APPENDICES

Contents

Appendix H Before Use

H.1 Acceptance Inspection (Nameplates for Inverter Type H)

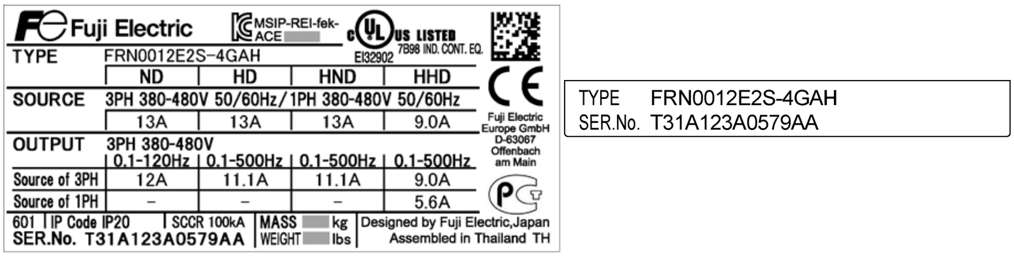
Unpack the package and check the following:

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

Accessories
- DC reactor (for ND-mode inverters of FRN0139E2■-4□ or above, HD/HND-mode inverters of FRN0168E2■-4□ or above, and HHD-mode inverters of FRN0203E2■-4□ or above)
- Keypad rear cover (with three screws for securing the keypad)
- Instruction manual
- CD-ROM (containing the FRENIC-Ace User's Manual)
- Wiring guide (for FRN0012E2■-4□ or below, FRN0115E2■-2□ or below, FRN0011E2■-7□ or below)

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

(3) The inverter is the type you ordered. You can check the type and specifications on the main nameplate. (The main and sub nameplates are attached to the inverter as shown on Figure H-3.)



(a) Main Nameplate (b) Sub Nameplate

Figure H-1 Nameplates

TYPE: Type of inverter

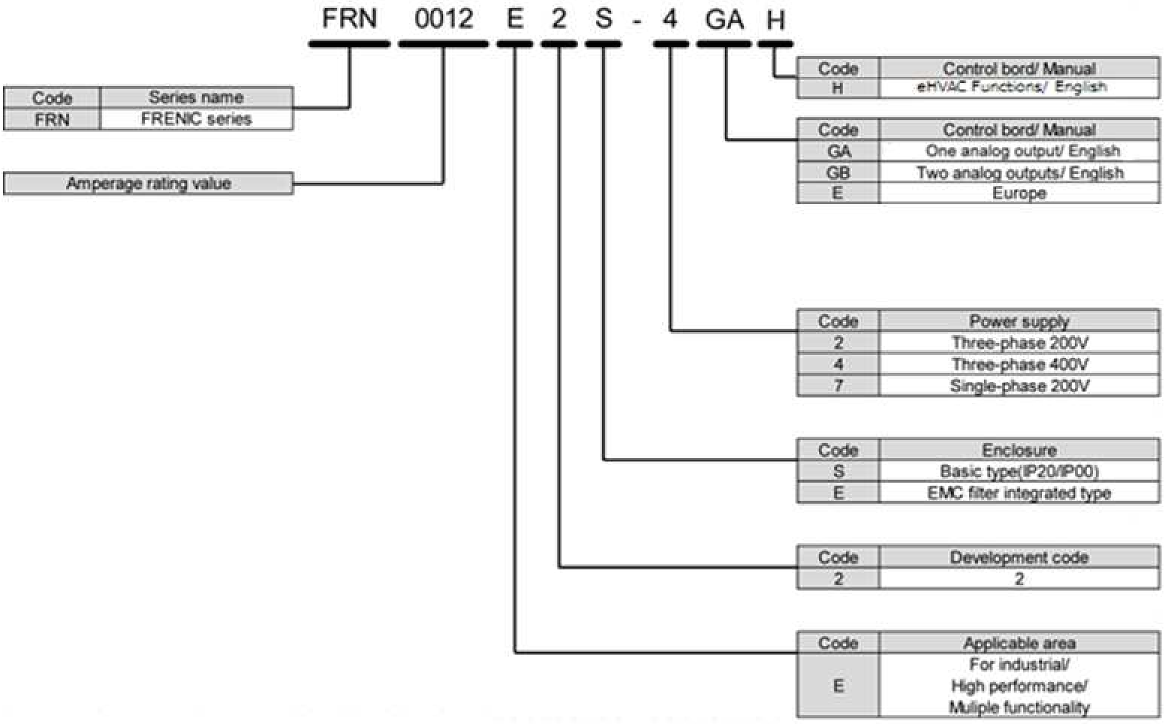


Figure H-2 Type of inverter

The FRENIC-Ace is available in four different drive modes--ND (Normal Duty), HD (Heavy Duty), HND (High, Normal Duty), and HHD (High, Heavy Duty). One of these modes should be selected to match the load property of your system. Specifications in each mode are printed on the main nameplate.

ND mode : Designed for general load applications.
Overload capability: 120% for 1 min.

HD mode : Designed for heavy duty load applications.
Overload capability: 150% for 1 min.

HND mode : Designed for general load applications.
Overload capability: 120% for 1 min.

HHD mode : Designed for heavy duty load applications.
Overload capability: 150% for 1 min. and 200% for 0.5 s.

SOURCE : Number of input phases (three-phase: 3PH), input voltage, input frequency, input current

OUTPUT : Number of output phases, rated output voltage, output frequency range, rated output capacity, rated output current, and overload capability

SCCR : Short-circuit capacity

MASS : Mass of the inverter in kilogram

SER. No. : Product number

6 8 A 1 2 3 A 0 5 7 9 E   BB   6 0 1

- 0 1 — Production week
  This indicates the week number that is numbered from 1st week of January.
  The 1st week of January is indicated as '01'.
- 6 — Production year: Last digit of year
- BB — Product version

: Compliance with European Standards (See Appendix G Section G-1)

: Compliance with UL Standards and Canadian Standards (cUL certification)
(See Appendix G Section G-2)

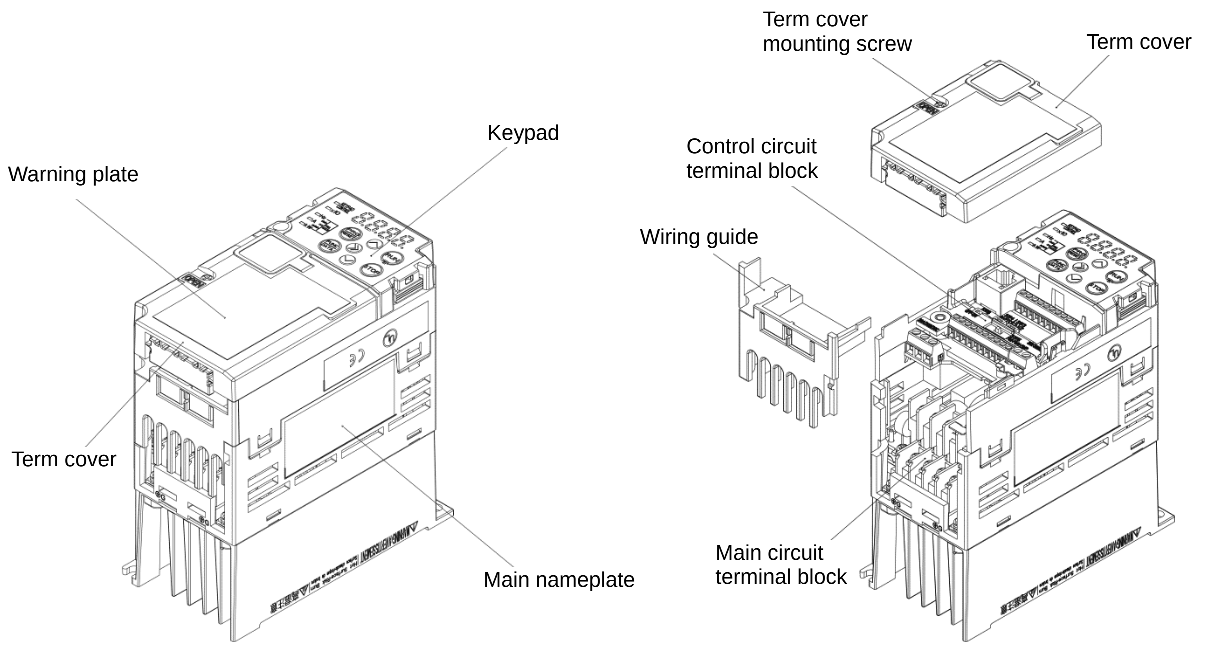
: Compliance with the Radio Waves Act (South Korea) (Refer to the FRENIC-Ace User's Manual Appendix G Section G-3)

: Compliance with Russian Standards

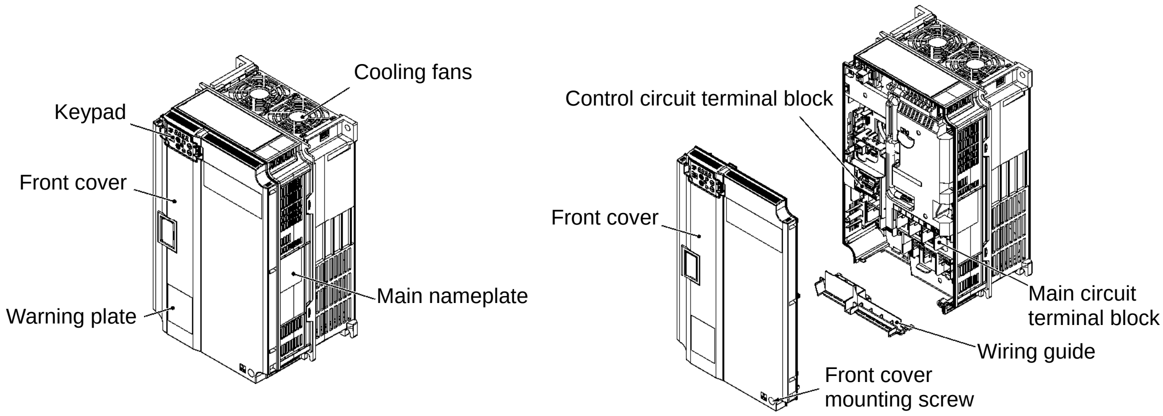
If you suspect the product is not working properly or if you have any questions about your product, contact your Fuji Electric representative.

H.2 External View and Terminal Blocks

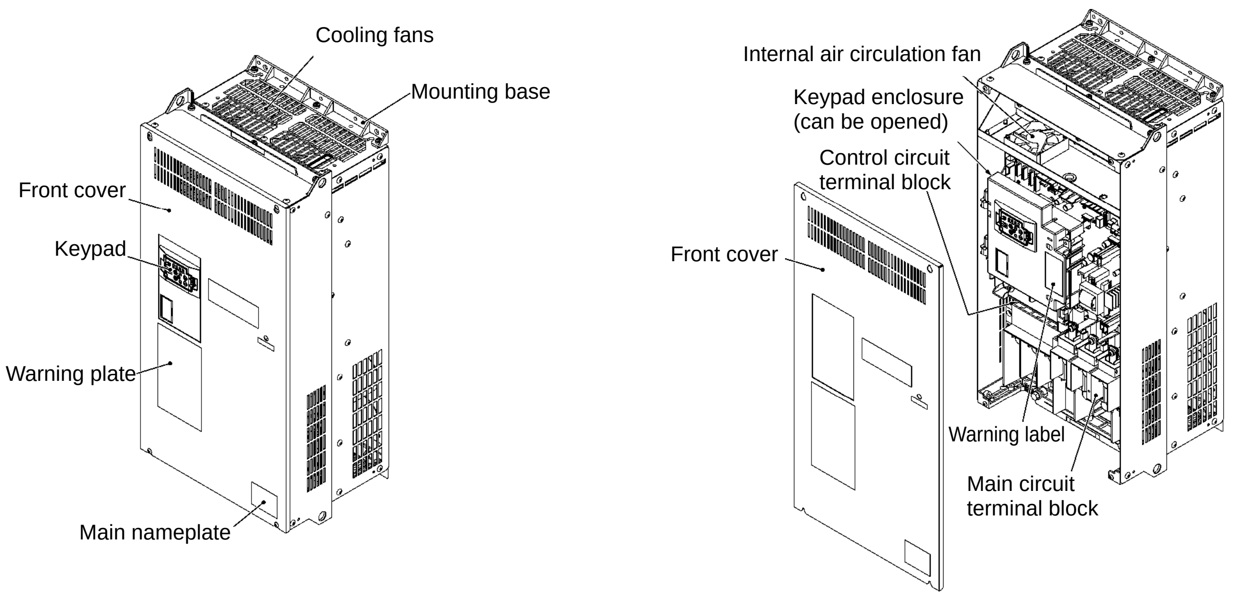
(1) Outside and inside views



(a) FRN0006E2■-2G☐H



(b) FRN0072E2■-4EH



(c) FRN0590E2■-4EH

Figure H-3 Outside and Inside Views of Inverters

(2) Warning plates and label

(a) FRN0006E2■-4G☐H

(b) FRN0203E2■-4EH

Figure H-4 Warning Plates and Label

Appendix I Function Codes Overview

Function codes are used for selecting various functions of FRENIC-Ace. Function codes comprise 3 digits or 4 digits of alphanumeric character. The first digit categorizes the group of function code alphabetically and the subsequent 2 or 3 digits identify each code within the group by number. Function code comprises 11 groups: Basic function (F code), Terminal function (E code), Control code (C code), Motor 1 parameter (P code), High-level function (H code) (H1 code), Speed control 2 parameter (A code), Application function 1 (J code) (J1 code) (J4 code) (J5 code), Application function 2 (d code), Customizable logic (U code) (U1 code), Link function (y code), Keypad functions (K code), and Option function (o code) . The function of each function code is determined according to the data to be set. The following descriptions are for supplementary explanation of function code table. Refer to instruction manual of each option to find the details of the option function (o code).

I.1 Supplementary note

■ Change, reflect, and save function code data during operation

Function codes are categorized into those which data change is enabled during operation of the inverter and those which such change is disabled. The meaning of the code in the “Change during operation” column of the function code table is described in the following table.

Code	Change during operation	Reflect and save data
Y*	Allowed	At the point when data is changed by ∧/∨ key, the changed data is immediately reflected on the operation of inverter. However, at this stage, the changed value is not saved to the inverter. In order to save it to the inverter, press FUNC DATA key. Without saving by FUNC DATA key and leaving the state of when the change was made by the PRG RESET key, the data before the change is reflected on the operation of inverter.
Y	Allowed	Even if data is changed by the ∧/∨ key, the changed data will not be reflected on the operation of the inverter as is; by pressing the FUNC DATA key, the changed value is reflected on the operation of the inverter and is also saved to the inverter.
N	Not allowed	—

■ Copying data

Function code data can be copied collectively by using the optional keypad “TP-E1U” (program mode menu number 7 “Data copy”) or “TP-A1”. By using this function, it is possible to read out all function code data and write the same data to a different inverter.

However, if the specification of inverter at the copy source and copy destination is not identical, some function codes may not be copied due to security reason. According to necessity, configure the settings individually for the function codes that are not copied. The behaviour of the function codes regarding data copy is indicated in the “data copy” column in the function code table in the next page and following.

Y: to be copied.

Y1: When inverter capacity is different, copying will not be performed.

N: not to be copied.

■ Negative logic setting of data

Digital input terminal and transistor/contact output terminal can become a signal for which negative logic is specified by function code data setting. Negative logic is a function to reverse ON and OFF state of input or output, and switch Active ON (function enabled with ON: positive logic) and Active OFF (function enabled with OFF: negative logic). However, negative logic may not be enabled depending on the function of the signal.

Negative logic signal can be switched by setting the data with 1000 added to the function code data of the function to be set. For example, the following example shows when coast to a stop command “BX” is selected by function code E01.

Function code data	Action
7	“BX” is ON and coast to a stop (Active ON)
1007	“BX” is OFF and coast to a stop (Active OFF)

■ **Drive control**

The FRENIC-Ace runs under any of the following drive controls. Some function codes apply exclusively to the specific drive control, which is indicated by letters Y (Applicable) and N (Not applicable) in the “Drive control” column in the function code tables given on the following pages.

Abbreviation in “Drive control” column in function code tables	Control target (H18)	Drive control (F42)
V/f	Speed (Frequency for V/f and PG V/f)	0,2: V/f control 1: Dynamic torque vector control
PM	Speed	15: Vector control without speed sensor nor pole position sensor

For details about the drive control, refer to the description of F42 “Drive control selection 1.”

Note: The FRENIC-Ace is a general-purpose inverter whose operation is customized by frequency-basis function codes, like conventional inverters. Under the speed-basis drive control, however, the control target is a motor speed, not a frequency, so convert the frequency to the motor speed according to the following expression.

Motor speed (r/min) = 120 × Frequency (Hz) ÷ Number of poles

I.2 Function codes table

The table of function codes to be used in FRENIC-Ace is shown below.

■ F codes: Fundamental Functions (Basic function)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
F00	Data protection	0: No data protection, no digital setting protection 1: With data protection, no digital setting protection 2: No data protection, with digital setting protection 3: With data protection, with digital setting protection	1	Y	Y	0	Y	Y	87
F01	Frequency setting 1	0: Keypad key operation (∧/∨ key) 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] (C1 function)) (4 to 20mA DC, 0 to 20mA DC) 3: Analog voltage input (Terminal [12]) + Analog current input (Terminal [C1] (C1 function)) 5: Analog voltage input (Terminal [C1] (V2 function)) (0 to 10 VDC) 7: UP/DOWN control 8: Keypad key operation (∧/∨ key) (With balanceless bumpless) 10: Pattern operation 11: Digital input/output interface card (option) 12: Pulse train input	1	N	Y	0	Y	Y	88
F02	Operation method	0: Keypad operation (rotation direction input: terminal block) 1: External signal (digital input) 2: Keypad operation (forward rotation) 3: Keypad operation (Reverse rotation)	1	N	Y	2	Y	Y	99
F03	Maximum output frequency 1	25.0 to 500.0 Hz	3	N	Y	50.0	Y	Y	100
F04	Base frequency 1	25.0 to 500.0 Hz	3	N	Y	50.0	Y	Y	101
F05	Rated voltage at base frequency 1	0: AVR disable (output voltage proportional to power voltage) 160 to 500V: AVR operation (400V class)	1	N	Y	380	Y	Y	
F06	Maximum output voltage 1	160 to 500V: AVR operation (400V class)	1	N	Y		Y	Y	
F07	Acceleration time1	0.00 to 3600 s * 0.00 is for acceleration and deceleration time cancel (when performing soft-start and stop externally)	12	Y	Y	20.0	Y	Y	103
F08	Deceleration time1			Y	Y		Y	Y	
F09	Torque boost 1	0.0 to 20.0% (% value against base frequency voltage 1)	3	Y	Y	*2	Y	N	105
F10	Electronic thermal overload protection for motor 1 (Select motor characteristics)	1: Enable (For a general-purpose motor with self-cooling fan) 2: Enable (For an inverter-driven motor (FV) with separately powered cooling fan)	1	Y	Y	1	Y	Y	105
F11	(Overload detection level)	0.00 (disable) (Inverter rated current dependent on F80)	24	Y	Y1	*3	Y	Y	
F12	(Thermal time constant)	0.5 to 75.0 min	3	Y	Y	*4	Y	Y	
F14	Restart mode after momentary power failure (Mode selection)	0: Trip immediately 1: Trip after a recovery from power failure 2: Trip after momentary deceleration is stopped 3: Continue to run (for heavy inertia load or general load) 4: Restart from frequency at power failure (for general load) 5: Restart from starting frequency	1	Y	Y	1	Y	Y	108
F15	Frequency limiter (Upper limit)	0.0 to 500.0 Hz	3	Y	Y	70.0	Y	Y	115
F16	(Lower limit)	0.0 to 500.0 Hz	3	Y	Y	0.0	Y	Y	
F18	Bias (for frequency setting 1)	-100.00 to 100.00%	6	Y*	Y	0.00	Y	Y	115
F20	DC braking 1 (Braking starting frequency)	0.0 to 60.0Hz	3	Y	Y	0.0	Y	Y	116
F21	(Braking level)	0 to 80%	1	Y	Y	0	Y	Y	
F22	(Braking time)	0.00 (Disable): 0.01 to 30.00 s	5	Y	Y	0.00	Y	Y	
F23	Starting frequency 1	0.1 to 60.0Hz	3	Y	Y	0.5	Y	Y	119
F24	(Holding time)	0.00 to 10.00 s	5	Y	Y	0.00	Y	Y	
F25	Stop frequency	0.0 to 60.0 Hz	3	Y	Y	0.2	Y	Y	

Indicates quick setup target function code.

*2: Factory defaults are depended on motor capacity. Refer to "I.3 Factory default value per applicable electric motor capacitance".

*3: The motor rated current is automatically set. Refer to "I.4 Motor constant".

*4: 5.0min for inverters of nominal applied motor 22kW or below; 10.0min for those of 30kW or above.

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
F26	Motor sound (Carrier frequency)	ND mode - 0.75 to 10 kHz (FRN0002 to 0059E2■-4EH) - 0.75 to 6 kHz (FRN0072E2■-4EH or above) HD/HND mode - 0.75 to16 kHz (FRN0001 to 0020E2■- ・G ・H) - 0.75 to16 kHz (FRN0020 to 0059E2■-4EH) - 0.75 to10 kHz (FRN0072 to 0168E2■-4EH) - 0.75 to 6 kHz (FRN0203E2■-4EH or above) HHD mode - 0.75 to16 kHz (FRN0001 to 0020E2■- ・G ・H) - 0.75 to16 kHz (FRN0022 to 0168E2■-4EH) - 0.75 to10 kHz (FRN0203E2■-4EH or above)	1	Y	Y	2	Y	Y	120
F27	(Tone)	0: Level 0 (Disable) 1 to 3 : Level 1 to 3	1	Y	Y	0	Y	N	
F29	Terminal FM1 (Mode selection)	0: Voltage output (0 to +10 VDC) 1: Current output (4 to 20 mA DC) 2: Current output (0 to 20 mA DC) 3: Pulse output	1	Y	Y	0	Y	Y	121
F30	(Output gain)	0 to 300%	1	Y*	Y	100	Y	Y	
F31	(Function selection)	0: Output frequency 1 (PM: Speed command value) 1: Output frequency 2 (PM: Speed estimated value) 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback value 8: Estimated speed 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Calibration (+) 15: PID command (SV) 16: PID output (MV) 18: Inverter heat sink temperature 20: Reference frequency 60: External PID control1 feedback value (EPID1-PV) 61: External PID control1 command (EPID1-SV) 65: External PID control1 output (EPID1-OUT) 111 to 120 Customizable logic output signal 1 to 10	1	Y	Y	0	Y	Y	
F32	Terminal FM2 (Mode selection)	0: Voltage output (0 to +10 VDC) 1: Current output (4 to 20 mA DC) 2: Current output (0 to 20 mA DC)	1	Y	Y	0	Y	Y	
F33	Terminal FM1 (Pulse rate)	25 to 32000 p/s (number of pulse at monitor value 100%)	1	Y*	Y	1440	Y	Y	
F34	Terminal FM2 (Output gain)	0 to 300% (Inverter rated current dependent on F80)	1	Y*	Y	100	Y	Y	
F35	(Function selection)	Same as F31	1	Y	Y	2	Y	Y	
F37	Load selection/ Auto torque boost/ Auto energy-saving operation 1	0: Variable torque load 1: Constant torque load 2: Auto torque boost 3: Auto energy-saving operation (variable torque load) 4: Auto energy-saving operation (constant torque load) 5: Auto energy-saving operation with auto torque boost (Inverter rated current dependent on F80)	1	N	Y	1	Y	N	124
F40	Torque limiter 1 (Driving)	0 to 300%; 999 (Disable)	1	Y	Y	999	Y	Y	126
F41	(Braking)	0 to 300%; 999 (Disable)	1	Y	Y	999	Y	Y	
F42	Drive control selection 1	0: V/f control without slip compensation 1: Vector control without speed sensor (dynamic torque vector) 2: V/f control with slip compensation 15: Vector control for synchronous motor without speed or pole position sensor	1	N	Y	0	Y	Y	128
F43	Current limiter (Mode selection)	0: Disable (No current limiter works.) 1: Enable at constant speed (Disable during ACC/DEC) 2: Enable during ACC/constant speed operation	1	Y	Y	2	Y	N	131
F44	(Level)	20 to 150% (Rated current of the inverter for 100%)	1	Y	Y	130	Y	N	
F50	Electronic thermal overload protection for braking resistor (Discharging capacity)	1 to 9000 kWs OFF: Cancel	1	Y	Y1	OFF	Y	Y	132
F51	(Allowable average loss)	0.001 to 99.99 kW	45	Y	Y1	0.001	Y	Y	
F52	(Braking resistance value)	0.00: Resistance not required (Compatible mode with FRENIC-Multi series) 0.01 to 999 Ω	12	Y	Y1	0.00	Y	Y	
F80	Switching between ND, HD, HND and HHD drive modes	0: HHD mode 1: HND mode 3: HD mode 4: ND mode ND/HD mode is not supported for 200V class series.	1	Y	Y	4	Y	Y	134

Indicates quick setup target function code.

■ E code: Extension Terminal Functions (Terminal function)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
E01	Terminal [X1] function	0 (1000): Select multistep frequency (0 to 1 steps) "SS1"	1	N	Y	0	Y	Y	135
E02	Terminal [X2] function	1 (1001): Select multistep frequency (0 to 3 steps) "SS2"	1	N	Y	1	Y	Y	
E03	Terminal [X3] function	2 (1002): Select multistep frequency (0 to 7 steps) "SS4"	1	N	Y	35	Y	Y	
E04	Terminal [X4] function	3 (1003): Select multistep frequency (0 to 15 steps) "SS8"	1	N	Y	7	Y	Y	
E05	Terminal [X5] function	4 (1004): Select ACC/DEC time (2 steps) "RT1"	1	N	Y	8	Y	Y	
		5 (1005): Select ACC/DEC time (4 steps) "RT2"					Y	Y	
		6 (1006): Select 3-wire operation "HLD"					Y	Y	
		7 (1007): Coast to a stop command "BX"					Y	Y	
		8 (1008): Reset alarm (Abnormal) "RST"					Y	Y	
		9 (1009): External alarm "THR" (9 = Active OFF/ 1009 = Active ON)					Y	Y	
		11 (1011): Select frequency setting 2/ setting 1 "Hz2/ Hz1"					Y	Y	
		13: DC braking command "DCBRK"					Y	N	
		14 (1014): Select torque limit 2/ torque limit 1 "TL2/ TL1"					Y	Y	
		15: Switch to commercial power (50 Hz) "SW50"					Y	N	
		16: Switch to commercial power (60 Hz) "SW60"					Y	N	
		17 (1017): UP command "UP"					Y	Y	
		18 (1018): DOWN command "DOWN"					Y	Y	
		19 (1019): Allow function code editing (Data change enabled) "WE-KP"					Y	Y	
		20 (1020): Cancel PID control "Hz/PID"					Y	Y	
		21 (1021): Switch normal/ inverse operation "IVS"					Y	Y	
		22 (1022): Interlock "IL"					Y	Y	
		24 (1024): Select link operation (RS-485, BUS option) "LE"					Y	Y	
		25 (1025): Universal DI "U-DI"					Y	Y	
		26 (1026): Select auto search for idling motor speed at starting "STM"					Y	Y	
		30 (1030): Force to stop "STOP" (30 = Active OFF/1030 = Active ON)					Y	Y	
		33 (1033): Reset PID integral and differential terms "PID-RST"					Y	Y	
		34 (1034): Hold PID integral term "PID-HLD"					Y	Y	
		35 (1035): Select local (Keypad) command "LOC"					Y	Y	
		38 (1038): Run enable "RE"					Y	Y	
		39 : Dew condensation prevention "DWP"					Y	Y	
		40 : Enable integrated sequence to switch to commercial power (50Hz) "ISW50"					Y	N	
		41: Enable integrated sequence to switch to commercial power (60Hz) "ISW60"					Y	N	
		48: Pulse train input (Only for X5 terminal (E05)) "PIN"					Y	Y	
		49 (1049): Pulse train sign "SIGN" (Other than X5 terminal (E01 to E04))					Y	Y	
		50 (1050): Clear running motor regular switching time "MCLR"					Y	Y	
		59 (1059): Enable battery-driven operation "BATRY/UPS					Y	N	
		72 (1072): Count the run time of commercial power-driven motor 1 "CRUN-M1"					Y	N	
		78 (1078): Select speed control parameter 1 "MPRM1"					N	Y	
		80 (1080): Cancel customizable logic "CLC"					Y	Y	
		81 (1081): Clear all customizable logic timers "CLTC"					Y	Y	
		82 (1082): Cancel anti-regenerative control "AR-CCL"					Y	Y	
		87 (1087): Run command 2/ 1 "FR2/FR1"					Y	Y	
		88 (1088): Run forward / stop 2 "FWD2"					Y	Y	
		89 (1089): Run reverse / stop 2 "REV2"					Y	Y	
		100: No function assigned "NONE"					Y	Y	
		134: Switch fire mode "FMS"					Y	Y	
		149 (1149): Switch pump control "PCHG"					Y	Y	
		150 (1150): Enable master motor drive in mutual operation "MEN0"					Y	Y	
		151 (1151): Enable pump control motor 1 to be driven "MEN1"					Y	Y	
		152 (1152): Enable pump control motor 2 to be driven "MEN2"					Y	Y	
		153 (1153): Enable pump control motor 3 to be driven "MEN3"					Y	Y	
		154 (1154): Enable pump control motor 4 to be driven "MEN4"					Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
		171 (1171): PID control multistage command 1 "PID-SS1"					Y	Y	
		172 (1172): PID control multistage command 2 "PID-SS2"					Y	Y	
		181 (1181): External PID1 multistage command 1 "EPID-SS1"					Y	Y	
		182 (1182): External PID1 multistage command 2 "EPID-SS2"					Y	Y	
		201 (1201): External PID1 ON command "EPID1-ON"					Y	Y	
		202 (1202): External PID1 Cancel "%EPID1"					Y	Y	
		203 (1203): External PID1 Switch normal/inverse operation "EPID1-IVS"					Y	Y	
		204 (1204): External PID1 reset integral and differential components "EPID1-RST"					Y	Y	
		205 (1205): External PID1 hold integral component ˝EPID1-HLD˝					Y	Y	
		* Inside the ( ) is the negative logic signal (OFF at short-circuit)							
E10	Acceleration time 2	0.00 to 3600 s * 0.00 is for acceleration and deceleration time cancel (when performing soft-start and stop externally)	12	Y	Y	20.0	Y	Y	156
E11	Deceleration time 2								
E12	Acceleration time 3								
E13	Deceleration time 3								
E14	Acceleration time 4								
E15	Deceleration time 4								
E16	Torque limiter 2 (Driving)	0 to 300%; 999 (Disable)	1	Y	Y	999	Y	Y	157
E17	(Braking)								
E20	Terminal [Y1] function	0 (1000): Inverter running "RUN"	1	N	Y	0	Y	Y	158
E21	Terminal [Y2] function	1 (1001): Frequency (speed) arrival "FAR"	1	N	Y	1	Y	Y	
E27	Terminal [30A/B/C] function	2 (1002): Frequency (speed) detected "FDT"	1	N	Y	2	Y	Y	
		3 (1003): Under voltage detected (inverter stopped) "LU"	1	N	Y	15	Y	Y	
		5 (1005): Inverter output limiting "IOL"	1	N	Y	99	Y	Y	
		6 (1006): Auto-restarting after momentary power failure "IPF"					Y	Y	
		7 (1007): Motor overload early warning "OL"					Y	Y	
		8 (1008): Keypad operation enabled "KP"					Y	Y	
		10 (1010): Inverter ready to run "RDY"					Y	Y	
		11: Switch motor drive source between commercial power and inverter output (For MC on commercial line) "SW88"					Y	N	
		12: Switch motor drive source between commercial power and inverter output (For secondary side) "SW52-2"					Y	N	
		13: Switch motor drive source between commercial power and inverter output (For primary side) "SW52-1"					Y	N	
		15 (1015): Switch MC on the input power lines "AX"					Y	Y	
		16 (1016): Pattern operation stage transition "TU"					Y	Y	
		17 (1017): Pattern operation cycle completed "TO"					Y	Y	
		18 (1018): Pattern operation stage 1 "STG1"					Y	Y	
		19 (1019): Pattern operation stage 2 "STG2"					Y	Y	
		20 (1020): Pattern operation stage 4 "STG4"					Y	Y	
		25 (1025): Cooling fan in operation "FAN"					Y	Y	
		26 (1026): Auto-resetting "TRY"					Y	Y	
		27 (1027): Universal DO "U-DO"					Y	Y	
		28 (1028): Heat sink overheat early warning "OH"					Y	Y	
		30 (1030): Lifetime alarm "LIFE"					Y	Y	
		33 (1033): Reference loss detected "REF OFF"					Y	Y	
		35 (1035): Inverter outputting "RUN 2"					Y	Y	
		36 (1036): Overload prevention controlling "OLP"					Y	Y	
		37 (1037): Current detected "ID"					Y	Y	
		41 (1041): Low current detected "IDL"					Y	Y	
		42 (1042): PID alarm "PID-ALM"					Y	Y	
		43 (1043): Under PID control "PID-CTL"					Y	Y	
		44 (1044): Under sleep mode of PID control "PID-STP"					Y	Y	
		45 (1045): Low torque detected "U-TL"					Y	Y	
		52 (1052): Running forward "FRUN"					Y	Y	
		53 (1053): Running reverse "RRUN"					Y	Y	
		54 (1054): Under remote mode "RMT"					Y	Y	
		55 (1055): Run command entered "AX2"					Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control		Related page
							V/f	PM	
		56 (1056): Motor overheat detected by thermistor "THM"					Y	Y	
		59 (1059): Terminal [C1] (C1 function) wire break detected "C1OFF"					Y	Y	
		68(1068): Motor regular switching early warning "MCHG"					Y	Y	
		69(1069): Pump control output limit signal "MLIM"					Y	Y	
		76 (1076): Speed deviation excess "PG-ERR"					N	Y	
		77 (1077): Low DC link bus voltage detection "U-EDC"					Y	Y	
		79 (1079): During decelerating at momentary power failure "IPF2"					Y	Y	
		84 (1084): Maintenance timer counted up "MNT"					Y	Y	
		87 (1087): Frequency arrival and detected "FARFDT"					Y	Y	
		88 (1088): Auxiliary motor drive signal "AUX_L"					Y	Y	
		95 (1095): Running in fire mode "FMRUN"					Y	Y	
		98 (1098): Light alarm "L-ALM"					Y	Y	
		99 (1099): Alarm output "ALM"					Y	Y	
		101 (1101): EN circuit failure detected "DECF"					Y	Y	
		102 (1102): EN terminal input OFF "ENOFF"					Y	Y	
		111 (1111): Customizable logic output signal 1 "CLO1"					Y	Y	
		112 (1112): Customizable logic output signal 2 "CLO2"					Y	Y	
		113 (1113): Customizable logic output signal 3 "CLO3"					Y	Y	
		114 (1114): Customizable logic output signal 4 "CLO4"					Y	Y	
		115 (1115): Customizable logic output signal 5 "CLO5"					Y	Y	
		116 (1116): Customizable logic output signal 6 "CLO6"					Y	Y	
		117 (1117): Customizable logic output signal 7 "CLO7"					Y	Y	
		118 (1118): Customizable logic output signal 8 "CLO8"					Y	Y	
		119 (1119): Customizable logic output signal 9 "CLO9"					Y	Y	
		120 (1120): Customizable logic output signal 10 "CLO10"					Y	Y	
		160 (1160): Motor 1 being driven by inverter "M1_I"					Y	Y	
		161 (1161): Motor 1 being driven by commercial power "M1_L"					Y	Y	
		162 (1162): Motor 2 being driven by inverter "M2_I"					Y	Y	
		163 (1163): Motor 2 being driven by commercial power "M2_L"					Y	Y	
		164 (1164): Motor 3 being driven by inverter "M3_I"					Y	Y	
		165 (1165): Motor 3 being driven by commercial power "M3_L"					Y	Y	
		167 (1167): Motor 4 being driven by inverter "M4_L"					Y	Y	
		180 (1180): In mutual operation "M-RUN"					Y	Y	
		181 (1181): Alarm in mutual operation "M-ALM"					Y	Y	
		211 (1211): Under external PID1 control "EPID1-CTL"					Y	Y	
		212 (1212): External PID1 output "EPID1-OUT"					Y	Y	
		213 (1213): Running under external PID1 "EPID1-RUN"					Y	Y	
		214 (1214): External PID1 alarm "EPV1-ALM"					Y	Y	
		215 (1215): External PID1 feedback error "EPV1-OFF"					Y	Y	
		* Inside the ( ) is written the negative logic signal setting (OFF at short-circuit)							
E30	Frequency arrival detection width (Detection width)	0.0 to 10.0 Hz	3	Y	Y	2.5	Y	Y	165
E31	Frequency detection 1 (Level)	0.0 to 500.0 Hz	3	Y	Y	50.0	Y	Y	167
E32	(Hysteresis width)	0.0 to 500.0 Hz	3	Y	Y	1.0	Y	Y	
E34	Overload early warning/Current detection (Level)	0.00 (Disable)	24	Y	Y	*3	Y	Y	168
E35	(Timer)	0.01 to 600.00 s	5	Y	Y	10.00	Y	Y	
E37	Current detection 2/ Low current detection (Level)	0.00 (Disable) (Inverter rated current dependent on F80)	24	Y	Y1	*3	Y	Y	
E38	(Timer)	0.01 to 600.00 s	5	Y	Y	10.00	Y	Y	
E42	LED display filter	0.0 to 5.0 s	3	Y	Y	0.5	Y	Y	169

*3: The motor rated current is automatically set. Refer to “I.4 Motor constant”.

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
E43	LED monitor (Item selection)	0: Speed monitor (Selectable with E48) 3: Output current 4: Output voltage 8: Calculated torque 9: Input power 10: PID process command 12: PID feedback value 14: PID output 15: Load factor 16: Motor output 17: Analog signal input monitor 25: Input watt-hour 60: External PID1 process command (final) (physical value) 61: External PID1 feedback value (physical value) 62: External PID1 output (%) 63: External PID1 manual command (%)	1	Y	Y	0	Y	Y	169
E44	(Display when stopped)	0: Specified value 1: Output value	1	Y	Y	0	Y	Y	170
E48	LED monitor (Speed monitor item)	0: Output frequency 1 (PM: Speed command value) 1: Output frequency 2 (PM: Speed estimated value) 2: Reference frequency 3: Motor rotation speed 4: Load rotation speed 7: Speed (%)	1	Y	Y	0	Y	Y	170
E50	Display coefficient for speed monitor	0.01 to 200.00	5	Y	Y	30.00	Y	Y	170
E51	Display coefficient for “Input watt-hour data”	0.000 (Cancel/Reset). 0.001 to 9999	45	Y	Y	0.010	Y	Y	170
E52	Keypad (Menu display mode)	0: Function code data setting mode (Menu 0, Menu1, and Menu 7) 1: Function code data check mode (Menu 2 and Menu 7) 2: Full-menu mode	1	Y	Y	0	Y	Y	171
E59	Terminal [C1] function selection	0: Current input (C1 function) 1: Voltage input (V2 function)	1	N	Y	0	Y	Y	172
E61	Terminal [12] extended function	0: None 1: Auxiliary frequency setting 1 2: Auxiliary frequency setting 2 3: PID process command 5: PID feedback value 20: Analog signal input monitor 40: External PID process command 41: External PID feedback value 42: External PID manual command	1	N	Y	0	Y	Y	173
E62	Terminal [C1] (C1 extended function)		1	N	Y	0	Y	Y	
E63	Terminal [C1] (V2 extended function)		1	N	Y	0	Y	Y	
E64	Saving of digital reference frequency	0: Auto saving (main power is turned off) 1: Save by turning key ON	1	Y	Y	0	Y	Y	173
E65	Reference loss detection	0: Stop deceleration 20 to 120%, 999: Cancel	1	Y	Y	999	Y	Y	174
E76	DC link bus low-voltage detection level	400 to 800 V (400 V class)	1	Y	Y	470	Y	Y	174
E80	Low torque detection (Level)	0 to 300%	1	Y	Y	20	Y	Y	175
E81	(Timer)	0.01 to 600.00 s	5	Y	Y	20.00	Y	Y	
E98	Terminal [FWD] function	0 (1000): Select multistep frequency (0 to 1 steps) “SS1”	1	N	Y	98	Y	Y	175
E99	Terminal [REV] function	1 (1001): Select multistep frequency (0 to 3 steps) “SS2”	1	N	Y	99	Y	Y	
		2 (1002): Select multistep frequency (0 to 7 steps) “SS4”					Y	Y	
		3 (1003): Select multistep frequency (0 to 15 steps) “SS8”					Y	Y	
		4 (1004): Select ACC/DEC time (2 steps) “RT1”					Y	Y	
		5 (1005): Select ACC/DEC time (4 steps) “RT2”					Y	Y	
		6 (1006): Select 3-wire operation “HLD”					Y	Y	
		7 (1007): Coast to a stop command “BX”					Y	Y	
		8 (1008): Reset alarm (Abnormal) “RST”					Y	Y	
		9 (1009): External alarm “THR” (9 = Active OFF/1009 = Active ON)					Y	Y	
		11 (1011): Select frequency setting 2/ frequency setting 1 “Hz2/ Hz1”					Y	Y	
		13: DC braking command “DCBRK”					Y	N	
		14 (1014): Select torque limit 2/ torque limit 1 “TL2/ TL1”					Y	Y	
		15: Switch to commercial power (50 Hz) “SW50”					Y	N	
		16: Switch to commercial power (60 Hz) “SW60”					Y	N	
		17 (1017): UP command “UP”					Y	Y	
		18 (1018): DOWN command “DOWN”					Y	Y	

indicates quick setup target function code.

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Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
		19 (1019): Allow function code editing (Data change enabled) "WE-KP"					Y	Y	
		20 (1020): Cancel PID control "Hz/PID"					Y	Y	
		21 (1021): Switch normal/ inverse operation "IVS"					Y	Y	
		22 (1022): Interlock "IL"					Y	Y	
		24 (1024): Select link operation (RS-485, BUS option) "LE"					Y	Y	
		25 (1025): Universal DI "U-DI"					Y	Y	
		26 (1026): Select auto search for idling motor speed at starting"STM"					Y	Y	
		30 (1030): Force to stop "STOP" (30 = Active OFF/1030 = Active ON)					Y	Y	
		33 (1033): Reset PID integral and differential terms "PID-RST"					Y	Y	
		34 (1034): Hold PID integral term "PID-HLD"					Y	Y	
		35 (1035): Select local (Keypad) command "LOC"					Y	Y	
		38 (1035): Run enable "RE"					Y	Y	
		39: Dew condensation prevention "DWP"					Y	Y	
		40: Enable integrated sequence to switch to commercial power (50Hz) "ISW50"					Y	Y	
		41: Enable integrated sequence to switch to commercial power (60Hz) "ISW60"					Y	Y	
		49 (1049): Pulse train sign "SIGN"					Y	Y	
		50 (1050): Clear running motor regular switching time "MCLR"					Y	Y	
		59 (1059): Enable battery-driven operation "BATRY/UPS"					Y	Y	
		72 (1072): Count the run time of commercial power-driven motor 1 "CRUN-M1"					Y	N	
		78 (1078): Select speed control parameter 1 "MPRM1"					N	Y	
		80 (1080): Cancel customizable logic "CLC"					Y	Y	
		81 (1081): Clear all customizable logic timers "CLTC"					Y	Y	
		82 (1082): Cancel anti-regenerative control "AR-CCL"					Y	Y	
		87 (1087): Run command 2/ 1 "FR2/FR1"					Y	Y	
		88 (1088): Run forward / stop 2 "FWD2"					Y	Y	
		89 (1089): Run reverse / stop 2 "REV2"					Y	Y	
		98: Run forward / stop command "FWD"					Y	Y	
		99: Run reverse / stop command "REV"					Y	Y	
		100: No function assigned "NONE"					Y	Y	
		149 (1149): Switch pump control "PCHG"					Y	Y	
		150 (1150): Enable master motor drive in mutual operation "MEN0"					Y	Y	
		151 (1151): Enable pump control motor 1 to be driven "MEN1"					Y	Y	
		152 (1152): Enable pump control motor 2 to be driven "MEN2"					Y	Y	
		153 (1153): Enable pump control motor 3 to be driven "MEN3"					Y	Y	
		154 (1154): Enable pump control motor 4 to be driven "MEN4"					Y	Y	
		171 (1171): PID control multistage command 1 "PID-SS1"					Y	Y	
		172 (1172): PID control multistage command 2 "PID-SS2"					Y	Y	
		181 (1181): External PID1 multistage command 1 "EPID-SS1"					Y	Y	
		182 (1182): External PID1 multistage command 2 "EPID-SS2"					Y	Y	
		201 (1201): External PID1 ON command "EPID1-ON"					Y	Y	
		202 (1202): External PID1 Cancel "%EPID1"					Y	Y	
		203 (1203): External PID1 Switch normal/inverse operation "EPID1-IVS"					Y	Y	
		204 (1204): External PID1 reset integral and differential components "EPID1-RST"					Y	Y	
		205 (1205): External PID1 hold integral component "EPID1-HLD"					Y	Y	
		* Inside the ( ) is the negative logic signal. (OFF at short-circuit)							

■ C code: Control Functions of Frequency (Control Function)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
C01	Jump frequency 1	0.0 to 500.0 Hz	3	Y	Y	0.0	Y	Y	176
C02	2								
C03	3								
C04	(Skip width)	0.0 to 30.0Hz	3	Y	Y	3.0	Y	Y	
C05	Multistep frequency 1	0.00 to 500.00Hz	22	Y	Y	0.00	Y	Y	177
C06	2								
C07	3								
C08	4								
C09	5								
C10	6								
C11	7								
C12	8								
C13	9								
C14	10								
C15	11								
C16	12								
C17	13								
C18	14								
C19	15								
C21	Pattern operation (Mode selection)	0: 1 cycle operation 1: Repetition operation 2: Constant speed operation after 1 cycle operation	1	N	Y	0	Y	Y	178
C22	(Stage 1)	Special setting: Press FUNC/DATA key three times. 1st: Set run time 0.0 to 3600 s and press FUNC/DATA key. 2nd: Set rotational direction F (forward) or r (reverse) and press FUNC/DATA key. 3rd: Set acceleration/deceleration time 1 to 4 and press FUNC/DATA key.	84	Y	Y	1st: 0.00 2nd: F 3rd: 1	Y	Y	
C23	(Stage 2)								
C24	(Stage 3)								
C25	(Stage 4)								
C26	(Stage 5)								
C27	(Stage 6)								
C28	(Stage 7)								
C30	Frequency setting 2	0: Keypad ∧/∨ key operation 1: Analog voltage input (Terminal [12]) (from 0 to ±10 VDC) 2: Analog current input (Terminal [C1] (C1 function)) (4 to 20 mA DC, 0 to 20 mA DC) 3: Analog voltage input (Terminal [12]) + Analog current input (Terminal [C1] (C1 function)) 5: Analog voltage input (Terminal [C1] (V2 function)) (0 to 10 VDC) 7: UP DOWN control 8: Keypad key operation (∧/∨ key) (With balanceless bumpless) 10: Pattern operation 11: Digital input/output interface card (option) 12: Pulse train input	1	N	Y	2	Y	Y	180
C31	Analog input adjustment (Terminal [12]) (Offset)	-5.0 to 5.0%	4	Y*	Y	0.0	Y	Y	181
C32	(Gain)	0.00 to 200.00%	5	Y*	Y	100.0	Y	Y	
C33	(Filter)	0.00 to 5.00 s	5	Y	Y	0.05	Y	Y	
C34	(Gain base point)	0.00 to 100.00%	5	Y*	Y	100.0	Y	Y	
C35	(Polarity selection)	0: Bipolar 1: Unipolar	1	N	Y	1	Y	Y	
C36	Analog input adjustment (Terminal [C1] (C1 function)) (Offset)	-5.0 to 5.0%	4	Y*	Y	0.0	Y	Y	
C37	(Gain)	0.00 to 200.00%	5	Y*	Y	100.0	Y	Y	
C38	(Filter)	0.00 to 5.00 s	5	Y	Y	0.05	Y	Y	
C39	(Gain base point)	0.00 to 100.00%	5	Y*	Y	100.0	Y	Y	
C40	Terminal [C1] (C1 function) range / polarity selection	0: 4 to 20 mA Unipolar 1: 0 to 20 mA Unipolar 10: 4 to 20 mA Bipolar 11: 0 to 20 mA Bipolar	1	N	Y	0	Y	Y	

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Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
C41	Analog input adjustment (Terminal [C1] (V2 function)) (Offset)	-5.0 to 5.0%	4	Y*	Y	0.0	Y	Y	181
C42	(Gain)	0.00 to 200.00%	5	Y*	Y	100.0	Y	Y	
C43	(Filter)	0.00 to 5.00 s	5	Y	Y	0.05	Y	Y	
C44	(Gain base point)	0.00 to 100.00%	5	Y*	Y	100.0	Y	Y	
C45	(Polarity selection)	0: Bipolar 1: Unipolar	1	N	Y	1	Y	Y	
C50	Bias (for frequency setting 1) (Bias base point)	0.00 to 100.00%	5	Y*	Y	0.00	Y	Y	183
C53	Selection of normal/inverse operation(Frequency setting 1)	0: Normal 1: Inverse	1	Y	Y	0	Y	Y	183
C55	Analog input adjustment (Terminal 12) (Bias)	-100.00 to 100.00%	6	Y*	Y	0.00	Y	Y	181 184
C56	(Bias base point)	0.00 to 100.00 %	5	Y*	Y	0.00	Y	Y	
C58	(Display unit)	* Same as J105 (However, setting range is, 1 to 80)	1	Y	Y	2	Y	Y	
C59	(Maximum scale)	-999 to 0.00 to 9990	12	N	Y	100	Y	Y	
C60	(Minimum scale)	-999 to 0.00 to 9990	12	N	Y	0.00	Y	Y	
C61	Analog input adjustment (Terminal[C1](C1 function)) (Bias)	-100.00 to 100.00 %	6	Y*	Y	0.00	Y	Y	181
C62	(Bias base point)	0.00 to 100.00 %	5	Y*	Y	0.00	Y	Y	
C64	(Display unit)	* Same as J105 (However, setting range is, 1 to 80)	1	Y	Y	2	Y	Y	
C65	(Maximum scale)	-999 to 0.00 to 9990	12	N	Y	100	Y	Y	184
C66	(Minimum scale)	-999 to 0.00 to 9990	12	N	Y	0.00	Y	Y	
C67	Analog input adjustment (Terminal [C1] (V2 function)) (Bias)	-100.00 to 100.00 %	6	Y*	Y	0.00	Y	Y	181
C68	(Bias base point)	0.00 to 100.00 %	5	Y*	Y	0.00	Y	Y	
C70	(Display unit)	* Same as J105 (However, setting range is,1 to 80)	1	Y	Y	2	Y	Y	184
C71	(Maximum scale)	-999 to 0.00 to 9990	12	N	Y	100	Y	Y	
C72	(Minimum scale)	-999 to 0.00 to 9990	12	N	Y	0.00	Y	Y	

■ P codes: Motor 1 Parameters (Motor 1 parameter)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
P01	Motor 1 (No. of poles)	2 to 22 poles	1	N	Y1	4	Y	Y	185
P02	(Rated capacity)	0.01 to 1000 kW (At P99 = 0, 4, 21, or 22) 0.01 to 1000 HP (At P99 = 1)	11	N	Y1	*6	Y	Y	
P03	(Rated current)	0.00 to 2000A	24	N	Y1	*6	Y	Y	
P04	(Auto-tuning)	0: Disable 1: Stop tuning 2: Rotation tuning 5: Stop tuning(%R1, %X)	21	N	N	0	Y	Y	186
P05	(Online tuning)	0: Invalid 1: Valid	1	Y	Y	0	Y	N	188
P06	(No-load current)	0.00 to 2000A	24	N	Y1	*6	Y	N	188
P07	(%R1)	0.00 to 50.00%	5	Y	Y1	*6	Y	N	
P08	(%X)	0.00 to 50.00%	5	Y	Y1	*6	Y	N	
P09	(Slip compensation gain for driving)	0.0 to 200.0%	5	Y*	Y	100.0	Y	N	188
P10	(Slip compensation response time)	0.01 to 10.00 s	5	Y	Y1	0.5	Y	N	
P11	(Slip compensation gain for braking)	0.0 to 200.0 %	5	Y*	Y	100.0	Y	N	
P12	(Rated slip frequency)	0.00 to 15.00 Hz	5	N	Y1	*6	Y	N	190
P13	(Iron loss factor 1)	0.00 to 20.00 %	5	Y	Y1	*6	Y	N	190
P30	(PMSM drive magnetic pole position detection mode)	0: Pull-in by current 1: For IPMSM (Interior permanent magnet synchronous motor) 2: For SPMSM (Surface permanent magnet synchronous motor) 3: Pull-in by current for IPMSM (Interior permanent magnet synchronous motor)	1	N	Y1	1	N	Y	190
P53	(%X correction factor 1)	0 to 300 %	1	Y	Y1	100	Y	N	190
P60	(PMSM armature resistance)	0.000 to 50.000 ohm	45	N	Y1	*7	N	Y	190
P61	(PMSM d-axis inductance)	0.00 to 500.00 mH	24	N	Y1	*7	N	Y	
P62	(PMSM q-axis inductance)	0.00 to 500.00 mH	24	N	Y1	*7	N	Y	
P63	(PMSM induced voltage)	160 to 500V (400Vclass)	1	N	Y1	*7	N	Y	
P64	(PMSM iron loss)	0.0 to 20.0 %	3	Y	Y1	*7	N	Y	
P65	(PMSM d-axis inductance magnetic saturation correction)	0.0 to 100.0 % ; 999	3	Y	Y1	*7	N	Y	190
P74	(PMSM reference current at starting)	10 to 200 % (100%= motor rated current)	1	Y*	Y1	*7	N	Y	190
P83	(Reserved for PMSM) *9	0.0 to 50.0; 999	3	Y	Y1	999	N	–	191
P84	(Reserved for PMSM) *9	0.0 to 100.0; 999	3	N	Y1	999	N	–	
P85	(PMSM flux limitation value)	50.0 to 150.0; 999	3	Y	Y1	999	N	Y	190
P86	(Reserved for PMSM)	0.0 to 100.0%	3	N	N	0.0	N	–	191
P87	(PMSM reference current for polarity discrimination)	0 to 200 %	1	N	Y1	60	N	Y	–
P88	(Reserved for PMSM) *9	0 to 100 %; 999	1	N	Y1	999	N	–	191
P89	(Reserved for PMSM) *9	0; 1 to 100	1	N	Y1	0	N	–	
P90	(PMSM overcurrent protection level)	0.00(disable); 0.01 to 2000 A	24	N	Y1	*7	N	Y	191
P99	Motor 1 selection	0: Motor characteristics 0 (Fuji standard IM, 8-series) 1: Motor characteristics 1 (HP rating IMs) 4: Other IMs 20: Other motors(PMSMs) 21: Motor characteristics (Fuji PMSM GNB2 series)	1	N	Y1	0	Y	Y	191

(cyan box) Indicates quick setup target function code.
*6: Factory defaults are depended on motor capacity. Refer to "I.4 Motor constant".
*7: Factory defaults are the parameters for Fuji standard PMSM and depended on motor capacity.
*9: Factory use. Do not access these function codes.

■ H codes: High Performance Functions (High Level Function)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
H02	Data initialization (Method)	0: Standard 1: User	1	N	Y	0	Y	Y	192
H03	(Target)	0: Manual setting value 1: Initial value (factory default value) 2: Initialize motor 1 parameters 11: Initialize the parameters(excluding parameters related to communication) 12: Initialize the parameters related to customizable logic	1	N	N	0	Y	Y	
H04	Auto-reset (Times)	0: Disable 1 to 20: Number of retries	1	Y	Y	0	Y	Y	194
H05	(Interval)	0.5 to 20.0 s	3	Y	Y	5.0	Y	Y	
H06	Cooling fan ON/OFF control	0: Disable (Always Fan ON) 1: Enable (ON/OFF control effective)	1	Y	Y	0	Y	Y	195
H07	Curve acceleration/ deceleration	0: Disable (Linear acceleration/deceleration) 1: S-curve acceleration/deceleration (Weak) 2: S-curve acceleration/deceleration (Strong) 3: Curve acceleration/deceleration	1	Y	Y	0	Y	Y	195
H08	Rotational direction limitation	0: Disable 1: Enable (Reverse rotation inhibited) 2: Enable (Forward rotation inhibited)	1	N	Y	0	Y	Y	195
H09	Starting mode (Auto search)	0: Disable 1: Enable (Only at restart after momentary power failure) 2: Enable (At normal start and at restart after momentary power failure)	1	N	Y	0	Y	N	196
H11	Deceleration mode	0: Normal deceleration 1: Coast to a stop	1	Y	Y	0	Y	Y	198
H12	Instantaneous overcurrent limiting (Mode selection)	0: Disable 1: Enable	1	Y	Y	1	Y	N	198
H13	Restart mode after momentary power failure (Restart timer)	0.1 to 20.0 s	3	Y	Y1	*2	Y	N	198
H14	(Frequency fall rate)	0.00: Selected deceleration time 0.01 to 100.00Hz/s 999: According to current limiter)	5	Y	Y	999	Y	N	
H15	(Continuous running level)	400 to 600V	1	Y	Y	470	Y	Y	
H16	(Allowable momentary power failure time)	0.0 to 30.0s, 999 (Depend on inverter judgment)	3	Y	Y	999	Y	Y	
H26	Thermistor (for motor) (Mode selection)	0: Disable 1: PTC: *0h4* trip and stop the inverter 2: PTC: Output motor overheat detected “THM” and continue to run	1	Y	Y	0	Y	Y	198
H27	(Level)	0.00 to 5.00 V	5	Y	Y	1.60	Y	Y	
H30	Communication link function (Mode selection)	Frequency command / Run command 0: F01/C30 / F02 1: RS-485 (Port 1) / F02 2: F01/C30 / RS-485 (Port 1) 3: RS-485 (Port 1) / RS-485 (Port 1) 4: RS-485 (Port 2) / F02 5: RS-485 (Port 2) / RS-485 (Port 1) 6: F01/C30 / RS-485 (Port 2) 7: RS-485 (Port 1) / RS-485 (Port 2) 8: RS-485 (Port 2) / RS-485 (Port 2)	1	Y	Y	0	200	Y	
H42	Capacitance of DC link bus capacitor	For adjustment at replacement (0000 to FFFF (in hexadecimal))	1	Y	N	–	Y	Y	202
H43	Cumulative run time of cooling fan	For adjustment at replacement Displays the cumulative run time of cooling fan in units of ten hours.	74	Y	N	–	Y	Y	
H44	Startup count for motor 1	For adjustment at replacement (0000 to FFFF in hexadecimal)	1	Y	N	–	Y	Y	206
H45	Mock alarm	0: Disable 1: Occurrence of mock Alarm	1	Y	N	0	Y	Y	206
H46	Starting mode (Auto search delay time 2)	0.1 to 20.0 s	3	Y	Y1	*6	Y	Y	206

*2: Factory defaults are depended on motor capacity. Refer to “I.3 Factory default value per applicable electric motor capacitance”.
*6: Factory defaults are depended on motor capacity. Refer to “I.4 Motor constant”.

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
H47	Initial capacitance of DC link bus capacitor	For adjustment at replacement (0000 to FFFF in hexadecimal)	1	Y	N	–	Y	Y	206
H48	Cumulative run time of capacitors on printed circuit boards	For adjustment at replacement Change in cumulative motor run time (Reset is enabled) (in units of ten hours)	74	Y	N	–	Y	Y	202 206
H49	Starting mode (Auto search delay time 1)	0.0 to 10.0 s	3	Y	Y	0.0	Y	Y	207
H50	Non-linear V/f 1 (Frequency)	0.0: Cancel 0.1 to 500.0 Hz	3	N	Y	0.0	Y	N	207
H51	(Voltage)	0 to 500V:AVR operation (400V class)	1	N	Y	0	Y	N	
H52	Non-linear V/f 2 (Frequency)	0.0: Cancel 0.1 to 500.0 Hz	3	N	Y	0.0	Y	N	
H53	(Voltage)	0 to 500V:AVR operation (400V class)	1	N	Y	0	Y	N	
H56	Deceleration time for forced stop	0.00 to 3600 s	12	Y	Y	20.0	Y	Y	207
H63	Low limiter (Mode selection)	0: Limit by F16 (Frequency limiter: Low) and continue to run 1: If the output frequency lowers below the one limited by F16 (Frequency limiter: Low), decelerate to stop the motor.	1	Y	Y	0	Y	Y	207
H64	(Lower limiting frequency)	0.0: Depends on F16 (Frequency limiter, Low) 0.1 to 60.0 Hz	13	Y	Y	1.6	Y	Y	207
H68	Slip compensation 1 (Operating conditions selection)	0: Enable during acceleration/deceleration, enable at base frequency or higher 1: Disable during acceleration/deceleration, enable at base frequency or higher 2: Enable during acceleration/deceleration, disable at base frequency or higher 3:Disable during acceleration/deceleration, disable at base frequency or higher	1	N	Y	0	Y	N	207
H69	Anti-regenerative control (Mode selection)	0: Disable 2: Torque limit control with force-to-stop (Cancel limit control after three times of deceleration time has passed) 3: DC link bus voltage control with force-to-stop (Cancel voltage control after three times of deceleration time has passed) 4: Torque limit control without force-to-stop 5: DC link bus voltage control without force-to-stop	1	Y	Y	0	Y	Y	208
H70	Overload prevention control	0.00: Follow the deceleration time selected 0.01 to 100.00 Hz/s, 999 (Cancel)	5	Y	Y	999	Y	Y	209
H71	Deceleration characteristics	0: Disable 1: Enable	1	Y	Y	0	Y	N	209
H72	Main power shutdown detection (Mode selection)	0: Disable 1: Enable (Available FRN0045E2E-4EH or above)	1	Y	Y	1	Y	Y	209
H76	Torque limiter (Braking) (Frequency rising limiter for braking)	0.0 to 500.0 Hz	3	Y	Y	5.0	Y	N	210
H77	Service life of DC link bus capacitor	0 to 8760 (in units of ten hours)	74	Y	N	6132 (ND spec)	Y	Y	210
H78	Maintenance interval (M1)	0 (Disable): 1 to 9999 (in units of ten hours)	74	Y	N	6132 (ND spec)	Y	Y	210
H79	Preset startup count for maintenance (M1)	0000 (Disable): 0001 to FFFF (in hexadecimal)	1	Y	N	0	Y	Y	211
H80	Output current fluctuation damping gain for motor 1	0.00 to 1.00	5	Y	Y	0.20	Y	N	211
H81	Light alarm selection 1	0000 to FFFF (in hexadecimal)	1	Y	Y	0	Y	Y	212
H82	Light alarm selection 2	0000 to FFFF (in hexadecimal)	1	Y	Y	0	Y	Y	
H86	Reserved *9	0 to 2	1	Y	Y	0	–	–	214
H89	Electronic Thermal Overload Protection for Motor 1 (data store)	0: Inactive 1: Active	1	Y	Y	1	–	–	214
H90	Reserved *9	0 to 1	1	Y	Y	0	–	–	214
H91	PID feedback wire break detection	0.0 (Alarm disable): 0.1 to 60.0 s	3	Y	Y	0.0	Y	Y	214

*9: Factory use. Do not access these function codes.

APPENDICES

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
H92	Continuous running at the momentary power failure (P)	0.000 to 10.000 times; 999 999:Manufacturer adjustment value	7	Y	Y1	999	Y	Y	214
H93	(I)	0.010 to 10.000 s; 999 999:Manufacturer adjustment value	7	Y	Y1	999	Y	Y	
H94	Cumulative motor run time 1	0 to 9999 Change in cumulative motor run time (Reset is enabled) (in units of 10 hours)	74	N	N	–	Y	Y	210 215
H95	DC braking (Braking response mode)	0: Slow response 1: Quick response	1	Y	Y	1	Y	N	116 215
H96	STOP key priority/ Start check function	0: STOP key priority disable/ Start check function disable 1: STOP key priority enable/ Start check function disable 2: STOP key priority disable/ Start check function enable 3: STOP key priority enable/ Start check function enable	1	Y	Y	0	Y	Y	215
H97	Clear alarm data	0: Disable 1: Alarm data clear (Automatically return to 0 after clearing data)	1	Y	N	0	Y	Y	215
H98	Protection/Maintenance function (Mode selection)	0 to 127 (Data is displayed in decimal) Bit 0: Lower the carrier frequency automatically (0: Disable; 1: Enable) Bit 1: Input phase loss protection (0: Disable; 1: Enable) Bit 2: Output phase loss protection (0: Disable; 1: Enable) Bit 3: Main circuit capacitor life judgment selection (0: Factory default referenced; 1 User measurement value standard) Bit 4: Judge the life of main circuit capacitor (0: Disable; 1: Enable) Bit 5: Detect DC fan lock (0: Enable; 1: Disable) Bit 6: Braking transistor error detection (0: Disable; 1: Enable)	1	Y	Y	*11	Y	Y	216
H99	Password 2 setting/check	0000 to FFFF (Hexadecimal)	1	Y	N	0	Y	Y	218
H101	Destination	0:Not selected 1:Japan 2:Asia 3:China 4:Europe 5:Americas 7:Korea	1	Y	Y	G(AEU): 0 J:1 C:3 K:7	Y	Y	221
H111	UPS operation level	120 to 220 VDC: (200 V class) 240 to 440 VDC: (400 V class)							221
H114	Anti-regenerative control (Level)	0.0 to 50.0%, 999: disabled	3	Y	Y	999	Y	Y	221
H116	Fire Mode (Mode selection)	0: FMS: ON 1: FMS toggle method 2: FMS latch method		N	Y	0			222
H117	(Confirmation time)	0.5 to 10.0 s * Set ON/OFF setting time for FMS signals.		Y	Y	3.0			
H118	(Reference frequency)	Inherit: Follow the ordinary reference frequency specified with F01, etc. 0.1 to 500.0 Hz		Y	Y	Inherit			
H119	(Rotation direction)	0: Follow the run command specified with F02, etc. 2: Forward rotation 3: Reverse rotation		N	Y	0			
H120	(Start method)	0: Follows the start methods specified with instant power failure restart 1: Auto search		Y	Y	0			
H121	(Reset interval)	0.5 to 20.0 s		Y	Y	5.0			
H193	User initial value (Save)	0: Disable 1: Save	1	Y	N	0	Y	Y	193 224
H194	(Protection)	0: Save enable 1: Protected (Save disable)	1	Y	Y	0	Y	Y	
H195	DC braking (Braking timer at the startup)	0.00: Disable 0.01 to 30.00 s	5	Y	Y	0.00	Y	N	116 224
H197	User password 1 (Selection of protective operation)	0: All function codes are disclosed, but the change is not allowed. 1: Only the function code for quick setup can be disclosed/changed. 2: Only the function code for customize logic setting is not disclosed/not changed.	1	Y	Y	0	Y	Y	218
H198	(Setting/check)	0000 to FFFF (Hexadecimal)	1	Y	N	0000	Y	Y	
H199	User password protection valid	0: Disable 1: Protected	1	Y	N	0	Y	Y	

*11: FRN0020E2■-2G□H or below: 83, FRN0072E2■-4EH or below: 83, FRN0012E2■-7G□H or below: 83, FRN0085E2■-4EH or above: 19.

■ A codes: Motor 2 Parameters (Motor 2 parameters)

	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
A43	Speed control 2 (Speed command filter)	0.000 to 5.000 s	7	Y	Y	0.200	N	Y	293
A44	(Speed detection filter)	0.000 to 0.100 s	7	Y*	Y	0.025	N	Y	
A45	P (Gain)	0.1 to 200.0 times	3	Y*	Y	2.0	N	Y	
A46	I (Integral time)	0.001 to 9.999 s 999: Cancel integral term	7	Y	Y	0.600	N	Y	

■ J codes: Application Functions 1 (Application function 1)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
J01	PID control (Mode selection)	0: Disable 1: Process (normal operation) 2: Process (inverse operation)	1	N	Y	0	Y	Y	226
J02	(Remote command)	0: Keypad key operation (∧/∨ key) 1: PID process command 1 (Analog input: Terminals 12, C1 and V2) 3: UP/DOWN 4: Communication	1	N	Y	0	Y	Y	227
J03	P (Gain)	0.000 to 30.000 times	7	Y	Y	0.100	Y	Y	232
J04	I (Integral time)	0.0 to 3600.0 s	3	Y	Y	0.0	Y	Y	
J05	D (Differential time)	0.00 to 600.00 s	5	Y	Y	0.00	Y	Y	
J06	(Feedback filter)	0.0 to 900.0 s *1	3	Y	Y	0.5	Y	Y	
J10	(Anti-reset windup)	0 to 200%	1	Y	Y	200	Y	Y	235
J11	(Select Warning output)	0: Warning caused by process command value 1: Warning caused by process command value with hold 2: Warning caused by process command value with latch 3: Warning caused by process command value with hold and latch 4: Warning caused by PID error value 5: Warning caused by PID error value with hold 6: Warning caused by PID error value with latch 7: Warning caused by PID error value with hold and latch	1	Y	Y	0	Y	Y	236
J12	(Upper limit of warning (AH))	0% to 100%	1	Y	Y	100	Y	Y	
J13	(Lower limit of warning (AL))	0% to 100%	1	Y	Y	0	Y	Y	
J15	(Sleep frequency)	0.0: Disable 1.0 to 500.0 Hz	3	Y	Y	0.0	Y	Y	238
J16	(Sleep timer)	0 to 60 s	1	Y	Y	30	Y	Y	
J17	(Wakeup frequency)	0.0 to 500.0 Hz	3	Y	Y	0.0	Y	Y	
J18	(Upper limit of PID process output)	0 to 500 Hz; 999 (Depends on setting of F15)	1	Y	Y	999	Y	Y	239
J19	(Lower limit of PID process output)	0 to 500 Hz; 999 (Depends on setting of F16)	1	Y	Y	999	Y	Y	
J21	Dew Condensation Prevention (Duty)	1～50 %	1	N	Y	0	Y	N	240
J22	Commercial Power Switching Sequence	0: Keep inverter operation (Stop due to alarm) 1: Automatically switch to commercial-power operation	1	Y	Y	0.0	Y	Y	-
J23	(Wakeup level of PID error)	0.0 to 100.0%	3	Y	Y	0.0	Y	Y	238
J24	(Wakeup timer)	0 to 3600 s	1	Y	Y	0	Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
J105	PID control (Display unit)	0 to 80 0: Inherit (PID Control 1 feedback unit) 1: none 2: % 4: r/min 7: kW [Flow] 20: m3/s 21: m3/min 22: m3/h 23: L/s 24: L/min 25: L/h [Pressure] 40: Pa 41: kPa 42: MPa 43: mbar 44: bar 45: mmHg 46: psi PSI (Pounds per square inch absolute) 47: mWG 48: inWG [Temperature] 60: K 61: degreeC 62: degreeF [Concentration] 80: ppm		N	Y	0	Y	Y	240
J106	(Maximum scale)	-999 to 0.00 to 9990		N	Y	100	Y	Y	
J107	(Minimum scale)	-999 to 0.00 to 9990		N	Y	0.00	Y	Y	
J136	PID multistep command (Multistep command 1)	-999 to 0.00 to 9990		Y	Y	0.00	Y	Y	240
J137	(Multistep command 2)	-999 to 0.00 to 9990		Y	Y	0.00	Y	Y	
J138	(Multistep command 3)	-999 to 0.00 to 9990		Y	Y	0.00	Y	Y	

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Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
J401	Pump Control Mode Selection	0: Disable 1: Enable (Inverter drive motor fixed system, judged by MV) 2: Enable (Inverter drive motor floating system, judged by MV) 3: Enable (Inverter drive motor floating + commercial power-driven motor system, judged by MV) 11 Enable (Inverter drive motor fixed system, judged by output frequency) ***7** 12 Enable (Inverter drive motor floating system, judged by output frequency) ***7** 13 Enable (Inverter drive floating + commercial power-driven motor system, judged by output frequency) ***7** 52: Enable (Communications-linked inverter drive motor floating system) 54: Enable (Communications-linked all motors simultaneous PID control system)	1	N	Y	0	Y	Y	259
J402	Communication Master/Slave Selection	0: Communication master inverter 1: Communication slave inverter	1	N	Y	1	Y	Y	261
J403	Number of Slaves	1 to 3 units * Set for a master only.	1	N	Y	1	Y	Y	261
J404	Master Input Permeation Selection	0000H to 007FH (hexadecimal) Bit 0: FWD Bit 1: REV Bit 2: X1 Bit 3: X2 Bit 4: X3 Bit 5: X4 Bit 6: X5 * The inverter sends the master terminal input info to the slave. * The slave stores the received data to S06 after masking.	1	N	Y	0000H	Y	Y	261
J411	Motor 1 Mode Selection	0: Disable (off at all times) 1: Enable 2: Forced drive ON (forced commercial power drive)	1	Y	Y	0	Y	Y	262
J412	Motor 2 Mode Selection		1	Y	Y	0	Y	Y	
J413	Motor 3 Mode Selection		1	Y	Y	0	Y	Y	
J414	Motor 4 Mode Selection		1	Y	Y	0	Y	Y	
J425	Motor Switching Procedure	0: Fixing procedure 1: Equal operating time (Cumulative run time of each motor is equalized.) 2: Fixing procedure (Switching the motor at slow flowrate stop) 3: Equal operating time (Switching the motor at slow flowrate stop)	1	N	Y	0	Y	Y	263
J430	Stop of Commercial Power-driven Motors	0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run	1	Y	Y	0	Y	Y	264
J435	Motor Regular Switching Mode Selection	1: Inverter-driven pumps are subject to switching. 2: Commercial power-driven pumps are subject to switching. 3: All pumps (inverter-driven pumps/commercial power-driven pumps) are subject to switching.	1	Y	Y	1	Y	Y	266
J436	Motor Regular Switching Time	0.0: Disable 0.1 to 720.0 h: Enable: (Switching time) 999: Enable (Switching time fixed at three minutes)	3	Y	Y	0.0	Y	Y	
J437	Motor Regular Switching Signal Output Time	0.00 to 600.00 s	5	Y	Y	0.10	Y	Y	
J450	Motor Increase Judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J18	1	Y	Y	999	Y	Y	269
J451	(Duration time)	0.00 to 3600.00 s	12	Y	Y	0.00	Y	Y	
J452	Motor Decrease Judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J19	1	Y	Y	999	Y	Y	
J453	(Duration time)	0.00 to 3600.00 s	12	Y	Y	0.00	Y	Y	
J454	Contactor Restart Time when Switching the Motor	0.01 to 2.00 s	5	Y	Y	0.10	Y	Y	270
J455	Motor Increase Switching Time (Deceleration time)	0.00: Depends on F08 0.01 to 3600.00 s	12	Y	Y	0.00	Y	Y	270
J456	Motor Increase Switching Level	0 to 100%	1	Y	Y	0	Y	Y	
J457	Motor Increase PID Control Start Frequency	0 to 500 Hz 999: Depends on J452	1	Y	Y	999	Y	Y	
J458	Motor Decrease Switching Time (Acceleration time)	0.00: Depends on F07 0.01 to 3600.00 s	12	Y	Y	0.00	Y	Y	271
J459	Motor Decrease Switching Level	0 to 100% 999: Depends on J456	1	Y	Y	999	Y	Y	
J460	Motor Decrease PID Control Start Frequency	0 to 500 Hz 999: Depends on J450	1	Y	Y	999	Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
J461	Motor Increase/Decrease Switching Judgment Non-responsive Area Width	0.0: Disable 0.1 to 50.0%	3	Y	Y	0.0	Y	Y	271
J462	Failure Inverter Judgment Time	0.0: Disable 0.5 to 600.0 s	3	Y	Y	5.0	Y	Y	272
J463	PID control start frequency	0: Disable 1 to 500Hz 999: Depends on J19	1	Y	Y	0	Y	Y	272
J465	Auxiliary Motor (Frequency operation level)	0.0: Disable 0.1 to 500.0 Hz	3	Y	Y	50.0	Y	Y	272
J466	(Hysteresis width)	0.0 to 500.0 Hz	3	Y	Y	1.0	Y	Y	
J467	(PV operation level)	0.00: Disable 0.01 to 9990	12	Y	Y	0.00	Y	Y	272
J468	(Connection timer)	0.00 to 2.00 s	5	Y	Y	0.00	Y	Y	
J469	(Interrupting timer)	0.00 to 2.00 s	5	Y	Y	0.00	Y	Y	
J480	Motor Cumulative Run Time (Motor 0)	0 to 65535 For adjustment at the replacement time	1	Y	N	0	Y	Y	274
J481	(Motor 1)		1	Y	N	0	Y	Y	
J482	(Motor 2)		1	Y	N	0	Y	Y	
J483	(Motor 3)		1	Y	N	0	Y	Y	
J484	(Motor 4)		1	Y	N	0	Y	Y	
J490	Y Terminal ON Maximum Cumulation Count (Y1,Y2)	0.000 to 1000 (The display of "1.000" indicates 1000 times.)	45	Y	N	0.000	Y	Y	275
J492	Relay ON Maximum Cumulation Count (30A/B/C)		45	Y	N	0.000	Y	Y	
J493	Relay ON Maximum Cumulation Count (Y6RY to Y8RY)		45	Y	N	0.000	Y	Y	
J501	External PID Control 1 (Mode selection)	0: Disable 1: Enable process control (Normal operation) 2: Enable process control (Inverse operation) 11: Enable process control, interlocking with inverter running (Normal operation) 12: Enable process control, interlocking with inverter running (Inverse operation) 21: Enable process control by external digital signal (Normal operation) 22: Enable process control by external digital signal (Inverse operation) 31: Enable process control by external digital signal, interlocking with inverter running (Normal operation) 32: Enable process control by external digital signal, interlocking with inverter running (Inverse operation)	1	N	Y	0	Y	Y	276
J502	(Remote command selection)	0: Keypad (∧/∨ key) 3: Terminal command "UP/DOWN" 4: Command via communications link (Use function code S13) 51: External PID command 1 (Analog input: Terminals [12], [C1] and [V2])	1	N	Y	0	Y	Y	277
J505	(Display unit)	Same as J105	1	N	Y	0	Y	Y	282
J506	(Maximum scale)	-999 to 0.00 to 9990	12	N	Y	100.0	Y	Y	283
J507	(Minimum scale)	-999 to 0.00 to 9990	12	N	Y	0.00	Y	Y	
J510	P (Gain)	0.000 to 30.000 times 999: ON/OFF control	7	Y	Y	0.100	Y	Y	284
J511	I (Integral time)	0.0 to 3600.0 s	3	Y	Y	0.0	Y	Y	
J512	D (Differential time)	0.00 to 600.00 s	5	Y	Y	0.00	Y	Y	
J513	(Feedback filter)	0.0 to 900.0 s	3	Y	Y	0.5	Y	Y	
J514	(Anti-reset wind-up)	0.00 to 9990 0.00: Disable Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	0.00	Y	Y	285
J515	(ON/OFF control hysteresis width)	0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	0.00	Y	Y	285
J516	(Proportional operation output convergent value)	0 to 150%	1	Y	Y	0	Y	Y	286
J517	(Proportional cycle)	1 to 150 s	1	Y	Y	30	Y	Y	286

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
J518	External PID Control 1 (Upper limit of PID process output)	-10 to +110%	2	Y	Y	100	Y	Y	287
J519	(Lower limit of PID process output)	-10 to +110%	2	Y	Y	0	Y	Y	
J520	(Upper and lower limits)	0: Limit PID output with J518, J519 1: 110%, -10% of PID output with J518 exceeded or less than J519	1	Y	Y	0	Y	Y	
J521	(Alarm output selection)	0: Absolute-value alarm (PV) 1: Absolute-value alarm (PV) (with Hold) 2: Absolute-value alarm (PV) (with Latch) 3: Absolute-value alarm (PV) (with Hold and Latch) 4: Deviation alarm (PV) 5: Deviation alarm (PV) (with Hold) 6: Deviation alarm (PV) (with Latch) 7: Deviation alarm (PV) (with Hold and Latch 8: Absolute-value alarm (SV) 9: Absolute-value alarm (SV) (with Hold) 10: Absolute-value alarm (SV) (with Latch) 11: Absolute-value alarm (SV) (with Hold and Latch) 12: Absolute-value alarm (MV) 13: Absolute-value alarm (MV) (with Hold) 14: Absolute-value alarm (MV) (with Latch) 15: Absolute-value alarm (MV) (with Hold and Latch)	1	Y	Y	0	Y	Y	288
J522	(Upper level alarm (AH))	OFF: Disable -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	OFF	Y	Y	
J524	(Lower level alarm (AL))	OFF: Disable -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	OFF	Y	Y	
J527	(Feedback error detection mode)	0: Disable (Turns ON output signals (EPV1-ERR) and continues operation.) 1: Enable (Free run stop (PVA trip)) 2: Enable (Deceleration and stop (PVA trip))	1	Y	Y	0	Y	Y	291
J529	(Feedback error upper-limit)	Auto: 105% equivalent -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	AUTO	Y	Y	
J530	(Feedback error lower-limit)	Auto: -5% equivalent -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	12	Y	Y	AUTO	Y	Y	
J531	(Feedback error detection time)	0.0 to 300.0 s	3	Y	Y	0.1	Y	Y	
J540	(Manual command)	0: Keypad (⌃/⌄key) 8: Keypad (⌃/⌄key) (Balanceless-bumpless) 51: External PID command 1 (Analog input: Terminals [12], [C1] and [V2])	1	N	Y	0	Y	Y	292
J551	External PID 1 Multistep Command (Multistep command 1)	-999 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	292
J552	(Multistep command 2)	-999 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	
J553	(Multistep command 3)	-999 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	

■ d codes: Application Functions 2 (Application function 2)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
d01	Speed control 1 (Speed command filter)	0.000 to 5.000 s	7	Y	Y	0.200	N	Y	293
d02	(Speed detection filter)	0.000 to 0.100 s	7	Y*	Y	0.025	N	Y	
d03	P (Gain)	0.1 to 200.0 times	3	Y*	Y	2.0	N	Y	
d04	I (Integral time)	0.001 to 9.999 s 999: Cancel integral term	7	Y	Y	0.600	N	Y	
d21	Speed agreement / PG error (Hysteresis width)	0.0 to 50.0 %	3	Y	Y	10.0	N	Y	295
d22	(Detection timer)	0.00 to 10.00 s	5	Y	Y	0.50	N	Y	
d23	PG error processing	0: Continue to run 1 1: Stop with alarm 1 2: Stop with alarm 2 3: Continue to run 2 4: Stop with alarm 3 5: Stop with alarm 4	1	N	Y	2	N	Y	
d25	ASR switching time	0.000 to 1.000 s	7	Y	Y	0.000	N	Y	295
d32	Speed limit / Over speed level 1	0 to 110 %	1	Y	Y	100	N	Y	295
d33	Speed limit / Over speed level 2	0 to 110 %	1	Y	Y	100	N	Y	
d35	Over speed detection level	0 to 120 %; 999 999: Depend on d32, d33	1	Y	Y	999	N	Y	296
d51	Reserved *9	-500 to 500 *12	2	N	Y	*12	Y	Y	296
d55	Reserved *9	0000 to 00FF (Display in hexadecimal)	1	N	Y	0	Y	Y	
d61	Command pulse input (Filter time constant)	0.000 to 5.000 s	7	Y	Y	0.005	Y	Y	296
d62	(Pulse scaling factor 1)	1 to 9999	1	Y	Y	1	Y	Y	
d63	(Pulse scaling factor 2)	1 to 9999	1	Y	Y	1	Y	Y	
d67	PMSM starting mode (Auto search)	0: Disable 1: Enable (At restart after momentary power failure) 2: Enable (At restart after momentary power failure and at normal start)	1	N	Y	2	N	Y	196 296
d69	Reserved *9	30.0 to 100.0Hz	3	Y	Y	30.0	Y	N	296
d79	Reserved *9	0; 160 to 500 V (400V order); 999	1	N	Y	0	N	Y	
d91	Reserved *9	0.00 to 2.00, 999	5	Y	Y	999	–	–	296
d92	Reserved *9	0.00 to 10.00	5	Y	Y	0.30	–	–	
d99	Extension function 1	0 to 127	1	Y	Y	0			
		Bit 0-8: Reserved *9					–	–	

*9: Factory use. Do not change these function codes.
*12: FRN0012E2■-7G☐H or below: 20, FRN0020E2■-2G☐H or below: 20, FRN0290E2■-4EH or below: 20, FRN0361E2■-4EH and FRN0415E2■-4EH: 50, FRN0520E2■-4EH or above: 100.

APPENDICES

■ U codes: Application Functions 3 (Customizable logic)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
U00	Customizable logic (Mode selection)	0: Disable 1: Enable (Customizable logic operation) ECL alarm occurs when the value is changed from 1 to 0 during operation.	1	Y	Y	0	Y	Y	299
U01	Customizable logic: Step 1 (Block selection)	[Digital] 0: No function assigned 10 to 15: Through output + General-purpose timer 20 to 25: Logical AND + General-purpose timer 30 to 35: Logical OR + General-purpose timer 40 to 45: Logical XOR + General-purpose timer 50 to 55: Set priority flip-flop + General-purpose timer 60 to 65: Reset priority flip-flop + General-purpose timer 70, 72, 73: Rising edge detector + General-purpose timer 80, 82, 83: Falling edge detector + General-purpose timer 90, 92, 93: Rising & falling edges detector + General-purpose timer 100 to 105: Hold + General-purpose timer 110: Increment counter 120: Decrement counter 130: Timer with reset input General-purpose timer function (Least significant digit 0 to 5) _0: No timer _1: On-delay timer _2: Off-delay timer _3: Pulse (1 shot) _4: Retriggerable timer _5: Pulse train output [Analog] 2001: Adder 2002: Subtracter 2003: Multiplier 2004: Divider 2005: Limiter 2006: Absolute value of input 2007: Inverting adder 2008: Variable limiter 2009: Linear function 2051 to 2056: Comparator1 to 6 2071, 2072: Window comparator1, 2 2101: High selector 2102: Low selector 2103: Average of inputs 2151: Loading function from S13 2201: Clip and map function 2202: Scale converter 3001: Quadratic function 3002: Square root function [Digital, Analog] 4001: Hold 4002: Inverting adder with enable 4003, 4004: Selector 1, 2 4005: LPF(Low-pass filter) with enable 4006: Rate limiter with enable 5000: Selector 3 5100: Selector 4 6001: Reading function code 6002: Writing function code 6003: Temporary change of function code	1	N	Y	0	Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
U02	Customizable logic: Step 1 (Input 1)	[Digital] 0 to 105: The same as E20 value. However, 27, 111 to 120 cannot be selected	1	N	Y	100	Y	Y	299
U03	(Input 2)	2001 to 2200 (3001 to 3200): Output of Step 1 to 200 "SO01" to"SO200" 4001 (5001): X1 terminal input signal "X1" 4002 (5002): X2 terminal input signal "X2" 4003 (5003): X3 terminal input signal "X3" 4004 (5004): X4 terminal input signal "X4" 4005 (5005): X5 terminal input signal "X5" 4010 (5010): FWD terminal input signal "FWD" 4011 (5011): REV terminal input signal "REV" 6000 (7000): Final run command RUN "FL_RUN" 6001 (7001): Final run command FWD "FL_FWD" 6002 (7002): Final run command REV "FL_REV" 6003 (7003): Accelerating "DACC" 6004 (7004): Decelerating "DDEC" 6005 (7005): Under anti-regenerative control "REGA" 6007 (7007): With/without alarm factor "ALM_ACT" * Inside the ( ) is the negative logic signal. (OFF at short-circuit) [Analog] 8000 to 8065: The value with 8000 added to F31 9001: Analog 12 terminal input signal [12] 9002: Analog C1 terminal input signal [C1] (C1) 9003: Analog V2 terminal input signal [C1] (V2) *9004: Analog 32 terminal input signal [32] *9005: Analog C2 terminal input signal [C2] *9006: RTD1 [PT1] *9007: RTD2 [PT2]	1	N	Y	100	Y	Y	
U04	(Function 1)	-9990 to 0.00 to 9990	12	N	Y	0.00	Y	Y	
U05	(Function 2)		12	N	Y	0.00	Y	Y	

*: The use of the option card lets those functions remain in effect.

Customizable logic Step 1 to 14 function codes are assigned as follows: Setting value is the same as U01 to U05.

	Step1	Step2	Step3	Step4	Step5	Step6	Step7	Step8	Step9	Step10
Block selection	U01	U06	U11	U16	U21	U26	U31	U36	U41	U46
Input 1	U02	U07	U12	U17	U22	U27	U32	U37	U42	U47
Input 2	U03	U08	U13	U18	U23	U28	U33	U38	U43	U48
Function 1	U04	U09	U14	U19	U24	U29	U34	U39	U44	U49
Function 2	U05	U10	U15	U20	U25	U30	U35	U40	U45	U50

	Step11	Step12	Step13	Step14
Block selection	U51	U56	U61	U66
Input 1	U52	U57	U62	U67
Input 2	U53	U58	U63	U68
Function 1	U54	U59	U64	U69
Function 2	U55	U60	U65	U70

APPENDICES

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
U71	Customizable logic (Output selection) Output signal 1	0: Disable 1 to 200: Output of Step 1 to 200 "S001" to "S0200"	1	N	Y	0	Y	Y	299
U72	Output signal 2								
U73	Output signal 3								
U74	Output signal 4								
U75	Output signal 5								
U76	Output signal 6								
U77	Output signal 7								
U78	Output signal 8								
U79	Output signal 9								
U80	Output signal 10								
U81	Customizable logic (Function selection) Output signal 1	0 to 205 (1000 to 1205): Same as E98 8001 to 8043: The value with 8000 added to E61	1	N	Y	100	Y	Y	
U82	Output signal 2								
U83	Output signal 3								
U84	Output signal 4								
U85	Output signal 5								
U86	Output signal 6								
U87	Output signal 7								
U88	Output signal 8								
U89	Output signal 9								
U90	Output signal 10								
U91	Customizable logic timer monitor (Step selection)	0: Monitor disable 1 to 200: Step 1 to 200	1	Y	N	0	Y	Y	
U92	Customizable logic (The coefficients of the approximate formula) (Mantissa of KA1)	-9.999 to 9.999	8	N	Y	0.000	Y	Y	
U93	(Exponent part of KA1)	-5 to 5	2	N	Y	0	Y	Y	
U94	(Mantissa of KB1)	-9.999 to 9.999	8	N	Y	0.000	Y	Y	
U95	(Exponent part of KB1)	-5 to 5	2	N	Y	0	Y	Y	
U96	(Mantissa of KC1)	-9.999 to 9.999	8	N	Y	0.000	Y	Y	
U97	(Exponent part KC1)	-5 to 5	2	N	Y	0	Y	Y	
U100	Task process cycle setting	0: Auto select from 2, 5, 10 or 20 ms depending on the number of steps 2: 2 ms (Up to 10 step) 5: 5 ms (Up to 50 step) 10: 10 ms (Up to 100 step) 20: 20 ms (Up to 200 step)	1	N	Y	0	Y	Y	299
U101	Customizable logic (Operating point 1 (X1))	-999 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	299 322
U102	(Operating point 1 (Y1))								
U103	(Operating point 2 (X2))								
U104	(Operating point 2 (Y2))								
U105	(Operating point 3 (X3))								
U106	(Operating point 3 (Y3))								
U107	Customizable logic (Auto calculation of the coefficients of the approximate formula)	0: Invalid 1: Execute calculation (When the calculation is finished, the results are stored to the function code U92 to U97)	1	N	N	0	Y	Y	299 323

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
U121	Customizable logic (User parameter 1)	-9990 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	299
U122	(User parameter 2)								
U123	(User parameter 3)								
U124	(User parameter 4)								
U125	(User parameter 5)								
U126	(User parameter 6)								
U127	(User parameter 7)								
U128	(User parameter 8)								
U129	(User parameter 9)								
U130	(User parameter 10)								
U131	(User parameter 11)								
U132	(User parameter 12)								
U133	(User parameter 13)								
U134	(User parameter 14)								
U135	(User parameter 15)								
U136	(User parameter 16)								
U137	(User parameter 17)								
U138	(User parameter 18)								
U139	(User parameter 19)								
U140	(User parameter 20)								
U171	Customizable logic (Storage area 1)	-9990 to 0.00 to 9990	12	Y	Y	0.00	Y	Y	
U172	(Storage area 2)								
U173	(Storage area 3)								
U174	(Storage area 4)								
U175	(Storage area 5)								
U190	Customizable logic setting step (Step number)	1 to 200	1	Y	Y	15	Y	Y	
U191	Setting step (Select block)	Same as U01	1	N	Y	0	Y	Y	
U192	(Input 1)	Same as U02	1	N	Y	100	Y	Y	
U193	(Input 2)	Same as U03	1	N	Y	100	Y	Y	
U194	(Function 1)	Same as U04	12	N	Y	0.00	Y	Y	
U195	(Function 2)	Same as U05	12	N	Y	0.00	Y	Y	
U196	Customizable logic ROM version Upper digit (Monitor)	0 to 9999	1	N	N	0	Y	Y	
U197	Customizable logic ROM version Upper digit (For User setting)	0 to 9999	1	N	Y	0	Y	Y	
U198	Customizable logic ROM version Lower digit (Monitor)	0 to 9999	1	N	N	0	Y	Y	
U199	Customizable logic ROM version Lower digit (For User setting)	0 to 9999	1	N	Y	0	Y	Y	

■ y codes: LINK Functions (Link function)

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
y01	RS-485 Communication 1 (Station address)	0 to 255 *Set 1 when other than BACnet is 0. *Set 127 when BACnet is 128 or above.	1	N	Y	1	Y	Y	326
y02	(Communications error processing)	0: Immediately trip with alarm er8 1: Trip with alarm er8 after running for the period specified by timer y03 2: Retry during the period specified by timer y03. If the retry fails, trip with alarm er8. If it succeeds, continue to run. 3: Continue to run	1	Y	Y	0	Y	Y	
y03	(Timer)	0.0 to 60.0 s	3	Y	Y	2.0	Y	Y	
y04	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 6: 76800 bps	1	Y	Y	3	Y	Y	
y05	(Data length selection)	0: 8 bit 1: 7 bits	1	Y	Y	0	Y	Y	
y06	(Parity selection)	0: None (Stop bit: 2 bits) 1: Even number parity (Stop bit: 1 bits) 2: Odd number parity (Stop bit: 1 bits) 3: None (Stop bit: 1 bits)	1	Y	Y	0	Y	Y	
y07	(Stop bit selection)	0: 2 bits 1: 1 bits	1	Y	Y	0	Y	Y	
y08	(Communication time-out detection timer)	0: Not check of the time-out 1 to 60 s	1	Y	Y	0	Y	Y	
y09	(Response interval time)	0.00 to 1.00 s	5	Y	Y	0.01	Y	Y	
y10	(Protocol selection)	0: Modbus RTU protocol 1: FRENIC Loader protocol (SX protocol) 2: Fuji general-purpose inverter protocol 3: Metasys N2 5: BACnet protocol	1	Y	Y	1	Y	Y	
y11	RS-485 Communication 2 (Station address)	1 to 255	1	N	Y	1	Y	Y	
y12	(Communications error processing)	0: Immediately trip with alarm erp 1: Trip with alarm erp after running for the period specified by timer y13 2: Retry during the period specified by timer y13. If the retry fails, trip with alarm erp. If it succeeds, continue to run. 3: Continue to run	1	Y	Y	0	Y	Y	
y13	(Timer)	0.0 to 60.0 s	3	Y	Y	2.0	Y	Y	
y14	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 6: 76800 bps	1	Y	Y	3	Y	Y	
y15	(Data length selection)	0: 8 bits 1: 7 bits	1	Y	Y	0	Y	Y	
y16	(Parity selection)	0: None (Stop bit: 2 bits) 1: Even number parity (Stop bit: 1 bits) 2: Odd number parity (Stop bit: 1 bits) 3: None (Stop bit: 1 bits)	1	Y	Y	0	Y	Y	
y17	(Stop bit selection)	0: 2 bits 1: 1 bit	1	Y	Y	0	Y	Y	
y18	(Communication time-out detection timer)	0: Not check of the time-out 1 to 60 s	1	Y	Y	0	Y	Y	
y19	(Response interval time)	0.00 to 1.00 s	5	Y	Y	0.01	Y	Y	
y20	(Protocol selection)	0: Modbus RTU protocol 1: FRENIC Loader protocol (SX protocol) 2: Fuji general-purpose inverter protocol 3: Metasys N2 5: BACnet protocol 50: Pump control protocol	1	Y	Y	0	Y	Y	

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
y60	BACnet Device instance number (Upper)	0 to 4194	1	N	Y	37	Y	Y	329
y61	(Lower)	0: Compatible with present version, 128 to 999	1	N	Y	0	Y	Y	329
y95	Data clear processing for communications error	0: Do not clear the data of function codes Sxx when a communications error occurs. (compatible with the conventional inverters) 1: Clear the data of function codes S01/S05/S19 when a communications error occurs. 2: Clear the run command assigned bit of function code S06 when a communications error occurs. 3: Clear both data of S01/S05/S19 and run command assigned bit of S06 when a communications error occurs. * Related alarms: *er8*, *erp*, *er4*, *er5*, *ert*	1	Y	Y	0	Y	Y	329
y97	Communication data storage selection	0: Store into nonvolatile memory (Rewritable times are limited) 1: Write into temporary memory (Rewritable times are unlimited) 2: Save all data from temporary memory to nonvolatile memory (After all save, return to Data 1)	1	Y	Y	0	Y	Y	329
y98	Bus link function (Mode selection)	Frequency command / Run command 0: Follow H30 / Follow H30 1: Bus link / Follow H30 2: Follow H30 / Bus link 3: Bus link / Bus link	1	Y	Y	0	Y	Y	329
y99	Loader link function (Mode selection)	Frequency command / Run command 0: Follow H30, y98 / Follow H30, y98 1: FRENIC loader / Follow H30, y98 2: Follow H30, y98 / FRENIC loader 3: FRENIC loader / FRENIC loader	1	Y	N	0	Y	Y	330

■ K codes: Keypad functions for TP-A1-E2C

Code	Name	Data setting range	Communication format	Change when running	Data copying	Factory Default	Drive control V/f	Drive control PM	Related page
K01	Multifunction keypad TP-A1 (Language selection)	0: Japanese 1: English 2: German 3: French 4: Spanish 5: Italian 6: Chinese 8: Russian 9: Greek 10: Turkish 11: Polish 12: Czech 13: Swedish 14: Portuguese 15: Dutch 16: Malay 17: Vietnamese 18: Thai 19: Indonesian 100: User-Customizable language	1	Y	Y	6	Y	Y	–
K02	(Backlight OFF time)	0: Always OFF 1 to 30 min	1	Y	Y	5	Y	Y	–
K03	(Backlight brightness adjustment)	0 (dark) - 10 (bright)	1	Y	Y	5	Y	Y	–
K04	(Contrast adjustment)	0 (low) - 10 (high)	1	Y	Y	5	Y	Y	–
K08	(LCD monitor status display)	0: Not displayed 1: Fully displayed	1	Y	Y	1	Y	Y	–
K15	(Sub-monitor display selection)	0: Operation guide display 1: Bar graph display	1	Y	Y	0	Y	Y	–
K16	(Sub-monitor 1 display selection)	1 to 35 1: Output frequency 1 (PM: Speed command value) 2: Output frequency 2 (PM: Speed estimated value) 3: Reference frequency 4: Motor rotation speed 5: Load rotation speed 8: Speed (%) 13: Output current 14: Output voltage 18: Calculated torque 19: Input power 25: Load factor 26: Motor output 27: Analog input monitor 35: Input watt-hour 50: PID command (final)(physical data) 51: PID feedback(final)(physical data) 52: PID output 53: PID control1 command (physical data) 54: PID control1 feedback value (physical data) 55: PID control2 command (final)(physical data) 56: PID control2 feedback value (physical data) 60: External PID command (final)(physical data) 61: External PID feedback(final)(physical data) 62: External PID output (%) 63: External PID manual command (%)	1	Y	Y	13	Y	Y	–
K17	(Sub-monitor 2 display selection)		1	Y	Y	19	Y	Y	–
K20	(Bar graph 1 display selection)	1: Output frequency 1 (PM: Speed command value) 13: Output current 14: Output voltage 18: Calculated torque 19: Input power 25: Load factor 26: Motor output	1	Y	Y	1	Y	Y	–
K21	(Bar graph 2 display selection)		1	Y	Y	13	Y	Y	–
K22	(Bar graph 3 display selection)		1	Y	Y	19	Y	Y	–
K91	(< key shortcut selection)	0: disabled 11 to 99: respective mode	1	Y	Y	0	Y	Y	–
K92	(> key shortcut selection)		1	Y	Y	64	Y	Y	–

The keypad function K codes are used when the multi-function keypad (TP-A1) is connected. For details about the K codes, refer to the instruction manual for the keypad.

I.3 Factory default value per applicable electric motor capacitance

Applicable electric motor capacity		Torque boost 1 to 2 F09/ A05	Restart mode after momentary power failure (Restart timer) H13
kW	HP		
0.1	1/8	6.7	0.5
0.2	1/4	4.0	
0.4	1/2	3.5	
0.75	1	6.5	
1.5	2	4.9	
2.2	3	4.5	
3.7	5	4.1	
5.5	7.5	3.4	
7.5	10	2.7	
11	15	2.1	1.0
15	20	1.6	
18.5	25	1.3	
22	30	1.1	
30	40	0.0	
37	50		
45	60		1.5
55	75	0.0	
75	100		
90	125		
110	150		
132	175		2.0
160	200		
200	250		2.5
220	300		
280	400		
315	450		4.0
355	500		

I.4 Motor constants

[1] When Fuji standard motor 8-series, or other motors are selected by motor selection (Function code P99 = 0 or 4)

■ **3-phase 400V class, Fuji standard motor**

Motor rated capacity setting range (kW) P02	Applicable motor capacity (kW)	Rated current (A) P03	No-load current (A) P06	%R1 (%) P07	%X (%) P08	Starting mode (Auto search delay time 2) H46
0.01 to 0.09	0.06	0.22	0.20	13.79	11.75	0.5
0.10 to 0.19	0.1	0.35	0.27	12.96	12.67	
0.20 to 0.39	0.2	0.65	0.53	12.95	12.92	
0.40 to 0.74	0.4	1.15	0.83	10.20	13.66	
0.75 to 1.49	0.75	1.80	1.15	8.67	10.76	
1.50 to 2.19	1.5	3.10	1.51	6.55	11.21	
2.20 to 3.69	2.2	4.60	2.43	6.48	10.97	0.6
3.70 to 5.49	3.7	7.50	3.84	5.79	11.25	0.8
5.50 to 7.49	5.5	11.50	5.50	5.28	14.31	1.0
7.50 to 10.99	7.5	14.50	6.25	4.50	14.68	1.2
11.00 to 14.99	11	21.00	8.85	3.78	15.09	1.3
15.00 to 18.49	15	27.50	10.00	3.25	16.37	2.0
18.50 to 21.99	18.5	34.00	10.70	2.92	16.58	
22.00 to 29.99	22	39.00	12.60	2.70	16.00	
30.00 to 36.99	30	54.00	19.50	2.64	14.96	2.3
37.00 to 44.99	37	65.00	20.80	2.76	16.41	2.5
45.00 to 54.99	45	78.00	23.80	2.53	16.16	
55.00 to 74.99	55	95.00	29.30	2.35	16.20	2.6
75.00 to 89.99	75	130.0	41.60	1.98	16.89	2.8
90.00 to 109.9	90	155.0	49.60	1.73	16.03	3.2
110.0 to 131.9	110	188.0	45.60	1.99	20.86	3.5
132.0 to 159.9	132	224.0	57.60	1.75	18.90	4.1
160.0 to 199.9	160	272.0	64.50	1.68	19.73	4.5
200.0 to 219.9	200	335.0	71.50	1.57	20.02	4.7
220.0 to 249.9	220	365.0	71.80	1.60	20.90	
250.0 to 279.9	250	415.0	87.90	1.39	18.88	5.0
280.0 to 314.9	280	462.0	93.70	1.36	19.18	5.5
315.0 to 354.9	315	520.0	120.0	0.84	16.68	5.6
355.0 to 399.9	355	580.0	132.0	0.83	16.40	
400.0 to 449.9	400	670.0	200.0	0.62	15.67	7.5
450.0 to 499.9	450	770.0	270.0	0.48	13.03	9.8
500.0 to 559.9	500	835.0		0.51	12.38	
560.0 to 629.9	560	940.0		0.57	13.94	
630.0 to 709.9	630	1050.0	355.0	0.46	11.77	10.5
710.0 or above	710	1150.0	290.0	0.54	14.62	

[2] When HP rating motor is selected by motor selection (Function code P99/A39 = 1)

■ **3-phase 400V class, HP rating motor**

Motor rated capacity setting range (HP) P02/A16	Applicable motor Capacity (HP)	Rated current (A) P03	No-load current (A) P06	%R1 (%) P07	%X (%) P08	Starting mode (Auto search delay time 2) H46
0.01 to 0.11	0.1	0.22	0.20	13.79	11.75	0.5
0.12 to 0.24	0.12	0.34	0.27	12.96	12.67	
0.25 to 0.49	0.25	0.70	0.56	11.02	13.84	
0.50 to 0.99	0.5	1.00	0.61	6.15	8.80	
1.00 to 1.99	1	1.50	0.77	3.96	8.86	
2.00 to 2.99	2	2.90	1.40	4.29	7.74	
3.00 to 4.99	3	4.00	1.79	3.15	20.81	0.6
5.00 to 7.49	5	6.30	2.39	3.34	23.57	0.8
7.50 to 9.99	7.5	9.30	3.12	2.65	28.91	1.0
10.00 to 14.99	10	12.7	4.37	2.43	30.78	1.2
15.00 to 19.99	15	18.7	6.36	2.07	29.13	1.3
20.00 to 24.99	20	24.6	4.60	2.09	29.53	2.0
25.00 to 29.99	25	30.0	8.33	1.75	31.49	
30.00 to 39.99	30	36.2	9.88	1.90	32.55	
40.00 to 49.99	40	45.5	6.80	1.82	25.32	2.3
50.00 to 59.99	50	57.5	9.33	1.92	24.87	2.5
60.00 to 74.99	60	68.7	10.4	1.29	26.99	
75.00 to 99.99	75	86.9	14.3	1.37	27.09	2.6
100.0 to 124.9	100	113.0	18.7	1.08	23.80	2.8
125.0 to 149.9	125	134.0	14.9	1.05	22.90	3.2
150.0 to 174.9	150	169.0	45.2	0.96	21.61	3.5
175.0 to 199.9	175	188.5	45.2	0.96	21.61	4.1
200.0 to 249.9	200	231.0	81.8	0.72	20.84	4.5
250.0 to 299.9	250	272.0	41.1	0.71	18.72	4.7
300.0 to 324.9	300	323.0	45.1	0.53	18.44	
325.0 to 349.9	325	342.9	45.1	0.53	18.44	5.0
350.0 to 399.9	350	375.0	68.3	0.99	19.24	5.5
400.0 to 449.9	400	429.0	80.7	1.11	18.92	5.6
450.0 to 499.9	450	481.0	85.5	0.95	19.01	
500.0 to 599.9	500	534.0	99.2	1.05	18.39	7.5
600.0 to 699.9	600	638.0	140.0	0.85	18.38	9.8
700.0 to 749.9	700					
750.0 to 799.9	750					
800.0 or above	800					10.5

APPENDICES

Appendix J Description of Function Codes

This section describes details of function code. In principle, explanation is given for each function code in order of group and numerical order. However, function codes that are strongly related to one function are explained together in the first paragraph.

J.1 F codes (Basic functions)

F00	Data protection

This is a function to protect currently set data by disabling to make changes in function code data (except F00) and all types of command values (frequency setting, PID command) by ∧/∨ key operation from keypad.

F00 data	Change of function code		Changing digital reference data with the ∧/∨ keys
	Change from keypad	Change from communication	
0	Allowed	Allowed	Allowed
1	Not allowed *	Allowed	Allowed
2	Allowed	Allowed	Not allowed
3	Not allowed *	Allowed	Not allowed

*Although it is not possible to change function code from keypad, function code F00 can be changed.

F00 data can be changed by the double key operation using "STOP key +∧ key" or "STOP key +∨ key".

As a similar function related to data protection, "Allow function code editing (Data change enabled) 'WE-KP'" which can be assigned to a digital input terminal is available (Function code E01 to E05 Data = 19).

By combining data protection F00, protection of function code functions as follows:

Input signal "WE-KP"	Change in function code	
	Change from keypad	Change from communication
OFF	Not allowed	Allowed
ON	Follow setting of F00	

Note

- If "enable data change with keypad" [WE-KP] is set to a digital input terminal by mistake, it is not possible to make changes in function codes. In this case, after shortening (ON) the terminal to which temporarily "WE-KP" function is assigned, and the terminal [CM], change to a different function.
- "WE-KP" is the change enable signal for function code; this is not the function to protect frequency setting and PID command by ∧∨ key operation.

F01	Frequency setting 1
	Related function codes: F18 bias (for frequency setting 1) C30 frequency setting 2 C31 to C35 analog input adjustment (Terminal [12]) C36 to C39 analog input adjustment (Terminal [C1] (C1 function)) C40 terminal [C1] (C1 function) (Range / polarity selection) C41 to C45 analog input adjustment (Terminal [C1] (V2 function)) C55 to C56 analog input adjustment (Terminal [12]) (Bias･Bias base point) C61 to C62 analog input adjustment (Terminal [C1] (C1 function) (Bias･Bias base point) C67 to C68 analog input adjustment (Terminal [C1] (V2 function)) (Bias･Bias base point) C50 bias (for frequency setting 1) (Bias base point) d61 to d63 Command (Pulse train input)

Select setting method of frequency setting. Set frequency setting 1 by function code F01, frequency setting 2 by C30.

F01, C30 data	Command sources
0	Frequency setting by keypad (refer to the following descriptions to find the setting method)
1	Set by voltage value to be input in the terminal [12] (0 to ±10VDC, Maximum output frequency /DC±10V)
2	Setting by current value to be input in the terminal [C1] (C1 function) (4 to 20mADC or 0 to 20 mADC, Maximum output frequency / 20 mADC) (Set slide switch SW4 of printed circuit board to [AI] side (factory default state), SW3 to [C1] side (factory default state), respectively.) (It is necessary to select C1 function (factory default state) by E59=0) (It is necessary to disable PTC input function by H26=0)
3	Set by the addition result of voltage value to be input in the terminal [12] (0 to ±10VDC, Maximum output frequency /±10 VDC) and current value to be input in the terminal [C1] (C1 function) (4 to 20 mA DC or 0 to 20 mA DC, Maximum output frequency/20 mA DC) When the addition result becomes maximum output frequency or higher, it is restricted by the maximum output frequency)
5	Set by voltage value to be input in the terminal [C1] (V2 function) (0 to +10 VDC, Maximum output frequency /+10 VDC) (Set slide switch SW4 of printed circuit board to [AI] side (factory default state), SW3 to [V2] side, respectively.) (It is necessary to select V2 function by E59 = 1) (It is necessary to disable PTC input function by H26 = 0)
7	Set by UP command “UP” and DOWN command “DOWN” assigned to the digital input terminal It is necessary to assign UP command (Data = 17) and DOWN command (Data =18) to the digital input terminal [X1] to [X5]. (E01 toE05)
8	Frequency setting by keypad (with balanceless bumpless function)
10	Set by pattern operation (C21 to C28)
11	Enable a digital input/output interface card (option). (For details, refer to the Digital Input Output Interface Card Instruction Manual.)
12	Setting by pulse train input “PIN” (Data = 48), which was assigned to the digital input terminal [X5]. Note: When using X5 terminal with pulse train input, it might be affected by noise from other wire. Keep away from other wire from the wire to X5 terminal as far as possible.

Setting method of reference frequency

[1] Frequency setting by keypad (F01 = 0 (Factory default state), 8)

(1) Set the data of function code F01 to “0” or “8”. When keypad is at program mode or alarm mode, it is not possible to perform frequency setting with ∧/∨ keys. In order to enable frequency setting with ∧/∨ keys, shift to the operation mode.

(2) When ∧/∨ key is pressed, reference frequency is displayed and the least significant digit of the reference frequency flashes.

(3) By pressing the ∧/∨ key again, it is possible to change the reference frequency. To save the set frequency, press FUNC DATA key. (E64=0: Factory default state). When the frequency is saved, it is possible to operate with the saved frequency next time the power is turned on.

Tip

- Automatic saving method (Function code E64 = 0) is available other than the above method as a data saving method of frequency setting.
- While the data of function code F01 is set to “0” or “8”, when frequency setting method other than frequency setting 1 (frequency setting 2, communication, multistep frequency) is selected as frequency setting, it is not possible to change the reference setting with ∧/∨ keys even if keypad is at operation mode. In this case, pressing ∧/∨ keys displays the currently selected reference frequency.
- When frequency setting is performed with ∧/∨ keys, the least significant digit displayed flashes and the data is changed from the least significant digit and the changing digit gradually shifts to the upper digit.
- In order to perform setting such as reference frequency, press ∧/∨ once and when the least significant digit flashes push down the » key, and then, the flashing digit will move. Therefore, it is possible to change the large numerical number easily. This operation is called cursor movement.
- When the data of function code F01 is set to “8”, balanceless bumpless function becomes enabled. When switching to frequency setting with keypad from frequency setting method other than keypad, the switched initial value of frequency setting with keypad takes the value of the frequency setting before it is switched. By using this function, even if frequency setting is switched, it is possible to perform operation without shock.

[2] Setting up a reference frequency using analog input (F01 = 1 to 3, 5)

It is possible to arbitrarily specify a frequency setting from the analog inputs (voltage value to be input to terminal [12] or terminal [C1] (V2 function) or current value to be input to terminal [C1] (C1 function)) by multiplying them with the gain and adding the bias. The polarity can be selected and the filter time constant and offset can be adjusted.

Adjustment constants of frequency setting 1

F01 data	Input terminal	Input range	Bias		Gain		Polarity selection	Filter	Offset
			Bias	Base point	Gain	Base point			
1	[12]	0 to +10V, -10 to +10V	F18	C50	C32	C34	C35	C33	C31
2	[C1] (C1 function)	4 to 20 mA 0 to 20 mA	F18	C50	C37	C39	C40	C38	C36
3	[12]+ [C1] (C1 function) (Set by result of addition)	0 to +10V, -10 to +10V	F18	C50	C32	C34	C35	C33	C31
		4 to 20 mA 0 to 20 mA	F18	C50	C37	C39	C40	C38	C36
5	[C1] (V2 function)	0 to +10V	F18	C50	C42	C44	C45	C43	C41

Adjustment constants of frequency setting 2

C30 data	Input terminal	Input range	Bias		Gain		Polarity selection	Filter	Offset
			Bias	Base point	Gain	Base point			
1	[12]	0 to +10V, -10 to +10V	C55	C56	C32	C34	C35	C33	C31
2	[C1] (C1 function)	4 to 20 mA 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
3	[12]+ [C1] (C1 function) (Set by result of addition)	0 to +10V, -10 to +10V	C55	C56	C32	C34	C35	C33	C31
		4 to 20 mA 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
5	[C1] (V2 function)	0 to +10V	C67	C68	C42	C44	C45	C43	C41

■ Offset (C31, C36, C41)

C31, C36 or C41 configures an offset for an analog voltage/current input. The offset also applies to signals sent from the external equipment.

■ Filter (C33, C38, C43)

C33, C38, and C43 provide the filter time constants for the voltage and current of the analog input. The larger time constant, the slower response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noises, increase the time constant.

■ Terminal [12] Polarity selection (C35)

C35 configures the polarity and therefore the input range for analog input voltage.

C35 data	Modes for terminal inputs
0	-10 to +10 V
1	0 to +10 V (Negative value of voltage is regarded as 0 V)

■ **Terminal [C1] (C1 function) range / polarity selection (C40)**

C40 data	Terminal input range	Handling when bias value is set to minus
0	4 to 20 mA (Factory default)	Limit below 0 point with 0
1	0 to 20mA	
10	4 to 20mA	Enable below 0 point as minus value.
11	0 to 20mA	

■ **Terminal [C1] (V2 function) polarity selection (C45)**

C45 data	Modes for terminal inputs
0	0 to +10V When bias value is set to minus, enable below 0 point as a minus value.
1	0 to +10V (factory default) When bias value is set to minus, limit below 0 point by 0.

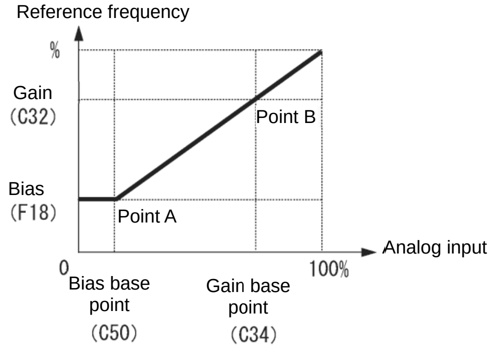
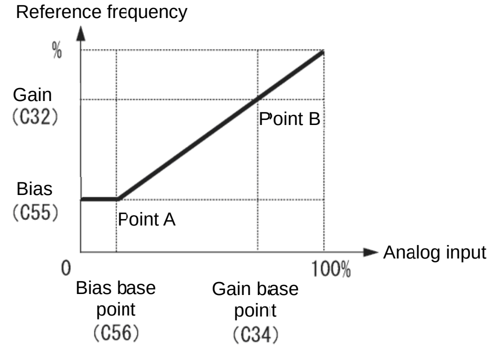
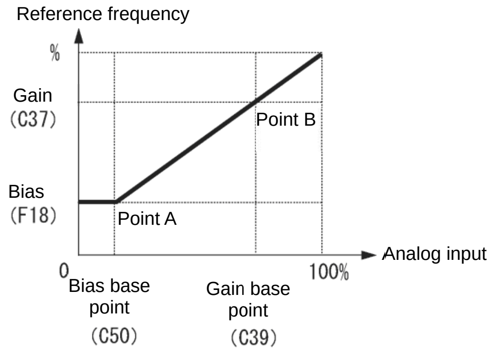
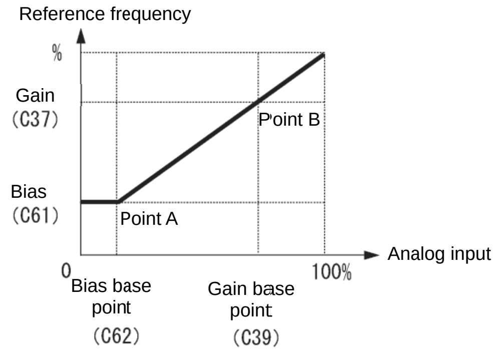
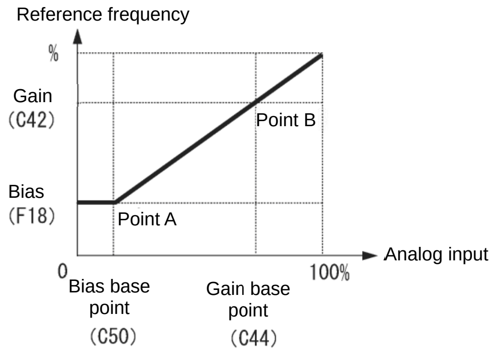
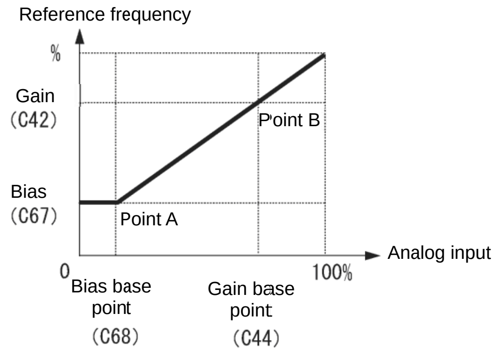
In order to use [C1] terminal as C1 function, V2 function, and PTC function, the following setting are necessary.

[C1] terminal	SW3	SW4	E59	H26	C40
When using C1 function (4 to 20 mA)	C1 side	AI side	0	0	0,10
When using C1 function (0 to 20 mA)	C1 side	AI side	0	0	1,11
When using V2 function (0 to +10V)	V2 side	AI side	1	0	Not relevant
When using PTC function	C1 side	PTC side	Not relevant	1, 2	Not relevant

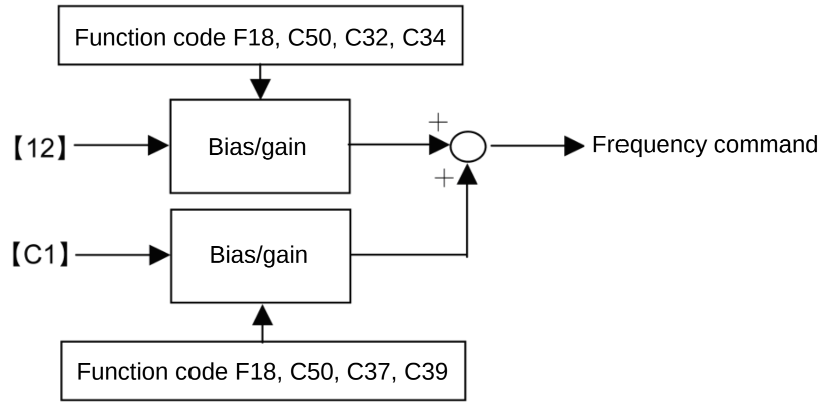
For details of SW3 and SW4, refer to the FRENIC-Ace User’s Manual Chapter 2, Section 2.2.8.

Caution is necessary because if the above switch settings are not performed accurately, unexpected frequency setting may be performed for the inverter.

■ Gain･Bias

Terminal	<Frequency setting 1: F01>	<Frequency setting 2: C30>
[12]		
[C1] (C1 function)		
[C1] (V2 function)		

Note: For [12] + [C1] (C1 function) (setting by the result of addition), bias and gain are reflected to [12] and [C1] (C1 function) individually, and added by frequency command value of the result.



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For single polarity (Terminal [12] (C35=1), Terminal [C1] (C1 function), Terminal [C1] (V2 function). As the above diagram indicates, for reference frequency and analog input of frequency setting 1, it is possible to set arbitrary relationship by A point (determined by bias (F18) and bias reference point (C50)) and B point (determined by the gain corresponding to each analog input and the gain reference point (C32 and C34, C37 and C39, and C42 and C44)).

For reference frequency and analog input of frequency setting 2 (C30), it is possible to set arbitrary relationship by A point (determined by bias and bias reference point (C55 and C56, C61 and C62, and C67 and C68)) and B point (determined by the gain corresponding to each analog input and the gain reference point (C32 and C34, C37 and C39, and C42 and C44)).

Both data of bias and gain are set with 100% as the maximum frequency. The data of bias reference point and gain reference point are set up with full scale of analog input (10V or 20mA) as 100%.

By setting the bias to minus value, even if the analog input is unipolar, it is possible to perform frequency setting as bipolar. For terminal [C1] (C1 function), C40 is set to 10 or 11, and for terminal [C1] (V2 function), C45 is set to 1, and then, the frequency setting at analog input at or below 0 point becomes negative polarity, as a result, it becomes possible to perform forward and reverse operation only by analog command.

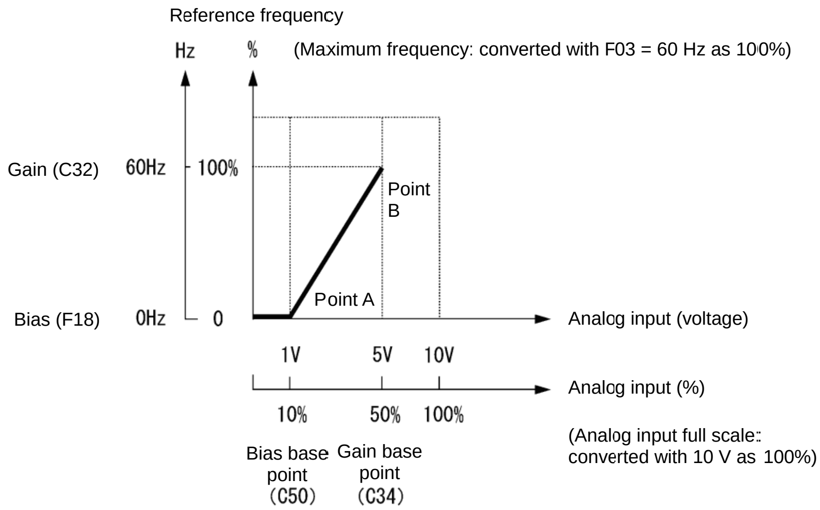
Note <Frequency setting 1: F01>

- Analog input at or below bias reference point (C50) is restricted by bias value (F18).
- When the value set in bias reference point (C50)≥ each gain reference point (C34, C39, C44), it is judged as incorrect setting and reference point becomes 0 Hz.

<Frequency setting 2: C30>

- Analog input at or below bias reference point (C56, C62, and C68) is restricted by bias value (C55, C61 and C67).
- When the value set in bias reference point (C56, C62, C68) ≧ each gain reference point (C34, C39, C44), it is judged as incorrect setting and reference point becomes 0 Hz.

Example) When setting reference frequency to 0 to 60 Hz by analog input (terminal [12]) 1 to 5V
(When maximum frequency is F03=60 Hz)



(A point)

In order to set reference frequency to 0 Hz when analog input is 1V, set bias (F18) to 0%. At this point, 1V has to become the bias reference point and 1V is equivalent to 10% against full scale 10V of terminal [12], therefore, set the bias reference point (C50) to 10%.

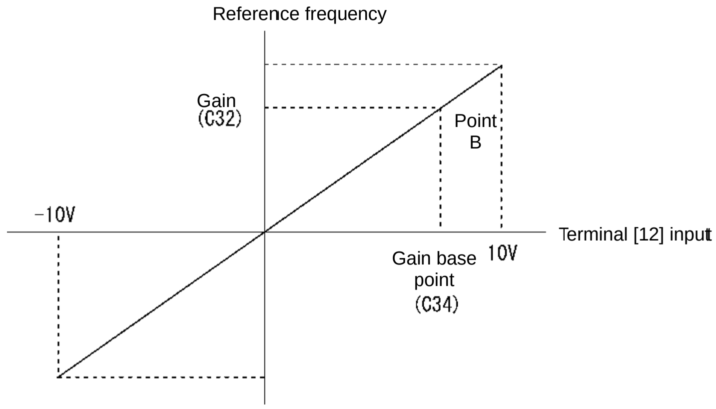
(B point)

In order to set reference frequency so that the frequency becomes the highest when analog input is 5V, set the gain (C32) to 100%. At this point, 5V has to become the gain reference point and 5V is equivalent to 50% against full scale 10V of terminal [12], therefore, set the gain reference point (C34) to 50%.

Note The setting method without changing reference point and by using gain and bias individually is the same as for Fuji Electric inverter of old model.

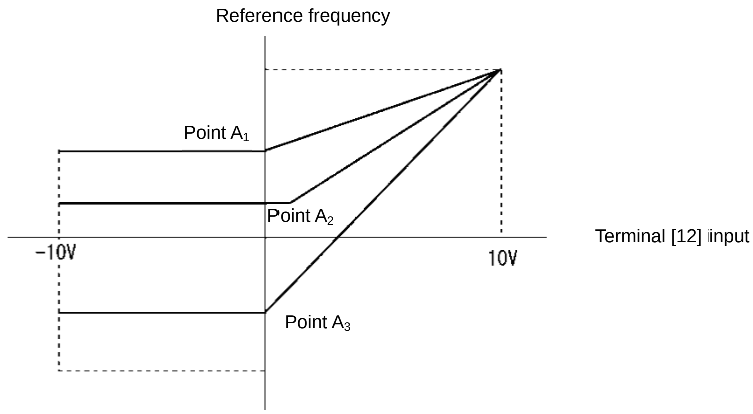
For bipolar (Terminal [12] (C35=0)). For terminal [12], by setting function code C35 to "0", it is possible to use bipolar input (-10V to +10V).

When both bias (F18) and bias reference point (C50) are set to "0", command becomes forward and reverse symmetric as shown in the diagram below.



Note

- When bias (F18) and bias reference point (C50) is set to arbitrary value (A1 point, A2 point, and A3 point, etc.), as shown in the diagram below, it is determined by the bias value (F18).



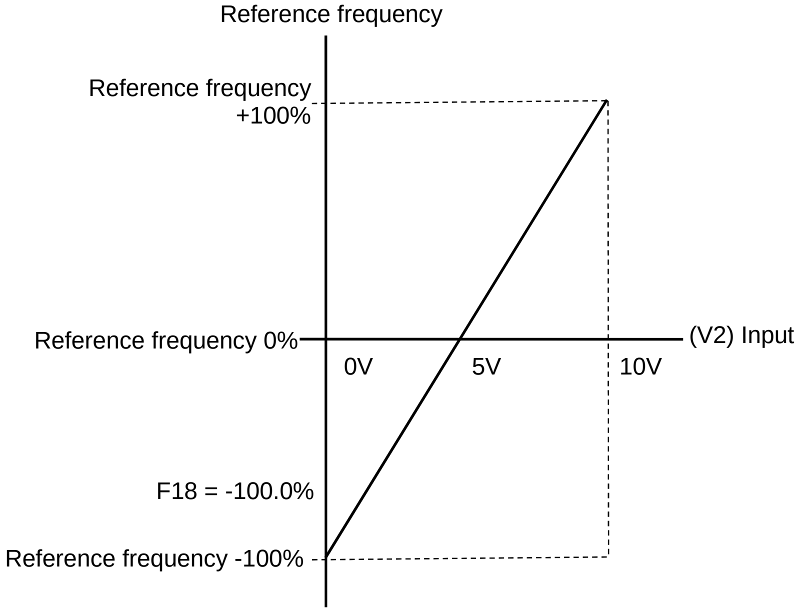
Note

- To input bipolar (0 to ±10 VDC) analog voltage at analog input (terminal [12]), set function code C35 to "0". When the data of C35 is "1", only DC 0 to +10V is effective and negative polar input DC0 to -10V is regarded as 0 (Zero) V.
- When setting reference frequency by display other than frequency (Hz), please change the speed monitor unit in E48.

When operating unipolar analog input as bipolar (terminal [C1] (C1 function) (C40 = 10, 11), terminal [C1] (V2 function) (C45 = 0)

For C1 function set C40 = 10, 11, for V2 function set C45 = 0, and by setting bias value to minus value, it is possible to obtain a negative reference frequency.

Example of frequency setting by V2 function when -100% is set to the bias value is shown in the diagram below.



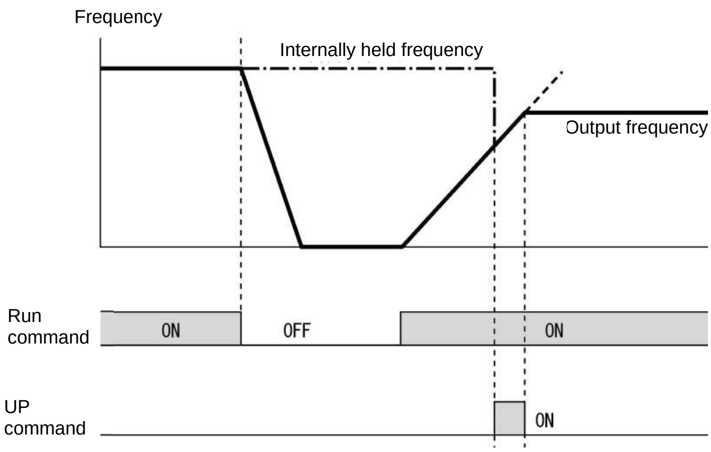
[3] Frequency setting by digital input signal “UP”/“DOWN” (F01=7)

As frequency setting, UP/DOWN control is selected, and when the terminal command UP or DOWN is turned on with Run command ON, the output frequency increases or decreases accordingly, within the range from 0 Hz to the maximum frequency.
The set frequency is stored internally, and the previous operating frequency is set first when resuming operation (including when turning ON power, switching the setting means).

To perform frequency setting by UP/DOWN control, it is necessary to set the data of function code F01 to “7” and assign “UP command [UP], down command [DOWN]” to the digital input terminals.
(📖 Function code E01 to E05 Data = 17, 18)

Input signal “UP”	Input signal “DOWN”	Action
Data = 17	Data = 18	
OFF	OFF	The output frequency will be held
ON	OFF	Increase output frequency by currently selected acceleration time
OFF	ON	Decrease output frequency by currently selected deceleration time
ON	ON	The output frequency will be held

Note: At the restart of operation, before the internal frequency reaches the previous output frequency, when UP/DOWN command is input, output frequency at the point is held internally and UP/DOWN control starts from that value. Therefore, the previous output frequency data is overwritten and deleted.



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[4] Frequency setting using digital inputs (option DIO interface card) (F01 = 11)

The frequency setting with binary (8,12bit) or BCD code via option DIO interface card (OPC-DIO) is also available to be selected. Refer to the Digital Input Output Interface Card Instruction Manual.

[5] Frequency setting using pulse train input (F01=12)

■ The pulse train input format

By assigning a “PIN” (E05= 8) to terminal [X5] and inputting a serial pulse, a frequency proportional to the pulse frequency can be set. “SIGN” can also be assigned (E01 is E4=49) to other than terminal [X5], and pulse train sign commands can also be specified. If no “SIGN” is assigned, the polarity will be positive.

The command polarity is determined by the pulse train sign. Motor rotation direction is determined by a combination of the pulse train input polarity and “FWD”/“REV” commands. The relationship between pulse train input polarity and rotation direction is shown in Table .

Table J.1 The relationship between the pulse train input polarity and rotation direction

Polarity according to the pulse train input	Run command	Rotational direction
+	“FWD” (Forward rotation command)	Forward rotation
+	“REV” (Reverse rotation command)	Reverse rotation
-	“FWD” (Forward rotation command)	Reverse rotation
-	“REV” (Reverse rotation command)	Forward rotation

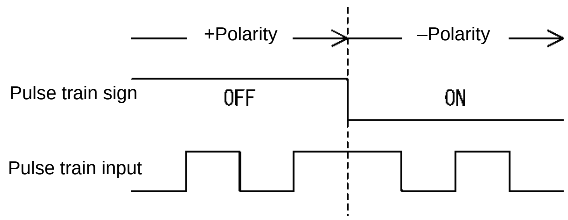


Figure J.1 Pulse train sign/Pulse train input.

■ Pulse scaling factor 1 (d62), pulse scaling factor 2 (d63)

For pulse train input, set the relationship between input pulse frequency and frequency setting value by function code d62 (Command (pulse train input) pulse scaling factor 1) and d63 (command (pulse train input) pulse scaling factor 2).

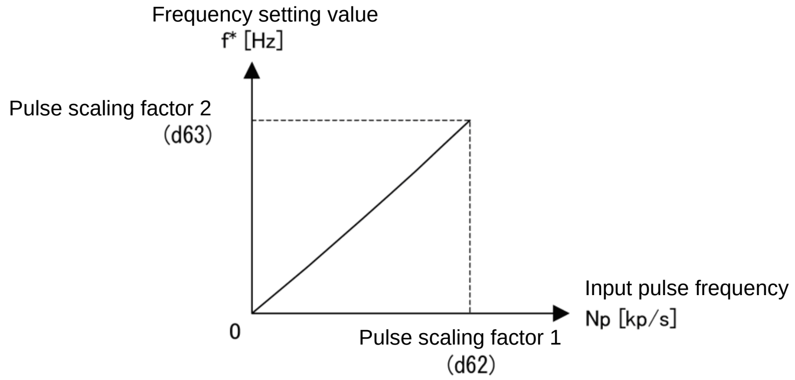


Figure J.2 Relationship between input pulse frequency and frequency setting value

As shown in the figure above, set input pulse frequency [kp/s] to function code d62 (command (pulse train input) pulse scaling factor 1) and set frequency setting value [Hz] (when the input pulse frequency becomes the value set to function code d62) to function code d63 (command (pulse train input) pulse scaling factor 2). At this time, the relationship formula of input pulse frequency to be entered and frequency setting value f^* (or speed command value) is as follows:

$$f^* \text{ [Hz]} = \text{Np [kp/s]} \times \frac{\text{Pulse scaling factor 2 (d63)}}{\text{Pulse scaling factor 1 (d62)}}$$

f* [Hz]: Frequency setting value

Np [kp/s]: Input pulse frequency to be input

Depending on the pulse train sign, polarity of the command is determined. Rotation direction of the motor is determined by the polarity of pulse train input and "FWD"/"REV" command. J.1 The relationship between the pulse train input polarity and rotation direction is specified in Table .

■ Filter time constant (d61)

Set filter time constant for pulse train input. The larger the time constant, the slower the response. Specify the proper filter time constant by taking into account the response speed of the machine. If the pulse is lower and frequency command fluctuates, set larger time constant.

■ Switching frequency setting

Switch frequency setting 1 (F01) and frequency setting 2 (C30) by the signal "Frequency setting 2/frequency setting 1" "Hz2/ Hz1", which was assigned to the external digital input terminal.

📖 (Refer to Function code E01 to E05 (Data =11) to find the details of "Hz2/ Hz1".

Input signal "Hz2/ Hz1"	Frequency setting method to be selected
OFF	Frequency setting 1 (F01)
ON	Frequency setting 2 (C30)

F02	Operation method

Select setting method of run command. Indicate instruction method of run/stop and rotation direction (forward/reverse rotation) for each setting method.

F02 data	Setting method of run command	
	Run/stop	Rotation direction command
0: Keypad operation (Rotation direction input: Terminal block)	RUN/STOP keys	"FWD", "REV"
1: External signal (digital input)	"FWD", "REV"	
2: Keypad operation (forward rotation)	RUN/STOP keys	Rotation direction command is unnecessary (Forward rotation operation only, reverse rotation operation disabled)
3: Keypad operation (Reverse rotation)	RUN/STOP keys	Rotation direction command is unnecessary (Reverse rotation operation only, forward rotation operation disabled)

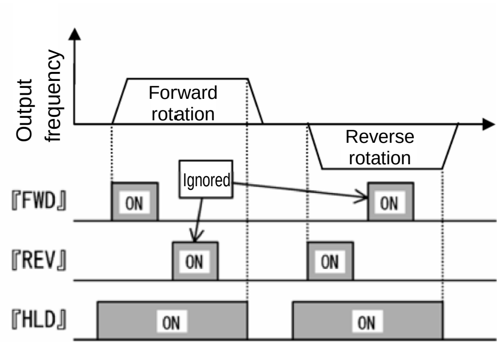
Digital input signal, "FWD", "REV" needs to be assigned to terminals [FWD], [REV].
(📖 Function code E98, E99 data = 98, 99)

Note
- F02 cannot be changed when "FWD" or "REV" is ON.
- If F02 = 1 and when assignment of terminal [FWD] or [REV] is changed from other function to "FWD" function or "REV" function, turn the terminal [FWD] and [REV] off in advance (motor may rotate due to change in the setting).

■ 3-wire operation by external signal

Although external signal of "FWD" and "REV" is 2-wire operation at the initial state, by assigning "Select 3-wire operation (HLD)", it is possible to use as self-hold signal at 3-wire operation by using "FWD", "REV" and "HLD" signals. When "HLD" is ON, inverter self-holds "FWD" or "REV" signal, and the hold state can be released by OFF. If there is no "HOLD" function assignment, "FWD" and "REV" become 2-wire operation.

📖 Refer to Function code E01 to E05 (Data =6) to find the details of "HLD".



As a setting method of run command, high-priority setting methods (remote/local switch (refer to the FRENIC-Ace User's Manual Chapter 3, Section 3.3.6), communication, etc.) are available in addition to the above mentioned settings.

F03	Maximum frequency 1

F03 specifies the maximum frequency that the inverter outputs. When the device to be driven is set to rated or higher, the device may be damaged. Make sure to make an adjustment to design mode value of the machinery.

- Data setting range: 25.0 to 500.0 (Hz)

⚠WARNING
Inverter can perform setting of high speed operation easily. When changing the setting, make sure to check the motor and machine mode before use. **Injuries could occur. Failure may occur.**

Note When changing maximum output frequency (F03) in order to make the operation frequency a larger value, change the frequency limiter (upper limit) (F15) as well.

F04, F05 F06	**Base frequency 1, Rated voltage at base frequency 1** **Maximum output voltage 1** **Related function codes: H50, H51 Non-linear V/f 1 (Frequency, voltage)** **H52, H53 Non-linear V/f 2 (Frequency, voltage)**

Set the base frequency and base frequency voltage that are essential to operation of the motor. By combining related function codes H50 to H53, it is possible to set non-linear V/f pattern (weak or strong voltage by arbitrary point) and perform setting of V/f characteristics that is suitable for the load.

Impedance of the motor becomes larger with high frequency, and when output voltage becomes less, output torque may be reduced. In order to prevent this, increase the voltage at high frequency by setting function code F06 (maximum output voltage 1). However, it is not possible to output voltage at or higher than the input power voltage of the inverter.

Point of V/f	Function code		Remarks
	Frequency	Voltage	
Maximum output frequency	F03	F06	During auto torque boost, vector control with/ without speed sensor, the maximum output voltage setting is disabled.
Base frequency	F04	F05	
Non-linear V/f 2	H52	H53	This code is disabled during auto torque boost, vector control with/ without speed sensor.
Non-linear V/f 1	H50	H51	

<Setting example>

■ **Normal V/f pattern setting**

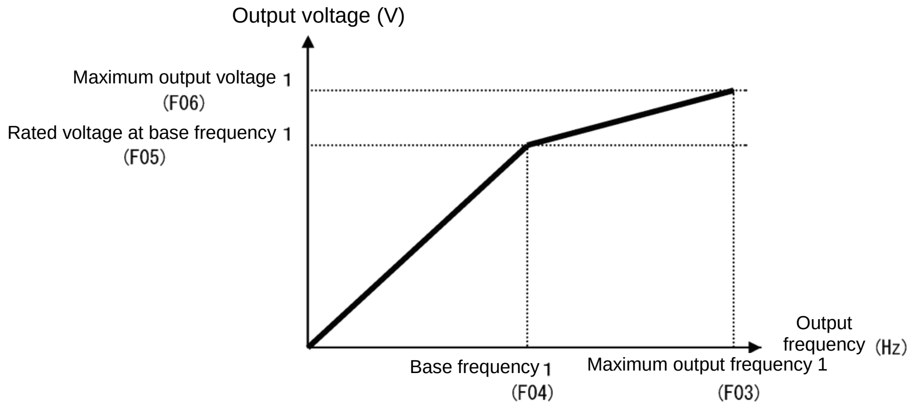


Figure J.3 Characteristics diagram of normal V/f pattern setting

■ **Non-linear V/f pattern setting (2 points)**

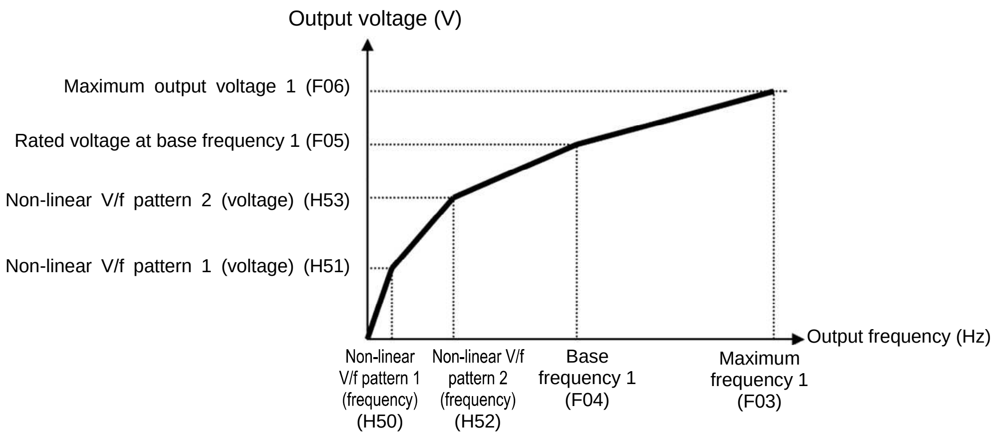


Figure J.4 Characteristics diagram of no-linear V/f pattern setting (2 points)

■ **Base frequency (F04)**

Set the data in accordance with rated frequency of the motor (given on the nameplate of the motor).

- Data setting range: 25.0 to 500.0 (Hz)

■ **Rated voltage at base frequency (F05)**

Set the data to "0" in accordance with rated voltage of the motor (given on the nameplate of the motor).

- Data setting range: 0 : AVR disable
160 to 500 (V) : AVR operation (at 400 V class)
- When data is set to "0", the base frequency voltage becomes equivalent to inverter input voltage. When input voltage fluctuates, output voltage fluctuates as well.
- When data is set to arbitrary voltage other than "0", automatically keeps the output voltage constant. When control function such as auto torque boost and auto energy-saving operation is used, it is necessary to adjust to the rated voltage (given on the nameplate of the motor) of the motor.

Note The voltage that the inverter can output is lower than the input voltage of the inverter. Appropriately set the voltage in accordance with the motor.

■ **Non-linear V/f 1, 2 (Frequency) (H50, H52)**

Set frequency at the arbitrary point of non-linear V/f pattern.

- Data setting range: 0.0 (Cancel), 0.1 to 500.0 (Hz)

Note When 0.0 is set, the setting becomes the pattern without using non-linear V/f pattern.

■ **Non-linear V/f 1, 2 (Voltage) (H51, H53)**

Set voltage at the arbitrary point of non-linear V/f pattern.

- Data setting range: 0 to 500 (V) : AVR operation (at 400 V class)

■ **Maximum output voltage 1 (F06)**

Set the voltage at maximum output frequency 1 (F03).

- Data setting range: 160 to 500 (V) : AVR operation (at 400V class)

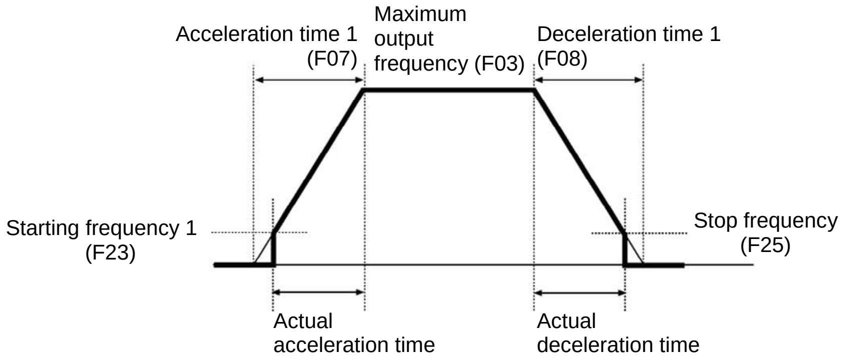
Note When rated voltage at base frequency (F05) is "0", the data of non-linear V/f (H50 to H53, H65, and H66) and F06 becomes invalid (linear V/f for at or below base frequency, and constant voltage for at or higher than base frequency).

F07, F08	**Acceleration time1, Deceleration time 1** **Related function codes:** **E10, E12, E14 Acceleration time 2, 3, 4** **E11, E13, E15 Deceleration time 2, 3, 4** **H07 Curve acceleration/deceleration** **H56 Deceleration time for forced stop**

Acceleration time sets the time taken by the output frequency to reach the maximum output frequency from 0Hz, and deceleration time sets the time taken by the output frequency to reach 0Hz from the maximum frequency.

- Data setting range: 0.00 to 3600 (s)

For V/f control



■ **Acceleration/Deceleration time**

Type of Acceleration/deceleration time	Function code		Select ACC/DEC time (Function code E01 to E05)		
	Acceleration time	Deceleration time	"RT2"	"RT1"	
ACC/DEC time 1	F07	F08	OFF	OFF	Switch by acceleration/deceleration selection "RT1" "RT2". (Data = 4 or 5) When there is no assignment, acceleration/deceleration time 1 (F07, F08) are valid.
ACC/DEC time 2	E10	E11	OFF	ON	
ACC/DEC time 3	E12	E13	ON	OFF	
ACC/DEC time 4	E14	E15	ON	ON	
At Force to stop	-	H56	Turning the Force to stop "STOP" command OFF causes the motor to decelerate to a stop in accordance with the deceleration time for forced stop (H56). After the motor stops, the inverter enters the alarm state with the alarm er6 displayed. (Data = 30)		

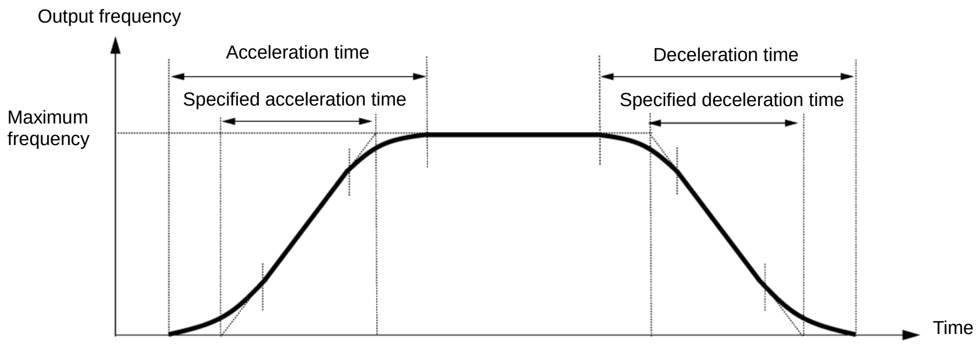
■ Curve acceleration/deceleration (H07)

Select acceleration/deceleration pattern (change pattern of frequency) at acceleration/deceleration

<table>
<tr><th>H07 data</th><th>Curve acceleration/ deceleration</th><th colspan="2">Action</th></tr>
<tr><td>0</td><td>Disable (Linear acceleration/deceleration)</td><td colspan="2">Acceleration/deceleration with constant acceleration.</td></tr>
<tr><td>1</td><td>S-curve acceleration/deceleration (Weak)</td><td rowspan="2">Smoothen the speed change and reduce shock when starting acceleration and right before the speed becomes constant, as well as when starting deceleration and right before the deceleration stops.</td><td>Weak: Fix acceleration/deceleration change rate to 5% of the maximum output frequency within each S-curve range.</td></tr>
<tr><td>2</td><td>S-curve acceleration/deceleration (Strong)</td><td>Strong: Fix acceleration/deceleration change rate to 10% of the maximum output frequency within each S-curve range.</td></tr>
<tr><td>3</td><td>Curve acceleration/deceleration</td><td colspan="2">Linear acceleration/deceleration (constant torque) at or below base frequency and acceleration becomes gradually slower at or higher than the base frequency, and acceleration/deceleration with constant load rate (rated output). It is possible to accelerate/decelerate with the maximum capability.</td></tr>
</table>

<u>S-curve acceleration/deceleration</u>

For the purpose of decreasing the shock on the load machine side, smoothen the speed change at the start of acceleration and right before it becomes constant speed, and at the start of deceleration and right before the stop of deceleration. As for s-curve acceleration/deceleration values, fix with 5% (Weak) or 10% (Strong) for S-curve acceleration/deceleration. The specified acceleration/deceleration time determines acceleration of linear part and the actual acceleration/deceleration time becomes longer than the specified acceleration /deceleration time.



Acceleration/Deceleration time

< S-curve acceleration/deceleration (Weak): When frequency change is 10% or higher than the maximum frequency>

Acceleration or deceleration time (s) = $(2 \times 5/100 + 90/100 + 2 \times 5/100) \times$ reference acceleration or deceleration time
= $1.1 \times$ reference acceleration or deceleration time

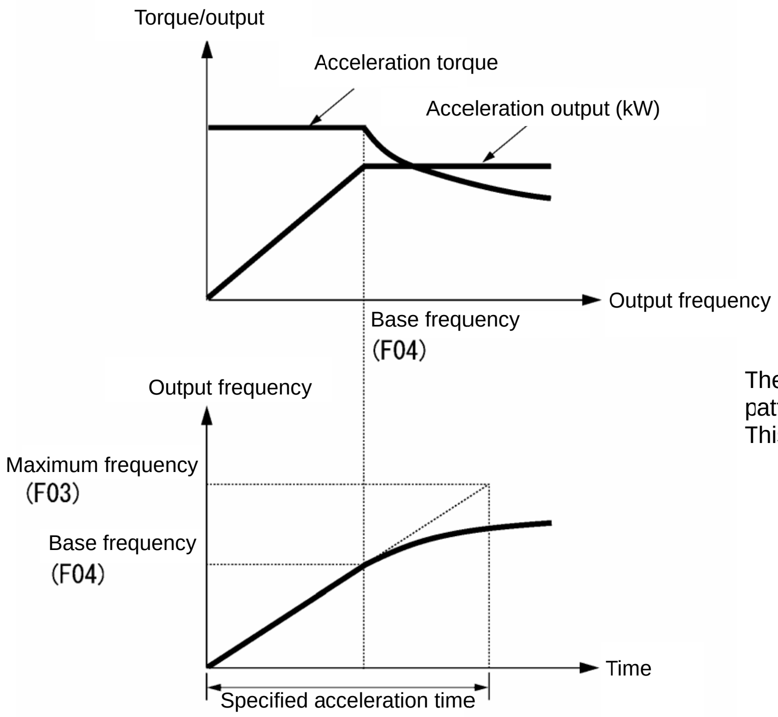
< S-curve acceleration/deceleration (Strong): When frequency change is 20% or higher than the maximum frequency.>

Acceleration or deceleration time (s) = $(2 \times 10/100 + 80/100 + 2 \times 10/100) \times$ (reference acceleration or deceleration time)
= $1.2 \times$ (reference acceleration or deceleration time)

Curve acceleration/deceleration

This is a pattern to perform linear acceleration/deceleration (rated torque) at or below base frequency and acceleration becomes gradually slower at or higher than the base frequency, and acceleration/deceleration with constant load rate (rated output).

It is possible to accelerate/decelerate with the maximum capability of the motor to be driven by the inverter.



The diagram on the left shows pattern at acceleration.
This is the same as at deceleration.

Note
- When S-curve acceleration/deceleration and curve acceleration/deceleration is selected by curve acceleration/deceleration H07, the actual acceleration/deceleration time becomes longer than the set value.
- If acceleration/deceleration time is set shorter than necessary, current limiting function, torque limit or anti-regenerative function may operate and acceleration/deceleration time may become longer than the set value.

F09	Torque boost 1 (Refer to F37)

For details of torque boost 1 setting, refer to the section of function code F37.

F10 to F12	Electronic thermal overload Protection for motor 1 (Select motor characteristics, Thermal time constant)

In order to detect overload of motor (electronic thermal function by inverter output current), set temperature characteristics of motor (Select motor characteristics (F10), thermal time constant (F12), and overload detection level (F11).

When overload of motor is detected, inverter is turned off, protecting the motor with motor overload alarm *0l1*.

Note Improper setting of the electronic thermal function may result in a failure to protect the motor from burning.

Note Temperature characteristics of motor is used for motor overload early warning "OL" as well. Even if only overload early warning is used, it is necessary to set temperature characteristics of the motor (F10, F12). (📖 Function code E34)

For disabling motor overload alarm, set F11 = 0.00 (Disable).

Note For PTC thermistor built-in motor, by connecting PTC thermistor to terminal [C1], it is possible to protect the motor. Refer to H26 to find the details.

■ Select motor characteristics (F10)

F10 selects characteristics of cooling system of the motor.

F10 data	Function
1	Self-cooling fan of general-purpose motor (Self-cooling) (When operating with low frequency, cooling performance decreases.)
2	Inverter-driven motor, High-speed motor with separately powered cooling fan (Keep constant cooling capability irrespective to output frequency)

Figure J shows electronic thermal operation characteristics diagram when F10=1 is set. The characteristics coefficient α1 and α3 and the switch coefficient f2, f3 differ depending on the characteristics of the motor.

Each coefficient that is set by motor characteristics that is selected by motor capacitance and motor selection (P99) is shown in Table J., Table J. and

Table .

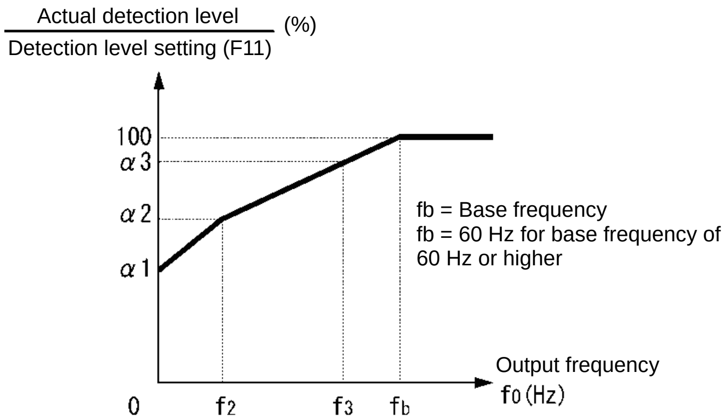


Figure J.5 Characteristics diagram of motor cooling system

Table J.2 When P99 = 0, 4 (Motor characteristics 0, other)

Motor capacity	Thermal time constant τ (Factory default)	Thermal time constant setting Standard current value Imax	Characteristics coefficient switch frequency		Characteristics coefficient		
			f2	f3	α1	α2	α3
0.4, 0.75 kW	5 min	Continuous allowance current value x 150%	5 Hz	7Hz	75%	85%	100%
1.1 to 3.0 kW					85%	85%	100%
5.5 to 11 kW				6Hz	90%	95%	100%
15 kW				7Hz	85%	85%	100%
18.5, 22 kW				5Hz	92%	100%	100%
30 to 45 kW	10 min		Base frequency × 33%	Base frequency × 83%	54%	85%	95%
55 to 90 kW					51%	95%	95%
110 kW or above					53%	85%	90%

Table J.3 When P99 = 1 (Motor characteristics 1)

Motor capacity	Thermal time constant τ (Factory default)	Thermal time constant setting Standard current value Imax	Characteristics coefficient switch frequency		Characteristics coefficient		
			f2	f3	α1	α2	α3
0.2 to 22 kW	5 min	Continuous allowance current value x 150%	Base frequency × 33%	Base frequency × 33%	69%	90%	90%
30 to 45 kW	10 min			Base frequency × 83%	54%	85%	95%
55 to 90 kW					51%	95%	95%
110 kW or above					53%	85%	90%

Table J.4 When P99 = 20, 21 (Motor characteristics)

Motor capacity	Thermal time constant τ (Factory default)	Thermal time constant setting Standard current value Imax	Characteristics coefficient switch frequency		Characteristics coefficient		
			f_2	f_3	α1	α2	α3
90 kW or below	5 min	Continuous allowance current value x 150%	Base frequency × 33%	Base frequency × 83%	53%	85%	95%
110 kW or above	10 min				53%	85%	90%

When F10=2 is set, cooling effect by output frequency will not decrease, therefore, overload detection level becomes constant value (F11) without decrease.

■ Overload detection level (F11)

F11 sets operation level of electronic thermal.

- Data setting range: 1 to 135% of the rated current value of inverter (continuous allowance current value)

Normally, set to the motor continuous allowance current (in general, about 1.0 to 1.1 times of motor rated current) when operating at base frequency.

For disabling electronic thermal as disable, set F11 = 0.00: Disable.

■ Thermal time constant (F12)

F12 sets thermal time constant of the motor. For overload detection level that is set by F11, set the electronic thermal operation time when 150% of current is flowing continuously. Thermal time constant of general-purpose motor of Fuji Electric and general motors is 5 minutes for 22 kW or lower, and 10 minutes (factory default state) for 30kW or higher.

- Data setting range: 0.5 to 75.0 (min)

(Example) When the data of function code F12 is set to “5” (5 minutes).

As shown in Figure 6, when 150% of current of operation level that was set flows for 5 minutes, motor overload (alarm 0l1) protection function will operate. In addition, with 120%, it operates after 12.5 minutes.

The time when alarm actually occurs is shorter than the set data because the time until the current reaches 150% level after exceeding the continuous allowance current (100%) is considered.

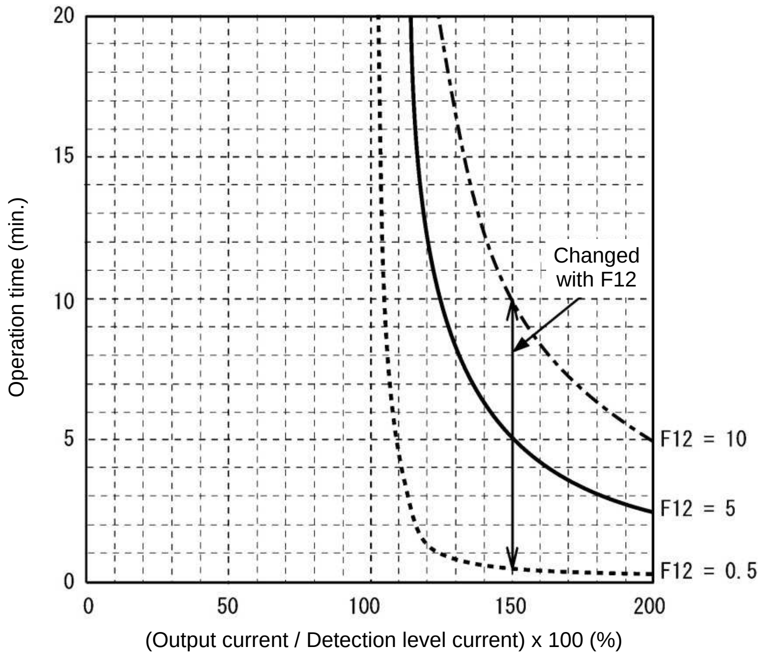


Figure J.6 Example of current-operation time characteristics

F14	Restart mode after momentary power failure (Mode selection)
	Related function codes: H13 (Restart timer) H14 (frequency lowering rate) H15 (Continuous running level) H16 (Allowable momentary power failure time) H92 Continuous running at the momentary power failure (P) H93 Continuous running at the momentary power failure (I)

Set the operation for when momentary power failure occurs (trip operation, restart operation method at auto-restarting)

■ Restart mode after momentary power failure (Mode selection) (F14)

V/f control (F42=0,2,3), dynamic torque vector control(F42=1,4), PM motor control(F42=15)

<table>
<tr><th rowspan="2">F14 data</th><th colspan="2">Operation contents</th></tr>
<tr><th>Without auto search</th><th>With auto search</th></tr>
<tr><td>0: Trip immediately</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, undervoltage alarm lu is outputted, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>1: Trip after a recovery from power failure</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter , the inverter output shuts down and the motor coasts to stop, but the undervoltage alarm will not be outputted.
When auto-started from momentary power failure, undervoltage alarm lu is outputted.</td></tr>
<tr><td>2: Trip after momentary deceleration is stopped</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked.
Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor and continuing the deceleration operation. After decelerate-to-stop operation, an undervoltage alarm lu is issued.</td></tr>
<tr><td rowspan="3">3: Continue to run (for heavy inertia load or general load)</td><td colspan="2">As soon as the DC link bus voltage drops below the continuous running level due to a momentary power failure, decelerate-to-stop control is invoked.
Decelerate-to-stop control regenerates kinetic energy from the load's moment of inertia, slowing down the motor, and operation is continued to wait for auto-restarting. If there is not enough energy for regeneration and when undervoltage is detected, the inverter output shuts down and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the frequency of when undervoltage is detected.</td><td>If run command is entered at auto-restarting, auto-searching is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suitable for the fan with large inertia moment of load.</td></tr>
<tr><td rowspan="3">4: Restart from frequency at power failure (for general load)</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the frequency of when undervoltage is detected.</td><td>If run command is entered at auto-restarting, auto-searching is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suitable for the case (fan) when load inertial moment is large, and motor speed does not decrease so much even if the motor coasts to a stop due to momentary power failure.</td></tr>
<tr><td rowspan="3">5: Restart from starting frequency</td><td colspan="2">When momentary power failure occurs while operating the inverter, and at the time when undervoltage is detected by the DC link bus voltage of the inverter, the inverter output shuts down, and the motor coasts to a stop.</td></tr>
<tr><td>If run command is entered at auto-restarting, restart from the starting frequency that was set by function code F23.</td><td>If run command is entered at auto-restarting, auto-searching is performed, motor speed is estimated, and restart from the frequency.</td></tr>
<tr><td colspan="2">This setting is most suitable for the case (pump etc.) when load inertia moment is small, when the load is heavy, and motor speed decreases up to 0 in a short time after the motor coasts to a stop due to momentary power failure.</td></tr>
<tr><td colspan="3">With auto-searching: Auto-searching is selected by starting mode selection “STM” ON or H09/d67 = 1 or 2.
Refer function code H09/d67 (Starting mode) to find the detail of starting mode selection “STM” ON auto-searching.</td></tr>
</table>

⚠WARNING

When momentary power failure restart operation (F14 = 3 to 5) is selected, operation will resume automatically at auto-restarting. Design your machinery so that safety is ensured even at restarting.

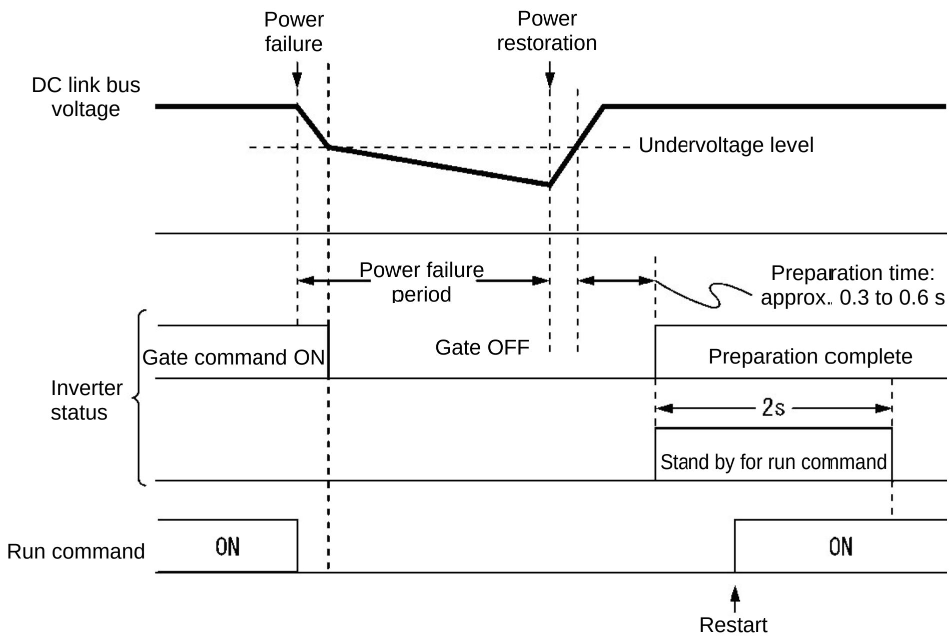
Otherwise an accident could occur.

■ **Restart mode after momentary power failure (Basic operation: Without auto-searching setting)**

When inverter detected that DC link bus voltage becomes at or drops below undervoltage level while operating, it is judged as a momentary power failure. When load is light and momentary power failure is very short, momentary power failure may not be detected and motor operation might be continued because DC link bus voltage does not drop so much.

When inverter judges the state as momentary power failure, returns to momentary power failure restart mode and prepares for restart. After power is auto-restarted, the inverter becomes at inverter ready to run state after elapse of initial charging time. At momentary power failure, power of external circuit (relay circuit etc.), which controls the inverter, decreases as well, and run command may be turned off. Therefore, when the inverter becomes at inverter ready to run state, wait 2 seconds for input of run command. When input of run command is confirmed within 2 seconds, initiate restarting according to F14 (mode selection). When there is no input of run command at run command input waiting state, momentary power failure restart mode will be released and start from normal starting frequency. Therefore, input run command within 2 seconds after auto-restarting or hold run command by off-delay timer or mechanical latch relay.

In case of F02=0 (run command from keypad and rotation direction command determined by terminal), it operates in the same way as above. For rotation direction fixed mode (F02 = 2, 3), run command is held within the inverter, therefore, it restarts immediately at inverter ready to run state.



Note

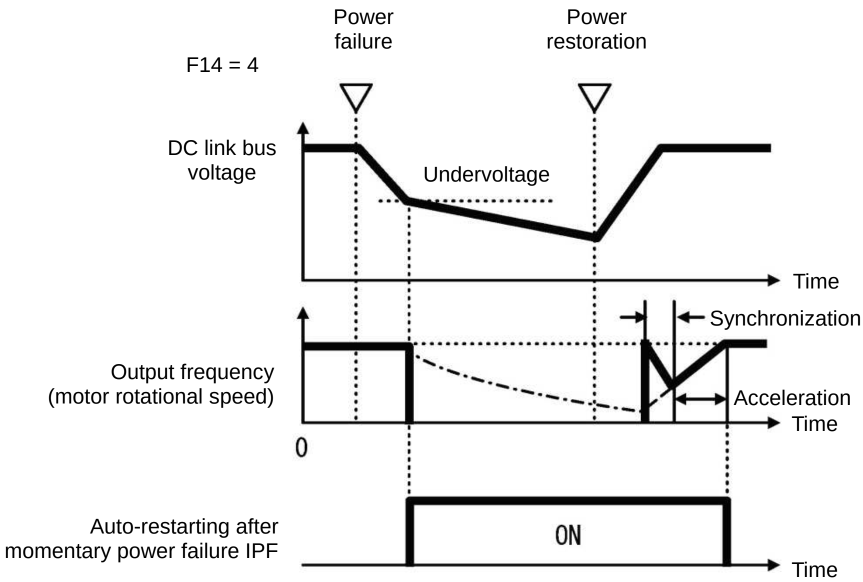
- At auto-restarting, inverters waits 2 seconds for input of run command, however, if allowable momentary power failure time (H16) is elapsed after the state is judged as power failure, the state of run command input waiting for 2 seconds will be cancelled and normal starting operation is performed.
- When coast to a stop command "BX" is entered during power failure, momentary power failure restart waiting state is released and returns to normal run mode, and when run command is inputted, start from normal starting frequency.
- Detection of momentary power failure within the inverter is performed by detecting DC link bus voltage drop of the inverter. With the structure in which a magnetic contactor is equipped on the output side of the inverter, there will be no operation power of the magnetic contactor at momentary power failure and the magnetic contactor becomes at open state. When the magnetic contactor becomes open, connection of inverter and motor is released and load of the inverter is shutdown. Therefore, it becomes difficult to decrease DC link bus voltage of the inverter and it may not be judged as a momentary power failure. If this is the case, momentary power failure restart will not be performed normal. As a countermeasure against this case, by connecting auxiliary contact signal of the magnetic contactor to the interlock signal "IL" it is possible to detect momentary power failure without fail.

  Function code E01 to E05 Data = 22

Terminal command "IL"	Meaning
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Restart after a momentary power failure enabled)

When motor speed decreases during momentary power failure, and when restarting from frequency of before momentary power failure after power is recovered (auto-restarting), current limiter becomes active and output frequency of the inverter decreases automatically.

When output frequency and motor rotation speed synchronize, the speed is accelerated up to the original output frequency. Refer to the figure below. However, it is necessary to enable instantaneous overcurrent limiting (H12 = 1) to bring in synchronization of the motor.



- Auto-restarting after momentary power failure “IPF”

During momentary power failure auto-restarting “IPF” signal is turned on until returning to original frequency after auto-restarting after momentary power failure occurred. When “IPF”: is turned ON, motor speed decreases, therefore, take necessary measures. (🕮 Function code E20, E21 and E27 Data = 6)

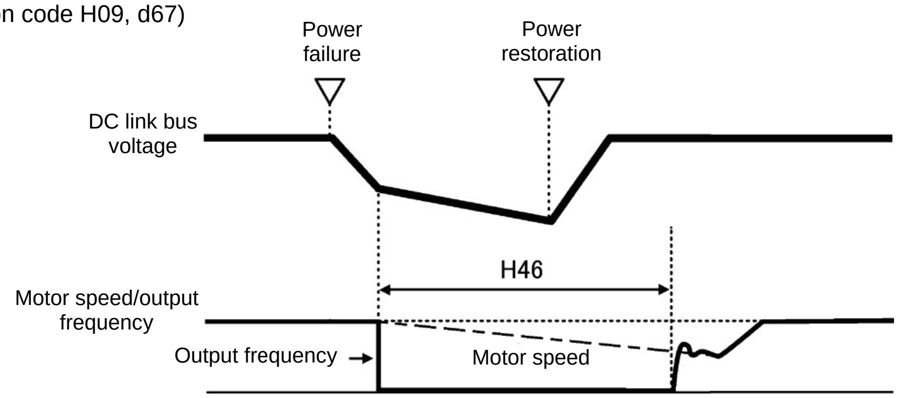
APPENDICES

■ **Restart mode after momentary power failure (Basic operation: Without auto-searching setting)**

Auto-searching is not performed normally if there is residual voltage of the motor.

Therefore, it is necessary to secure the time until residual voltage runs out.

Restart mode after momentary power failure secures the necessary time with function code H46 starting mode (auto search delay time 2). Even if starting conditions are satisfied, inverter does not start unless auto-search delay time elapses after inverter goes into OFF state. Inverter starts after elapse of auto-searching delay time.
(🕮 Function code H09, d67)

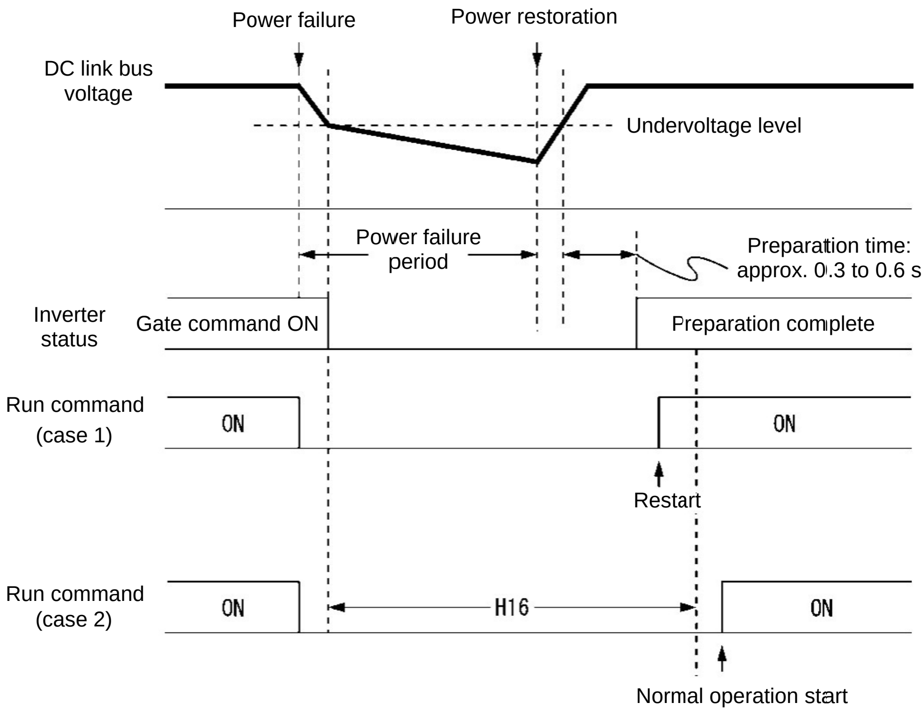


Note

- When operating auto-searching, it is necessary to perform auto-tuning in advance.
- When the estimated speed exceeds the maximum frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum frequency or the upper limit frequency, whichever is lower.
- During auto search, if an overcurrent or overvoltage trip occurs, the inverter will restart the auto search.
- Use 60 Hz or below for auto-searching
- Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.
- When output circuit filter OFL-・・・-2, -4 is equipped on the output side of the inverter, auto-searching must be disabled. Use OFL-・・・・-A type.
- If using permanent magnetic type synchronous motors to restart following a momentary power interruption, do not set d67 = 0.

■ Restart mode after momentary power failure (Allowable momentary power failure time) (H16)

Sets the maximum time from when momentary power failure (undervoltage level) occurs until restart (setting range: 0.0 to 30.0 s). Set coast to a stop time which is allowable for machine and equipment. Momentary power failure restart operation should be performed within the specified time, however, if the set time is exceeded, the inverter judges the state as a power shut down, and then operates as powering on again without performing momentary power failure restart operation.



When allowable momentary power failure time (H16) is set to "999", momentary power failure restart is performed until DC link bus voltage decreases by momentary power failure restart allowance voltage (100 V for 400 V class), however, if the voltage becomes at or below the momentary power failure allowance voltage, the state is judged as a power shut down. As a result, the inverter operates as powering ON again without performing momentary power failure restart operating.

Power supply voltage	Allowance voltage of momentary power failure restart
400V	100V

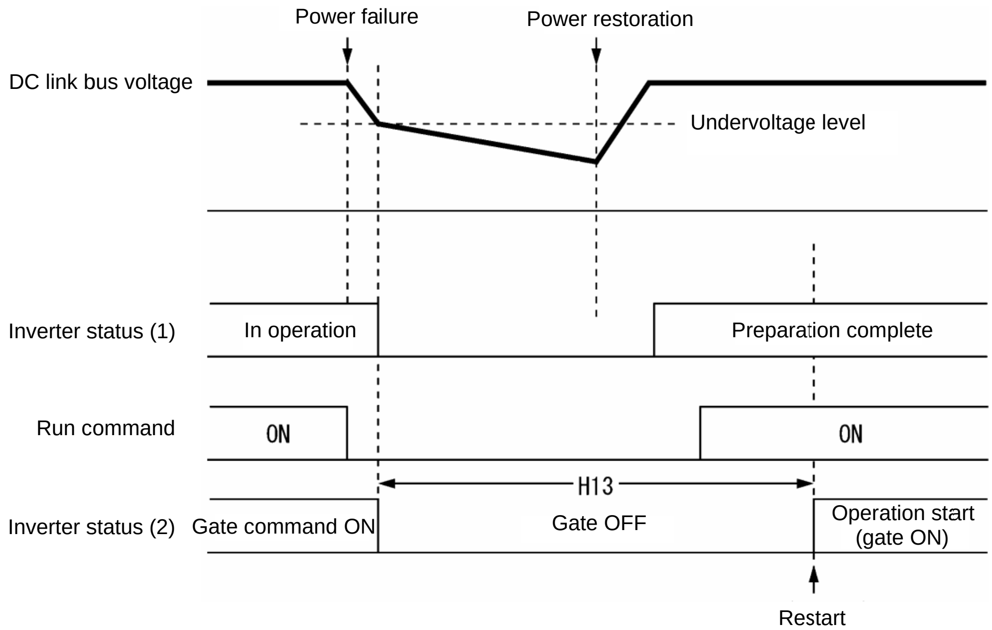
Note: The time until voltage decreases to the momentary power failure restart allowance voltage from undervoltage differs greatly depending on the inverter capacity and with/without option.

APPENDICES

■ **Restart mode after momentary power failure (Restart timer) (H13) (Exclusive to V/f control for IM)**

H13 set the time until restart is performed after momentary power failure occurred. (At auto-searching setting, use H46 (auto search holding time 2)).

Restarting at the state when residual voltage of the motor is high, inrush current becomes greater or temporarily becomes at regeneration state, and overcurrent alarm may occur. For security reason, in order to restart after residual voltage is reduced to some extent, adjust H13. Even if auto-restarted, restart cannot be performed until the holding time (H13) elapses.



Factory default: At the factory default state, setting is performed so that it is appropriate to the standard motor (refer to "I.3 Factory default value per applicable electric motor capacitance"). Basically, there is no need to modify the default setting. However, when problems occur due to the long holding time or decrease in flow rate of pump becomes significant, change to about half of the standard value and make sure that alarm etc. will not occur.

■ **Restart Mode after Momentary Power Failure (H14)(Exclusive to V/f control for IM)**

At momentary power failure restart operation, when inverter output frequency and motor rotation speed does not synchronize, overcurrent occurs and current limiter will operate. when current limit is detected, automatically decrease the output frequency and synchronize with the motor rotation speed. H14 sets the slope of lowering output frequency (frequency lowering rate in Hz/s).

H14 data	Output frequency lowering operation
0.00	Decrease by the selected deceleration time.
0.01 to 100.00 (Hz/s)	Decrease by the lowering rate that is set by H14.
999	Depending on the PI regulator of current limiting processing (PI constant is fixed value within the inverter), the rate will decrease.

Note When frequency lowering rate is increased, regeneration operation is performed at the moment when output frequency of the inverter and rotation speed of inverter synchronize, and overvoltage trip may occur. When frequency lowering rate is reduced, the time until output frequency of the inverter and motor rotation speed synchronize (current limiting operation) becomes longer, and protection operation of inverter overload may be activated.

■ Restart mode after momentary power failure (Continuous running level) (H15) Continued operation at the momentary power failure (P, I) (H92, H93)

- Trip after momentary deceleration is stopped

When trip after deceleration stopped is selected (F14 = 2), at momentary power failure restart operation (Mode selection), momentary power failure occurs while operating the inverter, and deceleration stop control starts when DC link bus voltage of the inverter becomes at or drops below the continuous running level.

Adjust voltage level of DC link bus to start deceleration stop control by H15.

Under decelerate-to-stop control, the inverter decelerates its output frequency keeping the DC link bus voltage constant using a PI regulator.

P (proportional) and I (integral) components of the PI regulator are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.

- Continue to run

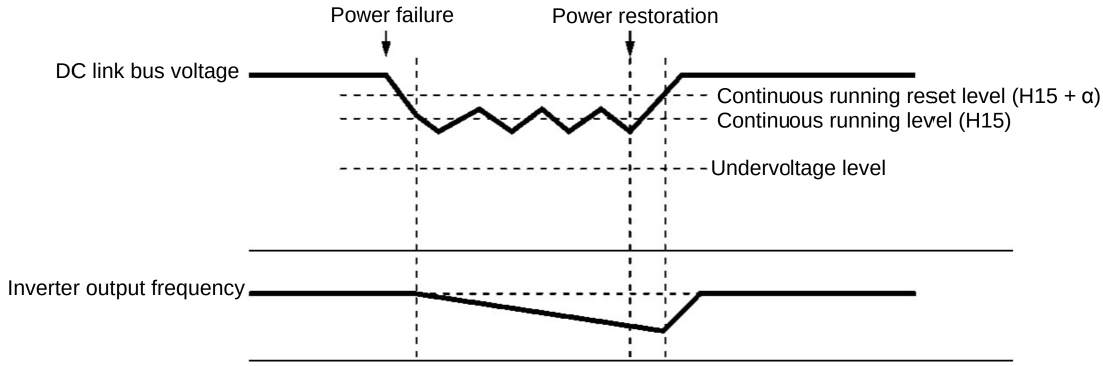
When momentary power failure restart operation (Continue to run) is selected (F14 = 3) at momentary power failure restart (operation selection), momentary power failure occurs while operating the inverter and continue to run control starts when DC link bus voltage of the inverter becomes at or drops below the continue to run level.

Adjust continue to run level to start continue to run control by H15.

Under continue to run control, the inverter continues to run keeping the DC link bus voltage constant using the PI regulator.

P (proportional) and I (integral) components of the PI regulator are specified by H92 and H93, respectively.

For normal inverter operation, it is not necessary to modify data of H15, H92 or H93.



Power supply group	Alpha (α)	
	FRN0060E2E-4EH or below	FRN0075E2E-4EH or above
400 V	10 V	20 V

Note Even if “Deceleration stop control” or “Continue to run”, is selected, the inverter may not be able to perform the function when the inertia of the load is small or the load is heavy, due to undervoltage caused by the control delay. In such a case, when “Deceleration stop control” is selected, the inverter allows the motor to coast to a stop; when “Continue to run” is selected, the inverter saves the output frequency being applied when the undervoltage alarm occurs and perform momentary power failure restart operation.

When the input power voltage for the inverter is high, setting continue to run level high makes the control more stable even if the inertia of the load is relatively small. Raising the continuous running level too high, however, might cause continue to run control activated even during normal operation.

When the input power voltage for the inverter is extremely low, continue to run control might be activated even during normal operation, at the beginning of acceleration or at an abrupt change in load. To avoid this, lower the continuous running level. Lowering it too low, however, might cause undervoltage that result from voltage drop due to the control delay.

Before you change the continuous running level, make sure that the continuous running control will be performed properly, by considering the fluctuations of the load and the input voltage.

APPENDICES

F15, F16	**Frequency limiter (Upper limit), Frequency limiter (Lower limit)** **Related function codes: H63 Lower limit Limiter (Mode selection)**

■ Frequency limiter (Upper limit) (Lower limit) (F15, F16)

F15 and F16 specify the upper and lower limits of the output frequency or reference frequency, respectively.

Frequency Limiter		Object to which the limit is applied
Frequency limiter (Upper)	F15	Output frequency
Frequency limiter (Lower)	F16	Reference frequency
Note	When the limit is applied to the reference frequency or reference speed, delayed responses of control may cause an overshoot or undershoot, and the frequency may temporarily go beyond the limit level.	

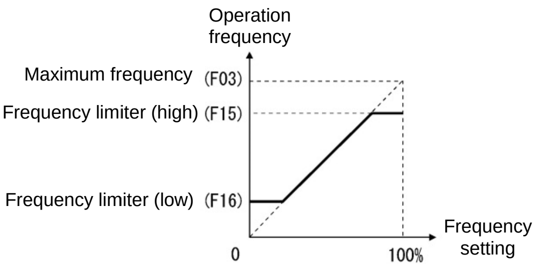
- Data setting range: 0.0 to 500.0 (Hz)

■ Low Limiter (Mode selection) (H63)

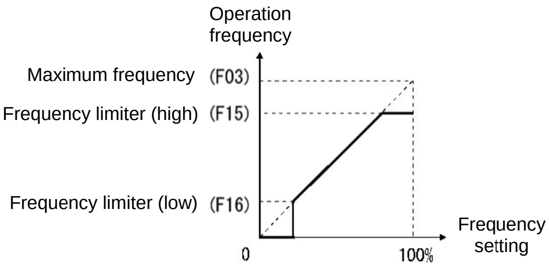
H63 specifies the operation to be carried out when the reference frequency drops below the low level specified by F16, as follows:

H63 data	Action
0	The output frequency will be held at the low level specified by F16.
1	The inverter decelerates to stop the motor.

Refer to the figure below.



(For H63 = 0)



(For H63 = 1)

Note

- When changing the frequency limiter (Upper) (F15) in order to raise the reference frequency, be sure to change the maximum frequency (F03) accordingly.
- Set each function code related to operation frequency so that the relationship among data becomes the following magnitude relationship.
  - F15>F16, F15>F23, F15>F25
  - F03>F16

  However, F23 is the starting frequency, and F25 is stop frequency

  If any wrong data is specified for these function codes, the inverter may not run the motor at the desired speed, or cannot start it normally.

F18	**Bias (for frequency setting 1)** **(Refer to F01)**

Refer to the description of function code F01 to find the details of bias (Frequency setting 1) setting.

F20 to F22	**DC braking1 (Starting frequency, braking level, braking time)**
H95	**DC braking (Braking response mode)**
H195	**DC braking (Braking timer at the startup)**

These function codes specify the DC braking that prevents motor 1 from running by inertia during decelerate-to-stop operation.

If the motor enters a decelerate-to-stop operation by turning OFF the run command or by decreasing the reference frequency below the stop frequency, the DC braking starts when output frequency reached the DC braking starting frequency. Set braking starting frequency (F20), braking level (F21), and braking time (F22) to start DC braking when deceleration is stopped.

Setting the braking time to “0.00” (F22 = 0) disables the DC braking.

By H195, it is possible to perform DC braking when starting up inverter. By doing so, it is efficient for preventing from falling down when the brake is released, and prompt torque startup when starting up.

■ Braking starting frequency (F20)

F20 specifies the frequency at which the DC braking starts its operation during motor decelerate-to-stop state.

- Data setting range: 0.0 to 60.0 (Hz)

■ Braking level (F21)

F21 specifies the output current level to be applied when the DC braking is activated. The function code data should be set, assuming the rated output current of the inverter as 100%, in increments of 1%.

- 0 to 80%

■ Braking time (F22)

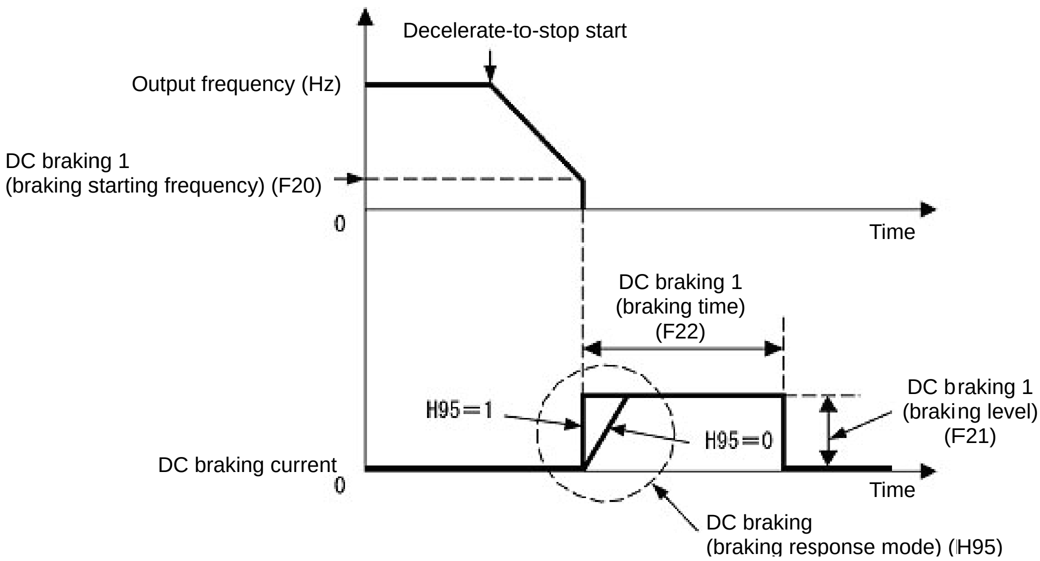
F22 specifies the braking period that activates DC braking.

- Data setting range: 0.00 (Disable), 0.01 to 30.00 (s)

■ **Braking response mode (H95)**

H95 specifies the DC braking response mode.

H95 data	Characteristics	Note
0	Slow response. Slows the rising edge of the current, thereby preventing reverse rotation at the start of DC braking.	Insufficient braking torque may result at the start of DC braking.
1	Quick response. Quickens the rising edge of the current, thereby accelerating the build-up of the braking torque.	Reverse rotation may result depending on the moment of inertia of the mechanical load and the coupling mechanism.



Tip

It is also possible to input DC braking command “DCBRK” by using an external digital input signal as the terminal command. As long as the DCBRK is ON, the inverter performs DC braking, regardless of the braking time specified by F22.
(📖 Refer to function code E01 to E05 Data =13 to find the details of “DCBRK”)

Turning the “DCBRK” ON even when the inverter is in a stopped state activates the DC braking. This feature allows the motor to be excited before starting, resulting in smoother acceleration (quicker build-up of acceleration torque) (under V/f control).

Depending on the timing of the activation of “DCBRK”, alarm of overvoltage or overcurrent occurs.

Note

In general, specify data of function code F20 at a value close to the rated slip frequency of motor. If an extremely high value is set, control may become unstable and an overvoltage alarm may result in some cases.

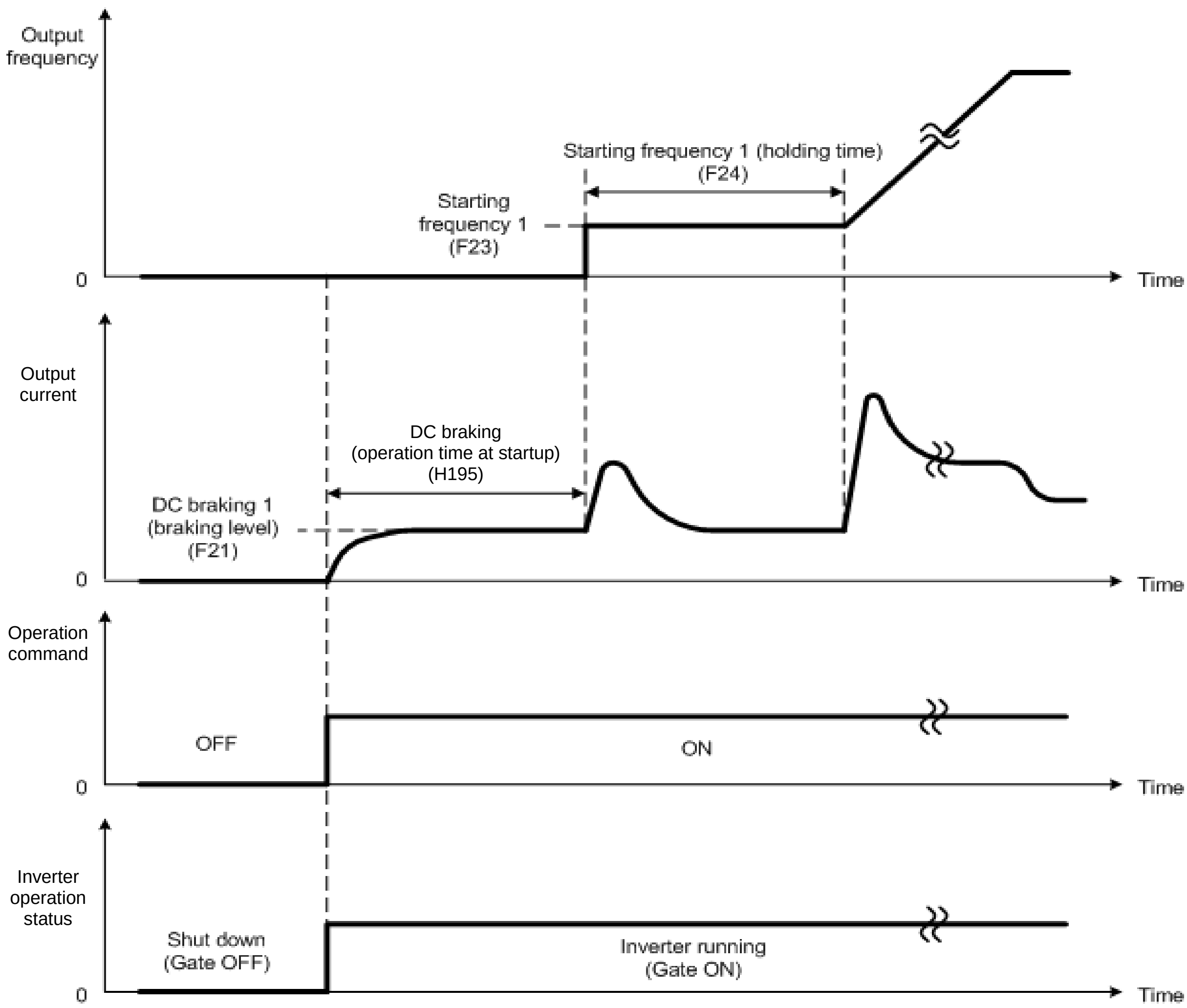
⚠CAUTION
The DC braking function of the inverter does not provide any holding mechanism. **Injuries could occur.**

■ Braking timer at the startup (H195)

When starting up inverter by run command, it is possible to start by operating DC braking.

This is particularly useful in applications such as hoists and elevators where the inverter runs at low speed braking mode after starting up, preventing loads from falling.

- Data setting range: 0.00: No DC braking at the start up 0.01 to 30.00 (s)



F23 to F25	Starting frequency 1, Starting frequency 1 (Holding time) and Stop frequency

Under V/f control

At the startup of an inverter, the initial output frequency is equal to the starting frequency. The inverter stops its output when the output frequency reaches the stop frequency. Set the starting frequency to a level at which the motor can generate enough torque for startup. Generally, set the rated slip frequency of the motor as the starting frequency.

Specifying the holding time for the starting frequency compensates for the delay time for the establishment of a magnetic flux in the motor; specifying that for the stop frequency stabilizes the motor speed at the stop of the inverter.

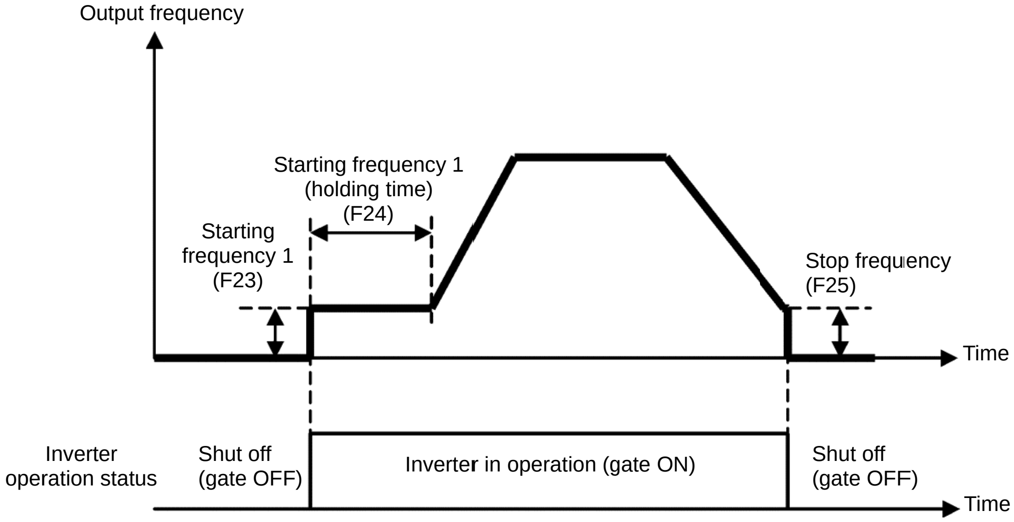


Figure J.7 Inverter operation diagram

■ Starting frequency 1 (F23)

F23 specifies the starting frequency at the startup of an inverter.

- Data setting range: 0.0 to 60.0 (Hz)
  Under V/f control, even if the start frequency is set at 0.0 Hz, the inverter starts its output at 0.1 Hz.

■ Starting frequency 1 (Holding time) (F24)

F24 specifies the holding time for the starting frequency 1.

- Data setting range: 0.00 to 10.00 (s)

■ Stop frequency (F25)

F25 specifies the stop frequency at the stop of the inverter.

- Data setting range: 0.0 to 60.0 (Hz)
  Under V/f control, even if the stop frequency is set at 0.0 Hz, the inverter stops its output at 0.1 Hz.

Note: If the starting frequency is lower than the stop frequency, the inverter does not output any power as long as the reference frequency does not exceed the stop frequency.

F26, F27	Motor Sound (Carrier frequency, Tone) Related function codes: H98 Protection/Maintenance function (Mode selection)

■ **Motor Sound (Carrier frequency) (F26)**

Adjust carrier frequency. By changing carrier frequency, it is possible to reduce an audible noise generated by the motor or electromagnetic noise from the inverter itself, and to decrease a leakage current from the main output (secondary) wiring.

Setting frequency of carrier frequency differs depending on each model overload rating (ND/HD/HND/HHD).

Item	Characteristics		
Carrier frequency	Low	to	High
Motor sound noise emission	High	↔	Low
Motor temperature (due to harmonics components)	High	↔	Low
Ripples in output current waveform	Large	↔	Small
Leakage current	Low	↔	High
Electromagnetic noise emission	Low	↔	High
Inverter loss	Low	↔	High

Setting range of carrier frequency is as follows.

Modes	0.75 to 6kHz	0.75 to 10kHz	0.75 to 16kHz
FRN□□□□E2□-2G□H (HHD/HND)	—	—	0001 to 0020
FRN□□□□E2□-4G□H (ND)	—	0002 to 0012	—
FRN□□□□E2□-4G□H (HD/HND/HHD)	—	—	0002 to 0012
FRN□□□□E2□-4EH (ND)	0072 or above	0020 to 0059	—
FRN□□□□E2□-4EH (HD/HND)	0203 or above	0072 to 0168	0020 to 0059
FRN□□□□E2□-4EH (HHD)	—	0203 or above	0020 to 0168
FRN□□□□E2□-7G□H (HND/HHD)	—	—	0001 to 0011

Note

Specifying a carrier frequency that is too low will cause the output current waveform to have a large amount of ripple. As a result, the motor loss increases, causing the motor temperature to rise. Furthermore, the large amount of ripple tends to cause a current limiting alarm. When the carrier frequency is set to 1 kHz or lower, therefore, reduce the load so that the inverter output current comes to be 80% or less of the rated current.

When a high carrier frequency is specified, the temperature of the inverter may rise due to the ambient temperature rise or an increase of the load. If it happens, the inverter automatically decreases the carrier frequency to prevent the inverter overload (*0lu*) . With consideration for motor noise, the automatic reduction of carrier frequency can be disabled. Refer to the description of H98.

It is recommended to set the carrier frequency at 5 kHz or above under vector control with speed sensor. DO NOT set it at 1 kHz or below.

Running a PMSM at low carrier frequency may overheat the permanent magnet due to the output current harmonics, resulting in demagnetization. When decreasing the carrier frequency setting, therefore, be sure to check the allowable carrier frequency of the motor.

When using a Fuji standard PMSM with the rated load, decrease the carrier frequency. Setting a high carrier frequency decreases not only the harmonic components of the output current but also the allowed continuous running inverter output current.

■ Motor Sound (Tone) (F27)

F27 changes the motor running sound tone (only for motors under V/f control). This setting is effective when the carrier frequency specified by function code F26 is 7 kHz or lower. Changing the tone level may reduce the high and harsh running noise from the motor.

Note: If the tone level is set too high, the output current may become unstable, or mechanical vibration and noise may increase. Also, this function code may not be very effective for certain types of motor.

F27 data	Function
0	Disable (Level 0)
1	Enable (Level 1)
2	Enable (Level 2)
3	Enable (Level 3)

F29 to F35 — Terminal [FM1], [FM2] (Mode selection, Output gain, Function selection, Pulse rate)

These function codes allow outputting monitor data such as output frequency and output current to terminals [FM1], [FM2] as analog DC voltage, current, and pulse ([FM1] only). In addition, voltage and current output level on terminals [FM1], [FM2] is adjustable.

Note: When switching voltage, current, and pulse, it is necessary to switch both mode selection function code and switch on the PCB.

There is no pulse output function for terminal [FM2]

Terminal	Mode selection function	Gain	Function	Pulse rate	Switch
[FM1]	F29	F30	F31	F33	SW5
[FM2]	F32	F34	F35	None	SW7

■ Mode selection (F29, F32)

F29 and F32 select output form of terminals [FM1], [FM2]. Accordingly, change the switches SW5, SW7 on the control PCB.

For details of the switches on the control PCB, refer to the FRENIC-Ace User's Manual Chapter 12 "SPECIFICATIONS."

F29 data	Terminal [FM1] output form	Control PCB switch (SW5)
0	Voltage output (0 to +10 VDC)	FMV side
1	Current output (4 to 20 mA DC)	FMI side
2	Current output (0 to 20mA DC)	FMI side
3	Pulse output	FMP side

F32 data	Terminal [FM2] Output form	Control PCB switch (SW7)
0	Voltage output (0 to +10 VDC)	FMV side
1	Current output (4 to 20 mA DC)	FMI side
2	Current output (0 to 20mA DC)	FMI side

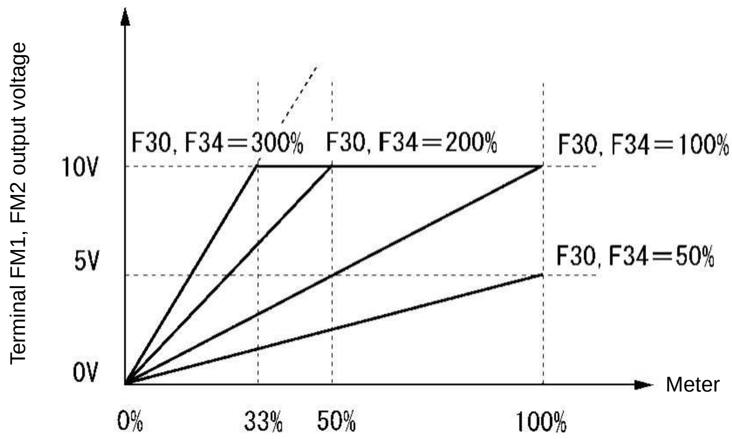
Note: The output current is not isolated from analog input, and does not have an isolated power supply.

Therefore, if an electrical potential relationship between the inverter and peripheral equipment has been established, e.g., by connecting an analog input, cascade connection of a current output device is not available.

Keep the optimum connection wire length.

■ **Output gain (F30, F34)**

F30, F34 allows you to adjust the output voltage within the range of 0 to 300%.



■ **Function selection (F31, F35)**

F31, F35 specify which data is monitored at the output terminals [FM1], [FM2].

F31/F35 data	[FMA] output	Data	Definition of monitor amount 100%
0	Output frequency 1 (PM: Speed command value)	Output frequency of the inverter	Maximum frequency (F03)
1	Output frequency 2 (PM: Speed estimated value)	Output frequency of the inverter	Maximum frequency (F03)
2	Output current	Output current (RMS) of the inverter	Twice the inverter rated current (Inverter rated output current depending on F80 setting)
3	Output voltage	Output voltage (RMS) of the inverter	400 V class: 500 V
4	Output torque	Motor shaft torque	Twice the rated motor torque
5	Load factor	Load factor (Equivalent to the indication of the load meter)	Twice the rated motor load
6	Input power	Input power of the inverter	Twice the rated output power (Inverter rated output power depending on F80)
7	PID feedback value	Feedback value under PID control	100% of the feedback amount
8	Estimated speed	Estimated speed under vector control without speed sensor	Maximum speed as 100%
9	DC link bus voltage	DC link bus voltage of the inverter	400 V class: 1000 V
10	Universal AO	Command from communication (🕮 RS-485 communication user manual)	20,000/100%
13	Motor output	Motor output (kW)	Twice the rated motor output (P02/A16 setting value)
14	Calibration (+)	For meter calibration Full scale output	Always full scale (equivalent to 100%) Output
15	PID command (SV)	Command value under PID control	PID command 100%
16	PID output (MV)	Output level of the PID processor under PID control (Frequency command)	Maximum frequency (F03)
18	Inverter heat sink temperature	Heat sink detection temperature of inverter	200°C/100%
20	Reference frequency	Reference frequency	Maximum frequency (F03) / 100%

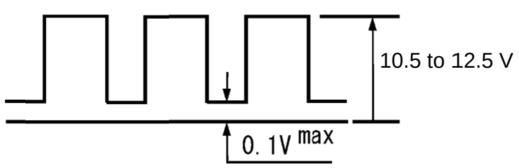
F31/F35 data	[FMA] output	Data	Definition of monitor amount 100%
60	External PID control1 feedback value (EPID1-PV)	External PID control1 feedback value	100% / 100%
61	External PID control1 command (EPID1-SV)	External PID control1 command	100% / 100%
65	External PID control1 output (EPID1-OUT)	External PID control1 output	Maximum frequency (F03) / 100%
111	Customizable logic output signal 1	Enable only at analog output	100% / 100%
112	Customizable logic output signal 2	Enable only at analog output	100% / 100%
113	Customizable logic output signal 3	Enable only at analog output	100% / 100%
114	Customizable logic output signal 4	Enable only at analog output	100% / 100%
115	Customizable logic output signal 5	Enable only at analog output	100% / 100%
116	Customizable logic output signal 6	Enable only at analog output	100% / 100%
117	Customizable logic output signal 7	Enable only at analog output	100% / 100%
118	Customizable logic output signal 8	Enable only at analog output	100% / 100%
119	Customizable logic output signal 9	Enable only at analog output	100% / 100%
120	Customizable logic output signal 10	Enable only at analog output	100% / 100%

■ **Pulse rate (F33)**

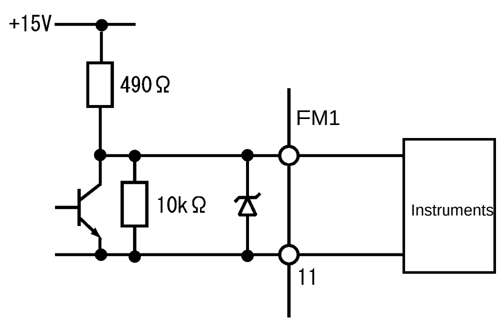
F33 specifies the pulse rate at which the output of the monitored item selected reaches 100%, in accordance with the modes of the pulse counter to be connected.

- Data setting range: 25 to 32000 (pulse/s)

Pulse output waveform



Pulse output circuit



F37	Load Selection/Auto Torque Boost/Auto Energy Saving Operation 1 Related function codes: F09 Torque boost 1

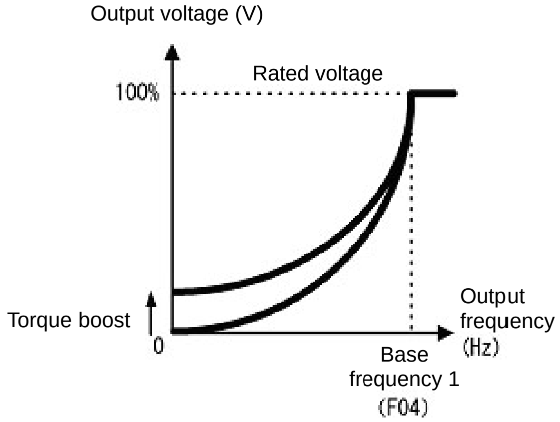
F37 specifies V/f pattern, torque boost type, and auto energy saving operation in accordance with the characteristics of the load.

F37 data	V/f characteristics	Torque boost	Auto Energy-saving Operation	Applicable load
0	Variable torque V/f pattern	By F09 torque boost	Disabled	Variable torque load (General-purpose fan and pumps)
1	Linear V/f pattern			Constant torque load
2		Auto torque Boost		Constant torque load (To be selected if a motor may be over-excited at no load)
3	Variable torque V/f pattern	By F09 torque boost	Enabled	Variable torque load (General-purpose fan and pumps)
4	Linear V/f pattern			Constant torque load
5		Auto torque Boost		Constant torque load (To be selected if a motor may be over-excited at no load)

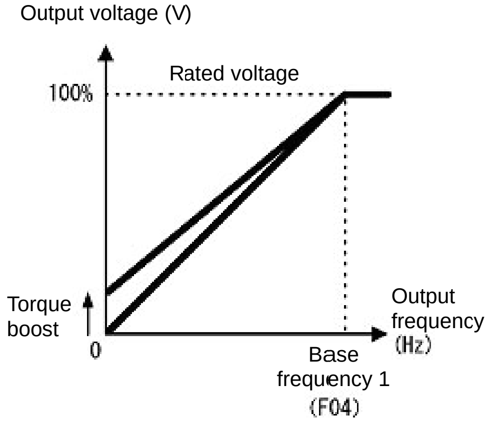
Note If a required "load torque + acceleration toque" is 50% or more of the rated torque, it is recommended to select the linear V/f pattern. Factory defaults are set to linear V/f pattern.

■ **V/f characteristics**

The FRENIC-Ace series of inverters offer a variety of V/f patterns and torque boosts, which include V/f patterns suitable for variable torque load such as general fans and pumps and for constant torque load (including special pumps requiring high starting torque). Two types of torque boosts are available: manual and automatic.



Variable torque V/f pattern (F37 = 0)

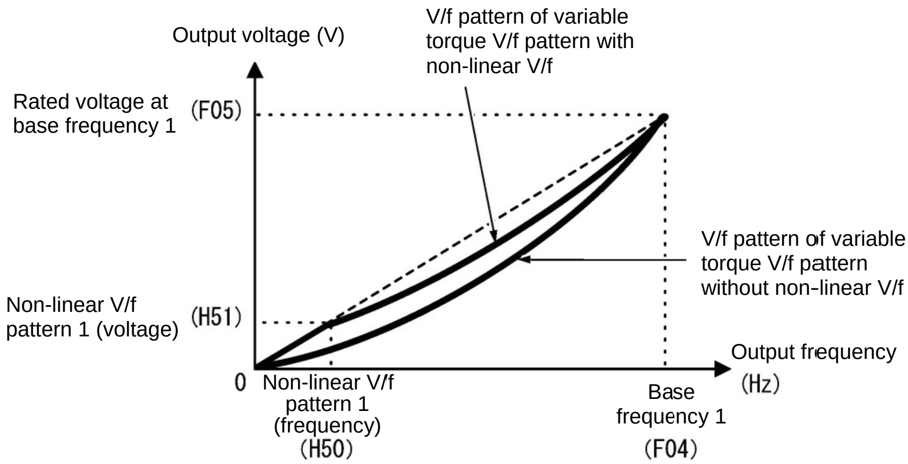


Linear V/f pattern (F37 = 1)

APPENDICES

Tip When the variable torque V/f pattern is selected (F37 = 0 or 3), the output voltage may be low at a low frequency zone, resulting in insufficient output torque, depending on the characteristics of the motor and load. In such a case, it is recommended to increase the output voltage at the low frequency zone using the non-linear V/f pattern.

Recommended value: H50 = 1/10 of the base frequency
H51 = 1/10 of the voltage at base frequency



■ Torque boost

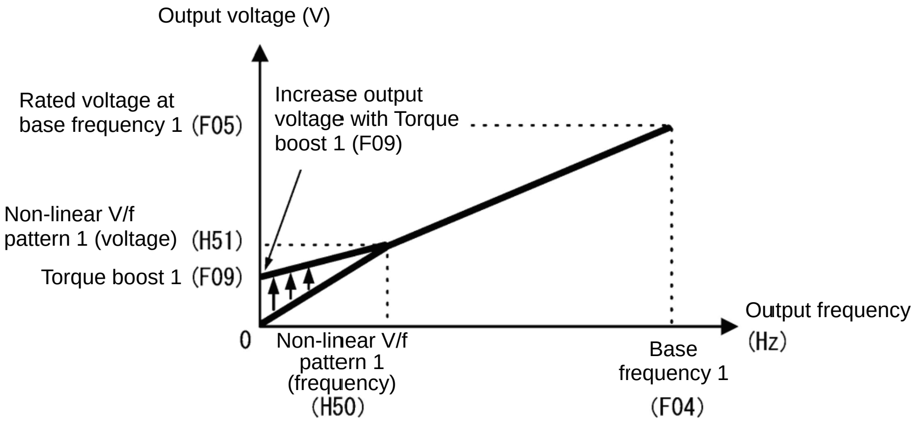
- **Manual torque boost by F09 (Manual adjustment)**
- Data setting range: 0.0 to 20.0 (%), (100%/base frequency voltage)

In torque boost using F09, constant voltage is added to the basic V/f pattern, regardless of the load. To secure a sufficient starting torque, manually adjust the output voltage to optimally match the motor and its load by using F09. Specify an appropriate level that guarantees smooth Startup and yet does not cause over-excitation at no or light load.

Torque boost using F09 ensures high driving stability since the output voltage remains constant regardless of the load fluctuation.

Specify the function code F09 data in percentage to the base frequency voltage. At factory shipment, boost amount with which approx. 100% of starting torque can be assured, is specified.

Note
- Specifying a high torque boost level will generate a high torque, but may cause overcurrent due to over-excitation at no load. If you continue to drive the motor, it may overheat. To avoid such a situation, adjust torque boost to an appropriate level.
- When the non-linear V/f pattern and the torque boost are used together, the torque boost takes effect below the frequency on the non-linear V/f pattern's point.



•Auto torque boost

This function automatically optimizes the output voltage to fit the motor with its load. Under light load, auto torque boost decreases the output voltage to prevent the motor from over-excitation. Under heavy load, it increases the output voltage to increase the output torque of the motor.

Note
- This function controls in accordance with motor characteristics. Therefore, set the base frequency 1 (F04), rated voltage at base frequency 1 (F05), and other pertinent motor parameters (P01 through P03 and P06 through P99) in line with the motor capacity and characteristics, or else perform auto-tuning (P04).
- When a special motor is driven or the load does not have sufficient rigidity, the maximum torque might decrease or the motor operation might become unstable. In such cases, do not use auto torque boost but choose manual torque boost using F09 (F37 = 0 or 1).

F40, F41	Torque limiter 1 (Driving), Torque limiter 1 (Braking) Related function codes: E16, E17 Torque limiter 2 (Driving), Torque limiter 2 (Braking) H76 Torque control (Braking) (Frequency rising limit for braking)

Under V/f control (F42=0)

If the inverter output torque exceeds the specified levels of the torque limiters (F40, F41, E16, E17), the inverter controls the output frequency and limits the output torque for preventing a stall.

To use the torque limiters, it is necessary to configure the function codes listed in Table J.1.

Note In braking, the inverter increases the output frequency to limit the output torque. Depending on the conditions during operation, the output frequency could dangerously increase. H76 (Frequency rising limit for braking) is provided to limit the increasing frequency component.

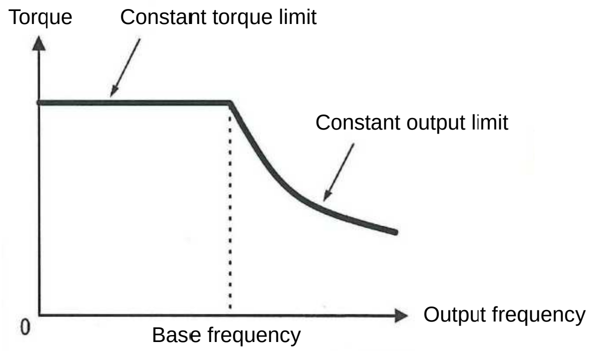
Table J.1 Related function codes

Function code	Name	V/f control	Remarks
F40	Torque limiter 1 (Driving)	Y	
F41	Torque limiter 1 (Braking)	Y	
E16	Torque limiter 2 (Driving)	Y	
E17	Torque limiter 2 (Braking)	Y	
H76	Torque limiter (Frequency rising limit for braking)	Y	

■ Torque limit control mode

Torque limit is performed by limiting torque current flowing across the motor.

The graph below shows the relationship between the torque and the output frequency at the constant torque current limit.



APPENDICES

■ Torque limiter (F40, F41, E16, E17) Data setting range: 0 to 300%; 999 (Disable)

These function codes specify the operation level at which the torque limiters become activated, as the percentage of the motor rated torque.

Function code	Name	Torque limit feature
F40	Torque limiter 1 (Driving)	Driving torque current limiter 1
F41	Torque limiter 1 (Braking)	Braking torque current limiter 1
E16	Torque limiter 2 (Driving)	Driving torque current limiter 2
E17	Torque limiter 2 (Braking)	Braking torque current limiter 2

Note Although the setting range of the torque is 300%, the torque limiter determined by the overload current of the unit internally limits the torque current output. Therefore, the torque current output is automatically limited at a value lower than 300%, the maximum setting value.

■ Torque limiter levels specified via communications link (S10, S11)

The torque limiter levels can be changed via the communications link. Communication dedicated codes S10, S11 interlock with the function codes F40, F41.

■ Switching torque limiters

The torque limiters can be switched by the function code setting and the terminal command “TL2/TL1” (Select torque limiter level 2/1) assigned to any of the digital input terminals. To assign the Torque limiter 2/Torque limiter 1, “TL2/TL1” set Data = 14 in function codes from E01 to E05. If no “TL2/TL1” is assigned, torque limiter levels 1-1 and 1-2 (F40 and F41) take effect by default.

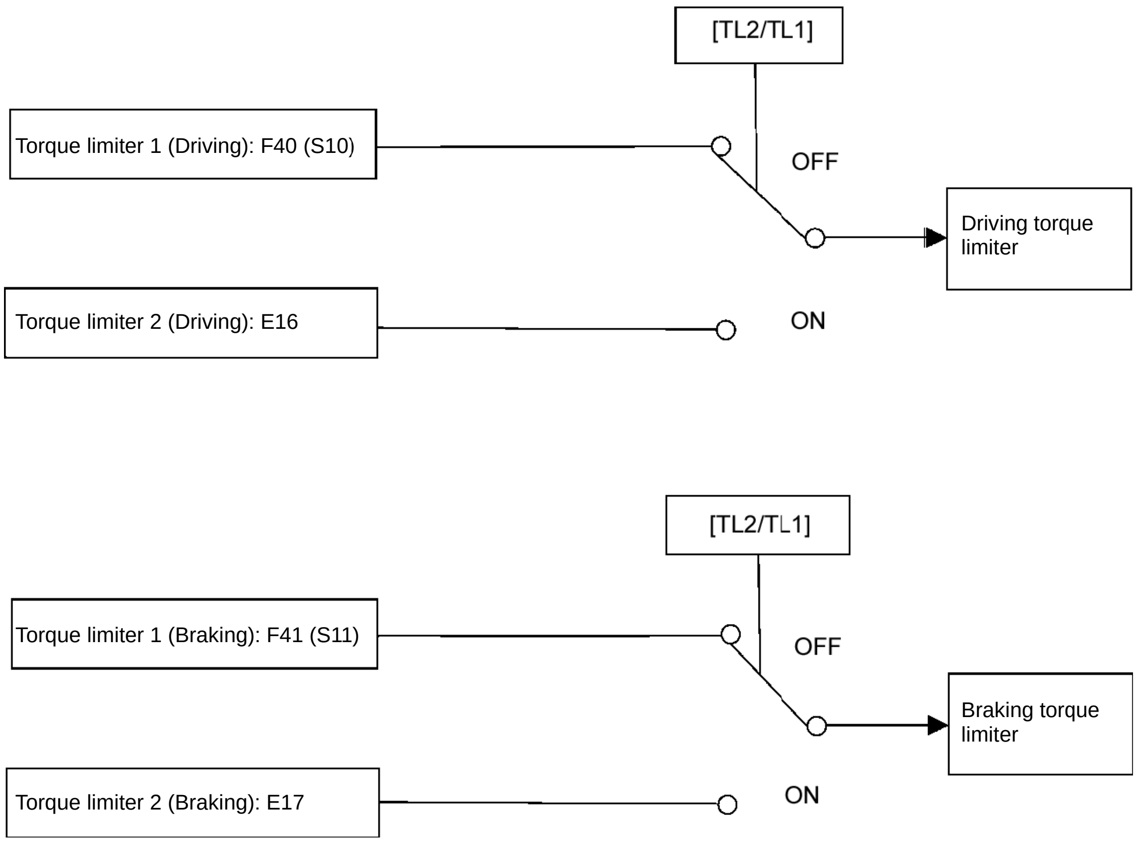


Figure J.8 Switching torque limits diagram

■ **Torque limiter (Braking) (Frequency rising limit for braking) (H76) Data setting range: 0.0 to 500.0 (Hz)**

H76 specifies the rising limit of the frequency in limiting torque for braking. The Factory defaults are 5.0 Hz. If the increasing frequency during braking reaches the limit value, the torque limiters no longer function, resulting in an overvoltage trip. Such a problem may be avoided by increasing the setting value of H76.

Note The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting. Avoid concurrent activation of these limiters.

Under vector control without speed sensor nor pole position sensor (PMSM) (F42=15)

When a PMSM is driven under vector control without speed sensor nor pole position sensor, the torque limiters are used like as IM driven under vector control without speed sensor.

Note When switching control target motor and control method with the function code F42, the Factory defaults are also switched.

The factory default for PMSM is 200%.

Table J.6 Related function codes

Function code	Name	Vector control	Remarks
F40	Torque limiter 1 (Driving)	Y	Factory defaults are “200%” (F42=15)
F41	Torque limiter 1 (Braking)	Y	
E16	Torque limiter 2 (Driving)	Y	Factory defaults are “999”
E17	Torque limiter 2 (Braking)	Y	

F42 Drive control selection 1

F42 specifies the motor drive control.

F42 data	Control mode	Basic control	Speed feedback	Speed control
0	V/f control without slip compensation	V/f control	Disable	Frequency control
1	Vector control without speed sensor (dynamic torque vector)			With slip compensation Frequency control
2	V/f control with slip compensation			
15	Vector control for synchronous motor without speed sensor nor pole position sensor	Vector control	Estimated speed	Speed control with automatic speed regulator (ASR)

■ **V/f control for induction motor without slip compensation (F42=0)**

Under this control, the inverter controls an induction motor with the voltage and frequency according to the V/f pattern specified by function codes.

Vector control without speed sensor (dynamic torque vector) (F42=1)

To get the maximal torque out of a motor, this control calculates the motor torque matched to the load applied and uses it to optimize the voltage and current vector output.

When the vector control without speed sensor (dynamic torque vector) is selected, automatically auto torque boost and slip compensation become enabled. This control is effective for improving the system response to external disturbances such as load fluctuations, and the motor speed control accuracy.

Note that the inverter may not respond to a rapid load fluctuation.

Note For slip compensation in case of vector control without speed sensor, constants of motor are used. Therefore, satisfy the following conditions below. If these conditions cannot be satisfied, sufficient control performance may not be obtained.

- A single motor is controlled per inverter.
- The prerequisite is that motor parameter P02, P03, P06 to P13 are accurately set or auto-tuning is performed.

- Under vector control without speed sensor, the capacity of the motor to be controlled must be not less than two ranks lower of the nominal applied motor capacity. Otherwise, the inverter may not control the motor due to decrease of the current detection resolution.
- The wiring distance between the inverter and motor should be 50 m (164 ft) or less. If it is longer, the inverter may not control the motor due to leakage current flowing through stray capacitance to the ground or between wires. Especially, small capacity inverters whose rated current is also small may be unable to control the motor correctly even if the wiring is less than 50 m (164 ft). In that case, make the wiring length as short as possible or use a wire with small stray capacitance (e.g., loosely-bundled cable) to minimize the stray capacitance.

■ V/f control with slip compensation (F42=2)

Applying any load to an induction motor causes a rotational slip due to the motor characteristics, decreasing the motor rotation. The inverter's slip compensation function first presumes the slip value of the motor based on the motor torque generated and raises the output frequency to compensate for the decrease in motor rotation. This prevents the motor from decreasing the rotation due to the slip.

That is, this function is effective for improving the motor speed control accuracy.

Function code		Action
P12	Rated slip frequency	Specify the rated slip frequency.
P09	Slip compensation gain for driving	Adjust the slip compensation amount for driving. Slip compensation amount for driving = Rated slip x Slip compensation gain for driving
P11	Slip compensation gain for braking	Adjust the slip compensation amount for braking. Slip compensation amount for braking = Rated slip x Slip compensation gain for braking
P10	Slip compensation response time	Specify the slip compensation response time. Basically, there is no need to modify the setting.

To improve the accuracy of slip compensation, perform auto-tuning.

H68 enables or disables the slip compensation function 1 according to the motor driving conditions.

H68 data	Motor driving conditions		Motor driving frequency zone	
	Accel / Decel	During constant speed	Base frequency or below	Above the base frequency
0	Enable	Enable	Enable	Enable
1	Disable	Enable	Enable	Enable
2	Enable	Enable	Enable	Disable
3	Disable	Enable	Enable	Disable

■ Vector control for synchronous motor without speed sensor nor pole position sensor (F42=15)

This control estimates the motor speed based on the inverter's output voltage and current, and uses the estimated speed for speed control. It also decomposes the motor drive current into the exciting and torque current components, and controls each of those components as vectors. No PG (pulse generator) interface card is required. It is possible to obtain the desired response by adjusting the control constants (PI constants) using the speed regulator (PI controller).

Note When changing function code F42 to data 15 "Vector control for synchronous motor without speed sensor nor pole position sensor" by the keypad, then the inverter automatically updates data of F03, F04, F05 and others.

■ Control parameters which are initialized when the control method F42 is changed

When control method (F42) is switched between synchronous motor and induction motor, the data of related function codes are also switched to the default value. See the table below.

Function code	Switch F42 between 0 and 15	Change P02	H03=2 with F42=0	H03=2 with F42=15
F03	Y	N	N	N
F04	Y	N	N	Y
F05	Y	N	N	Y
F06	Y	N	N	Y
F10	N	N	N	Y
F11	Y	N	N	Y
F12	Y	N	N	Y
F15	Y	N	N	N
F23	Y	N	N	N
F26	Y	N	N	N
F40, F41	Y	N	N	N
E50	Y	N	N	N
P01	Y	N	Y	Y
P02	N	N	N	N
P03	Y	Y	Y	Y
P06 to P08	N	Y	Y	Y
P30	N	Y	Y	Y
P60 to P64	N	Y	Y	Y
P65	N	Y	Y	Y
P74	N	Y	Y	Y
P83	N	Y	Y	Y
P84	N	Y	Y	Y
P85	N	Y	Y	Y
P87 to P89	N	Y	Y	Y
P90	N	Y	Y	Y
P99	Y	N	N	N
H46	N	Y	Y	Y
d01 to d04	Y	N	N	N

Y: Switched N: Not switched

F43, F44	Current limiter (Mode selection and Level) Related function codes: H12 Instantaneous overcurrent limiting (Mode selection)

When the output current of the inverter exceeds the level specified by the current limiter (F44), the inverter automatically manages its output frequency to prevent a stall and limits the output current. According to limit value based on Inverter's rated current, the default setting of the current limiter is 160% for HHD/HD mode, and 130% for HND/ND mode, respectively (Initial value is automatically written when selecting ND/HD/HND/HHD by function code F80) If overload current, higher than the current limiter level, flows instantaneously so that the output frequency decrease due to the current limiter causes a problem, consider to increase the current limiter level.

The current limiter mode should be also selected with F43. If F43 = 1, the current limiter is enabled only during constant speed operation. If F43 = 2, it is enabled during both of acceleration and constant speed operation. Choose F43 = 1 if you need to run the inverter at full capability during acceleration and to limit the output current during constant speed operation.

■ **Mode selection (F43)**

F43 selects the motor running state in which the current limiter becomes active.

F43 data	Running states that enable the current limiter		
	During acceleration	During constant speed	During deceleration
0	Disabled	Disabled	Disabled
1	Disabled	Action	Disabled
2	Action	Action	Disabled

■ **Level (F44)**

F44 specifies the operation level at which the output current limiter becomes activated, as a ratio of the inverter rating.

- Data setting range: 20 to 200 (%) of rated current of the inverter
  (Inverter's rated current changes according to the setting value of function code F80.)

■ **Instantaneous overcurrent limiting (Mode selection) (H12)**

H12 specifies whether the inverter invokes the current limit processing or enters the overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level. Under the current limit processing, the inverter immediately turns OFF its output gate to suppress the further current increase and continues to control the output frequency.

H12 data	Function
0	Disable (An overcurrent trip occurs at the instantaneous overcurrent limiting level.)
1	Enable (An instantaneous overcurrent limiting operation is activated)

If any problem could occur when the motor torque temporarily drops during current limiting processing, it is necessary to cause an overcurrent trip (H12 = 0) and actuate a mechanical brake at the same time.

Note
- Since the current limit operation with F43 and F44 is performed by software, it may cause a delay in control. If you need a quick response current limiting, also enable the instantaneous overcurrent limiting with H12.
- If an excessive load is applied when the current limiter operation level is set extremely low, the inverter will rapidly lower its output frequency. This may cause an overvoltage trip or dangerous turnover of the motor rotation due to undershooting. Depending on the load, extremely short acceleration time may activate the current limiting to suppress the increase of the inverter output frequency, causing hunting (undesirable oscillation of the system) or activating the inverter overvoltage trip (alarm 0u). When specifying the acceleration time, therefore, you need to take into account machinery characteristics and moment of inertia of the load.

Note
- The torque limiter and current limiter are very similar in function. If both are activated concurrently, they may conflict with each other and cause hunting. Avoid concurrent activation of these limiters.
- Vector control with speed sensor itself contains the current control system, so it disables the current limiter specified by F43 and F44, as well as automatically disabling the instantaneous overcurrent limiting (specified by H12). Accordingly, the inverter causes an overcurrent trip when its output current exceeds the instantaneous overcurrent limiting level.

F50 to F52 — Electronic thermal overload protection for braking resistor (Discharging capability, Allowable average loss and Braking resistance value)

These function codes specify the electronic thermal overload protection feature for the braking resistor.

Set the discharging capability, allowable average loss and resistance to F50, F51 and F52, respectively. These values are determined by the inverter and braking resistor models. For the discharging capability, allowable average loss and resistance, refer to the FRENIC-Ace User's Manual Chapter 11 "11.8.4 Specifications."

The values listed in the tables are for standard models and 10% ED models of the braking resistors which Fuji Electric provides. When using a braking resistor of any other manufacturer, confirm the corresponding values with the manufacturer and set the function codes accordingly.

Set 0.00 to F52 when replacing from FRENIC-Multi.

Note: Depending on the thermal characteristics of the braking resistor, the electronic thermal overload protection feature may act so that the inverter issues the overheat protection alarm *dbh* even if the actual temperature rise is not large enough. If this happens, review the relationship between the performance index of the braking resistor and settings of related function codes.

Tip: Using the standard models of braking resistor or using the braking unit and braking resistor together can output temperature detection signal for overheat. Assign terminal command THR ("Enable external alarm trip") to any of digital input terminals [X1] to [X5], [FWD] and [REV] and connect that terminal and its common terminal to braking resistor's terminals 2 and 1.

Calculating the discharging capability and allowable average loss of the braking resistor and configuring the function code data

When using any non-Fuji braking resistor, inquire to the resistor manufacturer about the resistor rating and then configure the related function codes.

The calculation procedures for the discharging capability and allowable average loss of the braking resistor differ depending on the application of the braking load as shown below.

<Applying braking load during deceleration>

In usual deceleration, the braking load decreases as the speed slows down. In the deceleration with constant torque, the braking load decreases in proportion to the speed.

Use Expressions (1) and (3) given below.

Applying braking load during running at a constant speed

Different from during deceleration, in applications where the braking load is externally applied during running at a constant speed, the braking load is constant.

Use Expressions (2) and (4) given below.

Braking load (kW)

(Braking time)

<Applying braking load during deceleration>

Braking load (kW)

(Braking time)

<Applying braking load during running at a constant speed>

APPENDICES

■ Discharging capability (F50)

The discharging capability refers to kWs allowance for a single braking cycle. It can be calculated from breaking

F50 data	Function
1 to 9000	1 to 9000 (kWs)
OFF	Disable the electronic thermal overload protection

$$\text{Discharging capability (kWs)} = \frac{\text{Braking time (s)} \times \text{Motor rated capacity (kW)}}{2} \qquad (1)$$

$$\text{Discharging capability (kWs)} = \text{Braking time (s) x Motor rated capacity (kW)} \qquad (2)$$

■ Allowable average loss (F51)

Allowance average loss is the resistor capacitor that enables continuous operation of motor. It can be calculated from ED (%) and motor capacity (kW).

F51 data	Function
0.001 to 99.99	0.001 to 99.99 (kW)

$$\text{Allowable average loss (kWs)} = \frac{\frac{\%ED(\%)}{100} \times \text{Motor rated capacity (kW)}}{2} \qquad (3)$$

$$\text{Allowable average loss (kWs)} = \frac{\%ED(\%)}{100} \times \text{Motor rated capacity (kW)} \qquad (4)$$

■ Braking resistance value (F52)

F52 specifies the resistance of the braking resistor.

F52 data	Function
0.00	Braking resistor protection method by FRENIC-Multi series method (Resistance not required)
0.01 to 999	0.01 to 999 (Ω)

F80	Switching between ND,HD,HND and HHD drive modes

ND is the standard mode for specifications other than J (for Japanese) model, therefore, it is possible to alleviate ambient temperature condition and increase overload capability by switching to HHD/HND/HD modes. However, rated current (applicable motor capacity) becomes one or two frames lower.

To change the data of function code F80 data, double key operation with "STOP key + ∧/∨ key" is necessary.

F80 data	Drive mode	Application	Rated current level	Ambient temperature	Overload capability	Maximum output frequency
0	HHD mode	Heavy load	Capable of driving a motor whose capacity is the same as the inverter capacity.	50°C (122°F)	150% 1min, 200% 0.5s	500Hz
1	HND mode	Light load	Capable of driving a motor whose capacity is one rank higher than the inverter capacity.	50°C (122°F)	120% 1 min	500Hz
3	HD mode	Medium load	Capable of driving a motor whose capacity is one rank higher than the inverter capacity.	40°C (104°F)	150% 1 min	500Hz
4	ND mode	Light load	Capable of driving a motor whose capacity is two ranks higher than the inverter capacity.	40°C (104°F)	120% 1 min	120Hz

For the concrete rated current level, refer to the FRENIC-Ace User's Manual Chapter 12 "SPECIFICATIONS." Factory defaults are 0: HHD for Japan and 4: ND for other countries.

Note When, by changing the mode, the motor capacity becomes 75kW or higher, make sure to connect direct current reactor (DCR) according to the motor capacity. However, it is not necessary when using PWM converter.

Failure may occur

ND, HD, HND, and HHD-mode inverters are subject to restrictions on the function code data setting range and internal processing as listed below.

Function code	Name	Remarks
F21	DC braking 1 (Braking level)	Upper limit restriction
F26	Motor sound (Carrier frequency)	Upper limit restriction
F44	Current limiter (Level)	Default setting, setting value
F03	Maximum frequency	Allowed output frequency range

Refer to explanation of each function code and selection guidance in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

J.2 E codes (Extension terminal functions)

E01 to E05	Terminals [X1] to [X5] function Related function codes: Terminal E98 [FWD] function Terminal E99 [REV] function

E01 to E05, E98 and E99 assign commands to general-purpose, programmable, digital input terminals, [X1] to [X5], [FWD], and [REV].

These function codes can also switch the logic system between normal and negative to define how the inverter logic interprets the ON or OFF state of each terminal. The factory default setting is normal logic system "Active ON." Functions assigned to digital input terminals [X1] to [X5], [FWD] and [REV] are as shown below. Descriptions that follow are given in normal logic system. Each signal has been described at data allocation order. However, the signal is related has been described together. Refer to the function codes in the "Related function codes" column, if any.

The FRENIC-Ace runs under "V/f: V/f control or "PM SLV: vector control without speed sensor nor pole position sensor for permanent magnet synchronous motor." Some terminal commands assigned apply exclusively to the specific drive control, which is indicated by letters Y (Applicable) and N (Not applicable) in the "Control mode" column in the table given below.

⚠CAUTION

- Run commands (e.g., Run forward "FWD"), stop commands (e.g., Coast to a stop "BX"), and frequency change commands can be assigned to digital input terminals. Depending on the state of digital input terminals, modifying a single function code setting may cause abrupt start of operation or significant change of the speed. Ensure safety before modifying the function code settings.
- Functions for switching run or frequency command sources (such as "SS1, SS2, SS4, SS8", "Hz2/Hz1", "Hz/PID", "IVS" and "LE") can be assigned to the digital input terminals. Switching these signals may cause a sudden motor start or an abrupt change in speed depending on the condition.

An accident or physical injury may result.

Data		Terminal commands assigned	Symbol	Control mode		Related function codes
Active ON	Active OFF			V/f	PM SLV	
0	1000	Select multistep frequency (1 to 15 steps)	"SS1"	Y	Y	C05 to C19
1	1001		"SS2"	Y	Y	
2	1002		"SS4"	Y	Y	
3	1003		"SS8"	Y	Y	
4	1004	Select ACC/DEC time (2 steps)	"RT1"	Y	Y	F07, F08, E10 to E15
5	1005	Select ACC/DEC time (4 steps)	"RT2"	Y	Y	
6	1006	Select 3-wire operation	"HLD"	Y	Y	F02
7	1007	Coast to a stop command	"BX"	Y	Y	—
8	1008	Reset alarm	"RST"	Y	Y	—
1009	9	External alarm	"THR"	Y	Y	—
11	1011	Select frequency setting 2/1	"Hz2/Hz1"	Y	Y	F01, C30
13	-	DC braking command	"DCBRK"	Y	N	F20 to F22
14	1014	Select torque limit 2/ Torque limit 1	"TL2/TL1"	Y	Y	F40, F41 E16, E17
15	—	Switch to commercial power (50Hz)	"SW50"	Y	N	—
16	—	Switch to commercial power (60Hz)	"SW60"	Y	N	—
17	1017	UP command	"UP"	Y	Y	Frequency setting: F01, C30 PID command: J02
18	1018	DOWN command	"DOWN"	Y	Y	
19	1019	Allow function code editing (Data change enabled)	"WE-KP"	Y	Y	F00
20	1020	Cancel PID control	"Hz/PID"	Y	Y	J01 to J19, J57 to J62

Data		Terminal commands assigned	Symbol	Control mode		Related function codes
Active ON	Active OFF			V/f	PM SLV	
21	1021	Switch normal/inverse operation	“IVS”	Y	Y	C53, J01
22	1022	Interlock	“IL”	Y	Y	F14
24	1024	Select link operation (RS-485, BUS option)	“LE”	Y	Y	H30, y98
25	1025	Universal DI	“U-DI”	Y	Y	—
26	1026	Select auto search for idling motor speed at starting	“STM”	Y	Y	H09, d67
1030	30	Force to stop	“STOP”	Y	Y	F07, H56
33	1033	Reset PID integral and differential terms	“PID-RST”	Y	Y	J01 to J19, J57 to J62
34	1034	Hold PID integral term	“PID-HLD”	Y	Y	
35	1035	Select local (keypad) command	“LOC”	Y	Y	(See Section 3.3.6)
38	1038	Run enable	“RE”	Y	Y	-
39	—	Dew condensation prevention	“DWP”	Y	Y	J21
40	—	Enable integrated sequence to switch to commercial power (50Hz)	“ISW50”	Y	N	J22
41	—	Enable integrated sequence to switch to commercial power (60Hz)	“ISW60”	Y	N	J22
48	—	Pulse train input (Only for X5 terminal (E05))	“PIN”	Y	Y	F01, C30 d62, d63
49	1049	Pulse train sign (Other than X5 terminal (E01 to E04))	“SIGN”	Y	Y	
50	1050	Clear running motor regular switching time	“MCLR”	Y	Y	-
72	1072	Count the run time of commercial power-driven motor 1	“CRUN-M1”	Y	N	H44,H94
78	1078	Select speed control parameter 1	“MPRM1”	N	N	d01 to d08
80	1080	Cancel customizable logic	“CLC”	Y	Y	E01 toE05, U81 to U90
81	1081	Clear all customizable logic timers	“CLTC”	Y	Y	
82	1082	Cancel anti-regenerative control	“AR-CCL”	Y	Y	H69
87	1087	Run command 2/ 1	“FR2/FR1”	Y	Y	-
88	—	Run forward / stop 2	“FWD2”	Y	Y	-
89	—	Run reverse / stop 2	“REV2”	Y	Y	-
98	—	Run forward (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	“FWD”	Y	Y	F02
99	—	Run reverse (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99)	“REV”	Y	Y	
100	—	No function assigned	“NONE”	Y	Y	U81 to U90
149	1149	Switch pump control	“PCHG”	Y	Y	J401 to J493
150	1150	Enable master motor drive in mutual operation	“MEN0”	Y	Y	
151	1151	Enable pump control motor 1 to be driven	“MEN1”	Y	Y	
152	1152	Enable pump control motor 2 to be driven	“MEN2”	Y	Y	
153	1153	Enable pump control motor 3 to be driven	“MEN3”	Y	Y	
154	1154	Enable pump control motor 4 to be driven	“MEN4”	Y	Y	
171	1171	PID control multistage command 1	“PID-SS1”	Y	Y	J136 to J138
172	1172	PID control multistage command 2	“PID-SS2”	Y	Y	

Data		Terminal commands assigned	Symbol	Control mode		Related function codes
Active ON	Active OFF			V/f	PM SLV	
181	1181	External PID1 multistage command 1	"EPID-SS1"	Y	Y	J501 to J553
182	1182	External PID1 multistage command 2	"EPID-SS2"	Y	Y	
201	1201	External PID1 ON command	"EPID1-ON"	Y	Y	
202	1202	External PID1 Cancel	"%EPID1"	Y	Y	
203	1203	External PID1 Switch normal/inverse operation	"EPID1-IVS"	Y	Y	
204	1204	External PID1 reset integral and differential omponents	"EPID1-RST"	Y	Y	
205	1205	External PID1 hold integral component	"EPID1-HLD"	Y	Y	

Note: Negative logic (Active OFF) command cannot be assigned to the functions marked with "-" in the "Active OFF" column.

The "External alarm" (data = 1009) and "Force to stop" (data = 1030) are fail-safe terminal commands. In the case of "External alarm" when data = 1009, "Active ON" (alarm is triggered when ON); when data = 9, "Active OFF" (alarm is triggered when OFF).

Terminal function assignment and data setting

■ **Select multistep frequency – "SS1", "SS2", "SS4", and "SS8" (Function code data = 0, 1, 2, and 3)**

The combination of the ON/OFF states of digital input signals "SS1", "SS2", "SS4" and "SS8" selects one of 16 different frequency commands defined beforehand by 15 function codes C05 to C19 (Multistep frequency 1 to 15). With this, the inverter can drive the motor at 16 different preset frequencies. (📖 Function codes C05 to C19)

■ **Select ACC/DEC time – "RT1" and "RT2" (Function code data = 4 and 5)**

These terminal commands switch between ACC/DEC time 1 to 4 (F07, F08 and E10 through E15).

(📖 Functions codes F07 and F08)

■ **Select 3-wire operation – "HLD" (Function code data = 6)**

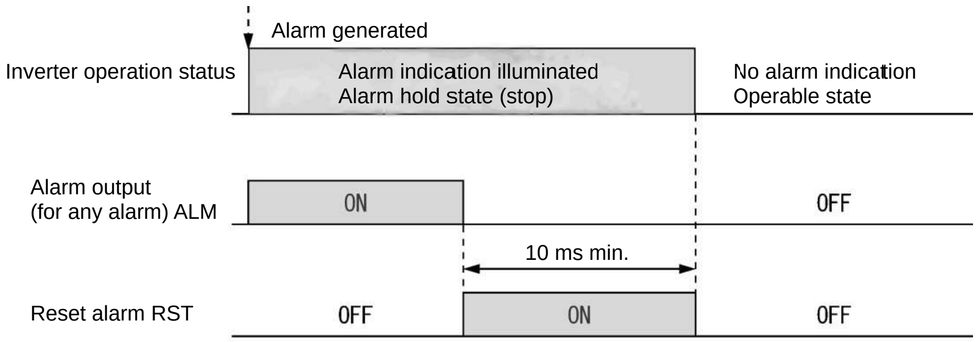
Turning this terminal command ON self-holds the forward "FWD", reverse "REV", run command, to enable 3-wire inverter operation. (📖 Function code F02)

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

Turning "BX" ON immediately shuts down the inverter output. The motor coasts to a stop, without issuing any alarm.

■ **Reset alarm – "RST" (Function code data = 8)**

Turning this terminal command ON clears the ALM state--alarm output (for any alarm). Turning it OFF erases the alarm display and clears the alarm hold state. When you turn the "RST" command ON, keep it ON for 10 ms or more. This command should be kept OFF for the normal inverter operation.



■ **External alarm – "THR" (Function code data = 9)**

Turning this terminal command OFF immediately shuts down the inverter output (so that the motor coasts to a stop), displays the alarm *0h2*, and issues the alarm output (for any alarm) ALM. The THR command is self-held, and is reset when an alarm reset takes place.

Tip: Use this alarm trip command from external equipment when you have to immediately shut down the inverter output in the event of an abnormal situation in peripheral equipment.

■ **Select frequency setting 2/1 – "Hz2/Hz1" (Function code data = 11)**

Turning this terminal command ON and OFF switches the frequency command source between frequency setting 1 (F01) and frequency setting 2 (C30). (📖 Function code F01)

■ **DC braking command – "DCBRK" (Function code data = 13)**

This terminal command gives the inverter a DC braking command through the inverter's digital input.

(Requirements for DC braking must be satisfied.) (📖 Function codes F20 to F22)

■ **Select torque limit 2/1 – "TL2/TL1" (Function code data = 14)**

This terminal command switches between torque limiter 1 (F40 and F41) and torque limiter 2-1, 2-2 (E16 and E17). (📖 Function codes F40 and F41)

■ **Switch to commercial power for 50 Hz or 60 Hz – "SW50" and "SW60" (Function code data = 15 and 16)**

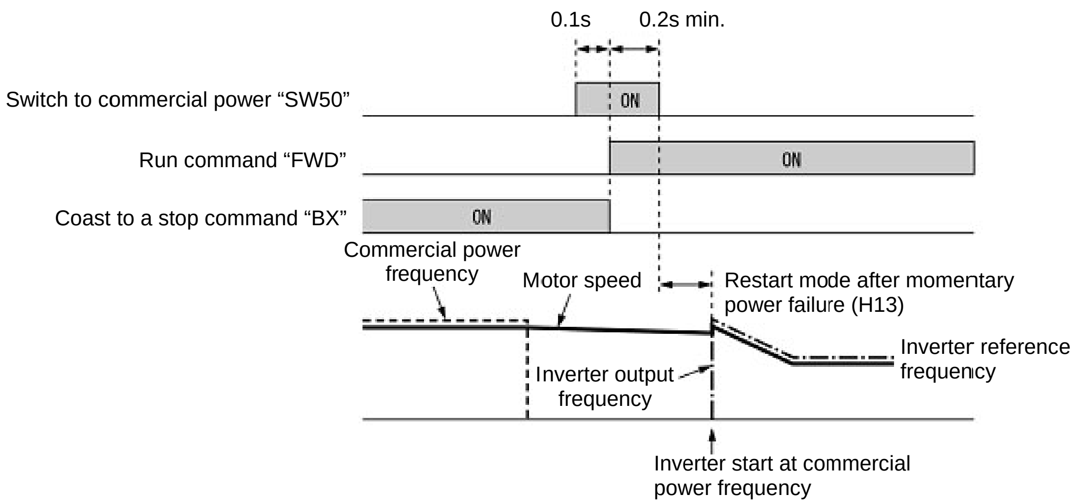
When an external sequence switches the motor drive power from the commercial line to the inverter, the terminal command SW50 or SW60 enables the inverter to start running the motor with the current commercial power frequency, regardless of settings of the reference/output frequency in the inverter. A running motor driven by commercial power is carried on into inverter operation. This command helps you smoothly switch the motor drive power source from the commercial power to the inverter power.

For details, refer to the table below, "Operation timing scheme", "Example of Sequence Circuit" and "Example of Operation Time Scheme" on the following pages.

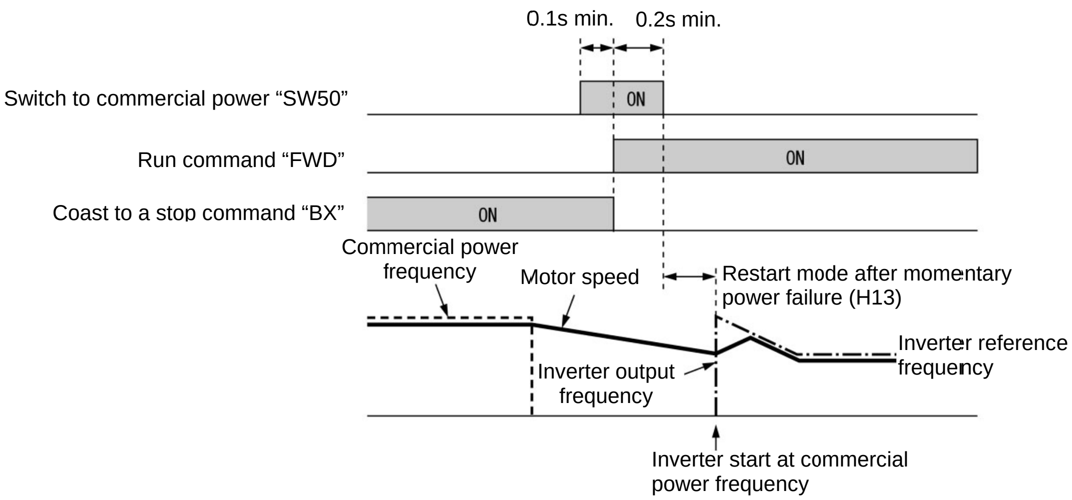
Terminal command assigned	Action	
Switch to commercial power for 50 Hz "SW50"	Starts at 50 Hz.	Note: Do not concurrently assign both SW50 and SW60.
Switch to commercial power for 60 Hz "SW60"	Starts at 60 Hz.	

<Operation timing scheme>

- When the motor speed remains almost the same during coast-to-stop:



- When the motor speed decreases significantly during coast-to-stop (with the current limiter activated)



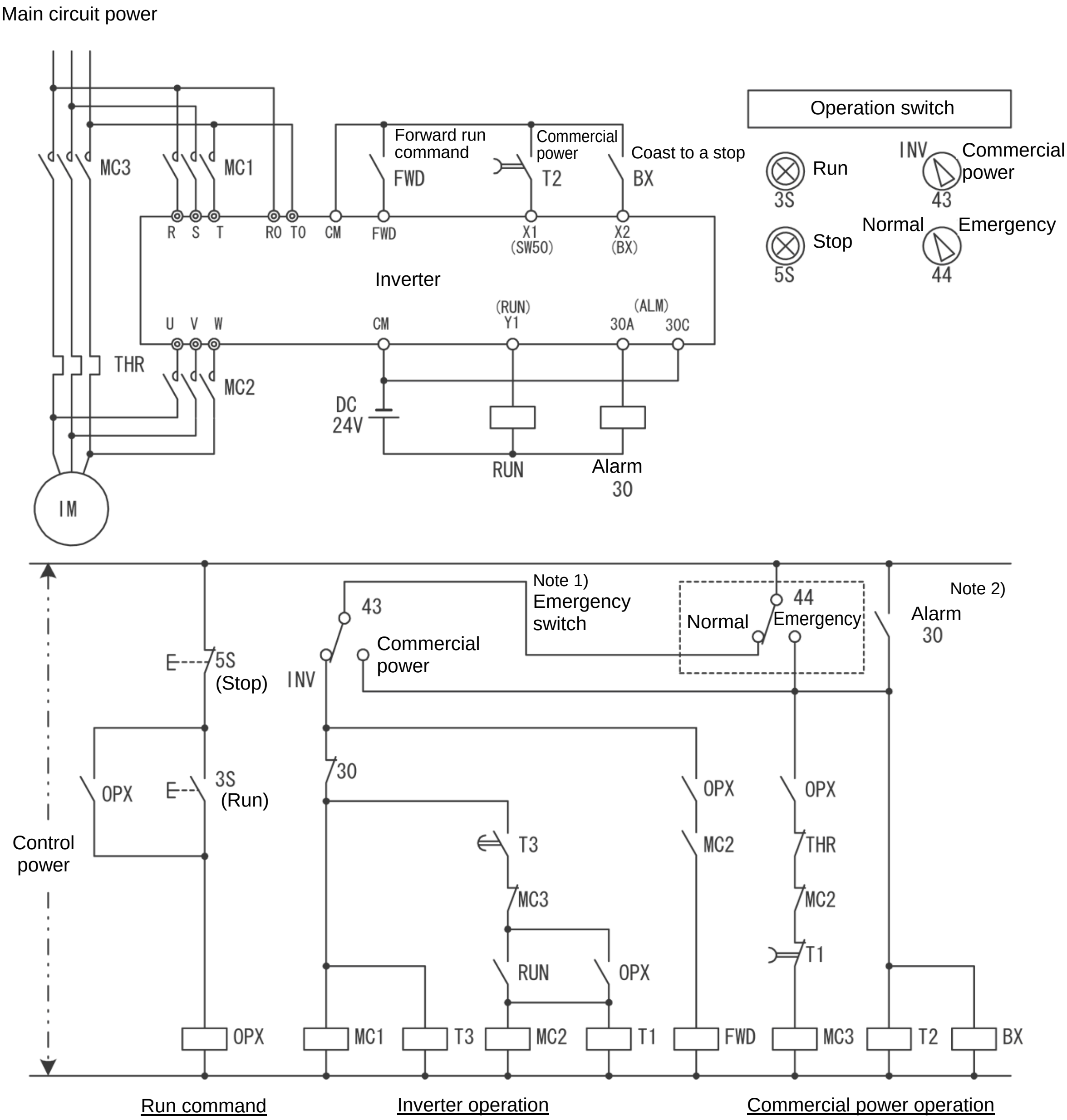
Note

- Secure more than 0.1 second after turning ON the “Switch to commercial power” signal before turning ON a run command.
- Secure more than 0.2 second of an overlapping period with both the “Switch to commercial power” signal and run command being ON.
- If an alarm has been issued or BX has been ON when the motor drive source is switched from the commercial power to the inverter, the inverter will not be started at the commercial power frequency and will remain OFF. After the alarm has been reset or “BX” turned OFF, operation at the frequency of the commercial power will not be continued, and the inverter will be started at the ordinary starting frequency.

If you wish to switch the motor drive source from the commercial line to the inverter, be sure to turn “BX” OFF before the “Switch to commercial power” signal is turned OFF.

- When switching the motor drive source from the inverter to commercial power, adjust the inverter’s reference frequency at or slightly higher than that of the commercial power frequency beforehand, taking into consideration the motor speed down during the coast-to-stop period produced by switching.
- Note that when the motor drive source is switched from the inverter to the commercial power, a high inrush current will be generated, because the phase of the commercial power usually does not match the motor speed at the switching. Make sure that the power supply and all the peripheral equipment are capable of withstanding this inrush current.
- If you have enabled “Restart mode after momentary power failure” (F14 = 3, 4, or 5), keep “BX” ON during commercial power driven operation to prevent the inverter from restarting after a momentary power failure.

<Example of Sequence Circuit>

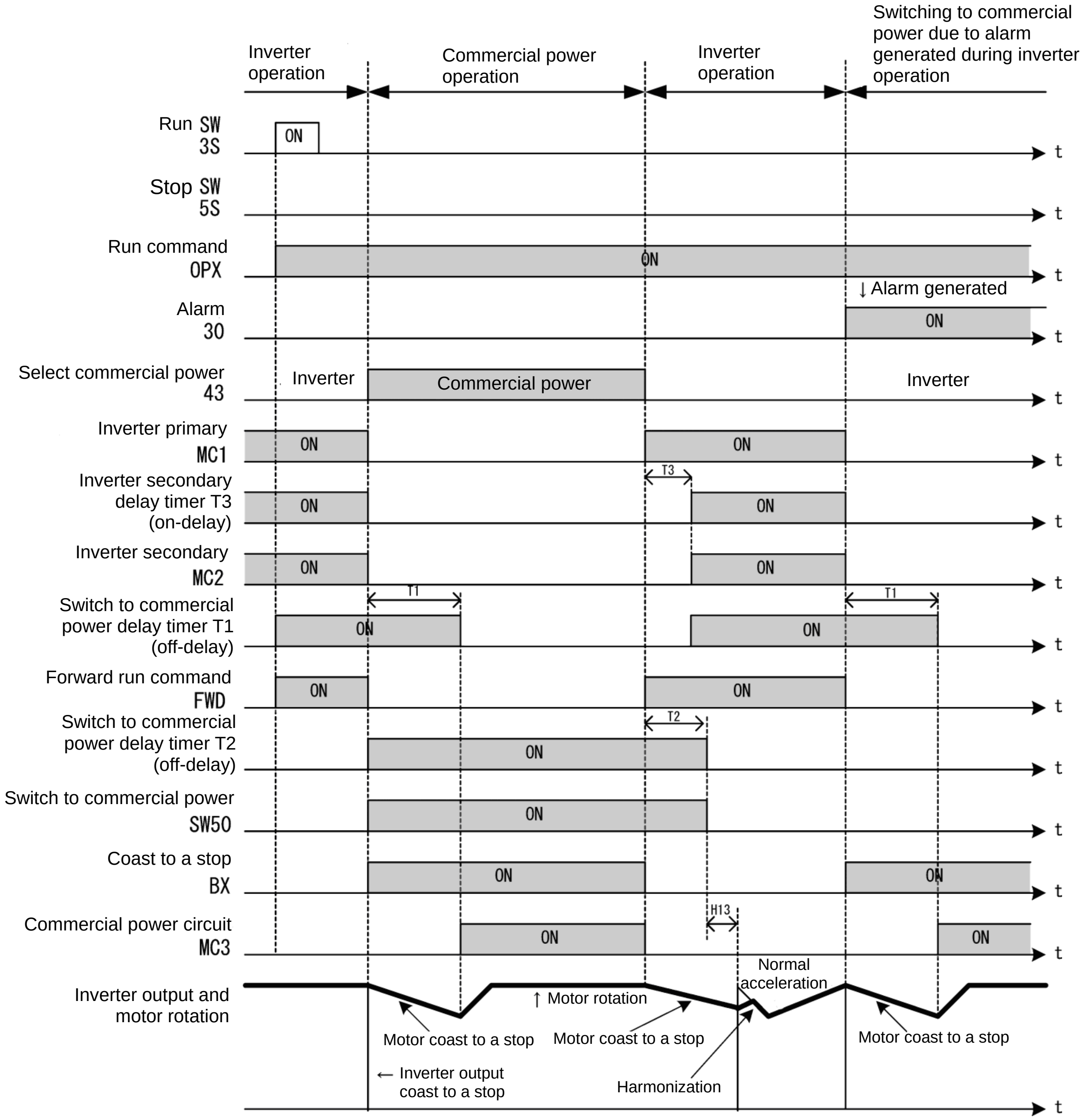


Note 1) Emergency switch

Manual switch provided for the event that the motor drive source cannot be switched normally to the commercial power due to a serious problem of the inverter

Note 2) When any alarm has occurred inside the inverter, the motor drive source will automatically be switched to the commercial power.

<Example of Operation Time Scheme>



■ **"UP" (Increase output frequency) and "DOWN" (Decrease output frequency) commands -- UP and DOWN (Function code data = 17 and 18)**

- Frequency command: Turning the terminal command "UP" or "DOWN" ON causes the output frequency to increase or decrease, respectively, within the range from 0 Hz to the maximum frequency. (🕮 Function code F01 data = 7)
- PID command: Turning the terminal command "UP" or "DOWN" ON causes the PID command value to increase or decrease, respectively, within the range from 0 to 100%. (🕮 Function code J02 (data= 3)

■ **Allow function code editing – "WE-KP" (Function code data = 19)**

Turning the terminal command "WE-KP" OFF protects function code data from accidentally getting changed by pressing the keys on the keypad. Only when this terminal command is ON, you can change function code data from the keypad. (🕮 Function code F00)

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

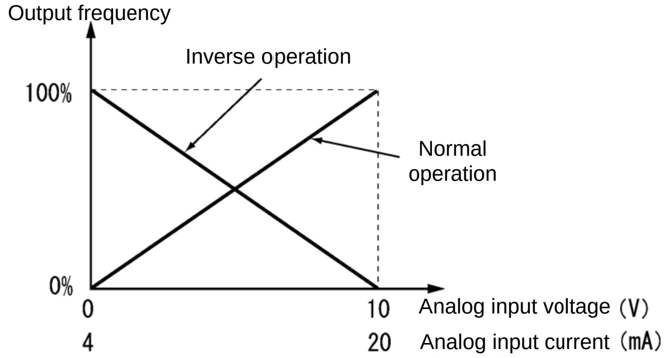
Turning this terminal command "Hz/PID" ON disables PID control. If the PID control is disabled with this command, the inverter runs the motor with the reference frequency manually set by any of the multistep frequency, keypad, analog input, etc.

Terminal command "Hz/PID"	Function
OFF	Enable PID control
ON	Disable PID control (Enable manual settings)

(📖 Function codes J01 to J19, J57 to J62)

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

This terminal command switches the output frequency control between normal (proportional to the input value) and inverse in analog frequency setting or under PID process control. To select the inverse operation, turn the IVS ON.



Tip: The normal/inverse switching operation is useful for air-conditioners that require switching between cooling and heating. In cooling, the speed of the fan motor (output frequency of the inverter) is increased to lower the temperature. In heating, the speed of the fan motor (output frequency of the inverter) is reduced to lower the temperature. This switching is realized by the IVS.

- **When the inverter is driven by an external analog frequency setting sources (terminals [12] and [C1] (C1 function) and [C1] (V2 function)):**

Switching normal/inverse operation can apply only to the analog frequency command sources (terminals [12] and [C1] (C1 function) and [C1] (V2 function)) in frequency setting 1 (F01) and does not affect frequency setting 2 (C30) or UP/DOWN control. As shown below, the combination of the "Selection of normal/inverse operation for frequency setting 1" (C53) and the terminal command "IVS" determines the final operation.

C53 data	Terminal command "IVS"	Action
0: Normal operation	OFF	Normal
0: Normal operation	ON	Inverse
1: Inverse operation	OFF	Inverse
1: Inverse operation	ON	Normal

- **When process control is performed by the PID processor integrated in the inverter:**

The terminal command Hz/PID ("Cancel PID control") can switch PID control between enabled (process is to be controlled by the PID processor) and disabled (process is to be controlled by the manual frequency setting). In either case, the combination of the "PID control" (J01) or "Selection of normal/inverse operation for frequency setting 1" (C53) and the terminal command IVS determines the final operation as listed Table and Table J.2.

Table J.7 When PID control is enabled:
The normal/inverse operation selection for the PID processor output (reference frequency) is as follows.

PID control (Mode selection) (J01)	Terminal command "IVS"	Action
1: Enable (normal operation)	OFF	Normal
	ON	Inverse
2: Enable (inverse operation)	OFF	Inverse
	ON	Normal

Table J.2 When PID control is disabled:
The normal/inverse operation selection for the manual reference frequency is as follows.

Selection of normal/inverse operation for frequency setting 1 (C53)	Terminal command "IVS"	Action
0: Normal operation	-	Normal
1: Inverse operation	-	Inverse

Note When process control is performed by the PID control facility integrated in the inverter, the "IVS" is used to switch the PID processor output (reference frequency) between normal and inverse, and has no effect on any normal/inverse operation selection of the manual frequency setting.

(🕮 Function codes J01 to J19, J57 to J62)

■ Interlock – "IL" (Function code data = 22)

In a configuration where a magnetic contactor (MC) is installed in the power output (secondary) circuit of the inverter, the momentary power failure detection feature provided inside the inverter may not be able to accurately detect a momentary power failure by itself. Using a digital signal input with the interlock command IL assures the accurate detection. (🕮 Function code F14)

Terminal command "IL"	Meaning
OFF	No momentary power failure has occurred.
ON	A momentary power failure has occurred. (Restart after a momentary power failure enabled)

■ Select link operation (RS-485, BUS option) – "LE" (Function code data = 24)

Turning this terminal command "LE" ON gives priority to frequency commands or run commands received via the RS-485 communications link (H30) or the fieldbus option (y98). No LE assignment is functionally equivalent to the "LE" being ON. (🕮 Function codes H30 and y98)

■ Universal DI -- "U-DI" (Function code data = 25)

Universal DI "U-DI" assigned to digital input terminals allow to monitor signals from peripheral equipment connected to those inputs from an upper controller via an RS-485 or fieldbus communications link. Input terminals assigned to "U-DI" are simply monitored and do not operate the inverter.

🕮 For an access to universal DI via the RS-485 or fieldbus communications link, refer to their respective Instruction Manuals.

■ Select auto search for idling motor speed at starting – "STM" (Function code data = 26)

This digital terminal command determines, at the start of operation, whether or not to search for idling motor speed and follow it. (🕮 Function code H09)

■ **Force to stop – "STOP" (Function code data = 30)**

Turning this terminal command "STOP" OFF causes the motor to decelerate to a stop in accordance with the H56 data (Deceleration time for forced stop). After the motor stops, the inverter enters the alarm state with the alarm *er6* displayed. (📖 Function code F07)

■ **Reset PID integral and differential terms – "PID-RST" (Function code data = 33)**

Turning this terminal command "PID-RST" ON resets the integral and differential components of the PID processor. (📖 Function codes J01 to J19, J23, J24, J57 to J62)

■ **Hold PID integral term – "PID-HLD" (Function code data = 34)**

Turning this terminal command "PID-HLD" ON holds the integral components of the PID processor.
(📖 Function codes J01 to J19, J23, J24, J57 to J62)

■ **Select local (keypad) command – "LOC" (Function code data = 35)**

This terminal command "LOC" switches the sources of run and frequency commands between remote and local.

📖 For details of switching between remote and local modes, refer to the FRENIC-Ace User's Manual Chapter 3 "3.3.6 Remote and local modes."

■ **Enable run commands – "RE" (Function code data = 38)**

Once this terminal command is assigned to any digital input terminal, the inverter no longer starts running with a run command only. Upon receipt of a run command, the inverter gets ready to run and outputs an "AX2" signal ("Run command entered").

Entering an "RE" signal ("Enable run commands") when the inverter is ready for running starts the inverter to run.

Input		Output	Inverter status
Run command (e.g., FWD)	Enable run commands ***RE***	Run command entered ***AX2***	
OFF	OFF	OFF	Stopped
OFF	ON	OFF	Stopped
ON	OFF	ON	Stopped
ON	ON	ON	Running

Typical operation sequence of RE

(1) A run command "FWD" is given to the inverter.

(2) When the inverter gets ready for running, it outputs an "AX2" signal ("Run command entered").

(3) Upon receipt of the "AX2", the upper equipment gets ready to operate the peripherals (e.g., opening a damper).

(4) Upon completion of preparation of the peripherals, the upper equipment gives an "RE" signal ("Enable run command") to the inverter.

(5) Upon receipt of the "RE", the inverter starts running.

■ **Dew condensation prevention – "DWP" (Function code data = 39)**

By turning ON dew condensation prevention "DWP" with the inverter stopped, DC current flows, and the motor temperature is raised to prevent dew condensation. (📖 Function code J21)

■ Enable integrated sequence to switch to commercial power for 50 Hz and 60 Hz – “ISW50” and “ISW60” (Function code data = 40 and 41)

With the terminal command ***ISW50*** or ***ISW60*** assigned, the inverter controls the magnetic contactor that switches the motor drive source between the commercial power and the inverter output according to the integrated sequence.

This control is effective when not only ***ISW50*** or ***ISW60**** has been assigned to the input terminal but also the ***SW88*** and SW52-2 signals have been assigned to the output terminals. (It is not essential to assign the ***SW52-1*** signal.)

* The ***ISW50*** or ***ISW60*** should be selected depending upon the frequency of the commercial power; the former for 50 Hz and the latter for 60 Hz.

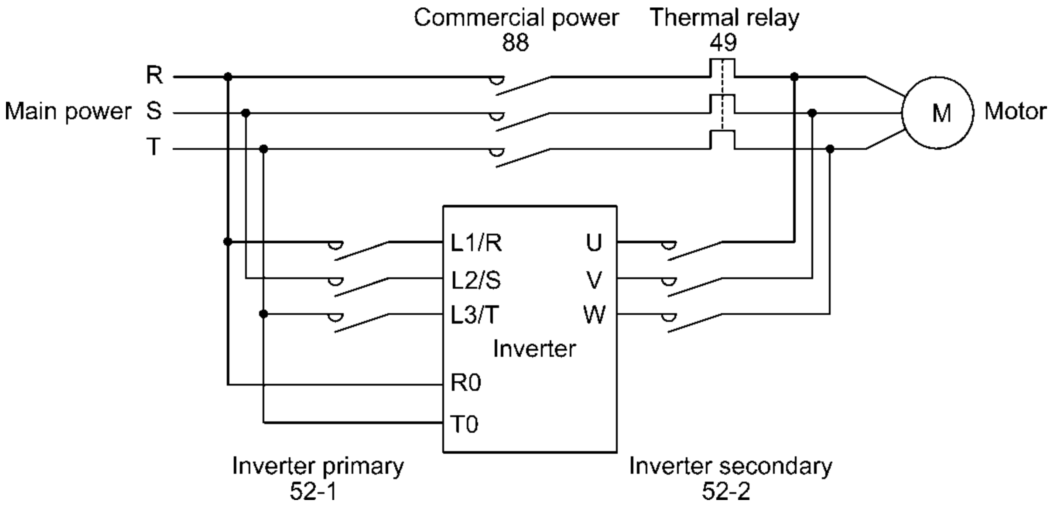
For details about ***SW88*** and ***SW52-2*** ("Switch motor drive source between commercial power and inverter output"), refer to E20, E21 and E27.

For details of these commands, refer to the circuit diagrams and timing schemes on the following pages.

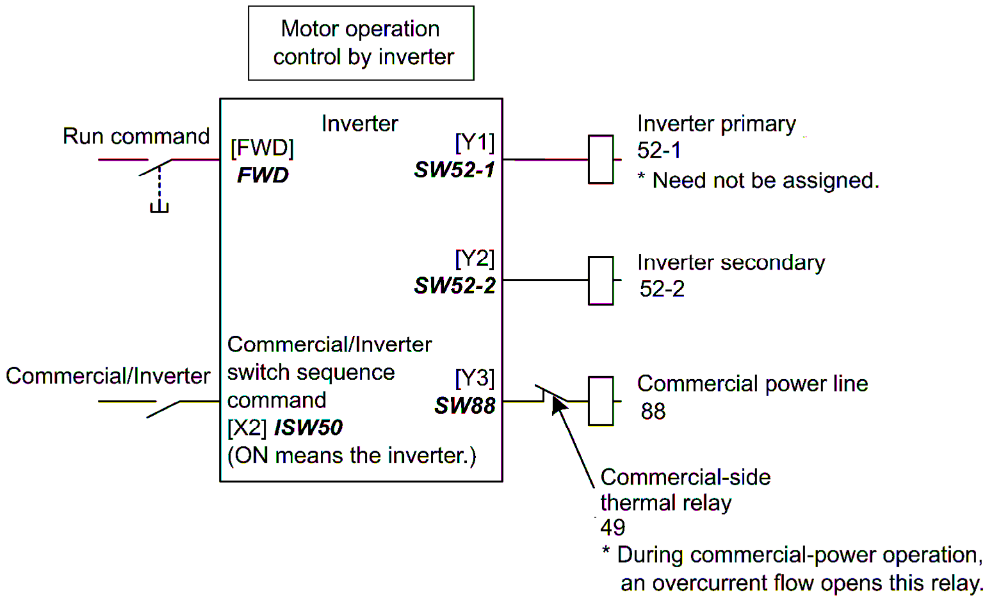
Terminal command assigned	Operation (Switching from commercial power to inverter)
ISW50 Enable integrated sequence to switch to commercial power (50 Hz)	Start at 50 Hz.
ISW60 Enable integrated sequence to switch to commercial power (60 Hz)	Start at 60 Hz.

Note Do not assign both ***ISW50*** and ***ISW60*** at the same time. Doing so cannot guarantee the result.

Circuit Diagram and Configuration



Main Circuit



Configuration of Control Circuit

Summary of Operation

Input		Output (Status signal and magnetic contactor)			Inverter operation
ISW50 or ***ISW60***	Run command	***SW52-1*** 52-1	***SW52-2*** 52-2	***SW88*** 88	
OFF (Commercial power)	ON	OFF	OFF	ON	OFF
	OFF			OFF	
ON (Inverter)	ON	ON	ON	OFF	ON
	OFF				OFF

Timing Scheme

Switching from inverter operation to commercial-power operation
ISW50/***ISW60***: ON → OFF

(1) The inverter output is shut OFF immediately (Power gate IGBT OFF)

(2) The inverter primary circuit ***SW52-1*** and the inverter secondary side ***SW52-2*** are turned OFF immediately.

(3) If a run command is present after an elapse of t1 (0.2 sec + time specified by H13), the commercial power circuit ***SW88*** is turned ON.

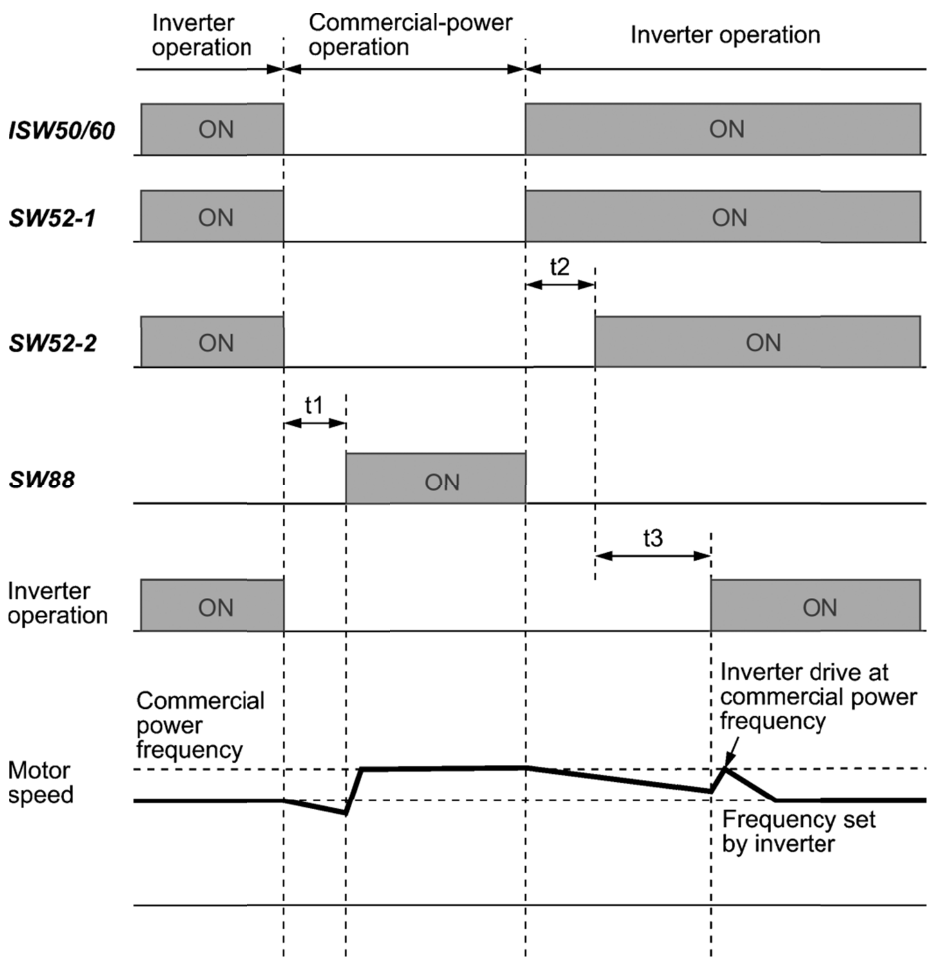
Switching from commercial-power operation to inverter operation
ISW50/ISW60: OFF → ON

(1) The inverter primary circuit ***SW52-1*** is turned ON immediately.

(2) The commercial power circuit ***SW88*** is turned OFF immediately.

(3) After an elapse of t2 (0.2 sec + time required for the main circuit to get ready) from when ***SW52-1*** is turned ON, the inverter secondary circuit ***SW52-2*** is turned ON.

(4) After an elapse of t3 (0.2 sec + time specified by H13) from when ***SW52-2*** is turned ON, the inverter harmonizes once the motor that has been freed from the commercial power to the commercial power frequency. Then the motor returns to the operation driven by the inverter.



t1: 0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

t2: 0.2 sec + Time required for the main circuit to get ready

t3: 0.2 sec + Time specified by H13 (Restart mode after momentary power failure)

Selection of Commercial Power Switching Sequence

J22 specifies whether or not to automatically switch to commercial-power operation when an inverter alarm occurs.

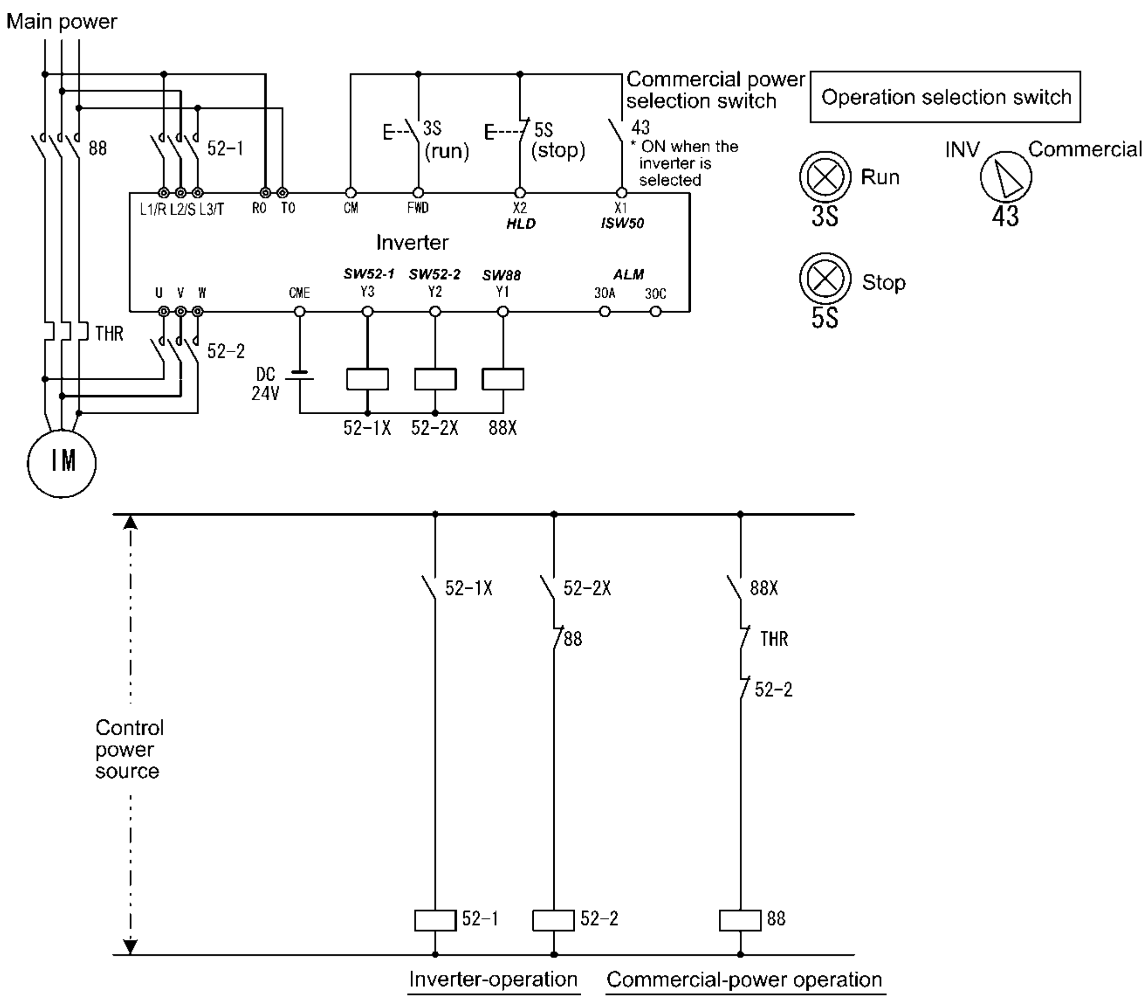
Data for J22	Sequence (upon occurrence of an alarm)
0	Keep inverter-operation (Stop due to alarm.)
1	Automatically switch to commercial-power operation

Note

- The sequence operates normally also even when ***SW52-1*** is not used and the main power of the inverter is supplied at all times.
- Using ***SW52-1*** requires connecting the input terminals [R0] and [T0] for an auxiliary control power. Without the connection, turning ***SW52-1*** OFF loses also the control power.
- The sequence operates normally even if an alarm occurs in the inverter except when the inverter itself is broken. Therefore, for a critical facility, be sure to install an emergency switching circuit outside the inverter.
- Turning ON both the magnetic contactor MC (88) at the commercial-power side and the MC (52-2) at the inverter output side at the same time supplies main power mistakenly from the output (secondary) side of the inverter, which may damage the inverter. To prevent it, be sure to set up an interlocking logic outside the inverter.

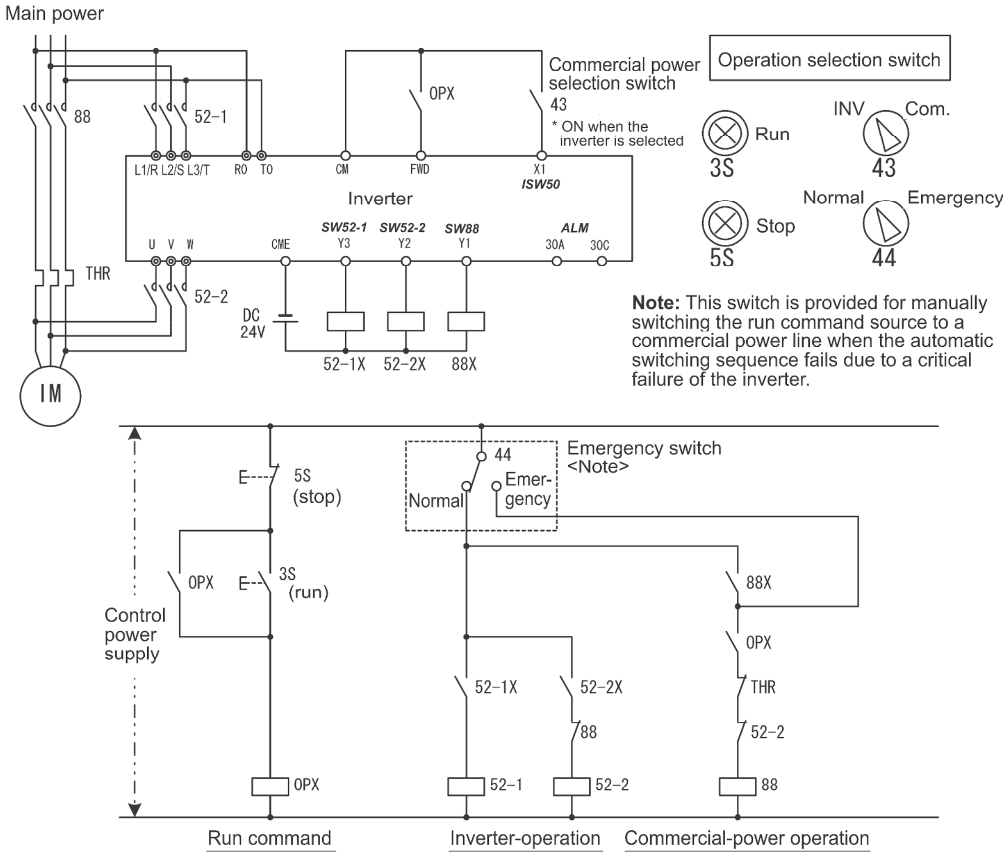
Examples of Sequence Circuits

1) Standard sequence

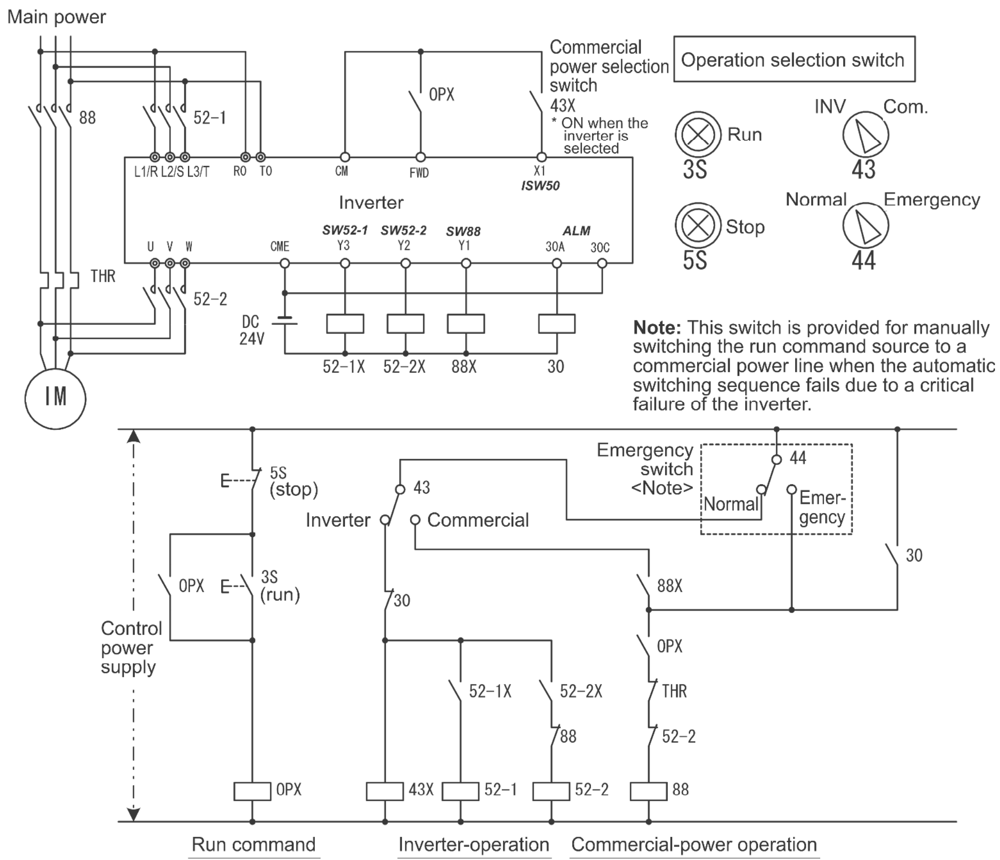


APPENDICES

2) Sequence with an emergency switching function



3) Sequence with an emergency switching function --Part 2 (Automatic switching by the alarm output issued by the inverter)



■ Pulse train input – "PIN" (Only for X5 terminal (E05)) (Function code data = 48), Pulse train sign – "SIGN" (For all terminal except X5 terminal (E05)) (Function code data = 49)

Assigning the command "PIN" to digital input terminal [X5] enables the frequency command by the pulse train input. Assigning the command "SIGN" to one of the digital input terminals except [X5] enables the pulse train sign input to specify the polarity of frequency command. (📖 Function code F01)

■ Clear running motor regular switching time – "MCLR" (Function code data = 50)

Turning the MCLR ON clears the regular switching time of the running motor. (📖 Refer to J436.)

■ Battery/UPS operation valid command "BATRY/UPS" (Function code data = 59)

Battery/UPS operation valid command "BATRY/UPS" (Function code data = 59)

The Battery/UPS operation can drive the motor during undervoltage situation.

FRENIC-Ace has two types of operation and those are selectively used depending on the inverter capacity.

When "BATRY/UPS" is assigned to the digital input terminal, the operation becomes same as F14 = 0 regardless of F14 setting, and the inverter trips immediately .

When "BATRY/UPS" is on, the input open phase protection operation becomes invalid regardless of the function code H98 bit 1 setting.

Battery/UPS operation is divided into battery operation and UPS operation. Battery operation assumes that operation is performed by supplying the main power from the battery, and control power from the UPS. Please note that depending on the inverter capacity, battery operation and UPS operation may not be possible for certain models.

Note

(1) Connect the battery power supply before or simultaneously with turning on the ***BATRY/UPS*** signal.

(2) Between the period from turning on of the ***BATRY/UPS*** signal and MC2 (and power supply start from the battery) to the state that the battery operation is possible, the delay time "T1" + "T2" indicated in the above "time chart" occurs.

(3) Do not turn on the ***BATRY/UPS*** signal when the voltage is same or higher than the specified undervoltage level (before *lu* is indicated after the power failure). If the ***BATRY/UPS*** signal is turned on with the voltage same or higher than the undervoltage value, the specified level, the short circuit for charging resistor 73X remains on.

(4) During the battery operation, avoid driving with application of the heavy load. Operate with no load or braking load.
(Sufficient torque cannot be obtained by the battery voltage, and the motor may stall in such case.)

(5) Operate the motor at a low speed, and pay attention to the battery capacity.
In addition, when the high voltage is supplied (such as when 300 VDC power supply at 200 V class inverter and 600 VDC power supply at 400 V class inverter), operate normally without the battery.

(6) During the normal operation, it is required to turn off the ***BATRY/UPS*** signal. If the main power is turned on with the ***BATRY/UPS*** signal on, the 73X remains ON, causing the rectifier diode getting damaged.

■ **UPS operation (Available in FRN0020E2■-2G□H / FRN0085E2■-4EH / FRN0012E2■-7G□H or below)**

When this terminal command is turned on, the undervoltage protection is invalidated. In that case, the motor can be operated by the inverter with undervoltage status by the UPS power.

Also the function codes are able to set during UPS operation. However, please note the following.

Alarm *er1* or *erf* may occur if power supply is turned OFF while the inverter is writing data to memory. In that case, the function code data are initialized by setting the data of H03 to “1”.

Related function codes	Setting range
H111 : UPS operation Level	120 to 220 VDC: (200 V class), 240 to 440 VDC: (400 V class)

Note

Prerequisite of UPS operation

(1) Terminal function ***BATRY/UPS*** (data = 59) can be assigned to any digital input terminal.

(2) As shown in Figure , voltage is supplied from the UPS to the main circuit (L1/R-L3/T or L2/S-L3/T).

(3) Required voltage level will differ depending on the operation speed and load.

(4) The terminal that ***BATRY/UPS*** (data = 59) is assigned has to be turned on simultaneously with the MC2.

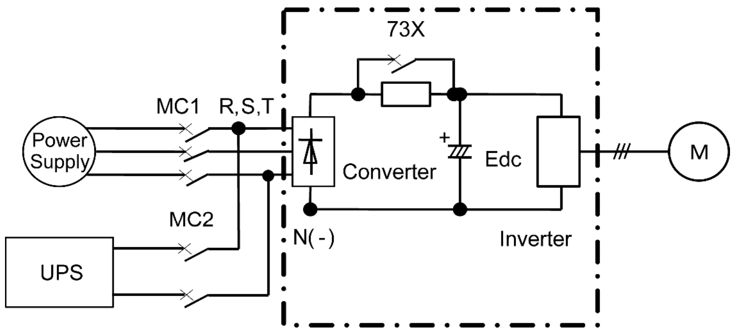


Figure J.9 Connection diagram example
(FRN0020E2■-2G□H or below, FRN085E2■-4EH or below, FRN0012E2■-7G□H or below)

■ **UPS operation UPS operation (When BATRY/UPS = ON)**

(1) The inverter can run the motor starting from the voltage level specified with H111.

(2) The ***RDY*** ("Inverter ready to run" signal) is forced to go OFF.

(3) The circuit of charging resistor is shorted (73X = ON) after the delay time T1 (0.2 sec) from the timing which ***BATRY/UPS*** terminal being turned on and the DC link bus voltage exceeds UPS operation level (specified with H111) or above. In addition, after the delay time T2 (max. 0.1 sec.), the UPS operation starts. For T1 specifications, see the table below.

(4) During the UPS operation, the inverter can run the motor.

(5) S-curve acceleration/deceleration becomes invalid.

Power supply condition	FRN0020E2■-2G☐H or below FRN0085E2■-4EH or below FRN0012E2■-7G☐H or below
Time required for turning on the control power supply, switching to the power supply from the battery, and then to turning on the charging resistor short circuit 73X	T1=0.2 s
Time required from the occurrence of momentary power failure in the control power supply ON status, switching to the power supply from the battery, and turning on of the short circuit 73X for the charging resistor	

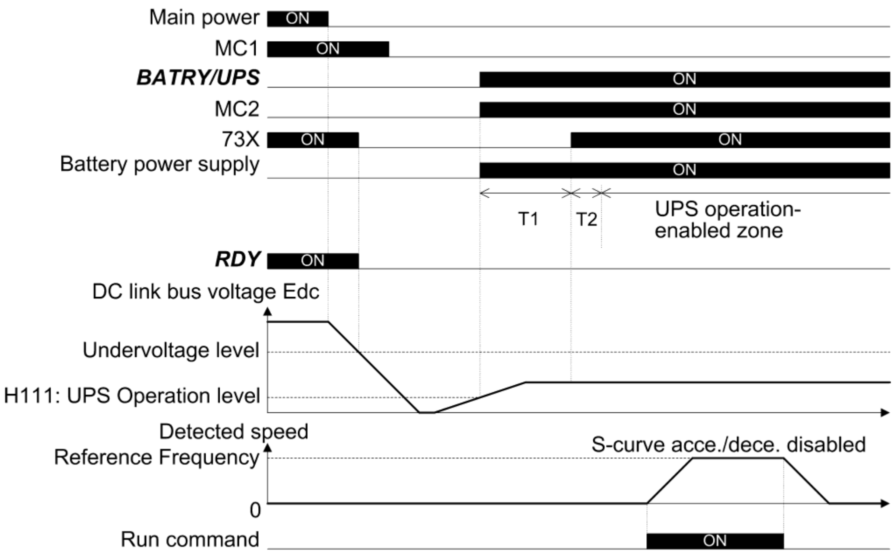


Figure J.10 UPS operation timing chart

■ **Battery operation (Available with FRN0059E2 •-4EH or above)**

When this terminal command is turned on, the undervoltage protection is invalidated. In that case, the motor can be operated by the inverter with undervoltage status by the battery power.

In addition, the main power down detection also becomes invalid regardless of H72 setting.

Note **<u>Prerequisite of battery operation</u>**

(1) Terminal function ***BATRY/UPS*** (data = 59) can be assigned to any digital input terminal.

(2) As shown in Figure and Figure , DC link bus voltage is supplied from the battery to the main circuit (L1/R-L3/T or L2/S-L3/T).

(3) The specified voltage (sinusoidal waveform or DC voltage) is input to auxiliary power terminal (R0-T0).

(4) In case of FRN0203E2■-4EH or above, input the specified power supply (sinusoidal waveform) to the fan power supply auxiliary input (R1-T1) as shown in Figure , and change the fan power supply switching connector as shown in Figure J.J in order to execute the battery operation.

(5) The terminal that ***BATRY/UPS*** (data = 59) is assigned has to be turned on simultaneously with the MC2.

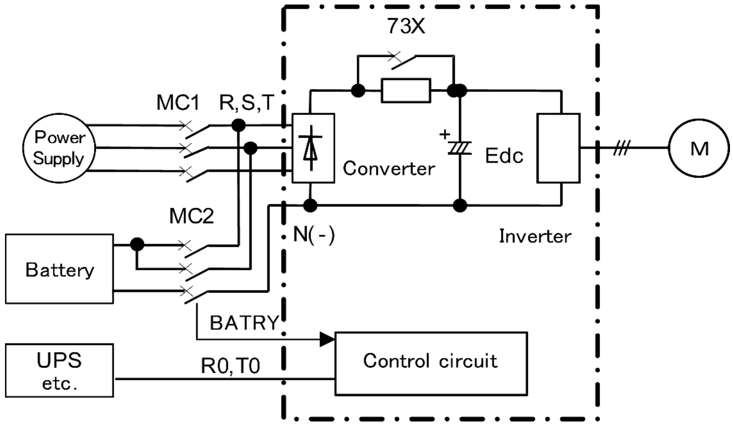
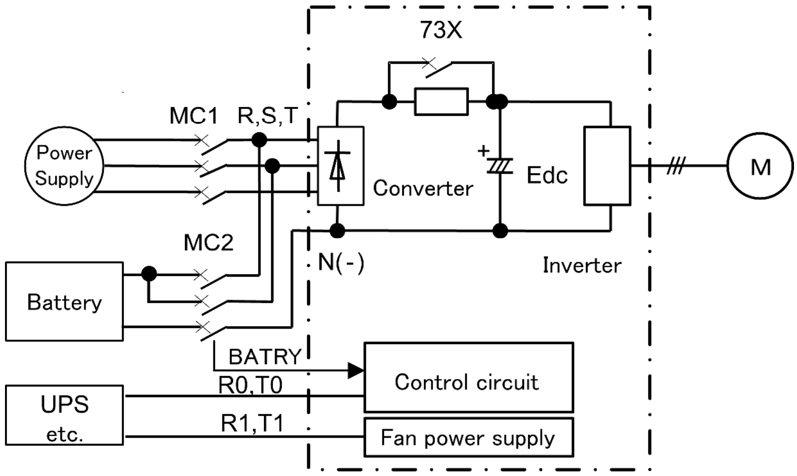


Figure J.11 Connection diagram example (FRN0020E2■-2G□H or below, FRN0168E2■-4EH or below)



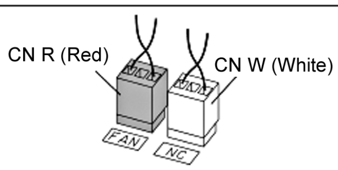
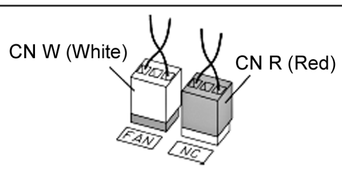
Setting	 CN R (Red) CN W (White)	 CN W (White) CN R (Red)
Application	When the terminals R1 and T1 are not used	When the terminal R1, T1 is used (Battery operation)

Figure J.13 Fan power supply switching

■ Battery operation (When BATRY/UPS = ON)

(1) Undervoltage protection function (lu)becomes non-operating status.

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

(3) Operation ready complete ***RDY*** signal is turned off.

(4) The circuit of charging resistor is shorted (73X = ON) after the delay time T1 from the ***BATRY/UPS*** terminal being turned on. In addition, after the delay time T2 (max. 0.1 sec.), the battery operation starts. For T1 specifications, see Table J..

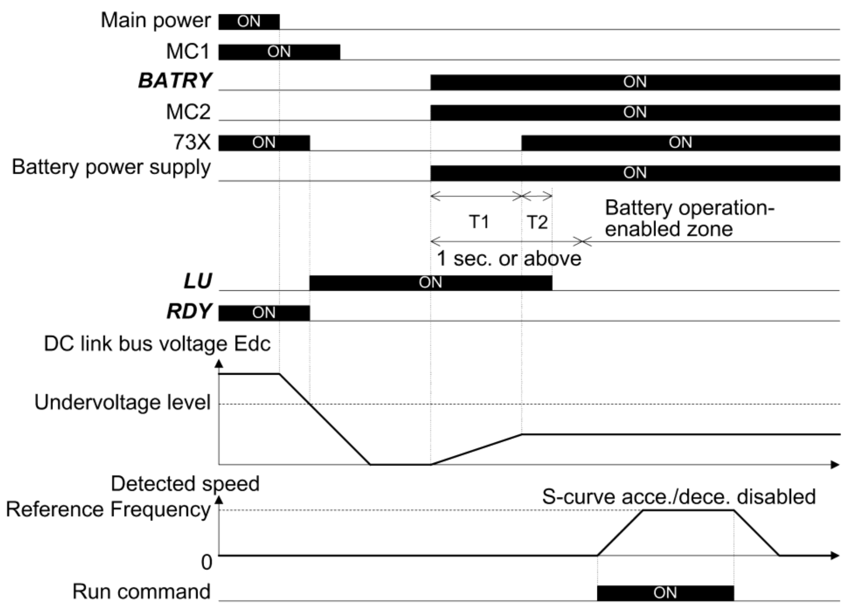


Figure J.J Battery operation timing chart

Table J.9 Power supply condition

Power supply condition	FRN0059E2■-4□H or above
Time required for turning on the control power supply, switching to the power supply from the battery, and then to turning on the charging resistor short circuit 73X	T1=500 ms
Time required from the occurrence of momentary power failure in the control power supply ON status, switching to the power supply from the battery, and turning on of the short circuit 73X for the charging resistor	

(5) S-curve acceleration/deceleration becomes invalid.

(6) The operable speed during the battery operation is calculated by using the following expression.

$$\text{Frequency command} \leq \frac{\text{Battery voltage} - 5[\text{v}]}{\sqrt{2} \times \text{Base voltage (F05)}} \times \text{Base frequency (F04)} \times \text{k}$$

Here,

Battery voltage	:	24 VDC or higher (200 V class) 48 VDC or higher (400 V class)
Rated frequency	:	F04
Rated voltage	:	F05 (Motor rated voltage (V))
K	:	Safety factor (Lower than 1 Approx. 0.8)

■ **Count the run time of commercial power-driven motor-1 – "CRUN-M1" (Function code data = 72)**

This terminal command enables the inverter to count the cumulative run time of motor-1 even when it is driven by commercial power (not by the inverter).

When the "CRUN-M1" is ON, the inverter judges that the motor-1 is driven by commercial power, respectively, and counts the run time of the corresponding motor. (🕮 Function codes H44, H94)

■ **Select speed control parameter 1 – "MPRM1" (Function code data = 78)**

The combination of the ON/OFF states of digital input signal "MPRM1" selects one of 2 different level speed control parameter sets for vector control PMSM. (🕮Function codes d01 to d08)

Input signal "MPRM1"	Speed control parameter
OFF	Speed control parameter sets 1 : d01～d08
ON	Speed control parameter sets 2 : A43～A50

■ **Cancel customizable logic – "CLC" (Function code data = 80), Clear all customizable logic timers – "CLTC" (Function code data = 81)**

Terminal command "CLC" stops the operation of customizable logic. Terminal command "CLTC" clears all customizable logic timers. (🕮 Function codes U codes)

■ **Cancel anti-regenerative control – "AR-CCL" (Function code data = 82)**

Terminal command "AR-CCL" ON disables anti-regenerative control. (🕮 Function code H69)

■ **Run command 2/1 – "FR2"/"FR1" (Function code data = 87), Run forward 2 – "FWD2" (Function code data = 88), Run reverse 2 – "REV2" (Function code data = 89)**

The FR2/FR1 switches between the run command source selected by Run command (FWD and REV) and the one selected by Run command 2 (FWD2 and REV2)

[FR2/FR1]	Run command expedient	
	Link disable	Link enable
OFF	By F02	S06：FWD/REV
ON	[FWD2]，[REV2]	S06：FWD2/REV2

■ **Run forward – "FWD" (Function code data = 98)**

Turning this terminal command ON runs the motor in the forward direction; turning it OFF decelerates it to stop.

Tip This terminal command "FWD" can be assigned only to E98 or E99.

■ **Run reverse – "REV" (Function code data = 99)**

Turning this terminal command "REV" ON runs the motor in the reverse direction; turning it OFF decelerates it to stop.

Tip This terminal command "REV" can be assigned only to E98 or E99.

■ **No function assigned – "NONE" (Function code data = 100)**

It allows the inverter to run unaffected by ON/OFF of signals. It is used when a signal is externally input using customizable logic. It is also used to temporarily disable a terminal function.

■ **Switch pump control – "PCHG" (Function code data = 149)**

Turning the PCHG ON enables the pump control switching signal to switch the motor regularly. This command is available only when J401 (Pump control mode selection) = any of 1 through 3, 11 through 13, and 52. (🕮Function code J401.)

■ **Enable master motor drive in mutual operation – "MEN0" (Function code data = 150)**

Turning the MEN0 ON enables the master motor to be driven in mutual operation. Turning it OFF disables the master motor to stop it. If no MEN0 is assigned, the master motor is capable of being driven. (📖 Function code J401.)

■ **Enable pump control motor 1 to 4 to be driven – "MEN1" to "MEN4" (Function code data = 151 to 154)**

Turning the MEN1 to MEN8 ON enables the corresponding motors to be driven under pump control. Turning them OFF prohibits the motors from being driven. If MEN1 to MEN8 are not assigned, those motors are capable of being driven. In mutual operation, slave inverters 1 and 2 correspond to MEN1 and MEN2, respectively. (📖 Function code J401.)

■ **PID control multistage command 1, 2 – "PID-SS1", "PID-SS2" (Function code data = 171, 172)**

"PID-SS1" and "PID-SS2" can be used to select 4 different PID commands. (📖 Function codes J136 to J138)

■ **External PID multistep command – "EPID-SS1", "EPID-SS2" (Function code data = 181, 182)**

Turning the "EPID-SS1" and "EPID-SS2" ON/OFF selectively switches the external PID multistep commands (preset by J551 through J553) in three steps. (📖 Function codes J550 to J553.)

■ **External PID control 1 ON command – "EPID1-ON" (Function code data = 201)**

Turning the EPID1-ON ON enables external PID control 1. (📖 Function codes J501.)

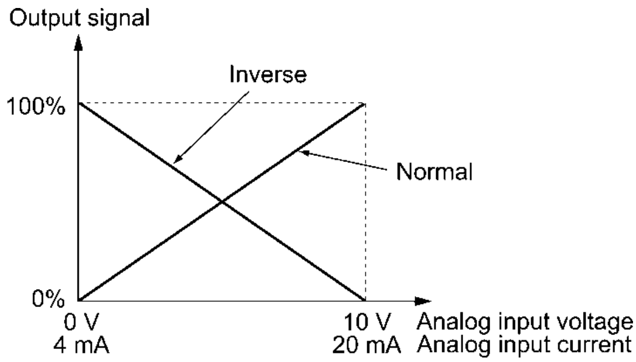
■ **Cancel external PID control 1 – "%/EPID1 "(Function code data = 202)**

Turning the %/EPID1 ON switches from external PID control 1 to manual commands (running at the frequency selected from the keypad or analog input). (📖 Function codes J540.)

Terminal command "%/EPID1"	Function
OFF	Enable external PID control 1
ON	Disable external PID control 1 (Enable manual commands)

■ **Switch normal/inverse operation under external PID control 1 – "EPID1-IVS" (Function code data = 203)**

The "EPID1-IVS" switches the output signal of external PID control 1 between normal and inverse operations.



■ **Reset external PID1 integral and differential components – "EPID1-RST" (Function code data = 204)**

Turning the "EPID1-RST" ON resets the integral and differential terms of the PID processor of external PID control 1.(📖 Function codes J501 thorough J553.)

■ **Hold external PID1 integral component – "EPID1-HLD" (Function code data = 205)**

When the "EPID1-HLD" is ON, the inverter holds the integral term of the PID processor of external PID control 1. (📖 Function codes J501 through J553.)

E10 to E15	**Acceleration time 2 to 4, Deceleration time 2 to 4**	**(Refer to F07)**

Refer to the description of F07.

E16, E17	Torque limiter 2 (driving), 2 (braking) (Refer to F40)

For the torque limiter 2 (driving) and 2 (braking) settings, refer to the description of F40.

E20 to E21 **E27**	**Terminals [Y1] function to [Y2] function** **Terminal [30A/B/C] function (Relay output)**

E20 through E21 and E27 assign output signals to general-purpose, programmable output terminals, [Y1], [Y2] and [30A/B/C]. These function codes can also switch the logic system between normal and negative to define how the inverter interprets the ON or OFF state of each terminal. The factory default setting is normal logic system “Active ON.”

Terminals [Y1] and [Y2] are transistor outputs and terminals [30A/B/C] are contact outputs. In normal logic, if an alarm occurs, the relay will be energized so that [30A] and [30C] will be closed, and [30B] and [30C] opened. In negative logic, the relay will be de-energized so that [30A] and [30C] will be opened, and [30B] and [30C] closed. This may be useful for the implementation of failsafe power systems.

Note
- When negative logic is employed, output signal is OFF(active) while the inverter is powered OFF. To avoid causing system malfunctions by this, interlock these signals to keep them ON using an external power supply. Furthermore, the validity of these output signals is not guaranteed for approximately 1.5 seconds (for 22 kW or below) or 3 seconds (for 30 kW or above) after power-ON, so introduce such a mechanism that masks them during the transient period.
- Terminals [30A/B/C] use mechanical contacts. They cannot stand frequent ON/OFF switching. Where frequent ON/OFF switching is anticipated (for example, by using frequency arrival signal), use transistor outputs [Y1] and [Y2] instead.
  The service life of a relay is approximately 200,000 times if it is switched ON and OFF at one-second intervals. For signals expected to be turned ON/OFF frequently, use terminals [Y1] and [Y2] for output.

The tables given on the following pages list functions that can be assigned to terminals [Y1], [Y2], and [30A/B/C]. The descriptions are, in principle, arranged in the numerical order of assigned data. However, the signal is related has been described together. Refer to the function codes or signals in the “Related function codes/signals (data)” column, if any.

Explanations of each function are given in normal logic system “Active ON.”

Data		Terminal commands assigned	Symbol	Control mode		Related function codes/ Related signals (data)
Active ON	Active OFF			V/f	PM SLV	
0	1000	Inverter running	“RUN”	Y	Y	—
1	1001	Frequency (speed) arrival	“FAR”	Y	Y	E30
2	1002	Frequency (speed) detected	“FDT”	Y	Y	E31, E32
3	1003	Undervoltage detected (Inverter stopped)	“LU”	Y	Y	—
5	1005	Inverter output limiting	“IOL”	Y	Y	—
6	1006	Auto-restarting after momentary power failure	“IPF”	Y	Y	F14
7	1007	Motor overload early warning	“OL”	Y	Y	E34, F10, F12
8	1008	Keypad operation enabled	“KP”	Y	Y	—
10	1010	Inverter ready to run	“RDY”	Y	Y	—
11	—	Switch motor drive source between commercial power and inverter output (For MC on commercial line)	"SW88"	Y	N	E01 to E05 “ISW50”(40) “ISW60”(41) J22
12	—	Switch motor drive source between commercial power and inverter output (For secondary side)	"SW52-2"	Y	N	
13	—	Switch motor drive source between commercial power and inverter output (For primary side)	"SW52-1"	Y	N	
15	1015	Switch MC on the input power lines	“AX”	Y	Y	—
16	1016	Pattern operation stage transition	“TU”	Y	Y	C21 to C28
17	1017	Pattern operation cycle completed	“TO”	Y	Y	
18	1018	Pattern operation stage No. 1	“STG1”	Y	Y	
19	1019	Pattern operation stage No. 2	“STG2”	Y	Y	
20	1020	Pattern operation stage No. 4	“STG4”	Y	Y	
25	1025	Cooling fan in operation	“FAN”	Y	Y	H06
26	1026	Auto-resetting	“TRY”	Y	Y	H04, H05
27	1027	Universal DO	“U-DO”	Y	Y	—
28	1028	Heat sink overheat early warning	“OH”	Y	Y	—
30	1030	Lifetime alarm	“LIFE”	Y	Y	H42

Data		Terminal commands assigned	Symbol	Control mode		Related function codes/ Related signals (data)
Active ON	Active OFF			V/f	PM SLV	
33	1033	Reference loss detected	“REF OFF”	Y	Y	E65
35	1035	Inverter outputting	“RUN2”	Y	Y	RUN (0)
36	1036	Overload prevention controlling	“OLP”	Y	Y	H70
37	1037	Current detected	“ID”	Y	Y	E34, E35, E37, E38, E55, E56
41	1041	Low current detected	“IDL”	Y	Y	
42	1042	PID alarm	“PID-ALM”	Y	Y	J11 to J13
43	1043	Under PID control	“PID-CTL”	Y	Y	J01
44	1044	Under sleep mode of PID control	“PID-STP”	Y	Y	J08, J09
45	1045	Low torque detected	“U-TL”	Y	Y	E80, E81
52	1052	Running forward	“FRUN”	Y	Y	—
53	1053	Running reverse	“RRUN”	Y	Y	—
54	1054	Under remote mode	“RMT”	Y	Y	(Refer to FRENIC-Ace User’s Manual Section 3.3.6)
55	1055	Run command entered	“AX2”	Y	Y	
56	1056	Motor overheat detected by thermistor	“THM”	Y	Y	H26, H27
59	1059	Terminal [C1] (C1 function)wire break detected	“C1OFF”	Y	Y	—
68	1068	Motor regular switching early warning	"MCHG"	Y	Y	J401 to J493
69	1069	Pump control output limit signal	"MLIM"	Y	Y	J401 to J493
76	1076	Speed deviation excess	“PG-ERR”	N	N	d21 to d23
77	1077	Low DC link bus voltage detection	“U-EDC”	Y	Y	E76
79	1079	During deceleration in momentary power failure	“IPF2”	Y	Y	F14, F15
84	1084	Maintenance timer counted up	“MNT”	Y	Y	H44, H78, H79
87	1087	Frequency arrival and frequency detected	“FARFDT”	Y	Y	E30, E31, E32
88	1088	Auxiliary motor drive signal	“AUX_L”	Y	Y	
98	1098	Light alarm	“L-ALM”	Y	Y	H81, H82
99	1099	Alarm output (for any alarm)	“ALM”	Y	Y	—
111 to 120	1111 to 1120	Customizable logic output signal 1 to 10	“CLO1” to “CLO10”	Y	Y	U71 to U75, U81 to U90
160	1160	Motor 1 being driven by inverter	"M1_I"	Y	Y	J401 to J493
161	1161	Motor 1 being driven by commercial power	"M1_L"	Y	Y	
162	1162	Motor 2 being driven by inverter	"M2_I"	Y	Y	
163	1163	Motor 2 being driven by commercial power	"M2_L"	Y	Y	
164	1164	Motor 3 being driven by inverter	"M3_I"	Y	Y	
165	1165	Motor 3 being driven by commercial power	"M3_L"	Y	Y	
167	1167	Motor 4 being driven by inverter	"M4_L"	Y	Y	
180	1180	In mutual operation	"M-RUN"	Y	Y	
181	1181	Alarm in mutual operation	"M-ALM"	Y	Y	
211	1211	Under external PID1 control	"EPID1-CTL"	Y	Y	
212	1212	External PID1 output	"EPID1-OUT"	Y	Y	
213	1213	Running under external PID1	"EPID1-RUN"	Y	Y	
214	1214	External PID1 alarm	"EPV1-ALM"	Y	Y	
215	1215	External PID1 feedback error	"EPV1-OFF"	Y	Y	

Note: Any negative logic (Active OFF) command cannot be assigned to the functions marked with “-” in the “Active OFF” column.

■ **Inverter running – “RUN” (Function code data = 0), Inverter outputting – “RUN2” (Function code data = 35)**

These output signals tell the external equipment that the inverter is running at a starting frequency or higher.

If assigned in negative logic (Active OFF), these signals can be used to tell the "Inverter being stopped" state.

<table>
<tr><th>Output signal</th><th>Basic function</th><th>Remarks</th></tr>
<tr><td>RUN</td><td rowspan="2">These signals come ON when the inverter is running.
Under V/f control: These signals come ON if the inverter output frequency exceeds the starting frequency, and go OFF if it drops below the stop frequency. The "RUN" signal can also be used as a "Speed valid" signal.</td><td>Goes OFF even during DC braking.</td></tr>
<tr><td>RUN2</td><td>Comes ON even during DC braking, pre-excitation, zero speed control.</td></tr>
</table>

■ **Frequency (speed) arrival– "FAR" (Function code data = 1)**

These output signals come ON when the difference between the output frequency (detected speed) and reference frequency (reference speed) comes within the frequency arrival hysteresis width specified by E30.

(Function code E30)

■ **Frequency (speed) detected – "FDT" (Function code data = 2)**

These output signal FDT come ON when the output frequency (detected speed) exceeds the frequency detection level specified by E31, E36 or E54, respectively, and go OFF when the output frequency (detected speed) drops below the "Frequency detection level (E31, E36 or E54) - Hysteresis width (E32)."

(Function codes E31 and E32)

■ **Undervoltage detected (Inverter stopped) – "LU" (Function code data = 3)**

This output signal comes ON when the DC link bus voltage of the inverter drops below the specified undervoltage level. When this signal is ON, the inverter cannot run even if a run command is given. It goes OFF when the voltage exceeds the level.

■ **Inverter output limiting – "IOL" (Function code data = 5)**

The output signal IOL comes ON when the inverter is limiting the output frequency by activating any of the following actions (minimum width of the output signal: 100 ms).

- Torque limiting (F40, F41, E16 and E17, Maximum internal value)
- Current limiting by software (F43 and F44)
- Instantaneous overcurrent limiting by hardware (H12 = 1)
- Automatic deceleration (Anti-regenerative control) (H69)

Note When the "IOL" is ON, it may mean that the output frequency may have deviated from the reference frequency because of the limiting functions above.

■ **Auto-restarting after momentary power failure – "IPF" (Function code data = 6)**

This output signal is ON either during continuous running after a momentary power failure or during the period after the inverter detects an undervoltage condition and shuts down the output until restart has been completed (the output has reached the reference frequency). (Function code F14)

■ **Motor overload early warning – "OL" (Function code data = 7)**

The OL signal is used to detect a symptom of an overload condition (alarm code 0l1) of the motor so that the user can take an appropriate action before the alarm actually happens. (Function code E34)

■ **Keypad operation enabled – "KP" (Function code data = 8)**

This output signal comes ON when the RUN / STOP keys are specified as the run command source.

■ **Inverter ready to run – "RDY" (Function code data = 10)**

This output signal comes ON when the inverter becomes ready to run by completing hardware preparation (such as initial charging of DC link bus capacitors and initialization of the control circuit) and no protective functions are activated.

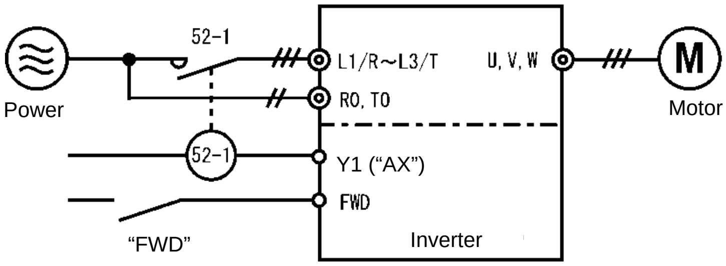
■ **Switch motor drive source between commercial power and inverter output – "SW88", "SW52-2" and "SW52-1" (Function code data = 11, 12, and 13)**

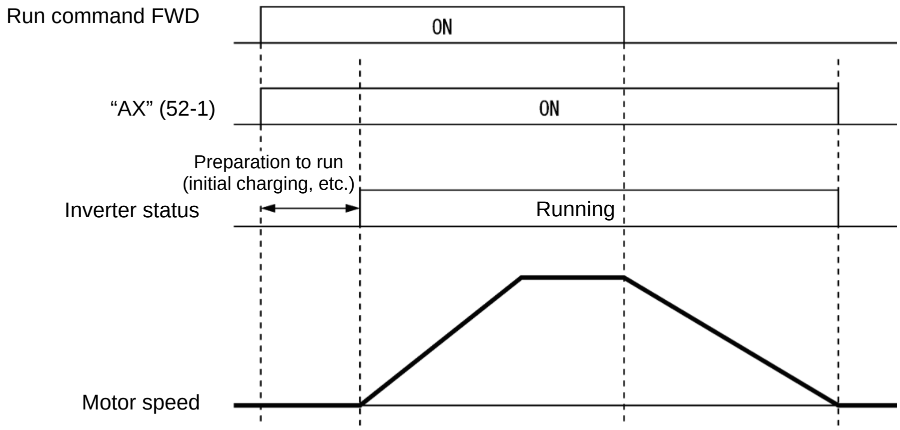
Assigning these output signals to transistor output terminals [Y1] and [Y2] enables the terminal command "ISW50" or "ISW60" that controls the magnetic contactor for switching the motor drive source between the commercial power and the inverter output according to the integrated sequence. (Function code E01 through E07 (data = 40 and 41).)

■ **Switch MC on the input power lines – "AX" (Function code data = 15)**

In response to a run command FWD, this output signal controls the magnetic contactor on the commercial-power supply side. It comes ON when the inverter receives a run command. It goes OFF after the motor decelerates to stop with a stop command received. This signal immediately goes OFF upon receipt of a coast-to-stop command or when an alarm occurs.

"AX" can be selected where there is control power such as with FRN0045E2E-4EH or above.





■ **Pattern operation stage No. 1 – "STG1" (Function code data = 18), Pattern operation stage No. 2 – "STG2" (Function code data = 19), Pattern operation stage No. 4 – "STG4" (Function code data = 20)**

Outputs the stage (operation process) currently performed during pattern operation.

Operation pattern stage No.	Output terminal signal		
	STG1	STG2	STG4
Stage 1	ON	OFF	OFF
Stage 2	OFF	ON	OFF
Stage 3	ON	ON	OFF
Stage 4	OFF	OFF	ON
Stage 5	ON	OFF	ON
Stage 6	OFF	ON	ON
Stage 7	ON	ON	ON

■ **Cooling fan in operation – "FAN" (Function code data = 25)**

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control. (🕮 Function code H06)

■ **Auto-resetting – "TRY" (Function code data = 26) This output signal comes ON when auto resetting (resetting alarms automatically) is in progress.**

(🕮 Function codes H04 and H05)

■ **Universal DO -- "U-DO" (Function code data = 27)**

Assigning this output signal to an inverter's output terminal and connecting the terminal to a digital input terminal of peripheral equipment, allows an upper controller to send commands to the peripheral equipment via the RS-485 or the fieldbus communications link. The universal DO can be used as an output signal independent of the inverter operation.

🕮 For the procedure for access to Universal DO via the RS-485 or fieldbus communications link, refer to the respective instruction manual.

■ **Heat sink overheat early warning – "OH" (Function code data = 28)**

This output signal is used to issue a heat sink overheat early warning that enables you to take a corrective action before an overheat trip *0h1* actually happens.

ON at [(Overheat trip (*0h1*) temperature) – 5°C (41°F)] or higher

OFF at [(Overheat trip (*0h1*) temperature) - 8°C (46°F)] or lower

This signal comes ON also when the internal air circulation DC fan (FRN0176E2E-4G☐H or above for 400 V class series) is locked.

■ **Lifetime alarm – "LIFE" (Function code data = 30)**

This output signal comes ON when it is judged that the service life of any one of capacitors (DC link bus capacitors or electrolytic capacitors on the printed circuit boards) or cooling fan has expired. This signal should be used as a guide for replacement of the capacitors and cooling fan. If this signal comes ON, use the specified maintenance procedure to check the service life of these parts and determine whether the parts should be replaced or not.
(🕮 Function code H42)

This signal comes ON also when the internal air circulation DC fan (FRN0176E2E-4G☐H or above for 400 V class series) is locked.

■ **Reference loss detected – "REF OFF" (Function code data = 33)**

This output signal comes ON when an analog input used as a frequency command source is in a reference loss state (as specified by E65) due to a wire break or a weak connection. This signal goes OFF when the normal operation under the analog input is resumed. (🕮 Function code E65)

■ **Overload prevention controlling – "OLP" (Function code data = 36)**

This output signal comes ON when overload prevention control is activated.
(The minimum ON-duration is 100 ms.) (🕮 Function code H70)

■ **Current detected – "ID" (Function code data = 37)**

When the inverter output current exceeds the level specified by E34 for the period specified by E35, the ID signal turns ON, respectively. (The minimum ON-duration is 100 ms.)
(🕮 Function code E34)

■ **Low current detected – "IDL" (Function code data = 41)**

When the inverter output current falls to or below the level specified by E34 for the period specified by E35, the IDL signal turns ON, respectively. (The minimum ON-duration is 100 ms.)
(🕮 Function code E34)

■ **PID alarm – "PID-ALM" (Function code data = 42)**

Assigning this output signal enables PID control to output absolute-value alarm or deviation alarm.
(🕮 Function codes J11 to J13)

■ **Under PID control – “PID-CTL” (Function code data = 43)**

This output signal comes ON when PID control is enabled (“Cancel PID control” (Hz/PID) = OFF) and a run command is ON. (📖 Function code J01)

Note: When PID control is enabled, the inverter may stop due to the slow flowrate stopping function or other reasons. If that happens, the “PID-CTL” signal remains ON. As long as the “PID-CTL” signal is ON, PID control is effective, so the inverter may abruptly resume its operation, depending on the feedback value in PID control.

⚠WARNING

When PID control is enabled, even if the inverter stops its output during operation because of sensor signals or other reasons, operation will resume automatically. Design your machinery so that safety is ensured even in such cases.

Otherwise an accident could occur.

■ **Under sleep mode of PID control – “PID-STP” (Function code data = 44)**

This output signal is ON when the inverter is in a stopped state due to the slow flowrate stopping function under PID control.) (📖 Function codes J15 to J17, J23 J24)

■ **Low torque detected – “U-TL” (Function code data = 45)**

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Low torque detection (Level)) for the period specified by E81 (Low torque detection (Timer)). (minimum width of the output signal: 100 ms) (📖 Function codes E80, E81)

■ **Running forward – “FRUN” (Function code data = 52) Running reverse – “RRUN” (Function code data = 53)**

Output signal	Assigned data	Running forward	Running reverse	Inverter stopped
“FRUN”	52	ON	OFF	OFF
“RRUN”	53	OFF	ON	OFF

■ **Under remote mode – “RMT” (Function code data = 54)**

This output signal comes ON when the inverter switches from local to remote mode.

📖 For details of switching between remote and local modes, refer to the FRENIC-Ace User’s Manual Chapter 3 “3.3.6 Remote and local modes.”

■ **Run command entered – “AX2” (Function code data = 55)**

This output signal comes ON the moment the inverter is ready to run after receipt of a run command.

📖 Refer to E01 through E07, Function code data = 38.

■ **Motor overheat detected by thermistor – “THM” (Function code data = 56)**

When the PTC thermistor on the motor detects an overheat, the inverter turns this signal ON and continues to run, without entering the alarm *0h4* state. This feature applies only when H26 data is set to “2.”

(📖 Function codes H26 and H27)

■ **Terminal [C1] (C1 function)wire break detected – “C1OFF” (Function code data = 59)**

This output signal comes ON when the inverter detects that the input current to terminal [C1] (C1 function) drops below 2 mA interpreting it as the terminal [C1] wire broken.

■ **Motor regular switching early warning – “MCHG” (Function code data = 68)**

This outputs a motor regular switching early warning signal. (📖 Function codes J437)

■ **Pump control output limit signal – “MLIM” (Function code data = 69)**

When the pump control mode selection is enabled (J401 ≠ 0), all of the enabled motors are to be driven. With all motors being driven, if the motor increase judgment is established by the motor increase judgment (Parallel Judgment F) (J450) and (Duration time) (J451), the inverter issues an “MLIM” signal.

This signal detects the discharge rate (pressure) remaining low due to pump pipe rupture. etc.

■ **Speed deviation excess detected -- "PG-ERR" (Function code data = 76)**

This output signal comes ON when the inverter detects a speed deviation excess error with the d23 (speed deviation excess error processing) data being set to "0: Continue to run," in which the inverter does not enter the alarm state. (📖Function codes d21 through d23.)

■ **Low DC link bus voltage detection – "U-EDC" (Function code data = 77)**

This output signal comes ON when the DC intermediate voltage drops below E76 (DC link bus low-voltage detection level), and it goes OFF when the DC intermediate voltage exceeds E76. (📖 Function code E76)

■ **During decelerating at momentary power failure – "IPF2" (Function code data = 79)**

When F14 data is set to 2 or 3, this output signal comes ON when the DC intermediate voltage drops below H15 (Continue to run level) and continue to run control starts. When the power returns and the DC intermediate voltage becomes "at least 10 V higher than the voltage specified by H15," the signal goes OFF.

Even when F14 data is set to 4 or 5, the signal comes ON when the DC intermediate voltage drops below the undervoltage level, and it goes OFF when the DC intermediate voltage becomes "at least 10 V higher than the undervoltage level." (📖 Function codes F14 and H15)

■ **Maintenance timer counted up – "MNT" (Function code data = 84)**

Once the inverter's cumulative run time or the startup times for the motor 1 exceeds the previously specified count, this output signal comes ON. (📖 Function codes H78 and H79)

■ **Frequency arrival AND frequency detected – "FARFDT" (Function code data = 87)**

The FARFDT, which is an AND signal of FAR and FDT, comes ON when both signal conditions are met.

(📖 Function codes E30 to E32)

■ **Auxiliary motor drive signal – "AUX_L" (Function code data = 88)**

This output signal comes ON when all motors enabled by MEN1 to MEN4 (Enable pump control motor 1 to 4 to be driven) are running and the frequency of inverter-driven motors reaches the frequency operation level of the auxiliary motor (J465).

When the frequency of inverter-driven motors drops below the hysteresis width of the auxiliary motor (J466), this signal goes OFF.

When PID control is disabled (J01 = 0) or pump control is disabled (J401 = 0), this output signal is OFF.
(📖 Function codes J465 to J469.)

■ **Light alarm – "L-ALM" (Function code data = 98)**

This output signal comes ON when a light alarm occurs. (📖 Function codes H81 and H82)

■ **Alarm output (for any alarm) – "ALM" (Function code data = 99)**

This output signal comes ON if any of the protective functions is activated and the inverter enters Alarm mode.

■ **Customizable logic output signal 1 to 10 – "CLO1" to "CLO10" (Function code data =111 to 120)**

Outputs the result of customizable logic operation. (📖 Function codes U codes)

■ **Motor 1 to Motor 3 being driven by inverter – "M1_I" to "M3_I" (Function code data = 160, 162, and 164)**

These signals are used to find inverter-driven motors in pump operation. Assign these signals for motors to be driven by the inverter when the "inverter drive motor floating system" (J401 = 2 or 12) or the "inverter drive motor floating + commercial power-driven motor system" (J401 = 3 or 13) is selected. (📖 Function code J401.)

■ **Motor 1 to Motor 4 being driven by commercial power -- M1_L to M4_L (Function code data = 161, 163, 165, and 167)**

These signals are used to find motors being driven by commercial power in pump operation. Assign these signals for motors to be driven by commercial power when the "inverter drive motor fixed system" (J401 = 1), the "inverter drive motor floating system" (J401 = 2 or 12), or the "inverter drive motor floating + commercial power-driven motor system" (J401 = 3 or 13) is selected. (📖 Function code J401.)

■ **In mutual operation – "M-RUN" (Function code data = 180)**

This output signal comes ON when two or more motors are running in mutual operation (J401 = 52 or 54).
(📖 Function code J401 through J404.)

■ Alarm in mutual operation – "M-ALM" (Function code data = 181)

This output signal comes ON when two or more motors are stopped due to alarm in mutual operation (J401 = 52 or 54). (📖 Function code J401 through J404.)

■ Under external PID1 control – "EPID1-CTL" (Function code data = 211)

This signal comes ON when external PID control is selected, respectively. (📖 Function code J501.)

■ External PID1 output -- EPID1-OUT (Function code data = 212)

This signal is duty output of external PID control. (📖 Function code J501).

■ Running under external PID1 – "EPID1-RUN" (Function code data = 213)

This signal comes ON when external PID is activated. (📖 Function code J501).

■ External PID1 alarm – "EPV1-ALM" (Function code data = 214)

This signal comes ON when external PID1 alarms occur with external PID control selected. (📖 Function code J521, J522, J524.)

■ External PID1 feedback error – "EPV1-OFF" (Function code data = 215)

This signal comes ON when a feedback (PV) level error occurs when external PID control is selected. (📖 Function code J529 through J531.)

E30	Frequency arrival detection width (Detection width)

E30 specifies the detection level for the Frequency (speed) arrival signal "FAR".

Output signal	E20, E21and E27 assigned data	Operating condition 1	Operating condition 2
"FAR"	1	The signals come ON when the difference between the output frequency (estimated/actual speed) and the reference frequency (reference speed) comes within the frequency arrival width specified by E30.	FAR always goes OFF when the run command is OFF or the reference speed is "0".

- Data setting range: E30: 0.0 to 10.0 (Hz)

The operation timings of each signal are as shown below.

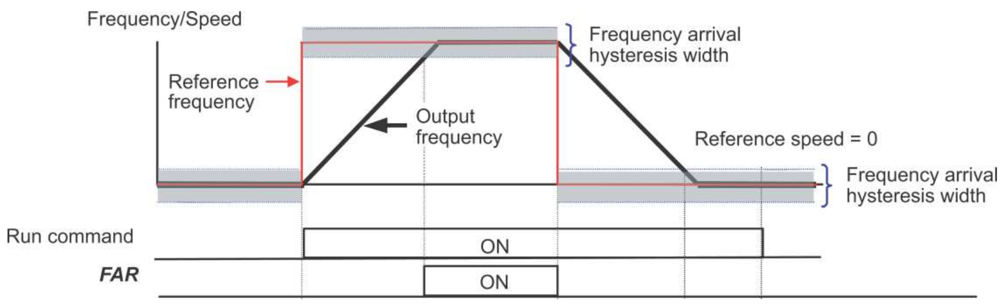


Figure J.15

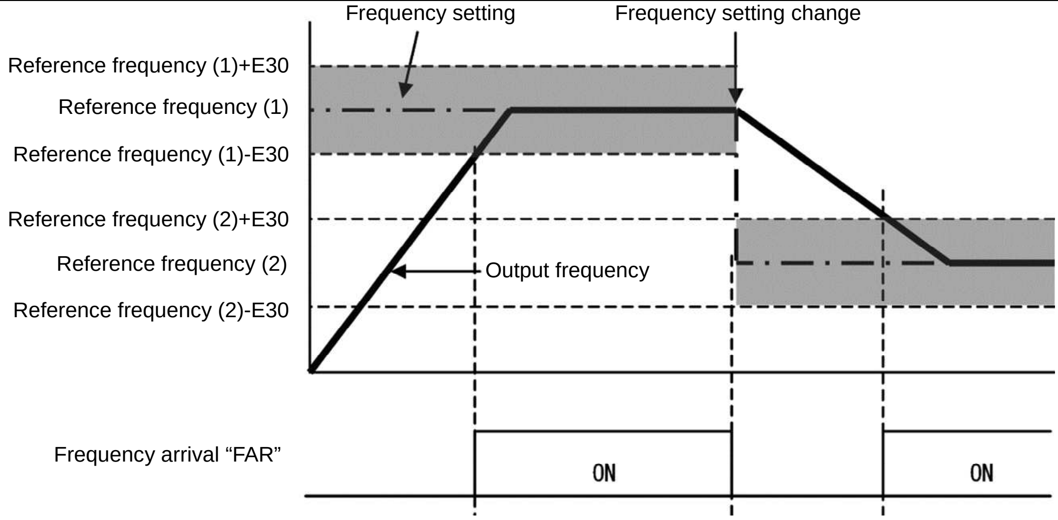


Figure J.16

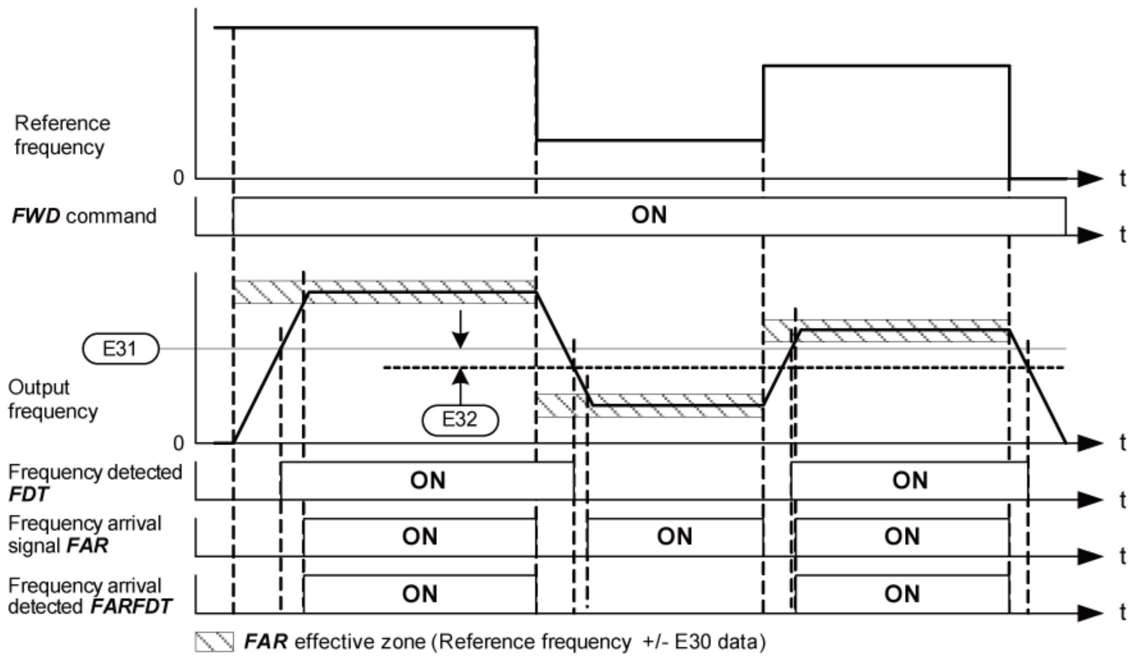


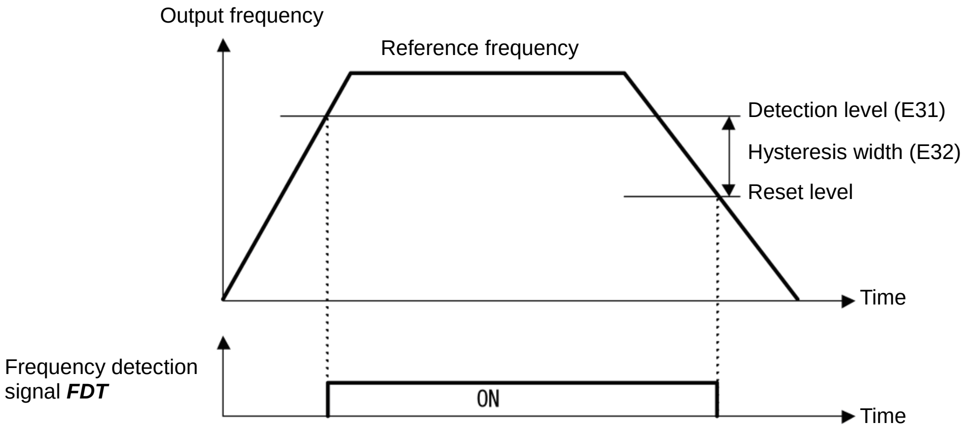
Figure J.17

E31, E32	Frequency detection (level and hysteresis width)

When the output frequency exceeds the frequency detection level specified by E31, the “Frequency (speed) detection signal” comes ON; when it drops below the “Frequency detection level minus Hysteresis width specified by E32,” it goes OFF.

The following three settings are available.

Name	Output signal	E20, E21 and E27 assigned data	Operation level Range: 0.0 to 500.0 Hz	Hysteresis width Range: 0.0 to 500.0 Hz
Frequency detection	“FDT”	2	E31	E32



E34, E35 E37, E38	Overload early warning/Current detection (level and timer) Low current detection (level and timer)

These function codes define the detection level and time for the Motor overload early warning “OL”, Current detected “ID”, and Low current detected “IDL” output signals.

Output signal	E20, E21 and E27 Assigned data	Detection level	Timer	Motor characteristics	Thermal time constant
		Range: See below	Range: 0.01 to 600.00 s	Range: See below	Range: 0.5 to 75.0 min
“OL”	7	E34	—	F10	F12
“ID”	37	E34	E35	—	—
“IDL”	41	E37	E38		

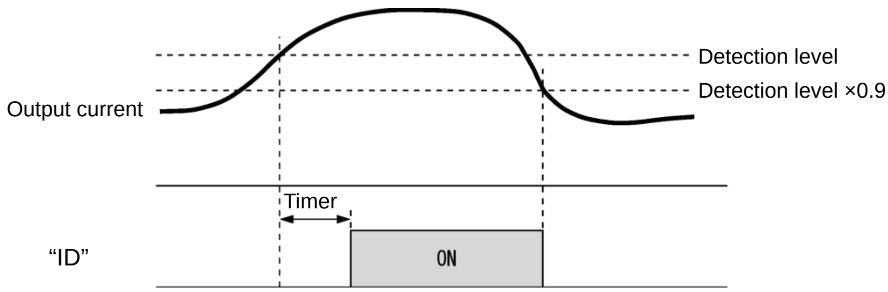
- Data setting range
  Detection level: 0.00 (Disable), 1 to 150% of inverter rated current
  Motor characteristics 1: Enable (For a general-purpose motor with shaft-driven cooling fan)
  2: Enable (For an inverter-driven motor, non-ventilated motor, or motor with separately powered cooling fan)

■ Motor overload early warning signal – “OL”

The OL signal is used to detect a symptom of an overload condition (alarm code 0l1) of the motor so that the user can take an appropriate action before the alarm actually happens. The OL signal turns ON when the inverter output current exceeds the level specified by E34. In typical cases, set E34 data to 80 to 90% against F11 data (Electronic thermal overload protection for motor 1, Overload detection level). Set the temperature characteristics of the motor with electronic thermal (motor characteristics selection, thermal time constant).

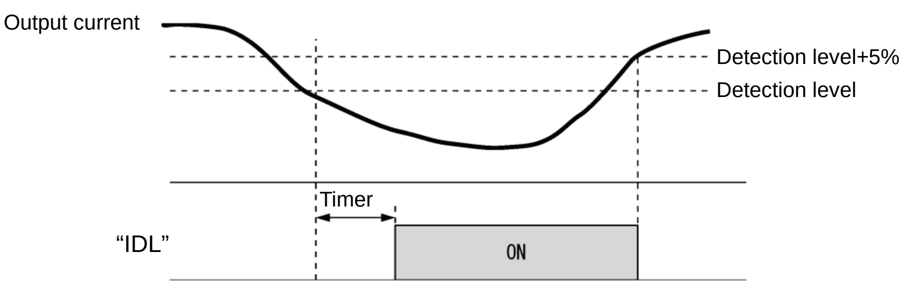
■ Current detected – “ID”

When the inverter output current exceeds the level specified by E34 for the period specified by E35, the ID signal turns ON, respectively. When the output current drops below 90% of the specified detection level, the ID turns OFF. (The minimum ON-duration is 100 ms.)



■ Low current detected – “IDL”

This signal turns ON when the output current drops below the level specified by E37 (Low current detection, Level) for the period specified by E38 (Timer). When the output current exceeds the “Low current detection level plus 5% of the inverter rated current,” it goes OFF. (The minimum ON-duration is 100 ms.)



E42	LED display filter

Excluding speed monitor (when E43 = 0), E42 specifies a filter time constant to be applied for displaying the output frequency, output current and other running status monitored on the LED monitor on the keypad. If the display varies unstably so as to be hard to read due to load fluctuation or other causes, increase this filter time constant.

- Data setting range: 0.0 to 5.0 (s)

E43	LED monitor (Item selection) Related function code: E48 LED monitor (speed monitor item)

E43 specifies the running status item to be monitored and displayed on the LED monitor.
Specifying the speed monitor with E43 provides a choice of speed-monitoring formats selectable with E48 (LED monitor).

Monitor item		Display sample on the LED monitor	LED indication	Unit	Meaning of displayed value	E43 data
Speed monitor		Function code E48 specifies what to be displayed on the LED monitor and LED indicators.				0
	Output frequency 1 (PM: Speed command value)	5*00	■Hz□A□kW	Hz	Indicated value = Output frequency (Hz)	(E48 = 0)
	Output frequency 2 (PM: Speed estimated value)	5*00	■Hz□A□kW	Hz	Indicated value = Output frequency (Hz)	(E48 = 1)
	Reference frequency	5*00	■Hz□A□kW	Hz	Indicated value = Reference frequency (Hz)	(E48 = 2)
	Motor rotation speed	1500	■Hz■A□kW	min^{-1}	$\text{Indicated value} = \text{Output frequency (Hz)} \times \frac{120}{P01}$	(E48 = 3)
	Load rotation speed	30*0	■Hz■A□kW	min^{-1}	Indicated value = Output frequency (Hz) × E50	(E48 = 4)
	Speed (%)	5*0	□Hz□A□kW	%	$\text{Indicated value} = \frac{\text{Output frequency (Hz)}}{\text{Maximum frequency}} \times 100$	(E48 = 7)
Output current		1˝34	□Hz■A□kW	A	Current output from the inverter in RMS	3
Output voltage		200u	□Hz□A□kW	V	Output voltage (RMS) of the inverter	4
Calculated torque		50	□Hz□A□kW	%	Motor output torque in % (Calculated value)	8
Input power		1*25	□Hz□A■kW	kW	Input power to the inverter	9
PID process command		1*0*	□Hz□A□kW	-	PID command and its feedback converted into physical quantities of the object to be controlled (e.g. temperature)	10
PID feedback value		)0*	□Hz□A□kW	-		12
PID output		10**	□Hz□A□kW	%	PID output in % as the maximum frequency (F03) being at 100%	14
Load factor		50;	□Hz□A□kW	%	Load factor of the motor in % as the rated output being at 100%	15
Motor output		)85	□Hz□A■kW	kW	Motor output in kW	16
Analog signal input monitor		8˝00	□Hz□A□kW	-	An analog input to the inverter in a format suitable for a desired scale.	17
Input watt-hour		10*0	□Hz□A□kW	kWh	$\text{Indicated value} = \frac{\text{Input watt-hour (kWh)}}{100}$	25
External PID1 process command (final) (physical value)		1*0*	□Hz□A□kW	-	External PID1 control command value or PID feedback value converted into physical quantities of the object to be controlled and then displayed.	60
External PID1 feedback value (physical value)		)0*	□Hz□A□kW	-		61
External PID1 output (%)		8˝00	□Hz□A□kW	%	External PID1 control output displayed as percentage with maximum output frequency (F03) being 100%.	62
External PID1 manual command (%)		8˝00	□Hz□A□kW	%	External PID1 control command value displayed as percentage with maximum output frequency (F03) being 100%.	63

■ Illuminated, □ Not illuminated

E44	LED monitor (display when stopped)

E44 specifies whether the specified value (data = 0) or the output value (data = 1) will be displayed on the LED monitor of the keypad when the inverter is stopped. The monitored item depends on the E48 (LED monitor, Speed monitor item) setting as shown below.

E48 data	Monitored item	Inverter stopped	
		E44 = 0 Specified value	E44 = 1 Output value
0	Output frequency 1 (PM: Speed command value)	Reference frequency	Output frequency 1 (PM: Speed command value)
1	Output frequency 2 (PM: Speed estimated value)	Reference frequency	Output frequency 2 (PM: Speed estimated value)
2	Reference frequency	Reference frequency	Reference frequency
3	Motor rotation speed	Reference motor rotation speed	Motor rotation speed
4	Load rotation speed	Reference load rotation speed	Load rotation speed
7	Speed (%)	Reference display speed	Display Speed

E48	LED monitor (speed monitor item) (refer to E43)

For details about LED Monitor (Speed monitor item), refer to the description of E43.

E50	Display coefficient for speed monitor

E50 specifies the coefficient that is used when the load shaft speed or line speed is displayed on the LED monitor. (Refer to the description of E43.)

Load shaft speed [min^{-1}] = (E50: Display coefficient for speed monitor) × (Output frequency Hz)

Line speed [m/min] = (E50: Display coefficient for speed monitor) × (Output frequency Hz)

- Data setting range: 0.01 to 200.00

E51	Display coefficient for “Input watt-hour data”

E51 specifies a display coefficient (multiplication factor) for displaying the input watt-hour data (5_10) in a part of maintenance information on the keypad.

Input watt-hour data = Display coefficient (E51 data) × Input watt-hour (100kWh)

- Data setting range: 0.000 (cancel/reset) 0.001 to 9999

Note: Setting E51 data to 0.000 clears the input watt-hour and its data to “0.” After clearing, be sure to restore E51 data to the previous value; otherwise, input watt-hour data will not be accumulated.

E52	Keypad (Menu display mode)

E52 provides a choice of three menu display modes for the standard keypad as listed below.

E52 data	Menu display mode	Menus to be displayed
0	Function code data editing mode	Menus #0, #1 and #7
1	Function code data check mode	Menus #2 and #7
2	Full-menu mode	Menus #0 through #7

E52 specifies the menus to be displayed on the standard keypad. There are eight menus as shown in the table below.

Menu #	LED monitor shows:	Function	Display content
0	*. fnc	Quick setup	Quick setup function code
1	!. f__	Data setting F to o	F to o group function code
2	". rep	Data check	Modified function code
3	#. ope	Operation monitor	Operation status indication
4	$. i_o	I/O check	DIO, AIO status indication
5	%. che	Maintenance	Maintenance information indication
6	&. al	Alarm information	Alarm information indication
7	' cpy	Data copy	Data copy function (only optional keypad)

📖 For details of each menu item, refer to the FRENIC-Ace User's Manual Chapter 3 "OPERATION USING THE KEYPAD."

E59	Terminal [C1] function selection (C1 function//V2 function)

Specifies whether terminal [C1] is used with current input +4 to +20 mA/0 to 20 mA or voltage input 0 to +10 V. In addition, switch SW7 on the interface board must be switched.

E59 data	Input form	Switch SW7
0	Current input: 4 to 20 mA/0 to 20 mA (C1 function)	C1
1	Voltage input: 0 to 10 V (V2 function)	V2

Note When using terminal [C1] as a PTC thermistor input, specify E59 = 0.

For using terminal [C1] for the C1, V2 or PTC function, switching as shown below is necessary.

Terminal [C1]	SW3	SW4	E59	H26	C40
For use of C1 function (4 to 20 mA)	C1	AI	0	0	0,10
For use of C1 function (0 to 20 mA)	C1	AI	0	0	1, 11
For use of V2 function (0 to +10 V)	V2	AI	1	0	Does not matter
For use of PTC function	C1	PTC	Does not matter	1,2	Does not matter

For details about SW3 and SW4, refer to the FRENIC-Ace User's Manual Chapter 2, Section 2.2.8.

⚠WARNING

Failure to correctly switch as shown above may cause a wrong analog input value, possibly leading to unexpected operation of the inverter.

Injuries may occur.

Failure may occur.

E61 to E63	Terminals [12], [C1] (C1 function), [C1] (V2 function) (extended function)

Select the functions of terminals [12], [C1] (C1 function) and [C1] (V2 function).

There is no need to set up these terminals if they are to be used for frequency command sources.

E61, E62, E63 data	Function	Description
0	None	—
1	Auxiliary frequency command 1	Auxiliary frequency input to be added to the reference frequency given by frequency setting 1 (F01). Will not be added to any other reference frequency given by frequency setting 2 and multistep frequency commands, etc. 100%/full scale
2	Auxiliary frequency command 2	Auxiliary frequency input to be added to all frequency commands. Will be added to frequency command 1, frequency command 2, multistep frequency commands, etc. 100%/full scale
3	PID process command	Inputs command sources such as temperature and pressure under PID control. You also need to set function code J02. 100%/full scale
5	PID feedback value	Inputs feedback values such as temperature and pressure under PID control. 100%/full scale
20	Analog signal input monitor	By inputting analog signals from various sensors such as the temperature sensors in air conditioners to the inverter, you can monitor the state of external devices via the communications link. By using an appropriate display coefficient, you can also have various values to be converted into physical quantities such as temperature and pressure before they are displayed. 100%/full scale
41	External PID process command	Inputs command values such as temperature and pressure for external PID control. 100%/full scale
42	External PID feedback value	Inputs feedback such as temperature and pressure for external PID control. 100%/full scale
43	External PID manual command (%)	Inputs manual command values such as temperature and pressure for external PID control. 100%/full scale

Note If these terminals have been set up to have the same data, E61 is given priority. For E62 and E63, only the terminal selected with E59 is enabled.

E64	Saving of digital reference frequency

E64 specifies how to save the reference frequency specified in digital format by the / keys on the keypad as shown below.

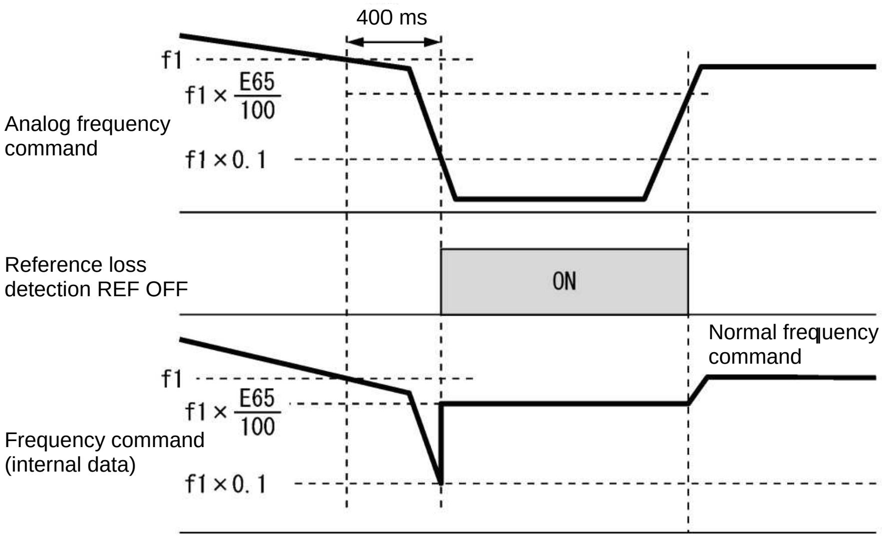
E64 data	Function
0	The reference frequency will be automatically saved when the main power is turned OFF. At the next power-on, the reference frequency at the time of the previous power-off applies.
1	Saving by pressing key. Pressing the key saves the reference frequency. If the control power is turned OFF without pressing the [image] key, the data will be lost. At the next power-ON, the inverter uses the reference frequency saved the key was pressed.

E65	Reference loss detection (continuous running frequency)

When the analog frequency command (setting through terminal [12], [C1] (C1 function) or [C1] (V2 function) has dropped below 10% of the reference frequency within 400 ms, the inverter presumes that the analog frequency command wire has been broken and continues its operation at the frequency determined by the ratio specified by E65 to the reference frequency. And "REF OFF" signal comes on.

(📖 Function codes E20, E21 and E27, data = 33)

When the frequency command level (in voltage or current) returns to a level higher than that specified by E65, the inverter presumes that the broken wire has been fixed and continues to run following the frequency command.



In the diagram above, f1 is the level of the analog frequency command sampled at any given time. The sampling is repeated at regular intervals to continually monitor the wiring connection of the analog frequency command.

- Data setting range:0 (Decelerate to stop) 20 to 120 % 999 (Disable)

Note

Avoid an abrupt voltage or current change for the analog frequency command. An abrupt change may be interpreted as a wire break.

Setting E65 data at "999" (Disable) allows the REF OFF signal ("Reference loss detected") to be issued, but does not allow the reference frequency to change. (The inverter runs at the analog frequency command as specified.)

When E65 = "0" or "999," the reference frequency level at which the broken wire is recognized as fixed is "f1 × 0.2."

When E65 = "100" (%) or higher, the reference frequency level at which the wire is recognized as fixed is "f1 × 1."

The reference loss detection is not affected by the setting of analog input adjustment (filter time constants: C33, C38, and C43).

E76	DC link bus low-voltage detection level

"U-EDC" signal comes ON when the DC intermediate voltage drops below E76 (DC link bus low-voltage detection level), and it goes OFF when the DC intermediate voltage exceeds E76.

(📖 Function codes E20, E21 and E27, data = 77)

E80, E81	Torque detection 2/low torque detection (level and timer)

E80 specifies the operation level and E81 specifies the timer, for the output signal “U-TL”.

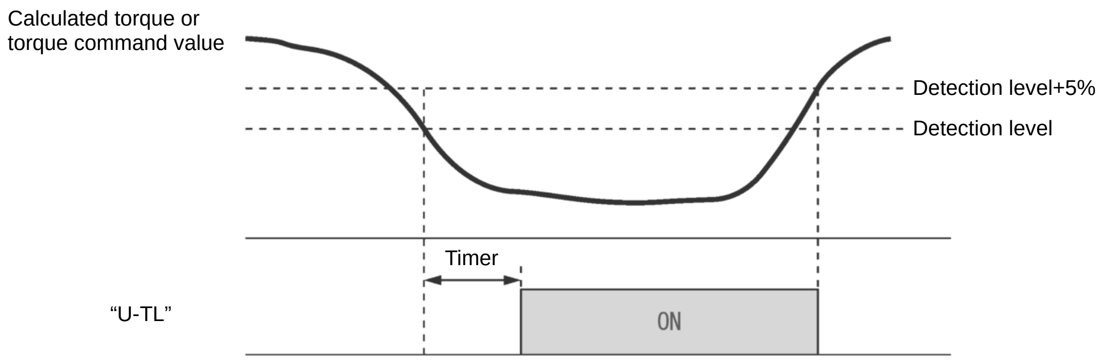
In the inverter’s low frequency operation, as a substantial error in torque calculation occurs, no low torque can be detected within the operation range at less than 20% of the base frequency (F04). (In this case, the result of recognition before entering this operation range is retained.) The U-TL signal goes off when the inverter is stopped.

Since the motor parameters are used in the calculation of torque, it is recommended that auto-tuning be applied by function code P04 to achieve higher accuracy.

Output signal	Assigned data	Detection level	Timer
		Range: 0 to 300%	Range: 0.01 to 600.00 s
“U-TL”	45	E80	E81

■ **Low torque detected – “U-TL”**

This output signal comes ON when the torque value calculated by the inverter or torque command drops below the level specified by E80 (Low torque detection (Level)) for the period specified by E81 (Low torque detection (Timer)). The signal turns OFF when the calculated torque exceeds “the level specified by E80 or E80 plus 5% of the motor rated torque.” (The minimum ON-duration is 100 ms.)



E98, E99	Terminal [FWD] function, Terminal [REV] function (refer to E01 to E05)

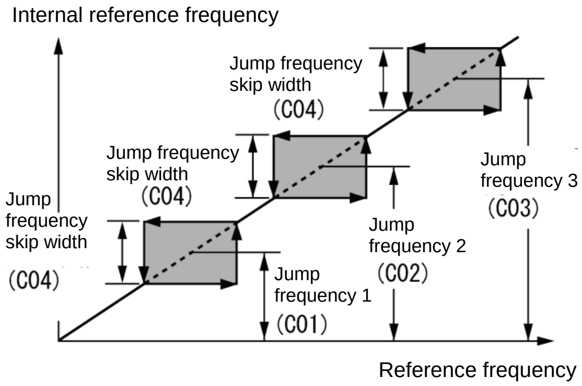
For details, refer to the descriptions of E01 to E05.

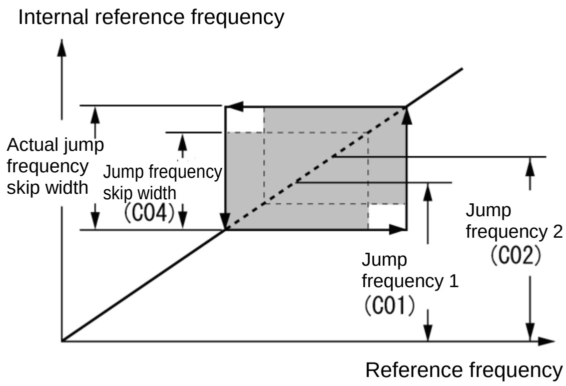
J.3 C codes (Control functions)

C01 to C04	Jump frequency 1, 2 and 3, Jump frequency (Skip width)

These function codes enable the inverter to jump over three different points on the output frequency in order to skip resonance caused by the motor speed and natural frequency of the driven machinery (load).

- While increasing the reference frequency, the moment the reference frequency reaches the bottom of the jump frequency band, the inverter keeps the output at that bottom frequency. When the reference frequency exceeds the upper limit of the jump frequency band, the internal reference frequency takes on the value of the reference frequency. When decreasing the reference frequency, the situation will be reversed. Refer to the left figure below.
- When more than two jump frequency bands overlap, the inverter actually takes the lowest frequency within the overlapped bands as the bottom frequency and the highest as the upper limit. Refer to the right figure below.





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

Specify the center of the jump frequency band.

- Data setting range: 0.0 to 500.0 (Hz) (Setting to 0.0 results in no jump frequency band.)

■ Jump frequency skip width (C04)

Specify the jump frequency skip width.

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

C05 to C19	Multistep frequency 1 to 15

■ **These function codes specify 15 frequencies required for driving the motor at frequencies 1 to 15.**

Turning terminal commands “SS1”, “SS2”, “SS4” and “SS8” ON/OFF selectively switches the reference frequency of the inverter in 15 steps. To use this features, you need to assign “SS1”, “SS2”, “SS4” and “SS8” (“Select multistep frequency”) to the digital input terminals with E01 to E05 (data = 0, 1, 2, and 3).

■ **Multistep frequency 1 to 15 (C05 through C19)**

- Data setting range: 0.00 to 500.0 (Hz)

The combination of “SS1”, “SS2”, “SS4” and “SS8” and the selected frequencies is as follows.

“SS8”	“SS4”	“SS2”	“SS1”	Selected frequency command
OFF	OFF	OFF	OFF	Other than multistep frequency*
OFF	OFF	OFF	ON	C05 (Multistep frequency 1)
OFF	OFF	ON	OFF	C06 (Multistep frequency 2)
OFF	OFF	ON	ON	C07 (Multistep frequency 3)
OFF	ON	OFF	OFF	C08 (Multistep frequency 4)
OFF	ON	OFF	ON	C09 (Multistep frequency 5)
OFF	ON	ON	OFF	C10 (Multistep frequency 6)
OFF	ON	ON	ON	C11 (Multistep frequency 7)
ON	OFF	OFF	OFF	C12 (Multistep frequency 8)
ON	OFF	OFF	ON	C13 (Multistep frequency 9)
ON	OFF	ON	OFF	C14 (Multistep frequency 10)
ON	OFF	ON	ON	C15 (Multistep frequency 11)
ON	ON	OFF	OFF	C16 (Multistep frequency 12)
ON	ON	OFF	ON	C17 (Multistep frequency 13)
ON	ON	ON	OFF	C18 (Multistep frequency 14)
ON	ON	ON	ON	C19 (Multistep frequency 15)

* “Other than multistep frequency” includes frequency setting 1 (F01), frequency setting 2 (C30) and other frequency command sources except multistep frequency commands.

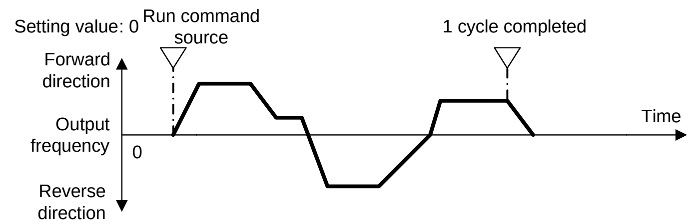
C21 C22 to C28	Pattern operation mode selection Stage 1 to 7

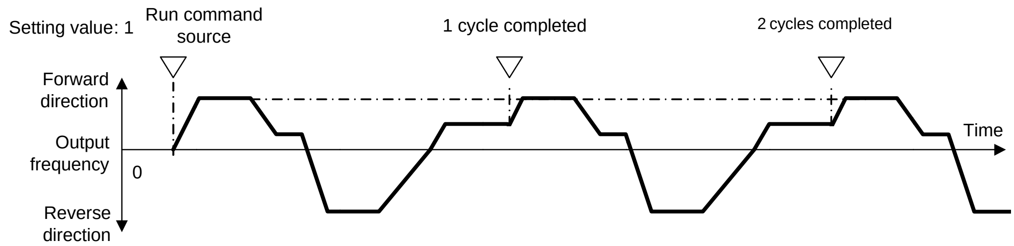
Pattern operation is a function of automatic operation according to the predefined run time, rotational direction, acceleration/deceleration time and reference frequency.

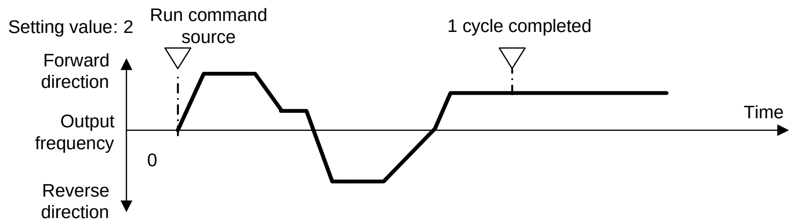
When using this function, set the frequency setting (F01) to 10 (pattern operation).

The following operation patterns are available:

C21:Setting	Operation pattern
0	Pattern operation performed for one cycle and stopped after the cycle.
1	Pattern operation repeatedly performed and immediately stopped with a stop command
2	Pattern operation performed for one cycle and operation continued at the reference frequency after the cycle.







■ C22 to C28 Stage 1 to Stage 7

Specify the run time for Stage 1 to Stage 7.

Press the key three times for each function code to set the following three data.

Setting	Description
1st	Specifies the run time between 0.0 and 3600 s.
2nd	2nd: Specifies the rotational direction F (forward) or r (reverse)
3rd	3rd: Specifies the acceleration/deceleration time between 1 and 4. 1: F07/F08 2: E10/E11 3: E12/E13 4: E14/E15

If the key is pressed to exit the function code before the three data are specified by pressing the key three times, no data are updated.

For any unused stage, specify 0.0 as the run time. The stage is skipped and the next stage becomes ready for setting.

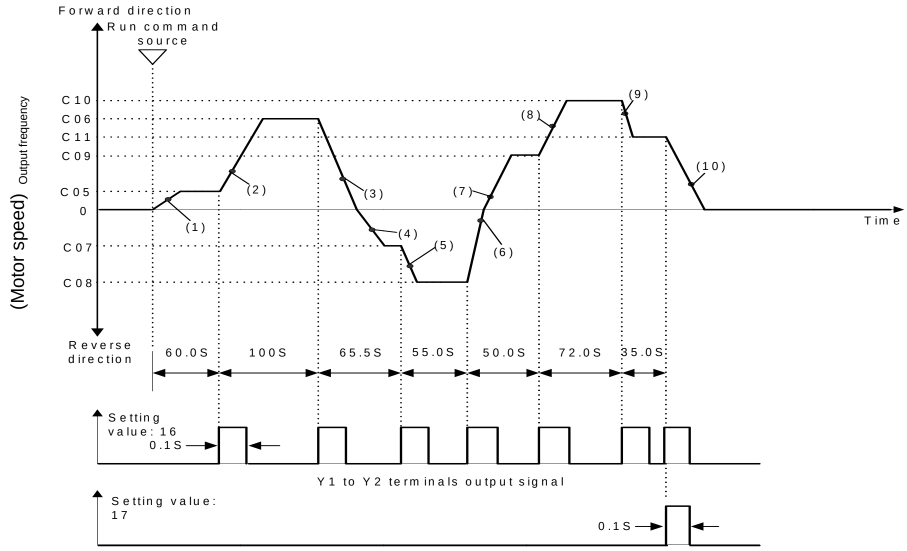
■ Reference frequency

Multistep frequencies 1 to 7 are assigned to the reference frequency of Stage 1 to 7.

■ Example of pattern operation setting

C21 (Mode selection)	Stage No.	Run time	Rotational direction	Acceleration/deceleration time	Operation (reference) frequency
		Setting value	Setting value	Setting value	
0	Stage 1	60.0	F	2	C05 Multistep frequency 1
	Stage 2	100	F	1	C06 Multistep frequency 2
	Stage 3	65.5	r	4	C07 Multistep frequency 3
	Stage 4	55.0	r	3	C08 Multistep frequency 4
	Stage 5	50.0	F	2	C09 Multistep frequency 5
	Stage 6	72.0	F	4	C10 Multistep frequency 6
	Stage 7	35.0	F	2	C11 Multistep frequency 7

The figure below illustrates the operation.



Set according to (1) to (10) Acceleration time or deceleration time

(1)	Acceleration time: E10
(2)	Acceleration time: F07
(3)	Deceleration time: E15
(4)	Acceleration time: E14
(5)	Acceleration time: E12
(6)	Deceleration time: E11
(7)	Acceleration time: E10
(8)	Acceleration time: E14
(9)	Deceleration time: E11
(10)	Deceleration time: F08

F08 Deceleration time 1 setting is used as deceleration time for deceleration to stop after the completion of one cycle.

◆ To run or stop, use input from the RUN key of the keypad or by switching the control terminal. When using the keypad, press the RUN key to run. Press the STOP key to suspend the progression of stages. Press the RUN key again to resume operation according to the stages from the point where it was suspended. For alarm stop, press the PRG/RESET key to reset the inverter protective functions. Then press the RUN key. The suspended progression of the cycle resumes. If a need arises for operation from the first stage “C22 (Stage 1 runtime)” and “C82 (Stage 1 rotational direction and acceleration/deceleration time)” during operation, input a stop command and press the PRG/RESET key.

When operation from the first stage is necessary after an alarm stop, press the PRG/RESET key for resetting the protective functions and press the PRG/RESET key again. For operation with input terminals, use of the “RST” terminal (set “8 (Active ON)” or “1008 (Active OFF)” for any of E01 to E05) function the same way.

Tip

- Pattern operation can be started by either a forward run command (specify F02 = 2 and press the RUN key, or specify F02 = 1 and turn the FWD terminal ON) or reverse run command (specify F02 = 3 and press the RUN key, or specify F02 = 1 and turn the REV terminal ON). However, the rotational direction is as specified by C82 to C88 regardless the operation is started by a forward run command or reverse run command.
- If using FWD or REV terminal, please use the alternate-type switch because it is not self-holding.

⚠CAUTION

When pattern operation is started by specifying C21 = 0 and turning the FWD (REV) terminal ON, the motor stops after the completion of the last stage even if the FWD (REV) terminal is kept turned ON.
In this case, modifying the value for F01 or C30 or switching the control terminal “Hz2/Hz1” ON/OFF without turning the FWD (REV) terminal OFF causes the operation to be immediately resumed according to the reference frequency after the change.

An accident or physical injury may result.

C30	Frequency setting 2 (refer to F01)

For details of frequency setting 2, refer to the description of F01.

C31 to C35	**Analog input adjustment (terminal [12])** **(offset, gain, filter time constant, gain base point, polarity)**
C36 to C40	**Analog input adjustment (terminal [C1] C1 function)** **(offset, gain, filter time constant, gain base point, range/polarity)**
C41 to C45	**Analog input adjustment (terminal [C1] V2 function)** **(offset, gain, filter time constant, gain base point, polarity)** **(refer to F01 for frequency setting)**

C55, C56	**Bias (for PID, frequency command 2 (terminal [12])) (bias, bias base point) (refer to F01)**
C61, C62	**Bias (for PID, frequency command 2 (terminal [C1]) (C1 function))** **(bias, bias base point)(refer to F01)**
C67, C68	**Bias (for PID, frequency command 2 (terminal [C1]) (V2 function))** **(bias, bias base point)(refer to F01)**

You can adjust the gain, bias, polarity, filter time constant and offset which are applied to analog inputs (voltage inputs to terminals [12] and [C1] (V2 function) and current input to terminal [C1] (C1 function)).

Adjustable items for analog inputs (excluding those for frequency command 1)

Input terminal	Input range	Bias		Gain		Polarity	Filter time constant	Offset
		Bias	Base point	Gain	Base point			
[12]	0 to +10 V, -10 to +10 V	C55	C56	C32	C34	C35	C33	C31
[C1] (C1)	4 to 20 mA, 0 to 20 mA	C61	C62	C37	C39	C40	C38	C36
[C1] (V2)	0 to +10 V	C67	C68	C42	C44	C45	C43	C41

■ Offset (C31, C36, C41)

C31, C36 or C41 configures an offset for an analog voltage/current input.

- Data setting range: -5.0 to +5.0 (%)

■ Filter time constant (C33, C38, C43)

C33, C38, and C43 provide the filter time constants for the voltage and current of the analog input. The larger the time constant, the slower the response. Specify the proper filter time constant taking into account the response speed of the machine (load). If the input voltage fluctuates due to line noises, increase the time constant.

- Data setting range: 0.00 to 5.00 (s)

■ Polarity Terminal [12] (C35)

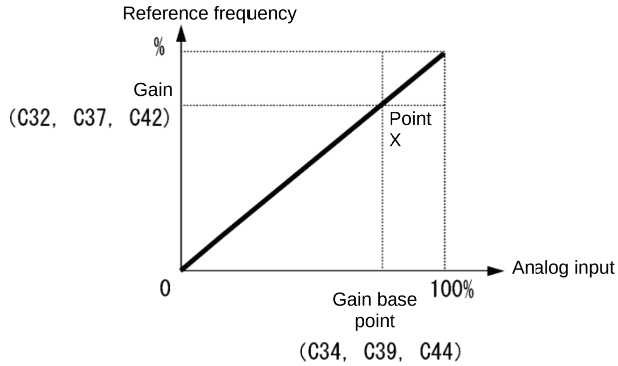
C35 and C45 configure the input range for analog input voltage.

C35 data	Modes for terminal inputs
0	-10 to +10 V
1	0 to +10 V (negative value of voltage is regarded as 0 V)

■ Polarity [C1] (V2 function) (C45)

C45 data	Modes for terminal inputs
0	0 to +10 V When the bias is specified to be a negative value, makes a point lower than 0 effective as a negative value.
1	0 to +10 V (factory default) When the bias is specified to be a negative value, limits a point lower than 0 to 0.

■ **Gain**



Note: To input bipolar analog voltage (0 to ±10 VDC) to terminal [12], set C35 data to "0." Setting C35 data to "1" enables only the voltage range from 0 to +10 VDC and interprets the negative polarity input from 0 to -10 VDC as 0 V.

■ **Terminal [C1] (C1 function) range / polarity selection(C40)**

Selects the range of current input terminal [C1](C1 function).

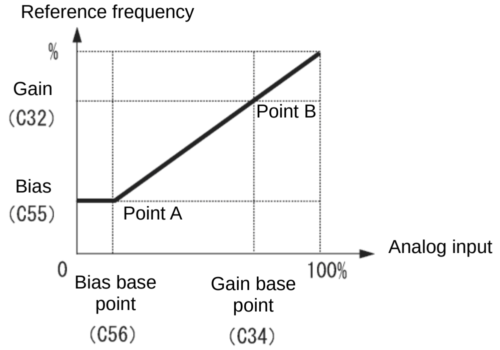
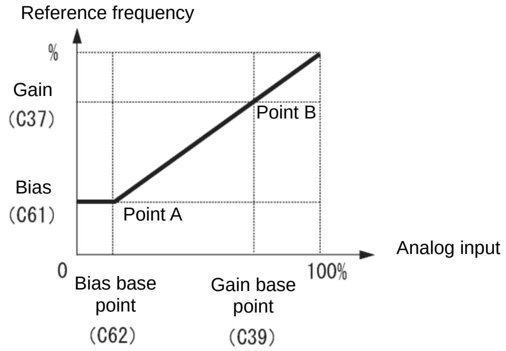
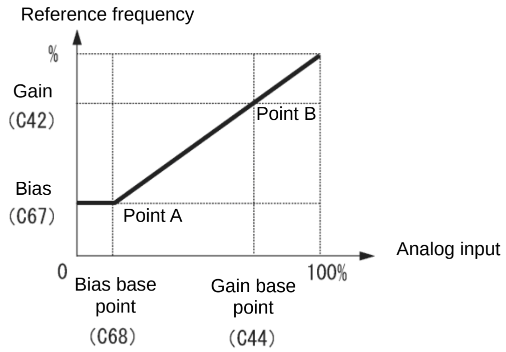
C40 data	Terminal input range	When specified bias is negative
0	4 to 20 mA (factory default)	Limits a point lower than 0 to 0.
1	0 to 20 mA	
10	4 to 20 mA	Makes a point lower than 0 effective as a negative value.
11	0 to 20mA	

For using terminal [C1] for the C1, V2 or PTC function, it is necessary to make the settings as shown below.

Terminal [C1]	SW3	SW4	E59	H26	C40
For use of C1 function (4 to 20 mA)	C1	AI	0	0	0, 10
For use of C1 function (0 to 20 mA)	C1	AI	0	0	1, 11
For use of V2 function (0 to +10V)	V2	AI	1	0	Does not matter
For use of PTC function	C1	PTC	Does not matter	1, 2	Does not matter

For details about SW3 and SW4, refer to the FRENIC-Ace User's Manual Chapter 2, Section 2.2.8.
Expected operation may not be obtained if the settings above are not switched correctly. Use sufficient caution.

■ **Gain/bias**

Terminal	PID command, feedback, analog monitor
[12]	
[C1] (C1 function)	
[C1] (V2 function)	

These are biases and bias base points used for PID command, PID feedback, frequency command 2 and analog monitor. For details, refer to the description of F01 and J01.

Bias (C55, C61, C67)

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

Bias base point (C56, C62, C68)

- Data setting range: 0.00 to 100.00 (%)

Specifying the bias as a negative value allows an input to be specified as bipolar for a unipolar analog input. By setting C40 data to 10 or 11 for terminal [C1] (C1 function) or C45 data to 1 for terminal [C1] (V2 function), an input value for an analog input equal to or lower than 0 point is specified to have negative polarity.

C50	Bias (Frequency setting 1) (Bias base point) (refer to F01)

Refer to the description of F01.

C53	Selection of normal/inverse operation (frequency setting 1)

Switches between the between normal and inverse operation of frequency setting 1 (F01) .

For details, refer to E01 through E05 (data = 21) for the terminal command IVS ("■ Switch normal/inverse operation – "IVS"").

C58	**Analog input adjustment (for analog monitor (terminal [12])) (Display unit)**
C64	**Analog input adjustment (for analog monitor (terminal [C1])) (C1 function) (Display unit)**
C70	**Analog input adjustment (for analog monitor (terminal [C1])) (V2 function) (Display unit)**

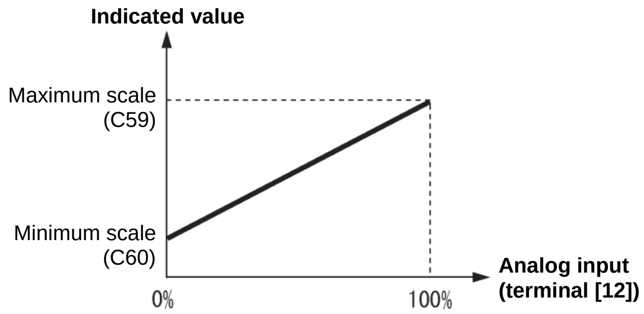
The units for the respective analog inputs can be displayed when a multi-function keypad (TP-A1-E2C) is used. Set these codes to use for command and feedback values of the PID control and the analog input monitor. Use the multi-function keypad to display the SV and PV values of the PID control and the analog input monitor on the main and sub-monitors. Indications are given in the specified units.

C58, C64, C70	Unit	C58, C64, C70	Unit	C58, C64, C70	Unit
—	—	23	L/s (flowrate)	45	mmHg (pressure)
1	No unit	24	L/min (flowrate)	46	Psi (pressure)
2	%	25	L/h (flowrate)	47	mWG (pressure)
4	r/min	40	Pa (pressure)	48	inWG (pressure)
7	kW	41	kPa (pressure)	60	K (temperature)
20	m^3/s (flowrate)	42	MPa (pressure)	61	°C (temperature)
21	m^3/min (flowrate)	43	mbar (pressure)	62	°F (temperature)
22	m^3/h (flowrate)	44	bar (pressure)	80	ppm (concentration)

C59, C60	**Analog input adjustment (terminal [12]) (Maximum scale, Minimum scale)**
C65, C66	**Analog input adjustment (terminal [C1] (C1 function)) (Maximum scale, Minimum scale)**
C71, C72	**Analog input adjustment (terminal [C1] (V2 function)) (Maximum scale, Minimum scale)**

Values of the analog input monitor (terminals [12] and [C1] (C1 and V2 functions) can be converted into easily recognizable physical quantities for display. This function can also be used for PID feedback and PID command values.

- Data setting range: (maximum scale and minimum scale) -999.00 to 0.00 to 9990.00



J.4 P codes (Motor 1 parameters)

To use the integrated automatic control functions such as auto torque boost, torque calculation monitoring, auto energy saving operation, torque limiter, automatic deceleration (anti-regenerative control), and auto search for idling motor speed, it is necessary to build a motor model in the inverter by specifying proper motor parameters including the motor capacity and rated current.

The FRENIC-Ace, provides built-in motor parameters for Fuji standard motors 8-series. To use these Fuji motors, it is enough to specify motor parameters for P99 (Motor 1 selection). If the cabling between the inverter and the motor is long (generally, 20 m (66 ft) or longer) or a reactor is inserted between the motor and the inverter, however, the apparent motor parameters are different from the actual ones, so auto-tuning or other adjustments are necessary.

For the auto-tuning procedure, refer to the FRENIC-Ace Instruction Manual, the FRENIC-Ace User's Manual Chapter 4 "TEST RUN PROCEDURE."

When using a motor made by other manufacturers or a Fuji non-standard motor, obtain the datasheet of the motor and specify the motor parameters manually or perform auto-tuning.

P01	Motor 1 (No. of poles)

P01 specifies the number of poles of the motor. Enter the value given on the nameplate of the motor. This setting is used to display the motor speed on the LED monitor and to control the speed (refer to E43). The following expression is used for the conversion.

Motor rotational speed (min^{-1}) = 120/No.of poles x Frequency (Hz)

- Data setting range: 2 to 22 (poles)

P02	Motor 1 (Rated capacity)

P02 specifies the rated capacity of the motor. Enter the rated value given on the nameplate of the motor.

P02 data	Unit	Function
0.01 to 1000	kW	When P99 (Motor 1 selection) = 0, 4, 20 or 21
	HP	When P99 (Motor 1 selection) = 1

When accessing P02 with the keypad, take into account that the P02 data automatically updates data of P03, P06 through P08, P53 and H46.

P03	Motor 1 (Rated current)

P03 specifies the rated current of the motor. Enter the rated value given on the nameplate of the motor.

- Data setting range: 0.00 to 2000 (A)

P04	Motor 1 (Auto-tuning)

The inverter automatically detects the motor parameters and saves them in its internal memory. Basically, it is not necessary to perform tuning when a Fuji standard motor is used with a standard connection with the inverter.

There are two types of auto-tuning as listed below. Select the appropriate one considering the limitations in your equipment and control mode.

<table>
<tr><th>P04 data</th><th>Auto-tuning</th><th>Action</th><th colspan="2">Motor parameters to be tuned</th></tr>
<tr><td>0</td><td>Disable</td><td>—</td><td colspan="2">—</td></tr>
<tr><td rowspan="2">1</td><td rowspan="2">Tune the motor while it is stopped</td><td rowspan="2">Tunes while the motor is stopped.</td><td>IM</td><td>Primary resistance (%R1) (P07)
Leakage reactance (%X) (P08)</td></tr>
<tr><td>PM</td><td>Armature resistance (P60)
d-axis inductance (P61)
q-axis inductance (P62)
Reserved (P84, P88)</td></tr>
<tr><td rowspan="2">2</td><td rowspan="2">Tune the motor while it is rotating.</td><td rowspan="2">After tuning the motor in a stopped state, retunes it running at 50% of the base frequency.</td><td>IM</td><td>No-load current (P06)
Primary resistance (%R1) (P07)
Leakage reactance (%X) (P08)</td></tr>
<tr><td>PM</td><td>Armature resistance (P60)
d-axis inductance (P61)
q-axis inductance (P62)
Reserved (P84, P88)</td></tr>
<tr><td>5</td><td>Tune the motor while it is stopped</td><td>Tunes while the motor is stopped.</td><td>IM</td><td>Primary resistance (%R1) (P07)
Leakage reactance (%X) (P08)</td></tr>
</table>

For details of auto-tuning, refer to the FRENIC-Ace User's Manual Chapter 4 "TEST RUN PROCEDURE."

Note In any of the following cases, perform auto-tuning since the motor parameters are different from those of Fuji standard motors so that the best performance cannot be obtained under some conditions.

- The motor to be driven is a non-Fuji motor or a non-standard motor.
- Cabling between the motor and the inverter is long. (Generally, 20 m (66 ft) or longer)
- A reactor is inserted between the motor and the inverter.

Other applicable cases

■ **Functions whose performance is affected by the motor parameters**

Function	Related function codes (representative)
Auto torque boost	F37
Output torque monitor	F31, F35
Load factor monitor	F31, F35
Auto energy saving operation	F37
Torque limit control	F40
Anti-regenerative control (Automatic deceleration)	H69
Auto search	H09
Low torque detection	E80 to E81

P05	**Motor 1 (Online tuning)**

When vector control without speed sensor (dynamic torque vector) or slip compensation control is used for long-time operation, the motor parameters change along with motor temperature rise.

If motor parameters change, the amount of speed compensation may change to cause the motor speed to be different from the initial speed.

Enabling auto-tuning allows the identification of the motor parameters that match the change in the motor temperature, which minimizes the motor speed variation.

To use this function, specify “2” for auto-tuning (P04).

Note Online tuning is enabled only when F42 = 1 (Vector control without speed sensor) or F42 = 2 (V/f control with slip compensation active) and F37 = 2, 5 (auto torque boost).

P06 to P08	Motor 1 (No-load current, %R1 and %X)

P06 through P08 specify no-load current, %R1 and %X, respectively. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Performing auto-tuning automatically sets these parameters.

- No-load current: Input the value obtained from the motor manufacturer.
- %R1: Enter the value calculated by the following expression.

$$\%R1 = \frac{R1 + \text{Cable } R1}{V / (\sqrt{3} \times I)} \times 100\,(\%)$$

R1: Primary resistance of the motor (Ω)
Cable R1: Resistance of the output cable (Ω)
V: Rated voltage of the motor (V)
I: Rated current of the motor (A)

- %X: Enter the value calculated by the following expression.

$$\%X = \frac{X1 + X2 \times XM / (X2 + XM) + \text{Cable } X}{V / (\sqrt{3} \times I)} \times 100\,(\%)$$

X1: Primary leakage reactance of the motor (Ω)
X2: Secondary leakage reactance of the motor (converted to primary) (Ω)
XM: Exciting reactance of the motor (Ω)
Cable X: Reactance of the output cable (Ω)
V: Rated voltage of the motor (V)
I: Rated current of the motor (A)

Note For reactance, use the value at the base frequency (F04).

P09 to P11	Motor 1 (slip compensation gain for driving, slip compensation response time and slip compensation gain for braking)

P09 and P11 determine the slip compensation amount in % for driving and braking individually and adjust the slip amount from internal calculation. Mode of 100% fully compensates for the rated slip of the motor. Excessive compensation (100% or more) may cause hunting (undesirable oscillation of the system), so carefully check the operation on the actual machine.

P10 determines the response time for slip compensation. Basically, there is no need to modify the default setting. If you need to modify it, consult your Fuji Electric representatives.

Function code		Operation (slip compensation)
P09	Slip compensation gain for driving	Adjust the slip compensation amount for driving. Slip compensation amount for driving = Rated slip × Slip compensation gain for driving
P11	Slip compensation gain for braking	Adjust the slip compensation amount for braking. Slip compensation amount for braking = Rated slip × Slip compensation gain for braking
P10	Slip compensation response time	Specify the slip compensation response time. Basically, there is no need to modify the setting.

For details about slip compensation control, refer to the description of F42.

APPENDICES

P12	Motor 1 (rated slip frequency)

P12 specifies rated slip frequency. Obtain the appropriate values from the test report of the motor or by calling the manufacturer of the motor. Performing auto-tuning automatically sets these parameters.

- Rated slip frequency: Convert the value obtained from the motor manufacturer to Hz using the following expression and enter the converted value.

  (Note: The motor rated value on the nameplate sometimes shows a larger value.)

$$\text{Rated slip frequency (Hz)} = \frac{(\text{Synchronous speed} - \text{Rated speed})}{\text{Synchronous speed}} \times \text{Base frequency}$$

For details about slip compensation control, refer to the description of F42.

P13	Motor 1 (iron loss factor 1)

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.
Basically, there is no need to modify the setting.

P30	**PMSM drive Motor 1 (Magnetic pole position detection mode)** **Related function codes:** **P74:PMSM Motor 1 (Reference current at starting)** **P87:PMSM Motor 1 (Reference current for polarity discrimination)**

P30 specifies the magnetic pole position detection mode. Select the appropriate mode that matches the PMSM to be used.

Data for P30	Function	Remarks
0: Pull-in by current	No magnet pole position detection is made. At the start of driving the motor, the inverter supplies current specified by P74 to pull in the magnetic pole position. In this position detection mode, the motor may rotate slightly in the direction opposite to the commanded direction depending upon the current motor shaft position.	—
1: For IPMSM (Interior permanent magnet synchronous motor)	The inverter starts the motor with the magnetic pole position detection suitable for IPMSM. The reference current for polarity discrimination specified by P87 applies. Usually it is not necessary to change the factory default.	—
2: For SPMSM (Surface permanent magnet synchronous motor)	The inverter starts the motor with the magnetic pole position detection suitable for SPMSM.	—
3: Pull-in by current for IPMSM (Interior permanent magnet synchronous motor)	The inverter starts the motor with the magnetic pole position detection suitable for IPMSM causing no magnetic saturation. In this position detection mode, the motor may rotate slightly in the direction opposite to the commanded direction depending upon the current motor shaft position.	—

Tip The reference current for polarity discrimination specified by P87 applies. Usually it is not necessary to change the factory default.

Note During the magnetic pole position pull-in operation or the magnetic pole position detection, the motor cannot generate enough torque. When applying to the application which needs torque at start, engage the mechanical brake by using brake signal ***BRKS*** until magnetic pole position pull-in operation is completed. (📖 Function code E20)

P53	**Motor 1 (%X correction factor 1)**

This is a factor for correcting the variation of leakage reactance %X. Basically, there is no need to modify the setting.

P60 to P64	**PMSM Motor 1 (Armature resistance, d-axis inductance, q-axis inductance, Induced voltage, and Iron loss)**

P60 through P64 specify the armature resistance, d-axis inductance, q-axis inductance, induced voltage and iron loss of the motor, respectively.

The combination of P99 (Motor 1 selection) and P02 (Motor 1 rated capacity) data determines the standard value.

Basically, there is no need to modify the setting.

P65, P85	**PMSM Motor 1 (d-axis inductance magnetic saturation correction, Flux limitation value)**

These are the control parameter for PMSMs. Normally, it is not necessary to change the data of these function codes.

P74	**PMSM Motor 1 (Reference current at starting)**

Refer to P30.

P83, P84, P86, P88, P89	PMSM Motor 1 (Reserved)

These function codes are displayed, but they are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

P90	PMSM Motor 1 (Overcurrent protection level)

A PMSM has a current limit to prevent demagnetization of permanent magnet. If a current exceeding that limit flows through the motor, it weakens the magnet force of permanent magnet so that the motor does not get the desired characteristics.

To prevent it, P90 specifies the overcurrent protection level. If a current flows exceeding the level, the inverter causes an overcurrent protection alarm *0c1*, *0c2* or *0c3*.

P99	Motor 1 selection

P99 specifies the motor type to be used.

P99 data	Function
0	Motor characteristics 0 (Fuji standard IM, 8-series)
1	Motor characteristics 1 (HP rating IMs)
4	Other IMs
20	Other PMSMs
21	Motor characteristics PM (Fuji standard PMSM, GNB-series)

To select the motor drive control or to run the inverter with the integrated automatic control functions such as auto torque boost and torque calculation monitoring, it is necessary to specify the motor parameters correctly.

First select the motor type with P99 from Fuji standard motors 8-series, set P02 (capacity) and then initialize the motor parameters with H03. This process automatically configures the related motor parameters (P01, P03, P06 through P08, P53 and H46).
The data of F09 (Torque boost 1), H13 (Restart mode after momentary power failure (Restart time)), and F11 (Electronic thermal overload protection for motor 1 (Overload detection level)) depends on the motor capacity, but the process stated above does not change them. Specify and adjust the data during a test run if needed.

J.5 H codes (High performance functions)

H02, H03	**Data initialization (Method, Target)** **Related function codes: H193,H194 User initialization data (Save, Protect)**

Initialize all function code data to the factory defaults. The motor parameters are also initialized.
To change the H02/ H03 data, it is necessary to press the STOP + ∧/∨ keys (simultaneous keying).

H03 data	Function
0	Disable initialization (Settings manually made by the user will be retained.)
1	Initialize all function codes (initialization in accordance with function code H02 setting)
2	Initialize motor 1 parameters in accordance with P02 (Rated capacity) and P99 (Motor 1 selection)
11	Limited initialization (initialization other than communications function codes): Communication can be continued after initialization.
12	Limited initialization (initialization of customizable logic function U codes only)

• When all function codes are initialized, select the initialization method in advance with function code H02.

Selection of H02		Initialization method when 1 is set to H03
Data=0	Fuji standard initial value	Initialize all function codes with the Fuji Electric standard factory defaults.
Data=1	User initial value	Initialize the value with the user setting value saved by H194. If the user initial value is not saved, initialize it with Fuji standard initial value (H02=0).

For saving the user initial value, refer to items in function codes H193 and H194.

• To initialize the motor parameters, set the related function codes as follows.

Step	Item	Data	Function code
			1st motor
(1)	Motor selection	Selects the motor type	P99
(2)	Motor (rated capacity)	Sets the motor capacity (kW)	P02
(3)	Data initialization	Initialize motor parameters	H03 = 2
Function code data to be initialized Please refer to the F42 when using PMSM drive (F42=15)			P01, P03, P06 to P08, P30, P60 to P65, P74,P83 to P90, H46

• Upon completion of the initialization, the H03 data reverts to “0” (factory default).
• If P02/A16 data is set to a value other than the standard nominal applied motor rating, data initialization with H03 internally converts the specified value parameters values to the standard nominal applied motor rating. (See “I.4 Motor constant.”)
• Motor parameters to be initialized are for motors listed below under V/f control. When the base frequency, rated voltage, and the number of poles are different from those of the listed motors, or when non-Fuji motors or non-standard motors are used, change the rated current data to that printed on the motor nameplate.

Motor selection		V/f control data
Data = 0 or 4	Fuji standard motors, 8-series	4 poles 400 V/50 Hz
Data = 1	HP rating motors	4 poles 460 V/60 Hz

Note: When accessing P02 with the keypad, take into account that the P02 data automatically updates data of P03, P06 through P08, P53 and H46. Also, when accessing function code A16 for the 2nd motor, data of related function codes for each are automatically updated.

APPENDICES

H193, H194	User initial value (save, protection)
	Relevant function code: Initialization of H02 and H03 data (initial value selection and target)

The value can be saved in the non-volatile memory in the inverter so that customers may use the setting value changed from the Fuji Electric standard factory default value as the initial value for inverter initialization.

The setting value saved and protected here can be selected as the user initial value for initialization with function code H03. When this function is used, set H02 data=1.

If initialization is performed without saved/protected setting data, it is initialized to the Fuji Electric standard factory default regardless of the H02 value.

For data initialization, refer to function codes H02 and H03.

To change the data of function codes H02, H193 and H194, it is necessary to operate double keys "STOP key + ∧/∨ key".

To save the user setting value, set 1 (saved as the user initial value) to function code H02 in advance. In addition, function code H194 must be set to 0 (save enable).

H02 data	H194 data	Function when 1 is set to H193
0	Optional	User setting value is not saved.
1	0 : Save enable	User setting value is saved.
	1 : Protected (save disable)	User setting value is not saved.

User initial value save procedures

(1) Set all function codes and determine the user setting value for initialization.

(2) Set H02=1 and H194=0.

(3) Set H193=1. The user setting value is saved.

(4) Set H194=1. The user setting value is protected.

Note: When the setting value of the function code has already saved by H193 and the step of H193 is repeated again, the saved data is overwritten. Be careful for error operation. To prevent overwriting by error, it is recommended to protect the data with H194 data=1 after saving.

H04, H05	Auto-reset (Times and reset interval)

H04 and H05 specify the auto-reset function that makes the inverter automatically attempt to reset the tripped state and restart without issuing an alarm output (for any alarm) even if any protective function subject to reset is activated and the inverter enters the forced-to-stop state (tripped state). If the protective function is activated in excess of the times specified by H04, the inverter will issue an alarm output (for any alarm) and not attempt to auto-reset the tripped state.

Listed below are the protective functions subject to auto-reset.

Protective function	LED monitor displays:	Protective function	LED monitor displays:
Overcurrent protection	*0c1, 0c2, 0c3*	Braking resistor overheat	*dbh*
Overvoltage protection	*0u1, 0u2, 0u3*	Motor overload	*0l1, 0l2*
Heat sink overheat	*0h1*	Inverter overload	*0lu*
Inverter internal overheat	*0h3*	Step-out/ Magnetic pole position detection failure	*erd*
Motor overheat	*0h4*		

■ **Number of reset times (H04)**

H04 specifies the number of reset times for the inverter to automatically attempt to escape the tripped state. When H04 = 0, the auto-reset function will not be activated.

- Data setting range: 0 (Disable), 1 to 20 (times)

⚠CAUTION

If the "auto-reset" function has been specified, the inverter may automatically restart and run the motor stopped due to a trip fault, depending on the cause of the tripping. Design the machinery so that human body and peripheral equipment safety is ensured even when the auto-resetting succeeds.

Otherwise an accident could occur.

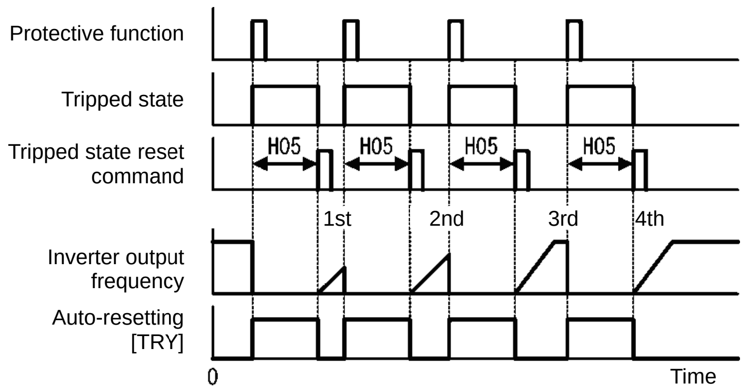
■ **Reset interval (H05)**

- Data setting range: 0.5 to 20.0 (s)

H05 specifies the reset interval time between the time when the inverter enters the tripped state and the time when it issues the reset command to attempt to auto-reset the state. Refer to "Operation timing scheme" below.

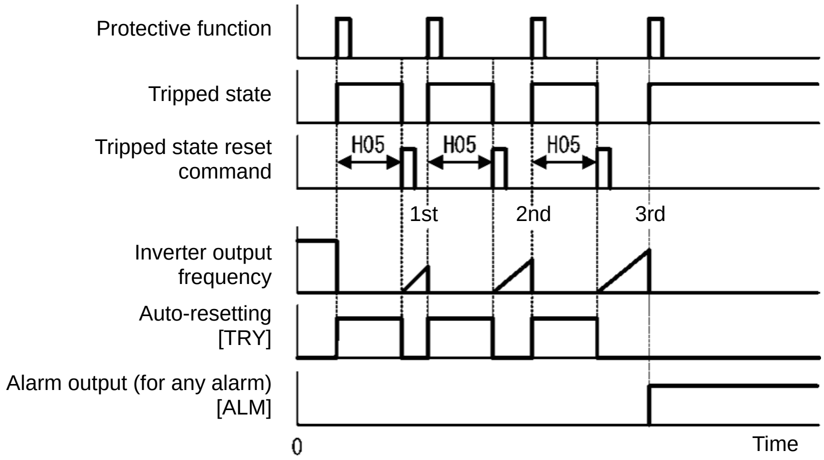
<Operation timing scheme>

- In the figure below, normal operation restarts in the 4-th retry.



APPENDICES

- In the figure below, the inverter failed to restart normal operation within the number of reset times specified by H04 (in this case, 3 times (H04 = 3)), and issued the alarm output (for any alarm) ALM.



- The auto-reset operation can be monitored from the external equipment by assigning the digital output signal TRY to any of the programmable, output terminals [Y1], [Y2] or [30A/B/C] by setting E20, E21 or E27 respectively (data = 26).

H06 Cooling fan ON/OFF control

To prolong the service life of the cooling fan and reduce fan noise during running, the cooling fan stops when the temperature inside the inverter drops below a certain level while the inverter stops. However, since frequent switching of the cooling fan shortens its service life, the cooling fan keeps running for at least 10 minutes once started.

H06 specifies whether to keep running the cooling fan all the time or to enable ON/OFF control.

H06 data	Function
0	Disable (Always in operation)
1	Enable (ON/OFF controllable)

■ Cooling fan in operation -- FAN (E20, E21 and E27, data = 25)

With the cooling fan ON/OFF control enabled (H06 = 1), this output signal is ON when the cooling fan is in operation, and OFF when it is stopped. This signal can be used to make the cooling system of peripheral equipment interlocked for an ON/OFF control

H07 Curve acceleration/ deceleration (refer to F07)

For details, refer to the description of F07.

H08 Rotational direction limitation

H08 inhibits the motor from running in an unexpected rotational direction due to miss-operation of run commands, miss-polarization of frequency commands, or other mistakes.

H08 data	Function
0	Disable
1	Enable (Reverse rotation inhibited)
2	Enable (Forward rotation inhibited)

H09, d67	Starting mode (Auto search)
	Related function codes: H49 (Starting mode, auto search delay time 1)
	H46 (Starting mode, auto search delay time 2)

Specify the mode for auto search without stopping the idling motor. The mode can be specified for each restart after momentary power failure and each start of normal operation. The starting mode can be switched by assigning "STM" to a general-purpose digital input signal. If it is not assigned, "STM" is regarded to be OFF. (Data = 26)

■ **H09/d67 (Starting mode, auto search) and terminal command "STM" ("Enable auto search for idling motor speed at starting")**

The combination of H09 data and the "STM" status determines whether to perform the auto search as listed below.

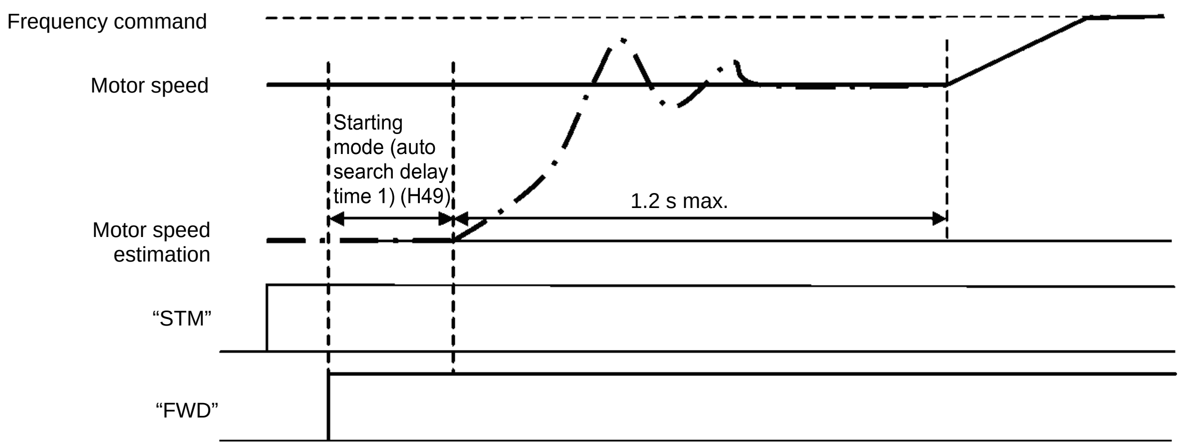
Function code	Drive control	Factory default
H09	V/f control (F42 = 0)	0: Disable
d67	Vector control for synchronous motor without pole position sensor nor speed sensor (F42 = 15)	2: Enable

H09/d67 data	Enable auto search for idling motor speed at starting "STM"	Auto search for idling motor speed at starting	
		Restart mode after momentary power failure (F14 = 3 to 5)	For normal startup
0: Disable	OFF	Disable	Disable
1: Enable	OFF	Enable	Disable
2: Enable	OFF	Enable	Enable
—	ON	Enable	Enable

When "STM" is ON, auto search for idling motor speed at starting is enabled regardless of the H09/d67 setting.
(📖 Function codes E01 to E05, data =26)

Auto search for idling motor speed to follow

Starting the inverter (with a run command ON, BX OFF, auto-reset, etc.) with STM being ON searches for the idling motor speed for a maximum of 1.2 seconds to run the idling motor without stopping it. After completion of the auto search, the inverter accelerates the motor up to the reference frequency according to the frequency command and the preset acceleration time.



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■ **Starting mode (auto search delay time 1) (H49)**

- Data setting range: 0.0 to 10.0 (s)

Auto search does not function normally when performed with the residual voltage remaining in the motor.

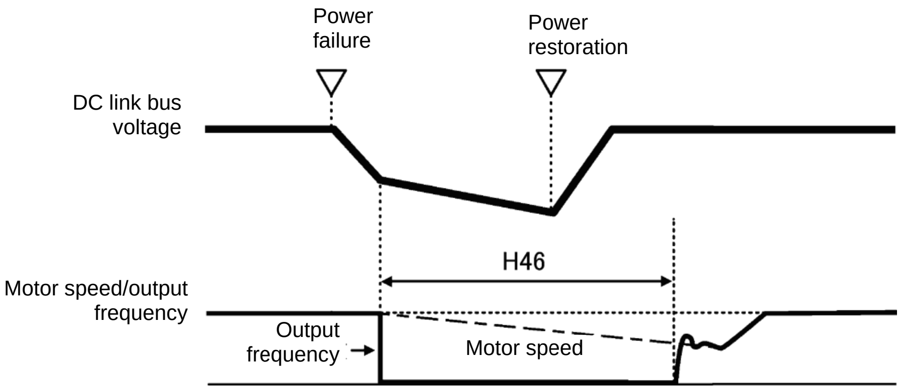
Accordingly, time to allow the residual voltage to disappear must be ensured.

When operation is started by turning a run command ON, auto search is started after the period specified with the starting mode (auto search delay time 1) (H49) has elapsed. When switching between two inverters for controlling one motor and if the motor is coasting to stop at the time of switching to start by auto search, by specifying H49 eliminates the need for timing the run command.

■ **Starting mode (auto search delay time 2) (H46)**

- Data setting range: 0.1 to 20.0 (s)

At the restart after a momentary power failure, at the start by turning the terminal command "BX" ("Coast to a stop") OFF and ON, or at the restart by auto-reset, the inverter applies the delay time specified by H46. The inverter will not start unless the time specified by H46 has elapsed, even if the starting conditions are satisfied. The inverter starts after the auto search delay time has elapsed.



Under auto search control, the inverter searches the motor speed with the voltage applied at the motor start and the current flowing in the motor, based on the model built with the motor parameters. Therefore, the search is greatly influenced by the residual voltage in the motor.

H46 is available for motor 1 only. At factory shipment, H46 data is preset to a correct value according to the motor capacity for the general-purpose motor, and basically there is no need to modify the data.

Depending on the motor characteristics, however, it may take time for residual voltage to disappear (due to the secondary thermal time constant of the motor). In such a case, the inverter starts the motor with the residual voltage remaining, which will cause an error in the speed search and may result in occurrence of an inrush current or an overvoltage alarm.

If it happens, increase the value of H46 data and remove the influence of residual voltage.
(If possible, it is recommended to set the value around two times as large as the factory default value allowing a margin.)

Note
- Be sure to auto-tune the inverter preceding the start of auto search for the idling motor speed.
- When the estimated speed exceeds the maximum frequency or the upper limit frequency, the inverter disables auto search and starts running the motor with the maximum frequency or the upper limit frequency, whichever is lower.
- During auto search, if an overcurrent or overvoltage trip occurs, the inverter restarts the suspended auto search.
- Perform auto search at 60 Hz or below.

Note Note that auto search may not fully provide the performance depending on load conditions, motor parameters, wiring length, and other external factors.

H11	Deceleration mode

H11 specifies the deceleration mode to be applied when a run command is turned OFF.

H11 data	Action
0	Normal deceleration
1	The inverter immediately shuts down its output, so the motor stops according to the inertia of the motor and machinery (load) and their kinetic energy losses.

Note When reducing the reference frequency, the inverter decelerates the motor according to the deceleration commands even if H11 = 1 (Coast-to-stop).

H12	Instantaneous overcurrent limiting (Mode selection) (refer to F43)

Refer to the descriptions of F43 and F44.

H13, H14 H15, H16	Restart mode after momentary power failure (Restart time, frequency fall rate) Restart mode after momentary power failure (Continue to run level, allowable momentary power failure time) (refer to F14)

For how to set these function codes (Restart time, Frequency fall rate, Continue to run level and Allowable momentary power failure time), refer to the description of F14.

H26, H27	Thermistor (for motor) (Mode selection and level)

These function codes specify the PTC (Positive Temperature Coefficient) thermistor embedded in the motor. The thermistor is used to protect the motor from overheating or output an alarm signal.

■ **Thermistor (for motor) (mode selection) (H26)**

H26 selects the function operation mode (protection or alarm) for the PTC thermistor as shown below.

H26 data	Action
0	Disable
1	When the voltage sensed by PTC thermistor exceeds the detection level, motor protective function (alarm *0h4*) is triggered, causing the inverter to enter an alarm stop state.
2	When the voltage sensed by the PTC thermistor exceeds the detection level, a motor alarm signal is output but the inverter continues running. You need to assign the “Motor overheat detected by thermistor” signal (“THM”) to one of the digital output terminals beforehand, by which a temperature alarm condition is indicated to the peripheral equipment (E20, E21 and E27, data = 56).

If H26 data is set to “1” or “2” (PTC thermistor), the inverter monitors the voltage sensed by PTC thermistor and protects the motor even when the 2nd motor is selected.

■ **Thermistor (for motor) (level) (H27)**

H27 specifies the detection level (expressed in voltage) for the temperature sensed by the PTC thermistor.

- Data setting range: 0.00 to 5.00 (V)

The alarm temperature at which the overheat protection becomes activated depends on the characteristics of the PTC thermistor. The internal resistance of the thermistor will significantly change at the alarm temperature. The detection level (voltage) is specified based on the change of the internal resistance.

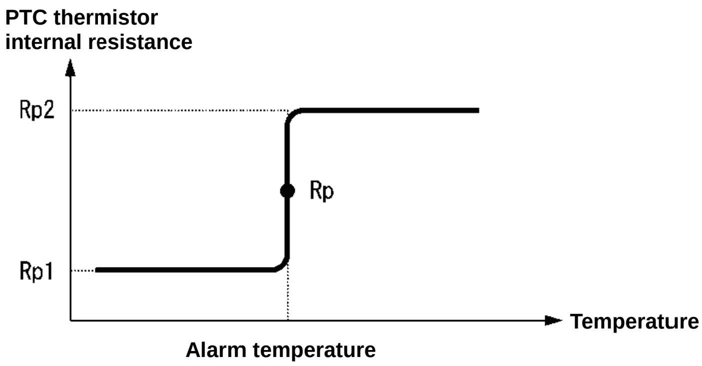


Figure J.18

Suppose that the internal resistance of the PTC thermistor at the alarm temperature is Rp, the detection level (voltage) V_{v2} is calculated by the expression below. Set the value of V_{v2} to function code H27.

$$V_{V2} = \frac{R_p}{1000 + 5 \times R_p} \times 10.5(V)$$

Connect the PTC thermistor as shown below. The voltage obtained by dividing the input voltage on terminal [C1] with a set of internal resistors is compared with the detection level voltage specified by H27.

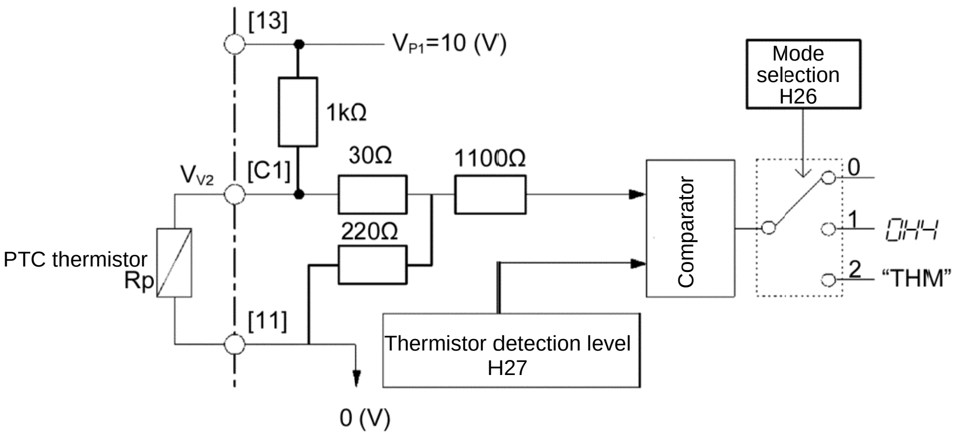


Figure J.19

Note: When using the terminal [C1] for PTC thermistor input, also set SW4 on the control printed circuit board to the PTC side. For details, refer to the FRENIC-Ace User’s Manual Chapter 2, Section 2.2.8.

H30	Communication link function (Mode selection) Related function codes: y98 bus link function (mode selection)

Using the RS-485 communications link, or fieldbus (option) allows you to issue frequency commands and run commands from a computer or PLC at a remote location, as well as monitor the inverter running information and the function code data. It is possible to sets the source that specifies the frequency and run commands with H30 and y98. H30 and y98 set the sources that specify RS-485 communications and fieldbus respectively.

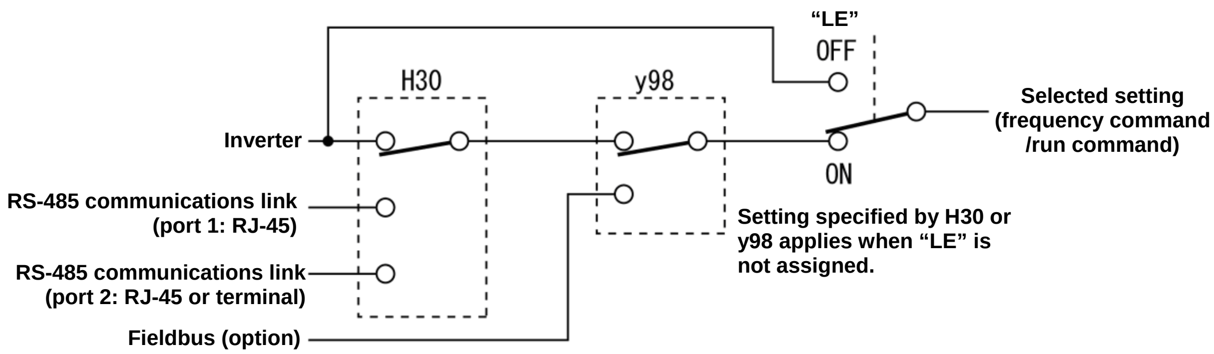


Table J.10 Command sources selectable

Command sources	Data
Inverter itself	Sources except RS-485 communications link and fieldbus Frequency setting source: Specified by F01/C30, or multistep frequency command Operation method source: Via the keypad or digital input terminals selected by F02
Via RS-485 communications link (port 1)	Via the standard RJ-45 port used for connecting a keypad
Via RS-485 communications link (port 2)	Terminals DX+ and DX-
Via fieldbus(option)	Via fieldbus (DeviceNet, PROFIBUS DP, etc.)

Table J.31 Command sources specified by H30 (Communications link function, Mode selection)

H30 data	Frequency command	Run command source
0	Inverter itself (F01/C30)	Inverter itself (F02)
1	RS-485 communications link (port 1)	Inverter itself (F02)
2	Inverter itself (F01/C30)	RS-485 communications link (port 1)
3	RS-485 communications link (port 1)	RS-485 communications link (port 1)
4	RS-485 communications link (port 2)	Inverter itself (F02)
5	RS-485 communications link (port 2)	RS-485 communications link (port 1)
6	Inverter itself (F01/C30)	RS-485 communications link (port 2)
7	RS-485 communications link (port 1)	RS-485 communications link (port 2)
8	RS-485 communications link (port 2)	RS-485 communications link (port 2)

Table J.12 Command sources specified by y98 (Bus link function, Mode selection)

y98 data	Frequency command	Run command source
0	Follow H30 data	Follow H30 data
1	Via fieldbus (option)	Follow H30 data
2	Follow H30 data	Via fieldbus (option)
3	Via fieldbus (option)	Via fieldbus (option)

Table J.13 H30 and y98 settings by combination of sources

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="4">Frequency command</td></tr>
<tr><td>Inverter itself</td><td>Via RS-485 communications link port 1</td><td>Via RS-485 communications link port 2</td><td>Via fieldbus (option)</td></tr>
<tr><td rowspan="4">Run command source</td><td>Inverter itself</td><td>H30 = 0
y98 = 0</td><td>H30 = 1
y98 = 0</td><td>H30 = 4
y98 = 0</td><td>H30 = 0 (1, 4)
y98 = 1</td></tr>
<tr><td>Via RS-485 communications link (port 1)</td><td>H30 = 2
y98 = 0</td><td>H30 = 3
y98 = 0</td><td>H30 = 5
y98 = 0</td><td>H30 = 2 (3, 5)
y98 = 1</td></tr>
<tr><td>Via RS-485 communications link (port 2)</td><td>H30 = 6
y98 = 0</td><td>H30 = 7
y98 = 0</td><td>H30 = 8
y98 = 0</td><td>H30 = 6 (7, 8)
y98 = 1</td></tr>
<tr><td>Via fieldbus (option)</td><td>H30 = 0 (2, 6)
y98 = 2</td><td>H30 = 1 (3, 7)
y98 = 2</td><td>H30 = 4 (5, 8)
y98 = 2</td><td>H30 = 0 (1 to 8)
y98 = 3</td></tr>
</table>

For details, refer to the RS-485 Communication User's Manual, the Field Bus (Option) Instruction Manual or the FRENIC-Ace User's Manual Chapter 9.

- When the terminal command "LE" ("Select link operation (RS-485, BUS option)") is assigned to a digital input terminal, turning "LE" ON makes the settings of H30 and y98 enabled. When LE is OFF, those settings are disabled so that both frequency commands and run commands specified from the inverter itself take control.
  (Function codes E01 to E05, data = 24)
  No "LE" assignment is functionally equivalent to the "LE" being ON.

H42, H43, H48	Capacitance of DC link bus capacitor, Cumulative run time of cooling fan Cumulative run time of capacitors on printed circuit boards Related function codes: H47 Initial capacitance of DC link bus capacitor H98 Protection/maintenance function

■ Life prediction function

The inverter has the life prediction function for some parts which measures the discharging time or counts the voltage applied time, etc. The function allows you to monitor the current lifetime state on the LED monitor and judge whether those parts are approaching the end of their service life. The life prediction function can also issue early warning signals if the lifetime alarm command LIFE is assigned to any of the digital output terminals by any of E20, E21 and E27.

The predicted values should be used only as a guide since the actual service life is influenced by the surrounding temperature and other usage environments.

Object of life prediction	Prediction function	End-of-life criteria	Prediction timing	On the LED monitor
DC link bus capacitor	<u>Calculating the capacitance of DC link bus capacitor</u> Measures the discharging time of the DC link bus capacitor when the main power is shut down and calculates the capacitance.	85% or lower of the initial capacitance at shipment (See "[1] Measuring the capacitance of DC link bus capacitor in comparison with initial one at shipment" on page 204.)	At periodic inspection H98 bit3 = 0	5_05 (Capacitance)
		85% or lower of the reference capacitance under ordinary operating conditions at the user site (See "[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown" on page 205.)	During ordinary operation H98 bit3 = 1	5_05 (Capacitance)
	<u>ON-time counting of DC link bus capacitor</u> Counts the time elapsed when the voltage is applied to the DC link bus capacitor, while correcting it according to the capacitance measured above.	Exceeding 87,600 hours (10 years) (ND mode: 61,320 hours (7 years))	During ordinary operation	5_26 (Elapsed time) 5_27 (Remaining hours)
Electrolytic capacitors on printed circuit boards	Counts the time elapsed when the voltage is applied to the capacitors, while correcting it according to the surrounding temperature.	Exceeding 87,600 hours (10 years) (ND mode: 61,320 hours (7 years))	During ordinary operation	5_06 (Cumulative run time)
Cooling fans	Counts the run time of the cooling fans.	Exceeding 87,600 hours (10 years) (ND mode: 61,320 hours (7 years))	During ordinary operation	5_07 (Cumulative run time)

APPENDICES

■ Capacitance of DC link bus capacitor (H42)

Calculating the capacitance of DC link bus capacitor

- The discharging time of the DC link bus capacitor depends largely on the inverter's internal load conditions, e.g. options attached or ON/OFF of digital I/O signals. If actual load conditions are so different from the ones at which the initial/reference capacitance is measured that the measurement result falls out of the accuracy level required, then the inverter does not perform measuring.
- The capacitance measuring conditions at shipment are extremely restricted, e.g., all input terminals being OFF in order to stabilize the load and measure the capacitance accurately. Those conditions are, therefore, different from the actual operating conditions in almost all cases. If the actual operating conditions are the same as those at shipment, shutting down the inverter power automatically measures the discharging time; however, if they are different, no automatic measurement is performed. To perform it, put those conditions back to the factory default ones and shut down the inverter. For the measuring procedure, see "[1] Measuring the capacitance of DC link bus capacitor in comparison with initial one at shipment" on page 204.
- To measure the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF, it is necessary to set up the load conditions for ordinary operation and measure the reference capacitance (initial setting) when the inverter is introduced. For the reference capacitance setup procedure, see "[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown" on page 205. Performing the setup procedure automatically detects and saves the measuring conditions of the DC link bus capacitor.

  Setting bit 3 of H98 data to 0 restores the inverter to the measurement in comparison with the initial capacitance measured at shipment.

Note When the inverter uses an auxiliary control power input, the load conditions widely differ so that the discharging time cannot be accurately measured. In this case, measuring of the discharging time can be disabled with the function code H98 (Bit 4 = 0) for preventing unintended measuring. (For details, refer to H98.)

ON-time counting of DC link bus capacitor

- In a machine system where the inverter main power is rarely shut down, the inverter does not measure the discharging time. For such an inverter, the ON-time counting is provided. If the capacitance measurement is made, the inverter corrects the ON-time according to the capacitance measured. The ON-time counting result can be represented as "elapsed time" and "remaining time" before the end of life.

[1] Measuring the capacitance of DC link bus capacitor in comparison with initial one at shipment

When bit 3 of H98 data is 0, the measuring procedure given below measures the capacitance of DC link bus capacitor in comparison with initial one at shipment when the power is turned OFF. The measuring result can be displayed on the keypad as a ratio (%) to the initial capacitance.

---Capacitance measuring procedure--

1) To ensure validity in the comparative measurement, put the condition of the inverter back to the state at factory shipment.
   - Remove the option card (if already in use) from the inverter.
   - In case another inverter is connected via the DC link bus to the P(+) and N(-) terminals of the main circuit, disconnect the wires. (You do not need to disconnect a DC reactor (optional), if any.)
   - Disconnect power wires for the auxiliary input to the control circuit (R0, T0).
   - In case the standard keypad has been replaced with an optional multi-function keypad TP-A1 after the purchase, put back the original standard keypad.
   - Turn OFF all the digital input signals fed to terminals [FWD], [REV], and [X1] through [X5] of the control circuit
   - If a potentiometer is connected to terminal [13], disconnect it.
   - If an external apparatus is attached to terminal [PLC], disconnect it.
   - Ensure that transistor output signals [Y1], [Y2] and relay output signal [30A/B/C] will not be turned ON.
   - Disable the RS-485 communications links.

     Note: If negative logic is specified for the transistor output and relay output signals, they are considered ON when the inverter is not running. Specify positive logic for them.

   - Keep the surrounding temperature within 25 ±10°C.
2) Turn ON the main circuit power.
3) Confirm that the cooling fan is rotating and the inverter is in stopped state.
4) Turn OFF the main circuit power.
5) The inverter automatically starts the measurement of the capacitance of the DC link bus capacitor. Make sure that " . . . . " appears on the LED monitor.

   Note: If " . . . . " does not appear on the LED monitor, the measurement has not started. Check the conditions listed in 1).
6) After " . . . . " has disappeared from the LED monitor, turn ON the main circuit power again.
7) Select Menu #5 "Maintenance Information" in Programming mode and note the reading (relative capacitance (%) of the DC link bus capacitor).

APPENDICES

[2] Measuring the capacitance of DC link bus capacitor under ordinary operating conditions at power shutdown

When bit 3 of H98 data is 1, the inverter automatically measures the capacitance of the DC link bus capacitor under ordinary operating conditions when the power is turned OFF. This measurement requires setting up the load conditions for ordinary operation and measuring the reference capacitance when the inverter is introduced to the practical operation, using the setup procedure given below.

Function code	Name	Data
H42	Capacitance of DC link bus capacitor	• Capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0000) • Measurement failure (0001)
H47	Initial capacitance of DC link bus capacitor	• Initial capacitance of DC link bus capacitor (measured value) • Start of initial capacitance measuring mode under ordinary operating conditions (0000) • Measurement failure (0001)

When replacing parts, clear or modify the H42 and H47 data. For details, refer to the maintenance related documents.

---------------------------------------Reference capacitance setup procedure---------------------------------------

1) Set function code H98 (Protection/maintenance function) to enable the user to specify the judgment criteria for the service life of the DC link bus capacitor (Bit 3 = 1) (refer to function code H98).
2) Turn OFF all run commands.
3) Make the inverter ready to be turned OFF under ordinary operating conditions.
4) Set both function codes H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) to “0000”.
5) Turn OFF the inverter, and the following operations are automatically performed.

   The inverter measures the discharging time of the DC link bus capacitor and saves the result in function code H47 (Initial capacitance of DC link bus capacitor).

   The conditions under which the measurement has been conducted will be automatically collected and saved.

   During the measurement, “ . . . . ” will appear on the LED monitor.
6) Turn ON the inverter again.

   Confirm that H42 (Capacitance of DC link bus capacitor) and H47 (Initial capacitance of DC link bus capacitor) hold right values. Shift to Menu #5 “Maintenance Information” and confirm that the relative capacitance (ratio to full capacitance) is 100%.

Note: If the measurement has failed, “0001” is entered into both H42 and H47. Remove the factor of the failure and conduct the measurement again.

Hereafter, each time the inverter is turned OFF, it automatically measures the discharging time of the DC link bus capacitor if the above conditions are met. Periodically check the relative capacitance of the DC link bus capacitor (%) with Menu #5 “Maintenance Information” in Programming mode.

Note: The condition given above tends to produce a rather large measurement error. If this mode gives you a lifetime alarm, set H98 (Protection/maintenance function) back to the default setting (Bit 3 (Select life judgment threshold of DC link bus capacitor) = 0) and conduct the measurement under the condition at the time of factory shipment.

■ **Cumulative run time of capacitors on printed circuit boards (H48)**

Function code	Name	Data
H48	Cumulative run time of capacitors on printed circuit boards	Displays the cumulative run time of capacitor on the printed circuit board in units of ten hours. • Data setting range: 0 to 9999 (0 to 99990 hours)

When replacing capacitors on printed circuit boards, clearing or modifying H48 data is required. For details, refer to the maintenance related documents.

■ **Cumulative run time of cooling fan (H43)**

Function code	Name	Data
H43	Cumulative run time of cooling fan	Displays the cumulative run time of cooling fan in units of ten hours. • Data setting range: 0 to 9999 (0 to 99990 hours)

When replacing the cooling fan, clearing or modifying H43 data is required. For details, refer to the maintenance related documents.

H44	Startup count for motor 1

H44 counts the number of inverter startups and displays it in hexadecimal format. Check the displayed number on the maintenance screen of the keypad, and use it as a guide for maintenance timing for parts such as belts. To start the counting over again, e.g. after a belt replacement, set the H44 data to "0000."

H45	Mock alarm Related function codes: H97 (Clear alarm data)

H45 causes the inverter to generate a mock alarm in order to check whether external sequences function correctly at the time of machine setup. Setting the H45 data to "1" displays mock alarm *err* on the LED monitor. It also issues alarm output (for any alarm) "ALM" (if assigned to a digital output terminal by any of E20, E21 and E27).

Accessing the H45 data requires simultaneous keying of the STOP key + ∧ key. After that, the H45 data automatically reverts to "0," allowing you to reset the alarm.

Same as other alarms that could occur when running the inverter, the inverter saves mock alarm data, enabling you to confirm the mock alarm status.

To clear the mock alarm data, use H97. (Accessing the H97 data requires simultaneous keying of the STOP key + ∧ key.) H97 data automatically returns to "0" after clearing the alarm data.

Tip A mock alarm can be issued also by simultaneous keying of the STOP key + FUNC/DATA key on the keypad for 5 seconds or more.

H46	Starting mode (Auto search delay time 2) (refer to H09)

For details, refer to the description of H09.

H47, H48	Initial capacitance of DC link bus capacitor, Cumulative run time of capacitors on printed circuit boards (refer to H42)

For details, refer to the description of H42.

H49	Starting mode (Auto search delay time 1) (refer to H09)

For details, refer to the description of H09.

H50, H51 H52, H53	Non-linear V/f 1 (Frequency and voltage) (refer to F04) Non-linear V/f 2 (Frequency and voltage)

For details, refer to the description of F04.

H56	Deceleration time for forced stop (refer to F07)

For details, refer to the description of F07.

H63	Low limiter (Mode selection) (refer to F15)

For details, refer to the description of F15.

H64	Low limiter (Lower limiting frequency)

H64 specifies the lower limit of frequency to be applied when the current limiter, torque limiter, or overload prevention control is activated. Normally, it is not necessary to change this data.

- Data setting range: 0.0 to 60.0 (Hz)

H68	Slip compensation 1 (Operating conditions) (refer to F42)

For details, refer to the description of F42.

H69	**Anti-regenerative control (Mode selection)** **Related function codes: H76 (Torque limiter) (Frequency rising limit for braking)**

Enable the automatic deceleration (anti-regenerative control) with this function code. In the inverter not equipped with a PWM converter or braking unit, if the regenerative energy returned exceeds the inverter's braking capability, an overvoltage trip occurs. Turning digital input "AR-CCL" ON cancels anti-regenerative control.

(📖 Function codes E01 to E05, data =82)

If anti-regenerative control is selected, the output frequency is controlled to suppress the regenerative energy for avoiding an overvoltage trip.

H69	Function		AR-CCL
	Control mode	Force-to-stop with actual deceleration time exceeding three times the specified one	
0	Disable automatic deceleration	—	OFF
2	Torque limit control	Enable	OFF
3	DC link bus voltage control	Enable	OFF
4	Torque limit control	Disable	OFF
5	DC link bus voltage control	Disable	OFF
—	Disable automatic deceleration	—	ON

FRENIC-Ace is equipped with two control modes: torque limiter and DC link bus voltage control.
Understand the features of the respective modes and select the appropriate one.

Control mode	Control operation	Operation mode	Characteristics
Torque limiter (H69 = 2, 4)	Controls the output frequency so that the braking torque is approximately 0.	Enabled during acceleration, constant speed operation and deceleration.	Features high response and makes less prone to overvoltage trips under impact load.
DC link bus voltage control (H69 = 3, 5)	Controls the output frequency so that the DC link bus voltage is decreased when it exceeds the limit level.	Enabled only during deceleration Disabled during constant speed operation	Regenerative capability of the inverter will be maximum use. Deceleration time will be shorter than the torque limit control.

■ **Torque limiter (Frequency rising limit for braking) (H76)**

- Data setting range: 0.0 to 500.0 (Hz)

With the torque limiter, the inverter increases the output frequency to limit the output torque. Excessive increase of the output frequency may cause danger, and therefore the frequency increment limit for braking (H76) is provided. This prevents the output frequency from increasing to exceed the "reference frequency + H76." If the limit is reached, however, anti-regenerative control is restricted and an overvoltage trip may occur. Increasing the frequency increment limit for braking improves the anti-regenerative capability.

If a run command is turned OFF, the anti-regenerative control causes the frequency to increase and operation may not stop depending on the load conditions. For safety, a function is provided in which the anti-regenerative control is forced to be disabled if the actual deceleration time becomes three times the deceleration time currently selected forcing the operation to stop. The function can be enabled/disabled by the setting of H69.

Note

- The deceleration time may be automatically increased by anti-regenerative control.
- Disable the anti-regenerative control when a braking unit is connected. Otherwise, the anti-regenerative control may be activated at the same time as the operation of the braking unit, resulting in a deceleration time not in accordance with the setting.
- An excessively short deceleration time causes the DC link bus voltage of the inverter to rise too fast for the anti-regenerative control to function. In that case, specify a longer deceleration time.

H70	Overload prevention control

Specifies the rate of decrease of the output frequency of overload prevention control. Before the inverter generates a heat sink overheat or overload trip (alarm *0h1* or *0lu*), the output frequency of the inverter is decreased for avoiding a trip. This is applied when operation is required to continue in a system in which the load decreases as the output frequency decreases, such as a pump.

H70 data	Function
0.00	Uses the deceleration time currently selected (F08, E11, E13, E15, etc.).
0.01 to 100.0	Decelerates at a deceleration rate of 0.01 to 100.0 (Hz/s).
999	Cancel overload prevention control

■ **Overload prevention controlling – "OLP" (E20, E21 and E27, data = 36)**

Outputs "OLP", which is a signal that turns ON during overload prevention control, in order to inform that the overload prevention control has been activated and the output frequency has changed.

Note No effect can be expected in a system in which the load does not decrease even if the output frequency decreases. Do not use this function.

H71	Deceleration characteristic

Enable hard braking control with this function code.

During motor deceleration, if the regenerative energy returned exceeds the inverter's braking capability, an overvoltage trip occurs. When hard braking control is selected, the motor loss is increased and the deceleration torque is increased during motor deceleration.

H71 data	Function
0	Disable
1	Action

Note This function suppresses the torque during deceleration and is not effective if braking load is applied. When anti-regenerative control of the torque limiter is enabled (H69 = 2, 4), the deceleration characteristic is disabled.

H72	Main power shutdown detection (Mode selection)

This function monitors the AC input power supply of the inverter to see if the AC input power supply (main circuit power) is established and prevents inverter operation when the main circuit power is not established.

Available FRN0045E2E-4EH or above.

H72 data	Function
0	Disables main circuit power cutoff detection
1	Enables main circuit power cutoff detection

With power supply via a PWM converter or DC link bus, there is no AC input. When the data for H72 is "1," the inverter cannot operate. Change the data for H72 to "0."

Note For single-phase supply, consult your Fuji Electric representatives.

H76	Torque limiter (Braking) (Frequency rising limiter for braking) (refer to H69)

For details, refer to the description of H69.

H77	Service life of DC link bus capacitor (Remaining time)

Indicates the time remaining (in units of ten hours) before the end of service life of the DC link bus capacitor.

Transfer the DC link bus capacitor life data when replacing the printed circuit board.

- Data setting range: 0 to 8760 (in units of 10 hours 0 to 87,600 hours)

H78 H94	Maintenance interval (M1) Cumulative motor run time 1

Specify the maintenance interval in hours with the maintenance interval (M1) (H78).

Specify in units of 10 hours. Up to 9999 x 10 hours can be specified.

- Data setting range: 0 (disable), 1 to 9999 (in units of 10 hours)

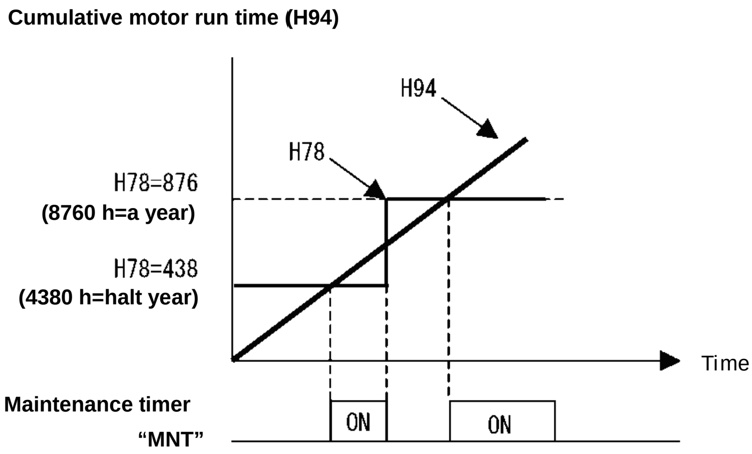
■ Maintenance timer counted up – “MNT” (E20, E21 and E27, data = 84)

When the cumulative motor run time 1 (H94) reaches the value specified by the maintenance interval (H78), the inverter outputs the maintenance timer signal “MNT”.

■ Cumulative motor run time 1 (H94)

The cumulative run time of the motor can be indicated by keypad operation. It can be used for management of the machinery or maintenance. Specifying an arbitrary time for the cumulative motor run time 1 (H94) allows an arbitrary value to be specified for the cumulative motor run time. It can be replaced with the initial data to use as a guide for the replacement of machine parts or inverter. Setting “0” allows the cumulative motor run time to be reset.

<For half yearly maintenance>



Note If the maintenance interval is reached, set a new value in H78 and press the key to reset the output signal and restart measurement.

This function is exclusively applied to the 1st motor.

■ Count the run time of commercial power-driven motor 1 – “CRUN-M1” (E01 to E05, data = 72)

Even when a motor is driven by commercial power, not by the inverter, it is possible to count the cumulative motor run time 1 (H94) by detecting the ON/OFF state of the auxiliary contact of the magnetic contactor for switching to the commercial power line.

Note Check the cumulative motor run time with *5_23* on Menu #5 “Maintenance Information” of the keypad.

H79	Preset startup count for maintenance (M1) Related function codes: H44 Startup count for motor 1

H79 specifies the number of inverter startup times to determine the next maintenance timing, e.g., for replacement of a belt.

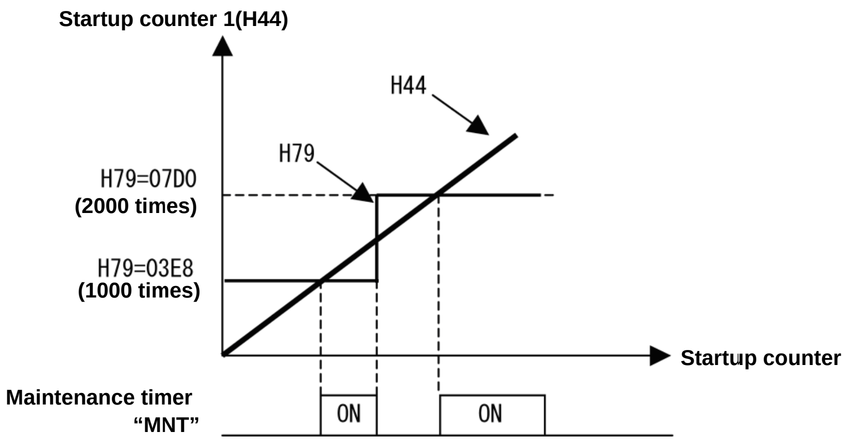
Set the H79 and H44 data in hexadecimal. The maximum setting count is 65,535 (FFFF in hexadecimal.)

- Data setting range: OFF (disable), 0001 to FFFF (hexadecimal)

■ Maintenance timer counted up – "MNT" (E20, E21 and E27, data = 84)

When the startup counter for motor 1 (H44) reaches the number specified by H79 (Preset startup count for maintenance (M1)), the inverter outputs the maintenance timer signal "MNT" (if assigned to any digital terminal with any to E20, E21 and E27) to inform the user of the need of the maintenance of the machinery.

< Maintenance every 1,000 times of startups >



Note: If the startup counter reaches the specified value, set a new value for the next maintenance in H79 and press the FUNC/DATA key to reset the output signal and restart counting.

This function is exclusively applied to the 1st motor.

H80	Output current fluctuation damping gain for motor 1

The inverter output current driving the motor may fluctuate due to the motor characteristics and/or backlash in the machinery (load). Modifying the H80 data adjusts the controls in order to suppress such fluctuation. However, as incorrect setting of this gain may cause larger current fluctuation, do not modify the default setting unless it is necessary.

- Data setting range: 0.00 to 1.00

H81, H82	**Light alarm selection 1 and 2**

If the inverter detects a minor abnormal state “light alarm”, it can continue the current operation without tripping while displaying the “light alarm” indication l-al on the LED monitor. In addition to the indication l-al, the inverter blinks the KEYPAD CONTROL LED. Function codes H81 and H82 specify which alarms should be categorized as “light alarm.”

The table below lists alarms selectable as “light alarm.”

Code	Name	Description
0h1	Heat sink overheat	Heat sink temperature increased to the trip level.
0h2	Enable external alarm trip	An error that has occurred in peripheral equipment turned the external alarm signal THR ON.
0h3	Inverter internal overheat	The temperature inside the inverter abnormally has increased.
dbh	Braking resistor overheat	Estimated temperature of the coil in the braking resistor exceeded the allowable level.
0l1	Overload of motor 1	Motor temperature calculated with the inverter output current reached the trip level.
er4	Option communications error	Communications error between the inverter and an option.
er5	Option error	An option judged that an error occurred.
er8 erp	RS-485 communications error (COM port 1, 2)	RS-485 communications error in COM ports 1 or 2.
cof	PID feedback wire break	The PID feedback signal wire(s) is broken.
fal	Detect DC fan lock	Failure of the air circulation DC fan inside the inverter
0l	Motor overload early warning	Early warning before a motor overload
0h	Heat sink overheat early warning	Early warning before a heat sink overheat trip
lif	Lifetime alarm	It is judged that the service life of any one of the capacitors (DC link bus capacitors or electrolytic capacitors on the printed circuit boards) or cooling fan has expired. Or, failure of the air circulation DC fan inside the inverter.
ref	Reference loss	Analog frequency command was lost.
pid	PID alarm	Warning related to PID control (absolute-value alarm or deviation alarm)
uTl	Low output torque detection	Output torque drops below the low torque detection level for the specified period.
pTc	PTC thermistor activated	The PTC thermistor on the motor detected a high temperature.
rTe	Machine life (Cumulative run time)	The motor cumulative run time reached the specified level.
cnT	Machine life (Number of startups)	Number of startups reached the specified level.

Set data for selecting “light alarms” in hexadecimal. For details on how to select the codes, see the next page.

- Data setting range: 0000 to FFFF (hexadecimal)

■ Selecting light alarm factors

To set and display the light alarm factors in hexadecimal format, each light alarm factor has been assigned to bits 0 to 15 as listed in Table and Table . Set the bit that corresponds to the desired light alarm factor to “1.” Table shows the relationship between each of the light alarm factor assignments and the LED monitor display.

Table gives the conversion table from 4-bit binary to hexadecimal.

Table J.14 Light Alarm Selection 1 (H81), Bit Assignment of Selectable Factors

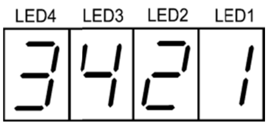
Bit	Code	Data	Bit	Code	Data
15	0h6	Charging resistor overheat	7	—	—
14	—	—	6	—	—
13	erp	RS-485 communications error (COM port 2)	5	0l1	Overload of motor 1
12	er8	RS-485 communications error (COM port 1)	4	dbh	Braking resistor overheat
11	er5	Option error	3	—	—
10	er4	Option communications error	2	0h3	Inverter internal overheat
9	—	—	1	0h2	External alarm
8	—	—	0	0h1	Heat sink overheat

Table J.15 Light Alarm Selection 2 (H82), Bit Assignment of Selectable Factors

Bit	Code	Data	Bit	Code	Data
15	—	—	7	lif	Lifetime alarm
14	—	—	6	0h	Heat sink overheat early warning
13	cnT	Inverter life (Number of startups)	5	0l	Motor overload early warning
12	rTe	Inverter life (Cumulative run time)	4	fal	Detect DC fan lock
11	pTc	PTC thermistor activated	3	cof	PID feedback wire break
10	uTl	Low output torque detection	2	—	—
9	pid	PID alarm	1	—	—
8	ref	Reference loss	0	—	—

Table J.16 Display of Light Alarm Factor

(Example) Light alarm factors “RS-485 communications error (COM port 2),” “RS-485 communications error (COM port 1),” “Option communications error,” “Overload of motor 1” and “Heat sink overheat” are selected by H81.

LED No.		LED 4				LED 3				LED 2				LED 1			
Bit		15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Code		—	—	erp	er8	er5	er4	—	—	—	—	00l1	dbh	—	0h3	00h2	00h1
Sample indication	Binary	0	0	1	1	0	1	0	0	0	0	1	0	0	0	0	1
	Hexadecimal * Refer to Table	3				4				2				1			
	Hexadecimal on the LED monitor																

■ Hexadecimal expression

A 4-bit binary number can be expressed in hexadecimal format (hexadecimal digit). The table below shows the correspondence between the two notations.

Table J.16 Binary and Hexadecimal Conversion

Binary				Hexadecimal	Binary				Hexadecimal
0	0	0	0	*0*	1	0	0	0	*8*
0	0	0	1	*1*	1	0	0	1	*9*
0	0	1	0	*2*	1	0	1	0	*a*
0	0	1	1	*3*	1	0	1	1	*b*
0	1	0	0	*4*	1	1	0	0	*c*
0	1	0	1	*5*	1	1	0	1	*d*
0	1	1	0	*6*	1	1	1	0	*e*
0	1	1	1	*7*	1	1	1	1	*f*

Note: When H26 = 1 (PTC (The inverter immediately trips with *0h4* displayed)), if the PTC thermistor is activated, the inverter stops without displaying l-al, blinking the KEYPAD CONTROL LED, or outputting L-ALM signal, regardless of the assignment of bit 11 (PTC thermistor activated) by H82 (Light Alarm Selection 2).

■ Light alarm – "L-ALM" (E20, E21 and E27, data = 98)

This output signal "L-ALM" comes ON when a light alarm occurs.

H89 — Electronic thermal overload protection for motor – data retention

When the electronic thermal overload protection for motor is used, whether to clear the cumulative value of the thermal by inverter power-off or retain the value after power-off can be specified.

Data for H89	Function
0	Clears cumulative value of thermal by inverter power-off.
1	Retains cumulative value of thermal after inverter power-off (factory default).

H86, H90 — Reserved for particular manufacturers

H86 and H90 are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

H91 — PID feedback wire break detection

Using the terminal [C1] (C1 function) (current input) for PID feedback signal enables wire break detection and alarm (*cof*) issuance. H91 specifies whether the wire break detection is enabled, or the duration of detection. (The inverter judges an input current to the terminal [C1] below 2 mA as a wire break.)

This function does not work unless C40 is set to 0.

- Data setting range: 0.0 (Disable wire break detection)
  0.1 to 60.0 s (Detect wire break and issue *cof* alarm within the time)

H92, H93 — Continuous running at the momentary power failure (P, I) (refer to F14)

Refer to the description of F14.

H94	Cumulative motor run time 1 (refer to H78)

Refer to the description of H78.

H95	DC braking (Braking response mode) (refer to F20 to F22)

Refer to the descriptions of F20 through F22.

H96	STOP key priority/Start check function

H96 specifies a functional combination of "STOP STOP key priority" and "Start check function" as listed below.

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

■ **STOP key priority**

Even when run commands are entered from the digital input terminals or via the RS-485 communications link (link operation), pressing the STOP key forces the inverter to decelerate and stop the motor. After that, *er6* appears on the LED monitor.

■ **Start check function**

For safety, this function checks whether any run command has been turned ON or not in each of the following situations. If one has been turned ON, the inverter does not start up but displays alarm code *er6* on the LED monitor.

- When the power to the inverter is turned ON.
- When the PRG/RESET key is pressed to release an alarm status or when the digital input terminal command "RST" ("Reset alarm") is turned ON.
- When the run command source is switched by a digital input terminal command such as "LE" ("Enable communications link via RS-485 or fieldbus") or "LOC" ("Select local (keypad) operation").

H97	Clear alarm data Related function codes: H45 Mock alarm

H97 clears alarm data (alarm history and relevant information) stored in the inverter.

To clear alarm data, simultaneous keying of "STOP key + ∧ key" is required.

H97 data	Function
0	Disable
1	Enable (Setting "1" clears alarm data and then returns to "0.")

H98	Protection/Maintenance function (Mode selection)

H98 specifies whether to enable or disable automatic lowering of carrier frequency, input phase loss protection, output phase loss protection, judgment threshold on the life of DC link bus capacitor, judgment on the life of DC link bus capacitor, DC fan lock detection and braking transistor error detection by setting a bit combination.

Automatic lowering of carrier frequency (Bit 0)

This function should be used for critical machinery that requires keeping the inverter running. Even if a heat sink overheat or overload occurs due to excessive load, abnormal surrounding temperature, or cooling system failure, enabling this function lowers the carrier frequency to avoid tripping (*0h1*, *0h3* or *0lu*). Note that enabling this function results in increased motor noise.

Input phase loss protection (*lin*) (Bit 1)

This function detects the voltage unbalance between the phases and phase loss of 3-phase power supply. And an alarm displays *lin* to stop the inverter when it detects.

Note: In configurations where only a light load is driven or a DC reactor is connected, phase loss or line-to-line voltage unbalance may not be detected because of the relatively small stress on the apparatus connected to the main circuit.

Output phase loss protection (*0pl*) (Bit 2)

Upon detection of output phase loss while the inverter is running, this feature stops the inverter and displays an alarm *0pl*.

Note: Where a magnetic contactor is installed in the inverter output circuit, if the magnetic contactor goes OFF during operation, all the phases will be lost. In such a case, this protection function does not work.

Judgment threshold on the life of DC link bus capacitor (Bit 3)

Bit 3 is used to select the threshold for judging the life of the DC link bus capacitor between the factory default setting and a user-defined setting.

Note: Before specifying a user-defined threshold, measure and confirm the reference level in advance.
(📖 Function code H42)

Judgment on the life of DC link bus capacitor (Bit 4)

Whether the DC link bus capacitor has reached its life is judged by measuring the discharging time after power OFF. The discharging time is determined by the capacitance of the DC link bus capacitor and the load inside the inverter. Therefore, if the load inside the inverter fluctuates significantly, the discharging time cannot be accurately measured. As a result, it may be mistakenly determined that the DC link bus capacitor has reached the end of its life. To avoid such an error, you can disable the judgment based on the discharging time. (Even if it is disabled, the judgment based on the “ON-time counting” while the voltage is applied to the DC link bus capacitor is performed.)

📖 For details about the life prediction function, refer to H42.

Since load may fluctuate significantly in the cases described below, disable the judgment on the life during operation even in user-defined setting mode. During periodical maintenance, either conduct the measurement with the judgment enabled under appropriate conditions or conduct the measurement under the operating conditions matching the actual ones.

- Auxiliary input for control power is used.
- An option card is used.

<u>Reserve (bit 5)</u>

<u>Braking transistor error detection (Bit 6)</u>
(*dba* FRN0060E2E-4EH or below)

Upon detection of a built-in braking transistor error, this feature stops the inverter and displays an alarm *dba*. Set data of this bit to “0” when the inverter does not use a braking transistor and there is no need of entering an alarm state.

To set data of function code H98, assign the setting of each function to each bit and then convert the 8-bit binary to the decimal number. Refer to the assignment of each function to each bit and a conversion example below.

Bit	Function	Data = 0	Data = 1	Factory default
Bit 0	Lower the carrier frequency automatically	Disable	Enable	1: Enable
Bit 1	Detect input phase loss	Continue to run	Enter alarm processing	1: Enter alarm processing
Bit 2	Detect output phase loss	Continue to run	Enter alarm processing	0: Continue to run
Bit 3	Select life judgment threshold of DC link bus capacitor	Factory default	User-defined setting	0: Factory default
Bit 4	Judge the life of DC link bus capacitor	Disable	Enable	1: Enable
Bit 5	reserve	Enter alarm processing	Continue to run	0: Enter alarm processing
Bit 6	Detect braking transistor breakdown	Continue to run	Enter alarm processing	0: Continue to run

Decimal and binary conversion

Decimal = Bit 6 × 2^6 + Bit 5 × 2^5 + Bit 4 × 2^4 + Bit 3 × 2^3 + Bit 2 × 2^2 + Bit 1 × 2^1 + Bit 0 × 2^0

= Bit 7 × 128 + Bit 6 × 64 + Bit 5 × 32 + Bit 4 × 16 + Bit 3 × 8 + Bit 2 × 4 + Bit 1 × 2 + Bit 0 × 1

= 64 + 0 × 32 + 1 × 16 + 0 × 8 + 0 × 4 + 1 × 2 + 1 × 1

= 16 + 2 + 1

= 19

H99, H197, H198 H199	Password 2 setting/check User password 1 (selection of protective operation, setting check) User password protection valid

The password function is the function to hide the function code entirely/partially which is set for the inverter. When this function is used, perform correct settings after familiarizing yourself with the following details. If incorrect settings are made, the function code cannot be changed or checked. An alarm may also occur and the inverter may stop. Perform the operation carefully.

Tip If the objective is to prevent inadvertent rewriting of the setting value from the touch panel, it is recommended to use the data protective function with function code F00 rather than the password function. For details of the data protection, refer to the items in F00.

Note If a password is inadvertently set, the setting values cannot be changed from the remote touch panel, multi-function touch panel or external device using the link function. Be careful for setting.

Note If an incorrect password setting value is entered and you failed to decode the password, the password protection state cannot be released. In addition, failure to decode the password consecutively 5 times results in minor failure *l-al*.

Note To prevent the password decoding by an ill-disposed third party, failure to decode the password for the specified number of times results in *lok* alarm, which disables the inverter operation. Therefore, it is recommended to decode the password during stop of the system. If it is necessary to decode the password during operation, perform decoding carefully.

Note We are not able to know the passwords set by customers. If you have forgotten the password setting value, the only way to decode the password is initialization of the function code. Set and control the password carefully.

■ **Password 1 (Rewrite disable protection)**

Function code setting values excluding some codes can be protected as rewrite disable.

Select the target function code which is protected by H197 and set the password (hexadecimal 4 digits) with function code H198. When function code H199 is set to 1, password 1 protective status (rewrite disable protection) is active.

Function code	Name	Remarks
H197	Protection operation selection	0: Displays all function codes, however, changes are prohibited. 1: Only function codes applicable to quick setup can be displayed or changed. 2: Only function codes for customize logic settings are hidden, and changes are prohibited.
H198	Set/verify	0000 to FFFF
H199	Protection enable	0: Disable 1: Protect

■ Temporary decoding of password 1 (rewrite disable protection)

When password 1 protective status is shown and the same value as the password set for function code H198 is entered in H198, password 1 protective status is temporarily released and the function code setting value can be rewritten.

If password 2 is set at the same time, it is necessary to decode password 2 with H99 in advance.

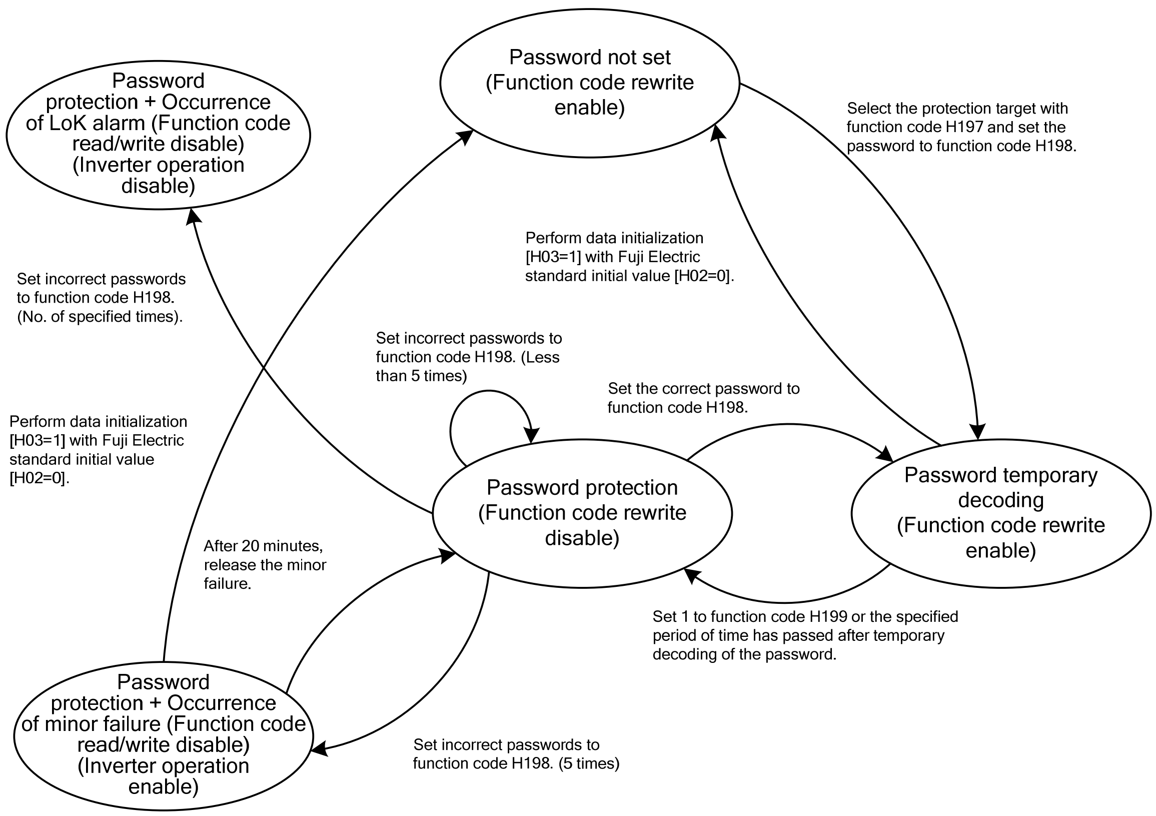


Figure J.20 Relation chart of password 1 protection status

■ Password 2 (Read/write disable protection)

Setting values of all function codes not by selecting function code H197 can be protected as read disable and rewrite disable. (Exceptionally, partial function codes are not protected.)

Set the password with function code H99 and set function code H199 to 1. Password 2 protective status (read/write disable protection) is active.

The function code of read/write disable does not allow writing of the setting value to the inverter with a remote touch panel, multi-function touch panel or external device using serial communication, or reading of the setting value.

■ Temporary decoding of password 2 (read/write disable protection)

When password 2 protective status is shown and the same value as the password (hexadecimal 4 digits) set for function code H99 is entered in H99, password 2 protective status is temporarily decoded and the function code value can be read and it can be displayed on the touch panel.

If password 1 protection (rewrite disable protection) is also set, the function code can be rewritten by temporarily decoding password 1 protective status continuously.

■ Failure of temporary decoding of passwords 1 and 2

In password 1 protective status or password 2 protective status, if the password value entered in function code H198 or H99 is incorrect when trying to temporarily cancel the protective status, temporary decoding is disabled.

In both function codes H198 and H99, 5 consecutive failures of password input result in minor failure *l-al*.

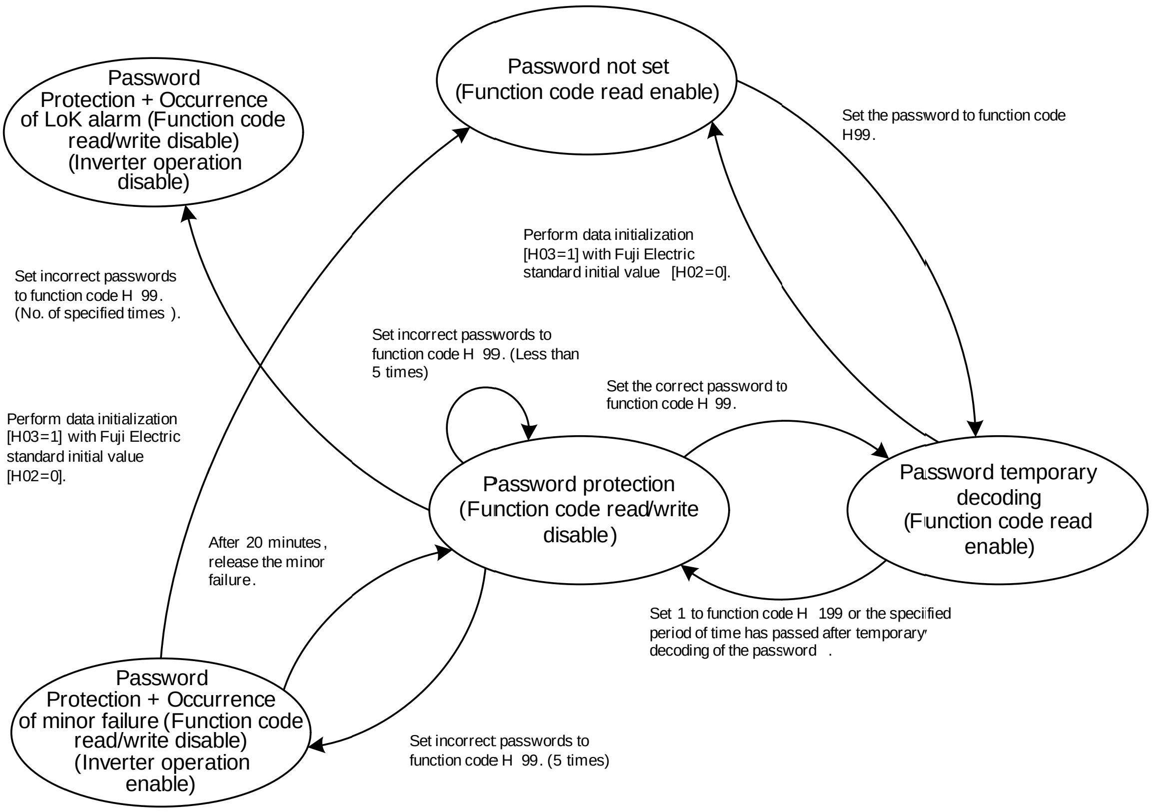


Figure J.21 Relation chart of password 2 protection status

Note: In our factory default status, passwords are not provided excluding special products. Therefore, if the password set for H198 or H99 is unknown or forgotten, we do not answer or inform you of the password or its decoding method from protective status.

For this reason, set and control the password at your own risk. If a password is set at the delivery of the product and its decoding is required, please contact the dealer you purchased or the unit manufacturer. (We are not able to know the passwords set by customers.)

■ Setting passwords 1 and 2 with multi-function touch panel and temporary decoding

Setting or temporary decoding of passwords 1 and 2 using the multi-function touch panel is performed by the special menu on the multi-function touch panel. Therefore, function codes H99, H198 and H199 are not displayed on the function code list of the function code setting menu or function code check menu on the multi-function touch panel (H197 is displayed).

For the special password menu of the multi-function touch panel, refer to the instruction manual of the multi-function touch panel.

H101	Destination

Refer to Chapter 4 “4.4 Destination Setting” of Frenic-Ace User’s Manual.

H111	UPS operation Level

Refer to the description of “■UPS operation (Available in FRN0020E2■-2G☐H ∕ FRN0085E2■-4EH / FRN0012E2■-7G☐H or below)

” in E01 to E05.

- Data setting range: 120 to 220 VDC: (200 V class), 240 to 440 VDC: (400 V class)

H114	Anti-regenerative control (Level) Related function code: H69

Allows the adjustment of the level when anti-regenerative control by torque limiter is performed with H69 = 2, 4. Basically, there is no need to modify the setting.

Data for H114	Function
0.0 to 50.0%	Adjusted level: Increasing the value increases the frequency operation.
999	Standard level

H116 **H117** **H118** **H119** **H120** **H121**	**Fire Mode (Mode selection)** **(Confirmation time)** **(Reference frequency)** **(Rotation direction)** **(Start method)** **(Reset interval)**

Set when enabling forced operation (Fire Mode). In an emergency, operation at a specified speed can be performed. Even when an alarm of the inverter is generated, operation is continued. In such a case where instant overcurrent protection occurs, the retry function is to be used to restart the operation.

Assigning the ***FMS*** to a digital input terminal and turning the ***FMS*** ON enables forced operation (Fire Mode). (Function code E01 to E07; data = 134)

Note When the inverter is running with the ***FMS*** being ON, the protective function is disabled. Therefore, the inverter keeps running even if an alarm occurs so that the inverter could be broken or a fire could occur.

- **Fire Mode (Mode selection) (H116)**
  - Data setting range: 0 to 2

Turning ***FMS*** ON enables forced operation (Fire Mode). Three different operation selections are possible.

Data 0: Enabled with ***FMS*** ON; disabled with ***FMS*** OFF

Data 1: Toggle method; Enabled with ***FMS*** ON/OFF; disabled with the next ***FMS*** ON/OFF

Data 2: Latch method; Enabled with ***FMS*** ON (This status is kept)

- **Fire Mode (Confirmation time) (H117)**
  - Data setting range: 0.5 to 10.0 (s)

Set ON/OFF setting time for ***FMS*** signals. If ***FMS*** is turned ON/OFF in time shorter than the specified value, forced operation (Fire Mode) is not enabled. ***FMS*** signals are to be kept ON longer than the H117 confirmation time.

H116 data	
0 ***FMS*** ON	
1 ***FMS*** toggle method	
2 ***FMS*** latch method	

■ **Fire Mode (Reference frequency) (H118)**

- Data setting range: Inherit, 0.1 to 500.0 (Hz)

Specify speed (reference frequency) at which operation is to be performed when forced operation (Fire Mode) is enabled.

H118 data	Function
Inherit	The frequency selected through frequency setting 1 (F01) and 2 (C30) is followed.
0.1 to 500.0	Arbitrary frequencies can be set in 0.1 Hz steps.

■ **Fire Mode (Rotation direction) (H119)**

- Data setting range: 0, 2, 3

Set an operation instruction (rotation direction) to be followed when forced operation (Fire Mode) is enabled.

H119 data	Function
0	Follows the operation instruction selected through drive operation (F02). * When the operation instruction is OFF, operation is not performed at the frequency specified with H118 (reference frequency). Note, however, that the mode at that time is forced operation execution status.
2	Operation through forward rotation (FWD) * Forward rotation is forcibly performed irrespective of presence and absence of an operation instruction.
3	Operation through reverse rotation (REV) * Reverse rotation is forcibly performed irrespective of presence and absence of an operation instruction.

■ **Fire Mode (Start method) (H120)**

- Data setting range: 0, 1

Set the start method to be followed when Fire Mode is enabled.

H120 data	Function
0	Follows the start methods specified with instant power failure restart (F14) and H09 (starting mode).
1	STM mode (auto search for idling motor speed to run the idling motor without stopping it)

■ **Fire Mode (Reset interval) (H121)**

- Data setting range: 0.5 to 20.0 (s)

Set time delay to auto cancel of trip status for a case where the inverter enters trip status and stops during forced operation (Fine Mode).

H193,H194	User initialization data (Save, Protect)	Related function code: H02,H03

Refer to H02, H03.

H195	DC braking (Braking timer at the startup)	Related function code: F21

DC braking can be activated at startup. For details, refer to the description of F21.

H197,H198 H199	User password 1 (selection of protective operation, setting check) User password protection valid	Related function code: H99

Refer to H99.

J.6 A codes (Motor 2 parameters)

FRENIC-Ace has two sets of speed control parameter. They can be selected by “MPRM1” signals.
For the description of speed control parameters, refer to function code d01.

Name		Speed control parameter sets	
		set1	set2
Speed control	(Speed command filter)	d01	A43
	(Speed detection filter)	d02	A44
	(P gain)	d03	A45
	(Integral time)	d04	A46

■ **Select speed control parameter 1 – “MPRM1” (E01 to E05 data = 78)**

The combination of the ON/OFF states of digital input signals “MPRM1” selects one between 2 different speed control parameter sets .

input signals	Selected speed control parameter set
“MPRM1”	
OFF	d01 to d04 speed control parameter set1
ON	A43 to A50 speed control parameter set2

J.7 J codes (Applied functions)

J01	PID control (Mode selection)

Under PID control, the inverter detects the state of a control target object with a sensor or similar device and compares it with the commanded value (e.g., temperature control command). If there is any deviation between them, PID control operates so as to minimize it. That is, it is a closed loop feedback system that matches a controlled variable (feedback amount).

PID control expands the application area of the inverter to process control (e.g., flow control, pressure control, and temperature control).

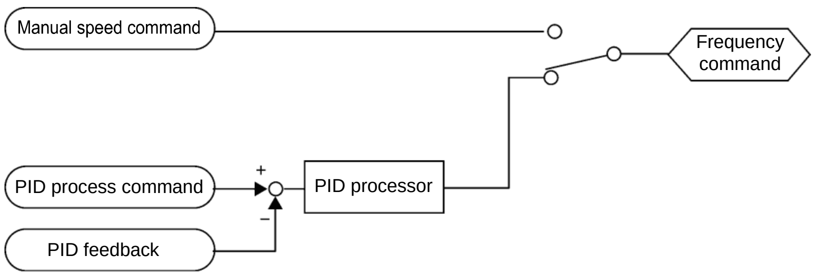
If PID control is enabled (J01 = 1 or 2), the frequency control of the inverter is switched from the drive frequency command generator block to the PID command generator block

■ Mode Selection (J01)

J01 selects the PID control mode.

J01 data	Function
0	Disable
1	Process control (normal operation)
2	Process control (inverse operation)

<PID process control block diagram>



- Using J01 allows switching between normal and inverse operations for the PID control output, so you can specify an increase/decrease of the motor rotating speed depending on the difference (error component) between the commanded (input) and feedback amounts, making it possible to apply the inverter to air conditioners. The terminal command IVS can also switch operation between normal and inverse.

📖 For details about the switching of normal/inverse operation, refer to the description of "■ Switch normal/inverse operation – "IVS"" (E01 to E05, data = 21).

J02	PID Control (Remote command)
	Related function code J105: PID control (Display unit) J106: PID control (Maximum scale) J107: PID control (Minimum scale) J136 to J138: PID control multistep command 1 to 3

J02 sets the source that specifies the command value (SV) under PID control.

J02 data	Function
0	Keypad Specify the PID command by using the ∧ / ∨ keys on the keypad.
1	PID command 1 (Analog input: Terminals [12], [C1] (C1 function), [C1] (V2 function)) Voltage input to the terminal [12] (0 to ±10 VDC, 100% PID command/ ±10 VDC) Current input to the terminal [C1] (C1 function) (4 to 20 mA DC, 100% PID command/ 20 mA DC) Voltage input to the terminal [C1] (V2 function) (0 to +10 VDC, 100% PID command/ +10 VDC)
3	Terminal command UP/DOWN Using the “UP” or “DOWN” command in conjunction with PID minimum scale to maximum scale (specified by J106 and J107) with which the command value is converted into a physical quantity, etc., you can specify 0 to 100% of the PID command.
4	Command via communications link Use function code S13 to specify the PID command by communications. The transmission data of 20000d (decimal) is equal to 100% (maximum set point value) of the PID command.

[1] PID command with the ∧ / ∨ keys on the keypad (J02 = 0, factory default)

Using the ∧ / ∨ keys on the keypad in conjunction with PID minimum / maximum scale (specified by J106 and J107), you can specify 0 to 100% of the PID command in an easy-to-understand, converted command format.

For details of operation, refer to the FRENIC-Ace User’s Manual Chapter 3 “3.3.5 setting up PID commands from the keypad.”

[2] PID command by analog inputs (J02 = 1)

When any analog input (voltage input to terminals [12] and [C1] (V2 function), or current input to terminal [C1] (C1 function)) for PID command 1 (J02 = 1) is used, it is possible to arbitrary specify the PID command by multiplying by the gain and adding the bias. The polarity can be selected and the filter time constant and offset can be adjusted. In addition to J02 setting, it is necessary to select PID process command 1 for analog input (specified by any of E61 to E63, function code data = 3). For details, refer to the descriptions of E61 to E63.

Table J.4 Adjustable elements of PID command

Input terminal	Input range	Bias		Gain		Polarity	Filter	Offset
		Bias	Base point	Gain	Base point			
[12]	0 to +10V, -10 to +10V	C55	C56	C32	C34	C35	C33	C31
[C1] (C1)	4 to 20mA, 0 to 20mA	C61	C62	C37	C39	C40	C38	C36
[C1] (V2)	0 to +10V	C67	C68	C42	C44	C45	C43	C41

■ **Offset (C31, C36, C41)**

C31, C36 or C41 configure the offset for an analog voltage/current input.

■ **Filter (C33, C38, C43)**

C33, C38, and C43 provide the filter time constants for the voltage and current of the analog input. The larger the setting of time constant is, the slower the response is. Specify the proper filter time constant taking into account the response speed of the machine (load). If an analog input signal fluctuates due to line noises, increase the filter time constant.

■ Polarity selection for terminal [12] (C35)

C35 configures the input range for analog input voltage of terminal [12].

C35 data	Modes for terminal inputs
0	-10 to +10V
1	0 to +10 V(negative value of voltage is regarded as 0 V)

■ Range / polarity selection for terminal [C1] (C1 function) (C40)

C40 configures the input range for analog input current of terminal [C1] (C1 function).

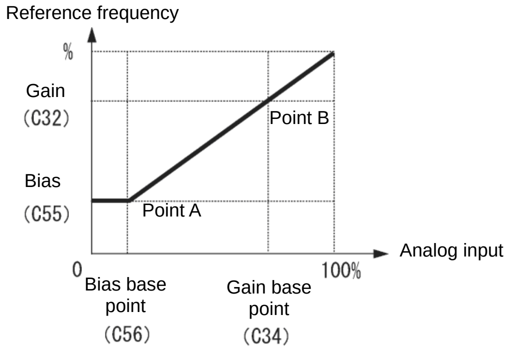
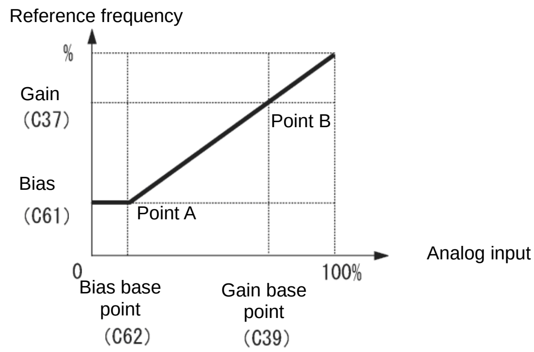
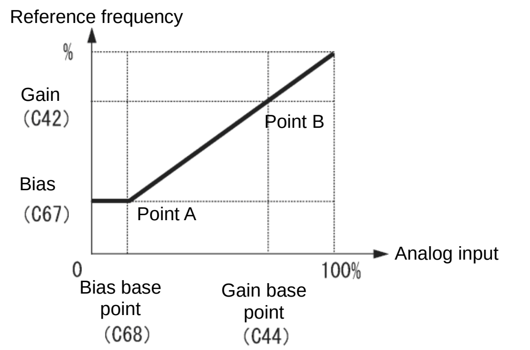
C40 data	Range of terminal inputs	Handling when a bias value is configured as minus
0	4 to 20 mA (Factory default)	Limits any value lower than 0 to 0.
1	0 to 20 mA	
10	4 to 20 mA	Enables any value lower than 0 as minus value.
11	0 to 20 mA	

■ Polarity selection for terminal [C1] (V2 function) (C45)

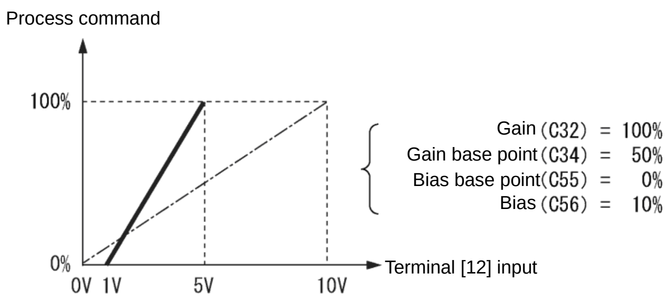
C45 configures the input range for analog input voltage of terminal [C1] (V2 function).

C45 data	Modes for terminal inputs	When bias is specified to be negative
0	0 to +10V	Makes a value lower than 0 effective as a negative value.
1	0 to +10V (factory default)	Limits a value lower than 0 to 0.

■ **Gain and bias**

Terminal	Data
[12]	
[C1] (C1) function	
[C1] (V2 function)	

(Example) In order to allocate for the range of 0 to 100% to the range of 1 to 5 V at terminal [12], set as follows.



[3] PID command with UP/DOWN control (J02 = 3)

When UP/DOWN control is selected as a PID speed command, turning the terminal command “UP” or “DOWN” ON causes the PID set point value to change within the range from minimum scale to maximum scale.

The PID set point value can be specified in physical quantity units (such as temperature or pressure) with the minimum scale (J106) and maximum scale (J107).

To select UP/DOWN control as a PID set point value, the “UP” and “DOWN” should be assigned to the digital input terminals [X1] to [X5]. (📖 Function codes E01 to E05 data = 17, 18)

“UP”	“DOWN”	Action
Data = 17	Data = 18	
OFF	OFF	Retain PID set point value.
ON	OFF	Increase PID set point value at a rate between 0.1%/0.1 s and 1%/0.1 s.
OFF	ON	Decrease PID set point value at a rate between 0.1%/0.1 s and 1%/0.1 s.
ON	ON	Retain PID set point value.

Note The inverter internally holds the PID command value set by UP/DOWN control and applies the held value at the next restart (including powering ON).

[4] PID command via communications link (J02 = 4)

Use function code S13 to specify the PID command by communications. The transmission data of 20000 (decimal) is equivalent to 100% (maximum set point value) of the PID command. For details of the communications format, refer to the RS-485 Communication User’s Manual.

Note
- Other than the remote command selection by J02, the PID multistep commands 1, 2 or 3 (specified by J106, J137 or J138, respectively) selected by the PID multistep commands “PID-SS1” and “PID-SS2” can also be used as preset set point values for the PID command.

Selecting Feedback Terminals

For feedback control, determine the connection terminal according to the type of the sensor output.

- If the sensor is a current output type, use the current input terminal [C1] (C1 function) of the inverter.
- If the sensor is a voltage output type, use the voltage input terminal [12] of the inverter, or switch over the terminal [C1] (V2 function) to the voltage input terminal and use it.

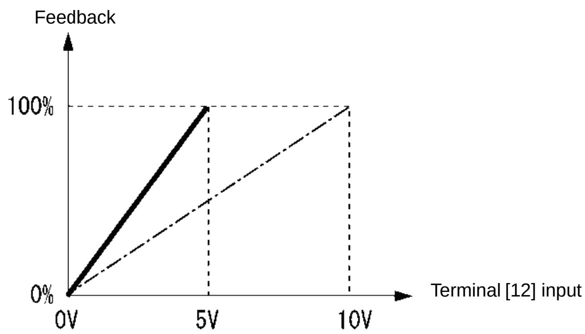
📖 For details, refer to the descriptions of E61 to E63.

<Application example: Process control> (for air conditioners, fans and pumps)

The operating range for PID process control is internally controlled as 0% through 100%. For the given feedback input, determine the operating range to be controlled by means of gain adjustment.

Example: When the external sensor has the output range of 1 to 5 V:

- Use terminal [12] as the input terminal in voltage.
- Set the gain (C32 for analog input adjustment) to 200% in order to make 5V of the maximum output of the external sensor to be 100% of input scale.
  For the input specification of terminal 12, 0-10V is equivalent to 0-100%.Therefore the gain has to be set 200% (= 10 V / 5 V *100). Note also that any bias setting does not apply to feedback control.



PID display coefficient and Monitoring

To monitor the PID command and its feedback value, set the scale to convert the values into easy-to-understand physical quantities such as temperature. The display unit is invalid on the standard keypad (TP-M2). The display unit is used with the multi-function keypad (TP-A1-E2C).

	Display unit	Maximum scale	Minimum scale
Terminal [12]	C58	C59	C60
Terminal [C1] (C1)	C64	C65	C66
Terminal [C1] (V2)	C70	C71	C72

📖 Refer to function codes C59, C60, C65, C66, C71 and C72 for details on scales, and to E43 for details on monitoring.

■ Display unit (J105)

J105 can select the display units for monitoring PID feedback value with the multi-function keypad (TP-A1-E2C).

Setting “0” selects the factory default unit for the PID feedback value.

J105	Display unit	J105	Display unit	J105	Display unit
0	* (Factory default)	23	L/s (flow)	45	mmHg (pressure)
1	No unit	24	L/min (flow)	46	Psi (pressure)
2	%	25	L/h (flow)	47	mWG (pressure)
4	r/min	40	Pa (pressure)	48	inWG (pressure)
7	kW	41	kPa (pressure)	60	K (temperature)
20	m^3/s (flow)	42	MPa (pressure)	61	°C (temperature)
21	m^3/min (flow)	43	mbar (pressure)	62	°F (temperature)
22	m^3/h (flow)	44	bar (pressure)	80	ppm (density)

* The unit and scale for feedback values are used.

■ Maximum scale/minimum scale (J106, J107)

The PID control values can be converted to a physical quantity that is easy to recognize and displayed accordingly. Set the maximum scale “PID command value/ display for 100% of a PID feedback value” with J106 and the minimum scale “PID command value/ display for 0% of a PID feedback value” with J107

The displayed value is determined as follows:

Display value = (PID command value (%)) / 100 * (Max. scale - Min. scale) + Min. scale

- Data setting range: (Max. scale and min. scale) -999.00 to 0.00 to 9990.00

■ PID multistep command 1 to 3 (J136, J137 and J138)

A PID command value can be given by the PID multistep command and selected by digital inputs programmed with “PID-SS1” and “PID-SS2” functions. Assign the digital input terminals with “PID-SS1” and “PID-SS2” (📖Function codes E01 to E05, data =171 and 172 respectively).

PID-SS2	PID-SS1	PID multistep command
OFF	OFF	Not selected
OFF	ON	J136: PID multistep command 1 setting range: -999.0 to 0.00 to 9990
ON	OFF	J137: PID multistep command 2 setting range: -999.0 to 0.00 to 9990
ON	ON	J138: PID multistep command 3 setting range: -999.0 to 0.00 to 9990

J03 to J06	PID Control P (Gain), I (Integral time), D (Differential time), Feedback filter

■ **P gain (J03)**

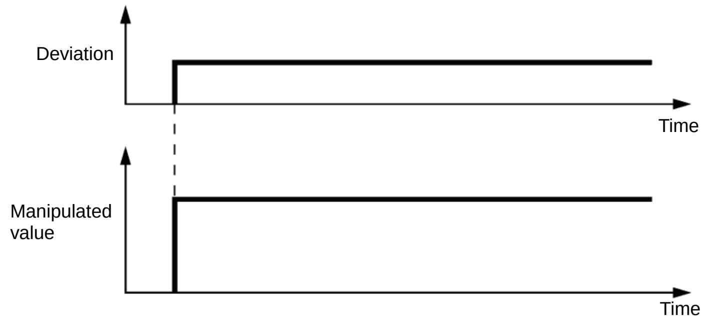
J03 specifies the proportional gain for the PID processor.

- Data setting range: 0.000 to 30.000 (times)

P (Proportional) action

An operation in which the MV (manipulated value: output frequency) is proportional to the deviation is called P action, which outputs the MV in proportion to deviation. However, P action alone cannot eliminate deviation.

Gain is data that determines the system response level against the deviation in P action. An increase in gain speeds up response, but an excessive gain may oscillate the inverter output. A decrease in gain delays response, but it stabilizes the inverter output.



■ **I integral time (J04)**

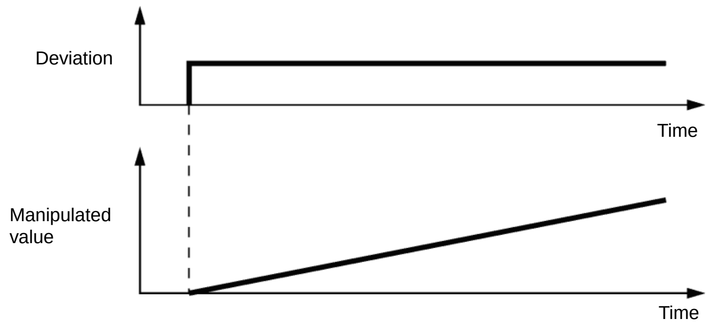
J04 specifies the integral time for the PID processor.

- Data setting range: 0.0 to 3600.0 (s)
  0.0 indicates that the integral component is ineffective

I (Integral) action

An operation in which the change rate of the MV (manipulated value: output frequency) is proportional to the integral value of deviation is called I action, which outputs the MV that integrates the deviation. Therefore, I action is effective in bringing the feedback value close to the commanded value. For the system whose deviation rapidly changes, however, this action cannot make it respond quickly.

The effectiveness of I action is expressed by integral time as parameter, that is J04 data. The longer the integral time, the slower the response. The reaction to the external disturbance also becomes slow. The shorter the integral time, the faster the response. Setting too short integral time, however, makes the inverter output tend to oscillate against the external disturbance.



■ D differential time (J05)

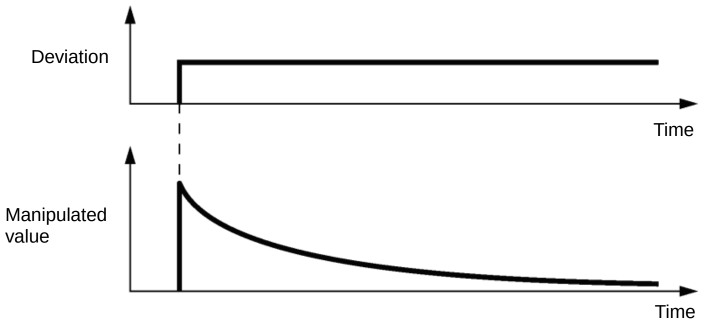
J05 specifies the differential time for the PID processor.

- Data setting range: 0.00 to 600.00 (s)
  0.00 indicates that the differential component is ineffective.

D (Differential) action

An operation in which the MV (manipulated value: output frequency) is proportional to the differential value of the deviation is called D action, which outputs the MV that differentiates the deviation. D action makes the inverter quickly respond to a rapid change of deviation.

The effectiveness of D action is expressed by differential time as parameter, that is J05 data. Setting a long differential time will quickly suppress oscillation caused by P action when a deviation occurs. Too long differential time makes the inverter output oscillation more. Setting short differential time will weakens the suppression effect when the deviation occurs.



The combined uses of P, I, and D actions are described below.

(1) PI control

PI control, which is a combination of P and I actions, is generally used to minimize the remaining deviation caused by P action. PI control always acts to minimize the deviation even if a commanded value changes or external disturbance steadily occurs. However, the longer the integral time of I action, the slower the system response to quick-changed control. P action can be used alone for loads with very large part of integral components.

(2) PD control

In PD control, the moment that a deviation occurs, the control rapidly generates greater MV (manipulated value: output frequency) than that generated by D action alone, to suppress the deviation increase. When the deviation becomes small, the behavior of P action becomes small. A load including the integral component in the controlled system may oscillate due to the action of the integral component if P action alone is applied. In such a case, use PD control to reduce the oscillation caused by P action, for keeping the system stable. That is, PD control is applied to a system that does not contain any damping actions in its process.

(3) PID control

PID control is implemented by combining P action with the deviation suppression of I action and the oscillation suppression of D action. PID control features minimal control deviation, high precision and high stability. In particular, PID control is effective to a system that has a long response time to the occurrence of deviation.

Follow the procedure below to set data to PID control function codes.

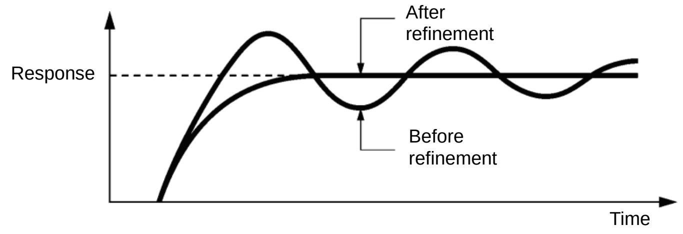
It is highly recommended that you adjust the PID control value while monitoring the system response waveform of the PID feedback with an oscilloscope or equivalent. Repeat the following procedure to determine the optimal solution for each system.

- Increase the data of J03 (PID control P (Gain)) within the range where the feedback signal does not oscillate.
- Decrease the data of J04 (PID control I (Integral time)) within the range where the feedback signal does not oscillate.
- Increase the data of J05 (PID control D (Differential time)) within the range where the feedback signal does not oscillate.

The method for refining the system response from the waveforms is shown below.

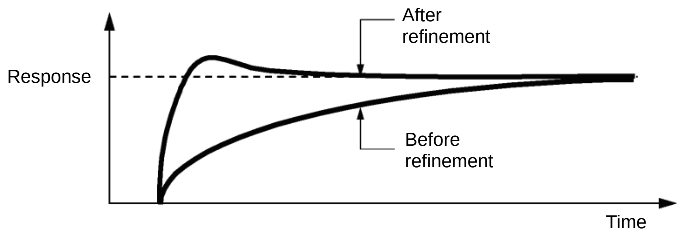
1) Suppressing overshoot

Increase the data of J04 (Integral time) and decrease that of J05 (Differential time).



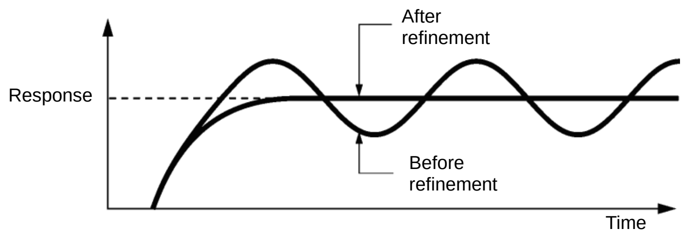
2) Quick stabilizing (Moderate overshoot is allowable.)

Decrease the data of J03 (Gain) and increase that of J05 (Differential time).



3) Suppressing oscillation whose period is longer than the integral time specified by J04

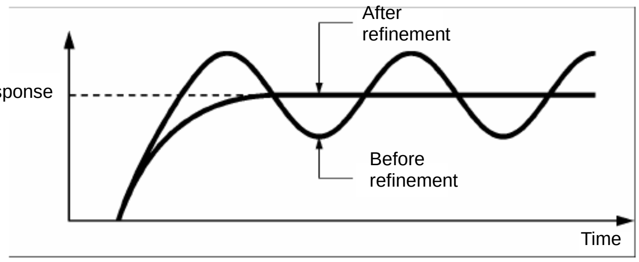
Increase the data of J04 (Integral time).



4) Suppressing oscillation whose period is approximately the same as the time specified by J05 (Differential time)

Decrease the data of J05 (Differential time).

Decrease the data of J03 (Gain), if the oscillation cannot be suppressed even though the differential time is set at 0 sec.



■ **Feedback filter (J06)**

J06 specifies the time constant of the filter for feedback signals under PID control.

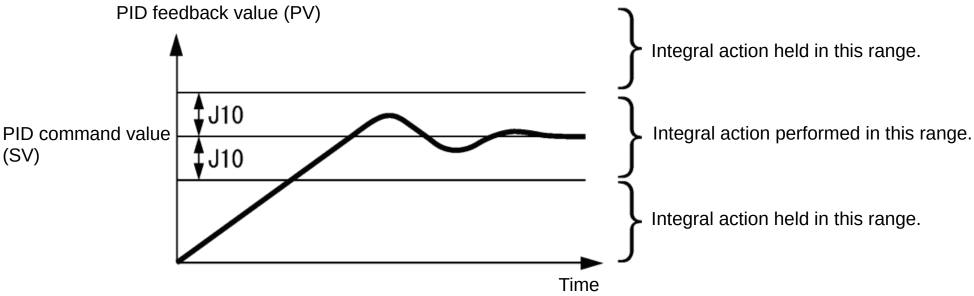
- Data setting range: 0.0 to 900.0 (s)
- This setting is used to stabilize the PID control loop. Setting a too long time constant makes the system response slow.

APPENDICES

J10	PID Control (Anti-reset windup)

J10 suppresses overshoot in control with the PID processor. As long as the error between the feedback and the PID command is beyond the preset range, the integrator holds its value and does not perform integration operation.

- Data setting range: 0 to 200 (%)



J11 to J13	PID Control (Select warning output, Upper limit of warning (AH) and Lower limit of warning (AL))

The inverter can output two types of warning signals (caused by process command value or PID error value) associated with PID control if the digital output signal "PID-ALM" is assigned to any of the programmable, output terminals with any of E20, E21 and E27 (data = 42).

J11 specifies the warning output types. J12 and J13 each specify the upper and lower limits for warnings.

■ PID Control (Select warning output) (J11)

J11 specifies one of the following alarms available.

J11 data	Alarm	Data
0	Warning caused by process command value	While PV < AL or AH < PV, "PID-ALM" is ON 
1	Warning caused by process command value with hold	Same as above (with Hold)
2	Warning caused by process command value with latch	Same as above (with Latch)
3	Warning caused by process command value with hold and latch	Same as above (with Hold and Latch)
4	Warning caused by PID error value	While PV < SV - AL or SV + AH < PV, "PID-ALM" is ON. 
5	Warning caused by PID error value with hold	Same as above (with Hold)
6	Warning caused by PID error value with latch	Same as above (with Latch)
7	Warning caused by PID error value with hold and latch	Same as above (with Hold and Latch)

Hold: During the power-on sequence, the alarm output is kept OFF (disabled) even when the monitored quantity is within the alarm range. Once it goes out of the alarm range, and comes into the alarm range again, the alarm is enabled.

Latch: Once the monitored quantity comes into the alarm range and the alarm is turned ON, the alarm will remain ON even if it goes out of the alarm range. To release the latch, perform a reset by using the PRG/RESET key on keypad or turning the terminal command RST ON. Resetting can be done by the same way as resetting an alarm.

■ PID Control (Upper limit of warning (AH)) (J12)

J12 specifies the upper limit of warning (AH) in percentage (%) of the feedback value.

■ PID Control (Lower limit of warning (AL)) (J13)

J13 specifies the lower limit of warning (AL) in percentage (%) of the feedback value.

Note The value displayed (%) is the ratio of the upper/lower limit to the full scale (10 V or 20 mA) of the feedback amount (in the case of a gain of 100%).

Upper limit of warning (AH) and lower limit of warning (AL) also apply to the following alarms.

Alarm	Data	How to handle the warning	
		Select warning output (J11)	Data setting
Upper limit (process command)	ON when AH < PV	Warning caused by process command	AL = 0
Lower limit (process command)	ON when PV < AL		AH = 100%
Upper limit (PID error value)	ON when SV + AH < PV	Warning caused by PID error value	AL = 100%
Lower limit (PID error value)	ON when PV < SV - AL		AH = 100%
Upper/lower limit (PID error value)	ON when |SV - PV| > AL		AL = AH
Upper/lower range limit (PID error value)	ON when SV - AL < PV < SV + AL	Warning caused by PID error value	A negative logic signal should be assigned to "PID-ALM".
Upper/lower range limit (process command)	ON when AL < PV < AH	Warning caused by process command	
Upper/lower range limit (PID error value)	ON when SV - AL < PV < SV + AH	Warning caused by PID error value	

J15	**PID control (Sleep frequency)**
J16	**PID control (Sleep timer)**
J17	**PID control (Wakeup frequency)**
J23	**PID control (Wakeup level of PID error)**
J24	**PID control (Wakeup timer)**

Sleep function (J15 to J17, J23, J24)

J15 to J17 configure the sleep function in pump control, a function that stops the inverter when the discharge pressure increases, causing the volume of water to decrease.

When the discharge pressure has increased, decreasing the reference frequency (output of the PID processor) below the sleep level (J15) for the period specified sleep timer (J16), the inverter decelerates to stop, while PID control itself continues to operate. When the discharge pressure decreases, increasing the reference frequency (output of the PID processor) above the wakeup frequency (J17), the inverter resumes operation.

The restarting conditions can be adjusted with J23 and J24.

■ **PID control (Sleep frequency) (J15)**

J15 specifies the frequency which triggers slow flowrate stop of inverter.

■ **PID control (Sleep timer) (J16)**

J16 specifies the period from when the PID output drops below the frequency specified by J15 until the inverter starts deceleration to stop.

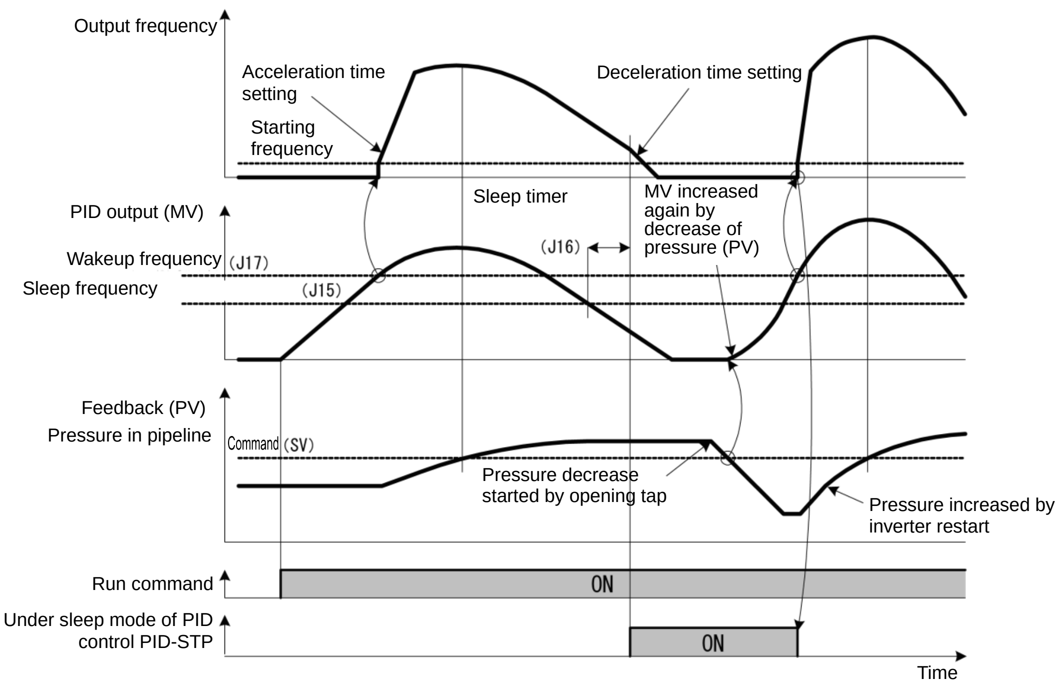
■ **PID control (Wakeup frequency) (J17)**

J17 specifies the wakeup frequency. Set J17 to a frequency higher than the sleep frequency (J15). If the specified wakeup frequency is lower than the sleep frequency, the sleep frequency is ignored; the sleep function is triggered when the output of the PID processor drops below the specified wakeup frequency.

■ **Assignment of "PID-STP" ("Under sleep mode of PID control") (E20, E21 and E27, data = 44)**

"PID-STP" ("Under sleep mode of PID control") is ON when the inverter is in a stopped state due to the sleep function under PID control. PID-STP should be assigned if it is necessary to output a signal to indicate that the inverter is stopped.

For the sleep function, see the chart below.



APPENDICES

■ **PID control (Wakeup level of PID error) (J23)**

■ **PID control (Wakeup timer) (J24)**

When both of the two conditions below are satisfied (AND), the inverter is restarted.

- The discharge pressure has decreased, increasing the frequency (output of the PID processor) to or above the wakeup frequency (J17) and the wakeup timer (J24) has elapsed.
- The absolute error of the PV (feedback value) against to the SV (command value) is equal to or higher than the wakeup level of PID error (J23), and the wakeup time (J24) has elapsed.

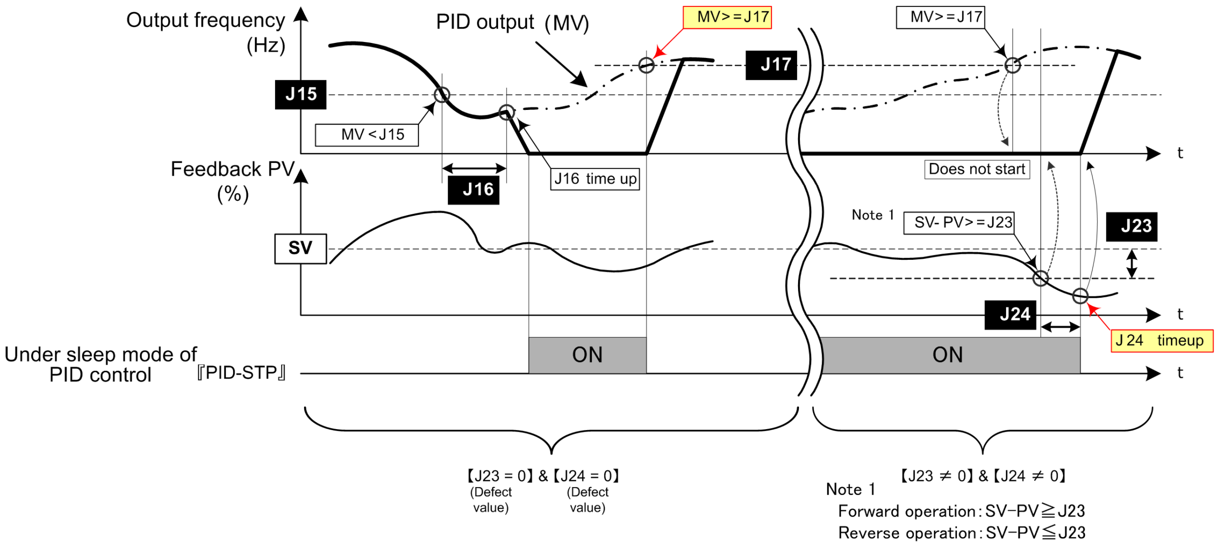


Figure J.22 PID control operation

J18, J19	PID Control (Upper limit of PID process output, Lower limit of PID process output)

The upper and lower limiters can be specified to the PID output, exclusively used for PID control. The settings are ignored when PID cancel “Hz/PID” is enabled and the inverter is operated at the reference frequency previously specified. (📖 Function codes E01 to E05 data = 20)

■ **PID Control (Upper limit of PID process output) (J18)**

J18 specifies the upper limit of the PID processor output limiter in Hz. If the value of “999” is specified to J18, the setting of the frequency limiter (Upper) (F15) will serve as the upper limit.

■ **PID Control (Lower limit of PID process output) (J19)**

J19 specifies the lower limit of the PID processor output limiter in Hz. If the value of “999” is specified to J19, the setting of the frequency limiter (Lower) (F16) will serve as the lower limit.

J21	Dew condensation Prevention

With the inverter stopped, dew condensation can be prevented by applying DC current at fixed intervals to raise the motor temperature.

If using the dew condensation prevention function, it is necessary to assign dew condensation prevention "DWP" to the general-purpose digital input terminal. (📖 Function code data = 39)

■ Enabling conditions

Turn ON dew condensation prevention “DWP” while the inverter is stopped to enable and start the dew condensation prevention function.

■ Dew condensation prevention

The current flowing to the motor is based on DC braking (braking level) (F21), and duty control is performed based on the dew condensation prevention duty (J21) ratio with respect to DC braking (time) (F22).

$$\text{Dew condensation prevention duty (J21)} = \frac{\text{DC braking (time) (F22)} \times 100}{\text{T}}$$

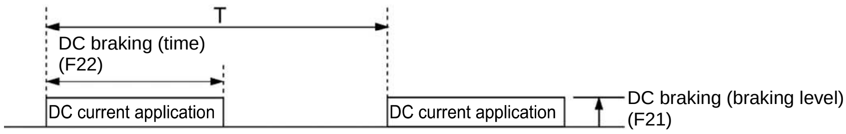


Figure J.23 Dew condensation prevention operation

J105 to J107	PID control (Display unit, Maximum scale, Minimum scale)

Refer to the description of J02.

J136 to J138	PID control 1 (PID multistep command 1 to 3)

For details, refer to the description of J02.

APPENDICES

[5] Pump control

Applying the FRENIC-Ace to a water supply system configured with two or more pumps combined with a header enables the FRENIC-Ace to control those pumps for operating the water supply system with optimum electric power.

Cascade control and mutual operation control are available for controlling two or more pumps. Understanding the features of each control and selecting the appropriate control allows the FRENIC-Ace to provide high economic efficiency.

Control	Features
J401 = 1 or 11 Cascade control (Inverter drive motor fixed system)	A single FRENIC-Ace drives a maximum of 5 pump motors. No. of pumps driven by inverter at variable speed: 1 (fixed) No. of commercial power-driven pumps: 4 max. (fixed) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of commercial power- driven pumps x 1" Pressure fluctuation at the time of adding/subtracting pumps: Large When J401 = 1, adding/subtracting pumps is judged with the ID controller output. When J401 = 11, adding/subtracting pumps is judged with the output frequency.
J401 = 2 or 12 Cascade control (Inverter drive motor floating system)	A single FRENIC-Ace drives a maximum of 3 pump motors. No. of pumps driven by inverter at variable speed: 1 (floating) No. of commercial power-driven pumps: 2 max. (floating) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of inverter drive pumps floating x 2 + 1 (for auxiliary pump)" Pressure fluctuation at the time of adding/subtracting pumps: Small When J401 = 2, adding/subtracting pumps is judged with the ID controller output. When J401 = 12, adding/subtracting pumps is judged with the output frequency.
J401 = 3 or 13 Cascade control (Inverter drive motor floating + commercial power-driven motor system)	A single FRENIC-Ace drives a maximum of 5 pump motors. No. of pumps driven by inverter at variable speed: 1 (floating) No. of commercial power-driven pumps: 2 max. (floating) No. of auxiliary pumps (commercial power-driven): 1 (fixed) No. of magnetic contactors required: "No. of inverter drive pumps floating x 2 + 1 (for auxiliary pump)" Pressure fluctuation at the time of adding/subtracting pumps: Small No. of magnetic contactor ON/OFF times: Small When J401 = 3, adding/subtracting pumps is judged with the ID controller output. When J401 = 13, adding/subtracting pumps is judged with the output frequency.
J401 = 52 Mutual operation control (Communications-linked inverter drive motor floating system)	Number of pumps controllable: 4 max. All pumps driven by inverter at variable speed (The same number of inverters is required.) All FRENIC-Ace units to be linked via RS-485 No magnetic contactor required. Start/stop sequence cycles under PID control.
J401 = 54 Mutual operation control (Communications-linked all motors simultaneous PID control system)	Number of pumps controllable: 4 max. All pumps driven by inverter at variable speed (The same number of inverters is required.) All FRENIC-Ace units to be linked via RS-485 No magnetic contactor required. All pumps operated at the same speed simultaneously. Closed-loop cycling pumps managing not pressure control but flowrate control, which provides large energy saving effect.

Details of each control are given on the following pages.

■ **J401 = 1 or 11 Cascade control (Inverter drive motor fixed system)**

Configure such a pump drive system that drives a particular pump (M0 in the configuration figure given below) with the FRENIC-Ace and drives other pumps (M1 to M4) with commercial power by turning magnetic contactors ON with the digital output signals issued by the FRENIC-Ace.

The FRENIC-Ace drives the M0 under PID control. If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the FRENIC-Ace outputs pump start signals to turn the magnetic contactors ON, thereby starting commercial power-driven pumps successively. After starting all pumps, the inverter can further drive a single auxiliary pump (MA).

If the PV signal level rises and the frequency of the inverter-driven pump drops to satisfy the pump subtracting conditions, the FRENIC-Ace cancels pump start signals to turn the magnetic contactors OFF, thereby stopping commercial power-driven pumps successively.

The number of start signal lines available on the FRENIC-Ace is a total of three transistor output lines and two relay output lines in a standard configuration, so the FRENIC-Ace can control a total of five pumps (one pump driven by inverter at variable speed and four commercial power-driven pumps) in a standard configuration.

The advantage of this system is low cost since the number of controllable pumps is large and the number of magnetic contactors is one per pump. The disadvantage is large pressure fluctuation since adding/subtracting of pumps targets commercial power-driven pumps.

The start/stop sequence of commercial power-driven pumps is changeable so that the operating time of pumps can be averaged.

< Maximum number connection configuration of inverter drive motor fixed system (J401 = 1) >

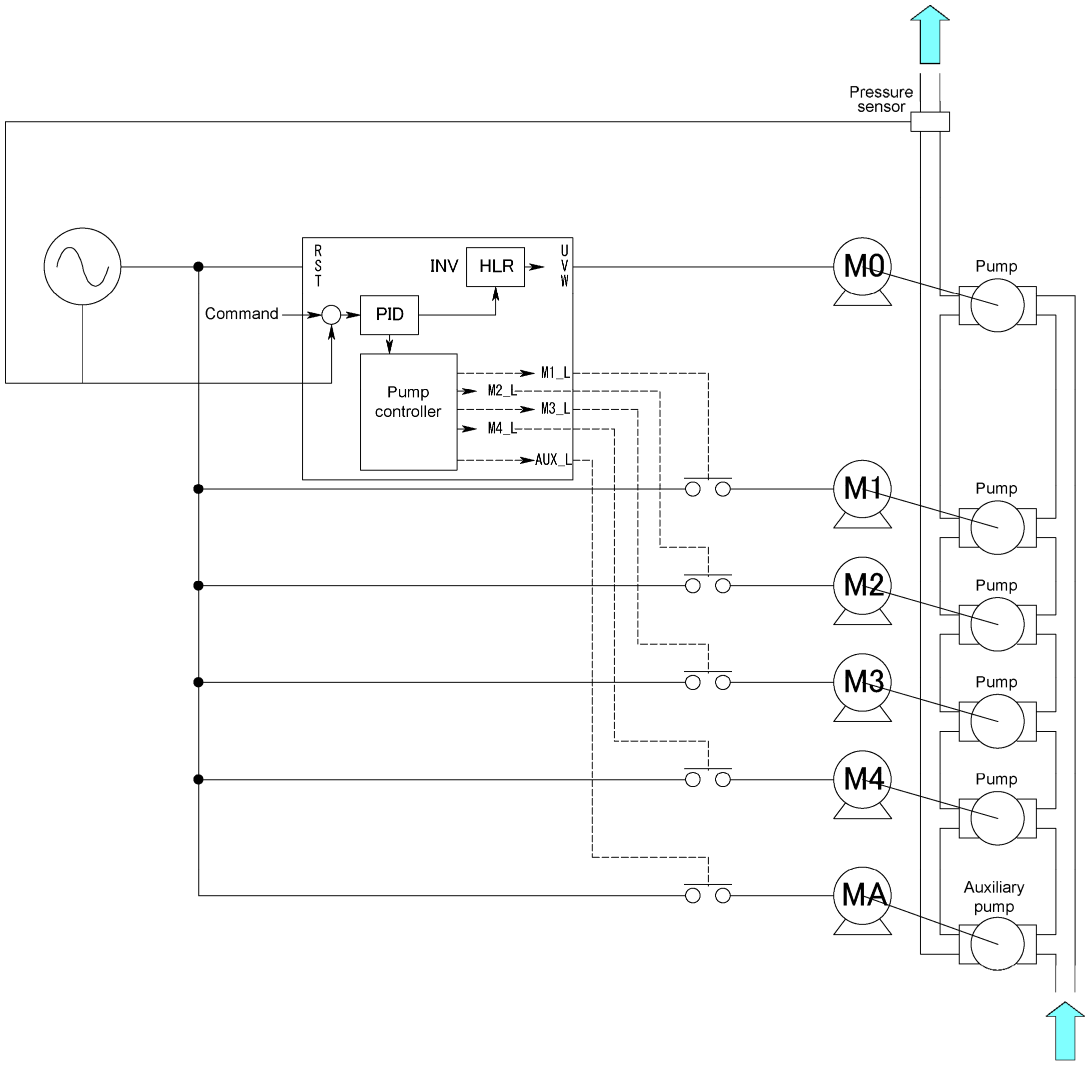


Figure J.24 Configuration diagram

APPENDICES

< Operation timing scheme of inverter drive motor fixed system (J401 = 1) >

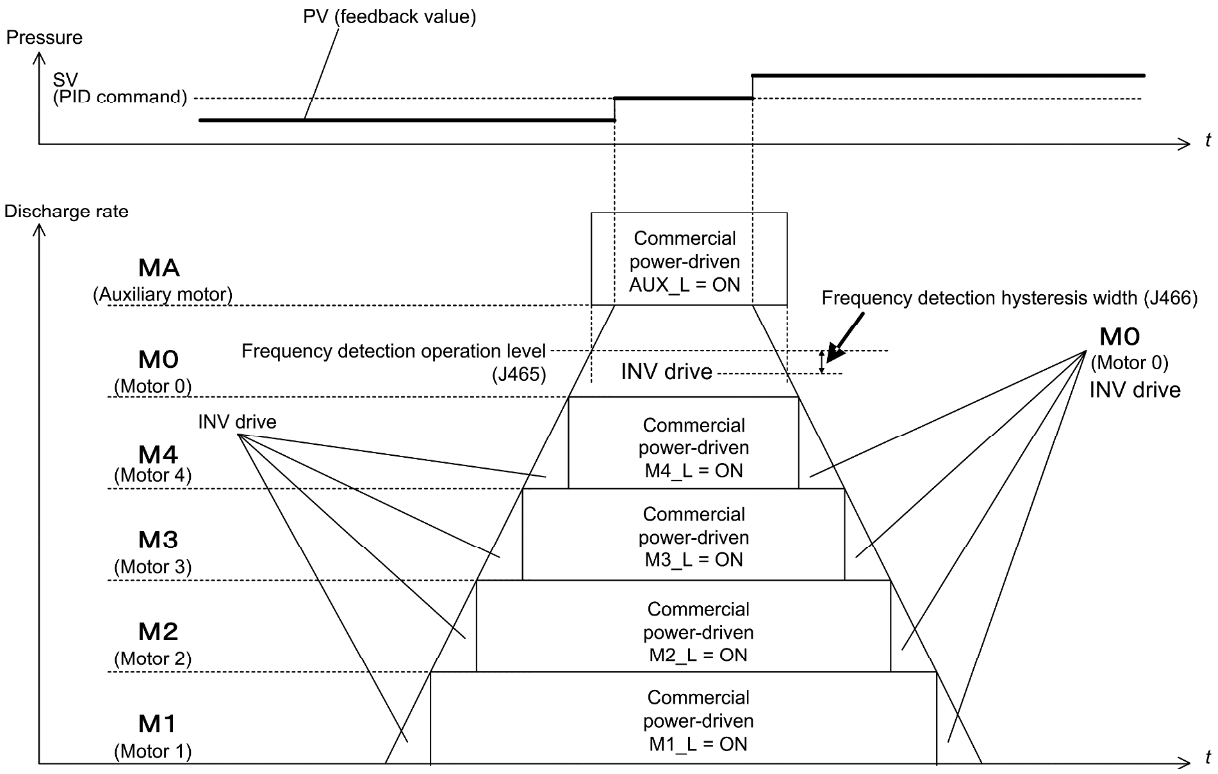


Figure J.25

< Pump operation time chart of inverter drive motor fixed system (J401 = 1 or 11) >

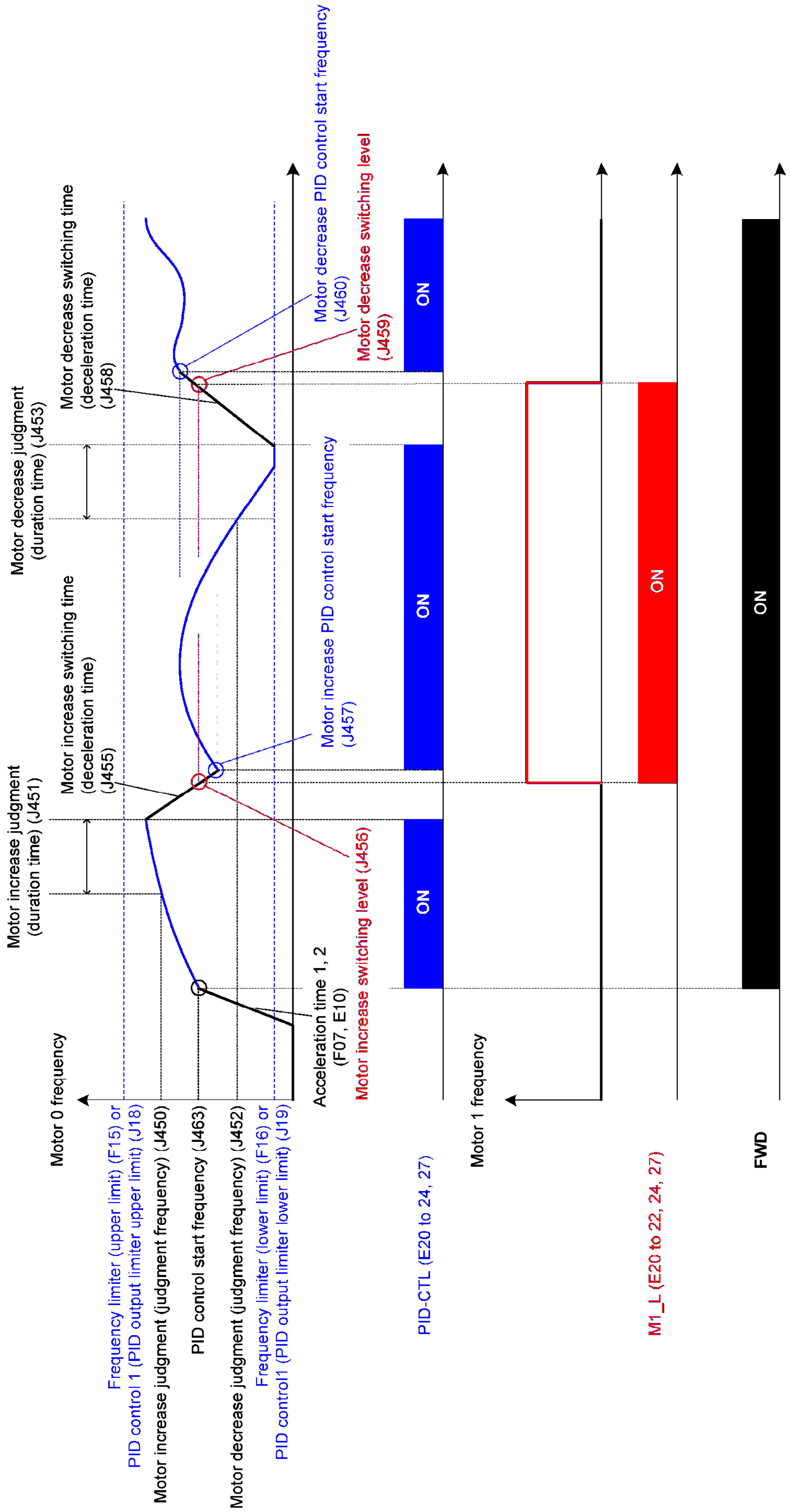


Figure J.26

< Function code configuration required for the inverter drive motor fixed system >

(1) Function codes to be configured

Configuring the following function codes as listed below activates the inverter drive motor fixed system under cascade control.

Function code	Name	Data	Description
J401	Pump control mode selection	1, 11: Inverter drive motor fixed system	
J01 to J138	PID control 1	Depends on each code setting	These function codes configure PID control in accordance with the system design.
E21, E21, E27	[Y1], [Y2], [30A/B/C]	88: ***AUX_L*** (Auxiliary motor drive signal) 161, 163, 165, 167: ***M1_L*** to ***M4_L*** (Motor 1 to 4 being driven by commercial power)	These function codes assign commercial drive start signals to the output terminals according to the number of commercial power-driven pumps. For a maximum configuration, the optional relay output card is required. ***AUX_L*** is a drive signal for auxiliary pump.
J411 to J414	Motor 1 to Motor 4 mode selection	1: Enable	These function codes configure motor modes according to the number of commercial power-driven pumps. Only motors enabled can be control targets.

(2) Function codes recommended to be configured

Function code	Name	Data	Description
J425	Motor switching procedure	1: Equal operating time	This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps.

(3) Function codes for individual adjustments

Configure the following function codes as needed.

Function code	Name	Data	Description
J450	Motor increase judgment (Parallel Judgment F)	0 to 500 Hz, 999: Depends on J18	This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. The default is that if the frequency reaches the setting of J18 (PID upper limiter), the adding conditions are immediately met.
J451	Motor increase judgment (Duration time)	0.00 to 3600 s	
J452	Motor decrease judgment (Parallel Judgment F)	0 to 500 Hz, 999: Depends on J19	This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. The default is that if the frequency reaches the setting of J19 (PID lower limiter), the subtracting conditions are immediately met.
J453	Motor decrease judgment (Duration time)	0.00 to 3600 s	
J461	Motor increase/ decrease switching judgment non-responsive area width	0.0: Disable 0.1 to 50.0%	If the deviation between SV and PV values is less than the setting of J461, no increase/ decrease judgment is made.

Function code	Name	Data	Description
J455	Motor increase switching time (Deceleration time)	0.01 to 3600 s, 0.00: Depends on F08	This function code adjusts the sequence to apply at the time of adding motors. If the adding conditions of commercial power-driven pumps are met, the inverter decelerates according to the setting of J455. If the inverter decelerates to the setting of J456, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to decelerate. When it reaches the setting of J457, it restarts PID control. J456 is a percentage within the PID control range (lower to upper limits). The initial speed decelerates according to the deceleration time selected. When it drops to the PID lower limit frequency, the start signal comes ON.
J456	Motor increase switching level	0 to 100%	
J457	Motor increase PID control start frequency	0 to 500 Hz, 999: Depends on J452	
J458	Motor decrease switching time (Acceleration time)	0.00 to 3600 s, 0.00: Depends on F07	This function code adjusts the sequence to apply at the time of motor decrease. If the subtracting conditions of commercial power-driven pumps are met, the inverter accelerates according to the setting of J458. If the inverter accelerates to the setting of J459, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to accelerate. When it reaches the setting of J460, it restarts PID control. J459 is a percentage within the PID control range (lower to upper limits). The initial speed accelerates according to the acceleration time selected. When it rises to the PID upper limit frequency, the start signal comes ON.
J459	Motor decrease switching level	0 to 100% 999: Depends on J456	
J460	Motor decrease PID control start frequency	0 to 500 Hz, 999: Depends on J450	
J430	Stop of commercial power-driven motors	0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run	This function code specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm. Regardless of this setting, entering a coast-to-stop command ***BX*** stops all commercial power-driven pumps. The initial setting is that inverter stop conditions satisfied stops commercial power-driven pumps.
J436	Motor regular switching time	0.1 to 720.0 h	If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time.
E01 to E05	[X1] to [X5]	151 to 154: MEN1 to MEN4 Pump control motor 1 to 4	These function codes individually separate pumps from the inverter drive motor fixed system with external signals. Only pumps whose MEN signals are ON are subject to this system.
J465	Auxiliary motor (Frequency operation level)	0.1 to 500 Hz 0.0: Disable	When all pumps subject to this system are operating and the inverter output exceeds the setting of J465, the auxiliary pump start signal comes ON. If the inverter decelerates from the setting of J465 by the setting of J466, the auxiliary pump start signal goes OFF.
J466	Auxiliary motor (Hysteresis width)	0.0 to 500 Hz	

Each function code is detailed separately.

■ **J401 = 2 or 12 Cascade control (Inverter drive motor floating system)**

To switch a maximum of three pumps between inverter drive and commercial power drive by a single FRENIC-Ace, configure two magnetic contactors per pump.

The FRENIC-Ace drives the first pump at variable speed under PID control. If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the FRENIC-Ace switches the inverter-driven pump to commercial power drive and drives the newly added pump. After starting all pumps, the inverter can further drive a single auxiliary pump (MA). If the PV signal level rises and the frequency of the inverter-driven pump drops to satisfy the pump subtracting conditions, the FRENIC-Ace cancels start signals of the pumps being driven by commercial power, thereby stopping them successively. At the time of decreasing pumps, the FRENIC-Ace continues to drive the last added pump.

In this system, each of pumps to be controlled requires two signal lines for inverter drive and commercial power drive. To operate the pump drive system in a maximum configuration, an auxiliary pump start signal line is further required.

The number of start signal lines available on the FRENIC-Ace is a total of three transistor output lines and two relay output lines in a standard configuration, so the FRENIC-Ace can control a total of two pumps in a standard configuration.

To operate the pump drive system using three pumps, it is necessary to add the optional relay output card (OPC-F2-RY) to the FRENIC-Ace. It can add three relay output lines.

The advantage of this system is that the operating times of pumps can be averaged since the FRENIC-Ace cycles through pump motors.

■ **J401 = 3 or 13 Cascade control (Inverter drive motor fixed + commercial power-driven motor system)**

This system is the same as the inverter drive motor floating system in the basic configuration, except that it fixes the inverter drive pump according to the slow flowrate unit and switches the inverter drive pump when the system is started at the next time.

The advantage of this system is that the ON/OFF times of the magnetic contactors can be reduced. Therefore, this system is suitable for clean water supply systems repeating slow flowrate stops frequently.

< Maximum number connection configuration of inverter drive motor floating system >

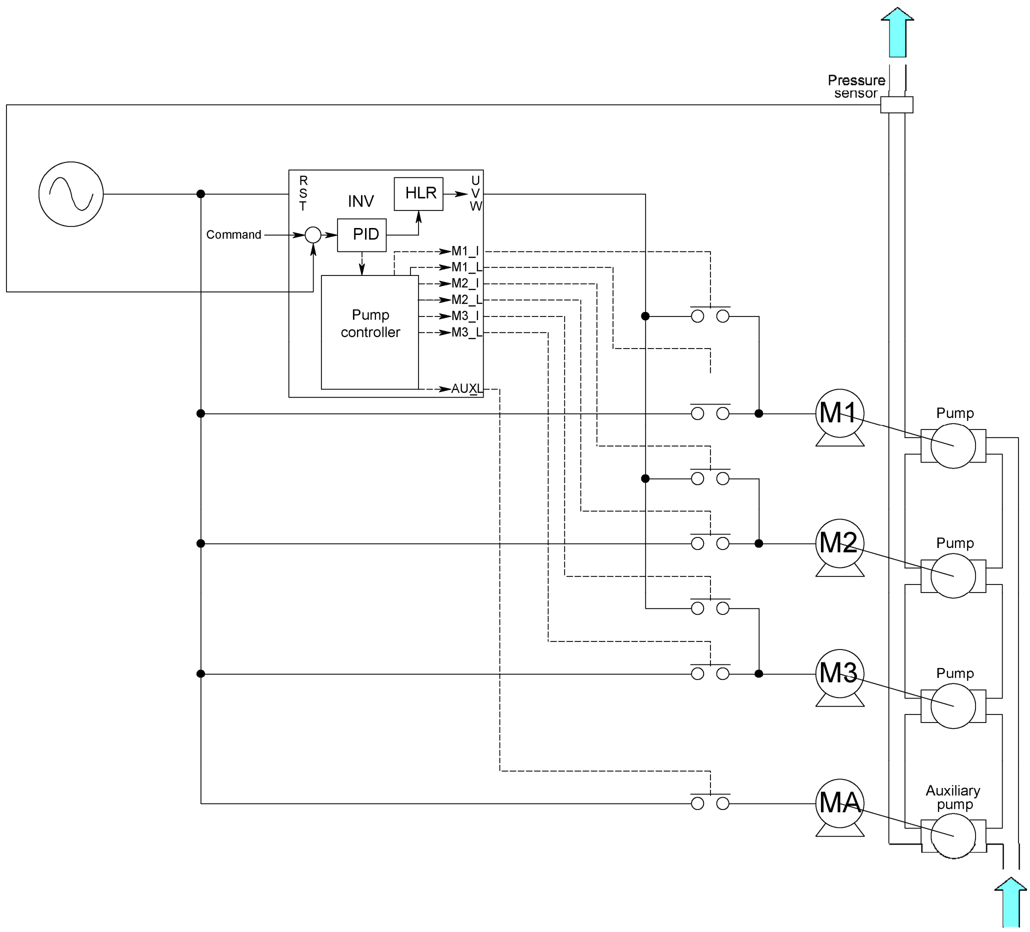


Figure J.27

< Operation timing scheme of inverter drive motor floating system (J401 = 2) >

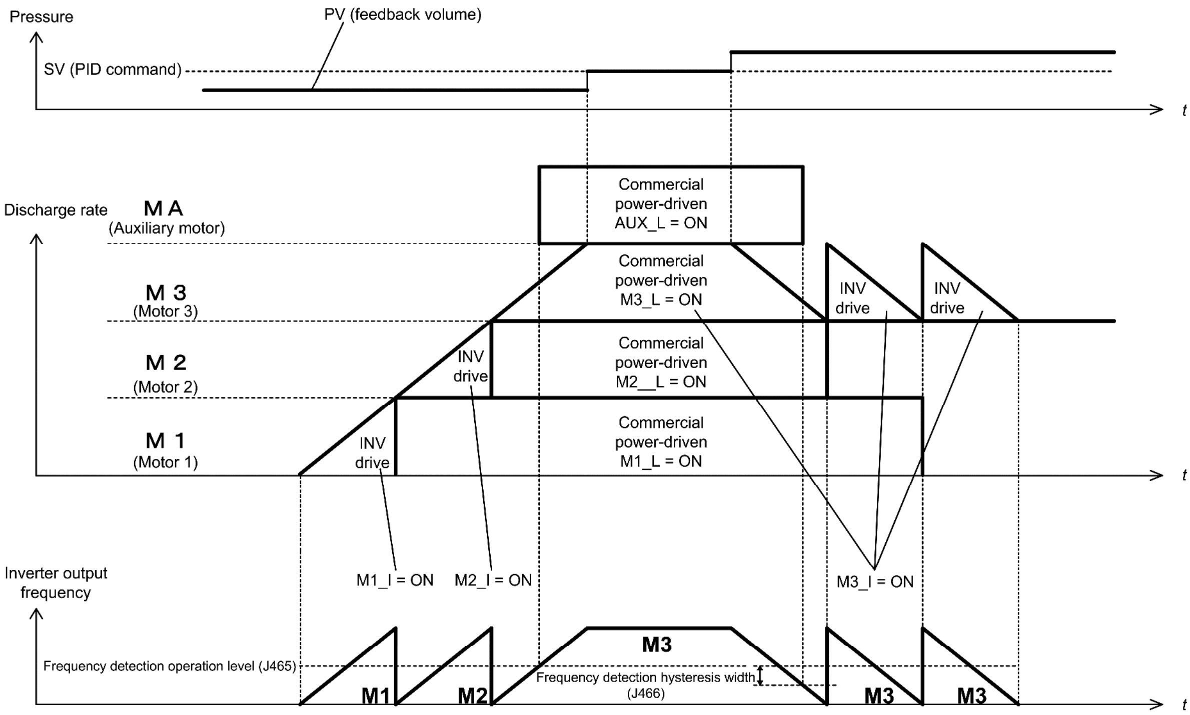


Figure J.28

< Operation timing scheme of inverter drive motor floating + commercial power-driven motor system (J401 = 3) >

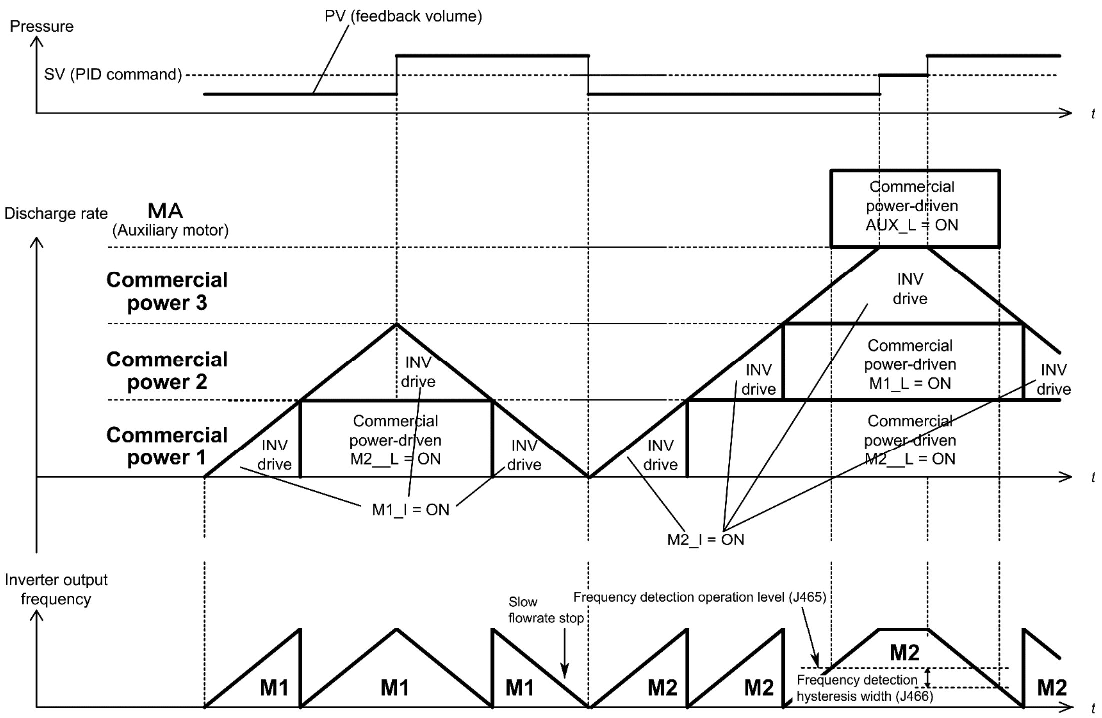


Figure J.29

APPENDICES

< Pump operation time chart of inverter drive motor floating system (J401 = 2) >

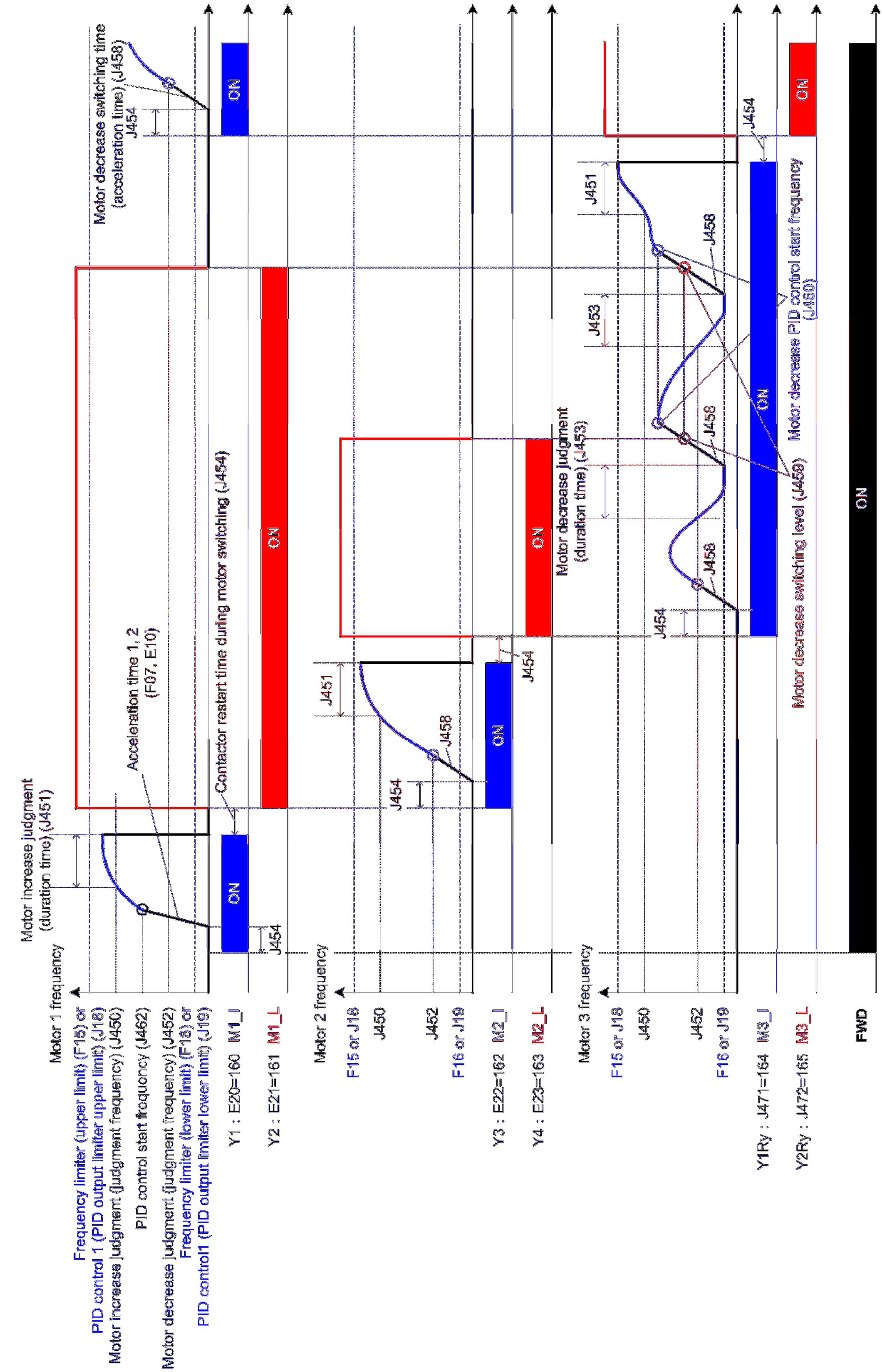


Figure J.30

< Pump operation time chart of inverter drive motor floating + commercial power-driven motor system (J401 = 3) >

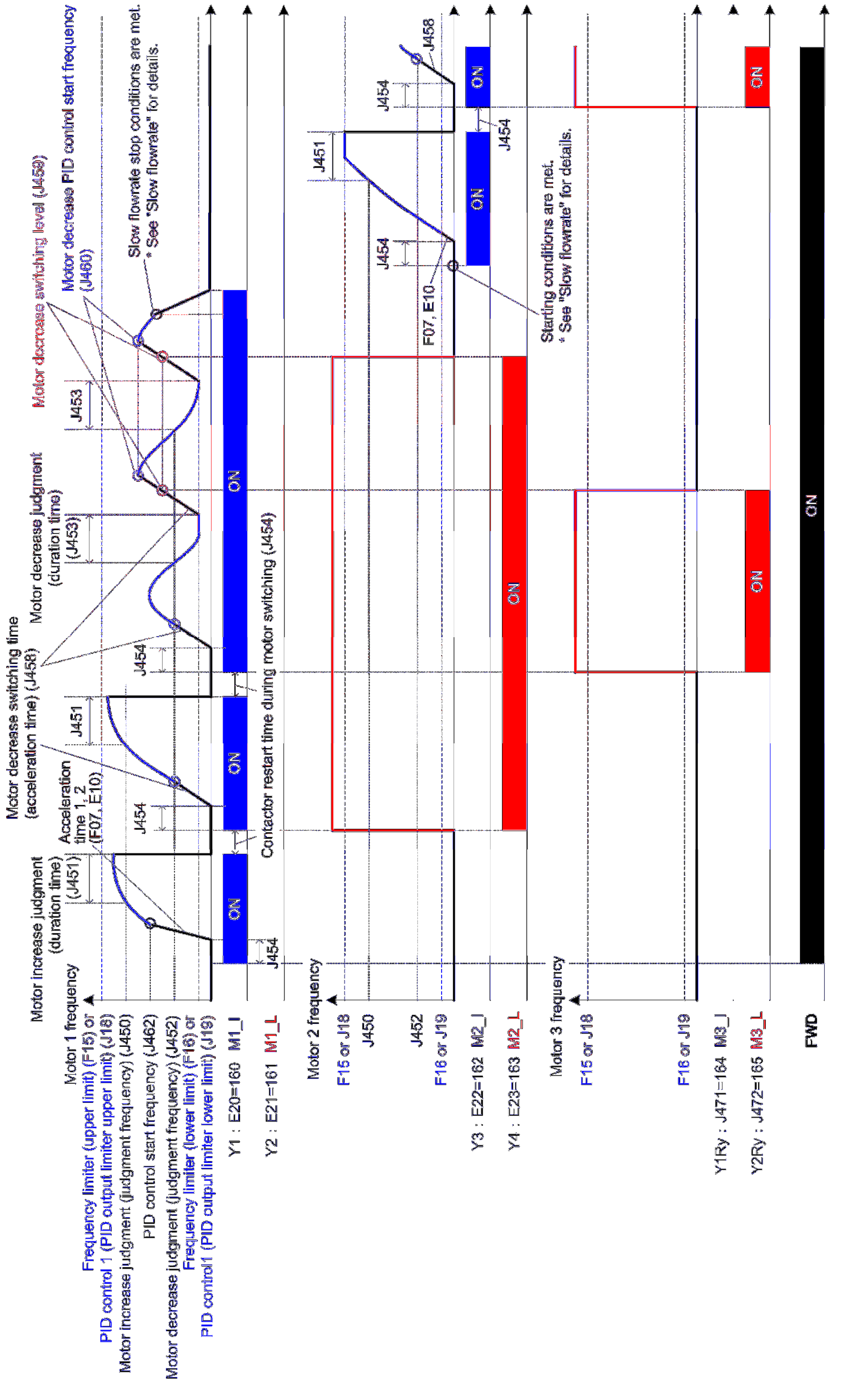


Figure J.31

APPENDICES

< Function code configuration required for the inverter drive motor floating system and the inverter drive motor floating + commercial power-driven motor system >

(1) Function codes to be configured

Function code	Name	Data	Description
J401	Pump control mode selection	2: Inverter drive motor floating system 3: Inverter drive motor floating + commercial power-driven motor system	
J01 to J138	PID control 1	Depends on each code setting	These function codes configure PID control in accordance with the system design.
E20, E21, E27	[Y1], [Y2], [30A/B/C]	88: ***AUX_L*** (Auxiliary motor drive signal) 160 to 164: ***M1_I*** to ***M3_I*** (Motor 1 to 4 being driven by inverter) 161 to 165: ***M1_L*** to ***M3_L*** (Motor 1 to 3 being driven by commercial power)	These function codes assign inverter drive start signals and commercial drive start signals to the output terminals according to the number of pumps. For a maximum configuration, the optional relay output card is required. ***AUX_L*** is a drive signal for auxiliary pump.
J411 to J413	Motor 1 to Motor 3 mode selection	1: Enable	These function codes configure motor modes according to the number of pumps. Only motors enabled can be control targets.

(2) Function codes recommended to be configured

Function code	Name	Data	Description
J425	Motor switching procedure	1: Equal operating time	This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps.

(3) Function codes for individual adjustments

Configure the following function codes as needed.

Function code	Name	Data	Description
J450	Motor increase judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J18	This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. The default is that if the frequency reaches the setting of J18 (PID upper limiter), the adding conditions are immediately met.
J451	Motor increase judgment (Duration time)	0.00 to 3600 s	
J452	Motor decrease judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J19	This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. The default is that if the frequency reaches the setting of J19 (PID lower limiter), the subtracting conditions are immediately met.
J453	Motor decrease judgment (Duration time)	0.00 to 3600 s	

Function code	Name	Data	Description
J461	Motor increase/ decrease switching judgment non-responsive area width	0.1 to 50.0% 0.0: Disable	If the deviation between SV and PV values is less than the setting of J461, no increase/ decrease judgment is made.
J454	Contact restart time when switching the motor	0.01 to 2.00 s	Taking into account the contactor delay at the time of adding motors, the start of an inverter output can be delayed. Adjust this value when the inverter trips due to a contactor delay.
J455	Motor increase switching time (Deceleration time)	0.00 to 3600 s 0.00: Depends on F08	This function code adjusts the sequence to apply at the time of adding motors. If the adding conditions of commercial power-driven pumps are met, the inverter decelerates according to the setting of J455. If the inverter decelerates to the setting of J456, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to decelerate. When it reaches the setting of J457, it restarts PID control. J456 is a percentage within the PID control range (lower to upper limits). The initial speed decelerates according to the deceleration time selected. When it drops to the PID lower limit frequency, the start signal comes ON.
J456	Motor increase switching level	0 to 100%	
J457	Motor increase PID control start frequency	0 to 500 Hz 999: Depends on J452	
J458	Motor decrease switching time (Acceleration time)	0.00 to 3600 0.00: Depends on F07	This function code adjusts the sequence to apply at the time of motor decrease. If the subtracting conditions of commercial power-driven pumps are met, the inverter accelerates according to the setting of J458. If the inverter accelerates to the setting of J459, it turns the commercial power-driven pump start signal ON. After that, the inverter continues to accelerate. When it reaches the setting of J460, it restarts PID control. J459 is a percentage within the PID control range (lower to upper limits). The initial speed accelerates according to the acceleration time selected. When it rises to the PID upper limit frequency, the start signal comes ON.
J459	Motor decrease switching level	0 to 100%	
J460	Motor decrease PID control start frequency	0 to 500 Hz 999: Depends on J450	
J430	Stop of commercial power-driven motors	0: Stop commercial power-driven motors 1: Stop commercial power-driven motors only when an inverter alarm occurs 2: Continue to run	This function code specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm. Regardless of this setting, entering a coast-to-stop command ***BX*** stops all commercial power-driven pumps. The initial setting is that inverter stop conditions satisfied stops commercial power-driven pumps.
J436	Motor regular switching time	0.1 to 720.0 h	If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time.

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Function code	Name	Data	Description
E01 to E05	[X1] to [X5]	151 to 155: ***MEN1*** to ***MEN3*** Pump control motor 1 to 3	These function codes individually separate pumps from the inverter drive motor fixed system with external signals. Only pumps whose ***MEN*** signals are ON are subject to this system.
J465	Auxiliary motor (Frequency operation level)	0.1 to 500 Hz 0.0: Disable	When all pumps subject to this system are operating and the inverter output exceeds the setting of J465, the auxiliary pump start signal comes ON. If the inverter decelerates from the setting of J465 by the setting of J466, the auxiliary pump start signal goes OFF.
J466	Auxiliary motor (Hysteresis width)	0.0 to 500 Hz	
J467 J468 J469	Auxiliary motor (PV operation level, Connection timer, Interrupting timer	0.00 to 9999.0 0.00 to 2.00 s 0.00 to 2.00 s	When an inverter drive motor is switched in the inverter drive motor floating system, the pressure may decreases. If it happens, run the auxiliary motor to compensate the pressure decrease. For details, refer to the description of function codes given later.

Each function code is detailed separately.

■ **J401 = 52 Mutual operation control (Communications-linked inverter drive motor floating system)**

This system controls up to three pumps which are individually connected with the FRENIC-Ace units in multidrop connection via RS-485.

The FRENIC-Ace specified as a master performs PID control and sends run commands and frequency commands to other two slaves.

If the frequency rises due to a PV signal level drop to satisfy the pump adding conditions, the second inverter is started. After the start of a total of three inverters, the master can output a start signal to drive an auxiliary pump. The start/stop sequence of pumps cycles.

Even if the master stops due to an alarm, the slaves can continue running.

The advantage of this system is very small pressure fluctuation at the time of adding/subtracting pumps and small load to piping since all pumps are driven by inverters. The disadvantage is high cost since each pump requires an inverter.

■ **J401 = 54 Mutual operation control (Communications-linked all motors simultaneous PID control system)**

This system is configured in the same way as the communications-link inverter drive motor floating system except that all motors are driven under PID control with the same frequency at the same time.

Even if an alarm occurs, the remaining inverters continue to run. If the pressure is insufficient, the inverter outputs a start signal to an auxiliary pump to add one pump.

The advantage of this system is that driving two or more pumps under PID control at the same time can deliver water with low power for optimum watt hour in the cooling water cycling system managing the flowrate.

< Maximum number connection configuration of mutual operation (J401 = 52 or 54) >

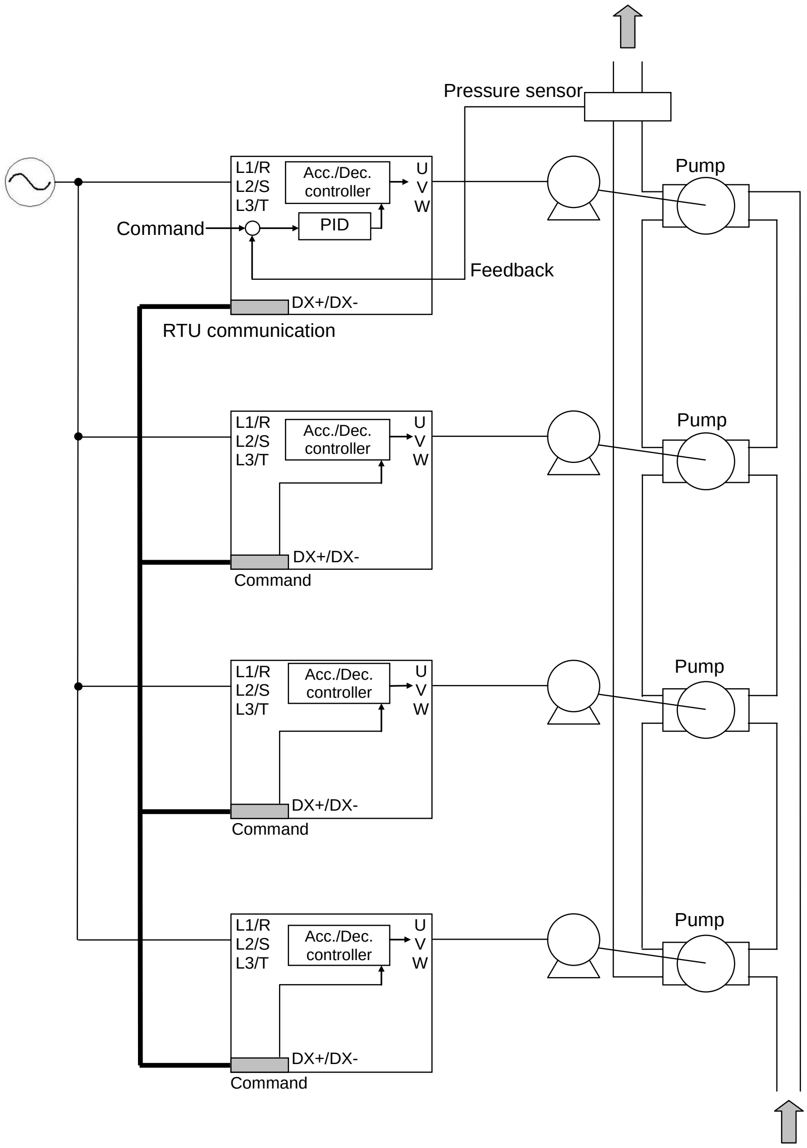


Figure J.32

< Operation timing scheme of communications-linked inverter-drive motor floating system >

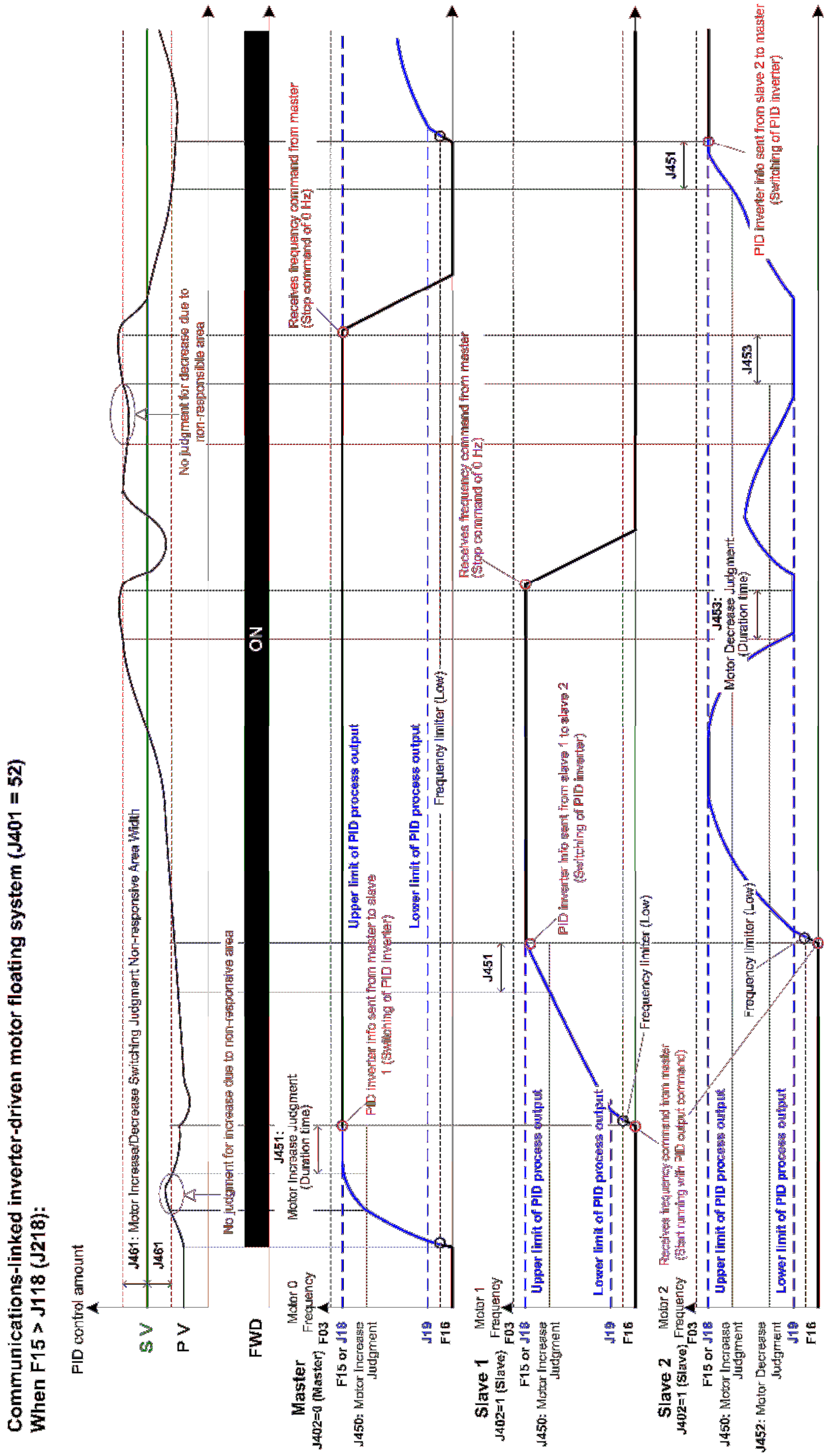


Figure J.33

< Operation timing scheme of communications link total simultaneous PID control method >

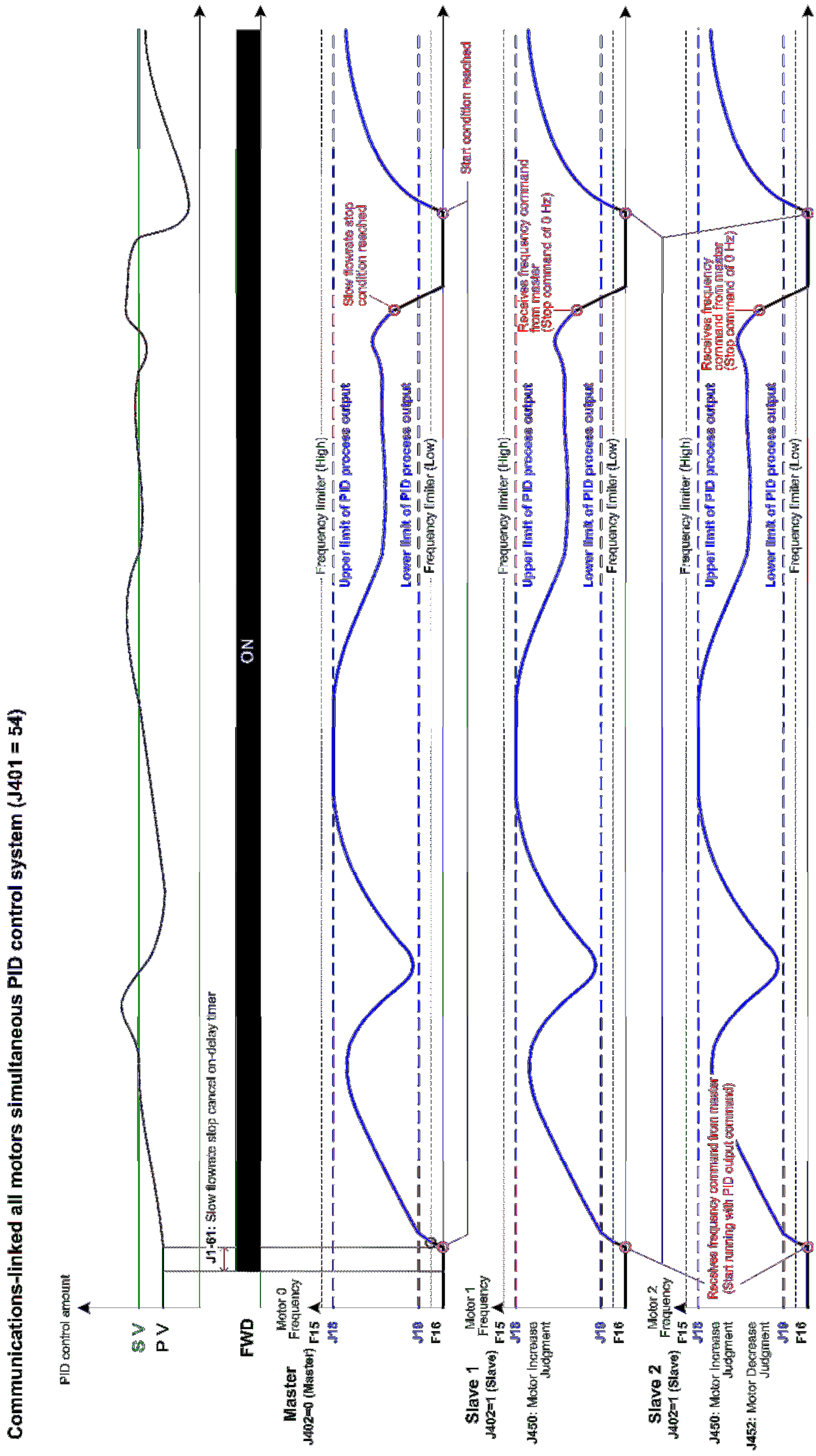


Figure J.34

APPENDICES

< Function code configuration required for the communications-linked inverter drive motor floating system and communications-linked all motors simultaneous PID control system >

(1) Function codes to be configured (Different between master and slaves)

For master

Function code	Name	Data	Description
J401	Pump control mode selection	52: Communications-linked inverter drive motor floating system 54: Communications-linked all motors simultaneous PID control system	
J01 to J138	PID control 1	Depends on each code setting	These function codes configure PID control in accordance with the system design.
J403	Number of slaves	1 to 3	
y20	RS-485 communication 2	50: Communications link pump control protocol	

For slaves

Function code	Name	Data	Description
J401	Pump control mode selection	52: Communications-linked inverter drive motor floating system 54: Communications-linked all motors simultaneous PID control system	
H30	Communications link function	8: Frequency command (RS-485) and run command (RS-485)	Ready to receive run commands and frequency command.
J402	Communication master/slave selection	1: Communication slave inverter	
y11	Station address	1 to 3	
y20	RS-485 communication 2	50: Communications link pump control protocol	

(2) Function codes recommended to be configured

Function code	Name	Data	Description
J425	Motor switching procedure	1: Equal operating time	This function code automatically adjusts the start/stop sequence of commercial power-driven pumps to equalize the operating times of pumps.

(3) Function codes for individual adjustments

Configure the following function codes as needed. No configuration is required for all motors simultaneous PID control system.

Function code	Name	Data	Description
J450	Motor increase judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J18	This function code adjusts the motor adding conditions. If the frequency of the inverter-driven pump exceeds the setting of J450 and keeps it for the setting of J451, commercial power-driven motor adding conditions are met. The default is that if the frequency reaches the setting of J18 (PID upper limiter), the adding conditions are immediately met.
J451	Motor increase judgment (Duration time)	0.00 to 3600 s	
J452	Motor decrease judgment (Parallel Judgment F)	0 to 500 Hz 999: Depends on J19	This function code adjusts the motor subtracting conditions. If the frequency of the inverter-driven pump drops below the setting of J452 and keeps it for the setting of J453, commercial power-driven motor subtracting conditions are met. The default is that if the frequency reaches the setting of J19 (PID lower limiter), the subtracting conditions are immediately met.
J453	Motor decrease judgment (Duration time)	0.00 to 3600 s	
J461	Motor increase/decrease switching judgment non-responsive area width	0.1 to 50.0% 0.0: Disable	If the deviation between SV and PV values is less than the setting of J461, no increase/ decrease judgment is made.
J436	Motor regular switching time	0.1 to 720.0 h	If feedback signals are kept stabilized, commercial power-driven pumps are not added or subtracted so that a particular pump is driven for a long time. Specifying the time to this function code forcibly adds or subtracts pumps if no adding or subtracting occurs for the specified time.

Each function code is detailed separately.

J401	Pump Control Mode Selection E01 to E05 Terminals X1 to X5 (Function selection) E20, E21 Terminals Y1 to Y2 (Function selection) E27 Terminal 30A/B/C (Ry output) H13 Restart Mode after Momentary Power Failure (Restart time) J01 PID Control (Mode selection)

J401 selects the pump control mode.

- Data setting range: 0 to 54

Data for J401	Function	Description
0	Disable	Pump quantity control (switching motor) is not performed.
1	Enable (Inverter drive motor fixed system)	Perform cascade control in the inverter drive motor fixed system. Adding/subtracting pumps is judged with the PID processor output.
2	Enable (Inverter drive motor floating system)	Perform cascade control in the inverter drive motor floating system. Adding/subtracting pumps is judged with the PID processor output.
3	Enable (Inverter drive motor floating + commercial power-driven motor system)	Perform cascade control in the inverter drive motor floating + commercial power-driven system. Adding/subtracting pumps is judged with the PID processor output.
11	Enable (Inverter drive motor fixed system)	Perform cascade control in the inverter drive motor fixed system. Adding/subtracting pumps is judged with the output frequency.
12	Enable (Inverter drive motor floating system)	Perform cascade control in the inverter drive motor floating system. Adding/subtracting pumps is judged with the output frequency.
13	Enable (Inverter drive motor floating + commercial power-driven motor system)	Perform cascade control in the inverter drive motor floating + commercial power-driven system. Adding/subtracting pumps is judged with the output frequency.
52	Enable (Communications-linked inverter drive motor floating system)	Perform mutual operation control in the communications- linked inverter drive motor floating system.
54	Enable (Communications-linked all motors simultaneous PID control system)	Perform mutual operation control in the communications- linked all motors simultaneous PID control system.

Note
- The default setting cannot be modified during operation.
- When performing pump control, specify the pump control mode selection (J401), PID control 1 (mode selection) (J01).
- During mutual operation, if the slave unit generates an alarm (SLA: slave alarm), the master unit generates a "light alarm."

Functions for different J401 operating formats

Some functions are disabled, depending on the J401 operating format. The chart below indicates whether functions are enabled or disabled.

<table>
<tr><th rowspan="2">Function code</th><th colspan="5">J401:
Pump control operation mode selection</th></tr>
<tr><th>1, 11</th><th>2, 12</th><th>3, 13</th><th>52</th><th>54</th></tr>
<tr><td>J01 to J138</td><td colspan="5">Y</td></tr>
<tr><td>Communication master/slave selection (J402)</td><td colspan="3">N</td><td colspan="2">Y</td></tr>
<tr><td>Number of slave units (J403)</td><td colspan="3">N</td><td colspan="2">Y</td></tr>
<tr><td>Master input transmission selection (J404)</td><td colspan="3">N</td><td colspan="2">Y</td></tr>
<tr><td>Motors 1 to 4 drive selection (J411 to J414)</td><td colspan="3">Y</td><td colspan="2">N</td></tr>
<tr><td>Motor switching sequence (J425)</td><td colspan="4">Y</td><td>N</td></tr>
<tr><td>Stop of commercial power-driven motors (J430)</td><td colspan="3">Y</td><td colspan="2">N</td></tr>
<tr><td>Motor fixed-period switch (J435 to J437)</td><td colspan="4">Y</td><td>N</td></tr>
<tr><td>Motor increase judgment (J450, J451)</td><td colspan="4">Y</td><td>N</td></tr>
<tr><td>Motor decrease judgment (J452, J453)</td><td colspan="4">Y</td><td>N</td></tr>
<tr><td>Motor switching time contact wait period (J454)</td><td>N</td><td colspan="2">Y</td><td colspan="2">N</td></tr>
<tr><td>Motor increase switching time (deceleration time) (J455)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor increase switching level (J456)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor increase PID control start frequency (J457)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor decrease switching time (acceleration time) (J458)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor decrease switching level (J459)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor decrease PID control start frequency (J460)</td><td>Y</td><td>N</td><td>Y</td><td colspan="2">N</td></tr>
<tr><td>Motor increase/decrease judgment dead zone (J461)</td><td colspan="4">Y</td><td>N</td></tr>
<tr><td>Abnormal unit judgment time (J462)</td><td colspan="3">N</td><td>Y</td><td>N</td></tr>
<tr><td>Auxiliary motor (J465 to J467)</td><td colspan="5">Y</td></tr>
<tr><td>Auxiliary motor (J468, J469)</td><td>N</td><td colspan="2">Y</td><td>N</td><td>N</td></tr>
</table>

Y: Enabled, N: Disabled

J402	Communication Master/Slave Selection

J402 defines inverters as a master or slave in mutual operation. This function code only needs to be set during mutual operation. Set the inverter used as the master unit to “0,” and the inverter used as the slave unit to “1.”

- Data setting range: 0, 1

  0: Master inverter

  1: Slave inverter

J403	Number of slaves

J403 specifies the number of slave inverters in mutual operation. This function code only needs to be set during mutual operation. (This is required only for master, not for slave.)

- Data setting range: 1 to 3

J404	Master Input Permeation Selection

During mutual operation, the input terminals for making these settings on the slave units (X1 to X5, FWD, REV), the master unit terminal input information is reflected via the master unit operation command (S06). As a result, terminal input on the master unit allows simultaneous terminal input on the slave unit. As terminal input on the master unit is also input on the slave unit, the same settings are applied to the master and slave for terminals X1 to X5, FWD, REV (function selection) (E01 to E05, E98, E99).

- Data setting range: 0 to 007F (hexadecimal display)

7	6	5	4	3	2	1	0
0	X5	X4	X3	X2	X1	REV	FWD

(All bits are 1, and master unit input information reflection is enabled.)

(Example)

If master units X1, X2 and X4 are reflected in slave unit 1 and
master units X4 and X5 are reflected in slave unit 2

The setting for slave unit 1 is 0010 1100 (binary) = 2C (hexadecimal), so J404 = 002C, and the setting for slave unit 2 is 0110 0000 (binary) = 60 (hexadecimal), to J404 = 0060.

Note

- When ***FWD*** and ***REV*** are set on J404, do not set function codes: E98 and E99 for terminals ***FWD*** and ***REV*** for both the master and slave to ***FWD***, ***REV***, ***FWD2*** and ***REV2***. While number of terminals in operation for the master unit is (F02 = 1) and the run command is entered, the run command remains entered on the slave unit, so the slave unit will not operate as commanded by the master unit pump control commands.

J411 to J414	Motor 1 Mode Selection to Motor 4 Mode Selection

For motor mode selection, select the motor operation subject to pump control. When specifying "2" with forced drive (forced commercial power drive) ON, the pump commercial power driving signal can be output regardless of run command. This function code only needs to be set during cascade operation.

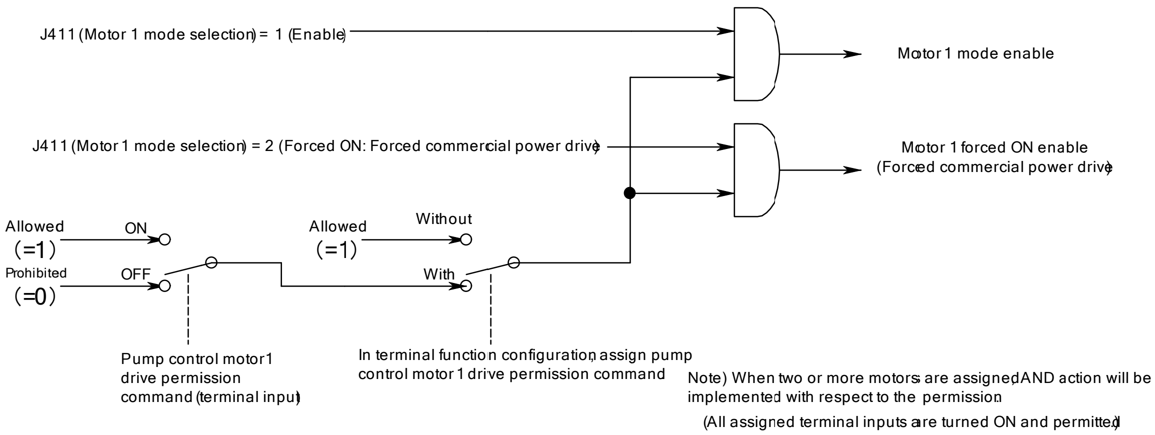
Data for J411 to J414	Function
0	Disable (off at all times)
1	Enable
2	Forced drive ON (forced commercial power drive)

Note
- Forced drive ON (forced commercial power drive) is a function to turn on the relay output forcibly to connect the motor to the commercial power supply. Thus, even if the run command is off, turn on the relay output to drive the motor by commercial power.

■ Pump control drive motor permission commands 1 to 4 of pump control motor ("MEN1" to "MEN4")

As mode selection of pump control motors, there are pump control drive motor permission commands 1 to 8 ("MEN1" to "MEN8") by terminal input. A combination of the pump control drive motor permission command and the motor mode selection enables motor degradation. Degradation is a state in which the system is under operation continually with only the corresponding motor stopped.

< Action block diagram of pump control drive motor permission command >



■ PID control action

In the inverter-driven motor floating system (J401 = 2), the following state (1) or (2) is developed depending on the setting of motor mode selection (J411 to J414).

(1) Driving of all motors are not permitted

When driving of all motors is not permitted (pump control drive motor permission commands 1 to 4 = OFF ("MEN1" to "MEN4") or the motors are set to disable with motor mode selection (J411 to J414), PID control will not start because no motors can control the pump.

(2) All motors are driven by commercial power forcibly

On changing all motors from forced commercial power drive state to enable state ("2 ⇒ 1" for J411 to J414) with the run command turned ON, motor increase/decrease judgment will be performed immediately based on the PID control.

APPENDICES

J425	Motor Switching Procedure

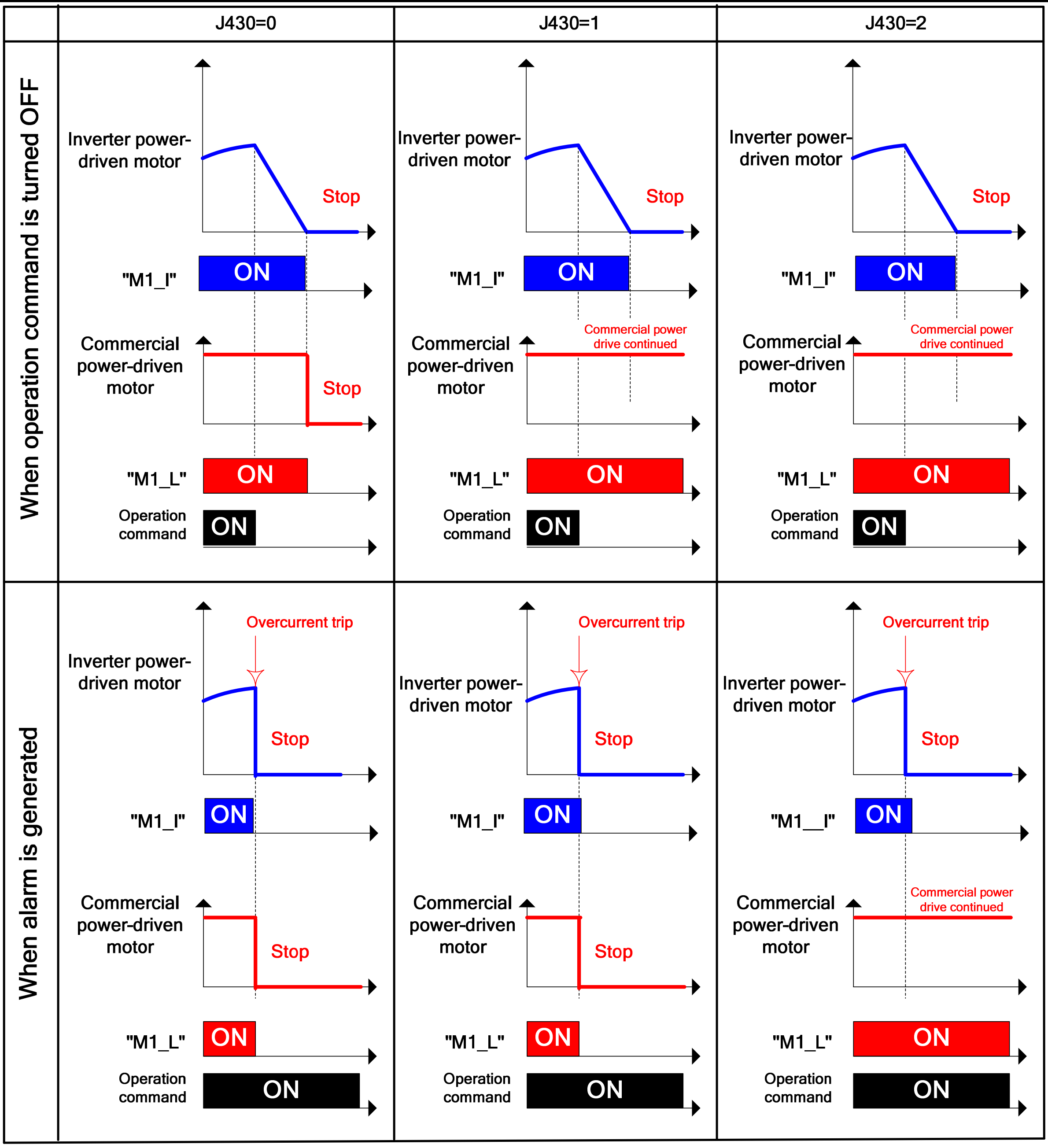
In pump control, two or more motors are operated while switching them. When increasing or decreasing the number of operating motors, specify the motors to be driven and the motors to be stopped in the motor switching procedure (J425). This allows cumulative run time for each motor to be equalized.

Data for J425	Function
0	Fixing procedure <When the number of motors increases> The number increases successively in order of increasing the motor number. (motor 1 ⇒ motor 2, motor 3...) <When the number of motors decreases> The number decreases successively in order of decreasing the motor number. (motor 3 ⇒ motor 2, motor 1...)
1	Equal operating time (Cumulative run time of each motor is equalized.) <When the number of motors increases> Of the motors that are not running, turn on the motor having the shortest operating time. <When the number of motors decreases> Of the motors that are running, turn off the motor having the longest operating time.
2	Fixing procedure (Switching the motor at slow flowrate stop) Mode selection is the same when J425 is configured to 0. However, the drive motor switches to the subsequent motor not only when motors are increased, but also during slow flowrate stop.
3	Equal operating time (Switching the motor at slow flowrate stop) The operation is the same as when J425 =1 is selected. However, the drive motor switches to the motor with least operating time not only when motors are increased, but also during slow flowrate stop.

J430	Stop of Commercial Power-driven Motors	J411 to J418 (Motor mode selection)

J430 specifies whether to stop commercial power-driven motors when an inverter run command is turned OFF or the inverter stops due to an alarm under cascade control.

Data for J430	Type of stop	Description	
		Inverter-driven motor	Commercial power-driven motor
0	When run command is turned off	The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M3_I") are turned off in concurrence with inverter output stop.	Motor commercial power driving signals ("M1_L" to "M4_L") are turned off at a time as soon as the inverter stops the output.
	When alarm is generated	Output to the motor is stopped and motor inverter drive signals ("M1_I" to "M3_I") are turned off.	Motor commercial power driving signals ("M1_L" to "M4_L") are turned off at a time as soon as the inverter stops the output.
1	When run command is turned off	The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M3_I") are turned off in concurrence with inverter output stop.	Operation is continued.
	When alarm is generated	Output to the motor is stopped and motor inverter drive signals ("M1_I" to "M3_I") are turned off.	Motor commercial power driving signals ("M1_L" to "M4_L") are turned off at a time as soon as the inverter stops the output.
2	When run command is turned off	The motor will decelerate and stop. Inverter drive motor signals ("M1_I" to "M3_I") are turned off in concurrence with inverter output stop.	Operation is continued.
	When alarm is generated	Output to the motor is stopped and inverter drive motor signals ("M1_I" to "M3_I") are turned off.	Operation is continued.



Commercial power-driven motors (including forced on motor) can be stopped in the following methods.

(1) When turning off commercial power-driven motors individually

- Set motor mode selection to disable (J411 to J418 = 0).
- Turn off the pump control motor drive permission command ("MEN1" to "MEN4").

(2) When turning off commercial power-driven motors at a time

- Set pump control to disable (J401 = 0 or J01 = 0).
- Perform BX input.

The above-mentioned function codes (J401, J01) cannot be changed during operation.

J435
J436
J437

Motor Regular Switching Mode Selection
Motor Regular Switching Time
Motor Regular Switching Signal Output Time

J401 (Pump Control Mode Selection)
J411 to J414 (Motor Mode Selection)
J425 (Motor Operating Time Procedure)
J454 (Contactor Restart Time during Motor Switching)
J458 (Motor Decrease Switching Time (Acceleration time))
J480 to J484 (Operating Time Cumulative Run Time)

When the number of motors under operation remains unchanged for a period of the motor regular switching time (J436), switch one motor under operation to another motor under suspension. This allows to equalize the operating time of the pump connected to each motor.

■ Motor regular switching mode selection (J435)

When the inverter drive motor floating system (J401 = 2) or inverter drive motor floating + commercial power-driven motor system (J401 = 3), communication link inverter floating method (J401 = 52) is specified in pump control mode selection, if the number of motors under operation remains unchanged switching, specifies the motor.

When the inverter drive motor fixed system (J401 = 1) is specified in pump control mode selection, commercial drive motors will be subject to switching. (Same as when J435 is configured to 2.)

Data for J435	Description
1	Inverter-driven motors are subject to switching during cascade operation. During mutual operation, PID controlled units are subject to switching.
2	During cascade operation, commercial drive motors are subject to switching. During mutual operation, units in highest frequency operation are subject to switching.
3	During cascade operation, all motors (inverter-driven motors /commercial power-driven motors) are subject to switching. During mutual operation, all motors (PID controlled units/units in highest frequency operation) are subject to switching.

■ Motor regular switching time (J436)

The time for judging the regular switching operation of the motor is specified on a 0.1-hour basis. If the period specified for regular motor switching (J436) elapses without any change in the number of motors in operation, regular motor switching is performed.

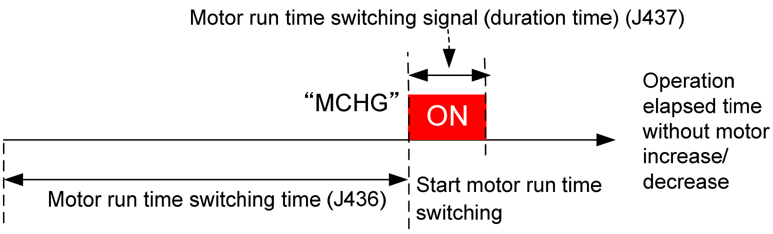
- Data setting range: 0.0, 0.1 to 720.0 h, 999

Data for J436	Description
0.0	Disabled
0.1 to 720.0 h	Enable: Switching time
999	Enable: Switching time fixed to three minutes

■ Motor regular switching signal output time (J437)

Motor regular switching signal output time (duration time) is specified. After a lapse of motor regular switching time (J436), switching forecast signal "MCHG" is output and switching operation is implemented.

- Data setting range: 0.00 to 600.00 second



Furthermore, the motors in which forced on (forced commercial power drive) (J411 to J414 = 2) is selected in motor mode selection shall not be subject to motor operating time switching.

■ **Motors subject to motor operating time switching**

After the number of motors remains unchanged for motor operating time switching time (J436), switching operation will be implemented on the following motors.

<table>
<tr><th>Motor regular switching time (J436)</th><th colspan="3">Description</th></tr>
<tr><td>0.0</td><td colspan="3">Motor regular switching operation is not implemented.</td></tr>
<tr><td rowspan="10">0.1 to 720.0 h</td><td colspan="3">After the number of motors under operation remains unchanged for a period specified in the motor regular switching time (J436), motor regular switching operation will be implemented.
The motor under operation with the maximum cumulative run time is stopped and then the motor under suspension with the minimum cumulative run time is driven.
However, when the motor subject to stop has a shorter (or the same) cumulative run time than the motor subject to operation, no switching will be implemented.
When there are two or more motors in which the maximum cumulative run time is the same with the minimum cumulative run time, the motor with smaller motor number will be subject to switching.</td></tr>
<tr><td>Pump control mode selection (J401)</td><td>Motor regular switching mode selection (J435)</td><td>Motor subject to switching during operation</td></tr>
<tr><td>1: Fixed system</td><td>-</td><td>Commercial drive motor</td></tr>
<tr><td rowspan="3">2: Floating system
3: Floating + commercial power-driven motor system</td><td>1: Subject to commercial power-driven pump</td><td>Commercial drive motor</td></tr>
<tr><td>2: Subject to inverter-driven pump</td><td>Inverter drive motor</td></tr>
<tr><td>3: Subject to all pumps</td><td>Inverter drive motor
Commercial drive motor</td></tr>
<tr><td rowspan="3">52: Communication link inverter floating method</td><td>1. Subject to commercial drive pumps</td><td>Unit in highest-frequency operation</td></tr>
<tr><td>2. Subject to inverter drive pumps</td><td>PID-controlled unit</td></tr>
<tr><td>3. Subject to all pumps</td><td>PID-controlled unit
Unit in highest-frequency operation</td></tr>
<tr><td>54: Method in which all communication links simultaneously controlled by PID</td><td colspan="2">Regular motor switching not performed.</td></tr>
<tr><td>999</td><td colspan="3">Switching operation is implemented as in the case with motor regular time switching function operation (J436 = 0.1 to 720.0 h) However, operating motor switching operation will be implemented after the number of motors under operation remains unchanged for three minutes. This setting is a function used for operation check upon start-up of the inverter.</td></tr>
</table>

■ Cancel regular switching operation

Operating time is counted during which there are no changes in the number of motors. When this count reaches the specified motor operation switching time (J436), regular switching occurs. Clearing this count by changing the regular switching time clearing command “MCLR” from ON to OFF cancels this regular switching. While the switching warning signal “MCHG” is being output, the regular switching time clearing command “MCLR” can be turned from ON to OFF to cancel regular switching.

Note

- When the motor regular switching time clearing command "MCLR" remains tuned on continually, the time in which the number of operating motors remains unchanged is always cleared, which prevents motor regular switching from running.

■ Regular switching via input terminal

Even if there are no changes in the number of motors and the specified motor operation switching time (J436) is not reached, changing the pump control switching command “PCHG” from ON to OFF allows regular switching to be performed. In this case, the count of the time during which the number of motors in operation remains unchanged is cleared.

J450	**Motor Increase Judgment**	**(Parallel Judgment F)**	
J451		**(Duration time)**	
J452	**Motor Decrease Judgment**	**(Parallel Judgment F)**	
J453		**(Duration time)**	

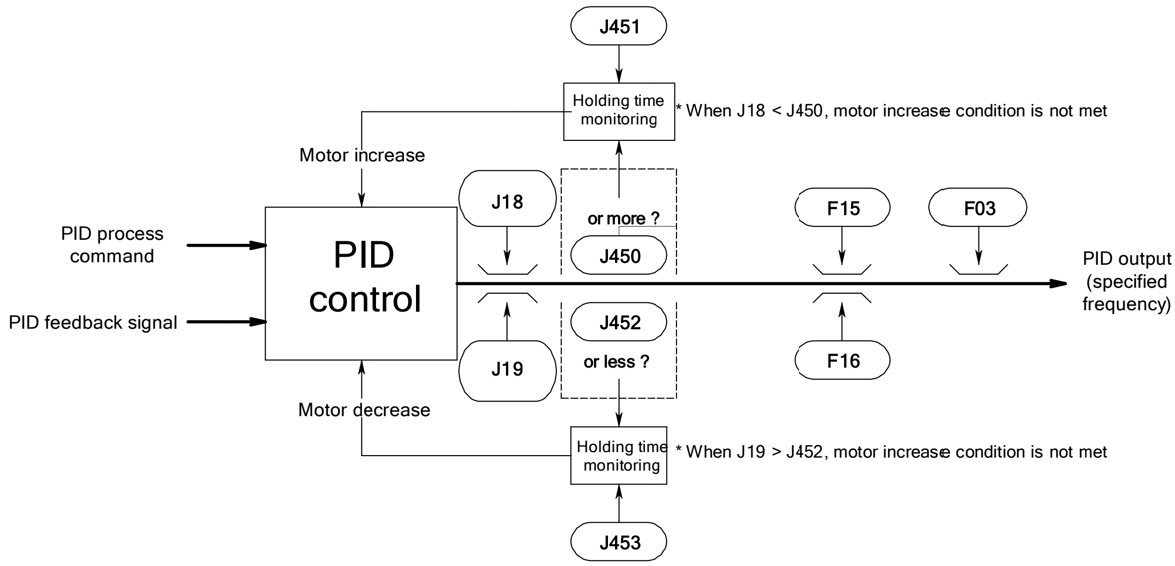
During cascade operation (J401 = 1, 2, 3) or during communication link inverter floating method (J401 = 52) in mutual operation, changes in the number of motors are implemented when the motor increase/decrease judgment (duration time) (J451/J453) has elapsed over the inverter operation frequency (PID output (MV)) higher or lower the motor increase/decrease judgment (Parallel Judgment F) (J450/J452).

When J401 = 11, 12 or 13, the judgment uses the actual output frequency instead of MV.

Note

- When the deviation between the PID command value (SV value) and the PID feedback value is within the non-responsive area, switching operations are not performed based on the motor change judgment.
- When the deviation between the PID command value (SV value) and the PID feedback value is negative, the number of motors is not increased based on the motor increase judgment. When the deviation between the PID command value (SV value) and the PID feedback value is positive, the number of motors is not decreased based on the motor decrease judgment.

< Action block diagram of upper and lower limiters >



■ Motor increase judgment (Parallel Judgment F) (J450)

Motor increase Parallel Judgment F is specified.

Data for J450	Description
0 to 500 Hz	Motor increase Parallel Judgment F
999	Depends on the PID control (PID output limiter upper limit) (J18)

■ Motor increase judgment (Duration time) (J451)

The duration time of motor increase Parallel Judgment F is specified.

- Data setting range: 0.00 to 3600 s

■ Motor decrease judgment (Parallel Judgment F) (J452)

Motor decrease Parallel Judgment F is specified.

Data for J452	Description
0 to 500 Hz	Motor decrease Parallel Judgment F
999	Depends on the PID control (PID output limiter upper limit) (J19)

■ **Motor decrease judgment (Duration time) (J453)**

The duration time of motor decrease Parallel Judgment F is specified.

- Data setting range: 0.00 to 3600.00 s

J454	Contactor Restart Time when Switching the Motor

■ **Contactor restart time during motor switching (J454)**

In the inverter drive motor floating system (J401 = 2, 12) and inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the motors are operated by delaying starting inverter-driven motors or commercial power-driven motors when the number of motors is increased or regular switching is implemented. The delay time (relay or contactor activation delay time) is specified.

- Data setting range: 0.01 to 2.00 s

J455 J456 J457	Motor Increase Switching Time (Deceleration time) Motor Increase Switching Level Motor Increase PID Control Start Frequency

■ **Motor increase switching time (Deceleration time) (J455)**

When the number of motors increases in the inverter drive motor fixed system (J401 = 1, 11) or the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the inverter-driven motor is slowed down during the motor increase switching time (deceleration time) (J455), and after the commercial power-driven motor is driven the output frequency reaches the motor increase PID start frequency (J457), and deceleration stops. At this point, PID control recommences, and the inverter-driven motor operates with the PID control MV frequency.

Data for J455	Description
0.01 to 3600.00 s	The deceleration time of the inverter-driven motor before commercial power-driven motor is driven with motor increase judgment.
0.00	Depend on F08 (Deceleration time 1). When RT1 is ON, the time depends on E11 (Deceleration time 2)

■ **Motor increase switching level (J456)**

When the number of motors increases in the inverter drive motor fixed system (J40 = 1, 11) or the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), if the output frequency of the inverter driven motor is below the motor increase switching level (J456), the contactors for the increased units is turned ON.

- Data setting range: 0 to 100%

  Switching frequency [Hz] = (J456/100%) × (J18 - J19) + J19

Note: J18: PID control 1 (PID output limiter upper limit), J19: PID control 1 (PID output limiter lower limit)

■ **Motor increase PID control start frequency (J457)**

When the number of motors increases in the inverter drive motor fixed system (J401 = 1, 11) or the inverter drive motor floating + commercial power-driven motor system (J401 = 3, 13), the frequency is set to create PID control.

Data for J457	Description
0 to 500 Hz	PID control start frequency after driving the commercial power-driven motor with motor increase judgment
999	The motor decrease judgment (Parallel Judgment F) (J452) depends on the motor increase PID control start frequency.

J458 **J459** **J460**	**Motor Decrease Switching Time (Acceleration time)** **Motor Decrease Switching Level** **Motor Decrease PID Control Start Frequency**

■ Motor decrease switching time (Acceleration time) (J458)

During motor decrease during cascade operation, the inverter-driven motor is accelerated at motor deceleration switching time (acceleration time) (J458). After the commercial driven motor is interrupted, acceleration stops when output frequency reaches the motor decrease PID start frequency (J460). At this point, PID control recommences, and the inverter-driven motor operates with the PID control MV frequency.

Data for J458	Description
0.01 to 3600.00 s	The acceleration time of inverter-driven motor before stopping the commercial power-driven motor with motor decrease judgment.
0.00	F07: Depends on acceleration time 1 (When RT1 is turned ON, E10: acceleration time 2)

■ Motor decrease switching level (J459)

When motors are decreased ruing cascade operation, if the output frequency of the inverter-driven motor is above that of the motor decrease switching level (J459), the contacts for the decreased units are turned OFF.

Data for J459	Description
0 to 100%	The inverter-driven motor frequency level when the commercial power-driven motor is stopped with motor decrease judgment.
999	The motor increase switching level (J456) depends on the motor decrease switching level (J459).

Switching frequency [Hz] = (J459/100%) × (J19) - J18) + J19

■ Motor decrease PID control start frequency (J460)

When motors are decreased ruing cascade operation, the PID control start frequency is specified.

Data for J460	Description
0 to 500 Hz	The PID control start frequency after the commercial power-driven motor is stopped with motor decrease judgment.
999	Depends on the motor increase judgment (Parallel Judgment F) (J450)

J461	**Motor Increase/Decrease Switching Judgment Non-responsive Area Width**

In the PID control, no motor increase/decrease judgment will be performed as long as the deviation between the PID command value (SV value) and the PID feedback value is less than the specified value.

Data for J461	Description
0.1 to 50.0%	Deviation between PID command value (SV value) and PID feedback value, assuming 100% of PID feedback full scale.
0.0	Disable (Always perform motor increase/decrease judgment)

J462	Failure Inverter Judgment Time

In the communications-linked inverter drive motor floating system (J401 = 52), if PID control comes to be at the hold state in the inverter running under PID control due to the limiter (e.g., current limit), then it is judged whether to exclude the PID control inverter.

If any other ready-to-run inverter exists in the system and the failure inverter judgment time (J462) has elapsed, the current PID control inverter will be switched to the other one.

This switching does not involve increase/decrease of inverters or regular switching even if their conditions are met.

If J462 = OFF, no switching occurs. During auto search for idling motor speed, no PID control inverter will be switched even if PID control comes to be at the hold state.

- Data setting range: OFF, 0.5 to 600.0 s

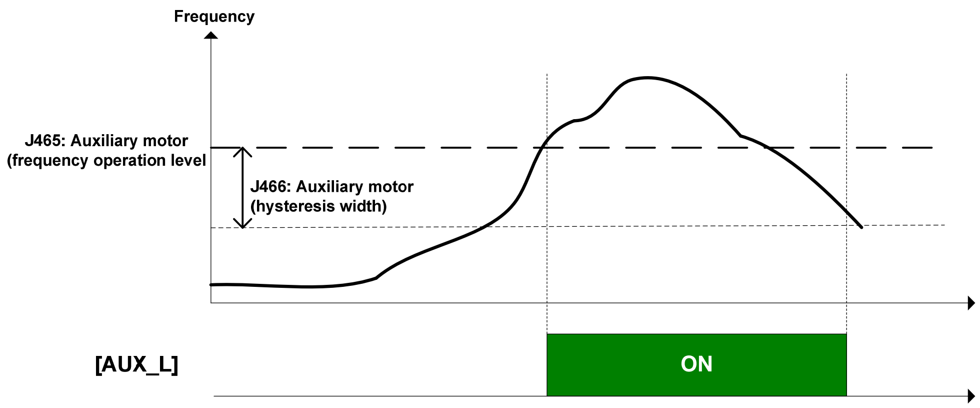
J463	PID control start frequency

After inputting a run command, the motor accelerates without performing PID control until the frequency set in J463 is reached. PID control is started after the value set in J463 is reached.

Data for J463	Description
0	Disable
1 to 500 Hz	Start frequency
999	Depends on J19

J465 J466	Auxiliary Motor (Frequency operation level) (Hysteresis width)

When all the set motors are under operation, the output frequency (for cascade operation: inverter-driven motor output frequency; for mutual operation: output frequency of units during PID control) reaches the auxiliary motor (frequency operation level) (J465), the auxiliary motor drive signal "AUX_L" is turned on and output. When the frequency is lowered below the auxiliary motor (frequency operation level) by more than the auxiliary motor (hysteresis width) (J466), the auxiliary motor drive signal "AUX_L" is turned OFF. However, when the configuration is set to disable (J01 = 0) in PID mode selection, or the configuration is set to disable (J401 = 0) in the pump control mode selection, the auxiliary motor drive signal "AUX_L" is turned OFF at all time.



■ **Auxiliary motor (frequency operation level) (J465)**

The frequency for determining the auxiliary motor drive is specified. When the frequency of the inverter-driven motor exceeds this value, the auxiliary motor is driven.

When the configuration is set to 0.0, the frequency at the frequency detection operation level (E31) is specified.

- Data setting range: OFF, 0.1 to 500.0 Hz

■ Auxiliary motor (hysteresis width) (J466)

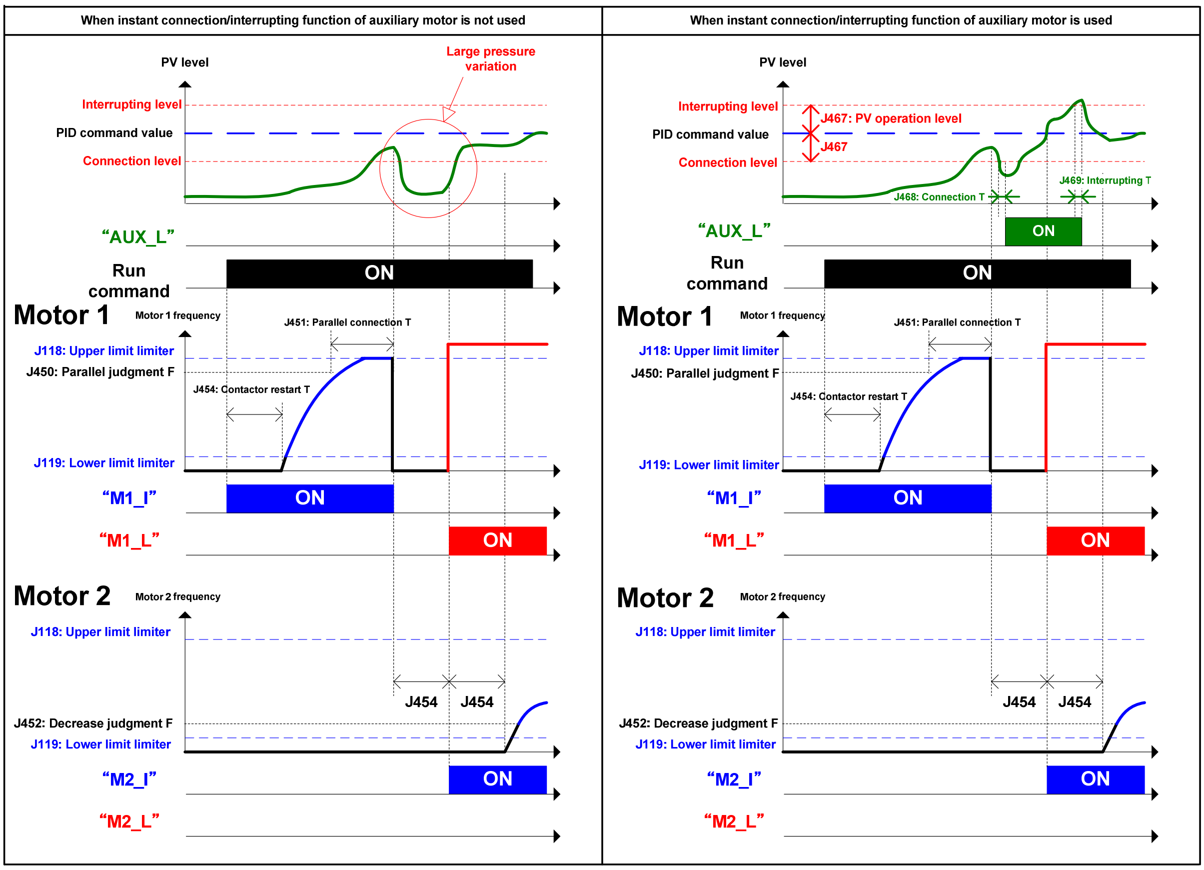
The frequency width for determining the auxiliary motor stop is specified. When the frequency is lowered below the auxiliary motor (frequency operation level) (J465) by more than this value, the auxiliary motor is stopped.

When the configuration is set to 0.0, the frequency detection hysteresis width (E32) is specified.

- Data setting range: 0.0 to 500.0 Hz

J467 **J468** **J469**	**Auxiliary Motor (PV operation level)** **(Connection timer)** **(Interrupting timer)**

For the inverter drive motor floating system (J401 = 2, 12) in the pump control mode selection, the inverter-driven motor is allowed to free-run before increasing the number of motors. The auxiliary motor is driven to control the pressure variation during a time period until the motor is commercial power-driven (contactor restart time during motor switching (J454)). Furthermore, when the number of motors is decreased, the auxiliary motor is not driven. The timing to drive and stop the auxiliary motor is determined by the connection level and the interrupting level. This judgment is implemented continually for a given period of time after allowing the inverter-driven motor to free-run. This period of time is ten times the larger value of the contactor restart time during motor switching (J454) or the auxiliary motor (connection timer) (J468).



J480 to J484	Motor Cumulative Run Time (Motor 0 to 4)

In the pump control, each motor cumulative run time (J480 to J484) is cumulated. The motor cumulative run time can be used for maintenance plan.

The motor cumulative run time is counted when the gate is turned ON and the dew condensation prevention function is not operated.

This is counted even during commercial operation due to the output signal, “M☐_L” from the inverter.

The cumulative run time is cumulated in the range from 0 to 65,535 hours and reset to zero as it exceeds 65,535 hours, and then the time is cumulated continually. For the display of cumulative run time, 1 hour is displayed as 1 hours in the keypad.

The cumulative run time can be specified to any value from the keypad. The initial time of replacing machine parts or inverter can be specified to any value.

The chart below indicates cumulative operating times and corresponding motor numbers for each pump control mode selection (J401) setting.

Function code		Pump control mode selection (J401)		
		1, 11	2, 3, 12, 13	52, 54
J480	Cumulative operating time (Motor 0)	Inverter drive motor	-	Master unit
J481	Cumulative operating time (Motor 1)	M1_L motor	M1_I and M1_L motor	Slave unit 1
J482	Cumulative operating time (Motor 2)	M2_L motor	M2_I and M2_L motor	Slave unit 2
J483	Cumulative operating time (Motor 3)	M3_L motor	M3_I and M3_L motor	Slave unit 3
J484	Cumulative operating time (Motor 4)	M4_L motor	-	-

J490 **J492** **J493**	**Y terminal ON Maximum Cumulation Count (Y1 Y2)** **(30A/B/C)** **(Y6RY to Y12RY)**

Y terminal output and relay output option ON/OFF cumulation count can be monitored. This serves as a guide for the operating life of each relay. The cumulation count stops when 1 million is reached. Furthermore, the relay time can be reset by the user by clearing the relay ON cumulation count and using the keypad. This is operational only when cascade operation is enabled (J401 = 1, 2, 3, 11, 12, 13). The count is stored in units of 16 when the power is off, so the maximum deviation is 16 each time the power is turned off.

Note
- The relay ON maximum cumulation count (J490 to J493) is resettable by keypad operation.

■ **Y terminal ON maximum cumulation count (Y1 Y2) (J490)**

The larger of the cumulation counts of Y terminal outputs (E20 and E21) ON of inverter main body is displayed. The display of "1.000" indicates 1000 times.

■ **Relay ON cumulation count (30A/B/C) (J492)**

The cumulation count of 30A/B/C relay outputs (E27) ON of inverter main body is displayed. The display of "1.000" indicates 1000 times.

■ **Relay ON maximum cumulation count (Y6RY to Y12RY) (J493)**

The larger of the relay ON cumulation counts on the relay output option (OPC-F2-RY) is displayed. The display of "1.000" indicates 1000 times.

Output terminals	Lifetime of contacts	Capacity of contacts
Transistor outputs (Y1, Y2)	Depends upon the specifications of the relay to be connected.	-
Relay outputs (30A/B/C)	200000 times (when turned ON/OFF at one-second intervals)	250 VAC 0.3A 48 VDC 0.5A
Relay output option OPC-F2-RY	200000 times (when turned ON/OFF at one-second intervals)	250 VAC 0.3A 48 VDC 0.5A

J501	External PID Control 1 (Mode selection)

Apart from PID control specified by J01, the inverter has three channels of PID control to control external devices such as dampers and valves so that no external PID controllers are required.

Under PID control, the inverter detects the state of a control target object with a sensor or the similar device and compares it with the commanded value (e.g., temperature control command). If there is any deviation between them, PID control operates to minimize it. That is, it is a closed loop feedback system that matches controlled variable (feedback amount). PID control expands the application area of the inverter to process control (e.g., flow control, pressure control, and temperature control).

Data for J501	Function
0	Disable
1	Enable process control (Normal operation)
2	Enable process control (Inverse operation)
11	Enable process control, interlocking with inverter running (Normal operation) When the output signal ***RUN*** ("Inverter running") is ON, the process control operates.
12	Enable process control, interlocking with inverter running (Inverse operation) When the output signal ***RUN*** ("Inverter running") is ON, the process control operates.
21	Enable process control by external digital signal (Normal operation) Turning ON the terminal command ***EPID1-ON*** ("External PID control 1 ON command") operates the process control.
22	Enable process control by external digital signal (Inverse operation) Turning ON the terminal command ***EPID1-ON*** ("External PID control 1 ON command") operates the process control.
31	Enable process control by external digital signal, interlocking with inverter running (Normal operation) Turning ON the terminal command ***EPID1-ON*** ("External PID control 1 ON command") when the output signal ***RUN*** ("Inverter running") is ON, the process control operates.
32	Enable process control by external digital signal, interlocking with inverter running (Inverse operation) Turning ON the terminal command ***EPID1-ON*** ("External PID control 1 ON command") when the output signal ***RUN*** ("Inverter running") is ON, the process control operates.

To use "External PID control 1 ON command", you need to assign the terminal command ***EPID1-ON*** to any of the general-purpose digital input terminals, respectively. (📖 E01 to E05)

External PID control: "External PID control 1 ON command" ***EPID1-ON*** (data = 201)

Note

- If data 11, 12, 31, 32 are set, during inverter deceleration the PID control is put on hold (I item hold). PID control is put on hold only during decelerating to stop when the run command is OFF. PID control is not put on hold when decelerating to stop if the set frequency is changed.

APPENDICES

J502	External PID Control 1 (Remote command selection)

J502 selects the source that specifies external PID control command 1, respectively. The table below lists the external PID control command sources.

Data for J502	External PID control command sources
0	Keypad Specify the external PID command by using the ∧ / ∨ keys on the keypad.
3	Terminal command ***UP/DOWN*** With the ***UP*** and ***DOWN*** commands, 0 to 100% of an external PID control command value can be set as a value converted into physical quantity in terms of the display unit and scale.
4	Command via communications link For J502, use function code S30. The transmission data of 20000 (decimal) is equal to 100% of the PID command.
51	Analog input Voltage input to terminal [12]: 0 to ±10 VDC, 100% PID command/ ±10 VDC Current input to terminal [C1] (C1 function): 4 to 20 mA DC, 100% PID command/ 20 mA DC, 0 to 20 mA DC, 100% PID command/ 20 mA DC Voltage input to the terminal [C1](V2function): 0 to 10 VDC, 100% PID command/ 10 VDC)

(1) External PID command with the ∧ / ∨ keys on the keypad (J502, data = 0 (factory default))

With the ∧ / ∨ keys on the keypad, 0 to 100% of an external PID control command value can be set as a value converted into easy-to-understand, physical quantity in terms of the display unit and scale.

For scale setting for terminals [12], [C1](C1 function) or [C1](V2 function), refer to function codes C59 and C60, C65 and C66, or C71 and C72, respectively.

(2) External PID command with ***UP/DOWN*** control (J502, data = 3)

When the UP/DOWN control is selected as an external PID command, turning the terminal command UP or DOWN ON causes the external PID command to change between the minimum scale and maximum scale.

The PID command can be specified in mnemonic physical quantities with the display unit (J505) and scale (J506/J507).

To select the *UP/DOWN* control as an external PID command, the ***UP*** and ***DOWN*** should be assigned to the digital input terminals [X1] to [X5]. (E01 to E05, data = 17, 18)

UP	***DOWN***	Function
Data = 17	Data = 18	
OFF	OFF	Retain the current external PID command value.
ON	OFF	Increase external PID command value at a rate between 0.1%/0.1 s and 1%/0.1 s.
OFF	ON	Decrease external PID command value at a rate between 0.1%/0.1 s and 1%/0.1 s.
ON	ON	Retain the current external PID command value.

Note Command settings via the UP/DOWN control are common to PID control 1(J02).

(3) External PID command via communications link (J502, data = 4)

Use function code S30 that specifies the communications function code. The transmission data of 20000 (decimal) is equal to 100% of the PID command.

For details of the communications format, refer to the RS-485 Communication User's Manual.

(4) External PID command by analog inputs (J502, data = 51)

When any analog input (voltage input to terminals [12] and [V2], or current input to terminal [C1]) for an external PID command is used, it is possible to arbitrary specify the PID command by multiplying the gain and adding the bias. The polarity can be selected and the filter time constant and offset can be adjusted. In addition to J502, J602 and J652 settings, it is necessary to select external PID command 1, 2 or 3 for analog input (specified by any of E61 to E63, function code data = 3). For details, refer to the descriptions of E61 to E63.

Adjustable elements of PID command

Input terminal	Input range	Bias		Gain		Polarity	Filter time constant	Offset	Input range
		Bias	Base point	Gain	Base point				
[12]	0 to +10 V, -10 to +10 V	C55	C56	C32	C34	C35	C33	C31	-
[C1](C1)	4 to 20 mA, 0 to 20 mA	C61	C62	C37	C39	-	C38	C36	C40
[C1](V2)	0 to +10 V	C67	C68	C42	C44	C45	C43	C41	-

■ **Offset (C31, C36, C41)**

C31, C36 or C41 configures an offset for an analog voltage/current input. The offset also applies to signals sent from the external equipment.

■ **Filter time constant (C33, C38, C43)**

C33, C38, and C43 provide the filter time constants for the voltage and current of the analog input. Choose appropriate values for the time constants considering the response speed of the machinery system, as large time constants slow down the response. If the input voltage fluctuates because of noise, specify large time constants.

■ **Polarity (C35, C45)**

C35 and C45 specify the input range for analog input voltage.

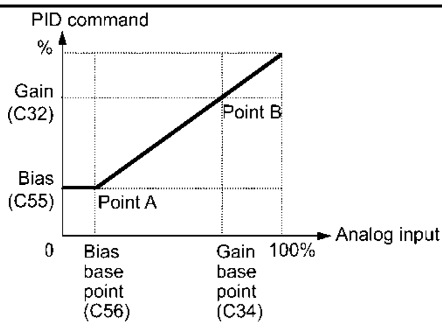
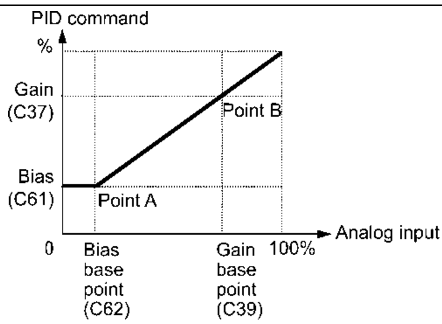
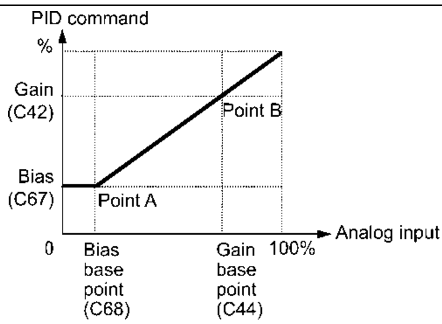
Data for C35/C45	Terminal input specifications
0	-10 to +10V With [C1] (V2 function), 0 to +10 V is converted to -100% to +100% based on the minus bias setting.
1	0 to +10V (negative value of voltage is regarded as 0 V)

■ **Terminal [C1] input range selection (C40)**

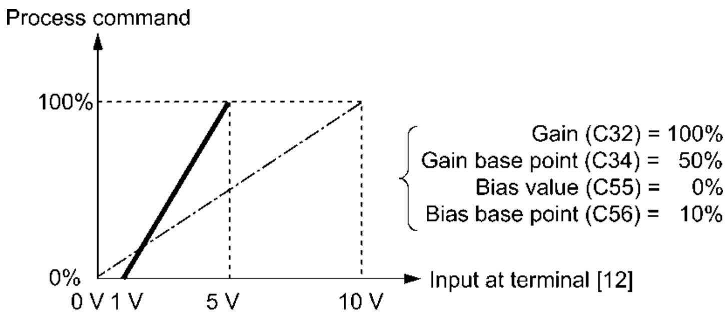
C40 specifies the input range for terminal [C1] (analog input current).

Data for C40	Terminal input range
0	4 to 20 mA (factory default)
1	0 to 20 mA

■ **Gain and bias**

Terminal	Action
[12]	
[C1](C1 function)	
[C1](V2 function)	

(Example) Mapping the range of 1 through 5 V at terminal [12] to 0 through 100%



Selecting Feedback Terminals

For feedback control, determine the connection terminal according to the type of the sensor output.

- If the sensor is a current output type, use the current input terminal [C1](C1 function) of the inverter.
- If the sensor is a voltage output type, use the voltage input terminal [12] of the inverter, or switch over the terminal [C1](V2 function) to the voltage input terminal and use it.

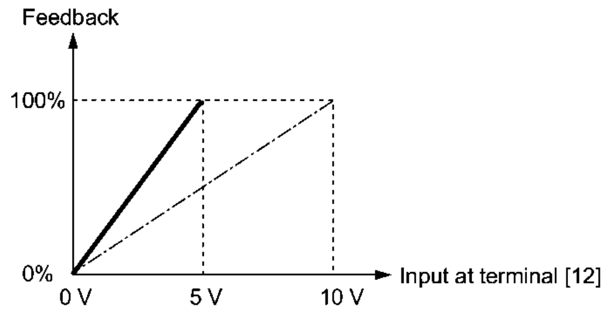
📖 For details, refer to the descriptions of E61 through E63.

Application example: Process control (for air conditioners, fans and pumps)

The operating range for PID process control is internally controlled as 0% through 100%. For the given feedback input, determine the operating range to be controlled by means of gain adjustment.

(Example) When the output level of the external sensor is within the range of 1 to 5 V:

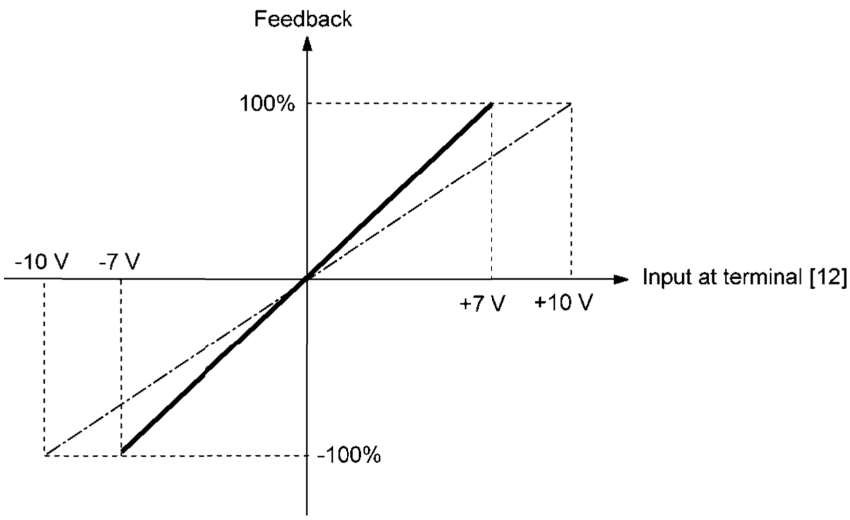
- Use terminal [12] designed for voltage input.
- Set the gain (C32 for analog input adjustment) at 200% in order to make the maximum value (5 V) of the external sensor's output correspond to 100%. Note that the input specification for terminal [12] is 0 to 10 V corresponding to 0 to 100%; thus, a gain factor of 200% (= 10 V ÷ 5 V × 100) should be specified. Note also that any bias setting does not apply to feedback control.



(Example 1) When the output level of the external sensor is ±7 VDC:

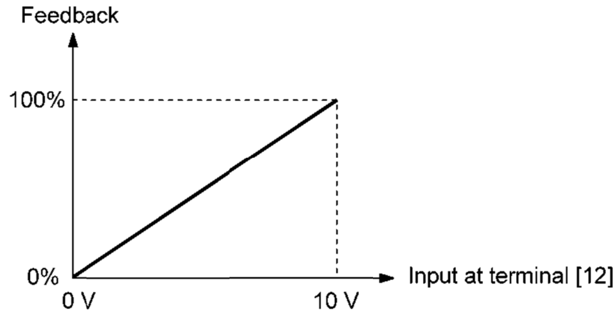
- Use terminal [12] since the voltage input is of bipolar.
- When the external sensor's output is of bipolar, the inverter controls the speed within the range of ±100%. To convert the output ±7 VDC to ±100%, set the gain (C32 for analog input adjustment) at 143% as calculated below.

$$\frac{10\ \mathrm{V}}{7\ \mathrm{V}} \approx 143\%$$



(Example 2) When the output level of the external sensor is 0 to 10 VDC:

- Use terminal [12] designed for voltage input.
- When the external sensor's output is of unipolar, the inverter controls the speed within the range of 0 to 100%.



PID Display Coefficient and Monitoring

To monitor the PID command and its feedback value, set a display unit, maximum scale, and minimum scale to convert the values into easy-to-understand physical quantities (such as temperature).

- Function code of display unit, maximum scale, and minimum scale, for each terminal

	Display unit	Maximum scale	Minimum scale
Terminal [12]	C58	C59	C60
Terminal [C1](C1)	C64	C65	C66
Terminal [C1](V2)	C70	C71	C72

For the monitor, refer to function code K10.

J505	External PID Control 1 (Display unit)

J505 selects a display unit for external PID control 1.

Under external PID control, the external PID command setting value (SV), feedback value (PV), manipulated value (MV) and others can be monitored on the keypad. For these values, select the display units.

For the setting procedure of the monitor display, refer to the FRENIC-Ace User's Manual Chapter 5, Section 5.5.1 "Monitoring the running status."

Note When external PID control is to be performed with the same unit and scale as for feedback values, the J505 settings need not be changed. (Factory default: In accordance with the unit and scale used for feedback values)

Configure the J505 to use different unit and scale from feedback values.

Data for J505	Display unit	Data for J505	Display unit	Data for J505	Display unit
0	(Factory default)*	23	L/s (flowrate)	45	mmHg (pressure)
1	No unit	24	L/min (flowrate)	46	Psi (pressure)
2	%	25	L/h (flowrate)	47	mWG (pressure)
4	r/min	40	Pa (pressure)	48	inWG (pressure)
7	kW	41	kPa (pressure)	60	K (temperature)
20	m^3/s (flowrate)	42	MPa (pressure)	61	°C (temperature)
21	m^3/min (flowrate)	43	mbar (pressure)	62	°F (temperature)
22	m^3/h (flowrate)	44	bar (pressure)	80	ppm (density)

* In accordance with the unit and scale used for feedback values

For feedback value selection, see function codes E61 to E63.

The table below lists function codes to be used for setting a unit and scale for feedback values.

	Display unit	Maximum scale	Minimum scale
Terminal [12]	C58	C59	C60
Terminal [C1](C1 function)	C64	C65	C66
Terminal [V2](V2 function)	C70	C71	C72

J506, J507	External PID Control 1 (Maximum scale, Minimum scale)

J506/J507 specify the maximum/minimum scale for external PID control 1.

Set the maximum scale "External PID command value / Display value at 100% of external PID feedback value" with J506, and the minimum scale "External PID command value / Display value at 0% of external PID feedback value" with J507.

Display values are calculated with the following expression.

Display value = (External PID control value (%)) / 100 x (Maximum scale - Minimum scale) + Minimum scale

- Data setting range: (Maximum scale and minimum scale) -999 to 0.00 to 9990

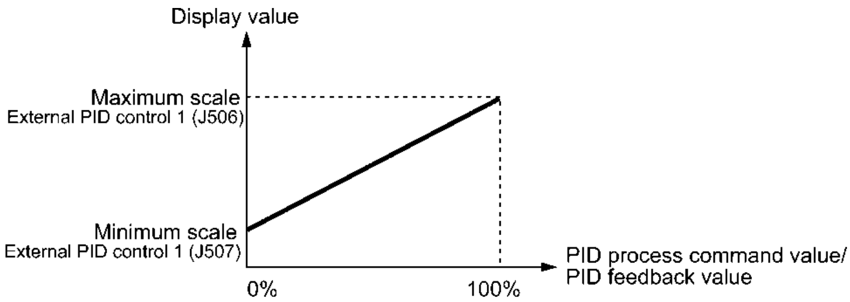


Figure J.35

Note: When external PID control is to be performed with the same unit and scale as for feedback values, the J506 or J507 settings need not be changed. (Factory default: In accordance with the unit and scale used for feedback values. Refer to J505.)

Configure the J506 and J507 to use different unit and scale from feedback values.

J510 **J511** **J512** **J513**	**External PID Control 1 P (Gain)** **I (Integral time)** **D (Differential time)** **(Feedback filter)**

The table below lists function codes to be used for setting the P (gain), I (integral time), D (differential time) and feedback filter for external PID controls.

	P (gain)	I (integral time)	D (differential time)	Feedback filter
External PID control 1	J510	J511	J512	J513

For details of P action, I action, D action, as well as their coordinated controls and adjusting method, see the description of J10, J11, and J12. Note that the P (gain) of External PID (J510) correspond to J10. Also, I (integral time) (J511) correspond to J11, and the D (differential time) (J512) correspond to J12.

■ **P gain (J510)**

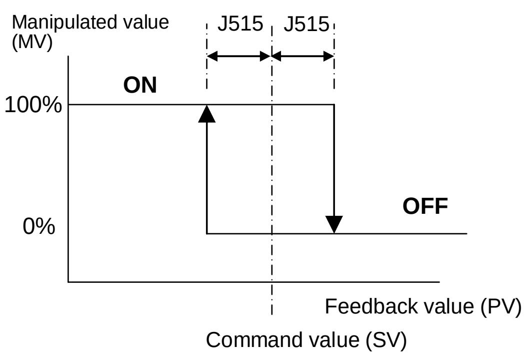
J510 specifies the gain for the external PID processor.

- Data setting range: 0.000 to 30.000 (times), 999: ON/OFF control

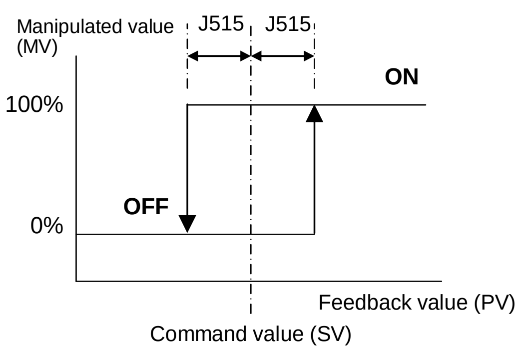
<u>ON/OFF control</u>

Setting the P gain (J510) to "999" enables ON/OFF control. If the feedback value (PV) exceeds the threshold value "Command setting value SV + Hysteresis width (J515)," the manipulated value (MV) switches between two positions 0% and 100%.

● Normal operation



● Reverse operation



■ **I integral time (J511)**

J511 specifies the integral time for the external PID processor.

- Data setting range: 0.0 to 3600.0 (s)
  0.0 means that the integral component is ineffective.

■ **D differential time (J512)**

J512 specifies the differential time for the external PID processor.

- Data setting range: 0.00 to 600.00 (s)
  0.00 means that the differential component is ineffective.

■ **Feedback filter (J513)**

J513 specifies the time constant of the filter for feedback signals under the external PID control.

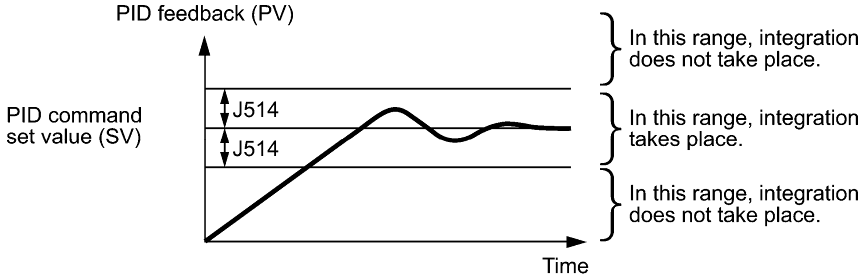
- Data setting range: 0.0 to 900.0 (s)
- This setting is used to stabilize the PID control loop. Setting too long a time constant makes the system response slow.

APPENDICES

J514	External PID Control 1 (Anti-reset wind-up)

J514 suppresses overshoot under external PID control 1 using an external PID processor. As long as the deviation between the PID command and its feedback is out of the preset range, the integrator holds its value and does not perform integration operation.

- Data setting range: 0.00, 0.01 to 9990 (The setting range is restricted by the maximum scale and minimum scale.)

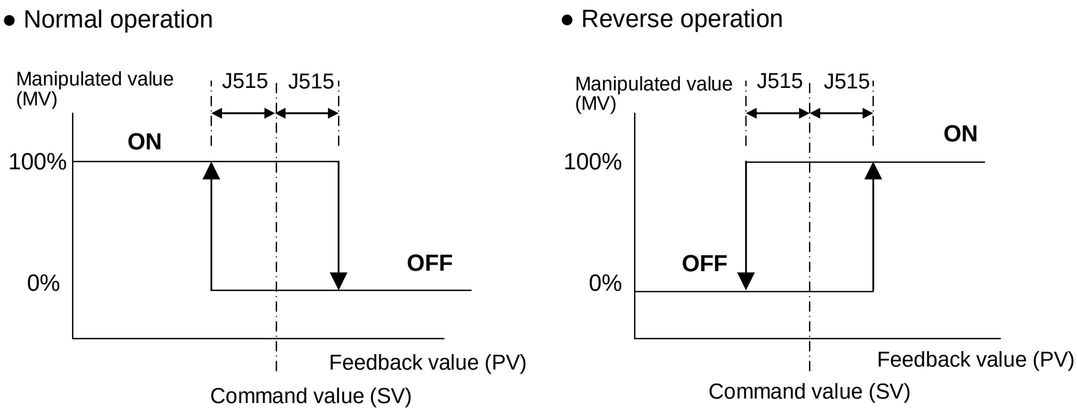


J515	External PID Control 1 (ON/OFF control hysteresis width)

J515 specifies the hysteresis width for ON/OFF control under external PID control 1 in a physical quantity.

Setting the P gain (J510) to "999" enables ON/OFF control. If the feedback value (PV) exceeds the threshold value "Command setting value SV + Hysteresis width (J515)," the manipulated value (MV) switches between two positions 0% and 100%.

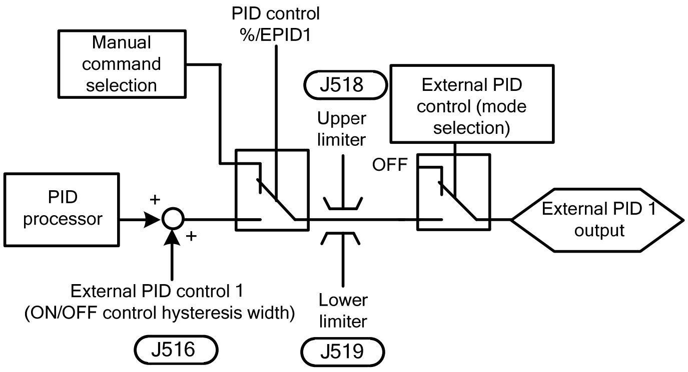
- Data setting range: 0.00 to 9990 (The setting range is restricted by the maximum scale and minimum scale.)



J516	External PID Control 1 (Proportional operation output convergent value)

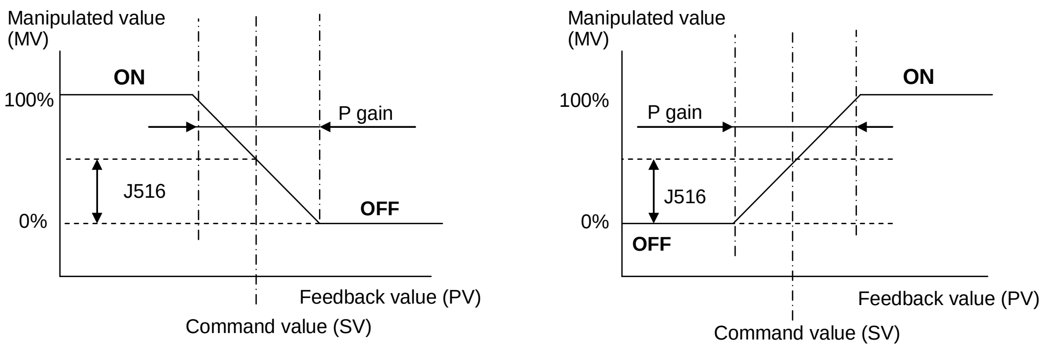
Exclusively for external PID control, this setting value can be added to the external PID output. J516 sets external PID controls 1 respectively.

- Data setting range: 0 to 150 (%)



Also, by disabling I (integral time) and D (differential time) to enable only P (gain) and this value, the following comparison is possible.

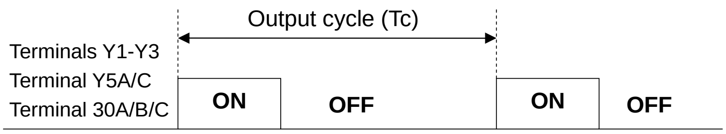
- Normal operation
- Reverse operation



J517	External PID Control 1 (Proportional cycle)

J517 specifies the output cycle (Tc) of pulse outputs under output duty control for external PID control 1.

- Data setting range: 1 to 150 (s)



The ON and OFF times are calculated by the following expressions.

ON time = Output cycle (Tc) x Manipulated value (MV) / 100

OFF time = Output cycle (Tc) - ON time

(Example) If output cycle (Tc) = 60 s, MV = 35%

ON time = 60 s x 35% / 100 = 21 s

OFF time = 60 s -21 s = 39 s

To use the proportional cycle, it is necessary to assign ***EPID1-OUT*** to any of digital output terminals as duty control output with any of E20, E21 and E27.

- External PID control 1: *EPID1-OUT* (E20, E21 and E27, data = 212)

J518 J519 J520	**External PID Control 1 (Upper limit of PID process output) (Lower limit of PID process output) (Upper and lower limits)**

J518/J519/J520 defines the upper and lower limiters for the external PID output, which exclusively apply to external PID control 1.

When external PID control is cancelled with ***%/EPID1*** and manual command is used to operate, the upper and lower limiters are effective.

📖 E01 to E05, data = 202 (***%/EPID1***)

■ PID Control 1 (Upper limit of PID process output) (J518)

- Data setting range: -10 to 110 (%)

J518 specifies the upper limit of the external PID processor output limiter in %.

■ PID Control 1 (Lower limit of PID process output) (J519)

- Data setting range: -10 to 110 (%)

J519 specifies the lower limit of the external PID processor output limiter in %.

■ PID Control 1 (Upper and lower limits) (J520)

J520 specifies the upper and lower limits of the external PID processor output limiter.

Data for J520	PID output limiter	
	Upper limit	Lower limit
0	J518	J519
1	J518 data or above ⇒ 110%	Less than J519 data ⇒ -10%

J521 J522 J524	**External PID Control 1**	**(Alarm output selection) (Upper level alarm (AH)) (Lower level alarm (AL))**

J521/J522/J524 define two types of alarm signals (absolute-value and deviation alarms) that the inverter can output for external PID control 1.

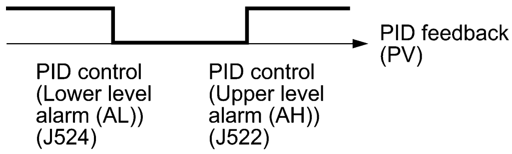
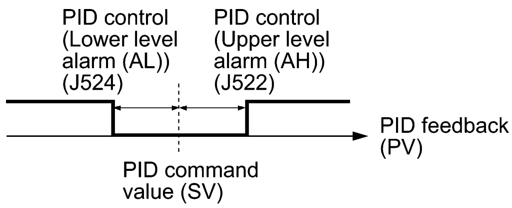
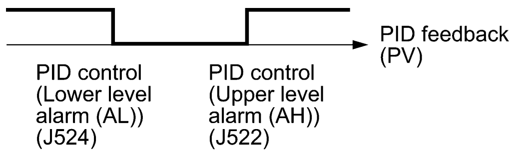
To use the alarm output, it is necessary to assign ***EPV1-ALM*** to any of digital output terminals as duty control output with any of E20, E21 and E27. To generate a light alarm, the following digital output signals can be extracted without setting the light alarm selection 4 (H184). For details of light alarms, see the description of function codes H181 to H184.

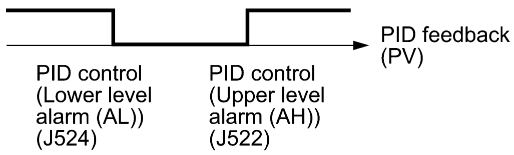
- External PID control 1: *EPV1-ALM* (E20, E21 and E27, data = 214)

J521 specifies the alarm output types. J522 and J524 specify the upper and lower limits for alarms.

■ PID control 1 (Alarm output selection) (J521)

J521 specifies one of the following alarms available.

Data for J521	Alarm	Description
0	Absolute-value alarm (PV)	While PV < AL or AH < PV, ***EPV1-ALM*** is ON. 
1	Absolute-value alarm (PV) (with Hold)	Same as above (with Hold)
2	Absolute-value alarm (PV) (with Latch)	Same as above (with Latch)
3	Absolute-value alarm (PV) (with Hold and Latch)	Same as above (with Hold and Latch)
4	Deviation alarm (PV)	While PV < SV - AL or SV + AH < PV, ***EPV1-ALM*** is ON. 
5	Deviation alarm (PV) (with Hold)	Same as above (with Hold)
6	Deviation alarm (PV) (with Latch)	Same as above (with Latch)
7	Deviation alarm (PV) (with Hold and Latch)	Same as above (with Hold and Latch)
8	Absolute-value alarm (SV)	While SV < AL or AH < SV, ***EPV1-ALM*** is ON. 

Data for J521	Alarm	Description
9	Absolute-value alarm (SV) (with Hold)	Same as above (with Hold)
10	Absolute-value alarm (SV) (with Latch)	Same as above (with Latch)
11	Absolute-value alarm (SV) (with Hold and Latch)	Same as above (with Hold and Latch)
12	Absolute-value alarm (MV)	While MV < AL or AH < MV, ***EPV1-ALM*** is ON. 
13	Absolute-value alarm (MV) (with Hold)	Same as above (with Hold)
14	Absolute-value alarm (MV) (with Latch)	Same as above (with Latch)
15	Absolute-value alarm (MV) (with Hold and Latch)	Same as above (with Hold and Latch)

SV: Process command value, PV: Feedback value, MV: Manipulated value

Hold: During the power-on sequence, the alarm output is kept OFF (disabled) even when the monitored quantity is within the alarm range. Once it goes out of the alarm range, and comes into the alarm range again, the alarm is enabled.

Latch: Once the monitored quantity comes into the alarm range and the alarm is turned ON, the alarm will remain ON even if it goes out of the alarm range. To release the latch, perform a reset by using the key or turning the terminal command *RST* ON. Resetting can be done by the same way as resetting an alarm.

■ External PID control 1 (Upper level alarm (AH) (J522)

J522 specifies the upper limit (AH) for alarms in a physical quantity.

- Data setting range: OFF: Disable, -999.00 to 0.00 to 9990.00

The physical quantity is dependent on the display unit and maximum/minimum scale specified by the following function codes.

	Display unit	Maximum scale	Minimum scale
External PID control 1	J505	J506	J507

■ External PID control 1 (Lower level alarm (AL) (J524)

J524 specifies the lower limit (AL) for alarms in a physical quantity. The physical quantity is dependent on the display unit and maximum/minimum scale specified by the function codes listed above.

- Data setting range: OFF: Disable, -999.00 to 0.00 to 9990.00

Upper level alarm (AH) and lower level alarm (AL) also apply to the following alarms.

Alarm	Description	How to handle the alarm:	
		Select alarm output (J521)	Parameter setting
Upper limit (absolute)	ON when AH < PV ON when AH < SV ON when AH < MV	Absolute-value alarm	AL = 0
Lower limit (absolute)	ON when PV < AL ON when SV < AL ON when MV < AL		AH = 100%
Upper limit (deviation)	ON when SV + AH < PV	Deviation alarm	AL = 100%
Lower limit (deviation)	ON when PV < SV - AL		AH = 100%
Upper/lower limit (deviation)	ON when |SV - PV| > AL		AL = AH
Upper/lower range limit (deviation)	ON when SV - AL < PV < SV + AL	Deviation alarm	A negative logic signal should be assigned to ***EPV1-ALM***
Upper/lower range limit (absolute)	ON when AL < PV < AH ON when AL < SV < AH ON when AL < MV < AH	Absolute-value alarm	
Upper/lower range limit (deviation)	ON when SV - AL < PV < SV + AH	Deviation alarm	

J527 **J529** **J530** **J531**	**External PID Control 1 (Feedback error detection mode)** **(Feedback error upper-limit)** **(Feedback error lower-limit)** **(Feedback error detection time)**

Under external PID control, the inverter can detect abnormal feedback values (PV).

In the case of external PID control 1, if the error level of a PV signal (Upper limit: J529, Lower limit: J53) is kept for the feedback error detection time (J531), the inverter regards it as an error, then stops or continues running according to the mode specified by J527.

	Feedback error detection mode	Feedback error upper limit	Feedback error lower limit	Error detection time
External PID control 1	J527	J529	J530	J531

■ **External PID control 1 (Feedback error detection mode) (J527)**

J527 specifies the error processing to be performed if a feedback error occurs.

- Data setting range: 0 to 2

Data for J527	Error processing
0	Disable: Turn ON the following output signal and continue to run. ***EPV1-OFF*** for external PID control 1
1	Enable: Coast to a stop (PVA trip)
2	Enable: Decelerate to a stop and cause a PVA trip.

Feedback errors can be monitored from the external equipment by assigning the digital output signal ***EPV1-OFF***, to any of the output terminals [Y1], [Y2], and [30A/B/C] with any of E20, E21 and E27.

- External PID control 1: ***EPV1-OFF*** (E20, E21 and E27, data = 215)

■ **External PID control 1 (Feedback error lower-limit) (J529)**

J529 specifies the upper limit for feedback errors in a physical quantity.

- Data setting range: -999.00 to 0.00 to 999.00, Auto = 105%

The physical quantity is dependent on the display unit and maximum/minimum scale specified by the following function codes.

	Display unit	Maximum scale	Minimum scale
External PID control 1	J505	J506	J507

■ **External PID control 1 (Feedback error lower-limit) (J530)**

J530 specifies the lower limit for feedback errors in a physical quantity. The physical quantity is dependent on the display unit and maximum/minimum scale specified by the function codes listed above.

- Data setting range: -999.00 to 0.00 to 999.00, 999: -5%

■ **External PID control 1 (Feedback error detection time) (J531)**

J531 specifies the feedback error detection time for the upper-limit (J529) and lower-limit (J530). If the detection time has elapsed after a feedback error occurred, the inverter regards it as an error.

- Data setting range: 0 to 300.0 (s)

J540	External PID Control 1 (Manual command)

■ **External PID control 1 (Manual command) (J540)**

J540 specifies the source that specifies a manual command to apply when external PID command is canceled.

Data for J540	Manual command sources
0	Keypad Specify the external PID command by using the ⌃ / ⌄ keys on the keypad.
8	Keypad (Balanceless-bumpless) Specify the external PID command by using the ⌃ / ⌄ keys on the keypad.
51	External PID command 1 (Analog input: Terminals [12], [C1](C1 function) and [C1](V2 function) Function codes E61 to E63 (terminal [12], [C1](C1), [C1](V2) Extended function selection): Data = 43 Voltage input to terminal [12] (0 to ±10 VDC, 100% PID command/ ±10 VDC) Current input to terminal [C1](C1 function) (4 to 20 mA DC, 100% PID command/ 20 mA DC) (0 to 20 mA DC, 100% PID command/ 20 mA DC) Voltage input to the terminal [C1](V2 function) (0 to ±10 VDC, 100% PID command/ ±10 VDC)

To cancel external PID controls, assign digital input signals ***%/EPID1*** to digital input terminals with E01 to E05 (data = 202) beforehand.

J551 J552 J553	External PID Multistep Command (Multistep command 1) (Multistep command 2) (Multistep command 3)

J551, J552 and J553 define an external PID control command as a preset value (3 steps).

■ **External PID multistep command (Multistep command 1 to 3) (J551, J552, J553)**

J551/J552/J553 specifies a multistep command in a physical quantity.

- Data setting range: -999.00 to 0.00 to 9990.00
- External PID command

EPID-SS2	***EPID-SS1***	Command
OFF	OFF	Command by J502
OFF	ON	J551 (Multistep 1)
ON	OFF	J552 (Multistep 2)
ON	ON	J553 (Multistep 3)

The physical quantity is dependent on the display unit and maximum/minimum scale specified by the following function codes.

	Display unit	Maximum scale	Minimum scale
External PID control 1	J505	J506	J507

Note: Factory default value is set at J505, J605, J655=0 (according to the PID control 1 feedback value unit/scale).

APPENDICES

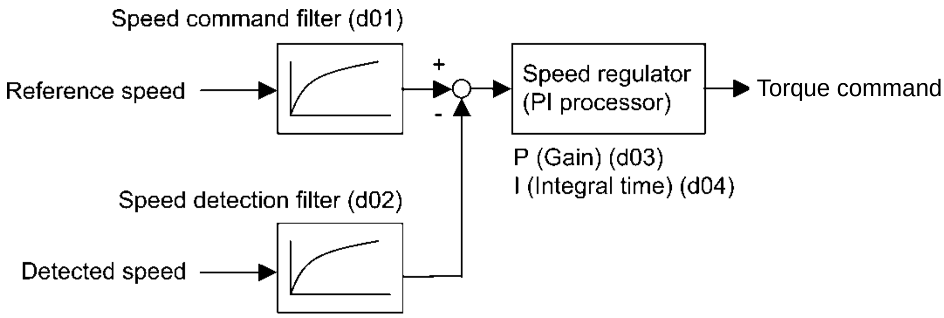
J.8 d codes (Applied functions 2)

[1] Speed control (Vector control without speed or pole position sensor for PMSM)

d01/A43 **d02/A44** **d03/A45** **d04/A46**	**Speed control 1, and 2**	**(Speed command filter)** **(Speed detection filter)** **P (Gain)** **I (Integral time)** **Related function code: d25:ASR switching**

These function codes are used to set up the speed control for vector control without speed sensor nor pole position sensor for PMSM.

■ **Block diagram of the speed control algorithm**



■ **Speed command filter (d01/A43)**

d01 specifies the time constant determining the first order delay of the speed command filter.

- Data setting range: 0.000 to 5.000 (s)

Modify this data when an excessive overshoot occurs against the change of the reference speed.

Increasing the filter time constant stabilizes the reference speed and reduces overshoot against the change of the reference speed, but it slows the response speed of the inverter.

■ **Speed detection filter (d02/A44)**

d02 specifies the time constant determining the first order delay of the speed detection filter.

- Data setting range: 0.000 to 0.100 (s)

Modify this data when the control target (machinery) is oscillatory due to deflection of a drive belt or other causes so that ripples (oscillatory components) are superimposed on the detected speed, causing hunting (undesirable oscillation of the system) and blocking the PI processor gain from increasing (resulting in a slow response speed of the inverter).

Increasing the time constant stabilizes the detected speed and allows to raise the PI processor gain even with ripples superimposed on the detected speed. However, speed detection itself is delayed, resulting in a slower speed response, larger overshoot, or hunting.

■ P(Gain) (d03/A45), I(integral time) (d04/A46)

d03 and d04 specify the gain and integral time of the speed regulator (PI processor), respectively.

- Data setting range: (d03) 0.1 to 200.0 (times)
  (d04) 0.001 to 9.999 (s), 999 (Cancel integral term)

P(Gain)

Definition of “P gain = 1.0” is that the torque command is 100% (100% torque output of each inverter capacity) when the speed deviation (reference speed – detected speed) is 100% (equivalent to the maximum speed).

Determine the P gain according to moment of inertia of machinery loaded to the motor output shaft. Larger moment of inertia needs larger P gain to keep the flat response during whole operation.

Specifying a larger P gain improves the quickness of control response, but may cause a motor speed overshooting or hunting (undesirable oscillation of the system). Moreover, mechanical resonance or vibration sound on the machine or motor could occur due to excessively amplified noise. If it happens, decreasing P gain will reduce the amplitude of the resonance/vibration. A too small P gain results in a slow inverter response and a speed fluctuation in low frequency, which may prolong the time required for stabilizing the motor speed.

I(Integral time)

Specifying a shorter integral time shortens the time needed to compensate the speed deviation, resulting in quick response in speed. Specify a short integral time if quick arrival to the target speed is necessary and a slight overshooting in the control is allowed; specify a long time if any overshooting is not allowed and taking longer time is allowed.

If a mechanical resonance occurs and the sound from the motor or gears is abnormal, setting a longer integral time can transfer the resonance point to the low frequency zone and suppress the resonance in the high frequency zone.

■ Select speed control parameter 1 – “MPRM1” (E01 toE05 data = 78)

The combination of the ON/OFF states of digital input signals “MPRM1” selects one between 4 different speed control parameter sets.

■ ASR switching time (d25)

Speed control parameters switching by “MPRM1” and “MPRM2” signals is possible even during motor drive operation. For example, speed control P (Gain) and I (Integral time) listed can be switched. Switching these parameters during operation may cause an abrupt change of torque and result in a mechanical shock, depending on the driving condition of the load. To reduce such a mechanical shock, the inverter decreases the abrupt torque change using the ramp function of ASR switching time (d25).

- Data setting range: 0.000 to 1.000 (s)

d21, d22 d23	Speed deviation excess detected (Hysteresis width, detection timer) Speed deviation excess detected processing

These function codes specify the detection levels of the speed deviation excess detected signal **"PG-ERR".**

<u>Speed deviation excess detected signal "PG-ERR" (E20, E21 and E27, data = 76)</u>

■ **Hysteresis width (d21), Detection timer (d22) and PG error processing (d23))**

- Data setting range: (d21) 0.0 to 50.0 (%), in (%) of the maximum speed
  (d22) 0.00 to 10.00 (s)
  (d23) 0 to 2

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

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

<table>
<tr><th>d23</th><th>Function</th><th>Detection condition
(and exception)</th><th>Processing after error detection</th><th>Hysteresis width for error detection</th></tr>
<tr><td>0</td><td>Continue to run 1</td><td rowspan="2">When the inverter cannot follow the reference speed (even after soft-starting) due to a heavy overload or similar, so that the detected speed is less than the reference speed, the inverter does not interpret this situation as a Speed deviation excess detected.</td><td>The inverter outputs the Speed deviation excess detected signal "PG-ERR" and continues to run.</td><td rowspan="3">Hysteresis width = d21, which is constant, even if the speed command is above the base frequency (F04).</td></tr>
<tr><td>1</td><td>Stop running with alarm 1</td><td rowspan="2">The inverter initiates a motor coast to stop, with the ere alarm.
It also outputs the Speed deviation excess detected signal "PG-ERR".</td></tr>
<tr><td>2</td><td>Stop running with alarm 2</td><td>No exception.</td></tr>
</table>

Note: Enabling an operation limiting function such as the torque limit will increase the deviation caused by a huge gap between the reference speed and detected one. In this case, the inverter may trip interpreting this situation as a PG error, depending on the running state. To avoid this incident, set the d23 data to "0" (Continue to run) to prevent the inverter from tripping even if any of those limiting functions is activated.

d25	ASR switching time (Refer to d01)

Refer to the description of d01.

d32, d33	Speed limits / Over speed level 1 and 2

Under speed control, the over speed detection levels are specified with 120% of these function codes.

- Forward overspeed level = Maximum frequency 1 (F03) × Speed limit 1 (d32) × 120 (%)
- Reverse overspeed level = Maximum frequency 1 (F03) × Speed limit 2 (d33) × 120 (%)

- Data setting range: (d32,d33) 0 to 110 (%)

d35	Over speed detection level

Setting d35 data to “999(factory default)” causes the inverter to issue an over speed alarm if either of the above conditions are satisfied.

or

Motor speed = 200 Hz (120Hz at [ND] mode) × (d32 or d33) × 120(%)

d35 specifies the over speed detection level by percentage of the maximum frequency (F03/A01).

- Over speed level = Maximum frequency 1 (F03/A01) × d35

d51 d55, d69, d79, d91 to d92, d99	Reserved for particular manufacturers

These function codes are reserved for particular manufacturers. Unless otherwise specified, do not access these function codes.

d61 to d63	Command (Pulse train input) (Filter time constant, Pulse scaling factor 1 and Pulse scaling factor 2) (Refer to F01.)

Refer to the description of the function code F01 for details on the pulse rate input.

d67	PMSM starting mode (Auto search)

Refer to the description of the function code H09 for details on the PMSM starting mode.

J.9 U codes (Customizable logic operation)

The customizable logic function allows the user to form a logic or operation circuit for digital/analog input/output signals, customize those signals arbitrarily, and configure a simple relay sequence inside the inverter.

In the customizable logic, one step (component), depending on the type, is composed of:

(1) Digital 2 inputs, digital 1 output + logical operation (including timer)

(2) Analog 2 inputs, analog 1 output/digital 1 output + numerical operation

(3) Analog 1 input, digital 1 input, analog 1 output + numerical operation, logical operation

and a total of 200 steps can be used to configure a sequence.

■ Modes

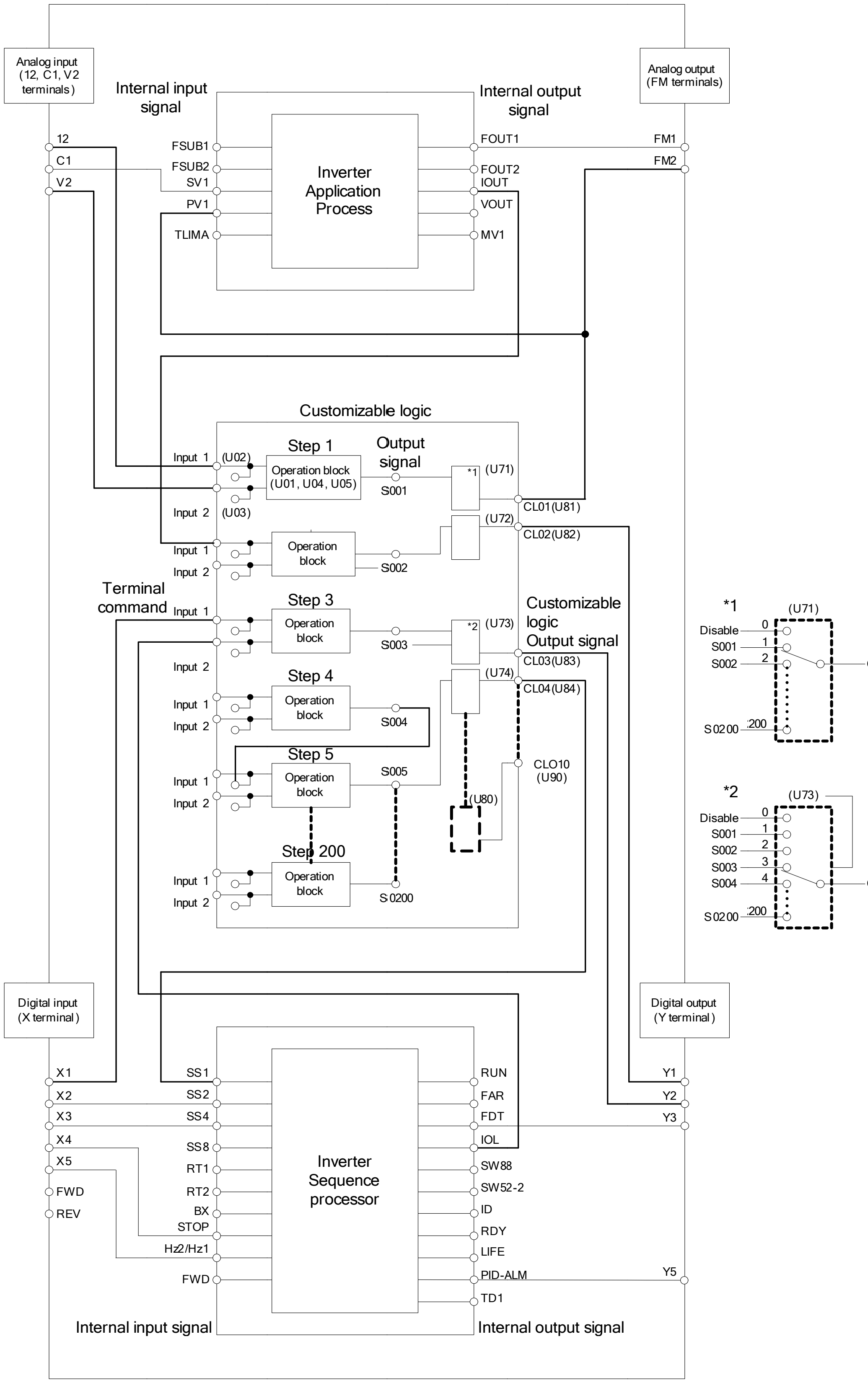
Item	Modes		
Terminal command	Digital 2 inputs	Analog 2 inputs	Analog 1 input Digital 1 input
Operation block	Logical operation, counter, etc.: 13 types Timer: 5 types	Numerical operation, comparator, limiter, etc.: 25 types	Selector, hold, etc.: 12 types
Output signal	Digital 1 output	Analog 1 output/ Digital 1 output	Analog 1 output
Number of steps	200 steps		
Customizable logic output signal	10 outputs		
Customizable logic processing time	2 ms (max. 10 steps), 5 ms (max. 50 steps), 10 ms (max. 100 steps), 20ms (max. 200 steps) Can be selected with a function code.		
Customizable logic cancellation command "CLC"	Allows to stop all the customizable logic operations by assigning "CLC" to a general-purpose input terminal and turning it ON. It is used when you want to deactivate the customizable logic temporarily.		
Customizable logic timer cancellation command "CLTC"	Resets the timer, counter and all the previous values used in customizable logic by assigning "CLTC" to a general-purpose input terminal and turning it ON. It is used when a customizable logic is changed or if you want to synchronize it with external sequence.		

Note If you use the customizable logic cancellation command and customizable logic timer cancellation command, the inverter can unintentionally start because the speed command is unmasked, depending on the structure of the customizable logic. Be sure to turn OFF the operation command to turn it ON.

A physical injury may result.

A damage may result.

■ Block diagram



Note Mode selection function codes for enabling customizable logic can be modified during operation but the customizable logic output may become temporarily unstable due to the setting modification. Therefore, since unexpected operation can be performed, change the settings if possible when the inverter is stopped.

A physical injury may result.

A damage may result.

U00	**Customizable logic (Mode selection)**
U01 to U70	**Customizable logic: Step 1 to 14 (Mode setting)**
U71 to U80	**Customizable logic: Output signal 1 to 10 (Output selection)**
U81 to U90	**Customizable logic: Output signal 1 to 10 (Function selection)**
U91	**Customizable logic: Timer monitor (Step selection)**
U92 to U97	**Customizable logic: The coefficients of the approximate formula**
U100	**Customizable logic: Task process cycle setting**
U101 to U106	**Customizable logic: Operating point 1 to 3**
U107	**Customizable logic: Auto calculation of the coefficients of the approximate formula**
U121 to U140	**Customizable logic: User parameter 1 to 20**
U171 to U175	**Customizable logic: Storage area 1 to 5**
U190 to U195	**Customizable logic: Step 15 to 200 setting**

■ Customizable Logic (Mode selection) (U00)

U00 specifies whether to enable the sequence configured with the customizable logic function or disable it to run the inverter only via its input terminals or others.

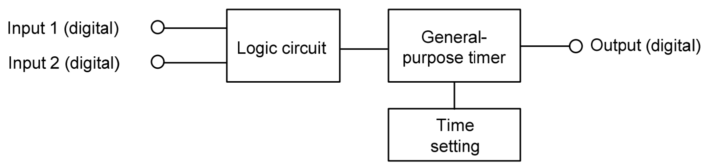
U00 data	Function
0	Disable
1	Enable (Customizable logic operation)

The *ecl* alarm occurs when changing U00 from 1 to 0 during operation.

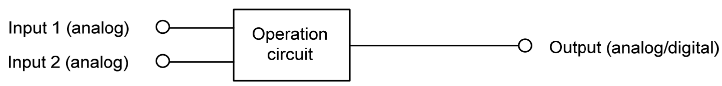
■ Customizable Logic (Mode Setting) (U01 to U70, U190 to U195)

In the customizable logic, the steps are categorized in the following three types:

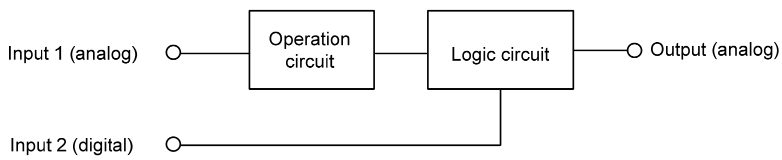
[Input: digital] Block selection (U01, U06, U11, etc.) = 1 to 1999



[Input: analog] Block selection (U01, U06, U11, etc.) = 2001 to 3999



[Input: digital, analog] Block selection (U01, U06, U11, etc.) = 4001 to 5999



The function code settings for each step are as follows:

- Step 1 to 14

Step No.	Block selection	Input 1	Input 2	Function 1	Function 2	Output Note)
Step 1	U01	U02	U03	U04	U05	“SO01”
	= 1 to 1999	Digital input 1	Digital input 2	Time setting	Not required	Digital output
	= 2001 to 3999	Analog input 1	Analog input 2	Value 1	Value 2	Analog/digital output
	= 4001 to 6999	Analog input 1	Digital input 2	Value 1	Value 2	Analog output
Step 2	U06	U07	U08	U09	U10	“SO02”
Step 3	U11	U12	U13	U14	U15	“SO03”
Step 4	U16	U17	U18	U19	U20	“SO04”
Step 5	U21	U22	U23	U24	U25	“SO05”
Step 6	U26	U27	U28	U29	U30	“SO06”
Step 7	U31	U32	U33	U34	U35	“SO07”
Step 8	U36	U37	U38	U39	U40	“SO08”
Step 9	U41	U42	U43	U44	U45	“SO09”
Step 10	U46	U47	U48	U49	U50	“SO10”
Step 11	U51	U52	U53	U54	U55`	“SO11”
Step 12	U56	U57	U58	U59	U60	“SO12”
Step 13	U61	U62	U63	U64	U65	“SO13”
Step 14	U66	U67	U68	U69	U70	“SO14”

Note) Output is not a function code. It indicates the output signal symbol.

- Step 15 to 200

Specify a step number in U190, and set the block selection, input 1, input 2, function 1, function 2 in U191 to U195 respectively.

Step No.	U190	Block selection	Input 1	Input 2	Function 1	Function 2	Output
Step 15	15	U191	U192	U193	U194	U195	“SO15”
Step 16	16						“SO16”
···	···						···
Step 199	199						“SO199”
Step 200	200						“SO200”

[Input: digital] Block function code setting

■ **Block selection (U01 etc.) (Digital)**

Any of the following items can be selected as a logic function block (with general-purpose timer):
The data can be logically inverted by adding 1000.

Data	Logic function block	Description
0	No function assigned	Output is always OFF.
10	Through output + General-purpose timer (No timer)	Only a general-purpose timer. No logic function block exists.
11	(On-delay timer)	Turning the input signal ON starts the on-delay timer. When the period specified by the timer has elapsed, the output signal turns ON. Turning the input signal OFF turns the output signal OFF.
12	(Off-delay timer)	Turning the input signal ON turns the output signal ON. Turning the input signal OFF starts the off-delay timer. When the period specified by the timer has elapsed, the output signal turns OFF.
13	(One-shot pulse output)	Turning the input signal ON issues a one-shot pulse whose length is specified by the timer.
14	(Retriggerable timer)	Turning the input signal ON issues a one-shot pulse whose length is specified by the timer. If the input signal is turned ON again during the preceding one-shot pulse length, however, the logic function block issues another one-shot pulse.
15	(Pulse train output)	If the input signal turns ON, the logic function block issues ON and OFF pulses (whose lengths are specified by the timer) alternately and repeatedly. This function is used to flash a luminescent device.
20 to 25	Logical AND + General-purpose timer	AND function with 2 inputs and 1 output, plus general-purpose timer.
30 to 35	Logical OR + General-purpose timer	OR function with 2 inputs and 1 output, plus general-purpose timer.
40 to 45	Logical XOR + General-purpose timer	XOR function with 2 inputs and 1 output, plus general-purpose timer.
50 to 55	Set priority flip-flop + General-purpose timer	Set priority flip-flop with 2 inputs and 1 output, plus general-purpose timer.
60 to 65	Reset priority flip-flop + General-purpose timer	Reset priority flip-flop with 2 inputs and 1 output, plus general-purpose timer.
70, 72, 73	Rising edge detector + General-purpose timer	Rising edge detector with 1 input and 1 output, plus general-purpose timer. This detects the rising edge of an input signal and outputs the ON signal for 5 ms (*1).
80, 82, 83	Falling edge detector + General-purpose timer	Falling edge detector with 1 input and 1 output, plus general-purpose timer. This detects the falling edge of an input signal and outputs the ON signal for 5 ms (*1).
90, 92, 93	Rising & falling edges detector + General-purpose timer	Rising and falling edge detector with 1 input and 1 output, plus general-purpose timer. This detects both the falling and rising edges of an input signal and outputs the ON signal for 5 ms (*1).

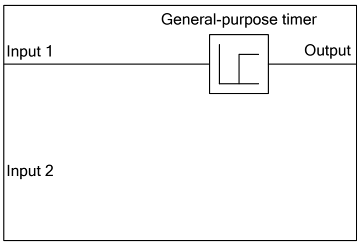
*1: Equals the task cycle: 2 ms for a task cycle of 2 ms, 5 ms for 5 ms, 10 ms for 10 ms, and 20 ms for 20 ms.

Data	Logic function block	Description
100 to 105	Hold + General-purpose timer	Hold function of previous values of 2 inputs and 1 output, plus general-purpose timer. If the hold control signal is OFF, the logic function block outputs input signals; if it is ON, the logic function block retains the previous values of input signals.
110	Increment counter	Increment counter with reset input. By the rising edge of the input signal, the logic function block increments the counter value by one. When the counter value reaches the target one, the output signal turns ON. Turning the reset signal ON resets the counter to zero.
120	Decrement counter	Decrement counter with reset input. By the rising edge of the input signal, the logic function block decrements the counter value by one. When the counter value reaches zero, the output signal turns ON. Turning the reset signal ON resets the counter to the initial value.
130	Timer with reset input	Timer output with reset input. If the input signal turns ON, the output signal turns ON and the timer starts. When the period specified by the timer has elapsed, the output signal turns OFF, regardless of the input signal state. Turning the reset signal ON resets the current timer value to zero and turns the output OFF.

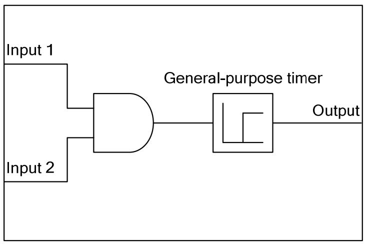
The data can be logically inverted by adding 1000.

The block diagrams for individual functions are given below.

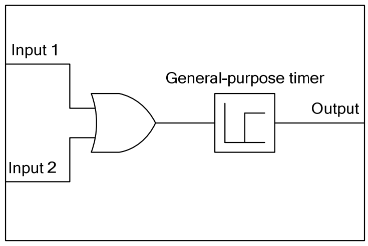
(Data=1☐) Through output



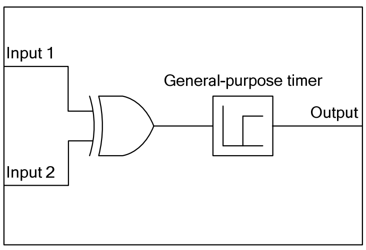
(Data=2☐) Logical AND



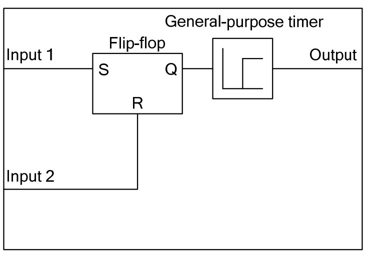
(Data=3☐) Logical OR



(Data=4☐) Logical XOR

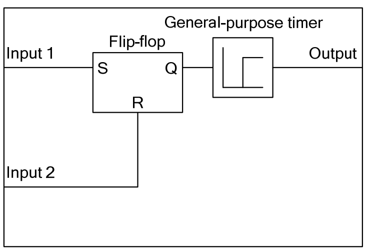


(Data=5☐) Set priority flip-flop



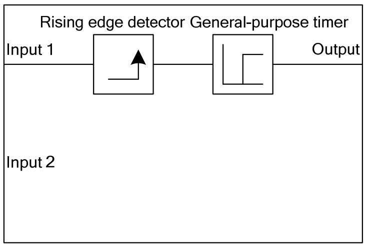
Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
	ON	–	OFF	
ON	–	–	ON	Set priority

(Data=6☐) Reset priority flip-flop

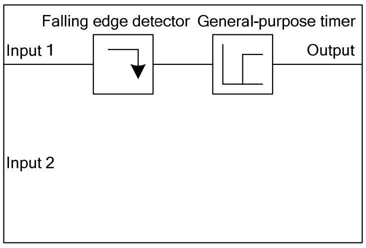


Input 1	Input 2	Previous output	Output	Remarks
OFF	OFF	OFF	OFF	Hold previous value
		ON	ON	
–	ON	–	OFF	Reset priority
ON	OFF	–	ON	

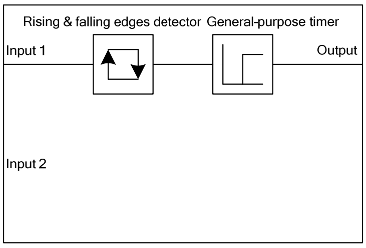
(Data=7☐) Rising edge detector



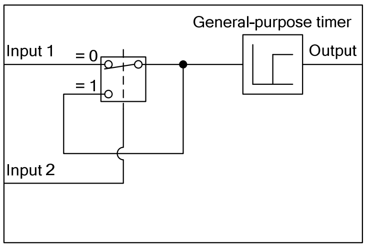
(Data=8☐) Falling edge detector



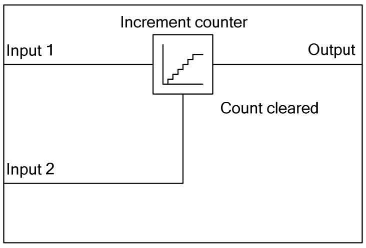
(Data=9☐) Rising & falling edges detector



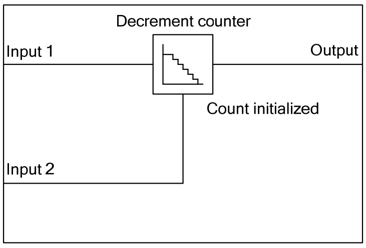
(Data=10☐) Hold



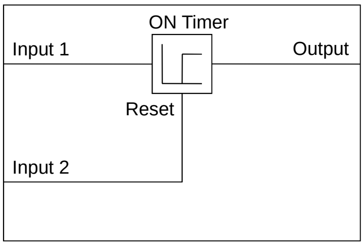
(Data=110) Increment counter

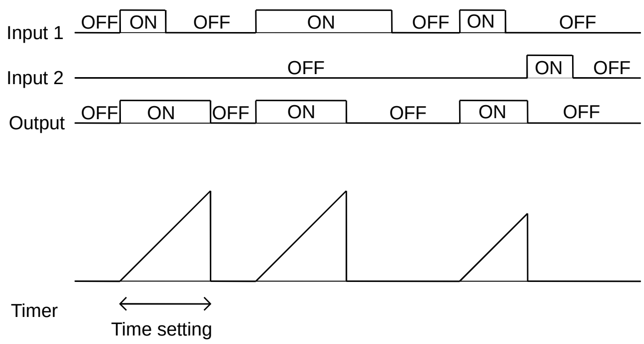


(Data=120) Decrement counter



(Data=130) Timer with reset input

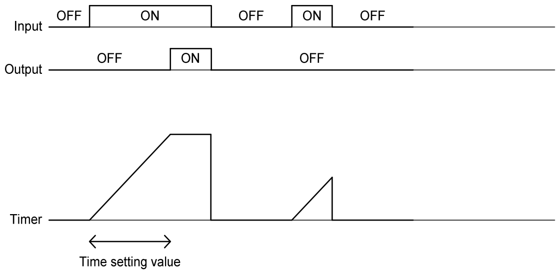




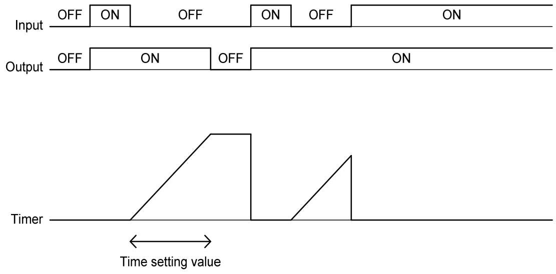
■ Operation of general-purpose timer(Digital)

The operation schemes for individual timers are shown below.

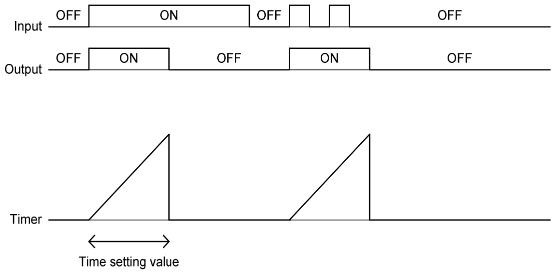
(End 1) On-delay timer



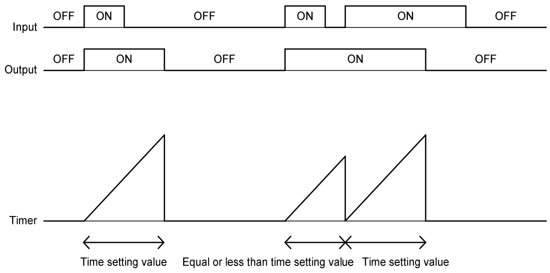
(End 2) Off-delay timer



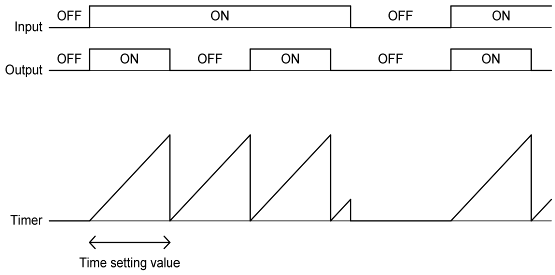
(End 3) One-shot pulse output



(End 4) Retriggerable timer



(End 5) Pulse train output



APPENDICES

■ Inputs 1 and 2 (U02, U03, etc.)(Digital)

The following digital signals are available as input signals. Value in ( ) is in negative logic.

Data	Selectable Signals
0000 (1000) to 0099 (1099) 0160 (1160) to 0215 (1215)	General-purpose output signals Same as the ones specified by E20, e.g., “RUN” (Inverter running), FAR (Frequency (speed) arrival signal), “FDT” (Frequency (speed) detected), “LU” (Undervoltage detected (Inverter stopped)), “B/D” (Torque polarity detected) Note: 27 (Universal DO) is not available. Note: Customizable logic output signals from 111 (1111) to 120 (1120) cannot be selected.
2001 (3001) to 2200 (3200)	Output of step 1 “SO01” to Output of step 200 “SO200”
4001 (5001)	Terminal X1 input signal “X1”
4002 (5002)	Terminal X2 input signal “X2”
4003 (5003)	Terminal X3 input signal “X3”
4004 (5004)	Terminal X4 input signal “X4”
4005 (5005)	Terminal X5 input signal “X5”
4010 (5010)	Terminal FWD input signal FWD
4011 (5011)	Terminal REV input signal REV
6000 (7000)	Final RUN command “FL_RUN” (ON when a run command is given)
6001 (7001)	Final FWD run command “FL_FWD” (ON when a run forward command is given)
6002 (7002)	Final REV run command “FL_REV” (ON when a run reverse command is given)
6003 (7003)	During acceleration “DACC” (ON during acceleration)
6004 (7004)	During deceleration “DDEC” (ON during deceleration)
6005 (7005)	Under anti-regenerative control “REGA” (ON under anti-regenerative control)
6007 (7007)	Alarm factor presence “ALM_ACT” (ON when there is no alarm factor)

■ Function 1 (U04 etc.)(Digital)

U05 and other related function codes specify the general-purpose timer period or the increment/decrement counter value.

Data	Function	Description
0.00 to +600	Timer	The period is specified in seconds.
	Counter value	The specified value is multiplied by 100 times. (If 0.01 is specified, it is converted to 1.)
-9990 to -0.01	—	The timer or counter value works as 0.00. (No timer)
+601 to +9990	Timer	The period is specified in seconds.

[Input: analog] Block function code setting

■ Block selection, function 1, function 2 (U01, U04, U05, etc.)(Analog)

The following items are available as operation function block.
Note that if the upper and lower limits have the same value, there are no upper and lower limits.

Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
0	No function assigned	This function always outputs 0% (or logical “0: False”; OFF).	Not required	Not required
2001	Adder	Addition function with two inputs (input 1 and input 2). This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2002	Subtracter	Subtraction function with two inputs (input 1 and input 2). This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2003	Multiplier	Multiplication function with two inputs (input 1 and input 2). This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2004	Divider	Division function with two inputs (input 1 and input 2). Input 1 is dividend and input 2 is divisor. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2005	Limiter	Upper and lower limit functions of single input (input 1). The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit
2006	Absolute value of input	Absolute value function of single input (input 1). Negative input numbers become positive. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides upper limit value and the 2nd one provides lower limit value.	Upper limit	Lower limit

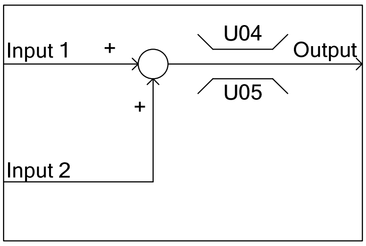
Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2007	Inverting adder	Inverting addition function with single input (input 1). This function subtracts the input 1 to the value specified with the 1st function code, inverts the result. And furthermore, the function adds the result to the value specified with the 2nd function code and outputs the result.	Subtraction value (former)	Addition value (latter)
2008	Variable limiter	Variable limit function of single input (input 1). Input 1 provides upper limit value and input 2 provides lower limit value.	Step number	Not required
2009	Linear function	Linear function of single input (input 1). This function receives single input (input 1), calculates pre-defined first-order polynomial, and outputs the result. The 1st and 2nd function codes provide the coefficients of the polynomial. The polynomial is represented by the following formula. $y = K_A \times \chi + K_B$ The output is limited within the range between -9990 and 9990 by the internal limiter.	Factor KA -9990.0 to +9990.0	Factor KB -9990.0 to +9990.0
2051	Comparator 1	Comparison function with hysteresis. This function compares the differential value between input 1 and input 2 with the threshold value specified with the 1st function code. The 2nd function code provides hysteresis width. If the differential value is (threshold value + hysteresis width) or bigger, this function outputs logical “1: True”. On the other hand, if the differential value is (threshold value - hysteresis width) or smaller, this function outputs logical “0: False”.	Threshold value	Hysteresis width
2052	Comparator 2	Comparison function with hysteresis. This function compares the differential value between input 1 and input 2 with the threshold value specified with the 1st function code. The 2nd function code provides hysteresis width. If the differential value is bigger than (threshold value + hysteresis width), this function outputs logical “1: True”. On the other hand If the value is smaller than (threshold value - hysteresis width), the function outputs logical “0: False”.	Threshold value	Hysteresis width
2053	Comparator 3	Comparison function with hysteresis. This function compares the absolute differential value between input 1 and input 2 with the threshold value specified with the 1st function code. The 2nd function code provides hysteresis width. This function works like as comparator 1	Threshold value	Hysteresis width
2054	Comparator 4	Comparison function with hysteresis. This function compares the absolute differential value between input 1 and input 2 with the threshold value specified with the 1st function code. The 2nd function code provides hysteresis width. This function works like as comparator 2	Threshold value	Hysteresis width

Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2055	Comparator 5	Comparison function with hysteresis. Input 1 is the input value of this function and input 2 is not used. The 1st function code provides threshold value and the 2nd one provides hysteresis width. If input 1 is (threshold value) or bigger, this function outputs logical “1: True”. On the other hand If input 1 is smaller than (threshold value - hysteresis width), this function outputs logical “0: False”.	Threshold value	Hysteresis width
2056	Comparator 6	Comparison function with hysteresis. Input 1 is the input value of this function and input 2 is not used. The 1st function code provides threshold value and the 2nd one provides hysteresis width. If input 1 is (threshold value) or smaller, this function outputs logical “1: True”. On the other hand If input 1 is bigger than (threshold value + hysteresis width), this function outputs logical “0: False”.	Threshold value	Hysteresis width
2071	Window comparator 1	Comparison function with limits. Whether the value of the input is within a preselected range specified with two function codes determines the status of the output. Input 1 is the input value of this function and input 2 is not used. The 1st function code provides upper threshold value and the 2nd one provides lower threshold value. If input 1 is within the range (defined with two function codes), this function outputs logical “1: True”. On the other hand If input 1 is outside of this range, this function outputs logical “0: False”.	Upper threshold	Lower threshold
2072	Window comparator 2	Comparison function with limit. This function has the inverting logic of “Window comparator 1”.	Upper threshold	Lower threshold
2101	High selector	High selector function. This function receives two inputs (input 1 and input 2), selects the higher one automatically, and outputs it. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit
2102	Low selector	Low selector function. This function receives two inputs (input 1 and input 2), selects the lower one automatically, and outputs it. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit
2103	Average of inputs	Average function. This function receives two inputs (input 1 and input 2), averages them, and outputs the result. This function has output limiters (upper/lower) specified with two function codes. The 1st function code provides the upper limit value and the 2nd one provides the lower one.	Upper limit	Lower limit

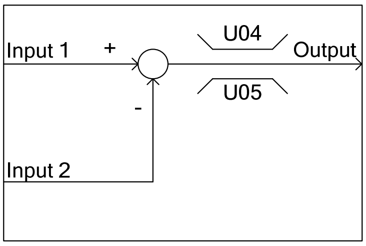
Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
2151	Loading function from S13	Loading function from the function code S13 with scale conversion function. This function loads the setting value of the function code S13, maps the pre-selected range which is specified with two function codes, and outputs the result. The 1st function code provides the maximum scale value of the range and the 2nd one provides the minimum scale value of the range. The function code S13 is the PID process command value via communications in (%).	Maximum scale	Minimum scale
2201	Clip and map function	This function receives single input (input 1), clips a pre-selected range which is specified with two function codes from it, maps 0.00 to 100.00%, and outputs the result. The 1st function code provides the upper limit value of the range and the 2nd one provides the lower limit value of the range. This function can be connected to analog outputs (8000 to 8021) only, and only two of these functions can be used.	Upper limit	Lower limit
2202	Scale converter	Scale conversion function with single input (input 1). This function receives single input (input 1), maps an pre-selected range which is specified with two function codes, and outputs the result. The 1st function code provides the maximum scale value of the range and the 2nd one provides the minimum scale value of the range. This function can be connected to analog outputs (8000 to 8021) only, and only two of these functions can be used.	Maximum scale	Minimum scale
3001	Quadratic function	Quadratic function with limit. This function receives single input (input 1), calculates pre-defined second-order polynomial represented by the following formula, limits the value, and outputs the result.] $K_A \times (\text{Input } 1)^2 + K_B \times \text{input } 1 + K_C$ The 1st function code provides the upper limit value and the 2nd one provides the lower limit value. The coefficients of the polynomial are given by the function codes U92 to U97. Either (3001) or (3002) is available to use, and only one of these functions can be used.	Upper limit	Lower limit
3002	Square root function	Square root function with limit. This function receives single input (input 1), calculates pre-defined square root function represented by the following formula, limits the value, and outputs the result. $\sqrt{\frac{\text{Input1} + K_A}{K_B}} \times K_C$ The 1st function code provides the upper limit value and the 2nd one provides the lower limit value. The coefficients of the polynomial are given by the function codes U92 to U97. Either (3001) or (3002) is available to use, and only one of these functions can be used.	Upper limit	Lower limit

The block diagrams for each operation function block are given below. The setting value for functions 1 and 2 is indicated with U04 and U05.

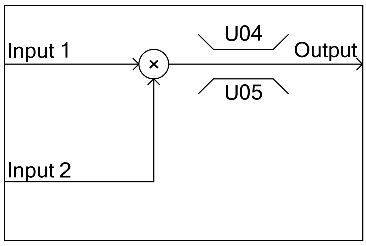
(2001) Adder



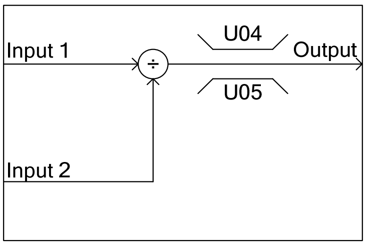
(2002) Subtracter



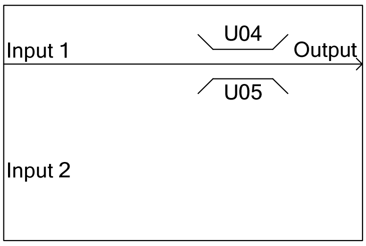
(2003) Multiplier



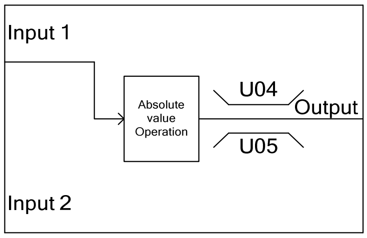
(2004) Divider



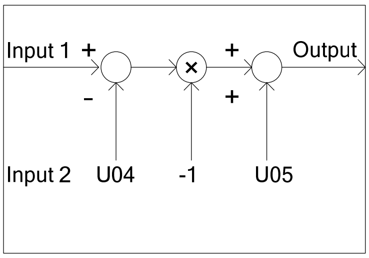
(2005) Limiter



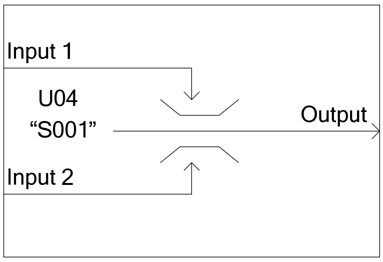
(2006) Absolute value of inputs



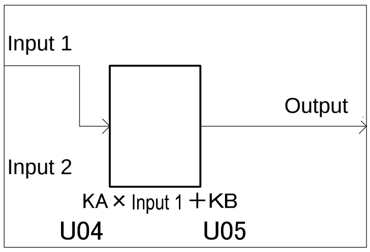
(2007) Inverting adder



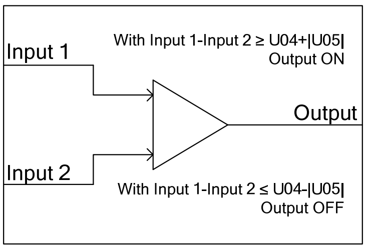
(2008) Variable limiter



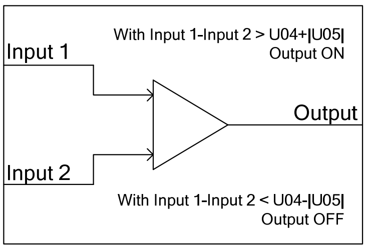
(2009) Linear function



(2051) Comparator 1

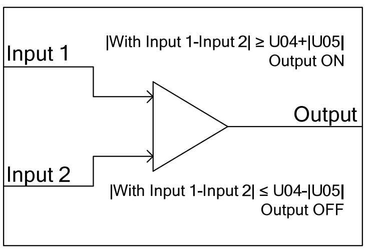


(2052) Comparator 2

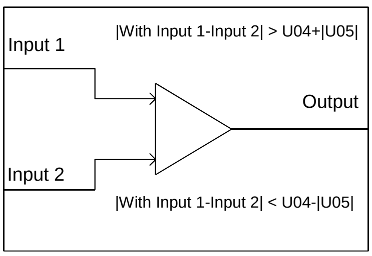


ON is prioritized when both conditions are satisfied.

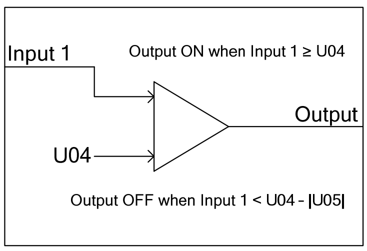
(2053) Comparator 3



(2054) Comparator 4



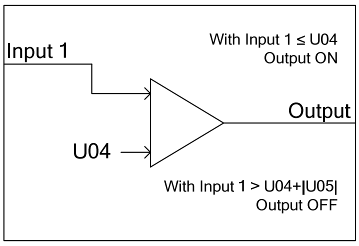
(2055) Comparator 5



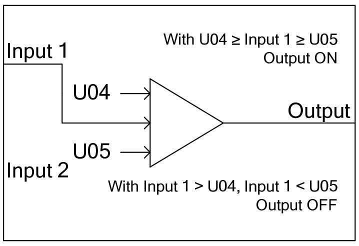
ON is prioritized when both conditions are satisfied.

APPENDICES

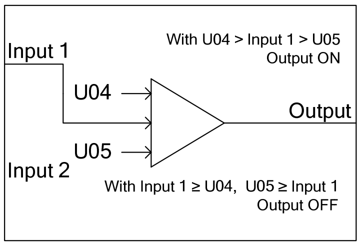
(2056) Comparator 6



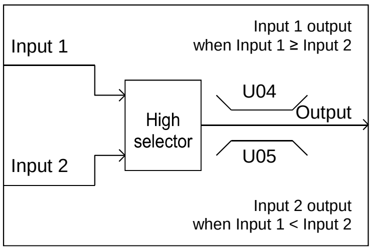
(2071) Window comparator 1



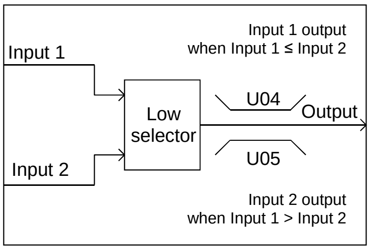
(2072) Window comparator 2



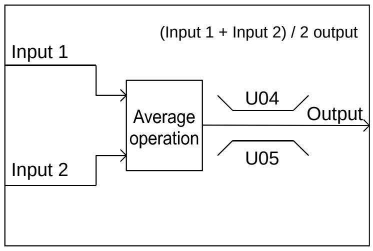
(2101) High selector



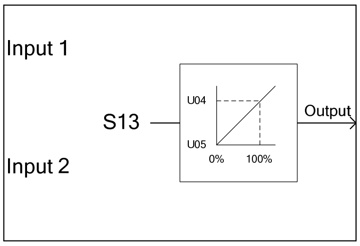
(2102) Low selector



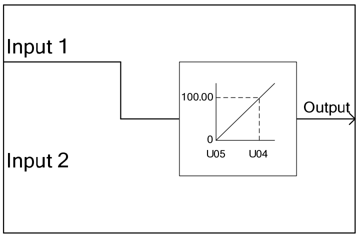
(2103) Average of inputs



(2151) Loading function from S13

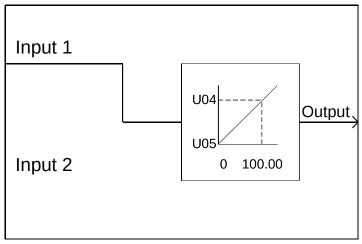


(2201) Clip and map function



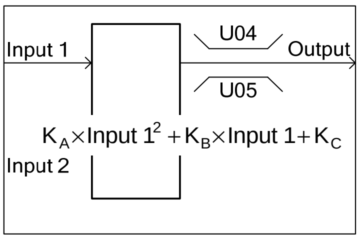
- * Use to connect to analog output terminals.
- * The maximum number of steps used is 2.

(2202) Scale converter

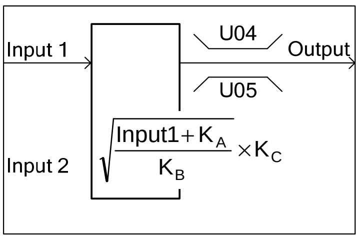


- * For input 1 signal selection, only settings 8000 to 8085 can be used.
- * The maximum number of steps used is 2.

(3001) Quadratic function



(3002) Square root function



* The maximum number of steps used is 1 for either (3001) or (3002).

■ Inputs 1 and 2 (U02, U03, etc.)(Analog)

The following signals are available as analog input signals.

Data	Selectable Signals
8000 to 8065	General-purpose analog output signal (same as signals selected in F31 and F35: output frequency 1, output current, output torque, Input power, DC link bus voltage, etc.) Example: For output frequency 1, maximum frequency (100%) is input as 100.00. Example: For output current, 200% of the inverter rated current is input 100.00. Note: 10 (Universal AO) is not available.
2001 to 2200	Output of step 1 to 200 “SO01” to “SO200”
9001	Analog 12 terminal input signal [12]
9002	Analog C1 terminal input signal [C1] (C1 function)
9003	Analog C1 terminal input signal [C1] (V2 function)
9004	Analog 32 terminal input signal [32] (on option card, OPC-AIO)
9005	Analog C2 terminal input signal [C2] (on option card, OPC-AIO)
9006	temperature detect channel 1 [PT1]
9007	temperature detect channel 2 [PT2]

■ Function 1, Function 2 (U04, U05, etc.)(Analog)

Sets the upper limit and lower limit of operation function block.

Data	Function	Description
-9990 to 0.00 to +9990	Reference value Hysteresis width Upper limit Lower limit Upper threshold Lower threshold Setting value Maximum scale Minimum scale	Setting values for the operation of the function block (selected with the corresponding function code such as U01).

■ **The coefficients of the** conversion functions **(U92 to U97) (Analog)**

Sets the factor of conversions function (3001, 3002) of operation function block.

Function code	Name	Data setting range	Factory default
U92	Mantissa of K_A	Mantissa: -9.999 to 9.999 Exponent part: -5 to 5	0.000
U93	Exponent part of K_A		0
U94	Mantissa of K_B		0.000
U95	Exponent part of K_B		0
U96	Mantissa of K_c		0.000
U97	Exponent part of K_c		0

U92 to U97 can automatically be calculated based on measured data. For details, refer to the descriptions of U101 to U107 (page 322).

[Input: digital, analog] Block function code setting

■ **Lock selection, function 1, function 2 (U01, U04, U05, etc.) (digital,analog)**

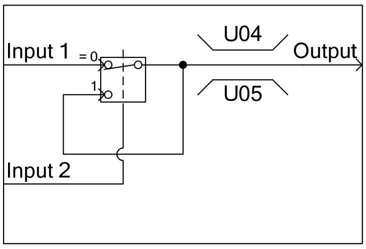
The following items are available as function block.

Note that if the upper and lower limits are identical, there are no upper and lower limits.

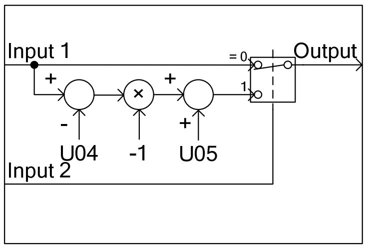
Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
4001	Hold	Function to hold analog input 1 based on digital input 1.	Upper limit	Lower limit
4002	Inverting adder with enable	Function to reverse analog input 1 based on digital input 1.	Subtracted value (former)	Addition value (latter)
4003	Selector 1	Function to select analog input 1 and setting value based on digital input 1.	Setting value	Not required
4004	Selector 2	Function to select setting value 1/2 based on digital input 1.	Setting value 1	Setting value 2
4005	LPF (Low pass filter) with enable	Value of an analog input 1 is filtered through LPF (time constant U04) when the digital input 1 is "1". When the digital input 1 is "0", the analog input 1 is directly output. (LPF maintains the previous output value. Therefore, when the digital 1 input changes from 0 to 1, the output will be the value with the previous output value added as the initial value of LPF.) (No upper/lower limiter)	Time constant 0: No filter 0.01 to 5.00s	Fixed as 0
4006	Rate limiter with enable	Value of an analog input is limited with change rate specified in functions 1 and 2 when the digital input 1 is "1". When the digital input 1 is "0", the analog 1 input is directly output. When setting the initial value, carry out an operation with the initial value for input 1 and 0 applied to input 2. Then, reflect the result as the initial value (= previous output value) with 1 applied to input 2. During the initialization or when the CLC terminal is ON, the previous output value is cleared to 0.	Upward change rate Time taken to change 100% 0: No limit 0.01 to 600 s	Downward change rate Time taken to change 100% 0: The same change rate as function 1 0.01 to 600 s
5000	Selector 3	Function to select analog input 2 based on "SO01" to "SO200".	Step No.	Not required
5100	Selector 4	Function to select analog input 1 and "SO01" to "SO200" based on digital input 1.	Step No.	Not required
6001	Reading function codes	Function to read the content of arbitrary function code. Use the 1st function code (such as U04) to specify a function code group, and the 2nd one (such as U05) to specify the last two digits of the function code number. For the function code settings, refer to "■ Configuration of function codes" in page 319. Both input 1 and input 2 are not used. Data formats that can be read correctly are as follows (the values are restricted between -9990 and 9990 and, for [29], 20000 is indicated as 100%): [1], [2], [3], [4], [5], [6], [7], [8], [9], [10], [12], [22], [24], [29], [35], [37], [45], [61], [67], [68], [74], [92] and [93] Data formats other than the above cannot be read correctly. Do not use any other format.	0 to 255	0 to 99

Block selection (U01 etc.)	Function block	Description	Function 1 (U04 etc.)	Function 2 (U05 etc.)
6002	Writing function codes	This function writes the value of input 1 to a function code (U171 to U175) on the volatile memory (RAM) when the input 2 becomes “1: True”. When the input 2 becomes “0: False”, this function stops to write to the function code (U171 to U175) and maintains the previous value. The value of input 1 is stored to the non-volatile memory (EEPROM) when the inverter detects undervoltage. Because the access arbitration from some steps at a time is not possible, only one step is allowed to access to the same function code in the customizable logic. If the access to the target function code from different steps at a time is executed, the alarm is displayed.	39	71 to 75
6003	Temporary change of function code	This function reflects the value of the specified function code on the volatile memory (RAM) when the input 2 becomes “0: False”. On the other hand when the input 2 does not become “0: False”, this function reflects the value of input 1 in the place of the function code. Refer to “■ Specific function codes” for the applicable function code on page 318. The value on the volatile memory (RAM) is cleared when the inverter is powered off. And the value is read from the non-volatile memory and restored when the inverter is powered on. Set the function code group (function type code) to the1st function code (U04, etc.). Set the lower 2 digits of the function code No. to the 2nd function (U05, etc.). If the specified function code (U04, U05, etc.) is not applicable one, this function outputs zero value. Because the access arbitration from some steps at a time is not possible, only one step is allowed with to access to the same function code in the customizable logic. When the function code is temporarily changed using 6003 during the customize logic operation and if the PC loader is read or copy to the touch panel is performed, the temporary changed data, not the non-volatile memory data, may be copied. Stop the customize logic before these operations.	0 to 255	0 to 99

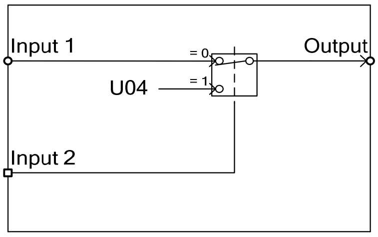
(4001) Hold



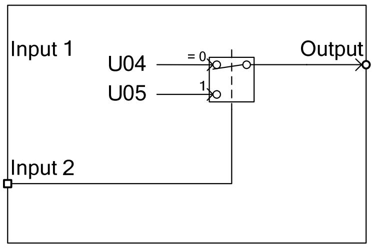
(4002) Inverting adder with enable



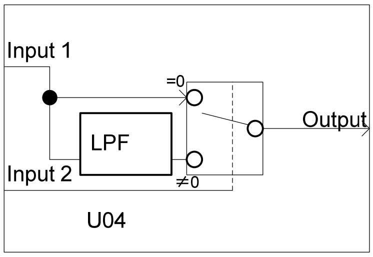
(4003) Selector 1



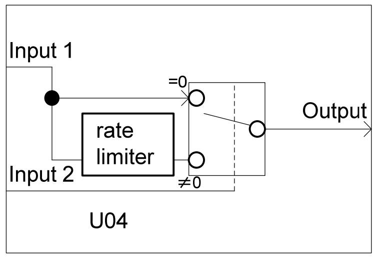
(4004) Selector 2



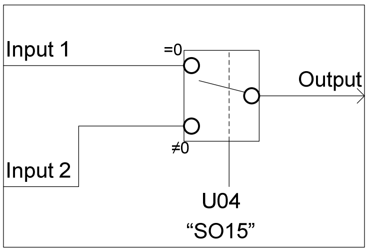
(4005) Low pass filter with enable



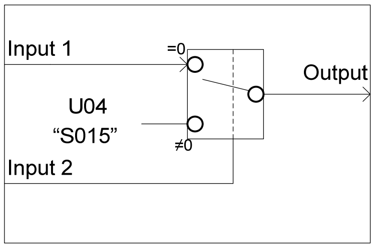
(4006) Rate limiter with enable



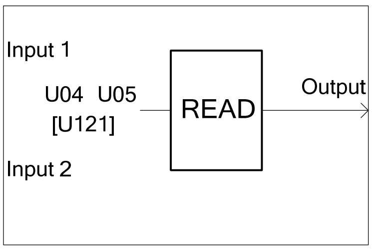
(5000) Selector 3



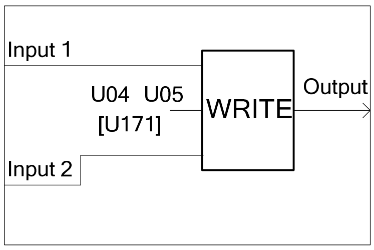
(5100) Selector 4



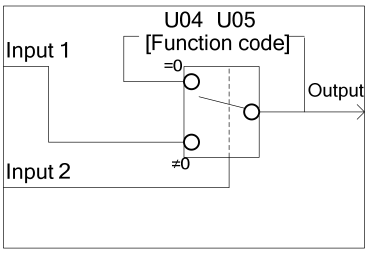
(6001) Reading function codes



(6002) Writing function codes



(6003) Temporary change of function code



■ **Output signal (Digital,analog)**

In the customizable logic, outputs from steps 1 to 10 are issued to SO01 to SO200, respectively.

SO01 to SO200 differ in configuration depending upon the connection destination, as listed below. To relay those outputs to any function other than the customizable logic, route them via customizable logic outputs CL01 to CLO010.

Connection destination of each step output	Configuration	Function code
Input of customizable logic	Select one of the internal step output signals "SO01" to "SO200" in customizable logic input setting.	Such as U02 and U03
Input of inverter sequence processor (such as multistep speed "SS1" or operation command "FWD")	Select one of the internal step output signals "SO01" to "SO200" to be connected to customizable logic output signals 1 to 10 ("CL01" to "CLO10").	U71 to U80
	Select an inverter's sequence processor input function to which one of the customizable logic output signals 1 to 10 ("CL01" to "CLO10") is to be connected. (Same as in E01)	U81 to U90
Analog input (such as auxiliary frequency commands or PID process commands)	Select one of the internal step output signals "SO01" to "SO200" to be connected to customizable logic output signals 1 to 10 ("CL01" to "CLO10").	U71 to U80
	Select an analog input function to which one of the customizable logic output signals 1 to 10 ("CL01" to "CLO10") is to be connected. (Same as in E61)	U81 to U90
General-purpose digital output ([Y] terminals)	Select one of the internal step output signals "SO01" to "SO200" to be connected to customizable logic output signals 1 to 10 ("CL01" to "CLO10").	U71 to U80
	To specify a general-purpose digital output function (on [Y] terminals) to which one of the customizable logic output signals 1 to 10 ("CL01" to "CLO10") is to be connected, select one of "CLO1" to "CLO10" by specifying the general-purpose digital output function on any Y terminal.	E20, E21, E27
General-purpose analog output ([FM1] terminals)	Select one of the internal step output signals "SO01" to "SO200" to be connected to customizable logic output signals 1 to 10 ("CL01" to "CLO10").	U71 to U80
	To specify a general-purpose analog output function (on [FM1] terminals) to which one of the customizable logic output signals 1 to 10 ("CL01" to "CLO10") is to be connected, select one of "CLO1" to "CLO10" by specifying the general-purpose digital output function on any [FM1] terminal.	F31, F35

Note General-purpose digital outputs (on [Y] terminals) are updated every 5 ms. To securely output a customizable logic signal via [Y] terminals, include on- or off-delay timers in the customizable logic. Otherwise, short ON or OFF signals may not be reflected on those terminals.

Function codes	Name	Data setting range	Factory default
U71	Customizable logic output signal 1 (Output selection)	0: Disable 1: Output of step 1, "SO01" 2: Output of step 2, "SO02" ••• 199: Output of step 199, "SO199" 200: Output of step 200, "SO200"	0
U72	Customizable logic output signal 2 (Output selection)		0
U73	Customizable logic output signal 3 (Output selection)		0
U74	Customizable logic output signal 4 (Output selection)		0
U75	Customizable logic output signal 5 (Output selection)		0
U76	Customizable logic output signal 6 (Output selection)		0
U77	Customizable logic output signal 7 (Output selection)		0
U78	Customizable logic output signal 8 (Output selection)		0
U79	Customizable logic output signal 9 (Output selection)		0
U80	Customizable logic output signal 10 (Output selection)		0
U81	Customizable logic output signal 1 (Function selection)	■ If a step output is digital The same value as E98 can be specified. 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" 3(1003): Select multistep frequency (0 to 15 steps) 4(1004): Select ACC/DEC time (2 steps) "RT1" 5(1005): Select ACC/DEC time (4 steps) "RT2" 6(1006): Enable 3-wire operation "HLD" 7(1007): Coast to a stop command "BX" 8(1008): Reset alarm "RST" 9(1009): Enable external alarm trip "THR" (9=Active OFF/1009=Active ON) and so on. ■ If a step output is analog 8001: Auxiliary frequency command 1 8002: Auxiliary frequency command 2 8003: PID process command 8005: PID feedback value 8006: Ratio setting 8007: Analog torque limit value A 8008: Analog torque limit value B 8020: Analog monitor	100
U82	Customizable logic output signal 2 (Function selection)		100
U83	Customizable logic output signal 3 (Function selection)		100
U84	Customizable logic output signal 4 (Function selection)		100
U85	Customizable logic output signal 5 (Function selection)		100
U86	Customizable logic output signal 6 (Function selection)		100
U87	Customizable logic output signal 7 (Function selection)		100
U88	Customizable logic output signal 8 (Function selection)		100
U89	Customizable logic output signal 9 (Function selection)		100
U90	Customizable logic output signal 10 (Function selection)		100

■ **Specific function codes**

The following function codes can take values on memory by using the customizable logic “Function code switch (6003)”. Overwritten values are cleared with power off.

Code	Name	Code	Name
F07	Acceleration time 1	H52	Non-linear V/f 2 (Frequency)
F08	Deceleration time 1	H53	Non-linear V/f 2 (Voltage)
F15	Frequency limiter (Upper)	H57	1st S-curve acceleration range (At starting)
F16	Frequency limiter (Lower)	H58	2nd S-curve acceleration range (At arrival)
F21	DC braking 1 (Braking level)	H59	1st S-curve deceleration range (At starting)
F22	DC braking 1 (Braking time)	H60	2nd S-curve deceleration range (At arrival)
F23	Starting frequency 1	H91	PID feedback wire break detection
F24	Starting frequency 1 (Holding time)	J03	PID control P (Gain)
F25	Stop frequency	J04	PID control I (Integral time)
F40	Torque limiter 1 (Driving)	J05	PID control D (Differential time)
F41	Torque limiter 1 (Braking)	J06	PID control (Feedback filter)
F44	Current limiter (Level)	J10	PID control (Anti-reset windup)
E10	Acceleration time 2	J12	PID control (Upper limit of warning (AH))
E11	Deceleration time 2	J13	PID control (Lower limit of warning (AL))
E12	Acceleration time 3	J15	PID control (Sleep frequency)
E13	Deceleration time 3	J16	PID control (Sleep timer)
E14	Acceleration time 4	J17	PID control (Wakeup frequency)
E15	Deceleration time 4	J18	PID control (Upper limit of PID process output)
C05	Multistep frequency 1	J19	PID control (Lower limit of PID process output)
C06	Multistep frequency 2	d01	Speed control 1 (Speed command filter)
C07	Multistep frequency 3	d02	Speed control 1 (Speed detection filter)
C08	Multistep frequency 4	d03	Speed control 1 (P (Gain))
C09	Multistep frequency 5	d04	Speed control 1(I (Integral time))
H50	Non-linear V/f 1 (Frequency)	d05	Speed control 1 (FF (Gain))
H51	Non-linear V/f 1 (Voltage)		

■ Function codes for the customizable logic

Function code number	Name	Range	Minimum unit	Remarks
U121 to U140	User parameter 1 to 20	-9990.00 to 9990.00 Effective number are 3 digits.	0.01 to 10	
U171 to U175	Storage area 1 to 5	-9990.00 to 9990.00 Effective number are 3 digits.	0.01 to 10	Memorize the data when powered off.

■ Configuration of function codes

Set a function code group (code from the following table) to function 1 (such as U04) and set the last two digits of the function code number to function 2 (such as U05) to specify individual function codes.

Group	Code		Name	Group	Code		Name
F	0	00_H	Basic function	U1	39	27_H	For customizable logic
E	1	01_H	Terminal function	y	14	$0E_H$	Link function
C	2	02_H	Control function	K	28	$1C_H$	Touch panel function
P	3	03_H	Motor1	M	8	08_H	Monitor data
H	4	04_H	High performance function	o	6	06_H	Option function
H1	31	$1F_H$	High performance function 1	d	19	13_H	Applied function 2
A	5	05_H	Speed control 2	U	11	$0B_H$	Customizable logic
J	13	$0D_H$	Applied function 1	W	15	$0F_H$	Monitor 2
J1	48	30_H	Applied function 1	X	16	10_H	Alarm 1
				Z	17	11_H	Alarm 2

■ Task process cycle setting (U100)

U100 data	Data
0	Automatically adjusts the task cycle from 2 ms to 10 ms depending on the number of used steps. This is the factory default. It is recommended to use this value.
2	2 ms: Up to 10 steps. If it exceeds 10 steps, the customizable logic does not work.
5	5 ms: Up to 50 steps. If it exceeds 50 steps, the customizable logic does not work.
10	10 ms: Up to 100 steps. If it exceeds 100 steps, the customizable logic does not work.
20	20 ms Up to 200 steps.

Note that if it exceeds the steps defined in 2, 5 or 10, the customizable logic does not work.

■ Operating precautions

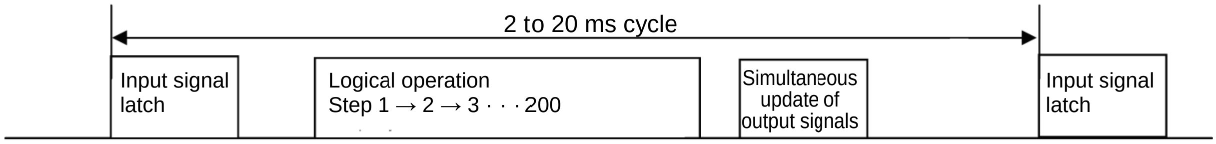
The customizable logics are executed within 2 ms to 20 ms (according to U100) and processed in the following procedure:

(1) First, latch the external input signals for all the customizable logics from step 1 to 200 to maintain synchronism.

(2) Perform logical operations sequentially from step 1 to 200.

(3) If an output of a step is an input to the next step, outputs of step with high priority can be used in the same process.

(4) The customizable logic simultaneously updates 10 output signals.



Note that if you do not consider the process order of customizable logic when configuring a function block, the expected output may not be obtained, the operation can be slower or a hazard signal can occur, because the output signal of a step is not available until the next cycle.

⚠CAUTION
Changing a functional code related to the customizable logic (U code etc.) or turning ON the customizable logic cancel signal "CLC" causes change in operation sequence depending on the setting, which may suddenly start an operation or start an unexpected action. Fully ensure it is safe before performing the operation. **An accident or physical injury may occur.**

■ Customizable logic timer monitor (Step selection) (U91, X89 to X93)

The monitor function codes can be used to monitor the I/O status or timer's operation state in the customized logics.

Table J.18 Selection of monitor timer

Function code	Function	Remarks
U91	0: Monitor not active (the monitor data is 0) 1 to 200: set the step No. to monitor	The setting value is cleared to 0 when powered off.

Table J.19 Monitor method

Monitor method	Function code	Data
Communication	X89 customizable logic (digital I/O)	Digital I/O data for the step defined in U91 (only for monitoring)
	X90 customizable logic (timer monitor)	Data of the timer/counter value for the step defined in U91 (only for monitoring)
	X91 customizable logic (analog input 1)	Analog input 1 data for the step defined in U91 (only for monitoring)
	X92 customizable logic (analog input 2)	Analog input 2 data for the step defined in U91 (only for monitoring)
	X93 customizable logic (analog output)	Analog output data for the step defined in U91 (only for monitoring)

■ **Cancel customizable logic "CLC" (function codes E01 to E05 Data = 80)**

Customizable logic operations can temporarily be disabled so that the inverter can be operated without the customizable logic's logical circuit and timer operation, for example during maintenance.

"CLC"	Function
OFF	Customizable logic enabled (according to U00 setting)
ON	Customizable logic disabled

Note: If you turn ON the customizable logic cancellation signal "CLC", a sequence by the customizable logic is cleared, which can suddenly start operation depending on the settings. Ensure the safety and check the operation before switching the signal.

■ **Clear all customizable logic timers "CLTC" (function codes E01 to E05 Data = 81)**

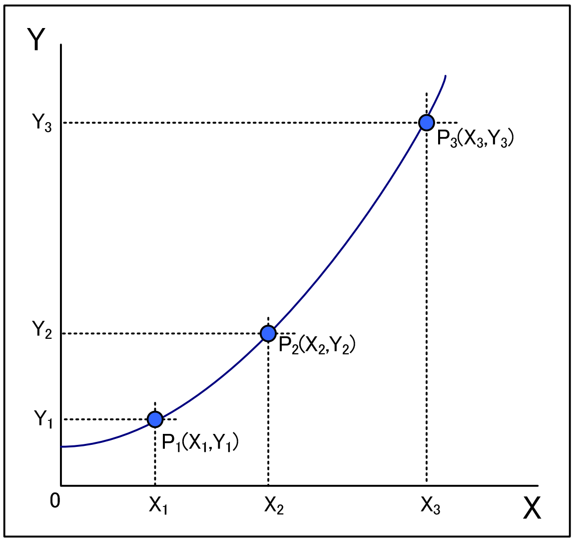
If the CLTC terminal function is assigned to a general-purpose input terminal and this input is turn ON, all the general-purpose timers and counters in the customizable logic are reset. It is used to reset and restart the system, when, for example, the timing of external sequence cannot be consistent with internal customizable logic due to a momentary power failure.

"CLTC"	Function
OFF	Normal operation
ON	Resets all the general-purpose timers and counters in the customizable logic. (To reactivate it, turn it OFF again.)

J.10 U1 codes (Customizable logic operation)

U101 to U106	Customizable logic (Operating point 1 (X1, Y1), Operating point 2 (X2, Y2), Operating point 3 (X3, Y3))

By using function block 3001, quadratic function $K_A \cdot x^2 + K_B \cdot x + K_C$ is calculated relative to the input signal x as shown in the following diagram, allowing the output to be obtained. Here, K_A, K_B, and K_C are coefficients, and they can be set with function codes.



Coefficients K_A, K_B, K_C

Coefficients K_A, K_B, K_C for quadratic function $K_A \cdot x^2 + K_B \cdot x + K_C$ can be set within the following ranges.

	Setting range
Coefficient KA	-9.999×10^5 to 9.999×10^5
Coefficient KB	-9.999×10^5 to 9.999×10^5
Coefficient KC	-9.999×10^5 to 9.999×10^5

These coefficients are set using function codes U92 to U97.

Function code	Name	Setting range
U92	Coefficient KA mantissa portion	-9.999 to 9.999
U93	Coefficient KA exponent portion	-5 to 5
U94	Coefficient KB mantissa portion	-9.999 to 9.999
U95	Coefficient KB exponent portion	-5 to 5
U96	Coefficient KC mantissa portion	-9.999 to 9.999
U97	Coefficient KC exponent portion	-5 to 5

Instead of setting the coefficients individually, they can be calculated and set automatically in function codes U92 to U97, by changing U107 from 0 to 1 after setting the arbitrary three sets of operating point data P_1 (X_1, Y_1), P_2 (X_2, Y_2), and P_3 (X_3, Y_3) from the above diagram in function codes U101 to U106.

Function code	Name	Setting range
U101	Operating point data P1 (X1)	-999.00 to 0.00 to 9990.00
U102	Operating point data P1 (Y1)	-999.00 to 0.00 to 9990.00
U103	Operating point data P2 (X2)	-999.00 to 0.00 to 9990.00
U104	Operating point data P2 (Y2)	-999.00 to 0.00 to 9990.00
U105	Operating point data P3 (X3)	-999.00 to 0.00 to 9990.00
U106	Operating point data P3 (Y3)	-999.00 to 0.00 to 9990.00
U107	Automatic calculation	0: No calculation, 1: Calculation

U107	Auto calculation of the coefficients of the quadratic function

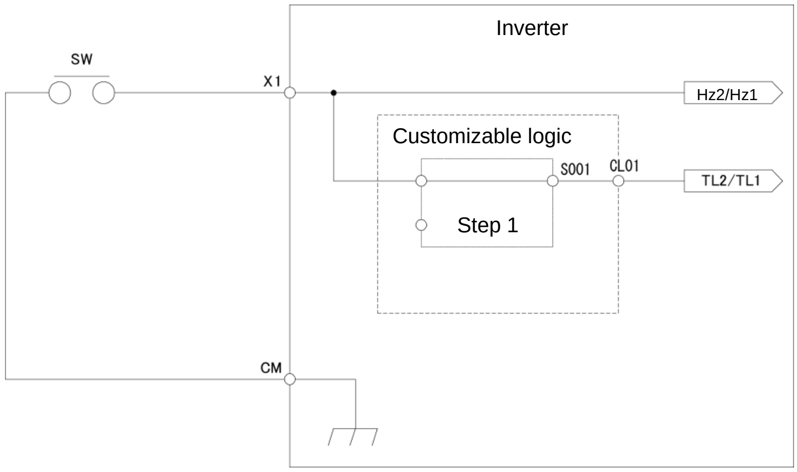
Set "1" to U107 in order to fit the approximate coefficients of the quadratic function (3001) ($K_A \times Input1^2 + K_B \times Input1 + K_C$) to a characteristic represented by three operating points which are given by function codes U101 to U106. Coefficients (K_A, K_B, K_C) of the polynomial are automatically calculated and the results are stored inside the function codes U92 to U97, and U107 reverts to "0".

U107 data	Function
0	Invalid
1	Execute calculation (to get the coefficients (KA, KB, KC) of the following polynomial $K_A \times Input1^2 + K_B \times Input1 + K_C$)

■ Setting examples of customizable logic

Setting example 1: Use one switch to change multiple signals

If you use one switch to change the frequency setting 2/frequency setting 1 and torque limit 2/torque limit 1 simultaneously, replace an external circuit that is conventionally needed with a customizable logic reducing the general-purpose input terminals used to a single terminal.

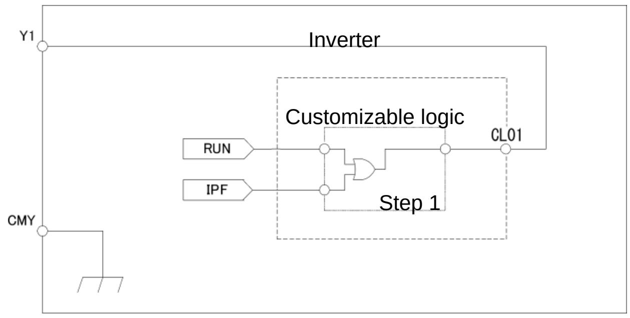


To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function code			Setting value	Settings	Remarks
E01	Terminal [X1] function		11	Select frequency command 2/1 "Hz2/Hz1"	Can be used in parallel as general-purpose input terminals
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	10	Through output + General-purpose timer	Mode selection
U02		(Input 1)	4001	Terminal [X1] input signal X1	
U71	Customizable logic: Output signal 1	(Output selection)	1	Output of step 1, "SO01"	
U81		(Function selection)	14	Select torque limiter level 2/1 "TL2/TL1"	

Setting example 2: Bring multiple output signals in a single signal

If the general-purpose RUN signal is kept ON at restart after momentary power failure, replace an external circuit that is conventionally needed with a customizable logic sequence to reduce the general-purpose output terminals and external relays.

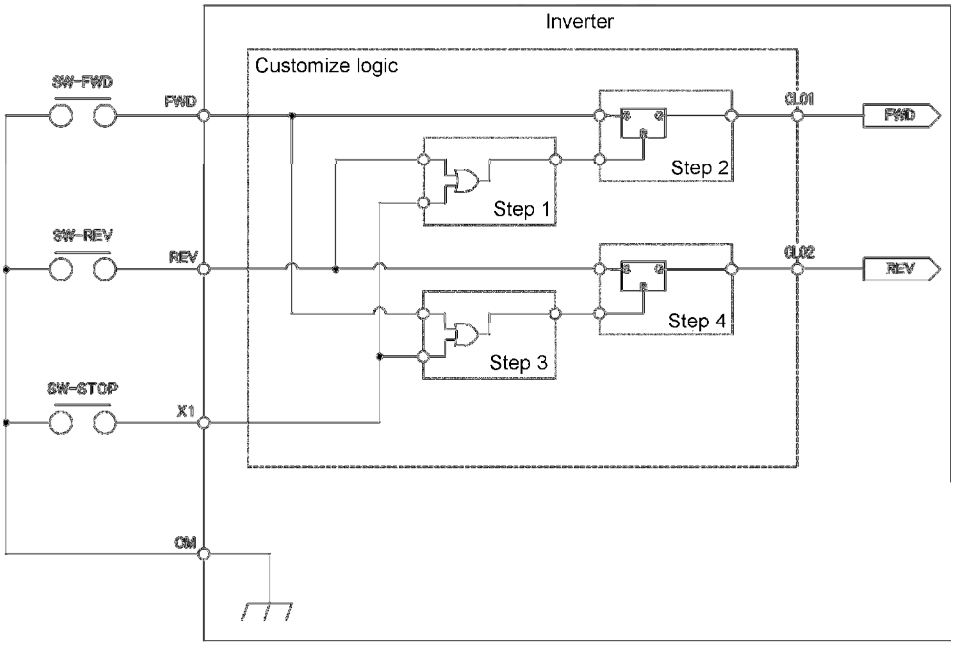


To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function code			Setting value	Settings	Remarks
E20	Terminal [Y1] function		111	Customizable logic output signal 1 “CL01”	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	30	Logical OR + General-purpose timer	Mode selection
U02		(Input 1)	0	During operation “RUN”	
U03		(Input 2)	6	Auto-restarting after momentary power failure “IPF”	
U71	Customizable logic output signal 1	(Output selection)	1	Output of step 1, “SO01”	
U81		(Function selection)	100	No function assigned “NONE”	

Setting example 3: One-shot operation

The required operation is as follows: SW-FWD or SW-REV switch is short-circuited to start the operation and the SW-STOP switch is short-circuited to stop the operation (equivalent to FWD/REV keys/STOP key on keypad), if the above operation is required, replace an external circuit that is conventionally needed with customizable the customized logic.



To configure this customizable logic, set the function codes as follows. (Timer selection) and (Timer setting) do not need to be modified if no change is made.

Function code			Setting value	Settings	Remarks
F02	Operation method		1	External signal	
E01	Terminal [X1] function		100	No function assigned “NONE”	
E98	Terminal [FWD] function		100	No function assigned “NONE”	
E99	Terminal [REV] function		100	No function assigned “NONE”	
U00	Customizable Logic (Mode selection)		1	Enable	
U01	Customizable logic: Step 1	(Block selection)	30	Logical OR + General-purpose timer	Mode selection
U02		(Input 1)	4011	Terminal REV input signal “SW-REV”	
U03		(Input 2)	4001	Terminal X1 input signal “SW-STOP”	
U06	Customizable logic: Step 2	(Block selection)	60	Reset priority flip-flop + General-purpose timer	Mode selection
U07		(Input 1)	4010	Terminal FWD input signal “SW-FWD”	
U08		(Input 2)	2001	Output of step 1 “SO01”	
U11	Customizable logic: Step 3	(Block selection)	30	Logical OR + General-purpose timer	Mode selection
U12		(Input 1)	4010	Terminal FWD input signal “SW-FWD”	
U13		(Input 2)	4001	Terminal X1 input signal “SW-STOP”	
U16	Customizable logic: Step 4	(Block selection)	60	Reset priority flip-flop + General-purpose timer	Mode selection
U17		(Input 1)	4011	Terminal REV input signal “SW-REV”	
U18		(Input 2)	2003	Output of step 3 “SO03”	
U71	Customizable logic output signal 1	(Output selection)	2	Output of step 2 “SO02”	“FWD” command
U72	Customizable logic output signal 2		4	Output of step 4 “SO04”	“REV” command
U81	Customizable logic output signal 1	(Function selection)	98	Run forward/stop command “FWD”	
U82	Customizable logic output signal 2		99	Run reverse/stop command “REV”	

J.11 y codes (Link functions)

y01 to y20	RS-485 setting 1, RS-485 setting 2

In the RS-485 communication, two systems can be connected.

System	Connection method	Function code	Equipment that can be connected
First system	Via RS-485 communication link (port 1) (RJ-45 connector to connect keypad)	y01 to y10	Standard/ optional keypad Inverter supporting loader Host equipments (upper equipments)
Second systems	Via RS-485 communications link (port 2) Via digital input terminal blocks (DX+, DX-)	y11 to y20	Host equipments (upper equipments) Other inverters at mutual operation Inverter supporting loader

Overview of the equipments is given below.

(1) Standard /optional keypad
Standard / optional keypad can be connected to operate and monitor the inverter.
Regardless of the y code settings, standard / optional keypad is available.

(2) Inverter supporting loader (FRENIC loader)
Inverter supporting (monitor, function code editing, test operation) can be performed by connecting a computer with the FRENIC loader installed.

For the y codes setting, refer to the function codes y01 to y10.

(3) Host equipments (upper equipments)
Host equipments (upper equipments) such as PLC and controller can be connected to control and monitor the inverter. Modbus RTU* protocol, BACnet protocol or Fuji general-purpose inverter protocol can be selected for communication.

(4) Other inverters in mutual operation

*: Modbus RTU is a protocol defined by Modicon.

For details, refer to the RS-485 Communication User's Manual.

■ **Station addresses (y01, y11)**

Set the station addresses for the RS-485 communication. The setting range depends on the protocol.

Protocol	Range	Broadcast
Modbus RTU	1 to 247	0
Protocol for loader commands	1 to 255	—
Fuji general-purpose inverter	1 to 31	99
N2 protocol	1 to 255	—
BACnet	0 to 127	255

- When specifying a value out of range, no response is returned.
- The settings to use inverter supporting loader should match with the computer's settings.

APPENDICES

■ Communications error processing (y02, y12)

Select an operation when an error occurs in the RS-485 communication.

The RS-485 errors are logical errors such as address error, parity error and framing error, transmission errors and disconnection errors (the latter specified in y08 and y18). These errors occur only when the inverter is configured to receive the operation command or frequency command via the RS-485 communication. If the operation command or frequency command is not issued via the RS-485 communication, or when the inverter is stopped, the system does not determine an error.

y02, y12 data	Function
0	Displays the RS-485 communication error (*er8* for y02, *erp* for y12), and immediately stops the operation (trip by alarm).
1	Operates for a period specified in the error process timer (y03, y13), and then displays the RS-485 communication error (*er8* for y02, *erp* for y12), and stops the operation (trip by alarm).
2	Retries the communication for a period specified in the error process timer (y03, y13), and if the communication is recovered, the operation continues. Displays the RS-485 communication error (*er8* for y02, *erp* for y12) if the communication is not recovered, and immediately stops the operation (trip by alarm).
3	Continues the operation if a communication error occurs.

For details, refer to the RS-485 Communication User's Manual.

■ Error process timer (y03, y13)

Sets the error process timer, as explained above for the communications error processing parameters (y02, y12). Refer also to the section of disconnection detection time (y08, y18).

- Data setting range: 0.0 to 60.0 (s)

■ Baud rate (y04, y14)

Sets the transmission baud rate.

- For inverter supporting loader (via RS-485): Match the value with the computer setting.

y04 and y14 data	Function
0	2400 bps
1	4800 bps
2	9600 bps
3	19200 bps
4	38400 bps

■ Data length selection (y05, y15)

Sets the character length.

- For inverter supporting loader (via RS-485): The value does not need to be set since it automatically becomes 8 bits. (It also applies to Modbus RTU.)

y05 and y15 data	Function
0	8 bits
1	7 bits

■ Parity selection (y06, y16)

Sets the parity.

- For inverter supporting loader (via RS-485): The value does not need to be set since it automatically becomes even parity.

y06 and y16 data	Function
0	No parity bit (2 bits of stop bit for Modbus RTU)
1	Even parity (1 bit of stop bit for Modbus RTU)
2	Odd parity (1 bit of stop bit for Modbus RTU)
3	No parity bit (1 bits of stop bit for Modbus RTU)

■ Stop bit selection (y07, y17)

Sets the stop bit.

- For inverter supporting loader (via RS-485):
  The value does not need to be set since it automatically becomes 1 bit.

  For Modbus RTU: The value does not need to be set since it is automatically determined in conjunction with the parity bit (function y06, y16).

y07 and y17 data	Function
0	2 bits
1	1 bit

■ Communication time-out detection timer (y08, y18)

Sets a period from the time when the system detects communication time-out (for any reason such as disconnection in equipment that periodically access to the station within a specific time) during the operation using the RS-485 communication, until the time when the system processes the communication errors.

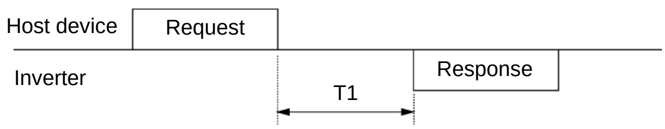
For details on processing communication errors, refer to y02 and y12.

y08 and y18 data	Function
0	Disconnection is not detected.
1 to 60	Detection time from 1 to 60 (s)

■ Response interval time (y09, y19)

Sets a period from the time when the system receives a request from host equipment (upper equipment such as computer or PLC) until the time when it returns a response. In case of the host equipments that are slow to process the task from completed transmission to completed reception preparation, a timing can be synchronized by setting a response interval time.

- Data setting range: 0.00 to 1.00 (s)



T1 = Response interval time + α

α: Processing time inside the inverter. It varies depending on the timing and command.

For details, refer to the RS-485 Communication User's Manual.

Note: To set an inverter by the inverter supporting loader via the RS-485 communication, consider the performance and condition of the computer and converter (such as USB-RS-485 converter).
(Some converters monitor communication status and switch transmission and reception with timer.)

■ Protocol selection (y10, y20)

Selects a communication protocol.

y10 and y20 data	Function
0	Modbus RTU protocol
1	FRENIC Loader protocol
2	Fuji general-purpose inverter protocol
3	N2 protocol
5	BACnet protocol
50	Mutual operation (only y20)

y60, y61	**BACnet Device instance number (Upper and Lower)**

These settings specify Device instance number for identifying itself on the application layer of BACnet protocol.

Setting method is different by y61 setting value as below:

Data for y61	Device instance number	Setting range*1
0	(y60 * 1000) + MAC address *2	(y60 * 1000) + (0 to 127)
128 to 999	(y60 * 1000) + y61	(y60 * 1000) + (128 to 999)

*1 Maximum setting range for device instance number is: 0 to 4194302.

*2 MAC address is specified by y01 or y11.

y95	**Data clear processing for communications**

If any of the communication error alarms (*er8*, *erp*, *er4*, *er5*, *ert*) occurs in RS-485 or bus option, the data of communication command function codes (S codes) can automatically be cleared.

Since the frequency and operation commands are also disabled when the data is cleared, the inverter does not start unintentionally when an alarm is released.

y95 data	Function
0	When a communication error alarm occurs, the function code Sxx data is not cleared (compatible with the conventional mode).
1	When a communication error alarm occurs, the function codes S01, S05 and S19 data is cleared.
2	When a communication error alarm occurs, the bits assigned in function code S06 for operation command is cleared.
3	Clear operations of 1 and 2 above are performed.

y97	**Communication data storage selection**

The inverter memory (non-volatile memory) has a limited rewritable times (100 thousand to 1 million times). If the count immoderately increases, the data cannot be modified or saved, causing a memory error.

If the data should frequently be overwritten via communication, it can be written in the temporary memory instead of the non-volatile memory. This allows saving rewritable times to the non-volatile memory, which can avoid a memory error.

If y97 is set to “2”, the data written in the temporary memory is stored (All Saved) in the non-volatile memory.

To change the y97 data, it is necessary to press the STOP + ⌃/⌄ keys (simultaneous keying).

y97 data	Function
0	Store into nonvolatile memory (Rewritable times are limited)
1	Write into temporary memory (Rewritable times are unlimited)
2	Store all data from temporary memory to nonvolatile memory (After storing all data, the y97 data return to 1)

y98	**Bus function (Mode selection)** (Refer to H30)

For details on setting the y98 bus function (mode selection), refer to the description of H30.

y99	Loader link function (Mode selection)

Function code to switch the links to the inverter supporting loader software (FRENIC Loader). Rewriting y99 with the inverter supporting loader software (FRENIC Loader) enables the frequency command and operation command from the inverter supporting loader software (FRENIC Loader). You do not need to use the keypad since the data is rewritten from the inverter supporting loader.

If the operation command is configured to be given from the inverter supporting loader software, and if the computer starts to go out of control during the operation and a stop command from the loader software is ignored, remove the communication cable connected to the computer that runs the inverter supporting loader software, and connect the keypad to set the y99 data to 0. By setting the y99 data to 0, the operation is isolated from the inverter supporting loader software's commands, switching to the commands of inverter's own settings (such as function code H30).

The y99 data is not saved in the inverter; the setting is lost and returned to 0 when powered off.

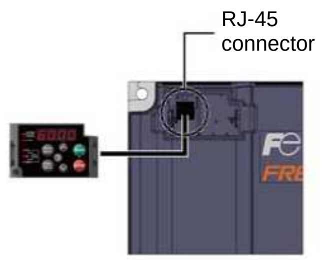
y99 data	Function	
	Frequency command	Run command source
0	From function codes H30 and y98	From function codes H30 and y98
1	Command issued from FRENIC loader	From function codes H30 and y98
2	From function codes H30 and y98	Command issued from FRENIC loader
3	Command issued from FRENIC loader	Command issued from FRENIC loader

Appendix K   Overview of RS-485 Communication

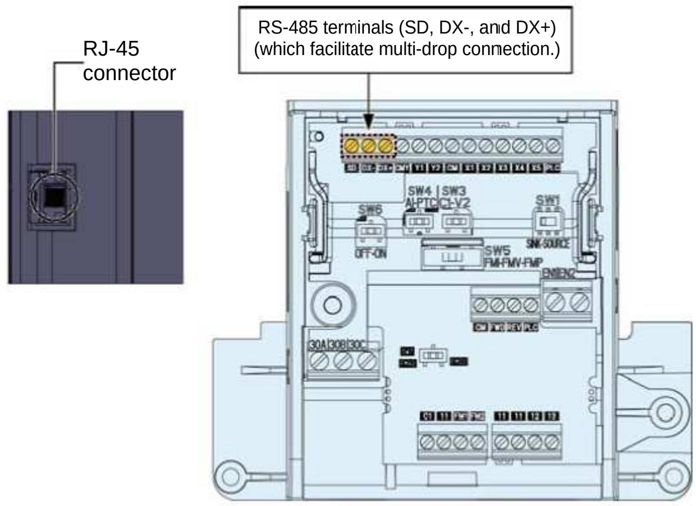
The FRENIC-Ace has two RS-485 communication ports at the locations shown below.

(i) Communication port 1: RJ-45 connector for the keypad (modular jack)

(ii) Communication port 2:
RJ-45 connector for RS-485 communication (modular jack) * only for type FRN-E2■-2/4/7GA/A/E/U/K, -2/4/7J-H;
RS-485 terminals (control circuit terminals SD, DX-, DX+) * only for FRN-E2■-2/4/7GB, -4C-H



COM port 1



COM port 2

Using the RS-485 communication ports shown above enables the extended functions listed below.

- Remote operation from a keypad at the remote location (COM port 1)
  The standard keypad enables remote operation by mounting the keypad on a remote panel and connecting the keypad to RJ-45 connector with an extension cable (maximum cable length: 20 m)
- Operation by FRENIC Loader (COM ports 1 and 2)
  It is possible to edit and monitor the function codes by connecting the RJ-45 connector (RS-485 communication) in the inverter and PC and using the inverter support loader (FRENIC Loader, see “Appendix L FRENIC Loader Overview”).
- Control via host equipment (COM ports 1 and 2)
  Connecting the inverter to the host equipment (upper controller), such as a computer and programmable controller (PLC), enables to control the inverter as a subordinate device.

  Besides the communication port 1 (RJ-45 connector) shared with the keypad, the FRENIC-Ace has the RS-485 communication port 2 by default.

  The protocols for controlling inverters support the Modbus RTU protocol (compliant to the protocol established by Modicon Inc.) that is widely used and the Fuji Electric’s general-purpose inverter protocol that is common to Fuji Electric’s inverters including conventional series.

Note
- Connecting the keypad to the COM port 1 automatically switches to the keypad protocol; there is no need to modify the function code setting.
- When using FRENIC Loader, which requires a special protocol for handling Loader commands, you need to set up some communication function codes accordingly.

  For details, refer to the FRENIC Loader Instruction Manual.

For details of RS-485 communication, refer to the RS-485 Communication User’s Manual.

K.1 RS-485 common specifications

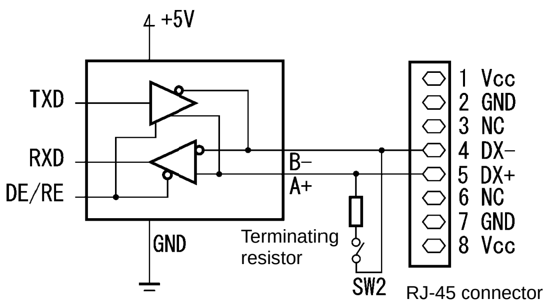
Item	Specifications				
Protocol	FGI-BUS	Modbus RTU	FRENIC Loader (support only for standard)	Metasys N2	BACnet
Compliance	Fuji general-purpose inverter protocol	Modicon Modbus RTU-compliant (only in RTU mode)	Dedicated protocol (Not disclosed)	Jonson control N2 prtocol	ASHRAE/ANSI /ISO-compliant
Connection quantity	Host device: 1, Inverters: Up to 31				
Electrical mode	EIA RS-485				
Connection to RS-485	RJ-45 connector or terminal block				
Synchronization	Asynchronous				
Communication system	Half-duplex				
Transmission speed (bps)	2400, 4800, 9600, 19200 and 38400 bps			9600 bps	9600, 19200, 38400 and 76800bps
Max. transmission cable length	500 m (1640 ft)				
Station No.	1 to 31	1 to 247	1 to 255	0 to 255	0 to 127
Message frame format	FGI-BUS	Modbus RTU	FRENIC Loader	Metasys N2	MS/TP frame format
Frame synchronization	Header character detection (SOH)	Detection of no-data time (for 3 characters period)	Header character detection (Start code: 96_H)	Header character detection (Start code: $3E_H$)	Detection of two header characters (preamble) (0×55, 0×FF)
Frame length	Normal transmission: 16 bytes (fixed) High-speed transmission: 8 or 12 bytes	Variable length	Variable length	Variable length	Variable length
Max. transfer data	Write: 1 word Read: 1 word	Write: 100 words Read: 100 words	Write: 41 words Read: 41 words	Write: 1 words Read: 1 words	Write: 50 words Read: 50 words
Messaging system	Polling/Selecting/Broadcast		Command message	Polling/Selecting	Polling/Selecting /Broadcast
Transmission character format	ASCII	Binary	Binary	ASCII	Binary *Data of character string read: ASCII
Character length	8 or 7 bit Selectable with the function code	8 bits (fixed)	8 bits (fixed)	8 bits (fixed)	8 bits (fixed)
Parity	Even, Odd, or None (selectable by the function code)		Even (fixed)	None	None
Stop bit length	1 or 2 bit Selectable with the function code	Parity none: 2/1 bit Parity: 1 bit Select by parity setting.	1 bit (fixed)	1 bit (fixed)	1 bit (fixed)
Error checking	Sum-check	CRC-16	Sum-check	Sum-check	Header CRC Data CRC

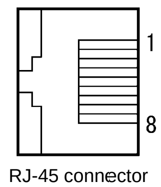
K.2 Terminal specifications

[1] RS-485 communication port 1 (for connecting the keypad)

The port designed for a standard keypad uses an RJ-45 connector having the following pin assignment:

Pin	Signal name	Description
1	Vcc	Power source for the keypad (5 V)
2	GND	Ground signal
3	NC	Not connected
4	DX-	RS-485 signal, low side *2
5	DX+	RS-485 signal, high side *2
6	NC	Not connected
7	GND	Ground signal
8	Vcc	Power source for the keypad (5 V)



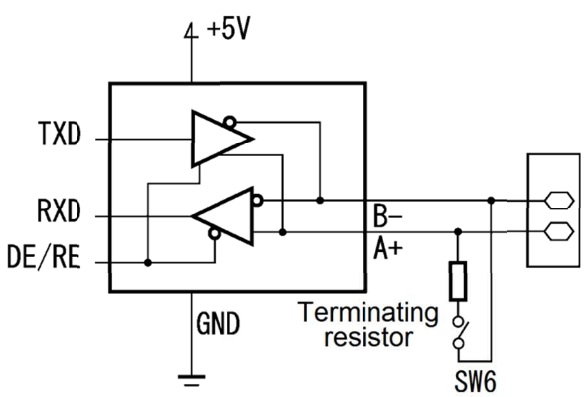


* The terminating resistor 112 Ω is built in. Open/close with SW2. *
For details about SW6, refer to the FRENIC-Ace User's Manual Chapter 2, "2.2.8 Operating slide switches."

Note: The power supply for keypad is available in the RJ-45 connector for RS-485 communication (Pins 1, 2, 7, and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use pins **4 and 5 only**.

[2] RS-485 communication port 2 (terminal block)

Terminal symbol	Description	Remarks
DX-	RS-485 signal, low side	Built-in terminating resistor: 112 Ω Open/close with SW6*
DX+	RS-485 signal, high side	



* The terminating resistor 112 Ω is built in. Open/close with SW6. *
For details about SW6, refer to the FRENIC-Ace User's Manual Chapter 2 of, "2.2.8 Operating slide switches".

K.3 Connection method

- Up to 31 inverters can be connected to one host equipment.
- The protocol is commonly used in the FRENIC series of general-purpose inverters, so programs for similar host equipment can run/stop the inverter.
  (The parameters modes may differ depending on the equipment.)
- Fixed-length transmission frames facilitate developing communication control programs for hosts.

For details of RS-485 communication, refer to the RS-485 Communication User's Manual.

Multi-drop connection using the RS-485 communication port 1 (for connecting the keypad)

For connecting inverters in multi-drop connection, use the branch adapters for multi-drop connection as shown below.

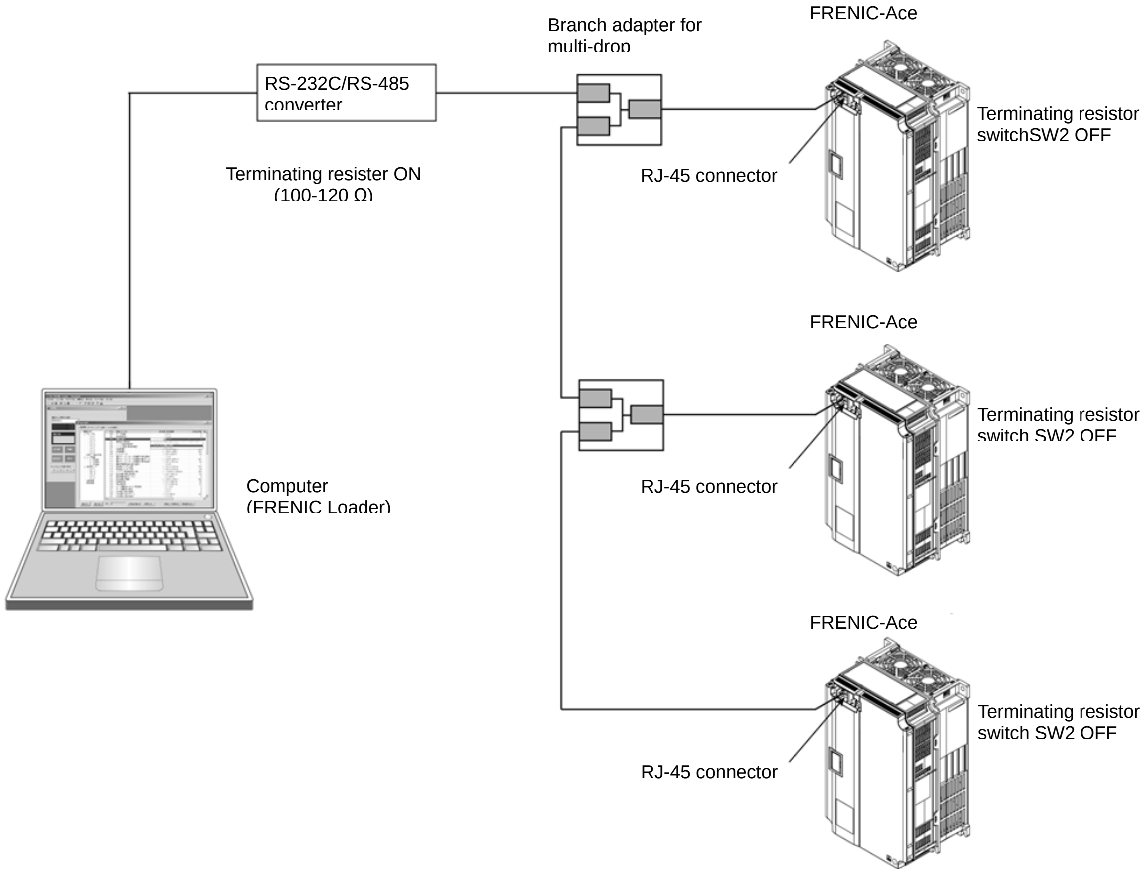


Figure K.3-1 Multi-drop Connection for RS-485 Communication Port 1 (Using the RJ-45 Connector)

Note
- The power supply for keypad is available in the RJ-45 connector for RS-485 communication (COM port 1) (pins 1, 2, 7 and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use pins **4 and 5 only**. (refer to "K.2 Terminal specifications")
- When selecting additional devices to prevent the damage or malfunction of the control PCB caused by external noises or eliminate the influence of common mode noises, be sure to see "K.4 RS-485 connection devices"
- The maximum wiring length must be 500 m.
- Use the cables and converters meeting the modes for connecting the RS-485 communication ports. (Refer to "[2] Requirements for the cable (COM port 1: for RJ-45 connector)" in " K.4 ")

APPENDICES

<u>Multi-drop connection using the RS-485 communication port 2 (RJ-45 connector) (only for FRN-E2 ■ -2/4/7GA/A/E/U/K, J-H)</u>

For connecting inverters in multi-drop connection, use the branch adapters for multi-drop connection as shown below. For connecting inverters in multi-drop connection, use the branch adapters for multi-drop connection as shown below.

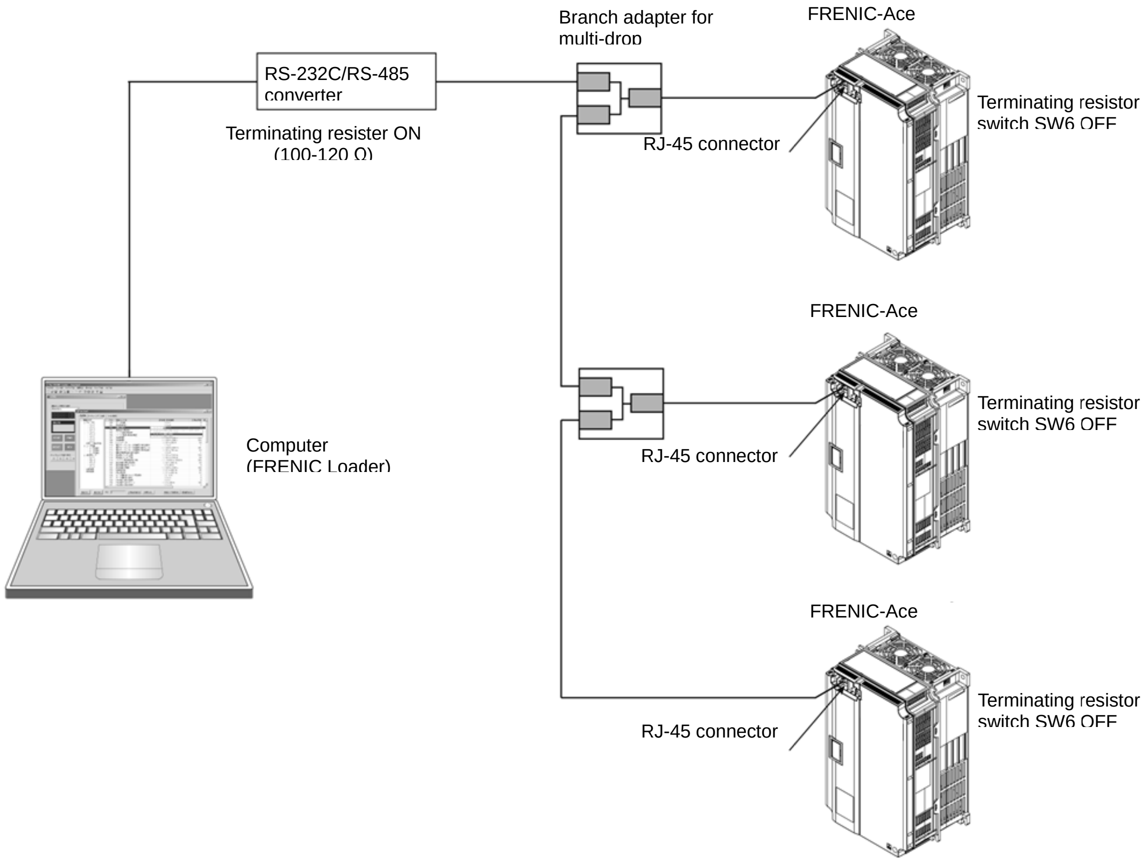


Figure K.3-2 Multi-drop Connection for RS-485 Communication Port 2 (Using the RJ-45 Connector)

Note Use the cables and converters meeting the modes for connecting the RS-485 communication ports. (Refer to "[2] Requirements for the cable (COM port 1: for RJ-45 connector)" in "K.4 ")

Multi-drop connection using the RS-485 communication port 2 (on the terminal block) (only for FRN-E2■ -2/4/7GB,-4C-H)

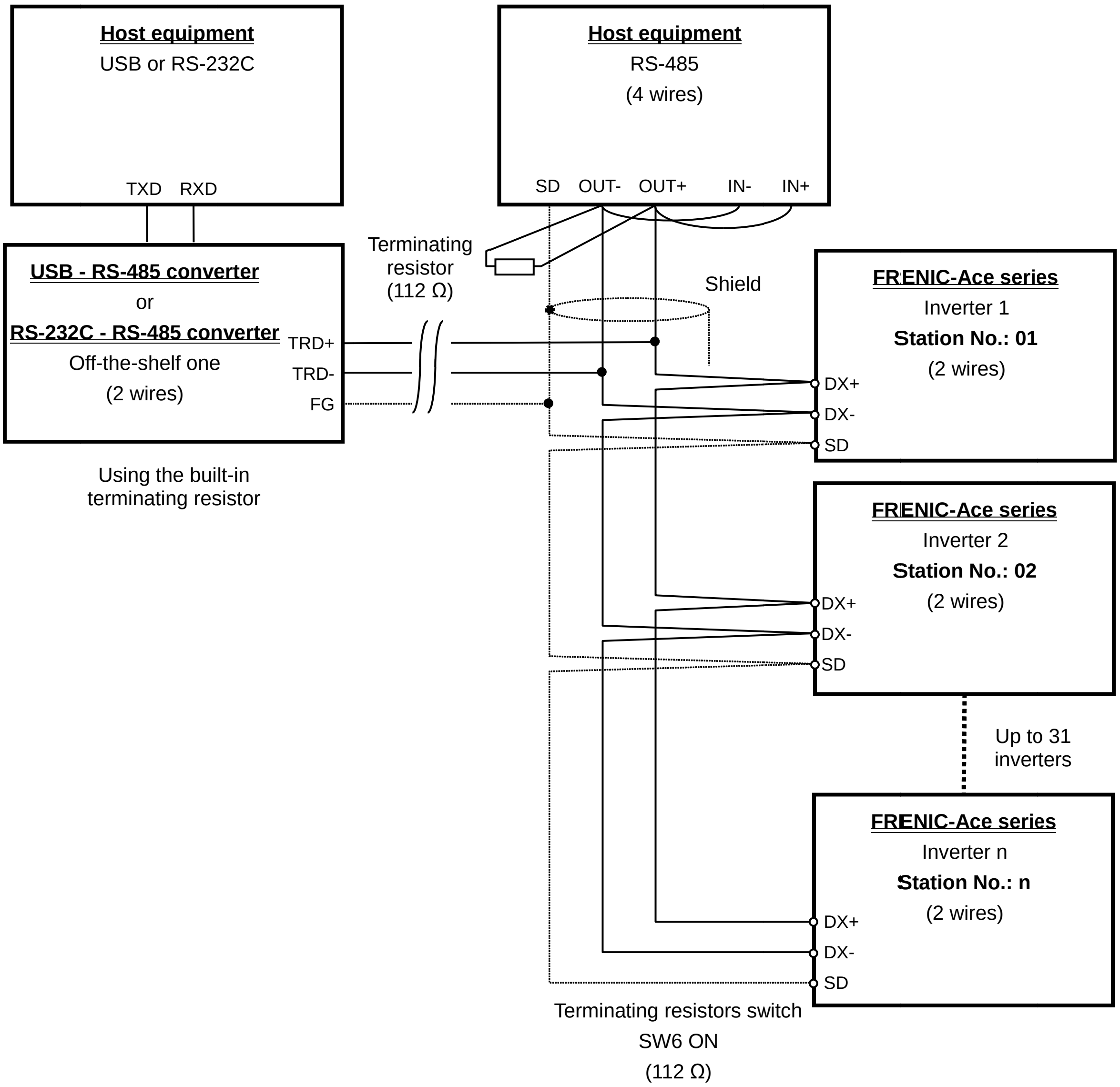


Figure K.3-3 Multi-drop Connection Diagram (Connecting to the Terminal Block)

Note: Use the cables and converters meeting the modes for connecting the RS-485 communication ports. (Refer to "[3] Requirements for the cable (COM port 2: for RS-485 connector)" in "K.4 "

K.4 RS-485 connection devices

This section describes the devices required for connecting the inverter to a PC having no RS-485 interface or for connecting two or more inverters in multi-drop network.

[1] Converter

In general, PC is not equipped with an RS-485 port. Therefore, an RS-232C–RS-485 or USB–RS-485 converter is required. To use the equipment properly, be sure to use the converter which meets the mode below. Be careful that a converter not recommended may not work properly.

Requirements for recommended converters

Send/receive switching system:	Auto-switching by monitoring the transmission data at PC (RS-232C)
Electric isolation:	Electrically isolated from the RS-485 port
Fail-safe:	Fail-safe facility (*)
Other requirements:	Superior noise immunity

Note: The fail-safe function refers to a feature that ensures the RS-485 receiver's output is at "logic high" even if the RS-485 receiver's input is opened or short-circuited or all the RS-485 drivers are inactive. (Refer to "Figure K.4-1 Communication Level Conversion".)

Recommended converters

System Sacom Sales Corporation (Japan) : KS-485PTI (RS-232C-RS-485 converter)
: USB-485I RJ45-T4P (USB-RS-485 converter)

Send/receive switching system

The RS-485 communication system of the inverter acts in half-duplex mode (2-wire), so the converter must have a send/receive switching function. Generally, the switching system may be either one of the followings.

(1) Auto-switching by monitoring the transmitted data
(2) Switching by RS-232C control signal (RTS or DTR) from the computer

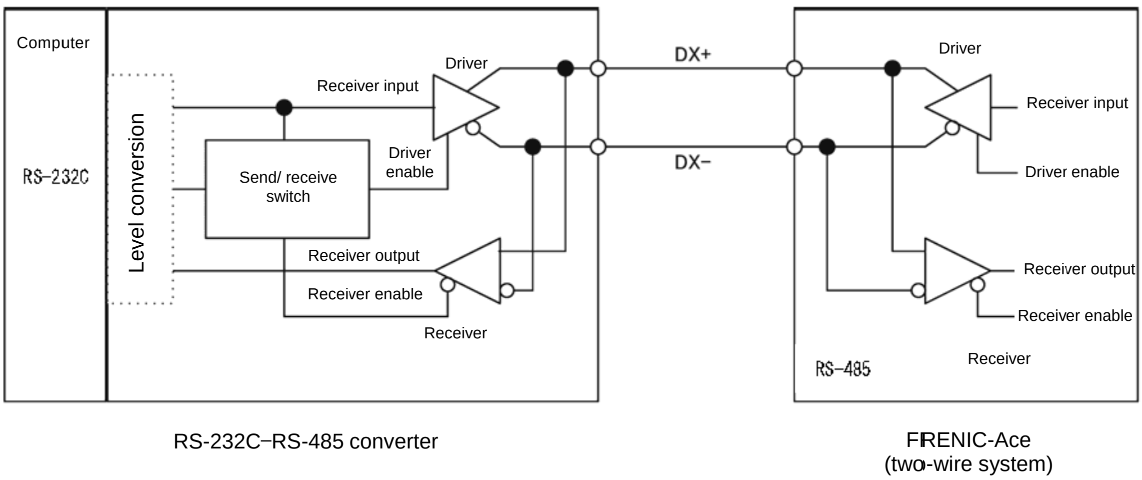


Figure K.4-1 Communication Level Conversion

[2] Requirements for the cable (COM port 1: for RJ-45 connector)

Use a standard 10BASE-T/100BASE-TX LAN cable (US ANSI/TIA/EIA-568A category 5 compliant, straight cable).

Note: The power supply for keypad is available in the RJ-45 connector for RS-485 communication (COM port 1) (pins 1, 2, 7 and 8). When connecting other devices to the RJ-45 connector, take care not to use those pins. Use pins **4 and 5 only**.

[3] Requirements for the cable (COM port 2: for RS-485 connector)

To ensure the reliability of connection, use twisted pair shield cables for long distance transmission AWG 16 to 26.

Recommended LAN cable manufacturer:

FURUKAWA Electric Co., LTD AWM2789 cable for long distance connection
Type (Product code): DC23225-2PB

[4] Branch adapter for multi-drop

The RJ-45 connector is used as the communication connector. To use a standard LAN cable for multi-drop connection, use the branch adapter for the RJ-45 connector.

Recommended branch adapter

SK Koki (Japan): MS8-BA-JJJ

K.5 RS-485 noise suppression

Depending on the operating environment, the malfunction may occur due to the noise generated by the inverter. Possible measures to prevent such malfunction are: separating the wiring, use of shielded cable, isolating the power supply, and adding an inductance component. The description shown below is an example of adding an inductance.

Refer to the RS-485 Communication User’s Manual, The FRENIC-Ace User’s Manual Chapter 2, Section 2.2.4 “Precautions for long wiring (between inverter and motor)” for details.

Adding inductance components

Keep the impedance of the signal circuit high against the high-frequency noises by inserting an inductance component, such as by inserting a choke coil in series or passing the signal line through a ferrite core.

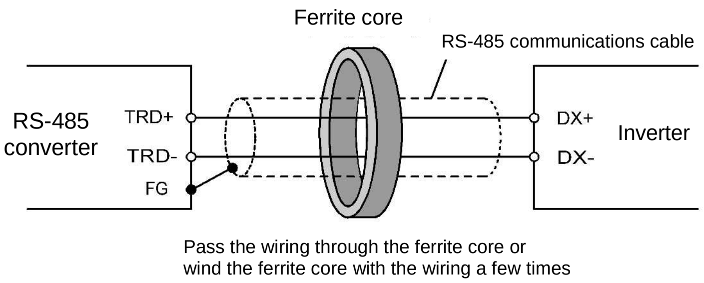


Figure K.5-1 Adding an Inductance Component

Appendix L FRENIC Loader Overview

FRENIC Loader is a software tool that supports the operation of the inverter via an RS-485 communication.

This software allows you to edit, set, and manage the inverter function codes, monitor running data, and remotely operate the operation and stop, as well as monitor the running status and alarm history.

Note: With special order-made inverters, FRENIC Loader may not be able to display some function codes normally.

For details, refer to the FRENIC Loader Instruction Manual.

L.1 Modes

Item		Modes	Remarks
Name		Inverter support loader (FRENIC Loader)	
Supported inverter		FRENIC-MEGA/Multi/VP/Mini/Ace/GX1/HF/ eHVAC	(Note 1)
Number of connected inverters		USB connection: 1 RS-485 connection: Up to 31	
Recommended cable		Cable (10BASE-T or more) compliant with EIA568 RJ-45 connector	For the RS-485 interface
Operating environment	CPU	Intel Pentium III 600 MHz or later	(Note 2)
	OS	Microsoft Windows XP (32 bit) Microsoft Vista (32 bit) Microsoft 7 (32 bit, 64 bit)	(Note 3)
	Memory	RAM area with 512 MB or more	1GB or more is recommended.
	Hard disk	40 MB or more of empty area	
	COM port	RS-232C (conversion to RS-485 communication is required to connect inverters) or USB	
	Monitor	800 x 600 or higher	XGA (1024×768) 32 bit Color or more monitor is recommended.
Transmission requirements	COM port	COM1 to COM255	PC COM ports assigned to Loader
	Transmission speed	USB connection: Between loader and keypad = fixed at 12 Mbps Between keypad and inverter = fixed at 19200 (bps) RS-485 connection: 38400, 19200, 9600, 4800, 2400 (bps)	19200 bps or more is recommended (Note 4)
	Character length	8 bit	Prefixed
	Stop bit length	1 bit	Prefixed
	Parity	Even	Prefixed
	No. of retries	None or 1 to 10	No. of retry times before detecting communication error
	Timeout setting	100 ms, 300 ms, 500 ms, 1.0 s to 1.5 s to 1.9 s, 2.0 to 9.0 s, 10.0 to 60.0 s	Set longer than the "Response interval time y09"

Note 1: The loader model is unavailable which does not support the protocol for loader commands (SX protocol).

Note 2: Use a PC with as high a performance as possible, since some slow PCs may not properly refresh the operation monitoring and test-running windows.

Note 3: Only Microsoft Windows XP service pack 2 (SP2) or later is supported.

Note 4: To connect to the network where there is a FRENIC-Mini inverter, choose 19200 bps or below.

L.2 Connection

By connecting a number of inverters to one PC, you can control one inverter at a time or a number of inverters simultaneously. You can also simultaneously monitor a number of inverters on the multi monitor.

📖 For information how to connect a PC to one or more inverters, refer to the RS-485 Communication User's Manual (MEH448).

L.3 Function overview

[1] Configuring inverter's function code

You can set, edit, and check the setting of the inverter's function code data.

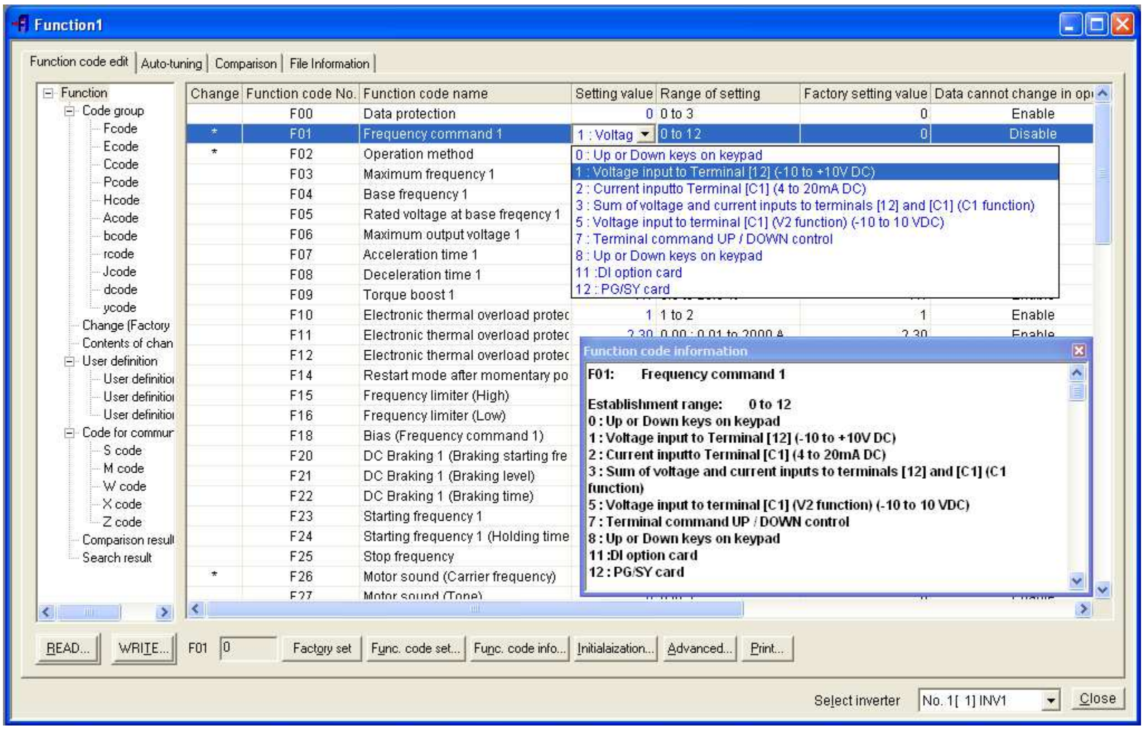
List and Edit

In List and edit, you can list and edit function codes with function code No., name, set value, set range, and factory default.

You can also list function codes by any of the following groups according to your needs:

- Function code group
- Function codes that have been modified from their factory defaults
- Result of comparison with the settings of the inverter
- Result of search by function code name
- User-specified function code set

etc.



Comparison

You can compare the function code data currently being edited with that saved in a file or stored in the inverter.

To perform a comparison and review the result displayed, click the Comparison tab and then click the Compared with inverter tab or click the Compared with file tab, and specify the file name.

The result of the comparison will be displayed also in the Comparison Result column of the list._

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File information

Clicking the File information tab displays the property and comments for identifying the function code editing file.

(1) Property
Shows file name, inverter model, inverter's capacity, date of readout, etc.

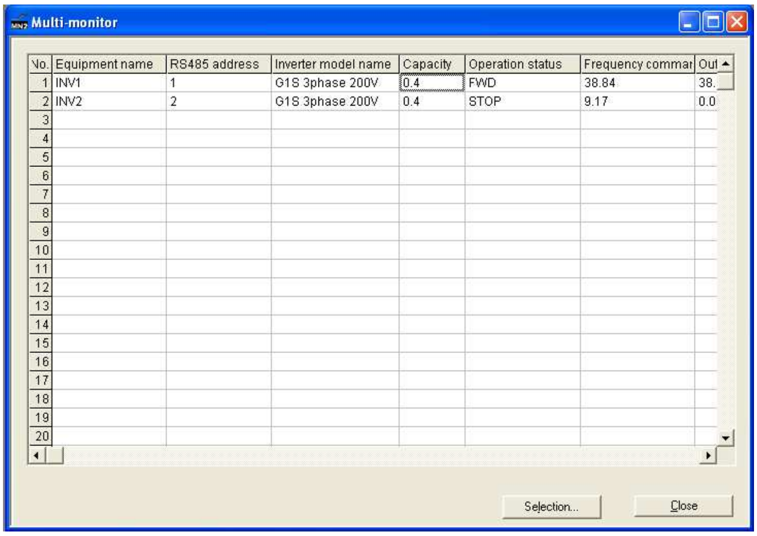
(2) Comment
Displays the comments you have entered. You can write any comments necessary for identifying the file.

[2] Multi-monitor

This feature lists the status of all the inverters that are marked "connected" in the configuration table.

Multi-monitor

Allows you to monitor the status of more than one inverter in a list format.

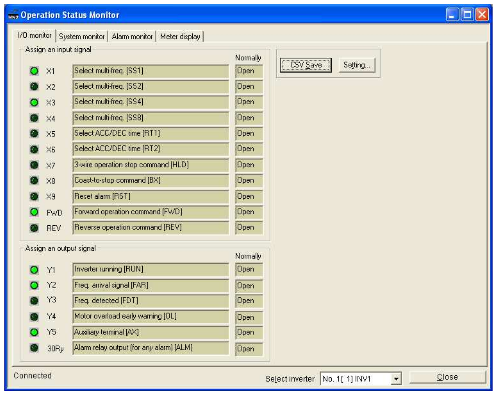


[3] Running status monitor

The running status monitor offers four monitor functions: I/O monitor, System monitor, Alarm monitor, and Meter display. You can choose an appropriate monitoring format according to the purpose and situation.

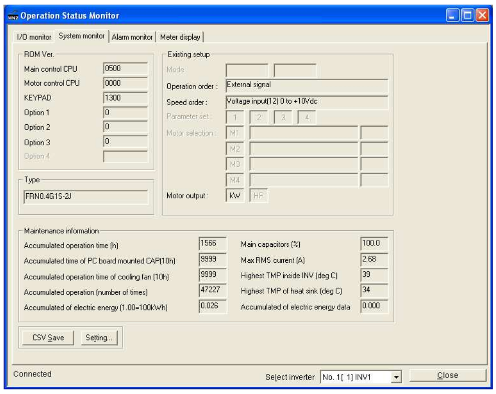
<u>I/O monitor</u>

Allows you to monitor the ON/OFF states of the digital input signals to the inverter and the transistor output signals.



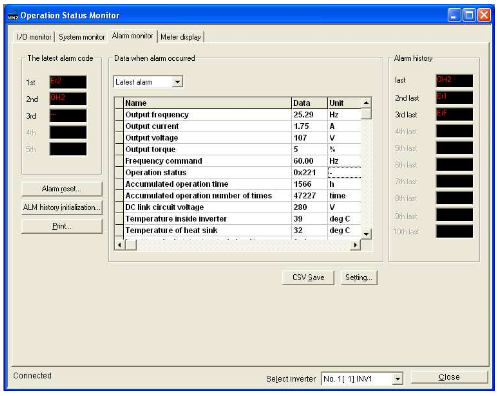
<u>System monitor</u>

The inverter’s system information (version, type, maintenance information, etc.) can be confirmed.



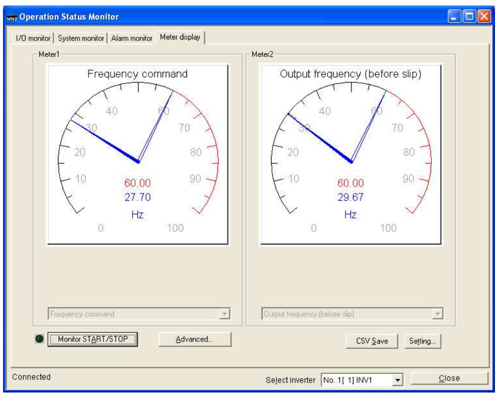
<u>Alarm monitor</u>

The alarm monitor shows the alarm status of the selected inverter. In this window you can check the details of the alarm currently active and related information.



<u>Meter display</u>

Displays analog readouts of the selected inverter (such as output frequency) on analog meters. The example on the right displays the reference frequency and the output frequency.



APPENDICES

[4] Test-running

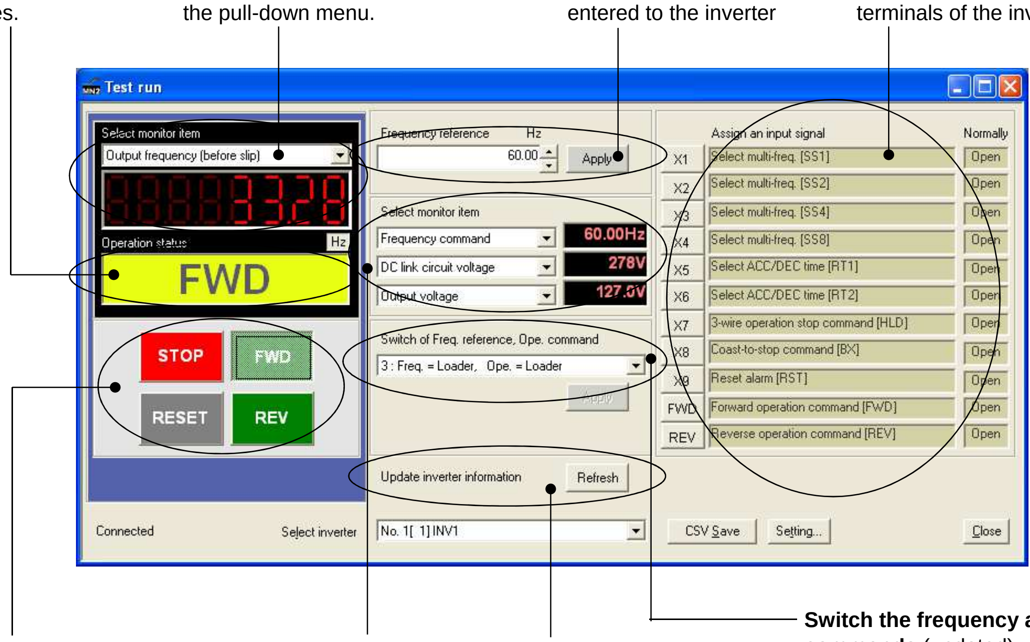
The Test-running feature allows you to test-run the motor in the forward or reverse direction while monitoring the running status of the selected inverter.

Operation status
Shows FWD, REV, STOP and alarm codes.

Select monitor item
Select what is to be displayed (e.g., output frequency or current) here using the pull-down menu.

Frequency command (updated)
Transmits the frequency entered to the inverter

I/O terminal status
Shows the status of the programmable digital I/O terminals of the inverter.



Operation buttons*

Select monitor item
Select the operation status information to be monitored in real-time.

Update with latest inverter information (updated)
Click the Refresh button to refresh the contents of this window to show the latest inverter status.

Switch the frequency and running commands (updated)
Select the frequency and run command sources and click Apply.

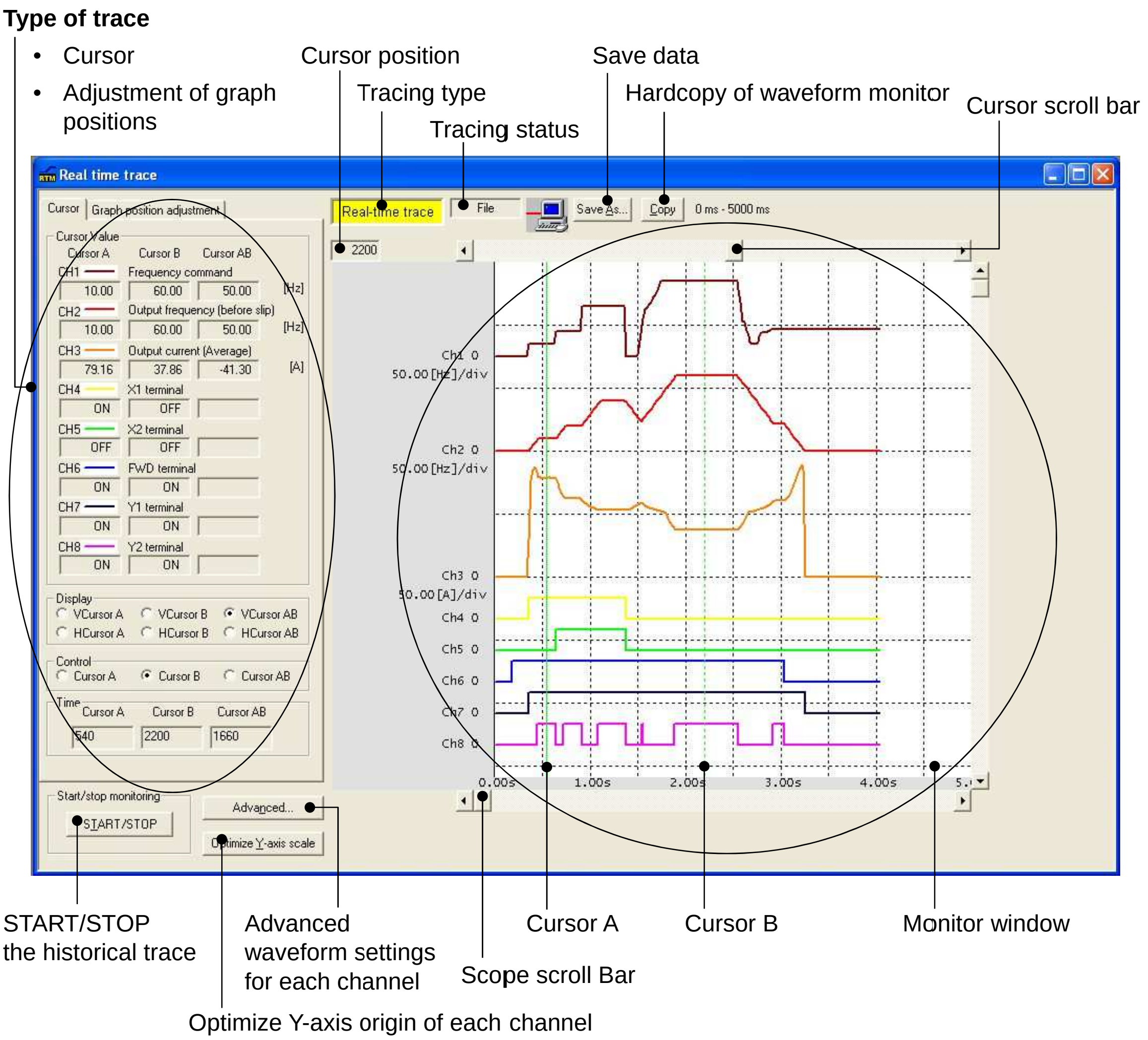
*: The table below lists the details of the operation buttons.

Button	Functionality
STOP	Stop the motor.
FWD	The motor runs in the normal rotation. (depressed state indicates running state.)
REV	The motor runs in the reverse rotation. (depressed state indicates running state.)
RESET	Reset all alarm information saved in the selected inverter.

[5] Real-time trace

When continuously observing the running state of inverters while the sampling time can be selected between 1 ms to 200 ms, up to 4 analog channels and up to 8 digital channels are available (up to 8 channels in total).

(Maximum waveform amount: 15360 sample/channel)



Note

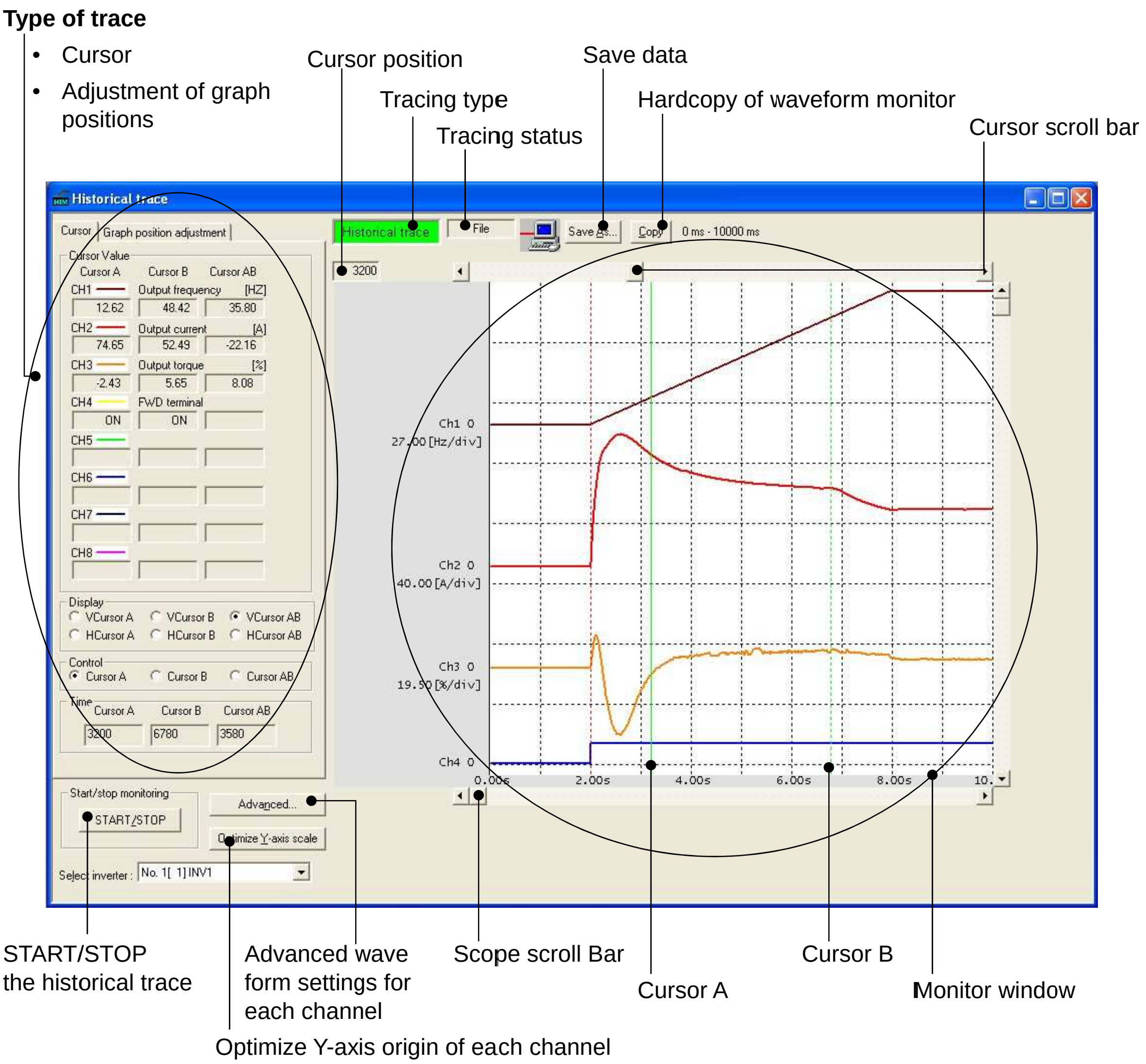
- The station No can not be changed while tracing waveforms real time.
- The detailed waveform can not be changed while tracing waveforms real time.
- Change the real time trace window to change the size of monitor window.
- The scrolling and cursor moving are unavailable in the waveform monitoring window while tracing waveforms real time.

[6] Historical trace

The sampling time can be selected between 1 ms to 200 ms. When observing the running state of inverters in much finer continuous waveforms than real-time trace, up to 4 analog channels and up to 8 digital channels are available (up to 8 channels in total).

- Amount of saved data: 2 kbyte

(Waveform capturing capability: Max. 500 sample/channel)



Note

- The station No can not be changed while tracing waveforms historically.
- The detailed waveform can not be changed while tracing waveforms historically.
- Change the historical trace window to change the size of monitor window.

Appendix M Options for communication and operation overview

In FRENIC-Ace it is possible to install one communication card and one terminal block type option card. A mounting adapter is required to install the communication card to the inverter.

M.1 Mounting adapter (for communication option card)

This adapter is required for mounting the communication option card to FRENIC-Ace.

Table M.1-1

Type	Option Name	Functions
OPC-E2-ADP1	Option card mounting adapter for small-size inverter.	FRN0001E2■-2□Hto FRN0020E2■-2□H. FRN0002E2■-4□H to FRN0044E2■-4□H. FRN0001E2■-7□H to FRN0011E2■-7□H.
OPC-E2-ADP2	Option card mounting adapter for mid-size inverter.	FRN0059E2■-4□H and FRN0072E2■-4□H
OPC-E2-ADP3	Option card mounting adapter for large-size inverter.	FRN0085E2■-4□H or above.

M.2 Communication option cards (required mounting adapter required)

Table M.2-1

Type	Option Name	Functions	Refer
OPC-DEV	DeviceNet communications card	This card enables the FRENIC-Ace to interface with DeviceNet and the FRENIC-Ace can be operated as a DeviceNet slave.	Section M.5
OPC-CCL	CC-Link communications card	This card enables the FRENIC-Ace to interface with CC-Link and the FRENIC-Ace can be operated as a CC-Link slave.	Section M.6 0
OPC-DIO	Digital I/O interface card	DI: The frequency set-point can be given by 8, 12 bits binary code or BCD code (0 to 99.9/0 to 999) and extended 13 digital inputs are available mounting this card. DO: The monitoring with 8bit binary code and the extended digital outputs (up to 8 outputs) are available.	Section M.7
OPC-AIO	Analog I/O interface card	This card enables the FRENIC-Ace to input analog set-points to the inverter and output analog monitors.	Section M.8
OPC-PT	RTD card	This card enables the FRENIC-Ace to input RDT.	Section M.9
OPC-LNW	LonWorks card	This card enables the FRENIC-Ace to interface with LonWorks and the FRENIC-Ace can be operated as a LonWorks slave.	Section M.10
OPC-PDP3	PROFIBUS-DP communications card	This card enables the FRENIC-Ace to interface with PROFIBUS DP and the FRENIC-Ace can be operated as a PROFIBUS DP slave.	Comming soon.
OPC-ETH2	EtherNet/IP communications card	This card enables the FRENIC-Ace to interface with EtherNet and the FRENIC-Ace can be operated as a EtherNet slave.	Comming soon.
OPC-PRT	ProfiNet-RT communications card	This card enables the FRENIC-Ace to interface with ProfiNet-RT and the FRENIC-Ace can be operated as a ProfiNet-RT slave.	Comming soon.
OPC-COP2	CANopen communications card	This card enables the FRENIC-Ace to interface with CANopen and the FRENIC-Ace can be operated as a CANopen slave.	Comming soon.
OPC-E2-D24	Power option	This card enables the FRENIC-Ace to keep the TP-A1 and communications supplied by 24DC when the main power is shutdown.	Comming soon

M.3 Terminal block type options

Table M.3-1

Type	Option Name	Functions	Refer
OPC-F2-RY	Relay output card	This card provides three relay output (1A relay).	Section M.11
OPC-E2-RS	RS485 communications card	This card provides two RS-485 connectors for multi-drop connection.	Section M.12

M.4 Option keypad

Table M.4-1

Type	Option Name	Functions	Refer
TP-E1U	Keypad with USB port.	The operation keypad adopted large-sized 7 segments LED to improve the visibility. Allows connecting a computer directly with a commercial USB cable (mini B) to be able to use FRENIC Loader software. Additional converter is not required. TP-E1U cannot be directly mounted on FRENIC-Ace. It can be connected only through a cable.	Section M.13
TP-A1	Multi-functional keypad	The operation keypad adopted LCD (Liquid Crystal Display) with a back light. The keypad corresponds to multi-languages. TP-A1-E2C cannot be directly mounted on FRENIC-Ace. It can be connected only through a cable.	Section M.14

M.5 DeviceNet communications card (OPC-DEV)

The DeviceNet communications card is used to connect the FRENIC-Ace series to a DeviceNet master via DeviceNet. Mounting the communications card on the FRENIC-Ace enables the user to control the FRENIC-Ace as a slave unit by configuring and monitoring run and frequency commands and accessing inverter's function codes from the DeviceNet master.

Note: Two or more communication cards cannot be mounted simultaneously. And this card requires a mounting adapter; refer to Section Appendix M .

DeviceNet specifications

Table M.5-1

<table>
<tr><th>Item</th><th colspan="4">Specifications</th></tr>
<tr><td>Number of nodes connectable</td><td colspan="4">Max. 64 (including the master)</td></tr>
<tr><td>MAC ID</td><td colspan="4">0 to 63</td></tr>
<tr><td>Insulation</td><td colspan="4">500 VDC (photocoupler insulation)</td></tr>
<tr><td>Transmission rate</td><td colspan="4">500, 250, or 125 kbps</td></tr>
<tr><td rowspan="4">Maximum cable length
(When using thick cables)</td><td>Transmission rate</td><td>500 kbps</td><td>250 kbps</td><td>125 kbps</td></tr>
<tr><td>Trunk line length</td><td>100 m (328 ft)</td><td>250 m (820 ft)</td><td>500m (1600 ft)</td></tr>
<tr><td>Drop line length</td><td colspan="3">6 m (20 ft)</td></tr>
<tr><td>Total length of drop lines</td><td>39 m (128 ft)</td><td>78 m (256 ft)</td><td>156 m (512 ft)</td></tr>
<tr><td>Messages supported</td><td colspan="4">1. I/O Message (Poll, Change of State)
2. Explicit Message</td></tr>
<tr><td>Vendor ID</td><td colspan="4">319 (Registered name: Fuji Electric Group)</td></tr>
<tr><td>Device type</td><td colspan="4">AC drive (code: 2)</td></tr>
<tr><td>Product code</td><td colspan="4">9219</td></tr>
<tr><td>Applicable device profile</td><td colspan="4">AC Drive</td></tr>
<tr><td>Number of input/output bytes</td><td colspan="4">Max. 8 bytes for each of input and output.
Depending on the format selected. Refer to Instruction manual of OPC-DEV.</td></tr>
<tr><td>Applicable DeviceNet Specifications</td><td colspan="4">CIP Specifications
Volume 1, Edition 2.2 Japanese version and Volume 3, Edition 1.1 Japanese version</td></tr>
<tr><td>Node type</td><td colspan="4">Group 2 only server (noncompliant with UCMM)</td></tr>
<tr><td>Network power consumption</td><td colspan="4">80 mA, 24 VDC
(Note) The network power is supplied by an external power source.</td></tr>
</table>

For the items not contained in the table above, the DeviceNet Specifications apply.

M.6 CC-Link communications card (OPC-CCL)

CC-Link (Control & Communication Link) is an FA open field network system. The CC-Link communications card connects the inverter to a CC-Link master via CC-Link using a dedicated cable. It supports the transmission speed of 156 kbps to 10 Mbps and the total length of 100 to 1,200 m so that it can be used in wide range of systems requiring a high-speed or long-distance transmission, enabling a flexible system configuration.

Note: Two or more communication cards cannot be mounted simultaneously. And this card requires a mounting adapter; refer to Section Appendix M .

<u>CC-Link specifications</u>

Table M.6-1

Item	Specifications				
Applicable controller	Mitsubishi Electric sequencer, etc. (CC-Link master)				
Transmission system	CC-Link version 1.10 and 2.0 (Broadcast polling system)				
Number of inverters connectable	Max. 42 units (one station occupied/unit)				
Number of stations occupied	CC-Link version 1.10: 1 station occupied CC-Link version 2.0: 1 station occupied (Selectable from among 2×, 4× and 8× settings)				
Transmission speed (Baud rate)	10 Mbps/5 Mbps/2.5 Mbps/625 kbps/156 kbps				
Maximum cable length (When using the CC-Link dedicated cable)	10 Mbps	5 Mbps	2.5 Mbps	625 kbps	156 kbps
	100 m (328 ft)	150 m (492 ft)	200 m (656 ft)	600 m (2000 ft)	1200 m (3900 ft)
Insulation	500 VDC (photocoupler insulation)				
Station type	Remote device station				
Remote device type	Inverter (0x20)				

For items not contained in the above table, the CC-Link specifications apply.

M.7 Digital I/O interface card (OPC-DIO)

This interface card can provide following features to the FRENIC-Ace series.

(1) Available to set frequency point with binary (8,12bit) or BCD code.

(2) Available to monitor with binary (8bit) code.

(3) Available to extend the digital input terminals as I1 to I13.

(4) Available to extend the transistor output terminals as O1 to O8.

Note: Two or more communication cards cannot be mounted simultaneously. And this card requires a mounting adapter; refer to Section M.7.

Applicable ROM version

This card is applicable to inverters with a ROM version 0300 or later.

Table M.7-1 Terminal functions

Symbol	Name	Function
I1 to I13	Signal input	Terminals for setting input Extended digital input signals
M1	External power supply connect	External power supply connect
CM	Common of input The terminal CM is isolated to terminal M2.	Common terminal for setting input
O1 to O8	Output	Terminals for output monitor Extended transistor output signals
M2	Common of Output The terminal M2 is isolated to terminal CM.	Common terminals for output monitor

Input terminal

Output terminal

Figure M.7-1 Terminal allocation on the DIO option interface card

Table M.7-2 Electrical Specifications

Terminal Symbol	Item		Specification	
			min.	max.
I1 to I13	Operating voltage (SINK)	ON level	0V	2V
		OFF level	22V	27V
	Operating voltage (SOURCE)	ON level	22V	27V
		OFF level	0V	2V
	Operating current at ON.		2.5mA	4.5mA
	Allowable leakage current at OFF		-	0.5mA
O1 to O8	Operating voltage	At ON level	-	2V
		At OFF level	-	27V
	Maximum current at ON		-	50mA
	Leakage current at OFF		-	0.1mA

Table M.7-3 Connecting Method input terminals

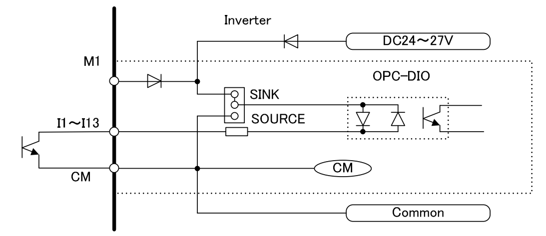
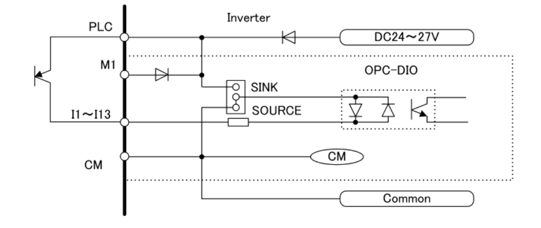
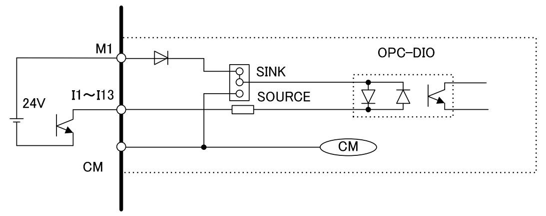
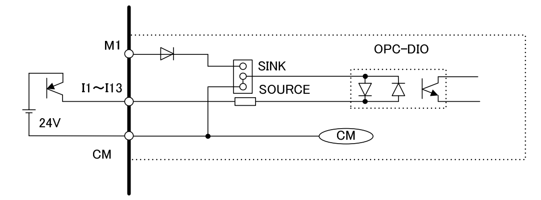
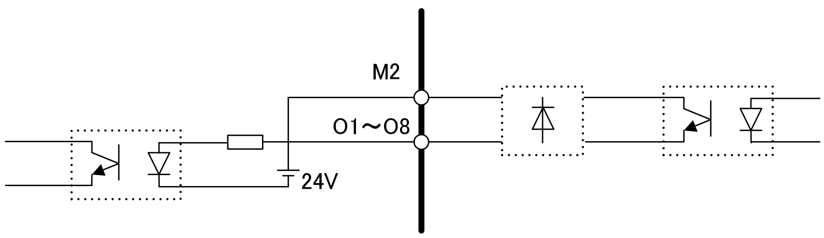
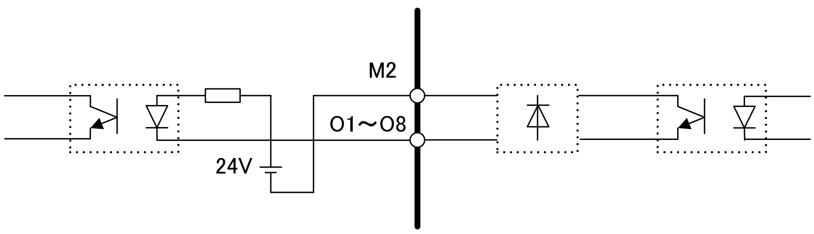
Power Supply	Connecting Method	
	Sink	Source
Internal		
External		

Table M.7-4 Connecting Method output terminals

Sink	
Source	

M.8 Analog interface card (OPC-AIO)

The analog interface card has the terminals listed below. Mounting this interface card on the FRENIC-Ace enables analog input and analog output to/from the inverter.

- One analog voltage input point (0 to ±10 V)
- One analog current input point (4 to 20 mA)
- One analog voltage output point (0 to ±10 V)
- One analog current output point (4 to 20 mA)

Applicable ROM version

This interface card is applicable to inverters with a ROM version 0300 or later.

Table M.8-1 Terminal functions

<table>
<tr><th>Classifi-cations</th><th>Symbol</th><th>Name</th><th>Functions</th><th>Remarks</th></tr>
<tr><td rowspan="4">Analog input</td><td>[P10]</td><td>Power supply for the potentiometer</td><td>Power supply for frequency command potentiometer (Variable resistor: 1 to 5 kΩ)
(10 VDC, 10 mA DC max.)</td><td></td></tr>
<tr><td>[32]</td><td>Analog voltage input</td><td>• Used as analog voltage input from external equipment.
0 to ±10 VDC/0 to ±100%
(0 to ±5 VDC/0 to ±100%)
• One of the following signals can be assigned to this terminal.
• Auxiliary frequency command
• PID command, PID feedback value
• Ratio setting
• Torque limiter level, Torque bias amount
• Torque command, Torque current command
• Speed limit value of FWD, Speed limit value of REV
• Analog input monitor
• Resolution: 1/3000</td><td>Input impedance: 22kΩ
Max. input: ±15 VDC</td></tr>
<tr><td>[C2]</td><td>Analog current input</td><td>• Used as analog current input from external equipment.
4 to 20 mA DC/0 to 100%
• One of the following signals can be assigned to this terminal.
• Auxiliary frequency command
• PID command, PID feedback value
• Ratio setting
• Torque limiter level, Torque bias amount
• Torque command, Torque current command
• Speed limit value of FWD, Speed limit value of REV
• Analog input monitor
• Resolution: 1/3000</td><td>Input impedance: 250Ω
Max. input: 30 mA DC</td></tr>
<tr><td>[31]</td><td>Analog common</td><td>• Reference terminal for [P10], [32], [C2].</td><td>Equipotent with the inverter's terminal [11]</td></tr>
</table>

Table M.8-1 Terminal functions (cont.)

Classifi-cations	Symbol	Name	Functions	Remarks

Analog output	[Ao+]	Analog voltage output (+)	• Outputs the monitor signal of analog DC voltage (0 to ±10 VDC).
			• One of the following signals can be issued from this terminal.
			  • Output frequency
			  • Output current, Output voltage, Output torque
			  • Load factor, Input power
			  • PID feedback value
			  • Actual speed / Estimated speed
			  • DC link bus voltage
			  • Universal AO
			  • Motor output
			  • Analog output test
			  • PID command, PID output
			  • Position deviation in master·follower operation
			  • Heat sink temperature
			  • PG feedback value
			  • Customizable logic output signal 1 to 4
			• Resolution: 1/3000
			* Capable of driving up to two analog voltmeters with 10 kΩ impedance.	

	[Ao-]	Analog voltage output (-)	• Reference terminal for [Ao+].	Equipotent with the inverter's terminal [11]

	[CS+]	Analog current output (+)	• Outputs the monitor signal of analog DC current (4 to 20 mA DC)
			• One of the following signals can be issued from this terminal.
			  • Output frequency
			  • Output current, Output voltage, Output torque
			  • Load factor, Input power
			  • PID feedback value
			  • Actual speed / Estimated speed
			  • DC link bus voltage
			  • Universal AO
			  • Motor output
			  • Analog output test
			  • PID command, PID output
			  • Position deviation in master-follower operation
			  • Heat sink temperature
			  • PG feedback value
			  • Customizable logic output signal 1 to 4
			• Resolution: 1/3000
				Isolated from terminals [31], [Ao-], and [11]

	[CS-]	Analog current output (-)	* Input impedance of the external device: Max. 500Ω	

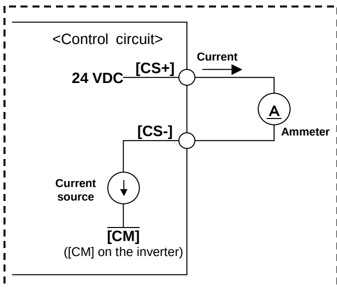
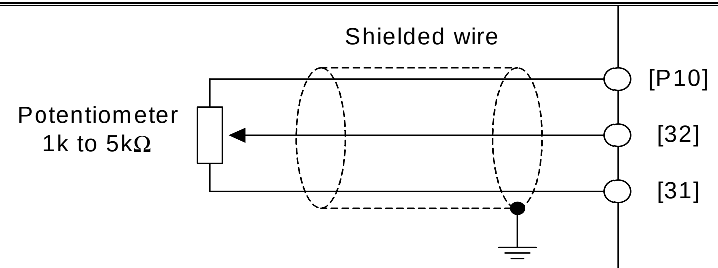
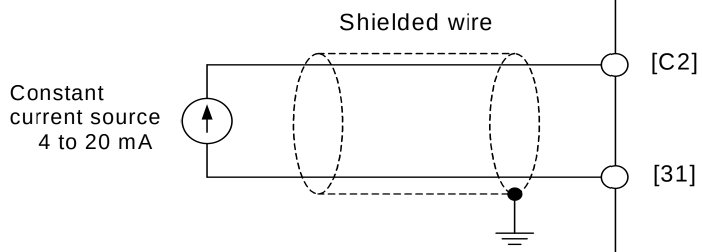
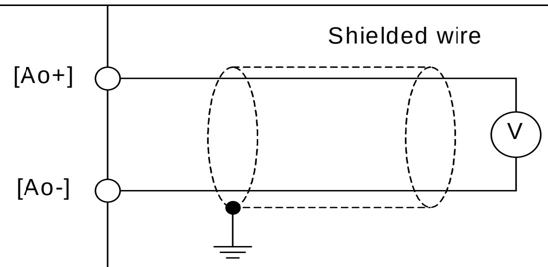
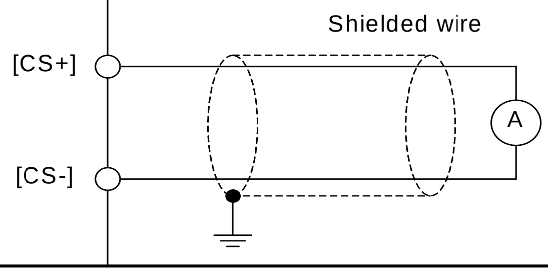


Table M.8-2 Connection example

Symbol	Connection of shielded wire
[32]	
[C2]	
[Ao]	
[CS]	

M.9 RTD Card (OPC-PT)

The RTD card (OPC-PT) makes it possible to connect up to two resistance temperature detectors (RTDs) to the FRENIC-Ace and digitalize temperatures. The following five types of RTDs can be connected: JPt100, Pt100, Ni100, Pt1000, and Ni1000.

The mounting of this card requires a mounting adapter. For details, refer to the Instruction Manual, which will be provided with the card.

RTD Card specifications

Item	Specifications	
Number of input channels	2 channels	
Types of RTDs connectable	JPt100, Pt100, Ni100, Pt1000, and Ni1000 (3-wire type) * The types of RTDs are set with function codes.	
RTD excitation current	JPt100, Pt100, and Ni100: 1 mA Pt1000 and Ni1000: 0.5 mA * Selected by switching.	
Measurement temperature range	-20 to +100ºC (-4 to +212ºF, 253 to 373 K)	
Resolution	0.01ºC (0.01ºF, 0.01 K)	
Accuracy	±0.3% FS (inverter ambient temperature: at 23°C (at 73.4°F, 296 K)) ±0.7% FS (inverter all temperature specification range) * RTD errors are not included.	
Sampling period	Max. 700 ms/2 channels	
Input filter time *1	Hardware (time constant): max. 50 ms Digital filter time: 0.0 to 100.0 s (Can be set in 0.1-s increments (default value: 1.0 s))	
Insulation method	Between the sensor input terminal and the internal logic	Photo-coupler insulation
	Between sensor input terminals and CM, 11, CMY	Transformer insulation
	Between sensor terminals	None
Error detection	Possible to detect sensor disconnection/short-circuiting and incorrect switching settings. *2	

*1 Input filtering time does not affect the display.

*2 Make sure that sensor selection settings (o10 and o15) are the same as the sensors in use. Do not perform wiring across channels, or otherwise error detection may not be possible. In addition, the error display will indicate “-30°C.”

M.10 LonWorks Card (OPC-LNW)

The LonWorks card (OPC-LNW) is an interface card that connects the FRENIC-Ace to peripheral devices (e.g., the master) through the LonWorks. The use of this communications card makes it possible to make run command and frequency settings or monitor them through the master equipment connected through the LonWorks, change settings of function codes required for the operation of the system and confirm the changes. Furthermore, the card allows data exchange with the peripheral devices.

The mounting of this card requires a mounting adapter. For details, refer to the Instruction Manual, which will be provided with the card.

LonWorks specifications

Item	Specifications
Communications baud rate	78 kbps
Profile	LonMark 3.3 Variable Speed Motor Drive functional Profile Ver. 1.1
Communications topology	Free topology
Network variable (NV)	62 variables (node objects: 3, VSD objects: 59)
Communications IC	Smart transceiver (FT3120-E4S40)
Communications transceiver	TP/FT-10 (free topology)
Communications protocol	LonTalk protocol
Configuration property (CP)	24

M.11 Relay Output Card (OPC-F2-RY)

This card adds three relay output points to the FRENIC-Ace Type H. Therefore, with the standard three relay output points of the FRENIC-Ace Type H and the three relay output points of this card will make six relay output points in total. These six relay output points are available for pump control. For details, refer to Appendix J codes (Applied functions) [5] Pump control".

M.12 RS-485 communication card (OPC-E2-RS)

RS-485 communication card (OPC-E2-RS) expands RS-485 communication by RJ-45 connector with FRENIC-Ace as a standard into 2 connectors to facilitate multi-drop. RS-485 port of this option card cannot be connected to the keypad. In the same way as RS485 of the standard port, Fuji general-purpose inverter protocol, Modbus RTU protocol, and loader command are available.

Refer to RS-485 communication user's manual for details of each protocol.

Table M.12-1 RS-485 ports

[Connector pin arrangement]

Pin number	Pin symbol	
	SW10=1 (Factry default)	SW10=2
1,6,7,8	N.C.	
2	SD	
3	N.C.	DX-
4	DX-	DX+
5	DX+	N.C.

[Names and functions]

Pin names	Function
DX+	RS-485 communicationdata (+)
DX-	RS-485 communicationdata (-)
SD	This is the terminal for relaying the shield of the shielded cable, insulated from other circuits. The SD terminal in each connector.
N.C.	No connection

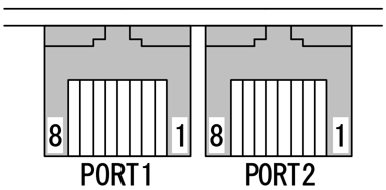


Figure M.12-1 Pin assignment

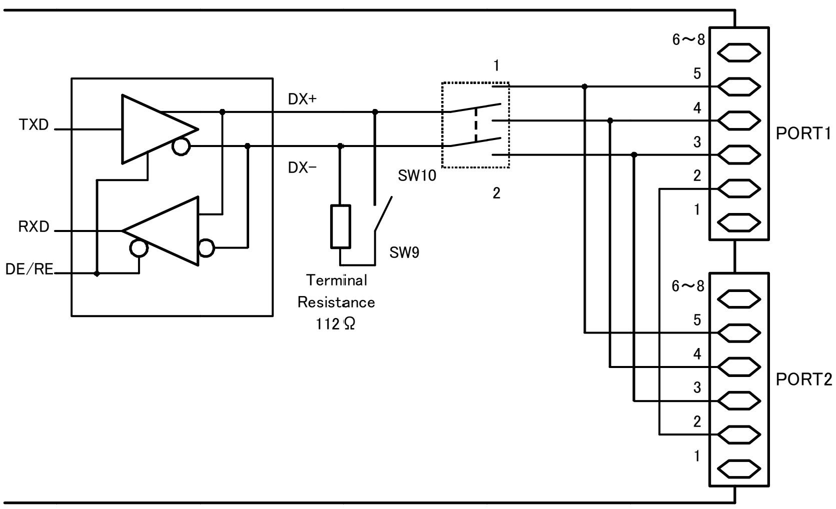


Figure M.12-2 internal circuit

■ Constraints on standard control circuit terminal

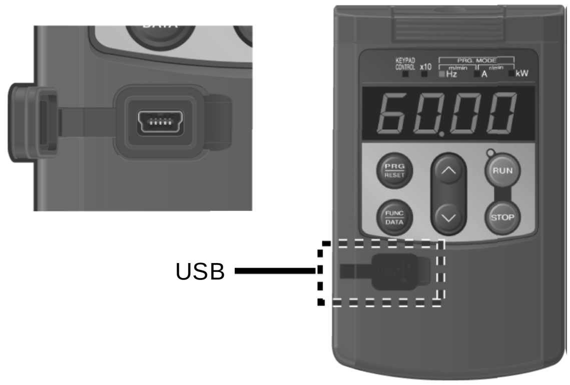
Control circuit terminal of OPC-E2-RS is different from some of the standard specification of FRENIC-Ace. Different specifications are as follows.

Table M.12-2

Item	Specifications		
	Standard control circuit terminal		OPC-E2-RS
	FRN□□□□E2■-2/4/7GA/A/E/U/K	FRN□□□□E2■-2/4/7GB,-4C	
Analog output **“FM2”**	N	Y	N
CAN-Open port	N	N	N
RS-485 port	Y	Y	Y

M.13 Simple keypad with USB port (TP-E1U)

Using the keypad in combination with FRENIC Loader enables a variety of data about the inverter unit to be saved in the keypad memory, allowing you to check the information in any place. TP-E1U cannot be directly mounted on FRENIC-Ace. It can be connected only through a cable.



Features

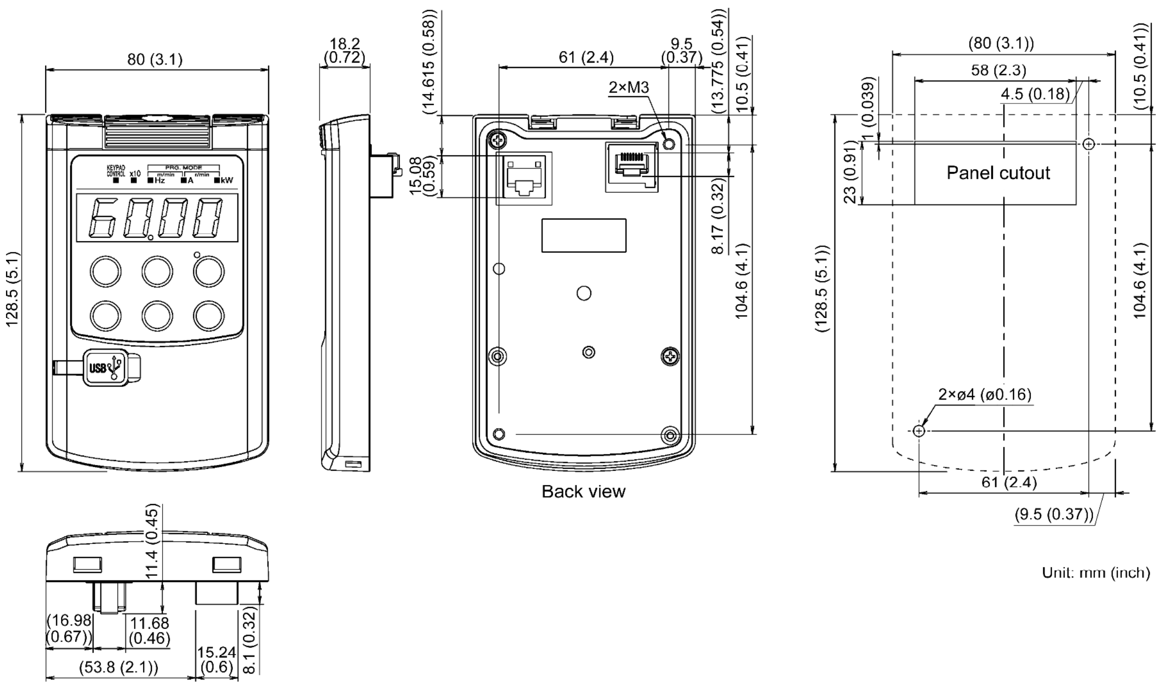
(1) The keypad can be directly connected to a computer through a commercial USB cable (mini B) without using a converter. The computer can be connected online with the inverter.

(2) With the FRENIC Loader, the inverter can support the following functions (1) to (4).

1) Editing, comparing, and copying the function code data
2) Real-time operation monitor
3) Trouble history (indicating the latest four troubles)
4) Maintenance information

Data can be transferred from the USB port of the keypad directly to the computer (FRENIC Loader) at the site of production. Periodical collection of life information can be carried out efficiently

Dimensions



APPENDICES

M.14 Multi-functional keypad (TP-A1-E2C)

Simple keypad with USB port (TP-E1U)

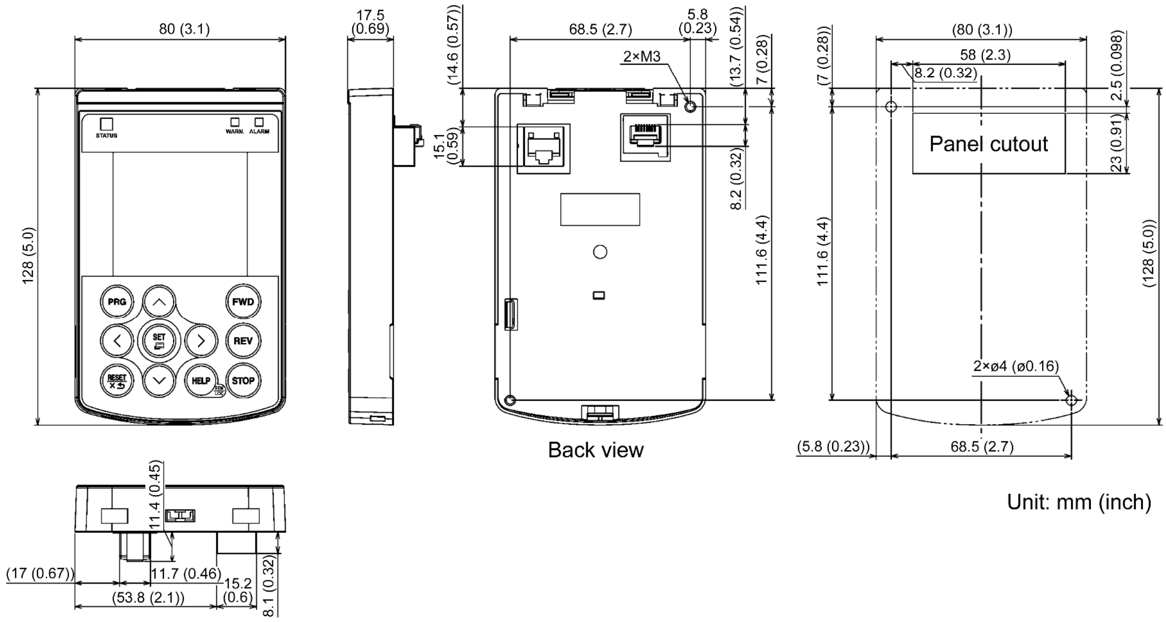
Replacing the standard keypad with the multi-function keypad enables setting and checking of function code data, and monitoring of the inverter running status, on the LCD monitor.

TP-A1-E2C cannot be directly mounted on FRENIC-Ace. It can be connected only through a cable.

Specifications

Items	Specifications	Remarks
Dimensions	Refer to the figures below	
Mass	120g	
Available languages	Japanese, English, Chinese	It is due to correspond to user-customized language.
Copy function	Possible to memorize or copy three function data sets.	
Applicable inverter	FRENIC-HVAC/AQUA series FRENIC-Ace series	Do not connect to FVR-E11S series otherwise Keypad or inverter may be damaged.
Number of connection	One inverter to one Multi-function keypad	
Connection cable	Conformed to ANSI/TIA/EIA568A Category 5 (For 10BASE-T/100BASE-TX straight connection)	Extension cable (CB-5S)
Extension cable length	20m or less	
Connector	RJ-45 connector	

External view, dimension



80 (3.1)
17.5 (0.69)
(14.6 (0.57))
68.5 (2.7)
5.8 (0.23)
(13.7 (0.54))
7 (0.28)
2×M3
15.1 (0.59)
8.2 (0.32)
111.6 (4.4)
128 (5.0)
STATUS
WARN. ALARM
PRG
FWD
SET
REV
RESET
HELP
STOP
Back view
(7 (0.28))
(80 (3.1))
58 (2.3)
8.2 (0.32)
2.5 (0.098)
Panel cutout
23 (0.91)
(128 (5.0))
2×ø4 (ø0.16)
(5.8 (0.23))
68.5 (2.7)
11.4 (0.45)
(17 (0.67))
11.7 (0.46)
15.2 (0.6)
(53.8 (2.1))
8.1 (0.32)

Unit: mm (inch)

M.15 FRENIC Visual Customizer

[1] Overview

FRENIC Visual Customizer is inverter support software which can provide the visual customizing environment for FRENIC-Ace. Customers can modify their inverter easily with this software by themselves.

[2] Specifications

Item		Specifications	Remarks
Name of software		**FRENIC Visual Customizer**	
No. of supported inverters		For USB connection: Only one inverter **For RS-485 connection: Up to 31 inverters**	
Recommended cable		USB : USB cable (mini B connecter) RS-485 : Shielded twisted pair cable for long distance transmission	
Operating environment	OS *	Microsoft Windows XP(SP3 or later) Microsoft Windows Vista Microsoft Windows 7	***
Operating environment	Memory	512MB or more RAM	2GB or more is recommended
Operating environment	Hard disk	35MB or more free space	
Operating environment	COM port	RS-232C or USB	Conversion to RS-485 communications required to connect inverters
Operating environment	Monitor resolution	800 × 600 or higher	SXGA(1280 × 1024) / 32-bit color is recommended
Transmission requirements	COM port **	**COM1** to COM255	PC COM ports assigned to Loader
Transmission requirements	Transmission rates **	USB connection : Fixed at 12 Mbps RS-485 connection : 38400, **19200**, 9600, 4800 and 2400 bps	38400bps or more is recommended.
Transmission requirements	Character length	8 bits	Prefixed
Transmission requirements	Stop bit length	1 bit	Prefixed
Transmission requirements	Parity	Even	Prefixed
Transmission requirements	No. of retries **	None or **1** to 10	No. of retry times before detecting communications error
Transmission requirements	Timeout setting **	100ms, 300ms, 500ms, 1.0s to **1.5s** to 1.9s, 2.0 to 9.0s, 10.0 to 60.0s	This setting should be longer than the response interval time specified by the function code H39.

* Use on the PC downgraded to Windows XP from Windows7 or Windows Vista is not recommended.

** **Bolded, underlined** values are factory defaults.

*** Only support 32bit version of Windows XP, Windows Vista.
Support both 32bit and 64bit version of Windows 7.

[3] Functions

This software can provide functions below.

Function	Overview
Customizable function editing	Draws functions and sends them to the inverter using a graphical editing tool.
Real-time trace	Displays the customizable function operation status with a waveform in real time.
Communication settings	Specifies settings for communicating with the inverter.

[4] Main Window

The following window appears when the software is started.

Project management window

Manages project files and function properties.

Select Inverter

Inverter to be connected is selected.

Execution cycle

Displays the customizable functions execution time.

Toolbox

Selects function symbols used in the layout.

Update

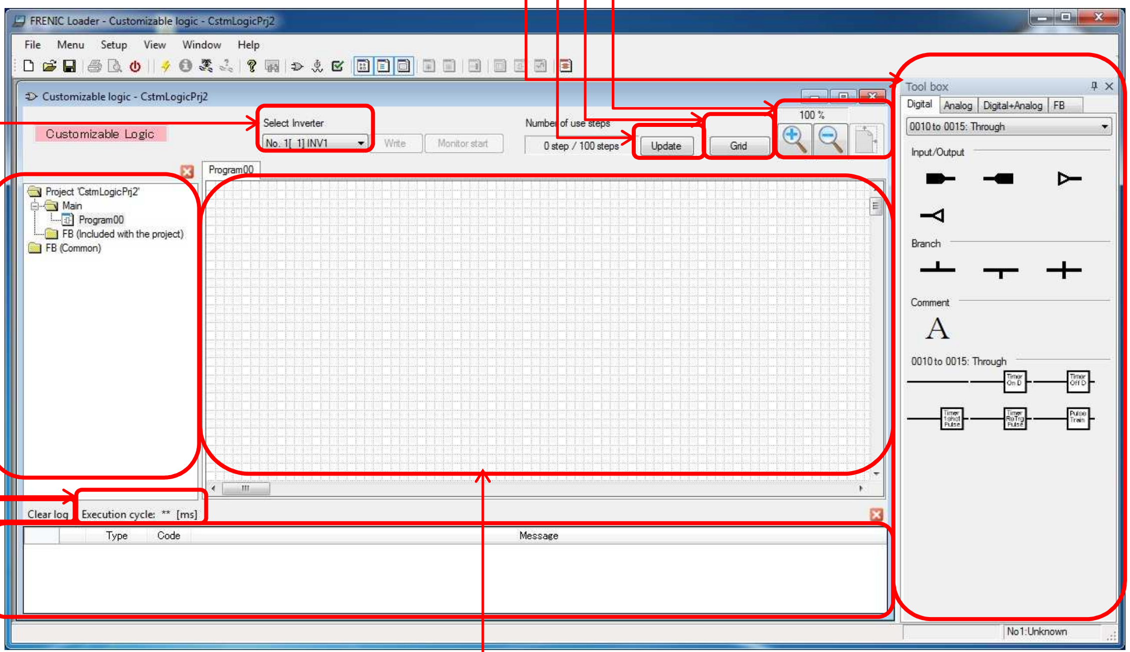
Updates the latest number of steps.

Grid

Change grid size.

Zoom in / out

Zoom in / out the layout window.



Message window

Displays information such as the results of function code automatic assignment.

Clear log

Clear log of Message window.

Layout area

Draws functions with symbols added to the layout.

APPENDICES

Appendix N　Standard Model Specifications

N.1　ND-mode inverters for general load

■ Standard-model, Three-phase 400 V (460 V) class series (ND-mode: 0.75 kW to 5.5 kW)

Item		Specifications				
Type (FRN_ _ _ _E2S-4G・H)		0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) *1		0.75 [1]	1.5 [2]	2.2 [3]	3.0 [4]	5.5 [7.5]
Output ratings	Rated capacity (kVA) *2	1.6 [1.7]	3.1 [3.3]	4.2 [4.4]	5.3 [5.5]	9.1 [9.6]
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)				
	Rated current (A) *4	2.1	4.1	5.5	6.9	12
	Overload capability	120%-1 min				
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz				
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%				
	Rated input current *7 (w/o DCR) (A)	2.7	4.8	7.3	11.3	16.8
	(with DCR) (A)	1.5	2.9	4.2	5.8	10.1
	Required capacity (with DCR) (kVA) *8	1.1	2.1	3.0	4.1	7.0
Braking	Torque (%) *9	53%	50%	48%	29%	27%
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 60%				
	Braking transistor	Built-in as standard				
	Minimum resistance value (Ω)	200		160		130
	Braking resistor	Separately mounted option				
DC reactor (DCR)		Separately mounted option				
Applicable safety standards		IEC/EN61800-5-1: 2007				
Enclosure (IEC60529)		IP20, UL open type				
Cooling method		Natural cooling		Fan cooling		
Weight / Mass (kg) [lbs]		1.2 [2.6]	1.5 [3.3]	1.5 [3.3]	1.6 [3.5]	1.9 [4.2]

Note: A box (□) in the above table replaces A or B depending on the model.

*1　Fuji 4-pole standard motor

*2　Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3　Output voltage cannot exceed the power supply voltage.

*4　Setting the carrier frequency (F26) to the following value or above requires current derating.
ND spec. of all types : 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6
$$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$$
(IEC 61800-3)
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7　This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8　This specification applies when a DC reactor (DCR) is used.

*9　Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (ND-mode: 11 kW to 55 kW)

Item		Specifications							
Type (FRN_ _ _ _E2S-4EH)		0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) *1		11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]	55 [75]
Output ratings	Rated capacity (kVA) *2	16 [17]	22 [23]	28 [29]	34 [35]	45 [47]	55 [57]	65 [68]	80 [84]
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)							
	Rated current (A) *4	21.5	28.5	37.0	44.0	59.0	72.0	85.0	105
	Overload capability	120%-1 min							
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%							
	Rated input current *7 (w/o DCR) (A)	33.0	43.8	52.3	60.6	77.9	94.3	114	140
	(with DCR) (A)	21.1	28.8	35.5	42.2	57.0	68.5	83.2	102
	Required capacity (with DCR) (kVA) *8	15	20	25	29	39	47	58	71
Braking	Torque (%) *9	12%						5% to 9%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 60%							
	Braking transistor	Built-in as standard						Separately mounted option	
	Minimum resistance value (Ω)	80	60	40	34.4	16		-	-
	Braking resistor	Separately mounted option							
DC reactor (DCR)		Separately mounted option							
Applicable safety standards		IEC/EN61800-5-1: 2007							
Enclosure (IEC60529)		IP20, UL open type						IP00, UL open type	
Cooling method		Fan cooling							
Weight / Mass (kg) [lbs]		5.0 [11]	5.0 [11]	8.0 [18]	9.0 [20]	9.5 [21]	10 [22]	25 [55]	26 [57]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
ND spec. of all types: 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (ND-mode: 75 kW to 315 kW)

Item		Specifications								
Type (FRN_ _ _ _E2S-4EH)		0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) ***1**		75 [100]	90 [125]	110 [150]	132 [200]	160 [200]	200 [300]	220 [350]	280 [450]	315 [500]
Output ratings	Rated capacity (kVA) ***2**	106 [111]	128 [134]	155 [162]	183 [191]	221 [231]	275 [288]	316 [331]	396 [414]	450 [470]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)								
	Rated current (A) ***4**	139	168	203	240	290	361	415	520	590
	Overload capability	120%-1 min								
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz	Three-phase 380 to 440 V, 50 Hz Three-phase 380 to 480 V, 60 Hz ***5**							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%								
	Rated input current ***7** (w/o DCR) (A)	–	–	–	–	–	–	–	–	–
	(with DCR) (A)	138	164	201	238	286	357	390	500	559
	Required capacity (with DCR) (kVA) ***8**	96	114	139	165	199	248	271	347	388
Braking	Torque (%) ***9**	5% to 9%								
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 60%								
	Braking transistor	Separately mounted option								
	Minimum resistance value (Ω)	–								
	Braking resistor	Separately mounted option								
DC reactor (DCR)		Must be used. Separately mounted component. Depending on the shipping destination, not provided with the inverter package. ***11**								
Applicable safety standards		IEC/EN61800-5-1: 2007								
Enclosure (IEC60529)		IP00, UL open type								
Cooling method		Fan cooling								
Weight / Mass (kg) [lbs]		30 [66]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
ND spec. of all types : 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*5 Inverters of FRN0203E2■-4・H or above (400 V class series) are equipped with a power switching connector. Use the connector depending upon the applied voltage. For details, refer to the FRENIC-Ace User's Manual Chapter 2 "2.2.7 Switching Connector."

*6 $\text{Voltage unbalance (\%)} = \dfrac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67$ (IEC 61800-3)
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

*11 Please consult your Fuji Electric sales representative.

N.2 HD-mode inverters for heavy duty load

■ **Standard-model, Three-phase 400 V (460 V) class series (HD-mode: 0.75 kW to 5.5 kW)**

Item		Specifications				
Type (FRN_ _ _ _E2S-4G・H)		0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) ***1**		0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
Output ratings	Rated capacity (kVA) ***2**	1.4 [1.4]	2.6 [2.7]	3.8 [4.0]	4.8 [5.0]	8.5 [8.8]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)				
	Rated current (A) ***4**	1.8	3.4	5.0	6.3	11.1
	Overload capability	150%-1 min				
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz				
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%				
	Rated input current ***7** (w/o DCR) (A)	2.7	3.9	7.3	11.3	16.8
	(with DCR) (A)	1.5	2.1	4.2	5.8	10.1
	Required capacity (with DCR) (kVA) ***8**	1.1	1.5	3.0	4.1	7.0
Braking	Torque (%) ***9**	53%	68%	48%	29%	27%
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%				
	Braking transistor	Built-in as standard				
	Minimum resistance value (Ω)	200		160		130
	Braking resistor	Separately mounted option				
DC reactor (DCR)		Separately mounted option				
Applicable safety standards		IEC/EN61800-5-1: 2007				
Enclosure (IEC60529)		IP20, UL open type				
Cooling method		Natural cooling		Fan cooling		
Weight / Mass (kg) [lbs]		1.2 [2.6]	1.5 [3.3]	1.5 [3.3]	1.6 [3.5]	1.9 [4.2]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HD spec. of all types : 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $\text{Voltage unbalance (\%)} = \dfrac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67$ (IEC 61800-3)
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimate to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (HD-mode: 7.5 kW to 45 kW)

Item		Specifications							
Type (FRN_ _ _ _E2S-4EH)		0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) ***1**		7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]
Output ratings	Rated capacity (kVA) ***2**	13 [14]	18 [18]	24 [25]	29 [30]	34 [36]	46 [48]	57 [60]	69 [73]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)							
	Rated current (A) ***4**	17.5	23	31	38	45	60	75	91
	Overload capability	150%-1 min							
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%							
	Rated input current ***7** (w/o DCR) (A)	23.2	33.0	43.8	52.3	60.6	77.9	94.3	114
	(with DCR) (A)	14.4	21.1	28.8	35.5	42.2	57.0	68.5	83.2
	Required capacity (with DCR) (kVA) ***8**	10	15	20	25	29	39	47	58
Braking	Torque (%) ***9**	15%						7% to 12%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%							
	Braking transistor	Built-in as standard						Separately mounted option	
	Minimum resistance value (Ω)	80	60	40	34.4	16		-	-
	Braking resistor	Separately mounted option							
DC reactor (DCR)		Separately mounted option							
Applicable safety standards		IEC/EN61800-5-1: 2007							
Enclosure (IEC60529)		IP20, UL open type						IP00, UL open type	
Cooling method		Fan cooling							
Weight / Mass (kg) [lbs]		5.0 [11]	5.0 [11]	8.0 [18]	9.0 [20]	9.5 [21]	10 [22]	25 [55]	26 [57]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HD spec. of all types : 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (HD-mode: 55 kW to 250 kW)

Item		Specifications								
Type (FRN_ _ _ _E2S-4EH)		0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) ***1**		55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]	250 [400]
Output ratings	Rated capacity (kVA) ***2**	85 [89]	114 [120]	134 [140]	160 [167]	193 [202]	232 [242]	287 [300]	316 [331]	364 [380]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)								
	Rated current (A) ***4**	112	150	176	210	253	304	377	415	477
	Overload capability	150%-1 min								
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz	Three-phase 380 to 440 V, 50 Hz Three-phase 380 to 480 V, 60 Hz ***5**							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%								
	Rated input current ***7** (w/o DCR) (A)	140	–	–	–	–	–	–	–	–
	(with DCR) (A)	102	138	164	201	238	286	357	390	443
	Required capacity (with DCR) (kVA) ***8**	71	96	114	140	165	199	248	271	307
Braking	Torque (%) ***9**	7% to 12%								
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%								
	Braking transistor	Separately mounted option								
	Minimum resistance value (Ω)	–								
	Braking resistor	Separately mounted option								
DC reactor (DCR)		Separately mounted option	Must be used. Separately mounted component. Depending on the shipping destination, not provided with the inverter package. ***11**							
Applicable safety standards		IEC/EN61800-5-1: 2007								
Enclosure (IEC60529)		IP00, UL open type								
Cooling method		Fan cooling								
Weight / Mass (kg) [lbs]		30 [66]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HD spec. of all types : 4 kHz
If the ambient temperature is 40°C (104°F) or above, derating of 2%/°C (2%/1.8°F) relative to the rated current given in this manual is required. For details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*5 Inverters of FRN0203E2■-4 •H or above (400 V class series) are equipped with a power switching connector. Use the connector depending upon the applied voltage. For details, refer to the FRENIC-Ace User's Manual Chapter 2 "2.2.7 Switching Connector."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

*11 Please consult your Fuji Electric sales representative.

N.3 HND-mode inverters for general load

■ **Standard-model, Three-phase 200 V (230 V) class series (HND-mode: 0.2 kW to 5.5 kW)**

Item		Specifications						
Type (FRN_ _ _ _E2S-2G・H)		0001	0002	0004	0006	0010	0012 ***10**	0020 ***10**
Nominal applied motor (kW) [HP] (Output rating) ***1**		0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
Output ratings	Rated capacity (kVA) ***2**	0.5 [0.5]	0.8 [0.8]	1.3 [1.4]	2.3 [2.4]	3.7 [3.8]	4.6 [4.8]	7.5 [7.8]
	Rated voltage (V) ***3**	Three-phase 200 to 240 V (with AVR function)						
	Rated current (A) ***4**	1.3	2.0	3.5	6.0	9.6	12	19.6
	Overload capability	120%-1 min						
Input power	Voltage, frequency	Three-phase 200 to 240 V, 50/60 Hz						
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%						
	Rated input current ***7** (w/o DCR) (A)	1.8	2.6	4.9	6.7	12.8	17.9	31.9
	(with DCR) (A)	0.93	1.6	3.0	4.3	8.3	11.7	19.9
	Required capacity (with DCR) (kVA) ***8**	0.4	0.6	1.1	1.5	2.9	4.1	6.9
Braking	Torque (%) ***9**	75%		53%	68%	48%	29%	27%
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80% (Types FRN0012E2S-2G・H and FRN0020E2S-2G・H : 0 to 60%)						
	Braking transistor	Built-in as standard						
	Minimum resistance value (Ω)	100				40		33
	Braking resistor	Separately mounted option						
DC reactor (DCR)		Separately mounted option						
Applicable safety standards		IEC/EN61800-5-1: 2007						
Enclosure (IEC60529)		IP20, UL open type						
Cooling method		Natural cooling				Fan cooling		
Weight / Mass (kg) [lbs]		0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.8 [1.8]	1.5 [3.3]	1.5 [3.3]	1.8 [4.0]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 220 V (230 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HND/ND spec. of types FRN0001E2■-2G・H to FRN0020E2■-2G・H: 4 kHz,
If reduction is necessary, for details, refer to the FRENIC-Ace User's Manual Chapter 10, Section 10.4.2 "Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

*10 Types FRN0012E2■-2G・H and FRN0020E2■-2G・H are ND spec; allowable ambient temperature 40°C (+104°F) or less. The rated output current is decreased 1% for every 1°C (1.8°F) when ambient temperature is +40°C (+104°F) or more.

■ **Standard-model, Three-phase 400 V (460 V) class series (HND-mode: 0.75 kW to 5.5 kW)**

Item		Specifications				
Type (FRN_ _ _ _E2S-4G・H)		0002	0004	0006	0007 *10	0012 *10
Nominal applied motor (kW) [HP] (Output rating) ***1**		0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
Output ratings	Rated capacity (kVA) ***2**	1.4 [1.4]	2.6 [2.7]	3.8 [4.0]	4.8 [5.0]	8.5 [8.8]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)				
	Rated current (A) ***4**	1.8	3.4	5.0	6.3	11.1
	Overload capability	120%-1 min				
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz				
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%				
	Rated input current ***7** (w/o DCR) (A)	2.7	3.9	7.3	11.3	16.8
	(with DCR) (A)	1.5	2.1	4.2	5.8	10.1
	Required capacity (with DCR) (kVA) ***8**	1.1	1.5	3.0	4.1	7.0
Braking	Torque (%) ***9**	53%	68%	48%	29%	27%
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80% (Type FRN0007E2S-4・H and FRN0012E2S-4・H : 0 to 60%)				
	Braking transistor	Built-in as standard				
	Minimum resistance value (Ω)	200		160		130
	Braking resistor	Separately mounted option				
DC reactor (DCR)		Separately mounted option				
Applicable safety standards		IEC/EN61800-5-1: 2007				
Enclosure (IEC60529)		IP20, UL open type				
Cooling method		Natural cooling		Fan cooling		
Weight / Mass (kg) [lbs]		1.2 [2.6]	1.5 [3.3]	1.5 [3.3]	1.6 [3.5]	1.9 [4.2]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HND spec of type FRN0002E2■-4G・H to FRN0006E2■-4G・H: 8 kHz,
ND spec of type FRN0007E2■-4G・H to FRN0012E2■-4G・H: 4 kHz,
HND spec of type FRN0022E2■-4G・H to FRN0059E2■-4G・H: 10 kHz,
HND spec of type FRN0072E2■-4G・H to FRN0168E2■-4G・H: 6 kHz,
HND spec of type FRN0203E2■-4G・H to FRN0590E2■-4G・H: 4 kHz
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.)

*10 Types FRN0007E2■-4G・H and FRN0012E2■-4G・H are ND spec; allowable ambient temperature 40°C (+104°F) or less. The rated output current is decreased 1% for every 1°C (1.8°F) when ambient temperature is +40°C (+104°F) or more.

■ Standard-model, Three-phase 400 V (460 V) class series (HND-mode: 7.5 kW to 45 kW)

Item		Specifications							
Type (FRN_ _ _ _E2S-4EH)		0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) ***1**		7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]
Output ratings	Rated capacity (kVA) ***2**	13 [14]	18 [18]	24 [25]	29 [30]	34 [36]	46 [48]	57 [60]	69 [73]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)							
	Rated current (A) ***4**	17.5	23	31	38	45	60	75	91
	Overload capability	120%-1 min							
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%							
	Rated input current ***7** (w/o DCR) (A)	23.2	33	43.8	52.3	60.6	77.9	94.3	114
	(with DCR) (A)	14.4	21.1	28.8	35.5	42.2	57.0	68.5	83.2
	Required capacity (with DCR) (kVA) ***8**	10	15	20	25	29	39	47	58
Braking	Torque (%) ***9**	15%						7% to 12%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%							
	Braking transistor	Built-in as standard						Separately mounted option	
	Minimum resistance value (Ω)	80	60	40	34.4	16		-	-
	Braking resistor	Separately mounted option							
DC reactor (DCR)		Separately mounted option							
Applicable safety standards		IEC/EN61800-5-1: 2007							
Enclosure (IEC60529)		IP20, UL open type						IP00, UL open type	
Cooling method		Fan cooling							
Weight / Mass (kg) [lbs]		5.0 [11]	5.0 [11]	8.0 [18]	9.0 [20]	9.5 [21]	10 [22]	25 [55]	26 [57]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HND spec of type FRN0022E2■-4EH to FRN0059E2■-4EH: 10 kHz,
HND spec of type FRN0072E2■-4EH to FRN0168E2■-4EH: 6 kHz,
HND spec of type FRN0203E2■-4EH to FRN0590E2■-4EH: 4 kHz
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ **Standard-model, Three-phase 400 V (460 V) class series (HND-mode: 55 kW to 280 kW)**

Item		Specifications								
Type (FRN_ _ _ _E2S-4EH)		0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) ***1**		55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]	280 [450]
Output ratings	Rated capacity (kVA) ***2**	85 [89]	114 [120]	134 [140]	160 [167]	193 [202]	232 [242]	287 [300]	316 [331]	396 [380]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)								
	Rated current (A) ***4**	112	150	176	210	253	304	377	415	520
	Overload capability	120%-1 min								
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz	Three-phase 380 to 440 V, 50 Hz Three-phase 380 to 480 V, 60 Hz ***5**							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%								
	Rated input current ***7** (w/o DCR) (A)	140	–	–	–	–	–	–	–	–
	(with DCR) (A)	102	138	164	201	238	286	357	390	500
	Required capacity (with DCR) (kVA) ***8**	71	96	114	140	165	199	248	271	347
Braking	Torque (%) ***9**	7% to 12%								
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 80%								
	Braking transistor	Separately mounted option								
	Minimum resistance value (Ω)									
	Braking resistor	Separately mounted option								
DC reactor (DCR)		Separately mounted option	Must be used. Separately mounted component. Depending on the shipping destination, not provided with the inverter package. ***11**							
Applicable safety standards		IEC/EN61800-5-1: 2007								
Enclosure (IEC60529)		IP00, UL open type								
Cooling method		Fan cooling								
Weight / Mass (kg) [lbs]		30 [66]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HND spec of type FRN0022E2■-4EH to FRN0059E2■-4EH: 10 kHz,
HND spec of type FRN0072E2■-4EH to FRN0168E2■-4EH: 6 kHz,
HND spec of type FRN0203E2■-4EH to FRN0590E2■-4EH: 4 kHz
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*5 Inverters of FRN0203E2■-4EH or above (400 V class series) are equipped with a power switching connector. Use the connector depending upon the applied voltage. For details, refer to the FRENIC-Ace User's Manual Chapter 2 "2.2.7 Switching Connector."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

*11 Please consult your Fuji Electric sales representative.

N.4 HHD-mode inverters for heavy duty load

■ Standard-model, Three-phase 200 V (230 V) class series (HHD-mode: 0.1 kW to 3.7 kW)

Item		Specifications						
Type (FRN_ _ _ _E2S-2G ･H)		0001	0002	0004	0006	0010	0012	0020
Nominal applied motor (kW) [HP] (Output rating) *1		0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]
Output ratings	Rated capacity (kVA) *2	0.3 [0.3]	0.6 [0.6]	1.1 [1.2]	1.9 [2.0]	3.0 [3.2]	4.2 [4.4]	6.7 [7.0]
	Rated voltage (V) *3	Three-phase 200 to 240 V (with AVR function)						
	Rated current (A) *4	0.8	1.6	3.0	5.0	8.0	11	17.5
	Overload capability	150%-1 min, 200%-0.5 s						
Input power	Voltage, frequency	Three-phase 200 to 240 V, 50/60 Hz						
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%						
	Rated input current *7 (w/o DCR) (A)	1.1	1.8	3.1	5.3	9.5	13.2	22.2
	(with DCR) (A)	0.57	0.93	1.6	3.0	5.7	8.3	14.0
	Required capacity (with DCR) (kVA) *8	0.2	0.4	0.6	1.1	2.0	2.9	4.9
Braking	Torque (%) *9	150%		100%		70%	40%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%						
	Braking transistor	Built-in as standard						
	Minimum resistance value(Ω)	100				40		33
	Braking resistor	Separately mounted option						
DC reactor (DCR)		Separately mounted option						
Applicable safety standards		IEC/EN61800-5-1: 2007						
Enclosure (IEC60529)		IP20, UL open type						
Cooling method		Natural cooling				Fan cooling		
Weight / Mass (kg) [lbs]		0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.8 [1.8]	1.5 [3.3]	1.5 [3.3]	1.8 [4.0]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 220 V (230 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HHD spec. of types FRN0001E2■-2G ･H to FRN0020E2■-2G ･H: 8 kHz,
If reduction is necessary, for details, refer to the FRENIC-Ace User's Manual Chapter 10, Section 10.4.2 "Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$

If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (HHD-mode: 0.4 kW to 3.7 kW)

Item		Specifications				
Type (FRN_ _ _ _E2S-4G・H)		0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) ***1**		0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]
Output ratings	Rated capacity (kVA) ***2**	1.1 [1.2]	1.9 [2.0]	3.2 [3.3]	4.2 [4.4]	6.9 [7.2]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)				
	Rated current (A) ***4**	1.5	2.5	4.2	5.5	9.0
	Overload capability	150%-1 min, 200%-0.5 s				
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz				
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%				
	Rated input current ***7** (w/o DCR) (A)	1.7	3.1	5.9	8.2	13.0
	(with DCR) (A)	0.85	1.6	3.0	4.4	7.3
	Required capacity (with DCR) (kVA) ***8**	0.6	1.2	2.1	3.1	5.1
Braking	Torque (%) ***9**	100%		70%	40%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%				
	Braking transistor	Built-in as standard				
	Minimum resistance value (Ω)	200		160		130
	Braking resistor	Separately mounted option				
DC reactor (DCR)		Separately mounted option				
Applicable safety standards		IEC/EN61800-5-1: 2007				
Enclosure (IEC60529)		IP20, UL open type				
Cooling method		Fan cooling				
Weight / Mass (kg) [lbs]		1.2 [2.6]	1.5 [3.3]	1.5 [3.3]	1.6 [3.5]	1.9 [4.2]

Note: A box (□) in the above table replaces A, B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HHD spec of type FRN0002E2■-4G・H to FRN0012E2■-4G・H: 8 kHz,
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V)} - \text{Min. voltage (V)}}{\text{Three-phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$

If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ Standard-model, Three-phase 400 V (460 V) class series (HHD-mode: 5.5 kW to 37 kW)

Item		Specifications							
Type (FRN_ _ _ _E2S-4EH)		0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) *1		5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]
Output ratings	Rated capacity (kVA) *2	9.9 [10]	14 [14]	18 [19]	23 [24]	30 [31]	34 [36]	46 [48]	57 [60]
	Rated voltage (V) *3	Three-phase 380 to 480 V (with AVR function)							
	Rated current (A) *4	13	18	24	30	39	45	60	75
	Overload capability	150%-1 min, 200%-0.5 s							
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%							
	Rated input current *7 (w/o DCR) (A)	17.3	23.2	33	43.8	52.3	60.6	77.9	94.3
	(with DCR) (A)	10.6	14.4	21.1	28.8	35.5	42.2	57.0	68.5
	Required capacity (with DCR) (kVA) *8	7.3	10	15	20	25	29	39	47
Braking	Torque (%) *9	20%						10% to 15%	
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%							
	Braking transistor	Built-in as standard							
	Minimum resistance value (Ω)	80	60	40	34.4	16		–	
	Braking resistor	Separately mounted option							
DC reactor (DCR)		Separately mounted option							
Applicable safety standards		IEC/EN61800-5-1: 2007							
Enclosure (IEC60529)		IP20, UL open type							
Cooling method		Fan cooling							
Weight / Mass (kg) [lbs]		5.0 [11]	5.0 [11]	8.0 [18]	9.0 [20]	9.5 [21]	10 [22]	25 [55]	26 [57]

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HHD spec of type FRN0002E2■-4EH to FRN0012E2■-4EH: 8 kHz,
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*6 $\text{Voltage unbalance (\%)} = \dfrac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67$ (IEC 61800-3)
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

■ **Standard-model, Three-phase 400 V (460 V) class series (HHD-mode: 45 kW to 220 kW)**

Item		Specifications								
Type (FRN_ _ _ _E2S-4EH)		0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) ***1**		45 [60]	55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]
Output ratings	Rated capacity (kVA) ***2**	69 [73]	85 [89]	114 [120]	134 [140]	160 [167]	193 [202]	232 [242]	287 [300]	316 [331]
	Rated voltage (V) ***3**	Three-phase 380 to 480 V (with AVR function)								
	Rated current (A) ***4**	91	112	150	176	210	253	304	377	415
	Overload capability	150%-1 min, 200%-0.5 s								
Input power	Voltage, frequency	Three-phase 380 to 480 V, 50/60 Hz	Three-phase 380 to 440 V, 50 Hz Three-phase 380 to 480 V, 60 Hz ***5**							
	Allowable voltage/frequency	Voltage: +10 to -15% (Interphase voltage unbalance: 2% or less) ***6**, Frequency: +5 to -5%								
	Rated input current (w/o DCR) (A) ***7**	114	140	–	–	–	–	–	–	–
	(with DCR) (A)	83.2	102	138	164	201	238	286	357	390
	Required capacity (with DCR) (kVA) ***8**	58	71	96	114	140	165	199	248	271
Braking	Torque (%) ***9**	10% to 15%								
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%								
	Braking transistor	Separately mounted option								
	Minimum resistance value (Ω)									
	Braking resistor	Separately mounted option								
DC reactor (DCR)		Separately mounted option	Must be used. Separately mounted component. Depending on the shipping destination, not provided with the inverter package. ***11**							
Applicable safety standards		IEC/EN61800-5-1: 2007								
Enclosure (IEC60529)		IP00, UL open type								
Cooling method		Fan cooling								
Weight / Mass (kg) [lbs]		30 [66]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

*1　Fuji 4-pole standard motor

*2　Rated capacity is calculated assuming the rated output voltage as 440 V (460 V).

*3　Output voltage cannot exceed the power supply voltage.

*4　Setting the carrier frequency (F26) to the following value or above requires current derating.
HHD spec of type FRN0022E2■-4EH to FRN0168E2■-4EH: 10 kHz,
HHD spec of type FRN0203E2■-4EH to FRN0590E2■-4EH: 6 kHz,
If reduction is necessary, for details, refer to Figure 10.4-1 in the FRENIC-Ace User's Manual Chapter 10 "10.4.2 Guideline for selecting inverter drive mode and capacity."

*5　Inverters of FRN0203E2■-4EH or above (400 V class series) are equipped with a power switching connector. Use the connector depending upon the applied voltage. For details, refer to the FRENIC-Ace User's Manual Chapter 2 "2.2.7 Switching Connector."

*6　$$\text{Voltage unbalance (\%)} = \frac{\text{Max. voltage (V) - Min. voltage (V)}}{\text{Three - phase average voltage (V)}} \times 67 \quad \text{(IEC 61800-3)}$$
If the unbalance ratio is 2% to 3%, use an optional AC reactor (ACR).

*7　This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected. When applying with motors of 75 kW (100 HP) or above, a DC reactor (DCR) should be used.

*8　This specification applies when a DC reactor (DCR) is used.

*9　Average braking torque for the motor running alone. It depends on the efficiency of the motor.

*11　Please consult your Fuji Electric sales representative.

■ Standard-model, Single-phase 200 V (230 V) class series (HHD-mode: 0.1 kW to 2.2 kW)

Item		Specifications					
Type (FRN_ _ _ _E2S-7G・H)		0001	0002	0003	0005	0008	0011
Nominal applied motor (kW) [HP] (Output rating) ***1**		0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]
Output ratings	Rated capacity (kVA) ***2**	0.3 [0.3]	0.6 [0.6]	1.1 [1.2]	1.9 [2.0]	3.0 [3.2]	4.2 [4.4]
	Rated voltage (V) ***3**	Three-phase 200 to 240 V (with AVR function)					
	Rated current (A) ***4**	0.8	1.6	3.0	5.0	8.0	11
	Overload capability	150%-1 min, 200%-0.5 s					
Input power	Voltage, frequency	Single-phase 200 to 240 V, 50/ 60 Hz					
	Allowable voltage/frequency	Voltage: +10 to -10%, Frequency: +5 to -5%					
	Rated input current (w/o DCR) (A) ***7**	1.8	3.3	5.4	9.7	16.4	24.8
	(with DCR) (A)	1.1	2.0	3.5	6.4	11.6	17.5
	Required capacity (with DCR) (kVA) ***8**	0.3	0.4	0.7	1.3	2.4	3.5
Braking	Torque (%) ***9**	150%		100%		70%	40%
	DC braking	Braking starting frequency: 0.0 to 60.0 Hz, Braking time: 0.0 to 30.0 s, Braking level: 0 to 100%					
	Braking transistor	Built-in as standard					
	Minimum resistance value (Ω)	100				40	
	Braking resistor	Separately mounted option					
DC reactor (DCR)		Separately mounted option					
Applicable safety standards		IEC/EN61800-5-1: 2007					
Enclosure (IEC60529)		IP00, UL open type					
Cooling method		Natural cooling				Fan cooling	
Weight / Mass (kg) [lbs]		0.5 [1.1]	0.5 [1.1]	0.6 [1.3]	0.9 [2.0]	1.6 [3.5]	1.8 [4.0]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*2 Rated capacity is calculated assuming the rated output voltage as 220 V (230 V).

*3 Output voltage cannot exceed the power supply voltage.

*4 Setting the carrier frequency (F26) to the following value or above requires current derating.
HHD spec of type FRN0001E2■-7G・H to FRN0011E2■-7G・H: 8 kHz,
If reduction is necessary, for details, refer to Figure 10.4-1 in The FRENIC-Ace User's Manual Chapter 10 "10.4.2 "Guideline for selecting inverter drive mode and capacity."

*7 This specification is an estimated value to be applied when the power supply capacity is 500 kVA (Inverter capacity × 10 when the capacity exceeds 50 kVA) and the power supply with %X = 5% is connected.

*8 This specification applies when a DC reactor (DCR) is used.

*9 Average braking torque for the motor running alone. It depends on the efficiency of the motor.

Appendix O EMC Filter Built-in Type Specifications

O.1 ND-mode inverters for general load

■ **Three-phase 400 V (460 V) class series**

Item	Specifications				
Type (FRN_ _ _ _E2E-4G・H)	0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) *1	0.75 [1]	1.5 [2]	2.2 [3]	3.0 [4]	5.5 [7.5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)				
Weight / Mass (kg) [lbs]	1.5 [3.3]	1.8 [4.0]	2.3 [5.1]	2.3 [5.1]	2.4 [5.3]

Item	Specifications							
Type (FRN_ _ _ _E2E-4EH)	0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) *1	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]	55 [75]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)							
Weight / Mass (kg) [lbs]	6.5 [14]	6.5 [14]	11.2 [25]	11.2 [25]	10.5 [23]	11.2 [24]	26 [57]	27 [60]

Item	Specifications								
Type (FRN_ _ _ _E2E-4EH)	0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) *1	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]	280 [450]	315 [500]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)								
Weight / Mass (kg) [lbs]	31 [68]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor. The specification other than the above items is the same as "N.1 ND-mode inverters for general load".

O.2 HD-mode inverters for heavy duty load

■ **Three-phase 400 V (460 V) class series**

Item	Specifications				
Type (FRN_ _ _ _E2E-4G・H)	0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) *1	0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)				
Weight / Mass (kg) [lbs]	1.5 [3.3]	1.8 [4.0]	2.3 [5.1]	2.3 [5.1]	2.4 [5.3]

Item	Specifications							
Type (FRN_ _ _ _E2E-4EH)	0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) *1	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)							
Weight / Mass (kg) [lbs]	6.5 [14]	6.5 [14]	11.2 [25]	11.2 [25]	10.5 [23]	11.2 [24]	26 [57]	27 [60]

Item	Specifications								
Type (FRN_ _ _ _E2E-4EH)	0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) *1	55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]	250 [400]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)								
Weight / Mass (kg) [lbs]	31 [68]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor. The specification other than the above items is the same as "N.2 HD-mode inverters for heavy duty load".

O.3 HND-mode inverters for general load

■ Three-phase 400 V (460 V) class series

Item	Specifications				
Type (FRN_ _ _ _E2E-4G・H)	0002	0004	0006	0007 ***10**	0012 ***10**
Nominal applied motor (kW) [HP] (Output rating) ***1**	0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)				
Weight / Mass (kg) [lbs]	1.5 [3.3]	1.8 [4.0]	2.3 [5.1]	2.3 [5.1]	2.4 [5.3]

Item	Specifications							
Type (FRN_ _ _ _E2E-4EH)	0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) ***1**	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]	45 [60]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)							
Weight / Mass (kg) [lbs]	6.5 [14]	6.5 [14]	11.2 [25]	11.2 [25]	10.5 [23]	11.2 [24]	26 [57]	27 [60]

Item	Specifications								
Type (FRN_ _ _ _E2E-4EH)	0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) ***1**	55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]	280 [450]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)								
Weight / Mass (kg) [lbs]	31 [68]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*10 Types FRN0007E2■-4G・H and FRN0012E2■-4G・H are ND spec; allowable ambient temperature 40°C (+104°F) or less. The rated output current is decreased 1% for every 1°C (1.8°F) when ambient temperature is +40°C (+104°F) or more.

The specification other than the above items is the same as “N.3 HND-mode inverters for general load”.

■ Three-phase 200 V (230 V) class series

Item	Specifications						
Type (FRN_ _ _ _E2E-2G・H)	0001	0002	0004	0006 *10	0010	0012 *10	0020 *10
Nominal applied motor (kW) [HP] (Output rating) ***1**	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.1 [1.5]	2.2 [3]	3.0 [4]	5.5 [7.5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env.						
Weight / Mass (kg) [lbs]	0.6 [1.3]	0.6 [1.3]	0.7 [1.5]	0.9 [2.0]	2.2 [4.9]	2.3 [5.1]	2.3 [5.1]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor

*10 Types FRN0006E2■-2G・H, FRN0012E2■-2G・H and FRN0020E2■-2G・H are ND spec; allowable ambient temperature 40°C (+104°F) or less. The rated output current is decreased 1% for every 1°C (1.8°F) when ambient temperature is +40°C (+104°F) or more.

The specification other than the above items is the same as “N.3 HND-mode inverters for general load”.

O.4 HHD-mode inverters for heavy duty load

■ Three-phase 400 V (460 V) class series

Item	Specifications				
Type (FRN_ _ _ _E2E-4G☐H)	0002	0004	0006	0007	0012
Nominal applied motor (kW) [HP] (Output rating) *1	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)				
Weight / Mass (kg) [lbs]	1.5 [3.3]	1.8 [4.0]	2.3 [5.1]	2.3 [5.1]	2.4 [5.3]

Item	Specifications							
Type (FRN_ _ _ _E2E-4EH)	0022	0029	0037	0044	0059	0072	0085	0105
Nominal applied motor (kW) [HP] (Output rating) *1	5.5 [7.5]	7.5 [10]	11 [15]	15 [20]	18.5 [25]	22 [30]	30 [40]	37 [50]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)							
Weight / Mass (kg) [lbs]	6.5 [14]	6.5 [14]	11.2 [25]	11.2 [25]	10.5 [23]	11.2 [24]	26 [57]	27 [60]

Item	Specifications								
Type (FRN_ _ _ _E2E-4EH)	0139	0168	0203	0240	0290	0361	0415	0520	0590
Nominal applied motor (kW) [HP] (Output rating) *1	45 [60]	55 [75]	75 [100]	90 [125]	110 [150]	132 [200]	160 [250]	200 [300]	220 [350]
EMC filter	Compliant with EMC Directives. Emission: Category C3. Immunity: 2nd Env. (EN61800-3:2004)								
Weight / Mass (kg) [lbs]	31 [68]	33 [73]	40 [88]	62 [137]	63 [139]	95 [209]	96 [212]	130 [287]	140 [309]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor.

The specification other than the above items is the same as “N.4 HHD-mode inverters for heavy duty load”.

■ Three-phase 200V (230 V) class series

Item	Specifications						
Type (FRN_ _ _ _E2E-2G☐H)	0001	0002	0004	0006	0010	0012	0020
Nominal applied motor (kW) [HP] (Output rating) *1	0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]	3.7 [5]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)						
Weight / Mass (kg) [lbs]	0.6 [1.3]	0.6 [1.3]	0.7 [1.5]	0.9 [2.0]	2.2 [4.9]	2.3 [5.1]	2.3 [5.1]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor.

The specification other than the above items is the same as “N.4 HHD-mode inverters for heavy duty load”.

■ Single-phase 200V (230 V) class series

Item	Specifications					
Type (FRN_ _ _ _E2E-7G☐H)	0001	0002	0003	0005	0008	0011
Nominal applied motor (kW) [HP] (Output rating) *1	0.1 [1/8]	0.2 [1/4]	0.4 [1/2]	0.75 [1]	1.5 [2]	2.2 [3]
EMC filter	Compliant with EMC Directives. Emission: Category C2. Immunity: 2nd Env. (EN61800-3:2004)					
Weight / Mass (kg) [lbs]	0.6 [1.3]	0.6 [1.3]	0.7 [1.5]	1.1 [2.4]	2.3 [5.1]	2.3 [5.1]

Note: A box (□) in the above table replaces A or B depending on the model.

*1 Fuji 4-pole standard motor.

The specification other than the above items is the same as “N.4 HHD-mode inverters for heavy duty load”.

Appendix P Common Specifications

Item			Explanation	Remarks
Output	Setting range	Maximum frequency	HHD/HND/HD mode: 25 to 500 Hz variable (under V/f control, Magnetic pole position sensorless vector control) (Up to 200 Hz in case of under vector control with speed sensor) ND mode: 25 to 120 Hz (under any drive control)	IMPG-VC
		Base frequency	25 to 500 Hz variable (in conjunction with the maximum frequency)	
		Starting frequency	0.1 to 60.0 Hz variable (0.0 Hz under vector control with speed sensor)	IMPG-VC
		Carrier frequency	Three phase 200 V class series FRN0001E2■-2G☐H to FRN0010E2■-2G☐H • 0.75 to 16 kHz variable (HHD/HND spec.) FRN0012E2■-2G☐H: • 0.75 to 16 kHz variable (HHD spec.) • 0.75 to 10 kHz variable (ND spec.) FRN0020E2■-2G☐H: • 0.75 to 16 kHz variable (HHD spec.) • 0.75 to 10 kHz variable (HND spec.) Three phase 400 V class series FRN0002E2■-4G☐H to FRN0059E2■-4EH: • 0.75 to 16 kHz variable (HHD/HND/HD spec.) • 0.75 to 10 kHz variable (ND spec.) FRN0072E2■-4EH to FRN0168E2■-4EH: • 0.75 to 16 kHz variable (HHD spec.) • 0.75 to 10 kHz variable (HND/HD spec.) • 0.75 to 6 kHz variable (ND spec.) FRN0203E2■-4EH to FRN0590E2■-4EH: • 0.75 to 10 kHz variable (HHD spec.) • 0.75 to 6 kHz variable (HND/HD/ND spec.) Single phase 200 V class series FRN0001E2■-7G☐H to FRN0011E2■-7G☐H: • 0.75 to 16 kHz variable (HHD spec.) **Note:** The carrier frequency may automatically lower depending upon the ambient temperature or the output current to protect the inverter. (The automatic lowering function can be disabled.)	
	Output frequency accuracy (Stability)		• Analog setting: ±0.2% of maximum frequency (at 25±10°C) (77±18°F) • Keypad setting: ±0.01% of maximum frequency (at -10 to +50°C) (14±22°F)	
	Frequency setting resolution		• Analog setting: 0.05% of maximum frequency • Keypad setting: 0.01 Hz (99.99 Hz or less), 0.1 Hz (100.0 to 500 Hz) • Link setting: 0.005% of maximum frequency or 0.01 Hz (fixed)	
	Speed control range		• 1: 1500 (Minimum speed : Nominal speed, 4P, 1 to 1500 r/min) • 1: 100 (Minimum speed : Nominal speed, 4P, 15 to 1500 r/min) • 1: 10 (Minimum speed : Nominal speed, 6P, 180 to 1800 r/min)	IMPG-VC IMPG-VF PM-SVC
	Speed control accuracy		• Analog setting: ±0.2% of maximum frequency or below (at 25 ±10°C) (77±18°F) • Digital setting: ±0.01% of maximum frequency or below (at -10 to +50°C) (14 to 122°F)	IMPG-VC
			• Analog setting: ±0.5% of base frequency or below (at 25 ±10°C) (77±18°F) • Digital setting: ±0.5% of base frequency or below (-10 to +50°C) (14 to 122°F)	PM-SVC
	Control method		• V/f control • Vector control without speed sensor (Dynamic torque vector) • V/f control, with slip compensation • V/f control, with slip sensor (PG option) • V/f Control with speed sensor (+Auto Torque Boost)(PG option) • Vector control with speed sensor (PG option) • Vector control without magnetic pole position sensor	VF IM-SVC VF with SC IMPG-VF IMPG-ATB IMPG-VC PM-SVC

	Item	Explanation	Remarks
Control	Control method	• V/f control • Vector control without speed sensor (Dynamic torque vector) • V/f control, with slip compensation • V/f control, with slip sensor (PG option) • V/f Control with speed sensor (+Auto Torque Boost)(PG option) • Vector control with speed sensor (PG option) • Vector control without magnetic pole position sensor	VF IM-SVC VF with SC IMPG-VF IMPG-ATB IMPG-VC PM-SVC
	Voltage/frequency characteristics	• Possible to set 80 to 240 V / 160 to 500 V at base frequency and at maximum output frequency.	
		• Non-linear V/f setting (3 points): Free voltage (0 to 240 V / 500 V) and frequency (0 to 500 Hz) can be set.	
	Torque boost	• Auto torque boost (For constant torque load) • Manual torque boost: Torque boost value can be set between 0.0 and 20.0% • Select application load with the function code. (Variable torque load or constant torque load)	
	Starting torque	Three phase 400 V class series • 200% or above, reference frequency 0.5 Hz (HHD-mode inverters of FRN0072E2■-4EH or below) 150% or above, reference frequency 0.5 Hz (HHD-mode inverters of FRN0085E2■-4EH or above) • 120% or above, reference frequency 0.5 Hz (HND/ND mode) • 150% or above, reference frequency 0.5 Hz (HD mode) Three phase 200 V class series • 200% or above, reference frequency 0.5 Hz (HHD-mode inverters of FRN0020E2■-2G□H or below) • 120% or above, reference frequency 0.5 Hz (HND-mode inverters of FRN0020E2■-2G□H or below) Single phase 200 V class series • 200% or above, reference frequency 0.5 Hz (HHD-mode inverters of FRN0011E2■-7G□H or below) Base frequency 50 Hz, with slip compensation and auto torque boost active	
	Start/stop operation	Keypad: Start and stop with (RUN) and (STOP) keys (Standard keypad) Start and stop with (FWD) / (REV) and (STOP) keys (Optional multi-function keypad)	
		External signals (digital inputs): Forward (Reverse) rotation, stop command (capable of 3-wire operation), coast-to-stop command, external alarm, alarm reset, etc.	
		Link operation: Operation through RS-485 (built-in as standard), CANopen (built-in as standard) or field bus (option) communications link	
		Switching run command: Remote/local switching, link switching	
	Frequency setting	Keypad: Using (∧) and (∨) keys	
		External potentiometer: Using external frequency command potentiometer. (External resistor of 1 to 5 kΩ 1/2 W)	
		Analog input: 0 to ±10 VDC (±5 VDC)/ 0 to ±100% (terminal [12]), 0 to +10 VDC (+5 VDC)/ 0 to +100% (terminal [12]) 4 to 20 mADC/ 0 to +100% (terminal [C1] (C1 function)) 4 to 20 mADC/ 0 to ±100% (terminal [C1] (C1 function)) 0 to 20 mADC/ 0 to +100% (terminal [C1] (C1 function)) 0 to 20 mADC/ 0 to ±100% (terminal [C1] (C1 function)) 0 to +10 VDC (+5 VDC)/ 0 to +100% (terminal [C1] (V2 function)), 0 to +10 VDC (+5 VDC)/ 0 to ±100% (terminal [C1] (V2 function))	
		UP/DOWN operation: Frequency can be increased or decreased while the digital input signal is ON.	
		Multistep frequency: Selectable from 16 different frequencies (step 0 to 15)	
		Pattern operation: The inverter runs automatically according to the previously specified run time, rotation direction, acceleration/deceleration time and reference frequency. Up to 7 stages can be specified.	
		Link operation: Operation through RS-485 (built-in as standard), CANopen (built-in as standard) or field bus (option) communications link	

Item		Explanation	Remarks
		Frequency setting: Two types of frequency settings can be switched with an external signal (digital input). Remote/local switching, link switching	
Control	Frequency setting	Auxiliary frequency setting: Inputs at terminal [12], [C1] (C1 function) or [C1] (V2 function) can be added to the main setting as auxiliary frequency settings.	
		Operation at a specified ratio: The ratio can be set by analog input signal. 0 to 10 VDC/0 (4) to 20 mA/0 to 200% (variable)	
		Inverse operation: Switchable from "0 to +10 VDC/0 to 100%" to "+10 to 0 VDC/0 to 100%" for the external command (terminals [12] and [C1] (V2 function) Switchable from "0 to -10 VDC/0 to -100%" to "-10 to 0 VDC/0 to -100%" for the external command (terminal [12]) Switchable from "4 to +20 mA DC/0 to 100%" to "20 to 4 mA DC/0 to 100%" for the external command (terminal [C1] (C1 function)) Switchable from "0 to +20 mA DC/0 to 100%" to "20 to 0 mA DC/0 to 100%" for the external command (terminal [C1] (C1 function))	
		Pulse train input (standard): Pulse input = Terminal [X5], Rotational direction = general terminal Complementary output: Max. 100 kHz, Open collector output: Max. 30 kHz	
		Pulse train input (option): A PG option card is required. CW/CCW pulse, pulse + rotational direction Complementary output: Max. 100 kHz, Open collector output: Max. 30 kHz	
	Acceleration/ deceleration time	Setting range: Between 0.00 and 6000 s	
		Switching: The four types of acceleration/deceleration time can be set or selected individually (switchable during operation).	
		Acceleration/deceleration pattern: Linear acceleration/deceleration, S-curve acceleration/deceleration (weak, arbitrary (with function code)), curvilinear acceleration/deceleration	
		Deceleration mode (coast-to-stop): Shutoff of the run command lets the motor coast to a stop.	
		Acceleration/deceleration time exclusive to jogging (0.00 to 6000 s)	
		Forcible stop deceleration time: Deceleration stop by the forcible stop ***STOP***. During forced stop operation, S-curve acceleration/deceleration is disabled.	
	Frequency limiter (Upper limit and lower limit frequencies)	• Specifies the upper and lower limits in Hz. • "Continue to run" or "Decelerate to a stop" selectable when the reference frequency drops below the lower limit.	
	Frequency/PID command bias	• Bias of reference frequency and PID command can be independently set (setting range: 0 to ±100%).	
	Analog input	• Gain: Setting range from 0 to 200% • Offset: Setting range from -5.0 to +5.0% • Filter: Setting range from 0.00 s to 5.00 s • Polarity selection (±/+)	
	Jump frequency	• Three operation points and their common jump width (0 to 30.0 Hz) can be set.	
	Timed operation	The inverter drives the motor for the run time specified from the keypad and stops its output. (Single-cycle operation)	
	Jogging operation	• Operation with RUN key (standard keypad), FWD or REV key (multi-function keypad), or digital input signal ***FWD*** or ***REV*** (Exclusive acceleration/deceleration time setting, exclusive frequency setting)	

Item		Explanation	Remarks
	Auto-restart after momentary power failure	• Trip immediately: Trip immediately at the time of power failure. • Trip after a recovery from power failure: Coast to a stop at the time of power failure and trip when the power is recovered. • Trip after decelerate-to-stop: Deceleration stop at power failure, and trip after stoppage • Continue to run: Operation is continued using the load inertia energy. • Start at the frequency selected before momentary power failure: Coast-to-stop at power failure and start after power recovery at the frequency selected before momentary stop. • Start at starting frequency: Coast-to-stop at power failure and start at the starting frequency after power recovery. • Start at the frequency searched at the time of power recovery: Coast-to-stop at power failure, search for the idling motor speed, and restart the motor.	
Control	Hardware current limiter	Limits the current by hardware to prevent an overcurrent trip from being caused by fast load variation or momentary power failure, which cannot be covered by the software current limiter. This limiter can be canceled.	
	Operation by commercial power supply	With commercial power selection commands (***SW50***, ***SW60***), the inverter outputs 50/60 Hz.	
	Slip compensation	• Compensates for decrease in speed according to the load • Possible to set constants for the response of slip compensation.	
	Droop control	• Decreases the speed according to the load torque.	
	Torque limiter	Control output torque so that output torque is preset limiting value or less. • Switchable between 1st and 2nd torque limit values	
	Torque current limiter	• Torque limit and Torque current limit are selectable. • Torque limit by analog input.	IMPG-VC PM-SVC
	Software current limiter	Automatically reduces the frequency so that the output current becomes lower than the preset operation level. This limiter can be canceled.	
	Overload stop	If the detected torque or current exceeds the preset value, the inverter decelerates the motor to a stop or causes the motor to coast to a stop.	
	PID control	• PID processor for process control/dancer control • Normal operation/inverse operation • PID command: Keypad, analog input (from terminals [12], [C1] (C1 function) and [C1] (V2 function)), multistep frequency (3 steps), RS-485 communication • PID feedback value: Analog input (from terminals [12], [C1] (C1 function) and [C1] (V2 function)) • Alarm output (absolute value alarm, deviation alarm) • Low liquid level stop function (pressurized operation possible before low liquid level stop) • Anti-reset wind-up function • PID output limiter • Integration reset/hold	
	Auto search for idling motor speed	The inverter automatically searches for the idling motor speed and starts to drive it without stopping it. Motor parameters require tuning. (Offline tuning)	
	Automatic deceleration	• If the DC link bus voltage or calculated torque exceeds the automatic deceleration level during deceleration, the inverter automatically prolongs the deceleration time to avoid overvoltage trip. (It is possible to select forcible deceleration actuated when the deceleration time becomes three times longer.) • If the calculated torque exceeds automatic deceleration level during constant speed operation, the inverter avoids overvoltage trip by increasing the frequency.	
	Deceleration characteristic (improved braking capacity)	The motor loss is increased during deceleration to reduce the regenerative energy in the inverter to avoid overvoltage trip.	
	Auto energy saving operation	Controls the output voltage to minimize the total sum of the motor loss and inverter loss.	
	Overload prevention control	If the surrounding temperature or IGBT junction temperature increases due to overload, the inverter lowers the output frequency to avoid overload.	
	Battery/UPS operation	Cancels the undervoltage protection so that the inverter under an undervoltage condition runs the motor with battery/UPS power.	

Item		Explanation	Remarks
	Offline tuning	Tunes the motor while the motor is stopped or running, for setting up motor parameters.	
	Online tuning	Controls the motor speed variation caused by the motor temperature rise during running.	
	Cooling fan ON/OFF control	• Detects inverter internal temperature and stops cooling fan when the temperature is low. • Possible to output a fan control signal to an external device.	
	1st to 2nd motor settings	• Switchable between two motors It is possible to set the base frequency, rated current, torque boost, and electronic thermal slip compensation as the data for 1st and 2nd motors.	

Item		Explanation	Remarks
Control	Universal DI	Transfers the status of an external digital signal connected with the general-purpose digital input terminal to the host controller.	
	Universal DO	Outputs a digital command signal sent from the host controller to the general-purpose digital output terminal.	
	Universal AO	Outputs an analog command signal sent from the host controller to the analog output terminal.	
	Speed control	• Notch filter for vibration control • Selectable among the four set of the auto speed regulator (ASR) parameters. (a PG option card is required.)	IMPG-VC PM-SVC
	Line speed control	In a machine such as winder/unwinder, regulates the motor speed to keep the peripheral speed of the spool constant. (a PG option card is required.)	IMPG-VF
	Positioning control with pulse counter	The positioning control starts from the preset start point and counts the feedback pulses by means of PG card installed in the inverter. The motor can be automatically started decelerating to the creep speed at which the target position can be detected, so that the motor can stop near the position (a PG option card is required).	Excluded IMPG-VC PM-SVC
	Master-follower operation	Enables synchronous operation of two motors equipped with a pulse generator (PG). (a PG option card is required.)	
	Pre-excitation	Excitation is carried out to create the motor flux before starting the motor. (a PG option card is required.)	IMPG-VC
	Zero speed control	The motor speed is held to zero by forcibly zeroing the speed command. (a PG option card is required.)	IMPG-VC
	Servo lock	Stops the motor and holds the motor in the stopped position.(a PG option card is required.)	IMPG-VC
	DC braking	Applies DC current to the motor at the operation start time or at the time of inverter stop to generate braking torque.	
	Mechanical brake control	• Possible to output mechanical brake control signals with the brake ON/OFF timing adjusted by the output current, torque command, output frequency and timer. • Mechanical brake application check input.	
	Torque control	• Analog torque/torque current command input • Speed limit function is provided to prevent the motor from becoming out of control. • Torque bias (analog setting, digital setting) (The PG option card is required.)	IMPG-VC
	Rotation direction control	Select either of reverse or forward rotation prevention.	
	Customizable logic interface	Possible to select or connect digital logic circuits or analog operation circuits with digital/analog I/O signals, configure a simple relay sequence, and operate it freely. • Logic circuits: (Digital) AND, OR, XOR, flip-flop, detection of rising and falling edges, various counters. (Analog) Addition, subtraction, multiplication, division, limiters, absolute values, sign inversion addition, comparison, maximum value selection, minimum value selection, average values, scale conversion. • Multifunction time: On-delay timer, off-delay timer, pulse train output, etc. Setting range: 0.0 to 9990 s • Input/output signals: Terminal input/output, inverter control functions • Others: Available in 200 steps configured with 2 inputs and 1 output per step.	
	Functions for wiredrawing machines, hoists, and spinning frames	Customizable logic function enables dedicated functions for each application.	

Item		Explanation	Remarks
Display	Indicators	Detachable, 7-segment, 4-digit LED, 7 push-buttons (PRG/RESET, FUNC/DATA, UP, DOWN, RUN, STOP, and SHIFT), and 6 LED indicators (KEYPAD CONTROL, Hz, A, kW, X10, and RUN)	
	Running/stopping	Speed monitor (reference frequency, output frequency, motor speed, load shaft speed, line speed, and speed indication with percent), output current (A), output voltage (V), calculated torque (%), input power (kW), PID command value, PID feedback amount, PID output, timer values for timed operation (s), load factor (%), and motor output (kW), Torque current [%] , Magnetic flux command [%], Analog input monitor, input watt-hour, constant feeding rate time (min.), and remaining time for timed operation (s) can be displayed.	
	Maintenance monitor	DC link bus voltage, maximum effective current, input watt-hour, input watt-hour data, temperature (inverter internal temperature, maximum inverter internal temperature, heat sink temperature, maximum heat sink temperature), capacitance of the DC link bus capacitor, service life of DC ink but capacitor (elapsed time/remaining time), cumulative run times (inverter power-ON time, electrolytic capacitors on printed circuit boards, cooling fans, individual motors), light-alarm contents (last four alarms), RS-485 error contents and number of error times, CANopen error contents, option error contents and number of error times, ROM version (inverter, keypad, and option)	
	I/O check	Displays the I/O signal states of control circuit terminals using the segment ON/OFF of the 7-segment LED monitor or hexadecimal format. (digital and analog signals)	
	Trip	Displays the cause of a trip by codes.	
	Light-alarm	Shows the light-alarm display l-al.	
	During running or at the time of a trip	• Trip history: Saves and displays the cause of the last four trips (with a code). • Saves and displays the detailed running status data of the last four trips.	

*Note: The meaning of the described abbreviations are shown as follows.
VF V/f Control
IM-SVC(DTV) Speed Sensorless Vector control (Dynamic Torque Vector Control)
VF with SC V/f Control with Slip Compensation
IMPG-VF V/f Control with Speed Sensor (a PG option card is required.)
IMPG-ATB V/f Control with speed sensor (＋Auto Torque Boost)(A PG option card is required.)
IMPG-VC Vector Control with Speed Sensor (a PG option card is required.)
PM-SVC Magnetic Pole Position Sensorless Vector Control

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

When the protective function is activated so that the LED monitor shows alarm codes, refer to the FRENIC-Ace User's Manual Chapter 6 "TROUBLESHOOTING."

For the usage environment and storage environment, refer to the FRENIC-Ace User's Manual Chapter 1 "1.3 Precautions for Using Inverters."

MEMO

APPENDICES