e-Front runners

QUICK GUIDE
PUMP CONTROL

FRENIC-Eco

Frequency inverter for pump control and HVAC applications

Date	Version
22/09/09	1.0.8

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1.0.7	Added titles in figures: 6.1 pg 40, 6.2 pg 41, 6.3 pg 42, 6.4 pg 44, 6.5 pg 45, 6.6 pg 46 Added title and format change in table 6.1 pg 43	22/09/09	J. M. Ibáñez	J. Català	
1.0.8	Title of Pg. 7 deleted Description of F07, F08 changed on Pg. 10 Explanation of parameter J01, J03 and J04 changed on Pg. 11 Description of J31=0, 1 or 2 changed on Pg. 43 Explanation of J42 changed on Pg. 44 PID Integral component hold titles and description changed on Pg. 44/45	19/10/09	J. M. Ibáñez	J. Català	D. Bedford

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

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-Eco 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.)
- Protective function to protect pump from the absence of water (Dry well function)
- "By-pass" sequence integrated
- 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-Eco 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-F1-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 up to 6 pumps (Mono-joker)					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 auxiliary pumps (On-Off control)			2	NO	
		3 auxiliary pumps (On-Off control)			3	NO	
		4 auxiliary pumps (On-Off control)			4	NO	
		4 auxiliary pumps (On-Off control)	+	1 additional pump (On-Off control)	5	NO	**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 up to 4 pumps (Multi-joker)			Necessary digital outputs	Do we need the optional relay card installed?	Explained in …
2 regulated pumps			4	NO	**CHAPTER 4**
3 regulated pumps			6	YES	
3 regulated pumps	+	1 additional pump (On-Off control)	7	YES	**CHAPTER 5**
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-Eco inverter, is as follows:

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

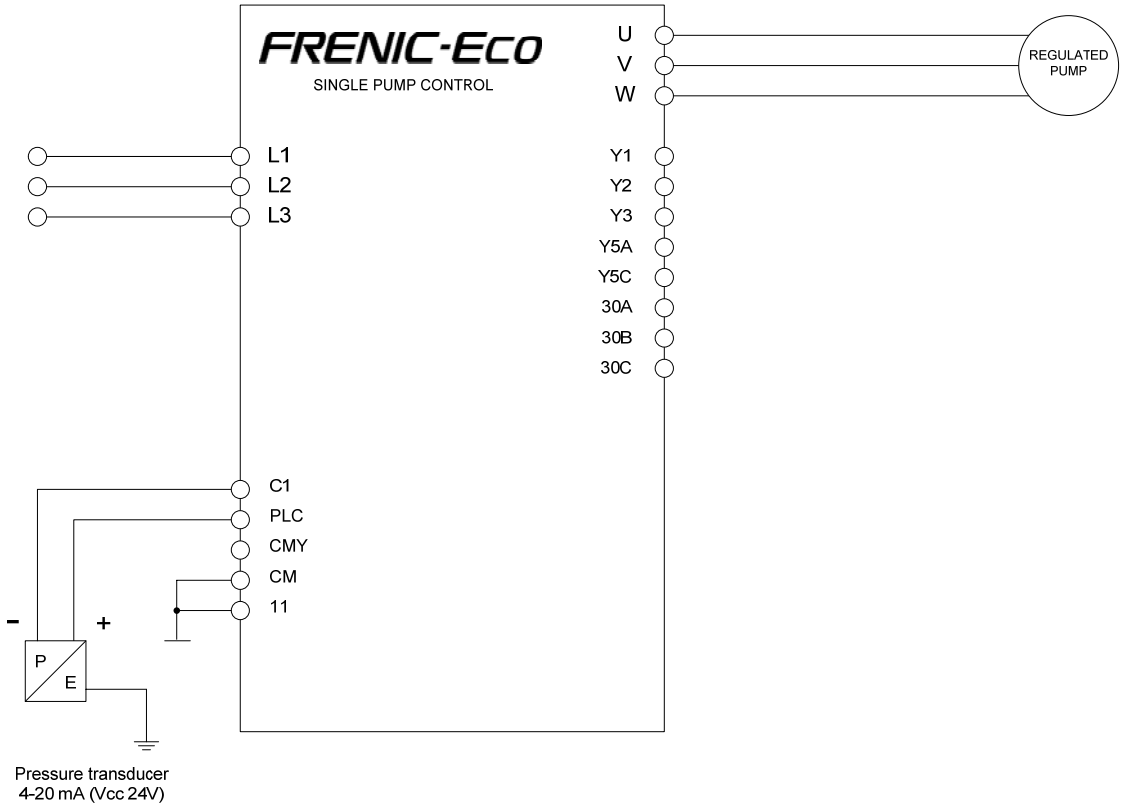


Figure 1.1: control schematic for 1 pump only

By means of the 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 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 J38 (s)). In order to control this rising output, some parameters are available: F23 (Hz) controls the starting frequency, J43 the starting PID frequency and the ramp from one to the other (F07) (s). Once J43 frequency level is achieved, PID control is enabled. 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.

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).
Once the demand frequency level is 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, is 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).

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, 3 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 can be ridden from *3. OPR MNTR* inverter's menu.)	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...	Both conditions must be met for longer than the time specified in J24

(*) J23 is related with E40 and E41 function codes as follows: **(|SV – PV|) / (E40 – E41) ≥ J23 (%)** (E40 and E41 explained on page 42).

As the three 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.

In figure 1.2 is shown how the pump wakes up when accomplishes the three conditions.

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

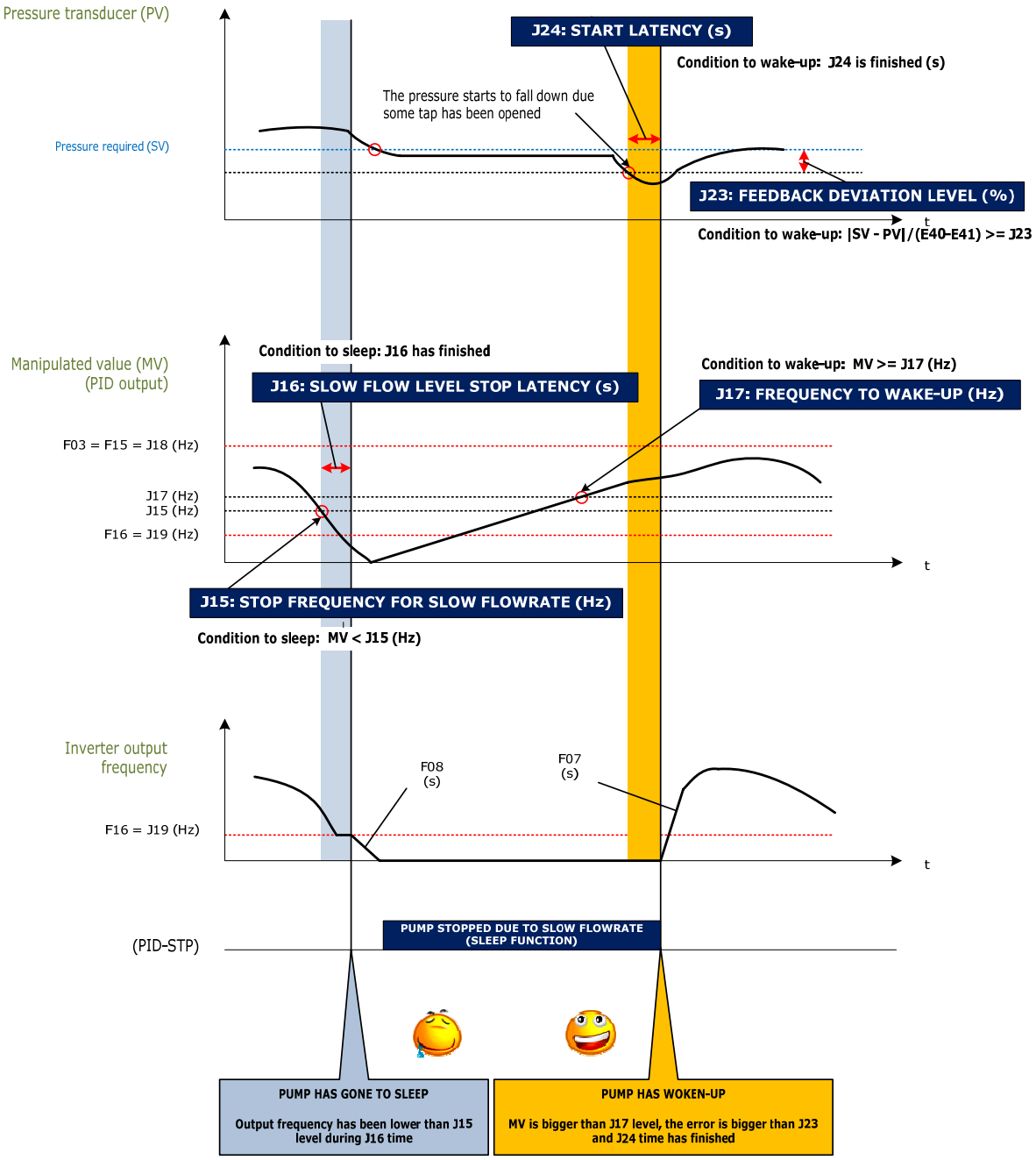


Figure 1.2: Speed control behaviour while sleep and wake-up functions are enabled

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-Eco, 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.

If you are adjusting the inverter by means of the TP-E1 keypad, is recommended to set E52 to "2", in order to be able to access to all the inverter menus.

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

	Common Parameters to all pump control systems		FRENIC-Eco	
	Name	Default setting	Example's Value	User's Value
F02	Run command	2	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. Overload detection Level	100% of the motor rated current	13.0 A	
F12	Electronic Thermal Overload protection. Time constant	5.0 min (22kW or below) / 10.0 min (30kW or above)	5 min	
F15	Frequency Limiter. High	70.0 Hz	50.0 Hz	
F16	Frequency Limiter. Low	0.0 Hz	25.0 Hz	
F26	Motor Sound. Carrier Frequency	15 kHz	3 kHz	
E40	PID Display coefficient A	+ 100.00	Transducer's pressure	
E43	LED monitor. Item selection	0	12	
E62	Analog Input for [C1]	0	5	
P01	Motor. Number of Poles	4	4	
P02	Motor. Rated capacity	Rated Capacity Standard Motor	5.5 kW	
P03	Motor. Rated current	Rated Current Standard Motor	13.0 A	
H91	C1 signal disconnection 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. Gain I	0.0 s	0.2	
J15	PID Control. Stop frequency for slow flow rate	0 Hz	35.0 Hz	
J16	PID Control. Slow flow rate level stop latency	30 s	15 s	
J17	PID Control. Starting Frequency	0 Hz	38.0 Hz	
J18	PID Control. Upper limit of process output	999	50.0 Hz	
J19	PID Control. Lower limit of process output	999	25.0 Hz	
J23	PID Control. Starting From the Slow Flow rate Stop (Dev. Level)	0 %	5 %	
J24	PID Control. Starting From the Slow Flow rate Stop (Latency)	0 s	1 s	

Table 1.1: Common parameters to all pump control systems

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 keypad, pushing FWD or REV buttons (in TP-G1 keypad) or RUN in basic keypad (TP-E1).

- 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 J43 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 J39 and J40 are set to 0.00 (please refer to the corresponding diagrams in the following chapters).

- F11: Electronic Thermal Overload Protection. Overload detection level
- F12: Electronic Thermal Overload Protection. 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: High Frequency Limiter. High
- F16: Frequency Limiter. Low

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: Analog Input for [C1]

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: C1 Signal disconnection 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 → function disabled.
H91 ≠ 0 → function enabled.

PID and pump control

- J01: PID control. 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. 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. Integral Time I

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

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

Chapter 2

Mono-regulated pump control with 1 regulated pump + 1, 2, 3 or 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-Eco inverter is as follows:

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

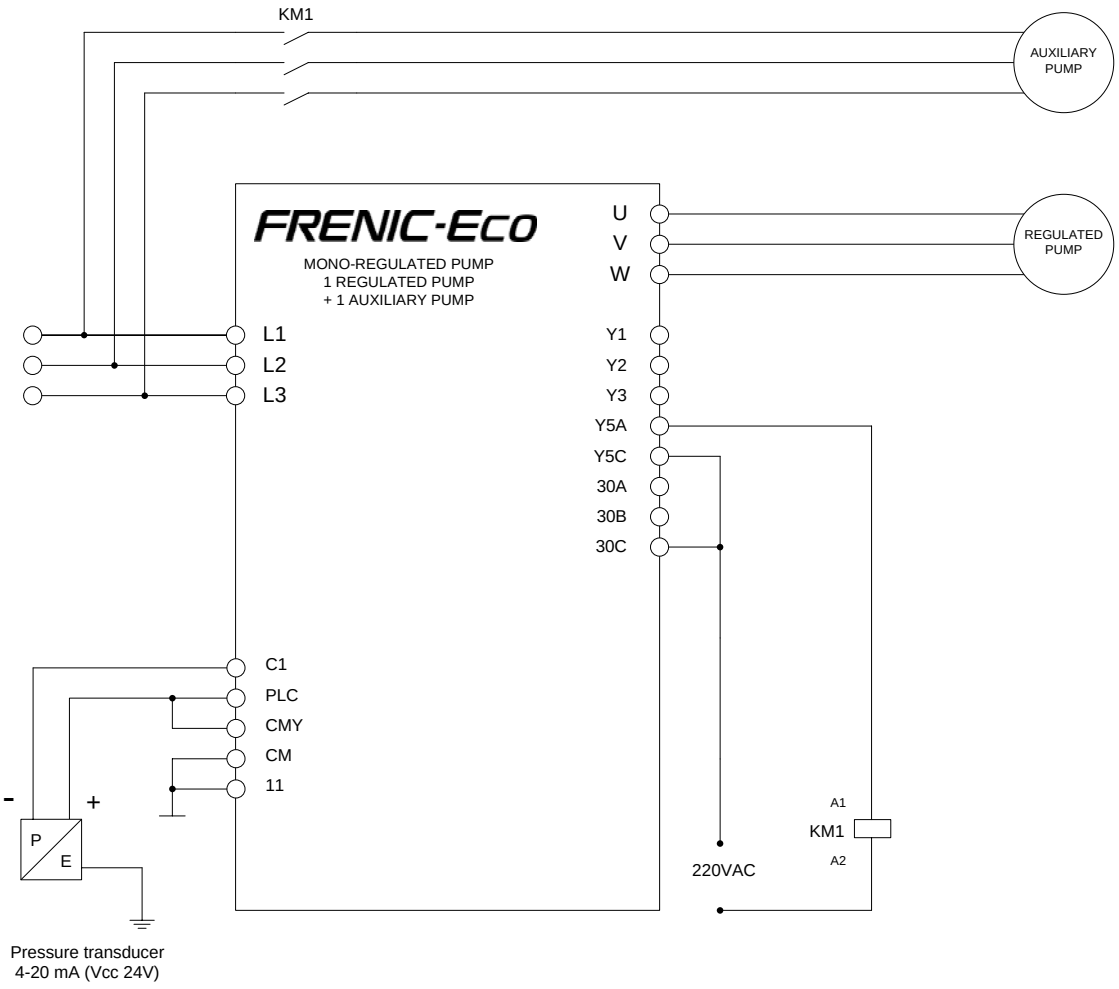


Figure 2.1: Schematic of a mono-regulated pump control with 1 regulated pump + 1 auxiliary pump.

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

The schematic for a mono-regulated pump control with 1 regulated pump + 2 auxiliary pumps by means of the FRENIC-Eco inverter is as follows:

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

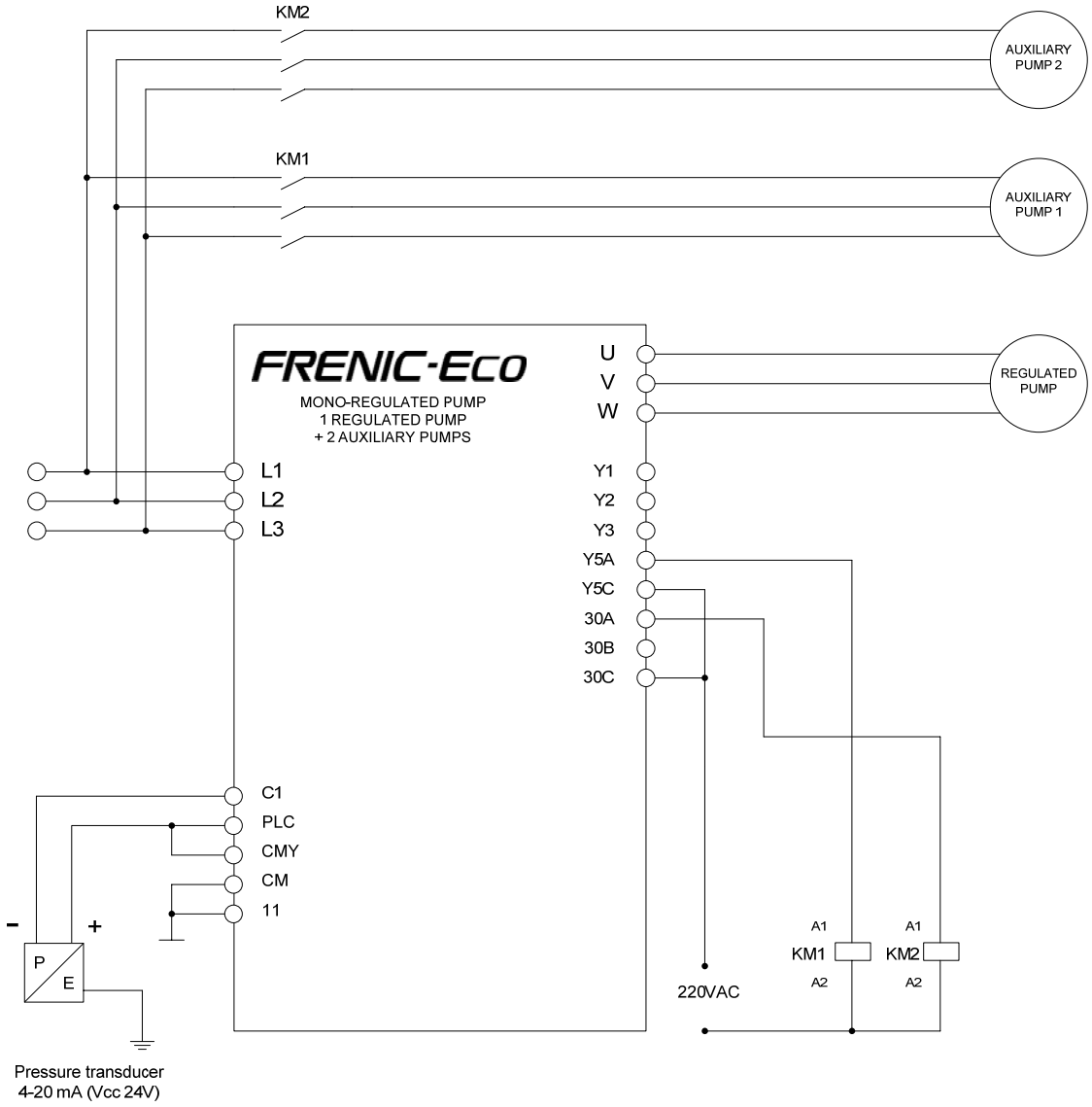


Figure 2.2: Schematic of a mono-regulated pump control with 1 regulated pump + 2 auxiliary pumps.

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

The schematic for a mono-regulated pump control with 1 regulated pump + 3 auxiliary pumps by means of the FRENIC-Eco inverter is as follows:

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

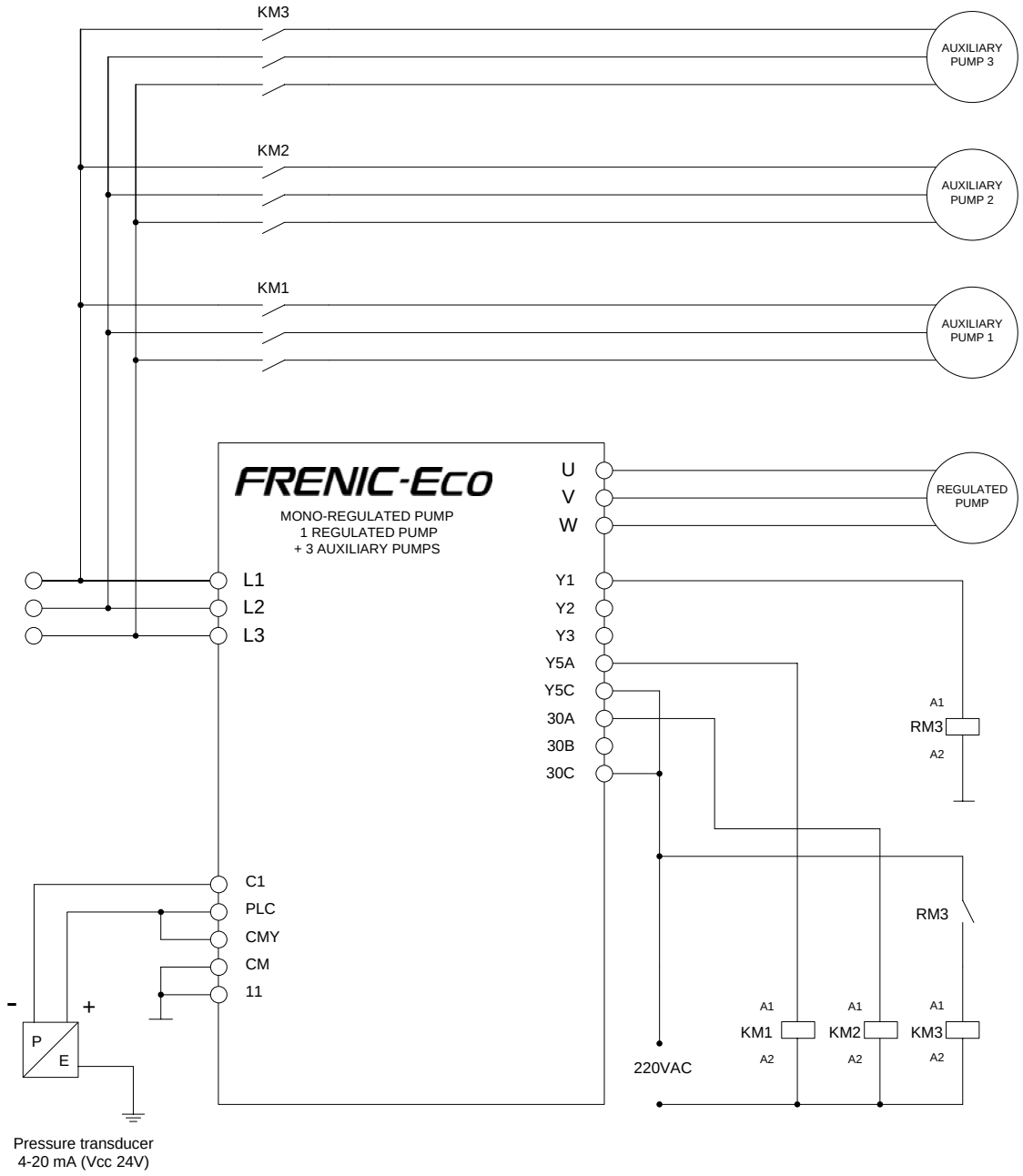


Figure 2.3: Schematic of a mono-regulated pump control with 1 regulated pump + 3 auxiliary pumps.

Mono-regulated pump control (Mono-joker)			Necessary digital outputs	Do we need the optional relay card installed?
1 inverter driven pump	+	4 auxiliary pump (ON / OFF)	4	NO

The schematic for a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps by means of the FRENIC-Eco inverter is as follows:

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

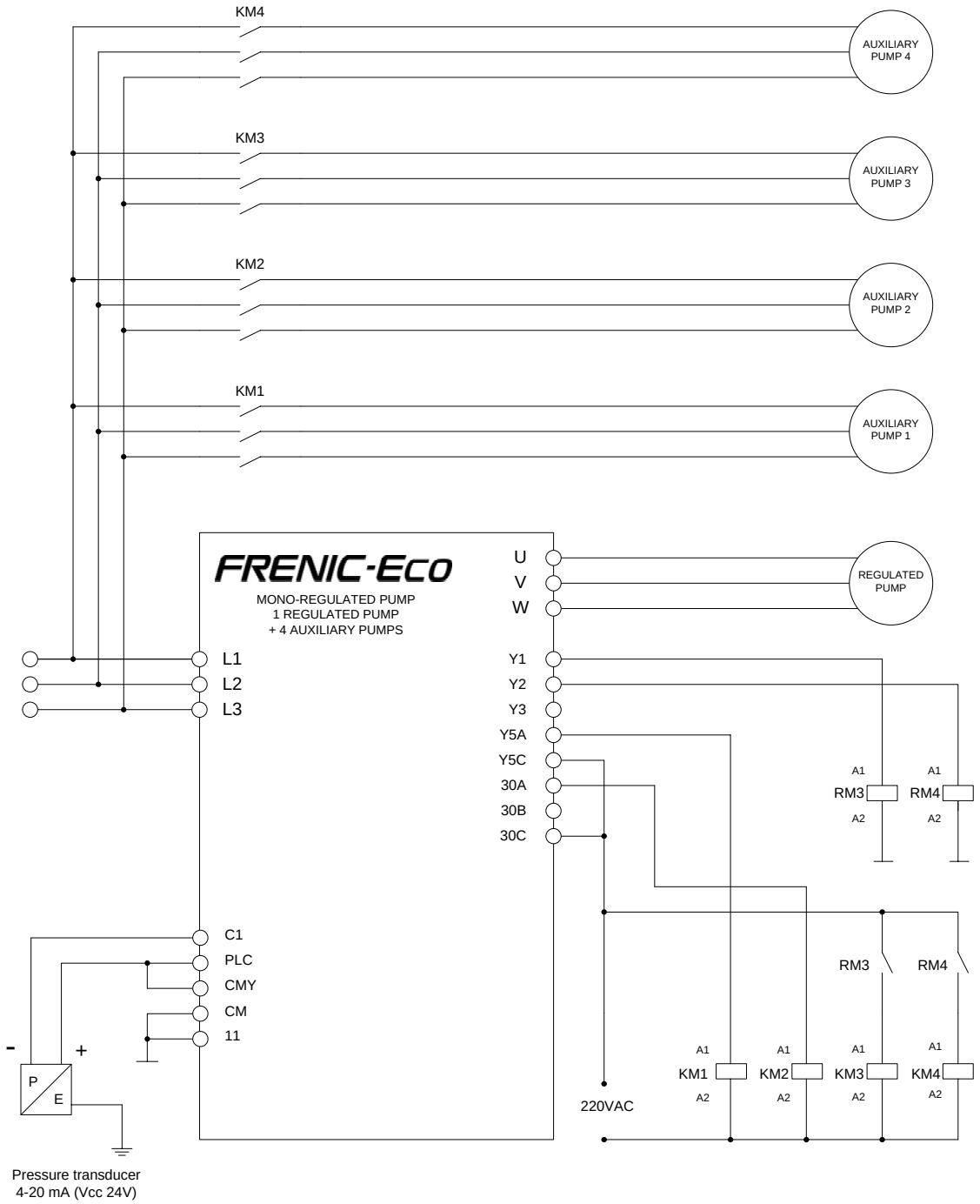


Figure 2.4: Schematic of a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps.

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 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 must be activated (J01) and adjusted accordingly, ensuring the inverter's response is what the installation requires all the time.

PID control 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.

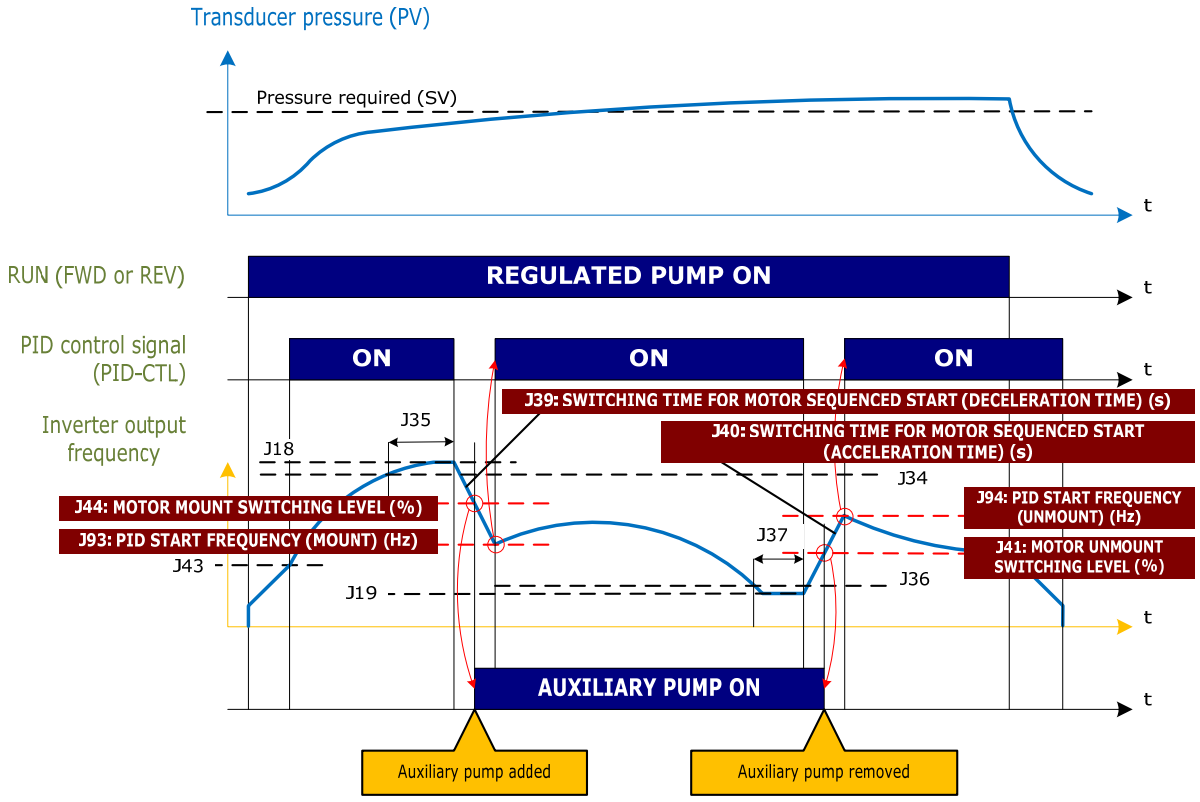


Figure 2.5: Speed pattern with mono-regulated pump control.
The Auxiliary pump is connected and disconnected

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 J34 during the time specified in J35, the inverter will understand that using the regulated pump is not enough to maintain the required pressure, and the inverter is ready 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 J93, by means of the deceleration ramp in J39. Once the frequency level J93 is achieved, the PID controller will be activated again.
The frequency level when the auxiliary pumps are connected is defined in function code J44.

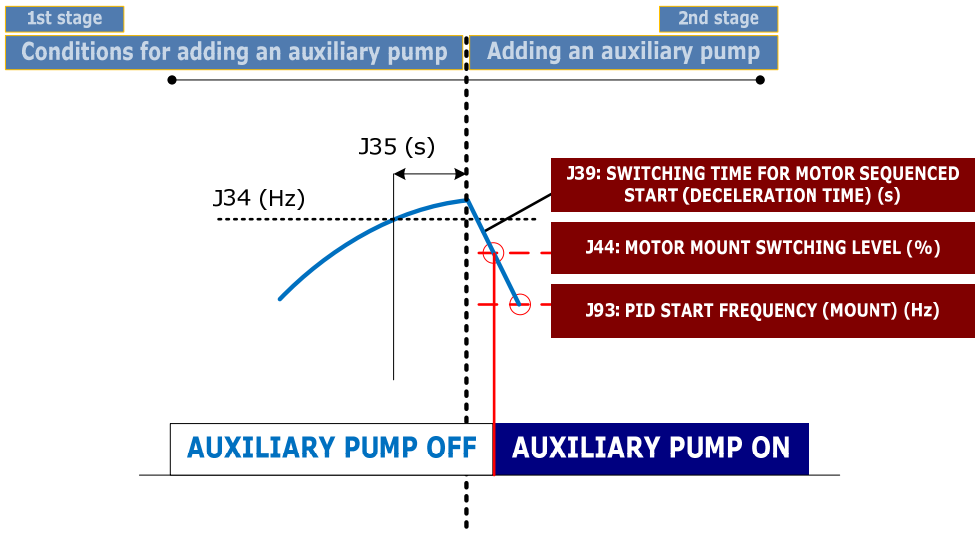


Figure 2.6: Auxiliary pump's connection

The exact frequency level where the inverter connects the auxiliary pumps to the commercial power supply is specified by means of the function code J44. The equation that defines this level is:

$$\text{Frequency for the connection of the auxiliary pumps (Hz)} = \left[\frac{J44}{100}\times(J18-J19)\right]+J19$$

As an example:

J44 = 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 J36 during a time longer than J37, 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 J94, by means of the acceleration ramp J40. The frequency level when the auxiliary pumps are disconnected is defined by function code J41.

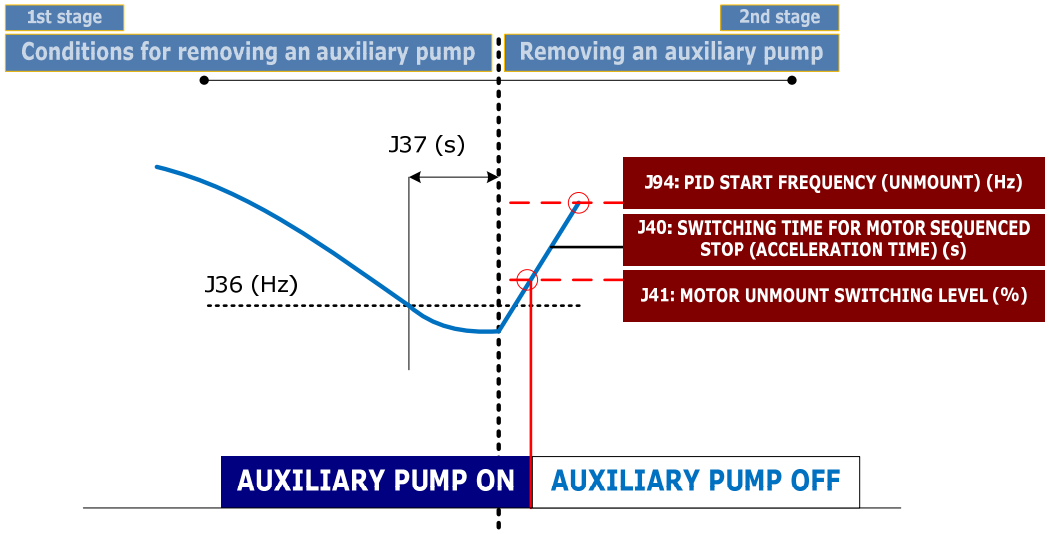


Figure 2.7: Disconnection of an auxiliary pump

The exact frequency level where the inverter disconnects the auxiliary pumps from the commercial power supply is specified by means of the function code J41. The equation that defines this level is:

$$\text{Frequency for disconnection of the auxiliary pumps (Hz)} = \left[\frac{J41}{100}\times\left(J18-J19\right)\right]+J19$$

For example:

J41 = 40 %
J18 = 50 Hz
J19 = 25 Hz

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

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, 2, 3 or 4 auxilliary 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-Eco inverter. These are known as the basic parameters.
In addition to the following table, there is also a specific parameters table.
If you are adjusting the inverter by means of the TP-E1 keypad, it is recommended to set E52 to "2", in order to be able to access to all of the inverter's menus.
Note: The following values are shown as an example and may not necessarily work in your application

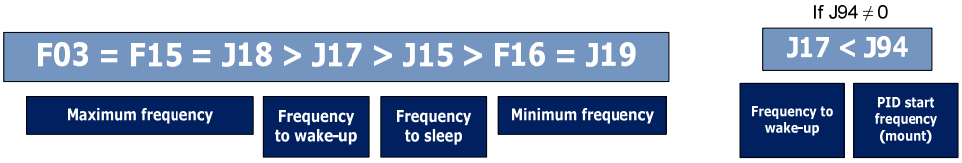
	Common parameters to all of the pump control systems FRENIC-Eco			
	Name	Default setting	Example's Value	User's Value
F02	RUN command	2	1	
F07	Acceleration time 1	20.00 s	3.00 s	
F08	Deceleration time 1	20.00 s	3.00 s	
F11	Electronic Thermal Overload protection. Overload detection Level	100% of the motor rated current	13.0 A	
F12	Electronic Thermal Overload protection. Time constant	5.0 min (22kW or below) / 10.0 min (30kW or above)	5 min	
F15	Frequency Limiter. High	70.0 Hz	50.0 Hz	
F16	Frequency Limiter. Low	0.0 Hz	25.0 Hz	
F26	Motor Sound. Carrier Frequency	15 kHz	3 kHz	
E40	PID display coefficient A	+ 100.00	Transducer's pressure	
E43	LED display. Function	0	12	
E62	Analog input for terminal C1(Extension function selection)	0	5	
P01	Motor. Number of poles	4	4	
P02	Motor. Rated Capacity	Rated capacity of standard motor	5.5 kW	
P03	Motor. Rated Current	Rated current of standard motor	13.0 A	
H91	C1 signal disconnection 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 I	0.0 s	0.2	
J15	PID Control. Sleep frequency	0 Hz	35.0 Hz	
J16	PID Control. Sleep frequency level latency	30 s	15 s	
J17	PID Control. Wake-up frequency	0 Hz	38.0 Hz	
J18	PID Control. Upper limit of PID process output	999	50.0 Hz	
J19	PID Control. Lower limit of PID process output	999	25.0 Hz	
J23	PID Control. Starting From the Slow Flow rate Stop (Dev. Level)	0 %	5 %	
J24	PID Control. Starting From the Slow Flow rate Stop (Latency)	0 s	1 s	

Table 2.1: Common parameters to all pump control systems

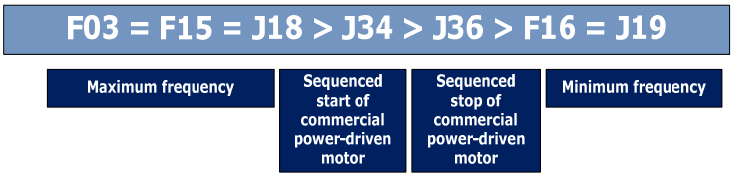
CONDITIONS TO ACHIEVE GOOD CONTROL IN A MONO-REGULATED PUMP CONTROL

The code values should meet the following conditions in order to achieve stable operational behaviour.

Conditions for sleeping/wake-up frequencies



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



The function codes J34, J36 and J94 belong to specific function codes group and will be explained 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:

	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	0	65 (M3_L)	65 (M3_L)	
E21	Status Signal Assignment to Y2	1	1	1	1	67 (M4_L)	
E24	Status Signal Assignment to Y5A/C	10	61 (M1_L)	61 (M1_L)	61 (M1_L)	61 (M1_L)	
E27	Status Signal Assignment to 30A/B/C	99	99	63 (M2_L)	63 (M2_L)	63 (M2_L)	
J25	Pump Control. Mode Selection	0	1	1	1	1	
J26	Motor 1 Mode	0	1	1	1	1	
J27	Motor 2 Mode	0	0	1	1	1	
J28	Motor 3 Mode	0	0	0	1	1	
J29	Motor 4 Mode	0	0	0	0	1	
J34	Start of commercial power-driven motor.Frequency	999	48 Hz	48 Hz	48 Hz	48 Hz	
J35	Start of commercial power-driven motor.Duration	0.00 s	5.00 s	5.00 s	5.00 s	5.00 s	
J36	Stop of commercial power-driven motor.Frequency	999	30 Hz	30 Hz	30 Hz	30 Hz	
J37	Stop of commercial power-driven motor.Duration	0.00 s	1.00 s	1.00 s	1.00 s	1.00 s	
J41	Motor Unmount switching level	0 %	50 %	50 %	50 %	50 %	
J44	Motor Mount Switching level	0 %	50 %	50 %	50 %	50 %	
J93	PID Start Frequency (Mount)	0 Hz	40 Hz	40 Hz	40 Hz	40 Hz	
J94	PID Start Frequency (Unmount)	0 Hz	39 Hz	39 Hz	39 Hz	39 Hz	

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

Note: The default setting for function code J93 and J94 (0 Hz) 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, E24, E27: Signal status assignment to Y1, Y2, Y5A/C, 30A/B/C

Function codes E20, E21, E24 and E27 define the function that will be assigned to terminals Y1, Y2, Y5A/C, 30A/B/C, 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 61: pump 1 to commercial power supply, 63: pump 2 to the commercial power supply, 65: pump 3 to commercial power supply and 67 pump 4 to commercial power supply).

PID and Pump control

- J25: Pump control. Mode Selection

Function code J25 defines the type of pump control that will be performed.

J25 = 0 Pump Control Disabled
J25 = 1 Mono-regulated pump Control Enabled
J25 = 2 Multi-regulated pump Control Enabled

➤ J26, J27, J28, J29: Motor 1 mode, Motor 2 mode, Motor 3 mode, Motor 4 mode

Function codes J26, J27, J28 and J29 define:

J26 = 0 Pump 1 unavailable
J26 = 1 Pump 1 available
J26 = 2 Pump 1 connected to commercial power supply

J27 = 0 Pump 2 unavailable
J27 = 1 Pump 2 available
J27 = 2 Pump 2 connected to commercial power supply

J28 = 0 Pump 3 unavailable
J28 = 1 Pump 3 available
J28 = 2 Pump 3 connected to commercial power supply

J29 = 0 Pump 4 unavailable
J29 = 1 Pump 4 available
J29 = 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 J26 to J29, 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	NO

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

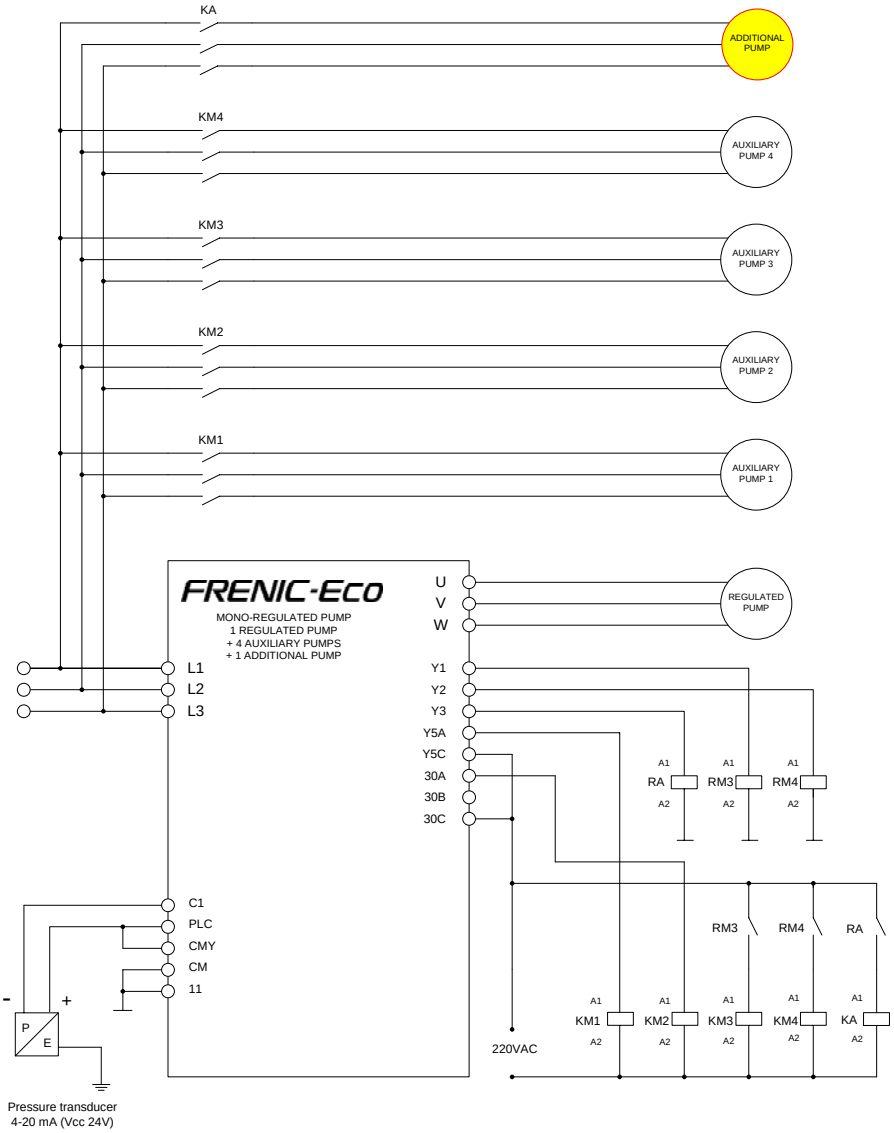


Figure 3.1: Schematic for a mono-regulated pump control with 1 regulated pump + 4 auxiliary pumps + 1 additional pump

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 E31 (Hz) (FDT function).

The additional pump will be disconnected from the commercial power supply when:
Output frequency ≤ (E31 – E32)

Using this control, the FRENIC-Eco inverter is able to control up to 6 pumps.

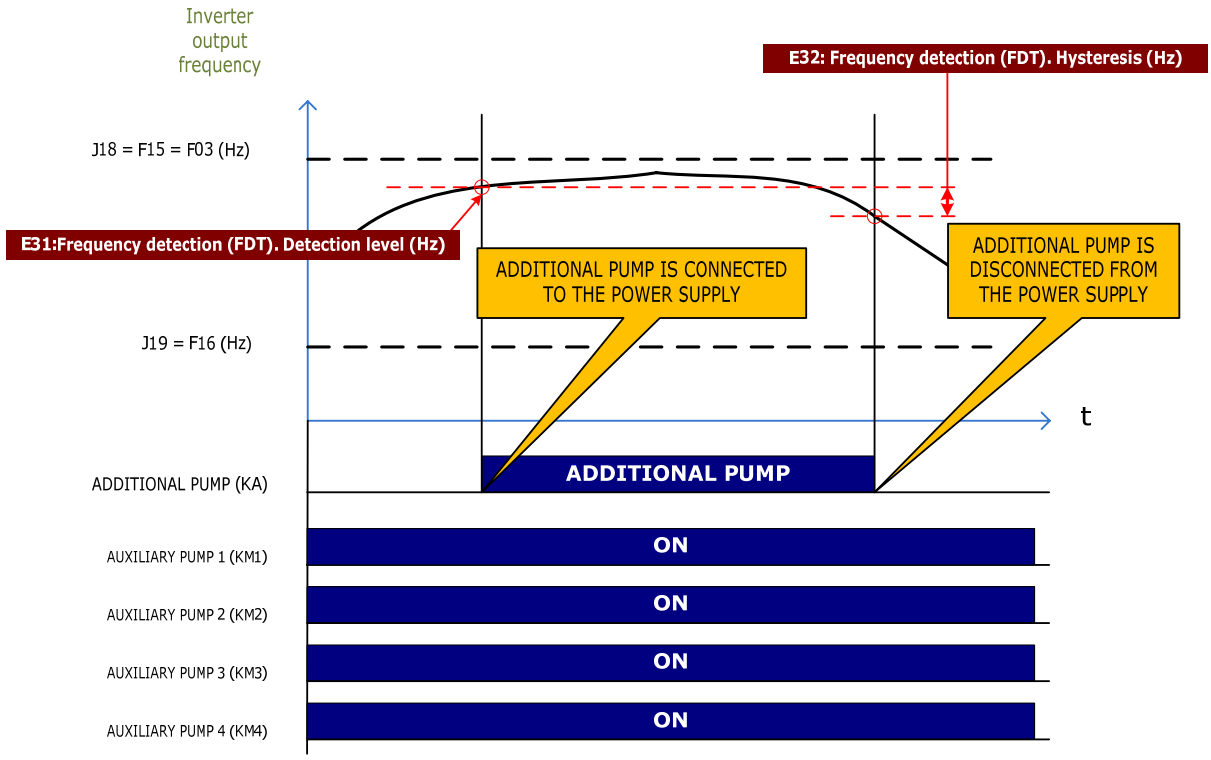


Figure 3.2: Additional pump's connection/disconnection diagram if all the auxiliary pumps are enabled

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-Eco inverter, these are the basic parameters.

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

If you are adjusting the inverter by means of the TP-E1 keypad, it is recommended to set E52 to "2", in order to be able to access all inverter menus.

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

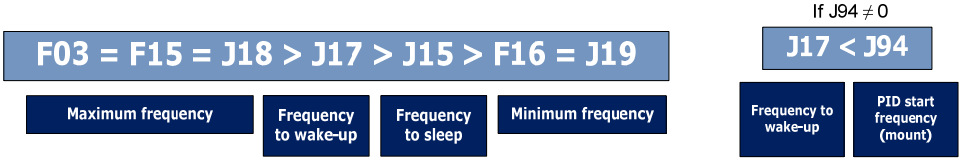
	Common parameters to all the pump control systems FRENIC-Eco			
	Name	Default Setting	Example's value	User's Value
F02	RUN command	2	1	
F07	Acceleration time 1	20.00 s	3.00 s	
F08	Deceleration time 1	20.00 s	3.00 s	
F11	Electronic Thermal Overload protection. Overload detection Level	100% of the rated motor current	13.0 A	
F12	Electronic Thermal Overload protection. Time constant	5.0 min (22kW or below) / 10.0 min (30kW or above)	5 min	
F15	Frequency Limiter. High	70.0 Hz	50.0 Hz	
F16	Frequency Limiter. Low	0.0 Hz	25.0 Hz	
F26	Motor Sound. Carrier Frequency	15 kHz	3 kHz	
E40	PID display coefficient A	+ 100.00	Transducer's pressure	
E43	LED display. Function	0	12	
E62	Analog input for terminal C1(Extension function selection)	0	5	
P01	Motor. Number of poles	4	4	
P02	Motor. Rated Capacity	Rated Capacity standard motor	5.5 kW	
P03	Motor. Rated Current	Rated current standard motor	13.0 A	
H91	C1 signal disconnection 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 I	0.0 s	0.2	
J15	PID Control. Sleep frequency	0 Hz	35.0 Hz	
J16	PID Control. Sleep frequency level latency	30 s	15 s	
J17	PID Control. Wake-up frequency	0 Hz	38.0 Hz	
J18	PID Control. Upper limit of PID process output	999	50.0 Hz	
J19	PID Control. Lower limit of PID process output	999	25.0 Hz	
J23	PID Control. Starting From the Slow Flow rate Stop (Dev. Level)	0 %	5 %	
J24	PID Control. Starting From the Slow Flow rate Stop (Latency)	0 s	1 s	

Table 3.1: Common parameters to all the pump control systems

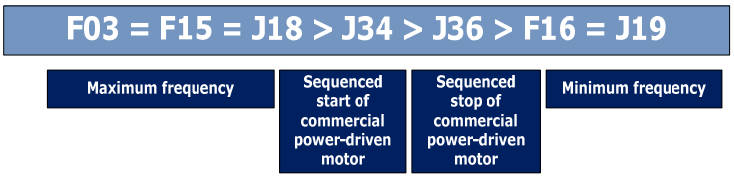
CONDITIONS TO ACHIEVE GOOD CONTROL WITH A MONO-REGULATED PUMP CONTROL + 4 AUXILIARY PUMPS + 1 ADDITIONAL PUMP

If setting function codes' values different from the "Example's Value" column, it is recommended to keep in mind the following restrictions:

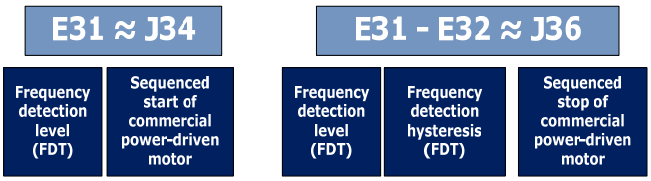
Conditions for Sleep/Wake-up frequency



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 (J37), 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:

	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
E20	Status Signal Assignment to Y1	0	65 (M3_L)	
E21	Status Signal Assignment to Y2	1	67 (M4_L)	
E22	Status Signal Assignment to Y3	2	88 (AUX_L)	
E24	Status Signal Assignment to Y5A/C	10	61 (M1_L)	
E27	Status Signal Assignment to 30A/B/C	99	63 (M2_L)	
E31	Frequency Detection (FDT). Level	50.0 Hz	47.0 Hz	
E32	Frequency Detection (FDT). Hysteresis	1.0 Hz	8.0 Hz	
J25	Pump Control. Mode Selection	0	1	
J26	Motor 1 mode	0	1	
J27	Motor 2 mode	0	1	
J28	Motor 3 mode	0	1	
J29	Motor 4 mode	0	1	
J34	Start of commercial power-driven motor. Frequency	999	48 Hz	
J35	Start of commercial power-driven motor. Duration	0.00 s	5.00 s	
J36	Stop of commercial power-driven motor. Frequency	999	30 Hz	
J37	Stop of commercial power-driven motor. Duration	0.00 s	1.00 s	
J41	Motor Unmount switching Level	0 %	50 %	
J44	Motor Mount switching Level	0 %	50 %	
J93	PID Start Frequency (Mount)	0 Hz	40 Hz	
J94	PID Start Frequency (Unmount)	0 Hz	39 Hz	

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

Note: The default setting for function code J93 and J94 (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

- E22: Status Signal Assignment to Y3

The function code E22 defines the signal assigned to digital output Y3.

In order to implement a mono-regulated pump control system with an additional pump, the Y3 terminal's signal must be set to 88, corresponding to AUX_L function.

If all the pumps that are enabled (using parameters J26-J29) have been activated (they are active due to the sate of the system), by means of AUX_L function it is possible to activate an extra digital output Y3 when the regulated pump's output frequency raises above the frequency level defined in the function code E31 (FDT function).

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 J26-J29 range, corresponding to this pump is different from zero

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

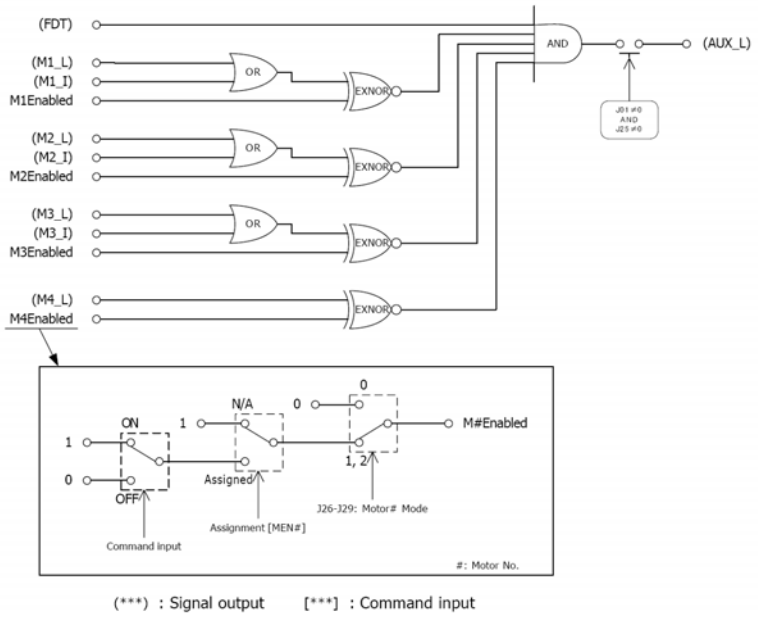


Figure 3.3: Additional pump function logic block diagram

Using function code E32 it is possible to define a hysteresis, for deactivating the pump below certain level of frequency and in order to avoid the signal Y3 activating/deactivating constantly.

- E31: Frequency Detection (FDT). 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 (FDT), the output with the AUX_L function assigned (88) will be activated. The level configured in E31 must be similar to the value of J34.

- E32: Frequency Detection (FDT). Hysteresis

With this parameter it is possible to adjust the hysteresis level for the deactivation of the FDT function and AUX_L accordingly. The result of E31-E32 must be similar to the value of J36.

Chapter 4
Multi-regulated pump 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	NO

The schematic to implement a multi-regulated pump control with 2 regulated pumps by means of FRENIC-Eco inverter is as follows:

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

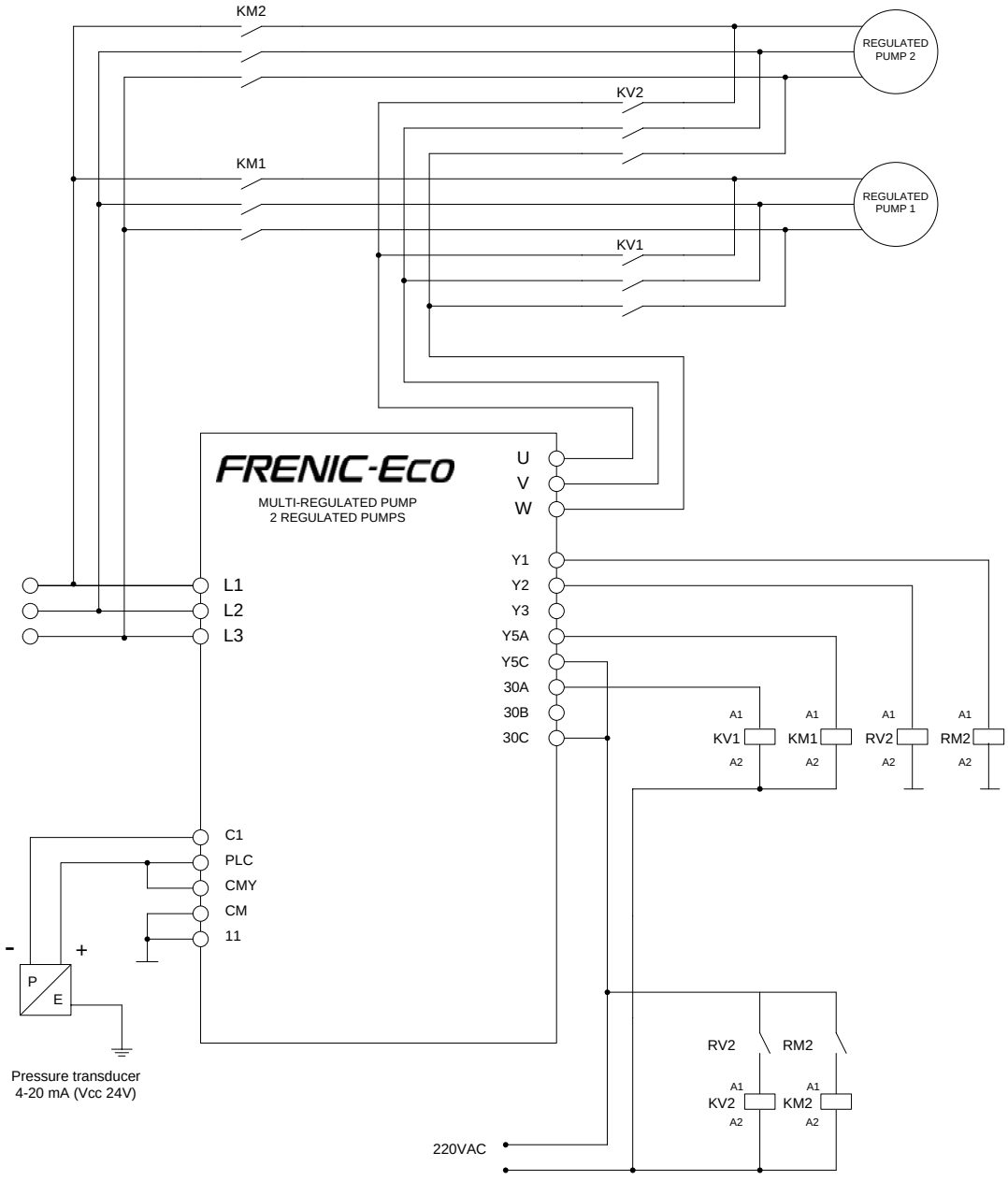


Figure 4.1: Schematics of multi-regulated pump control with 2 regulated pumps

Multi-regulated pump control (Multi-Joker)	Necessary digital outputs	Do we need the optional relay card installed?
3 regulated pumps	6	YES

The schematic to implement a multi-regulated pump control with 3 regulated pumps by means of FRENIC-Eco inverter is as follows:

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

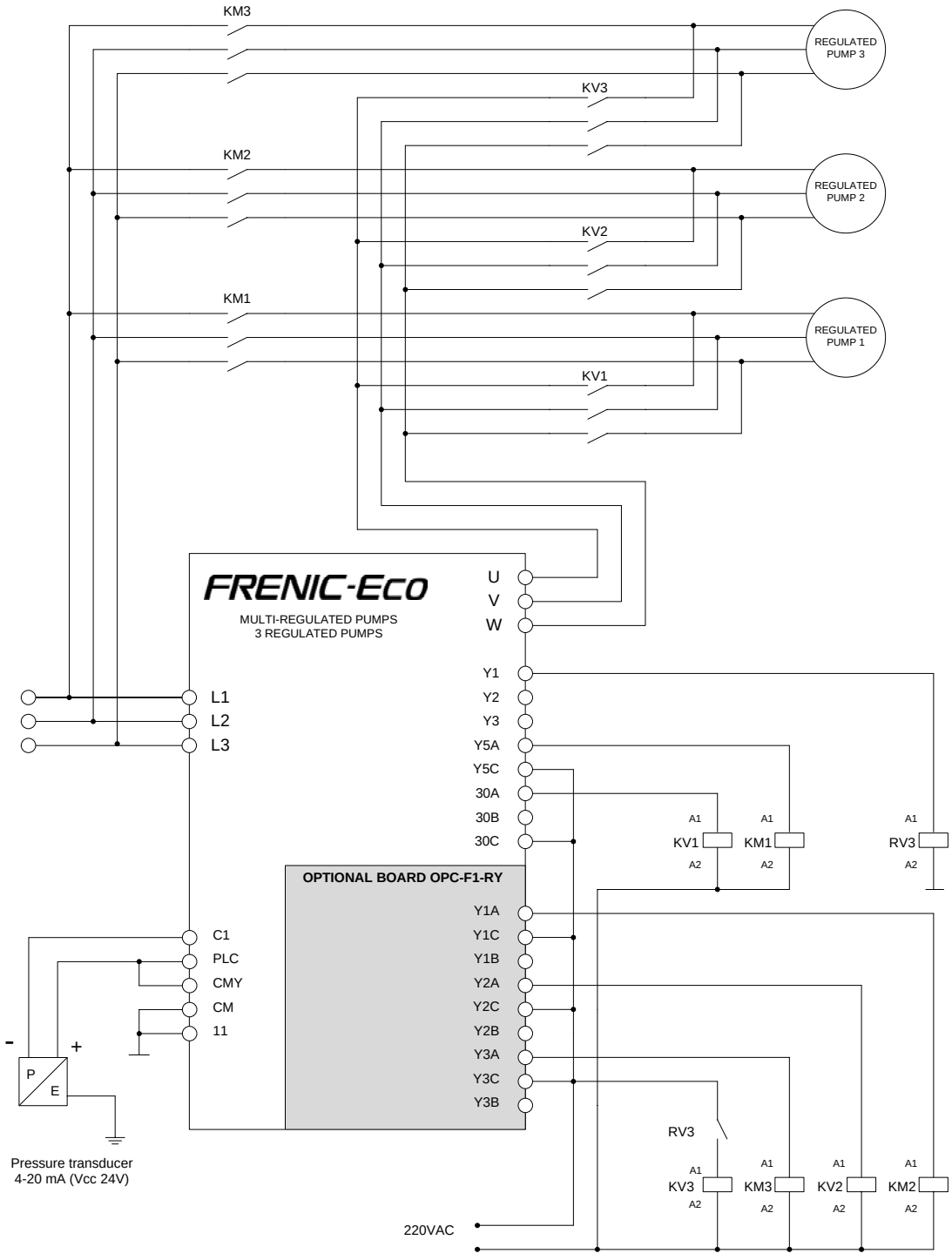


Figure 4.2: Schematics of multi-regulated pump control with 3 regulated pumps

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 keypad, digital inputs or analog 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 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 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 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 a regulated one.

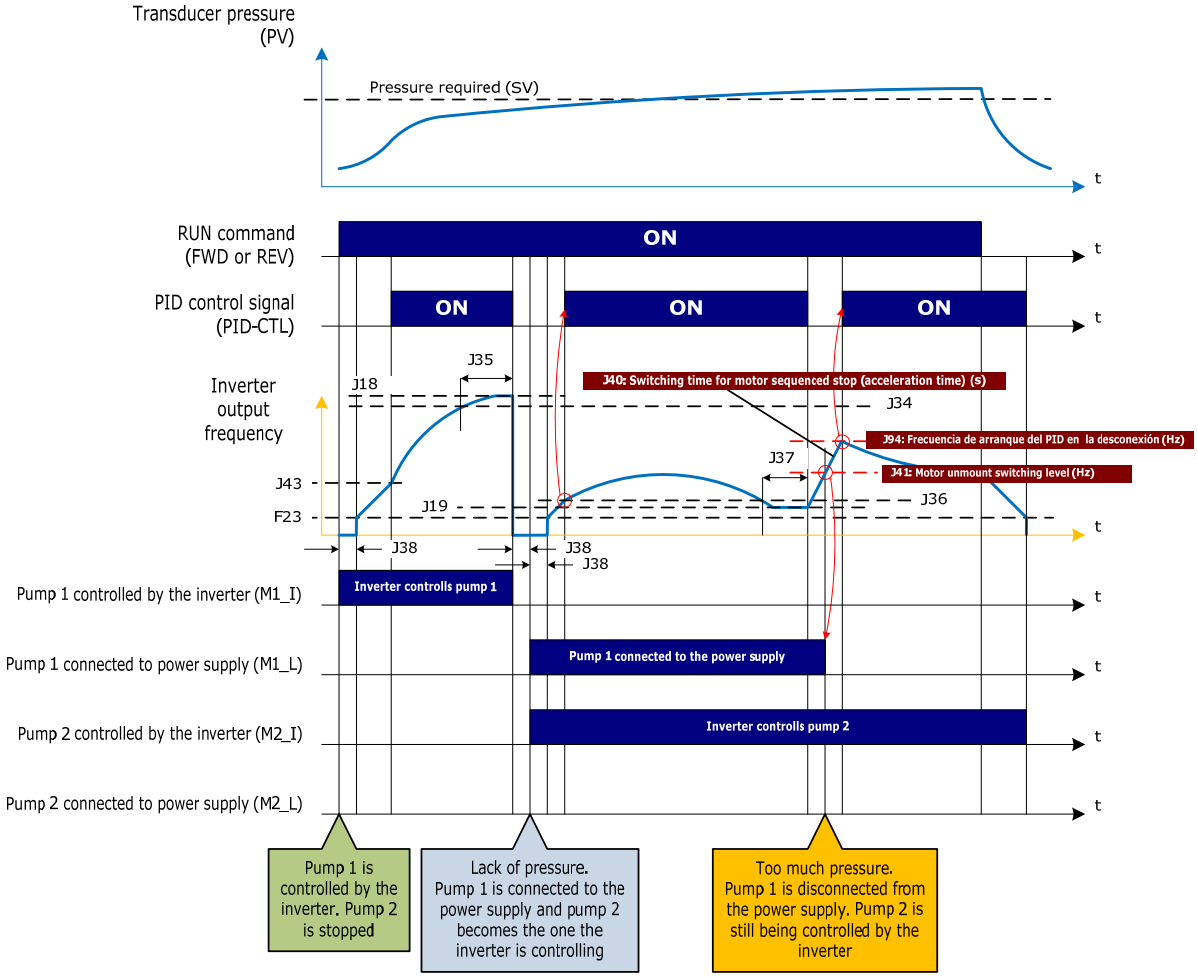


Figure 4.3: Speed pattern of a Multi-regulated pump Control with 2 regulated pumps

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:

• Connection of a regulated pump to the main 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 J34 during the time established in J35, the inverter will understand that the regulated pump is not enough to maintain the required pressure and will get ready 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 regulated pump to the commercial power supply and will take another pump of the system as a regulated one.

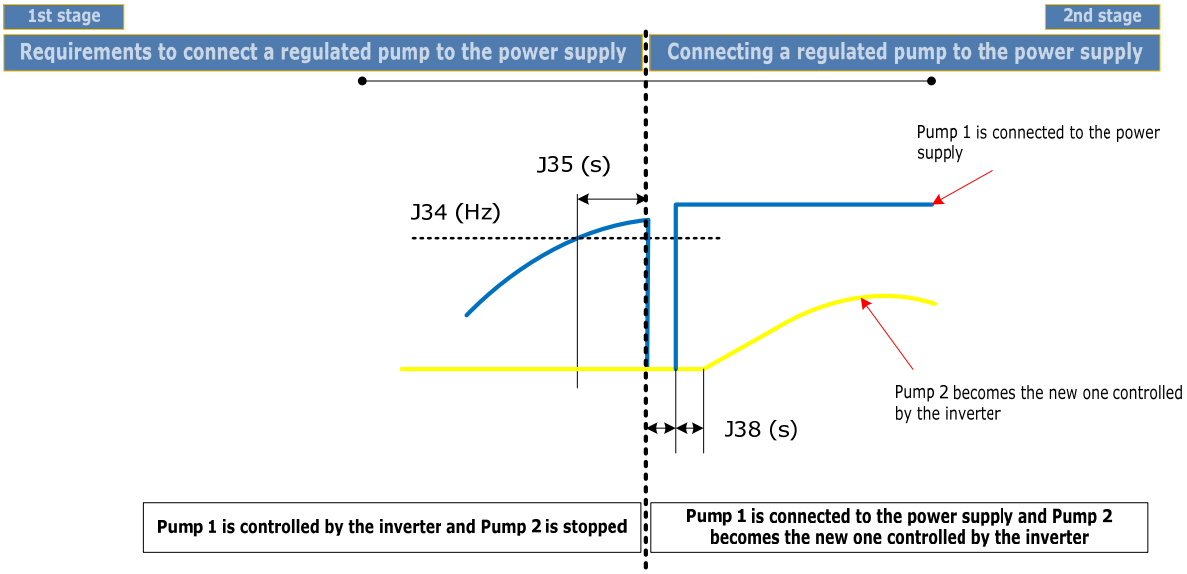


Figure 4.4: Connection of a regulated pump to the commercial power supply.

• Disconnection of a pump from the main 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 J36 during the time J37, the inverter will understand that is not necessary to keep a pump connected to the commercial power supply and will get ready for 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 J94 using the acceleration time in J40. 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.

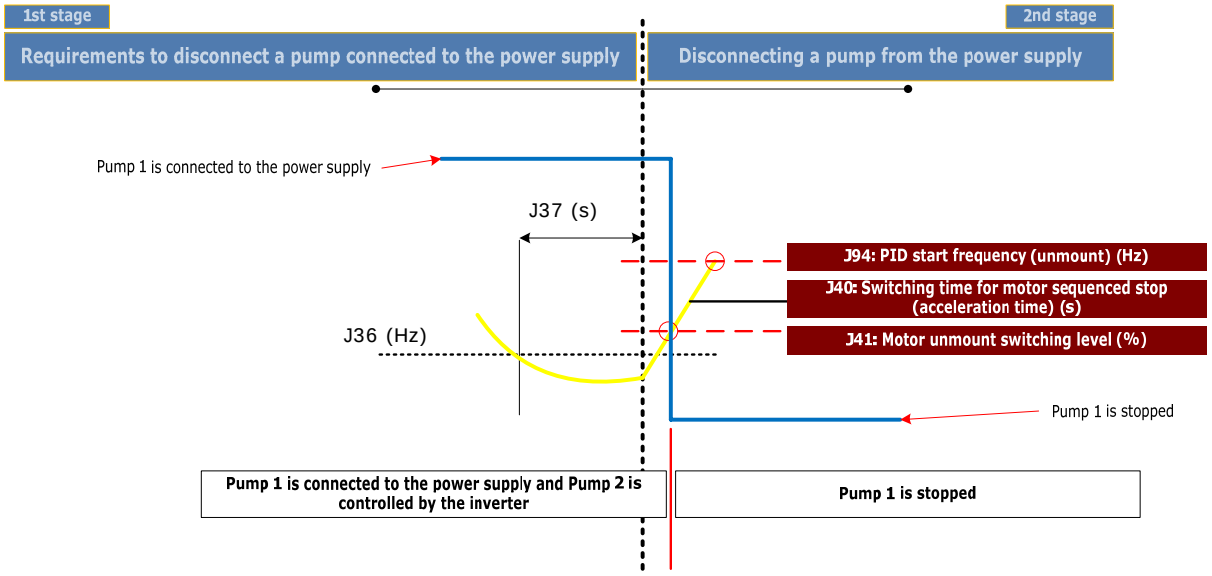


Figure 4.5: Increase of the pump's speed to disconnect the pump from the main supply

The exact point where the inverter will disconnect the pump from the main supply can be defined with function code J41. The equation to find this point is:

$$\text{Auxiliary pump's disconnection frequency (Hz)} = \left[\frac{J41}{100}\times(J18 - J19)\right] + J19$$

For example:

J41 = 40 %
J18 = 50 Hz
J19 = 25 Hz

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

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

2 / 3 Regulated Pumps Set-Up

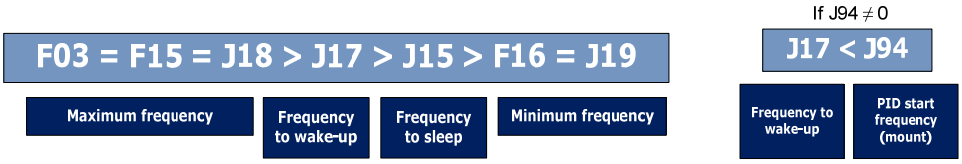
The following table (Table 4.1), called "Common Parameters to all the pump control systems", shows the common parameters to all the control systems using the FRENIC-Eco inverter, these are the basic function codes.
In addition to the common function codes' table, there is a table with the specific function codes.
If you are adjusting the inverter by means of the TP-E1 keypad, it is recommended to set E52 to "2", in order to be able to access all the inverter menus.
Note: The following values are only an example, and may not necessarily work in your application.

	Common Parameters to all the pump control systems FRENIC-Eco			
	Name	Default setting	Example's Value	User's Value
F02	Run command	2	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. Overload detection Level	100% of the motor rated current	15.0 A	
F12	Electronic Thermal Overload protection. Time constant	5.0 min (22kW or below) / 10.0 min (30kW or above)	15.0 A	
F15	Frequency Limiter. High	70.0 Hz	50.0 Hz	
F16	Frequency Limiter. Low	0.0 Hz	25.0 Hz	
F26	Motor Sound. Carrier Frequency	15 kHz	3 kHz	
E40	PID Display coefficient A	+ 100.00	Transducer's pressure	
E43	LED monitor. Item selection	0	12	
E62	Analog Input for [C1]	0	5	
P01	Motor. Number of Poles	4	4	
P02	Motor. Rated capacity	Rated Capacity Standard Motor	5.5 kW	
P03	Motor. Rated current	Rated Current Standard Motor	15.0 A	
H91	C1 signal disconnection 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. Gain I	0.0 s	0.2	
J15	PID Control. Stop frequency for slow flow rate.	0 Hz	35.0 Hz	
J16	PID Control. Slow flow rate level stop latency	30 s	15 s	
J17	PID Control. Starting Frequency	0 Hz	38.0 Hz	
J18	PID Control. Upper limit of process output	999	50.0 Hz	
J19	PID Control. Lower limit of process output	999	25.0 Hz	
J23	PID Control. Starting From the Slow Flow rate Stop (Dev. Level)	0 %	5 %	
J24	PID Control. Starting From the Slow Flow rate Stop (Latency)	0 s	1 s	

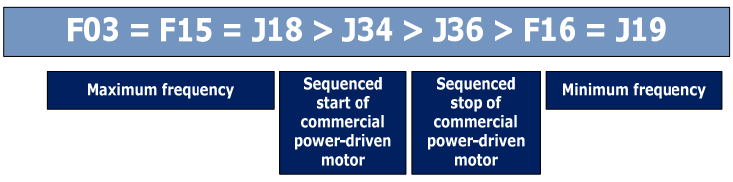
Table 4.1: Common parameters to all pump control systems

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



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

	Specific Parameters for Multi-regulated pump control with 2 / 3 regulated pumps				
	Name	Default value	For 2 regulated pumps (without OPC-F1-RY)	For 3 regulated pumps (with OPC-F1-RY)	User's Value
E20	Status Signal Assignment to Y1	0	63 (M2_L)	64 (M3_I)	
E21	Status Signal Assignment to Y2	1	62 (M2_I)	1	
E24	Status Signal Assignment to Y5A/C	10	61 (M1_L)	61 (M1_L)	
E27	Status Signal Assignment to 30A/B/C	99	60 (M1_I)	60 (M1_I)	
J25	Pump Control. Mode Selection	0	2	2	
J26	Motor 1 Mode	0	1	1	
J27	Motor 2 Mode	0	1	1	
J28	Motor 3 Mode	0	0	1	
J34	Start of commercial power-driven motor.Frequency	999	48 Hz	48 Hz	
J35	Start of commercial power-driven motor.Duration	0.00 s	5.00 s	5.00 s	
J36	Stop of commercial power-driven motor.Frequency	999	30 Hz	30 Hz	
J37	Stop of commercial power-driven motor.Duration	0.00 s	1.00 s	1.00 s	
J41	Motor Unmount switching level	0 %	50 %	50 %	
J45	Status Signal Assignment to Y1A/B/C	100	100	63 (M2_L)	
J46	Status Signal Assignment to Y2A/B/C	100	100	62 (M2_I)	
J47	Status Signal Assignment to Y3A/B/C	100	100	65 (M3_L)	
J94	PID Start Frequency (Unmount)	0 Hz	39 Hz	39 Hz	

Table 4.2: Specific parameters for Multi-regulated pump control with 2/3 regulated pumps

Note: The default setting for function code J94 (0 Hz) may work properly in your installation without adjusting it to the suggested value (39 Hz).

DESCRIPTION OF SPECIFIC PARAMETERS OF MULTI-REGULATED PUMP CONTROL WITH 2/3 REGULATED PUMPS

PID and pump control

- J25: Pump control. Mode selection

The function code J25 defines which type of pump control is going to be used
J25 = 0 Pump control disabled
J25 = 1 Mono-regulated pump control enabled
J25 = 2 Multi-regulated control enabled

- J26, J27, J28: Motor 1 mode, Motor 2 mode, Motor 3 mode

The function codes J26, J27, J28 define:

J26 = 0 pump 1 unavailable
J26 = 1 pump 1 available
J26 = 2 pump 1 connected to the commercial power supply

J27= 0 pump 2 unavailable
J27 = 1 pump 2 available
J27 = 2 pump 2 connected to the commercial power supply

J28 = 0 pump 3 unavailable
J28 = 1 pump 3 available
J28 = 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 J26 to J29, the corresponding pump will be turned on and will rotate at the speed marked by the commercial power supply. Take all necessary precautions.

DESCRIPTION OF SPCECIFIC PARAMETERS OF MULTI-REGULATED PUMP CONTROL WITH OPTIONAL RELAY CARD

PID and pump control

- J45, J46, J47: Status Signal Assignment to Y1A/B/C, Y2A/B/C, Y3A/B/C (modifying these function codes only makes sense when the OPC-F1-RY option card is installed in the inverter)

The function code J45, J46 and J47 define the signal assignment to the outputs Y1A/B/C, Y2A/B/C, and Y3A/B/C of the OPC-F1-RY option relay card.

In Multi-regulated pump control with 3 regulated pumps these digital outputs must be set correctly in order to connect/disconnect the 3 pumps to the inverter or to the commercial power supply (function 60: motor 1 inverter-driven, function 61: motor 1, commercial-power driven, function 62: motor 2 inverter-driven, function 63: motor 2 commercial-power driven, function 64: motor 3 inverter-driven and function 65: motor 3 commercial-power driven).

Chapter 5

Multi-regulated pump control with 3 regulated pumps + 1 additional pump

Multi-regulated pump Control (Multi-Joker)			Necessary digital outputs	Do we need the optional relay card installed?
3 regulated pumps	+	1 additional pump ("On-Off control")	7	YES

The schematic for a multi-regulated pump control with 3 regulated pumps + 1 additional pump by means of the FRENIC-Eco inverter is as depicted in figure 5.1.
Please, pay attention on the pressure transducer's wiring, connected to the inverter's analog input C1 (4 – 20 mA).

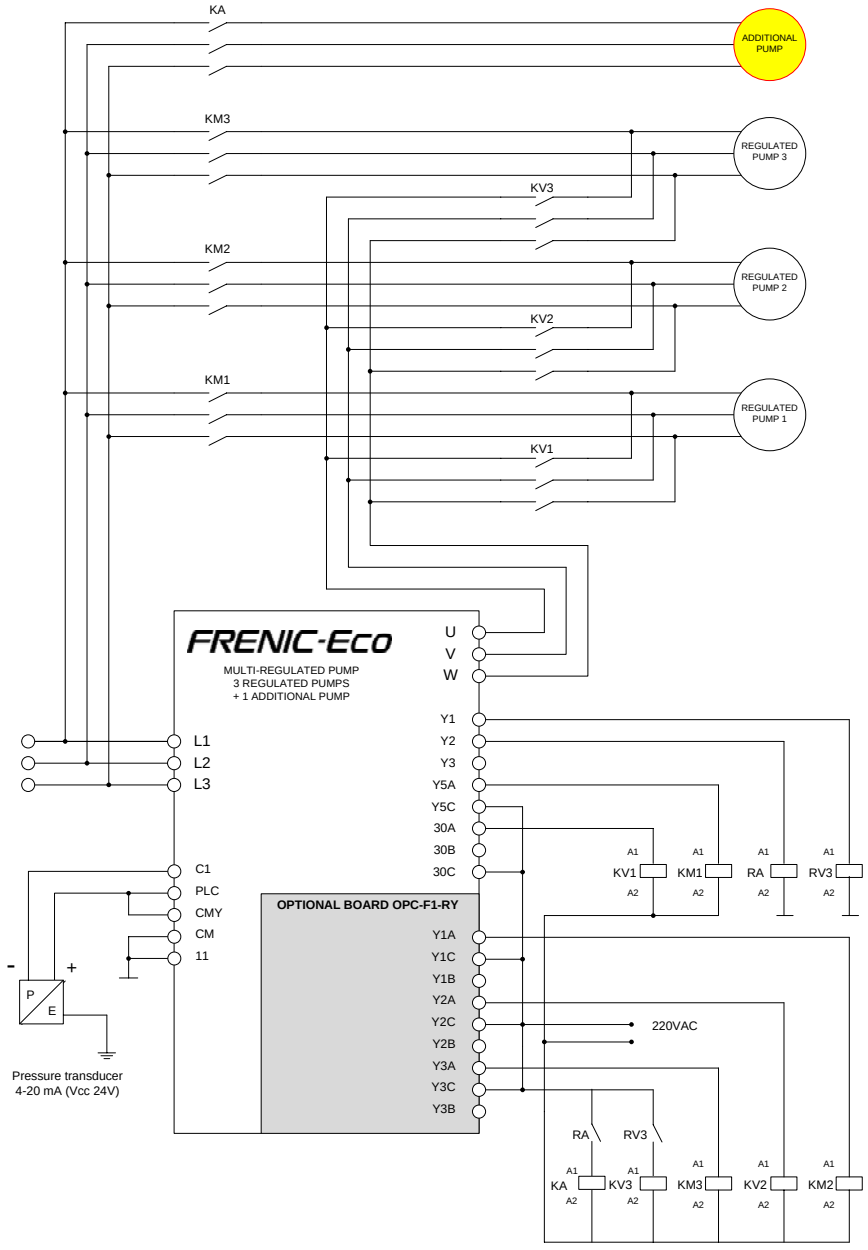


Figure 5.1: Schematic for multi-regulated pump control with 3 regulated pumps + 1 additional pump

In Multi-regulated pump Control, all the system pumps are regulated 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.
The control system explained in this chapter consists of 3 pumps regulated by means of the inverter plus an additional pump working in "On-Off control" mode.

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

1. Two of the three system pumps are connected to the commercial power supply, and

2. The frequency of the pump that is regulated by the inverter is higher than the level configured in function code E31 (Hz) (FDT function).

The additional pump will be disconnected from the commercial power supply when:
Output frequency ≤ (E31 – E32)

By means of this control system, FRENIC-Eco inverter is able to control up to 4 pumps.

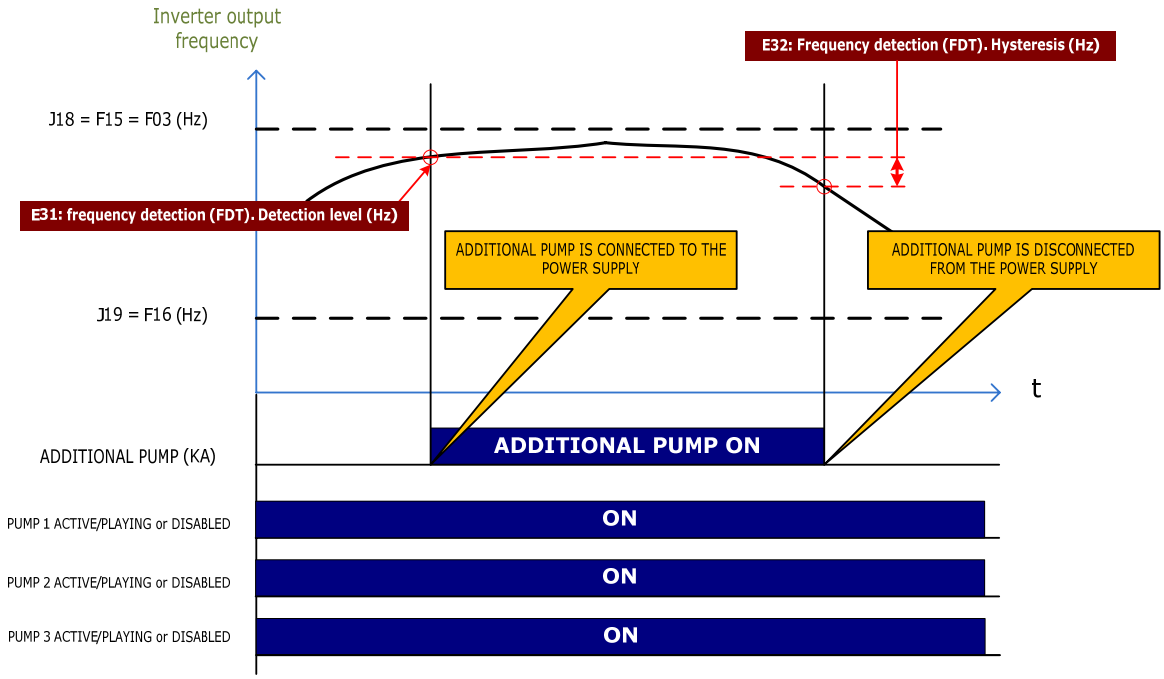


Figure 5.2: Additional pump connection/disconnection diagram if all the regulated pumps which are enabled are also active/playing

Note: In this case Active/playing means that the pump is either inverter driven or connected to the mains supply, depending on the state of the multi-regulated pump control.

In the same way as the multi-regulated pump control with 2/3 regulated pumps (chapter 4), if the pressure demand cannot be satisfied with only one pump, the inverter will connect it to the commercial power supply and pump 2 will become the new regulated pump.
If there is still not enough pressure, pump 2 will be connected to the main supply and pump 3 will become the new regulated pump.

If there is still not enough pressure, the additional pump will be finally turned on.

But, if the pressure is too high, the inverter will disconnect the pumps connected to the commercial power supply.

3 regulated pumps + 1 additional pump Set-up

The following table (Table 5.1), called "Common parameters to all the pump control systems", shows the common function codes to all the pump control systems using FRENIC-Eco inverter, these are the basic parameters.

Additional to the common parameters table, there is also a specific parameters table.

If you are adjusting the inverter by means of the TP-E1 keypad, it is recommended to set E52 to "2", in order to be able to access all the inverter menus.

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

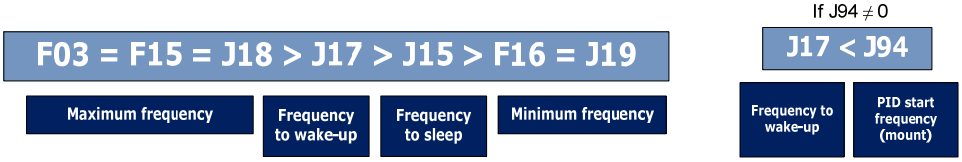
	Common parameters to all the pump control systems FRENIC-Eco			
	Name	Default setting	Example's value	User's Value
F02	RUN command	2	1	
F07	Acceleration time 1	20.00 s	3.00 s	
F08	Deceleration time 1	20.00 s	3.00 s	
F11	Electronic Thermal Overload protection. Overload detection Level	100% of the rated motor current	13.0 A	
F12	Electronic Thermal Overload protection. Time constant	5.0 min (22kW or below) / 10.0 min (30kW or above)	5 min	
F15	Frequency Limiter. High	70.0 Hz	50.0 Hz	
F16	Frequency Limiter. Low	0.0 Hz	25.0 Hz	
F26	Motor Sound. Carrier Frequency	15 kHz	3 kHz	
E40	PID display coefficient A	+ 100.00	Transducer's pressure	
E43	LED display. Function	0	12	
E62	Analog input for terminal C1(Extension function selection)	0	5	
P01	Motor. Number of poles	4	4	
P02	Motor. Rated Capacity	Rated Capacity standard motor	5.5 kW	
P03	Motor. Rated Current	Rated Current standard motor	13.0 A	
H91	C1 signal disconnection 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 I	0.0 s	0.2	
J15	PID Control. Sleep frequency	0 Hz	35.0 Hz	
J16	PID Control. Sleep frequency level latency	30 s	15 s	
J17	PID Control. Wake-up frequency	0 Hz	38.0 Hz	
J18	PID Control. Upper limit of PID process output	999	50.0 Hz	
J19	PID Control. Lower limit of PID process output	999	25.0 Hz	
J23	Control PID. Starting from the Slow Flow rate (Feedback deviation)	0 %	5%	
J24	Control PID. Starting from the Slow Flow rate (Start latency)	0.0 s	1 s	

Table 5.1: Common parameters to all the pump control systems

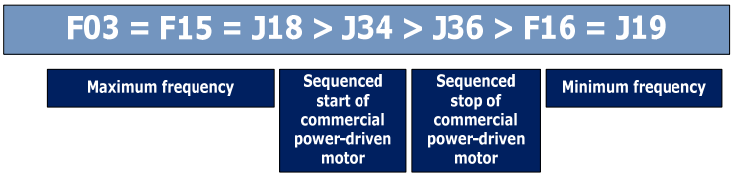
CONDITIONS TO ACHIEVE GOOD CONTROL IN MULTI-REGULATED PUMP CONTROL WITH 3 REGULATED PUMPS + 1 ADDITIONAL PUMP

Please follow the instructions below if it is necessary to change function codes data:

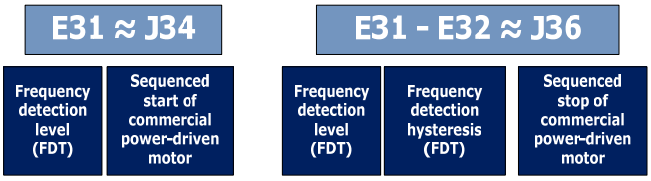
Conditions for Sleep/wake up frequencies



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



Conditions for the connection of an additional pump



With this topology, it may be necessary to extend the disconnection time of the motor from the commercial power supply (J37), to prevent that the additional and the regulated pumps could be disconnected at the same time. That is, the additional pump must be the first one to be disconnected, and then the regulated pump, but never at the same time.
The following table (Table 5.2) shows the specific parameters for multi-regulated pump control system with 3 regulated pumps + 1 additional pump:

	Specific Parameters for multi-regulated pump control with 3 regulated pumps + 1 additional pump			
	Name	Default setting	Example's value	User's value
E20	Status Signal Assignment to Y1	0	64 (M3_I)	
E21	Status Signal Assignment to Y2	1	88 (AUX_L)	
E24	Status Signal Assignment to Y5A/C	10	61 (M1_L)	
E27	Status Signal Assignment to 30A/B/C	99	60 (M1_I)	
E31	Frequency Detection (FDT). Detection Level	50.0 Hz	47.0 Hz	
E32	Frequency Detection (FDT). Hysteresis	1.0 Hz	15.0 Hz	
J25	Pump Control. Mode selection	0	2	
J26	Motor 1 mode	0	1	
J27	Motor 2 mode	0	1	
J28	Motor 3 mode	0	1	
J34	Start of commercial power-driven motor. Frequency	999	48 Hz	
J35	Start of commercial power-driven motor. Duration	0.00 s	5.00 s	
J36	Stop of commercial power-driven motor. Frequency	999	30 Hz	
J37	Stop of commercial power-driven motor. Duration	0.00 s	1.00 s	
J41	Motor Unmount switching level	0 %	50 %	
J45	Status Signal Assignment to Y1A/B/C	100	63 (M2_L)	
J46	Status Signal Assignment to Y2A/B/C	100	62 (M2_I)	
J47	Status Signal Assignment to Y3A/B/C	100	65 (M3_L)	
J94	PID Start Frequency (Unmount)	0 Hz	39 Hz	

Table 5.2: Specific parameters of multi-regulated pump control with 3 regulated pumps + 1 additional pump

Note: The default setting for function code J94 (0 Hz) may work properly in your installation without adjusting it to the suggested value (39 Hz).

DESCRIPTION OF SPECIFIC PARAMETERS OF MULTI-REGULATED PUMP CONTROL WITH 3 REGULATED PUMPS + 1 ADDITIONAL PUMP

Outputs Set-up

- E21: Status Signal Assignment to Y2

The function code E21 defines the signal assigned to digital output Y2.

In order to implement a multi-regulated pump control system with an additional pump, the Y2 terminal's signal must be set to 88, corresponding to AUX_L function.

If all the pumps that are enabled (using parameters J26-J28) have been activated (they are active due to the sate of the system), by means of AUX_L function it is possible to activate an extra digital output Y2 when the regulated pump's output frequency is higher than the frequency level defined in the function code E31 (FDT function).

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 J26-J28 range, corresponding to this pump is different from zero

In the picture below (Figure 5.3) this function logic block is depicted:

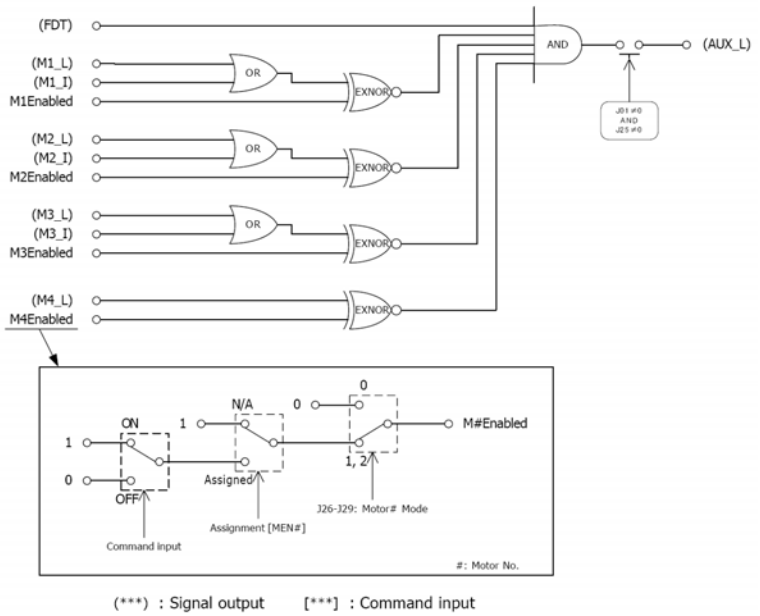


Figure 5.3: Additional pump function logic block diagram

Using function code E32 it is possible to define a hysteresis, for deactivating the pump below certain level of frequency and in order to avoid the signal Y3 activating/deactivating constantly.

- E31: Frequency Detection (FDT). 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 (FDT), the output with the AUX_L function assigned (88) will be activated. The level configured in E31 must be similar to the value of J34.

- E32: Frequency Detection (FDT). Hysteresis

With this parameter it is possible to adjust the hysteresis level for the deactivation of the FDT function and AUX_L accordingly. The result of E31-E32 must be similar to the value of J36.

Chapter 6
Additional Functions

Dry well function (Related function codes -> E80, E81)

Target: to make the inverter enter a STOP state, displaying an error code, when motor torque decreases below a set level for a specified period of time.

- Digital Inputs to use: X5 (with "Enable External alarm Trip" command assigned to it)
- Digital Outputs to use: Y1 (with "Low Output Torque Detected" signal assigned to it)
- Wiring:

  - Connect X5 to Y1
  - Connect CMY to PLC (*)

- Set-up:

  E05 (X5) = *1009: Enable external alarm trip (THR)*
  E20 (Y1) = *45: Low output torque detected (U-TL)*
  E80 = *Detect Low Torque. Level (%)*
  E81 = *Detect Low Torque. Timer (s)*

Error Message: when the output torque drops below the level set in E80 for the time in E81, the inverter output will be switched off, and the inverter will display the *OH2* error code. This error can be reset by means of the keypad or by means of a digital input (*8: "Reset Alarm" (RST)*).

(*) 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 together terminals CMY and CM and set the logic switch to the SINK position.

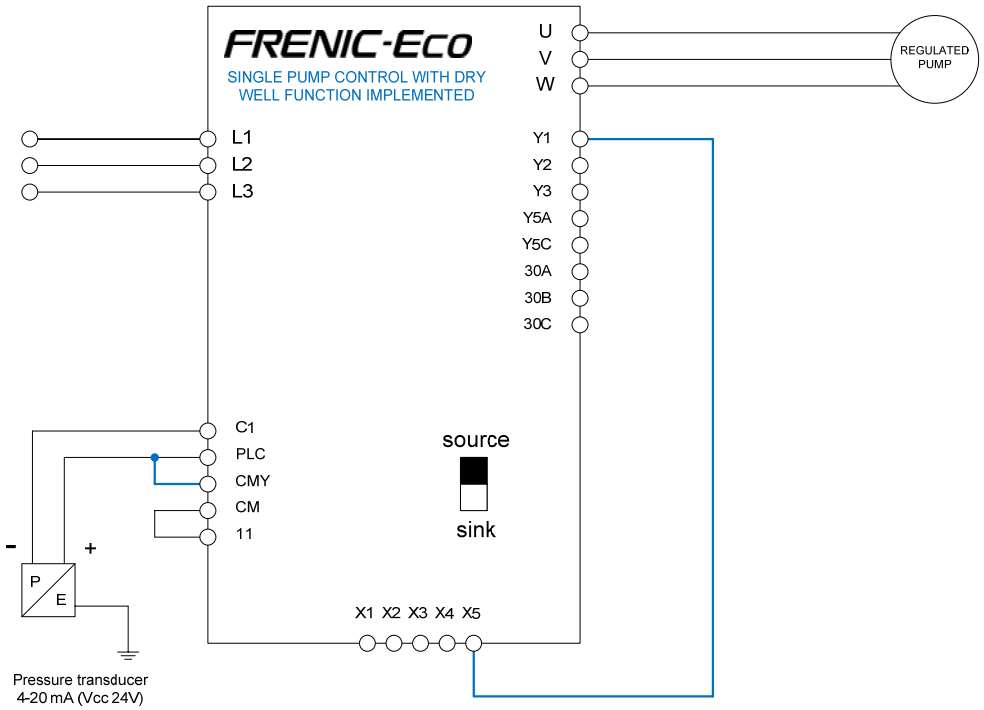


Figure 6.1: Pump control schematic for Dry well function

Overpressure alarm (related function codes -> J11, J12 and J13)

Target: make the inverter enter a STOP state and display an error code, when the process value (Feedback – pressure transducer) rises above a predefined level.

- Digital Input to use: X4 (with "Enable External alarm Trip" command assigned to it)
- Digital Output to use: Y2 (with "PID Alarm" signal assigned to it)
- Wiring:

  - Connect X4 to Y2
  - Connect CMY to PLC (*)

- Set-up:

  E04 (X4) = *1009: Enable External Alarm Trip (THR)*
  E21 (Y2) = *42: PID Alarm (PID-ALM)*
  J12 = *PID Control. Upper Limit Alarm (AH) (%)*
  J13 = *PID Control. Lower Limit Alarm (AL) (%)*

Error Message: when the process value (Feedback – Pressure transducer) is above the value set in J12 (upper limit) or below the value set in J13 (lower limit), the inverter's output is switched off and the inverter will display *OH2* error code. This error can be reset by means of the keypad or by means of a digital input (*8: "Reset Alarm" (RST)*).

(*) 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.

Note: In order to select other alarm modes, please see description of function code J11 (PID Control. Select Alarm Output) in the User Manual of the FRENIC-ECO inverter.

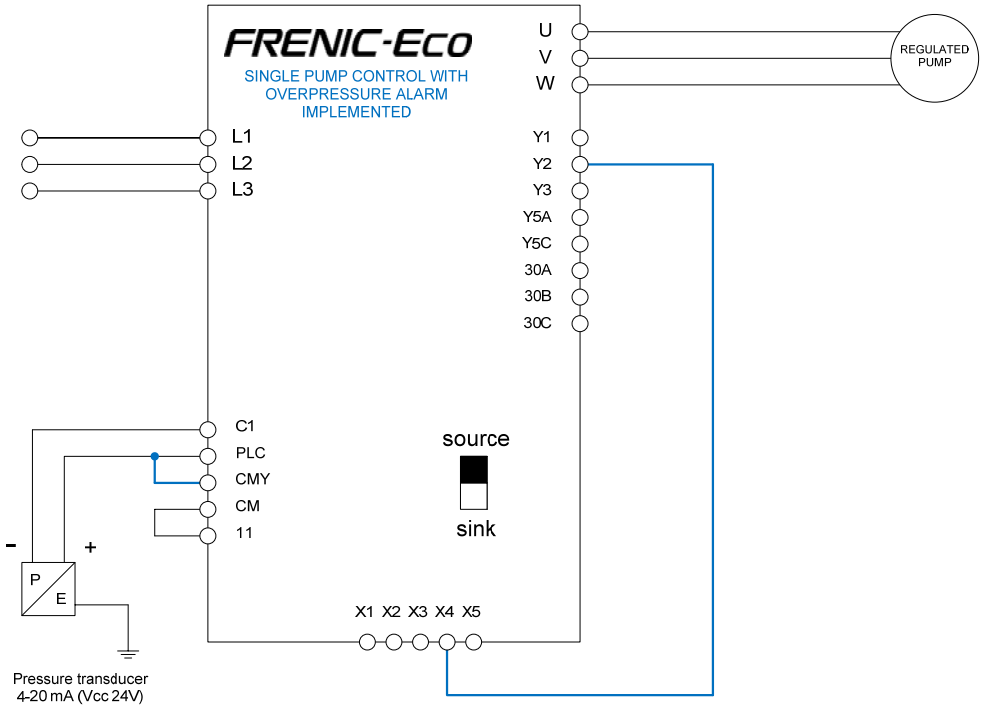


Figure 6.2: Pump control schematic for Overpressure alarm

PID Display units set-up (related function codes -> E40, E41)

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 E40 according to the sensor range.
Therefore the user will be able to enter the Command (set point) Value in user units, instead of percentage (of PID range).

For example, if the transducer used has a 4-20 mA output signal range, where 20mA correspond to 160 bars, the function code E40 must be set to 160.
If the transducer used has a 4-20 mA output signal range, where 20mA correspond to 10 bars, the function code E40 must be set to 10.

The feedback value, in bars, can be seen in parameter *3_11: PID Feedback Value*.
The process command value is displayed in parameter *3_10: PID Process command*.

If you are adjusting the inverter by means of the TP-E1 keypad, it is needed to set E52 to "2" in order to be able to access all the inverter menus.

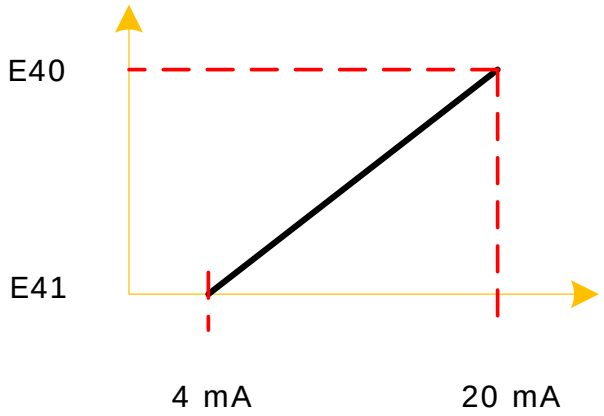


Figure 6.3: PID Display coefficients

Start-up and switching motors sequence (related function codes -> J30, J32)

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).*

J30 = 0 FIXED MOTOR SWITCHING ORDER
The inverter will activate the pumps in ascending order (PUMP 1 –> PUMP 2 –> PUMP 3 –> PUMP 4) and it will deactivate it in descending order (PUMP 4 –> PUMP 3 –> PUMP 2 –> PUMP 1).

J30 = 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.

2. The second method is to rotate the pumps.
   After the time specified by function code J32 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.

J32 = 0
The inverter does not switch the pumps

J32 = 0.1 a 720.0 h
The inverter switches the pumps after the time in J32's data (in hours)

J32 = 999
The inverter switches the pumps every 3 minutes. (Not recommended. Only for tests).

Note: Function codes from J48 to J52 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 -> J38)

The function code J38 can be used to make a delay between the stop of a pump and the start-up of another one.
During the time in J38, 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.

Motor stop mode when "RUN" signal is switched off (FWD or REV) (related function code -> J31)

The J31 function code establishes the stop mode when "RUN" (FWD or REV) signal is switched off.

J31 = 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**.

J31 = 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**.

J31 = 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 "*2: SS4* " and "*3: SS8* " must be assigned to two digitals inputs among X1, X2, X3, X4 or X5 (E01-E05).
The selected Set Value depends of the combination of these two inputs, as shown in the table below:

SS8	SS4	PID set point selection
0	0	Depends on J02 setting
0	1	C08 (Hz)
1	0	C12 (Hz)
1	1	C16 (Hz)

Table 6.1: Multiple PID set-point selection

To calculate the pressure set point from C08, C12 or C16, please use the following equation:

$$C08, C12, C16 = \frac{Desired\_pressure}{Sensor\_range\,(E40)} \times Maximum\_frequency(F03)$$

Dead Band (related function code -> J42)

Function code J42 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 (J41: Motor Unmount switching level, J44: Motor Mount switching level) . If the difference between the PID Feedback and PID Set point is less than the percentage stored in J42, 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.

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

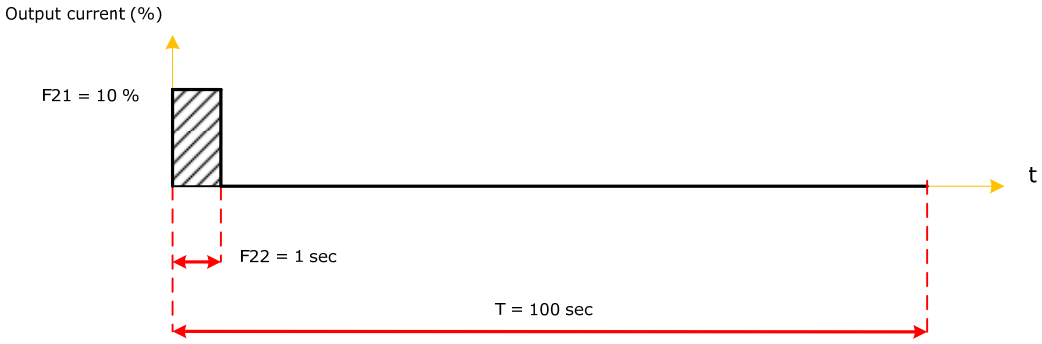


Figure 6.4: Output current when Dew Condensation prevention function is enabled

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 functions codes J23 and J24 can be useful (two additional conditions to wake up the regulated pump are added).
Normally, by means of using these function codes, 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 J24 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.

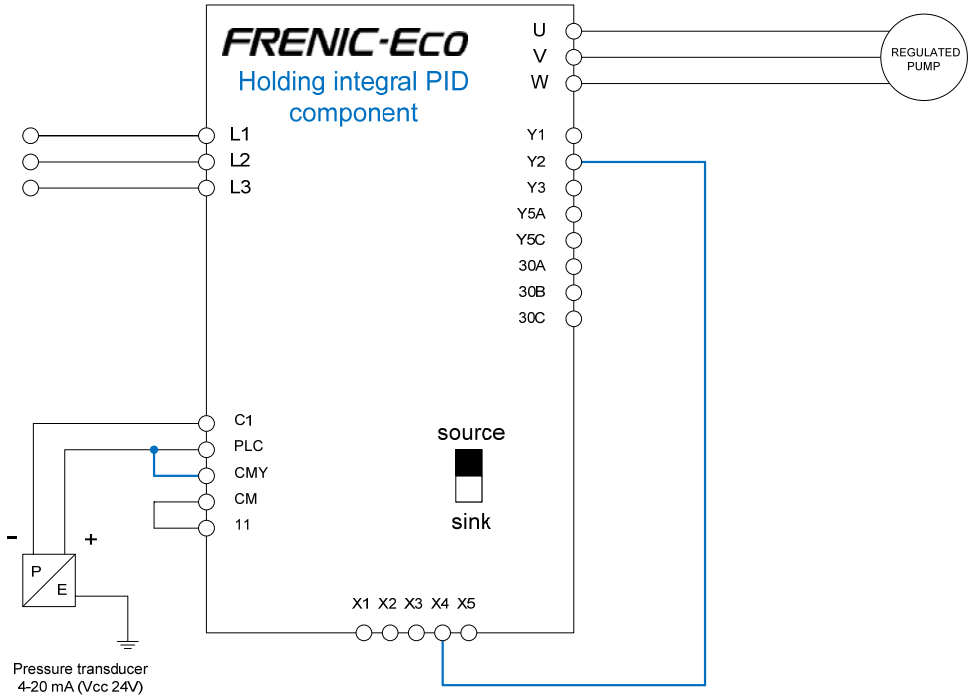


Figure 6.5: Pump control schematic for holding PID Integral component when pump is in sleep mode

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 E40 function code.

For instance, if the transducer installed is 10 bar (E40 = 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).

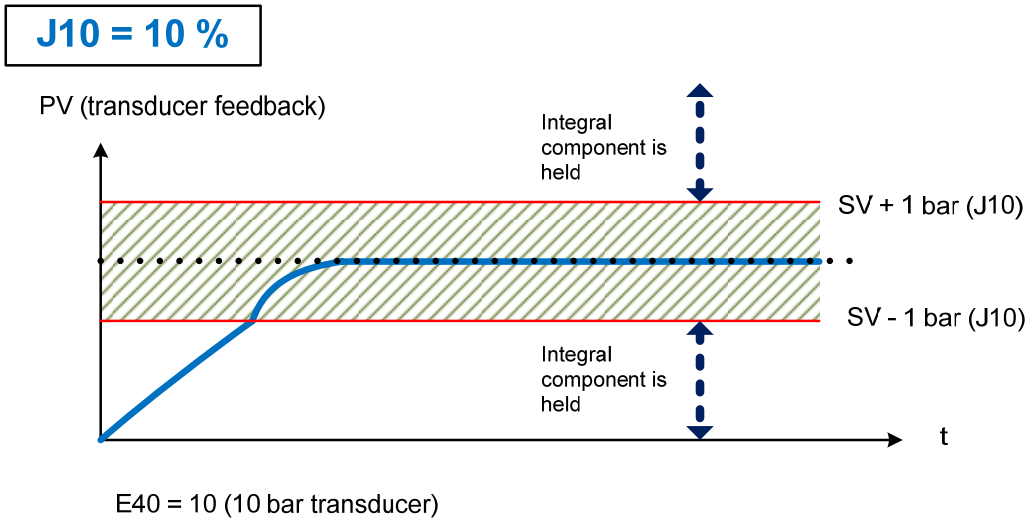


Figure 6.6: PID behaviour when function J10 is used.

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.

51 (1051): Enable pump drive (motor 1)	(MEN1)
52 (1052): Enable pump drive (motor 2)	(MEN2)
53 (1053): Enable pump drive (motor 3)	(MEN3)
54 (1054): Enable pump drive (motor 4)	(MEN4)

- Digital Inputs: for example X4 (set to Enable pump drive function).
- Wiring:

  - Bridge X4 and PLC (*)

- Set-up:

  E04 (X4) = *51: 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 7
Complete Function Codes' List v. F1S12100

	Name		Data setting range	Default setting	Current Value
F00	Data protection		0: Disable data protection (Fuction code data can be edited) 1: Enable data protection	0	
F01	Frequency command 1		0: Enable arrow keys on the keypad 1: Enable voltage input to terminal [12] (0 to 10 V DC) 2: Enable current input to terminal [C1] (4 to 20 mA) 3: Enable sum of voltage and current inputs to terminals [12] and [C1] 5: Enable voltage input to terminal [V2] (0 to 10 V DC) 7: Enable terminal command (UP) and (DOWN) control	0	
F02	Run Command		0: Enable RUN and STOP keys on keypad (Motor rotational direction from digital terminals [FWD] and [REV]) 1: Enable terminal command (FWD) or (REV) 2: Enable RUN/STOP keys on keypad (forward) 3: Enable RUN/STOP keys on keypad (reverse)	2	
F03	Maximum Frequency		25.0 to 120.0 Hz	50.0 Hz	
F04	Base Frequency		25.0 to 120.0 Hz	50.0 Hz	
F05	Rated voltage at base frequency		0: Output a voltage in proportion to input voltage 80 to 240: Output a voltage AVR-controlled (for 200 V AC series) 160 to 500: Output a voltage AVR-controlled (for 400 V AC series)	400 V	
F07	Acceleration Time 1		0.00 to 3600.00 s (Entering 0.00 cancels the acceleration time, requiring external soft-start.)	20.00 s	
F08	Deceleration Time 1		0.00 to 3600.00 s (Entering 0.00 cancels the deceleration time, requiring external soft-start.)	20.00 s	
F09	Torque Boost		0.0 to 20.0 (Percentage of the rated voltage at base frequency (F05)) Note: This setting is effective when F37 = 0, 1, 3, or 4.	Depends on the inverter capacity. Refer to table below.	
F10	Electronic Thermal Overload Protection for Motor	Select motor characteristics	1: For general-purpose motors with built-in self-cooling fan 2: For inverter-driven motors or high-speed motors with forced-ventilation fan	1	
F11		Overload detection level	0.00: Disable 1 to 135% of the rated current (allowable continuous drive current) of the motor	100% of the motor rated current	
F12		Thermal time constant	0.5 to 75.0 min	5.0 min (22 kW or below) / 10.0 min (30 kW or above)	
F14	Restart Mode after Momentary Power Failure (Mode selection)		0: Disable restart (Trip immediately) 1: Disable restart (Trip after a recovery from power failure) 3: Enable restart (Continue to run, for heavy inertia or general loads) 4: Enable restart (Restart at the frequency at which the power failure occurred, for general loads) 5: Enable restart (Restart at the starting frequency, for low-inertia load)	0	
F15	Frequency Limiter	High	0.0 to 120.0 Hz	70.0 Hz	
F16		Low	0.0 to 120.0 Hz	0.0 Hz	
F18	Bias (Frequency command 1)		-100.00 to +100.00 %	0.00 %	
F20	DC Braking	Braking start frequency	0.0 to 60.0 Hz	0.0 Hz	
F21		Braking level	0 to 60 % (Rated output current of the inverter interpreted as 100%)	0%	
F22		Braking time	0.00: Disable 0.01 to 30.00 s	0.00 s	
F23	Starting Frequency		0.1 to 60.0 Hz	0.5 Hz	
F25	Stop Frequency		0.1 to 60.0 Hz	0.2 Hz	
F26	Motor Sound	Carrier frequency	0.75 to 15 kHz (22kW or below) 0.75 to 10 kHz (30kW to 75kW) 0.75 to 6 kHz (90kW or above)	15 kHz	
F27		Sound Tone	0: Level 0 (Inactive) 1: Level 1 2: Level 2 3: Level 3	0	
F29	Analog Output [FMA]	Mode selection	0: Output in voltage (0 to 10 VDC) 1: Output in current (4 to 20 mA DC)	0	
F30		Output adjust	0 to 200 %	100%	
F31		Function	Select a function to be monitored from the followings. 0: Output frequency 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback value (PV) 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Calibration analog output (+10V DC / 20 mA DC) 15: PID process command (SV) 16: PID process output (MV)	0	
F33	Manufacturer				
F34	Analog Output (FMI)	Duty	0 to 200%: Voltage output adjustment	100%	
F35		Function	Select a function to be monitored from the following. 0: Output frequency 2: Output current 3: Output voltage 4: Output torque 5: Load factor 6: Input power 7: PID feedback value (PV) 9: DC link bus voltage 10: Universal AO 13: Motor output 14: Calibration analog input (20 mA DC) 15: PID process command (SV) 16: PID process output (MV)	0	
F37	Load Selection / Auto Torque Boost / Auto Energy Saving Operation		0: Variable torque load increasing in proportion to square of speed 1: Variable torque load increasing in proportion to square of speed (Higher startup torque required) 2: Auto-torque boost 3: Auto-energy saving operation (Variable torque load increasing in proportion to square of speed) 4: Auto-energy saving operation (Variable torque load increasing in proportion to square of speed (Higher startup torque required)) Note: Apply this setting to a load with short acceleration time. 5: Auto-energy saving operation (Auto torque boost) Note: Apply this setting to a load with long acceleration time.	1	
F43	Current limiter	Mode selection	0: Disable (No current limiter works.) 1: Enable at constant speed (Disabled during acceleration and deceleration) 2: Enable during acceleration and at constant speed	0	
F44		Level	20 to 120 % (The data is interpreted as the rated output current of the inverter for 100%.)	110%	

	Name		Data Range		Default Setting	Current value
E01	Command Assignment to: X1		Selecting function code data assigns the corresponding function to terminals [X1] to [X5] as listed below. Setting the value of 1000s in parentheses ( ) shown below assigns a negative logic input to a terminal. **Note:** In the case of (THR) and (STOP), data (1009) and (1030) are for normal logic, and "9" and "30" are for negative logic, respectively.		6	
E02	Command Assignment to: X2				7	
E03	Command Assignment to: X3				8	
E04	Command Assignment to: X4				11	
E05	Command Assignment to: X5				35	
			0 (1000): Select multistep frequency	(SS1)		
			1 (1001): Select multistep frequency	(SS2)		
			2 (1002): Select multistep frequency	(SS4)		
			3 (1003): Select multistep frequency	(SS8)		
			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)		
			11 (1011): Switch frequency command 2/1	(Hz2/Hz1)		
			13: Enable DC brake	(DCBRK)		
			15: Switch to commercial power (50 Hz)	(SW50)		
			16: Switch to commercial power (60 Hz)	(SW60)		
			17 (1017): UP (Increase output frequency)	(UP)		
			18 (1018): DOWN (Decrease output frequency)	(DOWN)		
			19 (1019): Enable write from keypad (Data changeable)	(WE-KP)		
			20 (1020): Cancel PID control	(Hz/PID)		
			21 (1021): Switch normal/inverse operation	(IVS)		
			22 (1022): Interlock	(IL)		
			24 (1024): Enable communications link via RS485 or field bus (option)	(LE)		
			25 (1025): Universal DI	(U-DI)		
			26 (1026): Select starting characteristics	(STM)		
			30 (1030): Force to stop	(STOP)		
			33 (1033): Reset PID integral and differential components	(PID-RST)		
			34 (1034): Hold PID integral component	(PID-HLD)		
			35 (1035): Select local (keypad) operation	(LOC)		
			38 (1038): Enable to run	(RE)		
			39: Protect motor from dew condensation	(DWP)		
			40: Enable integrated sequence to switch to commercial power (50 Hz)	(ISW50)		
			41: Enable integrated sequence to switch to commercial power (60 Hz)	(ISW60)		
			50 (1050): Clear periodic switching time	(MCLR)		
			51 (1051): Enable pump drive (motor 1)	(MEN1)		
			52 (1052): Enable pump drive (motor 2)	(MEN2)		
			53 (1053): Enable pump drive (motor 3)	(MEN3)		
			54 (1054): Enable pump drive (motor 4)	(MEN4)		
			58 (1058): Set to Zero	(- - -)		
			87 (1087): Switch run command 2/1	(FR2/FR1)		
			88: Run forward 2	(FWD2)		
			89: Run reverse 2	(REV2)		
E14	Acceleration Time (Multistep Frequency + UP/DOWN)		0.00 to 3600 s		20.00 s	
E15	Deceleration Time (Multistep Frequency + UP/DOWN)		0.00 to 3600 s		20.00 s	
E20	Status Signal Assignment to Y1		Selecting function code data assigns the corresponding function to terminals [Y1] to [Y3], [Y5A/C], and [30A/B/C] as listed below. Setting the value of 1000s in parentheses ( ) shown below assigns a negative logic input to a terminal.		0	
E21	Status Signal Assignment to Y2				1	
E22	Status Signal Assignment to Y3				2	
E24	Status Signal Assignment to Y5A/C				10	
E27	Status Signal Assignment to 30A/B/C				99	
			0 (1000): Inverter running	(RUN)		
			1 (1001): Frequency arrival signal	(FAR)		
			2 (1002): Frequency detected	(FDT)		
			3 (1003): Undervoltage detected (inverter stopped)	(LU)		
			5 (1005): Inverter output limiting	(IOL)		
			6 (1006): Auto-restarting after momentary power failure	(IPF)		
			7 (1007): Motor overload early warning	(OL)		
			10 (1010): Inverter ready to run	(RDY)		
			11: Switch motor drive source between commercial power and inverter output (For MC on commercial line)	(SW88)		
			12: Switch motor drive source between commercial power and inverter output (For primary side)	(SW52-2)		
			13: Switch motor drive source between commercial power and inverter output (For secondary side)	(SW52-1)		
			15 (1015): Select AX terminal function (For MC on primary side)	(AX)		
			25 (1025): Cooling fan in operation	(FAN)		
			26 (1026): Auto-resetting	(TRY)		
			27 (1027): Universal DO	(U-DO)		
			28 (1028): Heat sink overheat early warning	(OH)		
			30 (1030): Service life alarm	(LIFE)		
			33 (1033): Command loss detected	(REF OFF)		
			35 (1035): Inverter output on	(RUN2)		
			36 (1036): Overload prevention control	(OLP)		
			37 (1037): Current detected	(ID)		
			42 (1042): PID alarm	(PID-ALM)		
			43 (1043): Under PID control	(PID-CTL)		
			44 (1044): Motor stopping due to slow flowrate under PID control	(PID-STP)		
			45 (1045): Low output torque detected	(U-TL)		
			54 (1054): Inverter in remote operation	(RMT)		
			55 (1055): Run command activated	(AX2)		
			56 (1056): Motor overheat detected (PTC)	(THM)		
			59 (1059): C1 disconnection detected	(C1OFF)		
			60 (1060): Sequenced start motor 1, inverter-driven	(M1_I)		
			61 (1061): Sequenced start motor 1, commercial-power driven	(M1_L)		
			62 (1062): Sequenced start motor 2, inverter-driven	(M2_I)		
			63 (1063): Sequenced start motor 2, commercial-power driven	(M2_L)		
			64 (1064): Sequenced start motor 3, inverter-driven	(M3_I)		
			65 (1065): Sequenced start motor 3, commercial-power driven	(M3_L)		
			67 (1067): Sequenced start motor 4, commercial-power driven	(M4_L)		
			68 (1068): Periodic switching early warning	(MCHG)		
			69 (1069): Pump control limit signal	(MLIM)		
			87 (1087): Logical AND between FAR and FDT	(FARFDT)		
			88 (1088): Mount additional pump	(AUX_L)		
			99 (1099): Alarm output (for any alarm)	(ALM)		
E31	Frequency Detection	Detection Level	0.0 to 120.0 Hz		50.0 Hz	
E32	(FDT)	Hysteresis	0.0 to 120.0 Hz		1.0 Hz	
E34	Overload early warning/ Current detection	Level	0: Disable Current value of 1% to 150% of the inverter rated current		100%	
E35		Timer	0.01 to 600.00 s		10.00 s	
E40	PID display coefficient A		- 999 to 0.00 to + 9990.00		+ 100.00	
E41	PID display coefficient B		- 999 to 0.00 to + 9990.00		+ 0.00	
E43	LED monitor	Item selection	0: Speed monitor (Select by E48)		0	
			3: Output current			
			4: Output voltage			
			8: Calculated torque			
			9: Input power			
			10: PID process command (Final)			
			12: PID feedback value			
			14: PID output			
			15: Load factor			
			16: Motor output			
			17: Analog input			
E45	LCD monitor (only with multi-functional keypad TP-G1)	Item Selection	0: Running status, rotational direction and operation guide		0	
			1: Bar charts for output frequency, current and calculated torque			
E46		Language Selection	0: Japanese; 1: English; 2: German; 3: French; 4: Spanish; 5: Italian		1	
E47		Contrast control	0 (Low) to 10 (High)		5	

	Name		Data Range	Default Setting	Current value
E48	LED monitor	Speed item	0: Output frequency 3: Motor speed in r/min 4: Load shaft in r/min 7: Display speed in %	0	
E50	Coefficient for speed indication		0.01 to 200.00	30.00	
E51	Display coefficient for input watt-hour data		0.000: Cancel / reset 0.001 to 9999.000	0.010	
E52	Keypad (menu display mode)		0: Function code data editing mode (Menus #0, #1 and #7) 1: Function code data check mode (Menus #2 and #7) 2: Full-menu mode (Menus #0 through #7)	0	
E61	Analog input for	[12]	Selecting function code data assigns the corresponding function to terminals [12], [C1] and [V2] as listed below	0	
E62	(Extension function	[C1]		0	
E63	selection)	[V2]		0	
			0: None 1: Auxiliary frequency command 1 2: Auxiliary frequency command 2 3: PID process command 1 5: PID feedback value 20: Analog input monitor		
E64	Saving digital reference frequency		0: Auto saving (at the time of main power turned off) 1: Saving by pressing FUNC/DATA key	0	
E65	Command loss detection	Level	0: Decelerate to stop 20 to 120 % 999: Disable	999	
E80	Detect low torque	Detection level	0 to 150 %	20 %	
E81		Timer	0.01 to 600.00 s	20.00 s	
E98	Command assignment to: FWD		Selecting function code data assigns the corresponding function to terminals [FWD] and [REV] as listed below. Setting the value of 1000s in parentheses () shown below assigns a negative logic input to a terminal.	98	
E99	Command assignment to: REV		In the case of (THR) and (STOP), data 1009 and 1030 are for normal logic and 9 and 30 are for negative logic, respectively.	99	
			0 (1000): Select multistep frequency (SS1) 1 (1001): Select multistep frequency (SS2) 2 (1002): Select multistep frequency (SS4) 3 (1003): Select multistep frequency (SS8) 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) 11 (1011): Switch frequency command 2/1 (Hz2/Hz1) 13: Enable DC brake (DCBRK) 15: Switch to commercial power (50 Hz) (50 Hz) 16: Switch to commercial power (60 Hz) (60 Hz) 17 (1017): UP (Increase output frequency) (UP) 18 (1018): DOWN (Decrease output frequency) (DOWN) 19 (1019): Enable write from keypad (Data changeable) (WE-KP) 20 (1020): Cancel PID control (Hz/PID) 21 (1021): Switch normal/inverse operation (IVS) 22 (1022): Interlock (IL) 24 (1024): Enable communications link via RS485 or field bus (option) (LE) 25 (1025): Universal DI (U-DI) 26 (1026): Select starting characteristics (STM) 30 (1030): Force to stop (STOP) 33 (1033): Reset PID integral and differential components (PID-RST) 34 (1034): Hold PID integral component (PID-HLD) 35 (1035): Select local (keypad) operation (LOC) 38 (1038): Enable to run (RE) 39: Protect motor from dew condensation (DWP) 40: Enable integrated sequence to switch to commercial power (50 Hz) (ISW50) 41: Enable integrated sequence to switch to commercial power (60 Hz) (ISW60) 50 (1050): Clear periodic switching time (MCLR) 51 (1051): Enable pump drive (motor 1) (MEN1) 52 (1051): Enable pump drive (motor 2) (MEN2) 53 (1051): Enable pump drive (motor 3) (MEN3) 54 (1051): Enable pump drive (motor 4) (MEN4) 58 (1058): Set to zero (- - -) 87 (1087): Switch run command 2/1 (FR2/FR1) 88: Run forward 2 (FWD2) 89: Run reverse 2 (REV2) 98: Run forward (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99) (FWD) 99: Run reverse (Exclusively assigned to [FWD] and [REV] terminals by E98 and E99) (REV)		

	Name		Data Range	Default Setting	Current value
C01	Jump frequency	1	0.0 to 120.0 Hz	0.0 Hz	
C02		2		0.0 Hz	
C03		3		0.0 Hz	
C04		Band	0.0 to 30.0 Hz	3.0 Hz	
C05	Multistep frequency	1	0.00 to 120.00 Hz	0.00 Hz	
C06		2		0.00 Hz	
C07		3		0.00 Hz	
C08		4		0.00 Hz	
C09		5		0.00 Hz	
C10		6		0.00 Hz	
C11		7		0.00 Hz	
C12		8		0.00 Hz	
C13		9		0.00 Hz	
C14		10		0.00 Hz	
C15		11		0.00 Hz	
C16		12		0.00 Hz	
C17		13		0.00 Hz	
C18		14		0.00 Hz	
C19		15		0.00 Hz	
C30	Frequency command 2		0: Enable arrow keys on the keypad 1: Enable voltage input to terminal [12] (0 to 10V DC) 2: Enable current input to terminal [C1] (4 to 20 mA) 3: Enable sum of voltage and current inputs to terminals [12] and [C1] 5: Enable voltage input to terminal [V2] (0 to 10V DC) 7: Enable terminal command (UP) / (DOWN) control	2	
C32	Analog input adjustment	Gain for terminal input [12]	0.00 to 200.00 %	100.00 %	
C33	for [12]	Filter time constant	0.00 to 5.00 s	0.05 s	
C34		Gain reference point	0.00 to 100.00 %	100.00 %	
C37	Analog input adjustment	Gain for terminal input [C1]	0.00 to 200.00 %	100.0 %	
C38	for [C1]	Filter time constant	0.00 to 5.00 s	0.05 s	
C39		Gain reference point	0.00 to 100.00 %	100.00 %	
C42	Analog input adjustment	Gain for terminal input [V2]	0.00 to 200.00 %	100.00 %	
C43	for [V2]	Filter time constant	0.00 to 5.00 s	0.05 s	
C44		Gain reference point	0.00 to 100.00 %	100.00 %	
C50	Bias reference point (Frequency command 1)		0.00 to 100.0 %	0.00 %	
C51	Bias for PID command 1	Bias value	- 100.0 to + 100.00 %	+ 0.00 %	
C52		Bias reference point	0.00 to 100.00 %	0.00 %	
C53	Selection of normal/inverse operation (Frequency command 1)		0: Normal operation 1: Inverse operation	0	

	Name		Data Range	Default Setting	Current value
P01	Motor	No. Of Poles	2 to 22	4	
P02		Rated Capacity	0.01 to 1000 kW (If P99 is 0, 3 or 4)	Rated capacity of the motor	
			0.01 to 1000 HP (If P99 is 1)		
P03		Rated Current	0.00 to 2000 A	Rated current of Fuji standard motor	
P04		Autotuning	0: Disable	0	
			1: Enable (Tune %R1 and %X while the motor is stopped)		
			2: Enable (Tune %R1 and %X while the motor is stopped and no-load current while running)		
P06		No-Load Current	0.00 to 2000 A	Rated value of Fuji standard motor	
P07		%R1	0.00 to 50.00 %	Rated value of Fuji standard motor	
P08		%X	0.00 to 50.00 %	Rated value of Fuji standard motor	
P99		Motor Selection	0: Characteristics of motor 0	0	
			(Fuji standard motors, 8-series)		
			1: Characteristics of motor 1 (HP-rated motors)		
			3: Characteristics of motor 3 (Fuji standard motors, 6-series)		
			4: Other motors		

	Name		Data Range	Default Setting	Current value
H03	Data initialization		0: Disable initialization	0	
			1: Initialize all function code data to the factory defaults		
			2: Initialize motor parameters		
H04	Auto reset	Times	0: Disable	0 times	
			1 to 10 times		
H05		Reset Interval	0.5 to 20.0 s	5.0 s	
H06	Cooling fan ON/OFF control		0: Disable (Always in operation)	0	
			1: Enable (ON/OFF controllable)		
H07	Acceleration/Deceleration pattern		0: Linear	0	
			1: S-curve (Weak)		
			2: S-curve (Strong)		
			3: Curvilinear		
H09	Select starting characteristics (Auto search for idling motor's speed)		0: Disable	0	
			3: Enable (Follow RUN command, either forward or reverse)		
			4: Enable (Follow RUN command, both forward and reverse)		
			5: Enable (Follow RUN command, inversely both forward and reverse)		
H11	Deceleration mode		0: Normal deceleration	0	
			1: Coast-to-stop		
H12	Instantaneous overcurrent limiting		0: Disable	1	
			1: Enable		
H13	Restart mode after momentary power failure	Restart time	0.1 to 10.0 s	Depending on the inverter capacity	
H14		Frequency fall rate	0.00: Set deceleration time	999	
			0.01 to 100.0 Hz/s		
			999: Follow the current limit command		
H15		Continuous running level	200V series: 200 to 300VDC	235 V	
			400V series: 400 to 600VDC	470 V	
H16		Allowable momentary power failure time	0.0 to 30.0 s	999	
			999: The longest time automatically determined by the inverter		
H17	Select starting characteristics (Frequency for idling motor's speed)		0.0 to 120.0 Hz	999	
			999: Harmonize at the maximum frequency		
H26	PTC thermistor input	Mode selection	0: Disable	0	
			1: Enable (Upon detection of PTC, the inverter immediately trips and stops with OH4 displayed)		
			2: Enable (Upon detection of PTC, the inverter continues running while outputting alarm signal (THM))		
H27		Level	0.00 to 5.00 V DC	1.60 V	
H30	Communication link function (Mode selection)		Frequency command / RUN command	0	
			0: F01/C30 / F02		
			1: RS485 link / F02		
			2: F01/C30 / RS485 link		
			3: RS485 link / RS485 link		
			4: RS485 link (option) / F02		
			5: RS485 link (option) / RS485 link		
			6: F01/C30 / RS485 link (option)		
			7: RS485 link / RS485 link (option)		
			8: RS485 link (option) / RS485 link (option)		
H42	Capacitance of DC link bus capacitor		Indication for replacing DC link bus capacitor (0000 to FFFF: Hexadecimal)	Set at factory shipping	
H43	Cumulative run time of cooling fan		Indication of cumulative run time of cooling fan for replacement		
H47	Initial capacitance of DC link bus capacitor		Indication for replacing DC link bus capacitor (0000 to FFFF: Hexadecimal)		
H48	Cumulative run time of capacitors on the printed circuit board		Indication for replacing capacitors on the printed circuit board (0000 to FFFF: Hexadecimal). Resetable		
H49	Select starting characteristics (Auto search time for idling motor's speed)		0.0 to 10.0 s	0.0 s	
H50	Non-linear V/f patternl	Frequency	0.0: Cancel	0.0 Hz (22kW or below) / 5.0 Hz (30kW or above)	
			0.1 to 120.0 Hz		
H51		Voltage	0 to 240V: Output a voltage AVR-controlled (for 200V AC series)	0 (22kW or below)	
			0 to 500V: Output a voltage AVR-controlled (for 400V AC series)	20 (30kW or above, 200V ser.)	
				40 (30kW or above, 400V ser.)	
H56	Deceleration time for forced stop		0.00 to 3600.00 s	20.00 s	
H61	UP/DOWN Control		1 to 106	1	
			1: Last UP/DOWN command value on releasing run command.		
			3: Enable Multistep Frequency + UP/DOWN Control.		
			13 - 106: Enable memory function on Multistep Frequency + UP/DOWN Control		
H63	Low limiter	Mode selection	0: Limit by F16 (Frequency Limiter: Low) and continue to run	0	
			1: If the output frequency lowers less than the one limited by F16 (Frequency limiter: Low), decelerates to stop the motor		
H64		Lower limiting frequency	0.0: Depends on F16 (Frequency limiter: Low)	2.0 Hz	
			0.1 to 60.0 Hz		
H69	Automatic deceleration		0: Disable	0	
			3: Enable (Control DC link bus voltage at a constant)		
H70	Overload Prevention Control		0.00: Follow deceleration time specified by F08	999	
			0.01 to 100.00 Hz/s		
			999: Disable		
H71	Deceleration characteristics		0: Disable	0	
			1: Enable		
H80	Gain for suppression of output current fluctuation for motor		0.00 to 0.40	0.10 for 45 kW or above (200V series) and for 55 kW or above (400V series)	
				0.20 for 37 kW or below (200V series) and for 45 kW or below (400V series)	
H86	Reserved *1		0 to 2	2 for 45 kW or above (200V series) and for 55 kW or above (400V series)	
				0 for 37 kW or below (200V series) and for 45 kW or below (400V series)	
H87	Reserved *1		25.0 to 120.0 Hz	25.0 Hz	
H88	Reserved *1		0 to 3	0	
			999		
H89	Reserved *1		0 to 1	0	
H90	Reserved *1		0 to 1	0	
H91	C1 signal disconnection detection		0.0 s: Wire disconnection protection disabled	0.0 s	
			0.1-60.0 s: Wire disconnection detection time		
H92	Continue to run	P component: gain	0.000 to 10.000 times	999	
			999		
H93		I component: time	0.010 to 10.000 s	999	
			999		
H94	Cumulative run time of motor		Change or reset the cumulative data	-	

	Name	Data Range	Default Setting	Current value
H95	DC braking (braking response mode)	0: Slow 1: Quick	1	
H96	STOP key priority/start check function	STOP key priority / Start check function 0: Disable / Disable 1: Enable / Disable 2: Disable / Enable 3: Enable / Enable	0	
H97	Clear alarm data	Setting H97 data to "1" clears alarm data and then returns to zero	0	
H98	Protection/maintenance function	0 to 63: Display data on the keypad's LED monitor in decimal format (In each bit, "0" for disabled, "1" for enabled) Bit 0: Lower the carrier frequency automatically Bit 1: Detect input phase loss Bit 2: Detect output phase loss Bit 3: Select life judgement criteria of DC link bus capacitor Bit 4: Judge the life of DC link bus capacitor Bit 5: Detect DC fan lock	19 (decimal) (Bits 4,1,0 = 1 bits 5,3,2, = 0)	

	Name		Data Range	Default Setting	Current value
J01	PID control	Mode selection	0: Disable 1: Enable (normal operation) 2: Enable (inverse operation)	0	
J02		Remote process command	0: Enable arrow keys on keypad 1: PID process command 1 3: Enable terminal command UP/DOWN control 4: Command via communications link	0	
J03		P (gain)	0.000 to 30.000 times	0.100	
J04		I (integral time)	0.0 to 3600.0 s	0.0 s	
J05		D (differential time)	0.00 to 600.00 s	0.00 s	
J06		Feedback filter	0.0 to 900.0 s	0.5 s	
J10		Anti reset windup	0 to 200 %	200%	
J11		Select alarm output	0 to 7 (Refer to FRENIC-Eco user's manual)	0	
J12		Upper limit alarm (AH)	0 to 100 %	100%	
J13		Lower limit alarm (AL)	0 to 100 %	0%	
J15		Stop frequency for slow flowrate	0: Disable 1 to 120 Hz	0 Hz	
J16		Slow flowrate level stop latency	0 to 60 s	30 s	
J17		Starting frequency	0: Disable 1 to 120 Hz	0 Hz	
J18		Upper limit of PID process output	0 to 120Hz 999: Depends on setting of F15	999	
J19		Lower limit of PID process output	0 to 120Hz 999: Depends on setting of F16	999	
J21	Dew condensation prevention (Duty)		1 to 50 %	1%	
J22	Commercial power switching sequence		0: Keep inverter operation (Stop due to alarm) 1: Automatically switch to commercial-power operation	0	
J23	Starting From the Slow Flowrate Stop (Feedback deviation level)		0 to 100 %	0%	
J24	Starting From the Slow Flowrate Stop (Start latency)		0.0 to 60 s	0 s	
J25	Pump control	Mode selection	0: Disable 1: Enable (Fixed inverter-driven motor) 2: Enable (Floating inverter-driven motor)	0	
J26	Motor 1 mode		0: Disable (Always OFF)	0	
J27	Motor 2 mode		1: Enable	0	
J28	Motor 3 mode		2: Force to run by commercial power	0	
J29	Motor 4 mode			0	
J30	Motor switching order		0: (fixed) 1: Automatically (Constant run time)	0	
J31	Motor stop mode		0: Stop all motors (inverter-driven and commercial power-driven) 1: Stop inverter-driven motor only (excl. alarm state) 2: Stop inverter-driven motor only (incl. alarm state)	0	
J32	Periodic switching time for motor drive		0.0: Disable switching 0.1 to 720.0 h: Switching time range 999: Fix to 3 min	0.0 h	
J33	Periodic switching signaling period		0.00 to 600.00 s	0.10 s	
J34	Sequenced start of commercial power-driven motor	Frequency	0 to 120 Hz 999: Depends on setting of J18 (This code is used to judge whether or not to start a commercial power-driven motor by checking the output frequency of the inverter-driven motor)	999	
J35		Duration	0.00 to 3600.00 s	0.00 s	
J36	Sequenced stop of commercial power-driven motor	Frequency	0 to 120 Hz 999: Depends on setting of J19 (This code is used to judge whether or not to stop a commercial power-driven motor by checking the output frequency of the inverter-driven motor)	999	
J37		Duration	0.00 to 3600.00 s	0.00 s	
J38	Contactor delay time		0.01 to 2.00 s	0.10 s	
J39	Switching time for motor sequenced start (Deceleration time)		0.00: Depends on the setting of F08 0.01 to 3600.00 s	0.00 s	
J40	Switching time for motor sequenced stop (Acceleration time)		0.00: Depends on the setting of F07 0.01 to 3600.00 s	0.00 s	
J41	Motor Unmount Switching Level		0 to 100 %	0%	
J42	Switching motor sequenced start/sequenced stop (Dead band)		0.0: Disable 0.1 to 50.0 %	0.0 %	
J43	PID control startup frequency		0: Disable 1 to 120Hz 999: Depends on the setting of J36	999	
J44	Motor Mount Switching Level		0: Depends on the setting of J41 1 to 100 %	0%	
J45	Signal assignment to: (for relay output card)	[Y1 A/B/C]	Selecting function code data assigns the corresponding function to terminals [Y1A/B/C], [Y2A/B/C] and [Y3A/B/C]	100	
J46		[Y2 A/B/C]		100	
J47		[Y3 A/B/C]		100	
			100: Depends on the setting of E20 to E22 60 (1060): Sequenced start motor 1, inverter-driven (M1_I) 61 (1061): Sequenced start motor 1, commercial power-driven (M1_L) 62 (1062): Sequenced start motor 2, inverter-driven (M2_I) 63 (1063): Sequenced start motor 2, commercial power-driven (M2_L) 64 (1064): Sequenced start motor 3, inverter-driven (M3_I) 65 (1065): Sequenced start motor 3, commercial power-driven (M3_L) 67 (1067): Sequenced start motor 4, commercial power-driven (M4_L) 68 (1068): Periodic switching early warning (MCHG) 69 (1069): Pump control limit signal (MLIM) 88 (1088): Mount additional pump (AUX_L)		
J48	Cumulative run time of motor	Motor 0	0 to 65535 h: Indication of cumulative run time of motor for replacement	---	
J49		Motor 1		---	
J50		Motor 2		---	
J51		Motor 3		---	
J52		Motor 4		---	
J53	Maximum cumulative number of relay ON times	[Y1 A/B/C] to [Y3 A/B/C]	0.000 a 9999.000: Indication of maximum number of ON times of relay contacts on the relay output card or those built in inverter..Display of 1.000 means 1.000 times	---	
J54		[Y1], [Y2], [Y3]		---	
J55		[Y5A/C], [30A/B/C]	For relay output card For built-in mechanical contacts	---	
J93	PID Start Frequency (Mount)		0: Depends on the setting of J36 1 to 120 Hz	0 Hz	
J94	PID Start Frequency (Unmount)		0: Depends on the setting of J34 1 to 120 Hz	0 Hz	

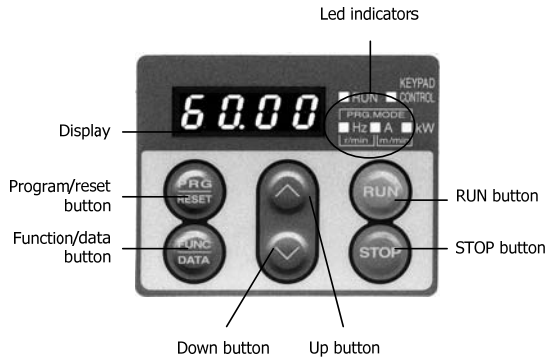
	Name		Data Range		Default Setting	Current value
Y01	RS485 communication (standard)	Station address	1 to 255		1	
Y02		Communications error processing	0: Immediately trip with alarm ErP 1: Trip with alarm ErP after running for the period specified by timer y13 2: Retry during the period specified by timer y13. If retry fails, trip and alarm ErP. If it succeeds, continue to run 3: Continue to run		0	
Y03		Error processing timer	0.0 to 60.0 s		2.0 s	
Y04		Transmission speed	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps		3	
Y05		Data length	0: 8 bits 1: 7 bits		0	
Y06		Parity check	0: None 1: Even parity 2: Odd parity		0	
Y07		Stop bits	0: 2 bits 1: 1 bit		0	
Y08		No-response error detection time	0 (No detection) 1 to 60 s		0 s	
Y09		Response latency time	0.00 to 1.00 s		0.01 s	
Y10		Protocol selection	0: Modbus RTU protocol 1: FRENIC Loader protocol (SX protocol) 2: Fuji general purpose inverter protocol 3: Metasys-N2		1	
Y11	RS485 communication (option)	Station address	1 to 255		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 retry fails, trip and alarm ErP. If it succeeds, continue to run 3: Continue to run		0	
Y13		Error processing timer	0.0 to 60.0 s		2.0 s	
Y14		Transmission speed	0: 2400 bps 1: 4800 bps 2: 9600 bps 3: 19200 bps 4: 38400 bps		3	
Y15		Data length	0: 8 bits 1: 7 bits		0	
Y16		Parity check	0: None 1: Even parity 2: Odd parity		0	
Y17		Stop bits	0: 2 bits 1: 1 bit		0	
Y18		No-response error detection time	0 (No detection) 1 to 60 s		0	
Y19		Response latency time	0.00 to 1.00 s		0.01 s	
Y20		Protocol selection	0: Modbus RTU protocol 2: Fuji general purpose inverter protocol 3: Metasys-N2		0	
Y98	Bus link function (Mode selection)		Frequency command	RUN command	0	
			0: Follow H30 data	Follow H30 data		
			1: Via field bus option	Follow H30 data		
			2: Follow H30 data	Via field bus option		
			3: Via field bus option	Via field bus option		
Y99	Loader link function (Mode selection)		Frequency command	RUN command	0	
			0: Follow H30 and Y98 data	Follow H30 and Y98 data		
			1: Via RS485 link (Loader)	Follow H30 and Y98 data		
			2: Follow H30 and Y98 data	Via RS485 link (Loader)		
			3: Via RS485 link (Loader)	Via RS485 link (Loader)		

Shaded function codes are applicable to the quick setup menu

Chapter 8
Operation using the TP-E1 keypad

The keypad consists of 4 digit LED monitor, 5 LED indicators and 6 keys, as shown in the figure.

The keypad allows you to start and stop the motor, monitor running status and switch to the menu mode. In the menu mode you may set the function code data, monitor I/O signal states and check the maintenance information as well as the alarm information.



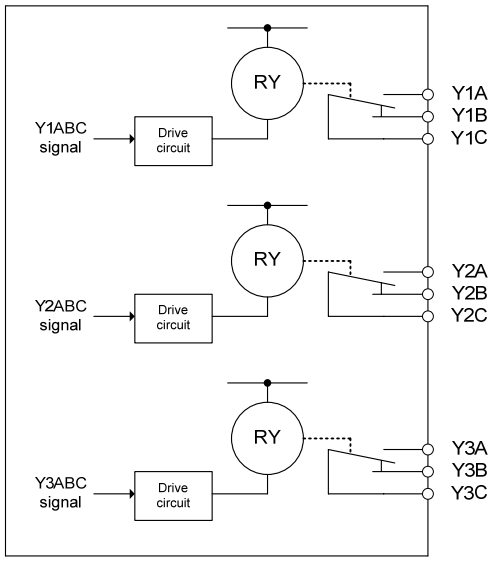
The keypad has 3 operation modes: programming, running and alarm modes.

Monitor, keys \ Operation mode		Programming Mode		Running Mode		Alarm Mode
		STOP	RUN	STOP	RUN	
Monitor: 8.8.8.8.	Function	Display the function code or data		Displays the output frequency, set frequency, loader motor speed, required power, output current and output voltage		Displays the alarm description and alarm history
	Display	ON		Blinking	ON	Blinking/ ON
PRG.MODE Hz A kW r/min m/min	Function	The program mode is indicated		Displays the unit of frequency, output current, required power, speed and line speed		----------
	Display	PRG.MODE Hz A kW r/min m/min		Frequency indication: PRG.MODE Hz A kW r/min m/min	Speed indication: PRG.MODE Hz A kW r/min m/min	OFF
				Current indication: PRG.MODE Hz A kW r/min m/min	Power indication: PRG.MODE Hz A kW r/min m/min	
KEYPAD CONTROL	Function	Operation Mode (keypad operation/terminal operation) is displayed				
	Display	Lit in keypad operation mode (F02 = 0, 2 or 3)				
RUN	Function	Absence of operation command is displayed	Presence of operation command is displayed	Absence of operation command is displayed	Presence of operation command is displayed	Under alarm: If the inverter is in local mode and running, this led will light. If the inverter is in remote mode and running, this led will off
	Display	RUN	RUN	RUN	RUN	

Keys: PRG RESET	Function	Switches to running mode		Switches to programming mode		Releases the trip and switches to stop mode or running mode
		Digit shift (cursor movement) in data setting				
FUNC DATA	Function	Determines the function code, stores and updates data		Switches the LED monitor display		Displays the operation information
▲ ▼	Function	Increases/decreases the function code and data		Increases/decreases the frequency, motor speed and other settings		Displays the alarm history
RUN	Function	----------		Starts running (switches to running mode (RUN))	----------	----------
STOP	Function	----------	Deceleration stop (switches to programming mode STOP)	----------	Deceleration stop (switches to running mode STOP)	----------

- If F02 = 1, the RUN key will not be enabled (RUN command by digital input terminals)
- If H96 = 1 or 3, the STOP key will not be enabled (RUN/STOP command by digital input terminals).

Chapter 9
Option relay Card OPC-F1-RY



Internal Diagram OPC – F1 – RY

The relay card is an option card with 3 additional relays of 3 contacts – 2 positions.

This card is essential in order to implement the following pump control systems:

- Multi-pump control with 3 regulated pumps
- Multi-regulated pump control with 3 regulated pumps + 1 additional pump

The functions that can be assigned to these relays are:

60 (1060): Sequenced start motor 1, inverter-driven	(M1_I)
61 (1061): Sequenced start motor 1, commercial-power driven	(M1_L)
62 (1062): Sequenced start motor 2, inverter-driven	(M2_I)
63 (1063): Sequenced start motor 2, commercial-power driven	(M2_L)
64 (1064): Sequenced start motor 3, inverter-driven	(M3_I)
65 (1065): Sequenced start motor 3, commercial-power driven	(M3_L)
67 (1067): Sequenced start motor 4, commercial-power driven	(M4_L)

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

Relay Y1A/B/C	**Function Code J45**
Relay Y2A/B/C	**Function Code J46**
Relay Y3A/B/C	**Function Code J47**

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