Fuji Electric

Innovating Energy Technology

QUICK GUIDE
PUMP CONTROL

FRENIC-Ace-H

Frequency inverter for pump control applications

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Thank you for purchasing **FRENIC-AceH** , Fuji Electric's inverter for pump and compressor applications. This guide is structured as follows:

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Chapter 0
Introduction to pressure control systems

The target of a pressure control system is to provide a variable flow with a constant pressure for the water system of an apartment building, machine refrigeration systems, mixing liquids in chemical industry, etc.

A very typical example is to provide the water supply for a residential building. In this case, the flow (water consumption) is greater in the morning than during the night (when it is almost zero). The pressure control system must be able to provide, at the same pressure, both types of consumption (daytime→higher flow, during the night→ almost no flow); in addition, the system has to adapt to the demand variations that occur normally in this kind of application, for example, when people turn on and off many taps at the same time.

The ***FRENIC-Ace-H*** inverter has been designed to fulfil all the requirements of the different pump control systems. Some of its more important functions are:

- Stop function due to low water flow (Sleep Function)
- Start-up function because of water demand (Wake-up Function)
- Operation limits (current, voltage and frequency) to protect the motor and the pump
- Control of multiple pumps on 1 regulated pump + auxiliary pumps topology (Mono-regulated pump Control)
- Control of multiple pumps on multi regulated pumps topology (Multi-regulated pump Control)
- Possibility to add an additional pump (AUX_L Function) to both topologies
- Many functions to avoid overpressure and water losses (Warnings, alarms, etc.)
- Possibility of precise adjustment of the levels for start-up and stop of the auxiliary pumps to fine tune the system behaviour
- Possibility of the precise adjustment of the levels to start-up and stop of the PID control, during the connection/disconnection of the auxiliary pumps, to fine tune the system behaviour
- Independent ramps for the start-up and the stop of the regulated pump, separate from the ramps for the connection/disconnection of auxiliary pumps
- Selection of the sequence for the pumps start-up and stop
- Sequenced switching rotation of the pumps (by timer or intelligent control)
- Possibility of sharing the working time between the pumps
- Information about the working time of each pump
- Pressure sensor disconnection detection
- Selecting different warnings (low-pressure, overpressure, etc.)
- Control of the delay time between connection and disconnection of the contactors
- Display units and sensor range adjustments
- Selectable ‘Pump Stop’ Strategy
- Multiple frequency command selection (by means of digital inputs)
- Dew condensation prevention Function
- Energy Saving Functions

<u>Regulation by means of PID control:</u>

A PID control is a regulation system involving the set value (SV - desired pressure) and a process value (PV - Feedback, measure of real pressure or flow from a transducer). From these two values the difference, or error, is calculated, subtracting one from the other. The PID control then adjusts its output demand (MV - pump’s speed) in order to minimize the error:
-If the error is positive (desired pressure greater than real pressure) speed should increase
-If the error is negative (desired pressure lower than the real pressure) speed should decrease
-If the error is zero (desired pressure equal to real pressure) speed should stay at the same level

Parameters (gains) to adjust: Proportional, Integral and Derivative components (though Derivative component is not normally used in this application) help to select how quickly the system will respond to pressure and consumption changes. Normally, a quick (dynamic) response is desired, but pressure peaks and oscillations must be avoided.

QUICK GUIDE
PUMP CONTROL

FRENIC-Ace-H frequency inverter is able to control single or multiple pumps in mono-regulated or multi-regulated configuration. Several control schemes may be built as shown below:

The necessary digital outputs will vary depending on the control type has been chosen (OPC-F2-RY optional card may be necessary).

	Necessary digital outputs	Do we need the optional relay card installed?	Explained in…
Single pump control	0	NO	**CHAPTER 1**
Single pump control consists of 1 pump exclusively controlled by the frequency inverter			

MONO-REGULATED PUMP CONTROL (FIXED) up to 6 pumps (Mono-joker) J401=1					Necessary digital outputs	Do we need the optional relay card installed?	Explained in …
1 regulated Pump	+	1 auxiliary pump (On-Off control)			1	NO	**CHAPTER 2**
		2/3 auxiliary pumps (On-Off control)			2/3	Optional (OPC-F2-RY)	
		4 auxiliary pumps (On-Off control)			4	YES (OPC-F2-RY)	
		4 auxiliary pumps (On-Off control)	+	1 additional pump (On-Off control)	5	YES (OPC-F2-RY)	**CHAPTER 3**
Mono-regulated pump control consists of 1 pump exclusively controlled by the frequency inverter and multiple auxiliary pumps working in On-Off control mode. Additional pump is added / removed depending on the regulated pump speed and if auxiliary pumps are all enabled or not.							

MULTI-REGULATED PUMP CONTROL (FLOATING) up to 3 pumps (Multi-joker) J401=2	Necessary digital outputs	Do we need the optional relay card installed?	Explained in …
2/3 regulated pumps	4/6	YES (OPC-F2-RY)	**CHAPTER 4**
Pumps working on Multi-regulated mode are all inverter driven. Additional pump is added / removed depending on the regulated pump speed and if others are also enabled or not.			

Chapter 1
Single pump control

	Necessary digital outputs	Do we need the optional relay card installed?
Single pump control	0	NO

When a regulated pump is being controlled, it's necessary to consider certain parameters in order to allow the inverter to control the pump's start-up and stop, controlling speed to maintain the desired pressure, etc.

The schematic to implement control by only 1 pump by means of **FRENIC-Ace-H** inverter, is as follows:

Please note the pressure transducer is connected to the inverter's analog input C1 (4-20 mA)

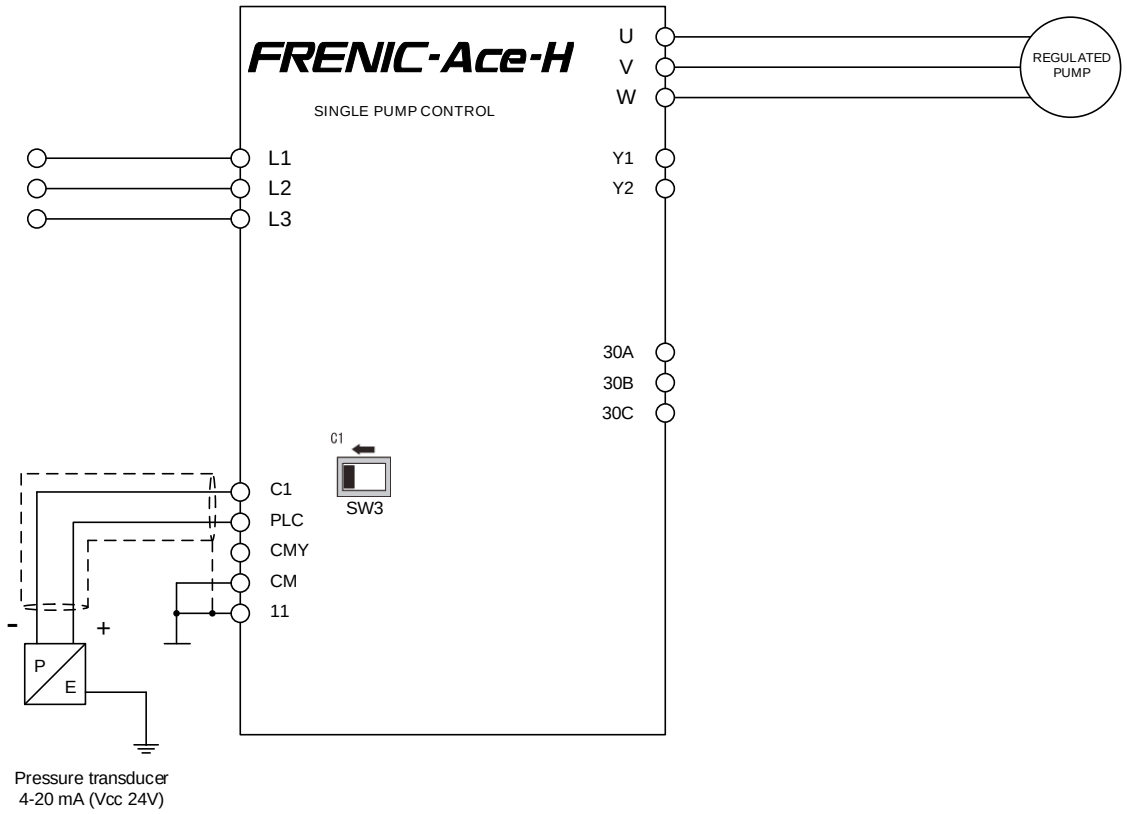


Figure 1.1: control schematic for 1 pump only

By means of the inverter's keypad, a digital input or an analog set point, the desired pressure can be selected. Once this pressure is set, inverter will modify pump's speed between a minimum (J19 = F16 (Hz)) and a maximum (J18=F15=F03 (Hz)) frequencies, in order to stabilize the pressure.

To work in this way, the integrated PID Control 1 must be enabled (J01) and adjusted properly. Then, the inverter's response should be the required action to control the application.
PID's response can be modified by means of parameters J03 and J04 (Proportional gain and Integral time).

When the "RUN" signal is switched on (either FWD or REV), the inverter will increase the output frequency (always after the period time defined in J454 (s)). In order to control this rising output, some parameters are available: F23 (Hz) controls the starting frequency, F16 the frequency limiter (low) and the ramp from one to the other (F07) (s). PID Control 1 is enabled since RUN command is given. In the same way, when the "RUN" signal is switched off, the inverter decrease its output frequency to the level defined in F25 (Hz) (the deceleration time is set in F08 (s)), and stops the PID Control 1.

- **Sleep Function *(related parameters: J15 (Hz), J16 (s))***

Sleep function can be useful to stop one pump when the speed is below a rate where there is no flow (pump doesn't impel the water).

Once the demand frequency level below this rate (the frequency when the pump begins to move the water but not enough to create a flow) is known, parameter J15 (Hz) should be set slightly higher than this frequency.

Through this function, it's possible to avoid possible mechanical problems that could (over time) damage pump components or 'boil' the water with the wasted energy causing excess pressure and leaks. In addition, stopping the pump when it's not really needed means, obviously, Energy Saving.

So, Sleep Function will be applied if the inverter's demand output frequency is lower than the 'sleep' level stored in parameter J15 (Hz) and it stays at a lower level for a time longer than that specified in J16 (s).

In Figure 1.2 sleep function is shown. The deceleration time to get to the "Stop Frequency" is stored in F08 (s).

In order to have this function active, J15 must be different than 0. For additional details, refer to J15 parameter description.

Important: Sleep frequency (J15 (Hz)) must be lower than the wake-up frequency (J17 (Hz)) and must be higher than the minimum frequency (F16=J19).

- **Wake-up function *(related parameters J17 (Hz), J23, J24 (s))***

Wake-up function is useful to start-up a pump again that previously was stopped by the sleep function.

In order to wake up a pump two conditions must be accomplished:

MV ≥ J17 (Hz)		**|SV – PV|≥ J23 (*)**		**Delay Time ≥ J24 (s)**
Manipulated value (MV, PID's output) must be greater than the level stored in J17 (the current MV value is shown on TP-A1 according to recommended setting)	and...	The absolute value of the process error (the subtraction between the process value and the set point value) must be greater than the percentage in J23	and...	The percentage set in J23 is kept and MV is above J17 level longer than the time specified in J24

(*) J23 units are always in %.

As two conditions have to be met in order for the pump to start, multiple start-ups due to pipe losses can be avoided. So, we avoid waking up the pump unnecessarily or too often.

Figure 1.2 shows how the pump goes to sleep mode and wakes up.

In addition, sleep frequency must be higher than minimum frequency (F16=J19)

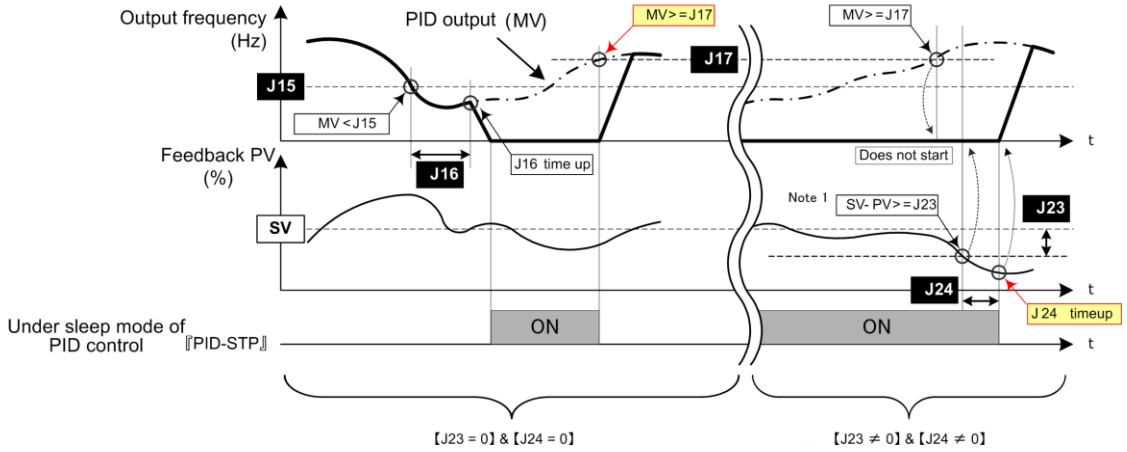


Figure 1.2: Speed control behaviour while sleep and wake-up functions are enabled and J14=1,11 or 21.

Function codes set-up, 1 pump

The following table (table 1.1), called “Common parameters to the all pump control systems”, shows the common parameters to all pump control systems using **FRENIC-Ace-H**, these are known as the basic parameters.

In other chapters, Specific Parameters’ table will be shown. These parameters will depend on the chosen control system.

Note: The following values are shown as an example and could not work properly in your application.

Table 1.1: Common parameters to all pump control systems

	Common Parameters to all pump control systems FRENIC-AceH			
	Name	Default setting	Example’s Value	User’s Value
F02	Operation method	0	**1**	
F07	Acceleration Time 1	20.00 s	**3.00 s**	
F08	Deceleration Time 1	20.00 s	**3.00 s**	
F11	Electronic Thermal Overload protection for motor 1. Overload detection Level	100% of the motor rated current	**13.0 A**	
F12	Electronic Thermal Overload protection for motor 1. Time constant	5.0 min (0074 or below) / 10.0 min (0085 or above)	**5 min**	
F15	Frequency Limiter. Upper limit	70.0 Hz	**50.0 Hz**	
F16	Frequency Limiter. Lower limit	0.0 Hz	**25.0 Hz**	
E62	Terminal [C1] (C1 extended function)	0	**5**	
C64	Analog input adjustment (Terminal [C1] (C1 function)). (Display unit)	2: %	**44: bar**	
C65	Analog input adjustment (Terminal [C1] (C1 function)).] (max. scale)	+ 100.00	**Transducer’s pressure**	
E43	LED monitor (item selection)	0: Speed monitor	**12: PV**	
K16	Sub monitor 1 display item selection	13: Output current	**50: SV**	
K17	Sub monitor 2 display item selection	19: Input power	**1: Fout1**	
P01	Motor 1. Number of Poles	4	**4**	
P02	Motor 1. Rated capacity	Rated Capacity Standard Motor	**5.5 kW**	
P03	Motor 1. Rated current	Rated Current Standard Motor	**13.0 A**	
H91	PID feedback wire break detection	0.0 s	**0.5 s**	
J01	PID Control. Mode Selection	0	**1**	
J03	PID Control. Gain P	0.100	**2.500**	
J04	PID Control. Integral time	0.0 s	**0.2 s**	
J15	PID Control. Sleep frequency	0.0 Hz	**35.0 Hz**	
J16	PID Control. Sleep timer	0 s	**15 s**	
J17	PID Control. Wakeup frequency	0.0 Hz	**38.0 Hz**	
J18	PID Control. Upper limit of PID process output	999	999	
J19	PID Control. Lower limit of PID process output	999	999	
J23	PID Control. Wakeup level of PID error	0.0%	**5%**	
J24	PID Control. Wakeup timer	0 s	**1 s**	

CONDITIONS TO ACHIEVE GOOD CONTROL WITH A SINGLE PUMP

If it’s necessary to use a different parameter set-up to that shown in the above “Example Values” column, please bear in mind the following conditions:

Sleeping/ Wake-up frequency Conditions

F03 = F15 = J18 > J17 > J15 > F16 = J19

Maximum frequency | Frequency to wake-up | Frequency to sleep | Minimum frequency

COMMON PARAMETERS DESCRIPTION

Basic Function

- F02: Run Command

This function code defines the way in what the “RUN” signal will be given to the inverter in order to start the pressure control.

Usually, “RUN Command” is sent to the inverter by means of the digital input (F02 = 1). That is, switching on FWD or REV (control terminals in the inverter) digital inputs enables the inverter output.

A RUN command can be also activated by means of the inverter’s keypad, pushing RUN (FWD or REV) button.

- F07: Acceleration Time 1
- F08: Deceleration Time 1

These acceleration/deceleration ramps are used in two cases:

1. After the RUN Command is ON, F07 ramp is used to achieve the frequency in F16 or J19 (the biggest one of both values).
   When the RUN Command is switched OFF, F08 value defines the deceleration ramp to go from the current frequency to the stop frequency (F25).
   At every change of output frequency, even due to the PID output change.

2. These ramps are also used when the inverter is connected/disconnected from the commercial power supply if function codes J455 and J458 are set to 0.00 (please refer to the corresponding diagrams in the following chapters).

- F11: Electronic Thermal Overload Protection for motor 1. Overload detection level
- F12: Electronic Thermal Overload Protection for motor 1. Thermal time constant

By means of these two parameters is possible to adjust the overload protection function. Normally, F11 will be adjusted to the motor’s rated current and F12 to 5 minutes.

- F15: Frequency Limiter. Upper limit
- F16: Frequency Limiter. Lower limit

These two parameters define the frequency limits, and the inverter will never go outside of these limits during pump control.

It’s normal to adjust the parameters F15, J18 and F03 with the same value.
Equally, F16 should be equal to J19, too.

Inputs Set-up

- E62: Terminal [C1] C1 extended function

This parameter can be used to select the function for analog input C1.
Usually this parameter is set to E62 = 5, this setting will define the [C1] analog input as PID Feedback (pressure transducer).

Motor Map

- P01: Motor. Number of poles
- P02: Motor. Rated Capacity
- P03: Motor. Rated Current

In these parameters must be stored the number of poles, rated capacity and rated current as are shown in the motor’s nameplate.

Special Functions

- H91: PID feedback wire break detection

Disconnection of pressure sensor (cable failure).

When a value is stored in parameter H91 (between 0.1 and 60.0 seconds) the inverter will generate an alarm (**CoF**) when it notices that C1 signal current is missing (C1 current < 2mA) during a time longer than the value in H91.

H91 = 0.0 → function disabled.
H91 ≠ 0 → function enabled.

PID and pump control

- J01: PID control 1. Mode selection

When J01 = 1 and the error between Set Point and Process Value is positive (SP - PV > 0), the PID controller makes a positive output action control (increasing MV). Alternatively, when the error between Set Point and Process Value is negative (SP - PV < 0), the PID controller makes a negative output action control (decreasing MV).

Alternatively, if J01 = 2 and the error between Set Point and Process Value is negative (SP – PV < 0) the PID controller makes a positive output action control (increasing MV). Alternatively, when the error between Set Point and Process Value is positive (SP - PV > 0), the PID controller makes a negative output action control (decreasing MV).

- J03: PID Control 1. P Gain

This parameter is used to set the PID controller's proportional gain (P). This parameter must be adjusted because its value depends on the application.

A high P value produces a PID controller's quick response. Otherwise, a low P-value produces a slow response.

- J04: PID Control 1. Integral Time

This parameter is used to adjust PID's integral time (I). This parameter must be adjusted because its value depends on the application.

A high integral time value produces a PID slow response. Otherwise, a low I value produces a quicker response.

- J18: PID control 1. Upper limit of PID process output
- J19: PID control 1. Lower limit of PID process output

These parameters specify upper and lower limit process output values.
We set J18 = F15 = F03 and J19 = F16.

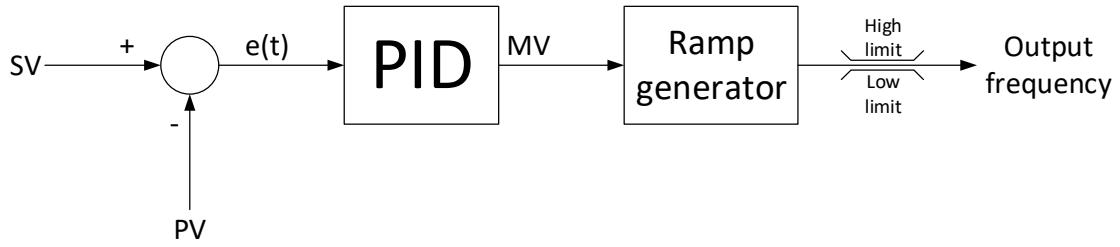


Figure 1.3: PID control schematics inside the inverter

Chapter 2

Mono-regulated pump control with 1 regulated pump + 1 to 4 auxiliary pumps

Mono-regulated pump control (Mono-joker)			Necessary digital outputs	Do we need the optional relay card installed?
1 inverter driven pump	+	1 auxiliary pump (ON / OFF)	1	NO

The schematic for a mono-regulated pump control with 1 regulated pump + 1 auxiliary pump by means of the **FRENIC-Ace-H** inverter is as follows:

Please, pay attention to the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA).

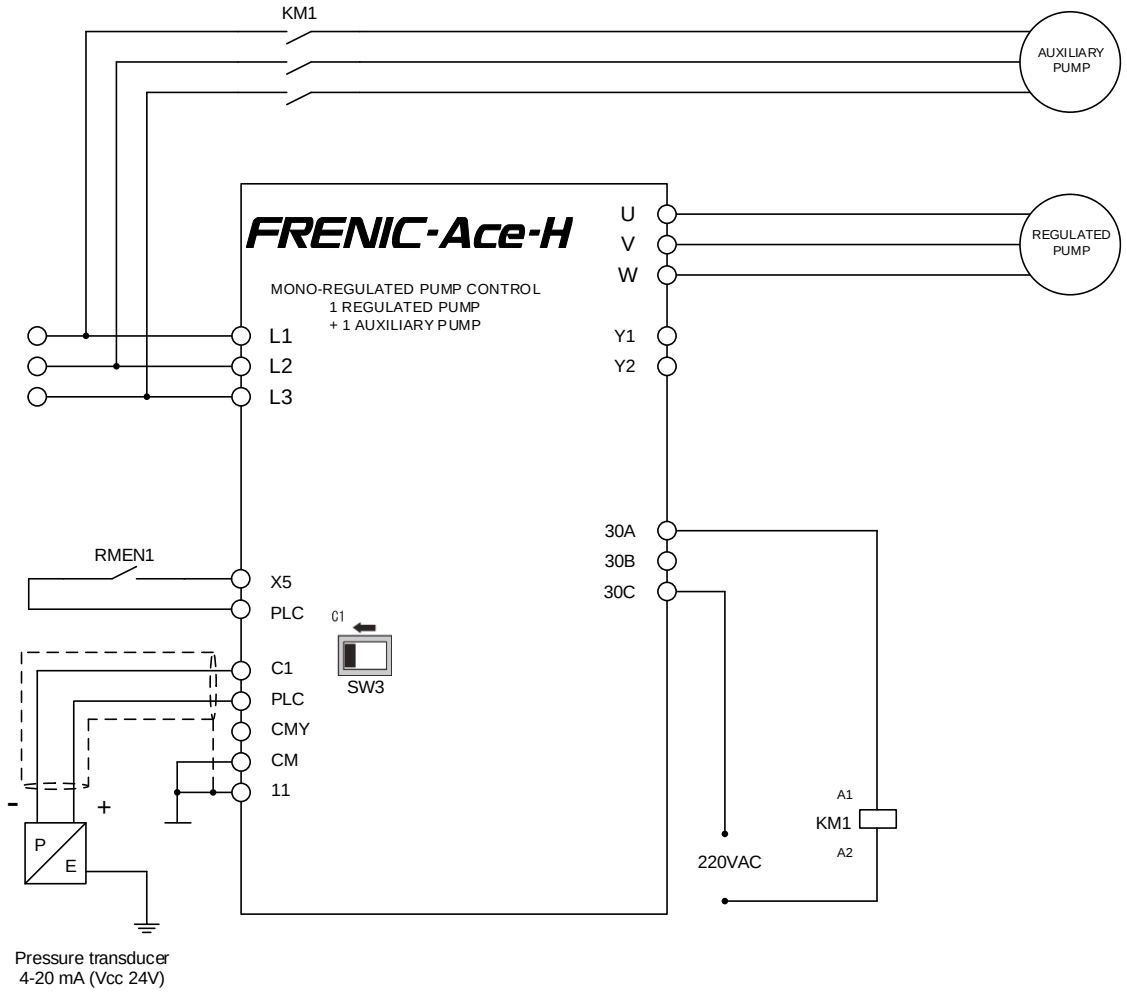


Figure 2.1: Schematic of a mono-regulated pump control with 1 regulated pump + 1 auxiliary pump.

Mono-regulated pump control (Mono-joker)			Necessary digital outputs	Do we need the optional relay card installed?
1 inverter driven pump	+	2/3 auxiliary pump (ON / OFF)	2/3	NO

The schematic for a mono-regulated pump control with 1 regulated pump + 2/3 auxiliary pumps (using additional relays) by means of the **FRENIC-Ace-H** inverter is as follows:

Please, pay attention to the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA)

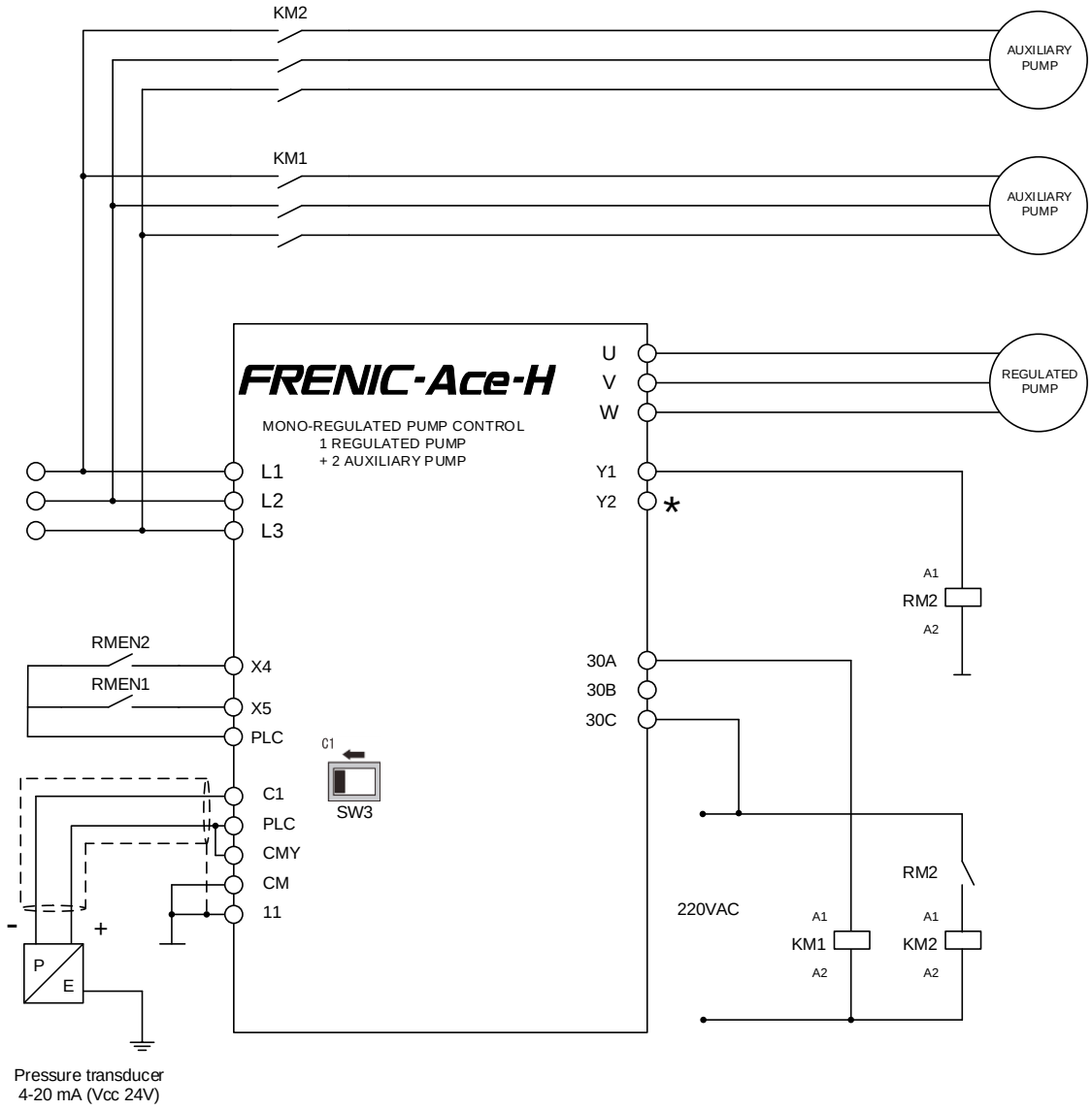


Figure 2.2: Schematic of a mono-regulated pump control with 1 regulated pump + 2 auxiliary pumps with external relays.

*[Y2] could be used for a third Auxiliary Pump

Mono-regulated pump control (Mono-joker)			Necessary digital outputs	Do we need the optional relay card installed?
1 inverter driven pump	+	2/3 auxiliary pump (ON / OFF)	2/3	YES (OPTIONAL) (OPC-E2-RY)

The schematic for a mono-regulated pump control with 1 regulated pump + 2/3 auxiliary pumps (using OPC-E2-RY) by means of the **FRENIC-Ace-H** inverter is as follows:

Please, pay attention to the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA)

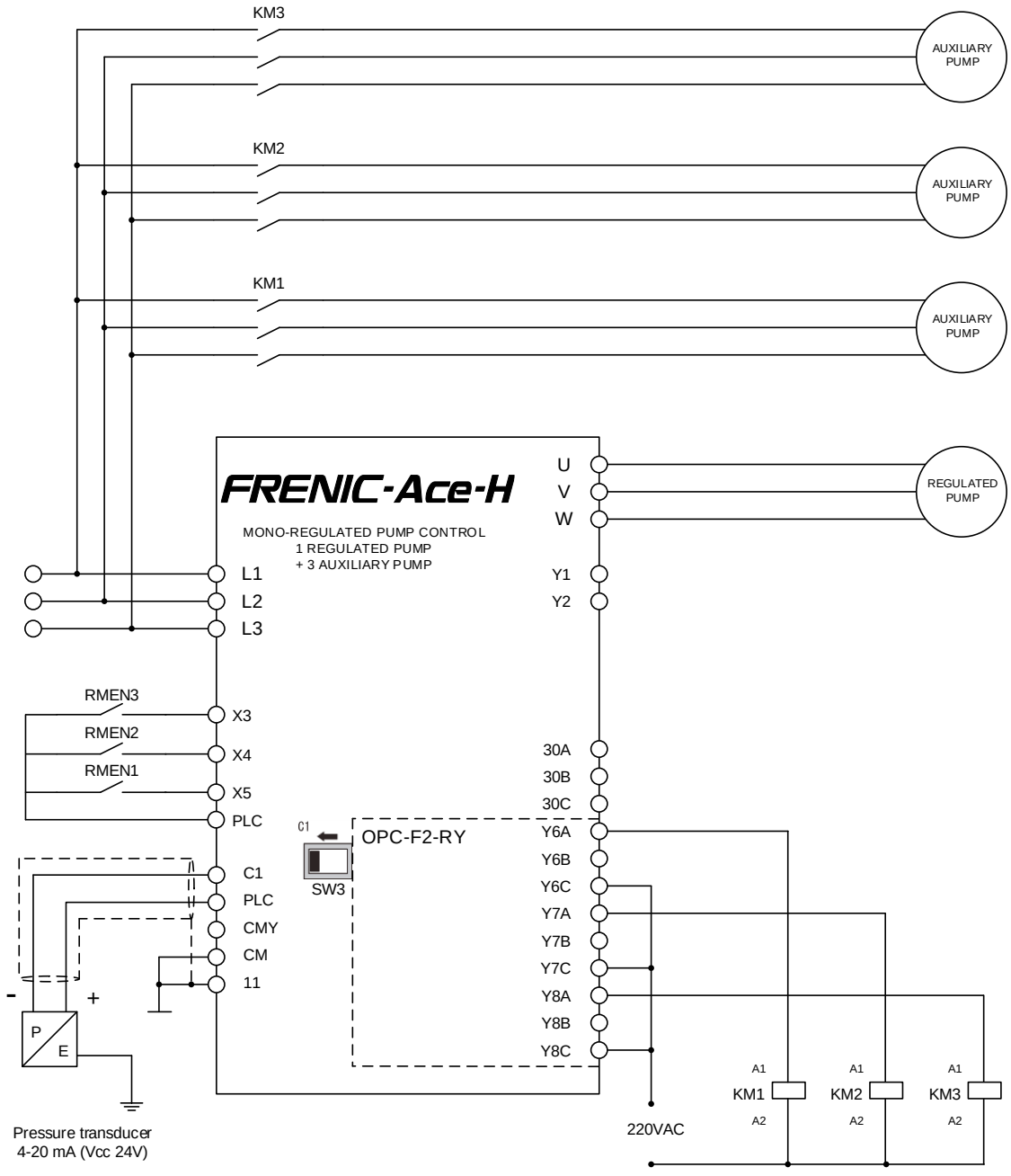


Figure 2.3: Schematic of a mono-regulated pump control with 1 regulated pump + 3 auxiliary pumps with relay option card.

Mono-regulated pump control (Mono-joker)			Necessary digital outputs	Do we need the optional relay card installed?
1 inverter driven pump	+	4 auxiliary pumps (ON / OFF)	4	YES (MANDATORY) (OPC-F2-RY)

The schematic for a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps (using additional relays) by means of the FRENIC-Ace-H inverter is as follows:

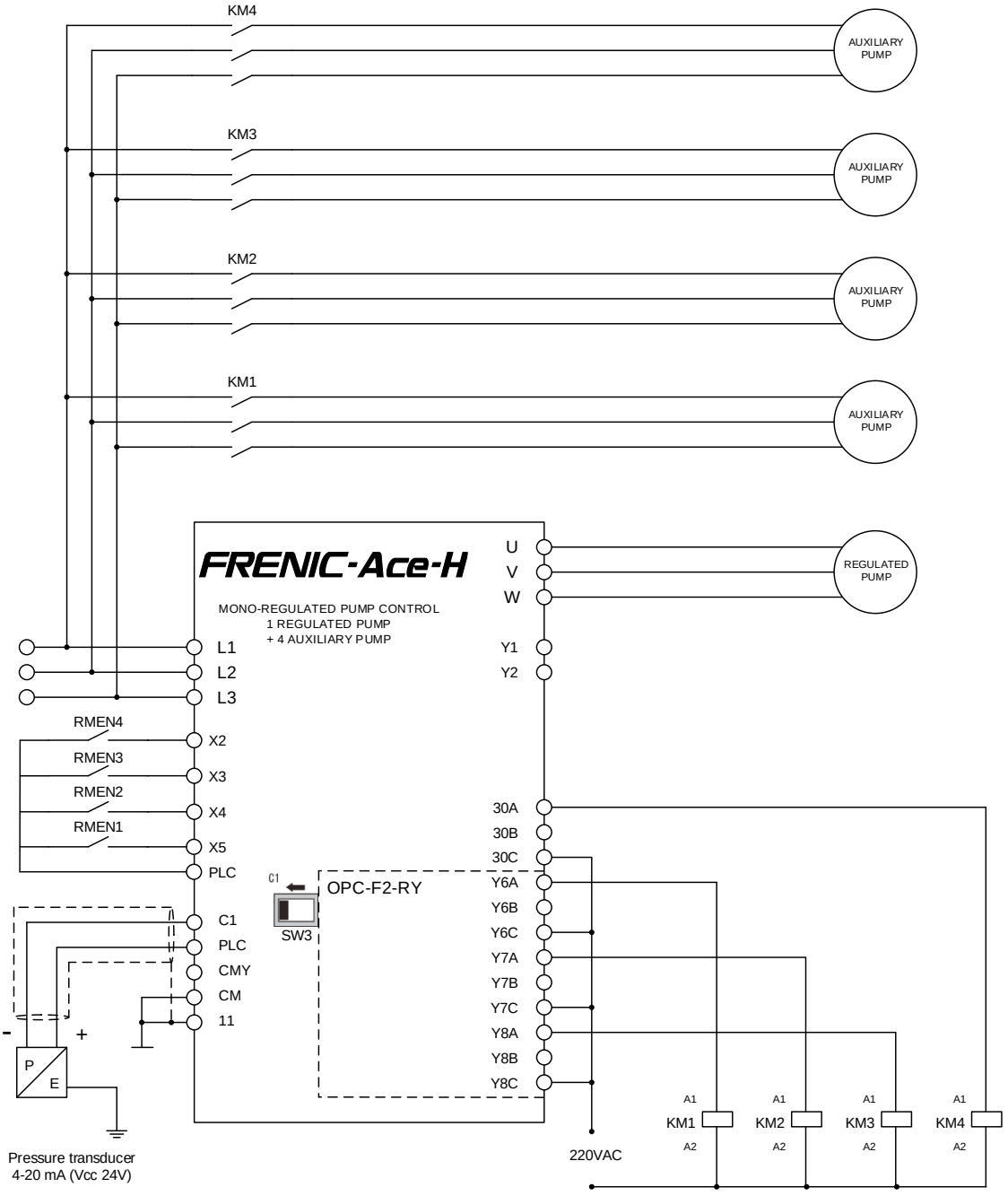


Figure 2.4: Schematic of a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps with external relays.

Mono-regulated pump control involves a pump exclusively driven by the inverter and other(s) pump(s), working in “On-Off control” mode and directly connected to the commercial power supply.

The inverter will connect/disconnect the auxiliary pump(s) to the commercial power supply, in order to achieve the desired pressure.

By means of the inverter’s keypad, digital input or analog command, the desired system pressure will be set. Then, the inverter will modify the speed of the regulated pump between the minimum frequency (J19 = F16) and a maximum frequency (J18 = F15 = F03), keeping the pressure under control.

The inverter’s PID control 1 must be activated (J01) and adjusted accordingly, ensuring the inverter’s response is what the installation requires all the time.

PID control 1 action can be adjusted by means of function codes J03 and J04 (proportional gain and integral time).

Connection/Disconnection of an auxiliary pump is shown in Figure 2.5, with all the related function codes.

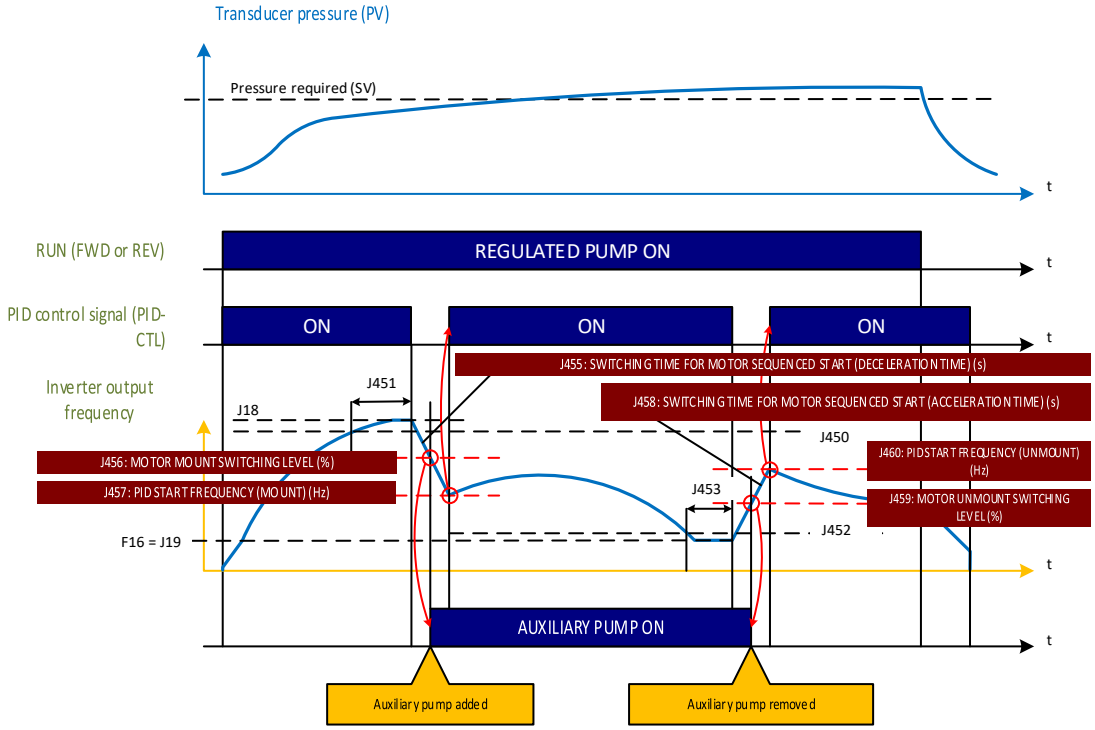


Figure 2.5: Speed pattern with mono-regulated pump control. The Auxiliary pump is connected and disconnected

Note: Decision to mount/unmount auxiliary pumps depend either on PID output or output frequency depending on J401 setting:

- J401 = 1, levels to mount/unmount depend on PID output, MV (same behaviour as FRENIC-Eco)
- J401 = 11, levels to mount/unmount depend on Output frequency.

The requirements or conditions to activate an auxiliary pump are described below:

- ## Connection of an auxiliary pump

1st stage — **Conditions for adding an auxiliary pump**

If the regulated pump's output frequency is higher than the level established by J450 during the time specified in J451, the inverter will understand that using the regulated pump is not enough to maintain the required pressure, and the inverter will start a process to connect an auxiliary pump to the commercial power supply.

2nd stage — **Adding an auxiliary pump**

When the conditions above are accomplished, the inverter will decrease the output frequency of the regulated pump to the value stored in J457, by means of the deceleration ramp in J455. Once the frequency level J457 is achieved, the PID controller will be activated again.
The frequency level when the auxiliary pumps are connected is defined in function code J456.

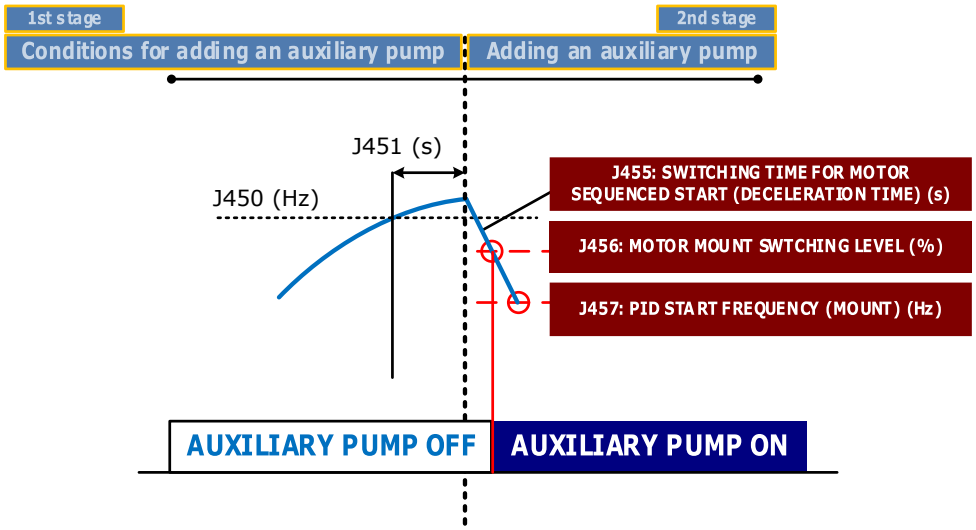


Figure 2.6: Auxiliary pump's connection

The exact frequency level where the inverter connects the auxiliary pumps to the commercial power supply is specified by means of the function code J456. The equation that defines this level is:

$$\text{Frequency for the connection of the auxiliary pumps (Hz)} = \left[\frac{J456}{100}\times(J18-J19)\right]+J19$$

As an example:

J456 = 50 %
J18 = 50 Hz
J19 = 25 Hz

$$\text{Frequency for the connection of the auxiliary pumps (Hz)} = \left[\frac{50}{100}\times(50-25)\right]+25 = 37{,}5Hz$$

In this case, the connection of the auxiliary pumps happens when the regulated pump is turning at 37.5 Hz.

The requirements or conditions to deactivate an auxiliary pump are described below:

- ## Disconnection of an auxiliary pump

1st stage | **Conditions for removing an auxiliary pump**

If the output frequency level of the regulated pump gets lower than the value stored in J452 during a time longer than J453, the inverter will understand that the auxiliary pump is no longer needed and will begin a disconnection process.

2nd stage | **Removing an auxiliary pump**

If the conditions above are accomplished, the inverter will increase the output frequency of the regulated pump until the frequency level specified by function code J460, by means of the acceleration ramp J458. The frequency level when the auxiliary pumps are disconnected is defined by function code J459.

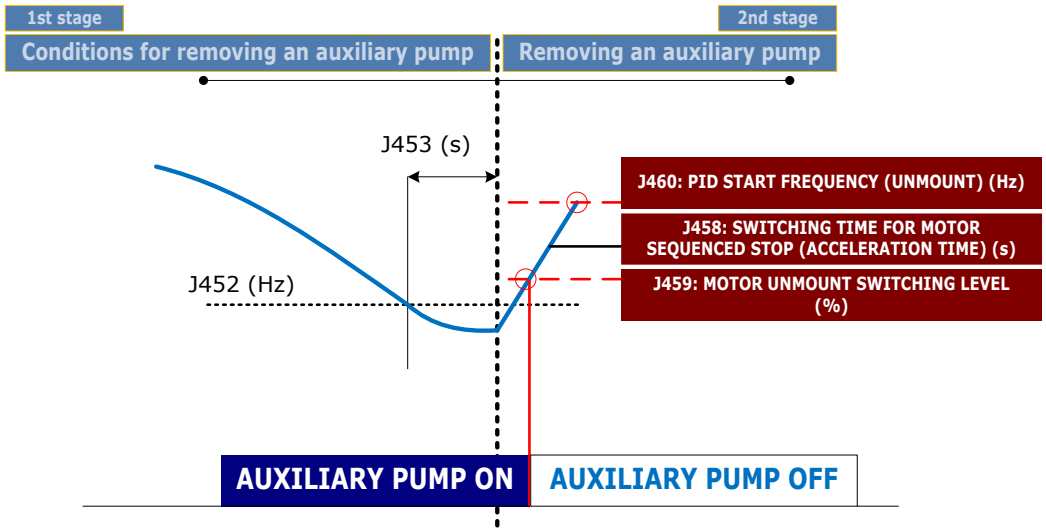


Figure 2.7: Disconnection of an auxiliary pump

The exact frequency level where the inverter disconnects the auxiliary pumps from the commercial power supply is specified by means of the function code J459. The equation that defines this level is:

$$\text{Frequency for the connection of the auxiliary pumps (Hz)} = \left[\frac{J459}{100}\times(J18-J19)\right]+J19$$

For example:

J459 = 40 %
J18 = 50 Hz
J19 = 25 Hz

$$\text{Frequency for disconnection of the auxiliary pumps (Hz)} = \left[\frac{40}{100}\times(50-25)\right]+25 = 35Hz$$

In this case, the disconnection of the auxiliary pumps happens when the regulated pump is turning at 35 Hz.

Set-up for 1 regulated pump + 1 to 4 auxiliary pumps

The following table (Table 2.1), "Common parameters to all the pump control systems", shows the common parameters to all of the control systems using FRENIC-Ace-H inverter. These are known as the basic parameters.
In addition to the following table, there is also a specific parameters table.
Note: The following values are shown as an example and may not necessarily work in your application

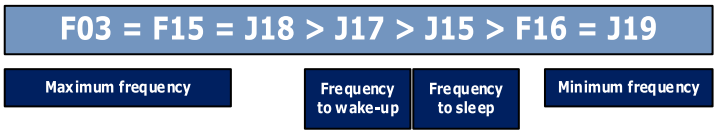
Table 2.1: Common parameters to all pump control systems

	Common Parameters to all pump control systems FRENIC-AceH			
	Name	Default setting	Example's Value	User's Value
F02	Operation method	0	**1**	
F07	Acceleration Time 1	20.00 s	**3.00 s**	
F08	Deceleration Time 1	20.00 s	**3.00 s**	
F11	Electronic Thermal Overload protection for motor 1. Overload detection Level	100% of the motor rated current	**13.0 A**	
F12	Electronic Thermal Overload protection for motor 1. Time constant	5.0 min (0074 or below) / 10.0 min (0085 or above)	**5 min**	
F15	Frequency Limiter. Upper limit	70.0 Hz	**50.0 Hz**	
F16	Frequency Limiter. Lower limit	0.0 Hz	**25.0 Hz**	
E62	Terminal [C1] (C1 extended function)	0	**5**	
C64	Analog input adjustment (Terminal [C1] (C1 function)). (Display unit)	2: %	**44: bar**	
C65	Analog input adjustment (Terminal [C1] (C1 function)).] (max. scale)	+ 100.00	**Transducer's pressure**	
E43	LED monitor (item selection)	0: Speed monitor	**12: PV**	
K16	Sub monitor 1 display item selection	13: Output current	**50: SV**	
K17	Sub monitor 2 display item selection	19: Input power	**1: Fout1**	
P01	Motor 1. Number of Poles	4	**4**	
P02	Motor 1. Rated capacity	Rated Capacity Standard Motor	**5.5 kW**	
P03	Motor 1. Rated current	Rated Current Standard Motor	**13.0 A**	
H91	PID feedback wire break detection	0.0 s	**0.5 s**	
J01	PID Control. Mode Selection	0	**1**	
J03	PID Control. Gain P	0.100	**2.500**	
J04	PID Control. Integral time	0.0 s	**0.2 s**	
J15	PID Control. Sleep frequency	0.0 Hz	**35.0 Hz**	
J16	PID Control. Sleep timer	0 s	**15 s**	
J17	PID Control. Wakeup frequency	0.0 Hz	**38.0 Hz**	
J18	PID Control. Upper limit of PID process output	999	999	
J19	PID Control. Lower limit of PID process output	999	999	
J23	PID Control. Wakeup level of PID error	0.0%	**5%**	
J24	PID Control. Wakeup timer	0 s	**1 s**	

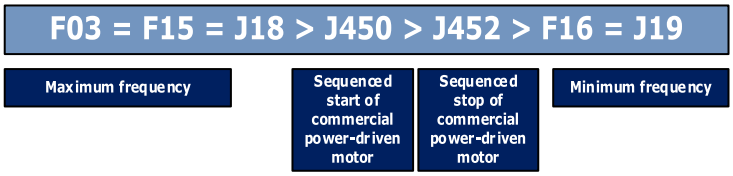
CONDITIONS TO ACHIEVE GOOD CONTROL IN MONO-REGULATED PUMP CONTROL

If it's necessary to use a different parameter set-up to that shown in the above "Example Values" column, please bear in mind the following conditions:

Conditions for Sleep/Wake-up frequency



Conditions for the frequencies that define when auxiliary pumps are connected/disconnected



The function codes J450, J452 and J460 belong to specific function codes group and will be depicted below.

The following table (Table 2.2) shows the specific function codes for a good control system with 1 regulated pump + 1, 2, 3 or 4 auxiliary pumps:

Table 2.2: Function codes mono-regulated pump control, 1 regulated pump + 1, 2, 3 or 4 auxiliary pumps

	Specific Function Codes , mono-regulated pump control with 1 regulated pump + 1, 2, 3 or 4 auxiliary pumps						
	Name	Default Setting	**For 1 auxiliary pump**	**For 2 auxiliary pumps**	**For 3 auxiliary pumps**	**For 4 auxiliary pumps**	**User's setting**
E20	Status Signal Assignment to Y1	0	**0**	**163(M2_L)**	**0**	**0**	
E21	Status Signal Assignment to Y2	1	**1**	**1**	**1**	**1**	
E27	Status Signal Assignment to 30A/B/C	99	**161(M1_L)**	**161(M1_L)**	**99**	**167(M4_L)**	
o01	Terminal [Y6] (OPC-F2-RY)	100	**100**	**100**	**161(M1_L)**	**161(M1_L)**	
o02	Terminal [Y7] (OPC-F2-RY)	100	**100**	**100**	**163(M2_L)**	**163(M2_L)**	
o03	Terminal [Y8] (OPC-F2-RY)	100	**100**	**100**	**165(M3_L)**	**165(M3_L)**	
J401	Pump Control. Mode Selection	0	**11**	**11**	**11**	**11**	
J411	Motor 1 Mode	0	**1**	**1**	**1**	**1**	
J412	Motor 2 Mode	0	**0**	**1**	**1**	**1**	
J413	Motor 3 Mode	0	**0**	**0**	**1**	**1**	
J414	Motor 4 Mode	0	**0**	**0**	**0**	**1**	
J450	Start of commercial power-driven motor.Frequency	999	**48 Hz**	**48 Hz**	**48 Hz**	**48 Hz**	
J451	Start of commercial power-driven motor.Duration	0.00 s	**5.00 s**	**5.00 s**	**5.00 s**	**5.00 s**	
J452	Stop of commercial power-driven motor.Frequency	999	**30 Hz**	**30 Hz**	**30 Hz**	**30 Hz**	
J453	Stop of commercial power-driven motor.Duration	0.00 s	**1.00 s**	**1.00 s**	**1.00 s**	**1.00 s**	
J459	Motor Decrease switching level	0 %	**50 %**	**50 %**	**50 %**	**50 %**	
J456	Motor Increase Switching level	0 %	**50 %**	**50 %**	**50 %**	**50 %**	
J457	PID Start Frequency (Mount)	0 Hz	**40 Hz**	**40 Hz**	**40 Hz**	**40 Hz**	
J460	PID Start Frequency (Unmount)	0 Hz	**39 Hz**	**39 Hz**	**39 Hz**	**39 Hz**	

Note: The default setting for function code J457 and J460 (999) may work properly in your installation without adjusting it to the suggested value (40 Hz and 39 Hz respectively).

DESCRIPTION OF THE SPECIFIC FUNCTION CODES FOR MONO-REGULATED PUMP CONTROL

Outputs Set-up

- E20, E21, E27, o01 to o03: Signal status assignment to Y1, Y2, 30A/B/C and [Y6] to [Y8]:

Function codes E20, E21, E27 and from o01 to o03 define the function that will be assigned to terminals Y1, Y2, 30A/B/C and [Y6] to [Y8] respectively.

In a mono-regulated pump control system these outputs must be set in order to connect / disconnect the auxiliary pumps to the commercial power supply (functions 161: pump 1 to commercial power supply, 163: pump 2 to the commercial power supply, 165: pump 3 to commercial power supply and 167 pump 4 to commercial power supply).

PID and Pump control

- J401: Pump control. Mode Selection

Function code J401 defines the type of pump control that will be performed.

J401 = 0 Pump Control Disabled
J401 = 1 Mono-regulated pump Control Enabled (11, mount decision depending on output frequency)
J401 = 2 Multi-regulated pump Control Enabled (12, mount decision depending on output frequency)

- J411, J412, J413, J414: Motor 1 mode, Motor 2 mode, Motor 3 mode, Motor 4 mode.

Function codes J411, J412, J413 and J414 define:

J411 = 0 Pump 1 unavailable
J411 = 1 Pump 1 available
J411 = 2 Pump 1 connected to commercial power supply

J412 = 0 Pump 2 unavailable
J412 = 1 Pump 2 available
J412 = 2 Pump 2 connected to commercial power supply

J413 = 0 Pump 3 unavailable
J413 = 1 Pump 3 available
J413 = 2 Pump 3 connected to commercial power supply

J414 = 0 Pump 4 unavailable
J414 = 1 Pump 4 available
J414 = 2 Pump 4 connected to commercial power supply

In normal operation, the mode to be used is 1.

The other modes can be useful in the following situations:

- Mode 0: The pump will be omitted. Can be useful to disconnect, software disabled, a pump from the pump control system, without modifying the current wiring.

- Mode 2: Can be useful to check the rotation direction of the pump, because the pump will be connected to the commercial power supply as soon as this mode is activated.

⚠ **ATTENTION**

If the mode 2 is set in any of the function codes J411 to J414, the corresponding pump will begin to rotate at the speed defined by the commercial power supply. Take the necessary measures.

Chapter 3

Mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional pump

Mono-regulated pump control (Mono-joker)					Necessary digital outputs	Do we need the optional relay card installed?
1 regulated pump	+	4 auxiliary pumps (On-Off control)	+	1 additional pump (On-Off control)	5	YES (MANDATORY) (OPC-F2-RY)

The schematic to implement a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional pump with a FRENIC-Ace-H inverter is as follows:
Please, pay attention on the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA).

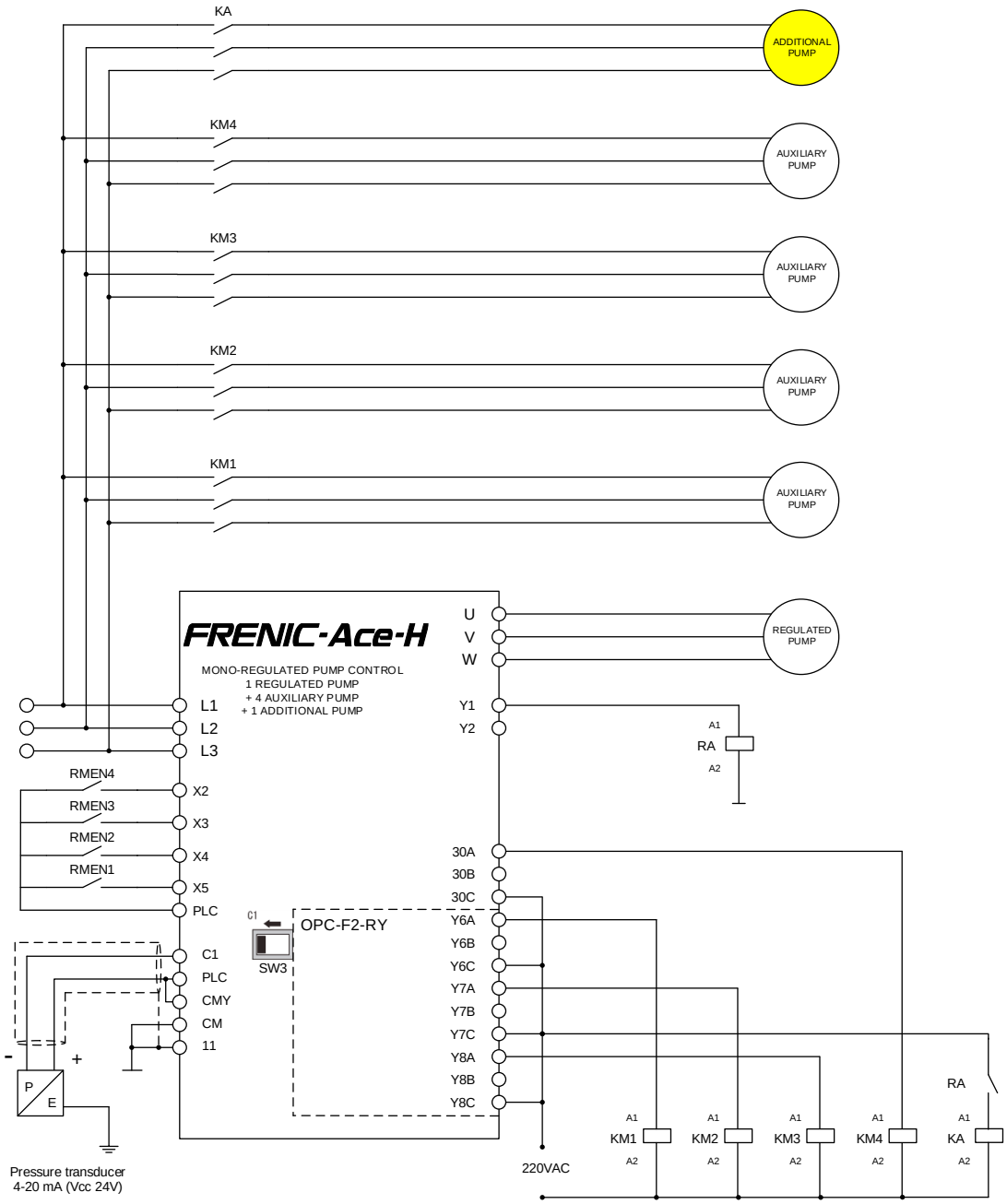


Figure 3.1: Schematic for a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional pump

This control system consists on a regulated pump controlled exclusively by the inverter and other 5 pumps working in “On-Off control” mode connected directly to the commercial power supply (4 auxiliary pumps + 1 additional pump). The inverter will connect/disconnect the auxiliary pumps to the commercial power supply in order to achieve the desired pressure.

The additional pump will be connected to the commercial power supply if the following two conditions are fulfilled:

1. All the auxiliary pumps that are enabled at this moment are connected to the commercial power supply, and

2. The regulated pump’s frequency is higher than the value stored in J465 (Hz).

The additional pump will be disconnected from the commercial power supply when:
Output frequency ≤ (J465 – J466)

Using this control, the **FRENIC-Ace-H** inverter is able to control up to 6 pumps.

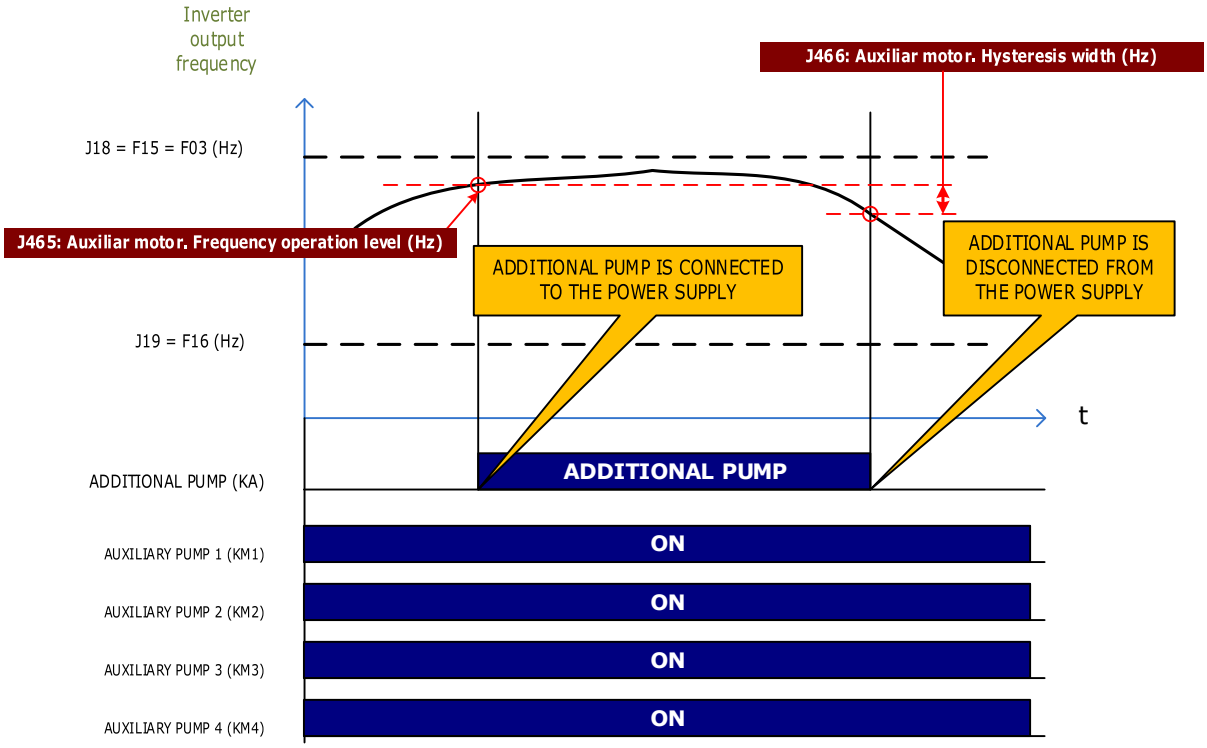


Figure 3.2: Additional pump’s connection/disconnection diagram if all the auxiliary pumps are enabled

Set-up with 1 regulated pump + 4 auxiliary pumps + 1 additional pump

The following table (Table 3.1), called “Common parameters to all the pump control systems”, shows the common parameters to all of the control systems using the **FRENIC-Ace-H** inverter, these are the basic parameters.

Additional to the common function codes’ table, there is also a table with specific function codes.

Note: The following values are only an example, and may not necessarily work in your application.

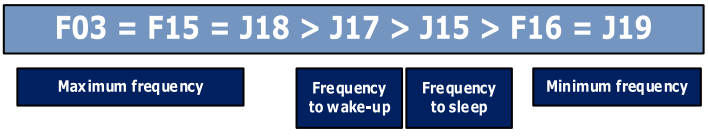
Table 3.1: Common parameters to all the pump control systems

	Common Parameters to all pump control systems			FRENIC-AceH
	Name	Default setting	Example’s Value	User’s Value
F02	Operation method	0	**1**	
F07	Acceleration Time 1	20.00 s	**3.00 s**	
F08	Deceleration Time 1	20.00 s	**3.00 s**	
F11	Electronic Thermal Overload protection for motor 1. Overload detection Level	100% of the motor rated current	**13.0 A**	
F12	Electronic Thermal Overload protection for motor 1. Time constant	5.0 min (0074 or below) / 10.0 min (0085 or above)	**5 min**	
F15	Frequency Limiter. Upper limit	70.0 Hz	**50.0 Hz**	
F16	Frequency Limiter. Lower limit	0.0 Hz	**25.0 Hz**	
E62	Terminal [C1] (C1 extended function)	0	**5**	
C64	Analog input adjustment (Terminal [C1] (C1 function)). (Display unit)	2: %	**44: bar**	
C65	Analog input adjustment (Terminal [C1] (C1 function)).] (max. scale)	+ 100.00	**Transducer’s pressure**	
E43	LED monitor (item selection)	0: Speed monitor	**12: PV**	
K16	Sub monitor 1 display item selection	13: Output current	**50: SV**	
K17	Sub monitor 2 display item selection	19: Input power	**1: Fout1**	
P01	Motor 1. Number of Poles	4	**4**	
P02	Motor 1. Rated capacity	Rated Capacity Standard Motor	**5.5 kW**	
P03	Motor 1. Rated current	Rated Current Standard Motor	**13.0 A**	
H91	PID feedback wire break detection	0.0 s	**0.5 s**	
J01	PID Control. Mode Selection	0	**1**	
J03	PID Control. Gain P	0.100	**2.500**	
J04	PID Control. Integral time	0.0 s	**0.2 s**	
J15	PID Control. Sleep frequency	0.0 Hz	**35.0 Hz**	
J16	PID Control. Sleep timer	0 s	**15 s**	
J17	PID Control. Wakeup frequency	0.0 Hz	**38.0 Hz**	
J18	PID Control. Upper limit of PID process output	999	999	
J19	PID Control. Lower limit of PID process output	999	999	
J23	PID Control. Wakeup level of PID error	0.0%	**5%**	
J24	PID Control. Wakeup timer	0 s	**1 s**	

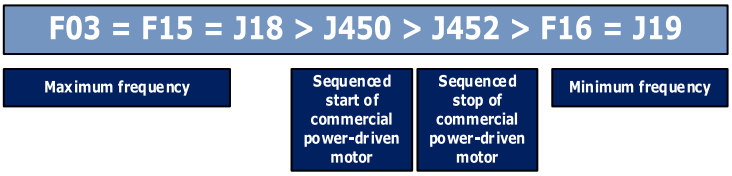
CONDITIONS TO ACHIEVE GOOD CONTROL WITH A MONO-REGULATED PUMP CONTROL + 4 AUXILIARY PUMPS + 1 ADDITIONAL PUMP

If it’s necessary to use a different parameter set-up to that shown in the above “Example Values” column, please bear in mind the following conditions:

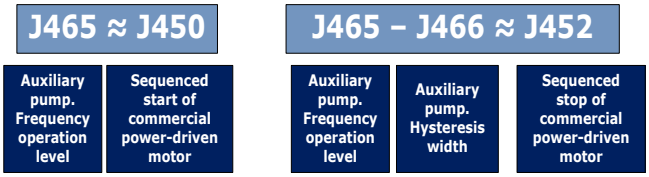
Conditions for Sleep/Wake-up frequency



Conditions for the frequencies that define when auxiliary pumps are connected/disconnected



Conditions for the connection of the additional pump



Using this control topology, it can be necessary to delay the disconnection of the motor from the commercial power supply (J453), in order to prevent the simultaneous disconnection of the auxiliary and the additional pumps. That is, the first pump to be disconnected should be the additional pump and then the auxiliary pump, but never at the same time.

The following table (Table 3.2) shows the specific function codes to successfully control a mono-regulated pump control system with 1 regulated pump + 4 auxiliary pumps + 1 additional pump:

Table 3.2: Specific function codes for Mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional pump

	Specific Function Codes for mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional			
	Name	Default Setting	Example's value	**User's value**
o01	Terminal [Y6] (OPC-F2-RY)	100	**161 (M1_L)**	
o02	Terminal [Y7] (OPC-F2-RY)	100	**163 (M2_L)**	
o03	Terminal [Y8] (OPC-F2-RY)	100	**165 (M3_L)**	
E20	Status Signal Assignment to Y1	0	**88 (AUX_L)**	
E27	Status Signal Assignment to 30A/B/C	99	**167 (M4_L)**	
J401	Pump Control. Mode Selection	0	**11**	
J411	Motor 1 mode	0	**1**	
J412	Motor 2 mode	0	**1**	
J413	Motor 3 mode	0	**1**	
J414	Motor 4 mode	0	**1**	
J450	Start of commercial power-driven motor. Frequency	999	**48 Hz**	
J451	Start of commercial power-driven motor. Duration	0.00 s	**5.00 s**	
J452	Stop of commercial power-driven motor. Frequency	999	**30 Hz**	
J453	Stop of commercial power-driven motor. Duration	0.00 s	**1.00 s**	
J459	Motor Decrease switching Level	0 %	**50 %**	
J456	Motor Increase switching Level	0 %	**50 %**	
J457	PID Start Frequency (Mount)	0 Hz	**40 Hz**	
J460	PID Start Frequency (Unmount)	0 Hz	**39 Hz**	
J465	Auxiliary Motor (Frequency operation level)	50.0 Hz	**47.0 Hz**	
J466	Auxiliary Motor (Hysteresis width)	1.0 Hz	**8.0 Hz**	

Note: The default setting for function code J457 and J460 (0 Hz) may work properly in your installation without adjusting it to the suggested value (40 Hz and 39 Hz respectively).

DESCRIPTION OF SPECIFIC PARAMETERS FOR A MONO-REGULATED PUMP CONTROL + 4 AUXILIARY PUMPS + 1 ADDITIONAL PUMP

Outputs Set-up

- E20: Status Signal Assignment to (Y1)

The function code E20 defines the signal assigned to transistor output Y1. In order to implement a mono-regulated pump control system with an additional pump, the Y1 terminal's signal must be set to 88, corresponding to AUX_L function.

If all the pumps that are enabled (using parameters J411-J414) have been activated (they are active due to the state of the system), by means of AUX_L function it is possible to activate an extra digital output Y1 when the regulated pump's output frequency raises above the frequency level defined in the function code J465.

In this function, one pump is considered "enabled" when the two conditions below are accomplished at the same time:

- If MEN# is assigned to any digital input, this digital input must be ON (where # is the number of the motor). If MEN# is not assigned to any digital input, this condition will always be true.
- If the parameter, within J411-J414 range, corresponding to this pump is different from zero

In the picture below (Figure 3.3) this function logic block is depicted:

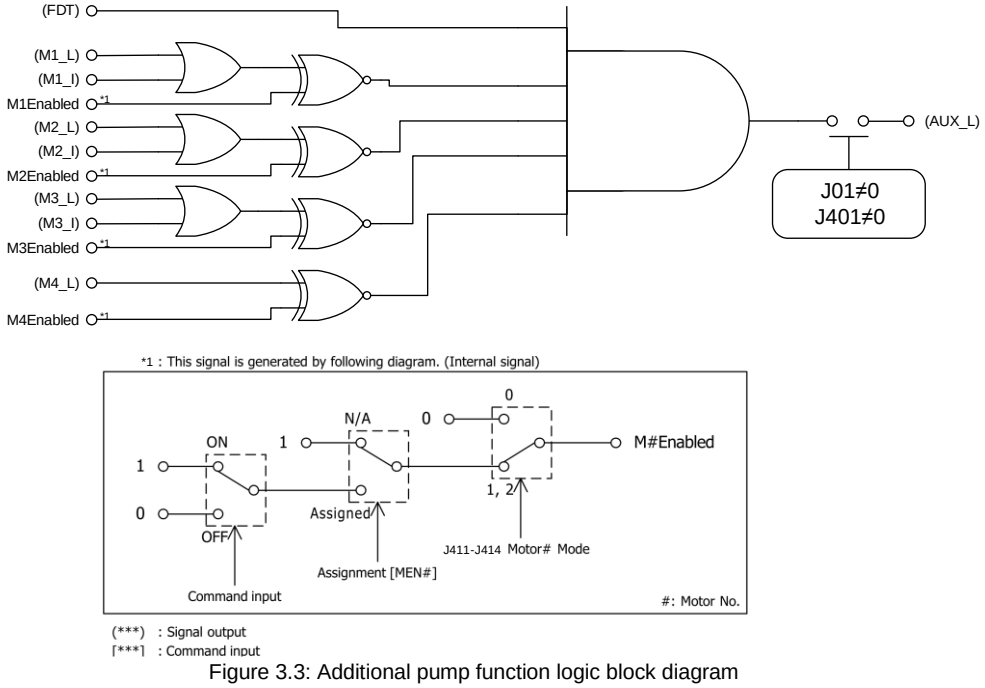


Figure 3.3: Additional pump function logic block diagram

Using function code J466 it is possible to define a hysteresis, for deactivating the pump below certain level of frequency and in order to avoid the signal Y1 activating/deactivating constantly.

- J465: Auxiliary Motor (Frequency operation level)

This function code defines the detection level where AUX_L function can be activated. That is, if the output frequency is higher than this level, the output with the AUX_L function assigned (88) will be activated. The level configured in J465 makes sense to be similar to the value of J450.

- J466: Auxiliary Motor (Hysteresis width)

With this parameter it is possible to adjust the hysteresis level for the deactivation of the AUX_L accordingly. The result of J465-J466 makes sense to be similar to the value of J452.

Chapter 4
Multi-regulated pump (Multi-joker) control with 2/3 regulated pumps

Multi-regulated pump Control (Multi-Joker)	Necessary digital outputs	Do we need the optional relay card installed?
2 Regulated pumps	4	YES (OPC-F2-RY)

The schematic to implement a multi-regulated pump control with 2 regulated pumps (Using OPC-F2-RY) by means of **FRENIC-Ace-H** inverter is as follows:

Please, pay attention on the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA).

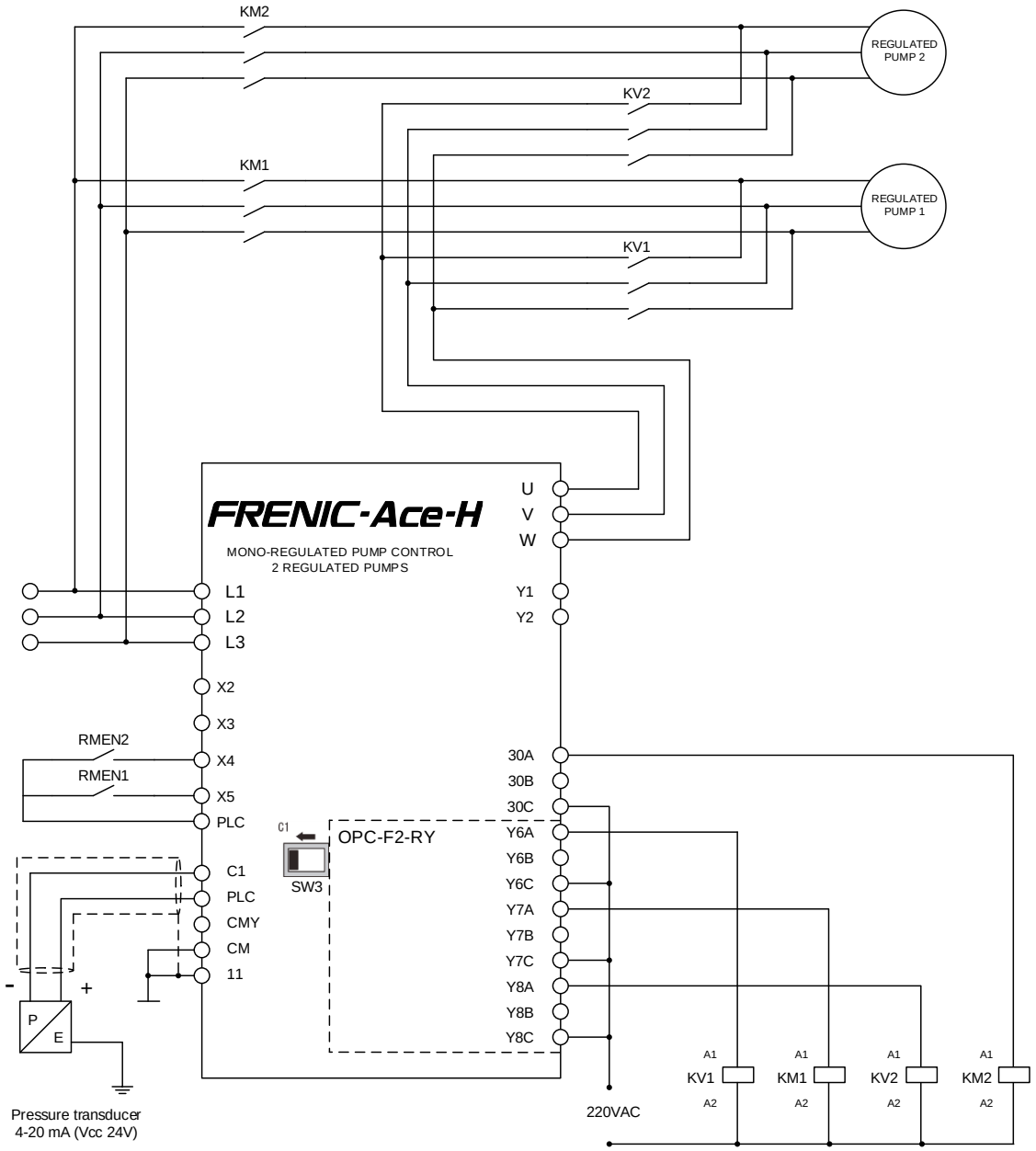


Figure 4.1: Schematics of multi-regulated pump control with 2 regulated pumps (Using OPC-F2-RY)

Multi-regulated pump Control (Multi-Joker)	Necessary digital outputs	Do we need the optional relay card installed?
3 Regulated pumps	6	YES (OPC-F2-RY)

The schematic to implement a multi-regulated pump control with 3 regulated pumps (Using OPC-F2-RY) by means of **FRENIC-Ace-H** inverter is as follows:

Please, pay attention on the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA).

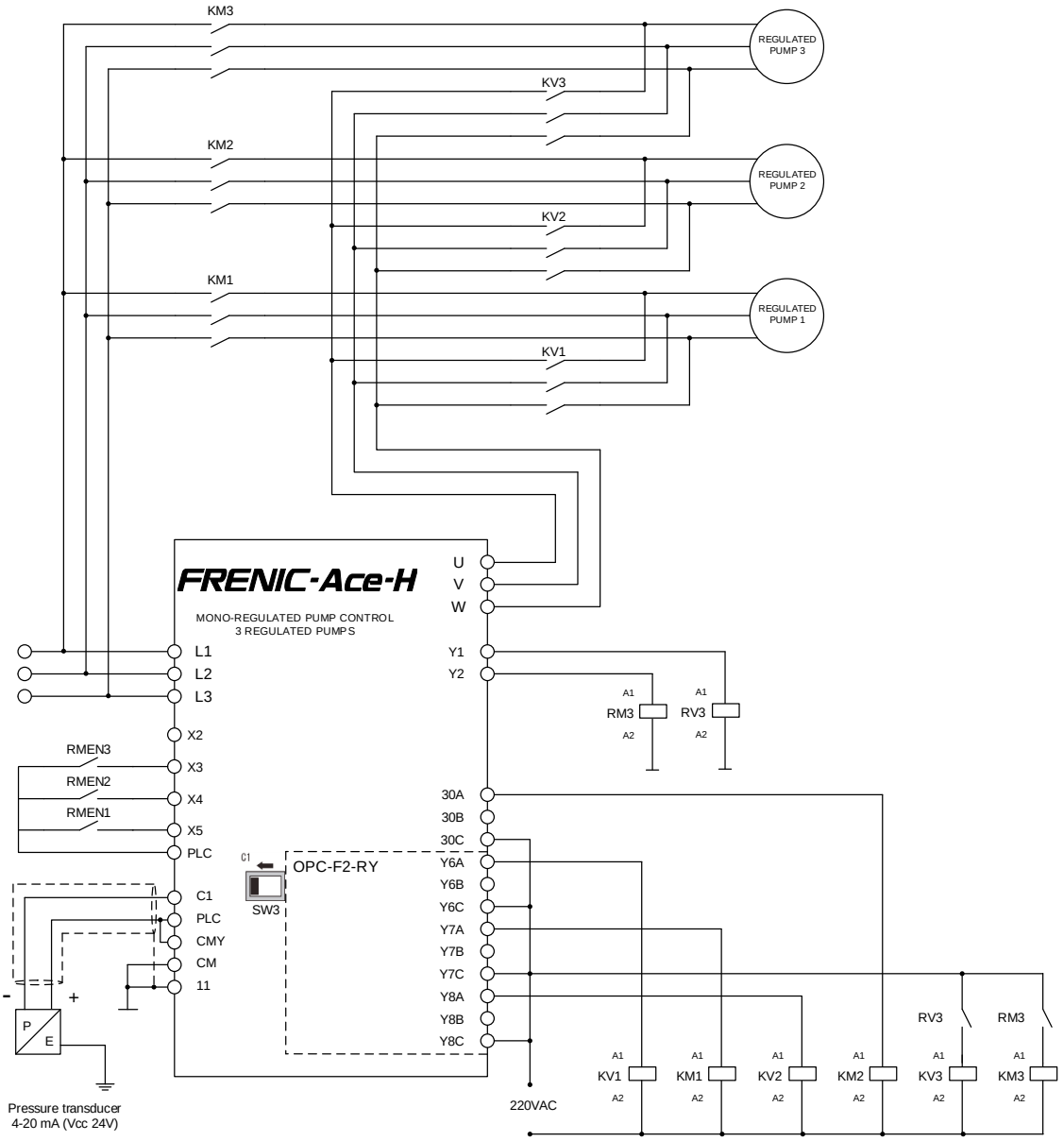


Figure 4.2: Schematics of multi-regulated pump control with 3 regulated pumps (Using OPC-F2-RY)

This control consists of 2/3 pumps regulated by the inverter.

In Multi-regulated pump Control, all of the system pumps are driven by means of the inverter. The inverter controls the pump and connects/disconnects each pump to/from the commercial power supply according to the application requirements.

By means of the inverter's keypad, digital inputs or analogue command, the desired pressure will be set. Then, the inverter will modify the regulated pump's speed between the minimum frequency (J19 = F16) and the maximum frequency (J18 = F15 = F03), in order to keep the pressure under control.

To do this, the PID control 1 that comes with the inverter must be activated (J01) and must be adjusted properly, in order to provide an appropriate response in the installation.

The PID control 1 response can be modified by means of the function codes J03 and J04 (Proportional gain and integral time).

The Figure 4.3 shows the regulation of two pumps, where, if the pressure's demand increases and is not possible to satisfy it with 1 pump, the inverter will connect the pump 1 to the commercial power supply and will take control of the second pump as a regulated one.

Similarly, if there is too much pressure, the inverter will disconnect pump 1 from the commercial power supply and will continue working only with pump 2 as the regulated one.

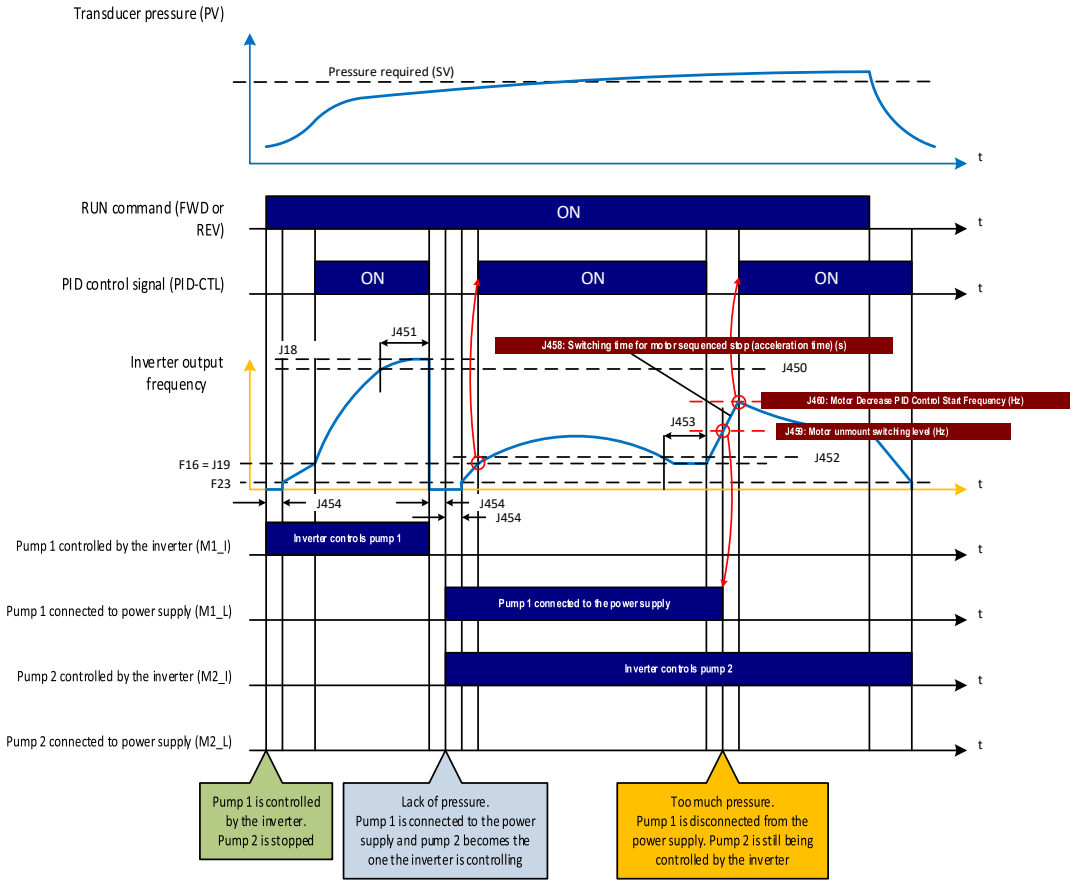


Figure 4.3: Speed pattern of a Multi-regulated pump Control with 2 regulated pumps

Note: Decision to mount/unmount auxiliary pumps depend either on PID output or output frequency depending on J401 setting:

- J401 = 2, levels to mount/unmount depend on PID output, MV (same behaviour as FRENIC-Eco)
- J401 = 12, levels to mount/unmount depend on the inverter's output frequency.

The following explanation describes the requirements or conditions to connect a regulated pump to the commercial power supply, and to disconnect a pump from the commercial power supply:

• Connecting a regulated pump to commercial power supply

1st stage | **Requirements to connect a regulated pump to the power supply**

If the regulated pump's output frequency rises above the level stored in J450 during the time established in J451, the inverter will understand that the regulated pump is not enough to maintain the required pressure and will start the sequence to connect the pump to the commercial power supply.

2nd stage | **Connecting a regulated pump to the power supply**

If the conditions above are accomplished, the inverter will connect the current regulated pump to the commercial power supply and will take another pump of the system as a regulated one, closing the corresponding contactors and ramping up the motor speed.

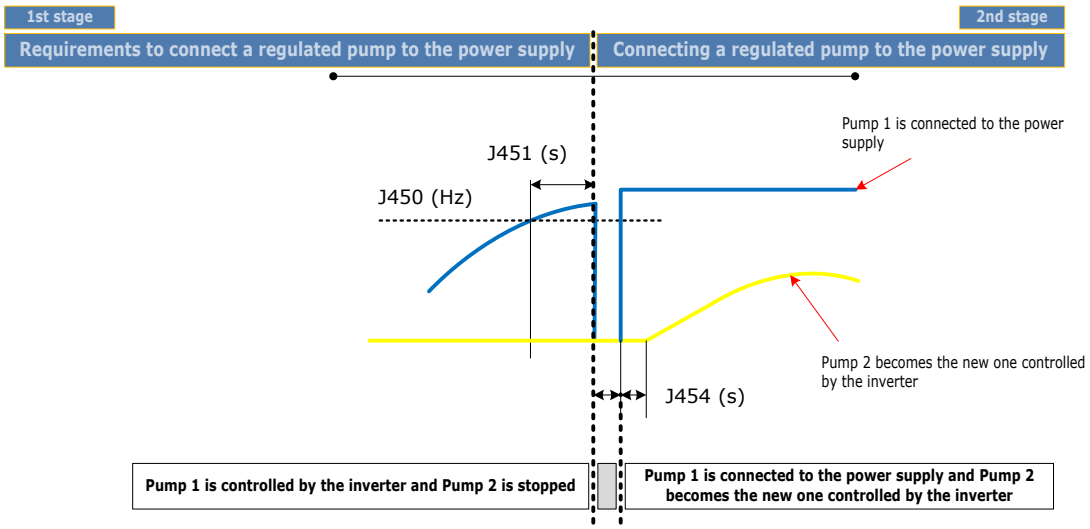


Figure 4.5: Connection of a regulated pump to the commercial power supply.

• Disconnecting a regulated pump from commercial power supply

1st stage | **Requirements to disconnect a pump connected to the power supply**

If the regulated pump's output frequency decreases under the level established in function code J452 during the time J453, the inverter will understand that is not necessary to keep a pump connected to the commercial power supply and will get ready to start its disconnection.

2nd stage | **Disconnecting a pump from the power supply**

If the conditions above are accomplished, the inverter will increase the regulated pump's output frequency until the frequency stored in J460 using the acceleration time in J458. Once the frequency level achieves this, the PID control will be activated.

This behaviour can be useful to reduce the possible sudden pressure fluctuations that may occur when a pump is disconnected from the commercial power supply.

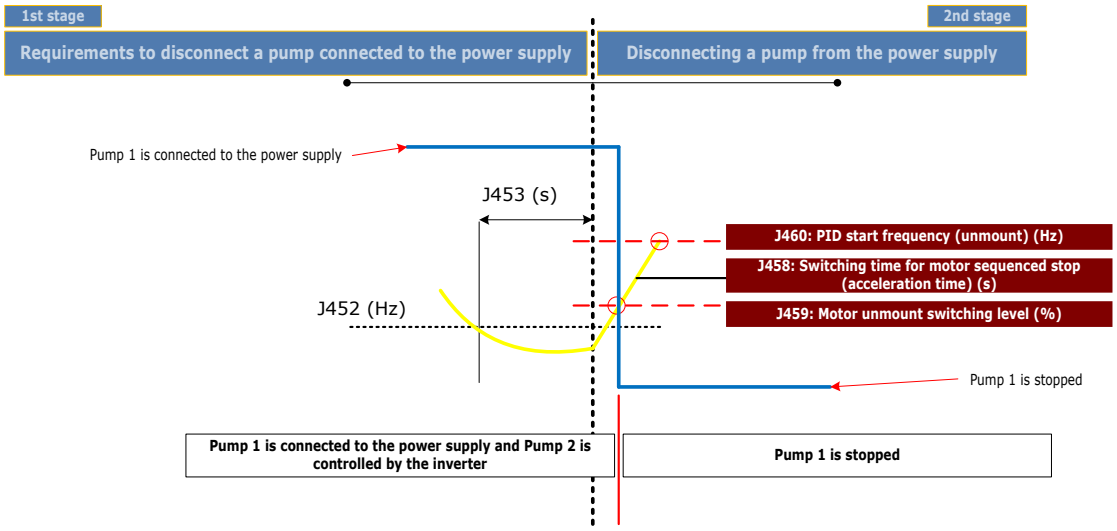


Figure 4.6: Increase of the pump's speed to disconnect the pump from the main supply

The exact point where the inverter will disconnect the pump from the main supply can be defined with function code J459. The equation to find this point is:

$$\text{Auxiliary pump's disconnection frequency (Hz)} = \left[\frac{J459}{100}\times\left(J118 - J119\right)\right] + J119$$

For example:

J459 = 40 %
J118 = 50 Hz
J119 = 25 Hz

$$\text{Auxiliary pump's disconnection frequency (Hz)} = \left[\frac{40}{100}\times\left(50 - 25\right)\right] + 25 = 35\,Hz$$

In this case, when the regulated pump is rotating at 35 Hz, the inverter will disconnect the pump from the main supply.

Common parameters for pump control

The following table (Table 4.1), called “Common Parameters to all the pump control systems”, shows the common parameters to all the control systems using the FRENIC-Ace-H inverter, these are the basic function codes.
In addition to the common function codes’ table, there is a table with the specific function codes.

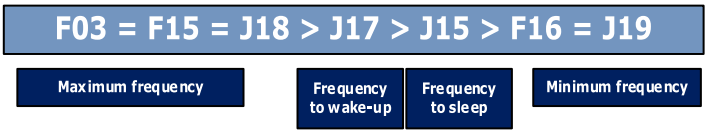
Note: The following values are only an example, and may not necessarily work in your application.

Table 4.1: Common parameters to all pump control systems

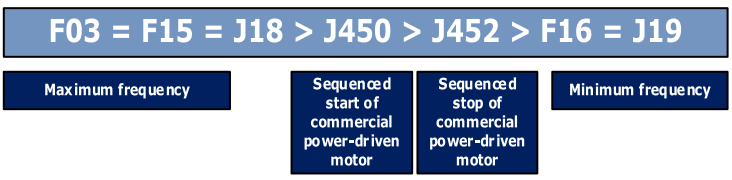
	Common Parameters to all pump control systems FRENIC-AceH			
	Name	Default setting	Example’s Value	User’s Value
F02	Operation method	0	**1**	
F07	Acceleration Time 1	20.00 s	**3.00 s**	
F08	Deceleration Time 1	20.00 s	**3.00 s**	
F11	Electronic Thermal Overload protection for motor 1. Overload detection Level	100% of the motor rated current	**13.0 A**	
F12	Electronic Thermal Overload protection for motor 1. Time constant	5.0 min (0074 or below) / 10.0 min (0085 or above)	**5 min**	
F15	Frequency Limiter. Upper limit	70.0 Hz	**50.0 Hz**	
F16	Frequency Limiter. Lower limit	0.0 Hz	**25.0 Hz**	
E62	Terminal [C1] (C1 extended function)	0	**5**	
C64	Analog input adjustment (Terminal [C1] (C1 function)). (Display unit)	2: %	**44: bar**	
C65	Analog input adjustment (Terminal [C1] (C1 function)).] (max. scale)	+ 100.00	**Transducer’s pressure**	
E43	LED monitor (item selection)	0: Speed monitor	**12: PV**	
K16	Sub monitor 1 display item selection	13: Output current	**50: SV**	
K17	Sub monitor 2 display item selection	19: Input power	**1: Fout1**	
P01	Motor 1. Number of Poles	4	**4**	
P02	Motor 1. Rated capacity	Rated Capacity Standard Motor	**5.5 kW**	
P03	Motor 1. Rated current	Rated Current Standard Motor	**13.0 A**	
H91	PID feedback wire break detection	0.0 s	**0.5 s**	
J01	PID Control. Mode Selection	0	**1**	
J03	PID Control. Gain P	0.100	**2.500**	
J04	PID Control. Integral time	0.0 s	**0.2 s**	
J15	PID Control. Sleep frequency	0.0 Hz	**35.0 Hz**	
J16	PID Control. Sleep timer	0 s	**15 s**	
J17	PID Control. Wakeup frequency	0.0 Hz	**38.0 Hz**	
J18	PID Control. Upper limit of PID process output	999	999	
J19	PID Control. Lower limit of PID process output	999	999	
J23	PID Control. Wakeup level of PID error	0.0%	**5%**	
J24	PID Control. Wakeup timer	0 s	**1 s**	

CONDITIONS TO ACHIEVE GOOD CONTROL IN A MULTI-REGULATED PUMP CONTROL WITH 2/3 REGULATED PUMPS

Conditions for Sleep/Wake-up frequencies



Conditions for the frequencies that define when auxiliary pumps are connected/disconnected



Specific parameters

The following table (table 4.2) shows the specific function codes for multi-regulated pump control system with 2 or 3regulated pumps:

Table 4.2: Specific parameters for Multi-regulated pump control with 2 or 3 regulated pumps (with option)

	Specific Parameters for Multi-regulated pump control with 2/3 regulated pumps				
	Name	Default value	For 2 regulated pumps (with OPC-F2-RY)	For 3 regulated pumps (with OPC-F2-RY)	User's Value
E20	Status Signal Assignment to Y1	0	-	**164 (M3_I)**	
E21	Status Signal Assignment to Y2	1	-	**165 (M3_L)**	
E27	Status Signal Assignment to 30A/B/C	99	**163 (M2_L)**	**163 (M2_L)**	
J401	Pump Control. Mode Selection	0	**2**	**2**	
J411	Motor 1 Mode	0	**1**	**1**	
J412	Motor 2 Mode	0	**1**	**1**	
J450	Start of commercial power-driven motor.Frequency	999	**48 Hz**	**48 Hz**	
J451	Start of commercial power-driven motor.Duration	0.00 s	**5.00 s**	**5.00 s**	
J452	Stop of commercial power-driven motor.Frequency	999	**30 Hz**	**30 Hz**	
J453	Stop of commercial power-driven motor.Duration	0.00 s	**1.00 s**	**1.00 s**	
J459	Motor Unmount switching level	0 %	**50 %**	**50 %**	
J460	PID Start Frequency (Unmount)	0 Hz	**39 Hz**	**39 Hz**	
o01	Terminal [Y6]	100	**160 (M1_I)**	**160 (M1_I)**	
o02	Terminal [Y7]	100	**161 (M1_L)**	**161 (M1_L)**	
o03	Terminal [Y8]	100	**162 (M2_I)**	**162 (M2_I)**	

Note: The default setting for function code J460 (0 Hz) may work properly in your installation without adjusting it to the suggested value (39 Hz).

SPECIFIC PARAMETERS DESCRIPTION

PID and pump control

- J401: Pump control. Mode selection

The function code J401 defines which type of pump control is going to be used
J401 = 0 Pump control disabled
J401 = 1 Mono-regulated pump Control Enabled (11, mount decision depending on output frequency)
J401 = 2 Multi-regulated pump Control Enabled (12, mount decision depending on output frequency)

- J411, J412, J413: Motor 1 mode, Motor 2 mode, Motor 3 mode.

The function codes J411, J412, J413 define:

J411 = 0 pump 1 unavailable
J411 = 1 pump 1 available
J411 = 2 pump 1 connected to the commercial power supply

J412= 0 pump 2 unavailable
J412 = 1 pump 2 available
J412 = 2 pump 2 connected to the commercial power supply

J413 = 0 pump 3 unavailable
J413 = 1 pump 3 available
J413 = 2 pump 3 connected to the commercial power supply

In normal operation, the mode to be used is 1.

The other modes can be useful for:

- Mode 0: The pump is omitted. Can be useful to disconnect, software disable, a pump from the system without modifying the wires.

- Mode 2: Can be useful to check the rotation direction of the pumps, because they will be connected to the commercial power supply as soon as this mode is activated.

⚠ **ATTENTION**

If mode 2 is set to any of the parameters from J411 to J413, the corresponding pump will be turned on and will rotate at the speed marked by the commercial power supply. Take all necessary precautions.

SPCECIFIC PARAMETERS DESCRIPTION HAVING OPTIONAL CARD RELAY INSTALLED (OPC-F2-RY)

PID and pump control

- o01, o02, o03: Status Signal Assignment to [Y6], [Y7], [Y8] (modifying these function codes only makes sense when the OPC-F2-RY option card is installed in the inverter)

The function code o01, o02, o03 define the signal assignment to the outputs [Y6], [Y7], [Y8] of the OPC-F2-RY option relay card.

In Multi-regulated pump control with 2 or 3 regulated pumps these digital outputs must be set correctly in order to connect/disconnect the 2 or 3 pumps to the inverter or to the commercial power supply (function 160: motor 1 inverter-driven, function 161: motor 1, commercial-power driven, function 162: motor 2 inverter-driven, function 163: motor 2 commercial-power driven, function 164: motor 3 inverter-driven and function 165: motor 3 commercial-power driven).

Chapter 5
Additional Functions

- ***PID Display units set-up (related function codes -> C64, C65, C66)***

In order to display the values of PID control (SV, PV, MV, etc.) in engineering units, it is needed the adjustment of the value in C65 according to the sensor range.

Therefore, the user will be able to enter the Command (set point) Value in user units (C58, C64 or C70), instead of percentage (of PID range).

For example, if the transducer used has a 4-20 mA output signal range, where 20 mA correspond to 160 bars, the function code C65 must be set to 160 and C64 to 44.

If the transducer used has a 4-20 mA output signal range, where 20 mA correspond to 10 bars, the function code C65 must be set to 10 and C64 to 44.

The feedback value, in bars and the process command value can be seen in Menu 6 > PID Monitor. Those parameters can be also displayed on keypad main screen. For additional information check k parameters.

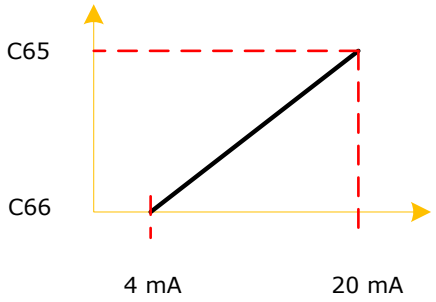


Figure 5.1: PID Display coefficients

The modification of C64 will modify also the units and the meaning of the following parameters:

Table 5.1: Parameters affected by C64 setting

Parameter	Description
C65	Analogue input adjustment for Terminal [C1] (Maximum Scale)
C66	Analogue input adjustment for Terminal [C1] (Minimum Scale)

- ***Start-up and switching motors sequence (related function codes -> J425, J436)***

There are two methods to try to extend the pumps' lifetime in Multi-regulated pump control systems

1. Controlling the order of connection of the pumps, by means of the data in function code *(Motor Switching Order)*.

J425 = 0 FIXED MOTOR SWITCHING ORDER
The inverter will activate the pumps in ascending order and it will deactivate it in descending order.
J425 = 1 AUTOMATIC MOTOR SWITCHING ORDER
The inverter will take into account the accumulated working times of each pump. In this way, the first pump to activate is the less used pump, and the first to be disconnected is the more used pump.
J425 = 2 FIXATION PROCEDURE
The inverter will change the driven pump in ascendant order during slow flow rate (sleeping).
J425 = 3 EQUAL OPERATING TIME
Same as motor mode 1 but switching also during slow flow rate (sleeping).

2. The second method is to rotate the pumps.
   After the time specified by function code J436 data *(Periodic switching time for motor drive)*, the inverter disconnects the pump with major accumulated run time and connects the pump with the minor accumulated run time.

J436 = OFF
The inverter does not switch the pumps (Default setting)
J436 = 0.1 a 720.0 h
The inverter switches the pumps after the time in J436's data (in hours)
J436 = TEST
The inverter switches the pumps every 3 minutes. (Not recommended. Only for tests).

Note: Function codes from J480 to J484 contain the accumulated run time of each pump. These values can be reset (set the time to "0"). It can be useful in case of replacement of an old pump for a newer one.

Using both solutions the pump's working time can be fairly distributed between all the pumps of the system.

- ***Contactor delay time (related function code -> J454)***

The function code J454 can be used to make a delay between the stop of a pump and the start-up of another one.
During the time in J454, the inverter's output will be switched off.
This delay can be useful to prevent possible electrically dangerous situations due to an overlapping of the contactors. On the other hand, if J454 time is too long could cause the pump speed to decrease, leading to a dangerous situation or a non-desired behaviour.

- ***Motor stop mode when RUN signal (FWD or REV) is switched off (related function code -> J430)***

The J430 function code establishes the stop mode when “RUN” (FWD or REV) signal is switched off.

J430 = 0
- The regulated pump slows down until it reaches the “Stop Frequency” (F25), decelerating following the F08 function code data. - The relay that controls the regulated pump is switched **OFF (**in case of multi-regulated pump control). - The relays that control the non-regulated pumps are switched **OFF** (in any case). - When an inverter’s alarm occurs, all the relays are switched **OFF**.

J430 = 1
- The regulated pump slows down until it reaches the “Stop Frequency” (F25), decelerating following the F08 function code data. - The relay that controls the regulated pump is switched **OFF (**in case of multi-regulated pump control). - The relays that control the non-regulated pumps keep in **ON** state (in any case). - When an inverter’s alarm occurs, all the relays are switched **OFF**.

J430 = 2
- The regulated pump slows down until it reaches the “Stop Frequency” (F25), decelerating following the F08 function code data. - The relay that controls the regulated pump is switched **OFF (**in case of multi-regulated pump control). - The relays that control the non-regulated pumps keep in **ON** state (in any case). - When an inverter’s alarm occurs, **ONLY** the regulated pump is switched **OFF** (in any case). The relays of the pumps connected to the commercial power supply are kept **ON** (in any case).

- ***Multiple PID set point selection***

Using digital inputs, it is possible to select between four PID set point values.

To perform the multiple selection, functions “*171: PID-SS1* “ and “*172: PID-SS2* “ must be assigned to two digitals inputs among X1, X2, X3, X4,X5,X6 or X7 (E01-E07).

The selected Set Value depends of the combination of these two inputs, as shown in the table below:

Table 6.3: Multiple PID set-point selection

PID-SS2	PID-SS1	PID set point selection
0	0	Depends on J02 setting
0	1	J136
1	0	J137
1	1	J138

- ***Dead Band (related function code -> J461)***

Function code J461 can be used to avoid the connection/disconnection (undesired) of any auxiliary pump, when the frequency of the regulated pump is close to the ON/OFF switching frequencies (J459: Motor Unmount switching level, J456: Motor Mount switching level) . If the difference between the PID Feedback and PID Set point is less than the percentage stored in J461, the inverter will not make a connection/disconnection of the pump.

- ***Dew condensation prevention function (related function codes -> F21, F22, J21)***

By means of a DC current injection, it’s possible to keep the motor warm to prevent condensation. Please note a digital input should be activated to enable this function (for instance X4, by using function code E04).

Example

E04 = *39: Protect motor from dew condensation (DWP)*
F21 = 10 %
F22 = 1 s (T ON)
J21 = 1 % (DUTY CYCLE)

With this adjustment, there will be a DC current injection every 100 seconds, equivalent to the 10% of the rated current, during 1 second.

$$J21(\%) = \frac{F22}{T} \times 100$$ In this example: $$T = \frac{F22}{J21} \times 100 = \frac{1}{1} \times 100 = 100s$$;

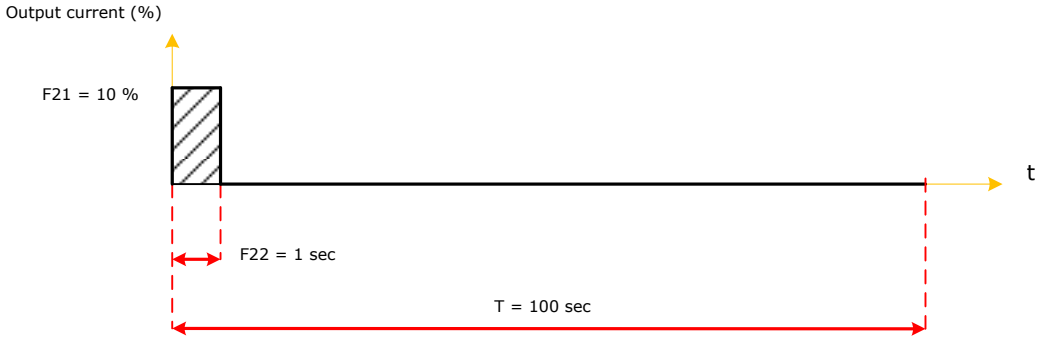


Figure 5.2: Output current when Dew Condensation prevention function is enabled

- ***PID Integral component hold***

1. Holding PID integral component while pump is in sleep mode

Target: Make the inverter maintain (hold) the PID controller integral component once the regulated pump has gone to sleep.
The main purpose is to avoid overshooting when the pump wakes up.

Applicable when: The installation has a lot of leakage.

Explanation: The pump provides pressure to the installation, and when the pressure command level is reached, if there is no consumption, the inverter will bring the pump to sleep.
Due to the leakages/losses, the pressure will decrease and the inverter will start up the pump again in order to reach the set point value. This cycle can be repeated until real flow consumption appears.

In old installations, this sleep/wake-up cycle is repeated continuously.

If you want to make this repetition slower (to make longer the time between sleep and wake-up), the function code J23 can be useful (an additional condition to wake up the regulated pump is added).
Normally, by means of using this function code, it is possible to separate the sleep and wake-up events. The idea is to increase J23 (% of error) until the time between sleep and wake-up is long enough.

But, what happens if the value in J23 is too high?

…of course, the pump's wake-up will be delayed enough, but the accumulated process error will cause a bigger integral action, producing a pressure overshoot when the regulated pump wakes up.
The pressure overshoot varies depending on each application, and it can be higher than expected. In addition, it depends also on the values in J23 and PID gains (J03, J04 and J05).
In order to avoid the overshoot, holding the integral while the pumps sleep can be useful (avoiding the error integration)

- Digital Inputs: X4 (set to hold integral action function)
- Digital Outputs: Y2 (set to "Motor stopping due to slow flow rate under PID control" function)
- Wiring:

  - Bridge X4 and Y2
  - Bridge CMY and PLC (*)

- Set-up:

  E04 (X4) = *34: Hold PID integral component (PID-HLD)*
  E21 (Y2) = *44: Motor stopping due to slow flowrate under PID control (PID-STP)*
  J23 = 20%

(*) Assuming that the logic of the digital inputs is Active-High Logic (the common of the inputs is PLC (+24VDC) and inputs' logic switch is in SOURCE).
If the common of the inputs is terminal CM (0 VDC) (Active-Low Logic in the inputs), please connect the terminals CMY and CM and set the switch to the SINK position.

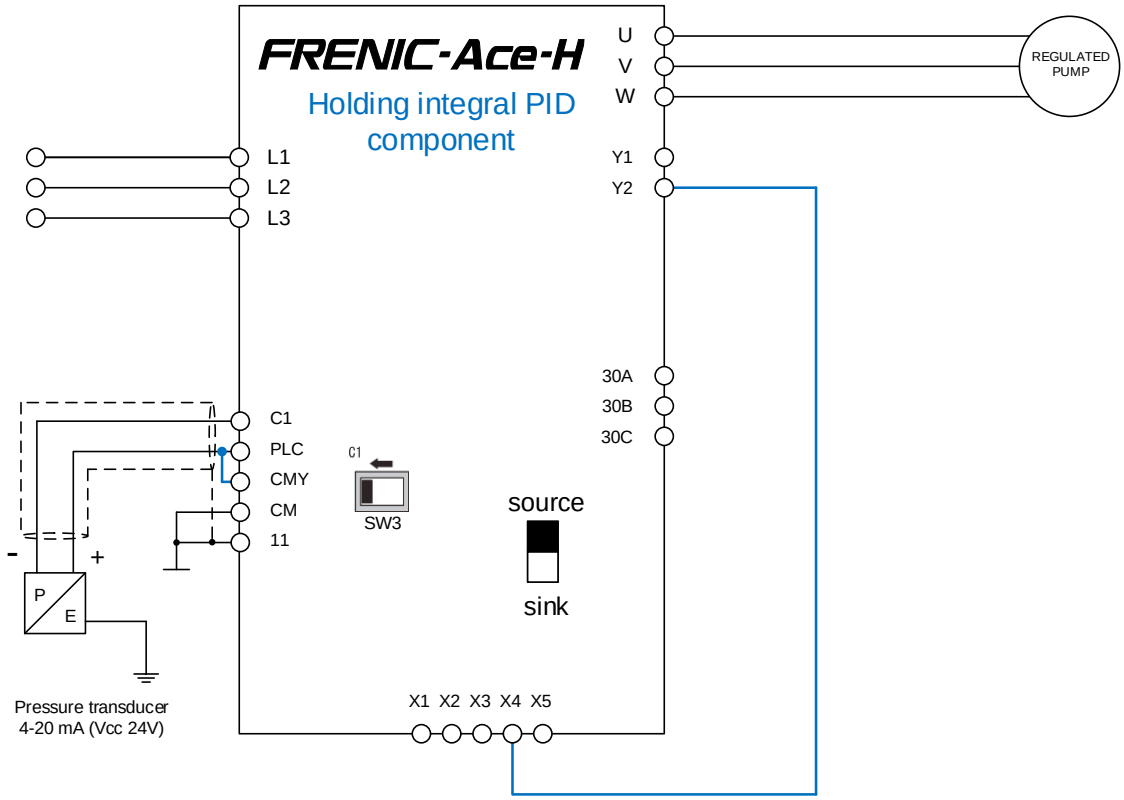


Figure 5.3: Pump control schematic for holding PID Integral component when pump is in sleep mode

2. Holding integral PID component during the process (anti-reset wind-up)

J10 function code can be used to hold the integral PID component.

The integral component will be active only when the difference (error) between process value (PV) and set point (SV) is inside the limits defined by J10 function code. If bigger than these limits, current integral PID component will be held.

J10 is a percentage related with C65 function code.

For instance, if the transducer installed is 10 bar (C65 = 10) and J10 is set at 10%, integral PID component will be active when the error of the system (error = SV-PV) is less than 1 bar (for errors larger than 1 bar integral PID component will be held at its current value).

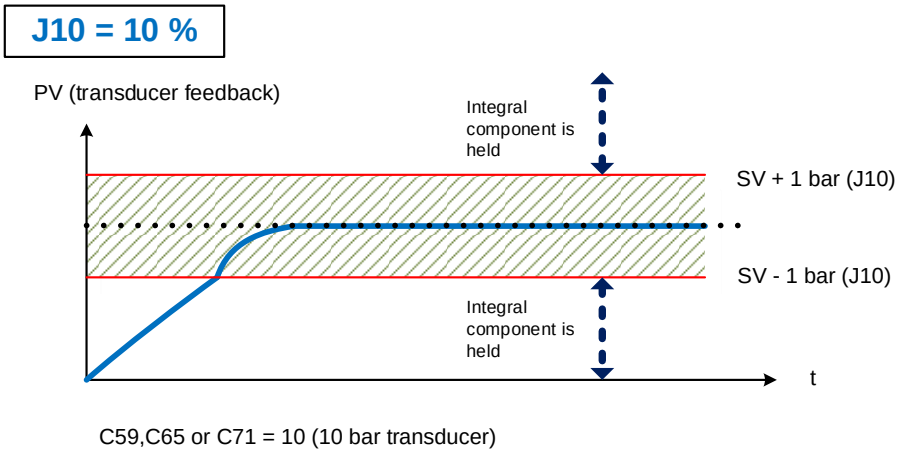


Figure 5.4: PID behaviour when function J114 is used.

- ***Enable / Disable pumps by means of external selectors***

It's possible to enable/disable pumps by means of external selection.

A pump can be disabled in order to prevent its operation in the pump control system. This function is useful when performing pump maintenance or other reasons.

151 (1151): Enable pump drive (motor 1)	(MEN1)
152 (1152): Enable pump drive (motor 2)	(MEN2)
153 (1153): Enable pump drive (motor 3)	(MEN3)
154 (1154): Enable pump drive (motor 4)	(MEN4)

- Digital Inputs: for example X5 (set to Enable pump drive function).
- Wiring:

  - Bridge X5 and PLC (*)

- Set-up:

  E05 (X5) = *151: Enable pump drive (motor 1) (MEN1)*

(*) Assuming that the logic of the digital inputs is Active-High Logic (the common of the inputs is PLC (+24VDC) and inputs' logic switch is in SOURCE).
If the common of the inputs is terminal CM (0 VDC) (Active-Low Logic in the inputs), please connect the terminals CMY and CM and set the switch to the SINK position.

Chapter 6
Complete Function Codes' List

*Only function codes' related with this Pump Control Quick Guide are shown. For more details about other functions, please check User Manual.

F codes: Fundamental Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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	Y	Y	0	
F01	Frequency Command 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	N	Y	0	
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)	N	Y	2	
F03	Maximum Frequency 1	25.0 to 500.0 Hz	N	Y	50.0	
F04	Base Frequency 1	25.0 to 500.0 Hz	N	Y	50.0	
F05	Rated Voltage at Base Frequency 1	0: AVR disable (output voltage proportional to power voltage) 160 to 500V: AVR operation (400V class)	N	Y	380	
F06	Maximum Output Voltage 1	160 to 500V: AVR operation (400V class)	N	Y		
F07	Acceleration Time 1	0.00 to 3600 s	Y	Y	20.00	
F08	Deceleration Time 1	* 0.00 is for acceleration and deceleration time cancel (when performing soft-start and stop externally).00 to 3600.00 s	Y	Y	20.00	
F09	Torque Boost 1	0.0 to 20.0% (% value against base frequency voltage 1)	Y	Y	*2	
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)	Y	Y	1	
F11	(Overload detection level)	0.00 (disable) (Inverter rated current dependent on F80)	Y	Y1	*3	
F12	(Thermal time constant)	0.5 to 75.0 min	Y	Y	*4	
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	Y	Y	E: 0	
F15	Frequency Limiter (Upper limit)	0.0 to 500.0 Hz	Y	Y	70.0	
F16	(Lower limit)	0.0 to 500.0 Hz	Y	Y	0.0	
F18	Bias (Frequency command 1)	-100.00% to 100.00%	Y*	Y	0.00	
F20	DC Braking 1 (Braking starting frequency)	0.0 to 60.0 Hz	Y	Y	0.0	
F21	(Braking level)	0 to 80%	Y	Y	0	
F22	(Braking time)	0.0 (Disable); 0.01 to 30.00 s	Y	Y	0.0	
F23	Starting Frequency 1	0.1 to 60.0 Hz	Y	Y	0.5	
F24	(Holding time)	0.00 to 10.00 s	Y	Y	0.00	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
F25	Stop Frequency	0.1 to 60.0 Hz	Y	Y	0.2	
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)	Y	Y	2	
F27	(Tone)	0: Level 0 (Disable) 1 to 3 : Level 1 to 3	Y	Y	0	
F29	Analog Output [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	Y	Y	0	
F30	(Voltage adjustment)	0% to 300%	Y*	Y	100	
F31	(Function)	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	Y	Y	0	
F33	Terminal FM1 (Pulse rate)	25 to 32000 p/s (number of pulse at monitor value 100%)	Y	Y	1440	
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)	N	Y	1	
F40	Torque Limiter 1 (Driving)	0 to 300%; 999 (Disable)	Y	Y	999	
F41	(Braking)					
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	N	Y	0	
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	Y	Y	2	
F44	(Level)	20 to 150% (Rated current of the inverter for 100%)	Y	Y	130	
F50	Electronic thermal overload protection for braking resistor (Discharging capacity)	1 to 9000 kWs OFF: Cancel	Y	Y1	OFF	
F51	(Allowable average loss)	0.001 to 99.99 kW	Y	Y1	0.001	
F52	(Braking resistance value)	0.00: Resistance not required (Compatible mode with FRENIC-Multi series) 0.01 to 999 Ω	Y	Y1	0.00	
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.	Y	Y	4	

E codes: Extension Terminal Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting
E01	Terminal [X1] Function	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) (***SS8***) 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 (***BX***) 8 (1008): Reset alarm (***RST***) 9 (1009): Enable external alarm trip (***THR***) (9 = Active OFF, 1009 = Active ON) 11 (1011): Select frequency command 2/1 (***Hz2/Hz1***) 13: Enable DC braking (***DCBRK***) 14 (1014): Select torque limiter level 2/1 (***TL2/TL1***) 15: Switch to commercial power (50 Hz) (***SW50***) 16: Switch to commercial power (60 Hz) (***SW60***) 17 (1017): UP (Increase output frequency) (***UP***) 18 (1018): DOWN (Decrease output frequency) (***DOWN***) 19 (1019): Enable data change with keypad (***WE-KP***) 20 (1020): Cancel PID control (***Hz/PID***) 21 (1021): Switch normal/inverse operation (***IVS***) 22 (1022): Interlock (***IL***) 24 (1024): Enable communications link via RS-485 or fieldbus (option) (***LE***) 25 (1025): Universal DI (***U-DI***) 26 (1026): Enable auto search for idling motor speed at starting (***STM***) 30 (1030): Force to stop (***STOP***) (30 = Active OFF, 1030 = Active ON) 33 (1033): Reset PID integral and differential components (***PID-RST***) 34 (1034): Hold PID integral component (***PID-HLD***) 35 (1035): Select local (keypad) operation (***LOC***) 38 (1038): Run enable (***RE***) 39: Dew condensation prevention (***DWP***) 40: Enable integrated sequence to switch to commercial power (50 Hz) (***ISW50***) 41: Enable integrated sequence to switch to commercial power (60 Hz) (***ISW60***) 48: Pulse train input (Only for X5 terminal(E05)) (***PIN***) 49 (1049): Pulse train sign (Other than X5 terminal (E01 to E04)) (***SIGN***) 50 (1050): Clear running motor regular switching time (***MCLR***) 59 (1059): Enable battery-driven operation (***BATRY/UPS***) 72 (1072): Count the run time of commercial power-driven motor 1 (***CRUN-M1***) 78 (1078): Select speed control parameter 1 (***MPRM1***) 80 (1080): Cancel customizable logic (***CLC***) 81 (1081): Clear all customizable logic timers (***CLTC***) 82 (1082): Cancel anti-regenerative control (***AR-CCL***) 87 (1087): Run command 2/1 (***FR2/FR1***) 88 (1088): Run forward/stop 2 (***FWD2***) 89 (1089): Run reverse/stop 2 (***REV2***) 100: No function assigned (***NONE***) 134: Switch to fire mode (***FMS***) 149 (1149): Switch pump control (***PCHG***) 150 (1150): Enable master motor drive in mutual operation (***MEN0***) 151 (1151): Enable pump control motor 1 to be driven (***MEN1***) 152 (1152): Enable pump control motor 2 to be driven (***MEN2***) 153 (1153): Enable pump control motor 3 to be driven (***MEN3***) 154 (1154): Enable pump control motor 4 to be driven (***MEN4***) 171 (1171): PID control multistage command 1 (***PID-SS1***) 172 (1172): PID control multistage command 2 (***PID-SS2***) 181 (1181): External PID1 multistep command (***EPID-SS1***) 182 (1182): External PID1 multistep command (***EPID-SS2***) 201 (1201): External PID1 ON command (***EPID1-ON***) 202 (1202): External PID1 Cancel (***%/EPID1***) 203 (1203): External PID1 Switch normal/inverse operation (***EPID1-IVS***) 204 (1204): External PID1 reset integral and differential components (***EPID1-RST***) 205 (1205): External PID1 hold integral component (***EPID1-HLD***) *Inside the () is the negative logic signal (OFF at short-circuit)	N	Y	0
E02	Terminal [X2] Function		N	Y	1
E03	Terminal [X3] Function		N	Y	35
E04	Terminal [X4] Function		N	Y	7
E05	Terminal [X5] Function		N	Y	8

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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)	Y	Y	20.00	
E11	Deceleration Time 2		Y	Y	20.00	
E12	Acceleration Time 3		Y	Y	20.00	
E13	Deceleration Time 3		Y	Y	20.00	
E14	Acceleration Time 4		Y	Y	20.00	
E15	Deceleration Time 4		Y	Y	20.00	
E16	Torque Limiter 2 (Driving)	0 to 300%; 999 (Disable)	Y	Y	999	
E17	(Braking)		Y	Y	999	
E20	Terminal [Y1] Function	0 (1000): Inverter running (***RUN***) 1 (1001): Frequency (speed) arrival signal (***FAR***) 2 (1002): Frequency (speed) detected (***FDT***) 3 (1003): Under voltage detected (Inverter stopped) (***LU***) 5 (1005): Inverter output limiting (***IOL***) 6 (1006): Auto-restarting after momentary power failure (***IPF***) 7 (1007): Motor overload early warning (***OL***) 8 (1008): Keypad operation enabled (***KP***) 10 (1010): Inverter ready to run (***RDY***) 11: Switch motor drive source between commercial power and inverter output (For MC on commercial line) (***SW88***) 12: Switch motor drive source between commercial power and inverter output (For secondary side) (***SW52-2***) 13: Switch motor drive source between commercial power and inverter output (For primary side) (***SW52-1***) 15 (1015): Switch MC on the input power lines (***AX***) 16 (1016): Pattern operation stage transition (***TU***) 17 (1017): Pattern operation cycle completed (***TO***) 18 (1018): Pattern operation stage 1 (***STG1***) 19 (1019): Pattern operation stage 2 (***STG2***) 20 (1020): Pattern operation stage 4 (***STG4***) 25 (1025): Cooling fan in operation (***FAN***) 26 (1026): Auto-resetting (***TRY***) 27 (1027): Universal DO (***U-DO***) 28 (1028): Heat sink overheat early warning (***OH***) 30 (1030): Lifetime alarm (***LIFE***) 33 (1033): Reference loss detected (***REF OFF***) 35 (1035): Inverter output on (***RUN 2***) 36 (1036): Overload prevention control (***OLP***) 37 (1037): Current detected (***ID***) 41 (1041): Low current detected (***IDL***) 42 (1042): PID alarm (***PID-ALM***) 43 (1043): Under PID control (***PID-CTL***) 44 (1044): Under sleep mode of PID control (***PID-STP***) 45 (1045): Low torque detected (***U-TL***) 52 (1052): Running forward (***FRUN***) 53 (1053): Running reverse (***RRUN***) 54 (1054): In remote operation (***RMT***) 55 (1055): Run command entered (***AX2***) 56 (1056): Motor overheat detected by thermistor (***THM***) 59 (1059): Terminal [C1] (C1 function) wire break detected (***C1OFF***) 68 (1068): Motor regular switching early warning (***MCHG***) 69 (1069): Pump control output limit signal (***MLIM***) 76 (1076): Speed deviation excess (***PG-ERR***) 77 (1077): Low DC link bus voltage detection (***U-EDC***) 79 (1079): During decelerating at momentary power failure (***IPF2***) 84 (1084): Maintenance timer counted up (***MNT***) 87(1087): Frequency arrival signal (***FARFDT***) 88(1088): Auxiliary motor drive signal (***AUX_L***) 95(1095): Running in fire mode (***FMRUN***) 98 (1098): Light alarm (***L-ALM***) 99 (1099): Alarm output (for any alarm) (***ALM***) 101(1101): EN terminal detection circuit error (***DECF***) 102(1102): EN terminal OFF (***ENOFF***)	N	Y	0	
E21	Terminal [Y2] Function		N	Y	1	
E27	Terminal [30A/B/C] Function		N	Y	99	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
		111 (1111): Customizable logic output signal 1 (***CLO1***) 112 (1112): Customizable logic output signal 2 (***CLO2***) 113 (1113): Customizable logic output signal 3 (***CLO3***) 114 (1114): Customizable logic output signal 4 (***CLO4***) 115 (1115): Customizable logic output signal 5 (***CLO5***) 116 (1116): Customizable logic output signal 6 (***CLO6***) 117 (1117): Customizable logic output signal 7 (***CLO7***) 118 (1118): Customizable logic output signal 8 (***CLO8***) 119 (1119): Customizable logic output signal 9 (***CLO9***) 120 (1120): Customizable logic output signal 10 (***CLO10***) 160 (1160): Motor 1 being driven by inverter (***M1_I***) 161 (1161): Motor 1 being driven by commercial power (***M1_L***) 162 (1162): Motor 2 being driven by inverter (***M2_I***) 163 (1163): Motor 2 being driven by commercial power (***M2_L***) 164 (1164): Motor 3 being driven by inverter (***M3_I***) 165 (1165): Motor 3 being driven by commercial power (***M3_L***) 167 (1167): Motor 4 being driven by commercial power (***M4_L***) 180 (1180): In mutual operation (***M-RUN***) 181 (1181): Alarm in mutual operation (***M-ALM***) 211 (1211): Under external PID1 control (***EPID1-CTL***) 212 (1212): External PID1 output (***EPID1-OUT***) 213 (1213): Running under external PID1 (***EPID1-RUN***) 214 (1214): External PID1 alarm (***EPV1-ALM***) 215 (1215): External PID1 feedback error (***EPV1-OFF***) *Inside the () is written the negative logic setting (OFF at short-circuit)				
E30	Frequency Arrival (Detection width)	0.0 to 10.0 Hz	Y	Y	2.5	
E31	Frequency Detection 1 (Level)	0.0 to 500.0 Hz	Y	Y	50.0	
E32	(Hysteresis width)	0.0 to 500.0 Hz	Y	Y	1.0	
E34	Overload Early Warning/Current Detection (Level)	0.0 (Disable) Inverter rated current dependent on F80	Y	Y1	*3	
E35	(Timer)	0.01 to 600.00s	Y	Y	10.00	
E37	Current Detection 2/ Low current detection (Level)	0.00 (Disable) (Inverter rated current dependent on F80	Y	Y1	*3	
E38	(Timer)	0.01 to 600.00s	Y	Y	10.00	
E42	LED display filter	0.0 to 5.0s	Y	Y	0.5	
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 (%)	Y	Y	0	
E44	(Display when stopped)	0: Specified value 1: Output value	Y	Y	0	
E48	(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 (%)	Y	Y	0	
E50	Display coefficient for speed monitor	0.01 to 200.0	Y	Y	30.0	
E51	Display coefficient for “Input watt-hour data”	0.000 (Cancel/Reset). 0.001 to 9999	Y	Y	0.010	
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	Y	Y	0	
E59	Terminal [C1] function selection	0: Current input (C1 function) 1: Voltage input (V2 function)	N	Y	0	

*3 The motor rated current is automatically set.

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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	N	Y	0	
E62	Terminal [C1] (C1 Extended Function)		N	Y	0	
E63	Terminal [C1] (V2 Extended Function)		N	Y	0	
E64	Saving of Digital Reference Frequency	0: Automatic saving (main power is turned OFF) 1: Saving by pressing key	Y	Y	0	
E65	Reference Loss Detection	0: Stop deceleration 20 to 120%, 999: Cancel	Y	Y	999	
E76	DC link bus low-voltage detection level	400 to 800V (400V class)	Y	Y	470	
E80	Low Torque Detection (Level)	0% to 300%	Y	Y	20	
E81	(Timer)	0.01 to 600.00 s	Y	Y	20.00	
E98	Terminal [FWD] Function	Selecting function code data assigns the corresponding function to terminals [FWD] and [REV] as listed below. 98: Run forward (***FWD***) 99: Run reverse (***REV***) Same functions described on parameters E01~E05 are also available. Inside the () is the negative logic signal. (OFF at short-circuit	N	Y	98	
E99	Terminal [REV] Function		N	Y	99	

C codes: Control Functions of Frequency

Code	Name	Data setting range	Change when running	Data copying	Default setting
C01	Jump Frequency 1	0.0 to 500.0 Hz	Y	Y	0.0
C02	2		Y	Y	0.0
C03	3		Y	Y	0.0
C04	(Hysteresis width)	0.0 to 30.0 Hz	Y	Y	3.0
C05	Multistep Frequency 1	0.00 to 500.00 Hz	Y	Y	0.00
C06	2		Y	Y	0.00
C07	3		Y	Y	0.00
C08	4		Y	Y	0.00
C09	5		Y	Y	0.00
C10	6		Y	Y	0.00
C11	7		Y	Y	0.00
C12	8		Y	Y	0.00
C13	9		Y	Y	0.00
C14	10		Y	Y	0.00
C15	11		Y	Y	0.00
C16	12		Y	Y	0.00
C17	13		Y	Y	0.00
C18	14		Y	Y	0.00
C19	15		Y	Y	0.00
C21	Pattern Operation (Mode selection)	0: 1 cycle operation 1: Repetition operation. 2: Constant speed operation after 1 cycle operation.	N	Y	0
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.	Y	Y	1st: 0.00 2nd: F 3rd: 1
C23	(Stage 2)				
C24	(Stage 3)				
C25	(Stage 4)				
C26	(Stage 5)				
C27	(Stage 6)				
C28	(Stage 7)				
C30	Frequency Command 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	N	Y	2
C31	Analog Input Adjustment (Terminal [12]) (Offset)	-5.0% to 5.0%	Y*	Y	0.0
C32	(Gain)	0.00% to 200.00%	Y*	Y	100.00
C33	(Filter time constant)	0.00 to 5.00 s	Y	Y	0.05
C34	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00
C35	(Polarity)	0: Bipolar 1: Unipolar	N	Y	1
C36	Analog Input Adjustment (Terminal [C1] (C1 function)) (Offset)	-5.0% to 5.0%	Y*	Y	0.0
C37	(Gain)	0.00% to 200.00%	Y*	Y	100.00
C38	(Filter time constant)	0.00 to 5.00s	Y	Y	0.05
C39	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00
C40	Terminal [C1] (C1 function) Input Range 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	N	Y	0
C41	Analog Input Adjustment (Terminal [C1] (V2 function)) (Offset)	-5.0% to 5.0%	Y*	Y	0.0
C42	(Gain)	0.00% to 200.00%	Y*	Y	100.00
C43	(Filter time constant)	0.00 to 5.00 s	Y	Y	0.05
C44	(Gain base point)	0.00% to 100.00%	Y*	Y	100.00
C45	(Polarity)	0: Bipolar 1: Unipolar	N	Y	1
C50	Bias (for frequency setting 1) (Bias base point)	0.00 to 100.00%	Y*	Y	0.00
C53	Selection of Normal/Inverse Operation (Frequency setting 1)	0: Normal 1: Inverse	Y	Y	0

Code	Name	Data setting range	Change when running	Data copying	Default setting	
C55	Analog Input Adjustment (Terminal [12]) (Bias value)	-100.00 to 100.00%	Y	Y	0.00	
C56	(Bias base point)	0.00 to 100.00%	Y	Y	0.00	
C58	(Display unit)	*Same as J105 (However, setting range is, 1 to 80)	Y	Y	2	
C59	(Maximum scale)	-999.00 to 0.00 to 9990.00	N	Y	100	
C60	(Minimum scale)	-999.00 to 0.00 to 9990.00	N	Y	0.00	
C61	Analog Input Adjustment (Terminal [C1] (C1 function)) (Bias value)	-100.00 to 100.00%	Y	Y	0.00	
C62	(Bias base point)	0.00 to 100.00%	Y	Y	0.00	
C64	(Display unit)	*Same as J105 (However, setting range is, 1 to 80)	Y	Y	2	
C65	(Maximum scale)	-999.00 to 0.00 to 9990.00	N	Y	100	
C66	(Minimum scale)	-999.00 to 0.00 to 9990.00	N	Y	0.00	
C67	Analog Input Adjustment for Terminal [V2] (Bias value)	-100.00 to 100.00%	Y	Y	0.00	
C68	(Bias base point)	0.00 to 100.00%	Y	Y	0.00	
C70	(Display unit)	*Same as J105 (However, setting range is, 1 to 80)	Y	Y	2	
C71	(Maximum scale)	-999.00 to 0.00 to 9990.00	N	Y	100	
C72	(Minimum scale)	-999.00 to 0.00 to 9990.00	N	Y	0.00	

P codes: Motor 1 Parameters

Code	Name	Data setting range	Change when running	Data copying	Default setting	
P01	Motor 1 (No. of poles)	2 to 22 poles	N	Y1	4	
P02	(Rated capacity)	0.01 to 1000.00 kW (when P99 = 0, 4, 21 or 22) 0.01 to 1000.00 HP (when P99 = 1)	N	Y1	*6	
P03	(Rated current)	0.00 to 2000.00 A	N	Y1	*6	
P04	(Auto-tuning)	0: Disable 1: Stop tuning 2: Rotation tuning 5: Stop tuning (%R1, %X)	N	N	0	
P05	(Online-tuning)	0: Invalid 1: Valid	Y	Y	0	
P06	(No-load current)	0.00 to 2000.00 A	N	Y1	*6	
P07	(%R1)	0.00% to 50.00%	Y	Y1	*6	
P08	(%X)	0.00% to 50.00%	Y	Y1	*6	
P09	(Slip compensation gain for driving)	0.0 to 200.0%	Y*	Y	100.0	
P10	(Slip compensation response time)	0.01 to 10.00 s	Y	Y1	0.50	
P11	(Slip compensation gain for braking)	0.0 to 200.0%	Y*	Y	100.0	
P12	(Rated slip frequency)	0.00 to 15.00 Hz	N	Y1	*6	
P13	(Iron loss factor 1)	0.00 to 20.00%	Y	Y1	*6	
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)	N	Y1	1	
P53	(%X Correction factor 1)	0 to 300%	Y	Y1	100	
P60	(PMSM armature resistance)	0.000 to 50.000 ohm	N	Y1	*7	
P61	(PMSM d-axis inductance)	0.00 to 500.00 mH	N	Y1	*7	
P62	(PMSM q-axis inductance)	0.00 to 500.00 mH	N	Y1	*7	
P63	(PMSM induced voltage)	160 to 500V (400V class)	N	Y1	*7	
P64	(PMSM iron loss)	0.0 to 20.0%	Y	Y1	*7	
P65	(PMSM d-axis inductance magnetic saturation correction)	0.0 to 100.0%; 999	Y	Y1	*7	
P74	(PMSM reference current at starting)	10 to 200% (100% = motor rated current)	Y*	Y1	*7	
P83	(Reserved for PMSM) *9	0.0 to 50.0; 999	Y	Y1	999	
P84	(Reserved for PMSM) *9	0.0 to 100.0; 999	Y	Y1	999	
P85	(PMSM flux limitation value)	50.0 to 150.0; 999	Y	Y1	999	
P86	(Reserved for PMSM)	0.0 to 100.0%	N	N	0.0	
P87	(PMSM reference current for polarity discrimination)	0 to 200%	N	Y1	60	
P88	(Reserved for PMSM) *9	0 to 100%; 999	N	Y1	999	
P89	(Reserved for PMSM) *9	0; 1 to 100	N	Y1	0	
P90	(PMSM overcurrent protection level)	0.00 (disable); 0.01 to 2000A	N	Y1	*7	
P99	Motor 1 Selection	0: Motor characteristics 0 (Fuji standard motors, 8-series) 1: Motor characteristics 1 (HP rating motors) 4: Other IMs 20: Other motors(PMSMs) 21: Motor characteristics (Fuji PMSM GNB2 series)	N	Y1	0	

H codes: High Performance Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	
H02	Data Initialization (Method)	0: Standard 1: User	N	Y	0	
H03	(Target)	0: Manual setting value 1: Initialize value (factory default value) 2: Initialize motor 1 parameters 11: Initialize the parameters (excluding the parameters related to communication) 12: Initialize the parameters related to customizable logic	N	N	0	
H04	Auto-reset (Times)	0: Disable 1 to 20: Number of retries	Y	Y	0	
H05	(Reset interval)	0.5 to 20.0 s	Y	Y	5.0	
H06	Cooling Fan ON/OFF Control	0: Disable (Always Fan ON) 1: Enable (ON/OFF control effective)	Y	Y	0	
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	Y	Y	0	
H08	Rotational Direction Limitation	0: Disable 1: Enable (Reverse rotation inhibited) 2: Enable (Forward rotation inhibited)	N	Y	0	
H09	Starting Mode (Auto search)	0: Disable 1: Enable (Only at restart after momentary power failure) 2: Enable (At restart after momentary power failure and at normal start)	N	Y	0	
H11	Deceleration Mode	0: Normal deceleration 1: Coast-to-stop	Y	Y	0	
H12	Instantaneous Overcurrent Limiting (Mode selection)	0: Disable 1: Enable	Y	Y	1	
H13	Restart Mode after Momentary Power Failure (Restart time)	0.1 to 20.0 s	Y	Y1	*2	
H14	(Frequency fall rate)	0.00: Selected deceleration time 0.01 to 100.00 Hz/s 999: According to current limiter	Y	Y	999	
H15	(Continuous running level)	400 to 600 V	Y	Y	470	
H16	(Allowable momentary power failure time)	0.0 to 30.0 s 999: Depend on inverter judgement	Y	Y	999	
H26	Thermistor (for motor) (Mode selection)	0: Disable 1: PTC: OH4 trip and stop the inverter 2: PTC: Output motor overheat detected “THM” and continue to run	Y	Y	0	
H27	(Level)	0.00 to 5.00 V	Y	Y	1.60	
H30	Communications 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)	Y	Y	0	
H42	Capacitance of DC Link Bus Capacitor	For adjustment at replacement (0000 to FFFF(in hexadecimal))	Y	N	-	
H43	Cumulative Run Time of Cooling Fan	For adjustment at replacement Displays the cumulative run time of cooling fan in units of ten hours	Y	N	-	
H44	Startup Counter for Motor 1	For adjustment at replacement (0000 to FFFF(in hexadecimal))	Y	N	-	
H45	Mock Alarm	0: Disable 1: Occurence of mock Alarm	Y	N	0	
H46	Starting Mode (Auto search delay time 2)	0.1 to 20.0 s	Y	Y1	*6	
H47	Initial Capacitance of DC Link Bus Capacitor	For adjustment at replacement (0000 to FFFF(in hexadecimal))	Y	N	-	
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)	Y	N	-	
H49	Starting Mode (Auto search delay time 1)	0.0 to 10.0 s	Y	Y	0.0	

*2 Factory defaults are depended on motor capacity.
*6 Factory defaults are depended on motor capacity.

Code	Name	Data setting range	Change when running	Data copying	Default setting	
H50	Non-linear V/f Pattern 1 (Frequency)	0.0: Cancel, 0.1 to 500.0 Hz	N	Y	0.0	
H51	(Voltage)	0 to 500: AVR operation (400V class)	N	Y	0	
H52	Non-linear V/f Pattern 2 (Frequency)	0.0: Cancel, 0.1 to 500.0 Hz	N	Y	0.0	
H53	(Voltage)	0 to 500: AVR operation (400V class)	N	Y	0	
H56	Deceleration Time for Forced Stop	0.00 to 3600 s	Y	Y	20.0	
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.	Y	Y	0	
H64	(Lower limiting frequency)	0.0: Depends on F16 (Frequency limiter, Low) 0.1 to 60.0 Hz	Y	Y	1.6	
H68	Slip Compensation 1 (Operating conditions selection)	0: Enable during ACC/DEC, enable at base frequency or above 1: Disable during ACC/DEC, enable at base frequency or above 2: Enable during ACC/DEC, disable at base frequency or above 3: Disable during ACC/DEC,disable at base frequency or above	N	Y	0	
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 with Force-to-stop	Y	Y	0	
H70	Overload Prevention Control	0.0: Follow the selected deceleration time 0.01 to 100.00 Hz/s, 999 (Cancel)	Y	Y	999	
H71	Deceleration Characteristics	0: Disable 1: Enable	Y	Y	0	
H72	Main Power Down Detection (Mode selection)	0: Disable 1: Enable (Available FRN0045E2E-4EH or above)	Y	Y	1	
H76	Torque Limiter for Braking (Frequency rising limiter for braking)	0.0 to 500.0 Hz	Y	Y	5.0	
H77	Service Life of DC Link Bus Capacitor	0 to 8760 (in units of 10 hours)	Y	N	6132	
H78	Maintenance Interval (M1)	0 (Disable): 0001 to FFFF (in hexadecimal)	Y	N	6132	
H79	Preset Startup Count for Maintenance (M1)	0000 (Disable): 0001 to FFFF (in hexadecimal)	Y	N	0	
H80	Output Current Fluctuation Damping Gain for Motor 1	0.00 to 1.00	Y	Y	0.20	
H81	Light alarm selection 1	0000 to FFFF (in hexadecimal)	Y	Y	0	
H82	Light alarm selection 2	0000 to FFFF (in hexadecimal)	Y	Y	0	
H86	Reserved *9	0 to 2	Y	Y	0	
H89	Electronic Thermal Overload Protection for Motor 1 (data store)	0, 1	Y	Y	1	
H90	Reserved *9	0, 1	Y	Y	0	
H91	PID feedback Wire Break Detection	0.0: (Alarm Disable), 0.1 to 60.0 s	Y	Y	0.0	
H92	Continuous running at the momentary power failure (P)	0.000 to 10.000 times; 999 999: Manufacturer adjustment value	Y	Y1	999	
H93	(I)	0.000 to 10.000 s; 999 999: Manufacturer adjustment value	Y	Y1	999	
H94	Cumulative Motor Run Time 1	0 to 9999 Change in cumulative motor run time (Reset is enabled) (in units of 10 hours)	N	N	-	
H95	DC Braking (Braking response mode)	0: Slow response 1: Quick response	Y	Y	1	
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	Y	Y	0	
H97	Clear Alarm Data	0: Disable 1: Alarm data clear (Automatically return to 0 after clearing data)	Y	N	0	
H98	Protection/Maintenance Function (Mode selection)	0 to 127 Bit 0: Lower the carrier frequency automatically (0: Disabled; 1: Enabled) Bit 1: Detect input phase loss (0: Disabled; 1: Enabled) Bit 2: Detect output phase loss (0: Disabled; 1: Enabled) Bit 3: Main circuit capacitor life judgement selection (0: Factory default referenced; 1: User measurement value standard) Bit 4: Judge the life of main circuit capacitor (0: Disabled; 1: Enabled) Bit 5: Detected DC fan lock (0: Disabled; 1: Enabled) Bit 6: Braking transistor error detection (0: Disabled; 1: Enabled)	Y	Y	*11	

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

Code	Name	Data setting range	Change when running	Data copying	Default setting	
H99	Password 2 setting/check	0000 to FFFF (Hexadecimal)	Y	N	0	
H101	Destination	0: Not Selected 1: Japan 2: Asia 3: China 4: Europe 5: Americas 7: Korea	Y	Y	G (AEU): 0 J: 1 C:3 K:7	
H111	UPS operation level	120 to 220 VDC: (200V class) 240 to 440 VDC: (400V class	Y	Y	0	
H114	Anti-regenerative control (Level)	0.0 to 50.0%, 999:disabled	Y	Y	999	
H116	Fire Mode (Mode selection)	0: FMS: ON 1: FMS toggle method 2: FMS latch method	N	Y	0	
H117	(Confirmation time)	0.5 to 10.0 s * Set ON/OFF setting time for FMS signals.	Y	Y	3.0	
H118	(Reference frequency)	0.0: Follow the ordinary reference frequency specified with F01, etc. 0.1 to 500.0 Hz	Y	Y	0.0	
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	Y	N	0	
H194	(Protection)	0: Save enable 1: Protected (save disable)	Y	Y	0	
H195	DC Braking (Braking timer at the startup)	0.00: Disable 0.01 to 30.00s	Y	Y	0.00	
H197	User Password 1 (Mode selection)	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.	Y	Y	0	
H198	(Setting/check)	0000 to FFFF (hexadecimal)	Y	N	0000	
H199	User password protection valid	0: Disable 1: Protected	Y	N	0	

A codes: Motor 2 Parameters (Motor 2 parameters)

Code	Name	Data setting range	Change when running	Data copying	Default setting	
A43	Speed control 2 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.200	
A44	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.025	
A45	P (Gain)	0.1 to 200.0 times	Y*	Y	2.0	
A46	I (Integral time)	0.001 to 9.999s 999: Cancel integral term	Y	Y	0.600	

J codes: Application Functions 1

Code	Name	Data setting range	Change when running	Data copying	Default setting	
J01	PID Control (Mode selection)	0: Disable 1: Process (normal operation) 2: Process (inverse operation)	N	Y	0	
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	N	Y	0	
J03	P (Gain)	0.000 to 30.000 times	Y	Y	0.100	
J04	I (Integral time)	0.0 to 3600.0s	Y	Y	0.0	
J05	D (Differential time)	0.00 to 600.00s	Y	Y	0.0	
J06	(Feedback filter)	0.0 to 900.0s	Y	Y	0.5	
J10	(Anti-reset windup)	0 to 200%	Y	Y	200	
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	Y	Y	0	
J12	(Upper limit of warning (AH))	0% to 100%	Y	Y	100	
J13	(Lower limit of warning (AL))	0% to 100%	Y	Y	0	
J15	(Sleep frequency)	0.0: Disable 1.0 to 500.0Hz	Y	Y	0.0	
J16	(Sleep frequency)	0 to 60s	Y	Y	30	
J17	(Wakeup level of PID error)	0.0 to 100.0%	Y	Y	0.0	
J18	(Upper limit of PID process output)	0 to 500Hz; 999 (Depends on setting of F15)	Y	Y	999	
J19	(Lower limit of PID process output)	0 to 500Hz; 999 (Depends on setting of F16)	Y	Y	999	
J21	Dew Condensation Prevention (Duty)	1% to 50%	N	Y	1	
J22	Commercial Power Switching Sequence	0: Keep inverter operation (Stop due to alarm) 1: Automatically switch to commercial-power operation	Y	Y	0.0	
J23	(Wakeup level of PID error)	0.0% to 100.0%	Y	Y	0.0	
J24	(Wakeup timer)	0 to 3600s	Y	Y	0	

J1 codes: PID Control 1

Code	Name	Data setting range	Change when running	Data copying	Default setting	
J105	PID Control 1 (Display unit)	0 to 80 0: Based on the unit/scale of the PID control 1 feedback amount 1: none 2: % 4: r/min 7: kW Flowrate 20: m^3/s 21: m^3/min 22: m^3/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 (Pound per square inch) 47: mWG 48: inWG Temperature 60: K 61: °C 62: °F Density 80: ppm	N	Y	0	
J106	(Maximum scale)	-999 to 0.00 to 9990	N	Y	100	
J107	(Minimum scale)	-999 to 0.00 to 9990	N	Y	0.00	
J136	PID Multistep Command (Multistep command 1)	-999 to 0.00 to 9990	Y	Y	0.00	
J137	(Multistep command 2)		Y	Y	0.00	
J138	(Multistep command 3)		Y	Y	0.00	

J4 codes: Pump APP Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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)	N	Y	0	
J402	Communication Master/Slave Selection	0: Communication master inverter 1: Communication slave inverter	N	Y	1	
J403	Number of Slaves	1 or 3 units * Set for a master only.	N	Y	1	
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.	N	Y	0000H	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
J411	Motor 1 Mode Selection	0: Disable (off at all times) 1: Enable 2: Forced drive ON (forced commercial power drive)	Y	Y	0	
J412	Motor 2 Mode Selection					
J413	Motor 3 Mode Selection					
J414	Motor 4 Mode Selection					
J425	Motor Switching Procedure	0: Fixation procedure 1: Equal operating time (Cumulative run time of each motor is equalized.) 2: Fixation procedure (Switching the motor at slow flowrate stop) 3: Equal operating time (Switching the motor at slow flowrate stop.)	N	Y	0	
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	Y	Y	0	
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.	Y	Y	1	
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)	Y	Y	0.0	
J437	Motor Regular Switching Signal Output Time	0.00 to 600.00 s	Y	Y	0.10	
J450	Motor Increase Judgment (Judgment frequency)	0 to 500 Hz, 999 999: Depends on J18	Y	Y	999	
J451	(Duration time)	0.00 to 3600.00 s	Y	Y	0.00	
J452	Motor Decrease Judgment (Judgment frequency)	0 to 500 Hz, 999 999: Depends on J19	Y	Y	999	
J453	(Duration time)	0.00 to 3600.00 s	Y	Y	0.00	
J454	Contactor Restart Time when Switching the Motor	0.01 to 2.00 s	Y	Y	0.10	
J455	Motor Increase Switching Time (Deceleration time)	0.00: Depends on F08 0.01 to 3600.00 s	Y	Y	0.00	
J456	Motor Increase Switching Level	0 to 100%	Y	Y	0	
J457	Motor Increase PID Control Start Frequency	0 to 500 Hz, 999 999: Depends on J452	Y	Y	999	
J458	Motor Decrease Switching Time (Acceleration time)	0.00: Depends on F07 0.01 to 3600.00 s	Y	Y	0.00	
J459	Motor Decrease Switching Level	0 to 100%, 999 999: Depends on J456	Y	Y	999	
J460	Motor Decrease PID Control Start Frequency	0 to 500 Hz, 999 999: Depends on J450	Y	Y	999	
J461	Motor Increase/Decrease Switching Judgment Non-responsive Area Width	0.0: Disable 0.1 to 50.0%	Y	Y	0.0	
J462	Failure Inverter Judgment Time	0.0: Disable 0.5 to 600.0 s	Y	Y	5.0	
J463	PID control start frequency	0: Disable 1 to 500Hz 999: Depends on J19	Y	Y	0	
J465	Auxiliary Motor (Frequency operation level)	0.0: Disable 0.1 to 500.0 Hz	Y	Y	50.0	
J466	(Hysteresis width)	0.0 to 500.0 Hz	Y	Y	1.0	
J467	(PV operation level)	0.00: Disable 0.01 to 9990	Y	Y	0.00	
J468	(Connection timer)	0.00 to 2.00 s	Y	Y	0.00	
J469	(Interrupting timer)	0.00 to 2.00 s	Y	Y	0.00	
J480	Motor Cumulative Run Time (Motor 0)	0 to 65535 For adjustment at the replacement time	Y	N	0	
J481	(Motor 1)					
J482	(Motor 2)					
J483	(Motor 3)					
J484	(Motor 4)					

Code	Name	Data setting range	Change when running	Data copying	Default setting	
J490	Y Terminal ON Maximum Cumulation Count (Y1 Y2)	0.000 to 1000 (The display of "1.000" indicates 1000 times.)	Y	N	0.000	
J492	Relay ON Maximum Cumulation Count (30A/B/C)					
J493	(Y6RY to Y8RY)					

J5 codes: External PID functions 1

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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)	N	Y	0	
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])	N	Y	0	
J505	(Display Units)	Sames as J105	N	Y	0	
J506	(Maximum scale)	-999 to 0.00 to 9990	N	Y	100.0	
J507	(Minimum scale)	-999 to 0.00 to 9990	N	Y	0.0	
J510	P (Gain)	0.000 to 30.000 times 999: ON/OFF control	Y	Y	0.100	
J511	I (Integral time)	0.0 to 3600.0 s	Y	Y	0.0	
J512	D (Differential time)	0.00 to 600.00 s	Y	Y	0.00	
J513	(Feedback Filter)	0.0 to 900.0 s	Y	Y	0.5	
J514	(Anti-reset wind-up)	0.00 to 9990 0.00: Disable Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	0.00	
J515	(ON/OFF control hysteresis width)	0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	0.00	
J516	(Proportional operation output convergent value)	0 to 150%	Y	Y	0	
J517	(Proportional cycle)	1 to 150s	Y	Y	30	
J518	(Upper limit of PID process output)	-10 to +110%	Y	Y	100	
J519	(Lower limit of PID process output)	-10 to +110%	Y	Y	0	
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	Y	Y	0	
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)	Y	Y	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
J522	External PID Control 1 (Upper level alarm (AH)))	OFF: Disable -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	OFF	
J524	(Lower level alarm (AL))	OFF: Disable -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	OFF	
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))	Y	Y	0	
J529	(Feedback upper-limit)	Auto: 105% equivalent -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	AUTO	
J530	(Feedback lower-limit)	Auto: -5% equivalent -999 to 0.00 to 9990 Upper/lower limit values are restricted by the maximum/minimum scales.	Y	Y	AUTO	
J531	(Feedback error detection time)	0.0 to 300.0s	Y	Y	0.1	
J540	(Manual command)	0: Keypad (△/▽ key) 8: Keypad (△/▽ key) (Balanceless-bumpless) 51: External PID command 1 (Analog input: Terminals [12], [C1] and [V2])	N	Y	0	
J551	External PID 1 Multistep Command (Multistep command 1)	-999 to 0.00 to 9990	Y	Y	0.00	
J552	(Multistep command 2)	-999 to 0.00 to 9990	Y	Y	0.00	
J553	(Multistep command 3)	-999 to 0.00 to 9990	Y	Y	0.00	

d codes: Application functions 2

Code	Name	Data setting range	Change when running	Data copying	Default setting	
d01	Speed Control 1 (Speed command filter)	0.000 to 5.000 s	Y	Y	0.200	
d02	(Speed detection filter)	0.000 to 0.100 s	Y*	Y	0.025	
d03	P (Gain)	0.1 to 200.0 times	Y*	Y	2.0	
d04	I (Integral time)	0.001 to 9.999 s 999: Cancel integral term	Y	Y	0.600	
d21	Speed control agreement / PG Error (Hysteresis width)	0.0 to 50.0 %	Y	Y	10.0	
d22	(Detection width)	0.00 to 10.00 s	Y	Y	0.50	
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	N	Y	2	
d25	ASR switching time	0.000 to 1.000 s	Y	Y	0.000	
d32	Speed limit / Over speed level 1	0 to 110 %	Y	Y	100	
d33	Speed limit / Over speed level 2	0 to 110 %	Y	Y	100	
d35	Over speed detection level	0 to 120 %; 999 999: Depend on d32, d33	Y	Y	999	
d51	Reserved *9	-500 to 500 *12	N	Y	*12	
d55	Reserved *9	0000 to 00FF (Display in hexadecimal)	N	Y	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
d61	Command pulse input (Filter time constant)	0.000 to 5.000 s	Y	Y	0.005	
d62	(Pulse scaling factor 1)	1 to 9999	Y	Y	1	
d63	(Pulse scaling factor 2)	1 to 9999	Y	Y	1	
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)	N	Y	2	
d69	Reserved *9	30.0 to 100.0Hz	Y	Y	30.0	
d79	Reserved *9	0; 160 to 500 V (400V order); 999	N	Y	0	
d91	Reserved *9	0.00 to 2.00, 999	Y	Y	999	
d92	Reserved *9	0.00 to 10.00	Y	Y	0.30	
d99	Extension function 1	0 to 127	Y	Y	0	

*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.

U codes: Application functions 2

Code	Name	Data setting range	Change when running	Data copying	Default setting	
U00	Customizable logic	0: Disable 1: Enable (Customizable logic operation)	Y	Y	0	
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	N	Y	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
U02	Customizable logic: Step 1 (Input 1)	[Digital] 0 to 105: The same as E20 value. However, 27, 111 to 120 cannot be selected	N	Y	100	
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]	N	Y	100	
U04	(Function 1)	-9990 to 0.00 to 9990	N	Y	0.00	
U05	(Function 2)		N	Y	0.00	

*: 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

Code	Name	Data setting range	Change when running	Data copying	Default setting	
U71	Customizable logic (Output selection) Output signal 1	0: Disable 1 to 200: Output of Step 1 to 200 "S001" to "S0200"	N	Y	0	
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					

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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	N	Y	100	
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	Y	N	0	
U92	Customizable logic (The coefficients of the approximate formula) (Mantissa of KA1)	-9.999 to 9.999	N	Y	0.000	
U93	(Exponent part of KA1)	-5 to 5	N	Y	0	
U94	(Mantissa of KB1)	-9.999 to 9.999	N	Y	0.000	
U95	(Exponent part of KB1)	-5 to 5	N	Y	0	
U96	(Mantissa of KC1)	-9.999 to 9.999	N	Y	0.000	
U97	(Exponent part KC1)	-5 to 5	N	Y	0	
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)	N	Y	0	
U101	Customizable logic (Operating point 1 (X1))	-999 to 0.00 to 9990	Y	Y	0.00	
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)	N	N	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
U121	Customizable logic (User parameter 1)	-9990 to 0.00 to 9990	Y	Y	0.0	
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	Y	Y	0.00	
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	Y	Y	15	
U191	Setting step (Select block)	Same as U01	N	Y	0	
U192	(Input 1)	Same as U02	N	Y	100	
U193	(Input 2)	Same as U03	N	Y	100	
U194	(Function 1)	Same as U04	N	Y	0.00	
U195	(Function 2)	Same as U05	N	Y	0.00	
U196	Customizable logic ROM version Upper digit (Monitor)	0 to 9999	N	N	0	
U197	Customizable logic ROM version Upper digit (For User setting)	0 to 9999	N	Y	0	
U198	Customizable logic ROM version Lower digit (Monitor)	0 to 9999	N	N	0	
U199	Customizable logic ROM version Lower digit (For User setting)	0 to 9999	N	Y	0	

y codes: LINK functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	
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.	N	Y	1	
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	Y	Y	0	
y03	(Timer)	0.0 to 60.0 s	Y	Y	2.0	
y04	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 6: 76800 bps	Y	Y	3	
y05	(Data length selection)	0: 8 bit 1: 7 bits	Y	Y	0	
y06	(Parity selection)	0: None (Stop bit: 2 bits)	Y	Y	0	
y07	(Stop bit selection)	0: 2 bits 1: 1 bits	Y	Y	0	
y08	(Communication time-out detection timer)	0: Not check of the time-out 1 to 60 s	Y	Y	0	
y09	(Response interval time)	0.00 to 1.00 s	Y	Y	0.01	
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	Y	Y	1	
y11	RS-485 Communication 2 (Station address)	1 to 255	N	Y	1	
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	Y	Y	0	
y13	(Timer)	0.0 to 60.0 s	Y	Y	2.0	
y14	(Baud rate)	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps 6: 76800 bps	Y	Y	3	
y15	(Data length selection)	0: 8 bits 1: 7 bits	Y	Y	0	
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)	Y	Y	0	
y17	(Stop bit selection)	0: 2 bits 1: 1 bit	Y	Y	0	
y18	(Communication time-out detection timer)	0: Not check of the time-out 1 to 60 s	Y	Y	0	
y19	(Response interval time)	0.00 to 1.00 s	Y	Y	0.01	
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	Y	Y	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
y60	BACnet Device instance number (Upper)	0 to 4194	N	Y	37	
y61	(Lower)	0: Compatible with present version, 128 to 999	N	Y	0	
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*	Y	Y	0	
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)	Y	Y	0	
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	Y	Y	0	
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	Y	N	0	

K codes: Keypad Functions for TP-A1-E2C

Code	Name	Data setting range	Change when running	Data copying	Default setting	
K01	LCD Monitor (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-customized language	Y	Y	1	
K02	(Backlight OFF Time)	OFF: Always OFF 1 to 30 min.	Y	Y	5	
K03	(Backlight brightness control)	0 (Dark) to 10 (Light)	Y	Y	5	
K04	(Contrast control)	0 (Low) to 10 (High)	Y	Y	5	
K08	(LCD Monitor Status Display)	0: Hide 1: Display	Y	Y	1	
K15	(Sub-monitor display selection)	0: Numeric values 1: Bar charts	Y	Y	0	

Code	Name	Data setting range	Change when running	Data copying	Default setting	
K16	LCD Monitor (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 (%)	Y	Y	13	
K17	(Sub-monitor 2 display selection)		Y	Y	19	
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	Y	Y	1	
K21	(Bar graph 2 display selection)		Y	Y	13	
K22	(Bar graph 3 display selection)		Y	Y	19	
K91	(< key shortcut selection)	0: disabled	Y	Y	0	
K92	(> key shortcut selection)	11 to 99: respective mode	Y	Y	64	

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.

o codes: Option Functions

Code	Name	Data setting range	Change when running	Data copying	Default setting	
o01	Terminal [Y6A/C] Function (Relay output)	Same as E20	N	Y	100	
o02	Terminal [Y7A/C] Function		N	Y	100	
o03	Terminal [Y8A/C] Function		N	Y	100	

Chapter 7
Names and functions of keypad components

Multi-functional keypad (option) allows you to run and stop the motor, monitor the running status, specify the function code data, and monitor I/O signal states, maintenance information, and alarm information.

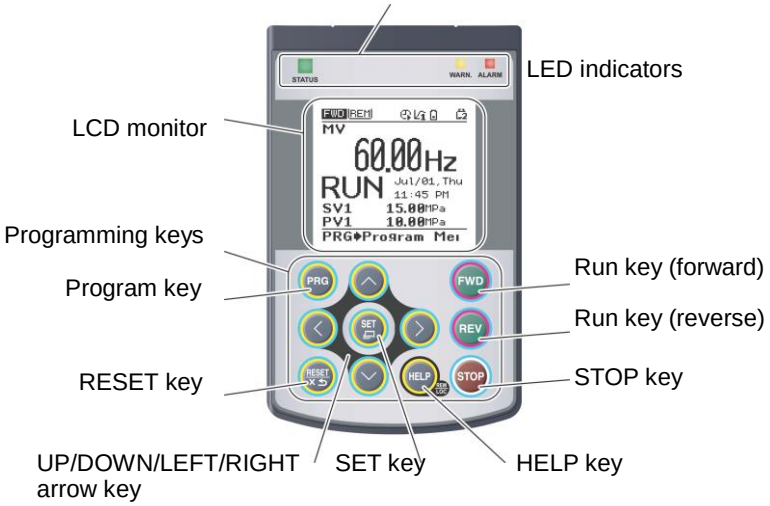


Figure 7.1: Names and Functions of Keypad Components

Table 7.1: Indication of LED Indicators

LED Indicators	Indication	
STATUS (Green)	Shows the inverter running state.	
	Flashing	No run command input (Inverter stopped)
	ON	Run command input
WARN. (Yellow)	Shows the light alarm state.	
	OFF	No light alarm has occurred.
	Flashing /ON	A light alarm has occurred.
ALARM (Red)	Shows the alarm state (heavy alarm).	
	OFF	No heavy alarm has occurred.
	Flashing	A heavy alarm has occurred.

Table 7.2: Overview of Keypad Functions

Number	Key	Function
3-1	PRG	This key switches the operation modes between Running mode/Alarm mode and Programming mode.
3-2	RESET	Reset key which works as follow according to operation modes: ■ In Running mode: This key cancels the screen transaction ■ In Programming mode: This key reset alarm states and switches to Programming mode ■ In Alarm mode: This key cancels the setting done or screen transition
3-3	/	UP/DOWN key which works as follows according to the operation modes: ■ In Running mode: These keys switch to the digital reference frequency and PID command modification screen (when commands from the keypad are enabled). ■ In Programming mode: These keys display multiple alarms and alarm history. ■ In Alarm mode: These keys select menu items, change data and scroll the screen.
	/	These keys move the cursor to the digit of data to be modified, shift the setting item, and switch the screen.
3-4	SET	Set key which works as follows according to the operation modes: ■ In Running mode: This key switch to the selection screen of the LCD content. ■ In Programming mode: Pressing this key switch to the alarm information screen. ■ In Alarm mode: Pressing this key establishes the selected items and data changed
3-5	HELP	Pressing this key call up the HELP screen according to the current display state. Holding it down for 2 seconds toggles between the remote and local modes.
3-6	FWD	Pressing this key starts running the motor in the forward rotation (when a run command from the keypad is enabled).

Chapter 8
Option relay Card (OPC-F2-RY)

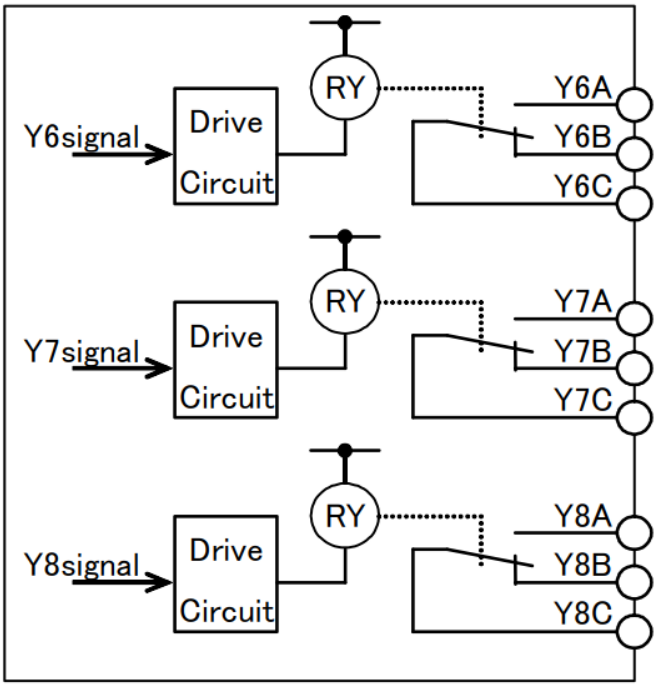


Figure 8.1 Internal Diagram OPC-F2-RY

The relay option card OPC-F2-RY is an option to add three additional relays (from Y6 A/C to Y8 A/C).

This card might be essential in order to implement the following pump control systems (for additional information check page 5):

- Mono-pump control with up to 4 line pumps (+ 1 additional pump)
- Multi-regulated pump control with 3 regulated pumps (+ 1 additional pump)

The functions that can be assigned to these relays are the same than the other output signals. Please refer to E20 parameter description for further reference.

The functions codes to change the function of each relay are:

Relay 6 A/C	**Function Code o01**
Relay 7 A/C	**Function Code o02**
Relay 8 A/C	**Function Code o03**

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