EMC Installation Guidelines
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1. SUMMARY

We have carried out EMC standard compliance confirmation tests with the servo amplifier in the installation environment described in this manual. After incorporating the servo amplifier in the machine or equipment, confirm the EMC standard compliance of the entire machine or equipment on customer side. For the EMC countermeasures, refer to this guideline or the instruction manual of the servo amplifier used.
2. EMC DIRECTIVE

Mitsubishi Electric general-purpose AC servo MELSERVO complies with products standard EN 61800-3. This directive largely regulates the following two withstand levels.

(1) Emission (EMI: Electromagnetic Interference)
   Capacity to prevent output of obstructive noise that adversely affects external sources.

(2) Immunity (EMS: Electromagnetic Susceptibility)
   Capacity to not malfunction due to obstructive noise from external source.

The details of each level are classified below.

<table>
<thead>
<tr>
<th>Class</th>
<th>Name</th>
<th>Details</th>
<th>Products standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emission (EMI)</td>
<td>Radiated noise</td>
<td>Electromagnetic noise radiated through the air, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Conducted noise</td>
<td>Electromagnetic noise discharged from power supply line, etc.</td>
<td></td>
</tr>
<tr>
<td>Immunity (EMS)</td>
<td>Electrostatic discharge immunity test</td>
<td>Noise from a charged human body, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Radiated, radio-frequency, electromagnetic field immunity test</td>
<td>Electromagnetic noise from wireless transmitters or broadcasting companies, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Electrical fast transient/burst immunity test</td>
<td>Relay noise or electromagnetic noise caused by live electricity being turned on or off, etc.</td>
<td>EN 61800-3</td>
</tr>
<tr>
<td></td>
<td>Immunity to conducted disturbances, induced by radio-frequency fields</td>
<td>Electromagnetic noise flowed from power supply wires or earthing wires, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power-frequency magnetic field immunity test</td>
<td>Electromagnetic noise of 50/60Hz power supply frequency, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Voltage dips, short interruptions and voltage variations immunity tests</td>
<td>Power supply drop, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Surge immunity test</td>
<td>Electromagnetic conducted noise discharged by thunder, etc.</td>
<td></td>
</tr>
</tbody>
</table>
3. EMC COUNTERMEASURES

CAUTION

• The servo amplifier must be installed in the metal cabinet.

3.1 Basic EMC countermeasures

POINT

• According to the NFPA79 approved by the United States, when the shielded wire is not used for wiring between a servo amplifier and a servo motor, the wiring must be insulated from wiring of other control or signal circuits.
  (Example: 100 mm or more for 20 A or less)

Take the following measures firmly as EMC countermeasures.

(1) Install the device in a sealed metal cabinet.

(2) Install a noise filter.

(3) Accurately earth the device.

(4) Use shielded wires for cables and wires.

(5) Separate the primary-side wiring and the secondary-side wiring as far as possible.

(6) Install the surge protector. (Refer to section 4.6.)

3.2 Cabinet design

The servo is a complex component incorporated into another machine. It must always be installed in a cabinet. The design of the cabinet is a very important factor for EMC countermeasures, so please take the following points into consideration.

(1) Use a metal cabinet.

(2) Accurately earth the cabinet unit with a thick and short cable.
3. EMC COUNTERMEASURES

(3) Weld or screw close the joining sections of the cabinet's top plate and side plate. Keep the joining clearance to 10cm or less. The diameter of the openings on the cabinet such as the ventilation hole should be 10cm or less. If there are holes larger than this, plug them with metal plates or punched metal. In this case, such as when painted surfaces are to be connected, make sure that there is a good electrical connection to prevent antenna effect.

Example)

![Diagram of cabinet with welding or screwing of joining sections and ventilation hole plugging with metal plates or punched metal.]

(4) The door of the cabinet must be accurately earthed with the cabinet. If the door earthing is insufficient, the door itself will act as a large antenna and will radiate noise. Take the following measures for this.

1) Use a metal door.

2) Connect the door and cabinet with thick braided wire at as many points as possible.

3) Use an EMI gasket or conductive packing for the contact between the door and cabinet.

![Diagram of metal cabinet with EMI gasket and conductive packing for door and cabinet contact.]

※ Provide an electrical continuity.
(5) To take preventive measures against the noise of the input power source cable in the cabinet, install the shielding partition at nearby site where the power is input so that the input power cable does not receive harmful effects of the radiated noise.

The power supply line noise is eliminated by the filter, but cable contains noise again because of the noise radiated in the cabinet.

Use a metal plate, etc., for the shielding partition. Make sure there are no gaps.
3. EMC COUNTERMEASURES

3.3 Filter wiring and installation

POINT

- For when multiple servo amplifiers are connected to one EMC filter, refer to section 6.4.

(1) Wire the servo and filter as shown below.

(2) Arrange the EMC filter input cable and output cable as far apart as possible. If they are too close, the output line noise will be induced into the input cable, and effect of the filter will be lost. Separate these cables by at least 30cm or more.

The output side noise is induced to the input side.
(3) Installation of filter.
Install the servo amplifier and EMC filter on the same cabinet.
Install the filter on the right or left side of the servo amplifier, as shown below.
(For details of the EMC filter, refer to section 4.2.)
The surface inside the cabinet where the filter is to be installed must be bare metal or metal plated surface
so that the rear surface of the filter electrically contacts the cabinet. Treat the surface where the servo
amplifier is installed in the same manner. The filter input wire (a) must be kept as far apart from the output
wires (b), (c) and (d). Keep the wiring ((b), (c), (d)) between the filter and servo amplifier as short as
possible.
(The sum of (b) and (c) is 1.5m or less.)
3.4 Cable treatment

(a) Securely earth the cabinets 1 and 2, and the servo motor.

(b) Keep the main circuit power supply cable of the servo amplifier, power cable of the servo motor, and wire for the control circuit signal apart (30 cm or more). These cables must not be routed in close parallel or bundled.

The following drawing shows an example of the installation. The methods for treating each cable are described separately. (The numbers assigned to each cable in the drawing indicate section number of this manual where details are explained.)
3. EMC COUNTERMEASURES

(1) Servo motor power cable

**POINT**
- If removing the insulator of a shield causes electrical shock or injuries and threatens the machinery safety, additional protective covers or enclosures may be required.

---

1) Use four wires (3-phase + earth), that is completely shielded and that has no breakage for the servo motor power cable. Connect the earth wire to the earth (\(\bar{\Theta}\)) terminal on the servo amplifier and servo motor.

   *Material of shield has to be copper.*

2) Connect the shield of the cable to the earth on both the cabinet side and servo motor chassis side.

   For the reasons why the shield is grounded on both the cabinet side and the servo motor chassis side, refer to section 6.1. Earth the shield on the servo amplifier side at a position 10cm or less from the cabinet. For the reasons why the shield grounding position on the servo amplifier side is specified to be 10 cm or less from the cabinet, refer to section 6.2.

3) Earth the shield with a metal P clip or U clip. For the reasons why the P clip or U clip is specified as a grounding method, refer to section 6.3.
4) Directly earth the shield. It is not recommended to solder the wire to the braided wire (shield) and ground with its end.

Example of earthing with wire soldering

5) When not using a shield cable for the servo motor power cable, put the cable into a metal conduit.

6) Earth the servo motor power cable on the cabinet side with the conduit connector and cabinet side wall. (Remove paint from the side wall of the cabinet.)

7) When grounding the servo motor power cable connected to the servo motor, take the following measure by fixing the cable cramp to the conduit connector shown in the following drawing.

8) Keep the cable length at 50m or less.

(2) Encoder cable

Use a shielded twisted pair cable, and earth on the servo amplifier and encoder side with a P clip or U clip. Keep the cable length at 50m or less.
3. EMC COUNTERMEASURES

(3) Controller connection (command) cable (except for SSCNET III cable)

1) If controller and servo amplifier are in the same cabinet
   Use a shielded twisted pair cable, and earth on the controller and servo amplifier side with a P clip or
   U clip. If the cable length is 2m or less, the earthing can be done at one position on the controller
   side.

   ![Diagram of controller and servo amplifier connection](image1)

2) If controller, etc. is in the different cabinet from servo amplifier
   Use a shielded twisted pair cable and earth the shield on the controller, etc. and servo amplifier side
   with a P clip and U clip.

   ![Diagram of controller and servo amplifier connection in different cabinets](image2)

(4) Cable of the same cabinet

For the connection cables of the options such as the parameter unit or dynamic brake option, etc., arranged
in the same cabinet as the servo amplifier, use a shielded cable (shielded twisted pair cable for parameter
unit). Earth the shield on the option and servo amplifier side with a P clip or U clip.
If the cable length is 2m or less, the earthing can be done at one position on the servo amplifier side.

   ![Diagram of option and servo amplifier connection](image3)
(5) Regenerative option connection cable
For the regenerative option cable, use a twisted cable with shield or a twisted cable covered with shield braid. Earth the shield on the option and servo amplifier with a P clip or U clip. The drawing shows the treatment for when the regenerative option is installed outside the cabinet.

(6) Input power supply cable
Use the conventional multiple core cable. Using shielded input power cables increases the effect of EMC countermeasures.

(7) 24VDC cable (for servo amplifier)
Use a vinyl wire or multiple core cable.
4. EMC COUNTERMEASURE PARTS

This chapter explains parts used in EMC countermeasures. For details of the parts, contact the parts manufacturer.

4.1 Noise filter (For controller power supply)

For the noise filter installed to the controller, refer to the manual of the controller used.

4.2 EMC filter (For servo amplifier power supply)

<table>
<thead>
<tr>
<th>POINT</th>
</tr>
</thead>
<tbody>
<tr>
<td>• For connection with servo amplifiers, refer to each servo amplifier instruction manual.</td>
</tr>
<tr>
<td>• For when multiple servo amplifiers are connected to one EMC filter, refer to section 6.4.</td>
</tr>
</tbody>
</table>

It is recommended to use the following filter. Some EMC filters are large in leakage current. Some EMC filters for servo amplifiers of special specifications (such as RJ, ED, PX, RU, and RZ) are also large in leakage current.
Select a molded-case circuit breaker in considering the increase of leakage current, so that the leakage current does not affect servo amplifiers, converter units and drive units.
Refer to instruction manuals of each product for the products other than series described in this section.
4. EMC COUNTERMEASURE PARTS

(1) Combination of 22kW or less servo amplifiers and filters

(a) For MR-J5 series

1) Manufactured by COSEL Co., Ltd.

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter/Operating temperature range: -40 °C to 85 °C (Category C2, C3 (Note))</th>
<th>Mass [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Rated current [A]</td>
<td>Rated voltage [VAC]</td>
</tr>
<tr>
<td>MR-J5-10 to MR-J5-100</td>
<td>FSB-10-254-HU</td>
<td>10</td>
</tr>
<tr>
<td>MR-J5W2-22G</td>
<td>FSB-20-254-HU</td>
<td>20</td>
</tr>
<tr>
<td>MR-J5W2-44G</td>
<td>FSB-30-254-HU</td>
<td>30</td>
</tr>
<tr>
<td>MR-J5W3-222G</td>
<td>FSB-40-324-HU</td>
<td>40</td>
</tr>
<tr>
<td>MR-J5W3-222G</td>
<td>FSB-20-254-HU</td>
<td>20</td>
</tr>
<tr>
<td>MR-J5W3-222G</td>
<td>FSB-30-254-HU</td>
<td>30</td>
</tr>
<tr>
<td>MR-J5W3-444G</td>
<td>FSB-30-254-HU</td>
<td>30</td>
</tr>
</tbody>
</table>

Note. Category C2: First environment (residential and other environments) and second environment (commercial, light industrial, and industrial environments)
Category C3: Second environment (commercial, light industrial, and industrial environments)

2) Manufactured by Soshin Electric Co., Ltd.

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter/Operating temperature range: -20 °C to 50 °C (Category C3 (Note))</th>
<th>Mass [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Rated current [A]</td>
<td>Rated voltage [VAC]</td>
</tr>
<tr>
<td>MR-J5-10L to MR-J5-100L</td>
<td>HF3010C-SZB</td>
<td>10</td>
</tr>
<tr>
<td>MR-J5W2-22B</td>
<td>HF3020C-SZB</td>
<td>20</td>
</tr>
<tr>
<td>MR-J5W3-222B</td>
<td>HF3030C-SZB</td>
<td>30</td>
</tr>
<tr>
<td>MR-J5-500L, MR-J5-700L</td>
<td>HF3040C-SZB</td>
<td>40</td>
</tr>
<tr>
<td>MR-J5-200L, MR-J5-350L</td>
<td>HF3030C-SZB</td>
<td>30</td>
</tr>
<tr>
<td>MR-J5W2-77G, MR-J5W2-1010G</td>
<td>HF3030C-SZB</td>
<td>30</td>
</tr>
<tr>
<td>MR-J5W3-444G</td>
<td>HF3030C-SZB</td>
<td>30</td>
</tr>
</tbody>
</table>

Note. Category C3: Second environment (commercial, light industrial, and industrial environments)

(b) For MR-J4 series

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] [lb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>Rated current [A]</td>
<td>Rated voltage [VAC]</td>
</tr>
<tr>
<td>MR-J4-10 to MR-J4-100</td>
<td>HF3010A-UN (Note)</td>
<td>10</td>
</tr>
<tr>
<td>MR-J4W2-22B</td>
<td>HF3010A-UN2 (Note)</td>
<td>20</td>
</tr>
<tr>
<td>MR-J4W2-44B</td>
<td>HF3030A-UN (Note)</td>
<td>30</td>
</tr>
<tr>
<td>MR-J4W3-444B</td>
<td>HF3030A-UN (Note)</td>
<td>100</td>
</tr>
<tr>
<td>MR-J4-40J4</td>
<td>TF3005C-TX</td>
<td>5</td>
</tr>
<tr>
<td>MR-J4-200L4</td>
<td>TF3020C-TX</td>
<td>20</td>
</tr>
<tr>
<td>MR-J4-11KL4</td>
<td>TF3030C-TX</td>
<td>30</td>
</tr>
<tr>
<td>MR-J4-15KL4</td>
<td>TF3040C-TX</td>
<td>40</td>
</tr>
<tr>
<td>MR-J4-22KC4</td>
<td>TF3060C-TX</td>
<td>60</td>
</tr>
<tr>
<td>MR-J4-10K1</td>
<td>HF3010A-UN (Note)</td>
<td>10</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)
# 4. EMC COUNTERMEASURE PARTS

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (COSEL Co., Ltd)</th>
<th>Mass [kg] [lb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-J4-11K to MR-J4-22K</td>
<td>FTB-100-355-L (Note)</td>
<td>100 500 40 5.3 (11.69)</td>
</tr>
<tr>
<td>MR-J4-22K</td>
<td>FTB-80-355-L (Note)</td>
<td>80 500 80 5.3 (11.69)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

(c) For MR-JN series

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] [lb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-JN-10A(1) to MR-JN-20A(1)</td>
<td>HF3010A-UN (Note)</td>
<td>10 250 5 3.5 (7.72)</td>
</tr>
<tr>
<td>MR-JN-40A</td>
<td>HF3030A-UN (Note)</td>
<td>30 5.5 (12.13)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

(d) For MR-J3W series

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] [lb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-J3W-22B to MR-J3W-44B</td>
<td>HF3010A-UN (Note)</td>
<td>10 250 5 3.5 (7.72)</td>
</tr>
<tr>
<td>MR-J3W-77B to MR-J3W-1010B</td>
<td>HF3030A-UN (Note)</td>
<td>30 5.5 (12.13)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

(e) For MR-J3 series

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] [lb]</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-J3-10 to MR-J3-100</td>
<td>HF3010A-UN (Note)</td>
<td>10 250 5 3.5 (7.72)</td>
</tr>
<tr>
<td>MR-J3-200 to MR-J3-350</td>
<td>HF3030A-UN (Note)</td>
<td>30 5.5 (12.13)</td>
</tr>
<tr>
<td>MR-J3-500L</td>
<td>HF3040A-UN (Note)</td>
<td>40 6.5 6.0 (13.23)</td>
</tr>
<tr>
<td>MR-J3-11KL to MR-J3-22K</td>
<td>HF3100A-UN (Note)</td>
<td>100 12.5 (27.56)</td>
</tr>
<tr>
<td>MR-J3-60 to MR-J3-100</td>
<td>TF3005C-TX</td>
<td>5 5.5 (12.13)</td>
</tr>
<tr>
<td>MR-J3-200 to MR-J3-700</td>
<td>TF3020C-TX</td>
<td>20 500 5.5 (12.13)</td>
</tr>
<tr>
<td>MR-J3-11K</td>
<td>TF3030C-TX</td>
<td>30 7.5 (16.54)</td>
</tr>
<tr>
<td>MR-J3-15K</td>
<td>TF3040C-TX</td>
<td>40 12.5 (27.56)</td>
</tr>
<tr>
<td>MR-J3-22K</td>
<td>TF3060C-TX</td>
<td>60</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)
(f) For MR-J2-Super series

**POINT**

- The production of the MR-J2-Super series was discontinued in August 2015.

<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (DEM Manufacturing Ltd.)</th>
<th>Mass [kg] ([lb])</th>
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</thead>
<tbody>
<tr>
<td>MR-J2S-10 to MR-J2S-100</td>
<td>SF1252</td>
<td>10.5</td>
</tr>
<tr>
<td>MR-J2S-10 to MR-J2S-40</td>
<td>SF1253</td>
<td>27.5</td>
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<table>
<thead>
<tr>
<th>Servo amplifier</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] ([lb])</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-J2S-500</td>
<td>HF3040A-TM (Note)</td>
<td>40</td>
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<tr>
<td>MR-J2S-700</td>
<td>HF3050A-TM (Note)</td>
<td>50</td>
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<td>MR-J2S-11K</td>
<td>HF3060A-TMA (Note)</td>
<td>60</td>
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<tr>
<td>MR-J2S-15K</td>
<td>HF3080A-TMA (Note)</td>
<td>80</td>
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<tr>
<td>MR-J2S-22K</td>
<td>HF3100A-TMA (Note)</td>
<td>100</td>
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<tr>
<td>MR-J2S-60 to MR-J2S-200</td>
<td>TF3005C-TX</td>
<td>5</td>
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<tr>
<td>MR-J2S-350 to MR-J2S-700</td>
<td>TF3020C-TX</td>
<td>20</td>
</tr>
<tr>
<td>MR-J2S-11K</td>
<td>TF3030C-TX</td>
<td>30</td>
</tr>
<tr>
<td>MR-J2S-15K</td>
<td>TF3040C-TX</td>
<td>40</td>
</tr>
<tr>
<td>MR-J2S-22K</td>
<td>TF3060C-TX</td>
<td>60</td>
</tr>
</tbody>
</table>

*Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6)*
4. EMC COUNTERMEASURE PARTS

(2) Combination of 30kW or more converter unit, drive unit and filter

(a) For MR-J4 series

<table>
<thead>
<tr>
<th>Converter unit</th>
<th>Drive unit</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] ([lb])</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-CR55K</td>
<td>MR-J4-DU30K</td>
<td>HF3200A-UN (Note)</td>
<td>18 (39.68)</td>
</tr>
<tr>
<td>MR-CR55K4</td>
<td>MR-J4-DU30K</td>
<td>TF3150C-TX (Note)</td>
<td>31 (68.34)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

<table>
<thead>
<tr>
<th>Converter unit</th>
<th>Drive unit</th>
<th>Recommended filter (COSEL Co., Ltd)</th>
<th>Mass [kg] ([lb])</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-CR55K4</td>
<td>MR-J4-DU30K</td>
<td>FTB-150-355-L (Note)</td>
<td>7.8 (17.12)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

(b) For MR-J3 series

<table>
<thead>
<tr>
<th>Converter unit</th>
<th>Drive unit</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] ([lb])</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-J3-CR55K</td>
<td>MR-J3-DU30K</td>
<td>HF3200A-UN (Note)</td>
<td>18 (39.68)</td>
</tr>
<tr>
<td>MR-J3-CR55K4</td>
<td>MR-J3-DU30K</td>
<td>TF3150C-TX (Note)</td>
<td>31 (68.34)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)

(c) For MR-J2-Super series

POINT

• The production of the MR-J2-Super series was discontinued in August 2015.

<table>
<thead>
<tr>
<th>Converter unit</th>
<th>Drive unit</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd)</th>
<th>Mass [kg] ([lb])</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR-HP30KA</td>
<td>MR-J2S-30K</td>
<td>HF3200A-TMA (Note)</td>
<td>23.5 (51.81)</td>
</tr>
<tr>
<td>MR-HP55KA4</td>
<td>MR-J2S-30K</td>
<td>TF3150C-TX</td>
<td>31 (68.34)</td>
</tr>
</tbody>
</table>

Note. A surge protector is separately required to use any of these EMC filters. (Refer to section 4.6.)
(3) Combination of a simple converter and filters

If the total length of a servo motor power cable is 50 m or less, select a filter recommended in section 4.2 (1) (a) 1).

If the total length of the servo motor power cable is more than 50 m, select a filter which satisfies the following conditions.

- **EMC filter rated current [A] ≥ Total rated input current of all servo amplifiers to be connected [A]**
- **Total length of servo motor power cables supported by the EMC filter [m] ≥ Total length of all servo motor power cables to be connected [m]**

<table>
<thead>
<tr>
<th>Simple converter</th>
<th>Total length of servo motor power cable [m]</th>
<th>Recommended filter (SOSHIN Electric Co., Ltd.)/Operating temperature range:</th>
<th>Mass [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Model</td>
<td>Rated current [A]</td>
</tr>
<tr>
<td>MR-CM3K</td>
<td>100 or less</td>
<td>HF3030C-SZL</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>200 or less</td>
<td>HF3060C-SZL</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>250 or less</td>
<td>HF3100C-SZL</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>250 or less</td>
<td>HF3150C-SZL</td>
<td>150</td>
</tr>
</tbody>
</table>

Note. Category C3: Second environment (commercial, light industrial, and industrial environments)
[SF1252, SF1253 wire connection method]

1) Peel the wire insulator.

2) Insert the core of the cable into the opening, and tighten with the slotted screwdriver. In addition, connect the cables to the terminals of SF1252 or SF1253 in a one-to-one connection.

<table>
<thead>
<tr>
<th>EMC filter</th>
<th>Screw size</th>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>SF1252</td>
<td>2.5mm</td>
<td>0.598N・m</td>
</tr>
<tr>
<td>SF1253</td>
<td>3mm</td>
<td>0.794N・m</td>
</tr>
</tbody>
</table>

4.3 Ferrite core (Data line filter)

Noise can be prevented by installing a data line filter onto the cables connected to the servo amplifier. The data line filter in the following is one such example.

<table>
<thead>
<tr>
<th>Model</th>
<th>(Note) Impedance (Ω)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ZCAT3035-1330</td>
<td>10 to 100MHz</td>
<td>100 to 500MHz</td>
</tr>
<tr>
<td>(Manufactured by TDK)</td>
<td>80</td>
<td>150</td>
</tr>
</tbody>
</table>

Note. The above values of impedance do not refer to the guaranteed values but the impedance values of the data line filter including those of the cable (measured reference values).

ESD-SR-250 by NEC TOKIN, E04SRM563218 by SEIWA ELECTRIC, etc. are also available.

[Usage example]

Passing through once  Passing through twice  Passing through three times
4.4 Shield clamp fitting

Generally, the earth of the shielded cable may only be connected to the connector's SD terminal. However, the effect can be increased by directly connecting the cable to an earth plate as shown below. Install the earth plate near the servo amplifier for the encoder cable. Peel part of the cable insulator to expose the external conductor, and press that part against the earth plate with the cable clamp. If the cable is thin, clamp several cables in bunch.

The clamp comes as a set with the earth plate.

<table>
<thead>
<tr>
<th>Model</th>
<th>Accessory fittings</th>
</tr>
</thead>
<tbody>
<tr>
<td>AERSBAN-DSET</td>
<td>2 cable cramps</td>
</tr>
<tr>
<td>AERSBAN-ESET</td>
<td>1 cable clamp</td>
</tr>
</tbody>
</table>

4.5 Line noise filter

The line noise filter is effective in suppressing noises radiated from the cables connected to the main circuit power in the servo amplifier (converter unit) and those connected to the servo amplifier power output, and also in suppressing high-frequency leakage current (zero-phase current) especially within 0.5MHz to 5MHz band.

4.5.1 Connection example

The line noise filters are used for the cables connected to (L1, L2, and L3) the main circuit power supply and for those connected to (U, V, and W) the servo amplifier power output. Pass each of 3-phase cables through line noise filters an equal number of times in the same direction.

(1) For use of 1 line noise filter
(2) For use of 2 line noise filters separately

(3) For use of 2 line noise filters closely

(4) For use of 4 line noise filters closely

Use the following models of the line noise filter in accordance with the capacity of the servo amplifier, converter unit, and drive unit.

2kW or less : FR-BSF01 (for the wire size of 3.5mm² (AWG12) or less)
3.5kW or more: FR-BLF (for the wire size of 5.5mm² (AWG10) or less)
4. EMC COUNTERMEASURE PARTS

4.5.2 Precautions

(1) When the line noise filter is used for the main circuit power side in the servo amplifier (converter unit), the effect of the filters is produced as the number of passes increases. The appropriate number of passage is four times.

(2) When using the line noise filter for the cable connected to the servo amplifier power output, pass through four times or less.

(3) Do not pass the earth wire through the line noise filter. Doing so may result in reducing the effect.

(4) Place the line noise filter as close to the servo amplifier as possible so that the effect of suppressing noises can increase.

(5) The line noise filter can be also used not only for the cables connected to the main circuit power supply in the servo amplifier (converter unit) or the cables connected to the servo amplifier power output but also the servo motor brake cable, encoder cable, and control signal cable. Pass through four times or less in this case. However, prevent the line noise filter from damaging the servo amplifier, converter unit, drive unit, and/or servo motor in considering the flexing life of the encoder cable.
4. EMC COUNTERMEASURE PARTS

4.6 Surge protector

**POINT**

- The surge protector is required to use the EMC filter with a 200 V class servo amplifier.
- The surge protector is required to use the EMC filter manufactured by COSEL with a 400 V class servo amplifier.

To prevent damage due to the applied surge to the AC power supply line (lightning, sparks, etc.), connect the following surge protector (Okaya Electric Industries) to the main circuit power supply (L1, L2, and L3).

(a) For MR-J5 · MR-J4 series

<table>
<thead>
<tr>
<th>Surge protector model</th>
<th>Max. continuous operating Voltage 50/60Hz</th>
<th>DC breakdown voltage</th>
<th>Voltage protection level</th>
<th>Normal discharge current 8/20μs</th>
<th>Max. discharge current 8/20μs</th>
<th>Surge current life 8/20μs-1000A</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>RSPD-250-U4</td>
<td>3AC 250V</td>
<td>700V±25%</td>
<td>1300V</td>
<td>2500A</td>
<td>5000A</td>
<td>Approx. 300 times</td>
<td>Okaya Electric Industries</td>
</tr>
<tr>
<td>RSPD-500-U4</td>
<td>3AC 500V</td>
<td>1300V±25%</td>
<td>2000V</td>
<td>2500A</td>
<td>5000A</td>
<td>Approx. 300 times</td>
<td>Okaya Electric Industries</td>
</tr>
<tr>
<td>LT-CS32G801WS</td>
<td>3AC 275V</td>
<td>660V±10%</td>
<td>1400V</td>
<td>5000A</td>
<td>8000A</td>
<td>Approx. 1000 times</td>
<td>Soshin Electric Co., Ltd.</td>
</tr>
</tbody>
</table>

(b) For MR-JN · MR-J3W · MR-J3 · MR-J2-Super series

**POINT**

- The production of the MR-J2-Super series was discontinued in August 2015.

<table>
<thead>
<tr>
<th>Surge protector model</th>
<th>Circuit voltage 50/60Hz</th>
<th>Maximum allowable circuit voltage</th>
<th>Clamp voltage</th>
<th>Surge immunity 8/20μs</th>
<th>Surge compression 1.2/50μs</th>
<th>Static capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAV-781BYZ-2</td>
<td>3AC 250V</td>
<td>300V</td>
<td>783V±10%</td>
<td>2500A</td>
<td>20kV</td>
<td>75pF</td>
</tr>
<tr>
<td>RAV-781BXZ-4</td>
<td>3AC 250V</td>
<td>300V</td>
<td>1700V±10%</td>
<td>2500A</td>
<td>2kV</td>
<td>75pF</td>
</tr>
</tbody>
</table>
5. CONNECTION EXAMPLE FOR EMC COUNTERMEASURES

5. CONNECTION EXAMPLE FOR EMC COUNTERMEASURES

5.1 For 22kW or less of 1-axis

![Diagram of connection example for EMC countermeasures]

Note 1. Specific EMC countermeasures are shown as □.

2. Shielded cables are shown as □.

3. Shielded cables or conduits are shown as □.

4. When the control circuit power supply (L11 • L21) of the servo amplifier is 24VDC, connect AC/DC power supply.
5. CONNECTION EXAMPLE FOR EMC COUNTERMEASURES

5.2 For 1kW or less of multi axis

Note 1. Specific EMC countermeasures are shown as __________.
2. Shielded cables are shown as __________.
3. Shielded cables or conduits are shown as __________.
4. The figure is for the 2-axis servo amplifier.
5. CONNECTION EXAMPLE FOR EMC COUNTERMEASURES

5.3 For 30kW or more

POINT

- The production of the MR-J2-Super series was discontinued in August 2015.
5. CONNECTION EXAMPLE FOR EMC COUNTERMEASURES

Note 1. Specific EMC countermeasures are shown as ____________.
2. Shielded cables are shown as ____________.
3. Shielded cables or conduits are shown as ____________.
4. The abbreviations of the terminals are P and N for MR-HP30KA or MR-HP55KA4.
5. The abbreviations of the terminals are P and N for MR-J2S-□(4).
6. Connect the converter unit and drive unit with the provided bus bar.
7. The abbreviation of the terminal is P for MR-HP30KA or MR-HP55KA4.
6. SUPPLEMENT

6.1 Reasons why the shield is grounded on both the cabinet side and the servo motor chassis side

As for a countermeasure against radiated emissions from inverters or servo amplifiers, multiple point grounding, in which grounding is performed at the cabinet exit and both ends of the cable between the servo amplifier and the servo motor, tends to decrease unnecessary noise.

6.1.1 Grounding the shield at the servo amplifier side only

The following figure shows only wiring of the servo motor power cable. Use a shielded wire for the detector cable as well as the power cable.

Figure 6.2 shows one of measurement result examples. It does not guarantee the effect of the countermeasure.

![Diagram showing grounding at the servo amplifier side](image)

**Fig. 6.1** When the cable between the servo amplifier and servo motor is grounded on the servo amplifier side only

![Graph showing radiated emissions](image)

**Fig. 6.2** Radiated emissions of when the cable between the servo amplifier and servo motor is grounded on the servo amplifier side
6. SUPPLEMENT

6.1.2 Grounding the shield at both ends of the cable

The following figure shows only wiring of the servo motor power cable. Use a shielded wire for the detector cable as well as the power cable. Figure 6.4 shows one of measurement result examples. It does not guarantee the effect of the countermeasure.

![Diagram showing grounding of shield at both ends of cable]

Fig. 6.3 When both ends of the cable between the servo amplifier and servo motor are grounded

![Graph showing radiated emissions when both ends of the cable are grounded]

Fig. 6.4 Radiated emissions of when both ends of the cable between the servo amplifier and servo motor are grounded

LIMIT: IEC/EN 61800-3 (10 m)
6. SUPPLEMENT

6.2 Reasons why the grounding position in the cabinet is specified to be 10 cm or less from the cabinet exit

Various devices are installed inside the cabinet. The devices radiate or transmit significant unnecessary noise. The generated noise may not be held inside the cabinet depending on a cable wiring method. When unnecessary noise is superimposed in the cable, grounding the cable near the cabinet exit should prevent the noise from flowing outside the cabinet. Thus, grounding within 10 cm from the cabinet exit is recommended.

![Fig. 6.5 Grounding within 10 cm from the cabinet exit](image)

6.3 Reasons why the shield must be grounded with the P clip or U clip

**POINT**

- If removing the insulator of a shield causes electrical shock or injuries and threatens the machinery safety, additional protective covers or enclosures may be required.

The surface of a shielded cable is covered with metallic foil or braid (braided wire). High-frequency noise is passed through the shield and unnecessary noise is released outside to the ground, lowering the radiated emissions level.

As to grounding the shielded cable, grounding with the P clip or U clip lowers impedance to the ground and allows noise current to flow more smoothly than soldering the wire to the shield or holding the shield cables and extending the length. Thus, grounding with the P clip or U clip is recommended.

![Example of grounding with the P clip](image)

![Example of grounding with the U clip](image)

![Example of grounding with wire soldering](image)

**Fig. 6.6 Example of grounding the shielded cable**
6.4 Connecting multiple servo amplifiers to one EMC filter (1: n connection)

Confirm the EMC standard compliance of the entire machine or equipment on customer side.

6.4.1 Selection method

When multiple servo amplifiers are connected to one EMC filter with the total length of servo motor power cables too long, the magnetized parts of the EMC filter become magnetically saturated and the noise attenuation properties may be lower than expected.

To gain the desired noise attenuation properties with every servo amplifier, select the EMC filter that satisfies the following formulas (6.1 to 6.3) and conditions in Table 6.1.

EMC filter rated input voltage [V] ≥ Servo amplifier rated input voltage [V] ........................................... (6.1)
EMC filter rated input current [A] ≥ Total rated input current of each servo amplifier [A] ...................... (6.2)
Total length of servo motor power cables supported by the EMC filter [m] ≥
Total length of servo motor power cables [m] ........................................... (6.3)

<table>
<thead>
<tr>
<th>Total length of servo motor power cable [m]</th>
<th>EMC filter (Soshin Electric) (Note)</th>
<th>Rated input current [A]</th>
<th>Rated input voltage [V]</th>
<th>Leakage current [mA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 or less</td>
<td>HF3030C-SZL</td>
<td>30</td>
<td>500</td>
<td>7</td>
</tr>
<tr>
<td>200 or less</td>
<td>HF3060C-SZL</td>
<td>60</td>
<td>500</td>
<td>7</td>
</tr>
<tr>
<td>250 or less</td>
<td>HF3100C-SZL</td>
<td>100</td>
<td>500</td>
<td>7</td>
</tr>
<tr>
<td>250 or less</td>
<td>HF3150C-SZL</td>
<td>150</td>
<td>500</td>
<td>7</td>
</tr>
</tbody>
</table>

Note. Install the surge protector on the primary side of the EMC filter.
6.4.2 Selection example

The following figure shows a connection example of when three servo amplifiers (MR-J4-100A) are connected with one EMC filter.

A selection result can be obtained by applying the formulas of 6.1 to 6.3.

EMC filter rated input voltage: 500 V ≥ Servo amplifier rated input voltage: 3-phase 200 V AC to 240 V AC
EMC filter rated input current: 30 [A] ≥ Total rated input current of servo amplifiers: 15 [A]
Total length of servo motor power cables supported by the EMC filter: 100 [m] ≥
Total length of servo motor power cables: 60 [m]

According to Table 6.1, HF3030C-SZL can be selected.
# REVISIONS

*The manual number is given on the bottom left of the back cover.*

<table>
<thead>
<tr>
<th>Print Data</th>
<th>Manual Number</th>
<th>Revision</th>
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<tbody>
<tr>
<td>Apr. 1996</td>
<td>IB(NA)67310-*</td>
<td>First edition</td>
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</tbody>
</table>
| Nov. 1997  | IB(NA)67310-A | Chapter 2 Table revisions  
Chapter 5 Addition  
Chapter 6 Addition |
| Nov. 2008  | IB(NA)67310-B | All pages change |
| Jul. 2009  | IB(NA)67310-C | Chapter 2 Change of table  
Section 4.2 Part added  
Section 4.2 (2)(b) Part changed  
Section 5.1 Note 4 and 5 added |
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Section 3.1 Part changed  
Section 3.2 Part changed  
Section 3.3 Part changed  
Section 3.4 Part changed  
Section 4.1 Part changed  
Section 4.2 Part added, part changed  
Section 4.3 Part changed  
Section 4.5 Part changed  
Section 4.6 Added  
Section 5.1 Title changed  "For 22kW or less"→"For 22kW or less of 1-axis"  
Part change of diagram  
Section 5.2 Added as "For 1kW or less of multi axis"  
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Section 5.3 |
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Section 4.2 (1)(f) Deleted  
Section 4.2 (2)(c) Deleted  
Section 4.6 POINT is added |
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Section 4.3 E04SRM563218 is added. |
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Section 4.2 (2)(a) MR-J4-DU30K□ to MR-J4-DU55K□ are added.  
Section 5.3 MR-CR55K□ and MR-J4-DU□ are added. |
| Dec. 2015  | IB(NA)67310-H | Chapter 6 is added.  
Section 3.1 POINT is added. Partially changed.  
Section 3.3 POINT is added. Partially changed.  
Section 3.3 (1) Partially added.  
Section 3.4 (1) POINT is added. Partially changed.  
Section 3.4 (3) Partially added.  
Section 4.2 POINT is added. Partially added.  
Section 4.6 POINT is added. Partially added.  
Chapter 6 Newly added. |
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Section 4.2 (3) Added  
Section 4.6 (a) Part added  
Section 6.4.1 Partially added. |
| Jul. 2020  | IB(NA)67310ENG-K | Section 4.2 (1)(a) Part added |

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