V) is input across terminals 2 (or 4)-5. When using A700 with FR-A7AZ, terminal 6 is available for frequency setting input. The power supply used may either be the inverter's built-in power supply or an external power supply. The internal power supply outputs 5VDC across terminals 10-5, or 10V across terminals 10E-5.

For operation at 0 to 5VDC, set [Pr. 125 Analog input selection] to 0 to 5VDC input. Use terminal 10 for the built-in power supply.

For operation at 0 to 10VDC, set [Pr. 126 Analog input selection] to 0 to 10VDC input. Use terminal 10E for the built-in power supply.

(2) Current input selection (2*, 4, 5, AU)

*Current input with terminal 2 is not available for (10, 10E*, 4) do not have terminal 10E nor terminal 1."

(1) Voltage input (10, 10E*, 2, 5, 1*, 6*, 4, 5) (common)

*Terminal 6 is available only in the (10E) with FR-A7AZ.

Enter the frequency setting input signal of 0 to 5VDC (or 0 to 10VDC) across terminals 2 (or 4)-5. The maximum output frequency is reached when 5V (10V) is input across terminals 2 (or 4)-5. When using A700 with FR-A7AZ, terminal 6 is available for frequency setting input. The power supply used may either be the inverter's built-in power supply or an external power supply. The internal power supply outputs 5VDC across terminals 10-5, or 10V across terminals 10E-5.

For operation at 0 to 5VDC, set [Pr. 125 Analog input selection] to 0 to 5VDC input. Use terminal 10 for the built-in power supply.

For operation at 0 to 10VDC, set [Pr. 126 Analog input selection] to 0 to 10VDC input. Use terminal 10E for the built-in power supply.
(3) Auxiliary input (1, 5)  

The compensation signal can be input to the main speed setting (terminals 2 (or 4)-5) for synchronous/continuous speed control operation, etc.

Functions of terminal 1 varies with the Pr. 73 setting.

(a) The Pr. 73 setting is 0 to 3, 6, 7 (initial value is 1)

The voltage signal across terminals 1-5 is added to the voltage signal (positive) across terminals 2 (or 4)-5. If the result of addition is negative, it is regarded as 0 and the motor comes to a stop.

(b) When the Pr. 73 setting is 10 to 13, 16, 17

The polarity reversible operation function is selected. The voltage signal across terminals 1-5 is added to the voltage signal (positive) across terminals 2 (or 4)-5. A positive addition result start forward rotation (if terminal STF is ON) and a negative result starts reverse rotation (if terminal STF is ON).

The compensation signal of terminal 1 can also be added to the multi-speed setting or 4 to 20mA current input.

### Specifications

#### Multi-speed input compensation

<table>
<thead>
<tr>
<th>Setting</th>
<th>Added Command Voltage</th>
<th>Start Signal Input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 3, 6, 7</td>
<td>+</td>
<td>Forward rotation</td>
</tr>
<tr>
<td>10 to 13, 16, 17</td>
<td>-</td>
<td>Reverse rotation</td>
</tr>
</tbody>
</table>

#### Override

For the above compensation input, the fixed compensation amount is applied to each speed. Using the override function easily varies each speed equally.

Set any of 4, 5, 14, 15 in Pr. 73 to use the override. The override allows the multi-speeds set in the parameters, analog input across terminals 1-5, or current input across terminals 4-5 to be changed at a constant rate between 50% and 150% (when initial value is set) according to the external analog signal input to across terminals 2-5.

### Inverter Output According to Start Signal and Auxiliary Input Terminal Polarity

<table>
<thead>
<tr>
<th>Power supply</th>
<th>Forward rotation</th>
<th>Reverse rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>STF</td>
<td>STR</td>
<td>SD</td>
</tr>
<tr>
<td>RH</td>
<td>RM</td>
<td>PL</td>
</tr>
</tbody>
</table>

### Override connection diagram

![Override connection diagram](image-url)
(4) **Frequency resolution**

The running frequency of the inverter can be set by the analog input to the frequency setting input terminal and the digital input from the operation panel or parameter unit. The operation panel allows setting in increments of 0.01Hz up to 100Hz and 0.1Hz at more than 100Hz, and the parameter unit allows setting in increments of 0.01Hz from its numeric keypad.

1) **Output frequency resolution**

For the output frequency resolution, refer to the common specifications on page 8. The output frequency resolution does not change if the output frequency varies between 0 and 400Hz.

2) **Set frequency resolution**

For set frequency resolution, refer to page 8 and page 92.

<table>
<thead>
<tr>
<th>Input Condition</th>
<th>Set Frequency Resolution of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analog input *1</td>
<td>For set frequency resolution, refer to page 8 and page 92.</td>
</tr>
<tr>
<td>Terminals 1-5</td>
<td>Digital input (setting from operation panel, parameter unit, or RS-485 terminal) A = 0.01Hz (A = 0.1Hz at 100Hz or more for operation panel)</td>
</tr>
<tr>
<td>Terminals 1*2 -5</td>
<td>Digital input (setting from option) Depends on the setting resolution of the FR-A7AX (16 bit digital input)</td>
</tr>
<tr>
<td>Terminals 2-5</td>
<td>Digital input (setting from option) Depends on the setting resolution of the FR-A7AX (16 bit digital input)</td>
</tr>
</tbody>
</table>

*1 Since the frequency resolution in the inverter is 0.01Hz, control cannot be exercised if the resolution setting is less than 0.01Hz.

*2 (E700, D700) do not have terminal 1.

*3 Terminal 6 is available in the A700 with FR-A7AZ.
(5) Function assignment to analog input terminal 1, terminal 4, and terminal 6 (FR-A7AZ)

Functions of terminal 1, terminal 4, and terminal 6 (FR-A7AZ) of analog input can be selected and changed by parameter.

For the terminal 1, terminal 4, and terminal 6 (FR-A7AZ) used for analog input, frequency (speed) command, torque command, etc. can be selected. In addition, functions change according to the control mode.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>406</td>
<td>High resolution analog input selection</td>
<td>9999</td>
<td>0, 2 to 6, 9999</td>
<td>Selection of terminal 6 function (refer to the table below)</td>
</tr>
<tr>
<td>858</td>
<td>Terminal 4 function assignment</td>
<td>0</td>
<td>0, 1, 4, 9999</td>
<td>Selection of terminal 4 function (refer to the table below)</td>
</tr>
<tr>
<td>868</td>
<td>Terminal 1 function assignment</td>
<td>0</td>
<td>0 to 6, 9999</td>
<td>Selection of terminal 1 function (refer to the table below)</td>
</tr>
</tbody>
</table>

Terminal 1 function according to control

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Setting</th>
<th>V/F Control, Advanced Magnetic Flux Vector Control</th>
<th>Real Sensorless Vector Control, Vector Control</th>
<th>Vector Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Speed control</td>
<td>Torque control</td>
<td>Speed control</td>
</tr>
<tr>
<td>0</td>
<td>(initial value)</td>
<td>Frequency setting auxiliary</td>
<td>Speed setting auxiliary</td>
<td>Speed limit auxiliary</td>
</tr>
<tr>
<td>1</td>
<td>—</td>
<td>Magnetic flux command</td>
<td>Magnetic flux command</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>Regenerative torque limit (Pr. 1197 = 1)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>Torque command (Pr. 1194 = 1)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>Stall prevention operation level input</td>
<td>Torque limit (Pr. 1195 = 1)</td>
<td>—</td>
<td>Torque limit (Pr. 1194 = 1)</td>
</tr>
<tr>
<td>5</td>
<td>—</td>
<td>Forward/reverse rotation speed limit (Pr. 1197 = 1)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>Torque bias input (Pr. 1197 = 2, 2, 2)</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

Terminal 4 function according to control

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Setting</th>
<th>V/F Control, Advanced Magnetic Flux Vector Control</th>
<th>Real Sensorless Vector Control, Vector Control</th>
<th>Vector Control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Speed control</td>
<td>Torque control</td>
<td>Speed control</td>
</tr>
<tr>
<td>0</td>
<td>(initial value)</td>
<td>Frequency command (AU signal-ON)</td>
<td>Speed command (AU signal-ON)</td>
<td>Speed limit (AU signal-ON)</td>
</tr>
<tr>
<td>1</td>
<td>—</td>
<td>Magnetic flux command</td>
<td>Magnetic flux command</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>Stall prevention operation level input</td>
<td>Torque limit (Pr. 1195 = 1)</td>
<td>—</td>
<td>Torque limit (Pr. 1194 = 1)</td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

—: No function

*1 When the same value (1 or 4) is set in [Pr. 1160.319], terminal 1 is made valid and terminal 4 has no function.

*2 When [Pr. 1197 = 1, 4] functions of terminal 4 become valid independently of whether the terminal AU is ON or OFF.
**SPECIFICATIONS**

- Terminal 6 function according to control (FR-A772)

<table>
<thead>
<tr>
<th>[Pn. No.] Setting</th>
<th>V/F Control, Advanced Magnetic Flux Vector Control</th>
<th>Real Sensorless Vector Control, Vector Control</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Frequency command</td>
<td>Speed control</td>
<td>Speed limit</td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>Regenerative torque limit ([Pn. \text{X} = 1])</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>—</td>
<td>—</td>
<td>Torque command ([Pn. \text{X} = 1])</td>
</tr>
<tr>
<td>4</td>
<td>Stall prevention operation level input</td>
<td>Torque limit ([Pn. \text{X} = 1])</td>
<td>Torque command ([Pn. \text{X} = 1])</td>
</tr>
<tr>
<td>5</td>
<td>—</td>
<td>—</td>
<td>Forward/reverse rotation speed limit ([Pn. \text{X} = 2])</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>Torque bias ([Pn. \text{X} = 1, 2, 3])</td>
<td>—</td>
</tr>
<tr>
<td>9999 (initial value)</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

— = No function

* Function assigned to terminal 1, 2, and 4 inputs become invalid if overlapping function is assigned to terminal 6.
1.4.7 External frequency selection (REX, RH, RM, RL) **(common)**

Up to 15 speeds may be selected according to the combination of REX", RH, RM and RL signals, and multi-speed operation can be performed as shown below by turning ON STF (STR) signal.

Speeds (frequencies) may be specified as desired as listed below.

*1 Assign function of 15-speed select signal (REX) by setting 8 in any of [Pr. 178 to Pr. 189 Input terminal function selection].

*2 Each of the multiple speeds may be compensated for by the external analog signal in .

*3 Has precedence over the main speed setting signal (0 to 5V, 0 to 10V, 4 to 20mADC).

<table>
<thead>
<tr>
<th>Multi-speed setting</th>
<th>Speed 1 (high speed)</th>
<th>Speed 2 (middle speed)</th>
<th>Speed 3 (low speed)</th>
<th>Speed 4</th>
<th>Speed 5</th>
<th>Speed 6</th>
<th>Speed 7</th>
<th>Speed 8</th>
<th>Speed 9</th>
<th>Speed 10</th>
<th>Speed 11</th>
<th>Speed 12</th>
<th>Speed 13</th>
<th>Speed 14</th>
<th>Speed 15</th>
<th>External setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed</td>
<td>REX</td>
<td>RH</td>
<td>RM</td>
<td>RL</td>
<td>Terminal Input</td>
<td>[Pr.]</td>
<td>Set Frequency Range</td>
<td>Remarks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 1 (high speed)</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 4]</td>
<td>0 to 400Hz</td>
<td>Setting value of [Pr. 4] when [Pr. 24 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 2 (middle speed)</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>[Pr. 5]</td>
<td>0 to 400Hz</td>
<td>Setting value of [Pr. 4] when [Pr. 25 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 3 (low speed)</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>[Pr. 6]</td>
<td>0 to 400Hz</td>
<td>Setting value of [Pr. 5] when [Pr. 26 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 4</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>[Pr. 24]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 4] when [Pr. 24 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 5</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 24]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 5] when [Pr. 25 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 6</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>[Pr. 23]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 6] when [Pr. 23 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Speed 7</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>[Pr. 27]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 4] when [Pr. 27 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 8</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>[Pr. 24]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 4] when [Pr. 24 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 9</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>[Pr. 23]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 5] when [Pr. 23 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 10</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 23]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 5] when [Pr. 24 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 11</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 27]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 6] when [Pr. 27 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 12</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 23]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 5] when [Pr. 23 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 13</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 27]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 6] when [Pr. 27 = 9999]</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 14</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 23]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 5] when [Pr. 24 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed 15</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[Pr. 27]</td>
<td>0 to 400Hz, 9999</td>
<td>Setting value of [Pr. 6] when [Pr. 27 = 9999]</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>External setting</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>Frequency setting potentiometer</td>
<td>0 to maximum setting value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Diagram:**

- External frequency selection diagram showing the connection of REX, RH, RM, RL signals for multi-speed operation.
- Speeds from Speed 1 (High speed) to Speed 15 are shown with their corresponding terminal inputs (REX, RH, RM, RL) and set frequencies.

---

**Table:**

<table>
<thead>
<tr>
<th>Speed</th>
<th>Terminal Input</th>
<th>[Pr.]</th>
<th>Set Frequency Range</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speed 1 (High speed)</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 2 (Middle speed)</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 3 (Low speed)</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Speed 4</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
</tr>
<tr>
<td>Speed 5</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 6</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 7</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 8</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>Speed 9</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 10</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 11</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 12</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 13</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>Speed 14</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
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<tr>
<td>Speed 15</td>
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<td>OFF</td>
</tr>
<tr>
<td>External setting</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>
1.4.8 Jog operation (JOG signal) (common)

(1) Jog operation using external signals

Jog operation can be started/stopped by turning ON the JOG signal and turning ON/OFF the start signal STF or STR.

Jog frequency and JOG acceleration/deceleration time can be changed using [Pr. 15] (initial value 5Hz, variable between 0 and 400Hz) and [Pr. 16] (initial value 0.5s, variable between 0 and 3600s).

(2) Jog operation using operation panel or parameter unit

Also, the PU operation mode of the operation panel or parameter unit may be used to perform Jog operation.

In this case, the Jog frequency is set in [Pr. 17] and Jog acceleration/deceleration time in [Pr. 17] and the forward and reverse rotation keys are used to perform Jog operation.

In the Jog operation mode, multi-speed compensation and polarity reversible operation are invalid.

* Set “5” to any of [Pr.178 to Pr.184 Input terminal function selection] to assign JOG signal in E700/D700.
1.4.9 External thermal relay input (OH) (common)

To protect the motor against overheat, use the OH signal when using an external thermal relay or the built-in thermal protector of the motor. When the thermal relay operates, the inverter trips and outputs the fault signal (E.OHT).

For the terminal used for OH signal input, assign the function by setting 7 in any of [Pr. 178 to Pr. 189 Input terminal function selection].

A thermal protector is provided for a vector control dedicated motor (SF-V5RU). When using the motor dedicated for vector control (SF-V5RU) in , assign OH (external thermal input) signal to the CS terminal. [Pr. 186 = 7]

Connect a 2W1kΩ resistor between the terminal PC and CS (OH).

Install the resistor pushing it against the bottom part of the terminal block so as to avoid a contact with other cables. Refer to page 37 for details of [Pr. 186 CS terminal function selection].

1.4.10 Thermistor input (PTC) (A700, F700) (10, 2) (D700) (TH1*, TH2*) (A700)

(1) When using PTC signal (A700, F700)

Built-in PTC thermistor output of the motor can be input to the PTC signal (terminal AU).

For the terminal used for PTC signal input, assign the function by setting 63 in [Pr.184 AU terminal function selection] and also set the AU/PTC switchover switch to the PTC terminal function.

When the overheat status of the motor is detected for 10s or more by the PTC thermistor input, output from the inverter is shut off and PTC thermal alarm signal (E.PTC) is output.

The input specifications of the PTC thermistor are shown below.

<table>
<thead>
<tr>
<th>Motor Temperature</th>
<th>PTC Thermistor Resistance (Ω)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>0 to 500</td>
</tr>
<tr>
<td>Boundary</td>
<td>500 to 4k</td>
</tr>
<tr>
<td>Overheat</td>
<td>4k or higher</td>
</tr>
</tbody>
</table>

*1 When the PTC signal was not assigned to [Pr. 1Ah] and the AU/PTC switcher switch was set to the PTC terminal function, the function assigned to the AU terminal is always OFF. Conversely, when the PTC signal was assigned to [Pr. 1Ah] and the AU/PTC switcher switch was set to the AU terminal function, a PTC thermal alarm (E.PTC) occurs since the function is always in a motor overheat state.

*2 When you want to input a current, assign the AU signal to the other signal.
(2) When using terminal 10 and 2

Terminal 2 and terminal 10 are available for inputting of motor built-in PTC thermistor output. For the power supply terminal of PTC thermistor input, do not use power supply other than terminal 10 (external power supply, etc). PTC thermistor does not work properly. When the PTC thermistor input reaches the resistance value set in [Pr. 561 PTC thermistor protection level], Inverter outputs PTC thermistor operation error signal (E.PTC) and trips.

Check the characteristics of the using PTC thermistor, and set the resistance value within a protection providing temperature TN, just around the center of R1 and R2 in a right figure. If the [Pr. 561] setting is closer to R1 or R2, the working temperature of protection goes higher (protection works later), or lower (protection works earlier).

PTC thermistor resistance can be displayed in operation panel, parameter unit (FR-PU07), or RS-485 communication when PTC thermistor protection is active ([Pr. 561 ≠ “9999”]).

*1 When using terminal 2 as PTC thermistor input ([Pr. 561 ≠ “9999”]), terminal 2 is not available for analog frequency command. Also unavailable when using terminal 2 for PID control and Dancer control. When PID control and Dancer control is not active ([Pr. 128 PID action selection = “0”]), terminal 4 functions as follows:

When [Pr. 79 = “4”] or in external operation mode........ Terminal 4 is active for frequency command when AU signal is ON

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>561</td>
<td>PTC thermistor protection level</td>
<td>9999</td>
<td>0.5 to 30kΩ</td>
<td>Set the level (resistance value) for PTC thermistor protection activates.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td></td>
<td>9999 PTC thermistor protection is inactive.</td>
</tr>
</tbody>
</table>

![Thermistor curve](image.png)

When using a dedicated motor with thermistor for vector control (SF-V5RU□□□□□□□), feeding back the motor temperature detected by the motor side thermistor to the inverter can reduce fluctuation of torque generated due to temperature.

Torque accuracy is ±3%.

Also, when \([\text{Pr. 407} = "9999"]\), thermal protection function by the motor thermistor is valid.

When \([\text{Pr. 407} = "9999"]\) (initial value), thermal protection function by motor thermistor is not activated.

(Electronic thermal relays operate following the current value set in \([\text{Pr.9 Electronic thermal O/L relay}]\).)

When the motor temperature remains at 145°C for 10s, the inverter protection function (E.THM) activates to shut off the inverter output.

When the motor temperature goes below -30°C during operation, the inverter protection function (E.THM) activates to shut off the inverter output. Motor thermal (E.THM) does not occur during a stop.

When operation is performed with thermal protection function valid without a thermistor or in the calibration status, protection function activates to shut off the inverter output.

Since a dedicated motor with thermistor has no thermal protector, always set a value other than "9999" in \([\text{Pr. 407 Motor temperature detection filter}]\) to make the thermal protection function valid. When the setting remains "9999", motor protection is not activated.

### Specifications

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>407</td>
<td>Motor temperature detection filter</td>
<td>1</td>
<td>0 to 100s</td>
<td>Set the response level to detect motor temperature in normal condition; set it around 30s. If the response level is not satisfactory, decrease the setting value.</td>
</tr>
<tr>
<td>408</td>
<td>Motor thermistor selection</td>
<td>0</td>
<td>0 to SF-V5RU□□□□□□□□□</td>
<td>SF-V5RU□□□□□□□□□ Motor thermistor input invalid.</td>
</tr>
<tr>
<td></td>
<td>Motor thermistor selection</td>
<td>1</td>
<td>SF-V5RU□□□□□□□□□</td>
<td>SF-V5RU□□□□□□□□□ Motor thermistor input invalid.</td>
</tr>
<tr>
<td>C29/925</td>
<td>Motor temperature detection calibration (analog input)</td>
<td>100%</td>
<td>0 to 200%</td>
<td>Calibration value for an inverter and FR-A7AZ (thermistor interface).</td>
</tr>
</tbody>
</table>

Thermistor calibration method \([\text{C29/925}]\)

Perform calibration of the inverter and FR-A7AZ (thermistor interface) before starting the motor at installation. Calibration must be performed at installation.

1) Set the thermistor calibration status switch (SW2) to the line to place the FR-A7AZ in the calibration status.
2) Read \([\text{C29} \ (\text{Pr. 925})]\) and set the compensation value.

(a) Compensation using the operation panel (FR-DU07)

- Select \(\text{C29}\) in parameter setting mode.
- Current compensation command value is displayed: "1"
- "102.7" and "C29" are alternately displayed, then "102.7" is set as compensation value.

*1 Take caution not to turn \(\bigcirc\) at this point.

(b) Calibration using the parameter unit (FR-PU07)

- Read \(\text{Pr. 925}\) in parameter setting mode.
- "99.2" is set as compensation value.

3) After compensation, reset the thermistor calibration status switch (SW2) to the original position. Always return the SW2 to the original position after calibration. Starting the motor in the calibration status results in motor thermal (E. THM), shutting off the inverter output.
**1.4.11 Second function selection signal, third function selection signal (RT, X9*)**

Second (third) function can be selected with the RT (X9) signal.

When the RT signal turns ON, the second function becomes valid.

When the X9 signal turns ON, the third function becomes valid.

For RT signal, set "3" to any of \[Pr.178 to 189 Input terminal function selection\] to assign the function. For X9 signal, set "9" to any of \[Pr.178 to 189 Input terminal function selection\] to assign the function.

The second (third) function has the following applications.

1) Switching between normal use and emergency use
2) Switching between heavy load and light load
3) Changing of acceleration/deceleration time by broken line acceleration/deceleration
4) Switching of characteristic between the main motor and sub motor

You can set the operating condition (reflection timing) for second (third) function with \[Pr.155\].

The function immediately activates by turning ON/OFF the RT signal in \(E700\) to \(D700\).

(*)X9 is not available for the \(F700\) and \(A700\) in \(A700\) to \(D700\).

---

**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>155</td>
<td>RT signal function validity condition selection</td>
<td>0</td>
<td>0, 10</td>
<td>Second (third) function is immediately made valid with ON of the RT (X9) signal.</td>
<td>(A700), (E700), (D700)</td>
</tr>
</tbody>
</table>

---

**Second function connection diagram**

**Second acceleration/deceleration time example**

---

**Table:**

<table>
<thead>
<tr>
<th>Inverter</th>
<th>STF (STR)</th>
<th>RT</th>
<th>RH</th>
<th>RM</th>
<th>SD (initial value)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>RT</th>
<th>R1</th>
<th>RM</th>
<th>PS</th>
</tr>
</thead>
</table>

---

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The list below shows functions which can be set as second and third functions.

<table>
<thead>
<tr>
<th>Function</th>
<th>First Function</th>
<th>Second Function</th>
<th>Third Function</th>
<th>Refer to Page</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque boost</td>
<td>Pr. 8</td>
<td>Pr. 49</td>
<td>Pr. 114/115</td>
<td>244</td>
<td></td>
</tr>
<tr>
<td>Basic frequency</td>
<td>Pr. 9</td>
<td>Pr. 64</td>
<td>Pr. 113</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Acceleration time</td>
<td>Pr. 10</td>
<td>Pr. 65</td>
<td>Pr. 115</td>
<td>234</td>
<td></td>
</tr>
<tr>
<td>Deceleration time</td>
<td>Pr. 34</td>
<td>Pr. 66</td>
<td>Pr. 112</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic thermal O/L relay</td>
<td>Pr. 4</td>
<td>Pr. 67</td>
<td></td>
<td>379</td>
<td></td>
</tr>
<tr>
<td>Stall prevention</td>
<td>Pr. 22</td>
<td>Pr. 68, 69</td>
<td>Pr. 114, 115</td>
<td>335</td>
<td></td>
</tr>
<tr>
<td>Frequency detection</td>
<td>Pr. 42, 43</td>
<td>Pr. 71</td>
<td>Pr. 116</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Applied motor</td>
<td>Pr. 72</td>
<td>Pr. 73</td>
<td></td>
<td>206</td>
<td></td>
</tr>
<tr>
<td>Motor constants</td>
<td>Pr. 80 to 84, 90, 96 to 99, 213</td>
<td>Pr. 453 to 457, 463, 464, 465</td>
<td>—</td>
<td>268</td>
<td></td>
</tr>
<tr>
<td>Online auto tuning</td>
<td>Pr. 93</td>
<td>Pr. 74</td>
<td></td>
<td>276</td>
<td></td>
</tr>
<tr>
<td>Motor control method</td>
<td>Pr. 104</td>
<td>Pr. 75</td>
<td></td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>Speed control gain</td>
<td>Pr. 212, 213</td>
<td>Pr. 76</td>
<td></td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>Wiring input filter</td>
<td>Pr. 212, 213</td>
<td>Pr. 77</td>
<td></td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>Speed detection filter</td>
<td>Pr. 212, 213</td>
<td>Pr. 78</td>
<td></td>
<td>252</td>
<td></td>
</tr>
<tr>
<td>Torque control gain</td>
<td>Pr. 212, 213</td>
<td>Pr. 79</td>
<td></td>
<td>256</td>
<td></td>
</tr>
<tr>
<td>Torque detection filter</td>
<td>Pr. 212, 213</td>
<td>Pr. 80</td>
<td></td>
<td>252</td>
<td></td>
</tr>
</tbody>
</table>

*1 [250 to 250] are not available for A700, E700, D700.

*2 Pr. 49 is not available for F700.

*3 It functions regardless of ON/OFF of RT and X9 signals.
### SPECIFICATIONS

#### 1.4.12 Inverter output stop (MRS)  
(common)

1. **Output shutoff signal (common)**
   - Turning ON the output shutoff signal (MRS) during inverter running shuts OFF the output immediately.
   - Terminal MRS may be used as described below.
     1. To stop the motor by mechanical brake (e.g. electromagnetic brake)
        - The inverter output is shut off when the mechanical brake is operated.
     2. To provide interlock to disable operation by the inverter
        - When the MRS signal ON, the inverter cannot be operated if the start signal is given to the inverter.
     3. To coast the motor to stop
        - When the start signal is turned OFF, the motor decelerates to stop according to the preset deceleration time, but when the MRS signal is turned ON, the motor coasts to stop.

   *1 For MRS signal in D700, set “24” to any of Pr.178 to 182 Input terminal function selection to assign the function.

2. **MRS signal logic inversion**
   - When \( \text{Pr.} 17 = 2 \), the MRS signal (output stop) can be changed to the normally closed (NC contact) input specification. When the MRS signal turns ON (opens), the inverter shuts off the output.
   - When \( \text{Pr.} 17 = 4 \), the MRS signal from external terminal (output stop) can be changed to the normally closed (NC contact) input, and the MRS signal from communication can be changed to the normally open (NO contact) input.
   - This function is used to perform operation by communication with MRS signal from external terminal remained ON.

<table>
<thead>
<tr>
<th>[Pr. 17] Setting</th>
<th>Terminal MRS Function</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normally open input</td>
<td>Normally closed input</td>
</tr>
<tr>
<td>0</td>
<td>( \diamond ) (Communication, external terminal)</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>—</td>
<td>( \diamond ) (Communication, external terminal)</td>
</tr>
<tr>
<td>4</td>
<td>( \diamond ) (Communication) (external terminal)</td>
<td>—</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>External MRS Signal</th>
<th>Communication MRS Signal</th>
<th>[Pr. 17] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>Operation enabled</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td></td>
</tr>
</tbody>
</table>
1.4.13 Reset signal (RES)  

Used to reset the fault stop state established when the inverter's protective function is activated. The reset signal immediately sets the control circuit to the initial (cold) status, e.g. initializes the electronic thermal relay function, built-in brake resistor overheat protection circuit. It shuts off the inverter output at the same time. During reset, the inverter output is kept shut off. To give this reset input, turn ON signal RES for more than 0.1s. When the shorting time is long, the operation panel or parameter unit displays the initial screen, which is not a fault. Operation is enabled within 1s after turning OFF signal RES.

*1 For RES signal in Pr.178 to Pr.182 input terminal function selection to assign the function.

The reset terminal is used to reset the inverter fault stop state. When the reset terminal is turned ON, then OFF while the inverter is running, the motor may be restarted during coasting (refer to the timing chart below) and the output may be shut off due to overvoltage.

Setting either 1, 3, 15, 17 in Pr.75 allows the accidental input of the reset signal during operation to be unacceptable.

*2 Frequent resetting will make the electronic thermal relay function and brake resistor overheat protection invalid.

<table>
<thead>
<tr>
<th>[Pr. 75] Setting</th>
<th>Reset Selection</th>
<th>Disconnected PU Detection</th>
<th>PU Stop Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Reset input normally enabled</td>
<td>If the PU is disconnected, operation will be continued.</td>
<td>Pressing decelerates the motor to a stop only in the PU operation mode.</td>
</tr>
<tr>
<td>1</td>
<td>Reset input is enabled only when the protective function is activated.</td>
<td>When the PU is disconnected, error is displayed on the PU and the inverter trips.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Reset input normally enabled</td>
<td>If the PU is disconnected, operation will be continued.</td>
<td>Pressing decelerates the motor to a stop only in the PU operation mode.</td>
</tr>
<tr>
<td>3</td>
<td>Reset input is enabled only when the protective function is activated.</td>
<td>When the PU is disconnected, error is displayed on the PU and the inverter trips.</td>
<td></td>
</tr>
<tr>
<td>14 (initial value)</td>
<td>Reset input normally enabled</td>
<td>If the PU is disconnected, operation will be continued.</td>
<td>Pressing decelerates the motor to a stop only in the PU operation mode.</td>
</tr>
<tr>
<td>15</td>
<td>Reset input is enabled only when the protective function is activated.</td>
<td>When the PU is disconnected, error is displayed on the PU and the inverter trips.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Reset input normally enabled</td>
<td>If the PU is disconnected, operation will be continued.</td>
<td>Pressing decelerates the motor to a stop only in the PU, external and communication operation modes.</td>
</tr>
<tr>
<td>17</td>
<td>Reset input is enabled only when the protective function is activated.</td>
<td>When the PU is disconnected, error is displayed on the PU and the inverter trips.</td>
<td></td>
</tr>
</tbody>
</table>

Reset Input Timing Chart during Normal Operation

T: Should be longer than the time of coasting to stop.
1.4.14 Automatic restart after instantaneous power failure selection (CS) (A700 F700)

This function allows the inverter to re-control the motor automatically when power is restored after an instantaneous power failure. (A700 F700) do not have CS signal but have automatic restart after instantaneous power failure function. (Refer to page 367 for details.)

When the automatic restart after instantaneous power failure selection signal (CS) is turned ON, automatic restart operation is enabled.

When [Pr. 57 = 9999] (automatic restart operation enabled), the inverter will not operate if used with the CS signal remained OFF.

CS signal is also used to switch inverter/bypass operation when bypass-inverter switchover function is active (Refer to page 416.)
1.4.15 High power factor converter connection (X10, X11)(common)

Used with the inverter in accordance with the Japanese harmonic suppression guidelines issued by the Agency for Natural Resources and Energy of Japanese Ministry of Economy, Trade and Industry (formerly Ministry of International Trade and Industry), the high power factor converter (FR-HC, MT-HC) is an optional high power factor converter unit designed to suppress harmonics to the input power supply.

When connecting the high power factor converter, perform wiring securely as shown in figure (1) and (2). Incorrect connection will damage the high power factor converter and inverter.

After making sure that the wiring is correct, set [Pr. 30 Regenerative function selection = 2] for , or set [Pr. 30 Regenerative function selection = 0 or 2] in . (Refer to page 340)

Having a power regeneration function, the high power factor converter returns power in the regeneration mode.

For the 7.5K or less, the brake circuit built-in the inverter is not activated.

Undervoltage and instantaneous power failure are detected by the high power factor converter. When the protective function of the high power factor converter is activated, the inverter operation enable signal shuts off the inverter output. The undervoltage and instantaneous power failure protective functions of the inverter itself are invalid.

When you need automatic restart after instantaneous power failure, choose automatic restart after instantaneous power failure in the inverter and also set the parameter to activate automatic restart after instantaneous power failure in the high power factor converter. The inverter restarts in accordance with the automatic restart after instantaneous power failure.

(1) Connection with the FR-HC (55K or less)(common)

*1 Always keep terminals R/L1, S/L2, T/L3 open. Incorrect connection will damage the inverter. (In C70D, E.OPT (Option fault) will occur. (Refer to page 97))

*2 Do not insert an MCCB between terminals P+ and N+. Opposite polarity of terminals N--P+ will damage the inverter.

*3 Use [Pr. 38 to Pr. 39: Input terminal function selection] to assign terminals used for X10 and X11 signal. For C70D, X11 signal is unavailable. (Refer to page 37)

Terminal MRS can be used when not using inverter operation enable signal (X10).

For communication where the start command is sent only once, for example RS-485 communication operation, use the X11 signal when making setting to hold the mode at occurrence of an instantaneous power failure. (Refer to page 331)

*4 For C70D, remove jumpers between terminal R/L1 and R/L11 as well as between S/L2 and S/L21, and connect the power supply for the control circuit to terminals R/L11 and S/L21.

For C70D, connection is unnecessary because C70D do not have terminal R/L11 and S/L21.

*5 The voltage phases of terminals R, S, T and terminals R4, S4, T4 must be matched.

*6 Use sink logic (factory setting) when the FR-HC is connected. The FR-HC cannot be connected when source logic is selected.
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(2) Connection with the MT-HC (75K or more)

*1 Remove the jumpers across the inverter terminals R/L1 and R1/L11, S/L2 and S1/L21, and connect the control circuit power supply to terminals R1/L11 and S1/L21. Always keep terminals R/L1, S/L2, T/L3 open. Incorrect connection will damage the inverter. (E.OPT (Option fault) will occur.) (Refer to page 97)

*2 Do not insert an MCCB between terminals P/+ and N/- (between P and P/+, between N and N/). Opposite polarity of terminals N/-, P/+ will damage the inverter.

*3 Use [Pr. 178 to Pr. 189  Input terminal function selection] to assign terminals used for X10 and X11 signal. (Refer to page 37)

Terminal MRS can be used when not using inverter operation enable signal (X10).

For communication where the start command is sent only once, e.g. RS-485 communication operation, use the X11 signal when making setting to hold the mode at occurrence of an instantaneous power failure. (Refer to page 321)

*4 Connect the power supply to terminals R1 and S1 of the MT-HC via an insulated transformer.

*5 The voltage phases of terminals R, S, T and terminals R4, S4, T4 must be matched.

*6 Use sink logic (factory setting) when the MT-HC is connected. The MT-HC cannot be connected when source logic is selected.

*7 When connecting the inverter to the MT-HC, do not connect the DC reactor provided to the inverter.

### 1.4.16 24VDC and external transistor common (PC) (common)

When the transistor output (open collector) of a programmable controller having an external power supply is input to the inverter, supply external interface power to prevent a malfunction from occurring due to undesirable current as shown below. Making connections as shown on the right supplies external power to the photocoupler in the inverter as indicated by the dotted lines. Since terminal SD is not connected, no power is supplied to the photocoupler from the control power supply of the inverter.

Also, terminals PC-SD may be used as a 24VDC 0.1A power output. When using terminals PC-SD as a 24VDC power supply, malfunction due to undesirable currents can not be prevented.

#### When terminal PC is not used

When the control power voltage in the inverter connected with the output module (open collector output) of the programmable controller has become higher than the external power supply voltage of the programmable controller as shown on the right, a current indicated by the dotted lines flows if the transistor of the programmable controller is not on, accidentally giving the inverter a command signal.

- **Measures**
  1. Insert a diode to prevent undesirable currents.
  2. Use an all-point independent type output module. (Such as QY68A)
### 1.4.17 Output signal (RUN, SU, IPF, OL, FU, A1(A), B1(B), C1(C), A2, B2, C2, Y0*, Y1*, Y2*, Y3*, Y4*, Y5*, Y6*, 1A*, 1B*, 1C*, 2A, 2B, 2C*, 3A*, 3B*, 3C*)

(*Y0, Y1, Y2, Y3, Y4, Y5, Y6 are output terminal of the FR-A7AY (option). 1A, 1B, 1C, 2A, 2B, 2C, 3A, 3B, 3C are output terminal of the FR-A7AR (option)).

#### (1) Terminal assignment of output terminal

The inverter has the output terminals of which functions can be changed by parameter setting.

#### 1) A700, F700

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>RUN terminal function selection</td>
<td>0</td>
</tr>
<tr>
<td>191</td>
<td>SU terminal function selection</td>
<td>1</td>
</tr>
<tr>
<td>192</td>
<td>IPF terminal function selection</td>
<td>2</td>
</tr>
<tr>
<td>193</td>
<td>OL terminal function selection</td>
<td>3</td>
</tr>
<tr>
<td>194</td>
<td>FU terminal function selection</td>
<td>4</td>
</tr>
<tr>
<td>195</td>
<td>ABC1 terminal function selection</td>
<td>99</td>
</tr>
<tr>
<td>196</td>
<td>ABC2 terminal function selection</td>
<td>9999</td>
</tr>
</tbody>
</table>

#### 2) F700

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>RUN terminal function selection</td>
<td>0</td>
</tr>
<tr>
<td>194</td>
<td>FU terminal function selection</td>
<td>4</td>
</tr>
<tr>
<td>195</td>
<td>ABC terminal function selection</td>
<td>99</td>
</tr>
</tbody>
</table>

#### 3) F700

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>190</td>
<td>RUN terminal function selection</td>
<td>0</td>
</tr>
<tr>
<td>192</td>
<td>ABC terminal function selection</td>
<td>99</td>
</tr>
</tbody>
</table>

#### 4) Plug-in options (FR-A7AY and FR-A7AR)

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>313</td>
<td>DO0 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>314</td>
<td>DO1 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>315</td>
<td>DO2 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>316</td>
<td>DO3 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>317</td>
<td>DO4 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>318</td>
<td>DO5 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>319</td>
<td>DO6 output selection</td>
<td>9999</td>
</tr>
<tr>
<td>320</td>
<td>RA1 output selection</td>
<td>0</td>
</tr>
<tr>
<td>321</td>
<td>RA2 output selection</td>
<td>1</td>
</tr>
<tr>
<td>322</td>
<td>RA3 output selection</td>
<td>2</td>
</tr>
</tbody>
</table>

(These options are not available for A700.)
<table>
<thead>
<tr>
<th>Setting</th>
<th>Signal Name</th>
<th>Functions</th>
<th>Operation</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 100</td>
<td>RLIN</td>
<td>Inverter running</td>
<td>Output during operation when the inverter output frequency rises to or above ([\text{Pr. 12: \text{Starting frequency}}]).</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>1 101</td>
<td>SU</td>
<td>Up to frequency (^*1)</td>
<td>Output when the output frequency reaches the set frequency.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>2 102</td>
<td>RPF</td>
<td>Instantaneous power failure/undervoltage detection</td>
<td>Output at occurrence of an instantaneous power failure or undervoltage protection activation.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>3 103</td>
<td>OL</td>
<td>Overload alarm</td>
<td>Output while stall prevention function is active.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>4 104</td>
<td>FU</td>
<td>Output frequency detection</td>
<td>Output when the output frequency reaches the frequency set in ([\text{Pr. 42}]) (for reverse rotation ([\text{Pr. 43}])).</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>5 105</td>
<td>FL2</td>
<td>Second output frequency detection</td>
<td>Output when the output frequency reaches the frequency set in ([\text{Pr. 17}]).</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>6 106</td>
<td>FL3</td>
<td>Third output frequency detection</td>
<td>Output when the output frequency reaches the frequency set in ([\text{Pr. 18}]).</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>7 107</td>
<td>RBP</td>
<td>Regenerative brake prealarm</td>
<td>Output when (85% ) of the regenerative brake duty set in ([\text{Pr. 70}]) is reached.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>8 108</td>
<td>TM</td>
<td>Electronic thermal relay function prealarm</td>
<td>Output when the electronic thermal relay set in ([\text{Pr. 83}]) is reached. (Electronic thermal relay function activates, when the value reaches (100%).</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>9 109</td>
<td>PU</td>
<td>PU operation mode</td>
<td>Output when the (1) operation mode is selected.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>10 110</td>
<td>RY</td>
<td>Inverter operation ready</td>
<td>Output when reset process is completed (with the inverter can be started by switching the start signal ON or when it is running) when powering ON the inverter.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>11 111</td>
<td>YI</td>
<td>Inverter operation ready</td>
<td>Output when the output current is higher than the ([\text{Pr. 150}]) setting for longer than the time set in ([\text{Pr. 151}]).</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>12 112</td>
<td>YI2</td>
<td>Output current detection</td>
<td>Output when the output current is higher than the ([\text{Pr. 150}]) setting.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>13 113</td>
<td>YI3</td>
<td>Direct current detection</td>
<td>Output when the output current is higher than the ([\text{Pr. 150}]) setting.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>14 114</td>
<td>FDN</td>
<td>PID lower limit</td>
<td>Output when the feedback value falls below the lower limit of PID control.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>15 115</td>
<td>FUP</td>
<td>PID upper limit</td>
<td>Output when the feedback value rises above the upper limit of PID control.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>16 116</td>
<td>BL</td>
<td>PID forward-reverse rotation output</td>
<td>Output when forward rotation is performed in PID control.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>17</td>
<td>M1C1</td>
<td>Electronic bypass MC1</td>
<td>Used when the bypass-inverter switchover function is used.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>18</td>
<td>M1C2</td>
<td>Electronic bypass MC2</td>
<td>使用者</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>19</td>
<td>M1C3</td>
<td>Electronic bypass MC3</td>
<td>使用者</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>20 120</td>
<td>BOP</td>
<td>Brake opening request</td>
<td>Output to open the brake when the brake sequence function is selected.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>21 125</td>
<td>FDN</td>
<td>Fan alarm output</td>
<td>Output when the fan alarm is detected.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>22 126</td>
<td>FIN</td>
<td>Heat run over load pre-alarm</td>
<td>Output when the electric run over load pre-alarm is activated.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>23 127</td>
<td>C1PA</td>
<td>Operation completion</td>
<td>When operation is valid (^*2).</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>24 128</td>
<td>C1PB</td>
<td>Operation fault</td>
<td>使用者</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>25 130</td>
<td>YF31</td>
<td>Forward motion output</td>
<td>Output when the motor is running in forward direction.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>26 131</td>
<td>YF31</td>
<td>Reverse motion output</td>
<td>Output when the motor is running in reverse direction.</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>27 132</td>
<td>YD2</td>
<td>Regenerative status output</td>
<td>Output in the regeneration status under vector control operation (^*3).</td>
<td>○ — — —</td>
</tr>
<tr>
<td>28 133</td>
<td>RF12</td>
<td>Operation ready 2</td>
<td>Output during vector control or pre-excitation operation under (\text{DSP sensorless vector control or vector control} ).</td>
<td>○ — — —</td>
</tr>
<tr>
<td>29 134</td>
<td>LS</td>
<td>Low speed output</td>
<td>Output when the output frequency reduces below the ([\text{Pr. 110}]) setting.</td>
<td>○ — — —</td>
</tr>
<tr>
<td>30 135</td>
<td>TU</td>
<td>Torque detection</td>
<td>Output when the motor torque rises above the ([\text{Pr. 112}]) setting.</td>
<td>○ — — —</td>
</tr>
<tr>
<td>31 136</td>
<td>YD39</td>
<td>Torque detection</td>
<td>Output when the number of droop pulses has fallen below the setting value.</td>
<td>○ — — —</td>
</tr>
<tr>
<td>32 137</td>
<td>YD39</td>
<td>Start-time tuning completion signal</td>
<td>Output on completion of start-time tuning.</td>
<td>○ — — —</td>
</tr>
<tr>
<td>Setting</td>
<td>Signal Name</td>
<td>Functions</td>
<td>Operation</td>
<td>Available Inverters</td>
</tr>
<tr>
<td>---------</td>
<td>-------------</td>
<td>-----------</td>
<td>-----------</td>
<td>--------------------</td>
</tr>
<tr>
<td>41</td>
<td>FB</td>
<td>Speed detection</td>
<td>Output when the actual motor speed (estimated actual speed value) reaches the Pr. 41 (Pr. 19) setting.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>42</td>
<td>FB2</td>
<td>Second speed detection</td>
<td>Output when the value reaches the Pr. 40 (Pr. 18) setting.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>43</td>
<td>FB3</td>
<td>Third speed detection</td>
<td>○ ○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>RUN2</td>
<td>Inverter running 2</td>
<td>Output when the inverter running and start commands are ON.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>45</td>
<td>RUN2</td>
<td>Inverter running and start commands are ON</td>
<td>Output when the inverter running and start commands are ON.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>46</td>
<td>Y45</td>
<td>Monitoring deceleration due to power failure stop function</td>
<td>Output when the power failure-time deceleration function is executed/retained until release.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>47</td>
<td>PID</td>
<td>PID control active</td>
<td>Output during PID control.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>48</td>
<td>Y48</td>
<td>During retry</td>
<td>Output during retry processing.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>49</td>
<td>Y49</td>
<td>During retry</td>
<td>Output during retry processing.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>50</td>
<td>Y50</td>
<td>PID output interruption</td>
<td>Output when the PID output interruption function is activated.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>51</td>
<td>Y51</td>
<td>During monitor output</td>
<td>Output when the monitor output function is activated.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>52</td>
<td>Y52</td>
<td>PID control ready</td>
<td>Output when the control circuit capacitor life falls below 10% of Pr. 257.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>53</td>
<td>Y53</td>
<td>Main circuit capacitor life</td>
<td>Output when the main circuit capacitor life falls below 85% of Pr. 258.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>54</td>
<td>Y54</td>
<td>Cooling fan life</td>
<td>Output when the cooling fan life falls below 50%.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>55</td>
<td>Y55</td>
<td>Inrush current limit circuit life</td>
<td>Output when the inrush current limit circuit life falls below 10% of Pr. 256.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>56</td>
<td>Y56</td>
<td>Life alarm</td>
<td>Output when any of the control circuit capacitor, main circuit capacitor and inrush current limit circuit or the cooling fan approaches the end of its service life.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>57</td>
<td>Y57</td>
<td>Current average value updated timing</td>
<td>Output when the power saving average value is updated when the power saving monitor is used. Cannot be set to a relay output terminal.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>58</td>
<td>Y58</td>
<td>Current average value monitor signal</td>
<td>Output when the power saving average value is updated when the power saving monitor is used. Cannot be set to a relay output terminal.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>59</td>
<td>Y59</td>
<td>Fault output 2 (power off signal)</td>
<td>Output when the power saving average value is updated when the power saving monitor is used. Cannot be set to a relay output terminal.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>60</td>
<td>Y60</td>
<td>Maintenance timer signal</td>
<td>Output when the maintenance timer signal is activated.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>61</td>
<td>Y61</td>
<td>Maintenance timer signal</td>
<td>Output when the maintenance timer signal is activated.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>62</td>
<td>Y62</td>
<td>Alarm output 2</td>
<td>Output when the protective function is activated to stop the output (major fault).</td>
<td>○ ○ ○ ○</td>
</tr>
</tbody>
</table>

*1* Positive logic
*2* Negative logic
*3* Available inverters: A700, F700, E700, D700

---

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**SPECIFICATIONS**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Signal Name</th>
<th>Functions</th>
<th>Operation</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>98</td>
<td>LF</td>
<td>Alarm output</td>
<td>Output when an alarm (fan failure or communication failure) occurs.</td>
<td>A700</td>
</tr>
<tr>
<td>99</td>
<td>ALM</td>
<td>Fault output</td>
<td>Output when the inverter protective function is activated to stop the output (fault). The signal output is stopped when the fault is reset.</td>
<td>A700</td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>No function</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

1. Note that when the frequency setting is varied using an analog signal or setting dial of the operation panel (FR-DU07), the output of the SU (up to frequency) signal may alternate ON and OFF, depending on the varying speed and the timing of the varying speed due to acceleration/deceleration time setting. (The output will not alternate ON and OFF when the acceleration/deceleration time setting is "0s".)

2. Up to frequency SU, frequency detection FU, FU2, FU3 under encoder feedback control or vector control (option FR-A7AP is mounted) signals output as below:

   - **FU:** Output when the actual speed (frequency) by the encoder feedback signal exceeds detected specification frequency.
   - **FU2:** Output when the inverter output frequency exceeds detected specification frequency.
   - **FU3:** Output when the inverter output frequency exceeds detected specification frequency.

3. When a power supply reset is performed, the alarm output 2 signal (ALM2) turns OFF as soon as the power supply switches OFF.

4. Available only when used with the FR-A7AP or FR-A7AL (option).

5. This can be assigned only when the FR-A7AY or FR-A7AR (option) is mounted. This cannot be set to [Pr. 190 to Pr. 196].

6. When the function is executed, the terminal conducts at the setting of any of 0 to 99, and does not conduct at the setting of any of 100 to 199.

7. When [Pr. 74 Fault code output selection = 1] in (AT00), the output signals of terminals SU, IPF, OL, and FU are switched as set in [Pr. 75]. (When an inverter fault occurs, the signal output is switched to the fault output.)

8. Changing the terminal assignment using [Pr. 190 to Pr. 196, Pr. 313 to Pr. 322 Output terminal function selection] may affect the other functions. Please make setting after confirming the function of each terminal.

9. Do not assign signals which repeat frequent ON/OFF to the relay output terminal. Otherwise, the life of the relay contact decreases.

<table>
<thead>
<tr>
<th>Setting</th>
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</thead>
<tbody>
<tr>
<td>98</td>
<td>LF</td>
<td>Alarm output</td>
<td>Output when an alarm (fan failure or communication error warning) occurs.</td>
<td>A700</td>
</tr>
<tr>
<td>99</td>
<td>ALM</td>
<td>Fault output</td>
<td>Output when the inverter protective function is activated to stop the output (fault). The signal output is stopped when the fault is reset.</td>
<td>A700</td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>No function</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

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<tr>
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<th>Signal Name</th>
<th>Functions</th>
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</thead>
<tbody>
<tr>
<td>98</td>
<td>LF</td>
<td>Alarm output</td>
<td>Output when an alarm (fan failure or communication failure) occurs.</td>
<td>A700</td>
</tr>
<tr>
<td>99</td>
<td>ALM</td>
<td>Fault output</td>
<td>Output when the inverter protective function is activated to stop the output (fault). The signal output is stopped when the fault is reset.</td>
<td>A700</td>
</tr>
<tr>
<td>9999</td>
<td>—</td>
<td>No function</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
(2) Sink logic type and source logic type

In sink logic, a signal switches ON when a current flows from the corresponding signal input terminal. Terminal SE is common to the open collector output signals.

In source logic, a signal switches ON when a current flows into the corresponding signal input terminal. Terminal SE is common to the open collector output signals.

- Current flow concerning the input/output signal when sink logic is selected

- Current flow concerning the input/output signal when source logic is selected

(3) Relay output (fault output)

A changeover contact is used for fault alarm output and the following table shows its operations.

When a fault occurs in A700, F700, ALARM lamp is lit, and fault output remains lit. If the contact is opened by the magnetic contactor, etc. provided on the inverter power supply side, the inverter control power is lost and the fault output is not kept ON. To keep the fault-output signal ON, the fault alarm output contact (across terminals B-C) must be kept open by the external circuit.

In A700, fault output signal can be kept ON by using terminal R1/L11, S1/L21 to connect the control circuit to the other power supply. (Refer to page 36)

Note that even if current limit function, stall prevention, fan fault, brake discharge resistor, overheat protection function operates, or fault alarm output is not activated and terminal B-C remains closed. In addition, ALARM lamp is not lit.

Fault description when a fault occurs can be read in fault history in monitor mode of the operation panel or parameter unit.

Open/close of fault alarm relay and lamp indication

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Open/Close of Contact</th>
</tr>
</thead>
<tbody>
<tr>
<td>During normal operation and the inverter power-OFF</td>
<td>The relay coil is non-excitation and NO contact is closed.</td>
</tr>
<tr>
<td>Abnormal</td>
<td>When a fault occurs, the coil of the relay is excited to open NO contact and close NC contact. Note that the protective function is not activated at the time of a fan alarm.</td>
</tr>
</tbody>
</table>
1.4.18 Inverter operating status output signal (RUN, RUN2*, RUN3*, RY, RY2*, Y30*, Y31*, Y32*, ALM, ALM2*, IPF*, Y91, OL, RBP, TP, FIN) (common)

(*RUN2, Y30, Y31, Y32 are not available for E700. *)
(*RUN2, RUN3, Y2, Y30, Y31, Y32, ALM2, IPF are not available for F700, E700.*

(1) Inverter operation ready signal (RY, RY2*) and inverter running signal (RUN, RUN2*, RUN3) (common)
(*RY2, RUN2 are not available for F700. *)
(*RY2, RUN2, RUN3 are not available for E700. *)

1) During V/F control, Advanced magnetic flux vector control *1, General-purpose magnetic flux vector control, Simple magnetic flux vector control *1. When the inverter is ready to operate, the output of the operation ready signal (RY) is ON. (It is also ON during inverter running.)

When the output frequency of the inverter rises to or above [Pr. 11 Starting frequency], the output of the inverter running signals (RUN, RUN2) is turned ON. During an inverter stop or DC injection brake operation, the output is OFF.

For the RUN3 signal, the output is ON while the inverter is running and the start signal is ON. (For the RUN3 signal, output is ON if the start command is on even when a fault occurs or the MRS signal is ON.)

The output is ON during DC injection brake operation and OFF during an inverter stop.

---

### Table: Output Signal Configuration

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>Start Signal OFF (during stop)</th>
<th>Start Signal ON (during stop)</th>
<th>Start Signal ON (during operation)</th>
<th>Under DC Injection Brake</th>
<th>At Alarm Occurrence or MRS Signal ON (output shut-off)</th>
<th>Automatic Restart after Instantaneous Power Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>RY</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>RY2</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>RUN</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>RUN2</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>RUN3</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
</tr>
</tbody>
</table>

*1 This signal turns OFF during power failure or undervoltage.
2) Real sensorless vector control, vector control

When the inverter is ready to operate, the output of the operation ready signal (RY) is ON. (It is also ON during inverter running.)

When the inverter output frequency rises to or above the \[Pr. 13 Starting frequency\] setting, turn ON the output of the inverter running signal (RUN). During an inverter stop, DC injection brake operation, start time tuning or pre-excitation, the output is OFF.

For the RUN2 signal, the output is ON while the inverter is running and the start signal is ON. (The RUN2 signal shuts OFF output when a fault occurs and the MRS signal is ON.)

For the RUN3 signal, the output is ON while the inverter is running and the start signal is ON. The RUN2 and RUN3 signals are ON when the start command is ON and even during pre-excitation with "0" set in speed command. (Note that the RUN2 signal turns OFF during pre-excitation by turning the LX signal ON.)

The RY2 signal turns ON at the start of pre-excitation. The signal is ON while pre-excitation is activated even during an inverter stop. The signal turns OFF while the output is shut off (MRS signal).

When using the RY, RY2, RUN2 and RUN3 signals, assign functions to \[Pr. 190 to Pr. 196 Output terminal selection function\] referring to the table below.

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>Start Signal OFF (during stop)</th>
<th>Start Signal ON (pre-excitation)</th>
<th>Start Signal ON (during operation)</th>
<th>LX Signal ON (pre-excitation)</th>
<th>Under DC Injection Brake (pre-excitation)</th>
<th>At Alarm Occurrence or MRS Signal (output shut off)</th>
<th>Automatic Restart after Instantaneous Power Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>RY</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>Off</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>RUN2</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
</tr>
<tr>
<td>RUN3</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>

When using the RY, RY2, RUN2 and RUN3 signals, assign functions to \[Pr. 150 to Pr. 156 Output terminal selection function\] referring to the table below.

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196 Setting]</th>
</tr>
</thead>
<tbody>
<tr>
<td>RY</td>
<td>11</td>
</tr>
<tr>
<td>RY2</td>
<td>33</td>
</tr>
<tr>
<td>RUN2</td>
<td>44</td>
</tr>
</tbody>
</table>

*1 Pre-excitation is made when the start signal is ON and frequency command is OFF.

*2 This signal turns OFF during power failure or undervoltage.

*3 There is a delay of 100ms (500ms for the 75K or more) when the signal is ON.

*4 This signal turns ON during servon (LX signal is ON) under position control.
(2) Forward rotation and reverse rotation signal (Y30, Y31)

The status during forward rotation (Y30) and reverse rotation (Y31) are output from the actual motor speed under vector control.

Y30 and Y31 signals turn OFF during pre-excitation (zero speed, servo lock) under speed control or torque control operation. Note that signals are output according to the motor rotation during servo lock under position control as same as inverter running.

When using the Y30, Y31 signal, set 30, 31 (positive logic) or 130, 131 (negative logic) in any of \[ Pr. 190 \rightarrow Pr. 196 \] Output terminal function selection] to assign the function to the output terminal.

*1 This signal is always OFF during V/F control, Advanced magnetic flux vector control or Real sensorless vector control.

*2 If the motor is made to run by external force, etc. during an inverter stop, Y30 and Y31 remain OFF.

*3 The FR-A7AP (option) is necessary for vector control.

(3) Regenerative mode output signal (Y32)

While the motor is in regeneration status (motor is in power regeneration status), the regenerative status output signal (Y32) is turned ON. If the signal is turned ON once, it will be retained for at least 100ms.

It turns OFF while the inverter is stopped and during pre-excitation.

When using the Y32 signal, set 32 (positive logic) or 132 (negative logic) in any of \[ Pr. 190 \rightarrow Pr. 196 Output terminal function selection] to assign the function to the output terminal.

*1 This signal is always OFF during V/F control, Advanced magnetic flux vector control or Real sensorless vector control.

(4) Fault output (ALM, ALM2)

* ALM2 is not available for

If the inverter comes to a fault stop, the ALM and ALM2 signals are output. The ALM2 signal remains ON during a reset period after fault occurrence.

When using the ALM2 signal, set 94 (positive logic) or 194 (negative logic) in any of \[ Pr. 190 \rightarrow Pr. 196 Output terminal function selection] to assign the function to the output terminal.

(5) Instantaneous power failure/undervoltage (IPF)

When instantaneous power failure protection (E.IP) and undervoltage protection (E.UVT) are activated, the inverter trips. (Refer to page 97 for E.IP and E.UVT)

When E.IP and E.UVT are activated, instantaneous power failure/undervoltage signal (IPF) is output.
(6) Power shut off signal (Y91)

The Y91 signal is output at occurrence of a fault due to the failure of the inverter circuit or a fault caused by a wiring mistake.

When using the Y91 signal, set 91 (positive logic) or 191 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection] to assign the function to the output terminal.

The following table indicates the faults that will output the Y91 signal. (Refer to page 97 for the fault description.)

<table>
<thead>
<tr>
<th>No.</th>
<th>Alarm Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Inrush current limit circuit fault (E.IOH)</td>
</tr>
<tr>
<td>2</td>
<td>CPU fault (E.CPU)</td>
</tr>
<tr>
<td>3</td>
<td>Parameter storage device fault (E.PST)</td>
</tr>
<tr>
<td>4</td>
<td>Parameter storage device fault (E.PST2)</td>
</tr>
<tr>
<td>5</td>
<td>24VDC power output short circuit (E.P24)</td>
</tr>
<tr>
<td>6</td>
<td>Operation panel power supply short circuit, RS-485 terminal power supply short circuit (E.CTE)</td>
</tr>
<tr>
<td>7</td>
<td>Output side earth (ground) fault overcurrent (E.OF)</td>
</tr>
<tr>
<td>8</td>
<td>Output phase loss (E.LF)</td>
</tr>
<tr>
<td>9</td>
<td>Brake transistor alarm detection (E.BB)</td>
</tr>
</tbody>
</table>

*1 Not available for D700
*2 Not available for F700

(7) Stall prevention (overcurrent) alarm output signal (OL)

When the output current exceeds the stall prevention operation level and stall prevention is activated, the stall prevention operation signal (OL signal) turns ON for longer than 100ms. When the output power falls to or below the stall prevention operation level, the output signal turns OFF.

Stall prevention operation stops acceleration (makes deceleration) during acceleration, makes deceleration during constant speed, and stops deceleration (makes acceleration) during deceleration.

The inverter does not trip even when the alarm signal is output.

*1 If an overload status lasts long, an inverter trip (for example electronic thermal O/L relay (E.THM)) may occur.
*2 When [Pr. 116] has been set to activate the fast-response current limit (index value), the [Pr. 22] setting should not be higher than 170%. The torque will not be developed by doing so.

(8) Regenerative brake duty alarm output signal (RBP)

[RBP] appears on the operation panel and an alarm signal (RBP) is output when 85% of the regenerative brake duty set in [Pr. 70] is reached. If the regenerative brake duty reaches 100% of the [Pr. 70] setting, a regenerative overvoltage (E.OV1 to E.OV3) occurs. (Refer to page 331 for details of [Pr. 70].)

For the terminal used for the RBP signal output, assign the function by setting 7 (positive logic) or 107 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection].

*1 For [700], setting can be made for the 75K or more.

(9) Electronic thermal O/L relay alarm output signal (THP)

The alarm signal (THP) is output when the electronic thermal value reaches 85% of the level set in [Pr. 9] or [Pr. 51]. If the regenerative brake duty reaches 100% of the [Pr. 70] setting, electronic thermal relay function protection (E.THM/E.THT) activates.

For the terminal used for the THP signal output, assign the function by setting 8 (positive logic) or 108 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection].

(10)fin overheat alarm output signal (FIN)

The alarm signal (FIN) is output when the temperature becomes approximately 85% of the heatsink overheat protection operation temperature. heatsink overheat (E.FIN) occurs if the temperature reaches 100%.

For the terminal used for the FIN signal output, assign the function by setting 26 (positive logic) or 126 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection].
1.4.19 Detection of output frequency (SU, FU, FU2, FU3*, FB*, FB2*, FB3*, LS*)

(common)

("FU3, FB, FB2, BS are not available for E700, D700")

("FU2, FU3, FB, FB2, FB3, LS are not available for F700, E700")

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>41</td>
<td>Up-to-frequency sensitivity</td>
<td>10%</td>
<td>0 to 100%</td>
<td>Set the level where the SU signal turns ON.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>42</td>
<td>Output frequency detection</td>
<td>6Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency where the FU (FB) signal turns ON.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>43</td>
<td>Output frequency detection</td>
<td>9999</td>
<td>0 to 400Hz</td>
<td>Set the frequency where the FU (FB) signal turns ON in reverse rotation.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>50</td>
<td>Second output frequency detection</td>
<td>30Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency where the FU (FB) signal turns ON.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>116</td>
<td>Third output frequency detection</td>
<td>60Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency where the FU (FB) signal turns ON.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
<tr>
<td>865</td>
<td>Low speed detection</td>
<td>1.5Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency where the LS signal turns ON.</td>
<td>○ ○ ○ ○ ○ ○ ○ ○ ○ ○</td>
</tr>
</tbody>
</table>

(1) Up-to-frequency sensitivity (SU)

When the output frequency reaches the running frequency, the up-to-frequency signal (SU) is output. The value can be adjusted within the range ± 1% to ± 100% on the assumption that the set frequency is 100%.

This parameter can be used to ensure that the running frequency has been reached to provide the operation start signal etc. for related equipment.

(2) Low speed detection (LS)

The low speed detection signal (LS) is output when the output frequency decreases below the [Pr. 865] setting.

When speed control is performed by Real sensorless vector control or vector control, a fault (E.OLT) is displayed and the inverter output is stopped if frequency drops to the [Pr. 865] setting by torque limit operation and the output torque exceeds [Pr. 874 OLT level setting] and remains for more than 3s.

For the LS signal, set 34 (positive logic) or 134 (negative logic) in [Pr. 196 to Pr. 198 Output terminal function selection] and assign functions to the output terminal.

*1 The output frequency to be compared with the set frequency at the SU signal and LS signal differs according to the control method.

Control Method | Compared Output Frequency
--- | ---
V/F control | Output frequency
Simple magnetic flux vector control | Output frequency before slip compensation
Advanced magnetic flux vector control | Frequency (actual motor speed) estimated value
Real sensorless vector control or vector control | Value of actual motor rotation represented in terms of frequency setting
(3) Detection of output frequency (FU, FU2*, FU3*, FB*, FB2*, FB3*)
(*FU3, FB, FB2, FB3 are not available for FU.)

(*FU2, FU3, FB, FB2, FB3 are not available for FU.)

The output frequency detection signal (FU (FB)) is output when the output frequency reaches or exceeds the [Pr. 42] setting.

FU (FU2, FU3) signal can be used for electromagnetic brake operation, open signal, etc.

The FU (FU2 and FU3) signal is output when the output frequency reaches the speed command value and output the FB (FB2, FB3) signal when the output frequency reaches the actual motor speed (estimated actual speed value under Real sensorless vector control, feedback value under vector control). The FU signal and FB signal are output simultaneously during V/F control and Advanced magnetic flux vector control.

When the detection frequency is set in [Pr. 43], frequency detection used exclusively for reverse rotation can also be set. This function is effective for switching the timing of electromagnetic brake operation between forward rotation (rise) and reverse rotation (fall) during vertical lift operation, etc.

When [Pr. 43] = 9999, the [Pr. 42] setting is used for forward rotation and the [Pr. 43] setting is used for reverse rotation.

When outputting a frequency detection signal besides the FU signal, set the detection frequency to [Pr. 50] or [Pr. 116]. The FU2 (FB2) signal is output when the output frequency reaches or exceeds the [Pr. 50] setting (FU3 (FB3) signal is output when reaches or exceeds the [Pr. 116] setting).

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FU2/FB2</td>
<td>[Pr. 50] or [Pr. 116]</td>
</tr>
<tr>
<td>FU3/FB3</td>
<td>[Pr. 42] or [Pr. 43]</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>

Refer to the table below to assign FU2, FU3, FB, FB2, FB3 signal to [Pr. 190 to Pr. 196 Output terminal function selection].

<table>
<thead>
<tr>
<th>Output Signal</th>
<th>[Pr. 190 to Pr. 196] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>FB</td>
<td>41</td>
</tr>
<tr>
<td>FU2</td>
<td>42</td>
</tr>
<tr>
<td>FU3</td>
<td>43</td>
</tr>
<tr>
<td>FB2</td>
<td>106</td>
</tr>
<tr>
<td>FB3</td>
<td>143</td>
</tr>
</tbody>
</table>
### 1.4.20 Output current detection function (Y12, Y13)  
#### Common

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>Output current detection level</td>
<td></td>
<td>150%</td>
<td>Set the output current detection level. 100% is the rated inverter current.</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>120%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 220%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 150%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 200%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0% to 100%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0% to 200%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>151</td>
<td>Output current detection signal delay time</td>
<td>0s</td>
<td>0 to 10s</td>
<td>Set the output current detection period. Set the time from when the output current has risen above the setting until the output current detection signal (Y12) is output.</td>
<td>○</td>
</tr>
<tr>
<td>152</td>
<td>Zero current detection level</td>
<td>5%</td>
<td>0 to 100%</td>
<td>Set the zero current detection level. Suppose that the rated inverter current is 100%.</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 120%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 150%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0 to 200%</td>
<td></td>
<td>○</td>
</tr>
<tr>
<td>153</td>
<td>Zero current detection period</td>
<td>0.5s</td>
<td>0 to 1s</td>
<td>Set this parameter to define the period from when the output current drops below the [Pr. 152] setting until the zero current detection signal (Y13) is output.</td>
<td>○</td>
</tr>
<tr>
<td>166</td>
<td>Output current detection signal retention time</td>
<td>0.1s</td>
<td>0 to 10s</td>
<td>Set the retention time when the Y12 signal is ON.</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>The Y12 signal ON status is retained. The signal is turned OFF at the next start.</td>
<td>○</td>
</tr>
<tr>
<td>167</td>
<td>Output current detection operation selection</td>
<td>0</td>
<td>0</td>
<td>Operation continues when the Y12 signal is ON.</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>The inverter is brought to trip (E.ODD) when the Y12 signal is ON.</td>
<td>○</td>
</tr>
</tbody>
</table>

*A700  
F700  
D700  
E700  
A700  
F700  
E700  
D700  

---

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1.4.21 Output torque detection (TU) (A700)

When the output torque reaches or exceeds the detected torque value set in [Pr. 864] under Advanced magnetic flux vector control, Real sensorless vector control, or vector control, the torque detection signal (TU) turns ON. It turns OFF when the torque falls below the detection torque value.

The signal is used as operation and open signal for an electromagnetic brake.

For the TU signal, set 35 (positive logic) or 135 (negative logic) in [Pr. 190 to Pr. 196 Output terminal function selection] and assign functions to the output terminal.
1.4.22 Maintenance timer alarm signal (Y95) (common)

When the cumulative energization time of the inverter reaches the parameter set time, the maintenance timer output signal (Y95) is output. “MT” is displayed on the operation panel (FR-DU07). This can be used as a guideline for the maintenance time of peripheral devices.

The cumulative energization time of the inverter is stored into the EEPROM every hour and indicated in [Pr. 503 Maintenance timer] in 100h increments. [Pr. 503] is clamped at 9998 (999800h).

When the [Pr. 503] setting reaches the time set in [Pr. 504 Maintenance timer alarm output set time] (100h increments), the maintenance timer alarm output signal (Y95) is output. For the terminal used for the Y95 signal output, assign the function by setting 95 (positive logic) or 195 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection].

*1 The cumulative energization time is counted every hour. The energization time of less than 1h is not counted.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>503</td>
<td>Maintenance timer</td>
<td>0</td>
<td>0 to 9998</td>
<td>Displays the cumulative energization time of the inverter in 100h increments. Reading only. Writing the setting of 0 clears the cumulative energization time.</td>
</tr>
<tr>
<td>504</td>
<td>Maintenance timer alarm output set time</td>
<td>9999</td>
<td>0 to 9998</td>
<td>Set the time taken until when the maintenance timer alarm output signal (Y95) is output.</td>
</tr>
</tbody>
</table>

First power ON

Maintenance timer [Pr. 503]

[9998] (999800h)

[Pr. 504]

9998

Y95 signal MT display OFF ON ON

Set “0” in [Pr. 503]
1.4.23 Current average value monitor signal (Y93)  (common)

The average value of the output current during constant speed operation and the maintenance timer value are output as a pulse to the current average value monitor signal (Y93).

The pulse width output to the I/O module of the programmable controller or the like can be used as a guideline due to abrasion of machines and elongation of belt and for aged deterioration of devices to know the maintenance time.

The current average value monitor signal (Y93) is output as pulse for 20s as 1 cycle and repeatedly output during constant speed operation.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>555</td>
<td>Current average time</td>
<td>1s</td>
<td>0.1 to 1.0s</td>
<td>Set the time taken to average the current during start pulse output (1s).</td>
</tr>
<tr>
<td>556</td>
<td>Data output mask time</td>
<td>0s</td>
<td>0.0 to 20.0s</td>
<td>Set the time for not obtaining (mask) transient state data.</td>
</tr>
<tr>
<td>557</td>
<td>Current average value monitor signal output reference current</td>
<td>Fixed inverter current</td>
<td>55K or less, 75K or more, 0 to 500A, 0 to 3600A</td>
<td>Set the reference (100%) for outputting the signal of the current average value.</td>
</tr>
</tbody>
</table>

The output pulse of Y93 signal

- The averaged current value is output as low pulse shape for 0.5 to 9s (10 to 180%) during start bit output.
- The output current set in [Pr. 555] time is averaged.
- The averaged current value is output as low pulse shape for 10 to 20s (15 to 780%) during start bit output.
- The output current is averaged during start bit output.
- The averaged current value is output as low pulse shape for 15 to 30s (16000 to 72000h).
- The maintenance timer value ([Pr. 503]) is output as Hi output pulse shape for 2 to 9s (16000h to 72000h).
- The output current set in [Pr. 555] time is averaged.

The output pulse of Y93 signal

- The averaged current value is output as low pulse shape for 0.5 to 9s (10 to 180%) during start bit output.
- The output current set in [Pr. 555] time is averaged.
- The averaged current value is output as low pulse shape for 10 to 20s (15 to 780%) during start bit output.
- The output current is averaged during start bit output.
- The averaged current value is output as low pulse shape for 15 to 30s (16000 to 72000h).
- The maintenance timer value ([Pr. 503]) is output as Hi output pulse shape for 2 to 9s (16000h to 72000h).
- The output current set in [Pr. 555] time is averaged.

The output pulse of Y93 signal
For the terminal used for the Y93 signal output, assign the function by setting 93 (positive logic) or 193 (negative logic) to the [Output terminal function selection]. (The function cannot be assigned to a relay output terminal.)

1) Setting of [Pr. 534 Data output mask time]
The output current is unstable (transient state) right after the operation is changed from the acceleration/deceleration state to the constant speed operation. Set the time for not obtaining (mask) transient state data in [Pr. 534].

2) Setting of [Pr. 533 Current average time]
The average output current is calculated during HI output of start pulse (1s). Set the time taken to average the current during start bit output in [Pr. 533].

3) Setting of [Pr. 537 Current average value monitor signal output reference current]
Set the reference (100%) for outputting the signal of the current average value. Obtain the time to output the signal from the following calculation.

Output current average value \( \times 5s \) (output current average value 100%/5s)

Note that the output time range is 0.5 to 9s, and it is 0.5s when the output current average value is less than 10% of the [Pr. 117] setting and 9s when exceeds 100%.

[Example] when [Pr. 357 = 10A] and output current average value is 15A.
As \( 15A/10A = 1.5 \times 5s = 7.5s \), the current average value monitor signal is output as low pulse shape for 7.5s.

4) Output of [Pr. 503 Maintenance timer]
After the output current average value is output as low pulse shape, the maintenance timer value is output as high pulse shape.
The output time of the maintenance timer value is obtained from the following calculation.

[Pr. 503] \( \times 5s \) (Maintenance timer value 100%/5s)

Note that the output time range is 2 to 9s, and it is 2s when the [Pr. 504] setting is less than 16000h and 9s when exceeds 72000h.

Note

1. Mask of data output and sampling of output current are not performed during acceleration/deceleration.
2. When the speed is changed to acceleration/deceleration from constant speed during start pulse output, the data is judged as invalid, the start pulse is output as high pulse shape for 3.5s, and the end signal is output as low pulse shape for 16.5s.
The signal is output for at least 1 cycle even when acceleration/deceleration state continues after the start pulse output is completed.

3. When the output current value (inverter output current monitor) is 0A on completion of the 1 cycle signal output, the signal is not output until the speed becomes constant next time.

4. The current average value monitor signal (Y93) is output as low pulse shape for 20s (without data output) under the following condition.
(a) When the motor is in the acceleration/deceleration state on completion of the 1 cycle signal output
(b) When 1-cycle signal output was ended during restart operation with the setting of automatic restart after instantaneous power failure [Pr. 17 p. 9999]
(c) When restart operation was being performed at the point of data output mask end with the setting of automatic restart after instantaneous power failure [Pr. 17 p. 9999]
1.4.24 Remote output function (REM)  (common)

You can utilize the ON/OFF of the inverter's output signals instead of the remote output terminal of the programmable controller.

The output terminal can be turned ON/OFF depending on the [Pr. 496 or Pr. 497] setting. The remote output selection can be controlled ON/OFF by computer link communication from the PU connector or RS-485 terminal or by communication from the communication option.

Set 96 (positive logic) or 196 (negative logic) in any of [Pr. 190 to Pr. 196] Output terminal function selection, and assign the remote output (REM) signal to the terminal used for remote output.

When you refer to the following diagram and set 1 to the terminal bit (terminal where the REM signal has been assigned) of [Pr. 496 or Pr. 497], the output terminal turns ON (OFF for negative logic). By setting 0, the output terminal turns OFF (ON for negative logic).

The output terminal where the REM signal is not assigned using any of [Pr. 190 to Pr. 196] does not turn ON/OFF if 0/1 is set to the terminal bit of [Pr. 496, Pr. 497]. (It turns ON/OFF with the assigned function.)

For example when [Pr. 390 RUN terminal function selection = 96] (positive logic) and set 1 (H01) in [Pr. 496], the terminal RUN turns ON.

When [h: 495 = 0, 10], performing a power ON reset (including a power failure) clears the REM signal output. (The ON/OFF status of the terminals are as set in [Pr. 196 to Pr. 198].) The [h: 496, 497] settings are also 0.

When [h: 495 = 1, 11], the remote output data before power OFF is stored into the EEPROM, so the signal output at power recovery is the same as before power OFF. However, it is not stored into EEPROM when the inverter is reset (terminal reset, reset request through communication). (Refer to the following diagram)

When [h: 495 = 10, 11], signal before reset is saved even at inverter reset.

---

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>495</td>
<td>Remote output selection</td>
<td>0</td>
<td>0 to 96</td>
<td>Remote output data clear at powering OFF</td>
<td>A700: F700: E700: D700:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0 to 96</td>
<td>Remote output data retention even at powering OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>0 to 96</td>
<td>Remote output data clear at powering OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>0 to 96</td>
<td>Remote output data retention even at powering OFF</td>
<td></td>
</tr>
</tbody>
</table>

You can select the following data at [Pr. 496, 497]:

- [Pr. 190 to Pr. 196] Output terminal function selection
- [Pr. 250 to Pr. 256] Power terminal function selection
- [Pr. 450 to Pr. 456] Input terminal function selection
- [Pr. 820 to Pr. 826] Counter/totalizer function selection

- See the following diagram to refer to the setting.

---

*1 When [Pr. 495 = 1, 11] (remote output data retention even at powering OFF), take such corrective action as connection of R1/L1, S1/L2 and P/+, N/- to hold the control power supply. If you do not take such a step, the output signals provided after power-ON are not guaranteed.

<Remote output data>

1) A700 (F700) [Pr. 495]

- [Pr. 496 = 0, 10]
- [Pr. 497 = 1, 11]

2) [Pr. 495]

- See the following diagram to refer to the setting.

---

*1 As desired
*2 Terminal Y0 to Y6 are available only when the extension output option (FR-A7AY) is fitted
*3 Terminal RA1 to RA3 are available only when the relay output option (FR-A7AR) is fitted
1.4.25 Indicator connection and adjustment (FM) (common)

Pulse train of 8VDC maximum, 2400 pulses/s is output. (When Pr. 291 Pulse train I/O selection = 0, 1) FM output is selected.) The pulse width can be adjusted by calibration parameter C0 (Pr. 900) FM terminal calibration using the operation panel and parameter unit.

The output frequency, etc. of the inverter can be indicated by a DC ammeter of 1mA full-scale deflection and maximum 300Ω internal resistance or a commercially available digital indicator which is connected across terminals FM-SD.

The indicator can be calibrated from the operation panel or parameter unit. Note that the reading varies according to the wiring distance if the indicator is placed away from the inverter. In this case, connect a calibration resistor in series with the indicator as shown below and adjust until the reading matches the operation panel or parameter unit indication (indicator monitoring mode).

The wiring length of the terminal FM should be 200m maximum and use the twisted cable or shielded cable.

*1 It is not necessary when the operation panel (FR-DU07) or parameter unit (FR-PU04/FR-PU07) is used for calibration.

*2 The default settings are 1mA full-scale and 1440 pulses/s terminal FM frequency at 60Hz.

Up to two 1mA analog indicators can be used in parallel for FM, but only one 1mA analog indicator can be used for FM. To use analog indicators in parallel, select such as 0.5mA full-scale indicators so that these will not exceed the maximum current of the inverter. A digital indicator and analog indicator can not be used together.

The type and number of digital indicators are limited according to the input impedance and input voltage specifications.
(1) Output waveform of terminal FM

The output signal of terminal FM has a pulse waveform as shown in the table below and the number of its pulse is proportional to the inverter output frequency. The output voltage (average voltage) is also proportional to the output frequency.

<table>
<thead>
<tr>
<th>Specifications</th>
<th>Pr.950</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output waveform</td>
<td>![Image]</td>
</tr>
<tr>
<td>Frequency</td>
<td>1/1440Hz</td>
</tr>
<tr>
<td>Number of output pulse (pulses)</td>
<td>Max. 2400 pulses/s</td>
</tr>
<tr>
<td>Set a full-scale value which achieves 1440 pulses/s.</td>
<td></td>
</tr>
<tr>
<td>Frequency monitoring reference</td>
<td>[Pr.97]</td>
</tr>
<tr>
<td>Current monitoring reference</td>
<td>[Pr.96]</td>
</tr>
<tr>
<td>Output voltage</td>
<td>8VDC max*</td>
</tr>
<tr>
<td>(approx. 3.5V at 1440 pulses/s in the initial setting)</td>
<td></td>
</tr>
</tbody>
</table>

*1 Output voltage is 0.5V or less when a DC ammeter of 300Ω or less internal resistance is connected to measure the output voltage.

*2 Output voltage is approximately 4.7V in

(2) Calibration of terminal FM

Calibrate the terminal FM in the following procedure.

1) Connect an indicator (frequency meter) across terminals FM-SD of the inverter. (Note the polarity. The terminal FM is positive.)
2) When a calibration resistor has already been connected, adjust the resistance to "0" or remove the resistor.
3) Refer to the monitor description list (page 345) and set [Pr. 55 Frequency monitoring reference] or [Pr. 56 Current monitoring reference].

At 1440 pulses/s, the meter generally shows to full-scale.

*1 When calibrating a monitor output which does not easily point to 100% even with an actual load, output current for example, set [Pr. 54 = 22] (reference voltage output) and make calibration.

*2 When a frequency meter is connected to across terminals FM and SD to monitor the running frequency, the FM terminal output reaches to the maximum when output frequency is 100Hz or more in the initial setting. In this case, the [Pr.55] setting has to be changed to the maximum frequency.

*3 For CO, calibration with [Calibration parameter CO (Pr.900)] is unavailable when [Pr.291 Pulse train I/O selection =10,11,20,21,100] (fast pulse train output).
1.4.26 Calibration of analog output (AM) (A700) (F700)

The terminal AM is factory-set to provide a 10VDC output in the full-scale status of the corresponding monitor item. Calibration parameter C1 (Pr. 901) allows the output voltage ratios (gains) to be adjusted according to the meter scale. Note that the maximum output voltage is 10VDC.

The analog output level can be calibrated by the operation panel or parameter unit. Terminal AM function selection can be set in [Pr. 158]. Since the terminal AM is not isolated from the control circuit of the inverter, use a shielded cable of shorter than 30m.

1) Connect a 0-10VDC meter (frequency meter) to across inverter terminals AM-5. (Note the polarity. The terminal AM is positive.)

2) Refer to the monitor description list (page 345) and set [Pr. 158]. When you selected the running frequency, inverter output current or the like as monitor, preset the running frequency or current value at which the output signal will be 10V in [Pr. 55] or [Pr. 56].

*1 When calibrating a monitor output signal, which cannot adjust to a 100% value without an actual load and a measurement equipment, set [Pr. 158 = 21] (reference voltage output) and make calibration. 10VDC is output from the terminal AM.

1.4.27 Control circuit common terminals (SD, 5, SE) (common)

The terminals SD, 5, and SE are all common terminals (0V) for I/O signals and are isolated from each other. Do not earth (ground). Avoid connecting the terminal SD and 5 and the terminal SE and 5.

Terminal SD is a common terminal for the contact input terminals (STF, STR, STOP, RH, RM, RL, JOG, RT, MRS, RES, AU, CS) and frequency output signal (FM). The open collector circuit is isolated from the internal control circuit by photocoupler.

Terminal 5 is a common terminal for frequency setting signal (terminal 2, 1 or 4) and analog output terminal AM. It should be protected from external noise using a shielded or twisted cable.

Terminal SE is a common terminal for the open collector output terminal (RUN, SU, OL, IPF, FU). The contact input circuit is isolated from the internal control circuit by photocoupler.

1.4.28 Signal inputs by contact-less switches (common)

The contacted input terminals of the inverter (STF, STR, STOP, RH, RM, RL, JOG, RT, MRS, RES, AU, CS) can be controlled using a transistor instead of a contacted switch as shown on the right.

(1) Electrical characteristics required for the external transistor (common)

1) IC (collector current [10mA or more])
   If the rating is small, the external transistor may be damaged or the inverter input may not be active.

2) VCES (open-time permissible collector-to-emitter voltage [30V or more])
   If the rating is small, the external transistor may be damaged.

3) ICES (conduction time collector-to-emitter saturation voltage [3V or less])
   If the saturation voltage is large, the inverter input may not be active.

4) ICEX (collector shut-off current (leakage current) [100µA or less])
   If the shut-off current is large, it may be accidentally input to the inverter.

*1 When using an external transistor connected to an external power supply, use terminal PC to prevent malfunctions due to undesirable currents. (Refer to page 60)

*2 Note that an SSR (solid-state relay) has a relatively large leakage current at OFF time and it may be accidentally input to the inverter.
1.4.29 Wiring and configuration of PU connector (common)

(1) PU connector pin-outs

<table>
<thead>
<tr>
<th>Pin Number</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>SG</td>
<td>Earth (Ground) (connected to terminal 5)</td>
</tr>
<tr>
<td>2)</td>
<td></td>
<td>Power supply for operation panel and PU</td>
</tr>
<tr>
<td>3)</td>
<td>RDA</td>
<td>Inverter receive+</td>
</tr>
<tr>
<td>4)</td>
<td>SDB</td>
<td>Inverter send-</td>
</tr>
<tr>
<td>5)</td>
<td>SDA</td>
<td>Inverter send+</td>
</tr>
<tr>
<td>6)</td>
<td>RDB</td>
<td>Inverter receive-</td>
</tr>
<tr>
<td>7)</td>
<td>SG</td>
<td>Earth (Ground) (connected to terminal 5)</td>
</tr>
<tr>
<td>8)</td>
<td></td>
<td>Power supply for operation panel and PU</td>
</tr>
</tbody>
</table>

*1 Pins No.2 and 8 provide power to the operation panel or parameter unit. Do not use these pins for RS-485 communication.

*2 Do not connect the PU connector to the computer’s LAN board, FAX modem socket or telephone modular connector. The product could be damaged due to differences in electrical specifications.

(2) When connecting the operation panel using a parameter unit connection cable

When connecting the operation panel (FR-DU07) to the inverter using a cable, the operation panel can be installed on the panel and operability is improved.

*1 Overall wiring length when the operation panel is connected should be less than 20m.
(3) PU connector communication system configuration and wiring

Using the PU connector, you can perform communication operation from a personal computer etc.

When the PU connector is connected with a personal, FA or other computer by a communication cable, a user program can run and monitor the inverter or read and write to parameters.

When performing RS-485 communication with multiple inverters, use the RS-485 terminal. (Refer to page 83)

1) System configuration

(a) Refer to the following when fabricating the cable on the user side.

Examples of product available on the market (as of February, 2008)

<table>
<thead>
<tr>
<th>Product</th>
<th>Type</th>
<th>Maker</th>
</tr>
</thead>
<tbody>
<tr>
<td>10BASE-T Cable</td>
<td>SGLPEV-T</td>
<td>Mitsubishi Cable Industries, Ltd</td>
</tr>
<tr>
<td>RJ-45 Connector</td>
<td>5-584723-3</td>
<td>Tyco Electrical Corporation</td>
</tr>
</tbody>
</table>

* Do not use pins No. 2, 8 of the 10BASE-T cable.

2) Connection with RS-485 computer

* Make connections in accordance with the manual of the computer used.

Fully check the terminal numbers of the computer since these vary with the model.
1.4.30 Wiring and arrangement of RS-485 terminals

(1) RS-485 terminal block  [A700] [F700] [E700]

- **Parameters**
  - Communication standard: CAN (RS-485)
  - Communication speed: MAX 115200bps
  - Overall length: 500m

- **Parameters for twisted pair cable (4 pairs)**
  - Screw size: M2
  - Tightening torque*: 0.22N ⋅ m to 0.25N ⋅ m
  - Cable size: 0.3mm² to 0.75mm²
  - Screwdriver: Flathead screwdriver (tip thickness: 0.4mm/tip width: 2.5mm)

- **Terminal**
  - **Screw**
    - Name: Description
    - [RDA] [RXD1+] Inverter receiver+
    - [RDB] [RXD1-] Inverter receiver-
    - [RDA2] [RXD2+] Inverter receiver+ (for branch)
    - [RDB2] [RXD2-] Inverter receiver- (for branch)
    - [SDA1] [TXD1+] Inverter send+
    - [SDB1] [TXD1-] Inverter send-
    - [SDA2] [TXD2+] Inverter send+ (for branch)
    - [SDB2] [TXD2-] Inverter send- (for branch)
    - [P5S] [VCC] 5V Permissible load current 100mA
    - [SG] [GND] Ground (connected to terminal SD)

- **Connection switch**
  - **Terminating resistor switch**
    - Factory-set to “OPEN”.
    - Set only the terminating resistor switch of the remotest inverter to the “100 Ω” position.
  - **Terminal 2/SG switch**
    - Set terminal 2/SG switch to the right position (ON) to pass a shielded wire across terminal SG. As a result, terminal 2 changes to terminal SG. (Note that analog input of terminal 2 is made invalid)

(2) FR-E7TR RS-485 terminal block  [E700]

RS-485 terminal can be used instead of a PU connector connected to a standard control circuit terminal to perform RS-485 communication. To do this, attach a control terminal option, FR-E7TR.

- **Parameters need to be set**
  - Same as ones need for RS-485 communication with a PU connector.
  - Refer to page 365 for the detail of initial settings and specification of RS485 communication with RS485 terminal.

(3) Connection of RS-485 terminals and wires

- **Connection**
  - Loosen the terminal screw and insert the cable into the terminal.
  - Wire the stripped cable after twisting it to prevent it from becoming loose. In addition, do not solder it.
  - Use a bar terminal as necessary.

*1 Undertightening can cause cable disconnection or malfunction. Overtightening can cause a short circuit or malfunction due to damage to the screw or unit.

Information on bar terminals

- **Introduced products** (as of September, 2006)
  - Phoenix Contact Co., Ltd.
  - Bar terminal crimping tool: CRIMPFOX ZA3 (Phoenix Contact Co., Ltd.)

Use shielded or twisted cables for connection to the control circuit terminals and run them away from the main and power circuits (including the 200V relay sequence circuit).

When using the bar terminal (without insulation sleeve), use care so that the twisted wires do not come out.
(4) RS-485 terminal system configuration

Use the RS-485 terminals to perform communication operation from a personal computer etc. When the PU connector is connected with a personal, FA or other computer by a communication cable, a user program can run and monitor the inverter or read and write to parameters.

1) Connection of a computer to the inverter (1:1 connection)

2) Combination of computer and multiple inverters (1:n connection)

* Make connection in accordance with the instruction manual of the computer. Check the terminal numbers of the computer since terminal number differs with the model.

*2 For the inverter farthest from the computer, set the terminating resistor switch to ON (100Ω position).

*3 For branching, connect the wires as shown below.

(5) RS-485 terminal wiring method

1) Wiring of one RS-485 computer and one inverter

2) Wiring of one RS-485 computer and n (multiple) inverters

* Make connection in accordance with the instruction manual of the computer. Check the terminal numbers of the computer since terminal number differs with the model.

*2 For the inverter farthest from the computer, set the terminating resistor switch to ON (100Ω position).

*3 For branching, connect the wires as shown below.

(6) Two-wire type connection

If the computer is 2-wire type, a connection from the inverter can be changed to 2-wire type by passing wires across reception terminals and transmission terminals of the RS-485 terminal. A program should be created so that transmission is disabled (receiving state) when the computer is not sending and receiving is disabled (sending state) during sending to prevent the computer from receiving its own data.

* Set the terminating resistor switch to the 100Ω position.

* Set only the terminating resistor switch of the remotest inverter to the 100Ω position.
1.4.31 USB connector (A700) (E700)

Connect the inverter and PC with USB cable and use FR Configurator to make the inverter setup easily. When using USB communication, set [Pr. 511 PU mode operation command source selection] = 3.

Parameter setting and monitoring are performed using FR Configurator. Refer to the instruction manual of FR Configurator for details. It is recommended to fit a ferrite core to the USB cable to reduce the effect of noises from the inverter.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>547</td>
<td>USB communication station number</td>
<td>0</td>
<td>0 to 31</td>
<td>Specifies the inverter station number.</td>
</tr>
<tr>
<td>548</td>
<td>USB communication check time interval</td>
<td>9999</td>
<td>9999</td>
<td>USB communication is enabled. However, the inverter will come to an alarm stop (E. USB) if operation is changed to PU operation mode.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 to 999.8s</td>
<td>If a no-communication state persists for longer than the permissible time, the inverter will come to trip (E. USB).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>No communication check</td>
</tr>
</tbody>
</table>

USB communication specifications

- Interface: Conforms to USB1.1
- Transmission Speed: 12Mbps
- Wiring length: Maximum 5m
- Connector
  - A700: USB B connector (B receptacle)
  - E700: USB mini B connector (receptacle mini B type)
- Power supply: Self-power supply

USB communication specifications

- Interface: Conforms to USB1.1
- Transmission Speed: 12Mbps
- Wiring length: Maximum 5m
- Connector
  - A700: USB B connector (B receptacle)
  - E700: USB mini B connector (receptacle mini B type)
- Power supply: Self-power supply

**Remove of cover**

Place a flat-blade screwdriver, etc. in a slot and push up the cover to open.

**How to open the USB connector cover**

Pull the cover in the direction of the arrow then turn it upward.
1.4.32 Connection of motor with encoder (vector control) (A700)

Orientation control and encoder feedback control, and speed control, torque control and position control by full-scale vector control operation can be performed using a motor with encoder and a plug-in option FR-A7AP.

(1) Structure of the FR-A7AP

- Terminal block
- Switch for manufacturer setting (SW3)
- Do not change from initially set status (1, 2: OFF).

- Terminating resistor selection switch (SW2)
- Switch ON/OFF of the internal terminating resistor.

- COM connector
- Not used.

(2) Terminals of the FR-A7AP

<table>
<thead>
<tr>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Application Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>PA1</td>
<td>Encoder A-phase signal input</td>
<td></td>
</tr>
<tr>
<td>PA2</td>
<td>Encoder A-phase inverse signal input</td>
<td></td>
</tr>
<tr>
<td>PB1</td>
<td>Encoder B-phase signal input terminal</td>
<td></td>
</tr>
<tr>
<td>PB2</td>
<td>Encoder B-phase inverse signal input terminal</td>
<td></td>
</tr>
<tr>
<td>PZ1</td>
<td>Encoder Z-phase signal input terminal</td>
<td></td>
</tr>
<tr>
<td>PZ2</td>
<td>Encoder Z-phase inverse signal input terminal</td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>Encoder power supply (positive side) input terminal</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>Encoder power ground terminal</td>
<td>Connect the external power supply (5V, 12V, 15V, 24V) and the power cable from encoder.</td>
</tr>
<tr>
<td>PIN</td>
<td>Not used.</td>
<td></td>
</tr>
<tr>
<td>PO</td>
<td>Not used.</td>
<td></td>
</tr>
</tbody>
</table>

(3) Terminals of the FR-A7AP

1) Encoder specification selection switch (SW1)
- Select either differential line driver or complementary.
- It is initially set to the differential line driver. Switch its position according to output circuit.

2) Terminating resistor selection switch (SW2)
- Select ON/OFF of the internal terminating resistor.
- Set the switch to ON (initial status) when an encoder output type is differential line driver and set to OFF when complementary.
- ON: with internal terminating resistor (initial setting status)
- OFF: without internal terminating resistor
- *1 Set all switches to the same setting (ON/OFF).
- *2 If the encoder output type is differential line driver, set the terminating resistor switch to the "OFF" position when sharing the same encoder with other unit (NC (numerical controller), etc) and a terminating resistor is connected to other unit.

- Internal terminating resistor ON (initial status)
- Internal terminating resistor OFF
### 3) Motor used and switch setting

<table>
<thead>
<tr>
<th>Motor Description</th>
<th>Encoder Specifications</th>
<th>Terminating Resistor</th>
<th>Switch Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi standard motor with encoder</td>
<td>SF-JR</td>
<td>Differential</td>
<td>ON</td>
</tr>
<tr>
<td>Mitsubishi high efficiency motor with encoder</td>
<td>SF-HE</td>
<td>Differential</td>
<td>ON</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>*1</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi constant torque motor with encoder</td>
<td>SF-TRCA</td>
<td>Differential</td>
<td>ON</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>*1</td>
<td></td>
</tr>
<tr>
<td>Vector dedicated motor with encoder</td>
<td>SF-V5RU</td>
<td>Complementary</td>
<td>OFF</td>
</tr>
<tr>
<td>Others</td>
<td></td>
<td>*1</td>
<td></td>
</tr>
</tbody>
</table>

*1 Set according to the motor (encoder) used.

*2 Choose a power supply (5V/12V/15V/24V) for encoder according to the encoder used. Control terminal option (FR-A7P3) has built-in 12VDC power supply for encoder.

*3 SW3 switch is for manufacturer setting. Do not change the setting.

### 4) Encoder specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Encoder for SF-JR</th>
<th>Encoder for SF-V5RU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Resolution</td>
<td>1024 pulses/rev</td>
<td>2048 pulses/rev</td>
</tr>
<tr>
<td>Power supply voltage</td>
<td>5VDC +10%</td>
<td>12VDC +10%</td>
</tr>
<tr>
<td>Current consumption</td>
<td>75mA</td>
<td>150mA</td>
</tr>
<tr>
<td>Output signal form</td>
<td>A, B phases (90° phase shift), 2-phase: 1 pulse/rev</td>
<td>A, B phases (90° phase shift), 2-phase: 1 pulse/rev</td>
</tr>
<tr>
<td>Output circuit</td>
<td>Differential line driver (74LS113 equivalent)</td>
<td>Complementary</td>
</tr>
<tr>
<td>Output voltage</td>
<td>&quot;H&quot; level 2.4V or more, &quot;L&quot; level 0.5V or less</td>
<td>&quot;H&quot; level power supply voltage for encoder -3V or more, &quot;L&quot; level 3V or less</td>
</tr>
</tbody>
</table>

*1 Encoder with resolution of 1000 to 4096 pulses/rev is recommended.
**SPECIFICATIONS**

(4) Encoder cable

When using the dedicated encoder cable (FR-JCBL, FR-V5CBL, etc.) for the conventional motor, cut the crimping terminal of the encoder cable and strip its sheath to make its cables loose.

Also, perform protective treatment of the shield to ensure that it will not make contact with the conductive area. Wire the stripped cable after twisting it to prevent it from becoming loose. In addition, do not solder it. Use a bar terminal as necessary.

<table>
<thead>
<tr>
<th>Model</th>
<th>Length L (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-JCBL5</td>
<td>5</td>
</tr>
<tr>
<td>FR-JCBL15</td>
<td>15</td>
</tr>
<tr>
<td>FR-JCBL30</td>
<td>30</td>
</tr>
</tbody>
</table>

* As the terminal block of the FR-A7AP is an insertion type, cables need to be modified. (Refer to page 83)

Connection terminal compatibility table

<table>
<thead>
<tr>
<th>Motor</th>
<th>SF-V5RU</th>
<th>SF-THY</th>
<th>SF-JR/HR/JRCA/HRCA (with encoder)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-A7AP terminal</td>
<td>FR-V7CBL</td>
<td>FR-JCBL</td>
<td></td>
</tr>
<tr>
<td>PR1</td>
<td>PR1</td>
<td>PR1</td>
<td></td>
</tr>
<tr>
<td>PR2</td>
<td>PR2</td>
<td>PR2</td>
<td></td>
</tr>
<tr>
<td>PB1</td>
<td>PB1</td>
<td>PB1</td>
<td></td>
</tr>
<tr>
<td>PB2</td>
<td>PB2</td>
<td>PB2</td>
<td></td>
</tr>
<tr>
<td>PG</td>
<td>PG</td>
<td>PG</td>
<td></td>
</tr>
<tr>
<td>SD</td>
<td>SD</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>NC</td>
<td>NC</td>
<td></td>
</tr>
</tbody>
</table>

Cable stripping length

5mm
(5) Wiring

1) Speed control

<table>
<thead>
<tr>
<th>Standard Motor with Encoder (SF-JR), 5V Differential Line Driver</th>
<th>Vector Control Dedicated Motor (SF-JVMR), For 12V Complementary Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase</td>
<td>Three-phase</td>
</tr>
<tr>
<td>AC power supply</td>
<td>AC power supply</td>
</tr>
<tr>
<td>Forward rotation star</td>
<td>Forward rotation star</td>
</tr>
<tr>
<td>Reverse rotation star</td>
<td>Reverse rotation star</td>
</tr>
<tr>
<td>Contact input common</td>
<td>Contact input common</td>
</tr>
<tr>
<td>Frequency command</td>
<td>Differential line driver</td>
</tr>
<tr>
<td>Torque command</td>
<td>Encoder</td>
</tr>
<tr>
<td>Torque limit</td>
<td>Encoder</td>
</tr>
<tr>
<td>Speed limit command</td>
<td>Encoder</td>
</tr>
<tr>
<td>Frequency setting command</td>
<td>Encoder</td>
</tr>
</tbody>
</table>

2) Torque control

<table>
<thead>
<tr>
<th>Standard Motor with Encoder (SF-JR), 5V Differential Line Driver</th>
<th>Vector Control Dedicated Motor (SF-JVMR), For 12V Complementary Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Three-phase</td>
<td>Three-phase</td>
</tr>
<tr>
<td>AC power supply</td>
<td>AC power supply</td>
</tr>
<tr>
<td>Forward rotation star</td>
<td>Forward rotation star</td>
</tr>
<tr>
<td>Reverse rotation star</td>
<td>Reverse rotation star</td>
</tr>
<tr>
<td>Contact input common</td>
<td>Contact input common</td>
</tr>
<tr>
<td>Speed limit command</td>
<td>Differential line driver</td>
</tr>
<tr>
<td>Torque command (P)</td>
<td>Encoder</td>
</tr>
<tr>
<td>Torque command (P)</td>
<td>Encoder</td>
</tr>
</tbody>
</table>

*1 For the fan of the 7.5kW or less dedicated motor, the power supply is single phase (200V/50Hz, 200 to 230V/ 60Hz).
*2 Assign OH (external thermal input) signal to the terminal CS.
*3 The pin number differs according to the encoder used. Speed control and torque control are properly performed even without connecting Z-phase.
*4 The encoder should be coupled on the same axis with the motor shaft without any mechanical looseness. Speed ratio should be 1:1.
*5 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (Refer to page 91)
*6 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to page 86)
*7 A separate power supply of 5V/12V/15V/24V is necessary according to the encoder power specification. When performing encoder feedback control and vector control together, an encoder and power supply can be shared.
*8 Refer to page 88 for terminal compatibility of the FR-JCBL, FR-A7CBL and FR-A7AP.
3) Position control

**Vector Control Dedicated Motor (SF-V5RU), 12V Complementary**

*1 For the fan of the 7.5kW or less dedicated motor, the power supply is single phase (200V/50Hz, 200 to 230V/60Hz).

*2 Assign OH (external thermal input) signal to the terminal CS. ([Pr. 186] = 7)

Connect a 2W1kΩ resistor between terminals PC and CS (OH).

Install the resistor pushing it against the bottom part of the terminal block so as to avoid a contact with other cables.

Refer to page 37 for details of [Pr. 186 CS terminal function selection].

*3 The pin number differs according to the encoder used.

Position control by pulse train input is properly performed even without connecting Z phase.

*4 The encoder should be coupled on the same axis with the motor shaft without any mechanical looseness. Speed ratio should be 1:1.

*5 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (Refer to page 91)

*6 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to page 86)

*7 A separate power supply of 5V/12V/15V/24V is necessary according to the encoder power specification. When performing encoder feedback control and vector control together, an encoder and power supply can be shared.

*8 Refer to page 88 for terminal compatibility of the FR-JCBL, FR-V7CBL and FR-A7AP.

*9 Assign the function using [Pr. 178 to Pr. 184, Pr. 187 to Pr. 189 Input terminal function selection].

*10 When position control is selected, terminal JOG function is made invalid and conditional position pulse train input terminal becomes valid.

*11 Assign the function using [Pr. 190 to Pr. 194 Output terminal function selection].

*12 Assign OH (external thermal input) signal to the terminal CS. (Pr. 186) = 7

Connect a 2W1kΩ resistor between terminals PC and CS (OH).

Install the resistor pushing it against the bottom part of the terminal block so as to avoid a contact with other cables. Refer to page 37 for details of [Pr. 186 CS terminal function selection].

*13 The pin number differs according to the encoder used.

Position control by pulse train input is properly performed even without connecting Z phase.

*4 The encoder should be coupled on the same axis with the motor shaft without any mechanical looseness. Speed ratio should be 1:1.

*5 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (Refer to page 91)

*6 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to page 86)
Instructions for encoder cable wiring

Use twisted pair shield cables (0.2mm² or larger) to connect the FR-A7AP and position detector. Cables to terminals PG and SD should be connected in parallel or be larger in size according to the cable length.

To protect the cables from noise, run them away from any source of noise (e.g. the main circuit and power voltage).

The wiring length can be extended to 100m by slightly increasing the power by 5V (approx. 5.5V) using six or more cables with gauge size of 0.2mm² in parallel or a cable with gauge size of 1.25mm² or more. Note that the voltage applied should be within power supply specifications of encoder.

To reduce noise of the encoder cable, earth (ground) the encoder shielded cable to the enclosure (as near as the inverter) with a P clip or U clip made of metal.

Earthing (grounding) example using a P clip

*1 For details of the optional encoder dedicated cable (FR-JCBL/FR-V7CBL), refer to page 88.

*2 The FR-V7CBL is provided with a P clip for earthing (grounding) shielded cable.
### SPECIFICATIONS

#### 1.4.33 I/O function plug-in option (FR-A7AX, FR-A7AY, FR-A7AR, FR-A7AZ*)

**FR-A7AX**

<table>
<thead>
<tr>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Description</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>X0 to X15</td>
<td>Digital signal input terminal (frequency setting signal terminal)</td>
<td>Input current: 5mA (24VDC) for each circuit</td>
<td>For the digital signal input, you can choose either the BCD code input or binary input. BCD code input: 3 digits (999 maximum) or 4 digits (9999 maximum) Binary input: Binary 12 bits (X0 to X11, FFFF (maximum)) or binary 16 bits (X0 to X15, FFFF (maximum)).</td>
<td>229</td>
</tr>
<tr>
<td>DY</td>
<td>Data read timing signal input terminal</td>
<td>Used when a digital signal read timing signal is necessary. Data is read only during the terminal DY is ON. By switching the terminal DY OFF, the terminal X0 to X15 data before signal-OFF can be retained.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**FR-A7AY**

<table>
<thead>
<tr>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Description</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>AM0</td>
<td>Voltage output terminal</td>
<td>Output voltage: 0 to 10VDC Output resolution: 3mV Maximum wiring length: 10m Non-isolated</td>
<td>Connect a DC voltmeter (full-scale 10V, internal impedance 10kΩ or more) Change the monitor to be output using [Pr. 306].</td>
<td>345</td>
</tr>
<tr>
<td>AM1</td>
<td>Current output terminal</td>
<td>Output voltage: 0 to 20mA DC Output resolution: 10 μA Maximum wiring length: 10m Non-isolated</td>
<td>Connect a DC voltmeter (full-scale 20mA, internal impedance 300Ω or less). Change the monitor to be output using [Pr. 306, Pr. 310].</td>
<td></td>
</tr>
<tr>
<td>AMC</td>
<td>Common terminal (for analog output)</td>
<td>—</td>
<td>Common terminal for the terminal AM0, AM1. Isolated from the terminal SE, SD of the inverter and terminal SD of the FR-A7AY. Do not earth (ground).</td>
<td></td>
</tr>
<tr>
<td>Y0 to Y6</td>
<td>Digital output terminals</td>
<td>Open collector output Permissible load: 24VDC 0.1A</td>
<td>Use [Pr. 111 to Pr. 114] to assign functions.</td>
<td>61</td>
</tr>
<tr>
<td>SE</td>
<td>Common terminal (for digital output)</td>
<td>—</td>
<td>Common terminal for the terminal Y0 to Y6. (for sink and source) Isolated from the terminal SE, SD, and 5 of the inverter and terminal AMC of the FR-A7AY. Do not earth (ground).</td>
<td></td>
</tr>
<tr>
<td>NC</td>
<td>—</td>
<td>—</td>
<td>This is an empty terminal. Do not use.</td>
<td></td>
</tr>
</tbody>
</table>

**FR-A7AR**

<table>
<thead>
<tr>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Description</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A, 2B, 3C</td>
<td>Relay output terminal RA1</td>
<td>Contact capacity: 230VAC 0.3A 30VDC 0.3A</td>
<td>1 changeover contact output Use [Pr. 109 to Pr. 112] to assign functions.</td>
<td>61</td>
</tr>
<tr>
<td>1A, 2B, 3C</td>
<td>Relay output terminal RA2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(* FR-A7AZ is compatible with only FR-A7AX)
4) FR-A7AZ

### Specifications

**Terminal Symbol** | **Terminal Name** | **Rating, etc.** | **Description** | **Refer to Page**
--- | --- | --- | --- | ---
DA1 | Bipolar analog output terminal | Output voltage: -10 to +10VDC | Connect a DC indicator (±10VDC). Change the monitor to be output with [Pr.838]. | 345

**E**

**High resolution input terminal**

- Frequency setting resolution: 10Hz (0.01Hz to 60Hz: 10kHz to 60kHz when option is not mounted)
- Torque setting resolution: 0.024% (0.1% to 100%) (-10V to +10V)
- Input resistance: 10kΩ
- Maximum input voltage: ±20VDC

**Common terminal**

- Common terminal of terminal E and the DA1.

**6**

**High resolution input**

<table>
<thead>
<tr>
<th>Terminal Symbol</th>
<th>Terminal Name</th>
<th>Rating, etc.</th>
<th>Description</th>
<th>Refer to Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>TH1</td>
<td>Thermistor input 1</td>
<td></td>
<td>Enter thermistor output signal for the motor dedicated to vector control (SF-V5RU).</td>
<td>50</td>
</tr>
<tr>
<td>TH2</td>
<td>Thermistor input 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SW2</td>
<td>Thermistor calibration status switch</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2) 16Bit digital input connection example

1) Relay contact signal input *(sink logic)*

- Inverter
- Terminal X0, X1, X2, X3, X4, X5, X6, X7, X8, X9, X10, X11, X12, X13, X14, X15

2) Open collector signal input *(sink logic)*

- Inverter
- Terminal B01, B02, A5, A01, A02, B16, B14, B13, B11, B9, B7, B5, B6, B8, B10, B12, B15, B17, B18, B19, B20

---

*1 Use terminals SD or PC on the inverter.

*2 AY41 type unit requires 24VDC power.

*3 Example of connection with the output module (AY41 type) of Mitsubishi programmable controller. Refer to the output module manual for details of the output module.

*4 The control logic is the same as that of the inverter (factory-set to sink). When the logic of the inverter is changed to source, the option logic also switches to source. To change the control logic, refer to page 40.

*5 As the input signals are at low level, use two parallel micro signal contacts or a twin contact for relay contact inputs to prevent a contact fault.

---

A transistor of the following specifications should be selected for the open collector signal:

- IC ≥ 100mA
- Leakage current: 100µA or less
- VCE ≥ 30V
- When IC ≥ 10mA, VCE(sat) voltage 3V or less.
(3) Extension analog output connection

**Example**:  

By setting the [Pr. 306 to Pr. 312] values, analog signals such as the output frequency and output current can be output from terminal AM0 and AM1.

* The wiring distance between the FR-A7AY and the voltmeter/ammeter should be 10m maximum.

(4) Bipolar analog signal output connection

**Example**:  

By setting [Pr.838] values, output analog signals, such as output frequency and output current, can be output from terminal DA1.

* The wiring distance to the voltmeter should be 30m maximum.

(5) High resolution analog input connection

**Example**:  

Analog voltage (-10 to 10VDC) can be input in high resolution (16bit). Set the function of terminal 6 by setting [Pr.406].
**1.4.34 Safety stop function (S1, S2, SO, SC)**  

This inverter has two lines of input terminal for inverter output shutoff, and one monitor output terminal for monitoring output shutoff state. Using these terminals, compliance with Machinery Directive in EU becomes more accessible.

*1 At initial state, terminal S1 and S2 are shorted to terminal SC with a shorting wire. When using the safety stop function, remove this shorting wire, and connect to a safety relay module.

*2 Set "80 (positive logic) or 180 (negative logic)" in [Pr. 196, Pr. 192 (output terminal function selection)] when assigning safety monitor output signal (SAFE) to other terminals.

* Changing the terminal assignment using [Pr. 196, Pr. 192 (output terminal function selection)] may affect the other functions. Make setting after confirming the function of each terminal.
1.5 Protective functions

When a fault occurs, the inverter trips and the PU display automatically changes to any of the following fault indications.

If your fault does not correspond to any of the following errors or if you have any other problem, please contact your sales representative.

1) Retention of fault output signal
   When the magnetic contactor (MC) provided on the input side of the inverter is opened when a fault occurs, the inverter’s control power will be lost and the fault output will not be held.

2) Fault or alarm indication
   When a fault or alarm occurs, the operation panel display automatically switches to the fault or alarm indication.

3) Reset
   When a fault occurs, the inverter output is kept stopped. Unless reset, therefore, the inverter cannot restart.

   When any failure occurs, take the appropriate corrective action, then reset the inverter, and resume operation. Not doing so may lead to the inverter failure and damage.

Inverter fault or alarm indications are roughly divided as below.

1) Faults
   When a fault occurs, the inverter trips and a fault signal is output.

2) Alarms
   The inverter does not trip. You can also output an alarm signal by making parameter setting.

3) Warning
   The inverter does not trip even when a warning is displayed. However, failure to take appropriate measures will lead to a fault.

4) Error message
   A message regarding operational fault and setting fault by the operation panel (FR-DU07) and parameter unit (FR-PU04/FK-PU07) is displayed. The inverter does not trip.

1.5.1 Reset method of fault

The inverter can be reset by performing any of the following operations. Note that the internal thermal integrated value of the electronic thermal relay function and the number of retries are cleared (erased) by resetting the inverter. Recover about 1s after reset is cancelled.

Operation 1

Using the operation panel, press to reset the inverter.
(Enabled only when the inverter protective function (fault) is activated)

Operation 2

Switch power OFF once, then switch it ON again.

Operation 3

Turn ON the reset signal (RES) for more than 0.1s. (If the RES signal is kept ON, “Err.” appears (flickers) to indicate that the inverter is in a reset status.
## 1.5.2 List of fault or alarm display (common)

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Indication</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>During acceleration</td>
<td>When the inverter output current reaches or exceeds specific value (approximately 220% of the rated current for E700, 200% for D700) of the rated current during acceleration, deceleration or constant speed operation. (when the output frequency is within 2Hz range of the set frequency), the protective circuit is activated to stop the inverter output.</td>
<td>OC During Acc</td>
<td>FR-PU04 FR-PU07</td>
</tr>
<tr>
<td>Constant speed</td>
<td></td>
<td>Steady Spd DC</td>
<td></td>
</tr>
<tr>
<td>During deceleration or stop</td>
<td></td>
<td>OC During Dec</td>
<td></td>
</tr>
<tr>
<td>During acceleration</td>
<td>If regenerative energy causes the inverter's internal main circuit DC voltage to reach or exceed the specific value, the protective circuit is activated to stop the inverter output. The circuit may also be activated by a surge voltage produced in the power supply system.</td>
<td>OC During Dec</td>
<td></td>
</tr>
<tr>
<td>Constant speed</td>
<td></td>
<td>Steady Spd OV</td>
<td></td>
</tr>
<tr>
<td>During deceleration or stop</td>
<td></td>
<td>OC During Dec</td>
<td></td>
</tr>
<tr>
<td>Inverter</td>
<td>If current of 150% or larger (120% for D700) of the rated output current flows and overcurrent trip does not occur in PR. 9 Electronic thermal O/L relay, the electronic thermal relay activates to stop the inverter output.</td>
<td>Inv. Overload</td>
<td></td>
</tr>
<tr>
<td>Motor</td>
<td>The electronic thermal relay function built in the inverter detects motor overheat due to overload or reduced cooling capability during constant-speed operation. If the internal thermal integrated data reaches 100% of the value set in PR. 9 Electronic thermal O/L relay, the protective circuit is activated to stop the inverter output. When running a special motor such as a multi-pole motor or multiple motors, provide a thermal relay on the inverter output side since such motor(s) cannot be protected by the electronic thermal relay function.</td>
<td>Motor Overload</td>
<td></td>
</tr>
</tbody>
</table>
## Specifications

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fin overheat</td>
<td>If the heatsink overheats, the temperature sensor is actuated to stop the</td>
<td>F.IN</td>
<td>H/Sink OTemp</td>
<td>FR-PU04</td>
</tr>
<tr>
<td></td>
<td>inverter output.</td>
<td></td>
<td></td>
<td>FR-PU17</td>
</tr>
<tr>
<td>Instantaneous power</td>
<td>If a power failure occurs for longer than 15ms (this also applies to</td>
<td>E.I PF</td>
<td>Inst. Pwr. Loss</td>
<td></td>
</tr>
<tr>
<td>failure</td>
<td>inverter input shut-off), the instantaneous power failure protective</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>function is activated to trip the inverter in order to prevent the control</td>
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<tr>
<td></td>
<td>circuit from malfunctioning. If a power failure persists for longer than</td>
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<tr>
<td></td>
<td>100ms, the fault output is not provided, and the inverter restarts if the</td>
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<tr>
<td></td>
<td>start signal is ON upon power restoration. (The inverter continues</td>
<td></td>
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<tr>
<td></td>
<td>operating if an instantaneous power failure is within 15ms.) In some</td>
<td></td>
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<tr>
<td></td>
<td>operating status (load magnitude, acceleration/deceleration time setting,</td>
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<tr>
<td></td>
<td>etc.), overcurrent or other protection may be activated upon power</td>
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<tr>
<td></td>
<td>restoration.</td>
<td></td>
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</tr>
<tr>
<td>Undervoltage</td>
<td>If the power supply voltage of the inverter decreases, the control circuit</td>
<td>E.UVT</td>
<td>Under Voltage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>will not perform normal functions. In addition, the motor torque will be</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>insufficient and/or heat generation will increase. To prevent this, if</td>
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<td></td>
<td>the power supply voltage decreases below approx. 150VAC (approx. 300V for</td>
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<tr>
<td></td>
<td>the 400V class or less), this function stops the inverter output.</td>
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</tr>
<tr>
<td></td>
<td>When a jumper is not connected across P/+ and P1, the undervoltage</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>protective function is activated.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase loss</td>
<td>This fault is output when function valid setting ( = 1) is set in [Pr. 872</td>
<td>E.LF</td>
<td>Fault 14</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Input phase loss protection selection] and one phase of the three phase</td>
<td></td>
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<tr>
<td></td>
<td>power input is lost. This fault is also output when phase-to-phase</td>
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<tr>
<td></td>
<td>voltage of the three-phase power input becomes unbalanced by large in</td>
<td></td>
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</tr>
<tr>
<td></td>
<td>[Pr.251].</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>If the output frequency has fallen to 0 Hz by stall prevention operation</td>
<td>E.OL F</td>
<td>E.OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and remains for 3s, the inverter stops. (OL appears while stall prevention</td>
<td></td>
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<tr>
<td></td>
<td>is being activated.) For [Pr. 352], when speed control is performed by</td>
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<tr>
<td></td>
<td>Freesl vector control or vector control, the inverter output is stopped</td>
<td></td>
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<tr>
<td></td>
<td>if frequency drops to the [Pr. 353 Low speed detection] (initial value is</td>
<td></td>
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<tr>
<td></td>
<td>1.9Hz) setting by torque limit operation and the output torque exceeds</td>
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<tr>
<td></td>
<td>[Pr. 874 OL limit setting] (initial value is 150%) and remains for more</td>
<td></td>
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<tr>
<td></td>
<td>than 3s.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stall prevention</td>
<td>If the output frequency has fallen to 0 Hz by stall prevention operation</td>
<td>E.OL F</td>
<td>Stall Prev STP</td>
<td></td>
</tr>
<tr>
<td></td>
<td>and remains for 3s, the inverter stops. (OL appears while stall prevention</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>is being activated.) For [Pr. 352], when speed control is performed by</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Freesl vector control or vector control, the inverter output is stopped</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>if frequency drops to the [Pr. 353 Low speed detection] (initial value is</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.9Hz) setting by torque limit operation and the output torque exceeds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Pr. 874 OL limit setting] (initial value is 150%) and remains for more</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>than 3s.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SPECIFICATIONS

**Output side earth (ground) fault overcurrent**
The inverter trips if an earth (ground) fault overcurrent flows due to an earth (ground) fault that occurred on the inverter's output side (load side).

*Indication:* E. GF (E.GF)

**Output side earth (ground) fault overcurrent at start**
The inverter trips if the current (if Pr. 249 Earth (ground) fault detection at start is set active (=1) and an earth (ground) fault overcurrent flows at start due to an earth (ground) fault that occurred on the inverter's output side (load side).

*Indication:* E. GF (E.GF)

**External thermal relay operation**
If the external thermal relay provided for motor overheat protection or the internally mounted temperature relay in the motor, etc. switches ON (contacts open), the inverter output is stopped.

*Indication:* E.OHT (E.OHT)

**PTC thermistor operation**
When the PTC thermistor input is connected to the terminal AU, the fault appears when the motor overheat status is detected for 10s or more by the external PTC thermistor input connected to the terminal AU. Inverters with resistance of PTC thermistor connected between terminal 2 and terminal 10 is more than the value set in Pr. 561 PTC thermistor protection level.

*Indication:* E.PTC (E.PTC)

**Option fault**
Appears when torque command by the plug-in option is selected using Pr. 804 Torque command source selection and no plug-in option is mounted.

*Indication:* E.OP1 (E.OP1)

**Communication option fault**
Stops the inverter output when a communication line fault occurs in the communication option.

*Indication:* E.OP3 (E.OP3)

**Option fault**
Appears when a fault occurred in parameters stored (EEPROM failure) and no plug-in option is mounted.

*Indication:* E.PR storage alarm

**Internal fault when control board and main circuit board is wrong**
When a combination of control board and main circuit board is wrong, the inverter is stopped.

*Indication:* E.PR storage alarm

---

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation panel</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output side earth (ground) fault overcurrent</td>
<td>The inverter trips if an earth (ground) fault overcurrent flows due to an earth (ground) fault that occurred on the inverter's output side (load side).</td>
<td>E. GF (E.GF)</td>
<td>Ground Fault</td>
<td>— — — —</td>
</tr>
<tr>
<td>Output side earth (ground) fault overcurrent at start</td>
<td>The inverter trips if the current (if Pr. 249 Earth (ground) fault detection at start is set active (=1) and an earth (ground) fault overcurrent flows at start due to an earth (ground) fault that occurred on the inverter's output side (load side).</td>
<td>E. GF (E.GF)</td>
<td>Ground Fault</td>
<td>— — — —</td>
</tr>
<tr>
<td>External thermal relay operation</td>
<td>If the external thermal relay provided for motor overheat protection or the internally mounted temperature relay in the motor, etc. switches ON (contacts open), the inverter output is stopped.</td>
<td>E.OHT (E.OHT)</td>
<td>Ground Fault</td>
<td>— — — —</td>
</tr>
<tr>
<td>PTC thermistor operation</td>
<td>For PTC thermistor input, the fault appears when the motor overheat status is detected for 10s or more by the external PTC thermistor input connected to the terminal AU.</td>
<td>E.PTC (E.PTC)</td>
<td>PTC activated</td>
<td>— — — —</td>
</tr>
<tr>
<td>Option fault</td>
<td>Appears when the AC power supply is connected to the terminal RL1, SL2, TL3 accidentally when a high power factor converter is connected. Appears when the switch for the manufacturer setting of the plug-in option is changed. Appears when the switch for the manufacturer setting of the plug-in option is selected using Pr. 804 Torque command source selection and no plug-in option is mounted.</td>
<td>E.OP1 (E.OP1)</td>
<td>Option Fault</td>
<td>— — — —</td>
</tr>
<tr>
<td>Communication option fault</td>
<td>Stops the inverter output when a communication line fault occurs in the communication option.</td>
<td>E.OP3 (E.OP3)</td>
<td>Option3 Fault</td>
<td>— — — —</td>
</tr>
<tr>
<td>Option fault</td>
<td>Stops the inverter output if a contact fault of the like of the connector between the inverter and built-in option occurs or if a communication option is fitted to the connector 1 or 2 (contact 1 only). Appears when the switch for the manufacturer setting of the plug-in option is changed.</td>
<td>E. PE (E.PE)</td>
<td>Compu Memory</td>
<td>— — — —</td>
</tr>
<tr>
<td>Internal fault when control board and main circuit board is wrong</td>
<td>When a combination of control board and main circuit board is wrong, the inverter is stopped.</td>
<td>E.PR storage alarm</td>
<td>— — — —</td>
<td></td>
</tr>
</tbody>
</table>
**PU disconnection**

- This function stops the inverter output if communication between the inverter and PU is suspended, for example the operation panel and parameter unit is disconnected, when 2, 3, 16 or 17 was set in [Pr. 73 Bus selection/disconnected PU detection/PU stop selection].
- This function stops the inverter output when communication errors occurred consecutively for more than permissible number of retries when [Pr. 71 Number of PU communication retries = 9999] during the RS-485 communication with the PU connector.
- This function also stops the inverter output if communication is broken for the period of time set in [Pr. 122 PU communication check interval].

**PU Leave Out**

- If operation cannot be resumed properly within the number of retries set, this function trips the inverter. (E.RET)

**CPU Fault**

- Stops the inverter output if the communication fault of the built-in CPU occurs.

**Short circuit of power supply for operation panel, power supply for RS-485 terminals**

- When the operation panel power supply (PU connector) is shorted, this function trips the inverter. At this time, the operation panel (parameter unit) cannot be used and RS-485 communication from the PU connector cannot be made.
- When the internal power supply for RS-485 terminals are shorted, the function shuts off the power output. At this time, communication from the RS-485 terminals cannot be made.
- To reset, enter the RES signal or switch power OFF, then ON again.

**24VDC power output short circuit**

- When the 24VDC power output from the terminal PC is shorted, this function shuts off the power output. At this time, all external contact inputs switch OFF. The inverter cannot be reset by entering the RES signal. To reset it, use the operation panel or switch power OFF, then ON again.

**Output current detection value exceeded**

- Because [Pr. 117 Output current detection operation selected] is set to the alarm stop setting (=1), this function is activated when the output current exceeds the [Pr. 116 Output current detection level] setting.

**Inrush current limit circuit fault**

- This function is activated when the resistor of the inrush current limit circuit overheats. Activates the inrush current limit circuit fault occurs.

---

### Specifications Table

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation panel</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>PU disconnection</td>
<td>This function stops the inverter output if communication between the inverter and PU is suspended, for example the operation panel and parameter unit is disconnected, when 2, 3, 16 or 17 was set in [Pr. 73 Bus selection/disconnected PU detection/PU stop selection]. This function stops the inverter output when communication errors occurred consecutively for more than permissible number of retries when [Pr. 71 Number of PU communication retries = 9999] during the RS-485 communication with the PU connector. This function also stops the inverter output if communication is broken for the period of time set in [Pr. 122 PU communication check interval].</td>
<td>PU Leave Out</td>
<td>○ ○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>Retry count excess</td>
<td>If operation cannot be resumed properly within the number of retries set, this function trips the inverter. (E.RET)</td>
<td>E.R.E (E.RET)</td>
<td>○ ○ ○ ○</td>
<td></td>
</tr>
<tr>
<td>CPU Fault</td>
<td>Stops the inverter output if the communication fault of the built-in CPU occurs.</td>
<td>E. 5 Fault 5</td>
<td>○ ○ ○ ○</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. 6 Fault 6</td>
<td>○ ○ ○ —</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>E. 7 Fault 7</td>
<td>○ ○ ○ —</td>
<td></td>
</tr>
<tr>
<td>Short circuit of power supply for operation panel, power supply for RS-485 terminals</td>
<td>When the operation panel power supply (PU connector) is shorted, this function trips the inverter. At this time, the operation panel (parameter unit) cannot be used and RS-485 communication from the PU connector cannot be made. When the internal power supply for RS-485 terminals are shorted, the function shuts off the power output. At this time, communication from the RS-485 terminals cannot be made. To reset, enter the RES signal or switch power OFF, then ON again.</td>
<td>E.E.E (E.CTE)</td>
<td>○ ○ — —</td>
<td></td>
</tr>
<tr>
<td>24VDC power output short circuit</td>
<td>When the 24VDC power output from the terminal PC is shorted, this function shuts off the power output. At this time, all external contact inputs switch OFF. The inverter cannot be reset by entering the RES signal. To reset it, use the operation panel or switch power OFF, then ON again.</td>
<td>E.P24 (E.P24)</td>
<td>○ ○ — —</td>
<td></td>
</tr>
<tr>
<td>Output current detection value exceeded</td>
<td>Because [Pr. 117 Output current detection operation selected] is set to the alarm stop setting (=1), this function is activated when the output current exceeds the [Pr. 116 Output current detection level] setting.</td>
<td>E.C.0D (E.C.DID)</td>
<td>Fault 14 DC detect level</td>
<td>○ ○ — ○</td>
</tr>
<tr>
<td>Inrush current limit circuit fault</td>
<td>This function is activated when the resistor of the inrush current limit circuit overheats. Activates the inrush current limit circuit fault occurs.</td>
<td>E.I.0H (E.I.CH)</td>
<td>Fault 14 Inrush overheat</td>
<td>○ ○ ○ ○</td>
</tr>
</tbody>
</table>
### Specifications

**Communication fault (inverter)**

This function stops the inverter output when communication error occurs consecutively for more than permissible retry count when a value other than “9999” is set in \([Pr.\ 331 \text{ RS-485 communication retry}]\) during RS-485 communication from the RS-485 terminals. This function also stops the inverter output if communication is broken for the period of time set in \([Pr.\ 336 \text{ RS-485 communication check time interval}]\).

**Analog input fault**

For \([\text{Pr.}\ 702]\), the fault appears when 30mA or more is input or a voltage (7.5V or more) is input with the terminal 2 or 4 set to current input.

For \([\text{Pr.}\ 706]\), the fault appears if voltage/current is input to terminal 4 when the setting in \([\text{Pr.}\ 267 \text{ Terminal 4 input selection}]\) and the setting of voltage/current input switch are different.

**Over speed occurrence**

Indicates that the motor speed exceeds the over speed setting level during encoder feedback control and vector control.

**Speed deviation excess detection**

Stops the inverter output if the motor speed is increased or decreased under the influence of the load etc. during vector control and cannot be controlled in accordance with the speed command value.

**Signal loss detection**

Trip the inverter output when the encoder signal is shut off under orientation control, encoder feedback control or vector control.

**Excessive position error**

Indicates that the difference between the position command and position feedback exceeded the reference under position control.

**Brake sequence error**

The inverter output is stopped when a sequence error occurs during use of the brake sequence function \([Pr.\ 278 \text{ to } 285 \text{ Brake sequence function}]\).

**Encoder phase error**

Appears when rotation command of the inverter differs from the actual motor rotation direction detected from the encoder during offline auto tuning.

**Brake transistor alarm detection**

This function stops the inverter output if an alarm occurs in the brake circuit, e.g. damaged brake transistors. In this case, the inverter must be powered OFF immediately.

**USB communication fault**

When communication has broken during the time set in \([\text{Pr.}\ 548 \text{ USB communication check time interval}]\), this function trips the inverter.

### Table

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Indication</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(\text{E.5E} \text{r (E.SER)})</td>
<td>(\text{F.D Comm error})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.5E} \text{r (E.AIE)})</td>
<td>(\text{Analog in error})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.05} \text{ (E.O5)})</td>
<td>(\text{E.O5})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.05} \text{d (E.O5d)})</td>
<td>(\text{E.O5d})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.EC} \text{r (E.ECT)})</td>
<td>(\text{E.ECT})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.0d (E.Od)})</td>
<td>(\text{E.0d})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.MB1 to E.MB7})</td>
<td>(\text{E.MB1 to E.MB7})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.EP})</td>
<td>(\text{Encoder phase error})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.bE (E.BE)})</td>
<td>(\text{Br. Oct. Fault})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(\text{E.USb (E.USB)})</td>
<td>(\text{USB comm error})</td>
<td>(\text{O} \quad \text{O} \quad \text{O} \quad \text{O})</td>
</tr>
</tbody>
</table>
### SPECIFICATIONS

#### (2) Alarms

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Indication</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opposite rotation deceleration fault</td>
<td>The speed may not decelerate during the speed operation if the rotation direction of the speed command and the estimated speed differ when the rotation is changing from forward to reverse or from reverse to forward under torque control of Real sensorless vector control. At this time, the inverter output is stopped if the rotation direction will not change, causing overload.</td>
<td>E. 11 (E.11) Fault 11</td>
<td>FR-PU04 FR-PU07 A700 F700 E700 D700</td>
</tr>
<tr>
<td>Internal circuit fault</td>
<td>Appears when an internal circuit fault occurred.</td>
<td>E. 13 (E.13) Fault 13</td>
<td>O O O —</td>
</tr>
<tr>
<td>Safety circuit fault</td>
<td>Appears when the safety circuit is malfunctioning, or when one of the lines between S1 and SC, or between S2 and SC is opened.</td>
<td>E.SAF (E.SAF) Fault 14 Fault E.SAF</td>
<td>— — O O</td>
</tr>
<tr>
<td>Fan alarm</td>
<td>For the inverter that contains a cooling fan, F_{fan} appears on the operation panel when the cooling fan stops due to a fault or different operation from the setting of [Pr. 244 Cooling fan operation selection].</td>
<td>( F_{\text{fan}} ) (FN)</td>
<td>FN O O O O</td>
</tr>
</tbody>
</table>

#### Table of Available Inverters

<table>
<thead>
<tr>
<th>Operation panel</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-PU04</td>
<td>FR-PU07</td>
<td>A700 F700 E700 D700</td>
</tr>
</tbody>
</table>
### (3) Warning

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation panel</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stall prevention</td>
<td>When the output current (output torque during real sensorless vector control and vector control) of the inverter exceeds the stall prevention operation level ([Pr. 22 Stall prevention operation level], etc.), this function stops the increase in frequency until the overload current decreases to prevent the inverter from resulting in overcurrent trip. When the overload current has reduced below stall prevention operation level, this function increases the frequency again.</td>
<td>OL (OL)</td>
<td>FR-PU04 FR-PU07</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>During acceleration</td>
<td>When the output current (output torque during real sensorless vector control and vector control) of the inverter exceeds the stall prevention operation level ([Pr. 22 Stall prevention operation level], etc.), this function reduces frequency until the overload current decreases to prevent the inverter from resulting in overcurrent trip. When the overload current has reduced below stall prevention operation level, this function increases the frequency up to the set value. Definition of constant speed is when the output frequency is within ±2Hz of the set frequency.</td>
<td>OL (OL)</td>
<td>FR-PU04 FR-PU07</td>
</tr>
<tr>
<td>Overcurrent</td>
<td>During deceleration</td>
<td>When the output current (output torque during real sensorless vector control and vector control) of the inverter exceeds the stall prevention operation level ([Pr. 22 Stall prevention operation level], etc.), this function stops the decrease in frequency until the overload current decreases to prevent the inverter from resulting in overcurrent trip. When the overload current has reduced below stall prevention operation level, this function decreases the frequency again.</td>
<td>OL (OL)</td>
<td>FR-PU04 FR-PU07</td>
</tr>
<tr>
<td>Overvoltage</td>
<td>During deceleration</td>
<td>If the regenerative energy of the motor becomes excessive and exceeds the regenerative energy consumption capability, this function stops the decrease in frequency to prevent overvoltage trip. As soon as the regenerative energy has reduced, deceleration resumes.</td>
<td>OL (OL)</td>
<td>FR-PU04 FR-PU07</td>
</tr>
<tr>
<td>Regenerative brake prealarm</td>
<td>Appears if the regenerative brake duty reaches or exceeds 85% of the [Pr. 70</td>
<td>Regenerative brake duty alarm] value. If the regenerative brake duty reaches 100%, a regenerative overvoltage (E.OV1 to E.OV3) occurs. For [FRU], this warning appears only for the 75K or more.</td>
<td>RB (RB)</td>
<td>FR-PU04 FR-PU07</td>
</tr>
</tbody>
</table>
## SPECIFICATIONS

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation panel</th>
<th>Parameter unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Electronic thermal relay function prealarm</strong></td>
<td>Appears if the cumulative value of the Pr. 9 Electronic thermal O/L relay reaches or exceeds 85% of the preset level. If it reaches 100% of the Pr. 9 Electronic thermal O/L relay setting, a motor overload trip (E. THM) occurs.</td>
<td>FH (TH)</td>
<td>TH</td>
<td>FR-PUS FR-PU07</td>
</tr>
<tr>
<td><strong>PU Stop</strong></td>
<td>Stop with PU stop in Pr. 75 Reset selection/disconnected PU detection/PU stop selection.</td>
<td>PS (PS)</td>
<td>PS</td>
<td>FR-PUS FR-PU07</td>
</tr>
<tr>
<td><strong>Maintenance signal output</strong></td>
<td>Indicates that the cumulative energization time of the inverter has reached a given time.</td>
<td>MT (MT)</td>
<td>MT</td>
<td>FR-PUS FR-PU07</td>
</tr>
<tr>
<td><strong>Parameter copy</strong></td>
<td>Appears when parameters are copied between models with capacities of 50K or less and 75K or more.</td>
<td>CP (CP)</td>
<td>CP</td>
<td>FR-PUS FR-PU07</td>
</tr>
<tr>
<td><strong>Speed limit display</strong></td>
<td>Output if the speed limit level is exceeded during torque control.</td>
<td>SL (SL)</td>
<td>SL</td>
<td>FR-PUS FR-PU07</td>
</tr>
<tr>
<td><strong>Undervoltage</strong></td>
<td>If the power supply voltage of the inverter decreases, the control circuit will not perform normal functions. In addition, the motor torque will be insufficient and/or heat generation will increase. To prevent this, if the power supply voltage decreases below about 115VAC (about 230VAC for 400V class), the function stops the inverter output and displays UV. An alarm is reset when the voltage returns to normal.</td>
<td>UV (UV)</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
## Error Message

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>Operation unit</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation panel lock</td>
<td>Operation lock mode is set. Operation other than HOLD is invalid.</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Password locked</td>
<td>Password function is active. Display and setting of parameter is restricted.</td>
<td>FR-PU07</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Parameter write error</td>
<td>1) You attempted to make parameter setting when [Pr. 77] has been set to disable parameter write. 2) Frequency jump setting range overlapped. 3) Adjustable 5 points V/F setting overlapped. 4) The PU and inverter cannot make normal communication</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Write error during operation</td>
<td>When parameter write was performed during operation with [Pr. 77] and the STF (ST1) is ON.</td>
<td>FR-PU07</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Calibration error</td>
<td>Analog input bias and gain calibration values are too close.</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Mode designation error</td>
<td>You attempted to make parameter setting in the NET operation mode when [Pr. 77]</td>
<td>FR-PU07</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Parameter read error</td>
<td>An error occurred in the EEPROM on the operation panel side during parameter copy reading.</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Parameter write error</td>
<td>1) You attempted to perform parameter copy write during operation. 2) An error occurred in the EEPROM on the operation panel side during parameter copy writing.</td>
<td>FR-PU07</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Parameter verification error</td>
<td>Data on the operation panel side and inverter side are different. 2) An error occurred in the EEPROM on the operation panel side during parameter verification.</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Model error</td>
<td>1) A different model was used for parameter write and verification during parameter copy. 2) When parameter copy write is stopped after parameter copy read is stopped.</td>
<td>FR-PU07</td>
<td>00 00 00 00 00</td>
</tr>
<tr>
<td>Error</td>
<td>1) The RES signal is ON 2) The PU and inverter cannot make normal communication (contact fault of the connector) 3) This indication may appear at turning ON the main circuit when the control circuit power (terminal R/L1, S/L2, T/L3) and the main circuit power (terminal R1, S1, L1, T/L3) are connected to separate power.</td>
<td>FR-PU04</td>
<td>00 00 00 00 00</td>
</tr>
</tbody>
</table>
1.5.3 Overcurrent protection (OC1 to OC3) (common)

To protect IGBT from overcurrent, the following protective functions are activated by detecting the output current of the inverter.

1) Rated output current (100%)
2) Overload current rating (150%) *1
3) Current limit operation (stall prevention (overcurrent) operation)

Overcurrent shut-off (220% or more) *2

*1 120% or more
*2 230% or more, 200% or more, 170% or more, 160% or more, 150% or more

1.5.4 Stall prevention (overcurrent) function and fast response current limit function (common)

Both functions are activated against the output current (output torque under Real sensorless vector control and vector control). If a rise in current is sharp, the overcurrent protection is activated because the stall prevention function cannot suppress the current. Better for current suppression (limit) capability than the stall prevention function, the fast response current limit function has a less possibility of activating the overcurrent protection, thus ensuring operation highly resistant to overload.

You can activate these functions using [Pr. 156]. Note that if an overload state is continued, the electronic thermal relay (E.THT) may be operated. Unlike the stall prevention (overvoltage), the current limit function does not function against regenerative overvoltage during deceleration.

1) Stall prevention (overcurrent) (during acceleration, during constant-speed operation) (common)

The inverter has a function for limiting the motor current. If the current reaches or exceeds [Pr. 22 Stall prevention operation level], the inverter lowers the output frequency during acceleration operation to reduce the load current and waits for the decrease of the load current. When the current returns to within [Pr. 22 Stall prevention operation level] etc., the inverter increases the frequency again, accelerates and operates at the set frequency.

The current limit function may not prevent overcurrent shut-off if the current changes suddenly as in a short circuit occurring in the output side.

2) Stall prevention (overcurrent) (during deceleration) (common)

If the current reaches or exceeds [Pr. 22 Stall prevention operation level] etc., the inverter increases the output frequency to reduce the load current and waits for the decrease of the load current. When the current returns to within [Pr. 22 Stall prevention operation level] etc., the inverter decreases the frequency again and decelerates to the set frequency or stops.

3) Fast-response current limit (common)

When the output current exceeds the specified value (independently of [Pr. 22]), the inverter shuts off the outputs, decelerates to the specified value and cancels the output shut-off. Action is the same regardless of acceleration, constant speed, and deceleration operation. Although response speed is fast, the output torque also decreases rapidly due to the rapid decrease of output voltage.
### 1.5.5 Regenerative overvoltage protection (OV1 to OV3) (common)

When the motor is decelerated by the inverter, the output frequency falls according to the deceleration time set value. When the load is light or inertia J (moment of inertia) is large, the motor speed may exceed the synchronous speed and enter the power regeneration range. At this time, the regeneration energy of the load is converted (regenerated) into electric energy and consumed by the motor itself and in the inverter. The regeneration overvoltage function is provided to prevent the built-in capacitor terminal voltage from rising abnormally due to large regenerative energy when motor slip has increased. Braking torque of approximately 20% of the rated motor torque is generated by the regenerative energy consumed in the motor and inverter. When the brake unit is used, braking torque of 100 to 150% of the rated torque is generated by the electrical energy consumed by the discharging resistor.

The regenerative energy of the transistorized inverter is not returned to the commercial power supply. Install the power supply regenerating converter (FR-CV) and high power factor converter (FR-HC, MT-HC) options to return the regenerative energy to the power supply.

If the regenerative energy from the motor has become excessive and the regenerative brake torque (current) has exceeded the specified value during motor deceleration, the stall prevention (overvoltage) function stops the fall of the output frequency to prevent regenerative overvoltage shut-off from being activated. If the deceleration time is extremely short or the load inertia J (moment of inertia) is very large, the stall prevention (overvoltage) function may not be enough to prevent regenerative overvoltage shut-off.

The stall prevention function is not available for regenerative overvoltage during constant-speed operation. When working with a negative load (in descending operation) which always is in the regenerative status, fit the power supply regenerating converter option to avoid regenerative overvoltage shut-off to activate. Also, to use power supply regenerating converter, install a brake register and inverter with sufficient heat capacities.

**Deceleration start**

1) Regenerative brake operation (approximately 360VDC)*1

2) Regenerative brake duty excessive

3) Regenerative overvoltage shut-off

(200V class : approximately 400VDC)*2

400V class : approximately 800VDC

*1 Voltage where the function activates differ according to the model. Refer to the below table.

<table>
<thead>
<tr>
<th>Voltage (V)</th>
<th>200V class</th>
<th>400V class</th>
</tr>
</thead>
<tbody>
<tr>
<td>DC380V</td>
<td>DC370V</td>
<td>DC376V</td>
</tr>
<tr>
<td>DC390V</td>
<td>DC740V</td>
<td>DC740V</td>
</tr>
<tr>
<td>DC376V</td>
<td>DC784V</td>
<td>DC760V</td>
</tr>
</tbody>
</table>

*2 Voltage where inverter trips differ according to the model.

1) Regenerative brake operation

Switches ON the brake transistor to start current in the brake discharge resistor.

2) Regenerative brake duty excessive

Stops use of the regenerative brake temporarily if the regenerative brake duty value exceeds the specified value. Resumes use of the regenerative brake when the brake discharge resistor has cooled down.

3) Regenerative overvoltage shut-off

Instantly activates the protective circuit to shut off the transistor gate.

---

**Operation of regenerative overvoltage stall prevention**
1.5.6 Brake resistor overheat protection and brake transistor alarm detection

(1) Brake resistor overheat protection

Any of the inverters 0.4K to 7.5K have a built-in regenerative brake discharge resistor. This brake resistor has a heat capacity of 100 to 150% torque and is used for a short time. (within 5 to 8s continuously)

If the regenerative brake beyond the above value is required (the brake transistor ON time has exceeded the permissible value), the brake resistor overheat protection is activated to shut off the brake transistor gate. The regenerative brake may be used again when the discharge resistor has cooled after the regenerative brake is shut off.

The heat capacity can be increased by using the external brake discharging resistor instead. (Refer to page 489)

The brake resistor overheat protection function is reset to the initial (cold) state by switching ON the inverter power or the reset signal (RES signal). Unnecessary reset and power-OFF should therefore be avoided. The inverter must not be installed on any combustible surface, such as wood, because the temperature of the built-in brake resistor reaches approximately 200°C maximum.

If the brake transistor output voltage becomes excessive during deceleration, the regenerative overvoltage protection may be activated to stop the inverter output.

(2) Brake transistor circuit alarm detection

When the regenerative brake transistor has been damaged due to an external brake discharge resistor wiring fault etc. (at internal circuit alarm for the 55K or less), this function detects the fault, shuts off the inverter output, and gives the alarm output signal. When this alarm output signal is provided, shut off the inverter power supply to protect the discharge resistor from overheating.

1.5.7 Electronic thermal relay function (THM, THT)

(1) Function

On detecting the overload of the motor or transistor, the electronic thermal relay in the inverter stops the transistor operation and output, and keeps them stopped.

*1 Protective function by electronic thermal relay function is reset by inverter power reset and reset signal input. Avoid unnecessary reset and power-OFF.

*2 When multiple motors are operated by a single inverter, protection cannot be provided by the electronic thermal function. Install an external thermal relay to each motor.

*3 A special motor cannot be protected by the electronic thermal relay function. Use an external thermal relay.

*4 The operation time of the transistor protection thermal shortens when the [Pn. 72 PWM frequency selection] setting is increased.

(2) Setting the electronic thermal relay function

Define the protection characteristic of the electronic thermal relay on the basis of the rated current value of the motor as indicated below:

Setting value = rated current value × α (A)

- 200V(400V)/50Hz: 1.0
- 200/220V(440V)/60Hz: 1.1

Set the value in terms of amperes from the operation panel (parameter unit). ([Pn. 9])

*1 Set 0 in [Pn. 9] when you do not want to operate the electronic thermal relay function when using the motor with the external thermal relay, etc. (Note that the output transistor protection [E.THT] of the inverter functions.)

*2 Since a thermal relay protector is built in a motor dedicated for vector control (SF-V5RU), set [Pn. 9 = 0] to use the motor.

*3 When a difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic thermal relay function will be deteriorated. In this case, use an external thermal relay.

*4 Electronic thermal relay may not function when 5% or less of inverter rated current is set to electronic thermal relay setting.

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Setting Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>200V(400V)</td>
<td>1.0</td>
</tr>
<tr>
<td>220V(440V)</td>
<td>1.1</td>
</tr>
</tbody>
</table>
(3) Electronic thermal relay function operation characteristic (THM) (common)

Electronic thermal relay function operation characteristics of the inverter when the ratio of the motor current to the \[Pr. 9\] Electronic thermal O/L relay is presented in horizontal axis. Horizontal axis is calculated as follows: (motor current [A]/Pr. 9 [A]) \times 100 [\%].

When constant-torque motor is selected in \[Pr. 7: Applied motor\], this characteristic curve applies to the operation at 6Hz or higher.
(4) Electronic thermal relay function operation characteristic (THT)

This electronic thermal relay function operates to protect output transistor in an inverter. Characteristic of the electronic thermal relay function is determined by the inverter, and cannot be changed with parameters.

Electronic thermal relay function (transistor protection thermal) operation characteristics of A700/F700 when the ratio of the motor current to the inverter rated current is presented in horizontal axis. Horizontal axis is calculated as follows: (motor current [A]/inverter rated current [A]) x 100 [%].

<table>
<thead>
<tr>
<th>Optimum Conditions</th>
<th>55K or less</th>
<th>75K or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running frequency : 1Hz or more</td>
<td><img src="chart1.png" alt="" /></td>
<td><img src="chart2.png" alt="" /></td>
</tr>
<tr>
<td>Carrier frequency: 2kHz</td>
<td><img src="chart3.png" alt="" /></td>
<td><img src="chart4.png" alt="" /></td>
</tr>
<tr>
<td>Running frequency : 1Hz or less</td>
<td><img src="chart5.png" alt="" /></td>
<td><img src="chart6.png" alt="" /></td>
</tr>
<tr>
<td>Carrier frequency: 2kHz</td>
<td><img src="chart7.png" alt="" /></td>
<td><img src="chart8.png" alt="" /></td>
</tr>
</tbody>
</table>
1.5.8 Instantaneous power failure protection (IPF) (A700, F700)

(1) Instantaneous power failure protection (IPF) (A700, F700)

If the power supply voltage of the inverter has reduced or the power is lost due to instantaneous power failure, etc., this function activates the protective circuit and shuts off the IPM gate to stop the output.

Operation is continued properly if the instantaneous power failure is within 15ms (fault output is not provided). If it exceeds 15ms, the instantaneous power failure protection circuit is activated to stop the inverter output. A fault output is provided (terminals B and C are open) when the instantaneous power failure is within approximately 100ms. When the power failure is longer than approximately 100ms, fault output is not provided. (Refer to page 35.) When the power is restored after the instantaneous power failure, the inverter must be restarted after the motor has stopped completely.

Set a value other than 9999 in [Pr. 57 Automatic restart after instantaneous power failure] to make a restart while the motor is coasting.

(2) Power supply undervoltage protection (UVT) (A700, F700)

Activates the protective function if the power supply voltage drops below approximately 150VAC (approximately 300VAC for the 400V class).

(3) Reset (A700, F700)

Once activated, the instantaneous power failure protection function remains activated. To reset, switch OFF the start signal, then recover the inverter by referring to page 96. The protective circuit is automatically reset by the reset function if the power failure persists for longer than approximately 100ms.

[Explanation of the instantaneous power failure protection circuit block diagram]

When the inverter power supply (R/L1, S/L2, T/L3) is switched ON, the converter smoothing capacitor (C) is charged. In the meantime, when the control power supply establishment pulse resets the instantaneous power failure protection circuit to the initial state. If the DC voltage of the smoothing capacitor is reduced by an instantaneous power failure (longer than 15ms and within approximately 100ms) or a power supply voltage reduction during inverter operation, the undervoltage detection circuit is activated to set the instantaneous power failure protection circuit and shut off the inverter at the gate. When the power is then restored, a fault display is switched ON (terminals B-C open, A-C closed).

The reset function is activated when the inverter power remains OFF for more than approximately 100ms. (Fault is not output.) If the fault output relay is switched ON (terminals B-C open, A-C closed) by other than the instantaneous power failure protection circuit to switch OFF the inverter power supply MC, the control power is lost, whereby the fault display and fault output relay are switched OFF (terminals B-C closed, A-C open).
1.5.9 Input/output phase loss protection selection

(1) Input phase loss protection (E.ILF) *(common)*

When \( \text{Pr. 872} = 1 \), input phase loss protection (E.ILF) is provided if a phase loss of one phase among the three phases is detected for 1s continuously.*1

If input phase is lost when \( \text{Pr. 872} = 1 \) (with input phase loss protection) and \( \text{Pr. 261} = 0 \) (instantaneous power failure stop function is enabled), input phase failure protection is not provided but power-failure deceleration is made. For \( \text{Pr. 870} = 0 \), input phase failure protection (E.ILF) is activated.

*1 As phase loss is detected according to the bus voltage change, phase loss cannot be detected if the load is light. Large unbalanced phase-to-phase voltage of the three-phase power supply may also cause input phase loss protection (E.ILF).

(2) Output phase loss protection (LF) *(common)*

The output current unbalance due to the phase loss is checked by the output phase loss detection. When the current value between the lost phase and other two phases differs, it is regarded as output phase loss and the inverter will come to a fault.

When \( \text{Pr. 251} = 0 \) (without output phase loss protection), output phase loss protection (E.LF) becomes invalid.

2) When the output phase loss protection malfunctions

When the motor capacity is smaller than the inverter capacity, the output current value is small as compared to the rated inverter current. At this time, if any of the phases enters the dead zone (assumed as 0A if within 5% of the rated inverter current value) due to noises, etc. when the output current flows more than 5% on average, the output phase loss protection (E.LF) may malfunction. To prevent this, set 0 in \( \text{Pr. 251} \) *Output phase loss protection selection* and make output phase loss protection invalid.

<table>
<thead>
<tr>
<th>( \text{Pr.} )</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>872</td>
<td>Input phase loss protection selection</td>
<td>(0)</td>
<td>0</td>
<td>Without input phase loss protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>1</td>
<td>With input phase loss protection</td>
</tr>
</tbody>
</table>

\[\text{Pr. 251} = 0\] Output phase loss protection selection

1) When the output phase loss protection activation properly

The output phase loss protection (E.LF) activates when

a) The average output current of the phase where lowest current flows is 5% or less than the rated inverter current

\[\text{Average output current} \leq \text{5\% of rated inverter current}\]

\[\text{Pr. 251} = 0\] Output phase loss protection selection

<table>
<thead>
<tr>
<th>( \text{Pr.} )</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>251</td>
<td>Output phase failure protection selection</td>
<td>(0)</td>
<td>0</td>
<td>Without output phase loss protection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1)</td>
<td>1</td>
<td>With output phase loss protection</td>
</tr>
</tbody>
</table>
3) When the output phase loss protection does not function

When the motor capacity is too small as compared to the inverter capacity, the output current becomes too small. At this time, when the average output current of all phases is 5% or less of the rated inverter current, the output phase loss protection (E.LF) does not function assuming that all phases is 0A even if one of the three phases is lost since all phases enter the dead zone (assumed as 0A if within 5% of the rated inverter current value).

When multiple motors are operated by a single inverter, output phase loss protection (E.LF) does not function.

The output phase loss protection (E.LF) functions when one phase is lost. This function is invalid if two phases or three phases are lost. Note that it may functions even if two phases are lost when an earth (ground) fault occurs. When an earth (ground) fault occurs in the lost phase, output phase loss protection (E.LF) may not function.

1.5.10 Inverter status and reset method at occurrence of fault (common)

<table>
<thead>
<tr>
<th>Inverter Status</th>
<th>Fault Occurrence</th>
<th>Reset terminal Connected</th>
<th>Output Stop Terminal Connected</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGBT</td>
<td>Gate is shut OFF instantly.</td>
<td>Gate is shut OFF instantly.</td>
<td>Gate is shut OFF instantly.</td>
</tr>
<tr>
<td>Frequency meter display</td>
<td>Reset to 0Hz instantly.</td>
<td>Reset to 0Hz instantly.</td>
<td>Reset to 0Hz instantly.</td>
</tr>
<tr>
<td>Operation panel</td>
<td>Fault code indication</td>
<td>Short terminals to erase the indication once.</td>
<td>Keep RES signal ON to display</td>
</tr>
<tr>
<td>Parameter unit display</td>
<td>Fault description display, Frequency, current, etc., at fault occurrence can be read in the monitor mode.</td>
<td>Short terminals to erase the indication once.</td>
<td>Keep RES signal ON to display</td>
</tr>
<tr>
<td>Fault output (relay output)</td>
<td>Excited instantly (terminals B-C open)</td>
<td>Drops instantly (terminals B-C closed)</td>
<td>No operation</td>
</tr>
<tr>
<td>Run signal</td>
<td>Switched OFF instantly.</td>
<td>Switched OFF instantly.</td>
<td>Switched OFF instantly.</td>
</tr>
<tr>
<td>Reset method</td>
<td>Reset or switch the power OFF, then ON.</td>
<td>Turn OFF RES signal</td>
<td>Turn OFF MRS signal</td>
</tr>
</tbody>
</table>

*1) If a fault has occurred, the IGBT gate is instantly shut off to stop the output. Hence, the inverter power may remain ON. If the power is switched OFF by using the MC etc., the inverter control power is lost and the fault signal cannot be output. To keep only the fault signal ON, keep the fault output contact (across terminals A-C) closed in the external circuit. The fault description is stored in the inverter and can be read later.
1.6 Precautions for use of the inverter

The FR series is a highly reliable product, but incorrect peripheral circuit making or operation/handling method may shorten the product life or damage the product.

Before starting operation, always recheck the following items.

1.6.1 Instructions on the inverter output side

Do not connect the power supply to the inverter output side terminal (U, V, W).

Application of power to the output terminals U, V, W of the inverter will damage the inverter module. Especially when there is a commercial power supply-inverter switchover circuit, use mechanically interlocked magnetic circuit (MC1, MC2) as shown on the right to prevent accidental application of commercial power to the inverter output side. To select the MC, refer to page 526 and use the ones which have sufficient capacities from the magnetic switch data. If the MC used have small capacities, this may be connected with the commercial power supply by arcs at current shut-off.

Also make connections so that the motor rotates in the same direction (phase rotation) in both the commercial power supply operation and inverter operation.

A short circuit or earth (ground) fault on the inverter output side may damage the inverter modules.

1. Fully check the to-earth (ground) insulation and phase to phase insulation of the inverter output side before power-ON. Especially for an old motor or use in hostile atmosphere, securely check the motor insulation resistance etc.
2. When \( \Delta \) start is made during commercial power supply operation or a pole-change motor is used, make up a circuit which provides mechanical interlock and sufficient timing so that the circuit is not shorted on the inverter output side (including arc short).

Do not install a power factor correction capacitor, surge suppressor or capacitor type filter on the inverter output side.

This will cause the inverter to trip or the capacitor and surge suppressor to be damaged. If any of the above devices are connected, immediately remove them.
1.6.2 MC on the inverter power supply side (common)

Do not use the inverter power supply side MC to start/stop the inverter.

On the inverter input side, it is recommended to provide an MC for the following purposes.

1) To release the inverter from the power supply when the inverter protective function is activated or the drive becomes faulty (e.g., emergency stop operation)

When cyclic operation or heavy-duty operation is performed with an optional brake resistor connected, overheating and burnout of the discharging resistor can be prevented if a regenerative brake transistor is damaged due to insufficient heat capacity of the discharging resistor and excess regenerative brake duty.

3) To prevent any accident due to an automatic restart at restoration of power after an inverter stop made by a power failure

4) To separate the inverter from the power supply to ensure safety of maintenance/inspection work

The control power supply for the inverter is always running and consumes a little power. When stopping the inverter for an extended period of time, powering OFF the inverter will save power slightly.

4) To separate the inverter from the power supply to ensure safety of maintenance/inspection work

The inverter’s input side MC is used for the above purpose, select class JEM1038-AC3 MC for the inverter input side current when making an emergency stop during normal operation.

Since repeated inrush current at powering ON will shorten the life of the converter circuit (switching life is 1 million times (about 500,000 times for the 200V class 37K or more), frequent starts/stops must be avoided.

As shown below, always use the start signal (turn ON/OFF terminals STF, STR-SD) to start/stop the inverter.

---

1.6.3 Inverter power restart (common)

When the motor is driven by the inverter, direct-on line starting is always made at a low frequency to suppress the motor starting current and the frequency is increased gradually. Hence, when the coasting motor is started by the inverter, the inverter attempts to draw the motor frequency into the starting frequency. However, if the load energy is large, a large current may flow to the inverter side due to the power returned from the motor to the inverter, causing an overcurrent shut-off (E.OC1 to E.OC3). Therefore, provide a coasting interlock circuit so that the inverter may only start the motor at a motor stop state. (Refer to page 559)

Since a similar phenomenon will take place when terminal RES is used during inverter operation, note the design of the circuit. (Refer to page 56)

However, the fast-response current limit function of the inverter makes it difficult to trip the inverter if the inverter is restarted during coasting.

Note that the function of automatic restart after instantaneous power failure may be used to restart the inverter while the motor is coasting.
1.6.4 Regenerative brake duty (A700) (E700) (D700)

Across P/+ and PR terminals, connect only an external regenerative brake discharge resistor.

Do not connect an electronic magnetic brake. When using an external, large thermal-capacity discharge resistor for regenerative brake in A700, always remove the jumper (between terminal PR and PX) of the built-in discharge resistor for regenerative brake.

1.6.5 I/O signal (common)

Do not apply a voltage higher than the permissible voltage to the inverter I/O signal circuits.

The I/O devices may be damaged if a voltage higher than the value indicated on page 28 is applied to the inverter I/O signal circuits or reverse polarity is used. Especially check the wiring to prevent the frequency setting potentiometer from being connected incorrectly to short terminals 10 (E)-5.

1.6.6 Connection to a large-capacity power supply (common)

When connecting the inverter near a large-capacity power supply, insert a power factor improving reactor.

The inverter input current varies with the impedance of the power supply. (i.e. the power supply’s power factor varies.) When the power supply capacity is 1000kVA or more for A700 (E700) (500kVA or more for E700, D700), insert a power factor improving reactor. (Refer to page 507 for details.)
1.6.7 Earthing (grounding) (common)

Always earth (ground) the motor and inverter.

(1) Purpose of earthing (grounding)

Generally, an electrical apparatus has an earth (ground) terminal, which must be connected to the ground before use. An electrical circuit is usually insulated by an insulating material and encased. However, it is impossible to manufacture an insulating material that can shut off a leakage current completely, and actually, a slight current flows into the case. The purpose of earthing (grounding) the case of an electrical apparatus is to prevent operator from getting an electric shock from this leakage current when touching it.

To avoid the influence of external noises, this earthing (grounding) is important to audio equipment, sensors, computers and other apparatuses that handle low-level signals or operate very fast.

(2) Earthing (grounding) methods and earthing (grounding) work

As described previously, earthing (grounding) is roughly classified into an electrical shock prevention type and a noise-affected malfunction prevention type. Therefore, these two types should be discriminated clearly, and the following work must be done to prevent the leakage current having the inverter’s high frequency components from entering the malfunction prevention type earthing (grounding):

1) If possible, use (I) independent earthing (grounding) in figure below for the inverter. If independent earthing (grounding) is not available, use (II) joint earthing (grounding) in the figure below which the inverter is connected with the other equipment at an earthing (grounding) point. The (III) common earthing (grounding) as in the figure below, which inverter shares a common earth (ground) cable with the other equipment, must be avoided.

A leakage current including many high frequency components flows in the earth (ground) cables of the inverter and inverter-driven motor. Therefore, use the independent earthing (grounding) and separated the earthing (grounding) cable of the inverter from equipments sensitive to EMI.

In a high building, it may be effective to use the EMI prevention type earthing (grounding) connecting to an iron structure frame, and electric shock prevention type earthing (grounding) with the independent earthing (grounding) together.

2) This inverter must be earthed (grounded). Earthing (grounding) must conform to the requirements of national and local safety regulations and electrical code. (NEC section 250, IEC 536 class 1 and other applicable standards).

3) Use the thickest possible earth (ground) cable. The earth (ground) cable should be of not less than the size indicated in the table on the page 530.

4) The grounding point should be as near as possible to the inverter, and the ground wire length should be as short as possible.

5) Run the earth (ground) cable as far away as possible from the I/O wiring of equipment sensitive to noises and run them in parallel in the minimum distance. Always earth (ground) the motor and inverter.
### 1.6.8 Wiring (common)

**After wiring, wire offcuts must not be left in the inverter.**

Wire offcuts can cause an alarm, failure or malfunction. Always keep the inverter clean. When drilling mounting holes in an enclosure etc., take care not to allow chips and other foreign matter to enter the inverter.

**Use cables of the size to make a voltage drop 2% maximum.**

If the wiring distance is long between the inverter and motor, a main circuit cable voltage drop will cause the motor torque to decrease especially at the output of a low frequency. Refer to page 530 for the recommended wire sizes.

**The overall wiring length should be 500m or less (within 100m during vector control)**

Especially for long distance wiring, the fast-response current limit function may decrease or the equipment connected to the output side may malfunction or become faulty under the influence of a charging current due to the stray capacity of the wiring. Therefore, note the overall wiring length.

The overall wiring length for connection of a single motor or multiple motors should be within the value in the table on the right. (The wiring length should be 100m maximum for vector control.)

When driving a 400V class motor by the inverter, surge voltages attributable to the wiring constants may occur at the motor terminals, deteriorating the insulation of the motor. In this case, refer to page 504.

<table>
<thead>
<tr>
<th>Overall wiring length (example: FR-A720-1.5K)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500m or less</td>
</tr>
<tr>
<td>300m ± 300m = 600m</td>
</tr>
</tbody>
</table>

### Table 1: SPECIFICATIONS

| Pr. 72 PWM Frequency Selection Setting (carrier frequency) | 0.4K | 0.75K | 1.5K or more |
|---|---|---|
| 2 (2kHz) or less | 300m | 500m | 500m |
| 3 to 15 (3kHz to 14.5kHz) | 200m | 300m | 500m |

### Table 2: SPECIFICATIONS

| Pr. 72 PWM Frequency Selection Setting (carrier frequency) | 0.4K | 0.75K | 1.5K |
|---|---|---|
| 2 (2kHz) or less | 300m | 500m |
| 3 to 15 (3kHz to 14.5kHz) | 200m | 300m |

### Table 3: SPECIFICATIONS

<table>
<thead>
<tr>
<th>Pr. 72 PWM Frequency Selection Setting (carrier frequency)</th>
<th>0.1K</th>
<th>0.2K</th>
<th>0.4K</th>
<th>0.75K</th>
<th>1.5K</th>
<th>2.2K or more</th>
</tr>
</thead>
<tbody>
<tr>
<td>300m or less</td>
<td>200V class</td>
<td>500m</td>
<td>200m</td>
<td>300m</td>
<td>500m</td>
<td>500m</td>
</tr>
<tr>
<td>—</td>
<td>400V class</td>
<td>—</td>
<td>200m</td>
<td>300m</td>
<td>500m</td>
<td>500m</td>
</tr>
<tr>
<td>2 to 15 (2kHz to 14.5kHz)</td>
<td>200V class</td>
<td>30m</td>
<td>100m</td>
<td>200m</td>
<td>300m</td>
<td>500m</td>
</tr>
<tr>
<td>—</td>
<td>400V class</td>
<td>—</td>
<td>30m</td>
<td>100m</td>
<td>200m</td>
<td>300m</td>
</tr>
</tbody>
</table>
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2.1 Parameter list

2.1.1 FR-A700

For simple variable-speed operation of the inverter, the initial setting of the parameters may be used. Set the necessary parameters to meet the load and operational specifications. Parameter setting, change and check can be made from the operation panel (FR-DU07).

- Indicates simple mode parameters. (initial setting is extended mode)
- The parameters marked with * in the table allow its setting to be changed during operation even if 0 (initial value) is set in [Pr. 77 Parameter write selection].

* Symbols in the table indicate parameters which function when an option is mounted.

- These instruction codes are used for parameter read and write by using Mitsubishi inverter protocol with the RS-485 communication.
- Symbols in the control mode-based correspondence table indicate the following;
  ○ Usable parameter
  × Unusable parameter
  △ Parameters available only during position control set by parameter
  - Symbols in the parameter copy, parameter clear, and all parameter clear columns indicate the following;
  ○ Valid
  × Invalid

<table>
<thead>
<tr>
<th>Function</th>
<th>Name</th>
<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial Value</th>
<th>Refer to Page</th>
<th>[Pr.]</th>
<th>Option</th>
<th>Instruction Code</th>
<th>Control Mode-based Correspondence Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque boost</td>
<td>0 to 30%</td>
<td>0.1%</td>
<td>6/4/2/1%</td>
<td>1</td>
<td>244</td>
<td>0</td>
<td>00, 03</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Minimum frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
<td>120/60Hz</td>
<td>1</td>
<td>232</td>
<td>1</td>
<td>01, 02</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Maximum frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
<td>120Hz</td>
<td>2</td>
<td>232</td>
<td>2</td>
<td>02, 02</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Base frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>3</td>
<td>244</td>
<td>3</td>
<td>03, 03</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Multi-speed setting (high speed)</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>60Hz/40Hz</td>
<td>4</td>
<td>216, 395</td>
<td>4</td>
<td>04, 04</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Multi-speed setting (middle speed)</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>30Hz</td>
<td>5</td>
<td>216, 395</td>
<td>5</td>
<td>05, 05</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Multi-speed setting (low speed)</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>10Hz</td>
<td>6</td>
<td>216, 395</td>
<td>6</td>
<td>06, 06</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Acceleration time</td>
<td>0 to 300/300s</td>
<td>0.1/0.1s</td>
<td>5/15s</td>
<td>7</td>
<td>234</td>
<td>7</td>
<td>07, 07</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Deceleration time</td>
<td>0 to 300/300s</td>
<td>0.1/0.1s</td>
<td>5/15s</td>
<td>8</td>
<td>234</td>
<td>8</td>
<td>08, 08</td>
<td>☑</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Electronic thermal O/L relay</td>
<td>0 to 500/300A</td>
<td>0.01/1A</td>
<td>Rated inverter current</td>
<td>9</td>
<td>379</td>
<td>9</td>
<td>09, 09</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>DC injection brake operation frequency</td>
<td>0 to 120Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
<td>10</td>
<td>323, 328</td>
<td>10</td>
<td>0A, 0A</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>DC injection brake operation time</td>
<td>0 to 100 ms</td>
<td>0.1μs</td>
<td>100μs</td>
<td>11</td>
<td>323, 328</td>
<td>11</td>
<td>0B, 0B</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Injection frequency</td>
<td>0 to 30%</td>
<td>0.1%</td>
<td>4/2/1%</td>
<td>12</td>
<td>328</td>
<td>12</td>
<td>0C, 0C</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Firing frequency</td>
<td>0 to 60Hz</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>13</td>
<td>232</td>
<td>13</td>
<td>0D, 0D</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Firing pattern selection</td>
<td>0 to 9s</td>
<td>0</td>
<td>9s</td>
<td>14</td>
<td>234</td>
<td>14</td>
<td>0E, 0E</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>DC injection brake operation voltage</td>
<td>0 to 30%</td>
<td>0.1%</td>
<td>4/2/1%</td>
<td>15</td>
<td>215</td>
<td>15</td>
<td>0F, 0F</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Starting frequency</td>
<td>0 to 60Hz</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>16</td>
<td>232</td>
<td>16</td>
<td>0G, 0G</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Shot input selection</td>
<td>0 to 216, 395</td>
<td>0</td>
<td>216, 395</td>
<td>17</td>
<td>234</td>
<td>17</td>
<td>0H, 0H</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>High speed maximum frequency</td>
<td>0 to 120Hz, 9999</td>
<td>0.01Hz</td>
<td>120/60Hz</td>
<td>18</td>
<td>232</td>
<td>18</td>
<td>0I, 0I</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Injection frequency voltage</td>
<td>0 to 100%, 50%, 33%</td>
<td>0.1%</td>
<td>50%, 33%</td>
<td>19</td>
<td>234</td>
<td>19</td>
<td>0J, 0J</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Acceleration/deceleration reference frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>400Hz</td>
<td>20</td>
<td>234</td>
<td>20</td>
<td>0K, 0K</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Acceleration/deceleration time increments</td>
<td>0 to 1</td>
<td>1</td>
<td>0</td>
<td>21</td>
<td>234</td>
<td>21</td>
<td>0L, 0L</td>
<td>○</td>
<td>☑ ☑ ☑ ☑ ☑ ☑ ☑ ☑</td>
</tr>
<tr>
<td>Parameter</td>
<td>Setting Range</td>
<td>Minimum Setting Increments</td>
<td>Initial Value</td>
<td>Refer to Page</td>
<td>Option</td>
<td>Instruction Code</td>
<td>Control Mode-based Correspondence Table</td>
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### Control Mode-based Correspondence Table

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<th>Minimum Setting Increments</th>
<th>Initial Value</th>
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<td>Cool</td>
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<td>Parameter control</td>
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### Motor Constants

#### Motor Capacity
- 0.4 to 55kW, 9999/0 to 3600kW, 9999
- 0.01/0.1kW

#### Number of Motor Poles
- 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 9999

#### Rated Motor Voltage
- 0 to 1000V
- 0.1V
- 200/400V

#### Motor Constants
- R1, R2, L1, L2, X
- 0 to 50, 9999
- 0.001 Ω
- 0 to 500

### V/F Control

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<tr>
<th>Parameter</th>
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### Fault Code Output Selection
- 0, 1, 2

### Parameter Write Selection
- 0, 1, 2

### Reverse Rotation Prevention Selection
- 0, 1, 2

### Applied Motor

### Analog Input Selection
- 0 to 7, 10 to 17

### Input Filter Time Constant
- 0 to 8

---

### Online Auto Tuning Selection
- 0 to 2

### Auto Tuning Setting/Status
- 0, 1, 101

### V/F1 (first frequency)
- 0 to 400Hz
- 0.01Hz

### V/F1 (first frequency voltage)
- 0 to 1000V
- 0.1V
- 0V

### V/F2 (second frequency)
- 0 to 400Hz
- 0.01Hz

### V/F2 (second frequency voltage)
- 0 to 1000V
- 0.1V
- 0V

### V/F3 (third frequency)
- 0 to 400Hz
- 0.01Hz

### V/F3 (third frequency voltage)
- 0 to 1000V
- 0.1V

### V/F4 (fourth frequency)
- 0 to 400Hz
- 0.01Hz

### V/F5 (fifth frequency voltage)
- 0 to 1000V
- 0.1V

### Third Deceleration Time
- 0 to 3600/360s
- 0.1/0.01s

### Third Torque Boost
- 0 to 30%

### Third Stall Prevention Operation Current
- 0 to 220%
- 0.1%

### Third Stall Prevention Operation Frequency
- 0 to 400Hz

### Third Output Frequency Detection
- 0 to 400Hz
- 0.01Hz

### Terminal 2 Frequency Setting Gain Frequency
- 0 to 400Hz
- 0.01Hz
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<th>Minimum Setting Increments</th>
<th>Initial Value</th>
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<td>Output current detection signal delay time</td>
<td>0 to 10s</td>
<td>0.1s</td>
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<td>Zero current detection delay time</td>
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<td>Phase detection delay</td>
<td>0 to 10s</td>
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<td>Stall prevention level at the input</td>
<td>0 to 100%</td>
<td>0.1%</td>
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9999, (0 to 16)

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User group registration

0 to 999, 9999

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User group clear

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9999

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178

STF terminal function selection

0 to 999, 9999
0 to 20, 22 to 28, 42 to 44, 60,

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179

STR terminal function selection

1

61

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179

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93

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180
181
182
183

RL terminal function selection
RM terminal function selection
RH terminal function selection
RT terminal function selection

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37
37
37
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180
181
182
183

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AU terminal function selection

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184

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185
186
187
188
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190

JOG terminal function selection
CS terminal function selection
MRS terminal function selection
STOP terminal function selection
RES terminal function selection
RUN terminal function selection

0 to 8, 10 to 20, 25 to 28,

1
1
1
1
1
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5
6
24
25
62
0

37
37
37
37
37
61

185
186
187
188
189
190

19
1A
1B
1C
1D
1E

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9A
9B
9C
9D
9E

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SU terminal function selection

30 to 36, 39, 41 to 47, 64, 70,

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1F

9F

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IPF terminal function selection

84, 85, 90 to 99, 100 to 108,

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193

OL terminal function selection

110 to 116, 120, 125 to 128,

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A1

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A2

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A3

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A4

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232
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241

28
29
2A
2B
2C
2D
2E
2F
30
31

A8
A9
AA
AB
AC
AD
AE
AF
B0
B1

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62, 64 to 71, 9999
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Refer to
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vector
control

Speed Torque
control control

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FU terminal function selection

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9999
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to 36, 39, 41 to 47, 64, 70,
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to 108, 110 to 116, 120,
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ABC2 terminal function selection

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9999

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Slip

compensation

setting

—

Multi-speed

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Multi-speed setting (speed 8)
Multi-speed setting (speed 9)
Multi-speed setting (speed 10)
Multi-speed setting (speed 11)
Multi-speed setting (speed 12)
Multi-speed setting (speed 13)
Multi-speed setting (speed 14)
Multi-speed setting (speed 15)
Soft-PWM operation selection
Analog input display unit switchover
Terminal 1 added compensation amount
(terminal 2)
Terminal 1 added compensation amount
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Cooling fan operation selection
Rated slip
Slip compensation time constant
Constant-power range slip compensation
selection

—

250

Stop selection

—

251

Output phase loss protection selection

0.01Hz

9999

1
1

1
0

216
216
216
216
216
216
216
216
430
217, 320

0 to 100%

0.1%

100%

217

242

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B2

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0 to 100%

0.1%

75%

217

243

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B3

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0, 1
0 to 50%, 9999
0.01 to 10s

1
0.01%
0.01s

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9999
0.5s

431
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246

34
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36

B4
B5
B6

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3B

BB

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0 to 400Hz, 9999

0, 1
0, 1

0, 9999
0 to 100s, 1000 to 1100s,
8888, 9999
0, 1

128

128

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PARAMETER

Position
control

All Parameter
Clear

Torque
control

Parameter
Copy

Speed
control

User group registered display/batch clear

173

Name

Write

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[Pr.]

Read

V/F
control

Control Mode-based Correspondence Table
Real sensorless
Advanced
Vector control
vector control
magnetic

Extended

User

Output terminal function assignment

Input terminal function assignment

group

Function

Instruction Code

Parameter
Clear

PARAMETER

PARAMETER


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<td>Ambient current display</td>
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<td>Ambient current display</td>
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<tr>
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<td>0 to 300%</td>
<td>0.1%</td>
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<td>C31</td>
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<td>0 to 300%</td>
<td>0.1%</td>
<td>0%</td>
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<td>C33</td>
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<td>C34</td>
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<td>C37</td>
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<td>C39</td>
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<td>0%</td>
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<td>C40</td>
<td>21 9D 9</td>
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<td>0%</td>
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<td>C41</td>
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<td>0%</td>
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<td>C42</td>
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<td>Speed control, Torque control</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*1 Differ according to capacities. (0.4K, 0.75K/1.5K to 3.7K/5.5K or more)
*2 Differ according to capacities. (55K or less/11K or more)
*3 Differ according to capacities. (7.5K or less/11K or more)
*4 Differ according to capacities. (7.5K or less/11K to 55K/75K or more)
*5 Differ according to capacities. (7.5K or less/11K to 55K/75K or more)
*6 Differ according to capacities. (7.5K or less/11K to 55K/75K or more)
*7 The initial value differs according to the voltage class. (200V class/400V class)
*8 Can be read and written by only communication from the PU connector.
*9 Can be read and written by only communication from the PU connector.
*10 The parameter number in parentheses is the one for use with the parameter unit (FR-PU04K/FR-PU07).
*11 These parameters are communication parameters that are not cleared when parameter clear (all clear) is executed from RS-485 communication.
### 2.1.2 FR-F700

In the initial setting, only the simple mode parameters are displayed. Set \[\text{Pr. 160 User group read selection}\] as required.

- Symbols in the option column indicate parameters which function when an option is mounted.
- Symbols in the control mode-based correspondence table indicate the following:
  - O: Usable parameter
  - X: Unusable parameter

#### Parameters

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial value</th>
<th>Reference</th>
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</thead>
<tbody>
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<td>Only the simple mode parameters can be displayed</td>
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</tbody>
</table>

#### Instruction Codes

These instruction codes are used for parameter read and write by using Mitsubishi inverter protocol with the RS-485 communication.

- Symbols in the control mode-based correspondence table indicate the following:
  - O: Valid
  - X: Invalid

---

### Symbols in the Option Column

- Indicates simple mode parameters.

### Symbols in the Table

- These parameters marked with \[\text{Pr. 77 Parameter write selection}\] allow its setting to be changed during operation even if 0 (initial value) is set in \[\text{Pr. 160 User group read selection}\].

- Symbols in the option column indicate parameters which function when an option is mounted.

- Symbols in the control mode-based correspondence table indicate the following:
  - O: Usable parameter
  - X: Unusable parameter

### Symbols in the Parameter Copy, Parameter Clear, and All Parameter Clear Columns

- These symbols indicate:
  - O: Valid
  - X: Invalid
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial Value</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>28 Multi-speed input compensation selection</td>
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<td>1</td>
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<td>29 Acceleration/deceleration pattern selection</td>
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</tr>
<tr>
<td>30 Regenerative function selection</td>
<td>0, 1, 2</td>
<td>1</td>
<td>0</td>
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</tr>
<tr>
<td>31 Frequency jump 1A</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
<td></td>
</tr>
<tr>
<td>32 Frequency jump 1B</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
<td></td>
</tr>
<tr>
<td>33 Frequency jump 2A</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
<td></td>
</tr>
<tr>
<td>34 Frequency jump 2B</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
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</tr>
<tr>
<td>35 Frequency jump 3A</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
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</tr>
<tr>
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<tr>
<td>37 Speed display</td>
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<td>0.01Hz</td>
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<td>0 to 400Hz, 9999</td>
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<td>Minimum Setting Increments</td>
<td>Initial value</td>
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<td>VT(F1) first frequency voltage</td>
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<td>VT(F3) third frequency</td>
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<td>VT(F3) third frequency voltage</td>
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<td>VT(F4) fourth frequency</td>
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<td>VT(F4) fourth frequency voltage</td>
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<td>109</td>
<td>VT(F5) fifth frequency voltage</td>
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<td>110</td>
<td>LU communication station number</td>
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<td>LU communication stop bit length</td>
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<td>Number of PU communication retries</td>
<td>0 to 10, 9999</td>
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<td>113</td>
<td>PU communication waiting time setting</td>
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<td>0.01Hz</td>
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<td>115</td>
<td>Terminal 4 frequency setting gain frequency</td>
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<td>0.01Hz</td>
<td>60Hz</td>
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<td>116</td>
<td>PID control automatic switch over frequency</td>
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<td>0.01Hz</td>
<td>9999</td>
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<td>117</td>
<td>PID action selection</td>
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<td>118</td>
<td>PID proportional band</td>
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<td>1s</td>
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<td>PID operation</td>
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<td>Electronic bypass sequence selection</td>
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<td>MC switchover interlock time</td>
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<td>Start waiting time</td>
<td>0 to 100s</td>
<td>0.1s</td>
<td>0.5s</td>
</tr>
<tr>
<td>128</td>
<td>Bypass selection at a fault</td>
<td>0, 1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>129</td>
<td>Automatic switchover frequency from inverter to bypass operation</td>
<td>0 to 80Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
</tr>
<tr>
<td>130</td>
<td>Backlash acceleration stopping frequency</td>
<td>0 to 400Hz</td>
<td>0.1Hz</td>
<td>238</td>
</tr>
<tr>
<td>131</td>
<td>Backlash acceleration stopping frequency</td>
<td>0 to 400Hz</td>
<td>0.1Hz</td>
<td>238</td>
</tr>
<tr>
<td>132</td>
<td>Backlash deceleration stopping frequency</td>
<td>0 to 400Hz</td>
<td>0.1Hz</td>
<td>238</td>
</tr>
<tr>
<td>133</td>
<td>Backlash deceleration stopping frequency</td>
<td>0 to 400Hz</td>
<td>0.1Hz</td>
<td>238</td>
</tr>
<tr>
<td>134</td>
<td>Speed setting switchover</td>
<td>0, 2, 4, 6, 8, 10, 12, 14, 20, 30, 40, 50, 52, 53, 60, 102, 104, 106, 108, 110</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>135</td>
<td>PU display language selection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>136</td>
<td>Start prevention level at 0V input</td>
<td>0 to 150%</td>
<td>0.1%</td>
<td>120%</td>
</tr>
<tr>
<td>137</td>
<td>Start prevention level at 10V input</td>
<td>0 to 150%</td>
<td>0.1%</td>
<td>150%</td>
</tr>
<tr>
<td>138</td>
<td>Zero current detection level</td>
<td>0 to 150%</td>
<td>0.1%</td>
<td>5%</td>
</tr>
<tr>
<td>139</td>
<td>Voltage reduction selection during stall prevention operation</td>
<td>0, 1</td>
<td>1</td>
<td>33</td>
</tr>
<tr>
<td>140</td>
<td>PT signal function validity condition selection</td>
<td>0, 1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>141</td>
<td>Start prevention operation selection</td>
<td>0, 1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>142</td>
<td>All terminal function selection</td>
<td>0, 1, 9, 10, 11, 12, 13, 14, 17, 21, 23, 24, 30, 32, 33</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>143</td>
<td>Automatic switchover frequency range from bypass to inverter operation</td>
<td>0 to 10Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
</tr>
<tr>
<td>144</td>
<td>Motor group read selection</td>
<td>0, 1, 9999</td>
<td>1</td>
<td>9999</td>
</tr>
</tbody>
</table>

**Control Mode-based Correspondence Table**
- VIF: Variable Frequency Inverter
- Simple: Simple Control
- Flux: Flux Vector Control
- Magnet: Magnetic Flux Control

**Parameter Settings**
- Read: Read
- Write: Write
- Extended: Extended
PARAMETER

PARAMETER

Control Mode-based
Correspondence Table
Simple
Parameter Parameter All Parameter
V/F
magnetic
Copy
Clear
Clear
Extended
control flux vector
control

Instruction Code

Automatic restart

functions

Current

detection

—

161
162

Frequency setting/key lock operation
selection
Automatic restart after instantaneous power

163
164

failure selection
First cushion time for restart
First cushion voltage for restart

165

Stall prevention operation level for restart

166
167

Output current detection signal retention
time
Output current detection operation
selection

Setting Range

Minimum Setting
Increments

Initial value Reference

[Pr.]

Option
Read

Write

0, 1, 10, 11

1

0

214, 389

161

01

81

2

{

{

{

×

{

0, 1, 10, 11

1

0

367

162

02

82

2

{

{

{

{

{

0 to 20s
0 to 100%

0.1s
0.1%

0s
0%

367
367

163
164

03
04

83
84

2
2

{
{

{
{

{
{

{
{

{
{

0 to 150%

0.1%

120%

367

165

05

85

2

{

{

{

{

{

0 to 10s, 9999

0.1s

0.1s

72

166

06

86

2

{

{

{

{

{

1

0

72

167

07

87

2

{

{

{

{

{

0, 1

Parameter for manufacturer setting. Do not set.

170

Watt-hour meter clear

0, 10, 9999

1

9999

345

170

0A

8A

2

{

{

{

×

{

171

Operation hour meter clear

0, 9999

1

9999

345

171

0B

8B

2

{

{

×

×

×

172
173
174

User group registered display/batch clear
User group registration
User group clear

1
1
1

0
9999
9999

386
386
386

172
173
174

0C
0D
0E

8C
8D
8E

2
2
2

{
{
{

{
{
{

{
×
×

×
×
×

×
×
×

178

STF terminal function selection

1

60

37

178

12

92

2

{

{

{

×

{

179

STR terminal function selection

9999 (0 to 16)
0 to 999, 9999
0 to 999, 9999
0 to 8, 10 to 12, 14, 16, 24,
25, 60, 62, 64 to 67, 9999
0 to 8, 10 to 12, 14, 16, 24,
25, 61, 62, 64 to 67, 9999

1

61

37

179

13

93

2

{

{

{

×

{

180
181
182
183

RL terminal function selection
RM terminal function selection
RH terminal function selection
RT terminal function selection

0 to 8, 10 to 12, 14, 16, 24,
25, 62, 64 to 67, 9999

1
1
1
1

0
1
2
3

37
37
37
37

180
181
182
183

14
15
16
17

94
95
96
97

2
2
2
2

{
{
{
{

{
{
{
{

{
{
{
{

×
×
×
×

{
{
{
{

184

AU terminal function selection

0 to 8, 10 to 12, 14, 16, 24,
25, 62 to 67, 9999

1

4

37

184

18

98

2

{

{

{

×

{

185
186
187
188
189
190
191
192
193

JOG terminal function selection
CS terminal function selection
MRS terminal function selection
STOP terminal function selection
RES terminal function selection
RUN terminal function selection
SU terminal function selection
IPF terminal function selection
OL terminal function selection

1
1
1
1
1
1
1
1
1

5
6
24
25
62
0
1
2
3

37
37
37
37
37
61
61
61
61

185
186
187
188
189
190
191
192
193

19
1A
1B
1C
1D
1E
1F
20
21

99
9A
9B
9C
9D
9E
9F
A0
A1

2
2
2
2
2
2
2
2
2

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194

FU terminal function selection

1

4

61

194

22

A2

2

{

{

{

×

{

195

ABC1 terminal function selection

1

99

61

195

23

A3

2

{

{

{

×

{

196

ABC2 terminal function selection

1

9999

61

196

24

A4

2

{

{

{

×

{

—
—

232
233
234
235
236
237
238
239
240
241

0.01Hz
0.01Hz
0.01Hz
0.01Hz
0.01Hz
0.01Hz
0.01Hz
0.01Hz
1
1

9999
9999
9999
9999
9999
9999
9999
9999
1
0

216
216
216
216
216
216
216
216
430
217

232
233
234
235
236
237
238
239
240
241

28
29
2A
2B
2C
2D
2E
2F
30
31

A8
A9
AA
AB
AC
AD
AE
AF
B0
B1

2
2
2
2
2
2
2
2
2
2

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242

Multi-speed setting (speed 8)
Multi-speed setting (speed 9)
Multi-speed setting (speed 10)
Multi-speed setting (speed 11)
Multi-speed setting (speed 12)
Multi-speed setting (speed 13)
Multi-speed setting (speed 14)
Multi-speed setting (speed 15)
Soft-PWM operation selection
Analog input display unit switchover
Terminal 1 added compensation amount

0 to 100%

0.1%

100%

217

242

32

B2

2

{

{

{

{

{

—

243

0 to 100%

0.1%

75%

217

243

33

B3

2

{

{

{

{

{

setting

User
Multi-speed

Output terminal function assignment

Input terminal function assignment

group

Cumulative

168
169

monitor clear

—
—

Name

(terminal 2)
Terminal 1 added compensation amount
(terminal 4)

168
169

0 to 8, 10 to 12, 14, 16, 24,
25, 62, 64 to 67, 9999
0 to 5, 7, 8, 10 to 19, 25, 26,
45 to 47, 64, 70, 90 to 96, 98,
99, 100 to 105, 107, 108, 110
to 116, 125, 126, 145 to 147,
164, 170, 190 to 196, 198,
199, 9999
0 to 5, 7, 8, 10 to 19, 25, 26,
45 to 47, 64, 70, 90, 91, 94 to
96, 98, 99, 100 to 105, 107,
108, 110 to 116, 125, 126,
145 to 147, 164, 170, 190,
191, 194 to 196, 198, 199,
9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0 to 400Hz, 9999
0, 1
0, 1

158

Parameter for manufacturer setting. Do not set.

158

2
PARAMETER

[Pr.]


<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name</th>
<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial Value</th>
<th>Reference</th>
<th>Pr.</th>
<th>Pr.</th>
<th>Instruction Code</th>
<th>Control Mode-based Correspondence Table</th>
<th>Parameter Copy</th>
<th>Parameter Clear</th>
<th>All Parameter Clear</th>
</tr>
</thead>
<tbody>
<tr>
<td>244</td>
<td>Cooling fan operation selection</td>
<td>0, 1</td>
<td>1</td>
<td>241</td>
<td>244</td>
<td>34</td>
<td>B4</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>245</td>
<td>Rated slip</td>
<td>0 to 50%, 9999</td>
<td>0.01%</td>
<td>9999</td>
<td>391</td>
<td>245</td>
<td>35</td>
<td>B5</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>246</td>
<td>Slip compensation time constant</td>
<td>0 to 10s</td>
<td>0.1s</td>
<td>9999</td>
<td>246</td>
<td>36</td>
<td>B6</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>247</td>
<td>Constant-power range slip compensation selection</td>
<td>0, 1, 9999</td>
<td>1</td>
<td>34</td>
<td>247</td>
<td>37</td>
<td>B7</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>250</td>
<td>Slip</td>
<td>0.1 to 100%</td>
<td>0.01%</td>
<td>9999</td>
<td>330</td>
<td>250</td>
<td>3A</td>
<td>B8</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>251</td>
<td>Slip compensation time constant</td>
<td>0.01 to 10s</td>
<td>0.01s</td>
<td>391</td>
<td>251</td>
<td>3B</td>
<td>B9</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>252</td>
<td>Slip compensation selection</td>
<td>0, 1, 9999</td>
<td>1</td>
<td>43</td>
<td>252</td>
<td>3C</td>
<td>B10</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>253</td>
<td>Stop selection</td>
<td>0 to 100s, 1000 to 1100s, 8888, 9999</td>
<td>0.1s</td>
<td>9999</td>
<td>253</td>
<td>3D</td>
<td>B11</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>254</td>
<td>Output phase loss protection selection</td>
<td>0, 1, 9999</td>
<td>1</td>
<td>38</td>
<td>254</td>
<td>3E</td>
<td>B12</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>255</td>
<td>Frequency compensation</td>
<td>0 to 200%</td>
<td>0.1%</td>
<td>50%</td>
<td>217</td>
<td>255</td>
<td>3F</td>
<td>B13</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>256</td>
<td>Frequency compensation</td>
<td>0 to 200%</td>
<td>0.1%</td>
<td>150%</td>
<td>217</td>
<td>256</td>
<td>40</td>
<td>C0</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>257</td>
<td>Life diagnosis</td>
<td>0 to 15</td>
<td>1</td>
<td>36</td>
<td>257</td>
<td>40</td>
<td>C1</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>258</td>
<td>Life alarm status display</td>
<td>0 to 100%</td>
<td>1%</td>
<td>100%</td>
<td>364</td>
<td>258</td>
<td>41</td>
<td>C2</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>259</td>
<td>Inrush current limit circuit life display</td>
<td>0 to 100%</td>
<td>1%</td>
<td>100%</td>
<td>364</td>
<td>259</td>
<td>42</td>
<td>C3</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>260</td>
<td>PWM frequency automatic switchover</td>
<td>0, 1</td>
<td>1</td>
<td>43</td>
<td>260</td>
<td>43</td>
<td>C4</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>261</td>
<td>Power failure stop selection</td>
<td>0, 1, 2</td>
<td>1</td>
<td>37</td>
<td>261</td>
<td>44</td>
<td>C5</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>262</td>
<td>Subtracted frequency at deceleration start</td>
<td>0 to 20Hz</td>
<td>0.01Hz</td>
<td>3Hz</td>
<td>373</td>
<td>262</td>
<td>45</td>
<td>C6</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>263</td>
<td>Subtraction starting frequency</td>
<td>0 to 120Hz, 9999</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>373</td>
<td>263</td>
<td>46</td>
<td>C7</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>264</td>
<td>Power-failure deceleration time</td>
<td>0 to 3600/360s, 9999</td>
<td>0.1/0.01s</td>
<td>9999</td>
<td>373</td>
<td>264</td>
<td>47</td>
<td>C8</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>265</td>
<td>Power-failure deceleration time switchover frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>373</td>
<td>265</td>
<td>48</td>
<td>C9</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>266</td>
<td>Terminal 4 input selection</td>
<td>0, 1, 2</td>
<td>1</td>
<td>217</td>
<td>266</td>
<td>49</td>
<td>CB</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>267</td>
<td>Parameter for manufacturer setting</td>
<td>267</td>
<td>50</td>
<td>CC</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>268</td>
<td>Rotation direction detection selection at restarting</td>
<td>0, 1, 9999</td>
<td>1</td>
<td>367</td>
<td>268</td>
<td>51</td>
<td>CD</td>
<td>2</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>300</td>
<td>BCD input bias</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>0Hz</td>
<td>229</td>
<td>300</td>
<td>00</td>
<td>80</td>
<td>3</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>301</td>
<td>BCD input gain</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>229</td>
<td>301</td>
<td>01</td>
<td>81</td>
<td>3</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>302</td>
<td>BIN input bias</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>0Hz</td>
<td>229</td>
<td>302</td>
<td>02</td>
<td>82</td>
<td>3</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>303</td>
<td>BIN input gain</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>60Hz</td>
<td>229</td>
<td>303</td>
<td>03</td>
<td>83</td>
<td>3</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>304</td>
<td>Digital input and analog input compensation enable/disable selection</td>
<td>0 to 3, 10 to 13, 9999</td>
<td>1</td>
<td>229</td>
<td>304</td>
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**Parameter Table**

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**Parameter for manufacturer setting** (Control Mode-based Correspondence Table 2)

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**Note:** The table continues with other parameters and their settings, including communication protocols, operation modes, and various control parameters. Each parameter is listed with its setting range, default value, and possible values for each setting.
## Calibration Parameters

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<th>Reference</th>
<th>Option</th>
<th>Instruction Code</th>
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<td>FM terminal calibration</td>
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**Notes:**
1. Differ according to capacities. (0.75K/1.5K to 3.7K/5.5K, 7.5K/11K to 37K/45K, 55K/75K or more)
2. Differ according to capacities. (55K or less/75K or more)
3. Differ according to capacities. (7.5K or less/11K or more)
4. Differ according to capacities. (7.5K or less/11K to 55K/75K or more)
5. Setting can be made for the 75K or more.
6. The initial value differs according to the voltage class. (200V class/400V class)
7. Can be read and written by only communication from the PU connector.
8. The parameter number in parentheses is the one for use with the parameter unit (FR-PU4A/FR-PU07).
9. These parameters are communication parameters that are not cleared when parameter clear (all clear) is executed from RS-485 communication.
For simple variable-speed operation of the inverter, the initial setting of the parameters may be used as they are. Set the necessary parameters to meet the load and operational specifications. Parameter setting, change and check can be made from the operation panel.

- **•** indicates simple mode parameters. (initially set to extended mode)
- **•** The parameters marked with **•** in the table allow its setting to be changed during operation even if "0" (initial value) is set in [Pr. 77 Parameter write selection].
- Symbols in the table indicate parameters which function when an option is mounted.
- **•** FR-A7AX E kit, **•** FR-A7AY E kit, **•** FR-A7AR E kit, **•** FR-A7NC E kit, **•** FR-A7ND E kit, **•** FR-A7NL E kit, **•** FR-A7NP E kit
- These instruction codes are used for parameter read and write by using Mitsubishi inverter protocol with the RS-485 communication.

<table>
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<tr>
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<th>Option</th>
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<td>2.1.3</td>
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<td>120Hz</td>
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- 6D E0 4
- 495 EF EF EF
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- 01 81 5
- 02 82 5
- 03 83 5
- 04 84 5
- 24 85 5
- 59 86 5
- 17 87 5
- 29 88 5
- 17 89 5
- 17 8A 5
- 17 8B 5
- 17 8C 5
- 00 8D 5
- 00 8E 5
- 00 8F 5
- 02 90 5
- 02 91 5
- 02 92 5
- 31 93 5
- 03 94 5
- 04 95 5
- 05 96 5
- 06 97 5
- 07 98 5
- 08 99 5
- 09 AA 5
- 0A AB 5
- 0B AC 5
- 0C AD 5
- 0D AE 5
- 0E AF 5
- 0F BG 5
- 10 BH 5
- 11 BI 5
- 12 BJ 5
- 13 BK 5
- 14 BL 5
- 15 BM 5
- 16 BN 5
- 17 BO 5
- 18 BP 5
- 19 BQ 5
- 20 BR 5
- 21 BS 5
- 22 BT 5
- 23 BU 5
- 24 BV 5
- 25 BW 5
- 26 BX 5
- 27 BY 5
- 28 BZ 5
- 29 CA 5
- 2A CB 5
- 2B CC 5
- 2C CD 5
- 2D CE 5
- 2E CF 5
- 2F CG 5
- 30 CH 5
- 31 CI 5
- 32 CJ 5
- 33 CK 5
<p>| Function | Name | Setting Range | Minimum Setting | Initial Value | Refer to Page | [Pr.] | Option | Instruction Code | Control Mode-based Correspondence | General- | Parameter | Parameter | Parameter | Clear | All Parameter Clear |
|----------|------|---------------|-----------------|---------------|---------------|-------|--------|-----------------|---------------------------------| purpose- | Copy | Clear | All Clear |
| Free parameter | Free parameter 1 | 0 to 9999 | 1 | 9999 | 388 | 888 | | | S8 | D6 | 8 | 0 | 0 | 0 | x | x |
| | Free parameter 2 | 0 to 9999 | 1 | 9999 | 388 | 889 | | | S9 | D9 | 8 | 0 | 0 | 0 | x | x |
| | FM terminal calibration | - | - | - | 356 | | | | C0 | (900) | | 5C | DD | 1 | 0 | 0 | 0 | x | x |
| | AM terminal calibration | - | - | - | 356 | | | | C1 | (901) | | 5D | DD | 1 | 0 | 0 | 0 | x | x |
| | Terminal 2 frequency setting bias frequency | 0 to 430Hz | 0.01Hz | 0Hz | 217 | | | | C2 | (902) | | SE | DE | 1 | 0 | 0 | 0 | 0 | x | x |
| | Terminal 2 frequency setting bias | 0 to 300% | 0.1% | 0% | 217 | | | | C3 | (903) | | SE | DE | 1 | 0 | 0 | 0 | x | x |
| | Terminal 2 frequency setting gain frequency | 0 to 400Hz | 0.01Hz | 60Hz | 217 | | | | C25 | (903) | | SD | DD | 1 | 0 | 0 | 0 | x | x |
| | Terminal 2 frequency setting gain | 0 to 300% | 0.1% | 100% | 217 | | | | C4 | (903) | | SF | DF | 1 | 0 | 0 | 0 | 0 | x | x |
| | Terminal 4 frequency setting bias frequency | 0 to 430Hz | 0.01Hz | 0Hz | 217 | | | | C6 | (904) | | SE | EE | 1 | 0 | 0 | 0 | 0 | x | x |
| | Terminal 4 frequency setting bias | 0 to 300% | 0.1% | 20% | 217 | | | | C8 | (904) | | SE | EE | 1 | 0 | 0 | 0 | 0 | x | x |
| | Terminal 4 frequency setting gain frequency | 0 to 400Hz | 0.01Hz | 60Hz | 217 | | | | C25 | (905) | | SE | EE | 1 | 0 | 0 | 0 | 0 | x | x |
| | Terminal 4 frequency setting gain | 0 to 300% | 0.1% | 100% | 217 | | | | C7 | (905) | | SE | EE | 1 | 0 | 0 | 0 | 0 | x | x |
| | Frequency setting voltage bias frequency (built-in potentiometer) | 0 to 400Hz | 0.01Hz | 0 | 380 | | | | C22 | (922) | | 16 | 96 | 9 | 0 | 0 | 0 | 0 | x | x |
| | Frequency setting voltage bias (built-in potentiometer) | 0 to 300% | 0.1% | 0 | 380 | | | | C23 | (922) | | 16 | 96 | 9 | 0 | 0 | 0 | 0 | x | x |
| | Frequency setting voltage gain frequency (built-in potentiometer) | 0 to 400Hz | 0.01Hz | 60Hz | 390 | | | | C24 | (922) | | 17 | 97 | 9 | 0 | 0 | 0 | 0 | x | x |
| | Frequency setting voltage gain (built-in potentiometer) | 0 to 300% | 0.1% | 100% | 390 | | | | C25 | (922) | | 17 | 97 | 9 | 0 | 0 | 0 | 0 | x | x |</p>
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<tr>
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<th>Option</th>
<th>Instruction Code</th>
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<th>Comment</th>
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<tr>
<td>[Pr.] 990</td>
<td>PU buzzer control</td>
<td>0, 1</td>
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<tr>
<td>[Pr.] 991</td>
<td>PU contrast adjustment</td>
<td>0 to 63</td>
<td>1</td>
<td>58</td>
<td>389</td>
<td>5B</td>
<td>Write</td>
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<td>Pr.CL - FC</td>
<td>Use of PU Unit in Network Operation Mode</td>
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<td>0</td>
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<td>ALLC</td>
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<td>0</td>
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<td>ALLC</td>
<td>Write</td>
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<td>Write</td>
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<td>Pr.CL - FC</td>
<td>Use of PU Unit in Network Operation Mode</td>
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<td>Initial value change list</td>
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<td>-</td>
<td>-</td>
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<td>Pr.CH</td>
<td>Write</td>
<td></td>
<td>Pr.CH - -</td>
<td>Use of PU Unit in Network Operation Mode</td>
</tr>
</tbody>
</table>

*1 Differ according to capacities.
6%: 0.75K or less
4%: 1.5K to 3.7K
3%: 5.5K, 7.5K
2%: 11K, 15K

*2 Differ according to capacities.
5s: 3.7K or less
10s: 5.5K, 7.5K
15s: 11K, 15K

*3 Differ according to capacities.
6%: 0.1K, 0.2K
4%: 0.4K to 7.5K
2%: 11K, 15K

*4 Write is disabled in the communication mode (Network operation mode) from the PU connector.

*5 The initial value differs according to the voltage class. (200V class/400V class)

*6 Differ according to \[Pr. 71\] setting.

*7 Set this parameter when calibrating the operation panel built-in potentiometer for the FR-E500 series operation panel (PA02) connected with cable.

*8 The parameter number in parentheses is the one for use with the operation panel (PA02) for the FR-E500 series or parameter unit (FR-PU04/FR-PU07).

*9 These parameters are communication parameters that are not cleared when parameter clear (all clear) is executed from RS-485 communication. (Refer to page 441 for RS-485 communication)
### 2.1.4 FR-D700

In the initial setting, only the simple mode parameters are displayed. Set [Pr. 160 User group read selection] as required.

• Indicates simple mode parameters.

• The parameters marked with \[ \] in the table allow its setting to be changed during operation even if 0 (initial value) is set in \[ Pr. 77 Parameter write selection \].

• Symbols in the control mode-based correspondence table indicate the following:
  - Valid
  - Unusable parameter

• Symbols in the parameter copy, parameter clear, and all parameter clear columns indicate the following:
  - Valid
  - Invalid

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial Value</th>
<th>Refer to Page</th>
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<th>Control Mode-based Correspondence Table</th>
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<th>Setting Range</th>
<th>Minimum Setting Increments</th>
<th>Initial Value</th>
<th>Refer to Page</th>
<th>Instruction Code</th>
<th>Control Mode-based Correspondence Table</th>
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<tbody>
<tr>
<td>1</td>
<td>Torque boost</td>
<td>0 to 50%</td>
<td>0.1%</td>
<td>0/60/90%</td>
<td>264</td>
<td></td>
<td></td>
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<tr>
<td>2</td>
<td>Minimum frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
<td>120Hz</td>
<td>234</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Maximum frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>400Hz</td>
<td>244</td>
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<td></td>
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<tr>
<td>4</td>
<td>Break frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>99Hz</td>
<td>244</td>
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<td></td>
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<tr>
<td>5</td>
<td>Vector-based setting (high speed)</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>30Hz</td>
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<tr>
<td>6</td>
<td>Vector-based setting (low speed)</td>
<td>0 to 35Hz</td>
<td>0.01Hz</td>
<td>30Hz</td>
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<td>7</td>
<td>Acceleration</td>
<td>0 to 380%</td>
<td>0.1s</td>
<td>5/10s</td>
<td>234</td>
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<tr>
<td>8</td>
<td>Deceleration</td>
<td>0 to 380%</td>
<td>0.1s</td>
<td>5/10s</td>
<td>234</td>
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<tr>
<td>9</td>
<td>Electronic thermal O/L relay</td>
<td>0 to 500A</td>
<td>0.01A</td>
<td>Rated inverter current</td>
<td>379</td>
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<td>10</td>
<td>DC injection brake operation frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
<td>9Hz</td>
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<td>11</td>
<td>DC injection brake operation time</td>
<td>0 to 10s</td>
<td>0.1s</td>
<td>3s</td>
<td>325</td>
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<td>DC injection brake operation voltage</td>
<td>0 to 30%</td>
<td>0.1%</td>
<td>4%</td>
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<td>Starting frequency</td>
<td>0 to 60Hz</td>
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<td>1 to 2</td>
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<td>Jog frequency</td>
<td>0 to 400Hz</td>
<td>0.01Hz</td>
<td>9Hz</td>
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<td>16</td>
<td>Jog acceleration/deceleration time</td>
<td>0 to 3800ms</td>
<td>0.1s</td>
<td>5s</td>
<td>213, 234</td>
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<td>2, 4</td>
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<td>Inverse vector gain frequency</td>
<td>0 to 150Hz, 8888, 9999</td>
<td>0.1Hz</td>
<td>9999</td>
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<td>19</td>
<td>Inverse vector gain reference frequency</td>
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<td>0.01Hz</td>
<td>60Hz</td>
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<td>0.01Hz</td>
<td>5Hz</td>
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<td>21</td>
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<td>0 to 200%</td>
<td>0.1%</td>
<td>150%</td>
<td>263</td>
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<td>22</td>
<td>Stall prevention operation level compensation factor at double speed</td>
<td>0 to 200%, 9999</td>
<td>0.1%</td>
<td>9999</td>
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<td>0 to 200%, 9999</td>
<td>0.1%</td>
<td>9999</td>
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<td>Highspeed maximum frequency &amp; 3</td>
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<tr>
<td>31</td>
<td>Frequency jump 1A</td>
<td>0 to 400Hz, 9999</td>
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<td>31</td>
<td>F, SF, 0</td>
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<td>32</td>
<td>Frequency jump 1B</td>
<td>0 to 400Hz, 9999</td>
<td>0.01Hz</td>
<td>9999</td>
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</tr>
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<td>43</td>
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<td>0.01Hz</td>
<td>9999</td>
<td>9999</td>
<td>70</td>
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<td>A9, 0</td>
</tr>
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<td>44</td>
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<td>0.1s</td>
<td>5/10s</td>
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<td>9999</td>
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<td>47</td>
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<td>9999</td>
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<td>0 to 5a, 9999</td>
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<td>6Hz</td>
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<td>6Hz</td>
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<td>C6, 0</td>
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<td>6Hz</td>
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<td>72</td>
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<td>73</td>
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<td>0 to 2, 3, 4, 5, 6, 7, 8, 9, 10, 11</td>
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<td>74</td>
<td>74</td>
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</table>

* Pr. Parameter
* Instruction Code
  - Read
  - Write
  - Storable
  - V/F control
  - General-purpose magnetic-flux vector control

* Parameter Copy
* Parameter Clear
* An All Parameter Clear
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<th>Minimum Setting Increments</th>
<th>Initial Value</th>
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<td>0 to 7.5kW, 0.1 to 7.5kW, 0.1 to 7.5kW</td>
<td>0.01kW</td>
<td>0.01kW</td>
<td>0.01kW</td>
<td>252, 258</td>
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<td>Rated motor voltage</td>
<td>0 to 1000V</td>
<td>0.1V</td>
<td>0.1V</td>
<td>0.1V</td>
<td>99</td>
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<tr>
<td>Motor constant (R1)</td>
<td>0 to 50Ω</td>
<td>0.001Ω</td>
<td>0.001Ω</td>
<td>0.001Ω</td>
<td>80, 81, 82</td>
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<td>Auto-tuning setting/status</td>
<td>0, 1, 2, 3, 4, 5, 6, 7</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<td>0 to 7, 8, 10, 12, 14, 15, 24, 25, 61, 62, 9999</td>
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<tr>
<td>180 RL terminal function selection</td>
<td>0 to 7, 8, 10, 12, 14, 16, 18, 24, 25, 65 to 67, 9999</td>
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<tr>
<td>181 RM terminal function selection</td>
<td>0 to 7, 8, 10, 12, 14, 16, 18, 24, 25, 65 to 67, 9999</td>
</tr>
<tr>
<td>182 RH terminal function selection</td>
<td>0 to 7, 8, 10, 12, 14, 16, 18, 24, 25, 9999</td>
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<tr>
<td>190 RUN terminal function selection</td>
<td>0, 1, 2, 4, 7, 8, 11 to 16, 18, 20, 26, 28, 64, 70, 80, 90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 125, 126, 146, 147, 164, 170, 180, 190, 191, 193, 195, 196, 198, 199, 9999</td>
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<tr>
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<td>0, 1, 2, 4, 7, 8, 11 to 16, 18, 20, 26, 28, 64, 70, 80, 90, 91, 93, 95, 96, 98, 99, 100, 101, 103, 104, 107, 108, 111 to 116, 125, 126, 146, 147, 164, 170, 180, 190, 191, 193, 195, 196, 198, 199, 9999</td>
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<tr>
<td>232 Multi-speed setting (speed 8)</td>
<td>0 to 400Hz, 9999</td>
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<td>233 Multi-speed setting (speed 9)</td>
<td>0 to 400Hz, 9999</td>
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<td>234 Multi-speed setting (speed 10)</td>
<td>0 to 400Hz, 9999</td>
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<td>235 Multi-speed setting (speed 11)</td>
<td>0 to 400Hz, 9999</td>
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<td>236 Multi-speed setting (speed 12)</td>
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<td>238 Multi-speed setting (speed 14)</td>
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<td>259 Main circuit capacitor life measuring</td>
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**Parameter Table**

- **Function**: Description of the function.
- **Name**: Name of the parameter.
- **Setting Range**: Range of values that can be set.
- **Minimum Setting Increments**: Smallest increment by which the setting can be changed.
- **Initial Value**: Default value for the parameter.
- **Refer to Page**: Page number where more information can be found.

**Instruction Code**

- **Read**: Whether the parameter can be read.
- **Write**: Whether the parameter can be written.
- **Extended**: Whether the parameter has an extended range.
- **V/F control**: Whether the parameter is related to V/F control.
- **General-purpose magnetic-flux vector control**: Whether the parameter is related to general-purpose magnetic-flux vector control.

**Control Mode-based Correspondence Table**

- **Parameter Copy**: Whether the parameter can be copied to other parameters.
- **Parameter Clear**: Whether the parameter can be cleared.
- **All Parameter Clear**: Whether all parameters can be cleared.

**Correspondence Table**

- **Function**: Description of the function.
- **V/F control**: Whether the parameter is related to V/F control.
- **General-purpose magnetic-flux vector control**: Whether the parameter is related to general-purpose magnetic-flux vector control.
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<td>575</td>
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<td>CB</td>
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<tr>
<td>576 Output interruption level</td>
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<td>0.01Hz</td>
<td>0Hz</td>
<td>402</td>
<td>576</td>
<td>4C</td>
<td>CC</td>
<td>5</td>
<td>○</td>
<td>○</td>
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<td>100%</td>
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<td>577</td>
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<td>CD</td>
<td>5</td>
<td>○</td>
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<td>578 PID operation</td>
<td>0 to 3000s, 9999</td>
<td>0.1s</td>
<td>1s</td>
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<td>0Hz</td>
<td>402</td>
<td>579</td>
<td>4C</td>
<td>CC</td>
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<tr>
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<td>6Hz</td>
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<td>583</td>
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<td>CC</td>
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<td>0.01Hz</td>
<td>6Hz</td>
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<td>4D</td>
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<td>0 to 300%</td>
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<td>4E</td>
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<tr>
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<td>0.1%</td>
<td>100%</td>
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<td>587</td>
<td>4G</td>
<td>DG</td>
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<tr>
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<td>9999</td>
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<td>588</td>
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<td>1</td>
<td>9999</td>
<td>388</td>
<td>589</td>
<td>4I</td>
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<td>340</td>
<td>0.01%</td>
<td>340</td>
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<td>DJ</td>
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<td>0.01Hz</td>
<td>0Hz</td>
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<td>4L</td>
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<td>0.1%</td>
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<td>4M</td>
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<td>0.01Hz</td>
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<td>217</td>
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<td>4U</td>
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<td>390</td>
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<td>390</td>
<td>604</td>
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<tr>
<td>Frequency setting voltage gain frequency (built-in potentiometer)</td>
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<td>0.1%</td>
<td>60Hz</td>
<td>390</td>
<td>605</td>
<td>4Y</td>
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<td>○</td>
<td>○</td>
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<td>Frequency setting voltage bias (built-in potentiometer)</td>
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<td>0.01Hz</td>
<td>0</td>
<td>390</td>
<td>606</td>
<td>4Z</td>
<td>DZ</td>
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<tr>
<td>Frequency setting voltage bias (built-in potentiometer)</td>
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<td>607</td>
<td>4AA</td>
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<td>○</td>
<td>○</td>
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<tr>
<td>Frequency setting voltage gain frequency (built-in potentiometer)</td>
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<td>0.01Hz</td>
<td>60Hz</td>
<td>390</td>
<td>608</td>
<td>4AB</td>
<td>DAB</td>
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<td>○</td>
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<td>0.1%</td>
<td>60Hz</td>
<td>390</td>
<td>609</td>
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<tr>
<td>PU buzzer control</td>
<td>0 to 63</td>
<td>1</td>
<td>58</td>
<td>389</td>
<td>610</td>
<td>4AD</td>
<td>DAD</td>
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<tr>
<td>PU buzzer control</td>
<td>0 to 9999</td>
<td>1</td>
<td>9999</td>
<td>389</td>
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<td>DA</td>
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<td>○</td>
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<tr>
<td>Function</td>
<td>[Pr.]</td>
<td>Name</td>
<td>Setting Range</td>
<td>Minimum Setting Increments</td>
<td>Initial Value</td>
<td>Refer to Page</td>
<td>[Pr.]</td>
<td>Instruction Code</td>
<td>Control Mode-based Correspondence Table</td>
<td></td>
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<td>Read Write Extend VIF control General-purpose magnetic-flux vector control Parameter Copy Parameter Clear All Parameter Clear</td>
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<tr>
<td>Pr.CL</td>
<td>Parameter clear</td>
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<td>1</td>
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<td>—</td>
<td>Pr.CL</td>
<td>-</td>
<td>FC</td>
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<td>All parameter clear</td>
<td>0, 1</td>
<td>1</td>
<td>0</td>
<td>—</td>
<td>ALLC</td>
<td>-</td>
<td>FC</td>
<td>-</td>
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<td>Er.CL</td>
<td>Faults history clear</td>
<td>0, 1</td>
<td>1</td>
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<td>—</td>
<td>Er.CL</td>
<td>-</td>
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<td>Pr.CH</td>
<td>Initial value change list</td>
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<td>Pr.CH</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

*1 Differ according to capacities.
6%: 0.75K or less
4%: 1.5K to 3.7K
3%: 5.5K, 7.5K
*2 Differ according to capacities.
5s: 3.7K or less
10s: 5.5K, 7.5K
*3 Write is disabled in the communication mode (network operation mode) from the PU connector.
*4 Set this parameter when calibrating the operation panel built-in potentiometer for the FR-E500 series operation panel (PA02) connected with cable.
*5 The parameter number in parentheses is the one for use with the operation panel (PA02) for the FR-E500 series or parameter unit (FR-PU04/FR-PU07).
*6 These parameters are communication parameters that are not cleared when parameter clear (all clear) is executed from RS-485 communication. (Refer to page 441 for RS-485 communication)
### 2.2 List of parameters classified by purpose of use

#### 2.2.1 FR-A700, F700

Set parameters according to the operating conditions. The following list indicates purpose of use and corresponding parameters.

<table>
<thead>
<tr>
<th>Purpose of Use</th>
<th>Parameter Number</th>
</tr>
</thead>
<tbody>
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<td><strong>Control mode</strong></td>
<td>FR-A700</td>
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<tr>
<td>Change the control method</td>
<td></td>
</tr>
<tr>
<td>FR-A700 (contact input)</td>
<td></td>
</tr>
<tr>
<td>Frequency setting</td>
<td></td>
</tr>
<tr>
<td>Position control by vector control</td>
<td></td>
</tr>
<tr>
<td>Torque limit</td>
<td></td>
</tr>
<tr>
<td>Speed control by vector control and vector control</td>
<td></td>
</tr>
<tr>
<td>Torque command</td>
<td></td>
</tr>
<tr>
<td>Torque control by vector control and Real sensorless control</td>
<td></td>
</tr>
<tr>
<td>Speed control by vector control and Real sensorless control</td>
<td></td>
</tr>
<tr>
<td>Control method Change the control method</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Speed control by Real sensorless vector control and vector control</strong></td>
<td></td>
</tr>
<tr>
<td>Torque limit</td>
<td></td>
</tr>
<tr>
<td>Position control by Vector control</td>
<td></td>
</tr>
<tr>
<td>Speed limit</td>
<td></td>
</tr>
<tr>
<td>Speed control by Vector control</td>
<td></td>
</tr>
<tr>
<td><strong>Position control by vector control</strong></td>
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<tr>
<td>Position control by pulse train input of the inverter</td>
<td></td>
</tr>
<tr>
<td>Setting the electronic gear</td>
<td></td>
</tr>
<tr>
<td>Setting of positioning adjustment parameter</td>
<td></td>
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<tr>
<td>Gain adjustment for torque control</td>
<td></td>
</tr>
<tr>
<td><strong>Adjust the output torque (current) of the motor</strong></td>
<td></td>
</tr>
<tr>
<td>Torque limit</td>
<td></td>
</tr>
<tr>
<td>Torque control by vector control and vector control</td>
<td></td>
</tr>
<tr>
<td>Torque limit</td>
<td></td>
</tr>
<tr>
<td>Position control by pulse train input of the inverter</td>
<td></td>
</tr>
<tr>
<td>Setting the electronic gear</td>
<td></td>
</tr>
<tr>
<td>Setting of positioning adjustment parameter</td>
<td></td>
</tr>
<tr>
<td>Gain adjustment for torque control</td>
<td></td>
</tr>
<tr>
<td><strong>Limit the output frequency</strong></td>
<td></td>
</tr>
<tr>
<td>Maximum/minimum frequency</td>
<td></td>
</tr>
<tr>
<td>Avoid mechanical resonance point (frequency jump)</td>
<td></td>
</tr>
<tr>
<td>Speed limit</td>
<td></td>
</tr>
<tr>
<td><strong>Set V/F pattern</strong></td>
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</tr>
<tr>
<td>Base frequency, voltage</td>
<td></td>
</tr>
<tr>
<td>V/F pattern matching application</td>
<td></td>
</tr>
<tr>
<td>Adjustable points V/F</td>
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<tr>
<td>Frequency setting with terminals (contact input)</td>
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<tr>
<td>Multi-speed setting operation</td>
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<tr>
<td>Jog operation</td>
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<tr>
<td>Input compensation of multi-speed and reference setting</td>
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</tr>
<tr>
<td>Remote setting function</td>
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</tr>
<tr>
<td>Purpose of Use</td>
<td>Parameter Number</td>
</tr>
<tr>
<td>---------------------------------------------------</td>
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<tr>
<td>Function assignment of input terminal</td>
<td>FR-A700 FR-F700</td>
</tr>
<tr>
<td>Start signal selection</td>
<td>[P. 7] [P. 9]</td>
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<tr>
<td>Logic selection of output stop signal (MRS)</td>
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<tr>
<td>Selection of action conditions of the second (third) function signal (Y130)</td>
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<tr>
<td>Function assignment of output terminal</td>
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<tr>
<td>Detection of output current (Y12 signal)</td>
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<td>Detection of zero current (Y13 signal)</td>
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<tr>
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<tr>
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<tr>
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<tr>
<td>Detection of output frequency (SU, FL2, FL3, FB, FB2, FB3, LS signal)</td>
<td>[P. 41 to P. 43] [P. 113] [P. 165]</td>
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<tr>
<td>Detection of output current (Y12 signal)</td>
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<tr>
<td>Detection of zero current (Y13 signal)</td>
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</table>
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</tr>
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<td>[P. 7], [P. 17], [P. 162 to P. 164], [P. 261 to P. 264]</td>
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When an undervoltage or a power failure occurs, the inverter can be decelerated to a stop.

### Operation setting at fault occurrence

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<th>Energy saving operation</th>
<th>Parameter Number</th>
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<td>Energy saving control selection (minimum excitation control)</td>
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### Frequency setting by analog input

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<th>Parameter Number</th>
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<td>[P. 7]</td>
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### Operation setting at fault occurrence

<table>
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**Parameter List:**

- FR-A700
- FR-F700

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<thead>
<tr>
<th>Parameter Number</th>
<th>Description</th>
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<tr>
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<td>Operation selection at power failure and instantaneous power failure</td>
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<tr>
<td>[P. 7], [P. 17], [P. 162 to P. 164], [P. 261 to P. 264]</td>
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<td>[P. 261 to P. 264]</td>
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<td>Instruction and reference value selection</td>
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<td>[Pr . 65], [Pr. 67 to Pr. 69]</td>
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## Purpose of Use

**Communication operation and setting**

- RS-485 communication initial setting
- Control of parameter write by communication
- ModbusRTU communication specifications
- Operation command source and speed command source during communication operation
- Use setup software (USB communication)
- NET mode command source selection
- ModbusRTU (communication protocol selection)

**Special operation and frequency control**

- PID control
- Sketch between the inverter operation and electronic bypass operation to use
- Operate at a high speed when a load is light (load torque high speed frequency control)
- Drop control
- Frequency control by pulse train input

**Useful functions**

- Free parameter
- Increase cooling fan life
- To determine the maintenance time of parts
- How much energy can be saved (energy saving monitor)

**Setting the parameter unit and operation panel**

- Parameter unit display language selection
- Operation selection of the operation panel
- Buzzer control of the operation panel
- Contrast adjustment of the parameter unit
2.2.2 FR-E700, D700

Set parameters according to the operating conditions. The following list indicates purpose of use and corresponding parameters.

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<td>Detection of output current (Y12 signal)</td>
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<tr>
<td>[Pr. 73, Pr. 248]</td>
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</tr>
<tr>
<td>[Pr. 73, Pr. 248]</td>
<td></td>
</tr>
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</tr>
<tr>
<td>--------------------------------------------------------</td>
<td>------------------</td>
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</tr>
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<tr>
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</table>
### 2.3 Operation mode

#### 2.3.1 Operation mode selection [Pr. 79]  (common)

The operation mode specifies the source of the start command and the frequency command for the inverter. Basically, there are following operation modes.

- **External operation mode**: For inputting start command and frequency command with an external potentiometer and switches which are connected to the control circuit terminal.
- **PU operation mode**: For inputting start command and frequency command with the operation panel (FR-DU07 / FR-PD07), parameter unit (FR-PU04 / FR-PD07), or RS-485 communication *4 using PU connector.
- **Network operation mode (NET operation mode)**: For inputting start command and frequency command with RS-485 terminal *2 or communication option *3.

The operation mode can be selected from the operation panel or with the communication instruction code. The operation mode is factory-set to allow the “PU operation” or “External operation mode” to be selected by using [A] and the “External operation mode” at power on.

Refer to page 434 for the “Network operation mode”.

---

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**Table 2.3.1 Operation mode selection**

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<th>Start command</th>
<th>External Operation command</th>
<th>Start command</th>
<th>Remarks</th>
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</thead>
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<tr>
<td></td>
<td>Operation mode selection</td>
<td>0</td>
<td>0</td>
<td>External/PU switching mode</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Switch with [A]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>79</td>
<td>Fixed to PU operation mode</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>79</td>
<td>Fixed to External operation mode</td>
<td>×</td>
<td>×</td>
<td>×</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>79</td>
<td>External/PU combined operation mode 1</td>
<td>○</td>
<td>×</td>
<td>×</td>
<td>○</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>79</td>
<td>External/PU combined operation mode 2</td>
<td>×</td>
<td>○</td>
<td>○</td>
<td>×</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>79</td>
<td>Switchover mode</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Switching is enabled while running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>79</td>
<td>PU operation interlock</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>External operation can be fixed with X12 signal</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0, 6, 7</td>
<td>79</td>
<td>16 signal/External/PU switching mode</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>Operation mode can be switched with X12 signal</td>
</tr>
</tbody>
</table>

---

*1 B connector for [A700] and mini B connector for [E700]  
[FTO0] and [D700] do not have USB connector.  
*2 [FTO0] and [D700] do not have RS-485 terminal.  
*3 Built-in option is not available for [D700].  
*4 For [E700] and [D700], change to Network operation mode for RS-485 communication with PU connector.

---

**Diagram**: Network operation mode
(1) External operation mode \([\text{Pr. 79} = 0, 2]\)

Select the External operation mode when the start command and the frequency command are applied from a frequency setting potentiometer, start switch, etc. which are provided externally and connecting them to the control circuit terminals of the inverter. Basically, parameter changing is disabled in the External operation mode. (Refer to page 384 for availability of parameter write).

When \([\text{Pr. 79} = 0, 2]\) is selected, the inverter is in the External operation mode at power-ON. (When using the Network operation mode, refer to page 434). When parameter changing is seldom necessary, setting \([\text{Pr. 79} = 0]\) fixes the operation mode to the External operation mode.

When frequent parameter changing is necessary, setting \([\text{Pr. 79} = 2]\) allows the operation mode to be changed easily to the PU operation mode by pressing \([\text{PU}]\) of the operation panel. When you switched to the PU operation mode for parameter change, always return to the External operation mode.

The STF and STR signal are used as a start command, and the voltage or current signal to terminal 2, 4, multi-speed signal, JOG signal, etc. are used as a frequency command.

(2) PU operation mode \([\text{Pr. 79} = 0, 1]\)

Select the PU operation mode when operating with a operation panel (FR-DU07/FR-PA07) or by keys on the parameter unit (FR-PU04/FR-PU07). For \([\text{PU} = \text{PU} (\text{PU2})]\), select PU operation mode for the communication using PU connector as well.

When \([\text{Pr. 79} = 1]\), the inverter enters the PU operation mode at power-ON. You cannot change to the other operation mode.

When \([\text{Pr. 79} = 0]\), External operation mode can be changed to PU operation mode with \([\text{PU}]\) of the operation panel.

The setting dial of the operation panel can be used for setting like a potentiometer. (Refer to page 214) When PU operation mode is selected, the PU operation mode signal (PU) can be output. For the terminal used for the PU signal output, assign the function by setting 10 (positive logic) or 110 (negative logic) in any of \([\text{Pr. } 190 \text{ to Pr. } 196 \text{ output terminal function selection}].)
(3) PU/External combined operation mode 1

[Pr. 79 = 3]

Select the PU/External combined operation mode 1 when inputting the frequency command from the operation panel (FR-DU07/FR-PA07) or parameter unit (FR-PU04/FR-PU07) and inputting the start command with the external start switch.

Select [Pr. 79 = 3]. You cannot change to the other operation mode.

When a frequency is input from the external signal by multi-speed setting, it has a higher priority than the frequency command from the PU. When AU signal is ON, command signal is given to terminal 4.

(4) PU/External combined operation mode 2

[Pr. 79 = 4]

Select the PU/External combined operation mode 2 when inputting the frequency command from the external potentiometer, multi-speed or JOG signal and inputting the start command by key operation of the operation panel (FR-DU07/FR-PA07) or parameter unit (FR-PU04/FR-PU07).

Select [Pr. 79 = 4]. You cannot change to the other operation mode.
(5) Switchover mode [Pr. 79 = 6]
When [Pr. 79 = 6] is set, you can switch between the PU operation, External operation and Network operation (when RS-485 terminals or communication option is used) while continuing operation.

When [Pr. 79 = 6] is set, you can switch between the PU operation, External operation and Network operation (when RS-485 terminals or communication option is used) while continuing operation.

<table>
<thead>
<tr>
<th>Operation Mode Switching</th>
<th>Switching Operation - Operating Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>External operation → PU operation</td>
<td>Select the PU operation mode with the operation panel or parameter unit.</td>
</tr>
<tr>
<td></td>
<td>• Rotation direction is the same as that of external operation.</td>
</tr>
<tr>
<td></td>
<td>• The frequency set with the potentiometer (frequency command) or like is used unchanged.</td>
</tr>
<tr>
<td></td>
<td>(Note that the setting will disappear when power is switched OFF or the inverter is reset.)</td>
</tr>
<tr>
<td>External operation → NET operation</td>
<td>Send the mode change command to the Network operation mode through communication.</td>
</tr>
<tr>
<td></td>
<td>• Rotation direction is the same as that of external operation.</td>
</tr>
<tr>
<td></td>
<td>• The value set with the setting potentiometer (frequency command) or like is used unchanged.</td>
</tr>
<tr>
<td></td>
<td>(Note that the setting will disappear when power is switched OFF or the inverter is reset.)</td>
</tr>
<tr>
<td>PU operation → External operation</td>
<td>Press the external operation key of the parameter unit.</td>
</tr>
<tr>
<td></td>
<td>• The rotation direction is determined by the input signal of the external operation.</td>
</tr>
<tr>
<td></td>
<td>• The set frequency is determined by the external frequency command signal.</td>
</tr>
<tr>
<td>NET operation → External operation</td>
<td>Command to change to external mode is transmitted by communication.</td>
</tr>
<tr>
<td></td>
<td>• The rotation direction is determined by the input signal of the external operation.</td>
</tr>
<tr>
<td></td>
<td>• The set frequency is determined by the external frequency command signal.</td>
</tr>
<tr>
<td>NET operation → PU operation</td>
<td>Send the PU operation mode with the operation panel or parameter unit.</td>
</tr>
<tr>
<td></td>
<td>• The rotation direction and frequency command in the Network operation mode are used unchanged.</td>
</tr>
</tbody>
</table>

(6) PU operation interlock [Pr. 79 = 7]

The PU operation interlock function is designed to forcibly change the operation mode to the External operation mode when the PU operation interlock signal (X12) input turns OFF.

This function prevents the inverter from being inoperative by the external command if the mode is accidentally left unchanged from PU operation mode.

Select [Pr. 79 = 7] (PU operation interlock).

For the terminal used for the X12 signal (PU operation interlock signal) input, set 12 in [Pr. 178 to Pr. 189 input terminal function selection] to assign functions.

When the X12 signal is not assigned, function of the MRS signal switches from MRS (output stop) to PU operation interlock signal. When the MRS signal is used as the PU operation interlock signal, the logic of the signal is as set in [Pr. 17]. When [Pr. 17 = 2], read ON as OFF and OFF as ON in the above explanation.

X12 (MRS) signal

<table>
<thead>
<tr>
<th>Function - Operation</th>
<th>Operation mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation mode</td>
<td>Parameter write</td>
</tr>
<tr>
<td>Operation mode (External, PU, NET) switching enabled</td>
<td>Parameter write enabled (depending on Pr. 77 Parameter write selection) and each parameter write conditions</td>
</tr>
<tr>
<td>Output stop during external operation</td>
<td>Parameter write disabled with exception of Pr. 79</td>
</tr>
</tbody>
</table>

X12 (MRS) signal

ON | Operation mode ON + OFF  
OFF | Forcibly switched to External operation mode

External operation allowed Switching to PU or NET operation mode is disabled

Parameter write enabled (depending on Pr. 77 Parameter write selection) and each parameter write conditions

Parameter write disabled with exception of Pr. 79

X12 (MRS) signal

<table>
<thead>
<tr>
<th>Operating condition</th>
<th>X12 (MRS) Status</th>
<th>Operating Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation mode</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU/NET</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Running             | ON + OFF  
|                   |                   | Disabled       |
| External            |                  |                 |
| Running             | OFF + OFF  
|                   |                   | Disabled       |
| External            |                  |                 |
| Running             | TO + ON  
|                   |                   | Enabled        |
| External            |                  |                 |
| Running             | OFF + ON  
|                   |                   | Disabled       |
| NET                 |                  |                 |
| Running             | ON + OFF  
|                   |                   | Disabled       |

The operation mode switches to the external operation mode independently of whether the start signal (STF, STR) is ON or OFF. Therefore, the motor is run in the External operation mode when the X12 (MRS) signal is turned OFF with either of STF and STR is ON.

1 At fault occurrence, pressing of the operation panel resets the inverter.

2 At fault occurrence, pressing of the operation panel resets the inverter.

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(7) Switching of operation mode by external signal (X16 signal)

When external operation and operation from the operation panel are used together, use of the PU-external operation switching signal (X16) allows switching between the PU operation mode and External operation mode during a stop (during a motor stop, start command OFF).

When \([\text{Pr. 79} = 0, 6, 7]\), the operation mode can be switched between the PU operation mode and External operation mode. (\([\text{Pr. 79} = 6]\) At switch-over mode, operation mode can be changed during operation)

For the terminal used for X16 signal input, set 16 in any of \([\text{Pr. 178 to 189 input terminal function selection}]\) to assign the function.

<table>
<thead>
<tr>
<th>Setting</th>
<th>X16 Signal State</th>
<th>Operation Mode</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON (External)</td>
<td>PU operation mode</td>
<td>Fixed to PU operation mode</td>
<td></td>
</tr>
<tr>
<td>OFF (PU)</td>
<td>External operation mode</td>
<td>Fixed to External operation mode (can be switched to NET operation mode)</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>PU operation mode</td>
<td>Fixed to PU operation mode</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>External operation mode</td>
<td>Fixed to External operation mode (can be switched to NET operation mode)</td>
<td></td>
</tr>
<tr>
<td>3, 4</td>
<td>External/PU combined operation mode</td>
<td>Fixed to External/PU combined mode</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>External operation mode</td>
<td>PU operation mode</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>External operation mode</td>
<td>PU operation mode</td>
<td></td>
</tr>
<tr>
<td>X12 (MRS)</td>
<td>External operation mode</td>
<td>PU operation mode</td>
<td></td>
</tr>
<tr>
<td>OFF</td>
<td>External operation mode</td>
<td>Fixed to External operation mode (forbids switching to External operation mode)</td>
<td></td>
</tr>
</tbody>
</table>

When \([\text{Pr. 79} = 7]\), the operation mode can be switched to External, PU or NET operation mode (Output stop in External operation mode)
### 2.4 Frequency setting

#### 2.4.1 When PU operation mode (key lock) [Pr. 161] **common**

Set the frequency setting from the operation panel (parameter unit).

When \([\text{Pr. } 161 = 0, 10]\), turn the setting dial of the operation panel and press \([\text{SET}]\) to set frequency. (Note that frequency changing is restricted by key lock setting.)

By setting \([\text{Pr. } 161 = 1, 11]\), frequency can be set only by turning the setting dial of the operation panel without pressing \([\text{SET}]\). (Note that frequency changing is restricted by key lock setting.) In this case, when the frequency is changed, it will be stored in EEPROM as the set frequency after 10s.

To make the setting dial and key operation valid again, press \([\text{SET}]\) for 2s.

Even if the setting dial and key operation are disabled, the monitor display and \([\text{HOLD}]\) are valid.

When using the parameter unit, inverter operation and frequency setting etc. are available regardless of \([\text{Pr. } 161]\) setting.

<table>
<thead>
<tr>
<th>[Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>161</td>
<td>Frequency setting/key lock operation selection</td>
<td>0</td>
<td>0, 10</td>
<td>Key lock invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Setting dial frequency setting mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Setting dial potentiometer mode</td>
</tr>
</tbody>
</table>

Set \([\text{Pr. } 161 = 10, 11]\), then press \([\text{SET}]\) for 2s to make the setting dial and key operation invalid. When the setting dial and key operation are invalid, \([\text{HOLD}]\) appears on the operation panel. When the setting dial and key operation is invalid, \([\text{HOLD}]\) appears if the setting dial or key operation is performed. (When the setting dial or key operation is not performed for 2s, the monitor display appears.)

To make the setting dial and key operation valid again, press \([\text{SET}]\) for 2s.

Even if the setting dial and key operation are disabled, the monitor display and \([\text{HOLD}]\) are valid.
2.4.2 When Jog operation [Pr. 15, 16] (common)

You can set the frequency and acceleration/deceleration time for Jog operation. Jog operation can be performed from either the External or the PU operation mode. This operation can be used for conveyor positioning, test operation, etc.

During Jog operation, the second acceleration/deceleration via RT signal cannot be selected. (The other second functions are valid). This function is invalid when [Pr. 79 = "3"]. Jog operation is invalid under position control. For [Pr. 1150], Jog operation is invalid with the position control of vector control.

<table>
<thead>
<tr>
<th>(Pr.)</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>Jog frequency</td>
<td>5Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency for Jog operation.</td>
</tr>
<tr>
<td>16</td>
<td>Jog acceleration/</td>
<td>0.5s</td>
<td>0 to 3600/</td>
<td>Acceleration/deceleration time cannot be set separately.</td>
</tr>
<tr>
<td></td>
<td>deceleration time</td>
<td></td>
<td>360s*</td>
<td></td>
</tr>
</tbody>
</table>

When the setting of [Pr. 17 Acceleration/deceleration (use increments)] is "0" (initial value), the setting range is "0 to 3600s" and the setting increments are "0.1s", and when the setting is "1", the setting range is "0 to 360s" and the setting increments are "0.01s".

[Pr. 21] is not available for . Setting range of [Pr. 16] is 0 to 3600s, and the increment is 0.1s.

(1) Jog operation from outside

When the JOG signal is ON, a start and stop can be made by the start signal (STF, STR). (The JOG signal is assigned to the terminal JOG in the initial setting.)

(2) Jog operation from PU

Press to choose the Jog operation mode.

Hold down the (or ) key to perform the operation.

When [Pr. 79 Operation mode selection = "4"], pressing (or ) of the parameter unit starts the inverter and pressing stops the inverter.
2.4.3 Multi-speed operation [Pr. 4 to 6, 24 to 27, 232 to 239] (common)

Can be used to change the preset speed in the parameter with the contact terminals. Each speed can be selected by merely turning ON or OFF the contact signals (RH, RM, RL, REX signals).

Refer to page 48 for the detail of input signal combinations.

The priority of the frequency command by the external signals is "Jog operation > Multi-speed operation > Terminal 4 analog input > Pulse train input > Terminal 2 analog input".

Valid in the External operation mode [Pr. 79 = 0, 2] or PU/external combined operation mode [Pr. 79 = 3, 4].

Multi-speed parameters can also be set in the PU or External operation mode.

### Table: Multi-speed parameters

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Multi-speed setting (high speed)</td>
<td>60Hz</td>
<td>0 to 400Hz</td>
<td>Frequency when RH turns ON</td>
</tr>
<tr>
<td>5</td>
<td>Multi-speed setting (middle speed)</td>
<td>30Hz</td>
<td>0 to 400Hz</td>
<td>Frequency when RM turns ON</td>
</tr>
<tr>
<td>6</td>
<td>Multi-speed setting (low speed)</td>
<td>10Hz</td>
<td>0 to 400Hz</td>
<td>Frequency when RL turns ON</td>
</tr>
<tr>
<td>24</td>
<td>Multi-speed setting (speed 4)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>Frequency from 4 speed to 15 speed can be set according to the combination of the RH, RM, RL and REX signals.</td>
</tr>
<tr>
<td>25</td>
<td>Multi-speed setting (speed 5)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>26</td>
<td>Multi-speed setting (speed 6)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>27</td>
<td>Multi-speed setting (speed 7)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>232</td>
<td>Multi-speed setting (speed 8)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>233</td>
<td>Multi-speed setting (speed 9)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>234</td>
<td>Multi-speed setting (speed 10)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>235</td>
<td>Multi-speed setting (speed 11)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>236</td>
<td>Multi-speed setting (speed 12)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>237</td>
<td>Multi-speed setting (speed 13)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>238</td>
<td>Multi-speed setting (speed 14)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
<tr>
<td>239</td>
<td>Multi-speed setting (speed 15)</td>
<td>9999</td>
<td>0 to 400Hz, 9999</td>
<td>9999: Not selected</td>
</tr>
</tbody>
</table>

#### (1) 3-speed setting [Pr. 4 to 6]

The inverter operates at frequencies set in [Pr. 4] when RH signal is ON, [Pr. 5] when RM signal is ON and [Pr. 6] when RL signal is ON.

In the initial setting, if two or three signals are simultaneously selected, priority is given to the set frequency of the lower signal.

For example, when the RH and RM signals turn ON, the RM signal [Pr. 5] has a higher priority.

#### (2) Multi-speed setting for 4 or more speeds [Pr. 24 to 27, 232 to 239]

Frequency from 4 speed to 15 speed can be set according to the combination of the RH, RM, RL and REX signals. Set the running frequencies in [Pr. 24 to 27, 232 to 239] (In the initial value setting, speed 4 to speed 15 are unavailable).

For the terminal used for REX signal input, set 8 in any of [Pr. 178 to 189 input terminal function selection] to assign the function.
2.4.4 When analog input (External operation mode) [Pr. 73, 74, 125, 126, 241, 242*, 243*, 252*, 253*, 267, 849*, C2 to C7 (Pr. 902 to Pr. 905), C30 to C33*(Pr. 926, 927)]

Frequency setting is available with 5VDC, 10VDC, 20mADC input and those combinations for external frequency command setting.

Select the input signal with [Pr. 73 Analog input selection] from 5VDC, 10VDC, and 4 to 20mADC. And set frequency for maximum input voltage or current with [Pr. 125, 126].

Analog input

<table>
<thead>
<tr>
<th>Input Terminal</th>
<th>DC power supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to +5V</td>
<td>2 and 5, or 4 and 5 Internal (terminal 10) or external</td>
</tr>
<tr>
<td>0 to +10V</td>
<td>2 and 5, or 4 and 5 Internal (terminal 10E)*1 or external</td>
</tr>
<tr>
<td>4 to 20mA</td>
<td>2 and 5, or 4 and 5 External</td>
</tr>
<tr>
<td>0 to ±5V</td>
<td>1 and 5 - External</td>
</tr>
<tr>
<td>0 to ±10V</td>
<td>1 and 5, or 0 and 5 - External</td>
</tr>
</tbody>
</table>

*(Pr.849, C30 to C33 (Pr.926, 927) are not available for common.)

(* [Pr.242, 243, 252, 253, 849, C30 to C33 (Pr.926, 927) are not available for common.)

(1) Selection of analog input specifications [Pr. 73, 267]

You can select the function that switches between forward rotation and reverse rotation according to the analog input terminal selection specifications, the override function and the input signal polarity.

For the terminals 2, 4 used for analog input, voltage input (0 to 5V, 0 to 10V) or current input (4 to 20mA) can be selected.

The current at terminal 2 and 4 is always 4 to 20mA when the voltage/current input switch is set to ON. When turning ON the voltage/current input switch, set input specifications of terminal to current input using [Pr. 73, 267].

Terminal 2, 4 is fixed for voltage input when the voltage/current input switch is set to OFF. When turning OFF the voltage/current input switch, set input specifications of the terminal to voltage input using [Pr. 73, 267].

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>73</td>
<td>Analog input selection</td>
<td>1</td>
<td>0 to 7, 10 to 17</td>
<td>You can select the input specifications of terminal 2 (0 to 5V, 0 to 10V, 4 to 20mA) and input specifications of terminal 1 (0 to ±5V, 0 to ±10V). Set the voltage/current input switch along with the selected input specification (voltage/current). Override and reversible operation can be selected.</td>
</tr>
<tr>
<td>267</td>
<td>Terminal 4 input selection</td>
<td>0</td>
<td>1</td>
<td>Terminal 4 input 0 to 5V Switch 1: ON Set the voltage/current input switch (Switch 1) along with the setting as shown on the left.</td>
</tr>
</tbody>
</table>
The terminal 1 (frequency setting auxiliary input) signal is added to the main speed setting signal of the terminal 2 or 4. When an override is selected, the terminal 1 or 4 is used for the main speed setting and the terminal 2 for the override signal (50% to 150% at 0 to 5V or 0 to 10V). (When the main speed of the terminal 1 or terminal 4 is not input, compensation by the terminal 2 is invalid.)

Use [Pr. 125 (P. 126) frequency setting gain] to change the maximum output frequency at input of the maximum output frequency command voltage (current). At this time, the command voltage (current) need not be input.

Also, the acceleration/deceleration time, which is a slope up/down to the acceleration/deceleration reference speed, is not affected by the change in [Pr. 7/7] setting.

When "4" is set in [Pr. 858 Terminal 4 function assignment], the setting of terminal 1, terminal 4 is used for stall prevention operation level setting. When terminal 1 and terminal 4 are used for frequency setting, set "0" (initial value) in [Pr. 855] and [Pr. 856].

Also when using [A700] with FR-A7AZ, terminal 6 is available. To use terminal 6 for frequency setting, set [Pr. 406 = 0]. (Refer to page 43)

<table>
<thead>
<tr>
<th>[Pr. 7/7] setting</th>
<th>Switch 2</th>
<th>Terminal 1 input</th>
<th>Terminal 4 input</th>
<th>Compensation input terminal and compensation method</th>
<th>Polarity</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>Yes</td>
</tr>
<tr>
<td>3</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>9</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>11</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>12</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>13</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>14</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>15</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>16</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
<tr>
<td>17</td>
<td>OFF</td>
<td>0 to 10V</td>
<td>0 to 10V</td>
<td>Terminal 1 Additional compensation</td>
<td>No</td>
</tr>
</tbody>
</table>

(Indicates the main speed setting)
You can select the function that switches between forward rotation and reverse rotation according to the analog input terminal specifications and input signal. For the terminal 2 for analog voltage input, 0 to 5V (initial value) or 0 to 10V can be selected. Either voltage input (0 to 5V, 0 to 10V) or current input (4 to 20mA initial value) can be selected for terminal 4 used for analog input. Change the input specifications to change [Pr. 267] and voltage/current input switch.

When [Pr. 561 PTC thermistor protection level ≠ 9999] in (indicating main speed setting) terminal 2 does not function as analog frequency command.
(2) Perform operation by analog input voltage

The frequency setting signal inputs 0 to 5VDC (or 0 to 10VDC) across the terminals 2 and 5. The 5V (10V) input is the maximum output frequency. The wiring length of the terminal 10, 2, 5 should be within 30m. When using FR-A7AZ, terminal 6 is also available. The power supply 5V (10V) can be input by either using the internal power supply or providing an external power supply. The internal power supply outputs 5VDC across terminals 10 and 5, or 10VDC across terminals 10 and 5.

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Inverter built-in Power Supply Voltage</th>
<th>Frequency Setting Resolution</th>
<th>[Pr. 73] Terminal 2 Input Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>5VDC</td>
<td>0.03Hz/60Hz</td>
<td>0 to 5VDC input</td>
</tr>
<tr>
<td>10E*</td>
<td>10VDC</td>
<td>0.015Hz/60Hz</td>
<td>0 to 10VDC input</td>
</tr>
</tbody>
</table>

* Not available for FR-E700.

When "1" (0 to 5 VDC) or "2" (0 to 10VDC) is set to [Pr. 73] and voltage/current input switch (switch 1) for the terminal 4 is turned OFF in [A700] or turned to V in [A700], the specification of the terminal 4 is voltage input. When the AU signal turns ON, the terminal 4 input becomes valid.

(3) Perform operation by analog input current

When the pressure or temperature is controlled constant by a fan, pump, etc., automatic operation can be performed by inputting the output signal 4 to 20mA of the adjuster to across the terminals 4 and 5. For [A700], set "0" (4 to 20mADC, initial value) to [Pr. 73] and current/voltage input switch (switch 1) of terminal 4 ON status. For [E700], set "0" to [Pr. 73] and current/voltage input switch to "I" (initial status). The AU signal must be turned ON to use the terminal 4.

To input current to terminal 2 in [A700], set one of "6, 7, 16, 17" to [Pr. 73] and current/voltage input switch (switch 2) of terminal 2 ON status. At this time, the AU signal need not be turned ON.
(4) Perform forward/reverse rotation by analog input (polarity reversible operation)

Setting any of "10 to 17" to [Pr. 73] in (A000, F000) enables polarity reversible operation.
Providing input (0 to ±5V or 0 to ±10V) to the terminal 1 enables forward/reverse rotation operation according to the polarity.

![Diagram of forward/reverse rotation characteristic](image-url)

Calibration input characteristic when bias voltage is other than 0% (STF is ON).

To enable reversible operation, set "10 or 11" to [Pr. 73] in (A000, F000)
(5) **Additional compensation**

(Pr. 242, 243)

The compensation signal can be added to the main speed setting for synchronous/continuous speed control operation, etc. The compensation input of the terminal 1 can also be added to the multi-speed setting or terminal 4 (initial value 4 to 20mA).

The added compensation for terminal 2 can be adjusted by [Pr. 242], and the compensation for terminal 4 by [Pr. 243].

**Analog command value using terminal 2**

\[
\text{Analog command value using terminal 2} = \left( \frac{\text{Terminal 2 input} + \text{Terminal 1 input}}{100} \right) \times \text{Pr. 242}
\]

**Analog command value using terminal 4**

\[
\text{Analog command value using terminal 4} = \left( \frac{\text{Terminal 4 input} + \text{Terminal 1 input}}{100} \right) \times \text{Pr. 243}
\]

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>242</td>
<td>Terminal 1 added compensation amount (terminal 2)</td>
<td>100%</td>
<td>0 to 100%</td>
<td>Set the ratio of added compensation amount when terminal 2 is the main speed.</td>
</tr>
<tr>
<td>243</td>
<td>Terminal 1 added compensation amount (terminal 4)</td>
<td>75%</td>
<td>0 to 100%</td>
<td>Set the ratio of added compensation amount when terminal 4 is the main speed.</td>
</tr>
</tbody>
</table>
(6) Override function [Pr. 252, 253]

Use the override function to change the main speed at a fixed ratio.

When an override is selected, the terminal 1 or terminal 4 is used for the main speed setting and the terminal 2 for the override signal. (When the main speed of the terminal 1 or terminal 4 is not input, compensation by the terminal 2 is invalid.)

When inputting compensation to multi-speed operation or remote setting, set [Pr. 28 Multi-speed input compensation selection = 1]. (Refer to page 227)

Using [Pr. 252, 253], set the override range. Use a following formula for the set frequency for override.

\[
\text{Main speed set frequency (Hz): Terminal 1, 4 input, multi-speed setting} \\
\text{Compensation amount (%): Terminal 2 input}
\]

Example: When [Pr. 73 = 5]

The set frequency changes as shown below according to the terminal 1 (main speed) and terminal 2 (auxiliary) inputs.

<table>
<thead>
<tr>
<th>Voltage across terminals 2 and 5</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 V</td>
<td>0</td>
</tr>
<tr>
<td>2.5 V</td>
<td>50</td>
</tr>
<tr>
<td>5 V</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Terminal 1 input voltage (V)</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50%</td>
<td>50</td>
</tr>
<tr>
<td>150%</td>
<td>150</td>
</tr>
<tr>
<td>200%</td>
<td>200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>252</td>
<td>Override bias</td>
<td>50%</td>
<td>0 to 200%</td>
<td>Set the bias side compensation value of override function</td>
</tr>
<tr>
<td>253</td>
<td>Override gain</td>
<td>150%</td>
<td>0 to 200%</td>
<td>Set the gain side compensation value of override function</td>
</tr>
</tbody>
</table>
(7) Bias and gain of frequency setting voltage (current) [Pr. 125, 126, 241, C2 to C7 (Pr. 902 to 905), C38 to C33 (Pr. 926, 927)]

(Available in A700 with FR-A7AZ.)

You can set the magnitude (slope) of the output frequency as desired in relation to the frequency setting signal (0 to 5VDC, 0 to 10VDC or 4 to 20mA/DC).

Refer to the following diagram for the relationships between the frequency setting signal and output frequencies. When using terminal 1 added compensation, terminal 2 (4) analog value + terminal 1 analog value is the analog calibration value.

1) Change the frequency at maximum analog input
Set a value in [Pr. 125 (C2)] when changing only the frequency setting (gain) of the maximum analog input voltage (current). [C3 (Pr. 902) to C7 (Pr. 905)] setting need not be changed. Set a value in [C32 (Pr. 927)] when using terminal 6 in A700 with FR-A7AZ.

2) Calibration of analog input bias and gain
As for voltage between frequency setting power supply terminal 10 (10E) and terminal 5, and input impedance of analog input terminal, there are variability in each inverters. Therefore exact output frequency for the frequency setting input is different in each inverters. When using a common frequency setting input for multiple inverters, calibration of frequency setting bias [C1 (C6)] and gain [C3 (C6)] is required for each inverters. When applying voltage (current) for calibration, the difference of the frequency setting input voltage (current) of [C1] and [C4] (C6) and [C7]) should be 0.6V (2mA) or more. If the difference is 0.5V (2mA) or less, a setting error will occur. Calibrate with [C3] to C7 (Pr. 926, 927) in terminal 6 in A700 with FR-A7AZ.

3) Analog input display unit changing
You can change the analog input display unit (%/V/mA) for analog input bias/gain calibration. Depending on the terminal input specification set to [Pr. 73], the display units of [C3 (Pr. 902), C4 (Pr. 903), C5 (Pr. 904), C6 (Pr. 904), C7 (Pr. 905), C31 (Pr. 926)] change as shown below.

<table>
<thead>
<tr>
<th>Analog Command (terminal 2, 4) [Pr. 74, 76]</th>
<th>[Pr. 241 = 0 (initial value)]</th>
<th>[Pr. 241 = 1]</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 5V input</td>
<td>Displayed in 0 to 100% (0.1% increments)</td>
<td>0 to 5V input</td>
</tr>
<tr>
<td>0 to 10V input</td>
<td>Displayed in 0 to 100% (0.1% increments)</td>
<td>0 to 10V input</td>
</tr>
<tr>
<td>0 to 20mA input</td>
<td>Displayed in 0 to 100% (0.1% increments)</td>
<td>0 to 20mA input</td>
</tr>
</tbody>
</table>

Analog input display is not displayed correctly if voltage is applied to terminal 1 when terminal 1 input specifications (0 to 5V, 0 to 10V, 0 to 20mA) and main speed (terminal 2, terminal 4 input) specifications (0 to 5V, 0 to 10V, 0 to 20mA) differ. (For example, 5V (100%) is analog displayed when 0V and 10V are applied to terminal 2 and terminal 1 respectively in the initial status.)

In this case, set [Pr. 241 = 0] (% display).

---

**PARAMETER**

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>125913</td>
<td>Terminal 2 frequency setting gain frequency</td>
<td>0.0V to 400V</td>
<td>0% to 100%</td>
<td>Set the frequency of terminal 2 input gain (maximum)</td>
</tr>
<tr>
<td>127913</td>
<td>Terminal 2 frequency setting gain frequency</td>
<td>0.0V to 400V</td>
<td>0% to 100%</td>
<td>Set the frequency of terminal 2 input gain (maximum)</td>
</tr>
<tr>
<td>241</td>
<td>Analog input display unit switcher</td>
<td>0</td>
<td>0</td>
<td>[Pr. 241 = 0] (% display)</td>
</tr>
<tr>
<td>242</td>
<td>Terminal 2 frequency setting gain frequency</td>
<td>0% to 100%</td>
<td>0% to 100%</td>
<td>Set the frequency of terminal 2 input gain (maximum)</td>
</tr>
<tr>
<td>246</td>
<td>Terminal 2 frequency setting gain frequency</td>
<td>0% to 100%</td>
<td>0% to 100%</td>
<td>Set the frequency of terminal 2 input gain (maximum)</td>
</tr>
<tr>
<td>926</td>
<td>Terminal 6 bias (speed)</td>
<td>0% to 300%</td>
<td>0% to 300%</td>
<td>Set the converted % on the bias side voltage of terminal 6 input</td>
</tr>
<tr>
<td>927</td>
<td>Terminal 6 gain frequency (speed)</td>
<td>0.0V to 400V</td>
<td>0% to 100%</td>
<td>Set the converted % on the gain side voltage of terminal 6 input</td>
</tr>
</tbody>
</table>

---

224
(8) Analog input filter and offset adjustment

**[Pr. 74, 849]**

You can adjust response level and stability of frequency command and torque command at analog input (terminal 1, 2, 4, terminal 6 (FR-A7AZ)).

For **[Pr. 74]**, if the setting of **[Pr. 822, 826]** (when RT signal is ON) is not 9999, **[Pr. 74]** setting is invalid. (Refer to page 323)

1) **Time constant of analog input**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Time Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Approx. 10ms</td>
</tr>
<tr>
<td>1</td>
<td>Approx. 20ms</td>
</tr>
<tr>
<td>2</td>
<td>Approx. 40ms</td>
</tr>
<tr>
<td>3</td>
<td>Approx. 80ms</td>
</tr>
<tr>
<td>4</td>
<td>Approx. 160ms</td>
</tr>
<tr>
<td>5</td>
<td>Approx. 320ms</td>
</tr>
<tr>
<td>6</td>
<td>Approx. 640ms</td>
</tr>
<tr>
<td>7</td>
<td>Approx. 1280ms</td>
</tr>
</tbody>
</table>

Increase the filter time constant if steady operation cannot be performed due to noise. A larger setting results in slower response. (Refer to the following table for time constant.)

2) **Offset adjustment of analog input**

For **[Pr. 849]**, if the setting of **[Pr. 822, 826]** (when RT signal is ON) is not 9999, **[Pr. 849]** setting is invalid. (Refer to page 323)

**[Pr. 849] offset adjustment**

When speed command by analog input is set, create the range where the motor remains stop to prevent malfunction at very low speed.

On the assumption that the **[Pr. 849]** setting 100% as 0, the offset voltage is offset as follows:

- **100%** **[Pr. 849]**......positive side
- **0%** **[Pr. 849]**......negative side

**Offset voltage = Voltage at 100% \( \times \frac{[\text{Pr. 849}]}{100} \)**

*According to the **[Pr. 74]** setting*
2.4.5 Remote setting function [Pr. 59] (common)

When “1 to 3” is set in [Pr. 59], the functions of the RH, RM signals are changed to input function of remote setting.

Setting is available for both PU operation mode and External operation mode.

Note that this is different with a function of motorized speed setter (FR-FK).

1) During acceleration
Set frequency increases when RH signal turns ON.
Speed of increase depends on [Pr. 44 Second acceleration/deceleration time].*1
When RH signal turns OFF, increase of set frequency is stopped and the set frequency at that moment is retained.

2) During deceleration
Set frequency decreases when RH signal turns ON.
Speed of decrease depends on [Pr. 45 Second deceleration time]. When “9999” is set to [Pr. 45], the speed of decrease is equal to the [Pr. 44] setting.*1
When RH signal turns OFF, decrease of set frequency is stopped and the set frequency at that moment is retained.

3) Output frequency
External operation
Frequency set with RH and RM operation + external operation frequency other than multi-speed (When making input compensation (terminal 1), set [Pr. 28 = 1]).

PU operation
Frequency set with RH and RM operation + PU operation frequency

4) Frequency setting storage
When [Pr. 59 = 1], the remotely-set frequency is stored every minute after turning OFF (ON) of both the RH (acceleration) and RM (deceleration) signals.
The set frequency when STF (STR) turned OFF is also stored. (The frequency is overwritten if the latest frequency is different from the past frequency when comparing the two. The state of the RL signal does not affect storing.)
When [Pr. 59 = 2, 3], set frequency is not stored. Therefore turning OFF the power and then turning ON will make the set frequency to 0Hz.

5) Setting Clear
Remotely-set frequency is cleared to 0Hz when RL signal turns ON with [Pr. 59 = 1 or 2], or when STF(STR) signal turns OFF with [Pr. 59 = 3].

*1 When the acceleration or deceleration signal switches on, the set frequency varies according to the slope set in [Pr. 44] and [Pr. 45].
The acceleration/deceleration time of output frequency is as set in [Pr. 7, 8]. Therefore, the longer preset time is used to vary the actual output frequency.

*2 Multi-speed operation does not function when remote setting function is selected (“1 to 3” is set in [Pr. 59]).

*3 Remote setting function does not function when Jog operation or PID control is selected.

*4 Keeping RH signal ON does not increase frequency beyond the maximum frequency.

*5 The wiring length should be within 30m.
2.4.6 Input compensation of multi-speed and remote setting [Pr. 28] (A700, F700)

Compensation for frequency setting of three-speed operation or multi-speed operation is available with analog input. Compensation is not used as an initial value. Set "1" in [Pr. 28] to use compensation.

Use [Pr. 73 Analog input selection] to select the terminal (terminal 1, 2) used for compensation input voltage (0 to ±6V, 0 to ±10V) and compensation type.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Compensation Input Terminal</th>
<th>Compensation Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>28</td>
<td>Multi-speed input</td>
<td>0</td>
<td>0</td>
<td>Without compensation</td>
<td>Terminal 2</td>
<td>Override</td>
</tr>
<tr>
<td></td>
<td>compensation selection</td>
<td></td>
<td>1</td>
<td>With compensation</td>
<td>0 to 3, 6, 7</td>
<td>Added compensation (not polarity reversible)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 to 13, 16, 17</td>
<td>Terminal 1</td>
<td>Added compensation (polarity reversible)</td>
<td></td>
</tr>
</tbody>
</table>
2.4.7 Frequency setting by pulse train input [Pr. 291, 384 to 386] (A700)

The inverter speed can be set by inputting pulse train from terminal JOG. In addition, synchronous speed operation of inverters can be performed by combining pulse train I/O.

### (1) Pulse train input selection [Pr. 291, 384]

Setting any of “1, 11, 21, 100” in [Pr. 291 Pulse train I/O selection] and a value other than “0” in [Pr. 384 Input pulse division scaling factor] switches terminal JOG to pulse train input terminal and frequency setting of the inverter can be performed. (The initial value is JOG signal)

Pulse train input of maximum of 100k pulse/s is enabled. When pulse train input is selected, a function assigned to terminal JOG using [Pr. 185 JOG terminal function selection] is invalid.

When [Pr. 419 Position command source selection = 2] (conditional position pulse train command by inverter pulse train input), JOG terminal serves as conditional position pulse train terminal regardless of the [Pr. 291].

The priority of the frequency command by the external signals is “Jog operation > Multi-speed operation > Terminal 4 analog input > Pulse train input > Terminal 2 analog input”.

#### Pulse train input specifications

<table>
<thead>
<tr>
<th>Name</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse train input</td>
<td>0 to PM output</td>
<td>Pulse train output</td>
</tr>
<tr>
<td>JOG PM output</td>
<td>1 to JOG PM output</td>
<td></td>
</tr>
<tr>
<td>10 Terminal JOG PM output</td>
<td>10 Terminal JOG PM output</td>
<td></td>
</tr>
<tr>
<td>11 Pulse train input</td>
<td>11 Pulse train input</td>
<td></td>
</tr>
<tr>
<td>20 Terminal JOG PM output</td>
<td>20 Terminal JOG PM output</td>
<td></td>
</tr>
<tr>
<td>21 Pulse train input</td>
<td>21 Pulse train input</td>
<td></td>
</tr>
<tr>
<td>100 Pulse train input</td>
<td>100 Pulse train input</td>
<td></td>
</tr>
</tbody>
</table>

#### Input pulse division scaling factor

- Setting any of “1, 11, 21, 100” in [Pr. 291 Pulse train I/O selection] and a value other than “0” in [Pr. 384 Input pulse division scaling factor] switches terminal JOG to pulse train input terminal and frequency setting of the inverter can be performed. (The initial value is JOG signal)
- Pulse train input of maximum of 100k pulse/s is enabled.
- When pulse train input is selected, a function assigned to terminal JOG using [Pr. 185 JOG terminal function selection] is invalid.
- When [Pr. 419 Position command source selection = 2] (conditional position pulse train command by inverter pulse train input), JOG terminal serves as conditional position pulse train terminal regardless of the [Pr. 291].
- The priority of the frequency command by the external signals is “Jog operation > Multi-speed operation > Terminal 4 analog input > Pulse train input > Terminal 2 analog input”.
- Connection with a complementary output system pulse generator
  - Sink logic
  - Inverter
  - Pull up resistor
  - Connection with an open collector output system pulse generator
  - Sink logic
  - Inverter

#### Available pulse method

- Open collector output
- Complementary output (power supply voltage 24V)

#### Input level

- 24V (open collector output terminal JOG 0V, 0V, 5V)
- 0 in case of terminal JOG 0V, 0V, 5V

#### Minimum input pulse rate

- 100μs

#### Input resistance/Load current

- 2kΩ
- 10mA (sink)

#### Maximum wiring length

- Open collector output method: 10m (0.75mm² twisted pair)
- Complementary output method: 100m (output resistance 50Ω)

### Connection with a complementary output system pulse generator

#### Wiring Length

- Less than 10m
- 10 to 50m
- 50 to 100m

#### Pull up resistor

- Not necessary
- 10mA
- 35mA

#### Stray capacitances

- Stray capacitances of the wiring greatly differ according to the cable type and cable laying, the above maximum cable length is not a guaranteed value.

### Connection with an open collector output system pulse generator

#### Wiring Length

- Less than 10m
- 10 to 50m
- 50 to 100m

#### Pull up resistor

- Not necessary
- 10mA
- 35mA

### Notice

- Stray capacitances of the wiring greatly differ according to the cable type and cable laying, the above maximum cable length is not a guaranteed value.

- When using a pull up resistor, check the permissible power of the resistor and permissible load current of output transistor and use them within a permissible range.
(2) Adjustment of pulse train input and frequency [Pr. 385, 386]

Frequency for zero input pulse can be set using [Pr. 385 Frequency for zero input pulse] and frequency at maximum input pulse can be set using [Pr. 386 Frequency for maximum input pulse].

\[
\text{Limit value} = (\text{Pr. 386} \times 400) \times (\text{maximum 100k pulses/s})
\]

For example, when you want to operate at 0Hz when pulse train input is zero and operate at 30Hz when pulse train is 4000 pulse/s, set parameters as below.

For 30Hz:
- \text{Pr. 384} = 10
- \text{Pr. 385} = 0Hz
- \text{Pr. 386} = 30Hz

(2.4.8) Frequency setting by 16 bit digital input (FR-A7AX) [Pr. 300 to 305, 329] (A700 F700 E700)

16 bit (12 bit) digital input is available for the inverter with a plug-in option FR-A7AX installed and [Pr. 9999 Digital input value is the output frequency] is set.

For A700 using digital input as a torque command is also available. (Refer to page 301)

For FR-A7AX, using digital input as a torque command is also available. (Refer to page 301)

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>300</td>
<td>BCD input bias</td>
<td>247</td>
<td>0 to 500 Hz</td>
<td>Set bias frequency for BCD code input</td>
<td>A700 F700 E700</td>
</tr>
<tr>
<td>301</td>
<td>BCD input gain</td>
<td>60 Hz</td>
<td>0 Hz to 500 Hz</td>
<td>Set gain frequency for BCD code input</td>
<td>A700 F700 E700</td>
</tr>
<tr>
<td>302</td>
<td>BIN input bias</td>
<td>247</td>
<td>0 to 500 Hz</td>
<td>Set bias frequency for binary input</td>
<td>A700 F700 E700</td>
</tr>
<tr>
<td>303</td>
<td>BIN input gain</td>
<td>60 Hz</td>
<td>0 Hz to 500 Hz</td>
<td>Set gain frequency for binary input</td>
<td>A700 F700 E700</td>
</tr>
<tr>
<td>304</td>
<td>Digital input and analog input compensation enable/disabled selection</td>
<td>9999</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>305</td>
<td>Read timing operation selection</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>329</td>
<td>Digital input increments selection</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 Use terminal 1 for analog input compensation.
*2 X12 to X15 signal of plug-in option FR-A7AX is invalid.
*3 Writing during running is unavailable even when [Pr. 77 = 2]. When changing the parameter setting, stop the operation. Also parameter clear is invalid.
(1) Selection of digital input \([\text{Pr. } 304]\)

16bit (12bit) digital input is available when \([\text{Pr. } 304 = 0, 2, 10, 12]\) or binary input \([\text{Pr. } 304 = 1, 3, 11, 13]\). For BCD code, input data is read as decimal. For binary input, input data is read as hexadecimal.

When 3 digits BCD code input or 12bit binary input is selected, \(X12\) to \(X15\) signal of plug-in option FR-A7AX is invalid.

When \([\text{Pr. } 304 = 2, 3, 12, 13]\), output frequency is a sum of digital input command and terminal 1 compensation input.

When switching the inputs e.g. between volume input to perform manual operation and BCD code input to perform automatic operation, set the BCD code input to "0" under manual operation.

The priorities of the frequency setting are as follows.

\(\text{JOG} > \text{Multi-speed operation (RH, RM, RL)} > \text{PID (X14)} > \text{AU (terminal 4)} > \text{Digital command by the FR-A7AX} > \text{terminal 2}^{*}\) (When digital input is valid, terminal 2 is invalid.)

\[\text{Example: To input BCD code 6325}\]

\[\text{Example: To input binary AB65H}\]

(2) Data read timing \([\text{Pr. } 305]\)

When \([\text{Pr. } 305 = 0, 10]\), the set frequency data entered from the digital signal input terminals \((X0 \text{ to } X15)\) is always imported independently of whether the DY signal of plug-in option FR-A7AX is ON or OFF.

When \([\text{Pr. } 305 = 10]\), filter is active for reading, and compensation for a digital signal change timing of each bit is available.

Each terminal from \(X0\) to \(X15\) is all recognized as \(\text{OFF}\) when the inverter is turned ON in terminal \(DY\) OFF status.

\[\text{Example: To input BCD code 6325}\]

<table>
<thead>
<tr>
<th>BCD Code Input</th>
<th>Terminal name</th>
<th>Terminal input state</th>
<th>Input value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(X0)</td>
<td>ON</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(X1)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X2)</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X3)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>(X4)</td>
<td>OFF</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(X5)</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X6)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X7)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>(X8)</td>
<td>ON</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(X9)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X10)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X11)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X12)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X13)</td>
<td>ON</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X14)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(X15)</td>
<td>OFF</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>(X16)</td>
<td>ON</td>
<td>6</td>
</tr>
</tbody>
</table>

* When the signal is used to enter a BCD code, \(0\) to \(9\) entries are ignored during operation and the previous inputs are used to continue operation. \(A\) to \(F\) entries are ignored. If binary input is changed to BCD code input with \(A\) to \(F\) input, the set frequency becomes \(0\)Hz.
(3) Bias/gain adjustment [Pr. 300 to 303, 329]

For setting output frequency of when input signal is 0, use [Pr. 300] for BCD code input, and use [Pr. 301] for binary input.

For setting output frequency of maximum input signal (999 or 9999 for BCD code input, and FFFF or FFFFFH for binary input), use [Pr. 302] for BCD code input, and use [Pr. 303] for binary input.

When "9999" is set in [Pr. 301] or [Pr. 303], use [Pr. 329] for changing the setting increments.

Set frequency = Digital input signal value \times [Pr. 329] input increments

Example: When [Pr. 304 = 0], [Pr. 301 = 9999], [Pr. 329 = 1] and BCD code = 120 is input

With the setting above, changing [Pr. 329] setting will change the output frequency as follows.

<table>
<thead>
<tr>
<th>[Pr. 329] Setting</th>
<th>BCD Code</th>
<th>Set Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>120</td>
<td>0Hz</td>
</tr>
<tr>
<td>1</td>
<td>120</td>
<td>1200Hz</td>
</tr>
<tr>
<td>2</td>
<td>120</td>
<td>2400Hz</td>
</tr>
<tr>
<td>3</td>
<td>120</td>
<td>3600Hz</td>
</tr>
</tbody>
</table>
2.5 Output frequency and acceleration/deceleration time

2.5.1 Output frequency range [Pr. 1, 2, 13, 18, 571]  common

Output frequency range is from 0.2 to 400Hz (0.5 to 400Hz for F700). Note that actual operating frequency is depending on parameter settings and operation mode as follows.

For PU operation mode, three-speed operation and multi-speed operation of External operation mode, and for network operation mode, output up to 400Hz is available, though output frequency is limited by maximum frequency setting.

For analog input of External operation mode, output frequency is limited by frequency setting gain frequency [Pr. 125] (or [Pr. 126]) and maximum frequency setting.

Frequency at start is set in [Pr. 1].

When decreasing the frequency command at constant speed, frequency up to 0.5Hz (when [Pr. 1i] ≥ 0.5Hz) or up to [Pr. 1i] setting (when [Pr. 1i] < 0.5Hz) is output.

When decreasing to stop with start signal OFF, up to DC injection brake operation frequency set in [Pr. 10] is output. And when decreasing to stop with frequency command OFF (with start signal ON), up to the above mentioned frequency at constant speed is output.

(1) Maximum frequency [Pr. 1, 18]

Set the maximum frequency for output using the operation panel (parameter unit). Set the maximum frequency limit of 0 to 120Hz in [Pr. 1].

Set the maximum frequency limit of 120 to 400Hz in [Pr. 18]. Parameter setting written in the last time between [Pr. 1] or [Pr. 18] is the valid maximum output frequency.

Maximum frequency for output is as follows.

1) For external analog input (voltage, current signal) Lower frequency between maximum frequency [Pr. 1] (or [Pr. 18]) setting and frequency setting gain frequency [Pr. 125] (or [Pr. 126]) is the actual maximum output frequency. The output frequency is clamped at the maximum frequency limit if the frequency setting input given is higher than the maximum frequency limit.

2) For using operation panel (parameter unit) Maximum frequency [Pr. 1] (or [Pr. 18]) setting is the maximum output frequency.

(2) Minimum frequency [Pr. 2]

Using the operation panel (parameter unit), set the minimum frequency limit that can be output during constant-speed operation. When the analog frequency setting input signal is used, the output frequency is clamped and does not drop below the minimum frequency limit if that frequency setting input signal is less than the minimum frequency limit in [Pr. 2 Minimum frequency] (this also applies to the input of 0). Any value less than the minimum frequency limit may be set from the operation panel (parameter unit) but the output frequency does not become less than the minimum frequency limit. (with the exception of the Jog frequency)

Note that when [Pr. 2 Minimum frequency] is set to any value equal to or more than [Pr. 13 Starting frequency], simply turning ON the start signal will accelerate the motor to the set frequency of [Pr. 2 Minimum frequency] according to the set acceleration time even if the command frequency is not input.

When stall prevention is activated to decrease the output frequency, the frequency may drop to [Pr. 2] or below.

### Table: Parameter Setting

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Maximum frequency</td>
<td>55K or less</td>
<td>120Hz</td>
<td>Set the upper limit of the output frequency.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75K or more</td>
<td>60Hz</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Minimum frequency</td>
<td>0Hz</td>
<td>0 to 120Hz</td>
<td>Set the lower limit of the output frequency.</td>
</tr>
<tr>
<td>18</td>
<td>High speed maximum frequency</td>
<td>55K or less</td>
<td>120Hz</td>
<td>Set when performing the operation at 120Hz or more.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>75K or more</td>
<td>60Hz</td>
<td>Set when performing the operation at 120Hz or more.</td>
</tr>
</tbody>
</table>
3. Starting frequency [Pr. 13]

Set the frequency at a voltage output start, which will be reached when the start signal is switched ON across terminals STF (or STR).

Starting frequency is used with [Pr. 0 Torque boost] to mainly adjust the starting torque. The rise in starting frequency not only raises the corresponding output voltage but also increases the starting current along with the starting torque. The following value is recommended as a guide to setting the starting frequency to keep the starting current less than the stall prevention operation current:

- 0.5Hz (initial value) for general application.
- 3Hz for a lifter and lowering device, etc.

When the lifter and lowering device is started at a low starting frequency, the load may slip down due to insufficient starting torque as soon as the mechanical brake is released. The inverter cannot be started if the frequency setting is less than the starting frequency.

4. Start-time hold function [Pr. 571]

For smooth motor driving at start, this function holds the output frequency set in [Pr. 13 Starting frequency] during the period set in [Pr. 571] to perform initial excitation for a motor.

At switching between forward rotation and reverse rotation, the starting frequency is valid but the start-time hold function is invalid.

When [Pr. 13 = 0Hz], the starting frequency is held at 0.01Hz.

For example, setting brake opening delay time for mechanical brake in [Pr. 571] limits current when brake is closed, makes the motor driving smooth at brake opening.

### Frequency jump [Pr. 31 to 36] (common)

If motor mechanical resonance occurs, this function allows the running frequency, at which the mechanical resonance has occurred, to be avoided (jumped). During acceleration/deceleration, the running frequency within the set area is valid.

Frequency jump is not performed if the initial value (9999) is set.

#### Frequency jump area

Up to three areas may be specified. Areas may be specified in any order.

#### Frequency jump range

The range is determined by setting the top and bottom points to be avoided, not a jump value.

#### Jump point

In the jump range, set the jump point at which operation is performed. If the jump range setting is between 32 and 38Hz, for example, determine at which frequency, 32Hz or 38Hz, the operation is to be performed when the frequency setting signal is within the above range. This jump point is defined by the frequency set in Frequency jump 1A, 2A or 3A [Pr. 31, 33 or 35].
2.5.3 Acceleration/deceleration time [Pr. 7, 8, 16, 20, 21', 44, 45, 110', 111', 147']

For the inverter operation, the output frequency is made to change linearly (linear acceleration/deceleration) to prevent the motor and inverter from excessive stress to reach the set frequency during start, acceleration, deceleration, stop, etc. when frequency changes. Linear acceleration/deceleration has a uniform frequency/time slope. S-pattern acceleration/deceleration may also be set in [Pr. 29]. (Refer to page 238)

The acceleration and deceleration times set in [Pr. 7, 8, 44, 45, 110 and 111] are the lengths of time required for the output frequency to change up to the acceleration/deceleration reference frequency set in [Pr. 20]. The setting of the acceleration/deceleration time is based on [Pr. 20 Acceleration/deceleration reference frequency], independently of whether the operation mode is the External or PU operation mode.

$$\text{Acceleration/Deceleration time setting} = \frac{\text{Amount of output frequency change}}{\text{Acceleration/deceleration time for the amount of output frequency change}}$$

(Example 1) Accelerating to the output frequency of 50Hz in 2.5s when [Pr. 13 Starting frequency] is 0Hz, and [Pr. 20 Acceleration/deceleration reference frequency] is 60Hz (initial setting)

[Pr. 7 Acceleration time] setting value = \(\frac{60Hz - 50Hz}{50Hz} \times 2.5s = 3.0s\)

(Example 2) Accelerating to the output frequency of 90Hz in 12.5s when [Pr. 13 Starting frequency] is 0Hz, and [Pr. 20 Acceleration/deceleration reference frequency] is 90Hz

[Pr. 7 Acceleration time] setting value = \(\frac{90Hz - 50Hz}{50Hz} \times 12.5s = 12.5s\)

The minimum input increments of the acceleration/deceleration time setting are factory-set to 0.1s. When the value is set from the operation panel with [Pr. 21 = 0], the setting increments are 1s for the setting of 1000s or more.)

By changing the setting to [Pr. 21 = 1], the acceleration/deceleration time can be set in increments of 0.01s. When the value is set from the operation panel with [Pr. 21 = 1], the setting increments are 0.1s for the setting of 100s or more.)

Note that changing the [Pr. 21] setting changes the acceleration/deceleration time setting. When [Pr. 21 = 1], and if the setting is changed to [Pr. 21 = 0], the acceleration/deceleration time setting will change to [Pr. 7 = 0.1s].

The setting conditions of the related functions (parameters) are indicated in the table in the next page. The initial settings of the acceleration/deceleration times are temporary and should be changed to actually operable values. Actually operable values varies according to the load conditions (load torque and load GD2 reflected back to the motor shaft) and motor conditions (motor torque capability and motor GD2).

Refer to page 487 for the way of calculating the acceleration/deceleration time according to the load conditions and motor conditions.

When the load conditions are unknown, perform the operation and determine the acceleration/deceleration time which does not activate stall prevention.

The initial settings of the acceleration/deceleration times are temporary and should be changed to actually operable values. Actually operable values varies according to the load conditions (load torque and load GD2 reflected back to the motor shaft) and motor conditions (motor torque capability and motor GD2).

Refer to page 487 for the way of calculating the acceleration/deceleration time according to the load conditions and motor conditions.

When the load conditions are unknown, perform the operation and determine the acceleration/deceleration time which does not activate stall prevention.
# Parameter Table

<table>
<thead>
<tr>
<th>[Pn]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Acceleration time</td>
<td>5/15s</td>
<td>0 to 3600 / 360s²</td>
<td>Set the motor acceleration time.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>8</td>
<td>Deceleration time</td>
<td>5/15s</td>
<td>0 to 3600 / 360s²</td>
<td>Set the motor deceleration time.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>16</td>
<td>Stop acceleration/ deceleration time</td>
<td>0.5s</td>
<td>0 to 3600 / 360s²</td>
<td>Set the acceleration/deceleration time for Jog Iteration.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>20</td>
<td>Acceleration/ deceleration reference freq</td>
<td>0 to 400Hz</td>
<td>0 to 3600 / 360s²</td>
<td>Frequency that will be the basis of acceleration/deceleration time.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>21</td>
<td>Deceleration time increments</td>
<td>0</td>
<td>0</td>
<td>Increments: 0.1s.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>44</td>
<td>Second acceleration/deceleration time</td>
<td>9999</td>
<td>0 to 3600 / 360s²</td>
<td>Set the acceleration/deceleration time when the RT signal is ON.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>45</td>
<td>Second deceleration time</td>
<td>9999</td>
<td>0 to 3600 / 360s²</td>
<td>Set the deceleration time when the RT signal is ON.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>110</td>
<td>Third acceleration/deceleration time</td>
<td>9999</td>
<td>0 to 3600 / 360s²</td>
<td>Set the acceleration/deceleration time when the X9 signal is ON.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>111</td>
<td>Third deceleration time</td>
<td>9999</td>
<td>0 to 3600 / 360s²</td>
<td>Set the deceleration time when the X9 signal is ON.</td>
<td>D700, E700, F700, A700</td>
</tr>
<tr>
<td>147</td>
<td>Acceleration/deceleration time switching frequency</td>
<td>9999</td>
<td>0 to 400Hz</td>
<td>Frequency when automatically switching to the acceleration/deceleration time of [Pn: 44] and [Pn: 45].</td>
<td>D700, E700, F700, A700</td>
</tr>
</tbody>
</table>

*1 Differ according to capacities. (7.5K or less / 11K or more)  
*2 Differ according to capacities. (3.7K or less / 5.5K, 7.5K / 11K or more)  
*3 Depends on the [Pn: 27 Acceleration/deceleration time increments] setting. The initial value for the setting range is "0 to 3600s" and setting increments is "0.1s". In (PID), the setting range is "0 to 3600s" and setting increments is "0.1s".

![Parameter Chart](235)
(1) Acceleration time [Pr. 7] (common)

Calculate the period of time required for linear acceleration from a stop to the maximum operating frequency under the load and motor conditions used. Using the following formula, calculate the acceleration time from stop to [Pr. 20: Acceleration/deceleration reference frequency]. When the setting value of [Pr. 7] is 0.03s or less, acceleration time is 0.04s (when V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, [Pr. 20] should be set to "120Hz" or less. For the acceleration time at automatic restart after instantaneous power failure, refer to [Pr. 611: Acceleration time at a restart] (page 387).

**Example**

When [Pr. 20] = 60Hz, and [Pr. 10] = 0.5Hz, and acceleration can be made up to the maximum operating frequency of 50Hz in 10s

\[
\text{[Pr. 7] = } \frac{50Hz}{0.5Hz} \times 10s \approx 12.1s
\]

(2) Deceleration time [Pr. 8] (common)

Calculate the period of time required for linear deceleration from the maximum operating frequency to a stop under the load and motor conditions used. Using the following formula, calculate the deceleration time from the maximum operating frequency to a stop.

When the setting value of [Pr. 8] is 0.03s or less, deceleration time is 0.04s (when V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, [Pr. 20] should be set to "120Hz" or less.

**Example**

When the frequency can be decelerated down to the maximum operating frequency of 50Hz in 10s with [Pr. 20 = 120Hz] and [Pr. 10 = 3Hz]

\[
\text{[Pr. 8] = } \frac{120Hz}{3Hz} \times 10s = 25.5s
\]

(3) Second acceleration/deceleration time [Pr. 44] (common)

When the second function selection signal (RT) turns ON, the acceleration/deceleration time set in [Pr. 7] is ignored and the acceleration/deceleration time set in [Pr. 44] is active. In this case, the acceleration time is equal to the deceleration time. When the setting value of [Pr. 44] is 0.03s or less, acceleration/deceleration time is 0.04s (when V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, [Pr. 20] should be set to "120Hz" or less.

(4) Second deceleration time [Pr. 45] (common)

When the second function selection signal (RT) turns ON, the acceleration/deceleration time changes to the value set in [Pr. 44]. In this case, the acceleration time is equal to the deceleration time.

To set the acceleration time and deceleration time separately, set the second deceleration time in [Pr. 45] and the second acceleration time in [Pr. 44]. Setting of 9999 (initial value) in [Pr. 45] causes the second deceleration time to be the value set in [Pr. 44], making the acceleration and deceleration times equal. When the setting value of [Pr. 45] is 0.03s or less, deceleration time is 0.04s (when V/F control, General-purpose magnetic flux vector control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, [Pr. 20] should be set to "120Hz" or less.
(5) Second acceleration/deceleration time

switching frequency \([\text{Pr. 147}]\)

When \([\text{Pr. 44}]\) and \([\text{Pr. 45}]\) are valid when the output frequency reaches or exceeds the setting of \([\text{Pr. 147}]\). When RT signal is OFF, automatic switching of the acceleration/deceleration time is available with \([\text{Pr. 147}]\). Even when automatic switching by the RT signal occurs at the frequency less than \([\text{Pr. 147}]\) setting, the acceleration/deceleration time switches to the second acceleration/deceleration time.

(6) Third acceleration/deceleration time

\([\text{Pr. 110}]\)

When the third function selection signal (X9) turns ON, the acceleration/deceleration time set in \([\text{Pr. 7, 8}]\) is ignored and the acceleration/deceleration time set in \([\text{Pr. 110}]\) is active. In this case, the acceleration time is equal to the deceleration time. Set "9999" in \([\text{Pr. 110}]\) to make this function invalid.

When both the RT and X9 signals are ON, \([\text{Pr. 100, 111}]\) are valid.

When the setting value of \([\text{Pr. 110}]\) is 0.03s or less, acceleration/deceleration time is 0.04s (when V/F control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, \([\text{Pr. 20}]\) should be set to "120Hz" or less.

(7) Third deceleration time \([\text{Pr. 111}]\)

When the third function selection signal (X9) turns ON, the acceleration/deceleration time changes to the value set in \([\text{Pr. 111}]\). In this case, the acceleration time equals to the deceleration time. For Jog operation, \([\text{Pr. 110}]\) should be set to "120Hz" or less.

When both the RT and X9 signals are ON, \([\text{Pr. 100, 111}]\) are valid.

When the setting value of \([\text{Pr. 111}]\) is 0.03s or less, acceleration/deceleration time is 0.04s (when V/F control, Advanced magnetic flux vector control, or Simple magnetic flux vector control). At that time, \([\text{Pr. 20}]\) should be set to "120Hz" or less.
S-pattern acceleration/deceleration and backlash measures

Generally, frequency/time gradient of acceleration/deceleration is a constant linear acceleration/deceleration \([Pr. 29 = 0 \text{ (initial value)}] \). This acceleration/deceleration gradient can be changed into S-pattern.

When the acceleration/deceleration time \([Pr. 7, 8]\) setting, etc.) setting under Real sensorless vector control or vector control is 0s, the S-pattern acceleration/deceleration A to D \([Pr. 29 = 1, 2, 4, 5]\) is linear acceleration/deceleration. Set linear acceleration/deceleration \([Pr. 29 = 0 \text{ (initial value)}]\) when torque control is exercised under Real sensorless vector control or vector control. When acceleration/deceleration patterns other than the linear acceleration/deceleration are selected, the protective function of the inverter may function.

1) S-pattern acceleration/deceleration \([Pr. 29 = 1]\)

In S-pattern acceleration/deceleration pattern, acceleration is maximum around \([Pr. 3 \text{ Base frequency}] \) as follows. Therefore using motor torque effectively, acceleration is fast for larger motor torque range, and slow for smaller motor torque range.

Effective for shortening the time taken to reach constant-power range where motor torque is small, when comparing with linear acceleration/deceleration pattern. (Example: for machine tool)
2) S-pattern acceleration/deceleration B \([\text{Pr. 29} = 2]\)

S-pattern acceleration/deceleration B is for accelerating/decelerating in S-pattern when set frequency is changed (running frequency by external input signal or operation panel). Therefore reducing an impact during start or stop, and effective for load collapse prevention. For example, when set frequency changes as the following diagram, S-pattern is active. (Example: conveyor)

3) S-pattern acceleration/deceleration C \([\text{Pr. 29} = 4, \text{Pr. 380 to 383}\]

Assign S-pattern acceleration/deceleration C switching signal \((X20)\) to an input terminal, and use S-pattern acceleration/deceleration C switching signal \((X20)\) to switch the acceleration/deceleration curve. Change the S-pattern acceleration/deceleration C switch \((X20\) signal) after the speed becomes constant. S-pattern operation before switching continues even if the X20 signal is changed during acceleration or deceleration.

4) S-pattern acceleration/deceleration D \([\text{Pr. 29} = 5, \text{Pr. 516 to 519}\]

Set the time taken for S-pattern operation of S-pattern acceleration/deceleration using \([\text{Pr. 516 to 519}\].

Even if the start signal is turned OFF during acceleration, the inverter will not decelerate immediately to avoid sudden frequency change. (Likewise, the inverter will not immediately accelerate when deceleration is changed to reacceleration by turning the start signal ON during deceleration, etc.)

When S-pattern acceleration/deceleration D is set, acceleration/deceleration time will become longer as follows:

- Set acceleration/deceleration time \(T1\) indicates the time taken for actual linear acceleration/deceleration calculated based on \([\text{Pr. 7, 8, 44, 45, 110 or 111}]\).

**[Example]** When starting the inverter with an S-pattern acceleration/deceleration D selected from a stop to 60Hz in the parameter initial setting as shown below

- Actual acceleration time \(T2 = \text{set acceleration time } T1 + \) (S-pattern time at a start of acceleration + S-pattern time at a completion of acceleration)/2
- Actual deceleration time \(T2 = \text{set deceleration time } T1 + \) (S-pattern time at a start of deceleration + S-pattern time at a completion of deceleration)/2

- \(T2 = \text{set acceleration time } T1 + \) (S-pattern time at a start of acceleration + S-pattern time at a completion of acceleration)/2
- \(T2 = \text{set deceleration time } T1 + \) (S-pattern time at a start of deceleration + S-pattern time at a completion of deceleration)/2

\[\text{Set acceleration time } T1 = \text{set acceleration time } T1 + \] (S-pattern time at a start of acceleration + S-pattern time at a completion of acceleration)/2

\[\text{Set deceleration time } T1 = \text{set deceleration time } T1 + \] (S-pattern time at a start of deceleration + S-pattern time at a completion of deceleration)/2

\[\text{Output frequency} = \text{Output frequency} \]
(2) Backlash measures [Pr. 29, 140 to 143]

Reduction gears have an engagement gap and have a dead zone between forward rotation and reverse rotation. This dead zone is called backlash, and this gap disables a mechanical system from following motor speed. More specifically, a motor shaft develops excessive torque when the direction of rotation changes or when constant-speed operation shifts to deceleration. Resulting in a sudden motor current increase or regeneration status. Use "Backlash measures" to avoid these conditions.

Set [Pr. 29 = 3] to use Backlash measures [Pr. 140 to 143].

Acceleration/deceleration pattern of Backlash measures is linear acceleration/deceleration. The acceleration/deceleration time is increased by the stopping time.

\[ f_1 \] [Pr. 141] \[ f_2 \] [Pr. 143] \[ t_1 \] [Pr. 142] \[ t_2 \] [Pr. 140] \[ t_1 \] [Pr. 141] \[ t_1 \] [Pr. 142] \[ t_1 \] [Pr. 143] \[ t_1 \] [Pr. 144]

Output frequency (Hz) Output frequency (Hz) Output frequency (Hz)

Time Time Time
2.5.5 Shortest acceleration/deceleration and optimum acceleration/deceleration (automatic acceleration/deceleration) [Pr. 61 to 63, 292, 293] (A700, E700)

The inverter operates in the same conditions as when appropriate values are set in each parameter even if acceleration/deceleration time and V/F pattern are not set. This function is useful when you just want to operate, etc. without fine parameter setting. Even if automatic acceleration/deceleration mode is selected, inputting the JOG signal (Jog operation) or RT signal (second function selection) or X9 signal (third function selection) during an inverter stop will switch to the normal operation and give priority to Jog operation or second and third function selection. Note that JOG and RT signal input is invalid even if JOG signal and RT signal are input during operation in automatic acceleration/deceleration mode.

When PID control or load torque high speed frequency control is selected, optimum acceleration/deceleration is invalid.

<table>
<thead>
<tr>
<th>[Pr-]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
<td>Reference current</td>
<td>9999</td>
<td>0 to 200% or 0 to 360%</td>
<td>Set the reference current during shortest/optimum acceleration/deceleration.</td>
<td>○ ○</td>
</tr>
<tr>
<td>62</td>
<td>Reference value at</td>
<td>9999</td>
<td>0 to 220%</td>
<td>Set the limit value/optimum value during shortest/optimum acceleration.</td>
<td>○ ○</td>
</tr>
<tr>
<td></td>
<td>acceleration</td>
<td></td>
<td></td>
<td>Optimum acceleration/deceleration: 100% is an optimum value.</td>
<td></td>
</tr>
<tr>
<td>63</td>
<td>Reference value at</td>
<td>9999</td>
<td>0 to 220%</td>
<td>Set the limit value/optimum value during shortest/optimum deceleration.</td>
<td>○ ○</td>
</tr>
<tr>
<td></td>
<td>deceleration</td>
<td></td>
<td></td>
<td>Optimum acceleration/deceleration: 100% is an optimum value.</td>
<td></td>
</tr>
<tr>
<td>292</td>
<td>Automatic acceleration/</td>
<td>0</td>
<td>0 to 220%</td>
<td>- Optimal Mode</td>
<td>○ ○</td>
</tr>
<tr>
<td></td>
<td>deceleration</td>
<td></td>
<td></td>
<td>0 Shortest acceleration/deceleration (without brake)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Shortest acceleration/deceleration (with brake)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Optimum acceleration/deceleration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Acceleration/</td>
<td>0</td>
<td>0 to 220%</td>
<td>Both acceleration and deceleration are made in the shortest (optimum)</td>
<td>○ ○</td>
</tr>
<tr>
<td></td>
<td>deceleration individual</td>
<td></td>
<td></td>
<td>acceleration/deceleration mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td>operation selection</td>
<td></td>
<td></td>
<td>0 Both acceleration and deceleration are made in the shortest (optimum)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>acceleration/deceleration mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1 Any acceleration is made in the shortest (optimum) acceleration/deceleration mode</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2 Any deceleration is made in the shortest (optimum) acceleration/deceleration mode</td>
<td></td>
</tr>
</tbody>
</table>
Optimum acceleration/deceleration mode

This function automatically controls acceleration/deceleration speed so as to achieve shortest time of acceleration/deceleration with using stall prevention function of the inverter.


Note that when proper values are set in [Pr. 7 Acceleration time] and [Pr. 8 Deceleration time], acceleration/deceleration time may be shorter than selecting shortest acceleration/deceleration mode.

1) Control method
Inverter regards that the shortest acceleration/deceleration time (0s) is set, and accelerates/decelerates with changing frequency with using stall prevention operation. Since accelerating/decelerating with using stall prevention function, acceleration/deceleration speed varies depending on load condition. (The setting values of [Pr. 7, 8] are not changed)

Settings of [Pr. 7 Acceleration time] and [Pr. 8 Deceleration time] are ignored. When the stall prevention operation level in [Pr. 61 to 63] are smaller than [Pr. 22] the setting of [Pr. 22] is valid. [Pr. 22] is valid when constant speed.

2) Applications

• Appropriate application
  - To make acceleration/deceleration in a shorter time for a machine tool, etc., but the design values of machine constants are unknown.
  - To exhibit the best performance of the inverter and motor performance.
  - To accelerate/decelerate in constant torque.

• Inappropriate application
  - Machine with a large inertia (more than 10 times) such as a fan. Since current limit function will be activated for a long time, this type of machine may be brought to a fault due to motor overloading, etc.
  - To perform operation always with a constant acceleration/deceleration time.

3) Setting of dedicated parameters

By setting the dedicated parameters, the application range can be made wider.

In the initial setting, the current limit function is activated at the 150% value of the rated inverter current.

Adjustment with [Pr. 61 to 63] is unavailable under real sensorless vector control and vector control. Operating with [Pr. 22] limit.

Since the [Pr. 61 to 63] settings automatically return to the initial value (9999) if the [Pr. 292] setting is changed, set [Pr. 292] first when you need to set [Pr. 61 to 63].

[Pr. 61]: Set the current value (A) that is referenced for stall prevention operation level. When the motor and inverter are different in capacity, for example, and it is desired to define the motor rating as reference, set the reference current value in this parameter.

[Pr. 62]: Set the stall prevention operation level (%) for acceleration. Set to change the limit for acceleration/deceleration.

[Pr. 63]: Set the stall prevention operation level (%) for deceleration. Set to change the limit for acceleration/deceleration.

[Pr. 293]: Set to select the Shortest acceleration/deceleration operation for only when accelerating or decelerating.
(2) Optimum acceleration/deceleration mode

[Pr. 292 = 3] (default)

Automatic setting of [Pr. 0 Torque boost], [Pr. 7 Acceleration time] and [Pr. 8 Deceleration time] is available. Set [Pr. 292 Automatic acceleration/deceleration = 3] and repeat actual operation to perform self learning of the inverter for proper current during acceleration/deceleration.

1) Control method

At the initial time when the optimum acceleration/deceleration mode has been selected, operation is performed at the values set in [Pr. 0 Torque boost], [Pr. 7 Acceleration time] and [Pr. 8 Deceleration time].

After operation, the average current and peak current are calculated from the motor current during acceleration/deceleration. These values are compared with the reference current (initial value is rated inverter current) and calculated for increase or decrease, then more appropriate values are set in [Pr. 0, 7, 8]. The calculated result is set in [Pr. 0, 7, 8] as the optimum value.

After that, operation is performed with that [Pr. 0, 7, 8] setting, and more appropriate values are calculated and set in [Pr. 0, 7, 8] as needed. Note that the [Pr. 0] value will not change under advanced magnetic flux vector control and real sensorless vector control and vector control. Therefore, by repeating operations will automatically set the appropriate value regardless of the initial value, and optimized acceleration/deceleration operation is available. Calculation is performed only when acceleration from a stop to 30.01Hz or more, or when deceleration from 30.01Hz or more to stop.

When the motor is not connected or output current is less than 5% of the rated inverter current, optimum acceleration/deceleration mode will not function.

2) Storage of appropriate parameter setting

The optimum values of [Pr. 0, 7, 8] are written to both the parameter RAM and EEPROM only three times after the optimum acceleration/deceleration mode has been selected or after the power is switched ON or the inverter is reset. At of after the fourth attempt, these are not stored into EEPROM. Hence, after power-ON or inverter reset, the values changed at the third time are valid. Operation and display of the operation panel is based on the latest optimum value. The [Pr. 0, 7, 8] value changed at the fourth or later time can be stored into EEPROM by reading and writing the values with the operation panel.

3) Applications

- Appropriate application
  - For applications such as automatic transfer machine, etc which is small in load change and is operated in a predetermined pattern.
  - For machines which change in load and operation conditions. Since the stored optimum values are used for the next operation, changing of the application condition causes miss setting, and results in non acceleration/deceleration or fault due to overcurrent protection function, etc.

- Inappropriate application
  - For machines which change in load and operation conditions. Since the stored optimum values are used for the next operation, changing of the application condition causes miss setting, and results in non acceleration/deceleration or fault due to overcurrent protection function, etc.

4) Setting of dedicated parameters

By setting the dedicated parameters, the application range can be made wider.

In the initial setting, 100% of the rated inverter current is regarded as the optimum current value. Since the [Pr. 61 to 63] settings automatically return to the initial value (9999) if the [Pr. 292] setting is changed, set [Pr. 292] first when you need to set [Pr. 61 to 63].

[Pr. 61]: Set the current value (A) that is referenced for optimum current value. When the motor and inverter are different in capacity, for example, and it is desired to define the motor rating as reference, set the reference current value in this parameter.

[Pr. 62]: Set the optimum current level (%) for acceleration. Set when you want to restrict average current at acceleration.

[Pr. 63]: Set the optimum current level (%) for deceleration. Set when you want to restrict average current at deceleration.

[Pr. 293]: Set to select the Optimum acceleration/deceleration operation for only when accelerating or decelerating.
2.6 Setting output voltage (V/F control)

2.6.1 V/F pattern and torque boost [Pr. 0, 3, 14, 19, 46, 47, 112*, 113*] (common)

The inverter controls not only the output frequency but also the output voltage. The relationship between the output frequency and voltage is as follows.

*Pr. 14* allows the load pattern to be selected between a linear ramp (for constant torque load) and a square curve (for variable torque load) for the ratio of the output voltage to the output frequency at not more than the base frequency.

When the base frequency is reached, the output voltage is maximum and is almost equal to the input power supply voltage. At not less than the base frequency, the output voltage is kept constant. *Pr. 19* allows the setting of the output voltage at not less than the base frequency. Note that the voltage output is less than the power supply voltage.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Load pattern selection</td>
<td></td>
<td></td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>3</td>
<td>V/F (base frequency)</td>
<td>60Hz</td>
<td>2 to 400Hz</td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>47</td>
<td>Second V/F (base frequency)</td>
<td>9999</td>
<td>2 to 400Hz, 9999</td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>19</td>
<td>Base frequency voltage</td>
<td>9999</td>
<td>2 to 1000V, 8888, 9999</td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>0</td>
<td>Torque boost</td>
<td></td>
<td></td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>46</td>
<td>Second torque boost</td>
<td>9999</td>
<td>2 to 30%, 9999</td>
<td>A700 E700 F700</td>
</tr>
<tr>
<td>112</td>
<td>Third torque boost</td>
<td>9999</td>
<td>2 to 30%, 9999</td>
<td>A700 E700 F700</td>
</tr>
</tbody>
</table>
PARAMETER

The setting conditions of related parameters and the relationship between output frequency and output voltage for A700 factory setting is indicated in the table in the last page and figure below.

![Diagram of relationship between output frequency and output voltage for A700 factory setting](image)

### Load pattern selection [Pr. 14]

**1. For constant torque load** [Pr. 14 = 0]

Set **Pr. 14 = 0** to drive a load which is constant in load torque if the speed varies, e.g. conveyor, cart, roll drive.

**2. For variable-torque load** [Pr. 14 = 1]

Set **Pr. 14 = 1** when driving the load whose load torque varies in proportion to the square of the speed, e.g. fan or pump.

If the load is a fan or pump, select “for constant-torque load” in any of the following cases.

- When a blower of large load inertia \( J \) (moment of inertia) is accelerated in a short time.

- When a variable-torque load such as rotary pump or gear pump.

- When load torque increases at low speed, e.g. screw pump.

When the variable-torque load has been selected, [Pr. 1 Maximum frequency] should be equal to or less than the [Pr. 3 Base frequency] setting (normally 50Hz or 60Hz) unless the motor capacity is considerably sufficient. When the output voltage is approximately proportional to the square of the output frequency.

**3. For constant torque vertical lift load** [Pr. 14 = 2, 3]

Set **Pr. 14 = 2** for a vertical lift which is kept in the driving mode during forward rotation and in the regenerative mode during reverse rotation. In this case the torque boost set in [Pr. 0 Torque boost] is made valid during forward rotation and the torque boost is automatically set to 0% during reverse rotation as shown below.

**4. Changing of load pattern selection** [Pr. 14 = 4, 5]

Set **Pr. 14 = 4, 5** to change the load pattern selection according to the RT signal.

<table>
<thead>
<tr>
<th>RT signal (X17 signal)</th>
<th>Output characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>For constant torque load (same as when the setting is 0)</td>
</tr>
<tr>
<td>OFF</td>
<td>For vertical lift load (torque boost = 0%) (same as the setting 2)</td>
</tr>
</tbody>
</table>

The RT signal may be replaced by the X17 signal.

### Relationship between output frequency and output voltage for factory setting

**a. When a blower of large load inertia \( J \) (moment of inertia) is accelerated in a short time.**

**b. For constant-torque load such as rotary pump or gear pump.**

**c. When load torque increases at low speed, e.g. screw pump.**

**Output frequency (Hz)**

<table>
<thead>
<tr>
<th>Output voltage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
</tr>
<tr>
<td>100</td>
</tr>
</tbody>
</table>

**Variable-torque load** [Pr. 14 = 1]

Output frequency and output voltage when variable-torque load is selected

245
(2) Base frequency \([Pr. 3]\) (common)

Second V/F (base frequency) \([Pr. 47]\) (common)

Third V/F (base frequency) \([Pr. 113]\) (common)

The base frequency indicates a frequency at the rated torque of the motor. It is 50Hz or 60Hz for standard motors.

To perform the switch-over operation of two (or three) motors by one inverter, the base frequency dedicated to one motor can be set in \([Pr. 47 (Pr. 113)]\). (Active when RT(X9) signal is ON.) Set 9999 (initial value) in \([Pr. 47 (Pr. 113)]\) to set the same value in \([Pr. 3]\).

For \([Pr. 113]\), \([Pr. 113]\) is valid when both the RT and X9 signals are ON.

The base frequency of the standard motor is determined as follows:

1. When a new machine is installed, it is recommended to set the base frequency to 60Hz because 60Hz can be output even in a 50Hz district and the motor torque may be utilized more effectively by setting the base frequency to 60Hz instead of 50Hz.
2. Set the base frequency to 50Hz when using the inverter with the existing machine which is driven by the commercial power supply in a 50Hz district.
3. Generally, setting the base frequency to higher than 60Hz has no advantage.
4. The following depends on whether the base frequency has been set to 50Hz or 60Hz:
   a. Selection of data on the torque capability of the standard motor used with the inverter.
   b. Rated torque value (in %) of the standard motor corresponding to 100% torque.

If the base frequency used is other than 50Hz or 60Hz, a special motor designed to meet that base frequency is required.

(3) Base frequency voltage \([Pr. 19]\) (common)

If the setting is equal to or less than the power supply voltage, the maximum output voltage of the inverter is the value set in \([Pr. 19]\). If the power supply voltage rises, the output voltage does not exceed the set value.

When \([Pr. 19 = 9999]\), the maximum output voltage of the inverter is same as power supply voltage.

When \([Pr. 19 = 8888]\), the maximum output voltage of the inverter is same as 95% of the power supply voltage.

The base frequency voltage can be utilized for the following cases:

1. Regenerative frequencies are high (such as continuous regeneration).
   At the time of regeneration, the output voltage may become higher than the V/F reference value, causing an overcurrent trip due to the increase in motor current. This can be prevented.
2. Fluctuation of power supply voltage is large.
   If the power supply voltage exceeds the rated motor voltage, excessive torque or increased motor current may cause the speed to fluctuate greatly or the motor to overheat.

When operation is discontinued under vector control due to failure of an encoder, etc., setting 9999 in \([Pr. 80\, Motor\ capacity]\) or \([Pr. 81\, Number\ of\ motor\ poles]\) enables V/F control operation. Set parameters as below when running the vector control dedicated motor (SF-V5RU, SF-VR) under V/F control.

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>([Pr. 19, Setting])</th>
<th>([Pr. 3, Setting])</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF-V5RU 3.7kW or less</td>
<td>170V</td>
<td>50Hz</td>
</tr>
<tr>
<td>SF-V5RU 5.5kW or less</td>
<td>160V</td>
<td>50Hz</td>
</tr>
<tr>
<td>SF-V5RUP 3.7kW or less</td>
<td>340V</td>
<td>50Hz</td>
</tr>
<tr>
<td>SF-V5RUP 5.5kW or less</td>
<td>320V</td>
<td>50Hz</td>
</tr>
<tr>
<td>SF-VR</td>
<td>160V</td>
<td>50Hz</td>
</tr>
<tr>
<td>SF-VR1</td>
<td>320V</td>
<td>50Hz</td>
</tr>
</tbody>
</table>

246
(4) Torque boost (Pr 0)
Second torque boost (Pr 46)
Third torque boost (Pr 112)

Allows the output voltage at the output frequency of 0Hz to be set to increase/decrease the motor starting torque. Change the setting of the torque boost only when the starting torque is not appropriate.

To perform the switch-over operation of two (or three) motors by one inverter, the torque boost dedicated to one motor can be set in [Pr 46 (Pr 112)]. (Active when RT(X9) signal is ON.) Set 0999 (initial value) in [Pr 46 (Pr 112)] to set the same value in [Pr 0].

For [Pr 112] is valid when both the RT and X9 signals are ON.

1) To increase the starting torque
The following figure shows the motor torque and current characteristic examples in which the [Pr 13 Starting frequency] is suppressed to a low value and the torque boost is increased so that the motor may be started at the starting current lower than the stall prevention current.

When the torque boost setting is greater than the initial setting, the continuously usable frequency range is narrowed because the no-load current of the motor increases. When the torque boost value is 8%, for example, the frequency of 15Hz or less cannot be used continuously.

Too high setting of the torque boost saturates the magnetic flux of the motor iron core, which increases the motor current and activates the current limit function.

If the starting torque is insufficient when using the surge voltage suppression filter (FR-ASF-H), increase the [Pr 0] value.

2) To suppress motor vibration at low frequency
Vibration may be suppressed by setting the torque boost value to lower than the factory setting (this is applicable only when the motor capacity is sufficient). In this case, the motor starting torque is reduced.

<table>
<thead>
<tr>
<th>[Pr 17] Setting</th>
<th>Standard motor (initial value)</th>
<th>Constant-torque motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.75K or less</td>
<td>6%</td>
<td>6%</td>
</tr>
<tr>
<td>1.5K to 3.7K</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>5.5K, 7.5K</td>
<td>3%</td>
<td>2%</td>
</tr>
<tr>
<td>11K to 37K</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>45K, 55K</td>
<td>1%</td>
<td>1%</td>
</tr>
<tr>
<td>75K or more</td>
<td>0.7%</td>
<td>0.7%</td>
</tr>
</tbody>
</table>

3) When using an inverter dedicated motor (constant-torque motor)
When using the inverter dedicated motor (constant torque motor) and energy saving motor, set the setting of [Pr 0 Torque boost] as shown below.

In addition, when the [Pr 71 Applied motor] setting is changed to the constant torque motor in the initial setting status, the [Pr 0] setting is automatically changed as shown below. The [Pr 0] setting is automatically changed also when the constant torque motor setting is changed to the standard motor setting.
2.6.2 Adjustable 5 points V/F [Pr. 71, 100 to 109] (A700) (F700)

When V/F control has been selected, set [Pr. 71 = 2] and define five points as shown on the right to perform operation in the V/F pattern connected by straight lines in sequence.

For a machine of large static friction coefficient and small dynamic static friction coefficient, for example, set a V/F pattern that will increase the voltage only in a low speed region since such a machine requires large torque at a start.

When [Pr. 19 Base frequency voltage = 8888, 9999], [Pr. 71 = 2] cannot be set. Set the rated voltage value in [Pr. 19] to set [Pr. 71 = 2].

The five points can be set as desired within the range of the [Pr. 3 Base frequency] and [Pr. 19 Base frequency voltage]. Note that if you attempt to set the same frequency in any two of the five points, an outside-of-range error occurs.

The setting of inappropriate V/F values will cause excessive current, abnormal machine collision or vibration during acceleration and deceleration.

The electronic thermal relay function calculates as standard motor.

Adjustable 5 points V/F does not function during Advanced magnetic flux vector control, Simple magnetic flux vector control, Real sensorless vector control, vector control.

### Parameter Table

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Applied motor</td>
<td>0</td>
<td>0 to 8, 13 to 18, 20, 23, 24, 30, 33, 34, 40, 43, 44, 50, 53, 54</td>
<td>Set 2 for adjustable 5 points V/F control.</td>
</tr>
<tr>
<td>100</td>
<td>V/F1 (first frequency)</td>
<td>9999</td>
<td>No V/F1 setting</td>
<td></td>
</tr>
<tr>
<td>101</td>
<td>V/F1 (first frequency voltage)</td>
<td>0V</td>
<td>0 to 1000V</td>
<td>Set the V/F1 voltage</td>
</tr>
<tr>
<td>102</td>
<td>V/F2 (second frequency)</td>
<td>9999</td>
<td>No V/F2 setting</td>
<td></td>
</tr>
<tr>
<td>103</td>
<td>V/F2 (second frequency voltage)</td>
<td>0V</td>
<td>0 to 1000V</td>
<td>Set the V/F2 voltage</td>
</tr>
<tr>
<td>104</td>
<td>V/F3 (third frequency)</td>
<td>9999</td>
<td>No V/F3 setting</td>
<td></td>
</tr>
<tr>
<td>105</td>
<td>V/F3 (third frequency voltage)</td>
<td>0V</td>
<td>0 to 1000V</td>
<td>Set the V/F3 voltage</td>
</tr>
<tr>
<td>106</td>
<td>V/F4 (fourth frequency)</td>
<td>9999</td>
<td>No V/F4 setting</td>
<td></td>
</tr>
<tr>
<td>107</td>
<td>V/F4 (fourth frequency voltage)</td>
<td>0V</td>
<td>0 to 1000V</td>
<td>Set the V/F4 frequency</td>
</tr>
<tr>
<td>108</td>
<td>V/F5 (fifth frequency)</td>
<td>9999</td>
<td>No V/F5 setting</td>
<td></td>
</tr>
<tr>
<td>109</td>
<td>V/F5 (fifth frequency voltage)</td>
<td>0V</td>
<td>0 to 1000V</td>
<td>Set the V/F5 voltage</td>
</tr>
</tbody>
</table>
2.6.3 Elevator mode [Pr. 61, 64, 292] (A700)

Operation matching a load characteristic of elevator with counterweight can be performed. Set 5 (stall prevention operation level 150%) or 6 (stall prevention operation level 180%) in [Pr. 61, 64] Automatic acceleration/deceleration to perform operation in the elevator mode 1 or 2.

1) Control method
Sufficient torque is generated for the drive mode load. For the regenerative load and no load, the torque boost value is controlled with respect to the [Pr. 0] setting as shown below to prevent an overcurrent trip due to overexcitation.

The starting frequency is factory-set to 2Hz, the stall prevention operation level to 150% (or 180%), and the base frequency voltage to 220V or 400V. Therefore settings of [Pr. 13 Starting frequency], [Pr. 19 Base frequency voltage], and [Pr. 22 Stall prevention operation level] are ignored.

2) Restriction conditions
When the Advanced magnetic flux vector control, Real sensorless vector control or vector control is selected, elevator mode selection is invalid.

3) Applications
• Elevator with counterweight
• Maximum torque may be insufficient for an elevator subjected to the load of higher than the rating.

For an elevator without counterweight, setting 2 or 3 in [Pr. 14 Load pattern selection] and setting a proper value in [Pr. 19 Base frequency voltage] makes the maximum torque larger and is more advantageous than the selection of the elevator mode.

4) Setting of dedicated parameters
By setting the dedicated parameters, the application range can be made wider.

In the factory setting, the stall prevention function is activated at the 150% (180%) value of the rated inverter current.

Since the [Pr. 61, 64] settings automatically return to the initial value (9999) if the [Pr. 292] setting is changed, set [Pr. 292] first when you need to set [Pr. 61, 64].

[Pr. 61]: Set the current value (A) that is referenced for stall prevention operation level (%). When the motor and inverter are different in capacity, for example, and it is desired to define the motor rating as reference, set the reference current value in this parameter.

[Pr. 64]: Used to set the starting frequency (Hz) in the elevator mode. Set this parameter when it is desired to increase/decrease the starting torque.

---

**Table:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr. 61</td>
<td>Reference current</td>
<td>9999</td>
<td>55K or less 0 to 500A 50K or more 0 to 800A</td>
</tr>
<tr>
<td></td>
<td>Rated inverter current value reference</td>
<td>9999</td>
<td></td>
</tr>
<tr>
<td>Pr. 64</td>
<td>Starting frequency for elevator mode</td>
<td>9999</td>
<td>0 to 10Hz</td>
</tr>
<tr>
<td></td>
<td>9999</td>
<td>Starting frequency 2Hz</td>
<td></td>
</tr>
<tr>
<td>Pr. 292</td>
<td>Automatic acceleration/deceleration</td>
<td>0</td>
<td>Normal mode</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>Shortest acceleration/ deceleration (without brake) (Refer to page 241)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>Shortest acceleration/ deceleration (with brake)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Optimum acceleration/deceleration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Stall prevention operation level 150%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>Stall prevention operation level 180%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7-8</td>
<td>Brake sequence mode 1, 2 (Refer to page 369)</td>
<td></td>
</tr>
</tbody>
</table>

**Torque boost characteristics**

![Torque boost characteristics graph](image-url)

Therefore settings of [Pr. 13 Starting frequency] [Pr. 19 Base frequency voltage] and [Pr. 22 Stall prevention operation level] are ignored.

By returning [Pr. 292 = 0] (normal mode), the [Pr. 61, 64] setting becomes valid. [Pr. 61, 64] also automatically return to the initial value (9999).
2.6.4 Energy saving control and optimum excitation control [Pr. 60] (common)

This inverter is optimum for fan and pump applications.

Without a fine parameter setting, the inverter automatically performs energy saving operation.

### (1) Energy saving operation mode [Pr. 60 = 4]

Set [Pr. 60 = 4] to perform operation with the minimum output power.

1) Control method
- After the output frequency has become constant (acceleration or deceleration is complete), the output voltage is reduced gradually and operation is performed with the output power (product of current and voltage) being minimum.
- When the output current begins to increase due to the increase in load torque, the output voltage is increased up to the normal V/F pattern to generate the torque required to maintain the speed.
- The output voltage is controlled within the range of +0% to -50% in relation to the normal V/F pattern, and the settings of [Pr. 0 Torque boost] and [Pr. 14 Load pattern selection] are ignored. By setting [Pr. 60 = 0] (Normal mode), the settings of [Pr. 0, Pr. 14] are valid.

2) Restriction conditions
- When Advanced magnetic flux vector control, Simple magnetic flux vector control, Real sensorless vector control, or vector control is selected, the selection of the energy-saving mode is invalid.
- When the encoder feedback function has been selected with the plug-in option (FR-A7AP) fitted to the inverter, the selection of the energy-saving mode is invalid.

3) Applications
- Appropriate application
  - Machine which is operated for a long time at constant speed, e.g. fan, air conditioner.
- Inappropriate application
  - Application in which large load torque is applied
  - Since there is naturally little power consumption loss, no energy-saving effect is expected.
  - Machine which makes frequent acceleration/ deceleration
  - Since torque is necessary for acceleration/ deceleration, no energy-saving effect is expected.

4) Dedicated parameters
- When constant speed is achieved in the energy-saving mode, the output voltage is automatically tuned and there are no dedicated parameters to be set.

5) Energy-saving effect
- The energy-saving effect depends greatly on the load magnitude.

Guideline of energy-saving mode

In applications such as air conditioning equipment, inverter operation produces a larger energy-saving effect on the running cost than damper control by commercial power supply operation. The energy-saving effect depends greatly on the speed (load).

<table>
<thead>
<tr>
<th>Load (%)</th>
<th>Power consumption (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>100</td>
<td>0</td>
</tr>
</tbody>
</table>

Energy-saving effect by air-conditioning equipment

---

<table>
<thead>
<tr>
<th>Pr. 60</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Normal operation mode</td>
<td></td>
<td></td>
<td>Available Inverters</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Energy saving operation mode</td>
<td></td>
<td></td>
<td>Available Inverters</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Optimum excitation control mode</td>
<td></td>
<td></td>
<td>Available Inverters</td>
<td></td>
</tr>
</tbody>
</table>
(2) Optimum excitation control mode

[Pr. 60 = 9] \( F700 \) \( E700 \) \( D700 \)

Optimum excitation control is a control method which controls excitation current to improve the motor efficiency to maximum and determines output voltage.

1) Control method
By converting the motor current to d-q axis to find the excitation current \( I_d \) and torque current \( I_q \), then obtain the motor loss by an original method. Since application is fan and pump, low speed torque is not required. Therefore, it controls excitation current \( I_d \) to make the motor loss minimum focusing on the improvement of motor efficiency rather than torque generation. Namely, it controls the ratio of the excitation current \( I_d \) and torque current \( I_q \) becomes maximum efficiency of the motor.

2) Restrictions
- Since it automatically sets the output voltage to V/F control, the output voltage is not as set in \[Pr. 6 \] \( Torque boost \) and \[Pr. 14 \] \( Load pattern selection \).
- When the motor capacity is too small as compared to the inverter capacity or two or more motors are connected to one inverter, the energy saving effect is not expected.
- Optimum excitation control functions only during V/F control. Optimum excitation control is disabled when Simple magnetic vector control, Advanced magnetic vector control or General-purpose magnetic vector control are selected.

3) Dedicated parameters
Dedicated parameters to automatically set the output voltage are not available.

4) Energy-saving effect
- Motor efficiency improvement example (when inverter operation frequency is 60Hz and the FR-F740-3.7K and motor SF-JR 4P3.7kW are used)
2.7 Selection of control method

2.7.1 Selection of control method [Pr. 80, 81 *, 450 *, 451 *, 453 *, 454 *, 800 *] (common)

V/F control (initial setting), Simple magnetic flux vector control, Advanced magnetic flux vector control, Real sensorless vector control and vector control are available.

1) V/F control (common)
   • It controls frequency and voltage so that the ratio of frequency (f) to voltage (V) is constant when changing frequency.
   • You can choose energy-saving operation mode (only), optimum excitation control (only), or adjustable 5 points V/F (only), and elevator mode (E700 only).

2) Simple magnetic flux vector control (common)
   • Providing optimum excitation to the motor can also produce high torque in a low-speed range.

3) General-purpose magnetic flux vector control (common)
   • This control divides the inverter output current into an excitation current and a torque current by vector calculation and makes voltage compensation to flow a motor current which meets the load torque.

4) Advanced magnetic flux vector control (仅限E700)
   • This control divides the inverter output current into an excitation current and a torque current by vector calculation and makes frequency and voltage compensation to flow a motor current which meets the load torque.

5) Real sensorless vector control (仅限A700)
   • By estimating the motor speed, speed control and torque control with more advanced current control function are enabled. When high accuracy and fast response control are necessary, select the Real sensorless vector control and perform offline auto tuning.
   • This control can be applied to the following applications.
     • To minimize the speed fluctuation even at a severe load fluctuation
     • To generate low speed torque
     • To prevent machine from damage due to too large torque (torque limit)
     • To perform torque control

6) Vector control (A700)
   • When the FR-A7AP or FR-A7AL is mounted, full-scale vector control operation can be performed using a motor with encoder. Fast response/high accuracy speed control (zero speed control, servo lock), torque control, and position control can be performed.
   • What is vector control?
     It has excellent control characteristics when compared to V/F control and other control techniques, achieving the control characteristics equal to those of DC machines.
     • It is suitable for applications below.
       • To minimize the speed fluctuation even at a severe load fluctuation
       • To generate low speed torque
       • To prevent machine from damage due to too large torque (torque limit)
       • To perform torque control or position control
       • Servo-lock torque control which generates torque at zero speed

Note: ([Pr. 81, 450, 451, 453, 454, 800] are not available for A700) ([Pr. 451, 453, 454] are not available for A700) ([Pr. 81, 451, 453, 454, 800] are not available for E700)
(1) Selection of control method and control mode

1) FR-A700 series

Select the inverter control method from V/F control, Advanced magnetic flux vector control (speed control), Real sensorless vector control (speed control, torque control) and vector control (speed control, torque control, and position control).

When vector control test operation ([Pr. 800] = 9) is selected, speed control test operation can be performed without the motor connected. The speed calculation value changes to track the speed command, and the transition can be checked with the operation panel and analog signal output at terminal FM and AM.

<table>
<thead>
<tr>
<th>[Pr]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>0.4 to 5500kW</td>
<td>Set the applied motor capacity.</td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>9999</td>
<td>2, 4, 6, 8, 10</td>
<td>Set the number of motor poles.</td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>18, 20, 24, 30</td>
<td>When using the second motor.</td>
</tr>
<tr>
<td>452</td>
<td>Second motor control method selection</td>
<td>9999</td>
<td>10, 12, 20, 9999</td>
<td>Real sensorless vector control</td>
</tr>
<tr>
<td>453</td>
<td>Second motor capacity</td>
<td>9999</td>
<td>0.4 to 5500kW</td>
<td>Set the capacity of the second motor.</td>
</tr>
<tr>
<td>451</td>
<td>Second motor control method selection</td>
<td>9999</td>
<td>10, 11, 12, 9999</td>
<td>Real sensorless vector control</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[Pr]</th>
<th>Name</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>452</td>
<td>Second motor control method selection</td>
<td>9999</td>
<td>10, 12, 20, 9999</td>
</tr>
<tr>
<td>453</td>
<td>Second motor capacity</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>800</td>
<td>Control method selection</td>
<td>9999</td>
<td>0 to 5</td>
</tr>
<tr>
<td>800</td>
<td>Control method selection</td>
<td>20</td>
<td>0 to 5</td>
</tr>
</tbody>
</table>

Control method in V/F control regardless of the setting value of [Pr. 451] and [Pr. 453] when [Pr. 450] = 9999. Control method in V/F control regardless of [Pr. 451] setting.

<First motor selection>

<table>
<thead>
<tr>
<th>[Pr]</th>
<th>Setting</th>
<th>Control Method</th>
<th>Control Mode</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>0</td>
<td>Speed control</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>2</td>
<td>Vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>4</td>
<td>Position control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>5</td>
<td>Position control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>9</td>
<td>Vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>11</td>
<td>Real sensorless vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>12</td>
<td>Real sensorless vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
</tbody>
</table>

When [Pr. 80 Motor capacity = 9999] or [Pr. 81 Number of motor poles = 9999], control method is V/F control regardless of [Pr. 80] setting.

<Second motor selection>

Setting [Pr. 450 = 9999] selects the second motor control.

<table>
<thead>
<tr>
<th>[Pr]</th>
<th>Setting</th>
<th>Control Method</th>
<th>Control Mode</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>9</td>
<td>Speed control</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>11</td>
<td>Real sensorless vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
<tr>
<td>80</td>
<td>12</td>
<td>Real sensorless vector control</td>
<td>Speed control</td>
<td>—</td>
</tr>
</tbody>
</table>

### PARAMETER

#### 2) FR-F700 series
Select the inverter control method from V/F control and Simple magnetic flux vector control.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>0.4 to 550kW (9999)</td>
<td>Simple magnetic flux vector control</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>55kW or less (9999)</td>
<td>set the applied motor capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>V/F control</td>
</tr>
</tbody>
</table>

#### 3) FR-E700 series
Select the inverter control method from V/F control, Advanced magnetic flux vector control, General-purpose magnetic flux vector control.
You can set the thermal characteristic of the second motor by setting [Pr. 450 ≠ 9999]. At this time, control method does not change. (Depends on the settings of [Pr. 80, 81, 800])

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>0.1 to 15kW (9999)</td>
<td>Set the applied motor capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>15kW or less (9999)</td>
<td>V/F control</td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>9999</td>
<td>2, 4, 6, 8, 10</td>
<td>set the number of motor poles</td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>0, 1</td>
<td>set when using the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0</td>
<td>Function invalid ([Pr. 71] is valid)</td>
</tr>
<tr>
<td>800</td>
<td>Control method selection</td>
<td>20</td>
<td>0, 1</td>
<td>Advanced magnetic flux vector control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>20</td>
<td>20</td>
<td>V/F control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>30</td>
<td>30</td>
<td>General-purpose magnetic flux vector control</td>
</tr>
</tbody>
</table>

#### 4) FR-D700 series
Select the inverter control method from V/F control and General-purpose magnetic flux vector control.
You can set the thermal characteristic of the second motor by setting [Pr. 450 ≠ 9999]. At this time, control method does not change. (Depends on the settings of [Pr. 80, 81, 800])

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>0.4 to 7.5kW (9999)</td>
<td>General-purpose magnetic flux vector control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>7.5kW or less (9999)</td>
<td>set the applied motor capacity</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>V/F control</td>
<td></td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>0, 1</td>
<td>set when using the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0</td>
<td>Function invalid ([Pr. 71] is valid)</td>
</tr>
</tbody>
</table>

#### Note
- **Other than 9999**
  - **[Pr. 80]** Motor capacity: 9999
  - **[Pr. 81]** Number of motor poles: 9999

- **9999** Setting
  - **[Pr. 450]** Second applied motor: 9999
- **Control Method**
  - Advanced magnetic flux vector control
  - General-purpose magnetic flux vector control

* Control method is V/F control regardless of the setting value of [Pr. 111], when [Pr. 80 Motor capacity = 9999] or [Pr. 81 Number of motor poles > 9999].
(2) Control method switching by external terminals (RT signal, X18 signal)

1) FR-A700 series

The switching of the control method (V/F control, Advanced magnetic flux vector control, Real sensorless vector control and vector control) by the external terminal may be made in either of the following two ways: switching by the second function selection signal (RT), or V/F switching signal (X18).

Two types of control method can be switched with the RT signal by setting the type of motor to be used as second control in [Pr. 450: Second applied motor] and control method of the motor in [Pr. 451: Second motor control method selection]. Turn ON the RT signal to select the second function. Other second function is also made valid.

The X18 signal decides the control method when [Pr. 81 = 12, 14, 16, 18, 20] and the X18 signal is ON. When the X18 signal is OFF, the V/F control is selected when the control mode switching external terminal (RT signal) is ON and torque control is selected when the control mode switching external terminal (RT signal) is OFF, and torque control is selected when the control mode switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control mode switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control method switching external terminal (RT signal) is ON, and torque control is selected when the control method switching external terminal (RT signal) is OFF, and torque control is selected when the control mode switching signal (MC) is OFF, and torque control is selected when the signal is ON under Real sensorless vector control or vector control. Switching between speed control and torque control is always enabled independently of whether the motor is at a stop or running or the DC injection brake operation (pre-excitation).

Under vector control, speed control/position control switcher and torque control/position control switcher can be made by setting [Pr. 800 = 10, 12] setting. Speed control/position control switcher and torque control/position control switcher is made when the signal is OFF under Real sensorless vector control or vector control. Switching between speed control and torque control is always enabled independently of whether the motor is at a stop or running or the DC injection brake operation (pre-excitation).

For the terminal used for MC signal input, set 26 in any of [Pr. 178=189] input terminal function selection to assign the function. For the terminal used for X18 signal input, set 18 in any of [Pr. 178=189] input terminal function selection to assign the function.

(3) Switching the control method from the external terminal (MC signal)

When [Pr. 800 = 10, 12] and [Pr. 451 = 2], speed control is selected when the control mode switching signal (MC) is OFF, and torque control is selected when the signal is ON under Real sensorless vector control or vector control. Switching between speed control and torque control is always enabled independently of whether the motor is at a stop or running or the DC injection brake operation (pre-excitation).

For the terminal used for MC signal input, set 26 in any of [Pr. 178=189] input terminal function selection to assign the function. When an analog input terminal (terminal 1, 4) is used for torque limit, torque command, etc., terminal functions also switch if control mode is switched. For the terminal function in different control modes, refer to page 43.

### TABLE

<table>
<thead>
<tr>
<th>First Motor Control Method (RT signal-OFF)</th>
<th>Second Motor Control Method (RT signal-ON)</th>
<th>[Pr. 450=1] Setting</th>
<th>[Pr. 451=1] Setting</th>
<th>[Pr. 452=1] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>V/F control</td>
<td>V/F control</td>
<td>9999</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>Advanced magnetic flux vector control</td>
<td>Advanced magnetic flux vector control</td>
<td>9999</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>Real sensorless vector control</td>
<td>Real sensorless vector control</td>
<td>9999</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>Vector control</td>
<td>Vector control</td>
<td>9999</td>
<td>9999</td>
<td>—</td>
</tr>
<tr>
<td>10 to 12</td>
<td>10 to 12</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

*V/F control is selected when *12, 14, 16, 18, 20* is set in [Pr. 41] and the X18 signal is ON. When the X18 signal is OFF, the V/F control is selected when the RT signal ON selects V/F control as the RT signal shares this function.

For switching by the X18 signal, setting [Pr. 41: Number of motor poles] = 12, 14, 16, 18, 20] and turning the X18 signal ON switches the currently selected control method (Advanced magnetic flux vector control, Real sensorless vector control or vector control) to V/F control. In this case, use this signal only for changing the control method of one motor since second function as electronic thermal relay characteristic, etc., cannot be changed. (Use the RT signal to change the second function.)

For the terminal used for X18 signal input, set 18 in any of [Pr. 178=189] input terminal function selection to assign the function.
2.7.2 Simple magnetic flux vector control [Pr. 71, 80, 90] (F700)

This control method improves the low speed torque when higher torque than V/F control is necessary in the low speed range. Simple magnetic flux vector control can be selected by setting the capacity and type of the motor used.

### Conditions of Simple magnetic flux vector control

Simple magnetic flux vector control may only be utilized effectively when all of the following conditions are satisfied. If any of the conditions cannot be satisfied, torque shortage, speed fluctuation or another fault may occur.

- The motor capacity should be equal to or one rank lower than the inverter capacity.
- The number of motor poles should be 2, 4 or 6. (Only 4 poles for constant-torque motor. Setting is not necessary.)
- Single-motor operation (one motor run by one inverter) should be performed.
- The wiring length from inverter to motor should be within 30m

### Selection method of Simple magnetic flux vector control

Simple magnetic flux vector control is selected by simply setting [Pr. 80 Motor capacity] = 9999. When [Pr. 81 Motor capacity] = 9999, V/F control is selected.
When using the Mitsubishi constant torque motor, set [Pr. 72 = 1].
Set the rated motor frequency in [Pr. 3] and rated motor voltage in [Pr. 4] when Simple magnetic flux vector control is selected. When [Pr. 19] is 9999 or 8888, motor voltage is regarded as 200V (200V class) or 400V (400V class).

### Motor constants setting

Although it is usually unnecessary, set the motor primary resistance value (R1) for connection in [Pr. 90] when you need more torque under Simple magnetic flux vector control for other manufacturer’s motor.
When the setting is 9999 (initial value), set by referring the motor constants of the Mitsubishi motor (SF-JR, SF-HRCA) as standard.

### Slip compensation setting

Since output frequency compensation is not performed under Simple magnetic flux vector control, the actual speed decreases by the motor slip (during driving load operation) if the load to the motor increases.
Set the slip compensation if you want to keep the actual speed constant even if the load to the motor varies. Refer to page 391 for slip compensation.

---

### Parameter Table

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Applied motor</td>
<td>0</td>
<td>0</td>
<td>Thermal characteristics of a standard motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1 to 55kW</td>
<td>Thermal characteristics of the Mitsubishi constant-torque motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>0 to 360kW</td>
<td>Adjustable 5 points V/F (Refer to page 248)</td>
</tr>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>55kW or less</td>
<td>Mitsubishi standard motor (SF-JR, SF-HRCA) or less</td>
</tr>
<tr>
<td></td>
<td>(Simple magnetic flux vector control)</td>
<td></td>
<td>55 to 550kW</td>
<td>Set the capacity of the motor used to select Simple magnetic flux vector control.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>550 to 360kW</td>
<td>V/F control is performed.</td>
</tr>
<tr>
<td>90</td>
<td>Motor constant (R1)</td>
<td>9999</td>
<td>55kW or less</td>
<td>Set the motor primary resistance value. (Usually setting is not necessary)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>75kW or less</td>
<td>Used to set the motor primary resistance value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>1 to 50k</td>
<td>Uses the Mitsubishi motor [SF-JR, SF-HRCA] constants.</td>
</tr>
</tbody>
</table>
2.7.3 General-purpose magnetic flux vector control (Pr. 71, 80, 81*, 800*)

General-purpose magnetic flux vector control is a control method which allows low-speed torque to be improved by dividing the motor current into an excitation current and a torque current and making voltage compensation to flow a motor current which meets the load torque.

(1) Conditions of General-purpose magnetic flux vector control

General-purpose magnetic flux vector control may only be utilized effectively when all of the following conditions are satisfied. If any of the conditions cannot be satisfied, torque shortage, speed fluctuation or another fault may occur.

- The motor capacity should be equal to or one rank lower than the inverter capacity. Note that the motor capacity should be 0.1kW or more.
- Compatible motor is any of Mitsubishi standard motor, high efficiency motor (SF-JR, SF-HR 0.2kW or more) or Mitsubishi constant-torque motor (SF-JRCA four-pole, SF-HRCA 0.4kW to 15kW). When using a motor other than the above (other manufacturer’s motor), always perform offline auto tuning.
- Single-motor operation (one motor run by one inverter) should be performed.
- Wiring length from inverter to motor should be within 30m. When the wiring length exceeds 30m, perform offline auto tuning with wires already in place.

(2) Selection method of General-purpose magnetic flux vector control

To select General-purpose magnetic flux vector control for (E702), set [Pr. 800] = 20 (initial value), and set a value other than 9999 in [Pr. 80 Motor capacity] and [Pr. 81 Number of motor poles]. If 9999 is set in either [Pr. 80] or [Pr. 81], the control method is V/F control.

To select General-purpose magnetic flux vector control for (E702), set a value other than 9999 in [Pr. 80 Motor capacity]. If 9999 is set in [Pr. 80], the control method is V/F control.

Set [Pr. 71] depending on the motor.

(3) Motor constants setting

In most cases, the setting is not necessary, but perform offline auto tuning when using other manufacturer’s motor or a long wiring.

(4) Slip compensation setting

Since output frequency compensation is not performed under General-purpose magnetic flux vector control, the actual speed decreases by the motor slip (during driving load operation) if the load to the motor increases.

Set the slip compensation if you want to keep the actual speed constant even if the load to the motor varies. Refer to page 391 for slip compensation.
Advanced magnetic flux vector control is a control method which allows low-speed torque to be improved by dividing the motor current into an excitation current and a torque current and making voltage compensation to flow a motor current which meets the load torque.

The magnitude of a load torque (i.e. motor slip) is estimated from the magnitude of the torque current on the basis of more accurate motor constants, thereby controlling the output frequency (slip compensation) to make the actual motor speed nearer to the speed command value.

Advanced magnetic flux vector control can be selected by setting the capacity, poles and type of the motor.

---

### Parameter Table

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name (Initial Value)</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Applied motor</td>
<td>0</td>
<td>By selecting a standard motor or constant torque motor, thermal characteristics and motor constants of each motor are set.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>Set the applied motor capacity.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>9999</td>
<td>12, 14, 16, 18, 20 Set 10 + number of motor poles.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>89</td>
<td>Speed control gain</td>
<td>9999</td>
<td>Motor speed fluctuation due to load fluctuation is adjusted during Advanced magnetic flux vector control. 100% is a referenced value.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>Set when using the second motor. Same specifications as [Pr. 71].</td>
<td>A700 E700</td>
</tr>
<tr>
<td>451</td>
<td>Second motor control</td>
<td>9999</td>
<td>Real time speed sensorless vector control</td>
<td>A700 E700</td>
</tr>
<tr>
<td>453</td>
<td>Second motor capacity</td>
<td>9999</td>
<td>Set the capacity of the second motor.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>454</td>
<td>Number of second motor poles</td>
<td>9999</td>
<td>Set the number of poles of the second motor.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>569</td>
<td>Second motor speed control gain</td>
<td>9999</td>
<td>Motor speed fluctuation due to load fluctuation is adjusted during Advanced magnetic flux vector control. 100% is a referenced value.</td>
<td>A700 E700</td>
</tr>
<tr>
<td>800</td>
<td>Control method selection</td>
<td>26</td>
<td></td>
<td>A700 E700</td>
</tr>
</tbody>
</table>

**Notes:**
- [Pr. 178 to Pr. 189] to assign the terminals used for the X18 and MC signal.
- ** When [Pr. 80 Motor capacity = 9999] or [Pr. 81 Number of motor poles = 9999], control method is V/F control regardless of the [Pr. 800] setting.
Conditions of Advanced magnetic flux vector control selection

Advanced magnetic flux vector control may only be utilized effectively when all of the following conditions are satisfied.
If any of the conditions cannot be satisfied, torque shortage, speed fluctuation or another fault may occur. Operate under V/F control in that case.

- The motor capacity should be equal to or one rank lower than the inverter capacity.
- Note that the motor capacity should be 0.4kW or more for A700, 0.1kW or more for E700.
- The motor type is the Mitsubishi standard motor, high efficiency motor (SF-JR, SF-HR 0.2kW or more) or Mitsubishi constant torque motor (SF-JRC 4 poles, SF-HRC 0.4kW to 55kW).
- When any other motor (other manufacturer standard motor, other manufacturer’s constant torque motor) is used, perform offline auto tuning (refer to page 268) without fail.
- Single-motor operation (one motor run by one inverter) should be performed.
- The wiring length from inverter to motor should be within 30m. If the length is over 30m, perform offline auto tuning with the cables wired.
- For 75k or more, do not use an option sine wave filter (MT-BSL/BSC) between the inverter and motor.

Selection method of Advanced magnetic flux vector control

Advanced magnetic flux vector control is selected by simply setting any value other than 9999 in [Pr. 80 Motor capacity] and [Pr. 81 Number of motor poles] when [Pr. 800 = 20] (initial value). V/F control is chosen when either of the [Pr. 80] or [Pr. 81] setting is 9999.

When [Pr. 81 = 12, 14, 16, 18, 20] in (N10H), V/F control and Advanced magnetic flux vector control can be switched by turning X18 signal ON/OFF. When Advanced magnetic vector control is set in (N10H), V/F control and Advanced magnetic vector control can be switched by turning X18 signal ON/OFF regardless of [Pr. 81] setting. Set [Pr. 70] depending on the motor.

Instructions on Advanced magnetic flux vector control

- A little inferior to V/F control in suppressing rotation ripple.
- There is an arithmetic operation delay of 0.1 to 0.2s at start-up.
- When a surge voltage suppression filter (FR-ASF-H) is connected between the inverter 55k or less and motor, output torque may decrease.
- Applications suitable for Advanced magnetic flux vector control
  - Machines requiring a large starting torque
  - Machines requiring a sufficient low-speed torque
  - Machines with load which varies greatly
  - Applications unsuitable for Advanced magnetic flux vector control
  - Grinders, lapping machines and other machines for which speed fluctuation at low speed is important.

Fine adjustment method for Advanced magnetic flux vector control

The motor speed fluctuation at load fluctuation can be adjusted using [Pr. M1]. When you have changed the conventional model FR-A500(L) series for the FR-A700 series, Advanced magnetic flux vector control is effective when motor speed does not match.
(5) Performing Advanced magnetic vector control by switching between two motors

Turning the RT signal ON allows the second motor to be controlled.
Set the second motor in [Pr. 450 Second applied motor].
(Initial setting is 9999 (without second applied motor).
Refer to page 266.)

<table>
<thead>
<tr>
<th>Functions</th>
<th>RT Signal is ON (Second Motor)</th>
<th>RT Signal is OFF (First Motor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied motor</td>
<td>[Pr. 450]</td>
<td>[Pr. 77]</td>
</tr>
<tr>
<td>Motor capacity</td>
<td>[Pr. 457]</td>
<td>[Pr. 84]</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>[Pr. 459]</td>
<td>[Pr. 85]</td>
</tr>
<tr>
<td>Speed control gain</td>
<td>[Pr. 569]</td>
<td>[Pr. 89]</td>
</tr>
<tr>
<td>Control method selection</td>
<td>[Pr. 451]</td>
<td>[Pr. 800]</td>
</tr>
</tbody>
</table>

Turning the RT signal ON allows the second motor to be controlled. Set the second motor in [Pr. 450 Second applied motor].
Note that control method is not selectable for the second motor, so the same control method as the first motor applies. When Advanced magnetic vector control is selected, use same type of motor for the first and second motors. Use X18 signal when you want to use the second motor in V/F control.
2.7.5 Real sensorless vector control [Pr. 71, 80, 450, 451, 453, 454, 800] (A700)

Real sensorless vector control is the control method which divides the inverter output current into an excitation current and a torque current by vector calculation, and improves low torque, speed control range, and speed response by controlling frequency and voltage optimally to flow a motor current which meets the load torque, achieving maximum of 200% (3.7kW or less) high torque at 0.3Hz. It responds to the load variation quickly (high response) by torque current control and torque control is also enabled by giving torque command.

(1) Conditions of Real sensorless vector control selection

Real sensorless vector control may only be utilized effectively when all of the following conditions are satisfied. If any of the conditions cannot be satisfied, torque shortage, speed fluctuation or another fault may occur. Operate under V/F control in that case.

- The motor capacity should be equal to or one rank lower than the inverter capacity.
- Note that the motor capacity should be 0.4kW or more.
- Perform offline auto tuning (refer to page 268) independently of the Mitsubishi motor and other manufacturer’s motor.
- Single-motor operation (one motor run by one inverter) should be performed.

(2) Selection method of Real sensorless vector control

Set any of 10 to 12 in [Pr. 80 Motor capacity] and [Pr. 81 Number of motor poles] selects Real-sensorless vector control. V/F control is chosen when either of the [Pr. 80 or Pr. 81] setting is 9999.
(3) Instructions on Real sensorless vector control

- Make sure to perform offline auto tuning before performing Real sensorless vector control.
- The carrier frequencies are selectable from 2kHz, 6kHz, 10kHz, 14kHz for Real sensorless vector control. (2kHz and 6kHz for the 75K or more.)
- Torque control cannot be performed in the low speed (about 10Hz or less) regeneration range or light load at low speed (about 20% or less of rated torque at about 0Hz or less). Choose vector control.
- Performing pre-excitation (LX signal and X13 signal) under torque control may start the motor running at a low speed even when the start signal (STF or STR) is not input. The motor may run also at a low speed when the speed limit value = 0 with a start command input. Perform pre-excitation after making sure that there will be no problem in safety if the motor runs.
- Do not switch between the forward rotation command (STF) and reverse rotation command (STR) during operation under torque control. Overcurrent trip (E.OC1 to 3) or opposite rotation deceleration fault (E.11) occurs.
- For the 0.4K to 3.7K, the speed deviation may become large at 20Hz or less and torque may become insufficient in the low speed range under 11Hz during continuous operation under Real sensorless vector control. In such case, stop operation once and reaccelerate to solve the problems.
- When the inverter is likely to start during motor coasting under Real sensorless vector control, set to make frequency search of automatic restart after instantaneous power failure valid ([Pr. 57 = 9999], [Pr. 162 = 10]).

(4) Performing Real sensorless vector control by switching between two motors

Turning the RT signal ON allows the second motor to be controlled.
Set the second motor in [Pr. 459 Second applied motor].
(Initial setting is 9999 (without second applied motor).
Refer to page 266.)

<table>
<thead>
<tr>
<th>Functions</th>
<th>RT Signal is ON (Second Motor)</th>
<th>RT Signal is OFF (First Motor)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied motor</td>
<td>[Pr. 450]</td>
<td>[Pr. 15]</td>
</tr>
<tr>
<td>Motor capacity</td>
<td>[Pr. 451]</td>
<td>[Pr. 15]</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>[Pr. 452]</td>
<td>[Pr. 16]</td>
</tr>
<tr>
<td>Speed control gain</td>
<td>[Pr. 453]</td>
<td>[Pr. 16]</td>
</tr>
<tr>
<td>Control method selection</td>
<td>[Pr. 454]</td>
<td>[Pr. 16]</td>
</tr>
</tbody>
</table>

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This method divides the currents flowing in the motor into a current for making a magnetic flux in the motor and a current for causing the motor to develop a torque and controls each current separately. Therefore, very high response is obtained and torque at low speed can be generated stably.

It is necessary to know the motor speed to perform this control, and a motor with an encoder and a plug-in option FR-A7AP or FR-A7AL are required. It responds to the load variation quickly (high response) by torque current control, and torque control is also enabled by giving torque command. It has excellent control characteristics and achieves the control characteristics equal to those of DC machines.

### Conditions of vector control selection

Vector control only may be utilized effectively when all of the following conditions are satisfied. If any of the conditions cannot be satisfied, torque shortage, speed fluctuation or another fault may have occurred. Operate under V/F control in that case.

- **A plug-in option FR-A7AP or FR-A7AL should be fitted to the inverter.**
- **The encoder should be coupled on the same axis with the motor shaft without any mechanical looseness.** The speed ratio should be 1:1.
- **When the standard motor or constant motor is used, the motor capacity should be equal to or one rank lower than the inverter capacity.**

Note that the motor capacity should be 0.4kW or more.

For the vector control dedicated motor, the inverter one or two ranks higher than the motor in capacity needs to be selected depending on the motor capacity. Refer to the table on the next page for combination with a vector control dedicated motor.

The motor type is the Mitsubishi standard motor with an encoder, Mitsubishi high efficiency motor (SF-JR, SF-HR 2 poles, 4 poles, 6 poles 0.4kW or more) or Mitsubishi constant torque motor (SF-JRCA 4 poles, SF-HRCA 0.4kW to 55kW), or vector control dedicated motor (SF-VSRU). When any other motor (other manufacturer standard motor, other manufacturer constant torque motor) is used, use this function after performing offline auto tuning (refer to page268) without fail.

Single-motor operation (one motor run by one inverter) should be performed.

Wiring length from inverter to motor should be within 30m. If the length is over 30m, perform offline auto tuning with the cables wired.
## Parameter

### Voltage

<table>
<thead>
<tr>
<th>Voltage Class</th>
<th>200V Class</th>
<th>400V Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated speed</td>
<td>1500/min</td>
<td>1000/min</td>
</tr>
<tr>
<td>Base frequency</td>
<td>50Hz</td>
<td>33.33Hz</td>
</tr>
</tbody>
</table>

### Maximum speed

<table>
<thead>
<tr>
<th>Motor capacity</th>
<th>Motor frame number</th>
<th>Motor type</th>
<th>Inverter type</th>
<th>Motor frame number</th>
<th>Motor type</th>
<th>Inverter type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5kW</td>
<td>90L</td>
<td>SF-V5RU1K</td>
<td>FR-A720-2.2K</td>
<td>90L</td>
<td>SF-V5RU1H1K</td>
<td>FR-A740-2.2K</td>
</tr>
<tr>
<td>2.2kW</td>
<td>100L</td>
<td>SF-V5RU2K</td>
<td>FR-A720-2.2K</td>
<td>100L</td>
<td>SF-V5RU2H2K</td>
<td>FR-A740-2.2K</td>
</tr>
<tr>
<td>3.7kW</td>
<td>100M</td>
<td>SF-V5RU1K</td>
<td>FR-A720-3.7K</td>
<td>100M</td>
<td>SF-V5RU1H1K</td>
<td>FR-A740-3.7K</td>
</tr>
<tr>
<td>5.5kW</td>
<td>132M</td>
<td>SF-V5RU2K</td>
<td>FR-A720-3.7K</td>
<td>132M</td>
<td>SF-V5RU2H2K</td>
<td>FR-A740-3.7K</td>
</tr>
<tr>
<td>7.5kW</td>
<td>160L</td>
<td>SF-V5RU3K</td>
<td>FR-A720-5.5K</td>
<td>160L</td>
<td>SF-V5RU3H3K</td>
<td>FR-A740-5.5K</td>
</tr>
<tr>
<td>11kW</td>
<td>160M</td>
<td>SF-V5RU2K</td>
<td>FR-A720-7.5K</td>
<td>200L</td>
<td>SF-V5RU2H2K</td>
<td>FR-A740-7.5K</td>
</tr>
<tr>
<td>15kW</td>
<td>200L</td>
<td>SF-V5RU4K</td>
<td>FR-A720-7.5K</td>
<td>200L</td>
<td>SF-V5RU4H4K</td>
<td>FR-A740-7.5K</td>
</tr>
<tr>
<td>18.5kW</td>
<td>200L</td>
<td>SF-V5RU5K</td>
<td>FR-A720-11K</td>
<td>250MD</td>
<td>SF-THY</td>
<td>FR-A740-11K</td>
</tr>
<tr>
<td>30kW</td>
<td>200L</td>
<td>SF-V5RU7K</td>
<td>FR-A720-22K</td>
<td>280L</td>
<td>SF-THY</td>
<td>FR-A740-22K</td>
</tr>
<tr>
<td>37kW</td>
<td>200L</td>
<td>SF-V5RU8K</td>
<td>FR-A720-37K</td>
<td>300MD</td>
<td>SF-THY</td>
<td>FR-A740-37K</td>
</tr>
<tr>
<td>45kW</td>
<td>200L</td>
<td>SF-V5RU9K</td>
<td>FR-A720-55K</td>
<td>400MD</td>
<td>SF-THY</td>
<td>FR-A740-55K</td>
</tr>
<tr>
<td>55kW</td>
<td>225S</td>
<td>SF-V5RU10K</td>
<td>FR-A720-75K</td>
<td>550MD</td>
<td>SF-THY</td>
<td>FR-A740-75K</td>
</tr>
<tr>
<td>75kW</td>
<td>250MD</td>
<td>SF-THY</td>
<td>FR-A740-75K</td>
<td>225S</td>
<td>SF-V5RU11K</td>
<td>FR-A740-110K</td>
</tr>
<tr>
<td>110kW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>280MD</td>
<td>SF-THY</td>
<td>FR-A740-110K</td>
</tr>
<tr>
<td>132kW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>280MD</td>
<td>SF-THY</td>
<td>FR-A740-110K</td>
</tr>
<tr>
<td>160kW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>280MD</td>
<td>SF-THY</td>
<td>FR-A740-110K</td>
</tr>
<tr>
<td>200kW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>280L</td>
<td>SF-THY</td>
<td>FR-A740-220K</td>
</tr>
<tr>
<td>250kW</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>315H</td>
<td>SF-THY</td>
<td>FR-A740-220K</td>
</tr>
</tbody>
</table>

### Notes

*1 The maximum speed is 2400/min.

*2 80% output in the high-speed range. (The output is reduced when the speed is 2400/min or more.)

*3 90% output in the high-speed range. (The output is reduced when the speed is 1000/min or more.)
(2) Selection method of vector control
Set any of 0 to 5 in [Pr. 800 Control method selection]. Setting any value other than 9999 in [Pr. 80 Motor capacity] and [Pr. 81 Number of motor poles] selects vector control. V/F control is chosen when either of the [Pr. 80 or 81] setting is 9999. When [Pr. 81 = 12, 14, 16, 18, 20], you can select between V/F control and vector control for operation by switching ON-OFF the X18 signal.
Set [Pr. 71, 359, 369] according to the motor and encoder used.

Vector control is controlled by the encoder at motor side. When performing vector control with the encoder on the machine side by using FR-A7AL, convert the number of encoder pulses at the machine side to the number equivalent for the motor side, and set the value to [Pr. 396 Number of encoder pulses]. When encoders at the motor side and machine side differ, set the same rotation direction as the motor side to [Pr. 359 Encoder rotation direction].

(3) Information on vector control
The carrier frequencies are selectable from 2k, 6k, 10k, 14kHz for vector control. (2k and 6kHz for the 75K or more)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi standard motor SF-JR</td>
<td>Rated motor current 0</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td>1</td>
<td>1024</td>
<td></td>
</tr>
<tr>
<td>SF-JR 4P Rated motor current 5</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-JR 4P 1.5kW or less</td>
<td>Rated motor current 20</td>
<td>Motor capacity</td>
<td>4</td>
<td>1</td>
<td>1024</td>
<td></td>
</tr>
<tr>
<td>SF-VR</td>
<td>Rated motor current 40</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td>1</td>
<td>1024</td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Rated motor current 3</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mitsubishi constant-torque motor SF-JRCA 4P</td>
<td>Rated motor current 1</td>
<td>Motor capacity</td>
<td>4</td>
<td>1</td>
<td>1024</td>
<td></td>
</tr>
<tr>
<td>SF-JRCA</td>
<td>Rated motor current 50</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td>1</td>
<td>1024</td>
<td></td>
</tr>
<tr>
<td>SF-HRCA</td>
<td>Rated motor current 13</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others</td>
<td>Rated motor current 1</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SF-VSHU (1500r/min series)</td>
<td>0</td>
<td>Motor capacity</td>
<td>4</td>
<td>1</td>
<td>2048</td>
<td></td>
</tr>
<tr>
<td>SF-VSHU (Other than 1500r/min series)</td>
<td>0</td>
<td>Motor capacity</td>
<td>4</td>
<td>1</td>
<td>2048</td>
<td></td>
</tr>
<tr>
<td>SF-THY</td>
<td>0</td>
<td>Motor capacity</td>
<td>4</td>
<td>1</td>
<td>2048</td>
<td></td>
</tr>
<tr>
<td>Other manufacturer’s standard motor</td>
<td>Raled motor current 3</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other manufacturer’s constant-torque motor</td>
<td>Raled motor current 13</td>
<td>Motor capacity</td>
<td>Number of motor poles</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Values in [ ] are initial values.
*1 Offline auto tuning is necessary. (Refer to page 268)
*2 Set this parameter according to the motor used.
*3 Use thermal relay protector input provided with the motor.
2.8 Applied motor selection and auto tuning

2.8.1 Applied motor selection [Pr. 71, 450] (common)

Setting the motor used selects the thermal characteristic appropriate for the motor stated below:

1) Electronic thermal relay function characteristic matching the motor (Refer to page 108)

2) Motor constants necessary for control when Advanced magnetic flux vector or Real sensorless vector control is selected

---

### Table 1: Applied motor setting

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Applied motor</td>
<td>0</td>
<td>7105 F1 to 2, 18 to 20</td>
<td>selecting the standard motor or constant-torque motor sets the corresponding motor thermal characteristic.</td>
<td>○ ☐</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>7105 F1 to 2, 18 to 20</td>
<td>selecting the second motor, same specifications as Pr. 71</td>
<td>○ ☐</td>
</tr>
</tbody>
</table>

### Table 2: Applied motor selection [Pr. 71, 450] (common)

<table>
<thead>
<tr>
<th>[Pr. 71]</th>
<th>Thermal Characteristic of the Electronic Thermal Relay Function</th>
<th>Motor (to use motor)</th>
<th>Standard Motor Setting (SF-JR, etc.)</th>
<th>Constant-Torque Motor Setting (SF-JRCA, etc.)</th>
<th>Vector Motor Setting (SF-V5RU)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Thermal characteristics of a standard motor</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Thermal characteristics of a standard motor</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Thermal characteristic of Mitsubishi high efficiency motor SF-HR</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>Vector control dedicated motor SF-V5RU (1500r/min series)</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Thermal characteristics of Mitsubishi constant-torque motor SF-HRCA</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Constant-torque motor</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Mitsubishi standard motor SF-JR (≤ 1.5kW or less)</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Vector control dedicated motor SF-V5RU (1500r/min series, SF-THY)</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>Mitsubishi high efficiency motor SF-HR</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>Mitsubishi constant-torque motor SF-HRCA</td>
<td>○</td>
<td>☑</td>
<td>☑</td>
<td></td>
</tr>
</tbody>
</table>

---

(Pr. 71) ([Pr. 450]) is not available for (Pr. 450).

1) Motor constants necessary for control when Advanced magnetic flux vector or Real sensorless vector control is selected

---

266
PARAMETER

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Motor Characteristics</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Standard motor</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Constant-torque motor</td>
<td>Auto tuning data can be read, changed, and set.</td>
</tr>
<tr>
<td>24</td>
<td>Mitsubishi standard motor SF-JR or less (SF-JR4P (1.5kW or less))</td>
<td></td>
</tr>
<tr>
<td>34</td>
<td>Mitsubishi constant-torque motor SF-V5RU (1500rpm series), SF-V5RU (1500rpm series), SF-THY, SF-HR, SF-HRCA</td>
<td></td>
</tr>
<tr>
<td>44</td>
<td>Mitsubishi high efficiency motor SF-HR, SF-HRCA</td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>Mitsubishi constant-torque motor SF-HRCA</td>
<td></td>
</tr>
</tbody>
</table>

- **Constant-torque motor**
- **Vector control dedicated motor**
- **Standard motor**
- **Delta connection**
- **Star connection**

<table>
<thead>
<tr>
<th>Motor Characteristics</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard motor</td>
<td></td>
</tr>
<tr>
<td>Delta connection</td>
<td></td>
</tr>
<tr>
<td>Star connection</td>
<td></td>
</tr>
</tbody>
</table>

*1 Motor constants of Mitsubishi high efficiency motor SF-HR.
*2 Motor constants of Mitsubishi constant-torque motor SF-HRCA.
*3 Setting values for [Pr. 71] and [Pr. 450] differ by the model. Refer to the setting range in the table above for the setting values.
*4 [Pr. 450] is not available for [Pr. 71].

---

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2.8.2 Offline auto tuning function

[Pr. 71, 80 to 84*, 90 to 94*, 96, 450*, 453 to 463*, 684*, 859*, 860*]

Auto tuning function is designed to automatically measure the motor constants necessary for Advanced magnetic flux vector control, Real sensorless vector control, and vector control operation. The motor can be run with the optimum operating characteristics even when each motor constant differs, other manufacturer's motor is used, or the wiring length is long.

Also, tuning data (motor constants) can be copied to another inverter with the operation panel or FR-PU07 parameter unit.

Note that a high-slip motor, high-speed motor, or other special motor cannot be tuned. Also, the highest speed should be 120Hz.

What is auto tuning?

1) The motor performance can be maximized.
2) Auto tuning function is recommended for improvement of motor operation performance. (Always perform auto tuning when using Real sensorless vector control.)
3) There are two different auto tuning: offline auto tuning (measures motor constants before machine operation) and online auto tuning (measures motor constants at every start of the inverter).
4) Tuning without motor running and with motor running are available for offline auto tuning.
5) Accuracy of speed characteristics

Online ➔ offline (with motor running) ➔ offline (without motor running) ➔ without tuning

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Applied motor</td>
<td>0 40 80 100 160 200 204 300</td>
<td>By selecting a standard motor or constant torque motor, thermal characteristic and motor constants of each motor are set.</td>
</tr>
<tr>
<td>80</td>
<td>Motor capacity</td>
<td>9999</td>
<td>Set the applied motor capacity.</td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>9999</td>
<td>Set the number of motor poles.</td>
</tr>
<tr>
<td>82</td>
<td>Motor excitation current</td>
<td>9999</td>
<td>(The value measured by offline auto tuning is automatically set.)</td>
</tr>
<tr>
<td>83</td>
<td>Rated motor voltage</td>
<td>9999</td>
<td>Set the rated motor voltage(V).</td>
</tr>
<tr>
<td>90</td>
<td>Motor constant (R1)</td>
<td>9999</td>
<td>(The initial value differs according to the voltage class. (200/400V)</td>
</tr>
<tr>
<td>91</td>
<td>Motor constant (R2)</td>
<td>9999</td>
<td>T作る (The value measured by offline auto tuning is automatically set.)</td>
</tr>
<tr>
<td>92</td>
<td>Motor constant (L1)</td>
<td>9999</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA, SF-V5RU(1500r/min series)) constants</td>
</tr>
<tr>
<td>93</td>
<td>Motor constant (L2)</td>
<td>9999</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA, SF-V5RU(1500r/min series)) constants</td>
</tr>
<tr>
<td>94</td>
<td>Motor constant (X)</td>
<td>9999</td>
<td>T作る (The value measured by offline auto tuning is automatically set.)</td>
</tr>
</tbody>
</table>
### PARAMETER

<table>
<thead>
<tr>
<th>[P.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>96</td>
<td>Auto tuning setting/status</td>
<td>0</td>
<td>0</td>
<td>Offline auto tuning is not performed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>Offline auto tuning is performed without motor running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>101</td>
<td>101</td>
<td>Offline auto tuning is performed with motor running</td>
</tr>
<tr>
<td>450</td>
<td>Second applied motor</td>
<td>9999</td>
<td>1 to 8, 13 to 16, 20, 21, 24, 30, 34, 40, 43, 44, 50, 53, 54</td>
<td>Set when using the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>1 to 75</td>
<td>(same specifications as [Pr. 71])</td>
</tr>
<tr>
<td>453</td>
<td>Second motor capacity</td>
<td>9999</td>
<td>0 to 5999kW</td>
<td>Set the capacity of the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600kW</td>
<td></td>
</tr>
<tr>
<td>454</td>
<td>Number of second motor poles</td>
<td>9999</td>
<td>2, 4, 6, 8, 10</td>
<td>Set the number of poles of the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0</td>
<td>(not effective)</td>
</tr>
<tr>
<td>455</td>
<td>Second motor excitation current</td>
<td>9999</td>
<td>0 to 3600A</td>
<td>Tuning data of the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td>(The value measured by offline auto tuning is automatically set)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td></td>
</tr>
<tr>
<td>456</td>
<td>Rated second motor voltage</td>
<td>200V, 400V</td>
<td>0 to 1000V</td>
<td>Set the rated voltage (V) of the second motor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 1000V</td>
<td>The initial value differs according to the voltage class. (200V/400V)</td>
</tr>
<tr>
<td>457</td>
<td>Rated second motor frequency</td>
<td>50Hz, 60Hz</td>
<td>10 to 120Hz</td>
<td>Set the rated motor frequency (Hz) of the second motor</td>
</tr>
<tr>
<td>458</td>
<td>Second motor constant (R1)</td>
<td>9999</td>
<td>0 to 99, 9999</td>
<td>Tuning data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 99, 9999</td>
<td>(The value measured by offline auto tuning is automatically set)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td></td>
<td>9999</td>
<td>0 to 99, 9999</td>
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</tr>
<tr>
<td>459</td>
<td>Second motor constant (R2)</td>
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<td>0 to 99, 9999</td>
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<td>(The value measured by offline auto tuning is automatically set)</td>
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<td>Second motor constant (L1)</td>
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<td>(The value measured by offline auto tuning is automatically set)</td>
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<td>0 to 99, 9999</td>
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<tr>
<td>461</td>
<td>Second motor constant (L2)</td>
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<td>0 to 99, 9999</td>
<td>Tuning data</td>
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<td>(The value measured by offline auto tuning is automatically set)</td>
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<td>0 to 99, 9999</td>
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<tr>
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<td>Second motor constant (X)</td>
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<td>Tuning data</td>
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<td>0 to 99, 9999</td>
<td>(The value measured by offline auto tuning is automatically set)</td>
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<td>9999</td>
<td>0 to 99, 9999</td>
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</tr>
<tr>
<td>463</td>
<td>Second motor auto tuning setting/status</td>
<td>0</td>
<td>0</td>
<td>Second motor auto tuning is not performed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>Second motor auto tuning is performed without second motor running</td>
</tr>
<tr>
<td></td>
<td></td>
<td>101</td>
<td>101</td>
<td>Second motor auto tuning is performed with second motor running</td>
</tr>
<tr>
<td>854</td>
<td>Tuning data unit switcher</td>
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<td>0</td>
<td>Internal data conversion value</td>
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<td></td>
<td>1</td>
<td>1</td>
<td>Displayed in &quot;A, %, mH, %&quot;</td>
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<tr>
<td>859</td>
<td>Torque current</td>
<td>9999</td>
<td>0 to 3600A</td>
<td>Tuning data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td>(The value measured by offline auto tuning is automatically set)</td>
</tr>
<tr>
<td></td>
<td></td>
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<td>0 to 3600A</td>
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</tr>
<tr>
<td>860</td>
<td>Second motor torque current</td>
<td>9999</td>
<td>0 to 3600A</td>
<td>Tuning data of the second motor</td>
</tr>
<tr>
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<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td>(The value measured by offline auto tuning is automatically set)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 3600A</td>
<td></td>
</tr>
</tbody>
</table>

269
## PARAMETER

<table>
<thead>
<tr>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied motor</td>
<td>0</td>
<td>0, 1, 3, 5, 7, 11, 13, 15, 17, 19</td>
<td>By selecting a standard motor or constant torque motor, thermal characteristic and motor constants of each motor are set.</td>
</tr>
<tr>
<td>Motor capacity</td>
<td>9999</td>
<td>0.1 to 180kW</td>
<td>Applied motor capacity.</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>9999</td>
<td>2, 4, 6, 8, 10</td>
<td>Number of motor poles.</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>9999</td>
<td>0 to 500A</td>
<td>The value measured by offline auto tuning is automatically set.</td>
</tr>
<tr>
<td>Rated motor voltage</td>
<td>200V class 2000</td>
<td>0 to 1000V</td>
<td>Rated motor voltage(V).</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>9999</td>
<td>0 to 500A</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Rated motor frequency</td>
<td>60Hz</td>
<td>10 to 120Hz</td>
<td>Rated motor frequency (Hz)</td>
</tr>
<tr>
<td>Motor constant (R1)</td>
<td>9999</td>
<td>0 to 600Ω</td>
<td>Tuning data.</td>
</tr>
<tr>
<td>Motor constant (R2)</td>
<td>9999</td>
<td>0 to 600Ω</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Motor constant (L1)</td>
<td>9999</td>
<td>0 to 1000mH</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Motor constant (L2)</td>
<td>9999</td>
<td>0 to 1000mH</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Motor constant (X)</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Auto tuning setting/ status</td>
<td>0</td>
<td></td>
<td>Offline auto tuning is not performed</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>Offline auto tuning is performed without motor running (all motor constants).</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>Offline auto tuning is performed without motor running. (motor constant (R1) only)</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td>Offline auto tuning for V/F control (automatic restart after instantaneous power failure (with frequency search)) (Refer to page 367)</td>
</tr>
<tr>
<td>Torque current</td>
<td>9999</td>
<td>0 to 500A</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
</tbody>
</table>

## PARAMETER

<table>
<thead>
<tr>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied motor</td>
<td>0</td>
<td>0, 1, 3, 13, 23, 40, 43, 50, 53</td>
<td>By selecting a standard motor or constant torque motor, thermal characteristic and motor constants of each motor are set.</td>
</tr>
<tr>
<td>Motor capacity</td>
<td>9999</td>
<td>0.1 to 7.5kW</td>
<td>Applied motor capacity.</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>9999</td>
<td>0 to 500A</td>
<td>Uses the Mitsubishi motor (SF-JR, SF-HR, SF-JRCA, SF-HRCA) constants</td>
</tr>
<tr>
<td>Rated motor voltage</td>
<td>400V class 4000</td>
<td>0 to 1000V</td>
<td>Rated motor voltage(V).</td>
</tr>
<tr>
<td>Rated motor frequency</td>
<td>60Hz</td>
<td>10 to 120Hz</td>
<td>Rated motor frequency (Hz).</td>
</tr>
<tr>
<td>Motor constant (R1)</td>
<td>9999</td>
<td>0 to 600Ω</td>
<td>Tuning data.</td>
</tr>
<tr>
<td>Auto tuning setting/ status</td>
<td>0</td>
<td></td>
<td>Offline auto tuning is not performed</td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td>Offline auto tuning is performed without motor running. (motor constant (R1) only)</td>
</tr>
<tr>
<td>21</td>
<td></td>
<td></td>
<td>Offline auto tuning for V/F control (automatic restart after instantaneous power failure (with frequency search)) (Refer to page 367)</td>
</tr>
</tbody>
</table>
(1) Wiring and load check

Check the following before performing auto tuning.

1) Connect the motor and select any of General-purpose magnetic flux vector control, Advanced magnetic flux control, Real sensorless vector control, or vector control. Note that the motor should be at a stop at a tuning start. Auto tuning cannot be performed when V/F control is selected. (Except when [Pr. 96 = 21] in [E700 D700])

2) The motor capacity should be equal to or one rank lower than the inverter capacity. (Note that the motor capacity should be ≥0.4kW or more for A700 and ≥0.1kW or more for D700.)

3) Tuning is enabled even when a load (friction, steady load, etc.) is connected to the motor. Note that tuning accuracy is higher as the load is lighter. Tuning accuracy does not change even if the inertia is large.

4) Note the following matters when [Pr. 96 = 101] (offline auto tuning performed with motor running).

5) Even if [Pr. 96 = 1, 11, 21] (tuning performed without motor running), the motor may run slightly. Therefore, fix the motor securely with a mechanical brake, or before tuning, and make sure that there will be no problem in safety.

(2) Parameter Setting

After General-purpose magnetic flux vector control, Advanced magnetic flux vector control, Real sensorless vector control, vector control is selected, refer to the parameter description to set the following parameters. Refer to page 367 for the auto tuning at [Pr. 96 = 21] V/F control (automatic restart after instantaneous power failure (with frequency search)).

1) [Pr. 96: Auto tuning setting/status] (offline auto tuning performed with motor running).

   a) Torque is not enough during tuning.
   b) The motor may be run at nearly its rated frequency ([Pr. A4] setting), make sure that there will be no problem in safety.
   c) The mechanical brake is open.
   d) No external force is applied to rotate the motor.

2) [Pr. 9 Electronic thermal O/L relay] (tuning performed without motor running), the motor may run slightly. Therefore, fix the motor securely with a mechanical brake, or before tuning, and make sure that there will be no problem in safety.

3) [Pr. 83 Rated motor voltage] (offline auto tuning performed with motor running).

   a) Torque is not enough during tuning.
   b) The motor may be run at nearly its rated frequency ([Pr. 84] setting), make sure that there will be no problem in safety.
   c) The mechanical brake is open.
   d) No external force is applied to rotate the motor.

4) [Pr. 84 Rated motor frequency] (offline auto tuning performed with motor running).

   a) Torque is not enough during tuning.
   b) The motor may be run at nearly its rated frequency ([Pr. 84] setting), make sure that there will be no problem in safety.
   c) The mechanical brake is open.
   d) No external force is applied to rotate the motor.

5) [Pr. 71 Applied motor] (offline auto tuning performed with motor running).

   a) Mitsubishi standard motor
   b) Mitsubishi high efficiency motor
   c) Mitsubishi constant-torque motor
   d) Other manufacturer’s standard motor
   e) Other manufacturer’s constant-torque motor

For the setting value, set the motor rating plate value. If there are several rating values as standard motor, set the value of 200V/60Hz or 400V/60Hz.

When using vector control dedicated motors, SF-V5RU and SF-THY, setting 33 or 34 to [Pr. 71] chooses the internal constant that meets the dedicated motor. Therefore, setting to [Pr. 83 and 84] is unnecessary.

Motor | [Pr. 71 Setting] | [Pr. 83 Setting] | [Pr. 84 Setting] |
------|-----------------|-----------------|-----------------|
SF-JR, SF-JTH | 3 | 3 | 3 |
SF-JR A 1.5kW or less | 1 | 1 |
SF-JRC-4P, SF-JTHCA | 3 | 3 | 3 |
Vector control dedicated motor | 3 | 3 |
SF-V5RU (1500mm series) | 33 |
SF-V5RU (except for 1500mm series) | 13 |
Other manufacturer’s standard motor | 3 |
Other manufacturer’s constant-torque motor | 13 |

* For the setting value, set the motor rating plate value. If there are several rating values as standard motor, set the value of 200V/60Hz or 400V/60Hz.

When using vector control dedicated motors, SF-V5RU and SF-THY, setting 33 or 34 to [Pr. 71] chooses the internal constant that meets the dedicated motor. Therefore, setting to [Pr. 83 and 84] is unnecessary.
### Auto tuning operation

When performing the auto tuning in PU operation mode, press the [MRS] or [RES] key in the 'Auto tuning operation' key. When performing auto tuning in the External operation mode, turn the starting switch (STF or STR signal) ON.

Since the motor runs when \([Pr. 96 = 101]\), caution must be taken.

Since the RUN signal turns ON when tuning is started, caution is required especially when a sequence which releases a mechanical brake by the RUN signal has been designed.

During online auto tuning, only the following I/O signals are valid (when initial setting):

- **Input terminals**
  - STOP, OH, MRS, RT, RES, STF, STR
  - MRS, RES, STF, STR
  - STF, STR

- **Output terminal**
  - RUN, OL, IPF, FM*, AM*, A1B1C1
  - RUN, FM*, ABC

* When output frequency and rotation speed are output from terminal FM and AM, offline auto tuning status (full scale when ended normally) is output (in 15 levels in 470, 8 levels in 471, 5 levels in 472)

### Auto tuning time

- **[Pr. 96]**
  - **Time**
  - 1: Non-rotation mode
    - Estimated time when the SF-JR is operated
    - 0.4kW: 22s
    - 3.7kW: 37s
    - 11kW: 50s
    - 37kW: 90s
    - 75kW: 130s
  - 11: Non-rotation mode
    - About 9s
  - 101: Rotation mode
    - About 40s*

  * Auto tuning time varies with the acceleration and deceleration time settings as indicated below.

  Auto tuning time = acceleration time + deceleration time + about 30s

To force tuning to end

- Enter signal to terminal MRS or RES, or press during PU operation mode. In External operation mode, turn OFF the starting switch (STR or STF signal) to end the operation.
- Check the [Pr. in] setting when auto tuning ended.

- Normal end: 3 or 103 is displayed
- Error-activated end: any of 8, 9, 91, 92, 93 is displayed

<table>
<thead>
<tr>
<th>Error</th>
<th>Display</th>
<th>Error Cause</th>
<th>Remedy</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Forced End</td>
<td>Set ([Pr. 96 = 101]) and perform tuning again.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Inverter protective function operation</td>
<td>Make setting again.</td>
<td></td>
</tr>
<tr>
<td>91</td>
<td>Current limit (stall prevention) function was activated.</td>
<td>Increase acceleration/deceleration time. Set ([Pr. 156 = 1]).</td>
<td></td>
</tr>
<tr>
<td>92</td>
<td>Converter output voltage reached 75% of rated value.</td>
<td>Check for fluctuation of power supply voltage.</td>
<td></td>
</tr>
<tr>
<td>93</td>
<td>Calculation error</td>
<td>Motor is not connected. Make setting again.</td>
<td></td>
</tr>
</tbody>
</table>

When tuning ends normally, press the [MRS] key for PU operation. For External operation, turn OFF the starting switch (STF or STR signal) once. This operation resets the auto tuning, and the PU's monitor display returns to the normal indication.

Without this operation, next operation cannot be done. When tuning was ended due to an error, the auto tuning did not end correctly and motor constants have not been set. Perform an inverter reset (refer to page 57) and restart tuning.

When using a motor which meets the below description, set \([Pr. 9 = \text{Electronic thermal O/L relay}}\) again after tuning has completed.

- **When using motors with rated power specifications of 200/220V (400/440V) 60Hz, set the value multiplied by 1.1 for the rated motor current value in \([Pr. 9]\).**
- **When using a motor with a temperature detector such as PTC Thermistor and Klixon to protect the motor from heat, set \([Pr. 9 = 0]\) (motor overheat protection by the inverter disabled).**

Do not change the \([Pr. 96]\) setting after completion of tuning (3, 13 or 103). When the \([Pr. 96]\) setting is changed, tuning data is invalid. Therefore, perform tuning again. Monitor is displayed on the operation panel (FR-DU07) and parameter unit (FR-PU04, FR-PU07) during tuning as shown in the next page.
<table>
<thead>
<tr>
<th>Parameter Unit (FR-PU04, FR-PU07) Display</th>
<th>Operation Panel (FR-DU07) Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Setting</td>
<td></td>
</tr>
<tr>
<td>(2) Tuning in progress</td>
<td></td>
</tr>
<tr>
<td>(3) Normal end</td>
<td></td>
</tr>
<tr>
<td>(4) Error end (when the inverter protective function is activated)</td>
<td></td>
</tr>
</tbody>
</table>

* Operation status indication (FWD or REV in [175], RUN in [175]) flickers.
(4) Utilizing or changing offline auto tuning data for use

**Operating procedure**

1) Perform auto tuning.
2) Set the following value in \[ Pr. 71 \]:

3) In the parameter setting mode, read the following parameters and set desired values. Mitsubishi motor constants are used when 9999 is set in \[ Pr. 82, Pr. 90 to Pr. 94, Pr. 859 \].

Constants measured by offline auto tuning are used when \[ Pr. 71 = 3, 13, 23, 33, 43, 53 \] are set. Constants measured by offline auto tuning is overwritten when the motor constants are changed after the \[ Pr. 71 \] is set to "4,14,24,34,44,54"

As the motor constants measured in the offline auto tuning have been converted into internal data (**), refer to the following setting example when making setting:

Setting example: To slightly increase \[ Pr. 90 \] value (5%) When \[ Pr. 90 = 2516 \] is displayed, set 2516 + 0.05 × 2516.8, i.e. \[ Pr. 90 = 2641.8 \].

(The value displayed has been converted into a value for internal use. Hence, simple addition of a given value to the displayed value has no significance.)

In Table 151, display unit of motor constants can be changed by setting \[ Pr. 684 Tuning data unit switchover \]. Note that tuning data can not be changed when \[ Pr. 684 = 1 \].

(5) Setting the motor constants directly

**Operating procedure**

1) Set the following value in \[ Pr. 71 \].

2) In the parameter setting mode, read the following parameters and set desired values. Mitsubishi motor constants are used when 9999 is set in \[ Pr. 82, Pr. 90 to Pr. 94, Pr. 859 \].

- **Star connection**
- **Delta connection**

To enter the \[ Pr. 92, Pr. 93 \] motor constants in \[ Ω \]

Before starting operation, confirm which motor constant unit is used.

To enter the \[ Pr. 92, Pr. 93 \] motor constants in \[ Ω \]

### Table 151

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
<th>Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor excitation current</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
<tr>
<td>Motor excitation constant R1</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
<tr>
<td>Motor excitation constant R2</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
<tr>
<td>Motor excitation constant L1</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
<tr>
<td>Motor excitation constant L2</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 152

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
<th>Increment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque current</td>
<td>0 to 9999</td>
<td>1</td>
</tr>
</tbody>
</table>

### Table 153

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Star connection</td>
<td>Standard motor</td>
</tr>
<tr>
<td>Motor constant</td>
<td>5(17)</td>
</tr>
</tbody>
</table>

When \[ Pr. 71 = 7, 8, 17, 18 \] in Table 152, after setting the motor constants directly, offline auto tuning can be performed.

2) In the parameter setting mode, read the following parameters and set desired values. Mitsubishi motor constants are used when 9999 is set in \[ Pr. 82, Pr. 90 to Pr. 94, Pr. 859 \]. Use the following formula to find \[ Pr. 859 Torque current \].

\[
I_q = \sqrt{I_{100}^2 - I_0^2}
\]

\(I_{100}\): Rated current
\(I_0\): No load current
To enter the [Pr. 82, 92] motor constants in [mH]

1) Set the following value in [Pr. 71]

2) In the parameter setting mode, read the following formula.

\[ M = \frac{1}{L T - L_2} \times 100\% \]

(6) Perform tuning of the second applied motor (A702)

When you want to switch between two motors with one inverter, set the second motor in [Pr. 450 Second applied motor] (refer to page 266). Initial setting is without second applied motor.

Turning the RT signal ON makes the following parameters for the second motor valid.

To perform auto tuning of the second motor, replace the parameter number stated in the previous explanation with the parameter number corresponding to the one for the second motor in the table below.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Setting Range</th>
<th>Setting Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>82</td>
<td>Motor excitation current (no load)</td>
<td>0 to 9999</td>
<td>1mA</td>
</tr>
<tr>
<td>90</td>
<td>Motor constant (R1)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>91</td>
<td>Motor constant (R2)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>92</td>
<td>Motor constant (L1)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>93</td>
<td>Motor constant (L2)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>94</td>
<td>Motor constant (X)</td>
<td>0 to 9999</td>
<td>0.1%</td>
</tr>
<tr>
<td>809</td>
<td>Torque current</td>
<td>0 to 9999</td>
<td>0.01A</td>
</tr>
</tbody>
</table>

*Available only for A702.*

3) Refer to the following table and set [Pr. 83 and Pr. 84].

To perform tuning of the second applied motor

When you want to switch between two motors with one inverter, set the second motor in [Pr. 450 Second applied motor] (refer to page 266). Initial setting is without second applied motor.

Turning the RT signal ON makes the following parameters for the second motor valid.

To perform auto tuning of the second motor, replace the parameter number stated in the previous explanation with the parameter number corresponding to the one for the second motor in the table below.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Setting Range</th>
<th>Setting Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>83</td>
<td>Rated motor voltage</td>
<td>0 to 1000V</td>
<td>0.1V</td>
</tr>
<tr>
<td>84</td>
<td>Rated motor frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
</tr>
</tbody>
</table>

(6) Perform tuning of the second applied motor (A702)

When you want to switch between two motors with one inverter, set the second motor in [Pr. 450 Second applied motor] (refer to page 266). Initial setting is without second applied motor.

Turning the RT signal ON makes the following parameters for the second motor valid.

To perform auto tuning of the second motor, replace the parameter number stated in the previous explanation with the parameter number corresponding to the one for the second motor in the table below.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Setting Range</th>
<th>Setting Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor capacity</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Rated motor voltage</td>
<td>0 to 1000V</td>
<td>0.1V</td>
</tr>
<tr>
<td>Rated motor frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
</tr>
<tr>
<td>Motor constant (R1)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (R2)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (L1)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (L2)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (X)</td>
<td>0 to 9999</td>
<td>0.1%</td>
</tr>
<tr>
<td>Auto tuning setting status</td>
<td>0 to 9999</td>
<td>0.01Ω</td>
</tr>
</tbody>
</table>

To perform auto tuning of the second motor, replace the parameter number stated in the previous explanation with the parameter number corresponding to the one for the second motor in the table below.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Setting Range</th>
<th>Setting Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor capacity</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Rated motor voltage</td>
<td>0 to 1000V</td>
<td>0.1V</td>
</tr>
<tr>
<td>Rated motor frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
</tr>
<tr>
<td>Motor constant (R1)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (R2)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (L1)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (L2)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (X)</td>
<td>0 to 9999</td>
<td>0.1%</td>
</tr>
<tr>
<td>Auto tuning setting status</td>
<td>0 to 9999</td>
<td>0.01Ω</td>
</tr>
</tbody>
</table>

To perform auto tuning of the second motor, replace the parameter number stated in the previous explanation with the parameter number corresponding to the one for the second motor in the table below.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Setting Range</th>
<th>Setting Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor capacity</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Number of motor poles</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>0 to 450</td>
<td>50HP</td>
</tr>
<tr>
<td>Rated motor voltage</td>
<td>0 to 1000V</td>
<td>0.1V</td>
</tr>
<tr>
<td>Rated motor frequency</td>
<td>0 to 120Hz</td>
<td>0.01Hz</td>
</tr>
<tr>
<td>Motor constant (R1)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (R2)</td>
<td>0 to 9999</td>
<td>0.001Ω</td>
</tr>
<tr>
<td>Motor constant (L1)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (L2)</td>
<td>0 to 9999</td>
<td>0.1mH</td>
</tr>
<tr>
<td>Motor constant (X)</td>
<td>0 to 9999</td>
<td>0.1%</td>
</tr>
<tr>
<td>Auto tuning setting status</td>
<td>0 to 9999</td>
<td>0.01Ω</td>
</tr>
</tbody>
</table>

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2.8.3 Online auto tuning function [Pr. 95, 574] (A700)

When online auto tuning is selected under Advanced magnetic flux vector control or Real sensorless vector control, excellent torque accuracy is provided by temperature compensation even if the secondary resistance value of the motor varies with the rise of the motor temperature.

(1) Start-time online auto tuning

[Pr. 95 = 1, Pr. 574 = 1]

By quickly tuning the motor constants at a start, high accuracy operation unaffected by the motor temperature and stable operation with high torque down to ultra low speed can be performed. Set when performing start time tuning under Advanced magnetic flux vector control or Real sensorless vector control. It can be set under vector control. However, it is recommended to set 2 (magnetic flux observer) under vector control.

<Operation method>
1) Perform offline auto tuning.
2) Read [Pr. 96] and check that the setting is either 3 or 103 (offline auto tuning completed).
3) Set [Pr. 95 = 1].
4) Before starting operation, check that the following parameters have been set.
5) Give the run command in the PU operation or External operation mode.

- Online auto tuning does not operate if the MRS signal is input, if the preset frequency is less than the [Pr. 13 Starting frequency], or if the starting conditions of the inverter are not satisfied, e.g. inverter error.
- Online auto tuning does not operate during deceleration or at a restart during DC brake operation.
- Invalid for Jog operation.
- Automatic restart after instantaneous power failure overrides when automatic restart after instantaneous power failure is selected.
- Invalid for start-time tuning in elevator, examine the utilization of a brake sequence for the brake opening timing at a start or consider tuning with external terminal.
- The tuning ends in about a maximum of 500ms after a start, torque is not provided fully during that period. Therefore, note that there may be a possibility of drop of elevator due to gravity.
- Zero current detection and output current detection are valid during online auto tuning.
- The RUN signal is not output during online auto tuning. The RUN signal turns ON at a start.
- If the period from an inverter stop to a restart is within 4s, online auto tuning is performed but the tuning results are not reflected.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Advanced Magnetic Flux Vector Control</th>
<th>Real Sensorless Vector Control</th>
<th>Vector Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>95</td>
<td>Online auto tuning selection</td>
<td>0</td>
<td>1</td>
<td>Start-time online auto tuning</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>574</td>
<td>Second motor online auto tuning</td>
<td>0</td>
<td>1</td>
<td>Online auto tuning at starting of the second motor</td>
<td>○</td>
<td>○</td>
<td>Setting is disabled</td>
</tr>
</tbody>
</table>

Magnetic flux observer is always activated under Real sensorless vector control independently of [Pr. 95, 774] setting.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Used as rated motor current and electronic thermal relay parameters</td>
</tr>
<tr>
<td>71</td>
<td>Motor capacity can be set down to one rank lower than the inverter capacity, note that the capacity should be 0.4kW or more</td>
</tr>
<tr>
<td>80</td>
<td>Number of motor poles</td>
</tr>
</tbody>
</table>

5) Give the run command in the PU operation or External operation mode.
(2) Start-time online auto tuning from external terminal (X28 signal, Y39 signal)

[Pr. 95 = 1, Pr. 574 = 1]

By turning ON the start-time tuning signal (X28) before the start signal (STF or STR) turns ON (at a stop), online tuning is performed and a starting delay after start signal turns ON due to tuning can be avoided.

Perform offline auto tuning and set [Pr. 95 = 1].

When the start-time tuning completion signal (Y39) is OFF, start-time tuning with the X28 signal is performed. Start-time tuning ends within 500ms maximum.

When using the X28 signal, set 28 in any of [Pr. 178 to Pr. 189 Input terminal function selection] to assign the function to the input terminal.

When using the Y39 signal, set 39 (positive logic) or 139 (negative logic) in any of [Pr. 190 to Pr. 196 Output terminal function selection] to assign the function to the output terminal.

*T1* Start-time tuning is performed when the start signal is turned ON during zero speed control or servo lock also.

*T2* The Y39 signal is in ON status while secondary magnetic flux exists after the motor stop.

*T3* While the Y39 signal is ON, the X28 signal is not valid.

*T4* The STF, STR signals are valid after completion of the start-time tuning.

*T5* Only the output signals below are valid during tuning.

IPF, THP, PU, Y12, BY, ER, LF, MT, FM, AM, A1, B1, C1, A2, B2, C2
(3) Magnetic flux observer (constant tuning)  

[Pr. 95 = 2]  
When exercising vector control using a motor with encoder, it is effective for torque accuracy improvement. The current flowing in the motor and the inverter output voltage are used to estimate/observe the magnetic flux in the motor. The magnetic flux of the motor is always (including during operation) detected with high accuracy so that an excellent characteristic is provided regardless of the change in the temperature of the secondary resistance.  
Set when performing constant tuning under vector control. Even magnetic flux observer is set, magnetic flux observer is not activated under Advanced magnetic flux vector control. Magnetic flux observer is always activated under Real sensorless vector control independently of [Pr. 95, 574] setting. For the SF-VRU, SF-JR (with encoder), SF-HR (with encoder), SF-JRCA (with encoder) or SF-HRCA (with encoder), it is not necessary to perform offline auto tuning to select adaptive magnetic flux observer. (Note that it is necessary to perform offline auto tuning (non-rotation mode) for the wiring length resistance to be reflected on the control when the wiring length is long. (30m or longer as reference))

(4) Perform tuning of the second applied motor  
When you want to switch between two motors with one inverter, set the second motor in [Pr. 450 Second applied motor]. (Initial setting is without second applied motor. (Refer to page 262))  
Perform tuning using [Pr. 574 Second motor online auto tuning].  
[Pr. 574] is valid when the RT signal is ON.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>91</td>
<td>Used as rated motor current and electronic thermal relay parameters.</td>
</tr>
<tr>
<td>450</td>
<td>Applied motor capacity can be used down to one rank lower than the inverter capacity, note that the capacity should be 0.4kW or more</td>
</tr>
<tr>
<td>453</td>
<td>Number of motor poles</td>
</tr>
</tbody>
</table>
2.9 Speed control by Real sensorless vector control and vector control

2.9.1 What is speed control? \[ A700 \]

(1) Control block diagram

The following shows a basic control block diagram during speed control.

---

**Diagram Description**

- **Terminal 2**: Connection point for control signals.
- **Terminal 4**: Connection point for feedback signals.
- **Operation panel**: Interface for manual operation.
- **Multi-speed selection**: Switch for selecting different speeds.
- **Terminal 2 bias**: Bias adjustment for Terminal 2 signals.
- **Terminal 2 gain**: Gain adjustment for Terminal 2 signals.
- **Speed setting filter**: Filter for speed setting signals.
- **Analog input offset adjustment**: Adjustment for analog input signals.
- **Analog input selection**: Selection of analog input signals.
- **Speed control**: Module for speed control logic.
- **Model speed control gain**: Gain for model speed control.
- **Speed feed forward**: Module for speed feed forward logic.
- **Speed feed forward torque limit**: Limit for speed feed forward torque.
- **Speed feed forward filter**: Filter for speed feed forward signals.
- **Load inertia ratio**: Ratio of load inertia.
- **Torque coefficient**: Coefficient for torque control.
- **Torque bias operation**: Operation for torque bias.
- **Servo lock**: Mechanism for servo lock.
- **DC injection brake operation**: Operation for DC injection brake.
- **Zero speed control**: Control for zero speed.

---

**Parameter List**

- **Pr. 800**: Real sensorless vector control (1: ON, 0: OFF).
- **Pr. 801**: Vector control (1: ON, 0: OFF).
- **Pr. 877**: Speed estimation (1: ON, 0: OFF).
- **Pr. 822**: Speed control P gain 1.
- **Pr. 821**: Speed control integral time 1.
- **Pr. 820**: Speed control P gain 2.
- **Pr. 831**: Speed control integral time 2.
- **Pr. 828**: Model speed control gain.
- **Pr. 878**: Speed feed forward filter.
- **Pr. 879**: Speed feed forward torque limit.
- **Pr. 880**: Load inertia ratio.
- **Pr. 881**: Speed feed forward gain.
- **Pr. 802**: Model speed calculation.
- **Pr. 845**: Torque bias operation time.
- **Pr. 823**: Speed detection filter 1.
- **Pr. 833**: Speed detection filter 2.
- **Pr. 849**: Analog input offset adjustment.
- **Pr. 862**: Notch filter.
- **Pr. 863**: Multi-speed selection.
- **Pr. 858**: Terminal 1 bias.
- **Pr. 868**: Terminal 2 bias.
- **Pr. 73**: Analog input selection.
- **Pr. 79**: Operation Mode.
- **Pr. 74**: Speed control settings.
(2) Operation

Speed control adjusts the difference between the speed command and speed feedback (actual speed under vector control, estimated speed under Real sensorless vector control) is 0, i.e. to match the speed command and actual speed or estimated speed.

The speed loop gain parameter that adjusts speed control operation status is provided for the \( Pr. 820 \). Although stable operation is possible with the initial value, refer to the following to make parameter adjustment when vibration, noise or any other unfavorable condition occurs due to large load inertia or gear backlash, for example, or when you want to exhibit the best performance that matches the machine.

The following figure indicates operation under speed control.

- Turning ON the start signal increases the speed up to the preset speed according to the acceleration time.
- Turning OFF the start signal decreases the speed according to the deceleration time. When the speed has decreased down to the DC brake operation speed, operation changes to DC injection brake operation.

(3) Concept of speed control gains

Speed control gain with motor alone is stated below. Refer to page 286 for how to adjust the speed control gain.

1) Speed control P (proportional) gain

   - During vector control, \( [Pr. 820 = 60\%] \) is equivalent to 120 rad/s. During Real sensorless vector control, \( [Pr. 820 = 60\%] \) is equivalent to 60 rad/s.

   - For the 75K or more, response level becomes half.

   - Increasing the proportional gain increases the response level. However, a too high gain will produce vibration and/or unusual noise.

   \[ Pr. 821 = 0.333s \] is equivalent to 3 rad/s.

   Decreasing the integral time shortens the return time at a speed change. However, a too short time will generate an overshoot. (Refer to the drawing below.)

2) Speed control integral time

   - Decreasing the integral time shortens the return time at a speed change. However, a too short time will generate an overshoot. (Refer to the drawing below.)

3) Speed gain when the load inertia is attached

   When there is load inertia, the actual speed gain decreases as indicated below.

\[
\text{Actual speed gain} = \frac{\text{Speed gain when with a motor alone}}{\frac{JM \times JL}{JM + JL}}
\]

\( JM \): Inertia of motor
\( JL \): Motor shaft-equivalent load inertia
### 2.9.2 Torque limit level setting [Pr. 22, 406, 803, 810 to 817, 858, 865, 868, 874]

This function limits the output torque to the predetermined value during speed control under Real sensorless vector control and vector control.

In [Pr. 810 Torque limit input method selection], you can select whether to set the torque limit level using parameters ([Pr. 22 to 817]) or using analog input terminals (terminal 1 to 6) ([Pr. A7AZ]).

Turning TL signal ON sets [Pr. 815 Torque limit level 2] as the torque limit level.

In addition, you can set torque limit level for forward (power driving/regeneration) and reverse (power driving/regeneration) operation individually.

Under Real sensorless vector control, the lower limit of torque limit level is set 30% if the value less than 30% is input.

### Table 2.9.2-1: Torque limit level setting [Pr. 803, 810, 812 to 817, 858, 865, 868, 874]

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 22  | Stall prevention operation level (Torque limit level) | 150/200% *1   | 0 to 400%     | Set the torque limit level in % on the assumption that the rated torque is 100%.
|     |                                           |               |               | *1 For the 3.7K or less, the value changes from 150% to 200% when V/F control or Advanced magnetic flux vector control is changed to Real sensorless vector control or vector control. |
| 406 | High resolution analog input selection BC | 9999          | 0, 2 to 6, 9999 | When the setting value is “0”, torque limit level can be changed with a signal to terminal 6.
|     |                                           |               |               | When the setting value is “2”, regenerative torque limit level can be changed with a signal to terminal 6. |
| 803 | Constant power range torque characteristic selection | 0             | 0             | Constant motor output limit                                                                                                                                 |
|     |                                           | 1             | Constant torque limit | Select the torque limit level by parameter setting. |
| 810 | Torque limit input method selection       | 0             | 0             | Internal torque limit (Torque limit by parameter setting). |
|     |                                           | 1             | External torque limit (Torque limit by terminal 1, 4*) |
| 811 | Set resolution switchover                | 0             | 0             | Speed monitor increments from the PU, RS-485 communication or communication option. |
|     |                                           | 1             |                 | Torque limit setting increments [Pr. 812 to Pr. 817] |
| 812 | Torque limit level (regeneration)         | 9999          | 0 to 400%     | Set the torque limit level for forward rotation regeneration. |
| 813 | Torque limit level (3rd quadrant)         | 9999          | 0 to 400%     | Set the torque limit level for reverse rotation. |
| 814 | Torque limit level (4th quadrant)         | 9999          | 0 to 400%     | Set the torque limit level for reverse rotation regeneration. |
| 815 | Torque limit level 2                      | 9999          | 0 to 400%     | When the torque limit selection (TL) signal is OFF, the [Pr. 815] value is a torque limit value regardless of [Pr. 817]. |
| 816 | Acceleration torque limit                 | 9999          | 0 to 400%     | Set the torque limit value during acceleration. |
| 817 | Deceleration torque limit                 | 9999          | 0 to 400%     | Set the torque limit value during deceleration. |
| 818 | Torque limit level Assignments            | 0             | 0, 4, 9999    | The torque limit can be changed with a signal to terminal 1. |
| 865 | Low speed detection                       | 1.5 Hz        | 0 to 400 Hz   | The low speed detection signal (LS) is output when the output frequency decreases below the setting. |
| 866 | Terminal function assignment              | 0             | 0, 6, 9999    | When 6 is set, the torque limit can be changed with a signal to terminal 1. When 2 is set, the regenerative torque limit can be changed with a signal to terminal 1. |
| 874 | S/L level setting                         | 150%          | 0 to 200%     | This function makes an inverter trip if the torque limit is activated to stall the motor. Set the output level for a trip. |

* When FR-A7AZ is installed, torque limit from terminal 6 is also available.
(1) Torque limit block diagram

(2) Selection of torque limit input method [Pr. 810]

- Set [Pr. 810 Torque limit input method selection] to select the method to limit output torque during speed control.
- Torque limit by parameter setting is initially set.

<table>
<thead>
<tr>
<th>[Pr.] Setting Range</th>
<th>Torque limit input method</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Internal torque limit parameter setting torque limit operation is performed. Changing the torque limit parameter value by communication enables torque limit to be input by communication.</td>
</tr>
<tr>
<td>1</td>
<td>External torque limit Torque limit using the analog voltage (current) input to any of terminal 1, terminal 4 or terminal 6 (FR-A7AZ) is enabled.</td>
</tr>
</tbody>
</table>

(3) Torque limit level by parameter setting

- In the initial setting, limit is made on all quadrants on the [Pr. 22 Stall prevention operation level (torque limit level)].
- When you want to set the level on a quadrant basis, set the torque limit level in [Pr. 812 Torque limit level (1st quadrant)] [Pr. 813 Torque limit level (3rd quadrant)] [Pr. 814 Torque limit level (4th quadrant)].
- When 9999 is set, [Pr. 22] is the torque limit level.

(4) Torque limit level by analog input

- [terminal 1, 4, 6 (FR-A7AZ)] [Pr.810=1, Pr. 406*, 858, 868] (* Pr. 406 is available only when FR-A7AZ is installed)
- Upper limit of torque limit is [Pr. 22], and torque limit value is the analog input to terminal 1, terminal 4 or terminal 6.
- When torque limit value is input to terminal 1, set [Pr. 858 Terminal 1 function assignment = 4]. When torque limit value is input to terminal 4, set [Pr. 858 Terminal 4 function assignment = 4]. Set [Pr. 406 High resolution analog input selection = 4] to input torque limit value to terminal 6 of FR-A7AZ. (Refer to page 46 for details of function assignment of analog input terminal.)
- When [Pr. 858 = 4] and [Pr. 868 = 4], terminal 1 serves as torque limit input and terminal 4 as without function. When [Pr. 858 = 4] and [Pr. 868 = 4] while [Pr. 406 = 4], terminal 6 is the torque limit input, and terminal 1 and terminal 4 do not have a function.

When [Pr. 858 = 4] and [Pr. 868 = 4], torque is limited by analog input to terminal 4 for regeneration and by terminal 4 for driving. If the setting of [Pr. 406] is same with [Pr. 858] or [Pr. 868], function of terminal 6 is valid, and terminal 1 or terminal 4 does not have a function.
(9) Second torque limit level (TL signal) [Pr.819]

For [Pr.815 Torque limit level 1], the [Pr.815] value is a torque limit value regardless of [Pr.810 Torque limit input method selection] when the torque limit selection signal (TL) is ON.

Set [Pr.178 to 189 Input terminal function selection] to assign a function to the TL signal.

(6) Torque limit value during acceleration/ deceleration [Pr.816, 817]

You can set torque limit during acceleration and deceleration individually.

Torque limit by [Pr.816 Torque limit level during acceleration] and [Pr.817 Torque limit level during deceleration] is shown below.

(7) Setting increments switchover of the torque limit level [Pr.821]

By setting [Pr.811 Set resolution switchover = 10, 10] under vector control, the setting increments of [Pr.22 Torque limit level] and [Pr.817 Torque limit level] can be switched to 0.01%.

Note that the internal resolution of the torque limit is 0.024% (1000/25) and the fraction less than the resolution is rounded off.

The fraction less than the resolution equivalent to 0.1% is rounded off even if [Pr.811 = 10, 10] when Real sensorless vector control is selected.

When the torque restriction setting increments have been changed (0.1% → 0.01%), reset is necessary because the settings of [Pr.22, Pr.813 to Pr.817] are multiplied by 1/10 (ten times). For example, when [Pr.22 = 150.00%] and [Pr.811 = 10 (0.01%) = 1 (0.1%)], [Pr.22 = 150.00%] and the maximum torque is 400%.

(8) Torque characteristic in the constant power range [Pr.880, 881]

You can select whether the torque limit in the constant power range be constant torque limit (setting is "1") or constant power limit (initial setting is "0") using [Pr.880 Constant power range torque characteristic selection] under torque limit operation.

(9) Fault stop when torque limit is activated [Pr.865, 867]

This function makes an inverter trip if the torque limit is activated to stall the motor.

The motor stalls if the torque limit is activated under a high load applied during speed control or position control. At this time, if the motor speed is lower than the speed set in [Pr.880 Low speed detection] and also the output torque exceeds the level set in [Pr.874 OLT level setting] for 3s, it is regarded as a stop affected by stall prevention and E.OLT is output, resulting in a fault.
The ratio of the load inertia to the motor inertia (load inertia moment) is estimated in real time from the torque command and speed during motor operation by vector control. As optimum gain of speed control and position control are automatically set from the load inertia ratio and response level, time and effort of making gain adjustment are reduced. (Easy gain tuning)

When the load inertia ratio can not be estimated due to load fluctuation or Real sensorless vector control is performed, control gain is automatically set by manually inputting the load inertia ratio.

Make a manual input adjustment when vibration, noise or any other unfavorable condition occurs due to large load inertia or gear backlash, for example, or when you want to have the best performance that matches the machine.

### Block diagram of easy gain tuning function

![Block diagram of easy gain tuning function](image)

**2.9.3 Gain adjustment [Pr. 818 to 821, 830, 831, 880]**

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>818</td>
<td>Easy gain tuning response level setting</td>
<td>2</td>
<td>1 to 15</td>
<td>Set the response level. 1: Slow response to 15: Fast response</td>
</tr>
<tr>
<td>819</td>
<td>Easy gain tuning selection</td>
<td>0</td>
<td>1</td>
<td>with load inertia ratio estimation, with gain calculation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>load inertia ratio manual input, with gain calculation</td>
</tr>
<tr>
<td>820</td>
<td>Speed control P gain 1</td>
<td>60%</td>
<td>0 to 1000%</td>
<td>Set the proportional gain for speed control. Increasing the value improves trackability in response to a speed command change and reduces speed variation with disturbance.</td>
</tr>
<tr>
<td>821</td>
<td>Speed control integral time 1</td>
<td>0.333s</td>
<td>0 to 20s</td>
<td>Set the integral time during speed control. Decreasing the value improves tracking capability of speed variation with disturbance.</td>
</tr>
<tr>
<td>830</td>
<td>Speed control P gain 2</td>
<td>9999</td>
<td>0 to 1000%</td>
<td>Second function of [Pr. 820] (valid when RT signal is ON)</td>
</tr>
<tr>
<td>831</td>
<td>Speed control integral time 2</td>
<td>9999</td>
<td>0 to 20s</td>
<td>Second function of [Pr. 821] (valid when RT signal is ON)</td>
</tr>
<tr>
<td>880</td>
<td>Load inertia ratio</td>
<td>7 times</td>
<td>0 to 200 times</td>
<td>Set the load inertia ratio to the motor.</td>
</tr>
</tbody>
</table>

- **Pr. 818**: Easy gain tuning response level setting
- **Pr. 819**: Easy gain tuning selection
- **Pr. 820**: Speed control P gain 1
- **Pr. 821**: Speed control integral time 1
- **Pr. 830**: Speed control P gain 2
- **Pr. 831**: Speed control integral time 2
- **Pr. 880**: Load inertia ratio
(2) Easy gain tuning execution procedure (load inertia ratio automatic estimation)

[Pr. 819 = 1, Pr. 818, 820, 821, 880]

Easy gain tuning (load inertia ratio automatic estimation) is valid only in the speed control or position control mode under vector control.
It is invalid under torque control, V/F control, Advanced magnetic flux vector control and Real sensorless vector control.

1) Set the response level using [Pr. 818 Easy gain tuning responsiveness setting]. Refer to the diagram below and set the response level.
   
   Increasing the value will improve trackability to the command, but too high value will generate vibration.
   
   The relationship between the setting and response level are shown below.

<table>
<thead>
<tr>
<th>Response level</th>
<th>Lower response</th>
<th>Middle response</th>
<th>Higher response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr. 819 = 1</td>
<td>Pr. 818, 820, 821, 880</td>
<td>Easy gain tuning responsiveness setting</td>
<td></td>
</tr>
</tbody>
</table>

2) Set [Pr. 819 Easy gain tuning responsiveness setting = 1] (load inertia ratio automatic estimation).

   Each control gain (refer to the table below) is automatically set from the load inertia ratio estimated during acceleration/deceleration operation and the [Pr. 818 Easy gain tuning response level setting] value.

   [Pr. 880 Load inertia ratio] is used as the initial value of the load inertia ratio for tuning. Estimated value is set in [Pr. 819] during tuning. Even when [Pr. 819] setting is returned to 0 after tuning, tuning results set in each parameter remain unchanged.

   The load inertia ratio may not be estimated well, e.g. it takes a long time for estimation, if the following conditions are not satisfied.
   
   • Time taken for acceleration/deceleration to reach 1500/min should be 5s or less.
   • Speed should be 150/min or more.
   • Acceleration/deceleration torque is 10% or more of the rated torque.
   • Abrupt disturbance is not applied during acceleration/deceleration.
   
   Load inertia ratio is about 30 times or less.
   • No gear backlash nor belt looseness is found.
   • Load inertia ratio is about 30 times or less.
   • Abrupt disturbance is not applied during acceleration/deceleration.

3) Press [Pr. 818] or [Pr. 819] to estimate the load inertia ratio or calculate gain any time.

   (The operation command for external operation is the STF or STR signal.)

(3) Easy gain tuning execution procedure (load inertia ratio manual input)

[Pr. 819 = 2, Pr. 818, 820, 821, 880]

Easy gain tuning (load inertia ratio manual input) is valid only in the speed control mode under Real sensorless vector control or in the speed control or position control mode under vector control.

1) Set the load inertia ratio to the motor in [Pr. 880 Load inertia ratio].

2) Set [Pr. 819 Easy gain tuning responsiveness setting = 1] (easy gain tuning is valid). When the value is set, each control gain (refer to the table below) is automatically set according to the gain calculation. Even when [Pr. 819] setting is returned to 0 after tuning, tuning results set in each parameter remain unchanged.

3) Perform a test run and set the response level in [Pr. 819 Easy gain tuning response level setting]. Increasing the value will improve trackability to the command, but too high value will generate vibration. When [Pr. 77 Parameter write selection = 2] (parameter write enabled during operation) is set, response level adjustment can be made during operation.
(4) Manual input speed control gain adjustment [Pr. 819 = 8, Pr. 820, 821]

Make adjustment when case like unusual machine vibration/noise, low response level and overshoot has occurred. When making manual input gain adjustment, set [Pr. 819 Easy gain tuning selection = 0] (without easy gain tuning) (initial value). [Pr. 830 Speed control P gain 2] and [Pr. 831 Speed control integral time 2] are valid when the RT terminal is switched ON.

Check the conditions referring to the table below and make adjustment.
1) Adjust speed control P (proportional) gain.
2) Check that no unusual vibration nor noises are generated, response is enough, the current value is correct, etc.
3) If you can not make proper adjustment, slightly change the speed control integral time and repeat from 1) again.

<table>
<thead>
<tr>
<th>No.</th>
<th>Case/Condition</th>
<th>Adjustment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Load inertia is large</td>
<td>Set the [Pr. 820, 821] value a little higher. When a speed rise is slow, increase the value by 10% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.</td>
</tr>
<tr>
<td>2</td>
<td>Vibration/noise generated from mechanical system</td>
<td>Set the [Pr. 820] value a little lower and the [Pr. 821] value a little higher. Increase the value by 10% until just before vibration/noise is not produced, and set about 0.8 to 0.9 of that value.</td>
</tr>
<tr>
<td>3</td>
<td>Slow response</td>
<td>Set the [Pr. 820] value a little higher. When a speed rise is slow, increase the value by 5% until just before vibration/noise is produced, and set about 0.8 to 0.9 of that value.</td>
</tr>
<tr>
<td>4</td>
<td>Long return time (response time)</td>
<td>Decrease the [Pr. 821] value by half until just before an overshoot or the unstable behavior does not occur, and set about 0.8 to 0.9 of that value.</td>
</tr>
<tr>
<td>5</td>
<td>Overshoot or unstable phenomenon occurs.</td>
<td>Set the [Pr. 821] value a little higher. Double the [Pr. 821] value until just before an overshoot or the unstable behavior does not occur, and set about 0.8 to 0.9 of that value.</td>
</tr>
</tbody>
</table>

(5) Switching of P/PI control (X44 signal)

By turning the P/PI control switching signal (X44) ON/OFF during speed control operation under Real sensorless vector control and vector control, you can select whether to add the integral time (I) or not when performing gain adjustment with P gain and integral time.

When the X44 signal is OFF......Pi control
When the X44 signal is ON......P control

For the terminal used for X44 signal input, set 44 in any of [Pr. 178 to Pr. 189 Input terminal function select] to assign the function.
2.9.4 Speed feed forward control, model adaptive speed control [Pr. 828, 877 to 881]

By making parameter setting, select the speed feed forward control or model adaptive speed control. The speed feed forward control enhances the trackability of the motor in response to a speed command change. The model adaptive speed control enables individual adjustment of speed trackability and motor disturbance torque response.

Since it is calculating the compensation amount according to the inertia ratio under any control, set the correct inertia ratio in [Pr. 820] or perform automatic estimation of the load inertia ratio using easy gain tuning [Pr. 821].

### 2.9.4.1 Speed feed forward control

By making parameter setting, select the speed feed forward control or model adaptive speed control [Pr. 828, 877 to 881].

The speed feed forward control enhances the trackability of the motor in response to a speed command change. The model adaptive speed control enables individual adjustment of speed trackability and motor disturbance torque response.

Since it is calculating the compensation amount according to the inertia ratio under any control, set the correct inertia ratio in [Pr. 820] or perform automatic estimation of the load inertia ratio using easy gain tuning [Pr. 821].

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>828</td>
<td>Model speed control gain</td>
<td>60%</td>
<td>0 to 100%</td>
<td>Set the gain for model speed controller.</td>
</tr>
<tr>
<td>877</td>
<td>Speed feed forward control model adaptive speed control selection</td>
<td>0</td>
<td>0: Normal speed control is performed. 1: Speed feed forward control is performed. 2: Model adaptive speed control is enabled.</td>
<td></td>
</tr>
<tr>
<td>878</td>
<td>Speed feed forward filter</td>
<td>0s</td>
<td>0 to 1s</td>
<td>Set the primary delay filter for the speed feed forward result calculated using the speed command and load inertia ratio.</td>
</tr>
<tr>
<td>879</td>
<td>Speed feed forward torque limit</td>
<td>150%</td>
<td>0 to 400%</td>
<td>Limit the maximum value of the speed feed forward torque.</td>
</tr>
<tr>
<td>880</td>
<td>Load inertia ratio</td>
<td>7 times</td>
<td>0 to 200 times</td>
<td>Set the load inertia ratio to the motor.</td>
</tr>
<tr>
<td>881</td>
<td>Speed feed forward gain</td>
<td>0%</td>
<td>0 to 1000%</td>
<td>Set the feed forward calculation result as a gain.</td>
</tr>
</tbody>
</table>

### 2.9.4.2 Speed feed forward control [Pr. 877 = 1, 878 to 881]

[Inverter calculates required torque in response to the acceleration/deceleration command for the inertia ratio set in [Pr. 820] and generates torque immediately.]

When [Pr. 881 - Speed feed forward gain = 100%], the calculation result of the speed feed forward is reflected as it is. If the speed command changes suddenly, large torque is generated due to the speed feed forward calculation. The maximum value of the speed feed forward is limited using [Pr. 879]. Using [Pr. 878], the speed feed forward result can be dulled by the primary delay filter.

The speed feed forward control is valid for the first motor only. When [Pr. 877 = 1], control target is switched to the second motor, and the second motor is handled as [Pr. 877 = 0].
(2) Model adaptive speed control \(Pr. 877 = 2, Pr. 828, 881\)

The motor’s model speed is calculated to provide feedback to the model side speed controller. This model speed is also used as the actual speed controller command. Acceleration/deceleration speed is limited by model speed calculation with \(Pr. 880\) Load inertia ratio. Therefore, note that setting a larger value than the actual inertia in \(Pr. 880\) may extend the acceleration/deceleration time than the setting.

The inertia ratio in \(Pr. 880\) is used for calculation of the torque current command value given by the model side speed controller. The torque current command value of the model side speed controller is added to the output of the actual speed controller and the result is used as the torque control input. \(Pr. 828\) is used for model side speed control (P control), and the first gain in \(Pr. 820\) is used for the actual speed controller. The model adaptive speed control is valid for the first motor only. When \(Pr. 877 = 0\), switching to the second motor handles the second motor as \(Pr. 877 = 0\).

(3) Combination of easy gain tuning

The following table indicates the relationships between the speed feed forward/model adaptive speed control and easy gain tuning function. Refer to page 286 for how to adjust the easy gain tuning function.

<table>
<thead>
<tr>
<th>(Pr. 880) Load inertia ratio</th>
<th>Manual input</th>
<th>(Pr. 828) Model speed control gain</th>
<th>Manual input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manual input</td>
<td>1</td>
<td>Manual input</td>
</tr>
<tr>
<td>1</td>
<td>Manual input</td>
<td>2</td>
<td>Manual input</td>
</tr>
<tr>
<td>2</td>
<td>Manual input</td>
<td>1</td>
<td>Manual input</td>
</tr>
<tr>
<td>3</td>
<td>Manual input</td>
<td>2</td>
<td>Manual input</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Pr. 820) Speed control P gain</th>
<th>Manual input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manual input</td>
</tr>
<tr>
<td>1</td>
<td>Manual input</td>
</tr>
<tr>
<td>2</td>
<td>Manual input</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Pr. 821) Speed control integral time</th>
<th>Manual input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manual input</td>
</tr>
<tr>
<td>1</td>
<td>Manual input</td>
</tr>
<tr>
<td>2</td>
<td>Manual input</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>(Pr. 829) Model speed control gain</th>
<th>Manual input</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Manual input</td>
</tr>
<tr>
<td>1</td>
<td>Manual input</td>
</tr>
<tr>
<td>2</td>
<td>Manual input</td>
</tr>
</tbody>
</table>
2.9.5 Torque bias [Pr. 840 to 848] (A700)

This function accelerates the rise of the torque at a start. Adjust the torque at a motor start using the contact signals or analog signals. Valid only during vector control.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>840</td>
<td>Torque bias selection</td>
<td>9999</td>
<td>0</td>
<td>Set the contact signal (X42, X43) based-torque bias amount using [Pr. 841 to 843]</td>
</tr>
<tr>
<td>841</td>
<td>Torque bias 1 [Pr. 841]</td>
<td>9999</td>
<td>600 to 599%</td>
<td>Negative torque bias amount (-400% to -1%)</td>
</tr>
<tr>
<td>842</td>
<td>Torque bias 2 [Pr. 842]</td>
<td>9999</td>
<td>1000 to 1400%</td>
<td>Positive torque bias amount (0% to 400%)</td>
</tr>
<tr>
<td>843</td>
<td>Torque bias 3 [Pr. 843]</td>
<td>9999</td>
<td>0</td>
<td>Without torque bias setting</td>
</tr>
<tr>
<td>844</td>
<td>Torque bias filter [Pr. 845]</td>
<td>9999</td>
<td>0 to 1s</td>
<td>Time until torque rises</td>
</tr>
<tr>
<td>845</td>
<td>Torque bias operation time</td>
<td>9999</td>
<td>0 to 1s</td>
<td>Time for maintaining torque equivalent to the torque bias amount</td>
</tr>
<tr>
<td>846</td>
<td>Torque bias balance compensation [Pr. 846]</td>
<td>9999</td>
<td>0 to 10V</td>
<td>Same operation as when 0V is set.</td>
</tr>
<tr>
<td>847</td>
<td>Fall-time torque bias terminal 1 bias [Pr. 847]</td>
<td>9999</td>
<td>0 to 400%</td>
<td>Set the bias value of the torque command.</td>
</tr>
<tr>
<td>848</td>
<td>Fall-time torque bias terminal 2 gain [Pr. 848]</td>
<td>9999</td>
<td>0 to 400%</td>
<td>Set the gain value of the torque command.</td>
</tr>
</tbody>
</table>

*When FR-A7AZ is installed, torque bias amount setting from terminal 6 is also available.*

(1) Block diagram

(2) Torque bias amount setting by contact input [X42, X43 signal] [Pr. 846 = 0, Pr. 847 to 849]

<table>
<thead>
<tr>
<th>X42 Signal</th>
<th>X43 Signal</th>
<th>Torque Bias Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>OFF</td>
<td>0</td>
</tr>
<tr>
<td>ON</td>
<td>OFF</td>
<td>[Pr. 841]</td>
</tr>
<tr>
<td>ON</td>
<td>ON</td>
<td>[Pr. 842]</td>
</tr>
</tbody>
</table>

Select the torque bias amount in the table below according to the combination of contact signals.

Set 42 in [Pr. 178 to 189 Input terminal function selection] for the terminal used for X42 signal input and set 43 for the terminal used for X43 signal input to assign functions.
(3) Setting torque bias amount with terminal 1 or terminal 6 (FR-A7AZ)

Calculate torque bias from the load input to terminal 1 or terminal 6 (FR-A7AZ) as shown below and multiply by the torque bias.

When torque bias amount is set to terminal 1, set \([Pr. 868 = 6]\) [Terminal 1 function assignment = 6]

When torque bias amount is set to terminal 6 (FR-A7AZ), set \([Pr. 406 = 6]\) [High resolution analog input selection = 6]. When \([Pr. 406 = 6]\) and \([Pr. 868 = 6]\), terminal 6 is the torque bias, and terminal 1 does not have a function.

For \([C14 to C19 (Pr. 919, 920)\) and \([C34 to C37 (Pr. 928, 929)\), refer to page 320.

- Torque bias by terminal 1

<table>
<thead>
<tr>
<th>([Pr. #]) Setting</th>
<th>Rise (Motor Forward Rotation)</th>
<th>Fall (Motor Reverse Rotation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image1" alt="Diagram 1" /></td>
<td><img src="image2" alt="Diagram 2" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image3" alt="Diagram 3" /></td>
<td><img src="image4" alt="Diagram 4" /></td>
</tr>
</tbody>
</table>

- Torque bias by terminal 6 (FR-A7AZ)

<table>
<thead>
<tr>
<th>([Pr. #]) Setting</th>
<th>Rise (Motor Forward Rotation)</th>
<th>Fall (Motor Reverse Rotation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><img src="image5" alt="Diagram 5" /></td>
<td><img src="image6" alt="Diagram 6" /></td>
</tr>
<tr>
<td>2</td>
<td><img src="image7" alt="Diagram 7" /></td>
<td><img src="image8" alt="Diagram 8" /></td>
</tr>
</tbody>
</table>
(4) Automatic setting of torque bias amount with terminal 1 or terminal 6 (FR-A7AZ)

When \[ Pr. 840 = 3 \] while using terminal 1, \([C16 to C19, C34 to C37]\) and \([Pr. 846]\) are automatically set according to the load. When \([Pr. 840 = 3]\) while using terminal 6, \([C16 to C19, C34 to C37]\) and \([Pr. 846]\) are automatically set according to the load. Refer to the following diagram for the setting method.

When torque bias amount is set to terminal 1, set \([Pr. 840 = 3, Pr. 846, C16 to C19, C34 to C37]\)

When \([Pr. 840 = 3]\) while using terminal 1, \([C16 to C19 (Pr. 919, 920)]\) and \([Pr. 846]\) are automatically set according to the load.

When starting torque bias operation after completion of automatic setting, set 1 or 2 in \([Pr. 840]\).

To set torque bias amount to terminal 6 (FR-A7AZ), set \([Pr. 846, High resolution analog input selection = 6]\).

When \([Pr. 840 = 3, Pr. 846, C16 to C19, C34 to C37]\) and \([Pr. 846]\) are automatically set according to the load.

When \([Pr. 840 = 3]\) while using terminal 6, \([C34 to C37, Pr. 846]\) and \([Pr. 846]\) are automatically set according to the load.

When starting torque bias operation after completion of automatic setting, set 1 or 2 in \([Pr. 840]\).

**Setting Method**

- **When using terminal 1**
  - Setting of \([C16, C17 (Pr. 919)]\): Operation without a load
    - Read \([C16, C17 (Pr. 919)]\) when speed is stable
    - Press \([ST]\)
    - Setting \([C16, C17 (Pr. 919)]\) completed
  - Setting of \([C18, C19 (Pr. 920)]\): Operation with a maximum load
    - Read \([C18, C19 (Pr. 920)]\) when speed is stable
    - Press \([ST]\)
    - Setting \([C18, C19 (Pr. 920)]\) completed
  - Setting of \([Pr. 846]\): Operation with a balanced load
    - Read \([Pr. 846]\) when speed is stable
    - Press \([ST]\)
    - Torque balance compensation is completed.

- **When using terminal 6 (FR-A7AZ)**
  - Setting of \([C34, C35 (Pr. 926)]\): Operation without a load
    - Read \([C34, C35 (Pr. 926)]\) when speed is stable
    - Press \([ST]\)
    - Setting \([C34, C35 (Pr. 926)]\) completed
  - Setting of \([C36, C37 (Pr. 927)]\): Operation with a maximum load
    - Read \([C36, C37 (Pr. 927)]\) when speed is stable
    - Press \([ST]\)
    - Setting \([C36, C37 (Pr. 927)]\) completed
  - Setting of \([Pr. 846]\): Operation with a balanced load
    - Read \([Pr. 846]\) when speed is stable
    - Press \([ST]\)
    - Torque balance compensation is completed.
2.9.6 Speed limit [Pr. 285, 853, 873] (A700)

This function prevents the motor from overrunning when the load torque is too large and incorrect number of encoder is set.

(1) Speed deviation excessive [Pr. 285, 853]

When the deviation between the set frequency and actual speed is large, e.g. too large load torque, this function can cause the inverter to provide a speed deviation excessive fault (E. OSD) and come to trip.

(2) Speed limit [Pr. 873]

This function prevents the motor from overrunning when the setting of number of encoder pulses and the actual number differ. When the setting of number of encoder pulses is smaller than the actual number, the motor may increase its speed. To prevent this, restrict the output speed by the frequency (set frequency and Pr. 873).

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pr. 285</td>
<td>9999</td>
<td>0 to 30Hz</td>
<td>If the difference (absolute value) between the speed command value and the actual speed exceeds the Pr. 285 Speed deviation excess detection frequency setting for longer than the time set in Pr. 853 Speed deviation time, speed deviation excessive occurs and error &quot;E. OSD&quot; appears, resulting in a stop.</td>
</tr>
<tr>
<td>Pr. 853</td>
<td>1.0s</td>
<td>0 to 100s</td>
<td>Frequency is limited at the set frequency + Pr. 873.</td>
</tr>
<tr>
<td>Pr. 873</td>
<td>20Hz</td>
<td>0 to 120Hz</td>
<td>Frequency is limited at the set frequency + Pr. 873.</td>
</tr>
</tbody>
</table>

*1 Acts as over speed detection frequency under encoder feedback operation. (Refer to page 392)
2.9.7 Notch filter [Pr. 862, 863] (A700)

You can reduce the response level of speed control in the resonance frequency band of the mechanical system to avoid mechanical resonance.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>862</td>
<td>Notch filter time constant</td>
<td>0</td>
<td>0 to 60</td>
<td>Refer to the following table</td>
</tr>
<tr>
<td>863</td>
<td>Notch filter depth</td>
<td>0</td>
<td>0 to 3</td>
<td>0 (deep) 3 (shallow)</td>
</tr>
</tbody>
</table>

1. Notch filter time constant [Pr. 862]

If you do not know the mechanical resonance frequency, decrease notch frequency gradually from the highest value. The point at which the smallest vibration is generated is the notch frequency setting. Machine characteristic can be obtained beforehand with machine analyzer by FR Configurator. Necessary notch frequency can be determined from this.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Frequency</th>
<th>Setting</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Invalid</td>
<td>30</td>
<td>33.3</td>
</tr>
<tr>
<td>1</td>
<td>1000</td>
<td>31</td>
<td>32.3</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
<td>32</td>
<td>31.3</td>
</tr>
<tr>
<td>3</td>
<td>333.3</td>
<td>33</td>
<td>30.3</td>
</tr>
<tr>
<td>4</td>
<td>250</td>
<td>34</td>
<td>29.4</td>
</tr>
<tr>
<td>5</td>
<td>200</td>
<td>35</td>
<td>28.6</td>
</tr>
<tr>
<td>6</td>
<td>166.7</td>
<td>36</td>
<td>27.8</td>
</tr>
<tr>
<td>7</td>
<td>142.9</td>
<td>37</td>
<td>27.0</td>
</tr>
<tr>
<td>8</td>
<td>125</td>
<td>38</td>
<td>26.3</td>
</tr>
<tr>
<td>9</td>
<td>111.1</td>
<td>39</td>
<td>25.6</td>
</tr>
<tr>
<td>10</td>
<td>100</td>
<td>40</td>
<td>25.0</td>
</tr>
<tr>
<td>11</td>
<td>90.9</td>
<td>41</td>
<td>24.4</td>
</tr>
<tr>
<td>12</td>
<td>83.3</td>
<td>42</td>
<td>23.8</td>
</tr>
<tr>
<td>13</td>
<td>76.9</td>
<td>43</td>
<td>23.3</td>
</tr>
<tr>
<td>14</td>
<td>71.4</td>
<td>44</td>
<td>22.7</td>
</tr>
<tr>
<td>15</td>
<td>66.7</td>
<td>45</td>
<td>22.2</td>
</tr>
<tr>
<td>16</td>
<td>62.5</td>
<td>46</td>
<td>21.7</td>
</tr>
<tr>
<td>17</td>
<td>58.8</td>
<td>47</td>
<td>21.3</td>
</tr>
<tr>
<td>18</td>
<td>55.6</td>
<td>48</td>
<td>20.8</td>
</tr>
<tr>
<td>19</td>
<td>52.8</td>
<td>49</td>
<td>20.4</td>
</tr>
<tr>
<td>20</td>
<td>50</td>
<td>50</td>
<td>20.0</td>
</tr>
<tr>
<td>21</td>
<td>47.6</td>
<td>51</td>
<td>19.8</td>
</tr>
<tr>
<td>22</td>
<td>45.5</td>
<td>52</td>
<td>19.2</td>
</tr>
<tr>
<td>23</td>
<td>43.5</td>
<td>53</td>
<td>18.9</td>
</tr>
<tr>
<td>24</td>
<td>41.7</td>
<td>54</td>
<td>18.5</td>
</tr>
<tr>
<td>25</td>
<td>40</td>
<td>55</td>
<td>18.2</td>
</tr>
<tr>
<td>26</td>
<td>38.5</td>
<td>56</td>
<td>17.9</td>
</tr>
<tr>
<td>27</td>
<td>37</td>
<td>57</td>
<td>17.5</td>
</tr>
<tr>
<td>28</td>
<td>35.7</td>
<td>58</td>
<td>17.2</td>
</tr>
<tr>
<td>29</td>
<td>34.5</td>
<td>59</td>
<td>16.9</td>
</tr>
<tr>
<td>30</td>
<td>33.3</td>
<td>60</td>
<td>16.7</td>
</tr>
</tbody>
</table>

2. Notch filter depth [Pr. 863]

The notch filter with deeper depth has an effect on minimizing mechanical resonance. However, large vibration may be generated adversely due to substantial phase delay. Adjust notch depth from the shallower depth.
# Troubleshooting (speed control) (A700)

<table>
<thead>
<tr>
<th>Case</th>
<th>Cause</th>
<th>Countermasures</th>
</tr>
</thead>
</table>
| Motor does not rotate (vector control) | The motor wiring is wrong | (1) Wiring check  
V/F control: set 9999 in either \[Pr. 41\] or \[Pr. 42\] and check the motor rotation direction. 
Check the speed monitor output from output terminal FM. For the FR-U5RU, set 170V for 3.7kW or less and 180V for more in \[Pr. 19 \: \text{bus frequency volts}\] and set 50Hz in \[Pr. 7 \: \text{bus frequency}\].  
When the forward rotation signal is input, the motor running in the counterclockwise direction as viewed from the motor shaft is normal. (If it runs in the clockwise direction, the phase sequence of the inverter secondary side wiring is incorrect.)  
(2) Encoder specifications (encoder specification selection switch (FR-A7AP, FR-A7AL)) are wrong | (1) Wiring check  
V/F control: set 9999 in either \[Pr. 41\] or \[Pr. 42\] and check the motor rotation direction. 
Check the speed monitor output from output terminal FM. For the FR-U5RU, set 170V for 3.7kW or less and 180V for more in \[Pr. 19 \: \text{bus frequency volts}\] and set 50Hz in \[Pr. 7 \: \text{bus frequency}\].  
When the forward rotation signal is input, the motor running in the counterclockwise direction as viewed from the motor shaft is normal. (If it runs in the clockwise direction, the phase sequence of the inverter secondary side wiring is incorrect.)  
(2) Encoder specifications (encoder specification selection switch (FR-A7AP, FR-A7AL)) are wrong |
|  | Encoder wiring is wrong. | (2) Check the encoder specifications  
Check the encoder specifications selection switch (FR-A7AP, FR-A7AL) of differential/complementary.  
(3) Check that FWD is displayed when running the motor in the counterclockwise direction from outside during a stop of the inverter with vector control setting. If REV is displayed, the encoder phase sequence is wrong. Perform the correct wiring or match the \[Pr. 175 \: \text{Encoder rotation direction}\] setting.  
(4) The \[Pr. 369 \: \text{Number of encoder pulses}\] setting and the number of encoder pulses used are different. | (2) Check the encoder specifications  
Check the encoder specifications selection switch (FR-A7AP, FR-A7AL) of differential/complementary.  
(3) Check that FWD is displayed when running the motor in the counterclockwise direction from outside during a stop of the inverter with vector control setting. If REV is displayed, the encoder phase sequence is wrong. Perform the correct wiring or match the \[Pr. 175 \: \text{Encoder rotation direction}\] setting.  
(4) The \[Pr. 369 \: \text{Number of encoder pulses}\] setting and the number of encoder pulses used are different.  
(5) Encoder power specifications are wrong. Or, power is not input. |
|  | Speed does not rise to the speed command. (vector control) | (1) Insufficient torque. Torque limit is activated.  
(2) Only P (proportional) control is selected. | (1) Increase the torque limit value. (Refer to torque limit of speed control on page 283) |
<table>
<thead>
<tr>
<th>Case</th>
<th>Cause</th>
<th>Countermeasures</th>
</tr>
</thead>
</table>
| 4 Motor speed is unstable. | (1) The speed command varies. | 1) Check that a correct speed command comes from the command device. (Take measures against noises.)  
2) Decrease [Pr. 72 PWM frequency selection].  
3) Increase [Pr. 322 Speed setting filter 1].  
(Refer to page 323)  
(2) Insufficient torque.  
3) The speed control gains do not match the machine. (Machine resonances.) | 1) Decrease [Pr. 72 PWM frequency selection].  
2) Increase the torque limit value.  
(Refer to torque limit of speed control on page 283)  
3) Perform easy gain tuning.  
4) Adjust [Pr. 421, 422].  
5) Perform speed feed forward/model adaptive speed control. |
| 5 Motor or machine hunts (vibration/noise is produced). | (1) The speed control gain is high. | 1) Perform easy gain tuning.  
2) Decrease [Pr. 421] and increase [Pr. 422].  
3) Perform speed feed forward control and model adaptive speed control. | 1) Decrease the [Pr. 421] value.  
2) Set the acceleration/deceleration time that meets the load.  
3) Check the wiring. |
| 6 Acceleration/deceleration time does not match the setting. | (1) Insufficient torque. | 1) Increase the torque limit value.  
(Refer to torque limit of speed control on page 283)  
2) Perform speed feed forward control. | 1) Change the acceleration/deceleration time to an optimum value.  
2) Set the acceleration/deceleration time that meets the load.  
3) Check the wiring. |
| 7 Machine operation is unstable. | (1) The speed control gains do not match the machine. | 1) Perform easy gain tuning.  
2) Adjust [Pr. 421, 422].  
3) Perform speed feed forward control and model adaptive speed control.  
4) Slow response because of improper acceleration/deceleration time of the inverter. | 1) Change the acceleration/deceleration time to an optimum value.  
2) Check the wiring. |
| 8 Speed fluctuation at low speed. | (1) Adverse effect of high carrier frequency. | 1) Decrease [Pr. 72 PWM frequency selection]. | 1) Increase [Pr. 421 Speed control P gain 1]. |
2.10 Torque control by Real sensorless vector control and vector control

2.10.1 Torque control (A700)

(1) Control block diagram

The following shows a basic control block diagram during torque control.
Actual speed or estimated speed
- Speed limit value

Motor Encoder

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value

Vector control

[Pr. 800 = 1]

Actual speed or estimated speed
- Speed limit value
(2) Operation

Torque control is exercised to develop torque as set in the torque command.

The motor speed becomes constant when the motor output torque and load torque are balanced.

For torque control, the motor gains speed as the motor output torque becomes greater than the motor load. To prevent overspeed, set the speed limit value so that the motor speed does not increase too high.

(Speed control is exercised during speed limit and torque control is disabled.)

When speed limit is not set, the speed limit value setting is regarded as 0ms to disable torque control.

When the actual speed reaches or exceeds the speed limit value, torque control is switched to speed control to prevent overspeed. STF (SL) appears on the operation panel during speed limit operation and the OL signal is output.

When speed limit operation starts, speed control is enabled internal torque limit ([Pr. 22 Stall prevention operation level]) (initial value). In such a case, speed control may not return to torque control. To prevent this, set torque limit to the setting same as torque command.

For example, when torque command is analog input to terminal 1, torque limit be set to external torque limit (terminal 4, 1). (Refer to page 283)

Undervoltage avoidance function ([Pr. 261 = 11, 12]) of power-failure deceleration stop function becomes invalid under torque control. When [Pr. 261 = 11 (12)], the inverter operates in the same manner as when [Pr. 261 = 1 (2)]. (Refer to page 373)

Set linear acceleration/deceleration (\[Pr. 79 = 0\] initial value)) when torque control is performed. When acceleration/deceleration patterns other than the linear acceleration/deceleration are selected, the protective function of the inverter may function. (Refer to page 234)

Performing pre-excitation (LX signal and X13 signal) under torque control (Real sensorless vector control, vector control) may start the motor running at a low speed even when the start command (STF or STR) is not input. The motor may run also at a low speed when the speed limit value = 0 with a start command input. Perform pre-excitation after making sure that there will be no problem in safety if the motor runs.

(Example) When [Pr. 804 = 0]

Torque control is enabled if the actual speed is less than the speed limit value.

When the actual speed reaches or exceeds the speed limit value, speed limit operation starts, torque control is stopped, and speed control (proportional control) starts.

The following shows the operations in response to the analog input command from terminal 1.

<table>
<thead>
<tr>
<th>Torque Command</th>
<th>Torque Developing Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command Polarity</td>
<td>STF signal ON</td>
</tr>
<tr>
<td>Positive torque command</td>
<td>Forward rotation direction (forward rotation driving/reverse rotation regeneration)</td>
</tr>
<tr>
<td>Negative torque command</td>
<td>Reverse rotation direction (forward rotation regeneration/reverse rotation driving)</td>
</tr>
</tbody>
</table>

(3) Concept of torque control gains

Normally, it is not necessary to change [Pr. 824, 834]

Torque control P gain, [Pr. 825, 835] Torque control integral time. Refer to page 306 to make adjustment.

1) Torque control P (proportional) gain

During vector control, [Pr. 824 = 100%] is equivalent to 2000rad/s.

During Real sensorless vector control, [Pr. 824 = 100%] is equivalent to 1000rad/s.

2) Torque control integral time

[Pr. 825 = 5ms] is equivalent to 200ms.
2.10.2  Torque command setting [Pr. 304, 305, 432, 433, 447, 448, 803 to 806]  \( A700 \)

Torque command source for torque control can be selected.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>304</td>
<td>Digital input and analog input compensation enable/disble selection</td>
<td>9999</td>
<td>0 to 4, 0 to 14, 9999</td>
<td>Set 4 when inputting 12 bit. Torque command value.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Set 14 when inputting 16 bit. Torque command value.</td>
</tr>
<tr>
<td>305</td>
<td>Read timing operation selection</td>
<td>0</td>
<td>0 to 1, 0 to 10</td>
<td>Data is always read regardless of DT signal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Data is read only when DT signal is ON.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Data is always read regardless of DT signal.</td>
<td></td>
</tr>
<tr>
<td>432</td>
<td>Pulse train torque command bias</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set torque command value when pulse train is 0.</td>
</tr>
<tr>
<td>433</td>
<td>Pulse train torque command gain</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set torque command value when pulse train is 400 kps.</td>
</tr>
<tr>
<td>447</td>
<td>Digital torque command bias</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set torque command value when input signal is TFFF04 (TFF04).</td>
</tr>
<tr>
<td>448</td>
<td>Digital torque command gain</td>
<td>100%</td>
<td>0 to 400%</td>
<td>The input signal is used as the torque command value.</td>
</tr>
<tr>
<td>803</td>
<td>Constant power range torque characteristic selection</td>
<td>0</td>
<td>0 to 1</td>
<td>Constant motor output command selects the torque command in the constant power range by torque command setting.</td>
</tr>
<tr>
<td>804</td>
<td>Torque command source selection</td>
<td>0</td>
<td>0 to 1</td>
<td>Torque command by terminal 1 analog input ( (\text{Refer to page } 43) )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>0 to 1</td>
<td>Torque command ( -400% ) to ( 400% ) by parameter setting ( \text{Pr. } 805, \text{Pr. } 806 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>0 to 1</td>
<td>Torque command ( -400% ) to ( 400% ) by parameter setting ( \text{Pr. } 805, \text{Pr. } 806 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>0 to 1</td>
<td>Torque command setting using CC-Link communication ( \text{FR-A7NC} ) remote register ( -400% ) to ( 400% )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>0 to 1</td>
<td>Torque command setting using CC-Link communication ( \text{FR-A7NC} ) remote register ( -327.68% ) to ( 327.67% )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>0 to 1</td>
<td>Torque command setting using CC-Link communication ( \text{FR-A7NC} ) remote register ( -327.68% ) to ( 327.67% )</td>
</tr>
</tbody>
</table>

*When FR-A7AZ is installed, torque command from terminal 6 is also available.

(1) Control block diagram
(2) Torque command by analog input
(terminal 1 or terminal 6 (FR-A7AZ) [Pr. 804 = 0])

Torque command is given by voltage (current) input to terminal 1 or terminal 6 (FR-A7AZ). When torque command is input to terminal 1, set [Pr. 406 High resolution analog input selection] = 3 or 4. When [Pr. 804 = 0] and a value other than 3 or 4 is set in [Pr. 406], torque command value = 0. (Refer to page 43)

To input torque command to terminal 6 (FR-A7AZ), set [Pr. 406 High resolution analog input selection] = 3 or 4. When the setting overlaps with terminal 1, terminal 6 is the torque command, and terminal 1 does not have a function. (Refer to page 43)

Torque command by analog input can be calibrated using calibration parameter [C16 to C19 (Pr. 919, 920)] and [C34 to C37 (Pr. 928, 929)]. (Refer to page 320)

(3) Torque command by parameter
[Pr. 804 = 1, Pr. 885, 886]

Torque command value can be set by setting [Pr. 885 Torque command value (RAM)] or [Pr. 886 Torque command value (RAM, EEPROM)].

For [Pr. 885] or [Pr. 886], the setting value 1000% is considered as torque command value 0% and the torque command is set by an offset from 1000%. The relationship between the [Pr. 885] or [Pr. 886] setting and actual torque command value at this time is shown below.

When changing the torque command frequently, write to [Pr. 885]. Performing frequent parameter write to [Pr. 886] will shorten the life of the EEPROM.

When torque command is set in [Pr. 885 (RAM)], powering off the inverter will erase the changed parameter values. Therefore, the parameter value available when power is switched ON again is the value set in [Pr. 886 (EEPROM)].

(4) Torque command by the pulse train input
[Pr. 804=2, Pr.432, 433]

Torque command is given by pulse train input of FR-A7AL (built-in option). The relation between input pulse and torque command value is shown below.

(5) Torque command by using CC-Link communication
[Pr. 804 = (1), 3, 5, 6]

Writing [Pr. 885] or [Pr. 886] from CC-Link communication or setting to remote register RWr or RWrc with the FR-A7NC (communication option) mounted will set the torque command value.

Refer to the table below for torque command setting method and setting increments during CC-Link communication.

---

<table>
<thead>
<tr>
<th>Setting</th>
<th>Write in [Pr. 885] or [Pr. 886]</th>
<th>Write in Remote Register (RWr or RWrc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Setting 600 to 1400</td>
<td>×</td>
</tr>
<tr>
<td>3</td>
<td>Setting 600 to 1400</td>
<td>Setting 600 to 1400</td>
</tr>
<tr>
<td>5</td>
<td>Setting -32768 to 32767</td>
<td>Setting -32768 to 32767</td>
</tr>
<tr>
<td>6</td>
<td>Setting -32768 to 32767</td>
<td>×</td>
</tr>
</tbody>
</table>

When the value is set from other than CC-Link communication, setting value 600 to 1400 becomes -400 to 400%.
(6) Torque command by 16 bit digital input

\[ Pr. 894 = 4, Pr. 304, 305, 447, 448 \]

Torque command by 12 bit digital input is given when \[ Pr. 304 = 4 \] and 16 bit digital input is given when \[ Pr. 304 = 14 \] using the FR-A7AX (plug-in option). When \[ Pr. 894 = 4 \] and a value other than 4 or 14 is set in \[ Pr. 304 \], torque command value \( = 0 \).

The digital torque command is input only by binary input. The input signal uses the last 15 (11) bits as torque command and the most significant bit as sign.

When 16bit is selected

<table>
<thead>
<tr>
<th>Bit15</th>
<th>Bit14</th>
<th>Bit13</th>
<th>Bit12</th>
<th>Bit11</th>
<th>Bit10</th>
<th>Bit9</th>
<th>Bit8</th>
<th>Bit7</th>
<th>Bit6</th>
<th>Bit5</th>
<th>Bit4</th>
<th>Bit3</th>
<th>Bit2</th>
<th>Bit1</th>
<th>Bit0</th>
</tr>
</thead>
<tbody>
<tr>
<td>-150%</td>
<td>-100%</td>
<td>-50%</td>
<td>0%</td>
<td>50%</td>
<td>100%</td>
<td>150%</td>
<td>Initial value</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Set the torque command value when the input signal is "0" in \[ Pr. 447 \] and the torque command value when the input signal is 7FFFH (7FFH) in \[ Pr. 448 \].

The input signal is used as the torque command value when \[ Pr. 448 = 9999 \].

(7) Torque characteristic in the constant power range \[ Pr. 803 \].

Due to the motor characteristics, torque is reduced at or above the base frequency. Set "1" in \[ Pr. 803 \] (Constant power range torque characteristic selection) when you want to keep the torque to be constant even at or above the base frequency.
2.10.3 Speed limit (Pr. 807 to Pr. 809, C12 to C15 (Pr. 917, 918), C30 to C33(Pr. 926, 927))

Set the speed limit value to prevent overspeed of the motor in case the load torque becomes less than the torque command value, etc during torque control operation. \( SL \) appears on the operation panel during speed limit operation and the OL signal is output.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>807</td>
<td>Speed limit selection</td>
<td>0</td>
<td></td>
<td>Use the speed command value during speed control as speed limit.</td>
</tr>
<tr>
<td>808</td>
<td>Forward rotation speed limit</td>
<td>60Hz</td>
<td>0 to 120Hz</td>
<td>Set the speed limit for the forward rotation direction.</td>
</tr>
<tr>
<td>809</td>
<td>Reverse rotation speed limit</td>
<td>9999</td>
<td>0 to 120Hz</td>
<td>Set the speed limit for the reverse rotation direction.</td>
</tr>
<tr>
<td>C12(917)</td>
<td>Terminal 1 bias frequency (speed)</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency (speed) on the bias side of terminal 1 input.</td>
</tr>
<tr>
<td>C13(917)</td>
<td>Terminal 1 bias (speed)</td>
<td>0%</td>
<td>0 to 300%</td>
<td>Set the converted % of the bias side voltage of terminal 1 input.</td>
</tr>
<tr>
<td>C14(918)</td>
<td>Terminal 1 gain frequency (speed)</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency (speed) of the maximum terminal 1 input gain.</td>
</tr>
<tr>
<td>C15(918)</td>
<td>Terminal 1 gain (speed)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Set the converted % of the gain side voltage of terminal 1 input.</td>
</tr>
<tr>
<td>C30(926)</td>
<td>Terminal 6 bias frequency (speed)</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency (speed) on the bias side of terminal 6 input.</td>
</tr>
<tr>
<td>C31(926)</td>
<td>Terminal 6 bias (speed)</td>
<td>0%</td>
<td>0 to 300%</td>
<td>Set the converted % of the bias side voltage of terminal 6 input.</td>
</tr>
<tr>
<td>C32(927)</td>
<td>Terminal 6 gain frequency (speed)</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency (speed) of the terminal 6 input gain.</td>
</tr>
<tr>
<td>C33(927)</td>
<td>Terminal 6 gain (speed)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Set the converted % of the gain side voltage of terminal 6 input.</td>
</tr>
</tbody>
</table>

* When FR-A7AZ is installed, forward/reverse rotation speed limit using terminal 6 is also available.

(1) Use the speed command for speed control

\( [\text{Pr. } 807 = 0] \)

Set the speed limit in the same method as speed setting for speed control. (speed setting by the PU (FR-DU07/FR-PU04/FR-PU07), multi-speed setting, plug-in options, etc.)

The speed limit level is increased from 0Hz upon turning ON of the start signal according to the acceleration time set in \([\text{Pr. } 7 \text{ Acceleration time}]\) and is decreased upon turning OFF of the start signal from the then speed limit level to the DC injection brake operation speed set in \([\text{Pr. } 8 \text{ Deceleration time}]\) to a stop in accordance with the deceleration time set in \([\text{Pr. } 8 \text{ Deceleration time}]\).

When the above speed limit command is greater than \([\text{Pr. } 1 \text{ Maximum speed}]\) value, the speed limit value is the \([\text{Pr. } 1 \text{ Maximum frequency}]\) value, and when the speed limit command is less than the \([\text{Pr. } 2 \text{ Minimum speed}]\) value, the speed limit value is the \([\text{Pr. } 2 \text{ Minimum frequency}]\) value. Similarly when the speed limit command is smaller than \([\text{Pr. } 13 \text{ Starting frequency}]\), the speed limit value is 0Hz.
(2) Set the forward rotation and reverse rotation individually.

\[ Pr. 807 = 1, \ Pr. 808, 809 \]

Set the speed limit during forward rotation using \[ Pr. 808 \] (Forward rotation speed limit) and the speed limit during reverse rotation using \[ Pr. 809 \] (Reverse rotation speed limit).

The speed during forward and reverse rotation is limited at the setting value of \[ Pr. 809 \] when \[ Pr. 809 = 9999 \] (initial value).

The speed limit value changes according to acceleration/deceleration time of \[ Pr. 7, Pr. 8 \].

(3) Forward rotation/reverse rotation speed limit \[ Pr. 807 = 2, C12 to C15(Pr. 917, 918), C30 to C33(Pr. 926, 927) \]

When making a speed limit using analog input to terminal 1 or terminal 6 (FR-A7AZ), the speed limit of the forward and reverse rotation can be switched according to the polarity of voltage.

Forward/reverse rotation speed limit is valid when \[ Pr. 406 = 5 \]. (Refer to page 43 for details of terminal function assignment)

Set \[ Pr. 406 \] (High resolution analog input selection) to 5 to limit forward/reverse rotation speed using terminal 6 (FR-A7AZ). When \[ Pr. 406 = 5 \] and \[ Pr. 809 = 5 \], terminal 6 is the forward/reverse speed limit, and terminal 1 does not have a function.

Speed limit by analog terminal input can be calibrated using calibration parameter \[ C12 to C15(Pr. 917, 918), C30 to C33(Pr. 926, 927) \].

For 0 to 10V input, set the forward rotation speed limit. The reverse rotation speed limit at this time is the value of \[ Pr. 1 \] (Maximum frequency). The speed limit value does not follow acceleration/deceleration time of \[ Pr. 7, Pr. 8 \].

For -10 to 0V input, set the reverse rotation speed limit. The forward rotation speed limit at this time is the value of \[ Pr. 1 \] (Maximum frequency). The forward rotation speed limit does not follow acceleration/deceleration time of \[ Pr. 7, Pr. 8 \].

The maximum speed of both the forward and reverse rotations is \[ Pr. 1 \] (Maximum frequency).
2.10.4 Gain adjustment [Pr. 824, 825, 834, 835] (A700)

Although stable operation is available with the initial value, make adjustment when any of such case as unusual motor and machine vibration noise and overcurrent has occurred.

### (1) Adjustment of current loop proportional (P) gain

Set the proportional gain for torque control. For general adjustment, make setting within the range 50 to 200% as a guideline. Increasing the value improves response to a current command change and reduces current variation with disturbance. However, a too large gain will cause instability, generating harmonic torque pulsation.

### (2) Adjustment of current control integral time

Set the integral time of current control during torque control. A small value enhances the torque response level, but a too small value will cause current fluctuation. Decreasing the value shortens the time taken to return to the original torque if current variation with disturbance occurs.

### (3) Use two gains

When you want to change the gain according to applications, or to switch multiple motors with one inverter, etc., use [Pr. 834 Torque control P gain 2] and [Pr. 835 Torque control integral time 2]. [Pr. 834 Torque control P gain 2] and [Pr. 835 Torque control integral time 2] are valid when the RT signal is ON.

### (4) Adjustment procedure

Make adjustment when any of unusual motor and machine vibration, noise, current, and overcurrent occurs.
1. Check the conditions and simultaneously change [Pr. 824].
2. If you cannot make proper adjustment, change the [Pr. 825] value and repeat step 1.

### Adjustment Method

- **Decrease the value by 10% until just before unusual noise and current are improved, and set about 0.8 to 0.9 of that value.**
  - Note that a too low value will produce current ripples, causing the motor to generate sound synchronizing with the cycle of current ripples.

- **Double the current value until just before an unusual noise and current does not occur, and set about 0.8 to 0.9 of that value.**
  - Note that taking too long time will produce current ripples, causing the motor to generate sound synchronizing with the cycle of current ripples.

### Table of Parameters

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>824</td>
<td>Torque control P gain 1</td>
<td>100%</td>
<td>0 to 200%</td>
<td>Set the current loop proportional gain.</td>
</tr>
<tr>
<td>825</td>
<td>Torque control integral time 1</td>
<td>5ms</td>
<td>0 to 500ms</td>
<td>Set the current loop integral compensation time.</td>
</tr>
<tr>
<td>834</td>
<td>Torque control P gain 2</td>
<td>9999</td>
<td>0 to 200%</td>
<td>Set the current loop proportional gain when the RT signal is ON.</td>
</tr>
<tr>
<td>835</td>
<td>Torque control integral time 2</td>
<td>9999</td>
<td>0 to 500ms</td>
<td>Set the current loop integral compensation time when the RT signal is ON.</td>
</tr>
</tbody>
</table>

**Note:**}

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### 2.10.5 Troubleshooting (torque control) (A700)

<table>
<thead>
<tr>
<th>Case</th>
<th>Cause</th>
<th>Countermeasures</th>
</tr>
</thead>
</table>
| 1    | Torque control is not exercised normally. | 1) The phase sequence of the motor or encoder wiring is wrong.  
(2) The [Pr. 49: Control mode selection] setting is improper.  
(3) The speed limit value is not input.  
(4) The torque command varies.  
(5) The torque command does not match the inverter-recognized value.  
(6) Torque variation due to the change in the motor temperature. | 1) Check the wiring. (Refer to page 95)  
(2) Check the [Pr. 49] setting. (Refer to page 252)  
(3) Set the speed limit value. (If the speed limit value is not input, the motor will not rotate since the speed limit value is regarded as 0Hz.)  
(4) 1 Check that the command device gives a correct torque command.  
(4) 2 Decrease [Pr. 72: PWM frequency selection].  
(4) 3 Increase [Pr. 826: Torque setting filter 1].  
(5) Recalibrate [C16: Terminal 1 bias command (torque/magnetic flux)], [C17: Terminal 1 bias (torque/magnetic flux)], [C18: Terminal 1 gain command (torque/magnetic flux)], [C19: Terminal 1 gain (torque/magnetic flux)]. (Refer to page 320)  
(6) Select magnetic flux observer by setting [Pr. 85: Online auto tuning selected]. (Refer to page 218) |
| 2    | When the torque command is small, the motor rotates in the direction opposite to the start signal. | The offset calibration of the torque command does not match. | Recalibrate [C16: Terminal 1 bias command (torque/magnetic flux)] and [C17: Terminal 1 bias (torque/magnetic flux)]. (Refer to page 320) |
| 3    | Normal torque control cannot be exercised during acceleration/deceleration. The motor vibrates. | The speed limit is activated. Since the speed limit value changes with the setting of the acceleration/deceleration time [Pr. 7, Pr. 8], the speed limit may be activated. | Reduce the acceleration/deceleration time.  
Or, set the acceleration/deceleration time to “0”. (The speed limit during acceleration/deceleration depends on the speed limit during the constant speed.) |
| 4    | Output torque is not linear in response to the torque command. Insufficient torque. | Return the [Pr. 854: Excitation ratio] to the initial value. |
2.11 Position control by vector control

2.11.1 Position control (A700)

(1) Control block diagram

The following shows a basic control block diagram during position control.

(2) Operation

The speed command given to rotate the motor is calculated to zero the difference between the number of internal command pulse train pulses (when \([Pr. 419 = 0]\), the number of pulses set by parameter \([Pr. 465 \text{ to } 494]\)) and the number of pulses fed back from the motor end encoder.

1) When a pulse train is input, pulses are accumulated in the deviation counter and these droop pulses act as position control pulses to give the speed command.

2) As soon as the motor starts running under the speed command of the inverter, the encoder generates feedback pulses and the droop of the deviation counter maintains a given droop pulse value to keep the motor running.

3) When the command pulse input stops, the droop pulses of the deviation counter decreases, reducing the speed. The motor stops when there are no droop pulses.

4) When the number of droop pulses has fallen below the value set in \([Pr. 426 \text{ in-position width}]\), it is regarded as completion of positioning and the in-position signal (Y36) turns ON.

For conditional position control function by contact input, the terminals STF and STR provide the forward (reverse) command signal. The motor can run only in the direction where the forward (reverse) signal is ON. Turning the STF signal OFF does not run the motor forward and turning the STR signal OFF does not run the motor reverse.

The pulse train is rough during acceleration and fine at the maximum speed. During deceleration the pulse train is rough and at last there are no pulses. The motor stops shortly after the command pulses stop. This time lag is necessary for maintaining the stop accuracy and called stop settling time.
(3) Concept of position control gains

1) The [Pr. 422 Position loop gain] setting is rad/s increments.
   Increasing the setting improves response for the position command and also improves servo rigidity at a stop, but oppositely makes an overshoot and vibration more liable to occur. Normally set this parameter within the range about 5 to 50.

2) To cancel all droop pulse, set 100% in [Pr. 423 Position feed forward gain].
   Feed forward gain is a function designed to cancel a delay caused by the droop pulses of the deviation counter. When a tracking delay for command pulses poses a problem, increase the setting gradually and use this parameter within the range where an overshoot or vibration will not occur.
   This function has no effects on servo rigidity at a stop. Normally set 0.

(4) Adjustment procedures

1) Select the speed control using [Pr. 800 Control method selection] and perform gain adjustment of speed control.
2) Then, change the control to position control using [Pr. 800 Control method selection] and adjust position loop gain.
3) Adjust position loop gain by checking response to the command pulses.

2.11.2 Conditional position feed function by contact input [Pr. 419, 464 to 494] (A700)

Inputting the number of pulses (positions) in the parameters and setting multi-speed and forward (reverse) commands enable position control.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>419</td>
<td>Position command source selection</td>
<td>0</td>
<td>0 Conditional position control function by contact input. (position command by parameter settings)</td>
<td>1 Pulse train position command by programmable controller positioning unit (when FR-A7AL installed)</td>
</tr>
<tr>
<td>464</td>
<td>Digital position control sudden stop deceleration time</td>
<td>0x</td>
<td>0 to 3600s</td>
<td>Set the time until the inverter stops when the forward rotation (reverse rotation) command is turned OFF with the position feed forward function.</td>
</tr>
</tbody>
</table>

The motor does not return to the home position with this conditional position feed function.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>465</td>
<td>First position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>High speed [Pr. 4]</td>
</tr>
<tr>
<td>466</td>
<td>First position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>467</td>
<td>Second position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>Middle speed [Pr. 5]</td>
</tr>
<tr>
<td>468</td>
<td>Second position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>469</td>
<td>Third position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>Low speed [Pr. 6]</td>
</tr>
<tr>
<td>470</td>
<td>Third position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>471</td>
<td>Fourth position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>4 speed [Pr. 24]</td>
</tr>
<tr>
<td>472</td>
<td>Fourth position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>473</td>
<td>Fifth position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>5 speed [Pr. 25]</td>
</tr>
<tr>
<td>474</td>
<td>Fifth position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>476</td>
<td>Sixth position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>6 speed [Pr. 26]</td>
</tr>
<tr>
<td>477</td>
<td>Sixth position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
<tr>
<td>478</td>
<td>Seventh position feed amount lower 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td>7 speed [Pr. 27]</td>
</tr>
<tr>
<td>479</td>
<td>Seventh position feed amount upper 4 digits</td>
<td>0</td>
<td>0 to 9999</td>
<td></td>
</tr>
</tbody>
</table>
### Setting of position feed amount by parameter (Pr. 419 = 0, Pr. 465 to 494)

<table>
<thead>
<tr>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servo ON (LX)</td>
<td>RH, STF, STR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feed speed</td>
<td>Pr. 4</td>
<td>First position feed amount</td>
<td></td>
</tr>
<tr>
<td>In-position</td>
<td>Pr. 7</td>
<td>Stopped part in the travel</td>
<td></td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>Pr. 8</td>
<td>Second position feed amount</td>
<td></td>
</tr>
<tr>
<td>Time</td>
<td>Pr. 466</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The feed amount set in each parameter is selected by multi-speed terminal (RH, RM, RL, REX).
- To set 819200 for the first position feed amount, divide the value into upper four digits and lower four digits and set 81 (decimal) in [Pr. 466] (upper) and 9200 (decimal) in [Pr. 465] (lower).

### Position command operation by parameter

- Information on multi-speed command (position command) is determined at rising of the forward (reverse) command to perform position control.
- Therefore, set forward (reverse) command after multi-speed command (position command by RL, RM, RH, and REX signals). Position feed is invalid if the multi-speed command is given after forward (reverse) command.
- For deceleration by turning the STF(STR) OFF, use [Pr. 464 Digital position control sudden stop deceleration time] to set deceleration time.
- Acceleration/deceleration time is 0.1s minimum and 360s maximum.

- [Pr. 20 Acceleration/deceleration reference frequency] is clamped at a minimum of 16.66Hz (500r/min).
- The acceleration/deceleration patterns for position control are all linear acceleration and the setting of [Pr. 29 Acceleration/deceleration pattern selection] is invalid.
2.11.3 Position control by the inverter pulse train input [Pr. 419, 428 to 430]

Simple position pulse train command can be input by pulse train input to terminal JOG and sign signal (NP).

### Operation Overview [Pr. 419 = 2]

Turning ON the servo on signal (LX) cancels the output shut-off and the operation ready signal (RDY) turns ON after 0.1s. Turning ON the STF (forward stroke end signal) or STR (reverse stroke end signal) runs the motor according to the commanded pulse. When the forward (reverse) stroke end signal turns OFF, the motor does not run in that direction.

### Pulse Train Form Type Selection (NP Signal) [Pr. 428]

1. Set [Pr. 419 = 2] (simple pulse train position command). In this case, terminal JOG serves as simple position pulse train input terminal regardless of [Pr. 293 Pulse train I/O selection].
2. Set “NP” in [Pr. 178 to 189 Input terminal function selection] to assign simple position pulse train signal (NP).
3. Select command pulse train using [Pr. 428].

<table>
<thead>
<tr>
<th>Setting</th>
<th>Command Pulse Train Form</th>
<th>At Forward Rotation</th>
<th>At Reverse Rotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 2</td>
<td>Negative logic, Pulse train + rotation direction sign</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 to 5</td>
<td>Positive logic, Pulse train + rotation direction sign</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Select vector control, then select position control.

---

### Parameter Table

<table>
<thead>
<tr>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Position command source selection</td>
<td>0</td>
<td>0, 1, 2</td>
<td>0: Simple position control function by contact input (position command by parameter settings), 1: Pulse train position command by programmable controller positioning unit (when FR-A7AL installed), 2: Simple pulse train position command by inverter pulse train input</td>
</tr>
<tr>
<td>Command pulse selection</td>
<td>0</td>
<td>0 to 2</td>
<td>0: Pulse train + rotation, Negative logic, 3 to 5: Positive logic</td>
</tr>
<tr>
<td>Clear signal selection</td>
<td>1</td>
<td>0, 1</td>
<td>0: Deviation counter is cleared at edge of turning ON of the clear signal (CLR) from OFF, 1: Deviation counter while the clear signal (CLR) is ON</td>
</tr>
<tr>
<td>Pulse monitor selection</td>
<td>9999</td>
<td>0 to 5</td>
<td>9999: Frequency monitor is displayed, 0 to 5: The status of various pulses during running are displayed.</td>
</tr>
</tbody>
</table>
(3) Selection of clear signal (CLR signal) [Pr. 429]

Use this function to make a drooping pulse 0 for home position operation, etc. When [Pr. 429 = 0], the deviation counter is cleared at the edge of turning ON of the clear signal (CLR). The CLR signal turns ON in synchronization with the zero pulse signal of encoder for home position operation, etc. and clears the deviation counter. When [Pr. 429 = 1] (initial value), the deviation counter is cleared while the clear signal (CLR) is ON.

For the terminal used for CLR signal input, set 69 in any of [Pr. 178 to Pr. 189 Input terminal function selection] to assign the function.

(4) Pulse monitor selection [Pr. 430]

The status of various pulses during running are displayed.

Set [Pr. 32 DU/PU main display data selection = 6] to display output frequency monitor.

Count the number of pulses when the servo is ON.

The cumulative pulse value is cleared when the base is shut off or the clear signal (CLR) is turned ON.

<table>
<thead>
<tr>
<th>Pr. 430 setting</th>
<th>Description</th>
<th>Display Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>The cumulative command pulse value is displayed.</td>
<td>Lower 4 digits, Upper 5 digits</td>
</tr>
<tr>
<td>1</td>
<td>The cumulative feedback pulse value is displayed.</td>
<td>Lower 4 digits, Upper 5 digits</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Upper 4 digits, Upper 5 digits</td>
</tr>
<tr>
<td>3</td>
<td>The droop pulses are displayed.</td>
<td>Upper 4 digits, Upper 5 digits</td>
</tr>
<tr>
<td>5</td>
<td>Frequency monitor is displayed. (Initial value)</td>
<td></td>
</tr>
</tbody>
</table>
2.11.4 Positioning control by pulse train input of FR-A7AL [Pr.419, 428 to 430]

The built-in option FR-A7AL enables position control by the programmable controller positioning unit.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 419   | Position command source selection | 0             | 0 to 2        | 0: Simple position control function by contact input (position command by parameter settings)  
|       |                                   |               |               | 1: Pulse train position command by programmable controller positioning unit (when FR-A7AL installed)  
|       |                                   |               |               | 2: Simple pulse train position command by inverter pulse train input       |
| 428   | Command pulse selection           | 0             | 0 to 5        | 0: Forward rotation pulse train + reverse rotation pulse train Negative logic  
|       |                                   |               |               | 1: Pulse train + rotation direction sign Positive logic  
|       |                                   |               |               | 2: A-phase pulse train + B-phase pulse train Positive logic  
|       |                                   |               |               | 3: Forward rotation pulse train + reverse rotation pulse train Positive logic  
|       |                                   |               |               | 4: Pulse train + rotation direction sign Negative logic  
|       |                                   |               |               | 5: A-phase pulse train + B-phase pulse train Negative logic  |
| 429   | Clear signal selection            | 1             | 0 to 1        | 0: Deviation counter is cleared at edge of turning ON of the clear signal (CLR) from OFF  
|       |                                   |               |               | 1: Deviation counter while the clear signal (CLR) is ON  |
| 430   | Pulse monitor selection           | 9999          | 0 to 5        | The status of various pulses during running are displayed.  
|       |                                   |               |               | 9999: Frequency monitor is displayed. |
(2) Pulse train form selection (PP, NP signal) [Pr. 428]
Command pulse can be changed according to the positioning unit as in the table below.

<table>
<thead>
<tr>
<th>Command Pulse Train Form</th>
<th>At Forward Rotation</th>
<th>At Reverse Rotation</th>
<th>Setting [Pr. 428]</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward rotation pulse train</td>
<td>0</td>
<td></td>
<td></td>
<td>(factory setting)</td>
</tr>
<tr>
<td>Reverse rotation pulse train</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulse train + rotation direction sign</td>
<td></td>
<td></td>
<td>1</td>
<td>QD75D (PLS/SIGN mode)</td>
</tr>
<tr>
<td>A phase pulse train</td>
<td></td>
<td></td>
<td>2</td>
<td>Counted after multiplying by four. Set the pulse train frequency multiplied by four to 500kpps or less with the differential driver type and to 200kpps or less with the open collector type.</td>
</tr>
<tr>
<td>B phase pulse train</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Forward rotation pulse train</td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Reverse rotation pulse train</td>
<td></td>
<td></td>
<td>5</td>
<td>Counted after being multiplied by four. Set the pulse train frequency multiplied by four to 500kpps or less with the differential driver type and to 200kpps or less with the open collector type.</td>
</tr>
</tbody>
</table>

(3) Interface of the positioning unit and inverter
When running the inverter by each positioning unit, interface of the positioning command pulse train need to be matched.

<table>
<thead>
<tr>
<th>Output Type</th>
<th>Hardware Configuration</th>
<th>Input Pulse Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open collector</td>
<td>Command unit — Connect externally — Inverter (FR-A7AL) — 2A</td>
<td>Max. 200kpps</td>
</tr>
<tr>
<td></td>
<td>* Wiring length : max. 2m</td>
<td></td>
</tr>
<tr>
<td>Differential line driver</td>
<td>Command unit — Do not connect — Inverter (FR-A7AL) — 2A</td>
<td>Max. 500kpps</td>
</tr>
<tr>
<td></td>
<td>* Wiring length : max. 10m</td>
<td></td>
</tr>
</tbody>
</table>
(4) Selection of clear signal (CLR signal) [Pr. 429]
Use this function to make a drooping pulse 0 for home position operation, etc.
When \([\text{Pr.} 429 = 0]\), the deviation counter is cleared at the edge of turning ON of the clear signal (CLR). The CLR signal turns ON in synchronization with the zero pulse signal of encoder for home position operation, etc. and clears the deviation counter.
When \([\text{Pr.} 429 = 1]\) (initial value), the deviation counter is cleared while the clear signal (CLR) is ON.
For the terminal used for CLR signal input, set 69 in any of [Pr. 178 to Pr. 189  Input terminal function selection] to assign the function.

(5) Pulse monitor selection [Pr. 430]
The status of various pulses during running are displayed.
Set \([\text{Pr.} 52 \ DU/PU main display data selection = 6]\) to display output frequency monitor.
Count the number of pulses when the servo is ON. The cumulative pulse value is cleared when the base is shut off or the clear signal (CLR) is turned ON.

2.11.5 Setting the electronic gear [Pr. 420, 421, 424] (A700)
Set the ratio of the machine side gear and the motor side gear.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>420</td>
<td>Command pulse scaling factor numerator</td>
<td>1</td>
<td>0 to 32767</td>
<td>Set the electric gear. ([\text{Pr.} 420]) is a numerator and ([\text{Pr.} 421]) is a denominator.</td>
</tr>
<tr>
<td>421</td>
<td>Command pulse scaling factor denominator</td>
<td>1</td>
<td>0 to 32767</td>
<td>Used when rotation is not smooth at a large electronic gear ratio (about 10 times or more) and low speed.</td>
</tr>
<tr>
<td>424</td>
<td>Position command acceleration/deceleration time constant numerator</td>
<td>0s</td>
<td>0 to 500s</td>
<td>Used when rotation is not smooth at a large electronic gear ratio (about 10 times or more) and low speed.</td>
</tr>
</tbody>
</table>

When the operation panel (FR-DU07) is used, the maximum setting is 9999. When a parameter unit is used, up to the maximum value within the setting range can be set.

(1) Calculation of the gear ratio [Pr. 420, 421]
The position resolution (travel per pulse \(\Delta f[\text{mm}]\)) is determined by the travel per motor revolution \(\Delta s[\text{mm}]\) and the feedback pulses \(PF[\text{pulse/rev}]\) of the detector, and is represented by the following expression.

\[
\Delta f = \Delta s \times PF
\]
Using the parameters, the travel per command pulse can be set separately to set the travel per command pulse without a fraction.

\[ \Delta \xi = \frac{\Delta \xi}{[Pr.420]} \]

In addition, the relationship between the motor speed and internal command pulse frequency is as follows:

\[ fo = \frac{No}{Pr.421} \]

where:
- \( fo \) = internal command pulse frequency [pps]
- \( No \) = motor speed [r/min]

Set the electronic gear in the range of 1/50 to 20. Note that too small a value will decrease the speed command and too large a value will increase the speed ripples.

### Setting example 1

The travel per pulse is \( \Delta \xi = 0.01 \) (mm) in a drive system where the ball screw pitch PB = 10 (mm) and the reduction ratio 1/n = 1 and the electronic gear ratio is \( \Delta \xi = 10 \) (mm) when the number of feedback pulses \( Pf = 4000 \) (pulses/rev). According to the following formula:

\[ \Delta \xi = \frac{PB}{[1/n]} \times \frac{[Pr.420]}{Pr.421} \]

\[ \Delta \xi = \frac{10}{1} \times \frac{4000}{4} \]

Therefore, set \( Pr.420 = 4, Pr.421 = 1 \).

### Setting example 2

Find the internal command pulse frequency of the dedicated motor rated speed. Note that the command pulse scaling factor \( [Pr.420] = 1 \). Assuming that the number of encoder pulses is 2048 (pulses/rev) (feedback pulse \( Pf = 2048 \times 4 \)),

\[ \frac{[Pr.420]}{Pr.421} = 204800 \]

Therefore, the internal command pulse frequency is \( 204800 \) (pps).

The relationship between position resolution \( \Delta \xi \) and overall accuracy is as follows. Since overall accuracy (positioning accuracy of machine) is the sum of electrical error and mechanical error, normally take measures to prevent the electrical system error from affecting the overall error. As a guideline, refer to the following relationship.

\[ \Delta \xi < (\frac{1}{100}) \times \Delta \xi \]

\( \Delta \xi \) : positioning accuracy

### Stopping characteristic of motor

When parameters are used to run the motor, the command pulse frequency and motor speed have the relationship as shown in the chart on page 308, and as the motor speed decreases, pulses are accumulated in the deviation counter of the inverter. These pulses are called droop pulses \( (\tau) \), and the relationship between command frequency \( (fo) \) and position loop gain \( (Kp: [Pr.422]) \) is as represented by the following formula.

\[ \tau = \frac{No}{Pr.422} \]

When the initial value of \( Kp \) is 25s\(^{-1} \), the droop pulses \( (\tau) \) are 8192 pulses.

Since the inverter has droop pulses during running, a stop settling time \( (ts) \) is needed from when the command has zeroed until the motor stops. Set the operation pattern in consideration of the stop settling time.

\[ ts = 3 \times \frac{1}{Pr.420} \] [s]

When the initial value of \( Kp \) is 25s\(^{-1} \), the stop settling time \( (ts) \) is 0.12s.

Positioning accuracy \( \Delta \xi \) is represented as the following formula.

\[ \Delta \xi = (5 \text{ to } 10) \times \frac{\Delta \xi}{[Pr.420]} \]

### (2) Position command acceleration/ deceleration time constant [Pr. 424]

When the electronic gear ratio is large (about 10 or more times) and the speed is low, rotation will not be smooth, resulting in pulse-wise rotation. At such a time, set this parameter to smooth the rotation. When acceleration/deceleration time cannot be provided for the command pulses, a sudden change in command pulse frequency may cause an overshoot or error excess alarm. At such a time, set this parameter to provide acceleration/deceleration time.

Normally set 0.
2.11.6 Setting of positioning adjustment parameter [Pr. 426, 427] (A700)

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>426</td>
<td>In-position width Y36</td>
<td>100 pulses</td>
<td>0 to 32767 pulses</td>
<td>When the number of droop pulses has fallen below the setting value, the in-position signal (Y36) turns ON.</td>
</tr>
<tr>
<td>427</td>
<td>Excessive level error Y36</td>
<td>40</td>
<td>0 to 400</td>
<td>A position error excessive (E.OD) occurs when the number of droop pulses exceeds the setting.</td>
</tr>
</tbody>
</table>

* When the operation panel (FR-DU07) is used, the maximum setting is 9999. When a parameter unit is used, up to the maximum value within the setting range can be set.

(1) In-position width [Pr. 426]

The Y36 signal acts as an in-position signal. When the number of droop pulses has fallen below the setting value, the in-position signal (Y36) turns ON. For the Y36 signal, assign the function by setting 36 (positive logic) or 136 (negative logic) in any of [Pr. 190 to 196 Output terminal function selection].

(2) Excessive level error [Pr. 427]

When droop pulses exceed the value set in [Pr. 427], position error becomes large, and a fault (E.OD) is displayed to stop the inverter. When you decrease the position loop gain [Pr. 422 Position loop gain] setting, increase the error excessive level setting. Also decrease the setting when you want to detect an error slightly earlier under large load.

When [Pr. 427 = 9999], position error large (E.OD) does not occur regardless of droop pulses.

2.11.7 Gain adjustment [Pr. 422, 423, 425] (A700)

Easy gain tuning is available as an easy tuning method. Refer to page 286 for easy gain tuning. If easy gain tuning does not produce any effect, make fine adjustment by using the following parameters.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>422</td>
<td>Position loop gain</td>
<td>25s⁻¹</td>
<td>0 to 150s⁻¹</td>
<td>Set the gain of the position loop.</td>
</tr>
<tr>
<td>423</td>
<td>Position feed forward</td>
<td>0%</td>
<td>0 to 100%</td>
<td>Function to cancel a delay caused by the droop pulses of the deviation counter.</td>
</tr>
<tr>
<td>425</td>
<td>Position feed forward command filter</td>
<td>0s</td>
<td>0 to 5s</td>
<td>Enters the primary delay filter in response to the feed forward command.</td>
</tr>
</tbody>
</table>

(1) Position loop gain [Pr. 422]

Make adjustment when any of unusual vibration, noise and overcurrent of the motor/machine occurs. Increasing the setting improves response for the position command and also improves servo rigidity at a stop, but oppositely makes an overshoot and vibration more liable to occur. Normally set this parameter within the range about 5 to 50.

<table>
<thead>
<tr>
<th>Phenomenon/Condition</th>
<th>Adjustment Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow response</td>
<td>Increase the [Pr. 422] setting by 3s⁻¹ until just before an overshoot or instable behavior such as stop-time vibration occurs, and set about 0.8 to 0.9 of that value.</td>
</tr>
<tr>
<td>Overshoot, stop-time vibration or other instable behavior occurs.</td>
<td>Decrease the [Pr. 422] setting by 3s⁻¹ until just before an overshoot or instable behavior such as stop-time vibration does not occur, and set about 0.8 to 0.9 of that value.</td>
</tr>
</tbody>
</table>

(2) Position feed forward gain [Pr. 423]

This function is designed to cancel a delay caused by the droop pulses of the deviation counter. When a tracking delay for command pulses poses a problem, increase the setting gradually and use this parameter within the range where an overshoot or vibration will not occur. This function has no effects on servo rigidity at a stop. Normally set this parameter to 0.
### 2.11.8 Troubleshooting (position control) (A700)

<table>
<thead>
<tr>
<th>Case</th>
<th>Cause</th>
<th>Countermeasures</th>
</tr>
</thead>
</table>
| 1 Motor does not rotate | (1) The phase sequence of the motor or encoder wiring is wrong.  
(2) [Pr. 800 The control mode selection] setting is improper.  
(3) The sensor ON signal or strobe end signal (STF, STR) is not input.  
(4) Command pulse, position pulse sign (NP) are not correctly input.  
(5) The [Pr. 419 Position command source selection] setting is not correct.  
(6) When the [Pr. 419 Position command source selection] setting is 0, the position feed amount [Pr. 465 to Pr. 494] settings are not correct. | (1) Check the wiring (Refer to page 86)  
(2) Check the [Pr. 800] setting. (Refer to page 252)  
(3) Check that the signals are input correctly.  
(4) Check that the command pulses are input correctly.  
(4)-1 Check that the command pulse form and [Pr. 428 Command pulse selection] setting.  
(4)-2 Check that the position pulse sign (NP) is assigned to the input terminal. (inverter pulse input)  
(5) Check the [Pr. 419 Position command source selection].  
(6) Check the position feed amount in [Pr. 465 to Pr. 494]. |
| 2 Position shift occurs | (1) The command pulses are not input correctly.  
(2) The command is affected by noise or the encoder feedback signal is compounded with noise. | (1)-1 Check the command pulse form and [Pr. 428 Command pulse selection] setting.  
(1)-2 Check that the command pulses are input correctly.  
(1)-3 Check that the position pulse sign (NP) is assigned to the input terminal. (inverter pulse input)  
(2)-1 Decrease [Pr. 72 PWM frequency selection].  
(2)-2 Change the earthing (grounding) point of shielded wire. Or leave the cable suspended. |
| 3 Motor or machine hunts | (1) The position loop gain is high.  
(2) The speed loop gain is high. | (1) Decrease [Pr. 4235].  
(2)-1 Perform easy gain tuning.  
(2)-2 Decrease [Pr. 4230] and increase [Pr. 4232]. |
| 4 Machine operation is unstable | (1) The acceleration/deceleration time setting has adverse effect. | (1) Decreased the [Pr. 7, Pr. 8] value. |
(1) Position control is not performed correctly

- **Motor or machine is hunting.**
  - **Y**
    - Pr. 422 Position loop gain is high.
    - Decrease \[ \text{Pr. 422 Position loop gain} \].
    - Perform easy gain tuning. The speed control gain is high. Decrease \[ \text{Pr. 820 Speed control P gain 1} \].
  - **N**
    - Incorrect excitation ratio.
    - Increase \[ \text{Pr. 854 Excitation ratio} \].
    - Machine operation is unstable.
    - Please contact your sales representative.

- **Position shift occurs.**
  - **N**
    - Have you made the electronic gear settings?
      - **Y**
        - Pr. 420, 421 electronic gear is set.
        - Set the electronic gear.
        - Do not turn OFF the forward (reverse) rotation stroke end signal before completion of positioning.
      - **N**
        - Pr. 422 Position loop gain is high.
        - Perform easy gain tuning. The speed control gain is high. Decrease \[ \text{Pr. 822 Speed control P gain 2} \].
        - Decrease \[ \text{Pr. 422 Position loop gain} \].
        - No rotation stroke end signal.
  - **Y**
    - Motor or machine is not operating correctly.
      - Have you checked the speed control items?
        - **Y**
          - Normal operation.
          - Please contact your sales representative.
        - **N**
          - Insufficient torque.
            - Increase \[ \text{Pr. 854 Excitation ratio} \].
            - Check the speed control measures.

- **Position control is not performed correctly**
  - **Y**
    - Speed command under position control is affected by the speed control.
    - Have you checked the speed control items?
      - **Y**
        - Normal operation.
        - Please contact your sales representative.
      - **N**
        - Insufficient torque.
          - Increase \[ \text{Pr. 854 Excitation ratio} \].
          - Check the speed control measures.


2.12 Adjustment of Real sensorless vector control, vector control

2.12.1 Bias and gain of torque (magnetic flux) setting voltage (current)  
[Pr. 241, C16 to C19 (Pr. 919, 920), C34 to C37 (Pr. 928, 929), C38 to C41 (Pr. 932, 933)] (A700)

You can set the magnitude (slope) of the torque as desired in relation to the torque setting signal (0 to 5VDC, 0 to 10V or 4 to 20mA). Set [Pr. 77, Pr. 267] to switch between 0 to 5VDC, 0 to 10VDC and 4 to 20mA. (Refer to page 217) In the initial setting status, terminal 1 and terminal 4 used for analog input are respectively set to speed setting auxiliary (speed limit auxiliary) and speed command (speed limit). To use an analog input terminal as torque command, torque limit, and magnetic flux input, set [Pr. 368 Terminal 1 function assignment] and [Pr. 448 Terminal 4 function assignment] to change functions. (Refer to page 46) Magnetic flux is valid only during vector control.

To use terminal 6 of FR-A7AZ for torque command or torque limit, set [Pr. 406 High resolution analog input selection] and change the function. (Refer to page 46)

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>241*</td>
<td>Analog input display unit switchover</td>
<td>0</td>
<td>0</td>
<td>Displays in % (Display in V/mA) Selects the unit for analog input display.</td>
</tr>
<tr>
<td>C16(919)</td>
<td>Terminal 1 bias command (torque/magnetic flux)</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) on the bias side of terminal 1 input.</td>
</tr>
<tr>
<td>C17(919)</td>
<td>Terminal 1 bias (torque/magnetic flux)</td>
<td>0%</td>
<td>0 to 300%</td>
<td>Set the converted % of the bias side voltage of terminal 1 input.</td>
</tr>
<tr>
<td>C18(920)</td>
<td>Terminal 1 gain command (torque/magnetic flux)</td>
<td>150%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) of the terminal 1 input gain (maximum).</td>
</tr>
<tr>
<td>C19(920)</td>
<td>Terminal 1 gain (torque/magnetic flux)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Set the converted % of the gain side voltage of terminal 1 input.</td>
</tr>
<tr>
<td>C34(928)</td>
<td>Terminal 6 bias command (torque/magnetic flux)</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) on the bias side of terminal 6 input.</td>
</tr>
<tr>
<td>C35(928)</td>
<td>Terminal 6 bias (torque/magnetic flux)</td>
<td>0%</td>
<td>0 to 300%</td>
<td>Set the converted % of the bias side voltage of terminal 6 input.</td>
</tr>
<tr>
<td>C36(929)</td>
<td>Terminal 6 gain command (torque/magnetic flux)</td>
<td>150%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) of the terminal 6 input gain (maximum).</td>
</tr>
<tr>
<td>C37(929)</td>
<td>Terminal 6 gain (torque/magnetic flux)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Set the converted % of the gain side voltage of terminal 6 input.</td>
</tr>
<tr>
<td>C38(932)</td>
<td>Terminal 4 bias command (torque/magnetic flux)</td>
<td>0%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) on the bias side of terminal 4 input.</td>
</tr>
<tr>
<td>C39(932)</td>
<td>Terminal 4 bias (torque/magnetic flux)</td>
<td>20%</td>
<td>0 to 300%</td>
<td>Set the converted % of the bias side current (voltage) of terminal 4 input.</td>
</tr>
<tr>
<td>C40(932)</td>
<td>Terminal 4 gain command (torque/magnetic flux)</td>
<td>150%</td>
<td>0 to 400%</td>
<td>Set the torque (magnetic flux) of the terminal 4 input gain (maximum).</td>
</tr>
<tr>
<td>C41(932)</td>
<td>Terminal 4 gain (torque/magnetic flux)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Set the converted % of the gain side current (voltage) of terminal 4 input.</td>
</tr>
</tbody>
</table>

* The above parameters allow for setting to be changed during operation in any operation mode even if "0" (initial value) is set in [Pr. 77 Parameter write selection].
### (1) The relationship between analog input terminal and calibration parameter

#### Terminal 1 functional calibration parameter

<table>
<thead>
<tr>
<th>[Pr. #] Setting</th>
<th>Terminal Function</th>
<th>Calibration Parameters</th>
<th>Bias setting</th>
<th>Gain setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Frequency (speed) indication speed limit</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Magnet frequency</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level */ Torque limit</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
</tbody>
</table>

---

### Terminal 4 functional calibration parameter

<table>
<thead>
<tr>
<th>[Pr. #] Setting</th>
<th>Terminal Function</th>
<th>Calibration Parameters</th>
<th>Bias setting</th>
<th>Gain setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Frequency (speed) indication speed limit</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Magnet frequency</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level /* Torque limit</td>
<td>C39 (Pr. 932) Terminal 6 gain (torque/magnetic flux)</td>
<td>C37 (Pr. 929) Terminal 6 gain command (torque/magnetic flux)</td>
<td>C41 (Pr. 933) Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
</tbody>
</table>

---

### Terminal 6 (FR-A7AZ) functional calibration parameter

<table>
<thead>
<tr>
<th>[Pr. #] Setting</th>
<th>Terminal Function</th>
<th>Calibration Parameters</th>
<th>Bias setting</th>
<th>Gain setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Speed command / speed limit</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>Regenerative torque limit</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>Torque command</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>Magnet frequency</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level */ Torque limit</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>Stall prevention level */ Torque limit</td>
<td>C8 (Pr. 905) Terminal 4 frequency setting bias</td>
<td>C6 (Pr. 904) Terminal 4 frequency setting frequency</td>
<td>C7 (Pr. 905) Terminal 4 frequency setting gain</td>
</tr>
<tr>
<td></td>
<td>——</td>
<td>——</td>
<td>——</td>
<td>——</td>
</tr>
</tbody>
</table>

---

* Use [Pr. 148 Stall prevention level at 0V input] and [Pr. 149 Stall prevention level at 10V input] to adjust bias/gain of stall prevention operation level.

* Use [Pr. 148 Stall prevention level at 0V input] and [Pr. 149 Stall prevention level at 10V input] to adjust bias/gain of stall prevention operation level.
(2) Change the torque at maximum analog input [C18 (Pr. 920), C36 (Pr. 929), C40 (Pr. 933)]

Set [C18 (Pr. 920), C36 (Pr. 929), C40 (Pr. 933)] when changing only torque setting (gain) of the maximum analog input voltage (current).

(3) Analog input bias/gain calibration [C16 to C19 (Pr. 919, 920), C34 to C37 (Pr. 928, 929), C38 to C41 (Pr. 932, 933)]

The "bias" and "gain" functions are used to adjust the relationship between the input signal entered from outside the inverter to set the torque command and torque limit, e.g. 0 to 5VDC, 0 to 10VDC or 4 to 20mADC, and the torque.

Set the bias torque of the terminal 1 input using [C16 (Pr. 919)]. (It is initial value to the torque at 0V)

Set the torque in [C18 (Pr. 920)] for the torque command voltage set with [Pr. 73 Analog input selection] (Initial value is 10V)

Set the bias torque of the terminal 4 input using [C38 (Pr. 932)]. (It is initial value to the torque at 4mA)

Set the torque in [C40 (Pr. 933)] for 20mA of the torque command current (4 to 20mA).

When the voltage/current input specifications were changed using [Pr. 73 and 267], be sure to make calibration.

(4) Analog input display unit switchover [Pr. 241]

You can change the analog input display unit (%/V/mA) for analog input bias/gain calibration.

Depending on the terminal input specification set in [Pr. 73] and [Pr. 267], the display units of [C17 (Pr. 919), C19 (Pr. 920), C39 (Pr. 932)] and [C41 (Pr. 933)] change as shown below.
2.12.2 Response level of analog input and noise elimination [Pr. 822, 826, 832, 836]

You can adjust response level and stability of frequency command and torque command at analog input (terminal 1, 2, 4, terminal 6 (FR-A7AZ))

### Table: Response level of analog input and noise elimination

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>822</td>
<td>Speed setting filter 1</td>
<td>9999</td>
<td>0 to 5s</td>
<td>Set the time constant of the primary delay filter relative to the external speed command (analog input command)</td>
</tr>
<tr>
<td>826</td>
<td>Torque setting filter 1</td>
<td>9999</td>
<td>0 to 5s</td>
<td>Set the time constant of the primary delay filter relative to the external torque command (analog input command)</td>
</tr>
<tr>
<td>832</td>
<td>Speed setting filter 2</td>
<td>9999</td>
<td>0 to 5s, 9999</td>
<td>Second function of [Pr. 822] (valid when RT signal is ON)</td>
</tr>
<tr>
<td>836</td>
<td>Torque setting filter 2</td>
<td>9999</td>
<td>0 to 5s, 9999</td>
<td>Second function of [Pr. 826] (valid when RT signal is ON)</td>
</tr>
</tbody>
</table>

(1) **Time constant of analog speed command input [Pr. 822, 832]**

Set the time constant of the primary delay filter relative to the external speed command (analog input command) using [Pr. 822 Speed setting filter 1].

Set a large time constant when you want to delay the tracking of the speed command, when the analog input voltage fluctuates, etc.

When you want to change time constant when switching multiple motors with one inverter, etc., use the [Pr. 832 Speed setting filter 2].

[Pr. 832 Speed setting filter 2] is valid when the RT signal turns ON.

(2) **Time constant of analog torque input [Pr. 826, 836]**

Set the time constant of the primary delay filter relative to the external torque command (analog input command) using [Pr. 826 Torque setting filter 1] during Real sensorless vector control.

Set a large time constant value when you want to delay the tracking of the torque command, when the analog input voltage fluctuates, etc.

When you want to change time constant when switching between two motors with one inverter, etc., use [Pr. 836 Torque setting filter 2].

[Pr. 836 Torque setting filter 2] is valid when the RT signal turns ON.
2.12.3 Speed detection filter and torque detection filter [Pr. 823, 827, 833, 837] (A700)

Set the time constant of the primary delay filter relative to the speed feedback signal and torque feedback signal. Since this function reduces the speed loop response, use it with the initial value.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>823</td>
<td>Speed detection filter 1</td>
<td>0.001 s</td>
<td>0 to 0.1 s</td>
<td>Set the time constant of the primary delay filter relative to the speed feedback signal.</td>
</tr>
<tr>
<td>827</td>
<td>Torque detection filter 1</td>
<td>0 s</td>
<td>0 to 0.1 s</td>
<td>Set the time constant of the primary delay filter relative to the torque feedback signal.</td>
</tr>
<tr>
<td>833</td>
<td>Speed detection filter 2</td>
<td>0</td>
<td>0 to 0.1 s</td>
<td>Second function of [Pr. 823] (valid when RT signal is ON)</td>
</tr>
<tr>
<td>837</td>
<td>Torque detection filter 2</td>
<td>0</td>
<td>0 to 0.1 s</td>
<td>Second function of [Pr. 827] (valid when RT signal is ON)</td>
</tr>
</tbody>
</table>

1) Stabilize speed detection [Pr. 823, 833]
Since the speed loop response reduces, use it with the initial value.
Increase the setting value gradually and adjust the value to stabilize the speed when speed ripples occur due to high frequency disturbance, etc. A too large value will run the motor unstably.
Speed detection filter is valid only during vector control.

2) Stabilize the torque detection [Pr. 827, 837]
Since the current loop response reduces, use it with the initial value.
Increase the setting value gradually and adjust the value to stabilize the speed when torque ripples occur due to high frequency disturbance, etc. A too large value will run the motor unstably.

3) Use multiple primary delay filters
Use [Pr. 833 and 837] to change the filter according to applications. [Pr. 833 and 837] are valid when the RT signal is ON. Other second function is also valid.

2.12.4 Excitation ratio [Pr. 854] (A700)

Decrease the excitation ratio when you want to improve efficiency under light load. (Motor magnetic noise decreases.)

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>854</td>
<td>Excitation ratio</td>
<td>100%</td>
<td>0 to 100%</td>
<td>Set the excitation ratio under no load.</td>
</tr>
</tbody>
</table>

Note that the rise of output torque becomes slow if excitation ratio is decreased.
This function is appropriate for applications as machine tools which repeat rapid acceleration/deceleration up to high speed.
When 1 (magnetic flux with terminal) is set in [Pr. 834 Terminal 4 function assignment] or [Pr. 844 Terminal 1 function assignment], the [Pr. 854] setting is invalid.
2.12.5 Pre-excitation (zero speed control, servo lock) [Pr. 10, 11, 802, 850] (A700)

When the start signal (STF, STR) is not input to the inverter (during a stop), turning ON the pre-excitation signal LX enables 0 speed control or servo lock.

At deceleration to stop, either zero speed control or stop with servo lock is selectable even if pre-excitation signal LX is not input.

Zero speed control can be selected during Real sensorless vector control and either zero speed control or servo lock can be selected under vector control.

In DC injection brake operation, DC voltage is directly applied to the motor to prevent the motor shaft from rotating. In zero speed control, vector control is performed to maintain 0r/min. In either control, the motor will not return to the original position if the motor shaft rotates due to external force.

The motor shaft position is maintained with servo rock. The motor will return to the original position if the motor shaft rotates due to external force.

### Table: Parameter Setting

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>DC injection brake operation frequency</td>
<td>3Hz</td>
<td>0 to 12Hz</td>
<td>Set the operation frequency of the DC injection brake (zero speed control, servo lock).</td>
</tr>
<tr>
<td>11</td>
<td>DC injection brake operation time</td>
<td>0.5s</td>
<td>0.1 to 10s</td>
<td>Set the operation time of the DC injection brake (zero speed control, servo lock).</td>
</tr>
<tr>
<td>802</td>
<td>Pre-excitation selection (FF, FC)</td>
<td>0</td>
<td>0</td>
<td>Without DC injection brake (zero speed control, servo lock).</td>
</tr>
<tr>
<td>850</td>
<td>Brake operation selection</td>
<td>0</td>
<td>0</td>
<td>DC injection brake operation.</td>
</tr>
</tbody>
</table>

### Control block diagram

![Control block diagram](image)

### Operation

When the LX signal is turned ON under Real sensorless vector control or vector control, pre-excitation (zero speed control, servo lock) is performed during a stop.

For the terminal used for LX signal input, set 23 in any of [Pr. 178 to 189] to assign the function.

Performing pre-excitation (LX signal and X13 signal) under torque control (Real sensorless vector control) may start the motor running at a low speed even when the start command (STF or STR) is not input. The motor may run also at a low speed when the speed limit value = 0 with a start command input. Perform pre-excitation after making sure that there will be no problem in safety if the motor runs.

Although FWD/REV of the operation panel is not lit during pre-excitation, note that voltage is applied to the motor.
(3) Brake operation selection [Pr. 850] during Real sensorless vector control
You can select DC injection brake (initial value) or zero speed control for brake operation during Real sensorless vector control.
When [Pr. 850 = 1], zero speed control is exercised when the frequency reaches or decreases below the frequency set in [Pr. 10].
When the X13 signal is ON with [Pr. 11 = 8888] under Real sensorless vector control, zero speed control is activated regardless of the setting of [Pr. 850 Brake operation selection].
When restarting from brake operation during Real sensorless vector control, set [Pr. 850 = 1] (zero speed control). When the setting value is 0 (DC injection brake), it may take about 2s until frequency is actually output from when the start command is input.

(4) Brake operation selection under vector control [Pr. 802]
When pre-excitation is performed, select zero speed control or servo lock using [Pr. 802].

<table>
<thead>
<tr>
<th>Pr. 802 setting</th>
<th>Pre-excitation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Zero speed control</td>
<td>Even under load, an attempt is made to maintain 0r/min to keep the motor shaft stopped. Note that if the shaft is overcome and turned by external force, it does not return to the original position. Position control is not exercised and only speed control is carried out to perform operation.</td>
</tr>
<tr>
<td>1</td>
<td>Servo lock</td>
<td>Even under load, an attempt is made to maintain the motor shaft position. Note that if the shaft is turned by external force, it returns to the original position after the external force has gone away. Since position control is exercised, you can adjust this position loop gain using [Pr. 422 Position loop gain].</td>
</tr>
</tbody>
</table>

(5) Operation frequency setting [Pr. 10].
After the frequency at which the DC injection brake (zero speed control, servo lock) will be operated is set to [Pr. 10], the DC voltage is applied (zero speed control, servo lock) to the motor when this frequency is reached during deceleration.
At [Pr. 10 = 9999], DC injection brake (zero speed control, servo lock) is operated when the speed has decreased to the frequency set in [Pr. 13 Start frequency].
Performing pre-excitation (zero speed control) under Real sensorless vector may cause motor vibration, etc. at deceleration to stop. To prevent this, set [Pr. 10 DC injection brake operation frequency] to 0.5Hz or less.
The initial value of [Pr. 10] automatically changes to 0.5Hz during vector control.

(6) Operation time setting (X13 signal) [Pr. 11]
Use [Pr. 11] to set the duration period the DC injection brake (zero speed control, servo lock) is applied.
When the motor does not stop due to large inertia (J), increasing the setting produces an effect.
When [Pr. 11 = 0s], DC injection brake (zero speed control, servo lock) will not operate. (At a stop, the motor coasts.)
When [Pr. 11 = 8888], the DC injection brake (zero speed control, servo lock) will operate when the X13 signal is turned ON. Turning the X13 signal ON during operation will operate DC injection brake (zero speed control, servo lock).
For the terminal used for the X13 signal input, set 13 in any of [Pr. 178 to 189] to assign the function.
When the X13 signal is ON with [Pr. 11 = 8888] under Real sensorless vector control, zero speed control is activated regardless of the setting of [Pr. 850 Brake operation selection].
Under vector control, zero speed control or servo lock is activated according to the [Pr. 802] setting.

When [Pr. 11 = 8888]

![Diagram](image-url)
<table>
<thead>
<tr>
<th>Control Method</th>
<th>Control Mode</th>
<th>[Pr. 820]</th>
<th>[Pr. 818]</th>
<th>Decelerate to Stop</th>
<th>LX-ON</th>
<th>[Pr. 6 = 8888]</th>
</tr>
</thead>
<tbody>
<tr>
<td>V/F control</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>DC injection brake</td>
<td>—</td>
<td>DC injection brake</td>
</tr>
<tr>
<td>Advanced magnetic flux vector control</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>DC injection brake</td>
<td>—</td>
<td>DC injection brake</td>
</tr>
<tr>
<td>Real sensorless vector control</td>
<td>Speed</td>
<td>—</td>
<td>0</td>
<td>DC injection brake</td>
<td>Zero speed</td>
<td>Zero speed</td>
</tr>
<tr>
<td></td>
<td>Torque</td>
<td>—</td>
<td>0</td>
<td>DC injection brake</td>
<td>Zero speed</td>
<td>Zero speed</td>
</tr>
<tr>
<td>Vector control</td>
<td>Speed</td>
<td>0</td>
<td>—</td>
<td>Zero speed</td>
<td>—</td>
<td>Zero speed</td>
</tr>
<tr>
<td></td>
<td>Torque</td>
<td>—</td>
<td>—</td>
<td>Zero speed</td>
<td>—</td>
<td>Zero speed</td>
</tr>
<tr>
<td></td>
<td>Position</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>
2.13 Selection of DC injection brake and regenerative brake

2.13.1 DC injection brake [Pr. 10 to 12] (common)

DC injection brake operation is a braking operation which prevents the motor shaft from rotating by directly applying DC voltage to the motor. When decelerating, the motor run by the inverter to stop, DC injection brake at 3Hz or less is applied. Operation time of this DC injection brake and braking torque (DC injection brake voltage) can be adjusted. In addition, DC injection brake operation frequency can be adjusted. Refer to page 325 for brake operation during Real sensorless vector control and vector control.

### Parameter Table

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>DC injection brake</td>
<td>3Hz</td>
<td>0 to 120Hz</td>
<td>Set the operation frequency of the DC injection brake (zero speed control, servo lock).</td>
<td>A700, F700, E700</td>
</tr>
<tr>
<td></td>
<td>operation frequency</td>
<td>9999</td>
<td></td>
<td>Operated at [Pr. 13] or less</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>DC injection brake</td>
<td>0.5s</td>
<td></td>
<td>0.1 to 10s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>operation time</td>
<td>0</td>
<td></td>
<td>Without DC injection brake (zero speed control, servo lock)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8888</td>
<td></td>
<td>Operates when X13 signal is ON</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>DC injection brake</td>
<td>0.1K, 0.2K</td>
<td>0 to 30%</td>
<td>Set the DC injection brake voltage (torque). When 0 is set, DC injection brake is disabled.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>operation voltage</td>
<td>0 to 30%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.4K to 7.5K</td>
<td>2%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11K to 55K</td>
<td>4%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>75K or more</td>
<td>6%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### (1) Operation frequency setting [Pr. 10]
When the DC injection operating frequency is set to [Pr. 11] and the output frequency reaches to the set frequency during deceleration, the DC voltage is applied to the motor. When the output frequency decreases to the set frequency of [Pr.13 Starting frequency] while [Pr.10 = 9999] in A700, F700, DC voltage applies to the motor.

#### (2) Operation time setting (X13 signal) [Pr. 11]
In [Pr. 11], set the operation time of the DC injection brake. When the motor does not stop due to inertia, setting produces an effect. When [Pr. 11 = 0], the DC injection brake is disabled. (At a stop, the motor coast.) For (A700), turning ON the X13 signal when [Pr. 11 = 8888] starts DC injection brake. Turning ON the X13 signal starts DC injection brake even during inverter operation. For the terminal used for the X13 signal input, set 13 in any of [Pr. 178 to 189] to assign the function.

When the X13 signal is ON with [Pr. 11 = 8888] under Real sensorless vector control, zero speed control is activated regardless of the setting of [Pr. 850 Brake operation selection]. (Refer to page 325)
(3) Operation voltage (torque) setting [Pr. 12]

Use [Pr. 12] to set the percentage to the power supply voltage. (For this parameter is not used during zero speed control or servo lock.)

When [Pr. 12 = 0%], the DC injection brake is disabled. (At a stop, the motor coasts.)

Even [Pr. 12] setting is set larger, braking torque is limited so that output current is within the inverter rated current.

When using the constant-torque motor (SF-JRCA) and energy saving motor (SF-HR, SF-HRCA), change the [Pr. 12] setting as follows:

For the 5.5K, 7.5K, when the [Pr. 12] setting is the following, changing the [Pr. 71 Applied motor] setting automatically changes the [Pr. 12] setting. Therefore, it is not necessary to change the [Pr. 12] setting.

<table>
<thead>
<tr>
<th>[Pr. 71] Setting</th>
<th>Standard Motor (Initial Value)</th>
<th>Constant-torque Motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.1K, 0.2K</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>0.4K to 3.7K</td>
<td>4%</td>
<td>4%</td>
</tr>
<tr>
<td>5.5K, 7.5K</td>
<td>4%</td>
<td>2%</td>
</tr>
<tr>
<td>11K to 55K</td>
<td>2%</td>
<td>2%</td>
</tr>
<tr>
<td>75K or more</td>
<td>1%</td>
<td>1%</td>
</tr>
</tbody>
</table>

SF-JRCA: 3.7K or less ...4%, 5.5K to 55K ...2%
SF-HR, SF-HRCA: 3.7K or less ...4%, 5.5K, 7.5K ...3%, 11K to 55K ...2% (30K...1.5%)
2.13.2 Stop selection, start signal selection [Pr. 250]  

-used to select the stopping method (deceleration to a stop or coasting) when the start signal turns OFF. Used to stop the motor with a mechanical brake, etc., together with switching OFF of the start signal.

- You can also select the operations of the start signals (STF/STR).

Stop selection is invalid when the following functions are activated:

- Position control ([Pr. 249] = 0)
- Power failure stop function ([Pr. 261])
- PU stop ([Pr. 71])
- Deceleration stop because of fault definition ([Pr. 277])
- Deceleration stop because of communication fault ([Pr. 503])
- JOG operation mode
- Offline auto tuning (with motor running)
- Emergency stop by LonWorks communication

### Table 2.13.2 Stop selection, start signal selection

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Stop operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>Stop selection</td>
<td>9999</td>
<td>0 to 100s</td>
<td>STF signal: Forward rotation start  STR signal: Reverse rotation start</td>
<td>The motor is coasted to a stop when the preset time elapses after the start signal is turned OFF.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1000s to 1100s</td>
<td>STR signal: Start signal  STF signal: Forward/reverse signal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td></td>
<td>STR signal: Forward rotation start</td>
<td>When the start signal is turned OFF, the motor decelerates to stop.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8888</td>
<td></td>
<td>STR signal: Start signal  STR signal: Forward/reverse signal</td>
<td>The motor is coasted to a stop after the preset time elapses after the start signal is turned OFF.</td>
</tr>
</tbody>
</table>

1) Decelerate the motor to a stop

Set [Pr. 250 = 9999 or 8888].

The motor decelerates to a stop when the start signal (STF/STR) turns OFF.

2) Coast the motor to a stop

In [Pr. 250], set the time from when the start signal turns OFF until the output is shut off. When any of 1000 to 1100 is set, the output is shut off after the preset time has elapsed after the start signal had turned OFF. The motor coasts to a stop.

Motor accelerates/decelerates according to the frequency command until output is stopped by start signal OFF. To maintain the output frequency until output is stopped by start signal OFF, do not turn OFF the frequency signal and keep it ON.

The RUN signal turns OFF when the output stops.
When making frequent starts/stops, use the optional high-duty brake resistor (FR-ABR), brake unit (FR-BU2, BU, FR- BU, MT-BU) to increase the regenerative brake duty. Use a power regeneration common converter (FR-CV) or power regeneration converter (MT-RC) for continuous operation in regeneration status.

Use a high power factor converter (FR-HC, MT-HC) to reduce harmonics, improve the power factor, or continuously use the regeneration mode. In addition, either DC feeding mode 1 in which operation is performed with DC power (terminal P, N) or DC feeding mode 2 in which operation is performed normally with the AC power (terminal R, S, T) and performed with DC power such as battery at occurrence of power failure can be selected.

### Table: Regenerative Function Selection [Pr. 30, 70] (common)

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Regenerative function selection</td>
<td>0</td>
<td></td>
<td>Built-in brake resistor, without regeneration function, brake unit (FR-BU2, BU, BU type)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>P, N</td>
<td>DC feeding mode 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>20</td>
<td>20</td>
<td>R, S, T, N</td>
<td>DC feeding mode 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>11</td>
<td>P, N</td>
<td>Power regeneration converter (MT-RC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>21</td>
<td>21</td>
<td>R, S, T, N</td>
<td>DC feeding mode 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>High power factor converter (FR-HC, MT-HC), Power regeneration common converter (FR-CV)</td>
<td></td>
<td>P, N</td>
<td></td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>Special regenerative brake duty</td>
<td>0%</td>
<td>0% to 10% or more</td>
<td>Set the %ED of the transistor operation when using a built-in brake resistor and brake unit (MT-BU5).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>10</td>
<td>Vertically less than or more than 10%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table: Special Regenerative Brake Duty [Pr. 30, 70] (common)

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>Regenerative function selection</td>
<td>0</td>
<td></td>
<td>Without regenerative function, Brake resistor (MRS type), Brake unit (FR-BU)</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>1</td>
<td>High duty brake resistor (FR-ABR)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
<td>High power factor converter (FR-HC) when automatic restart after instantaneous power failure is selected</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>Special regenerative brake duty</td>
<td>0%</td>
<td>0 to 10%</td>
<td>Brake duty when using the high duty brake resistor (FR-ABR)</td>
</tr>
</tbody>
</table>
(1) When using a built-in brake resistor

Set \( [Pr. 30] = 0, 10, 20 \). The \( [Pr. 70] \) setting is invalid. At this time, the regenerative brake duty is as follows. The built-in brake resistor is provided for the 7.5K or less.

<table>
<thead>
<tr>
<th>Inverter type</th>
<th>Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-A720-0.4K to 3.7K</td>
<td>3%</td>
</tr>
<tr>
<td>FR-A720-5.5K to 7.5K</td>
<td>2%</td>
</tr>
<tr>
<td>FR-A740-0.4K to 7.5K</td>
<td>2%</td>
</tr>
<tr>
<td>Other than above (without built-in brake resistor)</td>
<td>0%</td>
</tr>
</tbody>
</table>

A700 F700 E700 D700

(2) When using brake resistor (MRS type) \( [Pr. 30] = 0 \). \( [Pr. 70] \) setting becomes invalid. At this time, the regenerative brake duty is as follows.

<table>
<thead>
<tr>
<th>Inverter type</th>
<th>Duty</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-E720-2.3K to 3.7K</td>
<td>3%</td>
</tr>
<tr>
<td>FR-E720-5.5K to 15K</td>
<td>2%</td>
</tr>
<tr>
<td>FR-E740-0.4K to 15K</td>
<td>2%</td>
</tr>
</tbody>
</table>

(3) When using brake resistor (MYS type)

MYS type brake resistor is available for 200V class 3.7K. At this time, set \( [Pr. 30] = 1 \), \( [Pr. 70] = 6\% \).

(4) When using the high-duty brake resistor (FR-ABR) (22K or less)

Set \( [Pr. 30] = 2 \). \( [Pr. 70] \) setting is invalid. Assign inverter operation enable signal (X10) to contact input terminal. Shut off the inverter output by the inverter operation enable signal (X10) to make protective coordination with FR-HC and FR-CV. Input RDY signal of FR-HC (RDYB signal of FR-CV).

For the terminal to input X10 signal, assign the function by setting “10 (X10)” to any of \( [Pr. 178 to 184] \) to assign the function.

(5) When the brake unit (FR-BU2, BU, FR-BU) is used.

Set \( [Pr. 30] = 0, 10, 20 \). The \( [Pr. 70] \) setting is invalid.

(6) When using the brake unit (MT-BU5) or power regeneration converter (MT-RC) (75K or more)

Set \( [Pr. 30] = 2 \). \( [Pr. 70] \) setting is invalid. Assign inverter operation enable signal (X10) to contact input terminal. Shut off the inverter output by the inverter operation enable signal (X10) to make protective coordination with FR-HC and FR-CV. Input RDY signal of FR-HC (RDYB signal of FR-CV). For the terminal to input X10 signal, assign the function by setting “10 (X10)” to any of \( [Pr. 178 to 184] \) to assign the function.

(7) When using the high power factor converter (FR-HC, MT-HC) or power regeneration common converter (FR-CV)

Set \( [Pr. 30] = 1, 11, 21 \). \( [Pr. 70] \) setting is invalid. Also built-in brake transistor is invalid. Changing the setting to \( [Pr. 30] = 2 \) causes inverter reset and “Err” to be displayed on the operation panel.

Use any of \( [Pr. 178 to 189 \ input terminal function assignment] \) to assign the following signals to the contact input terminals.

(a) X10 signal: FR-HC, MT-HC connection, FR-CV connection (inverter operation enable signal)

To make protective coordination with the FR-HC, MT-HC or FR-CV, use the inverter operation enable signal to shut off the inverter output. Input the RDY signal of the FR-HC, MT-HC (RDYB signal of the FR-CV).

(b) X11 signal: FR-HC, MT-HC connection (instantaneous power failure detection signal)

When the setting has been made to hold the mode at occurrence of an instantaneous power failure for RS-485 communication operation, use this signal to hold the mode.

Input the Y1 or Y2 signal (instantaneous power failure detection signal) of the FR-HC, MT-HC. For the terminal used for the X10, X11 signal input, set 10 and 11 in any of \( [Pr. 178 to 189] \) to assign the function.

(8) When using power regeneration common converter (FR-CV), high power factor converter (FR-HC) \( [Pr. 30] = 0 \). \( [Pr. 70] \) setting is invalid. Assign inverter operation enable signal (X10) to contact input terminal. Shut off the inverter output by the inverter operation enable signal (X10) to make protective coordination with FR-HC and FR-CV. Input RDY signal of FR-HC (RDYB signal of FR-CV). For the terminal to input X10 signal, assign the function by setting “10 (X10)” to any of \( [Pr. 178 to 184] \) to assign the function.

(9) When automatic restart after instantaneous power failure function is valid while using high power factor converter (FR-HC) \( [Pr. 57 = \neq 9999] \) in FR-HC and inverter, set \( [Pr. 30] = 2 \). Set \( [Pr. 70] = 0\% \) (initial value). RDY signal turns ON if FR-HC detects power failure during inverter operation, and motor coasts. If RDY signal is turned OFF after power is restored, inverter detects motor speed (depending on the \( [Pr. 162 \ automatic restart after instantaneous power failure selection] \) setting) and restarts after instantaneous power failure. Changing the setting to \( [Pr. 30] = 2 \) causes inverter reset and “Err” to be displayed on the operation panel.
(10) DC feeding mode 1 \([\text{Pr. 30 = 10, 11}]\)

Setting \([\text{Pr. 30 = 10, 11}]\) enables DC power supply operation. Built-in brake transistor control is valid. Leave the AC power supply connection terminals \(R/L1, S/L2,\) and \(T/L3\) open and connect the DC power supply to terminals \(P/+\) and \(N/-\). Also, remove jumpers across terminals \(R/L1\) and \(R/L11\) and across terminals \(S/L2\) and \(S/L21\). And connect terminals \(R/L11\) and \(S/L21\) to terminal \(P/+\) and \(N/-\). The diagram below is an example connection.

(11) DC feeding mode 2 \([\text{Pr. 30 = 20, 21}]\)

When \([\text{Pr. 30 = 20, 21}]\), operation is performed with AC power normally and with DC power such as battery at power failure. Built-in brake transistor control is valid. Connect the AC power supply to terminal \(R/L1, S/L2,\) and \(T/L3\) and connect the DC power supply to terminal \(P/+\) and \(N/-\). Also, remove jumpers across terminal \(R/L1\) and \(R/L11\) and across terminal \(S/L2\) and \(S/L21\). And connect terminals \(R/L11\) and \(S/L21\) to terminal \(P/+\) and \(N/-\). Turning ON the DC feeding operation permission signal \((X70)\) enables DC power supply operation. The following shows the connection diagram when switching to a DC power using inverter power failure detection.
### Power Supply Specification at DC Feeding

As voltage between P and N becomes 415VDC or more temporarily at regeneration, select DC power supply carefully.

#### Signal Name

<table>
<thead>
<tr>
<th>Signal</th>
<th>Name</th>
<th>Description</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>X70</td>
<td>DC feeding operation permission signal</td>
<td>When performing operation with DC feeding, turn ON the X70 signal. When the inverter output is shut off because of power failure, the inverter starts about 150ms after switching ON X70 signal. (When automatic restart operation is valid, the inverter starts after additional ( Pr. 17 ) set time has elapsed.) When the X70 signal turns OFF during inverter operation, output is shut off (( Pr. 261 = 0 )) or the inverter is decelerated to a stop (( Pr. 261 \geq 1 )).</td>
<td>Set 70 in any of ( Pr. 278 ) to ( Pr. 290 ).</td>
</tr>
<tr>
<td>X71</td>
<td>DC feeding cancel signal</td>
<td>When the X71 signal is turned ON during inverter operation with turning ON the X70 signal, output is shut off (( Pr. 261 = 0 )) or the inverter is decelerated to a stop (( Pr. 261 \geq 1 )), then the X85 signal turns OFF after the inverter stop. After turning ON of the X71 signal, operation can not be performed even if the X70 signal is turned ON.</td>
<td>Set 71 in any of ( Pr. 278 ) to ( Pr. 290 ).</td>
</tr>
<tr>
<td>Y85</td>
<td>DC feeding signal</td>
<td>The signal turns ON during power failure or under voltage of AC power. The signal turns OFF when the X71 signal turns ON or power is restored. The Y85 signal does not turn OFF during inverter operation even if the power is restored and turns OFF after an inverter step. When the Y85 signal turns ON because of undervoltage, the Y85 signal does not turn OFF even if undervoltage is eliminated.</td>
<td>Set 85 (positive logic) or 185 (negative logic) in any of ( Pr. 190 ) to ( Pr. 196 ).</td>
</tr>
</tbody>
</table>

#### Operation Examples

**Operation example 1 at power failure**

- **AC power supply:** 200V class
- **DC power supply:** Rated input DC voltage 283 VDC to 339 VDC
- **Permissible fluctuation:** 240VDC to 373VDC

**Operation example 2 at power failure**

- **AC power supply:** 400V class
- **DC power supply:** Rated input DC voltage 537VDC to 679 VDC
- **Permissible fluctuation:** 457VDC to 740VDC

**Operation example 3 at power failure (when continuous operation is performed)**

- **AC power supply:** A700

2.14 Stall prevention operation and regeneration avoidance operation


This function monitors the output current and automatically changes the output frequency to prevent the inverter from coming to trip due to overcurrent, overvoltage, etc. It can also limit stall prevention and fast-response current limit operation during acceleration/deceleration, driving or regeneration.

It is invalid under Real sensorless vector control and vector control by (It serve as torque limit and not as stall prevention operation (current limit). Refer to page 283)

- Stall prevention: If the output current exceeds the stall prevention operation level, the output frequency of the inverter is automatically varied to reduce the output current. Also the second stall prevention function can restrict the output frequency range in which the stall prevention function is valid.

  In , output current and output torque can be chosen and limited.

- Fast-response current limit: If the current exceeds the limit value, the output of the inverter is shut off to prevent an overcurrent.

<table>
<thead>
<tr>
<th>(Pr.)</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Stall prevention operation level</td>
<td>0</td>
<td>0 to 200%</td>
<td>Stall prevention operation selection becomes invalid.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>23</td>
<td>Stall prevention operation level compensation factor at double speed</td>
<td>9999</td>
<td>0 to 200%</td>
<td>The stall operation level can be reduced when operating at a high speed above the rated frequency.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>48</td>
<td>Second stall prevention operation current</td>
<td>0</td>
<td>0 to 200%</td>
<td>The second stall prevention operation level can be set.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>49</td>
<td>Second stall prevention operation frequency</td>
<td>0Hz</td>
<td>0.01 to 400Hz</td>
<td>Set the frequency at which stall prevention operation of [Pr. 48] is started.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>66</td>
<td>Stall prevention operation reduction starting frequency</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Set the frequency at which the stall operation level is started to reduce.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>114</td>
<td>Third stall prevention operation current</td>
<td>150%</td>
<td>0.1 to 220%</td>
<td>Stall prevention operation can be changed with the X9 signal.</td>
<td>○ ○ ○ ○</td>
</tr>
<tr>
<td>115</td>
<td>Third stall prevention operation frequency</td>
<td>0Hz</td>
<td>0.01 to 400Hz</td>
<td>Set the frequency at which stall prevention operation starts when the X9 signal is ON.</td>
<td>○ ○ ○ ○</td>
</tr>
</tbody>
</table>
(1) Setting of stall prevention operation level

**[Pr.]**

<table>
<thead>
<tr>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>148</td>
<td>Stall prevention level at ON input</td>
<td>150% to 220%</td>
<td>Stall prevention operation level can be changed by the analog signal input to terminal 1 and 4</td>
<td>○ ○ — —</td>
</tr>
<tr>
<td>149</td>
<td>Stall prevention level at OFF input</td>
<td>100% to 150%</td>
<td>Stall prevention operation level can be changed by the analog signal input to terminal 1 and 4</td>
<td>○ ○ — —</td>
</tr>
</tbody>
</table>

2) Second, third stall prevention operation level **[Pr. 48, 49**, **114**, **115**]

("Not available for [F700]")

(Not available for [F700]). **[Pr. 48, 49**

In [F700], **[Pr. 48 Second stall prevention operation current] is valid when [Pr. 49 Second stall prevention operation frequency = 9999] and RT signal is ON. In [F700], **[Pr. 48, 49**

When [Pr. 49 = 0] in [F700], the stall prevention operation level for output frequency from 0Hz to [Pr. 49 = 9999] can be set to [Pr. 48, 49**

Note that the operation level follows the **[Pr. 22] setting during acceleration.

This function can also be used for stop-on-contact or similar operation by decreasing the fast-response current limit (initial value) to 95%, or by setting the X9 signal function to assign the X9 signal function.

**Operation example when frequency is set in [Pr. 49 (115)] in [F700].**

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The smaller setting of the stall prevention operation levels set in [Pr. 22] and [Pr. 48] has a higher priority. When [Pr. 48 = 0], stall prevention level operates as 0%.

When [Pr. 48 = 0], stall prevention operation level is variable by analog input, turning the RT signal ON also switches from analog input level to the stall prevention operation level using [Pr. 48]. (The second stall prevention operation level cannot be input by analog.)

When [Pr. 48 = 0], stall prevention operation is not performed.

When X9 signal is turned ON, the third stall prevention function has precedence.

As set in Second stall prevention operation:

Stall operation level is as set in [Pr. 48] when the RT signal is ON with [Pr. 48 = 0]. When [Pr. 48 = 0], stall prevention operation is not performed.

The smaller setting of the stall prevention operation levels set in [Pr. 22] and [Pr. 114] has a higher priority. When [Pr. 114 = 0], stall prevention level operates as 0%.

(3) Stall prevention at double speed [Pr. 23, Pr. 66]

During high-speed operation above the rated motor frequency, acceleration may not be made because the motor current does not increase. If operation is performed in a high frequency range, the current at motor lockup becomes smaller than the rated output current of the inverter, and the protective function (OL) is not executed even if the motor is at a stop.

To improve the operating characteristics of the motor in this case, the stall prevention level can be reduced in the high frequency range. This function is effective for performing operation up to the high-speed range on a centrifugal separator etc. Normally, set [Pr. 66 = 60Hz] and [Pr. 23 = 100%].

Setting [Pr. 23 Stall prevention operation level compensation factor at double speed = 9999] (initial value) will make the stall prevention operation level constant up to 400Hz with [Pr. 22] setting.

Stall prevention operation level at = \( A + B \)  
\[ A = \frac{\text{Pr.} 22 \times \text{Pr.} 66}{\text{Pr.} 22 \times \text{Pr.} 115} \times \left( \frac{\text{Pr.} 22 - 100}{100} \right) \]

\[ B = \frac{\text{Pr.} 22 \times \text{Pr.} 114}{\text{Pr.} 22 \times \text{Pr.} 115} \times \left( \frac{\text{Pr.} 22 - 100}{100} \right) \]

Note that

- \( A \) = \( \text{Pr.} 66 \times \frac{\text{Pr.} 22}{\text{Pr.} 115} \times \left( \frac{\text{Pr.} 22 - 100}{100} \right) \)
- \( B \) = \( \text{Pr.} 114 \times \frac{\text{Pr.} 22}{\text{Pr.} 115} \times \left( \frac{\text{Pr.} 22 - 100}{100} \right) \)
(4) Analog variable stall prevention operation

For [Pr. 22, 148, 149, 406*, 858*, 868*] (not available for F700, A700, E700, D700), set [Pr. 22 analog variable stall prevention operation level setting = 9999] to set stall prevention operation level using terminal 1 (analog input). When [Pr. 7] = 1 (initial value), 0 to ±10V is input.

When using FR-A7AZ, stall prevention operation level can be also set to terminal 6 (analog input). For this, set [Pr. 406 High resolution analog input selection = 4]. When [Pr. 858 = 4] and [Pr. 868 = 4] while [Pr. 406 = 4], terminal 6 has higher priority and terminal 4 has no function. Refer to page 46 for terminal 4 function assignment.

Stall prevention operation level can not be set using terminal 4. When using FR-A7AZ with FR-A7AZ, stall prevention operation level can be also set to terminal 6 (analog input). For this, set [Pr. 406 High resolution analog input selection = 4]. When [Pr. 858 = 4] and [Pr. 868 = 4] while [Pr. 406 = 4], terminal 6 is the stall prevention operation level, and terminal 1 and terminal 4 does not have a function.

Set stall prevention operation level at 0V (0mA) input voltage in [Pr. 148 Stall prevention level at 0V input] and set stall prevention operation level at 10V/5V (20mA) input voltage in [Pr. 149 Stall prevention level at 10V/5V input].

(5) Stall prevention operation and limit of fast-response current limit operation [Pr. 156]

Use [Pr. 156] to select whether stall prevention operation or fast-response current limit operation will be performed or not and the operation at OL signal output.

When the load is heavy, or the acceleration/deceleration time is short, stall prevention is activated and acceleration/deceleration may not be made according to the preset acceleration/deceleration time. Set [Pr. 156] and stall prevention operation level to the optimum values.

In vertical lift applications, make setting so that the fast-response current limit is not activated. Torque may not be produced, causing a drop due to gravity.

**Setting example**

Fan/Pump ................. 0
Lifting device/traveling machine ............... 9
(a stop distance at deceleration should not change)

### Table: Parameter Setting

<table>
<thead>
<tr>
<th>Pr. 156 Setting</th>
<th>Fast Response Current Limit*1</th>
<th>Stall Prevention Operation Selection</th>
<th>OL Signal Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>1</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>2</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>3</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>4</td>
<td>ON</td>
<td>ON</td>
<td>NO</td>
</tr>
<tr>
<td>5</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>6</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>7</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>8</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>9</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
</tr>
<tr>
<td>10</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>11</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>12</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>13</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>14</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>15</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>16</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>17</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>18</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>19</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>20</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>21</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>22</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
<tr>
<td>23</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>
During fast-response current limit operation, OL signal is output but not output in .

When "Operation not continued at OL signal output" is selected, the " " (stopped by stall prevention) is displayed at OL operation and inverter trips.

Stall prevention does not operate during fast-response current limit operation in , so the OL signal and E.OLT are not output. However, OL signal and E.OLT are output when regeneration avoidance function (refer to page 340) is active.

Since both fast-response current limit and stall prevention are not activated, OL signal and E.OLT are not output. However, OL signal and E.OLT are output when regeneration avoidance function (refer to page 340) is active.

The settings "100" and "101" allow operations to be performed in the driving and regeneration modes, respectively. The setting "101" disables the fast-response current limit in the driving mode.

Output voltage reduction during stall prevention operation [Pr. 154] When [Pr. 154 = 0], the output voltage decreases during stall prevention operation. By making setting to reduce the output voltage, an overcurrent trip can further become difficult to occur. Use this function where a torque decrease will not pose a problem.

<table>
<thead>
<tr>
<th>[Pr. 154] Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Output voltage reduced</td>
</tr>
<tr>
<td>(initial value)</td>
<td>Output voltage not reduced</td>
</tr>
</tbody>
</table>

(7) Stall prevention operation signal output and output timing adjustment (OL signal) [Pr. 157] When the output current exceeds the stall prevention operation level and stall prevention is activated, OL (overcurrent stall) is displayed and the stall prevention operation signal (OL signal) is ON for longer than 100ms. When the output current falls to or below the stall prevention operation level, the output signal turns OFF. When using E.OLT (overvoltage stall), OL signal is output during fast-response current limit operation. (OL signal is not output during fast-response current limit operation in .) Use [Pr. 157 OL signal output timer] to set whether the OL signal is output immediately or output if stall prevention is continuously activated after the preset time.

This operation is also performed when the overvoltage stall prevention operation and regeneration avoidance function E.OLT (overvoltage stall) are performed.

If the frequency has fallen to 0.5Hz by stall prevention operation and remains for 3s, a fault (E.OLT) appears and trips the inverter.

* 1Hz for E.OLT.

<table>
<thead>
<tr>
<th>[Pr. 157] Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Output immediately</td>
</tr>
<tr>
<td>0.1 to 25</td>
<td>Output after the set time (s) has elapsed</td>
</tr>
<tr>
<td>9999</td>
<td>Not output</td>
</tr>
</tbody>
</table>

Overload state (OL operation):

OL output signal (E.OLT) end time (s)
2.14.2 Overvoltage stall prevention operation level (common)

If the regenerative energy of the motor at deceleration becomes excessive and DC bus voltage exceeds the specified value, this function stops the decrease in frequency for 3s maximum to prevent overvoltage trip. As soon as the regenerative energy has reduced, deceleration resumes.

When overvoltage stall prevention is activated, OL (overvoltage stall) appears and the OL signal is output. Note that a stop distance extends if overvoltage stall prevention operation activates.

Whether to perform overvoltage stall prevention or not is selected using stall prevention operation selection of [Pr. 156] (refer to page 338). When stall prevention operation disabled is selected using [Pr. 156], overcurrent stall prevention operation is not also operated.

<table>
<thead>
<tr>
<th>Model</th>
<th>Overvoltage Stall Prevention Operation Start Level</th>
<th>Overvoltage Stall Prevention Operation Cancel Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>A2S9</td>
<td>300V or less 380VDC</td>
<td>380VDC</td>
</tr>
<tr>
<td></td>
<td>400V or more 780VDC</td>
<td>770VDC</td>
</tr>
<tr>
<td>F700</td>
<td>300V or less 380VDC</td>
<td>380VDC</td>
</tr>
<tr>
<td></td>
<td>400V or more 780VDC</td>
<td>770VDC</td>
</tr>
<tr>
<td>6715</td>
<td>200V 420VDC 395VDC</td>
<td>395VDC</td>
</tr>
<tr>
<td>6725</td>
<td>400V 780VDC 770VDC</td>
<td>770VDC</td>
</tr>
</tbody>
</table>

2.14.3 Regeneration avoidance function [Pr. 665*, 882, 883, 884*, 885, 886] (common)

This function detects a regeneration status and increases the frequency to avoid the regeneration status. It is possible to avoid regeneration by automatically increasing the frequency and continue operation if a fan happens to rotate faster than the set speed due to the effect of another fan in the same duct.

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>882</td>
<td>Regeneration avoidance operation selection</td>
<td>0</td>
<td>0</td>
<td>0: Regeneration avoidance function invalid</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1: Regeneration avoidance function is always valid</td>
<td>[A700] [F700] [E700] [D700]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>2: Regeneration avoidance function in valid only during a constant speed operation</td>
<td>[A700] [F700] [E700] [D700]</td>
</tr>
<tr>
<td>883</td>
<td>Regeneration avoidance operation level</td>
<td>0</td>
<td>0</td>
<td>0: Regeneration avoidance function by bus voltage change ratio is invalid</td>
<td>[A700] [F700] [E700] [D700]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 to 5</td>
<td>1 to 5: Setting to detect the bus voltage change ratio</td>
<td>[A700] [F700] [E700] [D700]</td>
</tr>
<tr>
<td>884</td>
<td>Regeneration avoidance at deceleration detection sensitivity</td>
<td>0</td>
<td>0</td>
<td>0: Regeneration avoidance by bus voltage change ratio is invalid</td>
<td>[A700] [F700] [E700] [D700]</td>
</tr>
</tbody>
</table>
When the regeneration status is serious, the DC bus voltage rises and an overvoltage fault (E. OV1 to 3) may occur. When this bus voltage rise is detected and the bus voltage level reaches or exceeds \([\text{Pr. 883}}\), increasing the frequency will avoid the regeneration status.

The \([\text{Pr. 883}}\) setting should be kept higher than the DC bus voltage level at a stop. Otherwise regeneration avoidance function always activates.

Whether regeneration avoidance operation is always activated \([\text{Pr. 882}} \neq 1\) or activated only at a constant speed \([\text{Pr. 882}} = 2\) can be selected.

While overvoltage stall \((\text{OL}^*)\) is activated only during deceleration and stops the decrease in output frequency, the regeneration avoidance function is always ON \((\text{Pr. 882}} = 1\) or activated only during a constant speed \((\text{Pr. 882}} = 2\) and increases the frequency according to the regeneration amount.

When regeneration avoidance operation is always ON \([\text{Pr. 882}} = 1\) is selected, overvoltage stall prevention during deceleration is not operated and regeneration avoidance operation is performed.

When regeneration avoidance operation is activated, \(\text{OL}^*\) (overvoltage stall) appears and the OL signal is output. Use \([\text{Pr. 156, Pr. 157}}\) to select OL signal ON/OFF and output timing (refer to page 338).

When regeneration avoidance operation is performed, stall prevention is also activated at the same time.

When using the regeneration unit (FR-BU2, FR-BU, MT-BU5, FR-CV, FR-HC, MT-HC) and brake resistor (FR-ABR etc.), set \([\text{Pr. 882}} = 0\) (initial value), (regeneration avoidance function invalid).

Under vector control operation of \(\text{Pr. 882}}\), unusual noise may be generated from the motor during deceleration when using regeneration avoidance function. To prevent this, make gain adjustment, e.g. by performing easy gain tuning. (Refer to page 286)
(2) Regeneration status detection sensitivity

[Pr. 884] (*Not available for D700.*)

As the regeneration avoidance function cannot respond to an abrupt voltage change by detection of the bus voltage level, the ratio of bus voltage change is detected to stop deceleration if the bus voltage is less than [Pr. 883 Regeneration avoidance operation level].

Set that detectable bus voltage change ratio to [Pr. 884] as detection sensitivity. Increasing the setting raises the detection sensitivity. Too small setting (low detection sensitivity) will disable detection, and too large setting will turn ON the regeneration avoidance function if the bus voltage is varied by an input power change, etc.

(3) Limit of regeneration avoidance operation frequency [Pr. 885]

The output frequency compensated for (increased by) the regeneration avoidance function can be limited. The frequency is limited to the output frequency (frequency prior to regeneration avoidance operation) + [Pr. 885 Regeneration avoidance compensation frequency limit value] during acceleration or constant speed.

If the regeneration avoidance frequency exceeds the limit value during deceleration, the limit value is held until the output frequency falls to 1/2 of [Pr. 885]. When the regeneration avoidance frequency has reached [Pr. 1 Maximum frequency], it is limited to the maximum frequency.

When [Pr. 885 = 9999], the frequency setting is invalid.

(4) Regeneration avoidance function adjustment

[Pr. 665’, 886] (*Not available for E700.)

If the frequency becomes unstable during regeneration avoidance operation, decrease the setting of [Pr. 886 Regeneration avoidance voltage gain]. On the contrary, if sudden regeneration causes an overvoltage alarm, increase the setting.

When the load inertia of the motor is large, decrease the [Pr. 886] setting. When vibration is not suppressed by decreasing the [Pr. 886] setting, set a smaller value in [Pr. 665 Regeneration avoidance frequency gain].
2.15 Monitor display and monitor output signal

2.15.1 Speed display and speed setting [Pr. 37, 144*, 505*, 811*] (common)

The monitor display and frequency setting of the PU (FR-DU07/FR-PU04/FR-PU07) can be changed to the motor speed and machine speed.

To display the machine speed on , set in [Pr. 37] the machine speed for operation with frequency set in [Pr. 505*].

For example, when [Pr. 505*] = 60Hz and [Pr. 37] = 1000, 1000 is displayed on the running speed monitor when the running frequency is 60Hz. When running frequency is 30Hz, 500 is displayed.

To display the motor speed in , set the number of motor poles (one of 2, 4, 6, 8, 10, 102, 104, 106, 108, 110) or number of motor poles + 100 (102, 104, 106, 108, 110) under V/F control. The displayed value is calculated from the output frequency when slip compensation is performed during Advanced magnetic vector control or when slip compensation is performed in .

To display the motor speed in , set the number of motor poles (one of 2, 4, 6, 8, 10) or number of motor poles + 100 (102, 104, 106, 108, 110) when running speed monitor is selected, each monitor and setting are determined by the combination of [Pr. 37] and [Pr. 144] as the tables on the next page. (Units in the bold frame are initial values.)

When both [Pr. 37] and [Pr. 144] have been set, their priorities are as given below:

- [Pr. 144 = 102 to 110] > [Pr. 37 = 1 to 9998] > [Pr. 144 = 2 to 10]

Refer to [Pr. 37] when you want to change the PU main monitor (PU main display). (Refer to page 285)

Since the panel display of the operation panel (FR-DU07) is 4 digits in length, the monitor value of more than 9999 is displayed as ----.

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>37</td>
<td>Speed display</td>
<td>0</td>
<td>0 to 9998</td>
<td>Frequency display, setting</td>
<td>00 00 00 00</td>
</tr>
<tr>
<td>144</td>
<td>Speed setting switchover</td>
<td>4</td>
<td>0, 2, 4, 6, 8, 10, 102, 104, 106, 108, 110</td>
<td>Set the number of motor poles when displaying the motor speed</td>
<td>00 00 00 00</td>
</tr>
<tr>
<td>505</td>
<td>Speed setting reference</td>
<td>9999</td>
<td>1 to 9999</td>
<td>Set the reference speed for [Pr. 37]</td>
<td>00 00 00 00</td>
</tr>
<tr>
<td>811</td>
<td>Set resolution switchover</td>
<td>0</td>
<td></td>
<td></td>
<td>00 00 00 00</td>
</tr>
</tbody>
</table>

When both [Pr. 37] and [Pr. 144] have been set, their priorities are as given below:

- [Pr. 144 = 102 to 110] > [Pr. 37 = 1 to 9998] > [Pr. 144 = 2 to 10]

Refer to [Pr. 37] when you want to change the PU main monitor (PU main display). (Refer to page 285)

Since the panel display of the operation panel (FR-DU07) is 4 digits in length, the monitor value of more than 9999 is displayed as ----.

When the running speed monitor is selected, each monitor and setting are determined by the combination of [Pr. 37] and [Pr. 144] as the tables on the next page. (Units in the bold frame are initial values.)

When [Pr. 144 = 102 to 110] > [Pr. 37 = 1 to 9998] > [Pr. 144 = 2 to 10] refer to [Pr. 37] when you want to change the PU main monitor (PU main display). (Refer to page 285)

Since the panel display of the operation panel (FR-DU07) is 4 digits in length, the monitor value of more than 9999 is displayed as ----.

When both [Pr. 37] and [Pr. 144] have been set, their priorities are as given below:

- [Pr. 144 = 102 to 110] > [Pr. 37 = 1 to 9998] > [Pr. 144 = 2 to 10]

Refer to [Pr. 37] when you want to change the PU main monitor (PU main display). (Refer to page 285)

Since the panel display of the operation panel (FR-DU07) is 4 digits in length, the monitor value of more than 9999 is displayed as ----.
### PARAMETER

#### 1) A700 (F700)

<table>
<thead>
<tr>
<th>[Pr. 37] Setting</th>
<th>[Pr. 144] Setting</th>
<th>Output Frequency Monitor</th>
<th>Set Frequency Monitor</th>
<th>Running Speed Monitor</th>
<th>Frequency Setting Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>0</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
</tr>
<tr>
<td>2 to 10</td>
<td>2 to 10</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
</tr>
<tr>
<td>102 to 110</td>
<td>102 to 110</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
</tr>
<tr>
<td>1 to 9998</td>
<td>1 to 9998</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
</tr>
</tbody>
</table>

*1 Motor speed r/min conversion formula ......... frequency \( \times 120 / \text{number of motor poles} \) (\[Pr. 144\] = \(102\) to \(110\))

Machine speed conversion formula ......... \[Pr. 37\] \( \times \) frequency \( \times 60 \Hz \) (\[Pr. 144\] in the above formula is \([Pr. 144] - 100\) \(\text{when} \ [Pr. 144] = 102 \text{ to } 110\) \(, \) and \(4 \) \(\text{when} \ [Pr. 37] = 0\) \(\text{and} \ [Pr. 144] = 0\).)

*2 The increments for Hz are \(0.01\Hz\), machine speed are \(1\) \(\text{m/min}\), and r/min are \(1\) \(\text{r/min}\). For \(A700\), \(r/\text{min}\) increments are available according to \([Pr. 144]\) setting.

*3 \(\text{For} \ A700 , \ [Pr. 505]\) is always set as frequency \(\Hz\).

#### 2) E700 (C700)

<table>
<thead>
<tr>
<th>[Pr. 37] Setting</th>
<th>Output Frequency Monitor</th>
<th>Set Frequency Monitor</th>
<th>Frequency Setting</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 to 9998</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
<td>Hz</td>
</tr>
</tbody>
</table>

*1 Machine speed conversion formula ......... \[Pr. 37\] \( \times \) frequency / \(60 \Hz\)

*2 The increments for Hz are \(0.01\Hz\), machine speed are \(1\) \(\text{m/min}\).
2.15.2 Monitor display selection of the DU/PU, terminal FM/AM, terminal AM0/AM1 (FR-A7AY), terminal DA1 (FR-A7AZ) [Pr. 52, 54, 158*, 170, 171, 268, 306*, 310*, 563, 564, 838*, 891*] (common)

The monitor to be displayed on the main screen of the operation panel (FR-DU07)/parameter unit (FR-PU04/FR-PU07) can be selected. In addition, signal to be output to terminal FM (pulse train output), AM (analog voltage output), AM0 (FR-A7AY analog voltage output), AM1 (FR-A7AY analog current output), and DA1 (FR-A7AZ bipolar analog voltage output) can be selected.

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>DU/PU main display data selection</td>
<td>0 (output frequency)</td>
<td>0.5 to 14, 17 to 20, 22 to 25, 32 to 35, 50 to 57, 100</td>
<td>Selects the monitor to be displayed on the operation panel and parameter unit. Refer to the table on the next page for monitor description.</td>
<td>o o o o</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0, 5, 6 to 14, 17, 20, 23 to 25, 50 to 57, 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0, 5, 7 to 12, 14, 20, 23 to 25, 52 to 57, 61, 62, 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0, 5, 8 to 12, 14, 20, 23 to 25, 52 to 57, 61, 62, 100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54</td>
<td>FM terminal function selection</td>
<td>1 (output frequency)</td>
<td>1 to 3, 5 to 14, 17, 18, 21</td>
<td>Select the monitor output to terminal FM.</td>
<td>o o o o</td>
</tr>
<tr>
<td>158*</td>
<td>AM terminal function selection</td>
<td>1 to 3, 5, 6, 8 to 14, 17, 21, 24, 50, 52, 53</td>
<td>Select the monitor output to terminal AM.</td>
<td>o o o o</td>
<td></td>
</tr>
<tr>
<td>306</td>
<td>Analog output signal selection</td>
<td>2 (output current)</td>
<td>1 to 3, 5, 7 to 12, 14, 21, 24, 52, 53, 61, 62</td>
<td>Select monitor to be output to terminal AM0 and AM1 of the plug-in option FR-A7AY.</td>
<td>o o o o</td>
</tr>
<tr>
<td>310</td>
<td>Analog meter voltage output selection</td>
<td>2 (output current)</td>
<td>1 to 3, 5, 8 to 12, 14, 21, 24, 52, 53, 61, 62</td>
<td>Select monitor to be output to terminal AM0 and AM1 of the plug-in option FR-A7AY.</td>
<td>o o o o</td>
</tr>
<tr>
<td>838*</td>
<td>DA1 terminal function selection</td>
<td>2 (output current)</td>
<td>1 to 3, 5 to 14, 17, 18, 21, 24, 32 to 34, 36, 50, 52, 53</td>
<td>Select the monitor to be output from terminal DA1 of the plug-in option FR-A7AZ.</td>
<td>o o o o</td>
</tr>
<tr>
<td>170</td>
<td>Watt-hour meter clear</td>
<td>9999</td>
<td>Not to clear the watt-hour meter monitor.</td>
<td>Not the maximum value when monitoring from communication to 0 to 9999kWh.</td>
<td>o o o o</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Not the maximum value when monitoring from communication to 0 to 9999kWh.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>Not the maximum value when monitoring from communication to 0 to 65535kWh.</td>
<td></td>
</tr>
<tr>
<td>171</td>
<td>Operation hour meter clear</td>
<td>9999</td>
<td>Not to clear the operation time monitor.</td>
<td>Setting 9999 has no effect.</td>
<td>o o o o</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0, 9999</td>
<td>Not to clear the operation time monitor.</td>
<td>Setting 9999 has no effect.</td>
<td></td>
</tr>
<tr>
<td>268</td>
<td>Monitor decimal digit selection</td>
<td>9999</td>
<td>Displayed as an integral value.</td>
<td>No function.</td>
<td>o o o o</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Displayed in 0.1 increments.</td>
<td>No function.</td>
<td></td>
</tr>
<tr>
<td>563</td>
<td>Energization time carrying-over times</td>
<td>0</td>
<td>0 to 85535 (reading only)</td>
<td>The number of cumulative energization time monitor exceeded 85535 is displayed. Reading only</td>
<td>o o o o</td>
</tr>
</tbody>
</table>
PARAMETER

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>564</td>
<td>Operating time carrying-over times</td>
<td>0</td>
<td>0 to 65535 (reading only)</td>
<td>The numbers of operation time</td>
<td>A700 F700 E700</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>monitor exceeded 65535h is</td>
<td>D700</td>
</tr>
<tr>
<td>891</td>
<td>Cumulative power</td>
<td>9999</td>
<td>0 to 4</td>
<td>Not the number of times to set</td>
<td>E700</td>
</tr>
<tr>
<td></td>
<td>monitor digit shifted</td>
<td></td>
<td></td>
<td>the cumulative power monitor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>times</td>
<td></td>
<td></td>
<td>digit</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clamp the monitor value at</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>maximum.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td></td>
<td>No 3008</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clears the monitor value when</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>it exceeds the maximum value.</td>
<td></td>
</tr>
</tbody>
</table>

*The above parameters allow its setting to be changed during operation in any operation mode even if [Pr. 77 Parameter write selection = 0] (initial value).

(1) Monitor description list [Pr. 52, 54, 158*, 306*, 310*, 838*]

("[Pr. 838] is not available for F700.")
("[Pr. 158, 838] are not available for F700.")
("[Pr. 158, 306, 310, 838] are not available for F700.")

<table>
<thead>
<tr>
<th>Types of Monitor</th>
<th>Increment</th>
<th>Setting</th>
<th>DU (Operation panel)</th>
<th>PU (Main monitor)</th>
<th>LED</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output frequency</td>
<td>0.01Hz</td>
<td>0/100</td>
<td>1 [Pr. 51]</td>
<td>Displays the inverter output frequency.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Output current</td>
<td>0.01A/0.1A</td>
<td>0/100</td>
<td>2 [Pr. 51]</td>
<td>Displays the inverter output current effective value.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td>0.1V</td>
<td>0/100</td>
<td>3 [Pr. 51]</td>
<td>Displays the inverter output voltage.</td>
<td>A700 F700 E700 D700</td>
<td></td>
</tr>
<tr>
<td>Fault or alarm indication</td>
<td>—</td>
<td>0/100</td>
<td>—</td>
<td>Displays 8 past faults individually.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Frequency setting</td>
<td>0.01Hz</td>
<td>5 °*</td>
<td>5 [Pr. 51]</td>
<td>Displays the set frequency.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Running speed</td>
<td>1.5°/min</td>
<td>6 °*</td>
<td>6 [Pr. 55]</td>
<td>Displays the running speed converted with the [Pr. 17] value and vector control.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Motor torque</td>
<td>0.1%</td>
<td>7 °*</td>
<td>7 [Pr. 55]</td>
<td>Displays the motor torque in % on the assumption that the rated motor torque is 100%.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Converter output voltage</td>
<td>0.1V</td>
<td>8 °*</td>
<td>8 [Pr. 50]</td>
<td>Displays the DC bus voltage value.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
<tr>
<td>Regenerative brake duty</td>
<td>0.1%</td>
<td>9 °*</td>
<td>9 [Pr. 70]</td>
<td>Brake duty setting.</td>
<td>A700 F700 E700</td>
<td></td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Types of Monitor</th>
<th>Increments</th>
<th>[Pr. 52] Setting</th>
<th>[Pr. 54] [FM]</th>
<th>[Pr. 158] [AM]</th>
<th>[Pr. 319] [Pr. 638] Setting</th>
<th>Full-scale Value</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electronic thermal relay function load factor</td>
<td>0.1%</td>
<td>10 *1 10</td>
<td>100%</td>
<td>Displays the motor thermal cumulative value on the assumption that the thermal operation level is 100%</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output current peak value</td>
<td>0.01A/0.1A</td>
<td>11 *1 11</td>
<td>[Pr. 6]</td>
<td>Displays the peak value of the output current monitor and displays (cleared at every start)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Converter output voltage peak value</td>
<td>0.1V</td>
<td>12 *1 12</td>
<td>200V class: 400V, 400V class: 800V</td>
<td>Displays the peak value of the DC bus voltage value and displays (cleared at every start)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input power</td>
<td>0.01kW/0.1kW</td>
<td>13 *1 13</td>
<td>Rated inverter power</td>
<td>Displays the power on the inverter input side</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output power</td>
<td>0.01kW/0.1kW</td>
<td>14 *1 14</td>
<td>Rated inverter power</td>
<td>Displays the power on the inverter output side</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Load meter</td>
<td>0.1%</td>
<td>17</td>
<td>17</td>
<td>[Pr. 66]</td>
<td>Torque current is displayed in % by regarding [Pr. 16] setting value as 100% (the motor rated torque is regarded as 100% during Real sensorless control and vector control for SDG)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor excitation current</td>
<td>0.01A/0.1A</td>
<td>18</td>
<td>18</td>
<td>[Pr. 6]</td>
<td>Displays the excitation current of the motor</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Position pulse</td>
<td>—</td>
<td>19</td>
<td>—</td>
<td>Displays the number of pulses per rotation of the motor under orientation control or position control</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative energization time</td>
<td>1h</td>
<td>20</td>
<td>—</td>
<td>Displays cumulative energization time since the inverter shipment You can check the numbers of the monitor value exceeded 65535h with [Pr. 56]</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reference voltage output</td>
<td>—</td>
<td>21</td>
<td>—</td>
<td>Terminal FM: when [Pr. 2V: 0, 1] outputs 144pulses when [Pr. 2V: 0, 1] outputs 56pulses</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>—</td>
<td>—</td>
<td>21</td>
<td>—</td>
<td>Terminal AM: output 10VDC</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Orientation status</td>
<td>1</td>
<td>22</td>
<td>—</td>
<td>Displays only when orientation control is valid (Refer to page 421)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual operation time</td>
<td>1h</td>
<td>23</td>
<td>—</td>
<td>Displays cumulative inverter running time You can check the numbers of the monitor value exceeded 65535h with [Pr. 56] Use [Pr. 71] to clear the value. (Refer to page 351)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of Monitor</td>
<td>Increments</td>
<td>DU Operation panel</td>
<td>PU main monitor</td>
<td>Full-scale Value</td>
<td>Description</td>
<td>Available Inverters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>---------------------</td>
<td>-----------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-------------------</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor load factor</td>
<td>0.1%</td>
<td>24</td>
<td>24</td>
<td>200%</td>
<td>Displays the output current value in % on the assumption that the inverter rated current value is 100%. Monitor value = output current monitor value/rated inverter current ×100 [%].</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative power</td>
<td>0.01kWh/ 0.1kWh</td>
<td>25</td>
<td>x</td>
<td>—</td>
<td>Displays cumulative power amount according to the output power monitor. See [Pr. 11] to clear the value. (Refer to page 351)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque command</td>
<td>0.1%</td>
<td>32</td>
<td>32%</td>
<td>[Pr. 866]</td>
<td>Displays torque command value obtained from vector control.</td>
<td>○ — — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque current command</td>
<td>0.1%</td>
<td>33</td>
<td>33%</td>
<td>[Pr. 866]</td>
<td>Displays the torque current command value.</td>
<td>○ — — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor output</td>
<td>0.01kWh/ 0.1kWh</td>
<td>34</td>
<td>34%</td>
<td>Rated motor capacity</td>
<td>Multiplies the motor speed by the output torque and displays the machine output of the motor shaft.</td>
<td>○ — — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feedback pulse</td>
<td>—</td>
<td>35</td>
<td>x</td>
<td>—</td>
<td>Displays the number of pulses fed back from the encoder during one sampling (displays during a stop).</td>
<td>○ — — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Torque monitor (driving/ regenerative polarity switching)</td>
<td>—</td>
<td>—</td>
<td>36%</td>
<td>[Pr. 866]</td>
<td>Outputs the motor torque in bipolar analog by regarding motor rated torque as 100%. (0% during V/F control)</td>
<td>○ — — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Power saving effect</td>
<td>—</td>
<td>50</td>
<td>50%</td>
<td>Inverter capacity</td>
<td>Displays energy saving effect monitor. You can change the monitor to power saving, power saving average value, charge display and % display using parameters. (Refer to page 360 for details)</td>
<td>○ ○ — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cumulative saving power</td>
<td>—</td>
<td>51</td>
<td>—</td>
<td>—</td>
<td>Displays the set point, measured value and deviation during PID control. (Refer to page 422 for details)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PID set point</td>
<td>—</td>
<td>52</td>
<td>52%</td>
<td>100%</td>
<td>Displays the set point, measured value and deviation during PID control. (Refer to page 422 for details)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PID deviation</td>
<td>0.1%</td>
<td>53</td>
<td>53%</td>
<td>100%</td>
<td>Displays the set point, measured value and deviation during PID control. (Refer to page 422 for details)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Input terminal status</td>
<td>—</td>
<td>54</td>
<td>x</td>
<td>—</td>
<td>Displays the input terminal ON/OFF status on the PU. (Refer to page 350 for the DU display)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output terminal status</td>
<td>—</td>
<td>55</td>
<td>x</td>
<td>—</td>
<td>Displays the output terminal ON/OFF status on the PU. (Refer to page 350 for the DU display)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option input terminal status</td>
<td>—</td>
<td>56</td>
<td>x</td>
<td>—</td>
<td>Displays the input terminal ON/OFF status of digital input option (FR-A7AX) on the DU (refer to page 350 for details)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Option output terminal status</td>
<td>—</td>
<td>57</td>
<td>x</td>
<td>—</td>
<td>Displays the output terminal ON/OFF status of digital input option (FR-A7AY) or relay output option (FR-A7AR) on the DU (refer to page 350 for details)</td>
<td>○ ○ ○ ○</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Types of Monitor</td>
<td>Increments</td>
<td>DU (Operation panel)</td>
<td>PU max monitor (LED)</td>
<td>[Pr. 52] Setting</td>
<td>[Pr. 54] (FM) [Pr. 158] (AM) [Pr. 306] [Pr. 315] [Pr. 538] Setting</td>
<td>Full-scale Value</td>
<td>Description</td>
<td>Available Inverters</td>
</tr>
<tr>
<td>-----------------</td>
<td>------------</td>
<td>----------------------</td>
<td>----------------------</td>
<td>------------------</td>
<td>-------------------------------------------------</td>
<td>-----------------</td>
<td>-------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>Motor thermal load ratio</td>
<td>0.1%</td>
<td>61</td>
<td>61</td>
<td>Thermal operation level (100%)</td>
<td>Displays the motor thermal integrated value (Motor overload shuts off (E.THM) occurs at 100%)</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>Inverter thermal load ratio</td>
<td>0.1%</td>
<td>62</td>
<td>62</td>
<td>Thermal operation level (100%)</td>
<td>Displays the transistor thermal heat integrated value. (Inverter overload trip (E.THT) occurs at 100%)</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
<tr>
<td>PTC thermistor resistance</td>
<td>0.01Ω</td>
<td>×</td>
<td>64</td>
<td>—</td>
<td>Displays the PTC thermistor resistance input value to terminal 2 when PTC thermistor protection is valid. (0.10Ω to 31.5Ω) (Refer to page 50)</td>
<td>—</td>
<td>—</td>
<td>○</td>
</tr>
</tbody>
</table>

*1 Frequency setting to output terminal status on the PU main monitor are selected by "other monitor selection" of the parameter unit (FR-PU04/FR-PU07).
*2 Position pulse and orientation status function when used with an option (FR-A7AP). If a value is set without using an option, the display remains 0.
*3 Feedback pulse functions when the option (FR-A7AP) is used and vector control is performed.
*4 The cumulative energization time and actual operation time are accumulated from 0 to 65535 hours, then cleared, and accumulated again from 0. When the operation panel (FR-OUST) is used, the time is displayed up to 65.53 (65530h) on the assumption that 1h = 0.001, and thereafter, it is added up from 0.
*5 The actual operation time is not added up if the cumulative operation time before power supply-off is less than 1h.
*6 When using the parameter unit (FR-PU04/FR-PU07), kW is displayed.
*7 The setting depends on the inverter capacity. (55k or less/75k or more)

By setting [Pr. 57 = 0], the monitoring of output frequency to alarm display can be selected in sequence by.

Example: When [Pr. 57 = 20] (cumulative energization time), the monitor is displayed on the operation panel as described below.

Example: When [Pr. 57 = 20] (cumulative energization time), the monitor is displayed on the operation panel as described below.

*11 Bigger value between motor thermal and transistor thermal integrated value is displayed.
*12 A value other than 0% may be displayed if surrounding air temperature (fin temperature) is high even during a stop in E700.
*13 Select torque command when using motor rating torque as a reference. Select torque current command when using motor rating current as a reference.
*14 When outputting from terminal DA1 of the built-in option FR-A7AZ when (Pr. 838) is set, + (plus) output at forward rotation and - (minus) output is at reverse rotation.
*15 When outputting from terminal DA1 of the built-in option FR-A7AZ when (Pr. 838) is set, + (plus) voltage is at forward rotation drive / reverse regeneration, and - (minus) voltage is at reverse drive / forward regeneration.

**Torque monitor can be set only to [Pr. 4.15].**
(2) Displays the set frequency during stop
[Pr. 52 = 100]
When [Pr. 52 = 100], the set frequency monitor is displayed during stop and the output frequency monitor is displayed during operation. (LED of Hz flickers during stop and is lit during operation.)
When [Pr. 52 = 100], the set frequency to be output at start is displayed during a stop. The value of the set frequency is different from what is displayed when [Pr. 52 = 5] and is calculated considering the maximum/minimum frequency and frequency jump. The output frequency at error occurrence is displayed during an error and the monitor displayed during MRS is the same as at stop.
During offline auto tuning, the tuning status monitor has priority.

<table>
<thead>
<tr>
<th>[Pr. 52] Setting</th>
<th>During running/stop</th>
<th>During stop</th>
<th>During running</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output frequency</td>
<td>Output frequency</td>
<td>Set frequency</td>
<td>Output frequency</td>
</tr>
<tr>
<td>Output current</td>
<td>Output current</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output voltage</td>
<td>Output voltage</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fault or alarm indication</td>
<td>Fault or alarm indication</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(3) I/O terminal monitor [Pr. 52 = 55 to 57] of the operation panel (FR-DU07)
When [Pr. 52 = 55 to 57], the I/O terminal status can be monitored on the operation panel (FR-DU07). The I/O terminal monitor is displayed on the third monitor. The LED is ON when the terminal is ON, and the LED is OFF when the terminal is OFF. The center line of LED is always ON.
On the unit I/O terminal monitor ([Pr. 52 = 55]), the upper LEDs denote the input terminal status and the lower the output terminal status.

On the input option (FR-A7AX) terminal monitor ([Pr. 52 = 56*]), the decimal point LED of the first digit LED is ON.
(Built-in options cannot be connected to FR-DU07.)

On the output option (FR-A7AY, FR-A7AR) terminal monitor ([Pr. 52 = 57*]), the decimal point LED of the second digit LED is ON.
(Built-in options cannot be connected to FR-DU07.)

* [Pr. 52 = 56, 57] can be set even if the option is not mounted. The monitor displays all OFF status if the option is not mounted.
(4) Cumulative power monitor and clear [Pr. 52 = 25, Pr. 170, 891] (*[Pr. 891] is not available for E700.)

On the cumulative energization power monitor ([Pr. 52 = 20]), the output power monitor value is added up and is updated in 1h increments.

The operation panel (FR-PU07), parameter unit (FR-PU04/FR-PU07) and communication (RS-485 communication, communication option) display increments and display ranges are as indicated below.

### Operation Panel

<table>
<thead>
<tr>
<th>Range</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 99.99kWh</td>
<td>0.01kWh</td>
</tr>
<tr>
<td>100.0 to 999.99kWh</td>
<td>0.1kWh</td>
</tr>
<tr>
<td>1000.0 to 9999.99kWh</td>
<td>1kWh</td>
</tr>
</tbody>
</table>

*1 Power is measured in the range 0 to 99.99kWh, and displayed in 4 digits. When the monitor value exceeds 99.99, a carry occurs, e.g., 100.0, so the value is displayed in 0.1kWh increments.

### Parameter Unit

<table>
<thead>
<tr>
<th>Range</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 999.99kWh</td>
<td>0.01kWh</td>
</tr>
<tr>
<td>1000.0 to 9999.99kWh</td>
<td>0.1kWh</td>
</tr>
<tr>
<td>10000.0 to 99999.99kWh</td>
<td>1kWh</td>
</tr>
</tbody>
</table>

*2 Power is measured in the range 0 to 99999.9999kWh, and displayed in 5 digits. When the monitor value exceeds 999.99, a carry occurs, e.g., 1000.0, so the value is displayed in 0.1kWh increments.

### Communication

<table>
<thead>
<tr>
<th>Range</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 170 = 120]</td>
<td>[Pr. 170 = 9999]</td>
</tr>
<tr>
<td>0 to 9999kWh</td>
<td>0 to 65535kWh (initial value)</td>
</tr>
</tbody>
</table>

The digits of the cumulative power monitor value can be shifted to the right for the number of [Pr. 891] setting values. For example, if the cumulative power value is 1278.56kWh when [Pr. 891 = 2], the RU/DU display is 12.78 (displayed in 100kWh increments), and the communication data is 12. When the monitor value exceeds the maximum value, e.g., 1000.0, the value is displayed in 0.1kWh increments.

(5) Cumulative energization time and actual operation time monitor

[Pr. 52 = 20, 23, Pr. 171, 563, 564] Cumulative energization time monitor ([Pr. 52 = 20]) accumulates energization time from shipment of the inverter every one hour.

On the actual operation time monitor ([Pr. 52 = 23]), the inverter running time is added up every hour. (The actual operation time does not add up if inverter operates for less than one hour.)

If the monitor value exceeds 65535, it is added up from 0. The numbers of cumulative energization time monitor exceeded 65535h can be checked with [Pr. 563] and the numbers of actual operation time monitor exceeded 65535h with [Pr. 564].

Writing [Pr. 171 = 0] will clear the actual operation time monitor. (The cumulative energization time monitor cannot be cleared.) If [Pr. 171 = 0] is written and [Pr. 171] is read again, “9999” is always displayed. Setting 9999 does not clear the actual operation time meter.

(6) Monitor decimal digits selection [Pr. 268]

As the operation panel (FR-DU07) display is 4 digits long, the decimal places may vary at analog input, etc. The decimal places can be hidden by selecting the decimal digits. In such a case, the decimal digits can be selected by [Pr. 268].

The number of display digits on the cumulative time ([Pr. 52 = 20]), actual operation time ([Pr. 52 = 23]), cumulative energization power ([Pr. 52 = 25]) or cumulative saving power monitor ([Pr. 52 = 51]) does not change.
### 2.15.3 Reference of terminal FM/AM, terminal AM0/AM1 (FR-A7AY), terminal DA1 (FR-A7AZ) [Pr. 55, 56, 291*, 839*, 866*, 867*] (common)

Two types of monitor outputs are available in: pulse train output from terminal FM and analog voltage output from terminal AM. Analog voltage output (terminal AM0) and analog current output (terminal AM1) become available when the plug-in option FR-A7AY is mounted. Bipolar analog voltage output (terminal DA1) becomes available when the plug-in option FR-A7AZ is mounted. Terminal FM for pulse output is available for monitor output in FR-A7AY. Analog voltage output (terminal AM0) and analog current output (terminal AM1) become available when the plug-in option FR-A7AY is mounted to FR-A7AY. For FR-A7AZ, pulse train output by voltage output and by open collector output can be selected for terminal FM.

Set the reference of the signal output from terminal FM and AM, AM0, AM1, DA1.

---

### Table: Parameter Selections

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>55</td>
<td>Frequency monitoring reference</td>
<td>60Hz</td>
<td>0 to 400Hz</td>
<td>Set the full-scale value to output the output frequency monitor value to terminal FM and AM.</td>
<td>☐ ☐ ☐</td>
</tr>
<tr>
<td>56</td>
<td>Current monitoring reference</td>
<td></td>
<td></td>
<td></td>
<td>☐ ☐ ☐</td>
</tr>
<tr>
<td>291</td>
<td>Pulse train I/O selection</td>
<td>0</td>
<td></td>
<td></td>
<td>☐ — —</td>
</tr>
<tr>
<td>839</td>
<td>DA1 output filter time (sec)</td>
<td>0.05s</td>
<td>0 to 5s</td>
<td>Set the output filter for terminal DA1 of built-in option FR-A7AZ.</td>
<td>☐ — —</td>
</tr>
<tr>
<td>866</td>
<td>Torque monitoring reference</td>
<td>150%</td>
<td>0 to 400%</td>
<td>Set a full-scale value when output torque monitor value is in analog.</td>
<td>☐ — —</td>
</tr>
<tr>
<td>867</td>
<td>AM output filter time (sec)</td>
<td>0.01s</td>
<td>0 to 5s</td>
<td>Set the output filter of terminal AM.</td>
<td>☐ ☐ ☐</td>
</tr>
</tbody>
</table>

* The above parameters allow their setting to be changed during operation in any operation mode even if [Pr. 77 Parameter write selection = 0] (initial value).
(1) Frequency monitor reference [Pr. 55]

For the calibration of terminal FM, set the full-scale value of the connected meter when the pulse speed of terminal FM is 1440 pulse/s (50k pulse/s when high speed pulse train output is selected in A700). Set the frequency to be indicated as the full-scale value on the frequency meter (1mA analog meter) connected between terminal FM and SD. (For example, 60Hz or 120 Hz.) Pulse speed is proportional to the output frequency of the inverter. The pulse speed and inverter output frequency are proportional to each other. (Maximum pulse train output is 2400 pulse/s (55k pulse/s when high speed pulse train output is selected on A700)).

For the calibration of terminal AM, AM0 in A700 and DA1 (only in A700), set the full-scale value of the connected frequency meter when the output voltage of terminal AM, AM1 and DA1 are 10VDC. For terminal AM0 of A700, set the full-scale value of the connected frequency meter when the output voltage of terminal AM0 is 10VDC. Set the frequency to be indicated as the full-scale value on the meter (10V analog meter) connected between terminal AM and 5 (AM0 and AMC, DA1 and 5). (For example, 60Hz or 120 Hz.) Output voltage is proportional to the frequency. (Maximum output voltage is 10VDC.)

For terminal AM1 of A700, set the full-scale value of the connected meter when the output current of the terminal AM1 is 20mA. Set the frequency to be indicated as the full-scale value on the meter (20mA analog meter) connected between terminal AM1 and AMC. (20mA current meter.) Output voltage is proportional to the frequency. (Maximum output current is 20mA.)

(2) Current monitor reference [Pr. 56]

For the calibration of terminal FM, set the full-scale value of the connected current meter when the pulse speed of terminal FM is 1440 pulse/s (50k pulse/s when high speed pulse train output is selected in A700). Set the current to be indicated as the full-scale value on the meter (1mA analog meter) connected between terminal FM and SD. Pulse speed is proportional to the monitored value of output current. (Maximum pulse train output is 2400 pulse/s (55k pulse/s when high speed pulse train output is selected on A700)).

For the calibration of terminal AM, AM0 and DA1 (only in A700), set the full-scale value of the connected current meter when the output voltage of terminal AM, AM1 and DA1 are 10VDC. For terminal AM0 of A700, set the full-scale value of the connected current meter when the output voltage of terminal AM0 is 10VDC. Set the current to be indicated as the full-scale value on the meter (10V analog meter) connected between terminal AM and 5 (AM0 and AMC, DA1 and 5). Output voltage is proportional to the monitored value of output current. (Maximum output voltage is 10VDC.)

For terminal AM1 of A700, set the full-scale value of the connected current meter when the output current of the terminal AM1 is 20mA. Set the current to be indicated as the full-scale value on the meter (20mA analog meter) connected between terminal AM1 and AMC. Output current is proportional to the monitored value of output current. (Maximum output current is 20mA.)
(3) Reference of torque monitor [Pr. 866]

For the calibration of terminal FM, set the full-scale value of the connected torque meter when the pulse speed of terminal FM is 1440 pulses/s (50k pulses/s when high speed pulse train output is selected). Set the torque to be indicated as the full-scale value on the torque meter (1mA analog meter) connected between terminal FM and 5D. Pulse speed is proportional to the monitored value of torque. (Maximum pulse train output is 2400 pulses/s (55k pulses/s when high speed pulse train output is selected on 5D)).

(4) Terminal AM response adjustment [Pr. 867]

Using [Pr. 867], the output voltage response of terminal AM can be adjusted within the range 0 to 5s. Increasing the setting stabilizes the terminal AM output more but reduces the response level. (Setting 0 sets the response level to 4ms).

(5) Terminal DA1 (FR-A7AZ) response adjustment [Pr. 839]

Using [Pr. 839], the output voltage response of terminal DA1 can be adjusted within the range 0 to 5s. Increasing the setting stabilizes the terminal DA1 output but reduces the response level. [Pr. 839 DA1 output filter] setting plus 5ms at maximum equals to the response time of terminal DA1.
(6) Pulse train output of terminal FM [Pr. 291]

Two types of pulse train can be selected for terminal FM of A700 according to the [Pr. 291] setting. Using [Pr. 291], input specifications (pulse train input or contact input) of terminal JOG can be selected. Change the setting value using care not to change input specifications of terminal JOG. (Refer to page 228 for pulse train input.)

For [Pr. 291 pulse train I/O selection = 0 or 1] on A700 and using [Pr. 138 pulse train I/O selection], FM output is selected and pulse train of 8VDC maximum, 2400 pulse/s is output.

The pulse width can be adjusted by calibration parameter [Pr. 900 FM terminal calibration] using the operation panel and parameter unit. Output frequency, etc. of the inverter can be commanded by connecting a DC ammeter of full-scale deflection, digital indicator, etc. The initial setting is 1mA full-scale and 1440 pulse/s terminal FM frequency at 60Hz.

1) FM output

When [Pr. 291 Pulse train I/O selection = 0 or 1] on A700 and using [Pr. 138 Pulse train I/O selection], FM output is selected and pulse train of 8VDC maximum, 2400 pulse/s is output.

Pulse width: Adjust using calibration parameter [Pr. 900 FM terminal calibration] using the operation panel and parameter unit.

Output frequency, etc. of the inverter can be commanded by connecting a DC ammeter of full-scale deflection, digital indicator, etc. The initial setting is 1mA full-scale and 1440 pulse/s terminal FM frequency at 60Hz.

2) High speed pulse train output

When [Pr. 291 Pulse train I/O selection = 10, 11, 20, 21, 100] on A700, high speed pulse train is output by open collector output. Maximum 55k pulse/s of pulse train is output.

Pulse width: Adjust using calibration parameter [Pr. 900 FM terminal calibration] using the operation panel and parameter unit.

Output frequency, etc. of the inverter can be commanded by connecting a DC ammeter of full-scale deflection, digital indicator, etc. The initial setting is 1mA full-scale and 1440 pulse/s terminal FM frequency at 60Hz.

High speed pulse train output specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output method</td>
<td>NPN open collector output</td>
</tr>
<tr>
<td>Voltage between a collector and emitter</td>
<td>30V (max)</td>
</tr>
<tr>
<td>Maximum permissible load current</td>
<td>80mA</td>
</tr>
<tr>
<td>Output pulse rate</td>
<td>0 to 55kpps</td>
</tr>
<tr>
<td>Output resolution</td>
<td>3ppps (excluding a jitter)</td>
</tr>
</tbody>
</table>

* When the output wiring length is long, a pulse shape is deformed due to the stray capacitances of the wiring and output pulse can not be recognized. If the wiring length is long, connect the open collector output signal and the power supply using an external pull-up resistance.

Check specifications of a pulse counter for a resistance value to pull up. Select an appropriate resistance value so that the load current is 80mA or less.

High speed pulse train output circuit

- When [Pr. 291 = 10, 11], pulse cycle is 50% Duty (ON width and OFF width are the same).
- When [Pr. 291 = 20, 21, 100], fixed ON width of pulse is output (approx. 10μs).
- When the setting value is 100, the pulse train from the pulse train output (terminal JOG) is output as is. Use this value for synchronous speed operation of multiple inverters. (Refer to page 567)

Pulse when [Pr. 291 = 10, 11]

When [Pr. 291 = 10, 11], pulse cycle is 50% Duty (ON width and OFF width are the same).

Pulse when [Pr. 291 = 20, 21, 100]

When [Pr. 291 = 20, 21, 100], pulse cycle is 50% Duty (ON width and OFF width are the same).

* Hi indicates that the open collector output transistor is OFF.

When high speed pulse train output is selected, performing all parameter clear will return the [Pr. 291] setting to the initial value 0, changing the terminal FM output from high speed pulse train output to FM output (voltage output).

Disconnect the device connected to terminal FM and perform all parameter clear.
By operation panel or parameter unit, terminal FM and terminal AM in \( \text{[A700]} \)/\( \text{[F700]} \) can be calibrated to full scale.

### Parameter Table

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C0(900)</td>
<td>FM terminal calibration</td>
<td>—</td>
<td>—</td>
<td>Calibrates the scale of the meter connected to terminal FM.</td>
</tr>
<tr>
<td>C1(901)*1</td>
<td>AM terminal calibration</td>
<td>—</td>
<td>—</td>
<td>Calibrates the scale of the analog meter connected to terminal AM.</td>
</tr>
</tbody>
</table>

*1 The setting is available for \( \text{[F700]} \) when it has built-in option FR-A7AY installed.

*2 The above parameters allow its setting to be changed during operation in any operation mode even if \([\text{Pr. 77 Parameter write selection}} = 0]\) (initial value).

### FM terminal calibration \([\text{C0 (Pr. 900)}]\)

When using \( \text{[A700]} \) with \( \text{[Pr. 291]} = 0, 1 \) and for \( \text{[F700]} \), terminal FM is preset to FM output. By setting the calibration parameter \([\text{C0 (Pr. 900)}]\), the meter connected to the inverter can be calibrated without using a calibration resistor.

1. **Pulse width T1:** Adjust using calibration parameter \([\text{C0 (Pr. 900)}]\)
2. **Pulse cycle T2:** Set with \([\text{Pr. 55 (frequency monitor)}]\)
3. **Set with \([\text{Pr. 56 (current monitor)}]\)**

* It is not necessary when the operation panel (FR-DU65) or parameter unit (FR-PW64/FR-PW67) is used for calibration.

Used when calibration must be made near the frequency meter for such a reason as a remote frequency meter.

However, the frequency meter needle may not deflect to full-scale if the calibration resistor is connected. In this case, use this resistor and perform calibration of operation panel or parameter unit.

Connect an indicator/frequency meter (moving-coil type DC ammeter 1mA) across terminals FM-SD of the inverter. (Note the polarity. The terminal FM is positive.)

Set the monitor description in \([\text{Pr. 54]}\) and operate the inverter. (It is not necessary to connect the motor.)

Read \([\text{C0]}\) and turn \( \bigcirc \) to change the pulse width.

The average value of the output voltage will change, enabling the indicator/frequency meter to be calibrated. When calibrating a monitor output signal, which cannot be adjusted to a 100% value without an actual load and a measurement equipment, set \([\text{Pr. 54 x 211]}\) (reference voltage output) and make calibration. When monitoring the frequency, the FM terminal output is filled to capacity at the initial value if the maximum output frequency reaches or exceeds 100Hz. In this case, the \([\text{Pr. 55]}\) setting has to be changed to the maximum frequency.

Using the FM output of the terminal FM, a digital display can be provided to connect a digital counter. The monitor value is 1440 pulse/s output at the full-scale value of monitor description list (page 346) \([\text{Pr. 54 FM terminal function selection}}]\). Change the reference value of \([\text{Pr. 55, Pr. 56, Pr. 866}}\) to change the number of pulses at full scale value. \([\text{Pr. 866}}\) is available for only \( \text{[A700]} \).
(2) AM terminal calibration [C1(Pr. 901)]

Terminal AM is factory-set to provide a 10VDC output in the full-scale status of the corresponding monitor item. Calibration parameter [C1(Pr. 901)] allows the output voltage ratios (gains) to be adjusted according to the meter scale. Note that the maximum output voltage is 10VDC.

Connect a meter/frequency meter (DC voltmeter 10V) across inverter terminals AM-5. (Note the polarity. The terminal AM is positive.) Set the monitor description in [Pr. 158] and operate the inverter. (It is not necessary to connect the motor.) Read [C1] and turn to change the output voltage, enabling the indicator/frequency meter to be calibrated. When calibrating a monitor output signal, which cannot adjust to a 100% value without an actual load and a measurement equipment, set [Pr. 54 = 21] (reference voltage output) and make calibration. 10VDC is output from the terminal AM.

2.15.5 Signal selection and calibration of terminal AM0, AM1 (FR-A7AY)

Signal output from terminal AM0 (analog voltage output) and AM1 (analog current output) when the plug-in option FR-A7AY is fitted to the inverter can be selected and calibrated.

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>307</td>
<td>Setting for zero analog output</td>
<td>0%</td>
<td>0 to 100%</td>
<td>Output signal selection, calibration/adjustment method</td>
</tr>
<tr>
<td>308</td>
<td>Setting for maximum analog output</td>
<td>100%</td>
<td>0 to 100%</td>
<td></td>
</tr>
<tr>
<td>309</td>
<td>Voltage/current selection for analog output</td>
<td>0</td>
<td>0</td>
<td>Output signal selection, calibration/adjustment method</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Selection of signal using [C1(Pr. 901)]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>Full-scale calibration using [C1(Pr. 901)]</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td>Full-scale calibration using [C1(Pr. 901)]</td>
<td></td>
</tr>
<tr>
<td>311</td>
<td>Setting for zero analog meter voltage output</td>
<td>0%</td>
<td>0 to 100%</td>
<td>Output signal selection for zero analog output</td>
</tr>
<tr>
<td>312</td>
<td>Setting for maximum analog meter voltage output</td>
<td>100%</td>
<td>0 to 100%</td>
<td>Output signal selection for maximum analog output</td>
</tr>
<tr>
<td>323</td>
<td>AM0 V adjustment</td>
<td>100%</td>
<td>950 to 1100%</td>
<td>The meter connected to terminal AM0 can be adjusted to stop at 0.</td>
</tr>
<tr>
<td>324</td>
<td>AM1 I adjustment</td>
<td>100%</td>
<td>950 to 1100%</td>
<td>The meter connected to terminal AM1 can be adjusted to stop at 0.</td>
</tr>
<tr>
<td>C0(900)</td>
<td>FM terminal calibration</td>
<td>—</td>
<td>—</td>
<td>Scale of the connected meter to terminal AM0 can be calibrated.</td>
</tr>
<tr>
<td>C1(901)</td>
<td>AM terminal calibration</td>
<td>—</td>
<td>—</td>
<td>Scale of the connected meter to terminal AM1 can be calibrated.</td>
</tr>
</tbody>
</table>

* The setting is available for [Pr. 54 = 21] when it has built-in option FR-A7AY installed.
(1) Analog output signal setting [Pr. 309]
Use [Pr. 309 Analog output signal voltage/current switchover] to select whether to output the same signal or different signals from terminal AM0 (analog voltage output) and terminal AM1 (analog current output).
When [Pr. 309 = 0, 10], same signal is output from terminal AM0 and AM1, and set the output signal using [Pr. 306]. (Refer to page 346 for output signal description.)
When [Pr. 309 = 5, 11], a different signal is output from each terminal, and set output signal from AM0 using [Pr. 310] and from AM1 using [Pr. 306]. (Refer to page 346 for output signal description.)

(2) Adjusting the meter needle to stop at 0 [Pr. 323, 324]
If the meter needle does not point to 0 when voltage or current output is 0, use [Pr. 323 AM0 0V adjustment] or [Pr. 324 AM1 0mA adjustment] to calibrate the meter. Setting a smaller value decreases the analog output and a larger value increases the analog output.

(3) Calibration of analog signal [C0 (Pr. 900), C1 (Pr. 901)]
When outputting the same signal from terminal AM0 and AM1 (Pr. 309 = 0, 10), set [Pr. 306 = 21] (reference voltage output) and adjust the output at full-scale using [Pr. 900].
When outputting the same signal from terminal AM0 and AM1 (Pr. 309 = 1, 11), set [Pr. 310 = 21] (reference voltage output) for terminal AM0 and [Pr. 306 = 21] (reference voltage output) for AM1 to adjust the output from these terminals at full-scale using [Pr. 900] and [Pr. 901] respectively. Refer to page 356 for details.
Calibrating AM0 and AM1 without setting 21 in [Pr. 306] or [Pr. 310] calibrates terminal FM and AM of the inverter. To prevent this, always set 21 before calibrating terminal AM0 and AM1.

(4) Analog signal adjustment [Pr. 307, 308, 311, 312]
Use [Pr. 307] or [Pr. 312] to set for zero analog output (meter points 0).
In addition, use [Pr. 308] or [Pr. 311] to set for maximum analog output (full-scale).
Output signal value can be calibrated when [Pr. 309 = 0, 1] and analog input value can be adjusted when [Pr. 309 = 10, 11].

* When [Pr. 307] and [Pr. 308] are set, the output value at terminal AM0 and AM1 are always zero.

* When [Pr. 311] ≥ [Pr. 309] and [Pr. 312] ≥ [Pr. 309] are set, the output value at terminal AM0 and AM1 are always zero.
2.15.6 Terminal DA1 (FR-A7AZ) calibration [Pr. 857, C0 (Pr. 900)]

Calibration can be performed for the signal that is output from terminal DA1 (bipolar analog voltage output) when the built-in option FR-A7AZ is installed in the inverter.

### (1) Adjusting the meter needle to stop at 0 [Pr. 857]

When the meter needle does not point 0 at 0 output voltage, calibrate the meter with [Pr. 857 DA1-0V adjustment]. Analog output becomes smaller by making the setting value smaller, and it becomes greater by making the setting value larger.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>857</td>
<td>DA1-0V adjustment</td>
<td>1000%</td>
<td>900 to 1100%</td>
<td>Adjustment can be made for the meter needle of the meter connected to terminal DA1.</td>
</tr>
<tr>
<td>C0</td>
<td>terminal calibration</td>
<td>—</td>
<td>—</td>
<td>Point of the connected meter to terminal DA1 can be calibrated.</td>
</tr>
</tbody>
</table>

### (2) Calibrating analog signal [C0(Pr. 900)]

For the calibration of terminal DA1, set [Pr. 838 = 21] (Reference voltage output), and perform full scale adjustment by [C0(Pr. 900)]. For the adjustment method, refer to page 356.

If calibration is attempted without setting 21 in [Pr. 838] (Reference voltage output), calibration is performed for the terminal FM of the inverter.

When using and installing both of FR-A7AZ and FR-A7AY, and [Pr. 309 Analog output signal voltage/current switched] = 5 or 11, and [Pr. 310 Analog meter voltage output selection] = 21, the terminal FM of FR-A7AY is calibrated by [C0(900)].
2.15.7 Energy saving monitor [Pr. 891 to 899] (A700) (F700)

From the power consumption estimated value during commercial power supply operation, the energy saving effect by use of the inverter can be monitored/output.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>DI/PU main display data selection</td>
<td>0 (output frequency)</td>
<td>0.5 to 14, 17 to 20, 22 to 25, 32 to 35, 50 to 57, 100</td>
<td>50: Power saving monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0, 5, 6 to 14, 17, 20, 23 to 25, 50 to 57, 100</td>
<td>51: Power saving cumulative monitor</td>
</tr>
<tr>
<td>54</td>
<td>FM terminal function selection</td>
<td>1 (output frequency)</td>
<td>1 to 3, 5 to 14, 17, 18, 21, 24, 32 to 34, 50, 52, 53</td>
<td>80: Power saving monitor</td>
</tr>
<tr>
<td>158</td>
<td>AM terminal function selection</td>
<td>1 (output frequency)</td>
<td>1 to 3, 5, 6, 8 to 14, 17, 21, 24, 32, 50, 52, 53</td>
<td>80: Power saving monitor</td>
</tr>
<tr>
<td>891</td>
<td>Cumulative power monitor digits shifted times</td>
<td>9999</td>
<td>0 to 4</td>
<td>Set the number of times to shift the cumulative</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>power monitor digit</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clinks the monitor value at maximum.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No shift</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Clear the monitor value when it exceeds the</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>maximum value.</td>
</tr>
<tr>
<td>892</td>
<td>Load factor</td>
<td>100%</td>
<td>30 to 150%</td>
<td>Set the load factor for commercial power-supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>operation. MUltipled by the power consumption</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>rate (page 363) during commercial power supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>operation.</td>
</tr>
<tr>
<td>893</td>
<td>Energy saving monitor reference value</td>
<td>9999</td>
<td>Inverter rated capacity 55K or less 0.1 to 55kW 75K or more 0 to 3600kW</td>
<td>Set the motor capacity (pump capacity). Set when</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>calculating power saving rate, power saving rate</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>average value, commercial operation power.</td>
</tr>
<tr>
<td>894</td>
<td>Control selection during commercial power-supply operation</td>
<td>0</td>
<td>0 Discharge damper control (fan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Inductor control (fan)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 Valve control (pump)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3 Commercial power supply drive (fixed value)</td>
<td></td>
</tr>
<tr>
<td>895</td>
<td>Power saving rate reference value</td>
<td>9999</td>
<td>0</td>
<td>Consider the value during commercial power-supply</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>operation as 100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Consider the [%] setting as 100%.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9999 No function</td>
</tr>
<tr>
<td>896</td>
<td>Power unit cost</td>
<td>9999</td>
<td>0 to 500</td>
<td>Set the power unit cost. Displays the power saving</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>amount charge on the energy saving monitor</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999 No function</td>
<td></td>
</tr>
<tr>
<td>897</td>
<td>Power saving monitor average time</td>
<td>9999</td>
<td>0 Average for 30 minutes</td>
<td>Set the power saving monitor average for the set</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 to 100h</td>
<td>time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999 No function</td>
<td></td>
</tr>
<tr>
<td>898</td>
<td>Power saving cumulative monitor clear</td>
<td>9999</td>
<td>0 Cumulative monitor value clear</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 Cumulative monitor value hold</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 Accumulation continued (communication data upper limit 9999)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999 Accumulation continued (communication data upper limit 65535)</td>
<td></td>
</tr>
<tr>
<td>899</td>
<td>Operation time rate (estimated value)</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Use for calculation of annual power saving</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>amount. Set the annual operation ratio (consider 365 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>x 24h as 100%).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999 No function</td>
<td></td>
</tr>
</tbody>
</table>

* The above parameters allow its setting to be changed during operation in any operation mode even if [Pr. 77 Parameter write selection] = 0 (initial value).
### Energy saving monitor list

The following items are monitored by the power saving monitor [Pr. 52, Pr. 54, Pr. 158 = 50]. Only 1) power saving and 3) power saving average can be output to [Pr. 54] (terminal FM) and [Pr. 158] (terminal AM).

<table>
<thead>
<tr>
<th>Energy Saving Monitor Item</th>
<th>Description and Calculation Formula</th>
<th>Increments</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Power saving</td>
<td>Difference between the estimated value of power necessary for commercial power supply operation and the input power calculated by the inverter</td>
<td>0.01kW/0.1kW</td>
<td>9999</td>
</tr>
<tr>
<td></td>
<td>Power saving during commercial power supply operation - input power monitor</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>2) Power saving rate</td>
<td>Ratio of power saving on the assumption that power during commercial power supply operation is 100% 1) Power saving</td>
<td>0.1%</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Power saving during commercial power supply operation</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>Ratio of power saving on the assumption that [Pr. 893] is 100%</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>3) Average power saving value</td>
<td>Average value of power saving amount per hour during the set time [Pr. 897]</td>
<td>0.01kW/0.1kW</td>
<td>9999</td>
</tr>
<tr>
<td></td>
<td>[Pr. 897] x 100</td>
<td>1</td>
<td>0 to 1000h</td>
</tr>
<tr>
<td>4) Average power saving rate</td>
<td>Average ratio of power saving value on the assumption that the value during commercial power supply operation is 100% 1) Power saving rate</td>
<td>0.1%</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>[Pr. 897] x 100</td>
<td>1</td>
<td>0 to 1000h</td>
</tr>
<tr>
<td>5) Average power saving amount</td>
<td>Average power saving value represented in terms of charge</td>
<td>0.01/0.1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>[Pr. 896]</td>
<td>0 to 500</td>
<td></td>
</tr>
</tbody>
</table>

The following items are monitored by the power saving monitor [Pr. 52 = 51]. The monitor value of the cumulative monitor can be shifted to the right with [Pr. 891 Cumulative power monitor digit shifted times].

<table>
<thead>
<tr>
<th>Energy Saving Monitor Item</th>
<th>Description and Calculation Formula</th>
<th>Increments</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>6) Power saving amount</td>
<td>Power saving is added up per hour. 1) Power saving</td>
<td>0.01kW/0.1kW</td>
<td>9999</td>
</tr>
<tr>
<td></td>
<td>[Pr. 893]</td>
<td>1</td>
<td>—</td>
</tr>
<tr>
<td>7) Power saving amount charge</td>
<td>Power saving amount represented in terms of charge 2) Power saving amount</td>
<td>0.01/0.1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>[Pr. 896]</td>
<td>0 to 500</td>
<td></td>
</tr>
<tr>
<td>8) Annual power saving amount</td>
<td>Estimated value of annual power saving amount 3) Power saving amount</td>
<td>0.01kW/0.1kW</td>
<td>9999</td>
</tr>
<tr>
<td></td>
<td>[Pr. 897] x 365X</td>
<td>1</td>
<td>0 to 100%</td>
</tr>
<tr>
<td>9) Annual power saving amount charge</td>
<td>Annual power saving amount represented in terms of charge 4) Annual power saving amount</td>
<td>0.01/0.1</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td>[Pr. 896]</td>
<td>0 to 500</td>
<td></td>
</tr>
</tbody>
</table>

1) For communication (RS-485 communication, communication option), the display increments are 1. For example, 10.00kWh indicates that communication data is 10.
2) When using the parameter unit (FR-PUA4/FR-PU07), kW is displayed.
3) The increments vary according to the inverter capacity. (55K or less75K or more)
4) Since four digits are displayed on the operation panel (FR-DU07), the value is displayed in 0.1 increments when a monitor value in 0.01 increments exceeds 99.99, then rounded up to 100.0. The maximum display is 9999.
5) Since five digits are displayed on the parameter unit (FR-PUA4/FR-PU07), the value is displayed in 0.1 increments when a monitor value in 0.01 increments exceeds 9999.99, then rounded up to 1000.0. The maximum display is 99999.
6) When [Pr. 84 Power saving cumulative monitor clear] = 999, the maximum value of communication (RS-485 communication, communication option) is 65535. The upper limit of 0.01 increments monitor is 655.35 and that of 0.1 increments monitor is 6553.5.
(2) Energy saving instantaneous monitor
1) Power saving,
2) Power saving rate

The power saving monitor 1) calculates power saving effect (difference) to the power consumption (estimated value) during commercial power supply operation and displays on the main monitor. In the following case, the power saving monitor 1) is 0.

(a) The calculated value of the power saving monitor is negative value.
(b) During DC injection brake operation
(c) The motor is not connected (output current monitor is 0A)

Power saving rate monitor 2) displays the power saving rate on the assumption that the power consumption (estimated value) during commercial power supply operation is 100% by setting [Pn: 895 Power saving rate reference value = 0]. In addition, when [Pn: 895 = 1], the monitor displays the power saving rate on the assumption that the [Pn: 893 Energy saving monitor reference (motor capacity)] is 100%.

(3) Power saving average value monitor
3) Average power saving value,
4) Average power saving rate
5) Average power saving amount charge

The power saving average value monitor is displayed by setting a value other than 9999 in [Pn: 897 Power saving monitor average time]. The power saving average value monitor 3) displays the unit time average value of power saving amount at every averaging. The average value is updated when the [Pn: 897 Power saving monitor average time] setting is changed, power is turned ON, or the average time has passed since the inverter is reset.

Power saving average value update timing signal (Y92) is inverted every time the average value is updated. When 0 or 1 is set in [Pn: 895 Power saving rate reference value], power saving average value monitor 4) displays unit time average value of power saving rate 2) at every averaging time.

When charge (unit power value) per 1kWh of power amount is set in [Pn: 896 Unit power value], power saving amount average value monitor 5) displays charge (power saving average value 3) \times [Pn: 896] to the power saving average value.

(4) Power saving cumulative monitor
6) Power saving amount,
7) Power saving amount charge,
8) Annual power saving amount,
9) Annual power saving amount charge

The power saving cumulative monitor data digit can be shifted to the right by the number set in [Pn: 891 Cumulative power monitor digit shifted time]. For example, if the cumulative power value is 1278.56kWh when [Pn: 891 = 2], the PU/DU display is 12.78 (displayed in 100kWh increments) and the communication data is 12.

If the maximum value exceeded at [Pn: 891 = 0 to 4], the power is clamped at the maximum value, indicating that a digit shift is necessary. When [Pn: 891 = 5999], the value returns to 0 if it exceeds the maximum value, then counting restarts.

The other monitors are clamped at the display upper limit.

The power saving cumulative monitor value is stored every hour. Hence, when the power supply is switched OFF within one hour, and switched ON again, the previously stored monitor value is displayed and accumulation starts. (The cumulative monitor value may decrease)

The power saving amount monitor 6) can measure the power amount during a predetermined period. Carry measurement according to the following steps.

i) Write 9999 or 10 in [Pn: 898 Power saving cumulative monitor clear].
ii) Write [Pn: 898 = 0] at measurement start timing to clear the power saving cumulative monitor value and start accumulation of power saving.

Power saving cumulative monitor value.

Parameter

<table>
<thead>
<tr>
<th>Power saving instantaneous value [kW]</th>
<th>Power saving average value [kW]</th>
<th>Y92: power saving average value update timing signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation start</td>
<td>0 in the first measurement</td>
<td>Average</td>
</tr>
</tbody>
</table>

Average power saving value when [Pn: 897 = 4] [Pn: 895]
363

(5) Power estimated value of commercial power supply operation [Pr. 892, Pr. 893, Pr. 894]

Select the commercial power supply operation pattern from among the four patterns of discharge damper control (fan), inlet damper control (fan), valve control (pump), and commercial power supply drive, and set it to [Pr. 894 Control selection during commercial power-supply operation].

Select motor capacity (pump capacity) in [Pr. 893 Energy saving monitor reference (motor capacity)].

The power consumption rate (%) during commercial power supply operation is estimated from the operation pattern and the ratio of speed to rating (current output frequency/[Pr. 3 Base frequency]) in the following chart.

From the motor capacity set in [Pr. 893] and [Pr. 892 Load factor], the power estimated value (kW) during commercial power supply operation is found by the following formula.

\[
\text{Power estimated value (kW) during commercial power supply operation (kW)} = \left( \frac{\text{Pr. 893 kW}}{100} \right) \times \left( \frac{\text{Pr. 892 %}}{100} \right)
\]

Since the speed does not increase above the power supply frequency in commercial power supply operation, it becomes constant when the output frequency rises to or above [Pr. 3 Base frequency].

(6) Annual power saving amount, power charge [Pr. 899]

By setting the operation time rate [%] (ratio of time when the motor is actually driven by the inverter during a year) in [Pr. 899 Operation time rate (estimated value)], the annual energy saving effect can be estimated. When the operation pattern is predetermined to some degree, the estimated value of the annual power saving amount can be found by measurement of the power saving amount during a given measurement period.

Refer to the following and set the operation time rate.

1) Estimate the average time [h/day] of operation in a day.
2) Find the annual operation days [days/year]. (Monthly average operation days x 12 months)
3) Calculate the annual operation time [h/year].
4) Calculate the operation time rate and set it to [Pr. 899].

\[
\text{Annual operation time (h/year)} = \text{average time (h/day)} \times \text{operation days (days/year)}
\]

[Operation time rate setting example]
When operation is performed for about 21 hours per day and the monthly average operation days are 16 days.

\[
\text{Annual operation time} = 21 \times 16 \times 12 = 4032 \text{h/year}
\]

\[
\text{Operation time rate} = \frac{4032 \text{(h/year)}}{24 \times 365 \text{(days/year)}} = 46.03\%
\]

Set [Pr. 899 = 46.03%].

Calculate the annual power saving amount from [Pr. 899 Operation time rate (estimated value)] and power saving average value monitor.

\[
\text{Annual power saving amount (kWh/year)} = \text{Annual operation time (h/year)} \times \text{Power saving average value (kW)} \times \frac{24 \times 365 \text{(days/year)}}{100}
\]

The annual power saving charge can be monitored by setting the power charge per hour in [Pr. 896 Power unit cost].

Calculate the annual power saving charge in the following method.

\[
\text{Annual power saving amount charge} = \text{Annual power saving amount (kWh/year)} \times \text{Power unit cost (yen/kWh)}
\]

In the regeneration mode, make calculation on the assumption that power saving = power during commercial power supply operation (input power = 0).
### 2.15.8 Display of the life of the inverter parts [Pr. 255 to 259] (common)

Degrees of deterioration of main circuit capacitor, control circuit capacitor, cooling fan and inrush current limit circuit can be diagnosed by monitor. When any part has approached the end of its life, an alarm can be output by self diagnosis to prevent a fault. (Use the life check of this function as a guideline since the main circuit capacitor is calculated theoretically.)

For the life check of the main circuit capacitor, the alarm signal (Y90) will not be output if a measuring method of (4) is not performed.

#### (1) Life alarm display and signal output (Y90 signal) [Pr. 255]

Whether any of the control circuit capacitor, main circuit capacitor, cooling fan and inrush current limit circuit has reached the life alarm output level or not can be checked by [Pr. 255 Life alarm status display] and life alarm signal (Y90).

The life alarm signal (Y90) turns ON when any of the control circuit capacitor, main circuit capacitor, cooling fan and inrush current limit circuit reaches the life alarm output level.

For the terminal to output Y90 signal, assign 90 (positive logic) or 190 (negative logic) to any of [Pr.190 to 196 Output terminal function selection], [Pr.190 to 192 Output terminal function selection], or [Pr.190, 192 Output terminal function selection].

When using a built-in option (FR-A7AY, FR-A7AR) in [Pr.256 to 258], the following life signals can be output individually: control circuit capacitor life signal (Y86), main circuit capacitor life signal (Y87), cooling fan life signal (Y88), and inrush current limit circuit life signal (Y89).

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>255</td>
<td>Life alarm status display</td>
<td>0</td>
<td>(0 to 15)</td>
<td>Displays whether the control circuit capacitor, main circuit capacitor, cooling fan, and each parts of the inrush current limit circuit has reached the life alarm output level or not. Reading only</td>
</tr>
<tr>
<td>256</td>
<td>Inrush current limit circuit life display</td>
<td>100%</td>
<td>(0 to 100%)</td>
<td>Displays the deterioration degree of the inrush current limit circuit. Reading only</td>
</tr>
<tr>
<td>257</td>
<td>Control circuit capacitor life display</td>
<td>100%</td>
<td>(0 to 100%)</td>
<td>Displays the deterioration degree of the control circuit capacitor. Reading only</td>
</tr>
<tr>
<td>258</td>
<td>Main circuit capacitor life display</td>
<td>100%</td>
<td>(0 to 100%)</td>
<td>Displays the deterioration degree of the main circuit capacitor. Reading only. The value measured by [Pr. 259] is displayed.</td>
</tr>
<tr>
<td>259</td>
<td>Main circuit capacitor life measuring</td>
<td>0</td>
<td>0, 1</td>
<td>(2, 3, 9, 9)</td>
</tr>
</tbody>
</table>

#### Table:

<table>
<thead>
<tr>
<th>[Pr.255] (Decimal)</th>
<th>Bit (Binary)</th>
<th>Inrush Current Limit Circuit Life</th>
<th>Cooling Fan Life</th>
<th>Main Circuit Capacitor Life</th>
<th>Control Circuit Capacitor Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>1111</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>O</td>
</tr>
<tr>
<td>14</td>
<td>1110</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>×</td>
</tr>
<tr>
<td>13</td>
<td>1111</td>
<td>O</td>
<td>O</td>
<td>O</td>
<td>×</td>
</tr>
<tr>
<td>12</td>
<td>1100</td>
<td>O</td>
<td>O</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>11</td>
<td>1011</td>
<td>O</td>
<td>O</td>
<td>×</td>
<td>×</td>
</tr>
<tr>
<td>10</td>
<td>1010</td>
<td>O</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>9</td>
<td>1001</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>8</td>
<td>1000</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>7</td>
<td>0111</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>6</td>
<td>0110</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>5</td>
<td>0101</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>4</td>
<td>0100</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>3</td>
<td>0011</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>2</td>
<td>0010</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>1</td>
<td>0001</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
<tr>
<td>0</td>
<td>0000</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
<td>⊗</td>
</tr>
</tbody>
</table>

O: With warnings, ⊗: Without warnings
(2) Inrush limit circuit life display [Pr. 256]
The life of the inrush current limit circuit (relay, contactor and inrush resistance) is displayed in [Pr. 259]. The number of contact (relay, contactor, thyristor) ON times is counted. It is counted down from 100% (used 0 time and 1,000,000 times left) at every 1% (at every 10,000 times). When the count reaches 10% (used 900,000 times and 100,000 times left), [Pr. 259] bit 3 is turned ON and Y90 signal is output to notify the life.

(3) Control circuit capacitor life display [Pr. 257]
The deterioration degree of the control circuit capacitor is displayed in [Pr. 257] as a life. The control circuit capacitor life is calculated from the energization time and temperature according to the operating status, and is counted down from 100%. As soon as the control circuit capacitor life falls below 10%, [Pr. 255] bit 0 is turned ON and also an alarm is output to the Y90 signal.

(4) Main circuit capacitor life display [Pr. 258, 259]
The deterioration degree of the main circuit capacitor is displayed in [Pr. 258] as a life. On the assumption that the main circuit capacitor capacitance at factory shipment is 100%, the capacitor life is displayed in [Pr. 259] every time measurement is made. When the measured value falls to or below 85%, [Pr. 259] bit 1 is turned ON and also an alarm is output to the Y90 signal.

1) Check that the motor is connected and at a stop.
2) Set [Pr. 259 = 1] (measuring start)
3) Switch power OFF. The inverter applies DC voltage to the motor to measure the capacitor capacity while the inverter is OFF.
4) After making sure that the power lamp is OFF in and LED on the operation panel is OFF in , switch ON the power supply again.
5) Confirm that [Pr. 259 = 3] (measurement complete), read [Pr. 258], and check the deterioration degree of the main circuit capacitor.

<table>
<thead>
<tr>
<th>[Pr.259]</th>
<th>Description</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No measurement</td>
<td>Initial value</td>
</tr>
<tr>
<td>1</td>
<td>Measurement start</td>
<td>Measurement starts when the power supply is switched OFF.</td>
</tr>
<tr>
<td>2</td>
<td>During measurement</td>
<td>Only displayed and cannot be set</td>
</tr>
<tr>
<td>3</td>
<td>Measurement complete</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Forced end</td>
<td>See (c), (g), (h), (i) below.</td>
</tr>
<tr>
<td>9</td>
<td>Measurement error</td>
<td>See (d), (e), (f) below.</td>
</tr>
</tbody>
</table>

Do not measure in the following conditions. If measured in the following conditions, "forced end" [Pr. 259=8] or "measurement error" [Pr. 259=9] would occur, or "measurement start" [Pr. 259=1] would continue. Even when "measurement complete" [Pr. 259=3] appears in the following conditions, the capacitor capacity is not measured correctly.

(a) FR-HC, MT-HC, FR-CV, or a sine wave filter is connected.
(b) Terminal R1/L1, S1/L2 or DC power supply is connected to terminal P/+ and N/-.
(c) Switching power ON during measuring.
(d) The motor is running (coasting)
(e) The motor capacity is two rank smaller as compared to the inverter capacity.
(f) The inverter output is shut off with the MRS signal.
(g) The start command is given while measuring.

(a) FR-HC or FR-CV is connected.
(b) DC power supply is connected to terminal P/+ and terminal N/-. 
(c) Switching power ON during measuring.
(d) The motor is not connected to the inverter.
(e) The motor is running (coasting)
(f) The motor capacity is two rank smaller as compared to the inverter capacity.
(g) The inverter is tripped or a fault occurred when power is OFF.
(h) The inverter output is shut off with the MRS signal.
(i) The start command is given while measuring.
(k) Using terminal PC as a power supply.
(l) I/O terminals on the control terminal block
(including the I/O terminals of built-in options
for E700) are ON (conducted).
(m) A built-in option is installed (only for E700
0.75K or less).
• Turning the power supply ON during
measurement before LED turns OFF may cause
"during measurement" [Pr. 259 =2] output to
continue. In that case, re-do the operation from 2.

(5) Cooling fan life display
The cooling fan speed of 50% or less is detected and
"FN" is displayed on the operation panel and
parameter unit (FR-PU04/FR-DU07). As an alarm
display, [Pr. 255] bit2 is turned ON and also an alarm
is output to the Y90 signal.
When the inverter is mounted with two or more
cooling fans, the life of even one cooling fan is
diagnosed.
2.16 Operation selection at power failure and instantaneous power failure

2.16.1 Automatic restart after instantaneous power failure/flying start

When instantaneous power failure protection (E.IPF) and undervoltage protection (E.UVT) are activated, the inverter output is shut off. (Refer to page 111 for E.IPF and E.UVT.) When automatic restart after instantaneous power failure operation is set with the following conditions, the motor can be restarted if power is restored after an instantaneous power failure or undervoltage. (E.IPF and E.UVT are not activated.)

- when electronic bypass operation is switched to inverter operation
- when power comes back ON after an instantaneous power failure
- when motor is coasting at start

Automatic restart after instantaneous power failure function is invalid when load torque high speed frequency control ([Pr. 270], [Pr. 271]) is set.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>Restart coasting time</td>
<td>9999</td>
<td></td>
<td>Set the waiting time for inverter-triggered restart after an instantaneous power failure.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 to 5s</td>
<td>7.5K or less: 0.1s</td>
<td>E700, D700, A700, F700</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.1 to 35s</td>
<td>7.5K or more: 1s</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>75K or more: 5s</td>
<td></td>
</tr>
<tr>
<td>58</td>
<td>Restart cushion time</td>
<td>1s</td>
<td>0 to 80s</td>
<td>Set a voltage starting time at restart.</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>Auto tuning setting/status</td>
<td>0</td>
<td></td>
<td>Offline auto tuning is not performed.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>Offline auto tuning (all motor constants) without running the motor. (Refer to page 294)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>11</td>
<td>Offline auto tuning (only motor constant (R1)) without running the motor. (Refer to page 294)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>21</td>
<td>Offline auto tuning (without running the motor) for automatic restart after instantaneous power failure (with frequency search)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>101</td>
<td>Offline auto tuning (all motor constants) by running the motor. (Refer to page 294)</td>
<td></td>
</tr>
<tr>
<td>162</td>
<td>Automatic restart after instantaneous power failure selection</td>
<td>0</td>
<td></td>
<td>With frequency search</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>Without frequency search (reduced voltage exists)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td>Encoder detection frequency search</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10</td>
<td>Frequency search at every start</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>12</td>
<td>Encoder detection frequency search at every start</td>
<td></td>
</tr>
</tbody>
</table>

("Pr. 163, 164\) are not available for \((\text{E700, D700})\)
("Pr. 295\) is not available for \((\text{E700, D700})\)
* These parameters are not used in instantaneous power failure function.

### Table: Available Inverters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A700</td>
<td>○</td>
</tr>
<tr>
<td>E700</td>
<td>○</td>
</tr>
<tr>
<td>D700</td>
<td>○</td>
</tr>
<tr>
<td>F700</td>
<td>○</td>
</tr>
</tbody>
</table>

### Parameter Description

1. **Connection (CS signal)**

When the automatic restart after instantaneous power failure selection signal (CS) is turned ON, automatic restart operation is enabled. To use automatic restart after instantaneous power failure or flying start function, turn ON CS signal. To operate by switching between bypass and inverter operation, configure a sequence which turns OFF CS signal during bypass operation and turns ON during inverter operation.

When [Pr. 7 > 9999] (automatic restart operation enabled), the inverter will not operate if used with the CS signal remained OFF.
(2) Automatic restart operation selection [Pr. 162, Pr. 299]

1) With frequency search
When [Pr. 162 = 0, 10], the inverter smoothly starts by increasing voltage up to the frequency set in [Pr. 58 Restart cushion time] after detecting the motor speed upon power restoration.

When performing Real sensorless vector control on [E700], control starts at the detected frequency (E700 Restart cushion time is invalid).

Even when the motor is rotating in the opposite direction, the inverter can be restarted smoothly as the direction of rotation is detected.

When selecting frequency search in [E700], perform offline auto tuning.

Whether to make a rotation direction detection or not can be selected using [Pr. 299 Rotation direction detection selection at restarting]. When capacities of the motor and inverter differ, set [Pr. 2W = 0] (without rotation direction detection).

When reverse rotation is detected when [Pr. 78 = 1] (reverse rotation disabled), the rotation direction is changed to forward rotation after decelerates in reverse rotation when the start command is forward rotation. The inverter will not start when the start command is reverse rotation.

<table>
<thead>
<tr>
<th>[Pr. 162] Setting</th>
<th>[Pr. 299] Setting</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (preset value)</td>
<td>○ the rotation direction is detected.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>× the rotation direction is not detected.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Speed detection time (frequency search) changes according to the motor speed: (maximum 500ms in [E700], maximum 100ms in [E700]).

When the inverter capacity is two or more than the motor capacity, the inverter may not start due to overcurrent (OCT) alarm.

If two or more motors are connected to one inverter, the inverter functions abnormally. (The inverter does not start smoothly.)

Since the DC injection brake is operated instantaneously when the speed is detected at a restart, the speed may decrease if the load inertia (J) is small.

When [E700] perform automatic restart after instantaneous power failure in low speed operation (less than 10Hz), [E700] restart with the same rotation direction as before the instantaneous power failure and does not detect rotation direction [Pr. 299 Rotation direction detection selection at restarting].

When result of frequency search is the setting frequency or higher, output frequency is limited to the set frequency.

When wiring length is longer than the values in the table below in [E700], select "without frequency search" [Pr. 76C7T, 11].

2) Frequency not searched
When [Pr. 162 = 1, 11], automatic restart operation is performed in a reduced voltage, where the voltage is gradually risen with the output frequency unchanged from prior to an instantaneous power failure independently of the coasting speed of the motor.

When performing Real sensorless vector control on [E700], control starts at the output frequency before instantaneous power failure ([Pr. 58 Restart cushion time] is invalid).

This system stores the output frequency prior to an instantaneous power failure and increases the voltage. Therefore, if the instantaneous power failure time exceeds 0.2s, the inverter starts at [Pr. 11 Starting frequency] (initial value = 0.5Hz) since the stored output frequency cannot be retained.
3) Encoder detection frequency search

Encoder detection frequency search is valid when the plug-in option FR-A7AP is mounted to and encoder signal is connected. When $Pr.162 = 2, 12$, frequency search ($Pr.162 = 0, 10$) is executed.

When encoder feedback control is invalid ($Pr.162 = 2, 12$), frequency search ($Pr.162 = 0, 10$) is executed.

4) Restart operation at every start

When $Pr.162 = 10, 11, 12$ is set, automatic restart operation is also performed every start, in addition to the automatic restart after instantaneous power failure (start after $Pr.17$ set time has elapsed). When $Pr.162 = 0, 1, 2$, automatic restart operation is performed at first start after power ON, but not performed at the second start or later.

5) Automatic restart operation selection by MRS(X10) signal.

When automatic restart operation of high power regeneration common converter (FR-HC) is selected by setting $Pr.30 = 2$ (Refer to page 331), automatic restart operation is performed at a start after tuning ON → OFF the MRS (X10) signal.

(3) Restart coasting time $[Pr.57]$

Coasting time is the time from when the motor speed is detected until automatic restart control is started. Set $Pr.57 = 0$ to perform automatic restart operation. The coasting time is automatically set to the value below. Generally this setting will pose no problems.

- $[Pr.61] [Pr.20]$
  - 1.5K or less................. 0.5s
  - 2.2K to 7.5K............... 1s
  - 11K to 55K................ 3.0s
  - 75K or more.............. 5.0s

- $[Pr.63] [Pr.65]$
  - 1.5K or less................. 1s
  - 2.2K to 7.5K............... 2s
  - 11K or more............... 3s

Operation may not be performed well depending on the magnitude of the load inertia (J) or running

* The output shut off timing differs according to the load condition.

---

PARAMETER

V/F control, Advanced magnetic flux vector control, General-purpose magnetic flux vector

4) Restart operation at every start

When $Pr.162 = 10, 11, 12$ is set, automatic restart operation is also performed every start, in addition to the automatic restart after instantaneous power failure (start after $Pr.17$ set time has elapsed). When $Pr.162 = 0, 1, 2$, automatic restart operation is performed at first start after power ON, but not performed at the second start or later.

5) Automatic restart operation selection by MRS(X10) signal.

When automatic restart operation of high power regeneration common converter (FR-HC) is selected by setting $Pr.30 = 2$ (Refer to page 331), automatic restart operation is performed at a start after tuning ON → OFF the MRS (X10) signal.

(3) Restart coasting time $[Pr.57]$

Coasting time is the time from when the motor speed is detected until automatic restart control is started. Set $Pr.57 = 0$ to perform automatic restart operation. The coasting time is automatically set to the value below. Generally this setting will pose no problems.

- $[Pr.61] [Pr.20]$
  - 1.5K or less................. 0.5s
  - 2.2K to 7.5K............... 1s
  - 11K to 55K................ 3.0s
  - 75K or more.............. 5.0s

- $[Pr.63] [Pr.65]$
  - 1.5K or less................. 1s
  - 2.2K to 7.5K............... 2s
  - 11K or more............... 3s

Operation may not be performed well depending on the magnitude of the load inertia (J) or running

* The output shut off timing differs according to the load condition.
frequency. Adjust the coasting time between 0.1s and 5s according to the load specifications.

(4) Restart cushion time [Pr. 58]
Cushion time is the length of time taken to raise the voltage appropriate to the detected motor speed (output frequency prior to instantaneous power failure when Pr. 266 = “1” or “11”). Normally the initial value need not be changed for operation, but adjust it according to the magnitude of the load inertia (J) of the load or torque. [Pr. 58 Restart cushion time] is invalid during encoder feedback control ([Pr. 266 = 2, 12]). Real sensorless vector control or vector control on [C26].
The SU and FU signals are not output during a restart. These are output after the restart cushion time has elapsed.

(5) Automatic restart operation selection [Pr. 163*, 164*, 165, 611] (*Not available for .)
In , voltage rise time at a restart can be adjusted as shown above using [Pr. 163, 164]. Using [Pr. 266], the stall prevention operation level at a restart can be set. Acceleration time (acceleration slope) can be set using [Pr. 611, Acceleration time at a restart] separately from the acceleration time in normal operation. For [Pr. 611], set the acceleration time to reach [Pr. 20, Acceleration/Deceleration reference frequency] from 0Hz. (If the [Pr. 21, Acceleration/Deceleration time increment] setting is changed, the setting increments of [Pr. 611] remain unchanged.)

(6) Frequency search gain (Pr. 298), offline auto tuning (Pr. 96) [상단 도표]
When automatic restart after instantaneous power failure operation (with frequency search) is valid at V/F control, perform offline auto tuning. Perform offline auto tuning during V/F control in the following order to set [Pr. 298, Frequency search gain] automatically. (Refer to page 268 during Advanced magnetic flux vector control and General-purpose magnetic flux vector control.)

Checking the wiring and load
Check the following before performing offline auto tuning.
1) Connect a motor, and select V/F control. Note that the motor should be at a stop at a tuning start.
2) The motor capacity should be equal to or one rank lower than the inverter capacity. (Note that the capacity is 0.1kW or more.)
3) Auto tuning can be performed with load (such as friction and steady load) connected to the motor. Note that tuning is more accurate with smaller load. Tuning accuracy is not affected if the inertia is large.
4) Even when [Pr. 96 = 21] (tuning without running motor), the motor may run slightly. Therefore, fix the motor securely with a mechanical brake, or before tuning, make sure that there will be no problem in safety if the motor runs. ( Especially, fix the motor securely in vertical lift applications.)

Parameter setting
Set the following parameters.
1) [Pr. 96 Auto tuning setting/status ]
   Set 21.
   Tuning is performed without running the motor.
2) [Pr. 9 Electric thermal]
   ________ Set motor rated current (A).
3) [Pr. 71 Applied motor]
   ________ Select the setting value from the below table.

<table>
<thead>
<tr>
<th>Motor</th>
<th>Pr. 71 Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mitsubishi standard motor</td>
<td>SF-JR</td>
</tr>
<tr>
<td>Mitsubishi high efficiency motor</td>
<td>SF-JR, SF-J</td>
</tr>
<tr>
<td>Others</td>
<td>SF-JRCR</td>
</tr>
<tr>
<td>Mitsubishi constant torque motor</td>
<td>SF-JRCA</td>
</tr>
<tr>
<td>Other manufacturer’s standard motor</td>
<td>SF-JRCA, JRC, etc.</td>
</tr>
<tr>
<td>Other manufacturer’s constant torque motor</td>
<td>—</td>
</tr>
</tbody>
</table>
Execution of auto tuning

When performing PU operation, press of the operation panel.

For External operation, turn ON the start command (STF signal or STR signal). Tuning starts. (Excitation noise generates at this time.)

Since the RUN signal turns ON when tuning is started, caution is required especially when a sequence which releases a mechanical brake by the RUN signal has been designed.

During offline auto tuning, the following I/O signals are the only valid signals (in the initial setting.)

It takes approximately 9s to complete the tuning.

To force tuning to end

Enter signal to terminal MRS or RES, or press during the PU operation mode. In the External operation mode, enter signal to terminal MRS or RES, or turn OFF the starting switch (STR or STR signal) to end the operation.

After tuning is completed, check \[Pr.96\] setting.

- Ended properly...............3 or 103 is displayed.
- Ended in error ................One of 8, 9, 91, 92, and 92 is displayed.

When offline auto tuning ends, press \[\text{STOP PU}\] of the operation panel during PU operation. For External operation, turn OFF the start signal (STF signal or STR signal) once.

This operation resets the offline auto tuning and the PU’s monitor display returns to the normal indication. (Without this operation, next operation cannot be started.)

When tuning ends in error, auto tuning is not performed properly, so the frequency search gain is not set. Perform inverter reset (refer to page 57), and re-do the tuning.

When using the motor corresponding to the following specifications and conditions, set \[Pr. 156 \text{Current limit (stall prevention) function was activated.}\]

When offline auto tuning ends, press \[\text{STOP PU}\] of the operation panel during PU operation. For External operation, turn OFF the start signal (STF signal or STR signal) once.

### Error Table

<table>
<thead>
<tr>
<th>Error Cause</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Forced end. Set “21” in [Pr. 96] and perform tuning again.</td>
</tr>
<tr>
<td>9</td>
<td>Inverter protective function operation was activated. Make setting again.</td>
</tr>
<tr>
<td>90</td>
<td>Converter output voltage reached 75% of rated value. Check for fluctuation of power supply voltage.</td>
</tr>
<tr>
<td>91</td>
<td>Current limit (stall prevention) function was activated. Set acceleration / deceleration time longer. Set “17” in [Pr. 151].</td>
</tr>
<tr>
<td>92</td>
<td>Calculation error. A motor is not connected. Check the motor wiring and make setting again. Set the rated current of the motor in [Pr. 9].</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Unit (FR-PU04, FR-PU07)</th>
<th>Operation Panel</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 96] setting 21</td>
<td>[STOP PU]</td>
</tr>
<tr>
<td>(1) Setting</td>
<td>[STOP PU]</td>
</tr>
<tr>
<td>(2) Tuning in progress</td>
<td>[STOP PU]</td>
</tr>
<tr>
<td>(3) Normal end</td>
<td>OPERATION</td>
</tr>
<tr>
<td>(4) Error and protective function operation is activated)</td>
<td>[STOP PU]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Error Display</th>
<th>Error Cause</th>
<th>Countermeasure</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>Forced end</td>
<td>Set “21” in [Pr. 96] and perform tuning again.</td>
</tr>
<tr>
<td>9</td>
<td>Inverter protective function operation</td>
<td>Make setting again.</td>
</tr>
<tr>
<td>90</td>
<td>Converter output voltage</td>
<td>Check for fluctuation of power supply voltage.</td>
</tr>
<tr>
<td>91</td>
<td>Current limit (stall</td>
<td>Set acceleration / deceleration time longer. Set “17” in [Pr. 151].</td>
</tr>
<tr>
<td>92</td>
<td>Calculation error</td>
<td>Check the motor wiring and make setting again. Set the rated current of the motor in [Pr. 9].</td>
</tr>
</tbody>
</table>

E700

D700

E700

D700

Parameter

Unit

Operation Panel

Indication

STOP PU

21

READ:List

FWD PU

22

TUNE

STOP PU

23

STF

TUNE

COMPLETION

Flickering

STOP PU

9

STF

TUNE

ERROR
### 2.16.2 Power failure stop mode [Pr. 261, 262 to 266*, Pr. 294]  (common)

When a power failure or undervoltage occurs, the inverter can be decelerated to a stop or can be decelerated and re-accelerated to the set frequency.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>261</td>
<td>Power failure stop selection</td>
<td>0</td>
<td>0 to 20Hz</td>
<td>When undervoltage or power failure occurs, the inverter can be decelerated to a stop.</td>
<td></td>
</tr>
<tr>
<td>262</td>
<td>Subtracted frequency at deceleration start</td>
<td>3Hz</td>
<td>0 to 20Hz</td>
<td>Normally operation can be performed with the initial value unchanged. But adjust the frequency according to the magnitude of the load specifications (moment of inertia, torque).</td>
<td></td>
</tr>
<tr>
<td>263</td>
<td>Subtraction starting frequency</td>
<td>0 to 120Hz</td>
<td>When output frequency ≥ [Pr. 262]: Decelerate from the speed obtained from output frequency minus [Pr. 266]; When output frequency &lt; [Pr. 262]: Decelerate from output frequency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>264</td>
<td>Power-failure deceleration time 1</td>
<td>5s 0 to 3600</td>
<td>Set a deceleration slope down to the frequency set in [Pr. 266].</td>
<td></td>
<td></td>
</tr>
<tr>
<td>265</td>
<td>Power-failure deceleration time 2</td>
<td>9999 0 to 3600</td>
<td>Set a deceleration slope below the frequency set in [Pr. 266].</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>266</td>
<td>Power-failure deceleration time switchover frequency</td>
<td>0 to 400Hz</td>
<td>Set the frequency at which the deceleration slope is switched from the [Pr. 264] setting to the [Pr. 265] setting.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>294</td>
<td>UV avoidance voltage gain</td>
<td>100% 0 to 200%</td>
<td>Adjusts the response level during undervoltage avoidance operation. A larger setting will improve responsiveness to the bus voltage change. Since the regeneration amount is large when the inertia is large, decrease the setting value.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The setting range is 0 to 3600 and the setting increments is 0.1s when [Pr. 21: Acceleration/deceleration time increments] = 0 (initial value) and the setting range is 0 to 360s and the setting increments is 0.01s when [Pr. 21 = 1].

The parameter [Pr. 294] is not available for [F700, E700, D700].

The parameters [Pr. 262 to 266, 294] are not available for [E700, D700].
1) Connection and parameter setting

For [Pr. 264 ≠ 0], remove a jumper across terminals R/L1-R1/L11 and terminals S/L2-S1/L21 and connect terminal R1/L11 to terminal P/+ and terminal S1/L21 to terminal N/−.

When [Pr. 261 = 0] and an undervoltage or power failure occurs, undervoltage protection (E.UVT) or instantaneous power failure protection (E.IPF) is not provided, but power failure deceleration is made.

If input phase is lost when [Pr. 872 ≠ 1] (input phase loss protection provided) and [Pr. 261 ≠ 0], input phase failure protection (E.ILF) is not provided but power-failure deceleration is made.

When [Pr. 261 ≠ 0] in [Pr. 262 ≠ 0], inverter decelerates to a stop at undervoltage and power failure.

2) Operation outline of deceleration to stop at power failure

If an undervoltage or power failure occurs in [Pr. 262 ≠ 0], the output frequency is dropped by the frequency set in [Pr. 262 Subtracted frequency at deceleration start], and deceleration is made for the deceleration time set in [Pr. 264 Power-failure deceleration time 1]. (Deceleration time setting is the time taken from the [Pr. 20 Acceleration/deceleration reference frequency] to a stop.)

When the frequency is low and enough regeneration energy is not provided, for example, the deceleration time (slope) from [Pr. 266 Power-failure deceleration time switchover frequency] to a stop can be changed using [Pr. 265 Power-failure deceleration time 2].

When automatic restart after instantaneous power failure is selected [Pr. 17 = 9999], power failure stop function is made invalid and automatic restart operation after instantaneous power failure is performed.

3) Power failure stop mode [Pr. 261 = 1, 11]

(*not available for [Pr. 770])

If power is restored during power failure deceleration, deceleration to a stop is continued and the inverter remains stopped. To restart, turn OFF the start signal once, then turn it ON again.

After a power failure stop, the inverter will not start even if the power is turned ON with the start signal (STF/STR) input. After switching ON the power, turn OFF the start signal once and then ON again to make a start.

When automatic restart after instantaneous power failure is selected [Pr. 17 = 9999], power failure stop function is invalid and automatic restart operation after instantaneous power failure is performed.
(4) Operation continuation function at instantaneous power failure [Pr. 261 = 2, 12]
(*not available for Y70D E70D D70D)
When power is restored during deceleration after a power failure, acceleration is made again up to the set frequency.

* Acceleration time follows the [Pr. 7] ([Pr. 4]) setting.

When this function is used in combination with the automatic restart after instantaneous power failure operation, deceleration can be made at a power failure and acceleration can be made again after power restoration. When power is restored after a stop by deceleration at an instantaneous power failure, automatic restart operation is performed if automatic restart after instantaneous power failure has been selected [Pr. 57 ≠ "9999"]
Keep start signal (STF/STR) ON during instantaneous power failure. When start signal turns OFF during instantaneous power failure, the inverter decelerates by the deceleration time setting. If regeneration energy is insufficient, the motor coasts.

(5) Undervoltage avoidance function [Pr. 261 = 11, 12, Pr. 284]
When [Pr. 261 = 11, 12], the deceleration time is automatically adjusted (shortened) to prevent undervoltage from occurring during deceleration at an instantaneous power failure. Adjust the slope of frequency decrease and response level with [Pr. 284]. A larger setting will improve responsiveness to the bus voltage. Since the regeneration amount is large when the inertia is large, decrease the setting value.

Undervoltage avoidance function is invalid during torque control by Real sensorless vector control.
When [Pr. 261 = 11 (12)], the inverter operates in the same manner as when [Pr. 261 = 1 (2)].

(6) Power failure deceleration signal (Y46 signal)
After deceleration at an instantaneous power failure, inverter can not start even if the start command is given. In this case, check the power failure deceleration signal (Y46).
The Y46 signal is ON during deceleration at an instantaneous power failure or during a stop after deceleration at an instantaneous power failure.
For the Y46 signal, set 46 (positive logic) or 146 (negative logic) in any of [Pr. 190 to Pr. 196 (output terminal function selection)] to assign the function.
2.17 Alarm function

2.17.1 Retry function [Pr. 65, 67 to 69] (common)

If a fault occurs, the inverter resets itself automatically to restart. You can also select the fault that causes a retry.

When you have selected automatic restart after instantaneous power failure ([Pr. 57 Restart coasting time ≠ 9999]), restart operation is performed at the retry operation time which is the same as that of a power failure. (Refer to page 367 for the restart function.)

(1) Retry operation [Pr. 67 to 69]

Retry operation automatically resets a fault and restarts the inverter at the starting frequency when the time set in [Pr. 68 Retry waiting time] elapses after the inverter is tripped.

Retry operation is performed by setting [Pr. 67 ≠ 0].

Set the number of retries at fault occurrence in [Pr. 67 Number of retries at fault occurrence]. When retries fail consecutively more than the number of times set in [Pr. 67], a retry count excess fault (E.RET) occurs, and the inverter trips. (Refer to retry failure example)

Use [Pr. 68 Retry waiting time] to set the waiting time from an inverter trip to a retry in the range of 0 to 10s in , 0.1 to 360s in , and 0.1 to 600s in . (When the setting value is 0s, the actual time is 0.1s.)

Reading [Pr. 69 Retry count display erase] provides the cumulative number of successful restart times made by retry. The cumulative count in [Pr. 69] is increased by 1 when a retry is regarded as successful after normal operation continues without faults occurring for more than four times longer than the time set in [Pr. 68] after a retry start. (After retry is succeeded, cumulative number of retry fail time is cleared.)

Writing 0 in [Pr. 69] clears the cumulative count. During a retry, the Y64 signal is ON. For the Y64 signal, assign the function by setting 64 (positive logic) or 164 (negative logic) in any of [Pr. 196 Output terminal/function selection].

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>65</td>
<td>Retry selection</td>
<td>0</td>
<td>0 to 5</td>
<td>A fault for retry can be selected. (Refer to the next page)</td>
</tr>
<tr>
<td>67</td>
<td>Number of retries at fault occurrence</td>
<td>0</td>
<td>1 to 10</td>
<td>Set the number of retries at fault occurrence. A fault output is not provided during retry operation.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>101 to 110</td>
<td>0.1 to 360s</td>
<td>Set the number of retries at fault occurrence. (The setting value of minus 100 is the number of retries.) A fault output is provided during retry operation.</td>
</tr>
<tr>
<td>68</td>
<td>Retry waiting time</td>
<td>1s</td>
<td>0 to 10s</td>
<td>Set the waiting time from when an inverter trips until a retry is made.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.1 to 360s</td>
<td>0.1 to 600s</td>
<td></td>
</tr>
<tr>
<td>69</td>
<td>Retry count display erase</td>
<td>0</td>
<td>0</td>
<td>Clear the number of restarts succeeded by retry.</td>
</tr>
</tbody>
</table>
(2) Retry selection[Pr. 65]

Use [Pr. 65 Retry selection] to select the fault to be activated for retries. No retry will be made for the fault not indicated. (Refer to page 97 for the fault description: ● in the table below indicates the fault items to be selected for retry.

For a retry error, only the description of the first fault is stored.

When an inverter fault is reset by the retry function at the retry time, the accumulated data such as the electronic thermal relay function, regeneration brake duty are not cleared. (Different from the power-ON reset.)

When E.PE (Parameter storage device fault) occurs at power-ON, retry is not performed.

Stay away from the motor and machine when inverter tripped while retry function is selected. The motor starts suddenly (after the reset time has elapsed) after the inverter trip.

<table>
<thead>
<tr>
<th>Fault for Retry</th>
<th>[Pr. 65] Setting</th>
<th>Fault for Retry</th>
<th>[Pr. 65] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.OC1</td>
<td>●</td>
<td>E.PE</td>
<td>●</td>
</tr>
<tr>
<td>E.OC2</td>
<td>●</td>
<td>E.MB1</td>
<td>●</td>
</tr>
<tr>
<td>E.OC3</td>
<td>●</td>
<td>E.MB2</td>
<td>●</td>
</tr>
<tr>
<td>E.OV1</td>
<td>●</td>
<td>E.MB3</td>
<td>●</td>
</tr>
<tr>
<td>E.OV2</td>
<td>●</td>
<td>E.MB4</td>
<td>●</td>
</tr>
<tr>
<td>E.OV3</td>
<td>●</td>
<td>E.MB5</td>
<td>●</td>
</tr>
<tr>
<td>E.THR</td>
<td>●</td>
<td>E.MB6</td>
<td>●</td>
</tr>
<tr>
<td>E.THT</td>
<td>●</td>
<td>E.MB7</td>
<td>●</td>
</tr>
<tr>
<td>E.UVT</td>
<td>●</td>
<td>E.PT1</td>
<td>●</td>
</tr>
<tr>
<td>E.BE</td>
<td>●</td>
<td>E.CO1</td>
<td>●</td>
</tr>
<tr>
<td>E.GF</td>
<td>●</td>
<td>E.SER</td>
<td>●</td>
</tr>
<tr>
<td>E.OP1</td>
<td>●</td>
<td>E.COG</td>
<td>●</td>
</tr>
<tr>
<td>E.OP2</td>
<td>●</td>
<td>E.EF</td>
<td>●</td>
</tr>
</tbody>
</table>

*1 E.OP1 appears on (F700) (E700).
*2 These are not available for (F700).
*3 These are not available for (F700).
*4 These are not available for (F700).
2.17.2 Fault code output selection [Pr. 76] (A700) (F700)

At fault occurrence, its definition can be output as 4 bit digital signal from the open collector output terminal. The fault code can be read by a programmable controller, etc., and its countermeasure can be shown on a display, etc.

By setting \([\text{Pr. 76}]=1\) or \(2\), the fault code can be output to the output terminals. When an fault occurs, the output terminals \(\text{SU}, \text{IPF}, \text{OL}, \text{FU}\) output the signal in the right table, independently of the \([\text{Pr. 190 to Pr. 196 Output terminal selection}]\) settings. Please be careful when inverter control setting has been made with the output signals of \([\text{Pr. 190 to Pr. 196}]\).

When \([\text{Pr. 76}]=2\), an fault code is output at only fault occurrence, and during normal operation, the terminals output the signals assigned using \([\text{Pr. 190 to Pr. 196 Output terminal function selection}]\).

The following table indicates fault codes to be output.

<table>
<thead>
<tr>
<th>Control panel indication (FR-6A)</th>
<th>Output of output terminals</th>
<th>Fault Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal: 0</td>
<td>0 0 0 0</td>
<td>0</td>
</tr>
<tr>
<td>E-OC1</td>
<td>0 0 0 1</td>
<td>1</td>
</tr>
<tr>
<td>E-OC2</td>
<td>0 0 0 0</td>
<td>2</td>
</tr>
<tr>
<td>E-OC3</td>
<td>0 0 1 0</td>
<td>3</td>
</tr>
<tr>
<td>E-OC4</td>
<td>0 0 1 1</td>
<td>4</td>
</tr>
<tr>
<td>E-OC5</td>
<td>0 1 0 0</td>
<td>5</td>
</tr>
<tr>
<td>E-OC6</td>
<td>0 1 0 1</td>
<td>6</td>
</tr>
<tr>
<td>E-OC7</td>
<td>0 1 1 0</td>
<td>7</td>
</tr>
<tr>
<td>E-OC8</td>
<td>0 1 1 1</td>
<td>8</td>
</tr>
<tr>
<td>E-OC9</td>
<td>1 0 0 0</td>
<td>9</td>
</tr>
<tr>
<td>E-OC10</td>
<td>1 0 0 1</td>
<td>A</td>
</tr>
<tr>
<td>E-OC11</td>
<td>1 0 1 0</td>
<td>B</td>
</tr>
<tr>
<td>E-OC12</td>
<td>1 0 1 1</td>
<td>C</td>
</tr>
<tr>
<td>E-OC13</td>
<td>1 1 0 0</td>
<td>D</td>
</tr>
<tr>
<td>E-OC14</td>
<td>1 1 0 1</td>
<td>E</td>
</tr>
<tr>
<td>E-OC15</td>
<td>1 1 1 0</td>
<td>F</td>
</tr>
<tr>
<td>Other than the above</td>
<td>1 1 1 1</td>
<td>1</td>
</tr>
</tbody>
</table>

*1 When \([\text{Pr. 76}]=2\), the output terminals output the signals assigned to \([\text{Pr. 190 to Pr. 196}]\).

*2 \(E\).OP1 appears on (F700).
2.17.3 Motor overheat protection (Electronic thermal O/L relay) [Pr. 9, 51, 875]

Set the current of the electronic thermal relay function to protect the motor from overheat. This feature provides the optimum protective characteristics, including reduced motor cooling capability, at low speed. Refer to page 50 to protect the motor from overheat using external thermal input (OH signal) and refer to page 50 using PTC thermistor input (PTC signal).

### PARAMETER

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>Electronic thermal O/L relay</td>
<td>0</td>
<td>0 to 500A</td>
<td>Rated inverter output current, set the rated motor current.</td>
<td>○ ○</td>
</tr>
<tr>
<td>51</td>
<td>Second electronic thermal O/L</td>
<td>0</td>
<td>0 to 500A</td>
<td>Rated inverter output current, valid when the RT signal is ON.</td>
<td>○ ○</td>
</tr>
<tr>
<td>875</td>
<td>Fault definition</td>
<td>0</td>
<td>1</td>
<td>Normal operation, the motor decelerates to stop when motor thermal protection is activated.</td>
<td>○ —</td>
</tr>
</tbody>
</table>

* The 0.4K and 0.75K are set to 85% of the rated inverter current on A700, E700.

1) **Electronic thermal O/L relay [Pr. 9]**

   This function detects the overload (overheat) of the motor and trips. (Refer to page 111.)
   Set the motor type to be used in [Pr. 7] and set the rated motor current value (A) in [Pr. 9].
   (If the motor has both 50Hz and 60Hz rating and the [Pr. 3 Base frequency] is set to 60Hz, set the 1.1 times of the 60Hz rated motor current.)
   Set [Pr. 9 = 0] when you do not want to operate the electronic thermal relay function when using the motor with the external thermal relay, etc. (Note that the output transistor protection of the inverter functions (E.THT).)
   Since a thermal relay protector is built in a motor dedicated for vector control (SF-V5RU), set [Pr. 9 = 0] to use the motor.
   Protective function by electronic thermal relay function is reset by inverter power reset and reset signal input. Avoid unnecessary reset and power-OFF.
   When multiple motors are operated by a single inverter, protection cannot be provided by the electronic thermal function. Install an external thermal relay to each motor.
   When a difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic thermal relay function will be deteriorated. In this case, use an external thermal relay.
   Electronic thermal may not operate when the setting value for the electronic thermal is 5% of the inverter's rated current or less.
   A special motor cannot be protected by the electronic thermal relay function. Use an external thermal relay.

2) **Set two different electronic thermal O/L relays [Pr. 51]**

   Use this function when running two motors of different rated currents individually by a single inverter. (When running two motors together, use external thermal relays.)
   Set the rated current of the second motor in [Pr. 51].
   When the RT signal is ON, thermal protection is provided based on the [Pr. 51] setting. The RT signal acts as the second function selection signal and makes the other second functions valid.

### Diagram

[Diagram of motor and control connections]
PARAMETER

<table>
<thead>
<tr>
<th>[Pr. #]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>251</td>
<td>Output phase loss protection</td>
<td>1</td>
<td>0</td>
<td>Without output phase loss protection</td>
</tr>
<tr>
<td>872</td>
<td>Input phase loss protection</td>
<td>0</td>
<td>0</td>
<td>Without input phase loss protection</td>
</tr>
</tbody>
</table>

Output phase loss protection function (E.THM) or PTC thermistor (E.PTC) is activated, turning ON the alarm output 2 signal (ER) starts the motor to decelerate and provides a fault after deceleration to a stop.

When the ER signal turns ON, decrease load, etc. to allow the inverter to decelerate.

At occurrence of a fault other than E.OHT, E.THM and E.PTC, the inverter trips immediately and a fault signal is output. Set 97 (positive logic) or 197 (negative logic) in [Pr: 190 to Pr: 196 Output terminal function selection] and assign the ER signal to the output terminal.

This function is invalid during vector control.

The value 0 is recommended for the system in which the motor continues running without deceleration due to a large torque on the load side.

2.17.4 Input/output phase loss protection selection [Pr. 251, 872] (common)

You can disable the output phase loss protection function that stops the inverter output if one of the inverter output side (load side) three phases (U, V, W) is lost.

The input phase loss protection function of the inverter input side (R/L1, S/L2, T/L3) can also be valid.

(1) Output phase loss protection selection [Pr. 251]

When [Pr. 251 = 0], output phase loss protection (EILP) becomes invalid.

(2) Input phase loss protection selection [Pr. 872]

When [Pr. 872 = 1], input phase loss protection (EILP) is provided if a phase loss of one phase among the three phases is detected for 1s continuously.

Note that if input phase is lost when [Pr. 261 ≠ 0] in [700] (power failure stop function valid), input phase loss protection (EILP) is not provided; but power-failure deceleration is made.

When an input phase loss occurs in the R/L1 and S/L2 phases, input phase loss protection is not provided but the inverter output is shut off.

If the load is light, lost phase cannot be detected under regenerative load either. Also, input loss protection (EILP) may occur when phase voltage is largely unbalanced among three phases.
2.17.5 Overspeed detection [Pr. 374] (A700)

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>374</td>
<td>Overspeed detection level</td>
<td>140Hz</td>
<td>0 to 400Hz</td>
<td>When the motor speed reaches or exceeds the speed set in [Pr. 374] during encoder feedback control, Real sensorless vector control, or vector control, over speed (E.OS) occurs and trips the inverter.</td>
</tr>
</tbody>
</table>

Motor speed

- The output frequency and [Pr. 374] are compared during Real sensorless vector control.

2.17.6 Encoder signal loss detection [Pr. 376] (A700)

When the encoder signal is lost during encoder feedback control, orientation control, or vector control, signal loss detection (E.ECT) is activated to trip the inverter.

2.17.7 Earth (ground) fault detection at start [Pr. 249] (E700) (D700)

You can choose whether to make earth (ground) fault detection at start valid or invalid.

<table>
<thead>
<tr>
<th>[Pr. ]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>249</td>
<td>Earth (ground) fault detection at start</td>
<td>0</td>
<td>0 to 1</td>
<td>Invert the inverter.</td>
</tr>
</tbody>
</table>

When [Pr. 249 = 1], earth (ground) fault detection is performed at start. Earth (ground) fault detection is performed only after start signal is input to the inverter. Protective function does not operate for the ground (earth) fault, which occurs while inverter is running. Because the detection is performed at a start, output delays for about 20ms at every start.

If earth (ground) fault is detected when [Pr. 249 = 1], output side earth (ground) fault overcurrent (E.GF) is output, and the inverter output is shutdown. (Refer to page 99)

If motor capacity is smaller than the inverter capacity in 5.5K or more, ground (earth) fault protection may not operate.
2.18 Misoperation prevention and parameter setting and PU setting

2.18.1 Reset selection/disconnected PU detection/PU stop selection [Pr. 75]

You can select the reset input acceptance, disconnected PU (FR-DU07/FR-PU04/FR-PU07) connector detection function and PU stop function.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>75</td>
<td>Reset selection/disconnected PU detection/PU stop selection</td>
<td>14</td>
<td>0 to 3, 14 to 17</td>
<td>For the initial value, reset always enabled, without disconnected PU detection, and with PU stop function are set.</td>
</tr>
</tbody>
</table>

* The [Pr. 75] value can be set any time. Also, if parameter (all) clear is executed, this setting will not return to the initial value.

<table>
<thead>
<tr>
<th>[Pr. 75] Setting</th>
<th>Reset Selection</th>
<th>Disconnected PU Detection</th>
<th>PU Stop Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reset input normally enabled</td>
<td>If the PU is disconnected, operation will be continued.</td>
<td></td>
</tr>
</tbody>
</table>
| 2               | Reset input normally enabled | Preparing  
| 3               | Reset input normally enabled | decelerates the motor |
| 14 (initial value) | Reset input normally enabled | When the PU is disconnected, the inverter output is shut off. |
| 15              | Reset input normally enabled | Preparing  
| 17              | Reset input normally enabled | decelerates the motor to a stop in any of the PU, External and communication operation modes. |

(1) Reset selection

You can select the enable condition of reset function (RES signal, reset command through communication) input.

When [Pr. 75 = 0, 2, 14, 16] and the reset signal (RES) is input during operation, the motor coasts since the inverter being reset shuts off the output. In addition, the cumulative values of the electronic thermal relay and regenerative brake duty are cleared.

When [Pr. 75 = 1, 3, 15, 17], a reset can be input only when a fault occurs. The reset key of the PU is only valid when the inverter is tripped, independently of the [Pr. 75] setting.

(2) Disconnected PU detection

Removal or reinstallation of the PU (FR-DU07/FR-PU04/FR-PU07) will not pose a problem. However, if the PU is accidentally removed in the PU operation mode, only resetting the power can stop the motor.

When [Pr. 75 = 2, 3, 16, 17] and this function detects that the PU (FR-DU07/FR-PU04/FR-PU07) has been disconnected from the inverter for 1s or longer, the inverter provides a fault output (E.PUE) and comes to trip. When the PU has been disconnected since before power-ON, it is not judged as a fault.

When [Pr. 75 = 0, 1, 14, 15], operation is continued if the PU is disconnected. Note that the motor decelerates to stop when the PU is disconnected during PU/JOG operation.

When RS-485 communication operation is performed through the PU connector, the reset selection/PU stop selection function is valid but the disconnected PU detection function is invalid.
(3) PU Stop Selection

When \( Pr. 75 = 14 \) to \( 17 \), the motor can be stopped by pressing \( \) of the PU in any of the PU operation, External operation, and Network operation modes. Even if \( Pr. 250 \) Stop selection \( \neq 9999 \) is set to select coasting to a stop, the motor will not coast to stop but decelerate to stop by the PU stop function during external operation.

When the inverter is stopped by the PU stop function in other than PU operation mode, \( \) is displayed on the PU. A fault signal is not provided.

When \( Pr. 75 = 0 \) to \( 3 \), deceleration to stop by \( \) is valid only in the PU operation mode.

How to restart the motor (cancel PU stop (PS)) by \( \) input from the PU in the External operation mode is shown below.

(a) Operation panel (FR-DU07)

1) After completion of deceleration to a stop, switch OFF the STF or STR signal.
2) Press \( \) to display \( \).

\( \text{(PS reset)} \)

3) Press \( \) to return to \( \).
4) Turn ON the STF or STR signal.

(b) Parameter unit (FR-PU04/FR-PU07)

1) After completion of deceleration to a stop, switch OFF the STF or STR signal.
2) Press \( \).

\( \text{(PS reset)} \)

3) Turn ON the STF or STR signal.

The motor can be restarted by making a reset using a power supply reset or RES signal.
2.18.2 Parameter write disable selection [Pr. 77]  

You can select whether write to various parameters can be performed or not. Use this function to prevent parameter values from being rewritten by misoperation.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
</table>
|  77   | Parameter write selection | 0             | 0, 1, 2                                           | 0: Write is enabled only during a stop.  
1: Parameter write is not enabled.  
2: Parameter write is enabled in any operation mode regardless of operating status. |

- [Pr. 77] can be always set independently of the operation mode and operation status.

1) Write parameters only during stop [Pr. 77 = 0]

Parameters can be written only during a stop in the PU operation mode.

The shaded parameters in the parameter list (page 120) can always be written, regardless of the operation mode and operation status. However, [Pr. 77 PWM frequency selection] and [Pr. 240 Soft-PWM operation selection] can be written during operation in the PU operation mode, but cannot be written in the External operation mode.

2) Disable parameter write [Pr. 77 = 1]

Parameter write is not enabled. (Read is enabled.) Parameter clear and all parameter clear cannot be performed, either.

The following parameters can be written even when [Pr. 77 = 1].

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>22</td>
<td>Stall prevention operation level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Reset selection/disconnected PU stop selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Parameter write selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>97</td>
<td>Operation mode selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>189</td>
<td>User group read selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>296</td>
<td>Password lock level</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- The setting is available for D700.

3) Write parameters during operation [Pr. 77 = 2]

Parameters can always be written. The following parameters cannot be written when the inverter is running even if [Pr. 77 = 2]. Stop the inverter when changing their parameter settings.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>Base frequency voltage</td>
<td>0 to 5000</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>Stall prevention operation level compensation factor at double speed</td>
<td>0.1 to 10.0</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td>RUN key rotation direction selection</td>
<td>0 to 255</td>
<td></td>
</tr>
<tr>
<td>48</td>
<td>Second stall prevention operation current</td>
<td>0 to 200.0</td>
<td></td>
</tr>
<tr>
<td>49</td>
<td>Second stall prevention operation frequency</td>
<td>0 to 50.0</td>
<td></td>
</tr>
<tr>
<td>50</td>
<td>Energy saving control selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>66</td>
<td>Stall prevention operation reduction starting frequency</td>
<td>0 to 50.0</td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Applied motor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75</td>
<td>Operation mode selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>81</td>
<td>Number of motor poles</td>
<td>1 to 5</td>
<td></td>
</tr>
<tr>
<td>82</td>
<td>Motor excitation current</td>
<td>0 to 200.0</td>
<td></td>
</tr>
<tr>
<td>94</td>
<td>Stacked motor frequency</td>
<td>0 to 50.0</td>
<td></td>
</tr>
<tr>
<td>95</td>
<td>Online auto tuning selection</td>
<td>0 to 200.0</td>
<td></td>
</tr>
<tr>
<td>96</td>
<td>Auto tuning settings mode</td>
<td>0 to 200.0</td>
<td></td>
</tr>
<tr>
<td>100</td>
<td>Adjustable 5 points V/F parameter</td>
<td>0 to 200.0</td>
<td>(Adjustable 5 points V/F parameter)</td>
</tr>
<tr>
<td>135</td>
<td>Parameter for electronic bypass sequence</td>
<td>0 to 200.0</td>
<td>(parameter for electronic bypass sequence)</td>
</tr>
</tbody>
</table>

- The input terminal function selection is 178 to 184, 190 to 192, 255.
- The life alarm status display is 250.
- The fault current fault circuit display is 258.
- The control circuit connection fault display is 254.
2.18.3 Reverse rotation prevention selection [Pr. 78] (common)

This function can prevent reverse rotation fault resulting from the incorrect input of the start signal. Set this parameter when you want to limit the motor rotation to only one direction.

This parameter is valid for all of the reverse rotation and forward rotation keys of the operation panel (FR-DU07) and parameter unit (FR-PU04/FR-PU07), the start signals (STF, STR signals) via external terminals, and the forward and reverse rotation commands through communication.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>78</td>
<td>Reverse rotation prevention selection</td>
<td>0</td>
<td>Both forward and reverse rotations enabled</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Reverse rotation disabled</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Forward rotation disabled</td>
<td>2</td>
</tr>
</tbody>
</table>
2.18.4 Extended parameter display and user group function [Pr. 160, 172 to 174*]

Parameter which can be read from the operation panel and parameter unit can be restricted.

(1) Display of simple mode parameters and extended parameters [Pr. 160]

When \[Pr. 160 = 9999\], only the simple mode parameters can be displayed on the control panel (FR-DU07) and parameter unit (FR-PU04/FR-PU07). (Refer to the parameter list on page 120, for the simple mode parameters.) When \[Pr. 160 = 0\], simple mode parameters and extended parameters can be displayed.

All parameter can be read regardless of \[Pr.160\] setting when performing parameter read using a communication option in OP and PU connector in OP or PU mode.

When reading parameters with RS-484 communication made by RS-484 communication made by RS-485 terminal in \(\text{A700}\) or PU connector in \(\text{E700}\), all parameters can be read regardless of \[Pr. 160\] setting by setting \[Pr. 350 = \text{auto detect}\] under the NET mode. (Refer to page 387)

(2) User group function [Pr. 160, 172 to 174*]

The user group function is designed to display only the parameters necessary for the setting.

Among all parameters, a maximum of 16 parameters can be registered to the user group. When \[Pr. 160 = 1\], only parameters registered in the user group can be accessed for reading and writing. (The
parameters not registered in the user group can not be read.)
To register a parameter to the user group, set its parameter number in \[Pr. 173\]. To delete a parameter in the user group, set its parameter number in \[Pr. 174\]. Set \[Pr. 172 = 9999\] to batch delete parameters registered.

\[Pr. 77, Pr. 160 and Pr. 991\] can always be read, independently of the user group setting. \[Pr. 77, Pr. 160, Pr. 172 to Pr. 174\] cannot be registered to the user group. When \[Pr. 173, Pr. 174\] is read, 9999 is always displayed.
When any value other than 9999 is set in \[Pr. 172\], no function is available.

### 2.18.5 Password function \[Pr. 296, 297\]
Registering 4-digit password can restrict parameter reading/writing.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>296</td>
<td>Password lock level</td>
<td>9999</td>
<td>1 to 6, 101 to 106</td>
<td>Select restriction level of parameter reading/writing when a password is registered.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>No password lock</td>
<td></td>
</tr>
<tr>
<td>297</td>
<td>Password lock/unlock</td>
<td>9999</td>
<td>(0 to 5)</td>
<td>Displays password unlock error count. (Reading only)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9999)</td>
<td>No password lock (Reading only)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>[Pr. 296] Setting</th>
<th>PU Mode Operation Command</th>
<th>NET Mode Operation Command</th>
<th>Read</th>
<th>Write</th>
<th>Read</th>
<th>Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>9999</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>1, 101</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>2, 102</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>3, 103</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>4, 104</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>5, 105</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>6, 106</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
</tbody>
</table>

*1) If the parameter reading is restricted by the \[Pr. 160\] setting, those parameters are unavailable for reading even when "O" is indicated.
*2) If the parameter writing is restricted by the \[Pr. 77\] setting, those parameters are unavailable for writing even when "O" is indicated.
*3) Parameter access from unit where parameter is written in PU operation mode (initially set to operation panel parameter unit) is restricted. (Refer to page 436 for PU mode operation command source selection)
*4) Parameter access in NET operation mode with RS-485 communication is restricted.

<table>
<thead>
<tr>
<th>[Pr. 296] Setting</th>
<th>PU Mode Operation Command</th>
<th>NET Mode Operation Command</th>
<th>Read</th>
<th>Write</th>
<th>Read</th>
<th>Write</th>
</tr>
</thead>
<tbody>
<tr>
<td>9999</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>1, 101</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>2, 102</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>3, 103</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>4, 104</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>5, 105</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
<tr>
<td>6, 106</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
<td>☒</td>
</tr>
</tbody>
</table>

*1) If the password reading is restricted by the \[Pr. 160\] setting, those parameters are unavailable for reading even when "O" is indicated.
*2) If the password writing is restricted by the \[Pr. 77\] setting, those parameters are unavailable for writing even when "O" is indicated.
*3) Parameter access from unit where parameter is written in PU operation mode (initially set to operation panel parameter unit) is restricted. (Refer to page 436 for PU mode operation command source selection)
*4) Parameter access in NET operation mode with RS-485 communication is restricted.

### 2.18.5 Password function \[Pr. 296, 297\]

#### 2.18.5.1 Lock
Set parameter reading/writing restriction level by \[Pr. 296\]. \(\text{Pr. 296 = 9999}\)
When the setting is "101 to 106", the number of password unlock errors (0 to 5 times) is displayed when \[Pr. 297\] is read.
When the \[Pr. 297\] setting is "1 to 6", the number is not displayed.
Write four-digit number (1000 to 9998) in \[Pr. 297\] as a password.
When \[Pr. 294 = "9999"\], \[Pr. 297\] cannot be written.

#### 2.18.5.2 Unlock
After registering a password, a read value of \[Pr. 297\] is always "0" to "5". When a password restricted parameter is read/written, \(\text{☆☆☆☆☆}\) is displayed. Even if a password is registered, parameters which the inverter itself writes, such as inverter parts life, are overwritten occasionally.
Even if a password is registered, \[Pr. 991\] can be read/written when a parameter unit (FR-PU04/FR-PU07) is connected.
2) Unlock
Enter a password in [Pr. 297].
The lock is unlocked when a password is correct.
If a password is incorrect, an error occurs and the lock is not unlocked.
During [Pr. 296 = "101 to 106"], if password unlock error has occurred 5 times, correct password will not unlock the restriction. (During password lock)

If the password has been forgotten, perform parameter all clear to unlock the parameter restriction. In that case, other parameters are also cleared. (All parameter clear cannot be performed during operation.)

3) Parameter operation during password lock/unlock
Parameter write is restricted as the following during password lock.

<table>
<thead>
<tr>
<th>Parameter operation</th>
<th>Unlocked</th>
<th>Password registered</th>
<th>Locked</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 296] Read</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>[Pr. 296] Write</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>[Pr. 297] Read</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>[Pr. 297] Write</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Performing parameter all clear</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Performing parameter copy</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*1 Reading/writing is unavailable when there is restriction to reading by the [Pr. 160] setting.
*2 Unavailable during operation of voltage output.
*3 Correct password will not unlock the restriction.
When [Pr. 296 = "4, 5, 104, 105"] and using the parameter unit (FR-PU04/FR-PU07), PUJOG operation is unavailable. When writing is restricted from PU mode operation command ([Pr. 296 = 1, 2, 4, 5, 101, 102, 104, 105]), switching of operation mode by easy setting mode is unavailable.

2.18.6 Free parameter [Pr. 888, 889] (common)
You can input any number within the setting range 0 to 9999.
For example, the parameter can be used:
- As a unit number when multiple units are used.
- As a pattern number for each operation application when multiple units are used.
- As the year and month of introduction or inspection.

*[Pr. 888, Pr. 889] do not influence the inverter operation.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>888</td>
<td>Free parameter 1</td>
<td>9999</td>
<td>0 to 9999</td>
</tr>
<tr>
<td>889</td>
<td>Free parameter 2</td>
<td>9999</td>
<td>0 to 9999</td>
</tr>
</tbody>
</table>

The above parameters allow its setting to be changed during operation in any operation mode even if [Pr. 77 Parameter write selection = 0].
### 2.18.7 Setting from the parameter unit and operation panel [Pr. 40*, 145, 161, 295*, 990, 991] \(\text{common}\)

Parameter unit (FR-PU04/FR-PU07), operation panel (FR-DU07) can be set.

("Not available for A700, F700, C1000, A800, \#\&\&")

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>RUN key rotation direction selection</td>
<td>0</td>
<td>0</td>
<td>Forward rotation</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>Reverse rotation</td>
<td>—</td>
</tr>
<tr>
<td>145</td>
<td>PU display language selection</td>
<td>0</td>
<td></td>
<td>Japanese</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>English</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>German</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>French</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
<td>Spanish</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td>Italian</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td></td>
<td>Swedish</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td></td>
<td>Finnish</td>
<td>—</td>
</tr>
<tr>
<td>161</td>
<td>Frequency setting/key lock operation selection</td>
<td>0</td>
<td>0</td>
<td>Setting dial frequency setting mode</td>
<td>Key lock invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>Setting dial potentiometer mode</td>
<td>Key lock valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td>Setting dial frequency setting mode</td>
<td>Key lock invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td>11</td>
<td></td>
<td>Setting dial potentiometer mode</td>
<td>Key lock valid</td>
</tr>
<tr>
<td>295</td>
<td>Magnitude of frequency change setting</td>
<td>0</td>
<td>0</td>
<td>Function invalid</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.01</td>
<td></td>
<td>The minimum varying width when the set frequency is changed by the setting dial can be set.</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.00</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10.00</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td>990</td>
<td>PU buzzer control</td>
<td>1</td>
<td>0</td>
<td>Without buzzer</td>
<td>—</td>
</tr>
<tr>
<td>991</td>
<td>PU contrast adjustment</td>
<td>58</td>
<td>0 to 63</td>
<td></td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1: Light</td>
<td></td>
<td></td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3: Dark</td>
<td></td>
<td></td>
<td>—</td>
</tr>
</tbody>
</table>

*1 The above parameter allows its setting to be changed during operation in any operation mode even if [Pr. 77 Parameter write selection = 0].
*2 This parameter is displayed as simple mode parameter only when the parameter unit (FR-PU04/FR-PU07) is connected.

1. **RUN key rotation direction selection [Pr. 40]**
   - Used to choose the direction of rotation by operating the operation panel.

2. **PU display language selection [Pr. 145]**
   - The display language of the parameter unit (FR-PU04/FR-PU07) can be changed to other language using [Pr. 41].

3. **Operation panel frequency setting/key lock operation selection [Pr. 161]**
   - The setting dial of the operation panel (FR-DU07) can be used like a potentiometer and key operation of the operation panel can be invalid by setting [Pr. 161]. For details refer to page 214.

4. **Magnitude of frequency change setting [Pr. 295]**
   - When setting the set frequency with the setting dial, frequency changes in 0.01Hz increments in the initial status. Setting [Pr. 295] increases the magnitude of frequency which changes according to the rotated amount of the setting dial, improving usability.
     - Example: when “1.00Hz” is set in [Pr. 295], one click (one dial gauge) of the setting dial changes the frequency in increments of 1.00Hz → 2.00Hz → 3.00Hz.
     - Magnitude of frequency change works only for the set frequency. Magnitude of frequency changes for other parameters which are set in frequency is not changed by [Pr. 295].
     - When 10 is set, the setting changes in 10Hz increments. Be cautious for the excess speed (in potentiometer mode).
     - Minimum increment for the magnitude of change is also determined by [Pr. 295] setting when machine speed unit is displayed by [Pr. 277]. However, setting value may differ since a set machine speed is converted to frequency, then the frequency is converted back to speed.

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When the set frequency (speed) is 100 or more, frequency is displayed in 0.1 increments. Therefore, the minimum varying width is 0.1 even when \( \text{Pr. } 295 < 0.1 \).

When the set frequency (speed) is 1000 or more, frequency is displayed in 1 increments. Therefore, the minimum varying width is 1 even when \( \text{Pr. } 295 < 1 \).

(5) Buzzer control [Pr. 990]

You can select to make the buzzer "beep" when you press key of the operation panel and parameter unit (FR-PU04/FR-PU07) or not by using \( \text{Pr. } 990 \).

(6) PU contrast adjustment [Pr. 991]

The LCD contrast of the parameter unit (FR-PU04/FR-PU07) can be adjusted using \( \text{Pr. } 991 \).

Decreasing the setting value makes contrast light.

The contrast can be adjusted by changing the setting with \( \uparrow \) \( \downarrow \) of the parameter unit.

At this time, press \( \Rightarrow \) to store the setting.

2.18.8 Setting an operation panel (PA02) for FR-E500 series (E700) (D700)

Operation panel for the FR-E500 series (PA02) can be used by connecting with PU cable.

(PA02 cannot be connected to the inverter body directly.)

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>146</td>
<td>Built-in potentiometer switching</td>
<td>1</td>
<td>0 to 1</td>
<td>PA02 built-in frequency setting potentiometer valid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Frequency setting by the built-in frequency setting potentiometer.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>PA02 built-in frequency setting potentiometer invalid</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Digital frequency setting by the ( \uparrow ) ( \downarrow ) key.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Changing frequency continuously by pressing the ( \uparrow ) ( \downarrow ) key.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>The value changes while pressing down the ( \uparrow ) ( \downarrow ) key.</td>
</tr>
<tr>
<td>C22(922)</td>
<td>Frequency setting voltage bias frequency (built-in potentiometer)</td>
<td>0Hz</td>
<td>0 to 400Hz</td>
<td>Frequency on the bias side of PA02 built-in frequency setting potentiometer.</td>
</tr>
<tr>
<td>C23(922)</td>
<td>Frequency setting voltage bias frequency (built-in potentiometer)</td>
<td>0%</td>
<td>0 to 300%</td>
<td>Converted % of the bias side setting level of PA02 built-in frequency setting potentiometer.</td>
</tr>
<tr>
<td>C24(923)</td>
<td>Frequency setting voltage gain frequency (built-in potentiometer)</td>
<td>60Hz</td>
<td>0 to 400Hz</td>
<td>Frequency on the gain side of PA02 built-in frequency setting potentiometer.</td>
</tr>
<tr>
<td>C25(923)</td>
<td>Frequency setting voltage gain frequency (built-in potentiometer)</td>
<td>100%</td>
<td>0 to 300%</td>
<td>Converted % of the bias side setting level of PA02 built-in frequency setting potentiometer.</td>
</tr>
</tbody>
</table>

(1) Built-in potentiometer switching [Pr. 146]

Switches the frequency setting method between the PA02 built-in frequency setting potentiometer and digital frequency setting by the \( \uparrow \) \( \downarrow \) key.

Set \( \text{Pr.} 146 = 0 \) only when operating by a built-in frequency setting potentiometer of an operation panel for the FR-500 series (PA02). When \( \text{Pr.} 146 = 0 \), operation may not be available from an inverter's operation panel or by communication.

(2) Bias and gain of the built-in frequency setting potentiometer (C22 [Pr. 922] to C25 [Pr. 923])

When the operation panel (PA02) for the FR-E500 series is hooked up with the PU cable, the magnitude (slope) of the output frequency to the frequency setting potentiometer of the operation panel can be set as desired.

Adjust the bias of the potentiometer of the operation panel using \( \text{Pr. } 922 \) (C22, C23) and gain with \( \text{Pr. } 923 \) (C24, C25).
2.19 Frequency compensation function

2.19.1 Slip compensation [Pr. 245 to 247] （common）

Motor speed can be kept constant by estimating motor slip from output current under V/F control, Simple magnetic flux vector control (only in [F700]), and General-purpose magnetic flux vector control (only in [E700], [D700]).

- Slip compensation is valid when the motor rated slip calculated by the following expression is set in [Pr. 245].
  \[
  \text{Rated slip} = \left( \frac{\text{Synchronous speed at base frequency}}{\text{Rated speed}} \right) \times 100 \%
  \]

- Slip compensation is not made when \([\text{Pr. 245} = 0, 9999]\).

When performing slip compensation, the output frequency may become greater than the set frequency. Set the [Pr. 1 Maximum frequency] value a little higher than the set frequency.

### Parameter Table

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>245</td>
<td>Rated slip</td>
<td>9999</td>
<td>0.01 to 50%</td>
<td>Used to set the rated motor slip.</td>
</tr>
<tr>
<td>246</td>
<td>Slip compensation time constant</td>
<td>0.5s</td>
<td>0.01 to 10s</td>
<td>Used to set the slip compensation response time. When the value is made smaller, response will be faster. However, as load inertia is greater, a regenerative overvoltage fault (E.OV1 to 3) is more liable to occur.</td>
</tr>
<tr>
<td>247</td>
<td>Constant-power range slip compensation selection</td>
<td>9999</td>
<td></td>
<td>Slip compensation is not made in the constant power range (frequency range above the frequency set in [Pr. 3]).</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>9999</td>
<td>Slip compensation is made in the constant power range.</td>
</tr>
</tbody>
</table>

[Pr.245 to 247] settings are invalid under Advanced magnetic flux vector control in [A700], Real sensorless vector control in [A700], and vector control since slip compensation is performed under these controls. When encoder feedback control is performed by [A700], [Pr. 245 to 247] settings are invalid.
2.19.2 Encoder feedback control [Pr. 144, 285, 359, 367 to 369] (A700)

This controls the inverter output frequency so that the motor speed is constant to the load variation by detecting the motor speed with the speed detector (encoder) to feed it back to the inverter under V/F control and Advanced magnetic flux vector control. Slip compensation of [Pr. 245 to Pr. 247] is invalid.

Plug-in option FR-A7AP or FR-A7AL is necessary.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 144   | Speed setting switchover | 4             | 0, 2, 4, 6, 8, 10, 104, 106, 108, 110 | Set the number of motor poles when performing encoder feedback control under V/F control. When [Pr. 144 = 0, 2, 4, 6, 8, 10] and run the inverter, fault E1 to E3 occurs. When [Pr. 144 = 104, 106, 108, 110], the value subtracting 100 is set as the number of motor poles. [Pr. 144] is used to change the monitor display increments. Refer to page 343 for details. Set the rotation direction of the encoder and number of pulses using [Pr. 359 Encoder rotation direction] and [Pr. 369 Number of encoder pulses]. Encoder feedback control can not be performed when the setting of encoder rotation direction is wrong. Encoder feedback control is invalid.
| 285   | Overspeed detection frequency 1 | 0 to 25Hz | 9999 | Encoder feedback control is invalid. If (detected frequency) - (output frequency) ≥ Pr. 285 during encoder feedback control, the inverter fault (E.MBI) is provided. |
| 359   | Encoder rotation direction CW | 1 | 0 | Encoder rotation direction as viewed from A is forward rotation. |
|       | Encoder rotation direction CCW | 1 | 0 | Encoder rotation direction as viewed from A is forward rotation. |
| 367   | Speed feedback range | 9999 | 0 to 400Hz | Set the region of speed feedback control. |
| 368   | Feedback gain | 1 | 0 to 100 | Set when the rotation is unstable or response is slow. |
| 369   | Number of encoder pulses | 1024 | 0 to 4096 | Set the number of pulses of the encoder. Encoder feedback control can not be performed when the setting of encoder rotation direction is wrong. (Inverter operation is enabled.) Encoder rotation direction can be checked with the rotation direction display of the parameter unit. |

1 When performing vector control with the FR-A7AP or FR-A7AL, this parameter changes to speed deviation excess detection frequency (For details, refer to page 294).

(1) Setting before the operation

[Pr. 144, 359, 369]

When performing encoder feedback control under V/F control, set the number of motor poles in [Pr. 144 Speed setting switchover] according to the motor used.

When [Pr. 144 = 0, 2, 4, 6, 8], the value subtracting 100 is set as the number of motor poles.

When [Pr. 144 = 104, 106, 108, 110], the value subtracting 100 is set as the number of motor poles.

If [Pr. 144 = 102, 104, 106, 108], the value subtracting 100 is set as the number of motor poles.

When [Pr. 144 = 0, 2, 4, 6, 8, 10, 104, 106, 108, 110], set the number of motor poles in [Pr. 144 Speed setting switchover] according to the motor used.

When [Pr. 144 = 102, 104, 106, 108], the value subtracting 100 is set as the number of motor poles.

[Pr. 359 Encoder rotation direction] is used to change the monitor display increments. Refer to page 343 for details.

Set the rotation direction of the encoder and number of pulses using [Pr. 359 Encoder rotation direction] and [Pr. 369 Number of encoder pulses]. Encoder feedback control can not be performed when the setting of encoder rotation direction is wrong.

Encoder feedback control is invalid.

(2) Selection of encoder feedback control [Pr. 367]

When [Pr. 367 Speed feedback range = 9999], encoder feedback control is valid.

Using the set point (frequency at which stable speed operation is performed) as reference, set the higher and lower setting range. Normally, set the frequency converted from the slip amount (r/min) of the rated motor speed (rated load). If the setting is too large, response becomes slow.

[Example]

When the rated speed of the motor (4P) is 1740 r/min and the slip is 60 Hz, calculate the slip amount (Nsp).

Slip amount Nsp = Synchronous speed - rated speed

= 1800 - 1740 = 60 (r/min)

Frequency fsp equivalent to the slip amount

fsp = \frac{Nsp}{\text{motor poles}} \times \text{number of encoder pulses}

When the number of motor poles is 120, the number of encoder pulses is 1024.

fsp = \frac{60}{120} \times 1024 = 400 Hz

Encoder feedback control is valid.

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Encoder feedback control is not performed during acceleration/deceleration to prevent unstable phenomenon such as hunting and performed when the output frequency once reaches [set frequency] ± [speed feedback range] without coming to trip nor tracking the motor speed.

- The pulse signals are not received from the encoder due to a signal loss or the like.
- The accurate pulse signal from the encoder can not be detected due to induction noise, etc.
- The motor has been forcibly accelerated (regeneration) or decelerated (motor lock or the like) by large external force.

For the motor with brake, use the RUN signal (inverter running) to open the brake. (The brake may not be opened if the FU (output frequency detection) signal is used.)

### Feedback gain [Pr. 368]

Set [Pr. 368 Feedback gain] when the rotation is unstable or response is slow.

<table>
<thead>
<tr>
<th>Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 368] &gt; 1</td>
<td>Although the response becomes faster, overcurrent or unstable rotation is liable to occur.</td>
</tr>
<tr>
<td>1 &lt; [Pr. 368]</td>
<td>Although the response becomes slow, rotation becomes stable.</td>
</tr>
</tbody>
</table>

### Overspeed detection [Pr. 285]

If (detection frequency) - (output frequency) > [Pr. 285] under encoder feedback control, E.MB1 occurs and the inverter output is stopped to prevent malfunction when the accurate pulse signal from the encoder can not be detected.

Overspeed is not detected when [Pr. 285 = 9999].

### Switching the control method from the external terminal (RT, X18 signal)

When Advanced magnetic flux vector control, Real sensorless vector control, or vector control is selected and [Pr. 18 = 12 to 20], use X18 signal to change to V/F control. When encoder feedback control is valid, turning X18 signal ON to change to V/F control becomes invalid, and encoder feedback control is valid.

### Changing First Motor Control Method

<table>
<thead>
<tr>
<th>First Motor Control Method Selection</th>
<th>Second Motor Control Method</th>
<th>[Pr. 405] Setting</th>
<th>[Pr. 423] Setting</th>
<th>[Pr. 451] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT Signal-OFF</td>
<td>V/F control</td>
<td>9999</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>VIP control with encoder feedback</td>
<td>V/F control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>VIP control without encoder feedback</td>
<td>Advanced magnetic flux vector control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>Real sensorless vector control</td>
<td>Real sensorless vector control</td>
<td>9999</td>
<td>10 to 12</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>First Motor Control Method Selection</th>
<th>Second Motor Control Method</th>
<th>[Pr. 405] Setting</th>
<th>[Pr. 423] Setting</th>
<th>[Pr. 451] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT Signal-OFF</td>
<td>VIP control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>Advanced magnetic flux vector control with encoder feedback</td>
<td>Advanced magnetic flux vector control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>Real sensorless vector control</td>
<td>Real sensorless vector control</td>
<td>9999</td>
<td>10 to 12</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>First Motor Control Method Selection</th>
<th>Second Motor Control Method</th>
<th>[Pr. 405] Setting</th>
<th>[Pr. 423] Setting</th>
<th>[Pr. 451] Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT Signal-OFF</td>
<td>VIP control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>Advanced magnetic flux vector control with encoder feedback</td>
<td>Advanced magnetic flux vector control</td>
<td>9999</td>
<td>Other than 9999</td>
<td>20, 9999</td>
</tr>
<tr>
<td>Real sensorless vector control</td>
<td>Real sensorless vector control</td>
<td>9999</td>
<td>10 to 12</td>
<td></td>
</tr>
</tbody>
</table>

1 Encoder feedback is invalid during Real sensorless vector control and vector control even if set.

2 Turning X18 signal ON selects V/F control. When the X18 signal is not assigned, turning the RT signal ON selects V/F control as the RT signal shares this function.
2.19.3 Droop control [Pr. 286 to 288] (A700) (E700)

Droop control makes the load balanced in proportion to the load torque and provides droop characteristic to the speed under Advanced magnetic flux vector control, Real sensorless vector control (only in A700), and vector control (only in A700).

This function is effective for balancing the load when using multiple inverters.

The output frequency is changed according to the magnitude of torque current under Advanced magnetic flux vector control and Real sensorless vector control.

By setting [Pr. 286] in [Pr. 287], droop control operation under Real sensorless vector control and vector control can be changed.

The drooping amount at the rated torque is set by the droop gain as a percentage using the rated frequency (motor speed when [Pr. 288 = 10, 11]) as a reference.

The maximum value of frequency after droop compensation is either 120Hz or [Pr. 1 Maximum frequency], whichever is smaller.

\[
\text{Rated slip} = \frac{(\text{Synchronous speed at base frequency}) - \text{Rated speed}}{\text{Rated value of torque current}} \times 100 \%
\]

The maximum value of frequency after droop compensation is either 120Hz or [Pr. 1 Maximum frequency], whichever is smaller.

\[
\text{Droop compensation frequency} = \frac{\text{Torque current after filtering} \times \text{Rated motor frequency} \times \text{Droop gain}}{100} \times \text{Rated value of torque current}
\]

\[
\text{Droop compensation frequency} = \frac{\text{Torque current after filtering} \times \text{Motor speed} \times \text{Droop gain}}{100} \times \text{Rated value of torque current}
\]
2.20 Other function

2.20.1 Load torque high speed frequency control [Pr. 4, 5, 270 to 274] (A700)

Load torque high speed frequency control is a function which automatically sets the operational maximum frequency according to the load. More specifically, the magnitude of the load is judged according to the average current at a certain time after starting to perform operation at higher than the preset frequency under light load. This function is designed to increase speed automatically under light load, for example to minimize the incoming/outgoing time in a multi-story parking lot.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Multi-speed setting (high speed)</td>
<td>60Hz</td>
<td>0 to 400Hz</td>
<td>Set the higher-speed frequency.</td>
</tr>
<tr>
<td>5</td>
<td>Multi-speed setting (middle speed)</td>
<td>30Hz</td>
<td>0 to 400Hz</td>
<td>Set the lower-speed frequency.</td>
</tr>
<tr>
<td>270</td>
<td>Stop-on contact/load torque high-</td>
<td>0</td>
<td>0 to 220%</td>
<td>Set the upper and lower limits of the current at high and middle speeds.</td>
</tr>
<tr>
<td></td>
<td>speed frequency control selection</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>271</td>
<td>High-speed setting maximum current</td>
<td>100%</td>
<td>0 to 220%</td>
<td>Average current during acceleration from [(Pr. 270) + 1/2] Hz to [(Pr. 273) + 1/2] Hz can be achieved.</td>
</tr>
<tr>
<td>272</td>
<td>Middle-speed setting minimum current</td>
<td>100%</td>
<td>0 to 220%</td>
<td>Average current during acceleration from [(Pr. 4) + 1/2] Hz to [(Pr. 5) + 1/2] Hz is achieved.</td>
</tr>
<tr>
<td>273</td>
<td>Current averaging range</td>
<td>9999</td>
<td>0 to 400Hz</td>
<td>Set the time constant of the primary delay filter relative to the output current. (The time constant [ms] is 0.75 [(Pr. 274)] and the initial value is 12ms.) A larger setting provides higher stability but poorer response.</td>
</tr>
<tr>
<td>274</td>
<td>Current averaging filter time constant</td>
<td>16</td>
<td>1 to 4000</td>
<td></td>
</tr>
</tbody>
</table>

Set [Pr. 270 Stop-on contact/load torque high-speed frequency control selection = 2 or 3] when operating with the load torque high speed frequency function selection signal (X19) ON, the inverter automatically changes the maximum frequency within the setting range of [Pr. 4 Multi-speed setting (high speed)] and [Pr. 5 Multi-speed setting (middle speed)] according to the magnitude of the average current during the time to accelerate from 1/2 of the frequency set in [Pr. 4] to the frequency set in [Pr. 5].

When the average current of the current averaging range (refer to A in the chart on the next page) during operation with the X19 signal on is less than the "rated inverter current" x [Pr. 272], the maximum frequency automatically becomes the [Pr. 4] setting value.

When the average current of the current averaging time period (refer to B in the chart on the next page) during operation with the X19 signal on is higher than the "rated inverter current" x [Pr. 272], the maximum frequency automatically becomes the [Pr. 5] setting value.

During regeneration load operation, [Pr. 4] is the maximum frequency regardless of the average current. When the average current during acceleration is too small, it may be judged as regeneration and the maximum frequency becomes the setting of [Pr. 4].

The current averaging range can be set between 1/2 frequency of the [Pr. 272] setting value and [Pr. 273] set frequency. When the current averaging range includes the constant power range, the output current may become large in the constant power range.

When the average current value in the current averaging range is small, deceleration time becomes longer as the running frequency increases.

The maximum output frequency is 120Hz. The output frequency is 120Hz even when the setting is above 120Hz.

This control can be activated at every start. Fully note that the speed changes every time if the magnitude of the load differs every time.

It is valid in the External operation mode only, and restart after instantaneous power failure function and fast-response current limit function are invalid.

The load torque high speed frequency function is invalid in the following operation conditions:

- PU operation [Pr. 79]
- PU+external operation [Pr. 79]
- JOG operation (JOG signal)
- PID control operation (X14 signal)
- Remote function selection operation (Pr. 59)
- Orientation control operation
- Multi-speed setting (RH, RM, and RL signals)
- 16bit digital input (FR-A7AX)
### 2.20.2 Stop-on contact control function [Pr. 6, 48, 270, 275, 276] **A700** **E700**

To ensure accurate positioning at the upper limit etc. of a lift, stop-on-contact control causes a mechanical brake to be closed while the motor is developing a holding torque to keep the load in contact with a mechanical stopper etc.

This function suppresses vibration which is liable to occur when the load is stopped upon contact in vertical motion applications, ensuring steady precise positioning.

To prevent the motor from starting a stall, the stall prevention operation current is set at a maximum of 150% of the rated current. The smaller setting value between Pr.22 Stall prevention operation level and Pr.48 Second stall prevention operation current has a priority.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>Multi-speed setting (low speed)</td>
<td>10Hz</td>
<td>0 to 400Hz</td>
<td>Set the output frequency for stop-on-contact control.</td>
<td>A700   E700</td>
</tr>
<tr>
<td>48</td>
<td>Second stall prevention operation current</td>
<td>150%</td>
<td>0 to 200%</td>
<td>Set the stall prevention operation level for stop-on-contact control.</td>
<td>A700   E700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999</td>
<td>0 to 1000%</td>
<td>The smaller setting value between Pr.22 Stall prevention operation level and Pr.48 has a priority.</td>
<td></td>
</tr>
<tr>
<td>270</td>
<td>Stop-on-contact/load torque high-speed frequency control selection</td>
<td>0</td>
<td>0 to 9999</td>
<td>1 Stop-on-contact control</td>
<td>A700   E700</td>
</tr>
<tr>
<td>275</td>
<td>Stop-on-contact excitation current low-speed multiplying factor</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Set the brake (holding) torque for stop-on-contact control. Normally set 130% to 180%. Valid only during Advanced magnetic flux vector control.</td>
<td>A700   E700</td>
</tr>
<tr>
<td>276</td>
<td>PM motor carrier frequency at stop-on-contact</td>
<td>9999</td>
<td>0 to 75K</td>
<td>Use a PWM carrier frequency for stop-on-contact control. For Real sensorsless vector control, carrier frequency is always 2Hz.</td>
<td>A700   E700</td>
</tr>
</tbody>
</table>
Confirm that the External operation mode is selected. In [PARAMETER], select Real sensorless vector control or Advanced magnetic flux vector control. This function is not activated during V/F control and vector control.

In [PARAMETER], select Advanced magnetic flux vector control or General-purpose magnetic flux vector control. This function is not activated during V/F control and vector control.

Set output frequency during stop-on-contact control in [Pr. 76 Multi-speed setting (low speed)]. The frequency should be as low as possible (about 2Hz). If it is set to more than 30Hz, the operating frequency will be 30Hz.

When both the RT and RL signals are switched ON, the inverter enters the stop-on-contact mode, in which operation is performed at the frequency set in [Pr. 11] independently of the preceding speed.

Under Advanced magnetic flux vector control and General-purpose magnetic flux control, increasing the [Pr. 275] setting enhances excitation at the low speed and increases torque. Normally set this parameter within the range about 130 to 180%. If the setting is too large, overcurrent fault (E.OC 1 to 3) may occur or the machine may oscillate in a stop-on-contact state.

The stop-on-contact function is different from servo-lock function, and if used to stop or hold a load for an extended period, this function can cause the motor to overheat. After a stop, immediately hold the load by a mechanical brake.

Under the following operating conditions, the stop-on-contact function is invalid:

- PU operation ([Pr. 79])
- JOG operation (JOG signal)
- PU + external operation ([Pr. 79])
- PID control function operation ([Pr. 220])
- Remote setting function operation ([Pr. 59])
- Start time tuning (only in [Pr. 59])
- Orientation control function operation (only in [Pr. 220])

When performing stop-on-contact control during encoder feedback control, encoder feedback control is invalid due to a mode shift to the stop-on-contact control mode.

<table>
<thead>
<tr>
<th>Main Functions</th>
<th>Normal Operation (either RL or RT is OFF or both are OFF)</th>
<th>With Stop-on-contact Control (both RL and RT are ON)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Real sensorless vector control</td>
<td>Advanced magnetic flux vector control</td>
</tr>
<tr>
<td>Output frequency</td>
<td>Multi-speed 0 to 5V, 0 to 10V 4 to 20mA etc.</td>
<td>[Pr. 6] setting</td>
</tr>
<tr>
<td>Stall prevention operation level</td>
<td>—</td>
<td>[Pr. 22] setting</td>
</tr>
<tr>
<td>Torque limit level</td>
<td>[Pr. 22] setting</td>
<td>[Pr. 22] setting</td>
</tr>
<tr>
<td>Excitation current low speed scaling factor</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Carrier frequency</td>
<td>[Pr. 77] setting</td>
<td>Output frequency is 3Hz or less</td>
</tr>
<tr>
<td>Fast-response current limit</td>
<td>—</td>
<td>Valid</td>
</tr>
</tbody>
</table>

* When RL and RT are ON, [Pr. 49 Second stall prevention operation frequency] is invalid.
PARAMETER

<table>
<thead>
<tr>
<th>Main Functions</th>
<th>Normal Operation (either RL or RT is OFF or both are OFF)</th>
<th>With stop-on-contact Control (both RL and RT are ON)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Output frequency</td>
<td>Multi-speed</td>
<td>[Pr. 6] setting</td>
</tr>
<tr>
<td>Stall prevention operation level</td>
<td>[Pr. 7] setting</td>
<td>[Pr. 49] setting</td>
</tr>
<tr>
<td>Excitation current low speed scaling factor</td>
<td>—</td>
<td>[Pr. 7] ([0 to 200%) is compensated from normal operation]</td>
</tr>
<tr>
<td>Carrier frequency</td>
<td>[Pr. 8] setting</td>
<td>[Pr. 29] setting (when [Pr. 49 = 9999])</td>
</tr>
<tr>
<td>Fast-response current level</td>
<td>Valid</td>
<td>Invalid</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Input Signal ([= ON])</th>
<th>Set Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>RH</td>
<td>[Pr. 1 Multi-speed setting (high speed)]</td>
</tr>
<tr>
<td>RM</td>
<td>[Pr. 2 Multi-speed setting (middle speed)]</td>
</tr>
<tr>
<td>RL</td>
<td>[Pr. 3 Multi-speed setting (low speed)]</td>
</tr>
<tr>
<td>RT</td>
<td>[Pr. 4 Multi-speed setting (high speed)]</td>
</tr>
<tr>
<td>JOG</td>
<td>[Pr. 6 Multi-speed setting (low speed)]</td>
</tr>
<tr>
<td>[Pr. 15 Jog frequency]</td>
<td>[Pr. 15 Jog frequency]</td>
</tr>
<tr>
<td>[Pr. 26 Multi-speed setting (speed 6)]</td>
<td>[Pr. 26 Multi-speed setting (speed 6)]</td>
</tr>
<tr>
<td>[Pr. 27 Multi-speed setting (speed 7)]</td>
<td>[Pr. 27 Multi-speed setting (speed 7)]</td>
</tr>
<tr>
<td>[Pr. 28 Multi-speed setting (speed 8)]</td>
<td>[Pr. 28 Multi-speed setting (speed 8)]</td>
</tr>
<tr>
<td>[Pr. 29 Multi-speed setting (speed 9)]</td>
<td>[Pr. 29 Multi-speed setting (speed 9)]</td>
</tr>
<tr>
<td>[Pr. 30 Multi-speed setting (speed 10)]</td>
<td>[Pr. 30 Multi-speed setting (speed 10)]</td>
</tr>
<tr>
<td>[Pr. 31 Multi-speed setting (speed 11)]</td>
<td>[Pr. 31 Multi-speed setting (speed 11)]</td>
</tr>
<tr>
<td>[Pr. 32 Multi-speed setting (speed 12)]</td>
<td>[Pr. 32 Multi-speed setting (speed 12)]</td>
</tr>
<tr>
<td>[Pr. 33 Multi-speed setting (speed 13)]</td>
<td>[Pr. 33 Multi-speed setting (speed 13)]</td>
</tr>
<tr>
<td>[Pr. 34 Multi-speed setting (speed 14)]</td>
<td>[Pr. 34 Multi-speed setting (speed 14)]</td>
</tr>
<tr>
<td>[Pr. 35 Multi-speed setting (speed 15)]</td>
<td>[Pr. 35 Multi-speed setting (speed 15)]</td>
</tr>
<tr>
<td>[Pr. 36 Multi-speed setting (speed 16)]</td>
<td>[Pr. 36 Multi-speed setting (speed 16)]</td>
</tr>
<tr>
<td>[Pr. 37 Multi-speed setting (speed 17)]</td>
<td>[Pr. 37 Multi-speed setting (speed 17)]</td>
</tr>
<tr>
<td>[Pr. 38 Multi-speed setting (speed 18)]</td>
<td>[Pr. 38 Multi-speed setting (speed 18)]</td>
</tr>
<tr>
<td>[Pr. 39 Multi-speed setting (speed 19)]</td>
<td>[Pr. 39 Multi-speed setting (speed 19)]</td>
</tr>
<tr>
<td>[Pr. 40 Multi-speed setting (speed 20)]</td>
<td>[Pr. 40 Multi-speed setting (speed 20)]</td>
</tr>
<tr>
<td>[Pr. 41 Multi-speed setting (speed 21)]</td>
<td>[Pr. 41 Multi-speed setting (speed 21)]</td>
</tr>
<tr>
<td>[Pr. 42 Multi-speed setting (speed 22)]</td>
<td>[Pr. 42 Multi-speed setting (speed 22)]</td>
</tr>
<tr>
<td>[Pr. 43 Multi-speed setting (speed 23)]</td>
<td>[Pr. 43 Multi-speed setting (speed 23)]</td>
</tr>
<tr>
<td>[Pr. 44 Multi-speed setting (speed 24)]</td>
<td>[Pr. 44 Multi-speed setting (speed 24)]</td>
</tr>
<tr>
<td>[Pr. 45 Multi-speed setting (speed 25)]</td>
<td>[Pr. 45 Multi-speed setting (speed 25)]</td>
</tr>
<tr>
<td>[Pr. 46 Multi-speed setting (speed 26)]</td>
<td>[Pr. 46 Multi-speed setting (speed 26)]</td>
</tr>
<tr>
<td>[Pr. 47 Multi-speed setting (speed 27)]</td>
<td>[Pr. 47 Multi-speed setting (speed 27)]</td>
</tr>
<tr>
<td>[Pr. 48 Multi-speed setting (speed 28)]</td>
<td>[Pr. 48 Multi-speed setting (speed 28)]</td>
</tr>
</tbody>
</table>

Input Signal ([= ON]) | Set Frequency |
---------------------|---------------|
RH | [Pr. 1 Multi-speed setting (high speed)] |
RM | [Pr. 2 Multi-speed setting (middle speed)] |
RL | [Pr. 3 Multi-speed setting (low speed)] |
RT | [Pr. 4 Multi-speed setting (high speed)] |
JOG | [Pr. 6 Multi-speed setting (low speed)] |
[Pr. 15 Jog frequency] | [Pr. 15 Jog frequency] |
[Pr. 26 Multi-speed setting (speed 6)] | [Pr. 26 Multi-speed setting (speed 6)] |
[Pr. 27 Multi-speed setting (speed 7)] | [Pr. 27 Multi-speed setting (speed 7)] |
[Pr. 28 Multi-speed setting (speed 8)] | [Pr. 28 Multi-speed setting (speed 8)] |
[Pr. 29 Multi-speed setting (speed 9)] | [Pr. 29 Multi-speed setting (speed 9)] |
[Pr. 30 Multi-speed setting (speed 10)] | [Pr. 30 Multi-speed setting (speed 10)] |
[Pr. 31 Multi-speed setting (speed 11)] | [Pr. 31 Multi-speed setting (speed 11)] |
[Pr. 32 Multi-speed setting (speed 12)] | [Pr. 32 Multi-speed setting (speed 12)] |
[Pr. 33 Multi-speed setting (speed 13)] | [Pr. 33 Multi-speed setting (speed 13)] |
[Pr. 34 Multi-speed setting (speed 14)] | [Pr. 34 Multi-speed setting (speed 14)] |
[Pr. 35 Multi-speed setting (speed 15)] | [Pr. 35 Multi-speed setting (speed 15)] |
[Pr. 36 Multi-speed setting (speed 16)] | [Pr. 36 Multi-speed setting (speed 16)] |
[Pr. 37 Multi-speed setting (speed 17)] | [Pr. 37 Multi-speed setting (speed 17)] |
[Pr. 38 Multi-speed setting (speed 18)] | [Pr. 38 Multi-speed setting (speed 18)] |
[Pr. 39 Multi-speed setting (speed 19)] | [Pr. 39 Multi-speed setting (speed 19)] |
[Pr. 40 Multi-speed setting (speed 20)] | [Pr. 40 Multi-speed setting (speed 20)] |
[Pr. 41 Multi-speed setting (speed 21)] | [Pr. 41 Multi-speed setting (speed 21)] |
[Pr. 42 Multi-speed setting (speed 22)] | [Pr. 42 Multi-speed setting (speed 22)] |
[Pr. 43 Multi-speed setting (speed 23)] | [Pr. 43 Multi-speed setting (speed 23)] |
[Pr. 44 Multi-speed setting (speed 24)] | [Pr. 44 Multi-speed setting (speed 24)] |
[Pr. 45 Multi-speed setting (speed 25)] | [Pr. 45 Multi-speed setting (speed 25)] |
[Pr. 46 Multi-speed setting (speed 26)] | [Pr. 46 Multi-speed setting (speed 26)] |
[Pr. 47 Multi-speed setting (speed 27)] | [Pr. 47 Multi-speed setting (speed 27)] |
[Pr. 48 Multi-speed setting (speed 28)] | [Pr. 48 Multi-speed setting (speed 28)] |

Input Signal ([= ON]) | Set Frequency |
---------------------|---------------|
RH | [Pr. 1 Multi-speed setting (high speed)] |
RM | [Pr. 2 Multi-speed setting (middle speed)] |
RL | [Pr. 3 Multi-speed setting (low speed)] |
RT | [Pr. 4 Multi-speed setting (high speed)] |
JOG | [Pr. 6 Multi-speed setting (low speed)] |
[Pr. 15 Jog frequency] | [Pr. 15 Jog frequency] |
[Pr. 26 Multi-speed setting (speed 6)] | [Pr. 26 Multi-speed setting (speed 6)] |
[Pr. 27 Multi-speed setting (speed 7)] | [Pr. 27 Multi-speed setting (speed 7)] |
[Pr. 28 Multi-speed setting (speed 8)] | [Pr. 28 Multi-speed setting (speed 8)] |
[Pr. 29 Multi-speed setting (speed 9)] | [Pr. 29 Multi-speed setting (speed 9)] |
[Pr. 30 Multi-speed setting (speed 10)] | [Pr. 30 Multi-speed setting (speed 10)] |
[Pr. 31 Multi-speed setting (speed 11)] | [Pr. 31 Multi-speed setting (speed 11)] |
[Pr. 32 Multi-speed setting (speed 12)] | [Pr. 32 Multi-speed setting (speed 12)] |
[Pr. 33 Multi-speed setting (speed 13)] | [Pr. 33 Multi-speed setting (speed 13)] |
[Pr. 34 Multi-speed setting (speed 14)] | [Pr. 34 Multi-speed setting (speed 14)] |
[Pr. 35 Multi-speed setting (speed 15)] | [Pr. 35 Multi-speed setting (speed 15)] |
[Pr. 36 Multi-speed setting (speed 16)] | [Pr. 36 Multi-speed setting (speed 16)] |
[Pr. 37 Multi-speed setting (speed 17)] | [Pr. 37 Multi-speed setting (speed 17)] |
[Pr. 38 Multi-speed setting (speed 18)] | [Pr. 38 Multi-speed setting (speed 18)] |
[Pr. 39 Multi-speed setting (speed 19)] | [Pr. 39 Multi-speed setting (speed 19)] |
[Pr. 40 Multi-speed setting (speed 20)] | [Pr. 40 Multi-speed setting (speed 20)] |
[Pr. 41 Multi-speed setting (speed 21)] | [Pr. 41 Multi-speed setting (speed 21)] |
[Pr. 42 Multi-speed setting (speed 22)] | [Pr. 42 Multi-speed setting (speed 22)] |
[Pr. 43 Multi-speed setting (speed 23)] | [Pr. 43 Multi-speed setting (speed 23)] |
[Pr. 44 Multi-speed setting (speed 24)] | [Pr. 44 Multi-speed setting (speed 24)] |
[Pr. 45 Multi-speed setting (speed 25)] | [Pr. 45 Multi-speed setting (speed 25)] |
[Pr. 46 Multi-speed setting (speed 26)] | [Pr. 46 Multi-speed setting (speed 26)] |
[Pr. 47 Multi-speed setting (speed 27)] | [Pr. 47 Multi-speed setting (speed 27)] |
[Pr. 48 Multi-speed setting (speed 28)] | [Pr. 48 Multi-speed setting (speed 28)] |

By 0 to 5V (0 to 10V), 4 to 20mA input
This function is used to output from the inverter the mechanical brake operation timing signal in vertical lift and other applications. This function prevents the load from dropping with gravity at a start due to the operation timing error of the mechanical brake or an overcurrent alarm from occurring at a stop, ensuring secure operation.

### Table: \[Pr.] Name Initial Value Setting Range Description Available Inverters

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>278</td>
<td>Brake opening frequency</td>
<td>3 Hz</td>
<td>0 to 30 Hz</td>
<td>Set to the rated slip frequency of the motor + about 1.0 Hz. Setting is enabled only when ([Pr. 278] \leq [Pr. 282]).</td>
<td>○ ○</td>
</tr>
<tr>
<td>279</td>
<td>Brake opening current</td>
<td>130%</td>
<td>100% to 200%</td>
<td>Generally, set this parameter to about 50 to 100%. If the setting is too low, the load is liable to drop due to gravity at start. Suppose that the rated inverter current is 100%.</td>
<td>○ ○</td>
</tr>
<tr>
<td>280</td>
<td>Brake opening current detection time</td>
<td>0.3 s</td>
<td>0 to 2 s</td>
<td>Generally, set this parameter to about 0.1 to 0.3 s.</td>
<td>○ ○</td>
</tr>
<tr>
<td>281</td>
<td>Brake operation time at a start</td>
<td>0.3 s</td>
<td>0 to 5 s</td>
<td>Set the mechanical delay time until the brake is loosened when ([Pr. 292] = 7). Set the mechanical delay time until the brake is loosened + about 0.1 to 0.2 s when ([Pr. 292] = 8).</td>
<td>○ ○</td>
</tr>
<tr>
<td>282</td>
<td>Brake operation frequency</td>
<td>8 Hz</td>
<td>0 to 30 Hz</td>
<td>Set the frequency to activate the mechanical brake by turning OFF the brake opening request signal (BOF). Generally, set this parameter to the ([Pr. 271]) setting + 3 to 4 Hz. Setting is enabled only when ([Pr. 282] \geq [Pr. 278]).</td>
<td>○ ○</td>
</tr>
<tr>
<td>283</td>
<td>Brake operation time at stop</td>
<td>0.3 s</td>
<td>0 to 5 s</td>
<td>Set the mechanical delay time until the brake is closed + 0.1 s when ([Pr. 292] = 7). Set the mechanical delay time until the brake is closed + 0.2 to 0.3 s when ([Pr. 292] = 8).</td>
<td>○ ○</td>
</tr>
<tr>
<td>284</td>
<td>Deceleration detection function selection</td>
<td>0</td>
<td>0</td>
<td>Deceleration is not detected.</td>
<td>○ —</td>
</tr>
<tr>
<td>285</td>
<td>Overspeed detection frequency*</td>
<td>9999</td>
<td>0 to 30 Hz</td>
<td>If (detected frequency) - (output frequency) (\geq 2 \times \text{Fr.} 285) during encoder feedback control, the inverter fault (E.MB1) is provided.</td>
<td>○ —</td>
</tr>
<tr>
<td>292</td>
<td>Automatic acceleration/deceleration</td>
<td>0</td>
<td>0</td>
<td>Normal operation mode</td>
<td>○ ○</td>
</tr>
</tbody>
</table>

* When performing vector control with the FR-A7AP or FR-A7AL, this parameter changes to speed deviation excess detection frequency. (For details, refer to page 204.)
(1) Setting of brake sequence function

For \( \text{A700, E700} \), select one of Real sensorless vector control, vector control (speed control), and Advanced magnetic flux vector control. For \( \text{E700} \), select Advanced magnetic flux vector control or General-purpose magnetic flux control. This function is invalid during V/F control.

The brake sequence function is valid only when the External operation mode, External/PU combined operation mode 1 or Network operation mode is selected. When brake sequence mode is selected, automatic restart after instantaneous power failure is invalid. In addition, set acceleration/deceleration time to 1s or more.

Set \( \text{Pr. 292 = 7 or 8} \) (brake sequence mode). To ensure more complete sequence control, it is recommended to set \( \text{Pr. 292 = 7} \) (brake opening completion signal input).

Set \( \text{Pr. 178 to Pr. 189} \) (input terminal function selection = \( \text{15} \)) and assign the brake opening completion signal (BRI) to the input terminal.

Set \( \text{20 (positive logic) or 120 (negative logic)} \) in any of \( \text{Pr. 190 to Pr. 196} \) (output terminal function selection) and assign the brake opening request signal (BOF) to the output terminal.

Even if brake sequence function is selected, inputting the JOG signal (JOG operation), RT signal (second function selection) or X9 signal (third function selection) during an inverter stop will switch to the normal operation and give priority to JOG operation or second and third function selection. Note that JOG and RT signal input is invalid even if JOG signal and RT signal are input during operation by brake sequence function.

When PID control or load torque high speed frequency control is selected, brake sequence function is invalid.

(2) With brake opening completion signal input \( \{ \text{Pr. 278 to Pr. 283, Pr. 292 = 7} \} \)

When the start signal is input to the inverter, the inverter starts running. When the output frequency reaches the value set in \( \text{Pr. 278} \) and the output current is more than the value set in \( \text{Pr. 279} \), the inverter outputs the brake opening request signal (BOF) after the time set in \( \text{Pr. 280} \) has elapsed.

When the time set in \( \text{Pr. 281} \) elapses after the brake opening completion signal (BRI) was activated, the inverter increases the output frequency to the set speed.

When the speed has decreased to the frequency set in \( \text{Pr. 282} \) during deceleration, the BOF signal is turned OFF.

When the time set in \( \text{Pr. 283} \) elapses after the electromagnetic brake operation was completed and the BRI signal was turned OFF, the inverter output is switched OFF.

*1 The input signal terminal used differs according to the \( \{ \text{Pr. 178 to Pr. 189} \} \) settings.

*2 The output signal terminal used differs according to the \( \{ \text{Pr. 190 to Pr. 196} \} \) settings.

*3 The current should be within the permissible current of transistor in the inverter. \( \text{24V} \ 0.1 \text{ADC} \).
(3) Without brake opening completion signal input [Pr. 278 to 283, Pr. 292 = 8]

When the start signal is input to the inverter, the inverter starts running. When the output frequency reaches the value set in [Pr. 279] and the output current is more than the value set in [Pr. 279], the inverter outputs the brake opening request signal (BOF) after the time set in [Pr. 280] has elapsed. When the time set in [Pr. 280] elapses after the BOF signal is output, the inverter increases the output frequency to the set speed.

When the speed has decreased to the frequency set in [Pr. 282] during deceleration, the brake opening request signal (BOF) is turned OFF. When the time set in [Pr. 283] has elapsed after the BOF signal is turned OFF, the inverter output is switched OFF.

(4) Protective function [Pr. 284, Pr. 285]

If any of the following errors occurs in the brake sequence mode, the inverter results in an alarm, shuts off the output, and turns OFF the brake opening request signal (BOF).

<table>
<thead>
<tr>
<th>Error Display</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E.MB1</td>
<td>During encoder feedback control (when detected frequency) ( \geq ) (output frequency) ( \geq ) ( Pr. 280 ) (overspeed detection function) is not detected.</td>
</tr>
<tr>
<td>E.MB2</td>
<td>When deceleration is not normal during deceleration operation from the set frequency to the set frequency in [Pr. 222]. (When [Pr. 224 = 2])</td>
</tr>
<tr>
<td>E.MB3</td>
<td>Brake opening request signal (BOF) turned ON through the motor is at a stop. (Gravity drop prevention function)</td>
</tr>
<tr>
<td>E.MB4</td>
<td>Although more than 2s have elapsed after the start command (forward or reverse rotation) is input, the brake opening request signal (BOF) does not turn ON.</td>
</tr>
<tr>
<td>E.MB5</td>
<td>Although more than 2s have elapsed after the brake opening request signal (BOF) turned ON, the brake opening completion signal (BRI) does not turn ON.</td>
</tr>
</tbody>
</table>

*1 Not available for [ETS].
*2 Overspeed detection ([Pr. 285]) is valid under encoder feedback control (used with the FR-A7AP or FR-A7AL option) even if a value other than 7 or 8 is set in [Pr. 292].
*3 A too large setting of [Pr. 278] (brake opening frequency) activates stall prevention operation and may cause E.MB4.
*4 When the acceleration time from [Pr.13 Starting frequency] to [Pr.278 Brake opening frequency] plus [Pr.281 Brake opening current detection time] exceeds 2s, E.MB4 occurs.
The inverter can be used to exercise process control, e.g. flow rate, air volume or pressure. The terminal 2 input signal or parameter setting is used as a set point and the terminal 4 input signal used as a feedback value to constitute a feedback system for PID control.

### PARAMETER

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>127</td>
<td>PID control automatic switchover frequency</td>
<td>9999</td>
<td>0 to 400Hz</td>
<td>Set the frequency at which the control is automatically changed to PID control.</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>128</td>
<td>PID action selection</td>
<td>0</td>
<td>PID action is not performed</td>
<td>-- ○ ○</td>
<td></td>
</tr>
<tr>
<td>129</td>
<td>PID proportional band</td>
<td>100%</td>
<td>0.1 to 100%</td>
<td>If the proportional band is narrow (parameter setting is small), the manipulated variable varies greatly with a slight change of the measured value. Hence, as the proportional band narrows, the response sensitivity (gain) improves but the stability deteriorates, e.g. hunting occurs. Gain Kp = 1/proportional band</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>130</td>
<td>PID integral time</td>
<td>1s</td>
<td>0.1 to 3600s</td>
<td>For deviation ramp input, time (Tt) required for only the integral (I) action to provide the same manipulated variable as for the proportional (P) action. As the integral time decreases, the set point is reached earlier but hunting occurs more easily.</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>131</td>
<td>PID upper limit</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Set the upper limit value. If the feedback value exceeds the setting, the FUP signal is output. The maximum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>132</td>
<td>PID lower limit</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Set the lower limit value. If the measured value falls below the setting range, the FDN signal is output. The maximum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>133</td>
<td>PID action set point</td>
<td>9999</td>
<td>0 to 100%</td>
<td>Used to set the set point for PID control.</td>
<td>○ ○ ○</td>
</tr>
<tr>
<td>134</td>
<td>PID differential time</td>
<td>9999</td>
<td>0.01 to 10.00s</td>
<td>For deviation ramp input, time (T) required for providing the manipulated variable for the proportional (P) action only. As the differential time increases, greater response is made to a deviation change.</td>
<td>○ ○ ○</td>
</tr>
</tbody>
</table>
(1) PID control basic configuration

**[Pr. 128] Deviation value signal input**

- **Terminal 1**: 0 to 10VDC (0 to 5V), 4 to 20mA
- **Terminal 2**: 0 to 10VDC (0 to 10V), 4 to 20mA

*Kp: Proportionality constant  Ti: Integral time  S: Operator  Td: Differential time

*1 Note that terminal 1 input is added to the set point of terminal 2 input. (Only in A700, F700)

*2 Set [Pr. 858 Terminal 4 function assignment = 0]. PID control is invalid when [Pr. 858 <> 0]. (Only in A700, F700)
(2) PID action overview

1) PI action
A combination of proportional control action (P) and integral control action (I) for providing a manipulated variable in response to deviation and changes with time. PI action is the sum of P and I actions.

2) PD action
A combination of proportional control action (P) and differential control action (D) for providing a manipulated variable in response to deviation speed to improve the transient characteristic. PD action is the sum of P and D actions.

3) PID action
The PI action and PD action are combined to utilize the advantages of both actions for control. PID action is the sum of P, I and D actions.

4) Reverse action
Increases the manipulated variable (output frequency) if deviation \( X = (\text{set point} - \text{measured value}) \) is positive, and decreases the manipulated variable if deviation is negative.

5) Forward action
Increases the manipulated variable (output frequency) if deviation \( X = (\text{set point} - \text{measured value}) \) is negative, and decreases the manipulated variable if deviation is positive.

<table>
<thead>
<tr>
<th>Deviation</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reverse action</td>
<td>X</td>
<td>x</td>
</tr>
<tr>
<td>Forward action</td>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

Relationships between deviation and manipulated variable (output frequency)
To perform PID control, turn X14 signal ON in Pr.128. When this signal is off, PID action is not performed and normal inverter operation is performed. (Note that it is not necessary to turn ON X14 signal when performing PID control with LONWORKS or CC-Link communication.)

Set \[\text{Pr.128} = 20, 21, 50, 51, 60, 61\] in Pr.128 and then turn X14 signal ON. When X14 signal is not assigned, PID control is valid by just setting \[\text{Pr.128}\].

If the multi-speed (RH, RM, RL) signal or JOG operation (JOG signal) is entered with X14 signal ON, PID control stops and multi-speed or JOG operation starts.

Enter the set point across inverter terminals 2 and 5 or in \[\text{Pr.133}\] and enter the measured value signal across inverter terminals 4 and 5. At this time, set \[\text{Pr.128}\] to 20 or 21.

When PID control is selected, the minimum frequency is the frequency set in \[\text{Pr.902}\] and the maximum frequency is the frequency set in \[\text{Pr.903}\]. \[\text{Pr.1 Maximum frequency}\] and \[\text{Pr.2 Minimum frequency}\] settings are also valid.

During PID operation, the remote operation function \[\text{Pr.59}\] and functions set using \[\text{Pr.292 Automatic acceleration/deceleration}\] are invalid.

When X14 signal switches the control from normal operation to PID control, the frequency command during the normal operation is not retained, and new frequency is calculated with PID by the 0Hz reference.

*1 The power supply must be selected in accordance with the power specifications of the detector used.
*2 The used output signal terminal changes depending on the \[\text{Pr.190 to Pr.196 Output terminal selection}\] setting.
*3 The used input signal terminal changes depending on the \[\text{Pr.178 to Pr.189 Input terminal selection}\] setting.
*4 The AU signal need not be input.

### I/O signals and parameter setting

To perform PID control, turn X14 signal ON in Pr.128. When this signal is off, PID action is not performed and normal inverter operation is performed. (Note that it is not necessary to turn ON X14 signal when performing PID control with LONWORKS or CC-Link communication.)

Set \([\text{Pr.216} = 20, 21, 50, 51, 60, 61]\) in \([\text{Pr.216}]\), and then turn X14 signal ON. When X14 signal is not assigned, PID control is valid by just setting \([\text{Pr.216}]\).

If the multi-speed (RH, RM, RL) signal or JOG operation (JOG signal) is entered with X14 signal ON, PID control stops and multi-speed or JOG operation starts.

Enter the set point across inverter terminals 2 and 5 or in \([\text{Pr.133}]\) and enter the measured value signal across inverter terminals 4 and 5. At this time, set \([\text{Pr.128}]\) to 20 or 21.

When PID control is selected, the minimum frequency is the frequency set in \([\text{Pr.902}]\) and the maximum frequency is the frequency set in \([\text{Pr.903}]\). \([\text{Pr.1 Maximum frequency}]\) and \([\text{Pr.2 Minimum frequency}]\) settings are also valid.

During PID operation, the remote operation function \([\text{Pr.59}]\) and functions set using \([\text{Pr.292 Automatic acceleration/deceleration}] are invalid.

When X14 signal switches the control from normal operation to PID control, the frequency command during the normal operation is not retained, and new frequency is calculated with PID by the 0Hz reference.

*1 The power supply must be selected in accordance with the power specifications of the detector used.
*2 The used output signal terminal changes depending on the \([\text{Pr.190 to Pr.196 Output terminal selection}]\) setting.
*3 The used input signal terminal changes depending on the \([\text{Pr.178 to Pr.189 Input terminal selection}]\) setting.
*4 The AU signal need not be input.
<table>
<thead>
<tr>
<th>Signal</th>
<th>Terminal Used</th>
<th>Functions</th>
<th>Description</th>
<th>Parameter Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>X14</td>
<td></td>
<td>PID control selection</td>
<td>Turn ON X14 to perform PID control</td>
<td>Set 14 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td>X64</td>
<td></td>
<td>PID forward/reverse action selection</td>
<td>You can select PID forward action (Pr 128 = 10, 20) or reverse action (Pr 128 = 11, 21).</td>
<td>Set 64 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>Set point input</td>
<td>Input the set point for PID control.</td>
<td>Set 2 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>Deviation signal input</td>
<td>Input the deviation signal calculated externally.</td>
<td>Set 2 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>Measured value input</td>
<td>Input the measured value signal.</td>
<td>Set 4 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Communication</td>
<td>Input the deviation value from LONWORKS, CC-Link communication.</td>
<td>Set 4 in any of [Pr. 178 to Pr. 189]</td>
</tr>
<tr>
<td>FUP</td>
<td></td>
<td>Upper limit output</td>
<td>Upper limit output.</td>
<td>Set 15 or 115 in any of [Pr. 190 to Pr. 196] *3</td>
</tr>
<tr>
<td>FDN</td>
<td></td>
<td>Lower limit output</td>
<td>Lower limit output.</td>
<td>Set 14 or 114 in any of [Pr. 190 to Pr. 196] *3</td>
</tr>
<tr>
<td>RL</td>
<td></td>
<td>Forward (reverse) rotation direction output</td>
<td>Forward (reverse) rotation direction output.</td>
<td>Set 16 or 116 in any of [Pr. 190 to Pr. 196] *3</td>
</tr>
<tr>
<td>PID</td>
<td></td>
<td>PID output interruption</td>
<td>Turn ON during PID control.</td>
<td>Set 47 or 147 in any of [Pr. 190 to Pr. 196] *3</td>
</tr>
<tr>
<td>SLEEP</td>
<td></td>
<td>SLEEP output interruption</td>
<td>Turn ON when the PID output interruption function is performed.</td>
<td>Set 70 or 170 in any of [Pr. 190 to Pr. 196] *3</td>
</tr>
<tr>
<td>SE</td>
<td>SE</td>
<td>Output terminal common</td>
<td>Common terminal for terminals FUP, FDN, RL, PID and SLEEP</td>
<td>Common terminal for terminals FUP, FDN, RL, PID and SLEEP</td>
</tr>
</tbody>
</table>

*1 The shaded area indicates the parameter initial value.
*2 For the setting method via LONWORKS communication, refer to the LONWORKS communication option (FR-A7NL) instruction manual.
*3 When 100 or larger value is set in any of [Pr. 190 to Pr. 196 Output terminal function selection], the terminal output has negative logic.

The shaded area indicates the parameter initial value.
*2 For the setting method via LONWORKS communication, refer to the LONWORKS communication option (FR-A7NL) instruction manual.
*3 When 100 or larger value is set in any of [Pr. 190 to Pr. 196 Output terminal function selection], the terminal output has negative logic.
<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Description</th>
<th>Function</th>
<th>Terminal Used</th>
<th>Signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turn ON X14 signal to perform PID control. +1</td>
<td>PID control selection</td>
<td>X14</td>
<td>Depending on</td>
<td>407</td>
</tr>
<tr>
<td>You can input the set point for PID control.</td>
<td>Set point input</td>
<td>2</td>
<td>2</td>
<td>407</td>
</tr>
<tr>
<td>Input the signal from the detector (measured value signal).</td>
<td>Measured value input</td>
<td>4</td>
<td>4</td>
<td>407</td>
</tr>
<tr>
<td>Output to indicate that the process value signal exceeded the maximum value (Pr. 131).</td>
<td>Upper limit output</td>
<td>FLIP</td>
<td>Depending on</td>
<td>407</td>
</tr>
<tr>
<td>Output when the process value signal falls below the minimum value (Pr. 132).</td>
<td>Lower limit output</td>
<td>FDN</td>
<td>Depending on</td>
<td>407</td>
</tr>
<tr>
<td>Turn is output to indicate that the output indication of the parameter unit is forward rotation (FWD) or “Low” to indicate that it is reverse rotation (REV) or stop (STOP).</td>
<td>Forward (reverse) rotation direction output</td>
<td>RL</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>Turns ON during PID control.</td>
<td>During PID control activated</td>
<td>PID</td>
<td>407</td>
<td></td>
</tr>
<tr>
<td>Turns ON when the PID output interruption function is performed.</td>
<td>PID output interruption</td>
<td>SLEEP</td>
<td>(Only in E700)</td>
<td>407</td>
</tr>
<tr>
<td>Common terminal for open collector output terminal.</td>
<td>Output terminal</td>
<td>SE E700</td>
<td>SE</td>
<td>407</td>
</tr>
</tbody>
</table>

1. When the X14 signal is not assigned, only the "Pr. 128 ≠ 0" setting makes PID control valid.
2. The shaded area indicates the parameter initial value.
3. When 100 or larger value is set in any of Pr.190 to Pr.192 (output function selection), the terminal output has negative logic. (Refer to page 61 for details)
4. When [Pr. 561: PTC thermistor protection level ≠ “9999”], terminal 2 is not available for set point input. Use [Pr. 133] for set point input. (Only in E700)
5. Refer to the LONWORKS communication option (FR-A7NL E kit) instruction manual for the setting method from LONWORKS communication. Refer to the CC-Link communication option (FR-A7NC E kit) instruction manual for the setting method from CC-Link communication. (Only in E700)
(5) PID automatic switchover control \([\text{Pr. 127}]\)
For a fast system startup at an operation start, the inverter can be started up in normal operation mode only at a start.
When the frequency is set to \([\text{Pr. 127} \text{ PID control automatic switchover frequency}]\) within the range of 0 to 400Hz, the inverter starts up without PID operation from a start until output frequency is reached \([\text{Pr. 127}]\), and then it shifts to PID control. Once the inverter has entered PID control operation, it continues PID control even if the output frequency falls to or below \([\text{Pr. 127}]\).

(6) PID output interruption function (SLEEP function) \([\text{SLEEP signal}]\) \([\text{Pr. 575 to 577}]\)
If the output frequency after PID calculation remains lower than the \([\text{Pr. 576 Output interruption detection level}]\) setting for longer than the time set in \([\text{Pr. 575 Output interruption detection time}]\), the inverter stops operation. The energy consumption in the inefficient low speed region can be reduced.
When the deviation (= set value - process value) reaches the PID output shutoff cancel level \([\text{Pr. 577}]\) setting - 1000% while the PID output interruption function is on, the PID output interruption function is cancelled and PID control operation is resumed automatically.
While the PID output interruption function is on, the PID output interruption signal (SLEEP) is output. At this time, the inverter running signal (RUN) is OFF, and the PID control operating signal (PID) is ON.

(7) PID monitor function
The PID control set value, measured value and deviation value can be displayed on the operation panel and output from terminal FM and AM.
Integral value indicating a negative % can be displayed on the deviation monitor. 0% is displayed as 1000. (The deviation monitor cannot be output from the terminal FM and AM.)
For each monitor, set the following values in \([\text{Pr. 52 DU/UI main display screen data selection}]\) and \([\text{Pr. 54 FM terminal function selection}]\) and \([\text{Pr. 158 AM terminal function selection}]\).

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Monitor Description</th>
<th>Terminal FM, AM</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52 PID set point</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>53 PID measured value</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>54 PID deviation</td>
<td>100%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Adjust the PID control parameters, \([\text{Pr. 127 to 134}]\) and \([\text{Pr. 575 to 577}]\).

(8) Adjustment procedure
Adjust the PID control parameters, \([\text{Pr. 127 to 134}]\) and \([\text{Pr. 575 to 577}]\).

**Parameter setting**
Set the I/O terminals for PID control \([\text{Pr. 178 to 199 Input terminal function selection}]\) and \([\text{Pr. 240 to 249 Output terminal function selection}]\).

**Terminal setting**
When the X14 signal is not assigned in \([\text{Pr. 128}]\), only the \([\text{Pr. 128} \neq 0 ]\) setting makes PID control valid.
(9) Calibration example
(A detector of 4mA at 0°C and 20mA at 50°C is used to adjust the room temperature to 25°C under PID control.
The set point is given across inverter terminals 2-5 (0 to 5V).)

- Set the room temperature to 25°C.
  Set [Pr. 138] and turn on the X14 signal to enable PID control.

- Detector specifications
  When 0°C → 4mA and 20°C → 20mA are used, the set point 25°C is 50% on the assumption that 4mA is 0% and 20mA is 100%.

- Make the following calibration* when the target setting input (0 to 5V) and detector output (4 to 20mA) must be calibrated.

- When the set point is 50%
  As the terminal 2 specifications are 0% → 0V and 100% → 5V, input 2.5V to the terminal 2 for the set point of 50%.

- When the parameter unit is used for operation, input the set point (0 to 100%) in [Pr. 131].
  When performing operation, first set the proportional band ([Pr. 129]) to a slightly larger value, the integral time ([Pr. 130]) to a slightly longer time, and the differential time ([Pr. 134]) to "9999" (no function), and while looking at the system operation, decrease the proportional band ([Pr. 129]), increase the integral time ([Pr. 130]), and increase the differential time ([Pr. 134]).

- To stabilize the measured value, decrease the proportional band ([Pr. 129]), decrease the integral time ([Pr. 130]), and increase the differential time ([Pr. 134]).

- When calibration is required

  Using [Pr. 125, C2 to C4 (Pr. 902, 903)] (terminal 2) or [Pr. 126, C5 to C7 (Pr. 904, 905)] (terminal 4), calibrate the detector output and target setting input.
  Make calibration in the PU mode during an inverter stop.

*When calibration is required

- Determine the set point of what is desired to be adjusted.

- Calculate the ratio of the set point to the detector output.

- Input a voltage across terminals 2-5 according to the set value %.

- Set the proportional band ([Pr. 129]) to a slightly larger value, the integral time ([Pr. 130]) to a slightly longer time, and the differential time ([Pr. 134]) to "9999" (no function), and turn ON the start signal.

- When the parameter unit is used for operation, input the set point (0 to 100%) in [Pr. 131].
- When the parameter unit is used for operation, input the set point (0 to 100%) in [Pr. 131].

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<Set point input calibration>
1) Apply the input voltage of 0% set point setting (e.g. 0V) across terminals 2-5.
2) Enter in [C2 (Pr. 902)] the frequency which should be output by the inverter at the deviation of 0% (e.g. 0Hz).
3) In [C3 (Pr. 903)], set the voltage value at 0%.
4) Apply the voltage of 100% set point (e.g. 5V) across terminals 2-5.
5) Enter in [Pr. 125] the frequency which should be output by the inverter at the deviation of 100% (e.g. 60Hz).
6) In [C4 (Pr. 904)], set the voltage value at 100%.

<Detector output calibration>
1) Apply the output current of 0% detector setting (e.g. 4mA) across terminals 4-5.
2) Make calibration using [C6 (Pr. 904)].
3) Apply the output current of 100% detector setting (e.g. 20mA) across terminals 4-5.
4) Make calibration using [C7 (Pr. 905)].
5) The frequency set in [C5 (Pr. 904)] and [Pr. 126] should be the same as set in [C2 (Pr. 902)] and [Pr. 125].

The results of the above calibration are as shown below:
2.20.5  Dancer control [Pr.44, 45, 128 to 134]  
Perform PID control by feedback of the position detection of the dancer roller, controlling the dancer roller is in the specified position.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>Second acceleration/deceleration time</td>
<td>2.7s or less</td>
<td>0 to 3600s</td>
<td>This parameter is the acceleration time of the main speed during dancer control. It will not function as second acceleration/deceleration time.</td>
<td>○ ○</td>
</tr>
<tr>
<td>45</td>
<td>Second deceleration time</td>
<td>9999</td>
<td>0 to 3600s</td>
<td>This parameter is the deceleration time of the main speed during dancer control. It will not function as second deceleration time.</td>
<td>○ ○</td>
</tr>
<tr>
<td>128</td>
<td>PID action selection</td>
<td>0</td>
<td>0 to 100%</td>
<td>0 PID action is not performed. 20 PID reverse action, 21 PID forward action, 40 PID reverse action (addition method: fixed), 41 PID forward action (addition method: fixed), 42 PID reverse action (addition method: ratio), 43 PID forward action (addition method: ratio), 50 PID reverse action (deviation value signal input (LwWorks, CC-Link communication)), 51 PID forward action (CC-Link communication), 60 PID reverse action (set point and measured value input (LwWorks, CC-Link communication)), 61 PID forward action (LwWorks, CC-Link communication).</td>
<td>○ ○</td>
</tr>
<tr>
<td>129</td>
<td>PID proportional band</td>
<td>100%</td>
<td>0.1 to 1000%</td>
<td>129 The proportional band is narrow (parameter setting is small), the manipulated variable varies greatly with a slight change of the measured value. Hence, as the proportional band narrows, the maneuver sensitivity (gain) improves but the stability deteriorates, e.g. hunting occurs. Gain Kp = 1/proportional band.</td>
<td>○ ○</td>
</tr>
<tr>
<td>130</td>
<td>PID integral time</td>
<td>1s</td>
<td>0 to 3600s</td>
<td>130 When deviation step is input, time (t) is the time required for integral (I) action to provide the same manipulated variable as the proportional (P) action. As the integral time decreases, the set point is reached earlier but hunting occurs more weakly.</td>
<td>○ ○</td>
</tr>
<tr>
<td>131</td>
<td>PID upper limit</td>
<td>9999</td>
<td>0 to 100%</td>
<td>131 The maximum value is the feedback value exceeds the setting, the FUP signal is output. The maximum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.</td>
<td>○ ○</td>
</tr>
<tr>
<td>132</td>
<td>PID lower limit</td>
<td>9999</td>
<td>0 to 100%</td>
<td>132 The minimum value is the feedback value falls below the setting range, the FDN signal is output. The minimum input (20mA/5V/10V) of the measured value (terminal 4) is equivalent to 100%.</td>
<td>○ ○</td>
</tr>
<tr>
<td>133</td>
<td>PID action set point</td>
<td>9999</td>
<td>0 to 100%</td>
<td>133 Used to set the set point for PID control.</td>
<td>○ ○</td>
</tr>
</tbody>
</table>

*1 PID proportional band, PID integral time, PID upper limit, PID lower limit, PID action set point are used when the PID action is set by Pr.133.
The main speed can be set independently of the operation mode.

Set point and measured value of PID control

<table>
<thead>
<tr>
<th>Input</th>
<th>Input Signal</th>
<th>[Pr.267] Setting</th>
<th>Current/Voltage Input Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Set point</td>
<td>When measured value is input as current (4 to 20mA)</td>
<td>0mA .... 0% 20mA .... 100%</td>
<td>Switch : I</td>
</tr>
<tr>
<td></td>
<td>When measured value is input as voltage (0 to -5V or 0 to +10V)</td>
<td>0V .... 0% 5V .... 100%</td>
<td>Switch : V</td>
</tr>
<tr>
<td></td>
<td>When measured value is input as voltage</td>
<td>0V .... 0% 10V .... 100%</td>
<td></td>
</tr>
</tbody>
</table>

Dancer control overview

Performs dancer control by setting 40 to 43 in Pr. 128 PID action selection. The main speed command is the speed command of each operation mode (External, PU, Network). Performs PID control by the position detection signal of the dancer roller, then the result is added to the main speed command. For acceleration/deceleration of the main speed, set the acceleration time in Pr. 44 Second acceleration/deceleration time in Pr. 45 Second deceleration time.

* Set 0s normally to Pr. 7 Acceleration time and Pr. 8 Deceleration time. When the Pr. 7 and Pr. 8 setting is large, response of dancer control during acceleration/deceleration is slow.
**PARAMETER**

### Connection diagram

- **Sink logic**
- **Pr. 128 = 41**
- **Pr. 183 = 14**
- **Pr. 190 = 15**
- **Pr. 192 = 16**

![Connection diagram](image)

- **The main speed command differs according to each operation mode (external, PU, communication)**
- **The used output signal terminal changes depending on the Pr. 190 to Pr. 192 (output terminal selection) setting.**
- **Pr. 730 has only one open collector output terminal.**
- **The used input signal terminal changes depending on the Pr. 178 to Pr. 184 (input terminal selection) setting.**
- **The AU signal need not be input.**
- **Available only in D700 and E700.**

### I/O signals and parameter setting

Set "40 to 43" in [Pr. 128] to perform dancer control. (Disable PID output interruption function if Pr. 575 = 9999) during dancer control.

Set "14" in any of [Pr. 178 to Pr. 184 (input terminal function selection)] to assign PID control selection signal (X14) to turn the X14 signal ON. When the X14 signal is not assigned, only the Pr. 128 setting makes dancer control valid.

Input the main speed command (External, PU, Network). The main speed command in any operation mode can be input. (Note that terminal 4 can not be used as the main speed command.) (Terminal 2 is not available for speed control when [Pr. 56] PTC thermistor protection level ≠ 9999 in [D700]. Terminal 2 functions as a PTC thermistor input terminal.)

Input the set point using [Pr. 133], then input the measured value signal (dancer roller position detection signal) across terminal 4 and 5 of the inverter.

When [Pr. 128] = "0" or X14 signal is OFF, normal inverter operation is performed without dancer control.

Turning ON/OFF of bit of the terminal, to which X14 signal is assigned through network as RS-485 communication, enables dancer control.

**Signal** | **Terminal Used** | **Function** | **Description** | **Parameter Setting**
--- | --- | --- | --- | ---
X14 | Depending on Pr. 178 to Pr. 184 | PID control selection | Turn ON X14 signal to perform dancer control. | Set 14 in any of Pr. 178 to Pr. 184 |
X14 | Depending on Pr. 178 to Pr. 184 | Measured value input | Input the signal from the dancer roller detector (measured value signal). | [Pr. 128 = 40, 41, 42, 43] |
FUP | Depending on Pr. 190 to Pr. 192 | Upper limit output | Output to indicate that the measured value signal exceeded the maximum value [Pr. 113]. | [Pr. 178 = 40, 41, 42, 43] |
FDN | Depending on Pr. 190 to Pr. 192 | Lower limit output | Output when the measured value signal falls below the minimum value [Pr. 112]. | [Pr. 178 = 40, 41, 42, 43] |
RL | Depending on Pr. 190 to Pr. 192 | Forward (reverse) rotation direction output | Output is ON when the output indication of the parameter unit is forward rotation (FWD) and OFF when reverse rotation (REV) or stop (STOP). | [Pr. 178 = 40, 41, 42, 43] |
PID | Depending on Pr. 190 to Pr. 192 | Control output | Turns ON during PID control. | Set 47 or 147 in any of Pr. 190 to Pr. 192 |
SE | | Output terminal common | Common terminal for open collector output terminal. | Set 47 or 147 in any of Pr. 190 to Pr. 192 |

*1 When the X14 signal is not assigned, only the Pr. 128 setting makes dancer control valid.
*2 The shaded area indicates the parameter initial value.
*3 When 100 or larger value is set in any of Pr. 190 to Pr. 192 (output terminal function selection), the terminal output has negative logic. (For details, Refer to page 68)
When ratio (Pr. 128 = \{42, 43\}) is selected for addition method, PID control \times (ratio of main speed) is added to the main speed. The ratio is determined by the \{Pr. 125 Terminal 2 frequency setting gain frequency\} and \{C2 (Pr. 902 Terminal 2 frequency setting bias frequency)\}. The frequency setting signal is set to 0 to 60Hz in the range of 0 to 100% in the initial setting. The ratio is (\times100\%) when the main speed is 60Hz and (\times50\%) when 30Hz.

Even when \(C4 \text{ (Pr. 903)}\) is set to other than 100%, the frequency setting signal is considered as 100%. Even when \(C3 \text{ (Pr. 903)}\) is set to other than 0%, the frequency setting signal is considered as 0%. When \(C2 \text{ (Pr. 902)}\) is set to other than 0Hz, the frequency setting signal is 0% when \(C2 \text{ (Pr. 902)}\) is less than the set frequency.

Turning X14 signal ON/OFF during operation by assigning X14 signal results in the following operation.

- When X14 signal is ON: Uses output frequency unchanged as the main speed command and continues operation by dancer control.
- When X14 signal is OFF: Ends dancer control and continues operation at the set frequency.

Action of \{Pr. 129 PID proportional band\}, \{Pr. 130 PID integral time\}, \{Pr. 131 PID upper limit\}, \{Pr. 132 PID lower limit\}, \{Pr. 134 PID differential time\} is the same as PID control. For the relationship of controlled variable (%) of PID control and frequency, 0% is equivalent to the set frequency of \{Pr. 902\}, and 100% to \{Pr. 903\}.

For the \{Pr. 133 PID action set point\} setting, set frequency of \{Pr. 902\} is equivalent to 0% and \{Pr. 903\} to 100%. When 9999 is set in \{Pr. 133\}, 50% is the set point.

1. PID control stops when RH, RM, RL, and REX signals (for multi-speed operation) or JOG signal is input during normal PID control. However, PID control continues when those signals are input during dancer control since these are treated as speed commands.

2. The second acceleration/deceleration time set in \{Pr. 44, 45\} is the acceleration/deceleration time for the main speed command during dancer control, and it does not function as second function.

3. Dancer control (PID control) is invalid when switchover mode is selected with \{Pr. 79\}.

4. Acceleration/deceleration of main speed command follows the frequency increase/decrease made by analog input. Therefore, the following situations may occur:
   - SU signal may stay ON even though start signal is switched ON/OFF. (Always in constant speed status)
   - When the start signal is OFF, the DC brake does not activate at the frequency set in \{Pr. 10\} but at the smaller frequency between \{Pr. 7, 8\} setting or 0.5Hz.

Even when \(C4 \text{ (Pr. 903)}\) is set to other than 100%, the frequency setting signal is considered as 100%. Even when \(C3 \text{ (Pr. 903)}\) is set to other than 0%, the frequency setting signal is considered as 0%. When \(C2 \text{ (Pr. 902)}\) is set to other than 0Hz, the frequency setting signal is 0% when \(C2 \text{ (Pr. 902)}\) is less than the set frequency.
(6) Output signal

PID signal turns ON during dancer control (PID control) or at a stop by PID control (in the status PID operation being performed inside). (The signal is OFF during normal operation.)

For the terminal used for PID signal output, assign the function by setting "47 (positive logic) or 147 (negative logic)" in any of [Pr. 190 to Pr. 192 (output terminal function selection)].

(7) PID monitor function

The PID control set point and measured value can be output to the operation panel monitor display and terminal FM.

For each monitor, set the following value in [Pr. 52 DU/PU main display data selection] and [Pr. 54 FM terminal function selection].

<table>
<thead>
<tr>
<th>Setting</th>
<th>Monitor Description</th>
<th>Minimum Increments</th>
<th>Terminal FM Full Scale</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>PID set point</td>
<td>0.1%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>PID measured value</td>
<td>0.1%</td>
<td>100%</td>
<td>Value cannot be set in [Pr. 74]. Displays 1000 when the PID deviation is 0%.</td>
</tr>
<tr>
<td>54</td>
<td>PID deviation value</td>
<td>0.1%</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>

(8) Priorities of main speed command

The priorities of the main speed command source when the speed command source is external are as follows:

- JOG signal > multi-speed setting signal (RL/RM/RH/REX) > 16 bit digital input (option) > terminal 2

The priorities of the main speed command source when "3" is set in [Pr. 79] are as follows:

- Multi-speed setting signal (RL/RM/RH/REX) > set frequency (digital setting by PU, operation panel)
- Terminal 4 can not be selected as the main speed command even when AU terminal is turned ON.
- Even when a remote operation function is selected by setting [Pr. 59], compensation of the remote setting frequency to the main speed is ignored (changes to 0).

(9) Adjustment procedure

**Dancer roll position detection signal adjustment**

When terminal 4 input is voltage input, 0V is the lower limit position and 5V(10V) is the upper limit position. When current input, 4mA is the lower limit position and 20mA is the upper limit position (initial value). When 0 to 7V is output from the potentiometer, it is necessary to calibrate [C7 (Pr. 905)] at 7V.

**(Example) Control at a dancer center position using a 0 to 7V potentiometer**

1. After changing the current/voltage input switch to "V", set "2" in [Pr. 267 = 2] to change terminal 4 input to voltage input.
2. Input 0V to across terminal 4 and 5 to calibrate [C6 (Pr. 904)]. (% display displayed at analog calibration is irrelevant to % of the feedback value.)
3. By inputting 7V across terminal 4 to S, calibrate [C7(Pr. 905)]. (% display displayed at analog calibration is irrelevant to % of the feedback value.)
4. Set 50% in [Pr. 133].

---

**PARAMETER**

<table>
<thead>
<tr>
<th>Setting</th>
<th>Monitor Description</th>
<th>Minimum Increments</th>
<th>Terminal FM Full Scale</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>PID set point</td>
<td>0.1%</td>
<td>100%</td>
<td></td>
</tr>
<tr>
<td>53</td>
<td>PID measured value</td>
<td>0.1%</td>
<td>100%</td>
<td>Value cannot be set in [Pr. 74]. Displays 1000 when the PID deviation is 0%.</td>
</tr>
<tr>
<td>54</td>
<td>PID deviation value</td>
<td>0.1%</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
2.20.6 Bypass-inverter switchover function [Pr. 57, 58, 135 to 139, 159] (A700, F700)

The complicated sequence circuit for bypass-inverter switchover is built-in to the inverter. Hence, simply inputting the start, stop or automatic switchover selection signal facilitates the interlock operation of the switchover magnetic contactor.

### PARAMETER

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>57</td>
<td>Restart coasting time</td>
<td>0s</td>
<td>0 to 60s</td>
<td>Set the waiting time for inverter-triggered restart after an instantaneous power failure.</td>
</tr>
<tr>
<td>58</td>
<td>Restart cushion time</td>
<td>1s</td>
<td>0 to 60s</td>
<td>Set a voltage starting time at restart.</td>
</tr>
<tr>
<td>135</td>
<td>Electronic bypass sequence selection</td>
<td>0</td>
<td>0 to 1</td>
<td>Without electronic bypass sequence</td>
</tr>
<tr>
<td>136</td>
<td>MC switchover interlock time</td>
<td>1s</td>
<td>0 to 100s</td>
<td>Set the operation interlock time of MC2 and MC3.</td>
</tr>
<tr>
<td>137</td>
<td>Start waiting time</td>
<td>0.5s</td>
<td>0 to 100s</td>
<td>Set the time slightly longer (0.3 to 0.5s or so) than the time from when the ON signal enters MC3 until it actually turns ON.</td>
</tr>
<tr>
<td>138</td>
<td>Bypass selection at a fault</td>
<td>0</td>
<td>0 to 1</td>
<td>Inverter output is stopped (motor coast) at inverter fault.</td>
</tr>
<tr>
<td>139</td>
<td>Automatic switchover frequency from inverter to bypass operation</td>
<td>0 to 60Hz</td>
<td></td>
<td>Set the frequency to switch the inverter operation to commercial power supply operation. Inverter operation is performed from a start until ([Pr. 139]) is reached, and when the output frequency is at or above ([Pr. 139]), inverter operation is automatically switched to bypass operation.</td>
</tr>
<tr>
<td>159</td>
<td>Automatic switchover ON range between commercial power supply and inverter operation</td>
<td>0 to 10Hz</td>
<td></td>
<td>Valid during automatic switchover operation ([Pr. 139 \neq 9999]). When the inverter start command (STF/STR) is turned OFF, operation is switched from inverter operation to commercial power supply operation. Operation is switched to the inverter operation and the motor decelerates to stop.</td>
</tr>
</tbody>
</table>

When the motor is operated at 60Hz (or 50Hz), more efficient operation can be performed by the commercial power supply than by the inverter. When the motor cannot be stopped for a long time for the maintenance/inspection of the inverter, it is recommended to provide the commercial power supply circuit. To switch between inverter operation and bypass operation, an interlock must be provided to stop the motor once and then start it by the inverter in order to prevent the inverter from resulting in an overcurrent fault.

Using the electronic bypass sequence function that outputs the timing signal for operation of the magnetic contactor, a complicated commercial power supply switchover interlock can be provided by the inverter. The electronic bypass sequence function is valid only in the external operation or combined operation mode (PU speed command, external operation command \([Pr. 79 = 3]\)). Commercial operation can not be performed with the Mitsubishi vector motor (SF-VSRU).
1) Main Circuit
   Fully note the phase rotation of the power supply. If the phase rotation of the power supply differs, the rotation direction of the motor is reversed, and the rotation direction of the motor is reversed when switching between the inverter operation and bypass operation, causing malfunction such as damage to the machine and motor shaft and overcurrent alarm of the inverter.
   - Connect MC1 to the inverter input side.
   - Connect MC2 to the bypass operation side.
   - Connect MC3 to the inverter output side.
   - Be sure to provide mechanical interlocks for MC1 and MC2.

2) Control circuit
   Connect the control power supply (terminal R1, S1) in front of input side MC1. If the control power supply is connected behind input side MC1, the electronic bypass sequence function is not executed. In such case, the input side MC1 will not close and the inverter operation will not be performed.
   - Remove a jumper across terminal R-R1 and S-S1.
   - Control power should be supplied from the front of MC1 and connected to R1 and S1.

3) Input signal (refer to the following table for details)
   - CS signal: Input a switchover signal for inverter operation and bypass operation. The inverter operation is selected if closed.
   - STF (STR) signal: Input an inverter forward rotation (reverse rotation) start signal.
   - MRS signal: Input an operation interlock signal. Both inverter operation and bypass operation are interlocked if opened.

4) Output signal (refer to the next page for details)
   - MC1 signal: Operation timing signal of a magnetic contactor MC1 on the inverter input side is output.
   - MC2 signal: Operation timing signal of a magnetic contactor MC2 on the inverter output side is output.
   - MC3 signal: Operation timing signal of a magnetic contactor MC3 for bypass operation is output.

5) External thermal relay installation
   When using an external thermal relay, connect it to the bypass operation side, not the inverter output side.
   When performing low-noise operation of 400V class small capacity inverter with an external thermal relay connected to the output side, the external thermal relay may operate unnecessarily.
   - OH signal: Input an external thermal signal.

**Connection diagram**
[Connection diagram image]

**Electronic bypass sequence connection diagram**

1. Take caution for the capacity of the sequence output terminal.
   - The used terminal changes depending on the [Pr. 190 to Pr. 196 Output terminal function selection] setting.

<table>
<thead>
<tr>
<th>Output Terminal</th>
<th>Output Terminal Permissible Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter open collector output (RUN, SUN, IPF, OL, FU)</td>
<td>24VDC 0.1A</td>
</tr>
<tr>
<td>Inverter relay output (A1-C1, B1-C1, A2-B2, B2-C2)</td>
<td>230VAC 0.3A</td>
</tr>
<tr>
<td>30VDC 0.3A</td>
<td></td>
</tr>
<tr>
<td>Relay output option (FR-A7AR)</td>
<td></td>
</tr>
<tr>
<td>Inverter/bypass operation interlock</td>
<td></td>
</tr>
<tr>
<td>External thermal reset</td>
<td></td>
</tr>
<tr>
<td>Frequency setting signal</td>
<td></td>
</tr>
<tr>
<td>Inverter start (forward rotation)</td>
<td></td>
</tr>
<tr>
<td>Frequency setting signal</td>
<td></td>
</tr>
<tr>
<td>Inverter/bypass operation interlock</td>
<td></td>
</tr>
<tr>
<td>MC1</td>
<td></td>
</tr>
<tr>
<td>MC2</td>
<td></td>
</tr>
<tr>
<td>MC3</td>
<td></td>
</tr>
</tbody>
</table>

| Magnetic Contactor | Installation Place | Operation ( || Shorted, - Open) | During bypass operation | During inverter operation | At an inverter fault occurrence |
|--------------------|-------------------|------------------------------|-----------------------|------------------------|-------------------------------|
| MC1                | Between power supply and inverter input | - | - | (Shorted by reset) |
| MC2                | Between power supply and motor | - | - | (Can be selected using [Pr. 138], always open when external thermal relay is ON) |
| MC3                | Between inverter output and motor | - | - | |

*1 Take caution for the capacity of the sequence output terminal.
*2 When connecting a DC power supply, insert a protective diode.
*3 When connecting an AC power supply, connect the relay output option (FR-A7AR) and use a contact output.
*4 The used terminal changes depending on the [Pr. 180 to Pr. 189 Input terminal function selection] setting.
### Operation

1) **Input signal function**

| Signal | Terminal Used | Functions | Operation | MC Operation
|--------|---------------|-----------|-----------|---------------
| MRS    | MRS           | Operation enable/disable selection | OFF...........Bypass-inverter operation enabled | MC1
| CS     | CS            | Inverter operation | OFF...........Bypass operation | MC2
| STF (STR) | STF (STR) | Inverter operation command (valid for bypass operation) | ON...........Forward rotation (reverse rotation) | MC3
| ON Set 7 in any of [Pr. 190 to 196] | ON........Motor normal | OFF........Motor stop | OFF...........Stop | OFF........Normal operation
| RES RES | Operating status initialization | No change | No change | No change

1. Unless the MRS signal is turned ON, neither commercial power supply operation nor inverter operation can be performed.
2. The CS signal functions only when the MRS signal is ON.
3. STF (STR) functions only when both the MRS signal and CS signal are ON.
4. The RES signal enables reset input acceptance selection using [Pr. 75 Reset selection/disconnected PU detection/PU stamp selection].
5. MC1 turns OFF when an inverter fault occurs.
6. MC operation
   - MC-ON
   - MC-OFF
   - MC operation: MC-ON, MC2 is OFF and MC3 is ON
   - MC2 is ON and MC3 is OFF
   - MC3 is ON and MC3 is OFF
   - No change: The status before the signal turns ON or OFF is held.

### Output signal function

<table>
<thead>
<tr>
<th>Signal</th>
<th>Terminal Used</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>MC1</td>
<td>Control signal output of inverter input side magnetic contactor MC1</td>
<td>[Pr. 190 to 196 Setting]</td>
</tr>
<tr>
<td>MC2</td>
<td>Control signal output of bypass operation magnetic contactor MC2</td>
<td></td>
</tr>
<tr>
<td>MC3</td>
<td>Control signal output of inverter output side magnetic contactor MC3</td>
<td></td>
</tr>
</tbody>
</table>

3) When performing bypass operation
   Cancel an operation interlock signal (by turning ON MRS signal). When signal CS is OFF, bypass operation is performed.
4) When performing inverter operation
   Cancel an operation interlock signal (by turning ON MRS signal), and turn ON CS signal. By turning ON/OFF the inverter's start signal (STF (STR)), perform inverter operation.
5) When switching from inverter operation to bypass operation
   Turn ON → OFF CS signal.
6) When switching from bypass operation to inverter operation
   Turn OFF → ON CS signal, and turn ON the inverter's start signal (STF (STR)). If an instantaneous power failure function is set at this time, smooth switchover without decreasing the motor speed is performed.
7) When switching to bypass operation at inverter fault
   When [Pr. 138 = 1], the operation automatically switches to commercial operation if an inverter fault has occurred during inverter operation.

Note that automatic switchover cannot be made if E CPU appears.
- Operation sequence example without automatic switchover sequence \([Pr. 139 = 9999]\):

- Operation sequence example with automatic switchover sequence \([Pr. 139 \neq 9999, Pr. 159 = 9999]\):

- Operation sequence example with automatic switchover sequence \([Pr. 139 \neq 9999, Pr. 159 \neq 9999]\):
### Operating procedure

1) Operating procedure for operation

- **Operation pattern**
  - [Pr. 135 = 1] (open collector output terminal of inverter)
  - [Pr. 136 = 2.0s]
  - [Pr. 137 = 1.0s] (Set the time longer than the time from when MC3 actually turns ON until the inverter and motor are connected. If the time is short, a restart may not function properly.)
  - [Pr. 57 = 0.5s]
  - [Pr. 58 = 0.5s] (Be sure to set this parameter when bypass operation is switched to inverter operation.)

2) Signal ON/OFF after parameter setting

<table>
<thead>
<tr>
<th>MRS</th>
<th>CS</th>
<th>STF</th>
<th>MC1</th>
<th>MC2</th>
<th>MC3</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power-on</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>External operation mode (PU operation mode)</td>
</tr>
<tr>
<td>At start (inverter)</td>
<td>OFF→ON</td>
<td>OFF→ON</td>
<td>OFF→ON</td>
<td>OFF→ON</td>
<td>OFF→ON</td>
<td></td>
</tr>
<tr>
<td>At constant speed (bypass)</td>
<td>ON</td>
<td>ON→OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF→ON</td>
<td>MC3 turns ON after MC3 turns OFF (coasting status during this period) waiting time 2s</td>
</tr>
<tr>
<td>Switched to inverter for deceleration (inverter)</td>
<td>ON</td>
<td>OFF→ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF→ON</td>
<td>MC3 turns ON after MC2 turns OFF (coasting status during this period) waiting time 4s</td>
</tr>
<tr>
<td>Stop</td>
<td>ON</td>
<td>OFF</td>
<td>ON→OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
</tr>
</tbody>
</table>

*1 In the operation mode other than External operation or combined operation mode (PU speed command, external operation command) [Pr. 79 = 3], MC1 and MC3 turn ON.
*2 When the MRS and CS signals are ON and the STF (STR) signal is OFF, MC3 is ON, but when the motor was coasted to a stop from bypass operation last time, a start is made after the time set in [Pr. 137] has elapsed.
*3 Inverter operation can be performed when the MRS, STF (STR) and CS signals turn ON. In any other case (MRS signal - ON), bypass operation is performed.
*4 When the CS signal is turned OFF, the motor switches to bypass operation. However, when the STF (STR) signal is turned OFF, the motor is decelerated to a stop in the inverter operation mode.
*5 When both MC2 and MC3 are OFF and either MC2 or MC3 is then turned ON, there is a waiting time set in [Pr. 136].
*6 When the electronic bypass-inverter switchover sequence function (Pr. 135 = 1) and PU operation interlock function (Pr. 79 = 3) are used simultaneously, the MRS signal is shared by the PU operation external interlock signal unless the X12 signal is assigned. (When the MRS and CS signals turn ON, inverter operation is enabled.)
2.20.7 Orientation control [Pr. 350 to 366, 369, 393, 396 to 399] (A700)

This function is used with a position detector (encoder) installed to the spindle of a machine tool, etc. to allow a rotation shaft to be stopped at the specified position (oriented). It requires a plug-in option FR-A7AP or FR-A7AL and valid under V/F control, Advanced magnetic flux vector control, and vector control. Orientation control is invalid when a Real sensorless vector control is selected. If the orientation command signal (X22) is turned on during operation after the various parameters have been set, the speed will decelerate to the “orientation switchover speed”.

After the “orientation stop distance” is calculated, the speed will further decelerate, and the “orientation state” (servo lock) will be entered. The “orientation complete signal” (ORA) will be output when the “orientation complete width” is entered.

[Pr. 350 Stop position command selection = 9999] at initial setting, orientation control function is invalid.

When orientation control is performed, PID control is invalid.

### Parameter Table

<table>
<thead>
<tr>
<th>No.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>350</td>
<td>Stop position command selection</td>
<td>9999</td>
<td>0</td>
<td>Internal stop position command (Pr. 356)</td>
</tr>
<tr>
<td>351</td>
<td>Orientation speed</td>
<td>2Hz</td>
<td>0 to 30Hz</td>
<td>Decreases the motor speed to the set value when the orientation command (X22) is given.</td>
</tr>
<tr>
<td>352</td>
<td>Creep speed</td>
<td>0.5Hz</td>
<td>0 to 10Hz</td>
<td>Increases to the creep speed set in [Pr.351] as soon as the current position pulse reaches the creep switchover position set in [Pr.353].</td>
</tr>
<tr>
<td>353</td>
<td>Creep switchover position</td>
<td>511</td>
<td>0 to 16383</td>
<td>Enter the position which the orientation speed, the speed decreases to the creep speed set in [Pr.351] as soon as the current position pulse reaches the creep switchover position set in [Pr.353] as soon as the current position pulse reaches the creep switchover position set in [Pr.353].</td>
</tr>
<tr>
<td>354</td>
<td>Position loop switchover position</td>
<td>96</td>
<td>0 to 8191</td>
<td>As soon as the current position pulse reaches the set position loop switchover position, control is changed to position loop.</td>
</tr>
<tr>
<td>355</td>
<td>DC injection brake start position</td>
<td>5</td>
<td>0 to 255</td>
<td>After changing to position loop, DC injection brake is applied and the motor stops as soon as the current position pulse reaches the set DC injection brake start position.</td>
</tr>
<tr>
<td>356</td>
<td>Internal stop position command</td>
<td>0</td>
<td>0 to 16383</td>
<td>When [Pr.111 = 1], the internal position command is activated and the setting value of [Pr.350] becomes a stop position.</td>
</tr>
<tr>
<td>357</td>
<td>Orientation in-position zone</td>
<td>5</td>
<td>0 to 255</td>
<td>Set the in-position zone at a step of the orientation.</td>
</tr>
<tr>
<td>358</td>
<td>Encoder rotation direction</td>
<td>1</td>
<td>0 to 13</td>
<td>Functions at orientation completion can be selected.</td>
</tr>
<tr>
<td>359</td>
<td>Encoder rotation direction</td>
<td>1</td>
<td>0</td>
<td>Encoder rotation direction as viewed from A is forward rotation</td>
</tr>
<tr>
<td>360</td>
<td>16 bit data selection</td>
<td>0</td>
<td>1</td>
<td>0: Speed command</td>
</tr>
<tr>
<td>361</td>
<td>Position shift</td>
<td>0</td>
<td>0 to 16383</td>
<td>Internal stop position command use the position obtained by adding the setting value of [Pr.350] to the position command.</td>
</tr>
</tbody>
</table>

*Note: Pr.304 = 1 and the FR-A7AX is mounted, set a stop position using 16-bit data. When 1 is set in [Pr.111 = 1] and the FR-A7AX is mounted, set a stop position using 16-bit data. Stop position command is input as binary regardless of the [Pr.111] setting.*
PARAMETER

<table>
<thead>
<tr>
<th>[Pn]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>V.I.P. Control</th>
<th>Advanced</th>
<th>Magnetic Flux</th>
<th>Vector Control</th>
</tr>
</thead>
<tbody>
<tr>
<td>362</td>
<td>Orientation position loop gain [Pf.C]</td>
<td>1</td>
<td>0.1 to 100</td>
<td>When servo torque function is selected using [Pr.777], output frequency for generating servo torque increases to the creep speed of [Pr.117] gradually according to the slope set in [Pr.116]. Although the operation becomes faster when the value is increased, a machine may hunt, etc.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>363</td>
<td>Completion signal output delay time [Pf.C]</td>
<td>0.5s</td>
<td>0 to 5s</td>
<td>The orientation complete signal is output delaying the set time after in-position zone is entered. Also, the signal turns OFF delaying the set time after in-position zone is out.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>364</td>
<td>Encoder stop check time [Pf.C]</td>
<td>0.5s</td>
<td>0 to 5s</td>
<td>Orientation fault signal (ORM) is output when the encoder remains stopped for the set time without orientation completion in the state where orientation complete signal (ORA) is not output even once. ORA signal is also output when the orientation was started once but stopped without completing the orientation before reaching to the set time.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>365</td>
<td>Orientation limit [Pf.C]</td>
<td>9999</td>
<td>0 to 60s</td>
<td>Measure the time taken after passing the creep switch/zone and output the orientation fault signal (ORM) if orientation is not completed within the set time.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>366</td>
<td>Recheck time [Pf.C]</td>
<td>9999</td>
<td>0 to 5s</td>
<td>Turning OFF the alert signal with orientation completed (ORA) 5s after stopping the motor by orientation control, the present position is checked again after the set time elapses and the orientation complete signal (ORA) or orientation fault signal (ORM) is output.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>369</td>
<td>Number of encoder pulses [Pf.C]</td>
<td>1024</td>
<td>0 to 4096</td>
<td>Set the number of pulses of the encoder. Set the number of pulses before multiplied by four.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>393</td>
<td>Orientation selection [Pf.C]</td>
<td>0</td>
<td>0</td>
<td>Orientation is executed from the current rotation direction.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>396</td>
<td>Orientation speed gain (P term) [Pf.C]</td>
<td>60</td>
<td>0 to 1000</td>
<td>Response level during position control loop (servo rigidity) at orientation stop can be adjusted.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>397</td>
<td>Orientation speed gain (I term) [Pf.C]</td>
<td>0.333</td>
<td>0 to 20.0s</td>
<td>Lag/advance compensation gain can be adjusted.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>399</td>
<td>Orientation deceleration ratio [Pf.C]</td>
<td>20</td>
<td>0 to 1000</td>
<td>Make adjustment when the motor rocks at orientation stop or the orientation time is long.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>529</td>
<td>Number of encoder pulses at machine side [Pf.C]</td>
<td>9999</td>
<td>0 to 4096</td>
<td>Set the number of encoder pulses at machine side. Set the number of pulses before multiplied by four.</td>
<td>○</td>
<td>×</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
(1) Connection example

- For the fan of the 7.5kW or less dedicated motor, the power supply is single phase.
- The pin number differs according to the encoder used.
- Use [Pr. 178 to Pr. 189: Input terminal function select] to assign the function to any of terminal (refer to page 81).
- The encoder should be coupled on the same axis with the motor shaft without any mechanical looseness. Speed ratio should be 1:1.
- Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (refer to page 91).
- For the differential line driver, set the terminating resistor selection switch to ON position (initial status) to use (refer to page 86). Note that the terminating resistor switch should be set to OFF position when sharing the same encoder with other unit (NC, etc.) and a terminating resistor is connected to other unit.

For the complementary, set the switch to OFF position.

- Refer to page 88 for terminal compatibility of the FR-JCBL, FR-V5CBL, FR-A7AP and FR-A7AL.
- A separate power supply of 5V/12V/15V/24V is necessary according to the encoder power specification.
- When performing encoder feedback control and vector control together, an encoder and power supply can be shared.
- When a stop position command is input from outside, a plug-in option FR-A7AX is necessary. Refer to page 424 for external stop position command.
- Assign CH (external thermal input) signal to the terminal CS.
- Connect 2W1kΩ resistor between the terminal PC and CS (OH). Install the resistor pushing it against the bottom part of the terminal block so as to avoid a contact with other cables.

(2) Setting I/O signals

<table>
<thead>
<tr>
<th>Terminal</th>
<th>Terminal Name</th>
<th>Application Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>X22</td>
<td>Orientation command input</td>
<td>Used to enter an orientation signal for orientation. For the terminal used for X22 signal input, set 22 in any of [Pr. 178 to Pr. 189] to assign the function.</td>
</tr>
<tr>
<td>SD</td>
<td>Contact input common</td>
<td>Common terminal for the orientation signal.</td>
</tr>
<tr>
<td>ORA</td>
<td>Orientation complete signal output</td>
<td>Switched low if the orientation has not stopped within the in-position zone while the start and orientation signals are input. For the terminal used for the ORA signal output, assign the function by setting 27 (positive logic) or 127 (negative logic) in any of [Pr. 190 to Pr. 196].</td>
</tr>
<tr>
<td>ORM</td>
<td>Orientation fault signal output</td>
<td>Switched low if the orientation has not stopped within the in-position zone while the start and orientation signals are input. For the terminal used for the ORM signal output, assign the function by setting 28 (positive logic) or 128 (negative logic) in any of [Pr. 190 to Pr. 196].</td>
</tr>
<tr>
<td>SE</td>
<td>Open collector output common</td>
<td>Common terminal for the ORA and ORM open collector output terminals.</td>
</tr>
</tbody>
</table>
(3) Selecting stop position command \([Pr.350]\)

Select either the internal stop position command \([Pr.350]\) or the external stop position command (16-bit data using the FR-A7AX).

<table>
<thead>
<tr>
<th>[Pr.350] Setting</th>
<th>Stop Position Command Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Internal stop position command ([Pr.356]) (1024 pulses)</td>
</tr>
<tr>
<td>1</td>
<td>Select external stop position command ([Pr.356]) (FR-A7AX) 16-bit data</td>
</tr>
</tbody>
</table>

1) Internal stop position command \([Pr.350 = 0]\)

The value set in \([Pr.356]\) is the stop position. When the number of encoder pulses is 1024/pulse, one revolution of the encoder \(360^\circ\) is divided into \(4096\) positions, i.e. \(360^\circ/4096 = 0.0879\) pulses per address as shown below. The stop positions (addresses) are indicated in parentheses.

\[
\begin{align*}
\text{Origin (0)} & & 270^\circ \quad (3072) \\
180^\circ \quad (2048) & & 90^\circ \quad (1024)
\end{align*}
\]

2) External stop position command \([Pr.350 = 1]\)

Mount the option FR-A7AX and set a stop position using 16-bit data (binary input). The value set in \([Pr.350\) 16-bit data selection] should be the number of stop positions minus 1. FR-A7AX parameters \([Pr.360]\) are invalid. Parameters are valid when \([Pr.350 = 0]\).

Terminal DY (data read timing input signal) is invalid during vector control. (The position data is downloaded at the start of orientation.)

<table>
<thead>
<tr>
<th>[Pr.350] Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>External position command is invalid</td>
</tr>
<tr>
<td>1</td>
<td>Mount the option FR-A7AX. The 16-bit digital signal from the FR-A7AX directly serves as stop position command.</td>
</tr>
</tbody>
</table>

Example:

- When the \([Pr.350\) 16-bit data selection] is set to 128, stop position command from 0 to 1535 can be directly input using the FR-A7AX and input digital signal of 2048 (H800) to stop the motor at the \(180^\circ\) position. The command more than 4096 is considered as 4095.

<table>
<thead>
<tr>
<th>[Pr.360] Setting</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>(0 \text{ to } 90 ) (90 \text{ to } 180 ) (180 \text{ to } 270 ) (270 \text{ to } 360 )</td>
</tr>
<tr>
<td>1</td>
<td>(90 \text{ to } 180 ) (180 \text{ to } 270 ) (270 \text{ to } 360 ) (360 \text{ to } 0 )</td>
</tr>
</tbody>
</table>

* Values in parentheses indicate binary data entered from the terminals. Even if the position pulse monitor \([Pr.352\) DU/PU main display data selection] is selected, the data monitored is not the number of stop positions but is 0 to 65535 pulses.

<table>
<thead>
<tr>
<th>[Pr.350] Stop Position Command Selection</th>
<th>[Pr.360] 16 Bit Data Selection</th>
<th>16 bit Data Selection</th>
<th>Speed command</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 : Internal</td>
<td>(0 \text{ to } 127 ) Position command</td>
<td>Internal ([Pr.356])</td>
<td>Speed command</td>
</tr>
<tr>
<td>1 : External</td>
<td>(0 \text{ to } 127 ) Position command</td>
<td>External ([Pr.356])</td>
<td>16 bit data</td>
</tr>
</tbody>
</table>

Example 1:

- \([Pr.350 = 0]\), \([Pr.360 = 1]\)

Example 2:

- \([Pr.350 = 0]\), \([Pr.360 = 128]\)

- \([Pr.350 = 1]\), \([Pr.360 = 1024]\)
Remarks

Orientation operation (under V/F control, Advanced magnetic flux vector control)

1) When the orientation command (X22) is input, the motor speed decreases to the orientation speed set in [Pr.351 Orientation speed], [Pr.355] initial value : 2Hz)

2) After the speed reaches the orientation speed, the speed decreases to the creep speed set in [Pr.352 Creep speed] as soon as the current position pulse reaches the creep switchover position in [Pr.355 Creep switchover position].

3) Position shift [Pr.367]

Shift the origin using a compensation value without changing the origin of the position detector (encoder). The stop position is a position obtained by adding the setting value of [Pr.367] to the position command.

4) Monitor display change

### Monitor position pulse display

<table>
<thead>
<tr>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ORA</td>
<td>Output signal complete (ORA) will be output.</td>
</tr>
<tr>
<td>ORM</td>
<td>Orientation fault signal (ORM) is output if the current position pulse has stopped within the in-position zone due to external force, etc., and the orientation complete signal (ORA) is turned OFF after the time set in [Pr.363 Completion signal output delay time] has elapsed. Moreover, the orientation complete signal (ORA) is not output, orientation fault signal (ORM) is output if the orientation has not completed within the time set in [Pr.363 Completion signal output delay time] has elapsed.</td>
</tr>
<tr>
<td>ORM</td>
<td>Orientation fault (pulse stop)</td>
</tr>
<tr>
<td>SOR</td>
<td>Orientation fault (orientation limit)</td>
</tr>
<tr>
<td>SF</td>
<td>Orientation fault (restart)</td>
</tr>
<tr>
<td>OR</td>
<td>Continuous multi-point orientation</td>
</tr>
</tbody>
</table>

* Invalid during vector control. (0 is always displayed.)

5) Orientation in-position zone [Pr.357]

The positioning width for orientation stop can be set. The initial setting of [Pr.357] is 5. To change the \( \beta \) value, finely adjust with \( \pm 10 \) increments, and make fine adjustment.

The positioning width for orientation stop can be set. The initial setting of [Pr.357] is 5. To change the \( \beta \) value, finely adjust with \( \pm 10 \) increments, and make fine adjustment.

6) Orientation operation (under V/F control, Advanced magnetic flux vector control)

**Orientation during running**

1) When the orientation command (X22) is input, the motor speed decreases to the orientation speed set in [Pr.351 Orientation speed], [Pr.355] initial value : 2Hz)

2) After the speed reaches the orientation speed, the motor speed decreases to the creep speed set in [Pr.352 Creep speed] as soon as the current position pulse reaches the creep switchover position in [Pr.355 Creep switchover position].

3) Moreover, as soon as the current position pulse reaches the set position loop switchover position in [Pr.354 Position loop switchover position], control is changed to position loop. ([Pr.354] initial value : 0Hz)

4) After switching to position loop, the inverter deaccelerates and stops with DC injection brake as soon as the current position pulse has reached the DC injection brake start position set in ([Pr.355 DC injection brake start position]). ([Pr.355] initial value : 5)

5) When the current position pulse has stopped within the in-position zone set in [Pr.357 Orientation in-position zone], the orientation complete signal (ORA) is output after the complete signal output delay time set in [Pr.363 Completion signal output delay time] has elapsed. If the current position pulse does not stop within the in-position zone due to external force, etc., the orientation completion signal is turned OFF after the time set in [Pr.363 Completion signal output delay time] has elapsed. ([Pr.357] initial value : 5)

6) When the orientation is not completed continuously for the time set in [Pr.363 Orientation time] after passing the creep switchover position, the orientation fault signal (ORM) is output.

7) When the current position pulse stops before reaching the in-position zone due to external force after orientation start and orientation complete signal (ORA) is not output, orientation fault signal (ORM) is output after the time set in encoder stop check time set in [Pr.364 Encoder stop check time] has elapsed. Moreover, the orientation complete signal (ORA) is turned OFF after the time set in [Pr.363 Completion signal output delay time] has elapsed. If the current position pulse is outside the in-position zone due to external force, etc., orientation fault signal (ORM) is output if the orientation has not completed within the time set in [Pr.363 Completion signal output delay time] has elapsed. ([Pr.357] initial value : 5)

8) When the start signal (STF or STR) is turned OFF with the orientation command on after outputting the orientation complete signal (ORA) and orientation fault signal (ORM), the orientation complete signal (ORC) or orientation fault signal (ORM) is output again after recheck time set in [Pr.366 Recheck time] has elapsed.

9) The orientation complete signal (ORA) and orientation fault signal (ORM) are output when the orientation command is OFF.

10) When terminating orientation, the start signal (STF or STR) must be first switched OFF and then the orientation signal (X22) must be switched OFF. As soon as the orientation signal is switched OFF, orientation control ends. (Depending on the [Pr.358 Servo torque selection] setting, orientation status continues if the orientation signal remains ON even if DC injection brake is released at turning OFF of the start signal. Therefore, the orientation status of the monitor function is not 0.)

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After turning on the orientation command (X22), turning ON the start signal will increase the motor speed to the orientation speed set in [Pr.351 Orientation speed], then orientation operation same as when “orientation during running” is performed.

Note that, DC injection brake is operated if the position signal is within the DC injection brake start position.

1) When the orientation command is OFF with the start signal ON, the speed accelerates to the command speed.
2) If the hunting of the motor shaft occurs, set a larger value in [Pr.354 Position loop switchover position] or a smaller value in [Pr.353 Creep speed] to prevent it.
3) DC injection brake operates when orientation stop is made. Release the DC injection brake in a time as short as possible (within several seconds) since continuous operation of the DC injection brake will cause the motor to overheat, leading to burnout.
4) Since no servo lock function is available after orientation stop, provide a holding mechanism such as mechanical brake or knock pin when secure holding of a main spindle is required.
5) When orientation control is performed, orientation can not be completed if DC injection brake operation is not set in the DC injection brake adjusting (voltage, frequency, speed, time) parameters. Always set the DC injection brake enabled.
6) When [Pr.11 DC injection brake operation time = 8888] (DC injection brake external selection), DC injection brake does not operate if the X13 signal is not turned ON. Note that the DC injection brake is applied under orientation control regardless of the X13 signal status.

Orientation from stop
After turning on the orientation command (X22), turning ON the start signal will increase the motor speed to the orientation speed set in [Pr.351 Orientation speed], then orientation operation same as when “orientation during running” is performed. Note that, DC injection brake is operated if the position signal is within the DC injection brake start position.

Continuous multi-point orientation
Orientation command and orientation with STF/STR ON (orientation in servo in status)

Read 16 bit data (position data) at starting up of terminal DY of the plug-in option FR-A7AX. 16 bit data with the FR-A7AX is valid only when terminal DY is ON.

When the position signal is within the creep switchover position, the speed starts up to the creep speed not to the orientation speed.

When the position signal is not within the creep switchover position, the speed starts up to the orientation speed.

The DC injection brake is operated if the position signal is within the DC injection brake start position.
- Servo torque selection \([\text{Pr. 358}]\)
  - Valid only under V/F control and Advanced magnetic flux vector control.

<table>
<thead>
<tr>
<th>Function</th>
<th>([\text{Pr. 358}]) Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Servo torque function selection until output of the orientation completion signal (ORA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Retry function selection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Frequency compensation function when the motor stops outside the in-position zone after output of the orientation complete signal (ORA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4) DC injection brake and servo torque selection when the motor stops outside of the in-position zone after output of the orientation complete signal (ORA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5) End switch selection of the DC injection brake and orientation complete signal (ORA)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6) Completion signal OFF selection when the position pulse stops outside of the in-position zone after output of the orientation completion signal (ORA)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1) When the orientation command is OFF with the start signal ON, the speed accelerates to the command speed.

2) When the motor shaft stops outside of the set setting range of stop position, the motor shaft is returned to the stop position by servo torque function (if enough torque is generated).

3) Servo torque selection until output of the orientation completion signal
   - Whether servo torque is available or not is selected using \([\text{Pr. 358 Servo torque selection}]\).
   - Servo torque is not generated if the current position pulse is in between the orientation stop position and DC injection brake start position. Although, the shaft is retained by the DC injection brake, servo torque is generated to return the shaft within the width if the shaft rotates out of the width by external force, etc. Once the orientation completion signal (ORA) is output, the motor runs according to the setting made in 4).

4) Retry function selection
   - Select retry function using \([\text{Pr. 358 Servo torque selection}]\).
   - Note that servo torque function can not be used together.
   - With this retry function, three orientations are performed again by retry function.

5) Frequency compensation function when the motor stops outside the orientation in-position zone
   - When the shaft stops rotation before entering the in-position zone due to external force, etc., output frequency is increased to rotate the shaft to the orientation stop position. The output frequency is gradually increased to the creep speed of \([\text{Pr. 352 Creep speed}]\).

6) DC injection brake and servo torque selection when the position pulse comes off the in-position zone after output of the orientation completion signal (ORA)
   - If the position pulse comes off the orientation in-position width, you can select a setting either fixing a shaft with the DC injection brake or returning the motor to the orientation stop position with servo torque.

7) Orientation operation or end switch operation selection
   - When ending the orientation operation, turn OFF the start signal (STF or STR), then turn OFF the orientation command signal (X22). At this time, you can select when to turn OFF the orientation completion signal (ORA) and turn OFF of the start signal or turning OFF of the orientation fault signal (ORM) is not output.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>(\text{Parameter} )</th>
<th>(\text{Value} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creep speed</td>
<td>([\text{Pr. 352 Creep speed}])</td>
<td>Gradually according to the slope set in ([\text{Pr. 352 Orientation position loop gain}]). Although the operation becomes faster when the value is increased, a machine may hunt, etc.</td>
</tr>
</tbody>
</table>
(7) Orientation operation explanation (during vector control)

- Setting the rotation direction [Pr. 393 Orientation selection]

<table>
<thead>
<tr>
<th>Pr. 393</th>
<th>Rotation direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Orientation is executed from the current rotation direction.</td>
</tr>
<tr>
<td>1</td>
<td>Orientation is executed from the forward rotation direction. (If the motor is running in reverse, orientation is executed from the forward rotation direction after deceleration.)</td>
</tr>
<tr>
<td>2</td>
<td>Orientation is executed from the reverse rotation direction. (If the motor is running in forward, orientation is executed from the reverse rotation direction after deceleration.)</td>
</tr>
</tbody>
</table>

1) Orientation from the current rotation direction

When the orientation command (X22) is input, the motor speed will decelerate from the running speed to [Pr. 351 Orientation speed]. At the same time, the orientation stop position command will be read in. (The stop position command is determined by the setting of [Pr. 350] and [Pr. 360].)

When the orientation switchover speed is reached, the encoder Z phase pulse will be confirmed, and the mode will change from speed control to position control ([Pr. 362 Orientation position loop gain]).

The distance to the orientation stop position is calculated at switching of the control, and the motor decelerates and stops with a set deceleration pattern ([Pr. 399]). The orientation (servo lock) state will be entered.

When entered in the [Pr. 357] Orientation in-position zone, the orientation completion signal (ORA) will be output.

The zero point position (origin) can be rotated using position shift [Pr. 361 Position shift].

2) Orientation from the forward rotation direction

This method is used to improve the stopping precision and maintain the mechanical precision when the backlash is large.

If the motor is running in the forward rotation direction, it will orientation stop with the same method as "orientation from the current rotation direction".

If the motor is running in reverse, it will decelerate, the rotation direction will be changed to forward run, and then orientation stop will be executed.

3) Orientation from the reverse rotation direction

If the motor is running in the reverse rotation direction, it will orientation stop with the same method as "orientation from the current rotation direction".

If the motor is running in forward, it will decelerate, the rotation direction will be changed to reverse run, and then orientation stop will be executed.
1) Increase the [Pr. 362 Orientation position loop gain] value to the extent that rocking does not occur during orientation stop.

2) Increase [Pr. 396, Pr. 397] at the same rate. Generally adjust [Pr. 396] in the range from 10 to 100, and [Pr. 397] from 0.1 to 1.0. (Note that these do not need to be set to the same rate.)

[Example]
When the [Pr. 396] value is multiplied by 1.2, divide the [Pr. 397] value by 1.2. If vibration occurs during orientation stop, the scale cannot be raised any higher.

3) [Pr. 398] is the lag/advance compensation gain. The limit cycle can be prevented by increasing the value, and the running can be stopped safely. However, the torque in regard to the position deviation will drop, and the motor will stop with deviation.

[Application of lag/advance control and PI control] PI control can be applied by setting [Pr. 398 = 0]. Normally, the lag/advance control is selected. When using a machine with a high spindle stationary friction torque and requires a stopping position precision.

*1: Servo rigidity: This is the response when a position control loop is configured. When the servo rigidity is raised, the holding force will increase, the running will stabilize, but vibration will occur easily.

*2: Limit cycle: This is a phenomenon that generates continuous vibration centering on the target position.

*3: Rocking: Movement in which return occurs if the stopping position is exceeded.

- **Orientation speed [Pr. 351]**

Set the speed when switching between the speed control mode and the position control mode is performed under orientation operation. Decreasing the set speed enables stable orientation stop. Note that the orientation time will increase.

When [Pr. 32 DC/PU main display data selector = 109], position pulse monitor is displayed on the PU instead of output voltage monitor.

- **Orientation deceleration ratio [Pr. 399]**

Make adjustments as shown below according to the orientation status. Refer to the [Pr. 398 and Pr. 397] details also.

Generally adjust [Pr. 362] in the range from 5 to 20 and [Pr. 398] from 5 to 50. Orientation stop operation cannot be performed and excessive position error alarm occurs. Or, if the motor does forward/reverse reciprocation operation, the parameter setting value for the orientation detector installation direction may be incorrect. Review [Pr. 398 Orientation selection] (refer to page 428) and [Pr. 392 Encoder rotation direction] (refer to page 428).

- **Orientation control at machine side**

To simultaneously perform orientation control at machine side with encoder feedback control / vector control using an encoder at machine side and FR-AT-AI, set the number of encoder pulses to [Pr. 329 Number of machine and encoder pulses]. Orientation control to the encoder at machine side is enabled.

**[Example]**
Number of pulses equivalent for the motor side is calculated as below when the number of encoder pulses at machine side is 4000 pulses, and the gear ratio between motor side and machine side is 4:1 (motor rotates four times while machine rotates once).

Number of pulses equivalent for the motor side = 4000 \times \frac{1}{4} = 1000

Thus, set [Pr. 369 = 1000] and [Pr. 329 = 4000] (encoder pulses at machine side.)
2.20.8 PWM carrier frequency and Soft-PWM control [Pr. 72, 240, 260] (common)

You can change the motor sound. Increasing PWM carrier frequency will reduce the motor acoustic noises, but increases EMI and leakage current from the inverter.

(1) PWM carrier frequency changing [Pr. 72]

You can change the PWM carrier frequency of the inverter.

Changing PWM carrier frequency is useful for the following purposes:
- To avoid mechanical or motor resonance
- To prevent EMI
- To reduce leakage current by PWM switching

When using an option sine wave filter (MT-BSL/BSC) for the 75K or more, set [Pr. 72 = 25 (2.5kHz)]. When [Pr. 72 = 0 to 5], V/F control is forcibly selected. At this time, perform continuous operation at less than 90% of the rated inverter output current.

When the carrier frequency is set to 3kHz or more ([Pr. 72 ≥ 3]) to the 75K or more inverter, perform continuous operation at less than 85% of the rated inverter output current.

Carrier frequencies under Real sensorless vector control and vector control by ( ) are as shown below.

<table>
<thead>
<tr>
<th>[Pr. 72] Setting</th>
<th>Carrier Frequency (kHz)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 15</td>
<td>0 to 15</td>
</tr>
<tr>
<td>15 or more</td>
<td>0 to 8.25</td>
</tr>
<tr>
<td>14 or more</td>
<td>0 to 6.25</td>
</tr>
</tbody>
</table>

When PWM carrier frequency is set to 1kHz or less ([Pr. 72 ≤ 2]), fast-response current limit may function before stall prevention operation due to increased ripple current, and torque may be insufficient. In such case, set fast-response current limit operation invalid using [Pr. 156 Stall prevention operation selection].

(2) Soft-PWM control [Pr. 240]

Soft-PWM control is a control method that changes the motor noise from a metallic tone into an unoffending complex tone.

(a) With Soft-PWM
Since the frequency components are dispersed, the sound becomes inoffensive with less metallic noises.

(b) Without Soft-PWM
Since the frequency components are concentrated, metallic noises are generated.

Motor noises data example
(When the motor SF-JR 4P 1.7KW carrier frequency 2kHz is used)
(3) PWM carrier frequency automatic reduction function [Pr. 260]  

When [Pr. 260 = 1] (initial value in \( Pr. 260 \)) in \( Pr. 260 \), performing continuous operation at the 85% or more of the rated inverter current with the inverter carrier frequency set to 3kHz or more \( \text{[Pr. 72]} \) will automatically reduce the carrier frequency to 2kHz to protect the inverter output transistor. (Although the motor acoustic noises increase, it is not a fault.)

When \( \text{[Pr. 260]} = 0 \) (initial value in \( \text{Pr. 260} \)) in \( \text{Pr. 260} \), the carrier frequency is constant (at the \( \text{[Pr. 72]} \) setting) regardless of the load, making the motor sound uniform. For \( \text{Pr. 260} \), make sure to operate continuously at less than 85% of the inverter rated current when carrier frequency is set 3kHz or more (less than the rated output current in parenthesis on page 4) for keeping the carrier frequency constant.

### 2.20.9 Cooling fan operation selection [Pr. 244] (common)

The operation of built-in cooling fan (in forced cooling inverters) can be controlled. (To confirm which inverters are forced cooling, refer to the specification list on page 2.)

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>244</td>
<td>Cooling fan operation selection</td>
<td>1</td>
<td>0, 1</td>
<td>The fan is always ON while the inverter is running. During a stop, the inverter status is monitored and the fan switches ON-OFF according to the temperature.</td>
</tr>
</tbody>
</table>

In either of the following cases, fan operation is regarded as faulty, [FAN] is shown on the operation panel, and the fan fault (FAN) and alarm (LF) signals are output.

- When [Pr. 244 = 0]  
  When the inverter is running and the fan stops during fan ON command.

For the terminal used for FAN signal output, set 25 (positive logic) or 125 (negative logic) in any of [Pr. 190 to Pr. 196] (Output terminal function selection), and for the LF signal, set 98 (positive logic) or 198 (negative logic).

[431]
2.20.10 PLG pulse division output [Pr.413] (A700)

Pulse input of encoder connected to the inverter is divided and output from the FR-A7AL terminal.

<table>
<thead>
<tr>
<th></th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>413</td>
<td>Encoder pulse division ratio</td>
<td>1</td>
<td>1 to 32767</td>
<td>The encoder pulse signal at the motor end can be divided in division ratio set in Pr.413 and output.</td>
</tr>
</tbody>
</table>

(1) Wiring Example

For open collector output, the signal may become unstable if the input resistance of the connected device is large and the device may detect the signal incorrectly. In this case, adding a pull up resistance as shown below will improve the phenomenon.

Select a pull-up resistance in consideration of the input current of the connected device so that the open collector output current will not exceed the output permissible load current.

(2) Division waveform by division ratio

Both ON-OFF width is division times. (50% duty)
- Pulse waveform example at 1000 pulse input when Pr.413 = "2"

<table>
<thead>
<tr>
<th>Division ratio</th>
<th>A phase</th>
<th>B phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/1</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
<tr>
<td>1/2</td>
<td><img src="image" alt="Waveform" /></td>
<td><img src="image" alt="Waveform" /></td>
</tr>
</tbody>
</table>

Control of forward rotation/reverse rotation by phase difference between A phase and B phase.
- When A phase is 90° advanced as compared to B phase: forward rotation
- When A phase is 90° behind as compared to B phase: reverse rotation
2.20.11 Speed smoothing control \([Pr.653]\) (E700)(D700)

Vibration due to mechanical resonance influences the inverter control, causing the output current (torque) unstable. In this case, the output current (torque) fluctuation can be reduced to ease vibration by changing the output frequency.

<table>
<thead>
<tr>
<th>([Pr.])</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>653</td>
<td>Speed smoothing control</td>
<td>0</td>
<td>0 to 200%</td>
<td>Increase or decrease the value using 100% as reference to check an effect.</td>
</tr>
</tbody>
</table>

(1) Control block diagram

(2) Setting method

If vibration due to mechanical resonance occurs, set 100% in \([Pr. 653]\), run the inverter at the frequency which generates maximum vibration and check if the vibration will be reduced or not after several seconds.

If effect is not produced, gradually increase the \([Pr. 653]\) setting and check the effect repeatedly until the most effective value is set in \([Pr. 653]\).

If vibration becomes large by increasing the \([Pr. 653]\) setting, gradually decrease the \([Pr. 653]\) setting than 100% to check the effect in a similar manner. (Depending on the machine, vibration may not be reduced enough or an effect may not be produced.)
2.21 Communication operation

When power is switched on or when power comes back on after instantaneous power failure, the inverter can be started up in the Network operation mode. After the inverter has started up in the Network operation mode, parameter write and operation can be performed from a program. Set this mode for communication operation using the inverter RS-485 terminals or communication option.

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>Operation mode selection</td>
<td>0</td>
<td>0, 1, 2, 3, 6, 7</td>
<td>Select the operation mode. (Refer to page 209)</td>
</tr>
<tr>
<td>340</td>
<td>Communication startup mode selection</td>
<td>0</td>
<td>0</td>
<td>As set in [Pr. 79]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
<td>Started in network operation mode. (When the setting is 1, it will resume the pre-instantaneous power failure operation mode after an instantaneous power failure occurs.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td></td>
<td>Started in network operation mode. Operation mode can be changed between the PU operation mode and Network operation mode from the operation panel. (When the setting is 2, it will resume the pre-instantaneous power failure operation mode after an instantaneous power failure occurs.)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td></td>
<td>Started in network operation mode. Operation mode can be changed between the PU operation mode and Network operation mode from the operation panel. (When the setting is 10, it will resume the pre-instantaneous power failure operation mode after an instantaneous power failure occurs.)</td>
</tr>
</tbody>
</table>

The above parameters can be changed during a stop in any operation mode.

1. However, the parameters can be set whenever the communication option is connected. Changed setting value is valid when powering on or resetting the inverter.

(1) Operation mode at power-on [Pr. 340]

Depending on the [Pr. 79] and [Pr. 340] settings, the operation mode at power-ON (reset) changes as described below.

<table>
<thead>
<tr>
<th>Pr. 340 Setting</th>
<th>Pr. 79 Setting</th>
<th>Operation Mode at Power ON or Power Restoration or Reset</th>
<th>Operation Mode Switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>0</td>
<td>External operation mode</td>
<td>Switching among the External, PU, and NET operation mode is enabled *3</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>PU operation mode</td>
<td>PU operation mode fixed</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>External operation mode</td>
<td>External operation mode fixed</td>
</tr>
<tr>
<td></td>
<td>3, 4</td>
<td>External/PU combined operation mode</td>
<td>Operation mode switching disabled</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>External operation mode</td>
<td>Switching among the External, PU, and NET operation mode is enabled while running</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>X12 (MRS) signal ON - · · · - External operation mode</td>
<td>Switching among the External, PU, and NET operation mode is enabled *3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X12 (MRS) signal OFF - · · · - External operation mode</td>
<td>Fixed to External operation mode (forcibly switched to external operation mode)</td>
</tr>
<tr>
<td>1, 2 *1</td>
<td>0</td>
<td>NET operation mode</td>
<td>Same as when [Pr. 340 = 1]</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NET operation mode</td>
<td>PU operation mode fixed</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>NET operation mode</td>
<td>Operation mode switching disabled</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>X12 (MRS) signal ON - · · · - NET operation mode</td>
<td>NET operation mode fixed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>X12 (MRS) signal OFF - · · · - NET operation mode</td>
<td>Fixed to NET operation mode</td>
</tr>
<tr>
<td>10, 12 *2</td>
<td>0</td>
<td>NET operation mode</td>
<td>Switching between the PU and NET operation mode is enabled</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>NET operation mode</td>
<td>NET operation mode</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>NET operation mode</td>
<td>Fixed to NET operation mode</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>NET operation mode</td>
<td>NET operation mode fixed</td>
</tr>
</tbody>
</table>

*1 Setting values 2 and 12 for [Pr. 340] are available only for A700/F700. These setting values are mainly used in a communication operation with RS-485 terminal. When [Pr. 340 = 2] (automatic restart after instantaneous power failure is selected), the inverter will resume the same operation state which was in before after power has been restored from an instantaneous power failure.

*2 The operation mode cannot be switched directly between the PU operation mode and Network operation mode.

*3 Operation mode can be changed between the PU operation mode and Network operation mode with X12 (MRS) signal of the control panel (PU07) and X15 signal.
(2) Operation mode switching method

When "0", "1", or "2" is set in [Pr. 140]

When "10 or 12" is set in [Pr. 140]

(3) Switching of operation mode by external signal (X65, X66 signals)

When [Pr. 79 = any of 0, 2, 6, 7], the operation mode switching signals (X65, X66) can be used to change the PU or External operation mode to the network operation mode during a stop (during a motor stop or start command OFF).

The priorities of [Pr. 79], [Pr. 340] and signals are [Pr. 79] > X12 > X66 > X65 > X16 > [Pr. 140].

1) When switching between the Network operation mode and PU operation mode

<table>
<thead>
<tr>
<th>[Pr. 340] Setting</th>
<th>[Pr. 79] Setting</th>
<th>X66 signal state</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>10, 12</td>
<td>ON (PU)</td>
<td>OFF (NET)</td>
</tr>
</tbody>
</table>
| 1                 |                  | PU operation mode| NET operation mode
| 2                 |                  | PU operation mode| NET operation mode
| 3                 |                  | NET operation mode| NET operation mode
| 4                 |                  | External/PU combined operation mode| External/PU combined operation mode
| 5                 |                  | Switching to External operation mode enabled | Switching to External operation mode disabled
| 6                 |                  | X12 (MRS) ON    | X12 (MRS) OFF |
| 7                 |                  | X12 (MRS) ON    | X12 (MRS) OFF |
|                   |                  | External operation mode | Forcibly switched to External operation mode |

*1 NET operation mode when the X66 signal is ON.
*2 PU operation mode is selected when the X16 signal is OFF. PU operation mode is selected when [Pr. 340 NET mode operation command source selection = 1] (communication option command source) and the communication option is not fitted.

*3 External operation mode when the X16 signal is ON.

2) When switching between the Network operation mode and External operation mode

<table>
<thead>
<tr>
<th>[Pr. 340] Setting</th>
<th>[Pr. 79] Setting</th>
<th>X66 signal state</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>1, 2</td>
<td>ON (NET)</td>
<td>OFF (External)</td>
</tr>
</tbody>
</table>
| 1                 |                  | NET operation mode| NET operation mode
| 2                 |                  | NET operation mode| NET operation mode
| 3                 |                  | External/PU combined operation mode| External/PU combined operation mode
| 4                 |                  | Operation mode can be switched with operation continued |
| 5                 |                  | NET operation mode| NET operation mode
| 6                 |                  | NET operation mode| NET operation mode
| 7                 |                  | X12 (MRS) ON    | X12 (MRS) OFF |
|                   |                  | X12 (MRS) ON    | X12 (MRS) OFF |
|                   |                  | External operation mode | Forcibly switched to External operation mode |

*1 External operation mode is selected when [Pr. 110 NET mode operation command source selection = 1] (communication option control source) and the communication option is not fitted.

*2 PU operation mode is selected when the X16 signal is OFF. When the X65 signal has been assigned, the operation mode changes with the ON/OFF state of the X65 signal.
2.21.2 Operation command source and frequency command source [Pr. 338, 339, 550*, 551] (common)

When the RS-485 terminals or communication option is used, the external operation command and speed command can be valid.

Also, the operation command source in the PU operation mode can be selected.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>338</td>
<td>Communication operation command source</td>
<td>0</td>
<td>0</td>
<td>Operation command source communication</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>Operation command source external</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td>339</td>
<td>Communication speed command source</td>
<td>0</td>
<td>0</td>
<td>Speed command source communication</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>Speed command source external</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>Speed command source external (frequency setting from communication is invalid, terminal 2 and 1 setting from external is valid)</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td>550*</td>
<td>NET mode operation command source selection</td>
<td>9999</td>
<td>9999</td>
<td>Communication option is valid</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td>RS-485 terminals are valid</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>2</td>
<td>PU connector is the command source when NET operation mode is valid</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td>551</td>
<td>PU mode operation command source selection</td>
<td>2</td>
<td>9999</td>
<td>USB / parameter unit automatic recognition</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>3</td>
<td>Selects the USB connector as the PU operation mode command source</td>
<td>A700 F700 E700 D700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>4</td>
<td>Operation panel is the command source when PU operation mode is valid</td>
<td>A700 F700 E700 D700</td>
</tr>
</tbody>
</table>

The above parameters can be set whenever the communication option is connected.

* [Pr. 550, Pr. 551] are always write-enabled. Changed setting value is valid when powering ON or resetting the inverter.

(1) Command source selection for the Network operation mode [Pr. 338]

Command sources in the Network operation mode can be RS-485 terminal (Pr.1701) or USB parameter unit (Pr.1702) or a communication option (Pr.550).

For example, set [Pr. 350 = 1] in [Pr.1701] when using RS-485 terminal to write parameters and to send start and frequency commands whether a communication option is connected or not.

In the initial setting, [Pr.550 = 9999] (automatic communication option recognition) is set. When a communication option is installed in that initial setting, parameter write, start and frequency commands cannot be sent using RS-485 terminal (Pr.1701) or USB parameter unit (Pr.1702). Monitoring and parameter read can be performed.

(2) Command source selection for the PU operation mode [Pr. 551]

Any of PU connector, RS-485 terminal (Pr.1702), or USB connector (Pr.1702) can be assigned as the source of control in the PU operation mode. Set [Pr. 332 = 1] when writing parameters and sending start and frequency commands by the communication from RS-485 terminal in the PU operation mode (Pr.1702). Set [Pr. 332 = 2] when sending these commands by USB connector (Pr.1702).

PU operation has priority over other control modes when [Pr. 350 = 1] in [Pr.1701] or [Pr. 551 = 1] in [Pr.1702].

Automatic communication option recognition (Pr.550) is not available for D700.

* [Pr. 550, Pr. 551] is not available for D700.

Change to NET mode for changing the command source.
### Parameter Setting for Command Source of Each Operation Location

<table>
<thead>
<tr>
<th>[Pr. 550] Setting</th>
<th>[Pr. 551] Setting</th>
<th>Command Source of Each Operation Location</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>PU connector</td>
<td>USB connector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (initial value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>9999 (initial value)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (initial value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9999 (initial value)</td>
<td></td>
</tr>
</tbody>
</table>

1. The Modbus-RTU protocol cannot be used in the PU operation mode. When using the Modbus-RTU protocol, set [Pr. 551 = 2].
2. When the communication option is not fitted, the operation mode cannot be switched to the Network operation mode.
3. This value is not available for [E700].

---

### Parameter Setting for Command Source of Each Operation Location

<table>
<thead>
<tr>
<th>[Pr. 550] Setting</th>
<th>[Pr. 551] Setting</th>
<th>Command Source of Each Operation Location</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Operation panel</td>
<td>USB connector</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (initial value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>9999 (initial value)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (initial value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>9999 (initial value)</td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2 (initial value)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

1. The Modbus-RTU protocol cannot be used in the PU operation mode. When using the Modbus-RTU protocol, set [Pr. 551 = 2].
2. When the communication option is not fitted, the operation mode cannot be switched to the Network operation mode.
3. The priorities of command sources for the PU operation mode are: USB connector ( ) parameter unit (FR-PU04/FR-PU07) > operation panel.
4. This value is not available for [E700].
(3) Controllability through communication

The following table shows whether control can be performed or not in each operation mode. Monitoring and parameter read are available in any operation regardless of the operation mode.

<table>
<thead>
<tr>
<th>Operation Location</th>
<th>[Pr. 551] Setting</th>
<th>Item</th>
<th>Operation Mode</th>
<th>PU Operation</th>
<th>External Operation</th>
<th>NET operation</th>
<th>Not using communication option*5</th>
<th>Not using communication option*6</th>
<th>Using communication option*7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control by RS-485 communication from PU connector</td>
<td>2 (PU connector)</td>
<td>Run command (start)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Run command (stop)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Run command (start)</td>
<td>(F170)</td>
<td>(A70)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Run command (stop)</td>
<td>(F170)</td>
<td>(A70)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Run command (start)</td>
<td>(F170)</td>
<td>(A70)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Run command (stop)</td>
<td>(F170)</td>
<td>(A70)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
<td>(F79)</td>
<td>(A79)</td>
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<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Control by communication from RS-485 terminals</td>
<td>1 (RS-485 terminals)</td>
<td>Run command (start, stop)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Operation from the USB connector</td>
<td>3 (USB connector) (automatic recognition)</td>
<td>Run command (start, stop)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Control by communication from option*10</td>
<td>—</td>
<td>Run command (start, stop)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitoring frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Parameter write</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Control circuit external terminals</td>
<td>—</td>
<td>Inverter reset</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Frequency setting</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

○ enabled, □ disabled, △ some are enabled
As set in [Pr. 338 Communication operation command source] and [Pr. 339 Communication speed command source]. (Refer to page 440)

2. At occurrence of RS-485 communication error, the inverter cannot be reset from the computer.

3. Enabled only when stopped by the PU. At a PU stop, PS is displayed on the operation panel. As set in [Pr. 75 PU stop selection]. (Refer to page 392)

4. Some parameters may be write-disabled according to the [Pr. 77 Parameter write selection] setting and operating status. Refer to page 394.

5. Some parameters are write-enabled independently of the operation mode and command source presence/absence. When [Pr. 77 = 2], write is enabled. (Refer to the parameter list on page 120) Parameter data is disabled.

6. When [Pr. 550 NET mode operation command source selection = 7] (RS-485 terminals valid) or [Pr. 550 NET mode operation command source selection = 9999] and the communication option is not fitted.

7. When [Pr. 550 NET mode operation command source selection = 0] (communication option is valid) or [Pr. 550 NET mode operation command source selection = 9999] and the communication option is fitted.

8. No communication option is installed when [Pr. 530 NET mode operation command source selection = 1] (PU connector valid) or [Pr. 530 NET mode operation command source selection = 9999]

9. Not available for [E700]

10. Not available for [E700]

11. Not available for [E700]

### (4) Operation at error occurrence

<table>
<thead>
<tr>
<th>Alarm Description</th>
<th>[Pr. 551] Setting</th>
<th>PU Operation</th>
<th>External/PU Combined Operation Mode 1 (Pr. 79 = 3)</th>
<th>External/PU Combined Operation Mode 2 (Pr. 79 = 4)</th>
<th>RS-485 terminals*5</th>
<th>PU connector*7</th>
<th>Communication option*10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter fault</td>
<td>—</td>
<td>Stop</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PU disconnection of the PU connector</td>
<td>2 (PU connector) 9999 (automatic recognition)</td>
<td>Stop/continued 1, 2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other than 2</td>
<td>Stop/continued</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication error of PU connector</td>
<td>2 (PU connector)</td>
<td>Stop/continued 1</td>
<td>Continued</td>
<td>Stop/continued 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other than 2</td>
<td>Continued</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication error of RS-485 terminals*10</td>
<td>1</td>
<td>Stop/continued 1</td>
<td></td>
<td>Stop/continued 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other than 1</td>
<td>Continued</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication error of USB connector*10</td>
<td>3</td>
<td>Stop/continued 1</td>
<td></td>
<td>Stop/continued 1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other than 3</td>
<td>Continued</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication error of communication option*10</td>
<td>—</td>
<td>Continued</td>
<td></td>
<td>Stop/continued 1</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Can be selected using [Pr. 75 Reset selection/disconnected PU detection/PU stop selection].

2. Can be selected using [Pr. 122 PU communication check time interval], [Pr. 310 RS-485 communication check time interval], and [Pr. 348 USB communication check time interval].

3. As controlled by the communication option.

4. In the PU Jog operation mode, operation is always stopped when the PU is disconnected. Whether error (E.PUE) occurrence is allowed or not is as set in [Pr. 75 Reset selection/disconnected PU detection/PU stop selection].

5. When [Pr. 350 NET mode operation command source selection = 1] (RS-485 terminals valid) or [Pr. 350 NET mode operation command source selection = 9999] and the communication option is not fitted.

6. When [Pr. 350 NET mode operation command source selection = 0] (communication option is valid) or [Pr. 350 NET mode operation command source selection = 9999] and the communication option is fitted.

7. No communication option is installed when [Pr. 350 NET mode operation command source selection = 1] (PU connector valid) or [Pr. 350 NET mode operation command source selection = 9999]

8. Not available for [E700]

9. Not available for [E700]

10. Not available for [E700]
As command sources, there are operation command sources that control signals related to the inverter start command and function selection and speed command source that controls signals related to frequency setting.

In the Network operation mode, the commands from the external terminals and communication (RS-485 terminals or communication option) are as listed below. [Pr. 338] [Pr. 339] settings can be changed while inverter is running when [Pr. 77 = 2], but new setting is reflected after a stop. Operation communication command source and communication speed command source, which are previously set, are kept until a stop.

<table>
<thead>
<tr>
<th>Operation Location Selection</th>
<th>Parameter Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 338 Communication operation command source]</td>
<td>0: NET 1: External</td>
<td>Internal temperature can be changed while inverter is running when [Pr. 77 = 2], but new setting is reflected after a stop. Operation communication command source and communication speed command source, which are previously set, are kept until a stop.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Internal temperature</td>
<td>Cannot be changed while inverter is running when [Pr. 77 = 2]. New setting is reflected after a stop. Operating communication command source and communication speed command source, which are previously set, are kept until a stop.</td>
</tr>
</tbody>
</table>

### Fixed function (terminal-equivalent function)

<table>
<thead>
<tr>
<th>Running frequency function Source</th>
<th>0: NET 1: External</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 2 — External — External</td>
<td>Terminal 1 Compensation</td>
<td>Terminal 2 — External — External</td>
</tr>
</tbody>
</table>

### Selective function

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0R</td>
<td>L Low speed operation command/remote setting clear/stop-on contact selection 0 NET External NET External</td>
</tr>
<tr>
<td>1R</td>
<td>M Middle speed operation command/remote set deceleration NET External NET External</td>
</tr>
<tr>
<td>2R</td>
<td>H High speed operation command/remote set acceleration NET External NET External</td>
</tr>
<tr>
<td>3R</td>
<td>T Second function selection/stop-on contact selection 1 NET External NET External</td>
</tr>
<tr>
<td>4AU</td>
<td>Current input selection — Combined — Combined</td>
</tr>
<tr>
<td>5JOG</td>
<td>Jog operation selection — External</td>
</tr>
<tr>
<td>6CS</td>
<td>Selection of automatic restart after instantaneous power failure External</td>
</tr>
<tr>
<td>7OH</td>
<td>External thermal relay input External</td>
</tr>
<tr>
<td>8REX</td>
<td>Receiver module setting NET External NET External</td>
</tr>
</tbody>
</table>

### Fixed function (terminal-equivalent function)

<table>
<thead>
<tr>
<th>Running frequency function Source</th>
<th>0: NET 1: External</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 2 — External — External</td>
<td>Terminal 1 Compensation</td>
<td>Terminal 2 — External — External</td>
</tr>
</tbody>
</table>

### Selective function

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0R</td>
<td>L Low speed operation command/remote setting clear/stop-on contact selection 0 NET External NET External</td>
</tr>
<tr>
<td>1R</td>
<td>M Middle speed operation command/remote set deceleration NET External NET External</td>
</tr>
<tr>
<td>2R</td>
<td>H High speed operation command/remote set acceleration NET External NET External</td>
</tr>
<tr>
<td>3R</td>
<td>T Second function selection/stop-on contact selection 1 NET External NET External</td>
</tr>
<tr>
<td>4AU</td>
<td>Current input selection — Combined — Combined</td>
</tr>
<tr>
<td>5JOG</td>
<td>Jog operation selection — External</td>
</tr>
<tr>
<td>6CS</td>
<td>Selection of automatic restart after instantaneous power failure External</td>
</tr>
<tr>
<td>7OH</td>
<td>External thermal relay input External</td>
</tr>
<tr>
<td>8REX</td>
<td>Receiver module setting NET External NET External</td>
</tr>
</tbody>
</table>

### Fixed function (terminal-equivalent function)

<table>
<thead>
<tr>
<th>Running frequency function Source</th>
<th>0: NET 1: External</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terminal 2 — External — External</td>
<td>Terminal 1 Compensation</td>
<td>Terminal 2 — External — External</td>
</tr>
</tbody>
</table>

### Selective function

<table>
<thead>
<tr>
<th>Parameter Setting</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0R</td>
<td>L Low speed operation command/remote setting clear/stop-on contact selection 0 NET External NET External</td>
</tr>
<tr>
<td>1R</td>
<td>M Middle speed operation command/remote set deceleration NET External NET External</td>
</tr>
<tr>
<td>2R</td>
<td>H High speed operation command/remote set acceleration NET External NET External</td>
</tr>
<tr>
<td>3R</td>
<td>T Second function selection/stop-on contact selection 1 NET External NET External</td>
</tr>
<tr>
<td>4AU</td>
<td>Current input selection — Combined — Combined</td>
</tr>
<tr>
<td>5JOG</td>
<td>Jog operation selection — External</td>
</tr>
<tr>
<td>6CS</td>
<td>Selection of automatic restart after instantaneous power failure External</td>
</tr>
<tr>
<td>7OH</td>
<td>External thermal relay input External</td>
</tr>
<tr>
<td>8REX</td>
<td>Receiver module setting NET External NET External</td>
</tr>
</tbody>
</table>
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PARAMETER

(6) Command source switchover by external terminal (X67 signal)

In the network operation mode, the command source switching signal (X67) switches start command source and frequency command source. This function is useful when controlling signal input from both of control terminal and communication. Set 67 in any of [Pr. 178 to Pr. 189 Input terminal function selection] to assign the X67 signal to the control terminal.

When X67 signal is OFF, control terminal has the start command source and frequency command source.

The ON/OFF state of the X67 signal is reflected only during a stop. It is reflected after a stop when the terminal is switched during operation.

When the X67 signal is OFF, a reset via communication is disabled.

<table>
<thead>
<tr>
<th>X67 Signal State</th>
<th>Start Command Source</th>
<th>Frequency Command Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>No signal assignment</td>
<td>According to [Pr. 338]</td>
<td>According to [Pr. 339]</td>
</tr>
<tr>
<td>ON</td>
<td>Command from control terminal is the only valid command.</td>
<td></td>
</tr>
</tbody>
</table>

2.21.3 Initial settings and specifications of RS-485 communication

[Pr. 117 to 124, 331 to 337*, 341*, 502*, 549] (common)

("[Pr. 331 to 337, 341] are not available for E700 D700.")

Used to perform required settings for RS-485 communication between the inverter and personal computer.

There are two different communications: communication using the PU connector of the inverter and communication using the RS-485 terminals. (only in D700)

You can perform parameter setting, monitoring, etc. using Mitsubishi inverter protocol or Modbus-RTU protocol.

To make communication between the personal computer and inverter, initialization of the communication specifications must be made to the inverter. Data communication cannot be made if the initial settings are not made or there is any setting error.

Always reset the inverter after making the initial settings of the parameters. After you have changed the communication related parameters, communication cannot be made until the inverter is reset.

[PU connector communication related parameter] (command)

<table>
<thead>
<tr>
<th>[Pr]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>PU communication station number</td>
<td>0</td>
<td>0 to 31</td>
<td>Specifies the inverter station number. Set the inverter station numbers when two or more inverters are connected to one personal computer.</td>
</tr>
<tr>
<td>118</td>
<td>PU communication speed</td>
<td>48, 96, 192, 384</td>
<td>48, 96, 192, 384</td>
<td>Set the communication speed. The setting value x 100 equals the communication speed. For example, the communication speed is 19200bps when the setting value is 192.</td>
</tr>
<tr>
<td>119F</td>
<td>PU communication stop bit length</td>
<td>1</td>
<td>0, 1</td>
<td>Data length</td>
</tr>
<tr>
<td>120</td>
<td>PU communication parity check</td>
<td>2</td>
<td>0, 1</td>
<td>Without parity check, With odd parity check, With even parity check</td>
</tr>
</tbody>
</table>
*1 When \([Pr.549]=1\) (Modbus-RTU protocol), setting range is the values in parentheses.

*2 For Modbus-RTU protocol, the data length is fixed to 8bit and the stop bit length is \([Pr.120]\) setting.

*3 Modbus-RTU protocol is invalid.

*4 The Modbus-RTU of \([Pr.122]\) is valid for only communication from the RS-485 terminals.

*5 Monitoring and parameter read are available during the communication with \([Pr.122]\) (communication check time interval \([Pr.122]\)) but inverter outputs fault as soon as operation mode is switched to NET operation mode. When operation mode is the Network operation mode at powering ON, communication error (E.PUE) occurs after first communication. To operate or write parameter using communication, set \([Pr.122]=9999\) or set a large value to \([Pr.122]\). (The setting value depends on the program of the computer.) (Refer to page 479)

*6 Setting value 2 is only available in \([Pr.549]\)

<table>
<thead>
<tr>
<th>([Pr.])</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>121*3</td>
<td>Number of PU communication retries</td>
<td>1</td>
<td>0 to 10</td>
<td>Set the permissible number of retries at occurrence of a data receive error. If the number of consecutive errors exceeds the permissible value, the inverter will come to trip. Valid only in Mitsubishi inverter (computer link operation) protocol.</td>
</tr>
<tr>
<td>122</td>
<td>PU communication check time interval</td>
<td>0</td>
<td>0.1 to 999.8s</td>
<td>Set the interval of communication check time. If no-communication state persists for longer than the permissible time, the inverter will come to trip.</td>
</tr>
<tr>
<td>123*3</td>
<td>PU communication waiting time setting</td>
<td>0</td>
<td>0 to 150ms</td>
<td>Set the waiting time between data transmission to the inverter and response.</td>
</tr>
<tr>
<td>124*3</td>
<td>PU communication CR/LF selection</td>
<td>1</td>
<td>Without CR/LF</td>
<td></td>
</tr>
<tr>
<td>502</td>
<td>Stop mode selection at communication error</td>
<td>0</td>
<td>0, 3*4</td>
<td>Coasts to stop E.PUE Output Stop (E.PUE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>Decelerates to stop After stop E.PUE Output Stop (E.PUE)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>Decelerates to stop After stop Without output Automatic restart functions</td>
<td></td>
</tr>
<tr>
<td>549</td>
<td>Protocol selection</td>
<td>1</td>
<td>Mitsubishi inverter (computer link operation) protocol</td>
<td></td>
</tr>
</tbody>
</table>
When parameter write is performed from the inverter PU connector, RS-485 terminals, USB communication and communication option, parameters can be written to the RAM. When changing the parameter values frequently, set [Pr. 342 = 1] to write them to the RAM.

### Communication EEPROM write selection [Pr. 342] (common)

<table>
<thead>
<tr>
<th>Pr.</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>342</td>
<td>Communication EEPROM write selection</td>
<td>0</td>
<td>0</td>
<td>Parameter values written by communication are written to the EEPROM and RAM.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>Parameter values written by communication are written to the EEPROM and RAM.</td>
</tr>
</tbody>
</table>

The life of the EEPROM will be shorter if parameter write is performed frequently with [Pr. 342 = 0] (initial value). When [Pr. 342 = 1] (write to EEPROM only), powering OFF the inverter will erase the changed parameter values.

When performing operation or parameter write through communication, set [Pr. 342 = 9999] or larger value. (The setting depends on the computer side program. Refer to page 449.)

*1 When [Pr. 549 = 1] (Modbus-RTU protocol) is set, the setting range within parenthesis is applied.

*2 For the Modbus-RTU protocol, the data length is fixed to 8 bits and the stop bit depends on the [Pr. 334] setting. (Refer to page 459)

*3 The Modbus-RTU protocol becomes invalid.

*4 The Modbus-RTU protocol of ([525] [522]) is only valid for the communication from the RS-485 terminals.

*5 If communication is made with [Pr. 136 RS-485 communication check time interval = 0] (initial value), monitor, parameter read, etc. can be performed, but the inverter results in an alarm as soon as it is switched to the NET operation mode. If the operation mode at power-ON is the Network operation mode, a communication alarm (E.SER) occurs after first communication.

When performing operation or parameter write through communication, set [Pr. 136 = 9999] or larger value. (The setting depends on the computer side program.) Refer to page 449.)
2.21.5 Mitsubishi inverter protocol (computer link communication)  

You can perform parameter setting, monitor, etc. from the PU connector or RS-485 terminals of the inverter using the Mitsubishi inverter protocol (computer link communication).

(1) Communication specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Related Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication protocol</td>
<td>Mitsubishi protocol (computer link)</td>
<td>Pr. 117</td>
</tr>
<tr>
<td>Number of connectable devices</td>
<td>1: N (maximum 32 units), setting is 0 to 31 stations</td>
<td>Pr. 118</td>
</tr>
<tr>
<td>Communication speed</td>
<td>PU connector: Selectable from among 4800/9600/19200 and 38400bps</td>
<td>Pr. 331</td>
</tr>
<tr>
<td></td>
<td>RS-485 terminals: Selectable from 300, 600, 1200, 2400, 4800, 9600, 19200 and 38400bps</td>
<td>Pr. 332</td>
</tr>
</tbody>
</table>

(2) Communication procedure

Data communication between the computer and inverter is made in the following procedure.

1) Request data is sent from the computer to the inverter. (The inverter will not send data unless requested.)
2) After waiting for the waiting time
3) The inverter sends return data to the computer in response to the computer request.
4) After waiting for the inverter data processing time.
5) Answer from the computer in response to reply data 3) of the inverter is transmitted. (Even if 5) is not sent, subsequent communication is made properly.)

*1 If a data error is detected and a retry must be made, execute retry operation with the user program. The inverter comes to an alarm stop if the number of consecutive retries exceeds the parameter setting.
*2 On receipt of a data error occurrence, the inverter returns retry data 3) to the computer again. The inverter comes to trip if the number of consecutive data errors reaches or exceeds the parameter setting.
(3) Communication operation presence/absence and data format types

- Data communication between the computer and inverter is made in ASCII code (hexadecimal code).
- Communication operation presence/absence and data format types are as follows:

<table>
<thead>
<tr>
<th>No.</th>
<th>Operation</th>
<th>Run Command</th>
<th>Operation Frequency</th>
<th>Multi command</th>
<th>Parameter Write</th>
<th>Inverter Reset</th>
<th>Monitor</th>
<th>Parameter Read</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Communication request is sent to the inverter in accordance with the user program in the computer.</td>
<td>A, A1</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>2)</td>
<td>Inverter data processing time</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>3)</td>
<td>Reply data from the inverter (Data 1) is checked for error</td>
<td>No error</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>4)</td>
<td>Computer processing delay time</td>
<td>No error</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
<tr>
<td>5)</td>
<td>Acknowledged from computer in response to reply data 3. (Data 3) is checked for error</td>
<td>No error</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
</tr>
</tbody>
</table>

*1 In the communication request data from the computer to the inverter, 10ms or more is also required after "no data error (ACK)". (Refer to page 447)

*2 Reply from the inverter to the inverter reset request can be selected. (Refer to page 452)

*3 When any of "0.01 to 9998" is set in [Pr.37] and "01" is set in the instruction code HHF in [E700, D700], data format is A2 or E2. In addition, data formats are always A2 and E2 for read or write of [Pr.37].

*4 All mode error, and data range error, C1 data contains an error code. (Refer to page 458) Except for those errors, the error is returned with data format D.

*5 Multi command is available only in E700.

**Data writing format**

Communication request data from the computer to the inverter 1)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>END #1 Instruction code #3 Data Sum check #4</td>
</tr>
<tr>
<td>A1</td>
<td>END #1 Instruction code #3 Data Sum check #4</td>
</tr>
<tr>
<td>A2</td>
<td>END #1 Instruction code #3 Data Sum check #4</td>
</tr>
<tr>
<td>A3</td>
<td>END #1 Instruction code #3 Data1 Data2 Sum check #4</td>
</tr>
</tbody>
</table>

Reply data from the inverter to the computer 3) (No data error detected)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>ACK #4</td>
</tr>
<tr>
<td>C1</td>
<td>STX #1 Instruction station number #2 Instruction data type Error code1 Error code2 Data1 Data2 ETX #1 Sum check #4</td>
</tr>
</tbody>
</table>


**PARAMETER**

Reply data from the inverter to the computer 3) (With data error)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1</td>
</tr>
</tbody>
</table>

- D
- NAK
- Inverter station number
- Error code

*1 Indicate a control code

*2 Specify the inverter station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 Set waiting time. When the \[Pr. 123, 337 (waiting time setting)\] is other than "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer. Whether the CR and LF codes will be present or absent can be selected using \[Pr. 124, 341 (CR, LF selection)\].

**Data reading format**

Communication request data from the computer to the inverter 1)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>1</td>
</tr>
</tbody>
</table>

- B
- ENQ
- Inverter station number
- Instruction code
- Sum check

*1 Indicate a control code

*2 Specify the inverter station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 Set waiting time. When the \[Pr. 123, 337 (waiting time setting)\] is other than "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer. Whether the CR and LF codes will be present or absent can be selected using \[Pr. 124, 341 (CR, LF selection)\].

Reply data from the inverter to the computer 3) (No data error detected)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>1</td>
</tr>
</tbody>
</table>

- E
- STX
- Inverter station number
- Read data ETX
- Sum check

*1 Indicate a control code

*2 Specify the inverter station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 Set waiting time. When the \[Pr. 123, 337 (waiting time setting)\] is other than "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer. Whether the CR and LF codes will be present or absent can be selected using \[Pr. 124, 341 (CR, LF selection)\].

Reply data from the inverter to the computer 3) (With data error)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>1</td>
</tr>
</tbody>
</table>

- E
- STX
- Inverter station number
- Read data (Inverter type information) ETX
- Sum check

*1 Indicate a control code

*2 Specify the inverter station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 Set waiting time. When the \[Pr. 123, 337 (waiting time setting)\] is other than "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer. Whether the CR and LF codes will be present or absent can be selected using \[Pr. 124, 341 (CR, LF selection)\].

Send data from the computer to the inverter 5)

<table>
<thead>
<tr>
<th>Format</th>
<th>Number of Characters</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>1</td>
</tr>
</tbody>
</table>

- D
- NAK
- Inverter station number
- Error code

*1 Indicate a control code

*2 Specify the inverter station numbers between H00 and H1F (stations 0 to 31) in hexadecimal.

*3 Set waiting time. When the \[Pr. 123, 337 (waiting time setting)\] is other than "9999", create the communication request data without "waiting time" in the data format. (The number of characters decreases by 1.)

*4 CR, LF code

When data is transmitted from the computer to the inverter, codes CR (carriage return) and LF (line feed) are automatically set at the end of a data group on some computers. In this case, setting must also be made on the inverter according to the computer. Whether the CR and LF codes will be present or absent can be selected using \[Pr. 124, 341 (CR, LF selection)\].
(4) Data definitions

1) Control codes

<table>
<thead>
<tr>
<th>Signal Name</th>
<th>ASCII Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>STX</td>
<td>H02</td>
<td>Start of Text (start of data)</td>
</tr>
<tr>
<td>ETX</td>
<td>H03</td>
<td>End of Text (end of data)</td>
</tr>
<tr>
<td>ENQ</td>
<td>H05</td>
<td>Enquiry (communication request)</td>
</tr>
<tr>
<td>ACK</td>
<td>H06</td>
<td>Acknowledge (no data error detected)</td>
</tr>
<tr>
<td>LF</td>
<td>H0A</td>
<td>Line Feed</td>
</tr>
<tr>
<td>CR</td>
<td>H0D</td>
<td>Carriage Return</td>
</tr>
<tr>
<td>NAK</td>
<td>H15</td>
<td>Negative Acknowledge (data error detected)</td>
</tr>
</tbody>
</table>

2) Inverter station number

Specify the station number of the inverter which communicates with the computer.

3) Instruction code

Specify the processing request, e.g., operation or monitoring, given by the computer to the inverter. Hence, the inverter can be run and monitored in various ways by specifying the instruction code as appropriate. (Refer to page 452)

4) Data

Indicates the data such as frequency and parameters transferred to and from the inverter. The definitions and ranges of set data are determined in accordance with the instruction codes. (Refer to page 452)

5) Waiting time

Specify the waiting time between the receipt of data at the inverter from the computer and the transmission of reply data. Set the waiting time in accordance with the response time of the computer between 0 and 150ms in 10ms increments (e.g., 1 = 10ms, 2 = 20ms).

When the [Pr. 123, 337 Waiting time setting 9999], create the communication request data without waiting time in the data format. (The number of characters decreases by 1.)

The data check time changes depending on the instruction code. (Refer to page 448)

6) Sum check code

The sum check code is 2-digit ASCII (hexadecimal) representing the lower 1 byte (8 bits) of the sum (binary) derived from the checked ASCII data.

[Example 1] Computer — inverter

[Example 2] Computer — inverter
7) Error code

If any error is found in the data received by the inverter, its definition is sent back to the computer together with the NAK code.

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Error Item</th>
<th>Error Description</th>
<th>Inverter Side Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0</td>
<td>Computer NAK error</td>
<td>The number of errors consecutively detected in communication request data from the computer is greater than allowed number of retries.</td>
<td>Brought to trip (E.PUE/E.SER) if error occurs continuously more than the allowable number of retry times.</td>
</tr>
<tr>
<td>H1</td>
<td>Parity error</td>
<td>The parity check result does not match the specified parity.</td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>Sum check error</td>
<td>The sum check code in the computer does not match that of the data received by the inverter.</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>Protocol error</td>
<td>The data received by the inverter has a grammatical mistake. Alternatively, data received is not completed within the predetermined time. CR or LF is not as set in the parameter.</td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>Framing error</td>
<td>The stop bit length differs from the initial setting.</td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>Overrun error</td>
<td>New data has been sent by the computer before the inverter completes receiving the preceding data.</td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td>— — —</td>
<td>The character received is invalid (other than 0 to 9, A to F, control code).</td>
<td>Does not accept received data</td>
</tr>
<tr>
<td>H7</td>
<td>Character error</td>
<td>Does not accept received data</td>
<td></td>
</tr>
<tr>
<td>H8</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H9</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HA</td>
<td>Mode error</td>
<td>Parameter write was attempted in the computer link operation mode, operation command source is not selected or inverter operation.</td>
<td></td>
</tr>
<tr>
<td>HB</td>
<td>Instruction code error</td>
<td>The specified command does not exist.</td>
<td></td>
</tr>
<tr>
<td>HC</td>
<td>Data range error</td>
<td>Invalid data has been specified for parameter write, frequency setting, etc.</td>
<td></td>
</tr>
<tr>
<td>HD</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HE</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HF</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(5) Response time

\[
\text{Data sending time} = \frac{\text{Inverter data processing time} + \text{Waiting time} + \text{Data check time}}{\text{Communication speed (bps)}}
\]

<table>
<thead>
<tr>
<th>Item</th>
<th>Check Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various monitors, run command, fail frequency (RAM)</td>
<td>&lt; 12ms</td>
</tr>
<tr>
<td>Parameter reset, frequency setting (EE/PROM)</td>
<td>&lt; 30ms</td>
</tr>
<tr>
<td>Parameter clear</td>
<td>&lt; 5s</td>
</tr>
<tr>
<td>Reset command</td>
<td>No answer</td>
</tr>
</tbody>
</table>

In addition to the above, 1 start bit is necessary. Minimum number of total bits: 9 bits
Maximum number of total bits: 12 bits

---

**PARAMETER**

**Error check table**

<table>
<thead>
<tr>
<th>Name</th>
<th>Number of Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop bit length</td>
<td>1 bit</td>
</tr>
<tr>
<td></td>
<td>2 bits</td>
</tr>
<tr>
<td>Data length</td>
<td>7 bits</td>
</tr>
<tr>
<td></td>
<td>8 bits</td>
</tr>
<tr>
<td>Parity check</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

**Data check time**

<table>
<thead>
<tr>
<th>Item</th>
<th>Check Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various monitors, run command, fail frequency (RAM)</td>
<td>&lt; 12ms</td>
</tr>
<tr>
<td>Parameter reset, frequency setting (EE/PROM)</td>
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</tr>
<tr>
<td>Parameter clear</td>
<td>&lt; 5s</td>
</tr>
<tr>
<td>Reset command</td>
<td>No answer</td>
</tr>
</tbody>
</table>

---

**Communication specifications**

<table>
<thead>
<tr>
<th>Name</th>
<th>Number of Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop bit length</td>
<td>1 bit</td>
</tr>
<tr>
<td></td>
<td>2 bits</td>
</tr>
<tr>
<td>Data length</td>
<td>7 bits</td>
</tr>
<tr>
<td></td>
<td>8 bits</td>
</tr>
<tr>
<td>Parity check</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

**Formula for data sending time**

\[
\text{Data sending time} = \frac{1}{\text{Communication speed (bps)}} \times \frac{\text{Number of data characters}}{\text{Communication specifications}} \times \text{Data sending time (s)}
\]

**Communication specifications**

<table>
<thead>
<tr>
<th>Name</th>
<th>Number of Bits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stop bit length</td>
<td>1 bit</td>
</tr>
<tr>
<td></td>
<td>2 bits</td>
</tr>
<tr>
<td>Data length</td>
<td>7 bits</td>
</tr>
<tr>
<td></td>
<td>8 bits</td>
</tr>
<tr>
<td>Parity check</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>No</td>
</tr>
</tbody>
</table>

Minimum number of total bits: 9 bits
Maximum number of total bits: 12 bits

---

**Error check table**

<table>
<thead>
<tr>
<th>Error Code</th>
<th>Error Item</th>
<th>Error Description</th>
<th>Inverter Side Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>H0</td>
<td>Computer NAK error</td>
<td>The number of errors consecutively detected in communication request data from the computer is greater than allowed number of retries.</td>
<td>Brought to trip (E.PUE/E.SER) if error occurs continuously more than the allowable number of retry times.</td>
</tr>
<tr>
<td>H1</td>
<td>Parity error</td>
<td>The parity check result does not match the specified parity.</td>
<td></td>
</tr>
<tr>
<td>H2</td>
<td>Sum check error</td>
<td>The sum check code in the computer does not match that of the data received by the inverter.</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>Protocol error</td>
<td>The data received by the inverter has a grammatical mistake. Alternatively, data received is not completed within the predetermined time. CR or LF is not as set in the parameter.</td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>Framing error</td>
<td>The stop bit length differs from the initial setting.</td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>Overrun error</td>
<td>New data has been sent by the computer before the inverter completes receiving the preceding data.</td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td>— — —</td>
<td>The character received is invalid (other than 0 to 9, A to F, control code).</td>
<td>Does not accept received data</td>
</tr>
<tr>
<td>H7</td>
<td>Character error</td>
<td>Does not accept received data</td>
<td></td>
</tr>
<tr>
<td>H8</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>H9</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HA</td>
<td>Mode error</td>
<td>Parameter write was attempted in the computer link operation mode, operation command source is not selected or inverter operation.</td>
<td></td>
</tr>
<tr>
<td>HB</td>
<td>Instruction code error</td>
<td>The specified command does not exist.</td>
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</tr>
<tr>
<td>HC</td>
<td>Data range error</td>
<td>Invalid data has been specified for parameter write, frequency setting, etc.</td>
<td></td>
</tr>
<tr>
<td>HD</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HE</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HF</td>
<td>— — —</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(5) Response time

\[
\text{Data sending time} = \frac{\text{Inverter data processing time} + \text{Waiting time} + \text{Data check time}}{\text{Communication speed (bps)}}
\]
(6) Retry count setting \([\text{Pr. 121, 335}]\)

Set the permissible number of retries at data receive error occurrence. (Refer to page 448 for data receive error for retry)

When data receive errors occur consecutively and exceed the permissible number of retries set, an inverter trip (E.PUE) may occur and stops the motor.

When 9999 is set, an inverter fault is not provided even if data receive error occurs but an alarm output signal (LF) is output.

For the terminal used for the LF signal output, assign the function by setting 98 (positive logic) or 198 (negative logic) in any of \([\text{Pr. 190 to Pr. 196 Output terminal function selection}]\).

(7) Signal loss detection (RS-485 communication check time interval) \([\text{Pr. 122, 336}]\)

If a signal loss (communication stop) is detected between the inverter and computer as a result of a signal loss detection, a communication fault (PU connector communication: E.PUE, RS-485 terminal communication: E.SER) occurs and the inverter trips.

A signal loss detection is made when the setting is any of 0.1 to 999.8s. To make a signal loss detection, it is necessary to send data (control code: refer to page 447) from the computer within the communication check time interval. (The inverter makes communication check (clearing of communication check counter) regardless of the station number setting of the data sent from the master).

Communication check is started at the first communication in the operation mode having the operation source (PU operation mode for PU connector communication in the default setting or network operation mode for RS-485 terminal communication).

When the setting is 9999, communication check (signal loss detection) is not made. If communication is broken due to signal cable breakage, computer fault etc., the inverter does not detect such a fault. This should be fully noted. It is recommended to set the communication check time interval before starting operation to prevent hazardous conditions.

When the setting is 0 (initial value) in \([\text{Pr. 122}]\), communication from the PU connector cannot be performed. For communication via the RS-485 terminals, monitor, parameter read, etc. can be performed, but a communication error (E.SER) occurs as soon as the inverter is switched to the network operation mode.

When the setting is 0 (initial value) in \([\text{Pr. 122}]\), communication from RS-485 can be performed, however, communication error (E.PUE) would occur if switched to another operation mode with command source (NET mode at initial setting).

Always set the communication check time interval before starting operation to prevent hazardous conditions. Data communication is not started automatically but is made only once when the computer provides a communication request. If communication is disabled during operation due to signal cable breakage etc., the inverter cannot be stopped. When the communication check time interval has elapsed, the inverter trips (E.PUE).

The inverter can be coasted to a stop by turning ON its RES signal or by switching power OFF.

If communication is broken due to signal cable breakage, computer fault, etc, the inverter does not detect such a fault. This should be fully noted.
(8) Stop operation selection at occurrence of communication fault (Pr. 502)

Stop operation when retry count exceeds (Mitsubishi inverter protocol only) or signal loss detection error occurs can be selected.

<table>
<thead>
<tr>
<th>Pr. 502 Setting</th>
<th>Operation</th>
<th>Indication</th>
<th>Fault Output</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 (initial value)</td>
<td>Decelerates to stop</td>
<td>E. PUE</td>
<td>Provided</td>
</tr>
<tr>
<td>1</td>
<td>Decelerates to stop</td>
<td>E. PUE</td>
<td>Provided after stop</td>
</tr>
<tr>
<td>2</td>
<td>Not provided</td>
<td>E. PUE</td>
<td>Provided</td>
</tr>
</tbody>
</table>

* Setting value 3 is only available in E700.

When “2” is set in [Pr. 502], run command/speed command at restart follows the command before an fault occurrence.

When “2” is set in [Pr. 502] at occurrence of a communication error and the error is removed during deceleration, the inverter accelerates again at that point.

After the fault is removed, the fault indication returns to the ordinary monitor, and the faults history returns to the preceding fault indication.

When the [Pr. 502] setting is “1 or 2”, the deceleration time is the ordinary deceleration time setting ([Pr. 8, Pr. 44, Pr. 45]). In addition, acceleration time for restart is the normal acceleration time ([Pr. 7, Pr. 44]).

When “2” is set in [Pr. 502], run command/speed command at restart follows the command before an fault occurrence.

When “2” is set in [Pr. 502] at occurrence of a communication error and the error is removed during deceleration, the inverter accelerates again at that point.

Operation at fault occurrence

- **Pr. 502 Setting: 0**
  - Stop operation: Decelerates to stop
  - Fault indication: E. PUE
  - Fault output: Provided

- **Pr. 502 Setting: 1**
  - Stop operation: Decelerates to stop
  - Fault indication: E. PUE
  - Fault output: Provided after stop

- **Pr. 502 Setting: 2**
  - Stop operation: Not provided
  - Fault indication: E. PUE
  - Fault output: Provided

* When “2” is set in [Pr. 502], run command/speed command at restart follows the command before an fault occurrence.

When “2” is set in [Pr. 502] at occurrence of a communication error and the error is removed during deceleration, the inverter accelerates again at that point.

### Diagram

- **Pr. 502 Setting: 0**
  - Communication fault: OFF
  - Output frequency: OFF
  - Motor coasting: Display OFF

- **Pr. 502 Setting: 1**
  - Communication fault: OFF
  - Output frequency: OFF
  - Motor coasting: Display OFF

- **Pr. 502 Setting: 2**
  - Communication fault: OFF
  - Output frequency: OFF
  - Motor coasting: Display OFF
(9) Instructions for the program

1) When data from the computer has any error, the inverter does not accept that data. Hence, in the user program, always insert a retry program for data error.

2) All data communication, e.g. run command or monitoring, are started when the computer gives a communication request. The inverter does not return any data without the computer’s request. Hence, design the program so that the computer gives a data read request for monitoring, etc. as required.

3) Program example

When switching the operation mode to NET operation.

Programming example of Microsoft® Visual C++® (Ver.6.0)

```
#include <stdio.h>
#include <windows.h>

void main(void)
{
HANDLE hCom; //Communication handle
DCB hDcb; //Structure for communication setting
COMMTIMEOUTS hTim; // Structure for time out setting
char szTx[0x10]; // Send buffer
char szRx[0x10]; // Receive buffer
char szCommand[0x10]; // Command
int nTx,nRx; // For buffer size storing
int nSum; // For sum code calculation
BOOL bRet;
int nRet;
i;

//∗∗∗∗Opens COM1 port∗∗∗∗
hCom = CreateFile ("COM1", (GENERIC_READ | GENERIC_WRITE), 0, NULL, OPEN_EXISTING, FILE_ATTRIBUTE_NORMAL, NULL);
if (hCom != NULL) {
//∗∗∗∗Makes a communication setting of COM1 port∗∗∗∗
GetCommState(hCom,&hDcb); // Retrieves current communication information
hDcb.BaudRate = 19200; // Communication speed=19200bps
hDcb.ByteSize = 8; // Data length=8bit
hDcb.Parity = 2; // Even parity
hDcb.StopBits = 2; // Stop bit=2bit
bRet = SetCommState(hCom,&hDcb); // Sets the changed communication data
if (bRet == TRUE) {
//∗∗∗∗Makes a time out setting of COM1 port∗∗∗∗
GetCommTimeouts(hCom,&hTim); // Obtains the current time out value
hTim.WriteTotalTimeoutConstant = 1000; // Write time out 1s
hTim.ReadTotalTimeoutConstant = 1000; // Read time out 1s
SetCommTimeouts(hCom,&hTim); // Changed time out value setting

//∗∗∗∗Sets the command to switch the operation mode of the station 1 inverter to the network operation mode∗∗∗∗
sprintf(szCommand,"01FB10000"); // Send data (NET operation write)
nTx = strlen(szCommand); //Send data size

//∗∗∗∗Generates sum code∗∗∗∗
nSum = 0; // Initialization of sum data
for (i = 0; i < nTx; i++)
    nSum += szCommand[i]; // Calculates sum code
nSum &= (0xff); // Masks data

//∗∗∗∗Generates send data∗∗∗∗
memset(szTx,0,sizeof(szTx)); // Initialization of send buffer
memset(szRx,0,sizeof(szRx)); // Initialization of receive buffer
sprintf(szTx,\"\0\%s%02X\",szCommand,nSum); // ENQ code+send data+sum code
nTx = 1 + nTx + 2; // Number of ENQ code+number of send data+number of sum code
nRet = WriteFile(hCom,szTx,nTx,&nTx,NULL);

//∗∗∗∗Sending∗∗∗∗
if(nRet != 0) {
    nRet = ReadFile(hCom,szRx,sizeof(szRx),&nRx,NULL);
    //∗∗∗∗Receiving∗∗∗∗
    for(i = 0; i < nRx; i++)
        printf("%02X ",(BYTE)szRx[i]); // Console output of receive data
    printf("\n\n");
}
CloseHandle(hCom); // Close communication port
}
```

General flowchart

1) Port open
2) Communication setting
3) Time out setting
4) Send data processing
   a) Data setting
      i) Sum code calculation
         a) Data transmission
   b) Receive data waiting
      a) Data retrieval
         b) Screen display

### (10) Setting items and set data

After completion of parameter settings, set instruction codes and data then start communication from the computer to allow various types of operation control and monitoring.

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Read/Write</th>
<th>Instruction Code</th>
<th>Data Description</th>
<th>Number of Data Digits' (Format)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Operation mode</td>
<td>Read</td>
<td>H7B</td>
<td>H0000: Network operation</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write</td>
<td>HFB</td>
<td>H0002: PU operation (RS-485 communication operation via PU connector)</td>
<td>4 digits (A, C, D)</td>
</tr>
<tr>
<td>2</td>
<td>Output frequency speed</td>
<td>Read</td>
<td>H6F</td>
<td>H0000 to HFFFF: Output frequency in 0.01Hz increments</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Speed increment: or 0.1/min increments</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Speed increment: 1.0/0.01 (when [Pr. 17]=0.01 to 9999).</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>When [Pr. 17] setting is any of 0.01 to 9999 and &quot;11&quot; is set to the instruction code H0F, increment is 0.001, and the data format is E2.</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>When [Pl. 17]=100, monitored values differ during a stop and during a run. (Refer to page 134 for details)</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td>2</td>
<td>Monitor</td>
<td>Read</td>
<td>H70</td>
<td>H0000 to HFFFF: Output current (hexadecimal)</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01A increments (55K or less)/0.1A increments (75K or more)</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td>2</td>
<td>Monitor</td>
<td>Read</td>
<td>H71</td>
<td>H0000 to HFFFF: Output voltage (hexadecimal) in 0.1V increments</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.01V increments (55K or less)/0.1V increments (75K or more)</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Speed increment: 1.0/0.01 (when [Pr. 17]=0.01 to 9999).</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>When [Pr. 17] setting is any of 0.01 to 9999 and &quot;11&quot; is set to the instruction code H0F, increment is 0.001, and the data format is E2.</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>When [Pl. 17]=100, monitored values differ during a stop and during a run. (Refer to page 134 for details)</td>
<td>6 digits (B, E, D)</td>
</tr>
<tr>
<td>3</td>
<td>Run command</td>
<td>Read</td>
<td>H74 to H77</td>
<td>H0000 to HFFFF: Two latest fault definitions.</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Refer to the fault data table (page 458)</td>
<td>4 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write</td>
<td>HF9</td>
<td>Sets control input commands such as the forward rotation signal (STF) and reverse rotation signal (STR). (Refer to page 457 for details)</td>
<td>4 digits (A, C, D)</td>
</tr>
<tr>
<td>4</td>
<td>Inverter status monitor</td>
<td>Read</td>
<td>H79</td>
<td>Monitors the states of the output signals such as forward rotation, reverse rotation and inverter running (RUN). (Refer to page 458 for details)</td>
<td>2 digits (B, E, D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write</td>
<td>HFA</td>
<td>Sets control input commands such as the forward rotation signal (STF) and reverse rotation signal (STR). (Refer to page 457 for details)</td>
<td>2 digits (A, C, D)</td>
</tr>
</tbody>
</table>
### Set frequency (RAM)  H6D
Read
H6D
Sets frequency/speed from RAM or EEPROM.

H000 to HFFFF: Set frequency in 0.01Hz increments

H000 to H027E: Speed 1.1mm increments or 0.1cm increments.

Speed increment is 10.001 (when Pr. 37 setting is any of 0.01 to 9999 and "01" is set to the instruction code HF6, increment is 0.001, and the data format is E2.

(Refer to page 343 for details)

### Set frequency (EEPROM)  H6E
Write
H6E
Sets frequency/speed to RAM or EEPROM.

H000 to H9C40 (0 to 400.00Hz): Frequency 0.01Hz increments

H000 to H270E (0 to 9998r/min): Speed 1 r/min increments

H000 to H8CA0 (0 to 3600.0r/min): Speed 0.1r/min increments (2, 4 poles)

H000 to H5DC0 (0 to 2400.0r/min): Speed 0.1 r/min increments (6 poles)

H000 to H4650 (0 to 1800.0r/min): Speed 0.1r/min increments (8 poles)

H000 to H2EE0 (0 to 1200.0r/min): Speed 0.1r/min increments (10 poles)

Speed increment is 1/0.001 (when Pr. 37 setting is any of 0.01 to 9999 and "01" is set to the instruction code HF6, increment is 0.001, and the data format is A2.

(Refer to page 343 for details)

### Inverter reset  HFD
Write
HFD
- As the inverter is reset on start of communication by the computer, the inverter cannot send reply data back to the computer.

- When data is sent normally, ACK is returned to the computer and then the inverter is reset.

### Fault definition all clear  HF4
Write
HF4
H9696: Fault history batch clear

### Parameter clear  HFC
All parameter clear
Read/Write
HFC
All parameters return to the initial values.

Whether to clear communication parameters or not can be selected according to data. (C: Clear, ×: Not clear)

Refer to page 120 for parameter clear, all clear, and communication parameters.

### Parameter  H6B
Read
H6B
Refer to the instruction code (page 120) and write and/or read parameter values as required.

### Link parameter expansion setting  HFF
Read/Write
HFF
Set any of H00 to H3F to change the parameter settings.

For details of the settings, refer to the instruction code (page 120).
### List of calibration parameters

<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Read/Write</th>
<th>Instruction Code</th>
<th>Data Description</th>
<th>Number of Data Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>Second parameter changing (instruction code HFF = 1, 9)</td>
<td>Read</td>
<td>HEC</td>
<td>Setting calibration parameter ¹</td>
<td>2 digits (B, E1D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Write</td>
<td>HEC' ³</td>
<td>H00: Frequency ¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H01: Parameter set analog value</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>H02: Analog value input from terminal</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&quot;(P. 902)&quot; and &quot;(P. 904)&quot;</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Multi command</td>
<td>Write/Read</td>
<td>HFD</td>
<td>Available for writing 2 commands, and monitoring 2 items for reading data</td>
<td>10 digits (A, C)</td>
</tr>
<tr>
<td>14</td>
<td>HFD00</td>
<td>Read</td>
<td>HTD</td>
<td>Reading inverter capacity in ASCII code.</td>
<td>8 digits (B, E2D)</td>
</tr>
</tbody>
</table>

¹ Refer to the list of calibration parameters below for calibration parameters.

² The gain frequency can be written using \[P. 25\] (instruction code H9F) or \[P. 26\] (instruction code H9A) also.

³ For the instruction codes HFF, HEC and HF3, their values are held once written but cleared to zero when an inverter reset or parameter clear is performed.

### Example

When reading the \(C3 \text{ (Pr. 902)}\) and \(C6 \text{ (Pr. 904)}\) settings from the inverter of station 0

```
<table>
<thead>
<tr>
<th>No.</th>
<th>Item</th>
<th>Read/Write</th>
<th>Instruction Code</th>
<th>Data Description</th>
<th>Number of Data Digits</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ENQ 00 FF 0 01 82</td>
<td>ACK 00</td>
<td>Set H01 to the expansion link parameter.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ENQ 00 EC 0 01 7E</td>
<td>ACK 00</td>
<td>Set H01 to second parameter changing.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ENQ 00 5E 0 0F STX 00 0000 ETX</td>
<td>(C3(\text{Pr. 902})) is read. 0% is read.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>ENQ 00 60 0 FB STX 00 0000 ETX</td>
<td>(C6(\text{Pr. 904})) is read. 0% is read.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
```

To read/write \(C3\) and \(C6\) after inverter reset or parameter clear, execute from 1) again.

### List of calibration parameters

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Instruction Code</th>
<th>Read/Write</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>C14</td>
<td>C14 (918)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 bias command (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>C15 (918)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 gain command (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>C16 (919)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 bias (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>C17 (919)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 gain (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>C18 (920)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 bias (torque/magnetic flux)</td>
</tr>
<tr>
<td></td>
<td>C19 (920)</td>
<td>17 91 9</td>
<td>Read</td>
<td>Terminal 4 gain (torque/magnetic flux)</td>
</tr>
</tbody>
</table>

¹ These are not available for \(A700 \text{ (7700)}\).

² These are not available for \(A700 \text{ (7700)}\) and \(A700 \text{ (7700)}\).
Refer to page 346 for details of the monitor description

<table>
<thead>
<tr>
<th>Description</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>H01 Output frequency/speed *1</td>
<td>0.01Hz/1</td>
</tr>
<tr>
<td>H02 Output frequency/speed *1</td>
<td>0.001Hz/1</td>
</tr>
<tr>
<td>H03 Output voltage</td>
<td>0.1V</td>
</tr>
<tr>
<td>H04 Output voltage</td>
<td>0.01Hz/0.001Hz</td>
</tr>
<tr>
<td>H05 Frequency setting/speed *1</td>
<td>0.01Hz/1</td>
</tr>
<tr>
<td>H06 Frequency setting/speed *1</td>
<td>0.001Hz/0.001Hz</td>
</tr>
<tr>
<td>H07 Running speed</td>
<td>0.1/min</td>
</tr>
<tr>
<td>H08 Input terminal status *2</td>
<td>—</td>
</tr>
<tr>
<td>H09 Output terminal state *3</td>
<td>—</td>
</tr>
<tr>
<td>H10 Load factor</td>
<td>0.1%</td>
</tr>
<tr>
<td>H11 Input power</td>
<td>0.01kWh/0.1kW</td>
</tr>
<tr>
<td>H12 Output power</td>
<td>0.01kWh/0.1kW</td>
</tr>
<tr>
<td>H13 Input terminal status *4</td>
<td>—</td>
</tr>
<tr>
<td>H14 Motorexcitation current</td>
<td>0.1A/0.1A</td>
</tr>
<tr>
<td>H15 Power saving factor</td>
<td>Variable</td>
</tr>
<tr>
<td>H16 PID measured value</td>
<td>0.1%</td>
</tr>
<tr>
<td>H17 PID deviation</td>
<td>0.1%</td>
</tr>
<tr>
<td>H18 Motor load factor</td>
<td>0.1%</td>
</tr>
<tr>
<td>H19 Cumulative power</td>
<td>1kW</td>
</tr>
<tr>
<td>H20 Orientation status</td>
<td>—</td>
</tr>
<tr>
<td>H21 Torque command</td>
<td>0.1%</td>
</tr>
<tr>
<td>H22 Torque current command</td>
<td>0.1</td>
</tr>
<tr>
<td>H23 Motor output</td>
<td>0.01kWh/0.1kW</td>
</tr>
<tr>
<td>H24 Feedback pulse</td>
<td>—</td>
</tr>
<tr>
<td>H25 Option input terminal status 1</td>
<td>—</td>
</tr>
<tr>
<td>H26 Option input terminal status 2</td>
<td>—</td>
</tr>
<tr>
<td>H27 Option output terminal status 1</td>
<td>—</td>
</tr>
<tr>
<td>H28 Option output terminal status 2</td>
<td>—</td>
</tr>
<tr>
<td>H29 Motor thermal load factor</td>
<td>0.1%</td>
</tr>
<tr>
<td>H30 Inverter thermal load factor</td>
<td>0.1%</td>
</tr>
<tr>
<td>H31 Cumulative power</td>
<td>2kWh</td>
</tr>
<tr>
<td>H32 PTC thermistor resistance</td>
<td>0.01kΩ</td>
</tr>
<tr>
<td>H33 Cumulative saving power</td>
<td>Variable</td>
</tr>
<tr>
<td>H34 PID set point</td>
<td>0.1%</td>
</tr>
<tr>
<td>H35 PID measured value</td>
<td>0.1%</td>
</tr>
<tr>
<td>H36 PID deviation</td>
<td>0.1%</td>
</tr>
<tr>
<td>H37 PID measured value</td>
<td>0.1%</td>
</tr>
<tr>
<td>H38 PID deviation</td>
<td>0.1%</td>
</tr>
<tr>
<td>H39 Option input terminal status 1</td>
<td>—</td>
</tr>
<tr>
<td>H40 Option input terminal status 2</td>
<td>—</td>
</tr>
<tr>
<td>H41 Option output terminal status 1</td>
<td>—</td>
</tr>
<tr>
<td>H42 Option output terminal status 2</td>
<td>—</td>
</tr>
<tr>
<td>H43 Torque command</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

*1 The setting depends on the inverter capacity. (55K or less/75K or more)
*2 Input terminal monitor details
*3 Output terminal monitor details
*4 Details of option input terminal monitor 1 (input terminal status of FR-A7AX)-all terminals are OFF when an option is not fitted
*5 Details of option input terminal monitor 2 (input terminal status of FR-A7AX)-all terminals are OFF when an option is not fitted
*6 Details of option output terminal monitor (output terminal status of FR-A7AX/A7AR)—all terminals are OFF when an option is not fitted.
*7 These are not available for (A700).
*8 These are not available for (F700).
*9 These are not available for (E700).
*10 These are not available for (D700).

*11 Increment is 1 when \((pr. 37=1 \text{ to } 9998)\) or \((pr. 144=2 \text{ to } 10, 102 \text{ to } 110)\) in (A700) (Refer to page 343).

*12 Data format is in 6 digits (E2) when \((pr. 37=0.01 \text{ to } 9998)\) and "01" is set to the instruction code HHF in (E700) (D700).

**Fault data**
Refer to page 97 for details of fault description.

<table>
<thead>
<tr>
<th>Data</th>
<th>Description</th>
<th>Data</th>
<th>Description</th>
<th>Data</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>H00</td>
<td>H01*3 H05</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H01</td>
<td>E.OC1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H02</td>
<td>E.OC2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H03</td>
<td>E.OC3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H04</td>
<td>E.OV1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H05</td>
<td>E.OV2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H06</td>
<td>E.OV3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H07</td>
<td>E.THT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H08</td>
<td>E.FIN</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H09</td>
<td>E.IPF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H10</td>
<td>E.UVT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H11</td>
<td>E.ILF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H12</td>
<td>E.OLT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H13</td>
<td>E.BE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H14</td>
<td>E.GF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H15</td>
<td>E.LF</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H16</td>
<td>E.OHT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*1 These are not available for (A700).
*2 These are not available for (F700).
*3 These are not available for (E700).
*4 These are not available for (D700).

For read data (H00):
- **Previous fault** (THT)
- **Latest fault** (OPT)

0 10 1 0000 0 0 0 0 0 011

b15 b8 b7 b0

For read data (H00):
- **Previous fault** (H00)
- **Latest fault** (H00)

0 10 1 0000 0 0 0 0 0 011

b15 b8 b7 b0

Fault definition display example (instruction code HHF)

<table>
<thead>
<tr>
<th>Description</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>H01*3 H05</td>
<td></td>
</tr>
<tr>
<td>E.OC1</td>
<td></td>
</tr>
<tr>
<td>E.OC2</td>
<td></td>
</tr>
<tr>
<td>E.OC3</td>
<td></td>
</tr>
<tr>
<td>E.OV1</td>
<td></td>
</tr>
<tr>
<td>E.OV2</td>
<td></td>
</tr>
<tr>
<td>E.OV3</td>
<td></td>
</tr>
<tr>
<td>E.THT</td>
<td></td>
</tr>
<tr>
<td>E.FIN</td>
<td></td>
</tr>
<tr>
<td>E.IPF</td>
<td></td>
</tr>
<tr>
<td>E.UVT</td>
<td></td>
</tr>
<tr>
<td>E.ILF</td>
<td></td>
</tr>
<tr>
<td>E.OLT</td>
<td></td>
</tr>
<tr>
<td>E.BE</td>
<td></td>
</tr>
<tr>
<td>E.GF</td>
<td></td>
</tr>
<tr>
<td>E.LF</td>
<td></td>
</tr>
</tbody>
</table>

*1 These are not available for (A700).
*2 These are not available for (F700).
*3 These are not available for (E700).
*4 These are not available for (D700).
<table>
<thead>
<tr>
<th>Item</th>
<th>Instruction Code</th>
<th>Bit Length</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Run command</td>
<td>HFA</td>
<td>8 bit</td>
<td>- b0: AU (current input selection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b1: forward rotation command</td>
<td>Example 1: H02 Forward rotation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b2: reverse rotation command</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b3: RL (low speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b4: RM (middle speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b5: RH (high speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b6: RT (Second function selection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b7: MRS (output stop)</td>
<td>Example 2: H06 Stop</td>
</tr>
<tr>
<td></td>
<td>(expansion)</td>
<td>16 bit</td>
<td>- b0: AU (current input selection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HP9</td>
<td></td>
<td>- b1: forward rotation command</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b2: reverse rotation command</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b3: RL (low speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b4: RM (middle speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b5: RH (high speed command)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b6: RT (Second function selection)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b7: MRS (output stop)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b8: JOG (JOG operation)</td>
<td>Example 1: H0302 Forward rotation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b9: CS (Selection of automatic restart after instantaneous power failure)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b10: STOP (start self-holding)</td>
<td>Example 2: H0800 low speed operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>- b11: RES (reset)</td>
<td></td>
</tr>
</tbody>
</table>

1. The signal within parentheses is the default setting. Descriptions change according to the [Pr. 180 to Pr. 184, Pr. 187 Input terminal function selection].
2. The signal within parentheses is the default setting. Since Jog operation/automatic restart after instantaneous power failure/ start self-holding/ reset cannot be controlled by the network, bit 8 to bit 11 are invalid in the initial status. When using bit 8 to bit 11, change the signals with [Pr. 185, Pr. 186, Pr. 188, Pr. 189 Input terminal function selection]. (Reset can be executed with the instruction code HFD)
3. These are not available for (7700).
4. These are not available for (7700).
5. When performing RS-485 communication from the PU connector of (7700), only forward and reverse rotation can be used. When [Pr. 531 PU mode operation command source selection = 2] is set in (7700), only forward and reverse rotation can be used.
### Inverter status monitor

<table>
<thead>
<tr>
<th>Item</th>
<th>Instruction Code</th>
<th>Bit</th>
<th>Length</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter status monitor</td>
<td>H7A</td>
<td>8bit</td>
<td></td>
<td>RUN (inverter running)</td>
<td>b7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1: Forward rotation</td>
<td>b1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2: Reverse rotation</td>
<td>b2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3: SU (up-to-frequency)</td>
<td>b3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4: OL (overload)</td>
<td>b4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5: PF (rotational power failure)</td>
<td>b5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6: FU (frequency detection)</td>
<td>b6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7: ABC1 (fault)</td>
<td>b7</td>
</tr>
</tbody>
</table>

1. Specify the data type of sending data (from computer to inverter).
2. Specify the data type of reply data (from inverter to computer).
3. Combination of data 1 and data 2 for sending.

<table>
<thead>
<tr>
<th>Item</th>
<th>Instruction Code</th>
<th>Bit</th>
<th>Length</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inverter status monitor (expansion)</td>
<td>H79</td>
<td>16bit</td>
<td></td>
<td>RUN (inverter running)</td>
<td>b7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1: Forward rotation</td>
<td>b1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2: Reverse rotation</td>
<td>b2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3: SU (up-to-frequency)</td>
<td>b3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4: OL (overload)</td>
<td>b4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5: PF (rotational power failure)</td>
<td>b5</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6: FU (frequency detection)</td>
<td>b6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7: ABC1 (fault)</td>
<td>b7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>8: ABC2 (---)</td>
<td>b8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>9: -</td>
<td>b9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10: -</td>
<td>b10</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>11: -</td>
<td>b11</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12: -</td>
<td>b12</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>13: -</td>
<td>b13</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>14: -</td>
<td>b14</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>15: Fault occurrence</td>
<td>b15</td>
</tr>
</tbody>
</table>

1. The signal within parentheses is the default setting. Descriptions change according to the [Pr. 190 to Pr. 196 Output terminal function selection].
2. These are not available for [E700, D700].

### Sending data format from computer to inverter

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Data 1</th>
<th>Data 2</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Run command (expansion)</td>
<td>Set frequency (AM, EEPROM)</td>
<td>Run command (expansion) is same as instruction code HF9 (Refer to page 477). The unit of set frequency is always by four digits, even when &quot;0.01 to 9998&quot; is set in [Pr. 37] and &quot;01&quot; is set in instruction code HFF.</td>
</tr>
<tr>
<td>1</td>
<td>Run command (expansion)</td>
<td>Set frequency (AM, EEPROM)</td>
<td>Run command (expansion) is same as instruction code HF9 (Refer to page 477). The unit of set frequency is always by four digits, even when &quot;0.01 to 9998&quot; is set in [Pr. 37] and &quot;01&quot; is set in instruction code HFF.</td>
</tr>
</tbody>
</table>

### Reply data format from inverter to computer (No data error detected)

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Data 1</th>
<th>Data 2</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Inverter status monitor (expansion)</td>
<td>Speed</td>
<td>Inverter status monitor (expansion) is same as instruction code H7F (Refer to page 477). The unit of speed monitor is always by four digits (rounds down after the decimal point), even when &quot;0.01 to 9998&quot; is set in [Pr. 37] and &quot;01&quot; is set in instruction code HFF.</td>
</tr>
<tr>
<td>1</td>
<td>Inverter status monitor (expansion)</td>
<td>Special monitor</td>
<td>Inverter status monitor (expansion) is same as instruction code H7F (Refer to page 477). The unit of speed monitor is always by four digits (rounds down after the decimal point), even when &quot;0.01 to 9998&quot; is set in [Pr. 37] and &quot;01&quot; is set in instruction code HFF.</td>
</tr>
</tbody>
</table>

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2.2.1.6 Modbus-RTU communication [Pr.117*, 118*, 120*, 122*, 331*, 332*, 334*, 343*, 502*, 539*, 549] common

Communication operation and parameter setting can be performed using the Modbus-RTU communication protocol from the RS-485 terminal in F700 or the PU connector in F700. Set [Pr. 549 Protocol selection = 1] to use Modbus RTU protocol.

If a communication option is installed while [Pr. 550 NET mode operation command source selection = 9999] (initial value) in A700, command source (for example, run command) at RS-485 terminal becomes invalid. Change the setting to [Pr. 550 = 1] in that case. (Refer to page 436)

When NET mode command source is at the PU connector in E700 ([Pr. 551 PU mode operation command source selection ≠ 2]), operation by Modbus RTU communication is available. When NET mode command source is at the PU connector in D700 ([Pr. 550 NET mode operation command source selection = 2 or 9999 (initial value)], no communication option), operation by Modbus RTU communication is available. (Refer to page 436)

*1 When Modbus-RTU communication is performed from the master with address 0 (station 0) set, broadcast communication is selected and the inverter does not send a response message to the master. When response from the inverter is necessary, set [Pr. 117, 332 RS-485 communication station ≠ 0 (initial value is 0)]. Some functions are invalid for broadcast communication.

*2 Not used in Modbus RTU communication.

<table>
<thead>
<tr>
<th>[Pr.]</th>
<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
<th>Available Inverters</th>
</tr>
</thead>
<tbody>
<tr>
<td>117</td>
<td>RS-485 communication station number</td>
<td>0</td>
<td>0 to 247</td>
<td>No reply to the master. Set the inverter station number when two or more inverters are connected to one personal computer.</td>
<td>A700:</td>
</tr>
<tr>
<td>118</td>
<td>RS-485 communication speed</td>
<td>96</td>
<td>3, 6, 12, 24, 48, 96, 192, 384</td>
<td>The setting value y, 100 equals the communication speed. For example, the communication speed is 9600 bps when the setting value is 96.</td>
<td>A700:</td>
</tr>
<tr>
<td>120</td>
<td>RS-485 communication parity check selection</td>
<td>2</td>
<td>0 to 2</td>
<td>Stop bit length 2bit</td>
<td>A700:</td>
</tr>
<tr>
<td>334</td>
<td>Modbus-RTU communication check time interval</td>
<td>0</td>
<td>0 to 999.8s</td>
<td>Displays the number of communication error during Modbus-RTU communication.</td>
<td>A700:</td>
</tr>
<tr>
<td>502</td>
<td>Stop mode selection at communication error</td>
<td>0</td>
<td>0 or 3 (F700)</td>
<td>Create to stop</td>
<td>A700:</td>
</tr>
<tr>
<td>549</td>
<td>Protocol selection</td>
<td>0</td>
<td>0 to 2</td>
<td>Remote terminal (computer link operation) protocol.</td>
<td>A700:</td>
</tr>
</tbody>
</table>

1 When Modbus-RTU communication is performed from the master with address 0 (station 0) set, broadcast communication is selected and the inverter does not send a response message to the master. When response from the inverter is necessary, set [Pr. 117, 332 RS-485 communication station ≠ 0 (initial value is 0)]. Some functions are invalid for broadcast communication.

2 Not used in Modbus RTU communication.
(1) Communication specifications

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Related Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication protocol</td>
<td>Modbus-RTU protocol</td>
<td>[Pr. 549]</td>
</tr>
<tr>
<td>Communication speed</td>
<td>Can be selected from 300, 600, 1200, 2400, 4800, 9600, 19200 and 38400 bps</td>
<td>[Pr. 118, 332]</td>
</tr>
<tr>
<td>Control procedure</td>
<td>Asynchronous</td>
<td></td>
</tr>
<tr>
<td>Character system</td>
<td>Binary (fixed to 8 bits)</td>
<td></td>
</tr>
<tr>
<td>Stop bit length</td>
<td>- No parity, stop bit length 2 bits</td>
<td>[Pr. 120, 334]</td>
</tr>
<tr>
<td>- Odd parity, stop bit length 1 bit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parity check</td>
<td>- Even parity, stop bit length 1 bit</td>
<td></td>
</tr>
<tr>
<td>Error check</td>
<td>CRC code check</td>
<td></td>
</tr>
<tr>
<td>Terminator</td>
<td>Unavailable</td>
<td></td>
</tr>
<tr>
<td>Waiting time setting</td>
<td>Unavailable</td>
<td></td>
</tr>
</tbody>
</table>

(2) Overview

The Modbus protocol is the communication protocol developed by Modicon for Programmable controller. The Modbus protocol performs serial communication between the master and slave using the dedicated message frame. The dedicated message frame has the functions that can perform data read and write. Using the functions, you can read and write the parameter values from the inverter, write the input command of the inverter, and check the operating status. In this product, the inverter data are classified in the holding register area (register addresses 40001 to 49999). By accessing the assigned holding register address, the master can communicate with the inverter which is a slave.

There are two different serial transmission modes: ASCII (American Standard Code for Information Interchange) mode and RTU (Remote Terminal Unit) mode. This product supports only the RTU mode in which 1-byte (8-bit) data is transmitted as-is.

Only the communication protocol is defined by the Modbus protocol, and the physical layer is not stipulated.
(3) Message format

1) Query
   The master sends a message to the slave (= inverter) at the specified address.

2) Normal Response
   After receiving the query from the master, the slave executes the requested function and returns the corresponding normal response to the master.

3) Error Response
   If an invalid function code, address or data is received, the slave returns it to the master.
   When a response description is returned, the error code indicating that the request from the master cannot be executed is added.
   No response is returned for the hardware-detected error, frame error and CRC check error.

4) Broadcast
   By specifying address 0, the master can send a message to all slaves. All slaves that received the message from the master execute the requested function. In this communication, the slaves do not return a response to the master.
   The slave executes the function independently of the Inverter station number setting [Pr. 117, 331] during broadcast communication.

(4) Message frame (protocol)

- Communication method
  Basically, the master sends a query message (question) and the slave returns a response message (response). When communication is normal, Device Address and Function Code are copied, and when communication is abnormal (function code or data code is illegal), bit 7 (= 80h) of Function Code is turned on and the error code is set to Data Bytes.

- Protocol details
  The four message fields will be explained below.

<table>
<thead>
<tr>
<th>Item</th>
<th>Check Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various monitors, run command set frequency (RAM)</td>
<td>&lt; 12ms</td>
</tr>
<tr>
<td>Parameter read/write, frequency setting (EEPROM)</td>
<td>&lt; 20ms</td>
</tr>
<tr>
<td>Parameter clear/all clear</td>
<td>&lt; 5ms</td>
</tr>
<tr>
<td>Reset command</td>
<td>No answer</td>
</tr>
</tbody>
</table>

The message frame consists of the four message fields as shown above.
By adding the no-data time (T1: Start, End) of 3.5 characters to the beginning and end of the message data, the slave recognizes it as one message.

- Data check time

<table>
<thead>
<tr>
<th>Item</th>
<th>Check Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Various monitors, run command set frequency (RAM)</td>
<td>12ms</td>
</tr>
<tr>
<td>Parameter read/write, frequency setting (EEPROM)</td>
<td>20ms</td>
</tr>
<tr>
<td>Parameter clear/all clear</td>
<td>5ms</td>
</tr>
<tr>
<td>Reset command</td>
<td>5s</td>
</tr>
</tbody>
</table>

By specifying address 0, the master can send a message to all slaves. All slaves that received the message from the master execute the requested function. In this communication, the slaves do not return a response to the master.

The slave executes the function independently of the Inverter station number setting [Pr. 117, 331] during broadcast communication.
The message formats corresponding to the function codes in Table 1 above will be explained.

- **Read holding register data (H03 or 03)**
  - Can read the description of 1) system environment variables, 2) real-time monitor, 3) faults history, and 4) inverter parameters assigned to the holding register area (refer to the register list (page 468)).

**Query message**

1) **Slave Address**
   - The address code is 1 byte long (8 bits) and any of 0 to 247 can be set. Set 0 to send a broadcast message (all-address instruction) or any of 1 to 247 to send a message to each slave.
   - The value set to [Pr. 117, 331] is the slave address.

2) **Function**
   - The function code is 1 byte long (8 bits) and any of 1 to 255 can be set. The master sets the function that it wants to request to the slave, and the slave performs the requested operation. The following table gives the supported function codes. An error response is returned if the set function code is other than those in the following table.
   - When the slave returns a normal response, it returns the function code set by the master. When the slave returns an error response, it returns H00 + function code.

3) **Starting Address**
   - Set the address at which holding register data read will be started.
   - Starting address = Starting register address (decimal) - 40001
   - For example, setting of the starting address 0001 reads the data of the holding register 40002.

4) **No. of Points**
   - Number of holding registers from which data will be read. The number of registers from which data can be read is a maximum of 125.

**Normal response (Response message)**

1) **Slave Address**
2) **Function**
3) **Byte Count**
4) **Data**
5) **CRC Check**

**Message setting**

1) **Slave Address**
   - The slave address to which a message will be sent. Broadcast communication cannot be made (0 is invalid).

2) **Function**
   - Set H03.

3) **Starting Address**
   - Set the address at which holding register data read will be started.
   - Starting address = Starting register address (decimal) - 40001

4) **No. of Points**
   - Number of holding registers from which data will be read. The number of registers from which data can be read is a maximum of 125.

---

### Table 1: Function code list

<table>
<thead>
<tr>
<th>Code</th>
<th>Function Name</th>
<th>Description</th>
<th>Broadcast Communication</th>
</tr>
</thead>
<tbody>
<tr>
<td>H03</td>
<td>Read Holding Register</td>
<td>Reads the holding register data</td>
<td>Disabled</td>
</tr>
<tr>
<td>H06</td>
<td>Preset Single Register</td>
<td>Write data to the holding register.</td>
<td>Enabled</td>
</tr>
<tr>
<td>H08</td>
<td>Diagnostics</td>
<td>Makes a function diagnosis. (communication check only)</td>
<td>Disabled</td>
</tr>
<tr>
<td>H10</td>
<td>Preset multiple registers</td>
<td>Write data to multiple consecutive holding registers.</td>
<td>Enabled</td>
</tr>
<tr>
<td>H46</td>
<td>Read Holding Register Access Log</td>
<td>Reads the number of registers that succeeded in communication last time.</td>
<td>Disabled</td>
</tr>
</tbody>
</table>

### Table 2: Message field

<table>
<thead>
<tr>
<th>Message field</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) ADDRESS field</td>
<td>The address code is 1 byte long (8 bits) and any of 0 to 247 can be set. Set 0 to send a broadcast message (all-address instruction) or any of 1 to 247 to send a message to each slave. When the slave responds, it returns the address set from the master. The value set to [Pr. 117, 331] is the slave address.</td>
</tr>
<tr>
<td>2) FUNCTION field</td>
<td>The function code is 1 byte long (8 bits) and any of 1 to 255 can be set. The master sets the function that it wants to request to the slave, and the slave performs the requested operation. The following table gives the supported function codes. An error response is returned if the set function code is other than those in the following table. When the slave returns a normal response, it returns the function code set by the master. When the slave returns an error response, it returns H00 + function code.</td>
</tr>
<tr>
<td>3) DATA field</td>
<td>The format changes depending on the function code. Data includes the byte count, number of bytes, description of access to the holding register, etc.</td>
</tr>
<tr>
<td>4) CRC CHECK field</td>
<td>The received message frame is checked for error. CRC check is performed, and 2 byte long data is added to the end of the message. When CRC is added to the message, the low-order byte is added first and is followed by the high-order byte. The CRC value is calculated by the sending side that adds CRC to the message. The receiving side recalculates CRC during message receiving, and compares the result of that calculation and the actual value received in the CRC CHECK field. If these two values do not match, the result is defined as error.</td>
</tr>
</tbody>
</table>

---

(5) **Message format types**

- Read holding register data (H03 or 03)
- Can read the description of 1) system environment variables, 2) real-time monitor, 3) faults history, and 4) inverter parameters assigned to the holding register area (refer to the register list (page 468)).
• Description of normal response

<table>
<thead>
<tr>
<th>Message</th>
<th>Setting Description</th>
</tr>
</thead>
</table>
| 5) Byte Count | The setting range is H02 to H14 (2 to 20).
| 6) Data | Twice greater than the No. of Point specified at 4) is set.

The number of data specified at 4) is set. Data are read in order of Hi-byte and Lo-byte, and set in order of starting address data, starting address + 1 data, starting address + 2 data.

Example) To read the register values of 41004 (Pr. 4) to 41006 (Pr. 6) from the slave address 17 (H11).

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Starting Address</th>
<th>No. of Points</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>H11 (8bit)</td>
<td>H03 (8bit)</td>
<td>H03 (8bit)</td>
<td>H00 (8bit)</td>
<td>H77 (8bit)</td>
</tr>
</tbody>
</table>

Normal response (Response message)

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Byte Count</th>
<th>Data</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>H11 (8bit)</td>
<td>H03 (8bit)</td>
<td>H06 (8bit)</td>
<td>H17 (8bit)</td>
<td>H0B (8bit)</td>
</tr>
</tbody>
</table>

Can write the description of 1) system environment variables and 4) inverter parameters assigned to the holding register area (refer to the register list (page 468)).

Example) To write the register data of 150 or (05) to a slave address 17 (H11).

<table>
<thead>
<tr>
<th>Message</th>
<th>Setting Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Slave Address</td>
<td>Set the address to which a message will be sent. Setting of address 0 enables broadcast communication.</td>
</tr>
<tr>
<td>2) Function</td>
<td>Set H06.</td>
</tr>
<tr>
<td>3) Register Address</td>
<td>Set the address of the holding register to which data will be written.</td>
</tr>
<tr>
<td>4) Preset Data</td>
<td>Register address = Holding register address (decimal) - 40001. For example, setting of register address 0001 writes data to the holding register address 40002.</td>
</tr>
<tr>
<td>5) CRC Check</td>
<td>Set the data that will be sent to the holding register. The written data is always 2 bytes.</td>
</tr>
</tbody>
</table>

Example) To write 0001 (H0001) to 40104 (running frequency RAM) at slave address 1 (H01).

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Register Address</th>
<th>Preset Data</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>H01 (8bit)</td>
<td>H06 (8bit)</td>
<td>H00 (8bit)</td>
<td>H17 (8bit)</td>
<td>H0B (8bit)</td>
</tr>
</tbody>
</table>

Normal response (Response message)

Same data as the query message.
A communication check can be made since the query message sent is returned unchanged as a response message (function of sub function code H00).

**Query message**

<table>
<thead>
<tr>
<th>1) Slave Address</th>
<th>2) Function</th>
<th>3) Sub function</th>
<th>4) Date</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8bit)</td>
<td>H08</td>
<td>H00</td>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

**Normal response (Response message)**

<table>
<thead>
<tr>
<th>1) Slave Address</th>
<th>2) Function</th>
<th>3) Sub function</th>
<th>4) Date</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8bit)</td>
<td>H08</td>
<td>H00</td>
<td>H</td>
<td>L</td>
</tr>
</tbody>
</table>

**Message setting**

<table>
<thead>
<tr>
<th>Message</th>
<th>Setting Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Slave address</td>
<td>Set the address to which a message will be sent. Broadcast communication cannot be made (0 is invalid).</td>
</tr>
<tr>
<td>2) Function</td>
<td>Set H08.</td>
</tr>
<tr>
<td>3) Sub function</td>
<td>Set H00.</td>
</tr>
<tr>
<td>4) Data</td>
<td>Any data can be set if it is 2 bytes long. The setting range is H0000 to HFFFF.</td>
</tr>
</tbody>
</table>

• Description of normal response

1) to 4) (including CRC check) of the normal response are the same as those of the query message. For broadcast communication, no response is returned in reply to a query. Therefore, the next query must be made when the inverter processing time has elapsed after the previous query.
Write multiple holding register data (H10 or 16)

You can write data to multiple holding registers.

Query message

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Starting Address</th>
<th>No. of Registers</th>
<th>Byte Count</th>
<th>Data</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H10</td>
<td>H L</td>
<td></td>
<td>H L</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Normal response (Response message)

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Starting Address</th>
<th>No. of Registers</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>H10</td>
<td>H L</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Query message setting

1) Slave Address
   Set the address to which a message will be sent. Setting of address 0 enables broadcast communication.

2) Function
   Set H10.

3) Starting Address
   Set the address where holding register data write will be started. Starting address = Starting register address (decimal) - 40001
   For example, setting of the starting address 0001 reads the data of the holding register 40002.

4) No. of Points
   Set the number of holding registers where data will be written. The number of registers where data can be written is a maximum of 125.

5) Byte Count
   The setting range is H02 to HFA (0 to 250). Set twice greater than the value specified at 4).

6) Data
   Set the data specified by the number specified at 4). The written data are set in order of Hi byte and Lo byte, and arranged in order of the starting address data, starting address + 1 data, starting address + 2 data...

Example: To write 0.5s (H05) to 41007 ([Pr. 7]) at the slave address 25 (H19) and 1s (H0A) to 41008 ([Pr. 8])

Query message

Normal response (Response message)
Read Holding Register Access Log (H46 or 70)

A response can be made to a query made by the function code H03, H10.

The starting address of the holding registers that succeeded in access during previous communication and the number of successful registers are returned.

In response to the query for other than the above function code, 0 is returned for the address and number of registers.

Query message

<table>
<thead>
<tr>
<th>1) Slave Address</th>
<th>2) Function</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8bit)</td>
<td>H46</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>(8bit)</td>
<td>H</td>
</tr>
</tbody>
</table>

Normal response (Response message)

<table>
<thead>
<tr>
<th>1) Slave Address</th>
<th>2) Function</th>
<th>3) Starting Address</th>
<th>4) No. of Points</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>(8bit)</td>
<td>H46</td>
<td>H</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td></td>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
</tr>
</tbody>
</table>

Example: To read the successful register starting address and successful count from the slave address 25 (H19).

Query message

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>H19</td>
<td>H10</td>
<td>H03</td>
</tr>
<tr>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
</tr>
</tbody>
</table>

Normal response (Response message)

<table>
<thead>
<tr>
<th>Slave Address</th>
<th>Function</th>
<th>Starting Address</th>
<th>No. of Points</th>
<th>CRC Check</th>
</tr>
</thead>
<tbody>
<tr>
<td>H19</td>
<td>H10</td>
<td>H03</td>
<td>HEE</td>
<td>H02</td>
</tr>
<tr>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
<td>(8bit)</td>
</tr>
</tbody>
</table>

Success of two registers at starting address 41007 (H-7) is returned.
An error response is returned if the query message received from the master has an illegal function, address or data.

No response is returned for a parity, CRC, overrun, framing or busy error.

No response message is sent in the case of broadcast communication also.

### Error response (Response message)

<table>
<thead>
<tr>
<th>Code</th>
<th>Error Item</th>
<th>Error Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>ILLEGAL FUNCTION (Function-code illegal)</td>
<td>The set function code in the query message from the master cannot be handled by the slave.</td>
</tr>
<tr>
<td>02</td>
<td>ILLEGAL DATA ADDRESS *1 (Address illegal)</td>
<td>The set register address in the query message from the master cannot be handled by the inverter. (No parameter, parameter read disabled, parameter write disabled)</td>
</tr>
<tr>
<td>03</td>
<td>ILLEGAL DATA VALUE (Data illegal)</td>
<td>The set data in the query message from the master cannot be handled by the inverter. (Out of parameter write range, mode specified, other error)</td>
</tr>
</tbody>
</table>

*1 An error will not occur in the following cases.
   1) Function code H03 (Read holding register data) When the No. of Points is 1 or more and there is one or more holding registers from which data can be read
   2) Function code H10 (Write multiple holding register data) When the No. of Points is 1 or more and there is 1 or more holding registers to which data can be written.

   Namely, when the function code H03 or H10 is used to access multiple holding registers, an error will not occur if a non-existing holding register or read disabled or write disabled holding register is accessed.

*2 An error will occur if all accessed holding registers do not exist.

*3 Data read from a non-existing holding register is 0, and data written there is invalid.

### Message data mistake detection

To detect the mistakes of message data from the master, the mistakes are checked for the following errors.

If an error is detected, a trip will not occur.

#### Error check item

<table>
<thead>
<tr>
<th>Error Item</th>
<th>Error Description</th>
<th>Inverter Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parity error</td>
<td>The data received by the inverter differs from the specified parity (Pr. 120, 134 setting).</td>
<td>1) [Pr. 145] is increased by 1 at error occurrence.</td>
</tr>
<tr>
<td>Framing error</td>
<td>The data received by the inverter differs from the specified stop bit length (Pr. 120, 134).</td>
<td>1) The terminal LF is output at error occurrence.</td>
</tr>
<tr>
<td>Overrun error</td>
<td>The following data was sent from the master before the inverter completes data receiving.</td>
<td>1) The terminal LF is output at error occurrence.</td>
</tr>
<tr>
<td>Message frame error</td>
<td>The message frame data length is checked, and the received data length of less than 4 bytes is regarded as an error.</td>
<td>1) The terminal LF is output at error occurrence.</td>
</tr>
<tr>
<td>CRC check error</td>
<td>A mismatch found by CRC check between the message frame data and calculation result is regarded as an error.</td>
<td>1) The terminal LF is output at error occurrence.</td>
</tr>
</tbody>
</table>
1) [Pr. 343 Communication error count]

You can check the cumulative number of communication errors by reading [Pr. 343]. The number of communication errors is temporarily stored into the RAM. As it is not stored into the EEPROM, performing a power supply reset or inverter reset clears the value to 0.

2) Output signal LF alarm output (communication error warnings)

During a communication error, the alarm signal (LF signal) is output by open collector output. Assign the used terminal with any of [Pr. 190 to Pr. 196 Output terminal function selection].

Modbus registers

- System environment variable
- Alarm data
- Normal data
- Reply data
- Master
- Slave

<table>
<thead>
<tr>
<th>Register</th>
<th>Definition</th>
<th>Read/Write</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>40002</td>
<td>Inverter reset</td>
<td>Write</td>
<td>Any value can be written</td>
</tr>
<tr>
<td>40003</td>
<td>Parameter read</td>
<td>Write</td>
<td>Set H965A as a written value</td>
</tr>
<tr>
<td>40004</td>
<td>All parameter clear</td>
<td>Write</td>
<td>Set H99AA as a written value</td>
</tr>
<tr>
<td>40005</td>
<td>Parameter clear</td>
<td>Write</td>
<td>Set H5A96 as a written value</td>
</tr>
<tr>
<td>40006</td>
<td>Inverter status and input instruction</td>
<td>Read/Write</td>
<td>See below</td>
</tr>
<tr>
<td>40007</td>
<td>Parameter clear</td>
<td>Write</td>
<td>Set H5A96 as a written value</td>
</tr>
<tr>
<td>40014</td>
<td>Running frequency (RAM value)</td>
<td>Read/Write</td>
<td>According to the [Pr. 37, Pr. 144] settings, the frequency and selectable speed are in 1r/min increments</td>
</tr>
<tr>
<td>40015</td>
<td>Running frequency (EEPROM value)</td>
<td>Write</td>
<td>*1 The communication parameter values are not cleared</td>
</tr>
</tbody>
</table>

*1 For write, set the data as a control input instruction. For read, data is read as an inverter operating status.

*2 The signal within parentheses is the default setting. Descriptions change according to the [Pr. 180 to Pr. 189 Input terminal function selection].

*3 These are not available for "M200".

*4 These are not available for "M105".

<Control input instruction>

<table>
<thead>
<tr>
<th>Bit</th>
<th>Control input instruction</th>
<th>Inverter status</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Stop command</td>
<td>RUN (inverter running)</td>
</tr>
<tr>
<td>1</td>
<td>Forward rotation command</td>
<td>Forward running</td>
</tr>
<tr>
<td>2</td>
<td>Reverse rotation command</td>
<td>Reverse running</td>
</tr>
<tr>
<td>3</td>
<td>RM (middle speed command)</td>
<td>W (at frequency)</td>
</tr>
<tr>
<td>4</td>
<td>DL (overload)</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RL (low speed command)</td>
<td>SF (mechanical power failure)</td>
</tr>
<tr>
<td>6</td>
<td>Stop operation</td>
<td>IM (frequency selection)</td>
</tr>
<tr>
<td>7</td>
<td>RT (second function selection)</td>
<td>AB1 (fault)</td>
</tr>
<tr>
<td>8</td>
<td>All (current input selection)</td>
<td>AB1 (fault)</td>
</tr>
<tr>
<td>9</td>
<td>Stop (deletion of automatic reset after instantaneous power failure)</td>
<td>0</td>
</tr>
</tbody>
</table>

<Operation mode/inverter setting>

<table>
<thead>
<tr>
<th>Mode</th>
<th>Read Value</th>
<th>Written Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXT</td>
<td>H0000</td>
<td>H0010</td>
</tr>
<tr>
<td>PU</td>
<td>H0001</td>
<td>---</td>
</tr>
<tr>
<td>EX</td>
<td>H0002</td>
<td>---</td>
</tr>
<tr>
<td>JOG</td>
<td>H0003</td>
<td>---</td>
</tr>
<tr>
<td>NET</td>
<td>H0004</td>
<td>H0014</td>
</tr>
<tr>
<td>PU+</td>
<td>H0005</td>
<td>---</td>
</tr>
</tbody>
</table>

*1 The signal within parentheses is the default setting. Descriptions change according to the [Pr. 180 to Pr. 189 Input terminal function selection].

*2 Each assigned signal is valid or invalid depending on NET. (Refer to page 440)

*3 These are not available for "M200".

*4 These are not available for "M105".

468
## Real-time Monitor
Refer to page 346 for details of the monitor description.

### Parameter Table

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>40201</td>
<td>Output frequency/speed</td>
<td>0.01Hz/1</td>
</tr>
<tr>
<td>40202</td>
<td>Output current</td>
<td>0.01A/1A</td>
</tr>
<tr>
<td>40203</td>
<td>Output voltage</td>
<td>0.1V</td>
</tr>
<tr>
<td>40204</td>
<td>Frequency setting value/speed</td>
<td>0.01Hz/1</td>
</tr>
<tr>
<td>40205</td>
<td>Running speed</td>
<td>1/min</td>
</tr>
<tr>
<td>40206</td>
<td>Motor torque</td>
<td>0.1</td>
</tr>
<tr>
<td>40207</td>
<td>Converter output voltage</td>
<td>0.1V</td>
</tr>
<tr>
<td>40208</td>
<td>Regenerative brake duty</td>
<td>0.1</td>
</tr>
<tr>
<td>40210</td>
<td>Electronic thermal relay (function load factor)</td>
<td>0.1</td>
</tr>
<tr>
<td>40211</td>
<td>Input terminal peak value</td>
<td>0.01A/1A</td>
</tr>
<tr>
<td>40212</td>
<td>Converter output voltage peak value</td>
<td>0.1V</td>
</tr>
<tr>
<td>40213</td>
<td>Input power</td>
<td>0.1kW</td>
</tr>
<tr>
<td>40214</td>
<td>Output power</td>
<td>0.1kW</td>
</tr>
<tr>
<td>40215</td>
<td>Input terminal status</td>
<td></td>
</tr>
<tr>
<td>40216</td>
<td>Output terminal status</td>
<td></td>
</tr>
<tr>
<td>40217</td>
<td>Load current</td>
<td>0.1A</td>
</tr>
<tr>
<td>40218</td>
<td>Motor acceleration current</td>
<td>0.01A/1A</td>
</tr>
<tr>
<td>40219</td>
<td>Position pulse</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Register</th>
<th>Description</th>
<th>Increments</th>
</tr>
</thead>
<tbody>
<tr>
<td>40220</td>
<td>Cumulative energization time</td>
<td>1s</td>
</tr>
<tr>
<td>40221</td>
<td>Orientation status</td>
<td></td>
</tr>
<tr>
<td>40222</td>
<td>Actual operation time</td>
<td>1s</td>
</tr>
<tr>
<td>40223</td>
<td>Motor fault status</td>
<td></td>
</tr>
<tr>
<td>40224</td>
<td>Cumulative power</td>
<td>kW</td>
</tr>
<tr>
<td>40225</td>
<td>Torque command</td>
<td></td>
</tr>
<tr>
<td>40226</td>
<td>Torque command</td>
<td></td>
</tr>
<tr>
<td>40234</td>
<td>Motor output</td>
<td>0.01A/1A</td>
</tr>
<tr>
<td>40235</td>
<td>Feedback pulse</td>
<td></td>
</tr>
<tr>
<td>40236</td>
<td>Power saving effect</td>
<td></td>
</tr>
<tr>
<td>40237</td>
<td>Power saving effect</td>
<td></td>
</tr>
<tr>
<td>40238</td>
<td>Input terminal status</td>
<td></td>
</tr>
<tr>
<td>40239</td>
<td>Output terminal status</td>
<td></td>
</tr>
<tr>
<td>40240</td>
<td>Motor Thermal load factor</td>
<td></td>
</tr>
<tr>
<td>40240</td>
<td>Motor Thermal load factor</td>
<td></td>
</tr>
<tr>
<td>40240</td>
<td>Cumulative power</td>
<td>0.01kW</td>
</tr>
<tr>
<td>40240</td>
<td>Cumulative power</td>
<td></td>
</tr>
<tr>
<td>40240</td>
<td>Cumulative power</td>
<td></td>
</tr>
<tr>
<td>40240</td>
<td>Cumulative power</td>
<td>0.01kW</td>
</tr>
</tbody>
</table>

*1 The setting depends on the inverter capacity. (55K or less/75K or more)

*2 Input terminal monitor details

<table>
<thead>
<tr>
<th>b15</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RES</td>
<td>MRS</td>
</tr>
<tr>
<td>JOY</td>
<td>RRM</td>
</tr>
<tr>
<td>RM</td>
<td>RL</td>
</tr>
<tr>
<td>AU</td>
<td>STR</td>
</tr>
<tr>
<td>STF</td>
<td></td>
</tr>
</tbody>
</table>

*3 Output terminal monitor details

<table>
<thead>
<tr>
<th>b15</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td></td>
</tr>
</tbody>
</table>

*4 Details of option input terminal monitor 1 (input terminal status of FR-A7AX) all terminals are OFF when an option is not fitted

<table>
<thead>
<tr>
<th>b15</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td></td>
</tr>
</tbody>
</table>

*5 Details of option input terminal monitor 2 (input terminal status of FR-A7AX) all terminals are OFF when an option is not fitted

<table>
<thead>
<tr>
<th>b15</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td></td>
</tr>
</tbody>
</table>

*6 Details of option output terminal monitor (output terminal status of FR-A7AY/A7AR) all terminals are OFF when an option is not fitted

<table>
<thead>
<tr>
<th>b15</th>
<th>b0</th>
</tr>
</thead>
<tbody>
<tr>
<td>RUN</td>
<td></td>
</tr>
</tbody>
</table>

*7 These are not available for A700

*8 These are not available for F700

*9 These are not available for E700

---

469
### Parameter

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Read/Write</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refer to the parameter list (page 120) for the parameter names.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>The parameter number + 41000 is the register number.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C2 (902)</strong></td>
<td>41002</td>
<td>Terminal 2 frequency setting bias (frequency)</td>
</tr>
<tr>
<td><strong>C3 (902)</strong></td>
<td>42002</td>
<td>Terminal 2 frequency setting bias (analog value)</td>
</tr>
<tr>
<td><strong>D700</strong></td>
<td></td>
<td>Analog value (%) set to ( \frac{C2 \cdot 1000}{10000} ) is read.</td>
</tr>
<tr>
<td><strong>E700</strong></td>
<td></td>
<td>Analog value (%) of the voltage (current) applied to terminal 2 is read.</td>
</tr>
<tr>
<td><strong>F700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>C4 (902)</strong></td>
<td>Terminal 2 frequency setting gain (frequency)</td>
</tr>
<tr>
<td><strong>C5 (902)</strong></td>
<td>43002</td>
<td>Terminal 2 frequency setting gain (analog value)</td>
</tr>
<tr>
<td><strong>C6 (902)</strong></td>
<td></td>
<td>Analog value (%) of the voltage (current) applied to terminal 2 is read.</td>
</tr>
<tr>
<td><strong>D700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>E700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>F700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>A700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>G700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>H700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>I700</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>C12 (917)</strong></td>
<td>41917</td>
<td>Terminal 1 bias frequency (speed)</td>
</tr>
<tr>
<td><strong>C13 (917)</strong></td>
<td>42107</td>
<td>Terminal 1 bias (speed)</td>
</tr>
<tr>
<td><strong>C14 (918)</strong></td>
<td>41918</td>
<td>Terminal 1 gain frequency (speed)</td>
</tr>
<tr>
<td><strong>C15 (918)</strong></td>
<td>43018</td>
<td>Terminal 1 gain (speed) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C16 (919)</strong></td>
<td>41919</td>
<td>Terminal 1 bias command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C17 (919)</strong></td>
<td>43019</td>
<td>Terminal 1 bias (torque/magnetic flux) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C18 (920)</strong></td>
<td>41920</td>
<td>Terminal 1 gain command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C19 (920)</strong></td>
<td>43020</td>
<td>Terminal 1 gain (torque/magnetic flux) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C20 (921)</strong></td>
<td>41921</td>
<td>Terminal 2 bias command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C21 (921)</strong></td>
<td>43021</td>
<td>Terminal 2 bias (torque/magnetic flux) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C22 (922)</strong></td>
<td>41922</td>
<td>Terminal 2 gain command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C23 (922)</strong></td>
<td>43022</td>
<td>Terminal 2 gain (torque/magnetic flux) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C24 (923)</strong></td>
<td>41923</td>
<td>Terminal 3 gain command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C25 (923)</strong></td>
<td>43023</td>
<td>Terminal 3 gain (torque/magnetic flux) (terminal analog value)</td>
</tr>
<tr>
<td><strong>C26 (924)</strong></td>
<td>41924</td>
<td>Terminal 4 gain command (torque/magnetic flux)</td>
</tr>
<tr>
<td><strong>C27 (924)</strong></td>
<td>43024</td>
<td>Terminal 4 gain (torque/magnetic flux) (terminal analog value)</td>
</tr>
</tbody>
</table>

*1 Increment is 1 when \( \text{Pr. 37} \geq 1 \) to 9998 or \( \text{Pr. 144} \geq 2 \) to 10, 102 to 110 in (E700) (F700). Increment is 1 when \( \text{Pr. 37} \geq 0.01 \) to 9998 in (E700) (F700).

*2 These are not available for (E700) (F700).

*3 These are not available for (E700) (F700).

*4 These are not available for (E700) (F700).

*5 These are not available for (E700) (F700).

*6 These are not available for (E700) (F700).

*7 These are not available for (E700) (F700).

*8 These are not available for (E700) (F700).

*9 These are not available for (E700) (F700).

*10 These are not available for (E700) (F700).

*11 These are not available for (E700) (F700).
PARAMETER

Faults history
Refer to page 97 for details of fault definition.

<table>
<thead>
<tr>
<th>Register</th>
<th>Definition</th>
<th>Read/write</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>40500</td>
<td>Faults history 1</td>
<td>Read/Write</td>
<td>Since data is 2 bytes in length, it is stored as H00. The error code can be referred to in the low-order 1 byte.</td>
</tr>
<tr>
<td>40501</td>
<td>Faults history 2</td>
<td>Read</td>
<td>Performing write using the register 40501 batch-clears the faults history.</td>
</tr>
<tr>
<td>40502</td>
<td>Faults history 3</td>
<td>Read</td>
<td>Set any value as data.</td>
</tr>
<tr>
<td>40503</td>
<td>Faults history 4</td>
<td>Read</td>
<td></td>
</tr>
<tr>
<td>40504</td>
<td>Faults history 5</td>
<td>Read</td>
<td></td>
</tr>
<tr>
<td>40505</td>
<td>Faults history 6</td>
<td>Read</td>
<td></td>
</tr>
<tr>
<td>40506</td>
<td>Faults history 7</td>
<td>Read</td>
<td></td>
</tr>
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*1 These are not available for P/T/0/0/0.
*2 These are not available for P/T/0/0/0.
*3 These are not available for P/T/0/0/0.
*4 These are not available for P/T/0/0/0.
(7) **Signal loss detection** [Pr. 122, 539]

If a signal loss (communication stop) is detected in the signal loss detection performed between the inverter and computer, communication error (E.SER) occurs, and the inverter output is shut off. (It depends on the [Pr. 502] setting.)

A signal loss detection is made when the setting is any of 0.1 to 999.8s. To make a signal loss detection, it is necessary to send data from within the communication check time interval.

When the setting is 9999, communication check (signal loss detection) is not made.

If communication is broken due to signal cable breakage, computer fault etc., the inverter does not detect such a fault. This should be fully noted.

It is recommended to set the communication check time interval before starting operation to prevent hazardous conditions.

When the setting is 0 (initial value) in [Pr. 502], monitoring and parameter read are available. However, communication error (E.SER) would occur if operation mode is switched to the Network operation mode.

When the setting is 0 (initial value) in [Pr. 539], operation mode External NET, communication from RS-485 can be performed, however, communication error (E.PUE) would occur if switched to another operation mode with command source (NET mode at initial setting).
2.21.7 USB communication [Pr. 547, 548] (A700) (E700)

Connect the inverter and PC with USB cable and use FR Configurator to make the inverter setup easily.

A personal computer and inverter can be easily connected with one USB cable.

Set [Pr. 551 PU mode operation command source selection =3] to use USB communication in A700. (Refer to page 436 for details)

Refer to the instruction manual for details of FR Configurator.

It is recommended to fit a ferrite core to the USB cable to reduce the effect of noises from the inverter.

### USB communication specifications

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<td>Maximum 5m</td>
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<tr>
<td>Power Supply</td>
<td>Self-power supply</td>
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### A700 USB communication specifications

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<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
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<td>0 to 31</td>
<td>Specifies the inverter station number.</td>
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<tr>
<td>Pr. 548</td>
<td>9999</td>
<td>0 to 9999</td>
<td>USB communication is enabled. However, the inverter will come to an alarm stop (E. USB) if operation is changed to PU operation mode.</td>
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### E700 USB communication specifications

<table>
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<th>Name</th>
<th>Initial Value</th>
<th>Setting Range</th>
<th>Description</th>
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<td>0 to 31</td>
<td>Specifies the inverter station number.</td>
</tr>
<tr>
<td>Pr. 548</td>
<td>9999</td>
<td>0 to 9999</td>
<td>USB communication is enabled. However, the inverter will come to an alarm stop (E. USB) if operation is changed to PU operation mode.</td>
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Information on the connection cable for E700

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<th>Inverter Type</th>
<th>Application/Specifications</th>
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<tbody>
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<td>Connector for amplifier mini-B connector (5 pin)</td>
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<td>Cable length 3m</td>
<td>Connector for personal computer A connector</td>
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</tbody>
</table>

---

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3 SELECTION

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### 3.1 Inverter selection

#### 3.1.1 Principle and control method of the inverter (Common)

##### (1) Principle

The inverter rectifies commercial power into a DC Voltage once in the converter circuit and converts it into an AC Voltage of desired frequency in the inverter circuit.

The speed \( N \) of the induction motor is expressed by the following formula:

\[
N = \frac{120 \times 60 \times f}{P} \times (1 - S) \quad [r/min]
\]

Where \( S \) is motor slip

- By changing the frequency \( f \) with the inverter, the motor speed can be changed freely.
- Actually, when the frequency \( f \) is changed, the output voltage \( V \) is also changed to produce a sufficient motor torque.

##### (2) Control Method

1) **V/F control**

When changing the frequency \( f \), the inverter controls to make the ratio \( \frac{V}{f} \) of output frequency \( f \) to output voltage \( V \) constant.

This method is the basic inverter control method and called V/F control. In this method, a sufficient torque will not be developed since the actual effective voltage decreases due to a voltage drop in the wiring and motor's primary winding. This phenomenon has greater influence as the speed gets lower. (Low-speed torque will be short)

Hence, a voltage drop is pre-estimated to increase the voltage \( (\text{torque boost}*) \) as indicated by the continuous line in the figure below to compensate for the torque shortage at low speed.

To make up for this disadvantage, we developed **Advanced magnetic flux vector control** and **Real sensorless vector control**.

* If the torque boost is too large, the torque is developed sufficiently but an excessive current flows, causing the inverter to be more easily resulting in an overcurrent (OCT) trip.

#### Comparison between Mitsubishi Inverter Control Method

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<thead>
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<th>Item</th>
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<th>Simple Magnetic Flux Vector Control</th>
<th>General-Purpose Magnetic Flux Vector Control</th>
<th>Advanced Magnetic Flux Vector Control</th>
<th>Real Sensorless Vector Control</th>
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<td>Standard motor (Mitsubishi, others)</td>
<td>Standard motor (Mitsubishi, others)</td>
<td>Standard motor (Mitsubishi, others)</td>
<td>Standard motor (Mitsubishi, others)</td>
<td>Standard motor (Mitsubishi, others)</td>
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<td>Graded</td>
<td>Graded</td>
<td>Graded</td>
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<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
</tr>
<tr>
<td>Starting torque low-speed torque</td>
<td>In: 30% or less 3Hz: 30% (when slip compensation is set)</td>
<td>In: 30% 3Hz: 60% (when slip compensation is set)</td>
<td>In: 150% 3Hz: 60% (when slip compensation is set)</td>
<td>0.8Hz: 150%</td>
<td>0.6Hz: 200%/150% (3.7kW or less/5.5kW or more)</td>
<td>1.0Hz: 200%</td>
</tr>
<tr>
<td>Speed detection</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
<td>Not necessary</td>
</tr>
<tr>
<td>Speed control range</td>
<td>1: 10</td>
<td>1: 15</td>
<td>1: 15</td>
<td>1: 15</td>
<td>1: 20</td>
<td>1: 20</td>
</tr>
<tr>
<td>Speed variation ratio</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
<td>0.5%</td>
</tr>
<tr>
<td>Torque control</td>
<td>Graded</td>
<td>Graded</td>
<td>Graded</td>
<td>Graded</td>
<td>Graded</td>
<td>Graded</td>
</tr>
<tr>
<td>Torque control 120Hz</td>
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<td>Graded</td>
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<tr>
<td>Torque response load</td>
<td>10 to 30kNm</td>
<td>20 to 30kNm</td>
<td>20 to 30kNm</td>
<td>20 to 30kNm</td>
<td>120kNm</td>
<td>120kNm</td>
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<tr>
<td>Applications</td>
<td>Fan, pump, General industrial machines, etc.</td>
<td>Fan, pump, General industrial machines, etc.</td>
<td>General industrial machines, transfer machines, lift applications, etc.</td>
<td>General industrial machines, transfer machines, lift applications, etc.</td>
<td>Transfer machines, lift application line control, etc.</td>
<td>Transfer machines, lift application line control, etc.</td>
</tr>
<tr>
<td>Applicable Inverters</td>
<td>(F700) (E700) (D700) (A700) (E700) (A700)</td>
<td>(A700) (E700) (A700)</td>
<td>(A700) (E700) (A700)</td>
<td>(A700) (E700) (A700)</td>
<td>(A700) (E700) (A700)</td>
<td>(A700) (E700) (A700)</td>
</tr>
</tbody>
</table>

* When the torque boost is too large, the torque is developed sufficiently but an excessive current flows, causing the inverter to be more easily resulting in an overcurrent (OCT) trip.
2) Simple magnetic flux vector control

This control method divides inverter output current by vector calculation, and compensates for amount of voltage drop which causes torque decrease. Comparing with V/F control, higher torque at low speed range is available. To compensate the speed variation, use slip compensation (Pr. 245 to Pr. 247).

3) General-purpose magnetic flux vector control

The output current of the inverter is divided into an exciting current and a torque current by vector operation and the voltage is compensated for to flow a motor current which meets the load torque, thereby improving the low-speed torque. This control method provides a high torque of 200% (3.7K or more) at 6Hz.

If the motor constants vary slightly (when the inverter is used with the another manufacturers motor, for example), this system provides a stable, large, low-speed torque without specific motor constant setting or tuning, achieving high versatility. Offline auto tuning can be performed to run the motor with the optimum characteristic.

When the motor current varies due to load fluctuation, the voltage drop of the motor's primary side (including the wiring) also changes, affecting the magnitude of the exciting current. This voltage drop is found from the motor and primary wiring constants and torque current magnitude, and the output voltage of the inverter is compensated for (increased/decreased) to keep the primary magnetic flux of the motor constant. Also, the motor speed varies with load fluctuation. You can choose the slip compensation function (Pr. 245 to 247) which estimates the motor slip from the output current of the inverter to keep the motor speed constant. (The control method is different from Advanced magnetic flux vector control.)

At this time, the torque characteristic is as shown on the below.

---

### Speed-Torque Characteristic Example for General-Purpose Magnetic Flux Vector Control

**Use of inverter with 0.75kW 4-pole motor**

(a) General-purpose magnetic flux vector control

(b) V/F control

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**Speed-Torque Characteristic Example for General-Purpose Magnetic Flux Vector Control when Slip Compensation Is Selected**

(Use of inverter with 0.75kW 4-pole motor)
4) Advanced magnetic flux vector control

The output current of the inverter is divided into an excitation current and a torque current by vector operation, and the frequency and voltage are compensated to flow a motor current which meets a load torque, thereby improving a low speed torque and speed accuracy. This method provides a high (150%) torque at 0.5Hz.

The actual motor speed is estimated from the torque current and the output frequency is compensated for (increased/decreased) to achieve the preset speed. (Slip compensation)

When the motor current varies due to load fluctuation, the voltage drop of the motor's primary side (including the wiring) also changes, affecting the magnitude of the excitation current. This voltage drop is found from the motor and primary wiring constants of the motor and torque current magnitude, and the output voltage of the inverter is compensated for (increased/decreased) to keep the primary magnetic flux of the motor constant.

Also, when the online auto tuning is selected in A700, the motor is tuned quickly when starting, allowing high-accuracy operation unaffected by motor temperatures and high-torque, stable operation down to an ultra-low speed.

The motor temperature-speed fluctuation characteristic example is shown below.

Motor temperature-speed fluctuation characteristic example
(when the motor SF-JR 4P 3.7kW is used)
(Online auto tuning selected, repeated operation at 90% duty)

Speed-torque characteristic example for Advanced magnetic flux vector control
(online auto tuning selected, inverter used with 3.7kW 4-pole motor)
5) Real sensorless vector control (A700)

Real sensorless vector control is a control method which estimates the motor speed from the motor constants, voltage, and current without using an encoder (with a standard motor without encoder). The response and characteristics at nearly zero speed are low as compared to vector control using a motor with encoder.

Real sensorless vector control is the control method which divides the inverter output current into an excitation current and a torque current by vector calculation, and improves low speed torque, speed control range, and speed response by controlling frequency and voltage optimally to flow a motor current which meets the load torque, achieving maximum of 200% (3.7kW or less) high torque at 0.3Hz.

It responds to the load variation quickly (high response) by torque current control, and torque control is also enabled by giving torque command.

To help explain vector control, the fundamental equivalent circuit of an induction motor is shown below:

In the above diagram, currents flowing in the induction motor can be classified into a current id (excitation current) for making a magnetic flux in the motor and a current iq (torque current) for causing the motor to develop a torque. With Real sensorless vector control, inverter controls the motor so that the excitation current and torque current to flow to the optimum by calculating the voltage and output frequency. Control block diagram is shown on the next page.

Motor-generated torque TM, slip angular velocity ωs and the motor's secondary magnetic flux ϕ can be found by the following calculation:

\[
TM = 0.2 \times iq \\
\omega_s = M \times id \\
\phi = \frac{\omega_s}{s} 
\]

where, \(L_2 = \text{secondary inductance} \)

\[L_2 \times \omega_s = M\]

Example of torque characteristic

For the motor SF-JR 4P (at 220V input)

Example of torque limit characteristic

SF-JR 4P 3.7kW motor

Also, when the online auto tuning is selected, the motor is tuned quickly when starting, allowing high-accuracy operation unaffected by motor temperatures and high-torque, stable operation down to an ultra-low speed.
Since the current control loop is configured same as the vector control with encoder, necessary excitation current (current required to generate magnetic flux) and torque current (current proportional to the load torque) can be calculated separately by using the speed estimated value found by the motor current and output voltage as the speed feedback value.

[Speed control]
Speed control operation is performed to zero the difference between the speed command $\omega^*$ and speed estimated value $\omega_{FB}$. At this time, the motor load is found and its result is transferred to the torque current controller as a torque current command $iq^*$.

[Torque current control]
A voltage ($Vq$) is calculated for the current ($iq$) to flow identical to the torque current command ($iq^*$) found by the speed controller.

[Magnetic flux control]
The magnetic flux $\phi_2$ of the motor is derived from the excitation current $id$. An excitation current command ($id^*$) is calculated for the motor magnetic flux $\phi_2$ to be the predetermined magnetic flux.

[Excitation current control]
A voltage ($Vd$) is calculated to flow a current $id$ which is identical to the excitation current command ($id^*$) found by magnetic flux control.

[Output frequency calculation]
Motor slip $\omega_s$ is calculated on the basis of the torque current value $iq$ and magnetic flux $\phi_2$. Output frequency $\omega_0$ is found by adding the slip amount $\omega_s$ to the speed estimated value $\omega_{FB}$.

The above results are used to make PWM modulation and run the motor.
6) Vector control

This method divides the currents flowing in the motor into a current for making a magnetic flux in the motor and a current for causing the motor to develop a torque, and controls each current separately. Therefore very high response is obtained and torque at low speed can be generated stably.

It is necessary to know the motor speed to perform this control and a motor with an encoder and a plug-in option FR-A7AP or FR-A7AL are required.

It responds to the load variation quickly (high response) by torque current control, and torque control is also enabled by giving torque command. It has excellent control characteristics and achieves the control characteristics equal to those of DC machines.

To help explain vector control, the fundamental equivalent circuit of an induction motor is shown below:

\[ T_M = 9.2 \times \phi_2 \]

where, \( L_2 = \text{secondary inductance} \)
\[ \phi_2 = 2 + M \]

Vector control requires a dedicated motor with less constants variation and high accuracy encoder (speed detector) to calculate with high accuracy.

Although torque accuracy decreases, vector control can be performed by fitting an encoder to the standard motor.

When magnetic flux observer is selected, the magnetic flux of the motor is always detected with high accuracy so that an excellent characteristic is provided regardless of the change in the temperature of the motor secondary resistance.

Motor-generated torque \( T_M \), slip angular velocity \( \Delta \) and the motor's secondary magnetic flux \( \phi_2 \) can be found by the following calculation:

Control block diagram is shown on the next page.
By detecting the motor speed with an encoder and computing the motor slip, the magnitude of the load can be found.

With the magnitude of the load found, the inverter output current is divided into an excitation current (current required to generate magnetic flux) and torque current (current proportional to the load torque) by vector operation, and frequency and voltage are controlled optimally to flow a current necessary for each. Since vector control has a current control loop, necessary excitation current and torque current can be calculated separately.

**[Speed control]**

Speed control operation is performed to zero the difference between the speed command \( \omega^* \) and actual rotation detection value \( \omega_{FB} \) by the encoder. At this time, the motor load is found and its result is transferred to the torque current controller as a torque current command \( iq^* \).

**[Torque current control]**

A voltage \( Vq \) is calculated to start a current \( iq \) which is identical to the torque current command \( iq^* \) found by speed controller.

**[Magnetic flux control]**

The magnetic flux \( \phi_2 \) of the motor is derived from the excitation current \( id \). An excitation current command \( (id^*) \) is calculated for the motor magnetic flux \( \phi_2 \) to be the predetermined magnetic flux.

**[Excitation current control]**

A voltage \( (Vd) \) is calculated to start a current \( id^* \) which is identical to the excitation current command \( (id^*) \) found by magnetic flux control.

**[Output frequency calculation]**

Motor slip \( s \) is calculated on the basis of the torque current value \( iq \) and magnetic flux \( \phi_2 \). The output frequency \( \omega_0 \) is found by adding that slip \( s \) to the feedback \( \omega_{FB} \) found by a feedback from the encoder.

The above results are used to make PWM modulation and run the motor.
3.1.2 Rated inverter capacity  common

Rated capacity of the inverter is calculated based on the rated output current.

\[
\text{Rated inverter capacity (kVA)} = \sqrt{3} \times \text{output voltage (V)} \times \text{Rated output current (A)} \times 10^{-3}
\]

The rated output current is a current value which the inverter can output continuously at the rated output voltage. The inverter must always be used at no more than this current value.

The overload capacity is defined as the permissible value of a current beyond the rated output current of the inverter. The overload capacity of the inverter is 150% for one minute and of the is 120% for one minute. At a start or for instantaneous overload, the inverter must be used at not more than the overload capacity.

The capacity of the inverter is classified by the rated motor output (kW). This rated capacity applies to the operation of one general-purpose squirrel-cage induction motor of two to six poles especially when there are no limits on acceleration time and starting torque. The suitable capacity must be selected when running a special motor or driving several motors in parallel by one inverter, or when an operation pattern or load torque has been specified.

1) Operation of one motor

Select the inverter to satisfy the following condition:

\[
\text{Rated inverter output current} \geq \text{rated motor current} \times 1.1
\]

(The current that flows when a standard motor is driven by the inverter is about 1.1 times larger than the current that flows when the motor is run with the commercial power supply.)

When the inverter is used continuously at rated torque at 50Hz, note the permissible continuous torque of the motor. For more information, refer to the catalog of the corresponding inverter series.

2) Operation of two or more motors

When two or more motors are connected to one inverter and the output side magnetic contactor is used to start/stops the motors during inverter operation, the inverter capacity selection depends on how to start the motor.

1) Simultaneous start

When two or more motors are always switched On-OFF at the same time, select the inverter to satisfy the following condition:

\[
\text{Rated inverter output current} \geq \sum \text{rated currents of all motors} \times 1.1
\]

[Example] Operation of three SF-JR 1.5kW 4-pole motors (rated current 6.0A, starting current 48.4A)

Select the FR-A720-5.5K inverter rated at (6.0A \times three motors \times 1.1 = 19.8A) or more and having current limit function.

When two or more motors are always switched On-OFF at the same time, select the inverter to satisfy the following condition:

\[
\text{Rated inverter output current} \geq \sum \text{rated currents of all motors} \times 1.1
\]

[Example] Operation of three SF-JR 1.5kW 4-pole motors (rated current 6.0A, starting current 48.4A)

Select the FR-A720-5.5K inverter rated at (6.0A \times three motors \times 1.1 = 19.8A) or more and having current limit function.

When motors are started from the first one

When the current limit function is activated, the frequency changes abruptly. In a sequential start, therefore, the speeds of the motors already started change suddenly. Therefore, select according to the machine specifications.

- When it is not desired to affect the motors already started

Select the inverter so that the starting current of the motor is 6 to 8 times greater than the rated current of the motor.

[Example] Operation of three SF-JR 1.5kW 4-pole motors (rated current 6.0A, starting current 48.4A)

- When the fast-response current limit function of the inverter is utilized to minimize the inverter capacity

Rated inverter output current ≥ sum of rated currents of motors already started \times 1.1

* Motor starting current of motor started last

* Motor starting current: Select the inverter so that the starting current of the motor is 6 to 8 times greater than the rated current of the motor.

* Motor starting current: Select the inverter so that the starting current of the motor is 6 to 8 times greater than the rated current of the motor.

* Motor starting current: Select the inverter so that the starting current of the motor is 6 to 8 times greater than the rated current of the motor.

3.2 Selection of an inverter with a DC link capacitor

When the starting current of the motor is high, select the inverter with a DC link capacitor.
(3) Light motor load

If the load is extremely light as compared to the rated torque of the motor used, the motor current is smaller than the rated current. Hence, cost may be reduced by using an inverter having a smaller rated capacity than the motor capacity. In this case, the following must be noted in determining the rated inverter capacity.

An excitation current (no-load current), 30 to 50% of the rated motor current, flows in a standard motor, even if under no load. For this reason, an inverter with extremely small rated capacity cannot be used. Under a light load, the ripple factor of the current is higher than that under a rated load even if the effective current value is the same. Since the inverter detects the instantaneous orient value of the motor current to provide protection against overcurrent, the current limit function may be activated at the orient value due to a ripple even if the effective current value is small.

For light-load operation, therefore, it is the best policy to select the inverter capacity which corresponds to the capacity of the motor used.

(4) Special motor (e.g., constant-torque motor dedicated to inverter use)

Special motors are different in motor electrical circuit constants from a standard motor. A motor dedicated to inverter for increased torque at low frequency may be more instable in motor characteristic or be larger in current ripple especially in the low frequency range (about 20Hz or less). When the inverter is used with such a special motor (different in electrical design from the standard motor), select the inverter capacity after fully checking the motor characteristics, noting the following:

1) Choose the inverter capacity one or two ranks higher than the standard.
2) Match the V/F pattern with the motor characteristic using \[ Pr.0 \] (torque boost).

(5) For selection of the Simple magnetic flux vector control method \[ (7F0) \]

Select Simple magnetic flux vector control when higher torque than V/F control is necessary in the low speed range.

Simple magnetic flux vector control may be used under the following conditions:

1) The number of motor poles should be any of 2, 4 and 6 poles.
2) Single-motor operation (one motor run by one inverter) should be performed.
3) The wiring length from inverter to motor should be within 30m.

(6) For selection of the General-purpose magnetic flux vector control method \[ (7F0) \]

Select the General-purpose magnetic flux vector control when you need a large starting torque (3Hz 200% torque (slip compensation is set for 3.7K or less)) for a small capacity or when it is desired to shorten the acceleration time.

When choosing the General-purpose magnetic flux vector control, set the capacity (kW) of the applied motor. (For \[ (7F0) \], set number of motor poles and control method.)

When using a constant-torque motor, select a constant-torque motor in \[ Pr.7 \] (applied motor voltage).

When using the General-purpose magnetic flux vector control, there are the following restrictions:

1) Motor of which capacity is equal to or one rank lower than the inverter capacity.
2) Single-motor operation (one motor is run by one inverter).
3) The wiring length from the inverter to the motor should be within 30m. (When the wiring length exceeds 30m, perform offline auto tuning with wires already in place.)

If any of the above conditions are not satisfied, excellent operation characteristics may not be provided.

(7) For selection of the Advanced magnetic flux vector control method \[ (7F0) \]

Select the Advanced magnetic flux vector control for a load which requires a large starting torque (0.5Hz 150% torque) or a load which requires a 130 to 140% average acceleration torque to decrease the acceleration time.

Advanced magnetic flux vector control may be used under the following conditions:

1) Motor to be used is either Mitsubishi standard motor (SF-JR, SF-JRHR two-pole, four-pole, six-pole 0.4kW or more) or Mitsubishi constant torque motor (SF-JRCA, SF-HRCA four-pole 0.4kW to 5kW). When using a motor other than the above (other manufacturer's motor, SF-JRC, etc.), perform offline auto tuning without fail.
2) The motor capacity should be equal to or one rank lower than the inverter capacity.
3) Single-motor operation (one motor run by one inverter) should be performed.
4) The wiring length from inverter to motor should be within 30m. (Perform offline auto tuning in the state where wiring work is performed when the wiring length exceeds 30m.)

(8) For selection of the Real sensorless vector control \[ (AX0) \]

Select Real sensorless vector control for a load which requires a quick response to the sudden load fluctuation and torque limit during speed control operation.

Real sensorless vector control may be used under the following restriction, conditions.

1) Make sure to perform offline auto tuning before performing Real sensorless vector control.
2) Torque control can not be performed in the low speed regeneration range and at a low speed with light load. In this case, select vector control.
3) Performing pre-excitation (LX signal and X13 signal) under torque control may start the motor running at a low speed even when the start signal (STF or STR) is not input. The motor may run also at a low speed when the speed limit value = 0 with a start command input. Perform pre-excitation after making sure that there will be no problem in safety if the motor runs.

4) Do not switch between the forward rotation command (STF) and reverse rotation command (STR) during operation under torque control. Overcurrent trip (E.OC1 to 3) or opposite rotation deceleration fault (E.11) occurs.

5) For the 0.4kW to 3.7kW, the speed deviation may become large at 20Hz or less and torque may become insufficient in the low speed range under 11Hz during continuous operation under Real sensorless vector control. In this case, stop once and accelerate again to improve.

6) When the inverter is likely to start during motor coasting under Real sensorless vector control, set to make frequency search of automatic restart after instantaneous power failure valid [Pr. 57 ≠ 9999, Pr. 162 = 10].

7) The motor capacity should be equal to or one rank lower than the inverter capacity. (note that the capacity should be 0.4kW or more)

8) Single-motor operation (one motor run by one inverter) should be performed.

9) For selection of the vector control

For a load which requires control characteristics equal to those of DC machines and torque control, fit an optional FR-A7AP or FR-A7AL and select vector control.

Vector control may be used under the following restriction, conditions.

1) Even when motors (other manufacturer's motor, SF-JRC, etc.) other than Mitsubishi standard motor, high efficiency motor (SF-HR, SF-HR0.4kW or more), Mitsubishi constant torque motor (SF-JRCA, SF-HRCA 4-pole 0.4kW to 55kW), vector control dedicated motor (SF-V5RU) are used, using the offline auto tuning function runs the motor with the optimum operating characteristics.

2) The motor capacity should be equal to or one rank lower than the inverter capacity. (note that the capacity should be 0.4kW or more)

3) For vector control operation, the encoder should be coupled on the same axis with the motor shaft without any mechanical looseness. The speed ratio should be 1:1.

4) Single-motor operation (one motor run by one inverter) should be performed.

5) The wiring length from inverter to motor should be within 30m. (Perform offline auto tuning in the state where wiring work is performed when the wiring length exceeds 30m.)

6) For the vector control dedicated motor, the inverter one or two ranks higher than the motor in capacity needs to be selected depending on the motor capacity.

The table on the right indicates the combinations of the SF-V5RU, SF-THY and inverter capacity.

<table>
<thead>
<tr>
<th>Motor Capacity</th>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5kW</td>
<td>SF-V5RU1K</td>
<td>FR-A720-2.2K</td>
</tr>
<tr>
<td>2.2kW</td>
<td>SF-V5RU2K</td>
<td>FR-A720-3.7K</td>
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<td>3.7kW</td>
<td>SF-V5RU3K</td>
<td>FR-A720-5.5K</td>
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<tr>
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<td>SF-V5RU5K</td>
<td>FR-A720-7.5K</td>
</tr>
<tr>
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<td>SF-V5RU7K</td>
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<td>FR-A740-11K</td>
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<td>FR-A740-15K</td>
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<td>FR-A740-18.5K</td>
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<td>FR-A740-30K</td>
</tr>
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<td>FR-A740-37K</td>
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<td>SF-V5RUT37K</td>
<td>FR-A740-45K</td>
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<td>SF-V5RUT45K</td>
<td>FR-A740-55K</td>
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<td>SF-V5RUT55K</td>
<td>FR-A740-75K</td>
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<td>FR-A740-75K</td>
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<td>SF-THY</td>
<td>FR-A740-110K</td>
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<td>SF-THY</td>
<td>FR-A740-132K</td>
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<td>SF-THY</td>
<td>FR-A740-160K</td>
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<td>FR-A740-185K</td>
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<td>FR-A740-220K</td>
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<td>250kW</td>
<td>SF-THY</td>
<td>FR-A740-280K</td>
</tr>
<tr>
<td>300kW</td>
<td>SF-THY</td>
<td>FR-A740-355K</td>
</tr>
</tbody>
</table>


3.1.3 Starting torque and starting current of the motor (common)

When the standard motor is full-voltage started with the commercial power supply, the starting current is generally about 6 to 7 times larger than the rated motor current and the starting torque is approximately 150 to 250% of the rated motor torque. However, the starting and acceleration characteristics of the motor used with the inverter are limited by the overload current rating of the inverter and are different from those when the motor is full-voltage started with the commercial power supply. Since the motor is accelerated with the motor starting acceleration current kept with the overload current rating (150% of the rated output current (120% for (700)) of the inverter, the starting torque and acceleration torque are smaller than the commercial power supply. Speed-torque and speed-current characteristic examples of the standard motor are as shown in the figure on the right. When the motor is used with the inverter of the corresponding capacity, the torque at the speed corresponding to the intersection of overload current rating (150% of the rated inverter output current (120% for (700)) and the current characteristics at each frequency is the maximum torque (short-duration rated) generated by the motor. In the example shown on the right, the starting torque at the speed of 0 is 118% (point A). When the capacity of the inverter used with the motor is increased by one rank, the starting torque and maximum torque increase in proportion to the rise in overload capacity as shown on the right. When the starting torque and acceleration torque are insufficient, it is effective to increase the inverter capacity by one rank. Changing in proportion to the square of the voltage, the motor-generated torque is influenced by the inverter output voltage.

3.1.4 Starting torque boost (common)

The ideal constant-torque characteristic is provided when the ratio of the inverter output voltage (V) to output frequency (f) is as indicated by the broken line in the figure on the right (terminal voltage and frequency) and the torque characteristic in the constant V/F control area is as indicated by the continuous line in the figure on the right (torque characteristic). In the low frequency area, however, since the air gap magnetic flux of the motor, i.e. \( E1/f \), is reduced by a voltage drop due to the primary resistance \( r1 \) of the induction motor as shown in the motor equivalent circuit (refer to the figure on the right), the motor torque drops as indicated by the broken line in the figure on the right (torque characteristic). To prevent the torque reduction at low frequencies, compensate for the voltage drop of the primary resistance to make the inverter output voltage compensation, as indicated by the continuous line in the right figure (torque characteristic). Therefore, the magnetic flux gap becomes constant, and torque characteristic will be closer to the constant torque characteristic on the right (torque characteristic).

The FR series inverters have a function to adjust the inverter output voltage (torque boost). When the starting load torque is large, the primary motor current \( I1 \) is higher than in the equivalent circuit in right figure and \( E1 \) is reduced by the voltage drop of the primary resistance \( r1 \). Since the output voltage of the FR series inverter changes in proportion to the change in input voltage (power supply voltage) of the inverter, the motor speed varies, changing the motor current. To compensate for this, the torque boost function raises the inverter output voltage. For details of the torque boost, refer to page 244.

To compensate for this, the torque boost function raises the inverter output voltage. For details of the torque boost, refer to page 244.

---

[Diagram: Equivalent circuit of the motor]

Motor terminal voltage (V) = DC link voltage (Vdc)

Torque (T) = \( \frac{V}{f \cdot r1} \) (constant)

Terminal voltage (V) and Frequency (f) (Hz)

Speed

Torque Characteristic

---

Table: Motor terminal voltage and frequency

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Terminal voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>100 V</td>
</tr>
<tr>
<td>55</td>
<td>110 V</td>
</tr>
<tr>
<td>60</td>
<td>120 V</td>
</tr>
</tbody>
</table>

---

Table: Motor terminal voltage and frequency

<table>
<thead>
<tr>
<th>Speed (r/min)</th>
<th>Current (%)</th>
<th>Torque (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>50</td>
<td>150</td>
</tr>
<tr>
<td>60</td>
<td>50</td>
<td>200</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>250</td>
</tr>
<tr>
<td>120</td>
<td>50</td>
<td>300</td>
</tr>
</tbody>
</table>

---

For details of the torque boost, refer to page 244.

---

[Table: Motor terminal voltage and frequency]

<table>
<thead>
<tr>
<th>Speed (r/min)</th>
<th>Current (%)</th>
<th>Torque (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>30</td>
<td>50</td>
<td>150</td>
</tr>
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<td>60</td>
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<td>200</td>
</tr>
<tr>
<td>90</td>
<td>50</td>
<td>250</td>
</tr>
<tr>
<td>120</td>
<td>50</td>
<td>300</td>
</tr>
</tbody>
</table>
3.1.5 Acceleration/deceleration time of the motor

To suppress the motor starting current within the overload capacity of the inverter, start the motor at a low frequency (initial value 0.5Hz) and increase the frequency gradually. When the motor is decreased from the set frequency, gradually decrease the frequency to prevent the DC bus voltage from being increased excessively by the regenerative energy from the motor. For these reasons, when the motor is accelerated and decelerated by the inverter, the acceleration time and deceleration time between zero and the maximum frequency must be set in advance.

(1) Setting the acceleration time and deceleration time

The acceleration time and deceleration time must be set longer than those found from the torque generated by the inverter-driven motor, the load torque, and the motor and load inertia (\(J\) (moment of inertia)).

If the acceleration time setting is too short, the overcurrent protective function (OC1) is activated to stop the inverter. If the deceleration time setting is too short, the overcurrent protective function (OC3) or regenerative overvoltage protective function (OV3) is activated to stop the inverter.

On the contrary, if the acceleration time is too long when the lift is descending, the overcurrent protective function (OC1) or overvoltage protective function (OV1) may be activated.

The acceleration or deceleration time \([Pn.7]\) or \([Pn.10]\) value set from the operation panel (parameter unit) is the length of time between zero and the acceleration/deceleration reference frequency \([Pn.20]\).

The time required to reach the set frequency can be calculated by proportion as indicated in [Example 1]. The frequency is found from the operating speed and the number of motor poles by using the formula below, with slip ignored:

\[
\text{Frequency [Hz]} = \frac{\text{Speed [r/min] \times number of poles}}{120}
\]

For full information on how to calculate acceleration and deceleration times, refer to any of the following manuals according to the operation pattern:

- Technical note No.30: Capacity selection II (data part)
- Technical note No.31: Capacity selection II (selection part)
1) Formula for calculating the acceleration and deceleration times (simple method)

Where,

- \( J_T \): All J = motor J_{M} + load J_{L} \) (converted to an equivalent J_{M} at the motor shaft) \( [kg \cdot m^2] \)
- \( N \): Difference between motor speeds before and after acceleration/deceleration \( N_1 - N_2 \) \( [r/min] \)
- \( T_{M} \): Rated motor torque
- \( T_{L_{\text{max}}} \): Maximum load torque (converted to an equivalent J_{M} at the motor shaft) \( [N \cdot m] \)
- \( T_{L_{\text{min}}} \): Minimum load torque (converted to an equivalent J_{M} at the motor shaft) \( [N \cdot m] \)
- \( \alpha_a \): Acceleration torque coefficient*
- \( \beta \): Brake torque coefficient regenerative braking torque*
- \( P \): Rated motor torque \( [kW] \)
- \( N \): Motor synchronous speed at 60Hz \( [r/min] \)
- \( * \): Refer to the Technical Note No.30 (data part)

2) Calculation and setting example of the acceleration and deceleration times (Pr. 7, Pr. 8)

Set the time to accelerate/decelerate using acceleration/deceleration reference frequency (Pr. 20) as reference in acceleration/deceleration time (Pr. 7, Pr. 8). Use "tas" and "tds" found in 1) to calculate the acceleration and deceleration times (Pr. 7, Pr. 8) at shortest acceleration/deceleration time as follows:

\[
\text{Acceleration time (Pr. 7)} = \frac{N}{N_1 - N_2} \times \text{tas}
\]
\[
\text{Deceleration time (Pr. 8)} = \frac{N}{N_1 - N_2} \times \text{tds}
\]

When fast response is required, set the smallest value of which the formula is satisfied. And when soft acceleration / deceleration is required, set the required time.

3) When there is a limit on acceleration time

When acceleration time exceeds the required value, select either Advanced magnetic flux vector control or Real sensorless vector control, increase torque boost, or select an inverter larger in capacity to increase the inverter current overload capacity at acceleration. Or, select a motor larger in capacity (select an inverter larger in capacity also) to increase the motor acceleration torque.

Example 2: Calculated in the conventional unit system

A conveyor is driven by the SF-JR 2.2kW 4P motor and FR-A720-2.2K inverter (V/F control). Suppose that \( J_T = 0.008 \) \( [kg \cdot m^2] \), \( T_{L_{\text{max}}} = 9.8 \) \( [N \cdot m] \), and the acceleration and deceleration times are as short as possible.

\[
JT = 0.008 \times 2.2 \times 9550 = 16.9[N \cdot m]
\]

Therefore set 2.4s or more for acceleration time, and 0.5s or more for deceleration time.

\[
\begin{align*}
\text{TM} & = \frac{9550 \times 2.2}{1800} \times 11.67[N \cdot m] \\
\text{tas} & = \frac{9.55 \times (11.67 - 1.15 - 9.55)}{0.046} \times 1800 = 2.39[s] \\
\text{tds} & = \frac{9.55 \times (11.67 + 1.0 + 5.88)}{0.046} \times 1800 = 0.49[s]
\end{align*}
\]
3.1.6 Deceleration characteristic of the inverter

To shorten the acceleration time, the torque boost is raised or the inverter capacity or motor capacity is increased. To shorten the deceleration time, add a brake unit or increase the capacity of the built-in brake (increase the inverter capacity).

When the motor is decelerated by the inverter, the inverter gradually lowers the output frequency at a slope of the set deceleration time. If you try to decelerate the motor in a shorter time than when it is coasted to a stop, the motor runs faster than the synchronous speed of the given frequency. Hence, the motor acts as an induction generator and its rotating energy is partly consumed in the motor winding and partly accumulated in the capacity inside the inverter. This energy is consumed by the discharge resistor. As a result, it provides braking force for the motor.

[Built-in brake resistor protection] *(A700)

Any inverter of 7.5K or less is provided on its rear surface with a discharge resistor for regenerative braking. When the brake resistor is used up to its rating, the temperature rises considerably. The inverter has a protective function to protect this resistor against use beyond its rating. When this protective function is activated, the built-in brake circuit shut-off to disable the braking action. Therefore, the terminal voltage of the capacity rises to activate the regenerative overvoltage shut-off (OV1 to OV3). Since this protective function returns to the initial state when the inverter is reset, the brake resistor is regarded as cold at the time of restart. Be cautious that operation performed by repeating reset will cause the brake resistor to overheat.

* The brake discharge resistor on the rear surface of the repeating reset will cause the brake resistor to overheat. Be cautious that operation performed by inverter is reset, the brake resistor is regarded as cold at protective function returns to the initial state when the regenerative overvoltage shut-off (OV1 to OV3). Since this terminal voltage of the capacity rises to activate the circuit shut-off to disable the braking action. Therefore, the brake resistor is regarded as cold at the time of restart. Be cautious that operation performed by repeating reset will cause the brake resistor to overheat.

* The brake discharge resistor on the rear surface of the inverter unit will rise to a high temperature. Carefully select the installation place of the inverter.

* Full information on how to select the brake resistor, brake unit and other braking units, refer to any of the following technical notes according to the operation pattern:
  - Technical note No.30 : Capacity selection II (data part)
  - Technical note No.31: Capacity selection II (selection part)

(1) Built-in brake resistor *(A700)

The built-in brake can provide 100 to 150% of the rated motor torque but must be used within 5s (duty: less than 2 to 3%ED). Select the inverter which satisfies the conditions after finding the permissible duty time, as in the Technical note No.30 (data part). When a higher brake duty is required, select the external brake resistor or brake unit in accordance with paragraphs 2) or 4). In this case, disconnect the jumper from the built-in brake resistor.

1) The maximum braking torque (% relative to the motor output used with the inverter) value of the built-in brake resistor is shown on page 2. When the braking torque is required is above this value, the inverter capacity must be increased. The addition of the external brake resistor does not increase the braking torque.

2) The regenerative braking duty (Pr. 70) value of the built-in brake resistor is indicated on page 321. If the duty required is above this value, use the external brake resistor (FR-ABR type) or brake unit (BU type, FR-BU type).

* When further larger braking capability is required, fit the power supply regeneration common converter (FR-CV)

(2) External brake resistor *(A700) (O700) (O700)

When the inverter is used in excess of the maximum duty of the built-in brake resistor, the external brake resistor may be installed for 0.4k to 22k. In this case for (O700), the jumper (across terminal PR and PX) on the built-in brake resistor must be disconnected.

(0 to 7.5kW)

* The (O700) 30k or more and (O700) 0.2k or less cannot use an external brake resistor.

(3) DC injection brake *(common)

The DC injection brake is applied during deceleration. Since the braking torque generated by the DC injection brake depends also on the winding resistance of the motor, it cannot be determined uniformly, but an average of more than 50% braking torque is provided in the factory-set state. In addition, the setting of the DC injection brake time (Pr. 13), DC injection brake voltage (Pr. 14), and DC injection brake frequency (Pr. 15) allows the positioning accuracy to be adjusted according to the load. (Refer to page 328 for details)

(4) Selection of brake unit *(common)

The brake unit is used when the brake capability required is greater than that of the built-in brake resistor and external brake resistor. In this case, the capability of the built-in brake resistor is not added to that of the brake unit.

To select the brake unit, determine the required deceleration pattern as shown below.
1) Calculate the brake torque required to decelerate the motor in the determined deceleration pattern:

\[ T_B = \frac{J_T}{2} \times (N_1 - N_2) \cdot T_{\text{min}} [N \cdot m] \]

2) Calculate the required brake torque coefficient \( \beta \) as following formula

\[ \beta = \frac{T_B}{T_M} \]

TM: rated motor torque to be used

3) From the technical note No.30 (data part), select the brake unit which satisfies the brake torque coefficient \( \beta \).

4) Using the following formula, find the power \( W_{\text{MECH}} \) returned from the load, and using the data manual, make sure that the intersection of the deceleration time of t and the permissible brake unit power \( W_{\text{RS}} \) is below the curve of the brake unit used (refer to Technical note No.31 (selection part).

\[ W_{\text{MECH}} = 0.1047 \times T_B \times \frac{(N_1 + N_2)}{2} [W] \]

5) When using the brake unit frequently (more than 10 times/hour as a guideline), ensure that the value calculated by the following formula is within the permissible continuous power \( W_{\text{RC}} \) (refer to Technical note No.30 (data part)).

\[ W = W_{\text{MECH}} \times \frac{\text{Brake operation time}}{1 \text{ cycle time}} [W] \]

(5) Continuous use of the brake unit

When the motor is used in the brake region, select a brake unit which satisfies the condition that the brake resistor power consumed continuously is not more than the permissible continuous power of the brake unit.

When a negative load is operated repeatedly as shown below, find the power returned from the load in the whole region where the negative load is applied during other than deceleration and check that it is within the permissible continuous power \( W_{\text{RC}} \) in the data part of Technical note.

\[ \text{Operation pattern of the continuous regenerative duty load} \]

(6) Combination of the brake unit and inverter

A larger brake unit may be required when the repeated use of the brake unit is frequent or a negative load is driven. When a larger brake unit is used, the inverter capacity must also be increased.

When higher brake capability is required, select the FR-CV (power supply regeneration common converter).
3.2 Motor characteristics

3.2.1 Characteristics of the induction motor (common)

There are the following relationships between the speed, voltage, frequency, magnetic flux density, torque and other factors of an induction motor:

\[ N = \frac{120f}{p} (1-S) \]

\[ B = K_1 \frac{V}{f} \]

\[ T = K_2 \frac{V}{f} I_1 (\frac{V}{f})^2 \]

\[ P = K_3 N T N = K_4 \]

\[ I_1 = K_5 T f = K_6 V I \]


When a three-phase standard motor is used, the value of magnetic flux B is maximum at 50Hz and cannot be increased beyond that value. In addition, motor current cannot be flown continuously at more than the rated current value, in principle. To run the standard motor without burnout, V/f must be controlled to be constant or below the constant value.

As indicated by the above formula, making V/f constant causes the motor torque at the rated current to be constant. Therefore, by controlling the voltage and frequency to be kept constant, the torque characteristic is made constant. However, a voltage drop due to the primary impedance cannot be ignored in the low frequency range and the torque lowers as shown below. Refer to page 486. The Advanced magnetic flux vector control and Real sensorless vector control compensate for a voltage drop due to the primary impedance and therefore provide an ideal constant-torque characteristic.

3.2.2 Torque generated by a motor driven by an inverter (common)

When the motor is driven with variable voltage/variable frequency power supply, the torque curve is as shown on page 486 (example of 1.5kW). When the inverter is used as a power supply, however, the overload capacity of the inverter suppresses the torque of the motor to be less than the maximum value of the motor. This value is the maximum torque for short time. Hence, the use of a large-capacity inverter raises the overload capacity, leading to the increase in maximum torque for short time. For the values for the standard combinations, refer to the Technical note No.30 (data part).

In the low frequency range, the torque value changes according to the V/f pattern of the inverter output and the electrical constant of the motor. Selecting General-purpose magnetic flux vector control, Advanced magnetic flux vector control or Real sensorless vector control minimizes the torque reduction. In the V/f control, the torque boost function (Pr . 0) also allows the torque to be raise especially in the low frequency range. Refer to page 486 starting torque boost. For the value increased by the torque boost function, refer to the Technical note No.30 (data part).

3.2.3 Continuous motor output characteristic (common)

When the motor is driven from the inverter, its power factor and efficiency are lower than those of the motor driven with a sine wave (commercial power supply) due to the influence of harmonics included in the inverter output. Therefore, since the motor current increases and the motor temperature rises to generate the same load torque, the motor must be used with its output torque reduced. Because the self-cooling fan of the motor has a less effect, especially at lower than 30Hz, the load torque must be reduced for continuous use. Refer to the corresponding inverter series catalog for the permissible continuous operation torque of the three rates, 200V/50Hz, 200V/60Hz, 220V/60Hz standard motor driven from the inverter. When the motor is run continuously with the rated torque down to the low speed range, consider the use of a constant-torque motor.
3.2.4 Efficiency

(1) Finding the overall efficiency

- Inverter efficiency \( n_{\text{INV}} \) indicates the efficiency of the inverter itself and is found by the following formula:

\[
\eta_{\text{INV}} = \frac{P_{\text{INV}}(\text{IN})}{P_{\text{INV}}(\text{IN})} \times 100\% 
\]

- Motor efficiency \( \eta_{\text{M}} \) indicates the efficiency of the motor driven by the inverter and is found by the following formula:

\[
\eta_{\text{M}} = \frac{P_{\text{M}}(\text{OUT})}{P_{\text{M}}(\text{IN})} \times 100\% 
\]

- Overall efficiency \( \eta_{T} \) indicates the efficiency of the inverter and motor combined and is found by the following formula:

\[
\eta_{T} = \eta_{\text{INV}} \times \eta_{\text{M}} = \frac{P_{\text{M}}(\text{OUT})}{P_{\text{INV}}(\text{IN})} \times 100\% 
\]

(2) Motor efficiency

The motor efficiency in (1) is further developed as indicated by the following formula:

\[
\eta_{\text{M}} = \frac{P_{\text{M}}(\text{OUT})}{P_{\text{M}}(\text{OUT}) + \text{motor loss}} \times 100\% 
\]

Main motor losses are iron loss, stator copper loss and rotor copper loss. When the load torque decreases, the ratio of the above losses to the output power increases, reducing the efficiency. Similarly, if the load torque remains the same, the decrease in output frequency results in reduced efficiency.

The reduction in motor terminal voltage (i.e., inverter output voltage) decreases the motor torque. The increase in motor slip and rotor copper loss decreases the motor efficiency.
3.2.5 Vibration (common)

Since the inverters use a high-carrier frequency sine-wave PWM control, the vibration of the motor is small. As compared to that of the motor driven with the commercial power supply, however, the vibration of the motor installed to a machine may be slightly larger. The possible causes of vibration are as follows.

1) Vibration due to mechanical imbalance of the rotating body including motor rotor and load vibration

Vibration happens by mechanical imbalance, which is caused by rotating body itself or connecting parts with the machine (runner, pulley).

When performing high-speed operation by an inverter, natural frequency of rotating body comes close to the operating frequency, and that increases vibration.

*1 Note that operation range is limited.

2) Vibration due to torsional natural vibration consist of motor rotor and load matching the cogging torque frequency (= mechanical resonance with natural vibration).

Harmonic components of the inverter output generates cogging torque, and that cogging torque causes vibration. When torsional natural vibration and cogging torque frequency matches, resonance occurs, applying larger torque to the axis.

*2 Setting PWM frequency higher causes EMI noise and leak current to increase. Setting PWM frequency lower causes acoustic motor noise to increase.

3) Vibration due to complex combination of mechanic element, which includes motor rotor and, load and, electric element, which consists of motor and inverter.

Electrical vibration element, which is caused by inverter control and motor slip, and mechanical vibration element, which is caused by load including motor rotor, combines and causes several resonance points. When this happens, large torque is applied to the axis in wide operating frequency range. Physical vibration by mechanical and electrical elements happens as follows: rotation speed of load changes suddenly (decelerates/accelerates) → motor slip amount changes suddenly (increase/decrease) → motor torque occurs (accelerate/decelerate) → continued.

### Countermeasure | Effect
--- | ---
**Inverter**
Set the speed limit by \[ \text{Pr.}\ [\text{Maximum frequency}] \].
Vibration is avoided by operating in the frequency less than the vibration enhancing frequency. *1

Use the function set by \[ \text{Pr.}\ [51\text{ to }61,\text{Frequency}] \].
Operation at resonance frequency is avoided (resonance point cannot be avoided during acceleration/deceleration).

Apply flexible coupling or tire-shaped coupling, strengthen the rigidity of the machine and motor, or place vibration-proof rubber.
Natural frequency at machine side is changed.

**System**
Apply flexible coupling or tire-shaped coupling.
Rotation vibration is absorbed.

Strengthen the rigidity of the machine and motor, or place vibration-proof rubber.
Natural frequency at machine side is changed.

*3 Take caution as output torque and speed may decrease.

Also, when vibration is exceptionally large, inverter’s protective function (E.OC 1 to 3 and E.OV 1 to 3) may occur.

In some cases, low vibration motor (refer to page 496) creates desirable effect.
### 3.3 Operation of various motors

A variety of motors are available; various types of motors classified according to protection types and structure, those provided with equipment such as brakes and speed reducers, and special-purpose motors. When identical to a general-purpose three-phase motor in electrical characteristics, any motor can be run by the inverter without fault.

For motors which have different electrical characteristics, adjustment is required in torque boost function ([Pr. 0]) of V/F pattern (Refer to page 486 for Starting Torque Boost), or a dedicated inverter which is matching to the motor characteristics may be required. When using a motor designed for commercial power supply (50Hz or 60Hz) with the inverter, set the base frequency of the inverter ([Pr. 3]) to 50Hz or 60Hz.

#### 3.3.1 Motor types according to protection structure

<table>
<thead>
<tr>
<th>Motor Protection Structure</th>
<th>Type Code</th>
<th>Protection Code</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drip-proof type</td>
<td>SB-JR, SB-TH</td>
<td>IP 22</td>
<td></td>
</tr>
<tr>
<td>Totally-enclosed fan-cooled type</td>
<td>SF-JR, SF-TR, SF-TH</td>
<td>IP 44</td>
<td>Available with a standard inverter (vertical or flange type is also available)</td>
</tr>
<tr>
<td>Totally-enclosed fan-cooled, outdoor type</td>
<td>SF-JRO, SF-HRO, SF-THD</td>
<td>IP 44</td>
<td></td>
</tr>
<tr>
<td>Explosion-protected type</td>
<td>XF(E)-NE, XF-E, XF-LH</td>
<td>IP 44</td>
<td>Explosion-proof test (Safety test of Ministry of Health, Labour and Welfare) is necessary in combination with the inverter. Refer to page 498 for further information.</td>
</tr>
</tbody>
</table>

#### 3.3.2 Constant-torque motor

A constant-torque motor is a motor dedicated to inverter operation which can be run continuously without reducing the load torque even in the low speed range. \(^{(10)}\) provides a 100% constant torque from 3 to 60Hz under Real sensorless vector control. (from 10 to 60Hz for 45kW, 55kW)

- Continuous use within the rated range (Real sensorless vector control)

Inverter has an electronic thermal relay dedicated to Mitsubishi constant motor, therefore external thermal relay is not necessary.

---

\(^{(10)}\) Maximum torque for short time (0.4kW to 3.7kW)

\(^{(11)}\) Provides a 100% constant torque from 3 to 60Hz under Real sensorless vector control.

\(^{(12)}\) Continuous use within the rated range (Real sensorless vector control)
### Standard Specifications of Constant-Torque Motor (Motor dedicated to magnetic flux vector control)

<table>
<thead>
<tr>
<th>Output (kW)</th>
<th>Number of poles</th>
<th>Type</th>
<th>Frame Number</th>
<th>Continuous operation torque (N · m)</th>
<th>Insulation</th>
<th>Inverter Power supply</th>
<th>Frequency range</th>
<th>Example of applicable inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>4</td>
<td>Totally-enclosed fan-cooled type SF-JRCA</td>
<td>71M</td>
<td>2.12</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>3 to 120Hz</td>
<td>FR-A720-0.4K</td>
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<tr>
<td>0.75</td>
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<td>63M</td>
<td>3.98</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>3 to 120Hz</td>
<td>FR-A720-0.75K</td>
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<tr>
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<td>90L</td>
<td>8.16</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>3 to 120Hz</td>
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<td>3 to 120Hz</td>
<td>FR-A720-2.2K</td>
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<tr>
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<td>3 to 120Hz</td>
<td>FR-A720-2.7K</td>
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<td>132M</td>
<td>23.2</td>
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<td>3 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-15K</td>
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<tr>
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<td>4</td>
<td>SF-HRCA</td>
<td>180L</td>
<td>117</td>
<td>Class E</td>
<td>200V/50Hz</td>
<td>3 to 120Hz (base frequency 60Hz)</td>
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<td>3 to 120Hz (base frequency 60Hz)</td>
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<td>Class E</td>
<td>200V/50Hz</td>
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<td>3 to 65Hz</td>
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<td>Class E</td>
<td>400V/60Hz</td>
<td>3 to 65Hz</td>
<td>FR-A740-55K</td>
</tr>
</tbody>
</table>

* Power supply of the forced cooling fan is three-phase 200/200/200V, 50/60/60Hz.
3.3.3 Low-vibration motor

When compared to a general-purpose motor, a low-vibration motor is designed to be insusceptible to time harmonics and space harmonics and is improved in machining accuracy to minimize gap imbalance. Hence, this type of motor has achieved low oscillation of a maximum 5 m full-amplitude and a maximum 1.5G oscillatory acceleration. It is also wider in continuous output range than a general-purpose motor.

### Standard Specifications of Low-Vibration Motor

<table>
<thead>
<tr>
<th>Output (kW)</th>
<th>Number of poles</th>
<th>Type</th>
<th>Frame Number</th>
<th>Continuous operation torque (N·m)</th>
<th>Insulation</th>
<th>Inverter Power supply</th>
<th>Frequency range</th>
<th>Example of applicable inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>4</td>
<td>Totally-enclosed fan-cooled type SF-JRC</td>
<td>71M</td>
<td>2.12</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-0.4K</td>
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<tr>
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<td>60M</td>
<td>3.36</td>
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<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>6.6</td>
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<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>100L</td>
<td>11</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-2.2K</td>
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<tr>
<td>3.7</td>
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<td>19.5</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>Class B</td>
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<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>39.8</td>
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<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>6 to 120Hz (base frequency 60Hz)</td>
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<td>15</td>
<td>8</td>
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</table>

* Power supply of the forced cooling fan is three-phase 200/200/200V, 50/60/60Hz.

### Standard Specifications of Constant-Torque Motor (Motor dedicated to V/F control)

<table>
<thead>
<tr>
<th>Output (kW)</th>
<th>Number of poles</th>
<th>Type</th>
<th>Frame Number</th>
<th>Continuous operation torque (N·m)</th>
<th>Insulation</th>
<th>Inverter Power supply</th>
<th>Frequency Range</th>
<th>Example of applicable inverter</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
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<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-30K</td>
</tr>
<tr>
<td>37</td>
<td>15</td>
<td>Totally-enclosed fan-cooled type SF-JRC</td>
<td>200L</td>
<td>196</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-45K</td>
</tr>
<tr>
<td>45</td>
<td>22</td>
<td>Totally-enclosed fan-cooled type SF-JRC</td>
<td>225S</td>
<td>239</td>
<td>Class B</td>
<td>200V/50Hz</td>
<td>6 to 120Hz (base frequency 60Hz)</td>
<td>FR-A720-55K</td>
</tr>
</tbody>
</table>

*1 Set the torque boost ([Pr. 0]) of the minimum value.
*2 Set 0 in Electronic thermal O/L relay ([Pr. 9]) and install an external thermal relay.
3.3.4 Brake motor

When a motor with magnetic brake is operated by the inverter, the power for the brake must be supplied from the primary side of the inverter. Modifications must be made to a motor with brake where the motor terminals are connected with the brake terminals inside the motor, e.g. a current type brake which operates the brake using a large starting current.

To stop the motor with the magnetic brake, turn ON the output stop signal (MRS) of the inverter, and at the same time, turn OFF the start input signal (STF or STR). If MRS signal is not used, the braking force will reduce at the time of braking and/or a lock current will flow in the motor, causing the electronic thermal relay to be activated by the current limit function which has been activated for a long time.

3.3.5 Pole changing motor

Since a pole-change motor has difference in rated current from a general-purpose motor, the inverter should be selected after checking the rated motor current. The number of poles must be changed after stopping the motor. If it is changed during rotation, the inverter is brought to a coasting state. Switching from high-speed operation to low-speed operation or vice versa requires the number of poles to be changed after stopping the motor. (The pole-change motor has difference in rated current depending on the value of load J (moment of inertia).

Other instructions
1) The brake should be used at a speed of 1800 r/min or less. If the motor running at high speed is brought to a sudden stop, the braking capacity of the electromagnetic brake may be insufficient depending on the value of load J (moment of inertia).
2) When the motor is provided with the NB brake, continuous low-speed operation below 900 r/min may cause noise to be generated due to the looseness of the brake disc, which does not cause a functional problem. This type of motor can be used without fault if operated at low speed for a short duration, e.g. positioning to a stop. Setting of factory shipment is AC synchronous OFF connection. For further reduction of the coasting time, DC OFF is available.

3.3.6 Submersible motor

Since its rotor and other parts rotate under water, a water seal type submersible motor is larger in both mechanical loss and rated current than a general-purpose motor. Select the inverter capacity so that its rated output current is more than 1.1 times greater than the rated current of the submersible motor. (An inverter of one rank higher capacity may be required for the motor.)

When large torque is required due to lodged sand etc., an inverter of one rank higher capacity may be selected to raise its overload capacity and the motor capacity may also be increased. Alternatively, the torque boost (Pr. 9) setting value may be increased.

Other instructions
1) As compared to the one driven by a commercial power supply, the submersible motor driven by an inverter is slightly higher in motor temperature rise. Particularly in a canned system, the increase in can loss causes the submersible motor driven by the inverter to be about 15% higher in temperature than the one driven by a commercial power supply.
2) Protection of submersible motor

Since the submersible motor may be installed deep in a well, it is difficult to detect its fault from the ground, and its permissible lock time is short. Hence, an appropriate protection relay must be selected to protect the submersible motor. Ideally, the installation of a thermal detector, e.g. thermistor, on the motor for the detection of coil temperature ensures safety, which detects faults occurring in a low-speed range (ambient water temperature rise, overload operation). Generally, provide a thermal relay between the inverter and motor, and set zero in electronic thermal O/L relay (Pr. 0) of the inverter. Set the overload protection to within 5 seconds (3 seconds preferable).

3) When the cable length between the motor and inverter is long, use a large-diameter cable to prevent the motor torque from decreasing due to the voltage drop over the cable.

When a motor with magnetic brake is operated by the inverter, the power for the brake must be supplied from the primary side of the inverter. Modifications must be made to a motor with brake where the motor terminals are connected with the brake terminals inside the motor, e.g. a current type brake which operates the brake using a large starting current.

To stop the motor with the magnetic brake, turn ON the output stop signal (MRS) of the inverter, and at the same time, turn OFF the start input signal (STF or STR). If MRS signal is not used, the braking force will reduce at the time of braking and/or a lock current will flow in the motor, causing the electronic thermal relay to be activated by the current limit function which has been activated for a long time.

When large torque is required due to lodged sand etc., an inverter of one rank higher capacity may be selected to raise its overload capacity and the motor capacity may also be increased. Alternatively, the torque boost (Pr. 9) setting value may be increased.

Other instructions
1) The brake should be used at a speed of 1800 r/min or less. If the motor running at high speed is brought to a sudden stop, the braking capacity of the electromagnetic brake may be insufficient depending on the value of load J (moment of inertia).
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Other instructions
1) The brake should be used at a speed of 1800 r/min or less. If the motor running at high speed is brought to a sudden stop, the braking capacity of the electromagnetic brake may be insufficient depending on the value of load J (moment of inertia).
2) When the motor is provided with the NB brake, continuous low-speed operation below 900 r/min may cause noise to be generated due to the looseness of the brake disc, which does not cause a functional problem. This type of motor can be used without fault if operated at low speed for a short duration, e.g. positioning to a stop. Setting of factory shipment is AC synchronous OFF connection. For further reduction of the coasting time, DC OFF is available.

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When large torque is required due to lodged sand etc., an inverter of one rank higher capacity may be selected to raise its overload capacity and the motor capacity may also be increased. Alternatively, the torque boost (Pr. 9) setting value may be increased.

Other instructions
1) The brake should be used at a speed of 1800 r/min or less. If the motor running at high speed is brought to a sudden stop, the braking capacity of the electromagnetic brake may be insufficient depending on the value of load J (moment of inertia).
2) When the motor is provided with the NB brake, continuous low-speed operation below 900 r/min may cause noise to be generated due to the looseness of the brake disc, which does not cause a functional problem. This type of motor can be used without fault if operated at low speed for a short duration, e.g. positioning to a stop. Setting of factory shipment is AC synchronous OFF connection. For further reduction of the coasting time, DC OFF is available.

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Other instructions
1) The brake should be used at a speed of 1800 r/min or less. If the motor running at high speed is brought to a sudden stop, the braking capacity of the electromagnetic brake may be insufficient depending on the value of load J (moment of inertia).
2) When the motor is provided with the NB brake, continuous low-speed operation below 900 r/min may cause noise to be generated due to the looseness of the brake disc, which does not cause a functional problem. This type of motor can be used without fault if operated at low speed for a short duration, e.g. positioning to a stop. Setting of factory shipment is AC synchronous OFF connection. For further reduction of the coasting time, DC OFF is available.

3.3.6 Submersible motor

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When large torque is required due to lodged sand etc., an inverter of one rank higher capacity may be selected to raise its overload capacity and the motor capacity may also be increased. Alternatively, the torque boost (Pr. 9) setting value may be increased.
3.3.7 Explosion-proof motor

The inverter cannot drive commercial power drive pressure-resistant explosion proof motors and safety-increased explosion-proof motors already in place. To operate an explosion-proof motor by an inverter in Japan, explosion proof certification by the Ministry of Health, Labour and Welfare for the inverter and motor unit is required. Strong cover of the Mitsubishi pressure-resistant explosion-proof motor is utterly unaffected by explosion-proof tests (10 explosion tests + 15 fire explosion tests). By applying Japanese d2G4 standard for the explosion proof structure, the explosion-proof motor can respond to various needs. The inverter used with this motor must be the Mitsubishi FR-B, B3 series inverter dedicated to explosion-proof motor (equivalent to the FR-A700) and must be installed in non-hazardous locations.

(1) Variable torque series (combination with FR-B)*

Operate a pressure resistant explosion-proof motor with a FR-B series inverter under V/F control.

*1 Above graph shows torque characteristic when the maximum frequency is 120Hz. The characteristic differs by the motor frame number.

*2 Continuous operation can be performed in the above mentioned torque range or less.

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Output</td>
</tr>
<tr>
<td>200V class</td>
<td>400V class</td>
</tr>
<tr>
<td>TF-RB 0.2kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>TF-RB 0.4kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>TF-RB 0.75kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>TF-RB 1.5kW</td>
<td>FR-B-1500</td>
</tr>
<tr>
<td>TF-RB 2.2kW</td>
<td>FR-B-2200</td>
</tr>
<tr>
<td>TF-RB 3.7kW</td>
<td>FR-B-3700</td>
</tr>
<tr>
<td>TF-RB 5.5kW</td>
<td>FR-B-5.5K</td>
</tr>
<tr>
<td>TF-RB 7.5kW</td>
<td>FR-B-7.5K</td>
</tr>
<tr>
<td>XF-NE 0.2kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>XF-NE 0.3kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>XF-NE 0.4kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>XF-NE 0.75kW</td>
<td>FR-B-750</td>
</tr>
<tr>
<td>XF-NE 1.5kW</td>
<td>FR-B-1500</td>
</tr>
<tr>
<td>XF-NE 2.2kW</td>
<td>FR-B-2200</td>
</tr>
<tr>
<td>XF-NE 3.7kW</td>
<td>FR-B-3700</td>
</tr>
<tr>
<td>XF-NE 5.5kW</td>
<td>FR-B-5.5K</td>
</tr>
<tr>
<td>XF-NE 7.5kW</td>
<td>FR-B-7.5K</td>
</tr>
<tr>
<td>XF-E 1.1kW</td>
<td>FR-B-11K</td>
</tr>
<tr>
<td>XF-E 1.5kW</td>
<td>FR-B-15K</td>
</tr>
<tr>
<td>XF-E 2.2kW</td>
<td>FR-B-22K</td>
</tr>
<tr>
<td>XF-E 3.0kW</td>
<td>FR-B-30K</td>
</tr>
<tr>
<td>XF-E 3.7kW</td>
<td>FR-B-37K</td>
</tr>
<tr>
<td>XF-E 4.5kW</td>
<td>FR-B-45K</td>
</tr>
<tr>
<td>XF-E 5.5kW</td>
<td>FR-B-55K</td>
</tr>
</tbody>
</table>

Motors with 45kW or less have 2-pole, 4-pole, or 6-pole. Note that some motors with 2 or 6 poles are required for the explosion proof test by the Ministry of Health, Labour and Welfare. Please consult your sales representative when placing an order. Motors with 55kW or more have 4 poles. Please consult our sales representative for the motor capacities not mentioned above.

* Above combinations are when Mitsubishi pressure-resistant explosion-proof motor with 4 poles is used.
(2) Constant-torque series (combination with FR-B3)
Operate a pressure-resistant explosion-proof motor with a FR-B3 series inverter under Advanced magnetic flux vector control. Be sure to operate offline auto tuning.

Constant-torque series standard type (combination with FR-B3)

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Output</td>
</tr>
<tr>
<td></td>
<td>200V class</td>
</tr>
<tr>
<td></td>
<td>FR-B3-400</td>
</tr>
<tr>
<td></td>
<td>FR-B3-750</td>
</tr>
<tr>
<td></td>
<td>FR-B3-1500</td>
</tr>
<tr>
<td></td>
<td>FR-B3-2200</td>
</tr>
<tr>
<td></td>
<td>FR-B3-3700</td>
</tr>
<tr>
<td></td>
<td>FR-B3-5.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-7.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-11K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-15K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-18.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-22K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-30K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-37K</td>
</tr>
</tbody>
</table>

The motor has 4 poles.

Constant-torque series low acoustic noise type (combination with FR-B3-N)

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Output</td>
</tr>
<tr>
<td></td>
<td>200V class</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N400</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N750</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N1500</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N2200</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N3700</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N5.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N7.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N11K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N15K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N18.5K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N22K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N30K</td>
</tr>
<tr>
<td></td>
<td>FR-B3-N37K</td>
</tr>
</tbody>
</table>

The motor has 4 poles.

(3) Constant-torque series with 60Hz standard (combination with FR-B)
Operate a pressure-resistant explosion-proof motor with a FR-B series inverter under V/F control.

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Output</td>
</tr>
<tr>
<td></td>
<td>200V class</td>
</tr>
<tr>
<td></td>
<td>FR-B-55K</td>
</tr>
<tr>
<td></td>
<td>FR-B-75K</td>
</tr>
<tr>
<td></td>
<td>FR-B-90K</td>
</tr>
<tr>
<td></td>
<td>FR-B-110K</td>
</tr>
</tbody>
</table>

Torque characteristic 3)

When 100% is the rated motor torque at 60Hz.
(4) Constant-torque series with 50Hz standard (combination with FR-B)

Operate a pressure-resistant explosion-proof motor with a FR-B series inverter under V/F control.

<table>
<thead>
<tr>
<th>Motor Type</th>
<th>Inverter Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Output</td>
</tr>
<tr>
<td>M1-TH 0.7kW</td>
<td>FR-B-35K</td>
</tr>
<tr>
<td>M1-TH 1.5kW</td>
<td>FR-B-55K</td>
</tr>
<tr>
<td>M1-TH 2.2kW</td>
<td>FR-B-75K</td>
</tr>
<tr>
<td>M1-TH 2.8kW</td>
<td>FR-B-80K</td>
</tr>
</tbody>
</table>

(5) Applicable options

<table>
<thead>
<tr>
<th>Name</th>
<th>Type</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>High-speed output</td>
<td>FR-ATAX</td>
<td></td>
</tr>
<tr>
<td>Relay output</td>
<td>FR-ATAY</td>
<td></td>
</tr>
<tr>
<td>Filtration communication</td>
<td>FR-A7CN</td>
<td></td>
</tr>
<tr>
<td>Motor control unit</td>
<td>FR-ACU</td>
<td></td>
</tr>
<tr>
<td>Fan motor control</td>
<td>FR-FCU</td>
<td></td>
</tr>
<tr>
<td>Line noise filter</td>
<td>FR-BSF01</td>
<td></td>
</tr>
<tr>
<td>High-duty brake resistor</td>
<td>FR-ABR</td>
<td></td>
</tr>
<tr>
<td>Brake unit, resistor unit</td>
<td>FR-ABR-R</td>
<td></td>
</tr>
<tr>
<td>Power regeneration common converter</td>
<td>FR-CV</td>
<td></td>
</tr>
<tr>
<td>Power regeneration converter</td>
<td>FR-HC</td>
<td></td>
</tr>
</tbody>
</table>

*1 Vector control is not applicable. When using an encoder in explosive area, use an explosion-proof encoder.

*2 High-duty brake resistor (FR-ABR) can be used for 22kW or less. To use, change the following parameters:

(Applies to the products manufactured in September 2008 or later.)

- Set [Pn. 70] as follow.
  - 7.5K or less: 10%
  - 11K or more: 6%

*3 Motors with frame number 250 or higher can be used in combination with MT-BR.

*4 Explosion-proof test by the Ministry of Health, Labour and Welfare is separately required. For that purpose, inverter needs to be a special model.
3.3.8 Vector control dedicated motor

Vector control dedicated motor is for full-scale vector control, and enables 100% of the continuous operation torque even at a low speed.

Install a plug-in option for encoder feedback control (FR-A7AP or FR-A7AL) in (1) Motor Type

1) Rated speed: 1500/min (4 poles) (200V, 400V)

<table>
<thead>
<tr>
<th>Model</th>
<th>Standard type</th>
<th>Rated speed (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard horizontal type</td>
<td>SF-V5RUH/11</td>
<td>110</td>
</tr>
<tr>
<td>Flange type</td>
<td>SF-V5RUF/11</td>
<td>110</td>
</tr>
<tr>
<td>Standard horizontal type with brake</td>
<td>SF-V5RUH/1B</td>
<td>110</td>
</tr>
<tr>
<td>Flange type with brake</td>
<td>SF-V5RUF/1B</td>
<td>110</td>
</tr>
</tbody>
</table>

Type name with H indicates 400V class. For example, when the model is standard horizontal type, use SF-V5RUH/ for 200V class, and SF-V5RUH/1 for 400V class.

2) Rated speed: 1000/min (4 poles), maximum speed: 2000/min speed ratio 1:2 (200V)

<table>
<thead>
<tr>
<th>Model</th>
<th>Standard type</th>
<th>Rated speed (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard horizontal type</td>
<td>SF-V5RU/12</td>
<td>110</td>
</tr>
<tr>
<td>Flange type</td>
<td>SF-V5RUF/12</td>
<td>110</td>
</tr>
<tr>
<td>Standard horizontal type with brake</td>
<td>SF-V5RU/1B</td>
<td>110</td>
</tr>
<tr>
<td>Flange type with brake</td>
<td>SF-V5RUF/1B</td>
<td>110</td>
</tr>
</tbody>
</table>

3) Rated speed: 1000/min (4 poles), maximum speed: 3000/min speed ratio 1:3 (200V)

<table>
<thead>
<tr>
<th>Model</th>
<th>Standard type</th>
<th>Rated speed (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard horizontal type</td>
<td>SF-V5RU/31</td>
<td>110</td>
</tr>
<tr>
<td>Flange type</td>
<td>SF-V5RUF/31</td>
<td>110</td>
</tr>
<tr>
<td>Standard horizontal type with brake</td>
<td>SF-V5RU/3B</td>
<td>110</td>
</tr>
<tr>
<td>Flange type with brake</td>
<td>SF-V5RUF/3B</td>
<td>110</td>
</tr>
</tbody>
</table>

4) Rated speed: 500/min (4 poles), maximum speed: 2000/min speed ratio 1:4 (200V)

<table>
<thead>
<tr>
<th>Model</th>
<th>Standard type</th>
<th>Rated speed (V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard horizontal type</td>
<td>SF-V5RU/41</td>
<td>110</td>
</tr>
<tr>
<td>Flange type</td>
<td>SF-V5RUF/41</td>
<td>110</td>
</tr>
<tr>
<td>Standard horizontal type with brake</td>
<td>SF-V5RU/4B</td>
<td>110</td>
</tr>
<tr>
<td>Flange type with brake</td>
<td>SF-V5RUF/4B</td>
<td>110</td>
</tr>
</tbody>
</table>

Type name with H indicates 400V class. For example, when the model is standard horizontal type, use SF-V5RUH/ for 200V class, and SF-V5RUH/1 for 400V class.

- Available — Not available

300V class models with the frame number 250 or higher are available as special products. Consult our sales office.
(2) Torque characteristic

SF-V5RU1, 3, 4

*1 Maximum speed of SF-V5RU-55kW and SF-V5RU1-30kW is 2400 r/min.

*2 Maximum speed of a dedicated motor SF-V5RU-3.7kW or less is 3600 r/min. Consult our sales office when using the motor at the maximum speed.

*3 Maximum speed of the motor with brake is 1800 r/min.

(3) Others

Refer to page 263 for the combination of an inverter and a vector control dedicated motor.
Combination of a standard motor with encoder is also available.
Connect the encoder directly to the backlash-free motor shaft.
3.3.9 Geared motor

Geared motors differ in the continuous-duty speed range according to the lubrication system and manufacturer. Particularly with oil lubrication, continuous operation only in the low speed range can cause gear seizure. When performing high-speed operation beyond 60Hz, please consult the manufacturer.

(1) Mitsubishi standard geared motors

The grease-lubricated GM-S, GM-D and GM-LJ may be used between low speed and high speed of 70 to 120Hz. The oil-lubricated GM-D, GM-LJ and GM-PJ are four-pole motors and may be used between 25Hz and high speed of 60 to 120Hz.

When the motor is inverter-driven, there is no restriction on the permissible number of start times as starting impact is lessened.

* Independent of the magnitude of load inertia, provided that the inverter capacity is equal to the motor capacity at the standard setting of the torque boost.

Available frequency range

<table>
<thead>
<tr>
<th>Series</th>
<th>Motor capacity 4P (kW)</th>
<th>Insulation class</th>
<th>Frequency Range (Hz)</th>
<th>Grease lubrication</th>
<th>Oil lubrication</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM-S</td>
<td>0.1</td>
<td>E</td>
<td>3 to 120*1</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GM-D</td>
<td>0.4</td>
<td>E</td>
<td>3 to 120*1</td>
<td>25 to 120</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>B</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td>F</td>
<td>3 to 120*1</td>
<td>25 to 115</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *1 If performing continuous operation with inverter frequency 60Hz or more, replace an oil sheet by one year.

(2) Built-in brake type geared motor

Refer to page 497 (Motor with Brake). When the brake is used, this type of motor should be used at less than 60Hz because there is restriction on the braking capacity. When a motor with TB brake is continuously operated at low speed, it will generate noise which gives no problem regarding function.

(3) Cyclo speed reducer directly coupled with motor

When the speed reducer is specified as inverter-driven in the purchase order, the motor may be different from the standard one.

If overcurrent trip (OC1) occurs immediately after a start, adjust the torque boost ([Pr. 0]).

1) An 1:10 speed range is standard. Consult the manufacturer when the speed reducer is used at more than 60Hz.
2) Lubricant: Frame numbers #208 to #211 are grease-lubricated.
   Frame numbers #84 to #89 of horizontal mounting type are oil-lubricated like the standard ones. For this type, oil used should be of low viscosity within the VG range.
   For frame numbers #84 to #89 of vertical type, the lubrication system must be considered according to the working speed range.

3) Note the starting characteristic at low temperature.
   The loss of the cyclo speed reducer depends on the ambient temperature, input speed, load factor and lubricant. The starting characteristic must be noted under hostile conditions where sudden acceleration is made from the start to 1800 r/min under load at a low temperature. The loss in torque of the oil-lubricated model at the ambient temperature of 0°C is 15 to 30% of the rated value at 60Hz.

<table>
<thead>
<tr>
<th>Series</th>
<th>Motor capacity 4P (kW)</th>
<th>Insulation class</th>
<th>Frequency Range (Hz)</th>
<th>Grease lubrication</th>
<th>Oil lubrication</th>
</tr>
</thead>
<tbody>
<tr>
<td>GM-S</td>
<td>5.5</td>
<td>F</td>
<td>3 to 110</td>
<td>25 to 120</td>
<td></td>
</tr>
<tr>
<td>GM-PJ</td>
<td>7.5</td>
<td></td>
<td>3 to 105</td>
<td>25 to 105</td>
<td></td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td>3 to 95</td>
<td>25 to 95</td>
<td></td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>3 to 85</td>
<td>25 to 85</td>
<td></td>
</tr>
<tr>
<td></td>
<td>22</td>
<td></td>
<td>3 to 75</td>
<td>25 to 75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>37</td>
<td></td>
<td>3 to 60</td>
<td>25 to 60</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45</td>
<td></td>
<td>3 to 55</td>
<td>25 to 55</td>
<td></td>
</tr>
<tr>
<td></td>
<td>55</td>
<td></td>
<td>3 to 45</td>
<td>25 to 45</td>
<td></td>
</tr>
</tbody>
</table>
3.3.10 Synchronous motor

Synchronous motor is not available in general. Synchronous motor may not synchronize to inverter output frequency, and may not start. And even if the motor is started, depending on a load, difference in synchronization may occur.

3.3.11 Single phase motor

It is not recommended to use a single-phase motor with an inverter. The small capacity of the single-phase motor is often rated at 100V and does not match the inverter. The SC, SL, SCL and other motors with capacitors cause an excessive current to flow in the capacitor, resulting in capacitor breakage.

3.3.12 Permissible maximum frequency of general-purpose motor

(1) Standard models

<table>
<thead>
<tr>
<th>Frame Number</th>
<th>Number of poles</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>2</td>
<td>120Hz (72)</td>
<td>120Hz (4800 r/min)</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>2</td>
<td>120Hz (7200 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>4</td>
<td>120Hz (3600 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>6</td>
<td>120Hz (2400 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>2</td>
<td>90Hz (5400 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>2</td>
<td>90Hz (4500 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>4</td>
<td>100Hz (3900 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>110</td>
<td>6</td>
<td>100Hz (3000 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>112</td>
<td>2</td>
<td>120Hz (5400 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>132</td>
<td>2</td>
<td>120Hz (4800 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>2</td>
<td>120Hz (3600 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>4</td>
<td>120Hz (2400 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>160</td>
<td>6</td>
<td>120Hz (1950 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>2</td>
<td>60Hz (3600 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>4</td>
<td>60Hz (2400 r/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td>6</td>
<td>60Hz (1950 r/min)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* The value in the parentheses indicates synchronous speed.

*2 When a two-pole motor of frame number 90 or 100 is run at 120Hz, noise will exceed 90dB (A).

3.3.13 Inverter-driven 400V motor

In the PWM type inverter, a surge voltage attributable to wiring constants is generated at the motor terminals. Especially for a 400V class motor, the surge voltage may deteriorate the insulation. When the 400V class motor is driven by the inverter, consider the following measures:

- Countermeasure

It is recommended to take either of the following measures:

(1) Reinforcing the motor insulation and limiting the PWM carrier frequency according to the wiring length

For a 400V class motor, use an insulation-enhanced motor. Specifically:
1) Specify the "400V class inverter-driven, insulation-enhanced motor".
2) As a dedicated motor such as a constant-torque motor or low-vibration motor, use a "motor dedicated to inverter operation".

(2) Other models

<table>
<thead>
<tr>
<th>Number of poles</th>
<th>2</th>
<th>4</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>With TB brake</td>
<td>Not available</td>
<td>65Hz (except vertical type)</td>
<td>90Hz (except vertical type)</td>
</tr>
<tr>
<td>Outdoor type</td>
<td>65 to 132</td>
<td>100Hz</td>
<td>120Hz</td>
</tr>
<tr>
<td>Waterproof type</td>
<td>200</td>
<td>60Hz</td>
<td>85Hz</td>
</tr>
</tbody>
</table>

3) Set [Pr. 72 PWM frequency selection] as indicated below according to the wiring length.

<table>
<thead>
<tr>
<th>Wiring Length</th>
<th>50m or less</th>
<th>50m to 100m</th>
<th>More than 100m</th>
</tr>
</thead>
<tbody>
<tr>
<td>[Pr. 72 PWM frequency selection]</td>
<td>10(10kHz) or less</td>
<td>9(9kHz) or less</td>
<td>8(8kHz) or less</td>
</tr>
<tr>
<td></td>
<td>2(2kHz) or less</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(2) How to suppress surge voltage on the inverter side

Connect the surge voltage suppression filter (FR-ASF-H or FR-BSMF-H) to the 55K or less and the sine wave filter (MT-BSL/BSC) to the 75K or more on the inverter output side.
3.4 Power supply of the inverter

3.4.1 Inverter input current and power factor

The converter circuit of the inverter consists of three-phase bridged diodes and capacitor-input smoothing circuit as shown below.

The capacitance of the DC smoothing capacitor is very large and the input current I from the power supply flows only when the voltage V of the power supply is higher than the terminal voltage Ed of the smoothing capacitor. Hence, the conduction width of the converter circuit is very narrow and the peak (crest) value of the input current is large. The input power factors given in the table on the right assume that the DC voltage does not vary. As shown in the table on the right, if the DC voltage Ed is greater than 1.35 times the input voltage V under a light load, two pulse currents flow in a half cycle and the power factor falls to 58.7% or less.

Ordinarily, the power factor is represented by a phase difference between voltage and current. When a current having a distorted waveform flows in the inverter input, the power factor is calculated from an apparent power and a three-phase input power found through the three-wattmeter method. The power factor thus calculated is called an overall power factor.

The AC power supply current and power factor converter circuit inverter

<table>
<thead>
<tr>
<th>Ed</th>
<th>Power Factor</th>
<th>Form Factor</th>
<th>Crest (peak) Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ed &gt; 1.35V</td>
<td>58.7% or less</td>
<td>1.99 or more</td>
<td>2.16 or more</td>
</tr>
<tr>
<td>Ed=1.35V</td>
<td>58.7%</td>
<td>1.99</td>
<td>2.16</td>
</tr>
<tr>
<td>Ed &gt; 1.35V</td>
<td>58.7 to 83.5%</td>
<td>1.99 to 1.27</td>
<td>2.16 to 1.71</td>
</tr>
<tr>
<td>Ed=1.225V</td>
<td>83.5%</td>
<td>1.27</td>
<td>1.91</td>
</tr>
<tr>
<td>Ed &gt; 1.225V</td>
<td>83.5 to 95.3%</td>
<td>1.27 to 1.23</td>
<td>1.71 to 1.28</td>
</tr>
</tbody>
</table>

Input current of inverter I = \frac{Power supply system capacity [kVA]}{V} \cdot I

Overall power factor of the inverter = \frac{Effective power}{Apparent power} = \frac{3 \times \text{input power found by 3-wattmeter method}}{\text{input current effective value}}

The power factor value measured through three-phase power factor meter which indicates a phase difference between voltage and current is different from the above overall power factor because the current flowing in the inverter is not a sine-wave current. Since the input current has a distorted waveform and the form factor is high (the form factor of a sine wave is 1.11) as described above, the overall input power factor of the inverter may become extremely low depending on the power supply voltage and load factor. The overall input power factor is usually about 75 to 80% for inverters. Accordingly, the input current (effective value) increases.
3.4.2 Improvement of power factor

A widespread method of improving the power factor is to insert a reactor in the AC or DC side of the converter in order to smooth the current. (The inverter input power factor is not improved if a power-factor improving power capacitor is inserted in the input circuit: A capacitor must not be inserted in the output circuit. If inserted, the capacitor will be damaged by the harmonic current of the inverter.)

By connecting the optional FR-HAL or FR-HEL power-factor improving reactor to the inverter, the current waveform is improved and the power factor improved as shown in Fig. (b). In addition, the effective value of the input current is reduced.

Use of the high power factor converter (FR-HC) will improve the input current waveform to a sine-waveform, improving the power factor to almost 1 (when the load is 100%). The inverter input current is influenced by the reactance of the power supply line and that of the input transformer. When the reactance of the line is large, the power factor is higher and the input current is smaller. When the input power factor is higher when the power factor improving reactor is installed, the input current may be smaller than the output current.

3.4.3 Inrush current

In a PWM inverter which comprises of a capacitor-input filter circuit, an inrush current flows into the large capacity smoothing electrolytic capacitor when the input MCCB is switched ON. This inrush current, which flows only for the capacitor charging time, is extremely large despite its short duration. Since the inrush current is inversely proportional to the impedance of the power supply, the inrush current increases in proportion to the rise in power supply capacity. To suppress the inrush current, an inrush current suppressing resistor of short-duration rating is provided in the converter circuit of the all models.

To suppress the inrush current, an inrush current suppressing resistor of short-duration rating is provided in the converter circuit of the all models.

3.4.4 Instantaneous power failure

In an instantaneous power failure has occurred (15ms or longer), the inverter protective circuit is activated to coast the motor to a stop. (Refer to page 54) When the power is restored in less than about 50 to 100ms, the instantaneous power failure protective circuit is kept activated and the motor does not restart. When the instantaneous power failure time is approximately 100ms or longer, the inverter is initial-reset at the time of power restoration and the inverter restarts if the start signal remains ON. (For FR-A700) do not have protection against instantaneous power failure. Inverter output is shut off when the bus voltage falls below the specified value. If the start signal has been ON when power restores, inverter restarts. If the motor is coasting at this time, a large current may flow in the inverter and activate the current limit function. In this case, the motor is suddenly decelerated, then reaccelerated. To ensure smooth restart of the coasting motor at the time of power restoration, use the automatic restart function after instantaneous power failure. Use power-failure deceleration stop function to stop the motor at occurrence of a power failure for fail-safe of machine tool, etc.

Use operation continuation function at instantaneous power failure to continue operation without the motor coasting even if an instantaneous power failure occurs during operation.
3.4.5 Power supply voltage variation

The permissible voltage variation range should be within the range from +10% to -15% of the rated voltage. If the power supply voltage rises sharply, the semiconductor devices and electrolytic capacitor may be damaged, adversely affecting the control transformer, magnetic contactor for shorting the inrush current preventing resistor, and the like. In addition, the regenerative brake capability will be reduced, more often resulting in regenerative overvoltage (OV1 to 3).

On the contrary, if the voltage is reduced greatly, undervoltage protection (UVT) or undervoltage warning (UV) is activated and operation may not be performed properly. Particularly when the power supply is shared between the inverter and a large-capacity motor requiring a long starting time, the power supply voltage may drop sharply at when starting the motor. For more information on power supply undervoltage, refer to page 111.

3.4.6 Imbalanced power supply voltage

If a small imbalance (about \( \pm 3\% \)) occurs in the power supply voltage of the inverter, the inverter input current may be unbalanced greatly. In the worst case, the current may flow only in two phases of the three phases. This takes place when the motor is operated by the inverter under a light load or at low speed. When the current flowing in the load is small, the terminal voltage of the smoothing capacitor only falls slowly, causing the input current not to flow in the phase lowest in AC power supply voltage. This is not a fault and the current is balanced when the load increases or when the motor reaches the high-speed range and the input current increases. To find the input current, average the currents measured at all the three phases.

3.4.7 Coordination with power supply

When the overall impedance of the power supply line is small or when there is a power capacitor switching device in the same power supply line, the peak value of the inverter input current may increase, damaging the converter circuit. To prevent this, the power-factor improving reactor must be used to reduce the current peak value by the current limiting action of the reactor. Insert the power-factor improving reactor (FR-HAL).

On the other hand, if an automatic power-factor regulator or a thyristor type controller is connected to the power supply line where the inverter is connected (see below), if the power supply voltage is distorted by running the above devices, the peak value of the inverter input current may increase, damaging the inverter. When such a condition is expected to occur, insert the power-factor improving reactor in the input circuit as when installing the inverter under the power supply transformer as described above.

\*1 Note that using an AC reactor will cause the voltage to drop about 6% = FR-BAL and about 2% = FR-HAL under rated inverter load, reducing the torque.

Diagram: Automatic power-factor regulator or a thyristor type controller is connected to the power supply line.
3.5 Inverter-generated harmonics, EMI and leakage current

3.5.1 Differences between EMI and harmonics

Sometimes inverter affects power supply or other peripherals. Confusion of EMI and harmonics may cause a malfunction of the peripheral devices. Countermeasures against EMI and harmonics are different, so different countermeasures for each cause are required. For example, electromagnetic interference produced by a personal computer are distinctly different in their sources, adverse effects etc. from harmonics in a power circuit, and their countermeasures differ greatly. Their differences will be described below.

Harmonics are defined to have a frequency that is an integral multiple of the fundamental wave and is different from high frequencies. The composition of a single fundamental wave and several harmonics is called a distorted wave. A distorted wave generally includes harmonics in a high-frequency wave (KHz to MHz order). However, a distorted wave handled as harmonics in a power distribution system is usually of up to about 40th to 50th degrees (to several kHz), and a distorted wave above that value generally assumes an irregular form and must therefore be handled as EMI.

<table>
<thead>
<tr>
<th>Item</th>
<th>EMI</th>
<th>Harmonics</th>
<th>Leakage Currents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency band</td>
<td>High frequency (several 10Hz to 1GHz order)</td>
<td>Normally 40th to 50th degrees or less (up to 3kHz or less) (several Hz to MHz order)</td>
<td></td>
</tr>
<tr>
<td>Source</td>
<td>Inverter circuit</td>
<td>Converter circuit</td>
<td>Inverter circuit</td>
</tr>
<tr>
<td>Cause</td>
<td>Transistor switching</td>
<td>Rectifying circuit commutation</td>
<td>Transistor switching</td>
</tr>
<tr>
<td>Generated amount</td>
<td>Depends on voltage variation ratio and switching frequency</td>
<td>Depends on current capacity</td>
<td>Depends on switching frequency and voltage</td>
</tr>
<tr>
<td>Propagation path</td>
<td>Electric channels, space, induction</td>
<td>Electrical channel</td>
<td>Insulating material</td>
</tr>
<tr>
<td>Transmission amount</td>
<td>Distance, wiring route</td>
<td>Line impedance</td>
<td>Capacitance</td>
</tr>
<tr>
<td>Main countermeasure examples</td>
<td>Change the wiring route</td>
<td>Install a reactor</td>
<td>Change detection sensitivity</td>
</tr>
</tbody>
</table>

3.5.2 Power harmonics and their reduction techniques

 Constituted by a power rectifier, the converter circuit of the inverter generates harmonics, distorting the voltage and current waveforms of the input power supply. It is necessary to have a correct understanding of harmonics and take appropriate measures against them when using equipment having a converter circuit in the power supply circuit, e.g. a large-capacity inverter, many inverters, thyristor leonard, thyristor motor or CVCF.

The Japanese harmonic reduction guidelines issued by the Ministry of Economy, Trade and Industry (formerly Ministry of International Trade and Industry) in September 1994 require that the following two main points should be considered as harmonic reduction techniques:

1) Actions taken for faults due to power harmonics (overheating of power capacitors, non-utility generators, etc.)
2) Comply to the Japanese harmonic suppression guidelines

The actions taken to achieve the two points on the left are not always the same, so specific actions must be taken after clarifying their purposes.

(1) Influence on and actions taken for the power supply line

The power supply line to which the inverter is connected with parallel loads such as a power capacitor and a generator. And a harmonic current generated in the inverter is divided into the power supply line and parallel loads according to their impedances. The influence of the harmonic current on the electrical devices (parallel loads) and actions taken against that current will be described below.

1) Power capacitor

For the maximum working voltages and maximum working currents of power capacitors, JIS-C4902
(high-voltage and special high-voltage power capacitors), JIS-C4901 (low-voltage power capacitors) stipulate their harmonic immunities. When parallel resonance is produced by harmonics, an excessive current entering the power capacitor may overheat the capacitor and cause dielectric breakdown. Ordinarily, the power supply impedance is often small enough (the power supply capacity is large) and the power capacitor rarely results in a failure. When a low-voltage power capacitor susceptible to harmonics is used, it is recommended to use the one with a 6% series reactor.

Indicated below is the single-wire diagram and its equivalent circuit where the power capacitor is connected in parallel with the inverter. The harmonic current $I_{\text{cn}}$ generated by the inverter is divided into a harmonic current $I_{\text{sn}}$ which flows into the power supply and a harmonic current $I_{\text{cn}}$ which flows into the capacitor. $I_{\text{cn}}$ is found by the following formula:

$$I_{\text{cn}} = \frac{nX_s}{nX_s + nX_r - X_c/n} \cdot I_{\text{in}}$$

If $nX_s + nX_r - X_c/n = 0$ in the above formula, resonance occurs and a very large current flows in the power capacitor, burning the capacitor. To prevent this, reduce the capacitor current using the series reactor, or insert the power-factor improving reactor in the inverter input circuit or DC circuit, thereby reducing the harmonic current from the inverter.

* The power-factor improving capacitor and surge suppressor on the inverter output side may be overheated or damaged by the harmonic. Also, since an excessive current flows in the inverter to activate overcurrent protection, do not provide a capacitor and surge suppressor on the inverter output side when the motor is driven by the inverter. To improve the power factor, insert a power-factor improving reactor on the inverter's primary side or DC circuit.
(2) Harmonic suppression guideline in Japan

1) Application to the guidelines
Harmonic currents flow from the inverter to a power receiving point via a power transformer. The harmonic suppression guideline was established to protect other consumers from these outgoing harmonic currents. The three-phase 200V input specifications 3.7kW or less are previously covered by "Harmonic reduction guideline for household appliances and general-purpose products" and other models are covered by "Harmonic reduction guideline for consumers who receive high voltage or special high voltage". However, the general-purpose inverter has been excluded from the target products covered by "Harmonic reduction guideline for household appliances and general-purpose products" in January 2004 and "Harmonic reduction guideline for household appliances and general-purpose products" was repealed on September 6, 2004. All capacity and all models of general-purpose inverter used by specific consumers are covered by "Harmonic reduction guideline for consumers who receive high voltage or special high voltage".

- Harmonic reduction guideline for consumers receiving power of high voltage or specially high voltage
The upper limit of the outgoing harmonic current per 1kW contract power is determined for the power receiving point of a consumer who receives power of high voltage or specially high voltage. Note that whether the reduction technique is required or not depends on whether the sum of outgoing harmonic current values of a consumer exceeds the upper limit of the permissible outgoing current determined by the contract power.

2) How to judge whether harmonic reduction technique is required or not at the consumer who receives power of high voltage or especially high voltage
When updating the contract power, a consumer is requested to present a calculation sheet in the format as shown on page 516. Calculation using the predetermined procedure clarifies whether the reduction technique is required or not. A specific procedure will be described below.

(a) Calculation of rated capacity [kVA]
Used to calculate the 6-pulse equivalent capacity to judge whether the inverter is covered by the "Harmonic reduction guideline for consumers receiving power of high voltage or specially high voltage". Independently of whether the inverter has a reactor or not, the rated capacity [kVA] is standardized according to the motor capacity and found by the following formula:

\[ \text{Rated capacity} = \sqrt{3} \times V \times \text{fundamental wave current} \times \text{coefficient} \times 10^{-3} [\text{kVA}] \]

- \( V \): 200V or 400V (input voltage)
- \( \text{Fundamental wave current} \)

Refer to the table on the following page for the coefficient. If the sum of equivalent capacities is higher than the limit found by the above formula, outgoing current of harmonics must be calculated with the following procedure:

(b) Calculation of 6-pulse equivalent capacity
6 pulses equivalent capacity

\[ \text{6 pulses equivalent capacity} = \text{Rated capacity} \times \text{Conversion factor Ki [kVA]} \]

Where, conversion factor Ki is as follows:

- Without reactor: 3.4
- With AC reactor: 1.8
- With DC reactor: 1.8
- With AC and DC reactors: 1.4

If the sum of equivalent capacities is higher than the limit found by the above formula, outgoing current of harmonics must be calculated with the following procedure:

(c) Conversion of received power voltage into rated current

\[ \text{Rated current converted from received power voltage} = \text{Fundamental wave current} \times \frac{200V \text{ or } 400V \text{ inverter power supply voltage}}{\text{received power voltage}} [\text{A}] \]
(d) Calculation of outgoing harmonic current of each degree

Outgoing harmonic current
= Rated current converted from received power voltage × maximum operation ratio × harmonic content \( \times 10^3 \) mA

Note that the harmonic content is as indicated in the table on the next page.

(If the consumer has a facility to reduce harmonic currents, its effect may be taken into consideration.)

<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>200V</td>
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<tr>
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<tr>
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<td>400</td>
<td>815</td>
<td>331</td>
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<tr>
<td>450</td>
<td>887</td>
<td>355</td>
</tr>
<tr>
<td>500</td>
<td>959</td>
<td>380</td>
</tr>
<tr>
<td>560</td>
<td>1031</td>
<td>405</td>
</tr>
</tbody>
</table>
3) Specific calculation example

When a 30kW 400V motor is driven by the FR-A740-30K inverter

Fundamental wave current of the inverter is 49.0A

Rated capacity

\[ \text{Rated capacity} = 34.7 \times \text{fundamental wave current} \times 10^{-3} \]

\[ = 34.7 \times 49.0 \times 1.0228 \times 10^{-3} \]

\[ = 118 \text{[kVA]} \]

Since this value exceeds 50 [kVA], the inverter is covered by the guideline.

Hence, find the outgoing harmonic current in the following procedure:

Rated current converted from received power voltage

\[ \text{Rated current} = \frac{\text{Fundamental wave current} \times (400 \text{V}/\text{received voltage})}{1000} \]

\[ = \frac{49.0 \times 400}{6600} \approx 2.97 \text{[A]} \]

Outgoing harmonic current

It is derived from the following table.

Assume that the operation ratio is 50%.

4) Harmonic reduction techniques

(a) Reactors for inverter (ACL, DCL)

Install a reactor (ACL) on the AC side of the inverter or a reactor (DCL) on its DC side or both to reduce outgoing harmonic currents.

Generally, installation of the reactor in only one side of the inverter often produces an insufficient suppression effect.

(b) Installation of power factor improving capacitor

When used with a series reactor, the power factor improving capacitor has an effect of absorbing harmonic currents.

This power factor improving capacitor may be installed in either a high or low voltage side.

(c) Transformer multi-phase operation

When two transformers are used, connecting them with a phase angle difference of 30 degrees as in \( \Delta \rightarrow \Delta' \rightarrow \Delta \) combination will produce an effect corresponding to 12 pulses.

In this case, it is ideal that the harmonic generating equipment of the load of each transformer is the same in model and capacity. If the capacity differs, however, a 12-pulse effect for smaller-capacity equipment can be expected. Therefore, the conversion factor for 6-pulse reference is halved.

(d) AC filter

A capacitor and a reactor are used together to reduce impedances at specific frequencies, producing a great effect of absorbing harmonic currents.

The AC filter exhibits an effect on a specific frequency. When there is more than one harmonic current degree, the AC filter must be installed for each degree.
(e) Active filter
This filter detects the current of a circuit generating a harmonic current equivalent to the difference between that current and the fundamental wave current to suppress the harmonic current at the detection point. As this filter compensates for a whole waveform, a single filter can provide effects on more than one degree of harmonic. The filter has a protective function. Therefore, if there is an incoming excessive harmonic current, the filter may be short of the harmonic current absorbing effect (i.e. not perform as good) but will not overheat or burn out. To utilize the performance of the active filter effective, circuit conditions and others must be examined before installing the active filter.

* For further information, refer to the Technical note No.28
Overview of the guideline (excerpt)

Harmonic reduction guideline for consumers who receive high voltage or special high voltage

1. Purpose
This guideline sets forth technological requirements to reduce harmonic currents generated when electric equipments are used by consumers who receive power of high voltage or specially high voltage (hereinafter referred to as the "specific consumers") from commercial power systems (hereinafter referred to as the "system"), after observing the technological standards in accordance with the Electricity Enterprises Act and taking into account the harmonic environment target levels of the systems.

2. Scope
(1) This guideline applies to the specific consumers whose sum of "equivalent capacities" of harmonic generating equipment falls within either of the following:
1) Consumers who receive power from high voltage systems 6.6kV system 50kVA or more
2) Consumers who receive power from specially high voltage systems 22kV or 33kV system 300kVA or more 66kV or more system 2000kVA or more
(2) Equipment covered by (1) shall be all harmonic generating equipment with the exception of the equipment covered by the "Harmonic reduction guideline for household appliances and general-purpose products".
(3) Any new harmonic generating equipment installed or added/renewed is covered by this guideline when the sum of equivalent capacities fall within the value indicated above in (1) after installation, addition or renewal.

3. Reduction of harmonic currents
The maximum outgoing harmonic current values at a specific consumer's receiving shall be values by multiplying the maximum outgoing harmonic current values per 1kW of contract power indicated in the table on the next page by the contract power of the corresponding consumer. If any of these values is exceeded, the necessary countermeasure must be taken.

4. Calculation of outgoing harmonic currents
Outgoing harmonic currents at a receiving point shall be as follows:
(1) Only the magnitude of an outgoing harmonic current is calculated and the 40th or less degree shall be covered by this guideline.
(2) An outgoing harmonic current at a receiving point is found by summing up harmonic currents generated in the rated operating status of individual harmonic generating equipment and multiplying the sum by the maximum operation ratio of the harmonic generating equipment. If the consumer has a facility to reduce harmonic currents, its effect may be taken into consideration.
Overview of the guideline (excerpt)

5. Other references

(1) Contract power

If the "contract power" is not determined at the point of a consumption contract between an electric power company and a consumer or more than one consumer and will be determined later, the contract power shall be as defined below:

1) The contract facility power applies to consumers to whom the "real amount system" of the industrial power of high-voltage power A or less than 500kW contract power is applied.
2) When there are more than one contract power such as time zone-based regulation contract, the largest contract power applies among the contract powers.

(2) Maximum operation ratio of harmonic generating equipment

The "maximum operation ratio of harmonic generating equipment" indicates the ratio of the maximum actual operation capacity (average during 30 minutes) to the sum of capacities of the harmonic generating equipment.

<table>
<thead>
<tr>
<th>Received Power Voltage</th>
<th>5th</th>
<th>7th</th>
<th>11th</th>
<th>13th</th>
<th>17th</th>
<th>19th</th>
<th>23rd</th>
<th>Over 23rd</th>
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</thead>
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<tr>
<td>6.6kV</td>
<td>3.5</td>
<td>2.5</td>
<td>1.6</td>
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<td>22</td>
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<td>0.04</td>
<td>0.03</td>
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(Unit: mA/kW)
Calculation sheet for outgoing harmonic currents from harmonic generating equipment (Part 1)

### STEP 1 HARMONIC GENERATING EQUIPMENT PARTICULARS

<table>
<thead>
<tr>
<th>Equipment Name</th>
<th>No.</th>
<th>Quantity</th>
<th>Rated Capacity (kVA)</th>
<th>Model</th>
<th>Manufacturer</th>
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### STEP 2 GENERATED HARMONIC CURRENT CALCULATION

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<th>27th</th>
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<th>31st</th>
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</tr>
</tbody>
</table>

### Calculation Details

- **5th 7th 11th 13th 17th 19th 23rd 25th Degree Maximum Harmonic Current Value** (mA)
- **Maximum Outgoing Harmonic Current Value** (Maximum outgoing harmonic value per kW contract × contract power)

### In-Plant Single-Wire Connection Diagram

1. Specify the installation position, specifications, electrical constants, etc. of harmonic generating equipment, power receiving transformers, and equipment and the like which reduce (branch) harmonic currents.
2. In consideration of equipment for harmonic current reduction and a suppression effect by branching, specifically describe the process of calculating outgoing harmonic currents at the power receiving point.

### Judgment of suppression technique requirement

If (outgoing harmonic current after consideration of reduction effect) > (maximum outgoing harmonic current value) for each degree, an additional suppression technique will be required.

---

* Refer to Technical note No.28 for format-3.
How about other than specific consumers?

Japan Electrical Manufacturer’s Association established JEM-TR236 for consumers who do not correspond to “Harmonic reduction guideline for consumers who receive high voltage or special high voltage”. “Harmonic reduction guideline of the general-purpose inverter (input current of 20A or less)” as a new technical information based on the conventional guideline to raise awareness on overall harmonic suppression.

The purpose of this guideline is that customers take measures against harmonic reduction with the inverter alone to a maximum extent.

For compliance to “Harmonic reduction guideline of the general-purpose inverter (input current of 20A or less)” for consumers other than specific consumers

Subject models

<table>
<thead>
<tr>
<th>Input Power</th>
<th>Applicable Motor Capacity</th>
<th>Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single phase 100V</td>
<td>0.75kW or less</td>
<td>Connect the AC reactor or DC reactor recommended in a catalog or an instruction manual.</td>
</tr>
<tr>
<td>Single phase 200V</td>
<td>2.2kW or less</td>
<td></td>
</tr>
<tr>
<td>Three phase 200V</td>
<td>3.7kW or less</td>
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</table>
3.5.3 Inverter-generated EMI and their reduction techniques

EMI generated by the inverter is largely classified into EMI radiated by cables connected to the inverter and its main circuit (input, output), magnetic and static induction EMI affecting peripheral device signal lines routed near the main circuit cable and electric path propagation EMI transmitted over the power supply path line.

The EMI types and their paths are shown below.

Influence given to the peripheral devices by high-frequency EMI of the inverter include the malfunctions of computers instrumentation equipment, electronic equipment etc. mainly caused by induction EMI and the malfunctions of radios and nearby switches chiefly caused by radiated EMI.

For details of noise reduction techniques, refer to the Technical note No.21 (Noise and leakage currents).

(1) EMI to electronic equipment

EMI to electronic devices include those transmitted directly over the power supply line and ground cable of the inverter (paths 7 and 8 in the figure above) and those transmitted where the inverter power line and electronic equipment signal line are coupled by electromagnetic induction (paths 4 and 5 in the figure above) or electrostatic induction (path 6 in the figure above).

The power supply line of the electronic devices should be different from the power line where the inverter is connected, protected from EMI incoming from the power supply line by a constant-voltage power supply, insulating transformer, filters etc. and separated from the wiring route. The I/O cables to and from the electronic devices should be separated from the inverter power cables. Basically, keep inverter power cable as far away as possible from cables which must not be subjected to EMI, or run inverter power cable in separate iron shields (ordinarily, iron ducts or metal pipes which should be grounded) to minimize electromagnetic induction and prevent a failure. The best way of grounding the devices is independent equipment must not be grounded jointly.

Especially as a countermeasure against EMI, run the cables in the shortest distance and twist them. Also, grounding should be carried out securely using a large-diameter cable over the shortest distance.
(2) Radio EMI

When the motor is driven from the inverter, high frequency EMI is radiated to the air from the inverter. Like radio-wave EMI, this EMI has a great influence on the frequency band of less than 10MHz and may generate noise when entering into a radio receiver. The radio EMI suppressing methods, radio EMI propagation paths and measurement methods are given below:

1) EMI propagation paths

Major propagation paths of the radio-wave EMI from the source of noise to a receiver affected may be as indicated below:

(a) Direct radiation
EMI radiated directly from the EMI source as an airborne wave and entering the antenna and circuit of the receiver.

(b) Direct transmission
EMI of which current is transmitted through the power supply line and enters the receiver.

(c) Radiation from the power supply line
EMI which leads to the power supply line is radiated from the distribution line and enters the receiver.

(d) Radiation from the power cables
EMI which is radiated from the wiring between the inverter and motor and enters the receiver.

2) EMI measuring methods

(a) Measurement of EMI terminal voltage
Disturbance wave strength flowing into the power cord of the disturbing device is measured as a disturbance wave voltage on the distribution line where that device is connected. The measured value is indicated on dB (1µV/m = 0dB).

(b) Measurement of EMI field strength
The strength of the electric field radiated by the disturbing device to the air is measured with an antenna. The distance of measurement between the devices and antenna is specified as 10m or 3m. The measured value is indicated on dB (1µV/m = 0dB).

(c) Also, disturbing power or the discontinuous EMI (click EMI) of a contact device is measured depending on the EMI type. As described above, the evaluation of disturbance wave EMI depends greatly on the difference of its propagation path and the type of EMI measuring method. The most appropriate method for comparing actual harm to the radio receiver by the disturbance wave is to measure the propagation EMI field strength because the receiver is mostly influenced by the propagation paths (a), (c) or (d).

3) Countermeasures against radio EMI

Radio EMI can be reduced by any of the following methods:

(a) Connect the capacitor type filter (FR-BIF) dedicated to FR-series inverters across the inverter input power supply terminals (Phase R, S, T) and securely ground it with the ground cable. This is effective when the wiring distance between the inverter and motor is short.

(b) When the wiring distance between the inverter and motor is long, run the cable between the inverter and motor in a grounding conduit.

(c) Also, disturbing power or the discontinuous EMI (click EMI) of a contact device is measured depending on the EMI type. As described above, the evaluation of disturbance wave EMI depends greatly on the difference of its propagation path and the type of EMI measuring method. The most appropriate method for comparing actual harm to the radio receiver by the disturbance wave is to measure the propagation EMI field strength because the receiver is mostly influenced by the propagation paths (a), (c) or (d).

Capacitor type filter

These FR-A700, A500, F700, and FR-A720 inverters are equipped with a built-in noise filter that is equivalent to a capacitor noise filter. Using the ON/OFF connector, whether to connect to the earth (ground) or not can be selected. (ON/OFF connector is not available for FR-A720-0.4K, 0.75K, and 1.5K. Connector is always in ON status.)

(b) When the wiring distance between the inverter and motor is long, run the cable between the inverter and motor in a grounding conduit.
(c) House the inverter in an iron cubicle (without any instrument windows and indicator light windows) and ground the cubicle.

(d) Connect the common mode filter(s) (FR-BSF01, FR-BLF) across either or both the input terminals and output terminals of the inverter and house the inverter and cables in a grounding conduit.

Use the common mode filter(s) together with the capacitor type filter to produce a greater effect.

Built-in EMC filter type of the 55kW or less has a filter corresponding to the common mode filter on the input side.

For example, a radio used in an urban area does not suffer from EMI if it is used more than about 30m away from the inverter and the main circuit wiring to the inverter.
(3) Specific technique examples

1) Techniques and effects

The following levels (estimated values) of effects are expected for the technique examples (on the next page).

Use this data for reference when determining the priority of actual techniques.

Symbol meanings

- Large effect
- Effect produced
- Small effect
- No effect

Effects of EMI reduction techniques

<table>
<thead>
<tr>
<th>Location Symbol</th>
<th>Technique</th>
<th>EMI Propagation</th>
<th>Air propagated EMI</th>
<th>Electro-magnetic induction interference</th>
<th>Electro-static induction interference</th>
<th>Power cables</th>
<th>Leakage current of ground cable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air propagated EMI</td>
<td>Radiation from inverter</td>
<td>Radiation from power cables</td>
<td>Radiation from motor cables</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EMI Propagation</td>
<td>Air propagated EMI</td>
<td>Electro-magnetic induction interference</td>
<td>Electro-static induction interference</td>
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<tr>
<td>Location Symbol</td>
<td>Technique</td>
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<td>Leakage current of ground cable</td>
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<tr>
<td>Air propagated EMI</td>
<td>Radiation from inverter</td>
<td>Radiation from power cables</td>
<td>Radiation from motor cables</td>
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<tr>
<td>EMI Propagation</td>
<td>Air propagated EMI</td>
<td>Electro-magnetic induction interference</td>
<td>Electro-static induction interference</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Examples:
- **A** Decrease carrier frequency
  - Decrease carrier frequency [Pr. 72]
- **B** Increase input S/W filter constant
  - Increase input S/W filter constant [Pr. 74] ——
- **C** Install capacitor type filter FR-BIF (-H)
  - Install capacitor type filter FR-BIF (-H) — — — —
- **D** Install common mode filter FR-BSF01 or FR-BLF
  - Install common mode filter FR-BSF01 or FR-BLF — — — —
- **E** Run power supply cables in metal conduit or use shielded cables as power supply cables
  - Run power supply cables in metal conduit or use shielded cables as power supply cables — — — — — — — —
- **F** Install insulated transformer or noise reduction transformer
  - Install insulated transformer or noise reduction transformer — — — — — — — —
- **G** Separate power supply line
  - Separate power supply line — — — — — — — —
- **H** Install common mode filter FR-BSF01 or FR-BLF
  - Install common mode filter FR-BSF01 or FR-BLF — — — — — — — —
- **I** Run output cables in metal conduit or use shielded cables
  - Run output cables in metal conduit or use shielded cables — — — — — — — —
- **J** Use 4-core cable as motor power line and use one wire as ground cable
  - Use 4-core cable as motor power line and use one wire as ground cable — — — — — — — —
- **K** Install capacitor type filter FR-BIF (-H)
  - Install capacitor type filter FR-BIF (-H) — — — —
- **L** Connect shield to common of sensor signal
  - Connect shield to common of sensor signal — — — — — — — —
- **M** Do not earth sensor power unit to control box etc. directly
  - Do not earth sensor power unit to control box etc. directly — — — — — — — —
- **N** Install insulated transformer or noise reduction transformer
  - Install insulated transformer or noise reduction transformer — — — — — — — —
- **O** Lower impedance of output circuit of mating equipment
  - Lower impedance of output circuit of mating equipment — — — — — — — —
- **P** Insert ferrite cores available commercially into speed input cables (output side of mating equipment)
  - Insert ferrite cores available commercially into speed input cables (output side of mating equipment) — — — — — — — —
- **Q** Insert ferrite cores available commercially in input side of mating equipment
  - Insert ferrite cores available commercially in input side of mating equipment — — — — — — — —
- **R** Separate more than 30cm from inverter and power line
  - Separate more than 30cm from inverter and power line — — — — — — — —
- **S** Do not run cables in parallel or together
  - Do not run cables in parallel or together — — — — — — — —
- **T** Provide masking shield
  - Provide masking shield — — — — — — — —
- **U** Keep away from ground
  - Keep away from ground — — — — — — — —
- **V** Insert ferrite cores available commercially in input side of mating equipment
  - Insert ferrite cores available commercially in input side of mating equipment — — — — — — — —

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2) Technique examples

The following method will produce some effects with regard to inverter EMI reduction. For effects, see the preceding page.

- **A. Lower carrier frequency.**
- **B. Increase inverter parameter, \( Pr. 74 \) (input filter constant) setting (note that response level is reduced).
- **C. Install radio noise filter FR-BIF on inverter input side.
- **D. Install line noise filter (FR-BLF, FR-BSF01) on inverter input side.
- **E. Run cables in metal pipe (conduit) or earth shield cable to machine at one point.
- **F. Install insulating transformer or EMI reduction transformer.
- **G. Separate power supply line.
- **H. Install line noise filter (FR-BLF, FR-BSF01) on inverter output side.
- **I. Run cables in metal pipe (conduit) or earth shield cable to control box.
- **J. Use 4-core cable as motor power line and use one wire as earth cable.
- **K. Use twisted pair shielded cable. DC power supply for sensor
- **L. Do not earth shield but connect it to signal common wire.
- **M. Do not earth to control box directly.
- **N. Earth to control box via 0.1 to 0.01 \( \mu \)F capacitor.
- **O. Use shielded cables and connect shield to SD.
- **P. Use twisted pair shielded cables and connect shield to terminal 5.
- **Q. Insert ferrite cores available on market.
- **R. Lower impedance of output circuit.
- **S. Separate sensor circuit more than 30cm (at least 10cm) away from inverter and power line.
- **T. Use sensor of high EMI immunity.
- **U. Keep as far away as possible from ground.
- **V. Keep as far away as possible from ground.
Instructions for installation of noise filters

<Installation in inverter input side>

- Normal inverter
- Common mode filter
- FR-BIF
- FR-BLF
- FR-BSF01
- Wire over shortest distance.

<Installation in inverter output side>

- Normal inverter
- Common mode filter
- FR-BIF
- FR-BLF
- FR-BSF01

Cable routing in control box

- T. Run cables as separately as possible and do not run cables in parallel or together. Cross them where inevitable.
- U. Masking shield
- V. Separate by more than 30cm (at least 10cm).

Instructions for encoder cable wiring

- To reduce EMI of the encoder cable, earth (ground) the encoder shielded cable to the enclosure (as near as the inverter) with a P clip or U clip made of metal. To protect the cables from EMI, run them away from any source of noise (e.g. the main circuit and power voltage).
3.5.4 Leakage currents and countermeasures

Due to capacitances existing in the inverter I/O lines and ground, leakage currents flow through them, in addition to the motor current. These leakage currents are determined by the magnitudes of switching frequency (fc) (carrier frequency) and line-to-line and to-ground capacitances:

1) When the carrier frequency increases, the leakage current of the inverter increases.
2) If the wiring length is long, the line-to-line and to-ground capacitances increase, increasing the leakage current.

Therefore, independent of the manufacture and inverter type, a low acoustic noise inverter using high-carrier frequency PWM control tends to increase leakage current.

(1) Influence of leakage currents

1) An earth leakage circuit breaker is actuated by to-ground leakage currents. Compared to a case where a motor is driven by a commercial power supply, leakage current produced by inverter operation includes more high-frequency components and to-ground leakage current in this high frequency band are higher than the operating current of the earth leakage circuit breaker, actuating the earth leakage circuit breaker.

(a) The earth leakage circuit breaker (NV1) is actuated when leakage current flow through to-ground capacitances C in paths A) and B) indicated by dotted lines and exceed the setting of the earth leakage circuit breaker in the same line.
(b) The earth leakage circuit breaker NV2 or NV1 in the other line is actuated when leakage current flows in paths C), D), E), etc. indicated by dotted line.

2) External thermal relay is tripped by line-to-line leakage currents. If the wiring distance on the inverter output side is long, line-to-line leakage currents A) may increase the effective value of the current flowing in the thermal relay, operating the thermal relay. A smaller-capacity model whose rated current is less than several amperes is more liable to be affected by leakage currents. A leakage current b) may produce a several volts potential at the terminal of the radio noise filter (FR-BIF) but it is not a fault.

(2) Leakage current data

To-ground leakage current example

<table>
<thead>
<tr>
<th>Carrier Frequency</th>
<th>Leakage Current (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2kHz</td>
<td>90</td>
</tr>
<tr>
<td>14.5kHz</td>
<td>210</td>
</tr>
</tbody>
</table>

(Wiring length: 50m) (Running frequency: 60Hz)

Motor Capacity (kW)

<table>
<thead>
<tr>
<th>Rated current</th>
<th>Leakage current value (A)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.4</td>
<td>1.4</td>
</tr>
<tr>
<td>0.75</td>
<td>3.2</td>
</tr>
<tr>
<td>1.5</td>
<td>5.6</td>
</tr>
<tr>
<td>2.2</td>
<td>8.2</td>
</tr>
</tbody>
</table>

(Leakage currents in commercial power supply operation are approximately 1mA)

Motor Capacity (kW) (Wire used: 3.5 × 4-core type cable)
(3) Countermeasure to be taken for unnecessary operation of earth leakage circuit breaker and thermal relay due to earth leakage current

1) Countermeasure to be taken for unnecessary operation of earth leakage circuit breaker
   (a) Use an earth leakage circuit breaker (or earth leakage relay) for which high frequency components have been considered
      Use the earth leakage circuit breaker developed for use with an inverter, e.g. Mitsubishi’s products designed for harmonic and surge suppression or set a large sensitivity current to prevent unnecessary operation.
   (b) Provide dedicated ground cable.
      Provide the motor with a dedicated ground cable to divide current, thereby reducing to-ground leakage current.

2) Countermeasure to taken for thermal relay malfunction
   (c) Use the electronic thermal relay function built into the inverter.
      Inverter detects output current after cutting high frequency components. And thermal relay function is rarely affected by leakage currents.
   (d) Increase the setting of the external thermal relay.
      When the electronic thermal relay cannot be used, e.g. when two or more motors are connected to one inverter and thermal relays are installed individually, increase the setting of each external thermal relay by the equivalence of the leakage current to make them difficult to be actuated. Motors of 11kW or more capacity rarely have leakage current to make them difficult to be actuated.

3) Countermeasure to be taken for unnecessary operation of earth leakage circuit breaker and thermal relay.
   (e) Set the carrier frequency of the inverter to a low value.
      Decrease leakage current by setting the carrier frequency of the inverter to a low value using the relevant parameter. However, it should be noted that the decrease in carrier frequency increases noise during motor running.
   (f) Decrease the to-ground and line-to-line capacitances.
      Wire cables of smaller capacitances between the inverter power supply side and motor side to minimize the wiring length.

Examples of countermeasure to be taken to prevent unnecessary operation

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>a) Operation of circuit breaker in the same line</td>
<td>✓</td>
<td>✔</td>
<td>×</td>
<td>×</td>
<td>✔</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>b) Operation of circuit breaker in the other line</td>
<td>✓</td>
<td>✔</td>
<td>×</td>
<td>×</td>
<td>✔</td>
<td>×</td>
</tr>
<tr>
<td>2)</td>
<td>c) Thermal relay operation</td>
<td>×</td>
<td>×</td>
<td>✓</td>
<td>○</td>
<td>×</td>
<td>×</td>
</tr>
</tbody>
</table>

Effect of countermeasure

Countermeasure marked ✓ are recommended for phenomena occurring due to the influence of leakage current.

Symbol meaning: ••• Adequate effect, • Effect produced, × No effect
### 3.6 Selection of peripheral devices

The moulded case circuit breakers, magnetic contactors and cables differ with the inverter models. For specific selection, refer to the corresponding model catalog or manual.

#### Peripheral device selection list (example)

<table>
<thead>
<tr>
<th>Voltage</th>
<th>Motor Output (kW)*1</th>
<th>Applied Inverter Type</th>
<th>Moulded Case Circuit Breaker (MCCB)*2 or Earth Leakage Circuit Breaker (ELB)</th>
<th>Magnetic contactor on the Input Side*3</th>
<th>Recommended Cable Size (mm²)*4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Reactor connection</td>
<td>Reactor connection</td>
<td>R, S, T</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Without</td>
<td>Without</td>
<td>U, V, W</td>
</tr>
<tr>
<td>200V</td>
<td>0.4</td>
<td>FR-A720-0.4K</td>
<td>30AF 5A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>0.75</td>
<td>FR-A720-0.75K</td>
<td>30AF 10A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
<td>FR-A720-1.5K</td>
<td>30AF 15A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2.2</td>
<td>FR-A720-2.2K</td>
<td>30AF 20A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>3.7</td>
<td>FR-A720-3.7K</td>
<td>30AF 30A</td>
<td>S-N20</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>5.5</td>
<td>FR-A720-5.5K</td>
<td>50AF 50A</td>
<td>S-N25</td>
<td>5.5</td>
</tr>
<tr>
<td></td>
<td>7.5</td>
<td>FR-A720-7.5K</td>
<td>100AF 50A</td>
<td>S-N25</td>
<td>14</td>
</tr>
<tr>
<td>380V</td>
<td>11</td>
<td>FR-A720-11k</td>
<td>150AF 75A</td>
<td>S-N25</td>
<td>14</td>
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<tr>
<td></td>
<td>15</td>
<td>FR-A720-15K</td>
<td>225AF 125A</td>
<td>S-N50</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>18.5</td>
<td>FR-A720-18.5K</td>
<td>225AF 150A</td>
<td>S-N65</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>FR-A720-22K</td>
<td>225AF 175A</td>
<td>S-N65</td>
<td>38</td>
</tr>
<tr>
<td></td>
<td>30</td>
<td>FR-A720-30K</td>
<td>225AF 225A</td>
<td>S-N65</td>
<td>38</td>
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<tr>
<td></td>
<td>37</td>
<td>FR-A720-37K</td>
<td>400AF 250A</td>
<td>S-N150</td>
<td>80</td>
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<tr>
<td></td>
<td>40</td>
<td>FR-A720-40K</td>
<td>400AF 300A</td>
<td>S-N180</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>55</td>
<td>FR-A720-55K</td>
<td>400AF 400A</td>
<td>S-N220</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>75</td>
<td>FR-A720-75K</td>
<td>400AF 400A</td>
<td>S-N300</td>
<td>125</td>
</tr>
<tr>
<td></td>
<td>90</td>
<td>FR-A720-90K</td>
<td>400AF 400A</td>
<td>S-N300</td>
<td>150</td>
</tr>
</tbody>
</table>
### Peripheral device selection list (example [A700])

<table>
<thead>
<tr>
<th>Motor Output (kW)*1</th>
<th>Applied Inverter Type</th>
<th>Moulded Case Circuit Breaker (MCCB) or Earth Leakage Circuit Breaker (ELB)</th>
<th>Magnetic contactor on the Input Side*2</th>
<th>Recommended Cable Size (mm²)*4</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Reactor connection</td>
<td>R, S, T</td>
<td>U, V, W</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reactor connection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.4 FR-A740-0.4K</td>
<td>30AF 5A</td>
<td>30AF 5A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td>0.75 FR-A740-0.75K</td>
<td>30AF 5A</td>
<td>30AF 5A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td>1.0 FR-A740-1.0K</td>
<td>30AF 10A</td>
<td>30AF 10A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td>1.5 FR-A740-1.5K</td>
<td>30AF 15A</td>
<td>30AF 15A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td>2.2 FR-A740-2.2K</td>
<td>30AF 20A</td>
<td>30AF 20A</td>
<td>S-N10</td>
<td>2</td>
</tr>
<tr>
<td>3.7 FR-A740-3.7K</td>
<td>30AF 30A</td>
<td>30AF 30A</td>
<td>S-N20, S-N21</td>
<td>2</td>
</tr>
<tr>
<td>5.5 FR-A740-5.5K</td>
<td>30AF 30A</td>
<td>30AF 30A</td>
<td>S-N20, S-N21</td>
<td>2</td>
</tr>
<tr>
<td>7.5 FR-A740-7.5K</td>
<td>30AF 30A</td>
<td>30AF 30A</td>
<td>S-N20, S-N21</td>
<td>2</td>
</tr>
<tr>
<td>11 FR-A740-11K</td>
<td>50AF 50A</td>
<td>50AF 50A</td>
<td>S-N20, S-N21</td>
<td>2</td>
</tr>
<tr>
<td>15 FR-A740-15K</td>
<td>50AF 50A</td>
<td>50AF 50A</td>
<td>S-N20, S-N21</td>
<td>2</td>
</tr>
<tr>
<td>18.5 FR-A740-18.5K</td>
<td>100AF 10A</td>
<td>100AF 10A</td>
<td>S-N20, S-N21</td>
<td>14</td>
</tr>
<tr>
<td>22 FR-A740-22K</td>
<td>100AF 10A</td>
<td>100AF 10A</td>
<td>S-N20, S-N21</td>
<td>14</td>
</tr>
<tr>
<td>30 FR-A740-30K</td>
<td>100AF 10A</td>
<td>100AF 10A</td>
<td>S-N20, S-N21</td>
<td>22</td>
</tr>
<tr>
<td>37 FR-A740-37K</td>
<td>225AF 15A</td>
<td>225AF 15A</td>
<td>S-N20, S-N21</td>
<td>22</td>
</tr>
<tr>
<td>45 FR-A740-45K</td>
<td>225AF 17A</td>
<td>225AF 17A</td>
<td>S-N20, S-N21</td>
<td>38</td>
</tr>
<tr>
<td>55 FR-A740-55K</td>
<td>225AF 19A</td>
<td>225AF 19A</td>
<td>S-N20, S-N21</td>
<td>38</td>
</tr>
<tr>
<td>75 FR-A740-75K</td>
<td>225AF 22A</td>
<td>225AF 22A</td>
<td>S-N20, S-N21</td>
<td>60</td>
</tr>
<tr>
<td>90 FR-A740-90K</td>
<td>225AF 22A</td>
<td>225AF 22A</td>
<td>S-N20, S-N21</td>
<td>60</td>
</tr>
<tr>
<td>110 FR-A740-110K</td>
<td>225AF 22A</td>
<td>225AF 22A</td>
<td>S-N20, S-N21</td>
<td>60</td>
</tr>
<tr>
<td>132 FR-A740-132K</td>
<td>400AF 40A</td>
<td>400AF 40A</td>
<td>S-N20, S-N21</td>
<td>80</td>
</tr>
<tr>
<td>150 FR-A740-150K</td>
<td>400AF 40A</td>
<td>400AF 40A</td>
<td>S-N20, S-N21</td>
<td>80</td>
</tr>
<tr>
<td>180 FR-A740-180K</td>
<td>400AF 40A</td>
<td>400AF 40A</td>
<td>S-N20, S-N21</td>
<td>80</td>
</tr>
<tr>
<td>220 FR-A740-220K</td>
<td>600AF 50A</td>
<td>600AF 50A</td>
<td>S-N20, S-N21</td>
<td>125</td>
</tr>
<tr>
<td>250 FR-A740-250K</td>
<td>600AF 50A</td>
<td>600AF 50A</td>
<td>S-N20, S-N21</td>
<td>125</td>
</tr>
<tr>
<td>280 FR-A740-280K</td>
<td>600AF 60A</td>
<td>600AF 60A</td>
<td>S-N20, S-N21</td>
<td>150</td>
</tr>
<tr>
<td>315 FR-A740-315K</td>
<td>600AF 70A</td>
<td>600AF 70A</td>
<td>S-N20, S-N21</td>
<td>150</td>
</tr>
<tr>
<td>355 FR-A740-355K</td>
<td>600AF 80A</td>
<td>600AF 80A</td>
<td>S-N20, S-N21</td>
<td>150</td>
</tr>
<tr>
<td>400 FR-A740-400K</td>
<td>600AF 80A</td>
<td>600AF 80A</td>
<td>S-N20, S-N21</td>
<td>150</td>
</tr>
<tr>
<td>450 FR-A740-450K</td>
<td>1000AF 100A</td>
<td>1000AF 100A</td>
<td>S-N20, S-N21</td>
<td>200</td>
</tr>
<tr>
<td>500 FR-A740-500K</td>
<td>1000AF 100A</td>
<td>1000AF 100A</td>
<td>S-N20, S-N21</td>
<td>200</td>
</tr>
</tbody>
</table>

*1 Selections for use of the Mitsubishi 4-pole standard motor with power supply voltage 200VAC (200V class)/400VAC (400V class) 50Hz.

*2 Install one MCCB per inverter. For the use in the United States or Canada, provide the appropriate UL and cUL listed Class RK5, Class T or Class L type fuse or UL489 molded case circuit breaker (MCCB) that is suitable for branch circuit protection. For details, refer to page 552.

*3 Magnetic contactor is selected based on the AC-1 class. When the magnetic contactor is used for emergency stop during motor driving, the electrical durability is 25 times.

When using the MC for emergency stop during motor driving or using on the motor side during commercial-power supply operation, select the class AC-3 rated current for the motor rated current.

*4 Cable For the 55K or less, the recommended cable size is the cable (HV cable (high voltage 400V class) class 2, power cable) etc.) with continuous maximum permissible temperature of 75°C. Assumes that the surrounding air temperature is 50°C or less and the wiring distance is 20m or less. For the 75K or more, the recommended cable size is the cable (e.g. LMFC (low voltage flexible cross-linked polyethylene insulated cable)) with continuous maximum permissible temperature of 90°C. Assumes that the surrounding air temperature is 50°C or less and wiring is performed in an enclosure.
### 3.6.1 Moulded case circuit breaker

<table>
<thead>
<tr>
<th>(1) Protective coordination (Breaking capacity)</th>
<th>(2) Setting the rated current of inverter primary MCCB</th>
</tr>
</thead>
<tbody>
<tr>
<td>The MCCB is used to protect the wiring from damage caused by overload or short-circuit currents. Install the MCCB to shut off any accidental current passing through the inverter input circuit, such as overload or short-circuit thereby minimizing the influence of the accident. Select the MCCB of which breaking capacity is appropriate for the estimated to the overall impedance of the power supply. (For full information, refer to the Mitsubishi no-fuse breaker technical information)</td>
<td>The MCCB in the inverter primary circuit is used to protect the inverter primary wiring from overload and short circuit. Since the inverter has a converter circuit and a large-capacity smoothing electrolytic capacitor, it serves as a capacitor-input rectifier with respect to the power supply and a pulse-shaped current flows in the inverter input circuit to charge the capacitor. The effective value of the inverter input current varies according to its form factor which is under the influence of the power supply impedance. Hence, the input current is not determined only by the load capacity of the motor and changes under the influence of the reactance of the power supply and wiring. The rated currents of the MCCB listed on the previous page have been selected in relation to the effective value of the inverter input power supply found by using the power supply impedance value on the assumption that the power supply capacity is about 200kVA to 500kVA, with the influence of the temperature rise and other factors such as harmonic components taken into consideration. Select a larger current rating version when an electro-magnetic type MCCB is used because its operational characteristic may change due to harmonic current. By inserting the power-factor improving reactor is improved and the current effective value is reduced.</td>
</tr>
<tr>
<td>The master MCCB and inverter MCCB must be fully coordinated for protection. Should a low-impedance short circuit occur, for example, if the transistors in the inverter circuit of the inverter are damaged or the diodes in the converter circuit are broken, the master MCCB may be tripped. Hence, it is necessary to make a pre-check using the operational characteristic curve. When the overall impedance of the power supply line is small, the peak value of the inverter input power supply increases. Therefore, the current peak value must be reduced by the current limiting action of the power-factor improving reactor. The power-factor improving reactor must be inserted in the input or DC circuit when the power transformer is large.</td>
<td></td>
</tr>
</tbody>
</table>

When the overall impedance of the power supply line is small, the peak value of the inverter input power supply increases. Therefore, the current peak value must be reduced by the current limiting action of the power-factor improving reactor. The power-factor improving reactor must be inserted in the input or DC circuit when the power transformer is large.
3.6.2 Magnetic contactor (MC)

(1) Inverter’s primary side magnetic contactor (MC)

On the inverter’s primary side, it is recommended to provide an MC for the following purposes. Refer to page 34.

1) To release the inverter from the power supply when the inverter protective function is activated or the drive becomes faulty (e.g., emergency stop operation). When cycle operation or heavy-duty operation is performed with an optional brake resistor connected, overheat burnout of the brake resistor can be prevented if a regenerative brake transistor is damaged due to insufficient heat capacity of the brake resistor and excess regenerative brake duty.

2) To prevent any accident due to an automatic restart at restoration of power after an inverter stop made by a power failure. For , when an instantaneous power failure is 15ms or longer, instantaneous power failure protection is activated to prevent the inverter from automatically restarting when power is restored. When a power failure is longer than about 100ms, the inverter is therefore restarted automatically if the RUN signal is ON.

3) To rest the inverter for an extended period of time. The control power supply for inverter is always running and consumes a little power. When stopping the inverter for an extended period of time, powering OFF the inverter will save power slightly.

4) To separate the inverter from the power supply to ensure safety of maintenance/inspection work. Since the inverter primary MC is used for the above purposes, select the MC which conforms to JEM1038-AC1 class. When making an emergency stop during running, select the MC which conforms to JEM1038-AC3 class to the inverter input side current.

(2) Inverter secondary side magnetic contactor

Refer to page 37 for details of the turn-ON condition of a magnetic contactor provided between the inverter and motor.

1) Switch between bypass operation and inverter operation. In this case, the commercial power supply MC and inverter output circuit MC must be magnetic contactors with electrical and mechanical interlocks and the two MCs must be designed not to turn on at the same time. The transistors will be damaged if the commercial power is applied to the inverter output terminals. Select the MC which has a sufficient capacity for the inverter output current (JEM 1038-AC Class 3 or higher). Take special care so that the inverter is not connected with the commercial power supply by an arc generated when the current is shut off.

2) To use one inverter with several motors by switching the inverter-driven motors from one to another. The MC may be switched OFF during stop. In a sequential start, select the MC which meets JEM1038-AC Class 3 or higher in consideration of the switching life.

3.6.3 Thermal relay

A thermal relay is generally used to protect a general-purpose motor. The current flowing in the general-purpose motor driven from an inverter is about 10% larger than that flowing in the motor driven from a commercial power supply.

For this reason, set the thermal relay to 1.1 times greater than the current value for use with the commercial power supply. Note that since the standard motor is designed for use are any of the three ratings of 200V/50Hz, 200V/60Hz and 220V/60Hz, the temperature rise of the motor may exceed the permissible value even when the load current is within the rated value when the motor is continuously run at the rated torque of 50Hz or at low speed. Therefore, select the motor capacity so that the load torque is less than the allowable motor torque as indicated in page 491.

The inverters are incorporated with an electronic thermal relay to protect the motor from overload in the low speed range. Therefore, a thermal relay need not be provided unless:

- Two or more motors are run by one inverter
- A special motor is run. In this case, provide a heat-operated thermal relay.
3.6.4 Cable size and wiring distance

(1) Main circuit cables

Like that of a general power cable, determine the size of the main circuit cables after examining its current capacity, short circuit protection and cable voltage drop.

The effective value of the inverter primary current must be noted because a current larger than the motor current may flow depending on the inverter input power factor (see page 505). If the wiring distance of the cable between the inverter and motor is long, the voltage drop increases, causing a reduction in motor torque and the current to increase. In an extreme case, the motor may overheat. Note that especially when the output frequency is low, the output voltage of the inverter is also low and the rate of voltage drop increases.

Select the cable size so that the voltage drop between the inverter and motor is 2% of the rated voltage.

The line voltage drop can be calculated by the following expression:

\[
\text{Line voltage drop [V]} = \frac{\text{cable resistance [m}Ω/\text{m}] \times \text{wiring distance [m]} \times \text{current [A]}}{1,000}
\]

Use a larger diameter cable when the wiring distance is long or when it is desired to decrease the voltage drop (torque reduction) in the low speed range.

When it is desired to use a larger-diameter cable but it cannot be connected directly with the motor and inverter terminals, provide relay terminal boxes as shown below:

- Wiring length to the motor
- When the wiring distance between the inverter and motor is long, overcurrent protection may be activated by the influence of the charging current (leakage current) due to the stray capacity of the wiring in addition to the aforementioned voltage drop. (The overall wiring length for connection of multiple motors should be within the value in the table below.)

---

### Table: Voltage drop over wiring distance of 30m

<table>
<thead>
<tr>
<th>Standard Motor 400V (kW)</th>
<th>Applicable Inverter</th>
<th>Inverter Output Voltage</th>
<th>Standard Applicable Cable</th>
<th>Voltage drop over 30m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>Current (A)</td>
<td>60Hz (V)</td>
<td>6Hz (V)</td>
<td></td>
</tr>
<tr>
<td>0.4</td>
<td>FR-A720-0.4K</td>
<td>3</td>
<td>2</td>
<td>2.94</td>
</tr>
<tr>
<td>0.75</td>
<td>FR-A720-0.75K</td>
<td>3</td>
<td>2</td>
<td>2.94</td>
</tr>
<tr>
<td>1.5</td>
<td>FR-A720-1.5K</td>
<td>8</td>
<td>2</td>
<td>2.94</td>
</tr>
<tr>
<td>2.2</td>
<td>FR-A720-2.2K</td>
<td>11</td>
<td>2</td>
<td>2.94</td>
</tr>
<tr>
<td>3.7</td>
<td>FR-A720-3.7K</td>
<td>17.5</td>
<td>3</td>
<td>5.30</td>
</tr>
<tr>
<td>5.5</td>
<td>FR-A720-5.5K</td>
<td>24</td>
<td>5.5</td>
<td>3.33</td>
</tr>
<tr>
<td>7.5</td>
<td>FR-A720-7.5K</td>
<td>33</td>
<td>8</td>
<td>2.31</td>
</tr>
<tr>
<td>10</td>
<td>FR-A720-10K</td>
<td>48</td>
<td>14</td>
<td>1.30</td>
</tr>
<tr>
<td>15</td>
<td>FR-A720-15K</td>
<td>61</td>
<td>22</td>
<td>0.824</td>
</tr>
<tr>
<td>18</td>
<td>FR-A720-18.5K</td>
<td>90</td>
<td>36</td>
<td>0.487</td>
</tr>
<tr>
<td>22</td>
<td>FR-A720-22K</td>
<td>90</td>
<td>36</td>
<td>0.487</td>
</tr>
<tr>
<td>30</td>
<td>FR-A720-30K</td>
<td>116</td>
<td>56</td>
<td>0.393</td>
</tr>
<tr>
<td>45</td>
<td>FR-A720-45K</td>
<td>175</td>
<td>100</td>
<td>0.186</td>
</tr>
<tr>
<td>55</td>
<td>FR-A720-55K</td>
<td>215</td>
<td>100</td>
<td>0.18</td>
</tr>
<tr>
<td>75</td>
<td>FR-A720-75K</td>
<td>286</td>
<td>125</td>
<td>0.156</td>
</tr>
<tr>
<td>90</td>
<td>FR-A720-90K</td>
<td>346</td>
<td>150</td>
<td>0.136</td>
</tr>
</tbody>
</table>

When it is desired to use a larger-diameter cable but it cannot be connected directly with the motor and inverter terminals, provide relay terminal boxes as shown below:

- Power
- Inverter
- Relay terminal boxes
- Large diameter cable
- Standard cable

---

### Table: when it is desired to use a larger-diameter cable but it cannot be connected directly with the motor and inverter terminals

<table>
<thead>
<tr>
<th>Power</th>
<th>Relay terminal boxes</th>
<th>Large diameter cable</th>
<th>Standard cable</th>
</tr>
</thead>
</table>

The wiring length should be 10m maximum for vector control.

When Advanced magnetic flux vector control has been selected, the cable length should be within 30m. A longer cable may cause speed fluctuation at low speed, in addition to reduced torque. Perform offline auto tuning in the state where wiring work is performed when the wiring length exceeds 30m.

When driving a 400V class motor by an inverter, surge voltage may occur at the motor terminals because of the
3.6.5 Earth leakage circuit breaker (NV)

Since harmonic components are included in the output voltage of an inverter which drives a motor, an earth leakage current flows due to the earth capacity between the motor winding and iron core. For this reason, the rated sensitivity current of the earth leakage circuit breaker installed in the power supply side of the inverter should be selected as described below:

- **Breaker designed for harmonic and surge suppression**
  - Rated sensitivity current: \( I_{\Delta n} \geq 10 \times (I_{g1} + I_{gn} + I_{g2} + I_{gm}) \)

- **Standard breaker**
  - Rated sensitivity current: \( I_{\Delta n} \geq 3 \times (I_{g1} + I_{gn} + I_{gm}) \)

---

- For connection \( \Delta \) or \( \Delta -y \), leakage currents are as follows:
  - \( I_{g1} \): Leakage currents in cable path during commercial power supply operation
  - \( I_{gn} \): Leakage current of noise filter on inverter input side
  - \( I_{g2} \): Leakage currents of motor during commercial power supply operation
  - \( I_{gm} \): Inverter unit leakage current

---

- **Example of leakage current** (mA) per 1km during the commercial power supply operation

<table>
<thead>
<tr>
<th>Cable size (mm²)</th>
<th>Leakage currents (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>23.5</td>
<td>0.1</td>
</tr>
<tr>
<td>5.5</td>
<td>0.2</td>
</tr>
<tr>
<td>8</td>
<td>0.3</td>
</tr>
<tr>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>15</td>
<td>1.0</td>
</tr>
<tr>
<td>20</td>
<td>2.0</td>
</tr>
</tbody>
</table>

- **Example of leakage current** (mA) during the inverter input side

<table>
<thead>
<tr>
<th>Motor capacity (kW)</th>
<th>Leakage currents (mA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>0.3</td>
</tr>
<tr>
<td>5</td>
<td>0.5</td>
</tr>
<tr>
<td>7.5</td>
<td>1.0</td>
</tr>
<tr>
<td>11</td>
<td>1.5</td>
</tr>
<tr>
<td>15</td>
<td>2.2</td>
</tr>
</tbody>
</table>

---

- **Rated sensitivity current** (mA):
  - For \( \Delta \) connection: \( I_{\Delta} = 10 \times (I_{g1} + I_{gn} + I_{g2} + I_{gm}) \)
  - For \( \Delta -y \) connection: \( I_{\Delta} = 3 \times (I_{g1} + I_{gn} + I_{gm}) \)

---

- **Note**
  - The earth leakage circuit breaker should be installed to the primary (power supply) side of the inverter.
  - An earth (ground) fault on the secondary side of the inverter can be detected at the running frequency of 120Hz or less.

---

- **Example**
  - Leakage current example of three-phase induction motor during the commercial power supply operation
  - Leakage current example of three-phase induction motor during the motor leakage currents

---

- **Breaker Designed for Harmonic and Surge Suppression**

<table>
<thead>
<tr>
<th>Leakage current Ig1</th>
<th>Leakage current Ig2</th>
<th>Leakage current Igm</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 ( \times ) 5m</td>
<td>33 ( \times ) 5m</td>
<td>( 0 ) (without noise filter)</td>
</tr>
<tr>
<td>( 0 ) (without EMC filter)</td>
<td>( 33 ) ( \times ) 5m</td>
<td>( 0 ) (without noise filter)</td>
</tr>
<tr>
<td>( 0 ) (without noise filter)</td>
<td>( 33 ) ( \times ) 5m</td>
<td>( 0 ) (without noise filter)</td>
</tr>
<tr>
<td>( 33 ) ( \times ) 5m</td>
<td>( 33 ) ( \times ) 5m</td>
<td>( 0 ) (without noise filter)</td>
</tr>
</tbody>
</table>

---

- **Rated sensitivity current** (mA):
  - \( I_{\Delta} = 10 \times (I_{g1} + I_{gn} + I_{g2} + I_{gm}) \)
  - \( I_{\Delta} = 3 \times (I_{g1} + I_{gm}) \)

---

- **Control circuit cable**
  - The cable size of 0.75mm² or larger is enough for use with cable other than the main circuit cables, e.g. operation and signal circuits.

---

- **Earthing (Grounding)**
  - Must conform to the requirements of national and local safety regulations and electrical codes.
  - Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes.

---

- **Non-compliance**
  - In the connection earthed-neutral system, the sensitivity current is blunt against an earth (ground) fault in the inverter output side.
  - Earthing (Grounding) must conform to the requirements of national and local safety regulations and electrical codes.

---

- **Note**
  - The leakage current value of the noise filter installed on the inverter input side.
  - (Refer to the table below for the leakage current value of the filter dedicated to the Mitsubishi inverter)
Inverter leakage currents
Leak current of an inverter without built-in EMC filter is 1mA.

Leak current of the EMC filter is as follow when turning the
input power conditions
(220V class 220V/60Hz, 440V class: 440V/60Hz,
power supply unbalance within 3%)

Leak current of is as follow when turning
the EMC filter ON/OFF.

Input power conditions
(220V class: 220V/60Hz, 400V class: 440V/60Hz,
power supply unbalance within 3%)

(1) Calculation of the continuous leakage current
The value of the leakage current depends on the
cable type, cable diameter, cable length from
inverter to motor, and inverter output frequency. It is
roughly calculated from a value for the commercial
power supply (50Hz, 60Hz).

1) Leakage current from cables (Ig 1, Ig 2)
Measure the electrical path length from ground
fault interrupter to inverter input terminals and the
types and sizes of cables and calculate the
leakage current according to the information.
(Apply the value for the commercial power supply.
Harmonic components can be ignored.)
Measure the electrical path length from inverter
output terminals to the motor and the types and
sizes of cables, calculate the leakage current
according to this information and multiply the
calculated value several times in consideration of
the harmonic components. (about three times on
average, through it depends on the inverter output
frequency)

2) Leakage current from the motor (Igm)
Determine the capacities and the number of
motors, calculate the total leakage current using
the in-operation leakage current value in the
information and multiply the total value several
times in consideration of the harmonic
components. (about three times on average, through it depends on the inverter output frequency)

3) Leakage current of noise filter on inverter input
side (Ign)
When using the inverter-dedicated radio noise
filter (FR-BIF), add approximately 4mA (400V:
approx. 8mA) per filter.

Voltage (V)

<table>
<thead>
<tr>
<th>Phase grounding</th>
<th>200</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>On (mA)</td>
<td>22</td>
<td>30</td>
</tr>
<tr>
<td>Off (mA)</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Table: Leakage currents equivalent to one phase of three
phase three wires connection cable.

(For the calculation of the continuous leakage
current, refer to the "Mitsubishi earth leakage
circuit breaker technical information".)

4) Leakage current in the inverter (Igi)
For the E700 200V class 1.5kW or more, all
capacities of 400V class, (F700) 200V class
2.2kW or more, and all capacities of 400V class,
the amount of the leakage currents changes by
the EMC filter ON/OFF connector.

(2) Selection of the rated sensitivity current
The rated sensitivity current, protective ground
resistance value, and continuous leakage current of
an electrical path are interrelated. From the
standpoint of protection from electric shock, the
relationship between the rated sensitivity current and
protective ground resistance value is important.
From the standpoint of unnecessary operation
prevention, the relationship between the rated
sensitivity current and leakage current cannot be
ignored.

1) Selection of the rated sensitivity current
Find the continuous leakage current using the
method described in paragraph (1) and use the
rated sensitivity current of more than 10 times
greater than the continuous leakage current,
considering a transient inrush current. Note that
when a breaker for harmonic and surge
suppression is used with the inverter circuit, the
harmonic components are cut. In this case, use
the value 10 times greater than the continuous
leakage current generated when a commercial
power supply is used.

2) Application to legally restricted areas
In some areas, the rated sensitivity current is
specified by the electrical facility standard,
occupational safety and health rules and indoor
wiring regulations. When installing the earth
leakage circuit breaker in such places, select the
rated sensitivity current in accordance with these
rules and regulations. If the rated sensitivity
current selected for a large continuous leakage
current cannot satisfy the rules and regulations,
take either of the following measures:
(a) When there are several loads, install an earth
leakage current breaker for each motor and
inverter.
(b) Reduce the length of the cable or increase the
distance from the ground.

3) Examination from the standpoint of electric shock
prevention.
Electric shock is divided into direct shock and
indirect shock. In Japan, protection is generally
provided against indirect electric shock. The
determination of the rated sensitivity current is
related to the contact voltage and the resistance
value of class 3 equipment earthing (protective grounding) and generally there are no restrictions on the rated sensitivity current. Hence, select the rated sensitivity current from among 15, 30, 100, 200 and 500mA, and conduct protective earthing so that the permissible contact voltage is not exceeded.

- 200V class -------- Class D grounding
  (grounding resistance 100 Ω or less)
- 400V class -------- Class C grounding
  (grounding resistance 10 Ω or less)
• When the power transformer is of ∆ connection, neutral point earthing type, use special class C grounding (10 Ω or less) because the sensitivity current is blunted with respect to an earth fault on the secondary side of the inverter.

3) Characteristics and operational instructions for the ground fault interrupter

1) When operating the low acoustic noise (high carrier frequency) inverter operation, the leakage current increases in harmonic current component as compared to a conventional inverter, resulting in a larger continuous leakage current. When a recent ground fault interrupter provided with a harmonic eliminating circuit to prevent malfunction is used, selection can be made in the same way as in the conventional inverter (see page 531).

2) Install the ground fault interrupter in the power supply side of the inverter. (Proper operation is not performed if it is installed in the load side)

3) If a ground fault occurs in the power supply side of the inverter, the ground fault interrupter operates properly, posing no problem. If a ground fault occurs in the load side of the inverter, the sensitivity current of the ground fault interrupter may change depending on the operating status (output frequency) of the inverter. This is mainly because the waveform of the ground fault current is not a sinusoidal wave but an AC non-sinusoidal wave including harmonic and DC components.

4) In Japan, installation of an earth leakage circuit breaker is mandated by the "Technological baseline related to electrical equipment, article 41" and "Occupational safety and health rules, articles 333, 334". For full information, refer to the corresponding ordinances.

3.6.6 Relays

Relays used in the control circuit, e.g. inputs STF, STR, 10, 2, 5 etc.
Relays used with outputs RUN, SU etc.

Relays used in the control circuit, e.g. inputs STF, STR, 10, 2, 5 etc.
Relays used with outputs RUN, SU etc.

Use small-signal relays (low contact) to prevent a contact fault.
Omron: Type G2A, Fuji: Type No. 473, No. 474

3.6.7 Start/stop switch

Use a low-current switch to prevent a contact fault.

Switch example (Nippon Kaiheiki):
Single-pole, double-throw switch (M-2012J-D)

Panel drilling diagram

Dimension A
Without bezel: +12.5 = +0.3
With bezel: +12.5 +15.3 = +0.3
(Unit: mm)

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3.6.8 Frequency setting potentiometer

Type: WA2W 1kΩ
Wire-wound variable resistor 2W1kΩ B characteristics

When frequency setting is not changed frequently, a variable resistor of 1/2W1kΩ may be used.

3.6.9 Frequency meter and calibration resistor

A manual controller with frequency meter (such as the FR-AX) is available. When only a frequency meter is installed separately, use an instrument of the following specifications:
- Moving-coil type DC ammeter
- Full scale 1mA (internal resistance 300Ω max.)
- Graduations: 60, 120, 240Hz in full scale
  Alternatively, graduate in rpm according to the number of poles of the motor used.

Since the frequency meter terminal FM on the inverter develops about 5VDC at the maximum frequency, calibrate the frequency meter using the variable resistor having the following specifications. It is not necessary when calibrating the meter from the operation panel (parameter unit).
- Calibration resistor 1/3W or more 10kΩ

The following frequency meter and calibration resistor are available for use.

- Analog frequency meter (64mm × 60mm)
  Type YM206NR 1mA
  Graduations: 0 to 65, 130Hz double graduations

- Calibration resistor
  Type: RV24YN 10kΩ
  Deposited carbon variable resistor 1/3W, 10kΩ B characteristic

* Not needed when the operation panel (FR-DU07) or parameter unit (FR-PU07) is used for calibration. This resistor is used when calibration must be made near the frequency meter for such a reason as a remote frequency meter. Note that the needle of the frequency meter may not deflect to full-scale when the calibration resistor is connected. In this case, use this resistor and operation panel or parameter unit together.
### 3.6.10 Twisted/shielded cables

**Example** Twisted cable

Type: KV-2C × 0.3SQ (Optec Dai-Ichi Denko)

<table>
<thead>
<tr>
<th>Qty. X Size (mm²)</th>
<th>Finish OD (mm)</th>
<th>Characteristics of a Single Cable</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 × 0.3</td>
<td>2 × 1.5</td>
<td>Structure (wires/mm) 1200.18 0.3</td>
<td>Red/white</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conductor resistance (Ω/km) 64.4 or less</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rated voltage (V) 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permissible temperature (°C) 80</td>
<td></td>
</tr>
</tbody>
</table>

**Example** Multi-core shielded cable

Type: VCT-S3C × 0.55SQ (Tokiwa Cable)

<table>
<thead>
<tr>
<th>Qty. X Size (mm²)</th>
<th>Finish OD (mm)</th>
<th>Characteristics of a Single Cable</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 × 0.3</td>
<td>8.3</td>
<td>Structure (wires/mm) 200.18</td>
<td>Grey</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rated voltage (V) —</td>
<td>—</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Permissible temperature (°C) —</td>
<td>—</td>
</tr>
</tbody>
</table>
3.6.5 Notes on installation of inverter in an enclosure

(1) Inverter placement
1) Clearances around the inverter
To ensure ease of heat dissipation and maintenance, leave at least the shown clearances around the inverter. At least the following clearances are required under the inverter as a wiring space, and above the inverter as a heat dissipation space.

- 3.7K or less
- 5.5K to 55K
- 75K or more

*1 Inverters can be installed side-by-side (with 0mm clearance) in the surrounding air temperature of 40°C or less.

*2 For replacing the cooling fan of the FR-A740-160K, FR-F740-185K or more, 300mm of space is necessary in front of the inverter.

2) Inverter mounting orientation
Mount the inverter on a wall as specified. Do not mount it horizontally or any other way.

3) Top of the inverter
Heat is blown up from inside the inverter by the small fan built in the unit. Any equipment placed above the inverter should be heat resistant.

4) Arrangement of several inverters
When several inverters are placed in the same enclosure, generally arrange them horizontally as shown in the following figure (a). When it is inevitable to arrange them vertically to minimize space, take such measures as to provide guides since heat from the bottom inverters can increase the temperatures in the top inverters, causing inverter failures.

Arrangement of several inverters
When mounting several inverters, fully take caution not to make the surrounding air temperature of the inverter higher than the permissible value by providing ventilation and increasing the panel size.

5) Placement of ventilation fan and inverter
Heat generated in the inverter is blown up from the bottom of the unit as warm air by the cooling fan. When installing a ventilation fan for that heat, determine the place of ventilation fan installation after fully considering an air flow (Air passes through areas of low resistance. Make an airway and airflow plates to expose the inverter to cool air.)
(2) External high-duty brake resistor (FR-ABR type)

1) Installation position
   (a) When the 7.5K or less is operated in excess of the duty of the built-in brake resistor supplied with the inverter and install an external brake resistor.
   For the 22K or less and 0.4K or more, an external brake resistor can be installed.
   (b) Since the external brake resistor generates much heat, its surface temperature may exceed 360°C in an operation pattern using the resistor at high-duty. Hence, install the external brake resistor in consideration of heat dissipation. The inverter and other devices must not be placed above the resistor.

2) Wiring
   (a) When wiring the brake resistor, note high DC voltage application and resistor-generated heat.
   (b) The wiring distance between the inverter and brake resistor should be as short as possible. If it exceeds 2m, twist the cables. (If twisted, the distance must not exceed 5m)
   (c) When wiring the brake resistor, the resistor-generated heat (maximum surface temperature is approximately 360°C) must be taken into consideration.
      - Take measures to prevent the cables from making contact with the resistor.

   • Use heat-resistant cables (such as glass-braided cables), or cover the cables with silicone tubes. Use cables of 2mm² or larger size.

   (d) The following sequence is recommended to prevent overheating and burnout of the brake resistor in case the brake transistor is damaged.

   Removing jumpers disables the built-in brake resistor (power is not supplied). Note that the built-in brake resistor is not need to be removed from the inverter. The lead wire of the built-in brake resistor is not need to be removed from the terminal.

*1 Remove the jumper connected across terminal PR-PX of the inverter. Since the series 11K or more, series inverter is not provided with the PX terminal, a jumper is not need to be removed.
*2 Refer to the table below for the type number of each capacity of thermal relay and the diagram below for the connection. (Always install a thermal relay when using a brake resistor whose capacity is 11K or more.)

---

### Table: Thermal Relay Type (Mitsubishi Product)

<table>
<thead>
<tr>
<th>Power Supply Voltage</th>
<th>High-duty Brake Resistor Type</th>
<th>Thermal Relay Type</th>
<th>Contact Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>200V</td>
<td>FR-ABR-0.4K</td>
<td>TH-A026D-00-1A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-0.75K</td>
<td>TH-A026D-00-2A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-1.5K</td>
<td>TH-A026D-00-3A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-2.2K</td>
<td>TH-A026D-00-4A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-3.7K</td>
<td>TH-A026D-00-5A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-5.5K</td>
<td>TH-A026D-00-6A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-7.5K</td>
<td>TH-A026D-00-7A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-11K</td>
<td>TH-A026D-00-8A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-15K</td>
<td>TH-A026D-00-9A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-22K</td>
<td>TH-A026D-00-A</td>
<td></td>
</tr>
<tr>
<td>400V</td>
<td>FR-ABR-0.4K</td>
<td>TH-A026D-00-B</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-0.75K</td>
<td>TH-A026D-00-C</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-1.5K</td>
<td>TH-A026D-00-D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-2.2K</td>
<td>TH-A026D-00-E</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-3.7K</td>
<td>TH-A026D-00-F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-5.5K</td>
<td>TH-A026D-00-G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-7.5K</td>
<td>TH-A026D-00-H</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-11K</td>
<td>TH-A026D-00-I</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FR-ABR-15K</td>
<td>TH-A026D-00-J</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

Example of installing an external brake resistor on top of the enclosure

---

Wiring the brake resistor

* Since the series 11K or more, series inverter is not provided with the PX terminal, a jumper is not need to be removed.
* Refer to the table above for the type number of each capacity of thermal relay and the diagram below for the connection. (Always install a thermal relay when using a brake resistor whose capacity is 11K or more.)
(3) BU type brake unit and discharging resistor

1) Installation position
For the installation position of the discharging resistor, refer to paragraph (2), part 1.

2) Wiring
(a) When wiring the brake unit (BU type) and discharging resistor, note high DC voltage application and discharging resistor-generated heat.
(b) Minimize the cable length between the inverter and brake unit and the discharging resistor and brake unit. If it exceeds 2m, twist the cables. (If twisted, the distance must not exceed 5m)
(c) When wiring the discharging resistor, the resistor-generated heat (maximum surface temperature is approximately 150 to 300°C) must be taken into consideration.
   • Take measures to prevent the cables from making contact with the resistor.
   • Use heat-resistant cables (such as glass-braided cables), or cover the cables with silicone tubes.
(d) Use cables of the size below or larger size.

<table>
<thead>
<tr>
<th>BU Brake Unit Type</th>
<th>Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>200V</td>
<td></td>
</tr>
<tr>
<td>BU-1500, 3700</td>
<td>2mm²</td>
</tr>
<tr>
<td>BU-7.5K, 15K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>400V</td>
<td></td>
</tr>
<tr>
<td>BU-H7.5K</td>
<td>2mm²</td>
</tr>
<tr>
<td>BU-H15K, H30K</td>
<td>3.5mm²</td>
</tr>
</tbody>
</table>

(e) Connect the cables so that the terminal symbols of the brake unit match those of the inverter. When the FR-HEL power-factor improving reactor has been connected, do not connect the brake unit to terminal P1 to protect the brake unit from damage.

(f) If the transistors in the brake unit become faulty, the resistor can be unusually hot, causing a fire. Therefore, install a magnetic contactor on the inverter's input side to configure a circuit so that a current is shut off in case of fault.

(4) FR-Bu2/FR-Bu/MT-Bu5 brake unit and resistor unit

1) Installation position
Always install the brake unit and resistor unit on a vertical surface in the vertical direction. Installing them in the horizontal direction or on a horizontal surface reduces the heat dissipation effect.
Since the case temperature of the resistor unit rises to or above 100°C (the temperature rise of the brake resistor of the MT-BU5 is 300K), install the unit in a place where it will not make contact with cables and flammables.

2) Wiring
(a) When wiring the brake unit (FR-BU2/FR-BU/MT-Bu5) and resistor unit, note high DC voltage application and resistor unit generated heat.
(b) Minimize the cable length between the inverter and brake unit and the resistor unit and brake unit. Use a twisted cable when the wiring length exceeds 5m.
   (Even when the wiring is twisted, the cable length must not exceed 10m.)

(c) When wiring the discharging resistor, the resistor-generated heat (maximum surface temperature is approximately 150 to 300°C) must be taken into consideration.
   • Take measures to prevent the cables from making contact with the resistor.
   • Use heat-resistant cables (such as glass-braided cables), or cover the cables with silicone tubes.
(d) Use cables of the size below or larger size.

<table>
<thead>
<tr>
<th>BU Brake Unit Type</th>
<th>Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>200V</td>
<td></td>
</tr>
<tr>
<td>BU-1500, 3700</td>
<td>2mm²</td>
</tr>
<tr>
<td>BU-7.5K, 15K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>400V</td>
<td></td>
</tr>
<tr>
<td>BU-H7.5K</td>
<td>2mm²</td>
</tr>
<tr>
<td>BU-H15K, H30K</td>
<td>3.5mm²</td>
</tr>
</tbody>
</table>

(e) Connect the cables so that the terminal symbols of the brake unit match those of the inverter. When the FR-HEL power-factor improving reactor has been connected, do not connect the brake unit to terminal P1 to protect the brake unit from damage.

(f) If the transistors in the brake unit become faulty, the resistor can be unusually hot, causing a fire. Therefore, install a magnetic contactor on the inverter's input side to configure a circuit so that a current is shut off in case of fault.
(c) Use cables of the size below or larger size.

Cables applicable to the FR-BU/MT-BU5 brake unit

<table>
<thead>
<tr>
<th>Type</th>
<th>Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-BU-15K, FR-BR-15K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU-30K, FR-BR-30K</td>
<td>5.5mm²</td>
</tr>
<tr>
<td>FR-BU-55K, FR-BR-55K</td>
<td>14mm²</td>
</tr>
<tr>
<td>FR-BU-H15K, FR-BR-H15K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU-H30K, FR-BR-H30K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU-H55K, FR-BR-H55K</td>
<td>5.5mm²</td>
</tr>
<tr>
<td>MT-BU-H75K, MT-BR-H75K</td>
<td>14mm²</td>
</tr>
<tr>
<td>MT-BU-H150K, MT-BR-H75K</td>
<td>14mm²</td>
</tr>
</tbody>
</table>

(400V class)

<table>
<thead>
<tr>
<th>Type</th>
<th>Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-BU2-H15K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H30K</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H55K</td>
<td>5.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H75K</td>
<td>14mm²</td>
</tr>
</tbody>
</table>

* Per one brake resistor

Cables applicable to the FR-BU2 brake unit

<table>
<thead>
<tr>
<th>Brake unit Type</th>
<th>Discharging resistor, Resistor unit type</th>
<th>Cable Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-BU2-1.5K</td>
<td>GZG 300W-50 (one)</td>
<td>2mm²</td>
</tr>
<tr>
<td>FR-BU2-3.7K</td>
<td>GZG 300W-50 (three in series)</td>
<td>2mm²</td>
</tr>
<tr>
<td>FR-BU2-7.5K</td>
<td>GZG 300W-50 (four in series)</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-10K</td>
<td>GZG 300W-50 (six in series)</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-30K</td>
<td>FR-BR-30K</td>
<td>5.5mm²</td>
</tr>
<tr>
<td>FR-BU2-55K</td>
<td>MT-BR-55K</td>
<td>14mm²</td>
</tr>
<tr>
<td>FR-BU2-H7.5K</td>
<td>(four in series)</td>
<td>2mm²</td>
</tr>
<tr>
<td>FR-BU2-H15K</td>
<td>(eight in series)</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H30K</td>
<td>(twelve in series)</td>
<td>3.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H55K</td>
<td>(twenty in series)</td>
<td>5.5mm²</td>
</tr>
<tr>
<td>FR-BU2-H75K</td>
<td>MT-BR-H75K</td>
<td>14mm²</td>
</tr>
</tbody>
</table>

(d) Connect the cables so that the terminal symbols of the brake unit match those of the inverter. When the FR-HEL power-factor improving reactor has been connected, do not connect the brake unit to terminal P1 to protect the brake unit from damage.

(e) If the transistors in the brake unit should become faulty, the resistor can be unusually hot, causing a fire. Therefore, install a magnetic contactor on the inverter's input side to configure a circuit so that a current is shut off in case of fault.

3) Brake unit operation indications

Brake unit operation indication description (FR-BU)

<table>
<thead>
<tr>
<th>7-Segment LED Indication</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Indicates that the brake unit is switched ON.</td>
</tr>
<tr>
<td>E'</td>
<td>Indicates that the brake is operated in excess of permissible %ED.</td>
</tr>
<tr>
<td>F*1</td>
<td>Indicates a brake transistor failure.</td>
</tr>
<tr>
<td>P, N</td>
<td>Indicates that the brake unit is switched OFF.</td>
</tr>
</tbody>
</table>

*1 When this operation indicator LED is lit to indicate the excess of the permissible %ED, the brake unit stops operating and therefore the "overcurrent", "overvoltage" or other protective function of the inverter is activated. To resume operation, find and remove its cause, then reset the inverter.

*2 By switching OFF the brake unit and making a reset, the cumulative data of the brake duty is cleared. Note that repeating reset many times to perform operation will overheat the resistor unit.

Indication of the brake unit operation (FR-BU2)

When \( p = i = 0 \) (initial value) in FR-BU2, 3rd digit of the 3-digit LED indicates regeneration status. Two segments flicker (rotate) at a time during regeneration as shown below and rotate quickly when regeneration amount is large. Another monitor can be also displayed by the setting of \( p = i \) in FR-BU2.

![Incorrect connection examples](image-url)
(5) EMI filter

The 55K or less has a built-in filter equivalent to common mode filter and capacitor type filter on the input side.

1) Installation position

Since the noise filter produces a greater effect when it is located closer to the source of noise, determine its installation position in consideration of the following:

(a) When used in the inverter power supply circuit, install the noise filter in a position where the wiring distance from the inverter input terminals is short.

(b) When used in the inverter output circuit, install the noise filter in a position where the wiring distance from the inverter output terminals is the shortest. (The FR-BIF capacitor type filter cannot be connected to the output circuit.)

2) Wiring

The noise filter cannot produce its effect unless it is wired as indicated below.

The noise filter must be installed as close as possible to the inverter and its wiring distance minimized. In addition, the primary and secondary wirings of the noise filter must not be close to each other or cross each other.

For the selection of the noise filter, see page 518.

(6) Surge voltage suppression filter

(FR-ASF-H, FR-BMF-H)

When a 400V class motor is inverter-driven, a micro surge voltage attributable to wiring constants is generated at the motor terminals and may deteriorate the motor insulation. In such a case, the micro surge voltage can be suppressed to 850V or less by inserting the surge voltage suppression filter (FR-ASF-H) in the secondary side of the inverter.

As surge voltage suppression measures at inverter renewal to 400V non insulation-enhanced motor, small/light FR-BMF-H as compared to the FR-ASF-H can be used.

FR-ASF-H

1) Installation:

When energized, the surge voltage suppression filter gets hot. Never install it near flammables or where it can easily make contact with a human body.

To release heat, leave at least 100mm clearances around the filter as an installation space.

2) Wiring:

(a) After checking the terminal symbols of the filter terminal block, connect the cables from the output terminals of the inverter to the filter input terminals (U, V, W) and the cables from the motor terminals to the output terminals (X, Y, Z) of the filter. Incorrect wiring may damage the device.

As the filter gets hot, avoid wiring the cables near the resistor.

(b) The wiring length between the inverter output terminals and filter input terminals should be within 5m.

The wiring length between the filter output terminals and motor input terminals should be within 300m.

(c) The cable size may be any size if it is as recommended for the inverter.

(d) The cable type recommended for use is a heat-resistant cable. Note that the temperature of the resistor section of the filter rises about 70 degrees when the filter is switched on. Therefore if the cables may make contact with the resistor, use heat-resistant, glass-braided cables.

3) Voltage drop

A voltage drop caused by the filter is proportional to the inverter output frequency and output current.

The voltage drop is approximately 30V when the inverter output frequency is 60Hz and the filter is on at the rated current, independent of the capacity.

4) Leakage currents

By connecting the filter, the leakage current slightly increases. When using many filters at the same time, take this into consideration when
selecting the earth leakage circuit breaker. (As a result of measurement in accordance with the measurement method specified in the New Electrical Appliances Control Rules, the leakage current of the H15K or less is approximately 1mA under the conditions of 60Hz inverter output frequency and 14.5kHz carrier frequency.)

5) Others
   Control can be applied to V/F control or Advanced magnetic flux vector control.

FR-BMF-H

1) Installation
   (a) The FR-BMF-H can be installed on the inverter rear side (up to 22K) or on the right side as viewed from the inverter front.
   (b) When installing on the side, leave 10mm or more between the filter and inverter to release heat.
   (c) When using the inverter with the filter pack installed on the side, do not install this combination on moving objects or places that have vibrations (exceeding 1.96m/s²).

2) Wiring
   (a) Connect the input cable (U, V, W) of the filter to the output terminal (U, V, W) of the inverter and connect the cable from the motor terminal to the output terminal (W, Y, Z) of the filter.
   (b) The wiring length of the filter input connected to the inverter output terminal should not be extended. The wiring length between the filter output terminals and motor input terminals should be within 100m.
   (c) The cable size may be any size if it is as recommended for the inverter.

3) Others
   The PWM carrier frequency of the inverter should be 2KHz or less.

(7) Sine wave filter
   For the 75K or more inverter, the motor voltage and current can be made to nearly sine wave shaped by providing a sine wave filter on the output side. As a result of this, the same characteristic as when the motor is driven with a sine wave current is obtained and the result as below can be expected.
   1. Low noise
   2. Surge less
   3. Motor loss reduction (use of standard motor)

   1) Installation
      (a) When connecting capacitors in parallel, leave installation space of 25mm or more.
      (b) The temperature rise of the reactor is equivalent to H class, leave an installation space of 30mm or more between the capacitor. Also perform wiring so that the wires do not make contact with the reactor.
      (c) Install a sine wave filter on the inverter side.

   2) Wiring
      Connecting the capacitor on the primary side (U, V, W) of the reactor may damage the capacitor.

   3) Others
      (a) Change to \[ Pr. 720 = 25 \]. (The initial value is 2.)
         The carrier frequency changes to 2.9kHz. (The sine wave filter is designed on condition that the carrier frequency is 2.5kHz. Be sure to change the setting properly.)
         If the inverter is operated with \[ Pr. 72 = 25 \], the inverter and sine wave filter may be damaged.
      (b) The sine wave filter can be used only for 60 Hz or less inverter frequency.
         Note that the filter can not be used for the higher frequency operation than this. (Otherwise the filter loss will increase.)
      (c) Use the inverter with capacity one rank higher. If the rated motor current x (1.05 to 1.1) is less than 90% of the inverter rated current, an inverter with same kW with a motor can be used.
(d) This function is valid for V/F control only. (When \( Pr. \text{ 72} = 25 \), V/F control is automatically selected.)

(e) A sine wave filter and MT-HC can not be used together.

(8) Wiring of control circuit

1) Use twisted or shielded cables for connection with the control circuit terminals (10, 2, 5, 1, 4, AM). Do not earth (ground) the shield but connect it as indicated below. (Keep the other end of the shield open.)

2) Use twisted or shielded cables for connection with the display (frequency) meter terminals (FM, SD) over a wiring distance of 200m maximum. If the distance exceeds 200m, the display (frequency) meter reading may result in a larger error.

3) Wire the control circuit cables away from the power line over the shortest distance.

(9) Countermeasures against external noise

1) Strengthening the countermeasures against noise
The FR series inverters are sufficiently protected from noise. However, extremely large external noise may cause the inverter to malfunction. When there is such external noise that cannot be eliminated, wire the inverter in accordance with the following figure.

2) Remote control, etc.
Acting as an antenna, the single lines are susceptible to external noise. Therefore, run the signal lines as far as possible from the power line. If the inverter is controlled 30m or further away from its installation position, it is recommended to use any of the following:

(a) Speed setting device
Use the FR-FK motorized speed setter. (For the operation information, see the corresponding manual.)

(b) External start/stop signal
Add a relay in the vicinity of the inverter.

(c) Cable
Use twisted or twisted shielded cables.

(d) Surge suppressors
Install surge suppressors to the coils of the relays, valves etc. around the inverter.

[Example 1] Shielded cables

[Example 2] Shielded cables joined

[Composition (Unit: mm)]

(manufactured by MATUSO ELECTRIC CO.,LTD.)
3.7 Enclosure design

When an inverter enclosure is to be designed and manufactured, heat generated by contained equipment, etc., the environment of an operating place, and others must be fully considered to determine the panel structure, size and equipment layout. The inverter unit uses many semiconductor devices. To ensure higher reliability and long period of operation, operate the inverter in the ambient environment that completely satisfies the equipment specifications.

3.7.1 Inverter installation environment

As the inverter installation environment should satisfy the standard specifications indicated in the following table, operation in any place that does not meet these conditions not only deteriorates the performance and life of the inverter, but also causes a failure. Refer to the following points and take adequate measures.

Environmental standard specifications of inverter

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Surrounding air</td>
<td>-10 to +50 °C (non-freezing)</td>
</tr>
<tr>
<td>temperature</td>
<td></td>
</tr>
<tr>
<td>Humidity</td>
<td>90% RH maximum (non-condensing)</td>
</tr>
<tr>
<td>Atmosphere</td>
<td>Free from corrosive and explosive gases</td>
</tr>
<tr>
<td></td>
<td>Free from dust and dirt</td>
</tr>
<tr>
<td>Altitude</td>
<td>1000m or less</td>
</tr>
<tr>
<td>Vibration</td>
<td>5.9m/s² or less (0.6G) or less</td>
</tr>
</tbody>
</table>

* For the (A700)160K or more and (F700)185K or more, the vibration is 2.9m/s² or less

(1) Temperature

The permissible surrounding air temperature of the inverter is between -10 and +50 °C. Always operate the inverter within this temperature range. Operation outside this range will considerably shorten the service lives of the semiconductors, parts, capacitors and others. Take the following measures so that the surrounding air temperature of the inverter falls within the specified range:

1) Measures against high temperature
   (a) Use a forced ventilation system or similar cooling system. (Refer to page 549)
   (b) Install the panel in an air-conditioned electrical room.
   (c) Block direct sunlight.
   (d) Provide a shield or similar plate to avoid direct exposure to the radiated heat and wind of a heat source.
   (e) Ventilate the area around the panel well.

2) Measures against low temperature
   (a) Provide a space heater in the enclosure.
   (b) Keep the inverter power ON. (Keep the start signal of the inverter OFF.)

3) Sudden temperature changes
   (a) Select an installation place where temperature does not change suddenly.
   (b) Avoid installing the inverter near the air outlet of an air conditioner.

(c) If temperature changes are caused by opening/closing of a door, install the inverter away from the door.

(2) Humidity

Normally operate the inverter within the 45 to 90% range of the ambient humidity. Too high humidity will pose problems of reduced insulation and metal corrosion. On the other hand, too low humidity may produce a through-air insulation breakdown. The insulation distance specified in JEM1103 "Control Equipment Insulator" is defined as humidity 45 to 85%.

1) Measures against high humidity
   (a) Make the panel enclosed, and provide it with a moisture absorber.
   (b) Take dry air into the enclosure from outside.
   (c) Provide a space heater in the enclosure.

2) Measures against low humidity

   (a) Take the measures against high humidity in 1).
   (b) Keep the inverter power ON. (Keep the start signal of the inverter OFF.)

3) Measures against condensation

   Condensation may occur if temperature in the panel changes suddenly due to frequent power ON/OFF switching or if atmospheric temperature changes suddenly. Condensation will cause insulation to be deteriorated and corrosion to occur.

   (a) Take the measures against high humidity in 1).
   (b) Keep the inverter power ON. (Keep the start signal of the inverter OFF.)

(3) Dust, dirt, oil mist

Dust and dirt will cause such faults as poor contact of contact points, reduced insulation or reduced cooling effect due to moisture absorption of accumulated dust and dirt, and in-panel temperature rise due to clogged filter. In the atmosphere where conductive powder floats, dust and dirt will cause such faults as malfunction, deteriorated insulation and short circuit in a short time.

Since oil mist will cause similar problems, it is necessary to take adequate measures.

Countermeasures
   (a) Place in a totally enclosed enclosure.
   (b) Take measures if the in-enclosure temperature rises. (Refer to page 548, 549.)
(b) Purge air.
Pump clean air from outside to make the in-panel pressure higher than the outside-air pressure.

(4) Corrosive gas, sea breeze
When the enclosure is installed in places exposed to corrosive gas or sea breeze, the printed circuit board patterns and parts will be corroded and/or contact faults of the relays and switches will occur. In such places, take the measures given in (a) and (b) in paragraph (3).

(5) Explosive, flammable gases
As the inverter is non-explosion proof, it must be contained in an explosion proof enclosure. In places where explosion may be caused by explosive gas, dust or dirt, an enclosure cannot be used unless it structurally complies with the guidelines and has passed the specified tests. This makes the enclosure itself expensive (including the test charges). The best way is to avoid installation in such places and install the inverter in a non-hazardous place. (Refer to page 498)

(6) Highland
Use the inverter at the altitude of within 1000m. If it is used at a higher place, it is likely that thin air will reduce the cooling effect and low air pressure will deteriorate dielectric strength.

(7) Vibration, impact
The vibration resistance of the inverter is up to 5.9m/s² at 10 to 55Hz frequency. Vibration or impact, if less than the specified value, applied for a long time may make the mechanism loose or cause poor contact to the connections. Especially when impact is imposed repeatedly, caution must be taken as the part mounting pins are likely to break.

Countermeasures
(a) Provide the enclosure with rubber vibration isolators.
(b) Strengthen the structure to prevent the enclosure from resonance.
(c) Install the enclosure away from sources of vibration.
### 3.7.2 Heat generated by inverter and related devices

#### Heat generated by inverter/related devices

<table>
<thead>
<tr>
<th>Capacity (KW)</th>
<th>Inverter Generated Heat (W)</th>
<th>Power regeneration converter</th>
<th>High power factor converter</th>
<th>Power factor improving reactor</th>
<th>Sine wave filter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Inverter</td>
<td>Power regeneration converter</td>
<td>High power factor converter</td>
<td>Power factor improving reactor</td>
<td>Sine wave filter</td>
</tr>
<tr>
<td>0.1</td>
<td>6.6</td>
<td>4.0</td>
<td>9.5</td>
<td>5.1</td>
<td>3.3</td>
</tr>
<tr>
<td>0.2</td>
<td>14.0</td>
<td>8.0</td>
<td>18.5</td>
<td>10.5</td>
<td>6.5</td>
</tr>
<tr>
<td>0.4</td>
<td>50.0</td>
<td>32.0</td>
<td>61.0</td>
<td>37.0</td>
<td>23.0</td>
</tr>
<tr>
<td>0.75</td>
<td>70.0</td>
<td>60.0</td>
<td>71.0</td>
<td>46.0</td>
<td>29.0</td>
</tr>
<tr>
<td>1.5</td>
<td>110.0</td>
<td>100.0</td>
<td>80.0</td>
<td>50.0</td>
<td>34.0</td>
</tr>
<tr>
<td>2.2</td>
<td>140.0</td>
<td>130.0</td>
<td>100.0</td>
<td>70.0</td>
<td>46.0</td>
</tr>
<tr>
<td>3.7</td>
<td>190.0</td>
<td>160.0</td>
<td>160.0</td>
<td>100.0</td>
<td>61.0</td>
</tr>
<tr>
<td>5.5</td>
<td>260.0</td>
<td>240.0</td>
<td>290.0</td>
<td>170.0</td>
<td>105.0</td>
</tr>
<tr>
<td>7.5</td>
<td>360.0</td>
<td>340.0</td>
<td>380.0</td>
<td>220.0</td>
<td>135.0</td>
</tr>
<tr>
<td>11</td>
<td>520.0</td>
<td>530.0</td>
<td>520.0</td>
<td>315.0</td>
<td>235.0</td>
</tr>
<tr>
<td>15</td>
<td>670.0</td>
<td>580.0</td>
<td>600.0</td>
<td>500.0</td>
<td>460.0</td>
</tr>
<tr>
<td>18.5</td>
<td>770.0</td>
<td>810.0</td>
<td>29.0</td>
<td>74.0</td>
<td>46.0</td>
</tr>
<tr>
<td>22</td>
<td>940.0</td>
<td>940.0</td>
<td>685.0</td>
<td>34.0</td>
<td>74.0</td>
</tr>
<tr>
<td>30</td>
<td>1050.0</td>
<td>1370.0</td>
<td>1020.0</td>
<td>810.0</td>
<td>1750.0</td>
</tr>
</tbody>
</table>

1. Heat generation when: output current is inverter rated current, power supply voltage is 220V (in 200V class)/440V (in 400V class), and carrier frequency is 2kHz.

2. Heat generation when: output current is inverter rated current, power supply voltage is 220V (in 200V class)/440V (in 400V class), and carrier frequency is 14.5kHz.

Heat generated by other equipment:
- Capacitor type filter FR-BIF(-H): 4W or less
- Common mode filter FR-BLF: 4W or less
- Common mode filter FR-BSF01: 4W or less
- Surge voltage suppression filter FR-ASF-H: 1.5K, 75W
- Surge voltage suppression filter FR-ASF-H: 3.7K, 129W
- Surge voltage suppression filter FR-ASF-H: 7.5K, 216W
- Surge voltage suppression filter FR-ASF-H: 15K, 342W
- Surge voltage suppression filter FR-ASF-H: 22K, 450W
- Surge voltage suppression filter FR-ASF-H: 55K, 1010W
(1) Inverter-generated heat

When the rated output current flows, the inverter generates heat as shown on the preceding page.

1) Reduction according to motor load factor
   At the rated output current, the following figure shows a reduction rate when operating the inverter with a light load.

2) Reduction according to duty
   The ratio of reduction during intermittent operation in a cycle of within five minutes is shown.

<table>
<thead>
<tr>
<th>Inverter Capacity (kW)</th>
<th>Standby Electricity (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan is ON</td>
<td>Fan is OFF</td>
</tr>
<tr>
<td>0.4</td>
<td>0.75</td>
</tr>
<tr>
<td>0.75</td>
<td>1.5</td>
</tr>
<tr>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>2.2</td>
<td>3.7</td>
</tr>
<tr>
<td>3.7</td>
<td>5.5</td>
</tr>
<tr>
<td>5.5</td>
<td>7.5</td>
</tr>
<tr>
<td>7.5</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>18.5</td>
</tr>
<tr>
<td>18.5</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inverter Capacity (kW)</th>
<th>Standby Electricity (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan is ON</td>
<td>Fan is OFF</td>
</tr>
<tr>
<td>0.4</td>
<td>0.75</td>
</tr>
<tr>
<td>0.75</td>
<td>1.5</td>
</tr>
<tr>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>2.2</td>
<td>3.7</td>
</tr>
<tr>
<td>3.7</td>
<td>5.5</td>
</tr>
<tr>
<td>5.5</td>
<td>7.5</td>
</tr>
<tr>
<td>7.5</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>18.5</td>
</tr>
<tr>
<td>18.5</td>
<td>22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Inverter Capacity (kW)</th>
<th>Standby Electricity (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan is ON</td>
<td>Fan is OFF</td>
</tr>
<tr>
<td>0.4</td>
<td>0.75</td>
</tr>
<tr>
<td>0.75</td>
<td>1.5</td>
</tr>
<tr>
<td>1.5</td>
<td>2.2</td>
</tr>
<tr>
<td>2.2</td>
<td>3.7</td>
</tr>
<tr>
<td>3.7</td>
<td>5.5</td>
</tr>
<tr>
<td>5.5</td>
<td>7.5</td>
</tr>
<tr>
<td>7.5</td>
<td>11</td>
</tr>
<tr>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>15</td>
<td>18.5</td>
</tr>
<tr>
<td>18.5</td>
<td>22</td>
</tr>
</tbody>
</table>

Electricity during standby (at a stop)
(2) Brake unit-generated heat

When a brake unit is used, heat is generated by the brake unit and the brake resistor.

1) Heat generated by the brake unit (excluding that of the brake resistor) is found according to the diagram as shown below.

2) Heat loss of the brake resistor is calculated by the following expression:

\[ P[W] = \frac{\sum T}{13700} \times N \times S \]

- \( T \): Overall reflected to motor shaft (including motor, etc.) [kg m²]
- \( N \): Motor speed [r/min]
- \( S \): Number of deceleration [times/min]

Heat generated (W)

<table>
<thead>
<tr>
<th>Brake unit duty (%ED)</th>
<th>a) BU type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 10 20 30 40 50 60 70 80 90 100</td>
<td></td>
</tr>
</tbody>
</table>

Heat generated (W)

<table>
<thead>
<tr>
<th>Brake unit duty (%ED)</th>
<th>b) FR-BU type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 10 20 30 40 50 60 70 80 90 100</td>
<td></td>
</tr>
</tbody>
</table>

Heat generated (W)

<table>
<thead>
<tr>
<th>Brake unit duty (%ED)</th>
<th>c) FR-BU2 type</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 10 20 30 40 50 60 70 80 90 100</td>
<td></td>
</tr>
</tbody>
</table>

400V class

200V class

20V class
3.7.3 Specification of enclosed enclosure

For the inverters, the installation of the semiconductor heat sink and brake resistor outside the enclosure allows heat generated in the enclosure to be greatly reduced to 30% and a compact enclosure to be designed. The following table lists the heat dissipation area and approximate dimensions of the enclosed dust-proof enclosure with respect to the loss (W).

### Heat dissipation area of the enclosed dust-proof enclosure (Heat sink outside enclosure) 55kW or less

<table>
<thead>
<tr>
<th>Inverter Capacity</th>
<th>Enclosed Dust-Proof Type (IP5X)</th>
<th>Loss (Rated) (W)</th>
<th>Area required for heat dissipation (m²)</th>
<th>Approximate box dimensions (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FR-A720-0.4K</td>
<td></td>
<td>50</td>
<td>0.9</td>
<td>400W + 600H + 250D</td>
</tr>
<tr>
<td>FR-A720-0.75K</td>
<td></td>
<td>70</td>
<td>1.2</td>
<td>550W + 600H + 250D</td>
</tr>
<tr>
<td>FR-A720-1.5K</td>
<td></td>
<td>150</td>
<td>2.9</td>
<td>2000W + 600H + 1500D</td>
</tr>
<tr>
<td>FR-A720-2.2K</td>
<td></td>
<td>140</td>
<td>2.4</td>
<td>800W + 800H + 1500D</td>
</tr>
<tr>
<td>FR-A720-5.7K</td>
<td></td>
<td>190</td>
<td>3.2</td>
<td>500W + 1000H + 800D</td>
</tr>
<tr>
<td>FR-A720-7.5K</td>
<td></td>
<td>260</td>
<td>4.4</td>
<td>1200W + 1200H + 800D</td>
</tr>
<tr>
<td>FR-A720-7.5K</td>
<td></td>
<td>260</td>
<td>4.4</td>
<td>1200W + 1200H + 800D</td>
</tr>
<tr>
<td>FR-A720-15K</td>
<td></td>
<td>1270</td>
<td>21.2</td>
<td>3000W + 2000H + 1500D</td>
</tr>
<tr>
<td>FR-A720-22K</td>
<td></td>
<td>1610</td>
<td>28.9</td>
<td>4000W + 2500H + 1500D</td>
</tr>
<tr>
<td>FR-A720-55K</td>
<td></td>
<td>1880</td>
<td>31.4</td>
<td>5000W + 2500H + 1200D</td>
</tr>
<tr>
<td>FR-A720-0.4K</td>
<td></td>
<td>50</td>
<td>0.8</td>
<td>300W + 300H + 250D</td>
</tr>
<tr>
<td>FR-A720-0.75K</td>
<td></td>
<td>70</td>
<td>1.2</td>
<td>550W + 600H + 250D</td>
</tr>
<tr>
<td>FR-A720-1.5K</td>
<td></td>
<td>150</td>
<td>2.9</td>
<td>2000W + 600H + 1500D</td>
</tr>
<tr>
<td>FR-A720-2.2K</td>
<td></td>
<td>140</td>
<td>2.4</td>
<td>800W + 800H + 1500D</td>
</tr>
<tr>
<td>FR-A720-5.7K</td>
<td></td>
<td>190</td>
<td>3.2</td>
<td>500W + 1000H + 800D</td>
</tr>
<tr>
<td>FR-A720-7.5K</td>
<td></td>
<td>260</td>
<td>4.4</td>
<td>1200W + 1200H + 800D</td>
</tr>
<tr>
<td>FR-A720-7.5K</td>
<td></td>
<td>260</td>
<td>4.4</td>
<td>1200W + 1200H + 800D</td>
</tr>
<tr>
<td>FR-A720-15K</td>
<td></td>
<td>1270</td>
<td>21.2</td>
<td>3000W + 2000H + 1500D</td>
</tr>
<tr>
<td>FR-A720-22K</td>
<td></td>
<td>1610</td>
<td>28.9</td>
<td>4000W + 2500H + 1500D</td>
</tr>
<tr>
<td>FR-A720-55K</td>
<td></td>
<td>1880</td>
<td>31.4</td>
<td>5000W + 2500H + 1200D</td>
</tr>
<tr>
<td>FR-A740-0.4K</td>
<td></td>
<td>15</td>
<td>0.3</td>
<td>300W + 300H + 150D</td>
</tr>
<tr>
<td>FR-A740-0.75K</td>
<td></td>
<td>20</td>
<td>0.6</td>
<td>550W + 300H + 150D</td>
</tr>
<tr>
<td>FR-A740-1.5K</td>
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<td>24</td>
<td>1.4</td>
<td>3000W + 300H + 150D</td>
</tr>
<tr>
<td>FR-A740-2.2K</td>
<td></td>
<td>30</td>
<td>1.0</td>
<td>550W + 300H + 150D</td>
</tr>
<tr>
<td>FR-A740-5.7K</td>
<td></td>
<td>45</td>
<td>1.8</td>
<td>500W + 600H + 300D</td>
</tr>
<tr>
<td>FR-A740-7.5K</td>
<td></td>
<td>60</td>
<td>3.0</td>
<td>500W + 600H + 300D</td>
</tr>
<tr>
<td>FR-A740-11K</td>
<td></td>
<td>90</td>
<td>4.5</td>
<td>800W + 600H + 300D</td>
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<tr>
<td>FR-A740-18.5K</td>
<td></td>
<td>120</td>
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<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-22K</td>
<td></td>
<td>165</td>
<td>10.0</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-30K</td>
<td></td>
<td>195</td>
<td>13.0</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-37K</td>
<td></td>
<td>240</td>
<td>16.0</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-55K</td>
<td></td>
<td>330</td>
<td>25.5</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-75K</td>
<td></td>
<td>390</td>
<td>33.0</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-110K</td>
<td></td>
<td>485</td>
<td>48.5</td>
<td>1200W + 800H + 300D</td>
</tr>
<tr>
<td>FR-A740-180K</td>
<td></td>
<td>548</td>
<td>54.8</td>
<td>1200W + 800H + 300D</td>
</tr>
</tbody>
</table>

1. **IP5X,…..** Type classified by JEM1030 (protective structure of control equipment)
2. The built-in brake resistor loss is not included.
3. The values in the above table depend on the operating conditions and surrounding air temperature. (Heat generated by other equipment has not been taken into consideration)
4. The values in the above table indicate areas effective for heat dissipation.
5. When the heat sink is installed outside the enclosure, the loss indicates the heat generated by the inverter unit in the enclosure.
3.7.4 Cooling of inverter enclosure

(1) Cooling method

The enclosure housing the inverter must efficiently dissipate heat generated by the inverter and other devices (transformer, lamps, resistors, etc.) and heat entering from the outside, e.g., direct sunlight, to keep the temperature inside the enclosure less than the permissible temperature of the equipment in the panel including the inverter.

The cooling systems are classified as follows in terms of the cooling calculation method:
1) Cooling by natural heat dissipation from the enclosure surface (totally enclosed type)
2) Cooling by heatsink (aluminum heatsink, etc.)
3) Cooling by ventilation (forced ventilation type, pipe ventilation type)
4) Cooling by heat exchanger or cooler (heat pipe, cooler, etc.)

(2) Cooling effect calculation

1) Calculation of heat dissipation energy by natural heat dissipation from enclosure surface:

\[ W_1 = K_1 \cdot A \cdot \Delta t \]

(a) The effective heat dissipation area does not include constructions, such as a floor and walls, and any surface proximate to the other enclosures.
(b) The temperature in the enclosure should be kept constant by an agitating fan.
(c) Constant \( K_1 \) is indicated as a reference value because it depends on the enclosure structure, parts layout inside the enclosure, and ambient temperature.

2) Calculation of heat dissipation energy from heatsink:

\[ W_2 = N \cdot K_2 \cdot \Delta t \]

3) Calculation of heat dissipation energy by ventilation:

\[ W_3 = K_3 \cdot Q \cdot \Delta t \]

4) Calculation of heat dissipation energy by heat exchange or cooler:

\[ W_4 = K_4 \cdot H \]

<table>
<thead>
<tr>
<th>Cooling Method</th>
<th>Enclosure Structure</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural ventilation (Enclosed, open type)</td>
<td></td>
<td>Low in cost and generally used, but the enclosure size increases as the inverter capacity increases. For relatively small capacities.</td>
</tr>
<tr>
<td>Natural ventilation (Totally enclosed type)</td>
<td></td>
<td>Being a totally enclosed type, the most appropriate for hostile environment having dust, dirt, oil mist, etc. The enclosure size increases depending on the inverter capacity.</td>
</tr>
<tr>
<td>Heatsink cooling</td>
<td></td>
<td>Having restrictions on the heatsink mounting position and area, and designed for relatively small capacities.</td>
</tr>
<tr>
<td>Forced ventilation</td>
<td></td>
<td>For general indoor installation. Appropriately for enclosure downsizing and cost reduction, and often used.</td>
</tr>
<tr>
<td>Heat pipe</td>
<td></td>
<td>Totally enclosed type for enclosure downsizing.</td>
</tr>
</tbody>
</table>
3.8 Meters and measurement methods

Since voltages and currents in the primary and secondary side of the inverter include harmonics, different meters indicate different measurement values. When making measurement with the meters designed for commercial frequency, use the following measuring instruments and circuits:

3.8.1 Measurement of powers

Use a digital power meter (designed for inverter) on both the input and output sides of the inverter.

3.8.2 Measurement of voltages and use of PT

(1) Inverter input side

As the input side voltage has a sine wave and it is extremely small in distortion, accurate measurement can be made with an ordinary AC meter.

(2) Inverter output side

Since the output side voltage has a PWM-controlled rectangular wave, always use a rectifier type voltmeter. A needle type tester can not be used to measure the output side voltage as it indicates a value much greater than the actual value. A moving iron type meter indicates an effective value which includes harmonics and therefore the value is larger than that of the fundamental wave. The value monitored on the operation panel (parameter unit) is the inverter-controlled voltage itself. Hence, that value is accurate and it is recommended to monitor values (or analog output) using the operation panel (parameter unit). An example of the measurement value difference produced by different measuring meters is shown on the right.

Examples of measuring points and instruments

When installing meters etc. on the inverter output side

When the inverter-to-motor wiring length is long, especially in the 400V class, small-capacity models, the meters and CTs may generate heat due to line-to-line leakage current. Therefore, choose the equipment which has enough allowance for the current rating.

When measuring and indicating the output voltage and output current of the inverter, it is recommended to utilize the AM-5 and FM-SD terminal output function of the inverter.

[Measurement conditions]
Motor 3.7kW 4-pole + inverter 3.7K
Value indicated by rectifier type voltmeter is 100%.

Example of measuring inverter output voltage

No PT can be used in the output side of the inverter. Use a direct-reading meter. (A PT can be used on the input side of the inverter.)
3.8.3 Measurement of currents

Use a moving-iron type meter on both the input and output sides of the inverter. However, if the carrier frequency exceeds 5kHz, do not use that meter since an overcurrent loss produced in the internal metal parts of the meter will increase and the meter may burn out. In this case, use an approximate-effective value type. Since current on the inverter input side tends to be unbalanced (refer to page 507), measurement of three phases is recommended. Correct value can not be obtained by measuring only one or two phases. On the other hand, the unbalanced ratio of each phase of the output side current should be within 10%.

When a clamp ammeter is used, always use an effective value detection type. A mean value detection type produces a large error and may indicate an extremely smaller value than the actual value. The value monitored on the operation panel (parameter unit) is accurate if the output frequency varies, and it is recommended to monitor values (provide analog output) using the operation panel (parameter unit).

An example of the measurement value difference produced by different measuring meters is shown on the right.

3.8.4 Use of CT and transducer

A CT may be used in both the input and output sides of the inverter, but the one used should have the largest possible VA ability because an error will increase if the frequency gets lower.

When using a transducer, use the effective value calculation type which is immune to harmonics.

3.8.5 Measurement of inverter input power factor

Use the effective power and apparent power to calculate the inverter input power factor (refer to page 505). A power-factor meter can not indicate an exact value.

3.8.6 Measurement of converter output voltage (across terminals P-N)

The output voltage of the converter is developed across terminals P-N and can be measured with a moving-coil type meter (fastener). If the power supply voltage, the converter output voltage is approximately 270 to 300V (approximately 540 to 600V for the 400V class) under no load and lowers under load.

When regenerative energy is returned from the motor during deceleration, for example, the converter output voltage rises to nearly 400V (800V for the 400V class) maximum. (When the converter output voltage reaches approximately 400V for the 200V class or approximately 800V for the 400V class, the inverter results in OVT shut-off)

3.8.7 Measurement of inverter output frequency

A pulse train proportional to the output frequency is output across the frequency meter signal output terminal FM-SD of the inverter. This pulse train output can be counted by a frequency counter, or a meter (moving-coil type voltmeter) can be used to read the mean value of the pulse train output voltage. When a meter is used to measure the output frequency, approximately 5VDC is indicated at the maximum frequency.

For detailed specifications of the frequency meter signal output terminal FM, refer to page 78.
3.9 Compliance with standards

The standard models of inverters comply with the UL Standard, cUL Standard and EN Standard.

3.9.1 Compliance with the UL and CSA standards

(conforming standard UL 508C, LSA C22.2 No.14)

About the UL and cUL compliance

The UL (Underwriters Laboratories Inc.) Standard is a safety standard in the U.S.A. UL is a non-profit testing institution established by the U.S. Fire Underwriters' Association and conducts approval tests on industrial products. UL has strictly prescribed the safety standard in an extremely wide range, assuming every possible situation during use of products. The UL mark has extremely high authority and reliability and is mandated by the state laws and city ordinances in many U.S. states. Canada has a similar standard, the CSA Standard. The standard equivalent to Canada's CSA Standard has been stipulated by the U.S.A. as the cUL Standard, and products approved by this Standard are regarded as approved by the CSA Standard. Refer to the instruction manual for information on UL and cUL.

Installation

This inverter is UL-listed as a product for use in an enclosure. Design an enclosure so that the inverter surrounding air temperature, humidity and atmosphere satisfy the specifications.

Wiring protection

For installation in the United States, branch circuit protection must be provided in accordance with the National Electrical Code and any applicable provincial codes.

For installation in Canada, branch circuit protection must be provided in accordance with the Canada Electrical Code and any applicable provincial codes. Provide the appropriate UL and cUL listed Class RK5, Class T or Class L type fuse or UL489 molded case circuit breaker (MCCB) that is suitable for branch circuit protection in accordance with the table below.

<table>
<thead>
<tr>
<th>FR-A700-‡‡K</th>
<th>FR-A740-‡‡K</th>
<th>FR-A750-‡‡K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated fuse voltage (V)</td>
<td>240V or more</td>
<td>480V or more</td>
</tr>
<tr>
<td>Fuse maximum allowable rating (A)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>With power factor improving reactor</td>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>Without power factor improving reactor</td>
<td>600</td>
<td>700</td>
</tr>
<tr>
<td>Molded case circuit breaker (MCCB) Maximum allowable rating (A)*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>With power factor improving reactor</td>
<td>600</td>
<td>700</td>
</tr>
</tbody>
</table>
(2) Wiring of the power supply and motor

For wiring the input (R/L1, S/L2, T/L3) and output (U, V, W) terminals of the inverter, use the UL-listed copper wires (rated at 75°C) and round crimping terminals. Crimp the crimping terminals with the crimping tool recommended by the terminal maker.

(3) Short circuit ratings

- 200V class
  Suitable for use in a circuit capable of delivering not more than 100kA rms symmetrical amperes maximum, 264 Volts Maximum.
- 400V class
  55k or less
  Suitable for use in a circuit capable of delivering not more than 100kA rms symmetrical amperes maximum, 528 Volts Maximum.
  75k or more
  Suitable for use in a circuit capable of delivering not more than 100kA rms symmetrical amperes maximum, 550 Volts Maximum.

(4) Motor overload protection

This inverter is certified as a motor overload protection device by UL. When using the electronic thermal relay function as motor overload protection, set the rated motor current to [Pr. 9 Electronic thermal O/L relay].

Electronic thermal relay function operation characteristics

This function detects the overload (overheat) of the motor and trips. (The operation characteristic is shown above)

- When using a Mitsubishi constant-torque motor
  1) Set any of 1, 13 to 18, 50, 53, or 54 in [Pr. 71].
     (This provides a 100% continuous torque characteristic in the low-speed range.)
  2) Set the rated current of the motor in [Pr. 9].

*1 When a value 50% of the inverter rated output current (current value) is set in [Pr. 9]
*2 The % value denotes the percentage to the inverter rated output current. It is not the percentage to the rated motor current.
*3 When you set the electronic thermal O/L relay dedicated to the Mitsubishi constant-torque motor, this characteristic curve applies to operation at 6Hz or higher.

Instructions

- Protective function by electronic thermal relay function is reset by inverter power reset and reset signal input. Avoid unnecessary reset and power OFF.
- When multiple motors are operated by a single inverter, protection cannot be provided by the electronic thermal function. Install an external thermal relay to each motor.
- When a difference between the inverter and motor capacities is large and the setting is small, the protective characteristics of the electronic thermal relay function will be deteriorated. In this case, use an external thermal relay.
- A special motor cannot be protected by the electronic thermal relay function. Use an external thermal relay.
- Electronic thermal relay may not function when 5% or less of inverter rated current is set to electronic thermal relay setting.
3.9.2 Compliance with the EU Directives

About the EU Directives
As a part of European integration, common rules for free transfer and commercial activities of people/goods/service within the EU member states are being formed. As one way of this rule making, the EC Committee has compiled 13 directives as the technological uniform standards on health and safety, and each country is legislating in accordance with these directives. Products covered by these directives are obliged to carry the CE mark, and the permission of export to and free movements and sales in the European district is only given to products carrying the CE mark. The following three directives are concerned with drive products:

(1) Machinery Directive
Stipulates the safety of machinery, and fundamentally requires that any machine should not threaten the health and safety of living creatures and the safety of things when it is installed and maintained correctly and operated properly. Since inverters are components designed to control machines/apparatuses, we understand that inverters are not covered by this directive directly.

(2) EMC Directive
We have self-confirmed as products compliant to the EMC Directive (second environment of conforming standard EN61800-3) and place the CE mark on the inverters.

*1 First environment
Environment including residential buildings. Includes buildings directly connected without a transformer to the low voltage power supply network which supplies power to residential buildings.

*2 Second environment
Environment including all buildings except buildings directly connected without a transformer to the low voltage power supply network which supplies power to residential buildings.

Instructions
Set the EMC filter valid and install the inverter and perform wiring according to the following instructions.
• The inverter is equipped with a built-in EMC filter. Set the EMC filter valid. (The filter is invalid when shipped from the factory. (A700 200V class 0.4K, 0.75K and F700 200V class 0.75K and 1.5K are always valid.))
• Connect the inverter to an earthed power supply.
• Install a motor and a control cable written in the EMC Installation Manual (BCN-A21041-204) according to the instruction.
• The cable length between the inverter and the motor is 5m maximum.
• Confirm that the inverter complies with the EMC Directive as the industrial drives application for final installation.
(3) Low Voltage Directive

We have self-confirmed our inverters as products compliant to the Low Voltage Directive (Conforming standard EN 50178 for A700, 7700, E700, EN61800-5-1 for F700) and place the CE mark on the inverters.

Outline of Instructions

• Do not use an earth leakage circuit breaker as an electric shock protector without connecting the equipment to the earth. Connect the equipment to the earth securely.
• Wire the earth (ground) terminal independently. (Do not connect two or more cables to one terminal.)
• Use the cable sizes of earth cable and main circuit under the following conditions.
  - Ambient temperature : 40 °C maximum
    If conditions are different from above, select appropriate wire according to EN60204 ANNEX C TABLE 5.
  - Use a tinned (plating should not include zinc) crimping terminal to connect the earth (ground) cable. When tightening the screw, be careful not to damage the threads.
  - For use as a product compliant with the Low Voltage Directive, use the recommended PVC cable.
  - Use the moulded case circuit breaker and magnetic contactor which conform to the EN or IEC Standard. Design notice : Where residual-current-operated protective device (RCD) is used for protection in case of direct or indirect contact, only RCD of Type B is allowed on the supply side of this Electronic Equipment (EE). Otherwise another protective measure shall be applied such as separation of the EE from the environment by double or reinforced insulation or isolation of EE and supply system by a transformer. (Extract from EN51078)
• On the input and output of the inverter, use cables of the type and size set forth in EN60204 Appendix C.
  - The operating capacity of the relay outputs (terminal symbols A1, B1, C1, A2, B2, C2) should be 30VDC, 0.3A. (Relay outputs are basically isolated from the inverter internal circuit.)
  - Control circuit terminals are safely isolated from the main circuit.
• Environment

<table>
<thead>
<tr>
<th>Environment</th>
<th>Running</th>
<th>In Storage</th>
<th>During Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>-10°C to +60°C</td>
<td>-20°C to +60°C</td>
<td>-20°C to +60°C</td>
</tr>
<tr>
<td>Humidity</td>
<td>90% RH or less</td>
<td>95% RH or less</td>
<td>98% RH or less</td>
</tr>
<tr>
<td>Maximum altitude</td>
<td>1000m</td>
<td>1000m</td>
<td>10000m</td>
</tr>
</tbody>
</table>

Details are given in the "Low Voltage Directive Conformance Guide" (BCN-A21041-203). Please contact your sales representative.

CE mark
MEMO
### 4 Practical Circuits

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</table>
4.1 Standard connection diagram

The circuit diagram shown in this chapter are reference circuit diagrams used to activate functions. When designing actual circuits, examine the operations of the machine and system and the rating, safety interlocks and other devices such as the contactors, relays and other equipment.

4.1.1 The inverter equipped with magnetic contactor on primary side (FR-AX manual controller used)

*1 This magnetic contactor is provided to prevent an automatic restart when power is restored after a power failure. Use the start signal (ON or OFF of STF, STR) to make a start or stop.

*2 The inverter stops when both terminals STF and STR are closed simultaneously.

*3 When the power supply is 400V class, install a step-down transformer.

*4 When the motor shaft inertia is small, for example, this circuit may be omitted by utilizing the current limit function of the inverter.
4.1.2 The inverter equipped with magnetic contactor on primary side (with FR-BU2 type brake unit) common

*1 This magnetic contactor is provided to prevent an automatic restart when power is restored after a power failure. Use the start signal (ON or OFF of STF, STR) to make a start or stop.

*2 When the power supply is 400V class, install a step-down transformer.

*3 Set \[Pr. 75 = 1\] "Reset input is enabled only when the fault occurs" to disable resetting of the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is to prevent the inverter from resulting in a fault if the motor is still coasting when the inverter has returned from the reset status.)
4.1.3 The inverter equipped with magnetic contactor on primary side (with high-duty brake resistor) (A700, E700, D700)

- **A700**: 22K or less
- **E700/D700**: 0.4K to 15K

*1 This magnetic contactor is provided to prevent an automatic restart when power is restored after a power failure. Use the start signal (ON or OFF of STF, STR) to make a start or stop.

*2 When the power supply is 400V class, install a step-down transformer.

*3 Set \([Pr. 75 = 1]\) "Reset input is enabled only when the fault occurs" to disable resetting of the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is to prevent the inverter from resulting in an alarm if the motor is still coasting when the inverter has returned from the reset status.)

*4 When using an external brake resistor or brake unit, remove the jumper from across PR-PX. (7.5K or less only. Not available for E700/D700)

Do not use PR and PX terminals for A700. Do not remove the jumper connected to terminal PR and PX.)
4.1.4 The inverter without magnetic contactor on the primary side

*1 Set [Pr. 75 = 1] "Reset input is enabled only when the fault occurs" to disable resetting of the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is to prevent the inverter from resulting in an alarm if the motor is still coasting when the inverter has returned from the reset status.)

*2 During operation, switch-over from "forward rotation" to "stop", then to "reverse rotation" is available. In this case, when the reverse rotation signal is turned ON, the regenerative brake is applied down to the forward rotation frequency of 0.5Hz, the opposite-phase brake is applied at or less than starting frequency and acceleration in reverse rotation is started at that frequency. (DC injection brake is not applied.)

*3 When making "forward rotation" to "reverse rotation" change-over during forward rotation in the above chart, change part of the connection diagram as shown on the above.

*4 When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the discharging resistor from overheating/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharging resistor, and excessive regenerative brake duty, etc.

*5 When the power supply is 400V class, install a step-down transformer.
4.2 Remote operation (common)

4.2.1 Use of the FR-FK motorized speed setter (common)

*1 Separate the signal cable from the power cable. Not doing so can cause the signal line to act as an antenna and be affected more easily by external noise.

*2 The frequency meter connection cable may be increased up to 200m in length. (Install the calibration resistor near the frequency meter.)

*3 Set \[ Pr. 75 = 1 \] "Reset input is enabled only when the fault occurs" to disable resetting of the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is to prevent the inverter from resulting in an alarm if the motor is still coasting when the inverter has returned from the reset status.)

*4 When the power supply is 400V class, install a step-down transformer.

*5 When the electric channel length between the inverter and motor is long:

1) As the output voltage of the inverter includes high frequency, continuous leakage current due to the to-ground capacitances in the inverter-to-motor electric channel increases and the earth leakage circuit breaker or earth leakage relay may operate unnecessarily.
   
   Wire the cables between the inverter and motor over the shortest distance and increase the electric channel-to-ground distance.

2) At a low frequency, the motor torque may decrease due to a voltage drop in the cables. (Refer to page 530)
4.2.2 Automatic operation using 4 to 20mADC current signal

1. Separate the signal cable from the power cable. Not doing so can cause the signal line to act as an antenna and be affected more easily by external noise.

2. The frequency meter connection cable may be increased up to 200m in length. (Install the calibration resistor near the frequency meter.)

3. When the electric channel length between the inverter and motor is long:
   1) As the output voltage of the inverter includes high frequency, continuous leakage current due to the to-ground capacitances in the inverter-to-motor electric channel increases and the earth leakage circuit breaker or earth leakage relay may operate unnecessarily. Wire the cables between the inverter and motor over the shortest distance and increase the electric channel-to-ground distance.
   2) At a low frequency, the motor torque may decrease due to a voltage drop in the cables. (Refer to page 530)

4. When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent discharging resistor from overheat/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharging resistor, and excessive regenerative brake duty, etc.

5. When running two inverters with a 4 to 20mADC current signal at the same time, connect terminals 4-5 in series. Note the power supply capacity of the 4 to 20mADC signal.
4.3 Motor equipped with brake  **common**

1. When stopping the motor equipped with electromagnetic brake, use the output stop terminal signal (MRS) of the inverter. A failure to do so causes a lock current to flow in the motor when the brake is applied, and OCT may occur.

2. The above caution must also be taken when using any other mechanical brake.

3. When the motor equipped with a brake is run at or less than 30Hz continuously, the brake disc may rattle but the motor may be used without any problem if it is run at low speed for a short period, for example, in orientation. Also, as there is a limit to the braking capacity, run the motor at no more than 60Hz.

4. In this circuit, pressing the stop button stops the motor with the electromagnetic brake. For operation of the electromagnetic brake after the motor is decelerated by the inverter, refer to page 576.

5. When the power supply is 400V class, install a step-down transformer.

6. When using an external brake resistor or brake unit, remove the jumper from across PR-PX. (7.5K or less. Not available for . Do not use PR and PX terminals for the . Do not remove the jumper connected to terminal PR and PX.)
4.4 Parallel motor operation

4.4.1 Motors driven by one inverter

*1 The electronic thermal relay built into the inverter cannot be used. Use an external thermal relay with each motor.
Note that when the capacity is small and the wiring length is large (50m or more), line-to-line leakage currents may operate the thermal relay. Refer to page 524 and take adequate actions.
Set 0 (A) in the electronic thermal relay parameter to switch off the electronic thermal relay.

*2 How to stop the inverter without switching off the magnetic contactor (MC) when the external thermal relay is actuated:
Use the external thermal input terminal (OH) to cause the inverter to stop the output. (Refer to page 50 for details)

*3 Motor selection
No problem will arise when a specific motor is connected or selected while all motors are at a stop. However, if any of the motors during a stop is direct-on line started by the contactor etc. during inverter operation, the current limit function of the inverter may be activated by the starting current of that motor, leading to a sudden change of the output frequency. In this case, it is recommended to increase the inverter capacity.

*4 Provide a step-down transformer when the power supply is 400V class.
4.4.2 Inverters and motors are in pairs (common)

By using the frequency setting gain/bias function of the inverter, you can make adjustment to match the output frequencies of the three inverters corresponding to the common voltage value from the frequency setting potentiometer.

When two or more motors are coupled mechanically, larger load may be applied to one motor, resulting in overload. Use the method described on page 565.

Provide a step-down transformer when the power supply is 400V class.

Multiple inverters of which total current is within the permissible load current in terminal 10 (+5V) can be connected. Total of three inverters can be connected using terminal 10E (+10V) and a 1kΩ potentiometer.
4.4.3 Using pulse I/O (A700)

*1 You can make adjustment to match the output frequency of the inverters regarding [Pr. 385, Pr. 386]. The ratio can be changed to make adjustment.

*2 When two or more motors are coupled mechanically, larger load may be applied to one motor, resulting in overload. Use the method described on page 565.

*3 When the power supply is 400V class, install a step-down transformer.

*4 Use [Pr. 291] to set the FM terminal output to "high speed pulse train output (ON width is always same)". Perform wiring terminal FM on the master side and terminal JOG on the slave side after setting [Pr. 291].

*5 Use [Pr. 291] to set the JOG terminal input to "pulse train input". In addition, to input the highest pulse train of 500 pulse/s, set [Pr. 384 = 125]. Refer to page 228.

*6 When the wiring length between FM and JOG is long, input pulse can not be recognized because of a pulse shape deformation due to the stray capacitances of the wiring. When wiring length is long (10m or more of recommended 0.75mm² twisted cable), connect terminal JOG and terminal PC using an external pull up resistance. The reference of resistance value to the wiring length is as in the table below.

<table>
<thead>
<tr>
<th>Wiring Length</th>
<th>Pull-up resistance (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 10m</td>
<td>100%</td>
</tr>
<tr>
<td>10 to 50m</td>
<td>85%</td>
</tr>
<tr>
<td>50 to 100m</td>
<td>65%</td>
</tr>
</tbody>
</table>

Stray capacitances of the wiring greatly differ according to the cable type and cable laying, the above cable length is not a guaranteed value.

When using a pull up resistance, check the permissible power of the resistor and permissible load current (terminal PC: 100mA, high speed pulse train output: 85mA) and use them within a permissible range.

*7 A pulse transmission delay in a slave is approximately 1 to 2 s. When wiring length is long, the delay further increases.

*8 The inverter can be operated by pulse train input as frequency command.
4.4.4 Soft starter is used to soft-start/soft-stop two motors at the same time

*1 Use the signal of the relay R2 to make a soft start/soft stop. Turn OFF the relay R1 after the motor has stopped. If it is turned OFF during motor operation, the motor may decelerate at the acceleration/deceleration time in the inverter, resulting in an OVT trip.

*2 The times of acceleration and deceleration made by the FR-FC soft starter are as indicated below at the maximum output voltage. (For the specifications of 90s or longer, contact the manufacturer.)

<table>
<thead>
<tr>
<th>Standard</th>
<th>C1-C2 (pr. 7)</th>
<th>C1-C2-C3 (pr. 8)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.15 to 1.3s adjustable</td>
<td>0.75 to 7.5s adjustable</td>
<td>10 to 90s adjustable</td>
</tr>
</tbody>
</table>

*3 Set the acceleration/deceleration time of the inverter to the minimum value of 0s.

*4 When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent discharging resistor from overheat/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharging resistor, and excessive regenerative brake duty, etc.

*5 Provide a control transformer when the power supply is 400V class.
4.5 Inverter - commercial power supply switch-over operation (common)

4.5.1 Star-Delta connection start (common)

When the motor is rotated at full speed of 60Hz (or 50Hz), running the motor by commercial power supply is more efficient than inverter operation. Also, when the motor cannot be stopped for a long time for the maintenance/inspection of the inverter, it is recommended to provide the commercial power supply circuit.

*1 For the control circuit, refer to page 570 and 572.
*2 For inverter operation, turn ON MC2 and MCD simultaneously. (Y-connection operation cannot be performed.)
*3 Provide electrical and mechanical interlocks to prevent the MC1 and MC2 from being turned ON at the same time.
*4 In principle, do not turn ON the MC2 to start the inverter while the motor is rotating (coasting). Refer to page 37 for details of the magnetic contactor (MC2) turn-ON conditions.
*5 Before making connection, ensure that the phase rotation of the commercial power supply is in R – S – T sequence.
4.5.2 Bypass inverter switch-over operation (common)

Bypass operation can be changed over to inverter operation without stopping the motor.

(Setting \( Pr. 57 \neq 9999 \) will make the restart function valid.)

1. When coasting the motor to a stop by pressing the stop pushbutton in the inverter mode, modify the circuit as shown below:

2. By pressing the inverter operation pushbutton, bypass operation can be changed over to inverter operation without stopping the motor.

3. When the inverter is tripped due to an instantaneous power failure (IPF), the motor restarts automatically when power is restored. (Note that when there is no type RD instantaneous power failure relay, the motor is coasted to a stop when the relay or MC turns OFF, and does not restart automatically.)

4. When an inverter trip occurs, inverter operation is changed over to bypass operation. (When the RA1 marked *4 is removed, bypass backup operation is not performed.)

5. When the stop pushbutton is pressed during inverter operation, the motor is inverter-controlled from deceleration to a stop. (When coasting the motor to a stop, modify the circuit portions marked *1 and *7.)

6. When the power supply is 400V class, install a step-down transformer.

7. do not have CS signal. Assign MRS signal and set the MRS signal logic as normally closed \( Pr. 17 = 2 \). Also, set to perform frequency search at every power ON \( Pr. 162 = 10 \) for automatic restart after instantaneous power failure.
When coasting the motor to a stop by pressing the stop pushbutton in the inverter mode, modify the circuit as shown below:

Inverter ready
OFF
ON

Inverter operation
Inverter start
Inverter trip

PB Stop

Bypass operation

Commercial power supply

Inverter operation selection

Inverter start

Inverter trip
4.5.3 Bypass-inverter switch-over operation [when bypass/inverter switch-over sequence is used]

[Relay output inboard option is used]*2

*1 When the inverter protective function is activated, reset the inverter by turning OFF the main breaker once or shorting the inverter reset terminal (RES) and (SD).

*2 Operation may be performed without the inboard option. In this case, however, a 24VDC power supply is required to drive the magnetic contactors.

*3 For switch-over from bypass operation to inverter operation, the motor coasting speed is automatically detected to continue operation without stopping the motor. In this case, note that a value other than 9999 should be set to the function of automatic restart after instantaneous power failure [Pr. 57, Pr. 58] of the inverter.

*4 Be sure to provide mechanical interlocks for MC2 and MC3.

*5 When [Pr. 138 = 1], the operation automatically switches to bypass operation if an inverter fault has occurred during inverter operation.

*6 When the power supply is 400V class, install a step-down transformer.

*7 Before making connection, ensure that the phase rotation of the commercial power supply is in R – S – T sequence.

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*1 When the inverter protective function is activated, reset the inverter by turning OFF the main breaker once or shorting the inverter reset terminal (RES) and (SD).

*2 Operation may be performed without the inboard option. In this case, however, a 24VDC power supply is required to drive the magnetic contactors.

*3 For switch-over from bypass operation to inverter operation, the motor coasting speed is automatically detected to continue operation without stopping the motor. In this case, note that a value other than 9999 should be set to the function of automatic restart after instantaneous power failure [Pr. 57, Pr. 58] of the inverter.

*4 Be sure to provide mechanical interlocks for MC2 and MC3.

*5 When [Pr. 138 = 1], the operation automatically switches to bypass operation if an inverter fault has occurred during inverter operation.

*6 When the power supply is 400V class, install a step-down transformer.

*7 Before making connection, ensure that the phase rotation of the commercial power supply is in R – S – T sequence.
4.6 Automatic restart after instantaneous power failure circuit (common)

When \( Pr. 57 \neq 9999 \), shorting terminals CD and SD *3 allows the motor to automatically restarted by the inverter without the motor being stopped when power is restored if an instantaneous power failure occurs during inverter operation.

*1 The start signal (STF) must be ON when power is restored. Restart cannot be made if the start signal is turned OFF by the self-holding circuit due to a power failure.

*2 Refer to page 367 for other operational details and application instructions.

*3 do not have CS signal, so the terminal need not to be shorted.
4.7 Automatic operation of fan, pump or the like using speed setter (common)

[Auto-manual switch-over operation]

*1 When the power supply is 400V class, install a step-down transformer.

*2 Using the frequency setting gain/bias function of the inverter, you can set the relationship between speed setter output and output frequency as shown above. See page 217.

[FR-AL DC tachometer follower]

*3 The FR-AL has the manual-auto change-over, start signal switch and frequency meter.
4.8 Positioning operation  

When the speed commands H, M, and L are turned on simultaneously, the lower speed has precedence in operation. (Example) When the speed commands H and L are turned ON simultaneously, the low speed command L is used in operation.

As do not have many input terminals, speed command can be input to only two terminals.

The 7.5K or less has a built-in discharging resistor designed for regenerative braking, but in the above diagram it was replaced by a high-duty brake resistor. The 22K or less, and 0.4K to 15K have a built-in brake transistor and a high-duty brake resistor can be connected. (For the A700, an external discharging resistor for regenerative braking can not be used.)

Also refer to the circuit example of the motor equipped with brake. (Refer to page 564)

When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the discharging resistor from overheating due to the thermal capacity shortage of the discharging resistor, and excessive regenerative brake duty, etc.

When the power supply is 400V class, install a step-down transformer.

In this circuit, pressing the stop button stops the motor with the electromagnetic brake. For operation of the electromagnetic brake after the motor is decelerated by the inverter, refer to page 576.
4.9 Vertical, winding lifter  (A700  E700)

4.9.1 Use of relay output option  (A700  E700)

*1 The brake is opened after terminal MRS is turned OFF by the start signal and the FU signal is then output from the inverter. At a stop, the brake is designed to be closed as soon as the motor has fully decelerated (FU signal).

*2 Connect terminals B-C to the brake circuit to always close the brake when an inverter fault occurs.

*3 The brake should not be opened except when the inverter provides normal output (RUN signal is ON).

*4 Install an emergency stop switch as provision against a failure. In case of an emergency, the motor is stopped by the mechanical brake without relying on the electric braking of the inverter.

*5 Whether acceleration/deceleration is completed within the given time is checked. If not completed, it is judged that the inverter is faulty and the brake is closed.

*6 The FR-A700 series 7.5K or less has a built-in brake resistor, but the above diagram shows a case where an external brake is required.

*7 When the power supply is 400V class, install a step-down transformer.

*8 It is recommended to install a magnetic contactor in the primary side to prevent the discharging resistor from overheating/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharging resistor, an excessive regenerative brake duty etc.

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![Diagram of Vertical, winding lifter](attachment:diagram.png)

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4.9.2 Use of brake sequence circuit function \( \text{A700} \) \( \text{E700} \)

- **At start**: When the start signal is input to the inverter, the output is provided at the starting frequency, and when the given frequency \([\text{Pr. 278}]\) is reached and the output current exceeds the current set in \([\text{Pr. 279}]\), the brake opening request signal BOF is output. When the given time set in \([\text{Pr. 281}]\) has elapsed after the brake opening completion signal BRI has been input, the output frequency is raised to the preset speed.

- **At stop**: When the speed is reduced to the brake operation frequency \([\text{Pr. 282}]\), the brake opening request signal BOF is turned OFF. When the given time set in \([\text{Pr. 283}]\) has elapsed after the brake opening completion signal BRI had been turned OFF, the output frequency is switched OFF.

*1 When the motor equipped with a brake is run at or less than 30Hz continuously, the brake disc may rattle but the motor may be used without any problem if it is run at low speed for a short period, e.g. in orientation. Also, as there is a limit to the braking capacity, run the motor at no more than 60Hz.

*2 When the power supply is 400V class, install a step-down transformer.
4.10 Inverter fault output display and failure reset

**A700**  **F700**

When a fault such as overcurrent, overvoltage, and instantaneous power failure occurs, the inverter outputs the corresponding fault signal. A relay contact is used to output the fault signal and is actuated (turned ON) when a fault occurs. This relay can be deactivated by using the reset terminal RES of the inverter. It may also be reset by switching OFF the inverter power. For details refer to page 57.

When the FR-A700 series 22K or less is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the brake discharge resistor from overheating/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharge resistor, an excessive regenerative brake duty, etc.

**Note:**
- Set **Pr. 75 = 1** “Reset can be made only when a fault occurs” to disable resetting the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is made to prevent the inverter from resulting in an over current alarm if the motor is still coasting when the inverter has returned from the reset status.)
- Do not press the inverter reset pushbutton unless required. It is recommended to provide the failure reset pushbutton of the external device and the inverter reset pushbutton individually.
- When an alarm indication is held, always remove jumpers or cables from across terminals R-R1 and across S-S1.

---

*1 Set \[ Pr. 75 = 1 \] “Reset can be made only when a fault occurs” to disable resetting the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is made to prevent the inverter from resulting in an over current alarm if the motor is still coasting when the inverter has returned from the reset status.)

*2 When the power supply is 400V class, install a step-down transformer.

*3 When an alarm indication is held, always remove jumpers or cables from across terminals R-R1 and across S-S1.
4.11 Multi-speed operation application example

Multi-speed operation of 15-speed is available. The following application gives an example of operation requires more multi-speed operation.

(1) 18 speed operation

<table>
<thead>
<tr>
<th>Speed</th>
<th>J</th>
<th>HH</th>
<th>EX</th>
<th>M</th>
<th>L</th>
<th>Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lowest speed</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 2]</td>
</tr>
<tr>
<td>JOG speed</td>
<td>ON</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>[p. 21, 26]</td>
</tr>
<tr>
<td>Speed 2 (low speed)</td>
<td>OFF</td>
<td>—</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 3]</td>
</tr>
<tr>
<td>Speed 3 (middle speed)</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>[p. 4]</td>
</tr>
<tr>
<td>Speed 4 (high speed)</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 5]</td>
</tr>
<tr>
<td>Speed 5</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>[p. 6]</td>
</tr>
<tr>
<td>Speed 6</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>[p. 7]</td>
</tr>
<tr>
<td>Speed 7</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>[p. 8]</td>
</tr>
<tr>
<td>Speed 8</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 225]</td>
</tr>
<tr>
<td>Speed 9</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 222]</td>
</tr>
<tr>
<td>Speed 10</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 222]</td>
</tr>
<tr>
<td>Speed 11</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>[p. 225]</td>
</tr>
<tr>
<td>Speed 12</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>[p. 225]</td>
</tr>
<tr>
<td>Speed 13</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>[p. 225]</td>
</tr>
<tr>
<td>Speed 14</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>[p. 225]</td>
</tr>
<tr>
<td>Highest speed</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>[p. 275]</td>
</tr>
</tbody>
</table>

(2) To add an external potentiometer to further increase the number of speeds

*1 When the relay R turns ON, operation is performed at the frequency set by the frequency setting potentiometer (external potentiometer). In this case, the relays J, HH, EX, H, M and L should all be OFF.
4.12 Jog operation in External operation mode

**PRACTICAL CIRCUITS**

**[With Jog mode selection switch]**

**[With Jog-dedicated pushbutton]**

*1 Jog speed setting [Pr. 15 Jog frequency]*

*2 Acceleration/deceleration time for Jog operation [Pr. 16 Jog acceleration/deceleration time]*

*3 Potentiometer for constant-speed operation
4.13 Operation using the second acceleration/deceleration time (common)

1. When the power supply is 400V class, install a step-down transformer.
2. When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the brake discharge resistor from overheating/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharge resistor, and excessive regenerative brake duty, etc.
3. Turning ON-OFF the RT signal changes the manual torque boost and base frequency to the second function, in addition to acceleration and deceleration, as listed below:

<table>
<thead>
<tr>
<th>Function Name</th>
<th>Parameters Selected by RT signal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acceleration time</td>
<td>Pr. 4 (Pr. 44)</td>
</tr>
<tr>
<td>Deceleration time</td>
<td>Pr. 5 (Pr. 45)</td>
</tr>
<tr>
<td>Torque boost</td>
<td>Pr. 6 (Pr. 46)</td>
</tr>
<tr>
<td>Base frequency</td>
<td>Pr. 7 (Pr. 47)</td>
</tr>
</tbody>
</table>

*Pr. 7 Acceleration time* (initial setting 5 seconds) | High-speed operation
---|---
*Pr. 8 Deceleration time* (initial setting 5 seconds) | Middle-speed operation

(Operation circuit explanation)
1. Using ready, turn ON the start signal.
2. Press the high speed pushbutton to make sudden acceleration only during the time set to timer T1 and perform high-speed operation.
3. Press the middle speed pushbutton to make sudden deceleration only during the time set to timer T2 and perform middle-speed operation.
4. Provide the stop signal to decelerate the motor to a stop.

![Operation Circuit Diagram](image-url)
4.14 Start signal (three-wire) holding common

*1 Set [Pr. 75 = 1] "Reset can be made only when a fault occurs" to disable resetting the inverter during normal operation. (If the inverter is reset during normal operation, the motor coasts to a stop. This setting is made to prevent the inverter from resulting in an alarm if the motor is still coasting when the inverter has returned from the reset status.)

*2 The inverter will stop when both terminals STF and STR are closed simultaneously.

*3 During operation, switch-over from "forward rotation" to "reverse rotation" may be made. In this case, when the reverse rotation signal is turned ON, the regenerative brake is applied down to the forward rotation frequency of 0.5Hz, the opposite-phase brake is applied at or less than 0.5Hz and acceleration in reverse rotation is started at that frequency. (DC injection brake is not applied.)

*4 When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the brake discharge resistor from overheating/burnout if the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharge resistor, and excessive regenerative brake duty, etc.
4.15 Reversible operation by analog input

By changing the polarity of the analog input signal to terminal 1 between positive and negative, reversible operation can be performed between forward rotation and reverse rotation.

*1 This magnetic contactor is provided to prevent an automatic restart when power is restored after a power failure. Use the start signal (ON or OFF of STF) to make a start or stop.

*2 When the power supply is 400V class, install a step-down transformer.

*3 Set [Pr. 75] = 1 “Reset can be made only when a fault occurs” to disable resetting the inverter during normal operation.

If the inverter is reset during normal operation, the motor coasts to a stop. This setting is made to prevent the inverter from resulting in an alarm if the motor is still coasting when the inverter has returned from the reset status.
4.16 Operation using stop-on-contact control function

*1 If the setting of the excitation current low-speed multiplying factor at stop-on-contact is too large, an overcurrent (OCT) alarm is liable to occur.

*2 If the setting of the excitation current low-speed multiplying factor is too large, the machine may oscillate in a stop-on-contact state.

*3 Unlike the servo lock function, the stop-on-contact function cannot hold the load for a long time. Stop-on-contact operation continued for long time can cause the motor to overheat. After a stop, therefore, immediately use the mechanical brake to hold the load.

*4 When an inverter with a regenerative brake resistor is used for cyclic or heavy duty operation, it is recommended to install a magnetic contactor in the primary side to prevent the brake discharge resistor from overheating. If the regenerative brake transistor is damaged due to the thermal capacity shortage of the discharge resistor, and excessive regenerative brake duty, etc.

*5 When the power supply is 400V class, install a step-down transformer.