SINAMICS G120: Pressure controlled compressor

SINAMICS G120 from FW 4.4

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SINAMICS G120
Pressure controlled compressor

SINAMICS G120 / G120P
CU240B-2, CU240E-2, CU230P-2 ab FW 4.4

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1 Introduction

Compressors and blowers compress the air e.g. the gases up to values significantly above atmospheric pressure. The main applications are

1. Generation of compressed air for aeration in wastewater sites , pneumatic controls , pneumatic transport for bulk goods , pneumatic compressed air for industrial manufacturing devices, forming containers of glass or plastic (PET), breathing air (scuba diving , breathing apparatus for fire protection) , medical applications.
2. Separation of gases such as in air separation plants.
3. Compression of the refrigerant in refrigerators after the linden method for freezers in household , commercial refrigeration , refrigerated counters in food retail , industrial refrigeration equipment such as cold stores or refrigerated ships , air conditioning systems for residential, commercial and industrial purposes.

Increasingly, fixed speed compressors with storage tank are replaced by compressors with variable speed drives, which are able to control the pressure needed in a narrow frame. Energy-intensive over-compression with fixed speed compressors and storage tank is avoided. High starting currents and starting torques with repeated switching on and off are when using the variable speed compressor drives are of the past.

Figure 1-1: Screw compressor for compressed air industrial applications

The following description is used to completely set the inverter parameters for the "Pressure controlled compressor" application with up to 4 pumps. It includes a standard connection circuit diagram for the control wiring, a script that can run in the STARTER commissioning software, as well as additional functions, which are used for subsequent parameterization.

2 Connection circuit diagram

2.1 Control Unit CU240B-2

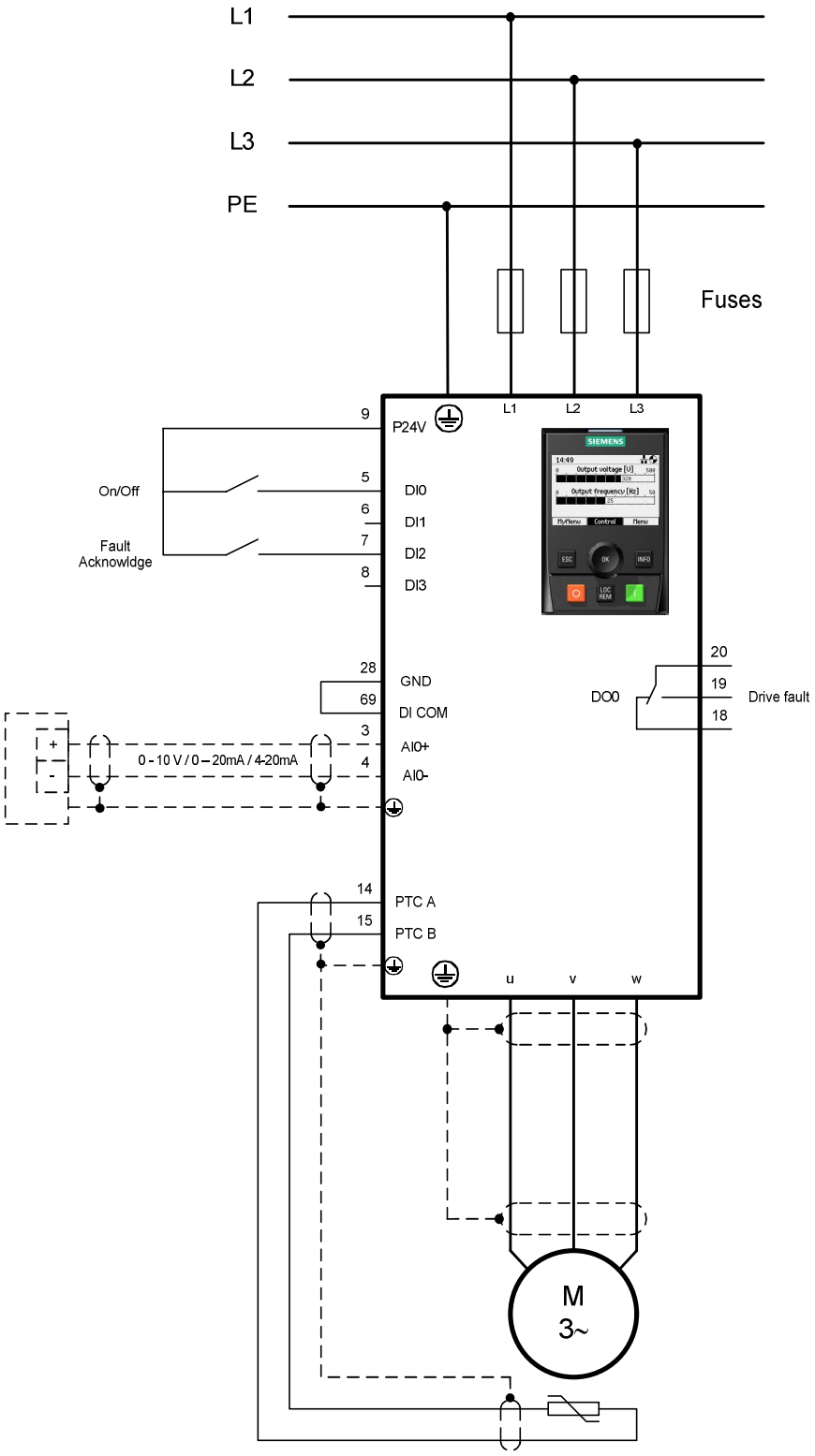

Fig. 2-1: Connection circuit diagram with SINAMICS G120 CU240B-2

CU240B-2:

The terminal assignment for the subsequent parameterization is as follows:

DI0 – On/Off
DI2 – Fault acknowledgement

AI0+/- -Connection for the pressure sensor

PTC A/B – Connection for the temperature sensor of the compressor motor
DO0 – Drive signal, fault

2.2 Control Unit CU240E-2

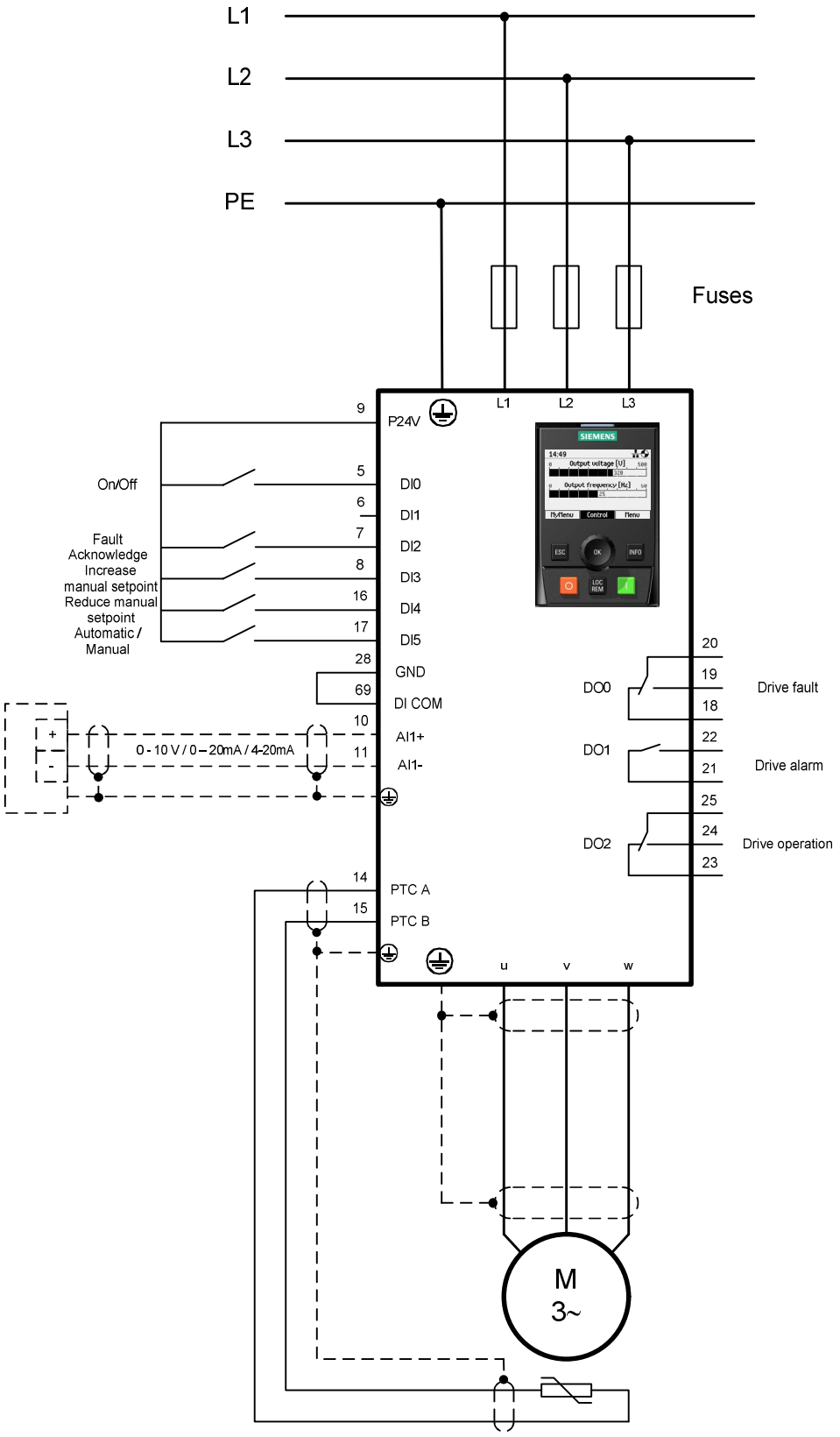

Fig. 2-2: Connection circuit diagram with SINAMICS G120 CU240E-2

CU240E-2:

The terminal assignment for the subsequent parameterization is as follows:

DI0 – On/Off

DI2 – fault acknowledgement

DI3 – Increases the setpoint (MOP) in manual operation

DI4 = Reduces the setpoint (MOP) in manual operation

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

AI1+/- - Connection for the pressure sensor

PTC A/B – Connection for the temperature sensor of the compressor motor

DO0 – Drive signal, fault

DO1 – Drive signal, alarm

DO2 – Drive signal, operation

2.3 Control Unit CU230P-2

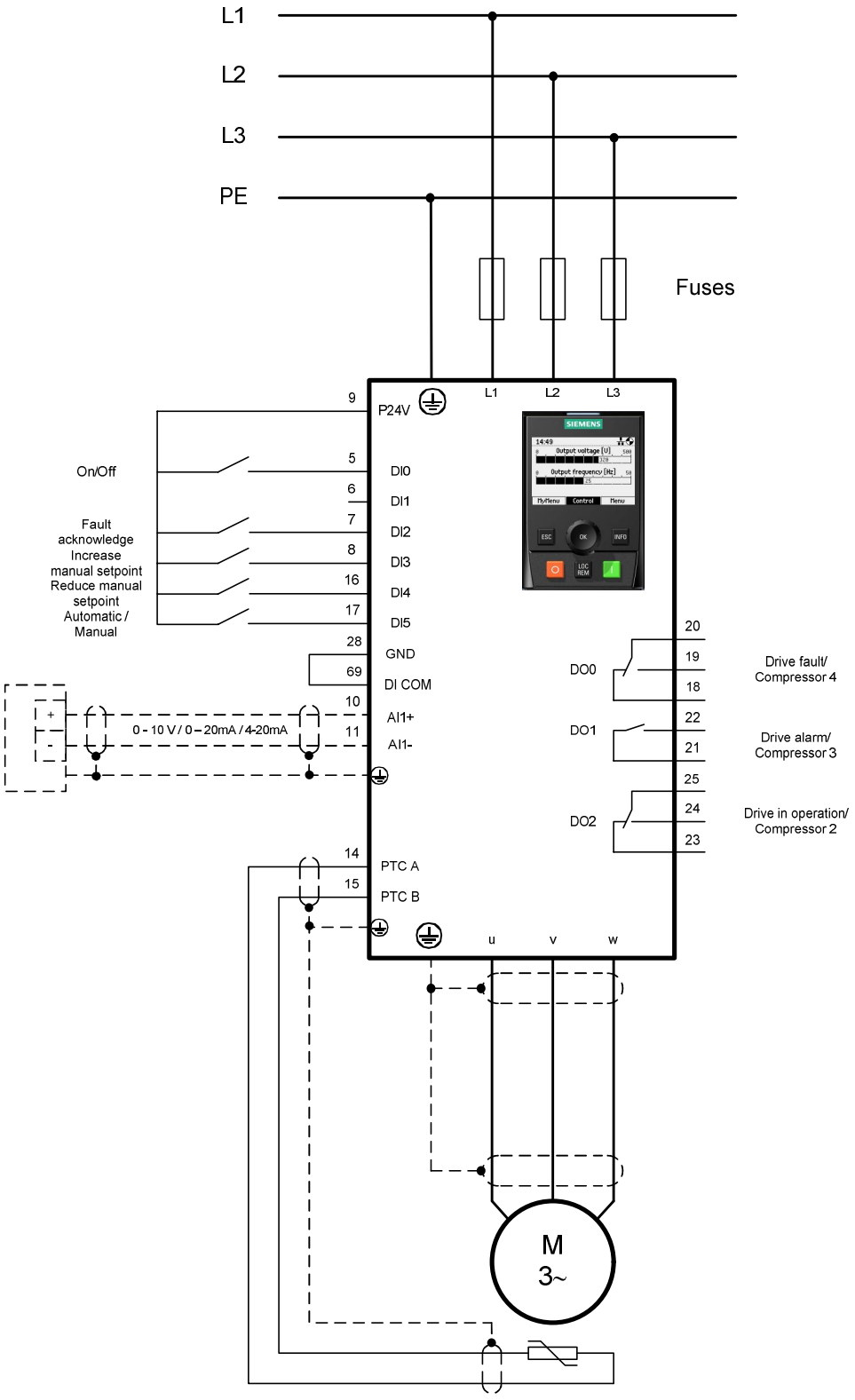

Fig. 2-3: Connection circuit diagram with SINAMICS G120 CU230P-2

CU230P-2:

The terminal assignment for the subsequent parameterization is as follows:

DI0 – On/Off

DI2 – fault acknowledgement

DI3 – Increases the setpoint (MOP) in manual operation

DI4 = Reduces the setpoint (MOP) in manual operation

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

AI1+/- - Connection for the pressure sensor

PTC A/B – Connection for the temperature sensor of the compressor motor

DO0 – Drive signal, fault / compressor 4 (with motor staging)

DO1 – Drive signal, alarm / compressor 3 (with motor staging)

DO2 – Drive signal, operation / compressor 2 (with motor staging)

3 Script functionality

- Check the CU module (CU240B-2, CU240E-2, CU230P-2) and SW Version (≥V4.4)
- Select between complete parameterization or subsequent setpoint change
- Factory setting
- Quick commissioning
- Motor temperature monitoring
- Enter the minimum speed
- Sensor selection 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 presetting necessary parameters for compressors (only CU230P-2)
- Select Hibernation mode, (CU230P-2), Energy saving mode (CU240B-2, CU240E-2) yes/no
- A fixed setpoint or two setpoints alternating using timer 1 and 2 (input in bar)
- BiCo wiring of the PID controller, the DI, DO
- Automatic/manual operation (only CU240E-2, CU230P-2)
- Execute the motor data identification in manual mode
- Save date to ROM

4 Description of the parameterization

4.1 Importing 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 righthand mouse key ⇒ Insert script folder

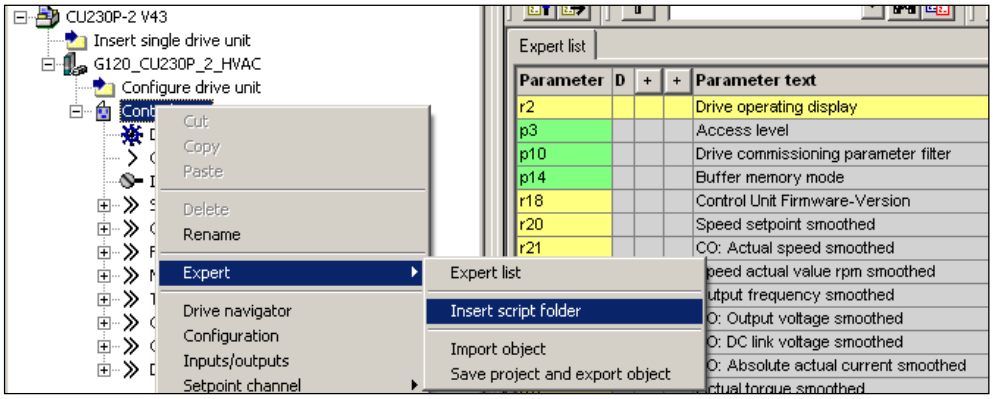

Fig. 4-1: Importing the script folder

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

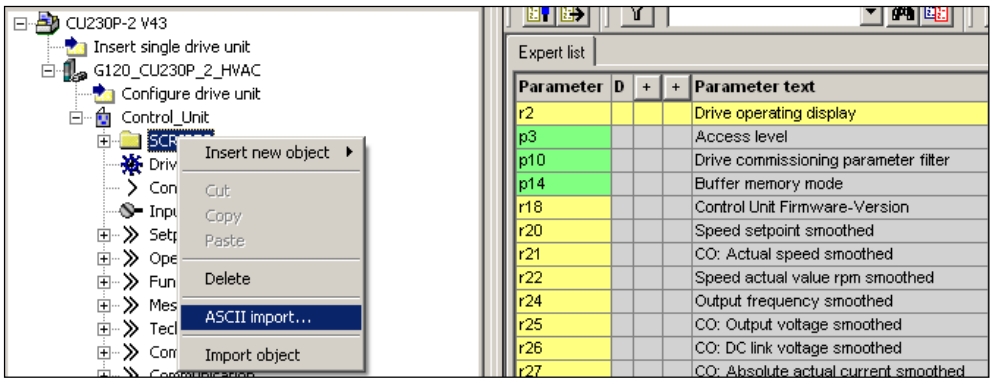

Fig. 4-2: Importing the script

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.

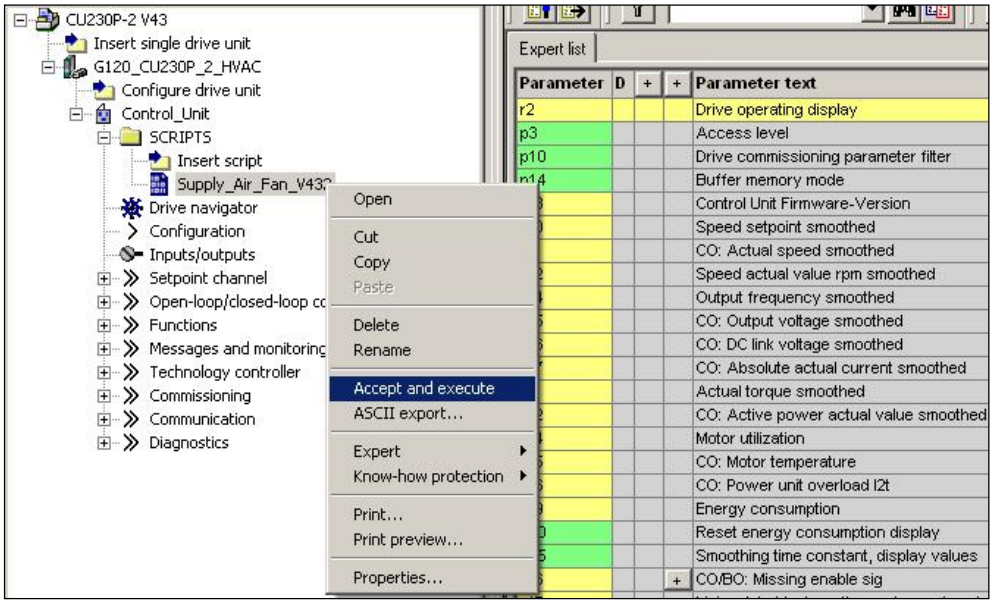

Fig. 4-3: Executing the script

The script is started by selecting the script using the righthand 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.

Note This script is only runnable in online mode, because a reset to factory setting and a motor commissioning are included.

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.

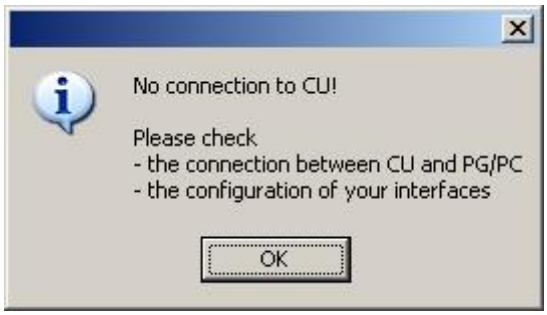

Fig. 4-4: Message no connection to CU

4.2.2 CU module interrogation

The script is only coordinated to the functionality of the CU230P, CU240B-2 and CU240E-2 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.

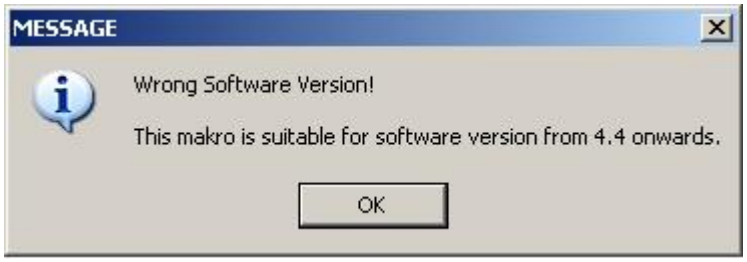

Fig. 4-6: Message, incorrect firmware version

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.

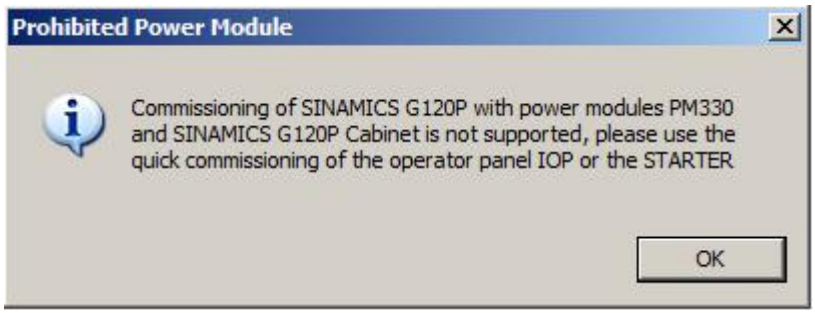

Fig. 4-7: Message, prohibited power module

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.

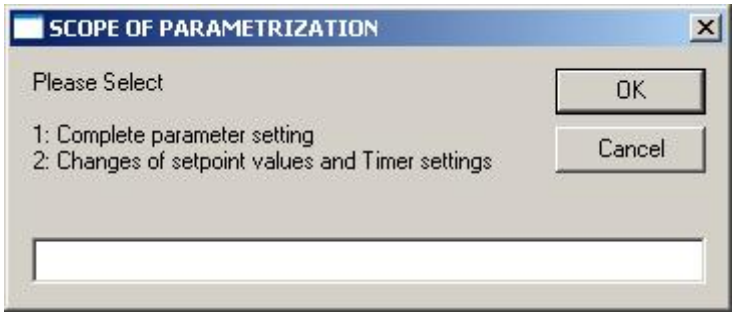

Fig. 4-8: Selection screen form, scope of parameterization

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.

Parameter	Value	Comment
p0015	12	Macro drive unit
p0096	0	Application class
p1110[0], [1]	1	Inhibit negative direction
p1030[0].4	1	Ramp-function generator always active
p1070[0]	0	Main setpoint

4.2.6 Quick commissioning

For the quick commissioning, a sensorless vector control is entered.

The user also has to select whether kW or hp values will be used in the application; 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 motor standard the power factor or the efficiency factor will be prompted. This completes the quick commissioning.

The Motor data identification is selected and becomes active with the first enable of the drive.

Parameter	Value	Comment
p0205	1	Load duty cycle with low overload
p0300[0]	1	Induction Motor
p0100	**0** **1** **2**	**IEC Motor (50Hz, SI Units)** **NEMA Motor (60Hz, US Units)** **NEMA Motor (60Hz, SI Units)**
p0304[0]	□□□□	**Input rated motor voltage**
p0305[0]	□□□□	**Input rated motor current**
p0307[0]	□□□□	**Input rated motor power**
p0308[0], **p0309[0]**	□□□□	**Rated motor power factor** **or rated efficiency**
p0310[0]	□□□□	**Input rated motor frequency**
p0311[0]	□□□□	**Input rated motor speed**
p1300[0]	20	Speed control encoderless
p3900[0]	3	Input rated motor freqency
p1900[0]	2	motor data identification

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 1 2	No sensor PTC 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 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.

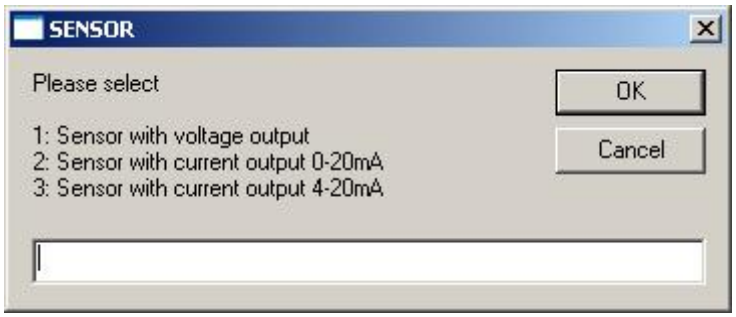

Fig. 4-11: Selection screen form, actual value sensor

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).

CU240B-2:

Sensor with voltage output

Parameter	Value	Comment
p0756[0]	0	Voltage input, unipolar (0 … 10V)
p0759[0]	**□□□□**	**Enter the max. output voltage**

Sensor with current output 0 … 20mA

Parameter	Value	Comment
p0756[0]	2	Current input, unipolar (0 … 20mA)

Sensor with current output 4 … 20mA

Parameter	Value	Comment
p0756[0]	3	Current input, unipolar (4 … 20mA)

CU240E-2, CU230P-2

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	Current 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[0]/[1]	Actual value from analogue input AI1

4.2.10 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
p2267	2 * max. pressure	Technology controller upper limit actual value
p2268	- 2 * max. pressure	Technology controller upper limit actual value

4.2.11 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**

4.2.12 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**

4.2.13 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.

4.2.14 Motor Staging (only CU230P-2)

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% of p2900	Switch-on threshold, Motor Staging
p2374	5.0	Delay time, Motor Staging
p2375	5.0	Delay time, Destaging
p2376	15% of 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)

4.2.15 Hibernation Mode (only CU230P-2)

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**

4.2.16 Energy saving mode (only CU240B-2, CU240E-2)

The Control Units CU240B-2 and CU240E-2 have no Hibernation mode. The Energy saving mode is realized with the free function blocks. The connection of the blocks is shown in chapter 6.

Parameter	Wert	Kommentar
p20236	r1114	LIM 1 input X
p20237	1	LIM 1 upper limit LU
p20238	=p1080/p2000	LIM 1 lower limit LL
p20242	5	LIM 1 run-time group
p20243	2	LIM 1 run sequence
p20030[0]	r20241	AND 0 input I0
p20030[1]	1	AND 0 input I1
p20030[2]	1	AND 0 input I2
p20030[3]	1	AND 0 input I3
p20032	5	AND 0 run-time group
p20033	3	AND 0 run sequence
p20228	r2273	LIM 0 input X
p20229	**□□□□**	**LIM 0 upper limit LU**
p20234	5	LIM 0 run-time group
p20235	4	LIM 0 run sequence
p20158	r20031	BI: PDE 0 input pulse I
p20159	**□□□□**	**PDE 0 pulse delay time in ms**
p20161	5	PDE 0 run-time group
p20162	5	PDE 0 run sequence
p20163	r20232	PDE 1 input pulse I
p20164	**□□□□**	**PDE 1 pulse delay time in ms**
p20166	5	PDE 1 run-time group
p20167	6	PDE 1 run sequence
p20188[0]	r20160	RSR 0 inputs, Set S
p20188[1]	r20165	RSR 0 inputs, Reset R
p20191	5	RSR 0 run-time group
p20192	7	RSR 0 run sequence
p20034[0]	r722.0	AND 1 input I0
p20034[1]	r20190	AND 1 input I1
p20034[2]	1	AND 1 input I2
p20034[3]	1	AND 1 input I3
p20036[0]	5	AND 1 run-time group
p20037[0]	8	AND 1 run sequence
p0840[0]	r20035	On/Off (OFF1

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 (only CU230P-2)

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	On/Off1
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)
p2103[0]	r722.2	DI2 - Fault acknowledgement
Only CU240E-2 and CU230P-2		
p810	r722.5	DI5 - CDS0/1 changeover
p840[1]	r722.0	DI0 - Drive On/Off

4.2.19 Manual mode (only CU240E-2 and CU230P-2)

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
p2103[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	r722.5	DI5 - CDS0/1 changeover
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 2, the common identifier of a pressure control and the already in p2901 existing identifier of the closed-loop control type.

Parameter	Value	Comment
p2901[0]	152	closed-loop pressure control

4.2.21 Setting the time and the date (only CU230P-2)

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.

A motor identification is activated for the first commissioning.

Now enable the drive in manual mod. You can also use a BOP or an IOP.

Fig. 4-14: Application of the script

When the motor data identification is successfully done, the drive parameters will be saved to ROM

5 Motor Staging circuit diagram

(Only for CU230P-2)

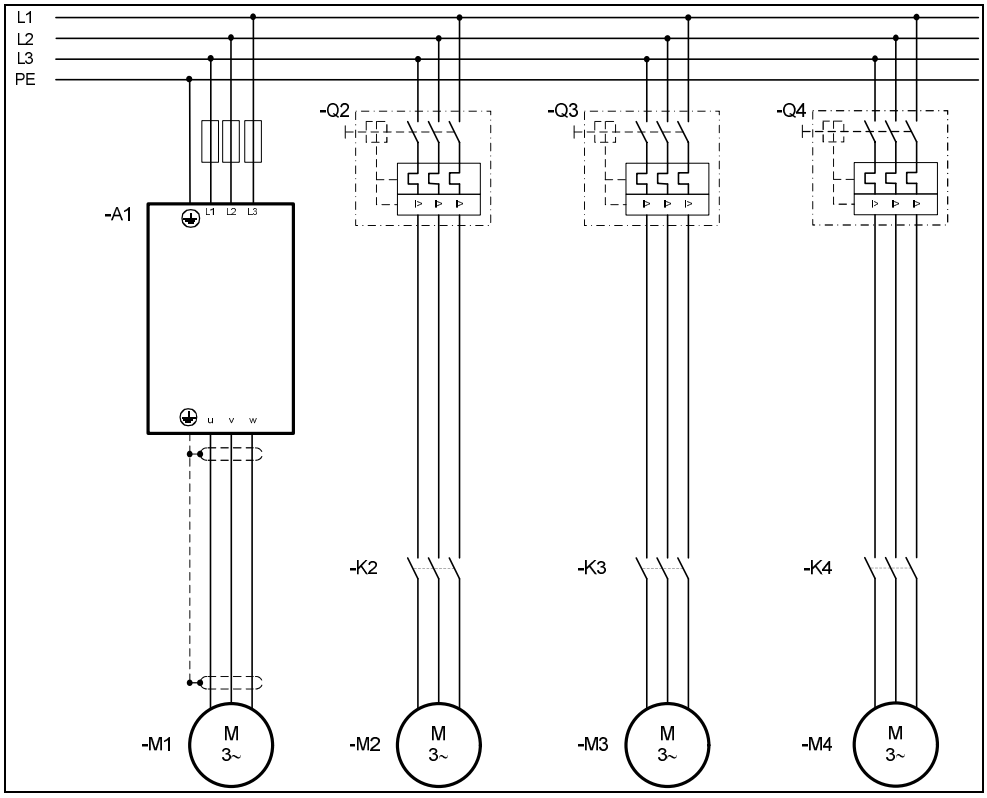

Fig. 5-1: Power wiring - inverter and fixed speed drives

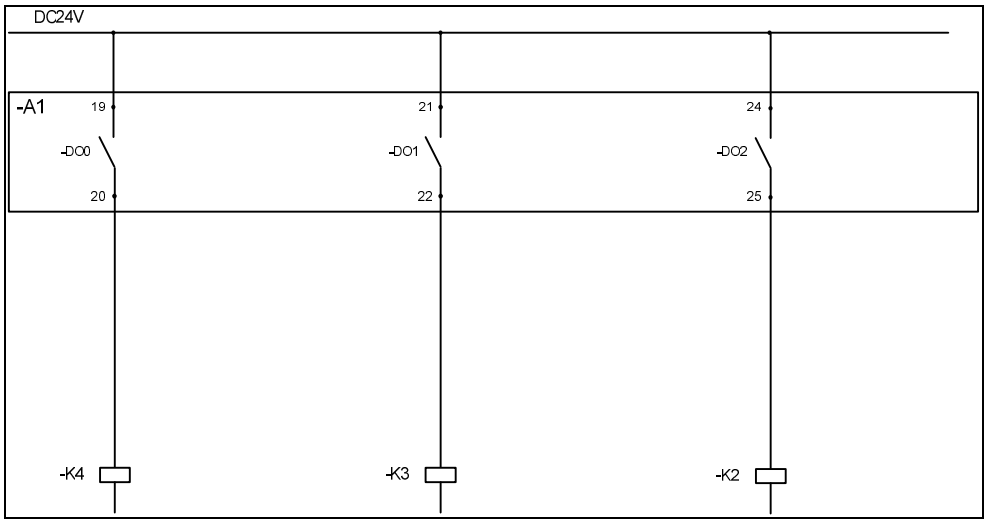

Fig. 5-2: Control wiring

6 Energy saving mode using function blocks

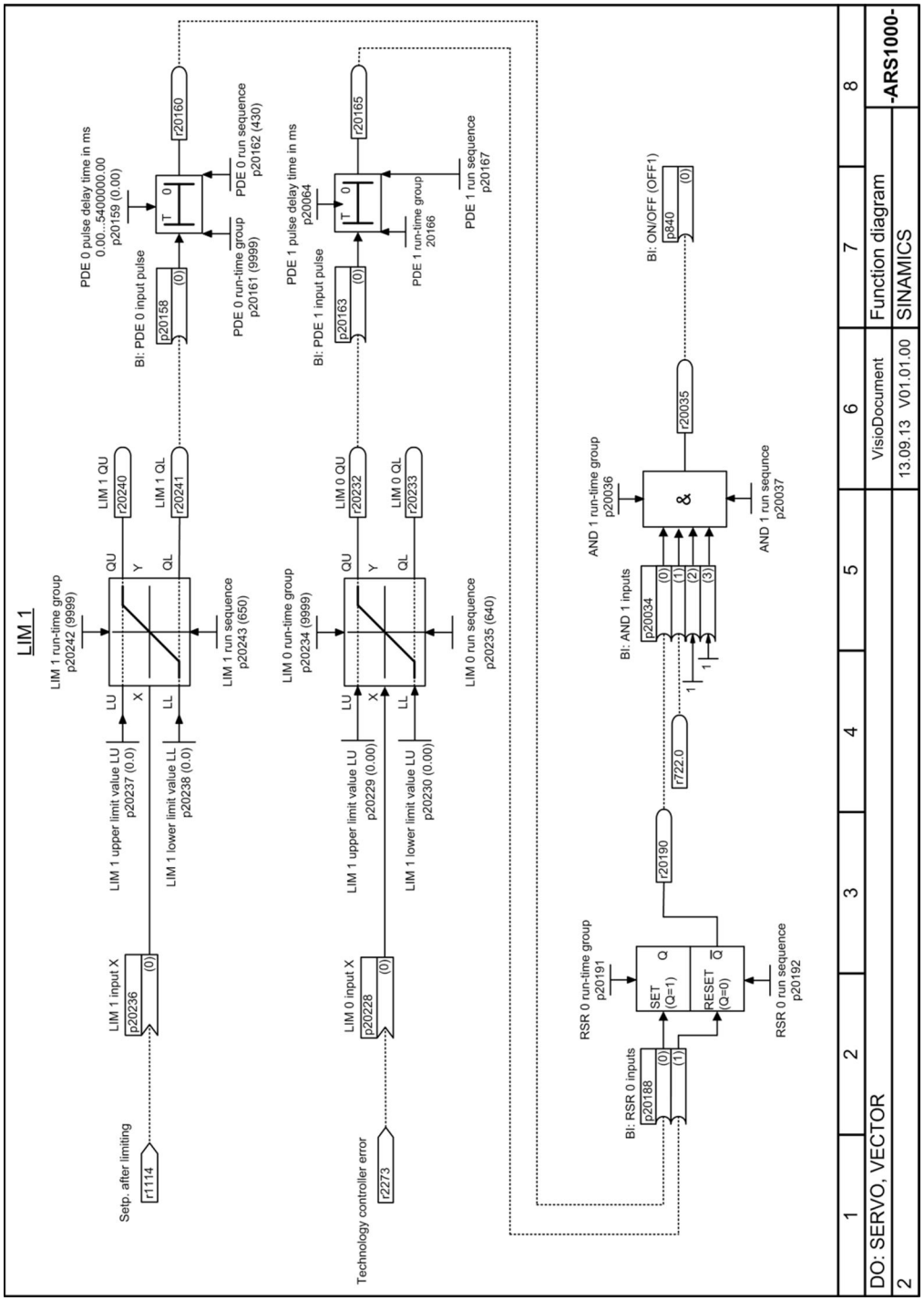

Fig. 6-1: Interconnection free function blocks

7 Contact

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8 History

Table 8-1

Version	Date	Modifications
V1.0	09/2013	First version
V1.1	06/2015	PM330 interrogation and tested for FW V4.7.3