MITSUBISHI

INSTRUCTION MANUAL

ORIENTATION CONTROL/PLG FEEDBACK CONTROL/PULSE TRAIN UNIT

FR-A5AP

TYPE	**FR-A5AP EIBUN TORISETSU**
CODE	**1A2H59**

IB (NA) 66848-A (9803) MEE

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

Safety Instructions

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 manual, the safety instruction levels are classified into "WARNING" and "CAUTION".

WARNING	Denotes that incorrect handling may cause hazardous conditions, resulting in death or severe injury.
CAUTION	Denotes 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 under some circumstances. Please follow the instructions of both levels as 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 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, switch power off, wait for more than 10 minutes, and check for no residual voltage with a tester or the like.
- Any person who is involved in the wiring or inspection of this equipment should be fully competent to do the work.
- Always install the option unit before wiring. Otherwise, you may get an electric shock or be injured.
- Operate the switches with dry hands to prevent 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 to prevent damage, etc.
- Ensure that the cables are connected to the correct terminals.
- Otherwise, damage, etc. may occur.
- Always make sure that polarity is correct to prevent damage, etc.
- 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 installation

⚠ CAUTION

- Do not install or operate the option unit 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 screws, metal fragments, conductive bodies or oil, other flammable substance from entering the inverter.

(2) Test operation and adjustment

⚠ 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.

⚠ CAUTION

- When parameter clear or all parameter clear is performed, each parameter returns to the factory setting. Re-set the required parameters before starting operation.
- 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

- Dispose of this product as general 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.

1. PRE-OPERATION INSTRUCTIONS
1.1. Unpacking and Product Confirmation

Take the option unit out of the package, check the unit name, and confirm that the product is as you ordered and intact.

Note: This product may be used with the inverter manufactured during and after February, 1998.
The inverter may be used with this unit if its SERIAL number indicated on the rating plate and package plate has the following version or later. (The SERIAL number on the package plate uses the 3 most significant digits of the following 6-digit control number and is indicated in 6 digits including the version symbol.)

Model	SERIAL Number
FR-A520-0.4K, 0.75K	U82○○○○○○
FR-A520-1.5K to 11K	T82○○○○○○
FR-A520-15K to 22K	U82○○○○○○
FR-A520-30K to 55K	K82○○○○○○
FR-A540-0.4K to 3.7K	L82○○○○○○
FR-A540-5.5K, 7.5K	K82○○○○○○
FR-A540-11K to 22K	L82○○○○○○
FR-A540-30K to 55K	D82○○○○○○

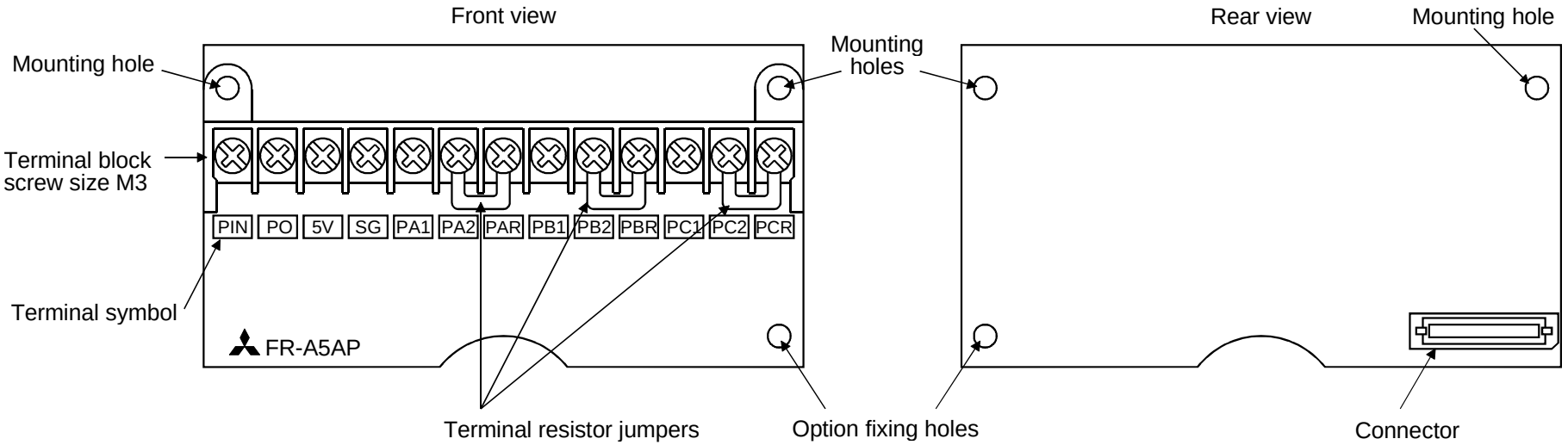
U 8 2 ○○○○○○
Symbol Year Month Control number
SERIAL number
SERIAL is made up of 1 version symbol and
8 numeric characters as shown above.

1.2. Packing Confirmation

Make sure that the package includes the following accessories:

- Instruction manual 1
- Mounting screws M3 × 10 2
- Terminal resistor jumpers (Jumpers fitted to the terminal block) 3

1.3. Structure



2.INSTALLATION

2.1. Pre-Installation Instructions

(1) Make sure that the input power of the inverter is off and make sure the charge light is off.

(2) When the FR-A5AP unit is used for PLG feedback control or orientation control, a PLG (motor with PLG) and external power supply are required.
When PLG feedback control and orientation control are used together, the PLG (motor with PLG) and external power supply are shared between these controls.

(3) When the FR-A5AP unit is fitted, the programmed operation function is made invalid.

⚠ CAUTION
⚠ **With input power on, do not install or remove the option unit. Otherwise, the inverter and option unit may be damaged.**

2.2. Installation Procedure

(1) Securely insert the connector of the option unit far into the connector of the inverter. At this time, also fit the option fixing holes securely.

(2) Securely fix the option unit to the inverter on both sides with the accessory mounting screws. If the screw holes do not match, the connector may not have been connected correctly. Check for loose connections.

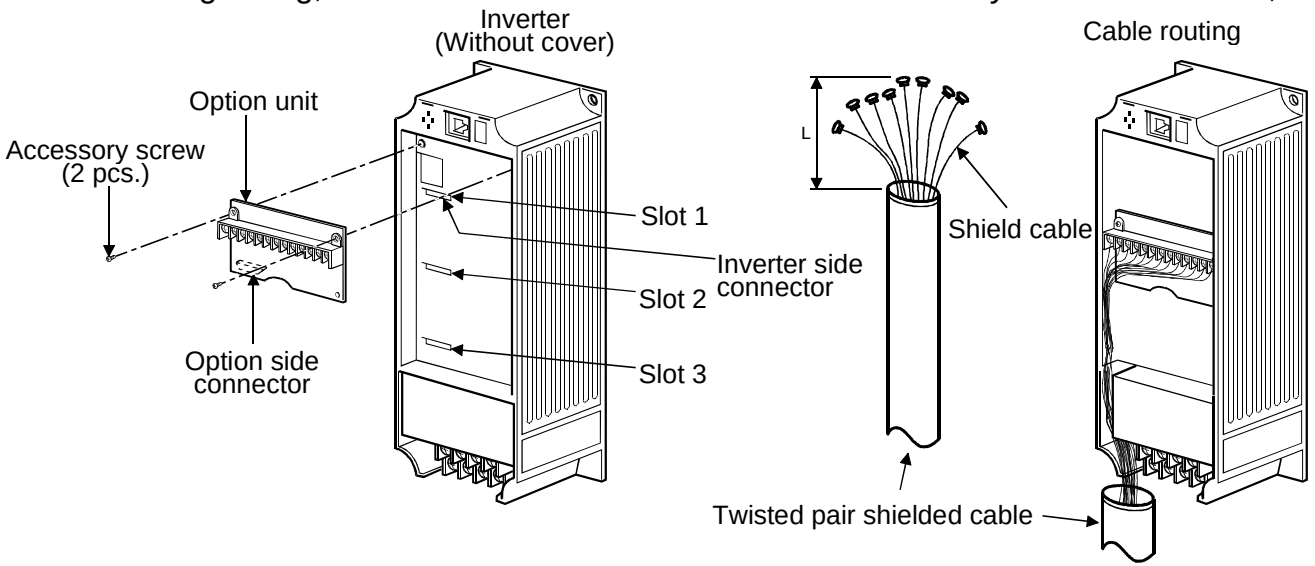
⚠ CAUTION
⚠ **When installing the inverter front cover, the cables to the inverter's control circuit terminals and option terminals should be routed properly in the wiring space to prevent them from being caught between the inverter and its cover.**

2.3. Wiring

Route the cables so that they do not take up a large space in the control circuit terminal block wiring area of the option unit.

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

Note: During wiring, do not leave wire off-cuts in the inverter. They can cause a fault, failure or malfunction.



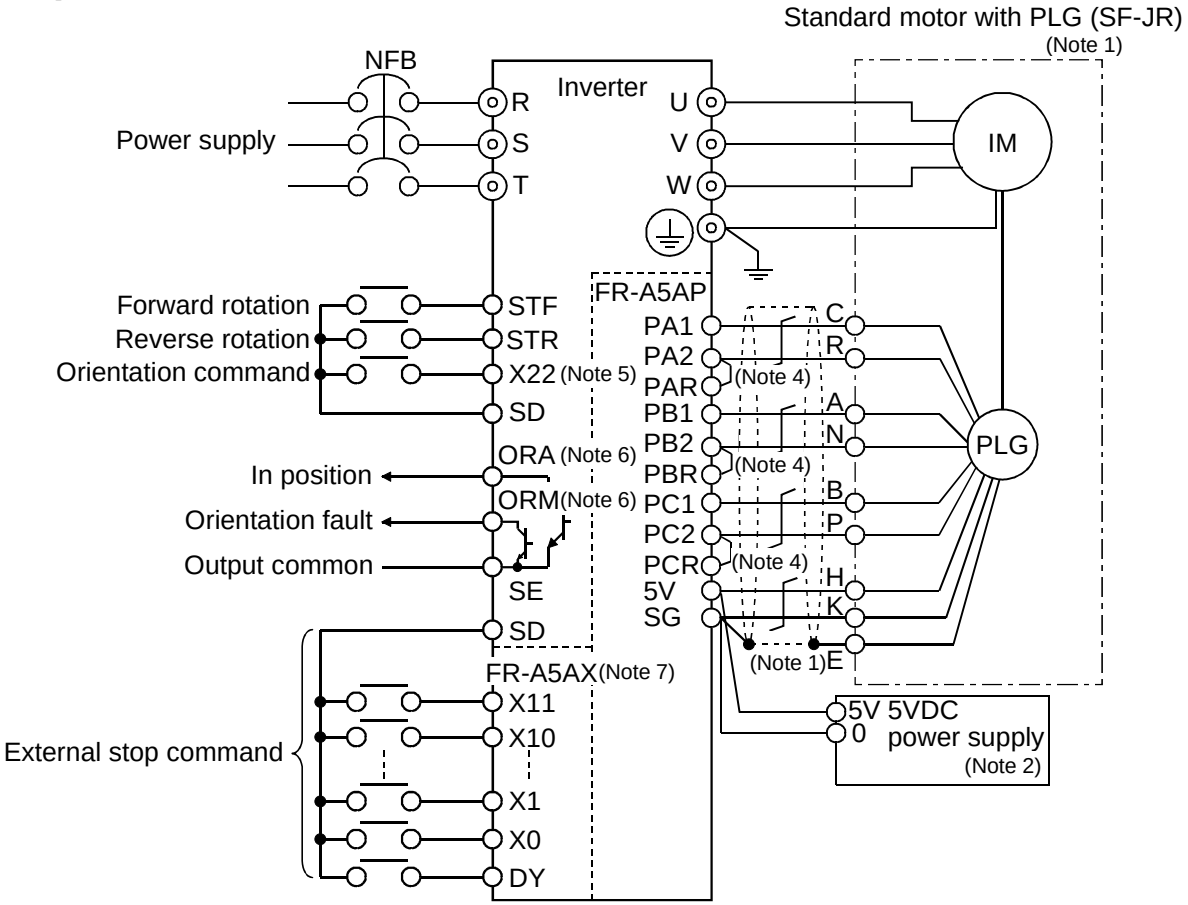
Sheath Stripping Dimensions for Shield Cable

Inverter Capacity	**Slot 1**	**Slot 2**	**Slot 3**
0.4K to 3.7K	L: 350mm	L: 300mm	L: 250mm
5.5K to 55K	L: 270mm	L: 220mm	L: 170mm

3. ORIENTATION CONTROL

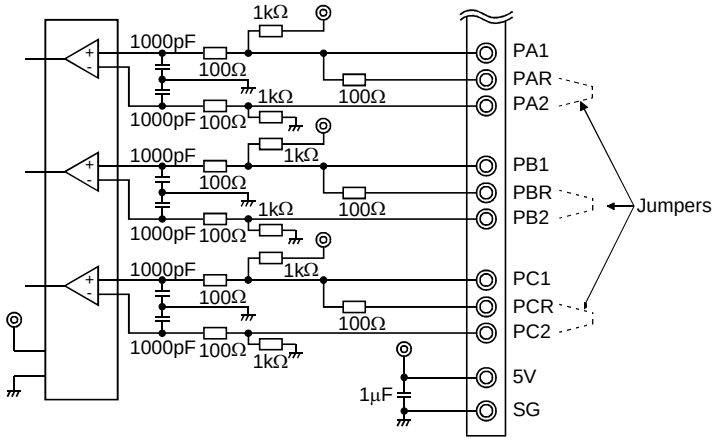
This function is used with a position detector (PLG) installed to the spindle of a machine tool (or the motor) to allow a rotary shaft to be stopped at the specified position (oriented).
Pr. 350 "stop position command selection" is factory-set to "9999" to make the orientation control function invalid.

3.1. Wiring Example



Note: 1. When the motor with a PLG used is other than the standard motor with PLG (SF-JR), the pin numbers are different. To reduce radiated noise, connect the shield wires of the PLG cables to the CG.
2. When orientation control is used with PLG feedback control, the PLG and 5V power supply may be shared between these controls.
3. Couple the PLG in line with the motor with a speed ratio of 1 to 1 without any mechanical looseness.
4. Keep the accessory jumpers connected. However, when the same PLG is shared between the FR-A5AP and another unit (e.g. NC) which is connected with a terminal resistor, the built-in terminal resistors are not required and should be removed. (Terminal resistors: 100Ω)
5. Assign this function to any of the input terminals using Pr. 180 to Pr. 186 "input terminal function selection".
6. Assign this function to any of the output terminals using Pr. 190 to Pr. 195 "output terminal function selection".
7. When the stop position command is entered from outside the inverter (externally), the FR-A5AX inboard option is required.

3.2. Input Circuit



3.3. Terminals

Symbol	Terminal	Remarks	Description
PA1	PLG A-phase signal input terminal	For information on the pulse signals, refer to page 11.	A-, B- and C(Z)-phase signals are input from the PLG
PA2	PLG A-phase inverse signal input terminal		
PB1	PLG B-phase signal input terminal		
PB2	PLG B-phase inverse signal input terminal		
PC1	PLG C(Z)-phase signal input terminal		
PC2	PLG C(Z)-phase inverse signal input terminal		
PAR	A-phase terminal resistor terminal		Factory-connected with "PA2" by the jumper. Remove the jumper when the terminal resistor is not needed
PBR	B-phase terminal resistor terminal		Factory-connected with "PB2" by the jumper. Remove the jumper when the terminal resistor is not needed
PCR	C(Z)-phase terminal resistor terminal		Factory-connected with "PC2" by the jumper. Remove the jumper when the terminal resistor is not needed
5V	DC power (positive) input terminal	4.75 to 6VDC (Current consumption 50mA)	PLG power supply common terminals. Input PLG power. Connect the positive side to 5V and the ground side to SG. Also, connect the shield of the shield wire to SG.
SG	DC power ground terminal		

<Inverter I/O terminals>

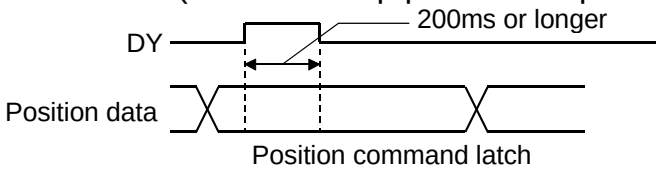
Symbol	Terminal	Remarks	Description
X22 (Note 1)	Orientation command input terminal		Used to enter an orientation signal.
SD	Common terminal		Common terminal for the orientation signal.
ORA (Note 2)	In-position signal output terminal	Open collector output. Permissible load 24VDC, 0.1A	Switched low if the orientation has stopped within the in-position zone while the start and orientation signals are input.
ORM (Note 2)	Orientation fault signal output terminal	Open collector output. Permissible load 24VDC, 0.1A	Switched low if the orientation has not stopped within the in-position zone while the start and orientation signals are input.
SE	Open collector output common terminal		Common terminal for the ORA and ORM open collector output terminals. Isolated from the common terminal of the control circuit.

Note: 1. Assign the function of the X22 signal to any of the input terminals using Pr. 180 to Pr. 186 "input terminal function selection".
2. Assign the functions of the ORA/ORM signal to any of the output terminals using Pr. 190 to Pr. 195 "output terminal function selection".

<FR-A5AX, inverter input terminals>

Symbol		Terminal	Remarks	Description
FR-A5AX input terminals	X0 to X11	Digital signal input terminals	Use a micro current switching contact relay for the relay contact. A transistor with the following specifications should be selected for the open collector signal: Electrical characteristics of the transistor used; • IC ≥ 10mA • VCE ≥ 30V • Leakage current 100μA max. • If IC ≥ 10mA, VCE(sat) voltage is 3V max.	Used to input digital signals through either relays or open collector transistors. As the command signals are entered, speed or position commands are selected using Pr. 360.
	DY ★	Data read timing input signal		Used when a digital signal read timing signal is necessary. Data is only read while terminals DY-SD are shorted. By opening terminals DY-SD, the data before opening is retained.
Inverter input terminals	SD	Common terminal (sink)		Common terminal for digital signal input terminals and data read timing signals
	PC	External transistor common terminal (source)		When connecting the transistor output (open collector output) of a programmable controller (PC), etc., connect the external power common (positive) to this terminal to prevent a fault occurring due to leakage current

★ How to use terminal DY (when the stop position is specified from outside the inverter (externally)).



When terminals DY-SD are open, the inverter does not import data. Therefore, if the input status of the X0-X11 signals change, the stop position data before opening of terminals DY-SD is valid.
Also, the position data is imported on the leading edge of the DY signal.

Note: Pr. 300 to Pr. 304 settings for the FR-A5AX are made invalid when the stop position is set to be specified from outside the inverter (externally), with the FR-A5AP (orientation control option) fitted to the inverter and when orientation control is used.
Pr. 300 to Pr. 305 of the FR-A5AX are made valid when the stop position is not set from outside the inverter.

3.4. Wiring Instructions

(1) Connection with the position detector (PLG).

Use twisted pair shielded cables (0.2mm^2 or larger) to connect the FR-A5AP and position detector (PLG). Cables to terminals 5V and SG should be connected in parallel or be larger in size according to the cable length table as indicated below.

To protect the cables from noise, run them (at least 10cm) away from any source of noise (e.g. the main circuit and power supply voltage).

Note: If the cable size is too large to connect the terminals to the terminal block or if the number of cables is increased due to parallel connection and they cannot be contained in the wiring space, provide a junction terminal block, for example.

(2) Cable length.

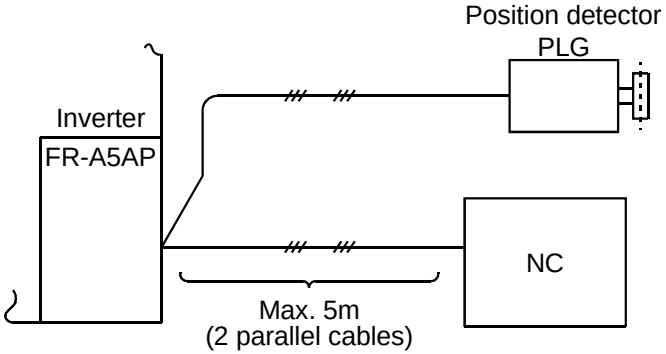
1) Cable length within 30m.

Cable Length	**Number of Parallel Cables of 0.2mm^2 Required**	**Larger-Size Cable**
Within 10m	At least 2 cables	0.4mm^2 or larger
Within 20m	At least 4 cables	0.75mm^2 or larger
Within 30m	At least 6 cables	1.25mm^2 or larger

2) Cable length of more than 30m.

Use a power supply slightly higher than 5V (approximately 5.5V) in addition to 6 or more parallel cables of 0.2mm^2 or cables of 1.25mm^2 or more. This allows the cable length to be increased up to 100m. Note that the voltage applied
across terminals 5V-SG must not exceed 6V.

3) Connection with NC. (Or similar device)
When one position detector is shared between the FR-A5AP and NC (or another device), its output signals should be connected as shown below. In this case, the cable length between the FR-A5AP and NC should be as short as possible, within 5m.



(3) Connection of terminal resistors.
Use the jumpers across PA2-PAR, PB2-PBR and PC2-PCR to connect terminal resistors to the A, B and C(Z)-phases of the PLG. Normally, keep the jumpers fitted.
However, remove the jumpers when the same PLG is shared between the FR-A5AP and the other unit (e.g. NC) which is connected with a terminal resistor.

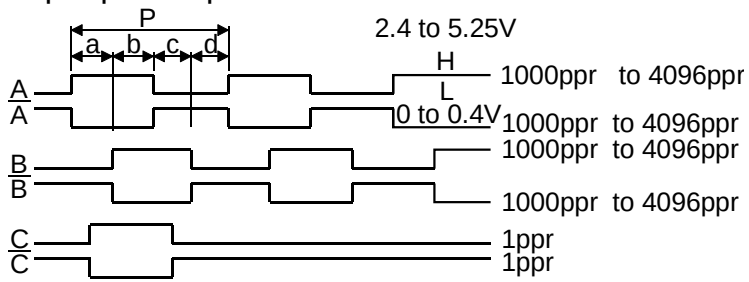
(4) Position detector (PLG).

Line driver LED type PLG

A. A signal 1000ppr to 4096ppr

B. B signal 1000ppr to 4096ppr

C(Z).C(Z) signal 1ppr Output pulse specifications



a, b, c and d should be (1/4 ± 1/8)P when rotation is clockwise as viewed from the shaft end of the PLG.

<Example of PLG available on the market>

Tamagawa Seiki: TS1508N207, TS5008N122, TS5108N122

Pin Numbers of PLG Output Signals (Tamagawa Seiki, TS1508N207)

Pin Number	**Output Signal**	**Pin Number**	**Output Signal**
C	A-phase signal	H	+5V power supply
R	A-phase inverse signal	K	Power supply common
A	B-phase signal	E	Case earth
N	B-phase inverse signal		
B	C(Z)-phase signal		
P	C(Z)-phase inverse signal		

Note: When PLG feedback control and orientation control are used together, the PLG is shared between these controls.
Use a PLG which has a pulse count of 1000 to 4096ppr (pulses per revolution).

3.5. Related Parameter List

Parameter Number	Name	Setting Range	Minimum Setting Increments	Factory Setting	Remarks
350	Stop position command selection	0, 1, 9999	1	9999	9999: No orientation
351	Orientation speed	0 to 30Hz	0.01Hz	2Hz	
352	Creep speed	0 to 10Hz	0.01Hz	0.5Hz	
353	Creep select position	0 to 16383 (Note)	1	511	
354	Position loop select position	0 to 8191	1	96	Set using ± with respect to the stop position.
355	DC dynamic braking start position	0 to 255	1	5	Set using ± with respect to the stop position.
356	Internal stop position command	0 to 16383 (Note)	1	0	
357	In-position zone	0 to 255	1	5	Set using ± with respect to the stop position.
358	Servo torque selection	0 to 13	1	1	
359	PLG rotation direction	0, 1	1	1	
360	12-bit data selection	0, 1, 2 to 127	1	0	0: Speed command, 1: Position command, 2 to 127: Number of stop positions −1
361	Position shift	0 to 16383 (Note)	1	0	
362	Position loop gain	1 to 10	1	1	
363	In-position signal output delay time	0 to 5 sec.	0.1 sec.	0.5 sec.	
364	PLG stop check time	0 to 5 sec.	0.1 sec.	0.5 sec.	
365	Orientation time limit	0 to 60 sec., 9999	1 sec.	9999	9999: 120 sec. setting
366	Recheck time	0 to 5 sec., 9999	0.1 sec.	9999	9999: No check
369	PLG pulse count	0 to 4096	1	1024	Number of pulses before it is multiplied by 4

Note: When the FR-DU04 is used, up to 9999 may be set. When the FR-PU04 is used, up to 16383 may be set.

3.6. Pre-Operation Settings

(1) Pr. 350 "stop position command selection".

- For the stop position command, either the internal stop position command or the external stop position command using external signals (12-bit data) may be selected.
- Set "9999" in Pr. 350 to make orientation control invalid.

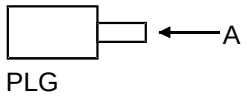
Pr. 350 Setting	Description
0	Internal stop position command
1	External stop position command
9999	Orientation control invalid (factory setting)

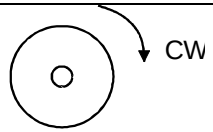
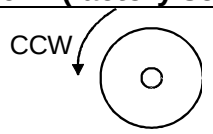
(2) Pr. 369 "number of PLG pulses".

Set the number of PLG pulses.
Set the number of pulses before it is multiplied by 4.
Example:Set "1024" for 1024 pulses per revolution (ppr).

(3) Pr. 359 "PLG rotation direction".

Indicates the direction in which the PLG rotates.



Pr. 359=0	Pr. 359=1 (factory setting)
 Forward rotation is clockwise rotation when viewed from A.	 Forward rotation is counterclockwise rotation when viewed from A.

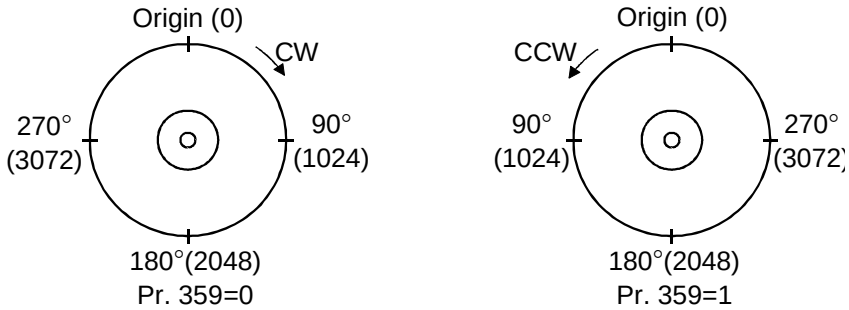
Note: When the FR-A5AP is fitted and Pr. 350 "stop position command selection" is set to make orientation control valid, the PU (FR-DU04/FR-PU04) shows the rotation direction of the PLG.
Make the setting of Pr. 359 so that FWD is displayed when the STF signal switches on or REV displayed when the STR signal switches on.

(4) Pr. 356 "internal stop position command".

Set "0" in Pr. 350 "stop position command selection" to choose the internal position command mode.

In the internal position command mode, the value set in Pr. 356 is processed as the stop position command.

When the PLG pulse count is 1024ppr, one revolution of the PLG (360 degrees) is divided into 4096 positions, i.e. 360 degrees/4096 = 0.0879 degrees per address (see below). The stop positions (addresses) are indicated in parentheses.



(5) Pr. 360 "12-bit data selection".

When "1" is set in Pr. 350 "stop position command selection" and the FR-A5AX option is used with the FR-A5AP, set stop positions using 12-bit data.

• The value set in Pr. 360 should be the number of stop positions less 1.

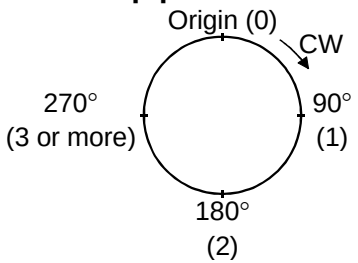
<Example>

When the number of stop positions is 20 (divided at intervals of 18 degrees), 20 − 1 = 19. Hence, set "19".

• The stop position command is entered in binary when using the FR-A5AX.

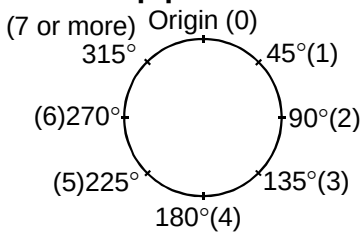
Pr. 360 Setting	**Description**
0	Speed command
1	Position command
2 to 127	The external stop position command may be used to set up to 128 stop positions at regular intervals. If the external stop command entered is greater than the setting, the stop positions are the same as those in the maximum external stop command value.

[Example 1]
4 stop positions



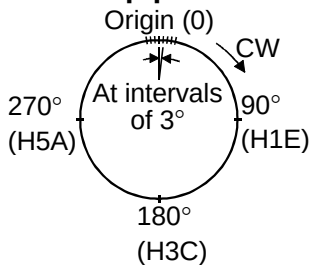
Pr. 360 = "3"

[Example 2]
8 stop positions



Pr. 360 = "7"

[Example 3]
120 stop positions



Pr. 360 = "119"

Note: Values in parentheses indicate binary data entered from the input terminals of the FR-A5AX. If the position signal monitoring (Pr. 52 = 19) is selected, the data monitored is not the number of stop positions but is 0 to 4095 pulses.

● Relationships between stop position command and 12-bit data

Pr. 350 "stop position command selection"	**Pr. 360 "12-bit data selection"**	**Operating Status**		
		Stop position command	**12-bit data**	**Speed command**
0: Internal	0: Speed command	Internal	Speed command	12-bit data
0: Internal	1, 2 to 127: Position command	Internal	Invalid	External command (or PU)
1: External	0: Speed command	Internal	Speed command	12-bit data
1: External	1, 2 to 127: Position command	External (Internal when FR-A5AX is not fitted)	Position command	External command (or PU)

(6) Pr. 361 "position shift".

The stop positions are those defined by the position command plus the value set in Pr. 361.

- <Position shift function>
  Electrically shifts the origin (the inverters reference point for the origin) without changing the origin of the position detector (PLG) (i.e. without any physical movement).

(7) Pr. 363 "in-position signal output delay time".
When the motor shaft enters the in-position zone, the in-position signal is output after a delay of the time set in Pr. 363. Also, when the motor shaft comes out of the in-position zone, the in-position signal is switched off after a delay of the time set in Pr. 363.

(8) Pr. 364 "PLG stop check time".
When the in-position signal has not yet been output in orientation operation, the orientation fault signal is output if orientation cannot be completed and the PLG is stopped for the period of time set in Pr. 364. When the in-position signal has been output once, the orientation fault signal is output if the orientation cannot be completed again within the time set in Pr. 364.

(9) Pr. 365 "orientation time limit".
If orientation cannot be completed within the time set in Pr. 365, which is measured from when the current position signal has passed the creep select position, the orientation fault signal is output.

(10) Pr. 366 "recheck time".
If the start signal is switched off with the orientation command ON after the PLG is stopped under orientation control, the current position is checked again after the time set in Pr. 366 has elapsed and the in-position signal or orientation fault signal is output according to the check result.

3.7. Operation

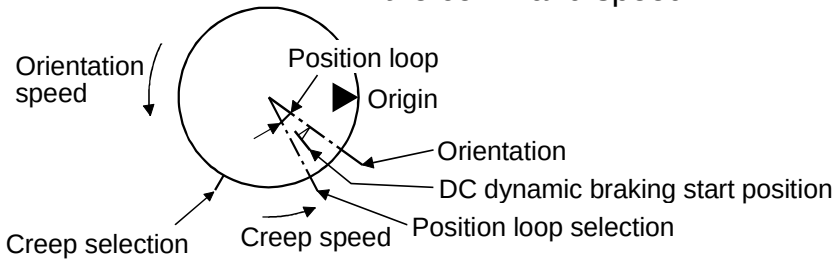
(1) Orientation starting during rotation.

1) The orientation command (X22) causes the motor to decelerate to the orientation speed set in Pr. 351.
2) After the orientation speed is reached, the motor decelerates to the creep speed set in Pr. 352 as soon as the current position signal reaches the creep select position set in Pr. 353.
3) Furthermore, the position loop begins to work as soon as the current position signal reaches the position loop select position set in Pr. 354.
4) After the position loop is selected, the motor keeps decelerating until the current position signal reaches the DC dynamic braking start position set in Pr. 355, at which time DC dynamic braking is started to stop the motor.
5) When the motor has stopped within the in-position zone set in Pr. 357, the in-position signal (ORA) is output with a delay of the in-position signal output delay time set in Pr. 363. If the current position signal comes out of the in-position zone due to external force etc., the in-position signal is switched off with a delay of the in-position signal output delay time set in Pr. 363.
6) The orientation fault signal (ORM) is output if the orientation cannot be completed within the time set in Pr. 365 after the current position signal has passed the creep select position.
7) If the orientation (once started) has been stopped by an external force etc. before the in-position zone is reached and the in-position signal (ORA) is not yet output, the orientation fault signal (ORM) is output after the PLG stop check time set in Pr. 364 has elapsed. If the current position signal comes out of the in-position zone due to an external force etc. after the output of the in-position signal (ORA), the in-position signal (ORA) is switched off after a delay of the in-position signal output delay time set in Pr. 363. If the orientation cannot be completed within the PLG stop check time set in

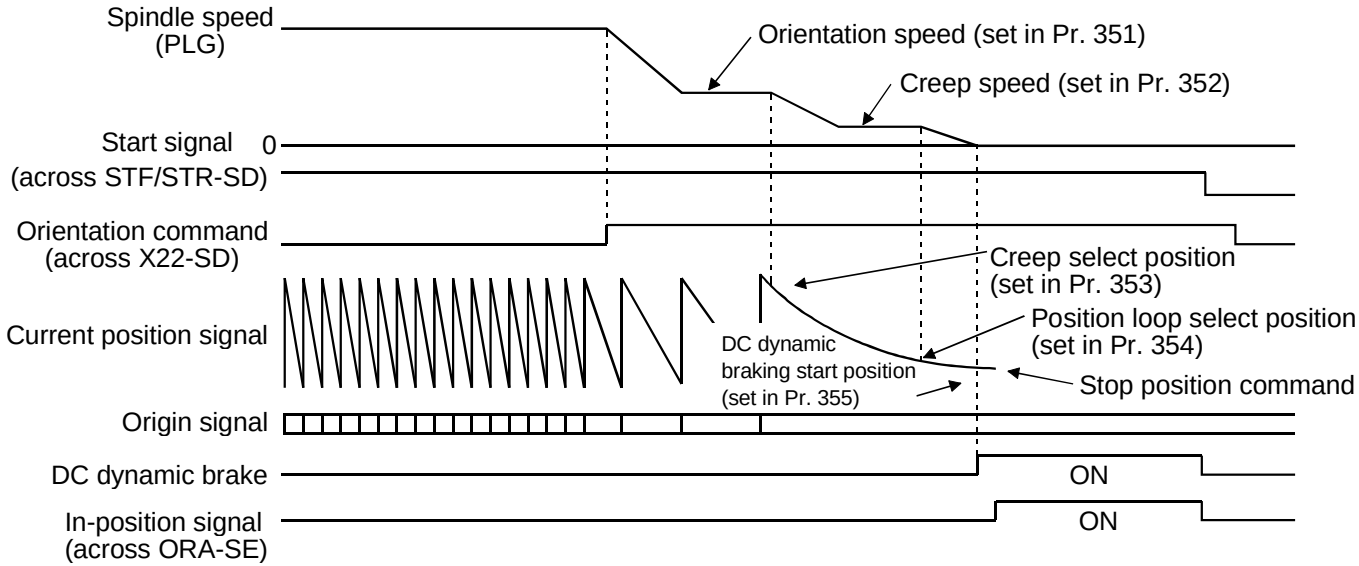
Pr. 364, the orientation fault signal (ORM) is output.

8) When the start signal (STF or STR) is switched off with the orientation command on after the in-position signal (ORA) or orientation fault signal (ORM) has been output once, the in-position signal (ORA) or orientation fault signal (ORM) is output again after the recheck time set in Pr. 366 has elapsed.

9) The in-position signal (ORA) and orientation fault signal (ORM) are not output if the orientation command is off.
CAUTION If the orientation command is switched off with the start signal on, the motor accelerates to the command speed.



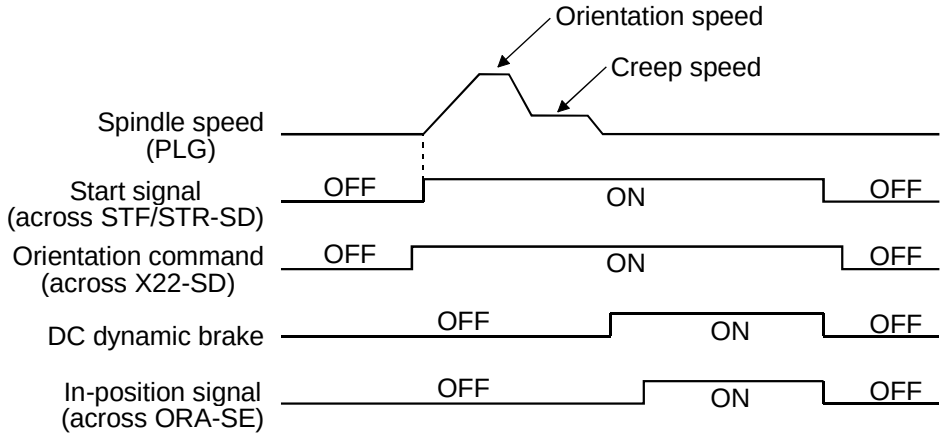
Operation Timing Chart



Note: A high level refers to a signal being ON.

(2) Orientation starting during stop.
Switch on the orientation command (X22), then switch on the start signal to start and accelerate the motor to the orientation speed set in Pr. 351 and perform orientation using the same procedure as in Section (1). Note that if the current position signal is within the DC dynamic braking start position, the spindle speed will not rise to the orientation speed and the DC dynamic brake is applied.

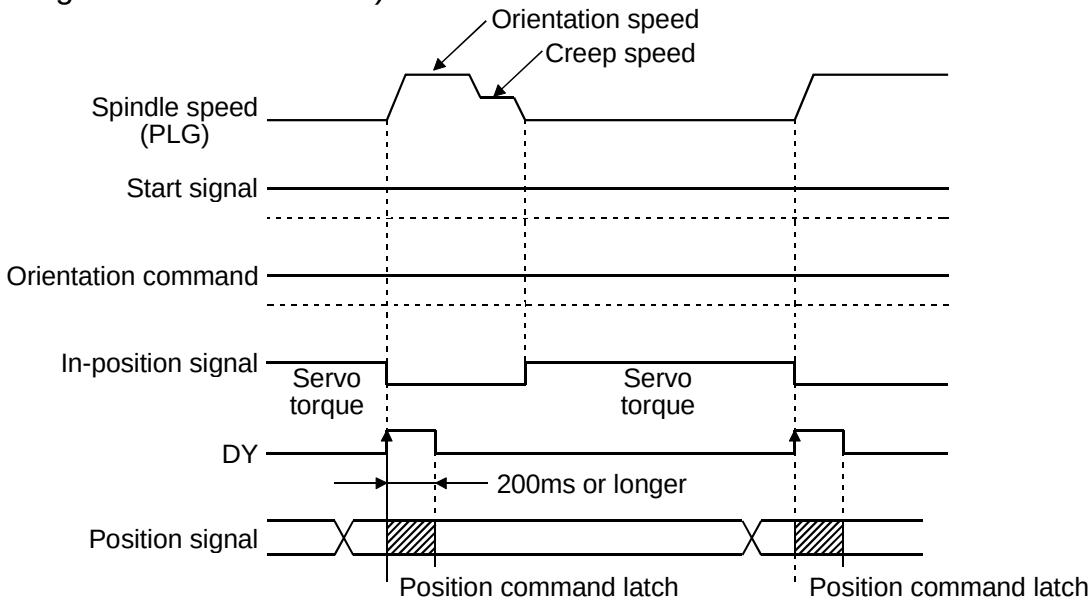
Operation Timing Chart



(3) Multi-position orientation.

Orientation starting with orientation command and STF/STR kept on

(Orientation starting in the servo-in state)



- Position data is read on the leading edge of DY (refer to the FR-A5AX instruction manual).
- If the current position signal is within the creep select position, the spindle speed rises not to the orientation speed but to the creep speed.
- If the current position signal is outside the creep select position, the spindle speed rises to the orientation speed.
- If the current position signal is within the DC dynamic braking start position, the DC dynamic brake is applied.

(4) Pr. 358 "servo torque selection"

Pr. 358 Setting / Function	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Remarks
1) Selection of servo torque function until output of in-position signal	X	O	O	O	O	X	O	X	O	X	O	X	X	O	O:Servo torque function valid X:Servo torque function invalid
2) Retry function selection	X	X	X	X	X	X	X	O	X	X	X	O	X	X	O:Retry function valid X:Retry function invalid
3) Output frequency is compensated for when motor shaft stops outside in-position zone.	X	X	O	O	X	O	O	X	X	X	X	X	O	O	O:Frequency compensation valid X:Frequency compensation invalid
4) DC dynamic braking or servo torque is selected when the motor shaft comes out of the in-position zone after the in-position signal is output.	O	X	X	X	X	O	O	O	O	O	O	O	O	O	O:DC dynamic braking selected X:Servo torque selected
5) Selection of DC dynamic braking or orientation termination timing	O	O	O	X	X	O	O	O	O	X	X	X	X	X	O:Start signal (STF, STR) or orientation command is switched off X:Orientation command is switched off
6) Selection of in-position signal OFF; when motor shaft comes out of in-position zone after in-position signal is output once.	O	O	O	O	O	X	X	X	X	X	X	X	X	X	O:In-position signal is switched off when motor shaft comes out of in-position zone. X:In-position signal remains on if motor shaft comes out of in-position zone. (Orientation fault signal is not output.)

Note: If the orientation command is switched off with the start signal remaining on, the motor accelerates toward the command speed.

1) Selection of servo torque function until the in-position signal is output.
   Set Pr. 358 "servo torque selection" to determine whether servo torque is required or not. When the current position signal is between the orientation stop position and DC dynamic braking start position, servo torque is not generated. The shaft is held by DC dynamic braking. If the current position signal comes out of this zone due to external force, etc., servo torque is generated to return the current position signal to within the zone. Once the in-position signal is output, operation is performed in accordance with the setting in 4).
2) Retry function.
   Set Pr. 358 "servo torque selection" to determine whether the retry function is required or not. Note that this function cannot be used with the servo torque function. If the motor shaft is confirmed to have stopped but is not in the in-position zone, the retry function causes the shaft to be oriented again.
   This retry is made three times, including the first orientation, but no more than three times. (The orientation fault signal is not output during retry operation.)
3) Frequency compensation function for use when the motor shaft has stopped outside the in-position zone.
   When the motor shaft has been stopped by external force, etc. before entering the in-position zone, the output frequency is increased to move the shaft to the orientation stop position. This output frequency rises gradually to the creep speed set in Pr. 352. This function cannot be used with the retry function.
4) Selection of whether DC dynamic braking or servo torque is started when the motor shaft comes out of the in-position zone after the in-position signal has been output once.
   You can select whether to start DC dynamic braking to lock the shaft or to start servo torque to return the shaft to the orientation stop position if the motor shaft comes out of the in-position zone due to external force, etc. after the output of the in-position signal.
5) Selection of DC dynamic braking, servo torque or orientation termination timing.
   To terminate orientation, switch off the start signal (STF or STR) and then switch off the orientation command (X22). At this time, you can select the point of switching off the in-position signal between when the start signal is switched off or when the orientation command is switched off.
6) In-position signal OFF selection; for use when the motor shaft comes out of the in-position zone after the in-position signal is output once. You can select either the mode in which the in-position signal is switched off when the motor shaft comes out of thein-position zone or the mode in which the in-position signal remains on (orientation fault signal is not output) when the motor shaft comes out of the in-position zone.

(5) Pr. 362 "position loop gain"

When Pr. 358 "servo torque selection" value has been set to choose the servo torque function, the output frequency provided to generate servo torque rises gradually up to the creep speed set in Pr. 352 according to the inclination set in Pr. 362 "position loop gain". Increasing the setting will increase the operation speed but may cause the machine to hunt.

(6) Monitoring functions

Monitoring	**Description**
Position signal monitoring	Set "19" in Pr. 52 to display the position signal on the PU instead of the voltage (Displayed only when the FR-A5AP is fitted.)
Orientation status	Set "22" in Pr. 52 to display the orientation status on the PU instead of the output voltage. (Displayed only when the FR-A5AP is fitted.) 0 - Orientation not selected (i.e. orientation mode has not been activated) or orientation speed has not been reached. 1 - Orientation speed reached. 2 - Creep speed reached. 3 - Position loop reached. 4 - In-position. 5 - Orientation fault (pulse stop). 6 - Orientation fault (orientation time limit elapsed). 7 - Orientation fault (recheck). 8 - Positioning orientation in progress.

Servo torque will return the motor to the stop position (if enough torque can be provided) if it is moved from the stop position. Servo torque is available in all modes vector, V/f, etc. When orientation control is selected.

3.8. Instructions

(1) The PLG should be coupled with the motor shaft or the spindle oriented with a speed ratio of 1 to 1 without any mechanical looseness.
(2) The DC dynamic brake operated for positioning must be released in the shortest time (within several seconds). Operating the brake continuously can cause the motor to generate heat and burn out.
(3) The servo lock function is not available after positioning stop. If the spindle must be held securely, prepare an appropriate holding means such as a mechanical brake or a dowel pin.
(4) To ensure correct positioning, the PLG must be set in the proper rotation direction and the A and B phases connected correctly.
(5) The orientation fault signal may be output if the pulse signal is not given from the PLG during orientation due to an open cable, etc.
(6) When orientation control is exercised, orientation cannot be completed if "no DC dynamic brake operation" is set in the DC dynamic brake adjusting (voltage, frequency, time) parameters. These parameters must be set to operate the DC dynamic brake.
(7) To terminate orientation, the start signal (STF or STR) must be first switched off and the orientation signal (X22) must be switched off. As soon as this orientation signal is switched off, orientation control ends. (Depending on the setting of
Pr. 358 "servo torque selection", when the orientation signal remains on, orientation will continue even if the DC dynamic brake is released as soon as the start signal is switched off. Hence, the orientation status monitored is not set to 0.)
(8) When the retry function has been selected in Pr. 358 "servo torque selection", retry is made three times. (Note: The first orientation counts as 1 retry.)
(9) For orientation control, set correct values in Pr. 350 "stop position command selection" and Pr. 360 "12-bit data selection". If the values set are incorrect, proper orientation control will not be performed.
(10) The value set in Pr. 11 (DC dynamic brake operation time) should be any of 1 to 10. If "8888" (DC dynamic brake external selection) is set in Pr. 11, the DC dynamic brake is not operated unless the X13 terminal signal is switched on. For orientation control the DC dynamic brake is operated independently of the X12 signal.
(11) When orientation control is exercised, PID control is invalid.

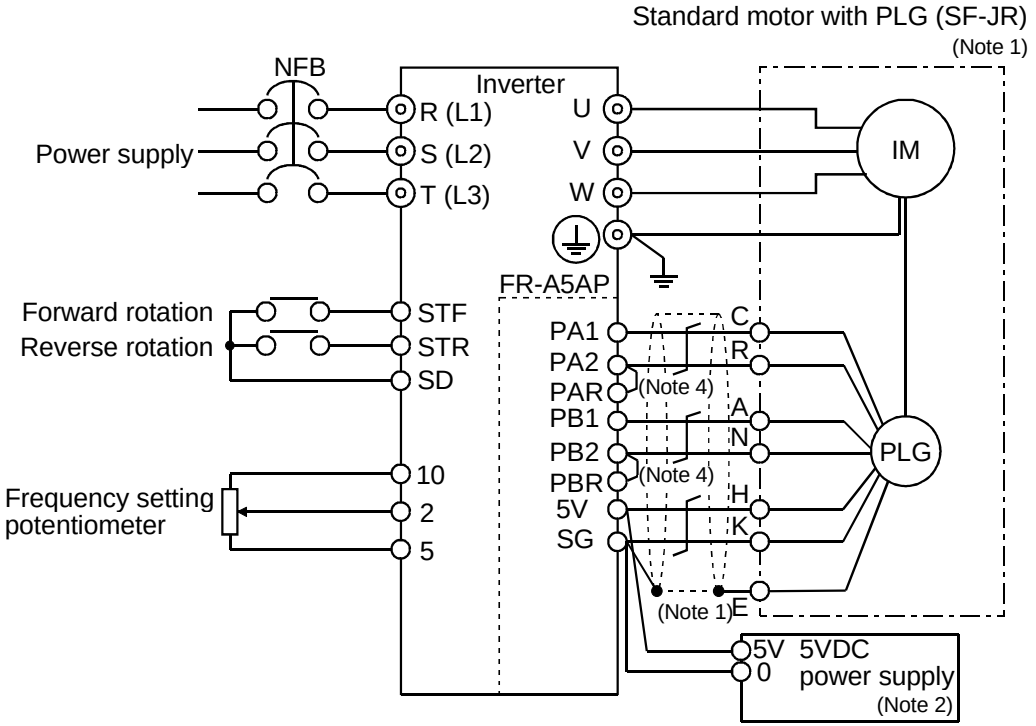
3.9. Specifications

Stop position accuracy	±1.5 degrees Note: Depends on the load torque, load GD2, orientation speed, creep speed, position loop select position, etc.
Permissible rotation speed	PLG-mounted shaft speed (6000r/min) Note: The motor and PLG-mounted shaft must be coupled directly or via a belt without any slip. A gear change type cannot be used.
Functions	• Orientation and creep speed setting. • Stop position command selection. • DC dynamic brake start position setting. • Creep speed and position loop select position setting. • Position shift. • In-position zone. • Position signal monitoring, etc. Note: Set the above functions from the parameter unit.
Holding force after positioning	Without servo lock function (However, when "2" is set in Pr. 370 to choose vector control, the servo lock function is valid.)
Input signals (contact input)	• Orientation command. • Forward and reverse rotation commands. • Stop position command (open collector signal may also be entered). Maximum 12-bit binary signal.
Output signals (open collector output)	• In-position signal. • Orientation fault signal.
DC power supply	Prepare a 5VDC power supply for the PLG. (Usually approximately 350mA) 5V, 50mA is also required for the option. Supply power from the NC or use a general power supply. Example: NEMIC LAMBDA ES15-5 (5V, 3A) *When PLG feedback control and orientation control are used together, the 5V power supply is shared between these controls.

4. PLG FEEDBACK CONTROL

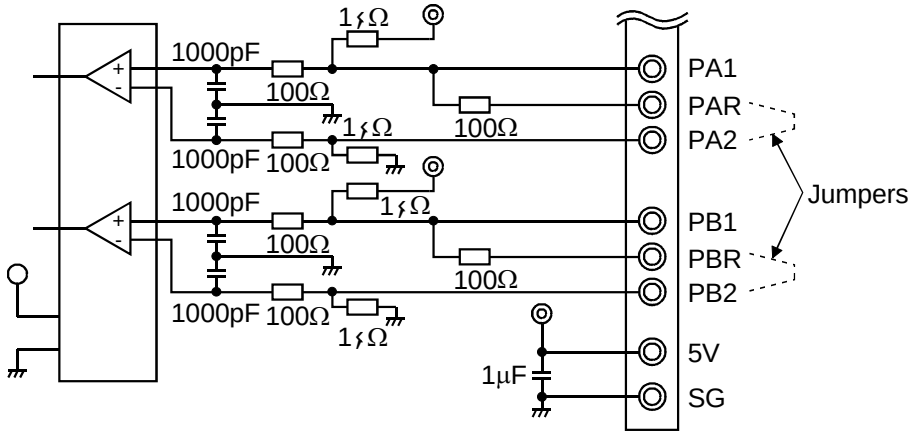
This function is used with a speed detector (PLG) to allow the motor speed to be detected by the speed detector and fed back to the inverter so that the output frequency of the inverter is controlled to keep the motor speed constant to load variations. Pr. 367 "speed feedback range" is factory-set to "9999" and Pr. 370 "control mode selection" to "0", making this function invalid.

4.1. Wiring Example



Note: 1. When the motor with PLG used is other than the standard motor with PLG (SF-JR), the pin numbers are different. To reduce radiation noise, connect the shield wires of the PLG cables to the case earth pin.
2. When PLG feedback control is used with orientation control, the PLG and 5V power supply may be shared between these controls.
3. Couple the PLG in line with the motor with a speed ratio of 1 to 1 without any mechanical looseness.
4. Keep the accessory jumpers connected. However, when the same PLG is shared between the FR-A5AP and the other unit (e.g. NC) which is connected with a terminal resistor, the built-in terminal resistors are not required and should be removed. (Terminal resistors; 100Ω)

4.2. Input Circuit



4.3. Terminals

Symbol	Terminal	Remarks	Description
PA1	PLG A-phase signal input terminal	For information on the pulse signals, refer to page 30.	A and B-phase signals are input from the PLG.
PA2	PLG A-phase inverse signal input terminal		
PB1	PLG B-phase signal input terminal		
PB2	PLG B-phase inverse signal input terminal		
PAR	A-phase terminal resistor terminal		Factory-connected with "PA2" by the jumper. Remove the jumper when the terminal resistor is not needed.
PBR	B-phase terminal resistor terminal		Factory-connected with "PB2" by the jumper. Remove the jumper when the terminal resistor is not needed.
5V	DC power (positive) input terminal	4.75 to 6VDC (Current consumption 50mA)	PLG power supply common terminals. Input PLG power. Connect the positive side to 5V and the ground side to SG. Also, connect the shield of the shield wire to SG.
SG	DC power ground terminal		

4.4. Wiring Instructions

(1) Connection with the speed detector (PLG).

Use twisted pair shielded cables (0.2mm2 or larger) to connect the FR-A5AP and speed detector (PLG). Cables to terminals 5V and SG should be connected in parallel or be larger in size according to the cable length table as indicated below. To protect the cables from noise, run them (at least 10cm) away from any source of noise (e.g. the main circuit and power supply voltage).

(2) Cable length.

1) Cable length within 30m.

Cable Length	Number of Parallel Cables of 0.2mm2	Larger-Size Cable
Within 10m	At least 2 cables	0.4mm2 or larger
Within 20m	At least 4 cables	0.75mm2 or larger
Within 30m	At least 6 cables	1.25mm2 or larger

2) Cable length of more than 30m

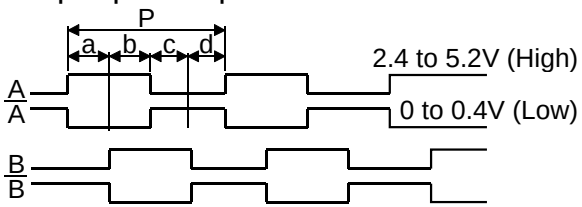
Use a power supply slightly higher than 5V (approximately 5.5V) in addition to 6 or more parallel cables of 0.2mm2 or cables of 1.25mm2 or more. This allows the cable length to be increased up to 100m. Note that the voltage applied across terminals 5V-SG must not exceed 6V.

(3) Connection of terminal resistors

Use the jumpers across PA2-PAR and PB2-PBR to connect terminal resistors to the A and B-phases of the PLG. Normally, keep the jumpers fitted. However, remove the jumpers when the same PLG is shared between the FR-A5AP and the other unit (e.g. NC) which is connected with a terminal resistor.

(4) Speed detector (PLG)
Line driver LED type PLG
A. $\overline{A}$ signal 1000ppr to 4096ppr
B. B signal 1000ppr to 4096ppr

Output pulse specifications



a, b, c and d should be (1/4 ± 1/8)P when rotation is clockwise as viewed from the shaft end of the PLG.

<Example of PLG available on the market>
Tamagawa Seiki:
TS1508N207, TS5008N122, TS5108N122

Pin Numbers of PLG Output Signals (Tamagawa Seiki, TS1508N207)

Pin Number	Output Signal	Pin Number	Output Signal
C	A-phase signal	H	+5V power supply
R	A-phase inverse signal	K	Power supply common
A	B-phase signal	E	Case earth
N	B-phase inverse signal		

Note: When PLG feedback control and orientation control are used together, the PLG is shared between these controls. Use the PLG with a pulse count is 1000 to 4096ppr.

4.5. Related Parameter List

Parameter Number	Name	Setting Range	Minimum Setting Increments	Factory Setting	Control Mode	
					PLG feedback control	Vector control
22	Torque limit level (Stall prevention operation level) (Note 1)	0 to 200%, 9999	0.1%	150%	— (Note 3)	○
29	Acceleration/deceleration pattern	0, 1, 2, 3, 4	1	0	○(Note 4)	○(Note 4)
144	Number of motor poles (Speed setting switch-over) (Note 1)	0, 2, 4, 6, 8, 10, 102, 104, 106, 108, 110	1	4	○	○
162	Automatic restart after instantaneous power failure selection	0, 1, 2	1	0	○	○
285	Overspeed detection frequency	0 to 30Hz, 9999	0.01Hz	9999	○	○
359	PLG rotation direction	0, 1	1	1	○	○
367	Speed feedback range	0 to 400Hz, 9999	0.01Hz	9999	○	—
368	Feedback gain	0 to 100	0.1	1	○	—
369	Number of PLG pulses	0 to 4096	1	1024	○	○
370	Control mode selection	0, 1, 2	1	0	○	○
371	Torque characteristic selection	0, 1	1	1	—	○
372	Speed control P gain	0 to 200%	0.1%	100%	—	○
373	Speed control I gain	0 to 200%	0.1%	20%	—	○
374	Overspeed detection level	0 to 400Hz	0.01Hz	120Hz	○	○
375	Servo lock gain	0 to 150	1	20	—	○
380	Acceleration S pattern 1	0 to 50%	1%	0%	—	○
381	Deceleration S pattern 1	0 to 50%	1%	0%	—	○
382	Acceleration S pattern 2	0 to 50%	1%	0%	—	○
383	Deceleration S pattern 2	0 to 50%	1%	0%	—	○

Note: 1. When the FR-A5AP is not fitted, the function names in parentheses are used.
2. • in the Control Mode field indicates that the corresponding function is valid.
3. Functions as the stall prevention operation level.
4. The acceleration/deceleration pattern C setting (Pr. 29 = 4) is made valid when the FR-A5AP is fitted.

4.6. Pre-Operation Settings

(1) Pr. 144 "number of motor poles (PLG)".

The either of the following motors may be used. Set the number of motor poles according to the motor used:

- Standard motor (with PLG) : SF-JR 0.2kW to 55kW
- Constant-torque motor (with PLG) : SF-JRCA 0.4kW to 55kW

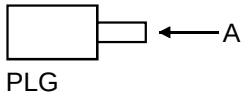
Note: 1. For vector control, this parameter value is made invalid and the setting of Pr. 81 "number of motor poles" is made valid.
2. If you set this parameter value to "0, 10 or 110" and operate the inverter, any of E.OP1 to E.OP3 occurs.
3. If you set "102, 104, 106 or 108", that value minus 100 is set as the number of poles.

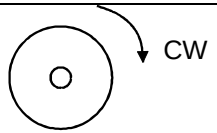
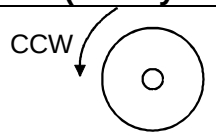
(2) Pr. 369 "number of PLG pulses".

Set the number of PLG pulses.
Set the number of pulses before it is multiplied by 4.
Example:Set "1024" for 1024 pulses per revolution (ppr).

(3) Pr. 359 "PLG rotation direction".

Indicates the direction in which the PLG rotates.



Pr. 359=0	Pr. 359=1 (factory setting)
 Forward rotation is clockwise rotation when viewed from A.	 Forward rotation is counterclockwise rotation when viewed from A.

Note: When the FR-A5AP is fitted and PLG feedback control or vector control is selected, the PU (FR-DU04/FR-PU04) shows the rotation direction of the PLG. Make the setting so that FWD is displayed when the STF signal switches on or REV displayed when the STR signal switches on.

4.7. Control Mode Setting

By setting the Pr. 370 "control mode selection" value, you can choose any of PLG feedback control (V/F control, advanced magnetic flux vector control) and vector control.
Torque control and position control are not performed. (However, torque limit can be done in the vector control mode.) When holding torque is required during a stop, choose vector control (zero speed control or servo lock).

Control Mode		**Motor**	**Pr. 80, Pr. 81 Setting**	**Pr. 370 Setting**	**Pr. 367 Setting**	**Zero Speed Control**	**Servo Lock**	**Torque Limit**
PLG feedback control	V/F control	Standard motor with PLG (same capacity)	9999	0 (1,2) (Note 2)	Other than 9999	×	×	×
	Advanced magnetic flux vector control	Standard motor with PLG (same capacity)	Other than 9999	0	Other than 9999			
Vector control (Note 1)		Standard motor with PLG (same capacity)	Other than 9999	1	—	○	×	○
			Other than 9999	2	—	×	○	○

Note: 1. When a speed control range of 1:1000 is required, choose vector control.
If vector control has been chosen, torque control and position control are not performed. The frequency response of vector control is 10 to 20rad/s.
2. When Pr. 80 and Pr. 81 = "9999", PLG feedback control (V/F control) is valid if "1" or "2" is set in Pr. 370.
3. The RT terminal may be used to select between V/F control, PLG feedback control + advanced magnetic flux vector control and vector control during a stop only.

4.8. PLG Feedback Control

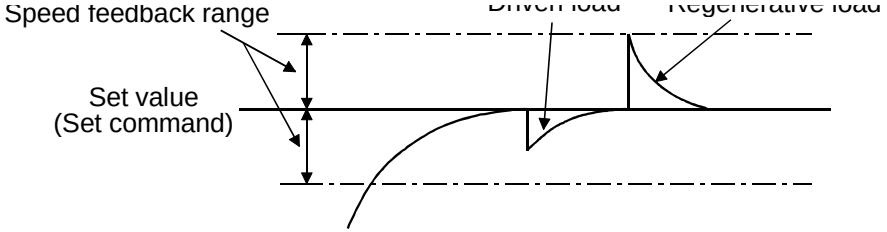
Make sure that Pr. 80 "motor capacity", Pr. 81 "number of motor poles", Pr. 144 "number of motor poles", Pr. 369 "number of PLG pulses", Pr. 359 "PLG rotation direction" and Pr. 370 "control mode" values are set properly. (Refer to Section 4.6 "Pre-Operation Settings and 4.7 "Control Mode Setting".)

(1) Pr. 367 "speed feedback range".
This parameter is used to make the PLG feedback function valid.
Set the speed feedback control range.
(When Pr. 367 = 9999 (factory setting), the PLG feedback function is invalid.)

<Setting>
Define the upper and lower limits in reference to the set value (frequency at which the motor is to be rotated at constant speed). Normally, set the frequency converted from the rated motor speed (rated load) and slip (r/min). Too large setting will result in slow response.

Example: Rated speed of a 4-pole motor is 1740r/min (60Hz)
Slip Nsp = synchronous speed - rated speed
= 1800 - 1740 = 60 (r/min)
Frequency equivalent to slip (fsp)

$$fsp = \frac{Nsp \times number\ of\ poles}{120} = \frac{60 \times 4}{120} = 2(Hz)$$



(2) Pr. 368 "feedback gain".

This parameter is valid when PLG feedback control is valid.
Set if rotation is instable or response is slow.
When the setting is greater than 1, response is faster but overcurrent or rotational instability is more liable to occur.
When the setting is less than 1, response is slower but rotation is more stable.

(3) Instructions for PLG feedback control.

1) The number of motor poles used must be checked before starting operation. The number of poles set must be correct to ensure proper control of the motor.
2) The PLG should be coupled in line with the motor shaft without any mechanical looseness with a speed ratio of 1 to 1.
3) Make sure that the PLG has been set to the correct rotation direction on the rotation direction display of the parameter unit. If the rotation direction is not correct, PLG feedback control cannot be carried out (the inverter can be operated).
4) During acceleration or deceleration, PLG feedback control is not performed to prevent instability such as hunting. PLG feedback control is started after the output frequency has once reached the [set speed] ± [speed feedback range].
5) If any of the following conditions occurs during PLG feedback control operation, the inverter is run at the output frequency of [set speed] ± [speed feedback range] without coming to an alarm stop and does not follow up the motor speed:
   - The pulse signal from the PLG is switched off due to an open cable, etc.
   - An accurate pulse signal cannot be detected due to induction noise, etc.
   - The motor is forced to accelerate (regenerative operation) or decelerate (e.g. motor lock) by large external force.
6) When opening the brake of the motor with brake, use the RUN (running) signal. (The brake may not be opened if the FU (output frequency detection) signal is used.)
7) <u>During PLG feedback control, do not switch off the 5V power of the PLG. If the power is switched off, normal PLG feedback control cannot be exercised.</u>
8) Programmed operation cannot be performed in the PLG feedback control mode (when the FR-A5AP is fitted).

9) Set Pr. 285 "overspeed detection frequency" to prevent misoperation caused if an accurate signal cannot be detected from the PLG. This shuts off the output and gives an inverter alarm (E.MB1) when;
(detection frequency) - (output frequency) > Pr. 285.

4.9. Vector control

Vector control can be performed using the standard motor with PLG.
Make sure that Pr. 80 "motor capacity", Pr. 81 "number of motor poles", Pr. 144 "number of motor poles", Pr. 369 "number of PLG pulses", Pr. 359 "PLG rotation direction" and Pr. 370 "control mode" values are set properly. (Refer to Section 4.6 "Pre-Operation Settings and 4.7 "Control Mode Setting".) Servo lock will resist and attempts to move it from the stop position, the limitation is the amount of torque that can be provided. Servo lock is only available in vector control mode (when using a PLG).

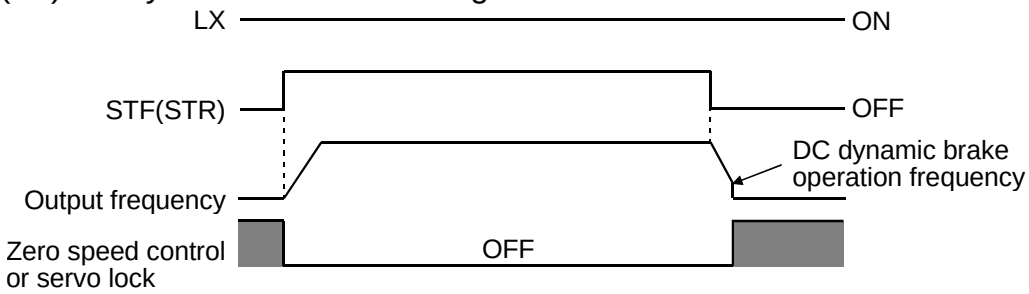
(1) Zero speed control and servo lock

<Zero speed control>
When the Pr. 370 value is "1" and Pr. 80 and Pr. 81 values are not "9999", zero speed control is made valid so that torque may be generated at zero speed.
Use Pr. 22 to set the torque limit level in the zero speed control mode. (150% torque (short duration) is possible.)

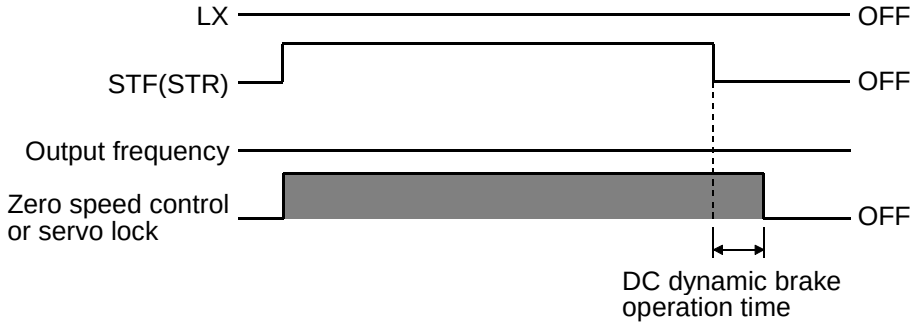
<Servo lock>
When the Pr. 370 value is "2" and Pr. 80 and Pr. 81 values are not "9999", servo lock is made valid.
Use Pr. 22 to set the torque limit level in the servo lock mode. (150% torque (short duration) is possible.)
Also, use Pr. 375 "servo lock gain" to set the servo lock gain.
A high setting will make response faster but increase the probability of instability.
When GD2 (inertia) is large, a high servo lock gain setting will increase the probability of instability.

<Zero speed control and servo lock timing charts>

1) Zero speed control or servo lock is made valid when the auxiliary exciting terminal (LX) is ON without the start signal (STF, STR) being entered into the inverter (during a stop). Assign the function of the auxiliary exciting terminal (LX) to any of the terminals using Pr. 180 to Pr. 186.

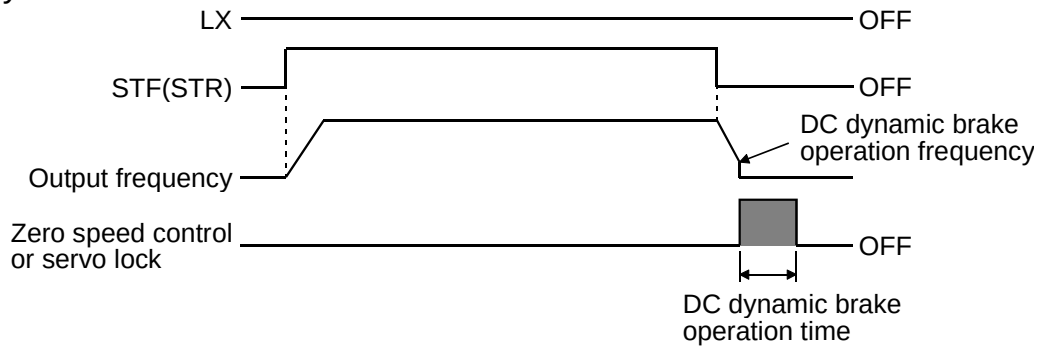


2) Zero speed control or servo lock is made valid when the frequency command is 0Hz (not more than the starting frequency) with the start signal being entered.



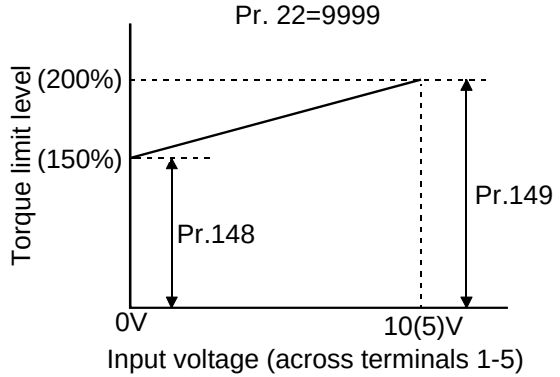
If a start is made during zero speed control or servo lock, online auto tuning is not activated.

3) Zero speed control or servo lock is made valid when the frequency command is not more than the DC dynamic brake frequency during deceleration of the inverter. The position at the DC dynamic brake operation frequency is held.



(2) Pr. 22 "torque limit level"

Torque limit may be activated only when vector control is selected. The second and third functions are Pr. 48 "second torque limit level" and Pr. 144 "third torque limit level". When vector control is not selected, the stall prevention functions are activated. Use the same parameter numbers for setting. The Pr. 22 setting may be changed during operation. When Pr. 22 = "9999", the torque limit level may be set by entering a signal into the No. 1 terminal. At this time, the auxiliary input override function of the No. 1 terminal is not activated.
The variable torque limit level analog signal can be limited.



(3) Pr. 371 "torque characteristic selection"

Used to change the torque characteristic according to the machine characteristics.

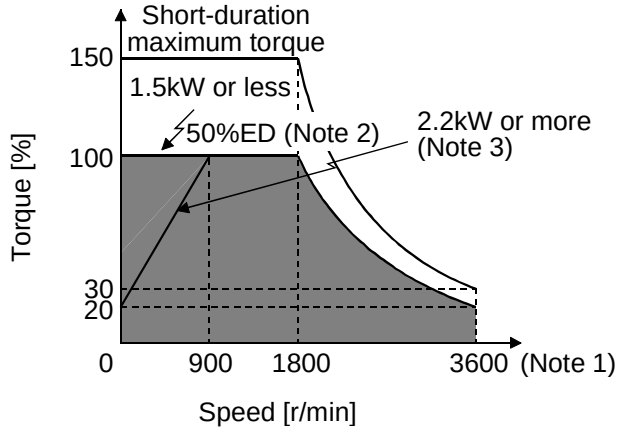
Pr. 371 Setting	**Standard Motor with PLG (e.g. SF-JR)**
0	Cyclic operation mode (Note)
1 (factory setting)	Continuous operation mode

Note: When the cyclic operation mode is used, the inverter capacity must be made one rank higher than the motor capacity.

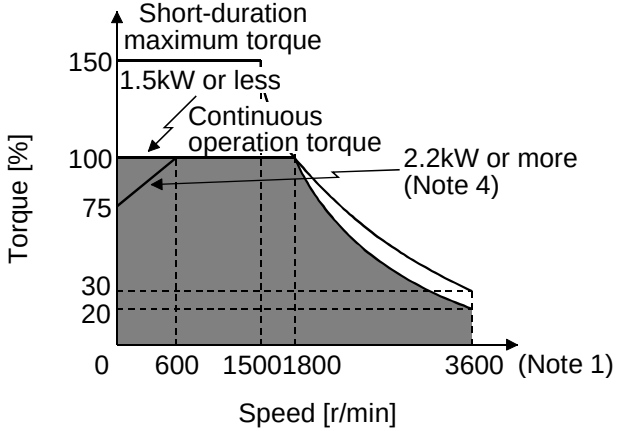
- Torque Characteristic of the Standard Motor with PLG (Example: SF-JR Standard Motor with PLG (4 poles))

With Reference to 1800r/min (60Hz) Torque

Cyclic operation mode setting
[When the inverter used has a capacity one rank higher than that of the motor and the rated voltage is input]



Continuous operation mode setting
[When the inverter used has the same capacity as that of the motor and the rated voltage is input]



Note: 1. The maximum speed is 1) 0.4kW to 7.5kW: 3600r/min, 2) 11kW to 30kW: 3000r/min, 3) 37kW to 55kW: 1950r/min.
2. Continuous, repetitive operation of 50%ED can be performed in cycle time of 10 minutes. Note that the maximum continuous operation time is 5 minutes.
3. Use the constant-torque motor (SF-JRCA with PLG) when 50%ED with 100% torque is required for 2.2kW or more at 900r/min or less.
4. Use the constant-torque motor (SF-JRCA with PLG) when continuous 100% torque is required for 2.2kW or more at 600r/min or less.
5. To provide 150% torque from 0Hz to the rated speed of the motor the inverter should be one rank higher than the motor.
6. Cyclic operation when the inverter and motor have the same capacity is possible but typically only 50% torque can be produced.
7. Continuous operation when the inverter capacity is one rank higher than the motor will produce the same results as when the inverter and motor capacity are the same (as shown above).

(4) Pr. 372 "speed control P gain".
Used to set the proportional gain of the speed loop.
A high setting will make the speed response faster but if the setting is too high this will cause vibrations and noise.

(5) Pr. 373 "speed control I gain".
Used to set the integral gain of the speed loop.
A high setting will shorten restoration time at occurrence of speed variation but if the setting is too high this will cause speed overshooting.

(6) Driving/regenerative status signal output.
When vector control is selected, the driving/regenerative status is output as a signal.
Assign the function of the output signal to any of the output terminals using Pr. 190 to Pr. 195 "output terminal function selection".

(7) Instructions for vector control.
1) When using vector control, perform offline auto tuning in the motor rotation mode (whilst the motor is running).
2) Before starting operation, always confirm that the correct number of poles of the motor used. Proper speed control cannot be performed if the number of motor poles is incorrect.
3) Couple the PLG in line with the motor shaft with a speed ratio of 1 to 1 without any mechanical looseness.
4) Make sure that the PLG has been set to the correct rotation direction on the rotation direction display of the parameter unit. If the rotation direction is not correct, vector control cannot be carried out.
5) In the vector control mode, vector control is also exercised during acceleration/deceleration.
6) When opening the brake of a motor with brake, use the RY2 (operation ready 2) signal. (The brake may not be opened if the FU (output frequency detection) signal is used.)
7) In the vector control mode, the maximum speed is 3600r/min (120Hz). If the speed is increased above that value, it is clamped (limited to 120Hz (3600r/min)).
8) Do not switch off the 5V power of the PLG during vector control. Proper vector control cannot be performed if that power is switched off.
9) Proper vector control cannot be performed if the pulse signal from the PLG is lost due to an open cable, etc.

10) In the vector control mode, the carrier frequency is as follows:

Pr. 72 Setting	**Carrier Frequency**	
	V/F control, advanced magnetic flux vector control	**Vector control**
0	0.7kHz	Approximately 1kHz
1	1kHz	
2	2kHz	
3	3kHz	Approximately 3kHz
4	4kHz	
5	5kHz	
6	6kHz	Approximately 6kHz (Note 1)
7	7kHz	
8	8kHz	
9	9kHz	
10	10kHz	
11	11kHz	
12	12kHz	
13	13kHz	
14	14kHz	
15	14.5kHz	

Note: 1. When the capacity of the inverter is the same as that of the motor, do not set "6" or a higher value in Pr. 72 "PWM frequency selection".
When the capacity of the inverter is one rank higher than that of the motor, "6" (appoximately 6KHz) or a higher value may be set in Pr. 72 "PWM frequency selection".
2. In the vector control mode, set the Pr. 72 "PWM frequency selection" value during a stop.

4.10. Additional Functions

(1) Pr. 162 "selection of automatic restart after instantaneous power failure selection".
By setting "2" in Pr. 162, automatic restart after instantaneous power failure can be made at the frequency detected from the PLG. In the vector control mode, automatic restart is made with the PLG detection frequency searched for, independently of the Pr. 162 setting.

Pr. 162 Setting	Description
0 (factory setting)	With frequency search
1	Without frequency search
2	PLG detection frequency search

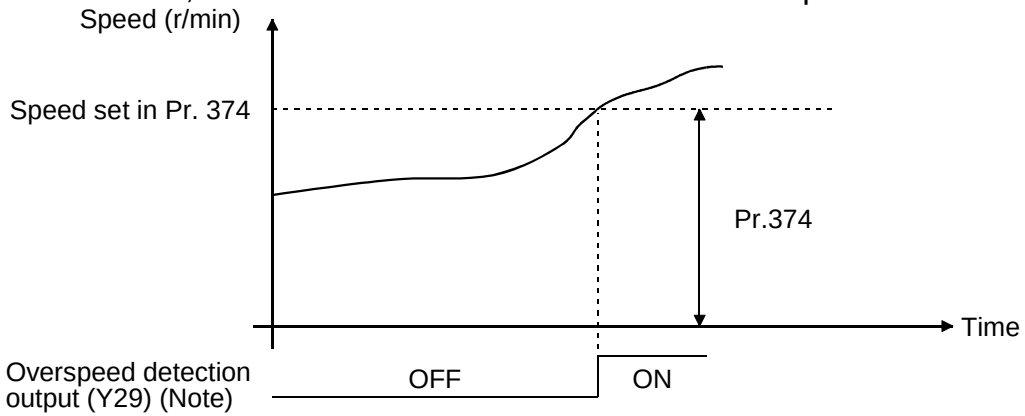
(2) Pr. 285 "overspeed detection frequency".
If (detection frequency) − (output frequency) > (Pr. 285 setting), E.MB1 occurs and the output is shut off.
When Pr. 285 = 9999, overspeed detection is not performed.

(3) Pr. 374 "overspeed detection level".

Used to limit the maximum speed. (0 to 400Hz)

Any speed higher than the speed set in Pr. 374 is judged as overspeed and the corresponding signal is output.

If overspeed is detected, the inverter will not come to an alarm stop.



Note: Assign the function to any of the terminals using Pr. 190 to Pr. 195 "output terminal function selection".

(4) Forward/reverse running signal output.

Whether forward or reverse rotation is being made is output as a signal according to the actual speed.

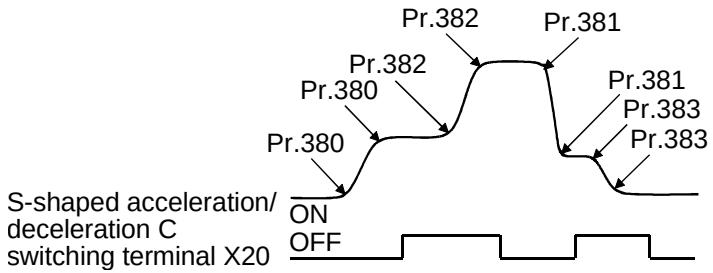
Assign the function of the output signal to any of the terminals using Pr. 190 to Pr. 195 "output terminal function selection".

(5) S-shaped acceleration/deceleration C

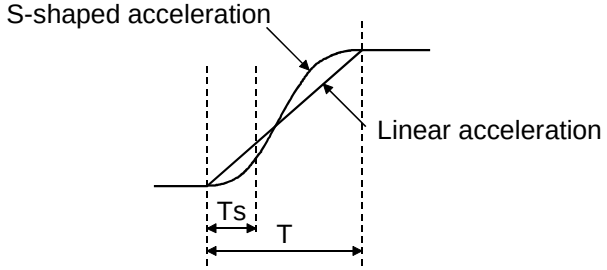
When the FR-A5AP is fitted, S-shaped acceleration/deceleration C can be selected by setting "4" in Pr. 29 "acceleration/deceleration pattern". The S-shaped acceleration/deceleration C function allows the speeds of S-shaped acceleration/deceleration to be set in the corresponding parameters and the required parameter to be selected by the S-shaped acceleration/deceleration C switching terminal (X20).

Assign the function of the S-shaped acceleration/deceleration C switching terminal (X20) to any of the terminals using Pr. 180 to Pr. 186 "input terminal function selection".

Operation / S-Pattern Switching Terminal	During Acceleration	During Deceleration
OFF	Pr. 380 "S-shaped acceleration 1"	Pr. 381 "S-shaped deceleration 1"
ON	Pr. 382 "S-shaped acceleration 2"	Pr. 383 "S-shaped deceleration 2"



Also, Pr. 380 to Pr. 383 are used to set the ratio of the S-shaped acceleration/deceleration time (Ts) to the acceleration/deceleration time (T) in %.



Note: During acceleration/deceleration, switching cannot be made using the S-shaped acceleration/deceleration C switching terminal (X20). When X20 is switched either ON or OFF during either acceleration or deceleration, the effect of the switch (to select a different acceleration or deceleration shape) does not take effect until either the acceleration or deceleration has stopped (i.e. a stable speed has been reached).

4.11. Specifications

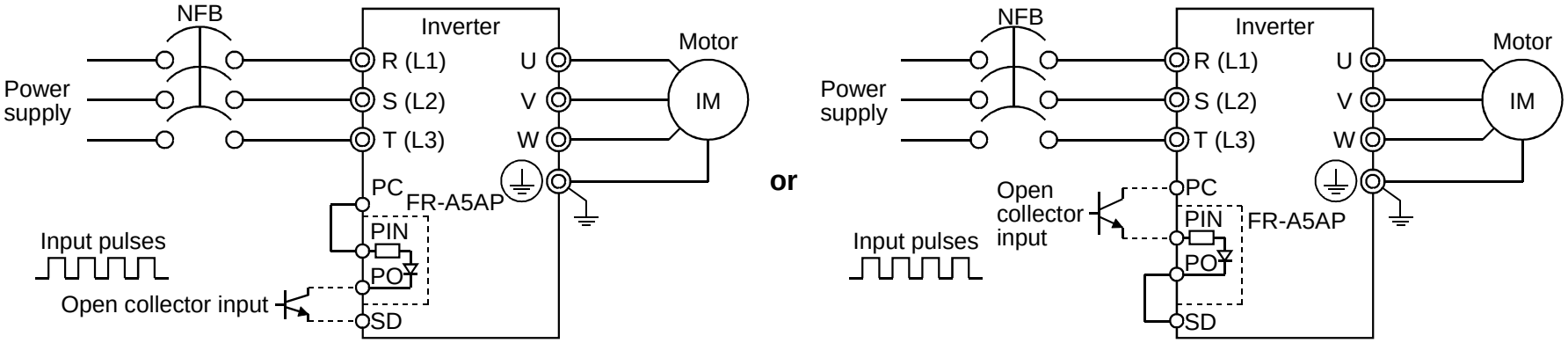
Speed variation ratio	±0.02% of the maximum speed (3600r/min) in vector control mode (load variation 0 to 100% at 6Hz or more). (Note 1)
Speed control range	1:1000 in vector control mode.
Functions	• Speed feedback range setting. • Feedback gain setting. • PLG rotation direction setting.
DC power supply	A 5VDC power supply is required for the PLG and option unit. The 5V power supply can be shared between orientation control and PLG feedback control. This power supply is optional. Power supply 5VDC, current capacity 400mA or more. (Normally approximately 350mA for PLG and 50mA for option unit) <Power supply example> NEMIC LAMBDA ES15-5 (5V 3A)
Maximum speed	3600r/min (120Hz) in vector control mode.
Frequency response	10 to 20rad/s.

Note: 1. Load variation 100% indicates the maximum continuous operation torque value of the motor output characteristic (refer to the relevent catalog or technical information) to the running frequency.

5. Wiring Example

A pulse train signal can be used to enter the speed setting of the inverter.
Pr. 384 is factory set to "0" to make this function invalid.

5.1. Wiring Example



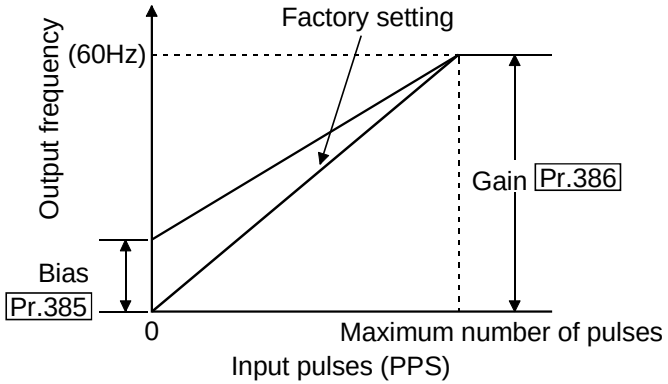
Note: This option unit must be wired using the open collector system to operate it properly.

5.2. Terminals

Symbol	Terminal	Description
PIN	Pulse input terminal 1	Terminal used to enter a pulse train of 0 to 100kpps (Note)
PO	Pulse input terminal 2	Terminal used to enter a pulse train of 0 to 100kpps (Note)

Note: Whether an input pulse is entered into PIN or PO depends on the wiring. Refer to Section 5.1 "Wiring Example".

5.3. Adjustment



Note: Maximum number of input pulses: 100kpps

Note: Number of input pulses are multiplied by 2 internally

5.4. Parameter Definition

Parameter No.	Name	Setting Range	Minimum Increments	Factory Setting
384(Note 1)	Input pulse frequency division ratio	0 to 250	1	0
385	Zero-input pulse frequency	0 to 400Hz	0.01Hz	0
386	Maximum-input pulse frequency	0 to 400Hz	0.01Hz	60

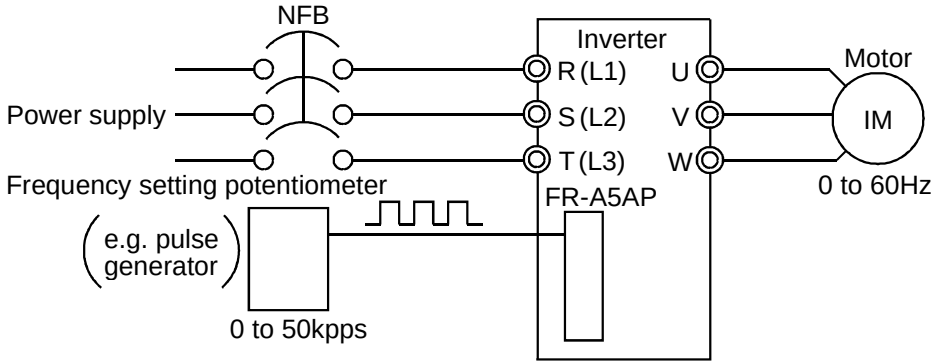
Note: 1. Indicates the frequency division ratio for the input pulses. The frequency resolution to the input pulses varies with the setting.
2. When the Pr. 384 value is "0" (factory setting), Pr. 385 and Pr. 386 do not function even if their values have been set.

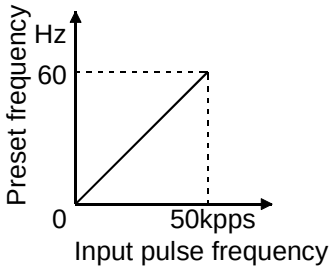
⚠ CAUTION

⚠ It should be noted that if the pulse train input command is not given, the motor will start at the preset frequency by merely switching on the start signal.

5.5. Setting Example

When the frequency is set to 0 to 60Hz at the input pulse frequency setting of 0 to 50kpps.





1) From the maximum number of input pulses, calculate the Pr. 384 "input pulse frequency division ratio" value.

$$\text{Pr. 384} = \frac{\text{Maximum number of input pulses(pps)}}{400}$$

$$= \frac{50000}{400} = 125$$

Set 125 in Pr. 384.

2) Set the zero-input pulse frequency and maximum-input pulse frequency.

Pr. 385 = 0Hz

Pr. 386 = 60Hz

<Example> The following is the calculation of the minimum frequency that may be detected using the above setting example:

$$\text{Minimum frequency} = \frac{\text{Pr. 386}}{2 \times 16.6\text{ms} \times \text{Pr. 384} \times 400}$$

$$= \frac{60}{2 \times 16.6 \times 10^{-3} \times 125 \times 400}$$

$$= 0.04\text{(Hz)}$$

Therefore, the frequency that may be detected is the starting frequency of 0.5Hz or higher.

Input example (Pr. 386 = 400Hz)

Input Pulse Frequency Division Ratio (Pr. 384)	Maximum Number of Input Pulses*1	Minimum Detectable Frequency*2
0 (factory setting)	Pulse input invalid	———
20	8kpps	1.5Hz
50	20kpps	1.0Hz
100	40kpps	0.5Hz
120	48kpps	0.5Hz
200	80kpps	0.5Hz
250	100kpps	0.5Hz

How to calculate the input pulse frequency division ratio

Use the following formula to calculate the input pulse frequency division ratio in Pr. 384:

*1. Maximum number of input pulses (pps) = Pr. 384x400

*2. Detectable frequency > $\frac{\text{Pr. 386}}{2 \times 16.6\text{ms} \times \text{Pr. 384} \times 400}$

The detectable frequency changes with the maximum number of input pulses.

5.6. Specifications

Circuit system	Open collector system
Input current	10mA
Max. permissible number of pulses	100kpps
Input pulse specifications	0 to 250 (variable frequency)
Response delay	16.6ms
Preset frequency resolution	0.012Hz/50Hz