Designed for Fan and Pump Applications

# *FRENIC-Eco* for DY model

# ⚠CAUTION

Thank you for purchasing our FRENIC-Eco series of inverters.

- This product is designed to drive a three-phase induction motor. Read through this instruction manual and be familiar with the handling procedure for correct use.
- Improper handling might result in incorrect operation, a short life, or even a failure of this product as well as the motor.
- Deliver this manual to the end user of this product. Keep this manual in a safe place until this product is discarded.
- For how to use an optional device, refer to the installation and instruction manuals for that optional device.

# Preface

Thank you for purchasing our FRENIC-Eco series of inverters.

This product is designed to drive a three-phase induction motor for fan and pump applications. Read through this instruction manual 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 as well as the motor.

Have this manual delivered to the end user of this product. Keep this manual in a safe place until this product is discarded.

Listed below are the other materials related to the use of the FRENIC-Eco. Read them in conjunction with this manual as necessary.

• FRENIC-Eco User's Manual

• RS-485 Communication User's Manual

• Catalog

• Relay Output Card "OPC-F1-RY" Instruction Manual

• Mounting Adapter for External Cooling "PB-F1" Installation Manual

• Panel-mount Adapter "MA-F1" Installation Manual

• FRENIC Loader Instruction Manual

The materials are subject to change without notice. Be sure to obtain the latest editions for use.

## ■ 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.

**Application**

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# ⚠ WARNING

- FRENIC-Eco is designed to drive a three-phase induction motor. Do not use it for single-phase motors or for other purposes.

   **Fire or an accident could occur.**

- FRENIC-Eco may not be used for a life-support system or other purposes directly related to the human safety.
- Though FRENIC-Eco is manufactured under strict quality control, install safety devices for applications where serious accidents or material losses are foreseen in relation to the failure of it.

   **An accident could occur.**

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**Installation**

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# ⚠ WARNING

- Install the inverter on a nonflammable material such as metal.

   **Otherwise fire could occur.**

- Do not place flammable matter nearby.

   **Doing so could cause fire.**

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# ⚠ CAUTION

- Do not support the inverter by its terminal block cover during transportation.

   **Doing so could cause a drop of the inverter and injuries.**

- Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.

   **Otherwise, a fire or an accident might result.**

- Do not install or operate an inverter that is damaged or lacking parts.

   **Doing so could cause fire, an accident or injuries.**

- Do not get on a shipping box.
- Do not stack shipping boxes higher than the indicated information printed on those boxes.

   **Doing so could cause injuries.**

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**Wiring**

# ⚠WARNING

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/a ground fault circuit interrupter(GFCI)(with overcurrent protection) in the path of power lines. Use the devices within the recommended current range.
- Use wires in the specified size.

  **Otherwise, fire could occur.**

- Do not use one multicore cable in order to connect several inverters with motors.
- Do not connect a surge suppressor to the inverter's output (secondary) circuit.

  **Doing so could cause fire.**

- Ground the inverter in compliance with the national or local electric code.

  **Otherwise, electric shock could occur.**

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after turning the power OFF.

  **Otherwise, electric shock could occur.**

- Be sure to perform wiring after installing the inverter body.

  **Otherwise, electric shock or injuries could occur.**

- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.

  **Otherwise fire or an accident could occur.**

- Do not connect the power source wires to output terminals (U, V, and W).

  **Doing so could cause fire or an accident.**

- Generally, control signal wires are not enforced- insulated. If they accidentally touch any of live parts in the main circuit, their insulation coat may break for any reasons. In such a case, an extremely high voltage may be applied to the signal lines. Make a complete remedy to protect the signal line from contacting any hot high voltage lines.

  **Otherwise, an accident or electric shock could occur.**

# ⚠CAUTION

- Wire the three-phase motor to terminals U, V, and W of the inverter, aligning phases each other.

  **Otherwise injuries could occur.**

- The inverter, motor and wiring generate electric noise. Take care of malfunction of the nearby sensors and devices. To prevent the motor from malfunctioning, implement noise control measures.

  **Otherwise an accident could occur.**

**Operation**

# ⚠ WARNING

- Be sure to install the terminal block cover and the front cover before turning the power ON. Do not remove the covers while power is applied.

  **Otherwise electric shock could occur.**

- Do not operate switches with wet hands.

  **Doing so could cause electric shock.**

- If the retry function has been selected, the inverter may automatically restart and drive the motor depending on the cause of tripping.

  (Design the machinery or equipment so that human safety is ensured after restarting.)

- If the stall prevention function (current limiter), automatic deceleration, and overload prevention control have been selected, the inverter may operate at an acceleration/deceleration time or frequency different from the commanded ones. Design the machine so that safety is ensured even in such cases.

  **Otherwise an accident could occur.**

- The (STOP) key on the keypad is effective only when the keypad operation is enabled with function code F02 (= 0, 2 or 3). When the keypad operation is disabled, prepare an emergency stop switch separately for safe operations.

  Switching the run command source from keypad (local) to external equipment (remote) by turning ON the "Enable communications link" command (LE) or "Switch run command 2/1" command (FR2/FR1), disables the (STOP) key. To enable the (STOP) key for an emergency stop, select the STOP key priority with function code H96 (= 1, 3 or 5).

- If an alarm reset is made with the Run command signal turned ON, a sudden start will occur. Ensure that the Run command signal is turned OFF in advance.

  **Otherwise an accident could occur.**

- If you enable the "Restart mode after momentary power failure" (Function code F14 = 3, 4, or 5), then the inverter automatically restarts running the motor when the power is recovered.

  (Design the machinery or equipment so that human safety is ensured after restarting.)

- If you set the function codes wrongly or without completely understanding this instruction manual and the FRENIC-Eco User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine.

  **An accident or injuries could occur.**

- Do not touch the inverter terminals while the power is applied to the inverter even if the inverter stops.

  **Doing so could cause electric shock.**

# ⚠CAUTION

- Do not turn the main circuit power (circuit breaker) ON or OFF in order to start or stop inverter operation.
  **Doing so could cause failure.**

- Do not touch the heat sink because they become very hot.
  **Doing so could cause burns.**

- Setting the inverter to high speeds is easy. Before changing the frequency (speed) setting, check the specifications of the motor and machinery.

- The brake function of the inverter does not provide mechanical holding means.
  **Injuries could occur.**

## Setting control switches

# ⚠WARNING

- Before setting up any internal control switches, turn OFF the power and wait at least five minutes for inverters of 30HP or below for 208V and 40HP or below for 460V, or at least ten minutes for inverters of 40HP or above for 208V and 50HP or above for 460V. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC)**.**
  **Otherwise electric shock could occur.**

## Maintenance and inspection, and parts replacement

# ⚠WARNING

- Turn the power OFF and wait for at least five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above, before starting inspection. Further, check that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are unlit and that the DC link bus voltage between the P (+) and N (-) terminals is lower than 25 VDC.
  **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 inverter as an industrial waste when disposing of it.
  **Otherwise injuries could occur.**

## Others

# ⚠WARNING

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

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## GENERAL PRECAUTIONS

Drawings in this manual may be illustrated without covers or safety shields for explanation of detail parts. Restore the covers and shields in the original state and observe the description in the manual before starting operation.

**Conformity with Low Voltage Directive in the EU**

If installed according to the guidelines given below, inverters marked with CE can be considered to be compliant with the Low Voltage Directive 73/23/EEC.

⚠**CAUTION**

1. Be sure to earth the grounding terminal ⏚G. Use an earth wire sized more than that of the power wires used in the power dispatch system. Do not use a residual-current-operated protective device (RCD)* or a ground fault circuit interrupter(GFCI)* as a sole mechanism of electric shock protection.
   *With overcurrent protection.

2. Use an MCCB, RCD/GFCI or MC in conformity with EN or IEC standards.

3. When an RCD/GFCI is used for protection of electric shock caused by a direct or indirect contact to the live parts, insert **a type B RCD/GFCI** in input lines (primary) of the inverter for the 3-phase 208 V or 460 V power source.

4. Use inverters in an environment that does not exceed pollution degree 2. If inverters are to be used in an environment with pollution degree 3 or 4, place them in an enclosure of IP54 or above.

5. To protect human body from an electric shock caused by a contact to live parts, install inverters, AC reactor and input /output filter in the enclosure of IP2X. In the case where human body easily contacts to live parts, a top panel of the enclosure should be IP4X or higher.

6. Do not directly connect a copper wire to the grounding terminal. Use a crimp terminal with tin or equivalent plating to connect the earth wire.

7. When using inverters at an altitude of more than 6600ft(2000 m), note that the basic insulation applies to the insulation degree of the control circuitry. At an altitude of more than 9800ft(3000 m), inverters cannot be used.

# ⚠ CAUTION

8. Use the wires listed in EN60204-1.

| Power supply voltage | Nominal applied motor (HP) | Inverter type | MCCB or RCD/GFCI *1 Rated current (A) W/ DCR | W/o DCR | Recommended wire size (mm²) Main power input *2 [L1/R, L2/S, L3/T] Inverter's grounding [⏚G] W/ DCR | W/o DCR | Inverter outputs *2 [U, V, W] | DC reactor [P1, P(+)] | Control circuit Europe type terminal block | Aux. control power supply [R0, T0] | Aux. fan power supply [R1, T1] |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Three-phase 208 V | 1 | FRN001F1S-2DY | 10 | 15 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 2 | FRN002F1S-2DY | 10 | 20 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 3 | FRN003F1S-2DY | 10 | 20 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 5 | FRN005F1S-2DY | 20 | 30 | 2.5 | 4.0 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 7.5 | FRN007F1S-2DY | 40 | 75 | 4.0 | 6.0 | 4.0 | 4.0 | 0.25 to 0.75 | 2.5 | - |
| | 10 | FRN010F1S-2DY | 50 | 100 | 6.0 | 10 | 6.0 | 6.0 | 0.25 to 0.75 | 2.5 | - |
| | 15 | FRN015F1S-2DY | 75 | 125 | 10 | 16 | 10 | 16 | 0.25 to 0.75 | 2.5 | - |
| | 20 | FRN020F1S-2DY | 100 | 150 | 16 | 25 | 16 | 25 | 0.25 to 0.75 | 2.5 | - |
| | 25 | FRN025F1S-2DY | 100 | 175 | 25 | 35 | 25 | 35 | 0.25 to 0.75 | 2.5 | - |
| | 30 | FRN030F1S-2DY | 150 | 200 | 35 | 50 | 35 | 35 | 0.25 to 0.75 | 2.5 | - |
| | 40 | FRN040F1S-2DY | 175 | 250 | 50 | 70 | 50 | 70 | 0.25 to 0.75 | 2.5 | - |
| | 50 | FRN050F1S-2DY | 200 | 300 | 25x2 | 50x2 | 25x2 | 25x2 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 60 | FRN060F1S-2DY | 250 | 350 | 95 | 70x2 | 95 | 120 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 75 | FRN075F1S-2DY | 350 | - | 50x2 | - | 70x2 | 150 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 100 | FRN100F1S-2DY | 350 | - | 95x2 | - | 95x2 | 95x2 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 125 | FRN125F1S-2DY | 500 | - | 240 | - | 240 | 150x2 | 0.25 to 0.75 | 2.5 | 2.5 |
| Three-phase 460 V | 1 | FRN001F1S-4DY | 5 | 5 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 2 | FRN002F1S-4DY | 5 | 10 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 3 | FRN003F1S-4DY | 10 | 15 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 5 | FRN005F1S-4DY | 10 | 20 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 7.5 | FRN007F1S-4DY | 15 | 30 | 2.5 | 2.5 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 10 | FRN010F1S-4DY | 20 | 40 | 2.5 | 4.0 | 2.5 | 2.5 | 0.25 to 0.75 | 2.5 | - |
| | 15 | FRN015F1S-4DY | 30 | 50 | 4.0 | 6.0 | 4.0 | 4.0 | 0.25 to 0.75 | 2.5 | - |
| | 20 | FRN020F1S-4DY | 40 | 60 | 6.0 | 10 | 6.0 | 6.0 | 0.25 to 0.75 | 2.5 | - |
| | 25 | FRN025F1S-4DY | 40 | 75 | 6.0 | 16 | 10 | 10 | 0.25 to 0.75 | 2.5 | - |
| | 30 | FRN030F1S-4DY | 50 | 100 | 10 | 16 | 10 | 16 | 0.25 to 0.75 | 2.5 | - |
| | 40 | FRN040F1S-4DY | 75 | 125 | 16 | 25 | 16 | 25 | 0.25 to 0.75 | 2.5 | - |
| | 50 | FRN050F1S-4DY | 100 | 125 | 25 | 35 | 25 | 25 | 0.25 to 0.75 | 2.5 | - |
| | 60 | FRN060F1S-4DY | 100 | 150 | 25 | 50 | 35 | 35 | 0.25 to 0.75 | 2.5 | - |
| | 75 | FRN075F1S-4DY | 125 | 200 | 35 | 25x2 | 50 | 16x2 | 0.25 to 0.75 | 2.5 | - |
| | 100 | FRN100F1S-4DY | 175 | - | 25x2 | - | 25x2 | 25x2 | 0.25 to 0.75 | 2.5 | - |
| | 125 | FRN125F1S-4DY | 200 | - | 95 | - | 95 | 120 | 0.25 to 0.75 | 2.5 | - |
| | 150 | FRN150F1S-4DY | 250 | - | 50x2 | - | 50x2 | 150 | 0.25 to 0.75 | 2.5 | - |
| | 200 | FRN200F1S-4DY | 300 | - | 50x2 | - | 70x2 | 70x2 | 0.25 to 0.75 | 2.5 | - |
| | 250 | FRN250F1S-4DY | 500 | - | 185 | - | 240 | 300 | 0.25 to 0.75 | 2.5 | - |
| | 300 | FRN300F1S-4DY | 500 | - | 300 | - | 300 | 185x2 | 0.25 to 0.75 | 2.5 | - |
| | 350 | FRN350F1S-4DY | 500 | - | 300 | - | 120x2 | 185x2 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 400 | FRN400F1S-4DY | 600 | - | 150x2 | - | 150x2 | 240x2 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 450 | FRN450F1S-4DY | 600 | - | 185x2 | - | 185x2 | 150x3 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 500 | FRN500F1S-4DY | 800 | - | 185x2 | - | 240x2 | 185x3 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 600 | FRN600F1S-4DY | 1000 | - | 240x2 | - | 185x3 | 240x3 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 700 | FRN700F1S-4DY | 1000 | - | 185x3 | - | 240x3 | 185x4 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 800 | FRN800F1S-4DY | 1200 | - | 240x3 | - | 185x4 | 240x4 | 0.25 to 0.75 | 2.5 | 2.5 |
| | 900 | FRN900F1S-4DY | 1200 | - | 185x4 | - | 240x4 | 240x4 | 0.25 to 0.75 | 2.5 | 2.5 |

*1 The frame size and model of the MCCB or RCD/GFCI (with overcurrent protection) will vary, depending on the power transformer capacity. Refer to the related technical documentation for details.
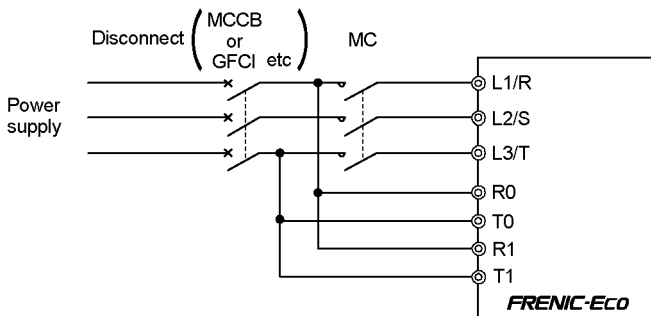
*2 The recommended wire size for main circuits is for the 70°C(158°F) 600V PVC wires used at an ambient temperature of 40°C(104°F).

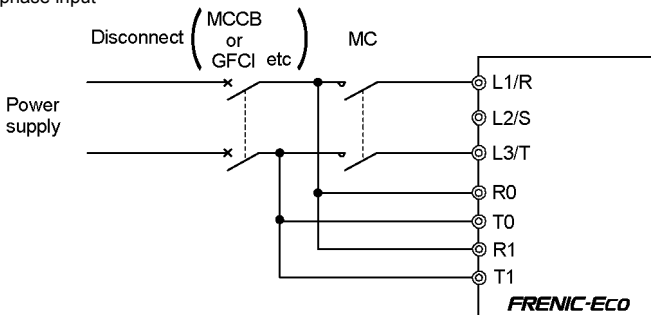### Conformity with UL standards and CSA standards (cUL-listed for Canada)

UL/cUL-listed inverters are subject to the regulations set forth by the UL standards and CSA standards (cUL-listed for Canada) by installation within precautions listed below.

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# ⚠CAUTION

1. Solid state motor overload protection (motor protection by electronic thermal overload relay) is provided in each model.
   Adjust function codes F10 to F12 to decide the protection level.

2. Suitable for use on a circuit capable of delivering not more than 100,000 rms three-phase symmetrical amperes, 240 Volts maximum for 208V class input 30HP or less, 230 Volts maximum for 208V class input 40HP or above or 480 Volts maximum for 460V class input.

3. Use 60°C/75°C Cu wire only.

4. Use Class 1 wire only.

5. Field wiring connections must be made by a UL Listed and CSA Certified closed-loop terminal connector sized for the wire gauge involved. Connector must be fixed using the crimp tool specified by the connector manufacturer.

6. All circuits with terminals L1/R, L2/S, L3/T, R0, T0, R1, T1 must have a common disconnect and be connected to the same pole of the disconnect if the terminals are connected to the power supply.

   • Three-phase input

   Disconnect ( MCCB or GFCI etc )   MC

   Power supply

   L1/R
   L2/S
   L3/T
   R0
   T0
   R1
   T1
   FRENIC-Eco

   • Single-phase input

   Disconnect ( MCCB or GFCI etc )   MC

   Power supply

   L1/R
   L2/S
   L3/T
   R0
   T0
   R1
   T1
   FRENIC-Eco

7. "Maximum Surrounding Air Temperature XXX °C". Where XXX stands for "50" for Models with suffix F1S, and F1H and models 050FIU to 100FIU; and "40" for Models with suffix F1G, F1B, F1D, F1L, F1W, F1V, F1C and Models 001F1U up to 040FIU.

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# ⚠WARNING

• For single-phase input, the power supply must connect to L1/R and L3/T.
  **Otherwise fire could occur.**

# Conformity with UL standards and CSA standards (cUL-listed for Canada) (continued)

## ⚠ CAUTION

7. Install UL-listed fuses or circuit breaker between the power supply and the inverter, referring to the table below.

| Power supply voltage | Inverter type | Required torque lb-in (N·m) | | | Wire size AWG (mm²) | | | | Class J fuse size (A) | Circuit breaker trip size (A) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Main terminal | Aux. Control Power Supply R0, T0 | Control circuit Europe type terminal block | Main terminal /Ring Terminal Cat.No | Aux.*2 Control Power Supply R0, T0 | Aux. Fan Power Supply R1, T1 | Control circuit Europe type terminal block | | |
| Three-phase 208 V / Single-phase 208 V | FRN001F1S-2DY | 15.9 (1.8) | 10.6 (1.2) | 4.4 (0.5) | 14 (2.1) | 14 (2.1) | - | 20 (0.5) | 20 | 15 |
| | FRN002F1S-2DY | | | | | | | | 30 | 20 |
| | FRN003F1S-2DY | | | | | | | | 30 | 20 |
| | FRN005F1S-2DY | 33.6 (3.8) | | | 10 (5.3) | | | | 40 | 30 |
| | FRN007F1S-2DY | | | | 8 (8.4) | | | | 75 | 75 |
| | FRN010F1S-2DY | | | | | | | | 100 | 100 |
| | FRN015F1S-2DY | 51.3 (5.8) | | | 6 (13.3) | | | | 150 | 125 |
| | FRN020F1S-2DY | | | | 4 (21.2) | | | | 175 | 150 |
| | FRN025F1S-2DY | | | | 3 (26.7) | | | | 200 | 175 |
| | FRN030F1S-2DY | 119.4 (13.5) | | | 2 (33.6) | | | | 250 | 200 |
| | FRN040F1S-2DY | | | | 3x2 (26.7) | | | | | |
| | FRN050F1S-2DY | 238.9 (27) | | | 3/0 (85.0) | | 14 (2.1) | | *1 | *1 |
| | FRN060F1S-2DY | | | | 4/0 (107.2) | | | | | |
| | FRN075F1S-2DY | | | | 300 (152) | | | | | |
| | FRN100F1S-2DY | | | | 2/0x2 (67.4) | | | | | |
| | FRN125F1S-2DY | 424.7 (48) | | | 250x2 (127) /R150-12 | | | | | |
| Three-phase 460 V / Single-phase 460 V | FRN001F1S-4DY | 15.9 (1.8) | 10.6 (1.2) | 4.4 (0.5) | 14 (2.1) | 14 (2.1) | - | 20 (0.5) | 6 | 5 |
| | FRN002F1S-4DY | | | | | | | | 10 | 10 |
| | FRN003F1S-4DY | | | | | | | | 15 | 15 |
| | FRN005F1S-4DY | | | | | | | | 20 | 20 |
| | FRN007F1S-4DY | 33.6 (3.8) | | | 12 (3.3) | | | | 30 | 30 |
| | FRN010F1S-4DY | | | | 10 (5.3) | | | | 40 | 40 |
| | FRN015F1S-4DY | | | | | | | | 60 | 50 |
| | FRN020F1S-4DY | 51.3 (5.8) | | | 8 (8.4) | | | | 70 | 60 |
| | FRN025F1S-4DY | | | | | | | | 90 | 75 |
| | FRN030F1S-4DY | | | | 6 (13.3) | | | | 100 | 100 |
| | FRN040F1S-4DY | 119.4 (13.5) | | | 4 (21.2) | | 14 (2.1) | | 125 | 125 |
| | FRN050F1S-4DY | | | | 3 (26.7) | | | | | |
| | FRN060F1S-4DY | | | | 2 (33.6) | | | | | |
| | FRN075F1S-4DY | | | | 1/0 (53.5) | | | | | |
| | FRN100F1S-4DY | | | | 2/0 (67.4) | | | | | |
| | FRN125F1S-4DY | 238.9 (27) | | | 4/0 (107.2) | | | | | |
| | FRN150F1S-4DY | | | | 250 (127) | | | | | |
| | FRN200F1S-4DY | | | | 1/0x2 (53.5) | | | | | |
| | FRN250F1S-4DY | 424.7 (48) | | | 3/0x2 (85.0) | | | | *1 | *1 |
| | FRN300F1S-4DY | | | | 4/0x2 (107.2) | | | | | |
| | FRN350F1S-4DY | | | | 300x2 (152) | | | | | |
| | FRN400F1S-4DY | | | | 400x2 (203) /R200-12 | | | | | |
| | FRN450F1S-4DY | | | | | | | | | |
| | FRN500F1S-4DY | | | | 350x3 (177) /180-12 | | | | | |
| | FRN600F1S-4DY | | | | | | | | | |
| | FRN700F1S-4DY | | | | 400x4 (203) /R200-12 | | | | | |
| | FRN800F1S-4DY | | | | | | | | | |
| | FRN900F1S-4DY | | | | | | | | | |

*1 Select the rated current of a fuse or a circuit breaker which is suitable to the connecting wire size.
*2 Defined by the closed-loop crimp-type connectors.

# ⚠CAUTION

When applying the single-phase to the three-phase drive, the applied motor must fulfill the table below and specifications other than table below are the same as those "Three-phase 208V ratings" and "Three-phase 460V ratings".

When operating with single-phase input, use function code H98 to deactivate input phase imbalance protection.

## Single-phase 208V ratings

| Item | | Specifications | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type (FRN□□□F1S-2DY) | | 001 | 002 | 003 | 005 | 007 | 010 | 015 | 020 | 025 | 030 | 040 | 050 | 060 | 075 | 100 | 125 |
| Nominal applied motor *1 [HP] | | 1/2 | 1 | 1.5 | 2 | 3 | 5 | 5 | 7.5 | 10 | 10 | 15 | 20 | 25 | 25 | 30 | 40 |
| Output ratings | Rated capacity *2 [kVA] | 0.8 | 1.6 | 2.3 | 3.3 | 3.9 | 6.1 | 7.5 | 8.6 | 11 | 13 | 16 | 21 | 27 | 27 | 34 | 41 |
| | Rated current *3 [A] | 2.4 | 4.6 | 6.6 | 9.3 | 11 | 17 | 21 | 24 | 31 | 37 | 46.2 | 59.4 | 75 | 76 | 95 | 114 |
| Input ratings | Main power supply | Single-phase, 200 to 240V, 50/60Hz | | | | | | | Single-phase, 200 to 220V / 50Hz, 200 to 230V / 60Hz | | | | | | | | |
| | Voltage/frequency variations | Voltage: +10 to -10%, Frequency: +5 to -5% | | | | | | | | | | | | | | | |
| | Rated current *4 [A] with DCR | 3.4 | 6.3 | 9.2 | 16.7 | 24.5 | 31.6 | 40.9 | 53.6 | 65.6 | 77.6 | 109 | 138 | 165 | 169 | 215 | 272 |
| | without DCR | 5.1 | 9.1 | 12.9 | 21.5 | 30.8 | 40.8 | 59.4 | 76.6 | 94.0 | 110 | 144 | 179 | 215 | --- | --- | --- |
| | Required power supply capacity *5 [kVA] | 0.8 | 1.4 | 2.0 | 3.5 | 5.1 | 6.6 | 8.6 | 12 | 14 | 17 | 23 | 29 | 35 | 36 | 45 | 57 |

## Single-phase 460V ratings

| Item | | Specifications | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type (FRN□□□F1S-4DY) | | 001 | 002 | 003 | 005 | 007 | 010 | 015 | 020 | 025 | 030 | 040 | 050 | 060 | 075 |
| Nominal applied motor *1 [HP] | | 1/4 | 1 | 1 | 2 | 3 | 3 | 7.5 | 7.5 | 10 | 10 | 15 | 20 | 20 | 30 |
| Output ratings | Rated capacity *2 [kVA] | 0.9 | 1.6 | 2.1 | 2.9 | 4.6 | 6.2 | 9.5 | 10 | 12 | 15 | 18 | 23 | 27 | 34 |
| | Rated current *3 [A] | 1.2 | 2.1 | 2.7 | 3.7 | 5.8 | 7.9 | 12 | 13 | 16 | 19 | 23 | 30 | 35 | 43 |
| Input ratings | Main power supply | Single-phase, 380 to 480V, 50/60Hz | | | | | | | Single-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | | | |
| | Voltage/frequency variations | Voltage: +10 to -10%, Frequency: +5 to -5% | | | | | | | | | | | | |
| | Rated current *4 [A] with DCR | 1.5 | 2.9 | 4.1 | 6.2 | 9.5 | 12.9 | 20.1 | 23.5 | 28.8 | 34.9 | 43.9 | 57.6 | 69.3 | 85.2 |
| | without DCR | 2.5 | 4.8 | 6.9 | 10.8 | 14.5 | 19.1 | 27.7 | 36.0 | 43.6 | 50.9 | 64.0 | 78.5 | 93.7 | 115 |
| | Required power supply capacity *5 [kVA] | 0.7 | 1.4 | 1.9 | 2.9 | 4.4 | 6.0 | 9.3 | 11 | 14 | 17 | 21 | 27 | 32 | 40 |

## Single-phase 460V ratings

| Item | | Specifications | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type (FRN□□□F1S-4DY) | | 100 | 125 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 700 | 800 | 900 |
| Nominal applied motor *1 [HP] | | 30 | 40 | 50 | 60 | 75 | 100 | 100 | 125 | 125 | 150 | 200 | 200 | 250 | 250 |
| Output ratings | Rated capacity *2 [kVA] | 40 | 50 | 60 | 73 | 78 | 107 | 129 | 136 | 160 | 195 | 228 | 263 | 309 | 327 |
| | Rated current *3 [A] | 51 | 63 | 76 | 92 | 98 | 135 | 162 | 171 | 202 | 246 | 287 | 331 | 388 | 411 |
| Input ratings | Main power supply | Single-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | | | | | | | | | | |
| | Voltage/frequency variations | Voltage: +10 to -10%, Frequency: +5 to -5% | | | | | | | | | | | | |
| | Rated current *4 [A] with DCR | 102 | 125 | 151 | 180 | 231 | 271 | 311 | 363 | 392 | 482 | 560 | 636 | 714 | 782 |
| | without DCR | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | Required power supply capacity *5 [kVA] | 47 | 58 | 70 | 83 | 107 | 125 | 144 | 167 | 181 | 222 | 258 | 293 | 329 | 360 |

Note:

*1  Standard 4-pole motor

*2  Rated capacity is calculated by assuming the output rated voltage as 208V for 208V ratings and 460V for 460V ratings.

*3  An excessively low setting of the carrier frequency may result in the higher motor temperature or tripping of the inverter by its overcurrent limiter setting. Lower the continuous load or maximum load instead. (When setting the carrier frequency (F26) to 1kHz, reduce the load to 80% of its rating.)

*4  Calculated under Fuji-specified conditions.

*5  Obtained when a DC reactor (DCR) is used.

*6  At single-phase input use, the output voltage may be lower than three-phase input.

# ■ Precautions for use

| | | |
|---|---|---|
| In running general-purpose motors | Driving a 460V general-purpose motor | When driving a 460V general-purpose motor with an inverter using extremely long wires, damage to the insulation of the motor may occur. Use an output circuit filter if necessary after checking with the motor manufacturer. Fuji motors do not require the use of output circuit filters because of their reinforced insulation. |
| | Torque characteristics and temperature rise | When the inverter is used to run a general-purpose motor, the temperature of the motor becomes higher than when it is operated using a commercial power supply. In the low-speed range, the cooling effect will be weakened, so decrease the output torque of the motor. |
| | Vibration | When an inverter-driven motor is mounted to a machine, resonance may be caused by the natural frequencies of the machine system. Note that operation of a 2-pole motor at 60 Hz or higher may cause abnormal vibration. * The use of a rubber coupling or vibration dampening rubber is recommended. * Use the inverter's jump frequency control feature to skip the resonance frequency zone(s). |
| | Noise | When an inverter is used with a general-purpose motor, the motor noise level is higher than that with a commercial power supply. To reduce noise, raise carrier frequency of the inverter. Operation at 60 Hz or higher can also result in higher noise level. |
| In running special motors | Explosion-proof motors | When driving an explosion-proof motor with an inverter, use a combination of a motor and an inverter that has been approved in advance. |
| | Submersible motors and pumps | These motors have a larger rated current than general-purpose motors. Select an inverter whose rated output current is greater than that of the motor. These motors differ from general-purpose motors in thermal characteristics. Set a low value in the thermal time constant of the motor when setting the electronic thermal function. |
| | Brake motors | For motors equipped with parallel-connected brakes, their braking power must be supplied from the primary circuit. If the brake power is connected to the inverter's output circuit by mistake, the brake will not work. Do not use inverters for driving motors equipped with series-connected brakes. |
| | Geared motors | If the power transmission mechanism uses an oil-lubricated gearbox or speed changer/reducer, then continuous motor operation at low speed may cause poor lubrication. Avoid such operation. |
| | Synchronous motors | It is necessary to take special measures suitable for this motor type. Contact your Fuji Electric representative for details. |
| | Single-phase motors | Single-phase motors are not suitable for inverter-driven variable speed operation. Use three-phase motors. |
| Environmental conditions | Installation location | Use the inverter within the ambient temperature range from -10 to +50°C (14 to 122°F). The heat sink of the inverter may become hot under certain operating conditions, so install the inverter on nonflammable material such as metal. Ensure that the installation location meets the environmental conditions specified in Chapter 2, Section 2.1 "Operating Environment." |

| | | |
|---|---|---|
| Combina-tion with peripheral devices | Installing an MCCB or RCD/GFCI | Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/a ground fault circuit interrupter (GFCI) (with overcurrent protection) in the primary circuit of the inverter to protect the wiring. Ensure that the circuit breaker rated current is equivalent to or lower than the recommended rated current. |
| | Installing an MC in the secondary circuit | If a magnetic contactor (MC) is mounted in the inverter's output (secondary) circuit for switching the motor to commercial power or for any other purpose, ensure that both the inverter and the motor are completely stopped before you turn the MC ON or OFF.<br><br>Remove the magnet contactor (MC) already installed and built-in surge suppressor from the inverter's output (secondary) circuit before installing the MC to switch the motor power. |
| | Installing an MC in the primary circuit | Do not turn the magnetic contactor (MC) in the primary circuit ON or OFF more than once an hour as an inverter failure may result.<br><br>If frequent starts or stops are required during motor operation, use (FWD)/(REV) signals or the RUN/STOP key. |
| | Protecting the motor | The electronic thermal function of the inverter can protect the motor. The operation level and the motor type (general-purpose motor, inverter motor) should be set. For high-speed motors or water-cooled motors, set a small value for the thermal time constant and protect the motor.<br><br>If you connect the motor thermal relay to the motor with a long wire, a high-frequency current may flow into the wiring stray capacitance. This may cause the relay to trip at a current lower than the set value for the thermal relay. If this happens, lower the carrier frequency or use the output circuit filter. |
| | Use of power-factor correcting capacitor | Do not mount power-factor correcting capacitors in the inverter's primary circuit. (Use the DC reactor to improve the inverter power factor.) Do not use power-factor correcting capacitors in the inverter's output (secondary) circuit. An overcurrent trip will occur, disabling motor operation. |
| | Use of surge suppressor | Do not connect a surge suppressor to the inverter's output (secondary) circuit. |
| | Reducing noise | Use of a filter and shielded wires is typically recommended to satisfy EMC Directives. |
| | Measures against surge currents | If an overvoltage trip occurs while the inverter is stopped or operated under a light load, it is assumed that the surge current is generated by open/close of the power-factor correcting capacitor in the power system.<br><br>* Connect a DC reactor to the inverter. |
| | Megger test | When checking the insulation resistance of the inverter, use a 500 V megger and follow the instructions contained in Chapter 7, Section 7.5 "Insulation Test." |
| Wiring | Control circuit wiring length | When using remote control, limit the wiring length between the inverter and operator box to 67ft (20m) or less and use twisted pair or shielded wire. |
| | Wiring length between inverter and motor | If long wiring is used between the inverter and the motor, the inverter will overheat or trip as a result of overcurrent (high-frequency current flowing into the stray capacitance) in the wires connected to the phases. Ensure that the wiring is shorter than 164ft (50m). If this length must be exceeded, lower the carrier frequency or mount an output circuit filter. |
| | Wiring size | Select wires with a sufficient capacity by referring to the current value or recommended wire size. |
| | Wiring type | When several inverters drive motors, do not use one multicore cable in order to connect several inverters with motors. |
| | Grounding | Securely ground the inverter using the grounding terminal. |

| | | |
|---|---|---|
| Selecting inverter capacity | Driving general-purpose motor | Select an inverter according to the applicable motor ratings listed in the standard specifications table for the inverter.<br><br>When high starting torque is required or quick acceleration or deceleration is required, select an inverter with a capacity one size greater than the standard. |
| | Driving special motors | Select an inverter that meets the following condition:<br><br>Inverter rated current > Motor rated current |
| Transpor-tation and storage | When transporting or storing inverters, follow the procedures and select locations that meet the environmental conditions listed in Chapter 1, Section 1.3 "Transportation" and Section 1.4 "Storage Environment." | |

# How this manual is organized

This manual is made up of chapters 1 through 10.

## Chapter 1  BEFORE USING THE INVERTER

This chapter describes acceptance inspection and precautions for transportation and storage of the inverter.

## Chapter 2  MOUNTING AND WIRING OF THE INVERTER

This chapter provides operating environment, precautions for installing the inverter, wiring instructions for the motor and inverter.

## Chapter 3  OPERATION USING THE KEYPAD

This chapter describes inverter operation using the keypad. The inverter features three operation modes (Running, Programming and Alarm modes) which enable you to run and stop the motor, monitor running status, set function code data, display running information required for maintenance, and display alarm data.

## Chapter 4  OPERATION

This chapter describes preparation to be made before running the motor for a test and practical operation.

## Chapter 5  FUNCTION CODES

This chapter provides a list of the function codes. Function codes to be used often and irregular ones are described individually.

## Chapter 6  TROUBLESHOOTING

This chapter describes troubleshooting procedures to be followed when the inverter malfunctions or detects an alarm condition. In this chapter, first check whether any alarm code is displayed or not, and then proceed to the troubleshooting items.

## Chapter 7  MAINTENANCE AND INSPECTION

This chapter describes inspection, measurement and insulation test which are required for safe inverter operation. It also provides information about periodical replacement parts and guarantee of the product.

## Chapter 8  SPECIFICATIONS

This chapter lists specifications including output ratings, control system, external dimensions and protective functions.

## Chapter 9  LIST OF PERIPHERAL EQUIPMENT AND OPTIONS

This chapter describes main peripheral equipment and options which can be connected to the FRENIC-Eco series of inverters.

## Chapter 10  CONFORMITY WITH STANDARDS

This chapter describes standards with which the FRENIC-Eco series of inverters comply.

## Icons

The following icons are used throughout this manual.

Note  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.

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

This icon indicates a reference to more detailed information.

# Table of Contents

# Chapter 1    BEFORE USING THE INVERTER

## 1.1   Acceptance Inspection

Unpack the package and check the following:

(1)   An inverter and accessories below are contained in the package.

  • Cooling fan fixing screws (for inverters of 7.5 to 30HP for 208V and 10 to 40HP for 460V)
  • Keypad fixing screws (for inverters of 1 to 30HP for 208V and 1 to 40HP for 460V)
  • Bush rubbers for cable guide plate (for inverters of 1 to 25HP for 208V and 1 to 30HP for 460V)
  • Instruction manual (this manual)

(2)   The inverter has not been damaged during transportation—there should be no dents or parts missing.

(3)   The inverter is the model you ordered. You can check the model name and specifications on the main nameplate. (Main and sub nameplates are attached to the inverter and are located as shown on the following page.) For the inverter whose capacity is 40HP for 208V, 50HP for 460V or above, its mass is printed on the nameplate.
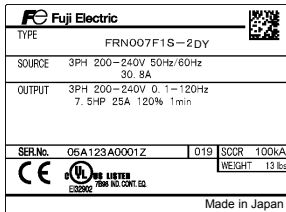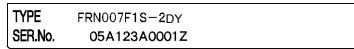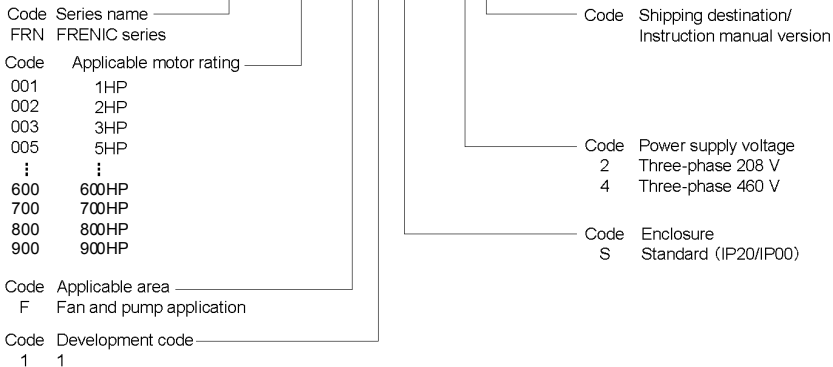


(a) Main Nameplate                    (b) Sub Nameplate

Figure 1.1  Nameplates

TYPE: Type of inverter



SOURCE:   Number of input phases (three-phase: 3PH), input voltage, input frequency, input current
OUTPUT:   Number of output phases, rated output capacity, rated output voltage, output frequency range, rated output current, overload capacity
WEIGHT:   Weight of the inverter in pound
SER. No.:   Product  number            manufacturing date
            0 5 A 1 2 3 A 0 0 0 1 Z        0 1 9



**Production week**
This indicates the week number that is numbered from 1st week of January.
The 1st week of January is indicated as '01'.
**Production year: Last digit of year**

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

## 1.2 External View and Terminal Blocks

(1) Outside and inside views



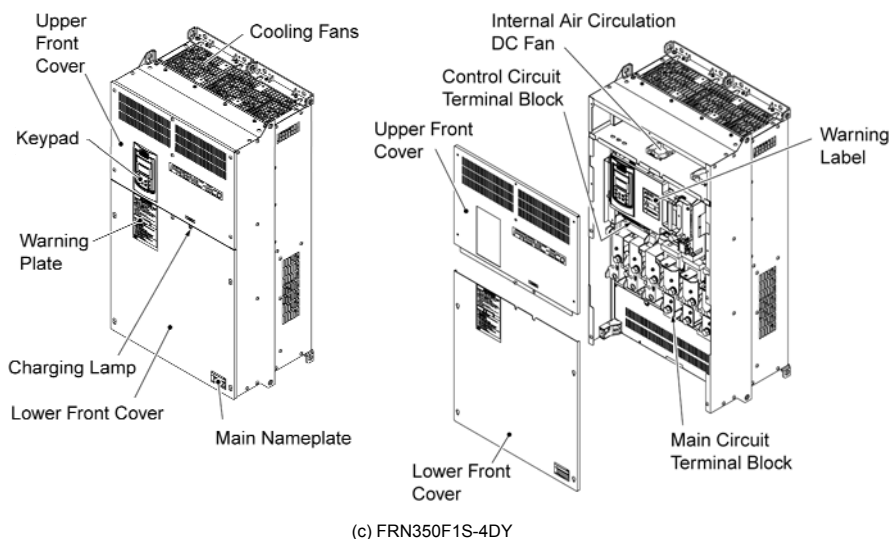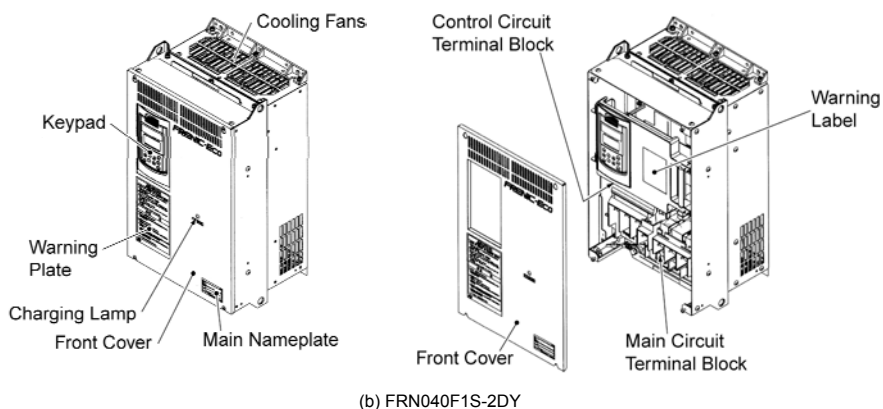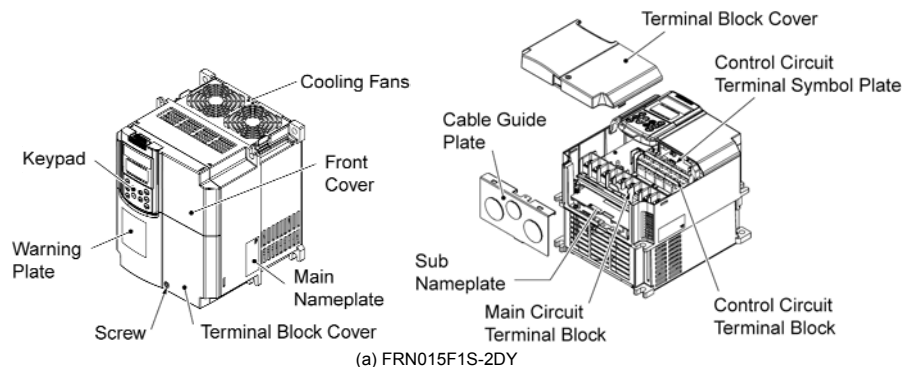(a) FRN015F1S-2DY



(b) FRN040F1S-2DY



(c) FRN350F1S-4DY

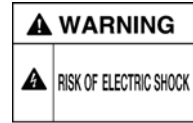Figure 1.2  Outside and Inside Views of Inverters

(2) Warning plates and label

**FRENIC-ECO**

⚠ **WARNING**
- RISK OF INJURY OR ELECTRIC SHOCK
- Refer to the instruction manual before installation and operation.
- Do not remove any cover while applying power and at least 5min. after disconnecting power.
- Securely ground (earth) the equipment.

Only type B of RCD is allowed.
See manual for details.

*Fe*

Warning Plate
(a) FRN015F1S-2DY

⚠ **WARNING**
- RISK OF INJURY OR ELECTRIC SHOCK
- Refer to the instruction manual before installation and operation.
- RISK OF ELECTRIC SHOCK
- Do not remove this cover while applying power.
- This cover can be removed after at least 10min of power off and after the "CHARGE" lamp turns off.
- Do not insert fingers or anything else into the inverter.
- Securely ground (earth) the inverter.

*Fe*

Warning Plate
(b) FRN040F1S-2DY

⚠ **WARNING**

⚠ RISK OF ELECTRIC SHOCK
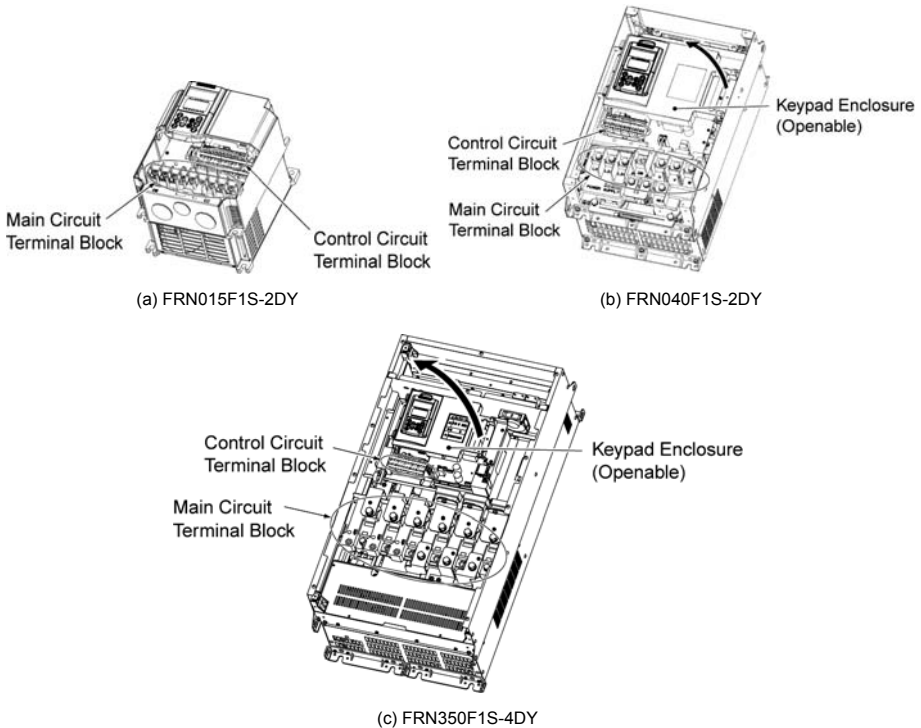
Warning Label

Figure 1.3  Warning Plates and Label

(3) Terminal block location



(a) FRN015F1S-2DY

(b) FRN040F1S-2DY



(c) FRN350F1S-4DY

Figure 1.4  Terminal Blocks and Keypad Enclosure Location

## 1.3 Transportation

- When carrying an inverter, always support its bottom at the front and rear sides with both hands. Do not hold covers or individual parts only. You may drop the inverter or break it.
- When hoisting an inverter with hoisting holes, hook or rope the 4 holes evenly.

## 1.4 Storage Environment

### 1.4.1 Temporary storage

Store the inverter in an environment that satisfies the requirements listed in Table 1.1.

Table 1.1 Environmental Requirements for Storage and Transportation

| Item | Requirements | |
|---|---|---|
| Storage temperature [1] | -25 to +70°C(-13 to 158°F) | A location where the inverter is not subject to abrupt changes in temperature that would result in the formation of condensation or ice. |
| Relative humidity | 5 to 95% [2] | |
| Atmosphere | The inverter must not be exposed to dust, direct sunlight, corrosive or flammable gases, oil mist, vapor, water drops or vibration. The atmosphere must contain only a low level of salt. (0.01 mg/cm$^2$ or less per year) | |
| Atmospheric pressure | 86 to 106 kPa (in storage) | |
| | 70 to 106 kPa (during transportation) | |

[1] Assuming a comparatively short storage period (e.g., during transportation or the like).
[2] Even if the humidity is within the specified requirements, avoid such places where the inverter will be subjected to sudden changes in temperature that will cause condensation to form.

Precautions for temporary storage

(1) Do not leave the inverter directly on the floor.
(2) If the environment does not satisfy the specified requirements, wrap the inverter in an airtight vinyl sheet or the like for storage.
(3) If the inverter is to be stored in an environment with a high level of humidity, put a drying agent (such as silica gel) in the airtight package described in item (2).

### 1.4.2 Long-term storage

The long-term storage methods for the inverter vary largely according to the environment of the storage site. General storage methods are described below.

(1) The storage site must satisfy the requirements specified for temporary storage.
    However, for storage exceeding three months, the ambient temperature should be within the range from -10 to +30 °C(14 to 86°F). This is to prevent the electrolytic capacitors in the inverter from deteriorating.
(2) The inverter must be stored in a package that is airtight to protect it from moisture. Include a drying agent inside the package to maintain the relative humidity inside the package to within 70%.
(3) If the inverter has been installed in the equipment or control board at a construction site where it may be subjected to humidity, dust or dirt, then remove the inverter and store it in a suitable environment specified in Table 1.1.

Precautions for storage over 1 year

If the inverter will not be powered on for a long time, the property of the electrolytic capacitors may deteriorate. Power the inverters on once a year and keep them on for 30 to 60 minutes. Do not connect the inverters to motors or run the motor.

# Chapter 2    MOUNTING AND WIRING OF THE INVERTER

## 2.1   Operating Environment

Install the inverter in an environment that satisfies the requirements listed in Table 2.1.

Table 2.1 Environmental Requirements

| Item | Specifications |
|---|---|
| Site location | Indoors |
| Ambient temperature | -10 to +50°C(14 to 122°F) (Note 1) |
| Relative humidity | 5 to 95% (No condensation) |
| Atmosphere | The inverter must not be exposed to dust, direct sunlight, corrosive gases, flammable gas, oil mist, vapor or water drops. Pollution degree 2 (IEC60664-1) (Note 2) |
| | The atmosphere can contain a small amount of salt. (0.01 mg/cm$^2$ or less per year) |
| | The inverter must not be subjected to sudden changes in temperature that will cause condensation to form. |
| Altitude | 3300ft(1000m) max. (Note 3) |
| Atmospheric pressure | 86 to 106 kPa |
| Vibration | For inverters of 100 HP or below |
| | 3 mm (Max. amplitude)      2 to less than 9 Hz |
| | 9.8 m/s$^2$                      9 to less than 20 Hz |
| | 2 m/s$^2$                         20 to less than 55 Hz |
| | 1 m/s$^2$                         55 to less than 200 Hz |
| | For inverters of 125 HP or above |
| | 3 mm (Max. amplitude)      2 to less than 9 Hz |
| | 2 m/s$^2$                         9 to less than 55 Hz |
| | 1 m/s$^2$                         55 to less than 200 Hz |

Table 2.2 Output Current Derating Factor in Relation to Altitude

| Altitude | Output current derating factor |
|---|---|
| 3300ft(1000m) or lower | 1.00 |
| 3300ft(1000m) to 4900ft(1500m) | 0.97 |
| 4900ft(1500m) to 6600ft(2000m) | 0.95 |
| 6600ft(2000m) to 8200ft(2500m) | 0.91 |
| 8200ft(2500m) to 9800ft(3000m) | 0.88 |

(Note 1)   When inverters are mounted side-by-side without any gap between them (5HP for 208V, 7.5HP for 460V or below), the ambient temperature should be within the range from -10 to +40°C(14 to 104°F).

(Note 2)   Do not install the inverter in an environment where it may be exposed to cotton waste or moist dust or dirt which will clog the heat sink in the inverter. If the inverter is to be used in such an environment, install it in the enclosure of your system or other dustproof containers.

(Note 3)   If you use the inverter in an altitude above 3300ft(1000m), you should apply an output current derating factor as listed in Table 2.2.

## 2.2   Installing the Inverter

### (1)   Mounting base

The temperature of the heat sink will rise up to approx. 90°C (194°F) during operation of the inverter, so the inverter should be mounted on a base made of material that can withstand temperatures of this level.

> # ⚠ WARNING
>
> Install the inverter on a base constructed from metal or other non-flammable material.
>
> **A fire may result with other material.**

### (2)   Clearances

Ensure that the minimum clearances indicated in Figure 2.1 are maintained at all times. When installing the inverter in the enclosure of your system, take extra care with ventilation inside the enclosure as the temperature around the inverter will tend to increase. Do not install the inverter in a small enclosure with poor ventilation.



*   2.0inch(50mm) for models of 460 V series 125HP or above

Figure 2.1  Mounting Direction and Required Clearances

■ **When mounting two or more inverters**

Horizontal layout is recommended when two or more inverters are to be installed in the same unit or enclosure. If it is necessary to mount the inverters vertically, install a partition plate or the like between the inverters so that any heat radiating from an inverter will not affect the one/s above. As long as the ambient temperature is 40°C(104°F)or lower, inverters can be mounted side-by-side without any gap between them (only for inverters with a capacity of 5HP for 208V, 7.5HP for 460V or below).

■ **When employing external cooling**

At the shipment time, the inverter is set up for mount inside your equipment or enclosure so that cooling is done all internally.

To improve cooling efficiently, you can take the heat sink out of the equipment or the enclosure (as shown on the right) so that cooling is done both internally and externally (this is called "external cooling").

In external cooling, the heat sink, which dissipates about 70% of the total heat (total loss) generated into air, is situated outside the equipment or the enclosure. As a result, much less heat is radiated inside the equipment or the enclosure.

To take advantage of external cooling, you need to use the external cooling attachment option for inverters with a capacity of 30HP for 208V, 40HP for 460V or below, or simply re-position the mounting bases for the cooling unit for inverters with a capacity of 40HP for 208V, 50HP for 460V or above.

In an environment with high humidity or a lot of fibrous dust, however, do not use external cooling in an environment with high humidity or a lot of fibrous dust, which tends to clog the heat sink.

📖 For details, refer to the Attachment for External Cooling "PB-F1" Installation Manual and FRENIC-Eco User's Manual.
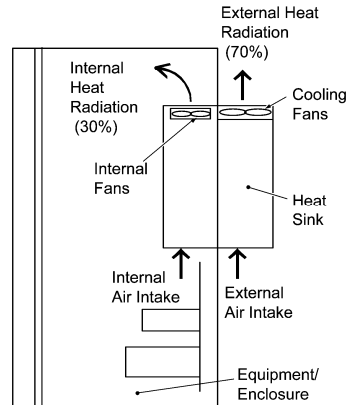


Figure 2.2   External Cooling

---

## ⚠CAUTION

Prevent lint, paper fibers, sawdust, dust, metallic chips, or other foreign materials from getting into the inverter or from accumulating on the heat sink.

**This may result in a fire or accident.**

To utilize external cooling for inverters with a capacity of 40HP for 208V, 50HP for 460V or above, change the position of the top and bottom mounting bases from the edge to the center of the inverter as illustrated in Figure 2.3.

Screws differ in size, length and count for each inverter. Be sure to refer to the table below.

Table 2.3   Screw Count and Tightening Torque

| Power supply voltage | Inverter type | Base fixing screw (Count) | Case fixing screw (Count) | Tightening torque lb-in (N•m) | Refer to: |
|---|---|---|---|---|---|
| 3-phase 208 V | FRN040F1S-2DY to FRN100F1S-2DY | M6 × 20 (3 pcs each for upper and lower sides) | M6 × 12 (3 pcs for upper side) | 51.3(5.8) | Figure A |
| | FRN125F1S-2DY | M6 × 20 (6 pcs each for upper and lower sides) | M5 × 20 (6 pcs each for upper and lower sides) | M6: 51.3(5.8) M5: 31.0(3.5) | |
| 3-phase 460 V | FRN050F1S-4DY to FRN150F1S-4DY | M6 × 20 (3 pcs each for upper and lower sides) | M6 × 12 (3 pcs for upper side) | 51.3(5.8) | Figure B |
| | FRN200F1S-4DY to FRN350F1S-4DY | M6 × 20 (2 pcs each for upper and lower sides) M5 × 16 (4 pcs each for upper and lower sides) | M6 × 20 (2 pcs each for upper and lower sides) M5 × 12 (4 pcs each for upper and lower sides) | 51.3(5.8) 31.0 (3.5) | |
| | FRN400F1S-4DY to FRN450F1S-4DY | M6 × 20 (2 pcs each for upper and lower sides) M5 × 16 (6 pcs each for upper and lower sides) | M6 × 20 (2 pcs each for upper and lower sides) M5 × 16 (6 pcs each for upper and lower sides) | M6: 51.3(5.8) M5: 31.0 (3.5) | Figure A |
| | FRN500F1S-4DY to FRN900F1S-4DY | M6 × 20 (6 pcs each for upper and lower sides) M5 × 16 (2 pcs each for upper and lower sides) | M6 × 20 (6 pcs each for upper and lower sides) M5 × 16 (2 pcs each for upper and lower sides) | M6: 51.3(5.8) M5: 31.0 (3.5) | |

① For models shown in Figure A

1) Remove all of the base fixing screws from the top and bottom of the inverter. Also remove the case fixing screws from the top. (The case fixing screws are not necessary in external cooling. Store them for future use. On the bottom are no case fixing screws.)

2) Secure the top mounting base to the center of the inverter with the base fixing screws, using case fixing screw holes.

3) Secure the bottom mounting base to the center of the inverter with the base fixing screws.

② For models shown in Figure B

1) Remove all of the base fixing screws from the top and bottom of the inverter. Also remove the case fixing screws.

2) Secure the top mounting base to the center of the inverter with the base fixing screws, using case fixing screw holes. Set the removed case fixing screws to the screw holes where the top mounting bases were secured.

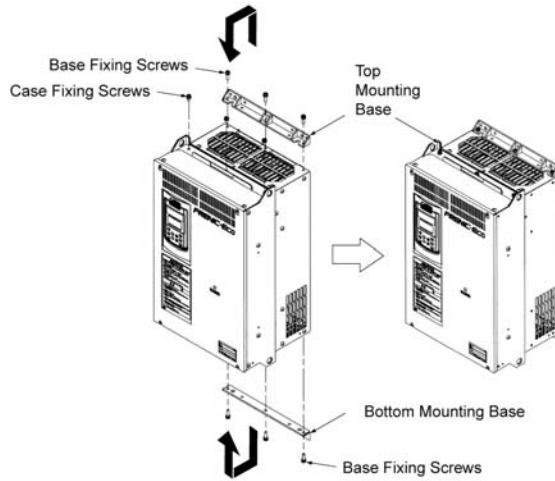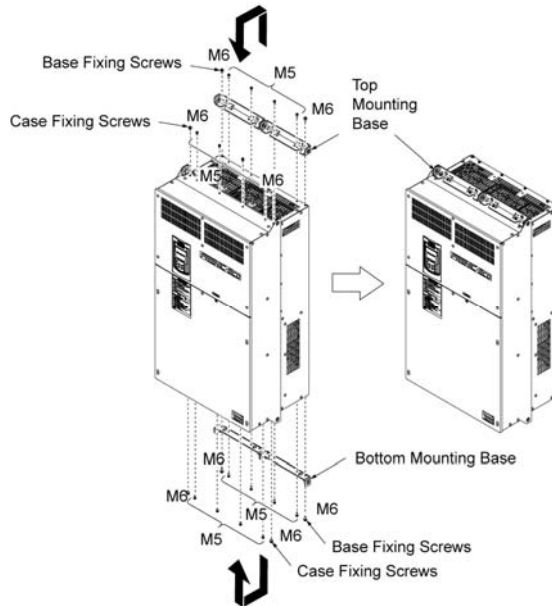3) In the same way, secure the bottom mounting base to the center of the inverter.

Figure A



Figure B

Figure 2.3   Relocating the Top and Bottom Mounting Bases

# ⚠CAUTION

When moving the top and bottom mounting bases, use only the specified screws.

**A fire or an accident may be caused.**

## (3) Mounting direction

Mount the inverter vertically to the mounting surface and fix it securely with four screws or bolts so that the logo "FRENIC-Eco" can be seen from the front.

**Note** Do not mount the inverter upside down or horizontally. Doing so will reduce the heat dissipation efficiency of the inverter and cause the overheat protection function to operate, so the inverter will not run.

## (4) Solving abnormal vibration after installation

If any vibration in the surroundings reaches the inverter and causes abnormal vibration to the cooling fan(s) or the keypad, fix them firmly using the fixing screws provided as accessories.

■ Fixing the cooling fan(s)

Table 2.4   Fixing Screws

| Power supply voltage | Nominal applied motor (HP) | Inverter type | Screw size (accessory) | Tightening torque lb-in (N·m) | Refer to: |
|---|---|---|---|---|---|
| Three-phase 208 V | 7.5 | FRN007F1S-2DY | M4x35 (4 pcs) | 7.1(0.8) | Figure A |
| | 10 | FRN010F1S-2DY | | | |
| | 15 | FRN015F1S-2DY | | | |
| | 20 | FRN020F1S-2DY | M4x50 (2 pcs) | 4.4(0.5) | Figure B |
| | 25 | FRN025F1S-2DY | | | |
| | 30 | FRN030F1S-2DY | | | |
| Three-phase 460 V | 10 | FRN010F1S-4DY | M4x35 (4 pcs) | 7.1(0.8) | Figure A |
| | 15 | FRN015F1S-4DY | | | |
| | 20 | FRN020F1S-4DY | | | |
| | 25 | FRN025F1S-4DY | M4x50 (2 pcs) | 4.4(0.5) | Figure B |
| | 30 | FRN030F1S-4DY | | | |
| | 40 | FRN040F1S-4DY | | | |
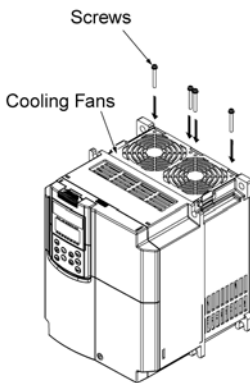


Figure A                    Figure B
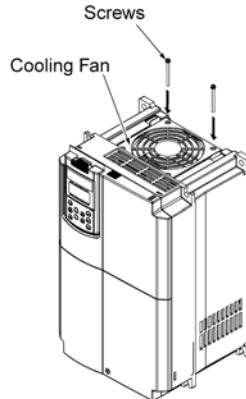
Figure 2.4   Fixing the Cooling Fan(s)

■ Fixing the keypad (for models of 30HP for 208V, 40HP for 460V or below)

① Remove the terminal block (TB) cover and the front cover. (For the procedure, refer to 2.3.1 "Removing and mounting the terminal block (TB) cover and the front cover.")

② To fix the front cover and keypad, hold the front cover and the keypad together and tighten the two attached screws (provided as accessories) from the back of the keypad.



Keypad fastening screws (M3 x 12)
(Attached to inverter)

Backside of front cover
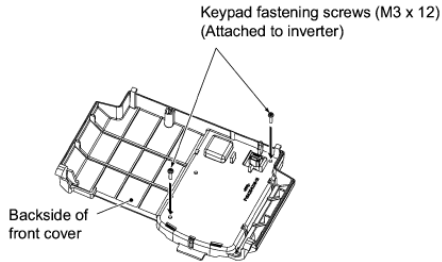
Tightening torque: 6.2lb-in(0.7 N·m)

Figure 2.5   Fixing a Keypad

## 2.3  Wiring

Follow the procedure below. (In the following description, the inverter has already been installed.)

### 2.3.1   Removing and mounting the terminal block (TB) cover and the front cover

**(1)  For inverters with a capacity of 30HP for 208V, 40HP for 460V or below**

■ Removing the covers

① To remove the terminal block (TB) cover, first loosen the TB cover fastening screw on it, and put your finger in the dimple of the terminal block (TB) cover (labeled "PULL"), and then pull it up toward you.

② To remove the front cover, hold it with both hands, slide it downward to unlatch. Tilt the front cover toward you, and pull it upward.



TB Cover Fastening Screw
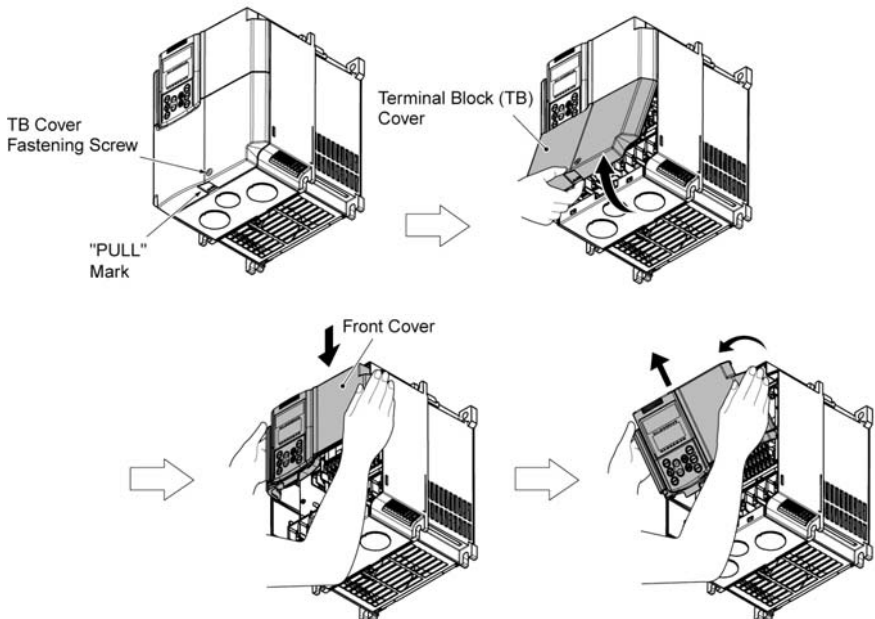
"PULL" Mark

Terminal Block (TB) Cover

Front Cover

Figure 2.6   Removing the Covers (FRN015F1S-2DY)*

■ Mounting the covers

① Put the front cover to the inverter case while fitting the edge of the front cover between the both hinges provided on the inverter case. Slide it upward until the front cover latches.

② Fit the latches on the terminal block (TB) cover in the holes provided to the front cover and push it towards the inverter case.

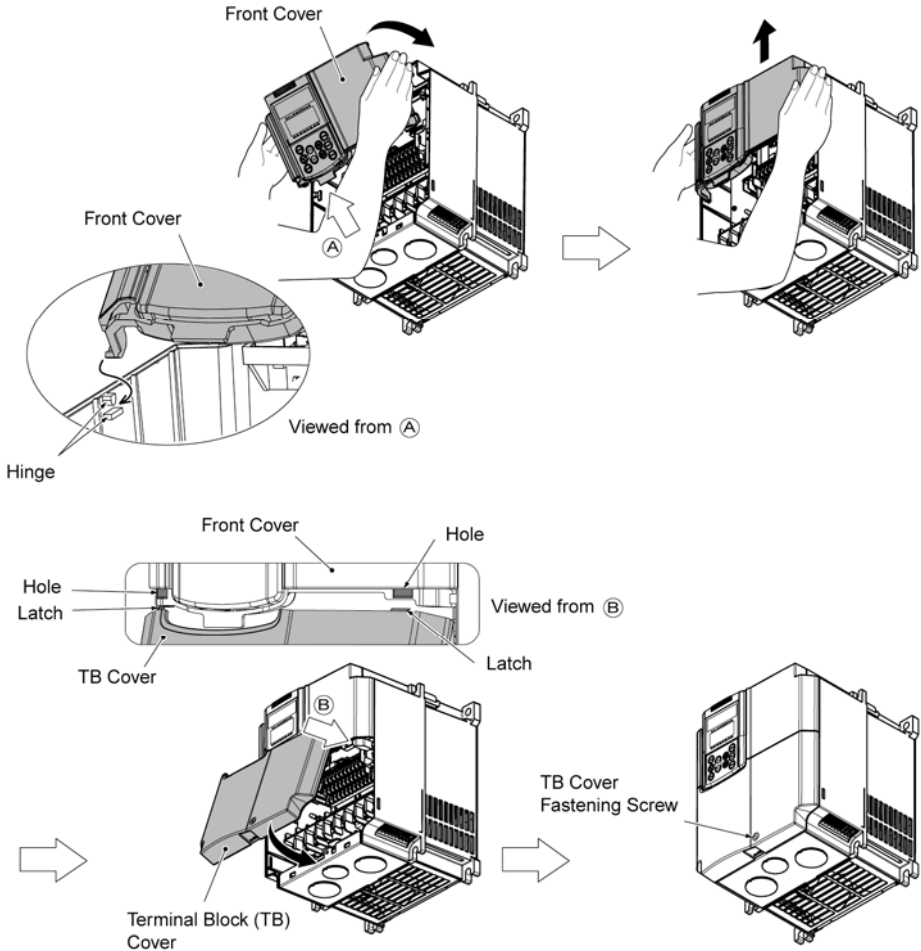③ Tighten the TB cover fastening screw on the terminal block (TB) cover (Tightening torque: 15.9lb-in(1.8 N·m)).



Figure 2.7   Mounting the Covers (FRN015F1S-2DY)*

**(2) For inverters with a capacity of 40HP for 208V, 50HP for 460V to 125HP for 208V, 200HP for 460V**

■ Removing and mounting the covers

① To remove the front cover, loosen the four fastening screws on it, hold it with both hands, and slide it upward. (Refer to Figure 2.8.)

② Put the front cover back in reverse order of the ①. Make sure to properly match the position of the screw holes on both of the front cover and inverter case.

Table 2.5   Screw count and tightening torque

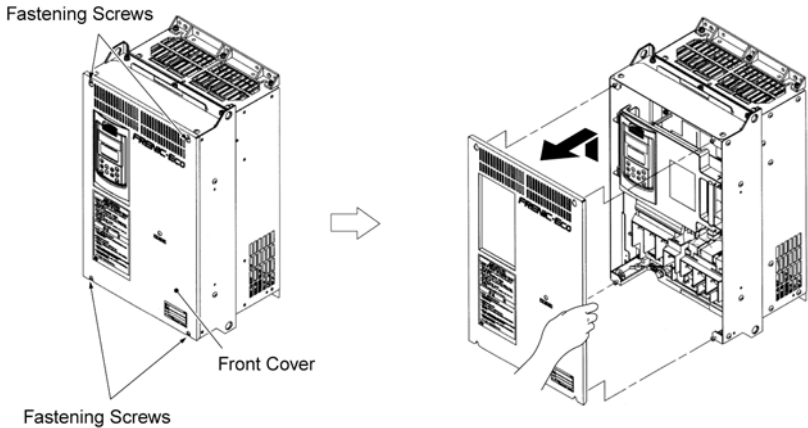| Power supply voltage | Inverter type | Front cover screw | Tightening torque lb-in(N·m) |
|---|---|---|---|
| Three-phase 208 V | FRN040F1S-2DY to FRN100F1S-2DY | M4x8 (4 pcs) | 15.9(1.8) |
| | FRN125F1S-2DY | M5x8 (12 pcs) | 31.0(3.5) |
| Three-phase 460 V | FRN050F1S-4DY to FRN150F1S-4DY | M4x8 (4 pcs) | 15.9(1.8) |
| | FRN200F1S-4DY | M5x8 (4 pcs) | 31.0(3.5) |



Figure 2.8   Removing the Front Cover (FRN040F1S-2DY)*
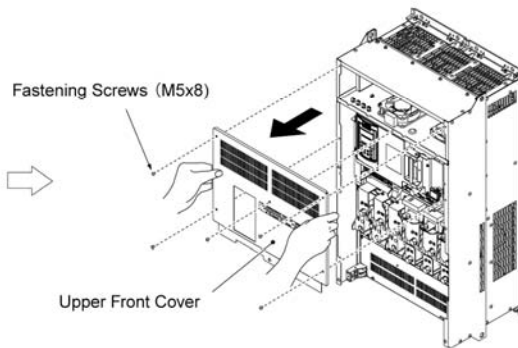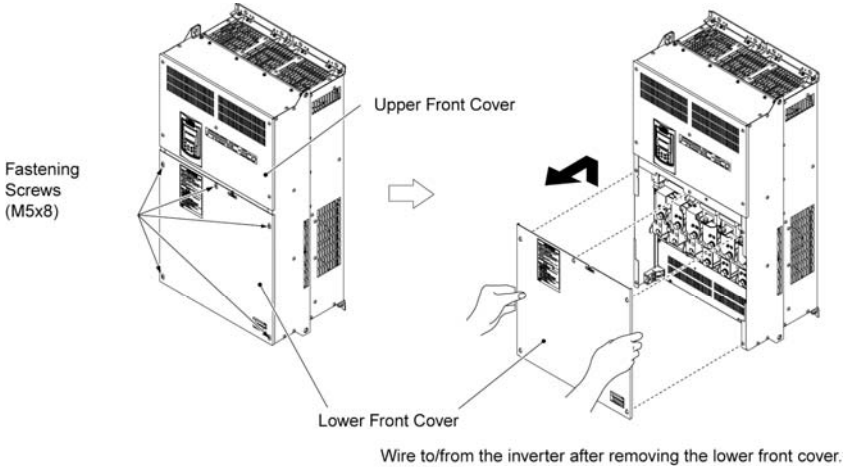
**(3) For inverters with a capacity of 250HP to 900HP**

■ Removing and mounting the covers

① To remove the lower front cover, loosen the five fastening screws on it, and hold it with both hands, and then slide it upward.

> Note  You can do wiring works just removing the lower front cover.

② To remove the upper front cover, loosen the five screws on it while supporting it with a hand. Pull and remove it with both hands. (Refer to Figure 2.9.)

③ Put back the upper and lower front covers in reverse order of ① and ②. Make sure to properly match the position of the screw holes on the upper and lower front covers and inverter case.

| Power supply voltage | Inverter type | Front cover screw | Tightening torque lb-in(N·m) |
|---|---|---|---|
| Three-phase 460 V | FRN250F1S-4DY to FRN350F1S-4DY | M5x8 (10 pcs) | 31.0(3.5) |
| | FRN400F1S-4DY to FRN450F1S-4DY | M5x8 (16 pcs) | 31.0(3.5) |
| | FRN500F1S-4DY to FRN600F1S-4DY | M5x8 (24 pcs) | 31.0(3.5) |
| | FRN700F1S-4DY to FRN900F1S-4DY | M5x8 (24 pcs) | 31.0(3.5) |



Upper Front Cover

Fastening Screws (M5x8)

Lower Front Cover

Wire to/from the inverter after removing the lower front cover.



Fastening Screws (M5x8)

Upper Front Cover

The upper front cover is removable as well as shown above.

Tightening torque: 31.0lb-in(3.5 N·m)

Figure 2.9   Removing the Front Covers (FRN350F1S-4DY)*

### 2.3.2 Removing and mounting the cable guide plate (for models of 1 to 25HP for 208V and 1 to 30HP for 460V)

For inverters of 25HP for 208V, 30HP for 460V or below use the cable guide plate to secure IP20 protective structure. Follow the steps to work on it.

■ Removing the cable guide plate

Before to proceed, remove the terminal block cover in advance.

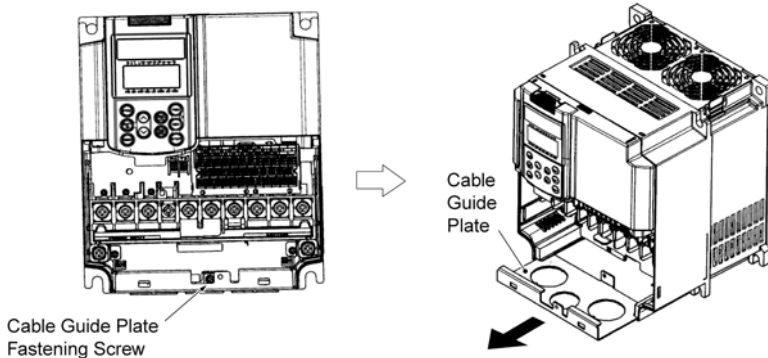Remove the cable guide plate fastening screw, and pull the cable guide plate.



Figure 2.10   Removing the Cable Guide Plate (FRN015F1S-2DY)*

■ Opening half-punched holes and mounting rubber bushes

① Tap the three half-punched holes of the cable guide plate by using a screwdriver grip end or the like and punch them out.

Note  Be careful not to injure yourself by sharp cutting edges of parts.

② Set the three attached rubber bushes in the punched holes. Make cut-outs on the rubber bushes before wiring.
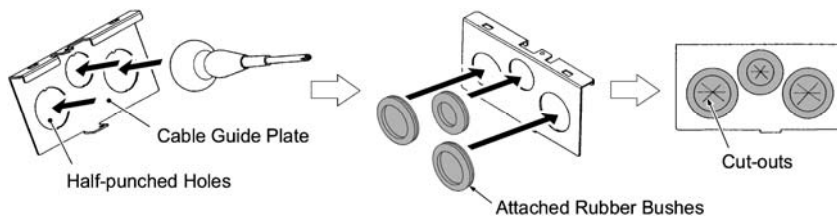


Figure 2.11   Punching out the Holes and Mounting the Rubber Bushes

| ⚠ WARNING |
| --- |
| Be sure to use the rubber bushes. If not, a sharp cutting edge of the cable guide plate hole may damage the cable sheath. This may induce a short-circuit fault or ground fault.<br>**A fire or an accident may be caused.** |

■ Mounting the cable guide plate

Mount the cable guide plate following the steps illustrated in Figure 2.10 in reverse. (Tightening torque: 15.9lb-in(1.8 N·m))

### 2.3.3 Terminal arrangement diagram and screw specifications

The table below shows the main circuit screw sizes, tightening torque and terminal arrangements. Note that the terminal arrangements differ according to the inverter types. Two terminals designed for grounding shown as the symbol, ⏚ in Figures A to J make no distinction between a power supply source (a primary circuit) and a motor (a secondary circuit).

### (1) Arrangement of the main circuit terminals

Table 2.6   Main Circuit Terminal Properties

| Power supply voltage | Nominal applied motor(HP) | Inverter type | Terminal screw size | Tightening torque lb-in(N·m) | Grounding screw size | Tightening torque lb-in (N·m) | Refer to: |
|---|---|---|---|---|---|---|---|
| Three-phase 208 V | 1 | FRN001F1S-2DY | M4 | 15.9(1.8) | M4 | 15.9(1.8) | Figure A |
| | 2 | FRN002F1S-2DY | | | | | |
| | 3 | FRN003F1S-2DY | | | | | |
| | 5 | FRN005F1S-2DY | | | | | |
| | 7.5 | FRN007F1S-2DY | M5 | 33.6(3.8) | M5 | 33.6(3.8) | Figure B |
| | 10 | FRN010F1S-2DY | | | | | |
| | 15 | FRN015F1S-2DY | M6 | 51.3(5.8) | M6 | 51.3(5.8) | Figure C |
| | 20 | FRN020F1S-2DY | | | | | |
| | 25 | FRN025F1S-2DY | | | | | |
| | 30 | FRN030F1S-2DY | M8 | 119(13.5) | M8 | 119(13.5) | Figure D |
| | 40 | FRN040F1S-2DY | | | | | Figure E |
| | 50 | FRN050F1S-2DY | M10 | 239(27) | | | Figure G |
| | 60 | FRN060F1S-2DY | | | | | |
| | 75 | FRN075F1S-2DY | | | | | |
| | 100 | FRN100F1S-2DY | | | | | |
| | 125 | FRN125F1S-2DY | M12 | 425(48) | M10 | 239(27) | Figure J |
| Three-phase 460 V | 1 | FRN001F1S-4DY | M4 | 15.9(1.8) | M4 | 15.9(1.8) | Figure A |
| | 2 | FRN002F1S-4DY | | | | | |
| | 3 | FRN003F1S-4DY | | | | | |
| | 5 | FRN005F1S-4DY | | | | | |
| | 7.5 | FRN007F1S-4DY | | | | | |
| | 10 | FRN010F1S-4DY | M5 | 33.6(3.8) | M5 | 33.6(3.8) | Figure B |
| | 15 | FRN015F1S-4DY | | | | | |
| | 20 | FRN020F1S-4DY | M6 | 51.3(5.8) | M6 | 51.3(5.8) | Figure C |
| | 25 | FRN025F1S-4DY | | | | | |
| | 30 | FRN030F1S-4DY | | | | | |
| | 40 | FRN040F1S-4DY | M8 | 119(13.5) | M8 | 119(13.5) | Figure D |
| | 50 | FRN050F1S-4DY | | | | | Figure E |
| | 60 | FRN060F1S-4DY | | | | | |
| | 75 | FRN075F1S-4DY | | | | | Figure F |
| | 100 | FRN100F1S-4DY | | | | | |
| | 125 | FRN125F1S-4DY | M10 | 239(27) | | | Figure G |
| | 150 | FRN150F1S-4DY | | | | | |
| | 200 | FRN200F1S-4DY | | | M10 | 239(27) | Figure H |
| | 250 | FRN250F1S-4DY | M12 | 425(48) | | | Figure I |
| | 300 | FRN300F1S-4DY | | | | | |
| | 350 | FRN350F1S-4DY | | | | | |
| | 400 | FRN400F1S-4DY | | | | | Figure K |
| | 450 | FRN450F1S-4DY | | | | | |
| | 500 | FRN500F1S-4DY | | | | | Figure L |
| | 600 | FRN600F1S-4DY | | | | | |
| | 700 | FRN700F1S-4DY | | | | | Figure M |
| | 800 | FRN800F1S-4DY | | | | | |
| | 900 | FRN900F1S-4DY | | | | | |

Terminal R0, T0 (Common to all types): Screw size M3.5, Tightening torque 10.6lb-in(1.2 (N·m))

Terminal R1, T1: Screw size M3.5, Tightening torque 7.9lb-in(0.9 (N·m)) (for the models of 208 V series 50HP or above, for 460 V series 75HP or above
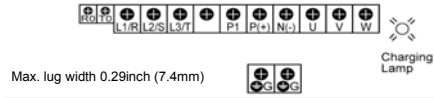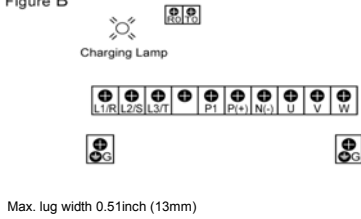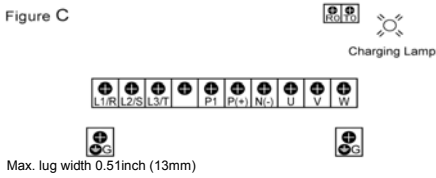
**Figure A**

L1/R L2/S L3/T P1 P(+) N(-) U V W

Charging Lamp

Max. lug width 0.29inch (7.4mm)

**Figure B**

Charging Lamp

L1/R L2/S L3/T P1 P(+) N(-) U V W

Max. lug width 0.51inch (13mm)

**Figure C**

Charging Lamp

L1/R L2/S L3/T P1 P(+) N(-) U V W

Max. lug width 0.51inch (13mm)

**Figure D**

Charging Lamp

R0 T0 U V W

L1/R L2/S L3/T P1 P(+) N(-)

Max. lug width 0.94inch (23.8mm)

**Figure E**

R0 T0

Charging Lamp

L1/R L2/S L3/T U V W

P1 P(+) N(-)

G

Max. lug width 1.17inch (29.6mm)

**Figure F**

Charging Lamp

R1 T1

R0 T0

L1/R L2/S L3/T U V W

P1 P(+) N(-)

Max. lug width 1.17inch (29.6mm)

**Figure G**

Charging Lamp

R1 T1

R0 T0

L1/R L2/S L3/T U V W

P1 P(+) N(-)

Max. lug width 1.47inch (37.4mm)

**Figure H**

Charging Lamp

R0 T0 R1 T1

L1/R L2/S L3/T U V W

P1 P(+) N(-)

Max. lug width 1.47inch (37.4mm)

**Figure I**

R0 T0 Charging Lamp R1 T1

L1/R L2/S L3/T U V W

P1 P(+) N(-)

G

Max. lug width 1.46inch (37mm)

**Figure J**

R0 T0 Charing Lamp

R1 T1

U V W

L1/R L2/S L3/T P1 P(+) N(-)

Max. lug width 1.26inch (32mm)

**Figure K**

R0 T0 Charing Lamp

R1 T1

L1/R L2/S L3/T U V W

P1 P(+) N(-)

G G

Max. lug width 1.46inch (37mm)

**Figure L**

R0 T0 Charing Lamp

R1 T1

L1/R L2/S L3/T U V W

L1/R L2/S L3/T U V W

P1 P(+) N(-)

G

Max. lug width 1.46inch (37mm)

**Figure M**

R0 T0 Charing Lamp

R1 T1

L1/R L2/S L3/T P1 U V W

L1/R L2/S L3/T P1 U V W

G P(+) N(-) G

Max. lug width 1.46inch (37mm)

**(2) The control circuit terminals (common to all models)**
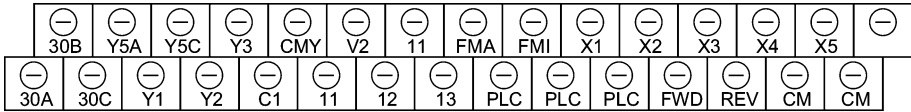


Screw size: M3    Tightening torque: 4.4 to 5.3lb-in(0.5 to 0.6 (N·m))
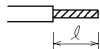
Table 2.7    Control Circuit Terminals

| Screwdriver type | Allowable wire size | Bared wire length | Dimension of openings in the control circuit terminals |
|---|---|---|---|
| Flat screw driver 0.02 x 0.14 inch (0.6 x 3.5 mm) | AWG26 to AWG16 (0.14 to 1.5 mm$^2$) | 0.28 inch (7 mm) | 0.10 (W) x 0.11 (H) inch (2.75 (W) x 2.86 (H) mm) |

**(3) The RS-485 communication terminals**



Screw size: M3    Tightening torque: 4.4 to 5.3 lb-in(0.5 to 0.6 (N·m))

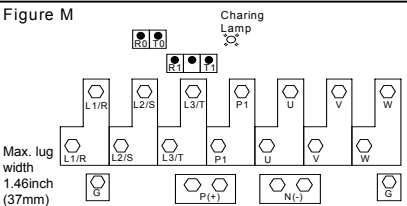| Screwdriver type | Allowable wire size | Bared wire length | Dimension of openings in the control circuit terminals |
|---|---|---|---|
| Flat screw driver 0.02 x 0.14 inch (0.6 x 3.5 mm) | AWG26 to AWG16 (0.14 to 1.5 mm$^2$) | 0.24 inch (6 mm) | 0.10 (W) x 0.07 (H) inch (2.51 (W) x 1.76 (H) mm) |



RS-485 Terminal Block

Control Circuit Terminal Block
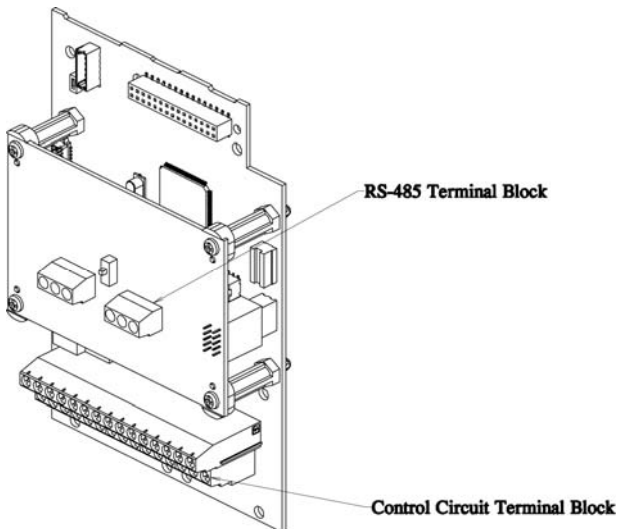
### 2.3.4 Recommended wire sizes

Table 2.8 lists the recommended wire sizes. Those for main circuits are examples for using a single wire (for 60/75°C(140/167°F)) at an ambient temperature of 50°C(122°F).

Table 2.8 Recommended Wire Sizes

| Power supply voltage | Nominal applied motor (HP) | Inverter type | Wire size[1] AWG (mm²) | | | |
|---|---|---|---|---|---|---|
| | | | Main terminal | Aux. Control Power Supply R0, T0 | Aux. Fan Power Supply R1, T1 | Control circuit<br>Europe type terminal block |
| Three-phase 208 V | 1 | FRN001F1S-2DY | 14 (2.1) | 14 (2.1) | - | 20 (0.5) |
| | 2 | FRN002F1S-2DY | | | | |
| | 3 | FRN003F1S-2DY | | | | |
| | 5 | FRN005F1S-2DY | 10 (5.3) | | | |
| | 7.5 | FRN007F1S-2DY | 8 (8.4) | | | |
| | 10 | FRN010F1S-2DY | 6 (13.3) | | | |
| | 15 | FRN015F1S-2DY | | | | |
| | 20 | FRN020F1S-2DY | 4 (21.2) | | | |
| | 25 | FRN025F1S-2DY | 3 (26.7) | | | |
| | 30 | FRN030F1S-2DY | 2 (33.6) | | | |
| | 40 | FRN040F1S-2DY | 3x2 (26.7) | | | |
| | 50 | FRN050F1S-2DY | 3/0 (85.0) | | 14 (2.1) | |
| | 60 | FRN060F1S-2DY | 4/0 (107.2) | | | |
| | 75 | FRN075F1S-2DY | 300 (152) | | | |
| | 100 | FRN100F1S-2DY | 2/0x2 (67.4) | | | |
| | 125 | FRN125F1S-2DY | 4/0x2 (107.2) | | | |
| Three-phase 460 V | 1 | FRN001F1S-4DY | 14 (2.1) | 14 (2.1) | - | 20 (0.5) |
| | 2 | FRN002F1S-4DY | | | | |
| | 3 | FRN003F1S-4DY | | | | |
| | 5 | FRN005F1S-4DY | | | | |
| | 7.5 | FRN007F1S-4DY | 12 (3.3) | | | |
| | 10 | FRN010F1S-4DY | 10 (5.3) | | | |
| | 15 | FRN015F1S-4DY | | | | |
| | 20 | FRN020F1S-4DY | 8 (8.4) | | | |
| | 25 | FRN025F1S-4DY | | | | |
| | 30 | FRN030F1S-4DY | 6 (13.3) | | | |
| | 40 | FRN040F1S-4DY | 4 (21.2) | | | |
| | 50 | FRN050F1S-4DY | 3 (26.7) | | | |
| | 60 | FRN060F1S-4DY | 2 (33.6) | | | |
| | 75 | FRN075F1S-4DY | 1/0 (53.5) | | 14 (2.1) | |
| | 100 | FRN100F1S-4DY | 2/0 (67.4) | | | |
| | 125 | FRN125F1S-4DY | 4/0 (107.2) | | | |
| | 150 | FRN150F1S-4DY | 250 (127) | | | |
| | 200 | FRN200F1S-4DY | 1/0x2 (53.5) | | | |
| | 250 | FRN250F1S-4DY | 3/0x2 (85.0) | | | |
| | 300 | FRN300F1S-4DY | 4/0x2 (107.2) | | | |
| | 350 | FRN350F1S-4DY | 300x2 (152) | | | |
| | 400 | FRN400F1S-4DY | 350x2 (177) | | | |
| | 450 | FRN450F1S-4DY | 400x2 (203) | | | |
| | 500 | FRN500F1S-4DY | 300x3 (152) | | | |
| | 600 | FRN600F1S-4DY | 350x3 (177) | | | |
| | 700 | FRN700F1S-4DY | 300x4 (152) | | | |
| | 800 | FRN800F1S-4DY | 350x4 (177) | | | |
| | 900 | FRN900F1S-4DY | 400x4 (203) | | | |

[1] Use crimp style terminals that are insulated or insulate using tubing or other methods acceptable by local and national codes. The insulation thermal rating of the wiring must be 60 or 75°C (140 or 167°F) with the inverter ambient temperature of 50°C (122°F).

### 2.3.5 Wiring precautions

Follow the rules below when performing wiring for the inverter.

(1) Make sure that the source voltage is within the rated voltage range specified on the nameplate.

(2) Be sure to connect the three-phase power wires to the main circuit power input terminals L1/R, L2/S and L3/T of the inverter. If the power wires are connected to other terminals, the inverter will be damaged when the power is turned on.

(3) Always connect the grounding terminal to prevent electric shock, fire or other disasters and to reduce electric noise.

(4) Use crimp terminals covered with insulated sleeves for the main circuit terminal wiring to ensure a reliable connection.

(5) Keep the power supply wiring (primary circuit) and motor wiring (secondary circuit) of the main circuit, and control circuit wiring as far away as possible from each other.

---

## ⚠ WARNING

- When wiring the inverter to the power source, insert a recommended molded case circuit breaker (MCCB) or a ground fault circuit interrupter (GFCI) (with overcurrent protection) in the path of each pair of power lines to inverters. Use the devices recommended ones within the related current range.
- Use wires in the specified size.
- Tighten terminals with specified torque.
  **Otherwise, fire could occur.**

- Do not connect a surge suppressor to the inverter's output circuit.
- Do not use one multicore cable in order to connect several inverters with motors.
  **Doing so could cause fire.**

- Ground the inverter in compliance with the national or local electric code.
  **Otherwise, electric shock or fire could occur.**

- Qualified electricians should carry out wiring.
- Be sure to perform wiring after turning the power off.
  **Otherwise, electric shock could occur.**

- Be sure to perform wiring after installing the inverter.
  **Otherwise, electric shock or injuries could occur.**

- Ensure that the number of input phases and the rated voltage of the product match the number of phases and the voltage of the AC power supply to which the product is to be connected.
- Do not connect the power source wires to output terminals (U, V, and W).
  **Doing so could cause fire or an accident.**

---

### 2.3.6 Wiring for main circuit terminals and grounding terminals

Table 2.9 shows the main circuit power terminals and grounding terminals.

Table 2.9   Symbols, Names and Functions of the Main Circuit Power Terminals

| Symbol | Name | Functions |
|---|---|---|
| L1/R, L2/S, L3/T | Main circuit power inputs | Connect the 3-phase input power lines. |
| U, V, W | Inverter outputs | Connect a 3-phase motor. |
| R0, T0 | Auxiliary power input for the control circuit | For a backup of the control circuit power supply, connect AC power lines same as that of the main power input. |
| P1, P(+) | DC reactor connection | Connect a DC reactor (DCR) for improving power factor (an option for the inverter whose capacity is 60HP for 208V, 75HP for 460V or below). |
| P(+), N(-) | DC link bus | Connect a DC link bus of other inverter(s). An optional regenerative converter is also connectable to these terminals. |
| R1, T1 | Auxiliary power input for the fans | Normally, no need to use these terminals. Use these terminals for an auxiliary power input of the fans in a power system using a power regenerative PWM converter (RHC series). |
| ⏚G | Grounding for inverter and motor | Grounding terminals for the inverter's chassis (or case) and motor. Earth one of the terminals and connect the grounding terminal of the motor. Inverters provide a pair of grounding terminals that function equivalently. |

Follow the procedure below for wiring and configuration of the inverter. Figure 2.12 illustrates the wiring procedure with peripheral equipment.

---

**Wiring procedure**

① Grounding terminals (⏚G)
② Inverter output terminals (U, V, W, and ⏚G)
③ DC reactor connection terminals (P1 and P(+))*
④ Switching connectors* (For the models of 208 V 50HP or above, for 460 V 75HP or above. Refer to page 2-18.)
⑤ DC link bus terminals (P(+) and N(-))*
⑥ Main circuit power input terminals (L1/R, L2/S and L3/T)
⑦ Auxiliary power input terminals for the control circuit (R0 and T0)*
⑧ Auxiliary power input terminals for the fans (R1 and T1)* (For models of 208 V 50HP or above, for 460 V 75HP or above. Refer to page 2-22.)
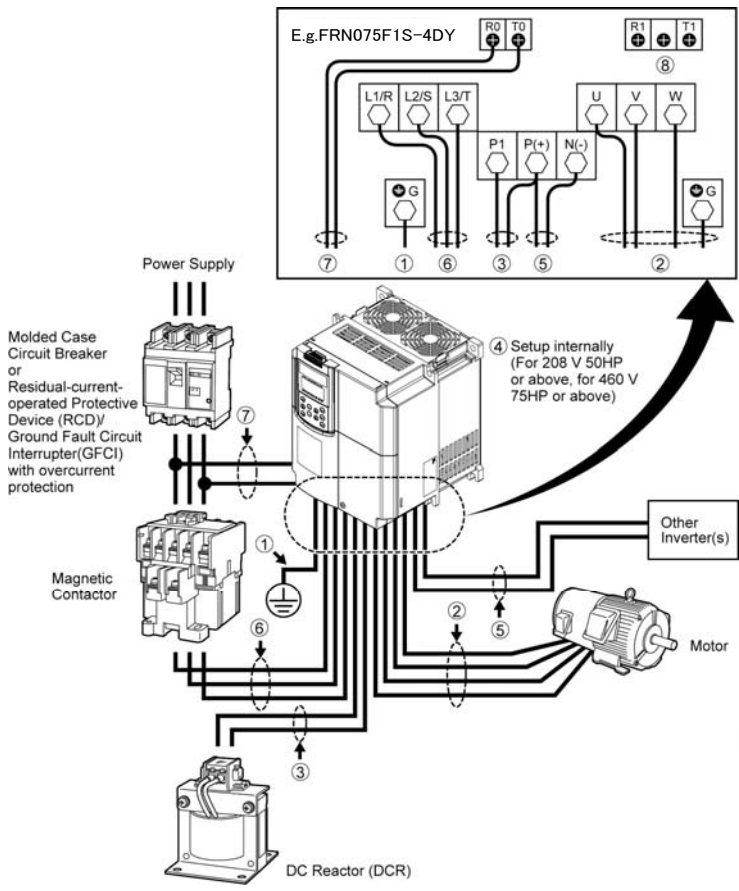
\* Perform wiring as necessary

---



Figure 2.12   Wiring Procedure for Peripheral Equipment

① **Grounding terminals (⏚G)**

Be sure to ground either of the two grounding terminals for safety and noise reduction. The inverter is designed to use with a safety grounding to avoid electric shock, fire and other disasters.

Grounding terminals should be grounded as follows:

1) Ground the inverter in compliance with the national or local electric code.
2) Use a thick grounding wire with a large surface area and keep the wiring length as short as possible.

② **Inverter output terminals (U, V, W)**

1) Connect these terminals to a 3-phase motor in the correct phase sequence. If the direction of motor rotation is incorrect, exchange any two of the U, V, and W phases.
2) Do not connect a power factor correction capacitor or surge absorber to the inverter output.
3) If the cable from the inverter to the motor is very long, a high-frequency current may be generated by stray capacitance between the cables and result in an overcurrent trip of the inverter, an increase in leakage current, or a reduction in current indication precision.

When a motor is driven by a PWM-type inverter, the motor terminals may be subject to surge voltage generated by inverter element switching. If the motor cable (with 460V series motors, in particular) is particularly long, surge voltage will deteriorate motor insulation. To prevent this, use the following guidelines:

| Inverter 7.5 HP and larger | | | |
|---|---|---|---|
| Motor Insulation Level | 1000V | 1300V | 1600V |
| 460 VAC Input Voltage | 66 ft (20 m) | 328 ft (100 m) | 1312 ft (400 m) * |
| 208 VAC Input Voltage | 1312 ft (400 m) * | 1312 ft (400 m) * | 1312 ft (400 m) * |

| Inverter 5 HP and smaller | | | |
|---|---|---|---|
| Motor Insulation Level | 1000V | 1300V | 1600V |
| 460 VAC Input Voltage | 66 ft (20 m) | 165 ft (50 m) * | 165 ft (50 m) * |
| 208 VAC Input Voltage | 328 ft (100 m) * | 328 ft (100 m) * | 328 ft (100 m) * |
| * For this case the cable length is determined by secondary effects and not voltage spiking. | | | |

Note | When a motor protective thermal O/L relay is inserted between the inverter and the motor, the thermal O/L relay may malfunction (particularly in the 460V series), even when the cable length is 165 ft (50m) or less. To correct, insert a filter or reduce the carrier frequency. (Use function code "F26 Motor sound".)

③ **DC reactor terminals, P1 and P (+)**

1) Remove the jumper bar from terminals P1 and P(+).
2) Connect a DC reactor (option) to terminals P1 and P(+).

**Note**
- The wiring length should be 33ft(10 m) or below.
- Do not remove the jumper bar if a DC reactor is not going to be used.
- An inverter with a capacity of 75HP for 208V, 100HP for 460V or above is equipped with a DC reactor as standard. Be sure to connect the DC reactor except when an optional converter is connected to the inverter.

④ **Switching connectors**

■ Power switching connectors (CN UX) (for the models of 460 V 75HP or above)

An inverter of 460 V 75HP or above is equipped with a set of switching connectors CU UX (male) which should be configured with a jumper according to the power source voltage and frequency. Set the jumper to U1 or U2 depending upon the power source voltage applied to the main power inputs (L1/R, L2/S, L3/T) or auxiliary power input terminals (R1, T1) for fans, as shown in Figure 2.16.

■ Fan power supply switching connectors (CN R) and (CN W) (for models of 208 V 50HP or above, for models of 460 V 75HP or above.)

The standard FRENIC-Eco series of inverters also accept DC-linked power input in combination with a power regenerative PWM converter (RHC series). Even when you drive the inverter with a DC-linked power, however, you also need to supply AC power for models of 208 V 50HP or above, for models of 460 V 75HP or above, since it contains components such as AC fans that are driven by AC power. In this case, reinstall the connectors (CN R) and (CN W) to the NC and FAN positions respectively and supply the power to the auxiliary power input terminals (R1, T1).

For the actual procedure, refer to Figures 2.14 to 2.16 below.

Note On the fan power supply switching connectors (CN R) and (CN W), the jumpers are installed at FAN and NC positions respectively by factory default. Do not relocate the jumper unless you drive the inverter with a DC-linked power supply.

If there is a mistake in the installation of the jumpers for the switching connectors, the cooling fan will not run, causing a heat sink overheating alarm "$OH1$" or a charger circuit error alarm "$PbF$ ."
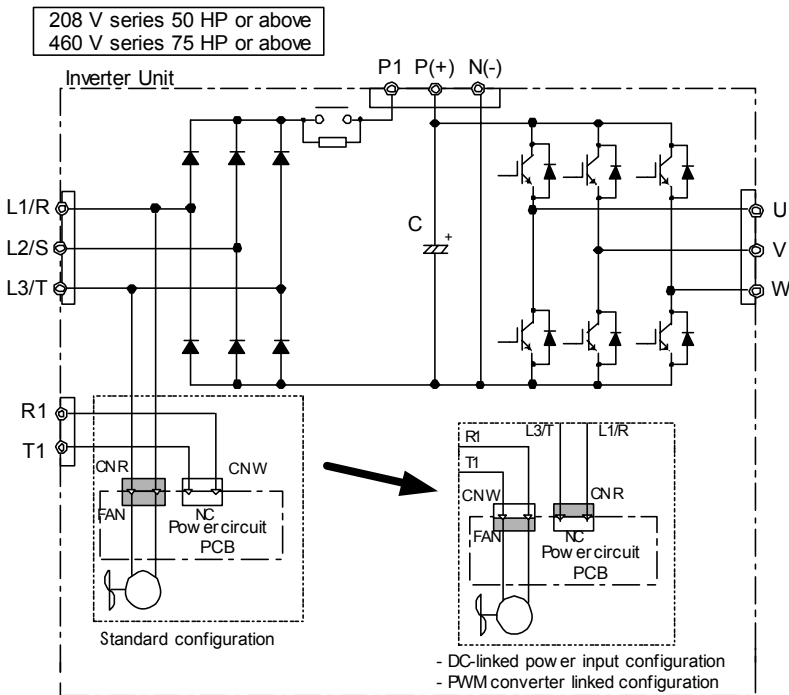


Figure 2.13    Switching Fan Power Source

■ Setting up the jumpers for the connectors (CN UX), (CN R) and (CN W)

These switching connectors are located on the power printed circuit board (power PCB) mounted at the right hand side of the control printed circuit board (control PCB) as shown below.
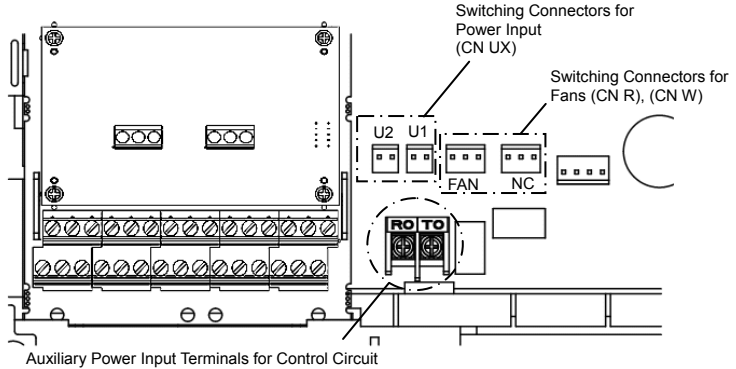


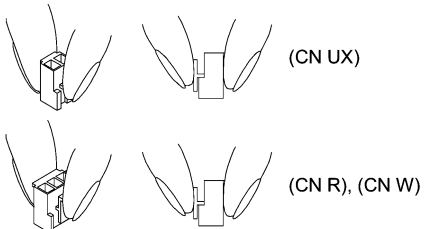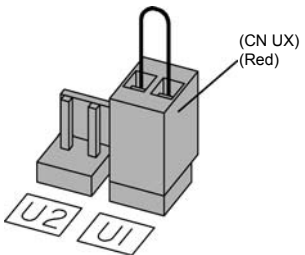Figure 2.14    Location of Switching Connectors and Auxiliary Power Input Terminals



Figure 2.15    Inserting/Removing the Jumpers

Note To remove the jumper, pinch its upper side between your fingers, unlock its fastener and pull it up. To insert it, pull it down as firmly as it locks with the connector until you will have heard a click sound.

Figure 2.16 shown below illustrates how the configuration jumpers of the connectors (CN UX), (CN R) and (CN W) are setup by factory defaults, and to change their settings for a new power configuration.

■ Setting up the power switching connector (CN UX)
(for the models of 460 V 75HP or above)

| Connector configuration |  |
|---|---|
| Note | Allowable power input voltage range should be within – 15% to +10% of power source voltage. |

■ Setting up the fan power supply switching connectors (CN R) and (CN W)
(for the models of 208 V 50HP or above ; 460 V 75HP or above)
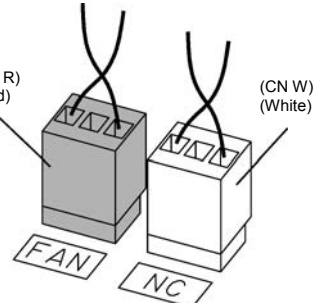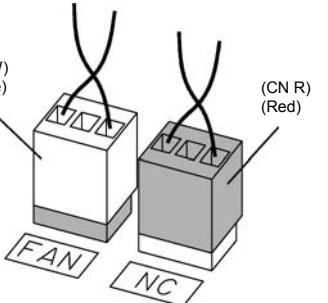
| Connector configuration |  |  |
|---|---|---|
| Power system operation | When using no terminal R1, T1 <br><br> (Factory default) | When using the terminals R1, T1 <br> • Feeding the DC-linked power <br> • Combined with a PWM converter |

Figure 2.16   Reconfiguration of the (CN UX), (CN R) and (CN W) Connectors

⑤ **DC link bus terminals, P (+) and N (-)**

These are provided for the DC link bus powered system. Connect these terminals with terminals P(+) and N (-) of other inverters.

Note  Consult your Fuji Electric representative if these terminals are to be used.

⑥ **Main circuit power input terminals, L1/R, L2/S, and L3/T (three-phase input)**

1) For safety, make sure that the molded case circuit breaker (MCCB) or magnetic contactor (MC) is turned off before wiring the main circuit power input terminals.

2) Connect the main circuit power supply wires (L1/R, L2/S and L3/T) to the input terminals of the inverter via an MCCB or residual-current-operated protective device (RCD)/a ground fault circuit interrupter (GFCI)*, and MC if necessary.

   It is not necessary to align phases of the power supply wires and the input terminals of the inverter with each other.

   *  With overcurrent protection

Tip  It is recommended that a magnetic contactor be inserted that can be manually activated. This is to allow you to disconnect the inverter from the power supply in an emergency (e.g., when the protective function is activated) so as to prevent a failure or accident from causing the secondary problems.

⑦ **Auxiliary power input terminals R0 and T0 for the control circuit**

In general, the inverter will run normally without power supplied to the auxiliary power input for the control circuit. However, if you share the input power for the control circuit with that for the main circuit, you would be lost when, in the event of an error or alarm, you turn OFF the magnetic contactor between the inverter and the commercial power supply. If the magnetic contactor is turned OFF, the input power to the control circuit is shut OFF, causing the alarm signals (30A/B/C) to be lost and the display on the keypad to disappear. To secure input power to the control circuit at all times, supply the power from the primary side of the magnetic contactor to control power auxiliary input terminals R0 and T0.

Note  When introducing a residual-current-operated protective device (RCD)/ground fault circuit interrupter (GFCI), connect its output (secondary) side to terminals R0 and T0. Connecting its input (primary) side to those terminals causes the RCD/GFCI to malfunction since the input power voltage to the inverter is three-phase but the one to terminals R0 and T0 is single-phase. To avoid such problems, be sure to insert an insulation transformer or auxiliary B contacts of a magnetic contactor in the location shown in Figure 2.17.
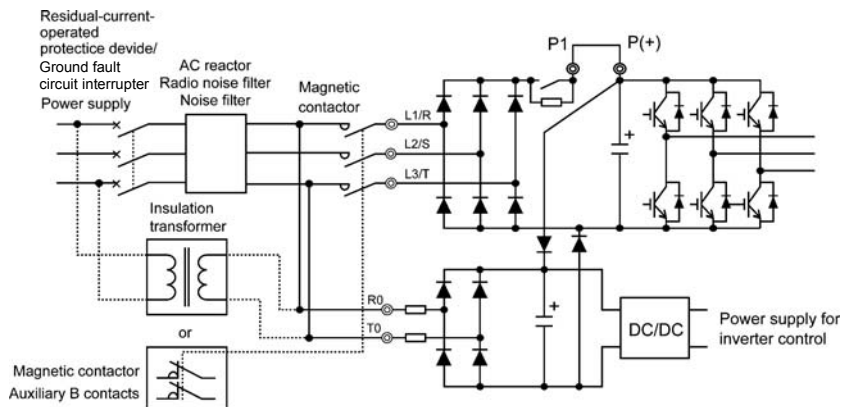


Figure 2.17  Connection Example of residual-current-operated protective device (RCD)/
Ground Fault Circuit Interrupter (GFCI)

**Note** When connecting a PWM converter with an inverter, do not connect the power supply line directly to terminals R0 and T0. If a PWM is to be connected, insert an insulation transformer or auxiliary B contacts of a magnetic contactor at the power supply side.

For connection examples at the PWM converter side, refer to the PWM Converter Instruction Manual.
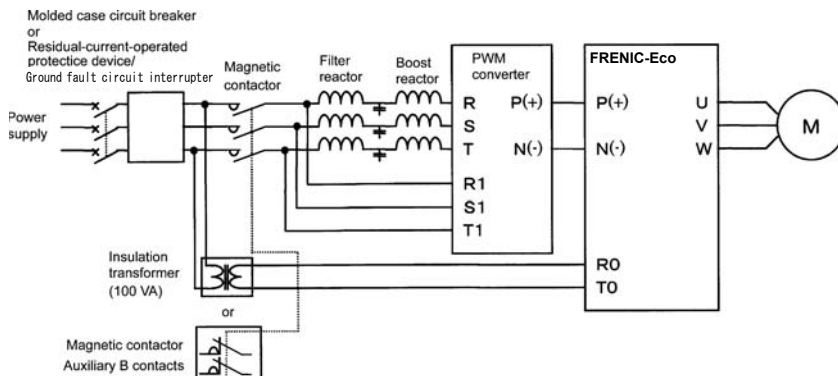


Figure 2.18    Connection Example of PWM Converter

⑧ **Auxiliary power input terminals R1 and T1 for the fan**

Inverters of 50HP or above for 208V and 75HP or above for 460V are equipped with these terminals R1 and T1. Only if the inverter works with the DC link power input whose source is a power regenerative PWM converter (e.g. RHC series), these terminals are used to feed power to the fans while they are not used in any power system of ordinary configuration. The fan power is:

Single phase 200 to 220 VAC/50 Hz, 200 to 230 VAC/60 Hz for 208 V 50HP or above
Single phase 380 to 440 VAC/50 Hz. 380 to 480 VAC/60 Hz for 460 V 75HP or above

### 2.3.7 Wiring for control circuit terminals

| ⚠WARNING |
|---|
| In general, sheaths and covers of the control signal cables and wires are not specifically designed to withstand a high electric field (i.e., reinforced insulation is not applied). Therefore, if a control signal cable or wire comes into direct contact with a live conductor of the main circuit, the insulation of the sheath or the cover might break down, which would expose the signal wire to a high voltage of the main circuit. Make sure that the control signal cables and wires will not come into contact with live conductors of the main circuit. |
| **Failure to observe these precautions could cause electric shock and/or an accident.** |

| ⚠CAUTION |
|---|
| Noise may be emitted from the inverter, motor and wires. |
| Take appropriate measure to prevent the nearby sensors and devices from malfunctioning due to such noise. |
| **An accident could occur.** |

Table 2.10 lists the symbols, names and functions of the control circuit terminals. The wiring to the control circuit terminals differs depending upon the setting of the function codes, which reflects the use of the inverter. Route wires properly to reduce the influence of noise, referring to the notes on the following pages.

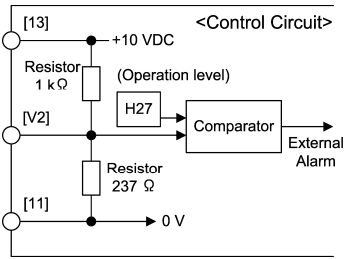| Classifi-cation | Symbol | Name | Functions |
|---|---|---|---|
| Analog input | [13] | Potenti-ometer power supply | Power supply (+10 VDC) for the potentiometer that gives the frequency command (Potentiometer: 1 to 5kΩ)<br>Allowable output current: 10 mA |
| | [12] | Voltage input | (1) The frequency is commanded according to the external analog input voltage.<br>0 to 10 VDC/0 to 100 (%) (Normal mode operation)<br>10 to 0 VDC/0 to 100 (%) (Inverse mode operation)<br>(2) Used for PID process command signal or its feedback.<br>(3) Used as an additional auxiliary frequency command to be added to one of various main frequency commands.<br>* Input impedance: 22kΩ<br>* The allowable maximum input voltage is +15 VDC. If the input voltage is +10 VDC or more, the inverter will interpret it as +10 VDC. |
| | [C1] | Current input | (1) The frequency is commanded according to the external analog input current.<br>4 to 20 mA DC/0 to 100 (%) (Normal mode operation)<br>20 to 4 mA DC/0 to 100 (%) (Inverse mode operation)<br>(2) Used for PID process command signal or its feedback.<br>(3) Used as an additional auxiliary frequency command to be added to one of various main frequency commands.<br>* Input impedance: 250Ω<br>* The allowable maximum input current is +30 mA DC. If the input current exceeds +20 mA DC, the inverter will interpret it as +20 mA DC. |
| | [V2] | Voltage input | (1) The frequency is commanded according to the external analog input voltage.<br>0 to 10 VDC/0 to 100 (%) (Normal mode operation)<br>10 to 0 VDC/0 to 100 (%) (Inverse mode operation)<br>(2) Used for PID process command signal or its feedback.<br>(3) Used as an additional auxiliary frequency command to be added to one of various main frequency commands.<br>* Input impedance: 22kΩ<br>* The allowable input voltage is +15 VDC. If the input voltage exceeds +10 VDC, however, the inverter will interpret it as +10 VDC.<br><br>(4) Connects PTC (Positive Temperature Coefficient) thermistor for motor protection. Ensure that the slide switch SW5 on the control PCB is turned to the PTC position (refer to Section 2.3.8 "Setting up slide switches and handling control circuit terminal symbol plate."<br><br>The figure shown at the right illustrates the internal circuit diagram where SW5 (switching the input of terminal [V2] between V2 and PTC) is turned to the PTC position. For details on SW5, refer to Section 2.3.8 "Setting up slide switches and handling control circuit terminal symbol plate." In this case, you must change data of the function code H26.<br><br><br>Figure 2.19   Internal Circuit Diagram (SW5 Selecting PTC) |
| | [11] | Analog common | Two common terminals for analog input and output signal terminals [13], [12], [C1], [V2] and [FMA].<br>These terminal are electrically isolated from terminals [CM]s and [CMY]. |

Table 2.10   Continued

| Classifi-cation | Symbol | Name | Functions |
|---|---|---|---|
| Analog input | Note | | - Since low level analog signals are handled, these signals are especially susceptible to the external noise effects. Route the wiring as short as possible (within 66ft(20 m)) and use shielded wires. In principle, ground the shielded sheath of wires; if effects of external inductive noises are considerable, connection to terminal [11] may be effective. As shown in Figure 2.18, ground the single end of the shield to enhance the shielding effect.<br><br>- Use a twin contact relay for low level signals if the relay is used in the control circuit. Do not connect the relay's contact to terminal [11].<br><br>- When the inverter is connected to an external device outputting the analog signal, a malfunction may be caused by electric noise generated by the inverter. If this happens, according to the circumstances, connect a ferrite core (a toroidal core or an equivalent) to the device outputting the analog signal and/or connect a capacitor having the good cut-off characteristics for high frequency between control signal wires as shown in Figure 2.21.<br><br>- Do not apply a voltage of +7.5 VDC or higher to terminal [C1]. Doing so could damage the internal control circuit. |

Figure 2.20   Connection of Shielded Wire          Figure 2.21   Example of Electric Noise Reduction

Table 2.10   Continued

| Classifi-cation | Symbol | Name | Functions |
|---|---|---|---|
| Digital input | [X1] | Digital input 1 | (1) The various signals such as coast-to-stop, alarm from external equipment, and multistep frequency commands can be assigned to terminals [X1] to [X5], [FWD] and [REV] by setting function codes E01 to E05, E98, and E99. For details, refer to Chapter 5, Section 5.2 "Overview of Function Codes." <br> (2) Input mode, i.e. Sink/Source, is changeable by using the internal slide switch. <br> (3) Switches the logic value (1/0) for ON/OFF of the terminals between [X1] to [X5], [FWD] or [REV], and [CM]. If the logic value for ON between [X1] and [CM] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa. <br> (4) The negative logic system never applies to the terminals assigned for (FWD) and (REV). |
| | [X2] | Digital input 2 | |
| | [X3] | Digital input 3 | |
| | [X4] | Digital input 4 | |
| | [X5] | Digital input 5 | |
| | [FWD] | Run forward command | (Digital input circuit specifications) <br><br>  <br> Figure 2.22   Digital Input Circuit <br><br> <table><tr><td colspan="2">Item</td><td>Min.</td><td>Max.</td></tr><tr><td rowspan="2">Operation voltage (SINK)</td><td>ON level</td><td>0 V</td><td>2 V</td></tr><tr><td>OFF level</td><td>22 V</td><td>27 V</td></tr><tr><td rowspan="2">Operation voltage (SOURCE)</td><td>ON level</td><td>22 V</td><td>27 V</td></tr><tr><td>OFF level</td><td>0 V</td><td>2 V</td></tr><tr><td colspan="2">Operation current at ON (Input voltage is at 0V)</td><td>2.5 mA</td><td>5 mA</td></tr><tr><td colspan="2">Allowable leakage current at OFF</td><td>-</td><td>0.5 mA</td></tr></table> |
| | [REV] | Run reverse command | |
| | [PLC] | PLC signal power | Connects to PLC output signal power supply. <br> (Rated voltage: +24 VDC: Allowable range: +22 to +27 VDC Maximum load current:50mA) <br> This terminal also supplies a power to the circuitry connected to the transistor output terminals [Y1] to [Y3]. Refer to "Transistor output" described later in this table for more. |
| | [CM] | Digital common | Two common terminals for digital input signal terminals. <br> These terminals are electrically isolated from the terminals, [11]s and [CMY]. |

Item table (Digital input circuit specifications):

| Item | | Min. | Max. |
|---|---|---|---|
| Operation voltage (SINK) | ON level | 0 V | 2 V |
| | OFF level | 22 V | 27 V |
| Operation voltage (SOURCE) | ON level | 22 V | 27 V |
| | OFF level | 0 V | 2 V |
| Operation current at ON (Input voltage is at 0V) | | 2.5 mA | 5 mA |
| Allowable leakage current at OFF | | - | 0.5 mA |

The

Table 2.10 Continued

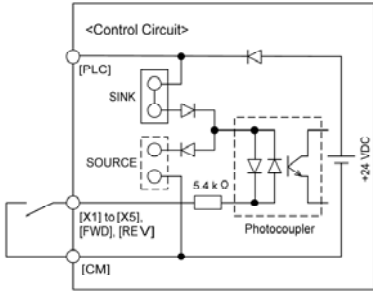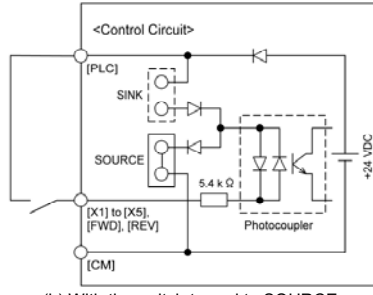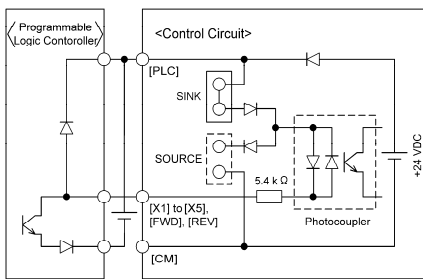| Classification | Symbol | Name | Functions |
|---|---|---|---|
| Analog output | [FMA] | Analog monitor | The monitor signal for analog DC voltage (0 to +10 V) or analog DC current (+4 to +20 mA) is output. You can select either one of the output switching the slide switch SW4 on the control PCB (Refer to Section 2.3.8.), and changing data of the function code F29. You can select one of the following signal functions with function code F31.<br>・ Output frequency  ・ Output current  ・ Output voltage<br>・ Output torque  ・ Load factor  ・ Input power<br>・ PID feedback value  ・ DC link bus voltage  ・ Universal AO<br>・ Motor output  ・ Analog output test  ・ PID command<br>・ PID output<br><br>\* Input impedance of the external device: Min. 5kΩ (0 to 10 VDC output)<br>Input impedance of the external device: Max. 500Ω (4 to 20 mA DC output)<br>\* While the terminal is outputting 0 to 10 VDC, an output less than 0.3 V may become 0.0 V.<br>\* While the terminal is outputting 0 to 10 VDC, it is capable of driving up to two meters with 10 kΩ impedance. While outputting the current, to drive a meter with 500 Ω impedance max. (Adjustable range of the gain: 0 to 200%) |
| | [FMI] | Analog monitor | The monitor signal for analog DC current (+4 to +20 mA) is output. You can select one of the following signal functions with function code F35.<br>・ Output frequency  ・ Output current  ・ Output voltage<br>・ Output torque  ・ Load factor  ・ Input power<br>・ PID feedback value  ・ DC link bus voltage  ・ Universal AO<br>・ Motor output  ・ Analog output test  ・ PID command<br>・ PID output<br><br>\* Input impedance of the external device: Max. 500Ω<br>\* It is capable of driving a meter with a maximum of 500Ω impedance.<br>(Adjustable gain range: 0 to 200%) |
| | [11] | Analog common | Two common terminals for analog input and output signal terminals<br>These terminals are electrically isolated from terminals [CM]s and [CMY]. |

Table 2.10   Continued

| Classifi-cation | Symbol | Name | Functions |
|---|---|---|---|
| Transistor output | [Y1] | Transistor output 1 | (1) Various signals such as inverter running, speed/freq. arrival and overload early warning can be assigned to any terminals, [Y1] to [Y3] by setting function code E20, E21 and E22. Refer to Chapter 5, Section 5.2 "Overview of Function Codes" for details.<br>(2) Switches the logic value (1/0) for ON/OFF of the terminals between [Y1] to [Y3] and [CMY]. If the logic value for ON between [Y1] to [Y3] and [CMY] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa. |
|  | [Y2] | Transistor output 2 | Transistor output circuit specification<br><br>Figure 2.25   Transistor Output Circuit |
|  | [Y3] | Transistor output 3 | Figure 2.26 shows examples of connection between the control circuit and a PLC.<br><br>Note  - When a transistor output drives a control relay, connect a surge-absorbing diode across relay's coil terminals.<br>- When any equipment or device connected to the transistor output needs to be supplied with DC power, feed the power (+24 VDC: allowable range: +22 to +27 VDC, 50 mA max.) through the [PLC] terminal. Short-circuit between the terminals [CMY] and [CM] in this case. |
|  | [CMY] | Transistor output common | Common terminal for transistor output signal terminals<br>This terminal is electrically isolated from terminals, [CM]s and [11]s. |

Transistor output circuit specification table:

| Item | | Max. |
|---|---|---|
| Operation voltage | ON level | 3 V |
|  | OFF level | 27 V |
| Maximum load current at ON | | 50 mA |
| Leakage current at OFF | | 0.1 mA |

Tip  ■ **Connecting Programmable Controller (PLC) to Terminal [Y1], [Y2] or [Y3]**

Figure 2.26 shows two examples of circuit connection between the transistor output of the inverter's control circuit and a PLC. In example (a), the input circuit of the PLC serves as a sink for the control circuit output, whereas in example (b), it serves as a source for the output.



(a)   PLC serving as Sink                     (b)   PLC serving as Source

Figure 2.26   Connecting PLC to Control Circuit

Table 2.10 Continued
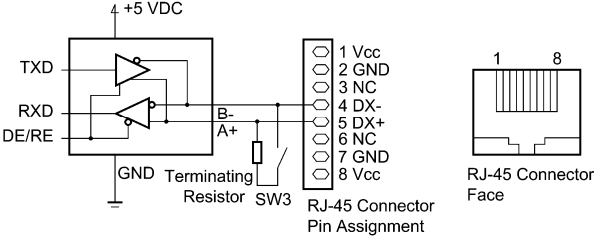
| Classification | Symbol | Name | Functions |
|---|---|---|---|
| Relay contact output | [Y5A/C] | General purpose relay output | (1) A general-purpose relay contact output usable as well as the function of the transistor output terminal [Y1], [Y2] or [Y3].<br>Contact rating: 250 VAC 0.3 A, cos φ = 0.3, 48 VDC, 0.5 A<br><br>(2) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Active ON" (Terminals [Y5A] and [Y5C] are closed (excited) if the signal is active.) and "Active OFF" (Terminals [Y5A] and [Y5C] are opened (non-excited) if the signal is active while they are normally closed.). |
| | [30A/B/C] | Alarm relay output (for any error) | (1) Outputs a contact signal (SPDT) when a protective function has been activated to stop the motor.<br>Contact rating: 250 VAC, 0.3A, cos φ = 0.3, 48 VDC, 0.5A<br><br>(2) Any one of output signals assigned to terminals [Y1] to [Y3] can also be assigned to this relay contact to use it for signal output.<br><br>(3) Switching of the normal/negative logic output is applicable to the following two contact output modes: "Terminals [30A] and [30C] are closed (excited) for ON signal output (Active ON)" or "Terminals [30B] and [30C] are closed (non-excited) for ON signal output (Active OFF)." |
| Communication | RJ-45 connector for the keypad | Standard RJ-45 connector | (1) Used to connect the inverter with PC or PLC using RS-485 port. The inverter supplies the power to the keypad through the pins specified below. The extension cable for remote operation also uses wires connected to these pins for supplying the keypad power.<br><br>(2) Remove the keypad from the standard RJ-45 connector, and connect the RS-485 communications cable to control the inverter through the PC or PLC (Programmable Logic Controller). Refer to Section 2.3.8 "Setting up slide switches and handling control circuit terminal symbol plate" for setting of the terminating resistor.<br><br>Figure 2.27   RJ-45 Connector and its Pin Assignment*<br>* Pins 1, 2, 7, and 8 are exclusively assigned to power lines for the keypad, so do not use those pins for any other equipment. |

Table 2.10    Continued

| Classifi-cation | Symbol | Name | Functions |
|---|---|---|---|
| Communication | [DX+] | RS-485 communications data (+) terminal | (1) This extends the functions of inverter to the below in addition to the RJ-45 connector to communicate on FRENIC-Eco .<br>- The inverter can be controlled as a subordinate device (slave) by connecting it to an upper level device (host (master)) such as a PLC or personal computer.<br>Note) The connection between this card and Keypad / Inverter support loader does not function.<br>Refer to RS-485 communication Users Manual about the details . |
| | [DX-] | RS-485 communications data (-) terminal | |
| | [SD] | Communications cable shield terminal | |
| | [DX+] | DX+ relay terminal for multidrop | |
| | [DX-] | DX- relay terminal for multidrop | |
| | [SD] | SD relay terminal for multidrop | |

TXD  A+  DX+

DX-

B-  SD

RXD

DE/RE  Terminating resistor  DX+

DX-

SW103  SD

**Wiring for control circuit terminals**

■ For models of FRN200F1S-4DY to FRN900F1S-4DY

① Route the control circuit cable in keeping with the left side panel of the inverter as shown in Figure 2.28.

② Fasten the control circuit cable to the cable tie support with a cable tie (insulation lock) as shown in Figure 2.28.

The hole in the cable tie support is 0.15 inch(3.8 mm) × 0.06 inch(1.5 mm) in size. To pass the cable tie through the hole, it should be 0.15 inch(3.8 mm) or less in width and 0.06 inch(1.5 mm )or less in thickness.
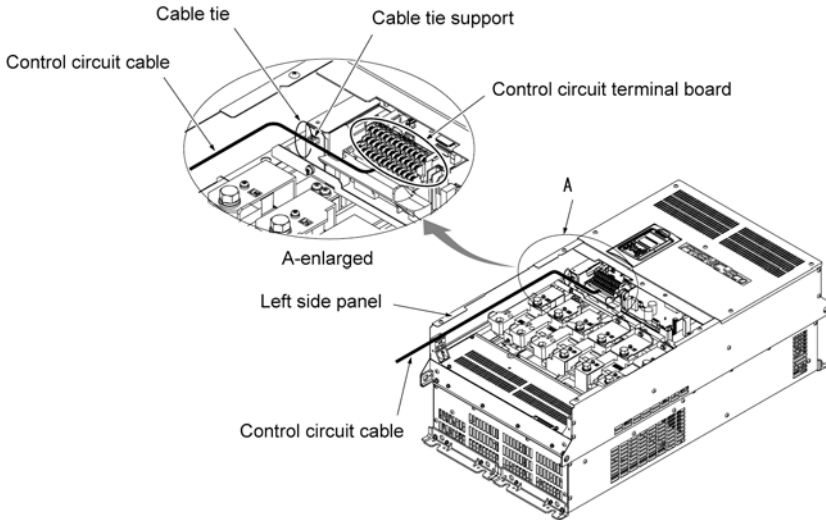


Figure 2.28   Routing and Fastening the Control Circuit Cable

Note
- Route the wiring of the control terminals as far from the wiring of the main circuit as possible. Otherwise electric noise may cause malfunctions.
- Fix the control circuit wires inside the inverter to keep them away from the live parts of the main circuit (such as the terminal block of the main circuit).

### 2.3.8 Setting up slide switches and handling control circuit terminal symbol plate

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# ⚠ WARNING

Before changing the switches or touching the control circuit terminal symbol plate, turn OFF the power and wait more than five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).

**An electric shock may result if this warning is not heeded as there may be some residual electric charge in the DC bus capacitor even after the power has been turned off.**

---

■ Setting up the slide switches

Switching the slide switches located on the control PCB allows you to customize the operation mode of the analog output terminals, digital I/O terminals, and communications ports. The locations of those switches are shown in Figure 2.29.

To access the slide switches, remove the front and terminal block covers so that you can watch the control PCB. For models of 40HP for 208V, 50HP for 460V or above, open also the keypad enclosure.

For a screw terminal base, close the control circuit terminal symbol plate since the plate being opened interferes with switching of some switches.

📖 For details on how to remove the front cover, terminal block cover, and keypad enclosure, refer to Section 2.3.1, "Removing and mounting the terminal block (TB) cover and the front cover" and Chapter 1, Section 1.2, "External View and Terminal Blocks," Figure 1.4.

Table 2.11 lists function of each slide switch.

Table 2.11    Function of Each Slide Switch

| Switch | Function |
|---|---|
| ① SW1 | Switches the service mode of the digital input terminals between SINK and SOURCE. <br>▪ To make the digital input terminal [X1] to [X5], [FWD] or [REV] serve as a current sink, turn SW1 to the SINK position. <br>▪ To make them serve as a current source, turn SW1 to the SOURCE position. <br>Factory default : SINK |
| ② SW3 | Switches the terminating resistor of RS-485 communications port on the inverter on and off. <br>▪ To connect a keypad to the inverter, turn SW3 to OFF. (Factory default) <br>▪ If the inverter is connected to the RS-485 communications network as a terminating device, turn SW3 to ON. |
| ③ SW4 | Switches the output mode of the analog output terminal [FMA] between voltage and current. When changing this switch setting, also change the data of function code F29. <br><br>|  | SW4 | Set data of F29 to: |<br>|---|---|---|<br>| Voltage output (Factory default) | VO | 0 |<br>| Current output | IO | 1 | |
| ④ SW5 | Switches property of the analog input terminal [V2] for V2 or PTC. When changing this switch setting, also change the data of function code H26. <br><br>|  | SW5 | Set data of H26 to: |<br>|---|---|---|<br>| Analog frequency command in voltage (Factory default) | V2 | 0 |<br>| PTC thermistor input | PTC | 1 or 2 | |
| ⑤ SW103 | Switches the terminating resistor of RS-485 communications (terminal). If more than one inverter is connected in your network and you are going to install the RS-485 Communications (Terminal) on the inverter at the network end, then be sure to turn SW103 to the ON position. |

Figure 2.29 shows the location of slide switches for the input/output terminal configuration.



Switching example

SW1

| SINK | SOURCE |
|------|--------|
| | |

SW3

| RS-485 comm. port terminator ||
|------|------|
| ON | OFF |
| | |

SW103

| RS-485 comm. port terminator ||
|------|------|
| ON | OFF |
| | |

SW103
(switch for connecting/disconnecting
terminating resistor)
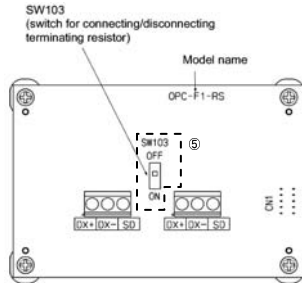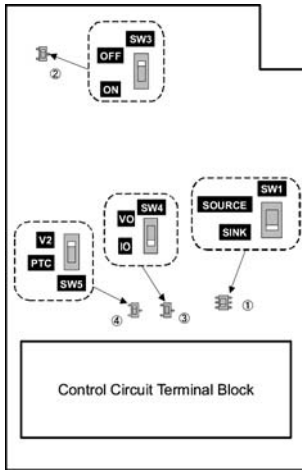
Figure 2.29   Location of the Slide Switches

## 2.4   Mounting and Connecting a Keypad

### 2.4.1   Mounting style and parts needed for connection

**(1)   Mounting style**

You can mount a keypad in any style described below.

■   Mounting a keypad on the enclosure wall (Refer to Figure 2.30.)
■   Installing a keypad at a remote site (e.g. for operation on hand) (Refer to Figure 2.31.)
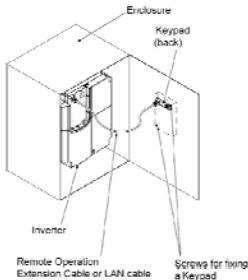


Figure 2.30   Mounting a Keypad on the
Enclosure Wall
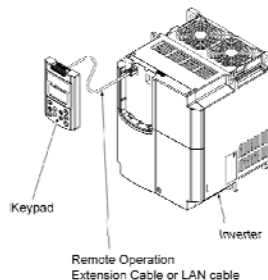
Figure 2.31   Installing a Keypad at a
Remote Site
(e.g. for Operation on Hand)

**(2) Parts needed for connection**

To mount/install a keypad on a place other than an inverter, parts listed below are needed.

| Parts name | Model | Remarks |
|---|---|---|
| Extension cable        (Note 1) | 10 BASE-T/100BASE-TX straight type cable compliant to US ANSI TIA/EIA-568A Category 5. | Less than 66ft(20m). |
| Fastening screw | M3 × 12 (2pcs fine thread screws) M3 x 12 (2pcs tapping screws) | Accessories |

(Note 1)    Recommended LAN cable
　　　　　Manufacturer:    SANWA Supply Co., LTD.
　　　　　Model:               KB-10T5-01K (3.3ft(1m))
　　　　　KB-STP-01K:      (3.3ft(1m)) (Shielded LAN cable compliant to EMC Directive)

### 2.4.2   Mounting/installing steps

**■  Mounting a keypad on the enclosure wall**

①  Pull the keypad toward you while holding down the hook (pointed to by the arrow in Figure 2.32)
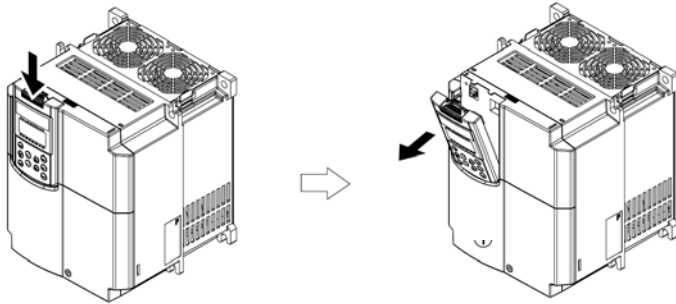


Figure 2.32   Removing a Keypad

②  Make a cut-out on the enclosure wall. For details, refer to Chapter 8, Section 8.5.3 "Keypad"

③  Mount the keypad onto the enclosure with 4 screws as shown in Figure 2.33. (Recommended tightening torque: 6.2lb-in (0.7 N·m)
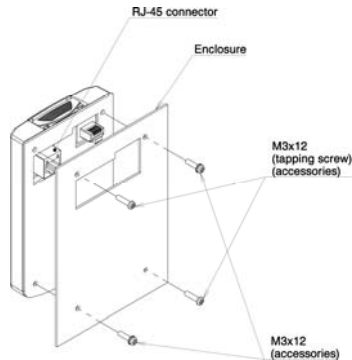


Figure 2.33   Mounting a Keypad

④ Remove the keypad mounted on the inverter (see Figure 2.32) and, using a Remote Operation Extension Cable, interconnect the Keypad and the Inverter (insert one end of the cable into the RS-485 port with RJ-45 connector on the Keypad and the other end into that on the inverter) (See Figure 2.34.).



RJ-45 connector (modular jack)

Enclosure

Remote Operation Extension Cable

Keypad

RJ-45 connector

To the standard RS485 port
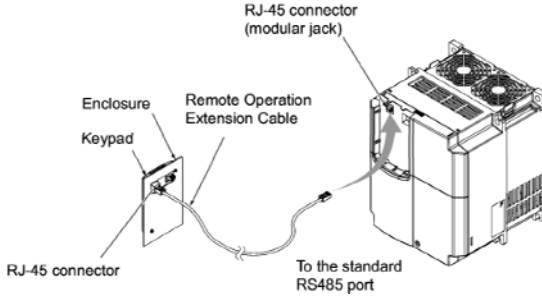
Figure 2.34   Connecting a Keypad to the Inverter with Remote Operation Extension Cable

■ **Using the keypad in hand**

Follow step ④ of "Installing the keypad on the enclosure panel" above.

■ **Retracting the keypad into the inverter**

Put the keypad in the original slot while engaging its bottom latches with the holes (as shown below), and push it onto the case of the inverter (arrow ②) while holding it downward (against the terminal block cover) (arrow ①).



Latches

Terminal Block Cover
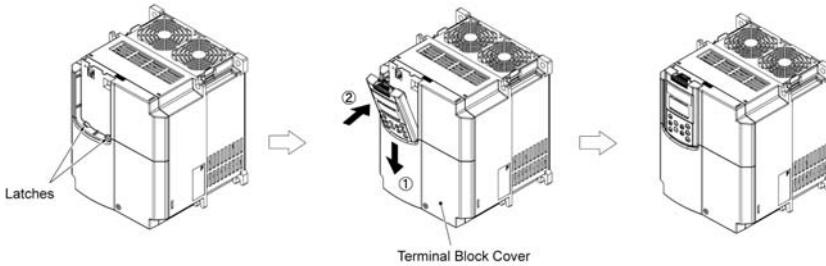
Figure 2.35   Retracting the Keypad

## 2.5 Cautions Relating to Harmonic Component, Noise, and Leakage Current

### (1) Harmonic component

Input current to an inverter includes a harmonic component, which may affect other loads and power factor correcting capacitors that are connected to the same power source as the inverter. If the harmonic component causes any problems, connect a DC reactor (option) to the inverter. It may also be necessary to connect an AC reactor to the power factor correcting capacitors.

### (2) Noise

If noise generated from the inverter affects other devices, or that generated from peripheral equipment causes the inverter to malfunction, follow the basic measures outlined below.

1) If noise generated from the inverter affects the other devices through power wires or grounding wires:
   - Isolate the grounded metal frames of the inverter from those of the other devices.
   - Connect a noise filter to the inverter power wires.
   - Isolate the power system of the other devises from that of the inverter with an insulated transformer.

2) If induction or radio noise generated from the inverter affects other devices through power wires or grounding wires:
   - Isolate the main circuit wires from the control circuit wires and other device wires.
   - Put the main circuit wires through a metal conduit and connect the pipe to the ground near the inverter.
   - Install the inverter onto the metal switchboard and connect the whole board to the ground.
   - Connect a noise filter to the inverter power wires.

3) When implementing measures against noise generated from peripheral equipment:
   - For the control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of the shielded wires to the common terminals of the control circuit or ground.
   - Connect a surge absorber in parallel with a coil or solenoid of the magnetic contactor.

### (3) Leakage current

Harmonic component current generated by insulated gate bipolar transistors (IGBTs) switching on/off inside the inverter becomes leakage current through stray capacitors of inverter input and output wires or a motor. If any of the problems listed below occur, take an appropriate measure against them.

Table 2.12   Leakage Current Countermeasures

| Problem | Measures |
|---|---|
| An earth leakage circuit breaker* (a ground fault circuit interrupter) that is connected to the input (primary) has tripped.<br>* With overcurrent protection | 1) Decrease the carrier frequency.<br>2) Make the wires between the inverter and motor shorter.<br>3) Use an earth leakage circuit breaker (a ground fault circuit interrupter) that has a longer sensitive current than one currently being used.<br>4) Use an earth leakage circuit breaker (a ground fault circuit interrupter) that features measures against harmonic component (Fuji SG and EG series). |
| An external thermal relay was activated. | 1) Decrease the carrier frequency.<br>2) Increase the settling current of the thermal relay.<br>3) Use the electronic thermal relay built in the inverter, instead of an external thermal relay. |

# Chapter 3   OPERATION USING THE KEYPAD

## 3.1   Key, LED, and LCD Monitors on the Keypad

The keypad allows you to start and stop the motor, view various data including maintenance information and alarm information, set function codes, monitor I/O signal status, copy data, and calculate the load factor.
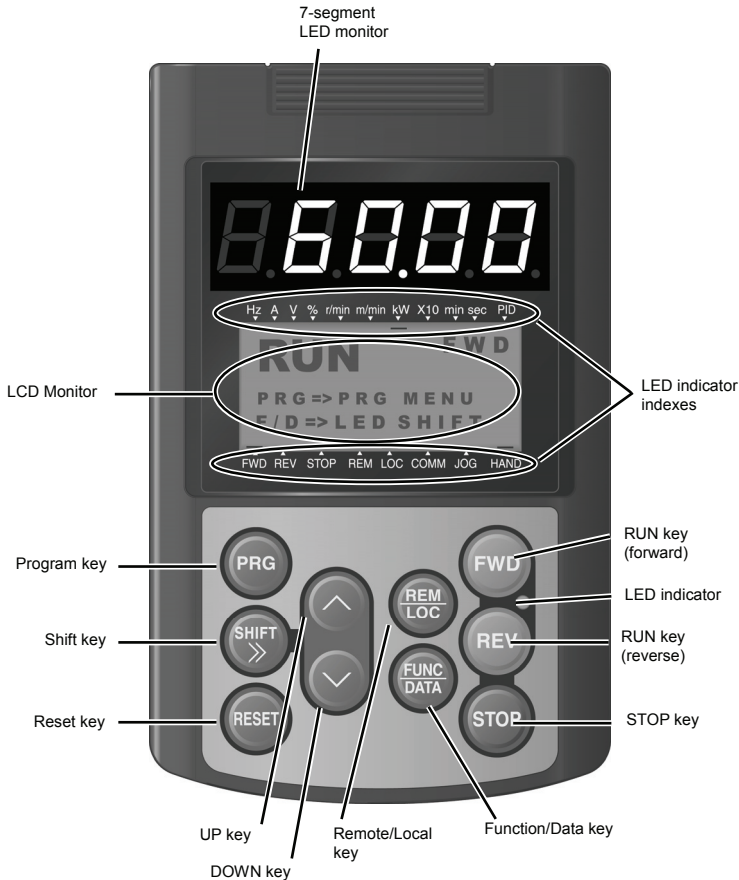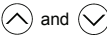
Table 3.1  Overview of Keypad Functions

| Item | Monitor, LED indicator or Key | Functions |
|---|---|---|
| LED/LCD Monitor | `60.00` | Five-digit, 7-segment LED monitor which displays the following according to the operation modes:<br>■ In Running Mode: Running status information (e.g., output frequency, current, and voltage)<br>■ In Programming Mode: same as above<br>■ In Alarm Mode: Alarm code, which identifies the cause of alarm if the protective function is activated. |
| | RUN  FWD<br>PRG => PRG MENU<br>F/D => LED SHIFT | LCD monitor which displays the following according to the operation modes:<br>■ In Running Mode: Running status information<br>■ In Programming Mode: Menus, function codes and their data<br>■ In Alarm Mode: Alarm code, which identifies the cause of alarm if the protective function is activated. |
| | LED indicator indexes | In running mode, display the unit of the number displayed on the LED monitor and the running status information shown on the LCD monitor. For details, see next page. |
| Keypad Operation Key | (PRG) | Switches the operation modes of the inverter. |
| | (SHIFT »）| Shifts the cursor to the right when entering a number. |
| | (RESET) | Pressing this key after removing the cause of an alarm will switch the inverter to Running Mode.<br>Used to reset a setting or screen transition. |
| | (∧) and (∨) | UP and DOWN keys. Used to select the setting items or change the function code data displayed on the LED monitor. |
| | (FUNC/DATA) | Function/Data key. Switches the operation as follows:<br>■ In Running Mode: Pressing this key switches the information to be displayed concerning the status of the inverter (output frequency (Hz), output current (A), output voltage (V), etc.).<br>■ In Programming Mode: Pressing this key displays the function code and confirms the data you have entered.<br>■ In Alarm Mode: Pressing this key displays the details of the problem indicated by the alarm code that has come up on the LED monitor. |
| Run Operation Key | (FWD) | Starts running the motor (forward rotation). |
| | (REV) | Starts running the motor (reverse rotation). |
| | (STOP) | Stops the motor. |
| | (REM/LOC) | Pressing this toggle key for more than 1 second switches between Local and Remote modes. |
| LED Indicator | (FWD) LED<br>(REV) | Lights while a run command is supplied to the inverter. |

Items Displayed on LED Indicators

| Type | Item | Description (information, condition, status) |
|------|------|---------------------------------------------|
| Unit of Number Displayed on LED Monitor | Hz | Output frequency, frequency command |
| | A | Output current |
| | V | Output voltage |
| | % | Calculated torque, load factor, speed |
| | r/min | Motor speed, set motor speed, load shaft speed, set load shaft speed |
| | m/min | Line speed, set line speed (Not applicable to FRENIC-Eco) |
| | kW | Input power, motor output |
| | X10 | Data greater than 99,999 |
| | min | Constant feeding rate time, constant feeding rate time setting (Not applicable to FRENIC-Eco) |
| | sec | Timer |
| | PID | PID process value |
| Operating Status | FWD | Running (forward rotation) |
| | REV | Running (reverse rotation) |
| | STOP | No output frequency |
| Source of Operation | REM | Remote mode |
| | LOC | Local mode |
| | COMM | Communication enabled (RS-485, field bus option) |
| | JOG | Jogging mode (Not applicable to FRENIC-Eco) |
| | HAND | Keypad effective (lights also in local mode) |



Hz A V % r/min m/min kW X10 min sec PID — Indicators for the unit of number on the LED monitor

Indicators for the running status and the source of command

FWD REV STOP REM LOC COMM JOG HAND
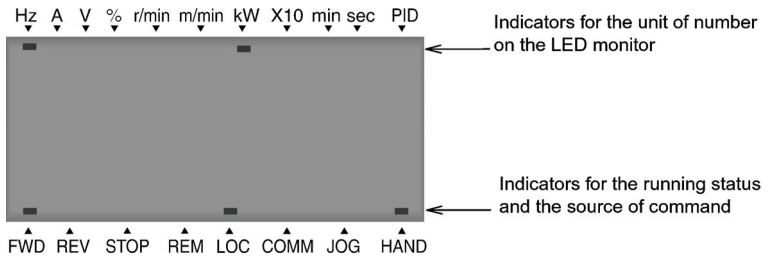
## 3.2  Overview of Operation Modes

FRENIC-Eco features the following three operation modes:

Running Mode:       This mode allows you to enter run/stop commands in regular operation. You can also monitor the running status in real time.

Programming Mode:   This mode allows you to set function code data and check a variety of information relating to the inverter status and maintenance.

Alarm Mode:         If an alarm condition occurs, the inverter automatically enters the Alarm Mode. In this mode, you can view the corresponding alarm code* and its related information on the LED and LCD Monitors.

* Alarm code: Indicates the cause of the alarm condition that has triggered a protective function. For details, refer to the FRENIC-Eco Instruction Manual, Chapter 8, Section 8.5 "Protection Features."

Figure 3.1 shows the status transition of the inverter between these three operation modes.
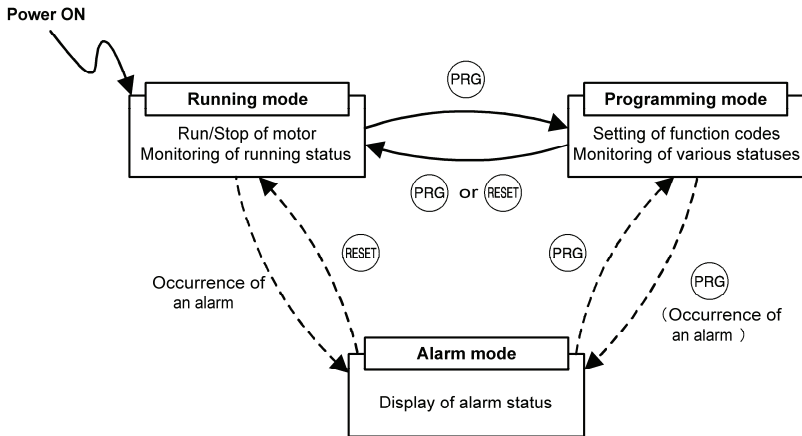


Figure 3.1    Status Transition between Operation Modes

## 3.3 Running Mode

When the inverter is turned on, it automatically enters Running Mode. In Running Mode, you can:

[ 1 ] Run or stop the motor;

[ 2 ] Set the frequency command and others;

[ 3 ] Monitor the running status (e.g., output frequency, output current)

### 3.3.1 Running/stopping the motor

By factory default, pressing the (FWD) key starts running the motor in the forward direction and pressing the (STOP) key decelerates the motor to stop. The (REV) key is disabled. You can run or stop the motor using the keypad only in Running mode and Programming mode.

To run the motor in reverse direction, or to run the motor in reversible mode, change the setting of function code F02.

📖 For details of function code F02, refer to the FRENIC-Eco Instruction Manual, Chapter 5.
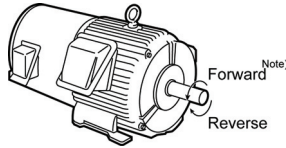
Figure 3.2   Rotational Direction of Motor

Note) The rotational direction of IEC-compliant motor is opposite to the one shown here.

**Display of running status (on LCD monitor)**

(1) When function code E45 (LCD Monitor (optional)) is set to "0," the LCD Monitor displays the running status, the rotational direction, and the operation guide.

(The indicators above the LCD Monitor indicate the unit of the number displayed on the LED Monitor; the indicators underneath the LCD Monitor indicate the running status and the source of Run command.)
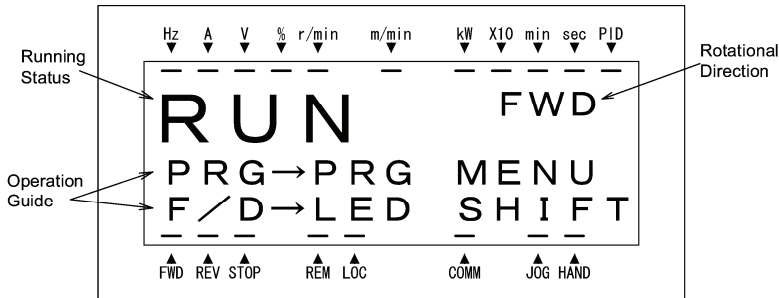
Figure 3.3   Display of Running Status

The running status and the rotational direction are displayed as shown in Table 3.2.

Table 3.2   Running Status and Rotational Direction

| Status/Direction | Description |
|---|---|
| Running status | RUN:  The Run command is present, or the inverter is driving the motor.<br>STOP: The Run command is not present, or the inverter is in stopped state. |
| Rotational direction | FWD:  Forward<br>REV:   Reverse<br>Blank:  Stopped |

(2) When function code E45 (LCD Monitor (optional)) is set to "1," the LCD Monitor displays the output frequency, output current, and calculated torque in a bar chart.

(The indicators above the LCD Monitor indicate the unit of the number displayed on the LED Monitor; the indicators underneath the LCD Monitor indicate the running status and the source of Run command.)
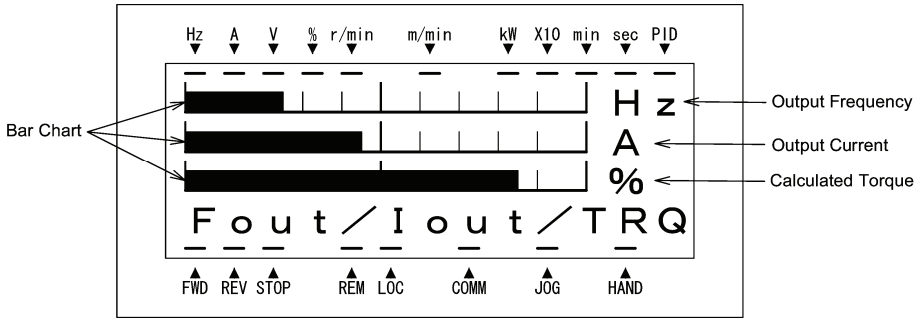


The full scale (maximum value) for each parameter is as follows:

Output frequency:   Maximum frequency
Output current:     200% of inverter's rated current
Calculated torque:  200% of rated torque generated by motor

Figure 3.4   Bar Chart

(3) When function code E45 (LCD Monitor (optional)) is set to "2," the LCD Monitor displays the Running status, running sub-status, PID process command (SV) and PID process output (MV).

(The indicators above the LCD Monitor indicate the unit of the number displayed on the LED Monitor; the indicators underneath the LCD Monitor indicate the running status and the source of Run command.)
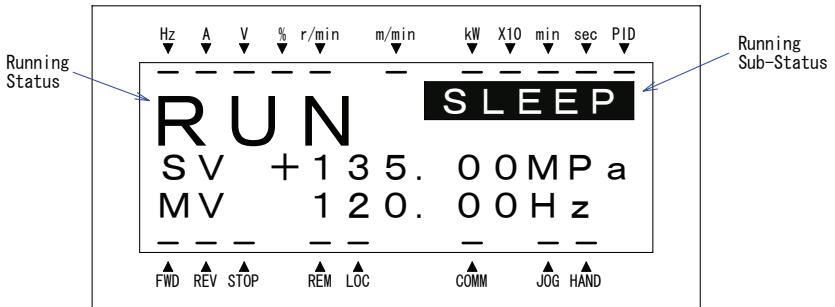


Figure 3.5   Display of Running Status

(4) When function code E45 (LCD Monitor (optional)) is set to "3," the LCD Monitor displays the Running status, running sub-status, PID feedback value (PV) and PID process command (SV).

(The indicators above the LCD Monitor indicate the unit of the number displayed on the LED Monitor; the indicators underneath the LCD Monitor indicate the running status and the source of Run command.)
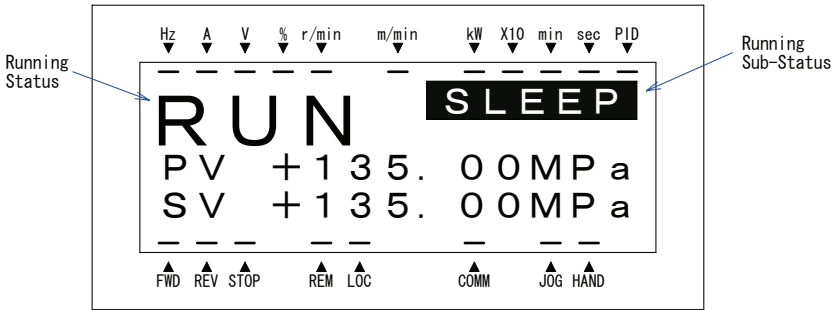
Figure 3.6   Display of Running Status

| Status | Description |
|---|---|
| Running Status | **RUN**:  The Run command is present, or the inverter is driving the motor.<br>**STOP**: The Run command is not present, or the inverter is in stopped state. |
| Running Sub-Status | Blank : Stopped<br>**FWD** : Forward<br>**REV** : Reverse<br>**PID-1** :  Under PID control 1<br>**PID-2** :  Under PID control 2<br>**PIDHz** :  Cancel PID control<br>**STABI** :  Start stabilize running<br>**SLEEP** :  Slow flowrate stop<br>**RETRY** :  Wait for retry (Refer to H04, H05)<br>**RESTA** :  Wait for alarm auto reset (Refer to H83, H84 and H85)<br>**P-CHG** :  During pump changed<br>**LOW-V** :  Undervoltage detected (Inverter stopped)<br>**IPF** :   Auto-restarting after momentary power failure |

**Switching the operation mode between remote and local**

The inverter can be operated either in remote mode or in local mode. In remote mode, which applies to normal operation, the inverter is driven under the control of the data settings held in it, whereas in local mode, which applies to maintenance operation, it is separated from the system and is driven manually under the control of the keypad.

Remote mode:   The sources for setting run and frequency commands is determined by various setting means switching signals such as function codes, switching of run command 1/2, and link priority function.

Local mode:   The sources for setting run and frequency commands is the keypad, regardless of the settings specified by function codes. The keypad takes precedence over the setting means specified by the run command 1/2 or the link priority function.

What follows shows the setting means of run command using the keypad in the local operation mode.

Table 3.3   Run Commands from the Keypad in the Local Operation Mode

| If function code F02 is set to: | Setting means of the run command |
|---|---|
| 0: Keypad | You can run/stop the motor using the (FWD) / (REV) / (STOP) key on the keypad. |
| 1: External signal | |
| 2: Keypad (forward) | You can run/stop the motor using the (FWD) / (STOP) key on the keypad. You can run the motor in forward direction only. (The (REV) key has been disabled.) |
| 3: Keypad (reverse) | You can run/stop the motor using the (REV) / (STOP) key on the keypad. You can run the motor in reverse direction only. (The (FWD) key has been disabled.) |

The source for setting run and frequency commands can be switched between Remote and Local modes by the (REM/LOC) key on the keypad. (This key is a toggle switch: Each time you press it for more than 1 second, the mode switches from Remote to Local or vice versa.)

The mode can be switched also by an external digital input signal. To enable the switching you need to assign (LOC) to one of the digital input terminals, which means that the commands from the keypad are given precedence (one of function codes E01 to E05, E98, or E99 must be set to "35"). By factory default, (LOC) is assigned to [X5].
You can confirm the current mode on the indicators (REM: Remote mode; LOC: Local mode).

When the mode is switched from Remote to Local, the frequency settings in the Remote mode are automatically inherited. Further, if the inverter is in Running mode at the time of the switching from Remote to Local, the Run command is automatically turned ON so that all the necessary data settings will be carried over. If, however, there is a discrepancy between the settings on the keypad and those on the inverter itself (e.g., switching from reverse rotation in the Remote mode to forward rotation in the Local mode using the keypad that is for forward rotation only), the inverter automatically stops.

The paths of transition between Remote and Local modes depend on the current mode and the value (ON/OFF) of (LOC), the signal giving precedence to the commands from the keypad, as shown in the state transition diagram (Figure 3.7) given below.

📖  For further details on how to set operation commands and frequencies in Remote and Local modes, refer to the FRENIC-Eco User's Manual, Chapter 4 "BLOCK DIAGRAMS FOR CONTROL LOGIC" (especially Section 4.3 "Drive Command Generator" block diagram).
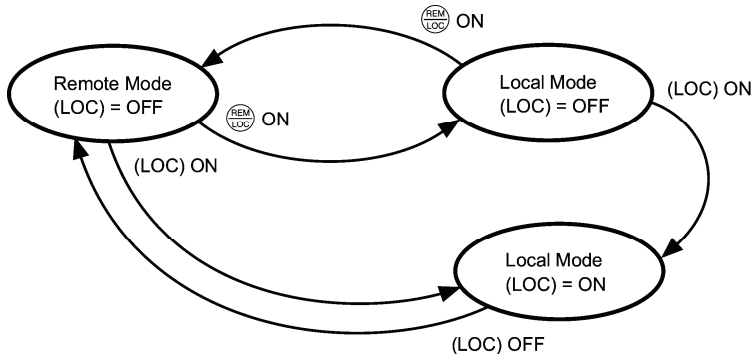


Figure 3.7   Transition between Remote and Local Modes

### 3.3.2 Setting up the frequency and PID process commands

You can set up the desired frequency command and PID process command by using ⌃ and ⌄ keys on the keypad.

You can also view and set up the frequency command as load shaft speed by setting function code E48.

**Setting the frequency command**

<u>Using ⌃ and ⌄ keys (factory default)</u>

(1) Set function code F01 to "0: Keypad operation." This cannot be done when the keypad is in Programming mode or Alarm mode. To enable frequency setting by using ⌃ and ⌄ keys, first move the keypad in Running mode.

(2) Pressing the ⌃ / ⌄ key causes the frequency command to be displayed on the LCD Monitor, with the lowermost digit blinking.
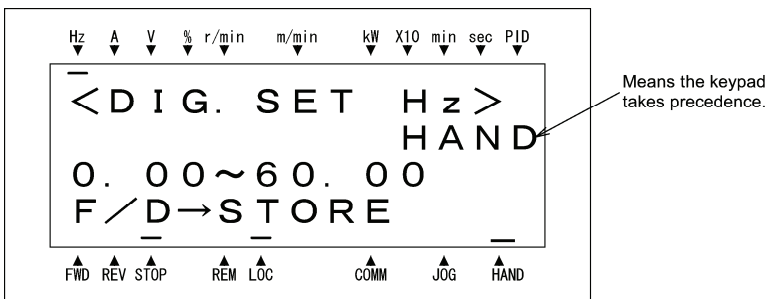


Figure 3.8   Setting the Frequency Command in Local Mode

(3) If you need to change the frequency command, press the ⌃ / ⌄ key again. The new setting will be automatically saved into the inverter's internal non-volatile memory. It is kept there even while the inverter is powered OFF, and will be used as the initial frequency next time the inverter is powered ON.

- The frequency setting can be saved either automatically as mentioned above or by pressing the FUNC/DATA key. You can choose either way using function code E64.

- When you start specifying or changing the frequency command or any other parameter with the ∧ / ∨ key, the lowest digit on the display will blink and start changing. As you are holding the key down, blinking will gradually move to the upper digit places and the upper digits will be changeable.

- Pressing the SHIFT key moves the changeable digit place (blinking) and thus allows you to change upper digits easily.

- By setting function code C30 to "0: Keypad operation (∧ / ∨ key)" and selecting frequency command 2 as the frequency setting method, you can also specify or change the frequency command in the same manner using the ∧ / ∨ key.

- If you have set the function code F01 to "0: Keypad operation (∧ / ∨ key)" but have selected a frequency setting other than frequency 1 (i.e., frequency 2, set it via communications, or as a multistep frequency), then you cannot use the ∧ / ∨ key for setting the frequency command even if the keypad is in Running Mode. Pressing either of these keys will just display the currently selected frequency command.

```
 Hz   A   V   %  r/min   m/min      kW  X10 min  sec  PID
  ▼   ▼   ▼   ▼    ▼        ▼        ▼    ▼   ▼    ▼    ▼
 _
 ＜ R E M O T E     R E F ＞
                                      1 2

        _     _                        _
      ▲   ▲  ▲     ▲  ▲       ▲        ▲    ▲
     FWD REV STOP REM LOC    COMM     JOG HAND
```

Means that the keypad is not in effect.

Means that the setting for the Analog 12 terminal is effective. (See Table below.)
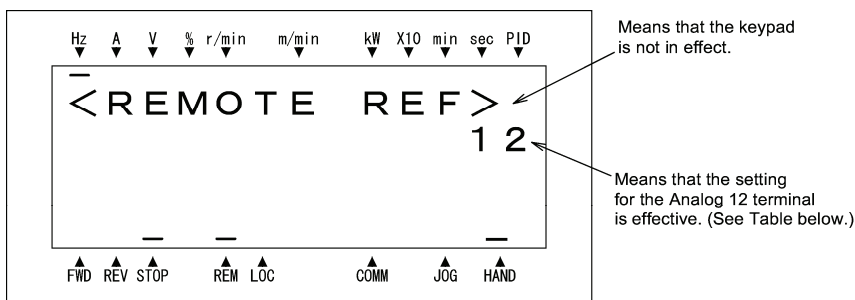
To have the frequency command displayed as the motor speed, load shaft speed, or speed (%), set function code E48 (speed monitor selection) to 3, 4, or 7, respectively, as shown in Table 3.6 Monitored Items.

Table 3.4   Available Means of Setting

| Symbol | Command sources | Symbol | Command sources | Symbol | Command sources |
|---|---|---|---|---|---|
| HAND | Keypad | MULTI | Multistep frequency | PID-HAND | PID keypad command |
| 12 | Terminal [12] | | | PID-P1 | PID process command 1 |
| C1 | Terminal [C1] | RS-485-1 | RS-485 (RJ-45) | PID-P2 | PID process command 2 |
| 12 + C1 | Terminal [12] + Terminal [C1] | RS-485-2 | RS-485 (Terminal) | PID-U/D | PID UP/DOWN process command |
| V2 | Terminal [V2] | BUS | Bus option | PID_LINK | PID communication process command |
| U/D | UP/DOWN control | LOADER | FRENIC loader | PID+MULTI | PID multistep frequency command |

**Make setting under PID control**

To enable PID control, you need to set function code J01 to 1 or 2.

Under the PID control, the items that can be set or checked with ⊘ and ⊘ keys are different from those under regular frequency control, depending upon the current LED monitor setting. If the LED monitor is set to the speed monitor, you may access manual speed commands (frequency command) with ⊘ and ⊘ keys; if it is set to any other value, you may access the PID process command with those keys.

📖 Refer to the FRENIC-Eco User's Manual for details on the PID control.

■ Setting the PID process command with ⊘ and ⊘ keys

(1) Set function code J02 to "0: Keypad operation."

(2) Set the LED monitor to something other than the speed monitor (E43 = 0) while the keypad is in Running Mode. You cannot modify the PID process command using the ⊘ / ⊘ key while the keypad is in Programming Mode or Alarm Mode. To enable the modification of the PID process command by the ⊘ / ⊘ key, first switch to Running Mode.

(3) Press the ⊘ / ⊘ key to have the PID process command displayed. The lowest digit will blink together with the dot on the LED monitor.
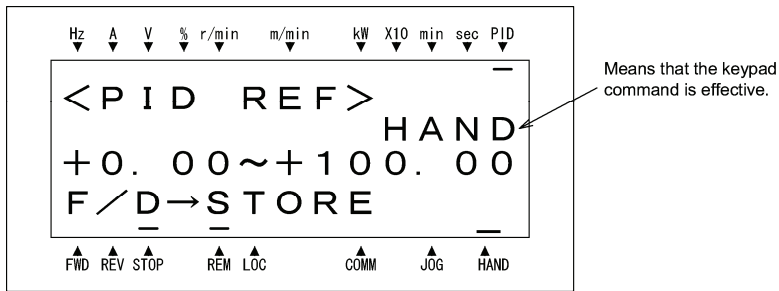


Figure 3.9   PID Process Commands

(4) To change the PID process command, press the ⊘ / ⊘ key again. The PID process command you have specified will be automatically saved into the inverter's internal memory. It is kept there even if you temporarily switch to another means of specifying the PID process command and then go back to the means of specifying the PID process command via the keypad. Also, it is kept there even while the inverter is powered OFF, and will be used as the initial PID process command next time the inverter is powered ON.

- Even if multistep frequency is selected as the PID process command ((SS4) = ON), you still can set the process command using the keypad.
- When function code J02 is set to any value other than 0, pressing the $\wedge$ / $\vee$ key displays, on the 7-segment LED monitor, the PID command currently selected, while you cannot change the setting.
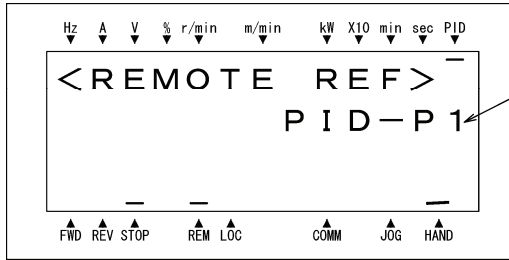
```
Hz  A   V   %  r/min    m/min       kW X10 min sec PID
  ▼  ▼  ▼  ▼   ▼        ▼          ▼  ▼   ▼  ▼  ▼
                                                   ‾
 <REMOTE  REF>
                  PID-P1          ← Means that PID Process
                                     Command 1 is effective.

       ‾     ‾   ‾             ‾
  ▲  ▲  ▲     ▲   ▲        ▲      ▲    ▲
 FWD REV STOP  REM LOC    COMM    JOG  HAND
```

- On the 7-segment LED monitor, the decimal point of the lowest digit is used to characterize what is displayed. The decimal point of the lowest digit blinks when a PID process command is displayed; the decimal point lights when a PID feedback value is displayed.

```
|2.|  ← Decimal point
```

■ Setting up the frequency command with $\wedge$ and $\vee$ keys under PID control

When function code F01 is set at "0: Keypad operation" and frequency command 1 (Frequency setting via communications link: Disabled; Multistep frequency setting: Disabled; PID control: Disabled) is selected as the manual speed command, you can modify the frequency setting using the $\wedge$ / $\vee$ key if you specify the LED monitor as the speed monitor while the keypad is in Running Mode. You cannot modify the frequency setting using the $\wedge$ / $\vee$ key while the keypad is in Programming Mode or Alarm Mode. To enable the modification of the frequency setting using the $\wedge$ / $\vee$ key, first switch to Running Mode. These conditions are summarized in Table 3.5 and the figure below. Table 3.5 shows the combinations of the parameters, while the figure below illustrates how the manual speed command ① entered via the keypad is translated to the final frequency command ②.

The setting and viewing procedures are the same as those for usual frequency setting.

Table 3.5   Speed (Frequency) Command Manually Set with $\wedge$ / $\vee$ Key and Requirements

| Frequency command 1 (F01) | Frequency setting via communications link | Multistep frequency setting | PID control disabled | Display during $\wedge$ / $\vee$ key operation |
|---|---|---|---|---|
| 0 | Disabled | Disabled | PID enabled | PID output (as final frequency command) |
| | | | Disabled | Manual speed setting by keypad (frequency setting) |
| Other than the above | | | PID enabled | PID output (as final frequency command) |
| | | | Disabled | Manual speed command currently selected (frequency setting) |

```
                              ①
                        F01 = 0   Link Disabled
                                  (LE) = OFF
Manual Speed Command ⌇                   (SS2,1) = OFF
from Keypad      ○                              PID Disabled
                      ○                         (Hz/PID) = ON    ②
Frequency Setting Other ○                               ⌇
than above              ○              ○                ○   — Final Frequency Command
                Command ○                   ○
                via Link       Multi-step Freq. ○
                               Command
               ┌──────────────────────────────────┐
               │ PID output (as Frequency Command) │
               └──────────────────────────────────┘
```
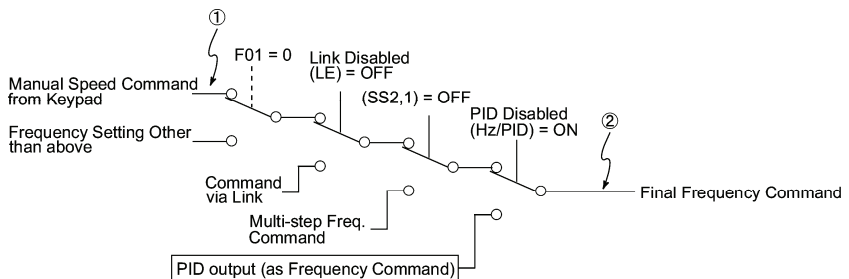
### 3.3.3 LED monitor (Monitoring the running status)

The eleven items listed below can be monitored on the LED Monitor. Immediately after the inverter is turned ON, the monitor item specified by function code E43 is displayed. In Running Mode, press the 🅵 key to switch between monitor items. The item being monitored shifts as you press the 🅵 key in the sequence shown in Table 3.6.

Table 3.6  Items Monitored

| Page to be selected | Monitored Item | Example | Unit | Meaning of Displayed Value | Function code E43 |
|---|---|---|---|---|---|
| 0 | Speed Monitor | | | Function code E48 specifies what to be displayed. | 0 |
| | Output frequency | *50.00* | Hz | Frequency actually being output (Hz) | (E48 = 0) |
| | Motor speed | *1500* | r/min | Output frequency × $\dfrac{120}{P01}$ | (E48 = 3) |
| | Load shaft speed | *300.0* | r/min | Output frequency (Hz) x E50 | (E48 = 4) |
| | Speed (%) | *50.0* | % | $\dfrac{\text{Output frequency}}{\text{Maximum frequency}} \times 100$ | (E48 = 7) |
| 8 | Output current | *12.34* | A | Output of the inverter in current in rms | 3 |
| 9 | Input Power | *10.25* | kW | Input power to the inverter | 9 |
| 10 | Calculated torque | *50* | % | Motor output torque in % (Calculated value) | 8 |
| 11 | Output voltage | *200* | V | Output of the inverter in voltage in rms | 4 |
| 12 | Motor output | *9.85* | kW | Motor output in kW | 16 |
| 13 | Load factor | *50* | % | Load rate of the motor in % with the rated output being at 100% | 15 |
| 14 | PID process command (Note 1) | *10.00.* | — | PID process command/feedback value transformed to that of physical value of the object to be controlled. | 10 |
| 15 | PID feedback value (Note 1) | *9.00.* | — | Refer to the function codes E40 and E41 for details. | 12 |
| 16 | PID output (Note 1) | *100.0.* | % | PID output in % with the maximum output frequency (F03) being at 100% | 14 |
| 18 | Analog input monitor (Note 2) | *82.00* | — | Analog input to the inverter converted per E40 and E41. Refer to the function codes E40 and E41 for details. | 17 |
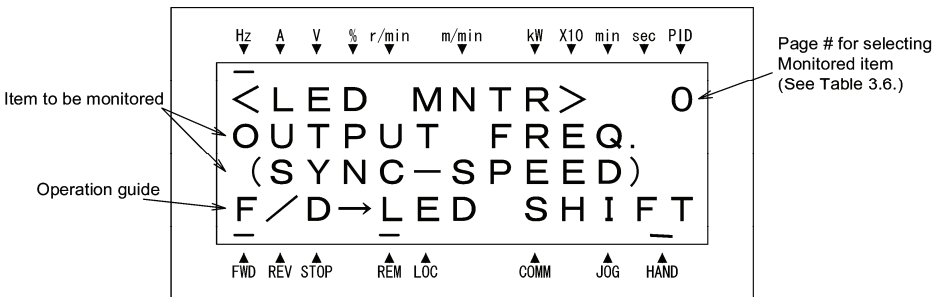


Figure 3.10   Selecting Items to be Monitored on LED Monitor

(Note 1)  Displayed only if the inverter PID-controls the motor according to a PID process command specified by the function code J01 (= 1 or 2). While the 7-segment LED monitor is displaying PID process command, PID feedback value, or PID output value, the dot (decimal point) at the lowest digit on it is lit or blinking respectively.

(Note 2)  Analog input monitoring becomes active only when enabled by any data of the function codes E61, E62 or E63 (Select terminal function).

### 3.3.4  Monitoring light alarms

The FRN-F1-DY identifies abnormal states in two categories--Heavy alarm and Light alarm. If the former occurs, the inverter immediately trips; if the latter occurs, the inverter shows the $L$-$AL$ on the LED monitor and blinks the "L-ALARM" indication in the operation guide area on the LCD monitor but it continues to run without tripping.

Which abnormal states are categorized as a light alarm ("Light alarm" object) should be defined with function codes H81 and H82 beforehand.

Assigning the **LALM** signal to any one of the digital output terminals with any of function codes E20 to E24 and E27 (data = 98) enables the inverter to output the **LALM** signal on that terminal upon occurrence of a light alarm.
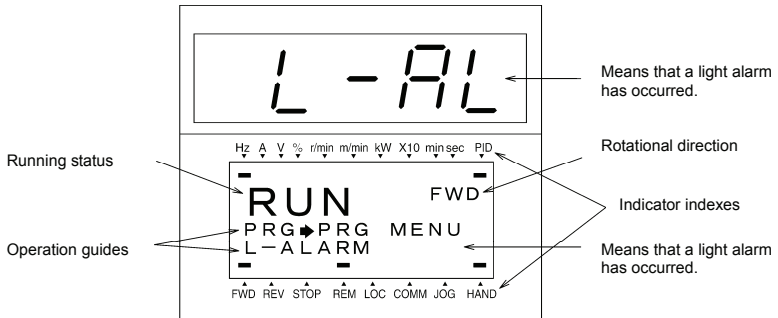


Figure 3.11   Display of Light Alarm

#### How to check a light alarm factor

If a light alarm occurs, $L$-$AL$ appears on the LED monitor. To check the current light alarm factor, enter Programming mode by pressing the (PRG) key and select LALM1 on Menu #5 "Maintenance Information." For details of the menu transition of the maintenance information, refer to Section 3.4.6 "Reading maintenance information."

It is also possible to check the factors of the last three light alarms by selecting LALM2 (last) to LALM4 (3rd last).

#### How to remove the current light alarm

After checking the current light alarm factor, to switch the LED monitor from the $L$-$AL$ indication state back to the running status display (e.g., output frequency), press the (FUNC/DATA) key in Running mode.

If the light alarm factor has been removed, the "L-ALARM" disappears and the **LALM** output signal turns OFF. If not, the $L$-$AL$ on the LED monitor disappears (normal monitoring becomes available), the "L-ALARM" remains displayed on the LCD monitor, and the **LALM** output signal remains ON.
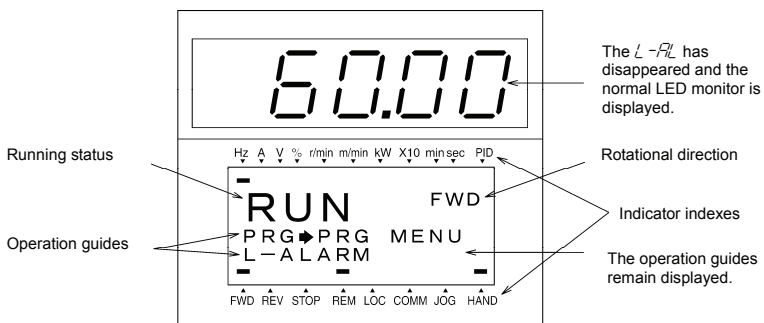


Figure 3.12   Display of Light Alarm

## 3.4  Programming Mode

Programming Mode provides you with the functions of setting and checking function code data, monitoring maintenance information and checking input/output (I/O) signal status. The functions can be easily selected with a menu-driven system. Table 3.7 lists menus available in the Programming Mode.

Table 3.7    Menus Available in Programming Mode

| Menu # | Menu | Main functions | Refer to: |
|--------|------|----------------|-----------|
| 0 | Quick Setup | Displays only basic function codes that are pre-selected. | 3.4.2 |
| 1 | Data Setting | Allows you to view and change the setting of the function code you select. (Note) | 3.4.1 |
| 2 | Data Checking | Allows you to view and change a function code and its setting (data) on the same screen. Also allows you to check the function codes that have been changed from their factory defaults. | 3.4.3 |
| 3 | Drive Monitoring | Displays the running information required for maintenance or test running. | 3.4.4 |
| 4 | I/O Checking | Displays external interface information. | 3.4.5 |
| 5 | Maintenance Information | Displays maintenance information including cumulative run time. | 3.4.6 |
| 6 | Alarm Information | Displays four latest alarm codes. Also allows you to view the information on the running status at the time the alarm occurred. | 3.4.7 |
| 7 | Alarm cause | Displays the cause of the alarm. | |
| 8 | Data Copying | Allows you to read or write function code data, as well as to verify it. | 3.4.8 |
| 9 | Load Factor Measurement | Allows you to measure the maximum output current, average output current, and average braking power. | |
| 10 | User Setting | Allows you to add or delete function codes covered by Quick Setup. | |
| 11 | Communication Debugging | Allows you to confirm the data of the function codes for communication (S, M, W, X, and Z codes). | |

(Note) The function codes for optional features (o code) are displayed only when they are installed. For details, refer to their instruction manuals.

Figure 3.13 shows the transitions between menus in Programming mode.
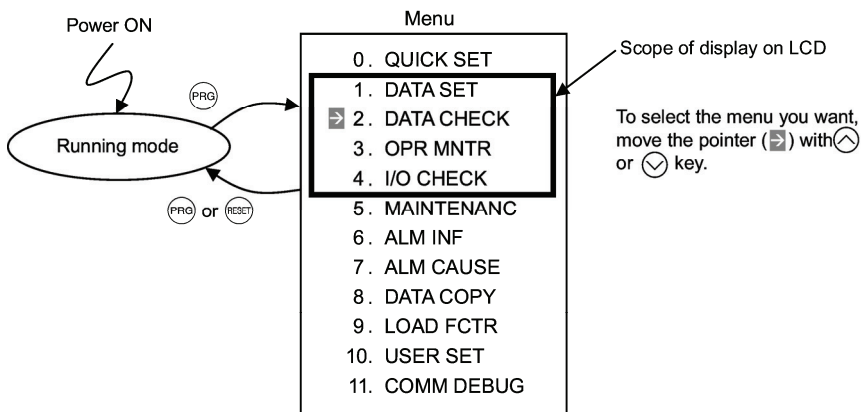


Figure 3.13    Menu Transition in Programming Mode

When there has been no key operation for about 5 minutes, the inverter automatically goes back to the Running mode and the back light goes OFF.

### 3.4.1 Setting function codes – "1. Data Setting"

Menu #1 "Data Setting" in Programming Mode allows you to set function codes according to your needs.

Table 3.8 lists the function codes available on the FRENIC-Eco.

Table 3.8 Function Codes Available on FRENIC-Eco

| Function Code Group | Function Code | Function | Description |
|---|---|---|---|
| F code (Fundamental functions) | F00 to F44 | Fundamental functions | Fundamental functions used in operation of the motor |
| E code (Extension terminal functions) | E01 to E99 | Terminal functions | Functions concerning the selection of operation of the control circuit terminals; Functions concerning the display on the LED monitor |
| C code (Control functions of frequency) | C01 to C58 | Control functions | Functions associated with frequency settings |
| P code (Motor parameters) | P01 to P99 | Motor parameters | Functions for setting up characteristics parameters (such as capacity) of the motor |
| H code (High performance functions) | H03 to H98 | High-level functions | Highly added-value functions; Functions for sophisticated control |
| J code (Application functions) | J01 to J99 | Application functions | Functions for applications such as PID Control |
| y code (Link functions) | y01 to y99 | Link functions | Functions for controlling communications |
| o code (Option functions) | o27 to o59 | Optional functions | Functions for optional features (Note) |

(Note) The o code is displayed only when the corresponding optional feature is installed.
For details of the o code, refer to the Instruction Manual for the corresponding optional feature.

#### ■ Function codes requiring simultaneous keying

To modify the data for function code F00 (data protection), H03 (data initialization), or H97 (clear alarm data), simultaneous keying is needed, involving the (STOP) key + the (∧) key, or the (STOP) key + the (∨) key.

#### ■ Modifying function code data during running; making the modification valid and saving the modification

Some function codes can be modified while the inverter is running, whereas others cannot. Further, depending on the function code, modifications may or may not become effective immediately. For details, refer to the "Change when running" column in 5.1 "Function Code Tables" in Chapter 5 of the FRENIC-Eco Instruction Manual.

📖 For details of function codes, refer to 5.1 "Function Code Tables" in Chapter 5 of the FRENIC-Eco Instruction Manual.

Figure 3.14 illustrates LCD screen transition for Menu item 1. DATA SET.
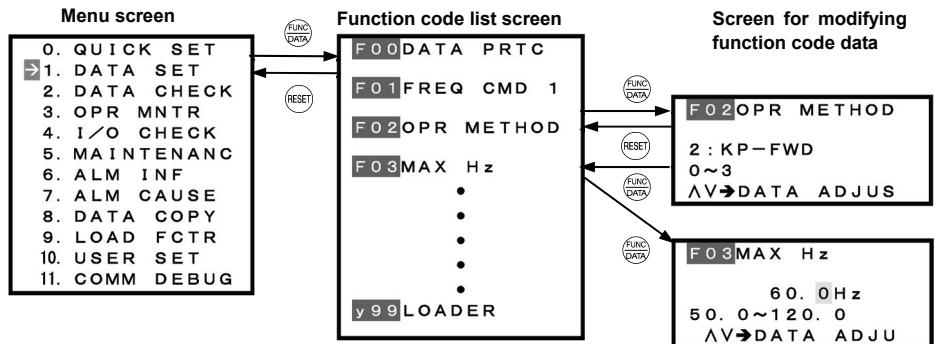


Figure 3.14 Screen Transition for Data Setting Menu

**Basic key operation**

This section will give a description of the basic key operation, following the example of the function code data changing procedure shown in Figure 3.15.

This example shows you how to change function code F03 data (maximum frequency) from 58.0 Hz to 58.1 Hz.
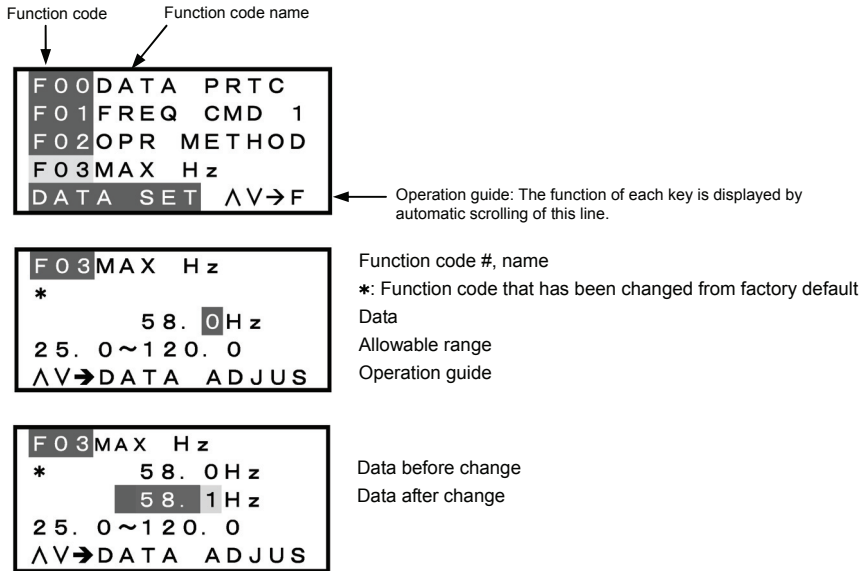
(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Using △ and ▽ keys, move the pointer → to "1. DATA SET" and then press the (FUNC/DATA) key, which will display a list of function codes.

(3) Use △ and ▽ keys to select the desired function code group (in this example, F03:), and press the (FUNC/DATA) key, which will display the screen for changing the desired function code data.

(4) Change the function code data by using △ and ▽ keys. Pressing the (SHIFT/>>) key causes the blinking digit place to shift (cursor shifting) (The blinking digit can be changed).

(5) Press the (FUNC/DATA) key to finalize the function code data.

The data will be saved in the memory inside the inverter. The display will return to the function code list, then move to the next function code (in this example, F04).

If you press the (RESET) key before the (FUNC/DATA) key, the change made to data of the function code is cancelled. The data reverts to the previous value, the screen returns to the function code list, and the function code (F03) reappears.

(6) Press the (RESET) key to return to the menu from the function code list.

Screen

Function code          Function code name

```
F00DATA  PRTC
F01FREQ  CMD  1
F02OPR  METHOD
F03MAX  Hz
DATA  SET  ∧V→F
```
◄── Operation guide: The function of each key is displayed by automatic scrolling of this line.

```
F03MAX  Hz
*
        58. 0Hz
25. 0~120. 0
∧V→DATA  ADJUS
```
Function code #, name
∗: Function code that has been changed from factory default
Data
Allowable range
Operation guide

```
F03MAX  Hz
*       58. 0Hz
        58. 1Hz
25. 0~120. 0
∧V→DATA  ADJUS
```
Data before change
Data after change

Figure 3.15   Screen for Changing Function Code Data

Tip   ■ Additional note on function code being selected

The function code being selected blinks, indicating the movement of the cursor (F03 blinks in this example).

```
→0. QUICK SET
 1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
∧∨→MENU SHIF▼
```

Press (PRG) key to enter Menu.

⌃ / ⌄

Select desired menu by shifting the pointer → with ⌃ / ⌄ key.

```
 0. QUICK SET
→1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
∧∨→MENU SHIF▼
```

(FUNC/DATA)        (RESET)

Press (FUNC/DATA) key to finalize desired menu.

```
F00DATAPRTC
F01FREQ CMD 1
F02OPR METHOD
F03MAX Hz
DATA SET ∧∨→F
```

Press (RESET) key to return to Menu.

⌃ / ⌄

Select desired function code by moving the cursor with ⌃ / ⌄ key.

```
F00DATA PRTC
F01FREQ CMD 1
F02OPR METHOD
F03MAX Hz
DATA SET ∧∨→F
```

(FUNC/DATA)

Press (FUNC/DATA) key to finalize desired function code.

```
F03MAX Hz
*
     58. 0Hz
25. 0~120. 0
∧∨→DATA ADJUS
```

⌃ / ⌄

Press ⌃ / ⌄ key to change function code data.

```
F03MAX Hz
*    58. 0Hz
     58. 1Hz
25. 0~120. 0
∧∨→DATA ADJUS
```

Press (FUNC/DATA) key to finalize function code data.
Press (RESET) key to cancel change of data.

Figure 3.16   Changing Function Code Data

### 3.4.2 Setting up function codes quickly using Quick setup – "0. QUICK SET"

Menu #0 "QUICK SET" in Programming Mode allows you to quickly set up a fundamental set of function codes that you specify beforehand. Whereas at shipment from factory, only a predetermined set of function codes is registered, you can add or delete some function codes using "10. USER SET." The set of function codes covered by Quick Setup is held in the inverter (not the keypad). Therefore, if you mount your keypad onto another inverter, the set of function codes held in the new inverter is subject to Quick Setup. If necessary, you may copy the set of function codes subject to Quick Setup using the copy function ("8. DATA COPY").

If you perform data initialization (function code H03), the set of function codes subject to Quick Setup will be reset to the factory default.

For the list of function codes subject to Quick Setup by factory default, refer to the FRENIC-Eco Instruction Manual, Chapter 5 "FUNCTION CODES."

LCD screen transition from the "0. QUICK SET" menu is the same as with "1. DATA SET."

**Basic key operation**

Same as the basic key operation for "1. DATA SET."

### 3.4.3 Checking changed function codes –"2. DATA CHECK"

Menu #2 "DATA CHECK" in Programming Mode allows you to check function codes (together with their data) that have been changed. The function codes whose data have been changed from factory default are marked with ∗. By selecting a function code and pressing the ⊙ key, you can view or change its data.

LCD screen transition from the "2. DATA CHECK" menu is the same as with "1. DATA SET," except for the different screen listing function codes as shown below.

Function code    Changed    Function code data

```
F 0 1 ∗ 1
F 0 3 ∗ 4 8 . 0 H z
F 0 4 ∗ 4 8 . 0 H z
F 0 5 ∗ 1 9 5 V
D A T A   C H E C K   ∧∨➜
```
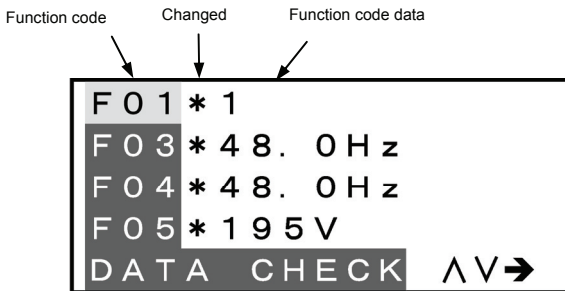
Figure 3.17    LCD Screen Listing Function Codes

**Basic key operation**

Same as the basic key operation for "1. DATA SET."

### 3.4.4 Monitoring the running status –"3. OPR MNTR"

Menu #3 "OPR MNTR" allows you to check the running status during maintenance and test running. The display items for "Drive Monitoring" are listed in Table 3.9.

Table 3.9    Drive Monitoring Display Items

| Symbol | Item | Description |
|---|---|---|
| Fot1 | Output frequency | Output frequency |
| Fot2 | | Reserved |
| Iout | Output current | Output current |
| Vout | Output voltage | Output voltage |
| TRQ | Calculated torque | Calculated output torque generated by motor |
| Fref | Frequency command | Frequency command |
| | Running direction | FWD: Forward, REV: Reverse, Blank: Stopped |
| | Running status | IL: Current limitation, LU: Undervoltage, VL: Voltage limitation |
| SYN | Motor shaft speed | Display value = (Output frequency Hz) $\times \dfrac{120}{P01}$ |
| LOD | Load shaft speed | Display value = (Output frequency Hz) $\times$ (Function code E50) |
| LIN | | Reserved |
| SV | PID process command | The PID process command and PID feedback value are displayed after converting the value to a virtual physical value (e.g., temperature or pressure) of the object to be controlled using the function code E40 and E41 data (PID display coefficients A and B). |
| PV | PID feedback value | Display value = (PID process command/feedback value) $\times$ (Coefficient A - B) + B |
| MV | PID output value | PID output value, displayed in % (with Maximum frequency (F03) being 100%). |
| SV% | PID process command | PID process command , displayed in % |
| PV1 PV2 | PID feedback value 1 PID feedback value 2 | PID feedback value , displayed in % |
| Err | PID error | PID error (SV% - PV1, SV% - PV2), displayed in % |

Figure 3.18 shows the LCD screen transition starting from the "OPR MNTR" menu.

```
→ 0.QUICK  SET
  1.DATA  SET
  2.DATA  CHECK
  3.OPR  MNTR
∧∨→MENU  SHIF▼
```

Select desired menu by moving the pointer → with ⌃ / ⌄ key.

```
  0.QUICK  SET
  1.DATA  SET
  2.DATA  CHECK
→ 3.OPR  MNTR
∧∨→MENU  SHIF▼
```

Press (FUNC/DATA) key to finalize desired menu.

```
Fot1=  60.99Hz
Fot2=   – – –Hz
Iout=    8.49A
Vout=  199.0V
OPR  MNTR 1／5  ▼
```

Output frequency
Reserved
Output current
Output voltage

```
TRQ=      99%
Fref=  60.00Hz
FWD  IL  LU

OPR  MNTR 2／5  ◆
```

Calculated torque
Frequency command
Running direction, status

Common operation:

To confirm data, call the desired page using ⌃ / ⌄ key.

Press (RESET) key to return to Menu.

```
SYN=  1800r／m
LOD=  60.00r／m
LIN=    – – –m／m

OPR  MNTR 3／5  ◆
```

Motor shaft speed
Load shaft speed
Reserved

```
SV  =   +0.00
PV  =   +0.00
MV  =    +0. 0

OPR  MNTR 4／5  ◆
```

PID process command
PID feedback value
PID output value

```
SV%=   +0.00%
PV1=   +0.00%
PV2=   +0.00%
ERR=   +0.00%
OPR  MNTR 5／5  ▲
```

PID process command
PID feedback value 1
PID feedback value 2
PID error

Figure 3.18    Menu Transition for "OPR MNTR"

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "3. OPR MNTR" by using ∧ and ∨ keys (moving →).

(3) Press the (FUNC/DATA) key to display the screen for Operation Monitor (1 page out of a total of 5 pages).

(4) Select the page for the desired item by using ∧ and ∨ keys and confirm the running status information for the desired item.

(5) Press the (RESET) key to go back to the menu.

### 3.4.5 Checking I/O signal status – "4. I/O CHECK"

Menu #4 "I/O CHECK" in Programming mode allows you to check the digital and analog input/output signals coming in/out of the inverter. This menu is used to check the running status during maintenance or test run.

Table 3.10 lists check items available.

Table 3.10 I/O Check Items

| Item | Symbol | Description |
|------|--------|-------------|
| Input signals at terminal block of control circuit | FWD, REV, X1 - X5 | Shows the ON/OFF state of the input signals at the terminal block of the control circuit.<br>(Highlighted when short-circuited; normal when open) |
| Input signals coming via Communication link | FWD, REV, X1 - X5, XF, XR, RST | Input information for function code S06 (communication)<br>(Highlighted when 1; normal when 0) |
| Output signals | Y1 - Y3, Y5, 30ABC, Y1A, Y2A, Y3A | Output signal information |
| I/O signals (hexadecimal) | DI | Input signal at terminal block of control circuit (in hexadecimal) |
|  | DO | Output signal (in hexadecimal) |
|  | LNK | Input signal via communication link (hexadecimal) |
| Analog input signals | 12 | Input voltage at terminal [12] |
|  | C1 | Input current at terminal [C1] |
|  | V2 | Input voltage at terminal [V2] |
| Analog output signals | FMA | Output voltage at terminal [FMA] |
|  | FMA | Output current at terminal [FMA] |
|  | FMI | Output current at terminal [FMI] |

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "4. I/O CHECK" by using ⌃ and ⌄ keys (moving ➡).

(3) Press the (FUNC DATA) key to display the screen for I/O Checking (1 page out of a total of 6 pages).

(4) Select the page for the desired item by using ⌃ and ⌄ keys and confirm the I/O check data for the desired item.

(5) Press the (RESET) key to go back to the menu.

Figure 3.19 shows the LCD screen transition starting from the "4. I/O CHECK" menu.

```
→ 0. Q U I C K   S E T
  1. D A T A   S E T
  2. D A T A   C H E C K
  3. O P R   M N T R
∧∨→M E N U   S H I F ▼
```

Select desired menu by moving the pointer → with ∧ / ∨ key.

```
  1. D A T A   S E T
  2. D A T A   C H E C K
  3. O P R   M N T R
→ 4. I ／ O   C H E C K
∧∨→M E N U   S H I F ◆
```

Press (FUNC DATA) key to finalize desired menu.

**Input signal at control circuit terminal block**
Highlighted when short-circuited; normal when open

```
T R M   X 2  ─ ─  ─ ─
F W D   X 3  ─ ─  ─ ─
R E V   X 4  ─ ─  ─ ─
X 1     X 5  ─ ─
I／O   C H E C K   1／6  ▼
```

**Input signal coming via communication link**
Highlighted when 1; normal when 0

```
L N K   X 2  ─ ─  X F
F W D   X 3  ─ ─  X R
R E V   X 4  ─ ─  R S T
X 1     X 5  ─ ─
I／O   C H E C K   2／6  ◆
```

**Output signal**
Highlighted when ON;
normal when OFF

```
Y 1     Y 5         Y 1 A
Y 2     3 0 A B C   Y 2 A
Y 3                 Y 3 A
─ ─
I／O   C H E C K   3／6  ◆
```

**I/O signal (hex)**
Input signal at control circuit terminal block
Output signal
Input signal coming via communication link

```
D i   =  0 0 0 0 H
D o   =  0 0 0 0 H
L N K =  0 0 0 0 H

I／O   C H E C K   4／6  ◆
```

**Analog input signal**
Input voltage at terminal [12]
Input current at terminal [C1]
Input voltage at terminal [V2]

```
1 2 =  + 0 . 0 V
C 1 =    0 . 0 m A
V 2 =  + 0 . 0 V

I／O   C H E C K   5／6  ◆
```

**Analog output signal**
Output voltage at terminal [FMA]
Output current at terminal [FMA]
Output current at terminal [FMI]

```
F M A =   0 . 0 V
F M A =   0 . 0 m A
F M I =   0 . 0 m A

I／O   C H E C K   6／6  ▲
```

Common operation:

To confirm data, call the desired page using ∧ / ∨ key.

Press (RESET) key to return to Menu.

Figure 3.19   Menu Transition for "I/O CHECK"

Hexadecimal expression

Each I/O terminal is assigned to one of the 16 binary bits (bit 0 through bit 15). The bit to which no I/O terminal is assigned is considered to have a value of "0." The I/O signals are thus collectively expressed as a hexadecimal number (0 through F).

In the FRENIC-Eco Series, digital input terminals [FWD] and [[REV] are assigned to bits 0 and 1, and [X1] through [X5] to bits 2 through 6, respectively. Each bit assumes a value of "1" when the corresponding signal is ON and a value of "0" when it is OFF[(Note)]. For example, when signals [FWD] and [X1] are ON while all the other signals are OFF, the status is expressed as "0005H."

(Note) The ON/OFF state of each signal at terminals [FWD], [REV], and X1 through [X5] is to be interpreted according to the states of the source/sink switch as shown in Table 2.8 in Chapter 2 of the FRENIC-Eco Instruction Manual.

Digital output terminals [Y1] through [Y3] are assigned to bits 0 through 2. Each is given a value of "1" when it is short-circuited to [CMY], or a value of "0" when its circuit to [CMY] is open. The status of relay output terminal [Y5A/C] is assigned to bit 4, which assumes a value of "1" when the contact between [Y5A] and [Y5C] is closed. The status of relay output terminal [30A/B/C] is assigned to bit 8, which assumes a value of "1" when the contact between [30A] and [30C] is closed or "0" when the contact between [30B] and [30C] is closed. For example, when terminal [Y1] is ON, terminals [Y2] and [Y3]] are OFF, the contact between [Y5A] and [Y5C] is opened, and the link between 30A and 30C is closed, the status is expressed as "0101H."

Table 3.11 Hexadecimal Notation

| Data Displayed | | Highest digit | | | | | | | | | | | | | | Lowest digit | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bit | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| Input signal | (RST)* | (XR)* | (XF)* | - | - | - | - | - | - | [X5] | [X4] | [X3] | [X2] | [X1] | [REV] | [FWD] |
| Output signal | - | [Y3 RY] | [Y2 RY] | [Y1 RY] | - | - | - | [30A/B /C] | - | - | - | [Y5A /C] | - | [Y3] | [Y2] | [Y1] |
| Example (input) — Binary | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| Example (input) — Hex | 0005H | | | | | | | | | | | | | | | |

-: unassigned

* (XF), (XR), (RST) are for communications. Refer to the subsection below.

■ **Displaying control I/O signal terminals under communication control**

During control via communication, input commands sent via RS-485 communications can be displayed in two ways depending on setting of the function code S06: "Display with ON/OFF of the LED segment" or "In hexadecimal format." The content to be displayed is basically the same as that for the control I/O signal terminal status display; however, (XF), (XR), and (RST) are added as inputs. Note that under communications control, I/O display is in normal logic (ON when active) (using the original signals that are not inverted).

📖 Refer to the RS-485 Communication User's Manual for details on input commands sent through RS-485 communications and the instruction manual of communication-related options as well.

### 3.4.6  Reading maintenance information – "5. MAINTENANC"

Menu #5 "MAINTENANC" in Programming Mode allows you to view information necessary for performing maintenance on the inverter.

Table 3.12 lists the maintenance information display items.

Table 3.12   Display Items for Maintenance

| Symbol | Item | Description |
|---|---|---|
| TIME | Cumulative run time | Shows the cumulative run time during which the inverter was powered ON.<br>When the total time exceeds 65,535 hours, the counter will be reset to 0 and the count will start again. |
| EDC | DC link circuit voltage | Shows the DC link circuit voltage of the inverter's main circuit. |
| TMPI | Max. temperature inside the inverter | Shows a maximum temperature inside the inerter every hour. |
| TMPF | Max. temperature of heat sink | Shows the maximum temperature of the heat sink every hour. |
| Imax | Max. effective current | Shows the maximum current in rms every hour. |
| CAP | Capacitance of the DC bus capacitor | Shows the current capacitance of the DC bus capacitor as % of the capacitance at factory shipment. Refer to the FRENIC-Eco Instruction Manual, Chapter 7 "MAINTENANCE AND INSPECTION" for details. |
| MTIM | Cumulative motor run time | Shows the cumulative run time of the motor.<br>When the total time exceeds 65,535 hours, the counter will be reset to 0 and the count will start again. |
| TCAP | Cumulative run time of electrolytic capacitor on the printed circuit board | Shows the product of the cumulative time of voltage being applied to the electrolytic capacitor on the printed circuit board and a coefficient determined by the environmental condition. When the total time exceeds 65,535 hours, the counting will stop.<br>As a guide, 61,000 hours is considered as life. |
| TFAN | Cumulative run time of the cooling fan | Shows the cumulative run time of the cooling fan. When the total time exceeds 65,535 hours, the counting will stop.<br>As a guide, 61,000 hours is considered as life (This number varies with the capacity of the inverter.) |
| NST | Count of start-ups | Shows the total count of start-ups of the motor (count of times when the run command for the inverter was turned ON). When the total time exceeds 65,535 hours, the counter will be reset to 0 and the count will start again. |
| Wh | Input watt-hour            Note 1) | Shows the input watt-hours of the inverter. Upon exceeding 1,000,000 kWh, the count goes back to 0. |
| PD | Input watt-hour data       Note 1) | Shows the input watt-hour data as input watt-hour (kWh) x function code E51. (The range of display is 0.001 to 9,999. Values exceeding 9,999 are expressed as 9,999.) |
| NRR1 | Count of RS-485-1 errors | Shows the cumulative count of RS-485 communications (RJ-45) errors since first power ON. |
| | RS-485-1 error content     Note 2) | Shows the latest error that has occurred with RS-485 communications (RJ-45) in a code. |
| NRR2 | Count of RS-485-2 errors | Shows the cumulative count of RS-485 communications (Terminal) errors since first power ON. |
| | RS-485-2 error content     Note 2) | Shows the latest error that has occurred with RS-485 communications (Terminal) in a code. |
| NRO | Count of option errors | Shows the cumulative count of errors detected during optional communication with option installed. |
| | Option error code | Shows the latest error that has been detected during optional communication in a code. |
| MAIN | ROM version of the inverter | Shows the ROM version of the inverter in 4 digits. |
| KP | ROM version of the keypad | Shows the ROM version of the keypad in 4 digits. |
| OP1 | ROM version of the option | Shows the ROM version of the option in 4 digits. |
| LALM | Light alarm | Shows the factor of the light alarm as an alarm code. |

Note 1) To reset the input watt-hour and input watt-hour data to 0, set function code E51 to "0.000."

Note 2) For details of errors, refer to the RS-485 Communication User's Manual.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "5. MAINTENANC" by using ⌃ and ⌄ keys (moving →).

(3) Press the (FUNC DATA) key to display the screen for Maintenance (1 page out of a total of 7 pages).

(4) Select the page for the desired item by using ⌃ and ⌄ keys and confirm the Maintenance data for the desired item.

(5) Press the (RESET) key to go back to the menu.

Figure 3.20 shows the LCD screen transition starting from the "5. MAINTENANC" menu.

```
→0. QUICK  SET
  1. DATA  SET
  2. DATA  CHECK
  3. OPR  MNTR
 ∧∨→MENU  SHIF▼
```
Select desired menu by moving the pointer → with ⌃ / ⌄ key.

⌃ / ⌄

```
  2. DATA  CHECK
  3. OPR  MNTR
  4. I／O  CHECK
→5. MAINTENANC
 ∧∨→MENU  SHIF◆
```

(FUNC DATA)          (RESET)   Press (FUNC DATA) key to finalize desired menu.

```
TIME=      14h
EDC  =     493V
TMPI=      38℃
TMPF=      88℃
MAINTENANC1／▼
```
Cumulative run time
DC link circuit voltage
Max. temperature inside the inverter
Max. temperature of heat sink

⌃ / ⌄

```
Imax=  0. 00A
CAP  =  0. 0%
MTIM=     14h

MAINTENANC2／◆
```
Max. effective current
Capacitance of the DC bus capacitor
Cumulative motor run time

Common operation:

To confirm data, call the desired page using ⌃ / ⌄ key.

Press (RESET) key to return to Menu.

⌃ / ⌄

```
TCAP=      11h
    (61000h)
TFAN=      31h
    (61000h)
MAINTENANC3／◆
```
Cumulative run time of electrolytic capacitor (reference)
Cumulative run time of the cooling fan (reference)

⌃ / ⌄

```
NST=       0
Wh  =999900kWh
PD  =    2265

MAINTENANC4／◆
```
Number of start-ups
Input watt-hour
Input watt-hour data

⌃ / ⌄

↑↓ ⊙ / ⊙

```
N R R 1 =    1 3    7 8
N R R 2 =    2 5    7 7
N R O  =    1 1    7 2
M A I N T E N A N C 5 ╱◆
```

No. of errors & Error content for RS-485-1
No. of errors & Error content for RS-485-2
No. of errors & Error code
for Option communication

↕ ⊙ / ⊙

```
M A I N =   0 0 0 0
K P    =   0 0 0 0

M A I N T E N A N C 6 ╱◆
```

ROM version of the inverter
ROM version of the keypad

↕ ⊙ / ⊙

```
O P 1  =   0 0 0 0

M A I N T E N A N C 7 ╱▲
```

ROM version of the option

↕ ⊙ / ⊙

```
L A L M 1 = O H 2
L A L M 2 = O H 3
L A L M 3 = O L 1
L A L M 4 = O L 2
M A I N T E N A N C 8 ╱◆
```

Light alarm (Latest)
Light alarm (Last)
Light alarm (2nd last)
Light alarm (3rd last)

Common operation:

To confirm data, call the desired page using ⊙ / ⊙ key.

Press (RESET) key to return to Menu.

Figure 3.20    Menu Transition for "MAINTENANC"

### 3.4.7 Reading alarm information – "6. ALM INF"

Menu #6 "ALM INF" in Programming Mode allows you to view the information on the four most recent alarm conditions that triggered protective functions (in alarm code and the number of occurrences). It also shows the status of the inverter when the alarm condition occurred.

Table 3.13 lists the details of the alarm information.

Table 3.13 Alarm Information Displayed

| Symbol | Item | Description |
|---|---|---|
| O/1 | Most recent alarm | Alarm code and count of occurrences |
| -1 | 2$^{nd}$ recent alarm | Alarm code and count of occurrences |
| -2 | 3$^{rd}$ recent alarm | Alarm code and count of occurrences |
| -3 | 4$^{th}$ recent alarm | Alarm code and count of occurrences |
| Fot1 | Output frequency | Output frequency |
| Iout | Output current | Output current |
| Vout | Output voltage | Output voltage |
| TRQ | Calculated torque | Motor output torque |
| Fref | Frequency command | Frequency command |
| | Running direction | FWD: Forward, REV: Reverse, Blank: Stopped |
| | Running status | IL: current limitation, LU: undervoltage, VL: voltage limitation |
| TIME | Cumulative run time | Shows the cumulative power-ON time of the inverter.<br>When the total time exceeds 65,535 hours, the display will be reset to 0 and the count will start again. |
| NST | Count of startups | Shows the cumulative count of times the motor has been started (the inverter run command has been issued). When the total count exceeds 65,535, the display will be reset to 0 and the count will start again. |
| EDC | DC link circuit voltage | Shows the DC link circuit voltage of the inverter's main circuit. |
| TMPI | Temperature inside the inverter | Shows the temperature inside the inverter. |
| TMPF | Max. temperature of heat sink | Shows the maximum temperature of the heat sink. |
| TRM | Input signal status at terminal block of control circuit | ON/OFF status of input signals of the terminals<br>[FWD], [REV], [X1] to [X5] (Highlighted when short-circuited; normal when open) |
| LNK | Terminal input signal status under communication control | ON/OFF status of input signals for function code S06 (Communication).<br>[FWD], [REV], [X1] to [X5], (XF), (XR), (RST) (Highlighted when 1; normal when o) |
| - | Output signal | Output signals to the terminals [Y1] to [Y3], [Y5], [30ABC], [Y1A], [Y2A], [Y3A] |
| 3 | Overlapping alarm 1 | Simultaneously occurring alarm codes (1)<br>("----" is displayed if no alarms have occurred.) |
| 2 | Overlapping alarm 1 | Simultaneously occurring alarm codes (2)<br>("----" is displayed if no alarms have occurred.) |
| SUB | Error sub-code | Secondary error code for the alarm. |

Note When the same alarm occurs a number of times in succession (reoccurring alarm), the alarm information for the first occurrence is retained and the information for the subsequent occurrences is discarded. Only the number of consecutive occurrences will be updated.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "6. ALM INF" by using ⌃ and ⌄ keys (moving ➔).

(3) Press the (FUNC/DATA) key to get the Alarm list screen, which displays information on the four most recent alarm conditions (alarm code and the number of occurrences for each alarm condition).

(4) Select the alarm condition to be displayed, by using ⌃ and ⌄ keys.

(5) Press the (FUNC/DATA) key to display the alarm code on the LED Monitor and the screen for the status data at the time of the alarm (1 page out of a total of 7 pages) on the LCD Monitor.

(6) Select the page for the desired item by using ⌃ and ⌄ keys and confirm the status data for the desired item.

(7) Press the (RESET) key to return to the alarm list. Press the (RESET) key again to return to the menu.


Figure 3.21 shows the LCD screen transition starting from the "6. ALM INF" menu.
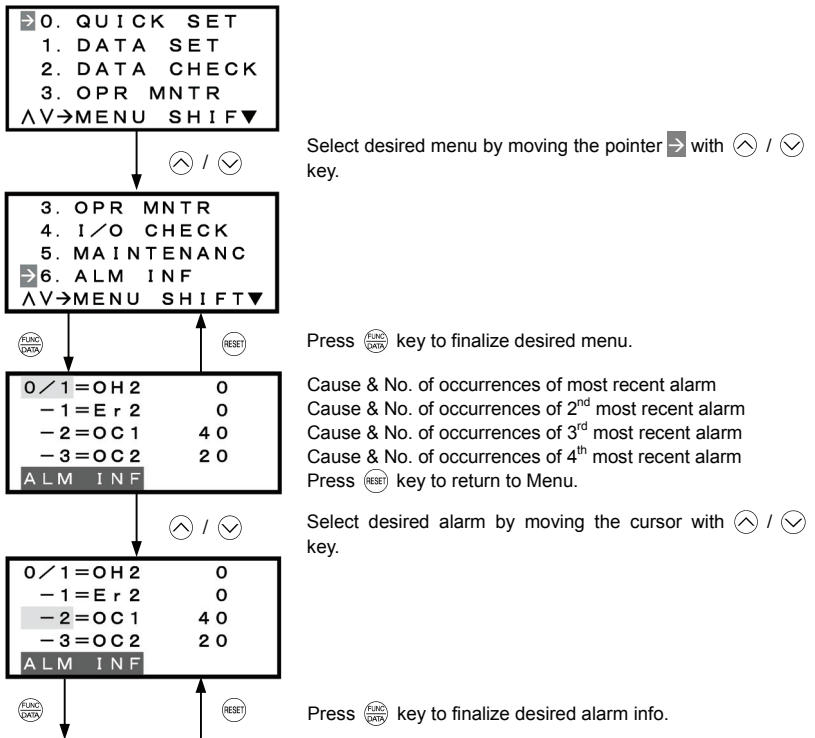


```
➔0. QUICK  SET
  1. DATA  SET
  2. DATA  CHECK
  3. OPR  MNTR
∧V➔MENU  SHIF▼
```

Select desired menu by moving the pointer ➔ with ⌃ / ⌄ key.

```
  3. OPR  MNTR
  4. I／O  CHECK
  5. MAINTENANC
➔6. ALM  INF
∧V➔MENU  SHIFT▼
```

Press (FUNC/DATA) key to finalize desired menu.

```
0／1＝OH2        0
 －1＝Er2        0
 －2＝OC1       40
 －3＝OC2       20
ALM  INF
```

Cause & No. of occurrences of most recent alarm
Cause & No. of occurrences of 2nd most recent alarm
Cause & No. of occurrences of 3rd most recent alarm
Cause & No. of occurrences of 4th most recent alarm
Press (RESET) key to return to Menu.

Select desired alarm by moving the cursor with ⌃ / ⌄ key.

```
0／1＝OH2        0
 －1＝Er2        0
 －2＝OC1       40
 －3＝OC2       20
ALM  INF
```

Press (FUNC/DATA) key to finalize desired alarm info.

Figure 3.21   Menu Transition for "ALM INF"

Press (FUNC/DATA) key to finalize desired alarm info.

```
Fot1=  54.32Hz
Iout=   8.49A
Vout=    199V
TRQ =     99%
ALM  INF1/7   ▼
```
Output frequency
Output current
Output voltage
Calculated torque

↕ ⊙ / ⊙

```
Fref=  60.00Hz
FWD  IL  LU
TIME=     14h

ALM  INF2/7   ◆
```
Frequency command
Running direction/status
Cumulative run time

↕ ⊙ / ⊙

```
NST  =    124
EDC  =    199V
TMPI=     44℃
TMPF=     89℃
ALM  INF3/7   ◆
```
No. of startups
DC link circuit voltage
Temperature inside inverter
Max. temperature of heat sink

↕ ⊙ / ⊙

```
TRM  X2  ──  ──
FWD  X3  ──  ──
REV  X4  ──  ──
X1   X5  ──
ALM  INF4/7   ◆
```
**Input signal status at terminal block of control circuit**

Highlighted when short-circuited; normal when opened

↕ ⊙ / ⊙

```
LNK  X2  ──  XF
FWD  X3  ──  XR
REV  X4  ──  RST
X1   X5  ──
ALM  INF5/7   ◆
```
**Terminal input signal status under communication control**

Highlighted when 1; normal when 0

↕ ⊙ / ⊙

```
Y1   Y5       Y1A
Y2   30ABC    Y2A
Y3            Y3A
──
ALM  INF6/7   ◆
```
**Output signal**

Highlighted when ON; normal when OFF

↕ ⊙ / ⊙

```
  3=───
  2=───
SUB=    0

ALM  INF7/7   ▲
```
Overlapping alarm 2
Overlapping alarm 1
Error sub-code

Common operation:

To confirm data, call the desired page using ⊙ / ⊙ key.

Press (RESET) key to return to Menu.

Figure 3.21   Menu Transition for "ALM INF" (continued)

### 3.4.8 Viewing cause of alarm – "7. ALM CAUSE"

Menu #7 "ALM CAUSE" in Programming Mode allows you to view the information on the four most recent alarm conditions that triggered protective functions (in alarm code and the number of occurrences). It also shows the cause of each alarm.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "7. ALM CAUSEF" by using ⌃ and ⌄ keys (moving ➔).

(3) Press the (FUNC/DATA) key to get the Alarm list screen, which displays information on the four most recent alarm conditions (alarm code and the number of occurrences for each alarm condition).

(4) Select the alarm condition to be displayed, by using ⌃ and ⌄ keys.

(5) Press the (FUNC/DATA) key to display the alarm code on the LED Monitor and the screen for the cause of the alarm (can be more than 1 page) on the LCD Monitor.

(6) Press ⌃ and ⌄ keys to view the previous/next page.

(7) Press the (RESET) key to return to the alarm list. Press the (RESET) key again to return to the menu.

Figure 3.22 shows the LCD screen transition starting from the "7. ALM CAUSE" menu.
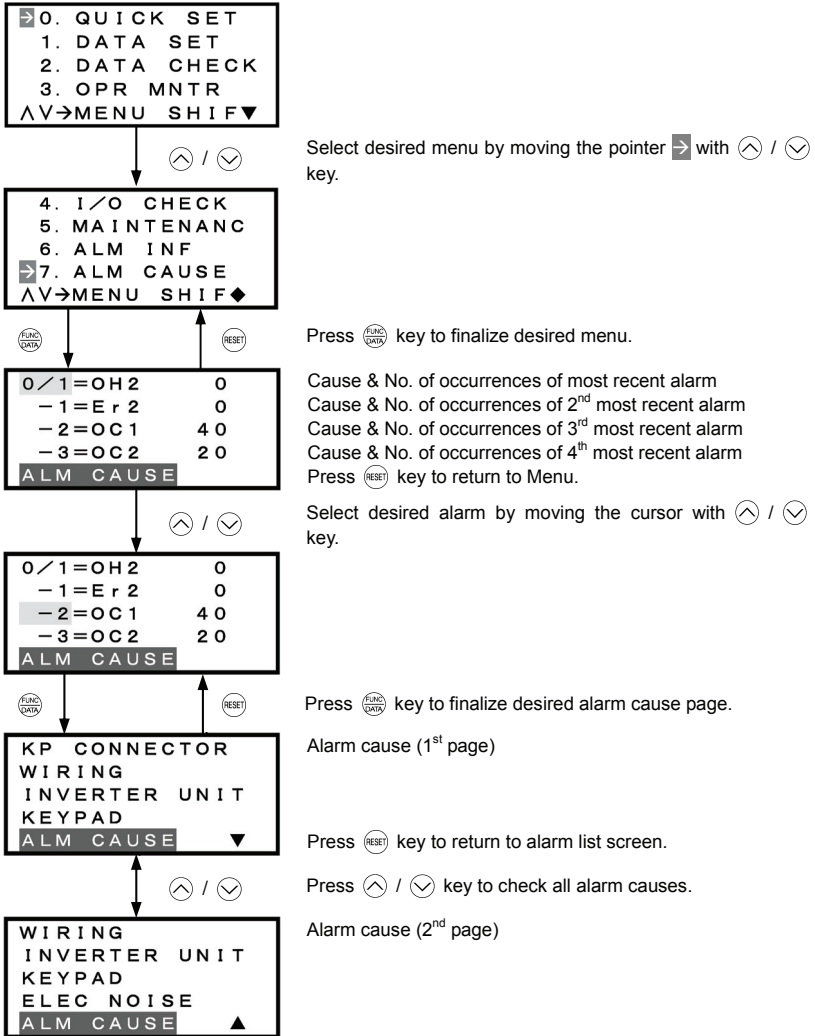
```
 0. QUICK  SET
 1. DATA  SET
 2. DATA  CHECK
 3. OPR  MNTR
∧∨→MENU  SHIF▼
```

Select desired menu by moving the pointer → with ∧ / ∨ key.

```
 4. I／O  CHECK
 5. MAINTENANC
 6. ALM  INF
 7. ALM  CAUSE
∧∨→MENU  SHIF◆
```

Press (FUNC DATA) key to finalize desired menu.

```
0／1＝OH2        0
 −1＝Er2        0
 −2＝OC1       40
 −3＝OC2       20
ALM  CAUSE
```

Cause & No. of occurrences of most recent alarm
Cause & No. of occurrences of 2nd most recent alarm
Cause & No. of occurrences of 3rd most recent alarm
Cause & No. of occurrences of 4th most recent alarm
Press (RESET) key to return to Menu.

Select desired alarm by moving the cursor with ∧ / ∨ key.

```
0／1＝OH2        0
 −1＝Er2        0
 −2＝OC1       40
 −3＝OC2       20
ALM  CAUSE
```

Press (FUNC DATA) key to finalize desired alarm cause page.

```
KP  CONNECTOR
WIRING
 INVERTER  UNIT
KEYPAD
ALM  CAUSE        ▼
```

Alarm cause (1st page)

Press (RESET) key to return to alarm list screen.

Press ∧ / ∨ key to check all alarm causes.

```
WIRING
 INVERTER  UNIT
KEYPAD
ELEC  NOISE
ALM  CAUSE        ▲
```

Alarm cause (2nd page)

Figure 3.22   Menu Transition for "ALM CAUSE"

### 3.4.9 Data copying – "8. DATA COPY"

Menu #8 "Data Copying" in Programming Mode allows you to read function code data out of an inverter for which function codes are already set up and then to write such function code data altogether into another inverter, or to verify the function code data held in the keypad with the one in the inverter.

The keypad can hold three sets of function code data in three areas of its internal memory so that it can be used with three different inverters. You can read the function code data of an inverter into one of these memory areas or write the function code data held in one of these memory areas into the inverter you select. On the LCD screen, each set of function code data or memory area is given a name such as DATA 1 and DATA 2.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the ⓅRG key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "8. DATA COPY" by using ⌃ and ⌄ keys (moving →).

(3) Press the FUNC/DATA key to get the data copy index screen (list of data copy operations).

(4) Select the operation (read, write, verify, check), by using ⌃ and ⌄ keys (moving →).

(5) Press the FUNC/DATA key to finalize the choice of operation and then select the data set (or storage area) on the keypad.

(6) Press the FUNC/DATA key to finalize the selection and perform the operation of your choice (for details, refer to the LCD screen transition diagram below).

(7) Press the RESET key to return to the menu.

Figure 3.23 shows the LCD screen transition starting from the "8. DATA COPY" menu.

**1) Selecting Copy Operation**



Select desired menu by moving the pointer → with ⌃ / ⌄ key.

Press FUNC/DATA key to finalize desired menu.

**List of data copy operations**
Select desired operation by moving the cursor with ⌃ / ⌄ key.

To return to Menu, press RESET key.
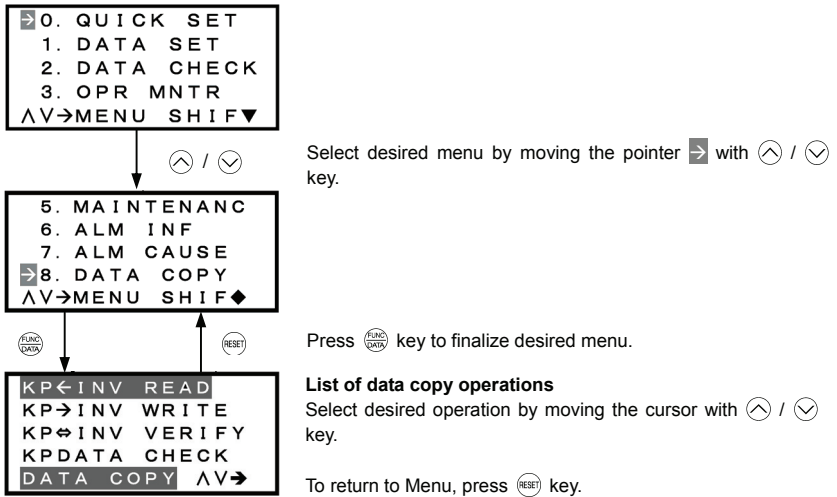
Figure 3.23   Menu Transition for "DATA COPY"

Table 3.14 List of DATA COPY Operations

| Operation | Description |
|---|---|
| Read: Read data | Reads out function code data from the inverter and stores it into the internal memory of the keypad. |
| Write: Write data | Writes the data held in the selected memory area of the keypad into the inverter. |
| Verify: Verify data | Verifies the data held in the keypad's internal memory against the function code data in the inverter. |
| Check: Check data | Checks the model information (format) and function code data held in the three memory areas of the keypad. |

## 2) Read Operation
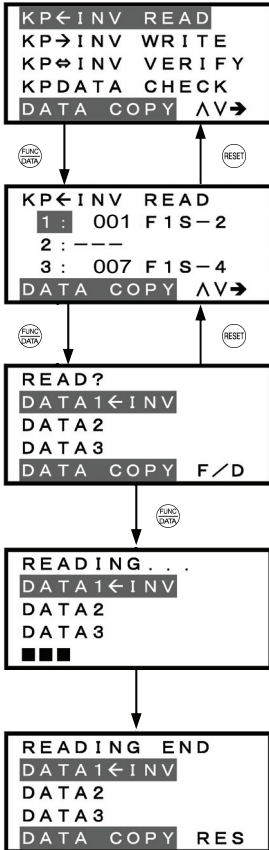
```
KP←INV  READ
KP→INV  WRITE
KP↔INV  VERIFY
KPDATA  CHECK
DATA  COPY  ∧∨→
```

**List of data copy operations**
Select desired operation by moving the cursor with ⊘ / ⊘ key.

Press (FUNC/DATA) key to finalize desired operation.

```
KP←INV  READ
 1:   001 F1S−2
 2:−−−
 3:   007 F1S−4
DATA  COPY  ∧∨→
```

**Data selection screen**
Select desired data by moving the cursor with ⊘ / ⊘ key.
To go back to List of data copy operations, press (RESET) key.

Press (FUNC/DATA) key to finalize desired data.

```
READ?
DATA1←INV
DATA2
DATA3
DATA  COPY  F／D
```

**Confirmation screen**
If "Read" is actually performed, the data read out from the inverter will overwrite the data held in this memory area in the keypad. If OK, press (FUNC/DATA) key.
To go back to Data selection screen, press (RESET) key.

Press (FUNC/DATA) key to start Read operation.

```
READING. . .
DATA1←INV
DATA2
DATA3
■■■
```

**"In progress" screen**
A bar indicating progress appears in the bottom.

Upon completion, Completion screen automatically appears.

```
READING  END
DATA1←INV
DATA2
DATA3
DATA  COPY  RES
```

**Completion screen**
Indicates that Read operation has completed successfully.
To go back to List of data copy operations, press (RESET) key.

### Error screens

```
ERROR
DATA1←INV
DATA2
DATA3
■■■
```
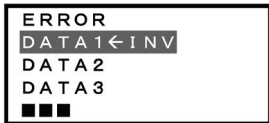
If you press (PRG) / (RESET) key during Read operation, the operation under way will be aborted, and this Error screen will appear.(Note) Once aborted, all the data held in the keypad's memory would be deleted.

```
ERROR
DATA1←INV
DATA2
DATA3
DATA  COPY  RES
```
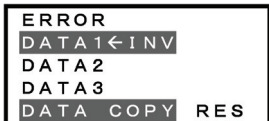
If a communication error is detected between the keypad and the inverter, this Error screen will appear.

Figure 3.24   Menu Transition for "READ"

Note  If an ERROR screen or an ERROR Ver. Screen appears during operation, press the (RESET) key to reset the error condition. When Reset is complete, the screen will go back to List of data copy operations.

**3) Write operation**
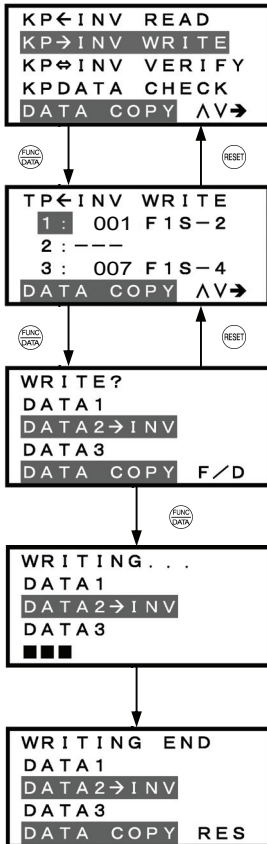
```
KP←INV  READ
KP→INV  WRITE
KP⇔INV  VERIFY
KPDATA  CHECK
DATA  COPY  ∧V→
```

**List of data copy operations**
Select desired operation by moving the cursor with ⊙ / ⊙ key.

Press (FUNC/DATA) key to finalize desired operation.

```
TP←INV  WRITE
 1:   001  F1S−2
 2:−−−
 3:   007  F1S−4
DATA  COPY  ∧V→
```

**Data selection screen**
Select desired data by moving the cursor with ⊙ / ⊙ key.
To go back to List of data copy operations, press (RESET) key.

Press (FUNC/DATA) key to finalize desired data.

```
WRITE?
DATA1
DATA2→INV
DATA3
DATA  COPY  F／D
```

**Confirmation screen**
If "Write" is actually performed, the selected data will overwrite the data held in the inverter. If OK, press (FUNC/DATA) key.
To go back to Data selection screen, press (RESET) key.

Press (FUNC/DATA) key to start Write operation.

```
WRITING. . .
DATA1
DATA2→INV
DATA3
■■■
```

**"In progress" screen**
A bar indicating progress appears in the bottom.

Upon completion, Completion screen automatically appears.

```
WRITING  END
DATA1
DATA2→INV
DATA3
DATA  COPY  RES
```

**Completion screen**
Indicates that Write operation has completed successfully.
To go back to List of data copy operations, press (RESET) key.

Figure 3.25   Menu Transition for "WRITE"

**Error screens**

```
ERROR
DATA1
DATA2→INV
DATA3
■■■
```

If you press (PRG) / (RESET) key during Write operation, the operation under way will be aborted, and this Error screen will appear.(Note) Updating of the function code data in the inverter is incomplete, with some of it remaining old. Do not run the inverter in this state. Before running the inverter, redo the writing or perform initialization.

```
ERROR
DATA1
DATA2→INV
DATA3
DATA COPY    RES
```

For safety considerations, the following situations are treated as an error:
- No valid data is found in the keypad's memory. (No Read operation has been performed since factory shipment; or, a Read operation has been cancelled or aborted.)
- The data held in the keypad's memory has an error.
- There is a mismatch in inverter's series.
- A Write operation has been performed while the inverter is running.
- The inverter is data-protected.
- The Write enable for keypad command (WE-KP) is OFF.

```
ERROR Ver.
DATA1
DATA2→INV
DATA3
DATA COPY    RES
```

The function code data held in the keypad is incompatible with that in the inverter. (Either data may be non-standard; or a version upgrade performed in the past may have made the keypad or the inverter incompatible. Contact your Fuji Electric representative.)

Figure 3.25   Menu Transition for "WRITE" (continued)

Note If an ERROR screen or an ERROR Ver. Screen appears during operation, press the (RESET) key to reset the error condition. When Reset is complete, the screen will go back to List of data copy operations.

#### 4) Verify operation
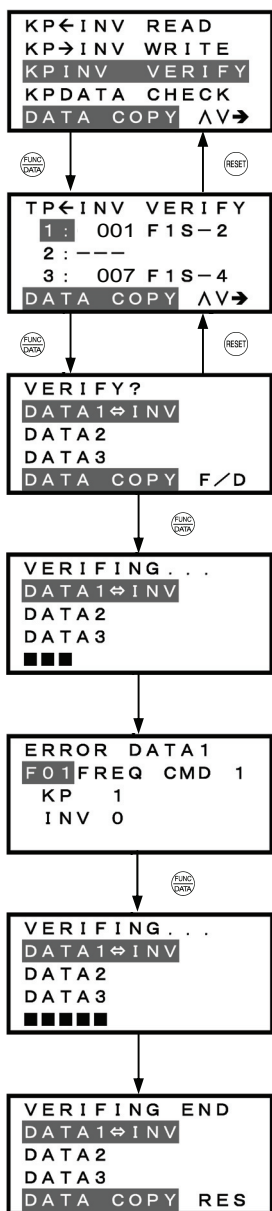
```
KP←INV  READ
KP→INV  WRITE
KPINV   VERIFY
KPDATA  CHECK
DATA COPY  ∧∨→
```

**List of data copy operations**
Select desired operation by moving the cursor with ⊘ / ⊘ key.

⬇ (FUNC/DATA)    (RESET)

Press (FUNC/DATA) key to finalize desired operation.

```
TP←INV  VERIFY
 1 :  001 F1S−2
 2 : −−−
 3 :  007 F1S−4
DATA COPY  ∧∨→
```

**Data selection screen**
Select data to be verified by moving the cursor with ⊘ / ⊘ key.
To go back to List of data copy operations, press (RESET) key.

(FUNC/DATA)    (RESET)

Press (FUNC/DATA) key to finalize desired data.

```
VERIFY?
DATA1⇔INV
DATA2
DATA3
DATA COPY  F/D
```

**Confirmation screen**
If OK, press (FUNC/DATA) key.
To go back to Data selection screen, press (RESET) key.

(FUNC/DATA)

Press (FUNC/DATA) key to start Verify operation.

```
VERIFING...
DATA1⇔INV
DATA2
DATA3
■■■
```

**"In progress" screen**
A bar indicating progress appears in the bottom.

```
ERROR  DATA1
F01FREQ  CMD  1
 KP   1
 INV  0
```

When a mismatch is found, the Verify operation is halted, with the function code and its data displayed on the LCD Monitor. To resume the Verify operation from the next function code, press (FUNC/DATA) key again.

(FUNC/DATA)

To resume Verify, press (FUNC/DATA) key.

```
VERIFING...
DATA1⇔INV
DATA2
DATA3
■■■■■
```

**"In progress" screen**
A bar indicating progress appears in the bottom.

Upon completion, Completion screen automatically appears.

```
VERIFING END
DATA1⇔INV
DATA2
DATA3
DATA COPY  RES
```
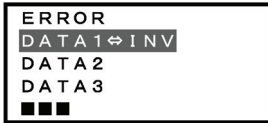
**Completion screen**
Indicates that Verify operation has completed successfully.
To go back to List of data copy operations, press (RESET) key.
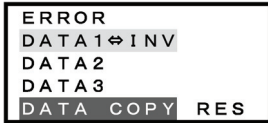
Figure 3.26   Menu Transition for "VERIFY"

**Error screens**

```
ERROR
DATA1⇔INV
DATA2
DATA3
■■■
```
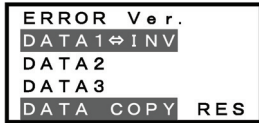
If you press (PRG) / (RESET) key during Verify operation, the operation under way will be aborted, and this Error screen will appear. (Note)

```
ERROR
DATA1⇔INV
DATA2
DATA3
DATA COPY  RES
```

If the keypad does not have any valid data, this Error screen will appear. (Note)

```
ERROR Ver.
DATA1⇔INV
DATA2
DATA3
DATA COPY  RES
```

The function code data held in the keypad is incompatible with that in the inverter. (Either data may be non-standard; or a version upgrade performed in the past may have made the keypad or the inverter incompatible. Contact your Fuji Electric representative.)

Figure 3.26   Menu Transition for "VERIFY" (continued)

Note If an ERROR screen or an ERROR Ver. Screen appears during operation, press the (RESET) key to reset the error factor. When Reset is complete, the screen will go back to List of data copy operations.

**5) Check operation**

```
┌──────────────────────┐
│ KP←INV  READ         │
│ KP→INV  WRITE        │
│ KPINV   VERIFY       │
│ KPDATA  CHECK        │
│ DATA  COPY    ∧V→     │
└──────────────────────┘
```

**List of data copy operations**
Select desired operation by moving the cursor with ⊙ / ⊙ key.

Press (FUNC/DATA) key to finalize desired operation.

```
┌──────────────────────┐
│ KPDATA  CHECK        │
│  1:   001 F1S−2      │
│  2:−−−               │
│  3:   007 F1S−4      │
│ DATA  COPY    ∧V→     │
└──────────────────────┘
```

**Data selection screen**
Select data to be checked by moving the cursor with ⊙ / ⊙ key.
To go back to List of data copy operations, press (RESET) key.

Press (FUNC/DATA) key to finalize desired data.

```
┌──────────────────────┐
│ CHECK  DATA1         │
│ F00  0               │
│ F01  1               │
│ F02  0               │
│ DATA  COPY    ∧V→     │
└──────────────────────┘
```

**"Check data" screen**
Displays function codes and their data.
To check other function codes, press ⊙ / ⊙ key.
To go back to List of data copy operations, press (RESET) key.

(RESET)

Figure 3.27    Menu Transition for "DATA CHECK"

**Error screen**

```
┌──────────────────────┐
│ ERROR                │
│ DATA1                │
│ DATA2                │
│ DATA3                │
│ DATA  COPY    RES     │
└──────────────────────┘
```
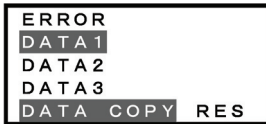
If no valid data is found in the keypad, this Error screen will appear. (Note)

Figure 3.28    Error Screen for "DATA COPY"

(Note) If an ERROR screen appears during operation, press the (RESET) key to reset the error factor. When Reset is complete, the screen will go back to List of data copy operations.

### 3.4.10 Measuring load factor – "9. LOAD FCTR"

Menu #9 "LOAD FCTR" in Programming Mode allows you to measure the maximum output current, the average output current, and the average braking power. There are two modes of measurement: "hours," in which the measurement takes place for a specified length of time, and "start to stop," in which the measurement takes place from the start of running to the stop.

Note  If the "start to stop" mode is entered while the inverter is running, the measurement takes place until it is stopped. If the "start to stop" mode is entered while the inverter is stopped, the measurement will take place from the next start of running until it is stopped.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "9. LOAD FCTR" by using ∧ and ∨ keys (moving →).

(3) Press the (FUNC/DATA) key to get the measurement mode selection screen.

(4) Select the measurement mode, by using ∧ and ∨ keys (moving →).

(5) Press the (FUNC/DATA) key to start the measurement. For "start to stop" mode, you will be prompted to enter a run command via a confirmation screen. For details, refer to the LCD screen transition chart.

(6) Press the (RESET) key to return to the menu.

Figure 3.29 shows the LCD screen transition starting from the "9. LOAD FCTR" menu.

**1) Selecting measurement mode**



Select desired menu by moving the pointer → with ∧ / ∨ key.

To finalize desired menu, press (FUNC/DATA) key.

**Mode selection screen**
HOURS SET: Measurement takes place for specified duration
START→STOP: Measurement takes place from start to stop.
EXECUTING: Measurement is taking place according to the specified duration set in HOURS SET.
To return to Menu, press (RESET) key.
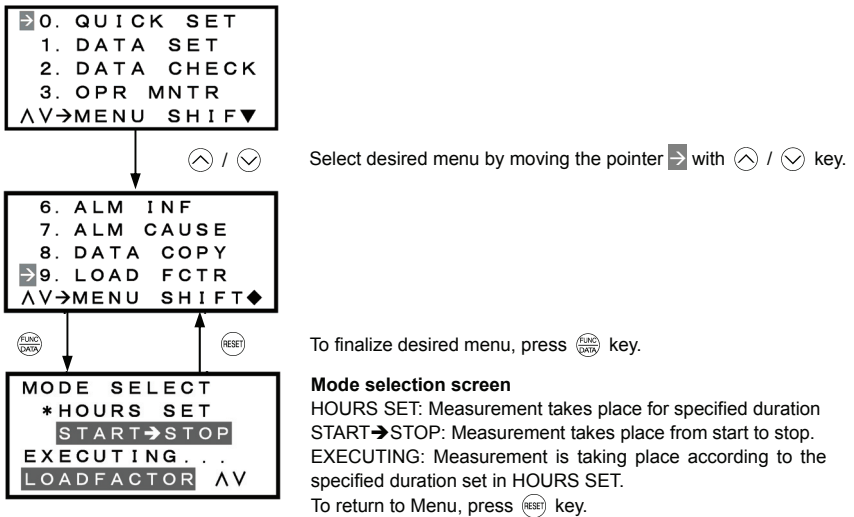
Figure 3.29   Menu Transition for Selecting Measurement Mode

**2) Selecting "hours set" mode**

```
MODE  SELECT
   HOURS  SET
  START➔STOP
EXECUTING...
LOADFACTOR  ∧∨
```

**Mode selection screen**
Select desired mode of measurement by moving the cursor with ⊙ / ⊙ key.

⊙ / ⊙    Select desired mode of measurement with ⊙ / ⊙ key.

```
MODE  SELECT
  HOURS  SET
  START➔STOP
EXECUTING...
LOADFACTOR  ∧∨
```

(FUNC DATA)    (RESET)    Press (FUNC DATA) key to finalize desired mode of measurement.

```
T=01h00m00s
Imax  =  0. 00A
Iave  =  0. 00A
BPave=   0. 0%
LOADFACTOR  ∧∨
```

**Set time duration** (Default: 1 hour)

To go back to Mode selection, press (RESET) key.

⊙ / ⊙    Set the duration by using ⊙, ⊙, and (SHIFT ≫) keys.

```
T=02h00m00s
Imax  =  0. 00A
Iave  =  0. 00A
BPave=   0. 0%
LOADFACTOR  ∧∨
```

(FUNC DATA)    Press (FUNC DATA) key to finalize the duration and start measurement.

```
T=01h59m59s
Imax  =  0. 00A
Iave  =  0. 00A
BPave=   0. 0%
LOADFACTOR  ∧∨
```

**Measurement in progress (remaining time)**
While the measurement is in progress, the remaining time is displayed.

When (FUNC DATA) key is pressed or the measurement duration has elapsed, the measurement stops, displaying the results.

```
T=01h00m00s
Imax  =289. 4A
Iave  =182. 2A
BPave=  24. 0%
LOADFACTOR  ∧∨
```

**Specified duration**
Max. output current
Average output current
Average braking power

**[Display of measurement results]**

Figure 3.30    Menu Transition for "LOAD FCTR" (hours set mode)

**3) Selecting "start to stop" mode**
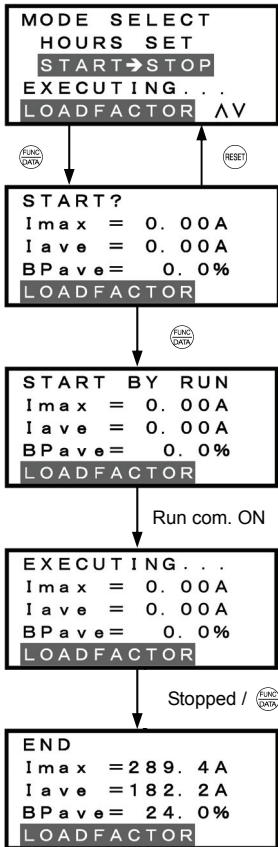
```
MODE  SELECT
  HOURS  SET
 START➔STOP
EXECUTING...
LOADFACTOR   ∧∨
```

**Mode selection screen**
Select desired mode of measurement by moving the cursor with ⊘ / ⊘ key.

(FUNC/DATA)     (RESET)

```
START?
Imax =  0. 00A
Iave =  0. 00A
BPave=   0. 0%
LOADFACTOR
```

**Confirmation screen**
If OK, press (FUNC/DATA) key.
To go back to Mode selection, press (RESET) key.

(FUNC/DATA)     Press (FUNC/DATA) key to signal "Ready."

```
START  BY  RUN
Imax =  0. 00A
Iave =  0. 00A
BPave=   0. 0%
LOADFACTOR
```

**Waiting for Run command (Standby for measurement)**
Upon receiving Run command, the measurement will start.
If a Run command has already been received, this screen will be skipped.

Run com. ON     Measurement will start upon receiving Run command.

```
EXECUTING...
Imax =  0. 00A
Iave =  0. 00A
BPave=   0. 0%
LOADFACTOR
```

**Measurement in progress**
The measurement will continue until the inverter is stopped.
To discontinue the measurement, press (FUNC/DATA) key.

Stopped / (FUNC/DATA)     Measurement will stop when the inverter is stopped or you press (FUNC/DATA) key.

```
END
Imax =289. 4A
Iave =182. 2A
BPave=  24. 0%
LOADFACTOR
```

**Duration**
Max. output current
Average output current
Average braking power

**[Display of measurement results]**

To return to Mode selection, press (RESET) key.

Figure 3.31    Menu Transition for "LOAD FCTR" (start to stop mode)

**4) Going back to Running mode**

While the measurement of the load factor is in progress, you can go back to the running mode by pressing the (PRG) key (or, to the Mode selection screen by pressing the (RESET) key).

In these cases, the measurement of the load factor will continue. You can go back to "9. LOAD FCTR" and confirm, on the Mode selection screen, that the measurement is in progress.

After the measurement has ended, you can view the results of the measurement by pressing the (FUNC/DATA) key on the Mode selection screen.

Note   The results of the measurement will be deleted when the inverter is powered OFF.

### 3.4.11 Changing function codes covered by Quick setup – "10. USER SET"

Menu #10 "USER SET" in Programming Mode allows you to change the set of function codes that are covered by Quick setup.

<u>**Basic key operation**</u>

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "10. USER SET" by using (∧) and (∨) keys (moving →).

(3) Press the (FUNC/DATA) key to get the list of function codes.

(4) Select the function codes to be added or deleted, by using (∧) and (∨) keys (moving →).

(5) Press the (FUNC/DATA) key to perform the addition or deletion.

(6) Press the (RESET) key to return to the menu.

Figure 3.32 shows the LCD screen transition starting from the "10. USER SET" menu.
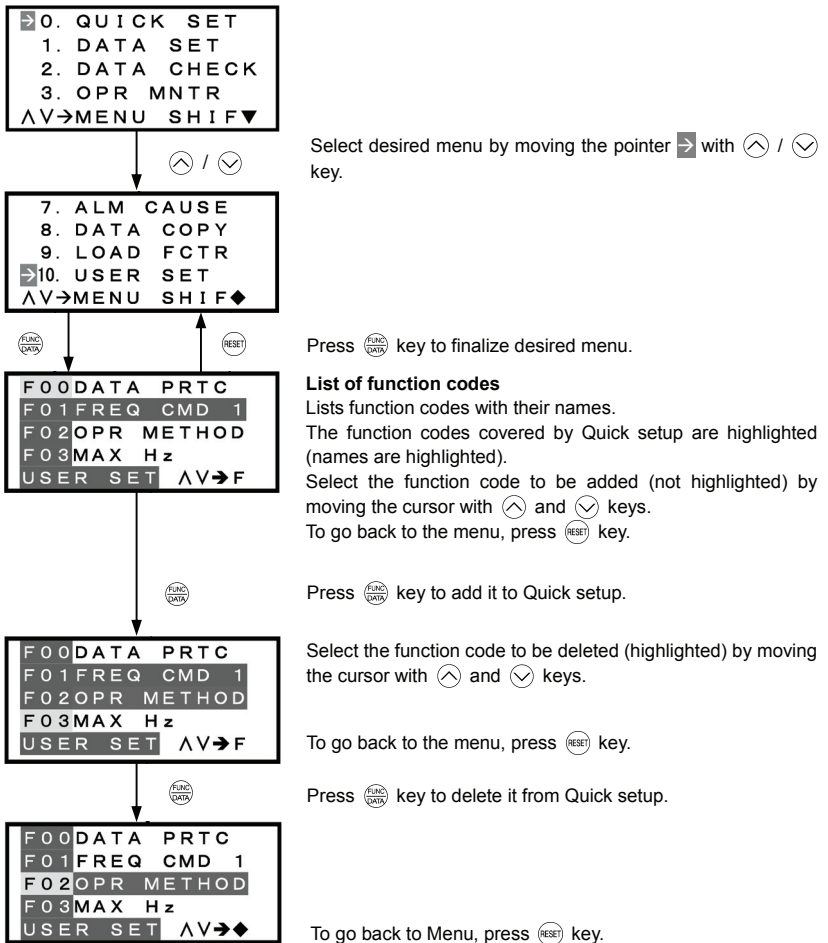


Select desired menu by moving the pointer → with (∧) / (∨) key.

Press (FUNC/DATA) key to finalize desired menu.

**List of function codes**
Lists function codes with their names.
The function codes covered by Quick setup are highlighted (names are highlighted).
Select the function code to be added (not highlighted) by moving the cursor with (∧) and (∨) keys.
To go back to the menu, press (RESET) key.

Press (FUNC/DATA) key to add it to Quick setup.

Select the function code to be deleted (highlighted) by moving the cursor with (∧) and (∨) keys.

To go back to the menu, press (RESET) key.

Press (FUNC/DATA) key to delete it from Quick setup.

To go back to Menu, press (RESET) key.

Figure 3.32   Menu Transition for Changing Function Codes Covered by Quick Setup

### 3.4.12 Performing communication debugging – "11. COMM DEBUG"

Menu #11 "COMM DEBUG" in Programming Mode allows you to view the data of communication-related function codes (S, M, W, X, and Z codes) to help debug programs for communication with an upper-level device.

**Basic key operation**

(1) When the inverter is powered ON, it automatically enters Running Mode. In Running Mode, press the (PRG) key to enter Programming Mode. The menu for function selection will be displayed.

(2) Select "11. COMM DEBUG" by using ⌃ and ⌄ keys (moving ➜).

(3) Press the (FUNC/DATA) key to get the list of communication-related function codes.

(4) Select the function code, by using ⌃ and ⌄ keys (moving ➜).

(5) Press the (FUNC/DATA) key to check or change the function code.

(6) Press the (RESET) key to return to the menu.

Figure 3.33 shows the LCD screen transition starting from the "11. COMM DEBUG" menu.

```
➜0. QUICK SET
 1. DATA SET
 2. DATA CHECK
 3. OPR MNTR
∧∨➜MENU SHIF▼
```

⌃ / ⌄     Select desired menu by moving the pointer ➜ with ⌃ / ⌄ key.

```
 8. DATA COPY
 9. LOAD FCTR
 10. USER SET
➜11. COMM DEBUG
∧∨➜MENU SHIF▲
```

(FUNC/DATA)     (RESET)     Press (FUNC/DATA) key to finalize desired menu.

```
S01  +20000
S05  39.49Hz
S06  0002H
S08  5.32sec
COMM DEBUG  ∧∨
```

**List of communication-related function codes**
Lists function codes with their names.
Select the function by moving the cursor with ⌃ and ⌄ keys.
To go back to the menu, press (RESET) key.

(FUNC/DATA)     Press (FUNC/DATA) key to finalize desired menu.

**S Code**

```
S05COMMAND
  ∗
    58.0 0 Hz
0.00~655.35
∧∨➜DATA ADJUS
```

**# & name of function code**
(∗: Data exists (≠ 0))
Data
Range
Operation guide

Data can be changed by pressing ⌃ / ⌄ key.

**M, W, X, Z Code**

```
M09MONITOR

    58.00Hz
MONITOR DATA
∧∨➜DATA ADJUS
```

Data

Operation guide

Reference only (Cannot be changed)

Figure 3.33    Menu Transition for Communication Debugging

## 3.5  Alarm Mode

When a protective function is triggered, resulting in an alarm, the inverter automatically enters the alarm mode, displaying the alarm code on the LED Monitor and the details of the alarm on the LCD Monitor as shown below.

**If there is no overlapping alarm**
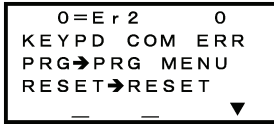
```
  0 = E r 2        0
KEYPD  COM  ERR
PRG➜PRG  MENU
RESET➜RESET
       ̶    ̶            ▼
```

Most recent cause; No. of consecutive occurrences
Cause of alarm
Operation guide
Operation guide

Figure 3.34   Without Non-overlapping Alarm

**If there is an overlapping alarm**

```
  1 = E r 2      0  ▲
KEYPD  COM  ERR
PRG➜PRG  MENU
RESET➜RESET
       ̶    ̶            ▼
```

Most recent cause; No. of consecutive occurrences
Cause of alarm        (▲ is added if there is an
Operation guide        overlapping alarm.)
Operation guide

Figure 3.35   With Overlapping Alarm

If there is an overlapping alarm, you can view more detailed information by pressing the ⌃ key.

In the examples below, "2 = Er6" corresponds to the first overlapping occurrence, and "3 = Er6" to the second overlapping occurrence.

■ Display of alarm history

In addition to the most recent (current) alarm, you can view three recent alarms and any overlapping alarms by pressing the ⌃ / ⌄ key while the most recent one is being displayed.

```
  2 = O H 2      1  ▲
KEYPD  COM  ERR
PRG➜PRG  MENU
RESET➜RESET
       ̶    ̶            ▼
```
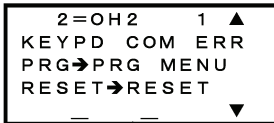
Overlapping alarm; No. of consecutive occurrences
Cause of alarm
Operation guide
Operation guide

⌃

```
  1 = E r 2      0  ▲
KEYPD  COM  ERR
PRG➜PRG  MENU
RESET➜RESET
       ̶    ̶            ▼
```
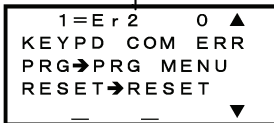
Most recent alarm; No. of consecutive occurrences
Cause of alarm        (▲ is added if there is an
Operation guide        overlapping alarm.)
Operation guide

⌄

```
 − 1 = E r 6      3  ▲
KEYPD  COM  ERR
PRG➜PRG  MENU
RESET➜RESET
       ̶    ̶            ▼
```
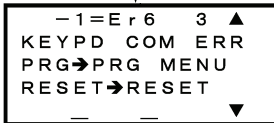
Previous alarm; No. of consecutive occurrences
Cause of alarm
Operation guide
Operation guide

Figure 3.36   Switching of Display of Overlapping Alarm History

■ Display of running status information at the time of alarm

By pressing the (FUNC/DATA) key while an alarm code is displayed, you can view the output frequency, output current, and other data concerning the running status. The data you can view is the same as with "6. ALM INF." Use (∧) and (∨) keys for scrolling pages within the menu.

Pressing the (PRG) key or the (RESET) key while the running status information is displayed will take you back to the display of the alarm code.

■ Transition to Programming mode

By pressing the (PRG) key while alarm information is displayed, you can switch to the Programming mode, in which you can use a variety of features such as changing function code data.

■ Resetting alarm; transition to Running mode

When you remove the cause of the alarm and press the (RESET) key, the alarm condition will be reset, and the inverter will go back to the Running mode.

Figure 3.37 summarizes the menu transition between these modes.
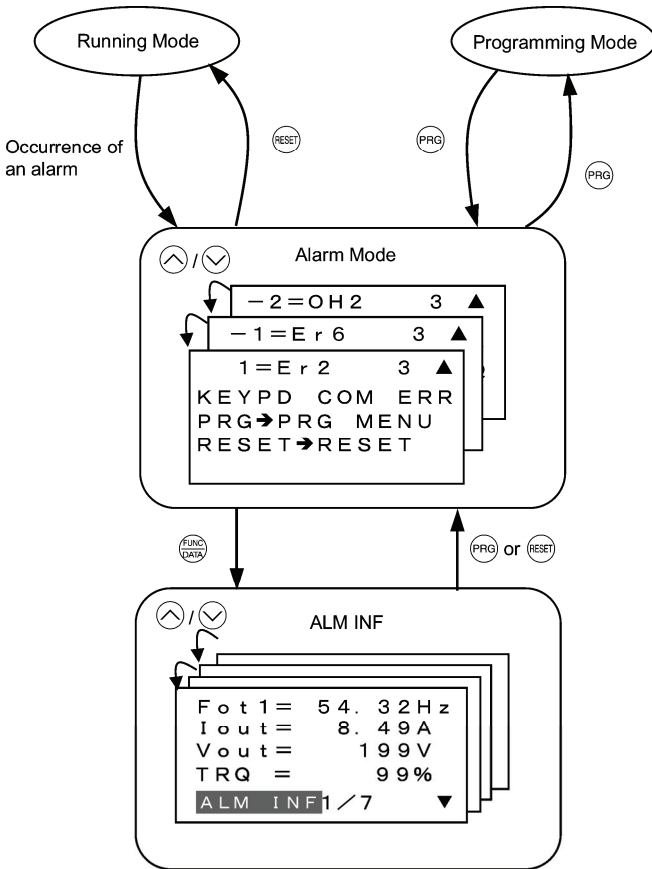


Figure 3.37   Menu Transition in/from Alarm Mode

## 3.6 Other Precautions

### 3.6.1 Function code setting for F02 (Run and operation)

The (FWD) / (REV) / (STOP) key on the keypad controls to run forward/reverse the motor without inputting any rotation command or stop it.

The function code F02 specifies the run command source to drive the motor.

| F02 data | Run command source |
|---|---|
| 0: Keypad | Pressing the (FWD) / (REV) / (STOP) key runs/stops the motor. |
| 1: Digital input | The terminal command (FWD) or (REV) runs/stops the motor. |
| 2: Keypad (Forward) | The (FWD) / (STOP) key runs the motor forward or stops it, but does not run it reverse. |
| 3: Keypad (Reverse) | The (REV) / (STOP) key runs the motor reverse or stops it, but does not run it forward. |

If you select Local by the Remote/Local switching command, operation of the run command from the keypad will be changed by setting of the function code F02.

📖 For details, refer to " Switching the operation mode between remote and local" in "3.3.1 Running/stopping the motor."

### 3.6.2 Remote/local operation

The keypad features the (REM/LOC) key to switch the operation between remote and local modes.

📖 For details, refer to " Switching the operation mode between remote and local" in "3.3.1 Running/stopping the motor."

### 3.6.3 Tuning motor parameters

The LCD monitor of a keypad shows the lead-through screen for tuning of motor parameters. To tune motor parameters follow screens below.

Entering into tuning motor parameters

Set data 1 or 2 into the function code P04 and press the (FUNC/DATA) key.

```
P04 M-TUN

0:DISABLE
0~2
∧V➜DATA ADJUS
```

Press ⌃ / ⌄ key to select the data either 1 or 2 being set to the function code P04.

```
P04 M-TUN
0:DISABLE
1:AT-STOP
0~2
∧V➜DATA ADJUS
```

Press (FUNC/DATA) key to select the tuning mode.

```
P04 M-TUN
1:AT-STOP

START BY RUN
COMMAND
```

Waiting for a run command.

Turn on the run command.

Give the specific run command, Run forward or Run reverse. (Note 1)

```
P04 M-TUN
1:AT-STOP


EXECUTING...
```

Tuning the motor parameters. (Note 2)

End of tuning

```
P04 M-TUN
1:AT-STOP

CLOSE BY RUN
COMMAND OFF
```

Turn off the run command.

Upon turning off the run command (while the run command given by the keypad or the link operation is automatically turned off) the lead-through ends the tuning process, and moves to the next function code P06.

```
P06 M-Io
P07 M-%R1
P08 M-%X
P99 M-SELECT
∧V➜FN CODE SH
```

(Note 1)  The factory default setting is "Run forward" by using the (FWD) key on the keypad. To tune the motor parameters in "Run reverse", change data of the function code F02.

(Note 2)  • Time needed for tuning while the motor is stopped (P04 = 1) will be less than 40 seconds.

  • In tuning while the motor is running (P04 = 2), the inverter accelerates the motor up to around 50% of the base frequency, starts tuning of motor parameters, and decelerates to stop the motor after the end of tuning. Estimated time needed for tuning in this case will be (acceleration time + 10 + deceleration time) seconds.

# Chapter 4    RUNNING THE MOTOR

## 4.1  Running the Motor for a Test

### 4.1.1  Inspection and preparation prior to powering on

Check the following prior to starting powering on.

(1) Check if connection is correct.

Especially check if the power wires are connected to the inverter input terminals L1/R, L2/S and L3/T, and output terminals U, V and W respectively and that the grounding wires are connected to the ground electrodes correctly. Note that FRENIC-Eco series inverter is designed for three phase input and driving three phase motors.

---

### ⚠ WARNING

- Do not connect power supply wires to the inverter output terminals U, V, and W. Otherwise, the inverter may be broken if you turn the power ON.
- Be sure to connect the grounding wires of the inverter and the motor to the ground electrodes.
  **Otherwise, electric shock may occur.**

---

(2) Check for short circuits between terminals and exposed live parts and ground faults.

(3) Check for loose terminals, connectors and screws.

(4) Check if the motor is separated from mechanical equipment.

(5) Turn the switches OFF so that the inverter does not start or operate erroneously at power-on.

(6) Check if safety measures are taken against runaway of the system, e.g., a defense to protect people from unexpectedly approaching your power system.
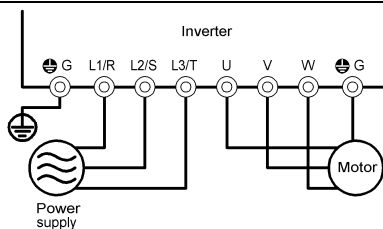
Figure 4.1  Connection of Main Circuit Terminals

### 4.1.2  Turning ON power and checking

---

### ⚠ WARNING

- Be sure to install the covers for both the main circuit terminal block, control circuit terminal block and the front cover if any before turning the power ON.
  Do not remove any cover while powering on.
- Do not operate switches with wet hands.
  **Otherwise electric shock could occur.**

---

Turn the power ON and check the following points. This is a case when no function code data is changed from the factory setting.

(1) Check if the LED monitor displays $\mathit{0.00}$ (means that the frequency command is 0 Hz) that is blinking. (See Figure 4.2.)

If the LED monitor displays numbers except $\mathit{0.00}$ then press ⌃ / ⌄ keys to set $\mathit{0.00}$ as the frequency command.

(2) Check if a built-in cooling fan rotates.
(When only the auxiliary power is fed while the main power is turned OFF, the cooling fan does not rotate. For the inverter of 1HP for 208V, 2HP for 460V or below no cooling fan is mounted.)

Figure 4.2  Display of the LED Monitor after Power-on

### 4.1.3  Preparation before running the motor for a test--Setting function code data

Before starting running the motor, set function code data specified in Table 4.1 to the motor ratings and your system design values. For the motor, check the rated values printed on the nameplate of the motor. For your system design values, ask system designers about them.

📖 For details about how to change function code data, refer to Chapter 3, Section 3.4.2 "Setting up function codes quickly using Quick setup." Refer to the function code H03 in Chapter 5 "FUNCTION CODES" for the factory default setting of motor parameters. If any of them is different from the default setting, change the function code data.

Table 4.1  Settings of Function Code Data before Driving the Motor for a Test

| Function code | Name | Function code data | Factory setting |
|---|---|---|---|
| F 04 | Base frequency | Motor ratings (printed on the nameplate of the motor) | 60.0 (Hz) |
| F 05 | Rated voltage (at base frequency) | | 208 (V) ~~~~~~~~~~~~~~~~~~~~~~ 460 (V) |
| P 02 | Motor parameter (Rated capacity) | | Applicable motor rated capacity |
| P 03 | Motor parameter (Rated current) | | Rated current of applicable motor |
| P 99 | Motor Selection | | 1: Characteristics of motor 1 (HP-rated motors) |
| F 03 | Maximum frequency | System design values * For a test-driving of the motor, increase values so that they are longer than your system design values. If the set time is short, the inverter may not start running the motor. | 60.0 (Hz) |
| F 07 | Acceleration time 1* | | 20.0 (s) |
| F 08 | Deceleration time 1* | | 20.0 (s) |

Tip  In any of the following cases, the default settings may not produce the best results for auto torque boost, torque calculation monitoring, or auto energy saving.

To get the best performance, tune the motor parameters according to the procedure set forth below.

• The cabling between the motor and the inverter is long.

• A reactor is inserted between the motor and the inverter.

＜Tuning procedure＞

1) Preparation

Referring to the rating plate on the motor, set the following function codes to their nominal ratings:

• F04: Base frequency
• F05: Rated voltage (at Base frequency)
• P02: Rated capacity
• P03: Rated current

2) Selection of Tuning Process

Check the situation of the machine system and choose between "Tuning while the motor is stopped (P04 = 1)" and "Tuning while the motor is running (P04 = 2)." In the case of "Tuning while the motor is running (P04 = 2)," also adjust the acceleration and deceleration times (F07 and F08) and set the rotation direction properly so that it matches the actual rotation direction of the machine system.

| Data for P04 | Motor parameters subject to Tuning: | Action | Choose the process when: |
|---|---|---|---|
| 1 | Primary resistance (%R1) Leakage reactance (%X) | Measure %R1 and %X while the motor is stopped. | The motor cannot be rotated, or more than 50% of the rated load would be applied on the motor if rotated. |
| 2 | Primary resistance (%R1) Leakage reactance (%X) No-load current | Measure %R1 and %X while the motor is stopped, and later no-load current while the motor is running. (At 50% of the Base frequency). | Even if the motor is rotated, it is safe and the load applied on the motor would be no more than 50% of the rating. (If you do the tuning with no load, you will get the highest precision.) |

Upon completion of the tuning, the primary resistance %R1 will be automatically saved into P07, the leakage reactance %X into P08, and the no-load current into P06.
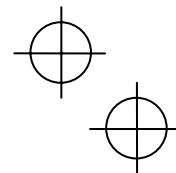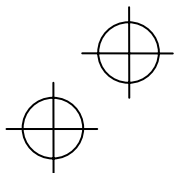
3) Preparation of Machine System

Perform appropriate preparations on the motor and its load, such as disengaging the coupling and deactivating the safety device.

4) Perform tuning

① Set function code P04 to "1" or "2" and press the (FUNC/DATA) key.

② Enter a Run command for the rotation direction you have chosen. To switch to reverse rotation, change the setting of function code F02.

③ The display of "1" or "2" stays lit, and tuning takes place while the motor is stopped.
(Maximum tuning time: approximately 40 (s).)

④ If the function code P04 = 2, the motor is accelerated to approximately 50% of the base frequency and then tuning takes place. Upon completion of measurements, the motor will coast-to-stop.
(Estimated tuning time: Acceleration time + 10 (s) + Deceleration time)

⑤ If the terminal signal (FWD) or (REV) is selected as the Run command (F02 = 1), "End" will appear upon completion of the measurements.

⑥ The Run command is turned OFF and the tuning completes, with the next function code P06 displayed on the keypad (the Run command given through the keypad or the communications link is automatically turned OFF).

■ Errors during tuning

Improper tuning would negatively affect the operation performance and, in the worst case, could even cause hunting or deteriorate precision. Therefore, if the inverter finds any abnormality in the results of the tuning or any error in the process of the tuning, it will display $Er\,7$ and discard the tuning data.

Listed below are the abnormal or error conditions that can be recognized during tuning.

| Abnormal/error condition | Description |
|---|---|
| Abnormal result of tuning | An inter-phase imbalance has been detected; Tuning has resulted in an abnormally high or low value of a parameter. |
| Abnormal output current | An abnormally high current has been caused during tuning. |
| Sequence error | During tuning, the Run command has been turned OFF, or forced STOP, coast-to-stop command (BX), dew condensation protection (DWP), or a similar abnormal command has been received. |
| Limitation exceeded | During tuning, a certain limitation has been reached or exceeded; The maximum output frequency or the peak limiter for output frequency has been reached or exceeded. |
| Other alarm condition | An undervoltage or an alarm has been occurred. |

If any of these conditions has occurred, either eliminate the abnormal or error factor(s) and perform tuning again, or contact your Fuji Electric representative.

Note If an output circuit filter is connected to the inverter's output (secondary) circuit, the result of tuning can be unpredictable. When you use the output circuit filter, please set the primary resistance %R1, the leakage reactance %X, and the no-load current by manual. Refer to the function codes P06, P07 and P08 for detail.
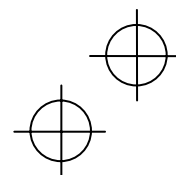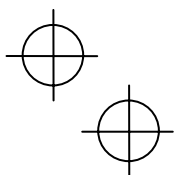
### 4.1.4  Test run

> ## ⚠ WARNING
>
> If the user set the function codes wrongly or without completely understanding this Instruction Manual and the FRENIC-Eco User's Manual, the motor may rotate with a torque or at a speed not permitted for the machine. **Accident or injury may result.**

Follow the descriptions of the previous Section 4.1.1, "Inspection and preparation prior to powering on" to Section 4.1.3, "Preparation before running the motor for a test," and begin test-driving of the motor.

> ## ⚠ CAUTION
>
> If any abnormality is found to the inverter or motor, immediately stop operation and determine the cause referring to Chapter 6, "TROUBLESHOOTING."

----------------------------------------------------- **Procedure for Test Run** -----------------------------------------------------

(1)  Turn the power ON and check that the LED monitor blinks while indicating the $0.00$ Hz frequency.

(2)  Set the frequency to a low frequency such as 5 Hz, using ⊼ / ⊻ keys. (Check that frequency command blinks on the LED monitor.)

(3)  Press the (FWD) key to start running the motor in the forward direction. (Check that the frequency command is displayed on the LED monitor correctly.)

(4)  To stop the motor, press the (STOP) key.

\<Check the following points\>

• Check if the direction of rotation is forward.

• Check for smooth rotation without motor humming or excessive vibration.

• Check for smooth acceleration and deceleration.

When no abnormality is found, press the (RUN) key again to start driving the motor, and increase the frequency command using ⊼ / ⊻ keys. Check the above points for the test-driving of the motor.

---------------------------------------------------------------------------------------------------------------------------------------

## 4.2  Operation

After confirming ordinary operation by performing a test run, make mechanical connections (connections of the machine system) and electrical connections (wiring and cabling), and set the necessary parameters properly before starting a production run.

Note  Depending on the conditions of the production run, further adjustments can be required, such as adjustments of torque boost (F09), acceleration time (F07), and deceleration time (F08). Make sure to set relevant function codes properly.

# Chapter 5

# FUNCTION CODES

This chapter contains overview lists of seven groups of function codes available for the FRENIC-Eco (TYPE: -DY) series of inverters and details of each function code.

Contents

# 5.1 Function Code Tables

Function codes enable the FRENIC-Eco (TYPE: -DY) series of inverters to be set up to match your system requirements.

Each function code consists of a 3-letter alphanumeric string. The first letter is an alphabet that identifies its group and the following two letters are numerals that identify each individual code in the group. The function codes are classified into eight groups: Fundamental Functions (F codes), Extension Terminal Functions (E codes), Control Functions of Frequency (C codes), Motor Parameters (P codes), High Performance Functions (H codes), Application Functions (J codes), Link Function (y codes) and Option Function (o codes). To determine the property of each function code, set data to the function code.

This manual does not contain the descriptions of Option Function (o codes). For Option Function (o codes), refer to the instruction manual for each option.

The following descriptions supplement those given in the function code tables on page 5-3 and subsequent pages.

■ Changing, validating, and saving function code data when the inverter is running

Function codes are indicated by the following based on whether they can be changed or not when the inverter is running:

| Notation | Change when running | Validating and saving function code data |
|----------|---------------------|-------------------------------------------|
| Y* | Possible | If the data of the codes marked with Y* is changed with ⊗ and ⊗ keys, the change will immediately take effect; however, the change is not saved into the inverter's memory. To save the change, press the 🔘 key. If you press the 🔘 key without pressing the 🔘 key to exit the current state, then the changed data will be discarded and the previous data will take effect for the inverter operation. |
| Y | Possible | Even if the data of the codes marked with Y is changed with ⊗ and ⊗ keys, the change will not take effect. Pressing the 🔘 key will make the change take effect and save it into the inverter's memory. |
| N | Impossible | — |

■ Copying data

A standard keypad is capable of copying of the function code data stored in the inverter's memory into the keypad's memory (refer to Menu #8 "Data copying" in Programming mode). With this feature, you can easily transfer the data saved in a source inverter to other destination inverters.

If the specifications of the source and destination inverters differ, some code data may not be copied to ensure safe operation of your power system. Whether data will be copied or not is detailed with the following symbols in the "Data copying" column of the function code tables given below.

 Y:  Will be copied unconditionally.
 Y1: Will not be copied if the rated capacity differs from the source inverter.
 Y2: Will not be copied if the rated input voltage differs from the source inverter.
 N:  Will not be copied. (The function code marked with "N" is not subject to the Verify operation, either.)

If necessary, set up uncopied code data manually and individually.

⟨Note⟩ For details of how to set up or edit function codes, refer to Chapter 3 "OPERATION USING THE MULTI-FUNCTION KEYPAD."

■ Using negative logic for programmable I/O terminals

The negative logic signaling system can be used for the digital input and output terminals by setting the function code data specifying the properties for those terminals. Negative logic refers to the inverted ON/OFF (logical value 1 (true)/0 (false)) state of input or output signal. An ON-active signal (the function takes effect if the terminal is short-circuited.) in the normal logic system is functionally equivalent to OFF-active signal (the function takes effect if the terminal is opened.) in the negative logic system. An ON-active signal can be switched to OFF-active signal, and vice verse, with the function code data setting.

To set the negative logic system for an I/O signal terminal, enter data of 1000s (by adding 1000 to the data for the normal logic) in the corresponding function code and then press the ⒡ key.

For example, if a coast-to-stop command (BX: data = 7) is assigned to any one of digital input terminals [X1] to [X5] by setting any of function codes E01 through E05, then turning (BX) on will make the motor coast to a stop. Similarly, if the coast-to-stop command (BX: data = 1007) is assigned, turning (BX) off will make the motor coast to a stop.

The following tables list the function codes available for the FRENIC-Eco (TYPE: -DY) series of inverters

## F codes: Fundamental Functions

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| F00 | Data Protection | 0: Disable data protection<br>(Function code data can be edited.)<br>1: Enable data protection | — | — | Y | Y | 0 | 5-26 |
| F01 | Frequency Command 1 | 0: Enable ⌃ / ⌄ keys on keypad<br>1: Enable voltage input to terminal [12]<br>(0 to 10 VDC)<br>2: Enable current input to terminal [C1]<br>(4 to 20 mA DC)<br>3: Enable sum of voltage and current inputs to terminals [12] and [C1]<br>5: Enable voltage input to terminal [V2]<br>(0 to 10 VDC)<br>7: Enable terminal command (UP) / (DOWN) control | — | — | N | Y | 0 | 5-26<br>5-100 |
| F02 | Run Command | 0: Enable FWD / REV / STOP keys on keypad<br>(Motor rotational direction from digital terminals [FWD] / [REV])<br>1: Enable terminal command (FWD) or (REV)<br>2: Enable FWD / STOP keys on keypad (forward)<br>3: Enable REV / STOP keys on keypad (reverse) | — | — | N | Y | 0 | 5-27 |
| F03 | Maximum Frequency | 25.0 to 120.0 | 0.1 | Hz | N | Y | 60.0 | 5-29 |
| F04 | Base Frequency | 25.0 to 120.0 | 0.1 | Hz | N | Y | 60.0 | 5-29<br>5-119 |
| F05 | Rated Voltage at Base Frequency | 0: Output a voltage in proportion to input voltage<br>80 to 240:   Output a voltage AVR-controlled<br>(for 208 V series)<br>160 to 500:  Output a voltage AVR-controlled<br>(for 460 V series) | 1 | V | N | Y2 | Refer to table below | |
| F07 | Acceleration Time 1 | 0.00 to 3600<br>Note: Entering 0.00 cancels the acceleration time, requiring external soft-start. | 0.01 | s | Y | Y | 20.0 | 5-32 |
| F08 | Deceleration Time 1 | 0.00 to 3600<br>Note: Entering 0.00 cancels the deceleration time, requiring external soft-start. | 0.01 | s | Y | Y | 20.0 | |
| F09 | Torque Boost | 0.0 to 20.0<br>(Percentage of the rated voltage at base frequency (F05))<br>Note: This setting is effective when F37 = 0, 1, 3, or 4. | 0.1 | % | Y | Y | 0.0 | 5-34<br>5-54 |

The shaded function codes ( ▭ ) are applicable to the quick setup.

## (F code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| F10 | Electronic Thermal Overload Protection for Motor (Select motor characteristics) | 1: For general-purpose motors with built-in self-cooling fan<br>2: For inverter-driven motors or high-speed motors with forced-ventilation fan | — | — | Y | Y | 1 | 5-37 |
| F11 | (Overload detection level) | 0.00: Disable<br>1 to 135% of the rated current (allowable continuous drive current) of the motor | 0.01 | A | Y | Y1 Y2 | Refer to table below | |
| F12 | (Thermal time constant) | 0.5 to 75.0 | 0.1 | min | Y | Y | Refer to table below | |
| F14 | Restart Mode after Momentary Power Failure (Mode selection) | 0: Disable restart (Trip immediately)<br>1: Disable restart (Trip after a recovery from power failure)<br>3: Enable restart (Continue to run, for heavy inertia or general loads)<br>4: Enable restart (Restart at the frequency at which the power failure occurred, for general loads)<br>5: Enable restart (Restart at the starting frequency, for low-inertia load) | — | — | Y | Y | 0 | 5-40<br>5-115<br>5-123 |
| F15 | Frequency Limiter (High) | 0.0 to 120.0 | 0.1 | Hz | Y | Y | 60.0 | 5-47<br>5-119 |
| F16 | (Low) | 0.0 to 120.0 | 0.1 | Hz | Y | Y | 35.0 | |
| F18 | Bias (Frequency command 1) | -100.00 to 100.00 *1 | 0.01 | % | Y* | Y | 0.00 | 5-48<br>5-100<br>5-101 |
| F20 | DC Injection Braking (Braking start frequency) | 0.0 to 60.0 | 0.1 | Hz | Y | Y | 0.0 | 5-49<br>5-123 |
| F21 | (Braking level) | 0 to 60 (Rated output current of the inverter interpreted as 100%) | 1 | % | Y | Y | 0 | |
| F22 | (Braking time) | 0.00: Disable<br>0.01 to 30.00 | 0.01 | s | Y | Y | 0.00 | |
| F23 | Starting Frequency | 0.1 to 60.0 | 0.1 | Hz | Y | Y | 0.5 | 5-51 |
| F25 | Stop Frequency | 0.1 to 60.0 | 0.1 | Hz | Y | Y | 0.2 | |
| F26 | Motor Sound (Carrier frequency) | 0.75 to 15<br>(208V : 25HP or below, 460V : 30HP or below)*2<br>0.75 to 10<br>(208V : 30HP or above, 460V : 40HP to 100HP)<br>0.75 to 6 (125HP above) | 1 | kHz | Y | Y | 2 | 5-125 |
| F27 | (Tone) | 0: Level 0 (Inactive)<br>1: Level 1<br>2: Level 2<br>3: Level 3 | — | — | Y | Y | 0 | |
| F29 | Analog Output [FMA] (Mode selection) | 0: Output in voltage (0 to 10 VDC)<br>1: Output in current (4 to 20 mA DC) | — | — | Y | Y | 0 | 5-52 |
| F30 | (Output adjustment) | 0 to 200 | 1 | % | Y* | Y | 100 | |

The shaded function codes ( ▭ ) are applicable to the quick setup.

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

*2 If the carrier frequency is set at 1 kHz or below, estimate the maximum motor output torque at 80% or less of the rated motor torque.

## (F code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|------------|------|---------------------|--------------|-----------------|----------------|
| F31 | Analog Output [FMA] (Function) | Select a function to be monitored from the followings.<br>0: Output frequency<br>2: Output current<br>3: Output voltage<br>4: Output torque<br>5: Load factor<br>6: Input power<br>7: PID feedback value (PV)<br>9: DC link bus voltage<br>10: Universal AO<br>13: Motor output<br>14: Test analog output<br>15: PID process command (SV)<br>16: PID process output (MV) | — | — | Y | Y | 0 | 5-52 |
| F33 | Reserved. *2 | 25 to 6000 | — | — | Y | Y | 1440 | — |
| F34 | Analog Output [FMI] (Output adjustment) | 0 to 200: Current output adjustment | 1 | % | Y | Y | 100 | 5-54 |
| F35 | (Function) | Select a function to be monitored from the followings.<br><br>0: Output frequency<br>2: Output current<br>3: Output voltage<br>4: Output torque<br>5: Load factor<br>6: Input power<br>7: PID feedback value (PV)<br>9: DC link bus voltage<br>10: Universal AO<br>13: Motor output<br>14: Test analog output<br>15: PID process command (SV)<br>16: PID process output (MV) | — | — | Y | Y | 0 | |
| F37 | Load Selection/ Auto Torque Boost / Auto Energy Saving Operation | 0: Variable torque load increasing in proportion to square of speed<br>1: Variable torque load increasing in proportion to square of speed (Higher startup torque required)<br>2: Auto-torque boost<br>3: Auto-energy saving operation<br>  (Variable torque load increasing in proportion to square of speed)<br>4: Auto-energy saving operation<br>  (Variable torque load increasing in proportion to square of speed (Higher startup torque required))<br>  Note: Apply this setting to a load with short acceleration time.<br>5: Auto-energy saving operation<br>  (Auto torque boost)<br>  Note: Apply this setting to a load with long acceleration time. | — | — | N | Y | 1 | 5-34 5-54 |
| F43 | Current Limiter (Mode selection) | 0: Disable (No current limiter works.)<br>1: Enable at constant speed<br>  (Disabled during acceleration and deceleration)<br>2: Enable during acceleration and at constant speed | — | — | Y | Y | 0 | 5-54 |
| F44 | (Level) | 20 to 120 (The data is interpreted as the rated output current of the inverter for 100%.) | 1 | % | Y | Y | 110 | |

*2 Unless otherwise specified, do not access these function codes.

## E codes: Extension Terminal Functions

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|---------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| E01 | Command Assignment to: [X1] | Selecting function code data assigns the corresponding function to terminals [X1] to [X5] as listed below. | — | — | N | Y | 6 | 5-55 5-97 5-146 |
| E02 | [X2] | Setting the value of 1000s in parentheses ( ) shown below assigns a negative logic input to a terminal. | — | — | N | Y | 7 | |
| E03 | [X3] | 0 (1000):  ⎫<br>1 (1001):  ⎬ Select multistep frequency    (SS1)<br>2 (1002):  ⎮                                          (SS2)<br>3 (1003):  ⎭                                          (SS4)<br>                                                            (SS8) | — | — | N | Y | 8 | |
| E04 | [X4] | | — | — | N | Y | 11 | |
| E05 | [X5] | 4 (1004):   Select ACC/DEC time              (RT1)<br>6 (1006):   Enable 3-wire operation         (HLD)<br>7 (1007):   Coast to a stop                        (BX)<br>8 (1008):   Reset alarm                            (RST)<br>9 (1009):   Enable external alarm trip       (THR)<br>11 (1011): Switch frequency command 2/1    (Hz2/Hz1)<br>13:           Enable DC brake                    (DCBRK)<br>15:           Switch to commercial power (50 Hz)  (SW50)<br>16:           Switch to commercial power (60 Hz)  (SW60)<br>17 (1017): UP (Increase output frequency)         (UP)<br>18 (1018): DOWN (Decrease output frequency)<br>                                                          (DOWN)<br>19 (1019): Enable write from keypad (Data changeable)<br>                                                          (WE-KP)<br>20 (1020): Cancel PID control              (Hz/PID)<br>21 (1021): Switch normal/inverse operation        (IVS)<br>22 (1022): Interlock                                  (IL)<br>24 (1024): Enable communications link via<br>                    RS485 or field bus (option)        (LE)<br>25 (1025): Universal DI                          (U-DI)<br>26 (1026): Select starting characteristics      (STM)<br>30 (1030): Force to stop                        (STOP)<br>33 (1033): Reset PID integral and differential<br>                    components                    (PID-RST)<br>34 (1034): Hold PID integral component    (PID-HLD)<br>35 (1035): Select local (keypad) operation      (LOC)<br>38 (1038): Enable to run                          (RE)<br>39:           Protect motor from dew condensation<br>                                                          (DWP)<br>40:           Enable integrated sequence to switch<br>                    to commercial power (50 Hz)      (ISW50)<br>41:           Enable integrated sequence to switch<br>                    to commercial power (60 Hz)      (ISW60)<br>50 (1050): Clear periodic switching time      (MCLR)<br>51 (1051): Enable pump drive (motor 1)      (MEN1)<br>52 (1052): Enable pump drive (motor 2)      (MEN2)<br>53 (1053): Enable pump drive (motor 3)      (MEN3)<br>54 (1054): Enable pump drive (motor 4)      (MEN4)<br>70 (1070): Switch PID control 2/1          (PID2/1)<br>71 (1071): Cancel PID controller switching      (CPS)<br>72 (1072): Cancel start stabilize                (SSC)<br>87 (1087): Switch run command 2/1        (FR2/FR1)<br>88:           Run forward 2                        (FWD2)<br>89:           Run reverse 2                        (REV2)<br><br>Note: In the case of (THR) and (STOP), data (1009) and (1030) are for normal logic, and "9" and "30" are for negative logic, respectively. | — | — | N | Y | 35 | |
| E10 | Acceleration Time 2 | 0.00 to 3600 | 0.01 | s | Y | Y | 20.0 | 5-32 |
| E11 | Deceleration Time 2 | 0.00 to 3600 | 0.01 | s | Y | Y | 20.0 | |
| E12 | Acceleration Time 3 | 0.00: Depends on the setting of F07, E10<br>0.01 to 3600 | 0.01 | s | Y | Y | 1.00 | |
| E13 | Deceleration Time 3 | 0.00: Depends on the setting of F08, E11<br>0.01 to 3600 | 0.01 | s | Y | Y | 1.00 | |
| E14 | Acc./Dec. Time Change Frequency | 0.0 (Depends on F16 (Frequency Limiter: Low))<br>0.1 to 120.0 | 0.1 | Hz | Y | Y | 30.0 | |

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|---|---|---|---|---|---|---|---|---|
| E20 | Status Signal Assignment to: (Transistor signal) [Y1] | Selecting function code data assigns the corresponding function to terminals [Y1] to [Y3], [Y5A/C], and [30A/B/C] as listed below. | — | — | N | Y | 0 | 5-78 5-160 |
| E21 | [Y2] | Setting the value of 1000s in parentheses ( ) shown below assigns a negative logic input to a terminal. | — | — | N | Y | 1 | |
| E22 | [Y3] | 0 (1000): Inverter running (RUN) | — | — | N | Y | 2 | |
| E24 | (Relay contact signal) [Y5A/C] | 1 (1001): Frequency arrival signal (FAR)<br>2 (1002): Frequency detected (FDT) | — | — | N | Y | 15 | |
| E27 | [30A/B/C] | 3 (1003): Undervoltage detected (Inverter stopped) (LU) | — | — | N | Y | 99 | |

Data setting range (continued):

5 (1005): Inverter output limiting (IOL)
6 (1006): Auto-restarting after momentary power failure (IPF)
7 (1007): Motor overload early warning (OL)
10 (1010): Inverter ready to run (RDY)
11: Switch motor drive source between commercial power and inverter output (For MC on commercial line) (SW88)
12: Switch motor drive source between commercial power and inverter output (For primary side) (SW52-2)
13: Switch motor drive source between commercial power and inverter output (For secondary side) (SW52-1)
15 (1015): Select AX terminal function (For MC on primary side) (AX)
25 (1025): Cooling fan in operation (FAN)
26 (1026): Auto-resetting (TRY)
27 (1027): Universal DO (U-DO)
28 (1028): Heat sink overheat early warning (OH)
30 (1030): Service life alarm (LIFE)
33 (1033): Command loss detected (REF OFF)
35 (1035): Inverter output on (RUN2)
36 (1036): Overload prevention control (OLP)
37 (1037): Current detected (ID)
41 (1041): Low current detected (IDL)
42 (1042): PID alarm (PID-ALM)
43 (1043): Under PID control (PID-CTL)
44 (1044): Motor stopping due to slow flowrate under PID control (PID-STP)
45 (1045): Low output torque detected (U-TL)
48 (1048): Excessive PID error detected (PERR)
49 (1049): Running over cycle (ROC)
50 (1050): PID feedback alarm 1 (FB1-ALM)
51 (1051): PID feedback alarm 2 (FB2-ALM)
54 (1054): Inverter in remote operation (RMT)
55 (1055): Run command activated (AX2)
56 (1056): Motor overheat detected (PTC) (THM)
59 (1059): Terminal [C1] wire break (C1OFF)
60 (1060): Mount motor 1, inverter-driven (M1_I)
61 (1061): Mount motor 1, commercial-power-driven (M1_L)
62 (1062): Mount motor 2, inverter-driven (M2_I)
63 (1063): Mount motor 2, commercial-power-driven (M2_L)
64 (1064): Mount motor 3, inverter-driven (M3_I)
65 (1065): Mount motor 3, commercial-power-driven (M3_L)
67 (1067): Mount motor 4, commercial-power-driven (M4_L)
68 (1068): Periodic switching early warning (MCHG)
69 (1069): Pump control limit signal (MLIM)
98 (1098): Light alarm (LALM)
99 (1099): Alarm output (for any alarm) (ALM)

## (E code continued)

| Code | Name | Data setting range | Increment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|--------------------|--------------|-----------------|-----------------|
| E31 | Frequency Detection (FDT) (Detection level) | 0.0 to 120.0 | 0.1 | Hz | Y | Y | 60.0 | 5-87 |
| E32 | (Hysteresis width) | 0.0 to 120.0 | 0.1 | Hz | Y | Y | 1.0 | |
| E34 | Overload Early Warning /Current Detection (Level) | 0: (Disable)<br>Current value of 1 to 150% of the inverter rated current | 0.01 | A | Y | Y1 Y2 | Refer to table below | |
| E35 | (Timer) | 0.01 to 600.00 *1 | 0.01 | s | Y | Y | 10.00 | |
| E37 | Low Current Detection (Level) | 0.00: (Disable)<br>Current value of 1 to 150% of the inverter rated current | 0.01 | A | Y | Y1 Y2 | 0.00 | 5-88 |
| E38 | (Timer) | 0.01 to 600.00 *1 | 0.01 | s | Y | Y | 10.00 | |
| E39 | PID Display Units | 0: -<br>1: %<br>2: Hz<br>3: WC<br>4: PSI<br>20: GPS<br>21: GPM<br>22: GPH<br>23: CFS<br>24: CFM<br>25: CFH<br>26: LPS<br>27: LPM<br><br>28: LPH<br>40: Bar<br>41: Hg<br>42: Pa<br>43: kPa<br>44: MPa<br>60: Ft<br>61: cm<br>62: m<br>80: K<br>81: °F<br>82: °C | — | — | Y | Y | 4 | 5-89 |
| E40 | PID Display Coefficient A | -999 to 0.00 to 999 *1 | 0.01 | — | Y | Y | 100 | |
| E41 | PID Display Coefficient B | -999 to 0.00 to 999 *1 | 0.01 | — | Y | Y | 0.00 | |
| E43 | LED Monitor (Item selection) | 0: Speed monitor (Select by E48.)<br>3: Output current<br>4: Output voltage<br>8: Calculated torque<br>9: Input power<br>10: PID process command (Final)<br>12: PID feedback value<br>14: PID output<br>15: Load factor<br>16: Motor output<br>17: Analog input | — | — | Y | Y | 10 | 5-91 5-94 |
| E45 | LCD Monitor (Item selection) | 0: Running status, rotational direction and operation guide<br>1: Bar charts for output frequency, current and calculated torque<br>2: Running status, running sub-status, PID process command (SV) and PID process output (MV)<br>3: Running status, running sub-status, PID feedback value (PV) and PID process command (SV) | — | — | Y | Y | 3 | 5-92 |
| E46 | (Language selection) | 0: Japanese<br>1: English | — | — | Y | Y | 1 | 5-94 |
| E47 | (Contrast control) | 0 (Low) to 10 (High) | 1 | — | Y | Y | 5 | |
| E48 | LED Monitor (Speed monitor item) | 0: Output frequency<br>3: Motor speed in r/min<br>4: Load shaft speed in r/min<br>7: Display speed in % | — | — | Y | Y | 0 | 5-91 5-94 |
| E50 | Coefficient for Speed Indication | 0.01 to 200.00 *1 | 0.01 | — | Y | Y | 30.00 | 5-94 |

The shaded function codes ( ▭ ) are applicable to the quick setup.

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

## (E code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|--------------------|--------------|-----------------|-----------------|
| E51 | Display Coefficient for Input Watt-hour Data | 0.000: (Cancel/reset)<br>0.001 to 9999 | 0.001 | — | Y | Y | 0.010 | 5-94 |
| E52 | Reserved. *2 | 0 to 2 | — | — | Y | Y | 2 | — |
| E61 | Analog Input for<br>(Extension function selection)<br>[12] | Selecting function code data assigns the corresponding function to terminals [12], [C1] and [V2] as listed below.<br>0: None<br>1: Auxiliary frequency command 1<br>2: Auxiliary frequency command 2 | — | — | N | Y | 0 | 5-95 |
| E62 | [C1] | 3: PID process command 1<br>4: PID process command 2 | — | — | N | Y | 5 | |
| E63 | [V2] | 5: PID feedback value 1<br>6: PID feedback value 2<br>20: Analog signal input | — | — | N | Y | 0 | |
| E64 | Saving Digital Reference Frequency | 0: Auto saving (at the time of main power turned off)<br>1: Saving by pressing ⬚ key | — | — | Y | Y | 0 | 5-96 |
| E65 | Command Loss Detection<br>(Level) | 0: Decelerate to stop<br>20 to 120<br>999: Disable | 1 | % | Y | Y | 999 | |
| E80 | Detect Low Torque<br>(Detection level) | 0 to 150 | 1 | % | Y | Y | 20 | 5-97 |
| E81 | (Timer) | 0.01 to 600.00 *1 | 0.01 | s | Y | Y | 20.00 | |

The shaded function codes ( ▭ ) are applicable to the quick setup.

*[1] When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

*[2] Unless otherwise specified, do not access these function codes.

# (E code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| E98 | Command Assignment to: [FWD] | Selecting function code data assigns the corresponding function to terminals [FWD] and [REV] as listed below. | — | — | N | Y | 98 | 5-55 5-97 |
| E99 | [REV] | Setting the value of 1000s in parentheses ( ) shown below assigns a negative logic input to a terminal.<br><br>0 (1000): ⎫<br>1 (1001): ⎬ Select multistep frequency (SS1)/(SS2)<br>2 (1002): ⎪ (SS4)<br>3 (1003): ⎭ (SS8)<br>4 (1004): Select ACC/DEC time (RT1)<br>6 (1006): Enable 3-wire operation (HLD)<br>7 (1007): Coast to a stop (BX)<br>8 (1008): Reset alarm (RST)<br>9 (1009): Enable external alarm trip (THR)<br>11 (1011): Switch frequency command 2/1 (Hz2/Hz1)<br>13: Enable DC brake (DCBRK)<br>15: Switch to commercial power (50 Hz) (SW50)<br>16: Switch to commercial power (60 Hz) (SW60)<br>17 (1017): UP (Increase output frequency) (UP)<br>18 (1018): DOWN (Decrease output frequency) (DOWN)<br>19 (1019): Enable write from keypad (Data changeable) (WE-KP)<br>20 (1020): Cancel PID control (Hz/PID)<br>21 (1021): Switch normal/inverse operation (IVS)<br>22 (1022): Interlock (IL)<br>24 (1024): Enable communications link via RS485 or field bus (option) (LE)<br>25 (1025): Universal DI (U-DI)<br>26 (1026): Select starting characteristics (STM)<br>30 (1030): Force to stop (STOP)<br>33 (1033): Reset PID integral and differential components (PID-RST)<br>34 (1034): Hold PID integral component (PID-HLD)<br>35 (1035): Select local (keypad) operation (LOC)<br>38 (1038): Enable to run (RE)<br>39: Protect motor from dew condensation (DWP)<br>40: Enable integrated sequence to switch to commercial power (50 Hz) (ISW50)<br>41: Enable integrated sequence to switch to commercial power (60 Hz) (ISW60)<br>50 (1050): Clear periodic switching time (MCLR)<br>51 (1051): Enable pump drive (motor 1) (MEN1)<br>52 (1052): Enable pump drive (motor 2) (MEN2)<br>53 (1053): Enable pump drive (motor 3) (MEN3)<br>54 (1054): Enable pump drive (motor 4) (MEN4)<br>70 (1070): Switch PID control 2/1 (PID2/1)<br>71 (1071): Cancel PID controller switching (CPS)<br>72 (1072): Cancel start stabilize (SSC)<br>87 (1087): Switch run command 2/1 (FR2/FR1)<br>88: Run forward 2 (FWD2)<br>89: Run reverse 2 (REV2)<br>98: Run forward (FWD)<br>99: Run reverse (REV)<br><br>Note: In the case of (THR) and (STOP), data (1009) and (1030) are for normal logic, and "9" and "30" are for negative logic, respectively. | — | — | N | Y | 99 | |

# C codes: Control Functions of Frequency

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| C01 | Jump Frequency 1 | 0.0 to 120.0 | 0.1 | Hz | Y | Y | 0.0 | 5-98 |
| C02 | 2 | | | | Y | Y | 0.0 | |
| C03 | 3 | | | | Y | Y | 0.0 | |
| C04 | (Band) | 0.0 to 30.0 | 0.1 | Hz | Y | Y | 3.0 | |
| C05 | Multistep Frequency 1 | 0.00 to 120.00 *1 | 0.01 | Hz | Y | Y | 0.00 | 5-99 |
| C06 | 2 | | | | Y | Y | 0.00 | |
| C07 | 3 | | | | Y | Y | 0.00 | |
| C08 | 4 | | | | Y | Y | 0.00 | |
| C09 | 5 | | | | Y | Y | 0.00 | |
| C10 | 6 | | | | Y | Y | 0.00 | |
| C11 | 7 | | | | Y | Y | 0.00 | |
| C12 | 8 | | | | Y | Y | 0.00 | |
| C13 | 9 | | | | Y | Y | 0.00 | |
| C14 | 10 | | | | Y | Y | 0.00 | |
| C15 | 11 | | | | Y | Y | 0.00 | |
| C16 | 12 | | | | Y | Y | 0.00 | |
| C17 | 13 | | | | Y | Y | 0.00 | |
| C18 | 14 | | | | Y | Y | 0.00 | |
| C19 | 15 | | | | Y | Y | 0.00 | |
| C30 | Frequency Command 2 | 0: Enable $\wedge$ / $\vee$ keys on keypad<br>1: Enable voltage input to terminal [12]<br>   (0 to 10 VDC)<br>2: Enable current input to terminal [C1]<br>   (4 to 20 mA DC)<br>3: Enable sum of voltage and current inputs to terminals [12] and [C1]<br>5: Enable voltage input to terminal [V2]<br>   (0 to 10 VDC)<br>7: Enable terminal command (UP) / (DOWN) control | | — | N | Y | 2 | 5-26<br>5-100 |
| C32 | Analog Input Adjustment for [12]        (Gain) | 0.00 to 200.00 *1 | 0.01 | % | Y* | Y | 100.0 | 5-48<br>5-100 |
| C33 | (Filter time constant) | 0.00 to 5.00 | 0.01 | s | Y | Y | 0.05 | 5-101 |
| C34 | (Gain reference point) | 0.00 to 100.00 *1 | 0.01 | % | Y* | Y | 100.0 | 5-48<br>5-100 |
| C37 | Analog Input Adjustment for [C1]        (Gain) | 0.00 to 200.00 *1 | 0.01 | % | Y* | Y | 100.0 | |
| C38 | (Filter time constant) | 0.00 to 5.00 | 0.01 | s | Y | Y | 0.05 | 5-101 |
| C39 | (Gain reference point) | 0.00 to 100.00 *1 | 0.01 | % | Y* | Y | 100.0 | 5-48<br>5-100 |
| C42 | Analog Input Adjustment for [V2]        (Gain) | 0.00 to 200.00 *1 | 0.01 | % | Y* | Y | 100.0 | |
| C43 | (Filter time constant) | 0.00 to 5.00 | 0.01 | s | Y | Y | 0.05 | 5-101 |
| C44 | (Gain reference point) | 0.00 to 100.00 *1 | 0.01 | % | Y* | Y | 100.0 | 5-48<br>5-100 |
| C50 | Bias Reference Point (Frequency command 1) | 0.00 to 100.0 *1 | 0.01 | % | Y* | Y | 0.00 | 5-48<br>5-101 |

*[1] When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

## (C code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|------------|------|---------------------|--------------|-----------------|----------------|
| C51 | Bias for PID command 1 (Bias value) | -100.0 to 100.00 *1 | 0.01 | % | Y* | Y | 0.00 | 5-101 |
| C52 | (Bias reference point) | 0.00 to 100.00 *1 | 0.01 | % | Y* | Y | 0.00 | |
| C53 | Selection of Normal/ Inverse Operation (Frequency command 1) | 0: Normal operation<br>1:     Inverse operation | — | — | Y | Y | 0 | |
| C54 | Bias for PID command 2 (Bias value) | -100.0 to 100.00 *1 | 0.01 | % | Y* | Y | 0.00 | |
| C55 | (Bias reference point) | 0.00 to 100.00 *1 | 0.01 | % | Y* | Y | 0.00 | |
| C56 | Multistep PID command 1 | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | 5-99 |
| C57 | 2 | | | | Y | Y | 0.00 | |
| C58 | 3 | | | | Y | Y | 0.00 | |

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

## P codes: Motor Parameters

| Code | Name | | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| P01 | Motor | (No. of poles) | 2 to 22 | 2 | Pole | N | Y1 Y2 | 4 | 5-102 |
| P02 | | (Rated capacity) | 0.01 to 1000 (where, the data of function code P99 is 0, 3, or 4.) | 0.01 | kW | N | Y1 Y2 | Refer to table below | |
| | | | 0.01 to 1000 (where, the data of function code P99 is 1.) | 0.01 | HP | | | | |
| P03 | | (Rated current) | 0.00 to 2000 | 0.01 | A | N | Y1 Y2 | Refer to table below | |
| P04 | | (Auto-tuning) | 0: Disable<br>1: Enable (Tune %R1 and %X while the motor is stopped.)<br>2: Enable (Tune %R1 and %X while the motor is stopped, and no-load current while running.) | — | — | N | N | 0 | |
| P06 | | (No-load current) | 0.00 to 2000 | 0.01 | A | N | Y1 Y2 | Refer to table below | 5-103 |
| P07 | | (%R1) | 0.00 to 50.00 | 0.01 | % | Y | Y1 Y2 | Refer to table below | |
| P08 | | (%X) | 0.00 to 50.00 | 0.01 | % | Y | Y1 Y2 | Refer to table below | |
| P99 | Motor Selection | | 0: Characteristics of motor 0<br>   (Fuji standard motors, 8- and 9-series)<br>1: Characteristics of motor 1 (HP-labeled motors)<br>3: Characteristics of motor 3<br>   (Fuji standard motors, 6- and 9-series)<br>4: Other motors | — | — | N | Y1 Y2 | 1 | 5-104 |

The shaded function codes ( ▭ ) are applicable to the quick setup.

## H codes: High Performance Functions

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|--------------------|--------------|-----------------|----------------|
| H03 | Data Initialization | 0: Disable initialization<br>1: Initialize all function code data to the factory defaults<br>2: Initialize motor parameters | — | — | N | N | 0 | 5-105 |
| H04 | Auto-resetting (Times) | 0: Disable<br>1 to 10 | 1 | Times | Y | Y | 0 | 5-108 |
| H05 | (Reset interval) | 0.5 to 20.0 | 0.1 | s | Y | Y | 5.0 | |
| H06 | Cooling Fan ON/OFF Control | 0: Disable (Always in operation)<br>1: Enable (ON/OFF controllable) | — | — | Y | Y | 0 | 5-109 |
| H07 | Acceleration/Deceleration Pattern | 0: Linear<br>1: S-curve (Weak)<br>2: S-curve (Strong)<br>3: Curvilinear | — | — | Y | Y | 0 | 5-110 |
| H08 | Rotational Direction Limitation | 0: Disable<br>1: Enable (Reverse rotation inhibited)<br>2: Enable (Forward rotation inhibited) | — | — | N | Y | 1 | 5-111 |
| H09 | Select Starting Characteristics (Auto search for idling motor's speed) | 0: Disable<br>3: Enable (Follow Run command, either forward or reverse.)<br>4: Enable (Follow Run command, both forward and reverse.)<br>5: Enable (Follow Run command, inversely both forward and reverse.) | — | — | N | Y | 0 | 5-112<br>5-115 |
| H11 | Deceleration Mode | 0: Normal deceleration<br>1: Coast-to-stop | — | — | Y | Y | 0 | 5-114 |
| H12 | Instantaneous Overcurrent Limiting | 0: Disable<br>1: Enable | — | — | Y | Y | 1 | 5-54<br>5-114 |
| H13 | Restart Mode after Momentary Power Failure (Restart time) | 0.1 to 10.0 | 0.1 | s | Y | Y1<br>Y2 | Refer to table below | 5-40<br>5-115 |
| H14 | (Frequency fall rate) | 0.00: Set deceleration time<br>0.01 to 100.00<br>999: Follow the current limit command | 0.01 | Hz/s | Y | Y | 999 | |
| H15 | (Continuous running level) | 208 V series: 200 to 300<br>460 V series: 400 to 600 | 1 | V | Y | Y2 | 235<br>470 | |
| H16 | (Allowable momentary power failure time) | 0.0 to 30.0<br>999: The longest time automatically determined by the inverter | 0.1 | s | Y | Y | 999 | |
| H17 | Select Starting Characteristics (Frequency for idling motor's speed) | 0.0 to 120.0<br>999: Synchronize at the maximum frequency | 0.1 | Hz | Y | Y | 999 | 5-112<br>5-115 |
| H26 | PTC Thermistor (Mode selection) | 0: Disable<br>1: Enable (Upon detection of (PTC), the inverter immediately trips and stops with *0h4* displayed.)<br>2: Enable (Upon detection of (PTC), the inverter continues running while outputting alarm signal (THM).) | — | — | Y | Y | 0 | 5-115 |
| H27 | (Level) | 0.00 to 5.00 | 0.01 | V | Y | Y | 1.60 | |

The shaded function codes ( ▭ ) are applicable to the quick setup.

## (H code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|-----------|------|--------------------|-------------|----------------|---------------|
| H30 | Communications Link Function (Mode selection) | Frequency command   Run command<br>0: F01/C30   F02<br>1: RS485 link   F02<br>2: F01/C30   RS485 link<br>3: RS485 link   RS485 link<br>4: RS485 link (Ext. port)   F02<br>5: RS485 link (Ext. port)   RS485 link<br>6: F01/C30   RS485 link (Ext. port)<br>7: RS485 link   RS485 link (Ext. port)<br>8: RS485 link (Ext. port)   RS485 link (Ext. port) | — | — | Y | Y | 0 | 5-117<br>5-170 |
| H42 | Capacitance of DC Link Bus Capacitor | Indication for replacing DC link bus capacitor (0000 to FFFF: Hexadecimal) | 1 | — | Y | N | — | 5-118 |
| H43 | Cumulative Run Time of Cooling Fan | Indication of cumulative run time of cooling fan for replacement | — | — | Y | N | — | |
| H47 | Initial Capacitance of DC Link Bus Capacitor | Indication for replacing DC link bus capacitor (0000 to FFFF: Hexadecimal) | — | — | Y | N | Set at factory shipping | |
| H48 | Cumulative Run Time of Capacitors on the Printed Circuit Board | Indication for replacing capacitors on printed circuit board (0000 to FFFF: Hexadecimal). Resettable. | — | — | Y | N | — | |
| H49 | Select Starting Characteristics (Auto search time for idling motor's speed) | 0.0 to 10.0 | 0.1 | s | Y | Y | 0.0 | 5-119 |
| H50 | Non-linear V/f Pattern (Frequency) | 0.0: Cancel<br>0.1 to 120.0 | 0.1 | Hz | N | Y | 0.0 | 5-29<br>5-119 |
| H51 | (Voltage) | 0 to 240:   Output voltage AVR-controlled<br>(for 208 V series)<br>0 to 500:   Output voltage AVR-controlled<br>(for 460 V series) | 1 | V | N | Y2 | 0 | |
| H56 | Deceleration Time for Forced Stop | 0.00 to 3600 | 0.01 | s | Y | Y | 20.0 | 5-119 |
| H63 | Low Limiter (Mode selection) | 0:   Limit by F16 (Frequency Limiter: Low) and continue to run<br>1:   If the output frequency lowers less than the one limited by F16 (Frequency Limiter: Low), decelerates to stop the motor. | — | — | Y | Y | 0 | 5-47<br>5-119 |
| H64 | (Lower limiting frequency) | 0.0 (Depends on F16 (Frequency Limiter: Low))<br>0.1 to 60.0 | 0.1 | Hz | Y | Y | 2.0 | 5-119 |
| H69 | Automatic Deceleration | 0:   Disable<br>3:   Enable (Control DC link bus voltage at a constant.) | — | — | Y | Y | 0 | |
| H70 | Overload Prevention Control | 0.00:   Follow deceleration time specified by F08<br>0.01 to 100.00<br>999:   Disable | 0.01 | Hz/s | Y | Y | 999 | 5-120 |
| H71 | Deceleration Characteristics | 0:   Disable<br>1:   Enable | — | — | Y | Y | 0 | |
| H80 | Gain for Suppression of Output Current Fluctuation for Motor | 0.00 to 0.40 | 0.01 | — | Y | Y | Refer to table below | |
| H82 | Light Alarm Selection | 0 to 127<br><br>Display data on the keypad's LCD monitor in each bit, "0" for alarm (immediately trips), "1" for light alarm (continues to run without trips).<br><br>Bit 0: _rol_ Running over cycle alarm<br>Bit 1: _idL_ Low current detection alarm<br>Bit 2: _LoF_ PID feedback wire break<br>Bit 3: _Fb1_ PID feedback 1 alarm<br>Bit 4: _Fb2_ PID feedback 2 alarm<br>Bit 5: _PE1_ Excessive PID error 1 alarm<br>Bit 6: _PE2_ Excessive PID error 2 alarm | — | — | Y | Y | 0 | 5-121 |

(H code continued)

| Code | Name | Data setting range | | | | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|---|---|---|---|---|---|---|---|---|---|
| H83 | Alarm Auto-reset (Selection) | 0 to 127<br>Display data on the keypad's LCD monitor in each bit, "0" for disabled, "1" for enabled.<br><br>Bit 0: $roC$ Running over cycle alarm<br>Bit 1: $idL$ Low current detection alarm<br>Bit 2: $CoF$ PID feedback wire break<br>Bit 3: $Fb1$ PID feedback 1 alarm<br>Bit 4: $Fb2$ PID feedback 2 alarm<br>Bit 5: $PE1$ Excessive PID error 1 alarm<br>Bit 6: $PE2$ Excessive PID error 2 alarm | | | | — | — | Y | Y | 0 | 5-122 |
| H84 | (Times) | 0: Disable<br>1 to 10 | | | | 1 | Times | Y | Y | 0 | |
| H85 | (Reset interval) | 0.5 to 600.0 | | | | 0.1 | s | Y | Y | 5.0 | |
| H86 | Reserved. *2 | 0 to 2 | | | | 1 | — | Y | Y1<br>Y2 | Refer to table below | — |
| H87 | Reserved. *2 | 25.0 to 120.0 | | | | 0.1 | Hz | Y | Y | 25.0 | |
| H88 | Reserved. *2 | 0 to 3, 999 | | | | 1 | — | Y | N | 0 | |
| H89 | Motor overload memory retention | 0: Inactive<br>1: Active | | | | — | — | Y | Y | 1 | |
| H90 | C1 disconnection (detection level) | 0.0 to 20.0 | | | | 0.1 | mA | Y | Y | 2.0 | 5-123 |
| H91 | (detection time)<br>(PID control feedback line) | 0.0: Disable<br>0.1 to 60.0: Detection time | | | | — | — | Y | Y | 0 | |
| H92 | Continue to Run (P-component: gain) | 0.000 to 10.000. 999 *1 | | | | 0.001 | Times | Y | Y1<br>Y2 | 999 | 5-40<br>5-123 |
| H93 | (I-component: time) | 0.010 to 10.000, 999 *1 | | | | 0.001 | s | Y | Y1<br>Y2 | 999 | 5-40<br>5-123 |
| H94 | Cumulative Run Time of Motor | Change or reset the cumulative data | | | | — | — | N | N | — | 5-123 |
| H95 | DC Injection Braking (Braking response mode) | 0: Slow<br>1: Quick | | | | — | — | Y | Y | 1 | 5-49<br>5-123 |
| H96 | STOP Key Priority/<br>Start Check Function/<br>Run Key Memory | Data / STOP key priority / Start check function / Run key memory table:<br>0: Disable / Disable / Disable<br>1: Enable / Disable / Disable<br>2: Disable / Enable / Disable<br>3: Enable / Enable / Disable<br>4: Disable / Disable / Enable<br>5: Enable / Disable / Enable<br><br>⚠ WARNING For details of "Run key memory", refer to the description of function codes H96 | | | | — | — | Y | Y | 3 | 5-124 |
| H97 | Clear Alarm Data | If H97 = 1 its data returns to zero after clearing alarm data). | | | | — | — | Y | N | 0 | 5-125 |
| H98 | Protection/<br>Maintenance Function | Display data on the keypad's LCD display in each bit, "0" for disabled, "1" for enabled.<br><br>Bit 0: Lower the carrier frequency automatically<br>Bit 1: Detect input phase loss<br>Bit 2: Detect output phase loss<br>Bit 3: Select life judgment criteria of DC link bus capacitor<br>Bit 4: Judge the life of DC link bus capacitor<br>Bit 5: Detect DC fan lock | | | | — | — | Y | Y | 19 (Bits 4, 1, 0 = 1 Bits 5, 3, 2 = 0) | 5-51<br>5-125 |

The H96 data sub-table:

| Data | STOP key priority | Start check function | Run key memory |
|------|-------------------|----------------------|----------------|
| 0: | Disable | Disable | Disable |
| 1: | Enable | Disable | Disable |
| 2: | Disable | Enable | Disable |
| 3: | Enable | Enable | Disable |
| 4: | Disable | Disable | Enable |
| 5: | Enable | Disable | Enable |

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

*2 The H86 through H88 are displayed, but they are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

## J codes: Application Functions

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|------------|------|---------------------|--------------|-----------------|----------------|
| J01 | PID Control 1 (Mode selection) | 0: Disable<br>1: Enable (normal operation)<br>2: Enable (inverse operation) | — | — | N | Y | 1 | 5-128 |
| J02 | (Remote process command) | 0: Enable ⊘ / ⊘ keys on keypad<br>1: PID process command 1<br>3: Enable terminal command (UP) / (DOWN) control<br>4: Command via communications link | — | — | N | Y | 0 | |
| J03 | P (Gain) | 0.000 to 30.000 *1 | 0.001 | Times | Y | Y | 0.500 | |
| J04 | I (Integral time) | 0.0 to 3600.0 *1 | 0.1 | s | Y | Y | 0.5 | |
| J05 | D (Differential time) | 0.00 to 600.00 *1 | 0.01 | s | Y | Y | 0.00 | |
| J06 | (Feedback filter) | 0.0 to 900.0 | 0.1 | s | Y | Y | 0.5 | |
| J07 | (Start stabilize frequency) | 0.0:        Disable<br>0.1 to 120.0 | 0.1 | Hz | Y | Y | 0.0 | 5-134 |
| J08 | (Start stabilize level) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J09 | (Start stabilize time) | 0.00 to 3600 | 0.01 | s | Y | Y | 0.00 | |
| J10 | (Start stabilize acceleration time) | 0.00: Set deceleration time (F07, E10, E12)<br>0.01 to 3600 | 0.01 | s | Y | Y | 0.00 | |
| J11 | (Select alarm output) | 0: Disable (Continue to run)<br>1: Absolute-value alarm<br>2: Absolute-value alarm (with Hold)<br>3: Absolute-value alarm (with Latch)<br>4: Absolute-value alarm (with Hold and Latch)<br>5: Deviation alarm<br>6: Deviation alarm (with Hold)<br>7: Deviation alarm (with Latch)<br>8: Deviation alarm  (with Hold and Latch) | — | — | Y | Y | 1 | 5-136 |
| J12 | (Upper limit alarm (AH)) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 999 | |
| J13 | (Upper alarm delay time) | 0.00:        Disable (Continue to run)<br>0.01 to 3600 | 0.01 | s | Y | Y | 2.00 | |
| J14 | (Lower limit alarm (AL)) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | -999 | |
| J15 | (Lower alarm delay time) | 0.00:        Disable (Continue to run)<br>0.01 to 3600 | 0.01 | s | Y | Y | 120 | |
| J16 | (Alarm hysteresis level) | 0.00:        Disable<br>0.01 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J18 | (Upper limit of PID process output) | 0.0 to 120.0<br>999: Depends on setting of F15 | 0.1 | Hz | Y | Y | 999 | 5-139 |
| J19 | (Lower limit of PID process output) | 0.0 to 120.0<br>999: Depends on setting of F16 | 0.1 | Hz | Y | Y | 999 | |
| J20 | (Anti reset windup) | 0.00:        Disable<br>0.01 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J21 | Dew Condensation Prevention (Duty) | 1 to 50 | 1 | % | Y | Y | 1 | 5-146 |
| J22 | Commercial Power Switching Sequence | 0: Keep inverter operation (Stop due to alarm)<br>1: Automatically switch to commercial-power operation | — | — | N | Y | 0 | |

The shaded function codes ( ▭ ) are applicable to the quick setup.

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|--------------------|-------------|-----------------|----------------|
| J23 | PID Start Frequency (Mount) | 0 to 120<br>999: Depends on setting of J36 | 1 | Hz | Y | Y | 999 | 5-156 |
| J24 | (Unmount) | 0 to 120<br>999: Depends on setting of J34 | 1 | Hz | Y | Y | 999 | |
| J25 | Pump Control (Mode selection) | 0: Disable<br>1: Enable (Fixed inverter-driven)<br>2: Enable (Floating inverter-driven) | — | — | N | Y | 0 | 5-146 |
| J26 | Motor 1 Mode | 0: Disable (Always OFF)<br>1: Enable<br>2: Force to run by commercial power | — | — | Y | Y | 0 | 5-153 |
| J27 | Motor 2 Mode | | — | — | Y | Y | 0 | |
| J28 | Motor 3 Mode | | — | — | Y | Y | 0 | |
| J29 | Motor 4 Mode | | — | — | Y | Y | 0 | |
| J30 | Motor Switching Order | 0: Fixed<br>1: Automatically (Constant run time) | — | — | Y | Y | 0 | 5-153 |
| J31 | Motor Stop Mode | 0: Stop all motors (inverter- and commercial power-driven)<br>1: Stop inverter-driven motor only (excl. alarm state)<br>2: Stop inverter-driven motor only (incl. alarm state) | — | — | Y | Y | 0 | 5-154 |
| J32 | Periodic Switching Time for Motor Drive | 0.0: Disable switching<br>0.1 to 720.0: Switching time range<br>999: Fix to 3 minutes | 0.1 | h | N | Y | 0.0 | 5-155 |
| J33 | Periodic Switching Signaling Period | 0.00 to 600.00 | 0.01 | s | Y | Y | 0.10 | 5-156 |
| J34 | Mount of Commercial Power-driven Motor (Frequency) | 0 to 120<br>999: Depends on setting of J18<br>(This code is used to judge whether or not to mount a commercial power-driven motor by checking the output frequency of the inverter-driven motor.) | 1 | Hz | Y | Y | 999 | |
| J35 | (Duration) | 0.00 to 3600 | Variable | s | Y | Y | 0.00 | |
| J36 | Unmount of Commercial Power-driven Motor (Frequency) | 0 to 120<br>999: Depends on setting of J19<br>(This code is used to judge whether or not to unmount a commercial power-driven motor by checking the output frequency of the inverter-driven motor.) | 1 | Hz | Y | Y | 999 | |
| J37 | (Duration) | 0.00 to 3600 | Variable | s | Y | Y | 0.00 | |
| J38 | Contactor Delay Time | 0.01 to 2.00 | 0.01 | s | Y | Y | 0.10 | 5-160 |
| J39 | Switching Time for Motor Mount (Decl. time) | 0.00: Depends on the setting of F08, E11, E13<br>0.01 to 3600 | Variable | s | Y | Y | 0.00 | 5-156 |
| J40 | Switching Time for Motor Unmount (Accl. time) | 0.00: Depends on the setting of F07, E10, E12<br>0.01 to 3600 | Variable | s | Y | Y | 0.00 | |
| J41 | Motor Mount/Unmount Switching Level | 0 to 100 | 1 | % | Y | Y | 0 | |
| J42 | Switching Motor Mount/Unmount (Dead band) | 0.0: Disable<br>0.1 to 50.0 | 0.1 | % | Y | Y | 0.0 | 5-160 |

## (J code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| J43 | PID Control Startup Frequency | 0: Disable<br>1 to 120<br>999: Depends on the setting of J36 | 1 | Hz | Y | Y | 999 | 5-160 |
| J44 | Motor Mount Switching Level | 0 to 100<br>999: Depends on the setting of J41 | 1 | % | Y | Y | 999 | 5-156 |
| J45 | Signal Assignment to:<br>(For relay output card)<br>[Y1A/B/C] | Selecting function code data assigns the corresponding function to terminals [Y1A/B/C], [Y2A/B/C], and [Y3A/B/C]. | — | — | N | Y | 100 | 5-160 |
| J46 | [Y2A/B/C] | 100: Depends on the setting of E20 to E22<br>60 (1060): Mount motor 1, inverter-driven (M1_I) | — | — | N | Y | 100 | |
| J47 | [Y3A/B/C] | 61 (1061): Mount motor 1,<br>    commercial-power-driven (M1_L)<br>62 (1062): Mount motor 2, inverter-driven (M2_I)<br>63 (1063): Mount motor 2,<br>    commercial-power-driven (M2_L)<br>64 (1064): Mount motor 3, inverter-driven (M3_I)<br>65 (1065): Mount motor 3,<br>    commercial-power-driven (M3_L)<br>67 (1067): Mount motor 4,<br>    commercial-power-driven (M4_L)<br>68 (1068): Periodic switching early warning (MCHG)<br>69 (1069): Pump control limit signal (MLIM) | — | — | N | Y | 100 | |
| J48 | Cumulative Run Time of Motor (Motor 0) | Indication of cumulative run time of motor for replacement | 1 | h | Y | N | — | |
| J49 | (Motor 1) | | 1 | h | Y | N | — | |
| J50 | (Motor 2) | | 1 | h | Y | N | — | |
| J51 | (Motor 3) | | 1 | h | Y | N | — | |
| J52 | (Motor 4) | | 1 | h | Y | N | — | |
| J53 | Maximum Cumulative Number of Relay ON Times [Y1A/B/C] to [Y3A/B/C] | Indication of the maximum number of ON times of relay contacts on the relay output card or those built in inverter<br>Display of 1.000 means 1000 times. | 1 | Times | Y | N | — | 5-161 |
| J54 | [Y1], [Y2], [Y3] | For relay output card | 1 | Times | Y | N | — | |
| J55 | [Y5A], [30A/B/C] | For built-in mechanical contacts | 1 | Times | Y | N | — | |

## (J code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| J56 | PID Control 1 (Slow flowrate level selection) | 0: Disable<br>1: PID process output (MV)<br>3: Output current<br>4: PID feedback value (PV) | — | — | Y | Y | 0 | 5-140 |
| J57 | (Stop level for slow flowrate) | -999 to 0.00 to 999 *1 | 0.01 | Hz A (E39) | Y | Y | 0.00 | 5-140 |
| J58 | (Slow flowrate level stop latency) | 0 to 60 | 1 | s | Y | Y | 0 | 5-140 |
| J61 | (Pressurization starting frequency) | 0.0 to 120.0Hz | 0.1 | Hz | Y | Y | 0.0 | |
| J62 | (Pressurizing time) | 0 to 60 | 1 | s | Y | Y | 0 | |
| J63 | (Starting level selection for slow flowrate) | 0: Disable<br>1: PID process output (MV)<br>4: PID feedback value (PV) | — | — | Y | Y | 0 | |
| J64 | (Starting level for slow flowrate) | -999 to 0.00 to 999 *1 | 0.01 | Hz (E39) | Y | Y | 0.00 | |
| J65 | (Starting delay time for slow flowrate) | 0 to 60 | 1 | s | Y | Y | 0 | |
| J66 | (Excessive PID error level) | 0.00: Disable<br>0.01 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | 5-143 |
| J67 | (Excessive PID error time) | 0 to 3600 | 1 | s | Y | Y | 60 | |
| J68 | (Cycling protection for slow flowrate) | 0: Disable<br>1 to 10 | 1 | Times | Y | Y | 0 | 5-144 |
| J69 | (Maximum cycling protection time for slow flowrate) | 0 to 3600 | 1 | s | Y | Y | 300 | |

The shaded function codes ( ▭ ) are applicable to the quick setup.

## (J code continued)

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|-----------|------|---------------------|--------------|-----------------|----------------|
| J70 | PID Control 2 (Mode selection) | 0: Disable<br>1: Enable (normal operation)<br>2: Enable (inverse operation) | — | — | N | Y | 0 | 5-162 |
| J71 | (Remote process command) | 0: Set value by J72' setting<br>2: PID process command 2 | — | — | N | Y | 0 | |
| J72 | (Set Value) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J73 | P (Gain) | 0.000 to 30.000 *1 | 0.001 | Times | Y | Y | 0.100 | |
| J74 | I (Integral time) | 0.0 to 3600.0 *1 | 0.1 | s | Y | Y | 0.0 | |
| J75 | D (Differential time) | 0.00 to 600.00 *1 | 0.01 | s | Y | Y | 0.00 | |
| J76 | (Feedback filter) | 0.0 to 900.0 | 0.1 | s | Y | Y | 0.5 | |
| J77 | (Start stabilize frequency) | 0.0: Disable<br>0.1 to 120.0 | 0.1 | Hz | Y | Y | 0.0 | |
| J78 | (Start stabilize level) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J79 | (Start stabilize time) | 0.00 to 3600 | 0.01 | s | Y | Y | 0.00 | |
| J80 | (Start stabilize acceleration time) | 0.00: Set deceleration time (F07, E10, E12)<br>0.01 to 3600 | 0.01 | s | Y | Y | 0.00 | |
| J81 | (Select alarm output) | 0: Disable (Continue to run)<br>1: Absolute-value alarm<br>2: Absolute-value alarm (with Hold)<br>3: Absolute-value alarm (with Latch)<br>4: Absolute-value alarm (with Hold and Latch)<br>5: Deviation alarm<br>6: Deviation alarm (with Hold)<br>7: Deviation alarm (with Latch)<br>8: Deviation alarm (with Hold and Latch) | — | — | Y | Y | 0 | |
| J82 | (Upper limit alarm (AH)) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 999 | |
| J83 | (Upper alarm delay time) | 0.00: Disable (Continue to run)<br>0.01 to 3600 | 0.01 | s | Y | Y | 2.00 | |
| J84 | (Lower limit alarm (AL)) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | -999 | |
| J85 | (Lower alarm delay time) | 0.00: Disable (Continue to run)<br>0.01 to 3600 | 0.01 | s | Y | Y | 120 | |
| J86 | (Alarm hysteresis level) | 0.00: Disable<br>0.01 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J88 | (Upper limit of PID process output) | 0.0 to 120.0<br>999: Depends on setting of F15 | 0.1 | Hz | Y | Y | 999 | |
| J89 | (Lower limit of PID process output) | 0.0 to 120.0<br>999: Depends on setting of F16 | 0.1 | Hz | Y | Y | 999 | |

*1 When you make settings from the keypad, the incremental unit is restricted by the number of digits that the LCD monitor can display.
(Example) If the setting range is from -200.00 to 200.00, the incremental unit is:
"1" for -200 to -100, "0.1" for -99.9 to -10.0 and for 100.0 to 200.0, and "0.01" for -9.99 to -0.01 and for 0.00 to 99.99.

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|-------------------|-----------|------|--------------------|-------------|----------------|----------------|
| J90 | PID Control 2 (Slow flowrate level selection) | 0: Disable<br>1: PID process output (MV)<br>3: Output current<br>4: PID feedback value (PV) | — | — | Y | Y | 0 | 5-162 |
| J91 | (Stop level for slow flowrate) | -999 to 0.00 to 999 *1 | 0.01 | Hz<br>A<br>(E39) | Y | Y | 0.00 | |
| J92 | (Slow flowrate level stop latency) | 0 to 60 | 1 | s | Y | Y | 0 | |
| J93 | (Starting level selection for slow flowrate) | 0: Disable<br>1: PID process output (MV)<br>4: PID feedback value (PV) | — | — | Y | Y | 0 | |
| J94 | (Starting level for slow flowrate) | -999 to 0.00 to 999 *1 | 0.01 | Hz<br>(E39) | Y | Y | 0.00 | |
| J95 | (Starting delay time for slow flowrate) | 0 to 60 | 1 | s | Y | Y | 0 | |
| J96 | (Excessive PID error level) | 0.00:   Disable<br>0.01 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |
| J97 | (Excessive PID error time) | 0 to 3600 | 1 | s | Y | Y | 60 | |
| J98 | Auto PID switch (Switching delay time) | 0.0:   Disable<br>0.1 to 60.0 | 0.1 | s | Y | Y | 0.0 | 5-163 |
| J99 | (Switch feedback value) | -999 to 0.00 to 999 *1 | 0.01 | (E39) | Y | Y | 0.00 | |

## y codes: Link Functions

| Code | Name | Data setting range | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|--------------------|-----------|------|--------------------|--------------|-----------------|----------------|
| y01 | RS485 Communication (Standard) (Station address) | 1 to 255 | 1 | — | N | Y | 1 | 5-168 |
| y02 | (Communications error processing) | 0: Immediately trip and alarm $Er-8$<br>1: Trip and alarm $Er-8$ after running for the period specified by timer y03<br>2: Retry during the period specified by timer y03. If retry fails, trip and alarm $Er-8$. If it succeeds, continue to run.<br>3: Continue to run | — | — | Y | Y | 0 | |
| y03 | (Error processing timer) | 0.0 to 60.0 | 0.1 | s | Y | Y | 2.0 | |
| y04 | (Transmission speed) | 0: 2400 bps<br>1: 4800 bps<br>2: 9600 bps<br>3: 19200 bps<br>4: 38400 bps | — | — | Y | Y | 3 | |
| y05 | (Data length) | 0: 8 bits<br>1: 7 bits | — | — | Y | Y | 0 | |
| y06 | (Parity check) | 0: None<br>1: Even parity<br>2: Odd parity | — | — | Y | Y | 0 | |
| y07 | (Stop bits) | 0: 2 bits<br>1: 1 bit | — | — | Y | Y | 0 | |
| y08 | (No-response error detection time) | 0 (No detection), 1 to 60 | 1 | s | Y | Y | 0 | |
| y09 | (Response latency time) | 0.00 to 1.00 | 0.01 | s | Y | Y | 0.01 | |
| y10 | (Protocol selection) | 0: Modbus RTU protocol<br>1: FRENIC Loader protocol (SX protocol) | — | — | Y | Y | 1 | |

## (y code continued)

| Code | Name | Data setting range | | | Incre-ment | Unit | Change when running | Data copying | Default setting | Refer to page: |
|------|------|------|------|------|------|------|------|------|------|------|
| y11 | RS485 Communication (Extension port) (Station address) | 1 to 255 | | | 1 | — | N | Y | 1 | 5-168 |
| y12 | (Communications error processing) | 0: Immediately trip and alarm $Er-P$<br>1: Trip and alarm $Er-P$ after running for the period specified by timer y13.<br>2: Retry during the period specified by timer y13. If retry fails, trip and alarm $Er-P$. If it succeeds, continue to run.<br>3: Continue to run. | | | — | — | Y | Y | 0 | |
| y13 | (Error processing timer) | 0.0 to 60.0 | | | 0.1 | s | Y | Y | 2.0 | |
| y14 | (Transmission speed) | 0: 2400 bps<br>1: 4800 bps<br>2: 9600 bps<br>3: 19200 bps<br>4: 38400 bps | | | — | — | Y | Y | 3 | |
| y15 | (Data length) | 0: 8 bits<br>1: 7 bits | | | — | — | Y | Y | 0 | |
| y16 | (Parity check) | 0: None<br>1: Even parity<br>2: Odd parity | | | — | — | Y | Y | 0 | |
| y17 | (Stop bits) | 0: 2 bits<br>1: 1 bit | | | — | — | Y | Y | 0 | |
| y18 | (No-response error detection time) | 0: (No detection),<br>1 to 60 | | | 1 | s | Y | Y | 0 | |
| y19 | (Response latency time) | 0.00 to 1.00 | | | 0.01 | s | Y | Y | 0.01 | |
| y20 | (Protocol selection) | 0: Modbus RTU protocol | | | — | — | Y | Y | 0 | |
| y98 | Bus Link Function (Mode selection) | | Frequency command | Run command | — | — | Y | Y | 0 | 5-117<br>5-170 |
| | | 0: | Follow H30 data | Follow H30 data | | | | | | |
| | | 1: | Via field bus option | Follow H30 data | | | | | | |
| | | 2: | Follow H30 data | Via field bus option | | | | | | |
| | | 3: | Via field bus option | Via field bus option | | | | | | |
| y99 | Loader Link Function (Mode selection) | | Frequency command | Run command | — | — | Y | N | 0 | 5-171 |
| | | 0: | Follow H30 and y98 data | Follow H30 and y98 data | | | | | | |
| | | 1: | Via RS485 link (Loader) | Follow H30 and y98 data | | | | | | |
| | | 2: | Follow H30 and y98 data | Via RS485 link (Loader) | | | | | | |
| | | 3: | Via RS485 link (Loader) | Via RS485 link (Loader) | | | | | | |

■208V Default setting

| Inverter type | F05 | F11 | F12 | E34 | P02 | P03 | P06 | P07 | P08 | H13 | H80 | H86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRN001F1S-2DY | 208 | 3.16 | 5.0 | 3.16 | 1.00 | 3.16 | 1.39 | 4.61 | 10.32 | 0.5 | 0.20 | 0 |
| FRN002F1S-2DY | 208 | 6.16 | 5.0 | 6.16 | 2.00 | 6.16 | 2.53 | 5.04 | 9.09 | 0.5 | 0.20 | 0 |
| FRN003F1S-2DY | 208 | 8.44 | 5.0 | 8.44 | 3.00 | 8.44 | 3.23 | 3.72 | 24.58 | 0.5 | 0.20 | 0 |
| FRN005F1S-2DY | 208 | 13.60 | 5.0 | 13.60 | 5.00 | 13.60 | 4.32 | 3.99 | 28.13 | 0.5 | 0.20 | 0 |
| FRN007F1S-2DY | 208 | 20.19 | 5.0 | 20.19 | 7.50 | 20.19 | 5.63 | 3.18 | 34.70 | 0.5 | 0.20 | 0 |
| FRN010F1S-2DY | 208 | 27.42 | 5.0 | 27.42 | 10.00 | 27.42 | 7.91 | 2.91 | 36.89 | 0.5 | 0.20 | 0 |
| FRN015F1S-2DY | 208 | 40.44 | 5.0 | 40.44 | 15.00 | 40.44 | 11.49 | 2.48 | 34.92 | 1.0 | 0.20 | 0 |
| FRN020F1S-2DY | 208 | 53.98 | 5.0 | 53.98 | 20.00 | 53.98 | 8.32 | 2.54 | 35.90 | 1.0 | 0.20 | 0 |
| FRN025F1S-2DY | 208 | 65.49 | 5.0 | 65.49 | 25.00 | 65.49 | 15.10 | 2.11 | 38.01 | 1.0 | 0.20 | 0 |
| FRN030F1S-2DY | 208 | 79.06 | 5.0 | 79.06 | 30.00 | 79.06 | 17.91 | 2.29 | 39.31 | 1.0 | 0.20 | 0 |
| FRN040F1S-2DY | 208 | 100.2 | 10.0 | 100.2 | 40.00 | 100.2 | 12.30 | 2.22 | 30.83 | 1.0 | 0.20 | 0 |
| FRN050F1S-2DY | 208 | 126.6 | 10.0 | 126.6 | 50.00 | 126.6 | 16.91 | 2.34 | 30.27 | 1.0 | 0.10 | 2 |
| FRN060F1S-2DY | 208 | 150.8 | 10.0 | 150.8 | 60.00 | 150.8 | 18.81 | 1.57 | 32.85 | 1.5 | 0.10 | 2 |
| FRN075F1S-2DY | 208 | 191.5 | 10.0 | 191.5 | 75.00 | 191.5 | 25.86 | 1.67 | 32.97 | 1.5 | 0.10 | 2 |
| FRN100F1S-2DY | 208 | 248.8 | 10.0 | 248.8 | 100.0 | 248.8 | 33.82 | 1.31 | 28.97 | 1.5 | 0.10 | 2 |
| FRN125F1S-2DY | 208 | 295.6 | 10.0 | 295.6 | 125.0 | 295.6 | 26.95 | 1.28 | 27.93 | 1.5 | 0.10 | 2 |

■460V Default setting

| Inverter type | F05 | F11 | F12 | E34 | P02 | P03 | P06 | P07 | P08 | H13 | H80 | H86 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRN001F1S-4DY | 460 | 1.50 | 5.0 | 1.50 | 1.00 | 1.50 | 0.77 | 3.96 | 8.86 | 0.5 | 0.20 | 0 |
| FRN002F1S-4DY | 460 | 2.90 | 5.0 | 2.90 | 2.00 | 2.90 | 1.40 | 4.29 | 7.74 | 0.5 | 0.20 | 0 |
| FRN003F1S-4DY | 460 | 4.00 | 5.0 | 4.00 | 3.00 | 4.00 | 1.79 | 3.15 | 20.81 | 0.5 | 0.20 | 0 |
| FRN005F1S-4DY | 460 | 6.30 | 5.0 | 6.30 | 5.00 | 6.30 | 2.39 | 3.34 | 23.57 | 0.5 | 0.20 | 0 |
| FRN007F1S-4DY | 460 | 9.30 | 5.0 | 9.30 | 7.50 | 9.30 | 3.12 | 2.65 | 28.91 | 0.5 | 0.20 | 0 |
| FRN010F1S-4DY | 460 | 12.70 | 5.0 | 12.70 | 10.00 | 12.70 | 4.37 | 2.43 | 30.78 | 0.5 | 0.20 | 0 |
| FRN015F1S-4DY | 460 | 18.70 | 5.0 | 18.70 | 15.00 | 18.70 | 6.36 | 2.07 | 29.13 | 1.0 | 0.20 | 0 |
| FRN020F1S-4DY | 460 | 24.60 | 5.0 | 24.60 | 20.00 | 24.60 | 4.60 | 2.09 | 29.53 | 1.0 | 0.20 | 0 |
| FRN025F1S-4DY | 460 | 30.00 | 5.0 | 30.00 | 25.00 | 30.00 | 8.33 | 1.75 | 31.49 | 1.0 | 0.20 | 0 |
| FRN030F1S-4DY | 460 | 36.20 | 5.0 | 36.20 | 30.00 | 36.20 | 9.88 | 1.90 | 32.55 | 1.0 | 0.20 | 0 |
| FRN040F1S-4DY | 460 | 45.50 | 10.0 | 45.50 | 40.00 | 45.50 | 6.80 | 1.82 | 25.32 | 1.0 | 0.20 | 0 |
| FRN050F1S-4DY | 460 | 57.50 | 10.0 | 57.50 | 50.00 | 57.50 | 9.33 | 1.92 | 24.87 | 1.0 | 0.20 | 0 |
| FRN060F1S-DY | 460 | 68.70 | 10.0 | 68.70 | 60.00 | 68.70 | 10.40 | 1.29 | 26.99 | 1.5 | 0.20 | 0 |
| FRN075F1S-4DY | 460 | 86.90 | 10.0 | 86.90 | 75.00 | 86.90 | 14.30 | 1.37 | 27.09 | 1.5 | 0.10 | 2 |
| FRN100F1S-4DY | 460 | 113.0 | 10.0 | 113.0 | 100.0 | 113.0 | 18.70 | 1.08 | 23.80 | 1.5 | 0.10 | 2 |
| FRN125F1S-4DY | 460 | 134.0 | 10.0 | 134.0 | 125.0 | 134.0 | 14.90 | 1.05 | 22.90 | 1.5 | 0.10 | 2 |
| FRN150F1S-4DY | 460 | 169.0 | 10.0 | 169.0 | 150.0 | 169.0 | 45.20 | 0.96 | 21.61 | 1.5 | 0.10 | 2 |
| FRN200F1S-4DY | 460 | 231.0 | 10.0 | 231.0 | 200.0 | 231.0 | 81.80 | 0.72 | 20.84 | 2.0 | 0.10 | 2 |
| FRN250F1S-4DY | 460 | 272.0 | 10.0 | 272.0 | 250.0 | 272.0 | 41.10 | 0.71 | 18.72 | 2.5 | 0.10 | 2 |
| FRN300F1S-4DY | 460 | 323.0 | 10.0 | 323.0 | 300.0 | 323.0 | 45.10 | 0.53 | 18.44 | 2.5 | 0.10 | 2 |
| FRN350F1S-4DY | 460 | 375.0 | 10.0 | 375.0 | 350.0 | 375.0 | 68.30 | 0.99 | 19.24 | 2.5 | 0.10 | 2 |
| FRN400F1S-4DY | 460 | 429.0 | 10.0 | 429.0 | 400.0 | 429.0 | 80.70 | 1.11 | 18.92 | 4.0 | 0.10 | 2 |
| FRN450F1S-4DY | 460 | 481.0 | 10.0 | 481.0 | 450.0 | 481.0 | 85.50 | 0.95 | 19.01 | 4.0 | 0.10 | 2 |
| FRN500F1S-4DY | 460 | 534.0 | 10.0 | 534.0 | 500.0 | 534.0 | 99.20 | 1.05 | 18.39 | 5.0 | 0.10 | 2 |
| FRN600F1S-4DY | 460 | 638.0 | 10.0 | 638.0 | 600.0 | 638.0 | 140.0 | 0.85 | 18.38 | 5.0 | 0.10 | 2 |
| FRN700F1S-4DY | 460 | 756.0 | 10.0 | 756.0 | 700.0 | 756.0 | 164.0 | 1.02 | 21.92 | 5.0 | 0.10 | 2 |
| FRN800F1S-4DY | 460 | 870.0 | 10.0 | 870.0 | 800.0 | 870.0 | 209.0 | 1.17 | 21.69 | 5.0 | 0.10 | 2 |
| FRN900F1S-4DY | 460 | 994.0 | 10.0 | 994.0 | 900.0 | 994.0 | 239.0 | 1.40 | 23.79 | 5.0 | 0.10 | 2 |

# 5.2 Overview of Function Codes

This section provides a detailed description of the function codes available for the FRENIC-Eco (TYPE: -DY) series of inverters. In each code group, its function codes are arranged in an ascending order of the identifying numbers for ease of access. Note that function codes closely related each other for the implementation of an inverter's operation are detailed in the description of the function code having the youngest identifying number. Those related function codes are indicated in the title bar as shown below.

| F01 | Frequency Command 1 | Refer to C30. |
|---|---|---|

## 5.2.1   F codes (Fundamental functions)

| F00 | Data Protection |
|---|---|

F00 specifies whether function code data is to be protected from being accidentally changed by keypad operation.

| Data for F00 | Function |
|---|---|
| 0 | Disable the data protection function, allowing you to change all function code data. |
| 1 | Enable the data protection function, allowing you to change only the data for function code F00. You cannot change any other function code data. |

If data protection is enabled (F00 = 1), the $\wedge$ / $\vee$ key operation to change data is disabled so that no function code data except F00 data can be changed from the keypad. To change F00 data, simultaneous keying of (STOP) + $\wedge$ (from 0 to 1) or (STOP) + $\vee$ (from 1 to 0) keys is required.

> **Tip**  Even when F00 = 1, function code data can be changed via the communications link.
>
> For similar purposes, (WE-KP), a signal enabling editing of function code data from the keypad is provided as a terminal command for digital input terminals. For details, refer to function codes E01 to E05, E98 and E99.

| F01 | Frequency Command 1 | Refer to C30. |
|---|---|---|

F01 selects the source of reference frequency 1 (F01) or reference frequency 2 (C30) for specifying the output frequency of the inverter (motor's rotation speed).

| Data for F01, C30 | Function |
|---|---|
| 0 | Enable $\wedge$ / $\vee$ keys on the standard or multi-function keypad. (Refer to Chapter 3 "OPERATION USING THE KEYPAD.") |
| 1 | Enable the voltage input to terminal [12] (0 to 10 VDC, maximum frequency obtained at 10 VDC). |
| 2 | Enable the current input to terminal [C1] (4 to 20 mA DC, maximum frequency obtained at 20 mA DC). |
| 3 | Enable the sum of voltage and current inputs to terminals [12] and [C1]. See the two items listed above for the setting range and the value required for maximum frequencies.<br>Note: If the sum exceeds the maximum frequency (F03), the maximum frequency will apply. |
| 5 | Enable the voltage input to terminal [V2] (0 to 10 VDC, maximum frequency obtained at 10 VDC). |
| 7 | Enable (UP) and (DOWN) commands assigned to the digital input terminals.<br>Assign (UP) command (data = 17) and (DOWN) command (data = 18) to the digital input terminals [X1] to [X5]. |

Note    Certain source settings (e.g., communications link and multistep frequency) have priority over the one specified by F01.

Tip    • You can modify the reference frequency anywhere you choose using the gain and bias settings, to these analog inputs (voltages entered via terminals [12] and [V2]; the current entered via terminal [C1]). For details, refer to function code F18.

• You can enable the noise reduction filter that applies to the analog input (voltages entered via terminals [12] and [V2]; the current entered via terminal [C1]). For details, refer to function codes C33, C38 and C43 (Terminal [12], [C1] and [V2] (Analog input) (Filter time constant)).

• Using the terminal command (Hz2/Hz1) assigned to one of the digital input terminals switches between frequency commands 1 and 2. For details, refer to function codes E01 to E05, E98 and E99.

• You can modify the reference frequency specified by frequency command 1 (F01) by using the selection (C53) and switching (IVS) of normal/inverse operation. For details, refer to the description of "Switch Normal/Inverse Operation (IVS)" in function codes E01 to E05.

| F02 | **Run Command** |
| --- | --- |

F02 selects the source issuing a run command for running the motor.

| Data for F02 | Run Command | Description |
| --- | --- | --- |
| 0 | Keypad | Enables (FWD) / (REV) / (STOP) keys to run (forward and reverse) and stop the motor. (There is no need to specify a rotation direction command.) |
| 1 | External signal | Enables the external signals given at terminals [FWD] and [REV] to run the motor. |
| 2 | Keypad (Forward rotation) | Enables only forward rotation. You cannot run the motor in the reverse direction. There is no need to specify the direction of rotation. Enables (FWD) / (STOP) keys to run and stop the motor. Disables the (REV) key. |
| 3 | Keypad (Reverse rotation) | Enables only reverse rotation. You cannot run the motor in the forward direction. There is no need to specify the direction of rotation. Enables (REV) / (STOP) keys to run and stop the motor. Disables the (FWD) key. |

Tip    When function code F02 = 0 or 1, the run forward (FWD) and run reverse (REV) commands must be assigned to terminals [FWD] and [REV], respectively.

In addition to the run command (F02) described, there are several other sources available with priority over F02: Remote/Local switching, Communications link, Run forward command 2 (FWD2), and Run reverse command 2 (REV2).

The table below shows relationship between keying and run commands in running per standard keypad (F02 = 0, rotation direction is defined by the digital inputs).

| Keying on the keypad | | | Digital inputs | | Results (Final command) |
|---|---|---|---|---|---|
| (FWD) key | (REV) key | (STOP) key | (FWD) | (REV) | |
| — | — | ON | — | — | Stop |
| ON | OFF | OFF | OFF | OFF | Stop |
| ON | OFF | OFF | ON | OFF | Run forward |
| ON | OFF | OFF | OFF | ON | Stop |
| ON | OFF | OFF | ON | ON | Stop |
| — | — | ON | — | — | Stop |
| OFF | ON | OFF | OFF | OFF | Stop |
| OFF | ON | OFF | ON | OFF | Stop |
| OFF | ON | OFF | OFF | ON | Run reverse |
| OFF | ON | OFF | ON | ON | Stop |

The table below shows relationship between keying and setting F02.

| F02 setting | Keying on the keypad | |
|---|---|---|
| | (FWD) key | (REV) key |
| 2 | Run forward | Stop |
| 3 | Stop | Run reverse |

Note
- Digital input commands (FWD) and (REV) are valid for specifying the motor rotation direction, and the commands (FWD2) and (REV2) are invalid.
- If you have assigned the (FWD) or (REV) function to the [FWD] or [REV] terminal, you cannot change the setting of function code F02 while the terminals [FWD] and [CM]* or the terminals [REV] and [CM]* are short-circuited.
- If you have specified the external signal (F02 = 1) as the run command and have assigned commands other than the (FWD) or (REV) command to the [FWD] or [REV] terminal, caution should be exercised in changing the settings. Because, if under this condition you assign the (FWD) or (REV) function to the [FWD] or [REV] terminal while the terminals [FWD] and [CM]* or the terminals [REV] and [CM]* are short-circuited, the motor would start running.

  *[CM] replaces with [PLC] for SOURCE mode.

When "Local" is selected in Remote/Local switching, the operation of the keypad concerning run commands varies with the setting of F02. The operation also varies between the standard keypad and the multi-function keypad. For details, refer to " Remote and local modes" in Section 3.6.1.

| F03 | Maximum Frequency |
|-----|-------------------|

F03 specifies the maximum frequency at which the motor can run. Specifying the frequency out of the range rated for the equipment driven by the inverter may cause damage or a dangerous situation. Set a maximum frequency appropriate for the equipment.

- Data setting range: 25.0 to 120.0 (Hz)

| ⚠CAUTION |
|---|
| The inverter can easily accept high-speed operation. When changing the speed setting, carefully check the specifications of motors or equipment beforehand. |
| **Otherwise injuries could occur.** |

Note Modifying F03 data to apply a higher output frequency requires also changing F15 data specifying a frequency limiter (high).

| F04 | Base Frequency | Refer to H50. |
|-----|----------------|---------------|

| F05 | Rated Voltage at Base Frequency | Refer to H51. |
|-----|----------------------------------|---------------|

These function codes specify the base frequency and the voltage at the base frequency essentially required for running the motor properly. If combined with the related function codes H50 and H51, these function codes may profile the non-linear V/f pattern by specifying increase or decrease in voltage at any point on the V/f pattern.

The following description includes setups required for the non-linear V/f pattern.

At high frequencies, the motor impedance may increase, resulting in an insufficient output voltage and a decrease in output torque. This feature is used to increase the voltage at high frequencies to prevent this problem from happening. Note, however, that you cannot increase the output voltage beyond the voltage of the inverter's input power.

■ **Base Frequency (F04)**

Set the rated frequency printed on the nameplate labeled on the motor.

- Data setting range: 25.0 to 120.0 (Hz)

■ **Rated Voltage at Base Frequency (F05)**

Set 0 or the rated voltage printed on the nameplate labeled on the motor.

| Data for F05 | Function |
|--------------|----------|
| 0 | Output a voltage in proportion to input voltage.<br>The Automatic Voltage Regulator (AVR) is disabled. |
| 80 to 240 (V) | Output a voltage AVR-controlled for 208 V series |
| 160 to 500 (V) | Output a voltage AVR-controlled for 460 V series |

- If 0 is set, the rated voltage at base frequency is determined by the power source of the inverter. The output voltage will vary in line with any variance in input voltage.

- If the data is set to anything other than 0, the inverter automatically keeps the output voltage constant in line with the setting. When any of the automatic torque boost settings, automatic energy saving or slip compensation is active, the voltage settings should be equal to the rated voltage of the motor.

■ **Non-linear V/f Pattern for Frequency (H50)**

Set the frequency component at an arbitrary point of the non-linear V/f pattern.

- Data setting range: 0.0 to 120.0 Hz
  (Setting 0.0 to H50 disables the non-linear V/f pattern operation.)

■ **Non-linear V/f Pattern for Voltage (H51)**

Sets the voltage component at an arbitrary point of the non-linear V/f pattern.

| Data for H51 | Function |
|---|---|
| 0 to 240 (V) | Output the voltage AVR-controlled for 208 V series |
| 0 to 500 (V) | Output the voltage AVR-controlled for 460 V series |

Note: If the rated voltage at base frequency (F05) is set to 0, settings of function codes H50 and H51 will be ignored.
If the auto torque boost (F37) is enabled, H50 and H51 will be ignored.

The factory default varies depending on the inverter's rated capacity and rated input voltage. See the table below.

| Function code | Name | Rated input voltage | |
|---|---|---|---|
| | | 208 V series | 460 V series |
| F04 | Base Frequency | 60.0 Hz | 60.0 Hz |
| F05 | Rated Voltage at Base Frequency | 208 V | 460 V |
| H50 | Non-linear V/f Pattern (Frequency) | 0 Hz | 0 Hz |
| H51 | Non-linear V/f Pattern (Voltage) | 0 V | 0 V |

■ **Normal (linear) V/f pattern**

Output voltage (V)

Constant torque range

Constant output range

Rated voltage at base frequency (F05)

0

Base frequency (F04)

Maximum frequency (F03)

Output frequency (Hz)
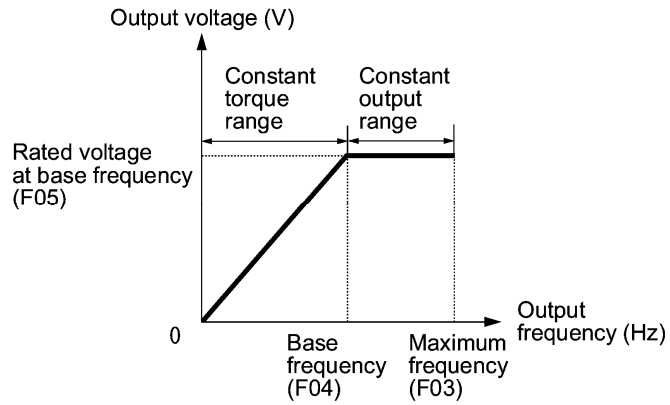
■ **V/f Pattern with Non-linear Point below the Base Frequency**

Output voltage (V)

Rated voltage at base frequency (F05)

Non-linear V/f pattern (Voltage) (H51)

0

Non-linear V/f pattern (Frequency) (H50)

Base frequency (F04)

Output frequency (Hz)
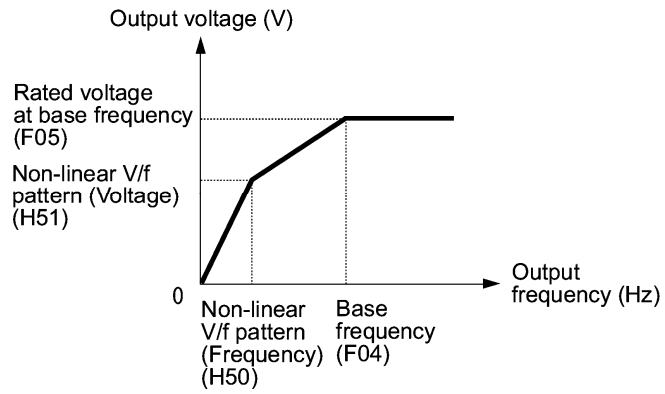
■ **V/f Pattern with Non-linear Point above the Base Frequency**

Output voltage (V)

Non-linear V/f pattern (Voltage) (H51)

Rated voltage at base frequency (F05)

0

Base frequency (F04)

Non-linear V/f pattern (Frequency) (H50)

Output frequency (Hz)
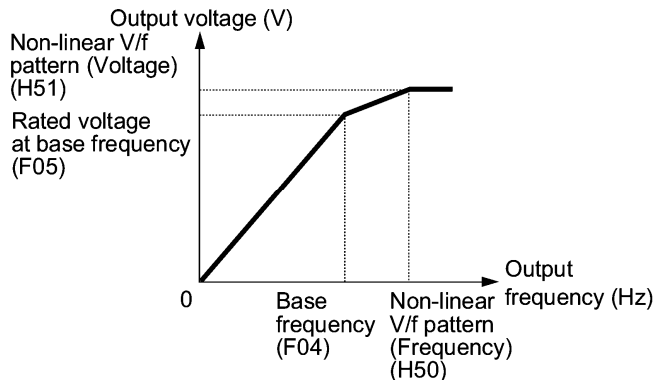
| F07 | **Acceleration Time 1** |
|---|---|

| F08 | **Deceleration Time 1** |
|---|---|

| E10 | **Acceleration Time 2** |
|---|---|

| E11 | **Deceleration Time 2** |
|---|---|

| E12 | **Acceleration Time 3** |
|---|---|

| E13 | **Deceleration Time 3** |
|---|---|

| E14 | **Acc./Dec. Time Change Frequency** |
|---|---|

F07 specifies the acceleration time, the length of time the frequency increases from 0 Hz to the maximum frequency. F08 specifies the deceleration time, the length of time the frequency decreases from the maximum frequency down to 0 Hz.

- Data setting range: 0.00 to 3600 (sec.)
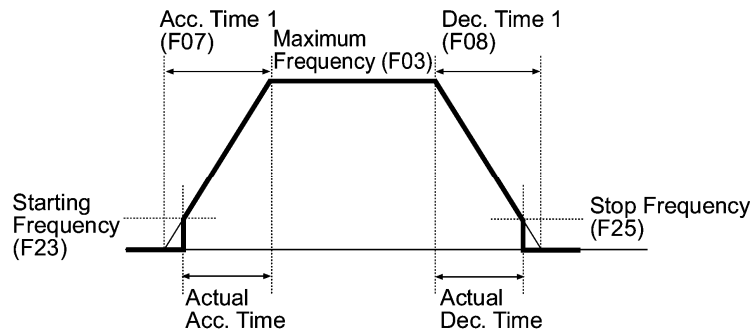


■ **Select ACC/DEC time -- (RT1)**
   **(Function code data of E01 to E05, E98 and E99 = 4)**

This terminal command switches between ACC/DEC time 1 (F07 or F08) or ACC/DEC time 2 (E10 or E11).

If no (RT1) command is assigned, ACC/DEC time 1 (F07/F08) takes effect by default.

| Input terminal command(FWD) | Acceleration/deceleration time |
|---|---|
| OFF | Acceleration/deceleration time 1 (F07/F08) |
| ON | Acceleration/deceleration time 2 (E10/E11) |

Also, acceleration and deceleration time can be switchable by output frequency.This terminal command switches between ACC/DEC time 1 (F07 or F08) or ACC/DEC time 2 (E10 or E11). And except for that case above, acceleration time and deceleration time are going to be E12 and E13 under the condition that output frequency is less than switchable acceleration and deceleration time frequency E14(Hz).

Priority to select acceleration and deceleration time is the followings.

High : H56 > J10,J80 > J39,J40 > E12,E13 > F07,F08,E10,E11 : Low

<E14＝0.0Hz>

E12 specifies the acceleration time, the length of time the frequency increases from 0 Hz to the Frequency Limiter (Low) (F16). E13 specifies the deceleration time, the length of time the frequency decreases from F16 down to 0 Hz.
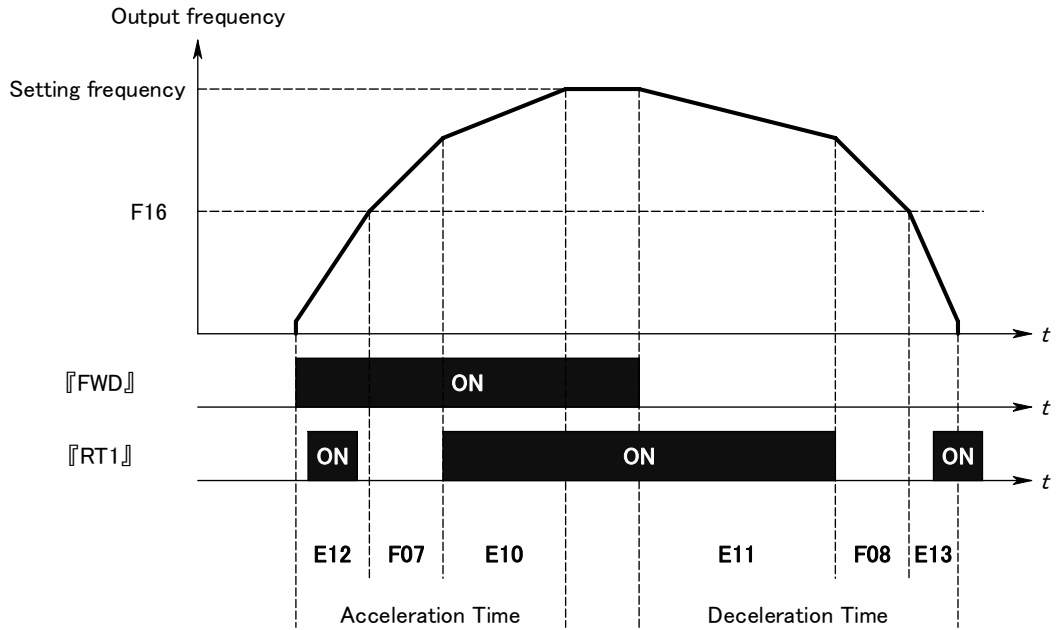


<E14≠0.0Hz>

E12 specifies the acceleration time, the length of time the frequency increases from 0 Hz to the Acc./Dec. Time Change Frequency (E14). E13 specifies the deceleration time, the length of time the frequency decreases from E14 down to 0 Hz.
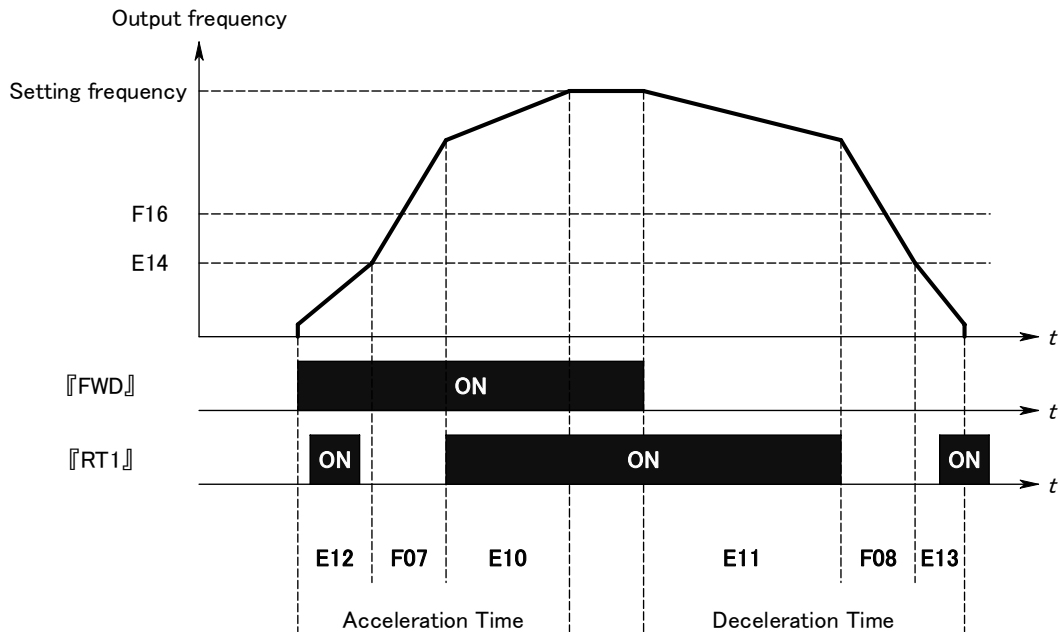


Note • If you choose S-curve acceleration/deceleration or curvilinear acceleration/ deceleration in Acceleration/Deceleration Pattern (H07), the actual acceleration/ deceleration times are longer than the specified times. Refer to the descriptions of

H07 for details.

- If you specify an improperly long acceleration/deceleration time, the current limiting function or the automatic deceleration function (regenerative bypass function) may be activated, resulting in an actual acceleration/deceleration time longer than the specified one.

| F09 | | | | Torque Boost | | Refer to F37. |
|---|---|---|---|---|---|---|

F37 specifies V/f pattern, torque boost type, and auto energy saving operation for optimizing the operation in accordance with the characteristics of the load. F09 specifies the type of torque boost in order to provide sufficient starting torque.

| Data for F37 | V/f pattern | Torque boost | Auto-energy saving | Applicable load |
|---|---|---|---|---|
| 0 | For non-linear torque load | Torque boost specified by F09 | Disabled | General purpose fans and pumps |
| 1 | For linear torque load | | | Pumps require high starting torque*1 |
| 2 | | Auto-torque boost | | Pumps require high start torque (A motor may be over-excited at no load.) |
| 3 | For non-linear torque load | Torque boost specified by F09 | Enabled | General-purpose fans and pumps |
| 4 | For linear torque load | | | Pumps require high start torque*1 |
| 5 | | Auto torque boost | | Pumps require high start torque (A motor may be over-excited at no load.) |

*1 If a required (load torque + acceleration toque) is more than 50% of the linear torque, it is recommended to apply the linear V/f pattern (factory default).

**Note** FRENIC-Eco is a series of inverters exclusively designed for fans and pumps whose torque loads are characterized by a term of variable torque load that is a torque load increasing proportional to square of the load speed. FRENIC-Eco cannot drive any linear torque load even if you select a linear V/f pattern. If you attempt to drive a linear torque load with a FRENIC-Eco inverter, the inverter's current limit function may be activated or an insufficient torque situation may result, and you would need to reduce the inverter output. For details, contact your Fuji Electric representative.

■ **V/f characteristics**

The FRENIC-Eco series of inverters offers a variety of V/f patterns and torque boosts, which include V/f patterns suitable for non-linear torque load such as general fans and pumps or for special pump load requiring high start torque. Two types of torque boost are available: manual and automatic.
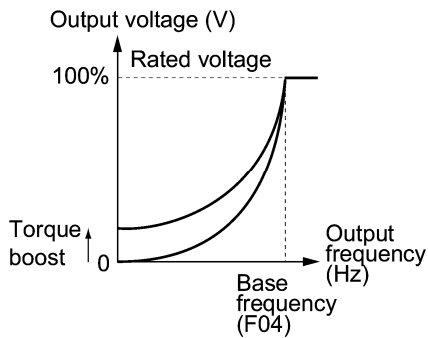
Non-linear torque characteristics (F37 = 0)
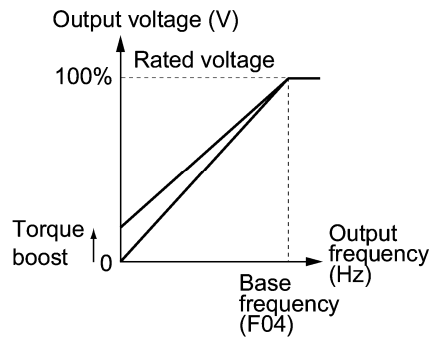
Linear torque characteristics (F37 = 1)

**Tip** When the non-linear torque load characteristics is selected in function code F37 (= 0 or 3), the output voltage may be low and insufficient voltage output may result in less output torque of the motor at a low frequency zone, depending on some motor itself and load characteristics. In such a case, it is recommended to increase the output voltage at the low frequency zone using the non-linear V/f pattern.
Recommended value: H50 =1/10 of the base frequency
H51 =1/10 of the voltage at base frequency
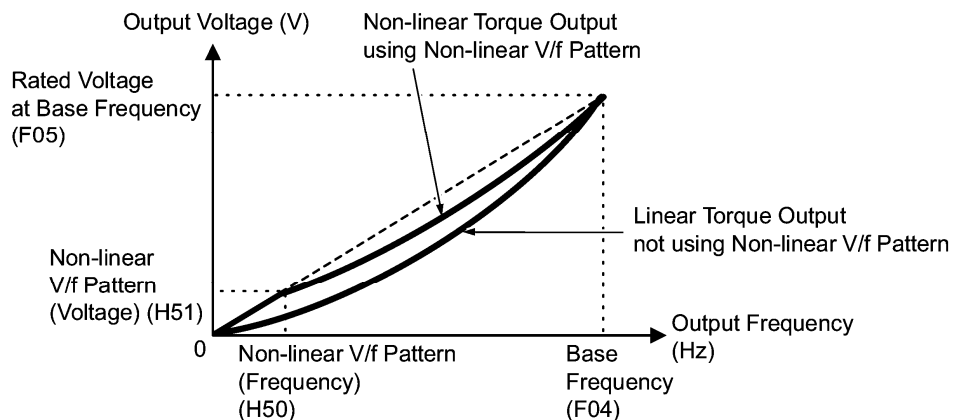
■ **Torque boost**

• Manual torque boost (F09)

In torque boost using F09, constant voltage is added to the basic V/f pattern, regardless of the load, to give the output voltage. To secure a sufficient start torque, manually adjust the output voltage to optimally match the motor and its load by using F09. Select an appropriate level that guarantees smooth start-up and yet does not cause over-excitation with no or light load.

Torque boost per F09 ensures high driving stability since the output voltage remains constant regardless of the load fluctuation.

Specify the data for F09 in percentage to the rated voltage at base frequency (F05). At factory shipment, F09 is preset to a level that ensures some 50% of start torque.

⌐Note  Specifying a high torque boost level will generate a high torque, but may cause overcurrent due to over-excitation at no load. If you continue to drive the motor, it may overheat. To avoid such a situation, adjust torque boost to an appropriate level.
When the non-linear V/f pattern and the torque boost are used together, the torque boost takes effect below the frequency on the non-linear V/f pattern's point.
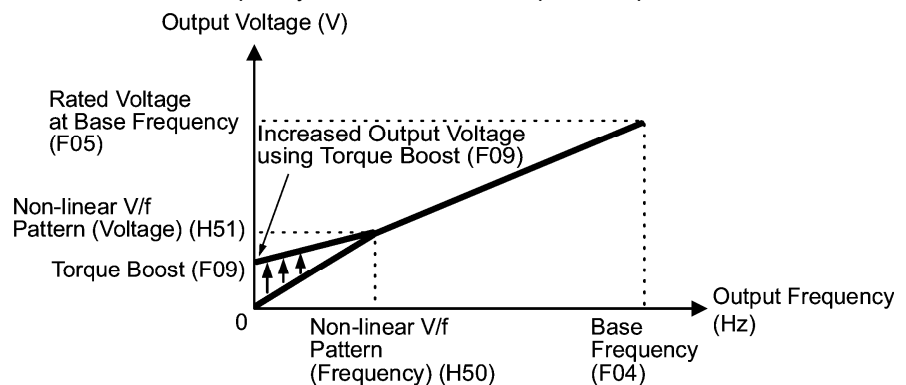


■ **Automatic torque boost**

This function automatically optimizes the output voltage to fit the motor with its load. Under light load, automatic torque boost decreases the output voltage to prevent the motor from over-excitation. Under heavy load, it increases the output voltage to increase output torque of the motor.

⌐Note  • Since this function relies also on the characteristics of the motor, set the base frequency (F04), the rated voltage at base frequency (F05), and other pertinent motor parameters (P01 though P03 and P06 though P99) in line with the motor capacity and characteristics, or else perform auto tuning per P04.

• When a special motor is driven or the load does not have sufficient rigidity, the maximum torque might decrease or the motor operation might become unstable. In such cases, do not use automatic torque boost but choose manual torque boost per F09 (F37 = 0 or 1).

### ■ Auto energy saving operation

This feature automatically controls the supply voltage to the motor to minimize the total power consumption of motor and inverter. (Note that this feature may not be effective depending upon the motor or load characteristics. Check the advantage of energy saving before actually apply this feature to your power system.).

The inverter enables this feature only upon constant speed operation. During acceleration and deceleration, the inverter will run with manual torque boost (F09) or automatic torque boost, depending on data of the function code F37. If auto energy saving operation is enabled, the response to a change in motor speed may be slow. Do not use this feature for a system that requires quick acceleration and deceleration.

Note
- Use auto energy saving only where the base frequency is 60 Hz or lower. If the base frequency is set at 60 Hz or higher, you may get little or no energy saving advantage. The auto energy saving operation is designed for use with the frequency lower than the base frequency. If the frequency becomes higher than the base frequency, the auto energy saving operation will be invalid.
- Since this function relies also on the characteristics of the motor, set the base frequency (F04), the rated voltage at base frequency (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto tuning per P04.

| F10 | Electronic Thermal Overload Protection for Motor (Select motor characteristics) |
|---|---|

| F11 | Electronic Thermal Overload Protection for Motor (Overload detection level) |
|---|---|

| F12 | Electronic Thermal Overload Protection for Motor (Thermal time constant) |
|---|---|

F10 through F12 specify the thermal characteristics of the motor for its electronic thermal overload protection that is used to detect overload conditions of the motor inside the inverter.

F10 selects the motor cooling mechanism to specify its characteristics, F11 specifies the overload detection current, and F12 specifies the thermal time constant.

Note
Thermal characteristics of the motor specified by F10 and F12 are also used for the overload early warning. Even if you need only the overload early warning, set these characteristics data to these function codes. To disable the electronic thermal motor overload protection, set function code F11 to "0.00."

### ■ Select motor characteristics (F10)

F10 selects the cooling mechanism of the motor--built-in cooling fan or externally powered forced-ventilation fan.

| Data for F10 | Function |
|---|---|
| 1 | For general-purpose motors with built-in self-cooling fan<br>(The cooling effect will decrease in low frequency operation.) |
| 2 | For inverter-driven motors or high-speed motors with forced-ventilation fan<br>(The cooling effect will be kept constant regardless of the output frequency.) |

The figure below shows operating characteristics of the electronic thermal overload protection when F10 = 1. The characteristic factors $\alpha1$ through $\alpha3$ as well as their corresponding switching frequencies f2 and f3 vary with the characteristics of the motor. The tables below lists the factors of the motor selected by P99 (Motor Selection).



Actual Output Current (Continuous) / Overload Detection Level (F11) (%)

fb = Base Frequency
where, If it exceeds 60 Hz, fb = 60 Hz.

Output Frequency f0 (Hz)
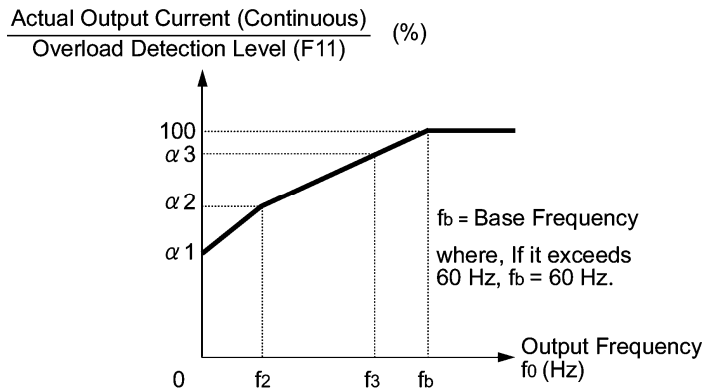
Cooling Characteristics of Motor Equipped with a Self-cooling Fan

Applicable Motor Rating and Characteristic Factors when P99 (Motor selection) = 0 or 4

| Applicable motor rating (HP) | Thermal time constant $\tau$ (Factory default) | Output current for setting the thermal time constant (Imax) | Switching frequency for motor characteristic factor | | Characteristic factor (%) | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | f2 | f3 | $\alpha1$ | $\alpha2$ | $\alpha3$ |
| 1/2, 1 | 5 min | Rated current × 150% | 5 Hz | 7 Hz | 75 | 85 | 100 |
| 2 to 5 | | | | | 85 | 85 | 100 |
| 7.5 to 15 | | | | 6 Hz | 90 | 95 | 100 |
| 20 | | | | 7 Hz | 85 | 85 | 100 |
| 25, 30 | | | | 5 Hz | 92 | 100 | 100 |
| 40 to 60 | 10 min | | Base frequency × 33% | Base frequency × 83% | 54 | 85 | 95 |
| 75 to 125 | | | | | 51 | 95 | 95 |
| 150 or above | | | | | 53 | 85 | 90 |

Applicable Motor Rating and Characteristic Factors when P99 (Motor selection) = 1 or 3

| Applicable motor rating (HP) | Thermal time constant $\tau$ (Factory default) | Output current for setting the thermal time constant (Imax) | Switching frequency for motor characteristic factor | | Characteristic factor (%) | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| | | | f2 | f3 | $\alpha1$ | $\alpha2$ | $\alpha3$ |
| 1/4 to 30 | 5 min | Rated current × 150% | Base frequency × 33% | Base frequency × 33% | 69 | 90 | 90 |
| 40 to 60 | 10 min | | | Base frequency × 83% | 54 | 85 | 95 |
| 75 to 125 | | | | | 51 | 95 | 95 |
| 150 or above | | | | | 53 | 85 | 90 |

■ Overload detection level (F11)

F11 specifies the level at which the electronic thermal overload protection becomes activated.

- Data setting range:  1 to 135% of the rated current (allowable continuous drive current) of the inverter

In general, set F11 to the rated current of motor when driven at the base frequency (i.e. 1.0 to 1.1 multiple of the rated current of motor (P03)). To disable the electronic thermal overload protection, set F11 to "0.00: Disable."

■ **Thermal time constant (F12)**

F12 specifies the thermal time constant of the motor. The time constant is the time until the electronic thermal overload protection detects the motor overload while the current of 150% of the overload detection level specified by F11 has flown. The thermal constants of most general-purpose motors including Fuji motors are set at about 5 minutes for capacities of 25 HP for 208V, 30 HP for 460V or below or about 10 minutes for capacities of 30 HP for 208V, 40 HP for 460V or above by factory default.

- Data setting range: 0.5 to 75.0 (minutes) in increments of 0.1 minute

(Example) When function code F12 is set at "5.0" (5 minutes)

As shown below, the electronic thermal overload protection is activated to detect an alarm condition (alarm code $OL1$ ) when the output current of 150% of the overload detection level (specified by F11) flows for 5 minutes, and 120% for approx. 12.5 minutes.

The actual driving time required for issuing a motor overload alarm tends to be shorter than the value specified as the time period from when the output current exceeds the rated current (100 %) until it reaches 150 % of the overload detection level.

Example of Operating Characteristics
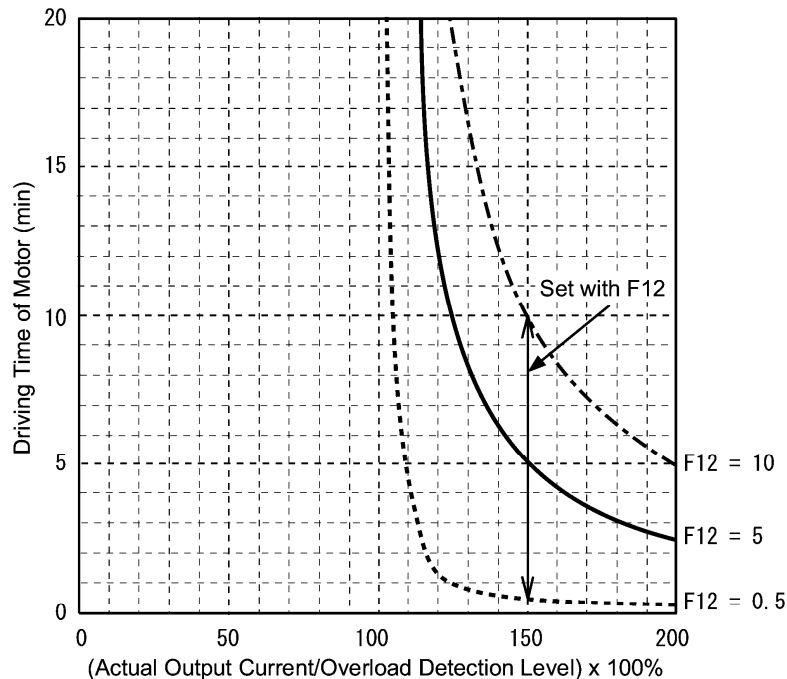
| F14 | | **Restart Mode after Momentary Power Failure (Mode selection)** |
| | | **Refer to H13, H14, H15, H16, H92 and H93.** |

F14 specifies the action to be taken by the inverter such as trip and restart in the event of a momentary power failure.

■ **Restart mode after momentary power failure (Mode selection) (F14)**

| Data for F14 | Mode | Description |
|---|---|---|
| 0 | Disable restart (Trip immediately) | As soon as the DC link bus voltage drops below the undervoltage detection level upon a momentary power failure, the output of the inverter is shut down, with undervoltage alarm $LU$ issued, and the motor enters a coast-to-stop state. |
| 1 | Disable restart (Trip after a recovery from power failure) | As soon as the DC link bus voltage drops below the undervoltage detection level upon a momentary power failure, the output of the inverter is shut down, the motor enters a coast-to-stop state, but no undervoltage alarm *lu* issued. When power is restored, an undervoltage alarm $LU$ is issued, while the motor remains in a coast-to-stop state. |
| 3 | Enable restart (Keep running, for heavy inertia or general loads) | When the DC link bus voltage drops below the continuous running level upon a momentary power failure, continuous running control is invoked. Continuous running control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and prolongs the running time. When an undervoltage condition is detected due to a lack of energy to be regenerated, the output frequency at that time is saved, the output of the inverter is shut down, and the motor enters a coast-to-stop state. When power is restored, if a run command has been input, restart begins at the reference frequency saved during the power failure processing. This setting is ideal for fan applications with a large moment of inertia. |
| 4 | Enable restart (Restart at the frequency at which the power failure occurred, for general loads) | As soon as the voltage of the DC link bus drops below the undervoltage detection level upon a momentary power failure, the output frequency at the time is saved, the output of the inverter is shut down, and the motor enters a coast-to-stop state. When power is restored, if a run command has been input restart begins at the reference frequency saved during the power failure processing. This setting is ideal for applications with a moment of inertia large enough not to slow down the motor quickly, such as fans, even after the motor enters a coast-to-stop state upon occurrence of a momentary power failure. |
| 5 | Enable: Restart at the starting frequency, for low-inertia load | After a momentary power failure, when power is restored and then a run command is input, restart will begin at the starting frequency commanded by function code F23. This setting is ideal for heavy load applications such as pumps, having a small moment of inertia, in which the motor speed quickly goes down to zero as soon as it enters a coast-to-stop state upon occurrence of a momentary power failure. |

## ⚠WARNING

If you enable the "Restart mode after momentary power failure" (Function code F14 = 3, 4, or 5), the inverter automatically restarts the motor running when the power is recovered. Design the machinery or equipment so that human safety is ensured after restarting.

**Otherwise an accident could occur.**

## ■ Restart mode after momentary power failure (Basic operation)

The inverter recognizes a momentary power failure upon detecting the condition that DC link bus voltage goes below the undervoltage level, while the inverter in running. If the load of the motor is light and the duration of the momentary power failure is extremely short, the voltage drop may not be great enough for a momentary power failure to be recognized, and the motor may continue to run uninterrupted.

Upon recognizing a momentary power failure, the inverter enters the restart mode (after a recovery from momentary power failure) and prepares for restart. When power is recovered, the inverter goes through an initial charging stage and enters the ready-to-run state. When a momentary power failure occurs, the power supply voltage for external circuits such as relay sequence circuits may also drop, the run command may be turned off. In consideration of such a situation, the inverter waits 2 seconds for input of a run command after the inverter enters ready-to-run state. If a run command is received within 2 seconds, the inverter begins the restart processing in accordance with the data of F14 (Mode selection). If no run command has been received within 2-second wait period, the restart mode (after a recovery from momentary power failure) will be canceled, and the inverter needs to be started again from the ordinary starting frequency. Therefore, ensure that a run command is entered within 2 seconds after a recovery of power, or install a mechanical latch relay.

In case the run commands are entered via a standard keypad, the above operation is also necessary for the mode (F02 = 0) in which the direction of rotation is determined by the terminal command, (FWD) or (REV). In the modes where the direction of rotation is fixed (F02 = 2 or 3), the direction of rotation is retained inside the inverter, and the restart will begin as soon as the inverter enters the ready-to-run state.
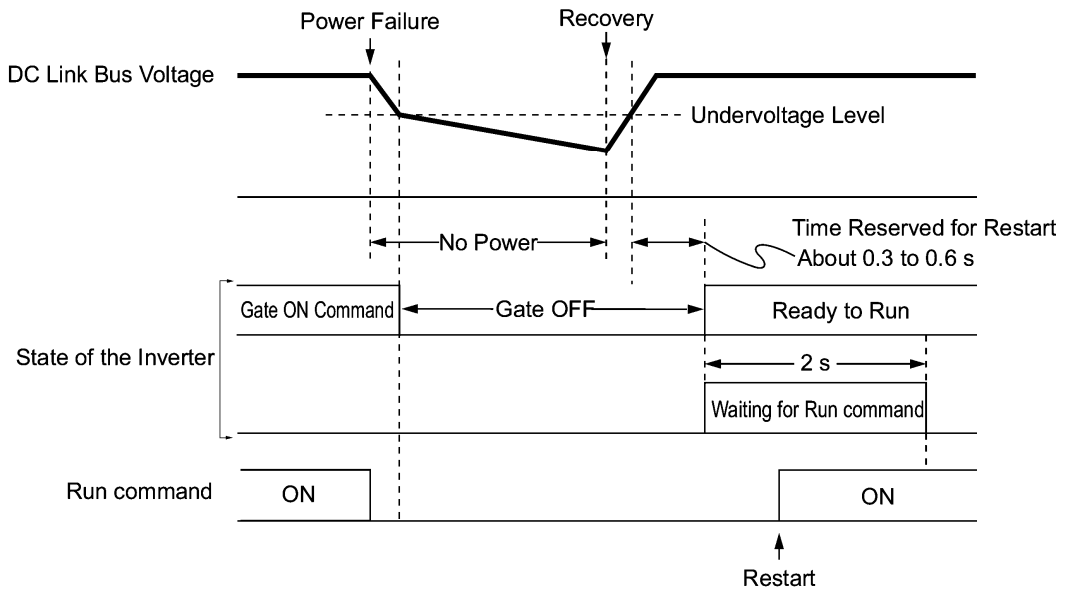
**Note** When the power is recovered, the inverter will wait 2 seconds for input of a run command. However, if the allowable momentary power failure time (H16) elapses after the power failure was recognized, even within the 2 seconds, the waiting time for a run command is canceled. The inverter will start operation in the normal stating sequence.

If a coast-to-stop command (BX) is entered during the power failure, the inverter gets out of the restart mode and enters the normal running mode. If a run command is entered with power supply applied, the inverter will start from the normal starting frequency.

The inverter recognizes a momentary power failure by detecting an undervoltage condition whereby the voltage of the DC link bus goes below the lower limit. In a configuration where a magnetic contactor is installed on the output side of the inverter, the inverter may fail to recognize a momentary power failure because the momentary power failure shuts down the operating power of the magnetic contactor, causing the contactor circuit to open. When the contactor circuit is open, the inverter is cut off from the motor and load, and the voltage drop in the DC link bus is not great enough to be recognized as a power failure. In such an event, restart after a recovery from momentary power failure does not work properly as designed. To solve this, connect the interlock command (IL) line to the auxiliary contact of the magnetic contactor, so that a momentary power failure can sure be detected.

During a momentary power failure the motor slows down. After power has been recovered, the inverter is restarted at the frequency just before the momentary power failure. Then, the current limiting function works and the output frequency of the inverter automatically decreases. When synchronization is established between the output frequency and the rotation of the motor, the motor accelerates up to the original frequency. See the figure below. In this case, to make the motor synchronize, the instantaneous overcurrent limiting must be enabled (H12 = 1).
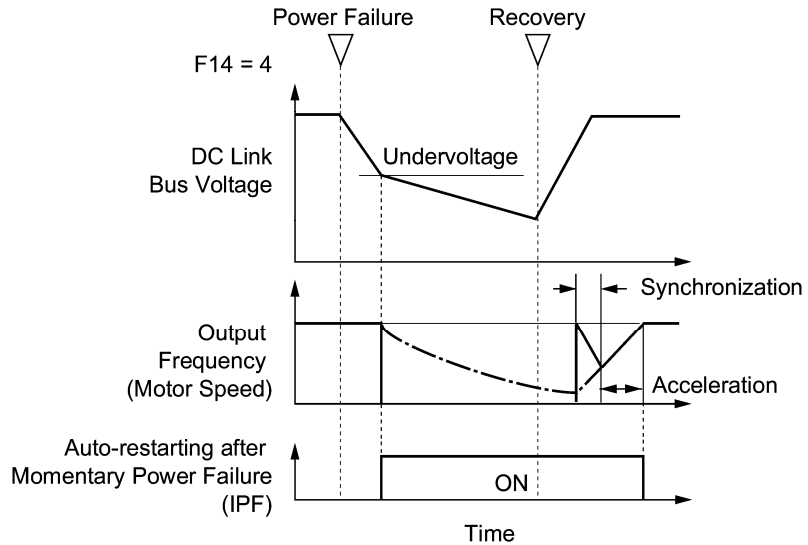
■ **Restart mode after momentary power failure**
  **(Allowable momentary power failure time) (H16)**

Specifies the maximum allowable duration (0.0 to 30.0 seconds) from a momentary power failure (undervoltage) occurrence until the inverter is to be restarted. Specify the maximum length of time that can be tolerated in terms of the machine system and facility during which the motor can coast to stop. Restart will take place if power is recovered within the specified duration. When the power is not recovered within the duration, the inverter recognizes the power has been shut down so that the inverter will make a start upon power recovery (normal starting).
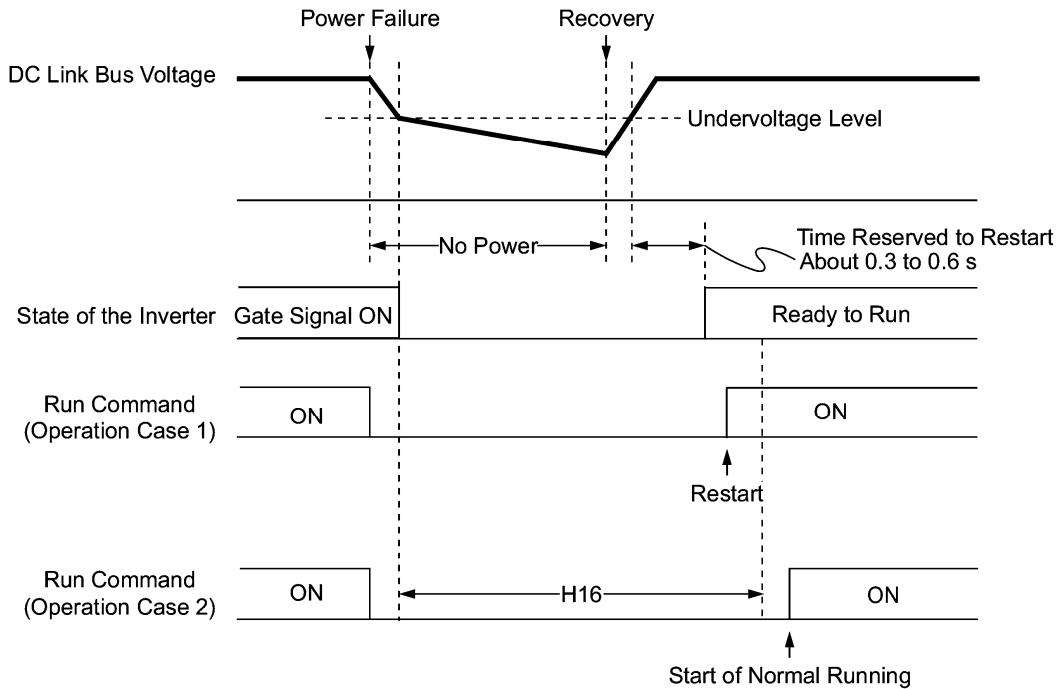


If you set the allowable momentary power failure time (H16) to "999," restart will take place until the DC link bus voltage drops down to the allowable voltage for restart after a momentary power failure as shown below. If the DC link bus voltage goes below the allowable voltage for restart after momentary power failure, the inverter recognizes the power has been shut down so that the inverter will make a start upon power recovery (normal starting).

Allowable voltage for restart after momentary power failure

| Power supply | Allowable voltage for restart after momentary power failure |
|---|---|
| 208 V series | 50 V |
| 460 V series | 100 V |

Note The time required from when the DC link bus voltage drops from the threshold of undervoltage until it reaches the allowable voltage for restart after momentary power failure, greatly varies depending on the inverter capacity, the presence of options, and other factors.

■ **Auto-restart after momentary power failure (Waiting time) (H13)**

This function specifies the time period from momentary power failure occurrence until the inverter reacts for restarting process.

If the inverter starts the motor while motor's residual electricity is still in a high level, an overvoltage alarm may be recognized due to a high inrush current or temporary regeneration occurrence. For safety, therefore, it is advisable to set H13 to a certain level so that restart will take place only after the residual electricity has dropped to a low level. Note that even when power is recovered, restart will not take place until the waiting time (H13) has elapsed.
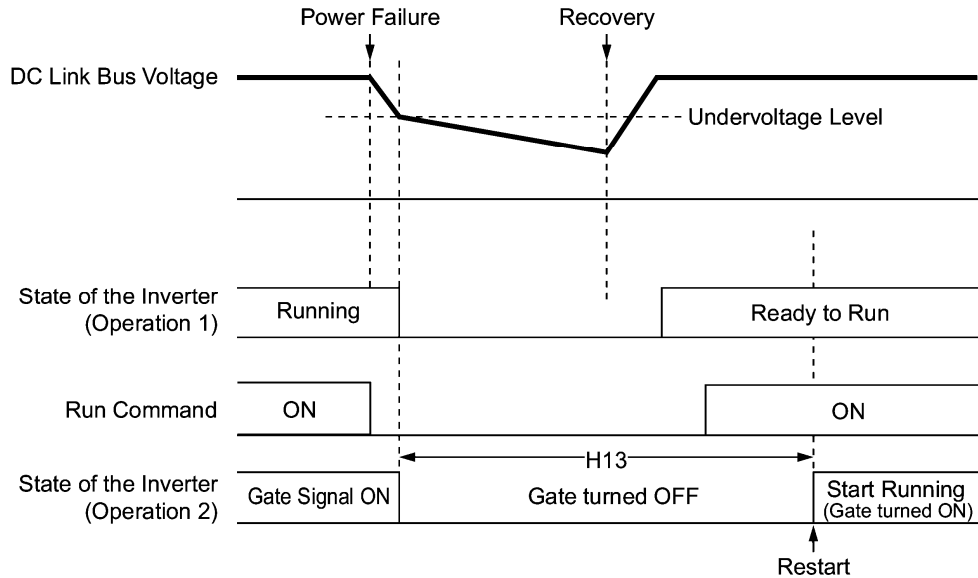


■ **Factory default**

By factory default, H13 is set at one of the values shown below according to the inverter capacity. Basically, you do not need to change H13 data. However, if the long waiting time causes the flow rate of the pump to overly decrease or causes any other problem, you might as well reduce the setting to about a half of the default value. In such a case, make sure that no alarm occurs.

| Inverter capacity(HP) | Factory default of H13 (Restart time in seconds) |
|---|---|
| 1/8 to 10 | 0.5 |
| 15 to 50 | 1.0 |
| 60 to 150 | 1.5 |
| 200 to 250 | 2.0 |
| 300 to 400 | 2.5 |
| 450 to 500 | 4.0 |
| 600 to 900 | 5.0 |

Note    Function code H13 (Restart mode after momentary power failure -- Restart time) also applies to the switching operation between line and inverter (refer to E01 through E05; terminals [X1] through [X5]).

## ■ Restart after momentary power failure (Frequency fall rate) (H14)

During restart after a momentary power failure, if the inverter output frequency and the motor rotation cannot be synchronized with each other, an overcurrent will flow, activating the overcurrent limiter. If it happens, the inverter reduces the output frequency to match the motor rotation according to the reduction rate (Frequency fall rate: Hz/s) specified by H14.

| Data for H14 | Inverter's action on the frequency fall rate |
|---|---|
| 0.00 | Follow the deceleration time specified by F08 |
| 0.01 to 100.00 Hz/s | Follow data specified by H14 |
| 999 | Follow the setting of the PI controller in current limiter (The PI constant is prefixed inside the inverter.) |

Note: If the frequency fall rate is too high, regeneration may take place at the moment the motor rotation comes into synchronization with the inverter output frequency, causing an overvoltage trip. On the contrary, if the frequency fall rate is too low, the time required to establish synchronization (duration of current limiting action) may be prolonged, triggering the inverter overload prevention control.

## ■ Restart after momentary power failure (Continuous running level) (H15)

## ■ Continue to run (P, I) (H92, H93)

If a momentary power failure occurs when the F14 data is set to "3: Enable restart (Continue to run)," the inverter enters the control sequence of the continuous running when the DC link bus voltage drops below the continuous running level specified by H15.

Under the continuous running control, the inverter decelerates its output frequency with the PI controller using P (proportional) and I (integral) components specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.
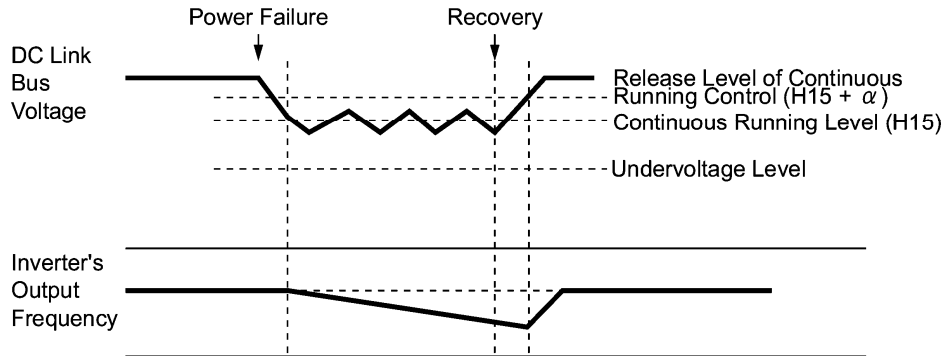


| Power Supply | $\alpha$ | |
| --- | --- | --- |
| | 30HP or below | 40HP or above |
| 200 V | 5 V | 10 V |
| 400 V | 10 V | 20 V |

Even if you select the continuous running control, the inverter may not be able to continue operation when the load's inertia is small or the load is heavy, due to undervoltage caused by a control delay. Even in such a case, however, the output frequency when the undervoltage alarm occurred is saved and the inverter will restart at the saved frequency after a recovery from the momentary power failure.

When the input power voltage for the inverter is high, setting the continuous running level high makes the control more stable even if the load's inertia is relatively small. Raising the continuous running level too high, however, might cause the continuous running control activated even during normal operation.

When the input power voltage for the inverter is extremely low, continuous running control might be activated even during normal operation, at the beginning of acceleration or at an abrupt change in load. To avoid this, lower the continuous running level. Lowering the continuous running level too low, however, might cause undervoltage that results from voltage drop due to a control delay. Even in such a case, however, the output frequency when the undervoltage alarm occurred is saved and the inverter will restart at the saved frequency after a recovery from the momentary power failure.

Before you change the continuous running level, make sure that the continuous running control will be performed properly, by considering the fluctuations of the load and the input voltage.

| F15 | Frequency Limiter (High) | |
|-----|--------------------------|---|
| F16 | Frequency Limiter (Low) | Refer to H63. |

F15 and F16 specify the upper and lower limits of the output frequency, respectively.

H63 specifies the operation to be carried out when the output frequency drops below the frequency limiter (Low) specified by F16 as follows:

• If H63 = 0, the output frequency will be held at the frequency limiter (Low).

• If H63 = 1, the inverter decelerates to stop the motor.

- Data setting range: 0.0 to 120.0 Hz



(H63 = 0)



(H63 = 1)
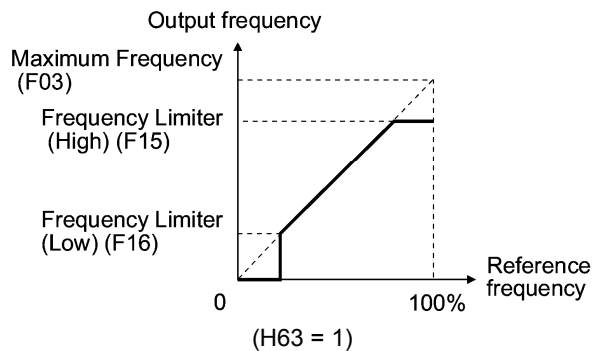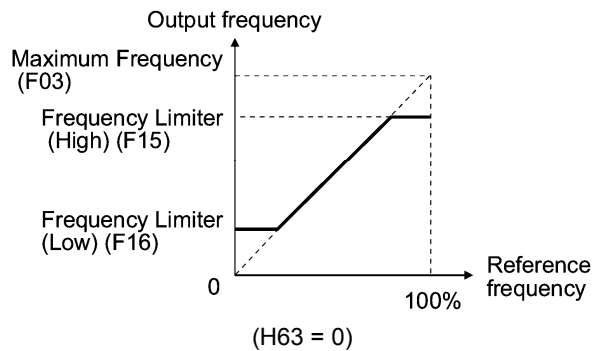
Note
• When you change the frequency limiter (High) (F15) in order to raise the running frequency, be sure to change the maximum frequency (F03) accordingly.

• Maintain the following relationship among the data for frequency control:

F15 > F16, F15 > F23, and F15 > F25

F03 > F16

where, F23 is of the starting frequency and F25 is of the stop frequency.

If you specify any wrong data for these function codes, the inverter may not run the motor at the desired speed, or cannot start it normally.

| F18 | Bias (Frequency command 1) | Refer to C50, C32, C34, C37, C39, C42 and C44. |

When any analog input for frequency command 1 (F01) is used, it is possible to define the relationship between the analog input and the reference frequency by multiplying the gain and adding the bias specified by F18.

| Function code | Function | Data setting range (%) |
|---|---|---|
| F18 | Bias | -100.00 to 100.00 |
| C50 | Bias reference point | 0.00 to 100.00 |
| C32 | Gain for terminal [12] | 0.00 to 200.00 |
| C34 | Gain reference point for terminal [12] | 0.00 to 100.00 |
| C37 | Gain for terminal [C1] | 0.00 to 200.00 |
| C39 | Gain reference point for terminal [C1] | 0.00 to 100.00 |
| C42 | Gain for terminal [V2] | 0.00 to 200.00 |
| C44 | Gain reference point for terminal [V2] | 0.00 to 100.00 |

As shown in the graph below, the relationship between the analog input and the reference frequency specified by frequency command 1 is determined by points "A" and "B." Point "A" is defined by the combination of the bias (F18) and its reference point (C50); Point B, by the combination of the gain (C32, C37 or C42) and its reference point (C34, C39 or C44).

The combination of C32 and C34 applies to terminal [12], that of C37 and C39, to [C1], and that of C42 and C44, to [V2].

Configure the bias (F18) and gain (C32, C37 or C42), assuming the maximum frequency as 100%, and the bias reference point (C50) and gain reference point (C34, C39 or C44), assuming the full scale (10 VDC or 20 mA DC) of analog input as 100%.

Note
- The analog input less than the bias reference point (C50) is limited by the bias value (F18).
- Specifying that the data of the bias reference point (C50) is equal to or greater than that of each gain reference point (C34, C39 or C44) will be interpreted as invalid, so the inverter will reset the reference frequency to 0 Hz.
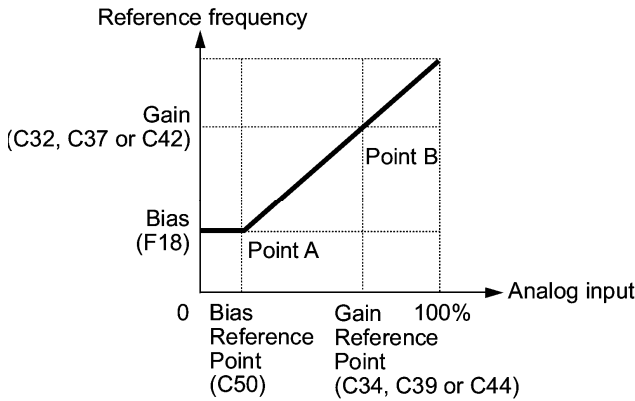
Example: Setting the bias, gain and its reference points when the reference frequency 0 to 100% follows the analog input of 1 to 5 VDC to terminal [12] (in frequency command 1).

Reference frequency

Gain (C32) 100%

Point B

Bias (F18) 0%

Point A

0  1V(10%)    5V(50%) 100%    Analog input

Bias
Reference
Point (C50)

Gain
Reference
Point (C34)
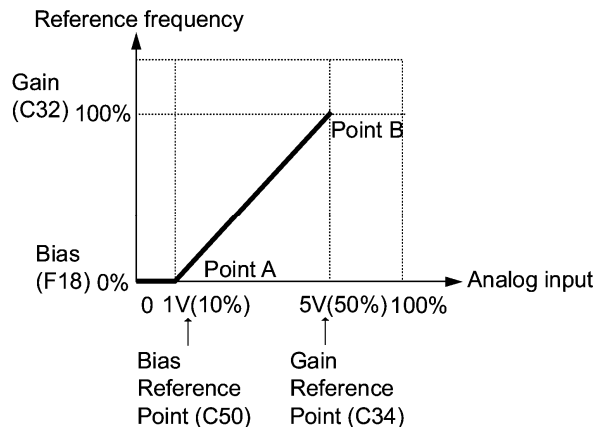
(Point A)

To set the reference frequency to 0 Hz for an analog input being at 1 V, set the bias to 0% (F18 = 0). Since 1 V is the bias reference point and it is equal to 10% of 10 V, set the bias reference point to 10% (C50 = 10).

(Point B)

To make the maximum frequency equal to the reference frequency for an analog input being at 5 V, set the gain to 100% (C32 = 100). Since 5 V is the gain reference point and it is equal to 50% of 10 V, set the gain reference point to 50% (C34 = 50).

| F20 | DC Injection Braking (Braking start frequency) | Refer to H95. |
|---|---|---|

| F21 | DC Injection Braking (Braking level) |
|---|---|

| F22 | DC Injection Braking (Braking time) |
|---|---|

F20 through F22 specify the DC injection braking that prevents the motor from running by inertia during deceleration-to-stop operation.

If the motor enters a deceleration-to-stop operation by turning off the run command or by decreasing the reference frequency below the stop frequency, the inverter activates the DC injection braking by flowing a current at the braking level (F21) during the braking time (F22) when the output frequency reaches the DC injection braking start frequency (F20).

Setting the braking time to "0.0" (F22 = 0) disables the DC injection braking.

■ **Braking start frequency (F20)**

F20 specifies the frequency at which the DC injection braking starts its operation during motor deceleration-to-stop state.

- Data setting range: 0.0 to 60.0 (Hz)

■ **Braking level (F21)**

F21 specifies the output current level to be applied when the DC injection braking is activated. The function code data should be set, assuming the rated output current of the inverter as 100% in increments of 1%.

- Data setting range: 0 to 60 (%)

■ **Braking time (F22)**

F22 specifies the braking period that activates DC injection braking.

- Data setting range: 0.01 to 30.00 (sec.)
  (Note that setting 0.00 disables DC injection braking.)
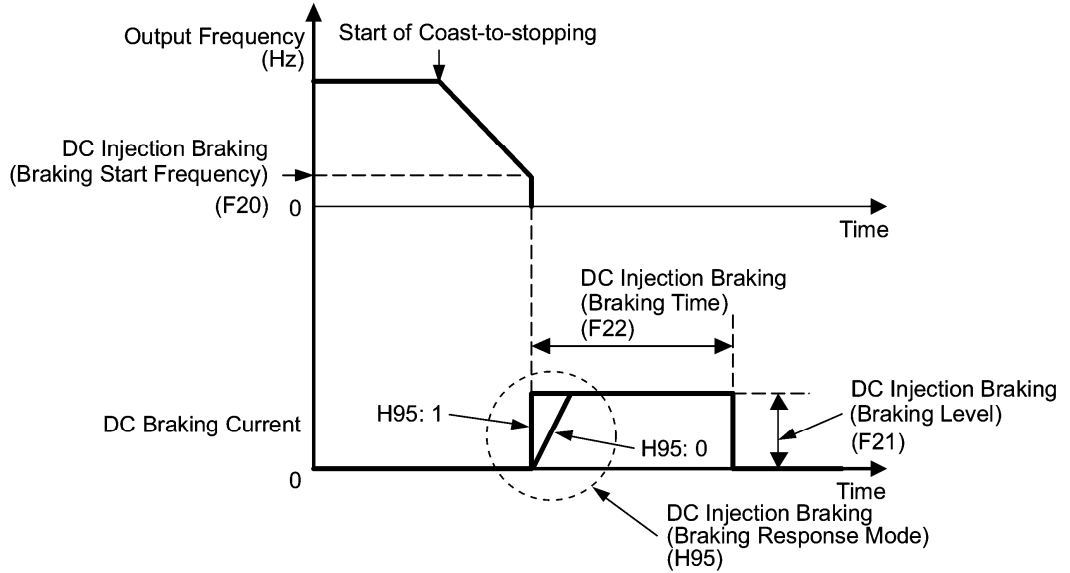


■ **Braking response mode (H95)**

H95 specifies the DC injection braking response mode.

| Data for H95 | Characteristics | Note |
|---|---|---|
| 0 | Slow response. Slows the rising edge of the current, thereby preventing reverse rotation at the start of DC injection braking. | Insufficient braking torque may result at the start of DC injection braking. |
| 1 | Quick response. Quickens the rising edge of the current, thereby accelerating the build-up of the braking torque. | Reverse rotation may result depending on the moment of inertia of the mechanical load and the coupling mechanism. |

**Tip** It is also possible to use an external digital input signal as a DC injection braking command (DCBRK).

As long as the (DCBRK) command is ON, the inverter performs DC injection braking, regardless of the braking time specified by F22.

Turning the (DCBRK) command ON even when the inverter is in a stopped state activates DC injection braking. This feature allows the motor to be excited before starting, resulting in smoother acceleration (quicker build-up of acceleration torque).

**Note** In general, specify data of the function code F20 at a value close to the rated slip frequency of motor. If you set it at an extremely high value, control may become unstable and an overvoltage alarm may result in some cases.

---

### ⚠CAUTION

The DC injection brake function of the inverter does not provide any holding mechanism.

**Injuries could occur.**

---

| F23 | **Starting Frequency** |
|---|---|

| F25 | **Stop Frequency** |
|---|---|

At the startup of an inverter, the initial output frequency is equal to the starting frequency. The inverter stops its output at the stop frequency.

Set the starting frequency to a level that will enable the motor to generate enough torque for startup. Generally, set the motor's rated slip frequency at the starting frequency F23.

- Data setting range: 0.0 to 60.0 (Hz) (for both starting and stop frequencies)

Note If the starting frequency is lower than the stop frequency, the inverter will not output any power as long as the frequency command does not exceed the stop frequency.
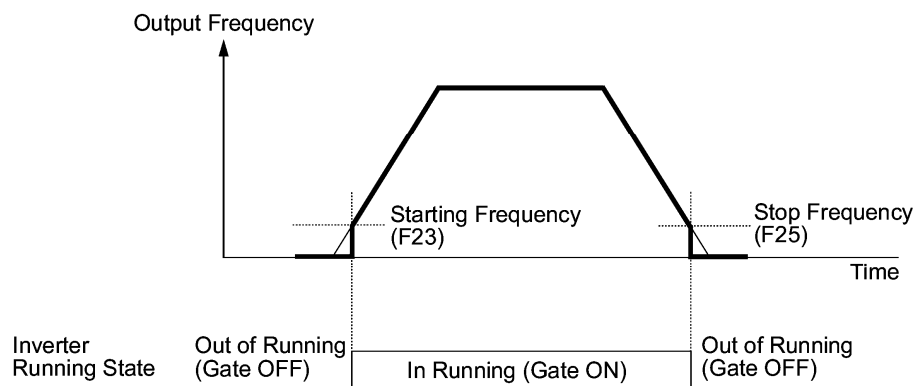


| F26 | **Motor Sound (Carrier frequency)** | **Refer to H98.** |
|---|---|---|

| F27 | **Motor Sound (Tone)** |
|---|---|

■ **Motor sound (Carrier frequency) (F26)**

F26 controls the carrier frequency so as to reduce an audible noise generated by the motor or inverter itself, and to decrease a leakage current from the main output (secondary) wirings.

| | | |
|---|---|---|
| Carrier frequency should be between: | Inverter rated capacity: 1 to 30HP | 0.75 and 15 kHz |
| | Inverter rated capacity: 40 to 100HP | 0.75 and 10 kHz |
| | Inverter rated capacity: 125 to 800 HP | 0.75 and 6 kHz |
| Motor sound noise emission | | The higher, the less. |
| Motor temperature (due to harmonics components) | | The higher, the less. |
| Output current waveform | | The higher, the better. |
| Leakage current | | The lower, the less. |
| Electromagnetic noise emission | | The lower, the less. |
| Inverter loss | | The lower, the less. |

> **Note** Specifying a too low carrier frequency will cause the output current waveform to have a large amount of ripples (many harmonics components). As a result, the motor loss increases, causing the motor temperature to rise. Furthermore, the large amount of ripples tends to cause a current limiting alarm. When the carrier frequency is set to 1 kHz or below, therefore, reduce the load so that the inverter output current comes to be 80% or less of the rated current.
>
> When a high carrier frequency is specified, the temperature of the inverter may rise due to an ambient temperature rise or an increase of the load. If it happens, the inverter automatically decreases the carrier frequency to prevent the inverter overheat alarm $\mathcal{O}H3$ or inverter overload alarm $\mathcal{O}LU$. With consideration for motor noise, the automatic reduction of carrier frequency can be disabled (see function code H98).

### ■ Motor sound (Tone) (F27)

F12 changes the motor running sound tone. This setting is effective when the carrier frequency set to function code F26 is 7 kHz or lower. Changing the tone level may reduce the high and harsh running noise from the motor.

| Data for F27 | Function |
|---|---|
| 0 | Disable (Tone level 0) |
| 1 | Enable (Tone level 1) |
| 2 | Enable (Tone level 2) |
| 3 | Enable (Tone level 3) |

> **Note** If the sound level is set too high, the output current may become unstable, or mechanical vibration and noise may increase. Also, these function codes may not be very effective for certain types of motor.

| F29 | Analog Output [FMA] (Mode selection) |
|---|---|

| F30 | Analog Output [FMA] (Output adjustment) |
|---|---|

| F31 | Analog Output [FMA] (Function) |
|---|---|

These function codes allow you to output to terminal [FMA] monitored data such as the output frequency and the output current in the form of an analog DC voltage or current. The magnitude of such analog voltage or current is adjustable.

### ■ Mode selection (F29)

F29 specifies the property of the output to terminal [FMA]. You need to set switch SW4 on the control printed circuit board accordingly, referring to the table below.

| Data for F29 | Output form | Positioning slide switch (SW4) mounted on the control PCB |
|---|---|---|
| 0 | Voltage (0 to 10 VDC) | VO |
| 1 | Current (4 to 20 mA DC) | IO |

> **Note** The current output is not isolated from the analog input and does not have its own independent power source. Therefore, this output must not be connected in cascade to outside instrument and gauges if some difference in potential is there between the inverter and peripheral equipment regarding connection of analog input etc. Avoid needlessly long wiring.

■ **Output adjustment (F30)**

F30 allows you to adjust the output voltage or current representing the monitored data selected by function code F31 within the range of 0 to 200%.

- Data setting range: 0 to 200 (%)
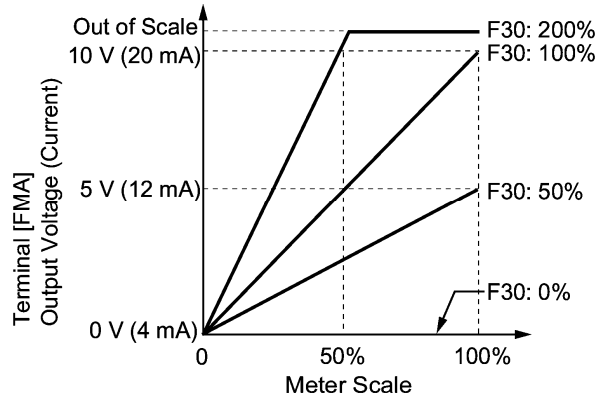


■ **Function (F31)**

F31 specifies what is output to the analog output terminal [FMA].

| Data for F31 | [FMA] output | Function (Monitor the following) | Meter scale (Full scale at 100%) |
|---|---|---|---|
| 0 | Output frequency | Output frequency of the inverter | Maximum frequency (F03) |
| 2 | Output current | Output current (RMS) of the inverter | Twice the inverter rated current |
| 3 | Output voltage | Output voltage (RMS) of the inverter | 250 V for 208 V series, 500 V for 460 V series |
| 4 | Output torque | Motor shaft torque | Twice the rated motor torque |
| 5 | Load factor | Load factor (Equivalent to the indication of the load meter) | Twice the rated motor load, or • Rated output torque of the motor at the base frequency or below • Rated motor output (kW) at the base frequency or above |
| 6 | Input power | Input power of the inverter | Twice the rated output of the inverter |
| 7 | PID feedback value (PV) | Feedback value under PID control | 100% of the feedback value |
| 9 | DC link bus voltage | DC link bus voltage of the inverter | 500 V for 208 V series, 1000 V for 460 V series |
| 10 | Universal AO | Command via communications link (Refer to the RS485 Communications User's Manual (MEH448d)) | 20,000 as 100% |
| 13 | Motor output | Motor output (kW) | Twice the rated motor output |
| 14 | Calibration analog output (+) | Full scale output of the meter calibration | 10 VDC or 20 mA DC |
| 15 | PID process command (SV) | Process command under PID control | 100% of the feedback value |
| 16 | PID process output (MV) | Output level of the PID controller under PID control (Frequency command) | Maximum frequency (F03) |

| F34 | **Analog Output [FMI] (Output adjustment)** |
|---|---|

| F35 | **Analog Output [FMI] (Function)** |
|---|---|

These function codes allow you to output to terminal [FMI] monitored data such as the output frequency and the output current in the form of an analog current. The magnitude of such analog current is adjustable.

### ■ Output adjustment (F34)

F34 allows you to adjust the output current representing the monitored data selected by function code F34 within the range of 0 to 200%.

- Data setting range: 0 to 200 (%)

### ■ Function (F35)

F35 selects the item (object) to monitor and to output to the [FMI] terminal. Those contents, and amounts (Definition of 100%) are the same as those for function code F31. Refer to the table in function code F31.

| F37 | **Load Selection/Auto Torque Boost/Auto Energy Saving Operation** <div align="right">**Refer to F09.**</div> |
|---|---|

Refer to the descriptions of function code F09.

| F43 | **Current Limiter (Mode selection)** <div align="right">**Refer to H12.**</div> |
|---|---|

| F44 | **Current Limiter (Level)** <div align="right">**Refer to H12.**</div> |
|---|---|

When the output current of the inverter exceeds the level specified by the current limiter (F44), the inverter automatically manages its output frequency to prevent a stall and limit the output current.

If F43 = 1, the current limiter is enabled only during constant speed operation. If F43 = 2, the current limiter is enabled during both of acceleration and constant speed operation. Choose F43 = 1 if you need to run the inverter at full capability during acceleration and to limit the output current during constant speed operation.

### ■ Operation selection (F43)

F43 selects the motor running state in which the current limiter will be active.

| Data for F43 | Function |
|---|---|
| 0 | Disable (No current limiter is active.) |
| 1 | Enable the current limiter during constant speed operation |
| 2 | Enable the current limiter during acceleration and constant speed operation |

### ■ Operation level (F44)

F44 selects the operation level at which the current limiter will be active.

- Data setting range: 20 to 120 (%) (Percentage ratio to rated current of the inverter)

Note
- Since the current limit operation with F43 and F44 is performed by software, it may cause a delay in control. If you need a quick response, specify a current limit operation by hardware (H12 = 1) at the same time.

- If an excessive load is applied when the current limiter operation level is set extremely low, the inverter will immediately lower its output frequency. This may cause an overvoltage trip or dangerous turnover of the motor rotation due to undershooting.

## 5.2.2 E codes (Extension terminal functions)

| E01 to E05 | Command Assignment to [X1] to [X5] | Refer to E98 and E99. |
|---|---|---|

Function codes E01 to E05, E98 and E99 allow you to assign commands to terminals [X1] to [X5], [FWD], and [REV] which are general-purpose, programmable input terminals.

These function codes may also switch the logic system between normal and negative to define how the inverter logic interprets either ON or OFF status of each terminal. The default setting is normal logic system "Active ON." So, explanations that follow are given in normal logic system "Active ON."

---

### ⚠CAUTION

In the case of digital input, you can assign commands to the switching means for the run command and its operation, the reference frequency and the motor drive power (e.g., (SS1), (SS2), (SS4), (SS8), (Hz2/Hz1), (SW50), (SW60), (Hz/PID), (IVS), (LE), (LOC), and (FR2/FR1)). Be aware of that switching of any of such signals may cause a sudden start (running) or an abrupt change in speed.

**An accident or physical injury may result.**

---

| Function code data | | Terminal commands assigned | Symbol |
|---|---|---|---|
| Active ON | Active OFF | | |
| 0 | 1000 | Select multistep frequency | (SS1) |
| 1 | 1001 | | (SS2) |
| 2 | 1002 | | (SS4) |
| 3 | 1003 | | (SS8) |
| 4 | 1004 | Select ACC/DEC time | (RT1) |
| 6 | 1006 | Enable 3-wire operation | (HLD) |
| 7 | 1007 | Coast to a stop | (BX) |
| 8 | 1008 | Reset alarm | (RST) |
| 1009 | 9 | Enable external alarm trip | (THR) |
| 11 | 1011 | Switch frequency command 2/1 | (Hz2/Hz1) |
| 13 | — | Enable DC brake | (DCBRK) |
| 15 | — | Switch to commercial power (50 Hz) | (SW50) |
| 16 | — | Switch to commercial power (60 Hz) | (SW60) |
| 17 | 1017 | UP (Increase output frequency) | (UP) |
| 18 | 1018 | DOWN (Decrease output frequency) | (DOWN) |
| 19 | 1019 | Enable write from keypad (Data changeable) | (WE-KP) |
| 20 | 1020 | Cancel PID control | (Hz/PID) |
| 21 | 1021 | Switch normal/inverse operation | (IVS) |
| 22 | 1022 | Interlock | (IL) |
| 24 | 1024 | Enable communications link via RS485 or field bus (option) | (LE) |
| 25 | 1025 | Universal DI | (U-DI) |
| 26 | 1026 | Select starting characteristics | (STM) |
| 1030 | 30 | Force to stop | (STOP) |

| 33 | 1033 | Reset PID integral and differential components | (PID-RST) |
|---|---|---|---|
| 34 | 1034 | Hold PID integral component | (PID-HLD) |
| 35 | 1035 | Select local (keypad) operation | (LOC) |
| 38 | 1038 | Enable to run | (RE) |
| 39 | — | Protect motor from dew condensation | (DWP) |
| 40 | — | Enable integrated sequence to switch to commercial power (50 Hz) | (ISW50) |
| 41 | — | Enable integrated sequence to switch to commercial power (60 Hz) | (ISW60) |
| 50 | 1050 | Clear periodic switching time | (MCLR) |
| 51 | 1051 | Enable Pump Drive (Motor 1) | (MEN1) |
| 52 | 1052 | Enable Pump Drive (Motor 2) | (MEN2) |
| 53 | 1053 | Enable Pump Drive (Motor 3) | (MEN3) |
| 54 | 1054 | Enable Pump Drive (Motor 4) | (MEN4) |
| 70 | 1070 | Switch PID control 2/1 | (PID2/1) |
| 71 | 1071 | Cancel Auto PID switching | (CPS) |
| 72 | 1072 | Cancel start stabilize | (SSC) |
| 87 | 1087 | Switch run command 2/1 | (FR2/FR1) |
| 88 | — | Run forward 2 | (FWD2) |
| 89 | — | Run reverse 2 | (REV2) |
| 98 | — | Run forward (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99) | (FWD) |
| 99 | — | Run reverse (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99) | (REV) |

Note  Any negative logic (Active off) command cannot be assigned to the functions marked with "−" in the "Active OFF" column.

The "Enable external alarm trip" and "Force to stop" are fail-safe terminal commands. For example, when data = "9" in "Enable external alarm trip," Active OFF (alarm is triggered when OFF); when data = 1009, "Active ON" (alarm is triggered when ON).

Terminal function assignment and data setting

■ **Select multistep frequency (1 to 15 steps) – (SS1), (SS2),(SS4) and (SS8)**
   **(Function code data = 0, 1, and 2)**

The combination of ON/OFF states of digital input signals (SS1), (SS2),(SS4) and (SS8) selects one of eight different frequency commands defined beforehand by seven function codes C05 to C19 (Multistep frequency 1 to 15). With this, the inverter can drive the motor at 15 different preset speeds.

The table below lists the frequencies that can be obtained by the combination of switching (SS1), (SS2),(SS4) and (SS8). In the "Selected frequency" column, "Other than multistep frequency" represents the reference frequency commanded by frequency command 1 (F01), frequency command 2 (C30), or others.

| Terminal [X4] (E04) | Terminal [X3] (E03) | Terminal [X2] (E02) | Terminal [X1] (E01) | Selected frequency |
|---|---|---|---|---|
| 3 (SS8) | 2 (SS4) | 1 (SS2) | 0 (SS1) | |
| OFF | OFF | OFF | OFF | Other than multistep frequency |
| OFF | OFF | OFF | ON | C05 (Multistep frequency 1) |
| OFF | OFF | ON | OFF | C06 (Multistep frequency 2) |
| OFF | OFF | ON | ON | C07 (Multistep frequency 3) |
| OFF | ON | OFF | OFF | C08 (Multistep frequency 4) |
| OFF | ON | OFF | ON | C09 (Multistep frequency 5) |
| OFF | ON | ON | OFF | C10 (Multistep frequency 6) |
| OFF | ON | ON | ON | C11 (Multistep frequency 7) |
| ON | OFF | OFF | OFF | C12 (Multistep frequency 8) |
| ON | OFF | OFF | ON | C13 (Multistep frequency 9) |
| ON | OFF | ON | OFF | C14 (Multistep frequency 10) |
| ON | OFF | ON | ON | C15 (Multistep frequency 11) |
| ON | ON | OFF | OFF | C16 (Multistep frequency 12) |
| ON | ON | OFF | ON | C17 (Multistep frequency 13) |
| ON | ON | ON | OFF | C18 (Multistep frequency 14) |
| ON | ON | ON | ON | C19 (Multistep frequency 15) |

Note   For details, refer to the description of C05 to C19.

■ **Select ACC/DEC time -- (RT1)**
  **(Function code data = 4)**

This terminal command switches between ACC/DEC time 1 (F07 or F08) or ACC/DEC time 2 (E10 or E11).

If no (RT1) command is assigned, ACC/DEC time 1 (F07/F08) takes effect by default.

| Input terminal command(FWD) | Acceleration/deceleration time |
|---|---|
| OFF | Acceleration/deceleration time 1 (F07/F08) |
| ON | Acceleration/deceleration time 2 (E10/E11) |

■ **Enable 3-wire operation -- (HLD)**
  **(Function code data = 6)**

Turning this terminal command ON self-holds the forward (FWD) or reverse (REV) run command issued with it, to enable 3-wire inverter operation.

Short-circuiting the terminals between (HLD) and [CM] (i.e., when (HLD) is ON) self-holds the first (FWD) or (REV) command at its leading edge. Turning (HLD) OFF releases the self-holding.

When (HLD) is not assigned, 2-wire operation involving only (FWD) and (REV) takes effect.
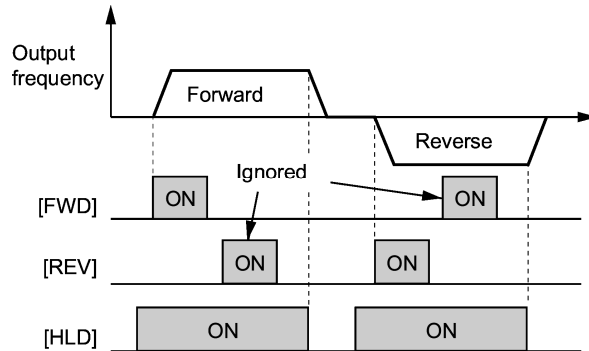


■ **Coast to a stop -- (BX)**
  **(Function code data = 7)**

Short-circuiting the terminals between (BX) and [CM] will immediately shutdown the inverter output so that the motor will enter the coast-to-stop operation without issuing any alarms.

■ **Reset alarm -- (RST)**
  **(Function code data = 8)**

Turning this terminal command ON clears the (ALM) state--alarm output (for any fault). Turning it OFF erases the alarm display and clears the alarm hold state.

When you turn the (RST) command ON, keep it ON for 10 ms or more. This command should be kept OFF for the normal inverter operation.
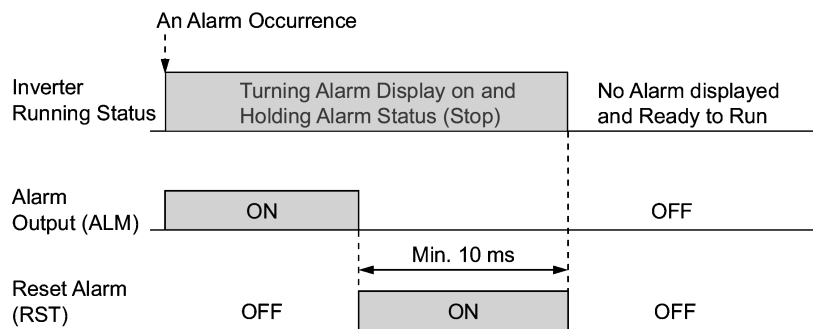
■ **Enable external alarm trip -- (THR)**
   **(Function code data = 9)**

Turning this terminal command OFF immediately shuts down the inverter output (so that the motor coasts to stop), displays the alarm *0h2*, and outputs the alarm relay (for any fault) (ALM). The (THR) is self-held, and is reset when an alarm reset takes place.

> Tip    Use a trip command from external equipment when you have to immediately shut down the inverter output in the event of an abnormal situation in a peripheral equipment.

■ **Switch frequency command 2/1 -- (Hz2/Hz1)**
   **(Function code data = 11)**

Turning this digital input signal ON and OFF switches the frequency command source between frequency command 1 (Hz1: F01) and frequency command 2 (Hz2: C30).

If nothing is assigned to this terminal command, the frequency specified by F01 takes effect by default.

| Frequency command (Hz2/Hz1) | Frequency command source |
|---|---|
| OFF | Follow F01 (Frequency command 1) |
| ON | Follow C30 (Frequency command 2) |

■ **Enable DC brake -- (DCBRK)**
   **(Function code data = 13)**

Turing this terminal command ON activates the DC injection braking. As long as this command remains ON, the DC injection braking is working regardless of the injection braking time specified by F22. Furthermore, turning this command ON even when the inverter is in a stopped state activates DC injection braking. This feature allows the motor to be excited before starting, resulting in smoother acceleration (quicker build-up of acceleration torque).

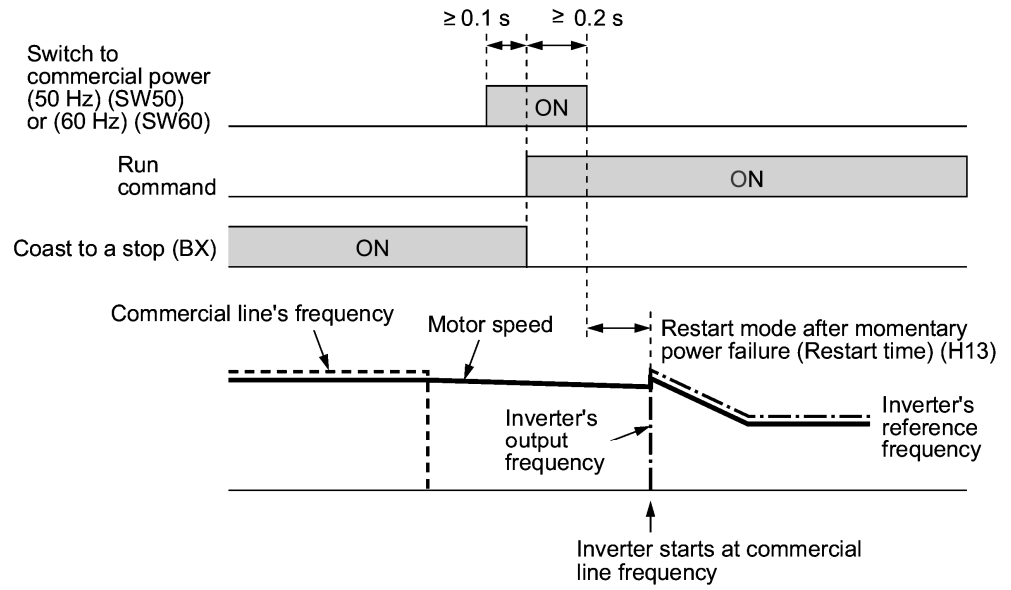> Note    For details, refer to the description of F20 to F22.

■ **Switch to commercial power for 50 Hz or 60 Hz -- (SW50) or (SW60)**

**(Function code data = 15, 16)**

When an external sequence switches the motor drive power from the commercial lines to the inverter according to the operation scheme shown on the next page, the terminal command (SW50) or (SW60) enables the FRENIC-Eco inverter to start running the motor with the current commercial power frequency, regardless settings of the reference/output frequency in the inverter. A running motor driven by commercial power is carried on into inverter operation. This command helps you smoothly switch the motor drive power source from the commercial power to the inverter power. For details, refer to the table below, the operation scheme and an example of an external sequence and its operation time scheme on the next following pages.
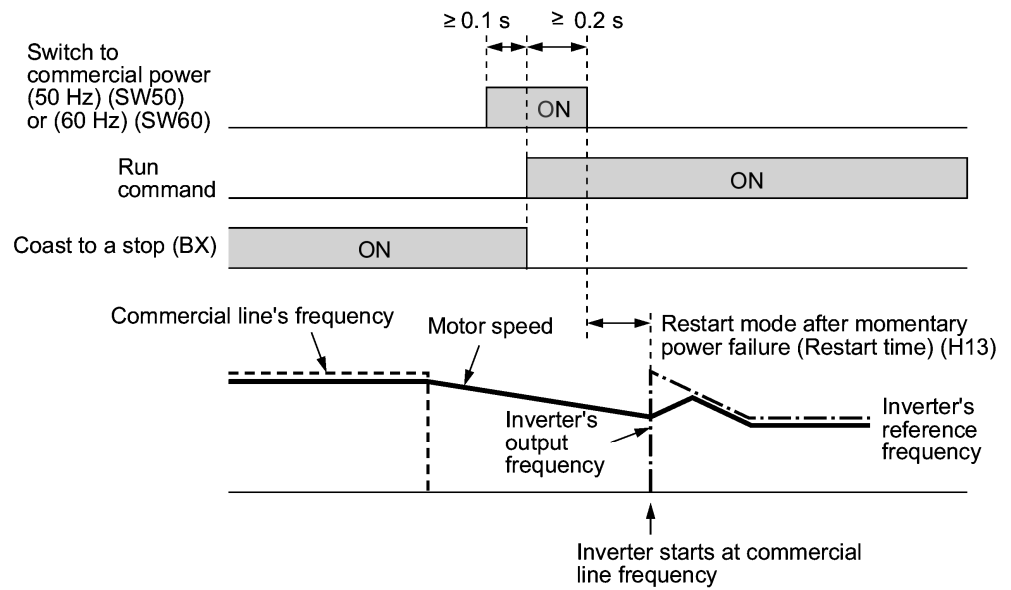
| Assignment | The inverter: | Description |
|---|---|---|
| (SW50) | Starts at 50 Hz. | Do not concurrently assign both (SW50) and (SW60). |
| (SW60) | Starts at 60 Hz. |  |

Operation Scheme

- When the motor speed remains almost the same during coast-to-stop:

≥ 0.1 s    ≥ 0.2 s

Switch to commercial power (50 Hz) (SW50) or (60 Hz) (SW60) — ON

Run command — ON

Coast to a stop (BX) — ON

Commercial line's frequency

Motor speed

Restart mode after momentary power failure (Restart time) (H13)

Inverter's output frequency

Inverter's reference frequency

Inverter starts at commercial line frequency

- When the motor speed decreases significantly during coast-to-stop:

≥ 0.1 s    ≥ 0.2 s

Switch to commercial power (50 Hz) (SW50) or (60 Hz) (SW60) — ON

Run command — ON

Coast to a stop (BX) — ON

Commercial line's frequency

Motor speed

Restart mode after momentary power failure (Restart time) (H13)

Inverter's output frequency

Inverter's reference frequency

Inverter starts at commercial line frequency

**Note**

- Secure more than 0.1 second after turning ON the "Switch to commercial power" signal before turning ON a run command.

- Secure more than 0.2 second of an overlapping period with both the "Switch to commercial power" signal and run command being ON.

- If an alarm has been issued or (BX) has been ON when the motor drive source is switched from the commercial power to the inverter, the inverter will not be started at the commercial power frequency and will remain OFF. After the alarm has been reset or (BX) turned OFF, operation at the frequency of the commercial power will not be continued, and the inverter will be started at the ordinary starting frequency.

  If you wish to switch the motor drive source from the commercial line to the inverter, be sure to turn (BX) OFF before the "Switch to commercial power" signal is turned OFF.

- When switching the motor drive source from the inverter to commercial power, adjust the inverter's reference frequency at or slightly higher than that of the commercial power frequency beforehand, taking into consideration the motor speed down during the coast-to-stop period produced by switching.

- Note that when the motor drive source is switched from the inverter to the commercial power, a large inrush current will be generated, because the phase of the commercial power usually does not match the motor speed at the switching. Make sure that the power supply and all the peripheral equipment are capable of withstanding this inrush current.

- If you have selected "Enable restart after a momentary power failure" (F14 = 3, 4, or 5), keep (BX) ON during commercial power driven operation to prevent the inverter from restarting after a momentary power failure.

Example of Sequence Circuit

Main power supply

Operation mode switch

Run 3S    Stop 5S

INV — Commercial 43
Normal — Emergency 44

Inverter

R S T    RO TO    CM    FWD    X1 (SW50)    X2 (BX)

Run forward command FWD    Commercial line T2    Coast-to-stop BX

U V W    THR    MC2    CM    (RUN) Y1    (ALM) 30A    30C

DC 24V    RUN    Alarm 30

IM

MC3    MC1

Control power supply

OPX    E— 5S (Stop) INV    E— 3S (Run)

43    Commercial    30    T3    MC3    RUN    OPX    MC2

Note 1) Emergency switch    Normal    Emer-gency    44

Note 2) Alarm 30

OPX    MC2    OPX    THR    MC2    T1

OPX    MC1    T3    MC2    T1    FWD    MC3    T2    BX

Run command    Driven by inverter    Driven by commercial line

Note 1) Emergency switch
Manual switch provided for the event that the motor drive source cannot be switched normally to the commercial power due to a serious problem of the inverter

Note 2) When any alarm has occurred inside the inverter, the motor drive source will automatically be switched to the commercial power.

## Example of Operation Time Scheme
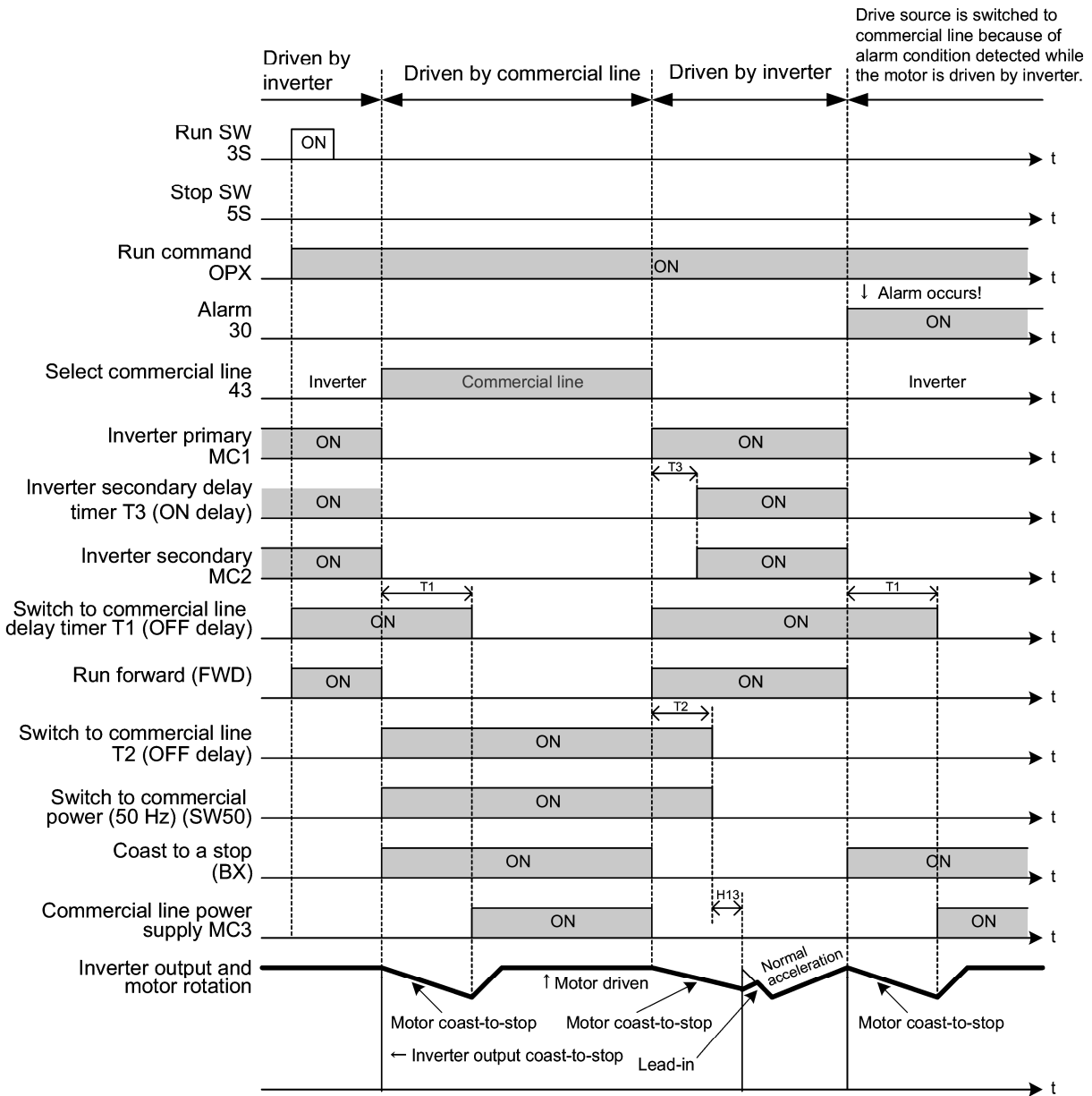


Tip — Alternatively, you may use the integrated sequence by which some of the actions above are automatically performed by the inverter itself. For details, refer to the description of (ISW50) and (ISW60).

■ **UP and DOWN commands -- (UP) and (DOWN)**
  **(Function code data = 17, 18)**

• Frequency setting

When the UP/DOWN control is selected for frequency setting with the run command ON, turning the (UP) or (DOWN) command ON causes the output frequency to increase or decrease, respectively, within the range from 0 Hz to the maximum frequency as listed below.

| Data = 17 | Data = 18 | Function |
|-----------|-----------|----------|
| (UP) | (DOWN) | |
| OFF | OFF | Keep the current output frequency. |
| ON | OFF | Increase the output frequency over the acceleration time specified by function code F07. |
| OFF | ON | Decrease the output frequency over the deceleration time specified by function code F08. |
| ON | ON | Keep the current output frequency. |

In UP/DOWN control, the inverter saves the current output frequency in its internal memory. At the time of restart (including powering on), it drives the motor at the frequency saved in the memory in the last operation. Refer to the timing scheme diagram shown below and table on the next page, for details of this operation.

⌒Note  At the time of restart, if an (UP) or (DOWN) command is entered before the internal frequency reaches the frequency saved in the memory, the inverter saves the current output frequency into the memory and starts the UP/DOWN control with the new frequency. The previous frequency saved will be overwritten by the current one and be lost.
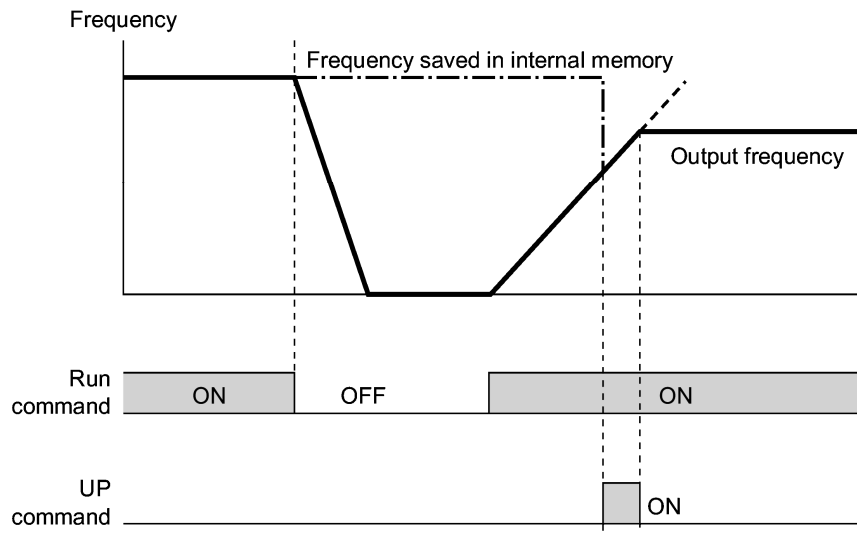
<u>Initial settings of UP/DOWN control when the frequency command source is switched:</u>

When the frequency command source is switched to UP/DOWN control from other sources, the initial frequency of the UP/DOWN control is as follows:

| Frequency command source | Switching command | Initial frequency of UP/DOWN control |
|---|---|---|
| Other than UP/DOWN (F01, C30) | Frequency command 2/1 (Hz2/Hz1) | Reference frequency given by the frequency command source just before switching |
| Local (keypad) | Select local (keypad) operation (LOC) | Digital reference frequency given by the keypad |
| PID conditioner | Cancel PID control (Hz/PID) | Reference frequency given by PID control (PID controller output) |
| Multistep frequency | Select multistep frequency (SS1) to (SS8) | Reference frequency at the time of previous UP/DOWN control |
| Communications link | Enable communications link (LE) | |

Note   To enable the UP command (UP) and the DOWN command (DOWN), you need to set frequency command 1 (F01) or frequency command 2 (C30) to "7" beforehand.

• PID process command

While UP/DOWN control is selected as the PID process command, turning the (UP) or (DOWN) command ON when the run command is ON causes the process command to change within the range of 0 to 100%.

The setting is enabled in units of the process amount according to the PID display coefficients.

| (UP) | (DOWN) | Function |
|---|---|---|
| Data = 17 | Data = 18 | |
| OFF | OFF | Retain the current process command |
| ON | OFF | Increase the process command at a rate between 0.1%/0.1 s and 1%/0.1 s. |
| OFF | ON | Decrease the process command at a rate between 0.1%/0.1 s and 1%/0.1 s. |
| ON | ON | Retain the current process command |

The process command specified by UP/DOWN control is internally retained. At the time of restart (including power on), the operation resumes with the previous process command.

Note   To enable the (UP) or (DOWN) command, you need to set the remote process command (J02 = 4) beforehand.

📖 For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

📖 For details of displaying the PID process command, refer to the descriptions of function codes E40 and E41 (PID display coefficients A and B).

■ **Enable write from keypad -- (WE-KP)**
**(Function code data = 19)**

Turning this terminal command OFF disables changing of function code data from the keypad.

Only when this command is ON, you can change function code data from the keypad according to the setting of function code F00 as listed below.

| (WE-KP) | F00 | Function |
|---------|---------|----------|
| OFF | Disable | Disable editing of all function code data except that of F00. |
| ON | 0 | Enable editing of all function code data |
| | 1 | Inhibit editing of all function code data except that of F00 |

If the (WE-KP) command is not assigned to any terminal, the inverter will interpret (WE-KP) to be always ON by default.

Note: If you mistakenly assign a (WE-KP) command to a terminal, you cannot edit or modify function code data anymore. In such a case, temporarily short-circuit (turn ON) the (WE-KP)-assigned terminal to the terminal [CM], and then reassign the (WE-KP) command to a correct terminal.

■ **Cancel PID control -- (Hz/PID)**
**(Function code data = 20)**

Turning this terminal command ON disables the PID control.

If the PID control is disabled with this command, the inverter runs the motor with the reference frequency manually set by any of the multistep, keypad, analog input, etc.

| (Hz/PID) | Function |
|----------|----------|
| OFF | Enable PID control |
| ON | Disable PID control/Enable manual settings |

For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

■ **Switch normal/inverse operation -- (IVS)**
**(Function code data = 21)**

This terminal command switches the output frequency control between normal (proportional to the input value) and inverse in PID process control and manual frequency command. To select the inverse operation, turn the (IVS) command ON.
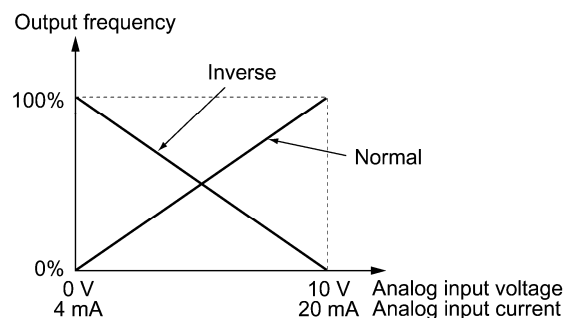


Tip: The normal/inverse switching operation is useful for air-conditioners that require switching between cooling and heating. In cooling, the speed of the fan motor (output frequency of the inverter) is increased to lower the temperature. In heating, it is reduced to lower the temperature. This switching is realized by the "Switch normal/inverse operation" command.

- When the inverter is driven by an external analog frequency command sources (terminals [12], [C1], and [V2]):

The "Switch normal/inverse operation" command (IVS) can apply only to the analog frequency command sources (terminals [12], [C1] and [V2]) in frequency command 1 (F01) and does not affect frequency command 2 (C30) or UP/DOWN control.

As listed below, the combination of the "Selection of normal/inverse operation for frequency command 1" (C53) and "Switch normal/inverse operation" (IVS) determines the final operation.

Combination of C53 and (IVS)

| Data for C53 | (IVS) | Final operation |
|---|---|---|
| 0: Normal operation | OFF | Normal |
| | ON | Inverse |
| 1: Inverse operation | OFF | Inverse |
| | ON | Normal |

- When the process control is performed by the PID control facility integrated in the inverter:

The "Cancel PID control" command (Hz/PID) can switch the PID control between enabled (process is to be controlled by the PID processor) and disabled (process is to be controlled by the manually frequency setting). In either case, the combination of the "PID control" (J01) or "Selection of normal/inverse operation for frequency command 1" (C53) and "Switch normal/inverse operation" (IVS) determines the final operation as listed below.

When the PID control is enabled:
The normal/inverse operation selection for the PID processor output (reference frequency) is as follows.

| PID control (Mode selection) (J01, J70) | (IVS) | Final operation |
|---|---|---|
| 1: Enable (normal operation) | OFF | Normal |
| | ON | Inverse |
| 2: Enable (inverse operation) | OFF | Inverse |
| | ON | Normal |

When the PID control is disabled:
The normal/inverse operation selection for the manual reference frequency is as follows.

| Selection of normal/inverse operation for frequency command 1 (C53) | (IVS) | Final operation |
|---|---|---|
| 0: Normal operation | − | Normal |
| 1: Inverse operation | − | Inverse |

Note: When the process control is performed under the PID control facility integrated in the inverter, the "Switch normal/inverse operation" (IVS) is used to switch the input (frequency setting) of the PID processor between normal and inverse, and has no effect on any normal/inverse operation selection of the manual frequency setting.

For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator".

## ■ Interlock -- (IL)
### (Function code data = 22)

In a configuration where a magnetic contactor (MC) is installed in the power output (secondary) circuit of the inverter, the momentary power failure detection feature provided inside the inverter may not be able to accurately detect a momentary power failure by itself. Using a digital signal input with the interlock command (IL) assures the accurate detection.

| (IL) | Meaning |
|------|---------|
| OFF | No momentary power failure has occurred. |
| ON | A momentary power failure has occurred. (Restart after a momentary power failure enabled) |

The details are as follows: When the inverter detects an undervoltage condition whereby the DC link bus voltage drops below the lower limit, it recognizes the state as a momentary power failure. In the configuration above, however, the momentary power failure may shut down the exciter power for the MC, causing the MC to open. Opening the MC circuit cuts off the inverter from the motor so that the voltage drop in the DC link bus is not high enough to be recognized as a power failure. Accordingly, the "Restart after a momentary power failure" function does not work properly as designed. To assure the accurate detection, connect an interlock command (IL) line to the auxiliary contact of the MC as shown below.
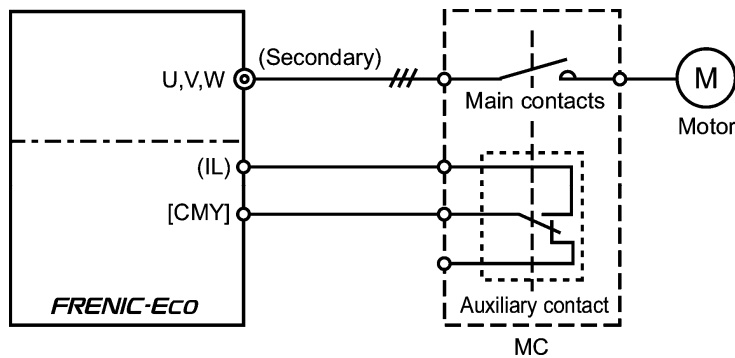


## ■ Enable communications link -- (LE)
### (Function code data = 24)

Turning this terminal command ON assigns priorities to frequency commands or run commands received via the RS485 communications link (H30) or the field bus option (y98).

No (LE) assignment is functionally equivalent to the (LE) being ON.

📖 For details of switching, refer to H30 (Communications link function) and y98 (Bus link function.

## ■ Universal DI -- (U-DI)
### (Function code data = 25)

Using (U-DI) enables the inverter to monitor digital signals sent from the peripheral equipment via an RS485 communications link or a field bus option by feeding those signals to the digital input terminals. Signals assigned to the universal DI are simply monitored and do not operate the inverter.

📖 For an access to universal DI via the RS485 or field bus communications link, refer to their respective Instruction Manuals.

■ **Select starting characteristics -- (STM)**
  **(Function code data = 26)**

This digital terminal command determines, at the start of operation, whether or not to search for idling motor's speed and follow it.

📖 For details of auto search for idling motor's speed, refer to H09 and H17 (Select starting characteristics).

■ **Force to stop -- (STOP)**
  **(Function code data = 30)**

Turning this terminal command OFF causes the motor to decelerate to a stop during the time specified by H56 (Deceleration time for forced stop). After the motor stops, the inverter enters the alarm state with alarm $Er-6$. Apply this command to a failsafe facility.

■ **Reset PID integral and differential components -- (PID-RST)**
  **(Function code data = 33)**

Turning this terminal command ON resets the integral and differential components of the PID processor.

📖 For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

■ **Hold PID integral component -- (PID-HLD)**
  **(Function code data = 34)**

Turning this terminal command ON holds the integral components of the PID processor.

📖 For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

■ **Select local (keypad) operation -- (LOC)**
  **(Function code data = 35)**

This terminal command switches the source of the run command and frequency command between remote and local by an external digital input signal.

📖 For details of the local mode, refer to "Switching between remote and local modes" in Section 3.6.1.

■ **Enable to run -- (RE)**
  **(Function code data = 38)**

Assigning this terminal command to a digital input terminal prevents the inverter from starting to run upon receipt of a run command only. If the inverter receives a run command, it readies itself for running and outputs the status signal "Run command activated" (AX2)*. At this status, turning the (RE) command ON causes the inverter to actually start running.

*For the (AX2) signal, refer to function codes E20 to E27.

| Input | | Output | Inverter's operation |
|---|---|---|---|
| Run command e.g., (FWD) | (RE) | (AX2) "Run command activated" | |
| OFF | OFF | OFF | Stop |
| OFF | ON | OFF | Stop |
| ON | OFF | ON | Stop |
| ON | ON | ON | Run |

Listed below is a typical example of starting sequence:

(1)  A run command (FWD) is issued to the inverter.

(2)  Upon receipt of the run command, the inverter readies itself for running and outputs the status signal "Run command activated" (AX2).

(3)  Upon receipt of the (AX2) signal, the host equipment starts preparation for the peripheral devices such as opening the mechanical damper/brake.

(4)  Upon completion of the preparation for the peripheral devices, the host equipment issues the "Enable to run" command (RE) to the inverter.

(5)  Upon receipt of the (RE), the inverter starts operation.

■ **Protect motor from dew condensation -- (DWP)**
   **(Function code data = 39)**

Turning this terminal command ON supplies a DC current to the motor that is on halt in order to generate heat, preventing dew condensation.

📖 For details of dew condensation protection, refer to function code J21 (Dew condensation prevention (Duty)).

■ **Enable integrated sequence to switch to commercial power (50 Hz) -- (ISW50)**
   **Enable integrated sequence to switch to commercial power (60 Hz) -- (ISW60)**
   **(Function code data = 40, 41)**

With the terminal command (ISW50) or (ISW60) assigned, the inverter controls the magnetic contactor that switches the motor drive source between the commercial power and the inverter output according to the integrated sequence.

This control is effective when not only (ISW50) or (ISW60)* has been assigned to the input terminal but also the (SW88) and (SW52-2)** signals have been assigned to the output terminals. (It is not essential to assign a (SW52-1) signal.)

*  The (ISW50) or (ISW60) should be selected depending upon the frequency of the commercial power; the former for 50 Hz and the latter for 60 Hz.

** For the (SW88) and (SW52-2) signals for "Switch motor drive source between commercial power and inverter output," refer to function codes E20 to E27.
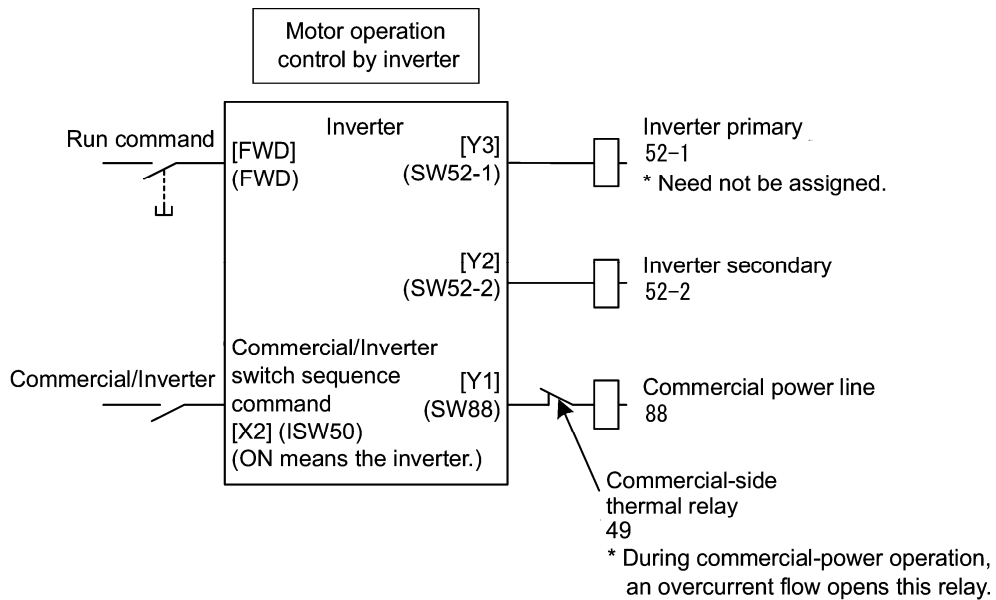
For details of these commands, refer to the circuit diagrams and timing schemes on the following pages.

| Terminal command assigned | Operation (Switching from commercial power to inverter) |
|---|---|
| (ISW50) Enable integrated sequence to switch to commercial power (50 Hz) | Start at 50 Hz. |
| (ISW60) Enable integrated sequence to switch to commercial power (60 Hz) | Start at 60 Hz. |

Note  Do not assign both (ISW50) and (ISW60) at the same time. Doing so cannot guarantee the result.

Circuit Diagram and Configuration

## Main Circuit

Commercial power 88 | Thermal relay 49

Main power — R, S, T

Inverter: R, S, T, R0, T0 / U, V, W

Motor — M

Inverter primary 52-1

Inverter secondary 52-2
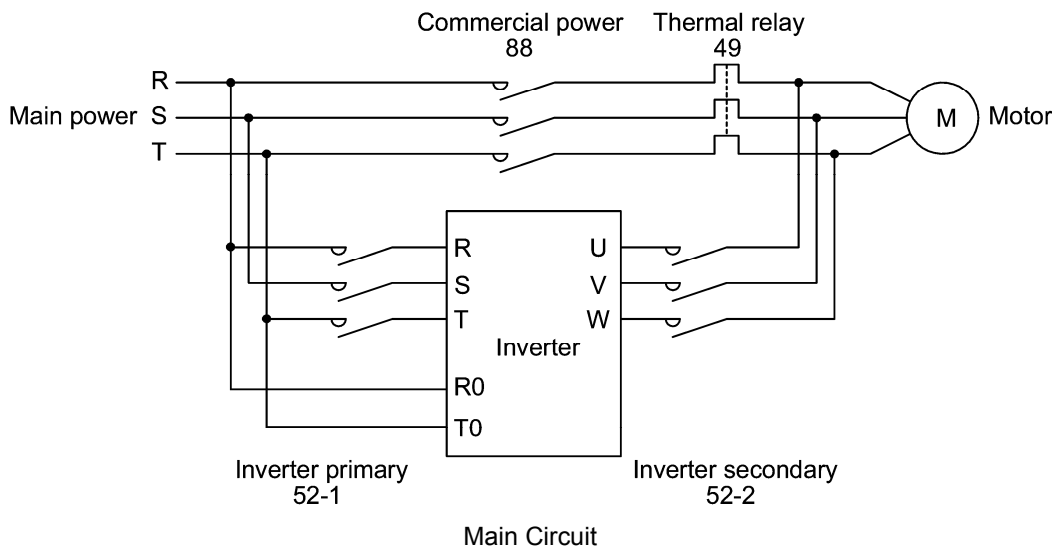
## Configuration of Control Circuit

Motor operation control by inverter

Run command — [FWD] (FWD)

Inverter

[Y3] (SW52-1) → Inverter primary 52-1 * Need not be assigned.

[Y2] (SW52-2) → Inverter secondary 52-2

Commercial/Inverter switch sequence command [X2] (ISW50) (ON means the inverter.)

[Y1] (SW88) → Commercial power line 88

Commercial/Inverter

Commercial-side thermal relay 49
* During commercial-power operation, an overcurrent flow opens this relay.

## Summary of Operation

| Input | | Output (Status signal and magnetic contactor) | | | Inverter operation |
|---|---|---|---|---|---|
| (ISW50) or (ISW60) | Run command | (SW52-1) 52-1 | (SW52-2) 52-2 | (SW88) 88 | |
| OFF (Commercial power) | ON | OFF | OFF | ON | OFF |
| | OFF | | | OFF | |
| ON (Inverter) | ON | ON | ON | OFF | ON |
| | OFF | | | | OFF |

<u>Timing Scheme</u>

Switching from inverter operation to commercial-power operation
(ISW50)/(ISW60): ON → OFF

(1)   The inverter output is shut off immediately (Power gate IGBT OFF)

(2)   The inverter primary circuit (SW52-1) and the inverter secondary side (SW52-2) are turned off immediately.

(3)   If a Run command is present after a lapse of t1 (time specified by function code H13 + 0.2 sec), the commercial power circuit (SW88) is turned on .


Switching from commercial-power operation to inverter operation
(ISW50)/(SW60): OFF → ON

(1)   The inverter primary circuit (SW52-1) is turned on immediately .

(2)   The commercial power circuit (SW88) is immediately shut off,

(3)   After an elapse of t2 (time required for the main circuit to get ready + 0.2 sec) after (SW52-1) is turned on, the inverter secondary circuit (SW52-2) is turned on.

(4)   After an elapse of t3 (time specified by H13 + 0.2 sec) from when (SW52-2) is turned on, the inverter starts to synchronize the motor that has freed from the commercial-power operation. Then the motor returns to the operation driven by the inverter.
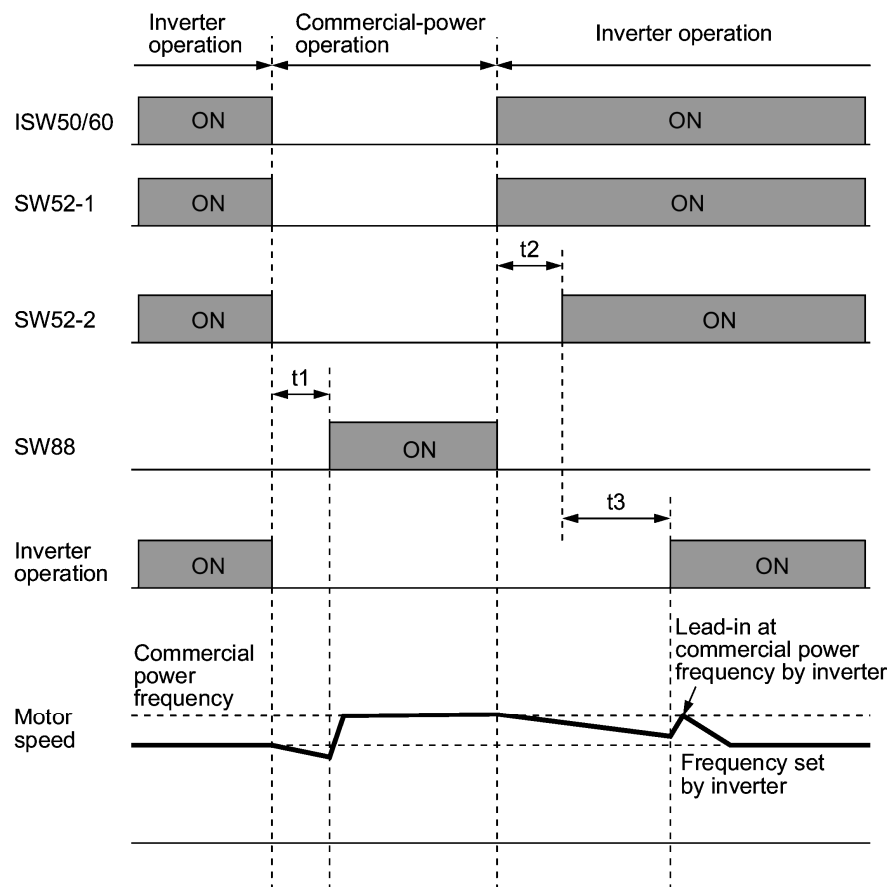


t1:   0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

t2:   Time required for inverter to get ready + 0.2 sec

t3:   0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

Selection of Commercial Power Switching Sequence

Function code J22 specifies whether or not to automatically switch to commercial-power operation when an inverter alarm occurs.

| Data for J22 | Sequence (for occurrence of an alarm) |
|---|---|
| 0 | Keep inverter-operation (Stop due to alarm.) |
| 1 | Automatically switch to commercial-power operation |

Note
- The sequence operates normally also even when (SW52-1) is not used and the main power of the inverter is supplied at all times.
- Using (SW52-1) requires connecting the input terminals [R0] and [T0] for an auxiliary control power. Without the connection, turning (SW52-1) OFF loses also the control power.
- The sequence operates normally even if an alarm occurs in the inverter except when the inverter itself is broken. Therefore, for a critical facility, be sure to install an emergency switching circuit outside the inverter.
- Turning ON both the magnetic contactor MC (88) at the commercial-power side and the MC (52-2) at the inverter output side at the same time supplies main power mistakenly from the output (secondary) side of the inverter, damaging the inverter. To prevent it, be sure to set up an interlocking logic outside the inverter.
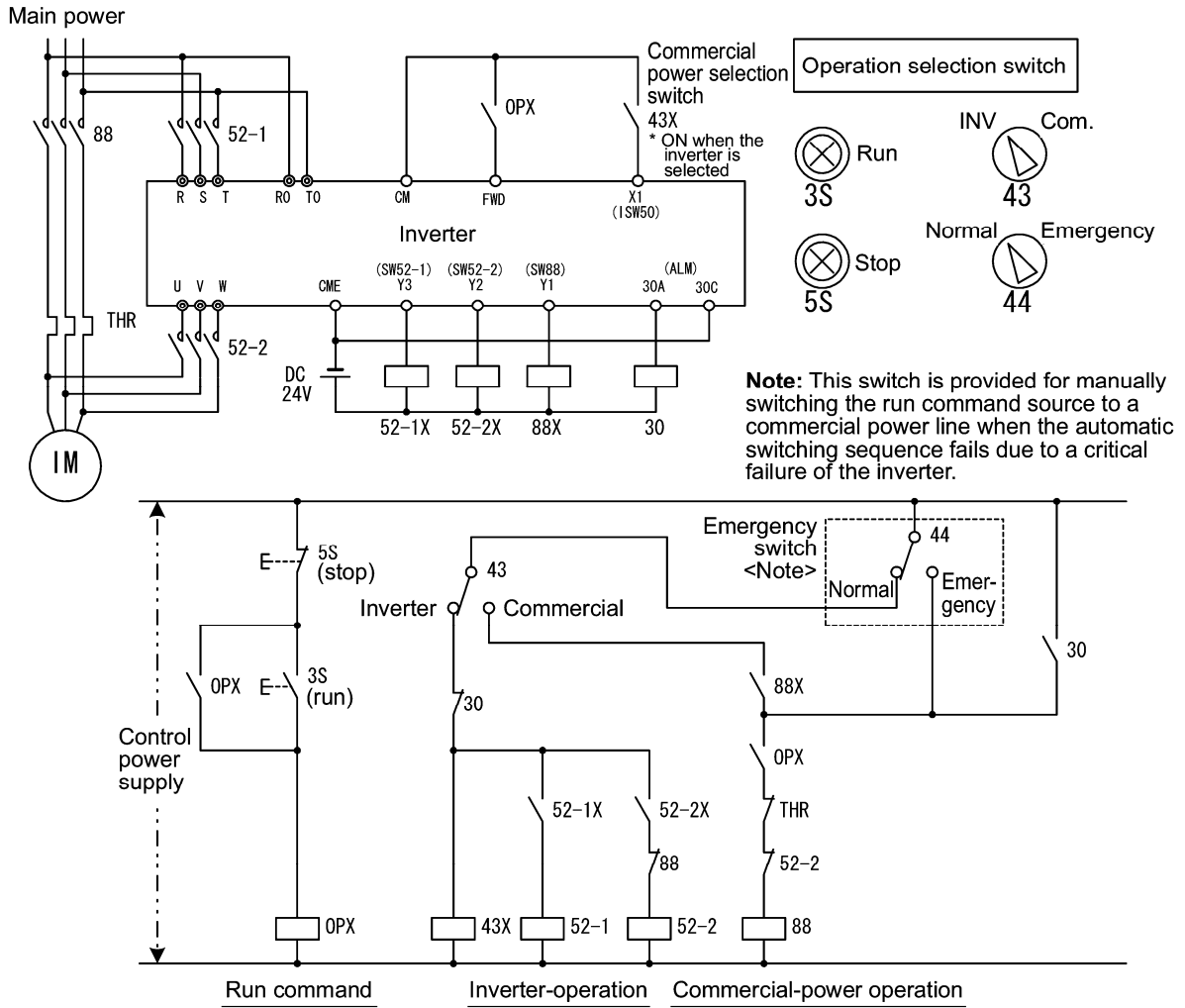
Examples of Sequence Circuits

1) Standard sequence
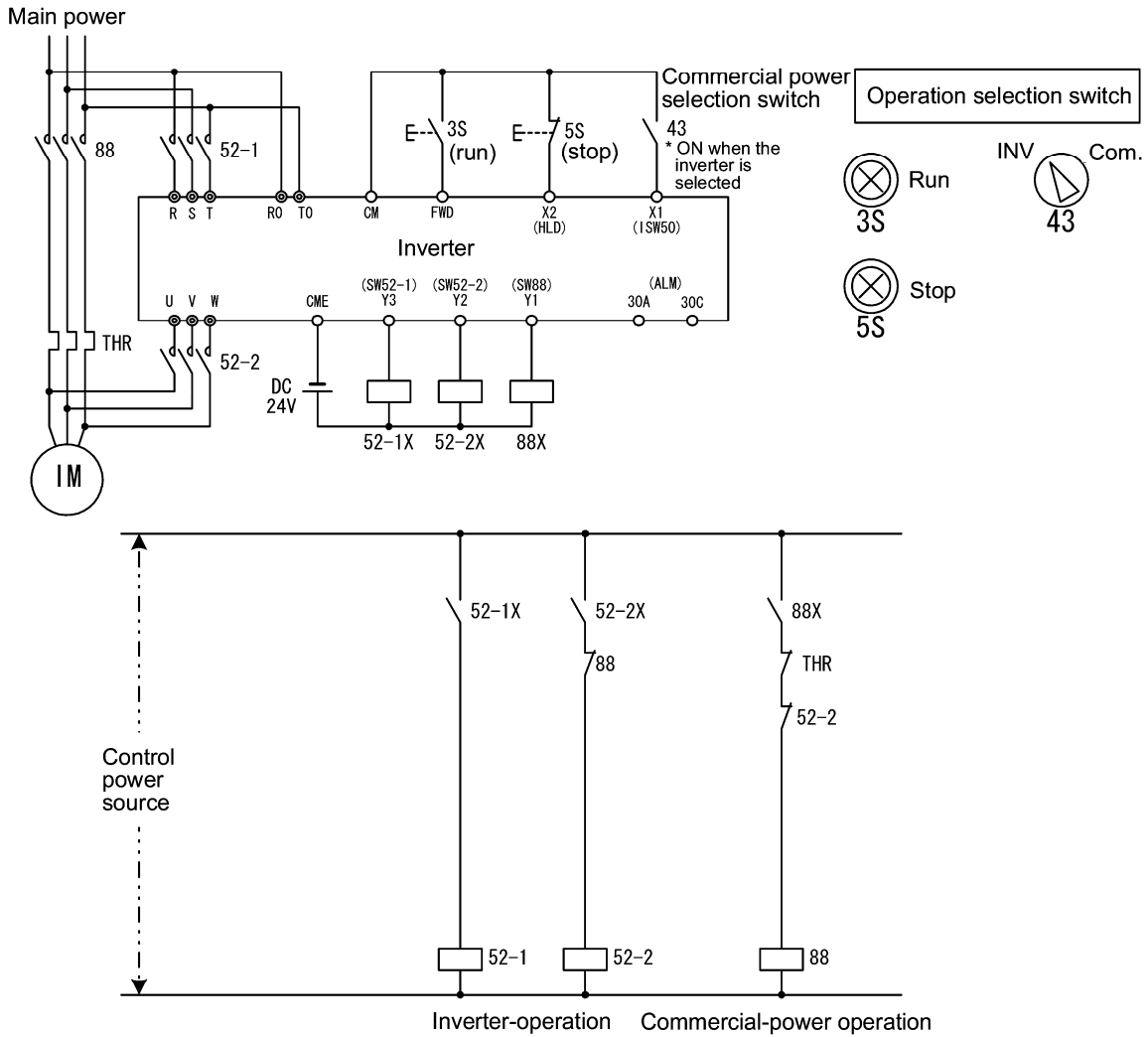
## 2) Sequence with an emergency switching function
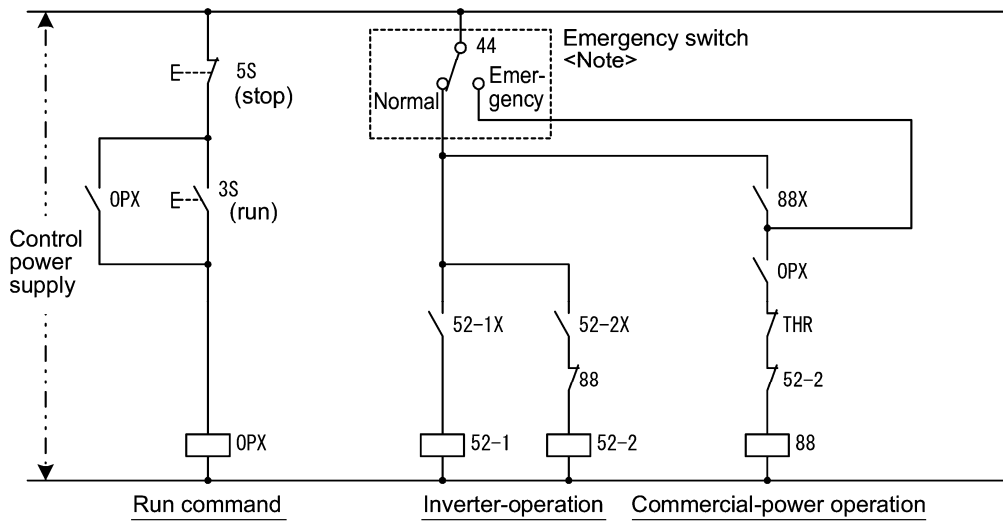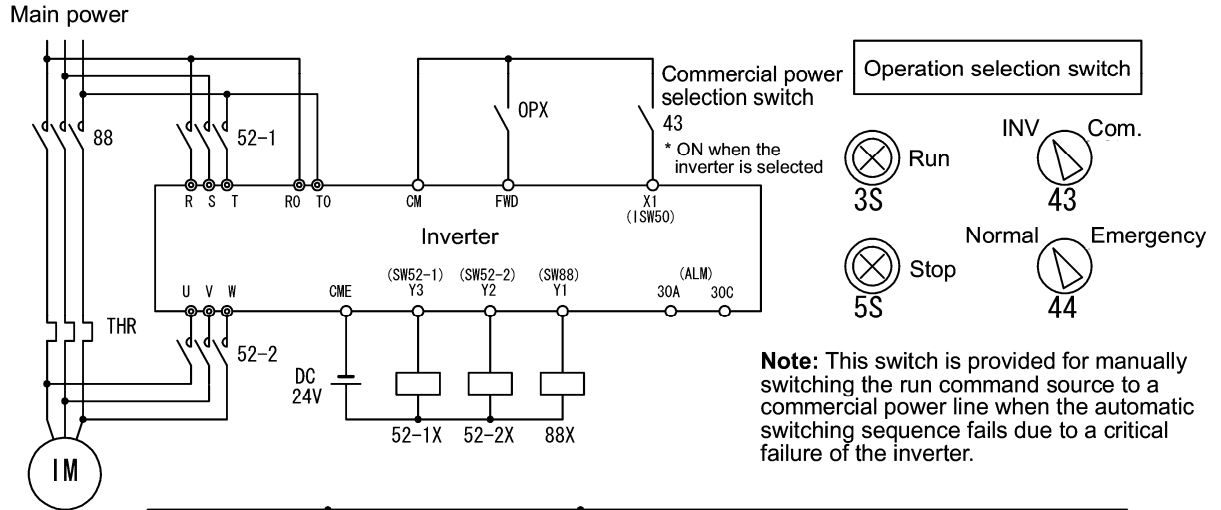
3) Sequence with an emergency switching function --Part 2 (Automatic switching by the alarm output issued by the inverter)

Main power

Commercial power selection switch

43X
* ON when the inverter is selected

Operation selection switch

INV    Com.
43

Normal    Emergency
44

⊗ Run
3S

⊗ Stop
5S

Inverter

R S T    RO TO    CM    FWD    X1 (ISW50)

U V W    CME    (SW52-1) Y3    (SW52-2) Y2    (SW88) Y1    (ALM) 30A 30C

THR

52-2

DC 24V

52-1X    52-2X    88X    30

**Note:** This switch is provided for manually switching the run command source to a commercial power line when the automatic switching sequence fails due to a critical failure of the inverter.

Emergency switch <Note>

Normal    Emer-gency

44

E---7 5S (stop)

43

Inverter    Commercial

30

OPX    E-- 3S (run)

88X

OPX

THR

30

Control power supply

52-1X    52-2X

88

52-2

OPX    43X    52-1    52-2    88

Run command    Inverter-operation    Commercial-power operation

■ **Clear periodic switching time -- (MCLR)**
   **(Function code data = 50)**

For details, refer to the description of J32.


■ **Enable Pump Drive (Motor 1) -- (MEN1)**
■ **Enable Pump Drive (Motor 2) -- (MEN2)**
■ **Enable Pump Drive (Motor 3) -- (MEN3)**
■ **Enable Pump Drive (Motor 4) -- (MEN4)**
   **(Function code data = 51, 52, 53 and 54)**

For details, refer to the description of J26 to J29.


■ **Switch PID control 2/1 -- (PID2/1)**
   **(Function code data = 70)**

Turning this digital input signal ON and OFF switches the PID control between PID control 1 (J01) and PID control 2 (J70).

No (PID2/1) assignment is functionally equivalent to the (PID2/1) being OFF.

| Switch PID control 2/1 (PID2/1) | PID control |
|---|---|
| OFF | Follow J01 (PID control 1) |
| ON | Follow J70 (PID control 2) |

For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .


■ **Cancel Auto PID switching -- (CPS)**
   **(Function code data = 71)**

Turning this terminal command ON disables the auto switching of PID controller.

No (CPS) assignment is functionally equivalent to the (CPS) being OFF.

| Cancel Auto PID switch (CPS) | Function |
|---|---|
| OFF | Enable auto switching of PID controller |
| ON | Disable auto switching of PID controller |

For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .


■ **Cancel start stabilize -- (SSC)**
   **(Function code data = 72)**

Turning this terminal command ON disables the start stabilize of PID control.

No (SSC) assignment is functionally equivalent to the (SSC) being OFF.

| Cancel start stabilize (SSC) | Function |
|---|---|
| OFF | Enable start stabilize of PID control |
| ON | Disable start stabilize of PID control |

For details, refer to the description of J07 to J10.

■ **Switch run command 2/1 -- (FR2/FR1)**
   **Run forward 2 and Run reverse 2 -- (FWD2) and (REV2)**
   **(Function code data = 87, 88 or 89)**

These terminal commands switch the run command source. They are useful to switch the source between the digital input and the local keypad when the "Enable communications link" command (LE) and "Select local (keypad) operation" command (LOC) are turned OFF.

| (FR2/FR1) | Run command source | |
|---|---|---|
| | Communications link disabled (Normal operation) | Communications link enabled |
| OFF | Follow the data of F02 | Follow the data of S06 (FWD/REV) |
| ON | (FWD2) or (REV2) | Follow the data of S06 (FWD2/REV2) |

Turning the (FWD2) command ON runs the motor forward, and turning the (REV2) command, reverse. Turning either of them OFF decelerates the motor to stop.

■ **Run forward -- (FWD)**
   **(Function code data = 98)**

Turning this terminal command ON runs the motor in the forward direction; turning it OFF decelerates it to stop.

📖 This terminal command can be assigned only by E98 or E99.

■ **Run reverse -- (REV)**
   **(Function code data = 99)**

Turning this terminal command ON runs the motor in the reverse direction; turning it OFF decelerates it to stop.

📖 This terminal command can be assigned only by E98 or E99.

| E20 to E22 | **Status Signal Assignment to [Y1] to [Y3]  (Transistor signal)** |
|---|---|
| E24, E27 | **Status Signal Assignment to [Y5A/C] and [30A/B/C]  (Relay contact signal)** |

E20 to E22, E24, and E27 assign output signals (listed on the next page) to general-purpose, programmable output terminals [Y1], [Y2], [Y3], [Y5A/C], and [30A/B/C]. These function codes can also switch the logic system between normal and negative to define the property of those output terminals so that the inverter logic can interpret either the ON or OFF status of each terminal as active. The factory default settings are "Active ON."

Terminals [Y1], [Y2], and [Y3] are transistor outputs and terminals [Y5A/C] and [30A/B/C] are relay contact outputs. In normal logic, if an alarm occurs, the relay will be energized so that [30A] and [30C] will be closed, and [30B] and [30C] opened. In negative logic, the relay will be deenergized so that [30A] and [30C] will be opened, and [30B] and [30C] closed. This may be useful for the implementation of failsafe power systems.

⌒Note
- When a negative logic is employed, all output signals are active (e.g. an alarm would be recognized) while the inverter is powered OFF. To avoid causing system malfunctions by this, interlock these signals to keep them ON using an external power source. Furthermore, the validity of these output signals is not guaranteed for approximately 3 seconds after power-on, so introduce such a mechanism that masks them during the transient period.

- Terminals [Y5A/C] and [30A/B/C]) use mechanical contacts that cannot stand frequent ON/OFF switching. Where a frequent ON/OFF switching is anticipated (for example, limiting a current by using signals subjected to inverter output limit control such as switching to commercial power line), use transistor outputs [Y1] through [Y3] instead. The service life of a relay is approximately 200,000 times if it is switched on and off at one-second intervals.

The table below lists functions that can be assigned to terminals [Y1], [Y2], [Y3], [Y5A/C], and [30A/B/C].

To make the explanations simpler, the examples shown below are all written for the normal logic (Active ON.)

| Function code data | | Functions assigned | Symbol |
|---|---|---|---|
| Active ON | Active OFF | | |
| 0 | 1000 | Inverter running | (RUN) |
| 1 | 1001 | Frequency arrival signal | (FAR) |
| 2 | 1002 | Frequency detected | (FDT) |
| 3 | 1003 | Undervoltage detected (Inverter stopped) | (LU) |
| 5 | 1005 | Inverter output limiting | (IOL) |
| 6 | 1006 | Auto-restarting after momentary power failure | (IPF) |
| 7 | 1007 | Motor overload early warning | (OL) |
| 10 | 1010 | Inverter ready to run | (RDY) |
| 11 | - | Switch motor drive source between commercial power and inverter output (For MC on commercial line) | (SW88) |
| 12 | - | Switch motor drive source between commercial power and inverter output (For primary side) | (SW52-2) |
| 13 | - | Switch motor drive source between commercial power and inverter output (For secondary side) | (SW52-1) |
| 15 | 1015 | Select AX terminal function (For MC on primary side) | (AX) |
| 25 | 1025 | Cooling fan in operation | (FAN) |
| 26 | 1026 | Auto-resetting | (TRY) |
| 27 | 1027 | Universal DO | (U-DO) |
| 28 | 1028 | Heat sink overheat early warning | (OH) |
| 30 | 1030 | Service life alarm | (LIFE) |
| 33 | 1033 | Command loss detected | (REF OFF) |
| 35 | 1035 | Inverter output on | (RUN2) |
| 36 | 1036 | Overload prevention control | (OLP) |
| 37 | 1037 | Current detected | (ID) |
| 41 | 1041 | Low current detected | (IDL) |
| 42 | 1042 | PID alarm | (PID-ALM) |
| 43 | 1043 | Under PID control | (PID-CTL) |
| 44 | 1044 | Motor stopping due to slow flowrate under PID control | (PID-STP) |
| 45 | 1045 | Low output torque detected | (U-TL) |
| 48 | 1048 | Excessive PID error detected | (PERR) |
| 49 | 1049 | Running over cycle | (ROC) |
| 50 | 1050 | PID feedback 1 alarm | (FB1-ALM) |
| 51 | 1051 | PID feedback 2 alarm | (FB2-ALM) |
| 54 | 1054 | Inverter in remote operation | (RMT) |
| 55 | 1055 | Run command activated | (AX2) |
| 56 | 1056 | Motor overheat detected (PTC) | (THM) |

| 59 | 1059 | Terminal [C1] wire break | (C1OFF) |
|----|------|--------------------------|---------|
| 60 | 1060 | Mount motor 1, inverter-driven | (M1_I) |
| 61 | 1061 | Mount motor 1, commercial-power-driven | (M1_L) |
| 62 | 1062 | Mount motor 2, inverter-driven | (M2_I) |
| 63 | 1063 | Mount motor 2, commercial-power-driven | (M2_L) |
| 64 | 1064 | Mount motor 3, inverter-driven | (M3_I) |
| 65 | 1065 | Mount motor 3, commercial-power-driven | (M3_L) |
| 67 | 1067 | Mount motor 4, commercial-power-driven | (M4_L) |
| 68 | 1068 | Periodic switching early warning | (MCHG) |
| 69 | 1069 | Pump control limit signal | (MLIM) |
| 98 | 1098 | Light alarm | (L-ALM) |
| 99 | 1099 | Alarm output (for any alarm) | (ALM) |

Note: A mark "-" in the Active OFF column means that a negative logic cannot be applied to the terminal function.

### ■ Inverter running -- (RUN)
### (Function code data = 0)

This output signal is used to tell the external equipment that the inverter is running at a starting frequency or higher. It comes ON when the output frequency exceeds the starting frequency, and it goes OFF when it is less than the stop frequency. It is also OFF when the DC injection braking is in operation.

If this signal is assigned in negative logic (Active OFF), it can be used as a signal indicating "inverter being stopped."

### ■ Frequency arrival signal -- (FAR)
### (Function code data = 1)

This output signal comes ON when the difference between the output frequency and reference frequency comes within the allowable error zone.(prefixed to 2.5Hz).

### ■ Frequency detected -- (FDT)
### (Function code data = 2)

This output signal comes ON when the output frequency exceeds the frequency detection level specified by E31, and it goes OFF when the output frequency drops below the "Frequency detection level (E31) - Hysteresis width (E32)."

### ■ Undervoltage detected -- (LU)
### (Function code data = 3)

This output signal comes ON when the DC link bus voltage of the inverter drops below the specified undervoltage level, and it goes OFF when the voltage exceeds the level.

This signal is ON also when the the undervoltage protective function is activated so that the motor is in an abnormal stop state (e.g., tripped).

When this signal is ON, a run command is disabled if given.

■ **Inverter output limiting -- (IOL)**
   **(Function code data = 5)**

This output signal comes ON when the inverter is limiting the output frequency by activating any of the following actions (minimum width of the output signal: 100 ms).

• Current limiting by software (F43 and F44: Current limiter (Mode selection) and (Level))

• Instantaneous overcurrent limiting by hardware (H12 = 1)

• Automatic deceleration (H69 = 3)

> (Note) When the (IOL) signal is ON, it may mean that the output frequency may have deviated from (or dropped below) the frequency specified by the frequency command because of this limiting function.

■ **Auto-restarting after momentary power failure -- (IPF)**
   **(Function code data = 6)**

This output signal is ON either during continuous running after a momentary power failure or during the period from when the inverter has detected an undervoltage condition and shut down the output until restart has been completed (the output has reached the reference frequency).

To enable this (IPF) signal, set F14 (Restart mode after momentary power failure) to "3: Enable restart (Continue to run)," "4: Enable restart (Restart at the frequency at which the power failure occurred)," or "5: Enable restart (Restart at the starting frequency)" beforehand.

■ **Motor overload early warning -- (OL)**
   **(Function code data = 7)**

This output signal is used to issue a motor overload early warning that enables you to take an corrective action before the inverter detects a motor overload alarm *0l1* and shuts down its output.

This signal comes ON when the current exceeds the level specified by E34 (Overload early warning).

> (Note) Function code E34 is effective for not only the (OL) signal, but also for the "Current detected" signal (ID).

**Inverter ready to run -- (RDY)**
   **(Function code data = 10)**

This output signal comes ON when the inverter becomes ready to run by completing hardware preparation (such as initial charging of DC link bus capacitors and initialization of the control circuit) and no protective functions is activated.

**Switch motor drive source between commercial power and inverter output -- (SW88),**
   **(SW52-2) and (SW52-1)**
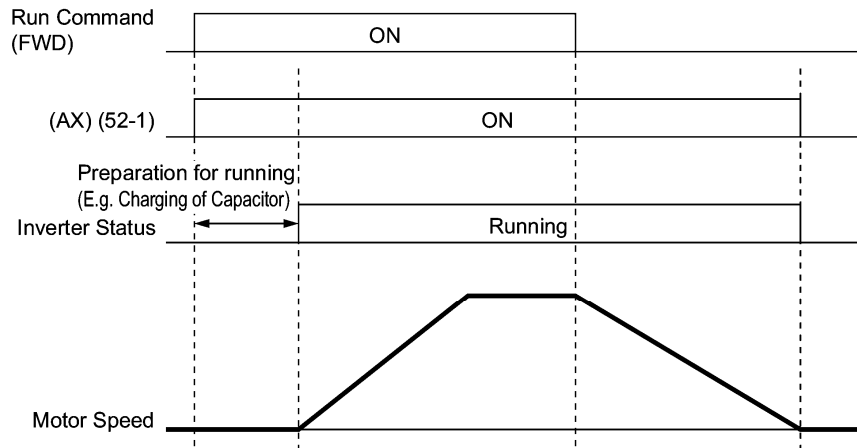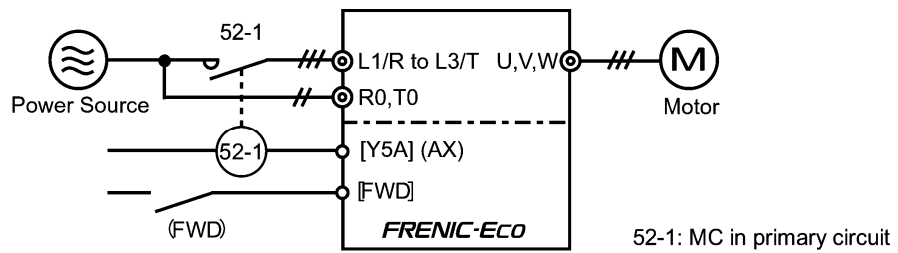   **(Function code data = 11, 12, 13)**

Assigning these output signals to transistor output terminals [Y1], [Y2] and [Y3] enables an (ISW5) or (ISW60) terminal command that controls the magnetic contactor for switching the motor drive source between the commercial power and the inverter output according to the integrated sequence.

For details, refer to the description and diagrams of the (ISW50) and (ISW60) terminal commands.

■ **Select AX terminal function -- (AX)**
   **(Function code data = 15)**

In response to a run command (FWD), this output signal controls the magnetic contactor on the commercial-power supply side. It comes ON when the inverter receives a run command and it goes OFF after the motor decelerates to stop because of a stop command received.

This signal immediately goes OFF upon receipt of a coast-to-stop command or when an alarm occurs.

52-1

Power Source → L1/R to L3/T   U,V,W → M Motor

R0, T0

(52-1) [Y5A] (AX)

[FWD]

(FWD)

FRENIC-ECO     52-1: MC in primary circuit

| Run Command (FWD) | ON |
| (AX) (52-1) | ON |
| Preparation for running (E.g. Charging of Capacitor) Inverter Status | Running |
| Motor Speed | |

### ■ Cooling fan in operation -- (FAN)
### (Function code data = 25)

Under the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control.

### ■ Auto-resetting -- (TRY)
### (Function code data = 26)

This output signal comes ON when auto resetting is in progress. The auto-resetting is specified by H04 and H05 (Auto-resetting). Refer to function codes H04 and H05 for details about the number of resetting times and reset interval.

### ■ Universal DO -- (U-DO)
### (Function code data = 27)

Assigning this output signal to an inverter's output terminal and connecting the terminal to a digital input terminal of peripheral equipment via the RS485 communications link or the field bus, allows the inverter to send commands to the peripheral equipment.

The universal DO can be used as an output signal independent of the inverter operation.

📖 For the procedure for access to Universal DO via the RS485 communications link or field bus, refer to the respective instruction manual.

### ■ Heat sink overheat early warning -- (OH)
### (Function code data = 28)

This output signal is used to issue a heat sink overheat early warning that enables you to take an corrective action before an overheat trip *0h1* actually happens.

This signal comes ON when the temperature of the heat sink exceeds the "overheat trip $0H1$ temperature minus 5°C," and it goes OFF when it drops down to the "overheat trip $0H1$ temperature minus 8°C."

This signal comes ON also when the internal air circulation DC fan (50 HP or above for 208V series or 75 HP or above for 460V series) has locked.

■ **Service life alarm -- (LIFE)**
  **(Function code data = 30)**

This output signal comes ON when it is judged that the service life of any one of capacitors (reservoir capacitor in the DC link bus and electrolytic capacitors on the printed circuit board) and cooling fan has expired.

This signal comes ON also when the internal air circulation DC fan (50 HP or above for 208V series or 75 HP or above for 460V series) has locked.

This signal should be used as a guide for replacement of the capacitors and cooling fan. If this signal comes ON, use the specified maintenance procedure to check the service life of these parts and determine whether the parts should be replaced or not.

📖 For details, refer to Section 7.3, Table 7.3 "Criteria for Issuing a Lifetime Alarm."

■ **Command loss detected -- (REF OFF)**
  **(Function code data = 33)**

This output signal comes ON when an analog input used as a frequency command source is in a command loss state (as specified by E65) due to a wire break or a weak connection. This signal goes OFF when the operation under the analog input is resumed.

📖 For details of the command loss detection, refer to the descriptions of function code E65.

■ **Inverter output on -- (RUN2)**
  **(Function code data = 35)**

This output signal comes ON when the inverter is running at the starting frequency or below or the DC injection braking is in operation.

■ **Overload prevention control -- (OLP)**
  **(Function code data = 36)**

This output signal comes ON when the overload prevention control is activated. The minimum ON-duration is 100 ms.

📖 For details of the overload prevention control, refer to the descriptions of function code H70.

■ **Current detected -- (ID)**
  **(Function code data = 37)**

This output signal comes ON when the output current of the inverter exceeds the level specified by E34 (Current detection (Level)) for the time longer than the one specified by E35 (Current detection (Timer)). The minimum ON-duration is 100 ms.

This signal goes OFF when the output current drops below 90% of the rated operation level.

⊘Note Function code E34 is effective for not only the motor overload early warning (OL), but also for the operation level of the current detection (ID).

📖 For details of the current detection, refer to the descriptions of function codes E34 and E35.

■ **Low current detected -- (IDL)**
  **(Function code data = 41)**

This output signal comes ON when the output current drops below the low current detection level specified by E37 for the period specified by E38 (Low current detection (Timer)). The minimum ON-duration is 100 ms.

📖 For details of the low current detection, refer to the descriptions of function codes E37 and E38. Refer to H82.

■ **PID alarm -- (PID-ALM)**
　**(Function code data = 42)**

Assigning this output signal enables PID control specified by function codes J11/J81 through J16/J86 to output absolute-value alarm and deviation alarm.

📖　For details of the PID alarm, refer to the descriptions of function codes J11/J81 through J16/J86.

■ **Under PID control -- (PID-CTL)**
　**(Function code data = 43)**

This output signal comes ON when PID control is enabled ("Cancel PID control" (Hz/PID) = OFF) and a run command is ON.

Note　Under PID control, the inverter may stop due to the slow flowrate stopping function or other reasons, with the (PID-CTR) signal being ON. As long as the (PID-CTL) signal is ON, PID control is effective, so the inverter may abruptly resume its operation, depending on the feedback value in PID control.

---

⚠ **WARNING**

When PID control is enabled, the inverter may stop its output during operation because of sensor signals or for some other reasons. In such cases, operation will resume automatically.

Design your machinery so that safety is ensured even in such cases.

**Otherwise, an accident could occur.**

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📖　For details of PID control, refer to the description of function codes J01 or later.

■ **Motor stopping due to slow flowrate under PID control -- (PID-STP)**
　**(Function code data = 44)**

This output signal is ON when the inverter is in a stopped state due to the slow flowrate stopping function under PID control.

📖　For details of the slow flowrate stopping function during PID control, refer to the description of function codes J56/J90 through J65/J95.

■ **Low output torque detected -- (U-TL)**
　**(Function code data = 45)**

This output signal comes ON when the torque value calculated by the inverter decreases below the level specified by E80 (Detect low torque (Detection level)) for the time longer than the one specified by E81 (Detect low torque (Timer)). The minimum ON-duration is 100 ms.

📖　For details of the low output torque detection, refer to the description of function codes E80 and E81.

■ **Excessive PID error detected -- (PERR)**
　**(Function code data = 48)**

This output signal comes ON When the PID error between the PID process command 1/2 (SV) and the PID feedback value 1/2 (PV) has exceeded the excessive PID error level specified by J66/J96 during the period longer than the timer setting specified by J67/J97. The minimum ON-duration is 100 ms.

📖　For details of the excessive PID error detection, refer to the description of function codes J66, J67, J96 and J97. Refer to H82.

■ **Running over cycle -- (ROC)**
　**(Function code data = 49)**

This output signal comes ON when the maximum number of cycles has been reached as defined by the slow flowrate.

📖　For details of the running over cycle, refer to the description of function codes J68 and J69. Refer to H82.

■ **PID feedback 1 alarm -- (FB1-ALM)**
  **(Function code data = 50)**

Assigning this output signal enables PID control 1 specified by function codes J11 through J16 to output absolute-value alarm and deviation alarm.

&#128214; For details of the PID alarm, refer to the descriptions of function codes J11 through J16. Refer to H82.

■ **PID feedback 2 alarm -- (FB2-ALM)**
  **(Function code data = 51)**

Assigning this output signal enables PID control 2 specified by function codes J81 through J86 to output absolute-value alarm and deviation alarm.

&#128214; For details of the PID alarm, refer to the descriptions of function codes J81 through J86. Refer to H82.

■ **Inverter in remote operation -- (RMT)**
  **(Function code data = 54)**

This output signal comes ON when the inverter switches from local to remote mode.

&#128214; For details about the remote and local modes, refer to Section 3.6.1 "Switching between remote and local modes."

■ **Run command activated -- (AX2)**
  **(Function code data = 55)**

Assigning a "Enable to run" command (RE) to a digital input terminal prevents the inverter from starting to run upon receipt of a run command only. If the inverter receives a run command, it readies itself for running and outputs this status signal (AX2). At this status, turning the (RE) command ON causes the inverter to actually start running.

&#128214; For details about the "Enable to run" command (RE) and "Run command activated" signal (AX2), refer to the description of (RE) (data = 38) for function codes E01 through E05.

■ **Motor overheat detected (PTC) -- (THM)**
  **(Function code data = 56)**

This output signal indicates that a temperature alarm condition has been detected by a PTC (Positive Temperature Coefficient) thermistor on the motor.

With this output signal assigned, setting function code H26 (PTC thermistor) to "2" enables the inverter to continue running instead of stopping with the $0H4$ alarm even if a temperature alarm condition has been detected.

&#128214; For details of the PTC thermistor, refer to the description of function codes H26 and H27.

■ **Terminal [C1] wire break -- (C1OFF)**
  **(Function code data = 59)**

This output signal comes ON when the inverter detects that the input current to terminal [C1] drops below H90's setting (mA) interpreting it as the terminal [C1] wire broken.

&#128214; Refer to the description of function code H90.

- ■ **Mount motor 1, inverter-driven -- (M1_I)**
- ■ **Mount motor 1, commercial-power-driven -- (M1_L)**
- ■ **Mount motor 2, inverter-driven -- (M2_I)**
- ■ **Mount motor 2, commercial-power-driven -- (M2_L)**
- ■ **Mount motor 3, inverter-driven -- (M3_I)**
- ■ **Mount motor 3, commercial-power-driven -- (M3_L)**
- ■ **Mount motor 4, commercial-power-driven -- (M4_L)**
  **(Function code data = 60 to 67)**

Specify "Mount pump motor" command signals according to the configuration and the number of pump motors, as listed below.

| Item | Configuration with a fixed inverter-driven motor | Configuration with a floating inverter-driven motor |
|---|---|---|
| "Mount pump motor" command signals | (M1_L): Mount pump motor 1, commercial-power-driven | (M1_I): Mount pump motor 1, inverter-driven |
| | (M2_L): Mount pump motor 2, commercial-power-driven | (M1_L): Mount pump motor 1, commercial-power-driven |
| | (M3_L): Mount pump motor 3, commercial-power-driven | (M2_I): Mount pump motor 2, inverter-driven |
| | (M4_L): Mount pump motor 4, commercial-power-driven | (M2_L): Mount pump motor 2, commercial-power-driven |
| | | (M3_I): Mount pump motor 3, inverter-driven |
| | | (M3_L): Mount pump motor 3, commercial-power-driven |

    📖 For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

- ■ **Periodic switching early warning -- (MCHG)**
  **(Function code data = 68)**

    📖 For details, refer to the description of the related function code. (J33: Periodic switching signaling period)

- ■ **Pump control limit signal -- (MLIM)**
  **(Function code data = 69)**

This signal turns on when the inverter detects such a condition that requires further mounting a motor(s) by J34 and J35 even after all pump motors are in operation. This signal can thus detect a situation where the output flowrate (pressure) does not increase because of a pipe crack or other reasons.

    📖 For details of PID control, refer to Section 5.2.6 "J codes" and Section 5.2.7 "PID Frequency Command Generator" .

- ■ **Light alarm -- (L-ALM)**
  **(Function code data = 98)**

This output signal comes ON when a light alarm occurs.

    📖 Refer to H82.

- ■ **Alarm output (for any alarm) -- (ALM)**
  **(Function code data = 99)**

This output signal comes ON if any of the protective functions is activated and the inverter enters Alarm mode.

| E31 | Frequency Detection (FDT) (Detection level) |
|-----|----------------------------------------------|

| E32 | Frequency Detection (FDT) (Hysteresis width ) |
|-----|------------------------------------------------|

When the output frequency has exceeded the frequency detection level specified by E31, the FDT signal comes ON; when it has dropped below the "Frequency detection level minus Hysteresis width specified by E32," it goes OFF.

You need to assign (FDT) (Frequency detection: data = 2) to one of digital output terminals.

- Data setting range: 0.0 to 120.0 (Hz)
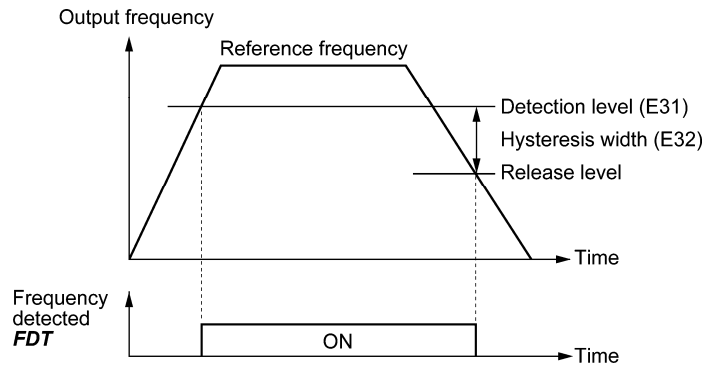


| E34 | Overload Early Warning/Current Detection (Level) |
|-----|---------------------------------------------------|

| E35 | Overload Early Warning/Current Detection (Timer) |
|-----|---------------------------------------------------|

E34 and E35 specify, in conjunction with output terminal signals (OL) and (ID), the level and duration of overload and current beyond which an early warning or an alarm will be issued.

■ **Overload Early Warning**

The warning signal (OL) is used to detect a symptom of an overload condition (alarm code $OL1$) of the motor so that the user can take an appropriate action before the alarm actually happens. The signal turns on when the current level specified by E34 (Overload early warning) is exceeded. In typical cases, set E34 to 80-90% against data of F11 (Electronic thermal motor overload protection (Operation level)). Specify also the thermal characteristics of the motor with F10 (Electronic thermal motor overload protection (Select the motor property)) and F12 (Electronic thermal motor overload protection (Thermal time constant)). To utilize this feature, you need to assign (OL) (Motor overload early warning) (data = 7) to any of the digital output terminals.

■ **Current Detection**

The signal (ID) turns on when the output current of the inverter has exceeded the level specified by E34 (Current detection (Level)) and the output current continues longer than the period specified by E35 (Current detection (Timer)). The signal turns off when the output current drops below 90% of the rated operation level. (Minimum width of the output signal: 100 ms)

To utilize this feature, you need to assign (ID) (Current detection) (data = 37) to any of digital output terminals.
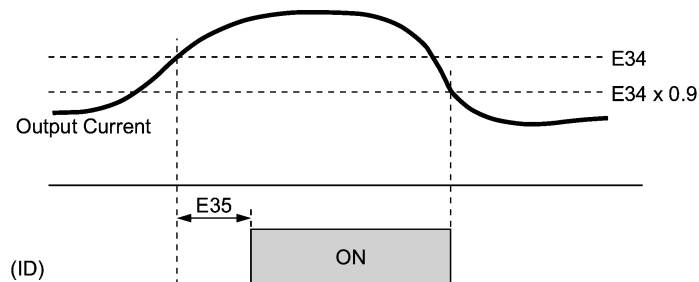


- Data setting range (E34): Current value of 1 to 150% of the rated inverter current in units of amperes. (0: disable)

- Data setting range (E35): 0.01 to 600.00 (sec.)

| E37 | Low Current Detection (Level) |
|------|-------------------------------|

| E38 | Low Current Detection (Timer) |
|------|-------------------------------|

### ■ Low level current detection

This signal is turned ON when the output current drops below the operation level specified by function code E37 and stays in this status for the duration specified by function code E38 (on delay timer). (Minimum width of the output signal: 100 ms)

To utilize this feature, you need to assign (IDL) (Low current detection) (data = 41) to any of digital output terminals.

- Data setting range (E37):  Current value of 1 to 150% of the rated inverter current in units of amperes. (0.00: disable)

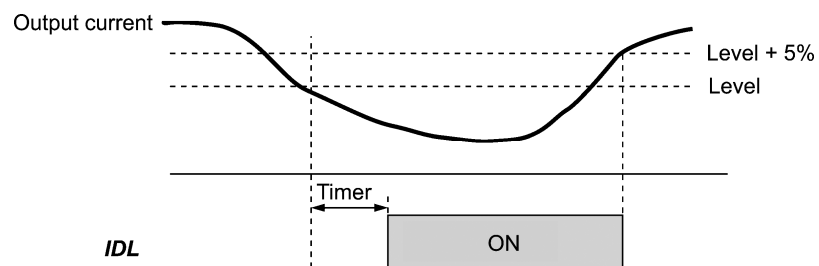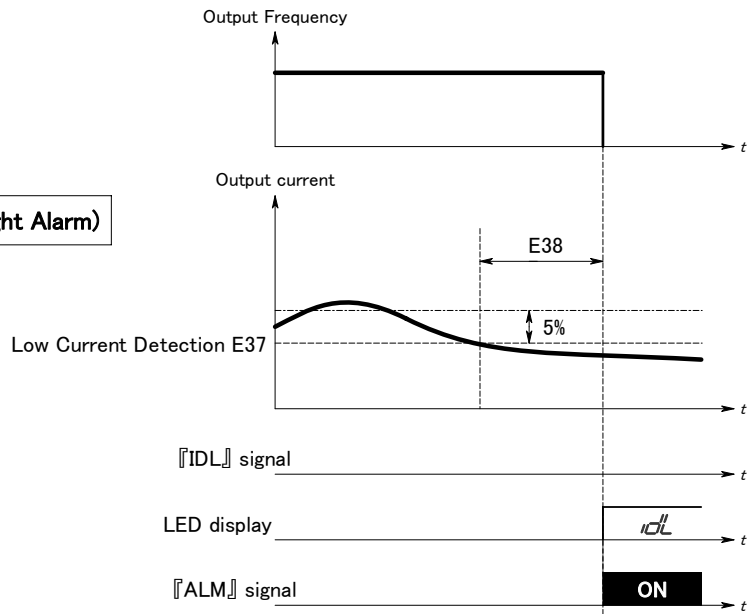- Data setting range (E38):  0.01 to 600.00 (sec.)



⌐ᴵᴸ alarm and light failure (H82) can be arisen if you meets the condition of E37 and E38 on the PID control. Please refer to the function code: H82 about the details on light failure. Also, it is recommended for automatic reset function: H83. Please refer to H83 to H85 in the details.

Output Frequency

H82 bit 1 = 0 (Disable Light Alarm)

Output current

E38

5%

Low Current Detection E37

『IDL』 signal

LED display    *idL*

『ALM』 signal    **ON**

H82 bit 1 = 1 (Enable Light Alarm)

Output current

E38

5%

Low Current Detection E37

『IDL』 signal    **ON**

LED display    *L -AL*

『ALM』 signal
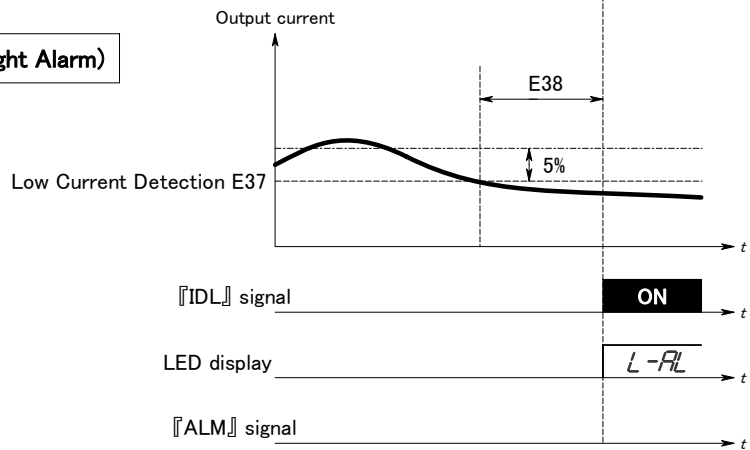
| E39 | PID Display Units |
|---|---|

| E40 | PID Display Coefficient A |
|---|---|

| E41 | PID Display Coefficient B |
|---|---|

These function codes provide display coefficients to convert the PID process command, PID feedback value, or analog input monitor in easy-to-understand mnemonic physical quantities to display.

- Data setting range: 0 to 82 for the PID display units.

- Data setting range: -999 to 0.00 to 9990 for the display coefficients A and B.

■ **PID display units**

The FRN-F1-DY drive can be configured to program the drive using units or scaling that are appropriate for the pumping system by programming the PID display units. The PID display units will affect setpoint references, feedback scaling, pump levels, and display monitors. The following is a list of parameters that are affected by the programming of the PID display units.

| Data for E39 | Unit | Description | Data for E39 | Unit | Description |
|---|---|---|---|---|---|
| 0 | - | None | 28 | LPH | Liters / h |
| 1 | % | | 40 | Bar | |
| 2 | Hz | | 41 | Hg | |
| 3 | WC | Inch of Water | 42 | Pa | Pascal |
| 4 | PSI | lb/Sqr Inch | 43 | kPa | |
| 20 | GPS | Gallons / s | 44 | MPa | |
| 21 | GPM | Gallons / min. | 60 | Ft | Feet |
| 22 | GPH | Gallons / h | 61 | cm | |
| 23 | CFS | Cubic / s | 62 | m | |
| 24 | CFM | Cubic / min. | 80 | K | |
| 25 | CFH | Cubic / h | 81 | °F | |
| 26 | LPS | Liters / s | 82 | °C | Deg Celsius |
| 27 | LPM | Liters / min. | | | |

■ **Display coefficients of PID process command and PID feedback value**

The PID display coefficients A and B convert the PID process command and the PID feedback value into mnemonic quantities before they are displayed. E40 specifies the PID display coefficient A (display of the value at 100% of the PID process command or PID feedback value); and E41 specifies the PID display coefficient B (display of the value at 0% of the PID process command or PID feedback value).

The value displayed is determined as follows:

Value displayed = (PID process command or PID feedback value (%))/100 × (display coefficient A - B) + B
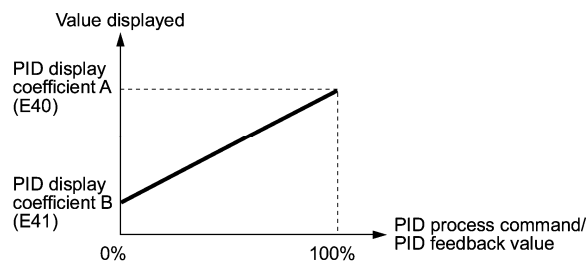
**Example**

You wish to maintain the pressure around 16 kPa (sensor voltage 3.13 V) while the pressure sensor can detect 0 - 30 kPa over the output voltage range of 1 - 5 V.

Select the terminal [12] as the feedback terminal and set the gain to 200% so that 5V corresponds to 100%.

By setting:

"Display at 100% of PID process command & PID feedback value = Display coefficient E40 = 30.0" and
"Display at 0% of PID process command & PID feedback value = Display coefficient E41 = -7.5,"
you can have the monitor and the setting on the keypad of the value of the PID process command and PID feedback value recognized as the pressure.

If you wish to control the pressure at 16 kPa on the keypad, you set the value to 16.0.
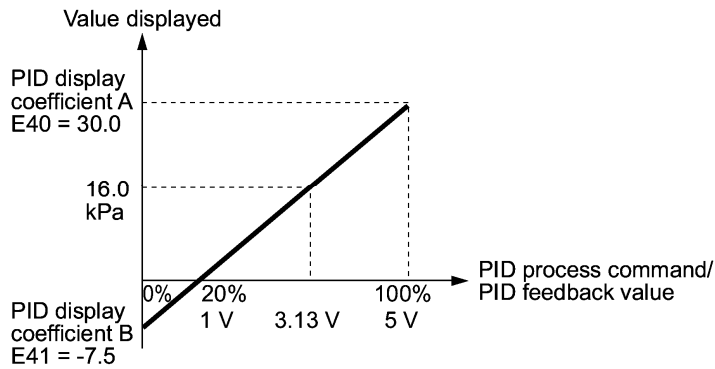


📖 For details of PID control, refer to the description of function codes J01 and later.

📖 For the method to display the PID process command and PID feedback value, refer to the description of function code E43.

■ **Display coefficient of analog input monitor**

By inputting analog signals from various sensors such as temperature sensors in air conditioners to the inverter, you can monitor the state of peripheral devices via the communications link. By using an appropriate display coefficient, you can also have various values converted into physical values such as temperature and pressure before being displayed.
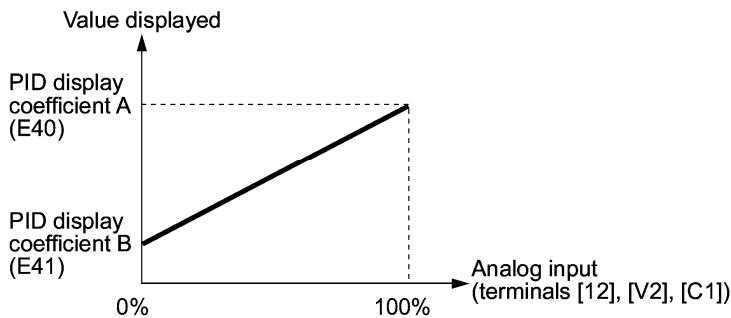


📖 To set up the analog input monitor, use function codes E61 through E63. Use E43 to choose the item to be displayed.

| E43 | **LED Monitor (Item selection)** | Refer to E48. |
|---|---|---|

E43 specifies the monitoring item to be displayed on the LED monitor.

| Data for E43 | Function (Displays the following.) | Description |
|---|---|---|
| 0 | Speed monitor | Selected by the sub item of function code E48 |
| 3 | Output current | Inverter output current expressed in RMS (A) |
| 4 | Output voltage | Inverter output voltage expressed in RMS (V) |
| 8 | Calculated torque | Output torque of the motor (%) |
| 9 | Input power | Inverter's input power (kW) |
| 10 | PID process command value (frequency) * | Refer to the function codes E39, E40 and E41. |
| 12 | PID feedback value * | |
| 14 | PID output value * | 100% at maximum frequency |
| 15 | Load factor | Inverter's load factor (%) |
| 16 | Motor output | Motor output (kW) |
| 17 | Analog input | Refer to function codes E40 and E41 |

\* If 0 (Disable) is set for function codes J01 and J70, "- - - -" appears on the LED monitor.

Specifying the speed monitor with E43 provides a choice of speed-monitoring formats selectable with E48 (LED Monitor).

Define the speed-monitoring format on the LED monitor as listed below.

| Data for E48 | Display format of the sub item | |
|---|---|---|
| 0 | Output frequency | Expressed in Hz |
| 3 | Motor speed in r/min | 120 ÷ Number of poles (P01) × Frequency (Hz) |
| 4 | Load shaft speed in r/min | Coefficient for speed display (E50) × Frequency (Hz) |
| 7 | Speed in % | 100% at maximum frequency (F03) |

| E45 | LCD Monitor (Item selection) |
|---|---|

E45 specifies the mode of the LCD display during Running mode using the multi-function keypad.

| Data for E45 | Function |
|---|---|
| 0 | Running status, rotational direction and operation guide |
| 1 | Bar charts for output frequency, current and calculated torque |
| 2 | Running status, running sub-status, PID process command (SV) and PID process output (MV) |
| 3 | Running status, running sub-status, PID feedback value (PV) and PID process command (SV) |

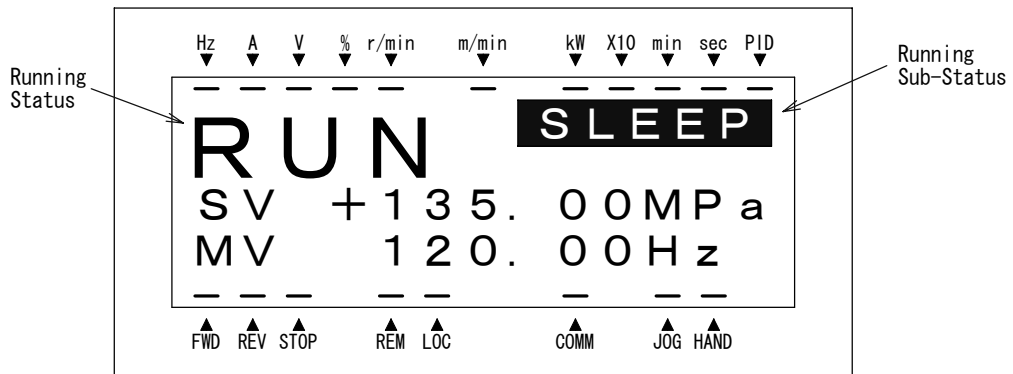Example of display for E45 = 0 (during running)
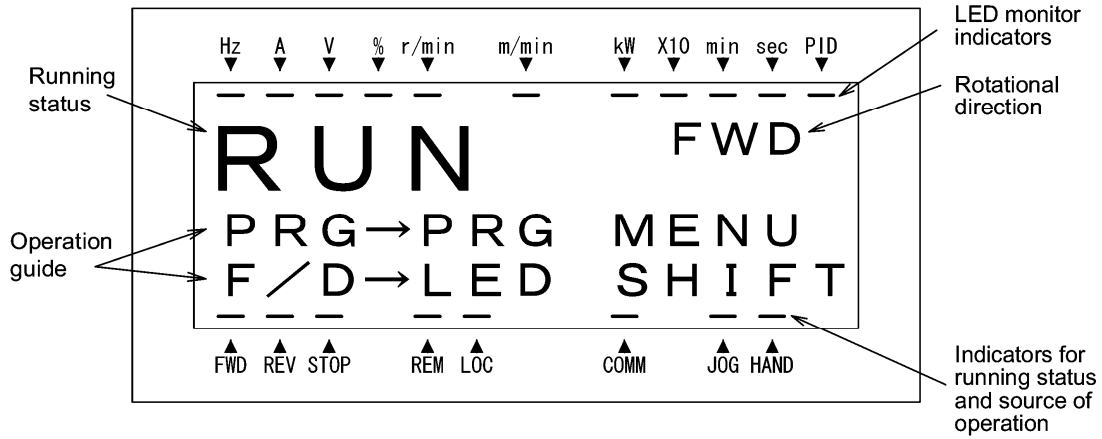


Example of display for E45 = 1 (during running)
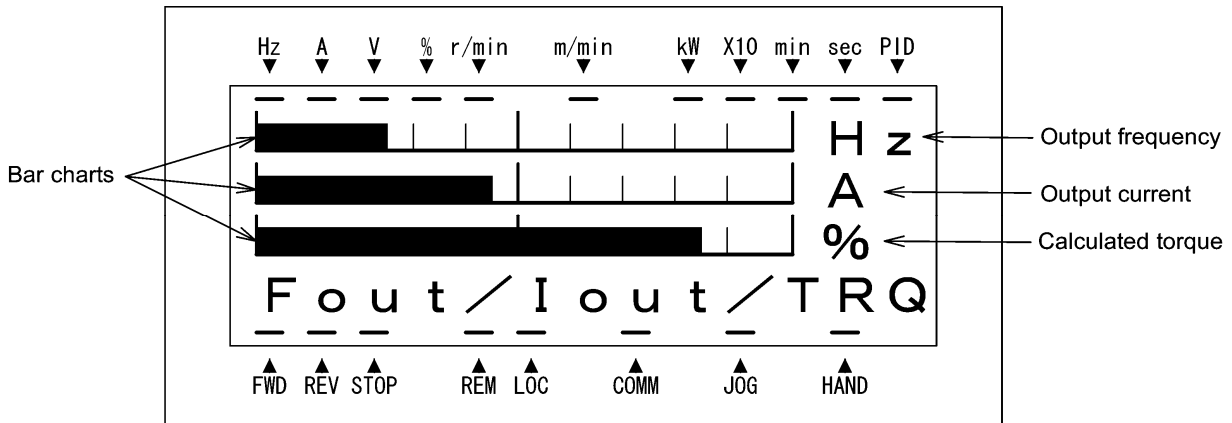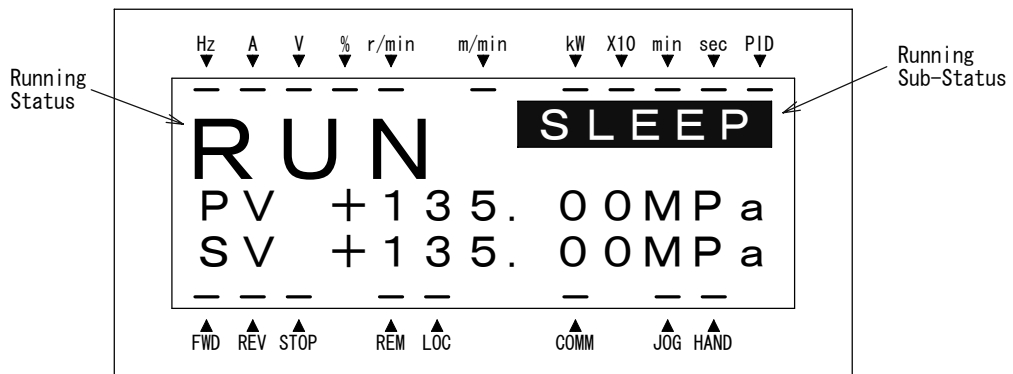


Full-scale values on bar charts

| Item displayed | Full scale |
|---|---|
| Output frequency | Maximum frequency (F03) |
| Output current | Inverter's rated current × 200% |
| Calculated torque | Motor's rated torque × 200% |

Example of display for E45 = 2 (during running)



Example of display for E45 = 3 (during running)



When the function code E45 = 2 or 3, the inverter status can be displayed, and then you can figure out each status such as PID control, stopping on low volume of water.

| Status | Description |
|---|---|
| Running Status | **RUN** : The Run command is present, or the inverter is driving the motor.<br>**STOP** : The Run command is not present, or the inverter is in stopped state. |
| Running Sub-Status | Blank : Stopped<br>**FWD** : Forward<br>**REV** : Reverse<br>**PID-1** : Under PID control 1<br>**PID-2** : Under PID control 2<br>**PIDHz** : Cancel PID control<br>**STABI** : Start stabilize running<br>**SLEEP** : Slow flowrate stop<br>**RETRY** : Wait for retry (Refer to H04, H05)<br>**RESTA** : Wait for alarm auto reset (Refer to H83, H84 and H85)<br>**P-CHG** : During pump changed<br>**LOW-V** : Undervoltage detected (Inverter stopped)<br>**IPF** : Auto-restarting after momentary power failure |

| E46 | LCD Monitor (Language selection) |
|---|---|

E46 specifies the language to display on the multi-function keypad as follows:

| Data for E46 | Language |
|---|---|
| 0 | Japanese |
| 1 | English |

| E47 | LCD Monitor (Contrast control) |
|---|---|

Adjusts the contrast of the LCD monitor on the multi-function keypad as follows:

| Data for E47 | 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 |
|---|---|
| Contrast | Low ←——————→ High |

| E48 | LED Monitor (Speed monitor item) | Refer to E43. |
|---|---|---|

For how to set this function code, refer to the description of function code E43.

| E50 | Coefficient for Speed Indication |
|---|---|

Use this coefficient for displaying the load shaft speed on the LED monitor (refer to function code E43).

■ **Load shaft speed**

The load shaft speed is displayed as E50 (Coefficient for speed indication) × Frequency (Hz).

| E51 | Display Coefficient for Input Watt-hour Data |
|---|---|

Use this coefficient (multiplication factor) for displaying the input watt-hour data in a part of maintenance information on the keypad.

The input watt-hour data will be displayed as follows:

E51 (Coefficient for input watt-hour data) × Input watt-hour (kWh)

⌒Note  Setting E51 data to 0.000 clears the input watt-hour and its data to "0." After clearing, be sure to restore E51 data to the previous display coefficient; otherwise, input watt-hour data will not be accumulated.

📖 For the procedure for viewing maintenance information, refer to Chapter 3 "OPERATION USING THE MULTI-FUNCTION KEYPAD."

| E61 | Analog Input for [12] (Extension function selection) |
|---|---|

| E62 | Analog Input for [C1] (Extension function selection) |
|---|---|

| E63 | Analog Input for [V2] (Extension function selection) |
|---|---|

E61, E62, and E63 define the function of the terminals [12], [C1], and [V2], respectively.

There is no need to set up these terminals if they are to be used for frequency command sources.

| Data for E61, E62, or E63 | Input assigned to [12], [C1] and [V2] | Description |
|---|---|---|
| 0 | None | -- |
| 1 | Auxiliary frequency command 1* | Auxiliary frequency input to be added to the reference frequency given by frequency command 1 (F01). Will not be added to any other reference frequency given by such as frequency command 2 and multistep frequency commands. |
| 2 | Auxiliary frequency command 2* | Auxiliary frequency to be added to all reference frequencies given by frequency command 1, frequency command 2, multistep frequency commands, etc. |
| 3 | PID process command 1 | Inputs process command sources such as temperature and pressure under PID control. You also need to set function code J02. |
| 4 | PID process command 2 | Inputs process command sources such as temperature and pressure under PID control. You also need to set function code J71. |
| 5 | PID feedback value 1 | Inputs feedback values such as temperature and pressure under PID control 1. |
| 6 | PID feedback value 2 | Inputs feedback values such as temperature and pressure under PID control 2. |
| 20 | Analog signal input monitor | By inputting analog signals from various sensors such as the temperature sensors in air conditioners to the inverter, you can monitor the state of external devices via the communications link. By using an appropriate display coefficient, you can also have various values to be converted into physical values such as temperature and pressure before being displayed. |

Note: If these terminals have been set up to have the same data, the operation priority is given in the following order:

E61 > E62 > E63

| E64 | Saving Digital Reference Frequency |
| --- | --- |

E64 specifies how to save the reference frequency specified in digital formats by the $\wedge$/$\vee$ keys on the keypad as shown below.

| Data for E64 | Function |
| --- | --- |
| 0 | Auto saving (at the time of main power turned off)<br>The reference frequency will be automatically saved when the main power is turned off. At the next power-on, the reference frequency at the time of the previous power-off applies. |
| 1 | Saving by pressing ⒡ key<br>Pressing the ⒡ key saves the reference frequency. If the control power is turned off without pressing the ⒡ key, the data will be lost. At the next power-on, the inverter uses the reference frequency saved when the ⒡ key was pressed last. |

| E65 | Command Loss Detection (Level) |
| --- | --- |

When the analog frequency command (by frequency setting through terminals [12], [C1], and [V2]) has dropped below 10% of the expected frequency command within 400 ms, the inverter presumes that the analog frequency command wire has been broken and continues its operation at the frequency determined by the ratio specified by E65 to the reference frequency. When the frequency command level (in voltage or current) returns to a level higher than that specified by E65, the inverter presumes that the broken wire has been fixed and continues to run following the frequency command.
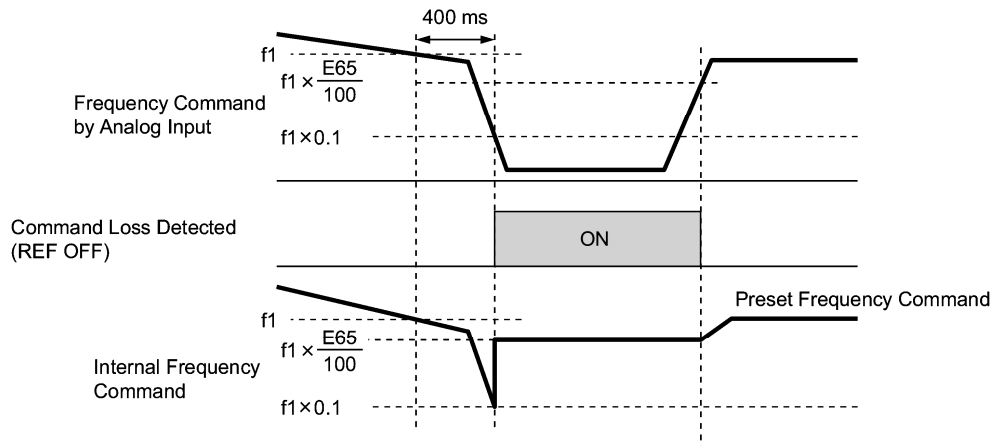


In the diagram above, f1 is the level of the analog frequency command sampled at any given time. The sampling is repeated at regular intervals to continually monitor the wiring connection of the analog frequency command.

Note  Avoid abrupt voltage or current change for the analog frequency command. Otherwise, a broken wire condition may be recognized.

When E65 is set at 999 (Disabled), though the command loss detection signal (REF OFF) is issued, the reference frequency remains unchanged (the inverter runs at the analog frequency command as specified).

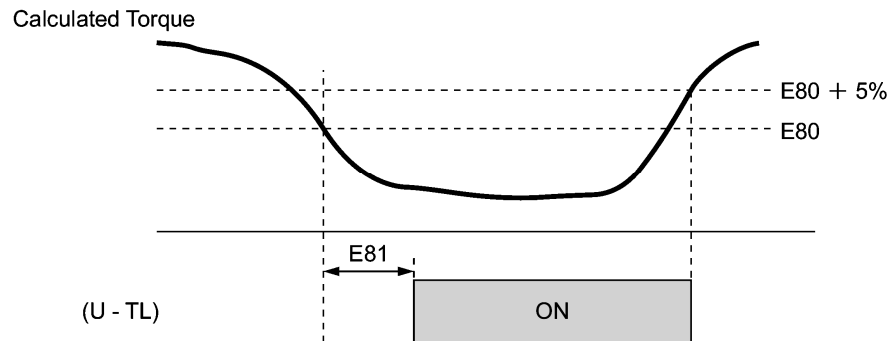When E65 is set at "0" or 999, the reference frequency level that the broken wire has been recognized as fixed is "f1 × 0.2."

When E65 is set at 100% or higher, the reference frequency level of the broken wire fixing is "f1 × 1."

The command loss detection is not affected by the setting of Analog input adjustment (filter time constants: C33, C38, and C43).

| E80 | Detect Low Torque (Detection level) |
|---|---|

| E81 | Detect Low Torque (Timer) |
|---|---|

The signal (U-TL) turns on when the torque calculated by the inverter with reference to its output current has dropped below the level specified by E80 for the time longer than the one specified by E81. The signal turns off when the calculated torque exceeds the level specified by E80 + 5%. The minimum width of output signal is 100 ms.

You need to assign the "Low output torque detected" signal (U-TL) (data = 45) to the general-purpose output terminals.

Calculated Torque

```
                                                              ---- E80 + 5%
                                                              ---- E80

                    E81
(U - TL)                      |         ON         |
```

The detection level is set so that 100% corresponds to the rated torque of the motor.

In the inverter's low frequency operation, as a substantial error in torque calculation occurs, no low torque can be detected within the operation range at less than 20% of the base frequency (F04). (In this case, the result of recognition before entering this operation range is retained.)

The (U-TL) signal goes off when the inverter is stopped.

Since the motor parameters are used in the calculation of torque, it is recommended that auto-tuning be applied by function code P04 to achieve higher accuracy.

| E98 | Command Assignment to [FWD] | (Refer to E01 to E05.) |
|---|---|---|

| E99 | Command Assignment to [REV] | (Refer to E01 to E05.) |
|---|---|---|

For details of the command assignment to terminals [FWD] and [REV], refer to the descriptions for function codes E01 to E05.

## 5.2.3 C codes (Control functions of frequency)

| C01 to C03 | Jump Frequency 1, 2 and 3 |
|---|---|

| C04 | Jump Frequency (Band) |
|---|---|

These function codes enable the inverter to jump over three different points on the output frequency in order to skip resonance caused by the motor running frequency and natural frequency of the driven machinery.

- While you are increasing the reference frequency, the moment the reference frequency reaches the bottom of the jump frequency band, the inverter keeps the output at that bottom frequency. When the reference frequency exceeds the upper limit of the jump frequency band, the internal reference frequency takes on the value of the reference frequency. When you are decreasing the reference frequency, the situation will be reversed.

- When the more than two jump frequency bands overlap, the inverter actually takes the lowest frequency within the overlapped bands as the bottom frequency and the highest as the upper limit. Refer to the figure on the lower right.
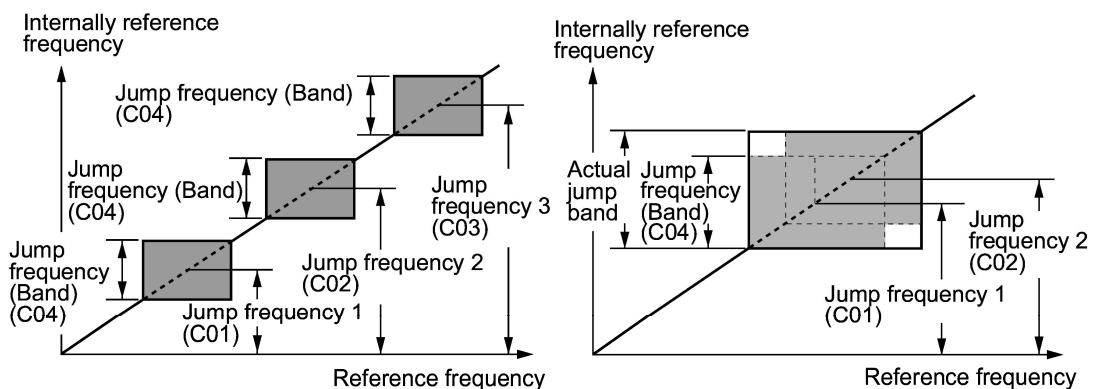


■ **Jump frequencies 1, 2 and 3 (C01, C02 and C03)**

Specify the center of the jump frequency band.

- Data setting range: 0.0 to 120.0 (Hz) (Setting at 0.0 results in no jump band)

■ **Jump frequency band (C04)**

Specify the jump frequency band.

- Data setting range: 0.0 to 30.0 (Hz) (Setting to 0.0 results in no jump band)

| C05 to C19 | **Multistep Frequency 1 to 15** |
| :--- | :--- |

| C56 to C58 | **Multistep PID command 1 to 3** |
| :--- | :--- |

■ **These function codes specify 15 frequencies required for driving the motor at frequencies 1 to 15.**

Turning terminal commands (SS1), (SS2), (SS4) and (SS8) ON/OFF selectively switches the reference frequency of the inverter in 15 steps. For details of the terminal function assignment, refer to the descriptions for function codes E01 to E05 "Command assignment to [X1] to [X5]."

- Data setting range: 0.00 to 120.00 (Hz)

The combination of (SS1), (SS2), (SS4) and (SS8) and the selected frequencies are as follows.

| (SS8) | (SS4) | (SS2) | (SS1) | Selected frequency command |
| :---: | :---: | :---: | :---: | :---: |
| OFF | OFF | OFF | OFF | Other than multistep frequency * |
| OFF | OFF | OFF | ON | C05 (multistep frequency 1) |
| OFF | OFF | ON | OFF | C06 (multistep frequency 2) |
| OFF | OFF | ON | ON | C07 (multistep frequency 3) |
| OFF | ON | OFF | OFF | C08 (multistep frequency 4) |
| OFF | ON | OFF | ON | C09 (multistep frequency 5) |
| OFF | ON | ON | OFF | C10 (multistep frequency 6) |
| OFF | ON | ON | ON | C11 (multistep frequency 7) |
| ON | OFF | OFF | OFF | C12 (multistep frequency 8) |
| ON | OFF | OFF | ON | C13 (multistep frequency 9) |
| ON | OFF | ON | OFF | C14 (multistep frequency 10) |
| ON | OFF | ON | ON | C15 (multistep frequency 11) |
| ON | ON | OFF | OFF | C16 (multistep frequency 12) |
| ON | ON | OFF | ON | C17 (multistep frequency 13) |
| ON | ON | ON | OFF | C18 (multistep frequency 14) |
| ON | ON | ON | ON | C19 (multistep frequency 15) |

\* "Other than multistep frequency" means any other frequency command sources than multistep frequency command sourced by frequency command 1 (F01) and frequency command 2 (C30).

To use these features, you need to assign multistep frequency selections (SS1), (SS2), (SS4) and (SS8) (data = 0, 1, 2, 3) to the digital input terminals.

📖 For the relationship between multistep frequency operation and other frequency commands."

■ **To enable PID control (J01/J70 = 1 or 2)**

You can set the process command in PID control as the preset value (multistep PID command 3). You can also use multistep frequency (multistep frequency 3) for manual speed command during disabling of PID control ((Hz/PID) = ON).

• Process Command

| (SS8) | (SS4) | (SS2) | (SS1) | Frequency Command |
|-------|-------|-------|-------|-------------------|
| OFF | OFF | — | — | Process command by J02/J71 |
| OFF | ON | — | — | Multistep PID command by C56 |
| ON | OFF | — | — | Multistep PID command by C57 |
| ON | ON | — | — | Multistep PID command by C58 |

The units for C56, C57 and C58 are determined by the PID Display Units (E39).

• Manual speed command

| (SS8) | (SS4) | (SS2) | (SS1) | Selected frequency |
|-------|-------|-------|-------|--------------------|
| — | — | OFF | OFF | Other than multistep frequency |
| — | — | OFF | ON | C05 (Multistep frequency 1) |
| — | — | ON | OFF | C06 (Multistep frequency 2) |
| — | — | ON | ON | C07 (Multistep frequency 3) |

📖 For PID process commands, refer to the block diagram in Section 5.2.7 "PID Frequency Command Generator."

| C30 | **Frequency Command 2** | **(Refer to F01.)** |
|-----|-------------------------|---------------------|

For details of frequency command 2, refer to the description of function code F01.

| C32 | **Analog Input Adjustment for [12] (Gain)** | **(Refer to F18.)** |
|-----|---------------------------------------------|---------------------|

| C34 | **Analog Input Adjustment for [12] (Gain reference point)** | **(Refer to F18.)** |
|-----|------------------------------------------------------------|---------------------|

| C37 | **Analog Input Adjustment for [C1] (Gain)** | **(Refer to F18.)** |
|-----|---------------------------------------------|---------------------|

| C39 | **Analog Input Adjustment for [C1] (Gain reference point)** | **(Refer to F18.)** |
|-----|------------------------------------------------------------|---------------------|

| C42 | **Analog Input Adjustment for [V2] (Gain)** | **(Refer to F18.)** |
|-----|---------------------------------------------|---------------------|

| C44 | **Analog Input Adjustment for [V2] (Gain reference point)** | **(Refer to F18.)** |
|-----|------------------------------------------------------------|---------------------|

For details of analog input commands, refer to the description of function code F18.

| C33 | Analog Input Adjustment for [12] (Filter time constant) |
|---|---|

| C38 | Analog Input Adjustment for [C1] (Filter time constant) |
|---|---|

| C43 | Analog Input Adjustment for [V2] (Filter time constant) |
|---|---|

These function codes provide the filter time constants for the voltage and current of the analog input at terminals [12], [C1], and [V2]. Choose appropriate values for the time constants considering the response speed of the mechanical system as large time constants slow down the response. In case the input voltage fluctuates because of noise, specify large time constants.

- Data setting range: 0.00 to 5.00 (sec.)

| C50 | Bias Reference Point (Frequency command 1)       (Refer to F18.) |
|---|---|

For details of setting the bias reference point for frequency command 1, refer to the descriptions of function code F18.

| C51 | Bias for PID command 1 (Bias value) |
|---|---|

| C52 | Bias for PID command 1 (Bias reference point) |
|---|---|

| C54 | Bias for PID command 2 (Bias value) |
|---|---|

| C55 | Bias for PID command 2 (Bias reference point) |
|---|---|

These function codes specify the bias and bias reference point of the analog PID process command 1/2 to enable defining arbitrary relationship between the analog input and PID process commands.

📖 The actual setting is the same as that of function code F18. For details, refer to the description of function code F18.

⚠ Note   Note that function codes C32, C34, C37, C39, C42, and C44 are shared by the frequency commands.

■ **Bias value (C51) (C54)**

- Data setting range: -100.00 to 100.00 (%)

■ **Bias reference point (C52) (C55)**

- Data setting range: 0.00 to 100.00 (%)

| C53 | Selection of Normal/Inverse Operation (Frequency command 1) |
|---|---|

C53 switches the reference frequency given by frequency command 1 (F01) or the manual frequency command source under PID control between normal and inverse.

📖 For details, refer to the description of "Switch normal/inverse operation" command (IVS) (data = 21) for function codes E01 through E05.

## 5.2.4  P codes (Motor parameters)

| P01 | Motor (No. of poles) |
|---|---|

P01 specifies the number of poles of the motor. Enter the value shown on the nameplate of the motor. This setting is used to display the motor speed on the LED monitor (refer to function code E43). The following formula is used for the conversion.

$$\text{Motor speed  (r/min)} = \frac{120}{\text{No. of poles}} \times \text{Frequency (Hz)}$$

| P02 | Motor (Rated capacity) |
|---|---|

P02 specifies the rated capacity of the motor. Enter the rated value shown on the nameplate of the motor.

| Data for P02 | Unit | Dependency on function code P99 |
|---|---|---|
| 0.01 to 1000 | kW | P99 = 0, 3 or 4 |
| | HP | P99 = 1 |

| P03 | Motor (Rated current) |
|---|---|

P03 specifies the rated current of the motor. Enter the rated value shown on the nameplate of the motor.

- Data setting range: 0.00 to 2000 (A)

| P04 | Motor (Auto-tuning) |
|---|---|

This function automatically detects the motor parameters and saves them in the inverter's internal memory. Basically, you do not need to perform tuning if you use a Fuji standard motor with a standard connection with the inverter.

In any of the following cases, you may not obtain the best performance under auto torque boost, torque calculation monitoring, or auto energy saving operation, by default settings, since the motor parameters are different from that of Fuji standard motors. In such a case, perform auto tuning.

• The motor to be driven is made by other manufacturer or is a non-standard motor.

• Cabling between the motor and the inverter is long.

• A reactor is inserted between the motor and the inverter.

📖 For details of auto tuning, refer to the Section 4.1.3 "Preparation before running the motor for a test -- Setting function code data."

| P06 | Motor (No-load current) |
|---|---|

| P07 | Motor (%R1) |
|---|---|

| P08 | Motor (%X) |
|---|---|

These function codes specify no load current, %R1, and %X. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. If you perform auto tuning, these parameters are automatically set as well.

- No load current: Enter the value obtained from motor manufacturer.

- %R1: Enter the value calculated by the following formula.

$$\%R1 = \frac{R1 + Cable\ R1}{V / (\sqrt{3} \times I)} \times 100\ (\%)$$

where,

R1:   Primary resistance of the motor ($\Omega$)

Cable R1: Resistance of the output cable ($\Omega$)

V:    Rated voltage of the motor (V)

I:    Rated current of the motor (A)

- %X: Enter the value calculated by the following formula:

$$\%X = \frac{X1 + X2 \times XM / (X2 + XM) + Cable\ X}{V / (\sqrt{3} \times I)} \times 100\ (\%)$$

where,

X1:   Primary leakage reactance of the motor ($\Omega$)

X2:   Secondary leakage reactance of the motor (converted to primary) ($\Omega$)

XM:   Exciting reactance of the motor ($\Omega$)

Cable X: Reactance of the output cable ($\Omega$)

V:    Rated voltage of the motor (V)

I:    Rated current of the motor (A)

Note   For reactance, choose the value at the base frequency (F04).

| P99 | Motor Selection |
|------|-----------------|

P99 specifies the motor to be used.

| Data for P99 | Motor type |
|:---:|---|
| 0 | Fuji standard motors, 8- and 9-series |
| 1 | GE motors |
| 3 | Fuji standard motors, 6- and 9-series |
| 4 | Other motors |

Automatic control (such as auto-torque boost and auto-energy saving) or electronic thermal motor overload protection uses the motor parameters and characteristics. To match the property of a control system with that of the motor, select characteristics of the motor and set H03 (Data Initialization) to "2" to initialize the old motor parameters stored in the inverter. When initialization is complete, data of P03, P06, P07, and P08 and the old related internal data is automatically updated.

For P99, enter the following data according to the motor type.

• P99 = 0:   Fuji standard 8- and 9-series motors

• P99 = 1:   Typical in North America motors (The inverter supports motors rated by HP)

• P99 = 3:   Fuji standard 6- and 9-series motors

• P99 = 4    Other manufacturer's or unknown motors

Note   • If P99 = 4 (Other motors), the inverter runs following the motor characteristics of Fuji standard 8-series.

## 5.2.5    H codes (High performance functions)

| H03 | Data Initialization |
|-----|---------------------|

H03 initializes the current function code settings to the factory defaults or initializes the motor parameters.

To change the H03 data, it is necessary to press ⓢⓣⓞⓟ and ⌃ keys or ⓢⓣⓞⓟ and ⌄ keys simultaneously.

| Data for H03 | Function |
|:---:|---|
| 0 | Disable initialization<br>(Settings manually made by the user will be retained.) |
| 1 | Initialize all function code data to the factory defaults |
| 2 | Initialize motor parameters in accordance with P02 (rated capacity) and P99 (motor selection)<br><br>Function codes subject to initialization: P01, P03, P06, P07, and P08, including the internal control constants<br><br>(These function codes will be initialized to the values listed in tables on the following pages.) |

- To initialize the motor parameters, set the related function codes as follows.

  1) P02 Motor (Rated capacity)    Set the rated capacity of the motor to be used in kW or HP.

  2) P99 Motor Selection    Select the characteristics of the motor. (Refer to the descriptions given for P99.)

  3) H03 Data Initializing    Initialize the motor parameters. (H03=2)

  4) P03 Motor (Rated current)    Set the rated current on the nameplate if the already set data differs from the rated current printed on the nameplate of the motor.

- Upon completion of the initialization, the data of function code H03 is reset to "0" (default setting).

- If a capacity other than that of applicable motor rating is set at P02, the capacity will be internally converted to the applicable motor rating (see the table on the following pages).

■ **When HP motors (P99 = 1) is selected, the motor parameters for P02 through P08 are as listed in following tables.**

For 208 V series motors shipped for FRN-F1-DY

| Motor capacity (HP) | Applicable motor rating (HP) | Rated current (A) | No-load current (A) | %R (%) | %X (%) |
|---|---|---|---|---|---|
| P02 | | P03 | P06 | P07 | P08 |
| 1.00 to 1.99 | 1 | 3.16 | 1.39 | 4.61 | 10.32 |
| 2.00 to 2.99 | 2 | 6.16 | 2.53 | 5.04 | 9.09 |
| 3.00 to 4.99 | 3 | 8.44 | 3.23 | 3.72 | 24.58 |
| 5.00 to 7.49 | 5 | 13.60 | 4.32 | 3.99 | 28.13 |
| 7.50 to 9.99 | 7.5 | 20.19 | 5.63 | 3.18 | 34.70 |
| 10.00 to 14.99 | 10 | 27.42 | 7.91 | 2.91 | 36.89 |
| 15.00 to 19.99 | 15 | 40.44 | 11.49 | 2.48 | 34.92 |
| 20.00 to 24.99 | 20 | 53.98 | 8.32 | 2.54 | 35.90 |
| 25.00 to 29.99 | 25 | 65.49 | 15.10 | 2.11 | 38.01 |
| 30.00 to 39.99 | 30 | 79.06 | 17.91 | 2.29 | 39.31 |
| 40.00 to 49.99 | 40 | 100.2 | 12.30 | 2.22 | 30.83 |
| 50.00 to 59.99 | 50 | 126.6 | 16.91 | 2.34 | 30.27 |
| 60.00 to 74.99 | 60 | 150.8 | 18.81 | 1.57 | 32.85 |
| 75.00 to 99.99 | 75 | 191.5 | 25.86 | 1.67 | 32.97 |
| 100.00 to 124.99 | 100 | 248.8 | 33.82 | 1.31 | 28.97 |
| 125.00 to 149.99 | 125 | 295.6 | 26.95 | 1.28 | 27.93 |
| 150.00 or above | 150 | 368.1 | 81.75 | 1.16 | 26.10 |

For 460 V series motors shipped for FRN-F1-DY

| Motor capacity (HP) | Applicable motor rating (HP) | Rated current (A) | No-load current (A) | %R (%) | %X (%) |
|---|---|---|---|---|---|
| P02 | | P03 | P06 | P07 | P08 |
| 1.00 to 1.99 | 1 | 1.50 | 0.77 | 3.96 | 8.86 |
| 2.00 to 2.99 | 2 | 2.90 | 1.40 | 4.29 | 7.74 |
| 3.00 to 4.99 | 3 | 4.00 | 1.79 | 3.15 | 20.81 |
| 5.00 to 7.49 | 5 | 6.30 | 2.39 | 3.34 | 23.57 |
| 7.50 to 9.99 | 7.5 | 9.30 | 3.12 | 2.65 | 28.91 |
| 10.00 to 14.99 | 10 | 12.70 | 4.37 | 2.43 | 30.78 |
| 15.00 to 19.99 | 15 | 18.70 | 6.36 | 2.07 | 29.13 |
| 20.00 to 24.99 | 20 | 24.60 | 4.60 | 2.09 | 29.53 |
| 25.00 to 29.99 | 25 | 30.00 | 8.33 | 1.75 | 31.49 |
| 30.00 to 39.99 | 30 | 36.20 | 9.88 | 1.90 | 32.55 |
| 40.00 to 49.99 | 40 | 45.50 | 6.80 | 1.82 | 25.32 |
| 50.00 to 59.99 | 50 | 57.50 | 9.33 | 1.92 | 24.87 |
| 60.00 to 74.99 | 60 | 68.70 | 10.40 | 1.29 | 26.99 |
| 75.00 to 99.99 | 75 | 86.90 | 14.30 | 1.37 | 27.09 |
| 100.00 to 124.99 | 100 | 113.0 | 18.70 | 1.08 | 23.80 |
| 125.00 to 149.99 | 125 | 134.0 | 14.90 | 1.05 | 22.90 |
| 150.00 to 174.99 | 150 | 169.0 | 45.20 | 0.96 | 21.61 |
| 200.00 to 249.99 | 200 | 231.0 | 81.80 | 0.72 | 20.84 |
| 250.00 to 299.99 | 250 | 272.0 | 41.10 | 0.71 | 18.72 |
| 300.00 to 324.99 | 300 | 323.0 | 45.10 | 0.53 | 18.44 |
| 350.00 to 399.99 | 350 | 375.0 | 68.30 | 0.99 | 19.24 |
| 400.00 to 449.99 | 400 | 429.0 | 80.70 | 1.11 | 18.92 |
| 450.00 to 499.99 | 450 | 481.0 | 85.50 | 0.95 | 19.01 |
| 500.00 to 599.99 | 500 | 534.0 | 99.20 | 1.05 | 18.39 |
| 600.00 to 699.99 | 600 | 638.0 | 140.0 | 0.85 | 18.38 |
| 700.00 to 749.99 | 700 | 756.0 | 164.0 | 1.02 | 21.92 |
| 750.00 to 799.99 | 750 | 806.0 | 144.0 | 1.15 | 24.53 |
| 800.00 to 849.99 | 800 | 870.0 | 209.0 | 1.17 | 21.69 |
| 850.00 to 899.99 | 850 | 923.0 | 172.0 | 1.34 | 25.44 |
| 900.00 or above | 900 | 994.0 | 239.0 | 1.40 | 23.79 |

| H04 | Auto-resetting | (Times) |
|---|---|---|

| H05 | Auto-resetting | (Reset interval) |
|---|---|---|

While the auto-resetting feature is specified, even if the protective function subject to retry is activated and the inverter enters the forced-to-stop state (tripped state), the inverter will automatically attempt to reset the tripped state and restart without issuing an alarm (for any faults). If the protection function works in excess of the times specified by H04, the inverter will issue an alarm (for any faults) and not attempt to auto-reset the tripped state.

Listed below are the recoverable alarm statuses to be retried.

| Alarm status | LED monitor displays: | Alarm status | LED monitor displays: |
|---|---|---|---|
| Instantaneous overcurrent protection | $OC1$ $OC2$ or $OC3$ | Motor overheated | $OH4$ |
| Overvoltage protection | $OU1$ $OU2$ or $OU3$ | Motor overloaded | $OL1$ |
| Heat sink overheated | $OH1$ | Inverter overloaded | $OLU$ |
| Inverter overheated | $OH3$ | | |

■ **Number of resetting times (H04)**

H04 specifies the number of auto-resetting "retry" times for automatically escaping the tripped state. If the protective function is activated more than the specified resetting (retry) times, the inverter issues an alarm (for any faults) and does not attempt to escape the tripped state.

- Data setting range: 1 to 10 (times) (If "0" is set, the "retry" operation will not be activated.)

---

<table>
<tr><td colspan="1" align="center">⚠ <b>WARNING</b></td></tr>
<tr><td>If the "retry" function has been specified, the inverter may automatically restart and run the motor stopped due to a trip fault, depending on the cause of the tripping.</td></tr>
<tr><td>Design the machinery so that human body and peripheral equipment safety is ensured even when the auto-resetting succeeds.<br><br><b>Otherwise an accident could occur.</b></td></tr>
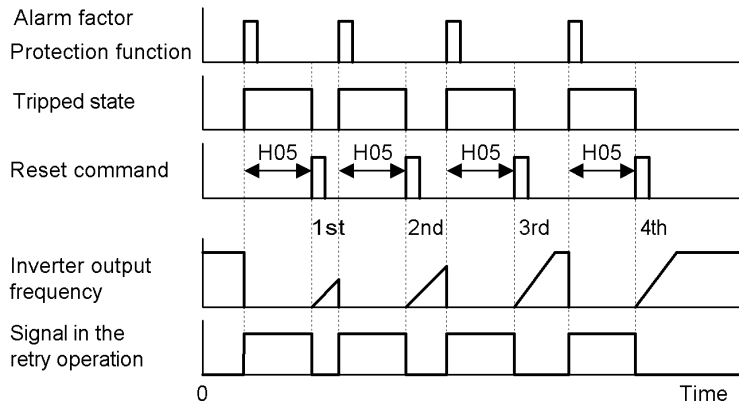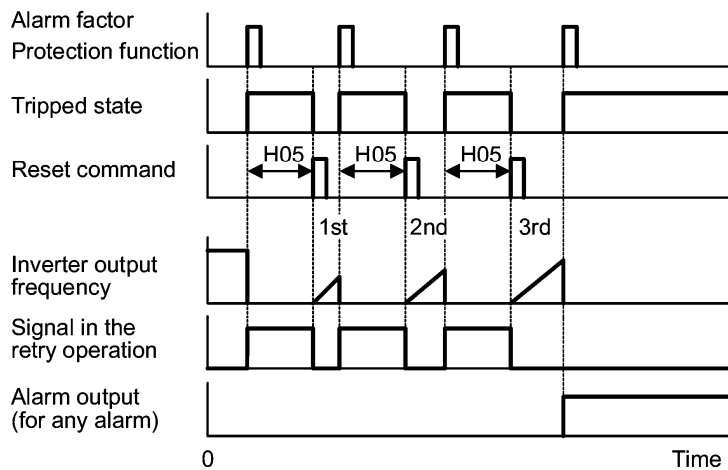</table>

■ **Reset interval (H05)**

- Data setting range: 0.5 to 20.0 (sec.)

H05 specifies the interval time to attempt performing auto-resetting the tripped state. Refer to the timing scheme diagram below.

<Operation timing scheme>



<Timing scheme for failed retry (No. of retry times: 3)>



- The retry operation state can be monitored by external equipment via the inverter's output terminal [Y1] through [Y3], [Y5A/C], or [30A/B/C]. Set the data "26" of terminal function (TRY) in function codes E20 through E22, E24 and E27 to one of these terminals.

| H06 | Cooling Fan ON/OFF Control |
|---|---|

To prolong the life of the cooling fan and to reduce fan noise during running, the cooling fan is stopped when the temperature inside the inverter drops below a certain level while the inverter is stopped. However, since frequent switching of the cooling fan shortens its life, it is kept running for 10 minutes once it is started.

This function code (H06: Cooling fan ON/OFF control) allows you to specify whether the cooling fan is to be kept running all the time or to be controlled ON/OFF.

| Data for H06 | Cooling fan ON/OFF |
|---|---|
| 0 | Disable (Always in operation) |
| 1 | Enable (ON/OFF controllable) |

| H07 | Acceleration/Deceleration Pattern |
|-----|-----------------------------------|

H07 specifies the acceleration and deceleration patterns (Patterns to control output frequency).

| Data for H07 | Accl./Decel. pattern |
|--------------|----------------------|
| 0 | Linear (default) |
| 1 | S-curve (Weak) |
| 2 | S-curve (Strong) |
| 3 | Curvilinear |

Linear acceleration/deceleration

The inverter runs the motor with the constant acceleration and deceleration.

S-curve acceleration/deceleration

To reduce the impact on the inverter-driven motor and/or its mechanical load during acceleration/deceleration, the inverter gradually accelerates/decelerates the motor in both the acceleration/deceleration starting and ending zones. Two types of S-curve acceleration/deceleration are available; 5% (weak) and 10% (strong) of the maximum frequency, which are shared by the four inflection points. The acceleration/deceleration time command determines the duration of acceleration/deceleration in the linear period; hence, the actual acceleration/deceleration time is longer than the reference acceleration/deceleration time.



Acceleration/deceleration time
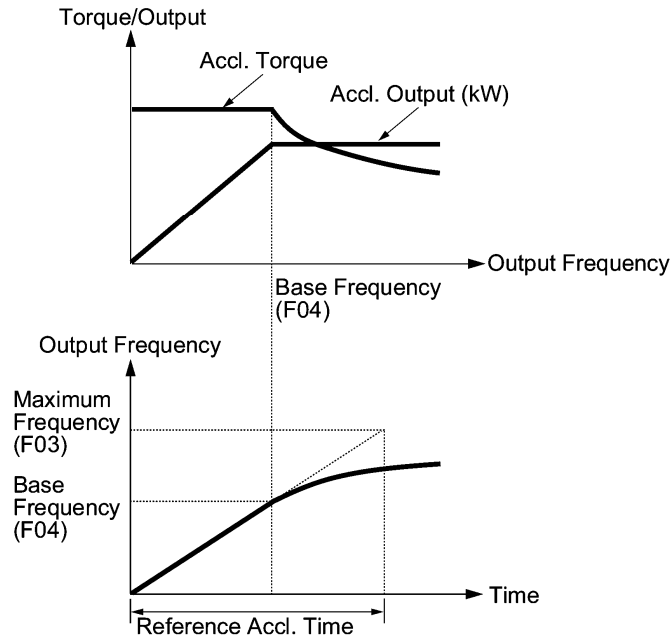
<S-curve acceleration/deceleration (weak): when the frequency change is more than 10% of the maximum frequency>
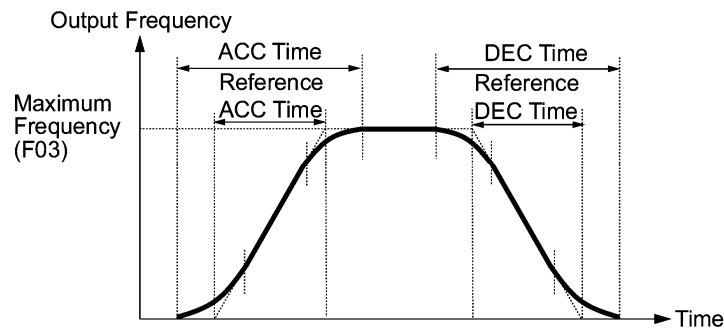
Acceleration/deceleration time (s): $(2 \times 5/100 + 90/100 + 2 \times 5/100) \times$ (reference acceleration or deceleration time)
= $1.1 \times$ (reference acceleration or deceleration time)

<S-curve acceleration/deceleration (strong): when the frequency change is more than 20% of the maximum frequency>

Acceleration/deceleration time (s): $(2 \times 10/100 + 80/100 + 2 \times 10/100) \times$ (reference acceleration/deceleration time)
= $1.2 \times$ (reference acceleration/deceleration time)

Curvilinear acceleration/deceleration

Acceleration/deceleration is linear below the base frequency (linear torque) but slows down above the base frequency to maintain a certain level of load factor (constant output).

This acceleration/deceleration pattern allows the motor to accelerate or decelerate with the maximum performance of the motor.

The figures at left show the acceleration characteristics.
Similar characteristics apply to the deceleration.

Note    Choose an appropriate acceleration/deceleration time considering the machinery's load torque.

| H08 | Rotational Direction Limitation |
|-----|--------------------------------|

H08 inhibits the motor from running in an unexpected rotational direction due to miss-operation of run commands, miss-polarization of frequency commands, or other mistakes.

| Data for H08 | Function |
|--------------|----------|
| 0 | Disable |
| 1 | Enable (Reverse rotation inhibited) |
| 2 | Enable (Forward rotation inhibited) |

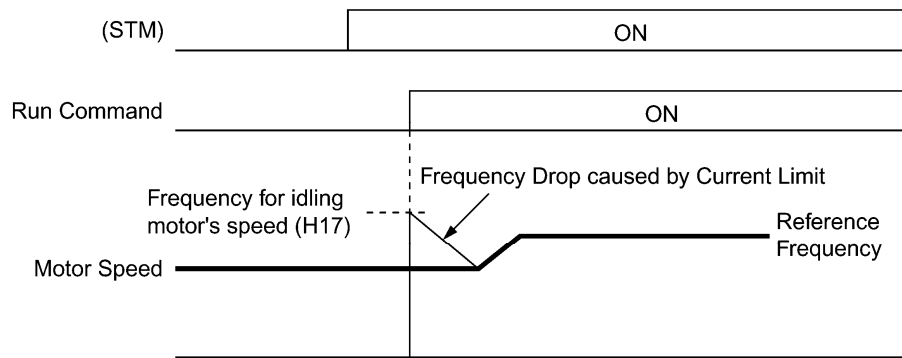| H09 | Select Starting Characteristics (Auto search for idling motor's speed) |
|------|------|
|      | Refer to H17. |

H09 and H17 specify the auto search mode for idling motor's speed and its frequency, respectively, to run the idling motor without stopping it.

The auto search mode can be switched by assigning the (STM) terminal command to one of digital input terminals (E01 to E05, function code data = 26). If no (STM) is assigned, the inverter interprets it as (STM) being ON by default.

Searching for idling motor's speed

When a run command is turned ON with the (STM) being ON, the inverter starts the auto search operation at the auto search frequency specified by H17 to run the idling motor without stopping it. If there is a large difference between the motor speed and the auto search frequency, the current limiting control may be triggered. The inverter automatically reduces its output frequency to homologize with the idling motor speed for synchronizing them each other. Upon completion of the synchronization, the inverter releases the current limiting control and accelerates the motor up to the reference frequency according to the preset acceleration time.



Searching for idling motor's speed to follow

Note: The frequency drop caused by the current limiting control during auto search for idling motor's speed is determined by the frequency fall rate specified by H14.

To use the auto search, be sure to enable the instantaneous overcurrent limiting (H12 = 1).

■ **Select starting characteristic (STM) (Digital input signal)**

The (STM) terminal command specifies whether or not to perform auto search operation for idling motor's speed at the start of running.

| Data for H09 | "Select starting characteristics" terminal command (STM) | Function |
|--------------|----------------------------------------------------------|----------|
| 0: Disable | -- | Start at the starting frequency |
| 3, 4, 5: Enable | ON | Start at the auto search frequency specified by H17 |
|  | OFF | Start at the starting frequency |

■ **Frequency for idling motor's speed (H17)**

H17 specifies the auto search frequency for idling motor's speed. Be sure to set a value higher than the idling motor's speed. Otherwise, an overvoltage trip may occur. If the current motor speed is unknown, specify "999" that uses the maximum frequency at the start of auto search operation.

■ **Auto search for idling motor's speed (H09)**

H09 specifies the starting rotational direction (forward/reverse) of the auto search and the starting pattern (patterns 1 to 4). If the motor is idling in the reverse direction that is against the specified direction because of natural convection, it is necessary to start it in the direction opposite to the rotational direction of the original reference frequency.

When the rotational direction of the idling motor is unknown, two starting patterns are provided as listed below, which start search from the forward rotation and, if not succeeded from the reverse rotation (e.g. H09 =5, pattern 3), start search from the reverse rotation (e.g. H09 =5, pattern 4).

| Data for H09 | Run command | Rotational direction at the start of auto search | Starting pattern |
|---|---|---|---|
| 3 | Run forward | Forward | Pattern 1 |
| | Run reverse | Reverse | Pattern 2 |
| 4 | Run forward | Forward | Pattern 3 |
| | Run reverse | Reverse | Pattern 4 |
| 5 | Run forward | Reverse | Pattern 4 |
| | Run reverse | Forward | Pattern 3 |

Starting patterns

The inverter makes its frequency shift in accordance with the starting patterns shown below to search the speed and rotation direction of the idling motor. When synchronization is complete between the motor speed (including its rotation direction) and the inverter output frequency, the frequency shift by auto search operation is terminated.
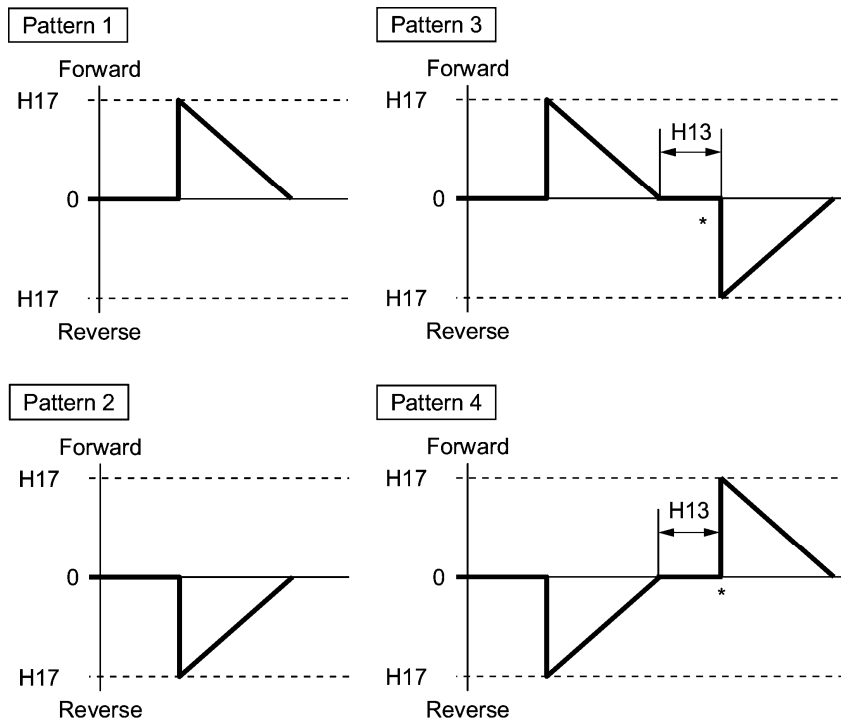


* Only when the auto search has not succeeded at the first trial, the starting from the opposite direction is attempted.

Starting Patterns

Note Auto search operation is attempted using one of the patterns shown above. If not succeeded, it will be tried again. If seven consecutive retries failed, the inverter will issue $OC3$ alarm and stop.

| H11 | Deceleration Mode |
|-----|-------------------|

H11 specifies the mode of deceleration when a run command is turned OFF.

| Data for H11 | Function |
|-----|-----|
| 0 | Normal deceleration |
|   | The inverter decelerates and stops the motor according to deceleration commands specified by H07 (Acceleration/deceleration pattern) and F08 (Deceleration time 1). |
| 1 | Coast-to-stop |
|   | The inverter immediately shuts down its output. The motor stops according to the inertia of motor and load machinery and their kinetic energy losses. |

Note: When the reference frequency is low, the inverter decelerates the motor according to the deceleration commands even if H11 = 1 (Coast-to-stop).

| H12 | Instantaneous Overcurrent Limiting |
|-----|-----|

H12 specifies whether the inverter invokes the current limit processing or enters the overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level. Under the current limit processing, the inverter immediately turns off its output gate to suppress the further current increase and continues to control the output frequency.

| Data for H12 | Function |
|-----|-----|
| 0 | Disable |
|   | An overcurrent trip occurs at the instantaneous overcurrent limiting level. |
| 1 | Enable |
|   | The current limiting operation is effective. |

If any problem occurs when the motor torque temporarily drops during current limiting processing, it is necessary to cause an overcurrent trip (H12 = 0) and actuate a mechanical brake at the same time.

Note: Function codes F43 and F44 have current limit functions similar to that of function code H12. Since the current limit functions of F43 and F44 implement the current control by software, an operation delay occurs. When you have enabled the current limit by F43 and F44, enable the current limit operation by H12 as well, to obtain a quick response current limiting.

Depending on the load, extremely short acceleration time may activate the current limiting to suppress the increase of the inverter output frequency, causing the system oscillation (hunting) or activating the inverter overvoltage trip ($\mathit{OU}$ alarm). When setting the acceleration time, therefore, you need to take into account machinery characteristics and moment of inertia of the load.

| H13 | **Restart after Momentary Power Failure (Restart time)** **(Refer to F14.)** |
|---|---|

| H14 | **Restart after Momentary Power Failure (Frequency fall rate)** **(Refer to F14.)** |
|---|---|

| H15 | **Restart after Momentary Power Failure (Continuous running level)** **(Refer to F14.)** |
|---|---|

| H16 | **Restart after Momentary Power Failure (Allowable momentary power failure time)** **(Refer to F14.)** |
|---|---|

For how to set these function codes (Restart time, Frequency fall rate, Continuous running level and Allowable momentary power failure time), refer to the description of function code F14.

| H17 | **Select Starting Characteristics (Frequency for idling motor's speed)** **(Refer to H09.)** |
|---|---|

For how to set the starting frequency for the auto search for idling motor's speed, refer to the description of function code H09.

| H26 | **PTC Thermistor (Mode selection)** |
|---|---|

| H27 | **PTC Thermistor (Level)** |
|---|---|

These function codes protect the motor from overheating or output an alarm signal using the PTC (Positive Temperature Coefficient) thermistor embedded in the motor.

■ **PTC thermistor (Selection) (H26)**

Selects the function operation mode (protection or alarm) for the PTC thermistor as shown below.

| Data for H26 | Action |
|---|---|
| 0 | Disable |
| 1 | Enable<br>When the voltage sensed by the PTC thermistor exceeds the detection level, the motor protective function (alarm $\mathit{0H4}$) is triggered, causing the inverter to enter an alarm stop state. |
| 2 | Enable<br>When the voltage sensed by the PTC thermistor exceeds the detection level, a motor alarm signal is output but the inverter continues running.<br>You need to assign the motor overheat protection (THM) to one of the digital output terminals beforehand, by which a temperature alarm condition can be detected by the thermistor (PTC) (function code data = 56). |

## ■ PTC thermistor (Level) (H27)

Specifies the detection level for the temperature (expressed in voltage) sensed by PTC thermistor.

- Data setting range: 0.00 to 5.00 (V)

The temperature at which the overheating protection is to be activated depends on the characteristics of the PTC thermistor. The internal resistance of the thermistor will significantly change at the alarm temperature. The detection level (voltage) is specified based on the change of internal resistance.
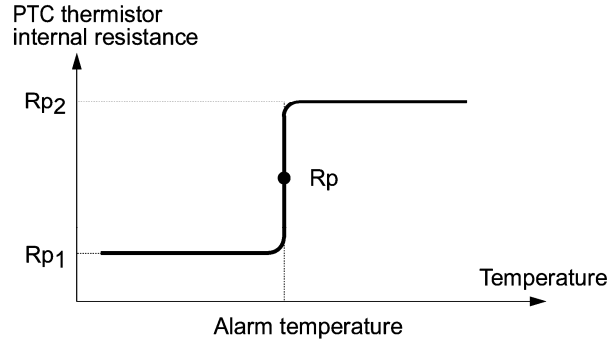


Suppose that the resistance of PTC thermistor at alarm temperature Rp, the detection (voltage) level $V_{v2}$ is calculated by the equation below. Set the result $V_{v2}$ to function code H27.

Substitute the internal resistance of the PTC thermistor at the alarm temperature with Rp to obtain $V_{v2}$.

$$V_{V2} = \frac{\dfrac{237 \times R_p}{237 + R_p}}{1000 + \dfrac{237 \times R_p}{237 + R_p}} \times 10 \ (V)$$

Connect the PTC thermistor as shown below. The voltage that is obtained by dividing the input voltage to the terminal [V2] with a set of internal resistors is compared with the preset detection level voltage (function code H27).
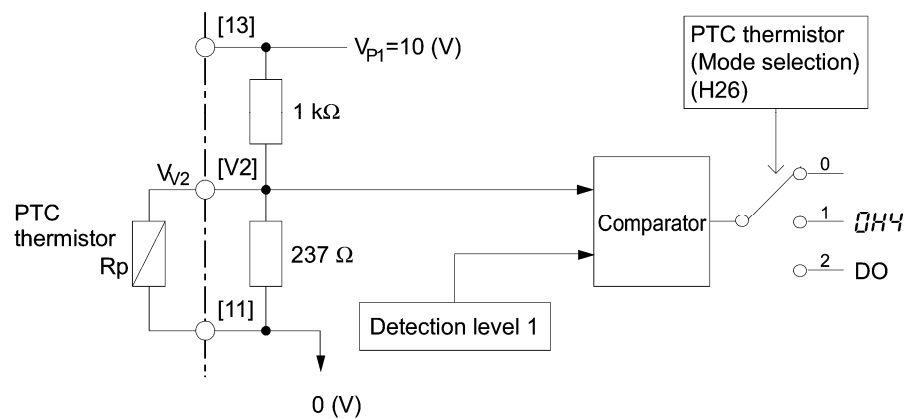
| H30 | Communications Link Function (Mode selection) | Refer to y98. |
|---|---|---|

H30 and y98 specify the sources of a frequency command and run command--"inverter itself" and "computers or PLCs via the RS485 communications link (standard or extension) or field bus (option)." H30 is for the RS485 communications link; y98 for the field bus.

Using the communications link function allows you to monitor the operation information of the inverter and the function code data, set frequency commands, and issue run commands from a remote location.
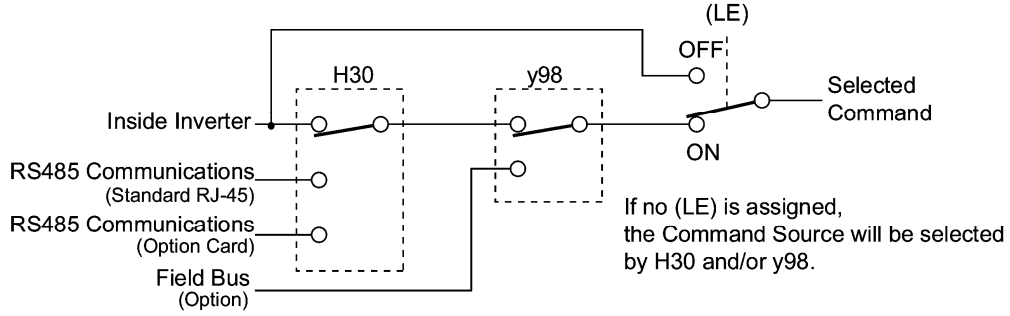


Command sources selectable

| Command sources | Description |
|---|---|
| Inverter itself | Sources except RS485 communications link and field bus |
| | Frequency command source: Specified by F01 and C30, or multistep frequency command |
| | Run command source: Via the keypad or digital input terminals |
| Via RS485 communications link (standard) | Via the standard RJ-45 port used for connecting keypad |
| Via RS48 communications link (extension card) | Via RS485 communications link (extension card) |
| Via field bus (option) | Via field bus (option) using FA protocol such as DeviceNet or PROFIBUS-DP |

Command sources specified by H30

| Data for H30 | Frequency command | Run command |
|---|---|---|
| 0 | Inverter itself (F01/C30) | Inverter itself (F02) |
| 1 | Via RS485 communications link (standard) | Inverter itself (F02) |
| 2 | Inverter itself (F01/C30) | Via RS485 communications link (standard) |
| 3 | Via RS485 communications link (standard) | Via RS485 communications link (standard) |
| 4 | Via RS485 communications link (extension card) | Inverter itself (F02) |
| 5 | Via RS485 communications link (extension card) | Via RS485 communications link (standard) |
| 6 | Inverter itself (F01/C30) | Via RS485 communications link (extension card) |
| 7 | Via RS485 communications link (standard) | Via RS485 communications link (extension card) |
| 8 | Via RS485 communications link (extension card) | Via RS485 communications link (extension card) |

Command sources specified by y98

| Data for y98 | Frequency command | Run command |
|---|---|---|
| 0 | Follow H30 data | Follow H30 data |
| 1 | Via field bus (option) | Follow H30 data |
| 2 | Follow H30 data | Via field bus (option) |
| 3 | Via field bus (option) | Via field bus (option) |

Combination of command sources

| | | Frequency command source | | | |
|---|---|---|---|---|---|
| | | Inverter itself | Via RS485 communications link (standard) | Via RS485 communications link (ext. card) | Via field bus (option) |
| Run command source | Inverter itself | H30 = 0<br>y98 = 0 | H30 = 1<br>y98 = 0 | H30=4<br>y98=0 | H30=0 (1 or 4)<br>y98=1 |
| | Via RS485 communications link (standard) | H30 = 2<br>y98 = 0 | H30 = 3<br>y98 = 0 | H30=5<br>y98=0 | H30=2 (3 or 5)<br>y98=1 |
| | Via RS485 communications link (ext. card) | H30 = 6<br>y98 = 0 | H30 = 7<br>y98 = 0 | H30=8<br>y98=0 | H30=6 (7 or 8)<br>y98=1 |
| | Via field bus (option) | H30 = 0 (2 or 6)<br>y98 = 2 | H30 = 1 (3 or 7)<br>y98 = 2 | H30 = 4 (5 or 8)<br>y98 = 2 | H30 = 0 (1 to 8)<br>y98 = 3 |

📖 For details, refer to the RS485 communication User's Manual (MEH448d) or the Field Bus Option Instruction Manual.

• When the (LE) terminal command is assigned to a digital input terminal, short-circuiting the assigned input terminal and the [CM] terminal makes the setting of function codes H30 and y98 effective, opening those terminals makes them ineffective. When the setting of those function codes are ineffective, both frequency commands and run commands specified from the inverter itself take control.

---

| H42 | **Capacitance of DC Link Bus Capacitor** |
|---|---|

H42 displays the measured capacitance of the DC link bus capacitor (reservoir capacitor).

---

| H43 | **Cumulative Run Time of Cooling Fan** |
|---|---|

H43 displays the cumulative run time of the cooling fan.

---

| H47 | **Initial Capacitance of DC Link Bus Capacitor** |
|---|---|

H47 displays the initial value of the capacitance of the DC link bus capacitor (reservoir capacitor).

---

| H48 | **Cumulative Run Time of Capacitors on the Printed Circuit Board** |
|---|---|

H48 displays the cumulative run time of the capacitors mounted on the printed circuit board.

| H49 | Select Starting Characteristics (Auto search time for idling motor's speed) |
|---|---|

H49 specifies the synchronizing time.

- Data setting range: 0.0 to 10.0 (sec.)

| H50 | Non-linear V/f Pattern (Frequency) | Refer to F04. |
|---|---|---|

| H51 | Non-linear V/f Pattern (Voltage) | Refer to F05. |
|---|---|---|

For details of setting the non-linear V/f pattern, refer to the descriptions of function codes F04 and F05.

| H56 | Deceleration Time for Forced Stop |
|---|---|

When (STOP) is turned on while the forced to stop signal (STOP) is assigned to the digital input terminal (function code data = 30), the inverter output decelerates to stop in accordance with the setting of H56 (Deceleration time for forced to stop). When the inverter output has stopped after deceleration, it enters an alarm stop state, with the *er6* alarm displayed.

| H63 | Low Limiter (Mode selection) | Refer to F15 and F16. |
|---|---|---|

For how to set up this function code data, refer to the description of function codes F15 and F16.

| H64 | Low Limiter (Lower limiting frequency) |
|---|---|

When the output current limiter and/or overload prevention control is activated, this function specifies the lower limit of the frequency that may vary with the limit control.

- Data setting range: 0.0 to 60.0 (Hz)

| H69 | Automatic Deceleration |
|---|---|

H69 specifies whether automatic deceleration control is to be enabled or disabled. During deceleration of the motor, if regenerative energy exceeds the level that can be handled by the inverter, overvoltage trip may happen. With automatic deceleration enabled, when the DC link bus voltage exceeds the level (internally fixed) for starting automatic deceleration, the output frequency is controlled to prevent the DC link bus voltage from rising further; thus regenerative energy is suppressed .

| Data for H69 | Function |
|---|---|
| 0 | Disable |
| 1 | Enable |

Note   If automatic deceleration is enabled, deceleration may take a longer time. This is designed to limit the torque during deceleration, and is therefore of no use where there is a braking load.
Disable the automatic deceleration when a braking unit is connected. The automatic deceleration control may be activated at the same time when a braking unit starts operation, which may make the acceleration time fluctuate. In case the set deceleration time is so short, the DC link bus voltage of the inverter rises quickly, and consequently, the automatic deceleration may not follow the voltage rise. In such a case, prolong the deceleration time.
Even if the time period of 3 times of the deceleration time 1 (F08) has elapsed after the inverter entered automatic deceleration, there may be a case that the motor does not stop or the frequency dose not decrease. In this case, cancel the automatic deceleration forcibly for safety and decelerate the motor according to the set deceleration time. Prolong the deceleration time also.

| **H70** | **Overload Prevention Control** |

H70 specifies the rate of decreasing the output frequency to prevent an overload condition. Under this control, an overload trip is prevented by decreasing the output frequency of the inverter before the inverter trips because of the overheating of the cooling fan or the overloading of the inverter (with an alarm indication of $\mathit{0H}$ / or $\mathit{0LU}$). This control is useful for facilities such as pumps where a decrease in the output frequency leads to a decrease in the load and it is necessary to keep the motor running even when the output frequency goes low.

| Data for H70 | Function |
|---|---|
| 0.00 | Decelerate the motor by deceleration time 1 specified by F08 |
| 0.01 to 100.0 | Decelerate the motor by deceleration rate 0.01 to 100.0 (Hz/s) |
| 999 | Disable overload prevention control |

Note | In applications where a decrease in the output frequency does not lead to a decrease in the load, this function is of no use and should not be enabled.

| **H71** | **Deceleration Characteristics** |

Setting this function code to "1" (ON) enables forced brake control. If the regenerative energy produced during the deceleration of the motor exceeds the inverter's regenerative braking capacity, an overvoltage trip will occur. Forced brake control increases the loss of the motor and the deceleration torque during deceleration.

| Data for H71 | Function |
|---|---|
| 0 | Disable |
| 1 | Enable |

Note | This function is aimed at controlling the torque during deceleration; it has no effect if there is braking load.

| **H80** | **Gain for Suppression of Output Current Fluctuation for Motor** |

The inverter output current driving the motor may fluctuate due to the motor characteristics and/or backlash in the mechanical load. Modify the data in function code H80 to adjust the controls in order to suppress such fluctuation. However, as incorrect setting of this gain may cause larger current fluctuation, do not modify the default setting unless it is necessary.

- Data setting range: 0.00 to 0.40

| H82 | Light Alarm Selection |
|------|----------------------|

If the inverter detects a minor abnormal state "light alarm", it can continue the current operation without tripping while displaying the "light alarm" indication _L -AL_ on the LED monitor. In addition to the indication _L -AL_, the inverter displays the "L-ALARM" (blinking) on the LCD monitor and outputs the "light alarm" signal **L-ALM** to a digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the **L-ALM**, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E20 through E24 and E27 to "98.")

Function code H82 specify which alarms should be categorized as "light alarm."

The table below lists alarms selectable as "light alarm."

| Code | Name | Description |
|------|------|-------------|
| _roC_ | Running over cycle alarm | This alarm occurs when the maximum number of cycles has been reached as defined by the slow flowrate. |
| _idL_ | Low current detection alarm | This alarm occurs when the output current value calculated by the inverter decreases below the level specified by E37 for the time longer than the one specified by E38. |
| _CoF_ | PID feedback wire break | The PID feedback signal wire(s) is broken. |
| _Fb1_ | PID feedback 1 alarm | Warning related to PID control 1 (absolute-value alarm or deviation alarm). |
| _Fb2_ | PID feedback 2 alarm | Warning related to PID control 2 (absolute-value alarm or deviation alarm). |
| _PE1_ | Excessive PID error 1 alarm | When the PID error between the PID process command 1 (SV) and the PID feedback value 1 (PV) has exceeded the excessive PID error level specified by J66 during the period longer than the timer setting specified by J67, the protective function issues this alarm. |
| _PE2_ | Excessive PID error 2 alarm | When the PID error between the PID process command 2 (SV) and the PID feedback value 2 (PV) has exceeded the excessive PID error level specified by J96 during the period longer than the timer setting specified by J97, the protective function issues this alarm. |

Set data for selecting "light alarm"s in binary.

- Data setting range:      0 to 127

■ **Selecting light alarm factors**

To set and display the light alarm factors in binary format, each light alarm factor has been assigned to bits 0 to 6 as listed in Tables 5.4. Set the bit that corresponds to the desired light alarm factor to "1".

Table 5.4  Light Alarm Selection (H82), Bit Assignment of Selectable Factors

| Bit | Code | Content | Description |
|-----|------|---------|-------------|
| 0 | _roC_ | Running over cycle alarm | Refer to the function codes J68 and J69. |
| 1 | _idL_ | Low current detection alarm | Refer to the function codes E37 and E38. |
| 2 | _CoF_ | PID feedback wire break | Refer to the function codes H90 and H91. |
| 3 | _Fb1_ | PID feedback 1 alarm | Refer to the function codes J11 through J16. |
| 4 | _Fb2_ | PID feedback 2 alarm | Refer to the function codes J81 through J86. |
| 5 | _PE1_ | Excessive PID error 1 alarm | Refer to the function codes J66 and J67. |
| 6 | _PE2_ | Excessive PID error 2 alarm | Refer to the function codes J96 and J97. |

■ Light alarm--**L-ALM** (Function codes E20 to E24, and E27 data = 98)

This output signal comes ON when a light alarm occurs.

| H83 | Alarm Auto-resetting    (Selection) |
|---|---|
| H84 | Alarm Auto-resetting    (Times) |
| H85 | Alarm Auto-resetting    (Reset interval) |

While the alarm auto-resetting feature is specified, even if the protective function subject to retry is activated and the inverter enters the forced-to-stop state (tripped state), the inverter will automatically attempt to reset the tripped state and restart. If the protection function works in excess of the times specified by H84, the inverter will issue an alarm (for select faults) and not attempt to auto-reset the tripped state.

- Data setting range:     0 to 127

■ **Selecting alarm auto-resetting factors**

To set and display the auto-reset alarm factors in binary format, each light alarm factor has been assigned to bits 0 to 6 as listed in Tables 5.4. Set the bit that corresponds to the desired light alarm factor to "1".

Table 5.4  Alarm Auto-Resetting Selection (H84), Bit Assignment of Selectable Factors

| Bit | Code | Content | Description |
|---|---|---|---|
| 0 | roC | Running over cycle alarm | Refer to the function codes J68 and J69. |
| 1 | idL | Low current detection alarm | Refer to the function codes E37 and E38. |
| 2 | CoF | PID feedback wire break | Refer to the function codes H90 and H91. |
| 3 | Fb1 | PID feedback 1 alarm | Refer to the function codes J11 through J16. |
| 4 | Fb2 | PID feedback 2 alarm | Refer to the function codes J81 through J86. |
| 5 | PE1 | Excessive PID error 1 alarm | Refer to the function codes J66 and J67. |
| 6 | PE2 | Excessive PID error 2 alarm | Refer to the function codes J96 and J97. |

■ **Number of resetting times (H84)**

H84 specifies the number of auto-resetting "alarm auto-resetting" times for automatically escaping the tripped state. If the protective function is activated more than the specified alarm auto-resetting times, the inverter issues an alarm (for select faults) and does not attempt to escape the tripped state.

- Data setting range: 1 to 10 (times) (If "0" is set, the "alarm auto-resetting" operation will not be activated.)

---

⚠ **WARNING**

If the "alarm auto-resetting" function has been specified, the inverter may automatically restart and run the motor stopped due to a trip fault, depending on the cause of the tripping.

Design the machinery so that human body and peripheral equipment safety is ensured even when the alarm auto-resetting succeeds.

**Otherwise an accident could occur.**

---

■ **Reset interval (H85)**

- Data setting range: 0.5 to 600.0 (sec.)

After the reset interval specified by H85 from when the inverter enters the tripped state, it issues a reset command to auto-reset the tripped state. Refer to the timing scheme diagrams below. When a no alarm state is continued for five minutes, the counter of the automatic reset function is cleared.

<Timing scheme for failed retry (No. of auto-resetting times: 3)>
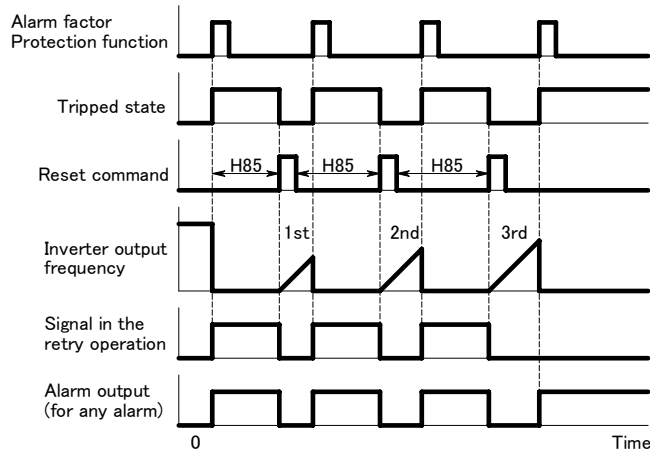


| H90 | **PID Feedback Wire Break Detection (Level)** |
|---|---|

| H91 | **PID Feedback Wire Break Detection (Time)** |
|---|---|

Using the terminal [C1] (current input) for PID feedback signal enables wire break detection and alarm ($\mathcal{C}\sigma\mathcal{F}$) issuance. H91 specifies whether wire break detection is enabled, and the duration of detection. (The inverter judges an input current to the terminal [C1] below H90 mA as a wire break.)

- Data setting range: 0.0 to 20.0 mA
- Data setting range: 0.0 (Disable alarm detection)
  0.1 to 60.0 s (Detect wire break and issue $\mathcal{C}\sigma\mathcal{F}$ alarm within the time)

| H92 | **Continue to Run (P-component: gain)** | **Refer to F14.** |
|---|---|---|

| H93 | **Continue to Run (I-component: time)** | **Refer to F14.** |
|---|---|---|

For how to set continuous running (P, I), refer to the description of function code F14.

| H94 | **Cumulative Run Time of Motor** |
|---|---|

You can view the cumulative run time of the motor on the keypad. This feature is useful for management and maintenance of the mechanical system. With this function code (H94), you can set the cumulative run time of the motor to any value you choose. For example, by specifying "0," you can clear the cumulative run time of the motor.

Note The data for H94 is in hexadecimal notation. Check the cumulative run time of the motor on the keypad.

| H95 | **DC Injection Braking (Braking response mode)** | **(Refer to F20 through F22.)** |
|---|---|---|

For how to set DC injection braking, refer to the description of function codes F20 through F22.

| H96 | **STOP Key Priority / Start Check Function / Run Key Memory** |

The inverter can be operated using a functional combination of "Priority on 🛑 Key", "Start Check." and "Run Key Memory".

| Data for H96 | STOP key priority | Start check function | Run key memory |
|:---:|:---:|:---:|:---:|
| 0 | Disable | Disable | Disable |
| 1 | Enable | Disable | Disable |
| 2 | Disable | Enable | Disable |
| 3 | Enable | Enable | Disable |
| 4 | Disable | Disable | Enable |
| 5 | Enable | Disable | Enable |

### ■ STOP key priority

Even when the run commands are received from the digital input terminals or via the RS485 communications link (link operation), pressing the 🛑 key forces the inverter to decelerate and stop the motor. "$Er6$" is displayed on the LED monitor after stopping.

### ■ Start check function

For safety, this function checks whether any run command has been turned ON or not. If a run command has been turned ON, an alarm code "$Er6$" is displayed on the LED monitor without the inverter being started up. This applies to the following situations:

• When any run command has been ON when the power to the inverter is turned ON.

• A run command is already input when the 🔄 key is pressed to release the alarm status or when the "Reset alarm" command (RST) (digital input) is input.

• When the run command source has been switched by the "Enable communications link" command (LE) (digital input) or "Switch run command 2/1" command (FR2/FR1), a run command is already turned ON at the new source.

### ■ Run key memory

This "Run" status can be stored when running from the 🔼 / 🔽 keys (F02 = 0, 2, 3) and in the PID control.

The primary use of this function is to automatically restart the inviter after a long period of power loss.

> **Note** This function does not work, if the PID control is disabled and power is removed.

---

<table>
<tr><td align="center">⚠ <strong>WARNING</strong></td></tr>
<tr><td>

When the drive is powered down while running, and upon the return of power, the drive will automatically initiate an internal "Run" command. Take extreme caution when using this function.

• Make sure it is safe to use this function in combination with the application requirements.

• This function is the sole responsibility of the user when activated (enabled) and the user accepts application liability.

**Otherwise, an accident could occur.**

</td></tr>
</table>

| H97 | Clear Alarm Data |
|------|------------------|

H97 deletes the information such as alarm history and data at the time of alarm occurrence, including alarms that have occurred during the check-up or adjustment of the machinery. Data is then brought back to a normal state without an alarm.

Deleting the alarm information requires simultaneous keying of ⊙ and ⊘ keys.

| Data for H97 | Function |
|:---:|----------|
| 0 | Disable |
| 1 | Clear all<br>(This data clears all alarm data stored and returns to "0.") |

| H98 | Protection/Maintenance Function | Refer to F26. |
|------|----------------------------------|---------------|

H98 specifies whether to enable or disable (a) automatic lowering of the carrier frequency, (b) protection against input phase loss, (c) protection against output phase loss, and (d) judgment on the DC link bus capacitor life, and the change of judgment criteria on the DC link bus capacitor life and the selection of handling on DC fan lock detection, in a style of combination.

Automatic lowering function of carrier frequency

You have to prevent important machinery from stopping as much as possible. Even if the inverter is in heat sink overheating or overload state because of excessive load, abnormal ambient temperature, or a trouble in the cooling system, with this function enabled, the inverter lowers the carrier frequency to avoid tripping ($OH1$, $OH3$ or $OLU$). Note that if this feature is enabled the motor noise increases.

Protection against input phase loss ($Lin$)

Upon detecting an excessive stress inflicted on the apparatus connected to the main circuit because of phase loss or inter-phase imbalance in the 3-phase power supplied to the inverter, this feature stops the inverter and displays an alarm $Lin$.

⟨Note⟩ In configurations where only a light load is driven or a DC reactor is connected, a phase loss or an inter-phase imbalance may not be detected because of the relatively small stress on the apparatus connected to the main circuit.

Protection against output phase loss ($OPL$ : Output Phase Loss)

Upon detecting a phase loss in the output while the inverter is running, this feature stops the inverter and displays an alarm $OPL$ Where a magnetic contactor is installed in the inverter output circuit, if the magnetic contactor goes OFF during operation, all the phases will be lost. In such a case, this protection feature does not work.

Selection of life judgment criteria of the DC link bus capacitors

Allows you to select the criteria for judging the life of the DC link bus capacitor/s (reservoir capacitor/s) between factory default setting and your own choice.

⟨Note⟩ Before specifying the criteria of your own choice, measure and confirm the reference level in advance. For details, refer to Chapter 7 "MAINTENANCE AND INSPECTION."

<u>Judgment on the life of DC link bus capacitors</u>

Whether the DC link bus capacitor (reservoir capacitor) has reached its life is determined by measuring the length of time for discharging after power off. The discharging time is determined by the capacitance of the DC link bus capacitor and the load inside the inverter. Therefore, if the load inside the inverter fluctuates significantly, the discharging time cannot be accurately measured, and as a result, it may be mistakenly determined that the life has been reached. To avoid such an error, you can disable the judgment on the life of the DC link bus capacitor.

Load may vary significantly in the following cases. Disable the judgment on the life during operation, and either conduct the measurement with the judgment enabled under appropriate conditions during periodical maintenance or conduct the measurement under the actual use conditions.

• Auxiliary input for control power is used

• An option card or multi-function keypad is used

• Another inverter or equipment such as a PWM converter is connected to the terminals of the DC link bus.

📖 For details, refer to Chapter 7 "MAINTENANCE AND INSPECTION."

<u>Detection of DC fan lock</u> (208 V : 50HP or above, 460 V : 75HP or above)

An inverter of 50HP or above (208 V series), or of 75HP or above (460 V series) is equipped with the internal air circulation DC fan. When the inverter detects that the DC fan is locked by a failure or other cause, you can select either continuing the inverter operation or entering into alarm state.

Entering alarm state: The inverter issues the alarm $OH1$ and coasts to stop the motor.

Continuing operation: The inverter does not enter the alarm mode, and continues operation of the motor.

Note that, however, the inverter turns on (OH) and (LIFE) signals on the transistor output terminals whenever the DC fan lock is detected regardless your selection.

⌒Note  If ON/OFF control of the cooling fan is enabled (H06 = 1), the cooling fan may stop depending on operating condition of the inverter. In this case, the DC fan lock detection feature is considered normal (e.g.; the cooling fan is normally stopped by the stop fan command.) so that the inverter may turn off the (LIFE) or (OH) signal output, or enable to cancel the $OH1$ alarm, even if the internal air circulation DC fan is locked due to a failure etc. (When you start the inverter in this state, it automatically issues the run fan command, then the inverter detects the DC fan lock state, and turn on the (LIFE) or (OH) output or enters the $OH1$ alarm state.)

Note that, operating the inverter under the condition that the DC fan is locked for long time may shorten the life of electrolytic capacitors on the printed circuit board due to local high temperature inside the inverter. Be sure to check with the (LIFE) signal etc., and replace the broken fan as soon as possible.

To set data of the function code H98, assign functions to each bit (total 6 bits) and set it in binary format. The table below lists functions assigned to each bit.

| Bit | Bit 5 | Bit 4 | Bit 3 | Bit 2 | Bit 1 | Bit 0 |
|---|---|---|---|---|---|---|
| Function | Detect DC fan lock | Judge life of DC link bus capacitor | Select life judgment criteria of DC link bus capacitor | Detect output phase loss | Detect input phase loss | Auto lowering of the carrier frequency |
| Data = 0 | Enter into the alarm state | Disable | Use the factory default | Disable | Disable | Disable |
| Data = 1 | Continue the operation | Enable | Use the user setting | Enable | Enable | Enable |
| Example of decimal expression (19) | Enter into the alarm state (0) | Enable (1) | Use the factory default (0) | Disable (0) | Enable (1) | Enable (1) |

## 5.2.6 J codes (Application functions)

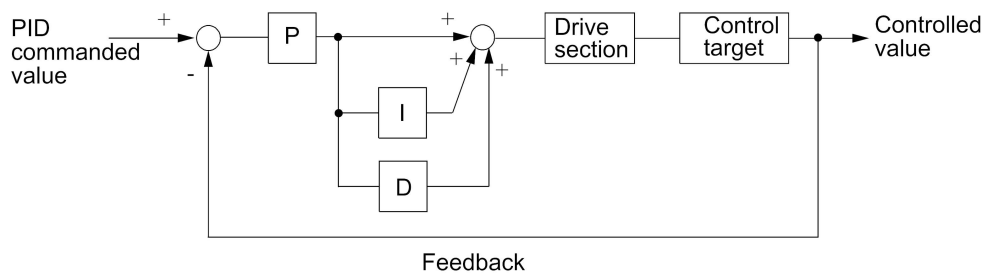| J01 | PID Control 1 (Mode selection) |
|---|---|

| J02 | PID Control 1 (Remote process command) |
|---|---|

| J03 | PID Control 1 (Gain) |
|---|---|

| J04 | PID Control 1 (Integral time) |
|---|---|

| J05 | PID Control 1 (Differential time) |
|---|---|

| J06 | PID Control 1 (Feedback filter) |
|---|---|

In PID control 1, the state of control object is detected by a sensor or similar device and is compared with the commanded value (e.g. temperature control command). If there is any deviation between them, the PID control operates so as to minimize it. Namely, it is a closed loop feedback system that matches controlled variable (feedback value). The PID control applies to a process control such as flowrate control, pressure control, and temperature control as shown in the schematic block diagram below.

If PID control is enabled (J01 = 1 or 2), the frequency control of the inverter is switched from the drive frequency command generator block to the PID frequency command generator block.

📖 Refer to Section 5.2.7 "PID Frequency Command Generator" for details.



### ■ Mode Selection (J01)

J01 selects PID control function.

| Data for J01 | Function |
|---|---|
| 0 | Disable PID control |
| 1 | Enable PID control (normal operation) |
| 2 | Enable PID control (inverse operation) |

- As normal operation or inverse operation against the output of PID control can be selected, you can fine-control the motor speed and rotation direction against the difference between commanded value and feedback value. Thus, FRENIC-Eco inverters can apply to many kinds of applications such as air conditioners. The operation mode can also be switched between normal and inverse by using the "Switch normal/inverse operation" terminal command (IVS).

📖 Refer to the function codes E01 to E05 for details of assignment of the (IVS) command.

<u>Selection of feedback terminals</u>

For feedback control, determine the connection terminal according to the type of the sensor output.

- If the sensor is current output type, use the current input terminal [C1] of the inverter.
- If the sensor is voltage output type, use the voltage input terminal [12] or [V2] of the inverter.

📖 For details, refer to the description of function codes E61 through E63.

The operating range for PID control is internally controlled as 0% through 100%. For the given feedback input, determine the range of control by means of gain adjustment.

For example, if the sensor output is in the range of 1 to 5 V:

- Use terminal [12] since this is a voltage input.
- Example of gain adjustment
  Set Gain adjustment (C32) at 200%, so that the maximum value (5 V) of the external sensor's output corresponds to 100%. Note that the input specification for terminal [12] is 0 - 10 V corresponding to 0 - 100%; thus, a gain factor of 200% (= 10 V ÷ 5 × 100) should be specified. Note also that any bias setting must not apply to feedback control.
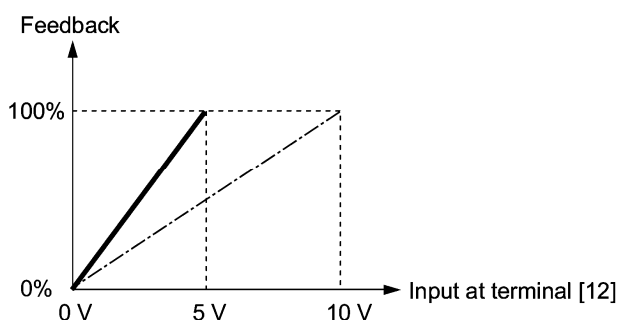


■ **Remote process command (J02)**

J02 specifies the source to set the command value (SV) under PID control.

| Data for J02 | Function |
|---|---|
| 0 | Keypad<br>Using the ⌃ / ⌄ key on the keypad in conjunction with display coefficients E40 and E41, you can specify the PID process command in PID Units (E39) of the easy-to-understand converted command format, such as in temperature and pressure. For details of operation, refer to Chapter 3 "OPERATION USING THE KEYPAD." |
| 1 | PID process command 1 (Terminals [12], [C1], [V2])<br>In addition to J02, various analog settings (function codes E61, E62, and E63) also need to select PID process command 1. For details, refer to function codes E61, E62, and E63. |
| 3 | UP/DOWN command<br>Using the UP (UP) or DOWN (DOWN) command in conjunction with display coefficients E40 and E41, you can specify the PID process command in 0 to 100% of the easy-to-understand converted command format. In addition to setting J02 at "3," you also need to assign the function selection for the E01 through E05 terminals ([X1] to [X5]) to the UP (UP) and DOWN (DOWN) commands (function code data = 17, 18). For details of (UP)/(DOWN) operation, refer to the assignment of the UP (UP) and DOWN (DOWN) command. |
| 4 | Command via communications link<br>Use the function code (S13) for communications-linked PID process command: the transmission data of 20000 (decimal) is equal to 100% (max. frequency) of the process command. For details of the communications format etc., refer to the RS485 communication User's Manual (MEH448d). |

Note Other than the process command selection by function code J02, the multistep frequency (C08 = 4) specified by the terminal command (SS4) can also be selected as a preset value for the PID process command.
Calculate the setting data of the process command using the equation below.
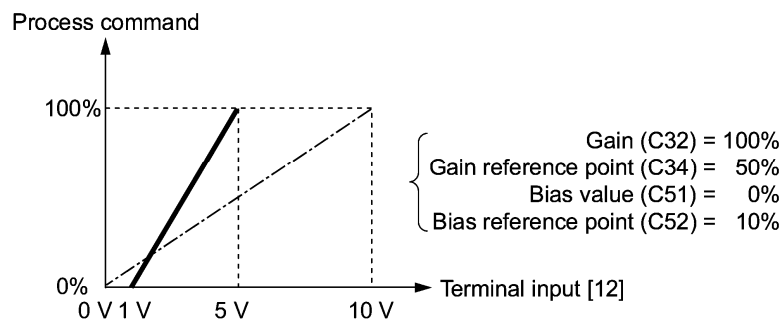Process command data (%) = (Preset multistep frequency) ÷ (Maximum frequency) × 100

Setting range for PID process command (for analog input only)

The operating range for PID control is internally controlled at 0% through 100%. Therefore, if you use an analog input as a PID process command, you need to set the range of the PID process command beforehand. As with frequency setting, you can arbitrary map relationship between the process command and the analog input value by adjusting the gain and bias.

For details, refer to the description of function codes C32, C34, C37, C39, C42, C44, C51, and C52.

Example) Mapping the range of 1 through 5 V at the terminal [12] to 0 through 100%



Gain (C32) = 100%
Gain reference point (C34) = 50%
Bias value (C51) = 0%
Bias reference point (C52) = 10%

PID display coefficient and monitoring

To monitor the PID process command and its feedback value, set the display coefficient to convert the displayed value into easy-to-understand numerals of the process control value such as temperature.

Refer to the function codes E40 and E41 for details on display coefficients, and to E43 for details on monitoring.
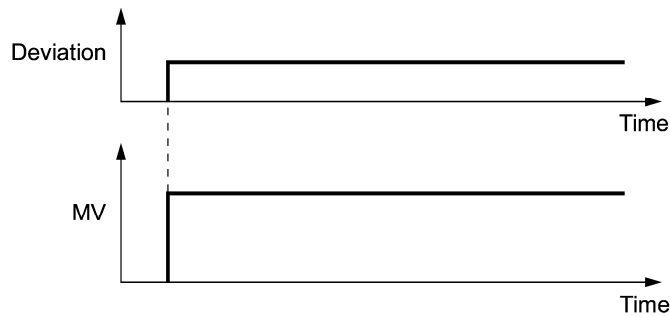
## ■ Gain (J03)

J03 specifies the gain for the PID processor.

- Data setting range: 0.000 to 30.000 (multiple)

P (Proportional) action

An operation that an MV (manipulated value: output frequency) is proportional to the deviation is called P action, which outputs a manipulated value in proportion to deviation. However, the manipulated variable alone cannot eliminate deviation.

Gain is data that determines the system response level against the deviation in the P action. An increase in gain speeds up response, an excessive gain may cause vibration, and a decrease in gain delays response.



## ■ Integral time (J04)

J04 specifies the integral time for the PID processor.

- Data setting range: 0.0 to 3600.0 (sec.)

    0.0 means that the integral component is ineffective.

I (Integral) action

An operation that the change rate of an MV (manipulated value: output frequency) is proportional to the integral value of deviation is called I action that outputs the manipulated value that integrates the deviation. Therefore, I action is effective in bringing the feedback value close to the commanded value. For the system whose deviation rapidly changes, however, this action cannot make it react quickly.

The effectiveness of I action is expressed by integral time as parameter, that is J04 data. The longer the integral time, the slower the response. The reaction to the external turbulence also becomes slow. The shorter the integral time, the faster the response. Setting too short integral time, however, makes the inverter output tend to oscillate against the external turbulence.

## ■ Differential time (J05)

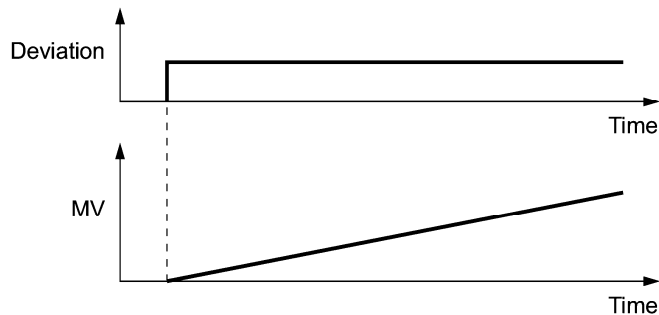J05 specifies the differential time for the PID processor.

- Data setting range: 0.00 to 600.00 (sec.)
  0.0 means that the differential component is ineffective.

D (Differential) action

An operation that the MV (manipulated value: output frequency) is proportional to the differential value of the deviation is called D action that outputs the manipulated value that differentiates the deviation. D action makes the inverter quickly react to a rapid change of deviation.

The effectiveness of D action is expressed by differential time as parameter, that is J05 data. Setting a long differential time will quickly suppress oscillation caused by P action when a deviation occurs. Too long differential time makes the inverter output oscillation more. Setting short differential time will weakens the suppression effect when the deviation occurs.
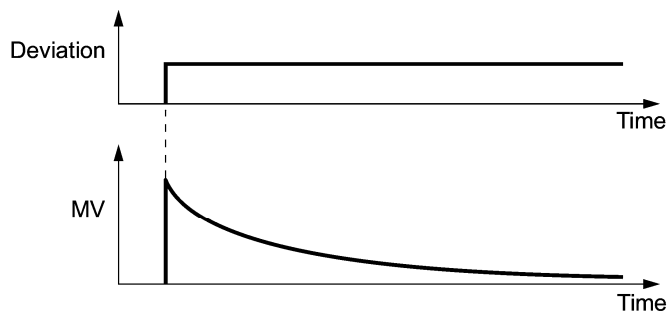
The combined use of P, I, and D actions are described below.

(1) PI control

PI control, which is a combination of P and I actions, is generally used to minimize the remaining deviation caused by P action. PI control acts to always minimize the deviation even if a commanded value changes or external disturbance steadily occurs. However, the longer the integral time, the slower the system response to quick-changed control.

P action can be used alone for loads with very large part of integral components.

(2) PD control

In PD control, the moment that a deviation occurs, the control rapidly generates much manipulative value than that generated by D action alone, to suppress the deviation increase. When the deviation becomes small, the behavior of P action becomes small.

A load including the integral component in the controlled system may oscillate due to the action of the integral component if P action alone is applied. In such a case, use PD control to reduce the oscillation caused by P action, for keeping the system stable. That is, PD control is applied to a system that does not contain any braking actions in its process.

(3) PID control

PID control is implemented by combining P action with the deviation suppression of I action and the oscillation suppression of D action. PID control features minimal control deviation, high precision and high stability.

In particular, PID control is effective to a system that has a long response time to the occurrence of deviation.

Follow the procedure below to set data to PID control function codes.

It is highly recommended that you adjust the PID control value while monitoring the system response waveform with an oscilloscope or equivalent. Repeat the following procedure to determine the optimal solution for each system.

- Increase the data of J03 (P (Gain) of PID control) within the range where the feedback signal does not oscillate.

- Decrease the data of J04 (I (Integral time) of PID control) within the range where the feedback signal does not oscillate.

- Increase the data of J05 (D (differential time) of PID control) within the range where the feedback signal does not oscillate.

Refining the system response waveforms is shown below.

1)  Suppressing overshoot

    Increase the data of J04 (Integral time) and decrease that of code J05 (Differential time)
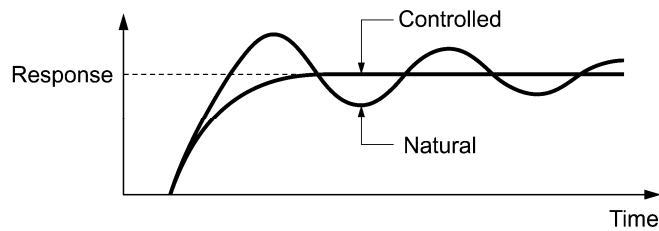


2)  Quick stabilizing (moderate overshoot allowable)

    Decrease the data of J03 (Gain) and increase that of code J05 (Differential time)
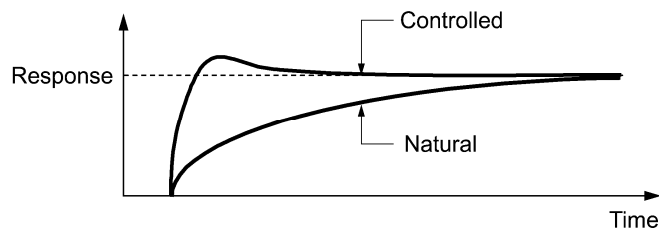


3)  Suppressing oscillation longer than the integral time specified by J04

    Increase the data of J04 (Integral time)
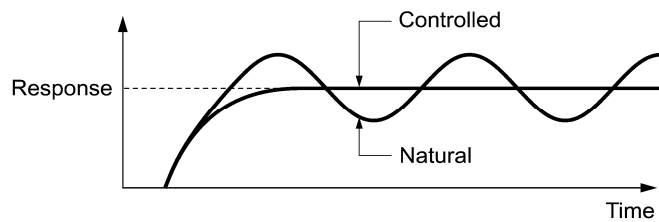


4)  Suppressing oscillation of approximately same period as the time set for function code J05 (Differential time)

    Decrease the data of J05 (Differential time).

    Decrease the data of J03 (Gain), when the oscillation cannot be suppressed even if the differential time is set at 0 sec.
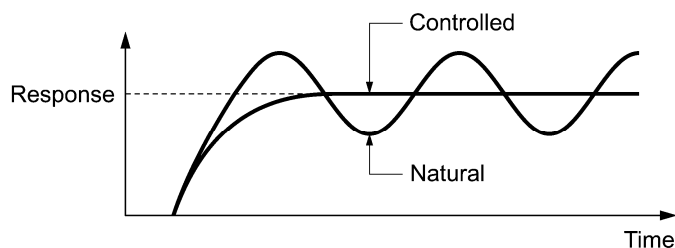


■ Feedback filter (J06)

J06 specifies the time constant of the filter for feedback signals under PID control.

- Data setting range: 0.0 to 900.0 (sec.)

- This setting is used to stabilize the PID control loop. Setting too long a time constant makes the system response slow.

| J07 | PID Control 1 (Start stabilize frequency) |
|-----|--------------------------------------------|
| J08 | PID Control 1 (Start stabilize level) |
| J09 | PID Control 1 (Start sabilize time) |
| J10 | PID Control 1 (Start stabilize acceleration time) |

The FRN-F1-DY drive can be configured for special functions for dedicated pumping applications. These functions are: Start Stabilize Level (J08) and Start Stabilize Frequency (J07).

Some pump systems require the system to be "Start stabilize" before normal operation can occur. The built-in start stabilize function allows the pump system to run at a fixed motor speed for a setting time. This function also operates in conjunction with a selectable feedback level and/or an external contact to indicate that the desired level has been reached.

The start stabilize level that the FRN-F1-DY drive will operate at is determined by setting the Start Stabilize Level (J08). The drive will monitor the Feedback Level (LED/LCD monitor) and compare the feedback level with the level programmed in the Start Stabilize Level (J08). When the feedback level reaches the Start Stabilize Level (J08), the drive will disable the start stabilize mode, and switch to PID control.

The frequency reference used during the start stabilize mode is determined by setting Start Stabilize Frequency (J07) for a maximum allowable time set in the Start Stabilize Time (J09).

The start stabilize mode can be canceled by assigning the (SSC) terminal command to one of digital input terminals (E01 to E05, function code data = 72).Turning (SSC) terminal command ON disables the start stabilize of PID control.

The start stabilize is only active in PID control. The Start Stabilize Level (J08) works in conjunction with the Start Stabilize Frequency (J07) and the Start Stabilize Time (J09). The units for this parameter are determined by the PID Display Units (E39).

Note: The drive will stop when one of the following conditions occur:
  • The feedback level rises above the Start Stabilize Level (J08)
  • The Start Stabilize Time (J09) elapses
  • The Cancel Start Stabilize input (SSC) is activated

The acceleration time used during start stabilize mode is determined by Start Stabilize Acceleration Time (J10).

If the Start Stabilize Frequency (J07) is less than the Frequency Limiter (Low) (F16), the drive will internally use a Start Stabilize Frequency equal to the Frequency Limiter (Low) value.

The Start Stabilize function can only be activated while the drive is in "stop" condition. To enable the Start Stabilize function requires the Start Stabilize Frequency (J07) to be set to a value greater than 0.0. When the Start Stabilize function is activated, a "STABI" will be displayed on the LCD monitor. Refer to the function code E45.

J09
(Start stabilize time)

Output Frequency

J07
(Start stabilize frequency)

t

Feedback value (PV)

J08
(Start stabilize level)

t

Run command                ON

t

Cancel start stabilize 『SSC』        ON

t

Under PID control 『PID-CTL』 signal        ON

t


J09
(Start stabilize time)

Output Frequency

J07
(Start stabilize frequency)

t

Feedback value (PV)

J08
(Start stabilize level)

t

Run command                ON

t

Cancel start stabilize 『SSC』        ON

t

Under PID control 『PID-CTL』 signal        ON

t


J09
(Start stabilize time)

Output Frequency

J07
(Start stabilize frequency)

t

Feedback value (PV)

J08
(Start stabilize level)

t

Run command                ON

t

Cancel start stabilize 『SSC』        ON

t

Under PID control 『PID-CTL』 signal        ON

t

| J11 | **PID Control 1 (Select alarm output)** |
|---|---|

| J12 | **PID Control 1 (Upper limit alarm (AH))** |
|---|---|

| J13 | **PID Control 1 (Upper alarm delay time)** |
|---|---|

| J14 | **PID Control 1 (Lower limit alarm (AL))** |
|---|---|

| J15 | **PID Control 1 (Lower alarm delay time)** |
|---|---|

| J16 | **PID Control 1 (Hysteresis level)** |
|---|---|

Two types of alarm signals can be output associated with PID control: absolute-value alarm and deviation alarm. You need to assign the PID alarm output (PID-ALM), (FB1-ALM) to one of the digital output terminals (function code data = 42, 50).

■ **PID Control 1 (Select alarm output) (J11)**

Specifies the alarm type. The table below lists all the alarms available in the system.

| Data for J11 | Alarm | Description |
|---|---|---|
| 1 | Absolute-value alarm | While PV < AL or AH < PV, (PID-ALM) is ON.<br> |
| 2 | Absolute-value alarm (with Hold) | Same as above (with Hold) |
| 3 | Absolute-value alarm (with Latch) | Same as above (with Latch) |
| 4 | Absolute-value alarm (with Hold and Latch) | Same as above (with Hold and Latch) |
| 5 | Deviation alarm | While PV < SV - \|AL\| or SV + \|AH\| < PV, (PID-ALM) is ON.<br> |
| 6 | Deviation alarm (with Hold) | Same as above (with Hold) |
| 7 | Deviation alarm (with Latch) | Same as above (with Latch) |
| 8 | Deviation alarm (with Hold and Latch) | Same as above (with Hold and Latch) |

Hold: During the power-on sequence, the alarm output is kept OFF (disabled) even when the monitored quantity is within the alarm range. Once it goes out of the alarm range, and comes into the alarm range again, the alarm is enabled.

Latch: Once the monitored quantity comes into the alarm range and the alarm is turned ON, the alarm will remain ON even if it goes out of the alarm range. To release the latch, perform a reset by using the (PRG/RESET) key or turning ON the terminal command (RST), etc. Resetting can be done by the same way as resetting an alarm.

## ■ PID Control 1 (Upper limit alarm (AH)) (J12)

Specifies the upper limit of the alarm (AH) in the PID Display Units (E39) of the process value.

## ■ PID Control 1 (Lower limit alarm) (AL)) (J14)

Specifies the lower limit of the alarm (AL) in the PID Display Units (E39) of the process value.

Upper limit alarm (AH) and lower limit alarm (AL) also apply to the following alarms.

| Alarm | Description | How to handle the alarm: | |
|---|---|---|---|
| | | Select alarm output (J11) | Parameter setting |
| Upper limit (absolute) | ON when AH < PV | Absolute-value alarm | J14 (AL) = E40 |
| Lower limit (absolute) | ON when PV < AL | | J12 (AH) = E41 |
| Upper limit (deviation) | ON when SV + \|AH\| < PV | Deviation alarm | J14 (AL) = E41 |
| Lower limit (deviation) | ON when PV < SV - \|AL\| | | J12 (AH) = E41 |
| Upper/lower limit (deviation) | ON when \|SV - PV\| > AL | | J14 (AL) = J12 (AH) |
| Upper/lower range limit (deviation) | ON when SV - \|AL\| < PV < SV + \|AL\| | Deviation alarm | J14 (AL) = J12 (AH) (DO) inversed |
| Upper/lower range limit (absolute) | ON when AL < PV < AH | Absolute-value alarm | (DO) inversed |
| Upper/lower range limit (deviation) | ON when SV - \|AL\| < PV < SV + \|AH\| | Deviation alarm | (DO) inversed |

## ■ PID Control 1 (Upper alarm delay time) (J13)

The FRN-F1-DY drive can be configured to display a Feedback 1 Alarm $Fb1$ when the feedback value 1 exceeds the level specified by J12 for the time longer than the one specified by J13 (Upper alarm Delay Time).
Setting J13 to a value of 0.00 will disable this function.
The Upper alarm Delay Time (J13) works in conjunction with J12.

Note: This function is active during operation in the PID control.

## ■ PID Control 1 (Lower alarm delay time) (J15)

The FRN-F1-DY drive can be configured to display a Feedback 1 Alarm $Fb1$ when the feedback value 1 decreases below the level specified by J14 for the time longer than the one specified by J15 (Lower alarm Delay Time).
Setting J15 to a value of 0.00 will disable this function.
The Lower alarm Delay Time (J15) works in conjunction with J14.

Note: This function is active during operation in the PID control.

## ■ PID Control 1 (Hysteresis level) (J16)

The FRN-F1-DY drive can be configured to detect the Upper Limit Alarm (J12) and the Lower limit Alarm (J14). The Hysteresis Level (J16) is used to provide a bandwidth before the drive returns to normal operation. The Hysteresis Level is used to prevent rapid cycling between alarm and normal operations.

The Hysteresis Level (J16) works in conjunction with the Upper Limit Alarm (J12) and Lower limit Alarm (J14) functions.

The units for this parameter are determined by the PID Display Units (E39).

## H82 bit 3 = 0 (Disable Light Alarm)

Feedback Value (PV)

(Upper limit alarm (AH)) J12

J16
(Hysteresis level)

(Lower limit alarm (AL)) J14

『PID-ALM』 signal
『FB1-ALM』 signal — ON — ON

LED display — *Fb1* — *Fb1*

J15
(Lower alarm delay time)  J13
(Upper alarm delay time)

『ALM』 — ON — ON

『RST』 input — ON — ON
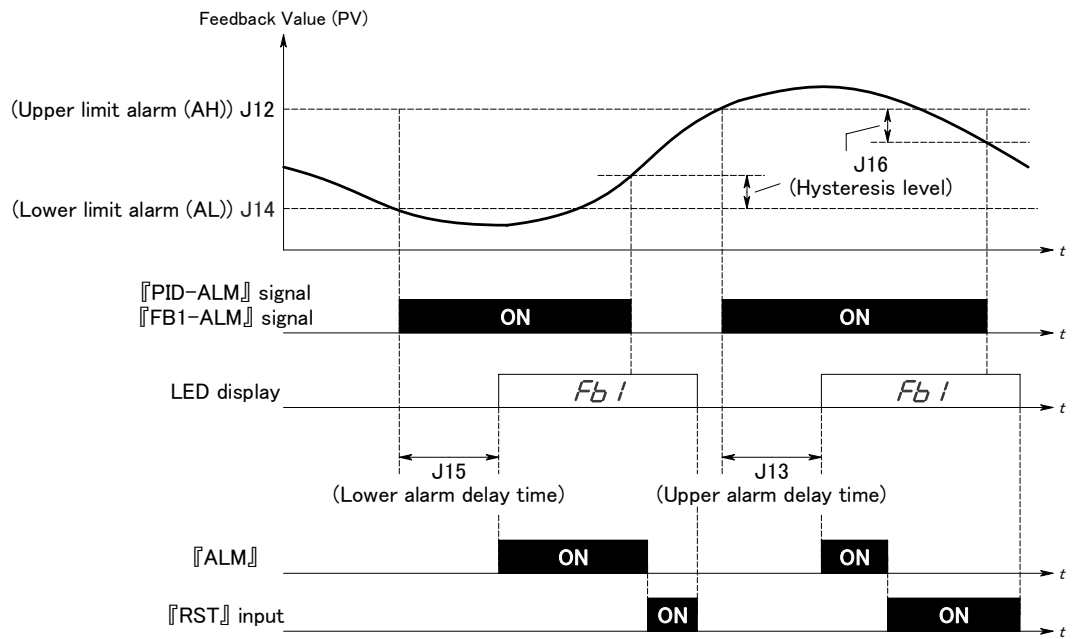
## H82 bit 3 = 1 (Enable Light Alarm)

Feedback Value (PV)

(Upper limit alarm (AH)) J12

J16
(Hysteresis level)

(Lower limit alarm (AL)) J14

『PID-ALM』 signal
『FB1-ALM』 signal — ON — ON

LED display — *L-AL* — *L-AL*

J15
(Lower alarm delay time)  J13
(Upper alarm delay time)

『ALM』

『RST』 input — ON — ON
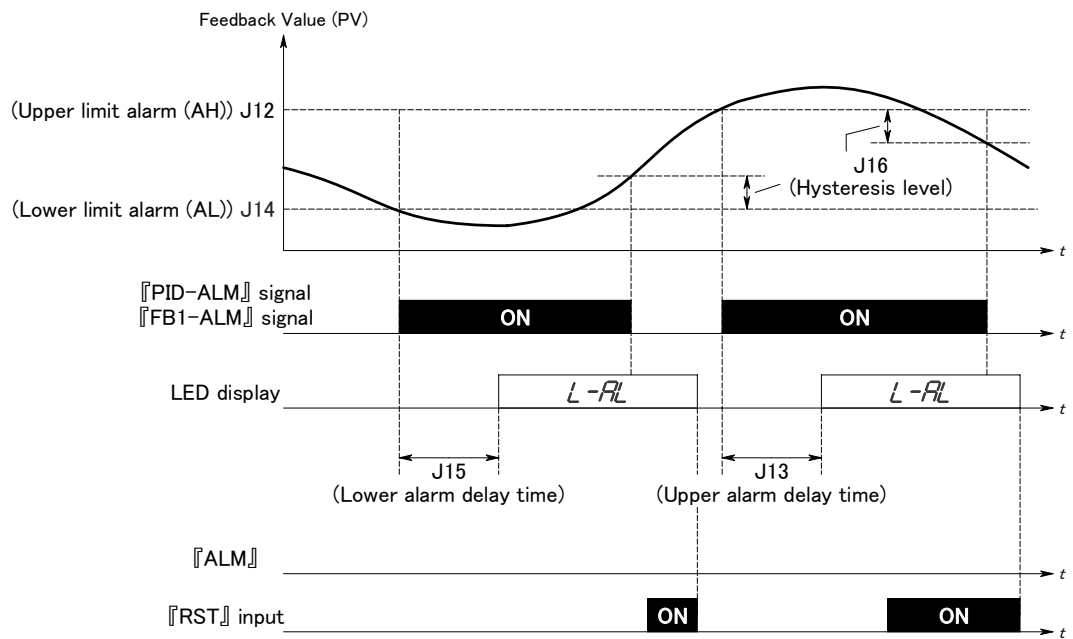
| J18 | PID Control 1 (Upper limit of PID process output) |
|-----|----------------------------------------------------|

| J19 | PID Control 1 (Lower limit of PID process output) |
|-----|----------------------------------------------------|

The upper and lower limiter can be specified to the PID output, exclusively used for PID control. The settings are ignored when PID cancel is enabled and the inverter is operated at the reference frequency previously specified.

### ■ PID Control (Upper limit of PID process output) (J18)

Specifies the upper limit of the PID processor output limiter in increments of 0.1 Hz. If you specify "999," the setting of the frequency limiter (High) (F15) will serve as the upper limit.

### ■ PID Control (Lower limit of PID process output) (J19)

Specifies the lower limit of the PID processor output limiter in increments of 0.1 Hz. If you specify "999," the setting of the frequency limiter (Low) (F16) will serve as the lower limit.

| J20 | PID Control 1 (Anti reset windup) |
|-----|-----------------------------------|

J20 suppresses overshoot in control with PID processor. As long as the deviation between the feedback value and the PID process command is beyond the preset range, the integrator holds its value and does not perform integration operation.

This function is effective only in PID control 1.

Setting J20 to a value of 0.00 will disable this function.

- Data setting range: 0.01 to +999 (The unit is based on E39.)
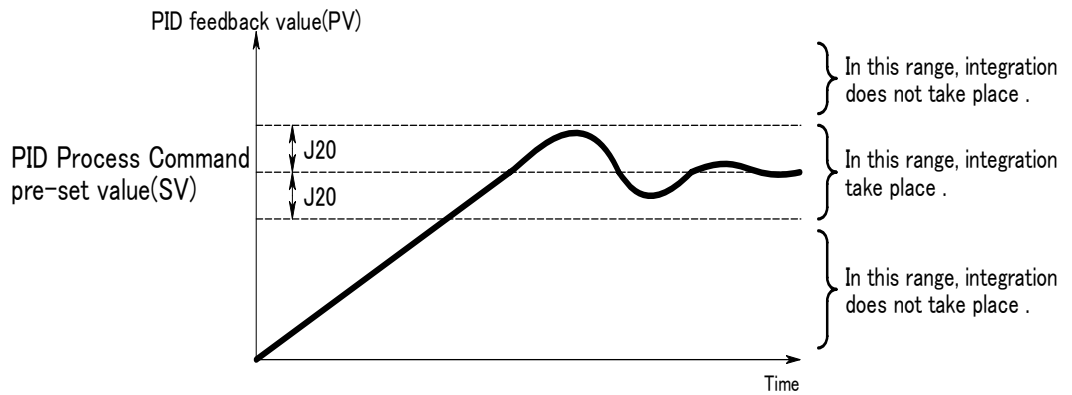
| J56 | PID Control 1 (Slow flowrate level Selection) |
| J57 | PID Control 1 (Stop level for slow flowrate) |
| J58 | PID Control 1 (Slow flowrate level stop latency) |
| J61 | PID Control 1 (Pressurization starting frequency) |
| J62 | PID Control 1 (Pressurizing time) |
| J63 | PID Control 1 (Starting level Selection for Slow flowrate) |
| J64 | PID Control 1 (Starting level for Slow flowrate) |
| J65 | PID Control 1 (Starting delay time for Slow flowrate) |

These function codes specify the data for the slow flowrate stop in pump control, a feature that stops the inverter when the discharge pressure rises, causing the volume of water to decrease.

■ **Slow flowrate stop feature**

When the discharge pressure has increased, decreasing the reference frequency (output of the PID processor) below the stop level for slow flowrate (J57)(J91) for more than the elapsed stopping time on slow flowrate level stop latency (J58)(J92), the inverter decelerates to stop, while PID control itself continues to operate. When the discharge pressure decreases, increasing the reference frequency (output of the PID processor) above the starting level (J64)(J94), the inverter resumes operation.

■ **Motor stopping due to slow flowrate under PID control -- (PID-STP)**
   **(Function code data of E01 to E05, E98 and E99 = 44)**

This output signal is ON when the inverter is in a stopped state due to the slow flowrate stopping function under PID control.

If you wish to have a signal indicating the state in which the inverter is stopped due to the slow flowrate stop feature, you need to assign (PID-STP) (Inverter stopping due to slow flowrate under PID control ) to one of the general-purpose output terminal (function code data = 44).

■ **PID Control (Stop level for slow flowrate) (J57)(J91)**

Specifies the frequency which triggers slow flowrate stop of inverter. The units for this parameter are determined by the PID Display Units (E39).

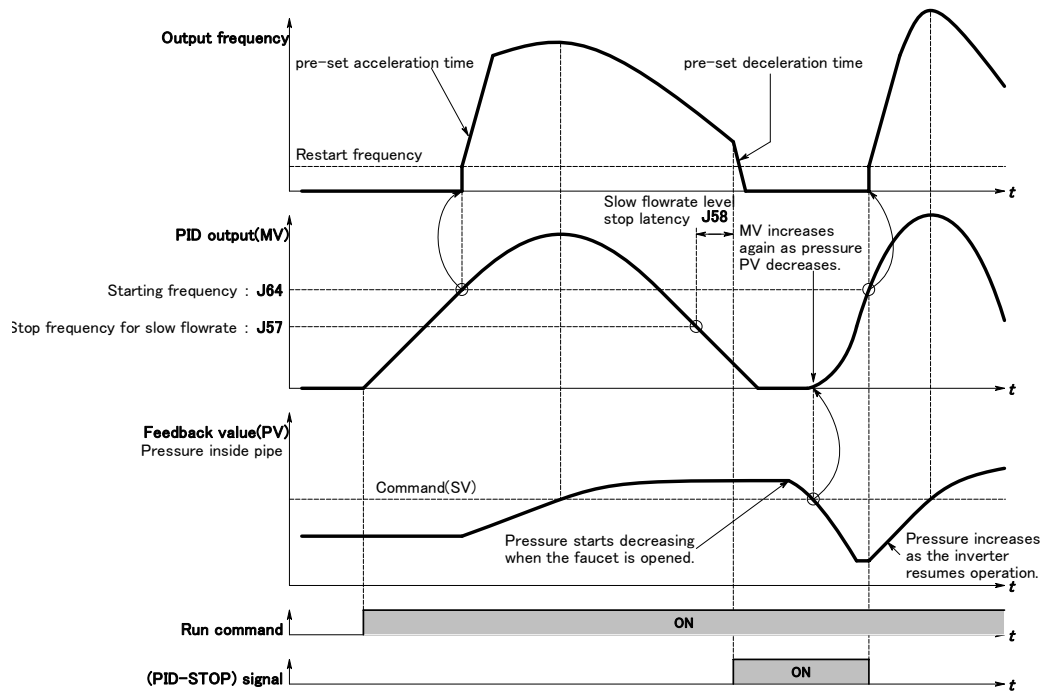■ **PID Control (Slow flowrate level stop latency) (J58)(J92)**

Specifies the elapsed time from when the inverter stops operation due to slow flowrate level condition.

■ **PID Control (Starting level for slow flowrate) (J64)(J94)**

Specifies the starting frequency. Select a frequency higher than the slow flowrate level stop frequency. If the specified starting frequency is lower than the slow flowrate level stop frequency, the latter stop frequency is ignored; the slow flowrate level stop is triggered when the output of the PID processor drops below the specified starting frequency. The units for this parameter are determined by the PID Display Units (E39).

■ **PID Control (Starting delay time for slow flowrate) (J65)(J95)**

Specifies the elapsed time from when the inverter starts operation due to slow flowrate level condition.

Output frequency

pre-set acceleration time

pre-set deceleration time

Restart frequency

PID output(MV)

Slow flowrate level stop latency **J58**

MV increases again as pressure PV decreases.

Starting frequency : **J64**

Stop frequency for slow flowrate : **J57**
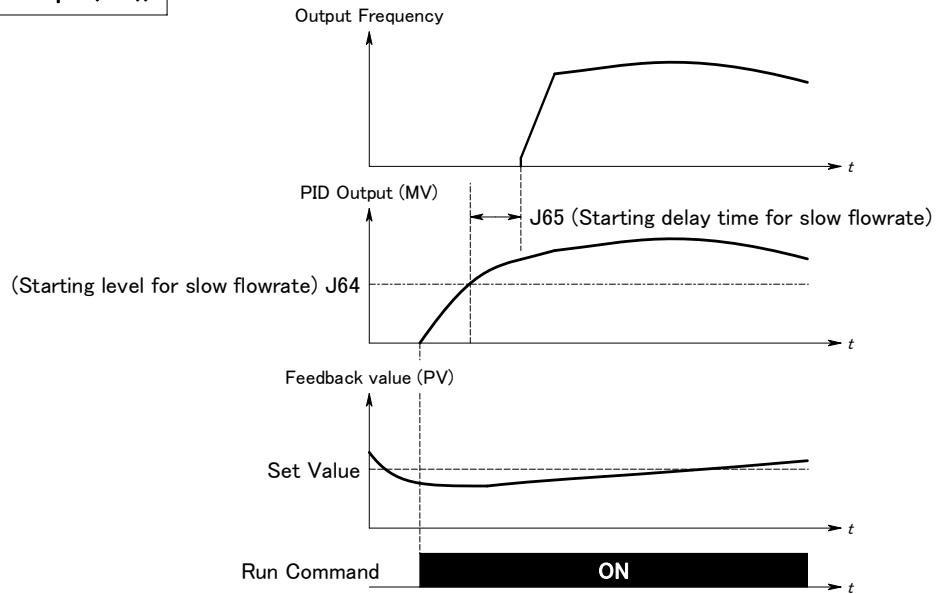
Feedback value(PV)
Pressure inside pipe

Command(SV)

Pressure starts decreasing when the faucet is opened.

Pressure increases as the inverter resumes operation.

Run command

ON

(PID-STOP) signal

ON

**J63 = 1 (PID process output(MV))**

Output Frequency

PID Output (MV)

J65 (Starting delay time for slow flowrate)

(Starting level for slow flowrate) J64

Feedback value (PV)

Set Value

Run Command    ON

**J63 = 4 (PID feedback value(PV))**

Output Frequency

PID Output (MV)

Feedback value (PV)

J65 (Starting delay time for slow flowrate)

Set Value

(Starting level for slow flowrate) J64

Run Command    ON

### ■ Pressurization before stopping for slow flowrate

Specifying J61 (Pressurization starting frequency) and J62 (Pressurizing time) enables pressurization control when the frequency drops below the level specified by J56 (Stop level for slow flowrate) for the period specified by J62 (Pressurizing time). During the pressurization, the PID control is held.

This function prolongs the stopping time of equipment with a bladder tank by pressurizing immediately before the frequency drops below the level at which the inverter stops the motor, thus enabling energy saving operation.

Because the pressurization starting frequency (J61) can be specified with a parameter, pressurization setting suitable for the equipment is possible.

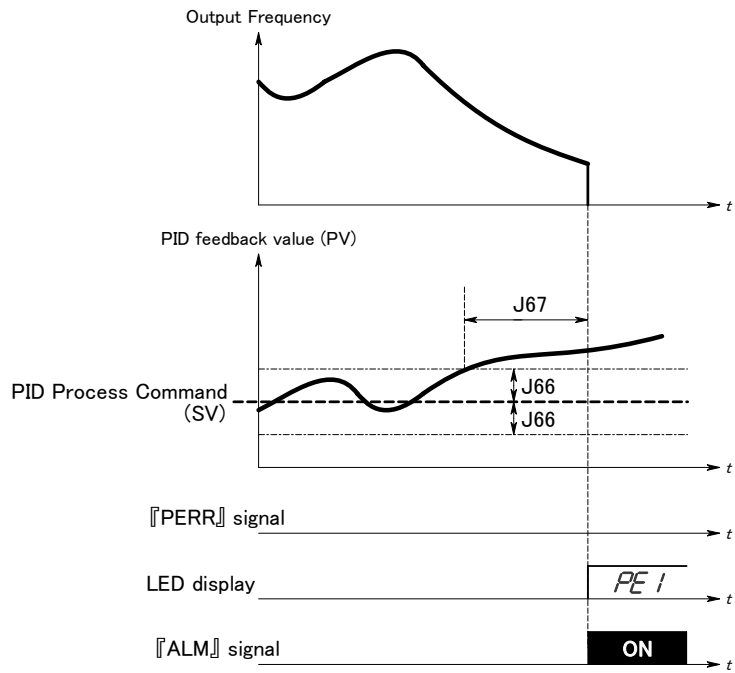This function is effective only in PID control 1.
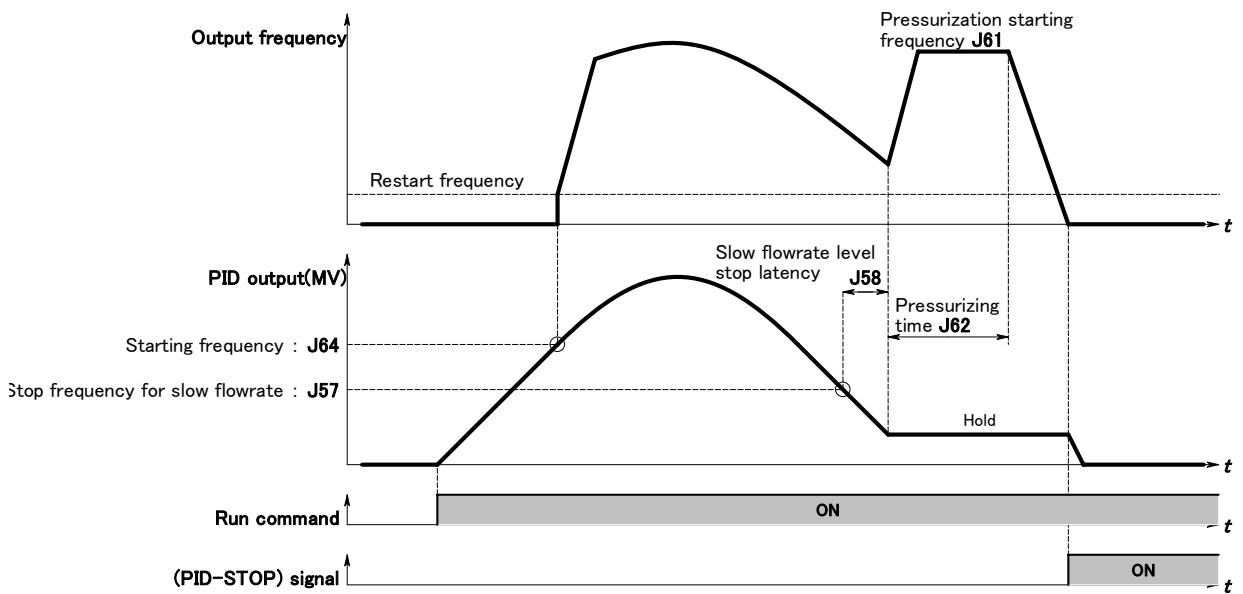
| J66 | PID Control 1 (Excessive PID error level) |
|---|---|

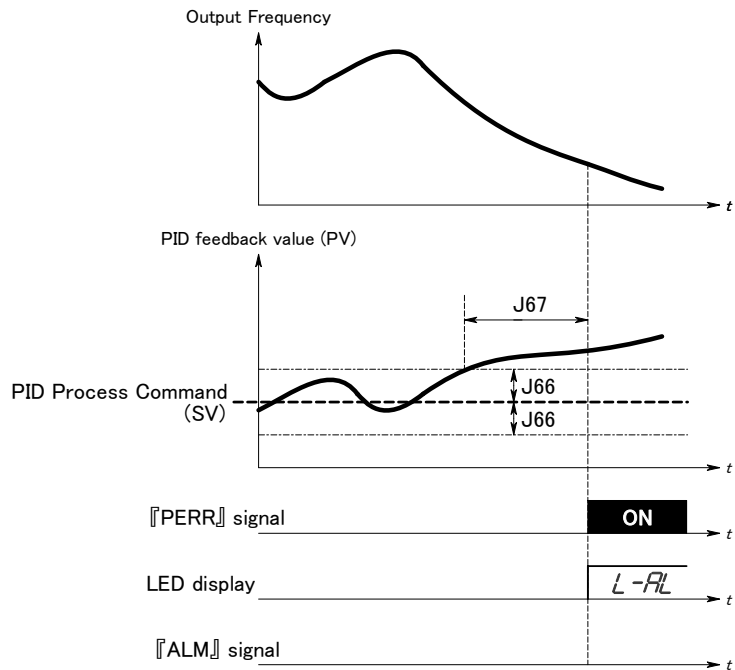| J67 | PID Control 1 (Excessive PID error time) |
|---|---|

When the PID error between the PID 1 process command (SV) and the PID 1 feedback value (PV) has exceeded the excessive PID error level specified by J66 during the period longer than the timer setting specified by J67, the protective function issues a $PE1$ alarm.

Setting J66 to a value of 0.00 will disable this function. This function is only active during operation in the PID control.

H82 bit 5 = 0 (Disable Light Alarm)

Output Frequency

PID feedback value (PV)

J67

PID Process Command
(SV)

J66
J66

『PERR』signal

LED display    $PE1$

『ALM』signal    ON

H82 bit 5 = 1 (Enable Light Alarm)

Output Frequency

PID feedback value (PV)

J67

PID Process Command
(SV)

J66
J66

『PERR』signal    ON

LED display    $L-AL$

『ALM』signal

| J68 | PID Control 1 (Cycling protection for slow flowrate) |
|-----|------------------------------------------------------|

| J69 | PID Control 1 (Maximum cycling protection time for slow flowrate) |
|-----|-------------------------------------------------------------------|

The FRN-F1-DY drive can be configured to allow a maximum number of cycles before initiating a "Run Over Cycle " $r o C$ alarm. The drive will determine the maximum number of cycles based on the programmed number in the Slow Flowrate Mode: Cycling Protection (J68).

One cycle is defined by the drive transferring from normal operation to sleep mode when operating in the PID control. A value of 0 programmed into the Slow Flowrate: Cycling Protection (J68) will disable this function.

The maximum time allowed between cycles can be programmed in the Slow Flowrate Mode: Maximum Cycling Protection Time (J69).
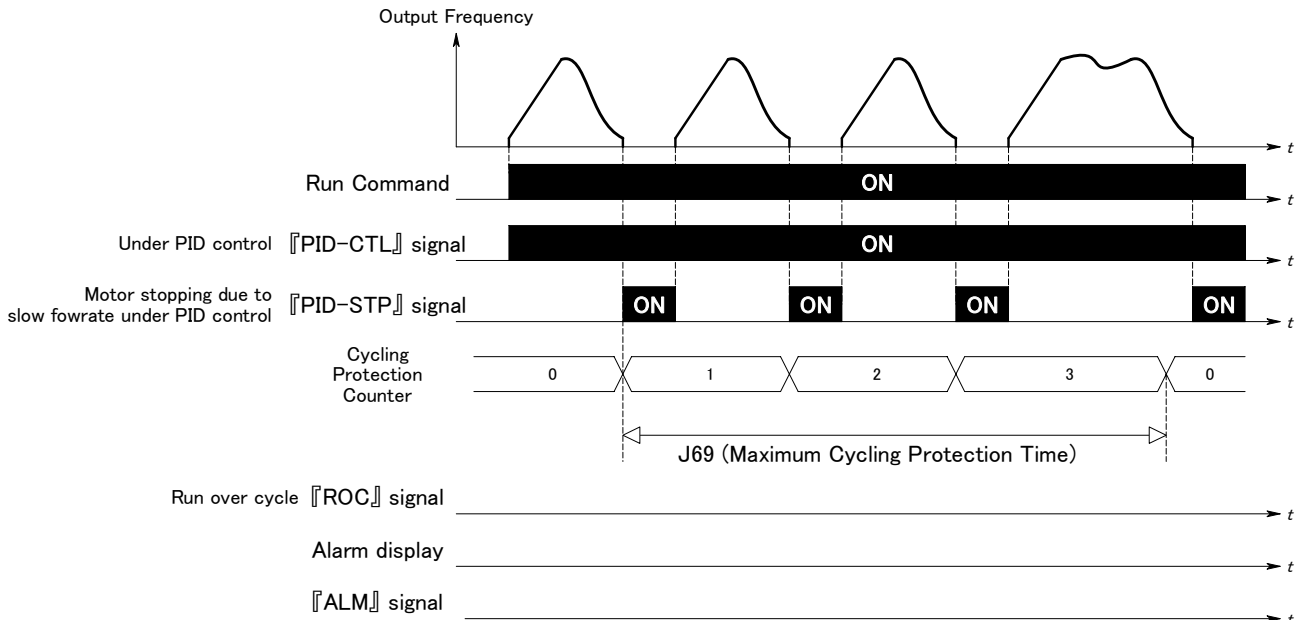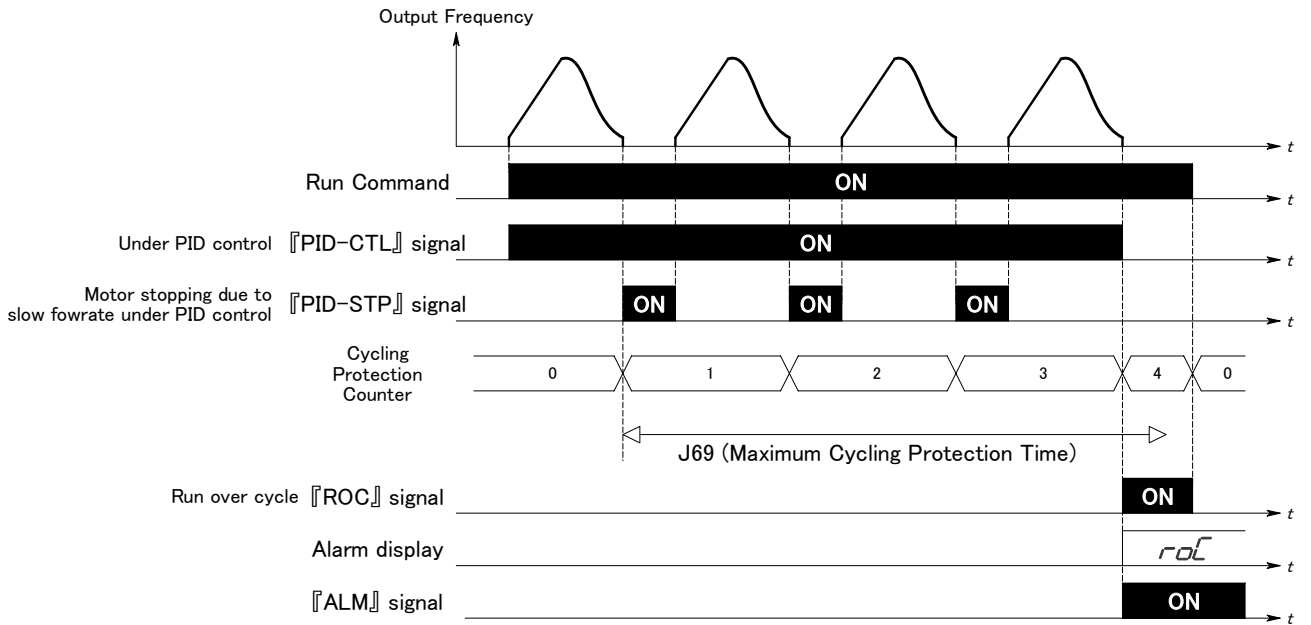
The Slow Flowrate Mode: Cycling Protection (J68) works in conjunction with the Slow Flowrate Mode: Maximum Cycling Protection Time (J69).

The number of cycles allowed is determined by programming the Slow Flowrate Mode: Cycling Protection (J68). The maximum time allowed between cycles can be programmed in the Slow Flowrate Mode: Maximum Cycling Protection Time (J69). If no cycling occurs within the programmed time, the drive will reset the internal cycle register.

The Slow Flowrate Mode: Maximum Cycling Protection Time (J69) works in conjunction with the Slow Flowrate Mode: Cycling Protection (J68).

<Timing scheme for failed retry (No. of retry times: 3)>

Operation count on the function of cycling protection is going to be clear when operation command = OFF or passage of time on the function code: J69 from first count-up.

Output Frequency

Run Command — ON

Under PID control 『PID-CTL』 signal — ON

Motor stopping due to slow fowrate under PID control 『PID-STP』 signal — ON ON ON

Cycling Protection Counter — 0 1 2 3 4 0

J69 (Maximum Cycling Protection Time)

Run over cycle 『ROC』 signal — ON

Alarm display — roC

『ALM』 signal — ON

Output Frequency

Run Command — ON

Under PID control 『PID-CTL』 signal — ON

Motor stopping due to slow fowrate under PID control 『PID-STP』 signal — ON ON ON ON

Cycling Protection Counter — 0 1 2 3 0

J69 (Maximum Cycling Protection Time)

Run over cycle 『ROC』 signal

Alarm display

『ALM』 signal

| J21 | Dew Condensation Prevention (Duty) |
|---|---|

When the inverter is stopped, dew condensation on the motor can be prevented, by feeding DC power to the motor at regular intervals to keep the temperature of the motor above a certain level.

To utilize this feature, you need to assign a terminal command (DWP) (dew condensation prevention) to one of general-purpose digital input terminals (function code data = 39).

■ **Enabling Dew Condensation Prevention**

To enable dew condensation prevention, turn ON the condensation prevention command (DWP) while the inverter is stopped. Then, this feature starts.

■ **Dew Condensation Prevention (Duty) (J21)**

The magnitude of the DC power applied to the motor is the same as the setting of F21 (DC Injection Braking, Braking level) and its duration inside each interval is the same as the setting of F22 (DC Injection Braking, Braking time). The interval T is determined so that the ratio of the duration of the DC power to T is the value (Duty) set for J21.

$$\text{Duty for condensation prevention} \ \ (J21) \ = \frac{F22}{T} \times 100 \ (\%)$$



Condensation Prevention Cycle
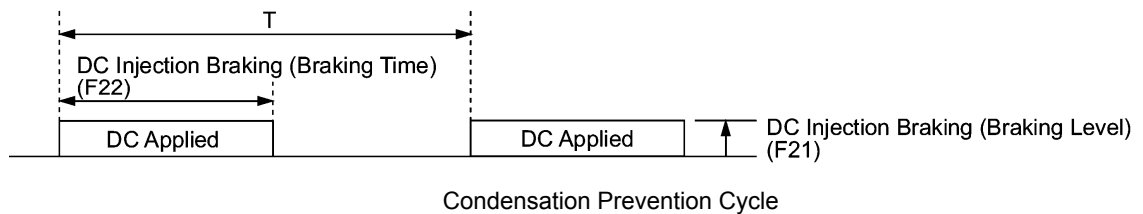
| J22 | Commercial Power Switching Sequence | (Refer to E01 through E05.) |
|---|---|---|

For how to set the commercial power switching sequence, refer to function codes E01 through E05.

| J25 | Pump Control (Mode selection) |
|---|---|

"Pump control" refers to controlling more than one pump motor by a single inverter. The inverter selectively drives one of pump motors in a liquid dispatch system, while switching power sources of other pump motors to commercial power lines as required.

In the pump control, the PID controller integrated in the inverter processes the PID command such as flowrate or pressure.

When the inverter-driven motor is no longer sustain the discharge flowrate required, the inverter issues an output signal that dynamically switches the power source for individual motors between the inverter output and commercial lines or mounts a commercial power-driven motor(s).

If the discharge flowrate is low, for example, the inverter drives one of the motors; if higher, it mounts more motors driven by commercial power in order to ensure the total discharge flowrate required. This pump control system further works to even the historical operation conditions of motors such as the cumulative run time.

The pump control system is available in two configurations: one with a fixed inverter-driven motor and the other with a floating inverter-driven motor. The details are described later in this manual.

| Item | Dynamic rotation of pumps | | Remarks |
|---|---|---|---|
| | With a fixed inverter-driven motor | With a floating inverter-driven motor | |
| Maximum number of pumps to drive | Inverter-driven: 1<br>Commercial power-driven: 4 | Inverter- and commercial power-driven: 3 | Optional relay output card (OPC-F1S-RY) required |
| Applicable motor rating | All pump motors managed by the inverter shall be of the same rating. | | |
| Control | PID control integrated in the inverter | | |
| Motor mount/unmount order | The inverter automatically mounts or unmounts a motor(s) to even the cumulative run time of all motors. | | Selectable by function code data |
| Periodic motor switching | The inverter switches motors at the specified intervals even if the number of motors in operation does not change. | | Selectable by function code data |
| Motor stop mode | Choice of the following two: To stop all motors or only the inverter-driven one with a Stop command issued to the inverter | | Selectable by function code data |
| Forced stop | Using function code data or digital input enables or disables a forced stop for individual motors. | | Selectable by function code data |
| Cumulative run time | The cumulative run time can be monitored for individual motors. | | |
| Cumulative number of relay ON times | The cumulative number of ON/OFF switching times can be monitored for each relay. | | |
| Clear periodic switching time | The interval for periodic switching can be reset to zero by terminal command (MCLR) from the external equipment. | | |
| Motor mount/unmount command | (M1_L):    Mount motor 1, commercial-power-driven | (M1_I):    Mount motor 1, inverter-driven | These signals can be assigned to transistor output [Y1] to [Y3], relay contact output [Y5A/C], [30A/B/C], or relay output card's [Y1A/B/C] to [Y3A/B/C]. |
| | (M2_L):    Mount motor 2, commercial-power-driven | (M1_L):    Mount motor 1, commercial-power-driven | |
| | (M3_L):    Mount motor 3, commercial-power-driven | (M2_I):    Mount motor 2 inverter-driven | |
| | (M4_L):    Mount motor 4, commercial-power-driven | (M2_L):    Mount motor 2 commercial-power-driven | |
| | | (M3_I):    Mount motor 3 inverter-driven | |
| | | (M3_L):    Mount motor 3 commercial-power-driven | |
| Periodic switching early warning signal | This signal gives the external equipment an early warning of the periodic switching. | | |
| Pump control limit signal | The inverter issues this signal when it detects such a condition that requires further mounting a motor(s) even after all pump motors are in operation. | | |

## ■ Dynamic Rotation of Pump Motors

Pump control is effective only when J25 = 1 or 2 and the PID control integrated in the inverter is enabled (J01 ≠ 0, J70 ≠ 0).

J25 specifies the configuration of dynamic motor rotation with a fixed inverter-driven motor or with a floating inverter-driven motor.

## ■ With a fixed inverter-driven motor

This configuration consists of a motor driven by the inverter (M0) and motors driven by commercial power (M1 to M4). The inverter-driven motor is fixed at M0 and is controlled for variable speed. When the inverter-driven motor M0 alone cannot sustain the desired discharge flowrate, the inverter mounts one or more motors driven by commercial power as necessary.





Profile of Motor Operation
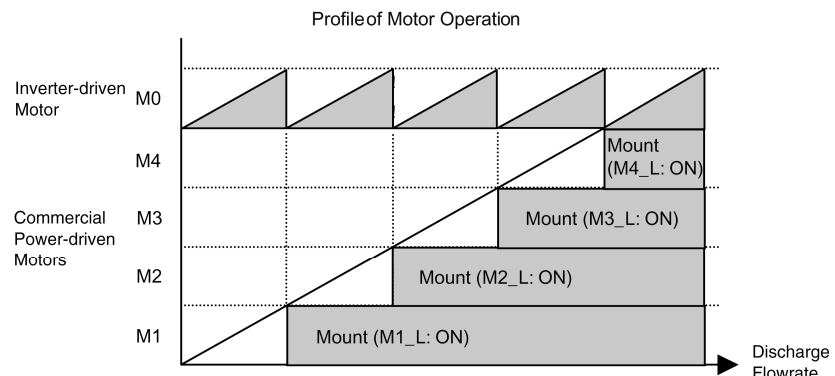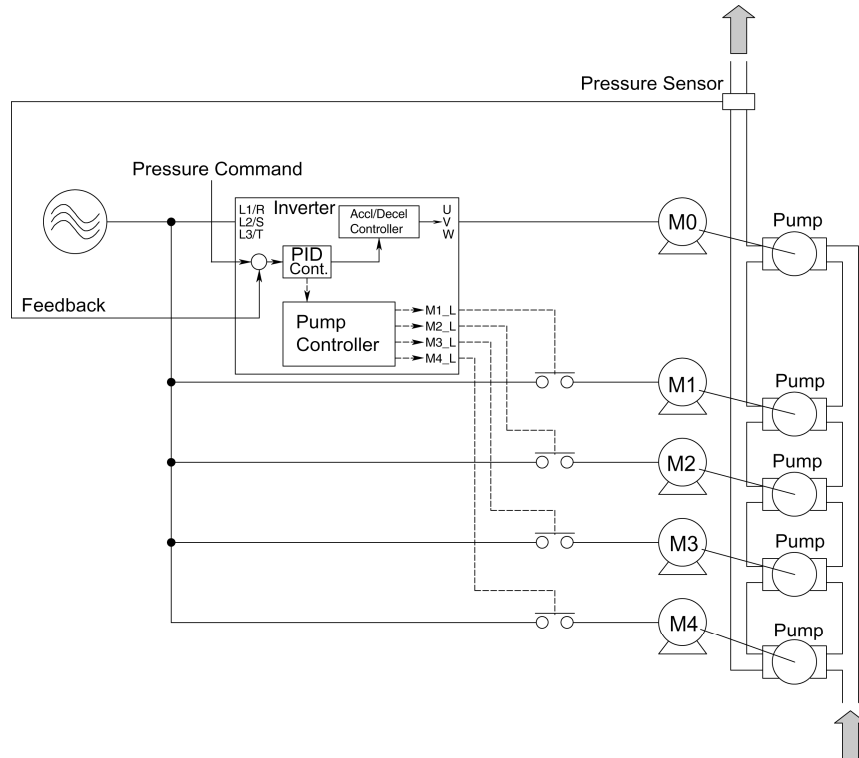
## ■ With a floating inverter-driven motor

In this configuration, all the motors can be driven by the inverter or commercial power. At the start of operation, each motor is driven by the inverter and is controlled for varying speed. When the first motor alone cannot sustain the desired discharge flowrate, it is switched to commercial-power operation, and the inverter drives the second motor.



Profile of Motor Operation
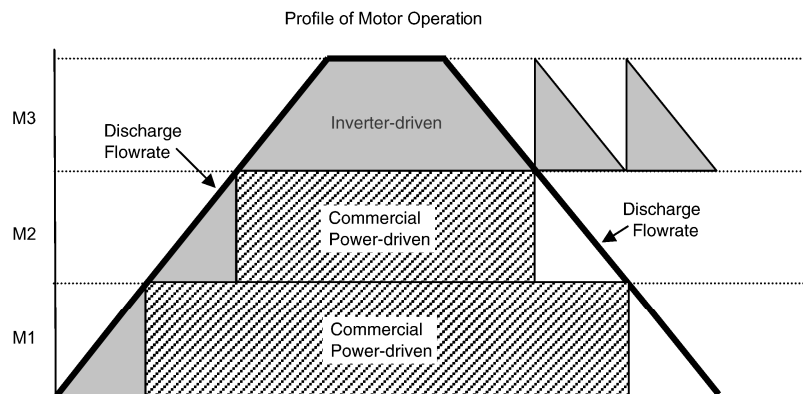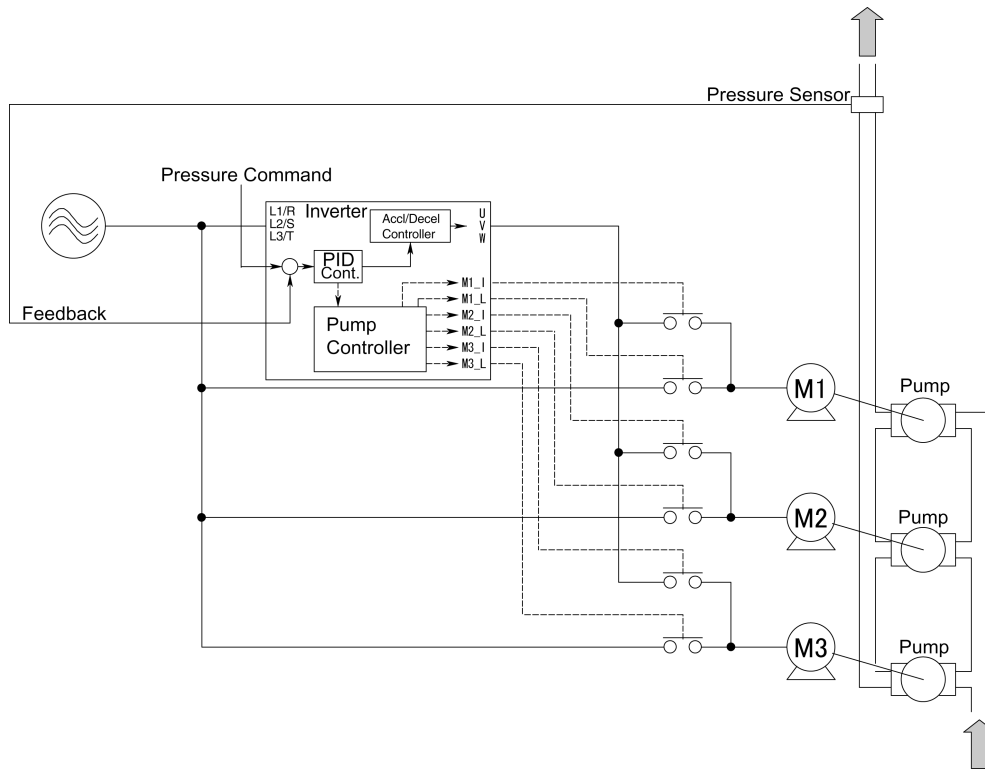
## ■ Assignment to output terminals

In the pump control, contactors (relay outputs) are used to change the configuration of several pump motors or to run/stop them.

The following number of contactor control signal lines is required for motor control:

Configuration with a fixed inverter-driven motor: Max. 4 output signal lines (4 motors x 1 line/motor)

Configuration with a floating inverter-driven motor: Max. 6 output signal lines (3 motors x 2 lines/motor)

The inverter has five output terminals (Y1, Y2, Y3, Y5A/C, and 30A/B/C) as standard. If more are needed, use output terminals (Y1A/B/CRY, Y2A/B/CRY, and Y3A/B/CRY) of an optional relay output card.

Using the relay output card for pump control requires setting up its contact functions for Y1, Y2, and Y3 on the inverter with function codes J45 to J47. When the card is used for the original purpose, that is, for converting Y1, Y2, and Y3 signals to relay contact ones, no special setup is required.

## ■ Other notices on pump control

a)   The electronic thermal overload protection (F10), PTC thermistor (H26) or cumulative motor run time cannot be used since they are not compatible with inverter operation of the dynamic pump motor rotation.

b)   While pump control is in effect, the restart mode after momentary power failure (Mode selection) works differently as shown below.

| Data of F14 | Restart mode when pump control is not in effect | Restart mode when pump control is in effect |
|---|---|---|
| 0 | Disable restart (Trip immediately) | Disable restart (Trip immediately) (same as F14 = 0) |
| 1 | Disable restart (Trip after a recovery from power failure) | |
| 3 | Enable restart (Continue to run, for heavy inertia or general loads) | Enable restart (Restart at the starting frequency, for low-inertia load) (same as F14 = 5) |
| 4 | Enable restart (Restart at the frequency at which the power failure occurred, for general loads) | |
| 5 | Enable restart (Restart at the starting frequency, for low-inertia load) | |

c)   No commercial-power-switching terminal commands (SW50), (SW60), (ISW50) and (ISW60) can be used.

d)   When pump control is in effect, the "Coast-to-stop" terminal command (BX) is used to stop (shut down) all pump motors, regardless of being driven by the inverter or by commercial power. For a configuration allowing commercial-power-driven motors to continue running even after a Run command is turned OFF, it is recommended that the (BX) input be provided.

## ■ Indication Diagrams for Dynamic Rotation of Pump Motors

(1)  With a fixed inverter-driven motor
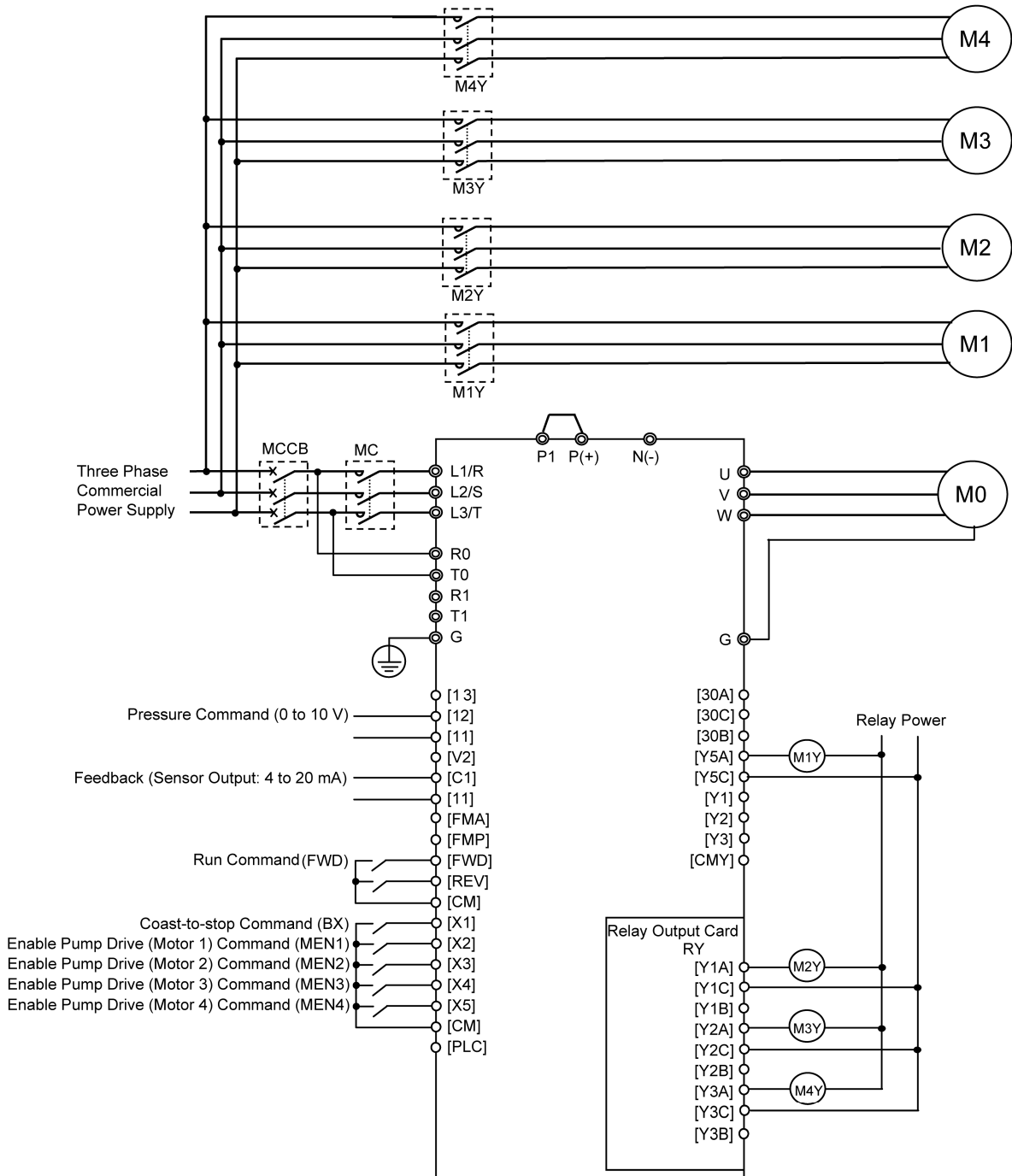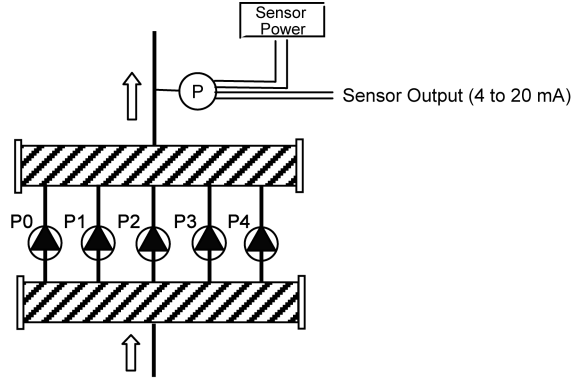
(2) With a floating inverter-driven motor
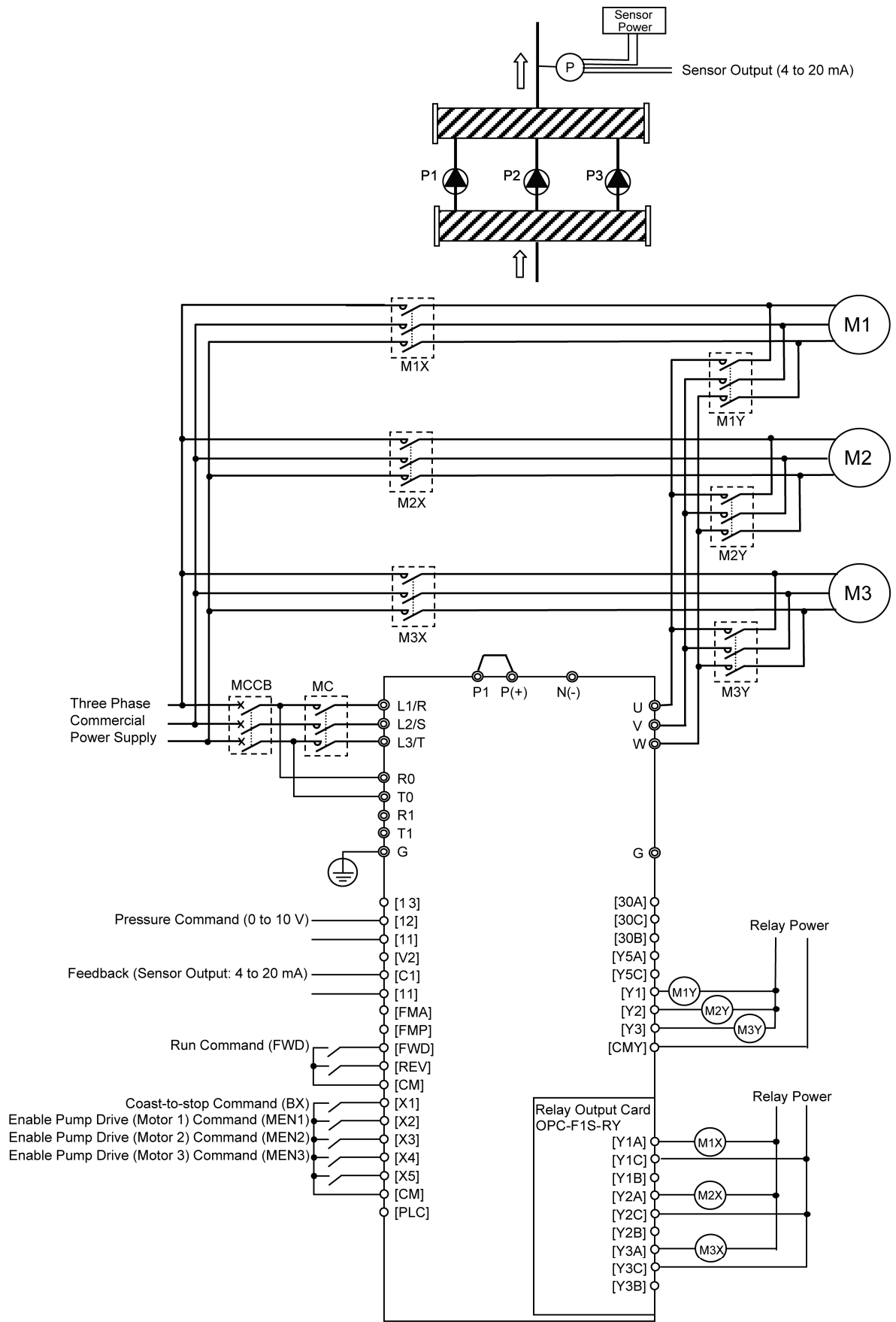
| J26 | Motor 1 Mode |
|---|---|

| J27 | Motor 2 Mode |
|---|---|

| J28 | Motor 3 Mode |
|---|---|

| J29 | Motor 4 Mode |
|---|---|

J26 to J29 allow you to specify the number of pump motors to be controlled and unmount a pump motor(s) from the control system.

The combination of J26 to J29 and "Enable pump drive" commands (MEN1) to (MEN4) assigned to the digital input terminals makes it also possible to enable or disable pump control.

**Assignment of "Enable pump drive" commands (MEN1) to (MEN4) (E01 to E05, E98, E99 = 51, 52, 53, 54)**

The operation of each pump motor is determined by the combination of J26 to J29 and "Enable pump drive" commands (MEN1) to (MEN4) as listed below.

| Motor 1 Mode to Motor 4 Mode (J26 to J29) | "Enable pump drive" (MEN1) to (MEN4) | Operation | |
|---|---|---|---|
| 0 | ─ | Disable: | Disable both inverter- and commercial power-driven motors. |
| 1 | ON | Enable: | Under pump control |
| 1 | OFF | Disable: | Disable both inverter- and commercial power-driven motors. |
| 2 | ON | Force to run (Forced ON): | Forcibly switch from "Driven by inverter" to "Driven by commercial power," regardless of Run commands. |
| 2 | OFF | Disable: | Disable both inverter- and commercial power-driven motors. |

**Note:** When the inverter is driving a forced-ON motor, changing data of J26 to J29 from "2" (Force to run) to "1" (Enable) continues to run the motor by commercial power under PID control.

When the inverter is stopped, changing data of J26 to J29 from "2" (Force to run) to "1" (Enable) determines the operation of the motor specified for "Force to run" depending upon the data of J31 (Motor stop mode). If J31 = 0, the motor will stop. If J31 = 1 or 2, it will continue to run by commercial power.

| J30 | Motor Switching Order |
|---|---|

In pump control, the inverter manages the number of motors to be driven. J30 specifies the mount/unmount motor sequence.

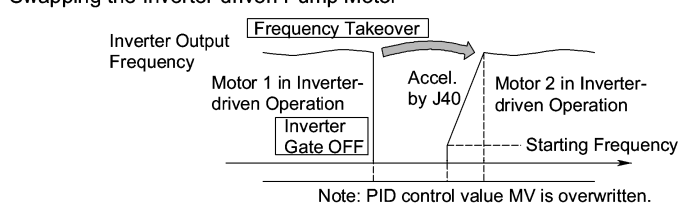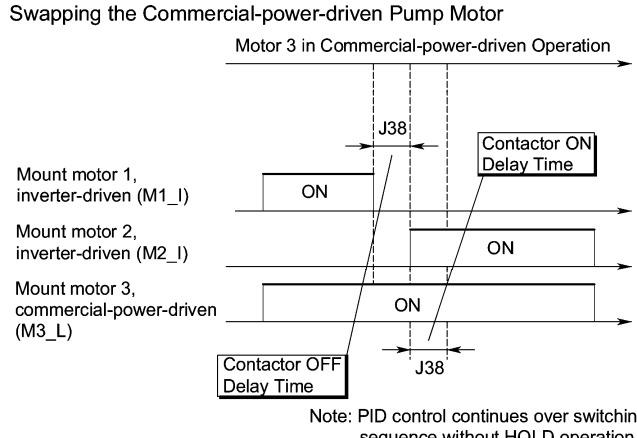| Data | Operation |
|---|---|
| 0 | The inverter mounts motors in ascending order of their numbers, i.e., Motor 1 → Motor 2 → Motor 3 → Motor 4 and unmounts them in descending order.<br><br>When restarting the motors after coast-to-stop, the inverter mounts Motor 1 first. |
| 1 | To even the cumulative run time among the motors, the inverter mounts the motor whose cumulative run time is shortest first and unmounts the one whose cumulative run time is longest first. |

| J31 | Motor Stop Mode |
|-----|-----------------|

J31 specifies how to stop the pump motors when a Run command (FWD or REV) is turned OFF under pump control.

| Data | Operation |
|------|-----------|
| 0 | The inverter-driven motor decelerates to the stop frequency (F25) during the deceleration time (F08) to stop.<br><br>As soon as the output of the inverter is shut down, the relays for the inverter-driven motor are turned OFF.<br><br>The relays for all the motors driven by commercial power are turned OFF when the inverter has come to a stop.<br><br>Also in an alarm state, all the motors are brought to a stop: the output to the inverter-driven motor is turned OFF and the relays for the commercial-power-driven motors are turned OFF. |
| 1 | The inverter-driven motor decelerates to the stop frequency (F25) during the deceleration time (F08) to stop.<br><br>As soon as the output of the inverter is shut down, the relays for the inverter-driven motor are turned OFF. Note that other relays remain ON so that the commercial-power-driven motors continue to run.<br><br>In an alarm state, all the motors are brought to a stop: the output to the inverter-driven motor is turned OFF and the relays for the commercial-power-driven motors are turned OFF. |
| 2 | The inverter-driven motor decelerates to the stop frequency (F25) during the deceleration time (F08) to stop.<br><br>As soon as the output of the inverter is shut down, the relays for the inverter-driven motor are turned OFF. Note that other relays remain ON so that the commercial-power-driven motors continue to run.<br><br>In an alarm state, only the output to the inverter-driven motor is turned OFF but the relays for the commercial-power-driven motors remain ON. The commercial-power-driven motors continue to run. |

**Note:** To stop commercial-power-driven motors when J31 is set at "1" or "2," take one of the following actions:-

- To stop pump motors individually, specify "Disable" for them using J26 to J29.

- To stop pump motors individually, turn OFF their corresponding "Enable pump drive" commands (MEN1) to (MEN4) assigned to the input terminals.

- To stop all the commercial-power-driven motors, disable pump control (J25 = 0 or (J01 = 0 and J70 = 0)).

- To stop all the commercial-power-driven motors, input the "Coast-to-stop" command (BX).

| J32 | Periodic Switching Time for Motor Drive |
|-----|-------------------------------------------|

The periodic switching time for motor drive is designed to balance the cumulative run time among multiple motors for extending the life of the pump motors and preventing rust. When the number of motors in operation does not change for the specified period, the inverter dynamically swaps the motors in operation.

| Data | Operation |
|------|-----------|
| 0.0 | Disable periodic switching. |
| 0.1h to 720.0h | Enable periodic switching.<br><br>When, during stable PID operation, the number of motors in operation does not change for the specified period (0.1 - 720.0h), the motors in operation are switched as follows:<br><br>**＜Configuration with a fixed inverter-driven motor＞**<br><br>Of the motors driven by commercial power, the one with the longest cumulative run time is turned OFF (relay output is turned OFF); at the same time, the one with the shortest one is turned ON (relay output is turned ON).<br><br>**＜Configuration with a floating inverter-driven motor＞**<br><br>The inverter-driven motor is turned OFF (output is shut down) and the one with the shortest cumulative run time is turned ON (see the figure below).<br><br>Swapping the Inverter-driven Pump Motor<br><br><br><br>Swapping the Commercial-power-driven Pump Motor<br><br> |
| 999 | Enable periodic switching for operation check.<br><br>The operation is the same as above, except that the periodic switching time is fixed at 3 minutes. This setting is used to check operation at the start of the system. |

**Note:** Periodic switching is not applicable to motors specified for "Force to run by commercial power" by J26 to J29 (data = 2).

**Assignment of "Clear periodic switching time" command (MCLR) (E01 to E05, E98, E99＝ 50)**

As long as (MCLR) is ON, the periodic switching timer is reset to "0." To restart the timer, turn OFF (MCLR).

| J33 | Periodic Switching Signaling Period |
|---|---|

J33 specifies the output timing of the periodic switching early warning signal (MCHG).

**Assignment of "Periodic switching early warning signal (MCHG) (E20 to E 22, E24, E27, J45 to J47 = 68)**

When the periodic switching conditions are met, the inverter outputs a periodic switching early warning for the period specified by J33 and then enters actual switching operation. This signal, therefore, can be used as an early warning of periodic switching.
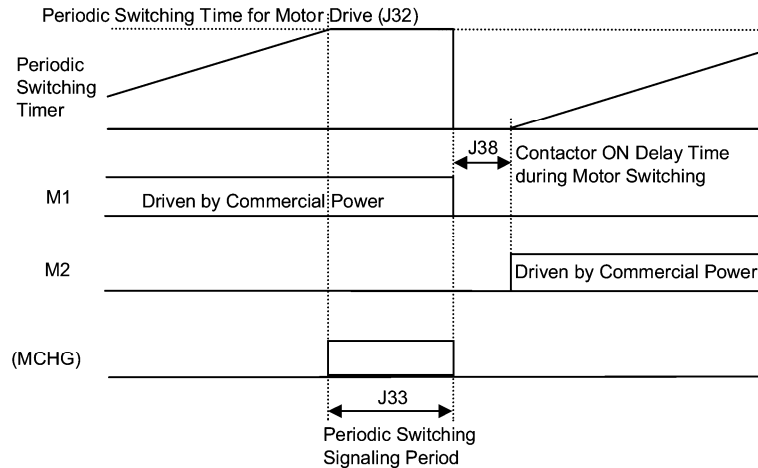


| J23 | PID Start Frequency (Mount) |
|---|---|

| J24 | PID Start Frequency (Unmount) |
|---|---|

| J34 | Mount of Commercial Power-driven Motor (Threshold frequency) |
|---|---|

| J35 | Mount of Commercial Power-driven Motor (Duration) |
|---|---|

| J36 | Unmount of Commercial Power-driven Motor (Threshold frequency) |
|---|---|

| J37 | Unmount of Commercial Power-driven Motor (Duration) |
|---|---|

| J39 | Switching Time for Motor Mount (Deceleration time) |
|---|---|

| J40 | Switching Time for Motor Unmount (Acceleration time) |
|---|---|

| J41 | Motor Unmount Switching Level |
|---|---|

| J44 | Motor Mount Switching Level |
|---|---|

< Mounting motor(s) >

When the PID output (which is fed to the inverter-driven motor) has exceeded the threshold frequency (specified by J34) longer than the duration specified by J35, the inverter mounts a pump motor(s).

When a decision is made to mount a motor, the inverter-driven motor decelerates to the threshold frequency (J36) for the motor mount switching time (deceleration time specified by J39) and then restarts PID control.
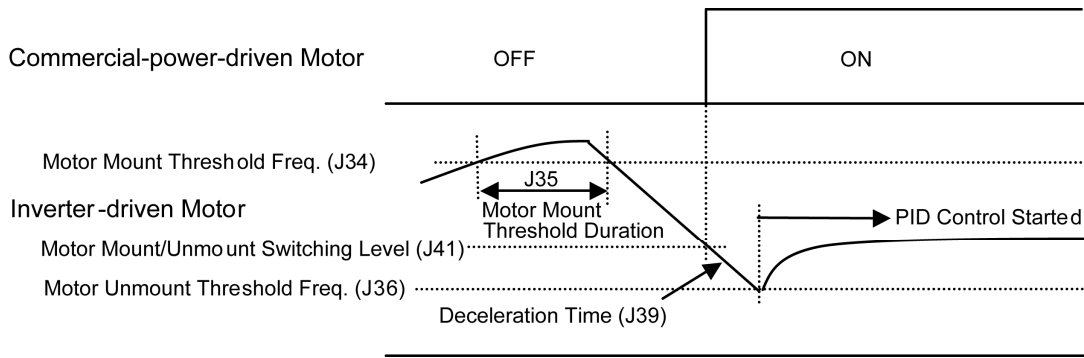
The motor to be mounted starts being driven by commercial power when the inverter-driven motor has reached the motor mount switching level (J44) during deceleration.

The motor mount switching level (J44) serves as an adjuster for ensuring smooth transition (switch-over) and operates at the timing indicated by the following formula:

Switching frequency (Hz) = (J44/100%) x (J18 - J19) + J19,

where J18 = PID upper limiter and J19 = PID lower limiter.

If J44 is set to 999, Depends on the setting of J41.

Commercial-power-driven Motor     OFF     ON

Motor Mount Threshold Freq. (J34)

J35
Motor Mount Threshold Duration

Inverter-driven Motor

Motor Mount/Unmount Switching Level (J41)

Motor Unmount Threshold Freq. (J36)

PID Control Started

Deceleration Time (J39)

< Unmounting motor(s) >

When the PID output (which is fed to the inverter-driven motor) has been dropped below the threshold frequency (specified by J36) longer than the duration specified by J37, the inverter unmounts a pump motor(s).
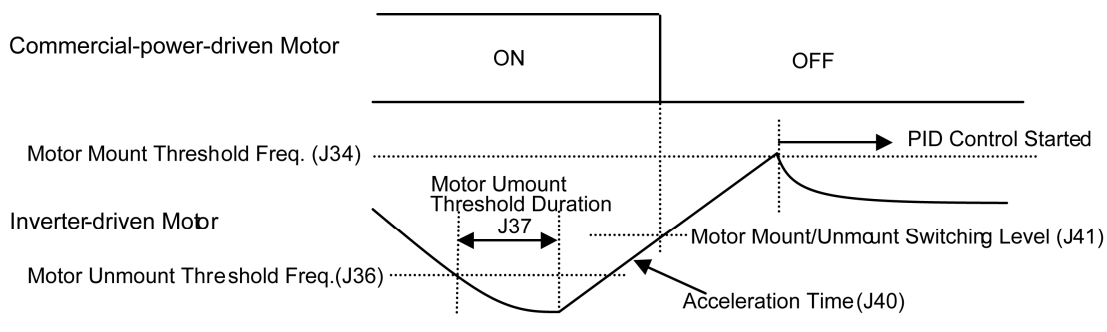
When a decision is made to unmount a motor, the inverter-driven motor accelerates to the threshold frequency (J34) for the motor unmount switching time (acceleration time specified by J40) and then restarts PID control.

Commercial power to the motor to be unmounted is cut OFF when the inverter-driven motor has reached the motor mount/unmount switching level (J41) during acceleration.

The motor mount/unmount switching level (J41) serves as an adjuster for ensuring smooth transition (switch-over) and operates at the timing indicated by the following formula:
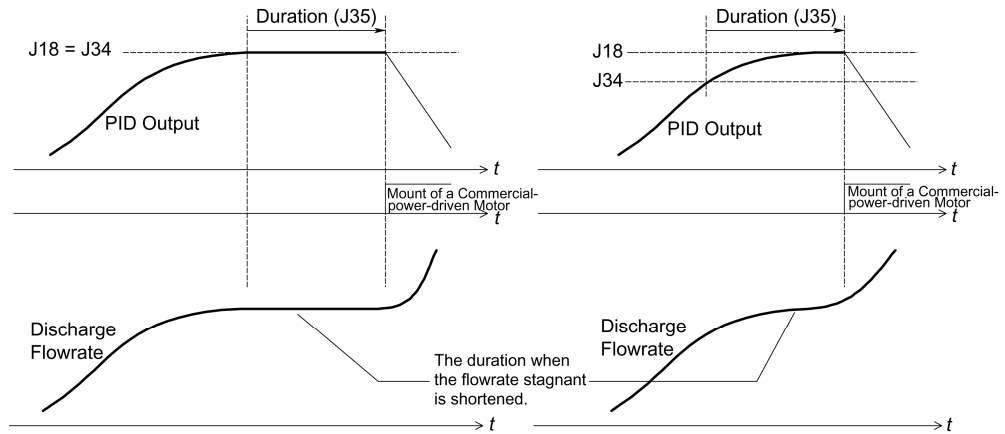
Switching frequency (Hz) = (J41/100%) x (J18 - J19) + J19,

where J18 = PID upper limiter and J19 = PID lower limiter.

Commercial-power-driven Motor     ON     OFF

Motor Mount Threshold Freq. (J34)

PID Control Started

Motor Umount Threshold Duration
J37

Inverter-driven Motor

Motor Mount/Unmount Switching Level (J41)

Motor Unmount Threshold Freq.(J36)

Acceleration Time (J40)

| Tip | It is recommended that the PID upper and lower limiters (J18, J19) be specified wider than the band specified by the threshold frequencies (J34, J36). In this way, the monitoring of the frequency going above or below the frequencies starts before it reaches the PID upper or lower limiter (J18, J19). This results in a shorter duration of the flowrate being limited, thereby minimizing the fluctuation of pressure when the number of motors is mounted or unmounted. |



| Upper limit of PID process output (J18) = Threshold frequency for mounting of a commercial-power-driven pump motor (J34) | Upper limit of PID process output (J18) > Threshold frequency for mounting of a commercial-power-driven pump motor (J34) |

Function codes for mounting/unmounting motors.

| Motor switching level | Mount | J44: Motor Mount Switching Level<br>        (If J44 is set to 999, Depends on the setting of J41.) |
|---|---|---|
| | Unmount | J41: Motor Unmount Switching Level |
| PID start frequency | Mount | J23: PID Start Frequency (Mount)<br>        (If J23 is set to 999, Depends on the setting of J36.) |
| | Unmount | J24: PID Start Frequency (Unmount)<br>        (If J24 is set to 999, Depends on the setting of J34.) |
| Motor mount/unmount frequency | Mount | J34: Mount of Commercial Power-driven Motor (Frequency) |
| | Unmount | J36: Unmount of Commercial Power-driven Motor (Frequency) |
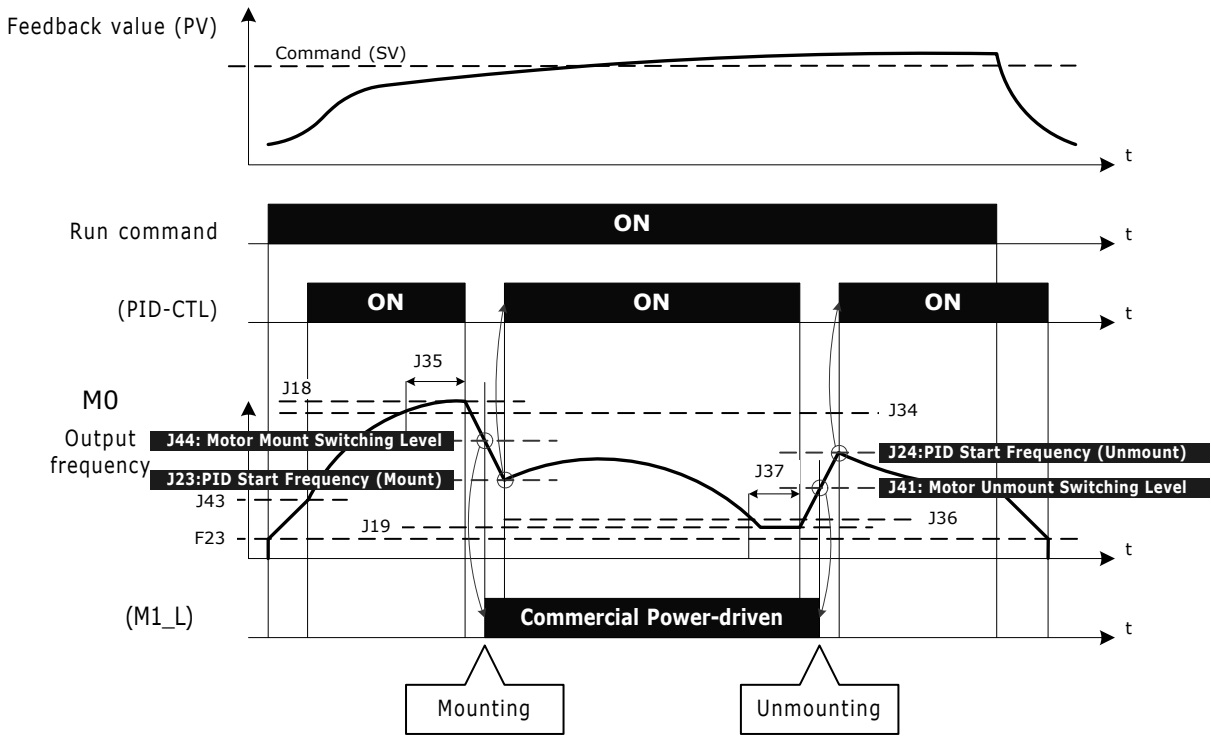
Motors mounting/unmounting process overview (J25=1: Fixed inverter-driven).
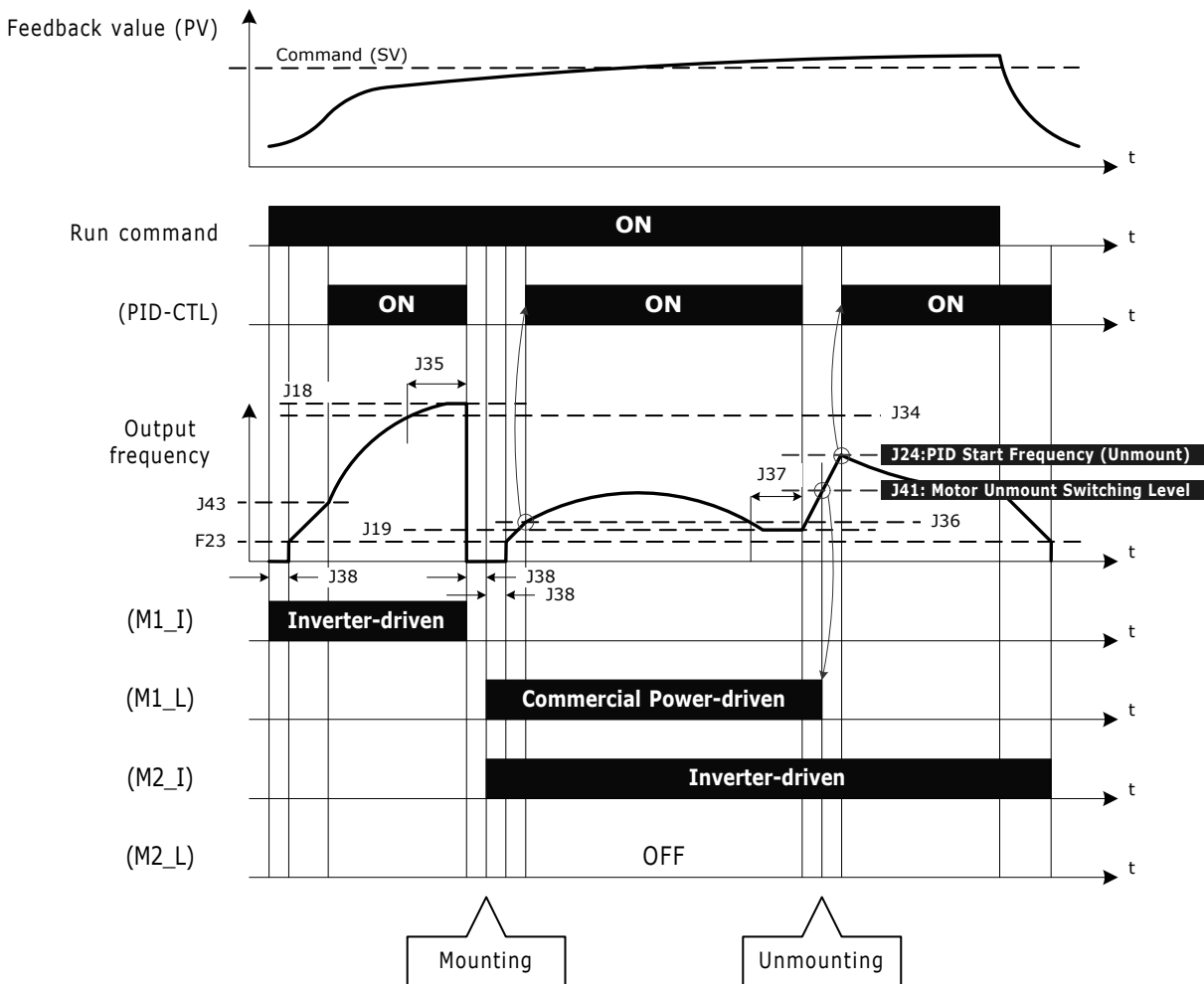


Motors mounting/unmounting process overview (J25=2: Floating inverter-driven).

| J38 | Contactor Delay Time |
|---|---|

J38 specifies the contactor delay time or latency (delay in relay or contactor activation) to be incorporated when the motor power source is switched from the inverter to commercial power when a motor is mounted.

| J42 | Switching Motor Mount/Unmount (Dead band) |
|---|---|

J42 suppresses the mount/unmount of a pump motor when the difference between the PID process command value and the feedback value is smaller than its setting value band. This feature is provided to prevent frequent actions of mounting or unmounting motors just around the threshold frequencies (J34, J36).

| J43 | PID Control Startup Frequency |
|---|---|

When turning ON a Run command starts a pump motor, the inverter accelerates the motor up to the frequency specified by J43 for the acceleration time specified by F07 and then starts PID control.

| J45 to J47 | Signal Assignment to: (For relay output card) |
|---|---|
| | **[Y1A/B/C],[Y2A/B/C],[Y3A/B/C]**             (Refer to E20 to E27.) |

Function codes E20 to E22, E24 and E27 allow you to assign output signals to general-purpose, programmable output terminals [Y1] to [Y3], [Y5A/C], and [30A/B/C]. If more terminals are needed, terminals [Y1A/B/C], [Y2A/B/C], and [Y3A/B/C] on the optional relay output card can be used as general-purpose programmable output terminals (for pump functions only).

Note   If J45 to J47 = 100, terminals [Y1A/B/C] to [Y3A/B/C] provide the same output signals as terminals [Y1] to [Y3]. Further, you cannot assign any functions other than those associated with pump control.

| J48 | Cumulative Run Time of Motor 0 |
|---|---|

| J49 | Cumulative Run Time of Motor 1 |
|---|---|

| J50 | Cumulative Run Time of Motor 2 |
|---|---|

| J51 | Cumulative Run Time of Motor 3 |
|---|---|

| J52 | Cumulative Run Time of Motor 4 |
|---|---|

J48 to J52 allow you to monitor the cumulative run time of each motor as reference data useful for maintenance.

The cumulative run time can be displayed in units of 1 hour in decimal format on the multi-function keypad or in hexadecimal format on the remote keypad.

The cumulative run time can be modified only through a keypad and cleared by setting "0h."

Reset the cumulative run time whenever you replace a pump or as required during maintenance.

| J53 | **Maximum Cumulative Number of Relay ON Times ([Y1A/B/C] to [Y3A/B/C])** |
|---|---|

| J54 | **Maximum Cumulative Number of Relay ON Times ([Y1],[Y2],[Y3])** |
|---|---|

| J55 | **Maximum Cumulative Number of Relay ON Times ([Y5A],[30A/B/C]]** |
|---|---|

During pump control, external relays and relays on the relay output card are frequently turned ON or OFF by transistor outputs Y1 to Y3. J53 to J55 allow you to monitor the number of ON times by relay group, which serves an indicator of relay life. The maximum cumulative number of relay ON times is displayed in units of 1,000 (A display of 1.000 means 1,000 ON times).

The cumulative number goes back to zero (0) when the number of actual ON times overruns 1,000,000.

You can reset the cumulative number of relay ON times to "0" only through a keypad.

Reset it whenever you replace a relay.

| Output | Life | Contact Capacity |
|---|---|---|
| Transistor output (Y1, Y2, Y3) | (Determined by specifications of external relay) | ─ |
| Y5A/C, 30A/B/C (control board in inverter) | 200,000 times (when turned ON every second) | 250 VAC 0.3 A<br>48 VDC 0.5 A |
| Relay output card (Y1A/B/C, Y2A/B/C, Y3A/B/C) | 200,000 times (when turned ON every second) | 250 VAC 0.3 A<br>48 VDC 0.5 A |

| J70 | PID Control 2 (Mode selection) | | (Refer to J01 to J65.) |

The FRN-F1-DY has the function code for PID control by two sets.

The relation of the function code of PID control 1 and PID control 2 is as shown in the table below.

2 PID controls can be utilized after selection by customer. Please refer to J98 and J99 for the details.

| Function Code Name | PID control1 | PID control 2 | Remarks |
|---|---|---|---|
| Mode selection | J01 | J70 | |
| Remote process command | J02 | J71 | |
| Set value | - | J72 | |
| P (Gain) | J03 | J73 | |
| I (Integral time) | J04 | J74 | |
| D (Differential time) | J05 | J75 | |
| Feedback filter | J06 | J76 | |
| Start stabilize frequency | J07 | J77 | |
| Start stabilize level | J08 | J78 | |
| Start stabilize time | J09 | J79 | |
| Start stabilize acceleration time | J10 | J80 | |
| Select alarm output | J11 | J81 | |
| Upper limit alarm (AH) | J12 | J82 | |
| Upper alarm delay time | J13 | J83 | |
| Lower limit alarm (AL) | J14 | J84 | |
| Lower alarm delay time | J15 | J85 | |
| Alarm hysteresis level | J16 | J86 | |
| Upper limit of PID process output | J18 | J88 | |
| Lower limit of PID process output | J19 | J89 | |
| Anti reset windup | J20 | - | Only PID control 1 |
| Slow flowrate level selection | J56 | J90 | |
| Stop level for slow flowrate | J57 | J91 | |
| Slow flowrate level stop latency | J58 | J92 | |
| Pressurization starting frequency | J61 | - | Only PID control 1 |
| Pressurizing time | J62 | - | |
| Starting level selection for slow flowrate | J63 | J93 | |
| Starting level for slow flowrate | J64 | J94 | |
| Starting delay time for slow flowrate | J65 | J95 | |
| Excessive PID error level | J66 | J96 | |
| Excessive PID error time | J67 | J97 | |
| Cycling protection for slow flowrate | J68 | - | Only PID control 1 |
| Maximum cycling protection time for slow flowrate | J69 | - | |

| J98 | Auto PID Switch (Switching delay time) |
| --- | --- |

| J99 | Auto PID Switch (Switch feedback value) |
| --- | --- |

In the FRN-F1-DY of inverters, switching PID control modes during operation is possible.

■ **Switch PID control 2/1 -- (PID2/1)**
  **(Function code data of E01 to E05, E98 and E99 = 70)**

Turning this digital input signal ON and OFF switches the PID control between PID control 1 (J01) and PID control 2 (J70).

No (PID2/1) assignment is functionally equivalent to the (PID2/1) being OFF.

| Switch PID control 2/1 (PID2/1) | PID control |
| --- | --- |
| OFF | Follow J01 (PID control 1) |
| ON | Follow J70 (PID control 2) |

■ **Cancel Auto PID switching -- (CPS)**
  **(Function code data of E01 to E05, E98 and E99 = 71)**

Turning this terminal command ON disables the auto switching of PID controller.

No (CPS) assignment is functionally equivalent to the (CPS) being OFF.

| Cancel Auto PID switch (CPS) | Function |
| --- | --- |
| OFF | Enable auto switching of PID controller |
| ON | Disable auto switching of PID controller |

■ **Auto PID controller switching**

Specifying J98 (Switching delay time) and J99 (Switching feedback value) enables the auto PID switching control when the feedback value drops below the level specified by J99 for the period specified by J98.

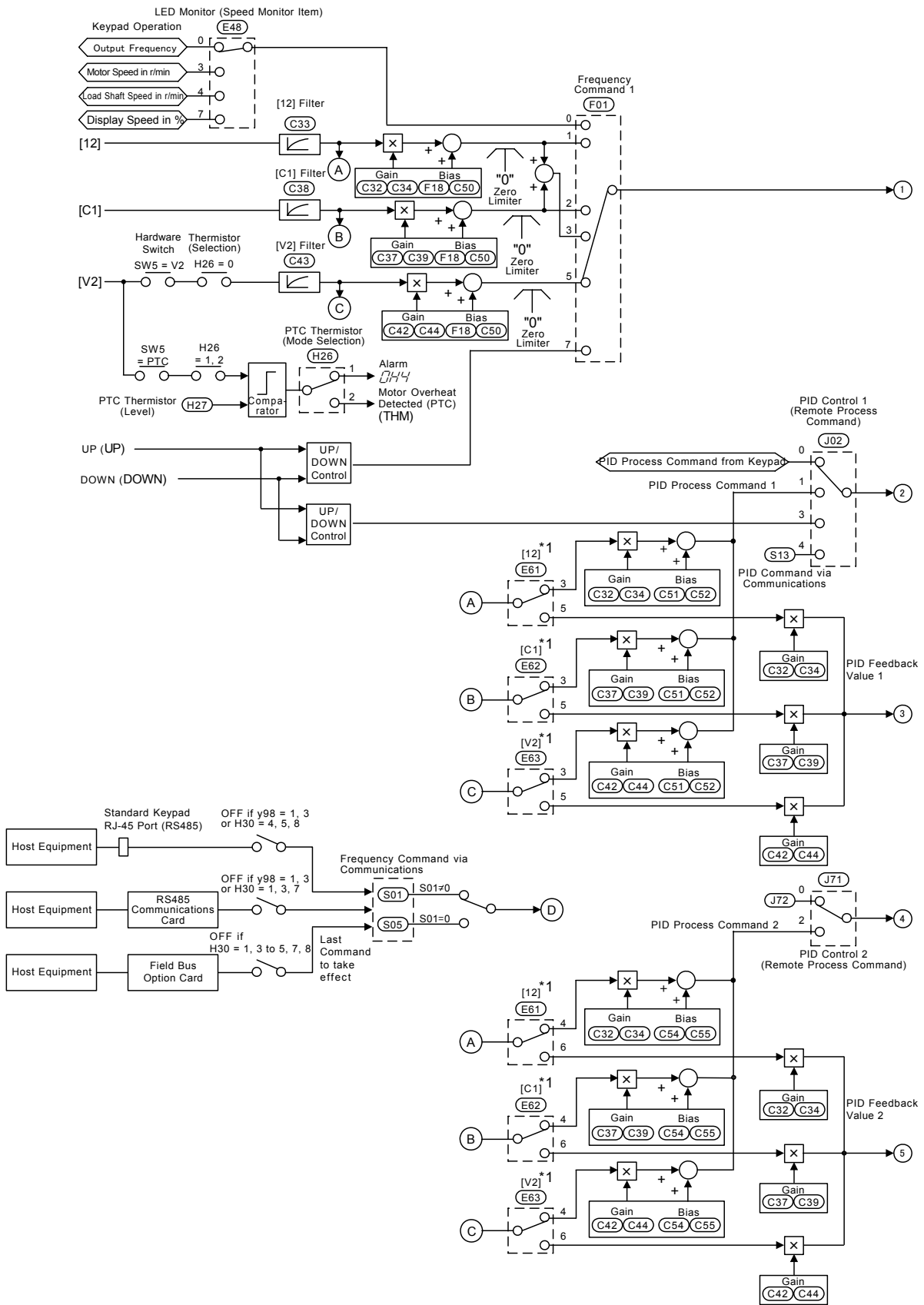Setting J98 to a value of 0.0 will disable this function.
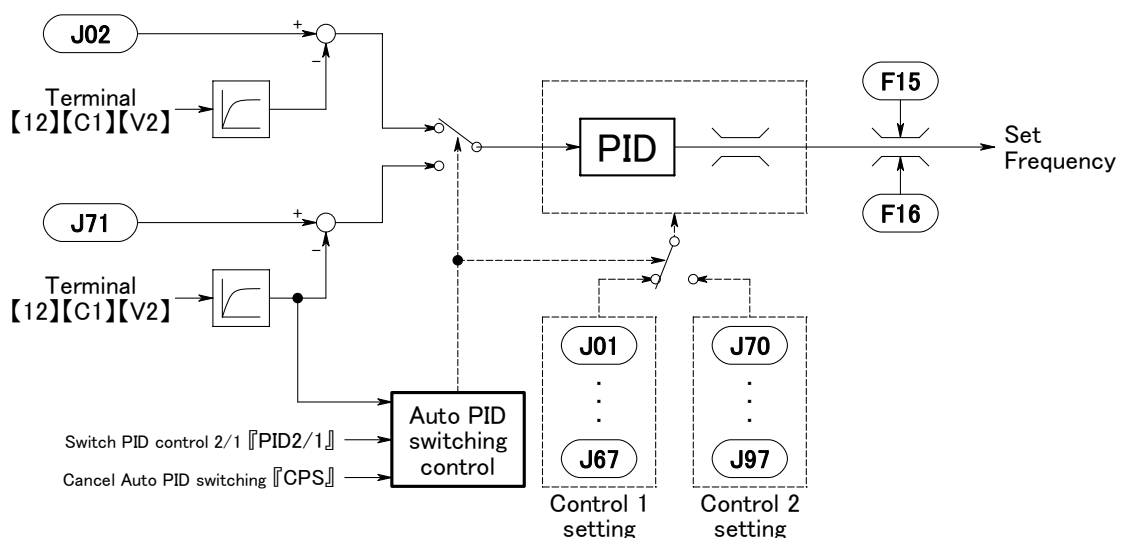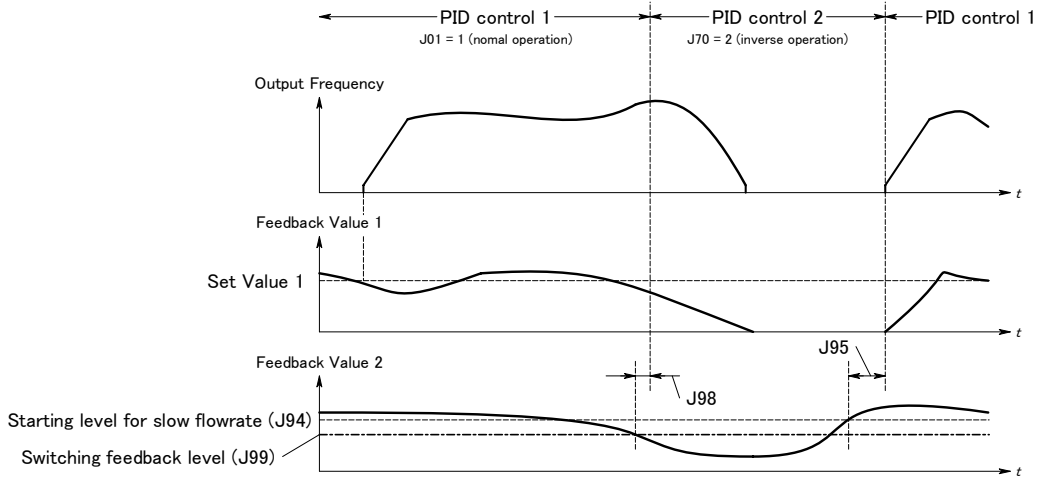
PID control switching process overview (J01=1, J70=2).

| J01<br>PID control 1<br>(Mode selection) | J70<br>PID control 2<br>(Mode selection) | 『PID2/1』<br>Switch PID control 2/1 | J98 | 『CPS』<br>Cancel Auto PID switchig | Active PID control |
|---|---|---|---|---|---|
| =0 | =0 | OFF | =0 | OFF | None (Disable PID) |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| | | ON | =0 | OFF | |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| | ≠0 | OFF | =0 | OFF | None (Cancel PID) |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| | | ON | =0 | OFF | PID control 2 |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| ≠0 | =0 | OFF | =0 | OFF | PID control 1 |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| | | ON | =0 | OFF | None (Cancel PID) |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |
| | ≠0 | OFF | =0 | OFF | PID control 1 |
| | | | | ON | |
| | | | ≠0 | OFF | PID control 1/2<br>(Enable Auto PID switching) |
| | | | | ON | PID control 1 |
| | | ON | =0 | OFF | PID control 2 |
| | | | | ON | |
| | | | ≠0 | OFF | |
| | | | | ON | |

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# 5.2.7 PID Frequency Command Generator



*1 Takes priority when the same function has been assigned by E61, E62 and E63:
    Terminal [12] > Terminal [C1] > Terminal [V2]

Notes:
S codes are communication-related function codes. Refer to the RS485
Communication User's Manual (MEH448d) for details.
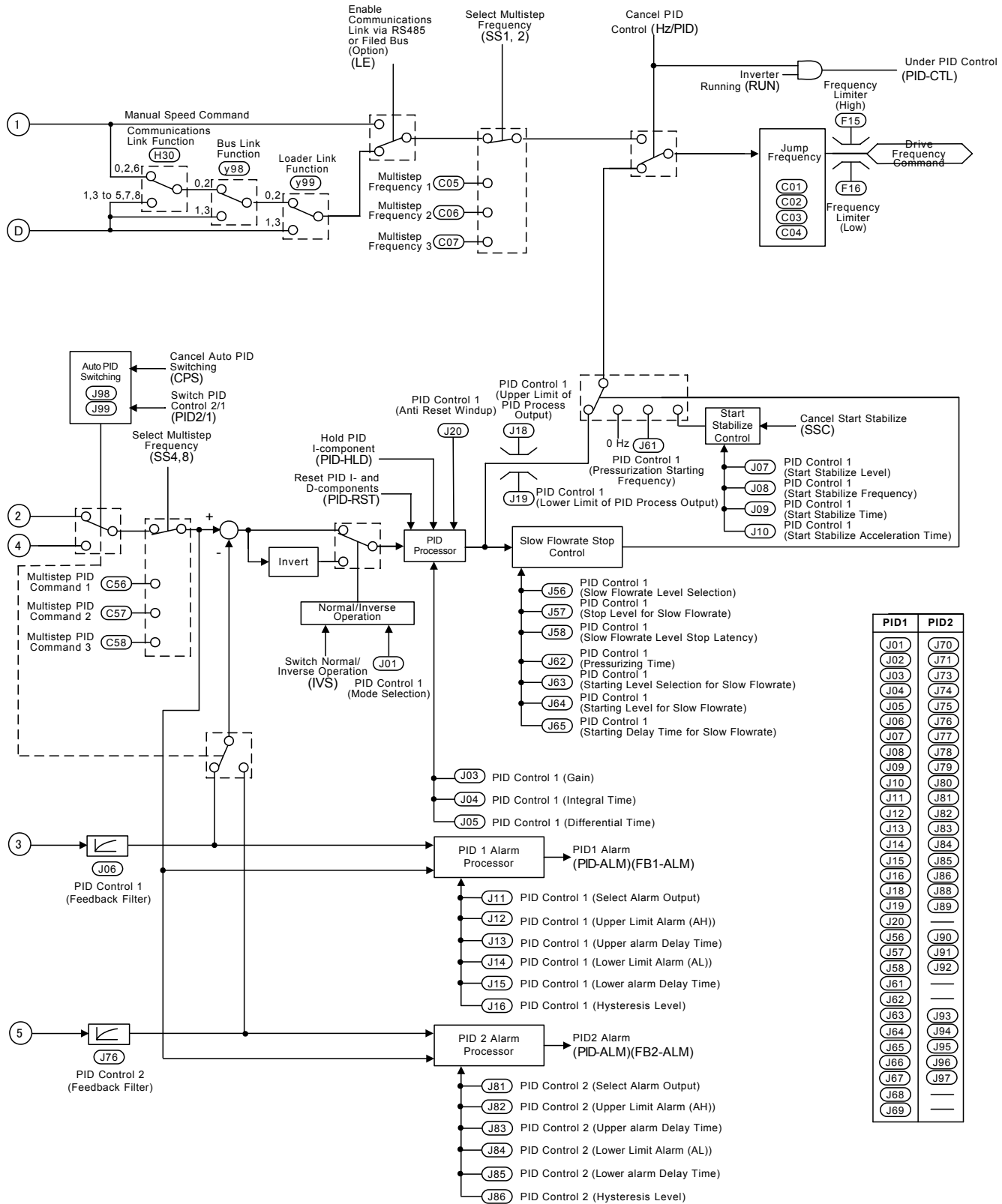
# 5.2.8 y codes (Link functions)

Up to two ports of RS485 communications link are available, including the terminal block extension as shown below.

| Port | Route | Function code | Applicable equipment |
|------|-------|---------------|----------------------|
| Port 1 | Standard RS485 Communications (for connection with keypad) via RJ-45 port | y01 through y10 | Multi-function keypad PC running FRENIC Loader Host equipment |
| Port 2 | Extension RS485 communications card via the terminal port on the card | y11 through y20 | Host equipment No FRENIC Loader supported |

To connect any of the applicable devices, follow the procedures shown below.

(1) Multi-function keypad

The multi-function keypad allow you to run and monitor the inverter.

There is no need to set the y codes.

(2) FRENIC Loader

Using your PC running FRENIC Loader, you can monitor the inverter's running status information, edit function codes, and test-run the inverters.

📖 For the setting of y codes, refer to function codes y01 to y10. For details, refer to the FRENIC Loader Instruction Manual (INR-SI47-0903-E).

(3) Host equipment

The inverter can be managed and monitored by connecting host equipment such as a PC and PLC to the inverter. Modbus RTU* is available for communications protocols.

*Modbus RTU is a protocol established by Modicon, Inc.

📖 For details, refer to the RS485 Communication User's Manual (MEH448d).

| y01 to y20 | RS485 Communication (Standard and extension) |
|---|---|

### ■ Station Address (y01 for standard port and y11 for extension port)

These function codes specify the station address for the RS485 communications link. The table below lists the protocols and the station address setting ranges.

| Protocol | Station address | Broadcast address |
|---|---|---|
| Modbus RTU protocol | 1 to 247 | 0 |
| FRENIC Loader protocol | 1 to 255 | None |

- If any wrong address beyond the above range is specified, no response is returned since the inverter will be unable to receive any enquiries except the broadcast message.
- To use FRENIC Loader, set the station address that matches the connected PC.

### ■ Communications error processing (y02 for standard port and y12 for extension port)

Set the operation performed when an RS485 communications error has occurred.

RS485 communications errors contain logical errors such as address error, parity error, framing error, and transmission protocol error, and physical errors such as communications disconnection error set by y08 and y18. In each case, these are judged as an error only when the inverter is running while the operation command or frequency command has been set to the configuration specified through RS485 communications. When neither the operation command nor frequency command are issued through RS485 communications, or the inverter is not running, error occurrence is not recognized.

| Data for y02 and y12 | Function |
|---|---|
| 0 | Immediately trip after showing an RS485 communications error ($Er$-$8$ for y02 and $Er$-$P$ for y12). (The inverter stops with alarm issue.) |
| 1 | Run during the time set on the error processing timer (y03, y13), display an RS485 communications error ($Er$-$8$ for y02 and $Er$-$P$ for y12), and then stop operation. (The inverter stops with alarm issue.) |
| 2 | Retry transmission during the time set on the error processing timer (y03, y13). If communications link is recovered, continue operation. Otherwise, display an RS485 communications error ($Er$-$8$ for y02 and $Er$-$P$ for y12) and stop operation. (The inverter stops with alarm issue.) |
| 3 | Continue to run even when a communications error occurs. |

📖 For details, refer to the RS485 Communication User's Manual (MEH448d).

### ■ Error processing timer (y03 and y13)

y03 or y13 specifies an error processing timer.

When the set timer count has elapsed because of no response on other end etc., if a response request was issued, the inverter interprets that an error occurs. See the section of "No-response error detection time (y08, y18)."

- Data setting range: 0.0 to 60.0 (sec.)

## ■ Transmission speed (y04 and y14)

Select the transmission speed for RS485 communications.

- Setting for FRENIC Loader: Set the same transmission speed as that specified by the connected PC.

| Data for y04 and y14 | Transmission speed (bps) |
|---|---|
| 0 | 2400 |
| 1 | 4800 |
| 2 | 9600 |
| 3 | 19200 |
| 4 | 38400 |

## ■ Data length (y05 and y15)

Select the character length for transmission.

- Setting for FRENIC Loader: Loader sets the length in 8 bits automatically. (The same applies to the Modbus RTU protocol.)

| Data for y05 and y15 | Data length |
|---|---|
| 0 | 8 bits |
| 1 | 7 bits |

## ■ Parity check (y06 and y16)

Select the property of the parity bit.

- Setting for FRENIC Loader: Loader sets it to the even parity automatically.

| Data for y06 and y16 | Parity |
|---|---|
| 0 | None |
| 1 | Even parity |
| 2 | Odd parity |

## ■ Stop bits (y07 and y17)

Select the number of stop bits.

- Setting for FRENIC Loader: Loader sets it to 1 bit automatically.

  For the Modbus RTU protocol, the stop bits are automatically determined associated with the property of parity bits. So no setting is required.

| Data for y07 and y17 | Stop bit(s) |
|---|---|
| 0 | 2 bits |
| 1 | 1 bit |

## ■ No-response error detection time (y08 and y18)

Set the time interval from the inverter detecting no access until it enters communications error alarm mode due to network failure and processes the communications error. This applies to a mechanical system that always accesses its station within a predetermined interval during communications using the RS485 communications link.

For the processing of communications errors, refer to y02 and y12.

| Data for y08 and y18 | Function |
|---|---|
| 0 | Disable |
| 1 to 60 | 1 to 60 sec. |

■ **Response latency time (y09 and y19)**

Sets the latency time after the end of receiving a query sent from the host equipment (such as a PC or PLC) to the start of sending the response. This function allows using equipment whose response time is slow while a network requires quick response, enabling the equipment to send a response timely by the latency time setting.

- Data setting range: 0.00 to 1.00 (sec.)

| Host equipment | Query | | |
|---|---|---|---|
| Inverter | | T1 | Response |
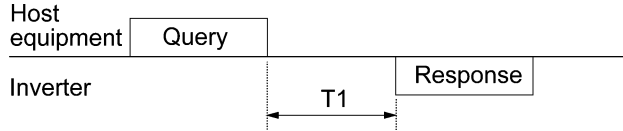
$T1 = $ Latency time $+ \alpha$

where $\alpha$ is the processing time inside the inverter. This time may vary depending on the processing status and the command processed in the inverter.

📖 For details, refer to the RS485 Communication User's Manual (MEH448d).

Note
When setting the inverter with FRENIC Loader, pay sufficient attention to the performance and/or configuration of the PC and protocol converter such as RS485-RS232C communications level converter. Note that some protocol converters monitor the communications status and switch the send/receive of transmission data by a timer.

■ **Protocol selection (y10)**

Select the communications protocol for the standard RS485 port.

- Specifying FRENIC loader to connect to the inverter can only be made by y10. Select FRENIC Loader (y10 = 1).

| Data for y10 | Protocol |
|---|---|
| 0 | Modbus RTU protocol |
| 1 | FRENIC Loader ptorocol |

■ **Protocol selection (y20)**

Select the communications protocol for the extensional communications port.

| Data for y20 | Protocol |
|---|---|
| 0 | Modbus RTU protocol |

| y98 | **Bus Link Function (Mode selection)** |
|---|---|
| | **(Refer to H30.)** |

For how to set y98 bus link function (Mode selection), refer to the description of function code H30.

| y99 | Loader Link Function (Mode selection) |
|-----|---------------------------------------|

This is a link switching function for FRENIC Loader. Rewriting the data of this function code y99 (= 3) to enable RS485 communications from Loader helps Loader send the inverter the frequency and run commands. Since the data in the function code of the inverter is automatically set by Loader, no keypad operation is required. While Loader is selected as the source of the run command, if the PC runs out of control and cannot be stopped by a stop command sent from Loader, disconnect the RS485 communications cable from the standard port (Keypad), connect a keypad instead, and reset the y99 to "0." This setting "0" in y99 means that the run and frequency command source specified by function code H30 takes place.

Note that the inverter cannot save the setting of y99. When power is turned off, the data in y99 is lost (y99 is reset to "0").

| Data for y99 | Function | |
|:---:|---|---|
| | Frequency command | Run command |
| 0 | Follow H30 and y98 data | Follow H30 and y98 data |
| 1 | Via RS485 communications link (FRENIC Loader, S01 and S05) | Follow H30 and y98 data |
| 2 | Follow H30 and y98 data | Via RS485 communications link (FRENIC Loader, S06) |
| 3 | Via RS485 communications link (FRENIC Loader, S01 and S05) | Via RS485 communications link (FRENIC Loader, S06) |

# Chapter 6   TROUBLESHOOTING

## 6.1   Before Proceeding with Troubleshooting

> # ⚠ WARNING
>
> If any of the protective functions have 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 while any run commands are set to on, the inverter may supply the power to the motor which may cause the motor to rotate.
>
> **Injury may occur.**
>
> - Even though the inverter has interrupted power to the motor, if the voltage is applied to the main circuit power input terminals L1/R, L2/S and L3/T, voltage may be output to inverter output terminals U, V, and W.
> - Turn OFF the power and wait more than five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).
>
> **Electric shock may occur.**

Follow the procedure below to solve problems.

(1)  First, check that the inverter is correctly wired, referring to Chapter 2 Section 2.3.6 "Wiring for main circuit terminals and grounding terminals."

(2)  Check whether an alarm code or the "light alarm" indication ($L-RL$) is displayed on the LED monitor.

- If neither an alarm code nor "light alarm" indication ($L-RL$) appears on the LED monitor

      Abnormal motor operation ──────────────────► Go to Section 6.2.1.
      [1]  The motor does not rotate.
      [2]  The motor rotates, but the speed does not increase.
      [3]  The motor runs in the opposite direction to the command.
      [4]  Speed fluctuation or current oscillation (e.g., hunting) occurs
           during running at constant speed.
      [5]  Grating sound is heard from the motor or the
           motor sound fluctuates.
      [6]  The motor does not accelerate or decelerate
           within the specified time.
      [7]  The motor does not restart even after the power
           recovers from a momentary power failure.
      Problems with inverter settings ──────────────► Go to Section 6.2.2.
      [1]  Nothing appears on the LED monitor.
      [2]  The desired menu is not displayed.
      [3]  Data of function codes cannot be changed.

- If an alarm code appears on the LED monitor ──────────────► Go to Section 6.3.

- If the "light alarm" indication ($L-RL$) appears on the LED monitor ──────────► Go to Section 6.4.

- If an abnormal pattern appears on the LED monitor ──────────► Go to Section 6.5.
  while neither an alarm code nor "light alarm" indication ($L-RL$) is displayed

■   For problems that could be caused by running the inverter on single-phase power ➜ Go to Section 6.6.

If any problems persist after the above recovery procedure, contact your Fuji Electric representative.

## 6.2 If Neither an Alarm Code Nor "Light Alarm" Indication ($L$-$RL$) Appears on the LED Monitor

### 6.2.1 Motor is running abnormally

#### [ 1 ] The motor does not rotate.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) No power supplied to the inverter. | Check the input voltage, output voltage and interphase voltage unbalance.<br><br>→ Turn ON a molded case circuit breaker, a ground fault circuit interrupter (with overcurrent protection) or a magnetic contactor.<br><br>→ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary.<br><br>→ If only auxiliary control power is supplied, turn ON the main power. |
| (2) No forward/reverse operation command was inputted, or both the commands were inputted simultaneously (external signal operation). | Check the input status of the forward/reverse command with Menu #4 "I/O Checking" using the keypad.<br><br>→ Input a run command.<br><br>→ Set either the forward or reverse operation command to off if both commands are being inputted.<br><br>→ Correct the assignment of commands (FWD) and (REV) to function codes E98 and E99.<br><br>→ Connect the external circuit wires to control circuit terminals [FWD] and [REV] correctly.<br><br>→ Make sure that the sink/source slide switch on the printed circuit board is properly configured. |
| (3) No indication of rotation direction (keypad operation). | Check the input status of the forward/reverse rotation direction command with Menu #4 "I/O Checking" using the keypad.<br><br>→ Input the rotation direction (F02=0), or select the keypad operation with which the rotation direction is fixed (F02=2 or 3). |
| (4) The inverter could not accept any run commands from the keypad since it was in Programming mode. | Check which operation mode the inverter is in, using the keypad.<br><br>→ Shift the operation mode to Running mode and enter a run command. |
| (5) A run command with higher priority than the one attempted was active, and the run command was stopped. | While referring to the block diagram of the drive command generator[*], check the higher priority run command with Menu #2 "Data Checking" and Menu #4 "I/O Checking" using the keypad.<br><br>[*]Refer to the FRENIC-Eco User's Manual, Chapter 4.<br><br>→ Correct any incorrect function code data settings (in H30, y98, etc.) or cancel the higher priority run command. |
| (6) The frequency command was set below the starting or stop frequency. | Check that a frequency command has been entered, with Menu #4 "I/O Checking" using the keypad.<br><br>→ Set the value of the frequency command to the same or higher than that of the starting or stop frequency (F23 or F25).<br><br>→ Reconsider the starting and stop frequencies (F23 and F25), and if necessary, change them to lower values.<br><br>→ Inspect the frequency command, signal converters, switches, or relay contacts. Replace any ones that are faulty.<br><br>→ Connect the external circuit wires correctly to terminals [13], [12], [11], [C1], and [V2]. |
| (7) A frequency command with higher priority than the one attempted was active. | Check the higher priority run command with Menu #2 "Data Checking" and Menu #4 "I/O Checking" using the keypad, referring to the block diagram of the drive command generator[*].<br><br>[*]Refer to the FRENIC-Eco User's Manual, Chapter 4.<br><br>→ Correct any incorrect function code data settings (e.g. cancel the higher priority run command). |
| (8) The upper and lower frequencies for the frequency limiters were set incorrectly. | Check the data of function codes F15 (Frequency limiter (high)) and F16 (Frequency limiter (low)).<br><br>→ Change the settings of F15 and F16 to the correct ones. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (9) The coast-to-stop command was effective. | Check the data of function codes E01, E02, E03, E04, E05, E98 and E99 and the input signal status with Menu #4 "I/O Checking" using the keypad.<br><br>→ Release the coast-to-stop command setting. |
| (10) Broken wire, incorrect connection or poor contact with the motor. | Check the cabling and wiring (Measure the output current).<br><br>→ Repair the wires to the motor, or replace them. |
| (11) Overload | Measure the output current.<br><br>→ Lighten the load (In winter, the load tends to increase.)<br><br>Check that a mechanical brake is in effect.<br><br>→ Release the mechanical brake, if any. |
| (12) Torque generated by the motor was insufficient. | Check that the motor starts running if the value of torque boost (F09) is increased.<br><br>→ Increase the value of torque boost (F09) and try to run the motor.<br><br>Check the data of function codes F04, F05, H50, and H51.<br><br>→ Change the V/f pattern to match the motor's characteristics.<br><br>Check whether the frequency command signal is below the slip-compensated frequency of the motor.<br><br>→ Change the frequency command signal so that it becomes higher than the slip-compensated frequency of the motor. |
| (13) Miss-/weak-connection of the DC reactor (DCR) | Check the wiring connection. A DC reactor is equipped for 75HP for 208V, 100HP for 460V or above models. FRENIC-Eco inverter cannot run without a DC rector.<br><br>→ Connect the DC reactor correctly. Repair or replace wires for the DC reactor. |

**[ 2 ]  The motor rotates, but the speed does not increase.**

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The maximum frequency currently specified was too low. | Check the data of function code F03 (Maximum frequency).<br><br>→ Readjust the data of F03. |
| (2) The data of frequency limiter currently specified was too low. | Check the data of function code F15 (Frequency limiter (high)).<br><br>→ Readjust the data of F15. |
| (3) The reference frequency currently specified was too low. | Check the signals for the frequency command from the control circuit terminals with Menu #4 "I/O Checking" on the keypad.<br><br>→ Increase frequency of the command.<br>→ If an external potentiometer for frequency command, signal converter, switches, or relay contacts are malfunctioning, replace them.<br>→ Connect the external circuit wires to terminals [13], [12], [11], [C1], and [V2] correctly. |
| (4) A frequency command (e.g., multistep frequency or via communications) with higher priority than the one expected was active and its reference frequency was too low. | Check the data of the relevant function codes and what frequency commands are being received, through Menu #1 "Data Setting," Menu #2 "Data Checking" and Menu #4 "I/O Checking," on the keypad by referring to the block diagram of the frequency command*.<br><br>*Refer to the FRENIC-Eco User's Manual, Chapter 4.<br>→ Correct any incorrect data of function code (e.g. The higher priority run command is mistakenly canceled, etc.). |
| (5) The acceleration time was too long. | Check the data of function code F07 (Acceleration time 1)<br><br>→ Change the acceleration/deceleration time to match the load. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (6) Overload | Measure the output current. |
| | ➔ Lighten the load. (Adjust the damper of the fan or the value of the pump). (In winter, the load tend to increase.) |
| | Check if mechanical brake is working. |
| | ➔ Release the mechanical brake. |
| (7) Mismatch with the characteristics of the motor | In case auto-torque boost or auto-energy saving operation is under way, check whether P02, P03, P06, P07, and P08 agree with the parameters of the motor. |
| | ➔ Set P02, P03, and P06 properly and perform auto-tuning in accordance with P04. |
| (8) The current limiting operation did not increase the output frequency. | Make sure that F43 (Current limiter (mode selection)) is set to "2" and check the setting of F44 (Current limiter (level)). |
| | ➔ If the current limiting operation is not needed, set F43 to "0" (disabled). |
| | Decrease the value of torque boost (F09), then turn the power OFF and back on again and check if the speed increases. |
| | ➔ Adjust the value of the torque boost (F09). |
| | Check the data of function codes F04, F05, H50, and H51 to ensure that the V/f pattern is right. |
| | ➔ Match the V/f pattern values with the motor ratings. |
| (9) Bias and grain set incorrectly. | Check the data of function codes F18, C50, C32, C34, C37, C39, C42, and C44. |
| | ➔ Readjust the bias and gain to appropriate values. |

**[ 3 ]   The motor runs in the opposite direction to the command.**

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Wiring has been connected to the motor incorrectly. | Check the wiring to the motor. |
| | ➔ Connect terminals U, V, and W of the inverter to the respective U, V, and W terminals of the motor. |
| (2) Incorrect connection and settings for run commands and rotation direction command (FWD) and (REV) | Check the data of function codes E98 and E99 and the connection to terminals [FWD] and [REV]. |
| | ➔ Correct the data of the function codes and the connection. |
| (3) The setting for the rotation direction via keypad operation is incorrect. | Check the data of function code F02 (Run command). |
| | ➔ Change the data of function code F02 to "2: Enable (FWD) / (STOP) keys on keypad (forward)" or "3: Enable (REV) / (STOP) keys on keypad (reverse)." |

**[ 4 ]   If the speed variation and current vibration (such as hunting) occur at the constant speed**

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The frequency command fluctuated. | Check the signals for the frequency command with Menu #4 "I/O Checking" using the keypad. |
| | ➔ Increase the filter constants (C33, C38, and C43) for the frequency command. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (2) The external frequency command source device was used. | Check that there is no noise in the control signal wires from external sources.<br><br>➔ Isolate the control signal wires from the main circuit wires as far as possible.<br>➔ Use shielded or twisted wires for the control signal. |
| | Check whether the frequency command source has not failed because of noise from the inverter.<br><br>➔ Connect a capacitor to the output terminal of the frequency command source or insert a ferrite core in the signal wire. (Refer to Chapter 2 Section 2.3.7 "Wiring for control circuit terminals.") |
| (3) Frequency switching or multistep frequency command was enabled. | Check whether the relay signal for switching the frequency command is chattering.<br><br>➔ If the relay has a contact problem, replace the relay. |
| (4) The connection between the inverter and the motor was too long. | Check whether auto-torque boost or auto-energy saving operation is enabled.<br><br>➔ Set P02, P03, and P06 properly and perform auto-tuning in accordance with P04.<br>➔ Enable load selection for higher startup torque (F37 = 1) and check for any vibration.<br>➔ Make the output wire as short as possible. |
| (5) The inverter output is hunting due to vibration caused by low stiffness of the load. Or the current is irregularly oscillating due to special motor parameters. | Cancel the automatic control system--automatic torque boost and energy saving operation (F37), overload prevention control (H70), and current limiter (F43), then check that the motor vibration is suppressed.<br><br>➔ Cancel the functions causing the vibration.<br>➔ Readjust the data of the oscillation suppression gain (H80) currently set to appropriate values. |
| | Check that the motor vibration is suppressed if you decrease the level of F26 (Motor sound (carrier frequency)) or set F27 (Motor sound (tone)) to "0".<br><br>➔ Decrease the carrier frequency (F26) or set the tone to "0" (F27=0). |

## [ 5 ]  If grating sound can be heard from motor

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The carrier frequency was set too low. | Check the data of function codes F26 (Motor sound (carrier frequency)) and F27 (Motor sound (tone)).<br><br>➔ Increase the carrier frequency (F26).<br>➔ Readjust the setting of F27 to appropriate value. |
| (2) The ambient temperature of the inverter was too high (when automatic lowering of the carrier frequency was enabled by H98). | Measure the temperature inside the enclosure of the inverter.<br><br>➔ If it is over 40℃(104°F), lower it by improving the ventilation.<br>➔ Lower the temperature of the inverter by reducing the load. (In the case of a fan or a pump, lower the setting data of the frequency limiter (F15).)<br>**Note:** If you disable H98, an $\mathit{0H1}$, $\mathit{0H3}$ or $\mathit{0LU}$ alarm may occur. |
| (3) Resonance with the load | Check the precision of the mounting of the load or check whether there is resonance with the enclosure or likes.<br><br>➔ Disconnect the motor and run it without the inverter, and determine where the resonance comes from. Upon locating the cause, improve the characteristics of the source of the resonance.<br>➔ Adjust the settings of C01 (Jump frequency 1) to C04 (Jump frequency (band)) so as to avoid continuous running in the frequency range causing resonance. |

**[ 6 ] The motor does not accelerate and decelerate at the set time.**

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The inverter ran the motor by S-curve or curvilinear pattern. | Check the data of function code H07 (Acceleration/deceleration pattern).<br>→ Select the linear pattern (H07 = 0).<br>→ Shorten the acceleration/deceleration time (F07, F08). |
| (2) The current limiting prevented the output frequency from increasing (during acceleration). | Make sure that F43 (Current limiter (mode selection)) is set to "2: Enable during acceleration and at constant speed," then check that the setting of F44 (Current limiter (level)) is reasonable.<br>→ Readjust the setting of F44 to appropriate value, or disable the function of current limiter in F43.<br>→ Increase the acceleration/deceleration time (F07/F08). |
| (3) The automatic regenerative braking was active. | Check the data of function code H69 (Automatic deceleration).<br>→ Increase the deceleration time (F08). |
| (4) Overload | Measure the output current.<br>→ Lighten the load (In the case of a fan or a pump load, lower the setting data of the F15 (Frequency limiter (high)). (In winter, the load tends to increase.). |
| (5) Torque generated by the motor was insufficient. | Check that the motor starts running if the value of the torque boost (F09) is increased.<br>→ Increase the value of the torque boost (F09). |
| (6) An external frequency command is being used. | Check that there is no noise in the external signal wires.<br>→ Isolate the control signal wires from the main circuit wires as far as possible.<br>→ Use shielded wire or twisted wire for the control signal wires.<br>→ Connect a capacitor to the output terminal of the frequency command or insert a ferrite core in the signal wire. (Refer to Chapter 2 Section 2.3.7 "Wiring for control circuit terminals.") |
| (7) The V2/PTC switch was turned to PTC (when V2 was being used). | Check whether control terminal [V2] is not set to the PTC thermistor input mode.<br>→ Turn the V2/PTC switch on the printed circuit board to V2. |

**[ 7 ]  Even if the power recovers after a momentary power failure, the motor does not restart.**

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The data of function code F14 is either 0 or 1. | Check if an undervoltage trip occurs.<br>→ Change the data of function code F14 (Restart mode after momentary power failure (mode selection)) to 3, 4 or 5. |
| (2) The run command stayed off even after power has been restored. | Check the input signal with Menu #4 "I/O Checking" using the keypad.<br>→ Check the power recovery sequence with an external circuit. If necessary, consider the use of a relay that can keep the run command on. |
| | While in 3-wire operation, the power source to the inverter's control circuit went down because of a long momentary power failure; or, the (HOLD) signal was turned OFF once.<br>→ Change the design or the setting so that a run command can be issued again within 2 seconds after power has been restored. |

### 6.2.2 Problems with inverter settings

### [ 1 ] Nothing appears on the LED monitor.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) No power supplied to the inverter (main circuit power, auxiliary power for control circuit). | Check the input voltage, output voltage and interphase voltage unbalance.<br><br>→ Connect a molded case circuit breaker, a ground fault circuit interrupter (with overcurrent protection) or a magnetic contactor.<br>→ Check for voltage drop, phase loss, poor connections, or poor contacts, and fix them if necessary. |
| (2) The power for the control circuit did not reach a high enough level. | Check if the short bar has been removed between terminals P1 and P (+) or if there is poor contact between the short bar and the terminals.<br><br>→ Connect the short bar or DC reactor between terminals P1 and P (+) or retighten the screws. |
| (3) The keypad was not properly connected to the inverter. | Check whether the keypad is properly connected to the inverter.<br><br>→ Remove the keypad, put it back, and see whether the problem persists.<br>→ Replace the keypad with another one and check whether the problem persists. |
| | When running the inverter remotely, ensure that the extension cable is securely connected both to the keypad and to the inverter.<br><br>→ Disconnect the cable, reconnect it, and see whether the problem persists.<br>→ Replace the keypad with another one and check whether the problem persists. |

### [ 2 ] Data of function codes cannot be changed

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) An attempt was made to change function code data that cannot be changed when the inverter is running. | Check if the inverter is running with Menu #3 "Drive Monitoring" using the keypad and then confirm whether the data of the function codes can be changed when the motor is running by referring to the function code tables.<br><br>→ Stop the motor then change the data of the function codes. |
| (2) The data of the function codes is protected. | Check the data of function code F00 (Data protection).<br><br>→ Change the setting of F00 from "1" to "0." |
| (3) The WE-KP command ("Enable editing of function code data from keypad") is not input though it has been assigned to a digital input terminal. | Check the data of function codes E01, E02, E03, E04, E05, E98 and E99 and the input signals with Menu #4 "I/O Checking" using the keypad.<br><br>→ Change the setting of F00 from "1" to "0," or input a WE-KP command through a digital input terminal. |
| (4) The (FUNC DATA) key was not pressed. | Check whether you have pressed the (FUNC DATA) key after changing the function code data.<br><br>→ Press the (FUNC DATA) key after changing the function code data. |
| (5) The setting data of function code F02 could not be changed. | The inputs to the terminals of (FWD) and (REV) commands are concurrently turned ON.<br><br>→ Turn OFF both (FWD) and (REV). |

## 6.3 If an Alarm Code Appears on the LED Monitor

■ Quick reference table of alarm codes

| Alarm code | Name | Refer to | Alarm code | Name | Refer to |
|---|---|---|---|---|---|
| $OC\square$  $\square = 1, 2, 3$ | Instantaneous overcurrent | 6-8 | $FUS$ | Fuse blown | 6-13 |
| | | | $PbF$ | Charger circuit fault | 6-13 |
| $EF$ | Ground fault | 6-9 | $OL1$ | Electronic thermal overload relay | 6-14 |
| $OU\square$  $\square = 1, 2, 3$ | Overvoltage | 6-9 | $OLU$ | Overload | 6-14 |
| | | | $Er1$ | Memory error | 6-15 |
| $LU$ | Undervoltage | 6-10 | $Er2$ | Keypad communications error | 6-15 |
| $Lin$ | Input phase loss | 6-10 | $Er3$ | CPU error | 6-15 |
| $OPL$ | Output phase loss | 6-11 | $Er4$ | Option card communications error | 6-16 |
| $OH1$ | Heat sink overheat | 6-11 | $Er5$ | Option card error | 6-16 |
| $OH2$ | Alarm issued by an external device | 6-12 | $Er6$ | Incorrect operation error | 6-16 |
| $OH3$ | Inside of the inverter overheat | 6-12 | $Er7$ | Tuning error | 6-17 |
| $OH4$ | Motor protection (PTC thermistor) | 6-12 | $Er8$ | RS-485 communications error (RJ-45) | 6-17 |
| $roL$ | Running over cycle alarm *1 | 5-144 | $ErF$ | Data saving error during undervoltage | 6-18 |
| $idL$ | Low current detection alarm *1 | 5-88 | $ErP$ | RS-485 communications error (Terminal) | 6-18 |
| $CoF$ | PID feedback wire break *1 | 5-123 | $ErH$ | LSI error (Power PCB) | 6-19 |
| $Fb1$  $Fb2$ | PID feedback alarm *1 | 5-136 | $PE1$  $PE2$ | Excessive PID error alarm *1 | 5-143 |

*1 "Light alarm" objects

## [ 1 ]  $OCn$  Instantaneous overcurrent

Problem          The inverter momentary output current exceeded the overcurrent level.

  $OC1$  Overcurrent occurred during acceleration.
  $OC2$  Overcurrent occurred during deceleration.
  $OC3$  Overcurrent occurred when running at a constant speed.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The inverter output terminals were short-circuited. | Remove the wires connected to the inverter output terminals (U, V, and W) and measure the interphase resistance of the wires. Check if the resistance is too low.  ➜ Remove the part that short-circuited (including replacement of the wires, relay terminals and motor). |
| (2) Ground faults occurred at the inverter output terminals. | Remove the wires connected to the inverter output terminals (U, V, and W) and perform a Megger test.  ➜ Remove the part that short-circuited (including replacement of the wires, relay terminals and motor). |
| (3) Loads were too heavy. | Measure the motor current with a measuring device, and to trace the current trend. Therefore, use this information to judge if the trend is over the calculated load value for your system design.  ➜ If the load is too heavy, decrease it or raise the inverter capacity. |
| | Trace the current trend and check if there are any sudden changes in the current.  ➜ If there are any sudden changes, make the load variation smaller or raise the inverter capacity.  ➜ Enable instantaneous overcurrent limiting (H12 = 1). |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (4) The value set for torque boost (F09) was too large. (F37 = 0, 1, 3, or 4) | Check that the output current decreases and the motor does not come to stall if you set a lower value than the current one for F09.<br><br>➔ Lower the value for torque boost (F09) if the motor is not going to stall. |
| (5) The acceleration/ deceleration time was too short. | Check that the motor generates enough torque required during acceleration/deceleration. That torque is calculated from the moment of inertia for the load and the acceleration/deceleration time.<br><br>➔ Increase the acceleration/deceleration time (F07 and F08).<br>➔ Enable current limitig (F43).<br>➔ Raise the inverter capacity. |
| (6) Malfunction caused by noise | Check if noise control measures are appropriate (e.g., correct grounding and routing of control and main circuit wires).<br><br>➔ Implement noise control measures. For details, refer to "Appendix A" of the FRENIC-Eco User's Manual.<br>➔ Enable the auto-resetting (H04).<br>➔ Connect a surge absorber to the coil or solenoid of the magnetic contactor causing the noise. |

## [ 2 ]  $EF$  Ground fault (125 HP or above)

Problem    A ground fault current flew from the output terminal of the inverter.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The output terminal of the inverter is short-circuited to the ground (ground fault, or earthed). | Disconnect the wires from the output terminals ([U], [V], and [W]) and perform a megger test.<br><br>➔ Remove the earthed path (including the replacement of the wires, the terminals, or the motor as necessary). |

## [ 3 ]  $OUn$  Overvoltage

Problem    The DC link bus voltage was over the detection level of overvoltage.

   $OU1$   Overvoltage occurs during the acceleration.
   $OU2$   Overvoltage occurs during the deceleration.
   $OU3$   Overvoltage occurs during running at constant speed.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The power supply voltage was over the range of the inverter's specifications. | Measure the input voltage.<br><br>➔ Decrease the voltage to within that of the specifications. |
| (2) A surge current entered the input power source. | If within the same power source a phase-advancing capacitor is turned ON or OFF or a thyristor converter is activated, a surge (temporary precipitous rise in voltage or current) may be caused in the input power.<br><br>➔ Install a DC reactor. |
| (3) The deceleration time was too short for the moment of inertia for load. | Recalculate the deceleration torque from the moment of inertia for load and the deceleration time.<br><br>➔ Increase the deceleration time (F08).<br>➔ Enable the regenerative braking (H69 = 3), or automatic deceleration (H71 = 1).<br>➔ Set the rated voltage (at base frequency) (F05) to "0" to improve braking ability. |
| (4) The acceleration time was too short. | Check if the overvoltage alarm occurs after rapid acceleration.<br><br>➔ Increase the acceleration time (F07).<br>➔ Select the S-curve pattern (H07). |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (5) Braking load was too heavy. | Compare the braking torque of the load with that of the inverter.<br>→ Set the rated voltage (at base frequency) (F05) to 0 to improve braking ability. |
| (6) Malfunction caused by noise. | Check if the DC link bus voltage was below the protective level when the alarm occurred.<br>→ Improve noise control. For details, refer to "Appendix A" of the FRENIC-Eco User's Manual.<br>→ Enable the auto-resetting (H04).<br>→ Connect a surge absorber to the coil or solenoid of the magnetic contactor causing the noise. |

## [ 4 ]  $LU$  Undervoltage

Problem        DC link bus voltage was below the undervoltage detection level.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) A momentary power failure occurred. | → Reset the alarm.<br>→ If you want to restart running the motor by not treating this condition as an alarm, set F14 to "3," "4" or "5," depending on the load. |
| (2) The power to the inverter was switched back on too soon (with F14 = 1). | Check if the power to the inverter was switched back on although its control circuit was still operating.<br>→ Switch ON the power again after the display on the keypad has disappeared. |
| (3) The power supply voltage did not reach the range of the inverter's specifications. | Measure the input voltage.<br>→ Increase the voltage to within that of the specifications. |
| (4) Peripheral equipment for the power circuit malfunctioned, or the connection was incorrect. | Measure the input voltage to find where the peripheral equipment malfunctioned or which connection is incorrect.<br>→ Replace any faulty peripheral equipment, or correct any incorrect connections. |
| (5) Other loads were connected to the same power source and required a large current to start running to the extent that it caused a temporary voltage drop on the supply side. | Measure the input voltage and check the voltage variation.<br>→ Reconsider the power system configuration. |
| (6) Inverter's inrush current caused the power voltage drop because power transformer capacity was insufficient. | Check if the alarm occurs when you switch on a molded case circuit breaker, a ground fault circuit interrupter (with overcurrent protection) or a magnetic contactor.<br>→ Reconsider the capacity of the power source transformer. |

## [ 5 ]  $L$  $in$  Input phase loss

Problem        Input phase loss occurred, or interphase voltage unbalance rate was large.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Main circuit power input wires broken. | Measure the input voltage.<br>→ Repair or replace the wires. |
| (2) The terminal screws for the main circuit power input of the inverter were not tight enough. | Check if the screws on the inverter input terminals have become loose.<br>→ Tighten the terminal screws to the recommended torque. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (3) Interphase unbalance rate of three-phase voltage was too large. | Measure the input voltage.<br>➔ Connect an AC reactor (ACR) to lower the voltage unbalance between input phases.<br>➔ Raise the inverter capacity. |
| (4) Overload cyclically occurred. | Measure ripple wave of DC link bus voltage.<br>➔ If the ripple is large, raise the inverter capacity |
| (5) Single-phase voltage was input to the inverter instead of three-phase voltage input. | Check the inverter type.<br>➔ Apply three-phase power. FRENIC-Eco cannot be driven by single-phase power source. |

(Note) You can disable input phase loss protection using the function code H98.

## [ 6 ] *OPL* Output phase loss

Problem        Output phase loss occurred.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Inverter output wires are broken. | Measure the output current.<br>➔ Replace the output wires. |
| (2) Wires for motor winding are broken. | Measure the output current.<br>➔ Replace the motor. |
| (3) The terminal screws for inverter output were not tight enough. | Check if any screws on the inverter output terminals have become loose.<br>➔ Tighten the terminal screws to the recommended torque. |
| (4) A single-phase motor has been connected. | ➔ Single-phase motors cannot be used. Note that the FRENIC-Eco only drives three-phase induction motors. |

## [ 7 ] *OH1* Heat sink overheat

Problem        Temperature around heat sink rose.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Temperature around the inverter exceeded that of inverter specifications. | Measure the temperature around the inverter.<br>➔ Lower the temperature around the inverter (e.g., ventilate the enclosure well). |
| (2) Air vent is blocked. | Check if there is sufficient clearance around the inverter.<br>➔ Increase the clearance. |
| | Check if the heat sink is not clogged.<br>➔ Clean the heat sink. |
| (3) Accumulated running time of the cooling fan exceeded the standard period for replacement, or the cooling fan malfunctioned. | Check the cumulative running time of the cooling fan. Refer to Chapter 3, Section 3.4.6 "Reading maintenance information – "MAINTENANC"."<br>➔ Replace the cooling fan. |
| | Visually check whether the cooling fan rotates abnormally.<br>➔ Replace the cooling fan. |
| (4) Load was too heavy. | Measure the output current.<br>➔ Lighten the load (e.g. lighten the load before the overload protection occurs using the overload early warning (E34). (In winter, the load tends to increase.)<br>➔ Decease the motor sound (carrier frequency) (F26).<br>➔ Enable the overload protection control (H70). |

The 208V inverters with a capacity of 50HP or above and the 460V inverters with a capacity of 75HP or above each have a cooling fan/fans for heat sinks and a DC fan for internal air circulation  (dispersing the heat generated inside the inverter). For their locations, refer to Chapter 1, Section 1.2 "External View and Terminal Blocks."

## [ 8 ]  $\mathit{OH2}$  Alarm issued by an external device

Problem     External alarm was inputted (THR).
(in case external alarm (THR) is assigned to one of digital input terminals [X1] through [X5], [FWD], or [REV])

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1)  An alarm function of the external equipment was activated. | Inspect external equipment operation.<br>➔ Remove the cause of the alarm that occurred. |
| (2)  Connection has been performed incorrectly. | Check if the wire for the external alarm signal is correctly connected to the terminal to which the "Alarm from external equipment" has been assigned (Any of E01, E02, E03, E04, E05, E98, and E99 is set to "9.").<br>➔ Connect the wire for the alarm signal correctly. |
| (3)  Incorrect settings. | Check if the "Alarm from external equipment" has not been assigned to an unassigned terminal assigned (E01, E02, E03, E04, E05, E98, or E99).<br>➔ Correct the assignment. |
|  | Check whether the assignment (normal/negative logic) of the external signal agrees with that of thermal command (THR) set by E01, E02, E03, E04, E05, E98, and E99.<br>➔ Ensure that the polarity matches. |

## [ 9 ]  $\mathit{OH3}$  Inside of the inverter overheat

Problem     The temperature inside the inverter exceeded the allowable limit.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1)  The ambient temperature exceeded the allowable limit specified for the inverter. | Measure the ambient temperature.<br>➔ Lower the ambient temperature by improving the ventilation. |

## [ 10 ]  $\mathit{OH4}$  Motor protection (PTC thermistor)

Problem     Temperature of the motor rose abnormally.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1)  Temperature around the motor exceeded that of motor specifications. | Measure the temperature around the motor.<br>➔ Lower the temperature. |
| (2)  Cooling system for the motor malfunctioned. | Check if the cooling system of the motor is operating normally.<br>➔ Repair or replace the cooling system of the motor. |
| (3)  Load was too heavy. | Measure the output current.<br>➔ Lighten the load (e.g., lighten the load before overload occurs using the overload early warning (E34) function) (In winter, the load tends to increase.).<br>➔ Lower the temperature around the motor.<br>➔ Increase the motor sound (carrier frequency) (F26). |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (4) The set activation level (H27) of the PTC thermistor for motor overheat protection was inadequate. | Check the thermistor specifications and recalculate the detection voltage.<br><br>→ Reconsider the data of function code H27. |
| (5) A PTC thermistor and pull-up resistor were connected incorrectly or the resistance was inadequate. | Check the connection and the resistance of the pull-up resistor.<br><br>→ Correct the connections and replace the resistor with one with an appropriate resistance. |
| (6) The value set for the torque boost (F09) was too high. | Check the data of function code F09 and readjust the data so that the motor does not stall even if you set the data to a lower value.<br><br>→ Readjust the data of the function code F09. |
| (7) The V/f pattern did not match the motor. | Check if the base frequency (F04) and rated voltage at base frequency (F05) match the values on the nameplate on the motor.<br><br>→ Match the function code data to the values on the nameplate of the motor. |
| (8) Wrong settings | Although no PTC thermistor is used, the V2/PTC switch is turned to PTC, which means that the thermistor input is active on the PTC (H26).<br><br>→ Set H26 (PTC thermistor Input) to "0" (inactive). |

[ 11 ] $FUS$ **Fuse blown (125HP or above)**

Problem    The fuse inside the inverter blew.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The fuse blew because of a short-circuiting inside the inverter. | Check whether there has been any excess surge or noise coming from outside.<br><br>→ Take measures against surges and noise.<br>→ Have the inverter repaired. |

[ 12 ] $PbF$ **Charger circuit fault**
   **(50HP or above (208 V), 75HP or above (460 V))**

Problem    The magnetic contactor for short-circuiting the resistor for charging failed to work.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Control power was not supplied to the magnetic contactor intended for short-circuiting the charging resistor. | Check whether, in normal connection of the main circuit (not connection via the DC link bus), the connector (CN) on the power supply printed circuit board is not inserted to NC .<br><br>→ Insert the connector to FAN . |
| | Check whether you have quickly turned the circuit breaker ON and OFF to confirm safety after cabling/wiring.<br><br>→ Wait until the DC link bus voltage has dropped to a sufficiently low level and then reset the current alarm, and turn ON the power again. (Do not turn the circuit breaker ON and OFF quickly.)<br>(Turning ON the circuit breaker supplies power to the control circuit to the operation level (lighting LEDs on the keypad) in a short period. Immediately turning it OFF even retains the control circuit power for a time, while it shuts down the power to the magnetic contactor intended for short-circuiting the charging resistor since the contactor is directly powered from the main power.<br>Under such conditions, the control circuit can issue a turn-on command to the magnetic contactor, but the contactor not powered can produce nothing. This state is regarded as abnormal, causing an alarm.) |

## [ 13 ] $\mathcal{OL}$ / Electronic thermal overload relay

Problem          Electronic thermal function for motor overload detection was activated.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The characteristics of electronic thermal did not match those of the motor overload. | Check the motor characteristics.<br>→ Reconsider the data of function codes P99, F10 and F12.<br>→ Use an external thermal relay. |
| (2) Activation level for the electronic thermal relay was inadequate. | Check the continuous allowable current of the motor.<br>→ Reconsider and change the data of function code F11. |
| (3) The acceleration/ deceleration time was too short. | Check that the motor generates enough torque for acceleration/ deceleration. This torque is calculated from the moment of inertia for the load and the acceleration/ deceleration time.<br>→ Increase the acceleration/ deceleration time (F07 and F08). |
| (4) Load was too heavy. | Measure the output current.<br>→ Lighten the load (e.g., lighten the load before overload occurs using the overload early warning (E34)). (In winter, the load tends to increase.) |

## [ 14 ] $\mathcal{OLU}$ Overload

Problem          Temperature inside inverter rose abnormally.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Temperature around the inverter exceeded that of inverter specifications. | Measure the temperature around the inverter.<br>→ Lower the temperature (e.g., ventilate the enclosure well). |
| (2) The torque boost setting (F09) was too high. | Check the setting of F09 (torque boost) and make sure that lowering it would not cause the motor to stall.<br>→ Adjust the setting of F09. |
| (3) The acceleration/ deceleration time was too short. | Recalculate the required acceleration/deceleration torque and time from the moment of inertia for the load and the deceleration time.<br>→ Increase the acceleration/deceleration time (F07 and F08). |
| (4) Load was too heavy. | Measure the output current.<br>→ Lighten the load (e.g., lighten the load before overload occurs using the overload early warning (E34)). (In winter, the load tends to increase.)<br>→ Decrease the motor sound (carrier frequency) (F26).<br>→ Enable overload protection control (H70). |
| (5) Air vent is blocked. | Check if there is sufficient clearance around the inverter.<br>→ Increase the clearance.<br>Check if the heat sink is not clogged.<br>→ Clean the heat sink. |
| (6) The service life of the cooling fan has expired or the cooling fan malfunctioned. | Check the cumulative running time of cooling fan. Refer to Chapter 3, Section 3.4.6 " Reading maintenance information – "MAINTENANC"."<br>→ Replace the cooling fan.<br>Visually check that the cooling fan rotates normally.<br>→ Replace the cooling fan. |
| (7) The wires to the motor are too long and caused a large amount of current to leak from them. | Measure the leakage current.<br>→ Insert an output circuit filter. |

## [ 15 ] $Er1$ Memory error

Problem         Error occurred in writing the data to the memory in the inverter.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) While the inverter was writing data (especially initializing data or copying data), power supply was turned OFF and the voltage for the control circuit dropped. | Check if pressing the (PRG/RESET) key resets the alarm after the function code data are initialized by setting the data of H03 to 1.<br>➔ Return the initialized function code data to their previous settings, then restart the operation. |
| (2) A high intensity noise was given to the inverter while data (especially initializing data) was being written. | Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires). Also, perform the same check as described in (1) above.<br>➔ Improve noise control. Alternatively, return the initialized function code data to their previous settings, then restart the operation. |
| (3) The control circuit failed. | Initialize the function code data by setting H03 to 1, then reset the alarm by pressing the (PRG/RESET) key and check that the alarm goes on.<br>➔ This problem was caused by a problem of the printed circuit board (PCB) (on which the CPU is mounted). Contact your Fuji Electric representative. |

## [ 16 ] $Er2$ Keypad communications error

Problem         A communications error occurred between the remote keypad and the inverter.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Break in the communications cable or poor contact. | Check continuity of the cable, contacts and connections.<br>➔ Re-insert the connector firmly.<br>➔ Replace the cable. |
| (2) A high intensity noise was given to the inverter. | Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires).<br>➔ Improve noise control. For details, refer to "Appendix A" of the FRENIC-Eco User's Manual. |
| (3) The keypad malfunctioned. | Check that alarm $Er2$ does not occur if you connect another keypad to the inverter.<br>➔ Replace the keypad. |

## [ 17 ] $Er3$ CPU error

Problem         A CPU error (e.g. erratic CPU operation) occurred.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) A high intensity noise was given to the inverter. | Check if appropriate noise control measures have been implemented (e.g. correct grounding and routing of control and main circuit wires and communications cable).<br>➔ Improve noise control. |

**[ 18 ] $Er4$ Option card communications error**

Problem        A communications error occurred between the option card and the inverter.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) There was a problem with the connection between the bus option card and the inverter. | Check whether the connector on the bus option card is properly mating with the connector of the inverter.<br>→ Reload the bus option card into the inverter. |
| (2) There was a high intensity noise from outside. | Check whether appropriate noise control measures have been implemented (e.g. correct grounding and routing of control and main circuit wires and communications cable).<br>→ Reinforce noise control measures. |

**[ 19 ] $Er5$ Option card error**

An error detected by the option card. Refer to the instruction manual of the option card for details.

**[ 20 ] $Er6$ Incorrect operation error**

Problem        You incorrectly operated the inverter.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The (STOP) key was pressed when H96 = 1,3 or 5. | Although a Run command had been inputted from the input terminal or through the communications port, the inverter was forced to decelerate to stop.<br>→ If this was not intended, check the setting of H96. |
| (2) The start check function was activated when H96 = 2 or 3. | With a Run command being inputted, any of the following operations has been performed:<br>- Turning the power ON<br>- Releasing the alarm<br>- Switching the enable communications link (LE) operation<br>→ Review the running sequence to avoid input of a Run command when this error occurs.<br>If this was not intended, check the setting of H96.<br>(To reset the alarm, turn the Run command OFF.) |
| (3) The forced stop digital input (STOP) was turned ON. | Turning ON the forced stop digital input (STOP) decelerated the inverter to stop according to the specified deceleration period (H96).<br>→ If this was not intended, check the settings of E01 through E05 on terminals X1 through X5. |

**[ 21 ]** $Er$ 7 **Tuning error**

Problem    Auto-tuning failed.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) A phase was missing (There was a phase loss) in the connection between the inverter and the motor. | ➔ Properly connect the motor to the inverter. |
| (2) V/f or the rated current of the motor was not properly set. | Check whether the data of function codes F04, F05, H50, H51, P02, and P03 agrees with the specifications of the motor. |
| (3) The connection between the inverter and the motor was too long. | Check whether the connection length between the inverter and the motor is not exceeding 50m.<br>➔ Review, and if necessary, change the layout of the inverter and the motor to shorten the connection wire. Alternatively, minimize the connection wire length without changing the layout.<br>➔ Disable both auto-tuning and auto-torque (set F37 to "1"). |
| (4) The rated capacity of the motor was significantly different from that of the inverter. | Check whether the rated capacity of the motor is smaller than that of the inverter by three or more orders of class or larger by two or more orders of class.<br>➔ Check whether it is possible to replace the inverter with one with an appropriate capacity.<br>➔ Manually specify the values for the motor parameters P06, P07, and P08.<br>➔ Disable both auto-tuning and auto-torque boost (set F37 to "1"). |
| (5) The motor was a special type such as a high-speed motor. | ➔ Disable both auto-tuning and auto-torque boost (set F37 to "1"). |

📖 For details of tuning errors, refer to "Errors during Tuning" in Chapter 4, Section 4.1.3 "Preparation before running the motor for a test – Setting function code data."


**[ 22 ]** $Er8$ **RS-485 communications error**

Problem    A communications error occurred during RS-485 communications.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Conditions for communications differ between the inverter and host equipment. | Compare the settings of the y codes (y01 to y10) with those of the host equipment.<br>➔ Correct any settings that differ. |
| (2) Even though no response error detection time (y08) has been set, communications is not performed within the specified cycle. | Check the host equipment.<br>➔ Change the settings of host equipment software, or make the no response error detection time be ignored (y08=0). |
| (3) Host equipment (e.g., PLCs and personal computers) did not operate due to incorrect settings and/or defective software/hardware. | Check the host equipment.<br>➔ Remove the cause of the equipment error. |
| (4) Relay converters (e.g., RS-485 relay converter) did not operate due to incorrect connections and settings, or defective hardware. | Check the RS-485 relay converter (e.g., check for poor contact).<br>➔ Change the various RS-485 converter settings, reconnect the wires, or replace hardware (such as recommended devices) as appropriate. |
| (5) Broken communications cable or poor contact. | Check continuity of the cable, contacts and connections.<br>➔ Replace the cable. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (6) A high intensity noise was given to the inverter. | Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires).<br><br>→ Improve noise control.<br>→ Improve noise reduction measures on the host side.<br>→ Replace the RS-485 relay converter with a recommended insulated converter. |

## [ 23 ] $Er\!F$ Data saving error during undervoltage

Problem    The inverter was unable to save data such as the frequency commands and PID process command set through the keypad when the power was switched off.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The control circuit voltage dropped suddenly while data was being saved when the power was turned OFF, because the DC link bus was rapidly discharged. | Check how long it takes for the DC link bus voltage to drop to the preset voltage when power is turned OFF.<br><br>→ Remove whatever is causing the rapid discharge of the DC link bus electricity. After pressing the (PRG/RESET) key and releasing the alarm, set, using a remote keypad, the data of the relevant function codes (such as the frequency commands and PID process command) back to the original values and then restart the operation. |
| (2) A high intensity noise affected the operation of the inverter while data was being saved when the power was turned OFF. | Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires).<br><br>→ Improve noise control. After pressing the (PRG/RESET) key and releasing the alarm, set, using a remote keypad, the data of the relevant function codes (such as the frequency commands and PID process command) back to the original values and then restart the operation. |
| (3) The control circuit failed. | Check if $Er\!F$ occurs each time power is switched on.<br><br>→ This problem was caused by a problem of the printed circuit board (PCB) (on which the CPU is mounted). Contact your Fuji Electric representative. |

## [ 24 ] $Er\!P$ RS-485 communications error

Problem    A communications error occurred during RS-485 communications.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) Conditions for communications differ between the inverter and host equipment. | Compare the settings of the y codes (y11 to y20) with those of the host equipment.<br><br>→ Correct any settings that differ. |
| (2) Even though no response error detection time (y18) has been set, communications did not occur cyclically. | Check the host equipment.<br><br>→ Change the settings of host equipment software, or make the no response error detection time invalid (y18=0). |
| (3) Host equipment (e.g., PLCs and personal computers) did not operate due to incorrect settings and/or defective software/hardware. | Check the host equipment.<br><br>→ Remove the cause of the equipment error. |
| (4) Relay converters (e.g., RS-485 relay converter) did not operate due to incorrect connections and settings, and defective hardware. | Check the RS-485 relay converter (e.g., check for poor contact).<br><br>→ Change the various RS-485 converter settings, reconnect the wires, or replace hardware (such as recommended devices) as appropriate. |

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (5) Broken communications cable or poor contact. | Check continuity of the cable, contacts and connections.<br>→ Replace the cable. |
| (6) A high intensity noise was given to the inverter. | Check if appropriate noise control measures have been implemented (e.g., correct grounding and routing of control and main circuit wires).<br>→ Improve noise control.<br>→ Improve noise reduction measures on the host side.<br>→ Replace the RS-485 relay converter with a recommended insulated converter. |
| (7) The RS-485 communications card malfunctioned. | → Replace the card. |

### [ 25 ] $Er H$ LSI error (Power PCB) (50HP or above (208 V); 75HP or above (460 V))

Problem      An error occurred in the LSI on the power printed circuit board (power PCB).

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The capacity is not set properly on the control printed circuit board. | The inverter capacity needs to be modified again.<br>→ Contact your Fuji Electric representative. |
| (2) The contents of the memory on the power supply printed circuit board are corrupted. | The power supply printed circuit board needs to be replaced.<br>→ Contact your Fuji Electric representative. |
| (3) Connection problem between the control printed circuit board and the power supply printed circuit board | Either the control printed circuit board or the power supply printed circuit board needs to be replaced.<br>→ Contact your Fuji Electric representative. |

## 6.4 If the "Light Alarm" Indication ($\mathit{L\text{-}AL}$) Appears on the LED Monitor

If the inverter detects a minor abnormal state "light alarm," it can continue the current operation without tripping while displaying the "light alarm" indication $\mathit{L\text{-}AL}$ on the LED monitor. In addition to the indication $\mathit{L\text{-}AL}$, the inverter displays the "L-ALARM" (blinking) on the LCD monitor and outputs the "light alarm" signal **L-ALM** to a digital output terminal to alert the peripheral equipment to the occurrence of a light alarm. (To use the **L-ALM**, it is necessary to assign the signal to any of the digital output terminals by setting any of function codes E20 through E24 and E27 to "98.")

Function code H82 specify which alarms should be categorized as "light alarm".

■ Quick reference table of light alarm codes

| Light alarm Code | Name | Refer to | Light alarm Code | Name | Refer to |
|---|---|---|---|---|---|
| $roC$ | Running over cycle alarm *1 | 5-144 | $CoF$ | PID feedback wire break *1 | 5-123 |
| $idL$ | Low current detection alarm *1 | 5-88 | | | |
| $Fb1$ $Fb2$ | PID feedback alarm *1 | 5-136 | $PE1$ $PE2$ | Excessive PID error alarm *1 | 5-143 |

To display the "light alarm" and escape from the light alarm state, follow the instructions below.

■ Displaying the light alarm

1) Press the (PRG) key to enter Programming mode.
2) Shift to Menu #5 "5: MAINTENANC," scroll to Page 11, and check the "LALM1" (Light alarm (Latest)). The light alarm is displayed in alarm codes.

    📖   For details about the menu transition in Menu #5 "Maintenance Information", see Chapter 3, Section 3.4.6 "Reading maintenance information – Menu #5 "Maintenance Information." It is also possible to display the factors of other three light alarms--"LALM2" (Light alarm (Last)) to "LALM4" (Light alarm (3rd)).

■ Switching the LED monitor from the light alarm to normal display

If it is necessary to return the LED monitor to the normal display state (showing the running status such as reference frequency) before the light alarm is removed (e.g., when it takes a long time to remove the light alarm), follow the steps below.

1) Press the (RESET) key to return the LED monitor to the light alarm indication ($\mathit{L\text{-}AL}$).
2) With $\mathit{L\text{-}AL}$ being displayed, press the (FUNC/DATA) key. The LED monitor returns to the normal display state, but the "L-ALARM" on the LCD monitor continues blinking.

■ Releasing the light alarm

1) First remove the "LALM1" (Light alarm (Latest)) under Menu #5, in accordance with the troubleshooting procedure. The reference page for the troubleshooting corresponding to each light alarm is shown in "Ref. page" column in Table 6.1.
2) To return the LED monitor from the $\mathit{L\text{-}AL}$ display to the normal display state (showing the running status such as reference frequency), press the (FUNC/DATA) key in Running mode.

    If the light alarm(s) has been successfully removed in step 1) above, the "L-ALARM" blinking on the LCD monitor disappears and the digital output **L-ALM** also goes OFF. (If any light alarm persists, e.g., detecting a DC fan lock, the "L-ALARM" continues blinking and the **L-ALM** remains ON.)

## 6.5 If an Abnormal Pattern Appears on the LED Monitor except Alarm Codes and "Light Alarm" Indication ($L$ -$\mathcal{A}L$)

### [ 1 ]  − − − − − (center bar) appears

Problem    A center bar (− − − − −) has appeared on the LED monitor.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) When PID control had been disabled (J01=0), you changed E43 (display selection) to 10 or 12.<br><br>You disabled PID control (J01=0) when the LED monitor had been set to display the PID final command value or PID feedback value by pressing the ⟨FUNC/DATA⟩ key. | Make sure that when you wish to view other monitor items, E43 is not set to "10: PID process command (final)" or "12: PID feedback value."<br><br>➔ Set E43 to a value other than "10" or "12."<br><br>Make sure that when you wish to view a PID process command or a PID feedback value, PID control is still in effect or J01 is not set to 0.<br><br>➔ Set J01 to "1: Enable (normal operation)" or "2: Enable (inverse operation)." |
| (2) Connection to the keypad was in poor connection. | Prior to proceed, check that pressing the ⟨FUNC/DATA⟩ key does not take effect for the LED display.<br>Check connectivity of the extension cable for the keypad used in remote operation.<br><br>➔ Replace the cable. |

### [ 2 ]  _ _ _ _ _ (under bar) appears

Problem    An under bar ( _ _ _ _ _ ) appeared on the LED monitor when you pressed the ⟨FWD⟩ / ⟨REV⟩ key or entered a run forward command (FWD) or a run reverse command (REV). The motor did not start.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The voltage of the DC link bus was low. | Select Menu #5 "Maintenance Information" in Programming mode on the keypad, and check the voltage of the DC link bus, which should be: 200 VDC or below for 3-phase 208V, and 400 VDC or below for 3-phase 460V.<br><br>➔ Connect the inverter to a power supply that meets its input specifications. |
| (2) The main power is not ON, while the auxiliary input power to the control circuit is supplied. | Check that the main power is turned ON.<br><br>➔ If it is not ON, turn it ON. |

### [ 3 ]  $\lceil \quad \rceil$ appears

Problem    Parentheses ($\lceil \quad \rceil$) has appeared on the screen while the keypad displaying the Drive Monitor.

| Possible Causes | What to Check and Suggested Measures |
|---|---|
| (1) The data to be displayed could not fit the LED monitor (e.g. overflown). | Check that the product of the output frequency and the display coefficient (E50) does not exceed 9999.<br><br>➔ Adjust the setting of E50. |

# Chapter 7   MAINTENANCE AND INSPECTION

Perform daily and periodic inspection to avoid trouble and keep reliable operation for a long time. Take care of the following items during work.

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## ⚠ WARNING

- Before proceeding to the maintenance/inspection jobs, turn OFF the power and wait more than five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).

  **Electric shock may occur.**

- Maintenance, inspection, and parts replacement should be made only by authorized persons.
- Take off the watch, rings and other metallic matter before starting work.
- Use insulated tools.
- Never modify the inverter.

  **Electric shock or injuries could occur.**

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## 7.1   Daily Inspection

Visually inspect errors in the state of operation from the outside without removing the covers while the inverter operates or while it is turned ON.

- Check if the expected performance (satisfying the standard specification) is obtained.
- Check if the surrounding environment satisfies Chapter 2, Section 2.1 "Operating Environment."
- Check that the LED monitor displays normally.
- Check for abnormal noise, odor, or excessive vibration.
- Check for traces of overheat, discoloration and other defects.

## 7.2   Periodic Inspection

Perform periodic inspection by following the items of the list of periodic inspection in Table 7.1. Before performing periodic inspection, be sure to stop the motor, turn OFF the inverter, and shut down power supply. Then remove the covers of the control and main circuit terminal blocks.

Table 7.1  List of Periodic Inspections

| Check part | Check item | How to inspect | Evaluation criteria |
|---|---|---|---|
| Environment | 1) Check the ambient temperature, humidity, vibration and atmosphere (dust, gas, oil mist, or water drops).<br>2) Check if tools or other foreign matter or dangerous objects are left around the equipment. | 1) Check visually or measure using apparatus.<br><br>2) Visual inspection | 1) The standard specification must be satisfied.<br>2) No foreign or dangerous objects are left. |
| Voltage | Check if the voltages of the main and control circuit are correct. | Measure the voltages using a multimeter or the like. | The standard specification must be satisfied. |
| Keypad | 1) Check if the display is clear.<br>2) Check if there is missing parts in the characters. | 1), 2)<br>Visual inspection | 1), 2)<br>The display can be read and there is no fault. |

Table 7.1  Continued

| Check part | | Check item | How to inspect | Evaluation criteria |
|---|---|---|---|---|
| Structure such as frame and cover | | 1) Abnormal noise and excessive vibration<br>2) Loosen bolts (tightened parts)<br>3) Deformation and breakage<br>4) Discoloration and deformation caused by overheat<br>5) Check for foulness and dust. | 1) Visual or hearing inspection<br>2) Retighten.<br>3), 4), 5)<br>  Visual inspection | 1), 2), 3), 4), 5)<br>  No abnormalities |
| Main circuit | Common | 1) Check if bolts and screws are tight and not missing.<br>2) Check the devices and insulators for deformation, cracks, breakage and discoloration caused by overheat and deterioration.<br>3) Check for foulness and dust. | 1) Retighten.<br>2), 3)<br>  Visual inspection | 1), 2), 3)<br>  No abnormalities |
| | Conductor and wire | 1) Check the conductor for discoloration and distortion caused by overheat.<br>2) Check the sheath of the cable for cracks and discoloration. | 1), 2)<br>  Visual inspection | 1), 2)<br>  No abnormalities |
| | Terminal block | Check that the terminals are not damaged. | Visual inspection | No abnormalities |
| | Filtering capacitor | 1) Check for electrolyte leakage, discoloration, cracks and swelling of the case.<br>2) Check if the safety valve does not protrude remarkably.<br>3) Measure the capacitance if necessary. | 1), 2)<br>  Visual inspection<br><br>3) Measure discharge time with capacitance probe. | 1), 2)<br>  No abnormalities<br><br>3) The discharge time is not shorter than time specified by the replacement manual. |
| | Transformer and reactor | Check for abnormal roaring noise and odor. | Hearing, visual and smelling inspection | No abnormalities |
| | Magnetic contactor and relay | 1) Check for chatters during operation.<br>2) Check for rough contacts. | 1) Hearing inspection<br>2) Visual inspection | 1), 2)<br>  No abnormalities |
| Control circuit | Printed circuit board | 1) Check for loose screws and connectors.<br>2) Check for odor and discoloration.<br>3) Check for cracks, breakage, deformation and remarkable rust.<br>4) Check the capacitors for electrolyte leaks and deformation. | 1) Retighten.<br>2) Smelling and visual inspection<br>3), 4)<br>  Visual inspection | 1), 2), 3), 4)<br>  No abnormalities |
| Cooling system | Cooling fan | 1) Check for abnormal noise and excessive vibration.<br><br>2) Check for loose bolts.<br>3) Check for discoloration caused by overheat. | 1) Hearing and visual inspection, or turn manually (be sure to turn the power OFF).<br>2) Retighten.<br>3) Visual inspection | 1) Smooth rotation<br>2), 3)<br>  No abnormalities |
| | Ventilation path | Check the heat sink, intake and exhaust ports for clogging and foreign matter. | Visual inspection | No abnormalities |

If the inverter is stained, wipe it off with a chemically neutral cloth to remove dust and use a vacuum cleaner.

## 7.3 List of Periodical Replacement Parts

Each part of the product has its own service life that will vary according to the environmental and operating conditions. It is recommended that the following parts be replaced as specified below.

When the replacement is necessary, contact your Fuji Electric representative.

Table 7.2 Replacement Parts

| Part name | Standard replacement intervals |
|---|---|
| DC link bus capacitor | 10 years |
| Electrolytic capacitor on the printed circuit board | 10 years |
| Cooling fan | 10 years (30HP for 208V and 40HP for 460V or below)<br>7 years (40HP for 208V, 50HP for 460V or above) |
| Fuse | 10 years (125HP for 208V, 125HP for 460V or above) |

(Note) These replacement intervals are based on the estimated service life of the inverter at an ambient temperature of 40°C(104°F) under 80% of full load. In environments with an ambient temperature above 40°C(104°F) or a large amount of dust or dirt, the replacement intervals may need to be reduced.

### 7.3.1 Judgment on service life

### (1) Viewing data necessary for judging service life; Measurement procedures

Through Menu #5 "Maintenance Information" in Programming mode, you can view on the keypad various data (as a guideline) necessary for judging whether key components such as the DC link bus capacitor, the electrolytic capacitor on the printed circuit board, and the cooling fan are approaching their service life.

①-1  Measuring the capacitance of the DC link bus capacitor (in comparison with that at factory shipment)

Measure the capacitance of the DC link bus capacitor according to the procedure given below. The result will be displayed on the keypad as a ratio (%) to the initial capacitance at the time of factory shipment.

---------------------------------------------- **Procedure for measuring capacitance** ----------------------------------------------

1) To ensure validity in the comparative measurement, put the condition of the inverter back to the state at factory shipment.

- Remove the option card (if already in use) from the inverter.
- In case another inverter is connected via the DC link bus to the P(+) and N(-) terminals of the main circuit, disconnect the wires. (You do not need to disconnect a DC reactor (optional), if any.)
- Disconnect power wires for the auxiliary input to the control circuit (R0, T0).
- Turn OFF all the digital input signals fed to terminals [FWD], [REV], and [X1] through [X5] of the control circuit.
- If a potentiometer is connected to terminal [13], disconnect it.
- If an external apparatus is attached to terminal [PLC], disconnect it.
- Ensure that transistor output signals ([Y1] - [Y3]) and relay output signals ([Y5A/C] and [30A/B/C]) will not be turned ON.

  Note  If negative logic is specified for the transistor output and relay output signals, they are considered ON when the inverter is not running. Specify positive logic for them.

- Keep the ambient temperature within 25 ±10°C(77 ± 50°F).

2) Switch ON the main circuit power.

3) Confirm that the cooling fan is rotating and the inverter is in stopped state.

4) Switch OFF the main circuit power.

5) Start the measurement of the capacitance of the DC link bus capacitor. Make sure that " . . . . " appears on the LED monitor.

  Note  If " . . . . " does not appear on the LED monitor, the measurement will not start. Check the conditions listed in 1).

6) Once " . . . . " has disappeared from the LED monitor, switch ON the main circuit power again.

7) Select Menu #5 "Maintenance Information" in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor).

---------------------------------------------------------------------------------------------------------------------------------------

① -2 Measuring the capacitance of the DC link bus capacitor (during power-off time under ordinary operating condition)

In general, the discharging condition of the DC link bus capacitor during a power-off time under the ordinary operating condition at the end user's installation is different from that under which the initial measurement is conducted at the time of factory shipment. As a result, the measured data for the DC link bus capacitor may not be updated. A method is provided, therefore, that allows you to measure the capacitance of the DC link bus capacitor during an ordinary power-off time by taking on (assuming) its discharging condition during a power-off time under the ordinary operation condition at the end user's installation.

Presented below is the procedure for taking on the discharging condition during a power-off time under the ordinary operating condition at the end user's installation.

-------------------------------------- **Procedure for setting up measurement condition** --------------------------------------

1) Set function code H98 (Protection/maintenance function) to enable the user to specify the judgment criteria for the service life of the DC link bus capacitor (Bit 3) (refer to function code H98).

2) Place the inverter in stopped state.

3) Place the inverter in the state of power-off under ordinary operating conditions.

4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to "0000."

5) Switch OFF the inverter.

   Measure the discharging time of the DC link bus capacitor and save the result in function code H47 (Initial capacitance of DC link bus capacitor).

   The condition under which the measurement has been conducted will be automatically collected and saved.

   During the measurement, " . . . . " will appear on the LED monitor.

6) Switch ON the inverter again. Confirm that H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) hold right values. Move to Menu #5 "Maintenance Information" and confirm that the relative capacitance (ratio to full capacitance) is 100%.

   Note If the measurement has failed, "0001" is entered into both H42 and H47. Check whether there has been any mistake in operation and conduct the measurement again.

--------------------------------------------------------------------------------------------------------------------------------------

To change the settings back to the state at the time of factory shipment, set H47 (Initial capacitance of DC link bus capacitor) to "0002"; the original values will be restored.

Hereafter, each time the inverter is switched OFF, the discharging time of the DC link bus capacitor is automatically measured if the above condition is met.

Note The condition given above produces a rather large measurement error. If this mode gives you a lifetime alarm, set H98 (Maintenance operation) back to the default setting (Bit 3 (Specify service life criteria for replacing the DC link bus capacitor) = 0) and conduct the measurement under the condition at the time of factory shipment.

② Electrolytic capacitor on the printed circuit board

Move to Menu #5 "Maintenance Information" in Programming mode and check the accumulated run time of the electrolytic capacitor on the printed circuit board. This value is calculated from the cumulative total number of hours a voltage has been applied on the electrolytic capacitor, adjusted with ambient temperature, and is used as the basis for judging whether it has reached its service life. The value is displayed on the LED monitor in units of 1000 hours.

③ Cooling fan

Select Menu #5 "Maintenance Information" and check the accumulated run time of the cooling fan. The inverter accumulates hours for which the cooling fan has run. The display is in units of 1000 hours. The accumulated time should be used just a guide since the actual service life will be significantly affected by the temperature and operation environment.

**(2) Early warning of lifetime alarm**

For the components listed in Table 7.3, you can get an early warning of lifetime alarm at one of the transistor output terminals ([Y1] to [Y3]) and the relay contact terminals ([Y5A] - [Y5C], and [30A/B/C]) as soon as any of the conditions listed under the "Judgment level" column has been exceeded.

The early warning signal is also turned ON when a lock condition on the internal air circulation DC fan (on 208V inverters with a capacity of 50HP or above; on 460V inverters with a capacity of 75HP or above) has been detected.

Table 7.3  Criteria for Issuing a Lifetime Alarm

| Parts to be replaced | Judgment level |
|---|---|
| DC link bus capacitor | 85% or lower of the capacitance than that of the factory setting |
| Electrolytic capacitor on the printed circuit board | 87000 hours or longer as accumulated run time |
| Cooling fan | Accumulated run time ≥ 87000 hours (30HP for 208V and 40HP for 460V or below) Accumulated run time ≥ 61000 hours (40HP for 208V, 50HP for 460V or above) (estimated service life at the inverter's ambient temperature of 40°C(104°F) under 80% of full load) |

## 7.4  Measurement of Electrical Amounts in Main Circuit
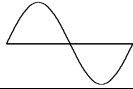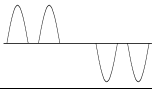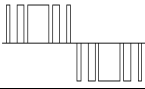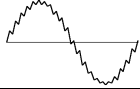
Because the voltage and current of the power supply (input, primary circuit) of the main circuit of the inverter and those of the motor (output, secondary circuit) include harmonic components, the readings may vary with the type of the meter. Use meters indicated in Table 7.4 when measuring with meters for commercial frequencies.

The power factor cannot be measured by a commercially available power-factor meter that measures the phase difference between the voltage and current. To obtain the power factor, measure the power, voltage and current on each of the input and output sides and calculate in the following formula.

■ Three-phase input

$$\text{Power factor} = \frac{\text{Electric power (W)}}{\sqrt{3} \times \text{Voltage (V)} \times \text{Current (A)}} \times 100\ \%$$

Table 7.4  Meters for Measurement of Main Circuit

| Item | Input (primary) side | | | Output (secondary) side | | | DC link bus voltage (P (+)-N (-)) |
|---|---|---|---|---|---|---|---|
| | Voltage | Current | | Voltage | Current | | |
| Waveform |  |  | |  |  | |  |
| Name of meter | Ammeter A$_R$, A$_S$, A$_T$ | Voltmeter V$_R$, V$_S$, V$_T$ | Wattmeter W$_R$, W$_T$ | Ammeter A$_U$, A$_V$, A$_W$ | Voltmeter V$_U$, V$_V$, V$_W$ | Wattmeter W$_U$, W$_W$ | DC voltmeter V |
| Type of meter | Moving iron type | Rectifier or moving iron type | Digital AC power meter | Digital AC power meter | Digital AC power meter | Digital AC power meter | Moving coil type |
| Symbol of meter |  |  | — | — | — | — |  |

Note: It is not recommended that meters other than a digital AC power meter be used for measuring the output voltage or output current since they may cause larger measurement errors or, in the worst case, they may be damaged.
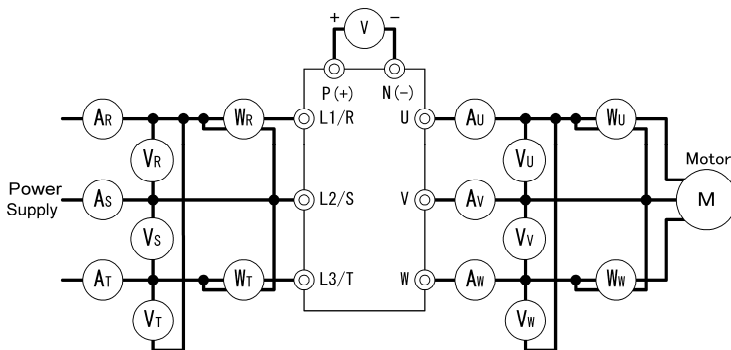
Figure 7.1  Connection of Meters

## 7.5  Insulation Test

Because an insulation test is made in the factory before shipment, avoid a Megger test.

If a Megger test is unavoidable, follow the procedure below. Because a wrong test procedure will cause breakage of the inverter, take sufficient care.

A dielectric strength test will cause breakage of the inverter similarly to the Megger test if the test procedure is wrong. When the dielectric strength test is necessary, contact your Fuji Electric representative.

### (1)  Megger test of main circuit

1) Use a 500 VDC Megger and shut off the main power supply without fail during measurement.
2) If the test voltage leaks to the control circuit due to the wiring, disconnect all the control wiring.
3) Connect the main circuit terminals with a common cable as shown in Figure 7.2.
4) The Megger test must be limited to across the common line of the main circuit and the ground terminal (⏚).
5) 5 MΩ (1 MΩ for the EMC filter built-in type of inverters) or a larger value displayed at the Megger indicates a correct state. (The value is for a discrete inverter.)
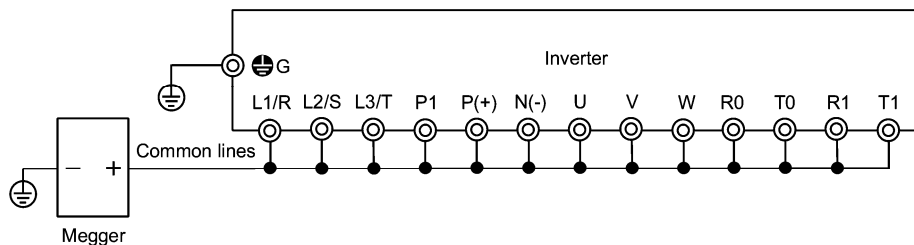


Figure 7.2  Megger Test

### (2)  Dielectric strength test of control circuit

Do not perform a Megger test or dielectric strength test for the control circuit. Prepare a high resistance range tester for the control circuit.

1) Disconnect all the external wiring from the control circuit terminals.
2) Perform a continuity test to the ground. 1 MΩ or a larger measurement indicates a correct state.

### (3)  Dielectric strength test of external main circuit and sequence control circuit

Disconnect all the inverter terminals so that the test voltage is not applied.

## 7.6 Inquiries about Product and Guarantee

**(1) When making an inquiry**

Upon breakage of the product, uncertainties, failure or inquiries, report the following information to your Fuji Electric representative.

1) Inverter type (Refer to Chapter 1, Section 1.1.)
2) SER No. (serial number of equipment) (Refer to Chapter 1, Section 1.1.)
3) Function codes and their data that you changed (Refer to Chapter 3, Section 3.4.3.)
4) ROM version (Refer to Chapter 3, Section 3.4.6.)
5) Date of purchase
6) Inquiries (for example, point and extent of breakage, uncertainties, failure phenomena, and other circumstances)

**(2) Product warranty**

The term of product warranty is "3 years from the shipment date". However, the product will not be repaired free of charge in the following cases, even if the warranty term has not expired.

1) The cause includes incorrect usage or inappropriate repair or modification.
2) The product is used outside the standard specified range.
3) The failure is caused by dropping, damage or breakage during transportation after the purchase.
4) The cause is earthquake, fire, storm or flood, lightening, excessive voltage, or other types of disaster or secondary disasters.

# Chapter 8 SPECIFICATIONS

## 8.1 Standard Models

### 8.1.1 Three-phase 208V

| Item | | | 001 | 002 | 003 | 005 | 007 | 010 | 015 | 020 | 025 | 030 | 040 | 050 | 060 | 075 | 100 | 125 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type (FRN□□□F1S-2DY) | | | | | | | | | | Specifications | | | | | | | | |
| Nominal applied motor for three phase input [*1] [HP] | | | 1 | 2 | 3 | 5 | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 75 | 100 | 125 |
| Output ratings for three-phase input | Rated capacity [*2] [kVA] | | 1.6 | 2.7 | 3.8 | 6.0 | 9.0 | 11 | 16 | 21 | 27 | 31 | 41 | 51 | 60 | 76 | 98 | 123 |
| | Rated voltage [*3] [V] | | Three-phase, 200V to 240V (With AVR function) | | | | | | | | | Three-phase, 200V to 230V (With AVR function) | | | | | | |
| | Rated current [*4] [A] | | 4.6 | 7.5 | 10.6 | 16.7 | 25 | 31 | 47 | 60 | 75 | 88 | 114 | 143 | 169 | 211 | 273 | 343 |
| | Overload capability | | 120% of rated current for 1min | | | | | | | | | | | | | | | |
| | Rated frequency | | 50, 60Hz | | | | | | | | | | | | | | | |
| Input ratings for three-phase input | Main power supply | | Three-phase, 200 to 240V, 50/60Hz | | | | | | | | | Three-phase, 200 to 220V / 50Hz, 200 to 230V / 60Hz | | | | | | |
| | Auxiliary control power input | | Single-phase, 200 to 240V, 50/60Hz | | | | | | | | | Single-phase, 200 to 220V / 50Hz, 200 to 230V / 60Hz | | | | | | |
| | Auxiliary fan power input [*5] | | None | | | | | | | | | | | Single-phase, 200 to 220V / 50Hz, 200 to 230V / 60Hz | | | | |
| | Voltage/frequency variations | | Voltage: +10 to -15% (Voltage unbalance: 2% or less) [*9], Frequency: +5 to -5% | | | | | | | | | | | | | | | |
| | Rated current [*6] [A] | with DCR | 3.1 | 5.8 | 8.7 | 14.5 | 20.6 | 27.5 | 41.3 | 55.1 | 68.8 | 82.6 | 109 | 134 | 160 | 199 | 270 | 333 |
| | | without DCR | 5.1 | 9.1 | 12.9 | 21.5 | 30.8 | 40.8 | 59.4 | 76.6 | 94.0 | 110 | 144 | 179 | 215 | — | — | — |
| | Required power supply capacity [*7] [kVA] | | 1.2 | 2.1 | 3.2 | 5.3 | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 49 | 58 | 72 | 98 | 120 |
| Braking | Torque [*8] [%] | | 20 | | | | | | | | | 10 to 15 | | | | | | |
| | DC injection braking | | Starting frequency: 0.0 to 60.0Hz, Braking time: 0.0 to 30.0s, Braking level: 0 to 60% | | | | | | | | | | | | | | | |
| DC reactor (DCR) | | | Option | | | | | | | | | | | | | Standard | | |
| Applicable safety standards | | | UL508C, C22.2 No.14, EN50178:1997 | | | | | | | | | | | | | UL508C C22.2 No.14 | | |
| Enclosure (IEC60529) | | | IP20 / UL open type | | | | | | | | | IP00 / UL open type | | | | | | |
| Cooling method | | | Natural cooling | Fan cooling | | | | | | | | | | | | | | |
| Mass [lbs(kg)] | | | 7.1 (3.2) | 7.3 (3.3) | 7.3 (3.3) | 7.5 (3.4) | 13 (5.8) | 13 (6.0) | 15 (6.9) | 21 (9.7) | 21 (9.7) | 25 (11.5) | 51 (23) | 73 (33) | 75 (34) | 90 (41) | 90 (41) | 265 (120) |

Note:
[*1]  Standard 4-pole motor

[*2]  Rated capacity is calculated by assuming the output rated voltage as 208V for three-phase 208V input.

[*3]  Output voltage cannot exceed the power supply voltage.

[*4]  An excessively low setting of the carrier frequency may result in the higher motor temperature or tripping of the inverter by its overcurrent limiter setting. Lower the continuous load or maximum load instead. (When setting the carrier frequency (F26) to 1kHz, reduce the load to 80% of its rating.)

[*5]  Use [R1,T1] terminals for driving AC cooling fans of an inverter powered by the DC link bus, such as by a high power factor PWM converter. (In ordinary operation, the terminals are not used.)

[*6]  Calculated under Fuji-specified conditions.

[*7]  Obtained when a DC reactor (DCR) is used.

[*8]  Average braking torque (Varies with the efficiency of the motor.)

[*9]  Voltage unbalance = $\dfrac{\text{Max. voltage [V]} - \text{Min. voltage [V]}}{\text{Three - phase average voltage [V]}} \times 67$ (IEC61800 3(5.2.3))

   If this value is 2 to 3%, use an AC reactor (ACR).

## 8.1.2　Three-phase 460 V

■ 1 to 75HP

| Item | | | Specifications | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | (FRN□□□F1S-4DY) | | 001 | 002 | 003 | 005 | 007 | 010 | 015 | 020 | 025 | 030 | 040 | 050 | 060 | 075 |
| Output ratings for three phase input | Nominal applied motor for three phase input [HP] | | 1 | 2 | 3 | 5 | 7.5 | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 75 |
| | Rated capacity [kVA] | | 1.9 | 2.9 | 4.3 | 7.1 | 9.9 | 13 | 18 | 23 | 29 | 35 | 47 | 57 | 67 | 83 |
| | Rated voltage [V] | | Three-phase, 380V to 480V (With AVR function) | | | | | | | | | | | | | |
| | Rated current [A] | | 2.5 | 3.7 | 5.5 | 9.0 | 12.5 | 16.5 | 23 | 30 | 37 | 44 | 59 | 72 | 85 | 105 |
| | Overload capability | | 120% of rated current for 1min | | | | | | | | | | | | | |
| | Rated frequency | | 50, 60Hz | | | | | | | | | | | | | |
| Input ratings for three phase input | Main power supply | | Three-phase, 380 to 480V, 50/60Hz | | | | | | | | | | Three-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | |
| | Auxiliary control power input | | Single-phase, 380 to 480V, 50/60Hz | | | | | | | | | | Single-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | |
| | Auxiliary fan power input [5] | | None | | | | | | | | | | | | | Single-phase, 380 to 440V / 50Hz 380 to 480V / 60Hz |
| | Voltage/frequency variations | | Voltage: +10 to -15% (Voltage unbalance: 2% or less) [9], Frequency: +5 to -5% | | | | | | | | | | | | | |
| | Rated current [6] [A] | with DCR | 1.3 | 2.5 | 3.8 | 6.2 | 8.9 | 11.8 | 17.7 | 23.7 | 29.6 | 35.5 | 46.8 | 57.0 | 68.4 | 85.7 |
| | | without DCR | 2.5 | 4.8 | 6.9 | 10.8 | 14.5 | 19.1 | 27.7 | 36.0 | 43.6 | 50.9 | 64.0 | 78.5 | 93.7 | 118 |
| | Required power supply capacity [7] [kVA] | | 1.1 | 2.0 | 3.1 | 5.0 | 7.1 | 9.5 | 15 | 19 | 24 | 29 | 38 | 46 | 55 | 69 |
| Braking | Torque [8] [%] | | 20 | | | | | | | | | | 10 to 15 | | | |
| | DC injection braking | | Starting frequency: 0.0 to 60.0Hz, Braking time: 0.0 to 30.0s, Braking level: 0 to 60% | | | | | | | | | | | | | |
| DC reactor (DCR) | | | Option | | | | | | | | | | | | | |
| Applicable safety standards | | | UL508C, C22.2 No.14, EN50178:1997 | | | | | | | | | | | | | |
| Enclosure (IEC60529) | | | IP20 / UL open type | | | | | | | | | | IP00 / UL open type | | | |
| Cooling method | | | Natural cooling | Fan cooling | | | | | | | | | | | | |
| Mass [lbs(kg)] | | | 6.8 (3.1) | 7.1 (3.2) | 7.3 (3.3) | 7.5 (3.4) | 7.5 (3.4) | 13 (6.0) | 13 (6.0) | 15 (6.9) | 22 (9.9) | 22 (9.9) | 25 (11.5) | 51 (23) | 53 (24) | 73 (33) |

Note:

[1]　Standard 4-pole motor

[2]　Rated capacity is calculated by assuming the output rated voltage as 460V for three-phase 460V input.

[3]　Output voltage cannot exceed the power supply voltage.

[4]　An excessively low setting of the carrier frequency may result in the higher motor temperature or tripping of the inverter by its overcurrent limiter setting. Lower the continuous load or maximum load instead. (When setting the carrier frequency (F26) to 1kHz, reduce the load to 80% of its rating.)

[5]　Use [R1,T1] terminals for driving AC cooling fans of an inverter powered by the DC link bus, such as by a high power factor PWM converter. (In ordinary operation, the terminals are not used.)

[6]　Calculated under Fuji-specified conditions.

[7]　Obtained when a DC reactor (DCR) is used.

[8]　Average braking torque (Varies with the efficiency of the motor.)

[9]　Voltage unbalance = $\dfrac{\text{Max. voltage [V]} - \text{Min. voltage [V]}}{\text{Three - phase average voltage [V]}} \times 67$ (IEC61800 3(5.2.3))

If this value is 2 to 3%, use an AC reactor (ACR).

■ 100 to 900HP

| Item | | | Specifications | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type (FRN□□□F1S-4DY) | | | 100 | 125 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 700 | 800 | 900 |
| Output ratings for three phase input | Nominal applied motor for three phase input *1 [HP] | | 100 | 125 | 150 | 200 | 250 | 300 | 350 | 400 | 450 | 500 | 600 | 700 | 800 | 900 |
| | Rated capacity *2 [kVA] | | 110 | 133 | 161 | 191 | 240 | 286 | 330 | 380 | 414 | 517 | 589 | 669 | 764 | 828 |
| | Rated voltage *3 [V] | | Three-phase, 380V to 480V (With AVR function) | | | | | | | | | | | | | |
| | Rated current *4 [A] | | 139 | 168 | 203 | 240 | 302 | 360 | 415 | 477 | 520 | 650 | 740 | 840 | 960 | 1040 |
| | Overload capability | | 120% of rated current for 1min | | | | | | | | | | | | | |
| | Rated frequency | | 50, 60Hz | | | | | | | | | | | | | |
| Input ratings for three phase input | Main power supply | | Three-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | | | | | | | | | | | |
| | Auxiliary control power input | | Single-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | | | | | | | | | | | |
| | Auxiliary fan power input *5 | | Single-phase, 380 to 440V / 50Hz, 380 to 480V / 60Hz | | | | | | | | | | | | | |
| | Voltage/frequency variations | | Voltage: +10 to -15% (Voltage unbalance: 2% or less) *9, Frequency: +5 to -5% | | | | | | | | | | | | | |
| | Rated current *6 [A] | with DCR | 113 | 140 | 169 | 222 | 275 | 330 | 382 | 440 | 495 | 545 | 652 | 756 | 869 | 981 |
| | | without DCR | − | − | − | − | − | − | − | − | − | − | − | − | − | − |
| | Required power supply capacity *7 [kVA] | | 91 | 112 | 135 | 177 | 220 | 263 | 305 | 351 | 395 | 435 | 520 | 603 | 693 | 782 |
| Braking | Torque *8 [%] | | 10 to 15 | | | | | | | | | | | | | |
| | DC injection braking | | Starting frequency: 0.0 to 60.0Hz, Braking time: 0.0 to 30.0s, Braking level: 0 to 60% | | | | | | | | | | | | | |
| DC reactor (DCR) | | | Standard (External) | | | | | | | | | | | | | |
| Applicable safety standards | | | UL508C, C22.2 No.14, EN50178:1997 | | | | | | UL508C, C22.2 No.14 | | | | | | | |
| Enclosure (IEC60529) | | | IP00 / UL open type | | | | | | | | | | | | | |
| Cooling method | | | Fan cooling | | | | | | | | | | | | | |
| Mass [lbs(kg)] | | | 75 (34) | 93 (42) | 99 (45) | 139 (63) | 212 (96) | 212 (96) | 216 (98) | 357 (162) | 357 (162) | 529 (240) | 529 (240) | 783 (355) | 794 (360) | 794 (360) |

Note:

*1  Standard 4-pole motor

*2  Rated capacity is calculated by assuming the output rated voltage as 460V for three-phase 460V input.

*3  Output voltage cannot exceed the power supply voltage.

*4  An excessively low setting of the carrier frequency may result in the higher motor temperature or tripping of the inverter by its overcurrent limiter setting. Lower the continuous load or maximum load instead. (When setting the carrier frequency (F26) to 1kHz, reduce the load to 80% of its rating.)

*5  Use [R1,T1] terminals for driving AC cooling fans of an inverter powered by the DC link bus, such as by a high power factor PWM converter. (In ordinary operation, the terminals are not used.)

*6  Calculated under Fuji-specified conditions.

*7  Obtained when a DC reactor (DCR) is used.

*8  Average braking torque (Varies with the efficiency of the motor.)

*9  Voltage unbalance = $\dfrac{\text{Max. voltage [V]} - \text{Min. voltage [V]}}{\text{Three - phase average voltage [V]}} \times 67$ (IEC61800 3(5.2.3))

If this value is 2 to 3%, use an AC reactor (ACR).

## 8.2 Specifications of Keypad Related

### 8.2.1 General specifications of keypad

Table 8.1 General Specifications

| Items | Specification | Remarks |
|---|---|---|
| Protective structure | Front side: IP40, Back (mounting) side: IP20 | |
| Site to be installed | In door | |
| Ambient temperature | -10 to 50°C (14 to 122°F) | |
| Ambient humidity | 5 to 95% RH, no condensation allowed | |
| Ambient air | No corrosive gas, no inflammable gas, no dust, and no direct sunlight allowed | |
| Altitude | 3300ft (1000m) or less | (Note) |
| Air pressure | 86 to 106 kPa | |
| Vibration | 3 mm (maximum amplitude):  Within 2 to 9 Hz<br>9.8 m/s$^2$:  Within 9 to 20 Hz<br>2 m/s$^2$:  Within 20 to 55 Hz<br>1 m/s$^2$:  Within 55 to 200 Hz | |
| Storage ambient temperature | -25 to 70°C (-13 to 158°F) | |
| Storage ambient humidity | 5 to 95% RH (no condensation allowed) | |
| External dimension | Refer to Section 8.5.3 "Keypad" | |
| Weight | 0.12 lbs(55g) | |

(Note) When using an inverter in a place of an altitude within 3300ft(1000 m) to 9800ft(3000 m), you need to lower the output current of the inverter. For details, refer to Chapter 2, Section 2.1 "Operating Environment."

### 8.2.2 Communications specifications of keypad

Table 8.2 Hardware specifications

| Items | Specification | Remarks |
|---|---|---|
| No. of linkable unit | One-to-one connection with an inverter | For a remote site operation. |
| Link cable | US ANSI TIA/EIA-568A category 5 compliant straight type cable (10BASE-T/100BASE-TX straight type) | Extension cable for the remote site operation |
| Maximum cable length | 65.6ft(20m) | |
| Connector | Standard RJ-45 connector/jack | Refer to Table 8.3 |

Table 8.3 Pin Assignment of RJ-45 Connector

| Pin number | Signal | Description | Remarks |
|---|---|---|---|
| 1 and 8 | Vcc | Power supply lines for keypad | 5 VDC |
| 2 and 7 | GND | Grounding lines | 0 V to the ground |
| 3 and 6 | NC | Reserved | |
| 4 | DX- | RS-485 communications data line (-) | |
| 5 | DX+ | RS-485 communications data line (+) | |

### 8.2.3 Data transmission specifications

Table 8.4  Data Transmission Specification

| Items | Specification | Remarks |
|---|---|---|
| Station address | No need to specify. | To use any keypad, no setup is needed for RS-485 communications related function codes y01 to y10 because their data is ignored. |
| Communications protocol | Modbus-RTU | |
| Synchronization system | Asynchronous start-stop system | |
| Communications system | Half-duplex | |
| Transmission speed | 19,200 bps | |
| Parity | Even | |
| Stop bits | 1 bit | |
| Error checking | CRC-16 | |

## 8.3   Common Specifications

| | Item | Explanation | Remarks |
|---|---|---|---|
| Output frequency — Setting range | Maximum frequency | 25 to 120 Hz | |
| | Base frequency | 25 to 120 Hz | |
| | Starting frequency | 0.1 to 60.0 Hz | |
| | Carrier frequency | • 0.75 to 15 kHz (1 to 25HP for 208V and 1 to 30HP for 460V)<br>• 0.75 to 10 kHz (30HP to 100HP for 208V and 40HP to 100HP for 460V)<br>• 0.75 to 6 kHz (125HP for 208V and 125 to 900HP for 460V) | The carrier frequency may drop automatically according to the ambient temperature or output current to protect the inverter. This protective operation can be canceled by function code H98. |
| | Accuracy (Stability) | • Analog setting: ±0.2% of maximum frequency (at 25±10°C(77±50°F))<br>• Keypad setting: ±0.01% of maximum frequency (at -10 to +50°C(14 to 122°F)) | |
| | Setting resolution | • Analog setting: 1/1000 of maximum frequency (ex. 0.06 Hz at 60 Hz, 0.12 Hz at 120 Hz)<br>• Keypad setting: 0.01 Hz (99.99 Hz or less), 0.1 Hz (100.0 Hz or more)<br>• Link setting: Selectable from 2 types-<br>  • 1/20000 of maximum frequency (ex. 0.003 Hz at 60 Hz, 0.006 Hz at 120 Hz)<br>  • 0.01 Hz (fixed) | Setting with ⌃/⌄ key. |
| Control | Control method | V/f control | |
| | Voltage/freq. characteristic (Non-linear V/f setting) | Possible to set output voltage at base frequency and at maximum output frequency (common spec.).    AVR control can be turned ON or OFF. | Three-phase 208 V: 80 to 240 V Three-phase 460 V: 160 to 500 V |
| | | 1 point (Arbitrary voltage and frequency can be set.) | Three-phase 208 V: 0 to 240 V/0 to 120 Hz Three-phase 460 V: 0 to 500 V/0 to 120 Hz |
| | Torque boost | Torque boost can be set with the function code F09. | Set when 0, 1, 3, or 4 is selected at F37. |
| | (Load selection) | Select application load type with the function code F37.<br>0: Variable torque load    1: Variable torque load (for high starting torque)    2: Auto-torque boost<br>3: Auto-energy-saving operation (variable torque load in acceleration/deceleration)<br>4: Auto-energy-saving operation (variable torque load (for high starting torque) for acceleration/deceleration)<br>5: Auto-energy-saving operation (auto-torque boost in acceleration/deceleration) | |
| | Starting torque | 50% or over | |
| | Start/stop | Keypad operation: Start and stop with ⒡ⓌⓄ or ⒭ⓔⓥ, and ⓢⓣⓞⓟ keys | |
| | | External signals (7 digital inputs): Forward (reverse) rotation, stop command (capable of 3-wire operation), second operation command, coast-to-stop command, external alarm, alarm reset, etc. | |
| | | Link operation: Operation through RS-485 communication and Field Bus communication (option) | |
| | | Operation command switch: Remote/local switch, link switch, second operation command switch | |
| | Frequency command source | Keypad operation: Can be set with ⌃/⌄ key. | |
| | | External potentiometer (1 to 5 kΩ, 1/2 W): Prepared by users | Connected to analog input terminals [13], [12], [11]. |
| | | Analog input: Can be set with external voltage/current input.<br>0 to 10 VDC (0 to 5 VDC) /0 to 100% (terminal [12], [V2])<br>4 to 20mA DC/0 to 100% (terminal [C1]) | E.g.: 0 to 5 VDC/1 to 5 VDC is applicable with bias/ gain for analog input. |
| | | Multistep frequency: Selectable from 16 steps (step 0 to15) | |
| | | UP/DOWN operation: The frequency rises or lowers while the digital input signal is turned on. | |
| | | Link operation: Can be set with RS-485 communications and field bus communications (option). | |
| | | Frequency setting change: Two types of frequency settings can be switched with an external signal (digital input). Changeover between remote and local (keypad operation) or frequency setup through communication is also possible. | |
| | | Auxiliary frequency setting: Inputs at terminal [12], [C1] or [V2] can be added to the main setting as auxiliary frequency settings. | |
| | | Inverse operation: The digital input signal and function code setting sets or switches between the normal and inverse operations.<br>• 10 to 0 VDC/0 to 100% (Terminal [12], [V2])    • 20 to 4 mA DC/0 to 100% (Terminal [C1]) | |
| | Acceleration/ deceleration time | 0.00 to 3600 s<br>• Acceleration and deceleration pattern can be selected from 4 types: Linear, S-curve (weak), S-curve (strong), Curve (constant output max. capacity).<br>• Shutoff of the operation command coasts the motor to decelerate and stop. | |

| | Item | Explanation | Remarks |
|---|---|---|---|
| Control | Frequency limiter | High and low limiters can be set (setting range: 0 to 120 Hz) | Selection can be made between continuation of operation and stopping at frequencies equal to or smaller than the lower limit. |
| | Bias frequency | Bias of frequency and PID commands can be set in the range between 0 and ±100%. | |
| | Gain for frequency setting | The analog input gain can be set in the range from 0 to 200%. | Voltage signals (terminal [12], [V2]) and current signal (terminal [C1]) can be set independently. |
| | Jump frequency setting | 3 operation points and their common jump hysteresis width (0 to 30 Hz) can be set. | |
| | Restart after momentary power failure | • The inverter restarts upon recovery from power failure without stopping the motor.<br>• In the "operation continuation mode," recovery of the power supply is waited for while the output frequency slightly drops.<br>• Selection can be made among starting at 0 Hz, starting at the frequency immediately before the momentary power failure, and starting at the frequency specified in the starting mode after power recovery. | |
| | Current limit | Keeps the current under the preset value during operation. | |
| | Line/inverter switching | • Line/inverter switching (starting at line frequency) can be made with a digital input signal (SW50, SW60).<br>• A built-in line/inverter switching sequence performs sequence control with a digital input signal (ISW50, ISW60) to output a signal (SW88, SW52-1, SW52-2) for controlling an external magnetic contactor (MC). As a built-in sequence, two types can be selected, including the one switching automatically to the line upon an inverter alarm. | |
| | PID control | Capable of PID regulator control for process | |
| | | Process commands<br>• Key operation (UP and DOWN keys): 0 to 100%<br>• Analog input (terminal [12], [V2 ]): 0 to 10 VDC/0 to 100%<br>• Analog input (terminal [C1]): 4 to 20 mA DC/0 to 100%<br>• UP/DOWN (digital input): 0 to 100%<br>• Communication (RS-485, Bus option): 0 to 20,000/0 to 100% | |
| | | Feedback value<br>• Analog input (terminal [12 ], [V2]): 0 to 10 VDC/0 to 100%<br>• Analog input (terminal [C1]): 4 to 20 mA DC/0 to 100% | |
| | | Accessory functions<br>• Alarm output (absolute value alarm, deviation alarm)   • Normal operation/inverse operation<br>• Sleep function   • Anti reset windup function<br>• PID output limiter   • Integration reset/hold | |
| | Auto search for idling motor's speed | Starting at the preset frequency, the inverter automatically searches the idling motor speed to be harmonized and starts to drive it without stopping it. | |
| | Automatic deceleration | Upon a DC link bus voltage exceeding the overvoltage limit level during deceleration, the deceleration time automatically extends to avoid an $OU$ trip. | |
| | Deceleration characteristic | The motor loss increases during deceleration to reduce the load energy regenerating at the inverter to avoid an $OU$ trip upon mode selection. | |
| | Automatic energy-saving operation | The output voltage is controlled to minimize the total sum of the motor loss and inverter loss at a constant speed. | |
| | Overload protection control | The output frequency is automatically reduced to suppress the overload protection trip of the inverter caused by an increase in the ambient temperature or motor load, or by other operating conditions. | |
| | Auto-tuning | The motor parameters are automatically tuned. | |
| | Cooling fan ON/OFF control | Detects inverter internal temperature and stops cooling fan when the temperature is low. | An external output can be issued in a transistor or relay output signal. |
| | Pump control | An inverter controls multiple driving pumps at a time combining with driving sources of the inverter and commercial power. The inverter's integrated PID controller controls them in the flowrate, pressure and so on. The inverter controls each member of pump control sequences issuing the power source switching signal between the power output and commercial power, Two control modes are available. One is a fixed motor-driving mode where the inverter exclusively controls the single pump. Another is a cyclic motor-driving mode where the inverter cyclically controls a member of pumps.<br>• Fixed motor-driving mode: Pumps under control = one inverter driven + four commercial power driven<br>• Cyclic motor-driving mode: Pumps under control = three inverter/commercial power driven (In this mode, a relay output card option (OPC-F1S-RY) is required.)<br>Furthermore, this control features a constantly periodic switching function, an average time drive-switching function, a cumulative pump run time monitor, a cumulative relay activating times monitor and so on. | |
| Indication | Running/stopping | • Speed monitor, output current (A), output voltage (V), torque calculation value, input power (kW), PID reference value, PID feedback value, PID output, load factor, motor output<br>• Select the speed monitor to be displayed from the following.<br>  Output frequency (Hz), motor speed (r/min), load shaft speed (r/min), % indication | |
| | Lifetime early warning | Shows the lifetime early warnings of the electrolytic capacitors on the printed circuit boards, the DC link bus capacitor, and the cooling fan. | An external output can be issued in a transistor or relay output signal. |
| | Cumulative run time | Shows the cumulative running hours of the motor and inverter, and the input watt-hour. | |

| Item | | Explanation | Remarks |
|---|---|---|---|
| Indication | Output | Transistor outputs - quantity 3<br>Relay outputs - quantity 1 form C and quantity 1 form A<br>Voltage output - 0 - 10 Vdc<br>Current output - 4-20 mA | |
| | Trip error code | Displays the cause of trip by codes.<br>• $OC1$ (Overcurrent during acceleration) • $OC2$ (Overcurrent during deceleration)<br>• $OC3$ (Overcurrent during running at constant speed) • $EF$ (Grounding fault)<br>• $Lin$ (Input phase loss) • $LU$ (Undervoltage)<br>• $OPL$ (Output phase loss) • $OU1$ (Overvoltage during acceleration)<br>• $OU2$ (Overvoltage during deceleration) • $OU3$ (Overvoltage during running at constant speed)<br>• $OH1$ (Overheating of the heat sink) • $OH2$ (External alarm)<br>• $OH3$ (Inverter overheat) • $OH4$ (Motor protection (PTC thermistor))<br>• $OL1$ (Motor overload) • $OLU$ (Inverter overload)<br>• $FUS$ (Blown fuse) • $PbF$ (Charging circuit fault)<br>• $Er1$ (Memory error) • $Er2$ (Keypad communication error)<br>• $Er3$ (CPU error) • $Er4$ (Optional communication error)<br>• $Er5$ (Option error) • $Er6$ (Operation action error)<br>• $Er7$ (Tuning error) • $Er8$ (RS-485 communication error(RJ-45))<br>• $ErF$ (Data save error due to undervoltage) • $ErP$ (RS-485 communication error(Terminal))<br>• $ErH$ (LSI error) | |
| | Trip history | Saves and displays the last 4 trip error codes and their detailed description. | |
| Protection | | Refer to Section 8.6 "Protective Functions." | |
| Environment | | Refer to Chapter 1, Section 1.4 "Storage Environment" and Chapter 2, Section 2.1 "Operating Environment." | |

## 8.4  Terminal Specifications

### 8.4.1  Terminal functions

For details about the main and control circuit terminals, refer to Chapter 2, Section 2.3.6 and Section 2.3.7 (Table 2.10), respectively.

## 8.4.2 Running the inverter with keypad



(Note 1) When connecting a DC reactor (DCR), first remove the short bar between terminals [P1] and [P+]. A DCR is optional for inverters below 75HP for 208V, 100HP for 460V but standard for inverters of 75HP for 208V, 100HP for 460V or above. For inverters of 75HP for 208V, 100HP for 460V or above, be sure to connect a DCR.

(Note 2) To protect wiring, insert a molded case circuit breaker (MCCB) or a ground fault circuit interrupter (GFCI) (with overcurrent protection) of the type recommended for the inverter between the commercial power supply and the inverter. Do not use a circuit breaker with a capacity exceeding the recommended capacity.

(Note 3) In addition to an MCCB or GFCI, insert, if necessary, a magnetic contactor (MC) of the type recommended for the inverter to cut off the commercial power supply to the inverter. Furthermore, if the coil of the MC or solenoid comes into close contact with the inverter, install a surge absorber in parallel.

(Note 4) To put the inverter on standby by making the control circuit only active with the main circuit power supply being opened, connect this pair of wires to terminals [R0] and [T0]. Without connecting this pair of wires to these terminals, you can still run the inverter as long as the main wires of the commercial power supply to the main circuit are properly connected.

(Note 5) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power factor PWM converter with a regenerative facility.

DCR (Note 1)

(Note 2) MCCB or GFCI  (Note 3) MC

Power supply Refer to "8.1 Standard Models" for details.

Aux. power input for control circuits (Note 4)

Aux. power input for AC fans

(Note 6)

Analog inputs

Power supply for potentiometer

Voltage input for setting 0 to 10 VDC

Voltage input for setting 0 to 10 VDC

Current input for setting 4 to 20 mA DC

Analog meter

DCR  : DC Reactor
GFCI : Ground Fault Circuit Interrupter
MC   : Magnetic Contactor
MCCB : Molded Case Circuit Breaker

Digital inputs

(Note 7)

Main circuit

Motor

Grounding terminal

Control circuit

Alarm relay output (for any fault)

Relay output

RS-485 Communication

Transistor outputs

(Note 1)   When connecting a DC reactor (DCR), first remove the short bar between terminals [P1] and [P+]. A DCR is optional for inverters below 75HP for 208V, 100HP for 460V but standard for inverters of 75HP for 208V, 100HP for 460V or above. For inverters of 75HP for 208V, 100HP for 460V or above, be sure to connect a DCR.

(Note 2)   To protect wiring, insert a molded case circuit breaker (MCCB) or a ground fault circuit interrupter (GFCI) (with overcurrent protection) of the type recommended for the inverter between the commercial power supply and the inverter. Do not use a circuit breaker with a capacity exceeding the recommended capacity.

(Note 3)   In addition to an MCCB or GFCI, insert, if necessary, a magnetic contactor (MC) of the type recommended for the inverter to cut off the commercial power supply to the inverter. Furthermore, if the coil of the MC or solenoid comes into close contact with the inverter, install a surge absorber in parallel.

(Note 4)   To put the inverter on standby by making the control circuit only active with the main circuit power supply being opened, connect this pair of wires to terminals [R0] and [T0]. Without connecting this pair of wires to these terminals, you can still run the inverter as long as the main wires of the commercial power supply to the main circuit are properly connected.

(Note 5) Normally no need to be connected. Use these terminals when the inverter is equipped with a high power factor PWM converter with a regenerative facility.

(Note 6) You can select the frequency command source either electronically by supplying a DC voltage signal (within the range of 0 to 10 V, 0 to 5 V, or 1 to 5 V) between terminals [12] and [11], or manually by connecting a frequency command potentiometer to terminals [13], [12], and [11].

(Note 7) For the wiring of the control circuit, use shielded or twisted wires. When using shielded wires, connect the shields to earth. To prevent malfunction due to noise, keep the control circuit wires as far away as possible from the main circuit wires (recommended distance: 4inch (10 cm) or longer), and never put them in the same wire duct. Where a control circuit wire needs to cross a main circuit wire, route them so that they meet at right angles.

## 8.5 External Dimensions

### 8.5.1 Standard models

Unit: inch (mm)
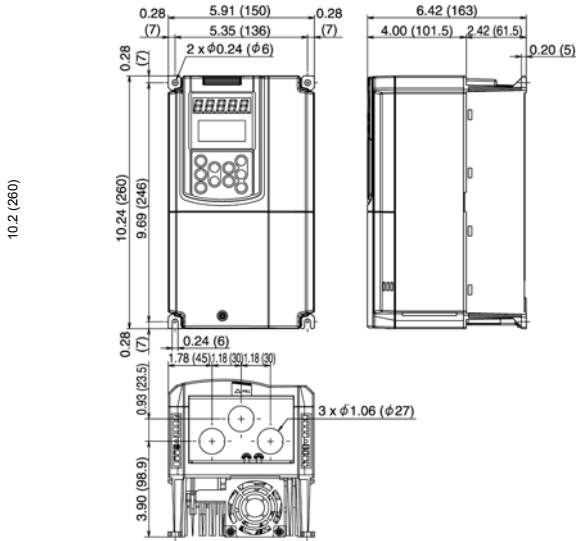


| Power supply voltage | Type |
|---|---|
| Three-phase 208V | FRN001F1S-2DY |
| | FRN002F1S-2DY |
| | FRN003F1S-2DY |
| | FRN005F1S-2DY |
| Three-phase 460V | FRN001F1S-4DY |
| | FRN002F1S-4DY |
| | FRN003F1S-4DY |
| | FRN005F1S-4DY |
| | FRN007F1S-4DY |

| Power supply voltage | Type | Dimensions [inch(mm)] | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | W1 | W2 | W3 | W4 | H | H1 | H2 | H3 | D | D1 | D2 | φA | φB |
| Three-phase 208 V | FRN007F1S-2DY | 8.66 (220) | 7.72 (196) | 2.50 (63.5) | 1.83 (46.5) | 1.83 (46.5) | 10.2 (260) | 9.37 (238) | 5.58 (141.7) | 0.63 (16) | 8.46 (215) | 4.67 (118.5) | 3.80 (96.5) | 1.10 (28) | 1.38 (35) |
| | FRN010F1S-2DY | | | | | | | | | | | | | | |
| | FRN015F1S-2DY | | | | | | | | 5.38 (136.7) | 0.83 (21) | | | | 1.34 (34) | 1.65 (42) |
| | FRN020F1S-2DY | 9.84 (250) | 8.90 (226) | 2.64 (67) | 2.28 (58) | 2.28 (58) | 15.7 (400) | 14.9 (378) | 6.54 (166.2) | 0.08 (2) | | 3.35 (85) | 5.12 (130) | 1.38 (35) | 1.34 (44) |
| | FRN025F1S-2DY | | | | | | | | | | | | | | |
| | FRN030F1S-2DY | | | — | — | — | | | — | — | | | | — | — |
| Three-phase 460 V | FRN010F1S-4DY | 8.66 (220) | 7.72 (196) | 2.50 (63.5) | 1.83 (46.5) | 1.83 (46.5) | 10.2 (260) | 9.37 (238) | 5.58 (141.7) | 0.63 (16) | 8.46 (215) | 4.67 (118.5) | 3.80 (96.5) | 1.10 (28) | 1.38 (35) |
| | FRN015F1S-4DY | | | | | | | | 5.38 (136.7) | 0.83 (21) | | | | 1.34 (34) | 1.65 (42) |
| | FRN020F1S-4DY | | | | | | | | | | | | | | |
| | FRN025F1S-4DY | 9.84 (250) | 8.90 (226) | 2.64 (67) | 2.28 (58) | 2.28 (58) | 15.7 (400) | 14.9 (378) | 6.54 (166.2) | 0.08 (2) | | 3.35 (85) | 5.12 (130) | 1.38 (35) | 1.34 (44) |
| | FRN030F1S-4DY | | | | | | | | | | | | | | |
| | FRN040F1S-4DY | | | — | — | — | | | — | — | | | | — | — |

| Power supply voltage | Type | Dimensions [inch(mm)] | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | W | W1 | H | H1 | D | D1 | D2 | D3 | M | N |
| Three-phase 208 V | FRN040F1S-2DY | 12.6 (320) | 9.45 (240) | 21.7 (550) | 20.9 (530) | 10.0 (255) |  | 5.51 (140) |  |  |  |
| | FRN050F1S-2DY | 14.0 (355) | 10.8 (275) | 24.2 (615) | 23.4 (595) | 10.6 (270) | 4.53 (115) | 6.10 (155) | 0.18 (4.5) | 2xφ0.39 (2xφ10) | 0.39 (10) |
| | FRN060F1S-2DY |  |  |  |  |  |  |  |  |  |  |
| | FRN075F1S-2DY |  |  | 29.1 (740) | 28.3 (720) |  |  |  |  |  |  |
| | FRN100F1S-2DY |  |  |  |  |  |  |  |  |  |  |
| | FRN125F1S-2DY | 26.8 (680) | 22.8 (580) | 34.6 (880) | 33.5 (850) | 15.6 (395) | 10.0 (255) | 5.51 (140) | 0.24 (6) | 3xφ0.59 (3xφ15) | 0.59 (15) |
| Three-phase 460 V | FRN050F1S-4DY | 12.6 (320) | 9.45 (240) | 21.7 (550) | 20.9 (530) | 10.0 (255) |  | 5.51 (140) |  |  |  |
| | FRN060F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN075F1S-4DY | 14.0 (355) | 10.8 (275) |  |  |  | 4.53 (115) |  | 0.18 (4.5) | 2xφ0.39 (2xφ10) | 0.39 (10) |
| | FRN100F1S-4DY |  |  | 24.2 (615) | 23.4 (595) | 10.6 (270) |  | 6.10 (155) |  |  |  |
| | FRN125F1S-4DY |  |  | 29.1 (740) | 28.3 (720) | 11.8 (300) | 5.71 (145) | 6.10 (155) |  |  |  |
| | FRN150F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN200F1S-4DY | 20.9 (530) | 16.9 (430) | 29.1 (740) | 28.0 (710) | 12.4 (315) | 5.31 (135) | 7.09 (180) | 0.24 (6) | 2xφ0.39 (2xφ10) | 0.39 (10) |
| | FRN250F1S-4DY |  |  | 39.4 (1000) | 38.2 (970) | 14.2 (360) | 7.09 (180) | 7.09 (180) |  |  |  |
| | FRN300F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN350F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN400F1S-4DY | 26.8 (680) | 22.8 (580) | 39.4 (1000) | 38.2 (970) | 15.0 (380) | 7.87 (200) | 7.09 (180) | 0.24 (6) | 3xφ0.59 (3xφ15) | 0.59 (15) |
| | FRN450F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN500F1S-4DY |  |  | 55.1 (1400) | 53.9 (1370) | 17.3 (440) | 10.2 (260) |  |  |  |  |
| | FRN600F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN700F1S-4DY | 34.6 (880) | 30.7 (780) |  |  |  |  |  |  | 4xφ0.59 (4xφ15) |  |
| | FRN800F1S-4DY |  |  |  |  |  |  |  |  |  |  |
| | FRN900F1S-4DY |  |  |  |  |  |  |  |  |  |  |

## 8.5.2  DC reactor
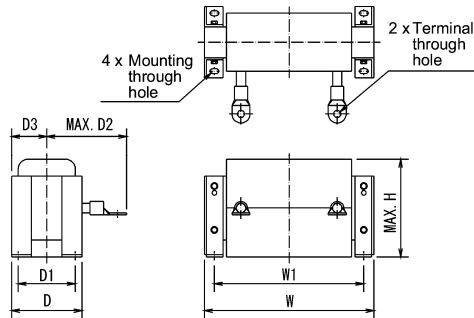


| Power supply voltage | Inverter type | Reactor | Dimension [inch (mm)] | | | | | | | | Mounting through hole for: | Terminal through hole for: | Mass [lbs(kg)] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | W | W1 | D | D1 | D2 | D3 | H | | | |
| Three-phase 208 V | FRN075F1S-2DY FRN100F1S-2DY | DCR2-75C | 10.0 ± 0.39 (255 ± 10) | 8.86 (225) | 4.17 ± 0.08 (106 ± 2) | 3.39 (86) | 5.71 (145) | 2.09 ± 0.04 (53 ± 1) | 5.71 (145) | M6 | M12 | 25 (11.4) |
| | FRN125F1S-2DY | DCR2-110C | 11.8±0.39 (300±10) | 10.4 (265) | 4.57±0.16 (116±4) | 3.54 (90) | 7.28 (185) | 2.28±0.08 (58±2) | 6.30 (160) | M8 | M12 | 37.5 (17.0) |
| Three-phase 460 V | FRN100F1S-4DY | DCR4-75C | 10.0 ± 0.39 (255 ± 10) | 8.86 (225) | 4.17 ± 0.08 (106 ± 2) | 3.39 (86) | 4.92 (125) | 2.09 ± 0.04 (53 ± 1) | 5.71 (145) | M6 | M10 | 27 (12.4) |
| | FRN125F1S-4DY | DCR4-90C | 10.0 ± 0.39 (255 ± 10) | 8.86 (225) | 4.57 ± 0.08 (116±2) | 3.78 (96) | 5.51 (140) | 2.28 ± 0.04 (58 ± 1) | 5.71 (145) | M6 | M12 | 32 (14.7) |
| | FRN150F1S-4DY | DCR4-110C | 11.8 ± 0.39 (300 ± 10) | 10.4 (265) | 4.57 ± 0.08 (116 ± 2) | 3.54 (90) | 6.89 (175) | 2.28 ± 0.04 (58 ± 1) | 6.10 (155) | M8 | M12 | 41 (18.4) |
| | FRN200F1S-4DY | DCR4-132C | 11.8 ± 0.39 (300 ± 10) | 10.4 (265) | 4.96 ± 0.16 (126 ± 4) | 3.94 (100) | 7.09 (180) | 2.48 ± 0.08 (63 ± 2) | 6.30 (160) | M8 | M12 | 49 (22.0) |
| | FRN250F1S-4DY FRN300F1S-4DY | DCR4-200C | 13.8 ± 0.39 (350 ± 10) | 12.2 (310) | 5.55 ± 0.16 (141 ± 4) | 4.45 (113) | 7.28 (185) | 2.78 ± 0.08 (70.5 ± 2) | 7.48 (190) | M10 | M12 | 65 (29.5) |
| | FRN350F1S-4DY | DCR4-220C | 13.8 ± 0.39 (350 ± 10) | 12.2 (310) | 5.75 ± 0.16 (146 ± 4) | 4.65 (118) | 7.87 (200) | 2.87 ± 0.08 (73 ± 2) | 7.48 190 | M10 | M12 | 72 (32.5) |
| | FRN400F1S-4DY FRN450F1S-4DY | DCR4-280C | 13.8±0.39 (350±10) | 12.2 (310) | 6.34±0.16 (161±4) | 5.24 (133) | 8.27 (210) | 3.17±0.08 (80.5±2) | 7.48 (190) | M10 | M16 | 81.6 (37.0) |
| | FRN500F1S-4DY | DCR4-355C | 15.8±0.39 (400±10) | 13.6 (345) | 6.14±0.16 (156±4) | 5.04 (128) | 7.87 (200) | 3.07±0.08 (78±2) | 8.86 (225) | M10 | φ15 | 107 (48.5) |
| | FRN600F1S-4DY | DCR4-400C | 17.5±0.39 (445±10) | 15.2 (385) | 5.71±0.16 (145±4) | 4.61 (117) | 8.39 (213) | 2.85±0.08 (72.5±2) | 9.65 (245) | M10 | φ15 | 115 (52.0) |
| | FRN700F1S-4DY | DCR4-450C | 17.3±0.39 (440±10) | 15.2 (385) | 5.91±0.16 (150±4) | 4.80 (122) | 8.46 (215) | 2.95±0.08 (75±2) | 9.65 (245) | M10 | φ15 | 136 (61.5) |
| | FRN800F1S-4DY | DCR4-500C | 17.5±0.20 (445±5) | 15.4 (390) | 6.50±0.16 (165±4) | 5.39 (137) | 8.66 (220) | 3.25±0.08 (82.5±2) | 9.65 (245) | M10 | φ15 | 158 (71.5) |
| | FRN900F1S-4DY | DCR4-560C | 10.6 (270) | 5.71 (145) | 7.99 (203) | 6.69 (170) | 7.87 (200) | 3.58 (91) | 18.9 (480) | φ14 | φ15 | 154 (70.0) |

### 8.5.3 Keypad

Unit: inch(mm)



3.15(80)

5.06(128.5)

0.72
(18.2)

0.58
(14.615)

0.59
(15.08)

A

Inside
panel

0.37
(9.5)

2.42(61.5)

2xM3

0.54(13.775)

0.41(10.5)

0.32(8.17)

4.12(104.6)

TP-G1 W·DY

Backside view

0.67(16.98)

0.45
(11.4)

0.46
(11.68)

0.6
(15.24)

2.12(53.8)

0.32(8.1)

0.41(10.5)

0.05(1.2)

0.16(4)

0.37(9.5)

0.91(23) 1.40(35.5)

Panel cut part

0.54(13.6)

0.35(9)

0.91
(23)

1.03
(26.1)

5.06(128.5)

4.14(105.1)

4.18(106.1)

4x∅ 0.14(∅ 3.5)

0.51(12.9)

0.35(9)

2.42(61.5)

2.44(62)

3.15(80)

0.37(9.5)

0.35(9)

0.53(13.4)

Dimensions of panel cutting
(viewed from "A")

### 8.5.4 Panel cut out

208V 3-phase

inch (mm)

FRN001F1S-2DY, FRN002F1S-2DY
FRN003F1S-2DY, FRN005F1S-2DY

6.06 (154)
5.35 (136)
0.39 (10)
6xM6ネジ
6xM6 Screw
6.85 (174)
5.59 (142)
5.59 (142)
10.4 (264)
6.54 (166)
0.39 (10)

FRN007F1S-2DY, FRN010F1S-2DY
FRN015F1S-2DY

8.74 (222)
7.72 (196)
1.54 (39)
10.8 (275)
8.39 (213)
10.8 (273)
4xM8
4xM8 Screw
0.3 (7.5)
6.85 (174)
8.43 (214)
0.83 (21)

FRN020F1S-2DY, FRN025F1S-2DY
FRN030F1S-2DY

9.92 (252)
8.9 (226)
4xM8ネジ
4xM8 Screw
16.5 (418.5)
14.1 (357)
16.4 (417)
8.07 (205)
0.31 (8)
9.57 (243)
0.75 (19)

FRN040F1S-2DY

12.3 (312)
4 x M8
9.54 (240)
0.35 (9)
20.2 (512)
20.9 (530)

208V 3-phase

inch (mm)



FRN050F1S-2DY, FRN060F1S-2DY

13.7 (347)
10.8 (275)
4 x M8
0.35 (9)
22.7 (577)
23.4 (595)



FRN075F1S-2DY, FRN100F1S-2DY

13.7 (347)
10.8 (275)
4 x M8
0.35 (9)
27.6 (702)
28.4 (720)



FRN125F1S-2DY

11.4 (290)
11.4 (290)
0.49 (12.5)
32.5 (825)
33.5 (850)
26 (660)
6 - M12

460V 3-phase

inch (mm)

FRN001F1S-4DY, FRN002F1S-4DY
FRN003F1S-4DY, FRN005F1S-4DY
FRN007F1S-4DY

6.06 (154)
5.35 (136)
0.39 (10)
6xM6ネジ
6xM6 Screw
6.85 (174)
5.59 (142)
5.59 (142)
10.4 (264)
6.54 (166)
0.39 (10)

FRN010F1S-4DY, FRN015F1S-4DY
FRN020F1S-4DY

8.74 (222)
7.72 (196)
1.54 (39)
10.8 (275)
4xM8
4xM8 Screw
8.39 (213)
10.8 (273)
0.3 (7.5)
6.85 (174)
8.43 (214)
0.83 (21)

FRN025F1S-4DY, FRN030F1S-4DY
FRN040F1S-4DY

9.92 (252)
8.9 (226)
4xM8ネジ
4xM8 Screw
16.5 (418.5)
14.1 (357)
16.4 (417)
8.07 (205)
0.31 (8)
9.57 (243)
0.75 (19)

FRN050F1S-4DY, FRN060F1S-4DY

12.3 (312)
9.54 (240)
4 x M8
0.35 (9)
20.2 (512)
20.9 (530)

460V 3-phase

inch (mm)



FRN075F1S-4DY

13.7 (347)
10.8 (275)
4 x M8
0.35 (9)
20.2 (512)
20.4 (530)

FRN100F1S-4DY

13.7 (347)
10.8 (275)
4 x M8
0.35 (9)
22.7 (577)
23.4 (595)

FRN125F1S-4DY, FRN150F1S-4DY

13.7 (347)
10.8 (275)
4 x M8
0.35 (9)
27.6 (702)
28.4 (720)

FRN200F1S-4DY

20.2 (514)
16.9 (430)
4 x M12
0.43 (11)
27.1 (688)
28 (710)

460V 3-phase

inch (mm)


FRN250F1S-4DY, FRN300F1S-4DY
FRN350F1S-4DY

20.2 (514)    4 x M12
16.9 (430)
0.43 (11)
37.3 (948)
38.2 (970)


FRN400F1S-4DY, FRN450F1S-4DY

11.4    11.4
(290)  (290)
0.43 (11)
37.3 (948)
38.2 (970)
26.1 (664)
6 x M12


FRN500F1S-4DY, FRN600F1S-4DY

11.4    11.4
(290)  (290)
0.43 (11)
53.1 (1348)
53.9 (1370)
26.1 (664)
6 x M12


FRN700F1S-4DY, FRN800F1S-4DY
FRN900F1S-4DY

10.2  10.2  10.2
(260)(260)(260)
0.43 (11)
53.1 (1348)
53.9 (1370)
34 (864)
8 x M12

## 8.6 Protective Functions

| Name | Description | | LED monitor displays | Alarm output [30A/B/C] |
|------|-------------|---|----------------------|------------------------|
| Overcurrent protection | Stops the inverter output to protect the inverter from an overcurrent resulting from overload. | During acceleration | $OC1$ | Yes |
| Short-circuit protection | Stops the inverter output to protect the inverter from overcurrent due to a short-circuiting in the output circuit. | | | |
| | | During deceleration | $OC2$ | |
| Ground fault protection | Stops the inverter output to protect the inverter from overcurrent due to a ground fault in the output circuit. This protection is effective only during startup of the inverter. If you turn ON the inverter without removing the ground fault, this protection may not work. (Applicable to inverters for 208V 100HP or below, for 460V 350HP or below.) | During running at constant speed | $OC3$ | |
| | Upon detection of zero-phase current in the output power, this function stops the inverter output to protect the inverter from overcurrent due to a ground fault in the output circuit. (Applicable to inverters for 208V 125HP, for 460V 400HP or above.) | | $EF$ | Yes |
| Overvoltage protection | The inverter stops the inverter output upon detection of an overvoltage condition (400 VDC for 3-phase 208V, 800 VDC for 3-phase 460V) in the DC link bus. This protection is not assured if extremely large AC line voltage is applied inadvertently. | During acceleration | $OU1$ | Yes |
| | | During deceleration | $OU2$ | |
| | | During running at constant speed (Stopped) | $OU3$ | |
| Undervoltage protection | Stops the inverter output when the DC link bus voltage drops below the undervoltage level (200 VDC for 3-phase 208V, 400 VDC for 3-phase 460 V). However, if data "3, 4, or 5" is selected for F14, no alarm is output even if the DC link bus voltage drops. | | $LU$ | Yes*1 |
| Input phase loss protection | Detects input phase loss, stopping the inverter output. This function prevents the inverter from undergoing heavy stress that may be caused by input phase loss or inter-phase voltage unbalance and may damage the inverter. If connected load is light or a DC reactor is connected to the inverter, this function will not detect input phase loss if any. | | $Lin$ | Yes |
| Output phase loss protection | Detects breaks in inverter output wiring at the start of running and during running, stopping the inverter output. | | $OPL$ | Yes |
| Overheat protection | - Stops the inverter output upon detecting excess heat sink temperature in case of cooling fan failure or overload. <br> - Detects a failure of the internal air circulation DC fan and alarm-stops the inverter <br> (For models of 50HP or above in 208 V, 75HP or above in 460 V) | | $OH1$ | Yes |
| | Stops the inverter output upon detecting an excessively high ambient temperature inside the inverter caused by a failure or an overload condition of the cooling fan. | | $OH3$ | Yes |
| Overload protection | Stops the inverter output if the Insulated Gate Bipolar Transistor (IGBT) internal temperature calculated from the output current and temperature of inside the inverter is over the preset value. | | $OLU$ | Yes |
| External alarm input | Places the inverter in alarm-stop state upon receiving digital input signal (THR). | | $OH2$ | Yes |

*1 This alarm on [30A/B/C] should be ignored depending upon the function code setting.

| Name | | Description | LED monitor displays | Alarm output [30A/B/C] |
|---|---|---|---|---|
| Blown fuse | | Upon detection of a fuse blown in the inverter's main circuit, this function stops the inverter output. (Applicable to 125HP or above (for both 3-phase 208 V and 3-phase 460 V)) | $FUS$ | Yes |
| Abnormal condition in charger circuit | | Upon detection of an abnormal condition in the charger circuit inside the inverter, this function stops the inverter output. (Applicable to 50HP or above (3-phase 208 V) or 75HP or above (3-phase 460 V)) | $PbF$ | Yes |
| Motor protection | Electronic thermal overload | In the following cases, the inverter stops running the motor to protect the motor in accordance with the electronic thermal overload protection setting. | $OL1$ | Yes |
| | | - Protects general-purpose motors over the entire frequency range (F10 = 1.) <br> - Protects inverter motors over the entire frequency range (F10 = 2.) <br> * The operation level and thermal time constant can be set by F11 and F12. | | |
| | PTC thermistor | A PTC thermistor input stops the inverter output for motor protection. | $OH4$ | Yes |
| | | Connect a PTC thermistor between terminals [V2] and [11] and set the function codes and slide switch on the control PCB accordingly. | | |
| | Overload early warning | Outputs a preliminary alarm at a preset level before the motor is stopped by the electronic thermal overload protection for the motor. | — | — |
| Stall prevention | | Operates when instantaneous overcurrent limiting is active. | — | — |
| | | - Instantaneous overcurrent limiting: <br> Operates if the inverter's output current exceeds the instantaneous overcurrent limit level, avoiding tripping of the inverter (during constant speed operation or during acceleration). | | |
| Alarm relay output (for any fault) | | - The inverter outputs a relay contact signal when the inverter issues an alarm and stops the inverter output. <br> < Alarm reset > <br> The alarm stop state is reset by pressing the (PRG/RESET) key or by the digital input signal (RST). <br> < Saving the alarm history and detailed data > <br> The information on the previous 4 alarms can be saved and displayed. | — | Yes |
| Memory error detection | | The inverter checks memory data after power-on and when the data is written. If a memory error is detected, the inverter stops. | $Er1$ | Yes |
| Keypad communications error detection | | The inverter stops by detecting a communications error between the inverter and the keypad during operation using the keypad. | $Er2$ | Yes |
| CPU error detection | | If the inverter detects a CPU error or LSI error caused by noise or some other factors, this function stops the inverter | $Er3$ | Yes |
| Option communications error detection | | Upon detection of an error in the communication between the inverter and an optional card, stops the inverter output. | $Er4$ | — |
| Option error detection | | When an option card has detected an error, this function stops the inverter output. | $Er5$ | — |
| Operation error detection | STOP key priority | Pressing the (STOP) key on the keypad forces the inverter to decelerate and stop the motor even if the inverter is running by any run command given via the terminals or communications link. After the motor stops, the inverter issues alarm $Er6$. | $Er6$ | Yes |

"—": Not applicable.

| Name | Description | | LED monitor displays | Alarm output [30A/B/C] |
|---|---|---|---|---|
| Operation error detection | Start check function | The inverter prohibits any run operations and displays $Er$-$6$ on the 7-segment LED monitor if any run command is present when:<br>- Powering up<br>- An alarm is released (the (PRG/RESET) key is turned ON or an alarm reset (RST) is input.)<br>- "Enable communications link (LE)" has been activated and the run command is active in the linked source. | $Er$-$6$ | Yes |
| Tuning error detection | During tuning of motor parameters, the tuning has failed or has aborted, or an abnormal condition has been detected in the tuning result, the inverter stops its output. | | $Er$-$7$ | Yes |
| RS-485 communications error | When the inverter is connected to a communications network via the RS-485 port designed for the keypad, detecting a communications error stops the inverter output and displays an error code $Er$-$8$. | | $Er$-$8$ | Yes |
| Data save error during undervoltage | If the data could not be saved during activation of the undervoltage protection function, the inverter displays the alarm code. | | $Er$-$F$ | Yes |
| RS-485 communications error | When the inverter is connected to a communications network via RS-485 communications terminal, detecting a communications error stops the inverter output and displays an error code $Er$-$P$. | | $Er$-$P$ | Yes |
| LSI error detection (Power PCB) | When an error occurred in the LSI on the power printed circuit board (power PCB), this function stops the inverter. (Applicable to: 208 V 50HP or above, and 460 V 75HP or above) | | $Er$-$H$ | Yes |
| Running over cycle alarm | This alarm occurs when the maximum number of cycles has been reached as defined by the slow flowrate | | $r$-$OC$ | Yes |
| Low current detection | This alarm occurs when the output current value calculated by the inverter decreases below the level specified by E37 for the time longer than the one specified by E38. | | $id$ | Yes |
| PID feedback wire break | The PID feedback signal wire(s) is broken. | | $CoF$ | Yes |
| PID feedback alarm | Warning related to PID control (absolute-value alarm or deviation alarm). | | $Fb1$<br>$Fb2$ | Yes |
| Excessive PID error alarm | When the PID error between the PID process command and the PID feedback value has exceeded the excessive PID error level specified during the period longer than the timer setting specified, the protective function issues this alarm. | | $PE1$<br>$PE2$ | Yes |
| Retry | When the inverter has stopped because of a trip, this function allows the inverter to automatically reset itself and restart. (You can specify the number of retries and the latency between stop and reset.) | | — | — |
| Surge protection | Protects the inverter against a surge voltage which might appear between one of the power lines for the main circuit and the ground. | | — | — |
| Command loss detected | Upon detecting a loss of a frequency command (because of a broken wire, etc.), this function issues an alarm and continues the inverter operation at the preset reference frequency (specified as a ratio to the frequency just before the detection). | | — | — |
| Protection against momentary power failure | Upon detecting a momentary power failure lasting more than 15 ms, this function stops the inverter output. | | — | — |
| | If restart after momentary power failure is selected, this function invokes a restart process when power has been restored within a predetermined period. | | | |
| Overload prevention control | In the event of overheating of the heat sink or an overload condition (alarm code: $OH1$ or $OLU$ ), the output frequency of the inverter is reduced to keep the inverter from tripping. | | — | — |

"—": Not applicable.

# Chapter 9   LIST OF PERIPHERAL EQUIPMENT AND OPTIONS

The table below lists the main peripheral equipment and options that are connected to the FRENIC-Eco. Use them in accordance with your system requirements.

📖  For details, refer to the FRENIC-Eco User's Manual, Chapter 6 "SELECTING PERIPHERAL EQUIPMENT."

| | Name of peripheral equipment | Function and application | | | | |
|---|---|---|---|---|---|---|
| Main peripheral equipment | Molded case circuit breaker (MCCB)<br><br>Residual-current-operated protective device (RCD) /Ground fault circuit interrupter (GFCI)<br><br>* with overcurrent protection | MCCBs are designed to protect the power circuits between the power control board and inverter's main terminals (L1/R, L2/S and L3/T) from overload or short-circuit which in turn prevents secondary disasters caused by the inverter malfunctioning.<br><br>RCDs/GFCIs function in the same way as MCCBs. Use the MCCBs and RCDs/GFCIs that satisfy the recommended rated current listed below. | | | | |

| Input power source (3-phase) | Applicable motor rating (HP) | Inverter type | Rated current of MCCB and GFCI (A) | |
|---|---|---|---|---|
| | | | w/ DCR | w/o DCR |
| 208 V | 1 | FRN001F1S-2DY | 10 | 10 |
| | 2 | FRN002F1S-2DY | 15 | 15 |
| | 3 | FRN003F1S-2DY | | 20 |
| | 5 | FRN005F1S-2DY | 30 | 30 |
| | 7.5 | FRN007F1S-2DY | 40 | 50 |
| | 10 | FRN010F1S-2DY | 50 | 70 |
| | 15 | FRN015F1S-2DY | 70 | 100 |
| | 20 | FRN020F1S-2DY | 100 | 125 |
| | 25 | FRN025F1S-2DY | 100 | 150 |
| | 30 | FRN030F1S-2DY | 150 | 175 |
| | 40 | FRN040F1S-2DY | 175 | 200 |
| | 50 | FRN050F1S-2DY | 200 | 225 |
| | 60 | FRN060F1S-2DY | 250 | 300 |
| | 75 | FRN075F1S-2DY | 300 | |
| | 100 | FRN100F1S-2DY | 350 | - |
| | 125 | FRN125F1S-2DY | 400 | |
| 460 V | 1 | FRN001F1S-4DY | 5 | 5 |
| | 2 | FRN002F1S-4DY | | 10 |
| | 3 | FRN003F1S-4DY | 10 | 15 |
| | 5 | FRN005F1S-4DY | | 20 |
| | 7.5 | FRN007F1S-4DY | 15 | 30 |
| | 10 | FRN010F1S-4DY | 20 | |
| | 15 | FRN015F1S-4DY | 30 | 40 |
| | 20 | FRN020F1S-4DY | 40 | 50 |
| | 25 | FRN025F1S-4DY | | 70 |
| | 30 | FRN030F1S-4DY | 50 | 80 |
| | 40 | FRN040F1S-4DY | 75 | 100 |
| | 50 | FRN050F1S-4DY | 100 | 125 |
| | 60 | FRN060F1S-4DY | | 150 |
| | 75 | FRN075F1S-4DY | 125 | |
| | 100 | FRN100F1S-4DY | 175 | |
| | 125 | FRN125F1S-4DY | 200 | |
| | 150 | FRN150F1S-4DY | 250 | |
| | 200 | FRN200F1S-4DY | 300 | |
| | 250 | FRN250F1S-4DY | 400 | |
| | 300 | FRN300F1S-4DY | 450 | |
| | 350 | FRN350F1S-4DY | 500 | - |
| | 400 | FRN400F1S-4DY | 600 | |
| | 450 | FRN450F1S-4DY | 700 | |
| | 500 | FRN500F1S-4DY | | |
| | 600 | FRN600F1S-4DY | 1000 | |
| | 700 | FRN700F1S-4DY | | |
| | 800 | FRN800F1S-4DY | 1200 | |
| | 900 | FRN900F1S-4DY | 1600 | |

Select the MCCB or RCD/GFCI with appropriate breaking capacity according to the power supply capacity.

| | Name of peripheral equipment | Function and application |
|---|---|---|
| | Molded case circuit breaker<br><br>Ground fault circuit interrupter * with overcurrent protection | <div align="center">⚠ **WARNING**</div><br>When connecting the inverter to the power supply, add a recommended molded case circuit breaker and ground fault circuit interrupter in the path of power supply. Do not use the devices with the rated current out of the recommenced range.<br><br>*With overcurrent protection<br><br>**Fire could occur.** |

Main peripheral equipment

| | Magnetic contactor (MC) | An MC can be used at both the power input (primary) and output (secondary) sides of the inverter. At each side, the MC works as described below. When inserted in the output circuit of the inverter, an MC can also switch the motor drive power source between the inverter output and commercial power lines. |
|---|---|---|

At the power source (primary) side

Insert an MC in the power source side of the inverter in order to:

1) Forcibly cut off the inverter from the power source (generally, commercial/factory power lines) with the protection function built into the inverter, or with the terminal signal line.

2) Stop the inverter operation in an emergency when the inverter cannot interpret the stop command due to internal/external circuit failures.

3) Cut off the inverter from the power source when the MCCB inserted in the power source side cannot cut it off for maintenance or inspection purpose. If you are to use the MC for this purpose only, it is recommended that you use an MC capable of turning the MC ON/OFF manually.

**Note:** When your system requires the motor(s) driven by the inverter to be started/stopped with the MC, the frequency of the starting/stopping operation should be once or less per hour. The more frequent the operation, the shorter operation life of the MC and capacitor/s used in the DC link bus due to thermal fatigue caused by the frequent charging of the current flow. If this is not necessary, start/stop the motor with the terminal commands (FWD), (REV) and/or (HLD), or with the keypad.

At the output (secondary) side

Prevent externally turned-around current from being applied to the inverter power output terminals (U, V, and W) unexpectedly. An MC should be used, for example, if a circuit that switches the motor driving source between the inverter output and commercial/factory power lines is connected to the inverter.

**Note:** As application of high voltage external current to the inverter's output side may break the IGBTs, MCs should be used in the power control system circuits to switch the motor drive power source to the commercial/factory power lines after the motor has come to a complete stop. Also ensure that voltage is never mistakenly applied to the inverter output terminals due to unexpected timer operation, or similar.

Driving the motor using commercial power lines

MCs can also be used to switch the power source of the motor driven by the inverter to a commercial power source.

| | Name of option | Function and application |
|---|---|---|
| **Main option** | DC reactors (DCRs) | A DCR is mainly used for power supply normalization and for supplied power-factor reformation (for reducing harmonic components).<br><br>1) For power supply normalization<br>  - Use a DCR when the capacity of a power supply transformer exceeds 500 kVA and is 10 times or more than the rated inverter capacity. In this case, the percentage-reactance of the power source decreases, and harmonic components and their peak levels increase. These factors may break rectifiers or capacitors in the converter section of inverter, or decrease the capacitance of the capacitor (which can shorten the inverter's service life).<br>  - Also use a DCR when there are thyristor-driven loads or when phase-advancing capacitors are being turned ON/OFF.<br><br>2) For supplied power-factor reformation (harmonic component reduction)<br>Generally a capacitor is used to reform the power factor of the load, however, it cannot be used in a system that includes an inverter. Using a DCR increases the reactance of inverter's power source so as to decrease harmonic components on the power source lines and reform the power factor of inverter. Using a DCR reforms the input power factor to approximately 86 to 90%.<br><br>**Note:** At the time of shipping, a short bar is connected across the terminals P1 and P (+) on the terminal block. Remove the short bar when connecting a DCR. |
| | Output circuit filters | Include an output circuit filter in the inverter power output (secondary) circuit to:<br><br>1) Suppress the voltage fluctuation at the motor input terminals<br>This protects the motor from insulation damage caused by the application of high voltage surge currents by the 400 V class of inverters.<br><br>2) Suppress leakage current from the power output lines (due to harmonic components)<br>This reduces the leakage current when the motor is hooked by long power feed lines. It is recommended that the length of the power feed line be kept to less than 400 m.<br><br>3) Minimize emission and/or induction noise issued from the power output lines<br>Output circuit filters are effective in reducing noise from long power feed lines, such as those used in plants, etc.<br><br>**Note:** Use an output circuit filter within the allowable carrier frequency range specified by function code F26 (Motor sound (Carrier frequency)). Otherwise, the filter will overheat. |
| | Ferrite ring reactors for reducing radio frequency noise | A ferrite ring reactor is used to reduce radio noise emitted by the inverter.<br><br>A ferrite ring reactor suppresses the outflow of high frequency harmonics caused by switching operation for the power supply (primary) lines inside the inverter. Pass the power supply lines together through the ferrite ring reactors for 4 turns (varied ferrite ring reactors impedance).<br><br>If wiring length between the inverter and motor is less than 65.6ft(20 m), insert a ferrite ring reactor to the power supply (primary) lines; if it is more than 65.6ft(20 m), insert it to the power output (secondary) lines of the inverter. |
| | EMC-compliant filter | A special filter for making the inverter in conformity with Europe's EMC directives. |
| | AC Reactor (ACR) | • This optional feature must be connected to the primary side (commercial power supply side) of the inverter, when the inter-phase unbalance factor of the commercial power supply is 2% to 3%.<br><br>$$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{3 - phase average voltage (V)}} \times 67$$<br><br>In case the inter-phase unbalance factor of the commercial power supply exceeds 3%, you would need to take other measures such as increasing the capacity of the inverter. Contact your Fuji Electric representative.<br><br>• In a DC link bus system (using terminals [P (+)] and [N (-)]), the AC reactor protects the inverter against damage caused by unbalance in current. |

|  | Name of option | Function and application |
|---|---|---|
| Options for Operation and Communications | External potentiometer for frequency commands | An external potentiometer may be used to set the drive frequency. Connect the potentiometer to control signal terminals 11 to 13 of the inverter. |
| | Extension cable for remote keypad operation | The extension cable connects the RS-485 communications port (RJ-45) with a keypad or an RS-485-USB converter.<br><br>This cable is required 10BASE-T/100BASE-TX straight type cable compliant to US ANSI TIA / EIA-586A Category 5. (Less than 66 ft (20m)) |
| | RS-485-USB converter | A converter that allows connection of an RS-485 communications port to a USB port on a PC. |
| | Inverter support loader software | Inverter support loader software, Windows GUI (Graphics User Interface) based, that makes setting of function codes easy. |
| Other peripheral equipment | Surge absorbers | A surge absorber suppresses surge currents and noise from the power lines to ensure effective protection of your power system from the malfunctioning of the magnetic contactors, mini-relays and timers. |
| | Surge suppressors | A surge suppressor eliminates surge currents induced by lightening and noise from the power supply lines. Use of a surge suppressor is effective in preventing the electronic equipment, including inverters, from damage or malfunctioning caused by such surges and/or noise. |
| | Arresters | An arrester suppresses surge currents and noise invaded from the power supply lines. Use of an arrester is effective in preventing electronic equipment, including inverters, from damage or malfunctioning caused by such surges and/or noise. |
| | Frequency meter | Displays the frequency in accordance with signal output from the inverter. |
| Other options | Attachment for external cooling | This adapter allows you to mount your FRENIC-Eco series of inverters on the panel in such a way that the heat sink assembly may be exposed to the outside. Using this adapter greatly reduces heat radiated or spread inside your enclosure.<br><br>Applicable only to inverters with a capacity of 30HP for 208V, 40HP for 460V or below.<br><br>(On inverters with a capacity of 40HP for 208V, 50HP for 460V or above, you only need to re-position the mounting bases.) |
| | NEMA1 kit | NEMA1 kit, when fitted to the FRENIC-Eco series, protects the inverter body with the structure the conforms to the NEMA1 standard (approved as UL TYPE1).<br><br>Using NEMA1 kit, inverter ambient temperature is -10 to +40°C (14 to 104°F). |

# Chapter 10   CONFORMITY WITH STANDARDS

## 10.1 Conformity with UL Standards and Canadian Standards (cUL-listed for Canada)

### 10.1.1 General

The UL standards, originally established by Underwriters Laboratories, Inc. of U.S., are now a set of standards authorized in the U.S. for preventing fire and accidents, thereby protecting operators, service personnel, and ordinary citizens.

"cUL-listed for Canada" means that the products have been evaluated to the CSA Standards by the UL. Therefore, cUL-listed products are equivalent to those in conformity with CSA Standards.

### 10.1.2 Considerations when using FRENIC-Eco as a product certified by UL or cUL

If you want to use the FRENIC-Eco series of inverters as a part of UL Standards or CSA Standards (cUL-listed for Canada) certified product, refer to the related guidelines described on pages viii and ix.

## 10.2 Conformity with EU Directives

The CE Marking on Fuji products indicates that they comply with the essential requirements of the Electromagnetic Compatibility (EMC) Directive 89/336/EEC issued by the Council of the European Communities and the Low Voltage Directive 73/23/EEC.

EMC-filter built-in inverters that bear a CE Marking are in conformity with EMC Directives. Inverters having no EMC filter can be in conformity with EMC Directives if an optional EMC-compliant filter is mounted to them.

Inverters that bear a CE Marking are compliant with the Low Voltage Directive.

■The FRENIC-Eco series of inverters is in conformity with the following standards:

| Low Voltage Directive | EN50178: | 1997 |
|---|---|---|
| EMC Directive | EN61800-3: 1996 + A11: 2000 | |
| | EN55011: | 1998 + A1:1999 |

**CAUTION**

The FRENIC-Eco series of inverters is categorized as a "restricted sales distribution class" according to the EN61800-3. When you use these products in a domestic environment, you may need to take appropriate countermeasures to reduce or eliminate any noise emitted from these products.

## 10.3 Conformity with Low Voltage Directive

### 10.3.1 General

General-purpose inverters are subject to the regulations set forth by the Low Voltage Directive in the EU. Fuji Electric declares the inverters bearing a CE marking are compliant with the Low Voltage Directive.

### 10.3.2 Considerations when using FRENIC-Eco as a product in conformity with Low Voltage Directive

If you wish to use the FRENIC-Eco series of inverters as a product in conformity with the Low Voltage Directive, refer to the related guidelines described on pages vi and vii.

## 10.4 Harmonic Component Regulation in the EU

### 10.4.1 General

When a general-purpose industrial inverter is to be used in the EU, the harmonics emitted from the inverter to power lines are strictly regulated as stated below.

When an inverter whose rated input is 1kW or below is connected to a public low-voltage power supply, it is subject to the harmonics emission regulations (users A and B below), except when the inverter is connected to an industrial low-voltage power supply (user C below). See Figure 10.1 for details.
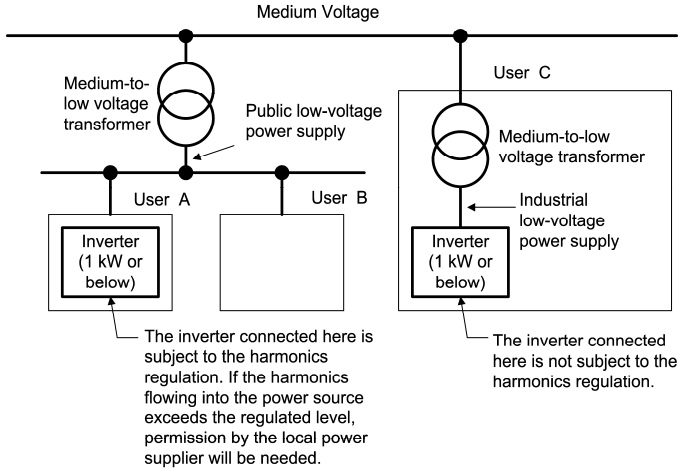


Figure 10.1  Connection to Power Line

### 10.4.2 Conformity with the harmonics regulation

A general-purpose industrial inverter is not a product in conformity with EN61000-3-2 (+A14). When you connect it to a low-voltage commercial power supply, you must obtain permission of the local power supplier (See the case of User A or B in Figure 10.1 above.) If you need harmonic current data of the inverter, consult your Fuji Electric representative.

## 10.5 Conformity with the EMC Directive in the EU

### 10.5.1 General

The CE Marking on inverters does not ensure that the entire equipment including CE-marked products is compliant with the EMC Directive. Therefore, it is the responsibility of the equipment manufacturer to ensure that the equipment including the product (inverter) or connected with it actually complies with the standard and to put a CE Marking as the equipment.

In general, the user's equipment comprises a variety of products supplied from a number of manufacturers in addition to Fuji inverters. Therefore, the manufacturer of the final equipment needs to take responsibility for conformity.

In addition, to satisfy the requirements noted above, it is necessary to use a Fuji inverter in connection with an EMC-compliant filter (option) and install it in accordance with the instructions contained in this instruction manual. Install the Fuji inverter in a metal enclosure.

> To use Fuji EMC-filter built-in inverters, refer to the FRENIC-Eco Instruction Manual Supplement for EMC-Filter Built-in Type, Chapter 10, "CONFORMITY WITH STANDARDS."

### 10.5.2 EMC-compliant filter (Option)

There are two installation styles of an optional EMC-compliant filter--Footmount and split styles. As listed on the next page, the footmount style applies to inverters with 3-phase 460 V, 1 to 30HP for 460V, and the split style, to inverters with 3-phase 208 V 30 to100HP, 3-phase 460 V 40 to 900HP.

For how to install the EMC-compliant filter, see Section 10.5.3 "Recommended installation of EMC-compliant filter."

> The use of an EMC-compliant filter increases leakage current as shown on the next page.

Table 10.1  EMC-compliant Filters and Leakage Current

| Power supply voltage | Inverter type | EMC-compliant filter model | Leakage current (mA) [1] [2] | | Installation style |
|---|---|---|---|---|---|
| | | | Normal condition | Worst condition | |
| 3-phase 208 V | FRN001F1S-2DY | EFL-4.0E11-2 | 2.96 | 2.96 | Split style See Figure 10.2 (B). |
| | FRN002F1S-2DY | | | | |
| | FRN003F1S-2DY | | | | |
| | FRN005F1S-2DY | | | | |
| | FRN007F1S-2DY | EFL-7.5E11-2 | 10.6 | 10.6 | |
| | FRN010F1S-2DY | EFL-15SP-2 | 20.0 | 23.0 | |
| | FRN015F1S-2DY | | | | |
| | FRN020F1S-2DY | EFL-22SP-2 | 20.0 | 23.0 | |
| | FRN025F1S-2DY | | | | |
| | FRN030F1S-2DY | FS5536-180-40 | 37.0 | 211.0 | |
| | FRN040F1S-2DY | FS5536-250-99 | 78.0 | 424.0 | |
| | FRN050F1S-2DY | | | | |
| | FRN060F1S-2DY | FS5536-400-99 | 89.0 | 484.0 | |
| | FRN075F1S-2DY | | | | |
| | FRN100F1S-2DY | | | | |
| | FRN125F1S-2DY | - | - | - | - |
| 3-phase 460 V | FRN001F1S-4DY | EFL-4.0G11-4 | 3.0 | 105.0 | Footmount style See Figure 10.2 (A). |
| | FRN002F1S-4DY | | | | |
| | FRN003F1S-4DY | | | | |
| | FRN005F1S-4DY | | | | |
| | FRN007F1S-4DY[3] | EFL-7.5G11-4 | 3.0 | 105.0 | |
| | FRN010F1S-4DY | | | | |
| | FRN015F1S-4DY | | | | |
| | FRN020F1S-4DY[3] | EFL-15G11-4 | 6.0 | 158.0 | |
| | FRN025F1S-4DY | EFL-22G11-4 | 3.0 | 105.0 | |
| | FRN030F1S-4DY | | | | |
| | FRN040F1S-4DY | FS5536-100-35 | 24.4 | 143.0 | Split style See Figure 10.2 (B). |
| | FRN050F1S-4DY | | | | |
| | FRN060F1S-4DY | FS5536-180-40 | 37.0 | 211.0 | |
| | FRN075F1S-4DY | | | | |
| | FRN100F1S-4DY | | | | |
| | FRN125F1S-4DY | | | | |
| | FRN150F1S-4DY | FS5536-250-99 | 78.0 | 424.0 | |
| | FRN200F1S-4DY | | | | |
| | FRN250F1S-4DY | FS5536-400-99-1 | | | |
| | FRN300F1S-4DY | | | | |
| | FRN350F1S-4DY | | | | |
| | FRN400F1S-4DY | FN3359-600-99 | 36.0 | 210.0 | |
| | FRN450F1S-4DY | | | | |
| | FRN500F1S-4DY | FN3359-800-99 | | | |
| | FRN600F1S-4DY | | | | |
| | FRN700F1S-4DY | | | | |
| | FRN800F1S-4DY | FN3359-1000-99 | 37.0 | 216.0 | |
| | FRN900F1S-4DY | | | | |

[1]  The values are calculated assuming the power supply frequency of 50 Hz for both 3-phase 240V and 3-phase 400V.
[2]  The worst condition includes a phase loss in the supply line.
[3]  Requires a panel-mount adapter (option).

### 10.5.3 Recommended installation of EMC-compliant filter

This section shows how to install an EMC-compliant filter. In the footmount style, mount the inverter on the EMC-compliant filter. In the split style, mount the filter beside or under the inverter.

For the footmount style, inverters with ratings of 460 V 7.5HP and 20HP require a panel-mount adapter (option) as listed below.

Table 10.2  EMC-compliant Filter and Panel-mount Adapter (option)

| 3-phase 460 V | Inverter type | EMC filter model<br>[Bundled screws to fix the filter onto panel-mount adapter] | Panel-mount adapter model<br>[Bundled screws to fix the adapter onto inverter] |
|---|---|---|---|
| 7.5HP | FRN007F1S-4DY | EFL-7.5G11-4<br>[Four M8 x 20 screws] | MA-F1-5.5<br>[Four M5 x 15 screws] |
| 20HP | FRN020F1S-4DY | EFL-15G11-4<br>[Four M8 x 20 screws] | MA-F1-15<br>[Four M8 x 25 screws] |



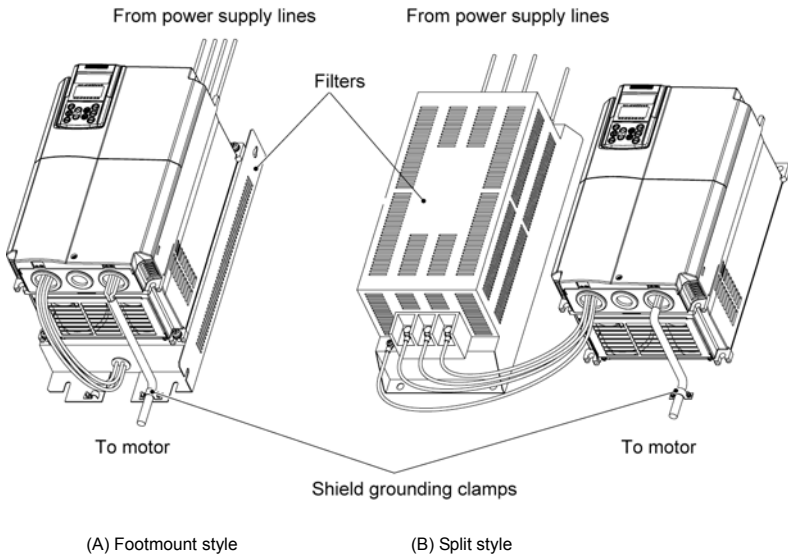(A) Footmount style                (B) Split style

Figure 10.2   Installing Inverter and EMC-compliant Filter

The EMC-compliant filter and the inverter should be connected with each other according to the procedure given below. The wiring on the inverter and motor should be performed by an authorized electrical engineer. In order to ensure compliance with the EMC Directive, this procedure should be followed as closely as possible.

■ **Basic connection procedure**

1) Install the inverter and the EMC-compliant filter on a grounded metal plate. Use a shielded cable also for connection to the motor and make it as short as possible. Connect the shield layer of the cable firmly to the metal plate. Also, at the motor side, connect the shield layer electrically to the grounding terminal of the motor.

2) Use a shielded cable for connection of control circuit lines of the inverter and also for connection of the signal cable of an RS-485 communications. As with the motor, clamp the shield layer of the cable firmly to a grounded plate.

3) If noise radiated from the inverter exceeds the level prescribed in the EMC Directive, enclose the inverter and its peripherals (EMC-compliant filter) inside a metal enclosure as shown in Figure 10.3.
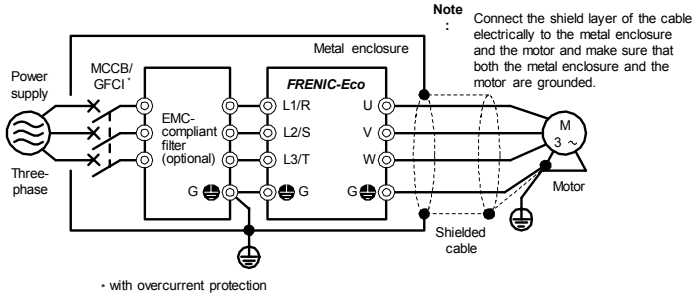


Figure 10.3 Installation of EMC-Compliant Filter (Option)

### 10.5.4 EMC-compliant environment and class

The table below lists the capacity and power supply voltage of the FRENIC-Eco and the EMC-compliant environment.

3-phase 208V

| Standards | Inverter capacity |
|---|---|
| | 1HP to 100HP |
| Immunity | EN61800-3 Second environment (Industrial environment) |
| Emission | EN61800-3 Category C3 |

3-phase 460V

| Standards | Inverter capacity | | |
|---|---|---|---|
| | 1HP to 125HP | 150HP to 350HP | 400HP to 900HP |
| Immunity | EN61800-3 Second environment (Industrial environment) | | |
| Emission | EN55011 Group 1 Class A | EN61800-3 Category C3 **Note 1** | EN61800-3 Category C3 |

**Note 1: Wiring change for compliance**
Changing the internal wiring makes EMC-compliant level (emission) be in conformity with Group 1 Class A. Refer to the wiring procedures given on the following pages.

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# ⚠ WARNING

Before changing any internal wiring, turn OFF the power and wait more than five minutes for models of 30HP for 208V, 40HP for 460V or below, or ten minutes for models of 40HP for 208V, 50HP for 460V or above. Make sure that the LED monitor and charging lamp (on models of 40HP for 208V, 50HP for 460V or above) are turned OFF. Further, make sure, using a multimeter or a similar instrument, that the DC link bus voltage between the terminals P (+) and N (-) has dropped below the safe voltage (+25 VDC).

**Otherwise electric shock could occur.**

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**FRN150F1S-4DY**

1) Remove the front cover. (Refer to Chapter 2, Section 2.3 "Wiring.")

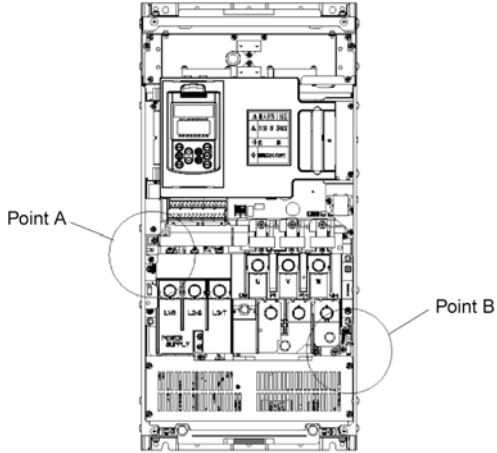2) Change wiring at points A and B shown in the internal location diagram below.

Point A

Point B

Figure 10.4  Internal Location Diagram (FRN150F1S-4DY)

**Point A**  As shown below, remove the screw (M4) to release the wire end terminal and secure the terminal to the support with the screw removed. (Tightening torque: 15.9lb-in(1.8 N·m))
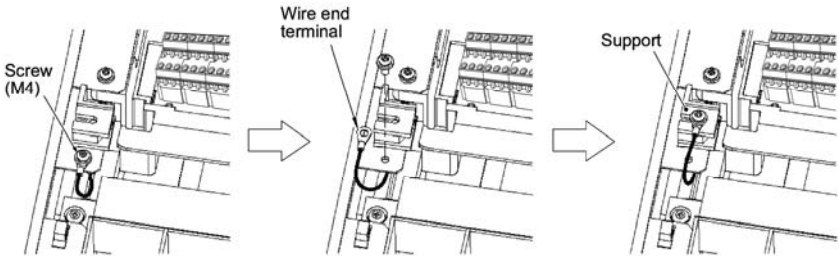
Wire end terminal

Screw (M4)

Support

Figure 10.5  Point A

**Point B**  As shown below, cut the cable tie (insulation lock) with a nipper to remove the protective cap. Remove the screw (M5) and secure the wire end terminal with the screw removed. (Tightening torque: 31.0lb-in(3.5 N·m))
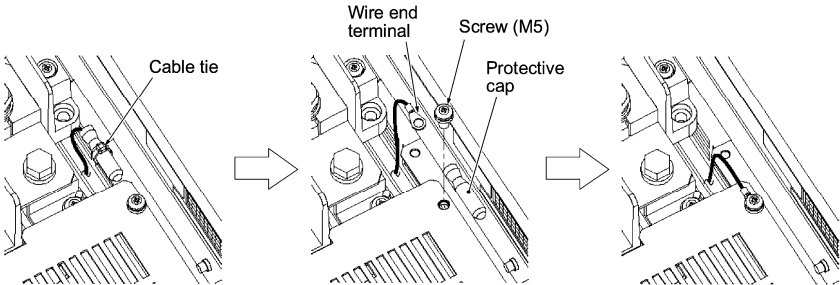
Wire end terminal

Screw (M5)

Cable tie

Protective cap

Figure 10.6  Pont B

**FRN200F1S-4DY**

1) Remove the front cover. Refer to Chapter 2, Section 2.3 "Wiring."

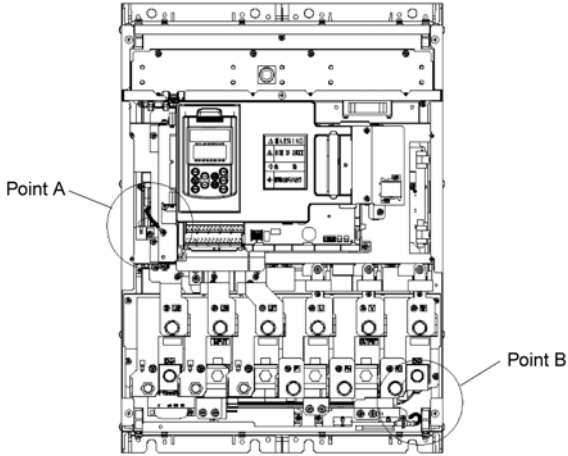2) Change wiring at points A and B shown in the internal location diagram below.



Figure 10.7  Internal  Location Diagram (FRN200F1S-4DY)

**Point A**  As shown below, remove the screw (M4) to release the wire end terminal and secure the terminal to the support with the screw removed. (Tightening torque: 15.9lb-in(1.8 N·m))
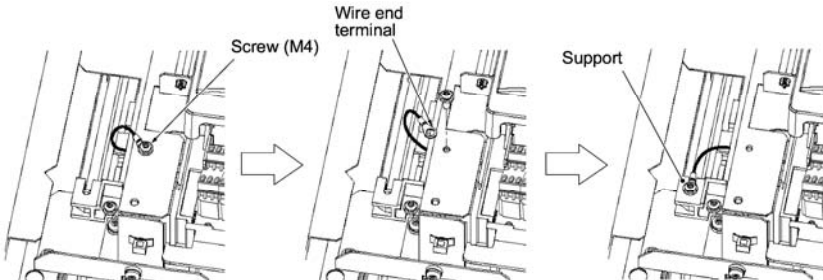


Figure  10.8  Point A

**Point B**  As shown below, cut the cable tie (insulation lock) with a nipper to remove the protective cap. Remove the screw (M5) and secure the wire end terminal with the screw removed. (Tightening torque: 31.0lb-in(3.5 N·m))
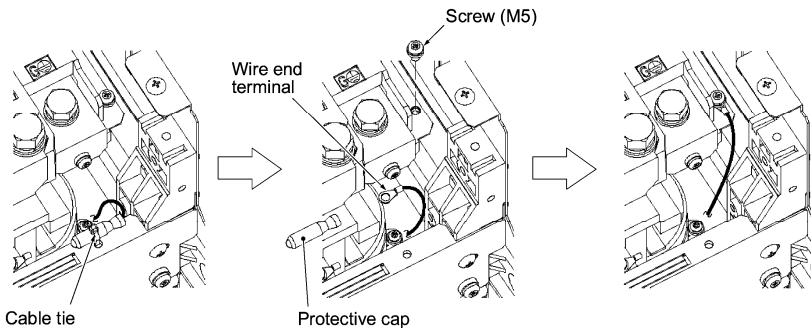


Figure  10.9  Point B

1) Remove the front cover. Refer to Chapter 2, Section 2.3 "Wiring."

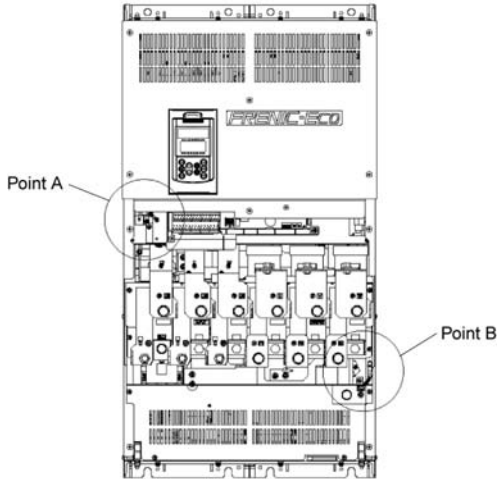2) Change wiring at points A and B shown in the internal location diagram below.

Figure 10.10  Internal Location Diagram (FRN250F1S-4DY to FRN350F1S-4DY)

**Point A**  As shown below, remove the screw (M4) to release the wire end terminal and secure the terminal to the support with the screw removed. (Tightening torque: 15.9lb-in(1.8 N·m))
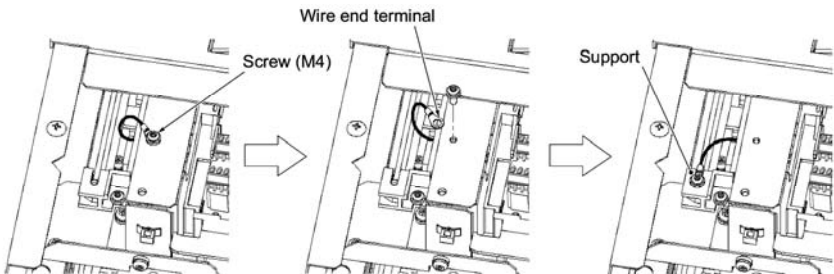
Figure 10.11  Point A

**Point B**  As shown below, cut the cable tie (insulation lock) with a nipper to remove the protective cap. Remove the screw (M5) and secure the wire end terminal with the screw removed. (Tightening torque: 31.0lb-in(3.5 N·m))
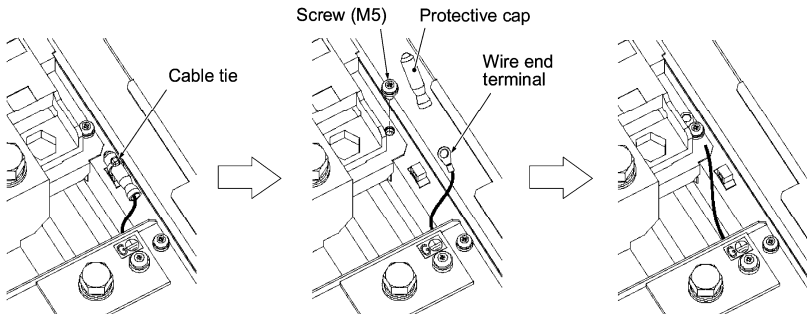
Figure 10.12  Point B

The wiring change in Note 1 can improve the EMC-compliant level of the inverter for an environment or class; however, it increases the leakage currents listed in Table 10.1 to the ones listed below. Make sure that these leakage currents are allowable for your system requirements beforehand.

| Power supply voltage | Inverter type | EMC-compliant filter model | Leakage current (mA) | |
|---|---|---|---|---|
| | | | Normal condition | Worst condition |
| 3-phase 460 V | FRN150F1S-4DY | FS5536-250-28 | 108.0 | 464.0 |
| | FRN200F1S-4DY | | | |
| | FRN250F1S-4DY FRN300F1S-4DY | FS5536-400-99-1 | | |
| | FRN350F1S-4DY | | | |

For improvement in EMC compliance for 3-phase 208 V types of inverters, consult your Fuji Electric representative for improving EMC-compliant level.

# App. Inverter Generating Loss

**FRENIC-Eco Watts Loss**

| Model | Watts Loss [W] | |
|---|---|---|
| | Low carrier frequency | High carrier frequency |
| FRN001F1S-2DY | 70 | 100*1 |
| FRN002F1S-2DY | 110 | 140*1 |
| FRN003F1S-2DY | 120 | 170*1 |
| FRN005F1S-2DY | 180 | 240*1 |
| FRN007F1S-2DY | 310 | 390*1 |
| FRN010F1S-2DY | 380 | 470*1 |
| FRN015F1S-2DY | 530 | 620*1 |
| FRN020F1S-2DY | 760 | 880*1 |
| FRN025F1S-2DY | 800 | 950*1 |
| FRN030F1S-2DY | 1020 | 1120*1 |
| FRN040F1S-2DY | 1380 | 1480*2 |
| FRN050F1S-2DY | 1280 | 1440*2 |
| FRN060F1S-2DY | 1580 | 1770*2 |
| FRN075F1S-2DY | 1920 | 2160*2 |
| FRN100F1S-2DY | 2470 | 2780*2 |
| FRN125F1S-2DY | 3620 | 3790*3 |
| FRN001F1S-4DY | 50 | 80*1 |
| FRN002F1S-4DY | 80 | 110*1 |
| FRN003F1S-4DY | 110 | 160*1 |
| FRN005F1S-4DY | 160 | 250*1 |
| FRN007F1S-4DY | 160 | 280*1 |
| FRN010F1S-4DY | 310 | 440*1 |
| FRN015F1S-4DY | 340 | 530*1 |
| FRN020F1S-4DY | 450 | 700*1 |
| FRN025F1S-4DY | 530 | 870*1 |
| FRN030F1S-4DY | 570 | 970*1 |
| FRN040F1S-4DY | 950 | 1200*1 |
| FRN050F1S-4DY | 1150 | 1440*2 |
| FRN060F1S-4DY | 1300 | 1670*2 |
| FRN075F1S-4DY | 1360 | 1740*2 |
| FRN100F1S-4DY | 1610 | 2130*2 |
| FRN125F1S-4DY | 2010 | 2250*3 |
| FRN150F1S-4DY | 2320 | 2630*3 |
| FRN200F1S-4DY | 2900 | 3260*3 |
| FRN250F1S-4DY | 3670 | 4130*3 |
| FRN300F1S-4DY | 4310 | 4860*3 |
| FRN350F1S-4DY | 5000 | 5620*3 |
| FRN400F1S-4DY | 5560 | 6110*3 |
| FRN450F1S-4DY | 6090 | 6690*3 |
| FRN500F1S-4DY | 7450 | 8210*3 |
| FRN600F1S-4DY | 8530 | 9370*3 |
| FRN700F1S-4DY | 9440 | 10470*3 |
| FRN800F1S-4DY | 10710 | 11840*3 |
| FRN900F1S-4DY | 12340 | 13570*3 |

Note)

Lower carrier frequency : 2kHz

"*1 : 15kHz,  *2 : 10kHz,  *3 : 6kHz"

**MEMO**

**Designed For Fan and Pump Applications**

# *FRENIC-ECO* for DY model

## Instruction Manual

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Fuji Electric Co., Ltd.
Fuji Electric Corp. of America

The purpose of this instruction manual is to provide accurate information in handling, setting up and operating of the FRENIC-Eco series of inverters. 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.

In no event will Fuji Electric Co., Ltd. be liable for any direct or indirect damages resulting from the application of the information in this manual.

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