

Pump Genius

CFW320

Application Manual



Application Manual

CFW320

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SUMMARY OF REVISIONS

The information below describes the reviews made in this manual.

Version	Revision	Description
V1.00	R00	First Edition.
V1.00	R01	Change in the diagram of Figure 4.22 and in the description of Section 5.17.

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0 QUICK REFERENCE OF PARAMETERS

SoftPLC Parameter Configuration for Pump Genius Application							
Param.	Description	Adjustable Range	Factory Setting	Prop.	SX	MP	MX
P102	Pipe Charging Acceleration Time (2nd Ramp)	0.0 to 999.9s	40.0s		•	•	•
P105	Enable Pipe Charging (1st/2nd Ramp Selection)	0 = Disable (1st Ramp) 6 = Enable (SoftPLC)	0		•	•	•
P510	Engineering Unit of Process Variable	0 to 1 = None 2 = Volt (V) 3 = Hertz (Hz) 4 = None 5 = Percent (%) 6 = None 7 = Rotation / min (rpm)	0		•	•	•
P511	Decimal Point of Engineering Unit of Process Variable	0 = wxyz 1 = wxy.z 2 = wx.yz 3 = w.xyz	2		•	•	•
P910	Pump Genius Application Version	0.00 to 90.00		ro	•	•	•
P911	Control Setpoint	-99.99 to 99.99	2.00		•	•	•
P912	Control Setpoint 1	-99.99 to 99.99	2.00		•	•	•
P913	Control Setpoint 2	-99.99 to 99.99	2.30		•	•	•
P914	Control Setpoint 3	-99.99 to 99.99	1.80		•	•	•
P915	Control Setpoint 4	-99.99 to 99.99	1.60		•	•	•
P916	Control Process Variable	-99.99 to 99.99		ro	•	•	•
P917	Control Auxiliary Variable	-999.9 to 999.9%		ro	•	○	○
P917	Time for Forcing Alternation of Pumps	0 to 9999	0		○	•	•
P918	PID Controller Setpoint in Manual Mode	0.0 to 400.0Hz	0.0Hz		•	○	○
P918	Time Interval for Forcing Alternation of Pumps	0 to 9999	72		○	•	•
P919	Pump Genius Simplex Logical Status	0 to FFFF (hexa) Bit 0 = Sleep Mode Active (A750) Bit 1 = PID in Manual (0) / Automatic (1) Bit 2 = Sleep Boost Active (A752) Bit 3 = Pipe Charging (A754) Bit 4 = Deragging in Execution (A756) Bit 5 = Low Level Process Variable (A760) Bit 6 = High Level Process Variable (A762) Bit 7 = Low Level Auxiliary Variable (A764) Bit 8 = External Sensor Acted (A768) Bit 9 = Dry Pump (A770) Bit 10 = Pump Clogging Detected (A772) Bit 11 = Deragging Configuration Error (A774) Bit 12 = Deragging will not be Executed (A776) Bit 13 to 15 = Reserved		ro	•	○	○
P919	Pump Motor Speed for Forcing Alternation of Pumps	0.0 to 400.0Hz	43.0Hz		○	•	•

QUICK REFERENCE OF PARAMETERS

0

SoftPLC Parameter Configuration for Pump Genius Application							
Param.	Description	Adjustable Range	Factory Setting	Prop.	SX	MP	MX
P920	Control Setpoint Source Selection	0 = Control Setpoint via HMI or Communication Networks (P911) 1 = Control Setpoint via Analog Input AI1 2 = Control Setpoint via Analog Input AI2 3 = Control Setpoint via Electronic Potentiometer (EP) 4 = Two Setpoints via Digital Input DI3 (P912 and P913) 5 = Three Setpoints via Digital Inputs DI3 and DI4 (P912, P913 and P914) 6 = Four Setpoints via Digital Inputs DI3 and DI4 (P912, P913, P914 and P915)	0	cfg	•	•	•
P921	Selection of the Control Process Variable Source	0 = Without Control Process Variable (Disable the PID Controller) 1 = Control Process Variable via Analog Input AI1 2 = Control Process Variable via Analog Input AI2 3 = Control Process Variable via Difference between Analog Input AI1 and AI2	1	cfg	•	•	•
P922	Control Process Variable Minimum Sensor Level	-99.99 to 99.99	0.00		•	•	•
P923	Control Process Variable Maximum Sensor Level	-99.99 to 99.99	4.00		•	•	•
P924	Value for Low Level Alarm for the Control Process Variable	-99.99 to 99.99	1.00		•	•	•
P925	Time Delay for Low Level Fault for the Control Process Variable	0.0 to 999.9s	0.0s		•	•	•
P926	Value for High Level Alarm for the Control Process Variable	-99.99 to 99.99	3.50		•	•	•
P927	Time Delay for High Level Fault for the Control Process Variable	0.0 to 999.9s	0.0s		•	•	•
P928	Automatic Adjustment of the PID Controller Setpoint	0 = P911 inactive and P918 inactive 1 = P911 active and P918 inactive 2 = P911 inactive and P918 active 3 = P911 active and P918 active	0		•	○	○
P928	Control Mode Configuration	0 = Fixed Control with Sequential Pump Activation 1 = Fixed Control with Pump Activation by Operating Time 2 = Floating Control 1 with Sequential Pump Activation 3 = Floating Control 1 with Pump Activation by Operating Time 4 = Floating Control 2 with Sequential Pump Activation 5 = Floating Control 2 with Pump Activation by Operating Time	0		○	•	○
P928	Pump Operation Configuration	0 = A Single Master Pump 1 = Master Pump 1 2 = Master Pump 2 3 = Master Pump 3 4 = Master Pump 4 5 = Slave Pump	0		○	○	•
P929	PID Controller Operation Mode	0 = Manual 1 = Automatic 2 = Select Control to Manual (0) or Automatic (1) via digital input DI2	1		•	○	○
P929	Time to Contactor Command	0.050 to 9.999s	0.500s		○	•	○
P929	Pumps Number Configuration	2 to 4	2		○	○	•

SoftPLC Parameter Configuration for Pump Genius Application							
Param.	Description	Adjustable Range	Factory Setting	Prop.	SX	MP	MX
P930	Selection of the PID Controller Control Action	0 = Disable PID Controller 1 = Enable PID Controller in Direct Mode 2 = Enable PID Controller in Reverse Mode	1	cfg	•	•	•
P931	Proportional Gain	0.00 to 99.99	1.00		•	•	•
P932	Integral Gain	0.00 to 99.99	25.00		•	•	•
P933	Derivative Gain	0.00 to 99.99	0.00		•	•	•
P934	Control Process Variable Deviation for Pump Genius to Wake Up	-99.99 to 99.99	0.30		•	•	•
P935	Control Process Variable Level to Starting the Pump Genius	-99.99 to 99.99	0.00		•	•	•
P936	Time Delay for Pump Genius to Wake up or Starting by Level	0.0 to 999.9s	5.0s		•	•	•
P937	Pump Motor Speed below which Pump Genius goes to Sleep Mode	0.0 to 400.0Hz	42.0Hz		•	•	•
P938	Time Delay for Pump Genius goes to Sleep Mode	0.0 to 999.9s	10.0s		•	•	•
P939	Sleep Boost Offset	-99.99 to 99.99	0.00		•	•	•
P940	Sleep Boost Maximum Time	0.0 to 999.9s	0.0s		•	•	•
P941	Pipe Charging Duration Time	0.0 to 999.9s	0.0s		•	•	•
P942	Maximum Output Current during the Pipe Charging	0.0 to 40.0A	0.0A		•	•	•
P943	Time Delay for Pump Protection via External Sensor Fault	0.0 to 999.9s	0.0s		•	•	•
P944	Motor Speed for Dry Pump	0.0 to 400.0Hz	55.0Hz		•	•	•
P945	Motor Current for Dry Pump	0.0 to 40.0A	10.0A		•	•	•
P946	Time Delay for Dry Pump Fault	0.0 to 999.9s	0.0s		•	•	•
P947	Control Auxiliary Variable Selection Source for Pump Protection	0 = Without Protection via Control Auxiliary Variable 1 = Control Auxiliary Variable via Analog Input AI1 2 = Control Auxiliary Variable via Analog Input AI2	0	cfg	•	○	○
P947	Pump Operating Time driven by the CFW320	0 to 9999	0		○	•	○
P947	Automatic Change Over Time	0.0 to 999.9s	2.0s		○	○	•
P948	Control Auxiliary Variable Sensor Maximum Level (Range)	0.0 to 100.0%	100.0%		•	○	○
P948	Operation Time of Pump 1	0 to 9999	0		○	•	•
P949	Value to detect Low Level of Control Auxiliary Variable	0.0 to 100.0%	0.0%		•	○	○
P949	Operation Time of Pump 2	0 to 9999	0		○	•	•
P950	Control Setpoint in Low Level	-99.99 to 99.99	0.00		•	○	○
P950	Operation Time of Pump 3	0 to 9999	0		○	•	•
P951	Hysteresis to reactivate the Control Setpoint	0.0 to 100.0%	0.0%		•	○	○
P951	Operation Time of Pump 4	0 to 9999	0		○	•	•
P952	Execution Mode of the Deragging Function	0 = Disable Derraging Function 1 = Executes with Command to Run the Pump 2 = Executes with Command via Digital Input DI1 3 = Executes when the Clogging of Pump is Detected	0		•	○	○
P952	Speed for Starting Pump in Parallel	0.0 to 400.0Hz	57.0Hz		○	•	•
P953	Number of Cycles for Deragging	0 to 100	0		•	○	○
P953	Deviation for Starting Pump in Parallel	0.00 to 99.99	0.10		○	•	•
P954	Speed Reference for Deragging	0.0 to 400.0Hz	0.0Hz		•	○	○
P954	Time Delay for Starting Pump in Parallel	0.0 to 999.9s	2.0s		○	•	•
P955	Deragging Run Time	0.0 to 999.9s	0.0s		•	○	○

QUICK REFERENCE OF PARAMETERS

0

SoftPLC Parameter Configuration for Pump Genius Application							
Param.	Description	Adjustable Range	Factory Setting	Prop.	SX	MP	MX
P955	Delay in the Deceleration when Starting Pump in Parallel	0.0 to 100.0s	0.0s		○	●	○
P956	Deragging Stop Time	0.0 to 999.9s	0.0s		●	○	○
P956	Speed for Stopping Pump in Parallel	0.0 to 400.0Hz	43.0Hz		○	●	●
P957	Motor Current to detect Clogging of Pump	0.0 to 40.0A	0.0A		●	○	○
P957	Deviation for Stopping Pump in Parallel	0.00 to 99.99	0.20		○	●	●
P958	Time Delay to detect Clogging of Pump	0.0 to 999.9s	0.0s		●	○	○
P958	Time Delay for Stopping Pump in Parallel	0.0 to 999.9s	2.0s		○	●	●
P959	Number of consecutives Clogging to generate the Fault	0 to 100	0		●	○	○
P959	Delay in the Acceleration when Stopping Pump in Parallel	0.0 to 100.0s	0.0s		○	●	○

Notes:

ro = Read only parameter

cfg = Configuration parameter, value can be programmed only with motor stopped

SX = Indicates that the parameter is compatible with the Pump Genius Simplex application

MP = Indicates that the parameter is compatible with the Pump Genius Multipump application

MX = Indicates that the parameter is compatible with the Pump Genius Multiplex application

1 QUICK REFERENCE OF ALARMS AND FAULTS

Faults and Alarms for Pump Genius Application					
Fault / Alarm	Description	Possible Causes	SX	MP	MX
A750 Sleep Mode Active	It indicates that the Pump Genius is in sleep mode.	■ Value of the pump motor speed is below the threshold programmed in P937 during the time programmed in P938.	•	•	•
A752 Sleep Boost Active	It indicates that the sleep boost is in execution.	■ Motor speed was below the value set in P937 during the time set in P938, but before going into sleep mode applies a boost (P939) in the control setpoint to increase the process variable.	•	•	•
A754 Pipe Charging	It indicates that the process of pipe charging is being executed.	■ The Run/Stop command was is executed or command Enable Pump Genius (Multipump and Multiplex) with the pipe filling enabled (P105 = 6).	•	•	•
A756 Deragging is in Execution	It indicates that the deragging function is running.	■ The deragging function is enabled (P952≠0) and the condition to start it was detected.	•	○	○
A758 Forcing Rotation of Pumps	It indicates to the user that the Pump Genius is forcing the alternation of pumps.	■ The Pump Genius is operating with only one pump running for a longer time than the value set in P918 and the speed value of this pump is lower than the value set in P919.	○	•	•
A760 Low Level of the Control Process Variable	It indicates that the control process variable (P916) is in low level.	■ The control process variable (P916) is lower than the value programmed in P924.	•	•	•
F761 Low Level of the Control Process Variable	It indicates that the Pump Genius was stopped due to low level of the control process variable.	■ The control process variable (P916) remained for a time (P925) at a value lower than the threshold programmed in P924.	•	•	•
A762 High Level of the Control Process Variable	It indicates that the control process variable (P916) is in high level.	■ The control process variable (P916) is higher than the value programmed in P926.	•	•	•
F763 High Level of the Control Process Variable	It indicates that the Pump Genius was stopped due to high level of the control process variable.	■ The control process variable (P916) remained for a time (P927) at a value higher than the threshold programmed in P926.	•	•	•
A764 Low Level of Control Auxiliary Variable	It indicates that the control auxiliary variable (P917) is in low level and the control setpoint was changed to the value of P950.	■ The control auxiliary variable (P917) is lower than the value programmed in P949.	•	○	○
A768 External Sensor Acted	It indicates that protection via external sensor via digital input is actuated.	■ Pump in operation and digital input has logic level "0".	•	•	•
F769 External Sensor Acted	It indicates that the pump was stopped due to protection to external sensor via digital input.	■ Pump in operation and digital input set to external sensor remained at logic level "0" for a defined time (P943).	•	•	•
A770 Dry Pump	It indicates that the dry pump condition was detected.	■ Value of the pump motor speed is above of the threshold programmed in P944 and motor current is below the threshold programmed in P945.	•	•	•
F771 Dry Pump	It indicates that the pump was stopped due to dry pump protection.	■ During a time (P946) the value of the pump motor speed remains above of the threshold programmed in P944 and motor current remains below the threshold programmed in P945.	•	•	•
A772 Clogging Detected	It indicates that the clogging of pump was detected due the high current in the pump motor.	■ Deragging was configured to execute when clogging is detected (P952=3) and the motor current was greater than the motor current to detect the pump clogging (P957) during a time to detect the pump clogging (P958).	•	○	○
F773 Excess of Clogging Detected	It indicates that the pump was stopped due a excess number of clogging detected.	■ Deragging was configured to execute when clogging is detected (P952=3) and the number of clogging detected was equal to the value defined as limit to generate a fault by consecutives clogging (P959).	•	○	○

QUICK REFERENCE OF ALARMS AND FAULTS

1

Faults and Alarms for Pump Genius Application					
Fault / Alarm	Description	Possible Causes	SX	MP	MX
A774 Deragging Configuration Error	It indicates that the pump cannot be deragged due to the direction of rotation of the motor in REMOTE mode (P226) is not configured to be via SoftPLC.	■ Speed reference in REMOTE mode has been programmed for SoftPLC (P222 = 12), the CFW320 frequency inverter is in REMOTE mode, but the direction of rotation of the motor in REMOTE mode has not been programmed for SoftPLC (P226 = 12).	●	○	○
A776 Deragging will not be Executed	It indicates that the deragging couldn't be executed due to the CFW320 inverter be in LOCAL mode.	■ The deragging function is enabled (P952≠0), but couldn't be executed due to the CFW320 inverter be operating in LOCAL mode.	●	○	○
A778 Pump Disabled in Operation	It indicates that the pump was disabled from operation in the Pump Genius.	■ Digital input DI2 configured in "45 = Enable use of the Pump" was set to logic level "0", issuing the command to disable the pump.	○	○	●
A780 Pump 1 disabled	It indicates that pump 1 was disabled while it was on.	■ Digital inputs DI2 or DI5 set in "45 = Enable Pump 1" went to logic level "0" while pump 1 was on.	○	●	○
A782 Pump 2 disabled	It indicates that pump 2 was disabled while it was on.	■ Digital inputs DI6 set in "46 = Enable Pump 2" went to logic level "0" while pump 2 was on.	○	●	○
A784 Pump 3 disabled	It indicates that pump 3 was disabled while it was on.	■ Digital inputs DI7 set in "47 = Enable Pump 3" went to logic level "0" while pump 3 was on.	○	●	○
A786 Pump 4 disabled	It indicates that pump 4 was disabled while it was on.	■ Digital inputs DI8 set in "48 = Enable Pump 4" went to logic level "0" while pump 4 was on.	○	●	○
A790 Master System Recognition	It indicates that the CFW320 frequency inverter is in the process of master pump recognition of the system.	■ Inverter was energized and waiting for the elapse of the 2-second time to recognize the system's master pump through the frequency inputs and outputs of the CFW320-IODF accessory module.	○	○	●
A792 Changing the System Master Pump	It indicates the loss of communication with the pump that was master at Pump Genius. Waits for user command to perform (I/O key) the manual change of the master pump in Pump Genius.	■ Loss of communication with the pump that assumed the master function in Pump Genius through the frequency inputs and outputs of the CFW320-IODF accessory module.	○	○	●
A794 Loss of System Master Pump	It indicates that a slave pump (P928=5) detected the loss of communication with the master pump in Pump Genius.	■ Loss of communication with the pump that assumed the master function in Pump Genius through the frequency inputs and outputs of the CFW320-IODF accessory module.	○	○	●
F795 Two Active Masters	It indicates that two or more master/slave pumps simultaneously assumed the role of master in Pump Genius.	■ User programmed two or more pumps to be master / slave (P928=1, 2, 3 and 4) and after a failure or energization of the CFW320 frequency inverter, two or more pumps simultaneously assumed the master function in Pump Genius.	○	○	●
A796 Alteration Test Interrupted	It indicates that the pump sequential alternation test was interrupted.	■ The pump sequential alternation test was interrupted by unavailability or fault with the pump to be driven.	○	●	●

Notes:

SX = Indicates that the fault or alarm is generated in the Pump Genius Simplex application.

MP = Indicates that the fault or alarm is generated in the Pump Genius Multipump application.

MX = Indicates that the fault or alarm is generated in the Pump Genius Multiplex application.

Fault and alarm operation:

- Faults operate by indicating their occurrence on the HMI, in the frequency inverter status word (P006), in the present fault parameter (P049) and disabling the motor. They can only be reset with a reset command or de-energizing the frequency inverter;
- Alarms operate by indicating their occurrence on the HMI and in the present alarm parameter (P048). They are automatically reseted when the alarm condition is removed.

2 GENERAL INFORMATION

This manual provides the necessary information for the configuration of Pump Genius Simplex, Multipump and Multiplex application developed with the CFW320 inverter SoftPLC function. This application manual must be used together with the CFW320 user's manual, the CFW320 programming manual and the WPS software manual.

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2

2.1 SAFETY NOTICES IN THE MANUAL

The following safety notices are used in this manual:



DANGER!

The procedures recommended in this warning have the purpose of protecting the user against death, serious injuries and considerable material damage.



ATTENTION!

The procedures recommended in this warning have the purpose of avoiding material damage.



NOTE!

The information mentioned in this warning is important for the proper understanding and good operation of the product.

2.2 TERMINOLOGY AND DEFINITIONS

2.2.1 Terms and Definitions Used

Amp, A: Ampère.

AIP: analog input via potentiometer.

Aix: analog input "x".

AOx: analog output "x".

° **C:** Celsius degrees.

CA: alternate current.

DC: direct current.

Pre-Charge Circuit: charges the capacitors of the DC link with limited current, avoiding current peaks in the inverter power-up.

CO/DN/PB/ETH: Interface CANopen, DeviceNet, ProfibusDP or Ethernet.

CV: cavalo-vapor = 736 Watts (Brazilian unit of measurement of power, normally used to indicate mechanical power of electric motors).

Heatsink: metal part designed to dissipate the heat produced by power semiconductors.

Dix: digital input "x".

DOx: digital output "x".

GENERAL INFORMATION

2

Switching Frequency: switching frequency of the IGBTs of the inverter bridge, normally expressed in kHz.

Run/Stop: inverter function which, when activated (run), accelerates the motor by acceleration ramp up to the reference frequency and, when deactivated (stop), decelerates the motor by deceleration ramp. It may be controlled by digital input set for this function, via serial or via SoftPLC.

h: hour; time unit.

General Enable: when activated, it accelerates the motor by acceleration ramp and Run/Stop = Run. When disabled, the PWM pulses will be immediately blocked. It may be controlled by digital input set for this function, via serial or via SoftPLC.

HMI: human-machine interface; device which allows controlling the motor, viewing and changing the inverter parameters. It features keys to control the motor, navigation keys and graphic LCD display.

hp: horse power = 746 Watts (power unit, normally used to indicate mechanical power of electric motors).

Hz: hertz; frequency unit.

IGBT: insulated gate bipolar transistor - basic component part of the output inverter bridge. It works as an electronic switch in the saturated (closed switch) and cut-off (open switch) modes.

I_{nom}: inverter rated current by P295.

kHz: kilohertz = 1000 Hertz; frequency unit.

200 V Line: Models powered from 110 to 127 Vac, 200 to 240 Vac or 280 to 340 Vdc, for more information refer to the inverter user manual.

400 V Line: Models powered from 380 to 480 Vac or 537 to 680 Vdc, for more information refer to the inverter user manual.

DC Link: intermediary circuit of the inverter; voltage in direct current obtained by rectifying the power supply alternate voltage or external supply; it supplies the output inverter bridge with IGBTs.

mA: milliampère = 0.001 Ampère.

min: minute; time unit.

ms: milisecond = 0.001 second.

Nm: Newton meter; torque unit.

NTC: resistor whose resistance value in ohms decreases proportionally to the increase of the temperature; it is used as a temperature sensor in power packs.

PE: Protective Earth.

PTC: resistor whose resistance value in ohms increases proportionally to the temperature; it is used as a temperature sensor in motors.

PWM: pulse width modulation - modulation by pulse width; pulsed voltage that supplies the motor.

Rectifier: input circuit of the inverters that transforms the input AC voltage into DC. It is formed by high-power diodes.

RMS: root mean square; effective value.

rpm: revolutions per minute; rotation unit.

s: second; time unit.

V: volts; electric voltage unit.

WPS: Programming Software "WEG Programming Suite".

Ω: ohms; electric resistance unit.

2.2.2 Numerical Representation

The decimal numbers are represented by means of digits without suffix. Parameters P012, P013, P045, P397, P680, P682, P684, P685, P690, P695, P697, P757, P758 and P840 are represented in hexadecimal numbers.

2.2.3 Symbols to Describe Parameter Properties

ro: read only parameter.

cfg: parameter that can be changed only with a stopped motor.

V/f: parameter available in the V/f mode.

VVW: parameter available in the VVW mode.

3 INTRODUCTION TO THE PUMP GENIUS APPLICATION

The Pump Genius application developed for the CFW320 inverter SoftPLC function provides the user with flexibility in the operation and configuration. It uses the tools already developed for the WPS programming software together with configuration and monitoring wizards. For the CFW320 frequency inverter, the Pump Genius application functions were implemented in three different control strategies: Simplex, Multipump and Multiplex.

3.1 PUMPS

Pumps are hydraulic operating machines that transfer energy to the fluid for the purpose of transporting it from one point to another. They receive energy from a motor source and transfer part of it to the fluid in the form of pressure energy, kinetic energy, or both, i.e., increase the fluid's pressure or speed, or both quantities.

Commonly used ways to drive pumps are:

- Electric motors;
- Internal combustion motors;
- Turbines.

Pumps can be classified into two wide categories:

- Centrifugal pumps or turbo pumps;
- Volumetric pumps or positive displacement pumps.

3.1.1 Centrifugal Pumps

This kind of pump has as its operating principle the transfer of mechanical energy to the fluid to be pumped in the form of kinetic energy. This kinetic energy is transformed into potential energy (pressure energy), which is its main characteristic. The rotational movement of a rotor inserted in a casing (pump body) is the functional part responsible for this transformation.

According to the types and shapes of rotors, centrifugal pumps can be classified as follows:

- **Radial or pure**, when the direction of the pumped fluid is perpendicular to the rotating axle;
- **Mixed flow or semi-axial**, when the direction of the pumped fluid is inclined in relation to the rotating axle;
- **Axial flow**, when the direction of the pumped fluid is parallel in relation to the rotating axle.

3.1.2 Positive Displacement Pumps

The operating principle of this type of pump is based on the direct transfer of mechanical work (of a motor shaft rotation against a load torque) into potential energy (pressure energy). This transfer is obtained by the movement of a mechanical apparatus of the pump (piston, diaphragm, gears, screws, etc.), which forces the fluid to execute the same movement.

The liquid cyclically fills and then is ejected from a given volume of space inside the pump, a process which is responsible for the name "Volumetric Pump".

Variations of these mechanical apparatuses permit the classification of volumetric or positive displacement pumps:

- **Piston or alternative pumps**, when the apparatus which produces the movement of the fluid is a piston which moves in alternating directions and expels the pumped fluid;
- **Rotary pumps**, when the apparatus which produces the movement of the fluid is driven by rotational movement, like a screw, gear, flukes, lobes, etc.

3.2 CRITERIA FOR ASSOCIATION OF PUMPS IN PARALLEL

It is useful to analyze some data in order to designing a pumping system to determine whether it shall be composed of a single pump or through association of pumps in parallel:

- Determine whether a single pump can alone meet the flow required by the pumping system;
- Determine if over the long term there is potential for a change in the needed flow rate, for example, due to a population increase;
- Note the range of consumption which needs to be supported by the pumping system during the day.

3

3.2.1 Advantages in the Association of Pumps in Parallel

A pumping system with association of pumps in parallel has the following advantages compared to a single pump system:

- Greater flexibility of the pumping system, both in operation and in implementation;
- Energy saving;
- Increased life span of the pumping system;
- It facilitates uninterrupted operation;
- It provides the necessary flow according to the pumping system demand;
- It simplifies a pumping system fault diagnosis;
- Pump operation time equalization, thus assuring uniform wear.

3.2.2 Disadvantages in the Association of Pumps in Parallel

A pumping system with association of pumps in parallel has the following disadvantages compared to a single pump system:

- More units (pumps, sensors, piping, etc.) to be maintained;
- Larger space of plant, increasing construction costs;
- The greater the number of pumps associated in parallel, the lower the flow of each individual pump. For example, if we have only one pump at maximum flow rate of 150 l/s, by associate a second pump in parallel, we will have a maximum flow of 260 l/s, i.e., each pump will have maximum flow of 130l/s.

3.3 GENERAL CHARACTERISTICS OF THE PUMP GENIUS

3.3.1 Pump Genius Simplex

The main characteristic of the Pump Genius Simplex application developed for the CFW320 inverter SoftPLC function is the control of one pump using for this a frequency inverter that will control your speed as required by the user demand.

Each is notable for the following characteristics:

- Control of only one pump driven by CFW320 frequency inverter;
- Acceleration and deceleration ramps for the pump driven by inverter;
- Maximum and minimum speed limits for the pump driven by inverter;
- Selection of the control setpoint via analog input, or HMI of the CFW320 frequency inverter, or communication networks, or logical combination of two digital inputs (maximum 4 setpoints), or via electronic potentiometer (EP) via two digital inputs;

- Election of the control process variable via analog input or the difference between analog input AI1 and AI2 (AI1–AI2); allows also not have the control process variable so disabling the PID controller;
- Selection of the engineering unit and range of the control process variable sensor via CFW320 parameters;
- Gain, offset and filter adjustments for the control signals via analog inputs;
- PID controller gains setting of the pumping control via HMI parameters;
- Control action of the PID controller configured for direct mode or reverse mode, or can be disabled;
- Selection of operation mode of the PID controller in Manual or Automatic, and may be selecting via digital input DI2 or via parameter;
- Enable or not of the sleep mode;
- Enable or not the boost function before entering sleep mode;
- Wake up mode or start level mode for starting the pump with the PID controller enabled;
- Initiate the pumping with pipe charging through the pump driven by inverter;
- Adjustment of the motor current limitation during the pipe charging process;
- Low level protection of the control process variable (pipe breaking);
- High level protection of the control process variable (pipe obstruction);
- Indication of the low or high level alarm protection for the control process variable via digital output DO3;
- Dry pump protection through evaluation of motor current and pump speed;
- Pump protection via external sensor in the digital input DIx;
- Selection of an analog input as a control auxiliary variable for pump protection;
- Pump cavitation protection via low level adjustment of control auxiliary variable;
- Detection of pump clogging driven by the inverter via high current in the motor;
- Execution of deragging of the pump via a command to start the pump, or a command in the digital input DIx or when the clogging of the pump is detected;
- Possibility of enabling the pump driven by the frequency inverter via HMI (local mode);
- Possibility of implementation or modification of the application by the user through the WPS software.

3.3.2 Pump Genius Multipump

The Pump Genius Multipump application developed for the SoftPLC function of the CFW320 frequency inverter has the main characteristic of controlling two or more pumps in parallel using only one CFW320 frequency inverter, and it will control the speed of just one pump.

Presents the main features:

- Fixed Control: control of up to 5 (five) pumps associated in parallel, one pump (always the same) driven by the CFW320 frequency inverter, and the others by some other starting method;
- Floating Control Type 1: control of up to 4 (four) pumps associated in parallel where the first pump to be connected is connected to the CFW320 frequency inverter, and the other pumps are switched on and off via contactors;
- Floating Control Type 2: control of up to 3 (three) pumps associated in parallel where the last pump turned on is connected to the CFW320 frequency inverter, and the other pumps are switched on and off via contactors;
- Floating Control Type 1 and 2: allows the exchange of the pump driven by the CFW320 frequency inverter;

- Floating Control Type 1 and 2: possibility of forcing the alternation of pumps, i.e., if the Pump Genius operates for a long time with only one pump (Pump Genius does not enter in sleep mode), the Pump Genius is disabled, then another pump is turned on (as operating time) for controlling the pumping;
- Control of the activation mode of the pumps (sequence or alternation);
- Logic for alternation of the pumps according to the operation time;
- Acceleration and deceleration ramps for the pump driven by inverter;
- Maximum and minimum speed limits for the pump driven by inverter;
- Selection of the control setpoint via analog input, or HMI of the CFW320 frequency inverter, or communication networks, or logical combination of two digital inputs (maximum 4 setpoints), or via electronic potentiometer (EP) via two digital inputs;
- Selection of the pumping control process variable via analog input AI1;
- Selection of the engineering unit and range of the control process variable sensor via CFW320 parameters;
- Gain, offset and filter adjustments for the control signals via analog inputs;
- PID controller gain setting of the pumping control via HMI parameters;
- Control action of the PID controller configured for direct or reverse mode;
- Enable or not of the Sleep mode;
- Enable or not the boost function before entering sleep mode;
- Wake up mode or start level mode for starting the pump with the PID controller enabled;
- Initiate the pumping with pipe charging through the pump driven by inverter;
- Adjustment of the pump motor current limitation during the pipe charging;
- Low level protection of the control process variable (pipe breaking);
- High level protection of the control process variable (pipe obstruction);
- Dry pump protection through evaluation of motor current and pump speed;
- Pump protection via external sensor in the digital input DIx;
- Possibility of enabling the use of the pump in Pump Genius through the digital input DIx;
- Possibility of running the pump driven by inverter via HMI (local mode);
- Possibility of implementation or modification of the application by the user through the WPS software.

3.3.3 Pump Genius Multiplex

The main characteristic of the Pump Genius Multiplex application developed for the CFW320 inverter SoftPLC function is the control of two or more pumps in parallel with each pump being driven by its respective CFW320 inverter.

Each is notable for the following characteristics:

- Control of up to 4 (four) associated pumps in parallel with each pump driven by their respective CFW320 inverter;
- Communication (data exchange) between associated pumps in parallel via frequency signals via the CFW320-IODF accessory module;
- Configuration of each pump to function as either master/slave pump or slave pump; this configuration determines how the respective pump will take appropriate actions to control the pumping;
- Logic to equalize the operating time of the pumps by alternating the active pump;

- In case of communication loss with the actual master pump, another master/slave pump can assume the master pump function. This change can be done automatically or manually via a command in the CFW320 HMI;
- Executes the change of the master pump if the control process variable sensor cable breaks when analog input is 4-20mA;
- Acceleration and deceleration ramps for each inverter driven pump;
- Maximum and minimum speed limits for each inverter driven pump;
- Selection of the control setpoint via analog input, or HMI of the CFW320 frequency inverter, or communication networks, or logical combination of two digital inputs (maximum 4 setpoints), or via electronic potentiometer (EP) via two digital inputs;
- Pumping control process variable via analog input AI1;
- Selection of the engineering unit and range of the control process variable sensor via CFW320 parameters;
- Gain, offset and filter adjustments for the control signals via analog input;
- PID controller gain setting of the pumping control via HMI parameters;
- Control action of the PID controller configured for direct or reverse mode;
- Enable or not of the sleep mode;
- Enable or not the boost function before entering sleep mode;
- Wake up mode or start level mode for starting the pump with the PID controller enabled;
- Initiate the pumping with pipe charging through inverter driven pump;
- Adjustment of the pump motor current limitation during the pipe charging;
- Low level protection of the control process variable (pipe breaking);
- High level protection of the control process variable (pipe obstruction);
- Dry pump protection through evaluation of motor current and pump speed;
- Pump protection via external sensor in the digital input DIx;
- Possibility to forcing the alternation of pumps, i.e., if the Pump Genius be operating for a long time with only one pump (Pump Genius does not go into sleep mode), the Pump Genius will be disabled and then, the other pump is started (as the operation time) for controlling the pumping;
- Possibility of enabling an individual pump to work within the Pump Genius through digital input DIx;
- Possibility of running the inverter driven pump via HMI (local mode);
- Possibility of implementation or modification of the application by the user through the WPS software.

4 CONTROL CONNECTIONS

The Pump Genius application (Simplex, Multipump and Multiplex) developed for the CFW320 frequency inverter SoftPLC function includes several features for pumping control, several of which impact specific connections on the control card and accessories. Following will be presented schematic suggestive as each functionality.



NOTE!

The Pump Genius application (Simplex, Multipump and Multiplex) only works on the CFW320 frequency inverter with a **firmware version higher than V1.20**.



NOTE!

Refer to the CFW320 User Manual for more details on installing and connecting the inverter.

4.1 CONTROL SETPOINT

4.1.1 HMI or Communication Networks

The user can configure the Pump Genius application (Simplex, Multipump and Multiplex) with the control setpoint defined in a parameter that can be changed via the HMI of the CFW320 frequency inverter or communication networks. It can be composed as follows:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- Command for Run/Stop (S1);
- Status light for motor running (H1).

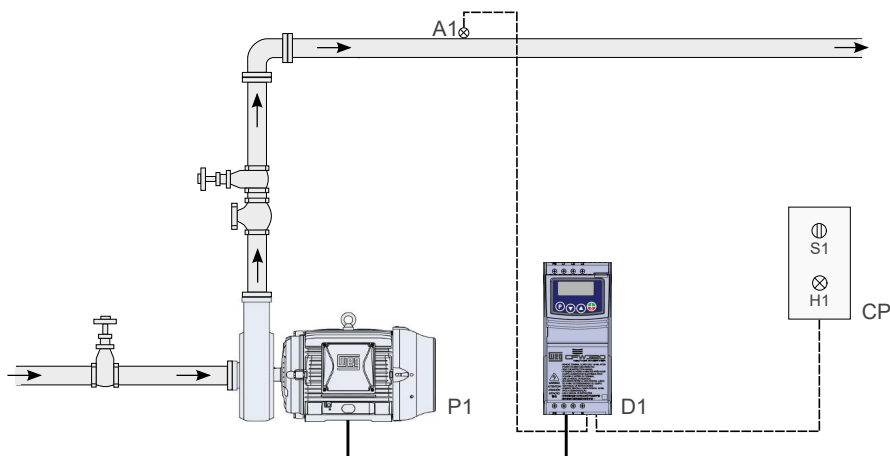


Figure 4.1: Pump Genius application with control setpoint via HMI or communication networks



NOTE!

Use the Pump Genius configuration wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with control setpoint via HMI or communication networks.



NOTE!
The indicating light H1 is not necessary for the operation of the Pump Genius with control setpoint via HMI or communication networks. It only indicates the condition of the pump operation at the command panel (CP).

The [Figure 4.2 at page 4-2](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter to have the control setpoint adjusted via HMI or communication networks.

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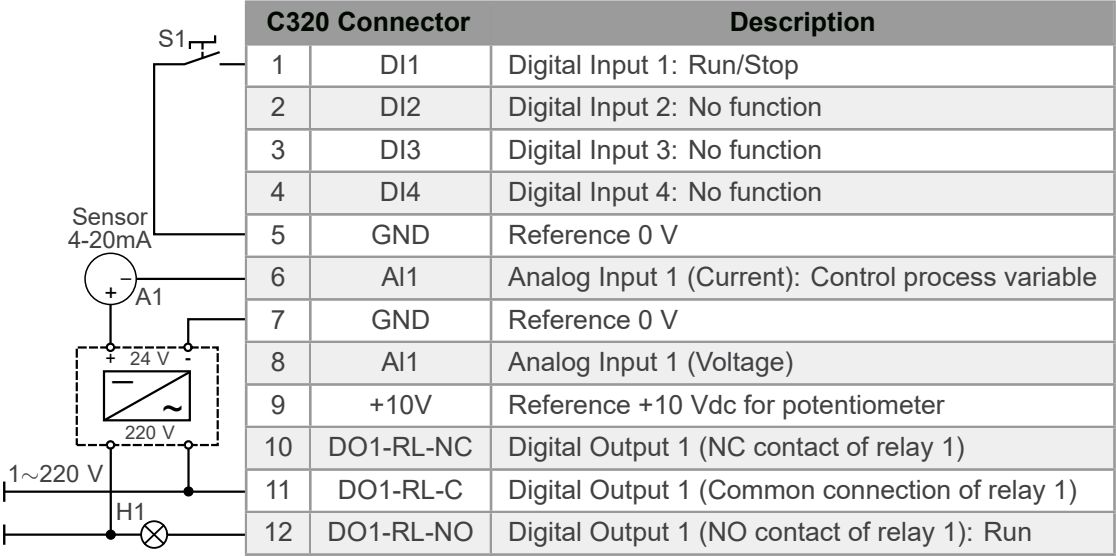


Figure 4.2: Signals on connector of the C320 control card for setpoint via HMI or communication networks.



NOTE!
Refer to the CFW320 frequency inverter manual for more information on connections.

4.1.2 Analog Input

The user can configure the Pump Genius application (only Simplex) to allow control the setpoint via one analog input of the CFW320 inverter, which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- 01 Potentiometer for adjusting the control setpoint via input analog (R1);
- Command for Run/Stop (S1);
- Status light for motor running (H1);
- Status light for inverter no fault (H2);
- Status light for low-level protection of the control process variable (H3);
- Status light for high-level protection of the control process variable (H4).

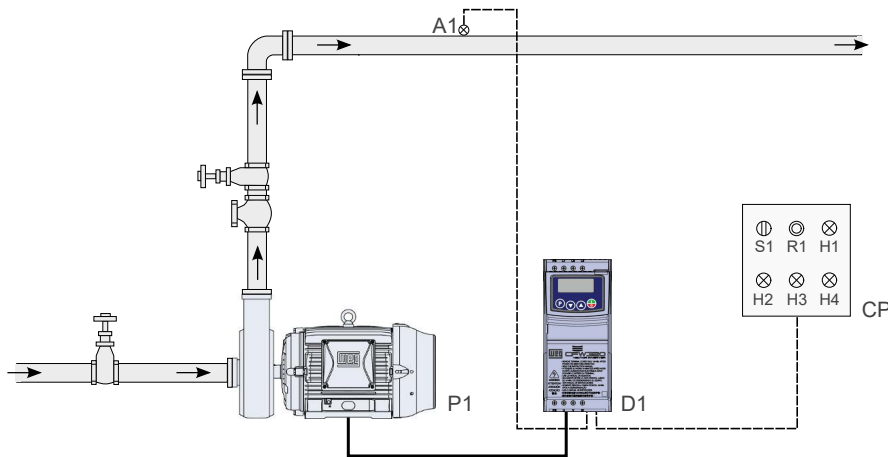


Figure 4.3: Pump Genius Simplex application and control setpoint via analog input



NOTE!

Use the Pump Genius configuration wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with control setpoint via analog input.



NOTE!

The indicating lights H1, H2, H3 and H4 are not necessary for the operation of the Pump Genius with control setpoint via analog input. They only indicate the condition of the pump operation at the command panel (CP).

The [Figure 4.4 at page 4-4](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter and to the connector of the accessory module for I/O expansion (CFW320-IOAR) to have the control setpoint adjusted via analog input.

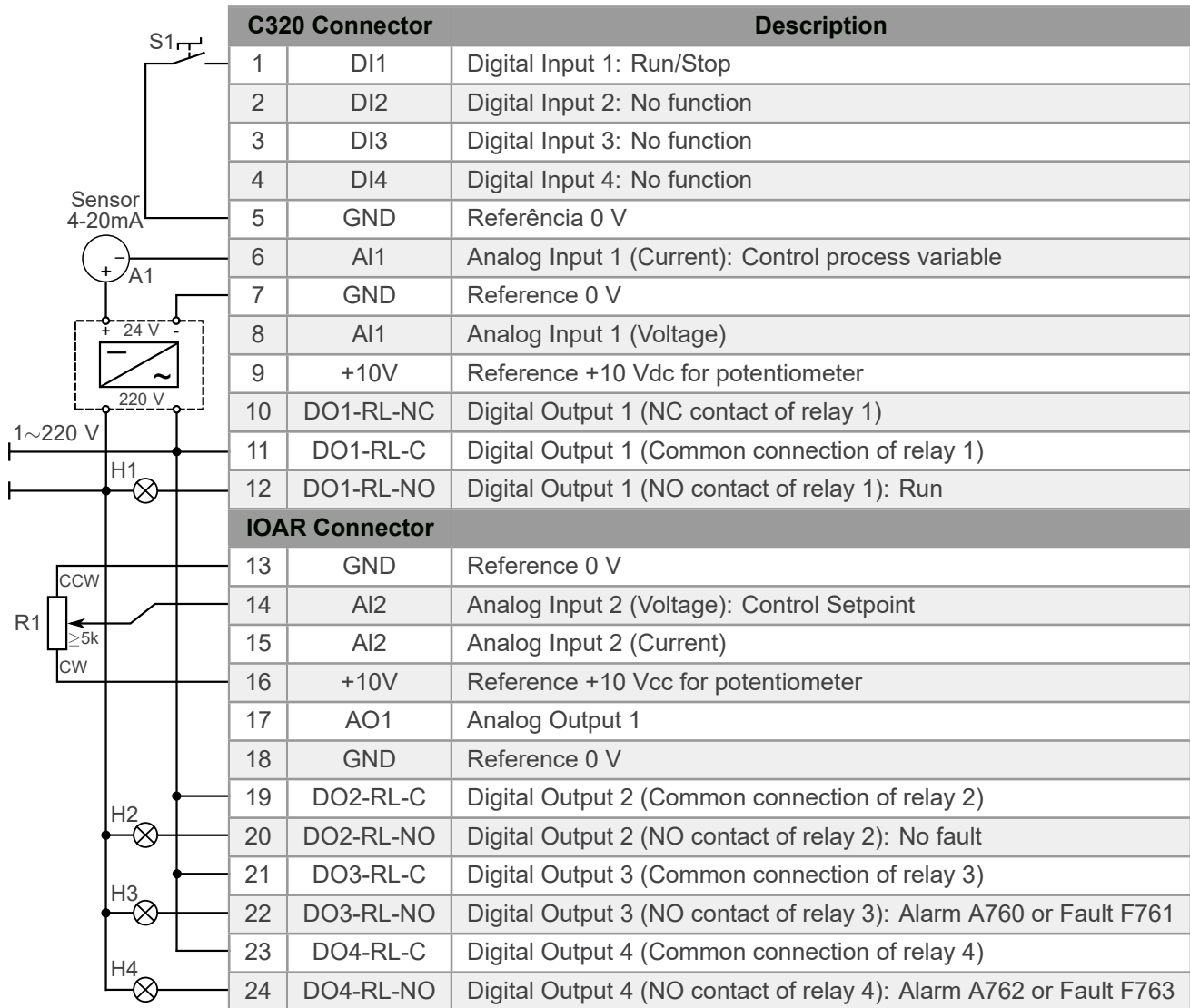


Figure 4.4: Signals on connector of the C320 control card and the accessory module for I/O expansion (CFW320-IOAR) for setpoint via analog input



NOTE!

Refer to the CFW320 frequency inverter and the CFW320-IOAR accessory module manuals for more information on connections.

4.1.3 Electronic Potentiometer (EP)

The user can configure the Pump Genius application (Simplex, Multipump and Multiplex) to have the control setpoint increased or decreased through commands on digital inputs, which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- Command for Run/Stop (S1);
- Command Increment Setpoint (S2);
- Command Decrement Setpoint (S3);
- Status light for motor running (H1).

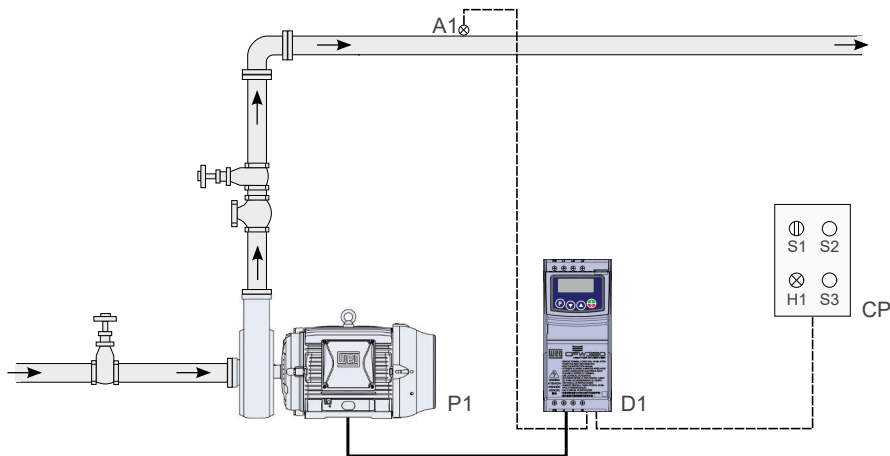


Figure 4.5: Pump Genius application with control setpoint via electronic potentiometer (EP)



NOTE!

Use the Pump Genius configuration wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with control setpoint via electronic potentiometer (EP).



NOTE!

The indicating light H1 is not necessary for the operation of the Pump Genius with control setpoint via electronic potentiometer (EP). It only indicates the condition of the pump operation at the command panel (CP).

The [Figure 4.6 at page 4-6](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter to have the control setpoint adjusted via electronic potentiometer (EP).

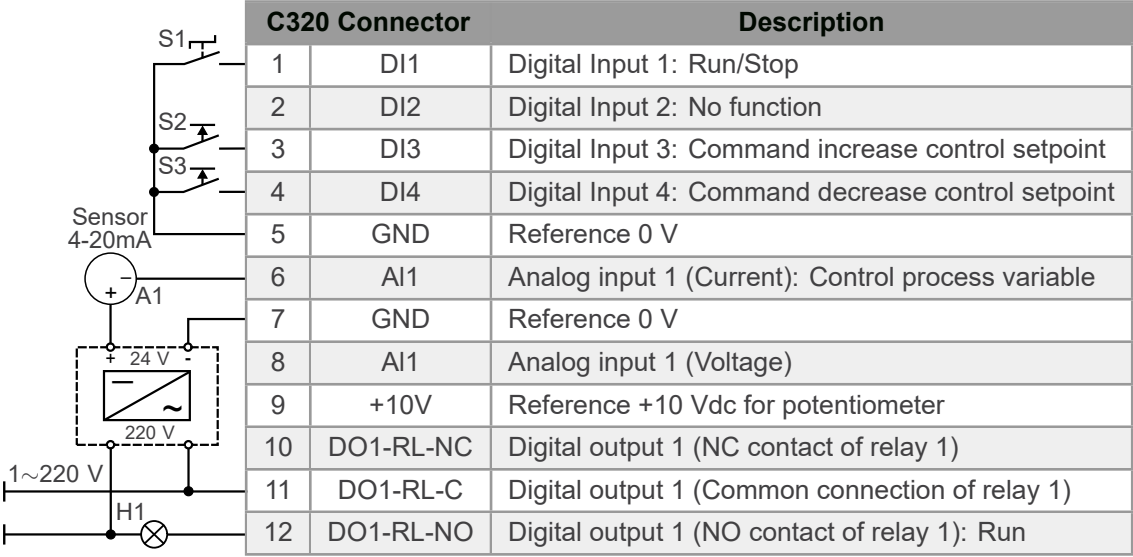


Figure 4.6: Signals on the C320 control card connector for control setpoint via electronic potentiometer (EP)



NOTE! Refer to the CFW320 frequency inverter manual for more information on connections.

4.1.4 Logic combination of the Digital Inputs

The user can configure the Pump Genius (Simplex, Multipump and Multiplex) application to have two, three or four setpoint values for control via logic combination of digital inputs, which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- Command for Run/Stop (S1);
- Switch of “n” positions for selection of the control setpoint (S4);
- Status light for motor running (H1).

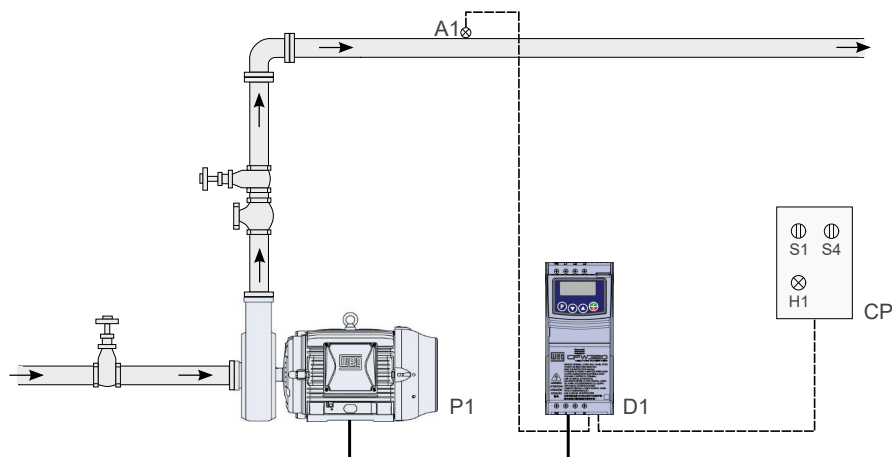


Figure 4.7: Pump Genius application and control setpoint via combination of the digital inputs



NOTE!

Use the Pump Genius configuration wizard in WPS software to configure the pump driven by CFW320 inverter with control setpoint via logical combination of the digital inputs.



NOTE!

The indicating light H1 is not necessary for the operation of the Pump Genius with control setpoint via logic combination of digital inputs. It only indicates the condition of the pump operation at the command panel (CP).

The [Figure 4.8 at page 4-8](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter to have the control setpoint adjusted via logic combination of digital inputs.

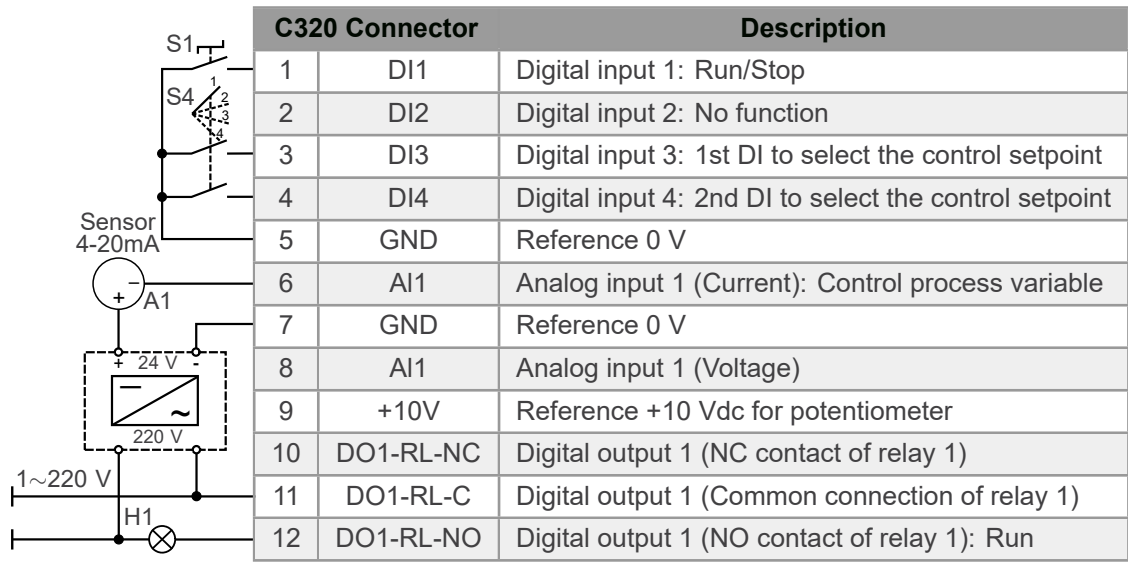


Figure 4.8: Signals on the C320 control card connector for control setpoint via logical combination of digital inputs



NOTE! Refer to the CFW320 frequency inverter manual for more information on connections.

4.1.5 PID Controller in Manual or Automatic mode via Digital Input

The user can configure the Pump Genius application (Simplex only) to have the PID controller operating mode defined according to the state of a digital input, where (0) indicates manual mode and (1) indicates automatic mode, which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- Command for Run/Stop (S1);
- Manual (0)/ Automatic (1) commutation switch to select the operation mode of the PID controller (S5);
- Status light for motor running (H1).

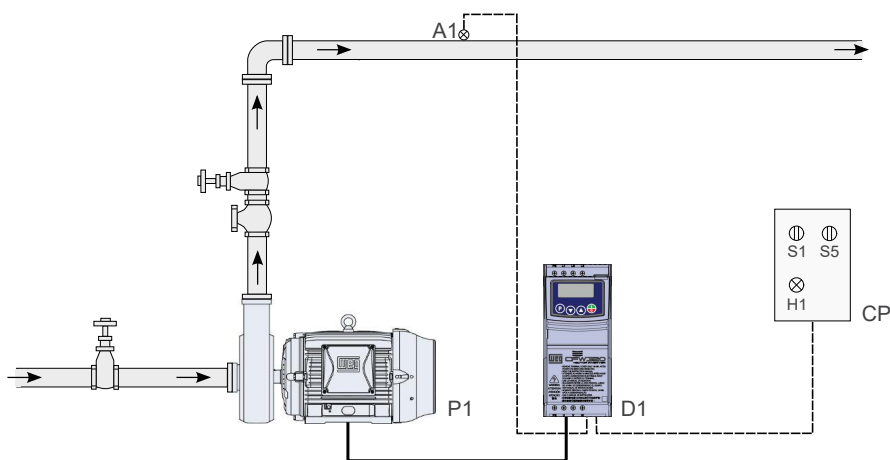


Figure 4.9: Pump Genius application with selection of PID controller in manual or automatic via digital input



NOTE!

Use the Pump Genius configuration wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with selection of PID controller in manual or automatic via digital input.



NOTE!

The indicating light H1 is not necessary for the operation of the Pump Genius with selection of PID controller in manual or automatic via digital input. It only indicates the condition of the pump operation at the command panel (CP).

The [Figure 4.10 at page 4-10](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made on the connector of the C320 control card of the CFW320 frequency inverter with selection of PID controller in manual or automatic via digital input.

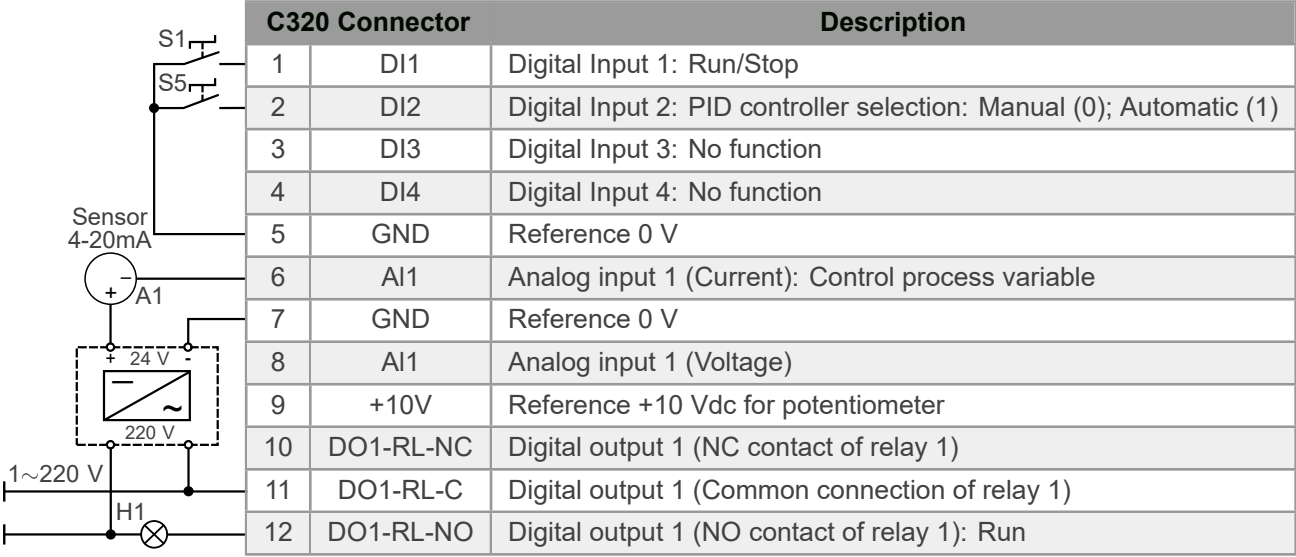


Figure 4.10: Signals on the C320 control card connector with selection of PID controller in manual or automatic via digital input



NOTE! Refer to the CFW320 frequency inverter manual for more information on connections.

4.2 ASSOCIATION OF PUMPS IN PARALLEL

The Pump Genius application basically contemplates two distinct methods for controlling pumping when the system has two or more pumps associated in parallel. The Multipump method uses only one CFW320 frequency inverter to vary the speed of the pump driven by it and drives the other pumps in parallel through commands via digital outputs. The Multiplex method uses a CFW320 frequency inverter for each pump in parallel with data exchange between them, thus allowing the speed variation of all pumps in parallel in the system.

4.2.1 Multipump Fixed Control

It is characterized by the fact that the system consists of the association of two to five pumps in parallel and the CFW320 frequency inverter always controls the speed of the same pump. The other pumps in the system are controlled by the digital outputs of the same frequency inverter and operate at the rated speed. Thus, the user can use the start mode that best suits his needs: direct on line, star delta, softstarter, etc.



NOTE!

Up to two pumps in parallel (one driven by the CFW320 frequency inverter and the other by digital output DO1) there is no need to add an I/O expansion module. From three to five pumps in parallel, it is necessary to install the CFW320-IODR I/O expansion accessory module (4 digital inputs and 3 relay outputs).

4

The [Figure 4.11 at page 4-12](#) presents a typical system with three pumps in parallel and control setpoint via HMI, basically composed of:

- 01 CFW320 frequency inverter (D1);
- 03 Electric motor + pump (P1, P2 and PD);
- 01 Sensor with analog output signal to measure the control process variable (A1);
- Command to enable Pump Genius (S0);
- Command to enable the use of the pump 1, and 2 (S1 and S2);
- Status light of the pump driven by the connected frequency inverter (PD) or for motor running (H0);
- Status light of the pumps 1 and 2 are running (H1 and H2).

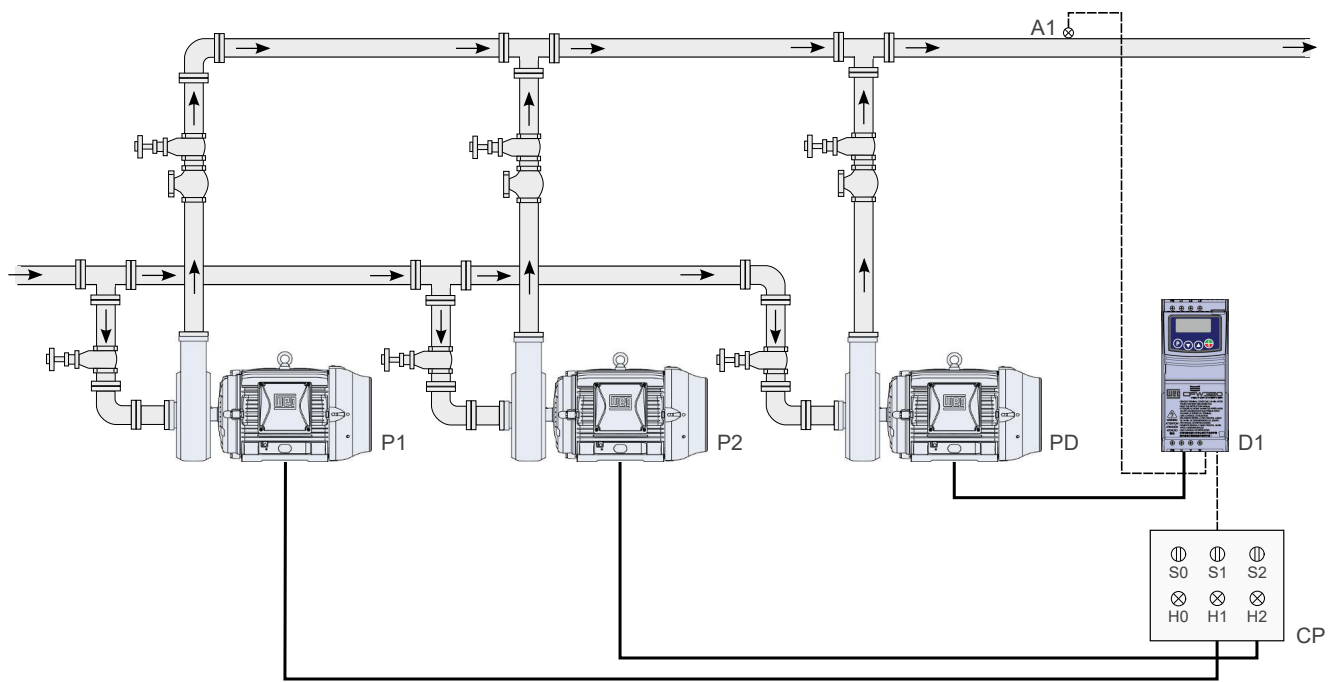


Figure 4.11: Pump Genius Multipump application with fixed control and control setpoint via HMI



NOTE!

Use the Pump Genius Multipump configuration wizard in the WPS software to configure the CFW320 frequency inverter to control the associated pumps in parallel with fixed control configuration and control setpoint via HMI.



NOTE!

Pumps 1 and 2 can be driven by contactors (direct on line or star delta), static starters (softstarter), smart relays, etc. The H0, H1 and H2 signals are not necessary for the operation of the Pump Genius Multipump with fixed control, as they only serve to indicate the operating condition of the pumps in the control panel (CP). In [Figure 4.11 at page 4-12](#), the H1 and H2 signals come from auxiliary contacts of contactors K1 and K2 that drive pumps 1 and 2 as shown in [Figure 4.14 at page 4-15](#).

The [Figure 4.12 at page 4-13](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made in the CFW320 frequency inverter C320 control card connector and the CFW320-IODR I/O expansion accessory module for a pumping system with three pumps in parallel with fixed control.

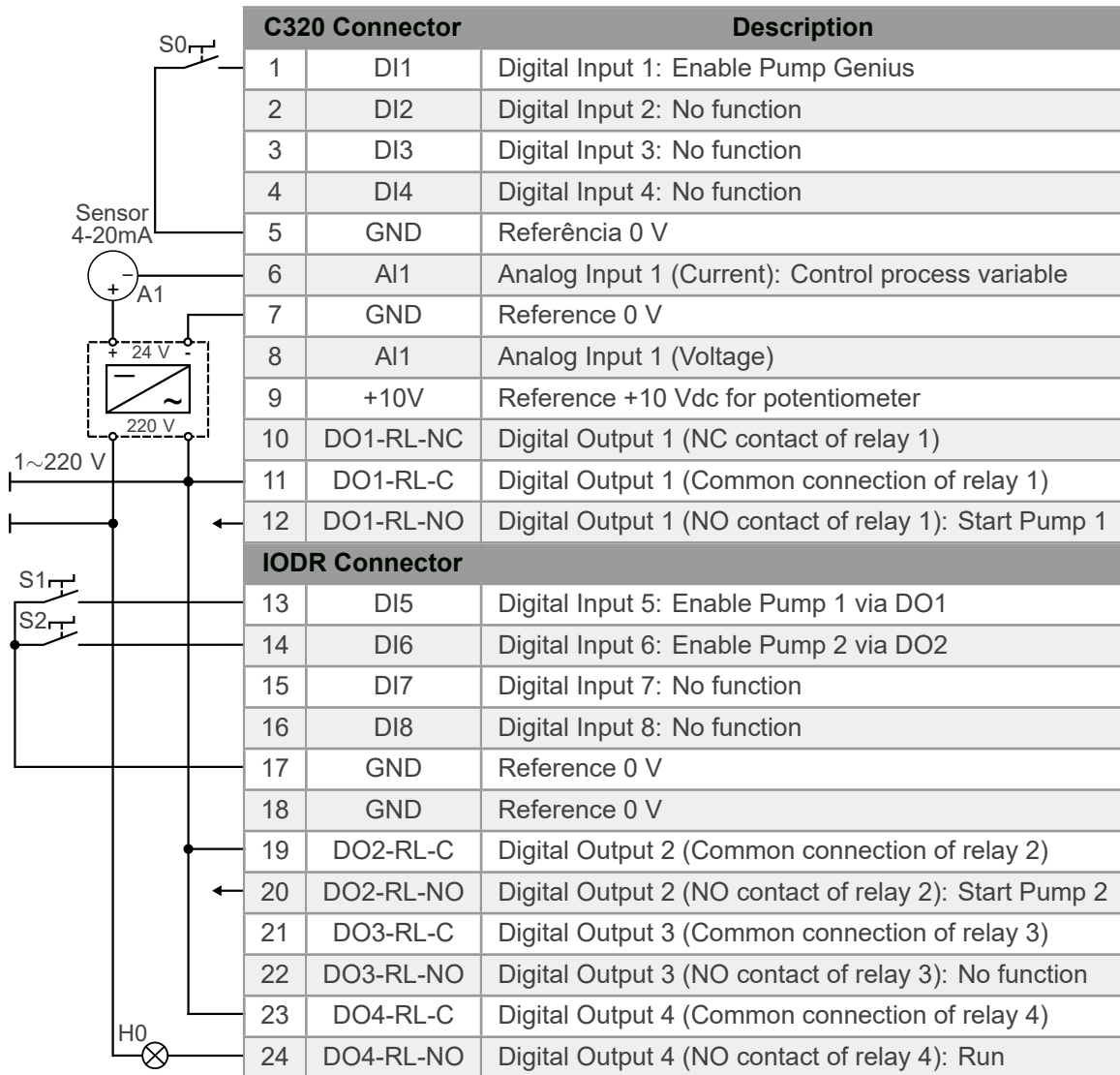


Figure 4.12: Signals on the connector of the C320 control card and the CFW320-IODR I/O expansion accessory module for a pumping system with three pumps in parallel with fixed control



NOTE!

Refer to the CFW320 inverter manual and the CFW320-IODR accessory module installation, configuration and operation guide for more information on connections.

4.2.1.1 Power Connections

The [Figure 4.13 at page 4-14](#) presents the power connection diagram for a system with three pumps in parallel with fixed control.

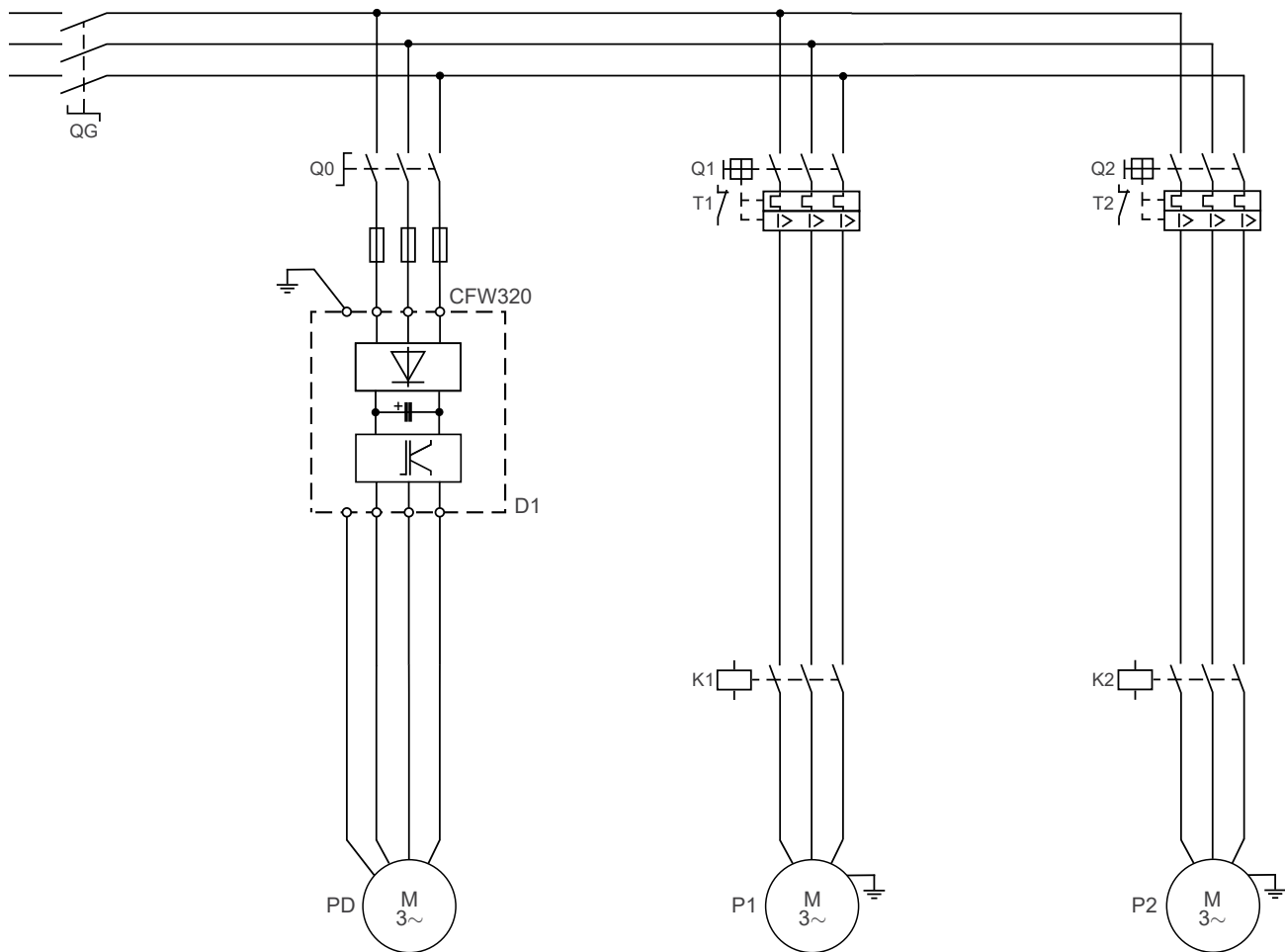


Figure 4.13: Power connections of the Pump Genius Multipump application with fixed control and three pumps in parallel

Where:

- QG: Protection circuit breaker for the system power supply;
- Q0: Device for disconnecting the CFW320 frequency inverter supply;
- Q1 and Q2: Motor circuit breaker for the protection of the pumps;
- K1 and K2: Contactors for starting the pumps;
- P1, P2 and PD: System pump motors;
- The protection of CFW320 inverter is done with fuses.



NOTE!

It is recommended to install the protection devices of the pump motors and the CFW320 frequency inverter to prevent damage to them.

4.2.1.2 Command Connections

The [Figure 4.14](#) at [page 4-15](#) presents the command connection diagram for fixed control and three pumps in parallel.

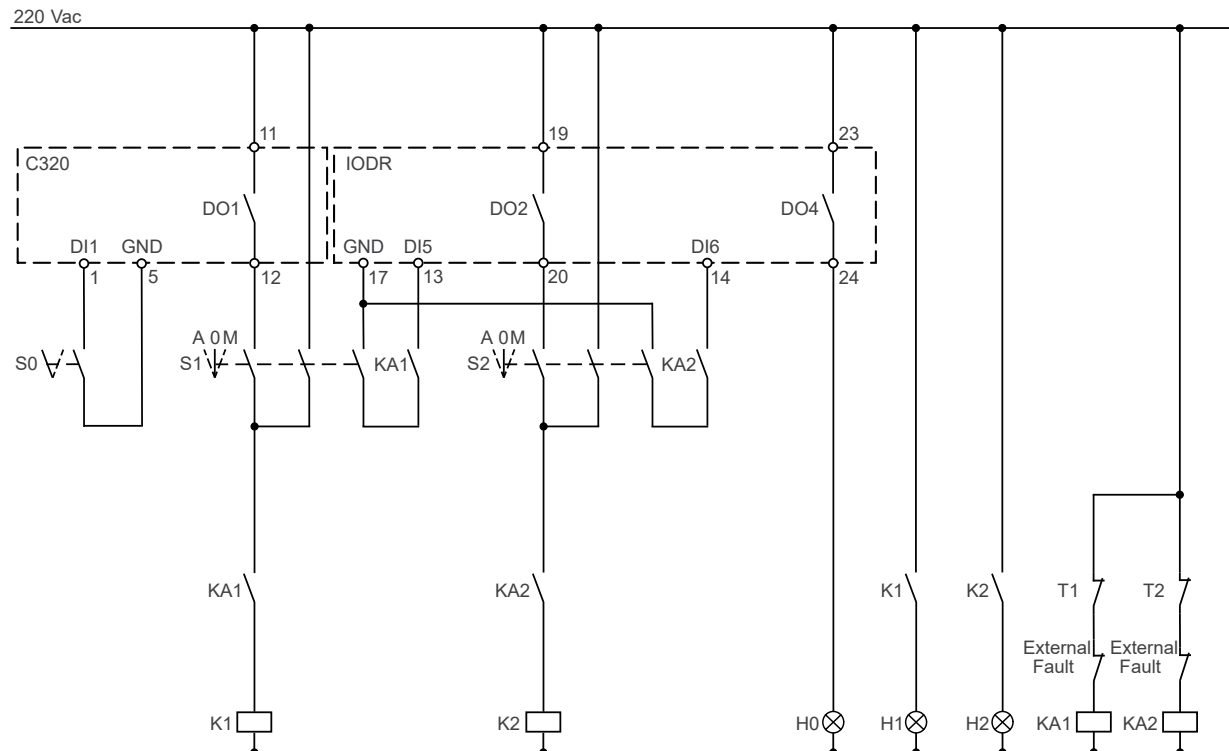


Figure 4.14: Command connections of the Pump Genius Multipump application with fixed control and three pumps in parallel

Where:

- S0: Start/Stop switch. The “Start” position perform the command for enabling the Pump Genius operation. The “Stop” position disables the Pump Genius operation, that is, it stops all the pumps of the system;
- S1 and S2: Manual/0/Automatic commutation switches (optional). The “Manual” position perform the command for starting the pump independent of the Pump Genius. The “0” position switches off the pump and disables it from the Pump Genius. The “Automatic” position enables the pump to be used in the Pump Genius;
- K1 and K2: Contactors for starting the pumps;
- KA1 and KA2: Auxiliary contactors for the pump protection logics;
- T1 and T2: Contact of the thermal relay for protection of the pumps;
- External Fault: A sensor, such as a pressure switch, can be used for the protection of the pumps;
- DO1 and DO2: Relay digital outputs of the CFW320 frequency inverter and of the CFW320-IODR accessory module to command pumps 1 and 2;
- DO4: Relay digital output of the CFW320-IODR accessory module for running pump indication;
- DI1: Digital input of the CFW320-IODR accessory module of the CFW320 frequency inverter to enable the pumping control operation;
- DI5 and DI6: Digital inputs of the CFW320-IODR accessory module of the CFW320 frequency inverter indicating that the pumps are enabled for the pumping control;
- H0: Status light of the pump driven by the connected frequency inverter (DP) or for motor running;
- H1 and H2: Status light of the pumps 1 and 2 are running.

4.2.2 Multipump Floating Control Type 1

The system is composed of the association of two to four pumps in parallel, and the CFW320 frequency inverter can be connected (via inverter output contactor commanded by a digital output) and control the speed of any of the pumps, but always the first started. The other pumps of the system are commanded by the digital outputs of the CFW320 frequency inverter that drive the contactors directly connected to the main power and operate at the rated speed. That is, with the control enabled and all the pumps turned off, the first pump to be started is connected to the inverter via the digital output command and the other pumps will be connected directly to the main power via the command of other outputs subsequently activated. At another moment, according to the setting, another pump can be driven by CFW320 inverter; by doing that, all pumps in the system are used in a uniform way. The interlock that prevents two or more pumps to be connected to the inverter is electrically done as [Figure 4.18 at page 4-20](#).

**NOTE!**

In this control method, it will always be necessary to install the CFW320-IODR I/O accessory module (4 digital inputs and 3 relay outputs).

4

The [Figure 4.15 at page 4-17](#) presents a typical system with three pumps and control setpoint via HMI, basically composed of:

- 01 CFW320 frequency inverter (D1);
- 03 Electric motor + pump (P1, P2 and P3);
- 01 Sensor with analog output signal to measure the control process variable (A1);
- Command to enable Pump Genius (S0);
- Command to enable the use of the pump 1, 2 and 3 (S1, S2 and S3);
- Status light of inverter fault (H0);
- Status light of the pumps 1, 2 and 3 are running (H1, H2 and H3).

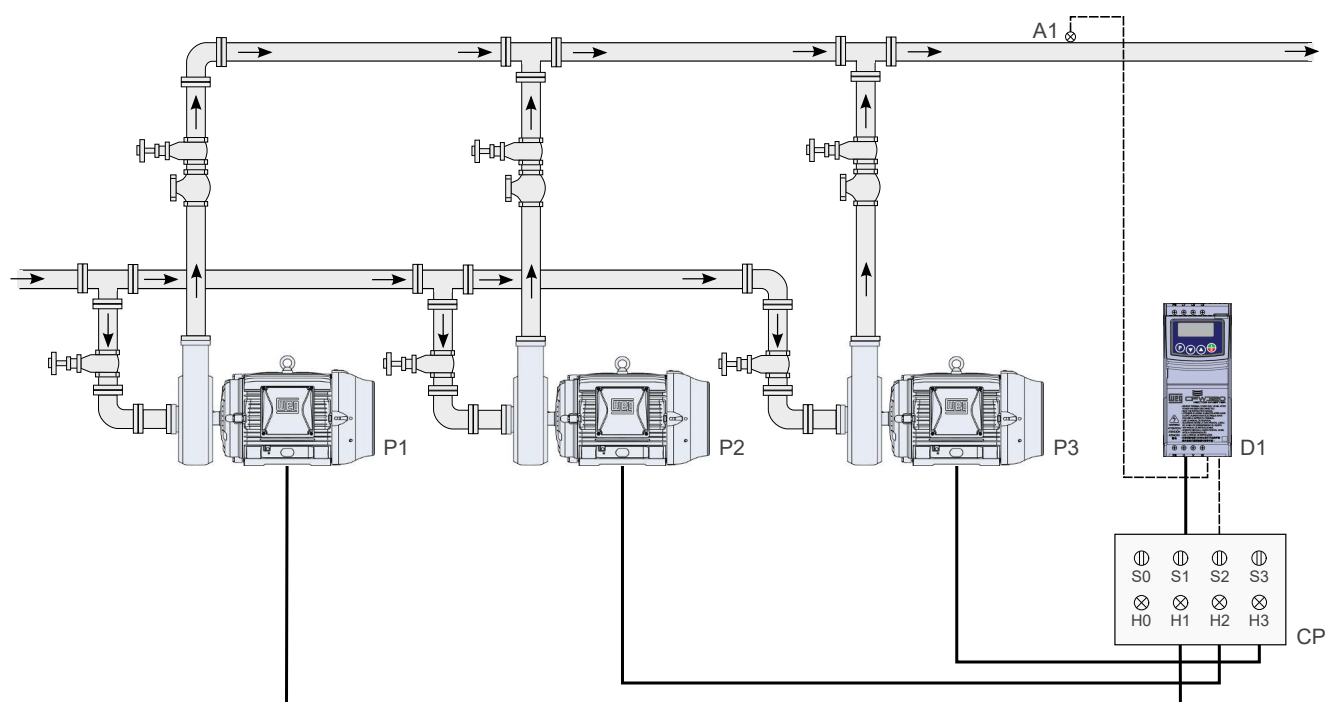


Figure 4.15: Pump Genius Multipump application with floating control type 1 and control setpoint via HMI



NOTE!

Use the Pump Genius Multipump configuration wizard in the WPS software to configure the CFW320 frequency inverter to control the associated pumps in parallel with floating control type 1 configuration and control setpoint via HMI.



NOTE!

The signals H0, H1, H2 and H3 are not necessary for the operation of the Pump Genius Multipump with floating control type 1, because they only serve to indicate the operating condition of the pumps on the command panel (CP). In [Figure 4.15 at page 4-17](#), the signals H1, H2 and H3 come from auxiliary contacts of contactors K1, K1.1, K2, K2.1, K3 and K3.1 which start the pumps 1, 2 and 3 as presented in [Figure 4.18 at page 4-20](#).

The [Figure 4.16 at page 4-18](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made on the CFW320 frequency inverter C320 control card connector and on the CFW320-IODR I/O accessory module for a pumping system with three pumps in parallel with floating control type 1.

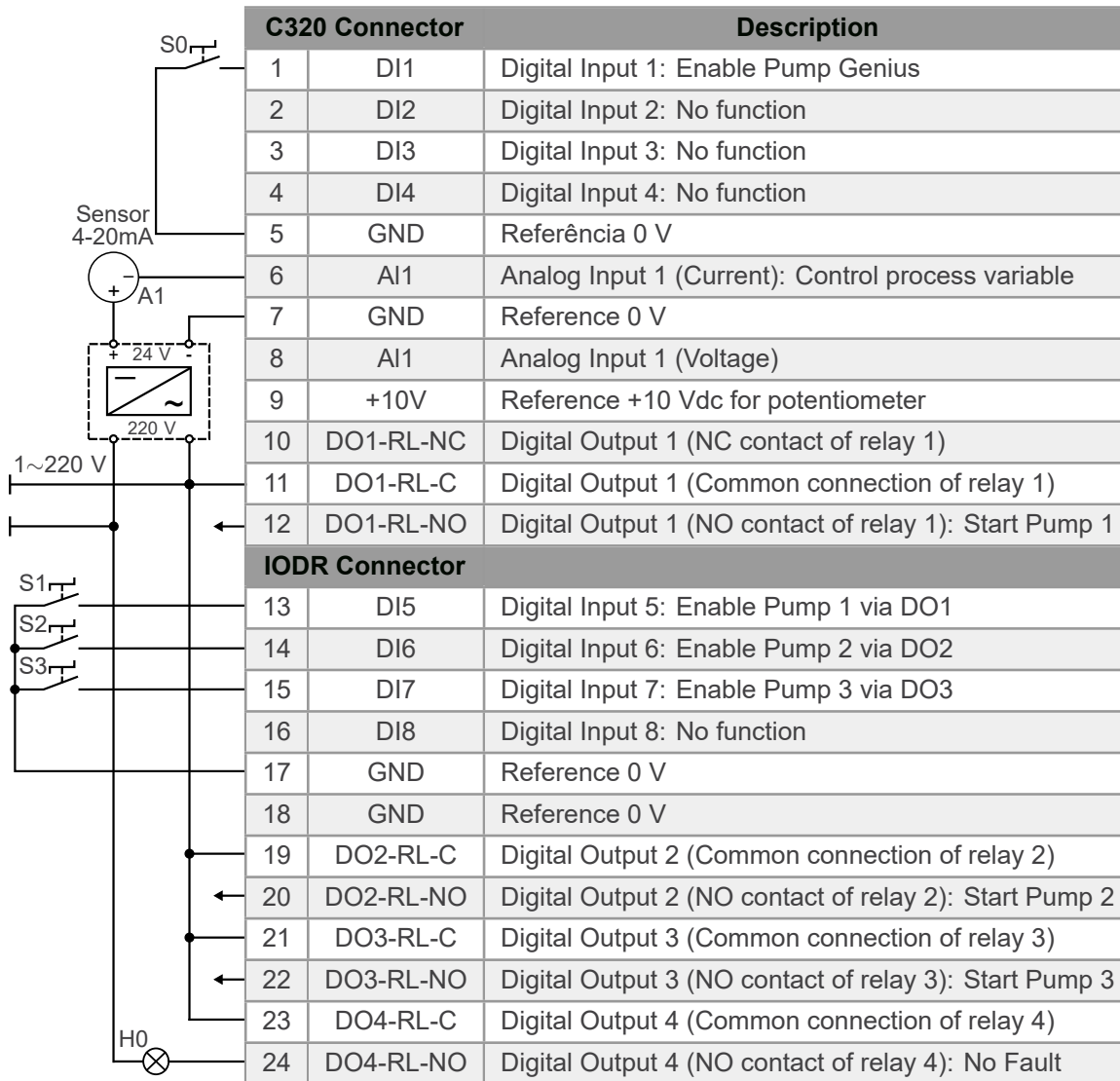


Figure 4.16: Signals on the connector of the C320 control card and the CFW320-IODR I/O accessory module for a pumping system with three pumps in parallel with floating control type 1



NOTE!

Refer to the CFW320 inverter manual and the CFW320-IODR accessory module installation, configuration and operation guide for more information on connections.

4.2.2.1 Power Connections

The [Figure 4.17 at page 4-19](#) presents the power connection diagram for a system with three pumps in parallel with floating control type 1.

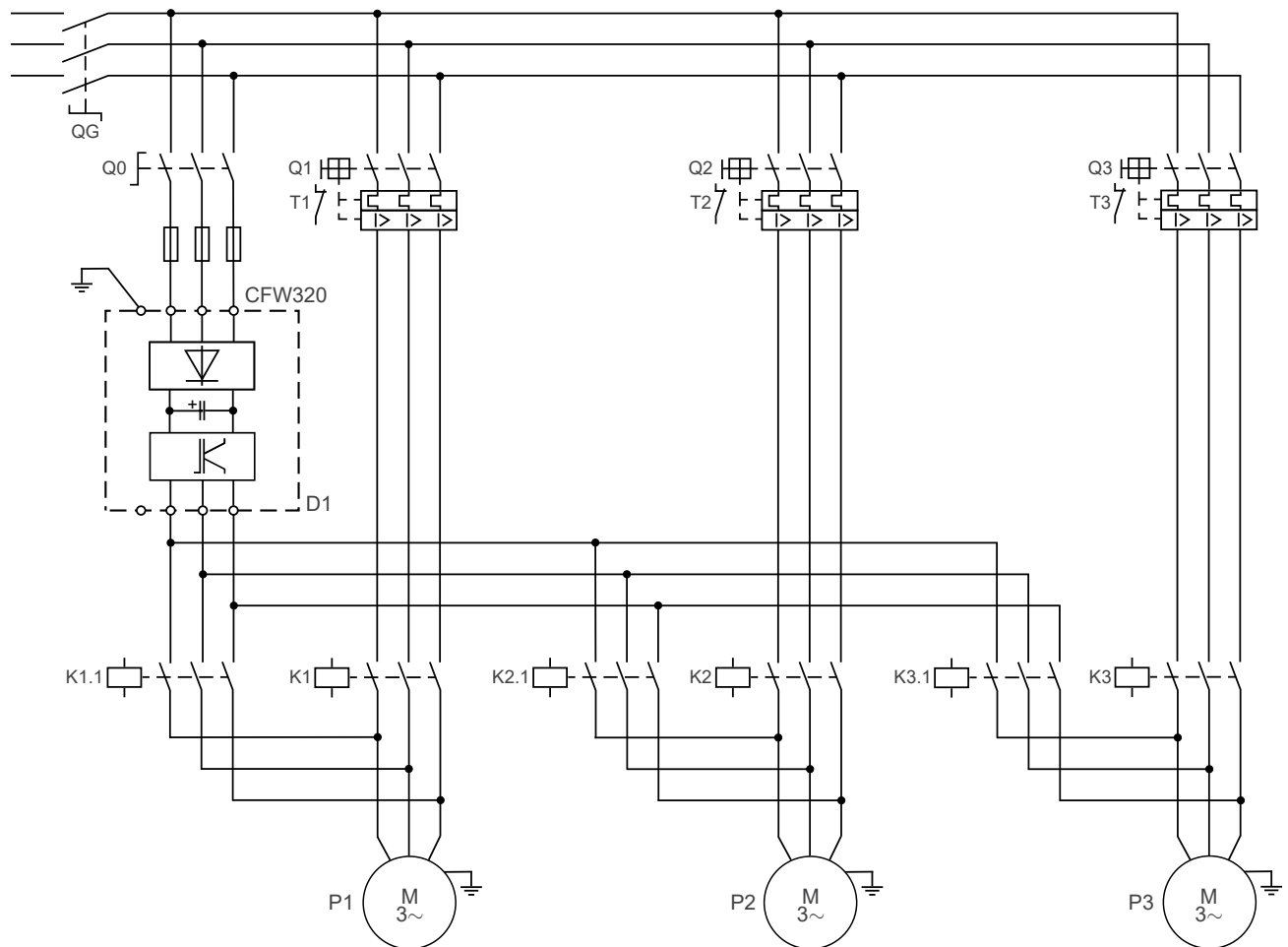


Figure 4.17: Power connections of the Pump Genius Multipump application with floating control type 1 and three pumps in parallel

Where:

- QG: Protection circuit breaker for the system power supply;
- Q0: Device for disconnecting the CFW320 frequency inverter supply;
- Q1, Q2 and Q3: Motor circuit breaker for the protection of the pumps;
- K1, K2 and K3: Contactors for starting the pumps directly on line, i.e., when they do not have their speed controlled by the CFW320 inverter;
- K1.1, K2.1 and K3.1: Contactors to start the pump with the CFW320 inverter;
- P1, P2 and P3: System pump motors;
- The protection of CFW320 inverter is done with fuses.



NOTE!

It is recommended to install the protection devices of the pump motors and the CFW320 frequency inverter to prevent damage to them.

4.2.2.2 Command Connections

The [Figure 4.18 at page 4-20](#) presents the command connection diagram for three pumps in parallel and floating control type 1.

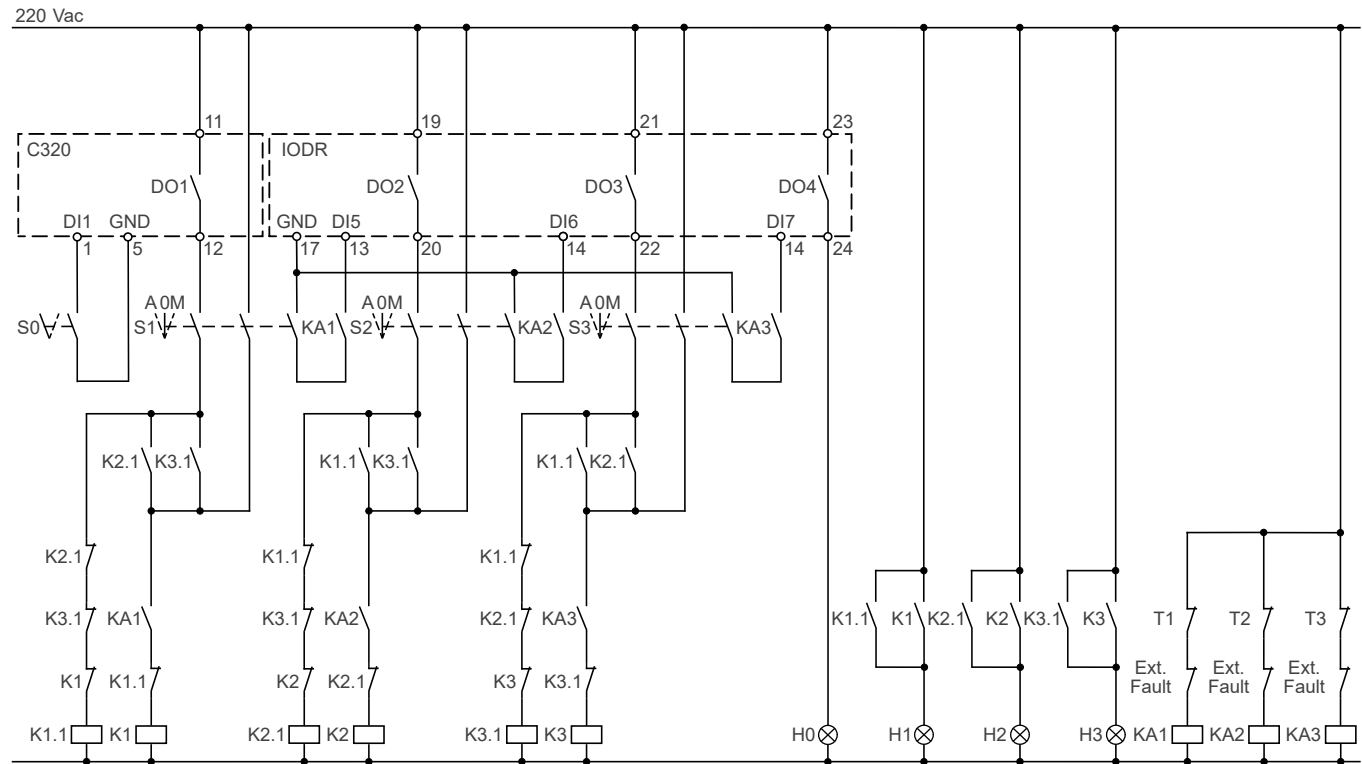


Figure 4.18: Command connections of the Pump Genius Multipump application with floating control type 1 and three pumps in parallel

Where:

- S0: Start/Stop switch. The “Start” position issues the command for enabling Pump Genius operation. The “Stop” position disables the Pump Genius operation, that is, it stops all the pumps of the system;
- S1, S2 and S3: Manual / 0 / Automatic commutation switches (optional). The “Manual” position issues the command for starting the pump independent of the pumping control. The “0” position switches off the pump and disables it from the pumping control. The “Automatic” position enables the pump to be used in the Pump Genius;
- K1, K2 and K3: Contactors for starting the pumps directly on line, i.e., when they do not have their speed controlled by the CFW320 inverter;
- K1.1, K2.1 and K3.1: Contactors to start the pump with the frequency inverter;
- KA1, KA2 and KA3: Auxiliary contactors for the pump protection logics;
- T1, T2 and T3: Contact of the pump motors thermal protection;
- External Fault: A sensor, such as a pressure switch, can be used for the protection of the pumps;
- DO1, DO2 and DO3: Relay digital outputs of the CFW320-IODR accessory module and of the CFW320 frequency inverter to command pumps 1, 2 and 3;
- DO4: Relay digital output of the CFW320-IODR accessory module for faultless inverter indication;
- DI1: Digital input of the CFW320 frequency inverter to enable the Pump Genius operation;
- DI5, DI6 and DI7: Digital inputs of the CFW320-IODR accessory module of the CFW320 frequency inverter indicating that the pumps are enabled for the Pump Genius;

- H0: Status light of inverter fault;
- H1, H2 and H3: Status light of the pumps 1, 2 and 3 are running.

4.2.3 Multipump Floating Control Type 2

The system is composed of the association of two to three pumps in parallel, and the CFW320 frequency inverter can be connected (via inverter output contactor commanded by a digital output) and control the speed of any of the pumps, but always the last started. The other pumps of the system are started by the CFW320 frequency inverter and commuted with contactors directly to the main power with rated speed.

That is, with the system turned off, the first pump to be started is connected to the inverter via the digital output command. When an additional pump is needed, the previous pump started is commuted to the main power and the next pump to be started will be driven by CFW320 inverter. The interlock that prevents two or more pumps to be connected to the inverter is electrically done as [Figure 4.22 at page 4-26](#).

**NOTE!**

In this control method, it will always be necessary to install the CFW320-IODR accessory module (4 digital inputs and 3 relay outputs).

4

The [Figure 4.19 at page 4-23](#) presents a typical system with three pumps and control setpoint via HMI, basically composed of:

- 01 CFW320 frequency inverter (D1);
- 03 Electric motor + pump (P1, P2 and P3);
- 01 Sensor with analog output signal to measure the control process variable (A1);
- Command to enable Pump Genius (S0);
- Command to enable the use of the pump 1, 2 and 3 (S1, S2 and S3);
- Status light of the pumps 1, 2 and 3 are running (H1, H2 and H3).

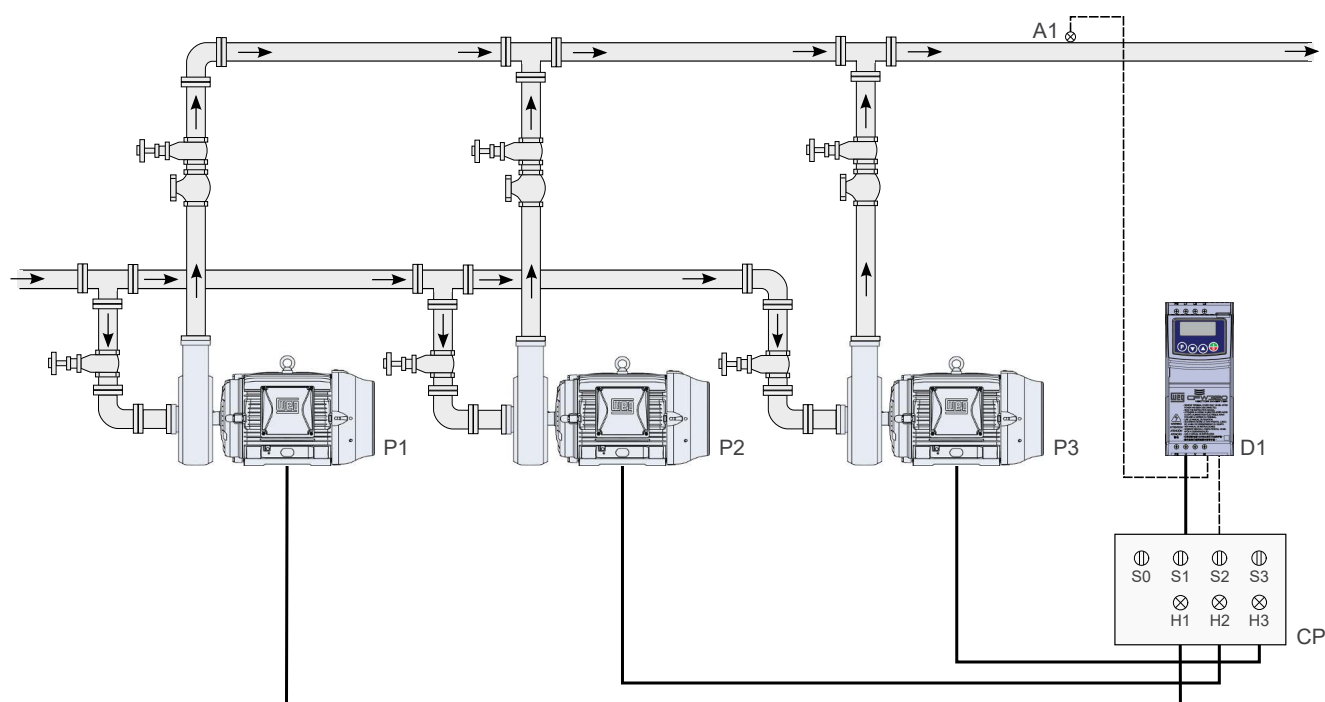


Figure 4.19: Pump Genius Multipump application with floating control type 2 and control setpoint via HMI



NOTE!

Use the Pump Genius Multipump application wizard in the WPS software to configure the CFW320 frequency inverter to control associated parallel pumps with floating control type 2 configuration.



NOTE!

The signals H1, H2 and H3 are not necessary for the operation of the Pump Genius Multipump with floating control type 2, because they only serve to indicate the operating condition of the pumps on the command panel (CP). In [Figure 4.19 at page 4-23](#), the signals H1, H2 and H3 come from auxiliary contacts of contactors K1, K1.1, K2, K2.1, K3 and K3.1 which start the pumps 1, 2 and 3 as presented in [Figure 4.22 at page 4-26](#).

The [Figure 4.20 at page 4-24](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made on the CFW320 frequency inverter C320 control card connector and on the CFW320-IOBR accessory module for a pumping system with three pumps in parallel with floating control type 2.

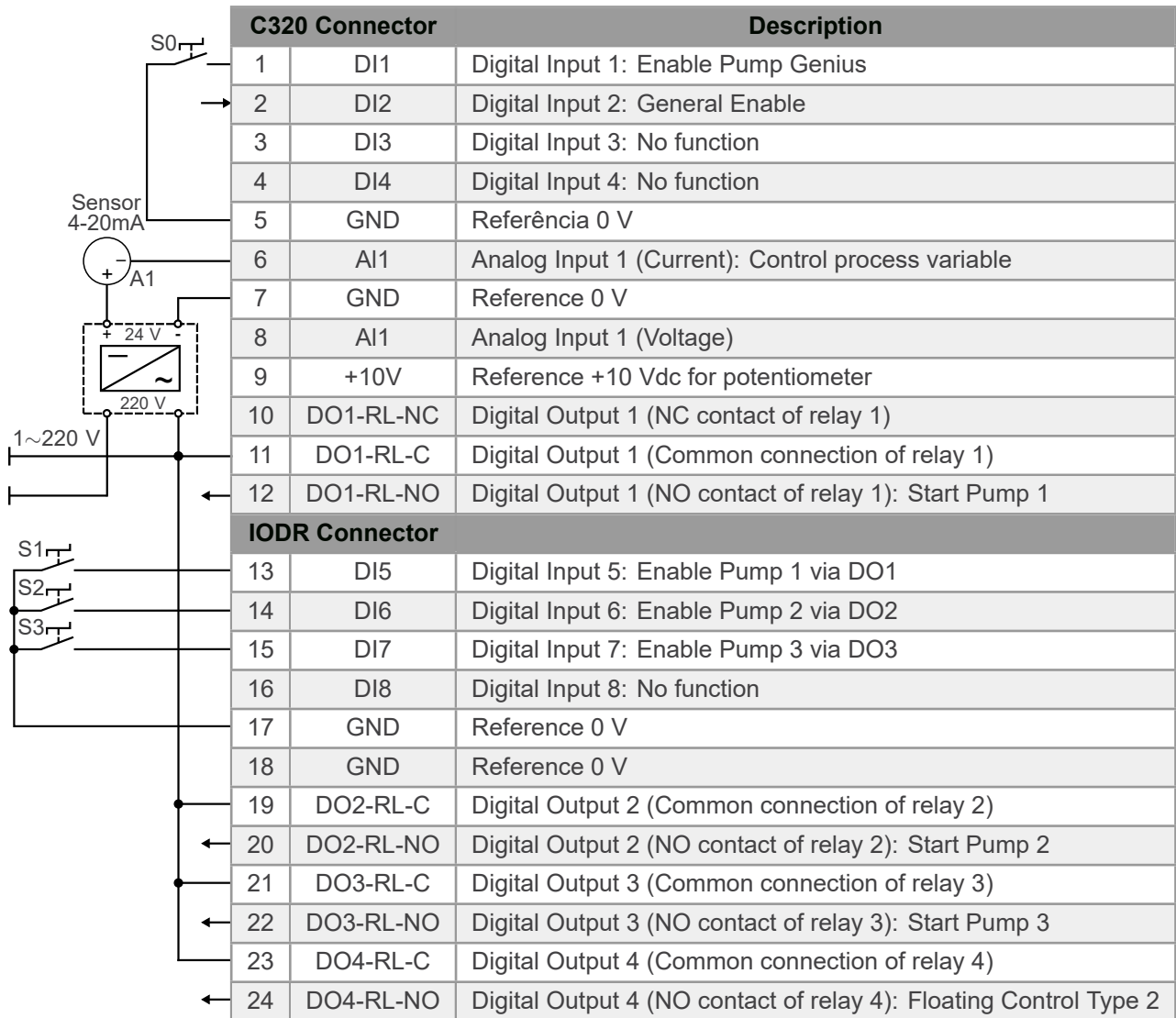


Figure 4.20: Signals on the connector of the C320 control card and the CFW320-IODR accessory module for a pumping system with three pumps in parallel with floating control type 2



NOTE!

Refer to the CFW320 inverter manual and the CFW320-IODR accessory installation, configuration and operation guide for more information on connections.

4.2.3.1 Power Connections

The [Figure 4.21 at page 4-25](#) presents the power connection diagram for a system with three pumps in parallel with floating control type 2.

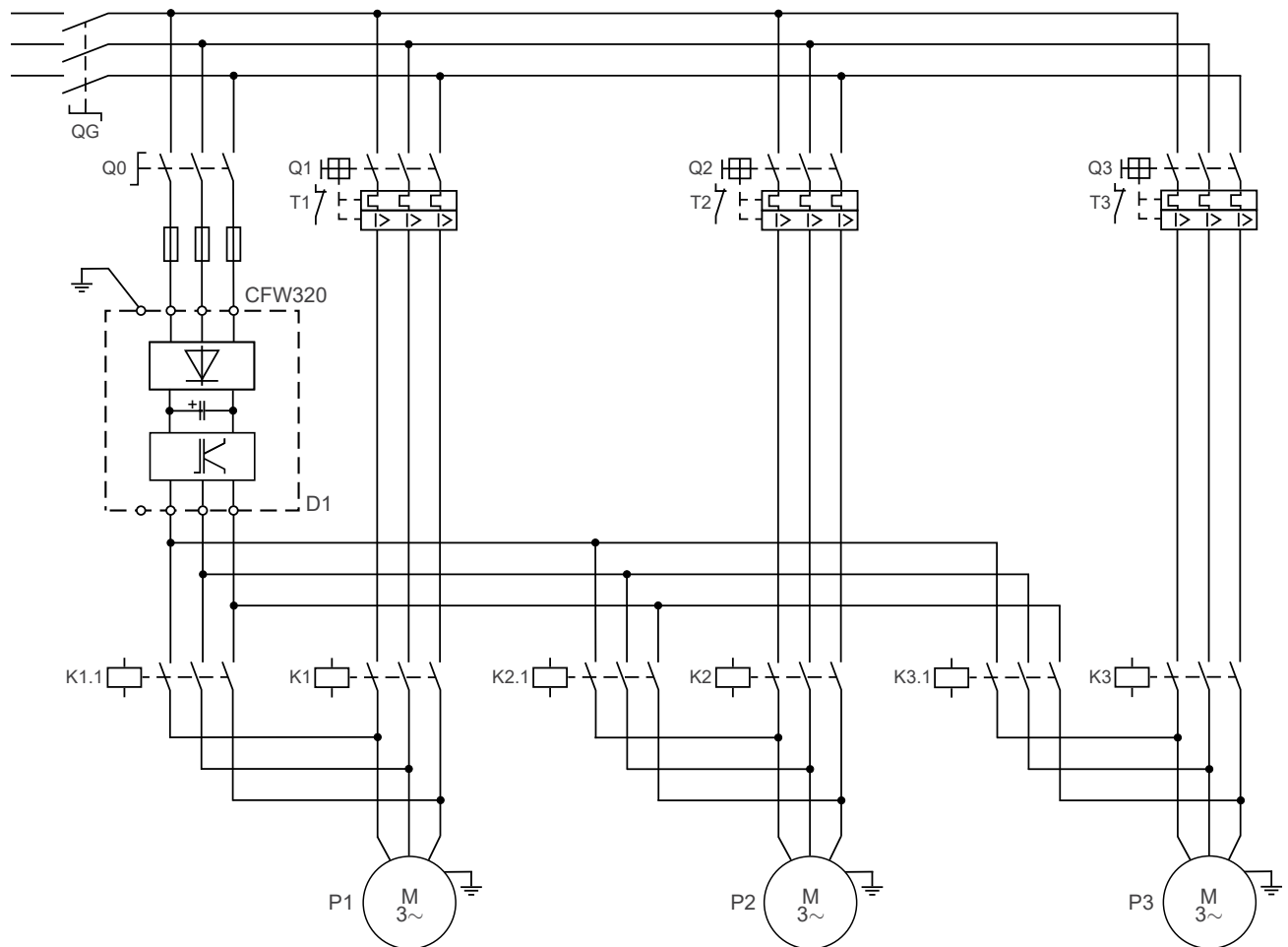


Figure 4.21: Power connections of the Pump Genius Multipump application with floating control type 2 and three pumps in parallel

Where:

- QG: Protection circuit breaker for the system power supply;
- Q0: Device for disconnecting the CFW320 frequency inverter supply;
- Q1, Q2 and Q3: Motor circuit breaker for the protection of the pumps;
- K1, K2 and K3: Contactors for starting the pumps directly on line, i.e., when they do not have their speed controlled by the CFW320 inverter;
- K1.1, K2.1 and K3.1: Contactors to start the pump with the CFW320 inverter;
- P1, P2 and P3: System pump motors;
- The protection of CFW320 inverter is done with fuses.



NOTE!

It is recommended to install the protection devices of the pump motors and the CFW320 frequency inverter to prevent damage to them.

4.2.3.2 Command Connections

The [Figure 4.22 at page 4-26](#) presents the command connection diagram for three pumps in parallel and floating control type 2.

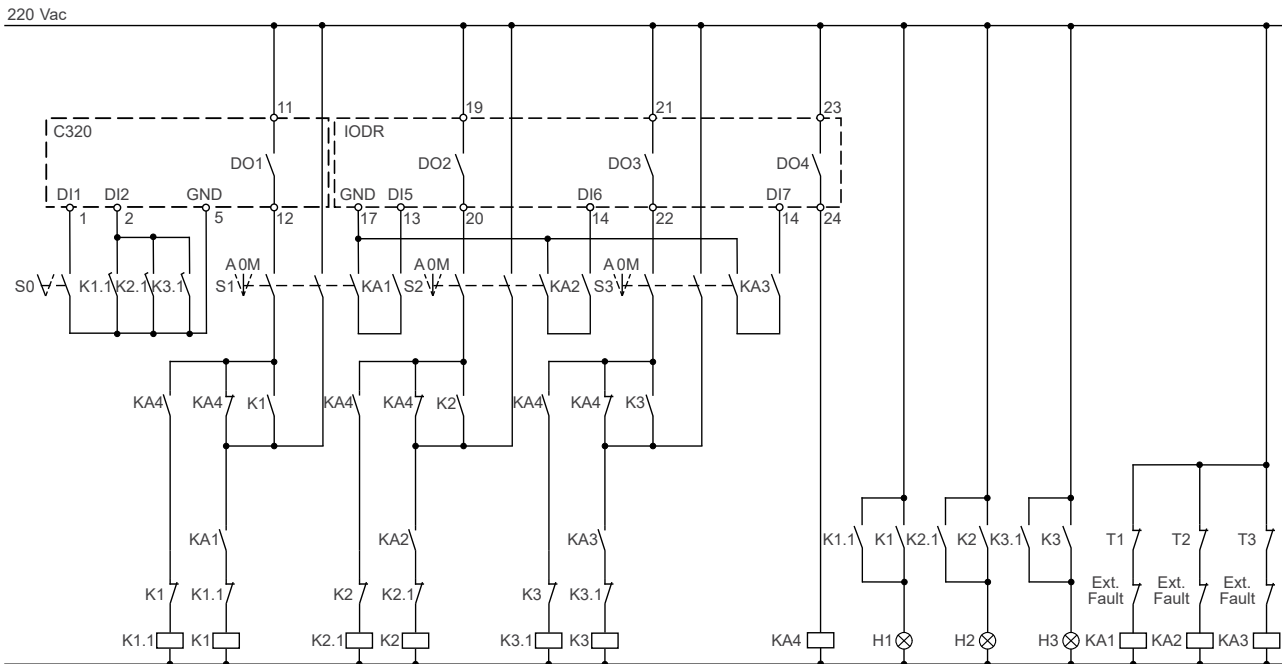


Figure 4.22: Command connections of the Pump Genius Multipump application with floating control type 2 and three pumps in parallel

Where:

- S0: Start/Stop switch. The “Start” position issues the command for enabling Pump Genius operation. The “Stop” position disables the Pump Genius operation, i.e., it stops all the pumps of the system;
- S1, S2 and S3: Manual / 0 / Automatic commutation switches (optional). The “Manual” position issues the command for starting the pump independent of the pumping control. The “0” position switches off the pump and disables it from the pumping control. The “Automatic” position enables the pump to be used in the Pump Genius;
- K1, K2 and K3: Contactors for starting the pumps directly on line, i.e., when they do not have their speed controlled by the CFW320 inverter;
- K1.1, K2.1 and K3.1: Contactors to start the pump with the frequency inverter;
- KA1, KA2 and KA3: Auxiliary contactors for the pump protection logics;
- KA4: Auxiliary contactor for floating type 2 electrical interlocks;
- T1, T2 and T3: Contact of the pump motors thermal protection;
- External Fault: A sensor, such as a pressure switch, can be used for the protection of the pumps;
- DO1, DO2 and DO3: Relay digital outputs of the CFW320-IODR accessory module and of the CFW320 frequency inverter to command pumps 1, 2 and 3;
- DO4: Relay digital output of the CFW320-IODR accessory module for floating type 2 electrical interlocks;
- DI1: Digital input of the CFW320 frequency inverter to enable the Pump Genius operation;
- DI5, DI6 and DI7: Digital inputs of the CFW320-IODR accessory module of the CFW320 frequency inverter indicating that the pumps are enabled for the Pump Genius;

- H1, H2 and H3: Status light indicating that the pumps 1, 2 and 3 are running.

**NOTE!**

The auxiliary contacts at DI2 from K1, K2 and K3 must be early-make normally open contacts for the properly working of the system interlock.

4.2.4 Multiplex

It is characterized by the fact that the system consists of the association of two or more pumps in parallel and each pump is driven by its respective CFW320 frequency inverter, thus allowing the speed of all pumps in the system to be varied (all operate at the same speed).

The user can configure the Pump Genius Multiplex application to have up to four associated pumps in parallel. Some pumps will work as a master/slave (perform the pumping control actions) and the other pumps will work as a slave (receive commands from the master/slave pump). The communication between the pumps is carried out through frequency inputs and outputs of the CFW320-IODF accessory module.



NOTE!

In this control method, it will always be necessary to install the CFW320-IODF accessory module (3 frequency inputs and 3 frequency outputs).

4

The [Figure 4.23 at page 4-28](#) presents a typical drive with three pumps in parallel (two master/slave pumps, one slave pump) and control setpoint via HMI, which basically comprises:

- 03 CFW320 frequency inverters (D1, D2 and D3);
- 03 Electric motors and pumps (P1, P2 and P3);
- 02 Sensor with analog output signal for measurement of the control process variable (A1 and A2);
- Command for enabling the Pump Genius (S0);
- Command for enabling the use of the pump driven by CFW320 inverter (S1, S2 and S3);
- Status light for motor running (H1, H2 and H3).

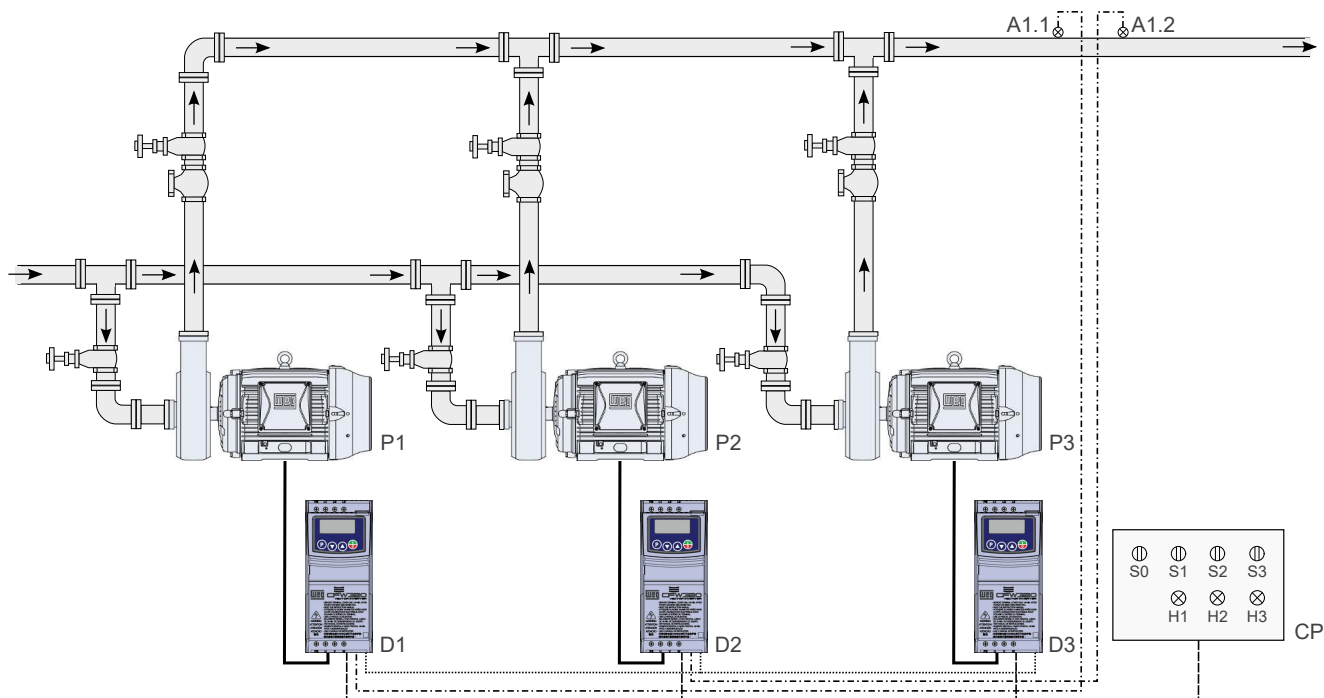


Figure 4.23: Pump Genius Multiplex application with two master/slave pumps and one slave pump, and control setpoint via HMI

**NOTE!**

Use the Master/Slave Pump configuration wizard in the WPS software to configure the CFW320 frequency inverters for pump 1 and pump 2, and the Slave Pump configuration wizard to configure the CFW320 frequency inverter for pump 3 in the pumping system with three pumps in parallel.

**NOTE!**

The indicating lights H1, H2 and H3 are not necessary for the operation of Pump Genius Multiplex. They only indicate the operating condition of the pumps on the control panel (CP).

The [Figure 4.24 at page 4-29](#), the [Figure 4.25 at page 4-30](#) and the [Figure 4.26 at page 4-31](#) present the control connections (analog inputs, digital inputs/outputs, frequency inputs/outputs) that must be made on the C320 control card connector and on the CFW320-IODF accessory module of CFW320 frequency inverter for a control system pumping with three pumps in parallel, two master/slave pumps and one slave pump.

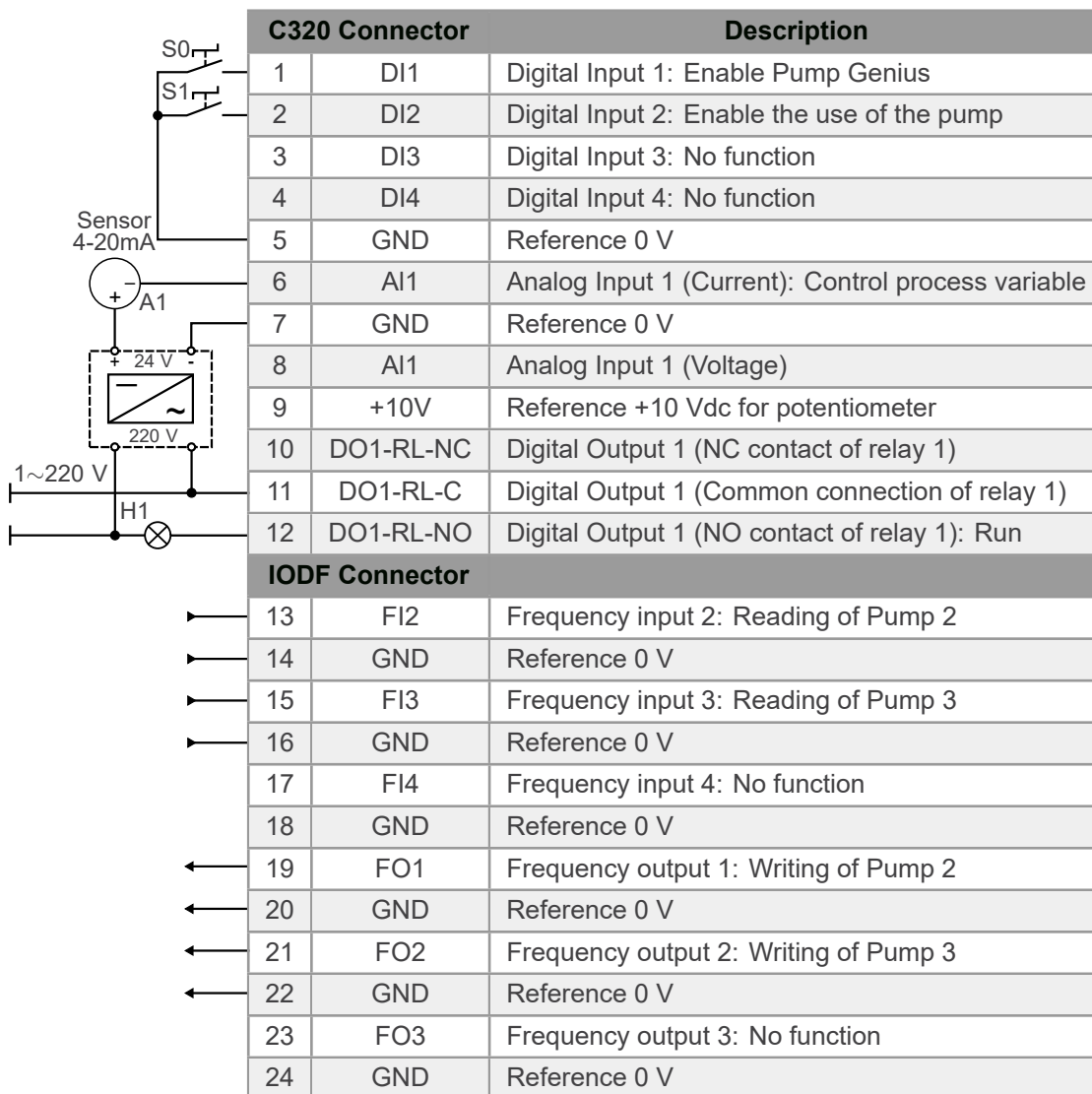


Figure 4.24: Signals on the connector of the C320 control card and the CFW320-IODF accessory module for master/slave pump (Pump 1)

CONTROL CONNECTIONS

4

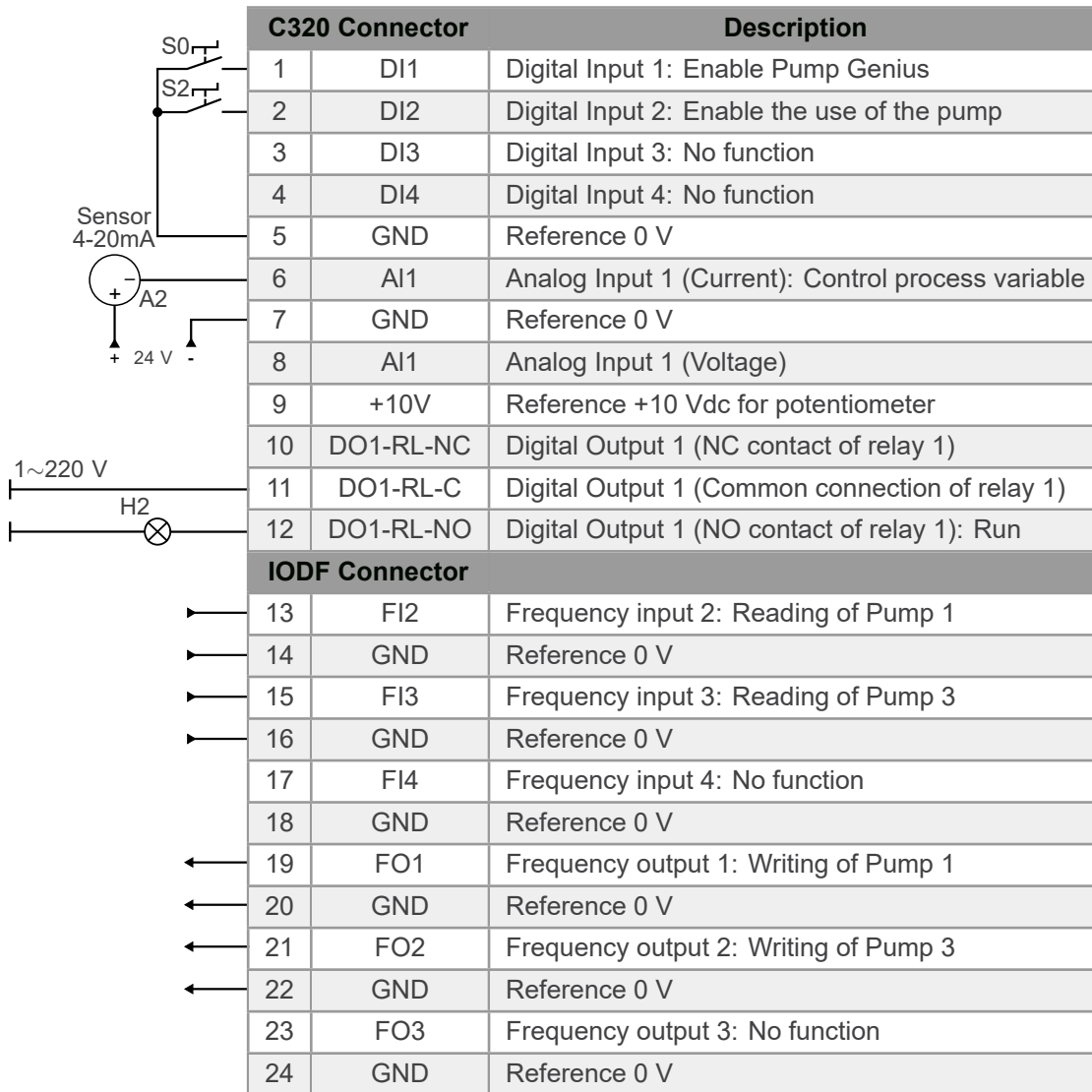
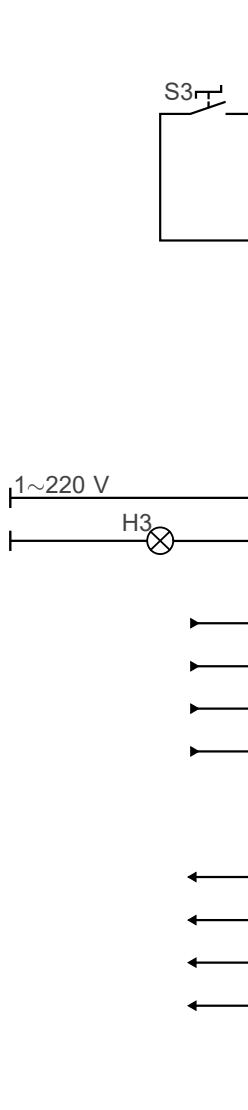


Figure 4.25: Signals on the connector of the C320 control card and the CFW320-IODF accessory module for master/slave pump (Pump 2)



C320 Connector		Description
1	DI1	Digital Input 1: No function
2	DI2	Digital Input 2: Enable the use of the pump
3	DI3	Digital Input 3: No function
4	DI4	Digital Input 4: No function
5	GND	Reference 0 V
6	AI1	Analog Input 1 (Current): No function
7	GND	Reference 0 V
8	AI1	Analog Input 1 (Voltage)
9	+10V	Reference +10 Vdc for potentiometer
10	DO1-RL-NC	Digital Output 1 (NC contact of relay 1)
11	DO1-RL-C	Digital Output 1 (Common connection of relay 1)
12	DO1-RL-NO	Digital Output 1 (NO contact of relay 1): Run
IODF Connector		
13	FI2	Frequency input 2: Reading of Pump 1
14	GND	Reference 0 V
15	FI3	Frequency input 3: Reading of Pump 2
16	GND	Reference 0 V
17	FI4	Frequency input 4: No function
18	GND	Reference 0 V
19	FO1	Frequency output 1: Writing of Pump 1
20	GND	Reference 0 V
21	FO2	Frequency output 2: Writing of Pump 2
22	GND	Reference 0 V
23	FO3	Frequency output 3: No function
24	GND	Reference 0 V

Figure 4.26: Signals on the connector of the C320 control card and the CFW320-IODF accessory module for slave pump (Pump 3)



NOTE!

Refer to the CFW320 frequency inverter manual and the CFW320-IODF accessory module installation, configuration and operation guide for more information on connections.

4.2.4.1 Power Connections

A [Figura 4.27 na página 4-32](#) presents the power connection diagram of a pumping system with three pumps in parallel, two master/slave pumps and one slave pump.

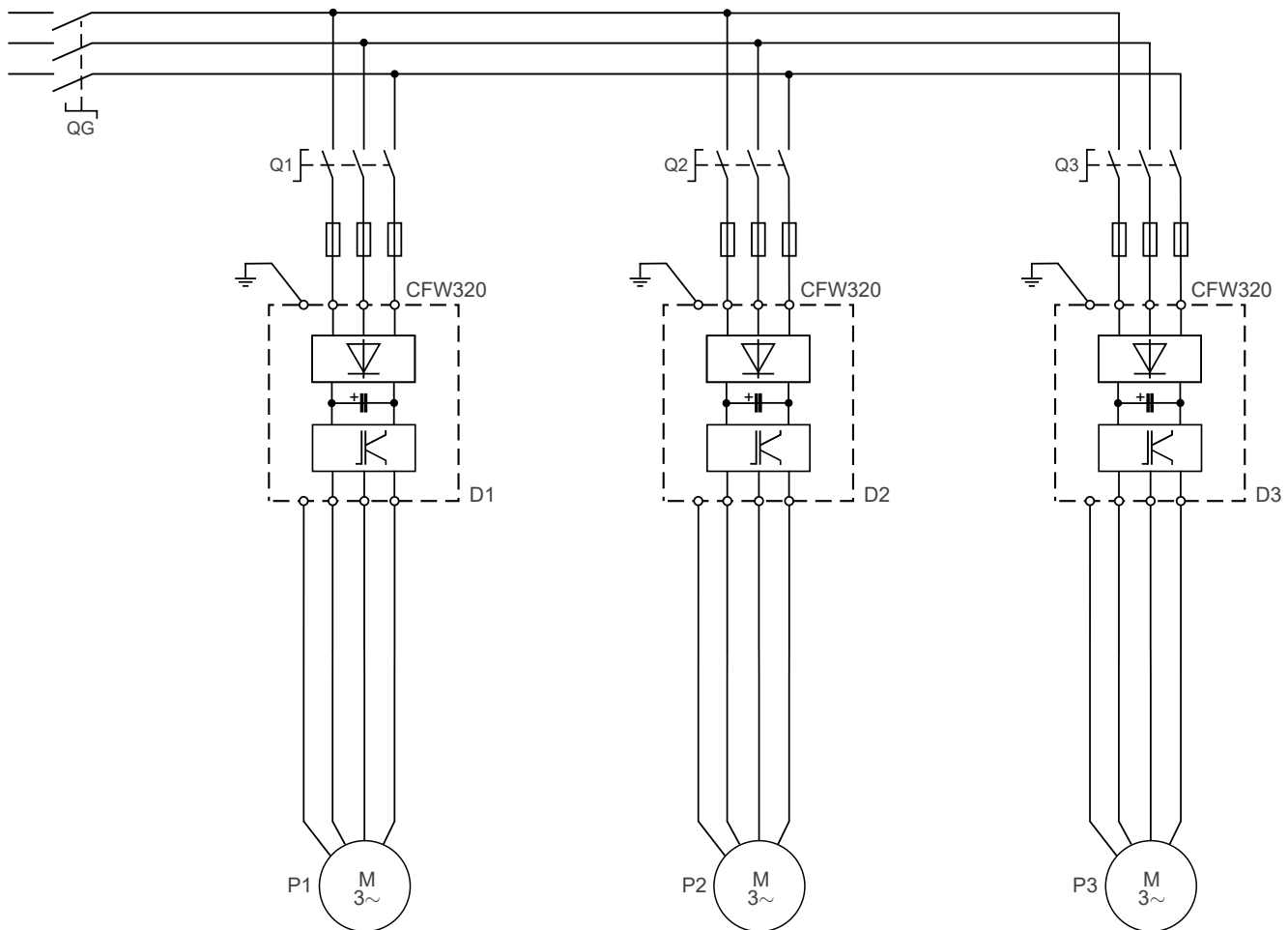


Figure 4.27: Power connections of the Pump Genius Multiplex application with three pumps in parallel

Where:

- QG: Protection circuit breaker for the system power supply;
- Q1, Q2 and Q3: Device for disconnecting the CFW320 frequency inverter supply;
- P1, P2 and P3: Pump motors;
- The protection of CFW320 frequency inverters is done with fuses.



NOTE!

It is recommended to install the protection devices of the pump motors and the CFW320 frequency inverter to prevent damage to them.

4.2.4.2 Control Connections

The [Figure 4.28 at page 4-33](#) and the [Figure 4.29 at page 4-34](#) presents the control connections diagram of a pumping system with three pumps in parallel, two master/slave pumps and one slave pump.

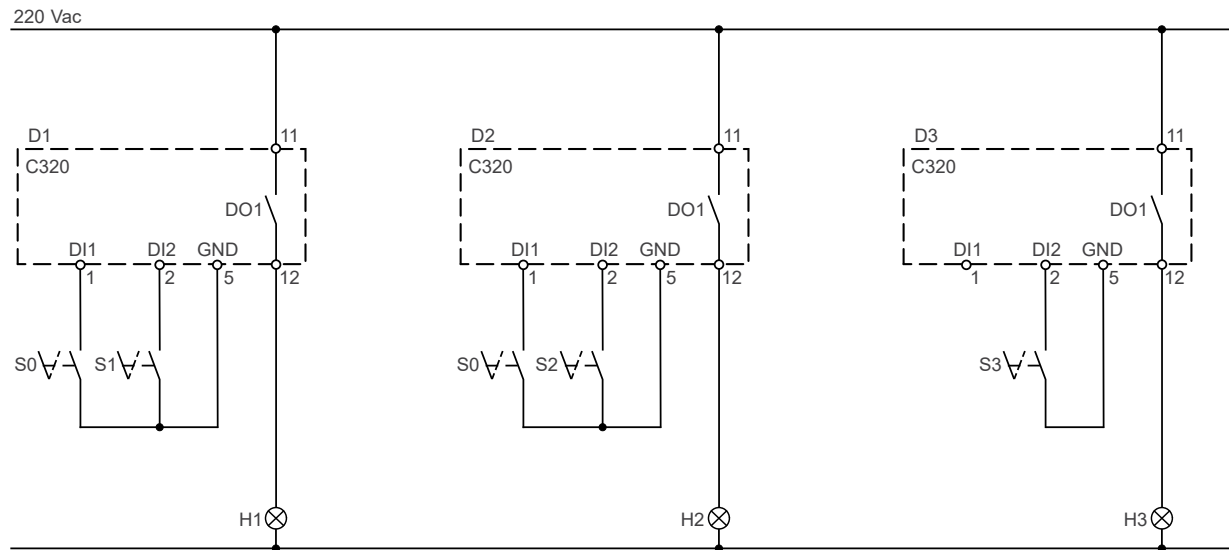
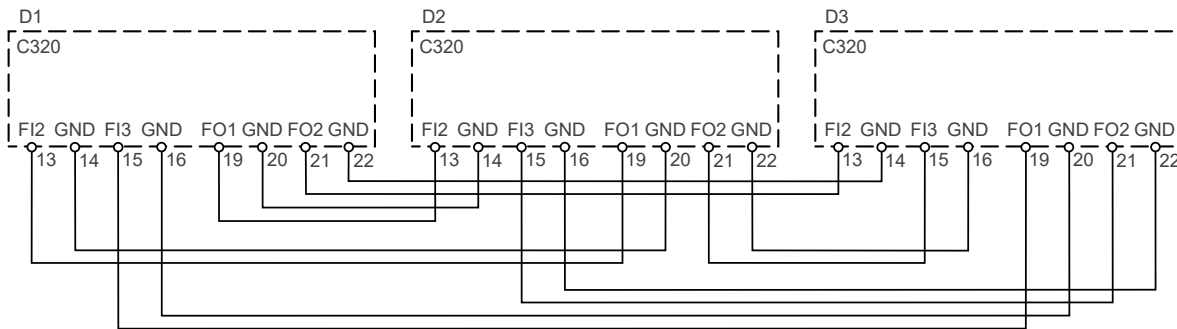


Figure 4.28: Control connections diagram (C320) for the Pump Genius Multiplex application and three pumps in parallel

Where:

- S0: Start/Stop switch. The “Start” position issues the command for enabling Pump Genius operation. The “Stop” position disables the Pump Genius operation, i.e., it stops all the pumps of the system;
- S1, S2 and S3: Enable/Disable switch. The “Enable” position allows the CFW320 frequency inverter to use the pump as needed by the Pump Genius. The “Disable” position inhibits the CFW320 frequency inverter from using the pump as needed by the Pump Genius;
- DO1: Relay digital output CFW320 frequency inverter for motor running indication;
- DI1: Digital input of the CFW320 frequency inverter to enable Pump Genius;
- DI2: Digital input of the CFW320 frequency inverter to enable the use of the pump;
- H1, H2 and H3: Status light indicating that the pumps 1, 2 and 3 are running.

220 Vac



4

Figure 4.29: Functional communication diagram (CFW320-IODF) for the Pump Genius Multiplex application with three pumps in parallel

Where:

- FI2 and FI3: Frequency input for reading data from pumps in parallel;
- FO1 and FO2: Frequency output for writing data to pumps in parallel.

4.3 PUMP PROTECTION

4.3.1 External Sensor in the Digital Input

The user can configure the Pump Genius application (Simplex, Multipump and Multiplex) to have a sensor installed on a digital input of the CFW320 frequency inverter to protect the pump. which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- 01 Sensor with “NO” contact for pump protection (S6);
- Command for Run/Stop (S1);
- Status light for motor running (H1).

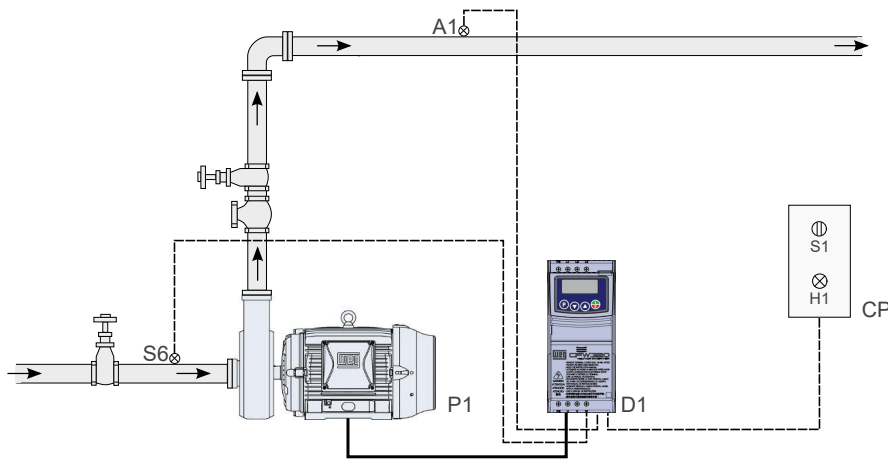


Figure 4.30: Pump Genius application with pump protection via external sensor in the digital input



NOTE!

Use the Pump Genius application setup wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with pump protection via an external sensor on a digital input.



NOTE!

The indicating light H1 is not necessary for the operation of the Pump Genius and pump protection with an external sensor via digital input. It only indicates the condition of the pump operation at the command panel (CP).

A [Figura 4.31 na página 4-36](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to C320 control card of the CFW320 frequency inverter to have the pump protection via external sensor in the digital input.

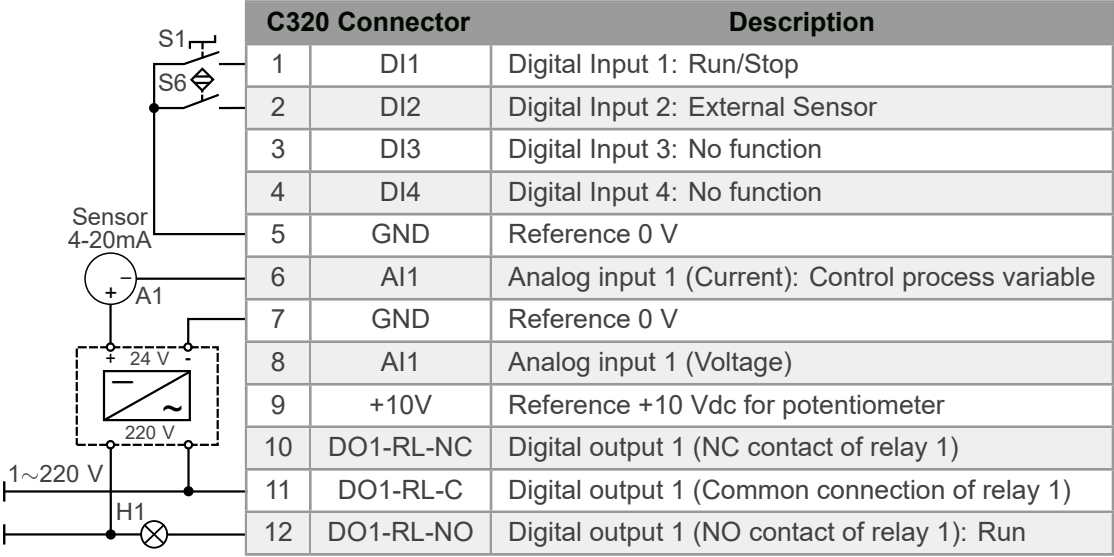


Figure 4.31: Signals on connector of the C320 control card for pump protection via external sensor in the digital input



NOTE! Refer to the CFW320 frequency inverter manual for further details about connections.

4.3.2 Control Auxiliary Variable

The user can configure the Pump Genius application (Simplex only) to have a sensor installed on an analog input of the CFW320 frequency inverter to protect the pump.

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- 01 Sensor with analog output signal for measurement of the control auxiliary variable (A2);
- Command for Run/Stop (S1);
- Status light for motor running (H1);
- Status light for inverter fault (H2);
- Status light for low-level protection of the control process variable (H3);
- Status light for high-level protection of the control process variable (H4).

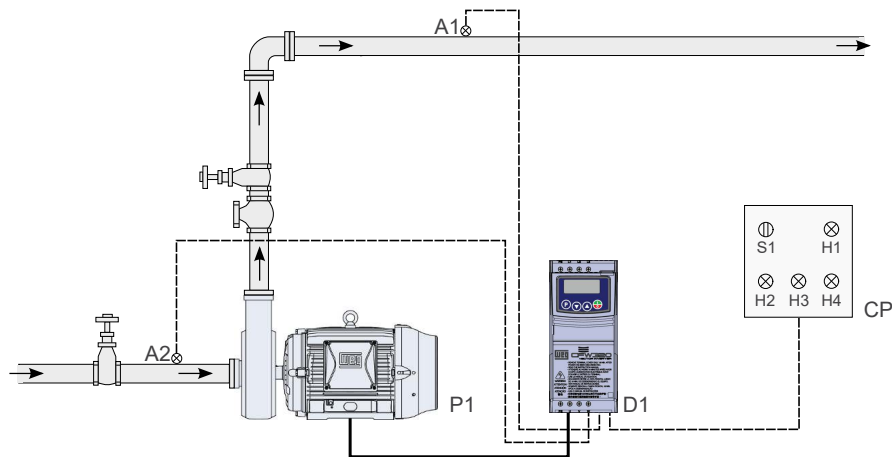


Figure 4.32: Pump Genius application with pump protection via control auxiliary variable read by analog input



NOTE!

Use the Pump Genius application setup wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with pump protection via control auxiliary variable read by analog input.



NOTE!

The indicating light H1, H2, H3 and H4 are not necessary for the operation of the Pump Genius and pump protection via control auxiliary variable read by analog input. They only indicate the condition of the pump operation at the command panel (CP).



NOTE!

To use this function is necessary to install the CFW320-IOAR or CFW320-IOAENC I/O accessory module.

The [Figure 4.33 at page 4-38](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter and to the accessory module to have the pump protection via control auxiliary variable read by analog input.

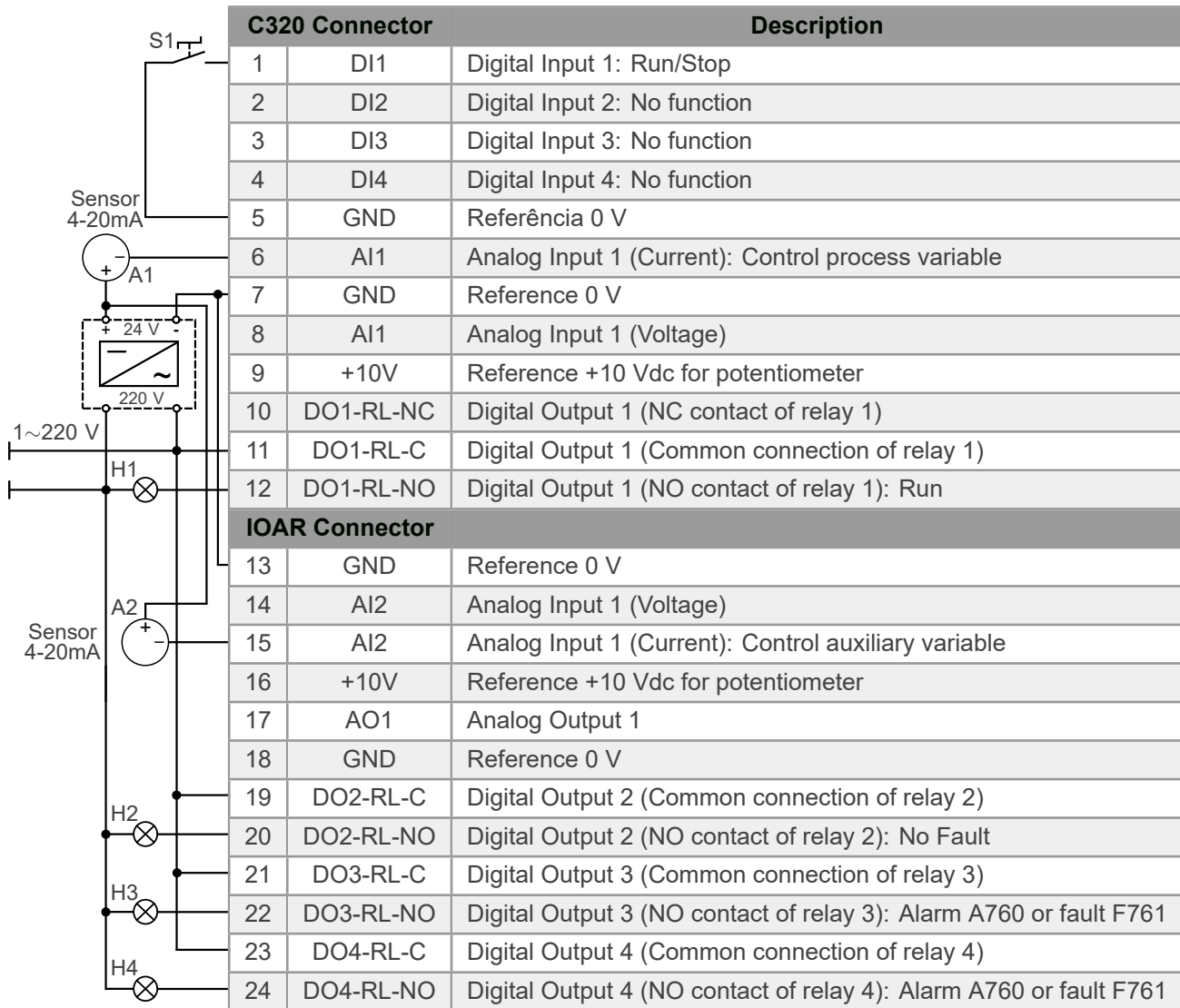


Figure 4.33: Signals on connector of the C320 control card and the CFW320-IOAR accessory module for pump protection via control auxiliary variable



NOTE!

Refer to the CFW320 frequency inverter manual and the CFW320-IOAR accessory for further details about connections.

4.3.3 Deragging Function with Command via Digital Input

The user can configure the Pump Genius application (Simplex only) to have an external command on a digital input of the CFW320 frequency inverter to execute the deragging function to clean and unblock the pump. Which basically comprises:

- 01 CFW320 frequency inverter (D1);
- 01 Electric motor and pump (P1);
- 01 Sensor with analog output signal for measurement of the control process variable (A1);
- Command for Run/Stop (S1);
- Command to execute the deragging function (S7);
- Status light for motor running (H1).

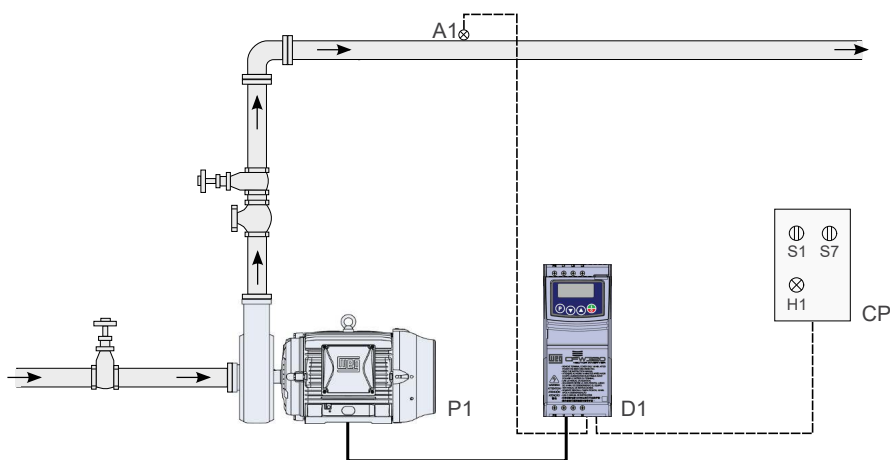


Figure 4.34: Pump Genius application with external command on a digital input to the pump



NOTE!

Use the Pump Genius application setup wizard in the WPS software to configure the pump driven by the CFW320 frequency inverter with external command on a digital input to perform the deragging function to clean and unblock the pump.



NOTE!

The indicating lights H1 is not necessary for the operation of the Pump Genius and the deragging function with command via digital input. It only indicates the condition of the pump operation at the command panel (CP).

The [Figure 4.35 at page 4-40](#) presents the control connections (analog inputs/outputs, digital inputs/outputs) that must be made to the connector of the C320 control card of the CFW320 frequency inverter to have the deragging function with command via digital input.

4

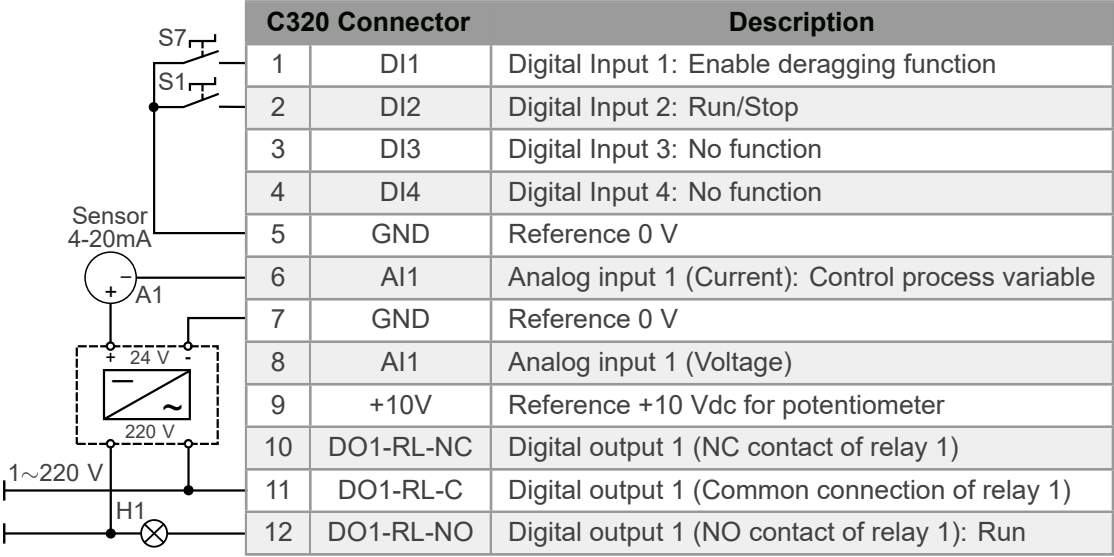


Figure 4.35: Signals on connector of the C320 control card for deragging function with command via digital input



NOTE! Refer to the CFW320 frequency inverter manual for further details about connections.

5 PARAMETERS DESCRIPTION

In the sequence, the parameters of the Pump Genius application will be presented, which includes parameters of the CFW320 frequency inverter (P000 to P899) and the SoftPLC function (P900 to P979).



NOTE!

The range of values for the CFW320 frequency inverter parameters are customized for the Pump Genius application (Simplex, Multipump and Multiplex). Refer to the CFW320 programming manual for more information on the parameters.

P910 - Pump Genius Application Version

Adjustable Range:	0.00 to 90.00	Factory Setting:
Properties:	ro	

Description:

This parameter indicates the software version of the Pump Genius application developed for the SoftPLC function of CFW320 frequency inverter.



NOTE!

The Pump Genius application (Simplex, Multipump and Multiplex) only works with the CFW320 frequency inverter with a **firmware version greater than V1.20**.

5.1 ORIGIN OF COMMANDS

This parameter group allows the user to configure the source of the CFW320 frequency inverter commands. For this application, the speed reference in LOCAL situation can be set by the HMI, but in REMOTE situation the SoftPLC option must be used for Pump Genius to work properly.

LOCAL Situation: It allows the user to control the pump driven by the CFW320 frequency inverter disregarding Pump Genius control logic.



NOTE!

The following conditions must be observed for each Pump Genius application when in LOCAL situation:

- Simplex: accepts any command source;
- Multipump: the command must be made via HMI and is only accepted with the pumping control disabled, that is, the digital input DI1 must be at logic level "0". For floating control, it is still necessary that only one of the digital inputs that enable the pumps be at logic level "1", which correspond to the pump to be driven by the CFW320 frequency inverter;
- Multiplex: the command can be done via HMI or digital input DI2 and is only accepted if the pump is not running.

REMOTE situation: Enables the logic of the Pump Genius control according to user programming.

P220 - LOCAL/REMOTE Selection Source

P221 - LOCAL Reference Selection

- P222 - REMOTE Reference Selection
- P223 - LOCAL FORWARD/REVERSE Selection
- P226 - REMOTE FORWARD/REVERSE Selection
- P224 - LOCAL Run/Stop Selection
- P227 - REMOTE Run/Stop Selection
- P225 - LOCAL JOG Selection
- P228 - REMOTE JOG Selection



NOTE!
Refer to the CFW320 programming manual for more information on the command source parameters. In the configuration wizard, some value options for the parameters were removed.

5

5.2 PID CONTROLLER

This group of parameters allows the user to adjust the operating conditions of the PID controller for controlling the pumping.

The PID controller allows controlling the speed of the motor (pump) driven by the CFW320 frequency inverter by comparing the control process variable (feedback) with the control setpoint required by the user, in order to eliminate the error to keep the variable equal to the control setpoint required by the user. The adjustment of gains P, I and D determine the speed with which the inverter will respond to eliminate this error. Below the block diagram of the PID controller.

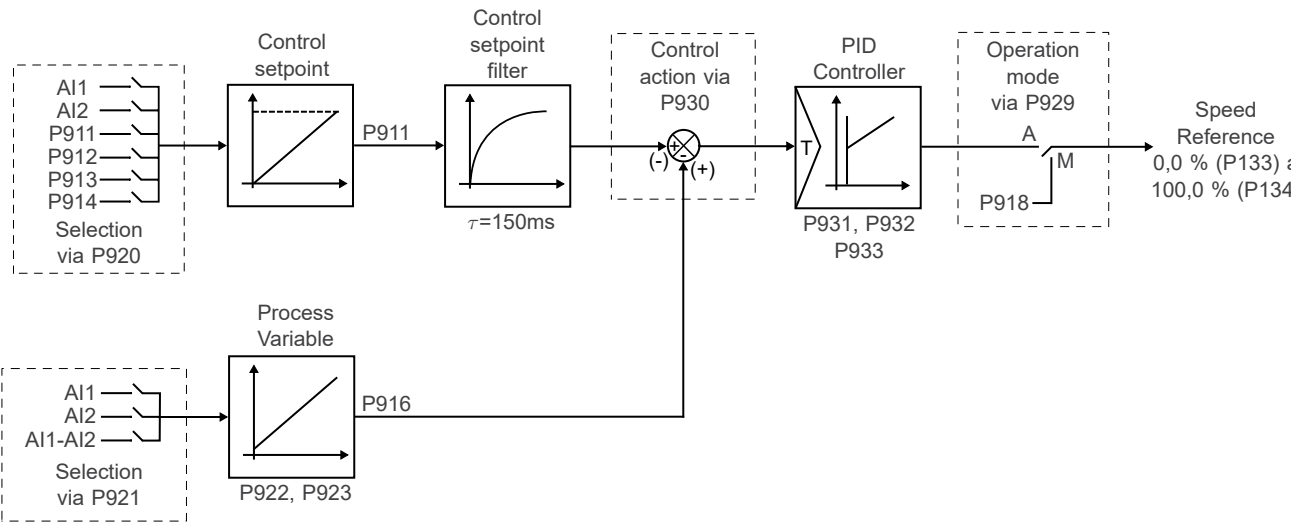


Figure 5.1: Block diagram of the PID controller

The PID controller will be set up to operate from 0.0 to 100.0%, where 0.0% equates to minimum speed programmed in P133 and 100.0% equates to maximum speed programmed in P134.

The process variable of the control is the one that the PID controller uses as a return (feedback) of its control action, being compared with the control setpoint required by the user, thus generating the error for the control. It is read via analog input, therefore, it will be necessary to configure which or which inputs will serve as the

control process variable for the PID controller.



NOTE!

The operating mode of the PID controller in Manual or Automatic is only valid for the Pump Genius Simplex application. In the Pump Genius Multipump and Pump Genius Multiplex applications, the PID controller always operates in automatic mode.

The "Academic PID" structure has been adopted as algorithm for the PID controller. According to the following equation:

$$y(k) = i(k - 1) + K_p \times \left[(1 + K_i T_s + K_d / T_s) \times e(k) - (K_d / T_s) \times e(k - 1) \right]$$

- Where:
- y(k):** PID controller output;
 - i(k-1):** PID controller integral part in the previous sampling instant;
 - K_p:** proportional gain;
 - K_i:** integral gain;
 - K_d:** derivative gain;
 - T_s:** PID controller cyclic sampling time (fixed at 50ms);
 - e(k):** error in the present sampling instant, with [SP(k) - PV(k)] for direct action and [PV(k) - SP(k)] for reverse action;
 - e(k-1):** error in the previous sampling instant, with [SP(k-1) - PV(k-1)] for direct action and [PV(k-1) - SP(k-1)] for reverse action;
 - SP:** PID controller control setpoint;
 - PV:** PID controller process variable, read through analog inputs (AI1 and/or AI2).

P930 - Selection of the PID Controller Control Action

Adjustable Range:	0 = Disable PID Controller 1 = Enable PID Controller in Direct Mode 2 = Enable PID Controller in Reverse Mode	Factory Setting: 1
Properties:	cfg	

Description:

This parameter defines how the control action of the PID controller will be when the Pump Genius control is enabled.

Table 5.1: Description of the PID controller control action

P930	Description
0	Defines that the PID controller will be disabled. In other words, there will be no control of the control process variable.
1	It defines that the PID controller will be enabled and the regulation or control action will be in direct mode. In other words, the error will be the control setpoint value (P911) minus the control process variable value (P916).
2	It defines that the PID controller will be enabled and the regulation or control action will be in reverse mode. In other words, the error will be the control process variable value (P916) minus the control setpoint value (P911).



NOTE!

The "0" option is valid only in the Pump Genius Simplex application.



NOTE!

The control action of the PID controller must be selected for direct mode when it is necessary to increase the PID controller output in order to increase the process variable value. E.g.: Pump driven by an inverter and filling a tank. For the level of the tank (process variable) to increase, it is necessary that the flow increase, which is accomplished by increasing the speed of the motor. The control action of the PID controller must be selected for reverse mode when it is necessary to decrease the PID controller output in order to increase the process variable value. E.g.: Fan driven by inverter cooling a refrigeration tower. When an increase in temperature is desired (process variable), it is necessary to reduce the ventilation by reducing the motor speed.

P929 - PID Controller Operation Mode

Adjustable Range:	0 = Manual 1 = Automatic 2 = Select Control to Manual (0) or Automatic (1) via digital input DI2	Factory Setting: 1
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5

Description:

This parameter defines the operation mode of the inverter PID controller for Pump Genius application.

Table 5.2: Description of the PID controller operation mode

P929	Description
0	It defines that the PID controller will always operate in manual mode. In other words, the process variable will not be controlled according to the control setpoint required by the user, and the PID controller output value will be the setpoint value in manual mode programmed in parameter P918.
1	It defines that the PID controller will operate in automatic mode, that is, the process variable will be controlled according to the control setpoint required by the user and the PID controller output value will respond according to the settings defined by the user.
2	It defines the PID controller will be able to operate in manual or automatic mode according to the state of digital input DI2. In other words, if the digital input is in logical level "0", the PID controller will operate in manual mode; if the digital input is in logical level "1", the PID controller will operate in automatic mode.



NOTE!

This parameter is only valid for the Pump Genius Simplex application.



NOTE!

The change from an operation mode to another with the motor running may cause disturbances on the system control. That can be optimized according to the automatic adjustment mode of the PID controller setpoint defined in parameter P928 together with the bumpless transfer characteristic from the manual mode to the automatic mode of the PID block of the SoftPLC function. Bumpless transfer is merely making the transfer from the manual mode to the automatic mode without causing variation in the PID controller output. In other words, when the transition from the manual mode to the automatic mode occurs, the PID controller output value in manual mode is used to start the integral part of the PID controller in automatic mode. That ensures that the output will start from this value.

P931 - Proportional Gain

Adjustable Range:	0.00 to 99.99	Factory Setting: 1.00
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Description:

This parameter defines the proportional gain value of the PID controller for the Pump Genius.

P932 - Integral Gain

Adjustable Range: 0.00 to 99.99

Factory Setting: 25.00

Description:

This parameter defines the integral gain value of the PID controller for the Pump Genius.

P933 - Derivative Gain

Adjustable Range: 0.00 to 99.99

Factory Setting: 0.00

Description:

This parameter defines the derivative gain value of the PID controller for the Pump Genius.

**NOTE!**

The Pump Genius PID controller type is academic. Changing the type will result in changes to the values of the PID controller gains that must be done by the user. Other PID block input arguments can only be changed by the ladder application developed in the WPS programming software. Refer to the help topics in the WPS programming software for more information about the PID block.

5**5.3 CONTROL PROCESS VARIABLE**

This group of parameters allows the user to configure the control process variable of the Pump Genius application.

P921 - Selection of the Control Process Variable Source

Adjustable Range: 0 = Without Control Process Variable (Disable the PID Controller)
1 = Control Process Variable via Analog Input AI1
2 = Control Process Variable via Analog Input AI2
3 = Control Process Variable via Difference between Analog Input AI1 and AI2

Factory Setting: 1

Properties: cfg

Description:

This parameter defines the source of the PID controller process variable.

Table 5.3: Description of the source of the PID controller process variable

P921	Description
0	It defines that there is no source for the control process variable of the Pump Genius, thereby disabling the PID controller.
1	It defines that the control variable source will be the value read by analog input AI1. The value is converted according to SoftPLC engineering unit and displayed in parameter P916.
2	It defines that the control variable source will be the value read by analog input AI2. The value is converted according to SoftPLC engineering unit and displayed in parameter P916.
3	It defines that the source of the control process variable of the Pump Genius is the value read by the analog input AI1 subtracted from the value read by the analog input AI2. The value is converted according to SoftPLC engineering unit and displayed in P916.

PARAMETERS DESCRIPTION



NOTE!

The options "0", "2" and "3" are valid only in the Pump Genius Simplex application. That is, in the Pump Genius Multipump and Pump Genius Multiplex application, only the analog input AI1 (option "1") can be the source of the control process variable.

P916 - Control Process Variable

Adjustable Range: -99.99 to 99.99
Properties: ro

Factory Setting:

Description:

This parameter indicates the value of the Pump Genius process variable according to the source defined in P921 and the scale defined in P922 and P923.

5



NOTE!

This parameter will be displayed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).

5.3.1 Engineering Unit Configuration

This group of parameters allows the user to configure the engineering unit of the Pump Genius control process variable.

P510 - Engineering Unit of Process Variable

Adjustable Range: 0 to 1 = None
2 = Volt (V)
3 = Hertz (Hz)
4 = None
5 = Percent (%)
6 = None
7 = Rotation / min (rpm)

Factory Setting: 0

Description:

This parameter selects the engineering unit to be displayed in the SoftPLC user parameter that is associated with it, it means that any SoftPLC user parameter that is associated with the SoftPLC engineering unit will be displayed in this format on the CFW320 inverter HMI.



NOTE!

The parameters P911, P912, P913, P914, P915, P916, P922, P923, P924, P926, P934, P935, P939 and P950 are associated with the SoftPLC engineering unit.

P511 - Decimal Point of Engineering Unit of Process Variable

Adjustable Range: 0 = wxyz
1 = wxy.z
2 = wx.yz
3 = w.xyz

Factory Setting: 2

Description:

This parameter selects the decimal point to be displayed in the SoftPLC user parameter that is associated with it, it means that any SoftPLC user parameter that is associated with the decimal point of SoftPLC engineering unit will be displayed in this format on the CFW320 inverter HMI.



NOTE!
The parameters P911, P912, P913, P914, P915, P916, P922, P923, P924, P926, P934, P935, P939 and P950 are associated with decimal point of SoftPLC engineering unit.

5.3.2 Sensor Scale Configuration

This group of parameters allows the user to configure a scale of the Pump Genius control process variable sensor.

P922 - Control Process Variable Minimum Sensor Level

Adjustable Range:	-99.99 to 99.99	Factory Setting:	0.00
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Description:

This parameter defines the minimum level of the Pump Genius control process variable sensor according to its engineering unit.



NOTE!
This parameter is displayed according to the selection of the SoftPLC engineering unit parameters (P510 and P511).

P923 - Control Process Variable Maximum Sensor Level

Adjustable Range:	-99.99 to 99.99	Factory Setting:	4.00
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Description:

This parameter defines the maximum level of the Pump Genius control process variable sensor according to its engineering unit.



NOTE!
This parameter is displayed according to the selection of the SoftPLC engineering unit parameters (P510 and P511).

Through the minimum and maximum levels of the sensor of the process variable of the control and the value of the analog input AI_x , we have the straight line equation for the conversion of the process variable of the Pump Genius control:

$$P916 = (P923 - P922) \times AI_x + P922$$

- Where:
- P916:** control process variable;
 - P922:** minimum level of the control process variable sensor;
 - P923:** maximum level of the control process variable sensor;

PARAMETERS DESCRIPTION

AI_x : value of analog input AI1, AI2 or AI1 - AI2 in %.

5.4 CONTROL SETPOINT

This group of parameters allows the user to configure the control setpoint for Pump Genius.

P920 - Control Setpoint Source Selection

Adjustable Range:	0 = Control Setpoint via HMI or Communication Networks (P911) 1 = Control Setpoint via Analog Input AI1 2 = Control Setpoint via Analog Input AI2 3 = Control Setpoint via Electronic Potentiometer (EP) 4 = Two Setpoints via Digital Input DI3 (P912 and P913) 5 = Three Setpoints via Digital Inputs DI3 and DI4 (P912, P913 and P914) 6 = Four Setpoints via Digital Inputs DI3 and DI4 (P912, P913, P914 and P915)	Factory Setting: 0
Properties:	cfg	

Description:

This parameter defines the source of the Pump Genius control setpoint.

Table 5.4: Description of the control setpoint source

P920	Description
0	Defines that the source of the Pump Genius control setpoint (PID in automatic) will be the value programmed in parameter P911 using the frequency inverter HMI or written via communication networks.
1	Defines that the Pump Genius control setpoint source (PID in automatic) will be the value read by the analog input AI1. The value is converted according to the scale and the SoftPLC engineering unit and displayed in parameter P915.
2	Defines that the Pump Genius control setpoint source (PID in automatic) will be the value read by the analog input AI2. The value is converted according to the scale and the SoftPLC engineering unit and displayed in parameter P915.
3	Defines that the source of the Pump Genius control setpoint (PID in automatic) will be the value defined with the electronic potentiometer function from the Increase Setpoint (DI3) and Decrease Setpoint (DI4) commands. The counting value is stored in parameter P915.
4	Defines that there will be two Pump Genius control setpoints (PID in automatic) selected via logical combination of the digital input DI3. The setpoint value of the selected control is displayed in parameter P915.
5	Defines that there will be three Pump Genius control setpoints (PID in automatic) selected via logical combination of the digital inputs DI3 and DI4. The setpoint value of the selected control is displayed in parameter P915.
6	Defines that there will be four Pump Genius control setpoints (PID in automatic) selected via logical combination of the digital inputs DI3 and DI4. The setpoint value of the selected control is displayed in parameter P915.



NOTE!

The options "1" and "2" are valid only in the Pump Genius Simplex application.

When the control setpoint is via the Electronic Potentiometer (EP) function (P920 = 3), the Pump Genius control setpoint is adjusted using digital inputs DI3 and DI4, with DI3 to increase the value and DI4 to decrease the value.

The [Figure 5.2 at page 5-9](#) presents the operation of the electronic potentiometer (EP) function. As the digital input DI3 is activated, the value of the control setpoint (P915) is increased and as the digital input DI4 is activated, the control setpoint value (P915) is decreased. If the two digital inputs are activated at the same time, the value remains the same.

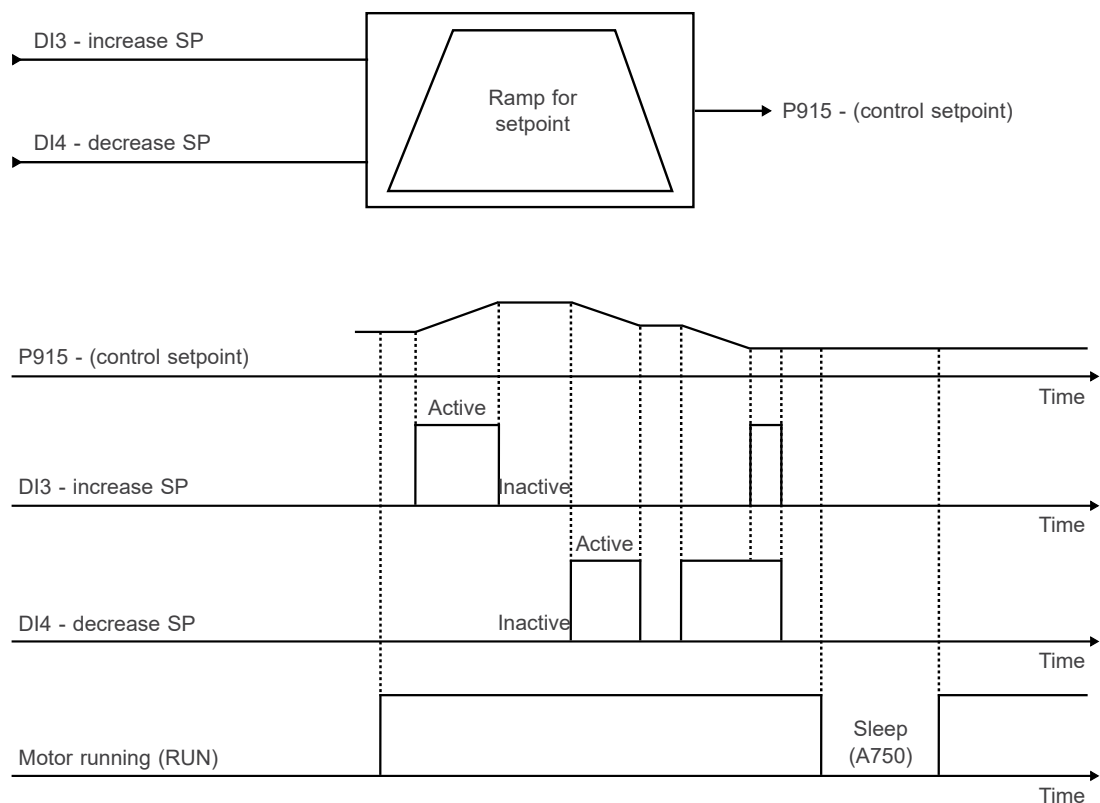


Figure 5.2: Operational graphic of the electronic potentiometer function (EP)

When the control setpoint is via a logical combination of digital inputs DI3 and DI4 (P920 = 4, 5 or 6) the following truth table must be applied to obtain the control setpoint of the PID controller.

Table 5.5: Truth table for control setpoint via logical combination of the digital inputs DI3 and DI4

	P911 - Control Setpoint 1	P912 - Control Setpoint 2	P913 - Control Setpoint 3	P914 - Control Setpoint 4
Digital Input DI3	0	1	0	1
Digital Input DI4	0	0	1	1

P911 - Control Setpoint

Adjustable Range:	-99.99 to 99.99	Factory Setting:	2.00
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Description:

This parameter defines the value of the control setpoint of the Pump Genius in engineering units when the control setpoint source was programmed to be via HMI or communication networks (P920=0). When the control setpoint source was programmed to be another source (P920≠0), it indicates the actual control setpoint of the Pump Genius.

**NOTE!** This parameter will be viewed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).

P912 - Control Setpoint 1

PARAMETERS DESCRIPTION

P913 - Control Setpoint 2

P914 - Control Setpoint 3

P915 - Control Setpoint 4

Adjustable Range: -99.99 to 99.99

Factory Setting: 2.00

Description:

These parameters define the setpoint value of the control setpoint of the Pump Genius in engineering unit when the control setpoint source is programmed to be via logical combination of digital inputs DI3 and DI4 (P920 = 4, 5 or 6) according to [Table 5.5 at page 5-9](#).



NOTE!

These parameters will be viewed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).

5

P918 - PID Controller Setpoint in Manual Mode

Adjustable Range: 0.0 to 400.0 Hz

Factory Setting: 0.0 Hz

Description:

This parameter defines the PID controller setpoint value when it is operating in manual mode. When the PID controller operates in manual mode, the speed value defined in parameter P918 (setpoint in manual mode) is transferred directly to the output of the PID controller, thus defining the speed reference of the pump driven by the CFW320 frequency inverter.



NOTE!

This parameter is only valid for the Pump Genius Simplex application.

P928 - Automatic Adjustment of the PID Controller Setpoint

Adjustable Range:
0 = P911 inactive and P918 inactive
1 = P911 active and P918 inactive
2 = P911 inactive and P918 active
3 = P911 active and P918 active

Factory Setting: 0

Description:

This parameter defines if the PID controller setpoint in automatic mode (P915) and/or in manual mode (P918) will be automatically changed or adjusted when the PID controller operation mode changes.

Table 5.6: Description of the PID controller setpoint automatic adjustment

P928	Description
0	It defines that, in the transition of the PID controller operation mode from manual to automatic, the control setpoint value (P915) will not be uploaded with the present value of the control process variable (P916), and in the transition of the PID controller operation mode from automatic to manual, the setpoint value of the PID controller in manual mode (P918) will not be uploaded with the present value of the motor speed (P002)
1	It defines that, in the transition of the PID controller operation mode from manual to automatic, the control setpoint value (P915) will be uploaded with the present value of the control process variable (P916), and in the transition of the PID controller operation mode from automatic to manual, the setpoint value of the PID controller in manual mode (P918) will not be uploaded with the present value of the motor speed (P002)
2	It defines that, in the transition of the PID controller operation mode from manual to automatic, the control setpoint value (P915) will not be uploaded with the present value of the control process variable (P916), and in the transition of the PID controller operation mode from automatic to manual, the setpoint value of the PID controller in manual mode (P918) will be uploaded with the present value of the motor speed (P002)
3	It defines that, in the transition of the PID controller operation mode from manual to automatic, the control setpoint value (P915) will be uploaded with the present value of the control process variable (P916), and in the transition of the PID controller operation mode from automatic to manual, the setpoint value of the PID controller in manual mode (P918) will be uploaded with the present value of the motor speed (P002)

**NOTE!**

This parameter is only valid for the Pump Genius Simplex application.

5

**NOTE!**

The adjustment of the control setpoint in automatic mode is only valid when the control setpoint source is HMI or communication networks (P920 = 0) or via the Electronic Potentiometer function (P920 = 3). For others control setpoint sources, the automatic adjustment is not executed.

5.5 STARTUP MODES

Defines the conditions for start the Pump Genius operation.

5.5.1 Wake up and Start Level Mode

This group of parameters allows the user to adjust the conditions to start the pump and control the pumping, which can be:

- **Wake up Mode:** Configures the Pump Genius to start the pump and resume control of the pumping when the deviation between the control process variable and the control setpoint reaches a programmed threshold;
- **Start Level Mode:** Configures the Pump Genius to start the pump and resume control of the pumping when the control process variable reaches a programmed threshold.

P934 - Control Process Variable Deviation for Pump Genius to Wake Up

Adjustable Range:	-99.99 to 99.99	Factory Setting:	0.30
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Description:

This parameter defines the value to be reduced (direct PID) or increased (reverse PID) to the control setpoint for starting the pump and resuming control of the pumping. Becoming this value is compared with the control process variable and, if the value of the control process variable is less (direct PID) or greater (reverse PID) than this value, the condition to wake up is enabled.

PARAMETERS DESCRIPTION



NOTE!

This parameter is displayed according to the selection of the SoftPLC engineering unit parameters (P510 and P511).

P935 - Control Process Variable Level to Starting the Pump Genius

Adjustable Range: -99.99 to 99.99

Factory Setting: 0.00

Description:

This parameter defines the control process variable level for starting the pump and resuming control of the pumping. With a Direct Mode PID controller, the pumping control will be enabling to start when the control process variable drops lower than P935. With a Reverse Mode PID controller it will be enabling to start when the process variable rises above P935.

5



NOTE!

This parameter will be displayed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).



NOTE!

Setting to "0" enables the use of the wake up mode and disables the start mode by level. Setting other than "0" enables the start by level mode and disables the wake up mode.

P936 - Time Delay for Pump Genius to Wake up or Starting by Level

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 5.0 s

Description:

This parameter defines the waiting time after the condition for wake up mode or start level mode becomes true, as follows:

- **Wake-up Mode:** The Wake up condition, as defined in P934, must remain TRUE continuously for the time programmed in P936, in order for the pump to start and pumping control to resume. The P936 waiting time restarts from zero, if the Wake up condition momentarily becomes FALSE;
- **Start by Level Mode:** The control process variable Start Level condition, as defined in P935, must remain TRUE continuously for the time programmed in P936, in order for the pump to start and pumping control to resume. The P936 waiting time restarts from zero, if the Start Level condition momentarily becomes FALSE.



NOTE!

If the Pump Genius is enabled for operation (active "Run / Stop" command or "Enable Pump Genius" command), the condition for Wake Up or Start by Level is active, the time programmed in P936 is not awaited, and thus, the pump will start operating immediately.

5.5.2 Sleep Mode

This group of parameters allows the user to configure the Pump Genius to stop the pump when the pump motor speed drops below a programmed threshold (low control demand). Even though apparently the pumping control

is off, the control process variable is still monitored for wake-up or start-level conditions.



DANGER!
When the inverter is in the sleep mode, the motor may start rotating at any moment depending of the conditions of the wake up mode or start by level. To handle the motor or execute any kind of maintenance the inverter must be powered off.

P937 - Pump Motor Speed below which Pump Genius goes to Sleep Mode

Adjustable Range:	0.0 to 400.0 Hz	Factory Setting:	42.0 Hz
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Description:
This parameter defines the value of the pump motor speed below which the Pump Genius will stop the pump keeping the control active, i.e., will sleep.



NOTE!
A setting of “0.0 Hz” disables the sleep mode, it means that the pump will be started or stopped according to the status of the command “Run/Stop” or the command “Enable Pump Genius”.

P938 - Time Delay for Pump Genius goes to Sleep Mode

Adjustable Range:	0.0 to 999.9 s	Factory Setting:	10.0 s
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Description:
This parameter defines the waiting time with the value of the pump motor speed should remain below the value set in P937 in order for sleep mode to be activated and the pump to be stopped.



NOTE!
The alarm message “A750: Active Sleep Mode” will be generated on the HMI of the inverter CFW320 to alert that Pump Genius is in sleep mode.

The [Figure 5.3 at page 5-14](#) presents an analysis of the Pump Genius operation with PID controller control action in direct mode when it is configured for Wake up Mode and Sleep Mode.

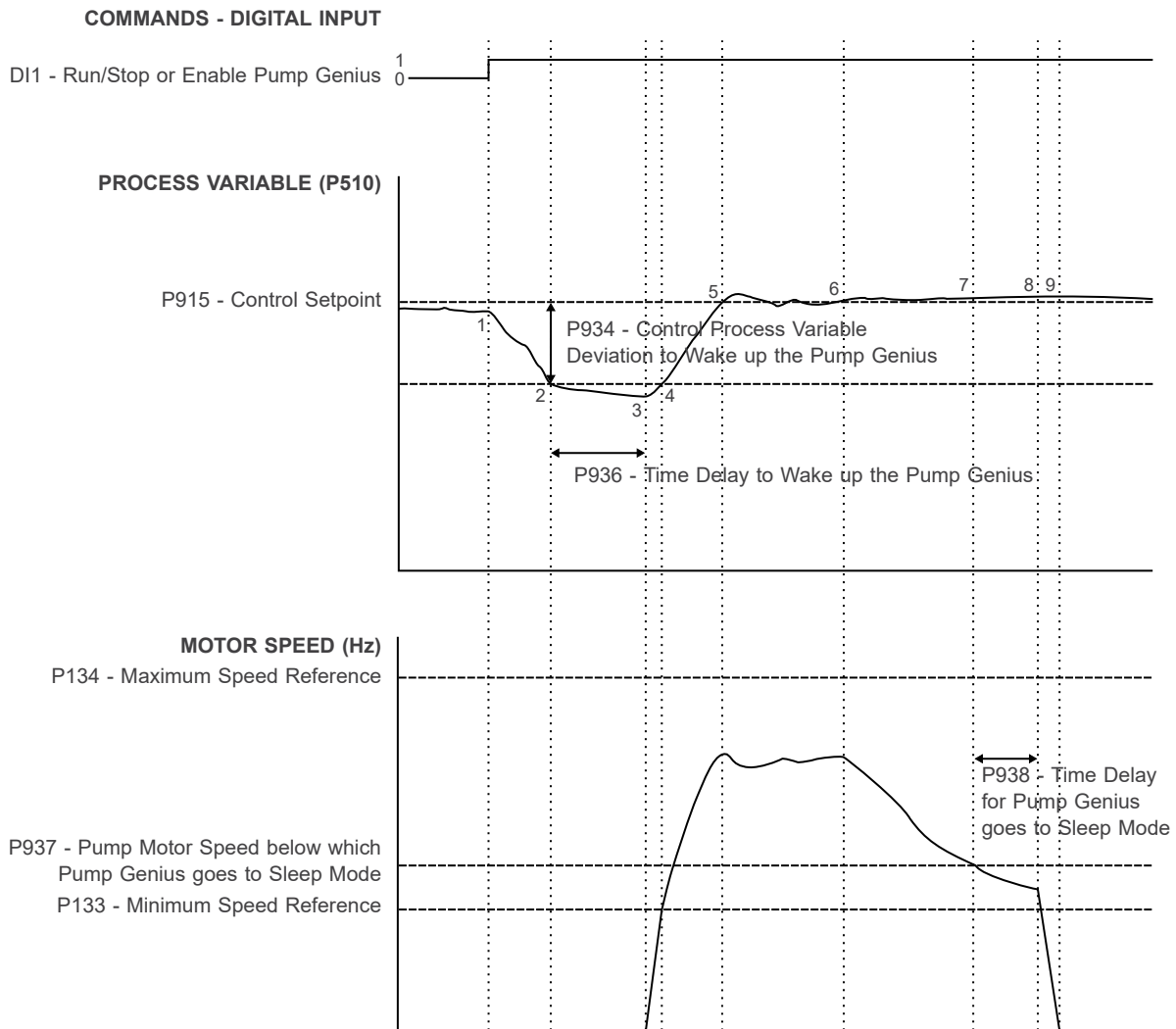


Figure 5.3: Pump Genius operation for Wake up and Sleep mode

1. The “Run/Stop” or “Enable Pump Genius” command via digital input DI1 enable starting the motor, but also enable the operation of Pump Genius. As the condition to wake up was not detected, the pumping control remains in the sleep mode and the pump remains stopped;
2. The control process variable begins to decrease and is lower than the control process variable deviation programmed to wake up the Pump Genius (P934); in this moment the time count to wake up (P936) is initiated;
3. The control process variable remains smaller than the control process deviation to wake up the Pump Genius (P934) and the time delay to wake up (P936) is elapsed; at this moment the control issues the command to start the pump and resumes controlling the pumping with variable speed;
4. The inverter accelerates the pump up to the minimum speed (P133). After that, the PID controller is enabled and starts controlling the pump speed;
5. The resumed Pump Genius allows the value of the control process variable to catch up with the control setpoint required by the user. The PID controller output increases during the catch-up phase, raising the pumping speed. A stable phase with constant pumping speed may follow;
6. The value of the control process variable continues above the setpoint due to a decrease in demand and pump speed begins to decrease;
7. The pump motor speed output drops below the speed for Pump Genius goes to sleep mode threshold (P937); the time counting for Pump Genius goes to sleep mode (P938) is initiated;

8. The pump motor speed remains below the speed for Pump Genius goes to sleep mode threshold (P937) and the time delay for Pump Genius goes to sleep mode (P938) is elapsed; at this moment the control issues the command to stop the pump;
9. The inverter driven pump reaches "zero" speed, and remains stopped; at this moment the Pump Genius goes into sleep mode.

The [Figure 5.4 at page 5-15](#) presents a timing analysis of the Pump Genius operation with a Direct Mode PID controller when it is configured for Start Level Mode and Sleep Mode.

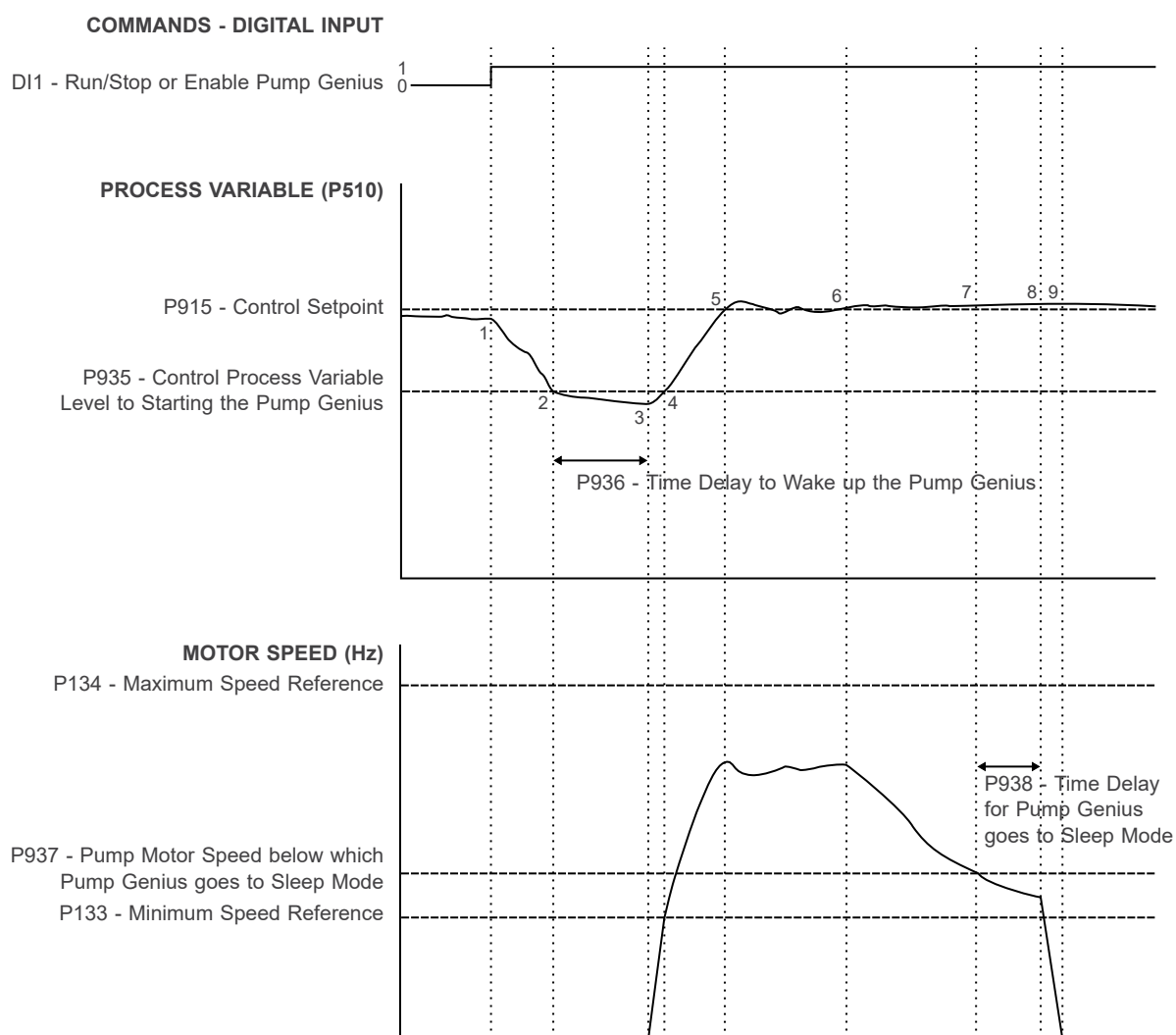


Figure 5.4: Operation of the Pump Genius for start level mode and sleep mode

1. The "Run/Stop" or "Enable Pump Genius" command via digital input DI1 enables starting the motor, but also enable the operation of Pump Genius. As the control process variable level condition to start the Pump Genius was not detected, the Pump Genius remains in the sleep mode and the pump remains stopped;
2. The control process variable begins to decrease and is lower than the control process variable threshold programmed starting the Pump Genius (P935); in this moment the time count for starting by level the Pump Genius (P936) is initiated;
3. The control process variable remains smaller than the threshold for starting the Pump Genius (P935) and the time delay for starting by level the Pump Genius (P936) is elapsed; at this moment the control issues the command to start the pump and resumes controlling the pumping with variable speed;

PARAMETERS DESCRIPTION

4. The inverter accelerates the pump up to the minimum speed (P133). After that, the PID controller is enabled and starts controlling the pump speed;
5. The resumed Pump Genius allows the value of the control process variable to catch up with the control setpoint required by the user. The PID controller output increases during the catch-up phase, raising the pumping speed. A stable phase with constant pumping speed may follow;
6. The value of the control process variable continues above the setpoint due to a decrease in demand and pump speed begins to decrease;
7. The pump motor speed output drops below the speed for Pump Genius goes to sleep mode threshold (P937); the time count for Pump Genius goes to sleep mode (P938) is initiated;
8. The pump motor speed remains below the speed for Pump Genius goes to sleep mode threshold (P937) and the time delay for Pump Genius goes to sleep mode (P938) is elapsed; at this moment the control issues the command to stop the pump;
9. The inverter driven pump reaches "zero" speed, and remains stopped; at this moment the Pump Genius goes into sleep mode.

5

5.5.3 Sleep Boost

This group of parameters allows the user to configure the Pump Genius so before stop the pump when the pump motor speed drops below a programmed threshold (low demand control), i.e., enable the sleep mode, to be added to the control setpoint a value to increase the control process variable with the purpose of the pump will remain in sleep mode longer.

P939 - Sleep Boost Offset

Adjustable Range: -99.99 to 99.99

Factory Setting: 0.00

Description:

This parameter defines the value to be added to the control setpoint in automatic mode to increase the control process variable before the Pump Genius go into sleep mode. When the control process variable reach the control setpoint value added to the sleep boost offset, the Pump Genius will go into sleep mode.



NOTE!

This parameter is displayed according to the selection of the SoftPLC engineering unit parameters (P510 and P511). A setting of "0" disable the sleep boost function. This function is only enabled to use for control action of the PID controller in direct mode.



NOTE!

The alarm message "A752: Sleep Boost Active" will be generated on the HMI of the CFW320 inverter to alert that the Pump Genius is executing the sleep boost.

P940 - Sleep Boost Maximum Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 0.0 s

Description:

This parameter defines the maximum time that the control process variable has to reach the control setpoint value added to the sleep boost offset, i.e., the maximum time that the sleep boost will be active. If the control

process variable does not reach the control setpoint value added to the sleep boost offset during this time, the Pump Genius will go into sleep mode.

The [Figure 5.5 at page 5-17](#) presents a timing analysis of the Pump Genius operation with a Direct Mode PID controller when it is configured for Wake up Mode and Sleep Mode with Sleep Boost enabled.

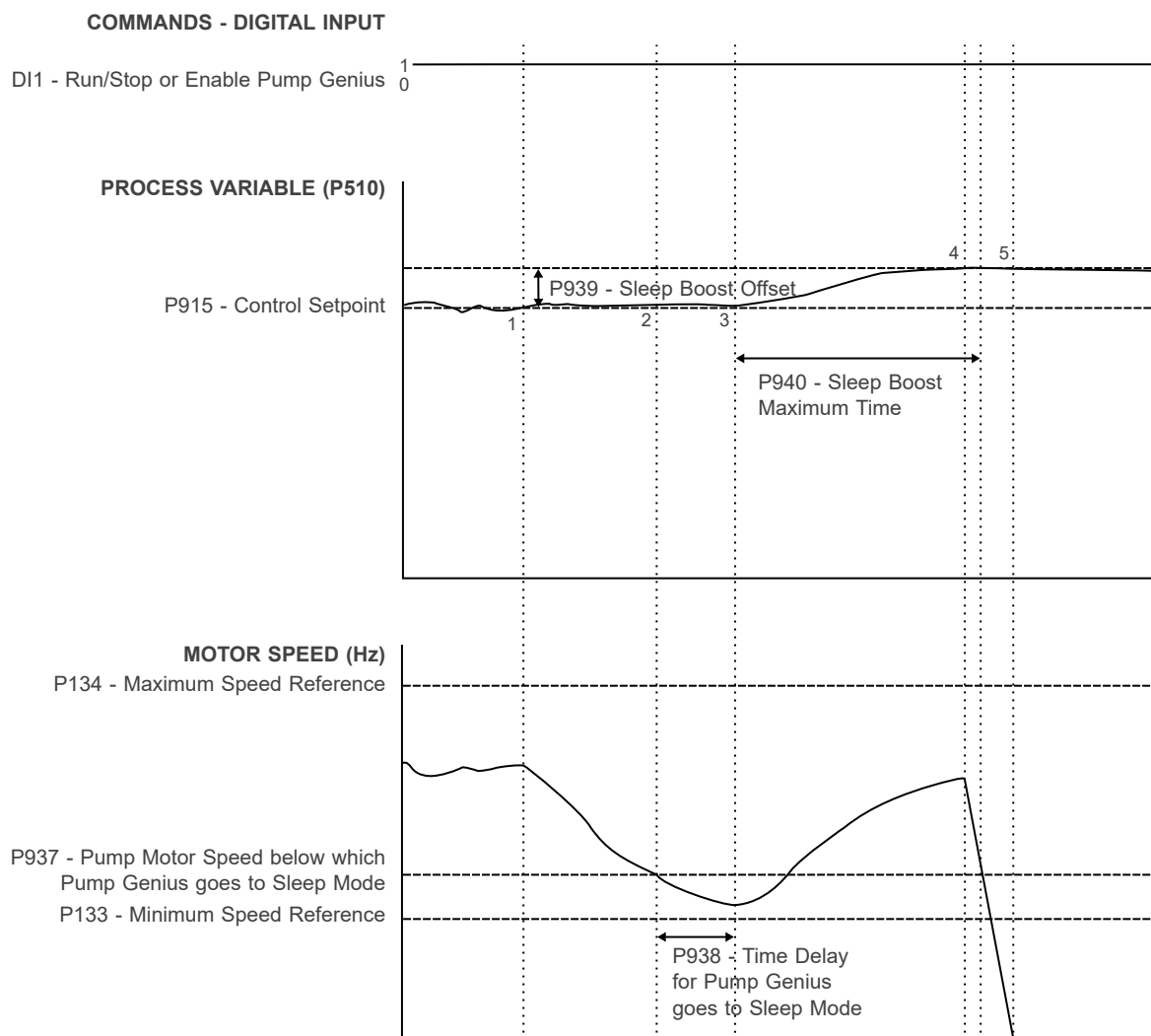


Figure 5.5: Operation of the Pump Genius for sleep mode with sleep boost enabled

1. The Pump Genius is keeping the system controlled as the control setpoint required by the user. At this moment the value of the control process variable begins to increase and the speed motor begins to decrease;
2. The pump motor speed output drops below the speed for Pump Genius goes to sleep mode threshold (P937); the time count for the Pump Genius to sleep mode (P938) is initiated;
3. The pump motor speed remains below the speed for Pump Genius goes to sleep mode threshold (P937) and the time delay for Pump Genius goes to sleep mode (P938) is elapsed; at this moment, as the sleep boost is enabled will not be made the command to stop the pump. It will be added the sleep boost offset (P939) to the control setpoint for increase the control process variable; at this moment the count of the sleep boost maximum time (P940) is initiated;
4. The inverter accelerates the pump again as the action of the PID controller and the control process variable reaches the control setpoint value added to the sleep boost active; at this moment the control issues the command to stop the pump before the count of the sleep boost maximum time be elapsed;
5. The inverter driven pump reaches "zero" speed, and remains stopped; at this moment the Pump Genius goes into sleep mode.

5.6 PIPE CHARGING

This group of parameters allows the user to configure the Pump Genius to perform the pipe charging when starting the pumping using a pump driven by the CFW320 frequency inverter.

The **pipe charging** assures that the pumping pipe is charged gradually, thus avoiding the “water hammer” pressure shock at the instant the pipe is filled with fluid. It is executed every time the Pump Genius receives a new enable, either via enable command or an exit from a disabled by fault state.



NOTE!
If in enabling the Pump Genius operation (command “Run/Stop” or “Enable Pump Genius active”) it enters into sleep mode, the pipe charging process will not executed.

P105 - Enable Pipe Charging (1st/2nd Ramp Selection)

Adjustable Range:	0 = Disable (1st Ramp) 6 = Enable (SoftPLC)	Factory Setting: 0
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Description:
This parameter allows enabling of the pipe charging sequence (assigns to the SoftPLC function the ramp selection command) using the pump driven by CFW320 inverter (Simplex and Multipump) or the 1st pump to be started by Pump Genius (Multiplex).

P102 - Pipe Charging Acceleration Time (2nd Ramp)

Adjustable Range:	0.0 to 999.9 s	Factory Setting: 40.0 s
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Description:
This parameter defines a second acceleration time for the pump driven by CFW320 inverter for the purpose of pipe charging.



NOTE!
Refer to the CFW320 inverter programming manual for more information on the ramp parameters.

P941 - Pipe Charging Duration Time

Adjustable Range:	0.0 to 999.9 s	Factory Setting: 0.0 s
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Description:
This parameter defines the elapsed time for pipe charging.



NOTE!
The alarm message “A754: Pipe Charging” will be generated on the HMI of the CFW320 frequency inverter to alert that the Pump Genius is in the process of pipe charging.

The [Figure 5.6 at page 5-19](#) presents an analysis of the Pump Genius operation when it is enabled the pipe charging when starting pumping.

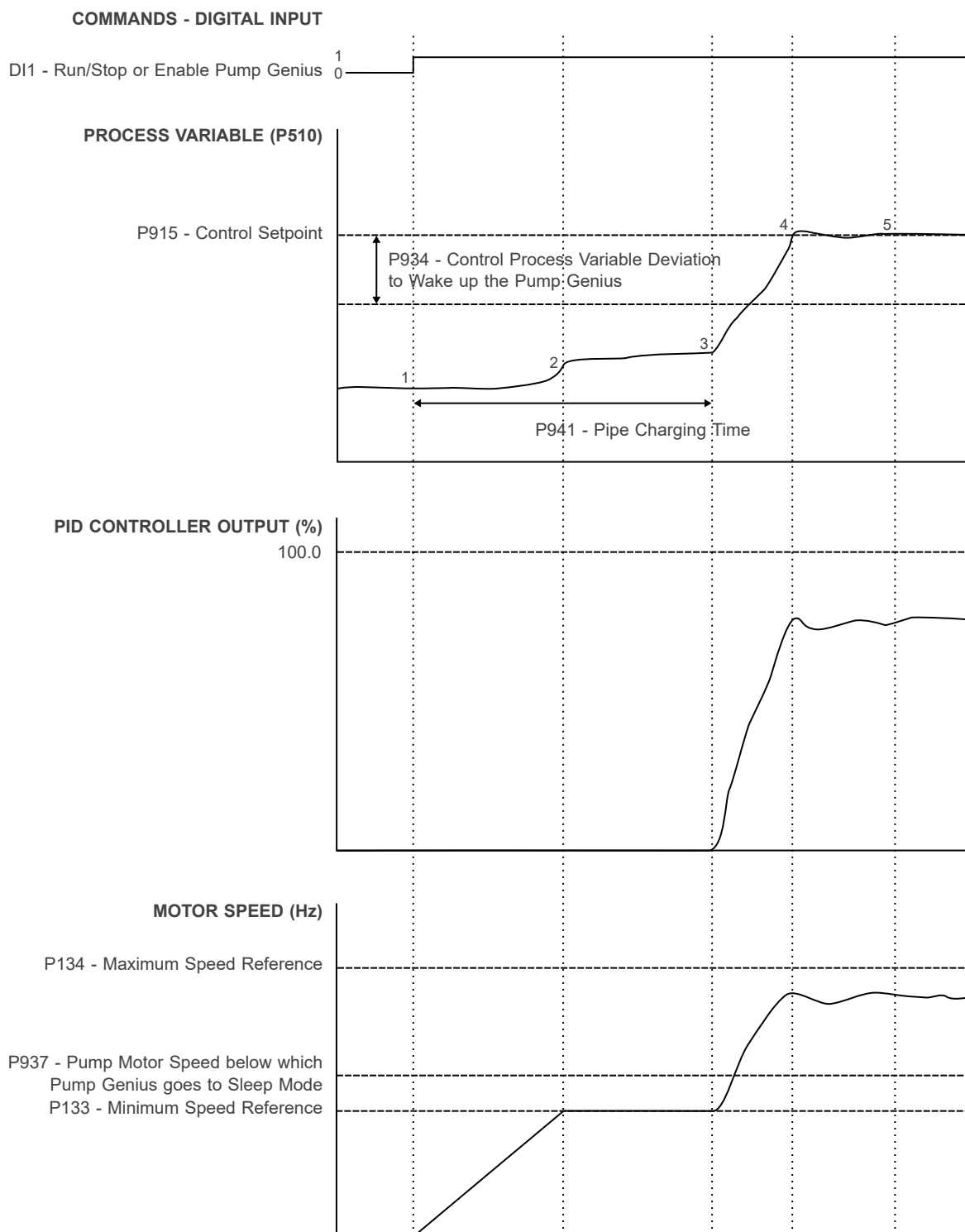


Figure 5.6: Operation of the Pump Genius with pipe charging enabled

1. The “Run/Stop” or “Enable Pump Genius” command via digital input DI1 enables starting the motor, but also enables the operation of Pump Genius. As the control process variable is lower than the control process deviation for Pump Genius to wake up (P934), the time delay to wake up (P936) is not awaited and the command run is issued. As pipe charging is enabled (P105), the time count (P941) is initiated, while the PID controller remains disabled. The pump is accelerated to the minimum speed (P133) with a slower ramp in order to avoid the water hammer;
2. The pump speed reaches the value programmed for minimum speed (P133) and continues at this speed during the course of time for pipe charging (P941). During this time the PID controller is disabled;
3. The time for pipe charging (P941) is elapsed; at this moment the PID controller is enabled and begins

PARAMETERS DESCRIPTION

to increase the pump speed in order for the control process variable to catch up with the control setpoint required by the user;

4. With increasing the pump speed, the control process variable reaches the control setpoint value;
5. A short time later the control process variable stabilizes and pumping continues at steady speed.

P942 - Maximum Output Current during the Pipe Charging

Adjustable Range: 0.0 to 40.0 A

Factory Setting: 0.0 A

Description:

This parameter defines the value of the maximum motor current during the pipe charging process to execute the current limit defined by P135.



NOTE!

A setting of "0.0 A" executed the motor current limitation only by the value set in P135 parameter.



NOTE!

Refer to the CFW320 inverter programming manual for more information on the motor current limitation parameters.

5.7 RAMPS

This group of parameters allows the user to configure the inverter ramps so that the motor is accelerated or decelerated faster or slower rate.

P100 - Acceleration Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 10.0 s

Description:

This parameter determines the time of linear acceleration between zero and maximum speed (defined in P134).

P101 - Deceleration Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 10.0 s

Description:

This parameter determines the time of linear deceleration between the maximum speed (defined in P134) and zero.



NOTE!

Refer to the CFW320 programming manual for more information on the ramp parameters.

5.8 SPEED LIMITS

This group of parameters allows the user to configure the motor speed limits.

P133 - Minimum Speed Reference

Adjustable Range:	0.0 to 400.0 Hz	Factory Setting:	40.0 (35.0) Hz
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Description:
This parameter defines the minimum value for the motor speed reference when the inverter is enabled.

P134 - Maximum Speed Reference

Adjustable Range:	0.0 to 400.0 Hz	Factory Setting:	60.0 (50.0) Hz
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Description:
This parameter defines the maximum value for the motor speed reference when the inverter is enabled.



NOTE!
Refer to the CFW320 programming manual for more information on the speed limit parameters.
With CFW320

5.9 ASSOCIATION OF PUMPS IN PARALLEL

This group of parameters allows the user to configure the CFW320 frequency inverter(s) when there is an association of pumps in parallel.



NOTE!
These parameters are valid for Pump Genius Multiplex and Multipump applications.

5.9.1 Multipump Control

This group of parameters allows the user to configure the control mode that the CFW320 frequency inverter will be used to drive the pumps in parallel with Pump Genius Multipump application.

P928 - Control Mode Configuration

Adjustable Range:	0 = Fixed Control with Sequential Pump Activation 1 = Fixed Control with Pump Activation by Operating Time 2 = Floating Control 1 with Sequential Pump Activation 3 = Floating Control 1 with Pump Activation by Operating Time 4 = Floating Control 2 with Sequential Pump Activation 5 = Floating Control 2 with Pump Activation by Operating Time	Factory Setting:	0
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Description:
This parameter defines the control mode that the CFW320 frequency inverter will be used to control the pump connected to it; and how the command to start and stop the additional pumps in the system will be executed.

PARAMETERS DESCRIPTION

Table 5.7: Description of the Pump Genius Multipump control mode

P928	Description
0	It defines that the system will be controlled by the speed variation of a fixed pump. When there is a need to start other pumps in parallel (up to four), the inverter drives direct starts (digital outputs) and these pumps operate at rated speed. The activation of the parallel pumps (start and stop) will be in sequence and the speed-controlled pump is always the same (fixed): - To Start: Start Inverter Pump → Start Pump 1 → Start Pump 2 → Start Pump 3 → Start Pump 4. - To Stop: Stop Pump 4 → Stop Pump 3 → Stop Pump 2 → Stop Pump 1 → Stop Inverter Pump
1	It defines that the system will be controlled by the speed variation of a fixed pump. When there is a need to start other pumps in parallel (up to four), the inverter drives direct starts (digital outputs) and these pumps operate at rated speed. The activation of the pumps in parallel (start and stop) will be according to the operating time. The pump with the lowest operating time will always be the next to be started and the one with the greatest operating time will be the first to be stopped, executing an alternation between them and the speed-controlled pump is always the same (fixed): - To Start: Start Inverter Pump → Start the pump with the lowest operating time. - To Stop: Stop the pump with the greatest operating time → Stop Inverter Pump.
2	It defines that the system will be controlled by the speed variation of any of the pumps and the system controls the speed of the first pump turned on by the operator. When there is a need to start other pumps in parallel (up to three), the inverter drives direct starts (digital outputs) and these pumps operate at rated speed. The actuation of the pumps in parallel (start and stop) will be in sequence: - To Start: Start Pump 1 → Start Pump 2 → Start Pump 3 → Start Pump 4. - To Stop: Stop Pump 4 → Stop Pump 3 → Stop Pump 2 → Stop Pump 1
3	It defines that the system will be controlled by the speed variation of any of the pumps and the system controls the speed of the first pump turned on according to the lowest operating time. When there is a need to start other pumps in parallel (up to three), the inverter drives direct starts (digital outputs) and these pumps operate at rated speed. The activation of the pumps in parallel (start and stop) will be according to the operating time. The pump with the lowest operating time will always be the next to be started and the one with the greatest operating time will be the first to be stopped, executing an alternation between them: - To Start: Start the pump with the lowest operating time. - To Stop: Stop the pump with the greatest operating time since it is not the pump being driven by the CFW320 inverter.
4	It defines that the system will be controlled by the speed variation of any of the pumps (the system chooses automatically). When there is a need to start other pumps to the system, the drive releases the current pump to be connected directly to the network (operating at nominal speed) and begins to control the speed of the next pump. This control method allows up to three pumps to be controlled. The actuation of the pumps (start and stop) to be controlled by the drive will be in sequence: - To Start: Start Pump 1 → Start Pump 2 → Start Pump 3. - To Stop: Stop Pump 2 → Stop Pump 1 → Stop Pump 3.
5	It defines that the system will be controlled by the speed variation of any of the pumps (the system chooses automatically). When there is a need to start other pumps to the system, the drive releases the current pump to be connected directly to the network (operating at nominal speed) and begins to control the speed of the next pump. This control method allows up to three pumps to be controlled. The activation of the pumps (start and stop) will be according to the operating time. The pump with the lowest operating time will always be the next to be started and the one with the greatest operating time will be the first to be stopped, executing an alternation between them: - To Start: Start the pump with the lowest operating time. - To Stop: Stop the pump with the greatest operating time since it is not the pump being driven by the CFW320 inverter.

5

P929 - Time to Contactor Command

Adjustable Range:	0.050 to 9.999 s	Factory Setting:	0.500 s
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Description:

This parameter defines the time that will be waited to make the command to close the contactor at the output of the frequency inverter, to ensure that power contacts are closed when the frequency converter is to apply voltage to the motor. This delay time is also used to ensure that before generating the command to open the contactor at the frequency inverter output, the frequency inverter is no longer applying voltage to the motor and it is already demagnetized, thus preventing the occurrence of fault F071 in the frequency inverter.



NOTE!

This parameter is valid for the Floating Control Type 1 and Floating Control Type 2 modes.

5.9.2 Multiplex Control

This group of parameters allows the user to configure the operating mode of the master pump and the slave pump in the Pump Genius Multiplex application.

P928 - Pump Operation Configuration

Adjustable Range:	0 = A Single Master Pump 1 = Master Pump 1 2 = Master Pump 2 3 = Master Pump 3 4 = Master Pump 4 5 = Slave Pump	Factory Setting: 0
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Description:

This parameter defines the operating mode of the pump in the Pump Genius Multiplex.

Table 5.8: Description of the pump operating mode in the Pump Genius Multiplex

P928	Description
0	Defines that this pump will be the only master pump in the system. This pump will manage the pumping, setting speed reference through the PID controller and need to turn on or turn off the other pumps (slaves) using the CFW320-IODF accessory frequency outputs.
1	Defines that during the System Master Recognition (A790) , this pump will be 1st in the priority criteria (Pump 1 → Pump 2 → Pump 3 → Pump 4) to assume the system's master function, and thus manage the pumping, defining speed reference through the PID controller and the need to turn on or turn off the other pumps (slaves) through the frequency outputs of the CFW320-IODF accessory. If this pump is not the active master it will operate as a slave pump, receiving the speed reference and the command to turn on or turn off via one of the frequency inputs of the CFW320-IODF accessory from the active master pump.
2	Defines that during the System Master Recognition (A790) , this pump will be 2nd in the priority criteria (Pump 1 → Pump 2 → Pump 3 → Pump 4) to assume the system's master function, and thus manage the pumping, defining speed reference through the PID controller and the need to turn on or turn off the other pumps (slaves) through the frequency outputs of the CFW320-IODF accessory. If this pump is not the active master it will operate as a slave pump, receiving the speed reference and the command to turn on or turn off via one of the frequency inputs of the CFW320-IODF accessory from the active master pump.
3	Defines that during the System Master Recognition (A790) , this pump will be 3rd in the priority criteria (Pump 1 → Pump 2 → Pump 3 → Pump 4) to assume the system's master function, and thus manage the pumping, defining speed reference through the PID controller and the need to turn on or turn off the other pumps (slaves) through the frequency outputs of the CFW320-IODF accessory. If this pump is not the active master it will operate as a slave pump, receiving the speed reference and the command to turn on or turn off via one of the frequency inputs of the CFW320-IODF accessory from the active master pump.
4	Defines that during the System Master Recognition (A790) , this pump will be 4th in the priority criteria (Pump 1 → Pump 2 → Pump 3 → Pump 4) to assume the system's master function, and thus manage the pumping, defining speed reference through the PID controller and the need to turn on or turn off the other pumps (slaves) through the frequency outputs of the CFW320-IODF accessory. If this pump is not the active master it will operate as a slave pump, receiving the speed reference and the command to turn on or turn off via one of the frequency inputs of the CFW320-IODF accessory from the active master pump.
5	Defines that this pump will always be a slave pump, it means that, this pump will receive the speed reference and the command to turn on or turn off via one of the frequency inputs of the CFW320-IODF accessory from the active master pump.

PARAMETERS DESCRIPTION



NOTE!

When a pump is configured as Master Pump 1, 2, 3 or 4, it can assume the function of a master pump in some circumstances:

- Failure to receive the frequency signal at one of the CFW320-IODF accessory inputs, indicating that there is a master pump in the system; this exchange can be done automatically ($P947 \neq 0$) or manually via command on the HMI (I/O key) of the CFW320 frequency inverter;
- Detection of wire breakage of the sensor of the control process variable when the analog input is 4-20mA; this exchange will be done automatically.

Every change of master pump in the Pump Genius results in the shutdown of all pumps. Another pump will have to assume the role of master in Pump Genius and thus, restart pumping control with this new configuration.

P929 - Pumps Number Configuration

5

Adjustable Range: 2 to 4

Factory Setting: 2

Description:

This parameter defines the total number of pumps that will operate in the pumping system in the Pump Genius Multiplex application.



NOTE!

This parameter is valid only when the pump is master or master/slave.

P947 - Automatic Change Over Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 2.0 s

Description:

This parameter defines the time for another master/slave pump to assume the function of master pump in Pump Genius when there is a loss of the frequency signal (A794) of the pump that was with the master function. This loss of the frequency signal will be detected by the pumps that are configured as master/slave.

If the time value (P947) has elapsed without a valid frequency signal from the current master pump, a command will be generated for all pumps so that a new master/slave pump can assume the master function in Pump Genius. Only pumps programmed with the Pump Master 1, 2, 3 or 4 function and that have an analog input programmed to read the process variable from the control can assume the function of master in Pump Genius.



NOTE!

Setting to "0s" disables automatic change of the master pump and enables the fault "F795: Two or more active masters". The exchange can still be done manually via the I/O key of the inverter's HMI frequency converter CFW320 in the presence of alarm A794.



NOTE!

This parameter is only valid when the pump is a master/slave.

5.9.3 Pumps Operation Time

This group of parameters allows the user to view the values of the operating times of the associated pumps in parallel in the Pump Genius Multipump and Pump Genius Multiplex applications.



NOTE!

It is allowed to change the operating time of the pumps if the password that allows changing the parameters is enabled.

P947 - Pump Operating Time driven by the CFW320

Adjustable Range:	0 to 9999	Factory Setting:	0
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Description:
This parameter indicates the operating time value of the pump driven by the CFW320 frequency inverter when the fixed control is programmed in the Pump Genius Multipump application.



NOTE!

This parameter is only valid in the Pump Genius Multipump application with fixed control.

P948 - Operation Time of Pump 1

Adjustable Range:	0 to 9999	Factory Setting:	0
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Description:
This parameter indicates the operating time value of the pump 1. It is the value used to define which pump in parallel will be turned on or off by Pump Genius.

P949 - Operation Time of Pump 2

Adjustable Range:	0 to 9999	Factory Setting:	0
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Description:
This parameter indicates the operating time value of the pump 2. It is the value used to define which pump in parallel will be turned on or off by Pump Genius.

P950 - Operation Time of Pump 3

Adjustable Range:	0 to 9999	Factory Setting:	0
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Description:
This parameter indicates the operating time value of the pump 3. It is the value used to define which pump in parallel will be turned on or off by Pump Genius.

PARAMETERS DESCRIPTION

P951 - Operation Time of Pump 4

Adjustable Range: 0 to 9999

Factory Setting: 0

Description:

This parameter indicates the operating time value of the pump 4. It is the value used to define which pump in parallel will be turned on or off by Pump Genius.

5.10 STARTING PUMPS IN PARALLEL

This group of parameters allows the user to adjust the operating conditions to connect another pump in parallel to the Pump Genius.



NOTE!

These parameters are valid for the Pump Genius Multipump and Pump Genius Multiplex applications.

5

P952 - Speed for Starting Pump in Parallel

Adjustable Range: 0.0 to 400.0 Hz

Factory Setting: 57.0 Hz

Description:

This parameter defines the pump motor speed above which starting an additional pump in parallel in the Pump Genius is enabled in order to maintain control according to the required setpoint.

P953 - Deviation for Starting Pump in Parallel

Adjustable Range: 0.00 to 99.99

Factory Setting: 0.10

Description:

This parameter defines the maximum deviation of the control process variable from the control setpoint (a negative value for a Direct Mode PID, or a positive value for a Reverse Mode PID), which, if exceeded, enables starting an additional pump in the Pump Genius.



NOTE!

A setting of "0" disables the P953 condition of the logic for starting an additional pump in parallel.



NOTE!

This parameter is displayed according to the selection of the SoftPLC engineering unit (P510 and P511).

P954 - Time Delay for Starting Pump in Parallel

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 2.0 s

Description:

This parameter defines a time delay during which both the conditions of P952 and P953 must remain satisfied before an additional pump is started in parallel in the Pump Genius.

P955 - Delay in the Deceleration when Starting Pump in Parallel

Adjustable Range:	0.0 to 100.0 s	Factory Setting:	0.0 s
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Description:

This parameter defines a delay for the beginning of the deceleration of the pump driven by the CFW320 frequency inverter when a new pump is started in parallel.

**NOTE!**

This parameter is only valid for the Pump Genius Multipump application.

**NOTE!**

Value of the parameter in 100.00 will not apply the deceleration of the pump driven by the CFW320 frequency inverter. The pump remains at the same speed it was before a new pump is started.

The [Figure 5.7 at page 5-27](#) presents a timing analysis of the Pump Genius Multipump operation when the need to start an additional pump in parallel is detected.

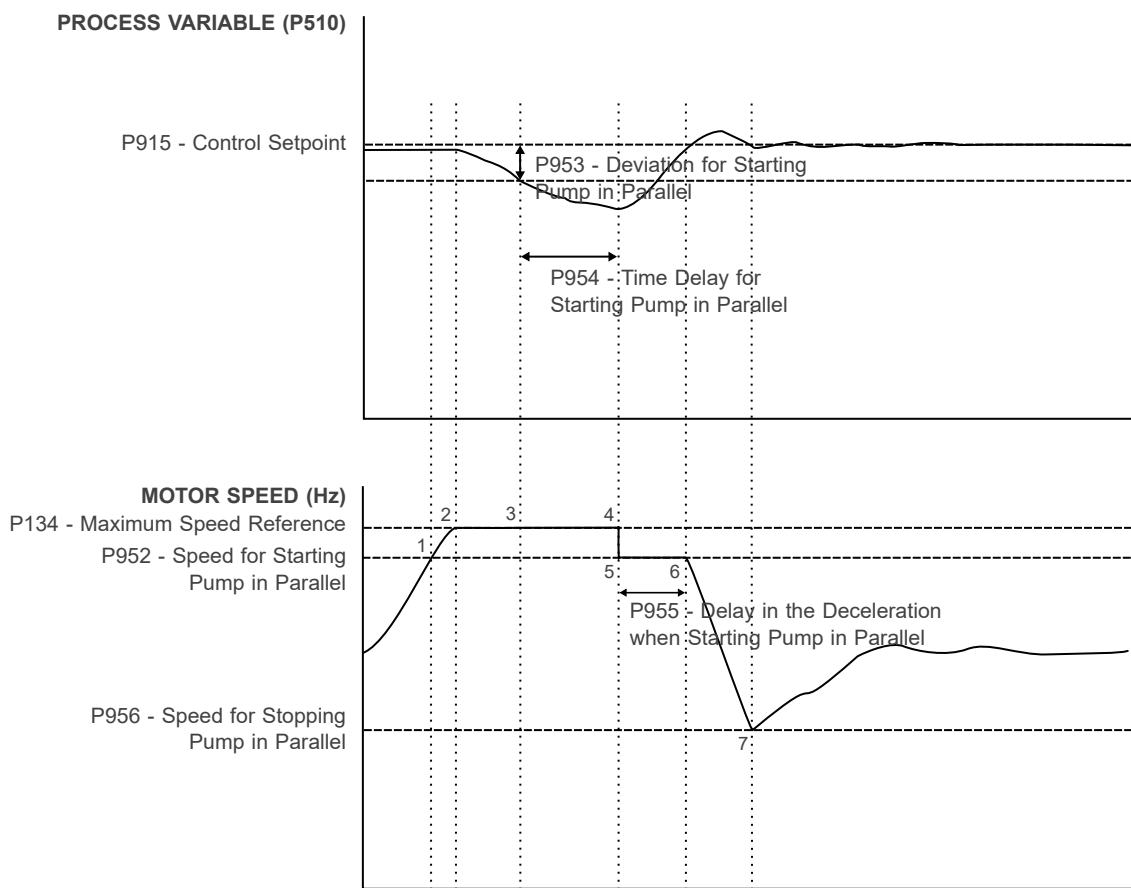


Figure 5.7: Pump Genius Multipump operation for starting an additional pump in parallel

- 1. The Pump Genius is operating with one pump running and it is increasing its speed to keep the pumping control according to the required setpoint. At this moment, it is detected that the PID controller output

PARAMETERS DESCRIPTION

is above the value set to start one more pump (P952), but the difference between the setpoint and the control process variable remains below the deviation set to start one more pump (P953); therefore, it is not still necessary to start one more pump in parallel;

2. The motor speed reaches the maximum speed programmed for the pump (P134) and the value of the control process variable keeps decreasing, the value of the difference between the setpoint and the control process variable continues lower than the deviation set to start one more pump (P953);
3. The motor speed still at the maximum speed programmed for the pump (P134) and the value of the control process variable keeps decreasing, the value of the difference between the setpoint and the control process variable is still above the deviation set to start one more pump (P953) and the time to start one more pump in parallel on the pumping control (P954) initiates;
4. The motor speed still at the maximum speed programmed for the pump (P134) and the value of the control process variable keeps decreasing, the value of the difference between the setpoint and the control process variable is still above the deviation set to start one more pump (P953) and the time to start one more pump in parallel on the pumping control (P954) elapses; at this moment, a command to start one more pump in parallel on the pumping control is used. The pump to be started will be the one with the shortest operation time among those which are enabled for operation;
5. One pump is started; at this moment, the PID controller goes into the manual control mode and the speed of the pump driven by the inverter goes to the value set in P952. Then the time count of the delay to start the deceleration of the pump driven by the inverter (P955) begins;
6. The time count of the delay to start the deceleration of the pump driven by the inverter (P955) elapses; the PID controller remains in the manual control mode and the speed reference of the pump driven by the inverter goes to the value set in P956;
7. The motor decelerates down to the value set to stop one pump (P956) and the PID controller goes to the automatic control mode. Then the PID controller begins to control the system again to stabilize the pumping control according to the setpoint required by the user, but now with one more pump in parallel.

The [Figure 5.8 at page 5-29](#) presents a timing analysis of the Pump Genius Multiplex operation when the need to start an additional pump in parallel is detected.

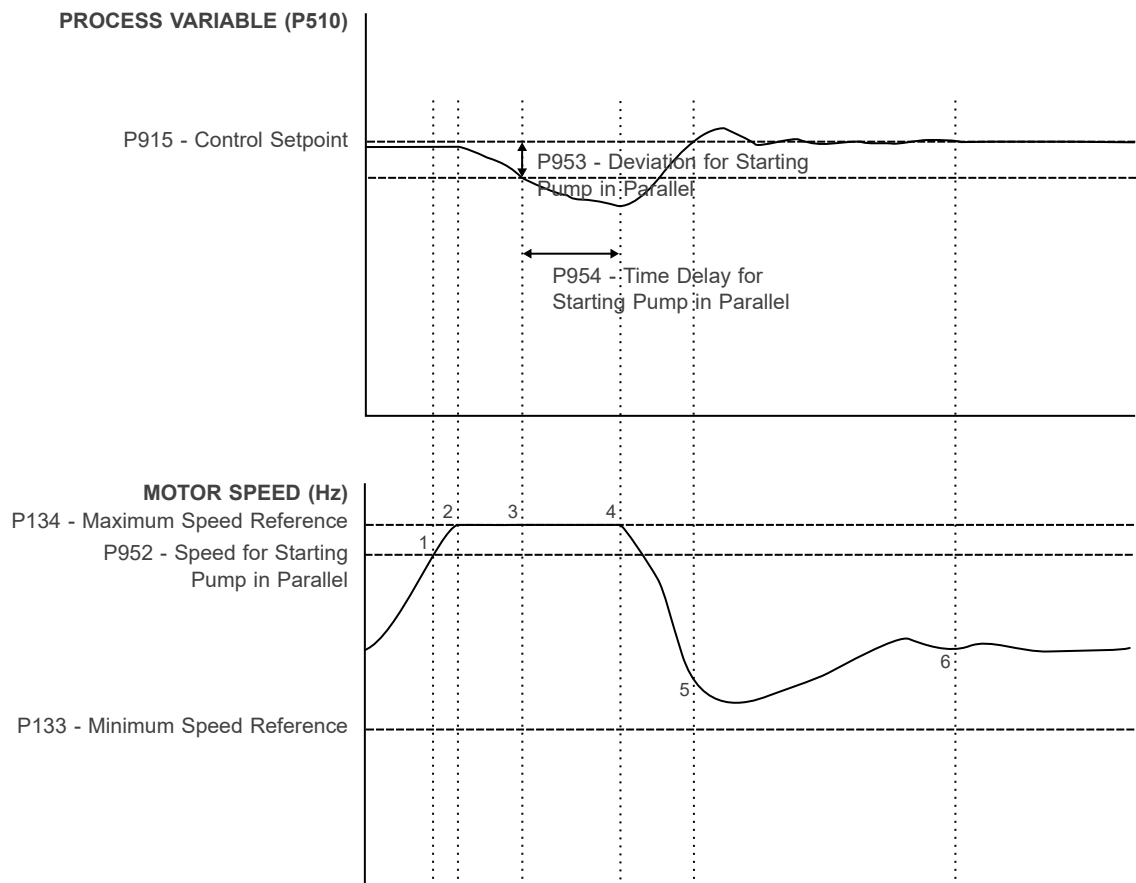


Figure 5.8: Pump Genius Multiplex operation for starting an additional pump in parallel

1. The Pump Genius is operating with one pump running and is increasing its speed according to PID control, to keep up with demand. At this moment, the pump motor speed exceeds the threshold value programmed for starting an additional pump (P952). However, the difference between the control setpoint and control process variable remains lower than the deviation programmed for starting an additional pump (P953); it is thus not yet necessary to start an additional pump;
2. The pump motor speed reaches its maximum value (P134) and the value of the control process variable begins to decrease, but its deviation from the control setpoint remains lower than the threshold programmed for starting an additional pump (P953); it is thus not yet necessary to start an additional pump;
3. The pump motor speed remains saturated at maximum value (P134), as the value of the control process variable continues to decrease. At this point, however, its deviation from the control setpoint exceeds the threshold programmed for starting an additional pump (P953), initiating the time count (P954);
4. The motor speed remains at the maximum value (P134) and the value of the control process variable continues to decrease. The difference between the setpoint and the control process variable remains greater than the deviation programmed to start another pump (P953) and the time to connect one more pump in parallel to the Pump Genius (P954) has elapsed. At this moment, a command is made to connect another pump in parallel in the pump control. The pump to be turned on will be the one with the shortest operating time among those that are enabled for use;
5. Another pump in parallel has been successfully connected and the PID controller sends the same speed reference to both pumps. At this moment, it is achieved that the control process variable reaches the control setpoint required by the user, but the pumping control is not yet stabilized;
6. With the addition of one more pump in parallel in the Pump Genius, the PID controller is able to stabilize the pumping control according to the control setpoint required by the user.

5.11 STOPPING PUMPS IN PARALLEL

This group of parameters allows the user to adjust the operating conditions to shut down a pump in parallel on the Pump Genius.

PARAMETERS DESCRIPTION



NOTE!

These parameters are valid for the Pump Genius Multipump and Pump Genius Multiplex applications.

P956 - Speed for Stopping Pump in Parallel

Adjustable Range: 0.0 to 400.0 Hz

Factory Setting: 43.0 Hz

Description:

This parameter defines the value of the pump motor speed below which stopping one pump in parallel in the Pump Genius becomes enabled.

P957 - Deviation for Stopping Pump in Parallel

Adjustable Range: 0.00 to 99.99

Factory Setting: 0.20

Description:

This parameter defines the maximum deviation of the control process variable from the control setpoint (a positive value for a Direct Mode PID, or a negative value for an Inverse Mode PID), which if exceeded, enables stopping one pump in parallel in the Pump Genius



NOTE!

A setting of "0" disables the P957 condition of the logic for stopping one pump in parallel.



NOTE!

This parameter is displayed according to the selection of the SoftPLC engineering unit parameters (P510 and P511).

P958 - Time Delay for Stopping Pump in Parallel

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 2.0 s

Description:

This parameter defines a time delay during which both conditions of P956 and P957 must remain satisfied before stopping one of the pumps in parallel in the Pump Genius.

P959 - Delay in the Acceleration when Stopping Pump in Parallel

Adjustable Range: 0.0 to 100.0 s

Factory Setting: 0.0 s

Description:

This parameter defines a delay for the beginning of the acceleration of the pump driven by the CFW320 frequency inverter when a pump in parallel is stopped.

**NOTE!**

This parameter is only valid for the Pump Genius Multipump application.

**NOTE!**

Value of the parameter in “100.00” will not apply the acceleration of the pump driven by the CFW320 frequency inverter, i.e., the pump remains at the same speed it was before a pump is stopped.

The [Figure 5.9 at page 5-31](#) presents a timing analysis of the Pump Genius operation with Direct Mode PID controller, when the need to stop one pump in parallel is detected.

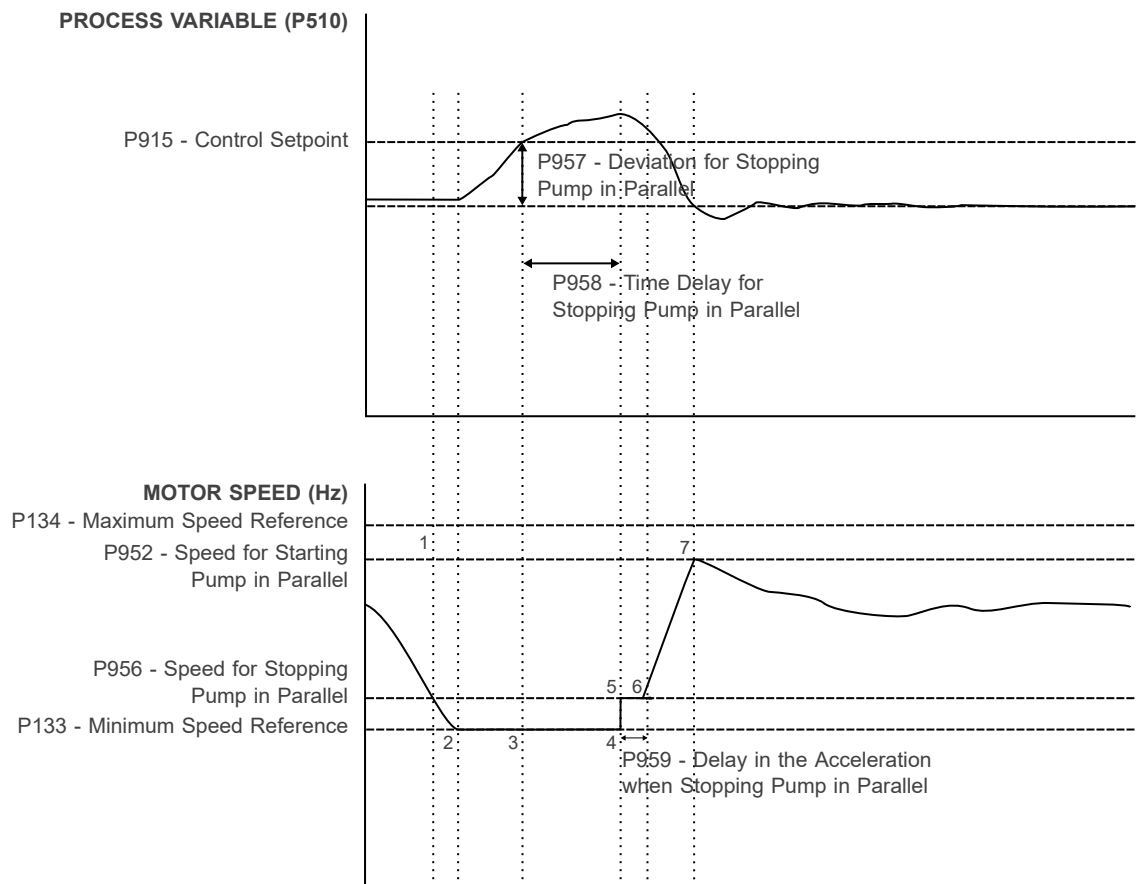


Figure 5.9: Pump Genius Multipump operation for stop one pump in parallel

1. The Pump Genius is operating with more than one pump activated and is decreasing its speed to control the process variable. At this moment the pumps motor speed drops below the threshold programmed for stopping one pump (P956), but the control process variable deviation from the control setpoint remains lower than the threshold programmed for stopping one pump (P957). Thus, it is not necessary to stop one pump in parallel;
2. The pumps motor speed reaches its minimum (P133) and the value of the control process variable begins to increase. however, the difference between the setpoint and the control process variable remains less than the deviation programmed to stop the pump;
3. The pumps motor speed continues at minimum speed (P133), as the value of the control process variable continues to increase. At this moment its deviation from the control setpoint exceeds the threshold programmed for stopping one pump in parallel (P957), and the time count (P958) is initiated;
4. The pumps motor speed continues at minimum speed (P133) and the value of the control process variable keeps increasing. The difference between the setpoint and the control process variable is still above the deviation set to stop one pump (P957) and the time to start one pump in parallel on the pumping control

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(P958) elapses. At this moment, a command to stop one pump in parallel on the pumping control. The pump to be stopped will be the one with the longest operation time among those which are enabled for operation;

5. One pump stop. At this moment, the PID controller goes into the manual control mode and the speed of the pump driven by the inverter goes to the value set in P956. Then the time count of the delay to start the acceleration of the pump driven by the inverter (P959) begins;
6. The time count of the delay to start the acceleration of the pump driven by the inverter (P959) elapses. The PID controller remains in the manual control mode and the speed reference of the pump driven by the inverter goes to the value set in P952;
7. The motor accelerates up to the value set to start a pump (P952) and the PID controller goes to the automatic control mode. Then the PID controller begins to control the system again to stabilize the pumping control according to the setpoint required by the user, but now with least one pump in parallel.

The [Figure 5.10 at page 5-32](#) presents a timing analysis of the Pump Genius Multiplex operation, when the need to stop one pump in parallel is detected.

5

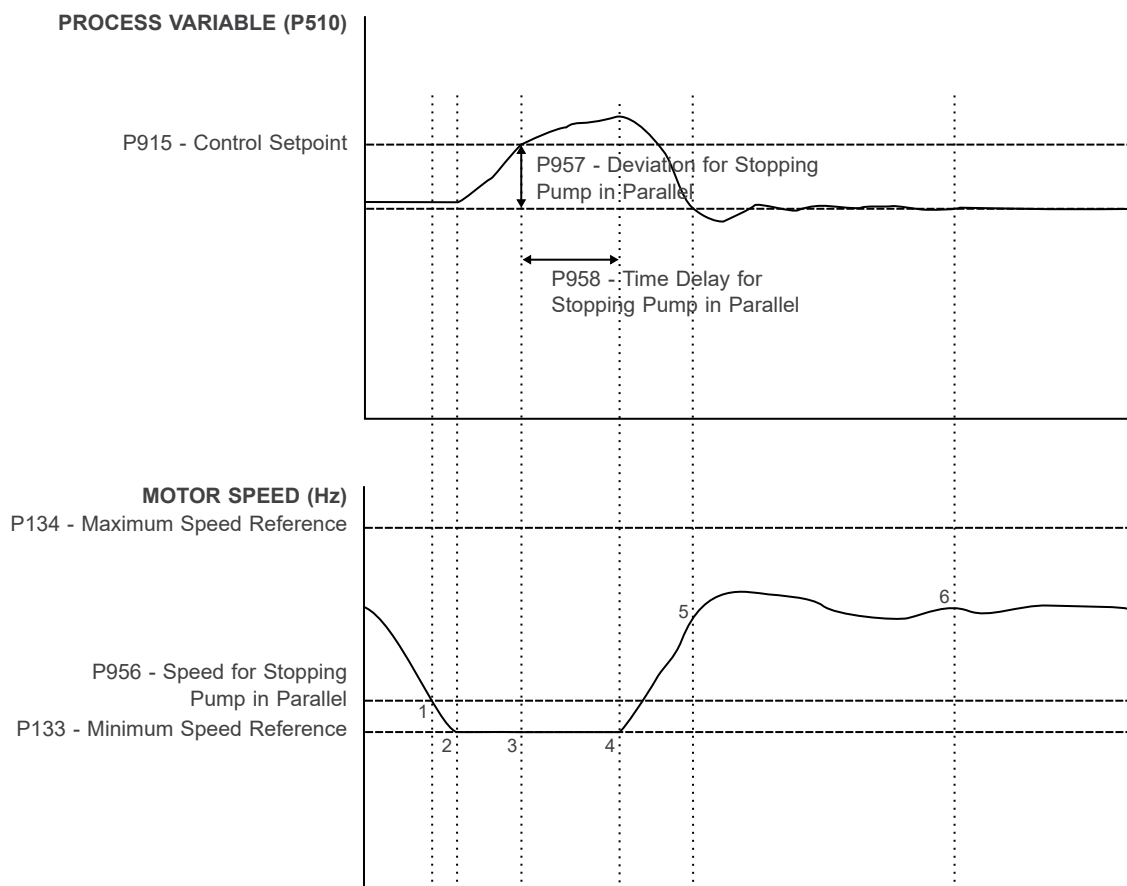


Figure 5.10: Pump Genius Multiplex operation for stop one pump in parallel

1. The Pump Genius is operating with more than one pump activated and is decreasing its speed to control the process variable. At this moment the pumps motor speed drops below the threshold programmed for stopping one pump (P956), but the control process variable deviation from the control setpoint remains lower than the threshold programmed for stopping one pump (P957). Thus, it is not necessary to stop one pump in parallel;
2. The pumps motor speed reaches its minimum value (P133) and the value of the control process variable begins to increase. However, its deviation from the control setpoint remains lower than the threshold programmed for stopping one pump in parallel (P957). Thus, it is not necessary to stop one pump in parallel;

3. The pumps motor speed continues at minimum speed (P133), as the value of the control process variable continues to increase. At this moment its deviation from the control setpoint exceeds the threshold programmed for stopping one pump in parallel (P957), and the time count (P958) is initiated;
4. All processes continue as at time point 3, until the time count (P958) is elapsed. At this moment, a command is made to stop a pump in parallel in the pump control. The pump to be turned off will be the one that has the longest operating time among those that are enabled for use;
5. One of the parallel pumps was successfully stopped; at this moment the control process variable reaches the control setpoint required by the user, but the system is not yet stabilized;
6. With the removal of a pump in parallel from the Pump Genius, the PID controller is able to stabilize the pumping control according to the control setpoint required by the user.

5.12 FORCE PUMP ALTERNATION

This group of parameters allows the user to adjust the operating conditions for forcing alternation of pumps in the Pump Genius in case it operates for an uninterrupted period of time. I.e., if the Pump Genius remains with only one pump operating for a certain period of time (the control does not go into sleep mode), a command is executed to turn off the pump is running; at this moment the Pump Genius verify which pump have the lower operation time. Then, the command is made to start another pump and continue to control the pumping according to the control setpoint required by the user. With this, the alternation of pumps still done even without the sleep mode is active.



NOTE!
These parameters are valid for the Pump Genius Multipump and Pump Genius Multiplex applications.

P917 - Time for Forcing Alternation of Pumps

Adjustable Range:	0 to 9999	Factory Setting:	0
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Description:
This parameter shows the Pump Genius operating time running with only one pump connected.



NOTE!
The hour value is reset to zero every time the Pump Genius has all pumps turned off. It is allowed to change the operating time of the pumps if the password that allows changing the parameters is enabled.



NOTE!
For the Pump Genius Multiplex application, the operating time will be counted by the frequency inverter CFW320 that is functioning as the system's master pump.

P918 - Time Interval for Forcing Alternation of Pumps

Adjustable Range:	0 to 9999	Factory Setting:	72
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Description:
This parameter defines the maximum time interval that the Pump Genius can run without interruption with only

PARAMETERS DESCRIPTION

one pump on. After this time, the condition defined in P919 is checked so that the Pump Genius turns off all pumps and then a new pump is started to continue to control the pumping according to the control setpoint required by the user.

The setting to "0h" enables the test mode, so every 60 seconds the logic to force the alternation of the pumps is enabled. The test mode works in a circular, sequential and uninterrupted way. The sequence, in case of 4 pumps, would be: Pump 1 → Pump 2 → Pump 3 → Pump 4 → Pump 1 → Pump 2 → If one or more pumps are not available, the inverter will interrupt the test and display the alarm "A796 - Alternation Test Interrupted". To remove the alarm it is necessary to change P918 to a value greater than "0 h", which removes it from test mode, or switch "Enable Pump Genius" on DI1, which returns the test to the pump where the test stopped. If the pump remains unavailable, with the test mode enabled, the alarm will remain.

P919 - Pump Motor Speed for Forcing Alternation of Pumps

Adjustable Range:	0.0 to 400.0 Hz	Factory Setting:	43.0 Hz
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Description:

This parameter defines the pump motor speed value below which the Pump Genius will be able to force the pumps to alternate.



NOTE!
Setting to "0.0 Hz" disables the Pump Genius forcing the pumps to alternate.

5.13 LOW LEVEL PROTECTION FOR THE CONTROL PROCESS VARIABLE (PIPE BREAKING)

This group of parameters allows the user to configure the conditions to detect alarm and fault for low level of the control process variable. This allows detecting non-ideal conditions of the pumping operation, for example, a pipe breaking.

P924 - Value for Low Level Alarm for the Control Process Variable

Adjustable Range:	-99.99 to 99.99	Factory Setting:	1.00
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Description:

This parameter defines the value below which the low level alarm will be generated for the control process variable (A760).



NOTE!
Setting it to "0" disables the low level alarm and fault for the control process variable.



NOTE!
This parameter will be viewed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).

P925 - Time Delay for Low Level Fault for the Control Process Variable

Adjustable Range:	0.0 to 999.9 s	Factory Setting:	0.0 s
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Description:

This parameter defines how long the low level alarm condition should remain so that the control process variable (A760) will generate fault "F761: Low Level Fault of the Control Process Variable".

**NOTE!**
Setting it to "0.0 s" disables the low level fault for the control process variable.

5.14 HIGH LEVEL PROTECTION FOR THE CONTROL PROCESS VARIABLE (PIPE OBSTRUCTION)

This group of parameters allows the user to configure the conditions for alarm and failure to detect high level for the control process variable for the Pump Genius. This allows detecting non-ideal conditions of the pumping operation, for example, a pipe obstruction.

P926 - Value for High Level Alarm for the Control Process Variable

Adjustable Range:	-99.99 to 99.99	Factory Setting:	3.50
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Description:

This parameter defines the value above which the high level alarm will be generated for the control process variable (A762).

**NOTE!**
Setting it to "0" disables the high level alarm and fault for the control process variable.

**NOTE!**
This parameter will be viewed according to the selection of the parameters for the SoftPLC engineering unit (P510 and P511).

P927 - Time Dealy for High Level Fault for the Control Process Variable

Adjustable Range:	0.0 to 999.9 s	Factory Setting:	0.0 s
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Description:

This parameter defines how long the high level alarm condition should remain so that the control process variable (A762) will generate fault "F763: High Level Fault of the Control Process Variable".

**NOTE!**
Setting it to "0.0 s" disables the high level fault for the control process variable.

5.15 PUMP PROTECTION VIA EXTERNAL SENSOR

This group of parameters allows the user to configure an external sensor (pressure switch, level sensor, etc.) to protect the pump driven by the CFW320 frequency inverter.

PARAMETERS DESCRIPTION



NOTE!

The use of the external sensor for pump protection is enabled by programming a digital input in “42 = External Sensor (Application Function 2)” according to the availability of each Pump Genius application:

- Simplex: Available for digital inputs DI1, DI2, DI3, DI4 and DI5;
- Multipump: Available for digital inputs DI2, DI3 and DI4;
- Multiplex: Available for digital inputs DI2, DI3 and DI4.

With the digital input at logic level “0”, it indicates that the external sensor for protection of the pump is activated. Then, when the pump is running the alarm “A768: Pump Protection via External Sensor actuated” will be generated to indicate that the pump’s protection condition has been detected. After the time programmed in P943, the “F769: Pump Protection via External Sensor actuated” fault will be generated and the pump will be disabled from operation.

With the digital input at logic level “1”, it indicates that the condition for protecting the pump has not been detected.

5

P943 - Time Delay for Pump Protection via External Sensor Fault

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 0.0 s

Description:

This parameter defines the waiting time with the condition of sensor (DIx) at logic level “0” while the pump is running, before the external sensor fault “F769: External Sensor Protection” is generated.



NOTE!

A setting of “0.0 s” disables the pump protection faults via external sensor.

5.16 DRY PUMP PROTECTION

This group of parameters allows the user to configure dry pump detection to protect the pump driven by the CFW320 frequency inverter.

P944 - Motor Speed for Dry Pump

Adjustable Range: 0.0 to 400.0 Hz

Factory Setting: 55.0 Hz

Description:

This parameter defines the pump motor speed threshold value, above which evaluation of actual motor current to detect the dry pump condition (P945) is enabled.

P945 - Motor Current for Dry Pump

Adjustable Range: 0.0 to 40.0 A

Factory Setting: 10.0 A

Description:

This parameter defines the current value of the pump motor below which the dry pump condition will be detected, and then the alarm message “A770: Dry Pump Alarm” is generated to indicate this situation.

P946 - Time Delay for Dry Pump Fault

Adjustable Range:	0.0 to 999.9 s	Factory Setting:	0.0 s
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Description:
This parameter defines the waiting time with the dry pump condition (A770) active, before the dry pump fault “F771: Dry Pump” is generated.

 **NOTE!**
A setting of “0.0s” disables the dry pump fault.

The [Figure 5.11 at page 5-38](#) presents a timing analysis of the Pump Genius operation when a Dry Pump Fault is detected.

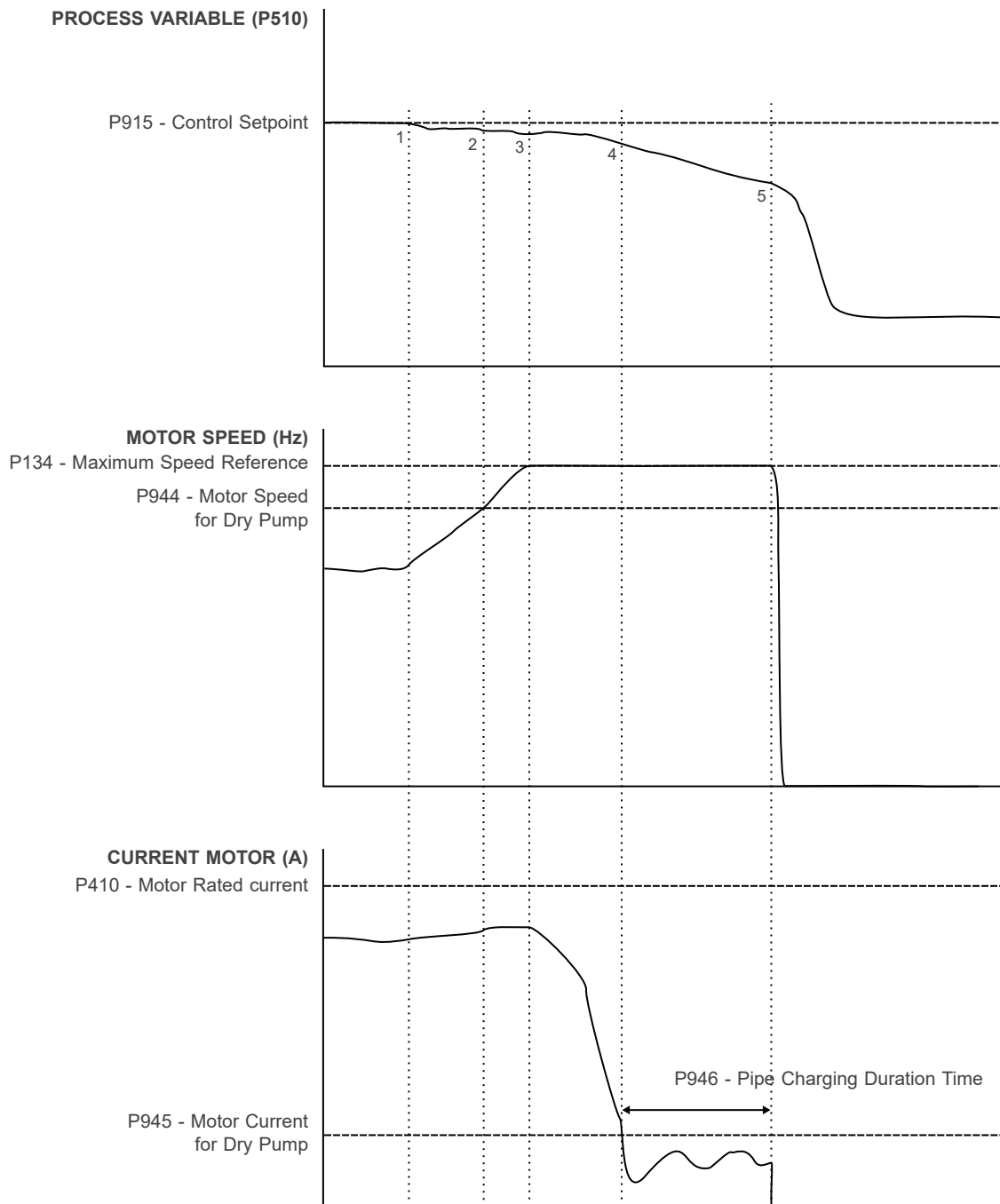


Figure 5.11: Operation of the Pump Genius for dry pump protection

1. The Pump Genius is running at a speed satisfying the control setpoint required by the user. At this moment the value of the control process variable begins to decrease and pump speed begins to increase;
2. The pump speed continues to increase and becomes greater than the threshold programmed for detecting dry pump (P944);
3. The pump speed continues to increase and reaches the maximum speed programmed for the pump (P134), but as the pump motor torque is still greater than the threshold programmed to detect dry pump (P945), pumping continues while the value of the control process variable continues to decrease;
4. As the pump continues to operate at maximum speed, and the process variable continues to decrease, the pump motor current drops below the threshold programmed to detect dry pump (P945). At this moment the time count to generate Dry Pump Fault (P946) is initiated and the alarm message “A770: Dry Pump” is generated to alert the user, that the protection for dry pump is about to act and disable the inverter driven pump;

5. The pump continues to operate at maximum speed, and the control process variable continues to decrease, while the pump motor current remains below the threshold programmed to detect Dry Pump (P945). At this moment the time delay to generate Dry Pump Fault (P946) is elapsed, and the fault “F771: Dry Pump” is generated, disabling the inverter driven pump.

5.17 CONTROL AUXILIARY VARIABLE FOR PUMP PROTECTION

This group of parameters allows the user to configure a control auxiliary variable for the protection of pump. This protection is accomplished by reading a sensor installed on an analog input, and comparing its value with low level conditions. The low level condition is directly associated with pump cavitation protection.

Cavitation is a phenomenon that occurs in a pump when the pressure at the inlet side of the rotor drops below the vapor pressure of the pumped liquid, resulting in evaporation with the formation of small vapor bubbles (cavities) in the liquid part. When these cavities, formed in the low pressure region of the rotor, reach the high pressure region at the outlet side of the rotor, they immediately collapse, returning to the liquid phase. The rapid implosion of the cavities results in violent shock waves and momentary huge temperature gradients between the bubble surface and the surrounding liquid (10000°C have been measured). If, prior to their collapse, these bubbles adhere to rotor surfaces, their implosion produces microjets, which impact the surface with sufficient energy to remove microscopic amounts of material. Immediate negative consequences of cavitation and its cumulative effects over extended periods of time are as follows:

- Operation with high level of noise and vibration;
- Impairment of performance, changing the pump characteristics;
- Premature wear of the rotor by removal of metal particles.

The occurrence of pump cavitation can be prevented by avoiding that the suction pressure reaches values lower than the fluid vapor pressure. The installation of a pressure sensor at the pump inlet allows continuous monitoring of suction conditions and the detection of situations that favor cavitation. When this level is below a certain threshold, the control setpoint is changed to a value that reduces pump suction, decreasing pressure losses in the suction line and ensuring that the absolute pressure at the pump inlet remains above the fluid vapor pressure, thus preventing the occurrence of cavitation.



NOTE!
This protection is only valid for the Pump Genius Simplex application.

P947 - Control Auxiliary Variable Selection Source for Pump Protection

Adjustable Range:	0 = Without Protection via Control Auxiliary Variable 1 = Control Auxiliary Variable via Analog Input AI1 2 = Control Auxiliary Variable via Analog Input AI2	Factory Setting: 0
Properties:	cfg	

Description:

This parameter defines the source of the control auxiliary variable for pump protection.

Table 5.9: Description of control auxiliary variable source for pump protection

P947	Description
0	It defines that there is no pump protection via control auxiliary variable.
1	It defines that the source of the control auxiliary variable for pump protection is the value read by the analog input AI1. The value is converted according to a percentage scale (%) and displayed in parameter P917
2	It defines that the source of the control auxiliary variable for pump protection is the value read by the analog input AI2. The value is converted according to a percentage scale (%) and displayed in parameter P917

PARAMETERS DESCRIPTION

P917 - Control Auxiliary Variable

Adjustable Range: -999.9 to 999.9 %

Factory Setting:

Properties: ro

Description:

This parameter shows the auxiliary control variable for pump protection according to the source of the auxiliary control variable defined in P947 and scale defined in P948.

5.17.1 Sensor Scale Configuration

This group of parameters allows the user to configure the sensor scale of the auxiliary control variable for pump protection.

P948 - Control Auxiliary Variable Sensor Maximum Level (Range)

Adjustable Range: 0.0 to 100.0 %

Factory Setting: 100.0 %

Description:

This parameter defines the maximum level (or range) of the control auxiliary variable sensor for pump protection in percentage (%).



NOTE!

The minimum level of the control auxiliary variable sensor is "0,0 %".

Through the maximum level (or range) of the sensor of the auxiliary control variable and the value of the analog input AI_x , there is the equation of the line for conversion of the auxiliary control variable for pump protection:

$$P917 = P948 * AI_x$$

Onde:

P917: control auxiliary variable;

P948: maximum level (or range) of the sensor of the auxiliary control variable;

AI_x : value of analog input AI1 or AI2 in %.

5.17.2 Pump Protection Configuration

This group of parameters allows the user to configure the pump protection via the auxiliary control variable.

P949 - Value to detect Low Level of Control Auxiliary Variable

Adjustable Range: 0.0 to 100.0 %

Factory Setting: 0.0 %

Description:

This parameter defines the control auxiliary variable threshold below which the control setpoint will be changed to the value programmed in P950. When low level is detected, the control setpoint can be changed to a different value (lower), thus assuring a decrease in consumption of the pump, preventing it to operate in cavitation, for example.



NOTE!
The alarm message “A764: Low Level of Control Auxiliary Variable” will be generated in the HMI of the CFW320 inverter, to alert that the control auxiliary variable is in low level.

P950 - Control Setpoint in Low Level

Adjustable Range:	-99.99 to 99.99	Factory Setting:	0.00
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Description:
This parameter defines the value of the control setpoint for the Pump Genius (PID in automatic mode) when a low level of the control auxiliary variable is detected.



NOTE!
The control setpoint should be adjusted to an appropriate value that reduces the consumption of the pump to prevent the cavitation, for example.



NOTE!
This parameter is displayed according to the selection of the SoftPLC engineering unit (P510 and P511).

P951 - Hysteresis to reactivate the Control Setpoint

Adjustable Range:	0.0 to 100.0 %	Factory Setting:	0.0 %
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Description:
This parameter defines the value of control auxiliary variable hysteresis to be applied to the reset of low level condition, after which the Pump Genius returns to operate with the control setpoint required by the user.
The [Figure 5.12 at page 5-42](#) presents a timing analysis of the Pump Genius operation when low level of the control auxiliary variable is detected.

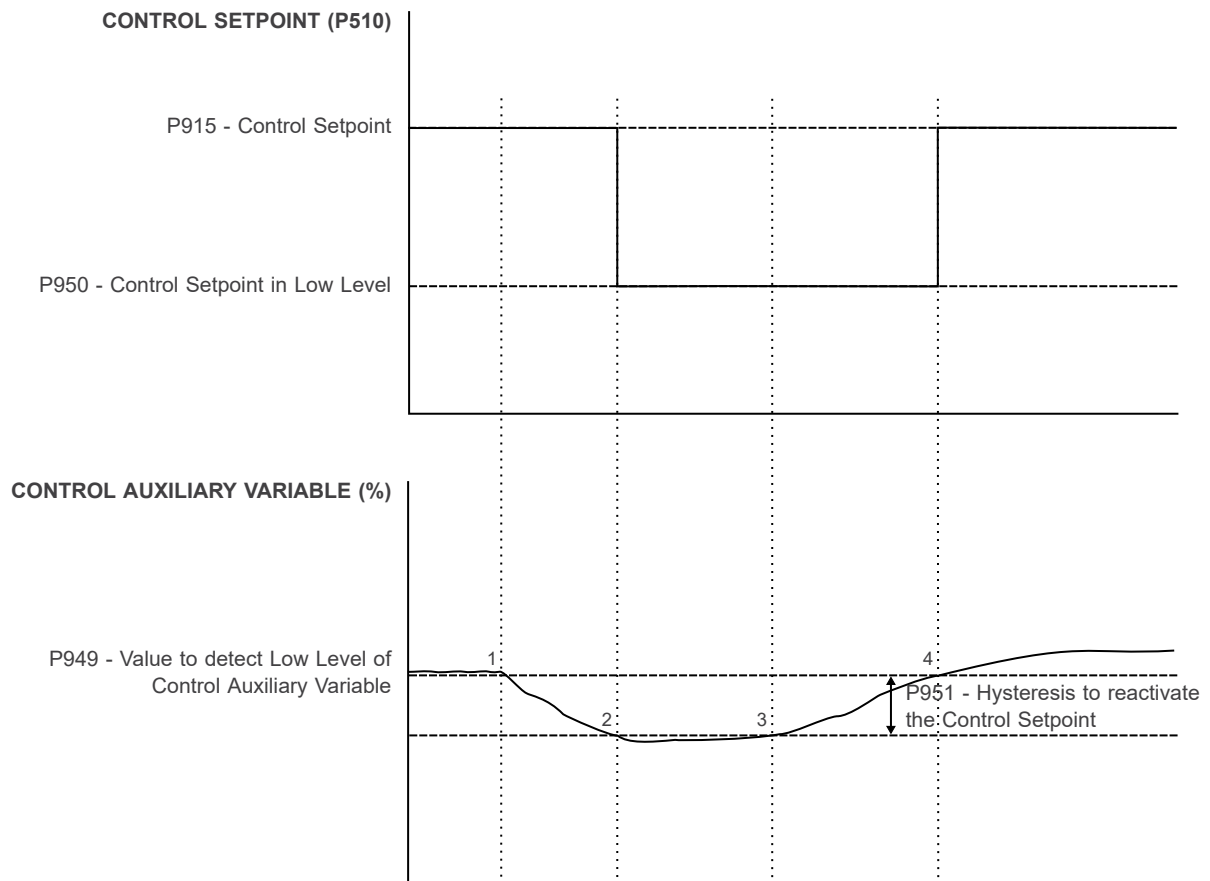


Figure 5.12: Pump Genius operation with pump protection via control auxiliary variable

1. The Pump Genius is running at a speed satisfying the control setpoint required by the user. At this moment, the value of the auxiliary variable begins to decrease;
2. The control auxiliary variable drops below the threshold programmed to detect low level of the control auxiliary variable (P949). At this moment, the value of the control setpoint is changed to the value programmed as control setpoint in low level (P950);
3. The change of control setpoint results in an increase of the control auxiliary variable and the same reaches the value programmed to detect low level of control auxiliary variable (P949), but to reactivate the control setpoint is necessary to be greater than the value set in hysteresis to reactivate the control setpoint (P951);
4. The auxiliary control variable continues to increase. At this moment, its value exceeds the programmed hysteresis threshold (P951), and the control setpoint is reset back to the value required by the user.

5.18 DERAGGING FUNCTION

This group of parameters allows the user to enable the logic to execute the deragging function in the inverter driven pump in order to prevent it reaches the clogging, and thus, it can't come into operation.

Its basic principle is running the pump in the reverse pumping direction to remove the accumulated debris, and thus, the pump can run again.



NOTE!

This function should only be enabled on a pump that can run with rotation in the reverse pumping direction; otherwise it may cause damage to it.

**NOTE!**

This protection is only valid for the Pump Genius Simplex application.

P952 - Execution Mode of the Deragging Function

Adjustable Range:	0 = Disable Derraging Function	Factory Setting:	0
	1 = Executes with Command to Run the Pump		
	2 = Executes with Command via Digital Input DI1		
	3 = Executes when the Clogging of Pump is Detected		

Description:

This parameter defines the execution mode of the deragging function for the pump driven by the CFW320 inverter.

Table 5.10: Description of execution mode of the deragging function

P952	Description
0	It defines that the deragging function will not be executed, i.e., is disabled.
1	It defines that the deragging function will be enabled and executed every time there is a command to run the pump. This command can be from HMI, a digital input, via communications networks, etc.
2	It defines that the deragging function will be enabled and executed every time the digital input DI1 receives a command, i.e., change the logic level "0" to logic level "1".
3	It defines that the deragging function will be enabled and executed every time that the clogging of pump is detected via high motor current.

**NOTE!**

Order to be able execute the deragging function, it is necessary that the SoftPLC function controls the motor speed direction to do with the pump operates in reverse pumping direction. Thus, was defined that the deragging function only will operate with the CFW320 inverter operating in REMOTE mode. Beyond that, is also necessary to program the P226 parameter in 12 (SoftPLC) to defines the motor speed direction in remote mode. When in P226=12, defines that the speed direction for pumping will be FOWARD and for deragging will be REVERSE.

P953 - Number of Cycles for Deragging

Adjustable Range:	0 to 100	Factory Setting:	0

Description:

This parameter defines the number of times (cycles) that the pump will operate in reverse pumping direction to execute the deragging function for the pump driven by CFW320 inverter.

P954 - Speed Reference for Deragging

Adjustable Range:	0.0 to 400.0 Hz	Factory Setting:	0.0 Hz

Description:

This parameter defines the speed reference value for the pump to execute the deragging function. This speed is used in the pumping direction as the deragging direction.

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P955 - Deragging Run Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 0.0 s

Description:

This parameter defines the value of time that the pump will run (with speed reference for deragging) in the deragging cycle execution. This time is used in the pumping direction as the deragging direction.

P956 - Deragging Stop Time

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 0.0 s

Description:

This parameter defines the value of time that the pump remains stopped in the deragging cycle execution.

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P957 - Motor Current to detect Clogging of Pump

Adjustable Range: 0.0 to 40.0 A

Factory Setting: 0.0 A

Description:

This parameter defines the value of motor current above which will be considered that the pump is running at high current, i.e., the pump is in clogging process.

P958 - Time Delay to detect Clogging of Pump

Adjustable Range: 0.0 to 999.9 s

Factory Setting: 0.0 s

Description:

This parameter define the waiting time with the condition of high current in the pump motor to detect that it is in clogging process, being thus generated the alarm message "A772: Clogging Detected" to indicate this situation.

P959 - Number of consecutives Clogging to generate the Fault

Adjustable Range: 0 to 100

Factory Setting: 0

Description:

This parameter defines the number of consecutives clogging detected to generate the fault "F773: Excess of Clogging Detected"



NOTE!

A setting of "0" disables the fault by excess of clogging detected. Every time that the Pump Genius is disabled or goes to sleep mode, i.e., the pump is stopped, the count of clogging is reset.

5.18.1 Deragging with Command to Run the Pump (P952=1)

Selecting the execution mode of the deragging function (P952) in 1 is defined that the deragging is enabled and it is executed every time there is a command to run the pump. This command can be from HMI, a digital input, via communications networks, etc.

The [Figure 5.13 at page 5-45](#) presents a timing analysis of the deragging function operation when occurs a command to run the pump driven by the CFW320 inverter.

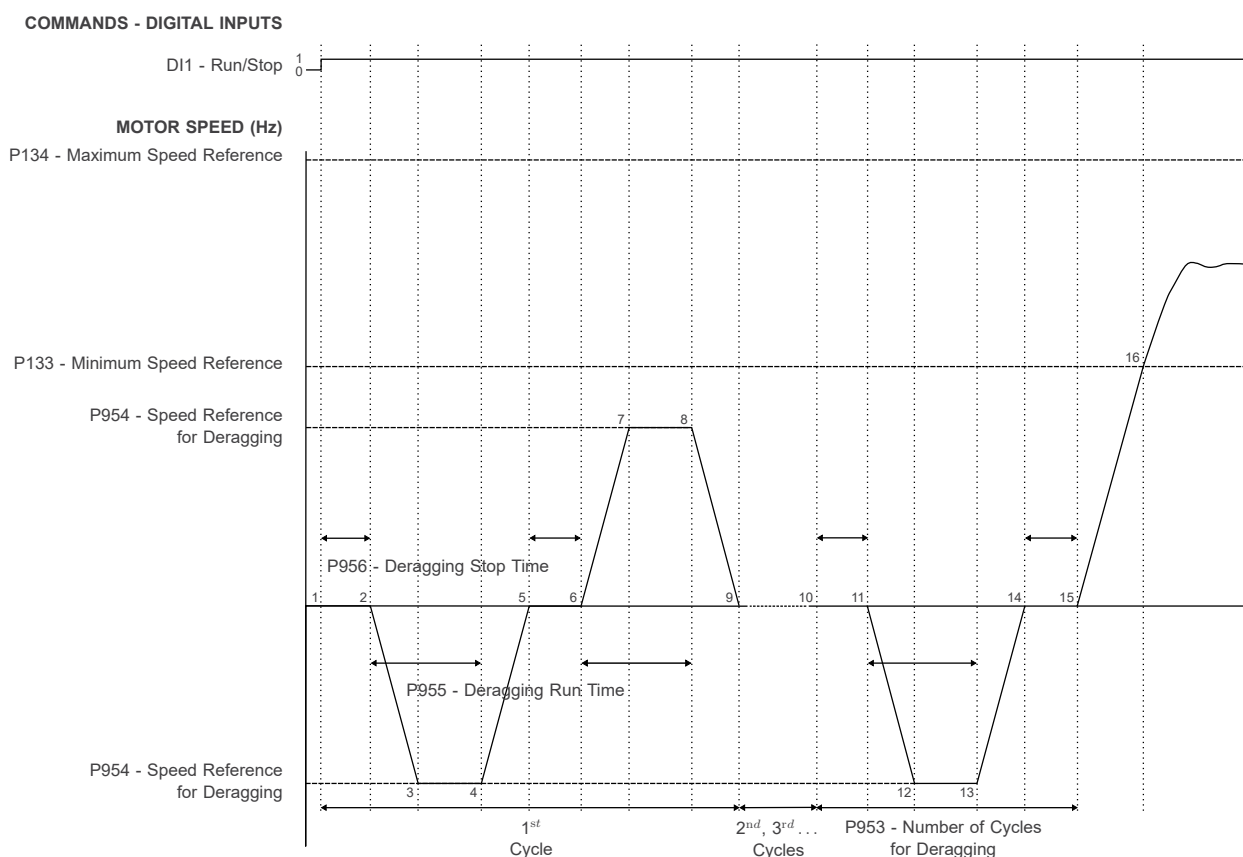


Figure 5.13: Deragging pump operation with command to run the pump

1. The command Run/Stop via digital input DI1 enables run the motor, as well as, enable the operation of Pump Genius. In this moment, initiate the count of the first cycle to deragging the pump and the counting time of pump stopped (P956) is initiated;
2. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
3. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
4. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in reverse direction of the pumping;
5. The pump is decelerated to the zero speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;
6. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
7. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed

8. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in direction of the pumping;
9. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counter of cycles is increased and the counting time of pump stopped (P956) is initiated; the steps 2 to 9 occur again until that the number of cycles is equal to the number of cycles for deragging (P953);
10. The number of cycles arrives to the number of cycles for deragging (P953) programmed and the last cycle is initiated; thus, the deragging stop time (P956) is initiated;
11. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
12. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
13. The deragging run time (P955) is elapsed. In this moment is done the command to stop the pump in reverse direction of the pumping;
14. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;
15. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump and control the pumping again, i.e., the deragging function was finished;
16. The pump is accelerated until the minimum speed reference. After this the PID controller is enabled and starts to control the pump speed in order for the control process variable to catch up with the control setpoint required by the user.

5.18.2 Deragging with Command via Digital Input DI1 (P952=2)

Selecting the execution mode of the deragging function (P952) in 2 is defined that the deragging is enabled and it is executed every time there is a command via digital input DI1, i.e., the digital input DI1 change the logic level “0” to logic level “1”.

The [Figure 5.14 at page 5-47](#) presents a timing analysis of the deragging function operation when occurs a command in the digital input DI1.

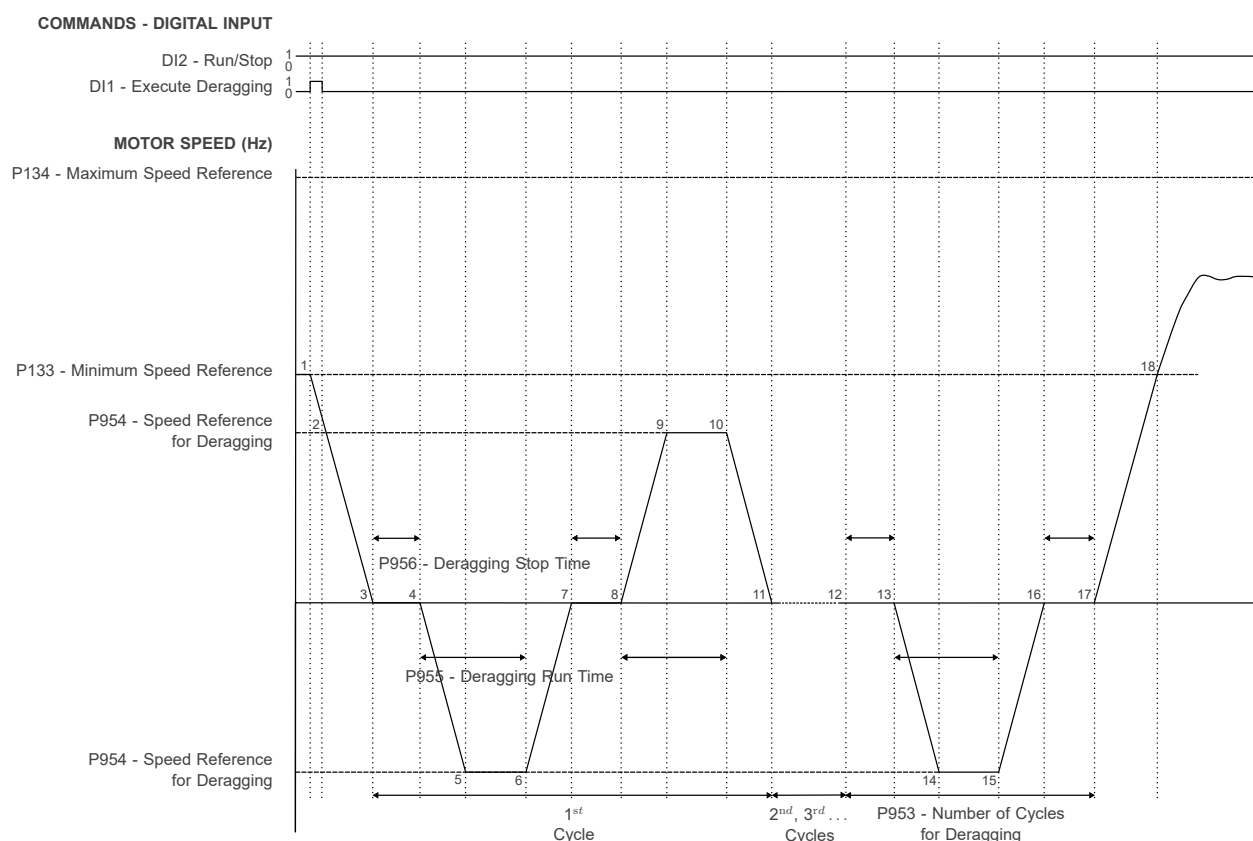


Figure 5.14: Deragging pump operation with command via digital input DI1

1. The Pump Genius is enabled to run through the command Run/Stop via digital input DI2 and is controlling the pump driven by the CFW320 inverter. In this moment, a command is done in the digital input DI1 to execute the deragging function, i.e., the digital input DI1 goes from logic level “0” to logic level “1”. So, it is done the command to stop the pump and starts the deragging function;
2. The digital input DI1 goes to logic level “0”, because the command to execute the deragging function is done when the pump change the logic level of “0” to “1”, i.e., when execute a pulse in the digital input DI1. The pump continues in deceleration process;
3. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment initiate the count of the first cycle to deragging the pump and the counting time of pump stopped (P956) is initiated;
4. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
5. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
6. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in reverse direction of the pumping;
7. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;
8. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
9. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;

10. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in direction of the pumping;
11. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counter of cycles is increased and the counting time of pump stopped (P956) is initiated; the steps 2 to 9 occur again until that the number of cycles is equal to the number of cycles for deragging (P953);
12. The number of cycles arrives to the number of cycles for deragging (P953) programmed and the last cycle is initiated; thus, the deragging stop time (P956) is initiated;
13. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated
14. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
15. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in reverse direction of the pumping;
16. The pump is decelerated to the zero speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;
17. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump and control the pumping again, i.e., the deragging function was finished;
18. The pump is accelerated until the minimum speed reference. After this the PID controller is enabled and starts to control the pump speed in order for the control process variable to catch up with the control setpoint required by the user.

5.18.3 Deragging when Clogging of Pump is Detected (P952=3)

Selecting the execution mode of the deragging function (P952) in 3 is defined that the deragging is enabled and it is executed when the clogging of pump is detected.

The [Figure 5.15 at page 5-49](#) presents a timing analysis of the deragging function operation when occurs a clogging of pump.

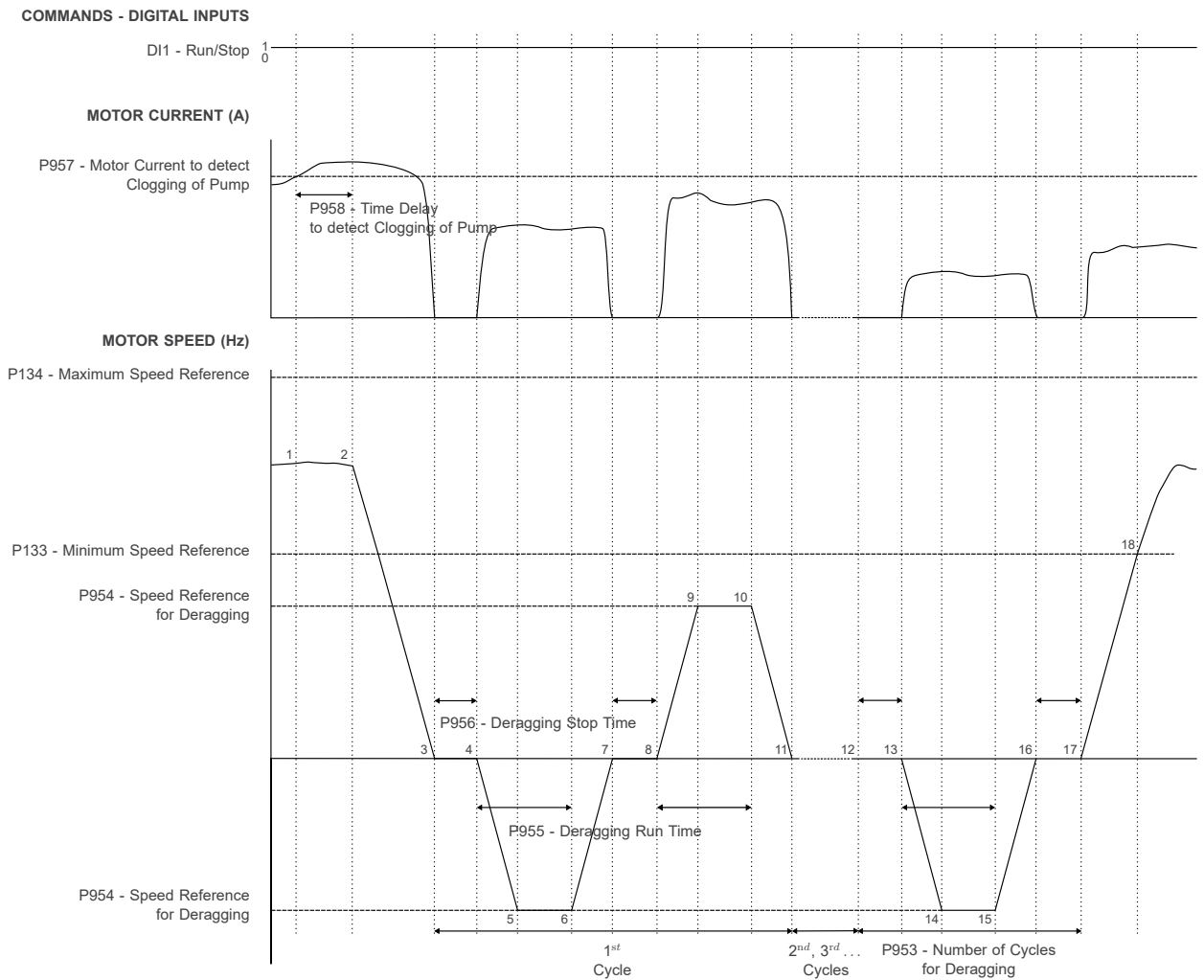


Figure 5.15: Deragging pump operation when a clogging of pump is detected

1. The Pump Genius is enabled to run through the command Run/Stop via digital input DI1 and is controlling the pump driven by the CFW320 inverter. In this moment the motor current is greater than the motor current to detect clogging of pump (P957) and the counting time to detect clogging of pump (P958) is initiated;
2. The motor current remains greater than the motor current to detect clogging of pump (P957) and the time to detect clogging of pump (P958) is elapsed; in this moment is done the command to stop the pump and starts the deragging function;
3. The pump is decelerated to the zero speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment, initiate the count of the first cycle to deragging the pump and the counting time of pump stopped (P956) is initiated;
4. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
5. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
6. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in reverse direction of the pumping;
7. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;

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8. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
9. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
10. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in direction of the pumping;
11. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counter of cycles is increased and the counting time of pump stopped (P956) is initiated; the steps 2 to 9 occur again until that the number of cycles is equal to the number of cycles for deragging (P953);
12. The number of cycles arrives to the number of cycles for deragging (P953) programmed and the last cycle is initiated; thus, the deragging stop time (P956) is initiated;
13. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump in the reverse direction of the pumping and with the speed reference to deragging (P954); the PID controller stays disabled. In this moment the counting time of pump running (P955) is initiated;
14. The pump is accelerated until the speed reference for deragging (P954) with the acceleration ramp set in P100 parameter and stays in this speed until that the counting time of pump running (P955) is elapsed;
15. The deragging run time (P955) is elapsed; in this moment is done the command to stop the pump in reverse direction of the pumping;
16. The pump is decelerated to the “zero” speed as the deceleration ramp set in the P101 parameter and stays stopped. In this moment the counting time of pump stopped (P956) is initiated;
17. The deragging stop time (P956) is elapsed; in this moment is done the command to run the pump and control the pumping again, i.e., the deragging function was finished;
18. The pump is accelerated until the minimum speed reference. After this the PID controller is enabled and starts to control the pump speed in order for the control process variable to catch up with the control setpoint required by the user.

5.19 PUMP GENIUS SIMPLEX LOGICAL STATUS

P919 - Pump Genius Simplex Logical Status

Adjustable Range:	0 to FFFF (hexa) Bit 0 = Sleep Mode Active (A750) Bit 1 = PID in Manual (0) / Automatic (1) Bit 2 = Sleep Boost Active (A752) Bit 3 = Pipe Charging (A754) Bit 4 = Deragging in Execution (A756) Bit 5 = Low Level Process Variable (A760) Bit 6 = High Level Process Variable (A762) Bit 7 = Low Level Auxiliary Variable (A764) Bit 8 = External Sensor Acted (A768) Bit 9 = Dry Pump (A770) Bit 10 = Pump Clogging Detected (A772) Bit 11 = Deragging Configuration Error (A774) Bit 12 = Deragging will not be Executed (A776) Bit 13 to 15 = Reserved	Factory Setting:
Properties:	ro	

Description:

This parameter allows the monitoring of the logical status of the Pump Genius Simplex application. Each bit represents a state.

Table 5.11: Description of the logical state of the Pump Genius Simplex application

Bits	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Function	Reserved			Deragging will not be Execut. (A776)	Deragging Conf. Error (A774)	Pump Clogging Detected (A772)	Dry Pump (A770)	External Sensor Active (A768)	Low Level Auxiliary Variable (A764)	High Level Process Variable (A762)	Low Level Process Variable (A760)	Deragging in Execution (A756)	Pipe Charging (A754)	Boost Function Active (A752)	Manual/ Automatic PID	Sleep Mode Active (A750)

Bits	Values
Bit 0 Sleep Mode Active (A750)	0: Inverter is not in the alarm condition 1: It indicates that the Pump Genius is in the sleep mode (A750)
Bit 1 PID Controller in Manual or Automatic	0: PID controller operating in Manual mode 1: PID controller operating in Automatic mode
Bit 2 Boost Function Active (A752)	0: Inverter is not in the alarm condition 1: It indicates that Pump Genius is running the boost function before going to sleep (A752)
Bit 3 Pipe Charging (A754)	0: Inverter is not in the alarm condition 1: It indicates that the pipe charging process is being performed (A754)
Bit 4 Pump Deragging in Execution (A756)	0: Inverter is not in the alarm condition 1: It indicates that the pump deragging process is in progress (A756)
Bit 5 Low Level of Control Process Variable (A760)	0: Inverter is not in the alarm condition 1: It indicates that the control process variable (P916) is low (A760)
Bit 6 High Level of Control Process Variable (A762)	0: Inverter is not in the alarm condition 1: It indicates that the control process variable (P916) is high (A762)
Bit 7 Low Auxiliary Control Variable Level (A764)	0: Inverter is not in the alarm condition 1: It indicates that the auxiliary control variable (P917) is at a low level and the control setpoint has been changed to the value of P950 (A764)
Bit 8 External Sensor Active (A768)	0: Inverter is not in the alarm condition 1: It indicates that protection via external sensor (DIx) is activated (A768)
Bit 9 Dry Pump (A770)	0: Inverter is not in the alarm condition 1: It indicates that the dry pump condition has been detected (A770)
Bit 10 Pump Clogging Detected (A772)	0: Inverter is not in the alarm condition 1: It indicates that pump clogging has been detected by operating at high current (A772)
Bit 11 Pump Clogging Configuration Error (A774)	0: Inverter is not in the alarm condition 1: It indicates that CFW320 frequency inverter is not operating in REMOTE mode when performing Pump Unblocking (A774)
Bit 12 Pump Clogging will not be Executed (A776)	0: Inverter is not in the alarm condition 1: It indicates that the pump clogging will not be executed due to the motor turning direction not being programmed for SoftPLC (P226 = 12) (A776)
Bit 13 Reserved	Reserved
Bit 14 Reserved	Reserved
Bit 15 Reserved	Reserved

5.20 I/O

This group of parameters allows the user to configure the inputs and outputs (analog, digital and frequency) of the CFW320 frequency inverter for use in the Pump Genius application. This configuration is dependent on the accessory connected to the product.



NOTE!

Refer to the CFW320 frequency inverter manual for more information on the inputs and outputs.

5.20.1 Analog Inputs

This group of parameters allows the user to configure the function of the analog inputs in the Pump Genius application.

Exclusive functions of analog inputs have been created for each of the Pump Genius applications:

■ Pump Genius Simplex

PARAMETERS DESCRIPTION

- Control Setpoint: available in parameters P231 and P236. Set value to 08.
- Control Process Variable: available in parameters P231 and P236. Set value to 09.
- Auxiliary Control Variable: available in parameters P231 and P236. Set value to 10.

■ Pump Genius Multipump

- Control Process Variable: available in parameter P231. Set value to 09.

■ Pump Genius Multiplex

- Control Process Variable: available in parameter P231. Set value to 09.

P018 - AI1 Value

P012 - Valor Value

P231 - AI1 Signal Function

P236 - AI2 Signal Function

P232 - AI1 Input Gain

P237 - AI2 Input Gain

P233 - AI1 Input Signal

PP238 - AI2 Input Signal

P234 - AI1 Input Offset

P239 - AI2 Input Offset

P235 - AI1 Input Filter

P240 - AI2 Input Filter



NOTE!

Refer to the CFW320 programming manual for more information on the parameters of the analog inputs. In the configuration wizard, some value options for the parameters were removed.

5.20.2 Digital Inputs

This group of parameters allows the user to configure the function of the digital inputs in the Pump Genius application.

Exclusive digital input functions have been created for each of the Pump Genius applications:

■ Pump Genius Simplex

- Perform Pump Clogging: available in parameter P263. Set value to 41.
- External Sensor: available in parameters P263, P264, P265, P266 and P267. Set value to 42.

- Increase Setpoint EP: available in parameter P265. Set value to 43.
- Decrease Setpoint EP: available in parameter P266. Set value to 43
- 1st DI for Setpoint Selection: available in parameter P265. Set value to 44.
- 2nd DI for Setpoint Selection: available in parameter P266. Set value to 44.
- Selection of PID in Manual/Automatic: available in parameter P264. Set value to 45.

■ Pump Genius Multipump

- Enable Pump Genius: available in parameter P263. Set value to 41.
- External Sensor: available in parameters P264, P265 and P266. Set value to 42.
- Increase Setpoint EP: available in parameter P265. Set value to 43.
- Decrease Setpoint EP: available in parameter P266. Set value to 43
- 1st DI for Setpoint Selection: available in parameter P265. Set value to 44.
- 2nd DI for Setpoint Selection: available in parameter P266. Set value to 44.
- Enable Pump 1: available in parameters P264 and P267. Set value to 45.
- Enable Pump 2: available in parameter P268. Set value to 46.
- Enable Pump 3: available in parameter P269. Set value to 47.
- Enable Pump 4: available in parameter P270. Set value to 48.

■ Pump Genius Multiplex

- Enable Pump Genius: available in parameter P263. Set value to 41.
- External Sensor: available in parameters P264, P265 and P266. Set value to 42.
- Increase Setpoint EP: available in parameter P265. Set value to 43.
- Decrease Setpoint EP: available in parameter P266. Set value to 43
- 1st DI for Setpoint Selection: available in parameter P265. Set value to 44.
- 2nd DI for Setpoint Selection: available in parameter P266. Set value to 44.
- Enable Pump: available in parameter P264. Set value to 45.

P012 - DI8 to DI1 Status

P263 - DI1 Input Function

P264 - DI2 Input Function

P265 - DI3 Input Function

P266 - DI4 Input Function

P267 - DI5 Input Function

P268 - DI6 Input Function

P269 - DI7 Input Function

P270 - DI8 Input Function

P271 - DIs Function

**NOTE!**

Refer to the CFW320 programming manual for more information on the parameters of the digital inputs. In the configuration wizard, some value options for the parameters were removed.

5.20.3 Digital Outputs

This group of parameters allows the user to configure the function of the digital outputs in the Pump Genius application.

Exclusive digital output functions have been created for each of the Pump Genius applications:

■ Pump Genius Simplex

- Alarm (A760) or Fault (F761) due to Low level of Process Variable: available in parameters P275, P276, P277 and P278. Set value to 37.
- Alarm (A762) or Failure (F763) due to High level Process Variable: available in parameters P275, P276, P277 and P278. Set value to 38.

■ Pump Genius Multipump

- Enable Pump 1: available in parameter P275. Set value to 41.
- Enable Pump 2: available in parameter P276. Set value to 42.
- Enable Pump 3: available in parameter P277. Set value to 43.
- Enable Pump 4: available in parameter P278. Set value to 44.

**NOTE!**

No exclusive digital output option has been created for Pump Genius Multiplex application.

P013 - DO4 to DO1 Status

P275 - DO1 Function

P276 - DO2 Function

P277 - DO3 Function

P278 - DO4 Function

**NOTE!**

Refer to the CFW320 programming manual for more information on the parameters of the digital outputs. In the configuration wizard, some value options for the parameters were removed.

5.20.4 Frequency Inputs

In the Pump Genius Multiplex application, the frequency inputs FI2, FI3 and FI4 of the CFW320-IODF accessory module are used for slave pumps to receive commands from the master pump and the master pump to check the status of the associated slave pumps in parallel.



NOTE!
The value of the frequency inputs FI2, FI3 to FI4 are accessed only in the Pump Genius Multiplex application ladder application through dedicated I/O markers for each input. Only these frequency inputs are treated in the Pump Genius Multiplex application ladder application.



NOTE!
Refer to the CFW320-IODF accessory module installation guide for more information on the operation of frequency inputs FI2, FI3 and FI4.

5.20.5 Frequency Outputs

In the Pump Genius Multiplex application, the frequency outputs FO1, FO2 and FO3 of the CFW320-IODF accessory module are used for slave pumps to send their status to the master pump and the master pump to send commands to the associated slave pumps in parallel.



NOTE!
The value of the frequency outputs FO1, FO2 and FO3 are written only in the Ladder application of the Pump Genius Multiplex application through dedicated I/O markers for each output. Only these frequency outputs are treated in the Pump Genius Multiplex application ladder application.



NOTE!
Refer to the CFW320-IODF accessory module installation guide for more information on the operation of the frequency outputs FO1, FO2 and FO3.

5.21 HMI MONITORING

This group of parameters allows the user to configure which variables will be shown on the HMI of the CFW320 frequency inverter in monitoring mode.

P205 - Main Display Parameter

P207 - Bar Graph Parameter

P208 - Ref. Scale Factor

P209 - Ref. Eng. Unit

P210 - Ref. Decimal Point

P213 - Bar Scale Factor



NOTE!
Refer to the CFW320 programming manual for more information on the monitoring parameters (indications) of the HMI.

6 CREATION AND DOWNLOAD THE APPLICATION

In order to configure the CFW320 inverter for Pump Genius applications, it is necessary to create the ladder application on the WPS and then download it to the SoftPLC function of the CFW320 inverter, as well as the parameter values configured on the configuration wizard.

The following steps show how to create and configure the Pump Genius application in the WPS and how to transfer it to the CFW320 inverter.

1st Step: Update the WPS plugins, create a new configuration/resource, and in step 1 select the resource type as application.

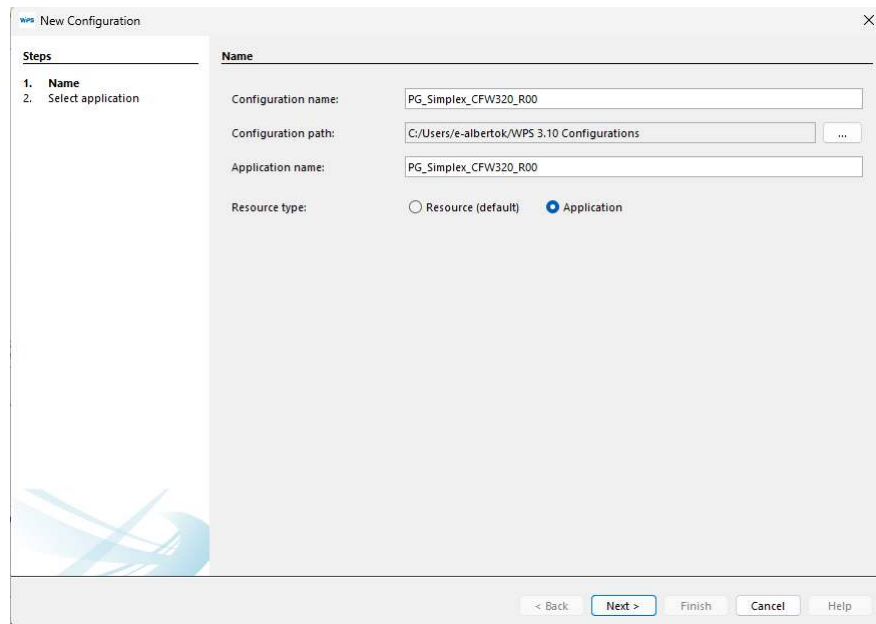


Figure 6.1: Create a new configuration in the WPS software

2st Step: Select the desired Pump Genius application template (Simplex, Multipump, or Multiplex) in its latest version in step 2.

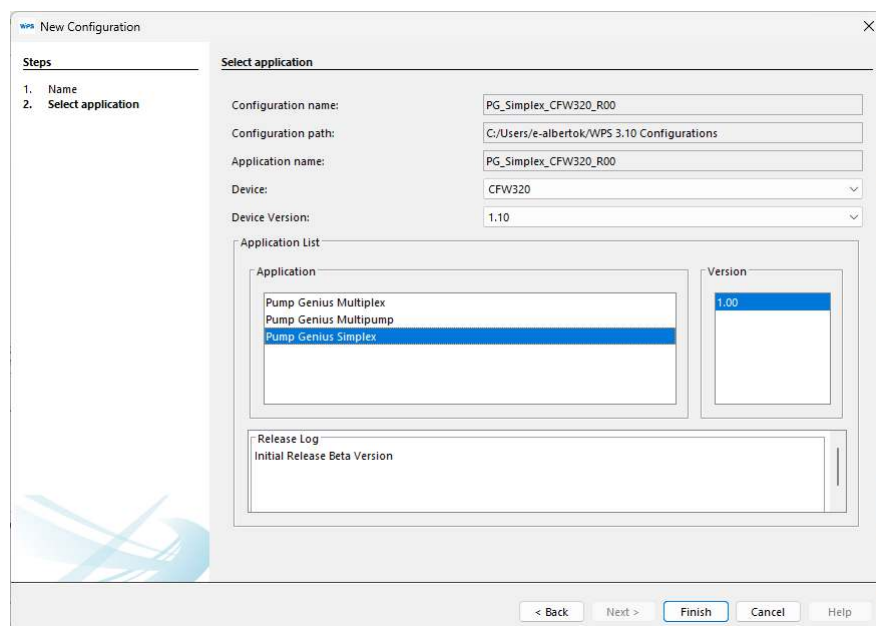


Figure 6.2: Create a Pump Genius application in the WPS software

CREATION AND DOWNLOAD THE APPLICATION

3rd Step: Download the ladder application and user parameters configured for the Pump Genius application. To do this, go to Online, Connect Device (F9) and then Download Resource (F8).

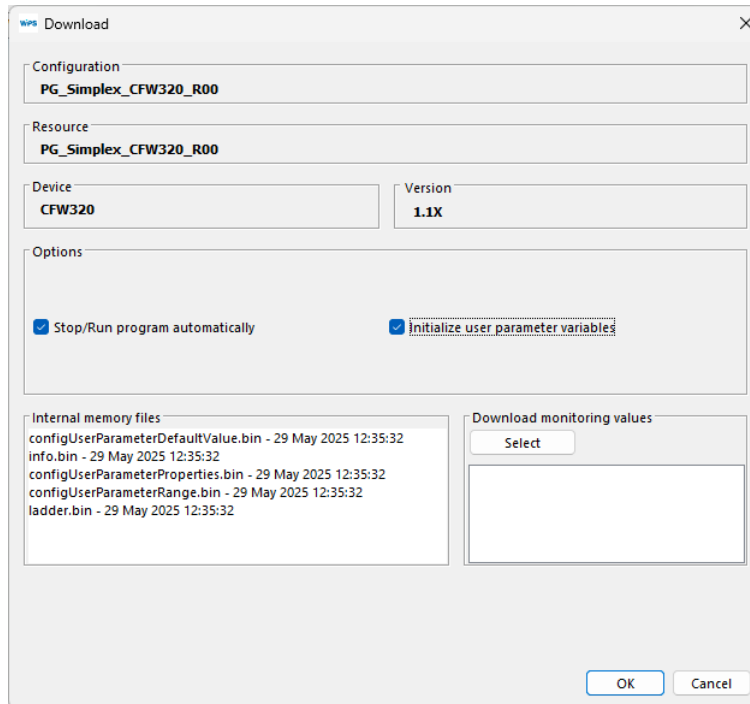


Figure 6.3: Download the Pump Genius application in the WPS software

4rd Step: Start the configuration wizard for programming the Pump Genius application and, after completing the wizard setup, perform the parameter writing. After writing, it is possible to monitor and modify parameters online.

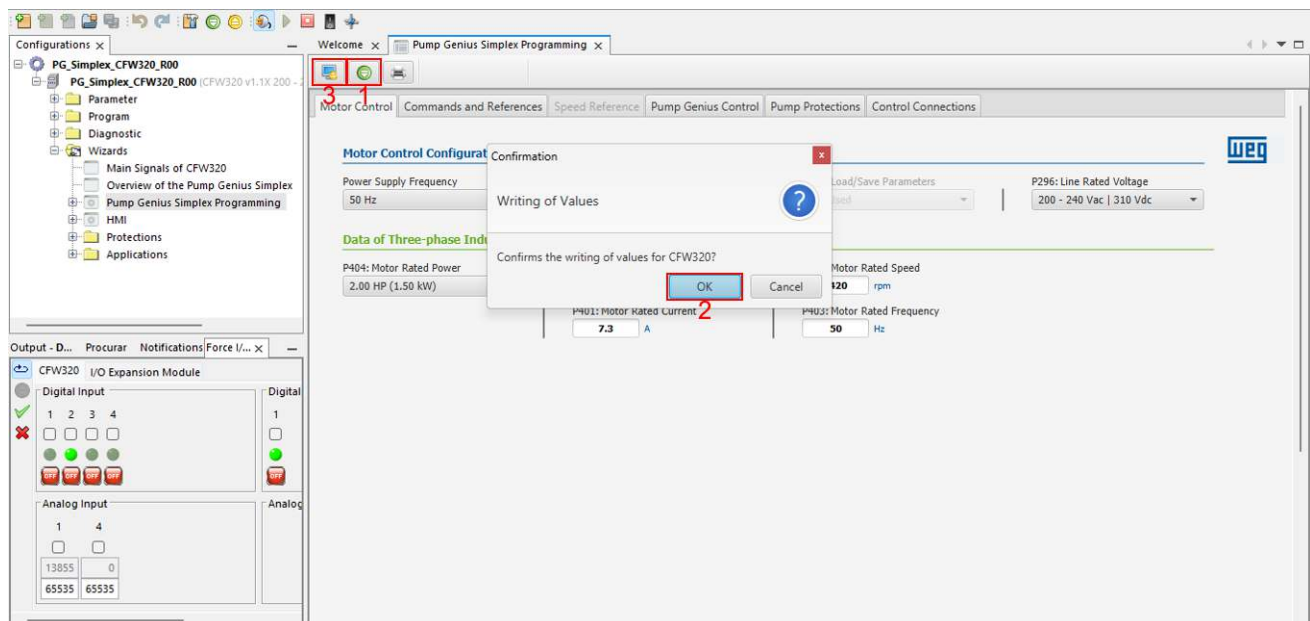


Figure 6.4: Select the configuration wizard for programming the Pump Genius application

5th Step: After programming the application using the configuration wizard, it is possible to save the programmed values. This procedure is done when closing the configuration wizard. After saving the file, you can rename it; for this, click the right mouse button on the created file.

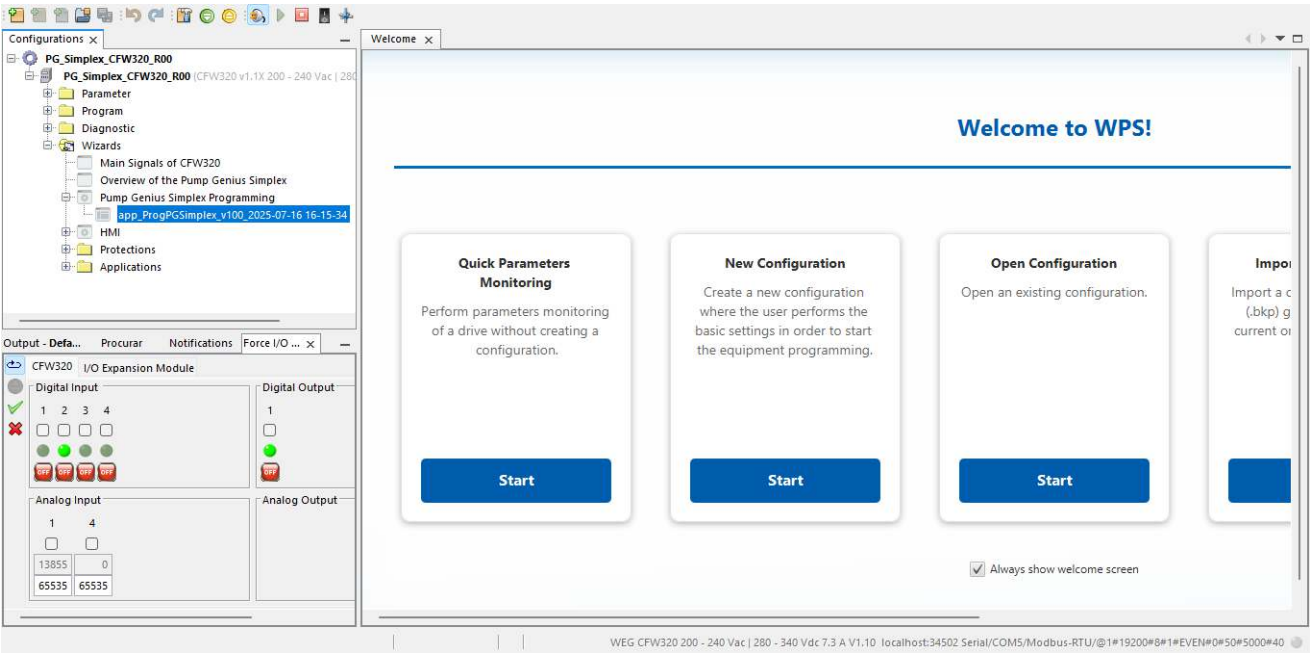


Figure 6.5: Save the configuration wizard with Pump Genius application programming



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