

Plug-in option
FR-A8AVP

INSTRUCTION MANUAL (FOR PHASE- SYNCHRONIZED BYPASS SWITCHING)

Phase-synchronized bypass switching function

OUTLINE	1
INSTALLATION AND WIRING	2
FUNCTION	3

Thank you for choosing this Mitsubishi Electric inverter plug-in option.

This Instruction Manual provides handling information and precautions for use of the this product. Incorrect handling might cause an unexpected fault. Before using this product, all relevant instruction manuals carefully to ensure proper use.

Please forward this Instruction Manual to the end user.

Safety instructions

Do not attempt to install, operate, maintain or inspect this product until you have read this Instruction Manual and appended documents carefully. Do not use this product until you have a full knowledge of this product mechanism, safety information and instructions.

In this Instruction Manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

 **WARNING** Incorrect handling may cause hazardous conditions, resulting in death or severe injury.

 **CAUTION** Incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause only material damage.

Note that even the  **CAUTION** level may lead to a serious consequence depending on conditions. Be sure to follow the instructions of both levels as they are critical to personnel safety.

◆ **Electric shock prevention**

 **WARNING**

- Do not remove the front cover or the wiring cover of the inverter while the inverter power is ON. Do not operate the inverter with any cover or wiring cover removed, as accidental contact with exposed high-voltage terminals and internal components may occur, resulting in an electrical shock.
- Even if power is OFF, do not remove the front cover of the inverter except for wiring or periodic inspection as you may accidentally touch the charged circuits and get an electric shock.
- Before wiring or inspection, check that the display of the inverter operation panel is OFF. Any person who is involved in wiring or inspection shall wait for 10 minutes or longer after the power supply has been cut off, and check that there are no residual voltage using a tester or the like. The capacitor is charged with high voltage for some time after power OFF, and it is dangerous.
- Any person who is involved in wiring or inspection of this product shall be fully competent to do the work.
- This product must be installed before wiring. Otherwise you may get an electric shock or be injured.
- Do not touch this product or handle the cables with wet hands. Doing so may cause an electric shock.
- Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Doing so may cause an electric shock.

◆ **Injury prevention**

 **CAUTION**

- The voltage applied to each terminal must be as specified in the Instruction Manual. Otherwise a burst, damage, etc. may occur.
- The cables must be connected to the correct terminals. Otherwise a burst, damage, etc. may occur.
- The polarity (+ and -) must be correct. Otherwise a burst or damage may occur.
- While power is ON or for some time after power OFF, do not touch the inverter as it will be extremely hot. Doing so may cause a burn.

◆ **Additional instructions**

The following instructions must be also followed. If this product is handled incorrectly, it may cause unexpected fault, an injury, or an electric shock.

 **CAUTION**

Transportation and installation

- Do not install or operate this product if it is damaged or has parts missing.
- Do not stand or place any heavy object on this product.
- The installing orientation of this product must be correct.
- Foreign conductive objects must be prevented from entering the inverter. That includes screws and metal fragments or other flammable substance such as oil.
- If halogen-based materials (fluorine, chlorine, bromine, iodine, etc.), included in fumigants to sterilize or disinfect wooden packages, infiltrate into this product, the product may be damaged. Prevent residual fumigant components from being infiltrated into the product when packaging, or use an alternative sterilization or disinfection method (heat disinfection, etc.). Note that sterilization or disinfection of wooden package should be performed before packing the product.

Wiring

- Never connect a PM motor to the commercial power supply. Applying the commercial power to the input terminals (U, V, W) on a PM motor will burn the PM motor.

Test operation

- Before starting the test operation, confirm or adjust the parameter settings. Failure to do so may cause some machines to make unexpected motions.

 **WARNING**

Usage

- Do not modify this product.
- Do not remove any part which is not instructed to be removed in the Instruction Manuals. Doing so may lead to a failure or damage of this product.

 **CAUTION**

Usage

- As all parameters return to their initial values after Parameter clear or All parameter clear is performed, the needed parameters for operation of the inverter and this product must be set again before the operation is started.
- To avoid damage to this product due to static electricity, static electricity in your body must be discharged before you touch this product.

Maintenance, inspection and parts replacement

- Do not carry out a megger (insulation resistance) test.

Disposal

- This product must be treated as industrial waste.

General instruction

- For clarity purpose, illustrations in this Instruction Manual may be drawn with covers or safety guards removed. Ensure all covers and safety guards are properly installed prior to starting operation.

CONTENTS

1	OUTLINE	4
1.1	Pre-operation instructions	4
1.1.1	Unpacking and checking the product.....	4
1.1.2	Component names	6
1.1.3	Terminals.....	6
1.2	Pre-installation instructions for the FR-A8AVP	7
1.3	Installation procedure	7
2	INSTALLATION AND WIRING	9
2.1	Installation of the phase detection transformer box (FR-A8VPB)	9
2.1.1	Installation.....	9
2.1.2	Outline dimension drawings.....	12
2.2	Connection diagram	13
3	FUNCTION	16
3.1	Setting the phase detection transformer box (FR-A8VPB) input voltage	16
3.2	Phase-synchronized bypass switching function	17
APPENDIX		26
	Appendix1 Restricted Use of Hazardous Substances in Electronic and Electrical Products.....	26

1 OUTLINE

1.1 Pre-operation instructions

This Instruction Manual explains the phase-synchronized bypass switching function. For instructions to convert between the inverter and the converter, refer to the FR-A8AVP Instruction Manual (For Inverter/Converter Switching) (IB-0600777ENG).

◆ Features of the product

The phase-synchronized bypass switching function permits smooth switching of the motor power supply from the inverter output power to the commercial power. The shock caused by the switch is suppressed because the inverter output voltage phase is synchronized with the commercial power voltage phase.

◆ Stand-alone option

The following stand-alone option is required for the phase-synchronized bypass switching function. Check the model and quantity of the option.

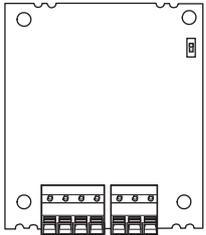
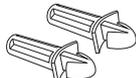
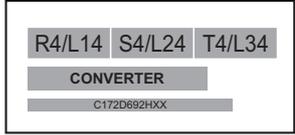
Model name	Product name	Quantity
FR-A8VPB-H	Phase detection transformer box	1

1.1.1 Unpacking and checking the product

Take the product out of the package, check the product name, and confirm that the product is as you ordered and intact. This product is a plug-in option made for the FR-A800/F800 series inverters.

◆ Product confirmation

Check the enclosed items.

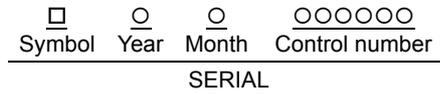
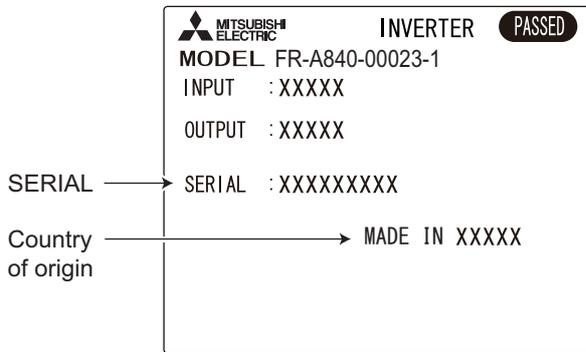
Plug-in option: 1 	Mounting screw (M3 × 8 mm): 2 (Refer to page 7 .) 	Spacer: 2 (Refer to page 7 .) 	Converter sticker sheet: 1*1 
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*1 The stickers are not required to use the phase-synchronized bypass switching function

◆ SERIAL (serial number) check

The FR-A8AVP can be used with the models of inverters listed which have the following SERIAL. Check the SERIAL indicated on the inverter rating plate or package.

Rating plate example



The SERIAL consists of one symbol, two characters indicating the production year and month, and six characters indicating the control number. The last digit of the production year is indicated as the Year, and the Month is indicated by 1 to 9, X (October), Y (November), or Z (December).

FR-A800 series

Applicable inverter	Country of origin indication	SERIAL
FR-A840(-E)(-GF): 00023(0.4K) to 06830(280K) FR-A842(-E)(-GF): 07700(315K) to 12120(500K) FR-A846(-E): 00023(0.4K) to 03610(132K)	MADE in Japan	□86○○○○○○ or later
	MADE in China	□87○○○○○○ or later

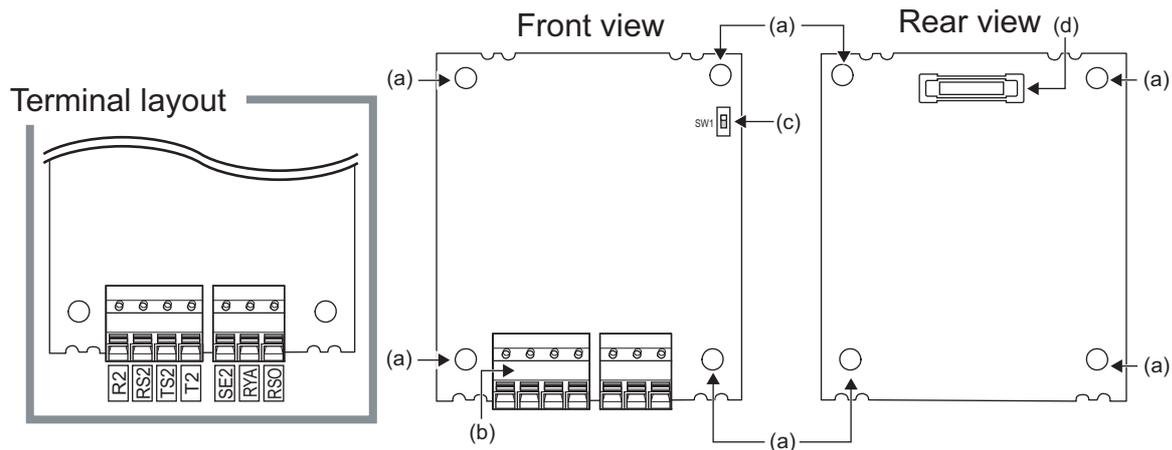
FR-A800 Plus series

Applicable inverter	Country of origin indication	SERIAL
FR-A840(-E)-CRN: 00023(0.4K) to 06830(280K) FR-A842(-E)-CRN: 07700(315K) to 12120(500K) FR-A840-LC: 03250(110K) to 06830(280K)	MADE in Japan	□86○○○○○○ or later
	MADE in China	□87○○○○○○ or later

FR-F800 series

Applicable inverter	Country of origin indication	SERIAL
FR-F840(-E): 00023(0.75K) to 06830(315K) FR-F842(-E): 07700(355K) to 12120(560K) FR-F846(-E): 00023(0.75K) to 03610(160K)	MADE in Japan	□86○○○○○○ or later
	MADE in China	□87○○○○○○ or later

1.1.2 Component names



Symbol	Name	Description	Refer to page
a	Mounting hole	Used to fix this product to the inverter by inserting a mounting screw or a spacer.	7
b	Terminal block	Used to connect this product to the phase detection transformer box.	13
c	Switch (SW1) for manufacturer setting	Do not change the switch setting from the initial setting (OFF:).	—
d	Board mounted option connector	Used to connect this product to the option connector on the inverter.	7

1.1.3 Terminals

Type	Symbol	Function description
Input	R2	Input terminals for the analog signal used for the R-S detection. Terminal RS2 is the common terminal for terminal R2. Connect each terminal to the same-name terminal on the phase detection transformer box.
	RS2	
	T2	Input terminals for the analog signal used for the T-S detection. Terminal TS2 is the common terminal for terminal T2. Connect each terminal to the same-name terminal on the phase detection transformer box.
	TS2	
Output	RYA	Not used.
	RSO	
	SE2	

1.2 Pre-installation instructions for the FR-A8AVP

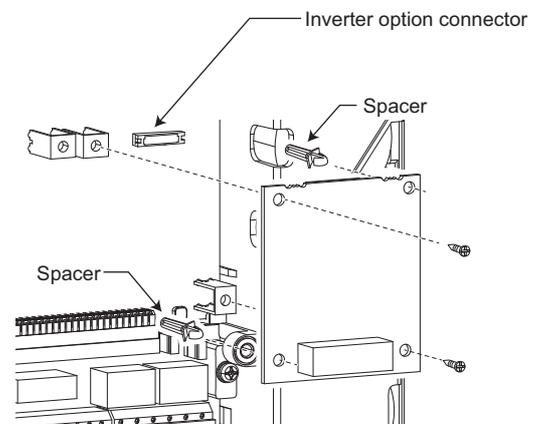
Check that the inverter's input power and the control circuit power are both OFF.

! CAUTION

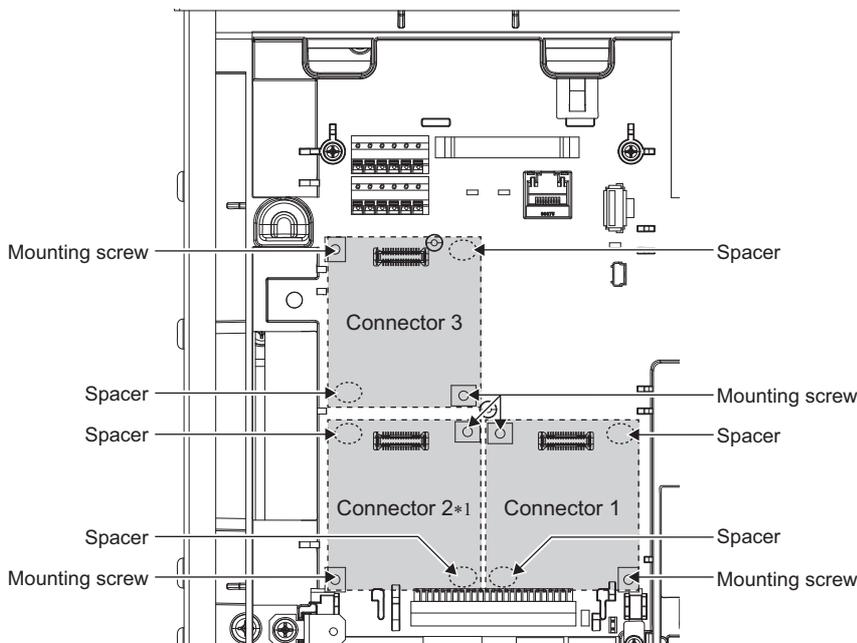
- Do not install or remove this product while the inverter power is ON. Doing so may damage the inverter or this product.
- To avoid damage due to static electricity, static electricity in your body must be discharged before you touch this product.

1.3 Installation procedure

- (1) Remove the inverter front cover.
- (2) Insert two spacers into the mounting holes that will not be used for mounting screws (see the diagrams to identify the holes).
- (3) Fit the board mounted option connector on this product to the guide of the option connector on the inverter, and insert the option as far as it goes.
- (4) Fasten this product to the inverter using the two mounting screws through the holes on either side (tightening torque: 0.33 to 0.40 N·m). If the screw holes do not line up, the connector may not be inserted deep enough. Check the connector.



Example: Attachment of this product to connector 1



Insertion positions for screws and spacers

*1 Option connector 2 on the FR-A800-E/FR-F800-E inverters is not available for use because it is occupied by the Ethernet board which is pre-installed in the initial status. To install this product to option connector 2, remove the Ethernet board. Be aware that Ethernet communication will be disabled.

Installation procedure

NOTE

- When installing/removing the plug-in option, hold the sides of the option. Do not press on the parts on the option circuit board. Stress applied to the parts by pressing, etc. may cause a failure.
- Be careful not to drop mounting screws during the installation or removal of the plug-in option.
- Only one option attached to the option connector with high priority can function at once if more than one option of the same name are installed together on an inverter. Priority is given to option connectors in ascending order (1 to 3), and options having a lower priority do not function.
- When the inverter cannot recognize the option due to improper installation or any other reason, the protective function (E.1 to E.3) is activated and the inverter cannot be operated. The indication to be shown depends on the position (option connector 1 to 3) used.

Mounted position	Fault indication
Option connector 1	E. 1
Option connector 2	E. 2
Option connector 3	E. 3

- When removing the plug-in option, remove the two screws on either side, and then pull it straight out. Pressure applied to the option connectors and to the option board may break the option.

2 INSTALLATION AND WIRING

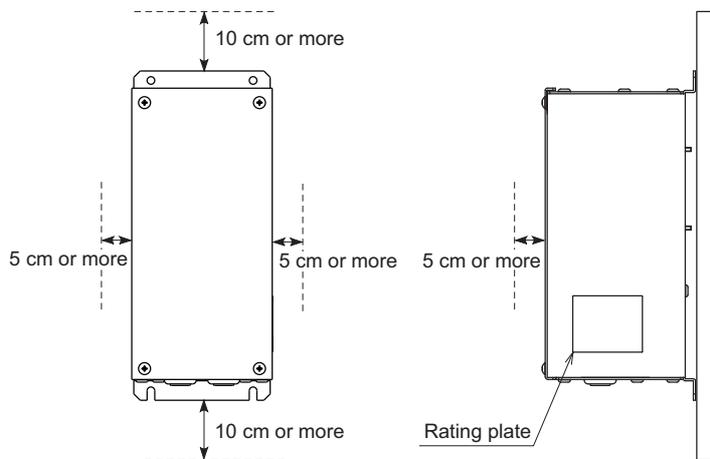
2.1 Installation of the phase detection transformer box (FR-A8VPB)

2.1.1 Installation

◆ Checking the rating plate of the FR-A8VPB

Before installing the transformer box, check the values to be set in **Pr.1344** and **Pr.1345** described on its rating plate, and take a note of them. The values you keep will be needed to set **Pr.1344** and **Pr.1345** in the inverter. (Refer to [page 16](#).)

◆ Clearances



◆ Installation place

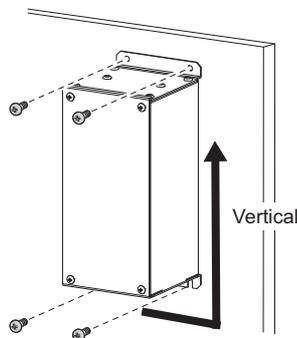
Install the transformer box on nonflammable wall surface. Otherwise a fire may occur.

◆ Surrounding environment

The transformer box must be used indoors (without corrosive gas, flammable gas, oil mist, dust and dirt). Otherwise the transformer box may be damaged.

◆ Installation orientation

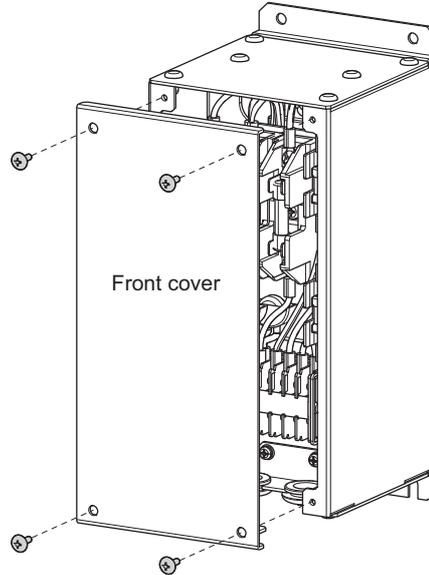
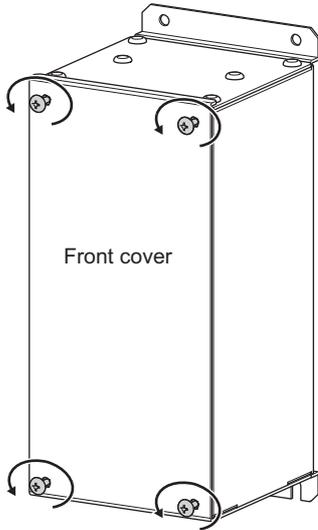
Install the transformer box in a vertical position.



◆ Removal and reinstallation of the front cover

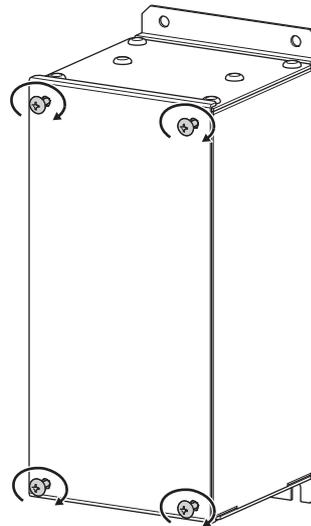
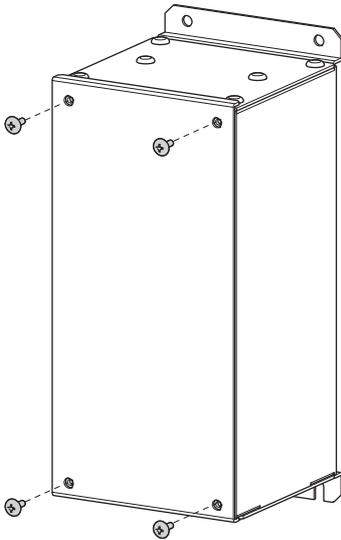
◆ Removal

- Loosen the mounting screws of the cover.
- Pull out the cover to remove it.



◆ Reinstallation

- Place the cover back into position.
- Tighten the mounting screws of the cover (tightening torque: 1.7 N·m).



NOTE

- Fully make sure that the front cover has been reinstalled securely. Always tighten the mounting screws of the cover.
- The capacity plate is placed on the cover, and the rating plate is on the remainder of the transformer box. For reinstallation, check the serial number on the capacity plate against the one on the rating plate to make sure they are identical with each other.

◆ Wiring method

Cut small slits in the rubber grommets mounted on the underside of the transformer box, and pass the cables through the slits.

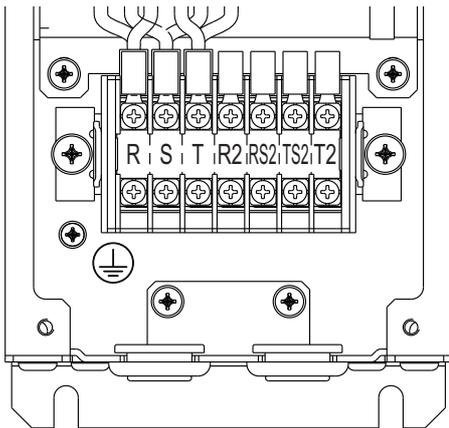
NOTE

- To satisfy IP20 protection requirements, note the following points for wiring of the transformer box.
 - Do not make any unneeded slit in grommets which do not need cable management.
 - Do not use the transformer box with the rubber grommets removed.

◆ Terminals

Symbol	Description	Rating
R	Input terminal for detection of the R-phase voltage of the system power supply.	Maximum permissible input voltage: 506 VAC
S	Input terminal for detection of the S-phase voltage of the system power supply.	
T	Input terminal for detection of the T-phase voltage of the system power supply.	
R2	Output terminals for the analog signal used for the R-S detection. Terminal RS2 is the common terminal for terminal R2.	—
RS2	These terminals are isolated from the main circuit. Connect each terminal to the same-name terminal on the FR-A8AVP.	
T2	Output terminals for the analog signal used for the T-S detection. Terminal TS2 is the common terminal for terminal T2.	—
TS2	These terminals are isolated from the main circuit. Connect each terminal to the same-name terminal on the FR-A8AVP.	
	Earthing (grounding) of the phase detection transformer box. This must be earthed (grounded).	—

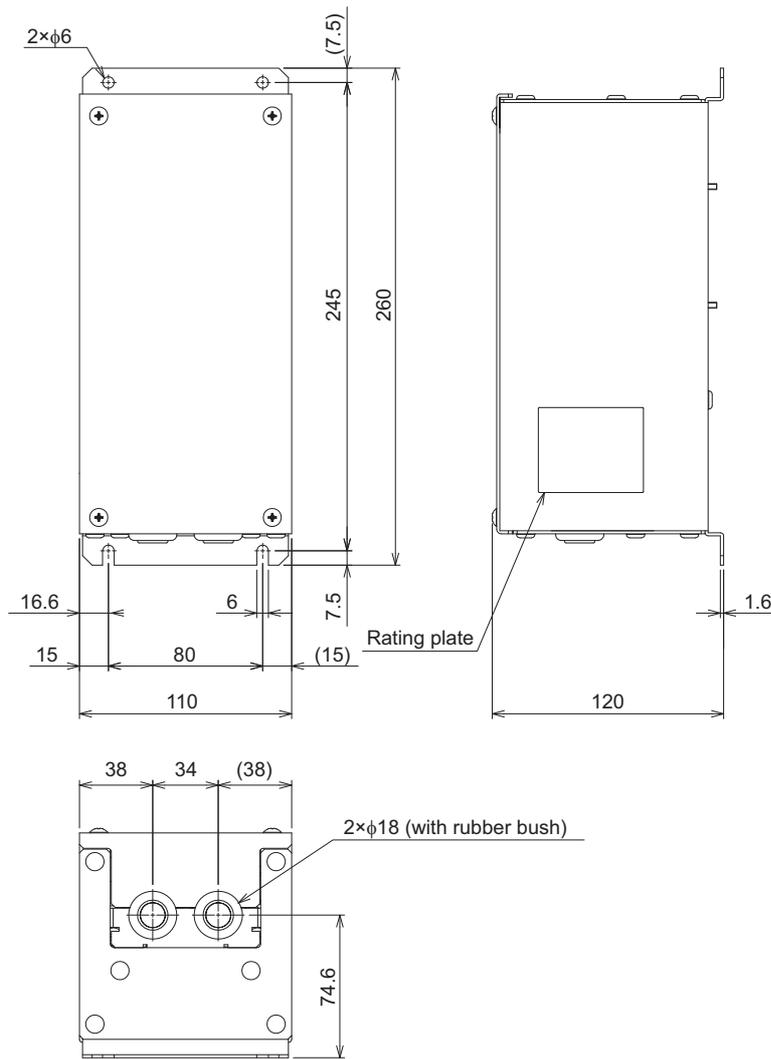
◆ Terminal layout



Terminal screw size

Model name	Terminals R, S, T, R2, RS2, TS2, and T2	Earth (ground) terminal
FR-A8VPB-H	M3.5	M3.5

2.1.2 Outline dimension drawings

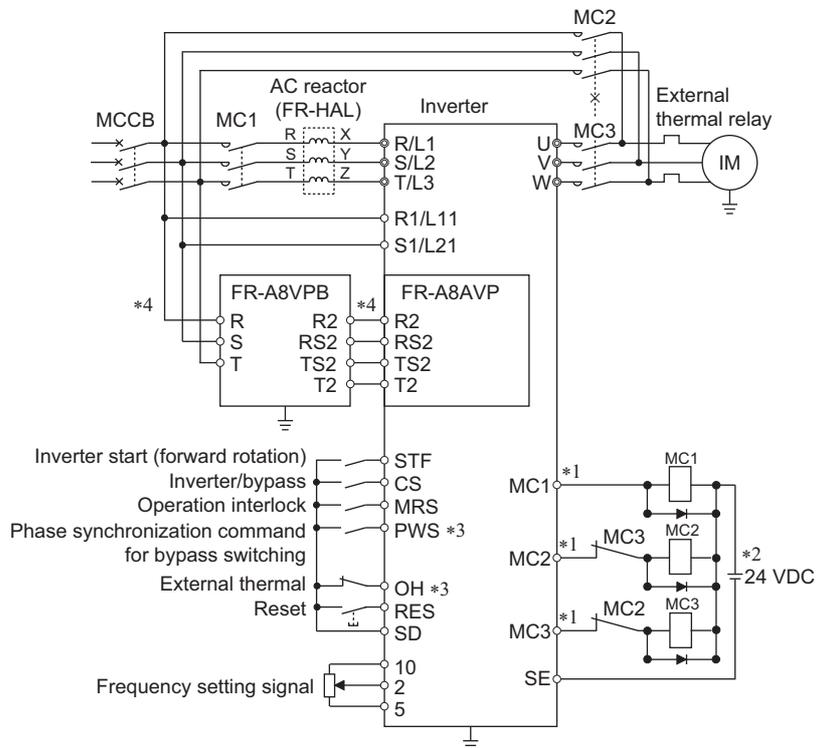


(Unit: mm)
Mass: 3.2 kg

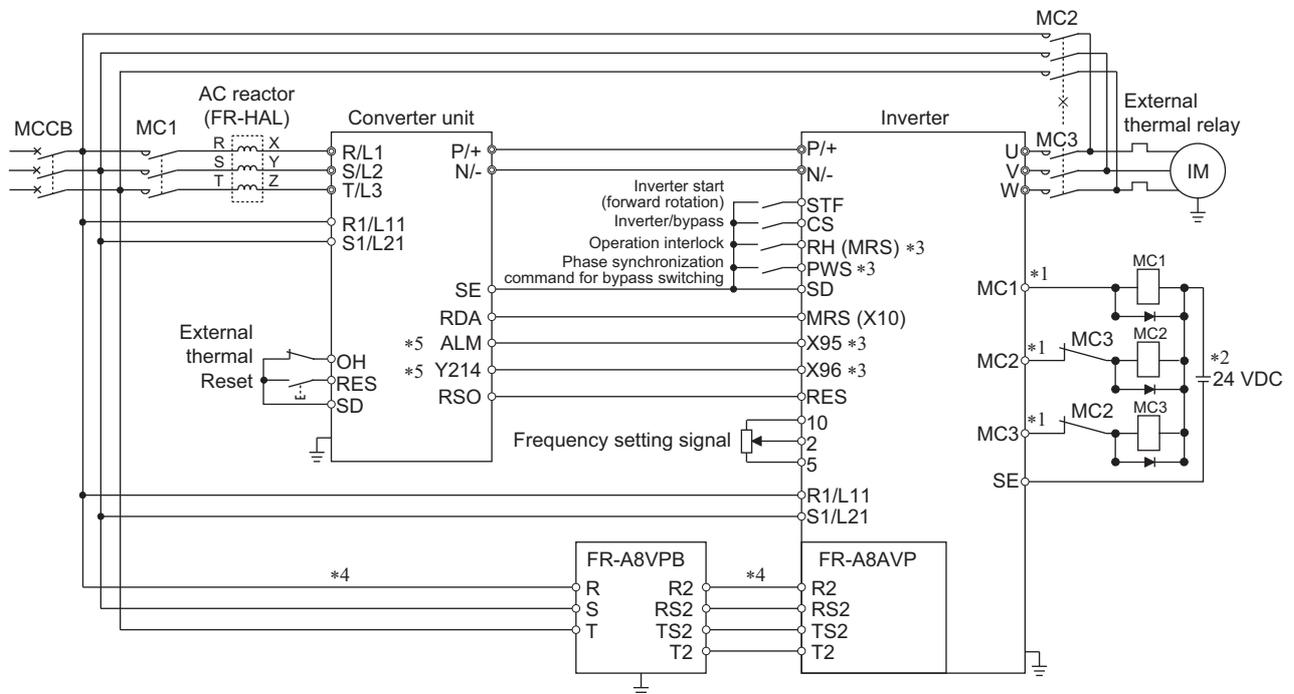
2.2 Connection diagram

- A typical connection diagram for use of the electronic bypass sequence is as follows.

[Example for the standard model or IP55 compatible model of the FR-A800 series inverter]



[Example for the separated converter type of the FR-A800 series inverter]



Connection diagram

- *1 Be careful of the capacity of the sequence output terminals.
The applied terminals differ depending on the settings of **Pr.190 to Pr.196 (Output terminal function selection)**.

Output terminal capacity	Output terminal permissible load
Open collector output of inverter (RUN, SU, IPF, OL, FU)	24 VDC 0.1 A
Inverter relay output (A1-C1, B1-C1, A2-B2, B2-C2) Relay output option (FR-A8AR)	230 VAC 0.3 A 30 VDC 0.3 A

- *2 When connecting a DC power supply, insert a protective diode.
When connecting an AC power supply, use the relay output option (FR-A8AR), and use contact outputs.
- *3 The applied terminals differ depending on the settings of **Pr.180 to Pr.189 (Input terminal function selection)**.
- *4 Use the wires satisfying the following requirements for each wiring location.

Wiring location	Wire gauge (mm ²)	Total wiring length
Wiring between the power supply and the phase detection transformer box	2	10 m or less
Wiring between the phase detection transformer box and the inverter	0.75 to 1.25	5 m or less

- *5 To use the signal, assign the function to the output terminal using **Pr.190 to Pr.195 (Output terminal function selection)** in the converter unit.
Always set the negative logic for the ALM signal.

NOTE

- Use the electronic bypass function in External operation mode. For proper operation, terminals R1/L11 and S1/L21 on the converter unit and the inverter must be connected between a molded case circuit breaker (MCCB) and magnetic contactor (MC) 1.
 - Be sure to provide a mechanical interlock between MC2 and MC3.
- Status of magnetic contactor (MC1, MC2, MC3)

Magnetic contactor	Installation location	Status		
		During commercial power supply operation	During inverter operation	During inverter fault
MC1	Between power supply and inverter input	Closed (Shorted)	Closed (Shorted)	Open (Status changes to shorted state after the reset.)
MC2	Between power supply and motor	Closed (Shorted)	Open	Open (Status depends on Pr.138 setting. Always open when the external thermal relay is operating.)
MC3	Between inverter output and motor	Open	Closed (Shorted)	Open

• Input signal list

Signal name	Terminal	Function	Description	MC status*8		
				MC1*6	MC2	MC3
MRS	MRS*1	Electronic bypass switching function (enable/disable)*2	ON: Electronic bypass switching function enabled.	○	—	—
			OFF: Electronic bypass switching function disabled.	○	×	Unchanged
CS	CS	Electronic bypass switching function (operation selection)*3	ON: Inverter operation	○	×	○
			OFF: Commercial power supply operation	○	○	×
PWS	Terminal selected from Pr.180 to Pr.189 to set "33".	Phase synchronization command for bypass switching	ON: Frequency command specifying the frequency of the commercial power supply	Unchanged	Unchanged	Unchanged
			OFF: Frequency command specifying the set frequency	Unchanged	Unchanged	Unchanged
STF/STR	STF/STR	Inverter operation command (Disabled during commercial power supply operation)*4	ON: Forward/reverse rotation command	○	×	○
			OFF: Command to stop operation	○	×	○
OH	Terminal selected from Pr.180 to Pr.189 to set "7".	External thermal relay input	ON: Motor normal	○	—	—
			OFF: Motor fault	×	×	×
RES	RES	Operation reset*5	ON: Operation reset.	Unchanged	×	Unchanged
			OFF: Operation continues.	○	—	—
X95/X96	Terminal selected from Pr.180 to Pr.189 to set "95/96".	Converter unit fault input / Converter unit fault (E.OHT, E.CPU) input	X95 OFF, X96 OFF: Converter fault (E.OHT or E.CPU)	×	×	×
			X95 ON, X96 ON: Converter normal	○	—	—
			X95 OFF, X96 ON: Converter fault (other than E.OHT and E.CPU)	×	—*7	×

- *1 For separated converter types, the X10 signal is assigned to terminal MRS in the initial setting. To use the MRS signal, set "24" in any of **Pr.180 to Pr.189 (Input terminal function selection)** to assign the function to a terminal.
- *2 When the MRS signal is OFF, neither the commercial power supply operation nor the inverter operation can be performed.
- *3 The CS signal is active only when the MRS signal is ON. For the F800 series inverters, no function is assigned to terminals CS in the initial setting. To enable the CS signal, set "6" in **Pr.186 CS terminal function selection** to assign the function to terminal CS.
- *4 The STF/STR signal is active only when both the MRS and CS signals are ON.
- *5 Whether or not to enable reset input using the RES signal depends on the setting of **Pr.75 Reset selection/disconnected PU detection/PU stop selection**. When the RES signal and another signal are simultaneously input, the RES signal has higher priority to determine the operation of MCs.
- *6 MC1 opens at an inverter fault.
- *7 MC2 opens when **Pr.138** (Automatic bypass switching after inverter fault) = "0" (disabled), and MC2 closes when **Pr.138** = "1" (enabled).
- *8 MC status
 ○: Closed
 ×: Open
 —: MC2 is open and MC3 is closed during inverter operation
 MC2 is closed and MC3 is open during commercial power supply operation.
 Unchanged: The status of the MC remains the same after turning ON or OFF of the signal.

• Output signal list

Signal name	Terminal (Pr.190 to Pr.196 setting)	Description
MC1	17	Output signal to control MC1 installed on the inverter input side.
MC2	18	Output signal to control MC2 installed for commercial power supply operation.
MC3	19	Output signal to control MC3 installed on the inverter output side.
LSYN*1	247	Signal output when phase synchronization for bypass switching has completed.

*1 The LSYN signal is active only when **Pr.139** = "9999".

3 FUNCTION

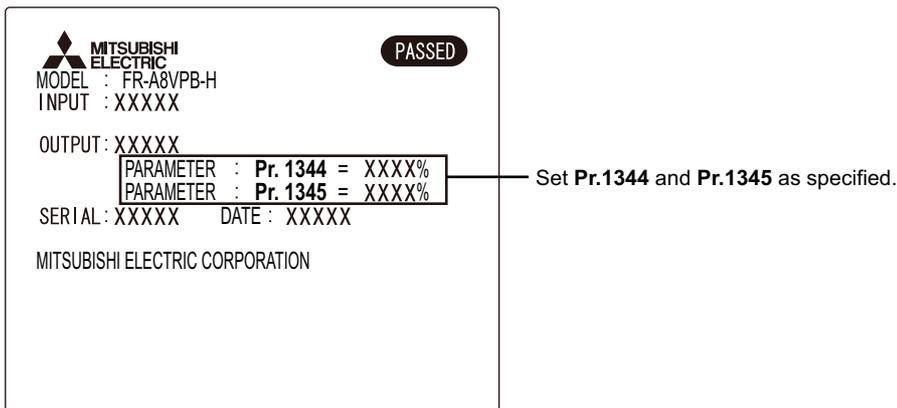
3.1 Setting the phase detection transformer box (FR-A8VPB) input voltage

Adjust the phase detection transformer box (FR-A8VPB) input voltage as follows.

Pr.	Name	Initial value	Setting range	Description
1344*1 E320	R-S turns ratio compensation	9999	95.0% to 105.0%	Compensates for fluctuations in the input voltage.
			9999	Compensation disabled.
1345*1 E321	T-S turns ratio compensation	9999	95.0% to 105.0%	Compensates for fluctuations in the input voltage.
			9999	Compensation disabled.

*1 The setting is applied after an inverter reset.

- Set the values specified on the rating plate of the FR-A8VPB in **Pr.1344** and **Pr.1345**. (If the **Pr.1344** and **Pr.1345** settings are not consistent with the values specified on the rating plate of the FR-A8VPB, the phase of the power supply cannot be accurately detected. This may increase shock in switching between two different power supplies or activate the protective function against the overcurrent or overvoltage.)



NOTE

- Stop the inverter operation before setting **Pr.1344** and **Pr.1345**.

3.2 Phase-synchronized bypass switching function

The inverter contains complicated sequence circuits for switching between the commercial power supply operation and inverter operation. Therefore, interlock operation of the magnetic contactor for switching can be easily performed by simply inputting start, stop, and automatic switching selection signals.

Pr.	Name	Initial value	Setting range	Description
1 H400	Maximum frequency	120 Hz*1	0 to 120 Hz	Set the upper limit of the output frequency.
		60 Hz*2		
57 A702	Restart coasting time	9999	0	Coasting time differs according to the inverter capacity.*3
			0.1 to 30 s	Set the waiting time for the inverter to perform a restart at power restoration after instantaneous power failure.
			9999	No restart
58 A703	Restart cushion time	1 s	0 to 60 s	Set the voltage cushion time for restart.
135 A000	Electronic bypass sequence selection	0	0	Electronic bypass sequence function disabled.
			1	Electronic bypass sequence function enabled.
137 A002	Start waiting time	0.5 s	0 to 100 s	Set the time a little longer than required (typically 0.3 to 0.5 seconds) of the magnetic contactor 3 (MC3) to produce a magnetic field to attract its armature after the MC3 signal turns ON.
138 A003	Bypass selection at a fault	0	0	Inverter output stop (motor coasting) at inverter failure
			1	Automatic switchover to commercial power supply operation at inverter failure. (Switchover is not possible when the External thermal relay operation fault (E.OHT) or CPU fault (E.CPU) has occurred.)
139 A004	Automatic switchover frequency from inverter to bypass operation	9999	0 to 60 Hz	When a frequency is set in this parameter, phase synchronization is disabled.
			8888	Automatic bypass switching enabled with phase synchronization enabled. The inverter operation automatically switches to the commercial power supply operation when phase synchronization has completed.
			9999	Automatic bypass switching disabled (manual switching enabled) with phase synchronization enabled.
159 A005	Automatic switchover frequency range from bypass to inverter operation	9999	0 to 10 Hz	While automatic bypass switching is enabled (Pr.139 ≠ "9999"), the frequency set in this parameter is used to determine the frequency at which the commercial power supply operation is switched back to inverter operation. When the frequency command becomes less than the frequency obtained by subtracting the frequency set in this parameter from the commercial power supply frequency, the motor switches automatically to inverter operation and operates at the frequency of the frequency command. Turning OFF the inverter start command (STF/STR signal) also switches the operation to the inverter operation.
			9999	To switch from the commercial power supply operation to the inverter operation again while Pr.139 ≠ "9999", turn OFF the inverter start command (STF/STR signal). After the switchover, the motor decelerates to a stop.
1382 A010	MC switchover interlock time (for phase-synchronized bypass switching function)	1000 ms	1 to 60000 ms	Set the operation interlock time between MC2 and MC3 (refer to page 22). When the FR-A8AVP is installed, Pr.136 MC switchover interlock time is disabled. (For information about Pr.136, refer to the Instruction Manual (Detailed) of the inverter.)
1383 A011	Phase compensation amount for synchronous bypass switching	0°	0° to 359°	Set an angle to compensate for the phase difference caused by the motor coasting during MC switchover interlock (refer to page 22).
1384 A012	PLL tuning gain	100%	0% to 500%	Use this parameter to change the phase locked loop (PLL) gain if an overcurrent or overvoltage occurs during output frequency compensation (refer to page 22).

Phase-synchronized bypass switching function

- *1 For the FR-A840-01800(55K) or lower, and FR-A840-01160(55K) or lower.
- *2 For the FR-A840-02160(75K) or higher, and FR-F840-01800(75K) or higher.
- *3 The coasting time when **Pr.57** = "0" is as follows. (When **Pr.162 Automatic restart after instantaneous power failure selection** is set to the initial value.)
 - FR-A840-00052(1.5K) or lower, and FR-F840-00038(1.5K) or lower: 0.5 seconds
 - FR-A840-00083(2.2K) to FR-A840-00250(7.5K), and FR-F840-00052(2.2K) to FR-F840-00170(7.5K): 1 second
 - FR-A840-00310(11K) to FR-A840-01800(55K), and FR-F840-00250(11K) to FR-F840-01160(55K): 3.0 seconds
 - FR-A840-02160(75K) or higher, and FR-F840-01800(75K) or higher: 5.0 seconds

◆ Electronic bypass sequence function

- When operating the motor at 60 Hz (or 50 Hz), the motor can be more efficiently operated with a commercial power supply. In addition, if the motor cannot be stopped for a long period of time even for an inverter maintenance and inspection, it is recommended that a commercial power supply circuit be installed.
- When switching between inverter operation and commercial power supply operation, make safety provisions to absolutely prevent the commercial power supply accidentally being applied to the output side of the inverter. Be sure to mechanically interlock two magnetic contactors (MCs) for the inverter operation and for the commercial power supply operation to prevent two MCs from being closed at the same time.
- Complicated switching control between the commercial power supply operation and the inverter operation is possible by using the inverter's electronic bypass sequence function which can output timing signals to control the operation of MCs.

◆ Phase-synchronized bypass switching function

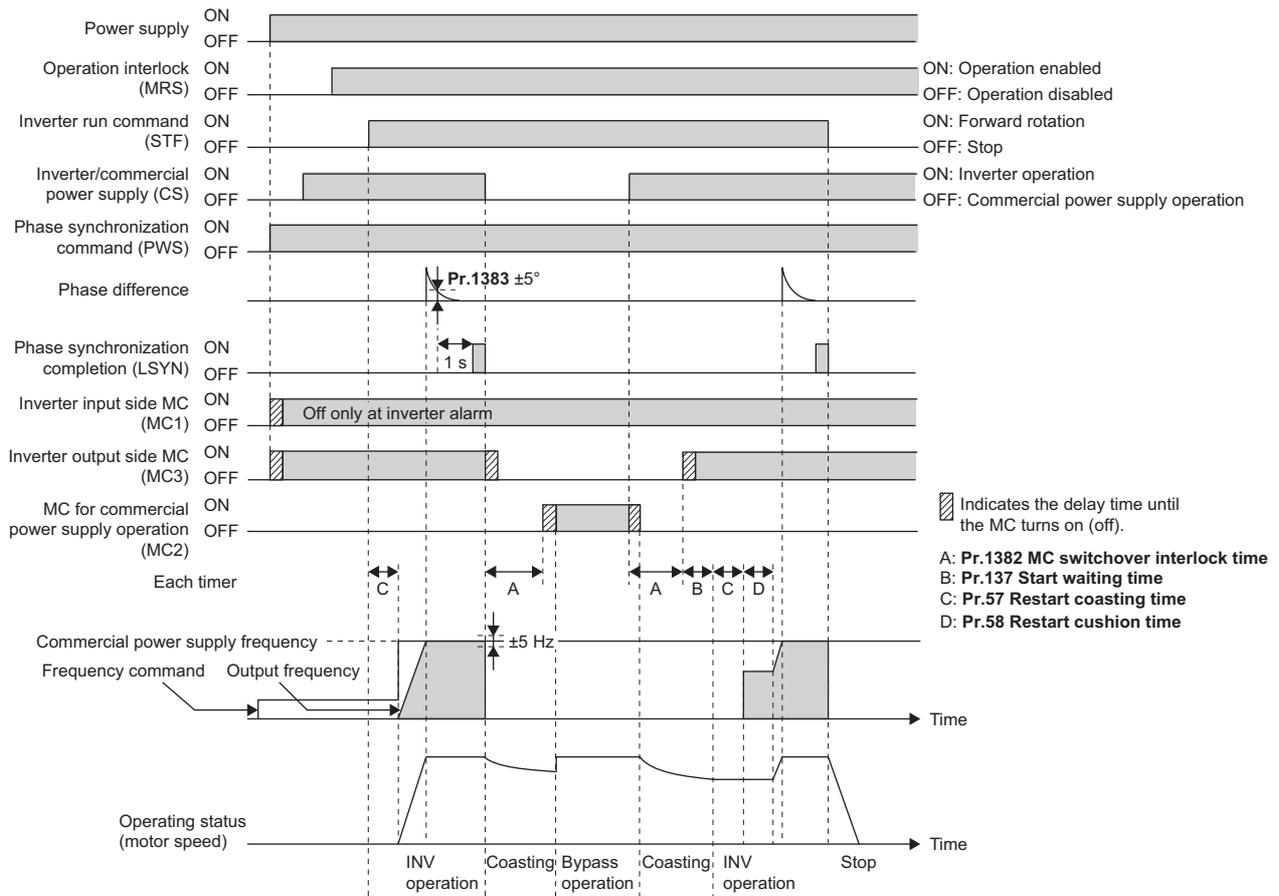
- Set **Pr.139** = "8888 or 9999", and then turn ON the Phase synchronization command (PWS) signal. The frequency command will be changed to specify the frequency of the commercial power supply.
- The output frequency compensation will be added for phase synchronization between the commercial power supply and the inverter output voltage.
- When the following conditions are satisfied and the state which passes the conditions remains for more than one second, it is recognized as the end of phase synchronization.
 - The frequency difference between the commercial power supply and the inverter output power is within 5 Hz.
 - The phase difference between the commercial power supply and the inverter output voltage is within a value set in **Pr.1383** $\pm 5^\circ$.
- When **Pr.139** = "9999", the Phase synchronization completion (LSYN) signal is output after phase synchronization for bypass switching has completed. Turning OFF the CS signal after the LSYN signal has been output allows the switching to the commercial power supply operation.
- When **Pr.139** = "8888", the inverter operation automatically switches to the commercial power supply operation after phase synchronization has completed. (The LSYN signal is not output.)

NOTE

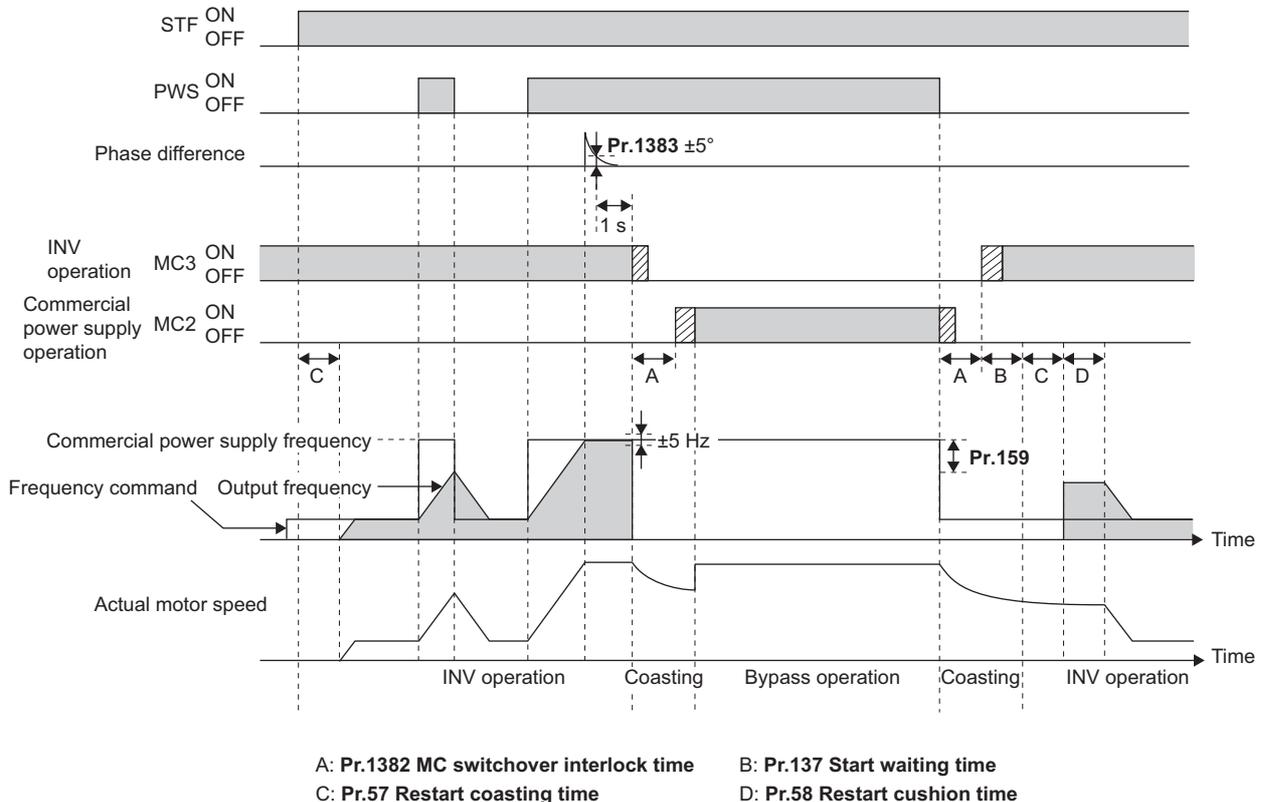
- The requirements to enable the phase-synchronized bypass switching function are as follows.
 - Electronic bypass sequence function is enabled (**Pr.135** = "1").
 - The forward rotation command (STF) signal is ON.
 - V/F control, or Advanced magnetic flux vector control is selected.

◆ Electronic bypass operation sequence

- Example of operation sequence when automatic bypass switching disabled (**Pr.139 = "9999"**)

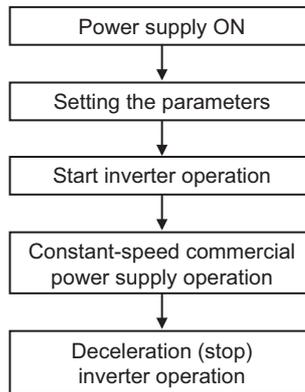


- Example of operation sequence when automatic bypass switching enabled (**Pr.139 = "8888"**, **Pr.159 \neq "9999"**)



◆ Operating overview

- Operation flowchart



◆ Parameter setting

- Operating procedure (for a magnetic contactor with delay time of 150 ms from closed state to open state)

1 Set the values specified on the rating plate of the FR-A8VPB in Pr.1344 and Pr.1345.

After the setting has completed, reset the inverter. (Refer to [page 16](#).)

2 Set the sum of the frequencies of the commercial power supply and 5 Hz in Pr.1.

3 Set Pr.135 to "1" (open collector output terminals of inverter).

4 Set Pr.1382 to 150 ms (refer to [page 22](#)).

5 Set Pr.137 to 0.5 s.

Set a value equal to or more than the time period from when the MC3 signal turns ON until when the inverter and the motor are electrically connected. If the set time is not longer than necessary, the inverter restart may not function properly.)

6 Set Pr.57 to 0.5 s.

Be sure to set the appropriate value in this parameter as the setting is necessary to switch from the commercial power supply operation to the inverter operation.

7 Set Pr.58 to 0.5 s.

- Signal status when setting parameters as shown in [page 20](#)
 - When automatic bypass switching disabled (**Pr.139** = "9999")

Motor status	Input signal				Output signal				Remarks
	MRS	CS	STF	PWS	MC1	MC2	MC3	LSYN	
Power ON	OFF	OFF	OFF	OFF	OFF→ ON	OFF	OFF→ ON	OFF	External operation mode
Beginning of operation (Inverter operation)	OFF→ ON	OFF→ ON	OFF→ ON	OFF→ ON	ON	OFF	ON	OFF	
Phase synchronization completed (Inverter operation)	ON	ON	ON	ON	ON	OFF	ON	OFF→ ON	
Constant-speed operation (Commercial power supply operation)	ON	ON→ OFF	ON	ON	ON	OFF→ ON	ON→ OFF	ON→ OFF	MC2 turns ON after MC3 turns OFF (motor is coasting during MC switchover). Start waiting time: 0.15 s
Switching to inverter operation due to deceleration (Inverter operation)	ON	OFF→ ON	ON	ON	ON	ON→ OFF	OFF→ ON	OFF	MC3 turns ON after MC2 turns OFF (motor is coasting during MC switchover). Start waiting time: 1.65 s
End of operation	ON	ON	ON→ OFF	ON	ON	OFF	ON	OFF	

- When automatic bypass switching enabled (**Pr.139** = "8888", **Pr.159** ≠ "9999")

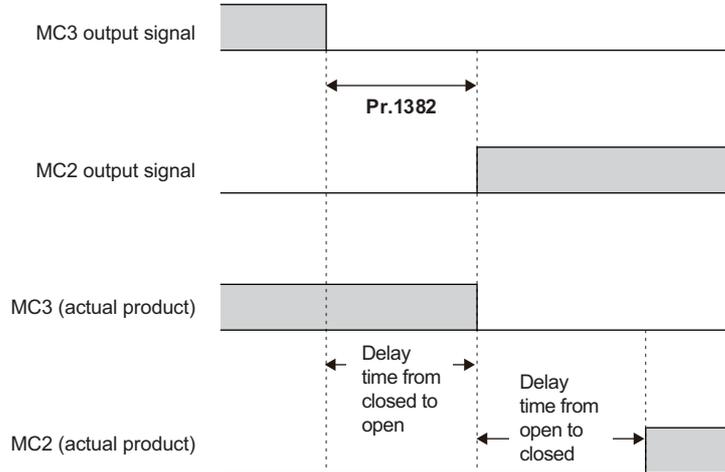
Motor status	Input signal				Output signal				Remarks
	MRS	CS	STF	PWS	MC1	MC2	MC3	LSYN	
Power ON	OFF	OFF	OFF	OFF	OFF→ ON	OFF	OFF→ ON	OFF	External operation mode
Beginning of operation (Inverter operation)	OFF→ ON	OFF→ ON	OFF→ ON	OFF→ ON	ON	OFF	ON	OFF	
Phase synchronization completed (Inverter operation)	ON	ON	ON	ON	ON	OFF	ON	OFF	
Constant-speed operation (Commercial power supply operation)	ON	ON	ON	ON	ON	OFF→ ON	ON→ OFF	OFF	MC2 turns ON after MC3 turns OFF (motor is coasting during MC switchover). Start waiting time: 0.15 s
Switching to inverter operation due to deceleration (Inverter operation)	ON	ON	ON	ON→ OFF	ON	ON→ OFF	OFF→ ON	OFF	MC3 turns ON after MC2 turns OFF (motor is coasting during MC switchover). Start waiting time: 1.65 s
End of operation	ON	ON	ON→ OFF	OFF	ON	OFF	ON	OFF	

◆ Adjustment method (Pr.1382, Pr.1383, Pr.1384)

- Use a storage type meter for setting of the following items and parameters.

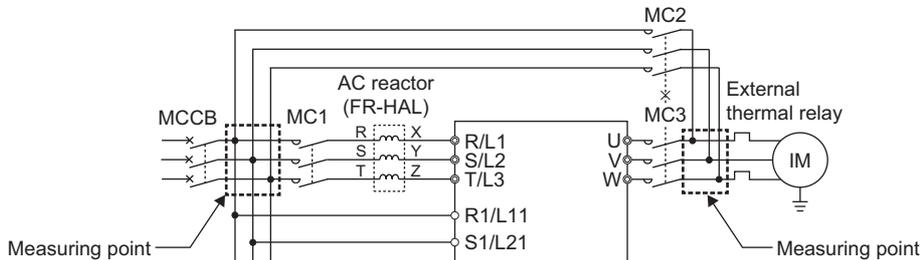
(1) Adjustment of MC switchover interlock time (Pr.1382 MC switchover interlock time (for phase-synchronized bypass switching function))

Check the specification of magnetic contactors you use as MC2 and MC3 for delay time from closed state to open state, and set the time (switchover interlock time between MC2 and MC3) in Pr.1382. To minimize the interlock time, measure the actual delay time of MC2 and MC3 with the meter. Set the shortest possible time calculated from the measurement results in Pr.1382.



(2) Phase compensation (Pr.1383 Phase compensation amount for synchronous bypass switching)

Measure the commercial power supply voltage and the residual voltage in the motor during MC switchover interlock time in actual use environment. Set an optimal value (angle) in Pr.1383 which is suited to synchronize phase between each voltage at the time when power is applied to MC2. Be sure to correct the Pr.1383 setting whenever there is changes in load.



- How to determine a value which should be set in Pr.1383

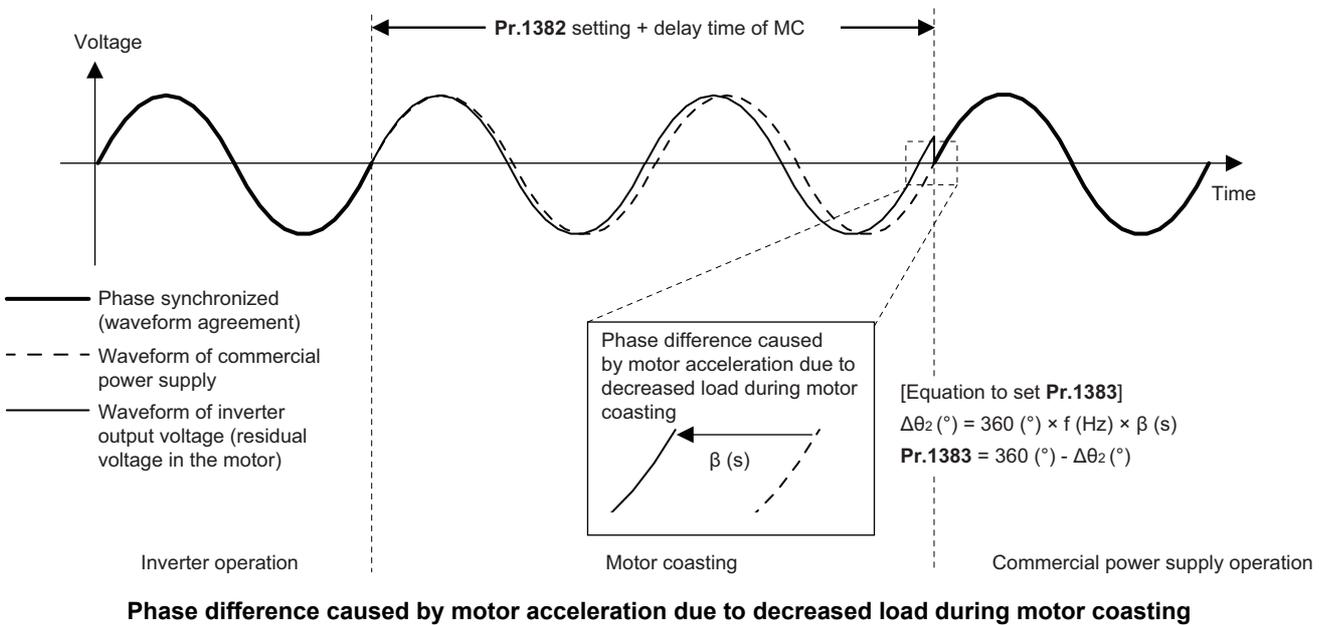
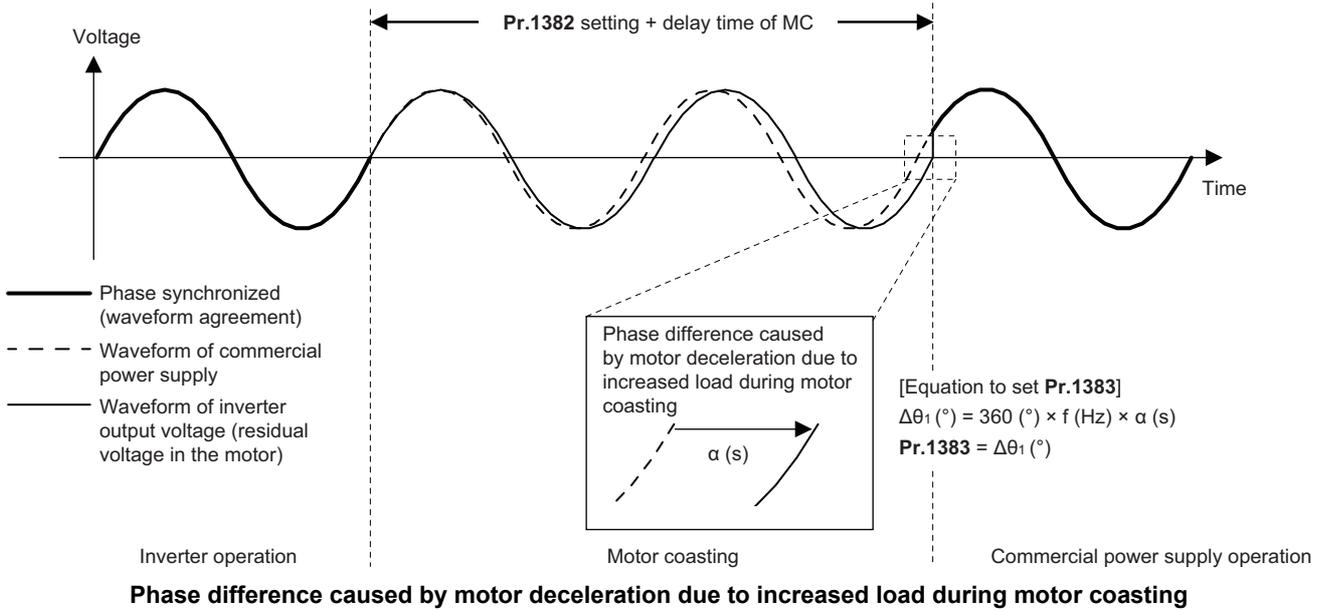
Example) Phase difference is caused by motor deceleration due to increased load during motor coasting.

- Measure the voltage of the commercial power supply and the inverter output voltage (residual voltage in the motor) at the time of switching of the motor status from coasting to being operated with the commercial power supply, and check the waveforms of each power displayed on the meter to calculate the time lag "α" (s) in phase synchronization.
- Calculate a phase difference angle "Δθ1" (°) from α (s) and the commercial power supply frequency "f" (Hz) by the following equation,

$$\Delta\theta_1 (^{\circ}) = 360 (^{\circ}) \times f (\text{Hz}) \times \alpha (\text{s})$$

- A value to set in Pr.1383 depends on whether the commercial power supply lags behind or leads the inverter output voltage (residual voltage in the motor).

When it has been shown in the waveforms that the commercial power supply lags behind the inverter output voltage, the phase difference is presumed to have been caused by the motor deceleration during motor coasting. In this case, set Pr.1383 so that the commercial power supply can overtake the inverter output voltage (Pr.1383 setting = Δθ1 (°)).



(3) Correction of the rate of output frequency compensation (**Pr.1384 PLL tuning gain**)

If an overcurrent or overvoltage occurs during output frequency compensation under heavy load conditions, set **Pr.1384** to a smaller value to decrease the rate of output frequency compensation.

Phase-synchronized bypass switching function

NOTE

- Take power from any point between the power supply and MC1 to the terminals for control circuit power input (R1/L11 and S1/L21). If power is taken from any point between MC1 and the inverter, the electronic bypass sequence function does not work.
- The electronic bypass sequence function is enabled only when **Pr.135** = "1" and the inverter is in the External operation mode or the PU/External combined operation mode 1 (**Pr.79** = "3" (frequency command using the PU and start command using the external signals)). When **Pr.135** = "1" but the inverter is in the operation mode other than mentioned above, the MC1 and MC3 signals are ON.
- When the MRS signal and the CS signal turn ON and the STF (STR) signal turns OFF, the MC3 signal turns ON but the inverter operation does not start. Turning ON the STF (STR) signal allows the inverter to start operation. However, the operation starts after a lapse of the time set in **Pr.137** if the motor starts after it has coasted to a stop due to the switchover from the commercial power supply operation.
- When the automatic switching is disabled, the inverter-driven motor operation is enabled while all of the MRS, CS, and STF (STR) signals are ON.
- The **Pr.1382** setting (MC switchover interlock time) applies to the time when the MC2 or MC3 signal turns ON after both signals are OFF.
- Even when the electronic bypass sequence is enabled (**Pr.135** = "1"), **Pr.137** and **Pr.1382** are disabled while the inverter is in PU operation mode.
Then, the inverter's input terminals (STF, CS, MRS, and OH) functions as if the electronic bypass sequence is disabled.
- When both the electronic bypass sequence function and the PU operation interlock function are enabled at the same time (**Pr.135** = "1" and **Pr.79** = "7") and the PU operation external interlock (X12) signal is not assigned to any input terminal, the MRS signal will have another function as the PU operation external interlock signal. (In this case, the inverter operation is enabled when both the MRS signal and the CS signal are ON.)
- Be sure to set the acceleration time to the level that does not activate the stall prevention operation.
- If the operation switches to the commercial power supply operation after a failure such as an output short circuit occurs between MC3 and the motor, the damage caused by the failure may spread. Therefore, make sure to take precautions against such a failure, for example, providing a protection circuit using the OH input signal.
- Changing the terminal assignment using **Pr.178 to Pr.189** or **Pr.190 to Pr.196** may affect other functions. Set parameters after confirming the function of each terminal.
- Switching using the electronic bypass sequence function is disabled during inverter retry. Switching can be performed after the retry finished. When **Pr.138** = "1" (the electronic bypass switchover enabled at a fault), switching can be performed even during inverter retry.
- When both the electronic bypass sequence function and the retry function of the converter unit are enabled at the same time for a separated converter type inverter, set "101" or more in **Pr.67** (Number of retries at fault occurrence) in the converter unit. When a value less than "100" is set, the ALM signal does not turn ON until the retry counter has exceeded the specified times, which results in a failure of the electronic bypass switching at a fault within the specified times of retry count.
- If the residual voltage in the motor drops during MC switchover interlock, the shock caused by the bypass switchover will not be suppressed even though the phase-synchronized bypass switching function is enabled.
- It is recommended to set **Pr.19** (Base frequency voltage) to "9999" before starting the phase-synchronized bypass switching. (The shock caused by the bypass switchover may not be suppressed even though the phase-synchronized bypass switching function is enabled when **Pr.19** ≠ "9999".)

◆ Operation in combination with the self power management function for the separated converter type inverter

- When both the electronic bypass sequence function and the self power management function are enabled at the same time for a separated converter type inverter, the status of the input signals are as follows.

X95 (Converter unit fault)	X96 (Converter unit fault (E.OHT, E.CPU))	X94 (Control signal for main circuit power supply MC)	MC status*3			Converter status
			MC1	MC2	MC3	
OFF	OFF	ON	O*2	x	x	Converter fault (E.OHT (Pr.248 = "2"))
		OFF	x	x	x	Converter fault (E.OHT (Pr.248 = "1") or E.CPU)
ON	ON	ON	O*2	—	—	Converter normal
OFF	ON	ON	O*2	—*1	x	Converter fault (other than the circuit failure fault and E.OHT) (Pr.248 = "2")
		OFF	x	—*1	x	Converter fault (other than E.OHT and E.CPU)

*1 MC2 opens when Pr.138 (Automatic bypass switching after inverter fault) = "0" (disabled), and MC2 closes when Pr.138 = "1" (enabled).

*2 The status is the same as the one at the time when the self power management function is enabled.

*3 MC status

O: Closed

x: Open

—: MC2 is open and MC3 is closed during inverter operation

MC2 is closed and MC3 is open during commercial power supply operation.

APPENDIX

Appendix 1 Restricted Use of Hazardous Substances in Electronic and Electrical Products

The mark of restricted use of hazardous substances in electronic and electrical products is applied to the product as follows based on the "Management Methods for the Restriction of the Use of Hazardous Substances in Electrical and Electronic Products" of the People's Republic of China.

电器电子产品有害物质限制使用标识要求



本产品中所含有的有害物质的名称、含量、含有部件如下表所示。

- 产品中所含有害物质的名称及含量

部件名称*2	有害物质*1					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
电路板组件 (包括印刷电路板及其构成的零部件, 如电阻、电容、集成电路、连接器等)、电子部件	×	○	×	○	○	○
金属壳体、金属部件	×	○	○	○	○	○
树脂壳体、树脂部件	○	○	○	○	○	○
螺丝、电线	○	○	○	○	○	○

上表依据SJ/T11364的规定编制。

○: 表示该有害物质在该部件所有均质材料中的含量均在GB/T26572规定的限量要求以下。

×: 表示该有害物质在该部件的至少一种均质材料中的含量超出GB/T26572规定的限量要求。

*1 即使表中记载为×, 根据产品型号, 也可能会有有害物质的含量为限制值以下的情况。

*2 根据产品型号, 一部分部件可能不包含在产品中。

REVISIONS

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

Revision date	*Manual number	Revision
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