MITSUBISHI ELECTRIC

700 series

INVERTER
Plug-in option

FR-A7AP
INSTRUCTION MANUAL

Orientation control

Encoder feedback control

Vector control

PRE-OPERATION INSTRUCTIONS 1

INSTALLATION 2

ORIENTATION CONTROL 3

ENCODER FEEDBACK CONTROL 4

VECTOR CONTROL 5

Thank you for choosing this Mitsubishi Inverter plug-in option.
This instruction manual gives handling information and precautions for use of this equipment. Incorrect handling might cause an unexpected fault. Before using the equipment, please read this manual carefully to use the equipment to its optimum.
Please forward this manual to the end user.

This section is specifically about safety matters

Do not attempt to install, operate, maintain or inspect this 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	Assumes that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
⚠ CAUTION	Assumes that incorrect handling may cause hazardous conditions, resulting in medium or slight injury, or may cause physical damage only.

Note that even the ⚠ CAUTION level may lead to a serious consequence according to conditions. Please follow the instructions of both levels because they are important to personnel safety.

SAFETY INSTRUCTIONS

1. Electric Shock Prevention

⚠ WARNING

- While power is on or when the inverter is running, do not open the front cover. You may get an electric shock.
- Do not run the inverter with the front cover or wiring cover removed. Otherwise, you may access the exposed high-voltage terminals and charging part and get an electric shock.
- If power is off, do not remove the front cover except for wiring or periodic inspection. You may access the charged inverter circuits and get an electric shock.
- Before starting wiring or inspection, check to make sure that Indication of the inverter operation panel is off, wait for at least 10 minutes after the power supply has been switched 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 the wiring or inspection of this equipment should be fully competent to do the work.
- Always install the plug-in option before wiring. Otherwise, you may get an electric shock or be injured.
- Do not touch the plug-in option 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.

2. Injury Prevention

⚠ CAUTION

- Apply only the voltage specified in the instruction manual to each terminal. Otherwise, burst, damage, etc. may occur.
- Ensure that the cables are connected to the correct terminals. Otherwise, burst, damage, etc. may occur.
- Always make sure that polarity is correct to prevent damage, etc. Otherwise, burst, damage may occur.
- While power is on or for some time after power-off, do not touch the inverter as it is hot and you may get burnt.

3. Additional Instructions

Also note the following points to prevent an accidental failure, injury, electric shock, etc.

1) Transportation and mounting

⚠ CAUTION

- 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.
- Check that the mounting orientation is correct.
- Prevent other conductive bodies such as screws and metal fragments or other flammable substance such as oil from entering the inverter.

2) Trial run

⚠ CAUTION

- Before starting operation, confirm and adjust the parameters. A failure to do so may cause some machines to make unexpected motions.

3) Usage

⚠ WARNING

- 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 inverter.

⚠ CAUTION

- When parameter clear or all parameter clear is performed, reset the required parameters before starting operations. Each parameter returns to the initial value.
- For prevention of damage due to static electricity, touch nearby metal before touching this product to eliminate static electricity from your body.

4) Maintenance, inspection and parts replacement

⚠ CAUTION

- Do not test the equipment with a megger (measure insulation resistance).

5) Disposal

⚠ CAUTION

- Treat as industrial waste.

6) General instruction

All illustrations given in this manual may have been drawn with covers or safety guards removed to provide in-depth description. Before starting operation of the product, always return the covers and guards into original positions as specified and operate the equipment in accordance with the manual.

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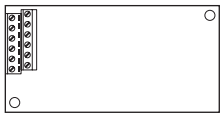
1 PRE-OPERATION INSTRUCTIONS

1.1 Unpacking and Product Confirmation

Take the plug-in option out of the package, check the unit name, and confirm that the product is as you ordered and intact.
This product is a plug-in option dedicated for the FR-A700 series.

1.1.1 Packing confirmation

Check the enclosed items.

Plug-in option ..... 1 	Mounting screw (M3 × 6mm) ..... 2 *(Refer to page 5.)* 	Hex-head screw for option mounting (5.5mm) ..... 1 *(Refer to page 5.)* 

1.1.2 SERIAL number check

The FR-A7AP can be used with the FR-A700 series having the following serial number or later. Check the SERIAL number indicated on the inverter rating plate or package.

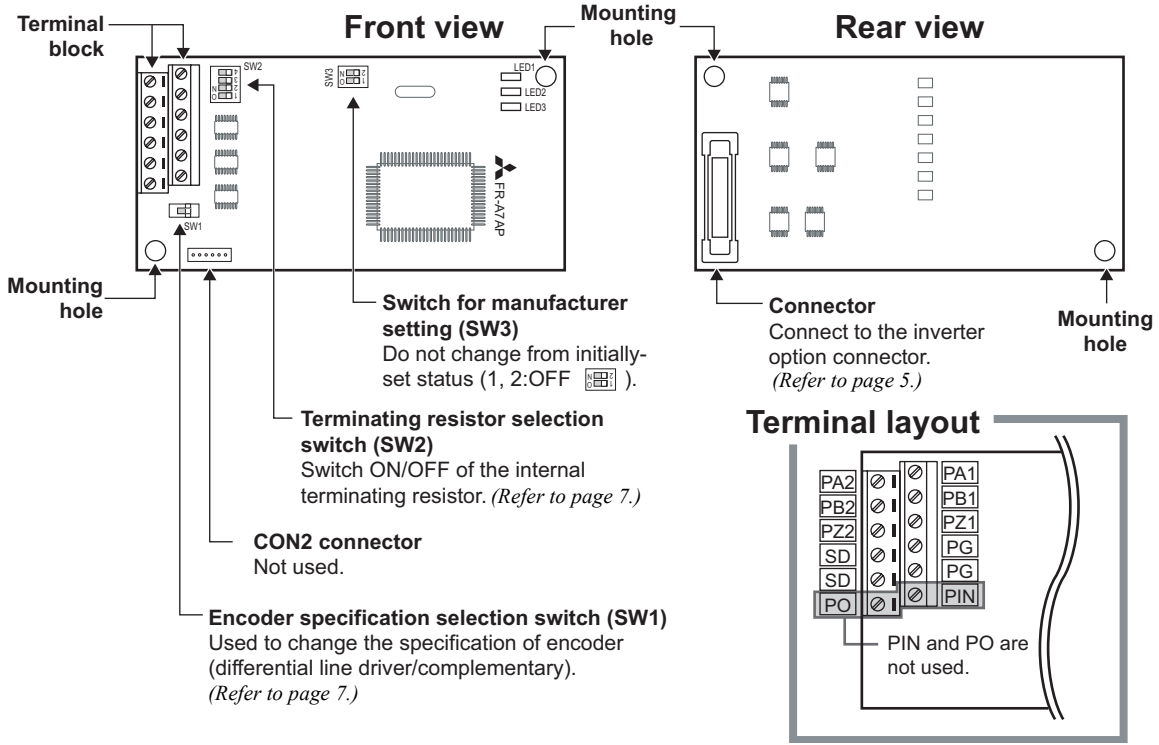
Model	SERIAL (Serial No.)	Model	SERIAL (Serial No.)
FR-A720-0.4K/0.75K	P5OOOOOOO	FR-A740-0.4K	L5OOOOOOO
FR-A720-1.5K/2.2K	Q5OOOOOOO	FR-A740-0.75K	K5OOOOOOO
FR-A720-3.7K	N5OOOOOOO	FR-A740-1.5K/2.2K	J5OOOOOOO
FR-A720-5.5K to 11K	L5OOOOOOO	FR-A740-3.7K	H5OOOOOOO
FR-A720-15K to 22K	M5OOOOOOO	FR-A740-5.5K/7.5K	G5OOOOOOO
FR-A720-30K	Q5OOOOOOO	FR-A740-11K to 22K	F5OOOOOOO
FR-A720-37K	M5OOOOOOO	FR-A740-30K to 55K	E5OOOOOOO
FR-A720-45K	L5OOOOOOO	FR-A740-75K/90K	G5OOOOOOO
FR-A720-55K	K5OOOOOOO	FR-A740-110K to 160K	E5OOOOOOO
FR-A720-75K/90K	E5OOOOOOO	FR-A740-185K to 500K	C5OOOOOOO

Rating plate example

□	5	O	OOOOOO
Symbol	Year	Month	Control number
SERIAL (Serial No.)			

The SERIAL is made up of 1 version symbol, 2 numeric characters or 1 alphabet letter and 2 numeric characters indicating year and month, and 6 numeric characters indicating control number.
Month is indicated as 1 to 9, X (October), Y (November), and Z (December).

1.1.3 Parts


Terminal block
Front view
Mounting hole
Rear view
SW2
SW3
LED1
LED2
LED3
SW1
FR-A7AP
Mounting hole
Switch for manufacturer setting (SW3)
Do not change from initially-set status (1, 2:OFF).
Terminating resistor selection switch (SW2)
Switch ON/OFF of the internal terminating resistor. (Refer to page 7.)
CON2 connector
Not used.
Encoder specification selection switch (SW1)
Used to change the specification of encoder (differential line driver/complementary).
(Refer to page 7.)
Connector
Connect to the inverter option connector.
(Refer to page 5.)
Mounting hole
Terminal layout
PA2
PB2
PZ2
SD
SD
PO
PA1
PB1
PZ1
PG
PG
PIN
PIN and PO are not used.

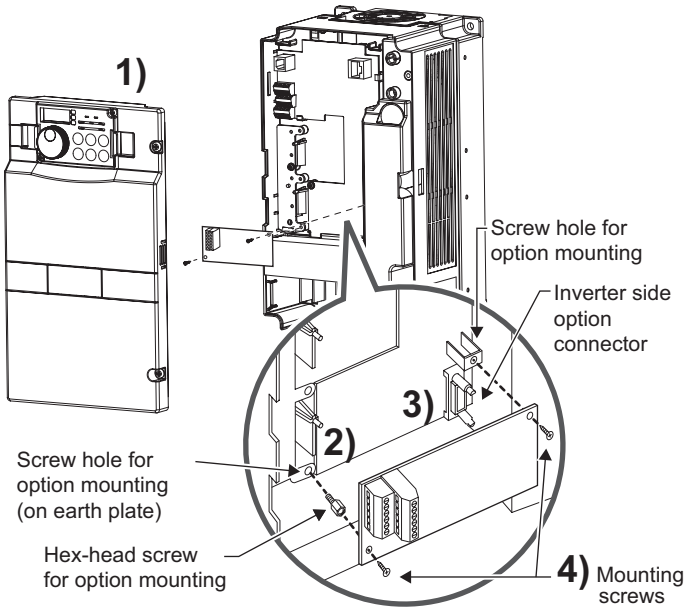
2 INSTALLATION

2.1 Pre-Installation Instructions

Make sure that the input power of the inverter is 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.**

2.2 Installation Procedure



1) Remove the inverter front cover.

2) Mount the hex-head screw for option mounting into the inverter screw hole (on earth plate). (size 5.5mm, tightening torque 0.56N·m to 0.75N·m)

3) Securely fit the connector of the plug-in option to the inverter connector along the guides.

4) Securely fix the both right and left sides of the plug-in option to the inverter with the accessory mounting screws. If the screw holes do not line-up, the connector may not have been plugged snugly. Check for loose plugging.

REMARKS

After removing two screws on the right and left places, remove the plug-in option.
(When the plug-in option is mounted in the connector 3, it is easier to remove the plug-in option after removing a control circuit terminal block.)

CAUTION

- **When two or more options are mounted, priority is in order of inverter option connectors 1, 2 and 3, the options having lower priority are inoperative.**
- **When the inverter cannot recognize that the option is mounted due to improper installation, etc., " E. 1 to E. 3 " (option alarm) are displayed for the FR-A700 series.The errors shown differ according to the mounting positions (connectors 1, 2, 3).**

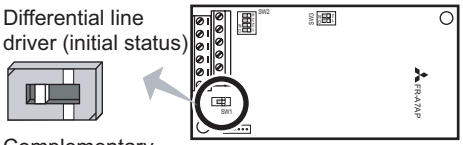
Mounting Position	Error Display
Connector 1	E. 1
Connector 2	E. 2
Connector 3	E. 3

- **The FR-F700 series has one connection connector for the plug-in option. When the inverter can not recognize that the option unit is mounted due to improper installation, etc., "E. 1 " (option alarm) is displayed.**
- **Note that a hex-head screw for option mounting or mounting screw may drop during mounting and removal.**
- **Pull out the option straight to remove. Otherwise, the connector may be damaged by some applied force.**

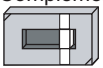
2.3 Switches

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

Differential line driver (initial status)

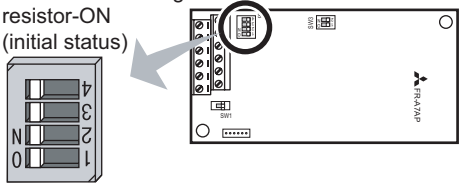


Complementary

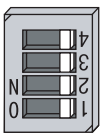


(2) Terminating resistor selection switch (SW2)
Select ON/OFF of the internal terminating resistor. Set the switch to ON (initial status) when an encoder output type is differential line driver and set to OFF when complimentary.
ON : with internal terminating resistor (initial setting status)
OFF : without internal terminating resistor

Internal terminating resistor-ON (initial status)



Internal terminating resistor-OFF



REMARKS

- Set all swithces 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 (NC (numerical controller), etc) or a terminating resistor is connected to other unit.

CAUTION

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

(3) Motor used and switch setting

Motor		Encoder Specification Selection Switch (SW1)	Terminating Resistor Selection Switch (SW2)	Power Specifications *2
Mitsubishi standard motor Mitsubishi high efficiency motor	SF-JR	Differential	ON	5V
	SF-HR	Differential	ON	5V
	Others	*1	*1	*1
Mitsubishi constant-torque motor	SF-JRCA	Differential	ON	5V
	SF-HRCA	Differential	ON	5V
	Others	*1	*1	*1
Dedicated motor	SF-V5RU	Complimentary	OFF	12V
	SF-VR	Differential	ON	5V
Other manufacturer motor	–	*1	*1	*1

*1 Set according to the motor encoder used.

*2 Choose a power supply for encoder according to the encoder used (5V/12V/15V/24V).

2.4 Wiring

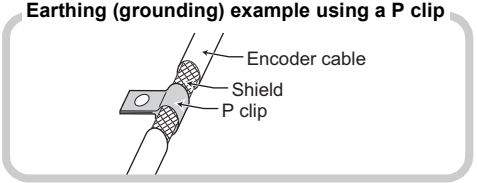
(1) Use twisted pair shield cables (0.2mm^2 or larger) to connect the FR-A7AP and position detector.
To protect the cables from noise, run them away from any source of noise (e.g. the main circuit and power voltage).

Wiring Length	Paralell Connection		Larger-Size Cable
Within 10m	At least 2 cables	Cable gauge 0.2mm^2	0.4mm^2 or larger
Within 20m	At least 4 cables		0.75mm^2 or larger
Within 100m *	At least 6 cables		1.25mm^2 or larger

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

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

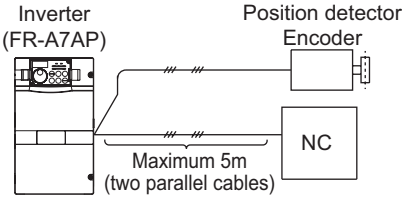
Earthing (grounding) example using a P clip



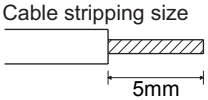
REMARKS

- For details of the optional encoder dedicated cable (FR-JCBL/FR-V7CBL), refer to *page 13*.
- The FR-V7CBL is provided with a P clip for earthing (grounding) shielded cable.

(2) Connection with the NC (numerical controller)
When one position detector is shared between the FR-A7AP and NC, its output signal should be connected as shown on the right. In this case, the wiring length between the FR-A7AP and NC should be as short as possible, within 5m.



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



Wire the stripped cable after twisting it to prevent it from becoming loose.
In addition, do not solder it.
Use a bar type terminal as required.

REMARKS

Information on bar terminals
Introduced products (as of August, 2005): Phoenix Contact Co.,Ltd.

Terminal Screw Size	Bar Terminal Model (with insulation sleeve)	Bar Terminal Model (without insulation sleeve)	Wire Size (mm^2)
M2	AI 0.5-6WH	A 0.5-6	0.3 to 0.5

· Bar terminal crimping tool: CRIMPFOX ZA3 (Phoenix Contact Co., Ltd.)

When using the bar terminal (without insulation sleeve), use care so that the twisted wires do not come out.



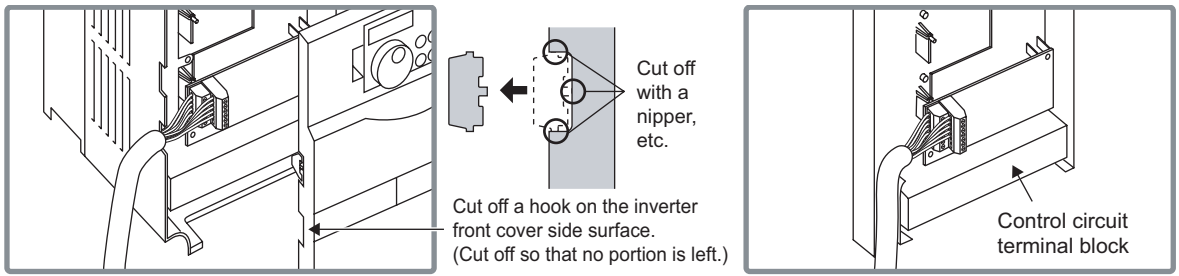
(4) Loosen the terminal screw and insert the cable into the terminal.

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

CAUTION

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

(5) For wiring of **22K or less**, remove a hook of the front cover and use a space become available.
For wiring of **30K or more**, use the space on the left side of the control circuit terminal block.



22K or less **30K or more**

REMARKS

When the hook of the inverter front cover is cut off for wiring, the protective structure (JEM1030) changes to open type (IP00).

⚠ CAUTION

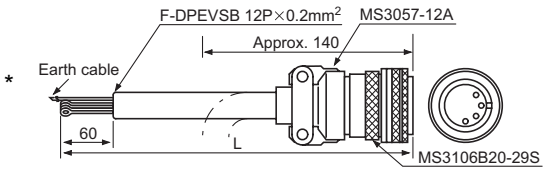
⚠ **Do not use empty terminals as junction terminals because they are used in the option unit. If they are used as the junction terminals, the option unit may be damaged.**

⚠ **When performing wiring using the space between the inverter front cover and control circuit terminal block, take care not to subject the cable to stress.**

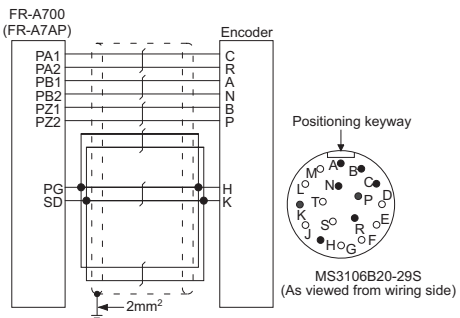
⚠ **After wiring, wire offcuts must not be left in the inverter. They may cause a fault, failure or malfunction.**

2.5 Encoder Cable

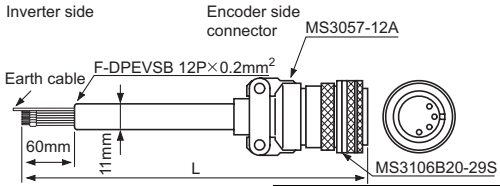
SF-JR Motor with Encoder



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

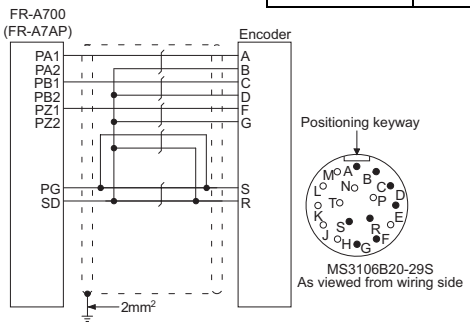


SF-V5RU



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

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



* As the terminal block of the FR-A7AP is an insertion type, earth cables need to be modified. *(Refer to page 11.)*

Connection terminal compatibility table

Motor		SF-V5RU	SF-JR/HR/JRCA/HRCA (with Encoder)
Encoder cable		FR-V7CBL/FR-V5CBL	FR-JCBL
FR-A7AP 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

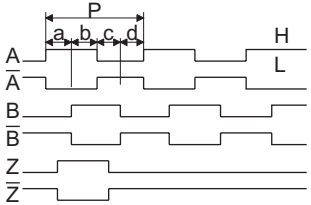
2.6 Encoder

(1) Position detection (pulse encoder)

Output pulse specifications

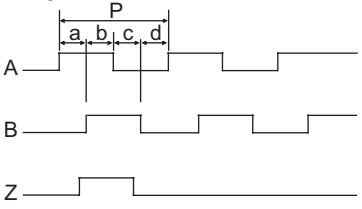
Differential line driver

A/$\overline{A}$ signal 1000P/R to 4096P/R
B/$\overline{B}$ signal 1000P/R to 4096P/R
Z/$\overline{Z}$ signal 1P/R



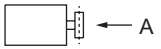
Complimentary

A signal 1000P/R to 4096P/R
B signal 1000P/R to 4096P/R
Z signal 1P/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 ± 1/8)P

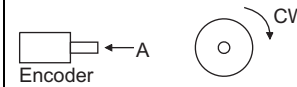
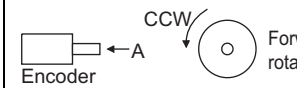
CAUTION

- **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 4096ppr (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.**

(2) Power supply

Choose a power supply for encoder according to the encoder used.
When an encoder is used under orientation control, encoder feedback control, and vector control, the power supply is shared between the inverter and encoder.

2.7 Parameter for Encoder

Parameter Number	Name	Initial Value	Setting Range	Description
359	Encoder rotation direction	1	0	 Forward rotation is clockwise rotation when viewed from A.
			1	 Forward rotation is counterclockwise rotation when viewed from A.
369	Number of encoder pulses	1024	0 to 4096	Set the number of encoder pulses output. Set the number of pulses before it is multiplied by 4.

Set *Pr. 359 Encoder rotation direction* and *Pr. 369 Number of encoder pulses* according to the encoder used.

Motor		*Pr. 359* Setting	*Pr. 369* Setting
Mitsubishi standard motor Mitsubishi high efficiency motor	SF-JR	1	1024
	SF-JR 4P 1.5kW or less	1	1024
	SF-HR	1	1024
	Others	*	*
Mitsubishi constant torque motor	SF-JRCA 200V 4P	1	1024
	SF-HRCA 200V 4P	1	1024
	Others (SF-JRC, etc.)	*	*
Vector control dedicated motor	SF-V5RU	1	2048
	SF-VR	1	1000
Other manufacturer's standard motor	–	*	*
Other manufacturer's constant torque motor	–	*	*

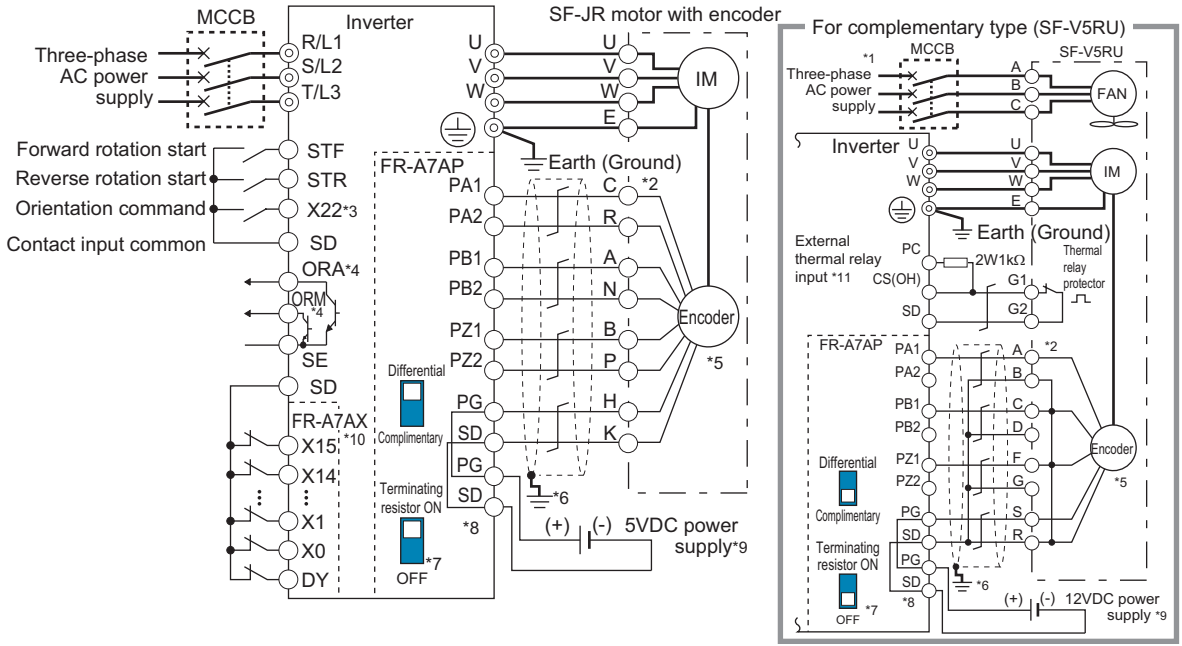
* Set this parameter according to the motor (encoder) used.

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3 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).

3.1 Wiring Example



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

*2 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 inverter manual 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 inverter manual 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 9.)*

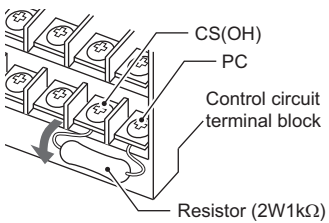
*7 For the differential line driver, set the terminating resistor selection switch to on position (initial status) to use. *(Refer to page 7.)*
Note that the terminating resistor switch should be set to off position when sharing the same encoder with other unit (NC, etc) or a terminating resistor is connected to other unit.
For the complementary, set the switch to off position.

*8 For terminal compatibility of the FR-JCBL, FR-V5CBL and FR-A7AP, refer to *page 14*.

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

*10 When a stop position command is input from outside, a plug-in option FR-A7AX is necessary. Refer to the inverter manual for details of external stop position command.

*11 Assign OH (external thermal input) signal to the terminal CS. (Set "7" in *Pr. 186*)
Connect a 2W1kΩ resistor between the terminal PC and CS.
Install the resistor pushing against the bottom part of the terminal block so as to avoid a contact with other cables.



3.2 Terminals

(1) Option FR-A7AP terminal

Terminal	Terminal Name	Application Explanation
PA1	Encoder A-phase signal input	A-, B- and Z-phase signals are input from the encoder. (For details of pulse signal, refer to *page 15*.)
PA2	Encoder A-phase inverse signal input	
PB1	Encoder B-phase signal input	
PB2	Encoder B-phase inverse signal input	
PZ1	Encoder Z-phase signal input	
PZ2	Encoder Z-phase inverse signal input	
PG	Power supply (positive side) input	Input power for the encoder power supply. Connect the external power supply (5V, 12V, 15V, 24V) and the encoder power cable.
SD	Power supply ground	

(2) Option FR-A7AX terminal

Terminal	Terminal Name	Application Explanation
X0 to X15	Digital signal input	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	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.
SD **(inverter)**	Common terminal (sink)	Common terminal for digital and data read timing signals. Use terminal SD of the inverter.
PC **(inverter)**	External transistor common (source)	When connecting the transistor output (open collector output), such as a programmable controller (PLC), connect the external power common (+) to this terminal to prevent a fault occurring due to leakage current.

(3) Inverter terminal

Terminal (Signal)		Terminal (Signal) Name	Application Explanation
Input	**X22**	Orientation command input terminal	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.
	SD	Contact input common	Common terminal for the orientation signal.
Output	**ORA**	In-position signal output signal	Switched low if the orientation has stopped within the in-position zone while the start and orientation signals are input. For the terminal used for the ORA signal output, assign the function by setting "27 (positive logic) or 127 (negative logic)" in any of *Pr. 190 to Pr. 196*.
	ORM	Orientation fault signal output signal	Switched low if the orientation has stopped within the in-position zone while the start and orientation signals are input. For the terminal used for the ORA signal output, assign the function by setting "28 (positive logic) or 128 (negative logic)" in any of *Pr. 190 to Pr. 196*.
	SE	Open collector output common	Common terminal for the ORA and ORM open collector output terminals.

3.3 Parameter List for Orientation Control

Fitting the FR-A7AP adds the following parameters for orientation control.
Refer to *the inverter manual (applied)* for details of parameter.

Parameter Number	Name	Setting Range	Increments	Initial Value
350	Stop position command selection	0, 1, 9999	1	9999
351	Orientation speed	0 to 30Hz	0.01Hz	2Hz
352	Creep speed	0 to 10Hz	0.01Hz	0.5Hz
353	Creep switchover position	0 to 16383 *	1	511
354	Position loop switchover position	0 to 8191	1	96
355	DC injection brake start position	0 to 255	1	5
356	Internal stop position command	0 to 16383 *	1	0
357	In-position zone	0 to 255	1	5
358	Servo torque selection	0 to 13	1	1
359	Encoder rotation direction	0, 1	1	1
360	16 bit data selection	0 to 127	1	0
361	Position shift	0 to 16383 *	1	0
362	Orientation position loop gain	0.1 to 10	0.1	1
363	Completion signal output delay time	0 to 5s	0.1s	0.5s
364	Encoder stop check time	0 to 5s	0.1s	0.5s
365	Orientation end time	0 to 60s, 9999	1s	9999
366	Double check time	0 to 5s, 9999	0.1s	9999
369	Number of encoder pulses	0 to 4096	1	1024
376	Encoder signal loss detection enable/disable selection	0, 1	1	0
393	Orientation selection	0, 1, 2	1	0
396	Orientation speed gain (P term)	0 to 1000	1	60
397	Orientation speed integral time	0 to 20s	0.001	0.333
398	Orientation speed gain (D term)	0 to 100	0.1	1
399	Orientation deceleration ratio	0 to 1000	1	20

* When an operation panel (FR-DU07) is used, the maximum setting is 9999. When a parameter unit is used, up to the maximum value within the setting range can be set.

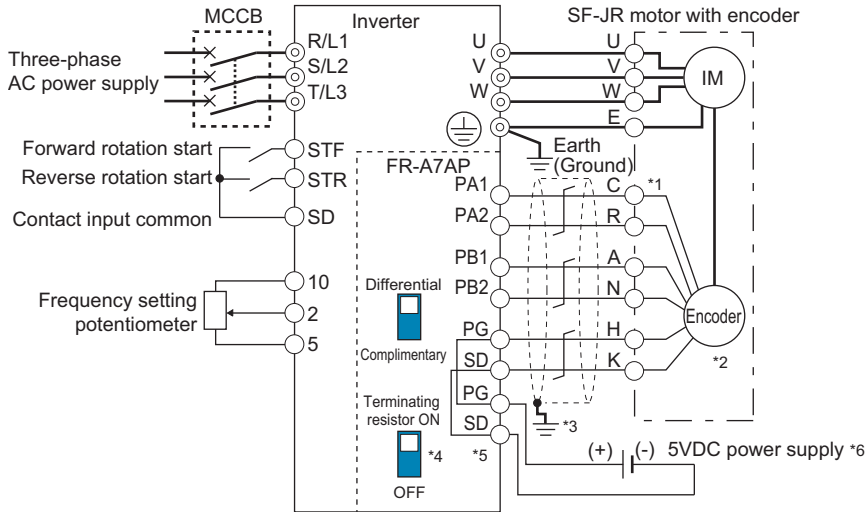
3.4 Specifications

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	Encoder-mounted shaft speed (6000r/min with 2048 pulse encoder) The drive shaft and encoder-mounted shaft must be coupled directly or via a belt without any slip.
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-A7AX)
Output signal (open collector output)	Orientation completion signal, orientation fault signal

4 ENCODER FEEDBACK CONTROL

Encoder feedback control is enabled when the FR-A7AP is mounted on the FR-A700 series. (under V/F control, 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.

4.1 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 9.)*
*4 For the differential line driver, set the terminating resistor selection switch to on position (initial status) to use. (*Refer to page 7)*
Note that the terminating resistor switch should be set to off position when sharing the same encoder with other unit (NC, etc) or 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-V5CBL and FR-A7AP, refer to *page 14*.
*6 A separate power supply of 5V is necessary according to the encoder power specification.
To perform orientation control together, an encoder and power supply can be shared.

4.2 Terminals

Terminal Symbol	Terminal Name	Application Explanation
PA1	Encoder A-phase signal input terminal	A-, B-phase signals are input from the encoder. (For details of pulse signal, refer to *page 15*.)
PA2	Encoder A-phase inverse signal input terminal	
PB1	Encoder B-phase signal input terminal	
PB2	Encoder B-phase inverse signal input terminal	
PG	Power supply (positive side) input terminal	Input power for the encoder power supply. Connect the external power supply (5V, 12V, 15V, 24V) and the encoder power cable.
SD	Power ground terminal	

4.3 Encoder Feedback Control Parameter List

Fitting the FR-A7AP adds the following parameters for encoder feedback operation.
Refer to *the inverter manual (applied)* for details of parameter.

Parameter Number	Name	Setting Range	Increments	Initial Value
359	Encoder rotation direction	0, 1	1	1
367	Speed feedback time	0 to 400Hz, 9999	0.01Hz	9999
368	Feedback gain	0 to 100	0.1	1
369	Number of encoder pulses	0 to 4096	1	1024
374	Overspeed detection level	0 to 400Hz	0.01Hz	140Hz
376	Encoder signal loss detection enable/disable selection	0, 1	1	0

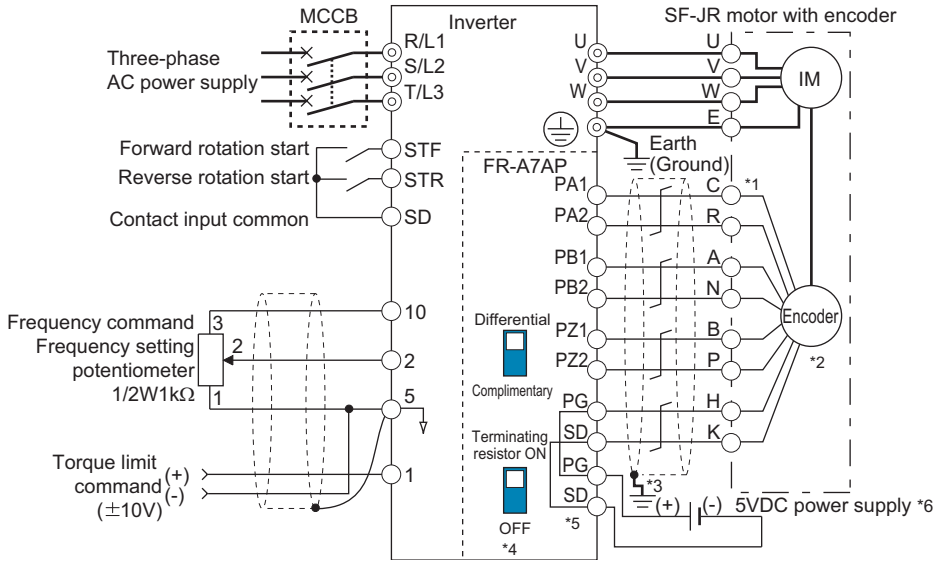
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5 VECTOR CONTROL

When the FR-A7AP is mounterd on the FR-A700 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 inverter manual (applied)* for details.)

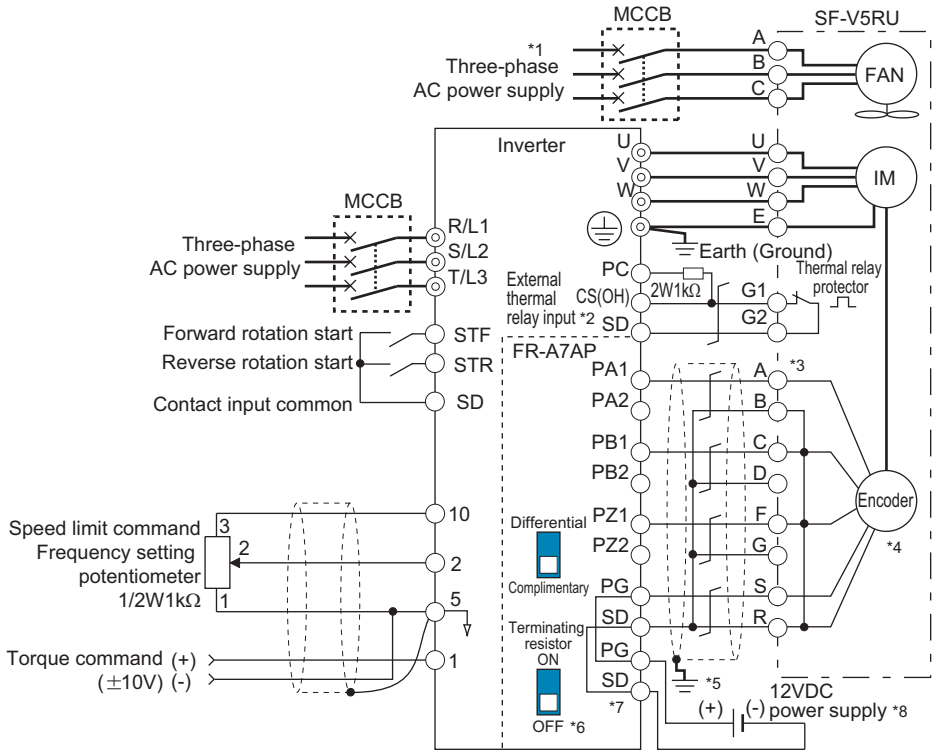
5.1 Wiring Examples

(1) Standard motor with encoder, 5V differential line driver (speed control)



*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 9.)*
*4 For the differential line driver, set the terminating resistor selection switch to on position (initial status) to use. *(Refer to page 7)*
Note that the terminating resistor switch should be set to off position when sharing the same encoder with other unit (NC, etc) or a terminating resistor is connected to other unit.
*5 For terminal compatibility of the FR-JCBL, FR-V5CBL and FR-A7AP, refer to *page 14*.
*6 A separate power supply of 5V/12V/15V/24V is necessary according to the encoder power specification.
To perform orientation control together, an encoder and power supply can be shared.

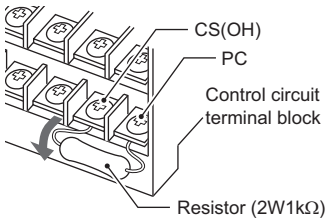
(2) Vector control dedicated motor (SF-V5RU), 12V complimentary (torque control)



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

*2 Assign OH (external thermal input) signal to the terminal CS. (Set "7" in *Pr. 186*)

Connect a 2W1kΩ resistor between the terminal PC and CS (OH). Install the resistor pushing against the bottom part of the terminal block so as to avoid a contact with other cables.



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

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

*5 Earth (Ground) the shielded cable of the encoder cable to the enclosure with a P clip, etc. *(Refer to page 9.)*

*6 For the complementary, set the terminating resistor selection switch to off position. *(Refer to page 7.)*

*7 For terminal compatibility of the FR-JCBL, FR-V5CBL and FR-A7AP, refer to *page 14*.

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

5.2 Terminals

Terminal	Terminal Name	Description
PA1	Encoder A-phase signal input	A-, B- and Z-phase signals are input from the encoder. (For details of pulse signal, refer to *page 15*.)
PA2	Encoder A-phase inverse signal input	
PB1	Encoder B-phase signal input	
PB2	Encoder B-phase inverse signal input	
PZ1	Encoder Z-phase signal input	
PZ2	Encoder Z-phase inversion signal input	
PG	Power supply (positive side) input	Input power for the encoder power supply. Connect the external power supply (5V, 12V, 15V, 24V) and the encoder power cable.
SD	Power supply ground	

5.3 Vector Control Extended Parameter List

Fitting the FR-A7AP adds the following parameters for vector control.
Refer to *the inverter manual (applied)* for details of parameter.

Parameter Number	Name	Setting Range	Increments	Initial Value
359	Encoder rotation direction	0, 1	1	1
369	Number of encoder pulses	0 to 4096	1	1024
374	Overspeed detection level	0 to 400Hz	0.01Hz	140Hz
376	Encoder signal loss detection enable/disable selection	0, 1	1	0
419	Position command right selection	0, 2	1	0
420	Command pulse scaling factor numerator	0 to 32767 *	1	1
421	Command pulse scaling factor denominator	0 to 32767 *	1	1
422	Position loop gain	0 to 150sec^{-1}	1sec^{-1}	25sec^{-1}
423	Position feed forward gain	0 to 100%	1%	0
424	Position command acceleration/deceleration time constant	0 to 50s	0.001s	0s
425	Position feed forward command filter	0 to 5s	0.001s	0s
426	In-position width	0 to 32767pulses *	1	100
427	Excessive level error	0 to 400, 9999	1	40
428	Command pulse selection	0 to 5	1	0
429	Clear signal selection	0, 1	1	1
430	Pulse monitor selection	0 to 5, 9999	1	9999
464	Digital position control sudden stop deceleration time	0 to 360.0s	0.1s	0

* When an operation panel (FR-DU07) is used, the maximum setting is 9999. When a parameter unit is used, up to the maximum value within the setting range can be set.

Parameter Number	Name	Setting Range	Increments	Initial Value
465	First position feed amount lower 4 digits	0 to 9999	1	0
466	First position feed amount upper 4 digits	0 to 9999	1	0
467	Second position feed amount lower 4 digits	0 to 9999	1	0
468	Second position feed amount upper 4 digits	0 to 9999	1	0
469	Third position feed amount lower 4 digits	0 to 9999	1	0
470	Third position feed amount upper 4 digits	0 to 9999	1	0
471	Fourth position feed amount lower 4 digits	0 to 9999	1	0
472	Fourth position feed amount upper 4 digits	0 to 9999	1	0
473	Fifth position feed amount lower 4 digits	0 to 9999	1	0
474	Fifth position feed amount upper 4 digits	0 to 9999	1	0
475	Sixth position feed amount lower 4 digits	0 to 9999	1	0
476	Sixth position feed amount upper 4 digits	0 to 9999	1	0
477	Seventh position feed amount lower 4 digits	0 to 9999	1	0
478	Seventh position feed amount upper 4 digits	0 to 9999	1	0
479	Eighth position feed amount lower 4 digits	0 to 9999	1	0
480	Eighth position feed amount upper 4 digits	0 to 9999	1	0
481	Ninth position feed amount lower 4 digits	0 to 9999	1	0
482	Ninth position feed amount upper 4 digits	0 to 9999	1	0
483	Tenth position feed amount lower 4 digits	0 to 9999	1	0
484	Tenth position feed amount upper 4 digits	0 to 9999	1	0
485	Eleventh position feed amount lower 4 digits	0 to 9999	1	0
486	Eleventh position feed amount upper 4 digits	0 to 9999	1	0
487	Twelfth position feed amount lower 4 digits	0 to 9999	1	0

Parameter Number	Name	Setting Range	Increments	Initial Value
488	Twelfth position feed amount upper 4 digits	0 to 9999	1	0
489	Thirteenth position feed amount lower 4 digits	0 to 9999	1	0
490	Thirteenth position feed amount upper 4 digits	0 to 9999	1	0
491	Fourteenth position feed amount lower 4 digits	0 to 9999	1	0
492	Fourteenth position feed amount upper 4 digits	0 to 9999	1	0
493	Fifteenth position feed amount lower 4 digits	0 to 9999	1	0
494	Fifteenth position feed amount upper 4 digits	0 to 9999	1	0
802	Pre-excitation selection	0, 1	1	0
823	Speed detection filter 1	0 to 0.1s	0.001s	0.001s
833	Speed detection filter 2	0 to 0.1s, 9999	0.001s	9999
840	Torque bias selection	0 to 3, 9999	1	9999
841	Torque bias 1	600 to 1400%, 9999	1%	9999
842	Torque bias 2	600 to 1400%, 9999	1%	9999
843	Torque bias 3	600 to 1400%, 9999	1%	9999
844	Torque bias filter	0 to 5s, 9999	0.001s	9999
845	Torque bias operation time	0 to 5s, 9999	0.01s	9999
846	Torque bias balance compensation	0 to 10V, 9999	0.1V	9999
847	Fall-time torque bias terminal 1 bias	0 to 400%, 9999	1%	9999
848	Fall-time torque bias terminal 1 gain	0 to 400%, 9999	1%	9999
853	Speed deviation time	0 to 100s	0.1s	1s
873	Speed limit	0 to 120Hz	0.01Hz	20Hz

5.4 Specifications

Speed control	Speed control range	1:1500 (both driving/regeneration *1)
	Speed variation ratio	±0.01% (100% means 3000r/min)
	Speed response	300rad/s Note that the internal response is 600rad/s (with model adaptive speed control)
	Maximum speed	120Hz
Torque control	Torque control range	1:50
	Absolute torque accuracy	±10% *2
	Repeated torque accuracy	±5% *2
Function		· Setting of speed feedback range · Setting of feedback gain · Setting of encoder rotation direction

*1 Regeneration unit (option) is necessary for regeneration

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

REVISIONS

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

Print Date	*Manual Number	Revision
Sep., 2005	IB(NA)-0600238ENG-A	First edition