# Pressure-Controlled Pumps

SINAMICS G120P_CU230P-2 from FW 4.4

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# Pressure-Controlled Pumps

SINAMICS G120P_CU230P-2 from FW 4.4

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# Table of Contents

# 1 Introduction

Pressure-controlled pumps are used in piping systems when pressure at the consumer must be kept constant even when the flow fluctuates. This predominantly involves water supply systems, where the water pressure at the house connection points must be kept constant and where it must be ensured that there is sufficient water in the top floors of high-rise buildings. These so-called pressure boosting stations comprise one or several centrifugal pumps, which using a PID controller control the pressure by changing the speed.

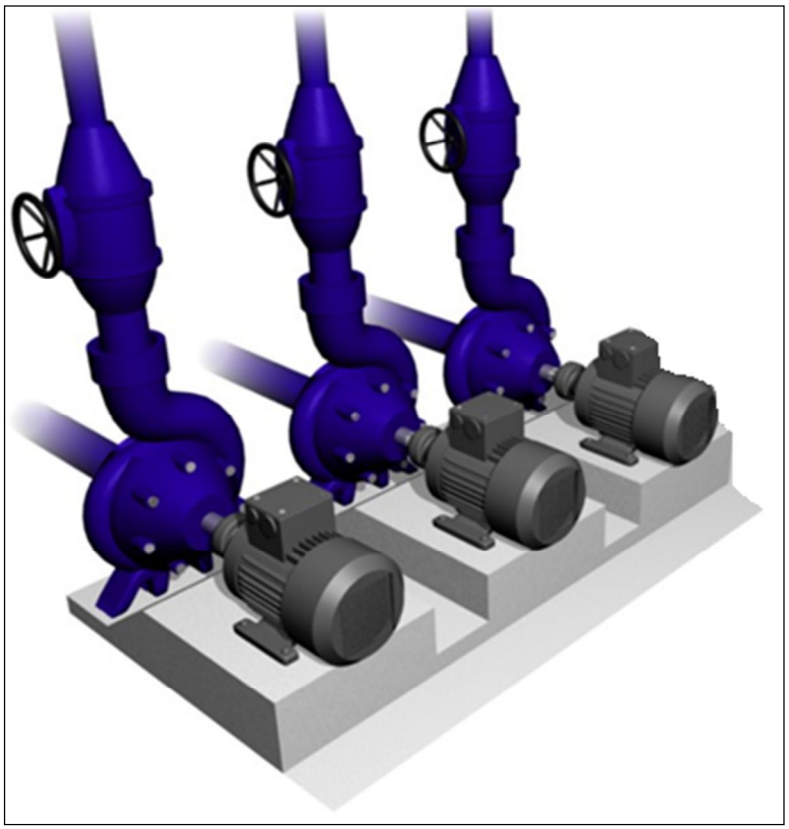

Fig. 1-1: Pressure boosting station with three centrifugal pumps

The following description is used to completely set the inverter parameters for the "closed-loop pressure controlled pumping system" application with up to 4 pumps. In includes a standard connection circuit diagram for the control wiring, a script that can run in the STARTER commissioning software, an associated flow diagram with explanation, as well as additional functions, which are used for subsequent parameterization.

# 2 Connection circuit diagram

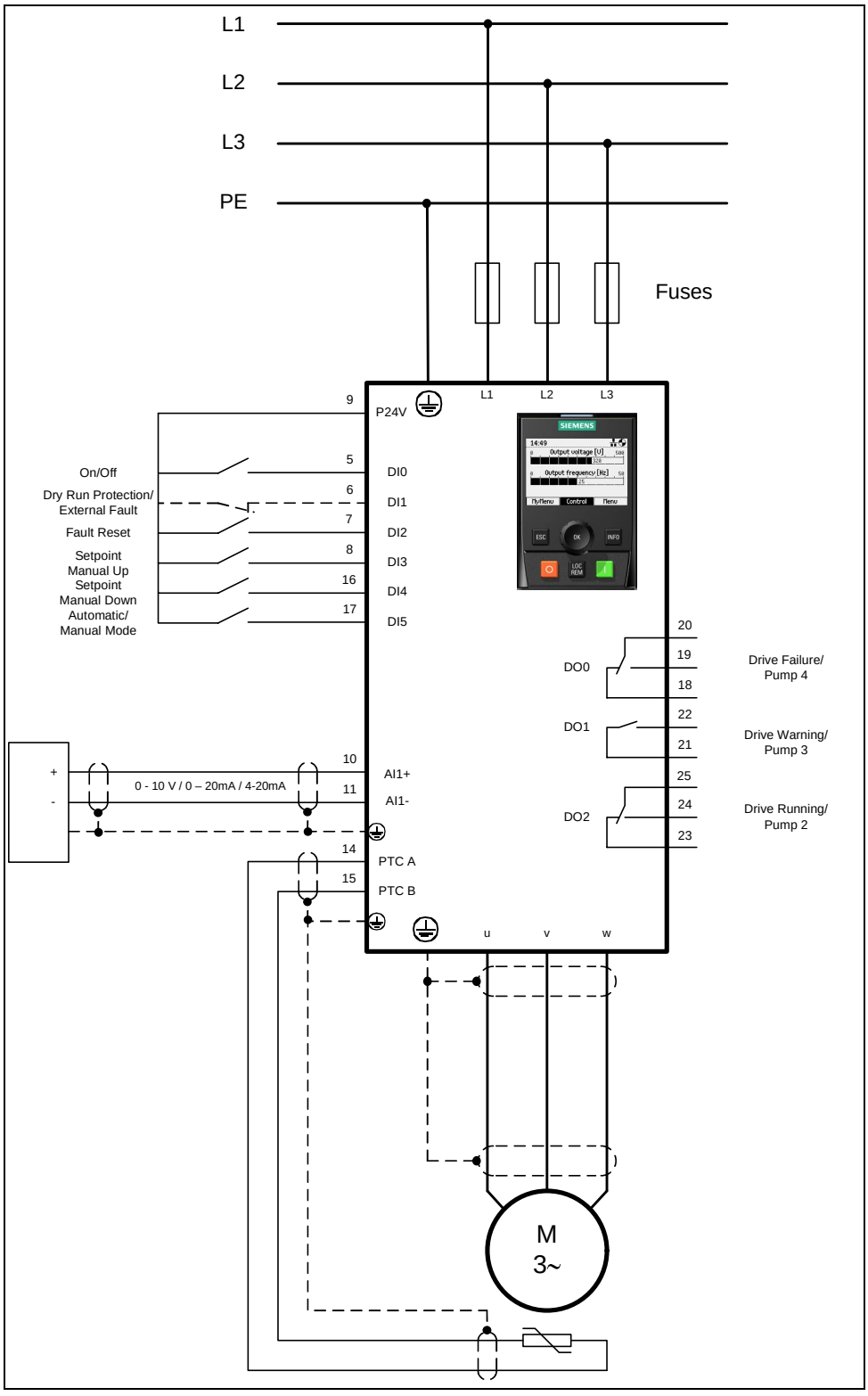


Fig. 2-1: Connection circuit diagram of the inverter

The terminal assignment for the subsequent parameterization is as follows:

DI0 – On/Off

DI1 – Optional connection of an external dry-running sensor

DI2 – fault acknowledgement

DI3 = Increases the set point (MOP) in manual operation

DI4 = Reduces the set point (MOP) in manual operation

DI5 – Changes over between automatic operation (closed-loop pressure control) and manual operation (open-loop controlled operation via MOP)

AI1+/- – Connection for the pressure transducer

PTC A/B – Connection for the temperature sensor of the variable-speed pump

DO0 – Signal, drive fault/control, pump 4 for Motor Staging

DO1 – Signal, drive alarm/control, pump 3 for Motor Staging

DO2 – Signal, drive operational/control, pump 2 for Motor Staging

# 3 Script functionality

- Check the CU module (CU230P-2) and SW Version (V4.4)
- Select between complete parameterization or subsequent set point change
- Factory setting
- Quick commissioning
- Motor temperature monitoring
- Enter or calculate the minimum speed
- Sensor setting incl. technological calibration (10V/20mA = xx.x bar)
- PID controller setting
- Select automatic restart, yes/no
- Select soft starting (PID controller enable is delayed), yes/no
- Select Motor Staging with pre-assignment of the necessary parameters for pumps
- Select Hibernation Mode, yes/no
- A fixed set point or two set points alternating using timer 1 and 2 (input in meters)
- BiCo wiring of the PID controller, the DI, DO incl. automatic/manual operation
- Only when using a PM330: Motor data identification

# 4 Description of the parameterization

## 4.1 Inserting and executing the script

In order to be able to work with scripts, a script folder must first be created below the CU module in STARTER. This is done by marking the CU module ⇒ Select Expert using the right-hand mouse key ⇒ Insert script folder

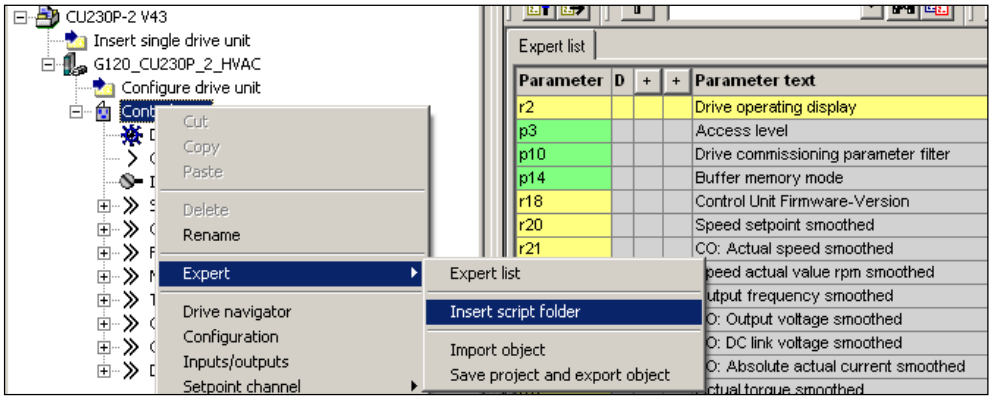


Fig. 4-1: Inserting the script folder

The scripts available as text file are imported using the "ASCII Import" link.

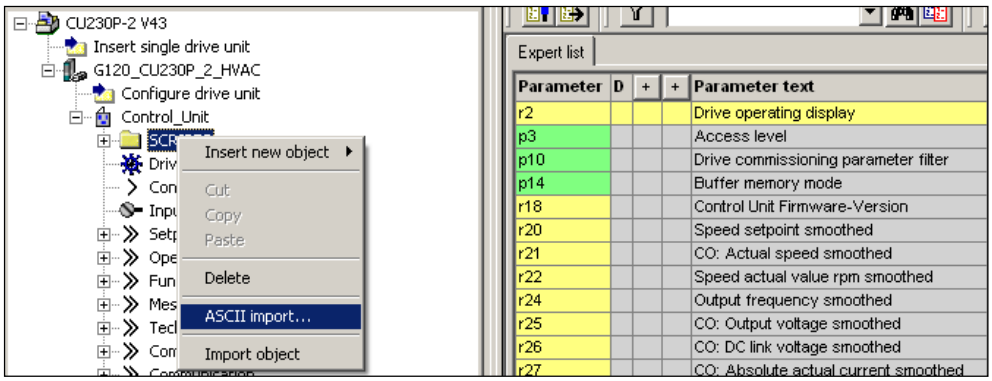


Fig. 4-2: Importing the script

When importing the script, the file manager opens with which the file to be run can be selected. The imported scripts are saved in the directory structure of the project in the Scripts folder.

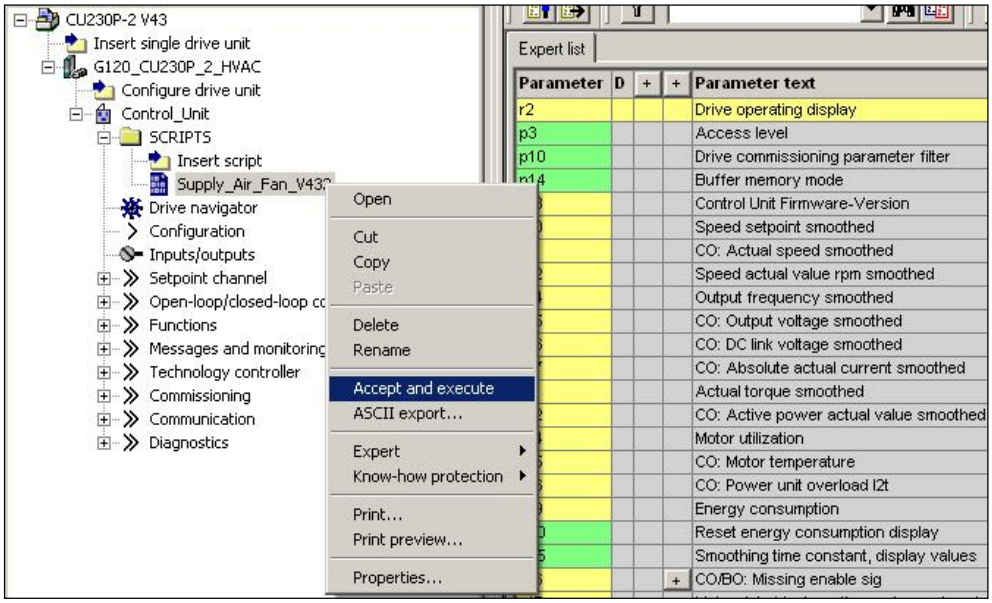


Fig. 4-3: Executing the script

The script is started by selecting the script using the right-hand mouse key and selecting "Accept and execute". The further sequence of the script is controlled using input screen forms, in which Yes/No prompts or value inputs are expected.

## 4.2 Parameterization sequence

The parameterization that is carried out using the script is described in the following. Most of the settings are carried out in the background, parameters shown in bold (□□□□) require that users make the appropriate entries.

### 4.2.1 Verifying of online status

This script can only run in online operation as it includes a reset to the factory setting (where the factory settings are restored) and motor commissioning.

Because of this the script tries to establish a connection to the CU if not already online. If there is still no online connection a fault message is performed.

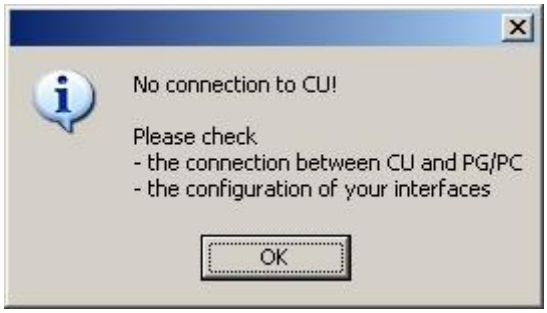


Fig. 4-4: Message no connection to CU

### 4.2.2 CU module interrogation

The script is only coordinated to the functionality of the CU230P-2 HVAC, CU230P-2 DP, and CU230P-2 CAN control modules; other modules are rejected.


Fig. 4-5: Message, incorrect CU module

Further, it is assumed that the module has a minimum firmware version of V4.4. For firmware version 4.3.2 exits a separate script.

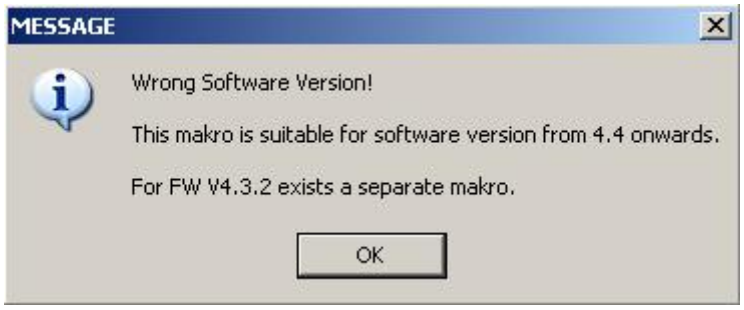


Fig. 4-6: Message, incorrect firmware version

Both of these facts are queried in the background; if they are not fulfilled, then the script is interrupted.

### 4.2.3 Power module interrogation

The script is not released for power module PM330 and SINAMICS G120P Cabinet drives.

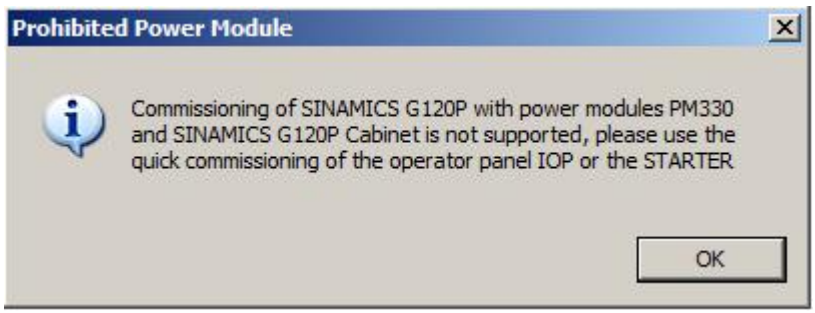


Fig. 4-7: Message, prohibited power module

### 4.2.4 Query, scope of the parameterization

A selection can be made as to whether the complete parameterization is run through or whether subsequently only set points and other inputs should be changed.

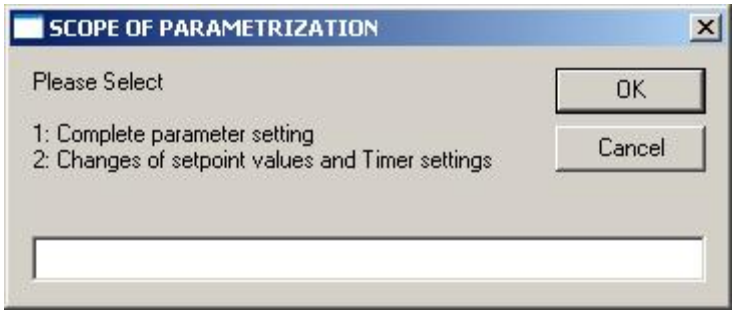


Fig. 4-8: Selection screen form, scope of parameterization

**CAUTION** **Make sure that no On-Signal at DI-0 is active!**



To finish the parameterization successful, make sure that there is no On-signal at DI-0.


Figure 4-9

In order that set points can be subsequently displayed and entered so that they are correctly technologically scaled/normalized, the maximum pressure is entered in p2900[0]. To identify the application macro, an identifier is entered into P2901[0]. Using this identifier, the script can identify that a basic parameterization was already performed.


Fig. 4-10: Message stating that the basic parameterization has not been performed

### 4.2.5 Factory setting

The parameterization using the script assumes that the inverter parameters are set to the values of the factory setting. Because of this the fully parameterization can only start, if factory setting is performed. In case of CU230P-2 DP the command source is changed to Terminals after the factory setting has been done.

After that in a number of parameters settings will be done. At CU230P-2 DP the connections from control word will be removed.

| Parameter | Value | Comment |
|---|---|---|
| P0015 | 0 | Macro drive unit |
| P0844[0], [1] | 1 | No coast-down / coast-down (OFF2) |
| P0852[0], [1] | 1 | Enable operation/inhibit operation |
| P0854[0], [1] | 1 | Control by PLC/no control by PLC |
| P1140[0], [1] | 1 | Enable ramp-function generator |
| P1141[0], [1] | 1 | Continue ramp-function generator |
| P1142[0], [1] | 1 | Enable set point |
| P1035[0] | 0 | Motorized potentiometer set point raise |
| P1036[0] | 0 | Motorized potentiometer lower set point |
| P1055[0], [1] | 0 | Jog bit 0 |
| P1056[0], [1] | 0 | Jog bit 1 |
| P1070[0] | 0 | Main set point |
| P1070[1] | 0 | Main set point |
| P1113[0], [1] | 0 | Set point inversion |
| P2103[0], [1] | 0 | Acknowledge faults |
| P2030 | 0 | Field bus protocol selection |



### 4.2.6 Quick commissioning

For the quick commissioning, square-law V/f characteristics for the fans as well as a low overload factor are entered. After this, the system prompts you to enter the rated supply voltage, the rated current, the rated power and rated frequency as well as the rated speed. Depending on the motorstandard the powerfactor or the efficiency factor will be prompted. This completes the quick commissioning.

| Parameter | Value | Comment |
|---|---|---|
| P0205 | 1 | Load cycle with low overload |
| P0300[0] | 1 | Selects induction motor, rotary |
| **P100** | **□□□□** | **Motorstandard** |
| **P0304[0]** | **□□□□** | **Enter rated motor voltage** |
| **P0305[0]** | **□□□□** | **Enter rated motor current** |
| **P0307[0]** | **□□□□** | **Enter rated motor power** |
| **P0308[0], P0309[0]** | **□□□□** | **Rated motor power factor or Rated motor efficiency** |
| **P0310[0]** | **□□□□** | **Enter rated motor frequency** |
| **P0311[0]** | **□□□□** | **Enter rated motor speed** |
| P1300[0] | 2 | V/f characteristic with parabolic characteristic |
| p3900[0] | 3 | Completion of quick commissioning |

### 4.2.7 Motor temperature sensing

The query allows you to select between either no sensor, PTC or KTY84. As a result of the quick commissioning, the motor over temperature is specified; for deviations, parameter P0604 can be changed.

| Parameter | Value | Comment |
|---|---|---|
| P0601[0] | 0<br>1<br>2 | No sensor<br>PTC<br>KTY84 |
| **P0604[0]** | **□□□□** | **Enter alarm threshold, motor over temperature** |

### 4.2.8 Calculating the minimum speed

The minimum speed is either calculated from the process data "static delivery head" and "zero delivery head" or is set to 20% of the maximum frequency. Other values can be set.

| Parameter | Value | Comment |
|---|---|---|
| **P1080[0]** | **□□□□** | **Enter a minimum speed** |



### 4.2.9 Evaluation of the external dry running protection

Digital input 1 is provided to connect an external sensor to monitor drive running operation of the pump. This function can also be deselected.

| Parameter | Value | Comment |
|---|---|---|
| P2106[0] | r722.1 | DI1 – external fault, automatic operation |
| P2106[1] | r722.1 | DI1 – external fault, manual operation |

### 4.2.10 Pressure Control

At pressure Control the pump carries depending on the pressure in the pipe. The control sense for the closed-loop pressure control is normal, i.e. with rising speed, the flow is rising and the pressure will rise.

**Applications**

For closed-loop pressure control, parameter P2901[0] is set temporary to a value of 2. Because of this the script identifies that the configuration is a closed-loop pressure control.

| Parameter | Value | Comment |
|---|---|---|
| P2901[0] | 2 | Identifier, not finished closed-loop pressure control |

**Pre-connecting the PID controller**

A fixed set point is used as step-in for the PID controller.

| Parameter | Value | Comment |
|---|---|---|
| P2253[0] | r2224 | Fixed set points are used |

**Actual value sensor setting**

Option of selecting between sensors with a voltage output or a current output.

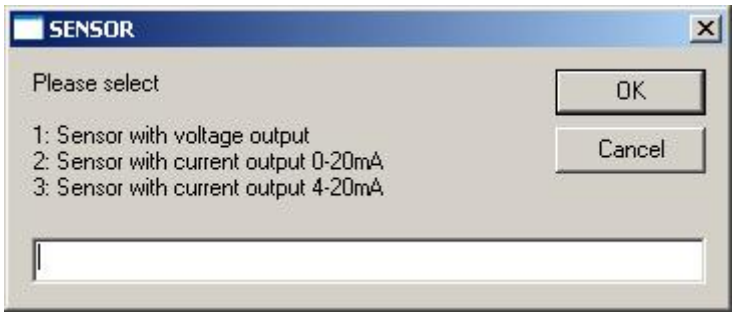


Fig. 4-11: Selection screen form, actual value sensor

For sensors with a voltage output, the maximum voltage can also be entered, which is then normalized (scaled) to 100% in the set point channel (e.g. sensors with 5V output voltage are generally used).



**Sensor with voltage output**

| Parameter | Value | Comment |
|---|---|---|
| P0756[1] | 0 | Voltage input, unipolar (0 … 10V) |
| **P0759[1]** | **□□□□** | **Enter the max. output voltage** |

**Sensor with current output 0 … 20mA**

| Parameter | Value | Comment |
|---|---|---|
| P0756[1] | 2 | Current input, unipolar (0 … 20mA) |

**Sensor with current output 4 … 20mA**

| Parameter | Value | Comment |
|---|---|---|
| P0756[1] | 3 | Voltage input, unipolar (4 … 20mA) |

**Technology standardization**

The maximum pressure that can be measured in Bar must be entered to normalize (scale) the technology values. The value must be saved in P2900[0]; the set points refer to this value. An actual value smoothing of 100 ms is specified using parameter P2265. The actual value is connected from analogue input AI1.

| Parameter | Value | Comment |
|---|---|---|
| **P2900[0]** | **□□□□** | **Enters the maximum pressure that can be measured** |
| P2265 | 0.1 | Time constant, actual value filter |
| P2264 | r755[1] | Actual value from analogue input AI1 |

### 4.2.11 Technological unit

The technological unit P595 will be set to [bar]. The Reference quantity P596 from the technological unit will be set to the same as maximum pressure P2900.

| Parameter | Value | Comment |
|---|---|---|
| P595 | 3 [bar] | Selecting technological units |
| P596 | Max. pressure | Reference quantity, technological units |

### 4.2.12 Configuration of the PID controller

The PID controller is interconnected as main set point. The actual value is connected from analogue input AI1. Fans are only operated with a positive direction of rotation. This is the reason that the PID controller limiting is set from 0% to 100%. Three windows are opened one after the other to input the gain factor, the integral time as well as the derivative action time.

| Parameter | Value | Comment |
|---|---|---|
| P2200[0] | 1 | Enables the PID controller |
| P2251 | 0 | Technology controller as main set point |
| P2297 | p2291 | Value, positive limit |
| P2298 | p2292 | Value, negative limit |
| **P2280** | **□□□□** | **Enter the proportional gain** |
| **P2285** | **□□□□** | **Enter the integral time** |
| **P2274** | **□□□□** | **Enter the differentiating time** |



### 4.2.13 Query - starting behaviour

A distinction can be made between immediately enabling the PID controller when switching-on the drive and soft starting; in this case, the PID controller output is opened using an up ramp that can be set.

| Parameter | Value | Comment |
|---|---|---|
| **P2293** | **□□□□** | **Technology controller, ramp-up/ramp-down time in sec** |

### 4.2.14 Automatic restart

It is possible to select an automatic restart after power failure.

| Parameter | Value | Comment |
|---|---|---|
| P1210 | 4 | Restart after power failure |

**NOTE** This value can only be changed in a status without faults, because of this an automatic fault acknowledge is performed. If the fault message is still active a warning message will appear and the script will go on without activating this function.

### 4.2.15 Motor Staging

Using the Motor Staging function, when required up to three pumps can be switched-in with a fixed speed in order to maintain the pressure. It is possible to quickly set the Motor Staging function. You can chose between 1 to 3 auxiliary motors. It is expected that all 3 Motors have the same size. The settings of the Motor Staging are set to experience values. Depending on the particular customer requirements, post-optimization is recommended.

| Parameter | Value | Comment |
|---|---|---|
| P2370 | 1 | Enables Motor Staging |
| **P2371** | **□□□□** | **Motor Staging configuration** |
| P2373 | 5.0% von P2900 | Switch-on threshold, Motor Staging |
| P2374 | 5.0 | Delay time, Motor Staging |
| P2375 | 5.0 | Delay time, Destaging |
| P2376 | 15% von P2900 | Override value, Motor Staging |
| P0732 | r2379.0 | Control auxiliary motor 1 |
| P0731 | r2379.1 | Control auxiliary motor 2 (if configured) |
| P0730 | r2379.2 | Control auxiliary motor 3 (if configured) |

### 4.2.16 Hibernation Mode

The Hibernation Mode ensures that the inverter switches itself off if the actual value is greater than the set point for a specific time. The PID controller also remains active with the inverter switched-off. The delay time can be set as to how long the pump operates at the minimum frequency before it is switched off. The restart value is used to set the accuracy with which the inverter is switched-on again if the actual value again drops below the set point. Low setting values in the range of several percent result in a quite narrow switch-in bandwidth; high setting values in the range greater than 10% mean that the level drops more before the drive is switched-in again.

**NOTE** The delay time of the Hibernation Mode must always be longer than the destaging time of the possibly parameterized Motor Staging, as otherwise malfunctions can occur.

| Parameter | Value | Comment |
|---|---|---|
| P2398 | 1 | Hibernation Mode activated |
| **P2391[0]** | **□□□□** | **Enter the hibernation delay time** |
| **P2392** | **□□□□** | **Enter the hibernation restart value** |

### 4.2.17 Set point input

The set point is entered in bar. Due to the normalization (scaling) of the actual value, the value is converted into a percentage and then entered as fixed set point. If a value is entered, which is greater than the maximum possible actual value, then value is rejected - and the input screen form is redisplayed. It is possible to select between a fixed set point and a change between two set points. When selecting two set points, a changeover is made using the two timers 1 and 2. If there is a gap between the timers where no set point is active, the drive will be switched off in this time.

**One set point**

| Parameter | Value | Comment |
|---|---|---|
| **P2201[0]** | **□□□□** | **Technology controller, fixed value 1** |
| P2216 | 1 | Fixed value direct selection |
| P840[0] | r722.0 | DI0 - Drive ON/OFF |
| P2220[0] | 1 | Fixed value selection, bit 0 |

**Set point change**

| Parameter | Value | Comment |
|---|---|---|
| **P2201[0]** | **□□□□** | **Technology controller, fixed value 1** |
| **P2202[0]** | **□** | **Technology controller, fixed value 2** |
| P2216 | 1 | Fixed value direct selection |
| P8410[0] | 1 | Activation, weekday time switch 1 |
| P8410[1] | 1 | Activation, weekday time switch 1 |
| P8410[2] | 1 | Activation, weekday time switch 1 |
| P8410[3] | 1 | Activation, weekday time switch 1 |
| P8410[4] | 1 | Activation, weekday time switch 1 |
| P8410[5] | 1 | Activation, weekday time switch 1 |
| P8410[6] | 1 | Activation, weekday time switch 1 |
| P8420[0] | 1 | Activation, weekday time switch 2 |
| P8420[1] | 1 | Activation, weekday time switch 2 |
| P8420[2] | 1 | Activation, weekday time switch 2 |
| P8420[3] | 1 | Activation, weekday time switch 2 |
| P8420[4] | 1 | Activation, weekday time switch 2 |
| P8420[5] | 1 | Activation, weekday time switch 2 |
| P8420[6] | 1 | Activation, weekday time switch 2 |
| **P8411[0]** | **□□□□** | **Switch-on time, time switch - 1 hour** |
| **P8411[1]** | **□□□□** | **Switch-on time, time switch - 1 minute** |
| **P8412[0]** | **□□□□** | **Switch-off time, time switch - 1 hour** |
| **P8412[1]** | **□□□□** | **Switch-off time, time switch - 1 minute** |
| **P8421[0]** | **□□□□** | **Switch-on time, time switch - 2 hours** |
| **P8421[1]** | **□□□□** | **Switch-on time, time switch - 2 minutes** |
| **P8422[0]** | **□□□□** | **Switch-off time, time switch - 2 hours** |
| **P8422[1]** | **□□□□** | **Switch-off time, time switch - 2 minutes** |
| P20030[0] | r722.0 | AND 0 Input, Input I0 – DI0 |
| P20030[1] | r2225.0 | AND 0 Input, Input I1 – Fixed value active |
| P20030[2] | 1 | AND 0 Input, Input I2 – 1 |
| P20030[3] | 1 | AND 0 Input, Input I3 – 1 |
| P20032 | 5 | AND 0 Run time group |
| P840[0] | r20031 | Ein/Aus1 |
| P2220[0] | r8413.0 | Selection, fixed value 1 using time switch 1 |
| P2221[0] | r8423.0 | Selection, fixed value 2 using time switch 2 |

### 4.2.18 Automatic mode

In the automatic mode, the fan is operated with closed-loop control using the PID controller depending on the required control version; the set points are saved as fixed set points. Depending on the selection, the drive operates with the Hibernation Mode

| Parameter | Value | Comment |
|---|---|---|
| P20030[0] | r722.0 | DI0 - AND 0 Input Drive on (time-dependent) |
| P2106[0] | r722.1 | DI1 – External Fault (dry running protection) |
| P2104[0] | r722.2 | DI2 - Fault acknowledgement |
| P810 | r722.5 | DI5 - CDS0/1 changeover |

### 4.2.19 Manual mode

The drive can be switched over from the automatic into the manual mode using DI5. In the manual mode, the PID controller is not operational, with DI3 and DI4, the motorized potentiometer, which is used as set point source, is controlled either higher or lower. The initial value of the motorized potentiometer is set to the minimum frequency, the maximum value to the maximum frequency.



| Parameter | Value | Comment |
|---|---|---|
| P840[1] | r722.0 | DI0 - Drive ON/OFF |
| P2106[1] | r722.1 | DI1 - External fault (dry running protection) |
| P2104[1] | r722.2 | DI2 - Fault acknowledgement |
| P1035[1] | r722.3 | DI3 - Set point, increase (raise) |
| P1036[1] | r722.4 | DI4 - Set point, decrease (lower) |
| P810[1] | r722.5 | DI5 - CDS0/1 changeover |
| P2200[1] | 0 | Inhibit PID controller |
| P1070[1] | r1050 | Main set point MOP |
| P1038[1] | p1080[0] | Motorized potentiometer, minimum speed |
| P1037[1] | p1082[0] | Motorized potentiometer, maximum speed |
| P1040[1] | p1080[0] | Start speed, motorized potentiometer |

### 4.2.20 Setting of the application identifier

The identifier of the application in P2901 identifier is completed as a sign of the finished script. The application identifier is the addition of 12, the common identifier of a pressure control and the already in P2901 existing identifier of the closed-loop control type.

| Parameter | Value | Comment |
|---|---|---|
| P2901[1] | 12 | closed-loop temperature control |

### 4.2.21 Setting the time and the date

The internal real-time clock is set to the time and date of the PC.

| Parameter | Value | Comment |
|---|---|---|
| P8400[0] | □□□□ | RTC time, hour |
| P8400[1] | □□□□ | RTC time, minute |
| P8400[2] | □□□□ | RTC time, second |
| P8401[0] | □□□□ | RTC date, day |
| P8401[1] | □□□□ | RTC date, month |
| P8401[2] | □□□□ | RTC date, year |


Fig. 4-12: Message, system time was set



### 4.2.22 Copying RAM to ROM

When parameterization has been completed, data is backed-up by copying from RAM to ROM.


Fig. 4-13: Message, save parameterization

### 4.2.23 Applying the script

After the complete parameterization has been performed, a message is displayed indicating that the script has been successfully applied. This completes parameterization.

After full parameterization some changes only become effective after a Power On.


Fig. 4-14: Application of the script

# 5 Motor Staging circuit diagram

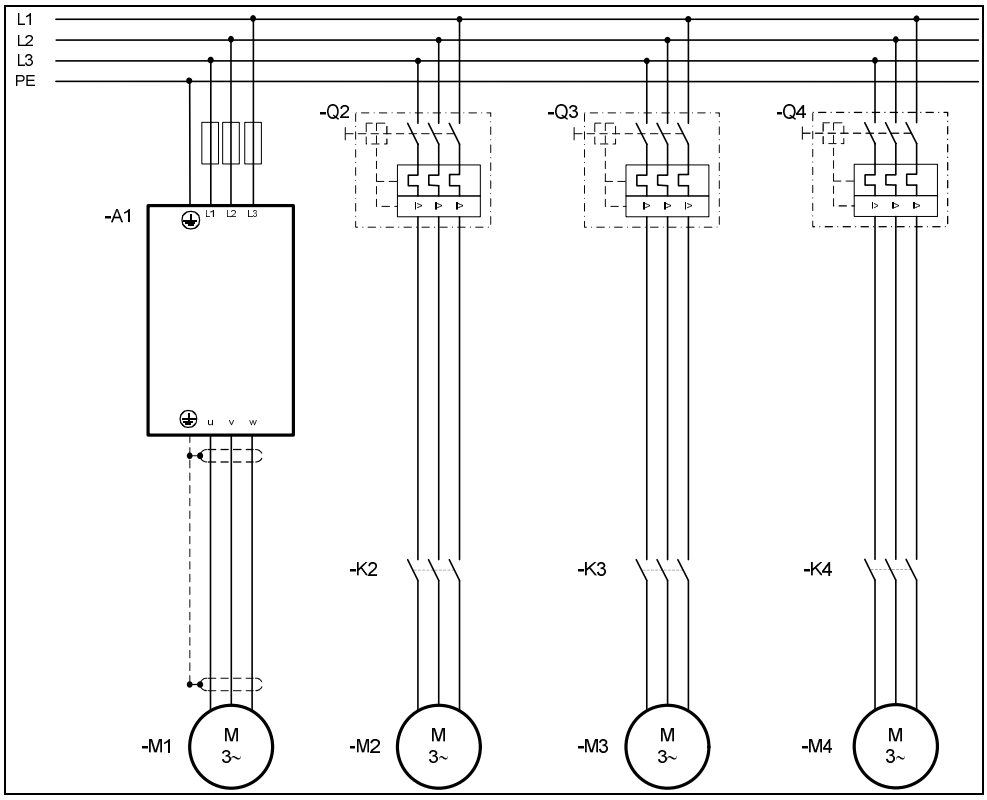


Fig. 5-1: Power wiring - inverter and fixed speed drives

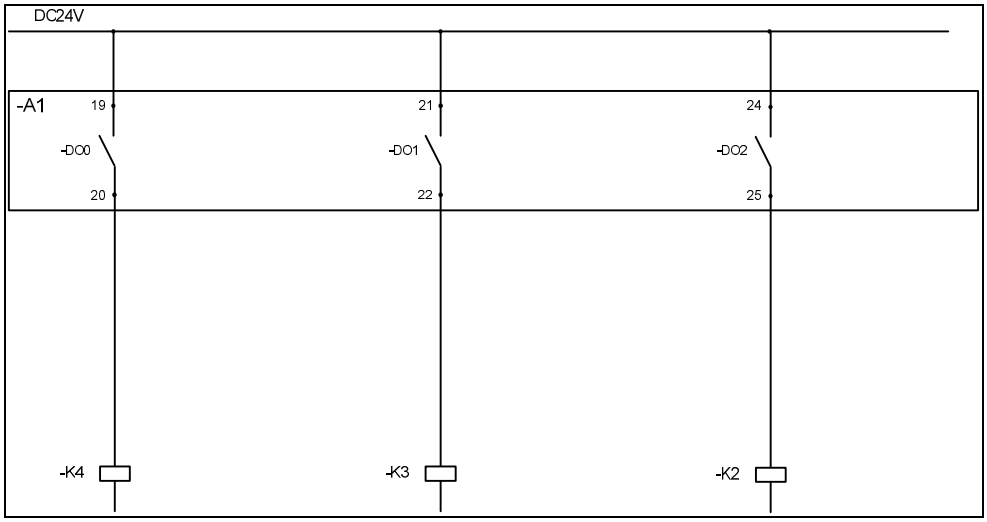


Fig. 5-2: Control wiring

# 6 Contact

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# 7 History

Tabelle 7-1

| Version | Datum | Änderung |
|---|---|---|
| V1.0 | 11/2010 | First Edition |
| V1.1 | 02/2011 | Changes on documentation |
| V1.2 | 05/2011 | Changes on script |
| V1.3 | 05/2012 | Revision for FW4.4 |
| V1.4 | 04/2014 | Vectorcontrol for PM330 added |
| V1.5 | 11/2014 | Power Module interrogation |