Instruction Manual

Supplement to Functional Safety Inverters

High Performance, Multifunction Inverter

FRENIC-MEGA

This manual is the translation of the original instruction of the original manual, a supplement to the FRENIC-MEGA Instruction Manual (INR-SI47-1223□-E, INR-SI47-1335□-E,INR-SI47-1457□-E), contains descriptions that exclusively apply to the functional safety inverter FRENIC-MEGA (Inverter type: FRN_ _ _G1■-□□). For other descriptions, refer to the FRENIC-MEGA Instruction Manual.

The functional safety inverter FRENIC-MEGA is compliant with European Safety Standard : EN61800-5-2 SIL2 and EN ISO13849-1 PL=d Cat. 3.

To comply with the requirements, refer to the original manual, Chapter 9, Section 9.3 "Compliance with EMC Standards" and Section 9.5 "Compliance with the Low Voltage Directive in the EU" in conjunction with this manual.

Checking the inverter's ROM version

The inverter's ROM version can be checked on Menu #5 "Maintenance Information" (5_ 14) as a 4-digit code. For the detailed keypad operation, refer to the inverter original manuals.

About newly added functions

The functions listed below are newly added to the FRENIC-MEGA series of inverters having a ROM version 3600 or later. For details about those functions, refer to Section 2 "Details of Function Codes Added" or the PG Interface Card Instruction Manual.

Inverter's ROM Version	Newly Added Functions
3600 or later	(1) Online tuning Performs tuning while the motor is rotating in order to cover the motor speed fluctuation caused by the temperature rise of the motor. (2) Function extension of brake signal Extends the brake-ON sequence function. (3) PG error processing Changes the PG error detection width if the speed command exceeds the base frequency. (4) Synchronous operation Enables synchronous operation of two motors equipped with a pulse generator (PG). The PG interface card (OPC-G1-PG or OPC-G1-PG22) is required. For details, refer to the PG Interface Card Instruction Manual. (5) Motor magnetic flux weakening control under "vector control without speed sensor" Improves the torque control stability. The overspeed detection level can be specified. (6) Improved regenerative power control under vector control Adjusts the motor magnetic flux level to be applied during deceleration under vector control. (7) Terminal command "Enable battery operation" ***BATRY*** (Function code data = 59) Cancels the undervoltage protection so that the inverter under an undervoltage condition runs the motor with battery power. (8) "0 to 20 mA" range added to analog input/output (9) Speed limit level adjustable with analog inputs under torque control (10) Adjustable ACR P gain under "vector control"

Note The PG interface card OPC-G1-PG22 is applicable to inverters having a ROM version 3510 or later.

List of Errata

The table below provides a list of errata for the FRENIC-MEGA Instruction Manuals (INR-SI47-1183b-E, INR-SI47-1223c -E, INR-SI47-1334-E, INR-SI47-1335a-E and INR-SI47-1457-E).

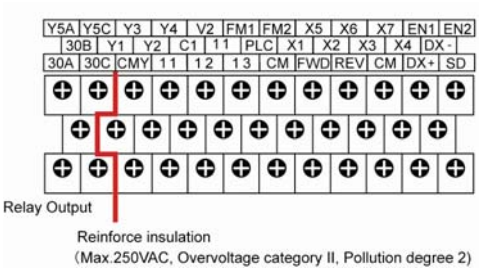
Page					Wrong	Correct (underlined)
1183b	1223c	1334	1335a	1457		
vii	-	v	-	-	Fuse rating column (IEC number): (FRN3.7G1■-2□/FRN3.7G1■-4□ or lower models) IEC60269-1	IEC60269-2
					Current rating in the fuse rating column: (FRN55G1■-4□) 400 (IEC60269-4)	350 (IEC60269-4)
ix	-	vi	-	-	Standard in item 9: EN60204 Appendix C.	IEC60364-5-52
					Note to be added.	In a power supply system (I-T NET) where a neutral point is not grounded, the control terminals are provided with basic insulation from the mains. If a person may touch them directly, an external insulation circuit should be added for double insulation.
						Grounding terminal can accept one wire only.
3-15	-	3-12	-	-	I/O Check Item, 4_ 15, 4_ 17 Shows the pulse rate (p/s) of the A/B phase signal…	Shows the pulse rate of the A/B phase signal… (e.g., 1000 p/s is expressed as 1.00.)
5-7	-	5-7	-	-	Drive control of E31, E32 Torque control: N	Torque control: Y
5-10	-	5-9	-	-	C32, C37, C42 Data setting range: 0.00 to 200.00%	0.00 to 400.00%
-	-	5-10	-	-	P56 Default setting: 85%	85% (90% for inverters of 132 kW or above)
5-12	-	5-11	-	-	H13 Data setting range: 0.1 to 10.0 s	0.1 to 20.0 s
					Drive control of H15 w/o PG: Y w/ PG: Y	w/o PG: N w/ PG: N
5-12	-	5-11, 5-100	-	-	H46 Data setting range: 0.1 to 10.0 s	0.1 to 20.0 s
5-14	5-14	5-12, 5-109	5-12	5-15	H80 Data setting range: 0.00 to 0.40 Drive control: Torque Control :Y	0.00 to 1.00 Torque Control : N
5-14	-	5-12	-	-	Drive control of H92, H93 w/o PG: Y w/ PG: Y	w/o PG: N w/ PG: N
5-16, 5-18, 5-20	-	5-14, 5-16, 5-18	-	-	A56, b56, r56 Default setting: 85%	85% (90% for inverters of 132 kW or above)
5-22	-	5-19	-	-	d55 Data setting range: 0, 1 d55 Default setting: 0	0000 to 00FF (in hex.) 0000
5-22	5-22	5-19	5-19	-	d68 Default setting: 40	4.0

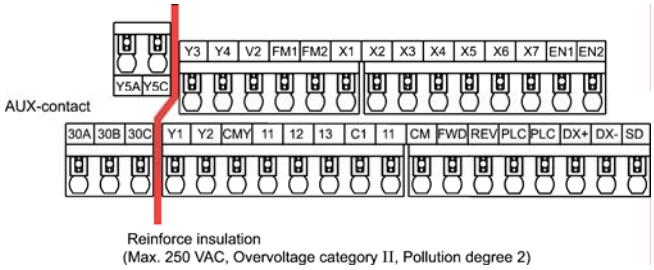
Page					Wrong	Correct (underlined)
1183b	1223c	1334	1335a	1457		
5-85, 5-87	-	5-110, 5-111	-	-	H81, H82: Light Alarm Selection 1 and 2 "PID feedback wire break" to be added.	Addition of Light Alarm Factor Code: LOF Name: PID feedback wire break Description: The PID feedback signal wire(s) is broken. Table 5.2 Light Alarm Selection 2 (H82), Bit Assignment of Selectable Factors Bit: 3 Code: LOF Content: PID feedback wire break
5-92	-	5-117	-	-	Table 5.5 Function Codes to be Switched Last line Reserved: d57 A57, b57, r57	P57, A57, b57, r57
-	-	5-127	-	-	J62 PID Control (PID control block selection) Table When J62 = 0, 1: Absolute value (Hz) When J62 = 2,3: Ratio (%)	When J62 = 0, 1: Ratio (%) When J62 = 2,3: Absolute value (Hz)
-	-	8-2 to 8-4	8-2 to 8-4	-	Noncompliance note to be added to "Applicable safety standards C22.2 No. 14."	The following inverters are not compliant with C22.2 No. 14. FRN160G1■-4□ to FRN220G1■-4□ FRN355G1■-4□, FRN400G1■-4□

Chapter 2

2.3.2 Terminal arrangement diagram and screw specifications

(2) Arrangement of control circuit terminals (common to all inverter types)





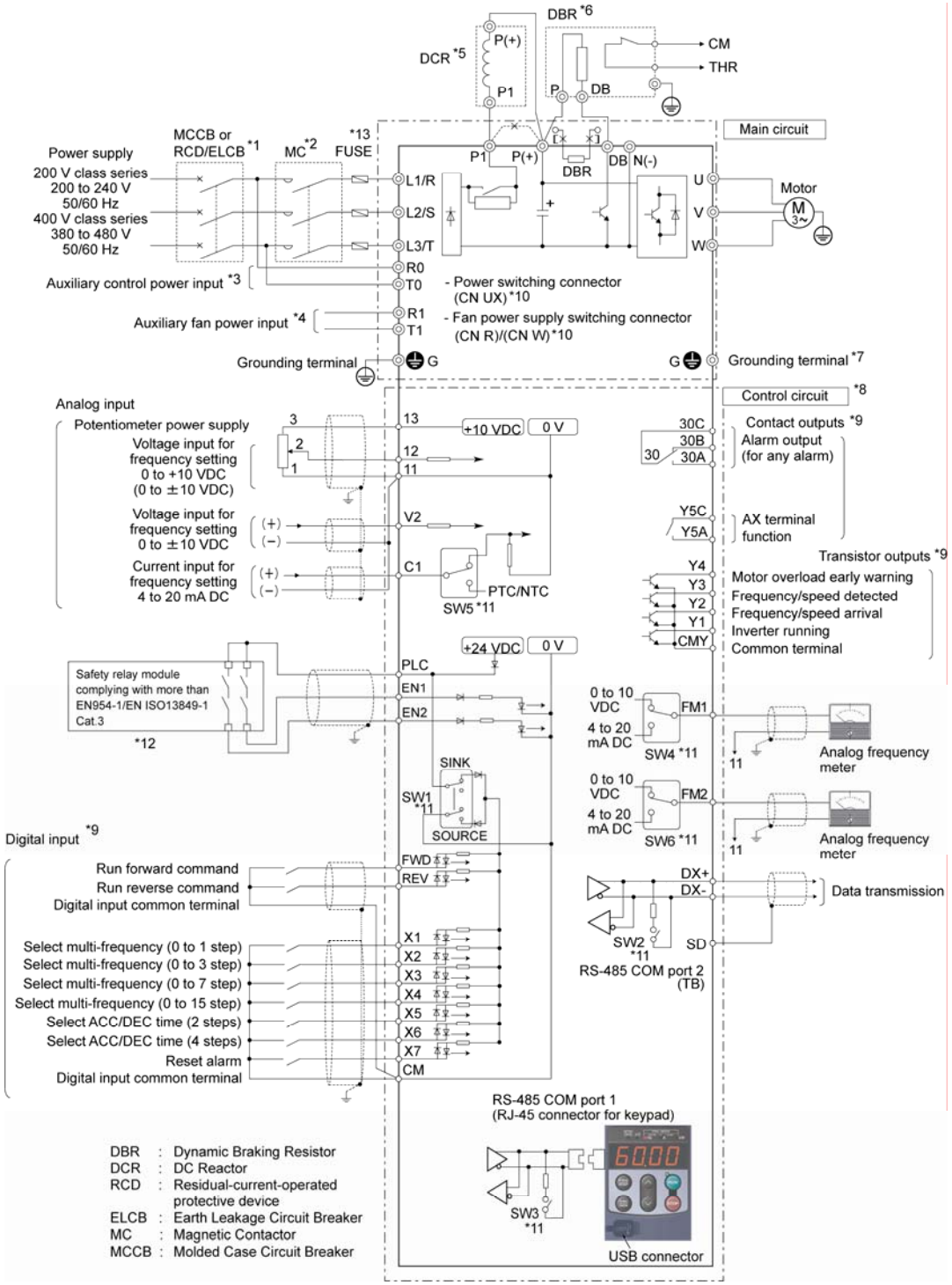
Terminal type	Screw size: M3 (0.7 N·m)	Spring (screwless)
Recommended wiring size (mm^2)*	0.75	0.65 to 0.82 (AWG 19 or 18)

* Using wires exceeding the recommended sizes may lift the front cover depending upon the number of wires used, impeding keypad's normal operation.

2.3.5 Wiring of main circuit terminals and grounding terminals

This section shows connection diagrams with the Enable input function used.

(1) FRN_ _ _G1■-2A/2U/4A/4U, with SINK mode input by factory default
(2) FRN_ _ _G1■-4E, with SOURCE mode input by factory default



*1 Install a recommended molded case circuit breaker (MCCB) or residual-current-operated protective device (RCD)/earth leakage circuit breaker (ELCB) (with overcurrent protection function) in the primary circuit of the inverter to protect wiring. Ensure that the circuit breaker capacity is equivalent to or lower than the recommended capacity.

*2 Install a magnetic contactor (MC) for each inverter to separate the inverter from the power supply, apart from the MCCB or RCD/ELCB, when necessary.
Connect a surge absorber in parallel when installing a coil such as the MC or solenoid near the inverter.

*3 The R0 and T0 terminals are provided for inverters with a capacity of 1.5 kW/2 HP or above.
To retain an alarm output signal ***ALM*** issued on inverter's programmable output terminals by the protective function or to keep the keypad alive even if the main power has shut down, connect these terminals to the power supply lines. Without power supply to these terminals, the inverter can run.

*4 Normally no need to be connected. Use these terminals when the inverter is equipped with a high power-factor, regenerative PWM converter (RHC series).

*5 When connecting an optional DC reactor (DCR), remove the jumper bar from the terminals P1 and P(+).
Inverters with a capacity of 55 kW/100 HP in LD mode and inverters with 75 kW/125 HP or above require a DCR to be connected. Be sure to connect it to those inverters.
Use a DCR when the capacity of the power supply transformer exceeds 500 kVA and is 10 times or more the inverter rated capacity, or when there are thyristor-driven loads in the same power supply line.

*6 Inverters with a capacity of 7.5 kW/15 HP or below have a built-in braking resistor (DBR) between the terminals P(+) and DB.
When connecting an external braking resistor (DBR), be sure to disconnect the built-in one.

*7 A grounding terminal for a motor. Use this terminal if needed.

*8 For control signal wires, use twisted or shielded-twisted wires. When using shielded-twisted wires, connect the shield of them to the common terminals of the control circuit. To prevent malfunction due to noise, keep the control circuit wiring away from the main circuit wiring as far as possible (recommended: 10 cm/3.9 inches or more). Never install them in the same wire duct. When crossing the control circuit wiring with the main circuit wiring, set them at right angles.

*9 The connection diagram shows factory default functions assigned to digital input terminals [X1] to [X7], [FWD] and [REV], transistor output terminals [Y1] to [Y4], and relay contact output terminals [Y5A/C] and [30A/B/C].

*10 Switching connectors in the main circuits. For details, refer to "Instruction manual for FRENIC-MEGA Section 2.3.4 ⑥ Switching connectors" later in this section.

*11 Slide switches on the control printed circuit board (control PCB). Use these switches to customize the inverter operations. For details, refer to Instruction manual for FRENIC-MEGA Section 2.3.6 "Setting up the slide switches."

*12 When the Enable input function is not to be used, keep terminals [EN1]-[PLC] and terminals [EN2]-[PLC] short-circuited using jumper wires. For opening and closing the hardware circuit between terminals [EN1] and [PLC] and between [EN2] and [PLC], use safety components such as safety relays and safety switches that comply with EN954-1 or EN ISO13849-1 Category 3 or higher.

*13 To bring the inverter into compliance with the European Standard, Low Voltage Directive EN61800-5-1, be sure to insert the specified fuse (see Instruction manual for FRENIC-MEGA page v) in the primary circuit of the inverter.

2.3.6 Wiring for control circuit terminals

⚠WARNING

In general, the covers of the control signal wires are not specifically designed to withstand a high voltage (i.e., reinforced insulation is not applied). Therefore, if a control signal wire comes into direct contact with a live conductor of the main circuit, the insulation of 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 wires will not come into contact with live conductors of the main circuit.

Failure to observe these precautions could cause electric shock or an accident.

⚠CAUTION

Noise may be emitted from the inverter, motor and wires.
Take appropriate measures to prevent the nearby sensors and devices from malfunctioning due to such noise.

An accident could occur.

■ Connecting/disconnecting wires to/from a control circuit terminal of spring(screwless) type

① Strip the wire end by 8 to 10 mm/0.31 to 0.39 inch as shown below.

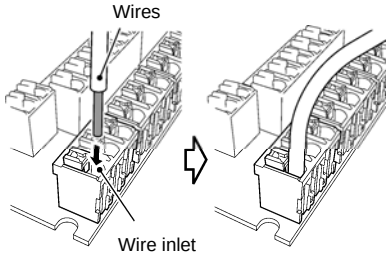
Strip length of wire end	8 to 10 mm 0.31 to 0.39 inch 
Type of screwdriver (tip shape)	Flat (0.6 × 3.5 mm/0.024 × 0.14 inch)

Note For strand wires, the strip length specified above should apply after twisting of them.
If the strip length is out of the specified range, the wire may not be firmly clamped or may be short-circuited with other wires.

② Twist the end of the stripped wires for easy insertion and insert it firmly into the wire inlet on the control circuit terminal. If the insertion is difficult, hold down the clamp release button on the terminal with a flat screwdriver.

③ When disconnecting the wires from the terminal, hold down the clamp release button on the terminal with a flat screwdriver and pull out the wires.

Connecting wire to terminal



Disconnecting wire from terminal

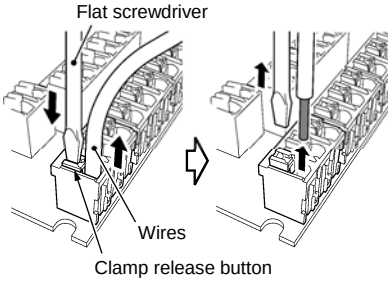


Table 2.7 lists the symbols, names and functions of the control circuit terminals. The wiring to the control circuit terminals differs depending upon the setting of the function codes, which reflects the use of the inverter. Route wires properly to reduce the influence of noise.

Table 2.7 Symbols, Names and Functions of the Control Circuit Terminals

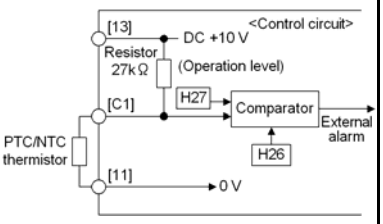
<table>
<tr><th>Classification</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="2">Analog input</td><td>[C1]</td><td>Analog setting current input</td><td>(1) The frequency is commanded according to the external current input.
• 4 to 20 mA DC/0 to 100% (Normal operation)
• 20 to 4 mA DC/0 to 100 % (Inverse operation)
(2) In addition to frequency setting, PID command, PID feedback signal, auxiliary frequency command setting, ratio setting, torque limiter level setting, or analog input monitor can be assigned to this terminal.
(3) Hardware specifications
• Input impedance: 250Ω
• The maximum input is +30 mA DC, however, the current larger than +20 mA DC is handled as +20 mA DC.</td></tr>
<tr><td>PTC/NTC thermistor input</td><td>(1) Connects PTC (Positive Temperature Coefficient)/NTC (Negative Temperature Coefficient) thermistor for motor protection. Ensure that the slide switch SW5 on the control PCB is turned to the PTC/NTC position (see Instruction manual for FRENIC-MEGA Section 2.3.6 "Setting up the slide switches").
The figure shown at the right illustrates the internal circuit diagram where SW5 (switching the input of terminal [C1] between C1 and PTC/NTC) is turned to the PTC/NTC position. For details on SW5, refer to Instruction manual for FRENIC-MEGA Section 2.3.6 "Setting up the slide switches." In this case, you must change data of the function code H26.
 

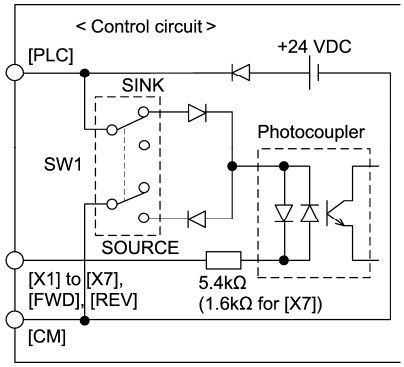
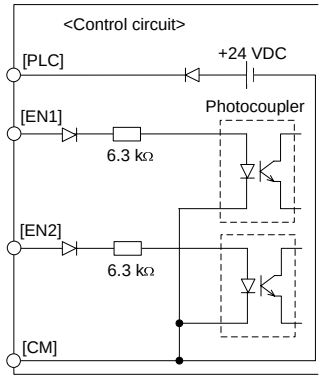
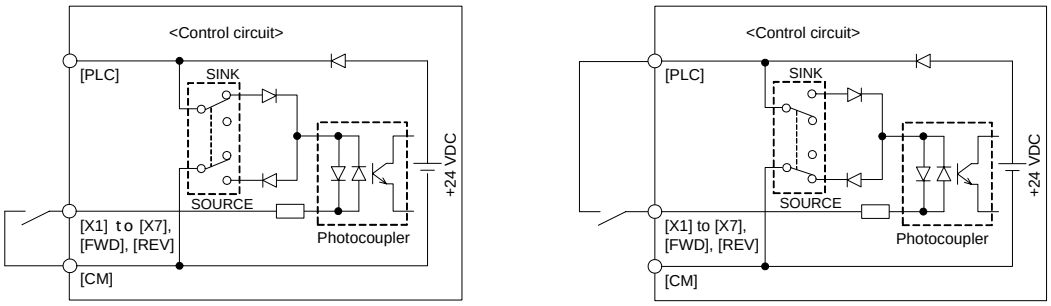
Figure 2.10 Internal Circuit Diagram (SW5 Selecting PTC/NTC)</td></tr>
<tr><td rowspan="10">Digital input</td><td>[X1]</td><td>Digital input 1</td><td rowspan="10">(1) Various signals such as "Coast to a stop," "Enable external alarm trip," and "Select multi-frequency" can be assigned to terminals [X1] to [X7], [FWD] and [REV] by setting function codes E01 to E07, E98, and E99. For details, refer to Chapter 5, Section 5.2 "Details of Function Codes."
(2) Input mode, i.e. SINK/SOURCE, is changeable by using the slide switch SW1. (Refer to Instruction manual for FRENIC-MEGA Section 2.3.6 "Setting up the slide switches.")
(3) Switches the logic value (1/0) for ON/OFF of the terminals [X1] to [X7], [FWD], or [REV]. If the logic value for ON of the terminal [X1] is 1 in the normal logic system, for example, OFF is 1 in the negative logic system and vice versa.
(4) Digital input terminal [X7] can be defined as a pulse train input terminal with the function codes.
Maximum wiring length 20 m/66 ft
Maximum input pulse 30 kHz: When connected to a pulse generator with open collector transistor output
(Needs a pull-up or pull-down resistor. See notes on page 2-22.)
100 kHz: When connected to a pulse generator with complementary transistor output
For the settings of the function codes, refer to FRENIC-MEGA User's Manual, Chapter 5 "FUNCTION CODES."
(Digital input circuit specifications)
 

Figure 2.13 Digital Input Circuit
<table><tr><th colspan="2">Item</th><th>Min.</th><th>Max.</th></tr><tr><td rowspan="2">Operating 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">Operating 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">Operating current at ON (Input voltage is at 0 V)
(For [X7])</td><td>2.5 mA
(9.7 mA)</td><td>5 mA
(16 mA)</td></tr><tr><td colspan="2">Allowable leakage current at OFF</td><td>–</td><td>0.5 mA</td></tr></table></td></tr>
<tr><td>[X2]</td><td>Digital input 2</td></tr>
<tr><td>[X3]</td><td>Digital input 3</td></tr>
<tr><td>[X4]</td><td>Digital input 4</td></tr>
<tr><td>[X5]</td><td>Digital input 5</td></tr>
<tr><td>[X6]</td><td>Digital input 6</td></tr>
<tr><td>[X7]</td><td>Digital input 7</td></tr>
<tr><td>[FWD]</td><td>Run forward command</td></tr>
<tr><td>[REV]</td><td>Run reverse command</td></tr>
</table>

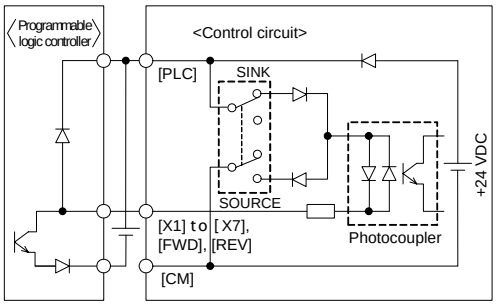
Table 2.7 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

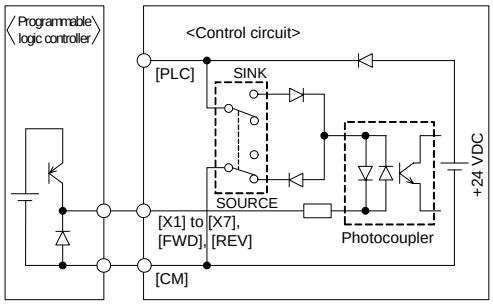
<table>
<tr><th>Classification</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td rowspan="4">Digital input</td><td>[EN1]
[EN2]</td><td>Enable input</td><td>(1) Turning off the circuit between terminals [EN1] and [PLC] or terminals [EN2] and [PLC] stops the inverter's output transistor. (Safe Torque Off: STO)
(2) These terminals are exclusively used for the source mode input and cannot be switched to the sink mode.
(3) If either one of these input terminals is kept OFF for 50 ms or more, the inverter interprets it as a discrepancy, causing an alarm  . This alarm state can be cleared only by turning the inverter power off and on.
<Digital input circuit specifications>
 

<table>
<tr><th colspan="2">Item</th><th>Min.</th><th>Max.</th></tr>
<tr><td rowspan="2">Operating voltage</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">Operating current at ON
(Input voltage is at 27 V)</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></td></tr>
<tr><td>[PLC]</td><td>PLC signal power</td><td>(1) Connects to the power supply of PLC output signals.
Rated voltage: +24 VDC (Allowable range: +22 to +27 VDC), Maximum 100 mA DC
(2) This terminal also supplies power to the load connected to the transistor output terminals. Refer to "Transistor output" described later in this table for more.</td></tr>
<tr><td>[CM]</td><td>Digital input common</td><td>Common terminal for digital input signals
This terminal is electrically isolated from the terminals [11]s and [CMY].</td></tr>
<tr><td colspan="3">Tip ■ Using a relay contact to turn [X1] to [X7], [FWD], or [REV] ON or OFF
Figure 2.14 shows two examples of a circuit that uses a relay contact to turn control signal input [X1] to [X7], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch SW1 is turned to SINK, whereas in circuit (b) it is turned to SOURCE.
Note: To configure this kind of circuit, use a highly reliable relay.
(Recommended product: Fuji control relay Model HH54PW.)
 

(a) With the switch turned to SINK (b) With the switch turned to SOURCE
Figure 2.14 Circuit Configuration Using a Relay Contact
Tip ■ Using a programmable logic controller (PLC) to turn [X1] to [X7], [FWD], or [REV] ON or OFF
Figure 2.15 shows two examples of a circuit that uses a programmable logic controller (PLC) to turn control signal input [X1] to [X7], [FWD], or [REV] ON or OFF. In circuit (a), the slide switch SW1 is turned to SINK, whereas in circuit (b) it is turned to SOURCE.
In circuit (a) below, short-circuiting or opening the transistor's open collector circuit in the PLC using an external power supply turns ON or OFF control signal [X1] to [X7], [FWD], or [REV]. When using this type of circuit, observe the following:
- Connect the + node of the external power supply (which should be isolated from the PLC's power) to terminal [PLC] of the inverter.
- Do not connect terminal [CM] of the inverter to the common terminal of the PLC.</td></tr>
</table>

Table 2.7 Symbols, Names and Functions of the Control Circuit Terminals (Continued)

<table>
<tr><th>Classifi-cation</th><th>Symbol</th><th>Name</th><th>Functions</th></tr>
<tr><td>Digital input</td><td colspan="3">


(a) With the switch turned to SINK


(b) With the switch turned to SOURCE
Figure 2.15 Circuit Configuration Using a PLC

For details about the slide switch setting, refer to Instruction manual for FRENIC-MEGA Section 2.3.6 "Setting up the slide switches."

Note ■ For inputting a pulse train through the digital input terminal [X7]

• Inputting from a pulse generator with an open collector transistor output

Stray capacity on the wiring between the pulse generator and the inverter may disable transmission of the pulse train. As a countermeasure against this problem, insert a pull-up resistor between the open collector output signal (terminal [X7]) and the power source terminal (terminal [PLC]) if the switch selects the SINK mode input; insert a pull-down resistor between the output signal and the digital common terminal (terminal [CM]) if the switch selects the SOURCE mode input.

A recommended pull-up/down resistor is 1kΩ 2 W. Check if the pulse train is correctly transmitted because stray capacity is significantly affected by the wire types and wiring conditions.
</td></tr>
<tr><td rowspan="2">Analog output</td><td>[FM1]
[FM2]</td><td>Analog monitor</td><td>
Both terminals output monitor signals for analog DC voltage (0 to +10 V) or analog DC current (+4 to +20 mA). The output form (VO/IO) for each of [FM1] and [FM2] can be switched with the slide switches on the control PCB and the function codes, as listed below.
<table>
<tr><th rowspan="2">Terminal</th><th rowspan="2">Terminal function is specified by:</th><th colspan="2">Output form</th><th rowspan="2">Content is specified by:</th></tr>
<tr><th>Analog DC voltage</th><th>Analog DC current</th></tr>
<tr><td rowspan="2">[FM1]</td><td>Slide switch SW4</td><td>VO1</td><td>IO1</td><td rowspan="2">Function code F31</td></tr>
<tr><td>Function code F29</td><td>0</td><td>1</td></tr>
<tr><td rowspan="2">[FM2]</td><td>Slide switch SW6</td><td>VO2</td><td>IO2</td><td rowspan="2">Function code F35</td></tr>
<tr><td>Function code F32</td><td>0</td><td>1</td></tr>
</table>
The signal content can be selected from the following with function codes F31 and F35.

• Output frequency • Output current • Output voltage

• Output torque • Load factor • Input power

• PID feedback amount • Speed (PG feedback value) • DC link bus voltage

• Universal AO • Motor output • Calibration

• PID command • PID output

* Input impedance of the external device: Min. 5kΩ (at 0 to 10 VDC output)
(While the terminal is outputting 0 to 10 VDC, it is capable of driving up to two analog voltmeters with 10 kΩ impedance.)

* Input impedance of the external device: Max. 500Ω (at 4 to 20 mA DC output)

* Adjustable range of the gain: 0 to 300%
</td></tr>
<tr><td>[11]</td><td>Analog common</td><td>Two common terminals for analog input and output signals.
These terminals are electrically isolated from terminals [CM] and [CMY].</td></tr>
</table>

Chapter 3 Monitoring the running status -- Menu #3 "Drive Monitoring" --

Listed below are monitoring items added or modified in the FRENIC-MEGA series of inverters having a ROM version 3000 or later.

LED monitor shows:	Item	Unit	Description
3_17	Target position pulse (synchronous operation)	Pulse	Shows the target position pulse for synchronous operation.
3_18	Current position pulse (synchronous operation)	Pulse	Shows the current position pulse for synchronous operation.
3_19	Current deviation pulse (synchronous operation)	Pulse	Shows the current deviation pulse for synchronous operation.
3_20	Control status monitor (synchronous operation)	--	Shows the current control status. 0: Synchronous operation disabled 20: Synchronous operation canceled 21: Synchronous operation stopped 22: Waiting for detection of Z phase 23: Z phase of reference PG detected 24: Z phase of slave PG detected 25: Synchronization in progress 26: Synchronization completed
3_25	Positioning deviation (synchronous operation)	degree	Shows the positioning deviation (in degree) for synchronous operation.

Note

Difference of notation between standard keypad and remote keypad

Descriptions in this manual are based on the standard keypad having a *four*-digit, 7-segment LED monitor (shown in the original FRENIC-MEGA Instruction Manuals, Chapter 3). The FRENIC-MEGA also provides a multi-function keypad as an option, which has an LCD monitor and a *five*-digit, 7-segment LED, but has no USB port.

If the standard keypad is replaced with an optional multi-function keypad, the display notation differs as shown below.

Function code	Name	Standard keypad	Multi-function keypad (TP-G1-J1)
H42	Capacitance of DC Link Bus Capacitor	Hexadecimal notation	Decimal notation
H44	Startup Counter for Motor 1		
H47	Initial Capacitance of DC Link Bus Capacitor		
H79	Preset Startup Count for Maintenance (M1)		
A52	Startup Counter for Motor 2		
b52	Startup Counter for Motor 3		
r52	Startup Counter for Motor 4		
d15	Feedback Input (Encoder pulse resolution)		
d60	Command (Pulse Rate Input) (Encoder pulse resolution)		
H43	Cumulative Run Time of Cooling Fan	Display in units of 10 hours	Display by hours
H48	Cumulative Run Time of Capacitors on Printed Circuit Boards		
H77	Service Life of DC Link Bus Capacitor (Remaining time)		
H78	Maintenance Interval (M1)		
H94	Cumulative Motor Run Time 1		
A51	Cumulative Motor Run Time 2		
b51	Cumulative Motor Run Time 3		
r51	Cumulative Motor Run Time 4		
d78	Synchronous Operation (Excessive deviation detection range)	Display in units of 10 pulses. (For 10000 pulses or more: Display in units of 100 pulses, with the x10 LED ON)	Display in units of 10 pulses

Chapter 5

Chapter 5-1 Function Code Tables

Listed below are function codes added or modified in the FRENIC-MEGA series of inverters having a ROM version 3600 or later.

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
F29 *1	Analog Output [FMA]/[FM1] (Mode selection)	0: Output in voltage (0 to 10 VDC) 1: Output in current (4 to 20 mA DC) 2: Output in current (0 to 20 mA DC)	Y	Y	0	Y	Y	Y	Y	Y	5
F31 *1	Analog Output [FMA]/[FM1] (Function)	17: Positional deviation in synchronous operation	Y	Y	0	N	Y	N	Y	N	5
F32	Analog Output [FM2] (Mode selection)	0: Output in voltage (0 to 10 VDC) 1: Output in current (4 to 20 mA DC) 2: Output in current (0 to 20 mA DC)	Y	Y	0	Y	Y	Y	Y	Y	5
F35 *1	Pulse Output [FMP] Analog Output [FM2] (Function)		Y	Y	0	N	Y	N	Y	N	5
E01	Terminal [X1] Function	59 (1059): Enable battery operation (***BATRY***)	N	Y	0	Y	Y	Y	Y	Y	5
E02	Terminal [X2] Function		N	Y	1						5
E03	Terminal [X3] Function		N	Y	2						5
E04	Terminal [X4] Function		N	Y	3						5
E05	Terminal [X5] Function		N	Y	4						5
E06	Terminal [X6] Function		N	Y	5						5
E07	Terminal [X7] Function		N	Y	*3						5
E08 *2	Terminal [X8] Function		N	Y	7						
E09 *2	Terminal [X9] Function		N	Y	8						
E20	Terminal [Y1] Function	29 (1029): Synchronization completed (***SY***)	N	Y	0	N	Y	N	Y	N	8
E21	Terminal [Y2] Function		N	Y	1						8
E22	Terminal [Y3] Function		N	Y	2						8
E23	Terminal [Y4] Function		N	Y	7						8
E24	Terminal [Y5A/C] Function		N	Y	15						8
E27	Terminal [30A/B/C] Function		N	Y	99						8
E61	Terminal [12] Extended Function	17: Speed limit FWD 18: Speed limit REV	N	Y	0	Y	Y	Y	Y	Y	8
E62	Terminal [C1] Extended Function		N	Y	0	Y	Y	Y	Y	Y	8
E63	Terminal [V2] Extended Function		N	Y	0	Y	Y	Y	Y	Y	8
E98	Terminal [FWD] Function	59 (1059): Enable battery operation (***BATRY***)	N	Y	98	Y	Y	Y	Y	Y	5
E99	Terminal [REV] Function		N	Y	99	Y	Y	Y	Y	Y	5
C40	Terminal [C1] Range Selection	0: 4 to 20 mA 1: 0 to 20 mA	N	Y	0	Y	Y	Y	Y	Y	8
P05	Motor 1 (Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	8
H81	Light Alarm Selection 1	0000 to FFFF (hex.)	Y	Y	0	Y	Y	Y	Y	Y	9
H82	Light Alarm Selection 2	0000 to FFFF (hex.)	Y	Y	0	Y	Y	Y	Y	Y	9
A19	Motor 2 (Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	8
b19	Motor 3 (Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	8
r19	Motor 4 (Online tuning)	0: Disable 1: Enable	Y	Y	0	Y	N	N	N	N	8
A46	Speed Control 2 I (Integral time)	999: Disable integral action	Y	Y	0.100	N	Y	Y	Y	N	9
b46	Speed Control 3 I (Integral time)	999: Disable integral action	Y	Y	0.100	N	Y	Y	Y	N	9
r46	Speed Control 4 I (Integral time)	999: Disable integral action	Y	Y	0.100	N	Y	Y	Y	N	9
J96	Brake Signal (Speed condition selection)	0 to 31	N	Y	0						9
		Bit 0: Criterion speed for brake-ON (0: Detected speed, 1: Reference speed)				N	N	Y	Y	N	
		Bit 1: Reserved.				N	N	N	N	N	
		Bit 2: Response for brake-OFF current (0: Slow response, 1: Quick response)				Y	Y	Y	Y	N	
		Bit 3: Criterion frequency for brake-ON (0: Stop frequency (F25), 1: Brake-ON frequency (J71))				N	N	Y	Y	N	
		Bit 4: Output condition of brake signal (0: Independent of a run command ON/OFF 1: Only when a run command is OFF)				N	N	Y	Y	N	
d04	Speed Control 1 I (Integral time)	999: Disable integral action	Y	Y	0.100	N	Y	Y	Y	N	9

*1 [FM1] and [FM2] for Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions

*2 Terminals [X8] and [X9] not provided on Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) or USA (FRN_ _ _G1■-□U) version

*3 "8" for Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions; "6" for other versions

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
d12	Speed Control (Jogging) I (Integral time)	999: Disable integral action	Y	Y	0.100	N	Y	Y	Y	N	9
d23	PG Error Processing	0: Continue to run 1 1: Stop running with alarm 1 2: Stop running with alarm 2 3: Continue to run 2 4: Stop running with alarm 3 5: Stop running with alarm 4	N	Y	2	N	Y	Y	Y	N	11
d35	Overspeed Detection Level	0 to 120% 999: Depends on setting of d32 or d33	Y	Y	999	N	Y	Y	Y	Y	12
d41	Application-defined Control	0: Disable (Ordinary control)	N	Y	0	Y	Y	Y	Y	Y	13
		1: Enable (Constant peripheral speed control)				N	Y	N	N	N	
		2: Enable (Simultaneous synchronization, without Z phase)				N	Y	N	Y	N	
		3: Enable (Standby synchronization)				N	Y	N	Y	N	
		4: Enable (Simultaneous synchronization, with Z phase)				N	Y	N	Y	N	
d60	Command (Encoder pulse resolution)	0014 to 0E10 (hex.) (20 to 3600 pulses)	N	Y	0400 (1024)	N	Y	N	Y	N	13
d71	Synchronous Operation (Main speed regulator gain)	0.00 to 1.50 times	Y	Y	1.00	N	Y	N	Y	N	13
d72	(APR P gain)	0.00 to 200.00 times	Y	Y	15.00	N	Y	N	Y	N	13
d73	(APR positive output limiter)	20 to 200%, 999: No limiter	Y	Y	999	N	Y	N	Y	N	13
d74	(APR negative output limiter)	20 to 200%, 999: No limiter	Y	Y	999	N	Y	N	Y	N	13
d75	(Z phase alignment gain)	0.00 to 10.00 times	Y	Y	1.00	N	Y	N	Y	N	13
d76	(Synchronous offset angle)	0 to 359 degrees	Y	Y	0	N	Y	N	Y	N	13
d77	(Synchronization completion detection angle)	0 to 100 degrees	Y	Y	15	N	Y	N	Y	N	13
d78	(Excessive deviation detection range)	0 to 65535 (Display in units of 10 pulses) (For 10000 or more: Display of the upper four digits in units of 100 pulses)	Y	Y	65535 *4	N	Y	N	Y	N	13
d81	Reserved	0 or 1	Y	Y	1	-	-	-	-	-	-
d82	Magnetic Flux Weakening Control (Vector control without speed sensor)	0: Disable 1: Enable	Y	Y	1	N	N	N	N	Y	13
d83	Magnetic Flux Weakening Low Limiter (Vector control without speed sensor)	10 to 70%	Y	Y	40%	N	N	N	N	Y	13
d84	Reserved	0 to 20 dB	Y	Y	5 dB	-	-	-	-	-	-
d85	Reserved	0 to 200%	Y	Y	95%	-	-	-	-	-	-
d90	Magnetic Flux Level during Deceleration (Vector control)	100 to 300%	Y	Y	150%	N	N	Y	Y	N	14
d91	ACR P gain (Vector control)	0.00 to 2.00, 999	Y	Y	999	N	N	Y	Y	Y	14
d92	Reserved	0.00 to 3.00	Y	Y	0.00	-	-	-	-	-	-
d98	Reserved	0000 to FFFF (hex.)	Y	Y	0000	Y	Y	N	N	N	-
d99	Function Extension 1	0 to 31	Y	Y	0						14
		Bit 0: Reserved				-	-	-	-	-	
		Bit 1: Reserved				-	-	-	-	-	
		Bit 2: Reserved				-	-	-	-	-	
		Bit 3: ***JOG*** (Ready for jogging) via the communications link (0: Disable, 1: Enable)				Y	Y	Y	Y	N	
		Bit 4: Reserved				-	-	-	-	-	
U01	Customizable Logic: (Input 1)	29 (1029): Synchronization completed (***SY***)	N	Y	0	N	Y	N	Y	N	8
U02	Step 1 (Input 2)		N	Y	0						8
U06	Customizable Logic: (Input 1)		N	Y	0						8
U07	Step 2 (Input 2)		N	Y	0						8
U11	Customizable Logic: (Input 1)		N	Y	0						8
U12	Step 3 (Input 2)		N	Y	0						8
U16	Customizable Logic: (Input 1)		N	Y	0						8
U17	Step 4 (Input 2)		N	Y	0						8
U21	Customizable Logic: (Input 1)		N	Y	0						8
U22	Step 5 (Input 2)		N	Y	0						8
U26	Customizable Logic: (Input 1)		N	Y	0						8
U27	Step 6 (Input 2)		N	Y	0						8
U31	Customizable Logic: (Input 1)		N	Y	0						8
U32	Step 7 (Input 2)		N	Y	0						8

*4 The standard keypad displays 6553 on the LED monitor and lights the x10 LED.

(For USA (FRN_ _ _G1■-□U) version, the standard keypad is Multi-function keypad (TP-G1W-J1).)

Code	Name	Data setting range	Change when running	Data copying	Default setting	Drive control					Refer to page:
						V/f	PG V/f	w/o PG	w/ PG	Torque control	
U36	Customizable Logic: (Input 1)		N	Y	0						8
U37	Step 8 (Input 2)		N	Y	0						8
U41	Customizable Logic: (Input 1)		N	Y	0						8
U42	Step 9 (Input 2)		N	Y	0						8
U46	Customizable Logic: (Input 1)		N	Y	0						8
U47	Step 10 (Input 2)		N	Y	0						8
U81	Customizable Logic Output Signal 1 (Function selection)	59 (1059): Enable battery operation (***BATRY***)	N	Y	100	Y	Y	Y	Y	Y	5
U82	Customizable Logic Output Signal 2		N	Y	100	Y	Y	Y	Y	Y	5
U83	Customizable Logic Output Signal 3		N	Y	100	Y	Y	Y	Y	Y	5
U84	Customizable Logic Output Signal 4		N	Y	100	Y	Y	Y	Y	Y	5
U85	Customizable Logic Output Signal 5		N	Y	100	Y	Y	Y	Y	Y	5

Chapter 5-2 Details of Function Codes Added

F29 Analog output [FMA]/[FM1] (Mode selection) *

F32 Analog output [FM2] (Mode selection) *

* [FM1] and [FM2] are for Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions.

Versions except Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions

■ 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 (control PCB).

Data for F29	[FMA] output form	Position of slide switch SW4 mounted on the control PCB
2	Current (0 to +20 mA DC)	IO

Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions

■ Mode selection (F29 and F32)

F29 and F32 specify the property of the output to terminals [FM1] and [FM2], respectively. You need to set the slide switches on the control printed circuit board (control PCB).

Output form	Terminal [FM1]		Terminal [FM2]	
	Data for F29	Position of slide switch SW4 on the control PCB	Data for F32	Position of slide switch SW6 on the control PCB
Current (0 to +20 mA DC)	2	IO1	2	IO2

F31 Analog Output [FMA]/[FM1] (Function) *

F35 Pulse Output [FMP] (Function)
Analog Output [FM2] (Function) *

* [FM1] and [FM2] are for Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) and USA (FRN_ _ _G1■-□U) versions.

These function codes enable monitoring of deviation in angle in synchronous operation. For details about synchronous operation, refer to the PG Interface Card Instruction Manual.

Data for F31 / Data for F35	[FMA]/[FM1] output / [FMP]/[FM2] output	Function (Monitor the following)	Meter scale (Full scale at 100%)
17	Positional deviation in synchronous operation	Deviation in angle	0% to 50% to 100%, representing -180° to 0° to +180° of the deviation

E01 to E09 Terminal [X1] to [X9] Function
E01 to E07 Terminal [X1] to [X7] Function *

E98 Terminal [FWD] Function
E99 Terminal [REV] Function

U81 to U85 Customizable Logic Output Signal 1 to 5 (Function selection)

* Terminals [X8] and [X9] are not provided on Asia (FRN_ _ _G1■-□A), EU (FRN_ _ _G1■-□E) or USA (FRN_ _ _G1■-□U) version.

Function code data		Terminal commands assigned	Symbol	Drive control					Related function codes
Active ON	Active OFF			V/f	PGV/f	w/oPG	w/PG	Torque control	
59	1059	Enable battery operation	***BATRY***	Y	Y	Y	Y	Y	

■ Enable battery operation -- ***BATRY*** (Function code data = 59)

Turning this terminal command ON cancels the undervoltage protection so that the inverter runs the motor with battery power under an undervoltage condition.

When ***BATRY*** is assigned to any digital input terminal, the inverter trips after recovery from power failure just as F14 = 1 regardless of F14 setting. When ***BATRY*** is ON, the main power down detection is disabled regardless of H72 setting.

Note **Prerequisites for battery operation**

(1) The terminal command ***BATRY*** (data = 59) must be assigned to any digital input terminal.

(2) A DC link bus voltage must be supplied from the battery to the main circuit (L1/R-L3/T or L2/S-L3/T) as shown in Figures A and B given below.

(3) A regulated voltage (sine-wave or DC voltage) must be supplied to the auxiliary power supply (R0-T0).

(4) For 200 V class series / 230V class series for USA of 37 kW / 60 HP or above and 400 V ones / 460V ones for USA of 75 kW / 125 HP or above, a regulated voltage (sine-wave) must be supplied to the auxiliary fan power supply (R1-T1) as shown in Figure B. The fan power supply connector must be configured for battery operation as shown in Figure C.

(5) The ***BATRY***-assigned terminal (data = 59) must be turned ON at the same moment as closing of MC2.

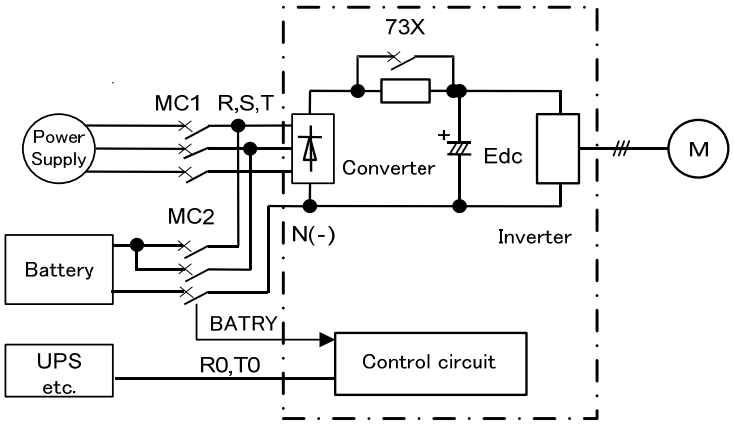


Figure A Connection Diagram
for 200 V Class Series of 30 kW
(230V Ones of 50HP for USA)
or Below
and 400 V Ones of 55 kW
(460V Ones of 100HP for USA)
or Below

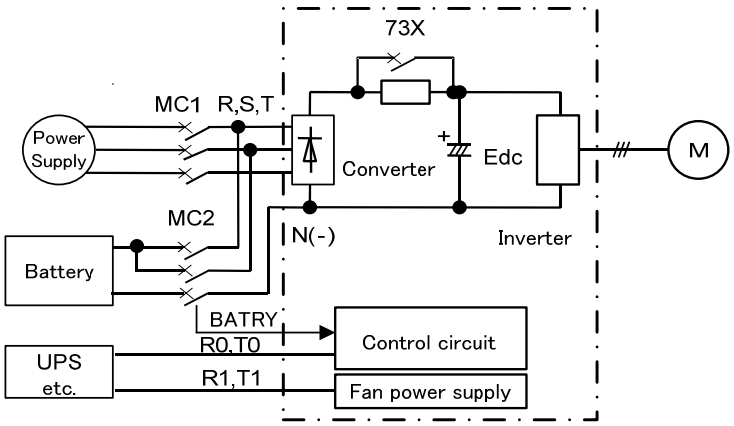


Figure B Connection Diagram
for 200 V Class Series of 37 kW
(230V Ones for USA of 60HP)
or Above
and 400 V Ones of 75 kW
(460V Ones for USA of 125HP)
or Above

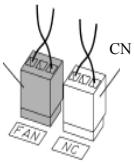
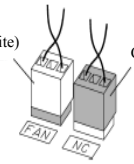
Setting	CN R (Red)  CN W (White)	CN W (White)  CN R (Red)
Usage	When not using R1 or T1 (Factory default)	When using R1 and T1 (BATRY operation)

Figure C Fan Power Supply Switching Connector

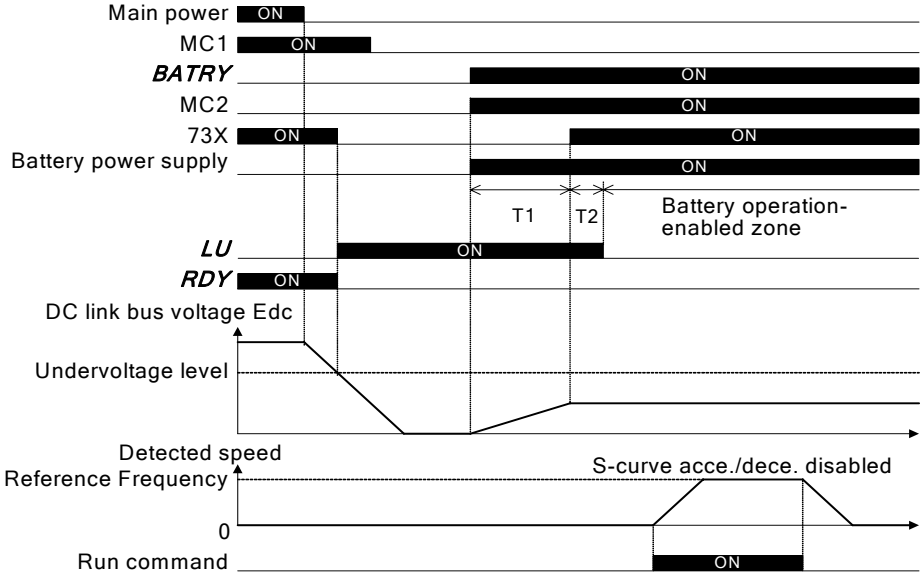
Note **About battery operation (when *BATRY* is ON)**

(1) The undervoltage protective function (*LU*) is deactivated.

(2) The inverter can run the motor even under an undervoltage condition.

(3) The ***RDY*** ("Inverter ready to run") output signal is forcedly turned OFF.

(4) The bypass circuit of the charging resistor comes to be closed (73X ON) after a delay of time T1 from when the ***BATRY*** is turned ON. Further, after a delay of time T2 (a maximum of 0.1 second), the battery operation starts. For the specifications of T1, see the table below.



Battery Operation Timing Diagram

T1 from ***BATRY*** ON to 73X ON

Power condition	30 kW / 50 HP or below	37 kW / 60 HP or above
After the control power supply goes OFF, the battery power and control power are turned ON.	100 ms	500 ms
The control power remains ON or after a momentary power failure happens.	205 ms	

(5) The S-curve acceleration/deceleration is disabled.

(6) The battery operation speed can be calculated by the following formula.

$$\text{Reference speed (pre-ramp) during battery operation} \le \frac{\text{Battery voltage} - 5[V]}{\sqrt{2} \times \text{Rated voltage}} \times \text{Rated speed} \times \text{k}$$

Where,

Battery voltage: 24 VDC or higher for 200 V class series / 230 V class series for USA
48 VDC or higher for 400 V class series / 460 V class series for USA.

Rated speed : F04

Rated voltage : F05 (Motor rated voltage (V))

k: Safety coefficient (Less than 1, about 0.8)

Precautions

(1) The battery power supply must be connected before or at the same moment as turning ON of ***BATRY***.

(2) As shown in the timing diagram above, battery operation is possible within the battery operation-enabled zone. There is a delay of "T1 + T2" after the ***BATRY***, MC2, and battery power supply are turned ON.

(3) The ***BATRY*** must not be turned ON when the voltage level is higher than the specified undervoltage level (that is, before the LU appears after a power failure). Turning the ***BATRY*** ON causes the bypass circuit (73X) of the charging resistor to stick to ON (closed).

(4) During battery operation, driving with a heavy load must be avoided and the motor must run with no load or braking load condition. Low battery voltage cannot generate sufficient torque, causing the motor to stall.

(5) The battery operation must be performed at a low speed. Be careful with the battery capacity.
When a high voltage (e.g., 300 VDC for 200 V class series / 230 V class series for USA of inverters or 600 VDC for 400 V ones / 460 V ones for USA) is applied, not battery operation but normal operation must be performed.

(6) In normal operation, the ***BATRY*** must be OFF. Turning the main power supply ON with the ***BATRY*** being ON could damage the rectifier diode because the 73X is ON.

E20 to E23 **Terminal [Y1] to [Y4] Function**
E24, E27 **Terminal [Y5A/C] and [30A/B/C] Functions (Relay output)**

U01, U02 … U46, U47 **Customizable Logic: Step 1 to 10 (Input 1, Input 2)**

Function code data		Functions assigned	Symbol	Drive control				
Active ON	Active OFF			V/f	PG V/f	w/o PG	w/ PG	Torque control
29	1029	Synchronization completed	***SY***	N	Y	N	Y	N
101	1101	Enable circuit failure detected	***DECF***	Y	Y	Y	Y	Y
102	1102	Enable input OFF	***EN OFF***	Y	Y	Y	Y	Y

■ Synchronization completed -- ***SY*** (Function code data = 29)

This output signal comes ON when the control target comes inside the synchronization completion detection angle in synchronous operation.

For details about synchronous operation, refer to the PG Interface Card Instruction Manual.

■ Enable circuit failure detected -- ***DECF*** (Function code data = 101)

This output signal comes ON when the inverter detects a failure of the Enable circuit (*1).

Configure a feedback circuit of the Enable input function as needed to feed back the transistor output of the ***DECF***-assigned inverter to the reset input of the upper safety relay unit for turning the Enable command off and shutting down the inverter output. (Refer to Figure 9.10 "In the case of FRN_ _ _G1■-□□" in Section 9.6.6.)

■ Enable input OFF -- ***EN OFF*** (Function code data = 102)

This output signal comes ON when Enable inputs on [EN1] and [EN2] terminals are OFF (opened). See the table below.

***1:** These signals do not assure detection of all of single failures. (Compliant with EN ISO13849-1 PL=d Cat. 3)

Logic Table for ***DECF*** and ***EN OFF*** Signals

Main power input L1/R, L2/S, L3/T	Enable input		Transistor output or Alarm relay output (for any error) *2		Output
	EN1-PLC	EN2-PLC	***DECF***	***EN OFF***	
OFF	x	x	OFF	OFF	Shut down (Safe Torque Off (STO) *3)
ON	OFF	OFF	OFF	ON	Shut down (Safe Torque Off (STO) *3)
	ON	ON	OFF	OFF	Wait for a run command
	ON	OFF	ON *4	OFF	Shut down (Safe Torque Off (STO) *3)
	OFF	ON	ON *4	OFF	Shut down (Safe Torque Off (STO) *3)

x: Independent of this state, the output is determined.

*2 To use these functions, it is necessary to assign ***DECF***/***EN OFF*** to digital output terminals (function codes E20 to E24 and E27, data = 101/102 or 1101/1102 (negative logic)).

*3 Output shutdown (Safe Torque Off) prescribed in IEC61800-5-2.

*4 If either one of these terminals are kept OFF for 50 ms or more, the inverter interprets it as a discrepancy, causing an alarm ECF. This alarm state can be cleared only by turning the inverter power off and on.

E61 Terminal [12] Extended Function
E62 Terminal [C1] Extended Function
E63 Terminal [V2] Extended Function

E61, E62, and E63 define the function of the terminals [12], [C1], and [V2], respectively.

As listed below, under torque control, analog inputs through terminals [12], [C1], and [V2] specify the motor speed limit values. To limit the motor speed to the maximum frequency (F02, A01, b01, r01), apply a full-scale analog input (maximum input).

It is recommended that this speed limit function be used together with d35 (Overspeed detection level).

Data for E61, E62, or E63	Input assigned to [12], [C1] and [V2]
17	Speed limit FWD
18	Speed limit REV

Note Function codes C31 to C45 (Analog input adjustment) apply to these analog inputs.

C40 Terminal [C1] Range Selection

C40 specifies the range of the input current signal on terminal [C1] as listed below.

Data for C40	Range of Input Current Signal on Terminal [C1]
0	4 to 20 mA
1	0 to 20 mA

P05, A19 Motor 1/2/3/4 (Online tuning)
b19, r19

Long run under "Dynamic torque vector control" or "Slip compensation control" causes motor temperature change, varying the motor parameters. This changes the motor speed compensation amount, resulting in motor speed deviation from the initial rotating speed.

Enabling online tuning identifies motor parameters covering the motor temperature change to decrease the motor speed fluctuation.

To perform online tuning enabled with P05/A19/b19/r19, set P04 (Auto-tuning) to "2."

Note Note: Online tuning can be performed only when F42 = 1 (Dynamic torque vector control) or when F42 = 2 (V/f control with slip compensation active) and F37 = 2 or 5 (Auto torque boost).

A46, b46, r46, d04, Speed Control 2, Speed Control 3, Speed Control 4, Speed Control 1,
d12 Speed Control (Jogging) (Integral time)

These function codes are used to configure the Automatic Speed Regulator (ASR) by selecting the PI controller or P controller.

Setting the function code data to "999" selects the P controller.

H81, H82 Light Alarm Selection 1 and 2

Assigning "1" to bit 2 of H82 defines excessive positioning deviation in synchronous operation as a light alarm.

For details about excessive positioning deviation, refer to the PG Interface Card Instruction Manual.

For details about definition of light alarms, refer to the FRENIC-MEGA Instruction Manual, Chapter 5.

Light Alarm Selection 2 (H82), Bit Assignment of Selectable Factors

Bit	Code	Content
2	Er-0	Positioning control error

Note Even if a positioning control error is defined as a light alarm with H82, the error that occurred when the inverter was servo-locked does not cause a light alarm operation but trips the inverter.

J68 to J72 J95, J96 Brake Signal

These function codes are for the brake releasing/turning-on signals of vertical carrier machines.

It is possible to set the conditions of the brake releasing/turning-on signals (current, frequency or torque) so that a hoisted load does not fall down at the start or stop of the operation, or so that the load applied to the brake is reduced.

Releasing the Brake

When any of the inverter output current, output frequency, or torque command value exceeds the specified level of the brake signal (J68/J69/J95) for the period specified by J70 (Brake signal (Brake-OFF timer)), the inverter judges that required motor torque is generated and turns the signal ***BRKS*** ON for releasing the brake.

This prevents a hoisted load from falling down due to an insufficient torque when the brake is released.

Function code	Name	Data setting range	Remarks
J68	Brake-OFF current	0% to 300%:	
J69	Brake-OFF frequency/speed	0.0 to 25.0 Hz	Available only under V/f control.
J70	Brake-OFF timer	0.0 to 5.0 s	
J95	Brake-OFF torque	0% to 300%	Available only under vector control.
J96	Speed condition selection (Braking conditions)	Response for brake-OFF current (Bit 2) 0: Slow response (default) 1: Quick response	Specifies the response type for brake-OFF current detection. Selecting slow response inserts a detection filter into the current detection circuit so that the brake-OFF timing will be slightly behind the rising edge of the actual current. If the delay is not negligible with adjustments, select quick response.

Turning the Brake ON

When the run command is OFF and the output frequency drops below the level specified by J71 (Brake signal (Brake-ON frequency/speed)) and stays below the level for the period specified by J72 (Brake signal (Brake-ON timer)), the inverter judges that the motor rotation is below a certain level and turns the signal ***BRKS*** OFF for activating the brake.

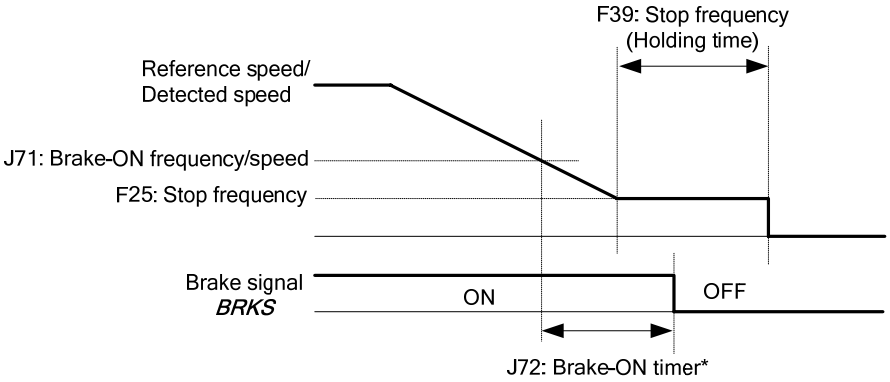
Under vector control, when the reference speed or the detected one drops below the level of the brake-ON frequency (specified by bit 3 of J96) and stays below the level for the period specified by J72 (Brake signal (Brake-ON timer)), the inverter judges that the motor rotation is below a certain level and turns the signal ***BRKS*** OFF for activating the brake.

This operation reduces the load applied to the brake, extending lifetime of the brake.

Function code	Name	Data setting range	Remarks
J71	Brake-ON frequency/speed	0.0 to 25.0 Hz	
J72	Brake-ON timer	0.0 to 5.0 s	
J96	Speed condition selection (Braking conditions)	Criteria of speed condition for brake-ON (Bit 0) 0: Detected speed 1: Reference speed	(Available only under vector control.) Specifies the criteria of speed to be used for brake-ON condition. When "Vector control without speed sensor" is selected, specify "Reference speed" (Bit 0 = 1).

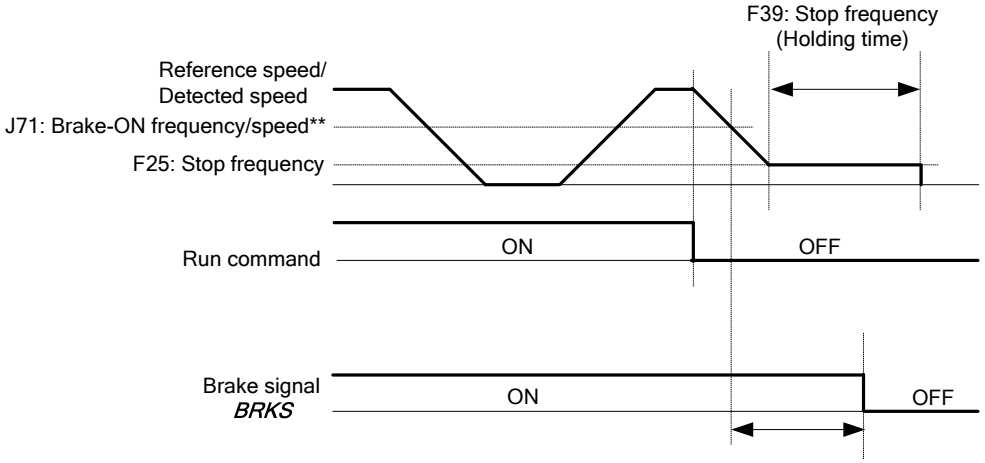
Function code	Name	Data setting range	Remarks
		Criteria of frequency for brake-ON (Bit 3) 0: Stop frequency (F25) 1: Brake-ON frequency (J71)	(Available only under vector control.) Specifies the criteria of frequency to be used for brake-ON timing. If "Detected speed" and "Stop frequency" are selected (Bit 0 = 0 and Bit 3 = 0) to determine brake-ON timing, the brake may be applied after running at the stop frequency (F25) due to a speed error. If it is required that brake is applied during running at the stop frequency, select "Brake-ON frequency" (Bit 3 = 1) as criteria of frequency. When jogging or inching the motor for vertical conveyance, use J71 as brake-ON frequency.
		Turn-on condition of brake signal (Bit 4) 0: Independent of a run command ON/OFF 1: Only when a run command is OFF	(Available only under vector control.) Specifies whether to turn on a brake signal independent of a run command ON/OFF or only when a run command is OFF. When normal and reverse operations are switched, brake-ON conditions may be met in the vicinity of zero speed. For such a case, select "Only when a run command is OFF" (Bit 4 = 1).

• Operation time chart when Criteria of frequency for brake-ON (Bit 3) = 1 (Brake-ON frequency)



*If the inverter output is shut down during the timer period specified by J72, the inverter ignores the timer count and activates the brake.

• Operation time chart when Turn-on condition of brake signal (Bit 4) = 1 (Only when a run command is OFF)



*If the inverter output is shut down during the timer period specified by J72, the inverter ignores the timer count and activates the brake.

**When bit 3 of J96 = 1

d23 PG Error Processing

d23 defines the detection condition and error processing to be applied when a PG error occurs.

- Data setting range: d23 = 0, 1, 2, 3, 4, 5

Data for d23	Function
0	Continue to run 1
1	Stop running with alarm 1
2	Stop running with alarm 2
3	Continue to run 2
4	Stop running with alarm 3
5	Stop running with alarm 4

If the speed regulator's deviation (between the reference speed and detected one) is out of the specified range (d21) for the specified period (d22), the inverter judges it as a PG error.

d23 defines the detection condition (and exception), processing after error detection, and hysteresis width as listed below.

Data for d23	Detection condition (and exception)	Processing after error detection	Hysteresis width for error detection
0	When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.	The inverter outputs the PG error detected signal ***PG-ERR*** and continues to run.	Detection width = d21 × Maximum frequency, which is constant even if the speed command is above the base frequency (F04).
1		The inverter initiates a motor coast to stop, with the Er-E alarm. It also outputs the PG error detected signal ***PG-ERR***.	
2	No exception.		
3	When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a PG error.	The inverter outputs the PG error detected signal ***PG-ERR*** and continues to run.	If the speed command is below the base frequency (F04), detection width = d21 × Maximum frequency, which is constant. If it is above the base frequency, detection width = d21 × Speed command × Maximum frequency ÷ Base frequency (F04).
4		The inverter initiates a motor coast to stop, with the Er-E alarm. It also outputs the PG error detected signal ***PG-ERR***.	
5	No exception.		

d35 Overspeed Detection Level

d35 specifies the overspeed detection level under torque control by percentage of the maximum frequency (F03, A01, b01, r01).

If the following condition is satisfied, the inverter detects an overspeed state and issues an overspeed alarm 05.

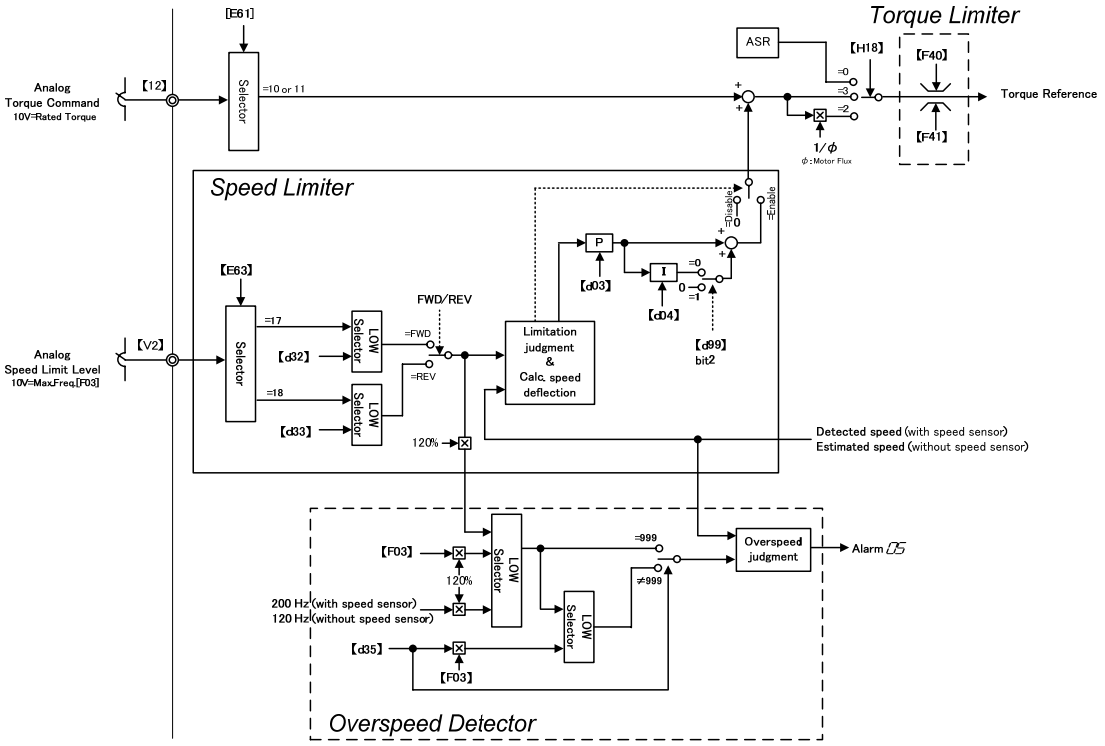
Motor speed ≥ Maximum frequency (F03/A01/b01/r01) × d35

Setting d35 data to "999" causes the inverter to issue an overspeed alarm 05 if either of the following conventional conditions is satisfied.

Motor speed ≥ Maximum frequency (F03/A01/b01/r01) × (d32 or d33) × 1.2

or

Motor speed ≥ 200 Hz (vector control with speed sensor) or 120 Hz (vector control without speed sensor) × (d32 or d33) × 1.2



Block Diagram of Torque Control

Note **Torque/Torque current command**

It is possible to command torque/torque current from an analog voltage input (terminal [12] or [V2]) or analog

current input (terminal [C1]), or via the communications link (function codes S02 and S03).

(To use the analog voltage/current input, function codes E61 (terminal [12]), E62 (terminal [C1]), and E63 (terminal [V2]) should be set to 10 or 11 as shown in the table below.

Input	Command form	Function codes	Setting specifications (Factory default)
Terminal [12] (-10 V to 10 V)	Torque command	E61=10	Motor rated torque ±100% / ±10V
	Torque current command	E61=11	Motor rated torque current ±100% / ±10V
Terminal [V2] (-10 V to 10 V)	Torque command	E63=10	Motor rated torque ±100% / ±10V
	Torque current command	E63=11	Motor rated torque current ±100% / ±10V
Terminal [C1] (0, 4 to 20 mA)	Torque command	E62=10	Motor rated torque 100% / 20 mA
	Torque current command	E62=11	Motor rated torque current 100% / 20 mA
S02 (-327.68 to 327.67%)	Torque command	-	Motor rated torque / ±100.00%
S03 (-327.68 to 327.67%)	Torque current command	-	Motor rated torque current / ±100.00%

Function codes C31 to C45 (Analog input adjustment) are applied to these analog inputs.

Speed limiter

The response of the speed limiter can be adjusted by using P gain and Integral time of the speed control as listed below.

Selected Motor	Function Codes	
	P gain	Integral time
M1	d03	d04
M2	A45	A46
M3	b45	b46
M4	r45	r46

d41 Application-Defined Control

d41 selects/deselects constant peripheral speed control or synchronous operation (simultaneous or standby synchronization).

Constant peripheral speed control suppresses an increase in peripheral speed (line speed) resulting from the increasing radius of the take-up roll in a winder system.

Synchronous operation drives two or more shafts of a conveyer while keeping their positions in synchronization. For details about synchronous control, refer to the PG Interface Card Instruction Manual.

■ Application-Defined Control (d41)

Data for d41	Function
0	Disable (Ordinary control)
1	Enable (Constant peripheral speed control) 🕮 Refer to the FRENIC-MEGA User's Manual, Chapter 5, Section 5.4.8 "d codes (Application functions 2)."
2	Enable (Simultaneous synchronization, without Z phase)
3	Enable (Standby synchronization)
4	Enable (Simultaneous synchronization, with Z phase)

d60 to d63 Command (Pulse Rate Input) (Encoder pulse resolution, Filter time constant, Pulse count factor 1, Pulse count factor 2)

d71 to d78 Synchronous Operation

These function codes specify various parameters required for synchronous operation. For details, refer to the PG Interface Card Instruction Manual.

d82 Magnetic Flux Weakening Control (Vector control without speed sensor)

Setting d82 data to "1" (Enable) controls the motor magnetic flux in accordance with the torque command.

When the torque command value is small, this control weakens the motor magnetic flux to improve the control stability.

d83 Magnetic Flux Weakening Low Limiter (Vector control without speed sensor)

d83 applies to the lower limit of the motor magnetic flux level when d82 = 1 (Enable).

Decreasing the d83 setting too much may cause hunting, speed stagnation, and other problems.

Use the default setting "40%" as long as there is no problem.

d90 Magnetic Flux Level during Deceleration (Vector control)

d90 specifies the magnetic flux level to be applied during deceleration under vector control by percentage of the rated motor magnetic flux (determined by P06/A20/b20/r20).

d90 data takes effect only when H71 = 1 (Deceleration Characteristics enabled) and F42/A14/b14/r14 = 5 or 6 (Vector control with/without speed sensor).

Increasing the d90 setting can reduce the deceleration time but increases the inverter output current and the motor temperature rise. In applications repeating frequent start/stop drive, an overload may apply to the inverter or motor.

Adjust the d90 setting so that the inverter output current (RMS equivalent) comes to be smaller than the motor rated current.

Use the default setting "150%" as long as there is no problem.

d91 ACR P gain (Vector control)

Vector control feeds back the motor output current to control a motor to follow the current command.
This function specify the gain for the current control (ACR).
Usually it must not be changed from the factory setting.
When a winding has a large inductance, it should be set a large P gain to compensate it in general.
When a winding has a small inductance, it should be set a small P gain to prevent OC(overcurrent) due to the overshoot of the current.

d99 Function Extension 1

Setting bit 3 of d99 to "1" enables a ***JOG*** ("Ready for jogging") given via the communications link.

Other bits of d99 are reserved for particular manufacturer, so do not change the settings.

Chapter 6

6.4 If an Alarm Code Appears on the LED Monitor

[34] ECF Enable circuit failure

Alarm code	Alarm name	Possible cause, what to check, and suggested measures
ECF	Enable circuit failure	(1) Contact failure of the interface printed circuit board (PCB). ➔ Check that the interface PCB is firmly mounted in place. (Turning the inverter power off and on clears this alarm.)
		(2) Enable circuit logic error ➔ Check that the two output levels of the safety switch or other safety device are not discrepant. (EN1/EN2 = High/High or Low/Low) (Turning the inverter power off and on clears this alarm.)

Chapter 9

9.2 Compliance with European Standards

The CE marking on Fuji products indicates that they comply with the essential requirements of the Electromagnetic Compatibility (EMC) Directive 2004/108/EC, Low Voltage Directive 2006/95/EC and Machinery Directive 2006/42/EC which are issued by the Council of the European Communities

The products comply with the following standards

		Basic type	EMC filter built-in type
Electromagnetic Compatibility		Depends upon a filter dedicated to Fuji inverters*	EN61800-3 : 2004 Immunity : Second environment (Industrial) Emission : Category C3
Electrical Safety		EN61800-5-1: 2007	
Functional Safety		EN954-1:1997, EN61800-5-2:2007 SIL 2, EN ISO 13849-1 :2008	
	Stop function	Safe torque off (STO: acc.EN61800-5-2:2007)	
	Response time	50 ms or less (delay time to "Safe torque off" from turning off either terminal [EN1] or [EN2)]	
	Safety integrity level	SIL 2	
	PFH	1.7 × 10^-9 (Probability of a dangerous random hardware failure per hour)	
	Category	3 (EN ISO 13849-1:2008)	
	Performance level	d (EN ISO 13849-1:2008)	

* If connected with an external EMC filter dedicated to Fuji inverters, the basic type of inverters that bear a CE marking but have no built-in EMC filter becomes compliant with these EMC Directives.

CAUTION

The EMC filter built-in type of the FRENIC-MEGA inverters is categorized as "Category C3" of the EN61800-3. It is not designed for use in a domestic environment. It may interfere with the operations of home appliances or office equipment due to noise emitted from it.

* To bring the inverter into compliance with Functional Safety Standard, it is necessary to bring it into compliance with European Standards EN61800-5-1 and EN61800-3.

9.6 Compliance with Functional Safety Standard

9.6.1 General

In FRENIC-MEGA series of inverters, opening the hardware circuit between terminals [EN1]-[PLC] or between terminals [EN2]-[PLC] stops the output transistor, coasting the motor to a stop. (EN1: Enable input 1, EN2: Enable input 2) This is the Safe Torque Off (STO) function prescribed in EN60204-1, Category 0 (Uncontrolled stop) and compliant with Functional Satety Standard.

Using the Safe Torque Off (STO) function eliminates the need of external safety circuit breakers while conventional inverters need those breakers to configure the Functional Satety Standard compliant safety system.

⚠WARNING⚠

- The output shutdown function of this inverter uses the Safe Torque Off (STO) function prescribed in IEC61800-5-2 so that it does not completely shut off the power supply to the motor electrically. Depending upon applications, therefore, additional measures are necessary for safety of end-users, e.g., brake function that locks the machinery and motor terminal protection that prevents possible electrical hazard(s).
- The output shutdown function does not completely shut off the power supply to the motor electrically. Before starting wiring or maintenance jobs, therefore, be sure to disconnect the input power to the inverter and wait at least five minutes for inverters with a capacity of 22 kW/40 HP or below, or at least ten minutes for inverters with a capacity of 30 kW/50 HP or above.

Enable terminals and peripheral circuit, and internal circuit configuration

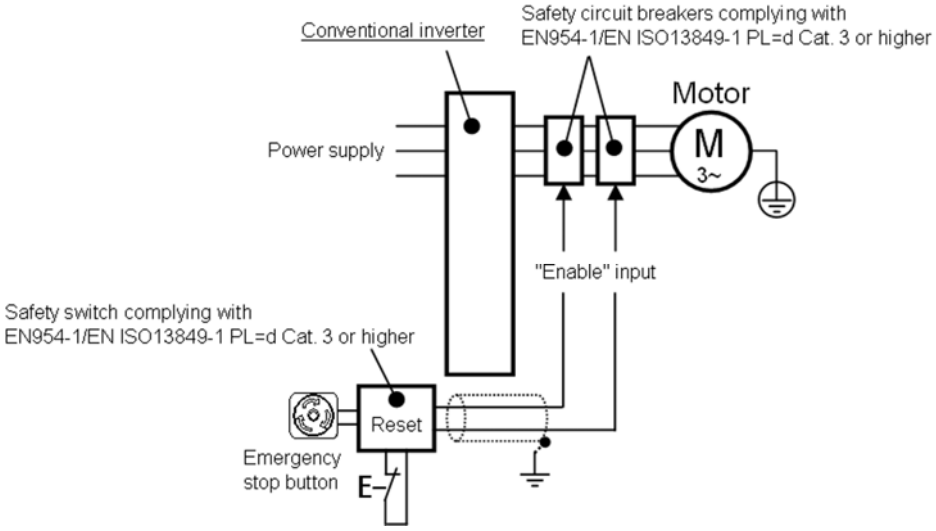
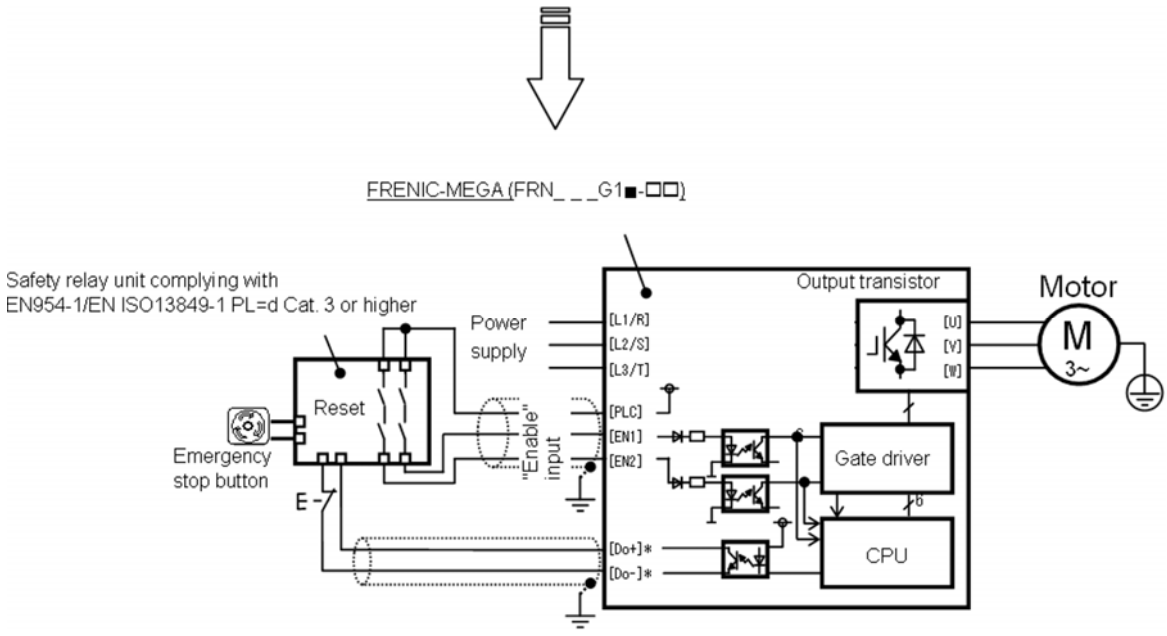


Figure 9.5 Conventional Inverters



*Transistor output terminals (e.g., [Y1]-[CMY], DECF(Function code data=1101), Refer to Section 9.6.6)

Figure 9.6 FRN_ _ _G1■-□□

9.6.2 Notes for compliance to Functional Safety Standard

(1) Wiring for terminals [EN1] (Enable input 1) and [EN2] (Enable input 2)

- [EN1]/[EN2] and [PLC] are terminals prepared for connection of safety related wires; therefore, careful wiring should be performed to ensure that no short-circuit(s) can occur to these terminals.
- For opening and closing the hardware circuit between terminals [EN1]/[EN2] and [PLC], use safety approved components such as safety relays that comply with EN954-1/EN ISO13849-1 PL=d Cat. 3 or higher to ensure a complete shutoff.
- It is the responsibility of the machinery manufacturer to guarantee that a short-circuiting or other fault does not occur in wiring of external safety components between terminals [EN1]/[EN2] and [PLC].

  Fault examples:
  - Terminals [EN1]/[EN2] and [PLC] are short-circuited due to the wiring being caught in the door of the control panel so that a current continues to flow in terminal [EN1]/[EN2] although the safety component is OFF and therefore the safety function may NOT operate
  - The wiring is in contact with any other wire so that a current continues to flow in terminal [EN1]/[EN2] and therefore the safety function may NOT operate

(2) Note for Safe Torque Off (STO)

- When configuring the product safety system with this Safe Torque Off (STO) function, make a risk assessment of not only the external equipment and wiring connected to terminals [EN1] and [EN2] (Enable input 1 and Enable input 2) but also the whole system including other equipment, devices and wiring against the product safety system required by the machinery manufacturer under the manufacturer's responsibility in order to confirm that the whole system conforms to the product safety system required by the machinery manufacturer.

  In addition, as preventive maintenance, the machinery manufacturer must perform periodical inspections to check that the product safety system properly functions.
- To bring the inverter into compliance with Functional Safety Standard, it is necessary to install the inverter on a control panel with the enclosure rating of IP54 or above.
- To bring the inverter into compliance with Functional Safety Standard, it is necessary to bring it into compliance with European Standards EN61800-5-1 and EN61800-3.
- This Safe Torque Off (STO) function coasts the motor to a stop. When a mechanical brake is used to stop or hold the motor for the sake of the product safety system of whole system, do not use the inverter's control signals such as output from terminal [Y]. (Using control signals does not satisfy the safety standards because of software intervention.) Use safety relay units complying with EN954-1/EN ISO13849-1 PL=d Cat. 3 or higher to activate mechanical brakes.
- The safety shutdown circuit between terminal [EN1] and [EN2] input sections and inverter's output shutdown section is dual-configured (redundant circuit) so that an occurrence of a single fault does not detract the Safe Torque Off (STO).

  If a single fault is detected in the safety shutdown circuit, the inverter coasts the motor to a stop even with the [EN1]-[PLC] and [EN2]-[PLC] states being ON, as well as outputting an alarm to external equipment. (Note that the alarm output function is not guaranteed to all of single faults. It is compliant with EN954-1/EN ISO13849-1 PL=d Cat. 3).
- The Safe Torque Off (STO) function does not completely shut off the power supply to the motor electrically. Before starting wiring or maintenance jobs, be sure to disconnect the input power to the inverter and wait at least 5 minutes.

(3) A test of Safe Torque Off (STO)

- In application where no regular activation of the Safe Torque Off (STO) function is guaranteed, check at least once a year that the Safe Torque Off (STO) function works correctly.

9.6.3 EN ISO13849-1 PL=d

European Standard EN ISO13849-1 PL=d (Safety of machinery–Safety related parts of control systems) prescribes the basic safety requirements for machinery categorized according to the requirement level. Category 3 represents the requirements that the machinery shall be designed with redundancy so that a single fault does not lead to the loss of the safety function. Table 9.3 shows an outline of the category levels and their safety requirements. (For detailed requirements, refer to EN ISO13849-1 PL=d.)

Table 9.3

Category	Summary of requirements	System behavior
B	SRP/CS and/or their protective equipment, as well as their components, shall be designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. Basic safety principles shall be used.	The occurrence of a fault can lead to the loss of the safety function.
1	Requirements of Category B shall apply. Well-tried components and well-tried safety principles shall be used.	The occurrence of a fault can lead to the loss of the safety function but the probability of occurrence is lower than for Category B.
2	Requirements of Category B and the use of well-tried safety principles shall apply. Safety function shall be checked at suitable intervals by the machine control system.	The occurrence of a fault can lead to the loss of the safety function between the checks. The loss of safety function is detected by the check.
3	Requirements of Category B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that - a single fault in any of these parts does not lead to the loss of the safety function, and - whenever reasonably practicable, the single fault is detected.	When a single fault occurs, the safety function is always performed. Some, but not all, faults will be detected. Accumulation of undetected faults can lead to the loss of the safety function.
4	Requirements of Category B and the use of well-tried safety principles shall apply. Safety-related parts shall be designed, so that - a single fault in any of these parts does not lead to a loss of the safety function, and - the single fault is detected at or before the next demand upon the safety function, but that if this detection is not possible, an accumulation of undetected faults shall not lead to the loss of the safety function.	When a single fault occurs, the safety function is always performed. Detection of accumulated faults reduces the probability of the loss of the safety function (high DC). The faults will be detected in time to prevent the loss of the safety function.

9.6.4 Inverter output state when Safe Torque Off (STO) is activated

Turning the emergency stop button ON turns EN1 and EN2 OFF, bringing the inverter into the Safe Torque Off (STO) state.

Figure 9.7 shows the timing scheme to apply when the emergency stop button is turned OFF with the inverter being stopped. Input to the EN1 and EN2 comes ON, making the inverter ready to run.

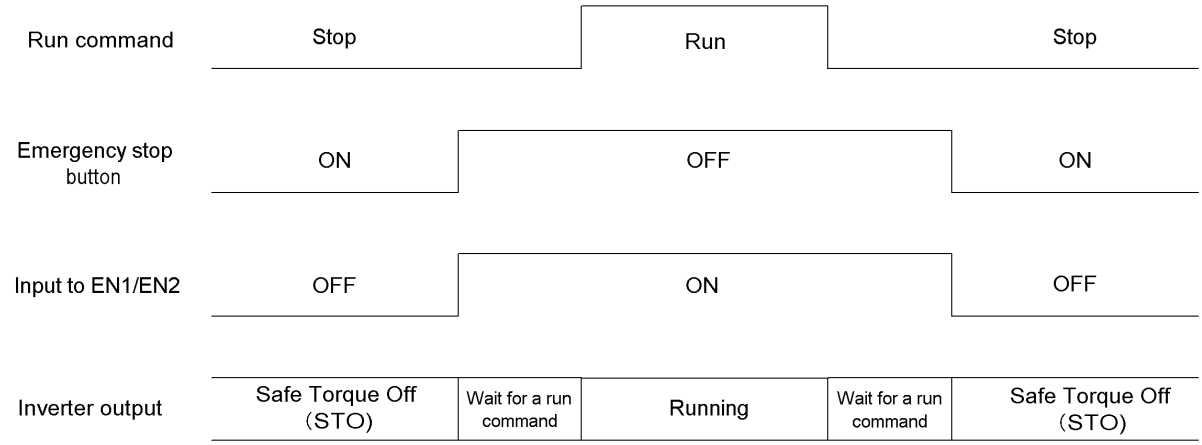


Figure 9.7 Inverter Output State when the Emergency Stop Button is turned OFF with the inverter being stopped

Figure 9.8 shows the timing scheme to apply when the emergency stop button is turned ON with the inverter running. Input to the EN1 and EN2 goes OFF, bringing the inverter into the Safe Torque Off (STO) state and coasting the motor to a stop.

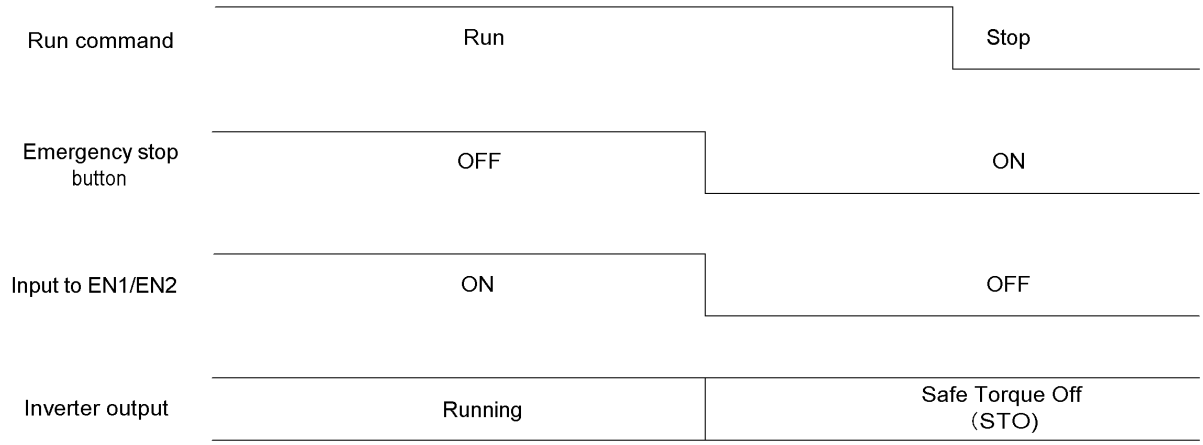


Figure 9.8 Inverter Output State when the Emergency Stop Button is turned ON with the inverter running

9.6.5 ECF alarm (caused by logic discrepancy) and inverter output state

Figure 9.9 shows the timing scheme to apply when EN1 and EN2 inputs are not aligned so that an alarm ECF occurs.

Turning the emergency stop button ON turns EN1 and EN2 inputs OFF, which usually brings the inverter into the Safe Torque Off (STO) state. If the misalignment of the EN1 and EN2 inputs is within 50 ms, no alarm occurs; if it is more than 50 ms, the inverter interprets it as a logic discrepancy, outputting an alarm ECF. The alarm can be cleared by restarting the inverter.

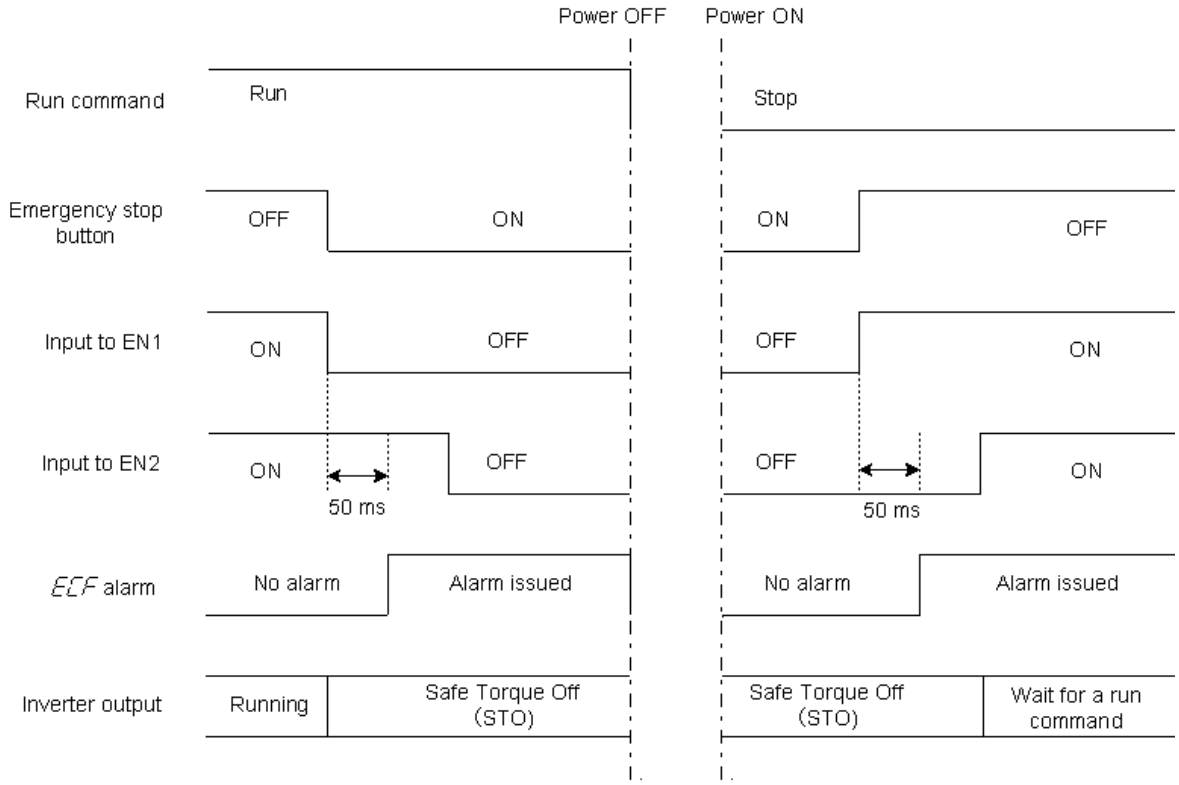


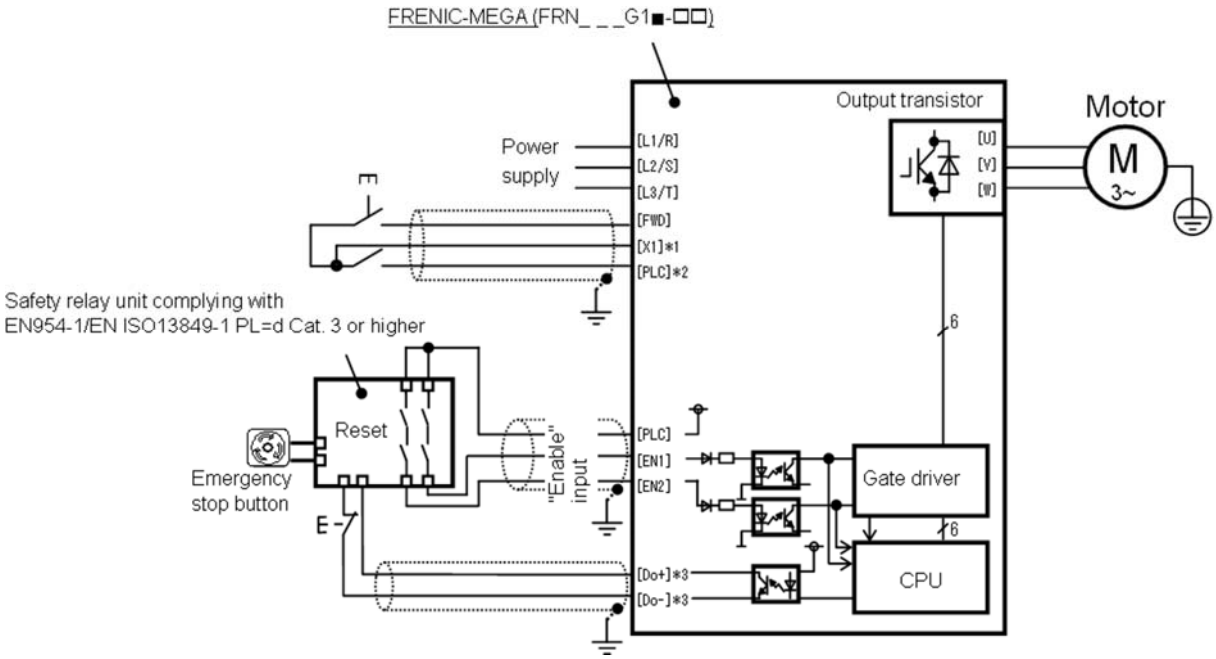
Figure 9.9 ECF Alarm (Caused by Logic Discrepancy) and Inverter Output State

9.6.6 Prevention of restarting

To prevent the inverter from restarting just by turning the emergency stop button OFF, configure the Enable input circuit as shown below. Figure 9.11 shows the timing scheme for prevention of restarting.

Assigning the ***HLD*** ("Enable 3-wire operation") to any digital input terminal and setting the E01 data to "6" sets up the ***HLD*** function at the [X1] terminal.

After the ***FWD*** comes ON with the ***HLD*** being ON, even turning the ***FWD*** OFF keeps the inverter running due to the ***HLD***. Turning the emergency stop button ON under the condition causes the motor to coast to a stop. After that, turning the emergency stop button OFF no longer starts the inverter to run. To run the inverter, turn the ***FWD*** ON again.



*1 Digital input terminal (e.g., [X1])
*2 If SW1 is in the SOURCE mode, [PLC] applies; if in the SINK mode, [CM] applies
*3 Transistor output terminals (e.g., [Y1]-[CMY], DECF(Function code data=1101))

Figure 9.10 Connection Diagram and Internal Circuit Configuration

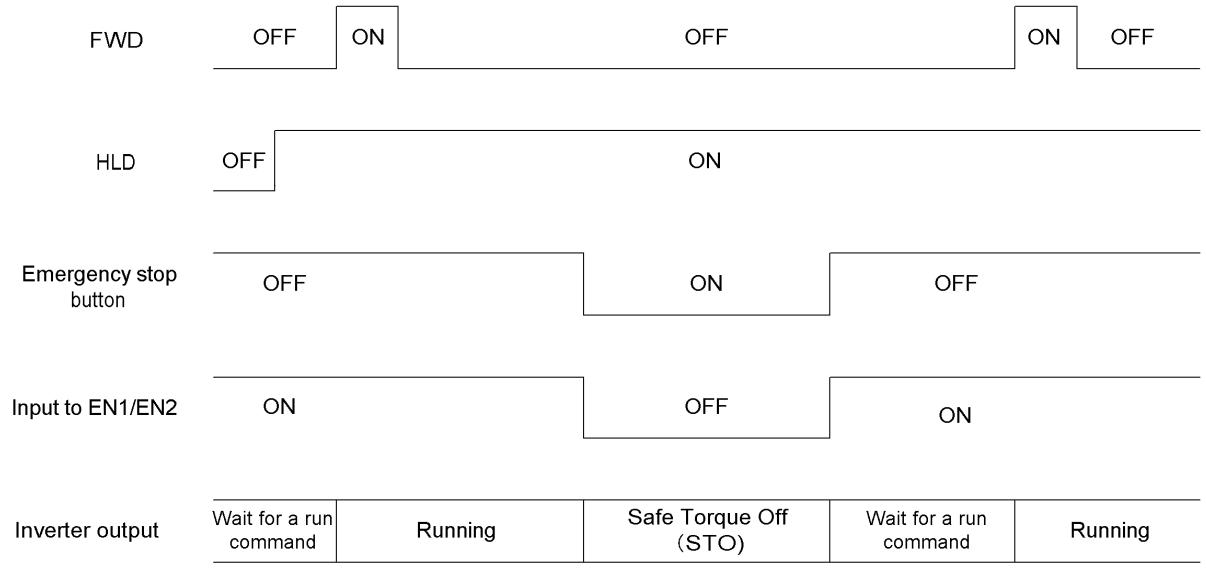


Figure 9.11 Prevention of Restarting

[MEMO]

High Performance, Multifunction Inverter

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The purpose of this instruction manual is to provide accurate information in handling, setting up and operating of the FRENIC-MEGA 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.

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