Chapter 9

FUNCTION CODES

This chapter contains overview lists of seven groups of function codes available for the FRENIC-Mini series of inverters and details of each function code.

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9.1 Function Code Tables

Function codes set up the FRENIC-Mini series of inverters to match your system requirements.

Each function code consists of a 3-letter 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 seven 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), and Link Functions (y codes).

Changing, validating, and saving function code data when the motor is running

Function codes are indicated by the following based on whether they can be changed or not when the motor is running:

- Function codes marked with N (in the "Change when running" column of the function code tables given below): The data of these codes cannot be changed when the motor is running.
- Function codes marked with Y: The data of these codes can be changed with ⌃ and ⌄ keys regardless of whether the motor is running or not. Pressing the FUNC/DATA key will make the change effective and save it into the inverter's memory.
- Function codes marked with Y*: The difference from function codes marked with Y and these is that if the data of these codes is changed, the change will immediately take effect; however, the change is not saved into the inverter's memory. To save the change, press the FUNC/DATA key. If you press the PRG/RESET key to exit the current state without pressing the FUNC/DATA key, then the changed data will be discarded and the previous data will take effect for the current inverter operation.

Copying data

Connecting a remote keypad (option) to an inverter via the RS485 communications card (option) allows copying the data stored in the inverter's memory into the keypad's memory (refer to Menu #7 "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 inverter and destination inverter differ from each other, some 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 copy" 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.

If necessary, manually set the function code data that cannot be copied.

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 codes specifying the properties for those terminals. Negative logic refers to inverted ON/OFF (logical value 1 (true)/0 (false)) state of input or output signal. An ON-active signal (the function takes effect for the ON signal.) in the normal logic system is functionally equivalent to OFF-active signal (the function takes effect for the OFF signal.) in the negative logic system.

To set the negative logic system for an I/O signal terminal, display data of 1000s (by adding 1000 to the data for the normal logic) in the corresponding function code and then press the FUNC/DATA key.

For example, if a coast-to-stop command (BX: data = 7) is assigned to any one of digital input terminals X1 to X3 by setting any of function codes E01 through E03, 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.

Limitation of data displayed on the LED monitor

Only four digits can be displayed on the 4-digit LED monitor. If you enter more than 4 digits of data valid for a function code, any digits after the 4th digit of the set data will not be displayed, however they will be processed correctly.

The following tables list the function codes available for the FRENIC-Mini series of inverters.

F codes: Fundamental Functions

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
F00	Data Protection	0: Disable data protection (Function code data can be edited.) 1: Enable data protection (Function code data cannot be edited.)	—	—	Y	N	0	9-12
F01	Frequency Command 1	0: Enable ∧ and ∨ keys on the built-in keypad 1: Enable the voltage input to terminal [12] 2: Enable the current input to terminal [C1] 3: Enable the sum of voltage and current inputs to terminals [12] and [C1] 4: Enable the built-in potentiometer (POT)	—	—	N	Y	4	9-12
F02	Running/Stopping and Rotational Direction	0: Enable RUN and STOP keys on the built-in keypad to run and stop motor (The (FWD) or (REV) command should be ON for forward or reverse rotation.) 1: Enable the external signal command (FWD) or (REV) command to run motor 2: Enable RUN and STOP keys on the built-in keypad to run/stop motor forward 3: Enable RUN and STOP keys on the built-in keypad to run/stop motor reverse	—	—	N	Y	2	9-13
F03	Maximum Frequency	25.0 to 400.0	0.1	Hz	N	Y	60.0 (50.0)*1	9-14
F04	Base Frequency	25.0 to 400.0	0.1	Hz	N	Y	60.0 (50.0)*1	9-15
F05	Rated Voltage (at Base Frequency)	0: Output a voltage in line with variance in input voltage 80 to 240: Output a voltage AVR-controlled *3 (Note 1) 160 to 500: Output a voltage AVR-controlled *3 (Note 2)	1	V	N	Y2	0	9-15
F07	Acceleration Time 1	0.00 to 3600 Note: Acceleration time is ignored at 0.00. (External gradual acceleration pattern)	0.01	s	Y	Y	6.00	9-17
F08	Deceleration Time 1	0.00 to 3600 Note: Deceleration time is ignored at 0.00. (External gradual deceleration pattern)	0.01	s	Y	Y	6.00	9-17
F09	Torque Boost	0.0 to 20.0 (The set voltage at base frequency for F05 is 100%.) Note: This setting is effective for auto torque boost/auto energy saving operations specified by function code F37 (= 0, 1, 3, or 4).	0.1	%	Y	Y	Fuji's *2 standard torque boost	9-17
F10	Electronic Thermal Overload for Motor Protection (Select motor characteristics)	1: For general-purpose motors with built-in self-cooling fan 2: For inverter-driven motors or high-speed motors with forced-ventilation fan	—	—	Y	Y	1	9-18
F11	(Overload detection level)	0.00 (Disable) 1 to 135% of rated current (allowable continuos load current) of the inverter	0.01	A	Y	Y1 Y2	Nominal *2 rated current of Fuji standard motor	

*1 Values in parentheses ( ) in the above table denote default settings for the EU version except three-phase 200 V series of inverters.
*2 "Fuji's standard torque boost," "Nominal rated current of Fuji standard motor," and "Nominal rated capacity of Fuji standard motor" differ depending upon the rated input voltage and rated capacity. Refer to Table 9.1 "Fuji Standard Motor Parameters" on page 9-11.
*3 AVR: Automatic Voltage Regulator
(Note 1) For the three-phase 200 V and single-phase 200 V series
(Note 2) For the three-phase 400 V series

Code	Name	Data setting range	Incre-ment	Unit	Change when running	Data copy	Default setting	Refer to:
F12	(Thermal time constant)	0.5 to 75.0	0.1	min	Y	Y	5.0	9-18
F14	Restart Mode after Instantaneous Power Failure	0: Disable (Trip immediately without restart) 1: Disable (Trip without restart after recovery of power) 4: Enable (Restart at the frequency at which the power failure occurred, for general load) 5: Enable (Restart at the start frequency, for low-inertia load)	—	—	Y	Y	1 (0)*1	9-19
F15	Frequency Limiter (High)	0.0 to 400.0	0.1	Hz	Y	Y	70.0	9-21
F16	(Low)	0.0 to 400.0	0.1	Hz	Y	Y	0.0	
F18	Bias (for frequency command 1)	-100.00 to 100.00	0.01	%	Y*	Y	0.00	9-22
F20	DC Braking (Start frequency)	0.0 to 60.0	0.1	Hz	Y	Y	0.0	9-23
F21	(Braking level)	0 to 100 (Rated output current of the inverter interpreted as 100%.)	1	%	Y	Y	0	
F22	(Braking time)	0.00 (Disable), 0.01 to 30.00	0.01	s	Y	Y	0.00	
F23	Start Frequency	0.1 to 60.0	0.1	Hz	Y	Y	1.0	9-25
F25	Stop Frequency	0.1 to 60.0	0.1	Hz	Y	Y	0.2	9-25
F26	Motor Sound (Carrier frequency)	0.75 to 15	1	kHz	Y	Y	2 (15)*1	9-25
F27	(Tone)	0: Level 0 1: Level 1 2: Level 2 3: Level 3	—	—	Y	Y	0	9-26
F30	Terminal [FMA] (Gain to output voltage)	0 to 200 If 100 is set, +10 VDC will be output from [FMA] at full scale.	1	%	Y*	Y	100	9-26
F31	Analog Output Signal Selection for [FMA] (Monitor object)	0: Output frequency 1 (before slip compensation) Maximum output frequency at full scale 1: Output frequency 2 (after slip compensation) Maximum output frequency at full scale 2: Output current Two times the inverter's rated output current at full scale 3: Output voltage 250 V (500 V) at full scale 6: Input power Two times the inverter's rated output capacity at full scale 7: PID feedback value Feedback value is 100% at full scale 9: DC link bus voltage 500 VDC (for 200 V series),1000 VDC (for 400 V series) at full scale 14: Test analog output (+) voltage If F30 = 100, +10 VDC at full scale	—	—	Y	Y	0	9-26

*1 Values in parentheses ( ) in the above table denote default settings for the EU version except the three-phase 200 V series of inverters.

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
F37	Load Selection/ Auto Torque Boost/ Auto Energy Saving Operation	0: Variable torque load 1: Constant torque load 2: Auto-torque boost 3: Auto-energy saving operation (Variable torque load during acceleration and deceleration) 4: Auto-energy saving operation (Constant torque load during acceleration and deceleration) 5: Auto-energy saving operation (Auto-torque boost during acceleration and deceleration)	—	—	N	Y	1	9-27
F43	Current Limiter (Operation condition)	0: Disable 1: In constant speed (Disable during acceleration and deceleration) 2: At acceleration and in constant speed (Disable during deceleration)	—	—	Y	Y	0	9-28
F44	(Limiting level)	20 to 200 (The data is interpreted as the rated output current of the inverter for 100%.)	1	%	Y	Y	200	
F50	Electronic Thermal Overload Relay (for braking resistor) (Discharging capability)	0: (To be set for braking resistor built-in type) 1 to 900 999: (Disable)	1	kWs	Y	Y	999/0 (Note)	9-28
F51	(Allowable loss)	0.000: Applied for built-in braking resistor, 0.001 to 50.000	0.001	kW	Y	Y	0.000	

(Note) The default setting of function code F50 is 999 for standard models, and 0 for braking resistor built-in type.

E codes: Extension Terminal Functions

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
E01	Terminal Command Assignment to:[X1]	To assign a negative logic input to a terminal, set the value of 1000s shown in ( ) below to the function code. 0: (1000) Select multistep frequency (0 to 1 steps) (SS1) 1: (1001) Select multistep frequency (0 to 3 steps) (SS2) 2: (1002) Select multistep frequency (0 to 7 steps) (SS4) 4: (1004) Select ACC/DEC time (2 steps) (RT1) 6: (1006) Enable 3-wire operation (HLD) 7: (1007) Coast to a stop (BX) 8: (1008) Reset alarm (RST) 9: (1009) Enable external alarm trip (THR) 10: (1010) Ready for jogging (JOG) 11: (1011) Switch set frequency 2/1 (Hz2/Hz1) 19: (1019) Enable write from keypad (WE-KP) 20: (1020) Cancel PID control (Hz/PID) 21: (1021) Switch normal/inverse operation (IVS) 24: (1024) Enable communications link (RS485 communication, option) (LE) 33: (1033) Reset PID integral and differential components (PID-RST) 34: (1034) Hold PID integral component (PID-HLD)	—	—	N	Y	0	9-33
E02	[X2]		—	—	N	Y	7	
E03	[X3]		—	—	N	Y	8	

Code	Name	Data setting range	Incre-ment	Unit	Change when running	Data copy	Default setting	Refer to:
E10	Acceleration Time 2	0.00 to 3600	0.01	s	Y	Y	6.00	9-17 9-38
E11	Deceleration Time 2	0.00 to 3600	0.01	s	Y	Y	6.00	9-17 9-38
E20	Status Signal Assignment to: [Y1]	To assign a negative logic output to a terminal, set the value of 1000s shown in ( ) on the table below to the function code. (OFF if short-circuited) 0: (1000) Inverter running (RUN) 1: (1001) Frequency equivalence signal (FAR) 2: (1002) Frequency level detection (FDT) 3: (1003) Undervoltage detection signal (LU) 5: (1005) Torque limiting (Current limiting) (IOL) 6: (1006) Auto-restart after recovery from instantaneous power failure (IPF) 7: (1007) Early warning for motor overload (OL) 26: (1026) Retry in operation (TRY) 30: (1030) Lifetime alarm (LIFE) 35: (1035) Inverter running (RUN2) 36: (1036) Overload prevention control (OLP) 37: (1037) Current detection (ID) 41: (1041) Low level current detection (IDL) 99: (1099) Alarm relay output (for any alarm) (ALM)	—	—	N	Y	0	9-39
E27	[30A/B/C] (Mechanical relay contacts)		—	—	N	Y	99	
E31	Frequency Detection (FDT) (Detection level)	0.0 to 400.0	0.1	Hz	Y	Y	60.0 (50.0)*1	9-42
E34	Overload Early Warning/ Current Detection/ Low Current Detection (Level)	0 (Disable) Current value of 1 to 200% of the rated inverter current	0.01	A	Y	Y1 Y2	Nominal *2 rated current of Fuji standard motor	9-42
E35	Current Detection/ Low Current Detection (Timer)	0.01 to 600.00	0.01	s	Y	Y	10.00	9-42
E39	Coefficient for Constant Feeding Rate Time	0.000 to 9.999	0.001	—	Y	Y	0.000	9-43
E40	PID Display Coefficient A	-999 to 0.00 to 999	0.01	—	Y	Y	100	9-43
E41	PID Display Coefficient B	-999 to 0.00 to 999	0.01	—	Y	Y	0.00	9-43
E43	Monitor Item Selection	0: Speed monitor (Select by E48.) 3: Output current 4: Output voltage 9: Input power 10: PID final command value 12: PID feedback value 13: Timer value (Timer operation)	—	—	Y	Y	0	9-43
E45	(Note)							
E46								
E47								
E48	LED Monitor (Speed monitor item)	0: Output frequency before slip compensation 1: Output frequency after slip compensation 2: Set frequency 4: Load shaft speed in rpm 5: Line speed in m/min 6: Constant feeding rate time	—	—	Y	Y	0	9-44

(Note) Function codes E45 to E47 appear on the LED monitor; however, the FRENIC-Mini series of inverters does not recognize these codes.

*1 Values in parentheses ( ) in the above table denote default settings for the EU version except the three-phase 200 V series of inverters.

*2 "Fuji's standard torque boost," "Nominal rated current of Fuji standard motor," and "Nominal rated capacity of Fuji standard motor" differ depending upon the rated input voltage and rated capacity. Refer to Table 9.1 "Fuji Standard Motor Parameters" on page 9-11.

Code	Name	Data setting range	Incre-ment	Unit	Change when running	Data copy	Default setting	Refer to:
E50	Coefficient for Speed Indication	0.01 to 200.00	0.01	—	Y	Y	30.00	9-43 9-44
E52	Menu Display Mode for Keypad	0: Function code data setting mode 1: Function code data check mode 2: Full-menu mode	—	—	Y	Y	0	9-44
E60	Built-in Potentiometer (Function selection)	0: None 1: Auxiliary frequency command 1 2: Auxiliary frequency command 2 3: PID process command 1	—	—	N	Y	0	9-44
E61	Analog Input Signal Definition for: [12]	0: None 1: Auxiliary frequency command 1 2: Auxiliary frequency command 2 3: PID process command 1 5: PID feedback value	—	—	N	Y	0	9-44
E62	[C1]		—	—	N	Y	0	9-44
E98	Terminal Command Assignment to: [FWD]	To assign a negative logic input to a terminal, set the value of 1000s shown in ( ) in the table below to the function code.	—	—	N	Y	98	
E99	[REV]	0: (1000) Select multistep frequency (0 to 1 steps) (SS1) 1: (1001) Select multistep frequency (0 to 3 steps) (SS2) 2: (1002) Select multistep frequency (0 to 7 steps) (SS4) 4: (1004) Select ACC/DEC time (2 steps) (RT1) 6: (1006) Enable 3-wire operation (HLD) 7: (1007) Coast to a stop (BX) 8: (1008) Reset alarm (RST) 9: (1009) Enable external alarm trip (THR) 10: (1010) Ready for jogging (JOG) 11: (1011) Switch set frequency 2/1 (Hz2/Hz1) 19: (1019) Enable write from keypad (WE-KP) 20: (1020) Cancel PID control (Hz/PID) 21: (1021) Switch normal/inverse operation (IVS) 24: (1024) Enable communications link (RS485 communication, option) (LE) 33: (1033) Reset PID integral and differential components (PID-RST) 34: (1034) Hold PID integral component (PID-HLD) 98: Run forward (FWD) 99: Run reverse (REV)	—	—	N	Y	99	9-33 9-45

C codes: Control Functions of Frequency

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
C01	Jump Frequency 1	0.0 to 400.0	0.1	Hz	Y	Y	0.0	
C02	2					Y	0.0	9-46
C03	3					Y	0.0	
C04	Jump Frequency Band	0.0 to 30.0	0.1	Hz	Y	Y	3.0	9-46
C05	Multistep Frequency Settings 1	0.00 to 400.00	0.01	Hz	Y	Y	0.00	
C06	2					Y	0.00	
C07	3					Y	0.00	
C08	4					Y	0.00	9-46
C09	5					Y	0.00	
C10	6					Y	0.00	
C11	7					Y	0.00	
C20	Jogging Frequency	0.00 to 400.00	0.01	Hz	Y	Y	0.00	9-47
C21	Timer Operation	0: Disable timer operation 1: Enable timer operation	—	—	N	Y	0	9-47
C30	Frequency Command 2	0: Enable ⌃ and ⌄ keys on the built-in keypad 1: Enable the voltage input to terminal [12] 2: Enable the current input to terminal [C1] 3: Enable the sum of voltage and current inputs to terminals [12] and [C1] 4: Enable the built-in potentiometer (POT)	—	—	N	Y	2	9-12 9-48
C32	Analog Input Adjustment (Gain for terminal input [12]) (Gain)	0.00 to 200.00	0.01	%	Y*	Y	100.0	9-22 9-48
C33	(Filter)	0.00 to 5.00	0.01	s	Y	Y	0.05	9-48
C34	(Gain reference point)	0.00 to 100.00	0.01	%	Y*	Y	100.0	9-22 9-48
C37	Analog Input Adjustment (Gain for terminal input [C1]) (Gain)	0.00 to 200.00	0.01	%	Y*	Y	100.0	9-22 9-48
C38	(Filter)	0.00 to 5.00	0.01	s	Y	Y	0.05	9-48
C39	(Gain reference point)	0.00 to 100.00	0.01	%	Y*	Y	100.0	9-22 9-48
C50	Bias (Frequency command 1) (Bias reference point)	0.00 to 100.00	0.01	%	Y*	Y	0.00	9-22 9-48
C51	Bias (PID command 1) (Bias value)	-100.00 to 100.00	0.01	%	Y*	Y	0.00	9-48
C52	(Bias reference point)	0.00 to 100.00	0.01	%	Y*	Y	0.00	9-48

P codes: Motor Parameters

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
P02	Motor Parameters (Rated capacity)	0.01 to 10.00 kW (where, the data of function code P99 is 0, 3, or 4.) 0.01 to 10.00 HP (where, the data of function code P99 is 1.)	0.01 0.01	kW HP	N	Y1 Y2	Nominal *2 rated capacity of Fuji standard motor	
P03	(Rated current)	0.00 to 99.99	0.01	A	N	Y1 Y2	Nominal *2 rated current of Fuji standard motor	9-49
P09	(Slip compensation gain)	0.0 to 200.0 Typical rated slip frequency at 100%	0.1	%	Y*	Y	0.0	
P99	Motor Selection	0: Characteristics of motor 0 (Fuji standard 8-series motors) 1: Characteristics of motor 1 (HP motors) 3: Characteristics of motor 3 (Fuji standard 6-series motors) 4: Other motors	—	—	N	Y1 Y2	0	9-50

H codes: High Performance Functions

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
H03	Data Initialization (Data reset)	0: Disable initialization 1: Initialize all function code data to the factory defaults 2: Initialize motor parameters	—	—	N	N	0	9-51
H04	Retry (No. of retries)	0: Disable 1 to 10	1	Times	Y	Y	0	9-54
H05	(Latency time)	0.5 to 20.0	0.1	s	Y	Y	5.0	
H06	Cooling Fan ON/OFF	0: Disable 1: Enable (1.5 kW or more)	—	—	Y	Y	0	9-55
H07	Gradual Acceleration/ Deceleration	0: Disable (Linear) 1: S-curve (Weak) 2: S-curve (Strong) 3: Curvilinear	—	—	Y	Y	0	9-56
H12	Instantaneous Overcurrent Limiting	0: Disable 1: Enable	—	—	Y	Y	1	9-57
H26	PTC Thermistor Input	0: Disable 1: Enable (PTC)	—	—	Y	Y	0	9-57
H27	(Level)	0.00 to 5.00	0.01	V	Y	Y	1.60	
H30	Communications Link (Function selection)	Monitor / Frequency command source / Run command source 0: Y / N / N 1: Y / RS485 / N 2: Y / N / RS485 3: Y / RS485 / RS485 Y: Enable by inverter and via RS485 communication (option) RS485: Enable via RS485 communication (option) N: Enable by inverter	—	—	Y	Y	0	9-59
H42	Capacity of DC link bus capacitor	For adjustment when replacing the capacitor	—	—	—	N	—	9-59
H43	Accumulated Run Time of Cooling Fan	For adjustment when replacing the cooling fan	—	—	—	N	—	9-59

* "Fuji's standard torque boost," "Nominal rated current of Fuji standard motor," and "Nominal rated capacity of Fuji standard motor" differ depending upon the rated input voltage and rated capacity. Refer to Table 9.1 "Fuji Standard Motor Parameters" on page 9-11.

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
H50	Non-linear V/f Pattern (Frequency)	0.0 (Cancel), 0.1 to 400.0	0.1	Hz	N	Y	0.0	9-15 9-60
H51	(Voltage)	0 to 240: Output voltage AVR-controlled for 200 V class motors 0 to 500: Output voltage AVR-controlled for 400 V class motors	1	V	N	Y2	0	
H54	ACC/DEC Time (Jogging operation)	0.00 to 3600	0.01	s	Y	Y	6.00	9-60
H64	Low Limiter (Min. freq. when limiter is activated)	0.0 (Depends on F16 : Freq. limiter (low)), 0.1 to 60.0	0.1	Hz	Y	Y	2.0	9-60
H69	Automatic Deceleration (Regenerative energy suppressing)	0: Disable 1: Enable	—	—	Y	Y	0	9-60
H70	Overload Prevention Control (Frequency drop rate)	0.00 (Equivalent to deceleration time), 0.01 to 100.00, 999 (Cancel)	0.01	Hz/s	Y	Y	999	9-61
H71	(Note 1)							
H80	Gain for Suppression of Output Current Fluctuation	0.00 to 0.20	0.01	—	Y	Y	0.20	9-61
H95	DC Braking (Note 2) (Braking mode)	0: Slow response 1: Quick response	—	—	Y	Y	0 (1) *1	9-61
H96	STOP Key Priority/ Start Check Function	STOP key priority / Start check function 0: Invalid / Invalid 1: Valid / Invalid 2: Invalid / Valid 3: Valid / Valid	—	—	Y	Y	0	9-62
H97	Clear Alarm Data	Returns to zero after clearing alarm data (if H97 = 1).	—	—	Y	N	—	9-62
H98	Protection/ Maintenance Functions	opL / Lin / ADFCF 0: Disable / Disable / Disable 1: Disable / Disable / Enable 2: Disable / Enable / Disable 3: Disable / Enable / Enable 4: Enable / Disable / Disable 5: Enable / Disable / Enable 6: Enable / Enable / Disable 7: Enable / Enable / Enable opL: Output Phase Loss Protection Lin: Input Phase Loss Protection ADFCF: Automatic DEC Function for Carrier Frequency Note: For single-phase power input inverters, Lin is always invalid regardless of H98 setting.	—	—	Y	Y	3	9-25 9-63

(Note 1) Function code H71 appears on the LED monitor; however, the FRENIC-Mini series of inverters does not recognize this code.

(Note 2) Function code H95 is valid on the inverters with ROM versions of C1S11000 or higher. (The lowest four digits of the ROM version can be displayed on the LED monitor. For details, refer to Chapter 3, Section 3.3.5 "Reading maintenance information."

* Value in parentheses ( ) in the H95 default setting column denotes the setting for the EU version. If initialized by H03, the H95 will be set to 0.

J codes: Application Functions

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
J01	PID Control (Selection)	0: Disable 1: Process control use (Normal action) 2: Process control use (Inverse action)	—	—	N	Y	0	9-64
J02	(Remote process command)	0: Keypad 1: PID process command 1 (Data settings of E60, E61 and E62 are also required.) 4: Communication	—	—	N	Y	0	
J03	P (Gain)	0.000 to 10.00	0.001	Times	Y	Y	0.100	
J04	I (Integration time)	0.0 to 3600.0	0.1	s	Y	Y	0.0	
J05	D (Differentiation time)	0.00 to 600.00	0.01	s	Y	Y	0.00	
J06	(Feedback filter)	0.0 to 900.0	0.1	s	Y	Y	0.5	

y codes: Link Functions

Code	Name	Data setting range	Increment	Unit	Change when running	Data copy	Default setting	Refer to:
y01	Link Functions for RS485 Communication (Station address)	1 to 255	1	—	N	Y	1	9-70
y02	(Mode selection on no response error)	0: Immediate trip and alarm *Er 8* 1: Trip and alarm *Er 8* after running for the period of the timer set by y03 2: Retry during the period of the timer set by y03. If retry fails, trip and alarm *Er 8* 3: Continue to run	—	—	Y	Y	0	
y03	(Timer)	0.0 to 60.0	0.1	s	Y	Y	2.0	
y04	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps	—	—	Y	Y	3	
y05	(Data length)	0: 8 bits 1: 7 bits	—	—	Y	Y	0	
y06	(Parity check)	0: None 1: Even parity 2: Odd parity	—	—	Y	Y	0	
y07	(Stop bits)	0: 2 bits 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 interval)	0.00 to 1.00	0.01	s	Y	Y	0.01	
y10	(Protocol selection)	0: Modbus RTU protocol 1: SX protocol (Loader protocol) 2: Fuji general-purpose inverter protocol	—	—	Y	Y	1	
y99	Link Function for Supporting Data Input	Frequency command source / Run command source 0: by H30 / by H30 1: via RS485 communication (option) / by H30 2: by H30 / via RS485 communication (option) 3: via RS485 communication (option) / via RS485 communication (option)	—	—	Y	N	0	9-73

* The table below lists the factory settings of "Fuji's standard torque boost," "Nominal rated current of Fuji standard motor," and "Nominal rated capacity of Fuji standard motor" in the "Default setting" column of the above tables.

Table 9.1 Fuji Standard Motor Parameters

Power supply voltage	Applicable motor rating (kW)	Inverter type	Fuji's standard torque boost (%)	Nominal rated current of Fuji standard motor (A)			Nominal rated capacity of Fuji standard motor (kW)
			Function code F09	Function codes F11, E34 and P03			Function code P02
				Shipping destination (version)			
				Asia	EU	Japan	
Three-phase 200 V	0.1	FRN0.1C1■-2□	8.4	0.62	0.68	0.61	0.1
	0.2	FRN0.2C1■-2□	8.4	1.18	1.30	1.16	0.2
	0.4	FRN0.4C1■-2□	7.1	2.10	2.30	2.13	0.4
	0.75	FRN0.75C1■-2□	6.8	3.29	3.60	3.36	0.75
	1.5	FRN1.5C1■-2□**	6.8	5.55	6.10	5.87	1.5
	2.2	FRN2.2C1■-2□**	6.8	8.39	9.20	8.80	2.2
	3.7	FRN3.7C1■-2□**	5.5	13.67	15.00	14.38	3.7
Three-phase 400 V	0.4	FRN0.4C1■-4□	7.1	1.09	1.15	1.07	0.4
	0.75	FRN0.75C1■-4□	6.8	1.71	1.80	1.68	0.75
	1.5	FRN1.5C1■-4□**	6.8	3.04	3.05	2.94	1.5
	2.2	FRN2.2C1■-4□**	6.8	4.54	4.60	4.40	2.2
	3.7 4.0	FRN3.7C1■-4□** FRN4.0C1■-4□**	5.5	7.43	7.50	7.20	3.7
Single-phase 200 V	0.1	FRN0.1C1■-7□	8.4	0.62	0.68	0.61	0.1
	0.2	FRN0.2C1■-7□	8.4	1.18	1.30	1.16	0.2
	0.4	FRN0.4C1■-7□	7.1	2.10	2.30	2.13	0.4
	0.75	FRN0.75C1■-7□	6.8	3.29	3.60	3.36	0.75
	1.5	FRN1.5C1■-7□	6.8	5.55	6.10	5.87	1.5
	2.2	FRN2.2C1■-7□	6.8	8.39	9.20	8.80	2.2

Note 1) A box (■) in the above table replaces S or E depending on the enclosure.

2) A box (□) in the above table replaces A, C, E, or J depending on the shipping destination.

3) Asterisks (**) in the above table denote the following:

21: Braking resistor built-in type
(Available for 1.5 kW or above, three-phase 200 V and 400 V models)

None: Standard

9.2 Details of Function Codes

This section provides a detailed description of the function codes available for the FRENIC-Mini 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.

9.2.1 F codes (Fundamental functions)

F00 Data Protection

Specifies whether function code data is to be protected from being accidentally changed by keypad operation. If data protection is enabled (F00 = 1), ⋀ / ⋁ key operation to change data is disabled so that no function code data, except F00 data, can be changed from the keypad.

Note Even if F00 = 1, function code data can still be changed using the communications facility.

Data for F00	Function	Setting procedure
0	Disable data protection.	Press STOP and ⋁ keys or STOP and ⋀ keys simultaneously to change data from 1 to 0 or from 0 to 1, respectively. Press the FUNC DATA key to save the change.
1	Enable data protection.	

F01 Frequency Command 1 Refer to C30.

Selects the devices to set the set frequency 1 for driving the motor.

Data for F01	Function
0	Enable ⋀ and ⋁ keys on the built-in keypad. (Refer to Chapter 3 "OPERATION USING THE KEYPAD.")
1	Enable the voltage input to terminal [12] (0 to 10 VDC, maximum output frequency obtained at 10 VDC).
2	Enable the current input to terminal [C1] (4 to 20 mA, maximum output frequency obtained at 20 mA).
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 maximum frequencies. Note: If the sum exceeds the maximum output frequency, the maximum output frequency will apply.
4	Enable the built-in potentiometer (POT). (Maximum frequency obtained at full scale of the POT)

Note There are other frequency setting means (such as the communications facility, multistep frequency and etc.) with higher priority than that of F01. Refer to Chapter 4, Section 4.2 "Drive Frequency Command Generator" for more details.

Tip

- For frequency settings by terminals [12] (voltage) and [C1] (current) and by the built-in potentiometer, setting the gain and bias changes the relationship between those frequency settings and the drive frequency to enable matching your system requirements. Refer to function code F18 for details.
- For the inputs to terminals [12] (voltage) and [C1] (current), low-pass filters can be enabled. Refer to function codes C33 and C38 for details.

In addition to "F01 Frequency command 1," "C30 Frequency command 2" is also available. To switch them, use the terminal command (Hz2/Hz1). For details of the (Hz2/Hz1), refer to "E01 to E03: Command Assignment to Terminals [X1] to [X3]."

F02 Running/Stopping and Rotational Direction

Selects a source issuing a run command--keypad or external control signal input.

- If F02 = 0, 2, or 3, the inverter can run the motor by (RUN) and (STOP) keys on the built-in keypad. The motor rotational direction can be specified in two ways, either by control signal input (F02 = 0) or by use of prefixed forward or reverse rotation (F02 = 2 or 3).

  When F02 = 0, to specify the motor rotational direction by control signal input, assign the commands (FWD) and (REV) to terminals [FWD] and [REV], respectively. Turn on the (FWD) or (REV) for the forward or reverse direction, respectively, and then press the (RUN) key to run the motor.
- If F02 = 1, the inverter can run the motor by control signal inputs. To specify the motor rotational direction, assign the commands (FWD) and (REV) to terminals [FWD] and [REV], respectively. Turn on the (FWD) or (REV) for the forward or reverse direction, respectively. If both of (FWD) and (REV) are turned on simultaneously, the inverter immediately decelerates to stop the motor.

Data for F02	Function
0	Enable (RUN) and (STOP) keys on the built-in keypad to run and stop the motor. (The (FWD) or (REV) command should be ON for forward or reverse rotation beforehand.)
1	Enable the (FWD) or (REV) command to run the motor. To turn on the (FWD) command, short-circuit terminals [FWD] and [CM]; to turn on the (REV) command, short-circuit terminals [REV] and [CM].
2	Enable (RUN) and (STOP) keys on the built-in keypad to run and stop the motor in the forward direction.
3	Enable (RUN) and (STOP) keys on the built-in keypad to run and stop the motor in the reverse direction.

The table below lists the operational relationship between function code F02 (Running/stopping and rotational direction), the (RUN) key operation, and control signal inputs to terminals [FWD] and [REV], which determines the rotational direction.

Data for F02	Key on the built-in keypad	Control Signal Inputs to Terminals [FWD] and [REV]		Motor rotational direction
		Function code E98 (FWD) command	Function code E99 (REV) command	
0	(RUN) key	OFF	OFF	Stop
		ON	OFF	Forward
		OFF	ON	Reverse
		ON	ON	Stop
	(STOP) key	OFF	OFF	Stop
		ON	OFF	
		OFF	ON	
		ON	ON	
1	Ignored.	OFF	OFF	Stop
		ON	OFF	Forward
		OFF	ON	Reverse
		ON	ON	Stop
2 (forward/fixed)	(RUN) key	Ignored.		Forward
	(STOP) key			Stop
3 (reverse/fixed)	(RUN) key	Ignored.		Reverse
	(STOP) key			Stop

F03 Maximum Frequency

Sets the maximum frequency to drive the motor. Setting 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 400.0 (Hz)

Note In general, internal impedance of high-speed motors is low. This may cause unstable motor/inverter behavior. When this kind of motor is used, it is recommended that the carrier frequency (F26) be set to 15 kHz and the motor/inverter operation be checked.

Tip Keep the ratio between base frequency (F04) and maximum frequency to 1:8 or less.

F04	Base Frequency	Refer to H50.
F05	Rated Voltage (at Base Frequency)	Refer to H51.

These function codes set 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 set data needed to drive the motor along the non-linear V/f pattern.

The following description includes setting-up required for the non-linear V/f pattern.

■ Base frequency (F04)

Set the rated frequency printed on the nameplate located on the motor.

- Data setting range: 25.0 to 400.0 (Hz)

■ Rated voltage (at base frequency) (F05)

Set 0 or the rated voltage printed on the nameplate labeled on the motor.

- 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 rating of the motor.

Note If F05 is set to match the rated voltage of the motor, the motor efficiency will be improved better than that it is set to 0. Therefore, when brakes are applied to the motor, energy loss decreases and the motor regenerates larger braking energy, which can easily activate the overvoltage protection function. Note that the allowable power consumption capacity of the inverter for braking energy is limited by the specifications. If the overvoltage protection function is activated, it may be necessary to increase deceleration time or use an external braking resistor.

Data for F05	Function
0	Output voltage in line with variance in input voltage. (The AVR is disabled. AVR: Automatic Voltage Regulator)
80 to 240 (V)	Output AVR-controlled voltage for 200 V class motors.
160 to 500 (V)	Output AVR-controlled voltage for 400 V class motors.

■ Non-linear V/f pattern for frequency (H50)

Sets the non-linear V/f pattern for frequency component.

- Data setting range: 0.0 to 400.0 Hz
  (Setting 0.0 to H50 disables the non-linear V/f pattern operation.)

■ Non-linear V/f pattern for voltage (H51)

Sets the non-linear V/f pattern for voltage component.

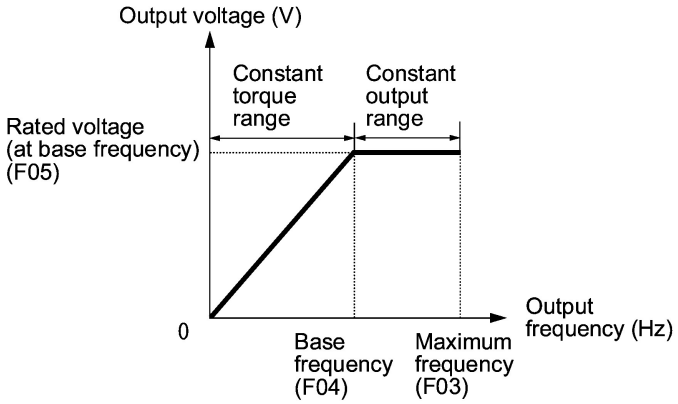
Data for H51	Function
0 to 240 (V)	Output the voltage AVR-controlled for 200 V class motors.
0 to 500 (V)	Output the voltage AVR-controlled for 400 V class motors.

If the voltage at base frequency (F05) is set to 0, the data settings of function codes H50 and H51 will be ignored.

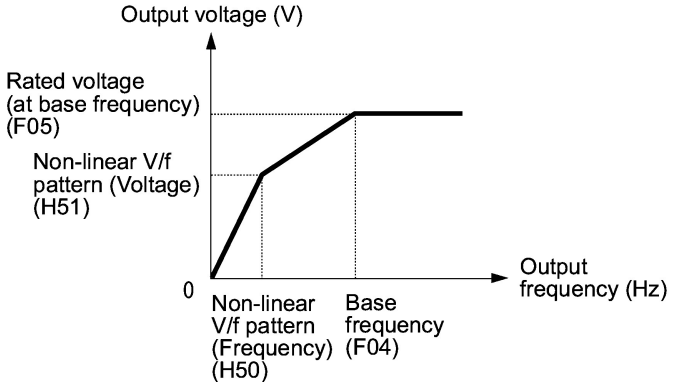
Defining non-linear V/f patterns (F04, F05, H50 and H51)

Function codes F04 and F05 define a non-linear V/f pattern that forms the relationship between the inverter's output frequency and voltage.

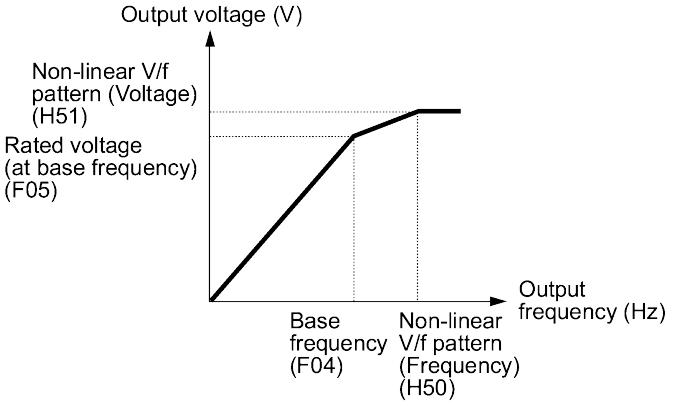
Furthermore, setting the non-linear V/f pattern using function codes H50 and H51 allows patterns with higher or lower voltage than that of the normal pattern to be defined at an arbitrary point inside or outside the base frequency. Generally, when a motor is driven at a high speed, its internal impedance may increase and output torque may decrease due to the decreased drive voltage. This feature helps you solve that problem. Note that setting the voltage in excess of the inverter's input source voltage cannot be done.



(1) Normal (linear) V/f pattern



(2) V/f pattern with single non-linear point inside the base frequency



(3) V/f pattern with single non-linear point outside the base frequency

F07	Acceleration Time 1	Refer to E10.
F08	Deceleration Time 1	Refer to E11.

F07 specifies the acceleration time from 0 to the maximum frequency in Hz. F08 specifies the deceleration time from the maximum frequency to 0 in Hz.

- Data setting range: 0.00 to 3600 (sec.)

Note
- Selecting an S-shaped pattern or curvilinear acceleration/deceleration pattern by function code H07 (Gradual acceleration/deceleration pattern) will make the actual acceleration/deceleration times longer than the set ones. Refer to the descriptions of function code H07.
- Setting shorter acceleration/deceleration times than is necessary may make the actual acceleration/deceleration time longer than the set ones, as the current limit or regenerative braking suppression facility may be activated.

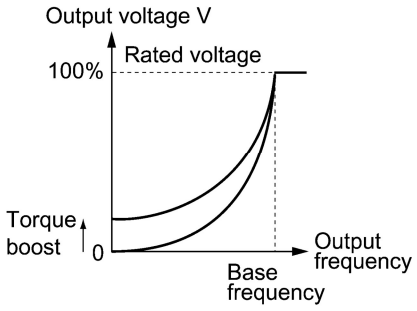
F09	Torque Boost

Specifies the torque boost rate to boost the voltage component in the V/f pattern for compensating magnetic flux shortage of the motor resulting from the voltage drop across the primary resistance of the motor in the low frequency zone.

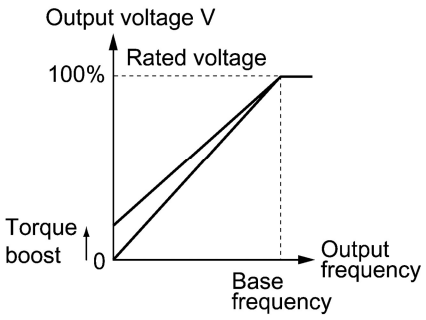
- Data setting range: 0.0 to 20.0 (%) (The set voltage at base frequency for F05 is 100%.)

Note
- Set an appropriate torque boost rate that will keep the starting torque of the motor within the voltage level in the low frequency zone. Setting an excessive torque boost rate may result in over-excitation or overheat of the motor during no load operation.
- The F09 data setting is effective for auto torque boost/auto energy saving operations specified by function code F37 being set to 0, 1, 3, or 4.

Variable torque characteristics (F37 = 0)



Constant torque characteristics (F37 = 1)



F10	Electronic Thermal Overload (for motor protection) (Select motor characteristics)
F11	Electronic Thermal Overload (Overload detection level)
F12	Electronic Thermal Overload (Thermal time constant)

F10 through F12 set 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.

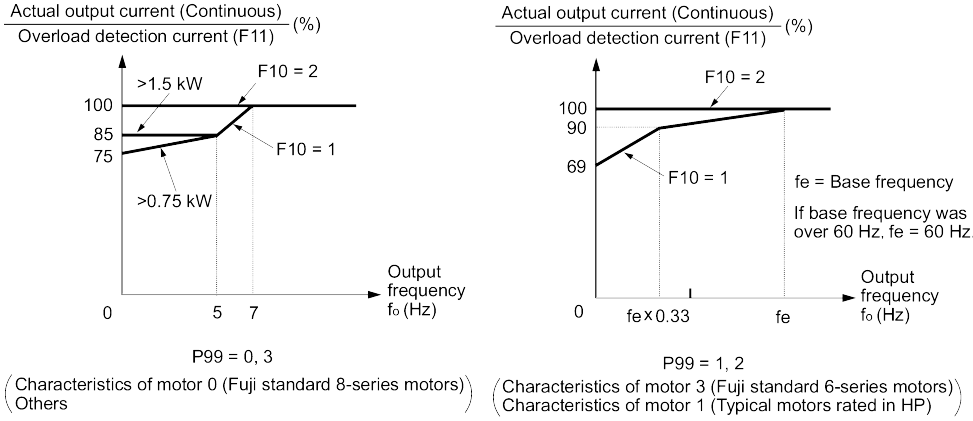
Note Thermal characteristics of the motor specified by F10 and F12 are also used for the overload early warning. Even if you need only the overload early warning, set these characteristics data to these function codes. To disable the electronic thermal motor overload protection, set data of F11 to "0.00."

■ 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 (The cooling effect will decrease in low frequency operation.)
2	For inverter-driven motors or high-speed motors with forced-ventilation fan (The cooling effect will be kept constant regardless of the output frequency.)

The figures below illustrate the cooling characteristics for the motor selected by function code P99 (Motor selection).



Cooling Characteristics of Motors

■ Overload detection current (F11)

F11 specifies the operation level of the electronic thermal motor overload protection that detects an overload condition.

- Data setting range: 1 to 135% of the rated current (allowable continuous drive current) of the inverter
- In general, set the rated current of the motor when driven at base frequency to F11, that is, 1.0 to 1.1 multiple of the rated current of motor (P03).
- To disable the electronic thermal motor overload protection, set 0.00 to F11.

■ Thermal time constant (F12)

F12 specifies the thermal time constant of the motor. The inverter uses the time constant as an operation period of the electronic thermal motor overload protection. If 150% of the overload detection current specified by F11 flows continuously, the inverter activates the electronic thermal motor overload protection during the specified operation period.

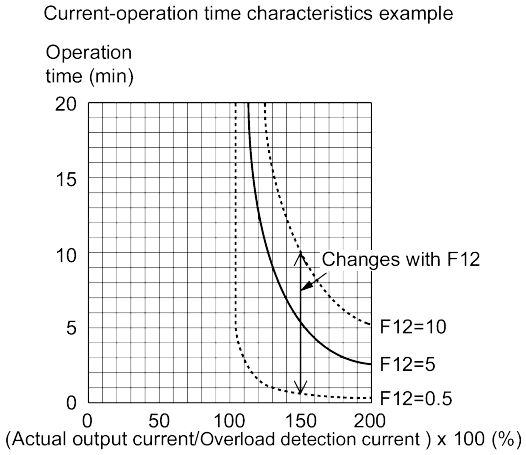
For Fuji general-purpose motors and other induction motors, set 5 minutes (factory default) to F12.

- Data setting range: 0.5 to 75.0 (minutes, in 0.1-minute increment)

(Example) When "5.0" (5 minutes) has been set to F12

As shown at the right, if 150% current of the operation level flows continuously for 5 minutes, the motor overload alarm will be activated (alarm code "*OL1*"). If 120% current flows, the alarm will be activated after approx. 13 minutes.

The thermal time constant includes the time interval from the time when actual current flowing into the motor exceeds the allowable continuous current (100% of the rated current) to the time when the current reaches 150% of the rated current. Therefore, the actual time when the alarm is issued will be earlier than the time specified by F12.



Typical operational characteristics of electronic thermal motor overload protection

Note When an inverter drives the motor with a very frequent running/stopping operation, the loaded current to the motor may fluctuate largely and enters the short-time rated current range (100% or more) of the motor repeatedly. This may cause an abnormal operation of the electronic thermal motor overload protection (e.g., for an externally-powered forced ventilation fan).

To prevent such a problem, calculate the "equivalent RMS current" and keep the loaded current within the motor rated current. Refer to Chapter 7, Section 7.1.3.4 "Calculating the RMS rating of the motor."

F14 Restart Mode after Instantaneous Power Failure

Selects the action of the inverter to be followed when an instantaneous power failure occurs.

Data for F14	Function
0	Trip immediately
1	Trip after recovery of power
4	Restart at the frequency at which the power failure occurred
5	Restart at the start frequency

If the inverter detects that the DC link bus voltage drops less than the specified undervoltage limit, it interprets the state as an occurrence of an instantaneous power failure. However, if the inverter runs with a light load and the period of the power failure is short, then it does not detect the power failure and continues to run.

■ Trip immediately (F14 = 0)

If an instantaneous power failure occurs when the inverter is in Running mode so that the inverter detects undervoltage of the DC link bus, then the inverter immediately shuts down its outputs and displays the undervoltage alarm "*LU*" on the LED monitor. The motor will coast to a stop and the inverter will not restart automatically.

■ Trip after recovery of power (F14 = 1)

If an instantaneous power failure occurs when the inverter is in Running mode so that the inverter detects undervoltage of the DC link bus, then the inverter immediately shuts down its outputs without transferring to Alarm mode or displaying the undervoltage alarm "*LU*." The motor will coast to a stop. When the power is recovered, the inverter will enter Alarm mode for undervoltage.

This setting is used when you run/stop the motor by turning the inverter power on/off with any run command being on. Turning off the controller power with the power switch will not cause the inverter to transfer to Alarm mode or trip.

■ Restart at the frequency at which the power failure occurred (F14 = 4)

If an instantaneous power failure occurs when the inverter is in Running mode so that the inverter detects undervoltage of the DC link bus, then the inverter saves the current output frequency.

When the power is recovered with any run command being ON, the inverter will restart at the saved frequency. During the instantaneous power failure, if the motor speed slows down, the current limiter facility of the inverter will be activated and automatically lower the output frequency. Upon synchronization of the output frequency and motor speed, the inverter accelerates up to the previous output frequency. Refer to the figure (F14 = 4) on the following page for details.

To synchronize the output frequency and motor speed, the instantaneous overcurrent limiter (H12 = 1) should be enabled.

This setting is optimal for operations in which the motor speed rarely slows down due to the heavy moment of inertia of its load even if the motor is coasting to a stop because of the instantaneous power failure.

■ Restart at the start frequency (F14 = 5)

If an instantaneous power failure occurs when the inverter is in Running mode so that the inverter detects undervoltage of the DC link bus, then the inverter immediately shuts down its outputs. After the power is recovered, entry of any run command will restart the inverter at the frequency specified by function code F23. Refer to the figure (F14 = 5) on the following page for details.

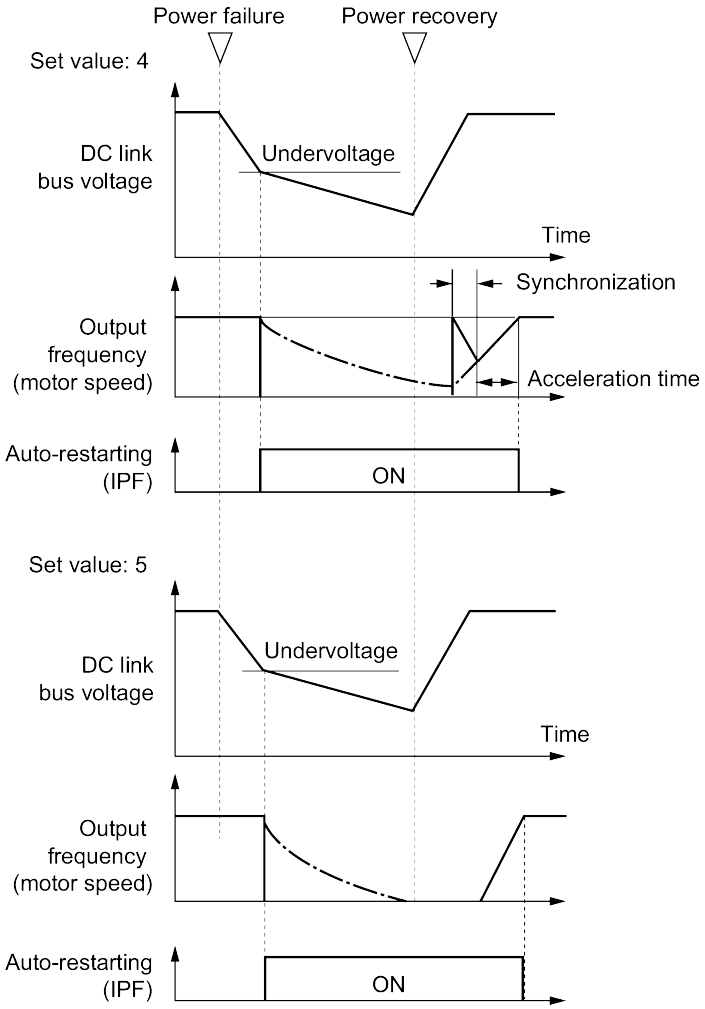
This setting is optimal for operations in which the motor speed quickly slows down to 0 r/min due to its heavy load with a very small moment of inertia if the motor coasts to a stop because of the instantaneous power failure.

Note

- There is a 0.5 second delay from detection of the undervoltage until the motor is restarted. This delay is due to the time required for the residual electricity (magnetic flux) in the motor to erase. Therefore, the motor will restart with a 0.5-second delay after the power is recovered, even if the instantaneous power failure period is shorter than 0.5 second.
- When an instantaneous power failure occurs, the power supply voltage for external circuitry (such as relay circuits) controlling the inverter may also drop as low as to cause run commands to be discontinued.

  Therefore, during recovery from an instantaneous power failure, the inverter waits 2 seconds for a run command to arrive. If it receives one within 2 seconds, it will restart. If a run command arrives more than 2 seconds later, then the inverter should be restarted at the start frequency (F23). The external circuitry should be so designed that it will issue a run command within 2 seconds in such an event; otherwise it should incorporate a relay with a mechanical locking feature.

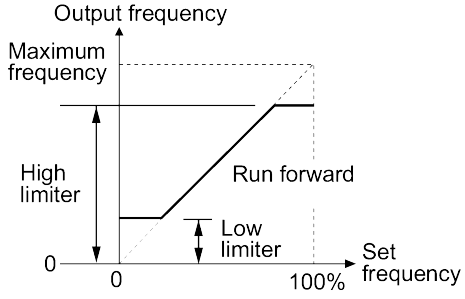
- If a coast-to-stop command (BX) is issued during an instantaneous power failure, the inverter exits from the state of waiting for restarting, and enters Running mode. If any run command is issued, the inverter will start at the start frequency preset.



F15	Frequency Limiter (High)
F16	Frequency Limiter (Low)

Frequency limiter F15 limits the peak of output frequency. Frequency limiter F16 maintains the output frequency at the bottom even if the set frequency is lower than the bottom. Refer to the figure at the right.

- Data setting range: 0.0 to 400.0 Hz



Note Set the peak and bottom frequencies correctly; otherwise, the inverter may not operate. Maintain the following relationship between the limiters:

- (Peak frequency) > (Bottom frequency), (Start frequency), (Stop frequency)
- (Bottom frequency) < (Maximum frequency)

F18	Bias (for frequency command 1)	Refer to C50, C32, C34, C37 and C39.

If you select any analog input for frequency command 1, it is possible to define the relationship between the analog input and the set frequency arbitrarily by combining the settings for bias (F18), bias reference point (C50), gains (C32 and C37), and gain reference points (C34 and C39) as shown below.

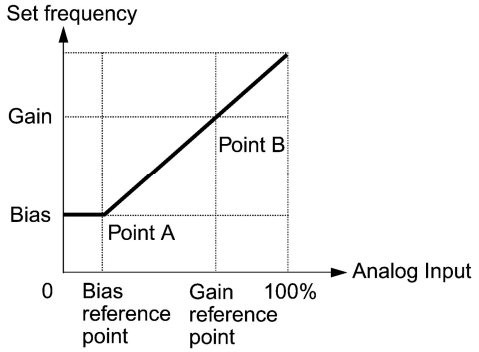
Function code	Function	Data entry range (%)
F18	Bias	-100.00 to 100.00
C50	Bias reference point	0.00 to 100.00
C32	Gain for terminal [12]	0.00 to 200.00
C34	Gain reference point for terminal [12]	0.00 to 100.00
C37	Gain for terminal [C1]	0.00 to 200.00
C39	Gain reference point for terminal [C1]	0.00 to 100.00

As illustrated in the graph below, the relationship between the set frequency and analog input for frequency command 1 is shown by a straight line passing through points "A" and "B." The "A" is determined by the bias (F18) and its reference point (C50). The "B" is determined by the gain (C32 or C37) and its reference point (C34 or C39). The combination of C32 and C34 will apply for terminal [12] and that of C37 and C39 for terminal [C1].

The bias (F18) and gain (C32 or C37) should be set, assuming the maximum frequency as 100%. The bias reference point (C50) and gain frequency point (C34 or C39) should be set, supposing the full scale (10 VDC or 20 mADC) as 100%.

If the set frequency 1 is set with the built-in potentiometer, point B is prefixed at both the gain and its reference point being 100%.

Note Analog input under the bias reference point is limited by the bias data.



The relations stated above are stated in the following expressions:

(1) If analog input ≤ bias reference point:

$$\text{Frequency Setting 1 (\%)} = \text{Bias (F18)}$$

(2) If analog input > bias reference point:

$$\text{Frequency Setting 1 (\%)} = \frac{(\text{Gain}) - (\text{Bias})}{(\text{Gain reference point}) - (\text{Bias reference point})}(\%) \times \text{Analog input (\%)} + \frac{(\text{Bias}) \times (\text{Gain reference point}) - (\text{Gain}) \times (\text{Bias reference point})}{(\text{Gain reference point}) - (\text{Bias reference point})}$$

$$= \frac{C32 - F18}{C34 - C50}(\%) \times \text{Analog input (\%)} + \frac{F18 \times C34 - C32 \times C50}{C34 - C50}$$

In the above expressions, it is assumed that each function code expresses its data.

Example: Setting the bias, gain and its reference point when analog input range from 1 to 5 VDC is selected for the frequency command 1

(Point A)
If the analog input is at 1 V, the set frequency is 0 Hz. Therefore, the bias is 0% (F18 = 0). Since 1 V is the bias reference point and it is equal to 10% of 10 V, then the bias reference point should be 10% (C50 = 10).

(Point B)
If the analog input is at 5 V, the set frequency comes to be the maximum value. Therefore, the gain is 100% (C32 = 100). Since 5 V is the gain reference point and it is equal to 50% of 10 V, then the gain reference point should be 50% (C34 = 50).

Note When using the function codes for setting a stand alone gain or bias without changing any reference points, the setting procedure for the function codes is the same as that of Fuji conventional inverter models.

F20	**DC Braking (Start frequency)**	
F21	**DC Braking (Braking level)**	**Refer to H95.**
F22	**DC Braking (Braking time)**	

These function codes specify the parameters for DC braking, a mechanism to pre-vent the motor from coasting due to the inertia of moving loads while it is decelerating to a stop. During a decelerated stop cycle, i.e., when any Run command "OFF" has been issued or the set frequency has dropped below the stop frequency, DC braking is invoked as soon as the output frequency has reached the start frequency (F20) for DC braking.

Set function codes F20 for the start frequency, F21 for the braking level, and F22 for the braking time. Optionally, you can also select the quick-response DC braking with H95.

■ Start frequency (F20)

Set the frequency with which to start DC braking.

- Data setting range: 0.0 to 60.0 (Hz)

Note Set function code F20 to a frequency that approximately equals the slip-compensated frequency of the motor. If you set it to an extremely high frequency, the inverter will be unstable, and in some cases the overvoltage protective function may work.

■ Braking level (F21)

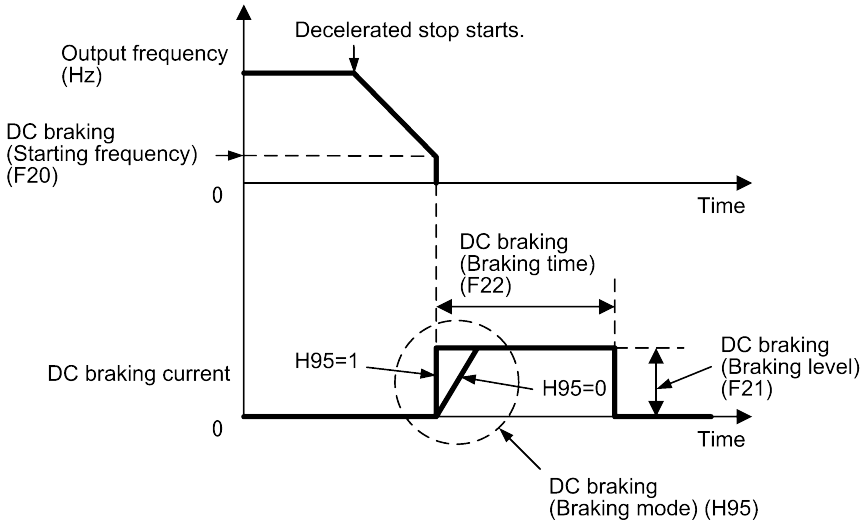
Set the output current level to be applied when DC braking is activated. Set the function code data, assuming the rated output current of the inverter as 100% with 1-% resolution.

- Data setting range: 0 to 100%

■ Braking period (F22)

Set the braking period during which DC braking is activated.

- Data setting range: 0.00 to 30.00 (sec.)
  (Note that setting 0.00 disables DC braking.)



H95 specifies the DC braking mode as follows:

Data for H95	Braking mode	Meaning
0	Slow response	The DC braking current gradually ramps up. (The torque may not be sufficient at the start of DC braking.)
1	Quick response	The DC braking current quickly ramps up. (Depending on the inertia of the moving loads or the coupling state, the revolution may be unstable.)

Note For three-phase 200 V and single-phase 200 V series inverters

The braking level setting for the three-phase 200 V and single-phase 200 V series should be calculated from the DC braking level I_{DB} (A) based on the reference current I_{ref} (A), as shown below.

$$\text{Setting (\%)} = \frac{I_{DB}\,(A)}{I_{ref}\,(A)} \times 100$$

(Example) Setting the braking level I_{DB} at 4.2 Amp (A) for 0.75 kW standard motors

$$\text{Setting (\%)} = \frac{4.2\,(A)}{5.0\,(A)} \times 100 = 84$$

Applicable motor rating (kW)	0.1	0.2	0.4	0.75	1.5	2.2	3.7
Reference current Iref (A)	0.8	1.5	3.0	5.0	8.0	11.0	17.0

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

F23	Start Frequency

F25	Stop Frequency

The start frequency refers to the output frequency that the inverter should output at start up. The inverter shuts down its output at the stop frequency.

Set the start frequency to a level that will enable the motor to generate enough torque for startup. Generally, set the rated slip frequency to F23.

- Data setting range: 0.0 to 60.0 (Hz) (for both start and stop frequencies)

Note If the start frequency is lower than the stop frequency, the inverter cannot output any power as long as the set frequency does not exceed the stop frequency.

F26	Motor Sound (Carrier frequency)	Refer to H98.

Sets the carrier frequency.

- Data setting range: 0.75 to 15 (kHz)
- Changing the carrier frequency may decrease the motor running noise, leakage current from the output lines, and electric noise from the inverter.

Carrier frequency	0.75 to 15 kHz
Motor running noise	Noisy to quiet
Output current waveform	Poor to good
Leakage current level	Low to high
Electric noise level	Low to high

Note Lowering the carrier frequency increases the ripple components (harmonic components) on the output current waveform so as to increase the motor's power loss and raises the temperature of the motor. If the carrier frequency is set at 0.75 kHz, for example, estimate the motor output torque at 85% or less of the rated motor torque.

On the contrary, raising the carrier frequency increases the inverter's power loss and raises the temperature of the inverter. The inverter has a built-in overload protection facility that automatically decreases the carrier frequency to protect the inverter. For details about the facility, refer to function code H98.

F27 Motor Sound (Tone)

Changes the motor running sound tone. This setting is effective when carrier frequencies set to function code F27 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	Tone level 0
1	Tone level 1
2	Tone level 2
3	Tone level 3

F30 Terminal [FMA] (Gain to output voltage)

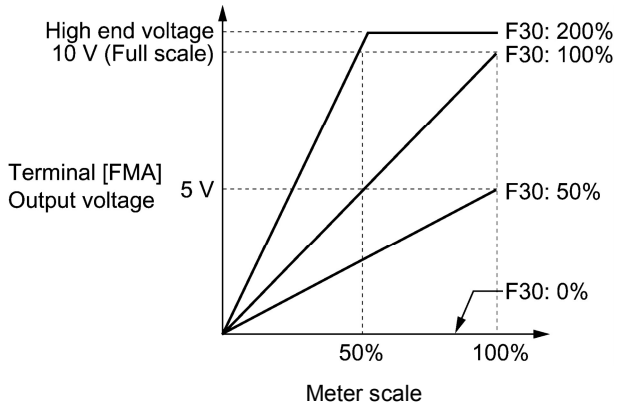
F31 Analog Output Signal Selection for [FMA] (Monitor object)

F31 allows you to output monitored data (such as the output frequency or output current) to terminal [FMA] as an analog data that can be adjusted with F30 for the meter scale.

■ Adjusting the output voltage level (F30)

Adjust the output voltage level within the range of 0 to 200%, supposing the monitored amount of the monitor selected with function code F31 as 100%.

- Data setting range: 0 to 200 (%)



■ Selecting object to be monitored (F31)

Select the output to terminal [FMA] for monitoring.

Data for F31	Function (Monitor the following)	Based on the following defined as 100% (full-scale)
0	Output frequency (before slip compensation)	Maximum output frequency
1	Output frequency (after slip compensation)	Maximum output frequency
2	Output current	Two times the inverter's rated output current
3	Output voltage	200 V class: 250 V 400 V class: 500 V
6	Input power	Two times the inverter's rated output capacity
7	PID feedback value	Feedback value is 100%
9	DC link bus voltage	200 V class: 500 V 400 V class: 1000 V
14	Test output (+)	10 V (with gain 100%)

F37 Load Selection/Auto Torque Boost/Auto Energy Saving Operation

Allows you to select the load type and enable/disable auto torque boost and auto energy saving operation. The load selection enables an optimal V/f pattern to be selected.

Load selection

There are two different properties of loads--the torque load which is in proportion to the square of speed and the constant torque load. You can select a V/f pattern optimized to the load property. Refer to the figure in the descriptions for function code F09 for details.

Auto torque boost

This feature optimizes the output voltage automatically to the motor and its load. Even if the load varies, the inverter can maintain the exciting current fed to the motor so as not to over-excite the motor. The maximum output torque of the motor will be increased.

Note
- If the automatic torque boost is enabled (F37 = 2 or 5), function code F09 will be ignored.
- If either the torque in proportion to the square of the speed or the constant torque is selected (F37 = 0, 1, 3, or 4), it is necessary to modify the F09 data (Torque boost: 0.0 to 20.0%).
- If a motor parameter is a special one or the rigidity of the load is not sufficient, lowering the maximum output torque or unstable operation may sometimes result. To avoid this happening, disable the automatic torque boost (F37 = 0 or 1) and set the torque boost with F09 manually.

Auto energy saving operation

This feature controls the terminal voltage of the motor automatically to minimize the motor power loss. (Note that this feature may not be effective depending upon the motor characteristics. Check the properties before using this feature.)

The inverter enables this feature for constant speed operation only. During acceleration and deceleration, the inverter will run with manual or automatic torque boost, depending on the data setting of 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.

Data for F37	Load selection	Auto torque boost	Auto energy saving	F09	Remarks
0	Variable torque	Disabled	Disabled	Enabled	
1	Constant torque	Disabled	Disabled	Enabled	
2	Not available	Enabled	Disabled	Disabled	
3	Variable torque	Disabled	Enabled	Enabled	The auto energy-saving feature is enabled only for constant speed operation. During acceleration/ deceleration, the inverter runs with manual or automatic torque boost.
4	Constant torque	Disabled	Enabled	Enabled	
5	Not available	Enabled	Enabled	Disabled	

Note When using the auto torque boost or energy-saving feature, you need to set the rated voltage of the motor to F05 (Voltage at the base frequency) and the motor parameters to the motor-related P codes.

F43 Current Limiter (Operation condition)

F44 Current Limiter (Limiting level)

F43 enables or disables the current limiter. If it is enabled, the inverter controls the output frequency while keeping the current set to F44 in order to prevent the motor from stalling.

With F43, you may select whether the current limiter works during constant speed operation only (F43 = 1) or during both acceleration and constant speed operation (F43 = 2). Set F43 to 1, for example, to drive the motor at maximum performance in the acceleration zone and to limit the drive current in the constant speed zone.

■ Operation condition (F43)

Select the motor running state in which the current limiter will work.

Data for F43	Function
0	Disable (No current limiter works.)
1	Enable the current limiter during constant speed operation
2	Enable the current limiter during acceleration and constant speed operation

■ Limiting level (F44)

Select the level at which the current limiter will work.

- Data setting range: 20 to 200% (Percentage ratio of rated current of the inverter)

Note

- The current limiting feature selected by F43 and F44 are implemented by software, so an operational delay may occur. To avoid the delay, use the current limiter (hardware) simultaneously (H12 = 1).
- If an overload is applied when the limiting 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.

F50 Electronic Thermal Overload Relay (Discharging capability)

F51 Electronic Thermal Overload Relay (Allowable loss)

These function codes configure the electronic thermal overload relay to protect the braking resistor from overheating.

Set the discharging capability and allowable average loss of braking resistors to F50 and F51, respectively. Those values differ depending upon the specifications of the braking resistor. Refer to the tables on the next page.

For built-in braking resistors, you may set 0 and 0.000 to F50 and F51, respectively. Doing so will automatically apply the settings given in the table on the next page.

Refer to Chapter 7, Section 7.2 "Selecting a Baking Resistor" for details.

Note

Depending on the discharging capability margin of a braking resistor, the electronic thermal function may operate and issue the overheat alarm "***dbH***," even if the actual temperature of the resistor is lower than that specified. Check braking resistor performance again and review the data setting of function codes F50 and F51.

The following tables list the discharging capability and allowable average loss of the FRENIC-Mini series of inverters. These values are determined by inverter model and specifications (built-in or external type) of braking resistors.

■ Built-in braking resistor

Power supply voltage	Inverter type	Resistance (Ω)	Capacity (W)	Continuous braking (Braking torque: 100%)		Repetitive braking (Period: 100 sec. or less)	
				Discharging capability (kWs)	Braking time (s)	Allowable average loss (kW)	Duty cycle (%ED)
Three-phase 200V	FRN1.5C1■-2□21	60	40	14	18	0.023	3
	FRN2.2C1■-2□21				12		2
	FRN3.7C1■-2□21	40	60	15	8	0.025	1.5
Three-phase 400V	FRN1.5C1■-4□21	240	40	14	18	0.023	3
	FRN2.2C1■-4□21				12		2
	FRN3.7C1■-4□21 FRN4.0C1■-4□21	160		15	8	0.025	1.5

Note 1) A box (■) in the above table replaces S or E depending on the enclosure.

2) A box (□) in the above table replaces A, C, E, or J depending on the shipping destination.

■ External braking resistor

Standard Models

The braking resistor is protected from overheating by a thermal relay incorporated in the braking resistor. Assign "external thermal relay tripped" (THR) to one of the inverter's digital input terminals [X1], [X2], [X3], [FWD], and [REV], and connect it to the terminals 2 and 1 of the braking resistor.

If you choose not to use the thermal relay incorporated in the braking resistor, set up the overheat protection device using the values given in the table below.

Power supply voltage	Inverter type	Braking resistor type	Q'ty	Resistance (Ω)	Capacity (W)	Continuous braking (Braking torque: 100%)		Repetitive braking (Period: 100 sec. or less)	
						Discharging capability (kWs)	Braking time (s)	Allowable average loss (kW)	Duty cycle (%ED)
Three-phase 200V	FRN0.4C1■-2□	DB0.75-2	1	100	200	9	45	0.044	22
	FRN0.75C1■-2□					17		0.068	18
	FRN1.5C1■-2□**	DB2.2-2		40	400	34		0.075	10
	FRN2.2C1■-2□**					33	30	0.077	7
	FRN3.7C1■-2□**	DB3.7-2		33		37	20	0.093	5
Three-phase 400V	FRN0.4C1■-4□	DB0.75-4		200	200	9	45	0.044	22
	FRN0.75C1■-4□					17		0.068	18
	FRN1.5C1■-4□**	DB2.2-4		160	400	34		0.075	10
	FRN2.2C1■-4□**					33	30	0.077	7
	FRN3.7C1■-4□** FRN4.0C1■-4□**	DB3.7-4		130		37	20	0.093	5
Single-phase 200V	FRN0.4C1■-7□	DB0.75-2		100	200	9	45	0.044	22
	FRN0.75C1■-7□					17		0.068	18
	FRN1.5C1■-7□	DB2.2-2		40	400	34		0.075	10
	FRN2.2C1■-7□					33	30	0.077	7

Note 1) A box (■) in the above table replaces S or E depending on the enclosure.

2) A box (□) in the above table replaces A, C, E, or J depending on the shipping destination.

3) Asterisks (**) in the above table denote the following:

21: Braking resistor built-in type, None: Standard

10% ED Models

Power supply voltage	Inverter type	Braking resistor type	Q'ty	Resis-tance (Ω)	Ca-pacity (W)	Continuous braking (Braking torque: 100%)		Repetitive braking (Period: 100 sec. or less)	
						Discharg-ing capability (kWs)	Braking time (s)	Allowable average loss (kW)	Duty cycle (%ED)
Three-phase 200V	FRN0.4C1■-2□	DB0.75-2C	1	100	200	50	250	0.075	37
	FRN0.75C1■-2□						133		20
	FRN1.5C1■-2□**	DB2.2-2C		40	400	55	73	0.110	14
	FRN2.2C1■-2□**						50		10
	FRN3.7C1■-2□**	DB3.7-2C		33		140	75	0.185	10
Three-phase 400V	FRN0.4C1■-4□	DB0.75-4C		200	200	50	250	0.075	37
	FRN0.75C1■-4□						133		20
	FRN1.5C1■-4□**	DB2.2-4C		160	400	55	73	0.110	14
	FRN2.2C1■-4□**						50		10
	FRN3.7C1■-4□** FRN4.0C1■-4□**	DB3.7-4C		130		140	75	0.185	10
Single-phase 200V	FRN0.4C1■-7□	DB0.75-2C		100	200	50	250	0.075	37
	FRN0.75C1■-7□						133		20
	FRN1.5C1■-7□	DB2.2-2C		40	400	55	73	0.110	14
	FRN2.2C1■-7□						50		10

Note 1) A box (■) in the above table replaces S or E depending on the enclosure.

2) A box (□) in the above table replaces A, C, E, or J depending on the shipping destination.

3) Asterisks (**) in the above table denote the following:

21: Braking resistor built-in type, None: Standard

Calculating discharging capability and allowable average loss and then setting function code data

■ Discharging capability (F50)

Discharging capability stands for the amount of electric power that a braking resistor can discharge for a single cycle of braking operation. It can be calculated using the braking period and rated motor capacity using equation (1), which is based on the regenerative power in deceleration or equation (2), which is based on that in constant speed operation.

$$\text{Discharging Capability (kWs)} = \frac{\text{Braking Time (s)} \times \text{Rated Motor Capacity (kW)}}{2} \quad (1)$$

$$\text{Discharging Capability (kWs)} = \text{Braking Time (s)} \times \text{Rated Motor Capacity (kW)} \quad (2)$$

Data for F50	Function
0	Apply the discharging capability specified for braking resistor built-in type
1 to 900	Discharge 1 to 900 kWs
999	Disable electronic thermal overload protection

■ Allowable average loss (F51)

Allowable average loss is a braking resistor capacity that can be applied for continuos operation of a motor. It can be calculated from the %ED and rated motor capacity using equation (3), which is based on the regenerative power in deceleration or equation (4), which is based on that in constant speed operation.

$$\text{Allowable Loss (kW)} = \frac{\frac{\%\text{ED (\%)}}{100} \times \text{Rated Motor Capacity (kW)}}{2} \quad (3)$$

$$\text{Allowable Average Loss (kW)} = \frac{\%\text{ED (\%)}}{100} \times \text{Rated Motor Capacity (kW)} \quad (4)$$

Data for F51	Function
0	Apply the allowable average loss specified for braking resistor built-in type
0.001 to 50.000	Discharge 0.001 to 50.000 kW

9.2.2 E codes (Extension terminal functions)

E01 to E03	Terminal Command Assignment to [X1] to [X3]	Refer to E98 and E99.

E01 to E03, E98 and E99 may assign commands (listed below) to terminals [X1] to [X3], [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, that is "Active ON."

To assign negative logic input to any input terminal, set the function code to the value of 1000s shown in ( ) in the table below. To keep explanations as simple as possible, the examples shown below are all written for the normal logic system.

Data for E01 to E03, E98 and E99	Terminal command assigned	Command symbols (Input signals)
0, 1, 2 (1000, 1001, 1002)	Select multistep frequency (0 to 7 steps)	(SS1), (SS2) and (SS4)
4 (1004)	Select ACC/DEC time	(RT1)
6 (1006)	Enable 3-wire operation (2 steps)	(HLD)
7 (1007)	Coarse to a stop	(BX)
8 (1008)	Reset alarm	(RST)
9 (1009)	Enable external alarm trip	(THR)
10 (1010)	Ready for jogging	(JOG)
11 (1011)	Switch frequency command 2/1	(Hz2/Hz1)
19 (1019)	Enable write from keypad	(WE-KP)
20 (1020)	Cancel PID control	(Hz/PID)
21 (1021)	Switch normal/inverse operation	(IVS)
24 (1024)	Enable communications link (RS485 communication, option)	(LE)
33 (1033)	Reset PID integral and differential components	(PID-RST)
34 (1034)	Hold PID integral component	(PID-HLD)
98*	Run forward. Short-circuiting terminals [FWD] and [CM] runs the motor forward. Opening them decelerates the motor to stop	(FWD)
99*	Run reverse. Short-circuiting terminals [REV] and [CM] runs the motor reverse. Opening them decelerates the motor to stop	(REV)

* No negative logic input is allowed for data 98 and 99. Note that negative logic input can never be used for the motor drive commands (FWD) and (REV).

Tip

(Example using negative logic system)
Assigning multistep frequency 2 (SS2) to terminal [X1]

If function code E01 is set to 1, logic is normal ("Active ON"). Short-circuiting terminals [X1] and [CM] makes (SS2) active.

If E01 is set to 1001, logic is negative ("Active OFF"). Opening the circuit between [X1] and [CM] makes (SS2) active.

Terminal function assignment and data setting

■ Select multistep frequency--(SS1), (SS2), and (SS4)
(Function code data = 0, 1, and 2)

Switching digital input signals (SS1), (SS2), and (SS4) ON/OFF may switch the present set frequency to those defined by function codes C05 through C11 (multistep frequencies). With this, the inverter may drive the motor at 8 different preset speeds.

The table below lists the frequencies that can be obtained by the combination of switching (SS1), (SS2), and (SS4). In the column "Selected frequency," "Other than multistep frequency" represents the set frequencies defined by frequency command 1 (F01), frequency command 2 (C30), and others. For details, refer to the block diagram in Chapter 4, Section 4.2 "Drive Frequency Command Generator."

Terminal [X3] (Function code E03)	Terminal [X2] (Function code E02)	Terminal [X1] (Function code E01)	Selected frequency
2 (SS4)	1 (SS2)	0 (SS1)	
OFF	OFF	OFF	Other than multistep frequency
OFF	OFF	ON	C05 (multistep frequency 1)
OFF	ON	OFF	C06 (multistep frequency 2)
OFF	ON	ON	C07 (multistep frequency 3)
ON	OFF	OFF	C08 (multistep frequency 4)
ON	OFF	ON	C09 (multistep frequency 5)
ON	ON	OFF	C10 (multistep frequency 6)
ON	ON	ON	C11 (multistep frequency 7)

■ Select ACC/DEC time (2 steps)--(RT1)
(Function code data = 4)

Digital input signal (RT1) assigned to the specified terminal ON/OFF may switch combinations between acceleration/deceleration time 1 (defined by function codes F07 and F08) and acceleration/deceleration time 2 (defined by E10 and E11).

Turning (RT1) ON, for example, enables the inverter to drive the motor using acceleration/ deceleration time 2.

(RT1)	Selected acceleration/deceleration time
OFF	F07: Acceleration time 1 F08: Deceleration time 1
ON	E10: Acceleration time 2 E11: Deceleration time 2

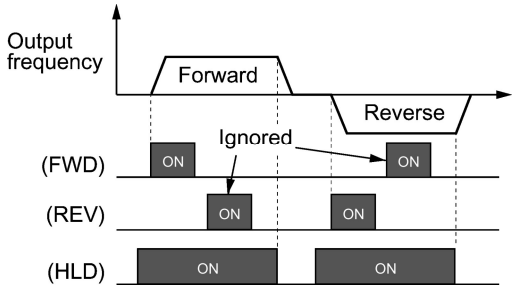
Tip The above acceleration/deceleration time switching takes effect also in S-curved or curvilinear operation defined by H07.

■ Enable 3-wire operation--(HLD)
(Function code data = 6)

Digital input signal (HLD) may self-hold the forward (FWD)/reverse (REV) run commands given at the external signal input terminals to enable 3-wire inverter operation.

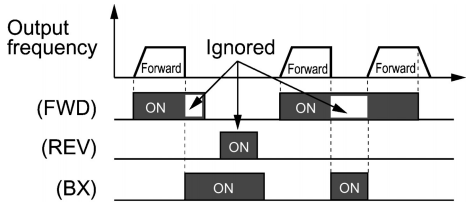
Shorting the circuit between the (HLD)-assigned terminal and terminal [CM] will self-hold the (FWD) or (REV) command. Opening the circuit will release the hold.

If (HLD) is not assigned to any terminal, the inverter runs in 2-wire operation using (FWD) and (REV).



■ Coast to a stop--(BX)
(Function code data = 7)

Shorting the circuit between the (BX)-assigned terminal and terminal [CM] will immediately shut down the inverter output so that the motor will coast to a stop without issuing any alarms.



■ Reset alarm--(RST)
(Function code data = 8)

When the protective function has been activated (the inverter is in Alarm mode), shorting the circuit between the (RST)-assigned terminal and terminal [CM] will reset the alarm output on terminals [Y1] and [30A/B/C]. Opening the circuit will release all the alarm indications to restart operation. Allow 10 ms or more for the short-circuit time.

(RST) should be kept OFF for normal inverter operation.

■ Enable external alarm trip--(THR)
(Function code data = 9)

When the motor is running, opening the circuit between the (THR)-assigned terminal and terminal [CM] will immediately shut down the inverter output and issue the alarm "*0H2*." The motor will coast to a stop.

This signal will be self-held inside the inverter until the PRG/RESET key is pressed to reset it or any other reset action is taken. If (THR) is not assigned to any terminal, the inverter interprets this as (THR) always being ON.

Tip Use this function to protect the external-braking resistor from overheating.

■ Ready for jogging--(JOG)
(Function code data = 10)

Turning ON the (JOG) command makes the motor ready for jogging. Use this command for fine adjustment to position a workpiece, for example.

Simultaneous (STOP) + (∧) keying may also make the motor ready for jogging depending upon whether keypad operation or terminal command operation is selected and whether the (JOG) command is ON or OFF, as listed below.

When keypad operation is selected (F02 = 0, 2, or 3)

If (JOG) is:	(STOP) + (∧) keying	The motor becomes ready for:
ON	Disabled.	Jogging
OFF	Toggles between normal and jogging.	Normal running
		Jogging

When terminal command operation is selected (F02 = 1), simultaneous (STOP) + (∧) keying is disabled.

Jogging

When the motor is ready for jogging with (JOG) being ON, pressing the (RUN) key or turning the (FWD) or (REV) command ON will start the motor to jog.

If the (RUN) key is released, the motor will decelerate to a stop.

Jogging operation follows the settings of:

- Jogging frequency set by function code C20
- Acceleration or deceleration time set by function code H54

Note

- Switching between the ready-to-jog and ready-to-run statuses is possible only when the inverter stops its output, not possible when it is running the motor.
- To jog the motor by the concurrent input of (JOG) and run command (e.g., (FWD), the input time lag between those commands should be within 100 ms; otherwise, the inverter will not jog the motor.

  If the (FWD) command is turned ON preceding the (JOG) command, the inverter runs the motor in ordinary operation until the (JOG) is turned ON.

■ Switch frequency command 2/1--(Hz2/Hz1)
(Function code data = 11)

Turning the digital input signal (Hz2/Hz1) ON/OFF can switch the frequency setting means between frequency command 1 (defined by function code F01) and frequency command 2 (defined by function code C30).

If (Hz2/Hz1) is not assigned to any terminal, the frequency setting means defined by function code F01 will take effect.

(Hz2/Hz1)	Frequency setting means
OFF	F01: Frequency command 1
ON	C30: Frequency command 2

For details of the relationship for frequency settings other than frequency command 1 or 2, refer to Chapter 4, Section 4.2 "Drive Frequency Command Generator."

■ Enable write from keypad--(WE-KP)
(Function code data = 19)

Turning OFF the (WE-KP) command prohibits changing of function code data from the keypad.

Only when the (WE-KP) command is turned ON, you may access function code data from the keypad according to the setting of function code F00 as listed below.

If the (WE-KP) command is not assigned to any terminal, the inverter will interpret (WE-KP) as being always ON.

If (WE-KP) is set to:	F00	Function
OFF	Disabled.	Inhibit editing of function code data
ON	0	Permit editing of function code data
	1	Inhibit editing of function code data except F00 and H03

Note If you mistakenly assign the (WE-KP) command to any terminal, function code data will be no longer edited. To cancel such an undesired assignment, turn the (WE-KP) command ON once (by short-circuiting between the (WE-KP)-assigned terminal and terminal [CM]) and then reassign a correct command to the terminal.

■ Cancel PID control--(Hz/PID)
(Function code data = 20)

Turning the (Hz/PID) command ON/OFF enables or disables the PID control.

If the PID control is disabled with the (Hz/PID) being OFF, the inverter runs the motor with the frequency manually set by any of the multistep, keypad, or analog input.

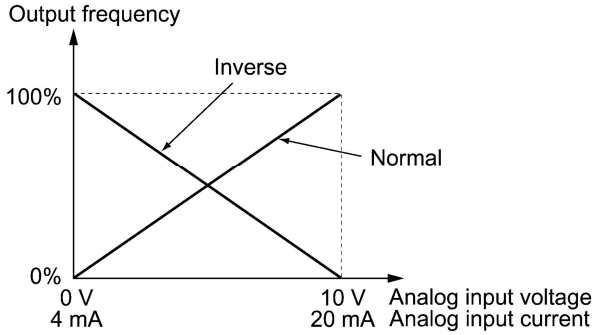
(Hz/PID)	Selected function
OFF	Enable PID control
ON	Disable PID control / Enable manual settings

Refer to Chapter 4, Section 4.8 "PID Frequency Command Generator" for details.

■ Switch normal/inverse operation--(IVS)
(Function code data = 21)

Turning the (IVS) command ON/OFF switches the output frequency control between normal (proportional to the set frequency components) and inverse operation for the PID process or manually set frequencies. To select the inverse operation, switch the (IVS) command to ON.

When the PID control is enabled, turning the (IVS) command ON inverts the PID process control selected by function code J01. For example, if the PID process control is normal, turning it ON switches it to inverse, or vice versa.



For ordinary set frequency (J01 = 0)

If (IVS) is:	Set frequency
OFF	Normal operation
ON	Inverse operation

For PID control (J01 = 1 or 2)

If (IVS) is:	Selected PID control (J01)	PID operation
OFF	1: Normal operation	Normal
ON	1: Normal operation	Inverse
OFF	2: Inverse operation	Inverse
ON	2: Inverse operation	Normal

■ Enable communications link--(LE)
(Function code data = 24)

Turning ON the (LE) command selects link operation. The inverter will run the motor with the frequency command or drive command given via the RS485 communications facility defined by function code H30.

If the (LE) command is not assigned to any terminal, the inverter will interpret (LE) as being always ON.

Refer to Chapter 4, Sections 4.2 "Drive Frequency Command Generator," 4.3 "Drive Command Generator" and 4.4 "Terminal Command Decoders," and the RS485 Communication User's Manual (MEH448) for more details.

■ Reset PID integral and differential components--(PID-RST)
(Function code data = 33)

Turning ON the (PID-RST) command resets the PID integral and differential components.

■ Hold PID integral component--(PID-HLD)
(Function code data = 34)

Turning ON the (PID-HLD) command holds the current inverter output voltage constant by suppressing an increase of PID integral component.

■ Run forward--(FWD)
(Function code E98/E99 data = 98)

If the (FWD) command is turned ON, the inverter runs the motor forward; if OFF, it decelerates the motor to a stop.

■ Run reverse--(REV)
(Function code E98/E99 data = 99)

If the (REV) is turned ON, the inverter runs the motor in reverse; if OFF, it decelerates the motor to a stop.

E10	**Acceleration Time 2**	**Refer to F07.**
E11	**Deceleration Time 2**	**Refer to F08.**

Refer to the descriptions of function codes F07 and F08.

E20 and E27 **Status Signal Assignment to [Y1], [30A], [30B] and [30C]**

E20 to E27 may assign output signals (listed below) to terminals [Y1] (transistor switch) and [30A], [30B] and [30C] (mechanical relay contacts) which are general-purpose programmable output terminals.

These function codes may also switch the logic system between normal and negative to define the property of those output terminals so that the inverter logic may interpret either the ON or OFF status of each terminal as active.

Terminals [30A], [30B], and [30C] are mechanical relay contacts. In the normal logic, if an alarm occurs, the relay will be excited so that [30A] and [30C] will be short-circuited, signaling an occurrence of the error to external equipment. On the other hand, in the negative logic, the relay will cut off the excitation current to open [30A] and [30C]. This may be useful for the implementation of failsafe power systems.

The default setting is normal logic, that is "Active ON."

To assign negative logic input to any input terminal, set the function code to the value of 1000s shown in ( ) in the table below. To keep explanations as simple as possible, the examples shown below are all written for the normal logic system.

Note When negative logic is active, the inverter switches all output signals to the active side (for example, the alarm side). To avoid system malfunctions caused by this, interlock the signals to keep them ON using an external power source. To use negative logic with the output signal, set the data of 1000s in ( ) as listed in the table below.

Data for E20 or E27	To assign the following status signals to terminals:	Output signal symbols
0 (1000)	Inverter running (Speed > 0)	(RUN)
1 (1001)	Frequency arrival signal	(FAR)
2 (1002)	Frequency detection	(FDT)
3 (1003)	Undervoltage detection	(LU)
5 (1005)	Torque limiting (Current limiting)	(IOL)
6 (1006)	Auto-restart after recovery from instantaneous power failure	(IPF)
7 (1007)	Motor overload early warning	(OL)
26 (1026)	Retry in operation	(TRY)
30 (1030)	Lifetime alarm	(LIFE)
35 (1035)	Inverter running	(RUN2)
36 (1036)	Overload prevention control	(OLP)
37 (1037)	Current detection	(ID)
41 (1041)	Low level current detection	(IDL)
99 (1099)	Alarm relay contact output (for any fault)	(ALM)

Terminal function assignment and data setting

■ Inverter running (Speed > 0)--(RUN)
(Function code data = 0)

This output signal is used to tell the external equipment that the inverter is running with a speed greater than 0. It switches ON when the inverter output frequency exceeds the start frequency of the motor. It switches OFF when the output frequency is less than the start frequency or the inverter is DC-braking the motor.

Tip If this signal is assigned to terminal [Y1] in negative logic (active OFF), it can be used to indicate the inverter stopping its output.

■ Frequency arrival signal--(FAR)
(Function code data = 1)

This signal is turned ON when the difference between the output and set frequencies is within the allowable error zone (prefixed to 2.5 Hz).

■ Frequency detection--(FDT)
(Function code data = 2)

This signal is turned ON when the output frequency of inverter has come to the frequency detection level specified by function code E31. It is turned OFF when the output frequency drops lower than the detection level for 1 Hz (hysteresis band of the frequency comparator: prefixed at 1 Hz).

■ Undervoltage detection--(LU)
(Function code data = 3)

This signal is turned ON when the voltage of the DC link bus of the inverter drops below the specified level or when the motor stops due to activation of the undervoltage protection feature (undervoltage trip). It is turned OFF if the DC link bus voltage exceeds the specified voltage.

■ Torque limiting (Current limiting)--(IOL)
(Function code data = 5)

This signal is turned ON when the inverter is limiting the motor drive current by activating the current limiter of either software (F43: Function select, F44: Operation level) or hardware (H12 = 1: Current limit). The minimum ON-duration is 100 ms.

Using this signal allows the inverter to show an overload alarm on the display panel of the external equipment.

■ Auto-restart after recovery from instantaneous power failure--(IPF)
(Function code data = 6)

This signal is turned ON during the period from when the inverter detects the undervoltage of the DC link bus and shuts down the output (if auto-restart after a recovery from momentary power failure is selected (F14 = 4 or 5)) until auto-restarting (the output frequency has recovered up to the set frequency). At that moment of auto-restarting, this signal is turned OFF.

■ Motor overload early warning--(OL)
(Function code data = 7)

This signal is used to issue a motor overload early warning for enabling you to take corrective action before the inverter detects a motor overload (*0L1* alarm) and shuts down its output.

The motor properties are specified by function codes F10 and F12 (Motor characteristics selection and thermal time constant for electronic thermal overload protection). If a value calculated from the settings of F10 and F12 exceeds the detection level of the early warning set by function code E34, this signal is turned ON. Normally, the recommended set current level for E34 is 80 to 90% of the allowable continuous load current set by function code F11.

Note Function code E34 is effective for not only the motor overload early warning (OL), but also the current detection (ID) and low level current detection (IDL).

■ Retry in operation--(TRY)
(Function code data = 26)

This signal is turned ON when the retry facility specified by function codes H04 (number of retries) and H05 (retry interval) is being activated.

Refer to function codes H04 and H05 for details of the output timing and number of retries.

■ Lifetime alarm--(LIFE)
(Function code data = 30)

This signal is turned ON when it is judged that the service life of any of capacitors (capacitor in the DC link bus and electrolytic capacitors on the printed circuit boards) and cooling fan has expired.

The judgement level for service life are as follows. This information can be checked in Menu #5 "Maintenance information" of Programming mode.

Parts	Judgement level for service life
Capacitor in the DC link bus	Capacitance: Max. 85% of factory default
Capacitor/s on the printed circuit boards	Accumulated run time: 61,000 hours or more
Cooling fan	Accumulated run time: 61,000 hours or more (1.5 to 3.7 kW models) (Based on the assumption that the inverter runs in an ambient temperature of 40°C)

This facility provides tentative information for service life of the parts. If this signal is issued, check the service life of these parts in your system according to the maintenance procedure to determine whether the parts should be replaced or not. To maintain stable and reliable operation and avoid unexpected failures, daily and periodic maintenance must be performed. For details, refer to the FRENIC-Mini Instruction Manual (INR-SI47-0791-E), Chapter 7 "MAINTENANCE AND INSPECTION."

■ Inverter running--(RUN2)
(Function code data = 35)

This signal is turned ON when the main switching circuit (IGBT gates) is activated; it is OFF when it is not activated.

■ Overload prevention control--(OLP)
(Function code data = 36)

This signal is turned ON when the overload prevention facility is activated if the frequency drop rate comes to be the setting specified by function code H70. The minimum ON-duration is 100 ms.

For details of the overload prevention control, refer to the descriptions of function code H70.

■ Current detection--(ID)
(Function code data = 37)

This signal is turned ON when the output current exceeds the operation level specified by function code E34 and stays in this status for the duration specified by function code E35 (on delay timer). The minimum ON-duration is 100 ms.

If the output current drops to 90% of the operation level, this signal is turned OFF.

This signal can be used as a reference for determining the running speed in the operation of load machinery or system, by monitoring the inverter's load state.

Note Function codes E34 and E35 are effective not only for the current detection (ID), but often also for the overload early warning (OL) and low level current detection (IDL).

■ Low level current detection--(IDL)
(Function code data = 41)

This signal is turned ON when the output current drops below the operation level specified by function code E34 and stays in this status for the duration specified by function code E35 (on delay timer).

If the output current exceeds the sum of the current level of operation and 5% of the rated current of the inverter, then this signal is turned OFF.

Use this signal to indicate 0A output current due to a broken output wire, zero motor torque, or any such factor undetectable by the inverter alarm facilities.

Note Function codes E34 and E35 are effective not only for the low level current detection (IDL), but often also for the overload early warning (OL) and current detection (ID).

■ Alarm relay contact output (for any fault)--(ALM)
(Function code data = 99)

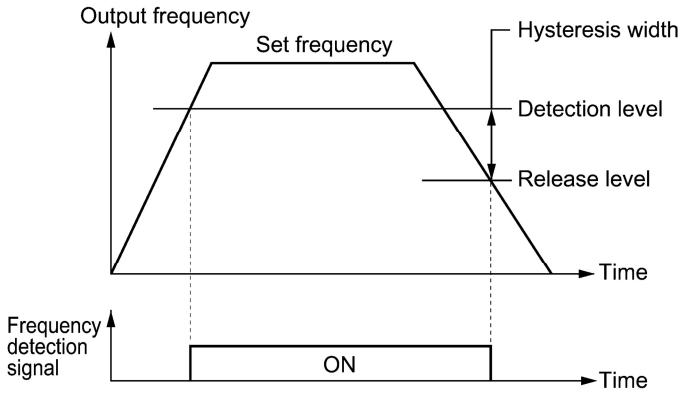
This signal is turned ON if the protection facility is activated so that the inverter enters Alarm mode.

In a system which monitors inverter alarm information through [30A/B/C] relay contacts, make sure that function code data of E20 or E27 is set to 99.

E31 Frequency Detection (FDT) (Detection level)

Specifies an operating level for the set frequency detection signal. The hysteresis frequency band between detection and release levels is 1.0 Hz.

- Data setting range: 0.0 to 400.0 (Hz)



E34 Overload Early Warning/Current Detection/Low Current Detection (Level)

E35 Current Detection/Low Current Detection (Timer)

E34 and E35 set the operation level for overload early warning, current detection and low current detection, and the timer count.

■ Operation Level (E34)

Sets the operation level for the motor overload early warning (OL), inverter output current detection (ID), or low current output detection (IDL).

- Data setting range: Current value of 1 to 200% of the rated inverter current in units of amperes.

■ Timer (E35)

Sets the timer for the inverter output current detection (ID) and low current output detection (IDL).

- Data setting range: 0.01 to 600.00 (sec.)

E39 Coefficient for Constant Feeding Rate Time — Refer to E50.

E39 and E50 set a coefficient to be used for setting the constant feeding rate time, load shaft speed or line speed and for displaying its output status.

Data setting ranges and calculation equations

- Data setting range for E39: 0.000 to 9.999
  for E50: 0.01 to 200.00

$$\text{Const. Feeding Rate Time (min)} = \frac{\text{Coeff. of Speed Indication (E50)}}{\text{Freq.} \times \text{Coeff. for Const. Feeding Rate Time (E39)}}$$

Load Shaft Speed = (E50: Coeff. for Speed Indication) × Frequency (Hz)

Line Speed = (E50: Coeff. for Speed Indication) × Frequency (Hz)

Where, Freq. is the set frequency if each expression is for one of the set data for the constant feeding rate time, load shaft speed, or line speed; it is the output frequency if each expression is for the output status monitor.

If the constant feeding rate time is 999.9 min or more, or the denominator on the right in the first equation is 0, then the number 999.9 will be displayed.

E40 PID Display Coefficient A

E41 PID Display Coefficient B

E40 or E41 sets the conversion factor to equal an indicated value (process amount) with the target and feedback values in PID control.

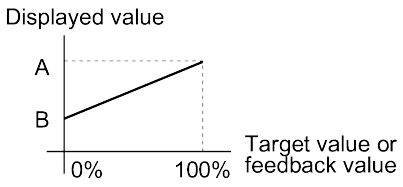
- Data setting range: -999 to 0.00 to 999 for conversion factors A and B.

Data setting and operation

■ Target (commanded) and feedback values in PID control

Set the maximum and minimum PID indication values to function code E40 (factor A) and E41 (factor B), respectively. Calculate the indication value using the equation below.

Indication value = (Target or feedback value) x (Factor A - B) + B



E43 Monitor Item Selection

Selects the monitoring item to be displayed on the LED monitor. When turning ON power to the inverter or after changing function code E43, the inverter will indicate the selected item on the LED monitor.

Data for E43	Function (Monitored items)
0	Speed monitor item (selected by the sub item of function code E48)
3	Inverter output current
4	Inverter output voltage
9	Inverter input power
10	PID command value*
12	PID feedback value*
13	Timer value**

* If 0 (Disable) is set for function code J01, "- - - -" appears on the LED.

** If 0 (Disable) is set for function code C21, "- - - -" appears on the LED.

E48 LED Monitor (Speed monitor item)

Selects the speed-monitoring format on the LED monitor.

Data for E48	The LED monitor displays the sub item:
0	Output frequency before slip compensation
1	Output frequency after slip compensation
2	Set frequency
4	Load shaft speed in r/min
5	Line speed in m/min
6	Constant feeding rate time

E50 Coefficient for Speed Indication

Refer to E39.

Detail for the speed display coefficient setting is given in the description of function code E39.

E52 Menu Display Mode for Keypad

Selects the menu display mode for the keypad in Programming mode.

Data for E52	The keypad will enter:
0	Function code data setting mode in which Menu #1 "Data setting" only is displayed.
1	Function code data check mode in which Menu #2 "Data checking" only is displayed.
2	Full-menu mode in which all menus may be displayed.

E60 Built-in Potentiometer (Function selection)

E61 Analog Input Signal Definition for [12]

E62 Analog Input Signal Definition for [C1]

E60, E61, and E62 define the function of the built-in potentiometer, terminals [12] and [C1], respectively.

Data for E60, E61, or E62	This function will be defined for potentiometer and terminals [12] and [C1]:
0	None
1	Auxiliary frequency command 1*
2	Auxiliary frequency command 2**
3	PID process command 1 (J02 setting is also required.)
5	PID feedback value (Not applicable to function code E60)

* This is an auxiliary frequency input to be added to frequency command 1, but never to frequency command 2. Frequency commands 1 and 2 are frequencies set by the means specified by F01 and C30, respectively. The set frequency can be switched between, for example, frequency command 1 added by the auxiliary frequency and the raw frequency 2 added by nothing, to drive the motor in the desired manner. For more details, refer to Chapter 4, Section 4.2 "Drive Frequency Command Generator."

** An auxiliary frequency input to be added to the set frequency. For example, the auxiliary frequency input to be added to the preset frequency used for the multistep frequency operation.

Note If the same data is set to these function codes, the priority order will be:
E60 > E61 > E62

E98	**Terminal Command Assignment to [FWD]**	**Refer to E01 to E03.**
E99	**Terminal Command Assignment to [REV]**	**Refer to E01 to E03.**

For details on the command assignment to terminals [FWD] and [REV], refer to the descriptions for function codes E01 to E03.

9.2.3 C codes (Control functions of frequency)

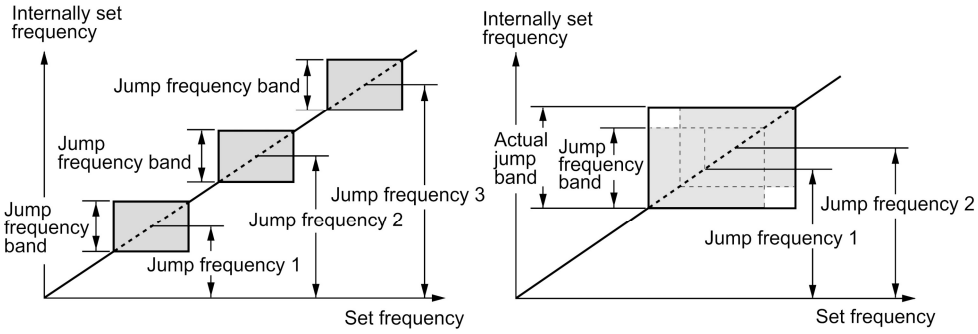
C01 to C03	Jump Frequencies 1, 2 and 3
C04	Jump Frequency Band

These function codes enable the inverter to jump up to three different points on the output frequency in order to skip the resonance frequency caused by the motor drive frequency and natural frequency of the driven mechanism.

- During acceleration, the moment the set frequency reaches the bottom of the set jump frequency band, the inverter keeps the output at that bottom frequency until the output frequency reaches the upper limit and proceeds with the acceleration until the next set point is reached or set speed is reached.

  During deceleration, the inverter processes the set jump frequency band in reverse to the acceleration curve. Refer to the left-hand figure below.

- When the set jump frequency bands overlap, the overlapped band is ignored, the inverter takes the lowest frequency within the overlapped bands as the bottom frequency and the highest as the peak. Refer to the right-hand figure below.



■ Jump frequencies 1,2 and 3 (C01, C02 and C03)

Set the center of the jump frequency band.

- Data setting range: 0.0 to 400.0 (Hz) (Setting to 0.0 results in no jump band)

■ Jump frequency band (C04)

Set the width of the jump frequency band.

- Data setting range: 0.0 to 30.0 (Hz) (Setting to 0.0 results in no jump band)

C05 to C11	Multistep Frequency Settings 1 to 7

These function codes set frequencies required for driving the motor at frequencies 1 to 7.

- Data setting range: 0.00 to 400.00 (Hz)
- Turning terminal commands (SS1), (SS2) and (SS4) ON/OFF selectively switches the set frequency of the inverter in 7 steps. For details of the terminal function assignment, refer to the descriptions for function codes E01 to E03 "Command Assignment to Terminals [X1] to [X3]."

For the multistep frequency driving, refer to Chapter 4, Section 4.2 "Drive Frequency Command Generator."

C20 Jogging Frequency

Sets the frequency for jogging operations.

- Data setting range: 0.00 to 400.00 (Hz)

For details on jogging operations, refer to the descriptions for function codes E01 to E03 "Command Assignment to Terminals [X1] to [X3]."

C21 Timer Operation

Enables or disables timer operation. If it is enabled, entering a run command will run the inverter to drive the motor for the period preset to the timer.

Data for C21	The timer operation is:
0	Disabled
1	Enabled

- Pressing the STOP key during the timer countdown cancels the timer operation.
- If the timer has counted down to zero (0), pressing the RUN key will not start the inverter to drive the motor even with C21 being set to 1.
- Timer operation can be started by turning ON the terminal command (FWD) or (REV).

An example of timer operation

Setting up the timer conditions beforehand

- Set C21 to 1 to enable timer operation.
- To display the timer count on the LED monitor, set function code E43 (LED monitor) to 13 (Timer count).
- Set up the frequency for the timer operation using the built-in potentiometer or the ▲ / ▼ key. If the LED displays the timer count, press the FUNC/DATA key to switch to the speed monitor and then set the frequency for the timer operation.

Timer operation (by giving a run command with the RUN key)

(1) Use the ▲ / ▼ key to set the timer count (in seconds) while monitoring the current count displayed on the LED monitor. Note that the timer count is expressed as integers.

(2) Press the RUN key to run the motor, and the timer will start the countdown. The moment the timer finishes the countdown, the inverter stops running the motor even if the STOP key is not pressed. (Timer operation is possible even when the timer count is not displayed on the LED monitor.)

Note If timer operation started by the terminal command (FWD) is finished and the inverter decelerates the motor to a stop, then the LED monitor displays "*End*" and the monitor indication ("0" if the timer count is selected) alternately. Turning (FWD) OFF will switch the LED back to the monitor indication.

C30	Frequency Command 2 (Refer to F01.)

For details on frequency command 2, refer to the description for function code F01.

C32	Analog Input Adjustment (Gain for terminal input [12]) (Refer to F18.)
C34	Analog Input Adjustment (Gain reference point for terminal input [12]) (Refer to F18.)
C37	Analog Input Adjustment (Gain for terminal input [C1]) (Refer to F18.)
C39	Analog Input Adjustment (Gain reference point for terminal input [C1]) (Refer to F18.)

For details on adjusting the analog inputs, refer to the description for function code F18.

C33	Analog Input Adjustment (Filter for terminal input [12])
C38	Analog Input Adjustment (Filter for terminal input [C1])

C33 (voltage input) and C38 (current input) set the time constant of the filter for the analog input on terminal [12] and [C1], respectively.

- Data setting range: 0.00 to 5.00 (sec.)
- The larger the time constant, the slower the response. Set the time constant suitable to the load with consideration given to the system response. When the analog input fluctuates due to electric noise, first remove the noise factor or protect the input from noise by electric means (grounding the shield, ferrite core or capacitor). After that, increase the time constant if you cannot remove the noise factor to a sufficiently degree.

C50	Bias (Bias reference point for 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 (Bias for PID command 1)
C52	Bias (Bias reference point for PID command 1)

These function codes modify the analog input of the PID process command 1 by gain and bias, enabling defining the arbitrary relationship between the analog input and PID process command to be arbitrarily defined.

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 and C39 are shared by the drive frequency commands.

■ Bias (C51)

- Data setting range: -100.00 to 100.00 (%)

■ Bias reference point (C52)

- Data setting range: 0.00 to 100.00 (%)

9.2.4 P codes (Motor parameters)

P02 Motor Parameter (Rated capacity)

Sets the nominal rated capacity that is denoted on the rating nameplate of the motor.

Data for P02	If the nominal rated capacity is:
0.01 to 10.00	0.01 to 10.00 kW when function code P99 is set to 0, 3 or 4.
0.01 to 10.00	0.01 to 10.00 HP when function code P99 is set to 1.

P03 Motor Parameter (Rated current)

Sets the nominal rated current that is printed on the rating nameplate of the motor.

- Data setting range: 0.00 to 99.99 (Amp.)

P09 Motor Parameter (Slip compensation gain)

Sets the gain to compensate for the motor slip frequency.

- Data setting range: 0.0 to 200.0 (%)

Compensation gains for the rated slip frequencies listed in the following table are ones for Fuji standard motors.

Typical rated slip frequencies for 100%

Rated capacity (kW/HP)	Fuji standard 8-series motors (Hz)	Typical motors rated in HP (Hz)	Fuji standard 6-series motors (Hz)	Other motors (Hz)
0.06/0.1	1.77	2.50	1.77	1.77
0.1/0.12	1.77	2.50	1.77	1.77
0.2/0.25	2.33	2.50	2.33	2.33
0.4/0.5	2.40	2.50	2.40	2.40
0.75/1	2.33	2.50	2.33	2.33
1.5/2	2.00	2.50	2.00	2.00
2.2/3	1.80	1.77	1.80	1.80
3.7/5	1.93	1.50	1.93	1.93

The 200 V and 400 V series of motors share the same data listed above.

Note To compensate slip of a motor correctly, the rated voltage (at base frequency) (F05) and P codes (Motor parameters) should be also set consistently.

P99 Motor Selection

Selects the motor to be used.

Data for P99	To use:
0	Fuji standard motors (8-series)
1	GE motors
3	Fuji standard motors (6- series)
4	Other motors

In order to perform automatic control features such as the auto torque boost/auto energy saving and slip compensation or electronic thermal overload protection for the motor, the inverter invokes the rated values and properties of the motor. To match the drive properties between the inverter and motor, set the motor properties to this code and set function code H03 (Initialize data) to 2 to initialize the motor parameter. This action automatically updates the data of function codes P03 and P09 and the constants used inside the inverter.

When using a Fuji standard motor, select the data listed below according to the model.

- P99 = 0 for Fuji standard 8-series motors (current models)
- P99 = 3 for Fuji standard 6-series motors (conventional models)

For motors from other manufacturers or unknown models, set P99 to 4 (Other motors).

Note

- If P99 is set to 4 (Other motors), the parameters of the Fuji standard 8-series motor will apply as an alternative.
- The inverter also supports motors rated by HP (horse power: typical in North America, P99 = 1).

9.2.5 H codes (High performance functions)

H03	Data Initialization

Initializes the current function code settings to the factory defaults or initializes the motor constants (parameters).

Data for H03	Function	Setting procedure
0	Disables initialization (Settings made by the user manually will be retained.)	Simultaneous keying of STOP + ∧ keys changes data in order of 0, 1, 2, and of STOP + ∨ keys changes data in the reverse order. Pressing the FUNC DATA key will fix the set data.
1	Initializes all function code data to the factory defaults	
2	Initializes the P03 data (Rated current of the motor) and internally used constants to the motor constants determined by P02 data (Motor capacity) and P99 (Motor characteristics), as listed on the next page. Initializes P09 data (Slip compensation gain) to 0.0.	

- If you do initialization while H03 is set at "1" or "2," H03 will automatically go back to "0" (factory default) at the completion of initialization.

<Procedure for initializing motor constants>

- To initialize the motor constants, set the related function codes as follows.
  1) P02 Motor Parameters: (Rated capacity) — Set the rated capacity of the motor to be used in kW.
  2) P99 Motor Selection: — Select the characteristics of the motor. (Refer to the descriptions given for P99.)
  3) H03 Data Initialization: — Initialize the motor constants. (H03=2)
  4) P03 Motor Parameters: (Rated current): — Set the rated current printed on the nameplate if the set data differs from the rated current.
- If any value out of the general motor capacity is set for P02, the capacity will be internally converted to the applicable motor rating (see the table on the next page).

■ If P99 (Motor selection) is set to 0 (Fuji standard 8-series motors), 3 (Fuji standard 6-series motors), or 4 (Other motors):

Power supply voltage	Setting range (kW) / Function code P02	Applicable motor rating (kW)	Rated current (A)								
			If P99 (Motor selection) is set to:								
			0			3			4		
			Shipping destination (Version)			Shipping destination (Version)			Shipping destination (Version)		
			Asia	EU	Japan	Asia	EU	Japan	Asia	EU	Japan
Three-phase 200V Single-phase 200V	0.01 to 0.06	0.06	0.40	0.44	0.38	0.40	0.44	0.38	0.40	0.44	0.38
	0.07 to 0.10	0.1	0.62	0.68	0.61	0.62	0.68	0.61	0.62	0.68	0.61
	0.11 to 0.20	0.2	1.18	1.30	1.16	1.19	1.30	1.18	1.18	1.30	1.16
	0.21 to 0.40	0.4	2.10	2.30	2.13	2.10	2.30	2.13	2.10	2.30	2.13
	0.41 to 0.75	0.75	3.29	3.60	3.36	3.29	3.60	3.36	3.29	3.60	3.36
	0.76 to 1.50	1.5	5.55	6.10	5.87	5.55	6.10	5.87	5.55	6.10	5.87
	1.51 to 2.20	2.2	8.39	9.20	8.80	8.39	9.20	8.80	8.39	9.20	8.80
	2.21 to 3.70	3.7	13.67	15.00	14.38	13.67	15.00	14.38	13.67	15.00	14.38
	3.71 to 5.50	5.5	20.04	22.00	21.19	20.04	22.00	21.19	20.04	22.00	21.19
	5.51 to 10.00	7.5	26.41	29.00	28.17	26.41	29.00	28.17	26.41	29.00	28.17
Three-phase 400V	0.01 to 0.06	0.06	0.19	0.22	0.19	0.19	0.22	0.19	0.19	0.22	0.19
	0.07 to 0.10	0.1	0.31	0.34	0.31	0.31	0.34	0.31	0.31	0.34	0.31
	0.11 to 0.20	0.2	0.58	0.65	0.58	0.59	0.65	0.59	0.58	0.65	0.58
	0.21 to 0.40	0.4	1.09	1.15	1.07	1.09	1.15	1.07	1.09	1.15	1.07
	0.41 to 0.75	0.75	1.71	1.80	1.68	1.71	1.80	1.68	1.71	1.80	1.68
	0.76 to 1.50	1.5	3.04	3.05	2.94	3.04	3.05	2.94	3.04	3.05	2.94
	1.51 to 2.20	2.2	4.54	4.60	4.40	4.54	4.60	4.40	4.54	4.60	4.40
	2.21 to 3.70	3.7	7.43	7.50	7.20	7.43	7.50	7.20	7.43	7.50	7.20
	3.71 to 5.50	5.5	10.97	11.00	10.59	10.97	11.00	10.59	10.97	11.00	10.59
	5.51 to 10.00	7.5	14.63	14.50	14.08	14.63	14.50	14.08	14.63	14.50	14.08

NOTE: The above values in the "Rated current" column are exclusively applicable to the four-pole Fuji standard motors rated for 200 V and 400 V at 60 Hz. If you use non-standard or other manufacturer's motors, change the P02 data to the rated current printed on the motor's nameplate.

■ If P99 (Motor selection) is set to 1 (HP motors):

Power supply voltage	Setting range (HP) / Function code P02	Applicable motor rating (HP)	Rated current (A) / If P99(Motor selection) is set to: 1 / Shipping destination (Version)		
			Asia	EU	Japan
Three-phase 200V Single-phase 200V	0.01 to 0.10	0.1	0.44	0.44	0.44
	0.11 to 0.12	0.12	0.68	0.68	0.68
	0.13 to 0.25	0.25	1.40	1.40	1.40
	0.26 to 0.50	0.5	2.00	2.00	2.00
	0.51 to 1.00	1	3.00	3.00	3.00
	1.01 to 2.00	2	5.80	5.80	5.80
	2.01 to 3.00	3	7.90	7.90	7.90
	3.01 to 5.00	5	12.60	12.60	12.60
	5.01 to 7.50	7.5	18.60	18.60	18.60
	7.51 to 10.00	10	25.30	25.30	25.30
Three-phase 400V	0.01 to 0.10	0.1	0.22	0.22	0.22
	0.11 to 0.12	0.12	0.34	0.34	0.34
	0.13 to 0.25	0.25	0.70	0.70	0.70
	0.26 to 0.50	0.5	1.00	1.00	1.00
	0.51 to 1.00	1	1.50	1.50	1.50
	1.01 to 2.00	2	2.90	2.90	2.90
	2.01 to 3.00	3	4.00	4.00	4.00
	3.01 to 5.00	5	6.30	6.30	6.30
	5.01 to 7.50	7.5	9.30	9.30	9.30
	7.51 to 10.00	10	12.70	12.70	12.70

NOTE: The above values in the "Rated current" column are exclusively applicable to the four-pole Fuji standard motors rated for 200 V and 400 V at 60 Hz. If you use non-standard or other manufacturer's motors, change the P02 data to the rated current printed on the motor's nameplate.

H04	Retry (No. of retries)
H05	Retry (Latency time)

To automatically exit from the alarm status and restart the inverter, use the retry functions. In doing so, the inverter automatically exits from Alarm mode and restarts without issuing a block alarm even if it has entered the forced Alarm mode. If the inverter has entered Alarm mode during retry (specified by function code H04), it issues a block alarm and does not exit Alarm mode for restarting.

Listed below are the recoverable alarm statuses of the inverter.

Alarm Status	LED monitor display
Instantaneous overcurrent protection	***0C1, 0C2*** or ***0C3***
Overvoltage protection	***0U1, 0U2*** or ***0U3***
Heat sink overheated	***0H1***
Motor overheated	***0H4***
Braking resistor overheated	***dbH***
Motor overloaded	***0L1***
Inverter overloaded	***0LU***

Settings and operations

■ Retry times (H04)

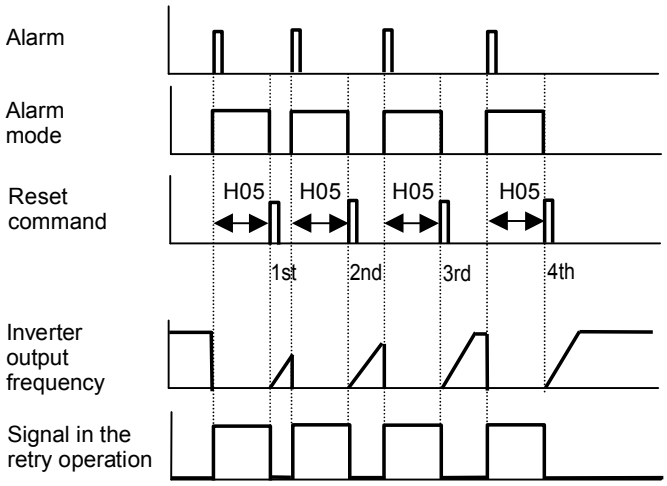
Set the number of retry times for automatic exit from Alarm mode. If the inverter has entered Alarm mode during the retry times specified, the inverter issues a block alarm and does not exit alarm mode for restarting.

- Data setting range: 0 to 10 (times) (If 0 is set, the "retry" operation will not be activated.)

■ Retry latency time (H05)

- Data setting range: 0.5 to 20.0 (sec.)

Sets the latency time for automatic exit from Alarm mode. Refer to the timing scheme diagram below.



- The retry operation can be monitored by external equipment via the inverter's digital output on terminal [Y1] or [30A/B/C]. Assign (TRY) to these terminals by setting "26" to function code E20 or E27.

H06 Cooling Fan ON/OFF

Stops the built-in cooling fan and monitoring the temperature inside the inverter when the inverter is idling, in order to extend the service life of the cooling fan and reduce running noise.

Note that as turning the cooling fan on/off too frequently may shorten the service life, leave the fan running for 10 minutes or longer each time it is turned on.

Function code H06 selects whether the cooling fan runs constantly or selectively.

Data for H06	Function
0	Disable (cooling fan runs constantly)
1	Enable (cooling fan is turned on/off as required)

H07 Gradual Acceleration/Deceleration

Specifies the acceleration and deceleration patterns (output frequency patterns).

Data for H07	Function
0	Disable: Linear
1	S-curve (weak)
2	S-curve (strong)
3	Curvilinear

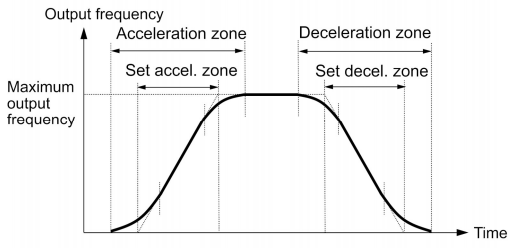
Linear acceleration/deceleration

The inverter runs the motor with the constant acceleration and deceleration.

S-curved acceleration/deceleration

To reduce the impact on the inverter driven motor during acceleration/ deceleration, the inverter gradually accelerates/decelerates the motor during both the acceleration/ deceleration zones.

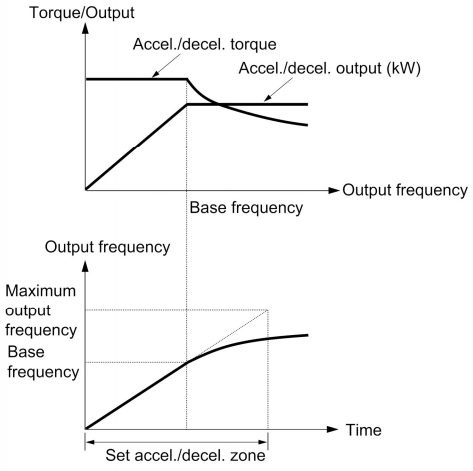
Two frequencies can be selected for S-curved acceleration/deceleration 5% (weak) or 10% (strong) of the maximum output frequency. The four centers of S-curves are not affected by this selection. Note the set acceleration/deceleration time defines the linear acceleration/ deceleration in the zones, so that the actual zone exceeds the set zone in this case. Zones are defined in units of time. Refer to the figure at the right.



Curvilinear acceleration/deceleration

The inverter drives the motor to output the maximum performance, with the following acceleration/deceleration patterns:

- In the zone under the base frequency, linear acceleration/deceleration of constant torque output for the motor
- In the zone above the base frequency, speed two times the base frequency and acceleration/deceleration half of the base frequency



Note Set the acceleration/deceleration time giving due consideration to the load torque. Refer to Chapter 7 "SELECTING OPTIMAL MOTOR AND INVERTER CAPACITIES" for details.

H12 Instantaneous Overcurrent Limiting

The inverter features a hardware-controlled output current limiter to protect it from an overload hazard. The moment that the output current exceeds the limited level due to overload or other factor, the inverter controls the output switching circuits so as to slow down the output frequency and suppress the output current momentarily.

Data for H12	Function
0	Disable
1	Enable

This control of the switching circuits may cause an instantaneous reduction in motor output torque. However, instantaneous torque reduction may not be allowable in some systems when the system is in a short time overloaded state. To solve this problem, this function should be disabled and the system set up with a proper facility that is activated by the alarm output from the inverter when it detects an overcurrent.

Note The same functions to limit the output current are implemented by software as function codes F43 and F44. Generally, software features have an operation delay, so enable function code H12 as well.

Depending upon the load, acceleration in an extremely short period may activate the current limiter to suppress the increase of the inverter output frequency, causing the system oscillate (hunting) or making the inverter enter the ***OU*** Alarm mode and trip. When setting the acceleration time, therefore, you need to take into account the load condition and moment of inertia. Refer to Chapter 7, Section 7.1, "Selecting Motors and Inverters."

H26 Thermistor Input (Selection)

H27 Thermistor Input (Operation level)

Set these function codes to protect the motor from an overheat hazard using the PTC (Positive Temperature Coefficient) thermistor embedded in the motor.

■ Thermistor (Select) (H26)

Enables or disables overheating protection for the motor using the PTC thermistor, which senses motor temperature.

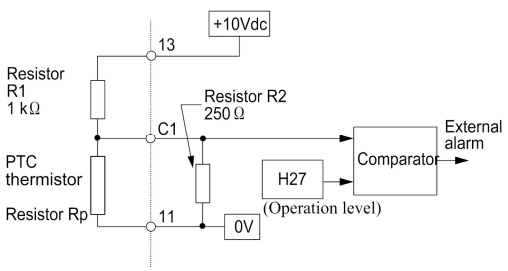
Data for H26	Function
0	Disable overheating protection
1	Enable overheating protection

■ Thermistor (Operation Level) (H27)

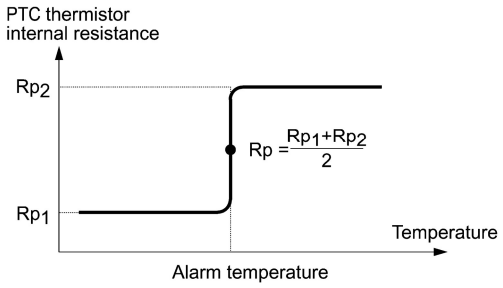
Determines the operation level for the overheating protection.

- Data setting range: 0.00 to 5.00 (V)

Connect the PTC thermistor as shown in the figure at the right. The input current from terminal [C1] flows across the resistor R_2 and yields the voltage. If the voltage exceeds the operation level set by function code H27, the overheating protection is activated, and the inverter enters Alarm mode and issues the alarm "***0H4***" (motor protection).



The temperature at which the overheating protection is to be activated depends on the characteristics of the PTC thermistor. As shown at the right, the internal resistance of the thermistor will step up near the alarm temperature detection point. Determine the operation level (voltage V_{c1}) with reference based on the variance in internal resistance.



Calculate the reference voltage Vc1 using the equation shown below and set it to function code H27.

Substitute the internal resistance of the PTC thermistor at the alarm temperature with Rp to obtain Vc1:

$$Vc_1 = \frac{\frac{250 \bullet Rp}{250 + Rp}}{R1 + \frac{250 \bullet Rp}{250 + Rp}} \times 10 \text{ (V)}$$

H30 Communications Link (Function selection)

This function enables the inverter to be managed (i.e. to monitor the operation status or data set in the function codes, to set the drive frequency and to manage the operation commands) from a personal computer or PLC via RS485 communication. To select information in the inverter that is to be accessible via RS485 communication, set each data to function code H30 as shown in the table below. "N" represents information that cannot be accessed via by RS485 communication, but by commands from the terminals.

Refer to Chapter 4 "BLOCK DIAGRAMS FOR CONTROL LOGIC" and the RS485 Communication User's Manual (MEH448) for details.

Data for H30	Function			Remarks
	Monitoring	Frequency setting	Operation command	
0	Y	N	N	
1	Y	Y	N	Y: Possible
2	Y	N	Y	N: Not possible
3	Y	Y	Y	

- Assign the terminal command (LE) to one of terminals [X1] to [X3] using function codes E01 to E03 to enable/disable the function specified by code H30 by terminal command, and short-circuit between the terminal assigned for (LE) command and [CM]. To disable the function, open the circuit ((LE) = OFF). When (LE) is set to OFF, the inverter enters the operation mode where the commands and frequencies given by the terminals or keypad are effective.

H42 Capacity of DC Link Bus Capacitor

This function code is used to clear the information related to the DC link bus capacitor if it is replaced. Follow the instructions for replacement.

H43 Accumulated Run Time of Cooling Fan

This function code is used to clear the information related to the cooling fan if it is replaced. Follow the instruction for the replacement.

H50	Non-linear V/f Pattern (Frequency)	Refer to F04.

H51	Non-linear V/f Pattern (Voltage)	Refer to F04.

For details of setting the non-linear V/f pattern, refer to the descriptions of function code F04.

H54 ACC/DEC Time (Jogging operation)

Sets both the acceleration and deceleration time for jogging operations.

- Data setting range: 0.00 to 3600 (sec.)

Refer to function codes E01 to E03 "Terminal assignment of [X1] to [X3] for details on jogging operations.

H64 Low Limiter (Min. freq. when limiter is activated)

When the output current limiter and/or overload-suppressing feature is activated, this function limits the bottom of the frequency that may vary due to reaction of the limit control.

- Data setting range: 0.0 to 60.0 (Hz)

H69 Automatic Deceleration (Regenerative energy suppressing)

Enables regenerative energy suppressing control.

Data for H69	Function
0	Disable
1	Enable

The moment that a regenerative energy exceeding the capacity of the inverter is returned when braking is being applied to the motor, the inverter will shut its output down and enter overvoltage alarm mode. If regenerative energy suppressing control is enabled, the inverter lengthens the deceleration time to 3 times that of the set time while the DC link bus voltage exceeds the preset voltage suppressing level, and decreases the deceleration torque to 1/3. In this way, the inverter makes the motor reduce the regenerative energy tentatively.

This control is used to suppress torque generated by the motor in deceleration. Conversely, when the load on the motor results in a braking effect, the control does not have any effect, so do not use it in this case. In addition, note that setting an extremely short deceleration time may cause an overvoltage alarm failure of the inverter even if the time is multiplied by 3 – keep this in mind when setting deceleration time.

Disable this function when the inverter features a braking resistor. If it is enabled, the braking resistor and regenerative energy suppressing control may conflict with each other, which may change the deceleration time unexpectedly.

H70 Overload Prevention Control (Frequency drop rate)

Enables overload suppressing control. If enabled, this function code is used to set the deceleration (Hz/s).

Before the inverter enters Alarm mode due to heat sink overheat or overload (alarm code: ***0H1*** or ***0LU***), this control decreases the output frequency of the inverter to suppress the trip.

Data for H70	Function
0.00	Decelerate by deceleration time 1 (F08) or 2 (E11).
0.01 to 100.0	Decelerate by 0.01 to 100.0 Hz/sec.
999	Disable overload suppression control

- When overload suppressing control is enabled, the inverter decelerates the motor according to the set deceleration rate if the temperature anywhere inside the inverter exceeds the alarm detection level.
- Apply this control to equipment (such as pumps) whose drive frequency drops in line with any decrease in load. If you want to proceed to drive such kind of equipment even the inverter slows down the output frequency, enable this control.

Note

- Do not use this function to equipment whose load does not slow if the inverter output frequency drops, as it will have no effect.
- To avoid any conflict between overload suppressing control and any other frequency lowering features, this control does not function if the features to limit the output current are enabled (F43 ≠ 0 and H12 = 1). To force this control to enabled status, set 0 for function codes F43 and H12.

H80 Gain for Suppression of Output Current Fluctuation

The inverter output current driving the motor may fluctuate due to the motor characteristics and/or backlash in the load mechanism. Modify the data in function code H80 to adjust the amount in order to suppress such fluctuation. However, as incorrect setting of this amount may cause a much larger current fluctuation, do not modify the default setting unless it is necessary.

- Data setting range: 0.00 to 0.20

H95 DC Braking (Braking mode) Refer to F21.

For details of setting the braking mode, refer to the descriptions of function code F21.

H96 STOP Key Priority/Start Check Function

The inverter can be operated using a functional combination of "STOP key priority" and "Start check function."

Data for H96	STOP key priority	Start check function
0	Disable	Disable
1	Enable	Disable
2	Disable	Enable
3	Enable	Enable

STOP key priority

When the drive commands are received from the terminals and via RS485 communication, pressing the STOP key forces the inverter to decelerate and stop the motor. "*Er 6*" is displayed on the LED after stopping.

Start check function

For safety, this function checks whether any run command has been switched on or not. If a run command has been switched on, "*Er 6*" is displayed on the LED without the inverter being started up. This occurs in the following situations:

(1) When any run command is switched on when the power to the inverter switched on.

(2) When the PRG RESET key is pressed to release the alarm status caused by the protective function, or the reset alarm command (RST) is switched on while any run command is input.

(3) When the run command source has been switched by the link command (LE), which selects whether to enable or disable communications, when a run command is being input at the source that being switched to.

H97 Clear Alarm Data

Clears all alarm information (e.g. historical records and information at time the alarm occurred) to return the inverter to default status (factory settings).

Data for H97	Function
0	Disable
1	Clear (data automatically reset to 0)

H98	Protection/Maintenance Functions (Selection)	Refer to F26.

Specifies a combination between the output phase loss protection, input phase loss protection and lowering of automatic carrier frequency.

Data for H98	Output phase loss	Input phase loss	Automatic lowering of carrier frequency
0	Disable	Disable	Disable
1	Disable	Disable	Enable
2	Disable	Enable	Disable
3	Disable	Enable	Enable
4	Enable	Disable	Disable
5	Enable	Disable	Enable
6	Enable	Enable	Disable
7	Enable	Enable	Enable

Output phase loss protection (*0PL*)

The inverter will enter Alarm mode activated by the output phase loss protection, and issue the alarm *0PL* if it detects an output phase loss while it is running.

If a magnetic contactor that has been inserted in the inverter output circuits switches off when the inverter is running, this protection will not be activated.

Input phase loss protection (*LIN*)

The inverter will enter Alarm mode and issue an alarm (*LIN*) if a phase loss is detected in the three-phase input power source.

Do not enable this protection with inverters with single-phase input, as it is not effective.

When operating an inverter with a three-phase input with a single phase for testing purposes, this protection may be disabled, but only if the load can be reduced.

Automatic lowering of carrier frequency

When using an inverter in a critical system or any other systems where inverter operation should not be interrupted, select this feature to protect the system from failures which could result from the inverter tripping due to the heat sink overheating (*0H1*) or overload (*0LU*), abnormally high ambient temperature or a cooling mechanism failure. This feature lowers the output frequency before the inverter enters Alarm mode, however, the level of motor noise may increase.

9.2.6 J codes (Application functions)

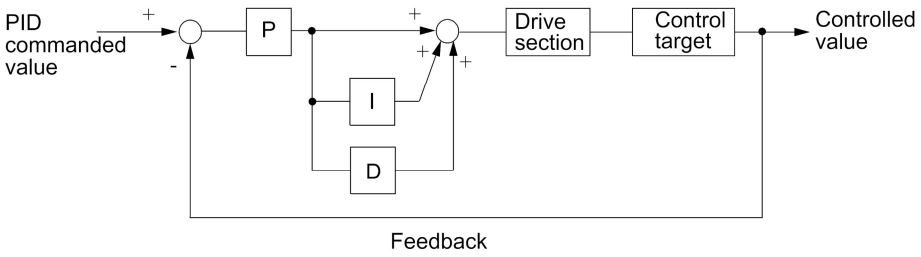
J01	**PID Control (Selection)**
J02	**PID Control (Remote process command)**
J03	**PID Control (Gain)**
J04	**PID Control (Integration time)**
J05	**PID Control (Differential time)**
J06	**PID Control (Feedback filter)**

The PID control is a closed loop feed back system that regulates control amounts with command values, as shown in the schematic block diagram below. Essentially, the system employs a sensor or similar device and compares it with the commanded amount (e.g. a temperature control command). If there is any difference between them, the system reacts so as to minimize it.

Apply the PID control system to process control mechanisms for flow-rate, pressure, temperature and the like.

If PID control is enabled (J01 = 1 or 2), the frequency block diagram changes to the PID control block diagram.

Refer to Chapter 4, section 4.8 "PID Frequency Command Generator" for details.



♦ PID Control Selection (J01)

Selects PID control status.

Data for J01	PID control
0	Disable
1	Enable process control (normal operation)
2	Enable process control (inverse operation)

- This function allows inserting the difference (error) between PID command and amount that have been fed-back so as to drive the motor for normal or inverse operation. Apply this control to a system increasing/decreasing the motor speed according to any such difference, such that occurring when an air conditioner is switched between cooling and heating. The operation mode can also be switched between normal and inverse using the terminal command (IVS).

Refer to function codes E01 to E03 for details of assignment of the terminal command (IVS).

■ Remote process command (J02)

Selects the means by which the PID control command can be set.

Data for J02	Means
0	Keypad
1	Built-in potentiometer, terminal [12] or [C1] for PID process command 1
4	Via RS485 communication

If an analog command (built-in potentiometer, terminal [12] or [C1]) is selected as the PID process command, it is also necessary to select PID process command 1 for the analog input side using function codes E60, E61 and E62.

Refer to function codes E60 to E62 for details.

Note The multistep frequency C08 set by the terminal command (SS4) can also be used as a preset amount for the PID process command, in addition to that of function code J02.
Calculate the setting data of the process command using the equation below.
Process command data (%) = set multistep frequency ÷ maximum output frequency × 100

Selecting feedback

Select either analog input terminal [12] or [C1] for the PID control feedback signal terminal.

Refer to function codes E60 to E62 for details.

Conversion factor for indication and monitoring of PID value

To monitor the PID process command and its feedback, set the conversion factor used for transformation between the PID control amount (such as temperature) and numerals expressing the value.

Refer to function codes E40 and E41 for details on the conversion factor, and to E43 for details on monitoring.

Gain and bias settings for the PID command

As with the drive frequency command, gain and bias can be set for the PID command.

Refer to function codes C51 and C52 for details.

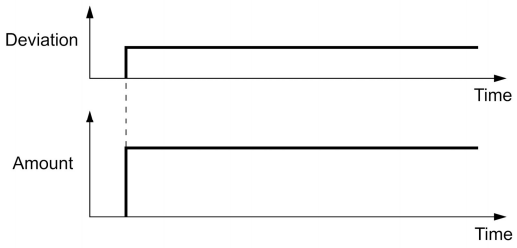
■ Gain (J03)

Sets the gain for the PID processor.

- Data setting range: 0.000 to 10.00 × (times)

P (Proportional) control

An operation using an output frequency proportional to deviation is called P operation, which outputs an operational amount proportional to deviation, through it cannot eliminate deviation alone.



Gain determines the system response level for the deviation in the P control. An increase in gain speeds up response, an excessive gain can cause vibration, and a decrease in gain delays response.

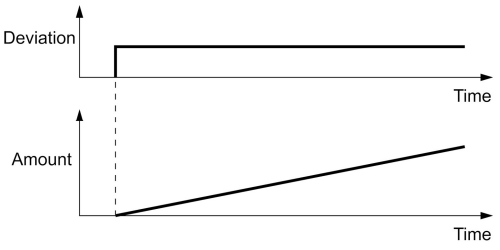
■ Integration time (J04)

Sets the integration time for the PID processor.

- Data setting range: 0.0 to 3600.0 (sec.)

I (Integral) control

The PID operation having the proportional relationship of deviation between the commanded (frequency) rate (Hz/s) and control amounts is called the I control. The I control outputs the control amount proportional to the integral amount of the deviation. Therefore, it is effective for making the feedback value consistent with the commanded one (such as frequency). For the system whose deviation of response rapidly changes, however, this control cannot make the system react quickly.



The effectiveness of I control is expressed by a parameter of integration time. The longer the integration time, the slower the response. The reaction force of the system to an external stimulus force becomes weak. The shorter integration time the faster response. Setting too short integration time, however, makes the system tend to oscillate.

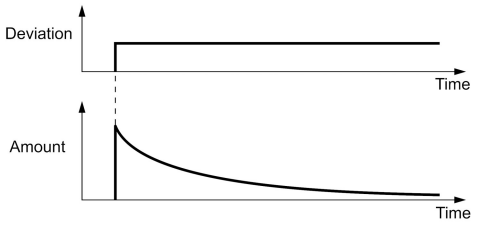
■ Differentiation time (J05)

Sets the differentiation time for the PID processor.

- Data setting range: 0.00 to 600.00 (sec.)

D (Derivative) control

The PID operation having the proportional relationship of deviation between derivative of the commanded (frequency) and control amounts is called the D control. The D control outputs derivative of the control amount. For rapidly change, this control makes the system react quickly.



The effectiveness of ID control is expressed by a parameter of differentiation time. Setting a long differentiation time will quickly converge on a system control error (deviation) caused by P control. Setting it too long makes the system tend to oscillate more. Setting it too short will suppress the convergent effect to the deviation caused by the system operation.

Descriptions combined use of P, I and D control are shown below.

(1) PI control

PI control, which is a combination of P and I control, is generally used to minimize the deviation caused by P control. PI control acts to minimize at all times the deviation caused by a variance of the commanded amount or external disturbance to the system as stationary events. However, the longer integration time set, the slower the system response.

Use P control alone for loads with integral component ratio that takes very large part of control amount.

(2) PD control

When PD control is applied to a system, the moment that a deviation occurs, the system instantaneously generates a control amount much greater than that of D control (frequency) to suppress the deviation. If the deviation converges, the P control amount may decrease.

A load including the integral component in the equipment to be controlled may oscillate from the action of the integral component if the P control alone is applied. In this case, use PD control to reduce the oscillation caused by P control for keeping the system stable. That is, PD control should be applied to any system that does not contain any braking actions in its process.

(3) PID control

PID control is implemented by combining P control with the deviation suppression of I control and the oscillation suppression of D control. PID control features minimal control deviation, high precision and high stability.

In particular, applying PID control to any system that has a long response time to the occurrence of deviation will yield excellent results.

Follow the procedure below to set PID data.

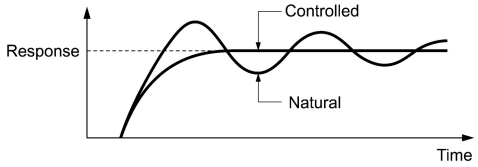
It is highly recommended that the PID control amount is selected and set while monitoring the system response waveform with an oscilloscope or equivalent. Repeat following procedure to identify the optimal solution for each system.

- Increase the data to be set to function code J03 (PID gain) in the range where the feedback signal does not oscillate.
- Decrease the data to be set to function code J04 (PID integration time) in the range where the feedback signal does not oscillate.
- Increase the data to be set to function code J05 (PID differentiation time) in the range where the feedback signal does not oscillate.

Refining the system response waveforms is shown below.

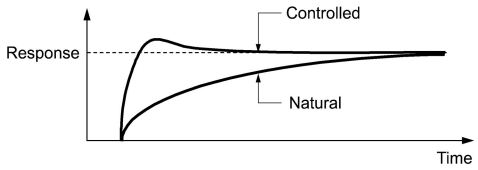
1) Suppressing overshoot

Increase the data value of function code J04 (integration time) and decrease that for code J05 (differentiation time)



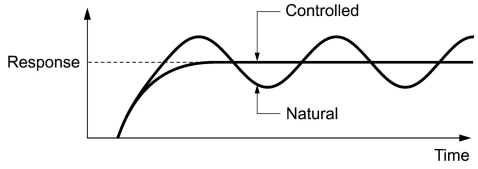
2) Quick stabilizing (small overshoot allowable)

Decrease the data value of function code J03 (gain) and increase that for code J05 (differentiation time)



3) Suppressing oscillation longer than the integration time set by function code J04

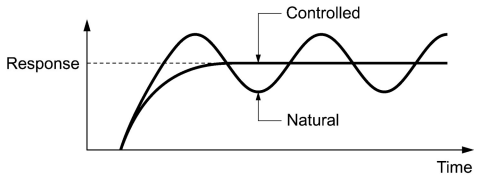
Increase the data value set to function code J04 (integration time)



4) Suppressing oscillation of approximately same period as the time set for function code J05 (differentiation time)

Decrease the data value set for function code J05 (differentiation time).

Decrease the data value set for function code J03 (gain), even if the differentiation time is set at 0 sec.



■ Feedback filter (J06)

Sets the time constant of the filter for PID feedback signals.

- 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.

9.2.7 y codes (Link functions)

Mounting an RS485 communications card (option) on the FRENIC-Mini series enables performing the operations listed below via the RS485 communications facility.

(1) Using the remote keypad (option)

The remote keypad (option) allows running inverter and monitoring the running status information to be monitored from remote locations, such as from the outside of the power control panel.

(2) FRENIC Loader

Monitoring the running status information, editing function codes and test-running the inverters can be performed on a Windows-based PC connected to the power system network (including the inverter/s) by installing FRENIC Loader (software).

Setting data to the y codes, refers to function codes y01 to y10.

(3) Host controller

The inverter can be managed and monitored by connecting a host controller such as a PLC to the power system network. Available communications protocols are the Modbus RTU* and Fuji general-purpose inverter protocol.

* Modbus RTU is a protocol established by Modicon, Inc.

Refer to the RS485 Communication User's Manual (MEH448) for details.

y01 to y10 **Link Functions for RS485 Communication**

■ Station Address (y01)

Sets the station address for the communications network. The table below lists the relation between the data setting range and the protocol.

Protocol	Station address	Broadcast address
Modbus RTU	1 to 247	0
FRENIC Loader	1 to 255	None
Fuji general-purpose inverter	1 to 31	99

- If the address is set outside of the range specified in the table above, no response will be returned as the inverter will be unable to receive any enquiries.
- Settings for FRENIC Loader: Set the same address as that specified in the connected PC.

■ Communications error processing (y02)

Specifies the error processing operation for RS485 communication.

Data for y02	The inverter will:
0	Immediately enter Alarm mode, issue RS485 communications error *Er8* and shut down its output.
1	Continue to run for the period preset by the timer, then enter Alarm mode, issue RS485 communications error *Er8*, and shut down its output.
2	Retry to receive/send the query/response during the period preset by the timer. If communications have not recovered, the inverter will enter Alarm mode, issue RS485 communications error *Er8* and shut down its output. If communications have recovered, the inverter will continue to run.
3	Continue to run even if a communications error occurs.

- Setting for FRENIC Loader: If the connected PC runs out during test-running of the inverter, no stop command may be able to be sent to stop the inverter. For safety, select the setting for this function code so as to prevent this happening.

■ Error processing timer (y03)

Sets the error processing timer (for waiting time)

- Data setting range: 0.0 to 60.0 (sec.)

■ Transmission speed (y04)

Selects the transmission speed for RS485 communication.

- Setting for FRENIC Loader: Set the same transmission speed as that specified for the connected PC.

Data for y04	Transmission speed
0	2400 bps
1	4800 bps
2	9600 bps
3	19200 bps

■ Transmission data length (y05)

Select the character data for transmission.

- Setting for FRENIC Loader:
  The loader will set the length in 8 bits automatically. (The same applies to the Modbus RTU.)

Data for y05	Data length
0	8 bits
1	7 bits

■ Parity check (y06)

Select the property of the parity bit.

- Setting for FRENIC Loader:
  The loader automatically sets it to the even parity.

Data for y06	Parity
0	No parity bit
1	Even parity
2	Odd parity

■ Stop bits (y07)

Select the number of stop bits.

- Setting for FRENIC Loader: The loader automatically sets it to 1 bit.

  The Modbus RTU protocol automatically determines number of the parity bits associated with its parity bit property so no setting is required.

Data for y07	Stop bits
0	2 bits
1	1 bit

■ No-response error detection time (y08)

Sets the time interval from the inverter detecting no access until it enters communications error *Er 8* alarm mode due to network failure.

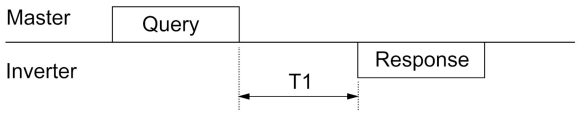
Data for y08	Function
0	Disable
1 to 60	1 to 60 sec.

- Setting for FRENIC Loader: As communication between loader software and inverters is classified into two categories--periodic access and event-driven access, depending on the selected facility, disable communications error detection (y08 = 0). When test running, the access period is to be 800 ms, however, it may vary depending on the operating system running on the PC and/or its processing status.

■ Response latency time (y09)

Sets the latency time from the end of receiving a query sent from the host (such as the PC or PLC) to the start of sending the response. This function allows using equipment whose response time is slow for a network requiring quick response.

- Data setting range: 0.00 to 1.00 (sec.)



T1 = Latency time + α

where α is the processing time of the inverter (may vary depending upon the processing status and the run command in the inverter).

Refer to the RS485 Communication User's Manual (MEH448).

- Setting for FRENIC Loader: Set the correct data to the function code depending on the performance and/or configuration of the PC and protocol converter (such as RS485/RS232C). Note that some protocol converters monitor the communications status and switch the send/receive of transmission data by timer.

■ Protocol selection (y10)

Selects the communications protocol.

- Setting for FRENIC Loader: Select the loader protocol (y10 = 1).

Data for y10	Protocol
0	Modbus RTU
1	FRENIC Loader
2	Fuji general-purpose inverter

y99 Link Function for Supporting Data Input

This function code switches an RS485 communications link with FRENIC Loader. Enabling the RS485 communications link allows the inverter to receive frequency and run commands from the Loader.

Since the Loader automatically sets data of function codes, no setting with the keypad is required.

If the PC runs out of control in RS485 communication, a stop command may not be sent to the inverter. To prevent this from happening, set 0 to y99 so that the inverter will follow the settings of function code H30.

Note that the inverter cannot save the data setting in y99. Turning the power off resets the data in y99 to 0.

Data for y99	Function	
	Frequency command source	Run command source
0	Setting of H30	Setting of H30
1	Loader (S01 and S05)	Setting of H30
2	Setting of H30	Loader (S06)
3	Loader (S01 and S05)	Loader (S06)