MITSUBISHI ELECTRIC

INVERTER

Plug-in option

FR-A8APR

INSTRUCTION MANUAL

Resolver interface

Orientation control

Resolver (encoder) feedback control

Vector control

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800 series

Thank you for choosing this Mitsubishi 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.

Safety instructions

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

⚠ **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 equipment 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**

⚠ **Caution**

- The voltage applied to each terminal must be the ones 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. Touching these devices may cause a burn.

◆ **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.

⚠ Caution

Transportation and mounting
- 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.
- The mounting orientation 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.) infiltrate into a Mitsubishi product, the product will be damaged. Halogen-based materials are often included in fumigant, which is used to sterilize or disinfest wooden packages. When packaging, prevent residual fumigant components from being infiltrated into Mitsubishi products, or use an alternative sterilization or disinfection method (heat disinfection, etc.) for packaging. Sterilization of disinfection of wooden package should also be performed before packaging the product.

Trial run
- Before starting operation, each parameter must be confirmed and adjusted. A failure to do so may cause some machines to make unexpected motions.

⚠ Warning

Usage
- Do not modify the equipment.
- Do not perform parts removal which is not instructed in this manual. Doing so may lead to fault or damage of the product.

⚠ Caution

Usage
- When parameter clear or all parameter clear is performed, the required parameters must be set again before starting operations. Because all parameters return to their initial values.
- 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 product must be treated as industrial waste.

General instruction

- 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.

─ CONTENTS ─

<Notes on descriptions in this Instruction Manual>
Connection diagrams in this Instruction Manual appear with the control logic of the input terminals as sink logic, unless otherwise specified.
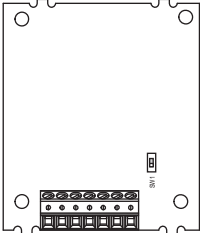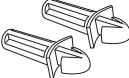
1 PRE-OPERATION INSTRUCTIONS

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.

1.1.1 Product confirmation

Check the enclosed items.

Plug-in option 1	Mounting screw (M3 × 8 mm) .... 2 (Refer to **page 9**)	Spacer .... 2 (Refer to **page 9**)

1.1.2 SERIAL number check

The FR-A8APR can be used for the inverter models listed below with the following SERIAL number or later. Check the SERIAL number indicated on the inverter rating plate or package.

Rating plate example


```
 □      O      O      OOOOOO
Symbol  Year  Month  Control number
              SERIAL
```

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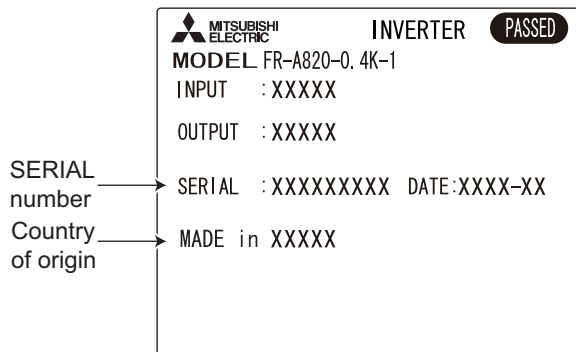The last digit of the production year is indicated as the Year, and the Month is indicated by 1 to 9, X (October), Y (November), or Z (December).

FR-A800 series

Model	Country of origin indication	SERIAL number
FR-A820-00046(0.4K) to 04750(90K) FR-A840-00023(0.4K) to 06830(280K) FR-A842-07700(315K) to 12120(500K) FR-A846-00023(0.4K) to 03610(132K)	MADE in Japan	□52OOOOOO or later
	MADE in China	□53OOOOOO or later

1.2   Component names

Terminal layout

Front view (a)

Rear view (d)

(a)

(a)

(a)

(c)

SW1

(a)

(a)

R1 R2 S2 S4 S1 S3 CM

(b)

(a)
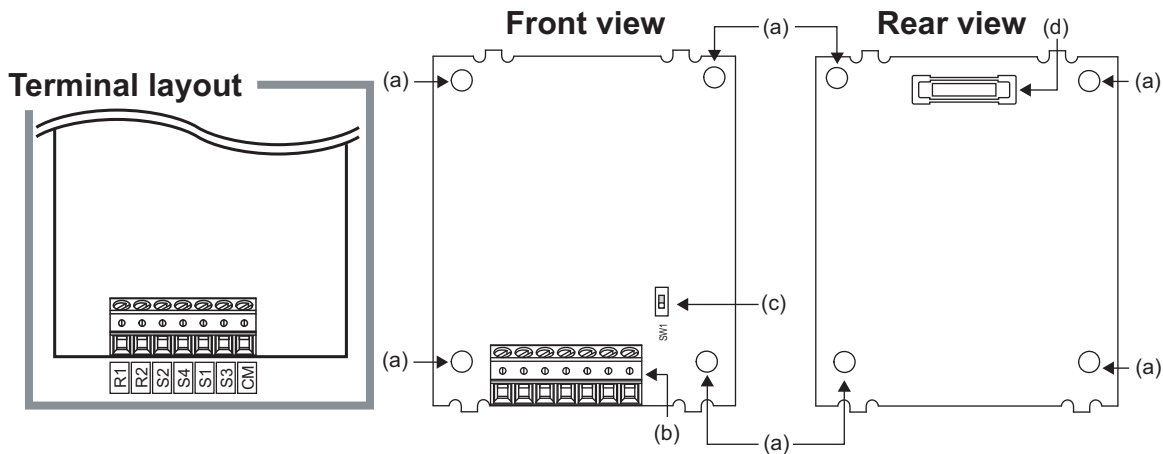
Symbol	Name	Description	Refer to page
a	Mounting hole	Fixes the option to the inverter with screws, or installs spacers.	**9**
b	Terminal block	Connected with a resolver.	**15**
c	Switch for manufacturer setting (SW1)	Do not change the initially-set status. (OFF ▯)	—
d	Connector	Connects to the option connector of the inverter.	**9**

2 INSTALLATION AND WIRING

2.1 Pre-installation instructions

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

> **⚠ Caution**
> - With input power ON, do not install or remove the plug-in option. Otherwise, the inverter and plug-in option may be damaged.
> - 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 for details on how to remove the front cover.)

(2) For the two mounting holes (as shown in the next page) that will not be tightened with mounting screws, insert spacers.

(3) Fit the connector of the plug-in option to the guide of the connector on the inverter unit side, and insert the plug-in option as far as it goes.

(4) Fit the two locations, the left and right, of the plug-in option securely to the inverter unit by screwing in the supplied mounting screws. (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.
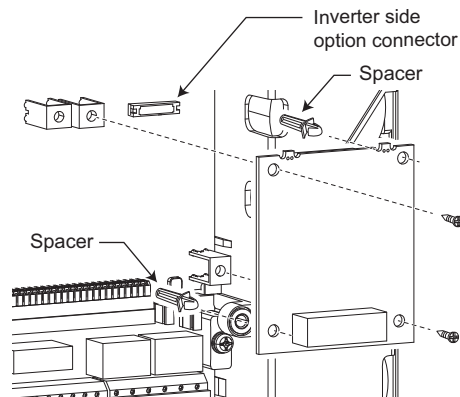
Example of installation to connector 1
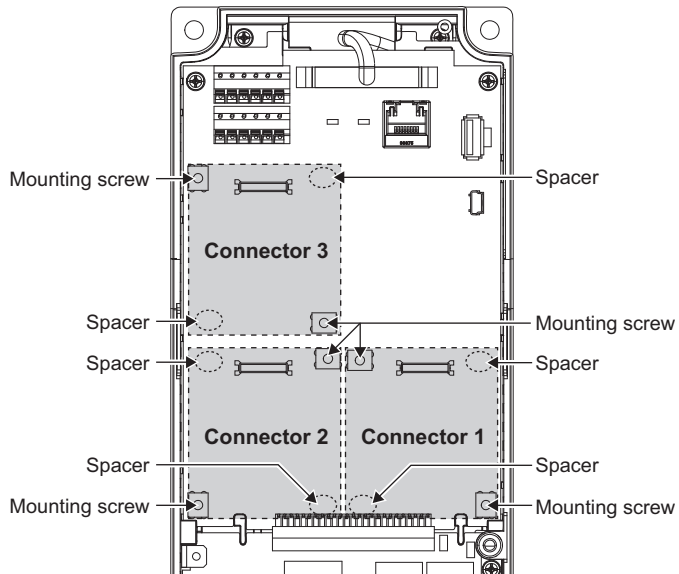
Insertion positions for screws and spacers

NOTE

- When mounting/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.
- Caution must be applied to mounting screws falling off when removing and mounting the plug-in option.
- If the FR-A8APR and the FR-A8AP are installed together, the FR-A8AP is disabled.
- Only one option can be used. When multiple options are mounted, priority is given to option connectors 1, 2 and 3 on the inverter in this order, and options having a lower priority do not function.
- When the inverter cannot recognize that the option unit is mounted due to improper installation, etc., or when an option unit fault occurs, the protective function (E.1 to E.3 or E.OP1 to E.OP3) is activated and the inverter cannot be operated. A different indication will appear according to the mounted position (option connector 1 to 3).

Mounted position	Fault indication	
Option connector 1	E. 1	E. OP1
Option connector 2	E. 2	E. OP2
Option connector 3	E. 3	E. OP3

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

2

2.3 Wiring

(1) Strip off the sheath of the signal cable from the resolver for the below length. If the length of the sheath peeled is too long, a short circuit may occur with neighboring wires. If the length is too short, wires might come off.
Wire the stripped signal cable after twisting it to prevent it from becoming loose. In addition, do not solder it.

Cable stripping length

5 mm
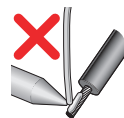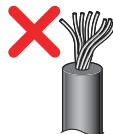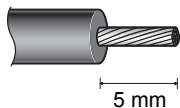
For connecting the FR-A8APR, use a blade terminal as necessary.
When using the blade terminal, use care so that the twisted wires do not come out.

Damaged   Crumpled tip   Wires are not inserted into the sleeve

Unstranded wires
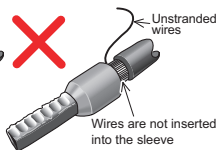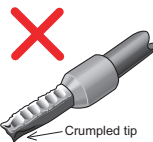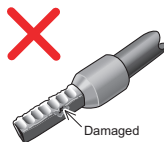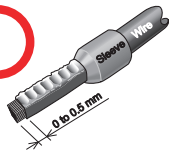
NOTE

• Blade terminals commercially available (as of January 2015. The product may be changed without notice.)

Terminal screw size	Wire size (mm^2)	Ferrule terminal model		Manufacturer	Crimping tool name
		With insulation sleeve	Without insulation sleeve		
M2	0.3 to 0.5	AI 0,5-6WH	A 0,5-6	Phoenix Contact Co.,Ltd.	CRIMPFOX 6

(2) Loosen the terminal screw and insert the cable into the terminal.

Screw size	Tightening torque	Cable size	Screwdriver
M2	0.22 N·m to 0.25 N·m	0.3 mm^2 to 0.75 mm^2	Small ⊖ flat-blade screwdriver (Tip thickness: 0.4 mm/tip width: 2.5 mm)

NOTE

- Undertightening can cause cable disconnection or malfunction. Overtightening can cause a short circuit or malfunction due to damage to the screw or unit.
- When wiring cables to the inverter's RS-485 terminals while a plug-in option is mounted, take caution not to let the cables touch the circuit board of the option or of the inverter. Otherwise, electromagnetic noises may cause malfunctions.

⚠ **CAUTION**

- **After wiring, wire offcuts must not be left in the inverter. They may cause a fault, failure or malfunction.**

2

• Extension of the signal cable

Use shielded twisted pair cables to extend the signal cable from the resolver. For connection with the signal cables, solder them or fix them with screws on the terminal block. Insulate and disconnect the shielded cable of the resolver.

Connect by soldering or using the terminal block.

A8APR circuit board

Terminals

Shielded cable

Resolver

R1 R2 S2 S4 S1 S3 CM

Shielded twisted pair cable

S3: Black *1
S1: Red
S4: Blue
S2: Yellow
R2: Yellow/White
R1: Red/White

Loose wires
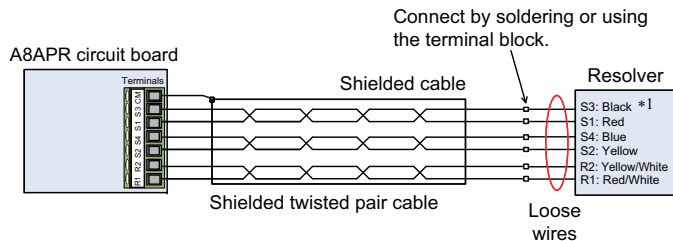
*1 Example of TS2640N321E64 manufactured by Tamagawa Seiki Co., Ltd.
For the extension of the signal cable used for the resolver above, the following wire is recommended.
V-3PB-02S manufactured by Totoku Electric Co., Ltd.

NOTE

• The wiring length should be 100 m at the maximum.

2.4　Terminals

Terminal symbol	Terminal name	Description
R1	Excitation output (R1)	Output 9.5 mArms (typ) of sine wave excitation current with which excitation can be performed directly to the resolver across terminals R1 and R2.
R2	Excitation output (R2)	
S1	Cos(+)	Input terminal for resolver Cos(+) signal.
S3	Cos(-)	Input terminal for resolver Cos(-) signal.
S2	Sin(+)	Input terminal for resolver Sin(+) signal.
S4	Sin(-)	Input terminal for resolver Sin(-) signal.
CM	Shield	Connect the shielded wire of the twisted pair cable.

2

3 PARAMETER

3.1 Extended parameter list

When the FR-A8APR is installed in the inverter, the following parameters are extended.

Pr.	Pr. group	Name	Setting range	Minimum setting increments	Initial value	Refer to page
350	A510	Stop position command selection	0, 1, 9999	1	9999	*1
351	A526	Orientation speed	0 to 30 Hz	0.01 Hz	2 Hz	*1
352	A527	Creep speed	0 to 10 Hz	0.01 Hz	0.5 Hz	*1
353	A528	Creep switchover position	0 to 16383	1	511	*1
354	A529	Position loop switchover position	0 to 8191	1	96	*1
355	A530	DC injection brake start position	0 to 255	1	5	*1
356	A531	Internal stop position command	0 to 16383	1	0	*1
357	A532	Orientation in-position zone	0 to 255	1	5	*1
358	A533	Servo torque selection	0 to 13	1	1	*1
359	C141	Encoder rotation direction	0, 1, 100, 101 *4	1	1	*1
360	A511	16-bit data selection	0 to 127	1	0	*1
361	A512	Position shift	0 to 16383	1	0	*1
362	A520	Orientation position loop gain	0.1 to 100	0.1	1.0	*1
363	A521	Completion signal output delay time	0 to 5 s	0.1 s	0.5 s	*1
364	A522	Encoder stop check time	0 to 5 s	0.1 s	0.5 s	*1
365	A523	Orientation limit	0 to 60 s, 9999	1 s	9999	*1
366	A524	Recheck time	0 to 5 s, 9999	0.1 s	9999	*1
367	G240	Speed feedback range	0 to 590 Hz, 9999	0.01 Hz	9999	*1
368	G241	Feedback gain	0 to 100	0.1	1	*1

Pr.	Pr. group	Name	Setting range	Minimum setting increments	Initial value	Refer to page
373	C142	Resolver position tuning setting/status	0, 1	1	0	**33**
376	C148	Encoder signal loss detection enable/disable selection	0, 1	1	0	∗1
393	A525	Orientation selection	0 to 2, 10 to 12	1	0	∗1
394	A540	Number of machine side gear teeth	0 to 32767	1	1	∗2
395	A541	Number of motor side gear teeth	0 to 32767	1	1	∗2
396	A542	Orientation speed gain (P term)	0 to 1000	1	60	∗1
397	A543	Orientation speed integral time	0 to 20 s	0.001 s	0.333 s	∗1
398	A544	Orientation speed gain (D term)	0 to 100	0.1	1	∗1
399	A545	Orientation deceleration ratio	0 to 1000	1	20	∗1
635	M610	Cumulative pulse clear signal selection	0, 1, 2, 3	1	0	∗1
636	M611	Cumulative pulse division scaling factor	1 to 16384	1	1	∗1
637	M612	Control terminal option-Cumulative pulse division scaling factor	1 to 16384	1	1	∗1
638	M613	Cumulative pulse storage	0, 1, 2, 3	1	0	∗1
823	G215	Speed detection filter 1	0 to 0.1 s	0.001 s	0.001 s	∗1
833	G315	Speed detection filter 2	0 to 0.1 s, 9999	0.001 s	9999	∗1
853	H417	Speed deviation time	0 to 100 s	0.1 s	1 s	∗1
862	C242	Encoder option selection	0, 1	1	0	∗3
873	H415	Speed limit	0 to 400 Hz	0.01 Hz	20 Hz	∗1
1105	C143	Resolver magnetic pole position offset	0 to 4095, 9999	1	9999	**33**

∗1 The setting method and the function are same as those of the FR-A8AP. Refer to the description for the FR-A8AP in the Instruction Manual (Detailed) of the inverter.

∗2 Set when the machine end orientation control is performed with the FR-A8APR and the FR-A8TP together. For the details, refer to the instruction manual of the FR-A8TP.

∗3 Set when using the FR-A8APR with the FR-A8TP. For the details, refer to the instruction manual of the FR-A8TP.

∗4 Under vector control for the PM motor with a resolver, the operation for the setting of "0" is performed when "100" is set. The operation for the setting of "1" is performed when "101" is set.

3

3.2   Function differences from the FR-A8AP

- The following tables show the function differences from the FR-A8AP (option compatible with encoder).
- Both the FR-A8APR and the FR-A8AP cannot be used together. If the FR-A8APR and the FR-A8AP are installed together in the inverter, the FR-A8AP is disabled.

◆ Parameter for detector

Item	FR-A8APR parameter	FR-A8AP parameter
Resolver/Encoder rotation direction	**Pr.359**	
Number of detector pulses	— (fixed 1024 pulses)	**Pr.369**
Encoder signal loss detection enable/disable selection	**Pr.376**	

◆ Control method

Control method	Motor	FR-A8APR	FR-A8AP
V/F control (orientation control, encoder feedback control)	Induction motor	O	O
Advanced magnetic flux vector control (orientation control, encoder feedback control)	Induction motor	O	O
Vector control	Induction motor	O	O
	PM motor	O	—

O: Supported, —: Not supported

◆ Major functions list

Function	FR-A8APR		FR-A8AP
	Induction motor	PM motor	Induction motor
Vector control (speed control)	O	O	O
Vector control (torque control)	O	—	O
Vector control (position control)	O	O	O
Orientation control	O	O	O
Encoder feedback control	O	—	O

Function	FR-A8APR		FR-A8AP
	Induction motor	**PM motor**	**Induction motor**
Automatic restart after instantaneous power failure	O	O	O
Servo lock	O	O	O
Online auto tuning (Adaptive magnetic flux observer)	O	—	O
Protective function (E.OS, E.OSD, E.ECT)	O	O	O
Notch filter	O	O	O
Easy gain tuning	O	O*1	O
Model adaptive speed control / Speed feed forward control	O	O	O
Torque bias	O	—	O
Droop control	O	O	O
Swinging suppression control	O	O	O
Brake sequence function	O	O	O
Offline auto tuning	O (Sensorless)	O	O
Forward rotation signal (Y30) / Reverse rotation signal (Y31) / Regenerative status signal (Y32)	O	O	O
Deceleration check	O	O	O
Speed limit	O	—	O
X18 signal switchover	O	—	O
Resolver position tuning	—	O	—

O: Supported, —: Not supported

∗1 Applied when the load inertia ratio manual input is selected (**Pr.819**="2").

3

3.3 Protective function

- When a protective function activates, the inverter trips and a fault signal is output.

| Operation panel indication	E.MP	$E.\ MP$	FR-PU07	Fault
Name	Magnetic pole position unknown (Data code: 222 (HDE))∗1			
Description	When the offset value between the motor home magnetic pole position and the resolver home position is unknown, the protective circuit is activated to stop the inverter output.			
Check point	• Check that the resolver position tuning was performed. • Check that the resolver position tuning ended properly. When **Pr.1105 Resolver magnetic pole position offset** = "9999", the resolver position tuning does not end properly.			
Corrective action	• Perform resolver position tuning with **Pr.373**. (Refer to **page 33**.) • Remove the cause of the tuning error, and perform tuning again. (Refer to **page 33**.)			

Operation panel indication	E.ECT	$E.\ ECT$	FR-PU07	E.ECT
Name	Signal loss detection (Data code: 210 (HD2))∗1			
Description	The inverter trips when the resolver input signal is shut off under orientation control, resolver (encoder) feedback control, or vector control. This protective function is not available in the initial status. A break in excitation output cable of a resolver cannot be detected. ∗2			
Check point	• Check for the resolver input signal loss. • Check that the resolver specifications are correct. • Check for loose wirings of terminal block.			
Corrective action	• Remedy the signal loss. • Use a resolver that meets the specifications. • Make connection securely.			

∗1   The data code is used for checking the fault detail via communication or for setting **Pr.997 Fault initiation**. (Refer to the Instruction Manual (Detailed) of the inverter.)

∗2   With a break in excitation output cable, the protective function of E.OC[], E.OSD, E.OS and so on may be activated due to the resolver input signal fault. If these protective functions are activated, check the wiring of the excitation output cable of a resolver and the details of the corresponding protective function in the Instruction Manual (Detailed) of the inverter.

4 ORIENTATION CONTROL V/F Magnetic flux Vector

This function is used with a resolver 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
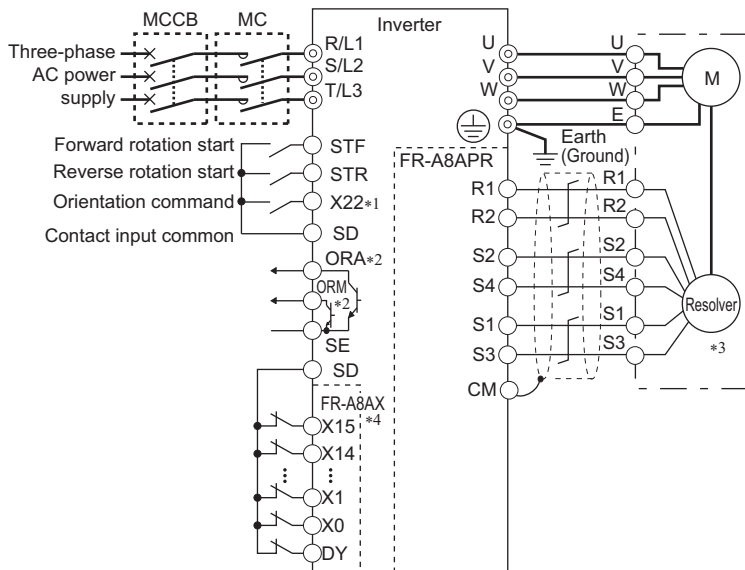
∗1 Use **Pr.178 to Pr.189 (input terminal function selection)** to assign the function to any of terminal.
Refer to the Instruction Manual (Detailed) for details of **Pr.178 to Pr.189 (input terminal function selection)**.

∗2 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)**.

∗3 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio should be 1:1.

∗4 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.

4

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 **Pr.360**, 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 **Pr.178 to Pr.189** to assign the function. ∗1
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 **Pr.190 to Pr.196**. ∗1
	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 **Pr.190 to Pr.196**. ∗1

∗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

Repeated positioning accuracy	±1.5° Depends on the load torque, moment of inertia of the load or orientaion, creep speed, position loop switching position, etc.
Permissible speed	Resolver-mounted shaft speed (6000 r/min). The drive shaft and resolver-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 RESOLVER (ENCODER) FEEDBACK CONTROL V/F Magnetic flux

Mount FR-A8APR to an FR-A800 series inverter to perform resolver (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 resolver to feed back to the inverter.
For the details of the parameters used for resolver (encoder) feedback control, refer to the Instruction Manual (Detailed) of the inverter.

5.1 Wiring examples
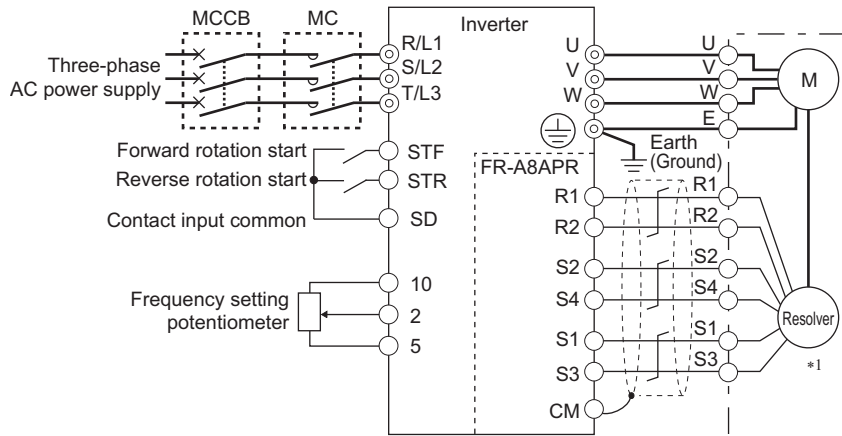
∗1 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio should be 1:1.

5.2   Specifications

Speed variation ratio	±0.1% (100% means 3600 r/min)
Function	• Setting of speed feedback range • Setting of feedback gain • Setting of resolver rotation direction
Maximum speed	V/F control: 590 Hz, Advanced magnetic flux vector control: 400 Hz

6 VECTOR CONTROL

When the FR-A8APR is installed on the FR-A800 series, full-scale vector control operation can be performed using a motor with resolver. (For the details of vector control, refer to the Instruction Manual (Detailed) of the inverter.)
Speed control, torque control, and position control are enabled under vector control for the induction motor.
Speed control and position control are enabled under vector control for the PM motor.

6.1 Wiring examples

◆ **Speed control**
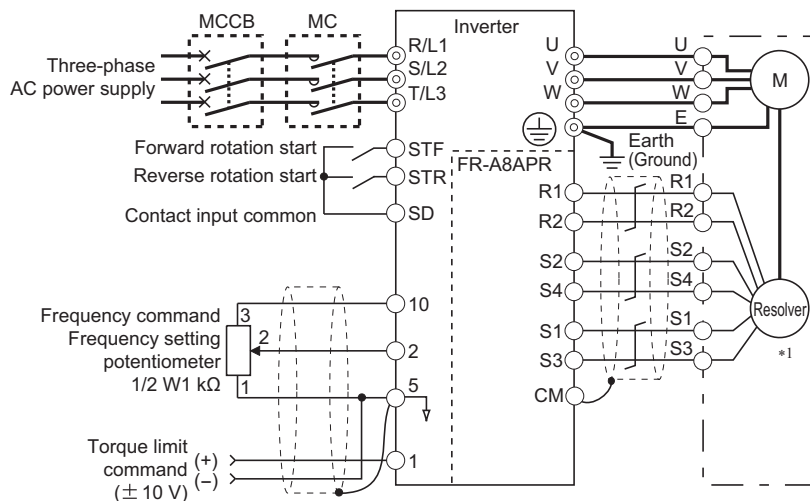
◆ Torque control (With induction motor only)
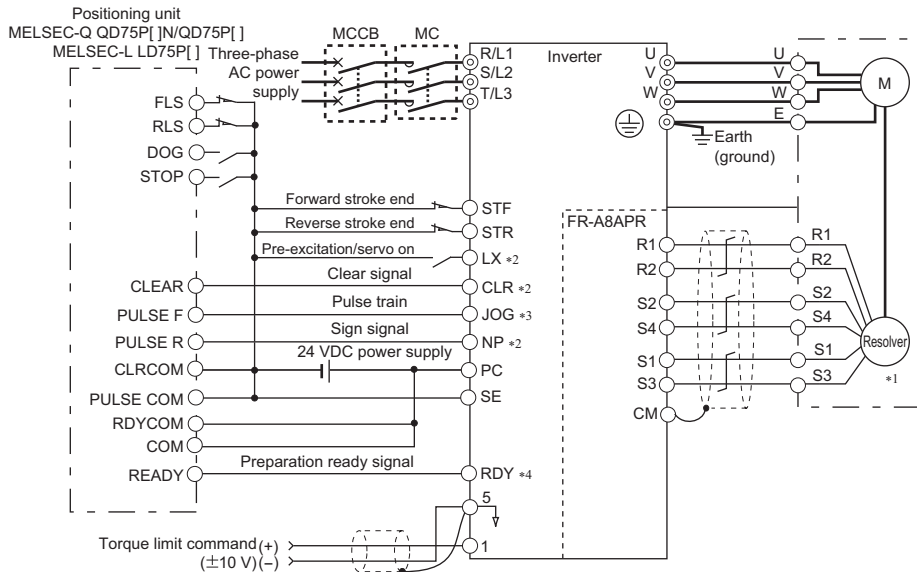
Wiring diagram showing:
- Three-phase AC power supply → MCCB → MC → Inverter terminals R/L1, S/L2, T/L3
- Inverter output U, V, W, E (Earth/Ground) → Motor M
- Forward rotation start → STF
- Reverse rotation start → STR
- Contact input common → SD
- FR-A8APR
- Resolver connections: R1, R2, S2, S4, S1, S3 → Resolver *1
- Speed limit command / Frequency setting potentiometer 1/2 W1 kΩ (terminals 3, 2, 1) → 10, 2, 5
- Torque command (+) (±10 V) (−) → 1
- CM

◆ Position control

*1 Connect the encoder so that there is no looseness between the motor and motor shaft. Speed ratio must be 1:1.
*2 Assign the function using **Pr.178 to Pr.184, Pr.187 to Pr.189 (input terminal function selection)**.
*3 When position control is selected, terminal JOG function is invalid and simple position pulse train input terminal becomes valid.
*4 Assign the function using **Pr.190 to Pr.194 (output terminal function selection)**.

6.2 Setting procedure of vector control for motor with resolver

Follow the following procedure to change the setting for the vector control for the motor with a resolver.

Set the applied resolver. **(Pr.359)**

> Set **Pr.359 Encoder rotation direction** in accordance with the resolver specification.

Set the motor. **(Pr.9, Pr.71, Pr.80, Pr.81, Pr.83, Pr.84)**

> Set **Pr.71 Applied motor**, **Pr.9 Rated motor current**, **Pr.80 Motor capacity**, **Pr.81 Number of motor poles**, **Pr.83 Rated motor voltage**, and **Pr.84 Rated motor frequency** according to the motor specifications.
> (Setting "9999 (initial value)" in **Pr.80** or **Pr.81** selects V/F control.)
> Set **Pr.702**, **Pr.706**, **Pr.707**, **Pr.724**, or **Pr.725** as required for the PM motor.

Select vector control (other than position control). (Refer to **page 30**.)

Perform offline auto tuning and the resolver position tuning. **(Pr.96)** (Refer to **page 31**.)

> Set **Pr.96**, and perform tuning.

Induction motor | PM motor

Configure the initial setting for the vector control (PM motor) using **Pr.998**.

> When the setting for the PM motor is selected in **Pr.998 PM parameter initialization**, the vector control for the motor with a resolver is selected.
> "8009": Parameter (rotations per minute) settings for an IPM motor other than MM-CF
> "8109": Parameter (frequency) settings for an IPM motor other than MM-CF
> "9009": Parameter (rotations per minute) settings for an SPM motor
> "9109": Parameter (frequency) settings for an SPM motor

Test run | Under position control
> • Set **Pr.800** again. (Refer to **page 30**.)

> **NOTE**
> • For PM motors, after performing offline auto tuning and resolver position tuning, first perform PM parameter initialization. If parameter initialization is performed after setting other parameters, some of those parameters will be initialized too. (For the parameters to be initialized, refer to the Instruction Manual (Detailed) of the inverter.)

6.3 Vector control for PM motor with resolver

• With the FR-A8APR, PM motors with a resolver can be driven under vector control. (For the setting of vector control for an induction motor, refer to the Instruction Manual (Detailed) of the inverter.)

Pr.80 (Pr.453), Pr.81 (Pr.454)	Pr.71 (Pr.450)	Pr.800 setting *1	Pr.451 setting *1	Control method	Control mode	Remarks
Other than 9999	IPM/SPM motor (other than MM-CF)	0, 100*2		Vector control*4	Speed control	—
		3, 103			Position control	—
		4, 104*3			Speed control/position control switchover	MC signal: ON Position control MC signal: OFF Speed control
		6, 106			Torque control by variable-current limiter control	—
		9, 109	—	PM sensorless vector control test operation		
		20 (initial value), 110*5	20, 110*5	PM sensorless vector control	Speed control	—
		—	9999 (initial value)	The setting value of **Pr.800** is used for the second motor. (PM sensorless vector control (speed control) when **Pr.800**="9 or 109")		
9999*6	—	—		—		

∗1 The setting values of 100 and above are used when the fast-response operation is selected.
∗2 The operation for the setting of "0 or 100" is performed when "1, 2, 101, or 102" is set.
∗3 The operation for the setting of "4 or 104" is performed when "5 or 105" is set.
∗4 Speed control under PM sensorless vector control when the FR-A8APR is not installed.
∗5 The operation for the setting of "20 or 110" is performed when "10 to 14, or 111 to 114" is set.
∗6 When a PM motor is used, set **Pr.80** and **Pr.81** according to the motor. Setting "9999" disrupts proper operation.

6.4 Offline auto tuning Vector

• The offline auto tuning enables the optimal operation of a motor with resolver.

Pr.	Name	Initial value	Setting range	Description	
				PM motor	**Induction motor**
96 C110	Auto tuning setting/status	0	0	No offline auto tuning	
			1	Performs offline auto tuning (without motor rotation)	
			11	Performs offline auto tuning only for motor constant R1 (without motor rotation)	
			101	Performs resolver position tuning and offline auto tuning (with motor slight rotation)	Performs offline auto tuning (with motor rotation)
463 C210	Second motor auto tuning setting/status	0	0, 1, 11, 101	Performs offline auto tuning for the second motor (Refer to **Pr.96** for the setting.)	

POINT

• Refer to the Instruction Manual (Detailed) of the inverter to perform the offline auto tuning.
• This section explains the specific information of the motor with a resolver.

◆ Parameters in which the tuning results are set to after tuning (PM motor)

Pr.	Name	Tuning items by Pr.96 (Pr.463) settings			Description
		101	1	11	
90 (458)	Motor constant (R1)	○	○	○	Resistance per phase
92 (460)	Motor constant (L1)/d-axis inductance (Ld)	○	○	—	d-axis inductance
93 (461)	Motor constant (L2)/q-axis inductance (Lq)	○	○	—	q-axis inductance
711 (739)	Motor Ld decay ratio	○	○	—	d-axis inductance decay ratio
712 (740)	Motor Lq decay ratio	○	○	—	q-axis inductance decay ratio
859 (860)	Torque current/Rated PM motor current	○	○	—	
96 (463)	Auto tuning setting/status	○	○	○	
373	Resolver position tuning setting/status	○	—	—	Resolver position tuning performing status
1105	Resolver magnetic pole position offset	○	○	—	Turning data of resolver position tuning

○: Perform turning, —: No turning

⊶ **NOTE**

- If the offline auto tuning is started before the resolver position tuning is finished (**Pr.1105**="9999") for a PM motor, the protective function (E.MP) is activated.

6.5 Resolver position tuning Vector

- Resolver position tuning is required when a PM motor with a resolver is driven. The measured offset value between the motor home magnetic pole position and the resolver home position is stored. Only the resolver position tuning can be performed when offline auto tuning is not required, such as when the parameters for motor constant are set manually, or when offline auto tuning is already performed.

Pr.	Name	Initial value	Setting range	Description
373 C142	Resolver position tuning setting/status	0	0	Resolver position tuning disabled
			1	Resolver position tuning enabled
1105 C143	Resolver magnetic pole position offset	9999	0 to 4095	Resolver position tuning result is set.
			9999	Resolver position tuning not performed

◆ Before performing resolver position tuning

- Check that the FR-A8APR, a motor, and a resolver are properly connected.
- Check that a motor (single, stop status) is connected. (Check that the motor is not rotated by an external force during tuning.)
- Check that the mechanical brake is released.
- Check that the vector control (speed control) for the PM motor with a resolver is selected (refer to **page 30**).

⋅•● NOTE ⋅
> - The resolver position tuning is required when a PM motor is used. (It is disabled when an induction motor is used.)
> - When auto tuning is performed at the setting of **Pr.96**="101", offline auto tuning and the resolver position tuning can be performed at the same time (refer to **page 31**).

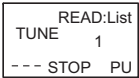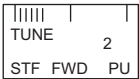### ◆ Setting

- To perform tuning, set **Pr.373**="1".

◆ Performing tuning

> :Q: **POINT**
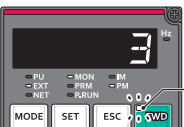>
> • Before performing tuning, check the monitor display of the operation panel or parameter unit if the inverter is in the state ready for tuning. Turning ON the start command while tuning is unavailable starts the motor.

• In the PU operation mode, press [FWD] / [REV] on the operation panel.

  For External operation, turn ON the start command (STF signal or STR signal). Tuning will start.

> •● **NOTE**
>
> • The motor shaft is rotated about 180 degrees during tuning.

• Monitor is displayed as below on the operation panel (FR-DU08) and the parameter unit (FR-PU07) during tuning.

Status	Parameter unit (FR-PU07) display	Operation panel (FR-DU08) display
Setting	READ:List TUNE 1 --- STOP PU	
During tuning	TUNE 2 STF FWD PU	
Normal completion	TUNE 3 COMPLETION STF STOP PU	Flickering

• When resolver position tuning ends, press ⎣STOP/RESET⎦ on the operation panel during PU operation. For External operation, turn OFF the start signal (STF signal or STR signal).
This operation resets the resolver position tuning, and the PU's monitor display returns to the normal indication. (Without this operation, next operation cannot be started.)

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    NOTE
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> • The data measured once in the resolver position tuning is stored in **Pr.1105**, and is held until the resolver position tuning is performed again. However, performing all parameter clear resets the tuning data.

• If the resolver position tuning has ended in error (see the table below), tuning data is not set. Perform an inverter reset and restart tuning.

Pr.373 setting	Error cause	Countermeasures
8	Forced end	Set **Pr.373**="1" and try again.
9	Inverter protective function operation	Identify and remove the cause of the protective function activation, and make the setting again.
93	The motor or the resolver is not connected.	Check the wiring of the motor and the resolver, the brake opening, and make the setting again.

• When tuning is ended forcibly by pressing ⎣STOP/RESET⎦ or turning OFF the start signal (STF or STR) during tuning, the tuning does not end properly. (The tuning data have not been set.)
Perform an inverter reset and restart tuning.
• When the protective function (E.EP) is activated during tuning, check the wiring of the motor and the resolver, **Pr.359** setting, and then perform tuning again.
• When the tuning ends properly, the counter value of the offset between the motor home magnetic pole position and the resolver home position is written in **Pr.1105**.

6.6   Specifications

Speed control	Speed control range	1:1500 (both driving/regeneration *1)
	Speed variation ratio	±0.01% (100% means 3000 r/min)
	Speed response	20 Hz (40 Hz during fast-response operation)
	Maximum speed	400 Hz
Torque control	Torque control range	1:50
	Absolute torque accuracy	±10% *2
	Repeated torque accuracy	±5% *2
Position control	Repeated positioning accuracy	±1.5° (at motor shaft end)
	Maximum input pulse frequency	100 kpps (Terminal JOG)
	Positioning feedback pulse	4096 pulses/rev
	Electronic gear setting	1/50 to 20
	In-position width	0 to 32767 pulses
	Error excess	0 to 400k pulses
Function		• Setting of speed feedback range • Setting of feedback gain • Setting of resolver rotation direction
Recommended resolver		TS2640N321E64 manufactured by Tamagawa Seiki Co., Ltd. or equivalent

*1   Regeneration unit (option) is necessary for regeneration
*2   With online auto tuning (adaptive magnetic flux observer), dedicated motor, rated load

MEMO

MEMO

REVISIONS

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

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INVERTER

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