Multipump System CFW-08

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Installation, Configuration and Operation Guide
CFW-08 Frequency Inverter

INDEX

Multipump System

1. ABOUT THE GUIDE

This guide supplies the necessary description for the operation of the CFW-08 frequency inverter in multipump system applications. It describes the new parameters and functions related to the multipump system, and the functions that were changed compared to the standard CFW-08 user manual.

NOTE!
Use this guide together with the CFW-08 user manual.

2. CFW-08 MULTIPUMP COMPATIBILITY

The CFW-08 Multipump inverter is compatible with the functions described in the user manual, except for the items listed below:

- ☑ Three relay outputs with normally open contacts;
- ☑ It does not have analog output;
- ☑ It is not available in the following models: 1.6-2.6-4.0-7.0A / 200V/240V and 1.0-1.6-2.6-4.0A / 380V/480V.

3. CFW-08 MULTIPUMP SPECIFICATION

The CFW-08 Multipump is defined by the code **"A5"** in the product intelligent code, for instance, CFW080100B2024PO**A5**Z.

The main modifications in this product, compared to the standard, are:

- ☑ ECC4 control board with more functions than the standard ECC3;
- ☑ V5.0X software, dedicated to the multipump control, instead of the standard software.

NOTE!
For more information on the intelligent code, refer to the section 2.4 in the user manual

4. INTRODUCTION TO THE MULTIPUMP SYSTEM

The CFW-08 Multipump implements a PID regulator together with a logic for the activation of up to three relay outputs. Those outputs are for activating the pumps connected to the system. Therefore, the control is able to activate multiple pumps, and one pump can have the speed controlled throughout the entire operation range while the others are activated directly (On/Off). The control logic for the activation of the relay outputs monitors the process variables in order to identify the need of activation or deactivation of pumps in the system. Refer to the figure 4.2.

The figure 4.1 illustrates the CFW-08 application in a 4 pump system with fixed control, i.e., the inverter controls the speed of the main pump and commands three other pumps through the relay outputs. Observe the pressure transducer connection, as well as the activation of the auxiliary pumps through direct on line start, SSW-07, and star-delta starter.

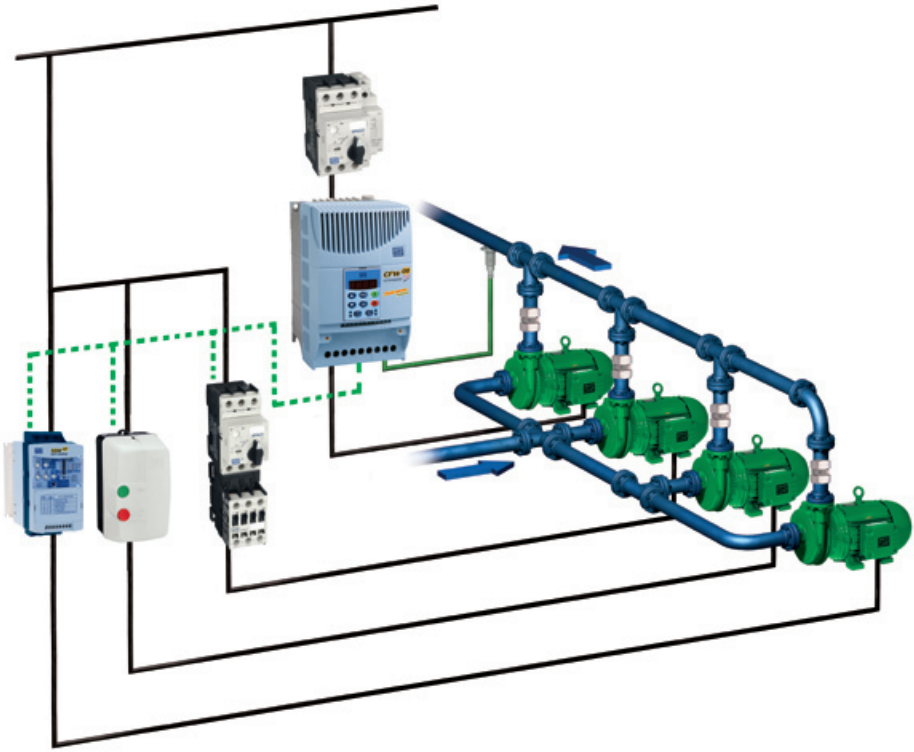


Figure 4.1: Multipump illustrative example

4.1. About the Multipump System

Multipump, or multiple pumps pumping system, refers to the control of more than one pump using only one frequency inverter to control the pump speed. The inverter selects which pumps will operate in order to keep/control the output pressure of a pumping system. An alternation between their activation is also performed, making it possible an equal use of the pumps.

In order to control the system output pressure a PID controller is used, together with the auxiliary pumps star/stop logic, according to the figure 4.2.

The system can be controlled in two manners:

- ☑ **Fixed Control,** where the pump with variable speed (connected to the inverter) is always the same one;
- ☑ **Floating Control,** where the pump with variable speed (connected to the inverter) is changed according to the alternating need.

4.2. General Characteristics of the Multipump System

The multipump system developed for the CFW-08 presents the following characteristics:

- ☑ Control of up to 4 pumps in Fixed Control mode;
- ☑ Control of up to 3 pumps in Floating Control mode;
- ☑ Auxiliary pumps activation mode control;
- ☑ Control of the inverter driven pump change (Floating Control);
- ☑ Acceleration and deceleration ramp for the inverter driven pump;
- ☑ Minimum and maximum speed limits for the inverter driven pump;
- ☑ System pressure setpoint setting via parameter or via analog input;
- ☑ Selection via digital inputs, of up to four pressure setpoint values;
- ☑ Whether or not the pump is enabled via digital input;
- ☑ Gain, offset and filter adjustment for analog inputs;
- ☑ Sleep mode possibility;
- ☑ Minimum output pressure fault (pipe breaking);
- ☑ Maximum output pressure fault (pipe obstruction);
- ☑ Alternation of pumps according to their operation time.

4.3. Advantages of a Multipump System

A multipump pumping system presents the following advantages compared to a single pump:

- ☑ Energy savings;
- ☑ Increased life span of the pumping system;
- ☑ It makes maintenance without operation interruption possible;
- ☑ It keeps a constant line pressure;
- ☑ It provides the necessary flow according to the system demand;
- ☑ System fault diagnosis;
- ☑ Pump operation time equalization, allowing thus the uniform wearing of them.

4.4. CFW-08 Multipump Control

The multipump control implemented in the CFW-08 frequency inverter is capable of activating up to 4 pumps with Fixed Control and 3 pumps with Floating Control. The used PID regulator is the same of the standard product; therefore, in order to adjust this regulator and the other software functions, it is strictly necessary that this guide be supplied together with the CFW-08 user manual.

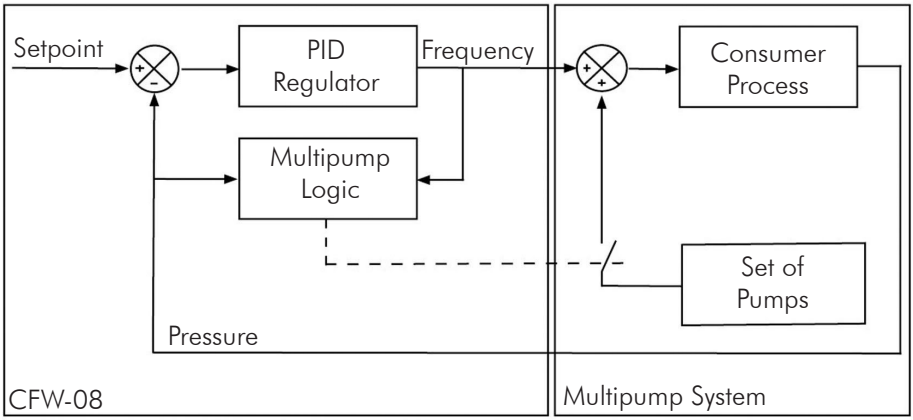


Figure 4.2: *Simplified schematic of the multipump system*

5. FIXED CONTROL MULTIPUMP SYSTEM

It is characterized by the fact that the inverter always controls the speed of the same pump, called the main pump. Auxiliary pumps are activated by the CFW-08 inverter digital outputs (relays). In that way, the more suitable starting technique can be chosen by the user, direct on line, star-delta, Soft-Starter, etc.

The CFW-08 Multipump Fixed Control is selected through the parameter P203=2, and makes the operation of up to 4 pumps possible, one connected directly to the inverter and the other three commanded through the CFW-08 relay outputs.

5.1. Electrical Connections

The suggested power section electrical schematic of the Multipump Fixed Control for the operation of a main pump and three more auxiliary pumps is presented in the figure 10.1.

Observe the connection of the inverter directly to the main pump, and the auxiliary pumps started directly on line through 2K1, 3K1 and 4K1 contactors. Note that the inverter protection is achieved through fuses, and for the auxiliary pumps via circuit breakers 2Q1, 3Q1 and 4Q1.

The figure 10.2 presents the command connections according to the CFW-08 factory default, i.e., the digital input DI1 enables the inverter with ramp (start/stop), and the other inputs, DI2, DI3 and DI4, are used for commanding the auxiliary pumps 2M1, 3M1 and 4M1, respectively.

2S2, 3S2 and 4S2 switches allow selecting between Manual / 0 / Automatic positions. The "Manual" position issues the command for starting the auxiliary pump without the multipump system control. The "0" position switches off the pump and disables it from the multipump system. The "Automatic" position enables the auxiliary pump to be used in the multipump system.

RL1, RL2 and RL3 relay outputs activate respectively 2K1, 3K1 and 4K1 contactors for starting the auxiliary pumps.

5.2. Operation of the Fixed Control

The Multipump control is implemented based on certain output pressure limits of the system, on the inverter output frequency, as well as on some time intervals necessary for the process stabilization. Through the system pressure and inverter output frequency variables, it is possible to identify the need of adding or removing a pump from the system. Therefore, the continuous control performed by the main pump has its range amplified through the activation of auxiliary pumps connected in parallel in the pumping system. The following sections synthesize the two rules for the operation of the auxiliary pumps:

5.2.1. Rule for Adding a Pump to the System

The parameters P575, P576 and P577, define the operation point where a pump must be added to the system. Parameters P575 and P576 determine frequency and pressure, respectively. The parameter P577, though, corresponds to the time interval (Δt) this condition must be sustained before the control activates the pump.

$Ps < SP - P576$
$Fs > P575$
$\Delta t > P577$
} Increments the number of pumps in case of direct PID action (P527=0).

$Ps > SP+P576$
$Fs > P575$
$\Delta t > P577$
} Increments the number of pumps in case of reverse PID action (P527=1).

Where: Ps = System output pressure (process variable)
Fs = Output frequency
SP = Pressure Setpoint (Keys, AI2 or DIx)
Δt = Time interval

5.2.2. Rule for Removing a Pump from the System

The parameters P580, P581 and P582, define the operation point where a pump must be removed from the system. Parameters P580 and P581 determine frequency and pressure, respectively. The parameter P582, though, corresponds to the time interval (Δt) this condition must be sustained before the control deactivates the pump.

$Ps > SP + P581$
$Fs < P580$
$\Delta t > P582$
} Decrements the number of pumps in case of direct PID action (P527=0).

$Ps < SP - P581$
$Fs < P580$
$\Delta t > P582$
} Decrements the number of pumps in case of reverse PID action (P527=1).

Where: Ps = System output pressure (process variable)
Fs = Output frequency
SP = Pressure Setpoint (Keys, AI2 or DIx)
Δt = Time interval

6. FLOATING CONTROL MULTIPUMP SYSTEM

In the Floating Control Multipump System the inverter can be connected to any of the pumps, whereas the others operate as auxiliary pumps. This is possible because of the interlocking between the pump commands combined to the CFW-08 relay command logic, which allows any of the pumps to be connected to the inverter or to the line, according to a pre-defined relay output activation sequence.

Starting from the point where all the CFW-08 relay outputs are off, the first one that is activated connects the CFW-08 to the respective pump, which operates as the main pump. The other relay outputs activated in the sequence start their respective pumps direct on line, and they operate as the auxiliary pumps.

6.1. Electrical Connections

The suggested electrical schematic for the power section of the Multipump Floating Control for the operation of three pumps is presented in the figure 10.3.

Observe that the schematic with 6 contactors makes it possible that the inverter be connected to any of the pumps, i.e., 1K1, 2K1 and 3K1 contactors connect the respective pumps to the CFW-08 power output terminals. On the other hand, 1K2, 2K2 and 3K2 contactors perform a direct on-line start of their respective pumps. Note that 1K2, 2K2 and 3K2 starters must not necessarily be contactors, they can be Soft Starters for instance.

The figure 10.4 presents the command connections according to the CFW-08 factory default, i.e., the digital input DI1 enables the inverter with ramp (start/stop), and the other inputs, DI2, DI3 and DI4, are used for commanding the pumps 1M1, 2M1 and 3M1, respectively.

1S2, 2S2 and 3S2 switches allow selecting between Manual / 0 / Automatic positions. The "Manual" position issues the command for starting the auxiliary pump without the multipump system control. The "0" position switches off the pump and disables it from the multipump system. The "Automatic" position enables the auxiliary pump to be used in the multipump system.

RL1, RL2 and RL3 relay outputs activate respectively 1K1, 2K1 and 3K1 contactors for starting the pumps. Note that in this schematic there is no representation of the auxiliary or main pumps, because the first started one is the main pump and the others will be auxiliaries.

6.2. Operation of the Floating Control

The Floating Multipump Control is identical to the Fixed Control regarding the decision making process for adding or removing pumps from the system, according to the section 5.2. The interlocking presented in the figure 10.4, however, allows that any of the three pumps be connected to the inverter output. Therefore, opposite to the Fixed Control, the pump controlled by the inverter can be changed by another, thus balancing the operation time among all the system pumps. The moment for changing the pump driven by the CFW-08 is totally programmable in a way that the user defines the system operation point, as well as the maximum time interval between changes.

According to the figures 10.3 and 10.4 schematics, the pump connected to the frequency inverter is always the first to be activated; the pumps that are activated next are connected directly to the line as auxiliary pumps. Therefore, in opportune moments, such as when the inverter is disabled or in sleep mode, or the system capacity is below a specific pre-defined point, then the inverter is able to switch off all the pumps and reinitiate the operation connecting itself to another pump of the system.

7. PARAMETERIZATION OF THE MULTIPUMP CONTROL

The CFW-08 Multipump Control was devised in order to support both multipump applications, with fixed and floating control. The section 7.1 presents the CFW-08 new parameters for the Multipump Control.

7.1. Detailed Parameter Description

7.1.1. Multipump Read-Only Parameters

P540 – System Pressure

Adjustable Range:	0 to P552	**Unit:** -	**Default:** -

Description:

Process variable or multipump system output pressure, with the scale defined by P552. The process variable and the parameters linked to it have no unit, so that the user can work with the unit system that better suits the application.

P541 – B_{RL1} Pump Operation Time

Adjustable Range:	0.0 to 3000	**Unit:** x10h	**Default:** -

Description:

It totalizes the operation time of the pump linked to the relay output RL1.

P542 – B_{RL2} Pump Operation Time

Adjustable Range:	0.0 to 3000	**Unit:** x10h	**Default:** -

Description:

It totalizes the operation time of the pump linked to the relay output RL2.

P543 – B_{RL3} Pump Operation Time

Adjustable Range:	0.0 to 3000	**Unit:** x10h	**Default:** -

Description:

It totalizes the operation time of the pump linked to the relay output RL3.

P544 – CFW-08 Operation Time

Adjustable Range:	0.0 to 3000	**Unit:** x10h	**Default:** -

Description:

It totalizes the operation time of the frequency inverter CFW-08.

7.1.2. Multipump System Writing Parameters – General Configuration

P550 – Number Auxiliary Pumps

Adjustable Range:	0 to 3	**Unit:** -	**Default:** 3

Description:

It defines the number of auxiliary pumps for the Multipump Fixed Control (P203=2), or the number of pumps for the Multipump Floating Control (P203=3).

P551 – Activation of the Auxiliary Pumps

Adjustable Range:	0 = In a sequence 1 = With rotation	**Unit:** -	**Default:** 1

Description:

It determines the mode of activating the pumps:

- ☑ In sequence (P551=0) → the multipump control activates the pumps in the sequential order B_{RL1}, B_{RL2} and B_{RL3} and deactivates them, according to the system needs, in the B_{RL3}, B_{RL2} and B_{RL1} order.
- ☑ With rotation (P551=1) → the multipump control activates the auxiliary pumps according to their operation times stored in P541, P542 and P543, in order to equalize these times.

P552 – Pressure Sensor Scale

Adjustable Range:	0.00 to 300.0	**Unit:** -	**Default:** 10.00

Description:

It adjusts the pressure sensor full scale. This value is also used as the full scale for the parameters linked to the system pressure.

P553 – Setpoint 2 via Digital Input

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 3.00

P554 – Setpoint 3 via Digital Input

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 4.00

P555 – Setpoint 4 via Digital Input

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 5.00

Description:

The PID regulator setpoint can be selected via digital inputs (DIx) in a similar way to the Multispeed function. The parameters P525, P553, P554 and P555 define the four possible setpoint values for the selection via digital inputs. Once the setpoint via DIx is active, the PID regulator assumes this value regardless of the local or remote reference programmed in the inverter. Refer to the table 7.1.

Table 7.1: Setpoint via DIx combinations

DI3 (SP1)	DI4 (SP0)	Setpoint
Off	Off	P525
Off	On	P553
On	Off	P554
On	On	P555

P556 – Operation Time Reset

Adjustable Range:	0 = Without reset 1 = B_{RL1} pump time reset 2 = B_{RL2} pump time reset 3 = B_{RL3} pump time reset 4 = CFW-08 operation time reset	**Unit:** -	**Default:** 0

Description:

It allows the operation time reset of every pump of the system.

7.1.3. Multipump System Writing Parameters – Fault Configuration

P560 – Pressure Sensor Signal Failure (E52)

Adjustable Range:	0 = Disables the function 1 = Enables the function	**Unit:** -	**Default:** 0

Description:

It enables the monitoring of the pressure sensor 4 to 20 mA signal. If the sensor current is less or equal to 2 mA, the inverter disables all the pumps and indicates E52.

P561 – Minimum Output Pressure (E54)

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 0.0

P562 – Maximum Output Pressure (E54)

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 10.00

P563 – Time for Output Pressure Failure (E54)

Adjustable Range:	0.0 to 999 0.0 = Disables the function	**Unit:** s	**Default:** 0.0

Description:

When the output pressure is below P561, the inverter output frequency is higher than P580 and all the auxiliary pumps enabled via the DIx are running, in this case, once the condition is kept during the interval programmed in P563, the inverter is disabled indicating E54 and it switches off all the pumps. On the other hand, when the output pressure is above P562, the inverter output frequency is lower than P575 and all the enabled pumps are switched off, the inverter will be switched off indicating E54 if this condition is kept during the P563 interval. In this way, the E54 error is able to detect breaking or obstruction in the pipes.

7.1.4. Multipump System Writing Parameters – Rotation Configuration

P565 – Number of Pumps Activated for Performing Rotation

Adjustable Range:	0 to P550 0 = Disabled rotation	**Unit:** -	**Default:** 0

P566 – Rotation Interval

Adjustable Range:	0.0 to 3000 0.0 = Test (every 60 s)	**Unit:** x10h	**Default:** 7.2

P567 – Rotation Frequency

Adjustable Range:	0.00 to P134	**Unit:** Hz	**Default:** 50.00

Description:

The parameters P565, P566 and P567 only have functions in the Multipump Floating Control (P203=3), because they define the conditions for the rotation of the pump connected to the frequency inverter.

By definition, rotation is the change of the pump controlled by the frequency inverter by another available on the system. The criteria for the connection of the other pump also takes into account the operation time in P541, P542 and P543, in order to equalize these times when P551=1.

The rotation occurs naturally while the inverter is disabled or in the sleep mode. If these events do not occur before the P566 interval, then the inverter performs the commutation switching all the pumps off and starting the system again. In order that this commutation event occurs, it is necessary that the number of running pumps be less or equal to P565, and output frequency of pump controlled less to P567. In this way the user defines the system operation criteria for the rotation event execution by means of the P566 timing.

7.1.5. Multipump System Writing Parameters – Sleep Mode Configuration

P570 – Sleep Mode Activation Frequency

Adjustable Range:	0.00 to P134 0.00 = Disables sleep function	**Unit:** Hz	**Default:** 30.00

Description:

It is the frequency value that starts the P571 timing, in order to activate the sleep mode.

P571 – Sleep Mode Activation Time

Adjustable Range:	0.0 to 999	**Unit:** s	**Default:** 10.00

Description:

If no auxiliary pump is on and the output frequency is lower than P570, and keeping this condition for a minimum interval given by P571, the inverter enters the sleep mode by deactivating the PWM pulses at the output and indicating “Srdy” on the display. The sleep function can be deactivated adjusting P570 in 0.00 Hz. Refer to the figure 7.1.

P572 – Wake up Pressure Deviation

Adjustable Range:	0 to P552	**Unit:** -	**Default:** 0.20

P573 – Wake up Time

Adjustable Range:	0.0 to 999	**Unit:** s	**Default:** 0.0

Description:

The parameter P572 defines the pressure value above or below the setpoint, depending on the PID action set in P527, where the inverter leaves the sleep mode and restarts controlling the system again after the P573 interval, as illustrated in the figure 7.1 for P573=0.0 s. This pressure limit determined by P572 will be below the setpoint if the PID controller action is direct (P527=0) or above the setpoint if the action is reverse (P527=1).

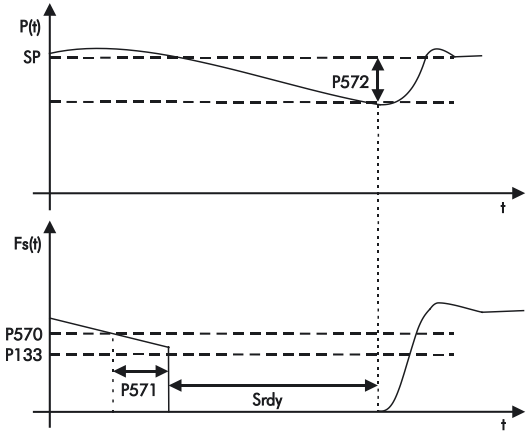


Figure 7.1: Example of the Sleep Mode behavior

7.1.6. Multipump System Writing Parameters – Pump Starting Configuration

P575 – Auxiliary Pump Starting Frequency

Adjustable Range:	P133 to P134	**Unit:** Hz	**Default:** 49.00

Description:

It defines the frequency above which the inverter will be able to start an auxiliary pump in order to increase the system pressure.

P576 – Auxiliary Pump Starting Pressure Deviation

Adjustable Range:	0.0 a P552	**Unit:** -	**Default:** 0.20

Description:

It defines the pressure deviation regarding to the setpoint, at which the inverter will be able to start an auxiliary pump in order to increase the system pressure. This pressure deviation will be below the setpoint if the PID controller action is direct (P527=0) or above the setpoint if the action is reverse (P527=1).

P577 – Auxiliary Pump Starting Time

Adjustable Range:	0.0 to 999	**Unit:** s	**Default:** 3.0

Description:

An auxiliary pump is started in the system if the P575 and P576 conditions remain during the time window defined in P577. If there is more than one auxiliary pump available and the pump rotation is active through P551, the inverter will activate the one with the shortest operation time among P541, P542 and P543.

P578 – Auxiliary Pump Starting Transition Delay

Adjustable Range:	0.0 to 100.0 100.0 = without transition	**Unit:** s	**Default:** 100.0

Description:

The parameter P578 has the purpose of reducing the pressure transient when an auxiliary pump is activated, reducing the output frequency to the value of the Auxiliary Pump Stopping Frequency – P580. Thus, if P578 is properly adjusted the impact of starting an auxiliary pump is minimized. Besides this, in some auxiliary starter types, as Soft-Starters and star-delta, the moment of the reduction must be controlled. At the transition moment the PID regulator output is ignored and the inverter follows the second ramp (P103) until the output frequency reaches P580. After this, the PID regulator retakes the control of the inverter output frequency normally.

7.1.7. Multipump System Writing Parameters – Pump Stopping Configuration

P580 – Auxiliary Pump Stopping Frequency

Adjustable Range:	P133 to P134	**Unit:** Hz	**Default:** 30.00

Description:

It defines the frequency below which the inverter will be able to stop an auxiliary pump in order to reduce the system pressure.

P581 – Auxiliary Pump Stopping Pressure Deviation

Adjustable Range:	0.00 to P552	**Unit:** -	**Default:** 0.00

Description:

It defines the pressure deviation regarding to the setpoint, at which the inverter will be able to stop an auxiliary pump in order to decrease the system pressure. This pressure deviation will be above the setpoint if the PID controller action is direct (P527=0) or below the setpoint if the action is reverse (P527=1).

P582 – Auxiliary Pump Stopping Time

Adjustable Range:	0.0 to 999	**Unit:** s	**Default:** 3.0

Description:

An auxiliary pump is stopped in the system if the P580 and P581 conditions remain during the time window defined in P582. If there is more than one auxiliary pump available and the pump rotation is active through P551, the inverter will deactivate the one with the longest operation time among P541, P542 and P543.

P583 – Auxiliary Pump Stopping Transition Delay

Adjustable Range:	0.0 a 100,0 100.0 = without transition	**Unit:** s	**Default:** 100.0

Description:

The parameter P583 has the purpose of reducing the pressure transient when an auxiliary pump is deactivated, increasing the output frequency to the value of the Auxiliary Pump Starting Frequency – P575. Thus, the impact of stopping an auxiliary pump is minimized if P583 is properly adjusted. Besides this, in some auxiliary starter types, as Soft-Starters and star-delta, the moment of the reduction must be controlled. At the transition moment the PID regulator output is ignored and the inverter follows the second ramp (P102) until the output frequency reaches P575. After this, the PID regulator retakes the control of the inverter output frequency normally.

The figure 7.2 presents an example of auxiliary pump commutation using the Multipump Fixed Control with three auxiliary pumps, so that the active B_{RL1} pump is deactivated, and after some time the B_{RL3} pump is activated, because it has an operation time shorter than the others. The description of the figure 7.2 steps is listed next.

- ☑ T0-T1 interval: Normal operation without any timing, only the PID regulator is acting in the system, and the pressure is increasing while the frequency is going down. At the T1 instant the frequency and pressure values trigger the P582 timer;
- ☑ T1-T2 interval: P577 timing, at T2 the inverter begins the frequency reduction;
- ☑ T2-T3 interval: The inverter decelerates with the 2nd ramp down to P580 without delay (P578=100.0);
- ☑ T3-T4 interval: The PID regulator retakes the control of the output frequency which stabilizes at T4;
- ☑ T4-T5 interval: Normal operation without any timing, only the PID regulator is acting in the system;
- ☑ T5-T6 interval: The pressure goes up and the frequency goes down;
- ☑ T6-T7 interval: At T7 the P582 timing switches off the B_{RL1} pump;
- ☑ T7-T8 interval: The inverter accelerates with the 2nd ramp up to P575 without delay (P583 = 100.0);
- ☑ T8-T9 interval: The PID regulator retakes the control of the output frequency which stabilizes at T9.

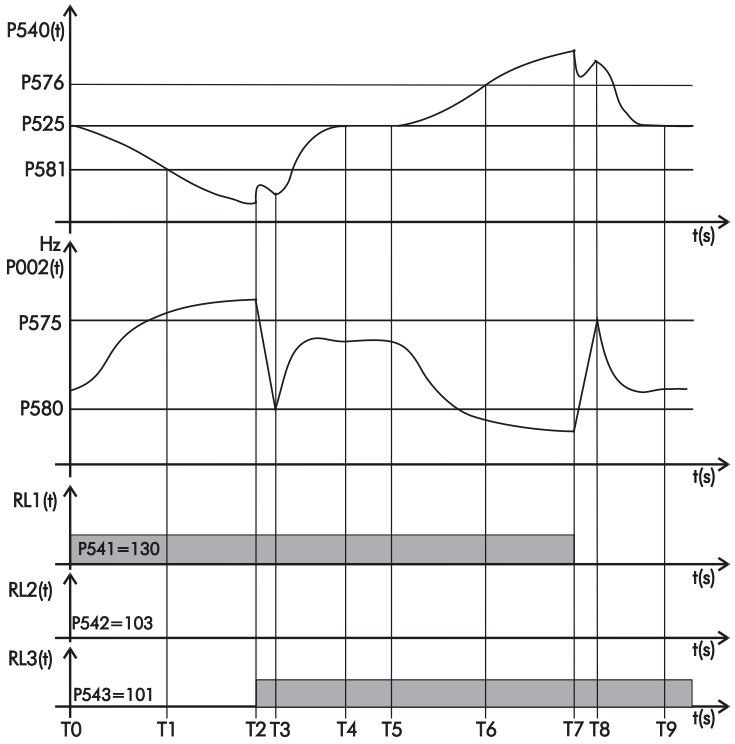
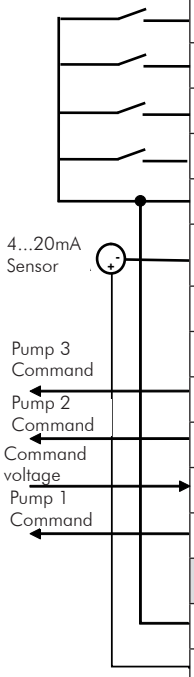


Figure 7.2.: Commutation example for the multipump control

7.2. ECC4 Control Board Connections

The ECC4 control board for the CFW-08 multipump is similar to the ECC3 of the standard CFW-08, however, instead of two relay outputs it has three relay outputs, and all of them are NO (Normally Open) with a common point at terminal XC1:11. The third relay output is located at the terminal XC1:9 in the place of the former analog output. Therefore, all the functions related to this output are disabled. The figure 7.3 presents the control connections (analog and digital inputs and outputs) made at the ECC4 control board terminal strip XC1, considering a multipump system with three auxiliary pumps, factory default programming, two-wire (4 to 20) mA sensor, and using the KDC-24V-CFW08 (24 V/100 mA supply) accessory.



XC1 terminal strip		ECC4 – Default functions for the Multipump System
1	DI1	Digital input 1: CFW-08 inverter enabling (start-stop)
2	DI2	Digital input 2: B_{RL1} pump enabling
3	DI3	Digital input 3: B_{RL2} pump enabling
4	DI4	Digital input 4: B_{RL3} pump enabling
5	GND	0 V Reference
6	AI1	Analog input 1 (4-20 mA): System pressure feedback for the PID control
7	+10V	+10 Vdc Reference for potentiometer
8	AI2	Analog input 2: Digital input DI6 (no function)
9	RL3	Relay output 3: B_{RL3} pump activation
10	RL2	Relay output 2: B_{RL2} pump activation
11	COM	Common point for the relay outputs
12	RL1	Relay output 1: B_{RL1} pump activation
XC16 terminal strip		**KDC-24V-CFW08 Accessory**
0V	GND	24Vdc power supply 0 V reference
24V	+24 Vdc	24Vdc power supply output

Figure 7.3: *Connections at the CFW-08 Multipump control board*

NOTE!
In order to enable 4-20 mA current reading at the analog input 1, select the S1.3 switch in ON. Refer to the CFW-08 frequency inverter manual for more information.

7.3. Modified Parameters at the CFW-08 Multipump

In order to facilitate the inverter parameterization some parameters suffered modification in their factory default values, regarding the user manual. The table in the section 11.1 presents the parameters that suffered modification in the factory default.

In the Multipump CFW-08 the parameters P525 and P040 indicate their values in the pressure sensor scale, P552, instead of the percentage value indicated in the standard CFW-08 user manual.

Some parameters received new functions, which are not described in the user manual, in the Multipump inverter software, according to the section 11.2 table.

The digital input function "B_{RLX} Pump Enable" configures the referred DIx for the Multipump command according to the schematics of sections 10.2 and 10.4. If a B_{RLX} pump does not have a digital input programmed for its command, the controls assumes that this pump will always be enabled for the multipump command.

The "SP1 Setpoint" function configures the DI3 for selecting the setpoint via DIx, according to the section 7.1.

The "SP0 Setpoint" function configures the DI4 for selecting the setpoint via DIx, according to the section 7.1.

Parameters P277 and P279 received the new option 4 that configures the relay output RLx for the Multipump control.

8. MULTIPUMP CONTROL CONFIGURATION TUTORIAL

A multipump control configuration sequence, with tips and examples, for applying the Multipump CFW-08 inverter in pumping systems, starting from the factory default, is showed in the next items.

Step 1 – Factory Default Configuration

The factory default is the starting point for this tutorial. The default values are loaded by setting P204=5. The factory default values are presented in the quick parameter reference tables of this guide and of the user manual.

The multipump factory default presents the following configurations:

- ☑ Local and remote commands via terminals (DI1 = start/stop, DI2 = B_{RL1} Pump Enable, DI3 = B_{RL2} Pump Enable, DI4 = B_{RL3} Pump Enable);
- ☑ Local and remote reference via keypad (PID setpoint via P525 = 2.00);
- ☑ Multipump Floating Control for the operation of three pumps;
- ☑ Pump rotation enabled for every 72 hours;
- ☑ 0 to 10.00 bar/4 to 20 mA pressure sensor;
- ☑ Inactive faults (E52 and E54).

Step 2 – Multipump Control Type

Adjust P203 in 2 or 3 for fixed control or floating control, respectively. Refer to the sections 6 and 7.

Step 3 – Analog Input Configuration

Verify the used pressure sensor specification and configure the parameter P235 accordingly, as well as the S1.3 switch on the ECC4 control board. Refer to the Chapter 3 – Installation, on the user manual.

Observe the pressure sensor connection to the CFW-08 terminal strip XC1. The figure 7.3 shows the connection of a two-wire sensor using the optional 24 V power supply. These connections are identical in the case of an external 24 V power supply.

Step 4 – General Configuration of the Multipump Control

Set the number of pumps in P550, for the fixed control (P203=2) this number refers to the number of auxiliary pumps. However, in the case of floating control (P203=3) this number is equal to the total of pumps.

The pressure sensor scale can be adjusted in P552, from 0.00 to 300.0. This scale is used for the analog inputs and other parameters related to the output pressure. Therefore, the user is free to choose the pressure unit system that better suits the application.

If necessary, the pressure setpoint can be forced to a value pre-defined in P553, P554 or P555. This function may be useful in systems were the operation pressure must be changed frequently.

Step 5 – Fault Configuration

The factory default parameterization disables the Multipump fault indications. The fault indications may be activated after the multipump control is operating in a satisfactory manner. Leave the fault settings for the end of the configuration.

The faults implemented in the CFW-08 Multipump are expressed by the E52 and E54 errors, and they can diagnose the following faults:

- ☑ Fault in the pressure sensor (4 to 20 mA);
- ☑ Input and output pipe break;
- ☑ The absence of liquid in the pipes.

Step 6 – Sleep Mode Configuration

The multipump characteristic of adapting itself to the system consumption makes it possible that during zero consumption periods the inverter disables the pulses, entering the "sleep" mode (Srdy). When the consumption is no longer null, the inverter works normally again (awakes). This allows significant energy savings in systems with large load variation.

The sleep function is activated when the conditions defined by the parameters P570 to P573 are fulfilled and all the pumps are off.

Step 7 – Auxiliary Pump Activation Configuration

Set the parameter P575 for a frequency slightly below the nominal frequency of the driven motors. The P576 value must be adjusted between 2% and 5% of the value defined as the setpoint, allowing main pump operation up to the nominal frequency, at the expense of a small deviation in the output pressure (P576) regarding the setpoint.

The auxiliary pump starting time defines the desired rapidity in taking actions with auxiliary pumps; however, a too low value of P577 may result in excessive activations of auxiliary pumps.

The P578 transition delay is more effective in the cases where the auxiliary pumps are activated by starters with transport delay, which is the case of Soft-Starters and star-delta starters.

Step 8 – Auxiliary Pump Deactivation Configuration

Depending on the pump constructive form, there is a minimum frequency below which the pump does not produce mechanical work. P580 value must be slightly above this point so that the controller switches off an auxiliary pump allowing thus the main pump to operate above this undesired operation point.

Set P580 initially at 50% of the motor nominal frequency, and after observing the system response, find out the optimal point for switching off an auxiliary pump when the controlled pump is no longer influencing the output pressure. Note that this point varies with the output pressure; therefore, by changing the setpoint a new adjustment may be necessary.

The parameters P581, P582 and P583 have functions similar to those of P576, P577 and P578, however, applied to the deactivation.

Step 9 – PID Regulator Configuration

In pumping system controls, a PI regulator is enough to produce a good performance control. The proportional "KP" (P520) and the integral "KI" (P521) gains must be changed if the controller response is not satisfactory, i.e., if there are oscillations around the setpoint value in the output pressure, if the response time is too slow, or if there is a constant error regarding the setpoint. For the majority of the multipump applications the factory default values should suffice for a good PID regulator response.

Below are some suggestions for adjusting the regulator:

a) Oscillation in the output pressure – In the majority of the cases this is caused by excessive gains in the PID controller. Reduce the KP and KI gains gradually and observe the response;
b) Too low response time – By increasing the KP gain the system must respond faster, however, above a certain limit the system may present overshoots.
c) Constant error at the output – In this case, by increasing the KI gain the error at the output, i.e., when the output is not able to match the setpoint, is eliminated. An excessive KI gain may generate output oscillations; in such case reduce the KP gain in order to reduce the total gains keeping the KI gain value.

9. ERRORS AND POSSIBLE CAUSES

The table 9.1 presents the error codes generated by the CFW-08 for the Multipump control, the other error codes are presented in the user manual chapter 7 - Diagnostics and Troubleshooting.

Table 9.1: Errors generated by the CFW-08 multipump

MULTIPUMP CONTROL ERRORS			
ERROR	RESET	POSSIBLE CAUSES	CORRECTIVE ACTIONS
E52: Pressure sensor signal failure	Power-on; HMI key; Auto reset via DIx.	☑ Interrupted pressure sensor wire; ☑ Analog input programming error.	☑ Refer to the item 3.2.5 – Control Wiring, (selection switches) in the user manual; ☑ Verify P560, P235 and P239.
E54: Exceeded pressure limit	Power-on; HMI Key; Auto reset via DIx.	☑ Pipe break; ☑ Pressure sensor failure.	☑ Verify P235, P561, P562 and P563; ☑ Verify the pipes and the pressure sensor.

10. MULTIPUMP CONTROL CONNECTION SCHEMATICS

10.1. Multipump Fixed Control Power Section Electrical Schematic

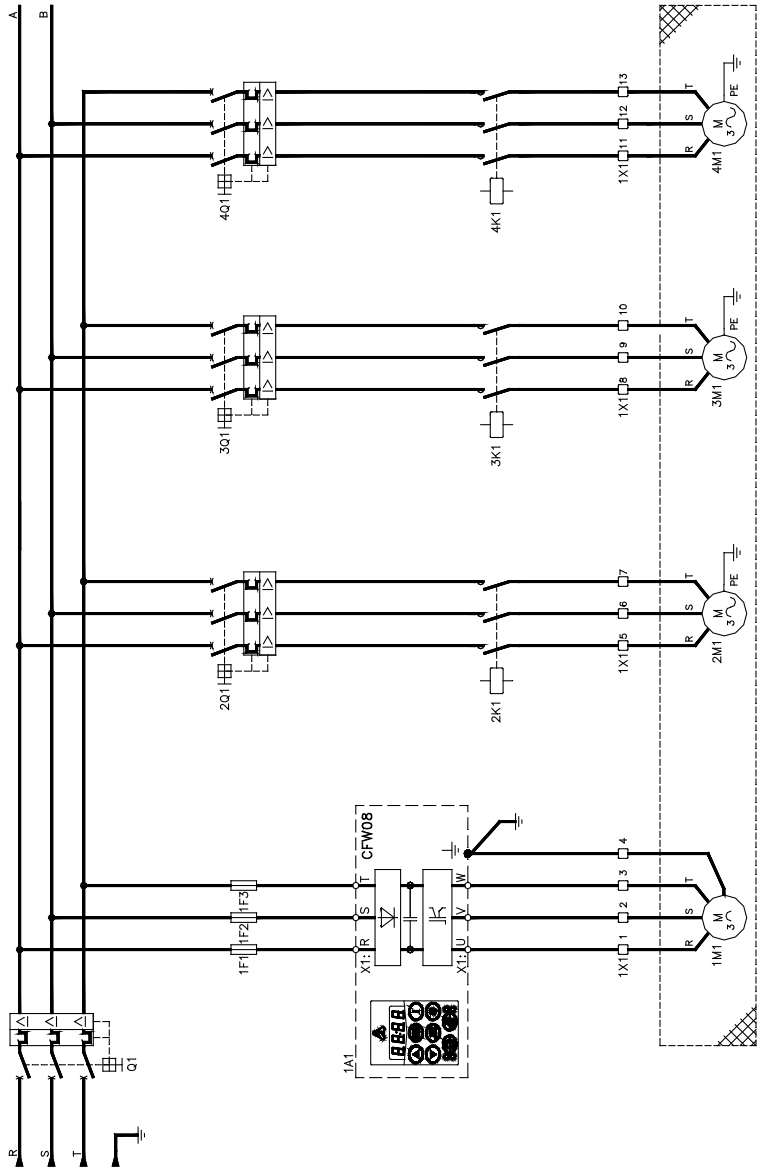


Figure 10.1: *Multipump fixed control power section electrical schematic*

10.2. Multipump Fixed Control Command Connections

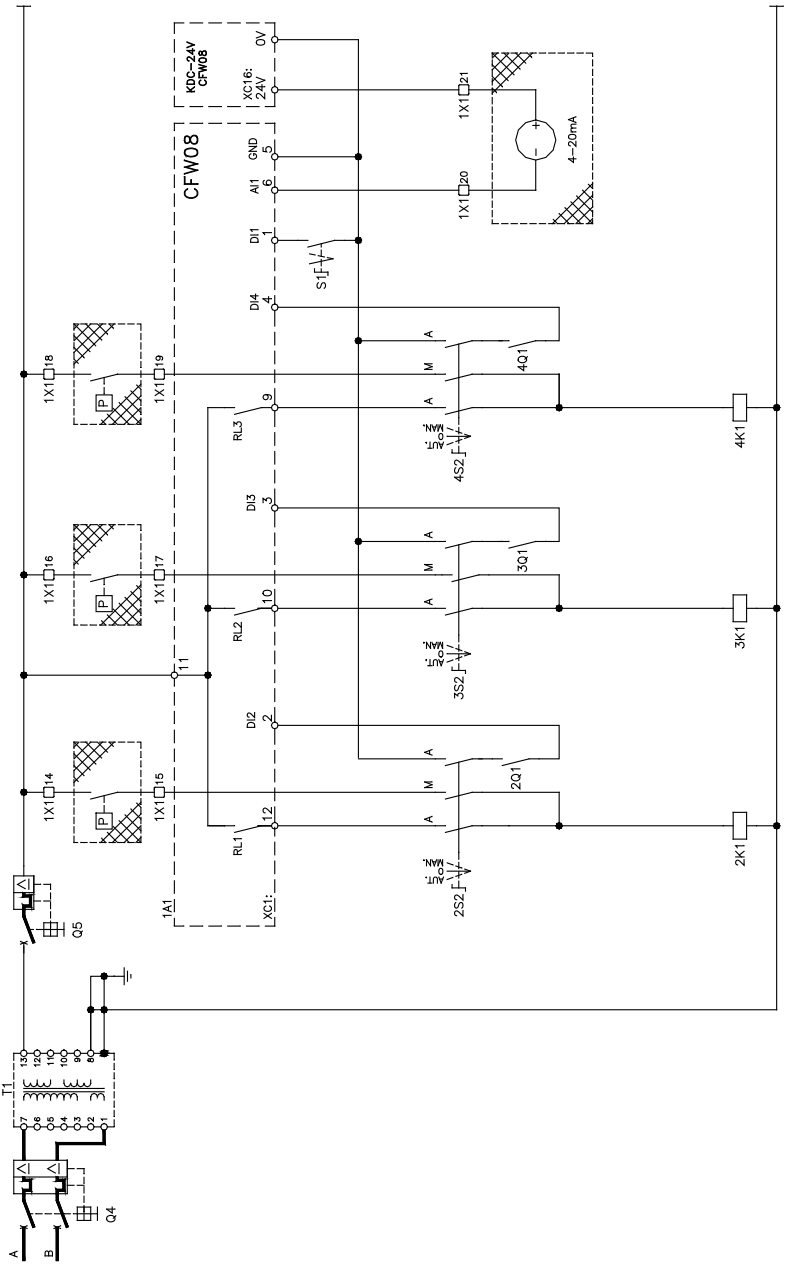


Figure 10.2: *Multipump fixed control command connections*

10.3. Multipump Floating Control Power Section Electrical Schematic

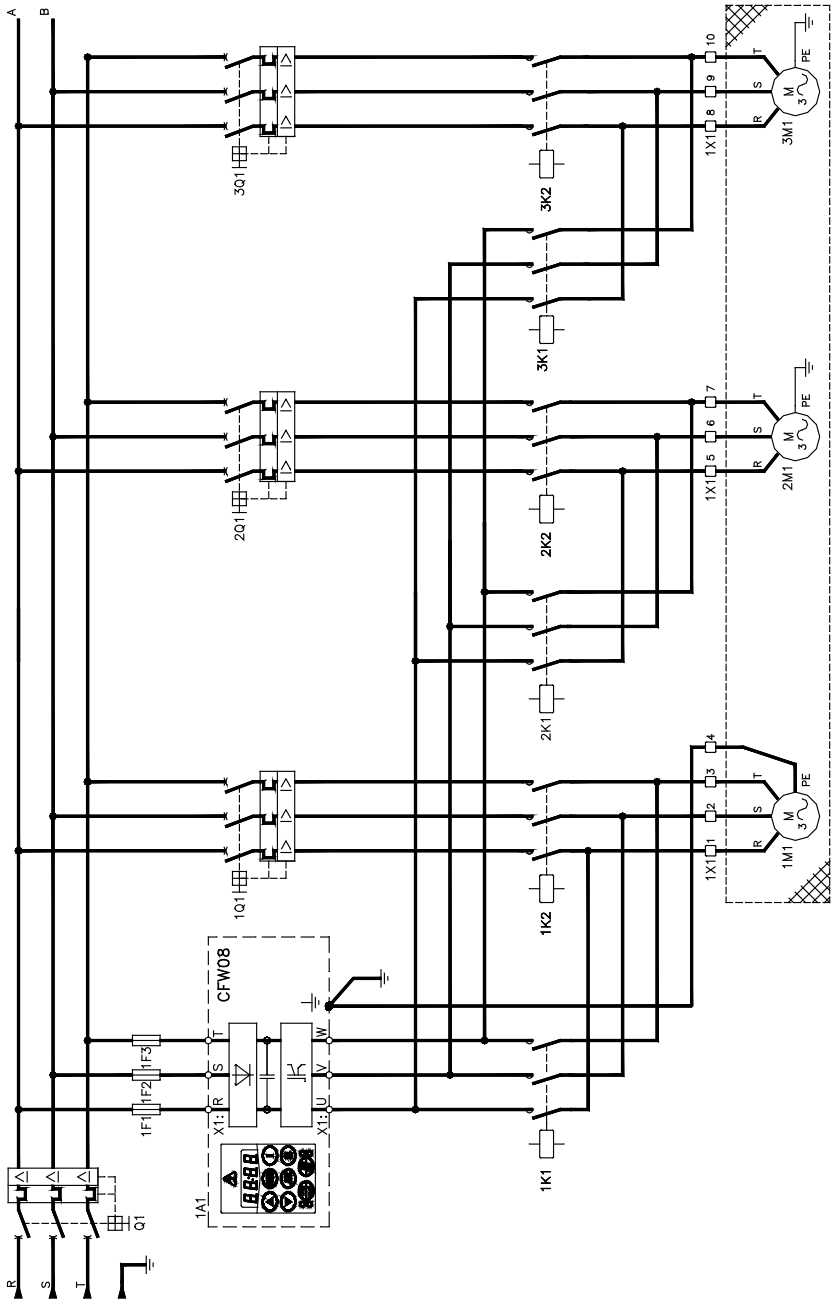


Figure 10.3: Multipump floating control power section electrical schematic

10.4. Multipump Floating Control Command Connections

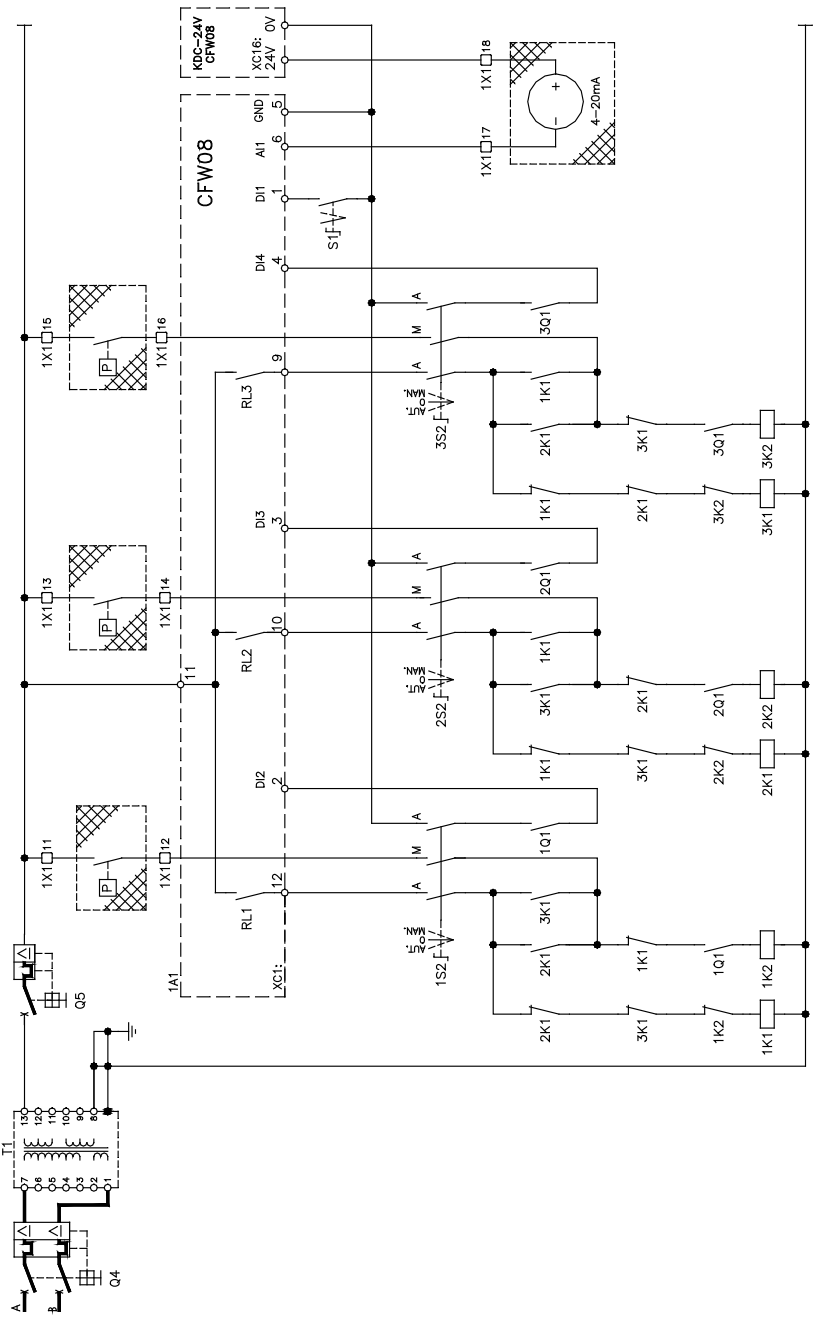


Figure 10.4: Multipump floating control command connections

11. QUICK PARAMETER REFERENCE

11.1. Parameters with Changes in the Factory Default Values

Parameter	Description	Adjustable Range	Unit	Default
P101	Deceleration Time Ramp 1	0.1 to 999	s	5.0
P102	Acceleration Time Ramp 2	0.1 to 999	s	1.0
P103	Deceleration Time Ramp 2	0.1 to 999	s	1.0
P133	Minimum Frequency	0.0 to P134	Hz	20.0
P134	Maximum Frequency	P133 to 300.0	Hz	50.0
P203	Special Function Selection	0 = No function 1 = PID Regulator 2 = Multipump Fixed Control 3 = Multipump Floating Control	-	3
P235	Analog Input AI1 Signal	0 = (0 to 10)V / (0 to 20)mA 1 = (4 to 20)mA 2 = DI5 PNP 3 = DI5 NPN 4 = DI5 TTL 5 = PTC	-	1
P239	Analog Input AI2 Signal	0 = (0 to 10)V / (0 to 20)mA 1 = (4 to 20)mA 2 = DI5 PNP 3 = DI5 NPN 4 = DI5 TTL 5 = PTC	-	3
P263	Digital Input DI1 Function	0 to 14	-	9
P264	Digital Input DI2 Function	0 to 14	-	11
P265	Digital Input DI3 Function	0 to 16	-	11
P266	Digital Input DI4 Function	0 to 16	-	11
P277	Relay Output RL1 Function	0 to 7	-	4
P279	Relay Output RL2 Function	0 to 7	-	4
P525	Setpoint via Keypad (Setpoint 1)	0.00 to P555	-	2.0
P536	Automatic Setting of P525	0 = Active 1= Inactive	-	1

11.2. Parameters with New Functions

Parameter	Description	New Functions	Default Value
P203	Special Function Selection	2 = Multipump Fixed Control 3 = Multipump Floating Control	3
P264	Digital Input DI2 Function	11 = B_{RL1} Pump Enable	11
P265	Digital Input DI3 Function	11 = B_{RL2} Pump Enable 12 = SP1 Setpoint (MSB)	11
P266	Digital Input DI4 Function	11 = B_{RL3} Pump Enable 12 = SP0 Setpoint (LSB)	11
P268	Digital Input DI6 Function	11 = B_{RL2} Pump Enable 12 = B_{RL3} Pump Enable	14
P277	Relay Output RL1 Function	4 = B_{RL1} Pump Command	4
P279	Relay Output RL2 Function	4 = B_{RL2} Pump Command	4

11.3. Multipump System Parameters

Multipump Read-Only Parameters					
Parameter	Description	Adjustable Range	Unit	Default	Page
P540	System Pressure	0 a P552	-	-	12
P541	B_{RL1} Pump Operation Time	0.0 a 3000	(x10h)	-	12
P542	B_{RL2} Pump Operation Time	0.0 a 3000	(x10h)	-	12
P543	B_{RL3} Pump Operation Time	0.0 a 3000	(x10h)	-	12
P544	CFW-08 Operation Time	0.0 a 3000	(x10h)	-	13
Multipump System Writing Parameters – General Configuration					
Parameter	Description	Adjustable Range	Unit	Default	Page
P550	Number of Auxiliary Pumps	0 to 3	-	3	13
P551	Activation of the Auxiliary Pumps	0 = In a sequence 1 = With rotation	-	1	13
P552	Pressure Sensor Scale	0.00 to 300.0	-	10.00	13
P553	Setpoint 2 via Digital Input	0.00 to P552	-	3.00	13
P554	Setpoint 3 via Digital Input	0.00 to P552	-	4.00	14
P555	Setpoint 4 via Digital Input	0.00 to P552	-	5.00	14
P556	Operation Time Reset	0 = Without reset 1 = B_{RL1} Pump time reset 2 = B_{RL2} Pump time reset 3 = B_{RL3} Pump time reset 4 = CFW-08 operation time reset	-	0	14
Multipump System Writing Parameters – Fault Configuration					
Parameter	Description	Adjustable Range	Unit	Default	Page
P560	Pressure Sensor Signal Failure (E52)	0 = Disables the function 1 = Enables the Function	-	0	14
P561	Minimum Output Pressure (E54)	0.00 to P552	-	0.00	15
P562	Maximum Output Pressure (E54)	0.00 to P552	-	10.00	15
P563	Time for Output Pressure Failure (E54)	0.0 to 999 0.0 = Disables the function	s	0.0	15

Multipump System Writing Parameters – Rotation Configuration (1)					
Parameter	Description	Adjustable Range	Unit	Default	Page
P565	Number of Pumps Activated for Performing Rotation	0 to P550 0 = Disabled rotation	-	0	15
P566	Rotation Interval	0.0 to 3000 0.0 = Test (every 60 s)	(x10h)	7.2	15
P567	Rotation Frequency	0.00 to P134	Hz	50.00	15
Multipump System Writing Parameters – Sleep Mode Configuration					
Parameter	Description	Adjustable Range	Unit	Default	Page
P570	Sleep Mode Activation Frequency	0.00 to P134 0.00 = Disables Sleep Mode Function	Hz	30.00	16
P571	Sleep Mode Activation Time	0.0 to 999	s	10.0	16
P572	Wake up Pressure Deviation	0.00 to P552	-	0.20	16
P573	Wake up Time	0.0 a 999	s	0.0	16
Multipump System Writing Parameters – Pump Starting Configuration					
Parameter	Description	Adjustable Range	Unit	Default	Page
P575	Auxiliary Pump Starting Frequency	P133 to P134	Hz	49.00	17
P576	Auxiliary Pump Starting Pressure Deviation	0.00 to P552	-	0.20	17
P577	Auxiliary Pump Starting Time	0.0 to 999	s	3.0	18
P578	Auxiliary Pump Starting Transition Delay	0.0 to 100.0 100.0 = without transition	s	100.0	18
Multipump System Writing Parameters – Pump Stopping Configuration					
Parameter	Description	Adjustable Range	Unit	Default	Page
P580	Auxiliary Pump Stopping Frequency	P133 to P134	Hz	30.00	18
P581	Auxiliary Pump Stopping Pressure Deviation	0.00 to P552	-	0.00	18
P582	Auxiliary Pump Stopping Time	0.0 to 999	s	3.0	19
P583	Auxiliary Pump Stopping Transition Delay	0.0 a 100.0 100.0 = without transition	s	100.0	19

(1) Valid only for Floating Control.

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