Fuji Electric
e-Front runners

**Instruction Manual**

*FRENIC-Multi*

# PG Interface Card "OPC-E1-PG"

## ⚠CAUTION

Thank you for purchasing our PG interface card.

- Read through this instruction manual and be familiar with the option card before proceeding with installation, connections (wiring), operation, or maintenance and inspection.
- Deliver this manual to the end user of this product. Keep this manual in a safe place until this product is discarded.
- Specifications of this option card are subject to change without prior notice for improvement.

**Fuji Electric Systems Co., Ltd.**

**INR-SI47-1118a-EU REV 052010**

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## Preface

Thank you for purchasing our PG interface card "OPC-E1-PG."

Mounting this optional card into your FRENIC-Multi inverter enables speed control with PG (e.g. V/f control with PG and dynamic torque vector control with PG), pulse train input and positioning control.

Read through this instruction manual in conjunction with the FRENIC-Multi Instruction Manual (INR-SI47-1204-E) and be familiar with proper handling and operation of this product. Improper handling might result in incorrect operation, a short life, or even a failure of this product.

This instruction manual does not contain inverter handling instructions. Refer to the FRENIC-Multi Instruction Manual (INR-SI47-1204-E), and keep this manual in a safe place.

### ■ Safety precautions

Read this manual thoroughly before proceeding with installation, connections (wiring), operation, or maintenance and inspection. Ensure you have sound knowledge of the device and familiarize yourself with all safety information and precautions before proceeding to operate the inverter.

Safety precautions are classified into the following two categories in this manual.

| | |
|---|---|
| ⚠WARNING | Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in death or serious bodily injuries. |
| ⚠CAUTION | Failure to heed the information indicated by this symbol may lead to dangerous conditions, possibly resulting in minor or light bodily injuries and/or substantial property damage. |

Failure to heed the information contained under the CAUTION title can also result in serious consequences. These safety precautions are of utmost importance and must be observed at all times.

### Installation and wiring

**⚠WARNING**

- Turn the inverter's power OFF and wait for at least five minutes before starting installation and wiring.
- Qualified electricians should carry out wiring.
  **Otherwise, electric shock could occur.**

**⚠CAUTION**

- Do not use the product that is damaged or lacking parts.
  **Doing so could cause failure or injuries.**
- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter.
  **Otherwise, a fire or an accident might result.**
- Incorrect handling in installation/removal jobs could cause a failure.
  **A failure might result.**
- Noise may be emitted from the inverter, motor and wires. Implement appropriate measure to prevent the nearby sensors and devices from malfunctioning due to such noise.
  **Otherwise, an accident could occur.**

### Operation

**⚠WARNING**

- Be sure to install the terminal cover before turning the power ON.
  Do not remove the cover while the power is on.
  **Doing so could cause electric shock.**
- Confirm and adjust the setting of the function codes before running the inverter.
  **Otherwise, an accident could occur.**

### Maintenance and inspection, and parts replacement

**⚠WARNING**

- Turn the power OFF and wait for at least five minutes before starting inspection or parts replacement.
  **Otherwise, electric shock could occur**
- Maintenance, inspection, and parts replacement should be made only by qualified persons.
- Take off the watch, rings and other metallic objects before starting work.
- Use insulated tools.
  **Otherwise, electric shock or injuries could occur.**

### Disposal

**⚠CAUTION**

- Treat the PG interface card as an industrial waste when disposing of it.
  **Otherwise injuries could occur.**

### Others

**⚠WARNING**

- Never attempt to modify the PG interface card or inverter.
  **Doing so could cause electric shock or injuries.**

### Icons

The following icons are used throughout this manual.


This icon indicates information which, if not heeded, can result in the inverter not operating to full efficiency, as well as information concerning incorrect operations and settings which can result in accidents.


This icon indicates information that can prove handy when performing certain settings or operations.

This icon indicates a reference to more detailed information.

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# Chapter 1 BEFORE USING THE INVERTER

## 1.1 Acceptance Inspection

Unpack the package and check the following:

(1) The PG interface card is the model you ordered.

(2) The PG interface card is not damaged during transportation--no defective parts or lacking parts.

(3) The model name "OPC-E1-PG" is printed on the PG interface card. (See Figure 1.2.)

If you suspect the product is not working properly or if you have any questions about your product, contact your Fuji Electric representative.

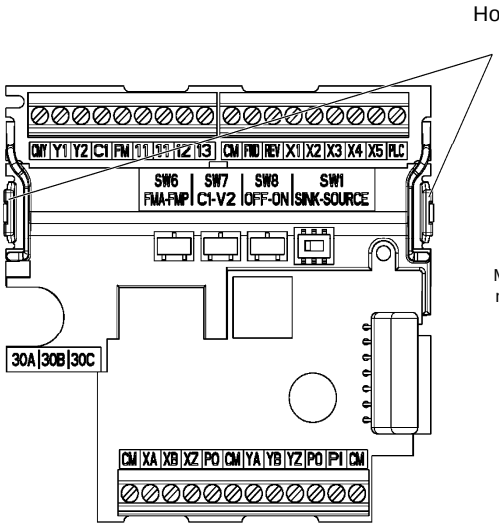



Figure 1.1

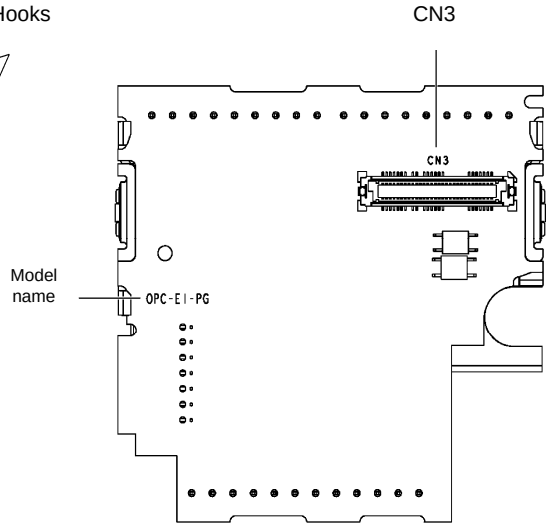



Figure 1.2

### 1.2 Mounting the PG Interface Card

## ⚠WARNING

- Turn the power OFF and wait for at least five minutes before starting installation.
  **Otherwise, electric shock could occur.**

## ⚠CAUTION

- Do not use the product that is damaged or lacking parts.
  **Doing so could cause a failure and injuries.**
- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter.
  **Otherwise, a fire or an accident might result.**
- Incorrect handling when mounting or removing the product could cause a failure.
  **A failure might result.**

When handling the PG interface card and interface printed circuit board (interface PCB), take any antistatic measure or hold their hooks taking care not to directly touch their circuit boards; otherwise, the static electricity charged in your body may damage them.

(1) Remove the terminal cover.
  📖 For details on how to remove the terminal cover, refer to the FRENIC-Multi Instruction Manual (INR-SI47-1204-E), Chapter 2, Section 2.3 "Wiring."
(2) If the interface PCB is installed on the inverter, push the hooks provided on both ends of the interface PCB and pull it up and out of the inverter with both hands. (Store the removed interface PCB for future use.)
(3) Connect the CN3 connector (shown in Figure 1.2) on the PG interface card to the connector on the inverter until it clicks into place.
(4) For inverters of 1 HP or below: Before reinstalling the terminal cover, cut off the barrier (see Figure 1.3) of the terminal cover using nippers or the like
(5) Reinstall the terminal cover, taking care not to pinch control signal lines.
  📖 When reinstalling the terminal cover, refer to the FRENIC-Multi Instruction Manual (INR-SI47-1204-E), Chapter 2, Section 2.3 "Wiring."

Note For inverters of 5 HP or below: When performing the wiring for the main circuit terminals, you need to remove the PG interface card beforehand.

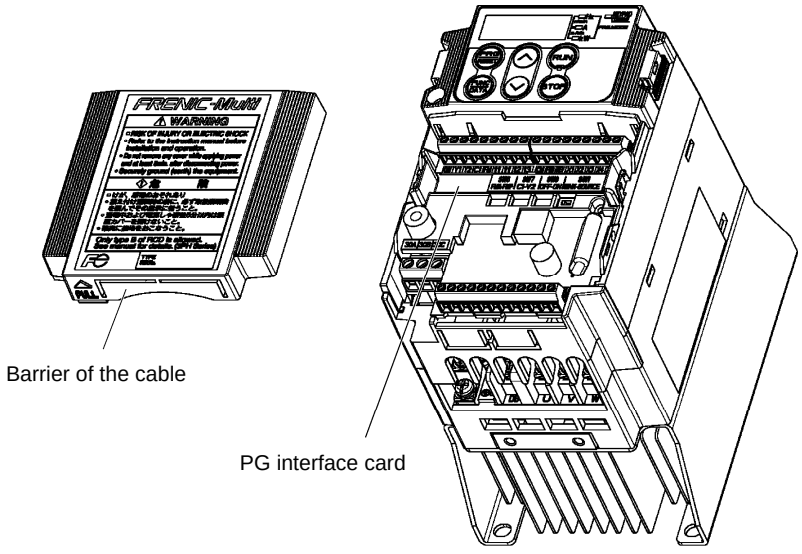



Figure 1.3

## 1.3 PG Specifications and PG Mounting Instructions

**⚠CAUTION**

- Using the PG whose specifications are not satisfied may cause the inverter and equipment to malfunction.
  **Doing so could cause failure or injuries.**

### 1.3.1 PG specifications

Table 1.2 lists the applicable PG specifications.

Table 1.2 Specifications of Applicable PG and PG Interface Card

| Item | | Specifications |
|---|---|---|
| Applicable PG | Encoder system | Incremental system |
| | Pulse resolution | 20 to 3000 P/R |
| | Input power requirements | 5 VDC ±10% / 100 mA<br>(200 mA, when a single PG is mounted.) |
| PG power supply | Internal power supply | +5 VDC ±10% / 200 mA |
| | External power supply | +5 VDC ±10%, 200 mA or more |
| Output signal | Open collector (pull-up resistor: 620Ω)<br>Complementary (totem-pole push-pull) voltage output | |

Note 1: The wiring length between the PG and inverter should not exceed 20 m.

Note 2: When the PG power is 200 mA or more, use an external power supply.

Note 3: The external power supply should satisfy the voltage specifications of the PG.

### 1.3.2 Mounting the PG to the motor

The counterclockwise rotation when viewed from the motor output shaft is regarded as "forward rotation" (see Figure 1.4). During rotation in the forward direction, the PG output pulse forms the forward signal as shown in Figure 1.5 (B phase advances 90 degrees from A phase). During rotation in the reverse direction, the PG output pulse forms reverse signal (A phase advances 90 degrees from B phase).

Mount the PG to the motor with a coupling, etc.

Table 1.3 lists the correct configurations of commands, rotational directions, and motor wiring. Any other configuration fails to perform speed control normally.

Table 1.3 Rotational Direction of Encoder and Motor Shafts

| Run command | Rotational direction | | Motor wiring |
|---|---|---|---|
| | Encoder shaft | Motor shaft | |
| FWD | Forward | Forward | U V W phases in order |
| REV | Reverse | Reverse | U V W phases in order |
| FWD | Forward | Reverse | U V W phases in reverse order |
| REV | Reverse | Forward | U V W phases in reverse order |

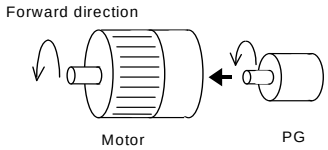



Figure 1.4 Forward Direction of Motor and PG

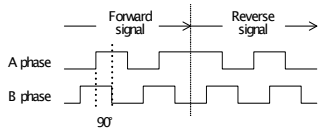



Figure 1.5 Rotational Direction and Output Signal of PG

You can monitor the digital input status of the PG interface card with the inverter keypad. For details, refer to the FRENIC-Multi Instruction Manual (INR-SI47-1204-E), Chapter 3, Section 3.4.5 "Checking I/O signal status."

### 1.3.3 Wiring between the PG interface card and PG

**⚠WARNING**

- Turn the inverter's power OFF and wait for at least five minutes before starting connection.
- Qualified electricians should carry out wiring.
  **Otherwise, electric shock could occur.**

**⚠CAUTION**

- Noise may be emitted from the inverter, motor and wires. Implement appropriate measure to prevent the nearby sensors and devices from malfunctioning due to such noise.
  **Otherwise, an accident could occur.**

Wire the PG to the PG interface card, observing the following precautions and referring to the connection diagrams given in Figures 2.1 to 2.3.

(1) Turn the inverter's power OFF.
(2) Use a shielded wire for wiring between the PG and the PG interface card.
(3) To prevent malfunction due to noise, keep the wiring away from the main circuit wiring of the inverter and the power wiring of other devices as far as possible (at least 10 cm(3.94 in)). Do not route them in the same duct.
(4) Complete the wiring for the PG before turning the inverter's power ON.
(5) The wire size applicable to the option connection terminal on the inverter is AWG 18-24(0.82 to 0.2 $mm^2$).
When using a wire with its end being stripped, strip its end by 5 to 7 mm(0.2 to 0.28 in). When using a ferrule, use a vinyl-insulated ferrule.
Loosen the fixing screw, insert the wire end into the opening of the terminal block, and tighten the screw.

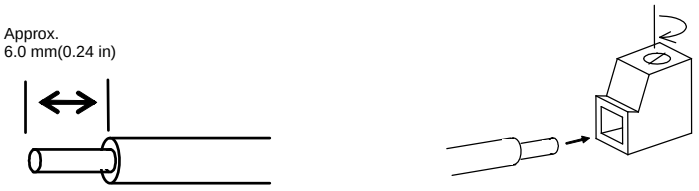



Figure 1.6 Stripping the Wire End Before Connection to Terminal Board

Recommended wire: AWG 18-24(0.82 to 0.2 $mm^2$) for rated temperature 105°C(221°F) (UL)

### 1.3.4 Setting up the power supply for the PG or pulse train generator

| ⚠CAUTION |
|---|
| The external power supply should match the PG power voltage or pulse train generator voltage.<br>**Otherwise, a failure might result.** |

When using an internal power supply

Connect the power supply wire to the terminal [PO] on the PG interface card.

When using an external power supply

Connect the power supply wire to the terminal [PI] on the PG interface card.

### 1.3.5 Connecting to option terminals

Table 1.4 lists terminal symbols, names and functions of the option terminals on the PG interface card.

Table 1.4 Option Terminals and Their Specifications

| Classifi-cation | Terminal symbol | Name | Functions |
|---|---|---|---|
| PG/ Pulse input | PI | External power supply input | Power input terminal from the external device<br>External power supply capacity:<br>5 VDC ±10%, 200 mA or more |
| | PO | Power supply for PG | Power output terminal<br>5 VDC ±10%, Maximum output 200 mA |
| | CM | PG common | Common terminal for power supply and PG input |
| | XA | A phase pulse input X | Pulse input terminal for commands<br>To supply speed commands from the pulse train generator or PG, connect an open-collector output signal or complementary output signal to these terminals.<br>Since [XZ] is not used for train input control, connection to [XZ] is not required if there is no corresponding output at the PG. In positioning control, however, connection to [XZ] enables positioning correction. |
| | XB | B phase pulse input X | |
| | XZ | Z phase pulse input X | |
| | YA | A phase pulse input Y | Pulse input terminal for feedback<br>These terminals are for the detection of the inverter-driven motor speed. Connect an open-collector output signal or complementary output signal to these terminals<br>Since [YZ] is not used for speed control, connection to [YZ] is not required if there is no corresponding output at the PG. In positioning control, however, connection to [YZ] enables positioning correction. |
| | YB | B phase pulse input Y | |
| | YZ | Z phase pulse input Y | |

**Note:** Incorrect wiring of A/B phase could fail to run the motor normally or cause an inverter trip.

### 1.3.6 Option terminals

| CM | XA | XB | XZ | PO | CM | YA | YB | YZ | PO | PI | CM |
|---|---|---|---|---|---|---|---|---|---|---|---|

Screw size: M2
Tightening torque: 0.22 to 0.25 N·m(0.16 to 0.18 lbf·ft)

Figure 1.8 Option Terminals

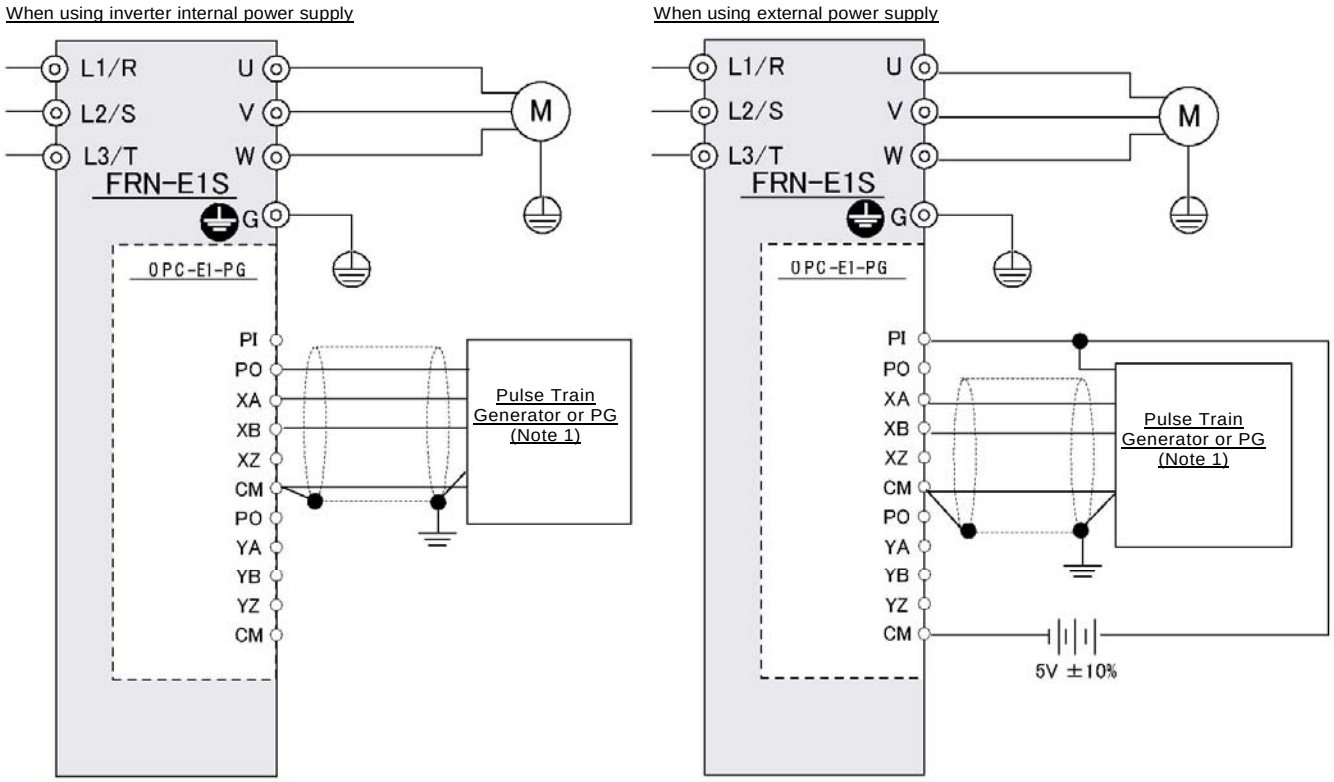
Note Terminal [PLC] on the PG interface card cannot supply power to external equipment. Use the terminal only for receiving power from external equipment.

# Chapter 2 CONNECTION DIAGRAMS

## 2.1 For Frequency Control with Pulse Rate Input

Figure 2.1 shows connection diagram examples for frequency control with pulse rate input.

Figure 2.1 Connection Diagrams for Frequency Control with Pulse Rate Input




Note 1) For details about applicable PG specifications, refer to Table 1.2 in Chapter 1, Section 1.3.1 "PG specifications."

## Chapter 3 PREPARATION FOR OPERATING

After completion of mounting/wiring but before turning the inverter's power ON, check the followings.

(1) The wiring is correct.
(2) There is no cable waste or screws left.
(3) The screws and terminals are firmly tightened.
(4) The straggling wires at ferrules are not short-circuited to other terminals.

Furthermore, after powering the inverter ON but before starting inverter operation, check the followings.

### ⚠CAUTION

- Check the wiring surely before running the inverter. Incorrect wiring causes the inverter or other devices to malfunction.
  **Failure to do so could cause failure or injuries.**

### ⚠WARNING

- Be sure to mount the terminal cover before turning the power ON.
  Do not remove any cover while the power is ON.
  **Doing so could cause electric shock.**
- Confirm and adjust the setting of the function codes before running the inverter.
  **Otherwise, an accident could occur.**

# Chapter 4 PG INTERFACE CARD FUNCTIONS

The combination of the PG interface card and the PG (open collector or complementary output) makes feedback signals available, enabling the following controls.

## 4.1 Speed Control

This refers to speed control with PG. (For details, refer to Chapter 6.)

## 4.2 Frequency Control with Pulse Rate Input

This control specifies a frequency command with pulse trains. (For details, refer to Chapter 5.)
It can be used together with speed control with PG at the same time.

## 4.3 Positioning Control

This refers to simplified positioning control that detects the pulse count with feedback signals sent from the PG. (For details, refer to Chapter 7.)

This control can be used together with speed control with PG and frequency control with pulse rate input at the same time.

## Chapter 5 FREQUENCY CONTROL WITH PULSE RATE INPUT

The pulse rate input feature supplies a frequency command to the inverter in pulse trains. Two pulse input modes are available--B phase pulse (with signs) and forward/reverse rotation pulse trains.
The frequency control with pulse rate input can be enabled concurrently with the speed and positioning controls with PG.

### 5.1 Specifications

Table 5.1 lists the specifications of frequency control with pulse rate input.

Table 5.1 Specifications for Pulse Train Inputs

| Item | Specifications |
|---|---|
| Reference frequency range | 0 to 400 Hz |
| Frequency accuracy | ±0.2% of maximum frequency |
| Output circuits | Open collector<br>Complementary |
| Input pulse level | 5 VDC ±10% |
| Maximum cable length and maximum input pulse rate | 20 m, 30 kp/s |

### 5.2 Terminal Functions

Table 5.2 lists terminal specifications.

Table 5.2 Terminal Specifications

| Terminal symbol | Name | Descriptions |
|---|---|---|
| PI | Power input terminal | Receives power for the PG from an external source. |
| PO | Power output terminal | Outputs power to the PG. |
| CM | Common terminal | Common terminal for the PG power. |
| XA | Command input terminal for A phase pulse train | Receives an A phase feedback pulse train. |
| XB | Command input terminal for B phase pulse train | Receives a B phase feedback pulse train. |
| XZ | -- | Reserved. |

The pulse count of [XA] and [XB] terminal inputs can be displayed on the keypad by using Menu #4 "I/O Checking," Check item 4_15. For details, refer to the inverter's instruction manual. (See the description of function code E52.)

### 5.3 Function Code List

Table 5.3 lists function codes to be used for pulse rate input. Mounting the PG interface card can display o codes.

Table 5.3 Related Function Codes

| Code | Name | Data setting range | Unit | Default setting | Change when running |
|---|---|---|---|---|---|
| F01<br>(C30<br>) | Frequency Command 1<br>(Frequency Command 2) | 0 to 3, 5.<br>7. 11, 12 | - | 0<br>(2) | N |
| o01 | Com-<br>mand/Feedback (Input mode)<br>Input | 0, 1, 2,<br>10, 11, 12<br>20, 21, 22 | - | 0 | N |
| o06 | Command:<br>(Pulse train (Filter time constant)<br>input) | 0.000 to<br>5.000 | s | 0.005 | Y |
| o07 | (Pulse count factor 1) | 1 to<br>9999 | - | 1 | N |
| o08 | (Pulse count factor 2) | 1 to<br>9999 | - | 1 | N |

## 5.4 Function Code Details

| F01 | Frequency Command 1 | (C30: Frequency Command 2) |
|---|---|---|

To drive the inverter with the pulse input frequency command, set the F01 (C30) data to "12" for frequency command 1 (frequency command 2).

| o01 | Command/Feedback Input (Input mode) |
|---|---|

This function code switches the pulse input mode with the data in the ones place as listed in Table 5.4.

Table 5.4 Data for o01

| Pulse input mode | Data for o01 | Remarks |
|---|---|---|
| B phase pulse input | □0 | |
| Pulse input with polarity | □1 | |
| A/B phase pulse input | □2 | Not available (This setting produces 0 p/s.) |

| o06 | Command (Pulse train input) (Filter time constant) |
|---|---|

This function code specifies a time constant determining a linear delay of the low pass filter for the reference speed given by pulse train. Adjusting this time constant can stabilize the speed command in low pulse rate.

| o07 | Command (Pulse train input) (Pulse count factor 1) |
|---|---|
| o08 | Command (Pulse train input) (Pulse count factor 2) |

For the pulse input command, these function codes define the relationship between the input pulse rate and reference frequency.

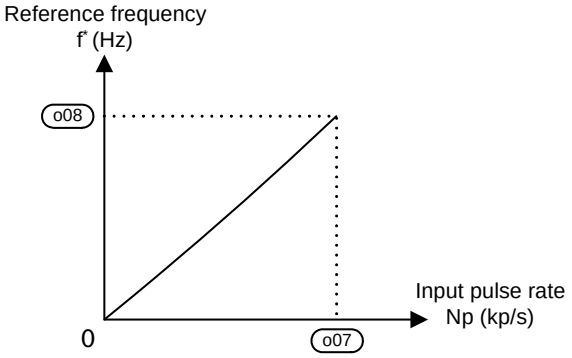



Figure 5.1 Relationship between the Input Pulse Rate and Reference Frequency

As shown in Figure 5.1, set the input pulse rate (kp/s) to the o07 data and set the reference frequency (Hz) at the pulse rate (specified by o07) to the o08 data. The relationship between the input pulse rate at A or B phase input and the reference frequency f* (or reference speed) can be calculated by the following expression.

$$f^*\,(\mathrm{Hz}) = Np\,(\mathrm{kp/s}) \times \frac{\text{Pulse count factor 2 (o08)}}{\text{Pulse count factor 1 (o07)}}$$

f* (Hz) : Reference frequency (In speed control, the frequency corresponding to the speed)

Np (kp/s) : Input pulse rate at A or B phase input

## 5.5 Description of the Control

### 5.5.1 Input pulse command polarity

In the B phase pulse input system shown in Figure 5.2, the A phase voltage determines the polarity of commands. In the run forward/reverse pulse input system shown in Figure 5.3, the presence of A or B phase input determines the polarity of commands.

The combination of the command pulse input and ***FWD***/***REV*** command determines the actual motor rotational direction. Table 5.5 lists the relationship between the polarity of the pulse input, ***FWD***/***REV*** command and motor rotational direction.

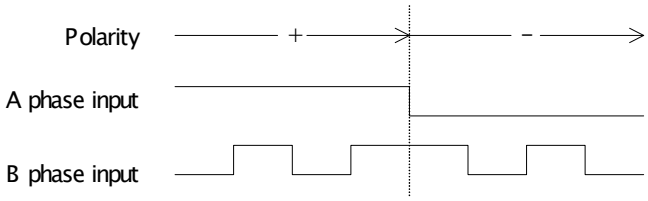



Figure 5.2 Polarity of the B Phase Pulse Input

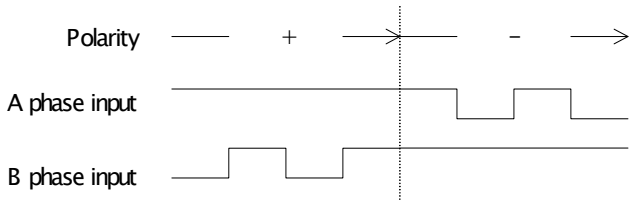



Figure 5.3 Polarity of the Run Forward/Reverse Pulse Input

Table 5.5 Relationship between Polarity of the Pulse Input, ***FWD***/***REV*** Command and Motor Rotational Direction

| Command polarity determined by pulse input | Run command | Motor rotational direction |
|---|---|---|
| + | ***FWD*** | Forward |
| + | ***REV*** | Reverse |
| - | ***FWD*** | Reverse |
| - | ***REV*** | Forward |

### 5.5.2 Block diagram

Figure 5.4 shows a block diagram of the pulse train input command system.

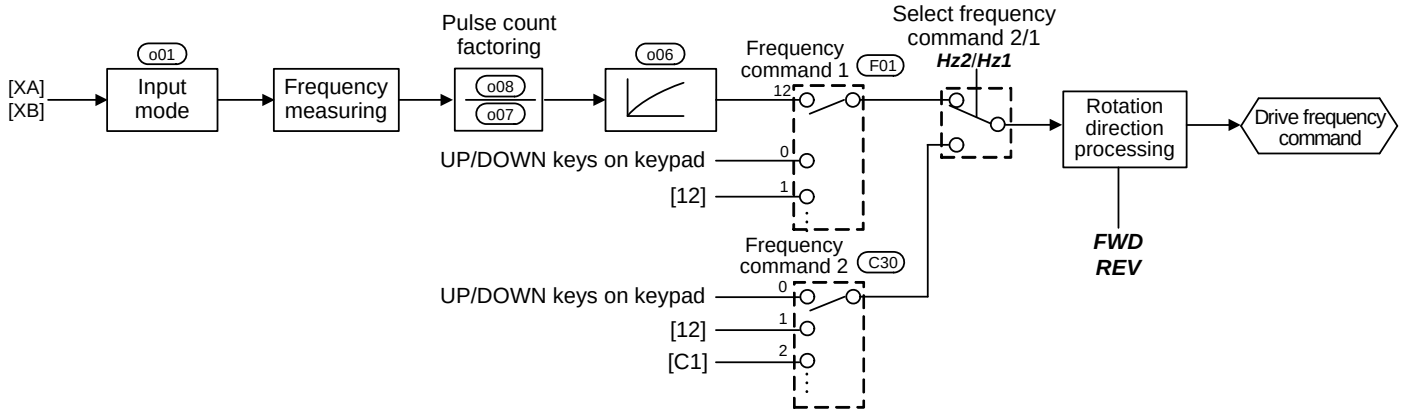



Figure 5.4 Block Diagram of the Pulse Train Input System

## Chapter 6 SPEED CONTROL

Using a PG feedback signal enables V/f control with PG and dynamic vector control with PG.
It speed-controls the detection speed of the motor via the PG and compensates the frequency with PI control so that the motor speed follows the speed command.
The speed control with PG can be enabled concurrently with the frequency control with pulse rate input and positioning control.

### 6.1 Specifications

Table 6.1 lists the specifications of speed control with PG.

Table 6.1 Specifications of Speed Control with PG

| | Item | Specifications | Remarks |
|---|---|---|---|
| Control | Speed control range | 180 to 3600 r/min | When running at constant speed<br>(The maximum speed refers to the speed corresponding to the maximum frequency.) |
| | Speed control accuracy | ±0.2% of maximum speed | |
| Electrical specifications | Input pulse rate | 75 p/s to 30 kp/s | Maximum wiring length: 20 m when using A/B phase pulse input |

### 6.2 Terminal Functions

Table 6.2 lists terminal functions.

Table 6.2 Terminal Functions

| Location | Terminal symbol | Name | Functions |
|---|---|---|---|
| PG interface card | PI | Power input terminal | Receives power for the PG from an external source. |
| | PO | Power output terminal | Outputs power to the PG. |
| | CM | Common terminal | Common terminal for the PG power. |
| | YA | Feedback input terminal for A phase pulse train | Receives an A phase feedback pulse train. |
| | YB | Feedback input terminal for B phase pulse train | Receives a B phase feedback pulse train. |
| | YZ | -- | Reserved. |
| Inverter | Terminal [X] (Note) | "Switch speed control" terminal | Temporarily cancels speed control with PG. |


The pulse count of [YA] and [YB] terminal inputs can be displayed on the keypad by using Menu #4 "I/O Checking," Check item 4_17. For details, refer to the inverter's instruction manual. (See the description of function code E52.)

(Note) "Switch speed control" terminal
Setting "27" to any of function codes E01 to E05, E98 and E99 assigns the "Switch speed control" command ***PG*/*Hz*** to the corresponding one of digital input terminals [X1] to [X5], [FWD] and [REV]. This setting enables the assigned terminal to be used for cancelling the speed control with PG. While the inverter is running, turning this terminal on or off will be ignored. After the inverter stops, it will be validated. If no ***PG*/*Hz*** is assigned, speed control with PG is always enabled.

Table 6.3 Function of ***PG*/*Hz*** Terminal Command

| Terminal command ***PG*/*Hz*** | Function |
|---|---|
| ON | Enable speed control with PG |
| OFF | Disable speed control with PG |

### 6.3 Function Code List

Table 6.4 lists function codes to be used for speed control with PG.
Mounting the PG interface card can display o codes.

Table 6.4 Related Function Codes

| Code | Name | | Data setting range | Unit | Default setting | Change when running |
|---|---|---|---|---|---|---|
| F42 (A14) | Control Mode Selection 1 (Control Mode Selection 2) | | 0 to 4 | - | 0 | N |
| o01 | Command/ Feedback Input | (Input mode) | 0, 1, 2, 10,11,12, 20,21,22 | - | 0 | N |
| o02 | Speed Control | (P Gain) | 0.01 to 200.00 | Times | 10.00 | Y |
| o03 | | (Integral time) | 0.000 to 5.000 | s | 0.100 | Y |
| o04 | | (Filter time constant) | 0.000 to 5.000 | s | 0.020 | Y |
| o09 | Feedback Input | (Encoder pulse resolution) | 20 to 3600 | P/R | 1024 | N |
| o10 | | (Filter time constant) | 0.000 to 5.000 | s | 0.005 | Y |
| o11 | | (Pulse count factor 1) | 1 to 9999 | - | 1 | N |
| o12 | | (Pulse count factor 2) | 1 to 9999 | - | 1 | N |
| o13 | Speed Control | (Output limiter) | 0.00 to 100.00 | % | 100.00 | Y |

### 6.4 Function Code Details

F42 Control Mode Selection 1 (A14: Control Mode Selection 2)

To select the V/f control with PG interface or dynamic torque vector control with PG interface, set the F42 (A14) data to "3" or "4," respectively.

o01 Command/Feedback Input (Input mode)

This function code switches the feedback pulse input mode with the data in the tens place as listed below.

Table 6.5 Data for o01

| Feedback pulse input mode | Data for o01 |
|---|---|
| B phase pulse input | 0□ |
| Forward/reverse pulse input | 1□ |
| A/B phase pulse input | 2□ |

o02 Speed Control (P Gain)
o03 Speed Control (Integral time)

These function codes specify the PI constants of a speed controller. The expression below shows the transfer function of the controller.

$$f_S = k_P \left(1 + \frac{1}{sT_I}\right) \times \varepsilon$$

$K_p$ : P gain (o02)
$T_I$ : Integral time (o03)
$f_S$ : Slip frequency
$\varepsilon$ : Speed deviation
s : Laplace operator

Suppose that the P gain is 1.0 when the speed deviation $\varepsilon$ = 100% (Maximum Frequency F03 (A01)) and $f_S$ is 1% of the maximum frequency.
Suppose that the I integral time = 1.000 seconds when the o03 data is 1.000.
Setting an excessive P gain may cause system hunting. A roughly recommended P gain should not exceed 35.00 in the ordinary system.
Modifying F03 (A01) data requires readjustment of o02 and o03 data.

| o04 | Speed Control (Filter time constant) |
|---|---|

This function code specifies a time constant determining a linear delay of the low pass filter for the speed command given by pulse train. Use this function code to suppress an overshoot that occurs, for example, when the speed command varies.

| o09 | Feedback Input (Encoder pulse resolution) |
|---|---|

This function code specifies the resolution of the encoder mounted on the inverter-driven motor.

| o10 | Feedback Input (Filter time constant) |
|---|---|

This function code specifies a time constant determining a linear delay of the low pass filter for the speed feedback given by pulse train. Use this function when large ripple components superpose the feedback pulse train.

| o11 | Feedback Input (Pulse count factor 1) |
|---|---|
| o12 | Feedback Input (Pulse count factor 2) |

These function codes specify pulse count factors 1 and 2.

Use these function codes when the motor shaft speed differs from the encoder (PG) shaft speed depending upon a transmission reduction ratio. Refer to Figure 6.1 and the expressions below for calculation of the count factors.

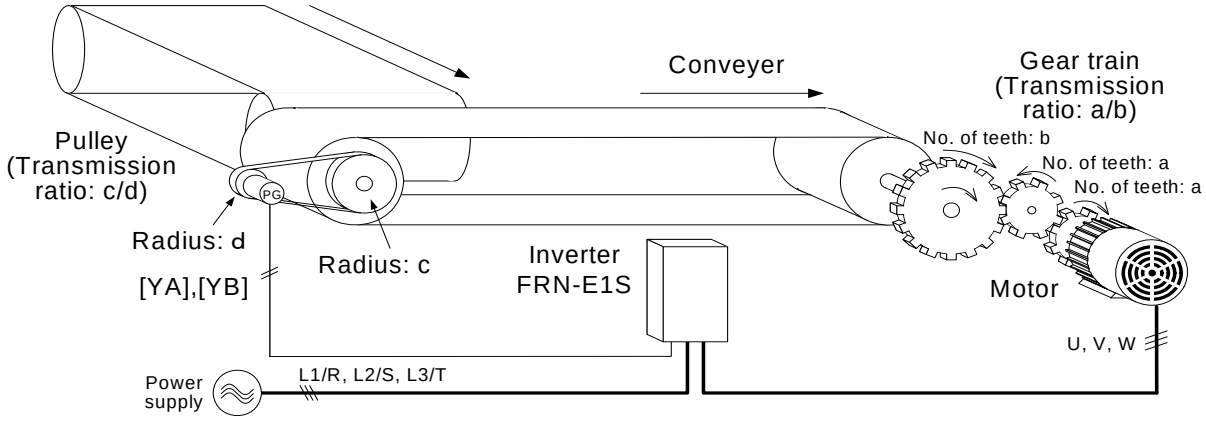



Figure 6.1 Speed Control Model Using a PG

$$\text{Motor shaft speed} = \frac{\text{Pulse count factor 2 (o12)}}{\text{Pulse count factor 1 (o11)}} \times \text{Encoder shaft speed}$$

$$\frac{\text{Pulse count factor 2 (o12)}}{\text{Pulse count factor 1 (o11)}} = \frac{b}{a} \times \frac{d}{c}$$

| o13 | Speed Control (Output limiter) |
|---|---|

This function code specifies the output limit percentage for the speed controller (PI controller). Specification of 100.00% is equivalent to the maximum speed (maximum frequency).

To suppress the frequency control amount (PI controller output) to the extent of the motor's slip frequency in the speed control mode, use this function.

# Chapter 7 POSITIONING CONTROL

Using PG feedback signals enables positioning control. The inverter internally counts the feedback pulses and controls the motor so that the control object moves from the previously specified start point, decelerates and switches to the creep speed operation to arrive at the specified stop position.
The positioning control can be enabled concurrently with the frequency control with pulse rate input and speed control with PG.

## 7.1 Specifications

Table 7.1 lists the specifications of positioning control.

Table 7.1 Specifications of Positioning Control

| | Item | Specifications | Remarks |
|---|---|---|---|
| Speed control | Range | 180 to 3600 r/min | |
| Pulse input | Maximum pulse rate | 30 kp/s | Wiring length: Max. 20 m |

## 7.2 Terminal Functions

Table 7.2 lists terminal functions for the positioning control alone (no concurrent use of the speed control with PG or frequency control with pulse rate input).

Table 7.2 Terminal Functions
(no concurrent use of speed control with PG or frequency control with pulse rate input)

| Terminal symbol | Name | Functions | Remarks |
|---|---|---|---|
| PI | Power input terminal | Receives power for the PG from an external source. | |
| PO | Power output terminal | Outputs power to the PG. | |
| CM | Common terminal | Common terminal for the PG power. | |
| XA | Command input terminal for A phase pulse train | Receives an A phase command pulse train. | Specify the input mode with J86. |
| XB | Command input terminal for B phase pulse train | Receives a B phase command pulse train. | |
| XZ | -- | Reserved. | |
| YA | Feedback input terminal for A phase pulse train | Receives an A phase feedback pulse train. | Specify the input mode with o01. |
| YB | Feedback input terminal for B phase pulse train | Receives a B phase feedback pulse train. | |
| YZ | Feedback input terminal for Z phase pulse train | Receives a Z phase feedback pulse train. | No connection needed if no preset positions are specified with J76 and J77. |

Tip

- The pulse count of [XA], [XB], [YA], [YB] and [YZ] inputs can be displayed on the keypad by using Menu #4, "I/O Checking," Check items 4_15, 4_17, and 4_18. For details, refer to the inverter's instruction manual. (See the description of function code E52.)
- When the positioning control is enabled concurrently with the speed control with PG or frequency control with pulse rate input, the specifications of terminals [XA], [XB], [XZ], [YA], [YB], and [YZ] differ from the ones listed above. For details, refer to Section 7.8 "Assignment of PG Terminals When Shared." (Refer to the description of function code o01.)

## 7.3 Function Code List

Table 7.3 lists function codes to be used for positioning control. Mounting the PG interface card can display o codes.

Table 7.3 Function Codes

| Code | Name | Data setting range | Unit | Default setting | Change when running |
|---|---|---|---|---|---|
| E01 to E05, E98, E99 | Terminal [Xn] Function | 42 (1042): Activate the limit switch at start point, ***LS***<br>43 (1043): Start/reset, ***S/R***<br>44 (1044): Switch to the serial pulse receiving mode, ***SPRM***<br>45 (1045): Enter the return mode, ***RTN*** | - | - | N |
| E20, E21, E27 | Terminal [Y1] Function<br>Terminal [Y2] Function<br>Terminal [30A/B/C] Function | 80 (1080): Stop position override alarm, ***OT***<br>81 (1081): Timer output, ***TO***<br>82 (1082): Positioning completed, ***PSET***<br>83 (1083): Current position count overflowed, ***POF*** | - | - | N |
| J73 | Positioning Control (Start timer) | 0.0: Disable<br>0.1 to 1000.0: Preset time | s | 0.0 | Y |
| J74 | (Start point, upper digits) | -999 to 999 | p | 0 | Y |
| J75 | (Start point, lower digits) | [P], 0 to 9999 *1 | p | 0 | Y |
| J76 | (Preset point, upper digits) | -999 to 999 | p | 0 | Y |
| J77 | (Preset point, lower digits) | [P], 0 to 9999 *1 | p | 0 | Y |
| J78 | (Creep speed switch point, upper digits) | 0 to 999 | p | 0 | Y |
| J79 | (Creep speed switch point, lower digits) | 0 to 9999 | p | 0 | Y |
| J80 | (Creep speed) | 0 to 400 | Hz | 0 | Y |
| J81 | (End point, upper digits) | -999 to 999 | p | 0 | Y |
| J82 | (End point, lower digits) | 0 to 9999 | p | 0 | Y |
| J83 | (Positioning allowance) | 0 to 9999 | p | 0 | Y |
| J84 | (End timer) | 0.0: Disable.<br>0.1 to 1000.0: Preset time | s | 0.0 | Y |
| J85 | (Coasting compensation) | 0 to 9999 | p | 0 | Y |
| J86 | (End point command) | 0: B phase pulse input<br>1: Pulse input with polarity | - | 0 | Y |
| J87 | (Preset positioning requirement) | 0: Forward rotation direction<br>1: Reverse rotation direction<br>2: Both forward/reverse rotation direction | - | 0 | N |
| J88 | *2 (Position detection direction) | 0: Forward direction<br>1: Invert the current direction (× -1). | - | 0 | N |
| o01 | Command/Feedback Input (Input mode) | 0, 1, 2,<br>10,11,12,<br>20,21,22 | - | 0 | N |

*1 [P]: Current position (Absolute position)
Switching between "0" and [P] requires the simultaneous keying: STOP + ⌄ keys from "0" to [P] and STOP + ⌄ keys from [P] to "0."

*2 Even if wrong wiring of the PG inverts the position detection direction, using J88 can correct the direction without rewiring.

## 7.4 Description of the Control

The PG interface card allows the inverter to internally count feedback pulses issued from the encoder (PG) and control the motor so that the control object starts moving from the previously specified start point (S point), decelerates and switches to the creep speed operation to arrive at the specified stop position (E point).

Turning a run command ON with "Start/reset" command ***S/R*** being ON starts the positioning control.

See Figure 7.1 "Positioning Control Model" and Table 7.4.

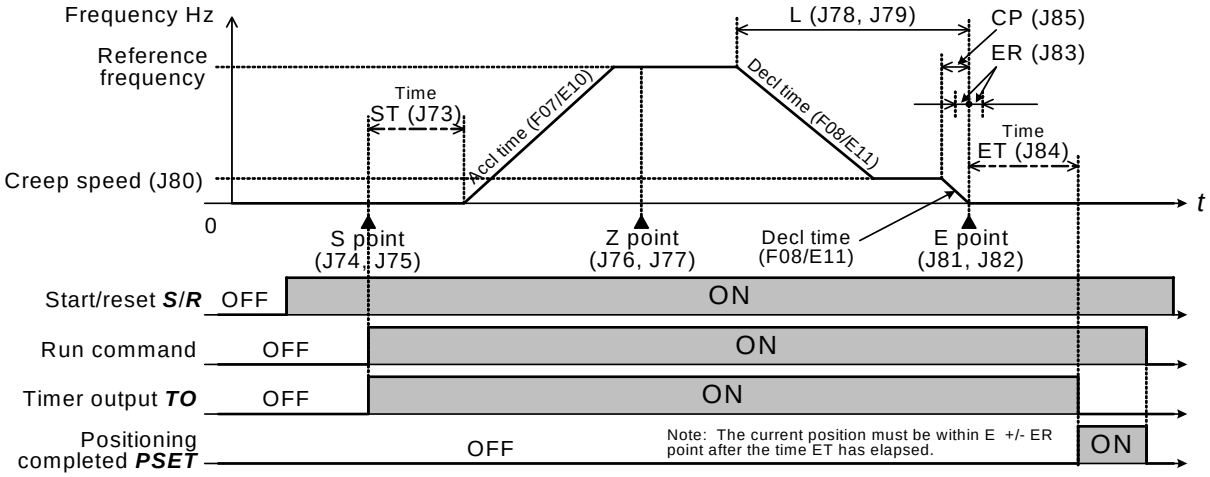



Figure 7.1 Positioning Control Model

Note
- The positioning control applies to motor 1 only.
- During jogging (inching) operation or when the PID control is enabled (J01 ≠ 0), the positioning control is disabled.
- An undervoltage alarm that occurs in positioning control triggers an alarm *ero*; however, the inverter does not enter the restart mode (specified by F14).
- Enabling the positioning control disables the auto-reset function specified by H04 and H05.

Tip The operation status in positioning control can be displayed on the keypad by using Menu #3 "Drive Monitoring." For details, refer to Section 7.6 "Monitoring." (See the description of function code E52.)

### 7.4.1 Symbols

Table 7.4 lists the meanings of symbols used in Figure 7.1.

Table 7.4 Symbol Details

| Symbol | Name | Function code | Descriptions |
|---|---|---|---|
| S point | Start point | J74, J75 | This specifies the start position data for the positioning control. It can be the current position [P] (absolute position) or numerical value (relative position). Specification of an absolute position and that of a relative position produce different results as described below.<br>**[Absolute position]**<br>Specifying [P] regards the current position as a start point. When starting the positioning control, the inverter applies the current position pulse count as start point data.<br>(Example) Suppose that the current position pulse count = 10,000, the start point data = [P], and the stop point (E point) pulse count = 20,000.<br>Then, when starting the positioning control, the inverter moves the control object from the current position (10,000, as start point data) to the E point (20,000). Accordingly, the object moving pulse count is 10,000 (20,000 - 10,000).<br>**[Relative position]**<br>Specifying "a" (numerical value) substitutes "a" for the current position data. When starting the positioning control, the inverter applies "a" pulses as start point data.<br>(Example) Suppose that the current position pulse count = 10,000, start point data "a" = 4,000, and the stop position (E point) pulse count = 20,000.<br>Then, when starting the positioning control, the inverter moves the control object from the start point pulse count "a" (4,000) instead of the current position data (10,000) to the E point (20,000). Accordingly, the object moving pulse count is 16,000 (20,000 - 4,000). |
| ST | Start timer | J73 | This specifies the waiting time from when a run command comes ON with the ***S***/***R*** terminal command being ON until the inverter starts running the motor. (This covers the delay of brake OFF.)<br>If the output frequency has not been zero (inverter running), turning the terminal command ***S***/***R*** ON does not start the timer count. (During deceleration triggered by turning the run command OFF, the start timer does not start as well.) |
| Z point | Preset position | J76, J77 | When the inverter detects that the Z signal is turned from Low to High first after the ***LS*** terminal command is turned from OFF to ON, it corrects the current position data for the preset position data (Z point). This is functionally equivalent to a mechanical position correction or origin point reset.<br>Specifying [P] to the preset position does not perform the Z point correction.<br>It is also possible to restrict the application of the Z point correction with the ***LS*** to the motor rotational direction specified by function code J87. |
| L | Creep speed switch point | J78, J79 | This specifies an absolute position pulse count required from a deceleration start point (towards the creep speed specified by J80) to the E point. |
| CP | Coasting correction | J85 | This specifies the deceleration start point that follows the end of creep-speed operation. Specify it with the pulse count from the E point.<br>Take into account the inertia produced when the control object decelerates to stop. |
| E point | End point | J81, J82 | This specifies a target stop position. |
| ER | Positioning allowance | J83 | This specifies the positioning allowance at the E point, that is, "Actual stop position - E point position."<br>After the end timer counts up:<br>If "Actual stop point - E point " ≤ ER, the inverter issues the "Positioning completed" signal ***PSET***.<br>If "Actual stop point - E point " > ER, the inverter issues the "Stop point alarm" signal ***OT***. |
| ET | End timer | J84 | This specifies the waiting time from when the control object stops at E point until the inverter can receive the next positioning control signal.<br>After completion of positioning, when this waiting time has elapsed or when 0.5 second has elapsed if ET < 0.5 second, the inverter issues the "Positioning completed" signal ***PSET*** or "Stop point alarm" signal ***OT***.<br>Turning the run command OFF when the ET is counting interrupts the counting, so the inverter does not issue ***PSET*** or ***OT***.<br>The inverter ensures that ***PSET*** and ***OT*** signals are kept ON for at least 100 ms. |

### 7.4.2 Input/output terminal functions

Table 7.5 Input Terminal Functions

| Terminal function | Terminal command | Description |
|---|---|---|
| Activate the limit switch at start point | ***LS*** | This is used when the inverter corrects the current position data for the preset position data (Z point) specified by function codes J76 and J77.<br>When the inverter detects that the Z signal is turned from Low to High first after the ***LS*** terminal command is turned from OFF to ON, it triggers the Z point correction.<br>In any other conditions, the ***LS*** terminal command produces nothing. |
| Start/reset | ***S/R*** | This enables or disables the positioning control.<br>ON: Enable<br>OFF: Disable |
| Switch to the serial pulse receiving mode | ***SPRM*** | This enables or disables the serial pulse receiving mode.<br>When the serial pulse input shares an input terminal with other functional pulse inputs (when the positioning control is concurrently enabled with frequency control with pulse rate input and/or speed control with PG) with function code setting, the inverter counts input pulses only from the PG for the stop position when the ***SPRM*** terminal command is ON.<br>ON: Enable<br>OFF: Disable<br>If the serial pulse receiving is exclusively assigned to the digital input terminal for the PG input, however, the inverter counts the input pulses for the stop position, regardless of the ***SPRM*** status.<br>Turning the ***SPRM*** ON zero-clears the pulse count (E point data previously specified by J81 and J82). |
| Enter the return mode | ***RTN*** | Starting the positioning control with the ***RTN*** terminal command being ON enables the return mode in which the inverter moves the control object in the reverse direction while keeping the S and E point data.<br>Using the ***RTN*** enables the reciprocal positioning control; moving from S to E points and returning from E to S points.<br>ON: Enable<br>OFF: Disable |

Note The zero-clear function of the received pulse count (E point specified by J81 and J82), which can be triggered by turning the ***SPRM*** from OFF to ON, is always enabled. Take care not to zero-clear the E point mistakenly.

Tip When the positioning control is enabled concurrently with the speed control with PG or frequency control with pulse rate input, the specifications of terminals [XA], [XB], [XZ], [YA], [YB], and [YZ] differ from the ones listed above. For details, refer to Section 7.8 "Assignment of PG Terminals When Shared." (Refer to the description of function code o01.)

Table 7.6 Output Terminal Functions

| Terminal function | Symbol | Description |
|---|---|---|
| Stop position override alarm | ***OT*** | ON conditions<br>• The ET time has elapsed (or after 0.5 second if ET < 0.5 s) or<br>• "Actual stop position – E-point" > ER data.<br>OFF conditions<br>Except the above ON conditions. |
| Timer output | ***TO*** | ON conditions<br>Until the ET time has elapsed after the start timer (J73) starts.<br>OFF conditions<br>Except the above ON conditions. When the ET is cancelled, the output frequency becomes 0 Hz, turning this signal OFF.. |
| Positioning completed | ***PSET*** | ON conditions<br>• The ET time has elapsed (or after 0.5 second if ET < 0.5 s) or<br>• "Actual stop position – E-point" > ER data.<br>OFF conditions<br>Except the above ON conditions. |
| Current position count overflowed | ***POF*** | ON conditions<br>The current position pulse count goes out of the range from -9,999,999 to +9,999,999, regardless of the ON/OFF state of the ***SR*** terminal command.<br>OFF conditions<br>• The position count comes within the specified range after going out of the range,<br>• Any run command is turned ON with the ***S***/***R*** being ON, or<br>• A Z point correction is performed. |

## 7.5 Function Code Details

o01 Command/Feedback Input (Input mode)

This function code switches the feedback pulse input mode with the data in the tens place as listed below.

Table 7.7 Data for o01

| Feedback pulse input mode | Data for o01 |
|---|---|
| B phase pulse input | 0□ |
| Forward/reverse pulse input | 1□ |
| A/B phase pulse input | 2□ |

Tip When the positioning control is enabled concurrently with the speed control with PG or frequency control with pulse rate input, the specifications of terminals [XA], [XB], [XZ], [YA], [YB], and [YZ] differ from the ones listed above. For details, refer to Section 7.8 "Assignment of PG Terminals When Shared." (Refer to the description of function code o01.)

## 7.6 Monitoring

The positioning control status and the pulse count can be displayed on the keypad by using Menu #3 "Drive Monitoring" as described in this section.

### 7.6.1 Monitoring items

Table 7.8 Function Code E43 (LED Monitor, Item selection)

| Data for E43 | Monitor items | Unit | Descriptions | Refer to: |
|---|---|---|---|---|
| 21 | Current position pulse count | p | Displays the current position pulse count. | Section 7.6.2 |
| 22 | Position deviation pulse count | p | Displays the pulse count deviation between the current position and the stop position. | |

Table 7.9 Menu #3 "Drive Monitoring"

| LED monitor shows: | Monitor items | Unit | Descriptions | Refer to: |
|---|---|---|---|---|
| *3_17* | E point pulse count | p | Displays the E point of positioning control in the pulse count. Turning ***RTN*** OFF displays E point (J81 and J82); turning it ON displays S point (J74 and J75). | Section 7.6.2 |
| *3_18* | Current position pulse count | p | Displays the current position pulse count. | |
| *3_19* | Position deviation pulse count | p | Displays the pulse count deviation between the current position and S point. | |
| *3_20* | Positioning control status | -- | Displays the position control status shown in Section 7.6.3 "Positioning control status." | Section 7.6.3 |

### 7.6.2 Displaying system on the LED monitor

The positioning control handles the pulse count ranging from 9,999,999 to +9,999,999. To display it, the 4-digit LED monitor alternately the upper and lower four digits for one second and three seconds, respectively. The lower four digits is followed by a decimal point.

Table 7.10 Displaying System for Pulse Count

| Pulse count | - Running status in Running mode and running info in Programming mode on the standard keypad<br>- Running status in Running mode on the multi-function keypad | | Remarks |
|---|---|---|---|
| | Upper 4 digits | Lower 4 digits | |
| +9,999,999 | +999 | 9999. | Maximum display value |
| +19,999 | +1 | 9999. | The lower digits are not zero-suppressed. |
| +10,000 | +1 | 0000. | |
| +9,999 | +0 | 9999. | |
| +10 | +0 | 0010. | |
| 0 | 0 | 0000. | |
| -10 | -0 | 0010. | |
| -9,999 | -0 | 9999. | |
| -10,000 | -1 | 0000. | |
| -19,999 | -1 | 9999. | |
| -9,999,999 | -999 | 9999. | Minimum display value |

### 7.6.3 Positioning control status

In positioning control, the keypad can display the current control status. Figure 7.2 shows a control status transition model and Table 7.11 lists details of the status.

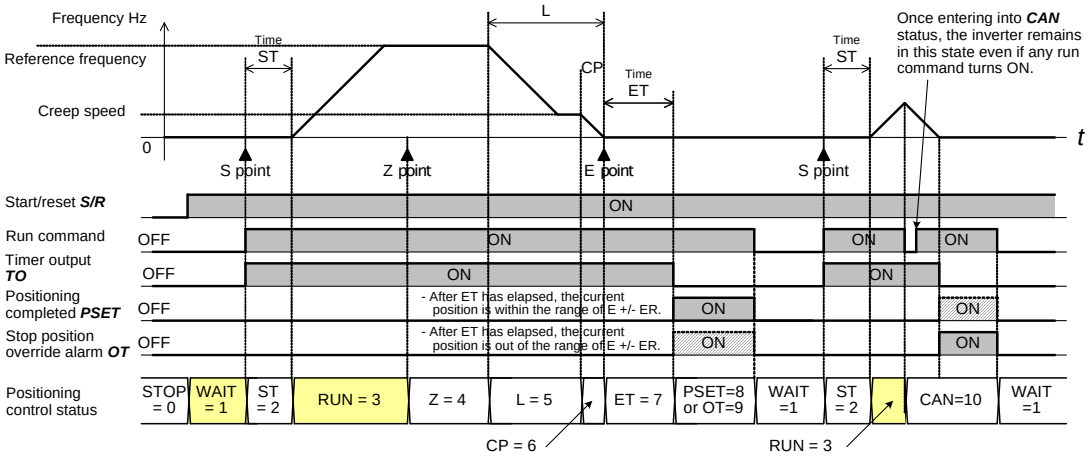



Figure 7.2 Positioning Control Status Transition Model

Table 7.11 Status Name and Number in Positioning Control

| Positioning control status | Status name *1 | Status number *2 | Descriptions |
|---|---|---|---|
| Positioning control stopped | STOP | 0 | Status where ***S/R*** is OFF. Turning ***S/R*** ON shifts to "WAIT = 1" where the inverter waits for a run command. If the inverter output frequency is other than 0 Hz (Gate output) when ***S/R*** is turned ON, it shifts to "RUN = 3" since the start timer does not count. |
| Waiting for run command | WAIT | 1 | Status where ***S/R*** is ON and a run command is OFF. Turning a run command ON in this status shifts to "ST = 2." If the start timer (J73 data) is 0.0 s, the status shifts from "WAIT = 1" to "RUN = 3." |
| Start timer counting | ST | 2 | Status where ***S/R*** and run command are ON and the start timer is counting. Upon completion of timer count, the status shifts to "RUN = 3." |
| Running | RUN | 3 | Status until the inverter enters into a control zone "Current position ≥ (E point - L point)" in forward operation or "Current position ≤ (E point + L point)" in returning operation, or until Z point correction occurs. |
| Z point correction completed | Z | 4 | If Z point correction occurs in "RUN = 3," the inverter shifts to this status. |
| Running in creep speed | L | 5 | Status where the inverter is decelerating down to the creep speed (J80) or is running at the creep speed. |
| Coasting | CP | 6 | Status where the inverter is decelerating to a stop after entering the control zone "Current position ≥ (E point - CP point)" in forward operation or "Current position ≤ (E point + CP point)" in returning operation. |
| End timer counting | ET | 7 | Status where the end timer is counting. |
| Positioning control completed | PSET | 8 | Status where the positioning control is completed and the inverter is issuing ***PSET***. |
| Stop position override alarm | OT | 9 | Status where the inverter is issuing a stop position override alarm ***OT***. |
| Stopped by cancellation | CAN | 10 | If any inverter operation under positioning control is canceled during any status of "ST = 2" to "ET = 7," the inverter enters "CAN = 10." After that, the inverter turns the "Timer output" ***TO*** OFF and issues the "Positioning completed" ***PSET*** or "Stop position override alarm" ***OT***. Once the inverter enters "CAN = 10", the inverter remains in this status and keeps the reference frequency at 0 Hz as long as the run command is not turned OFF. |

*1 The status name can be displayed in "Drive Monitoring" menu on the LCD monitor of the multi-function keypad.

*2 The status number can be displayed in Menu #3 "Drive Monitoring," Display item 3_20 on the standard keypad or on the LCD monitor of the multi-function keypad.

## 7.7 Serial Pulse Receiving Function

When the ***S***/***R*** terminal command is assigned to any digital input terminals [X]s and the serial pulse receiving function is enabled, the pulse train input from host equipment can specify the stop position (E point). Function codes J81 and J82 (Stop position) save the input pulse count.
Function code J86 specifies the pulse input mode for the serial pulse train input.

Note When the serial pulse receiving input shares an input terminal with other function input (e.g. Section 7.8), the inverter counts the PG input pulse train as the serial pulse receiving input for E point pulse count only when ***SPRM*** is ON. On the contrary, if the serial pulse receiving input terminal is exclusively assigned, the inverter counts the input for E point data independently the ON/OFF status of ***SPRM***.

## 7.8 Assignment of PG Terminals When Shared

Table 7.12 lists input assignments for terminals [XA], [XB], [XZ], [YA], [YB] and [YZ] when the positioning control, speed control with PG and speed control with pulse rate input share the PG terminals
The specifications of those terminals when shared differ from the ones when not shared.

Table 7.12 Function Assignments of PG Terminals

| Pulse train input, F01/C30 data is 12. | Speed control with PG, F42/A14 data is 3 or 4. | Positioning control, ***S***/***R*** is assigned. | Normal mode (Except the right column mode) | Serial pulse receiving mode, ***SPRM*** is ON |
|---|---|---|---|---|
| No | No | No | X: Pulse monitor (o01)<br>Y: Pulse monitor (o01) | |
| | | Yes | X: Serial pulse (J86)<br>Y: Positioning control (o01) | |
| | Yes | No | X: Pulse monitor (o01)<br>Y: Speed control (o01) | |
| | | Yes | X: Positioning control (o01)<br>Y: Speed control (o01) | X: Serial pulse (J86) |
| Yes | No | No | X: Pulse train input (o01)<br>Y: Pulse monitor (o01) | |
| | | Yes | X: Pulse train input (o01)<br>Y: Positioning control (o01) | X: Serial pulse (J86) |
| | Yes | No | X: Pulse train input (o01)<br>Y: Speed control (o01) | |
| | | Yes | X: Pulse train input (o01)<br>Y: Speed control / Positioning control (o01) | X: Serial pulse (J86) |

Symbol "X" in the above table stands for PG terminals [XA], [XB] and [XZ]. Specify their input modes with the data in the ones place of function code o01.
Symbol "Y" stands for PG terminals [YA], [YB] and [YZ]. Specify their input modes with the data in the tens place of function code o01.
Switching to the serial pulse receiving mode with ***SPRM*** involves switching of the input mode, so the idle time insertion is required for a stable switching as listed below.

Table 7.13 Idle Time Required for Stable Mode Switching by ***SPRM***

| Function switching | When ***SPRM*** is turned from OFF to ON: | When ***SPRM*** is turned from ON to OFF: | Remarks |
|---|---|---|---|
| Positioning control to/from serial pulse receiving | Insert a minimum of 100 ms idle time before the start of the serial pulse receiving input after ***SPRM*** is turned ON. | Do not input the serial pulse within 100 ms before or after ***SPRM*** is turned OFF. | -- |
| Pulse train input to/from serial pulse receiving | | Stop the serial pulse receiving input before a minimum of 100 ms before ***SPRM*** is turned OFF.<br>Start the pulse train input within 100 ms after ***SPRM*** is turned OFF. | During the "serial pulse receiving mode (***SPRM*** being ON) + 100 ms," the inverter holds the pulse train input count applied when ***SPRM*** is turned ON. |

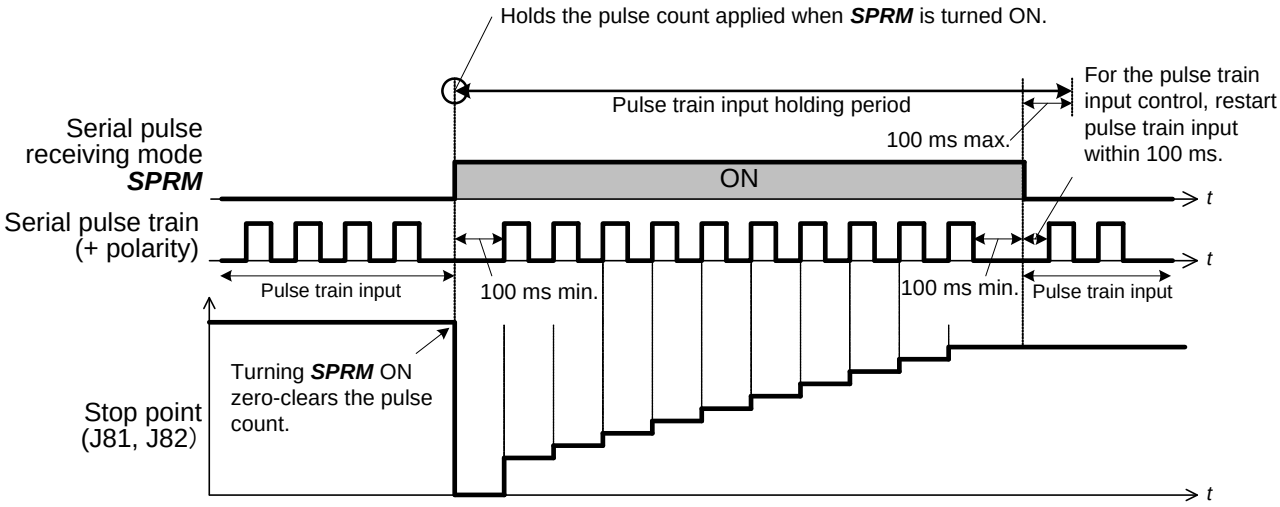



Figure 7.3 Switching the Input Mode between the Pulse Train Input and Serial Pulse Receiving Mode

## Chapter 8 PROTECTIVE FUNCTIONS

If any inverter protective function is activated to issue an alarm, the inverter displays the corresponding alarm code on the LED monitor of the keypad and shuts down its output. Accordingly, the motor coasts to a stop.

Table 8.1 lists alarm codes related to the PG interface card. For other alarm codes, refer to the FRENIC-Multi Instruction Manual (INR-SI47-1204-E), Chapter 6 "TROUBLESHOOTING."

Table 8.1 Related Alarm Codes

| Alarm code | Alarm name | Alarm for: | | | Refer to Section: |
|---|---|---|---|---|---|
| | | Frequency control with pulse rate input | Speed control | Positioning control | |
| *os* | Overspeed alarm | NA | Y | NA | 8.1 |
| *ere* | Excessive speed deviation alarm | NA | C | NA | 8.2 |
| *ero* | Positioning control alarm | NA | NA | Y and C | 8.3 |

Y: Always active. The protective function for the alarm is always active when the control is enabled.

C: Conditionally active. The protective function for the alarm is active when the control is enabled and the protective function is enabled with the function code. The factory default is "enabled."

NA: Not available when the control is enabled.

**⚠WARNING**

If any of the protective functions has been activated, first remove the cause. Then, after checking that the all run commands are set to off, reset the alarm. Note that if the alarm is reset when any run command is set to on, the inverter may supply the power to the motor which may cause the motor to rotate.
**Injury may occur.**

### 8.1 Overspeed Alarm (*os*)

Table 8.2 Overspeed Alarm Specifications

| Alarm code | Descriptions |
|---|---|
| *os* | • The inverter issues this alarm when the detected speed exceeds the 1.2 times the minimum value of either (1) or (2) below.<br>(1) For the selected motor,<br>Maximum frequency (F03 or A01) + Torque limiter (Frequency increment limit for braking, H76)<br>(2) Frequency limiter, High (F15)<br>• This protective function works when the inverter is outputting with the speed control with PG being enabled (F42 or A14 = 3 or 4 and ***PG/Hz*** is ON). |

### 8.2 Excessive Speed Deviation Alarm (*ere*)

Table 8.3 Excessive Speed Deviation Alarm Specifications

| Alarm code | Descriptions |
|---|---|
| *ere* | • This protective function recognizes a PG error by software based on the relationship between the speed command and the detected speed.<br>• When the speed deviation between the speed command and the detected speed has exceeded the excessive speed deviation level specified by o17 during the period longer than the timer setting specified by o18, the protective function issues this alarm.<br>• This protective function provides two choices--"Stop running" (o19 = 1 or 2) and "Continue to run" (o19 = 0) when it is activated. When the latter is selected, the inverter continues to run with output to terminal [Y] without issuing an alarm.<br>• This protective function works when the inverter is outputting with the speed control with PG being enabled (F42 or A14 = 3 or 4 and ***PG/Hz*** is ON). It does not, however, during DC braking or idling due to overload. |

### 8.2.1 Function codes

Table 8.4 lists function codes related to excessive speed deviation alarms.

Table 8.4 Related Function Codes

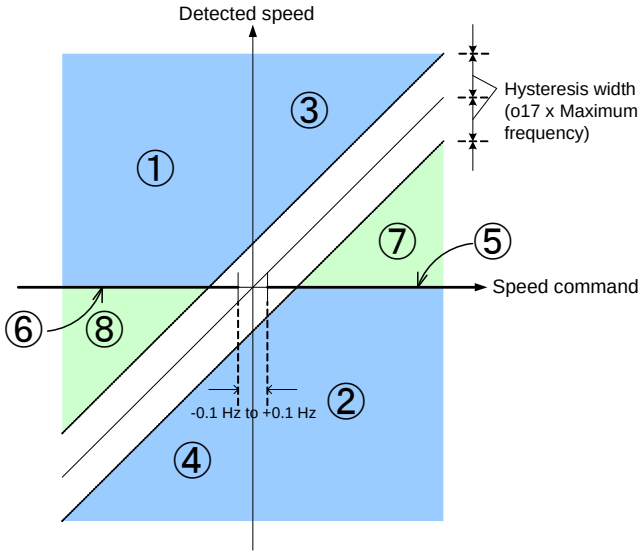
| Code | Name | Data setting range | Unit | Default setting | Change when running |
|---|---|---|---|---|---|
| o17 | Excessive Speed Deviation Level | 0 to 50 | % | 10 | Y |
| o18 | Excessive Speed Deviation Timer | 0.0 to 10.0 | s | 0.5 | Y |
| o19 | PG Error Processing | 0: Continue to run<br>1: Stop running (Alarm mode 1)<br>2: Stop running (Alarm mode 2) | - | 2 | N |
| E20 | Terminal [Y1] Function | 76(1076):<br>PG error signal<br>***PG-ERR*** | - | 0 | N |
| E21 | Terminal [Y2] Function | | | 7 | |
| E27 | Terminal [30A/B/C] Function | | | 99 | |

### 8.2.2 Excessive speed deviation detection

Table 8.5 lists the relationship between PG error detection conditions and error processing (o19.)

Table 8.5 Data for o19 Data and Error Detection

| Data for o19 | Conditions determining the excessive speed deviation | Alarm | ***PG-ERR*** output |
|---|---|---|---|
| 0: Continue to run | Any status of ① to ⑥ in Figure 8.1 is kept exceeding the timer setting specified by o18. | None | Active |
| 1: Stop running (Alarm mode 1) | | *ere* | Inactive |
| 2: Stop running (Alarm mode 2) | Any status of ① to ⑧ in Figure 8.1 is kept exceeding the timer setting specified by o18. | | |




①, ②:
A/B phases of the PG inversely wired

③, ④:
Excessive speed deviation
|Detected speed| > |Speed command|

⑤, ⑥:
PG wire broken or the load locked

⑦, ⑧:
Excessive speed deviation
|Detected speed| < |Speed command|

Figure 8.1 Excessive Speed Deviation Detection and Speed Command

Tip When *ere* alarm occurs, the current error factor (any of ① to ⑧) can be displayed on the keypad by using Menu #6 "Alarm Information," Item 6_21 "Error sub code." The relationship between the error code and error factors in Figure 8.1 are: 1 for ① or ②, 3 for ③ or ④, 5 for ⑤ or ⑥, and 7 for ⑦ or ⑧. For details, refer to the inverter's instruction manual. (Refer to the description of function code E52.)

## 8.3 Positioning Control Alarm (*ero*)

Table 8.6 Positioning Control Alarm Specifications

| Alarm code | Descriptions |
|---|---|
| *ero* | • When the protective function detects an undervoltage during operation in positioning control, it issues this alarm. This alarm is contained in alarm category "Y" in Table 8.1, so it cannot be disabled by any function code. |
| | • This protective function recognizes a PG error by software based on the position pulse feedback status against its output frequency.<br>• This alarm occurs if:<br>(1) The position pulse input count does not change when the inverter output frequency has exceeded the hysteresis width (specified by E30 Frequency Arrival, for 2.5 Hz min.) during the period longer than the timer setting specified by o18.<br>(2) The polarity is being incongruent between the inverter output frequency and feedback position pulse when the inverter output frequency has exceeded the hysteresis width (specified by E30 Frequency Arrival, for 2.5 Hz min.) during the period longer than the timer setting specified by o18.<br>• If the o18 data (Excessive speed deviation timer is set to 0.0 s (Disable detection), however, any alarm will not occur in both cases (1) and (2). This alarm is contained in alarm category "C" in Table 8.1. |

### 8.3.1 Function codes

Table 8.7 lists function codes related to positioning control alarms.

Table 8.7 Related Function Codes

| Code | Name | Data setting range | Unit | Default setting | Change when running |
|---|---|---|---|---|---|
| o18 | Excessive Speed Deviation Timer | 0.0 to 10.0 | s | 0.5 | Y |
| E30 | Frequency Arrival (Hysteresis width) | 0.0 to 10.0 | Hz | 2.5 | Y |
| J88 | Positioning Control (Position detection direction) | 0: Forward direction<br>1: Reverse direction (Inverts the current direction (x -1)) | - | 0 | N |

Tip Alarm (2) in Table 8.6 could occur due to wrong wiring of the PG. Using J88 can correct the direction without rewiring.

**PG Interface Card "OPC-E1-PG"**

**Instruction Manual**

First Edition, June 2006
Fuji Electric FA Components & Systems Co., Ltd.

The purpose of this instruction manual is to provide accurate information in handling, setting up and operating of the PG interface card. Please feel free to send your comments regarding any errors or omissions you may have found, or any suggestions you may have for generally improving the manual.

MEMO

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