



**INVERTER**

Plug-in option

**FR-A8AP**

**INSTRUCTION MANUAL**

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*Orientation control*

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*Encoder feedback control*

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*Vector control*

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## Safety instructions

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


This Instruction Manual provides handling information and precautions for use of this product. Incorrect handling might cause an unexpected fault. Before using this product, always read this Instruction Manual carefully to use this product correctly.

Please forward this Instruction Manual to the end user.

Do not attempt to install, operate, maintain or inspect the product until you have read through this Instruction Manual and supplementary documents carefully and can use the equipment correctly. 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.

The  **CAUTION** level may even lead to a serious consequence according to conditions. Both instruction levels must be followed because these are important to personal safety.

### ◆ Electric Shock Prevention

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#### **WARNING**

- While the inverter power is ON, do not open the front cover or the wiring cover. Do not run the inverter with the front cover or the wiring cover removed. Otherwise you may access the exposed high voltage terminals or the charging part of the circuitry and get an electric shock.
  - Do not remove the inverter front cover even if the power supply is disconnected. The only exception for this would be when performing wiring and periodic inspection. You may accidentally touch the charged inverter circuits and get an electric shock.
  - Before wiring or inspection, LED indication of the inverter unit operation panel must be switched OFF. Any person who is involved in wiring or inspection shall wait for at least 10 minutes after the power supply has been switched OFF and check that there is no residual voltage using a tester or the like. For some time after the power-OFF, a high voltage remains in the smoothing capacitor, and it is dangerous.
  - Any person who is involved in wiring or inspection of this product shall be fully competent to do the work.
  - The plug-in option must be installed before wiring. Otherwise you may get an electric shock or be injured.
  - Do not touch the plug-in option or handle the cables with wet hands. Otherwise you may get an electric shock.
  - Do not subject the cables to scratches, excessive stress, heavy loads or pinching. Otherwise you may get an electric shock.
-

## ◆ Injury Prevention

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### CAUTION

- The voltage applied to each terminal must be as specified in the Instruction Manual. Otherwise an explosion or damage may occur.
- The cables must be connected to the correct terminals. Otherwise an explosion or damage may occur.
- The polarity (+ and -) must be correct. Otherwise an explosion 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. Touching these devices may cause burns.

## ◆ Additional Instructions

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

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### CAUTION

#### Transportation and installation

- Do not install or operate the plug-in option if it is damaged or has parts missing.
- Do not stand or rest heavy objects on the product.
- Ensure the mounting orientation of this product is 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 halogens (including fluorine, chlorine, bromine, and iodine) contained in fumigants for wood packages enter this product, the product may be damaged. Prevent the entry of fumigant residuals or use an alternative method such as heat disinfection. Note that sterilization or disinfection of wood packages should be performed before packing the product.

#### Trial run

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

#### Usage

- Do not modify the 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 the product.
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## CAUTION

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### Usage

- As all parameters return to their initial values after the Parameter clear or All parameter clear is performed, the parameters must be set again as required before the operation is started.

- Static electricity in your body must be discharged before you touch the product.

### Maintenance, inspection and parts replacement

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

### Disposal

- The inverter must be treated as industrial waste.
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## General instruction

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- Many of the diagrams and drawings in this Instruction Manual show the inverter without a cover or partially open for explanation. Never operate the inverter in this manner. The cover must be reinstalled and the instructions in the Instruction Manual must be followed when operating the inverter.
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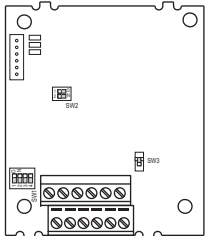

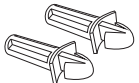
# 1 PRE-OPERATION INSTRUCTIONS

## 1.1 Unpacking and product confirmation

Take the plug-in option 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 dedicated for the FR-A800 series.

### ◆ Product confirmation

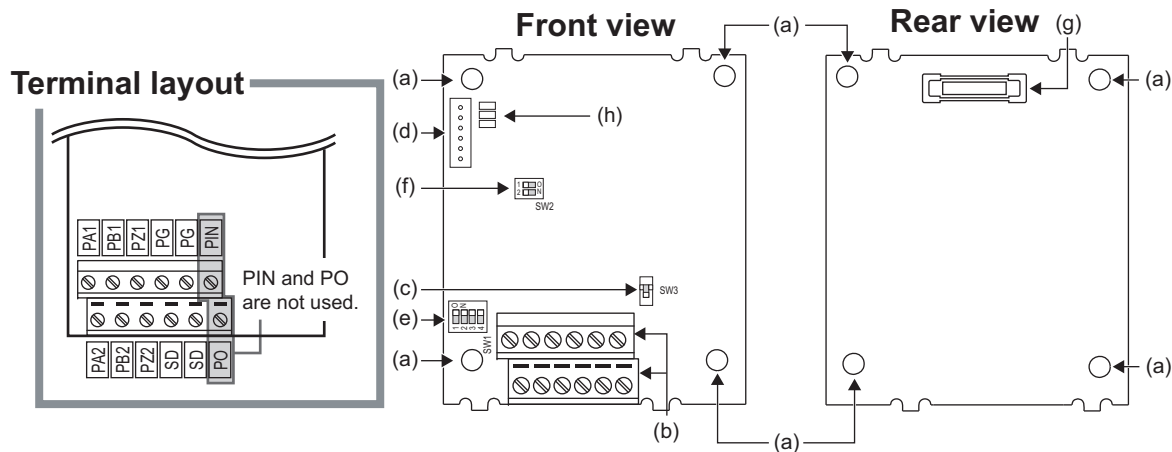
Check the enclosed items.


<p>Plug-in option .....1</p> 	<p>Mounting screw (M3 × 8 mm) .....2 (Refer to <a href="#">page 9</a>.)</p> 	<p>Spacer .....2 (Refer to <a href="#">page 9</a>)</p> 
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### NOTE

- Connection diagrams in this Instruction Manual appear with the control logic of the input terminals as sink logic, unless otherwise specified. (For the control logic, refer to the Instruction Manual(Detailed) of the inverter.)

## 1.2 Component names



Symbol	Name	Description	Refer to page
a	Mounting hole	Fixes the option to the inverter with screws, or installs spacers.	9
b	Terminal block	Connects to the encoder.	17
c	Encoder type selection switch (SW3)	Switches the encoder type (differential line driver/ complementary).	14
d	CON2 connector	Not used.	—
e	Terminating resistor selection switch (SW1)	Switches ON or OFF the internal terminating resistor.	14
f	Switch for manufacturer setting (SW2)	Do not change the initially-set status. (Switches 1 and 2 are OFF  .)	—
g	Board mounted option connector	Connects to the option connector of the inverter.	9
h	LED for manufacturer check	Not used.	—



# 2 INSTALLATION AND WIRING

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## 2.1 Pre-installation instructions

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

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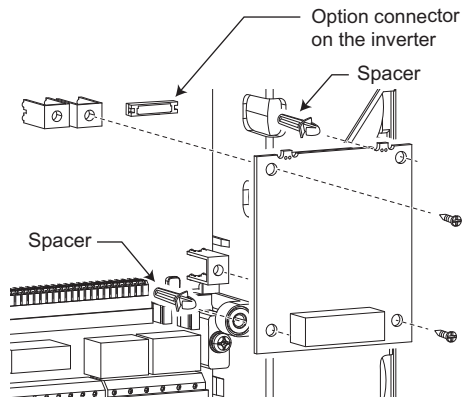
### CAUTION

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

## 2.2 Installation procedure

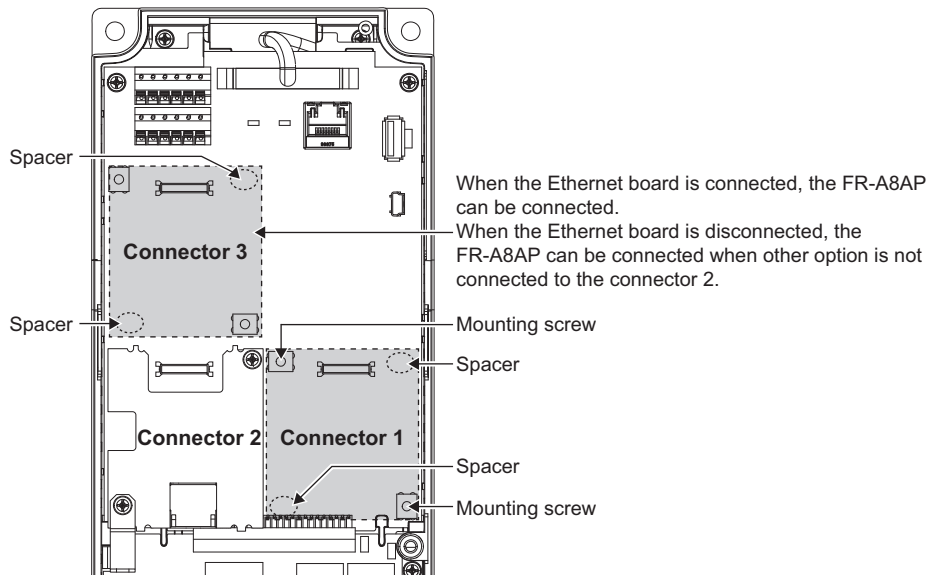
1. Remove the inverter front cover. (Refer to Chapter 2 of the Instruction Manual (Detailed) of the inverter instructions for removing the front cover.)
2. Insert two spacers into the mounting holes that will not be used for mounting screws (see the diagrams on [page 11](#) to identify the holes).
3. 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. (Insert it to the inverter option connector 1 or 2.)
4. Fasten this product to the inverter using the two mounting screws through the holes on either side (tightening torque 0.33 N·m 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 of installation to connector 1



## ◆ Insertion positions of screws and spacers (Ethernet model)



**NOTE**

- Be careful not to drop mounting screws during the installation or removal of the plug-in option.
- Only 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 descending order (1 to 3), and options having a lower priority do not function. (For the positions of the option connectors 1 to 3, refer to [page 11](#).)
- When the inverter cannot recognize the option due to improper installation or any other reason, the protective function (E.1 to E.3) is displayed. The indication shown (when a fault occurs) depends on the connector used (option connector 1 to 3).

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 connector and to the option board may break the option.

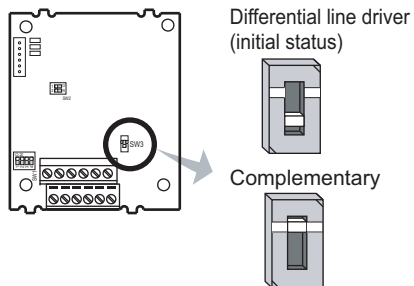
## 2.3 Encoder specification / terminating resistor switch setting

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### ◆ Encoder specification selection switch (SW3)

Select either differential line driver or complementary.

It is initially set to the differential line driver. Switch its position according to output circuit.



## ◆ Terminating resistor selection switch (SW1)

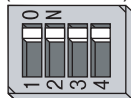
Select "ON"/"OFF" of the internal terminating resistor.

Set the switch to "ON" (initial status) when an encoder output type is differential line driver and set to "OFF" when complementary.

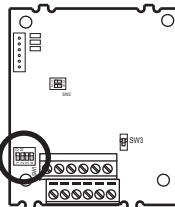
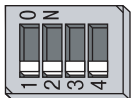
ON : with internal terminating resistor (initial setting status)

OFF : without internal terminating resistor

Internal terminating  
resistor-ON  
(initial status)



Internal terminating  
resistor-OFF



2

### NOTE

- Set all switches to the same setting ("ON"/ "OFF").
- 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 (CNC (computerized numerical controller), etc) or a terminating resistor is connected to other unit.

## ◆ Motor used and switch setting

Motor		Encoder specification selection switch (SW3)	Terminating resistor selection switch (SW1)	Power specifications <sup>*2</sup>
Mitsubishi Electric high-performance energy-saving motor with encoder	SF-PR-SC	Complementary	OFF	12V to 24V
Mitsubishi Electric Vector control dedicated motor	SF-V5RU	Complementary	OFF	12V to 24V
	SF-THY	Complementary	OFF	12 to 24 V
Mitsubishi standard motor with encoder Mitsubishi high-efficiency motor with encoder	SF-JR	Differential	ON	5V
	SF-HR	Differential	ON	5V
	Other	*1	*1	*2*3
Mitsubishi Electric constant-torque motor with encoder	SF-JRCA	Differential	ON	5V
	SF-HRCA	Differential	ON	5V
	Other	*1	*1	*1*3
Other manufacturer's motor with encoder		*1	*1	*1*3

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

\*2 Prepare the power supply (5 V/12 V/15 V/24 V) for the encoder according to the encoder's output voltage.

\*3 When the encoder output is the differential line driver type, only 5 V can be input.

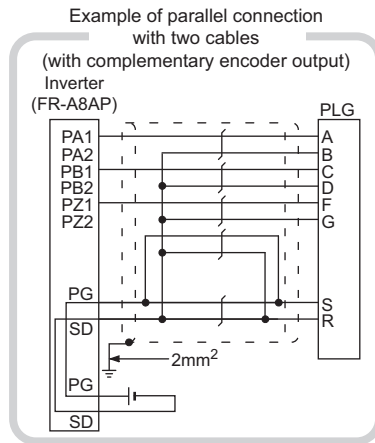
### NOTE

- Switch "SW2" is for manufacturer setting. Do not change the setting.
- When power is not supplied to the control circuit of the inverter, also turn OFF the encoder's power supply. Otherwise, the plug-in option may be damaged.



## 2.4 Wiring

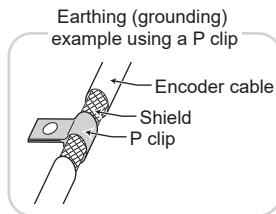
1. Use twisted pair shield cables (0.2 mm<sup>2</sup> or larger) to connect the FR-A8AP and position detector. For the wiring to the terminals PG and SD, use several cables in parallel or use a thick cable, according to the wiring length. To protect the cables from noise, run them away from any source of noise (e.g. the main circuit and power voltage).



Wiring length	Parallel connection (Cable gauge 0.2 mm <sup>2</sup> )	Larger-size cable
Within 10 m	At least two cables in parallel	0.4 mm <sup>2</sup> or larger
Within 20 m	At least four cables in parallel	0.75 mm <sup>2</sup> or larger
Within 100 m <sup>+1</sup>	At least six cables in parallel	1.25 mm <sup>2</sup> or larger

- \*1 When differential driver is set and a wiring length is 30 m or more  
The wiring length can be extended to 100 m by slightly increasing the 5 V power supply (approx. 5.5 V) and using six or more cables with gauge size of 0.2 mm<sup>2</sup> in parallel or a cable with gauge size of 1.25 mm<sup>2</sup> or more. Note that the voltage applied should be within power supply specifications of encoder.

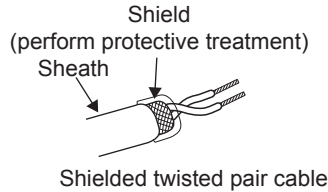
To reduce noise of the encoder cable, earth (ground) the encoder shielded cable to the enclosure (as close as the inverter) with a P clip or U clip made of metal.



## NOTE

- For details of the optional encoder dedicated cable (FR-JCBL/FR-V7CBL), refer to [page 22](#)
- FR-V7CBL is provided with a P clip for earthing (grounding) shielded cable.

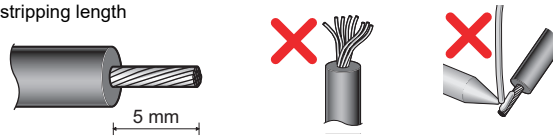
2. Wire the shielded twisted pair cable after stripping its sheath to make its cables loose. Also, protect the shielded cable of the shielded twisted pair cable to ensure that it will not make contact with the conductive area.



Strip the signal wires as follows. If too much of the wire is stripped, a short circuit may occur with neighboring wires. If not enough of the wire is stripped, wires may become loose and fall out.

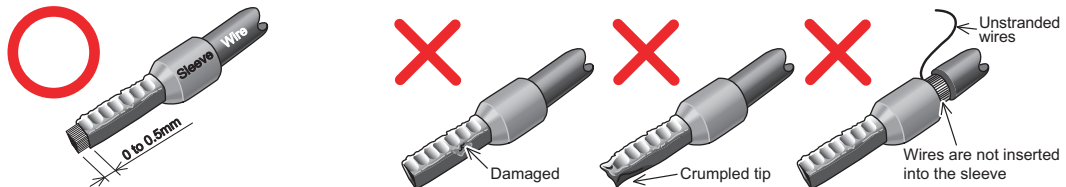
Twist the stripped end of wires to prevent them from fraying. Do not solder them.

Cable stripping length



Use a crimp terminal as necessary.

When using the crimp terminal, make sure that the stranded wire do not come out of the terminal.



**NOTE**

- Information on crimp terminals

Commercially available products (as of October 2020)

Phoenix Contact Co., Ltd.

Terminal screw size	Cable gauge (mm <sup>2</sup> )	Ferrule part No.		Crimping tool model No.
		With insulation sleeve	Without insulation sleeve	
M2	0.3 to 0.5	AI 0,5-6WH	A 0,5-6	CRIMPFOX 6

NICHIFU Co., Ltd.

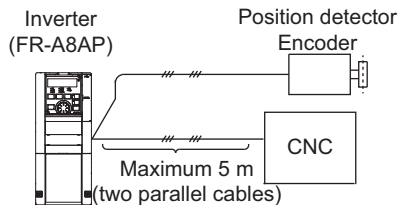
Screw size	Cable gauge (mm <sup>2</sup> )	Blade terminal part No.	Insulation cap part No.	Crimping tool model No.
M2	0.3~0.75	BT 0.75-7	VC 0.75	NH 69

3. Loosen the terminal screw and insert the cable into the terminal.

Screw size	Tightening torque	Cable gauge	Screwdriver
M2	0.22 N·m to 0.25 N·m	0.3 mm <sup>2</sup> to 0.75 mm	Small flathead screwdriver (tip thickness: 0.4 mm / tip width: 2.5 mm)

**NOTE**

- Undertightening may cause cable disconnection or malfunction. Overtightening can cause a short circuit or malfunction due to damage to the screw or unit.
- When wiring the RS-485 terminals on the inverter with the plug-in options installed, be careful not to let RS-485 cables touch the option circuit boards and the inverter circuit board. This is to prevent a malfunction due to electromagnetic noises.
- When one position detector is shared between FR-A8AP and CNC (computerized numerical controller), its output signal should be connected as shown below. In this case, the wiring length between FR-A8AP and CNC should be as short as possible, within 5 m.



**CAUTION**

- Do not use empty terminals as junction terminals because they are used internally used by the option. Doing so may damage the plug-in option.
- After wiring, do not leave wire offcuts in the inverter. Doing so may cause a fault, failure or malfunction.

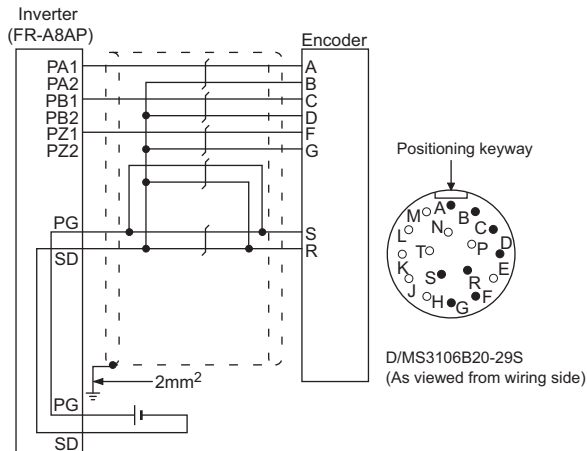
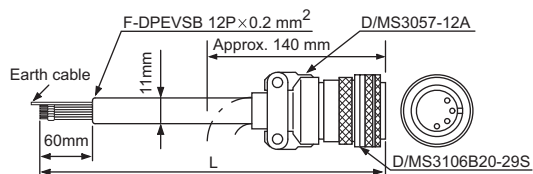
## 2.5 Encoder cables dedicated to Mitsubishi Electric motors

Use dedicated encoder cables to connect with Mitsubishi Electric encoder-equipped motors.

### ◆ FR-V7CBL

For SF-PR-SC/SF-V5RU/SF-THY

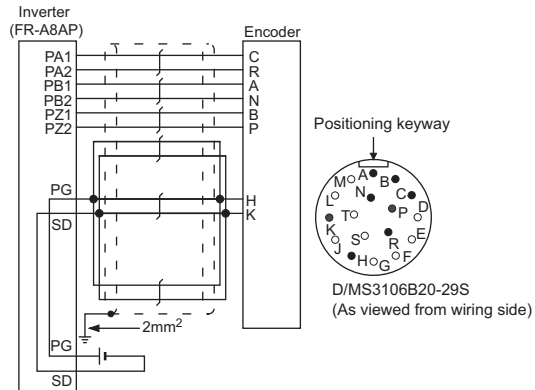
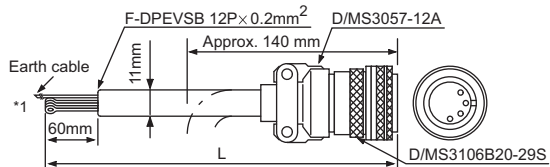
A P clip for earthing (grounding) a shielded cable is provided.



Type	Length L (m)
FR-V7CBL5	5
FR-V7CBL15	15
FR-V7CBL30	30

## ◆ FR-JCBL

For SF-JR/HR/JRCA/HRCA (with encoder)



Type	Length L (m)
FR-JCBL5	5
FR-JCBL15	15
FR-JCBL30	30

\*1 As the terminal block of the FR-A8AP is an insertion type, cables need to be treated. (Refer to [page 19](#).)

◆ **Connection terminal compatibility table**

Motor		SF-PR-SC/SF-V5RU/SF-THY	SF-JR/HR/JRCA/HRCA (with encoder)
Encoder cable		FR-V7CBL	FR-JCBL
FR-A8AP terminal	PA1	PA	PA
	PA2	Keep this open.	PAR
	PB1	PB	PB
	PB2	Keep this open.	PBR
	PZ1	PZ	PZ
	PZ2	Keep this open.	PZR
	PG	PG	5E
	SD	SD	AG2



## 2.6 Terminals

Terminal Symbol	Common	Terminal Name	Specification	Description	
PA1	Differential line driver: — Complementary: SD	Encoder A-phase signal input terminal	Differential line driver / Complementary	A-phase signal is input from the encoder.	For details of pulse signal, refer to <a href="#">page 26</a> .
PA2		Encoder A-phase inverse signal input terminal			
PB1		Encoder B-phase signal input terminal		B-phase signal is input from the encoder.	
PB2		Encoder B-phase inverse signal input terminal			
PZ1		Encoder Z-phase signal input terminal		Z-phase signal is input from the encoder. (Not used for the encoder feedback control.)	
PZ2		Encoder Z-phase inverse signal input terminal			
PG	SD	Encoder power supply (positive side) input terminal	—	Input power for the encoder power supply. Connect the external power supply (5 V, 12 V, 15 V, 24 V) and the encoder power cable. When the encoder output is the differential line driver type, only 5 V can be input. Make sure the voltage of the external power supply the same as the encoder output voltage. (Check the encoder specification.)	
SD	—	Encoder power supply ground terminal			

# 3 ENCODER SPECIFICATIONS AND PARAMETER SETTINGS

## 3.1 Encoder

### ◆ Position detection (pulse encoder)

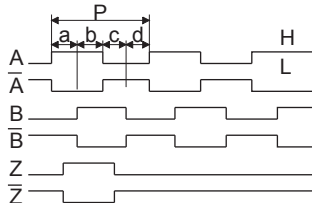
Output pulse specifications

Differential line driver

A/ $\bar{A}$  signal 1000 P/R to 4096 P/R

B/ $\bar{B}$  signal 1000 P/R to 4096 P/R

Z/ $\bar{Z}$  signal 1 P/R

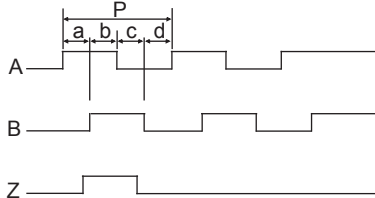


Complementary

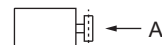
A signal 1000 P/R to 4096 P/R

B signal 1000 P/R to 4096 P/R

Z signal 1 P/R



Position detector  
Encoder



- When rotation is clockwise as viewed from the shaft end (A) of the encoder.
- a, b, c, d should be  $(1/4 \pm 1/8)P$

### NOTE

- When orientation control, encoder feedback control, vector control are used together, the encoder is shared between these controls. Use an encoder which has a pulse count of 1000 to 4096 ppr (pulse per revolution).
- The encoder should be coupled with the motor shaft or the spindle oriented with a speed ratio of 1 to 1 without any mechanical looseness.
- To ensure correct operation, the encoder must be set in the proper rotation direction and the A and B phases connected correctly.

### ◆ Power supply

Choose a power supply for encoder according to the encoder used (5 V/12 V/15 V/24 V). When the encoder output is the differential line driver type, only 5 V can be input. Make sure the voltage of the external power supply the same as the encoder output voltage. (Check the encoder specification.)

When an encoder is used under orientation control, encoder feedback control, and vector control, the power supply is shared between the inverter and encoder.

- Specifications of the encoders equipped in the motors with encoders and the vector-control dedicated motors

Item	Encoder for SF-PR-SC/SF-V5RU/SF-THY	Encoder for SF-JR/HR/JRCA/HRCA
Resolution	2048 pulses/rev	1024 pulses/rev
Power supply voltage	12 VDC $\pm$ 10%, 24 VDC $\pm$ 10%	5 VDC $\pm$ 10%
Current consumption	90 mA	60 mA or less
Output signal form	A, B phases (90° phase shift) Z phase: 1 pulse/rev	
Output circuit	Complementary	Equivalent to differential line driver AM26LS31
Output voltage	H level: "Power supply for encoder-3 V" or more L level: 3 V or less	H level: 2.4 V or more L level: 0.5 V or less



### NOTE

- When the input power supply voltage to the encoder and its output voltage differ, the protective function (E.ECT) may be activated.

### ◆ Parameters for encoder

For the parameters for encoder, refer to the FR-A800 Instruction Manual (Detailed).

### ◆ Parameter settings for the motor under Vector control

Using the control terminal option FR-A8TP together with the FR-A8AP enables Vector control or machine end orientation control by switching between two encoder-equipped motors. Use **Pr.862** to set the combination of the motors (first/second) and the options (FR-A8TP/FR-A8AP).

Pr.862 Encoder option selection	Pr.393 Orientation selection	RT signal-OFF (First motor)	RT signal-ON (Second motor) <sup>*1</sup>	Machine end orientation control
0 (initial value)	0, 1, 2	FR-A8AL	FR-A8TP	Disabled
	10, 11, 12			
1	0, 1, 2	FR-A8TP	FR-A8AL	Enabled
	10, 11, 12	Motor end: FR-A8TP Machine end: FR-A8AL	—	

\*1 When **Pr.450 Second applied motor** = "9999", the first motor is selected even if the RT signal turns ON.

Use the following parameters for the encoder input setting. The encoder input setting can be made regardless of the **Pr.862** setting and first/second motor setting.

Parameter name	Parameter for control terminal option (FR-A8TP)	Parameter for plug-in option (FR-A8AP)
Encoder rotation direction	852	359
Number of encoder pulses	851	369
Encoder signal loss detection enable/disable selection	855	376

#### NOTE

- To input the RT signal, set "3" in any of **Pr.178 to Pr.182, Pr.185, or Pr.189** (Input terminal function selection) to assign the function to a terminal.
- **Pr.862** setting is valid even when either the plug-in option or control terminal option is installed. For using the control terminal option alone, the motor does not run when **Pr.862** is the initial value as it is. (When the RT signal is OFF)

### ◆ Parameter settings for the motor under vector control

Motor Name		Pr.359 Encoder rotation direction	Pr.369 Number of encoder pulses
Mitsubishi Electric standard motor	SF-JR	1 (Initial value)	1024 (Initial value)
	SF-JR 4P 1.5 kW or less	1 (Initial value)	1024 (Initial value)
	SF-HR	1 (Initial value)	1024 (Initial value)
	Others	*1	*1
Mitsubishi Electric constant-torque motor	SF-JRCA 4P	1 (Initial value)	1024 (Initial value)
	SF-HRCA 4P	1 (Initial value)	1024 (Initial value)
	Others	*1	*1
Mitsubishi Electric high-performance energy-saving motor with encoder	SF-PR-SC	1 (initial value)	2048
Mitsubishi vector control dedicated motor	SF-V5RU	1 (Initial value)	2048
	SF-THY	1 (Initial value)	2048
Other manufacturer's standard motor	—	*1	*1
Other manufacturer's constant-torque motor	—	*1	*1

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

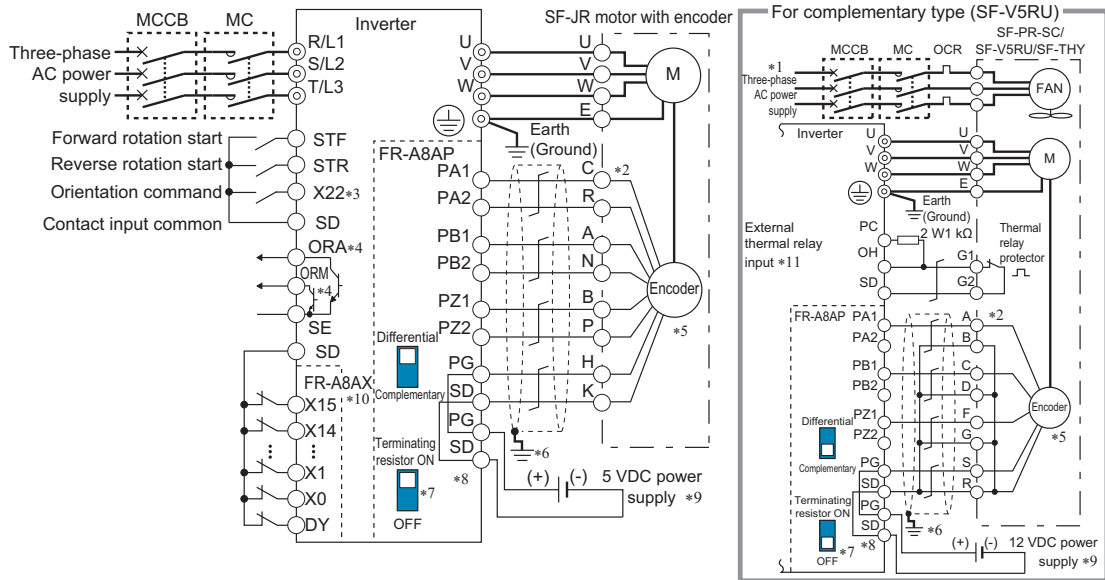
# MEMO

# 4 ORIENTATION CONTROL

This function is used with a position detector (encoder) installed to the spindle of a machine tool, etc. to allow a rotary shaft to be stopped at the specified position (oriented).

For the details of the parameters used for orientation control, refer to the Instruction Manual (Detailed) of the inverter.

## 4.1 Wiring example



4

- \*1 For the fan of the 7.5 kW or less dedicated motor, the power supply is single phase (200 V/50 Hz, 200 to 230 V/ 60 Hz).
- \*2 The pin number differs according to the encoder used.
- \*3 Use **Pr. 178 to Pr. 189 (input terminal function selection)** to assign the function to any of terminal.  
Refer to the Instruction Manual (Detailed) for details of **Pr. 178 to Pr. 189 (input terminal function selection)**.
- \*4 Use **Pr. 190 to Pr. 196 (output terminal function selection)** to assign the function to any of terminal.  
Refer to the Instruction Manual (Detailed) for details of **Pr. 190 to Pr. 196 (output terminal function selection)**.
- \*5 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio should be 1:1.
- \*6 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (Refer to [page 17](#).)
- \*7 For the differential line driver, set the terminating resistor selection switch to on position (initial status) to use. (Refer to [page 14](#).)  
Note that the terminating resistor switch should be set to off position when sharing the same encoder with other unit (CNC, etc.) and a terminating resistor is connected to other unit. For the complementary, set the switch to off position.
- \*8 For terminal compatibility of the FR-JCBL, FR-V7CBL and FR-A8AP, refer to [page 24](#).
- \*9 A separate power supply of 5 V/12 V/15 V/24 V is necessary according to the encoder power specification. When the encoder output is the differential line driver type, only 5 V can be input.  
Make the voltage of the external power supply the same as the encoder output voltage, and connect the external power supply between PG and SD.  
When performing encoder feedback control and vector control together, an encoder and power can be shared.
- \*10 When a stop position command is input from outside, a plug-in option FR-A8AX is necessary. Refer to the Instruction Manual (Detailed) for details of external stop position command.
- \*11 To use a terminal as the terminal OH, assign the OH (external thermal O/L relay input) signal to an input terminal. (Set "7" in any of **Pr.178 to Pr.189**. For details, refer to the Instruction Manual (Detailed) of the inverter.)



## 4.2 Terminals

### ◆ Option FR-A8AX terminal

Terminal Symbol	Terminal Name	Description
X0 to X15	Digital signal input terminal	Input the digital signal at the relay contact or open collector terminal. Using <b>Pr. 360</b> , speed or position command is selected as the command signal entered.
DY	Data read timing input signal terminal	Used when a digital signal read timing signal is necessary. Data is read only during the DY signal is on. By switching the DY signal off, the X0 to X15 data before signal-off is retained.

### ◆ Inverter terminal

Terminal (Signal)		Terminal (Signal) Name	Application Explanation
Input	X22	Orientation command	Used to enter an orientation signal for orientation. For the terminal used for X22 signal input, set "22" in any of <b>Pr. 178 to Pr. 189</b> to assign the function. <sup>*1</sup>
Output	ORA	Orientation complete	Switched LOW if the orientation has stopped within the in-position zone while the start and X22 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 <b>Pr. 190 to Pr. 196</b> . <sup>*1</sup>
	ORM	Orientation fault	Switched LOW if the orientation has not completed within the in-position zone while the start and X22 signals are input. For the terminal used for the ORA signal output, assign the function by setting "28 (positive logic) or 128 (negative logic)" in any of <b>Pr. 190 to Pr. 196</b> . <sup>*1</sup>

\*1 Refer to the Instruction Manual (Detailed) for details of **Pr.178 to Pr.189 (input terminal function selection)** and **Pr.190 to Pr.196 (output terminal function selection)**.

## 4.3 Specifications

Item	Description
Repeated positioning accuracy	$\pm 1.5^\circ$ Depends on the load torque, moment of inertia of the load or orientation, creep speed, position loop switching position, etc.
Permissible speed	Encoder-mounted shaft speed (6000 r/min with 1024-pulse encoder). The drive shaft and encoder-mounted shaft must be coupled directly or via a belt without any slip. Gear changing shafts cannot be applied.
Functions	Orientation, creep speed setting, stop position command selection, DC injection brake start position setting, creep speed and position loop switch position setting, position shift, orientation in-position, position pulse monitor, etc.
Holding force after positioning	Under V/F control, Advanced magnetic flux vector control...without servo lock function Under vector control...with servo lock function
Input signal (contact input)	Orientation command, forward and reverse rotation commands, stop position command (open collector signal input (complementary) is enabled) Binary signal of maximum 16 bit (when used with the FR-A8AX)
Output signal (open collector output)	Orientation completion signal, orientation fault signal

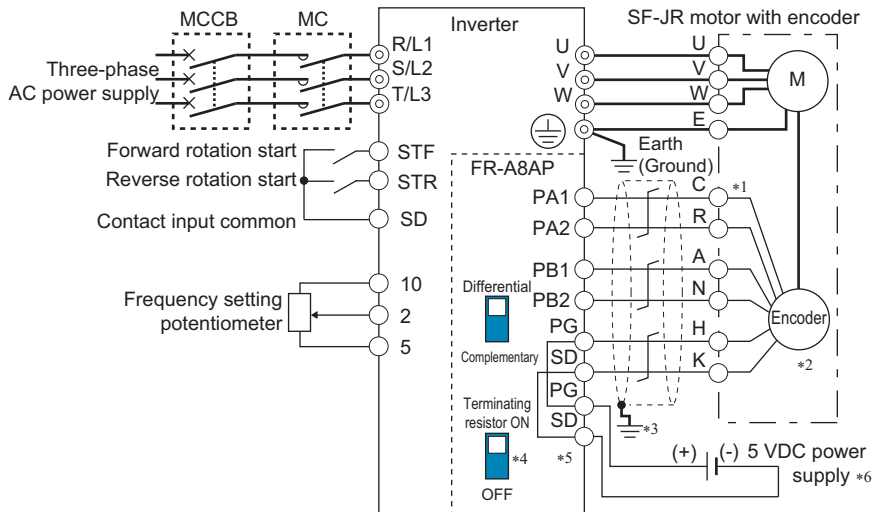
# 5 ENCODER FEEDBACK CONTROL

Mount FR-A8AP to an FR-A800 series inverter to perform encoder feedback control under V/F control or Advanced magnetic flux vector control.

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 back to the inverter.

For the details of the parameters used for encoder feedback control, refer to the Instruction Manual (Detailed) of the inverter.

## 5.1 Wiring examples



- \*1 The pin number differs according to the encoder used.
- \*2 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio should be 1:1.
- \*3 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. (Refer to [page 17](#).)
- \*4 For the differential line driver, set the terminating resistor selection switch to on position (initial status) to use. (Refer to [page 14](#)) Note that the terminating resistor switch should be set to off position when sharing the same encoder with other unit (CNC, etc) and a terminating resistor is connected to other unit.  
For the complementary, set the switch to off position.
- \*5 For terminal compatibility of the FR-JCBL, FR-V7CBL and FR-A8AP, refer to [page 24](#).
- \*6 A separate power supply of 5 V/12 V/15 V/24 V is necessary according to the encoder power specification. When the encoder output is the differential line driver type, only 5 V can be input.  
Make the voltage of the external power supply the same as the encoder output voltage, and connect the external power supply between PG and SD.  
To perform orientation control together, an encoder and power supply can be shared.

## 5.2 Specifications

Item	Description
Speed variation ratio	±0.1% (100% means 3600 r/min)
Function	<ul style="list-style-type: none"> <li>• Setting of speed feedback range</li> <li>• Setting of feedback gain</li> <li>• Setting of encoder rotation direction</li> </ul>
Maximum speed	V/F control: 590 Hz, Advanced magnetic flux vector control: 400 Hz (102400 pulse/s or less encoder pulses)

## 6 VECTOR CONTROL

---

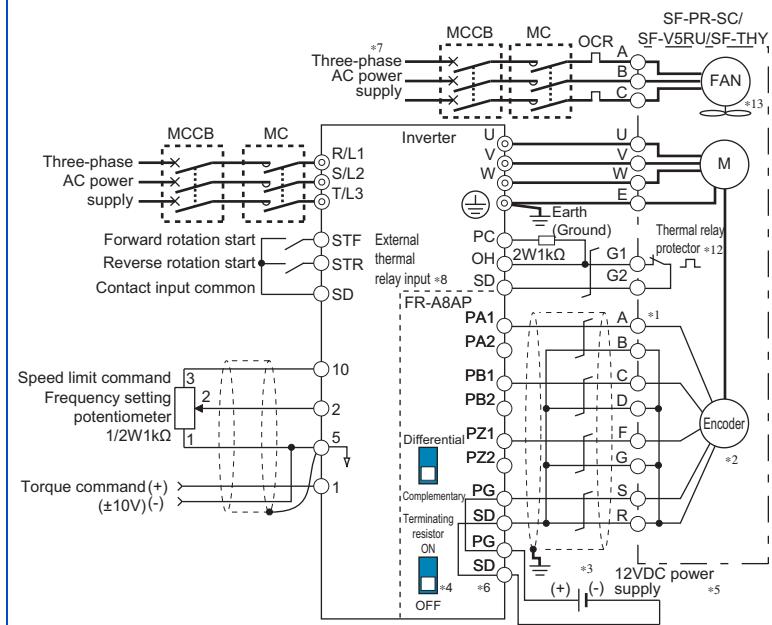
When FR-A8AP is installed on the FR-A800 series, full-scale vector control operation can be performed using a motor with encoder.

Speed control, torque control and position control by vector control can be performed. (Refer to the Instruction Manual (Detailed) for details.)

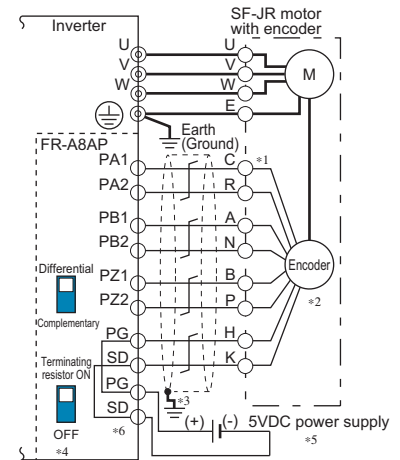


## ◆ Torque control

### Vector control dedicated motor (SF-PR-SC, SF-V5RU, or SF-THY), 12 V complementary

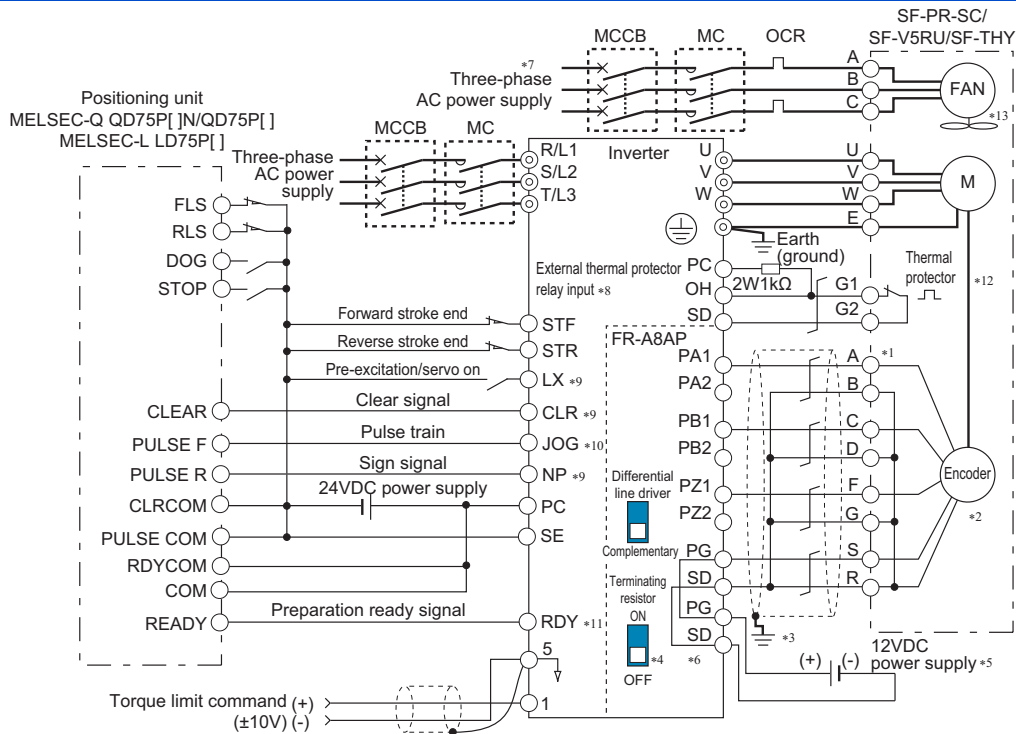


### Standard motor with encoder (SF-JR), 5 V differential line driver



## ◆ Position control

### Vector control dedicated motor (SF-PR-SC, SF-V5RU, or SF-THY), 12 V complementary





- \*1 The pin number differs according to the encoder used.  
Speed, control, torque control, and position control by pulse train input are available with or without the Z-phase being connected.
- \*2 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio must be 1:1.
- \*3 Earth (ground) the shield of the encoder cable to the enclosure using a tool such as a P-clip. (Refer to [page 17.](#))
- \*4 For the complementary, set the terminating resistor selection switch to OFF position. (Refer to [page 14.](#))
- \*5 A separate power supply of 5 V/12 V/15 V/24 V is necessary according to the encoder power specification.  
When the encoder output is the differential line driver type, only 5 V can be input.  
Make the voltage of the external power supply the same as the encoder output voltage, and connect the external power supply across PG and SD.  
When performing orientation control together, an encoder and power supply can be shared.
- \*6 For terminal compatibility of the FR-JCBL, FR-V7CBL, and FR-A8AP, refer to [page 24.](#)
- \*7 For the fan of the 7.5 kW or lower dedicated motor, the power supply is single phase. (200 V/50 Hz, 200 to 230 V/60 Hz)
- \*8 To use a terminal as the terminal OH, assign the OH (external thermal O/L relay input) signal to an input terminal. (Set "7" in any of **Pr.178 to Pr.189**. For details, refer to the Instruction Manual (Detailed) of the inverter.)
- \*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 invalid and simple position pulse train input terminal becomes valid.
- \*11 Assign the function using **Pr.190 to Pr.194 (output terminal function selection)**.
- \*12 Some SF-PR-SC models have a thermal protector.
- \*13 The SF-PR-SC does not have a cooling fan.

## 6.2 Specifications

Item		Description
Speed control	Speed control range	1:1500 (both driving/regeneration <sup>*1</sup> )
	Speed variation ratio	±0.01% (100% means 3000 r/min)
	Speed response	130 Hz
	Maximum speed	120 Hz (102400 pulse/s or less encoder pulses)
Torque control	Torque control range	1:50
	Absolute torque accuracy	±10% <sup>*2</sup>
	Repeated torque accuracy	±5% <sup>*2</sup>
Position control	Repeated positioning accuracy	±1.5° (at motor shaft end)
	Maximum input pulse frequency	100k pulses/s (Terminal JOG)
	Positioning feedback pulse	Number of encoder pulses per motor rotation ( <b>Pr.369</b> ) × 4
	Electronic gear setting	1/50 to 20
	In-position width	0 to 32767 pulses
	Error excess	0 to 400k pulses
Function		<ul style="list-style-type: none"> <li>• Setting of speed feedback range</li> <li>• Setting of feedback gain</li> <li>• Setting of encoder rotation direction</li> </ul>

\*1 Regeneration unit (option) is necessary for regeneration

\*2 With online auto tuning (adaptive magnetic flux observer), dedicated motor, rated load

# MEMO

# APPENDIX

## Appendix 1 Instructions for compliance with the EU Directives

The EU Directives are issued to standardize different national regulations of the EU Member States and to facilitate free movement of the equipment, whose safety is ensured, in the EU territory.

Since 1996, compliance with the EMC Directive that is one of the EU Directives has been legally required. Since 1997, compliance with the Low Voltage Directive, another EU Directive, has been also legally required. When a manufacturer confirms its equipment to be compliant with the EMC Directive and the Low Voltage Directive, the manufacturer must declare the conformity and affix the CE marking.

- The authorized representative in the EU

The authorized representative in the EU is shown below.

Name: Mitsubishi Electric Europe B.V.

Address: Mitsubishi-Electric-Platz 1, 40882 Ratingen, Germany

### ◆ EMC Directive

We declare that this product conforms with the EMC Directive when installed in a compatible inverter, and affix the CE marking on the packaging plate.

- EMC Directive: 2014/30/EC
- Standard(s): EN 61800-3:2004+A1:2012 (Second environment / PDS Category "C3")

### ■ Note

- To install and wire the inverter, refer to the "Instructions for compliance with the EU Directives" in the Instruction Manual enclosed with the inverter.
- Confirm that the final integrated system with the inverter conforms with the EMC Directive.

### ◆ EU RoHS Directive

We declare that this product conforms with the EU RoHS Directive (2011/65/EU) when installed in a compatible inverter, and affix the CE marking on the packaging plate.



## Appendix 2 Instructions for EAC

The product certified in compliance with the Eurasian Conformity has the EAC marking on the packaging plate.

Note: EAC marking

In 2010, three countries (Russia, Belarus, and Kazakhstan) established a Customs Union for the purposes of revitalizing the economy by forming a large economic bloc by abolishing or reducing tariffs and unifying regulatory procedures for the handling of articles.

Products to be distributed over these three countries of the Customs Union must comply with the Customs Union Technical Regulations (CU-TR), and the EAC marking must be affixed to the products.

For information on the country of origin, manufacture year and month, and authorized sales representative (importer) in the CU area of this product, refer to the following:

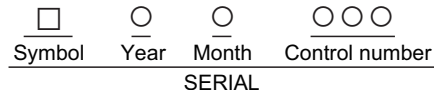
- Country of origin indication

Check the package of this product.

Example: MADE IN JAPAN

- Manufactured year and month

Check the SERIAL number indicated on this product.



The SERIAL consists of one symbol, two characters indicating the production year and month, and three 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).

- Authorized sales representative (importer) in the CU area

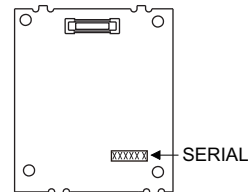
The authorized sales representative (importer) in the CU area is shown below.

Name: Mitsubishi Electric (Russia) LLC

Address: 52, bld 1 Kosmodamianskaya Nab 115054, Moscow, Russia

Phone: +7 (495) 721-2070

Fax: +7 (495) 721-2071



## Appendix 3 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。

## **Appendix 4 Referenced Standard (Requirement of Chinese standardized law)**

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This Product is designed and manufactured accordance with following Chinese standards.

EMC: GB/T 12668.3

## Appendix 5 Compliance with the UK certification scheme

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We declare that this product conforms with the related technical requirements under UK legislation when installed in a compatible inverter, and affix the UKCA (UK Conformity Assessed) marking on the packaging plate.

Approval conditions are the same as those for the EU Directives. (Refer to [page 45.](#))



UKCA marking:

The UKCA marking is used for products sold in the markets of Great Britain (England, Wales, and Scotland) from January 1, 2021 after the departure of the UK from the EU on January 31, 2020.



# MEMO

# MEMO



## REVISIONS

\*The manual number is given on the bottom left of the back cover. Instructions for compliance with the EU Directives

Revision date	*Manual Number	Revision
Aug. 2013	IB(NA)-0600505ENG-A	First edition
Sep. 2014	IB(NA)-0600505ENG-B	Edited <ul style="list-style-type: none"><li>• Crimp terminals commercially available</li></ul>
Sep. 2022	IB(NA)-0600505ENG-C	Added <ul style="list-style-type: none"><li>• Instructions for compliance with the EU Directives</li><li>• Instructions for EAC</li><li>• Restricted Use of Hazardous Substances in Electronic and Electrical Products</li><li>• Referenced Standard (Requirement of Chinese standardized law)</li><li>• Compliance with the UK certification scheme</li></ul>

INVERTER

**mitsubishi electric corporation**

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