BERG Kompressoren GmbH
Compressed Air Technology | Air Sepration

User Manual

Operation of the compressor controller

S7-1200

with a touch control panel

07.2019

TABLE OF CONTENTS

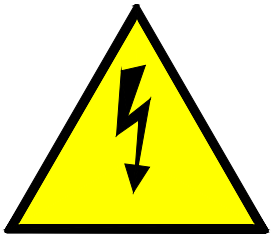
1. Important information 3
2. Structure of the control system 4
3. Algorithm of the compressor operation 7
   3.1 Operation mode according to CAL calendar 8
4. Operation of the controller 9
   4.1 Main screen....9
   4.2 Menu language 12
   4.3 Menu structure 12
   4.4 Introducing changes in the settings 17
   4.5 Diagrams and counters 18
   4.6 Access levels 19
   4.7 Record of events 19
   4.8 Maintenance procedures 22
   4.9 Communication in Modbus TCP protocol 22
   4.10 Ultra Speed function 26
   4.11 Changing the network settings 27

1. Important information

Please read this manual carefully and watch the equipment before its start-up.

Safety warnings

POWER SUPPLY: 400V/50Hz– danger of electrocution



Electrical equipment may only be operated by fully qualified personnel. This document is not intended for use by unqualified people.

The persons responsible for installation and operation of the equipment should ensure that they have met all the regulations, laws and rules and safety requirements required during installation and operation of electrical equipment.

Before installation, dismounting, connection or maintenance, always disconnect the equipment from power supply.

Use only the appropriate voltage to supply the equipment.

BERG Kompressoren GmbH. shall not be responsible for any consequences arising or resulting from the incorrect use of the equipment, changes in the control program of the controller operation and network attacks after connection to the LAN network.

2. Structure of the control system

The compressor controller consists of the PLC unit, analog extension modules and HMI touch control panel. It provides supervision of the compressor operation and introduction of changes in the parameter settings. The panel is equipped with the touch screen and four conventional keys, which is presented in Fig. 1.

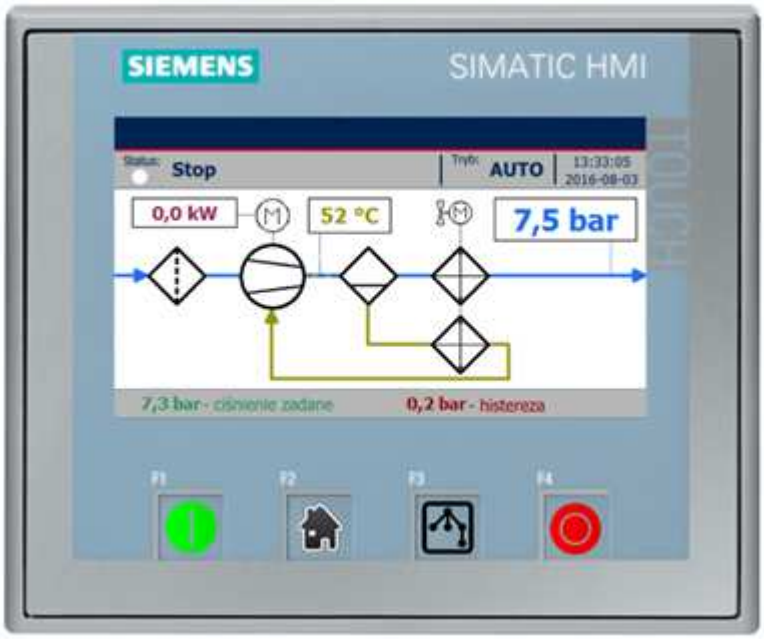


Fig. 1Arrangement of the screen elements.

Description of the functions of the conventional keys on the control panel are presented in Table 1.

Table 1 Functions of the conventional keys.

Icon	Number	Description	Function
	F1	Start	Activating the compressor in the AUTO mode. If all conditions are met, the compressor will be started.
	F2	Main	Calling the main screen
	F3	Menu	Calling the menu screen
	F4	Stop	After pressing this key in the AUTO mode, the compressor will be stopped. When the key is pressed and hold for two seconds in a mode other than AUTO, the compressor will be stopped and switched to AUTO mode.

The control system monitors the status of the compressor parameters by using sensors, transducers and protective devices that are listed in Table 2 and 3.The presence of the sensors in the system depends on the particular compressor configuration and can't exceeds the amount of three analogue sensors and eight digital sensors.

The control system is equipped with the 6 relay outputs monitored by the PLC controller. Each of them can be set to one of several functions that are presented in Table 3. A part of the outputs is closely related to the compressor configuration and its functions can not be changed. The relay outputs are switched off when the PLC is without power or is in STOP mode.

Table 2 List of analogue sensors of the control system.

Measured quantity	**Sensor type**	**Input signal to PLC**
Air pressure	0÷10V	obligatory
Oil temperature	PT100	
Oil pressure	0÷10V	optional
Water pressure		
Air temperature		
Water temperature		
Motor temperature		
Motor current		
Dew point temperature		

Table 3 List of digital sensors the control system.

Measured quantity	**Status while operating**
Suction sensor NC	Closed
Suction sensor NO	Open
Air filter NC	Closed
Air filter NO	Open
Oil filter NC	Closed
Oil filter NIO	Open
Power control	Closed
Confirmation of the softstart start up	Closed
Oil separator NC	Closed
Oil separator NO	Open
Remote control	Closed
Emergency STOP	Closed
Protection	Closed
Compressor motor protection	Closed
Fan motor protection	Closed

Table 4 Relay's outputs functions.

Name	ON State
Fault	The relay is switched on when the controller registers an event causing the compressor to stop.
No fault	The relay is switched on when the controller registers no event causing the compressor to stop.
Load solenoid	The relay is switched on when the compressor is to discharge.
Ready	The relay is switched on when the compressor has been activated.
Heater	The relay is switched on when the compressor is not running and when the oil temperature is lower than the temperature set point. The relay is switched off when the temperature rises by the set point value above the heater activation temperature or when the compressor starts.
Dryer	The relay is switched on before the compressor starts, and the compressor itself is waiting to start for a preset dryer start time. The relay is switched off after a preset time since switching the compressor off.
Operation	The relay is switched on when the compressor is running.
Service	The relay is switched on when it is necessary for the compressor to undergo servicing.
Compression	The relay is switched on when the compressor is compressing.
Slave compressor	The relay is switched on when the compressor is running, and the air pressure is lower than the set threshold. The relay is switched off when the air pressure is higher than the set threshold or when the compressor switches off.
Condensate drain	The relay is switched on at a certain time for a certain time. The time between activations is counted only when the compressor is running.
Softstart start	The relay is switched on when the compressor is to run.
Star contactor	The relay is switched on when the compressor is starting.
Line contactor	The relay is switched on when the compressor is to run.
Delta contactor	The relay is switched on after the compressor has started.
Fan	The relay is switched on after the compressor has started, and switched off when the compressor is not running.
Temperature fan	The relay is switched on when the compressor is running and the oil temperature is higher than the set switch-on threshold. The relay is switched off when the oil temperature is lower than the switch-off temperature, or when the compressor is not running.
Always ON	The relay is switched on when the PLC is operating in RUN mode.
Always OFF	The relay is never switched on.

3. Algorithm of the compressor operation

The compressor may be inactive (the compressor is not started when pressure drops below the switching on pressure threshold)or active (the compressor is started when pressure drops below the switching on pressure threshold). Activation of the compressor is carried out in different ways depending on the selected operation mode. Below there are presented the available operation modes including the ways of the compressor activation:

- AUTOmode – the compressor activation requires pressing the START key (active only in this mode)on the control panel (pressing the STOP key will deactivate the compressor)
- REM mode – the signal for the compressor activation is closing the external potential-free contact connected to the compressor terminal block (the contact opening results in the compressor deactivation)
- CAL mode – the compressor activation and deactivation occurs according to the setting calendar
- NET mode - the compressor activation and deactivation occurs according to the commands sent in the Modbus TCP protocol

The signal that causes the compressor to start and its loading is the signal from B3 transducer. Fig. 2 presents an example diagram of pressure changes in time with indicated states of the compressor operation.

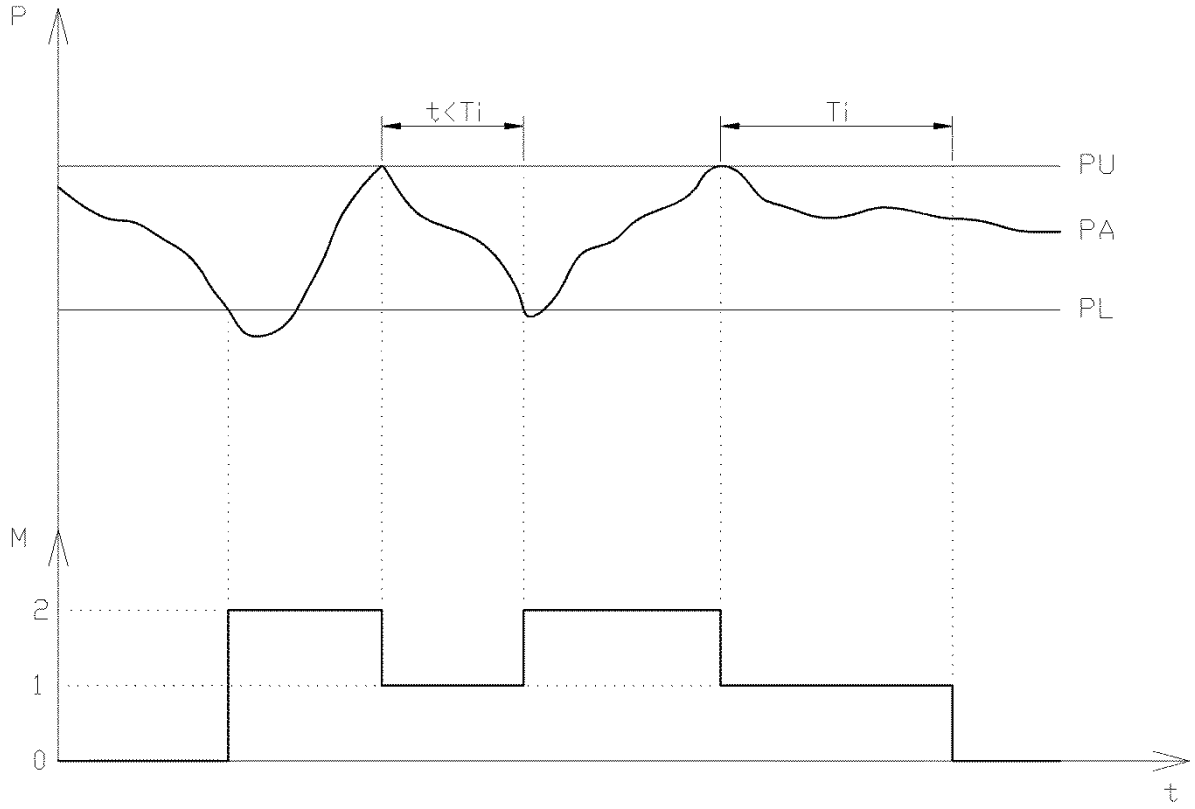


Fig. 2 Algorithm of the compressor operation.

The above diagram assumes that the compressor is active all the time. If the present pressure (PA) drops below the switching on pressure threshold (PL),the compressor will start and change from the stop state (0) to the compression state (2).

This state will be continued until pressure reaches the switching off pressure (PU). Then the compressor will switch to the idle running operation status(1). It means that the compressor is running but it does not compress. The next compression will occur when pressure drops below the switching on pressure. If that does not occur for the set idle running time (Ti), the compressor will stop and the cycle will be repeated.

Holding the STOP key pressed (in an operation mode other than AUTO) for 2 seconds results in the compressor deactivation and switching to the AUTO mode.

When an event resulting in the machine stop occurs, the compressor changes its operation mode to AUTO.It is necessary to confirm the events occurred and activate again the set operation mode.

It is possible to switch on the Autorestart function in the AUTO mode. It means that when the controller is switched on, the compressor is activated automatically.

In the case of controlling the operation of the compressor equipped with the variable frequency drive, a user has the possibility of setting the set pressure and hysteresis. The internal PID controller changes output frequency of the variable frequency drive so that to keep the set pressure. The switching off pressure is understood as the sum of the set pressure and hysteresis, and the switching on pressure is the difference between the set pressure and hysteresis.

3.1 Operation mode according to CAL calendar

In the operation mode according to the calendar, a user has the possibility of configuring the compressor activation in five time intervals, individually for each day of the week.0 presents an example configuration of the calendar for one day of the week.

Example configuration in CAL mode.

Mo	0:00	✗	**6:00**	✓	**13:45**	✗	**15:00**	✓	**22:45**	✗	23:59

The above example shows that the compressor will be active in hours from 6:00 to 13:45 and from 15:00 to 22:45 on each Monday. Time can be set with accuracy up to the minute in each of the fields in bold format. The controller has the algorithm implemented to prevent entry of false settings. Therefore, the settings entered may be automatically changed to the correct ones. The end of one interval is the beginning of the next one. The compressor activation in a particular time interval involves in clicking the key between the hours when the compressor is to be active. The signal to apply load to the compressor is the present pressure, similarly to the operation in the AUTO mode.

On the occurrence of any event resulting in the compressor stopping, the compressor is switched to the AUTO mode, but the calendar settings are not cancelled.

4. Operation of the controller

After switching on the power supply, the PLC controller and HMI control panel are started.The PLC unit switches to the operation mode after approx. 5 seconds. However, the compressor start-up is possible after initialization of the control panel, which takes approx. 30 seconds.

Operation of the compressor controller involves in moving between different screens, where you can, among other things,:

- read present values of the compressor parameters
- watch changes of the compressor parameters on the diagrams
- modify different types of the settings
- view the lists of events
- get the present readings from the running hours counter, energy counter etc.

4.1 Main screen

The main screen is displayed as the first one after initialization of the control panel. You can always return to it by pressing the home icon key. The view of the main screen is presented in Fig. 3. A view of elements on this screen is changed dynamically depending on the compressor status.

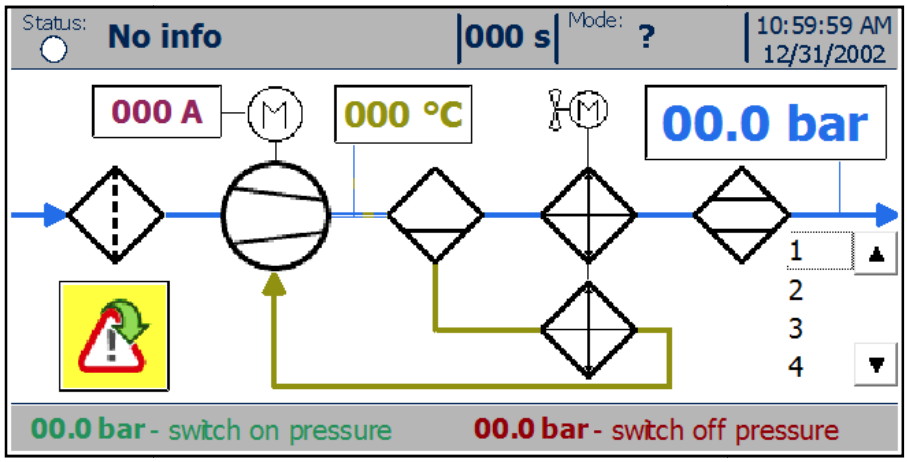


Fig. 3View of the main screen.

The main screen consists of the status bar and graphic field presenting the schematic operation of the compressor. The main elements of the status bar are:

- The status LED changing colour depending on the compressor status (description of the LED colours is included in Table 5)
- The status text changing according to the compressor status (possible status texts are presented in Table 6)
- The operation mode defining a source of the signal activating the compressor

- The system date and time (the clock backed up by the super capacitor; check the controller indications when it is not supplied for several days)
- The present settings of the compressor switching on and off pressure,

The graphic field consists of:

- The equipment symbols, whose meaning is presented in Table 7
- The multicolour lines and arrows connecting the equipment from individual circuits (of air, oil, drive systems)and indicating the flow direction
- The bar graph of output air pressure
- The fields with present values of the compressor parameters

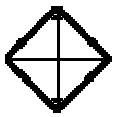
Table 5 State of the status LED.

LED colour	**Description of the compressor status**
White	The compressor is not running and there are no events.
Green	The compressor is running and there are no events.
White and orange	The compressor is not running and there are warning events.
Green and orange	The compressor is running and there are warning events.
Red	The compressor is not running and there are errors (with warnings possible at the same time).

Table 6 Status texts.

Text	**Explanation**
Stop	The compressor is stopped
Automatic stop	The compressor is in the ready status (it will start when the present pressure is lower than the switching on pressure)
Delayed start	The compressor will be started when the set time passes
Start	The compressor is started
Compression	The compressor is running and compressing
Idle running	The compressor is running, but it is not compressing
Delayed stop	The compressor will be stopped when the set time passes
Failure	Active event causing the compressor stop
Active sensor Vs	The compressor is in unloading status.A pressure drop at the suction side is awaited.
Dryer start	The compressor is waiting for the dryer readiness. It will start automatically after the set time.
Maximum number of starts	The maximum number of the compressor starts per hour has been reached.The compressor will be started automatically when the number of starts per hour is lower than the permissible one.
Auto restart	Auto restart initiated.

Table 7 Equipment icons in the graphic field.

Icon	Symbol description
	Symbol of the screw unit in different forms: • Presented – the compressor stopped • Centre filled partially – idle running or start • Centre filled totally–compression • Exclamation mark in the central field – an event causing the compressor stop occurred • Hourglass in the central field – start-up is awaited • Number in the central field – set rotation (expressed in %; only for the compressors equipped with the variable frequency drive)
	The driving motor in different forms: • Presented – the compressor is not started • Filled with green – the compressor is started • Filled with red –an event concerning the driving motor occurred
	Fan motor in different forms: • Presented – the fan is not started • Filled with green – the fan is started • Filled with red – an event concerning the fan motor occurred • No symbol – no fan motor in the system
	Air filter at the suction side in different forms: • Presented – air filter in a good condition • With a red centre line - dirty air filter
	Air dryer: • Presented – present in the system, but it is not switched on • Green contour – the dryer switched on • No symbol – no dryer in the system
	Air – oil separator.
	Air or oil cooler

The compressor parameters currently displayed change their highlight colour to red when permissible values are exceeded.Highlighting of the particular value results in recording an event on the list of active events. The particular parameter value will be highlighted on the main screen until an event is accepted.

Displaying of some elements on the main screen and menus may depend on the current status of the compressor, operation mode and other factors.

4.2 Menu language

The operator panel supports four menu languages: Polish, English, Russian and German. To change the language, press the flag symbol placed in the upper left corner of the menu screen. Switching is sequential and cyclical. Changing the language also changes the flag symbol.

4.3 Menu structure

The controller menu has a sequential tree design, which means that from a higher level you can access a lower, more detailed level. The presence of some screens depends on the configuration of the compressor.

List of all parameters is included in

Screen	Parameter	Subpage	Name	Unit	Type[1]	Credentials group[2]
Menu	1	1	Status		L	
Menu	2	1	Settings		L	
Menu	3	1	Events		L	
Menu	4	1	Counters		L	
Menu	5	1	Charts		L	
Menu	6	2	Users		L	
Menu	7	2	Information		L	
1	1	1	Status		O	
1	2	1	Mode		O	
1	3	1	Air pressure	bar	O	
1	4	1	Oil temperature	°C	O	
1	5	1	Inverter status		L	
1-5	1	1	Power consumption	kW	O	
1-5	2	1	Current drawn	A	O	
1-5	3	1	Current frequency	Hz	O	
1-5	4	1	Information from inverter		O	
2	1	1	Basic parameters		L	
2	2	1	CAL calendar mode		L	
2	3	1	Systems settings		L	
2	4	1	Service tasks		L	
2	5	1	Energy counters		L	
2	6	2	Admissible parameter values		L	
2	7	2	Time values and delays		L	
2	8	2	Sensor scaling		L	
2	9	2	PLC settings		L	
2-1	1	1	Switch-on pressure[3] Set pressure[4]	bar	O/Z	4[5]

2-1	2	1	Switch-off pressure[3] Hysteresis[4]	bar	O/Z	4[5]
2-1	3	1	Idling time	s	O/Z	4[5]
2-1	4	1	Operation mode		O/Z	4[5]
2-1	5	1	Autorestart delay	s	O/Z	4[5]
2-1	6	2	Adaptive idling		O/Z	4[5]
2-1	7	2	Ultra Speed feature		O/Z	4[5]
2-2		1	Calendar		O/Z	5
2-3	1	1	Date and time to set		O/Z	6
2-3	2	1	Screen saver		O/Z	6
2-3	3	1	OS shut-down		O/Z	6
2-3	4	1	Reading factory parameters		O/Z	6
2-3	5	1	Basic settings lock		O/Z	6
2-4	1	1	Next service at mileage		O/Z	28
2-4	1	1	Next service not later than		O/Z	28
2-4	1	1	Clear the event list		O/Z	28
2-4	1	1	Save the factory parameters		O/Z	28
2-4	1	1	Test the controller outputs		O/Z	28
2-5	1	1	Nominal capacity	m³/h	O/Z	27
2-5	2	1	Rated power	kW	O/Z	27
2-5	3	1	Rated voltage	V	O/Z	27
2-6	1	1	Maximum oil temperature	°C	O/Z	26
2-6	2	1	Minimum oil temperature	°C	O/Z	26
2-6	3	1	Maximum air pressure	bar	O/Z	26
2-6	4	1	Maximum switch-off pressure setting	bar	O/Z	26
2-6	5	1	Maximum number of starts per hour	1/h	O/Z	26
2-6	6	2	Maximum motor current	A	O/Z	26
2-6	6	2	Maximum motor temperature	°C	O/Z	26
2-6	6	2	Maximum air temperature	°C	O/Z	26
2-6	6	2	Maximum pressure drop in the separator	bar	O/Z	26
2-6	7	2	Unloading end pressure	bar	O/Z	26
2-7	1	1	Duration of start-up	s	O/Z	25
2-7	2	1	Switch-off delay after pressing the stop button	s	O/Z	25
2-7	3	1	Restart delay	s	O/Z	25
2-7	4	1	Minimum idle time	s	O/Z	25
2-8	1	1	Air pressure – minimum	bar	O/Z	24
2-8	1	1	Air pressure – maximum	bar	O/Z	24
2-8	1	1	Air pressure – boost	%	O/Z	24
2-8	1	1	Air pressure – offset	%	O/Z	24
2-8	2	1	Oil temperature – boost	%	O/Z	24
2-8	2	1	Oil temperature – offset	%	O/Z	24
2-8	3	1	Parameter[6] – minimum		O/Z	24
2-8	3	1	Parameter[6] – maximum		O/Z	24
2-8	3	1	Parameter[6] – boost	%	O/Z	24
2-8	3	1	Parameter[6] – offset	%	O/Z	24
2-9	1	1	Basic PLC settings		L	
2-9	2	1	Analogue inputs features		L	

2-9	3	1	Digital inputs features		L	
2-9	4	1	Digital outputs features		L	
2-9	5	1	Digital outputs parameters		L	
2-9	6	2	Modbus TCP settings		L	
2-9	7	2	IP Setting		L	
2-9	8	2	Inverter settings		L	
2-9-1	1	1	Compressor type		O/Z	23
2-9-1	2	1	Controller type		O/Z	23
2-9-1	3	1	Time lock activation		O/Z	23
2-9-2	1	1	Analogue input feature		O/Z	22
2-9-3	1	1	Digital input feature		O/Z	22
2-9-3	2	1	Digital input feature		O/Z	22
2-9-3	3	1	Digital input feature		O/Z	22
2-9-3	4	1	Digital input feature		O/Z	22
2-9-3	5	1	Digital input feature		O/Z	22
2-9-3	6	2	Digital input feature		O/Z	22
2-9-3	7	2	Digital input feature		O/Z	22
2-9-3	8	2	Digital input feature		O/Z	22
2-9-4	1	1	Digital output feature		O/Z	21
2-9-4	2	1	Digital output feature		O/Z	21
2-9-4	3	1	Digital output feature		O/Z	21
2-9-4	4	1	Digital output feature		O/Z	21
2-9-4	5	1	Digital output feature		O/Z	21
2-9-4	6	2	Digital output feature		O/Z	21
2-9-5	1	1	Fan switch-on temperature	°C	O/Z	20
2-9-5	2	1	Fan switch-off temperature	°C	O/Z	20
2-9-5	3	1	Time between condensate drain starts	m	O/Z	20
2-9-5	4	1	Condensate drain switch-on time	s	O/Z	20
2-9-5	5	1	Slave compressor switch-on pressure	bar	O/Z	20
2-9-5	6	2	Slave compressor switch-off pressure	bar	O/Z	20
2-9-5	7	2	Dryer start time	s	O/Z	20
2-9-5	8	2	Dryer stop time	s	O/Z	20
2-9-5	9	2	Heater switch-on temperature	°C	O/Z	20
2-9-5	10	2	Heater hysteresis	°C	O/Z	20
2-9-6	1	1	Sharing registers via Modbus TCP		O/Z	7
2-9-6	2	1	Communication port number		O/Z	7
2-9-6	3	1	Communication PIN		O/Z	7
2-9-6	4	1	Control level in NET mode		O/Z	7
2-9-7	1	1	Network settings of the PLC (IP, mask, gateway)		O/Z	8
2-9-8	1	1	Inverter address		O/Z	19
2-9-8	2	1	Base frequency		O/Z	19
2-9-8	3	1	Maximum communication time		O/Z	19
2-9-8	4	1	PID controller settings		L	
2-9-8	5	1	PID Ultra Speed controller settings		L	
2-9-8-4	1	1	Controller operating mode		O	
2-9-8-4	2	1	Status code	hex	O	
2-9-8-4	3	1	Boost		O/Z	19

2-9-8-4	4	1	Integration constant	s	O/Z	19
2-9-8-4	5	1	Differentiation constant	s	O/Z	19
2-9-8-5	1	1	Controller operating mode		O	
2-9-8-5	2	1	Status code	hex	O	
2-9-8-5	3	1	Boost		O/Z	19
2-9-8-5	4	1	Integration constant	s	O/Z	19
2-9-8-5	5	1	Differentiation constant	s	O/Z	19
3		1	Active events		O/Z	
3		2	Past events		O	
3		3	Controller status		O	
4	1	1	Running time		L	
4	2	1	Service tasks		L	
4	3	1	Energy consumption		L	
4	4	1	Other		L	
4	5	1	Time Lock		L	
4-1	1	1	Compressor operation time	h + m	O/Z	18
4-1	2	1	Compressor operation time under load	h + m	O/Z	18
4-1	3	1	PLC runtime	h + m	O/Z	18
4-1	4	1	Inverter runtime	h	O	
4-2	1	1	No. of operation hours until next service	h	O	
4-2	2	1	No. of days until next inspection	d	O	
4-3	1	1	Energy consumption	kWh	O	
4-3	2	1	Energy consumption under load	kWh	O	
4-3	3	1	Amount of air produced	m^3/h	O	
4-3	4	1	Average unit efficiency	kWh/(m^3/min)	O	
4-3	5	1	Instantaneous efficiency	kWh/(m^3/min)	O	
4-3	6	2	Energy saved	kWh	O	
4-3	7	2	Carbon dioxide emissions reduction	kg	O	
4-3	8	2	Trees saved		O	
4-4	1	1	Load factor	%	O	
4-4	2	1	No. of starts in the last hour		O/Z	18
4-4	3	1	No. of compressor starts		O/Z	18
4-4	4	1	No. of load solenoid switchings		O/Z	18
4-5	1	1	Time lock interval		O/Z	18
4-5	2	1	Lock activation at		O	
4-5	3	1	Request Code		O	
4-5	4	1	Unlock Password		O/Z	
5		1	Air pressure chart		O	
5		2	Oil temperature chart		O	
5		3	Motor power chart		O	
5		4	Revolutions chart		O	
6		1	Users		O/Z	
7		1	Information[6]		O	
7	1	2^6	Firmware version		O	
7	2	2^9	Build date		O	

Remarks:
[1] Designations: O – read, Z – save, L – link.
[2] Summary of logging data for parameters which can be changed by the user is given in Tab.8.
[3] Visible when VSD is not selected in parameter 1 on screen 2-9-1.
[4] Visible when VSD is selected in parameter 1 on screen 2-9-1.
[3] Credentials required when V is selected in parameter 5 on screen 2-3.
[5] Type of value depends on the parameter 1 on screen 2-9-2.
[6] The screen is displayed when the type of controller in parameter 2 on screen 2-9-1 is set to Brand. Otherwise, the following subpages move.

The structure of all screens in menu is based on one pattern that is presented in Fig. 4. Each screen consists of the following elements:

- The present menu level or the key with a flag icon of the country, whose language is used for menus(being displayed in the top left corner; language change by pressing the key)
- The header describing the contents of the particular screen
- The Up arrow to activate the previous screen of the particular menu level or to go a higher level in the menu
- The Down arrow to activate the next screen of the particular menu level
- The number on white background to call the lower menu level
- The content of the particular screen that may include e.g. diagrams, selection lists, fields with parameter values etc.

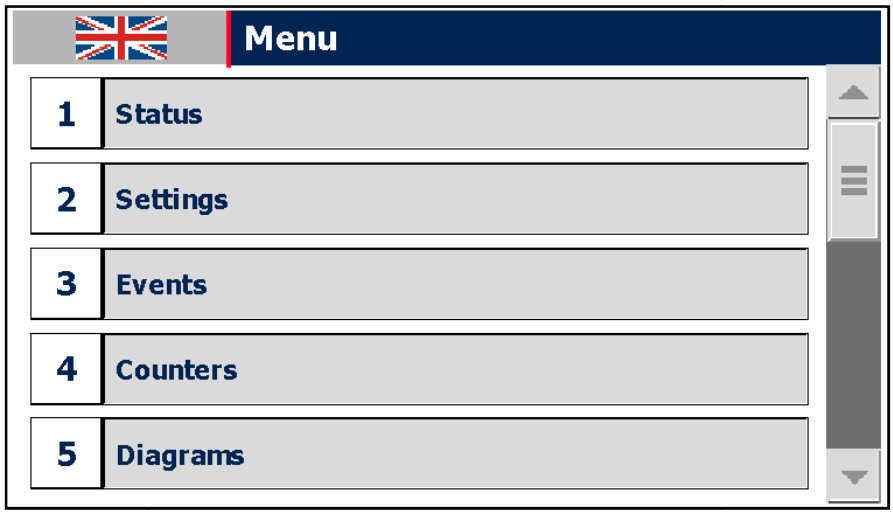


Fig. 4 View of the menu screen.

4.4 Introducing changes in the settings

To introduce changes in the settings, you must call the screen, where the parameter searched for is located. Then click the element you want to edit. Depending on a type of the element edited, you must select text/graphics from the drop-down list or enter a value with the numeric keypad presented in Fig. 6. Fig. 5 presents the screen of basic settings including the most important parameters.

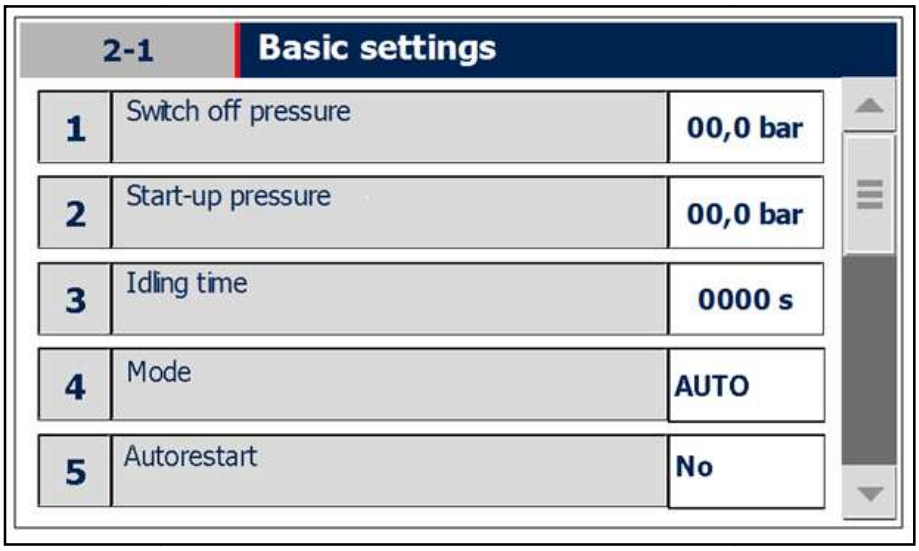


Fig. 5 Screen of basic settings.

Fig. 6 Numeric keypad for introducing the settings.

4.5 Diagrams and counters

On the control panel you can monitor changes of the compressor parameter values in time.Viewing is carried out by means of the diagrams that make it possible to increase, decrease, scroll and stop the time scope displayed by using the keys located on the left side of the diagram. The parameters resulting from the calculations carried out by the PLC controller are indicated with the broken line. Therefore, they may differ from the real values. Power supply disconnection resets the memory of the history recorded.

The controller is also equipped with different types of counters as follows:

- Running time and load running time counters
- Controller working time counter
- Energy counter
- Time to next service counters (information function – the detailed list of service operations is included in the mechanical part of the operation and maintenance manual)
- Number of the compressor and load solenoid starts,
- Amount of air produced.

The amount and type of counters may vary depending on the configuration of the compressor and software.

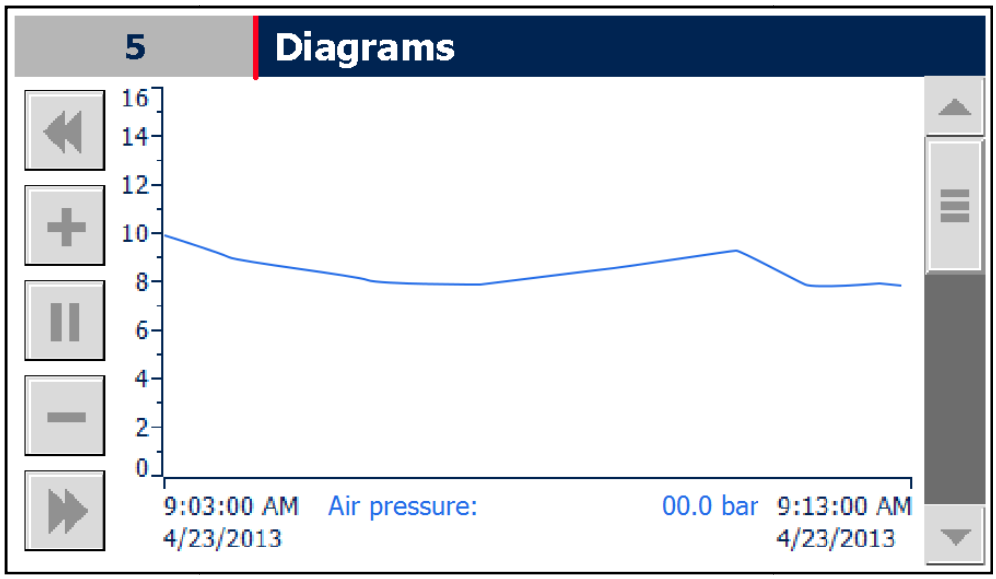


Fig. 7 View of the diagram screen.

4.6 Access levels

It may be required to log at the defined access level to get an access to edition of some parameters. Logging may be performed by the selection of the user management screen or by the dialog window appearing when the parameter selected is edited. To log, you need the following:

- User name – connected with an authorisation scope
- Password – necessary to authorise logging process

Table 8. User names and passwords are given to the authorised persons according to the needs.

Credentials group	**Login**	**Password**
9	u9	429008
8	u8	541681
7	u7	878129
6	u6	419654
5	u5	662103
4	u4	345403
Remarks: Credentials group marked as 9 is used to manage users from the screen 6.		

4.7 Record of events

The controller records many events that are saved together with event occurrence time in the memory of the control panel.If a number of events is higher than the available memory, part of them is erased to make space for new records. Moreover, the controller displays currently active events.To view records, use the list of events screen that is shown in Fig. 8.

When an event occurs, the status LED changes their colour in accordance with the Tab. 5.To identify an event occurred, go to the screen of active events by entering the menu and clicking the key number 3 described as the event or by clicking events icons on the main screen.

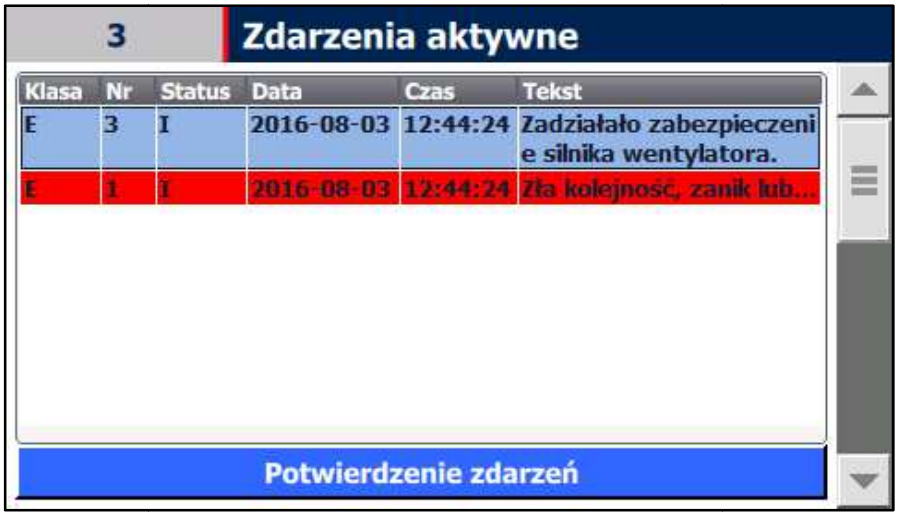


Fig. 8 View of the list of events screen.

Texts on the list of active events remain visible until a user confirms reading of events with the key located under the list. Confirmation of events is possible when the cause of the particular event is eliminated.

Each event has the defined structure that is presented in Table 9. The message elements are as follows:

- The date of an event occurrence
- The time of an event occurrence
- The status defining the present event status (I – active event; IO – historic event)
- The code defining unambiguously an event
- The class defining an event type (E – an event causing the compressor stop; A – warning event)
- The message content describing an event

Table 9 Structure of an alarm message.

Class	Code	Status	Data	Time	Content
E	5	IO	2016-06-01	12:00:00	Too low oil pressure

Table 10 presents all events recorded by the compressor controller.

Table 10 Events recorded by the controller.

Code	Class	Content
1	E	Incorrect sequence, loss or imbalance of power.
2	E	Compressor motor protection tripped.
3	E	Fan motor protection tripped.
4	E	Protection tripped.
5	E	Emergency button tripped.
6	E	PLC fault.
7	E	No connection between the HMI panel and the PLC.
8	E	Retentive memory lost. Restored to factory parameters. Check and adjust all the controller parameters.
9	E	Contaminated oil separator.
10	E	Contaminated oil filter.
11	E	Compressor failed to start within the time specified.
12	E	Inverter fault: *name and number of the fault in hex.*
13	E	Inverter safety circuit tripped.
14	E	No communication with inverter.
15	E	Error in communication with the inverter: *number in hex*.
16	E	The inverter is not ready for operation.
17	E	Oil temperature too high.
18	E	Air pressure too high.
19	E	Oil pressure too high.
20	E	Motor current too high.
21	E	Motor temperature too high.
22	E	Pressure drop in the separator too high.
23	E	Compressor locked. Please enter the unlock code.
49	A	Air filter contaminated.
50	A	Compressor starting stopped because of the ongoing load shedding.
51	A	The maximum number of compressor starts per hour has been exceeded.
52	A	Compressor service to be performed.
53	A	Web server error.
54	A	Real-time clock settings lost.
55	A	PID controller error. Error code: *number in hex*.
56	A	PID Ultra Speed controller error. Error code: *number in hex*.
57	A	Oil temperature too low.
58	A	Air temperature too high.
59	A	Controller outputs testing enabled.
81	S	Last PLC shut-down: *time and date.* Current PLC switch-on: *time and date.*Number of PLC starts: *number.*

4.8 Maintenance procedures

The controller informs the user about the needed maintenance procedures. After inspection, enter the number of working hours and the date of the next maintenance. In order to implement these changes, use the following procedure:

- log in with the required permissions,
- go into the maintenance procedures settings screen,
- click the working hours counter icon and enter the number of hours till next maintenance,
- click the date icon and enter the date of the next maintenance,
- check the maintenance counters screen if all the new parameters were set correctly,
- log out

Tab 11 shows example of maintenance counter settings.

Table 11Example of maintenance procedures counter settings:

Current hour and date counter	**Maintenance intervals**	**Maintenance procedures settings**	**Maintenance counter settings value**
2996 h	3000 h	5996 h	3000 h
14-05-2016	1 year	14-05-2015	365 days

4.9 Communication in Modbus TCP protocol

The PLC controller makes the records presented in Table 12available via the Modbus TCPprotocol as the Modbus server. The information contained in the records may be used for visual presentation of the compressor status in master control systems. When you use that communication form, pay attention to the following:

- Communication is performed via Profinet,
- The records 40011÷40070are only for reading, and you can write values into the records 40001÷40010,
- Each record is in a 16-bit fixed point number format with a mark (int16),
- It is possible to read all records during one calling,
- The available records are of holding type and 03 Modbus function must be used for their reading,
- The default PLC controller address is in the range of 192.168.0.11, the precise address can be read on the information screen on the control panel,
- The communication port is 502,

- The communication can be switched off on the PLC settings screen on the control panel,
- It is possible to control the compressor operation by sending a command (record 40001) and PIN code (record 40002) when the compressor is in the NET operation mode,
- Execution of the command depends on the current control level in NET mode (record 40045),
- If the value of the record 40002is compliant with the PIN code located in the controller memory, the command from the record 40001will be executed. Irrespective of the PIN code compliance, the record 40002will be set to value 10000 and status of the record 40011 will be updated,
- The default PIN code for control via the Modbus TCP protocol is 1234.

Table 12 Description of the PLC controller records.

Record no.	**Description**
40001	Control command: • 1 – compressor stop • 2 – compressor start • 3 – pressure entry from records 40003 and 40004 • 4 – compressor unloading • 5 – compressor loading • 6 - rotational speed set
40002	Transmission PIN from range 0000÷9999.
40003	Set switch-off pressure [kPa] (resolution of 10 kPa).
40004	Set switch-on pressure [kPa] (resolution of 10 kPa).
40005	Set rotational speed [%].
40011	Feedback message of the last control command: • 0 – there was no command • 1 – command executed • 2 – control level in the NET mode is too low to execute the command • 3 – command unrecognised • 4 – invalid PIN • 5 – compressor in a mode different than NET
40012	Compressor status: • 0 – stop • 1 – automatic stop • 2 – delayed stop • 3 – start • 4 – idle running • 5 – compression • 6 – delayed start • 7 – failure • 8 – active suction pressure sensor Vs • 9 – dryer start • 10 – maximum number of starts • 11 - autorestart
40013	Compressor operation mode:

	• 0 – local (AUTO) • 1 – remote (REM) • 2 – calendar (CAL) • 3 – net (NET)
40014	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 1, while bit 15 corresponds to event 16.
40015	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 17, while bit 15 corresponds to event 32.
40016	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 33, while bit 15 corresponds to event 48.
40017	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 49, while bit 15 corresponds to event 64.
40018	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 65, while bit 15 corresponds to event 80.
40019	Status indication of system events. If a bit is set, then its corresponding event is active. Bit 0 corresponds to event 81, while bit 15 corresponds to event 96.
40020	Current air pressure in kPa.
40021	Current oil temperature in °C.
40022	Process value from the additional analogue input, dependant on the configuration [kPa, °C, A] (configuration state can be read in the record 40064)
40023	Current running speed for compressors [%]
40024	Current power [kW]
40025	Status of PLC inputs. If a bit is set, the corresponding input is high. Bit 0 corresponds to input 0, while bit 15 corresponds to input 15.
40026	Status of PLC outputs. If a bit is set, the corresponding output is high. Bit 0 corresponds to output 0, while bit 15 corresponds to output 15.
40027	Current setting of the maximum compressor switch-off pressure, in kPa.
40028	Current compressor switch-on pressure setting, or the set pressure for compressors with a frequency converter, in kPa.
40029	Current compressor switch-off pressure setting, or the pressure hysteresis for compressors with a frequency converter, in kPa.
40030	Current setting of idling time in s.
40031	Number of worked hours.
40032	Number of worked hour counter rewinds. Total result value of the record 40031 + 32767 * value of the record 40032.
40033	Number of hours worked under load.
40034	Number of rewinds of the counter for hours worked under load. Total result value of the record 40033 + 32767 * value of the record 40034.
40035	Total energy consumption [kWh].
40036	Number of the total energy consumption counter rewinds. Total result value of the record 40035 + 32767 * value of the record 40036.
40037	Energy consumption during compression [kWh].
40038	Number of rewinds of the counter for energy consumption during compression. Total result value of the record 40037 + 32767 * value of the record 40038.
40039	Total amount of air produced [m³].
40040	Number of rewinds of the counter for energy consumption during compression. Total result value of the record 40039 + 32767 * value of the record 40040.
40041	Number of working hours until next service.
40042	Number of days until next service
40043	Compressor type: • 0 – direct start-up • 1 – star/delta start-up • 2 – softstart • 3 – fixed-speed frequency converter

	• 4 – variable-speed frequency converter
40044	Controller type: • 0 – without manufacturer data • 1 – with manufacturer data
40045	Control level in NET mode: • 0 – remote start and stop • 1 – remote setting of pressures • 2 – remote compressor loading • 3 – setting rotation for variable-speed compressor
40046	Hardware compatibility version number of the firmware.
40047	Functional version number of the firmware.
40048	Functional version revision number of the firmware.
40049	Configuration of digital input 0.
40050	Configuration of digital input 1.
40051	Configuration of digital input 2.
40052	Configuration of digital input 3.
40053	Configuration of digital input 4.
40054	Configuration of digital input 5.
40055	Configuration of digital input 6.
40056	Configuration of digital input 7.
40057	Configuration of digital output 0.
40058	Configuration of digital output 1.
40059	Configuration of digital output 2.
40060	Configuration of digital output 3.
40061	Configuration of digital output 4.
40062	Configuration of digital output 5.
40063	Configuration of analogue input 0.
40064	Configuration of analogue input 1.
40065	Configuration of the signal board pin.

Table 13 Configuration description of PLC controller inputs and outputs.

Value	**Function**	**Group**
0	No function	Digital outputs
1	Always switched off	
2	Always switched on	
3	Fan	
4	Fan from temperature	
5	Condensate drain	
6	Dryer	
7	Heater	
8	Failure	
9	Operation	
10	Compression	
11	Slave compressors	
12	Service	
13	Ready	
14	No failure	
15	AUTO mode	
16	REM mode	
17	CAL mode	

18	NET mode	
19	REM readiness	
20	Line contactor	
21	Star contactor	
22	Delta contactor	
23	Softstart start	
24	Frequency converter start	
25	Load solenoid	
101	Fan protection	Digital inputs
102	Suction sensor NO	
103	Suction sensor NC	
104	Air filter NO	
105	Air filter NC	
106	Power control	
107	Motor overload	
108	Softstart feedback signal	
110	Protection	
111	Oil filter NO	
112	Oil filter NC	
113	Oil separator NO	
114	Oil separator NC	
115	Remote operation	
117	Emergency stop	
118	Remote control with delay	
119	Motor temperature	
201	Air pressure	Analogue inputs
202	Oil pressure	
203	Water pressure	
204	Air temperature	
205	Oil temperature	
206	Water temperature	
207	Motor temperature	
208	Motor current	

4.10 Ultra Speed function

It is possible to activate Ultra Speed function in the compressors with the variable frequency drive (VFD). This function increases output frequency from the VFD when the motor is fully loaded and the compressor is working below the set pressure.When the control system is provided with the Ultra Speed function, a user may enable or disable it from the basic settings level. The use of the above control type features the following:

- Increase in the compressor capacity when it is operated at pressure lower than nominal one,
- Increase in the effective adjustment range of capacity,
- Reduction in the air receiver filling time.

4.11 Changing the network settings

Note

Most of the steps in the procedures outlined in the following section are performed on and with the operator panel firmware which has been developed by the manufacturer. Therefore, the steps or the availability of each of the procedures may vary depending on the firmware version. Carrying out any of the following procedures or changing other firmware settings requires specialized knowledge of computer science and automation. Therefore, the compressor manufacturer does not recommend manipulating the firmware settings, and is not responsible for the consequences of changes to the firmware settings, or any other changes made using the firmware tools.

To change the network settings of the PLC, use the following procedure:

- Change the network parameters in the parameters 1 on the screen 2-9-7, as shown in Fig. 9.
- Confirm the settings by clicking the V button next to the parameters 1 on the screen 2-9-7.
- Close the operating system using the parameter 3 on the screen 2-3 and carry out further procedures.

Ustawienia sieciowe sterownika PLC - *Controller network settings*
Maska - *Mask,* Bramka - *Gateway*

Fig. 9View of the IP settings screen.

To change the network settings of the HMI operator panel, use the following procedure:

- Close the operating system using the parameter 3 on the screen 2-3.
- Click on Settings in Start Center.
- Click on Network Interface in the Transfer, Network & Internet group.
- Set the new network parameters.

To change the connection between the HMI operator panel and the PLC, use the following procedure:

- Close the operating system using the parameter 3 on the screen 2-3.
- Click on Settings in Start Center.
- Click on Service & Commissioning in the System group.
- Select Edit Connections from the list.
- Wait until the right connection is found in Step 1/3 and continue.
- In IP Address, enter the address of the PLC and set the Override to ON in Step 2/3 and continue.
- Confirm the settings by clicking Accept in Step 3/3.

In order to start the operating system, click on Start in Start Center, the example of which is shown in Fig. 10.

Fig. 10 View of the Start Center of the operator panel firmware.

BERG Kompressoren GmbH
Compressed Air Technology | Air Sepration

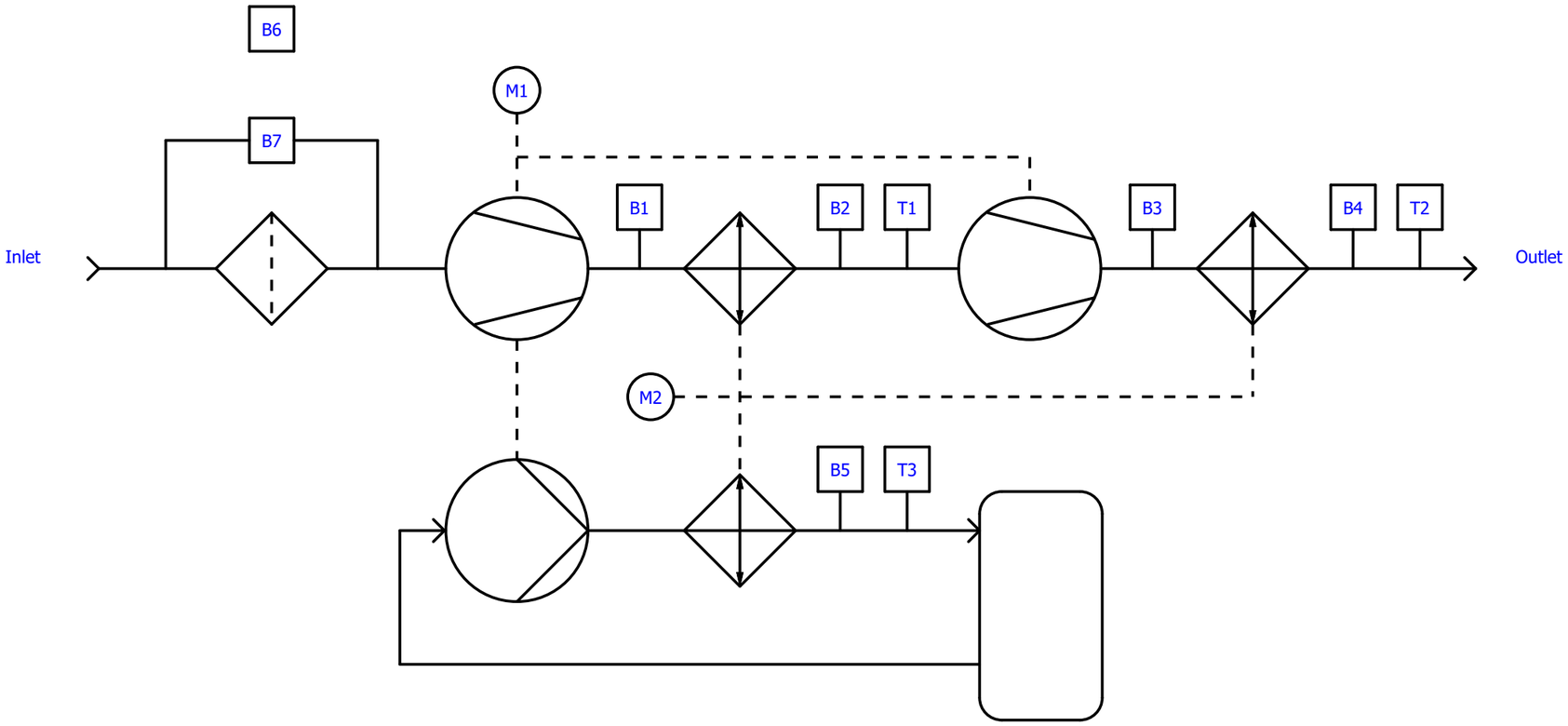
Operation and Maintenance Manual - Electrical part

Project name:	KOMPBERG ZXF 75
Project number:	786-740-000
Index:	EIE1110
Index version:	1
Power supply:	400V/50Hz/3ph
Power supply type:	L1, L2, L3, PE
Controller:	S7-1200

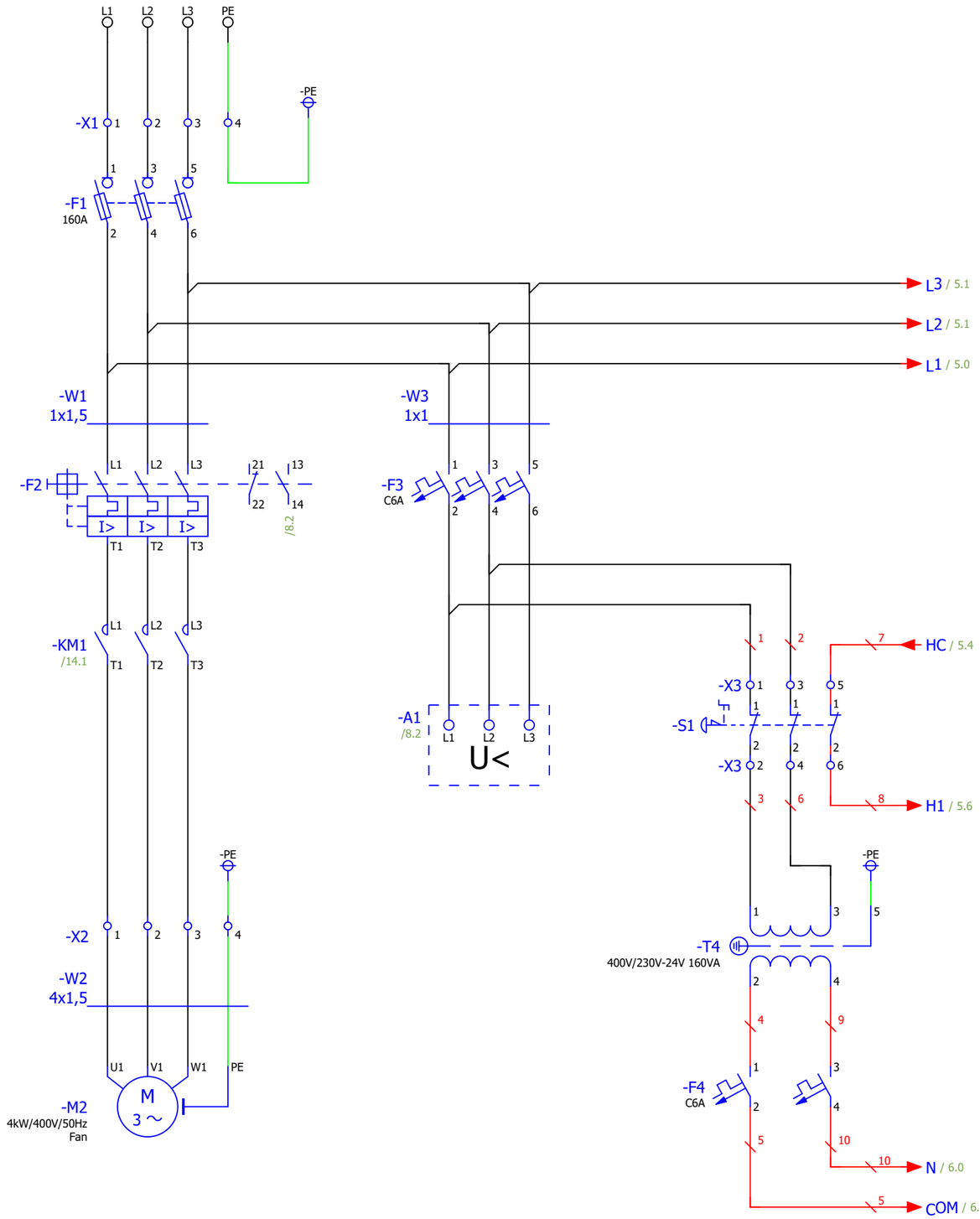
Last change:	11.05.2020
Number of pages:	20
Notes:	Siemens

Contents

Page	Page description	Date	
/1	Title page	29.08.2014	
/2	Contents	11.05.2020	
/3	P&I diagram	03.04.2017	
/4	Schematic diagram	11.05.2020	
/5	Schematic diagram	11.05.2020	
/6	Schematic diagram	11.05.2020	
/7	Schematic diagram	11.05.2020	
/8	Schematic diagram	11.05.2020	
/9	Schematic diagram	11.05.2020	
/10	Schematic diagram	11.05.2020	
/11	Schematic diagram	11.05.2020	
/12	Schematic diagram	11.05.2020	
/13	Schematic diagram	11.05.2020	
/14	Schematic diagram	11.05.2020	
/15	List of articles	11.05.2020	
/16	Plan of terminals	11.05.2020	
/17	Plan of terminals	11.05.2020	
/18	Plan of terminals	11.05.2020	
/19	Plan of terminals	11.05.2020	
/19.a	Plan of terminals	11.05.2020	



Modification date: 03.04.2017	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
Checked by: Martin Safari		Page description: P&I diagram	Index version: 1	Current page: /3	Number of pages: 20	



Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
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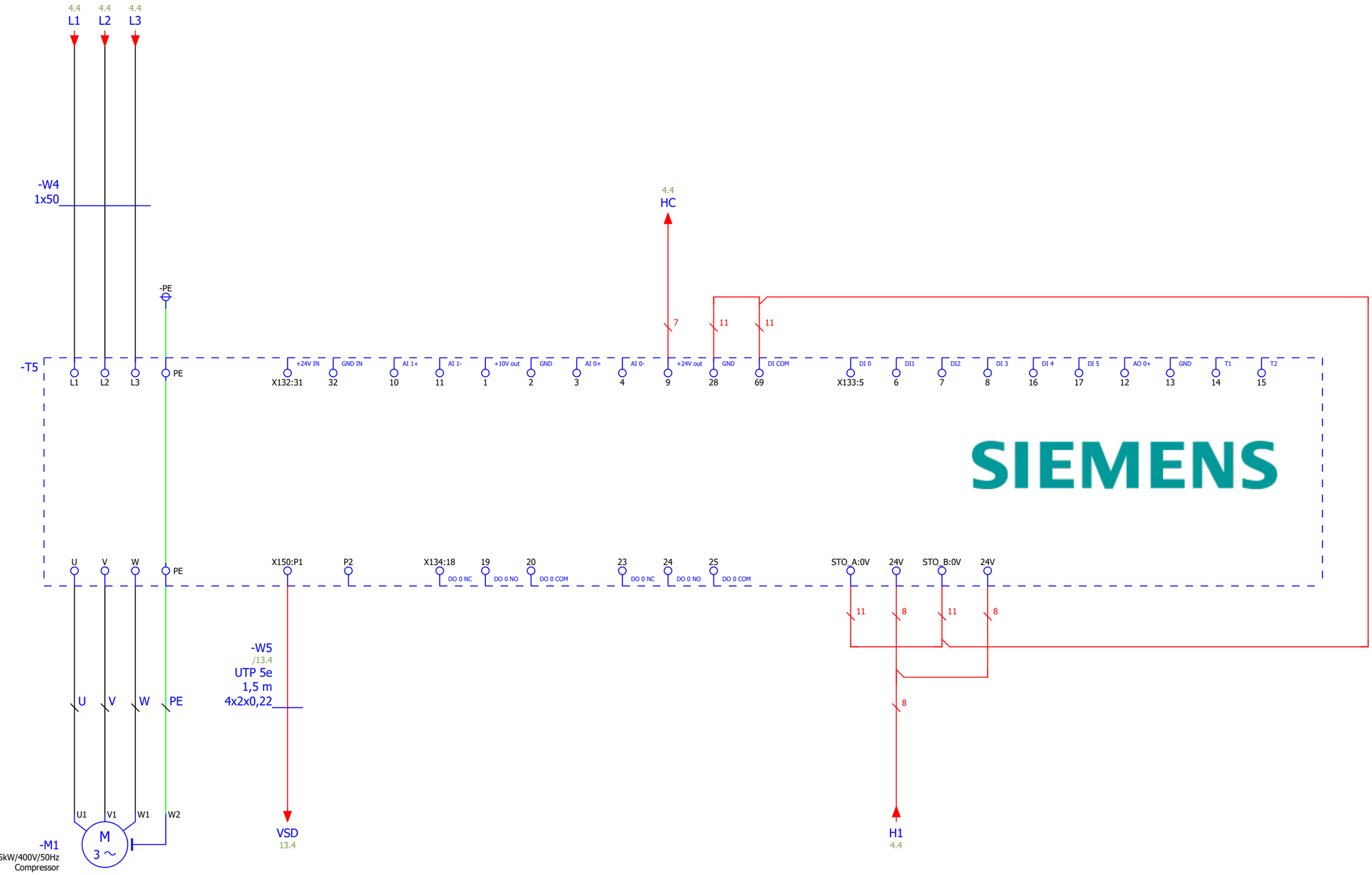

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		KOMPBERG ZXF 75	400V/50Hz/3ph	EIE1110		786-740-000
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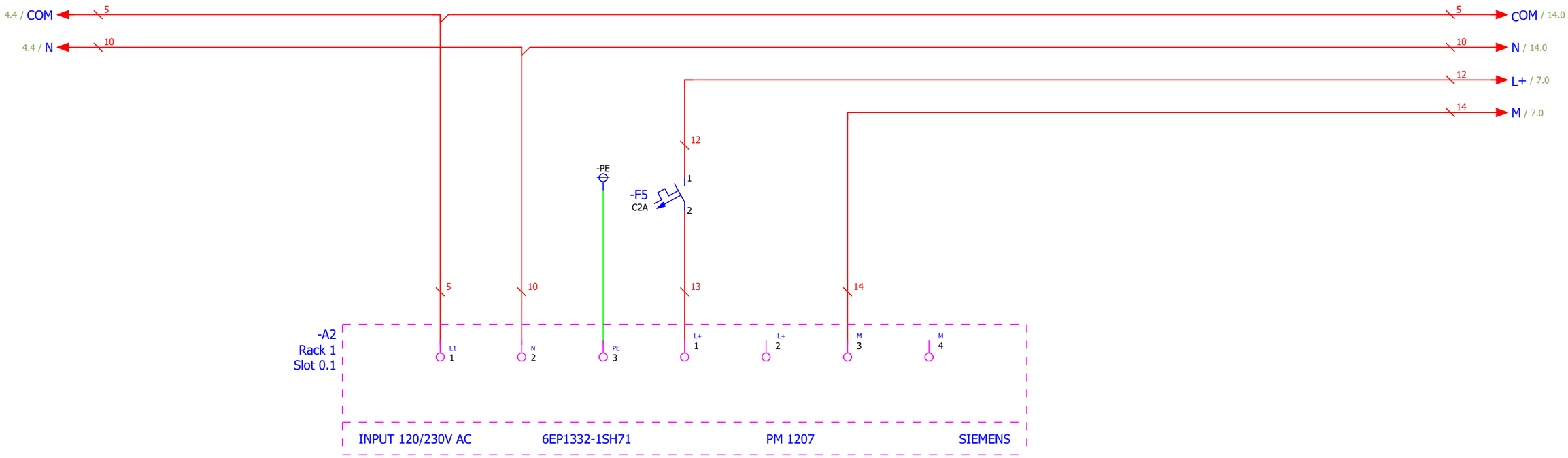

Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
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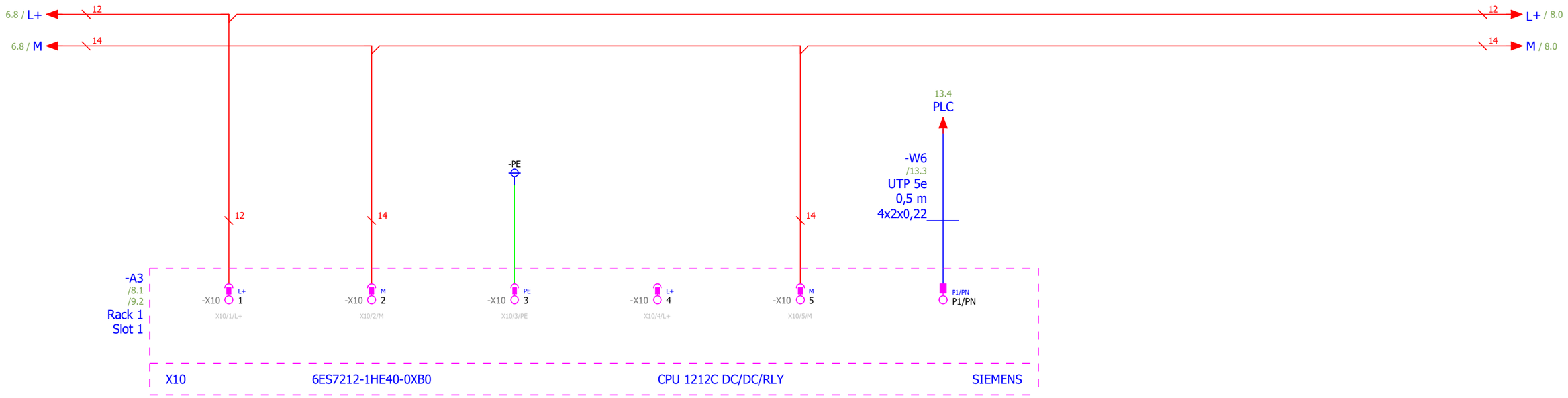

Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
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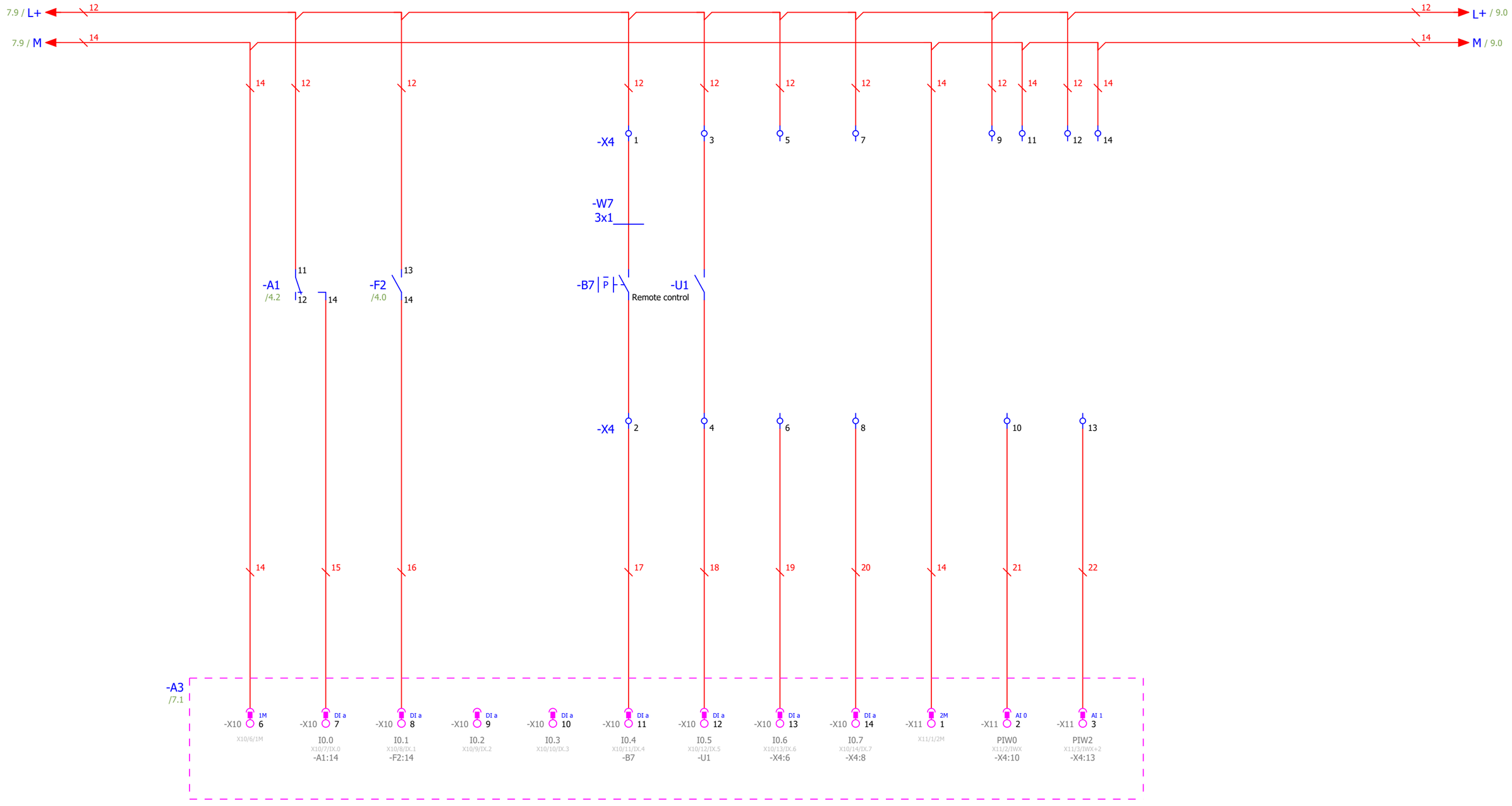

Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
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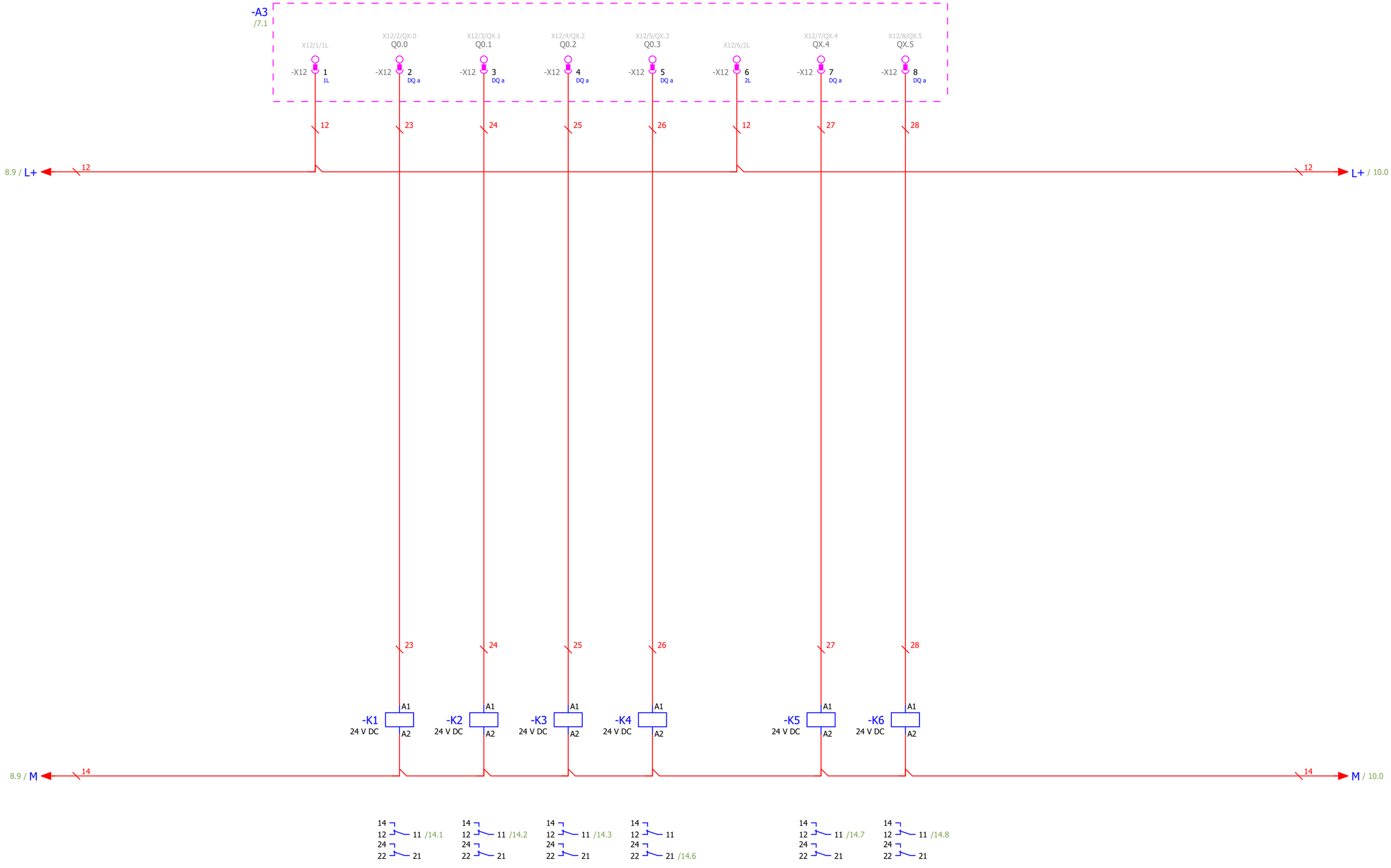

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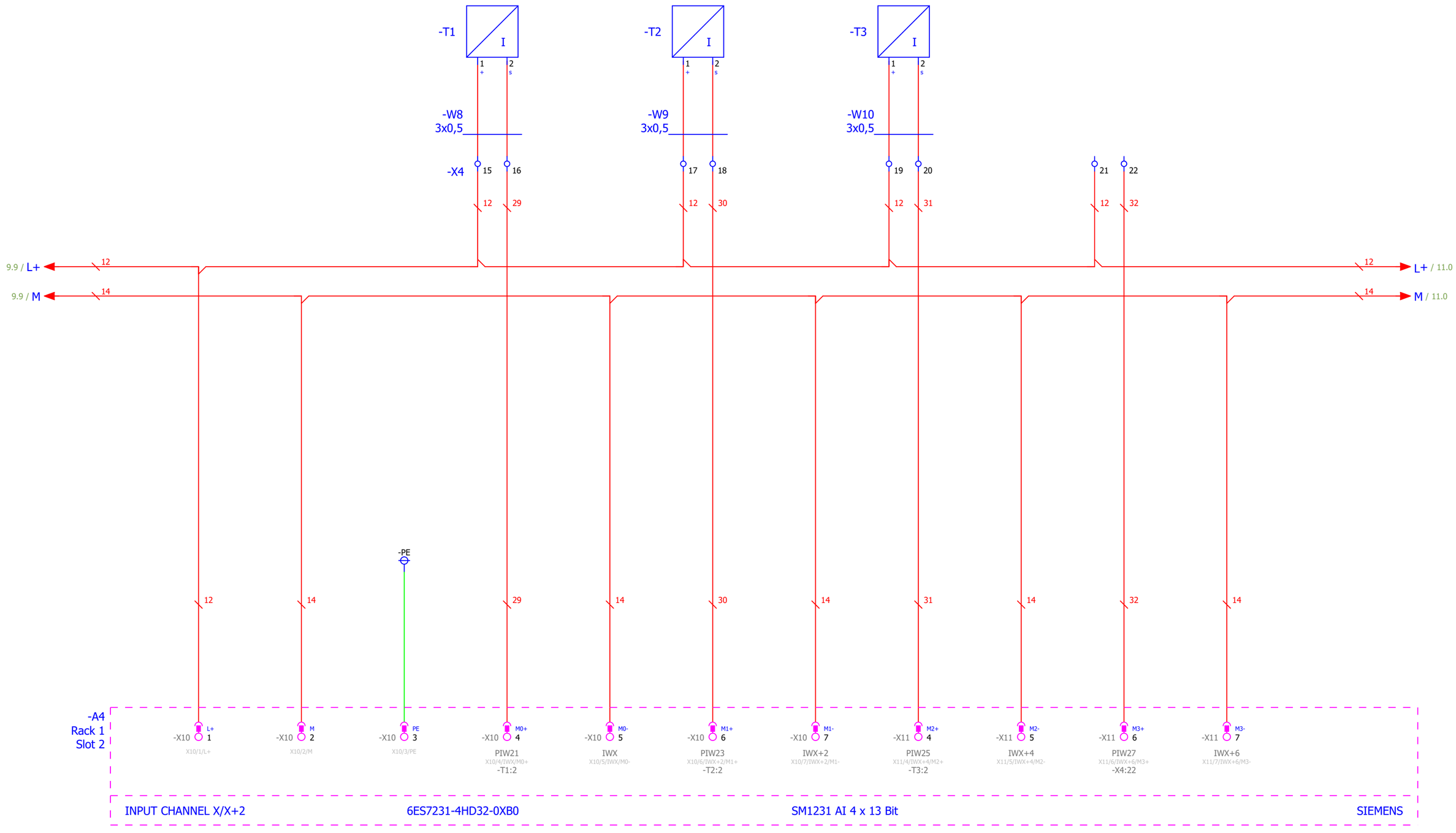

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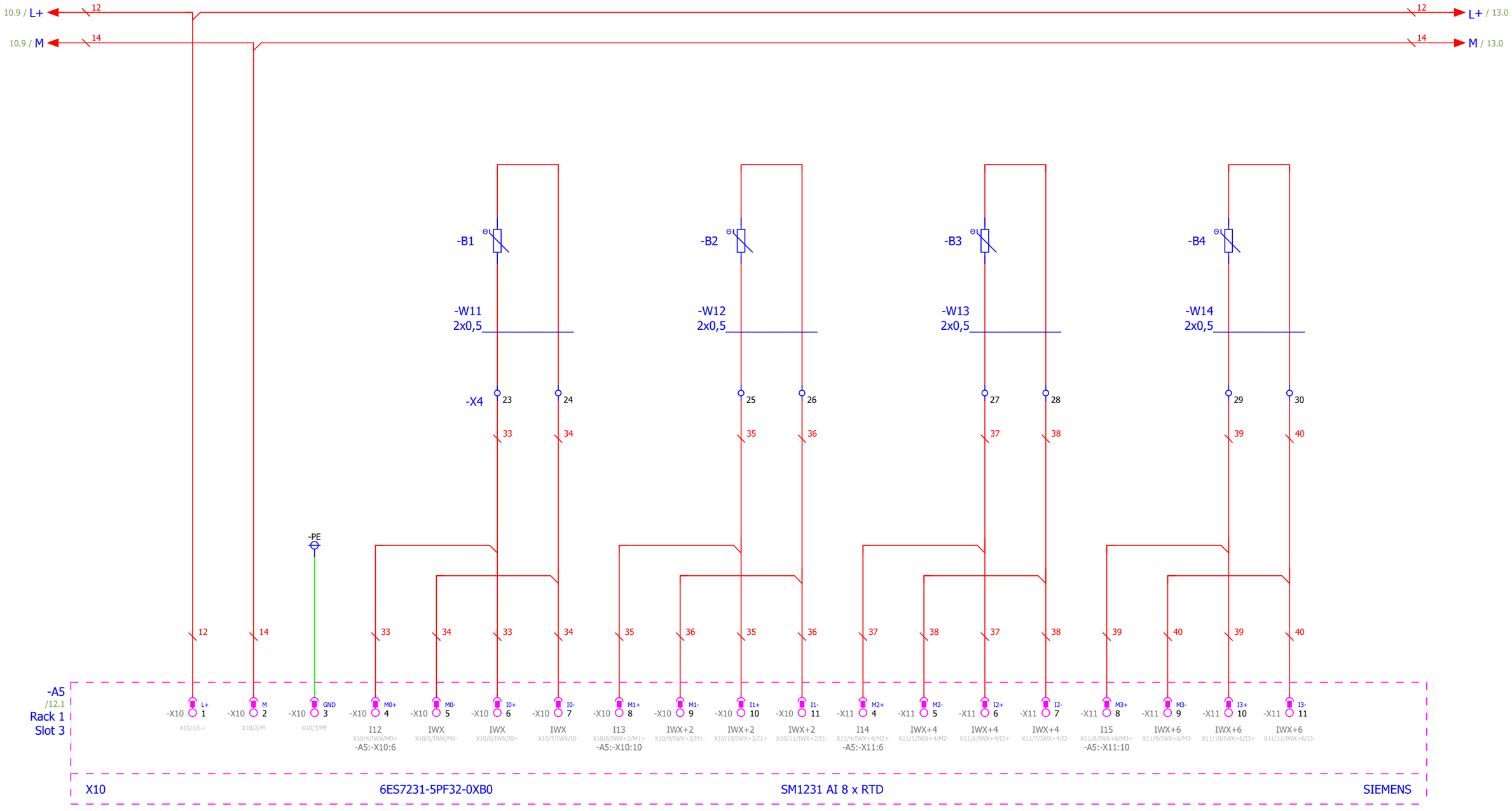

Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name:	KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000
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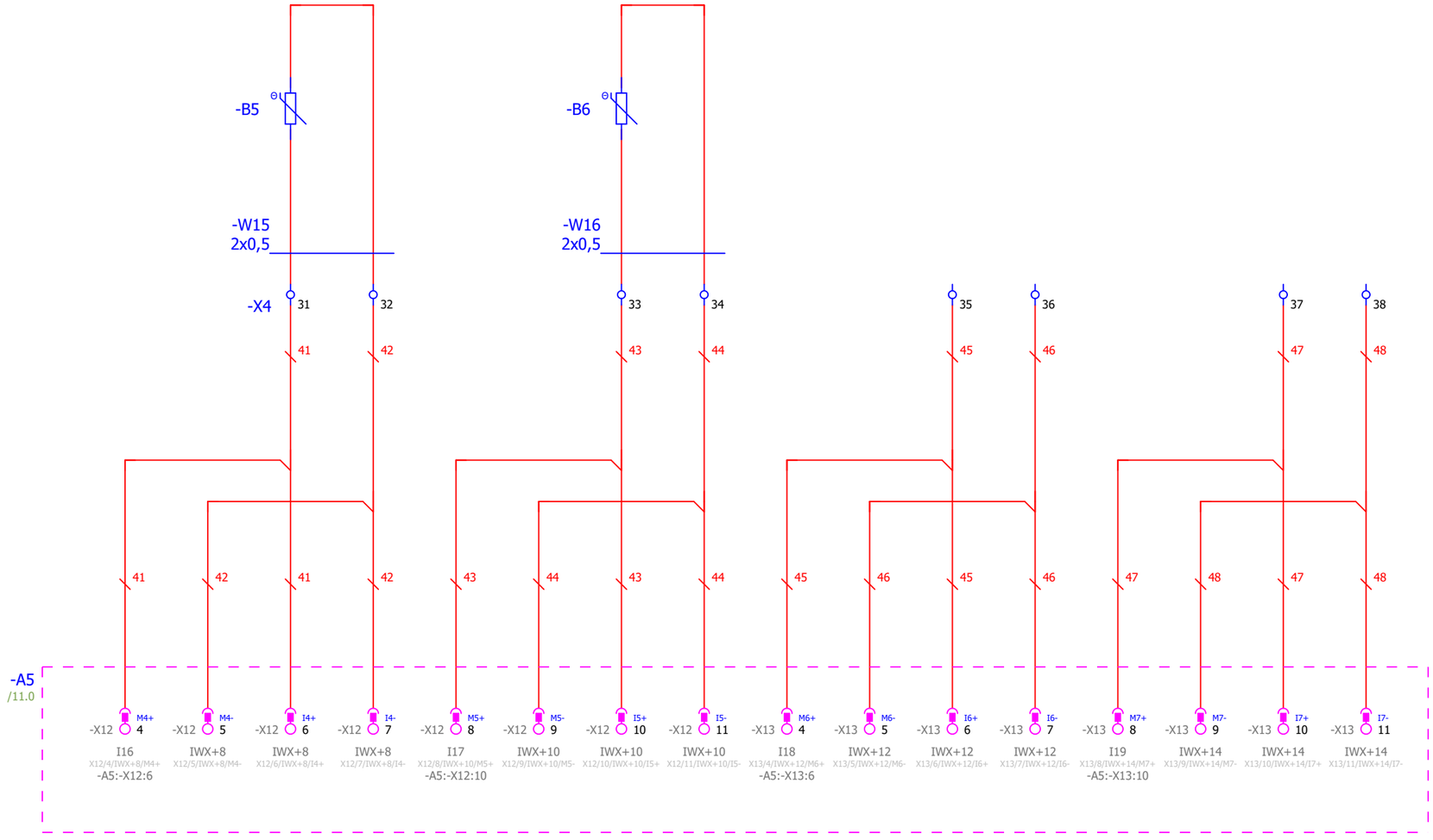

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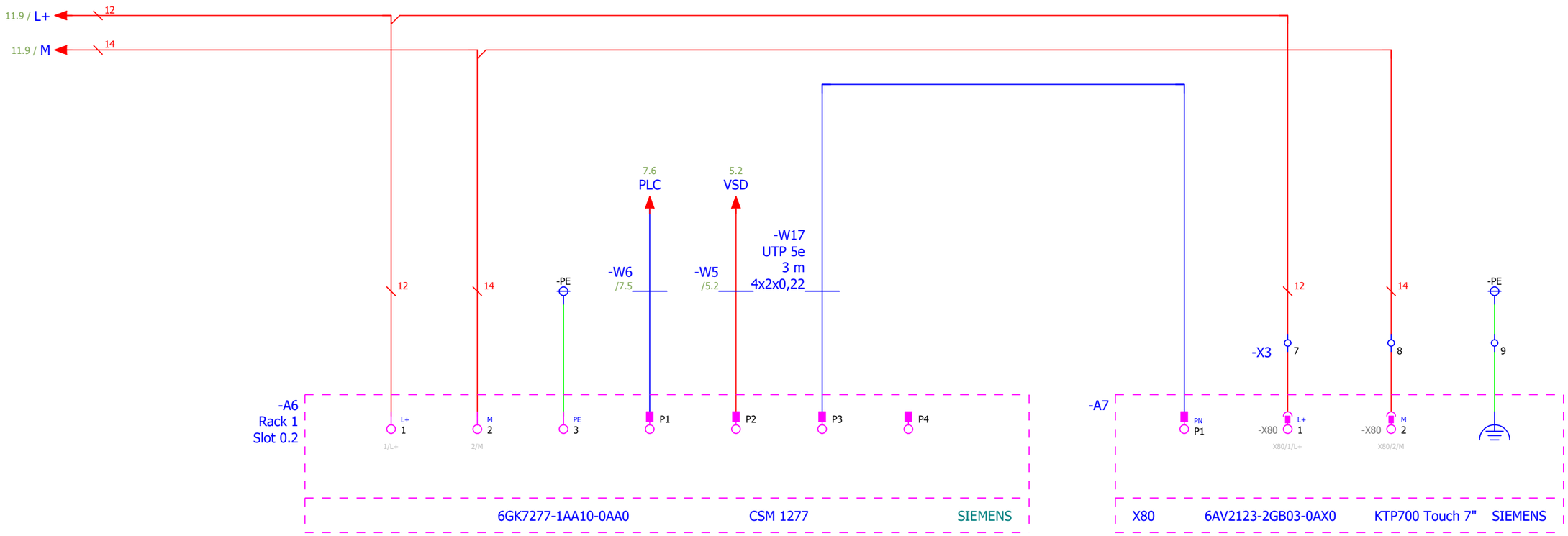

Modification date: 11.05.2020	**Berg Kompressoren GmbH** **47807 Krefeld, Deutschland**	Project name: KOMPBERG ZXF 75	Power supply: 400V/50Hz/3ph	Index: EIE1110	Project number: 786-740-000	
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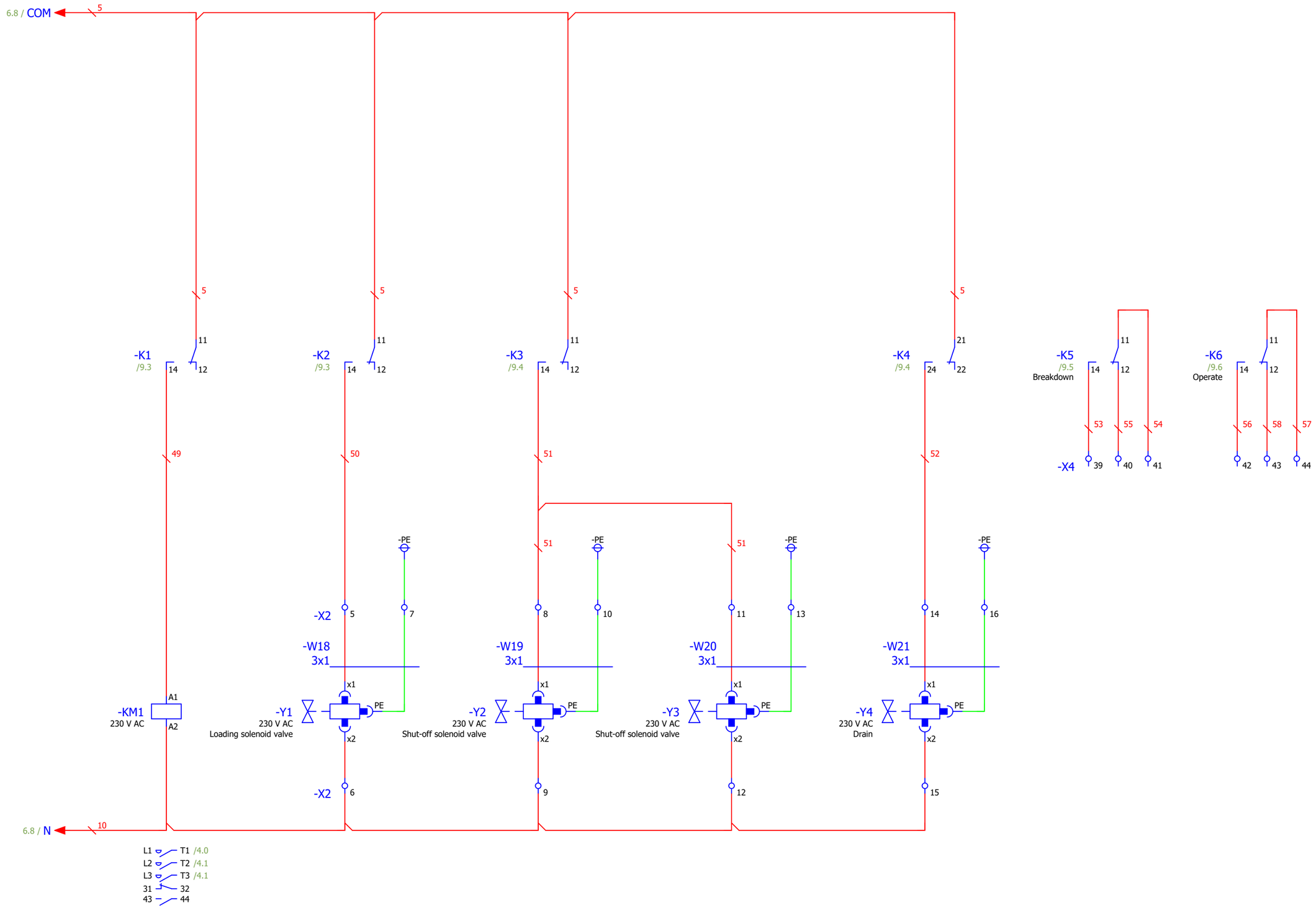

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List of articles

Apparatus identifier	Function	Technical data	Manufacturer	Type number	Notes	Index	Quantity
-A1	Phase monitor		Siemens	3UG4512-1AR20		ECE0922	1
-A2	Power supply		Siemens	6EP1332-1SH71		ECE0924	1
-A3	PLC controller CPU1212C DC/DC/RLY		Siemens	6ES7212-1HE40-0XB0		ESM0085	1
-A4	Module SM1231 4xAI		Siemens	6ES7231-4HD32-0XB0		ESM0059	1
-A5	Module SM1231 8xRTD		Siemens	6ES7231-5PF32-0XB0		ESM0092	1
-A6	Switch CSM1277		Siemens	6GK7277-1AA10-0AA0		ECE0524	1
-A7	Operator panel KTP700		Siemens	6AV2123-2GB03-0AX0		ECE1245	1
-F1	Fuse switch		Apator	RBK-00		ECE0504	1
-F1	Fuse link	160A	Apator	WTNH-00 160A		ECE0593	3
-F2	Motor starter		LS	MMS-32S 10A		ECE0874	1
-F2	Auxiliary contact		LS	FX-11		ECE1035	1
-F3	Overcurrent circuit-breaker	C6A		S303 C6		ECE0217	1
-F4	Overcurrent circuit-breaker	C6A		S302 C6		ECE0727	1
-F5	Overcurrent circuit-breaker	C2A		S301 C2		ECE0697	1
-K1	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K1	Relay socket		Finder	95.75		ECE0320	1
-K2	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K2	Relay socket		Finder	95.75		ECE0320	1
-K3	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K3	Relay socket		Finder	95.75		ECE0320	1
-K4	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K4	Relay socket		Finder	95.75		ECE0320	1
-K5	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K5	Relay socket		Finder	95.75		ECE0320	1
-K6	Relay	24 V DC	Finder	40.52 D24		ECE0300	1
-K6	Relay socket		Finder	95.75		ECE0320	1
-KM1	Contactor	230 V AC	LS	MC-9b		ECE0763	1
-S1	Emergency stop button		Giovenzana	PPFN1R4N		ECE0017	1
-S1	Auxiliary contact		Giovenzana	PCW01		ECE0323	2
-T4	Transformer	400V/230V-24V 160VA		400V/230V-24V 160VA		ECE0754	1
-T5	Variable frequency drive		Siemens	6SL3220-2YE42-0UF0		ESO0114	1
-W1	Connecting wire			LGY 1,5 BK		EPW0078	10
-W2	Flexible cable			OW 4x1,5		EPW0007	5
-W3	Connecting wire			LGY 1 BK		EPW0063	10
-W4	Connecting wire			LGY 50 BK		EPW0045	30
-W4	Connecting wire			LGY 25 GNYE		EPW0065	10
-W5	Network cable			Patchcord UTP 5e 1,5m		PRO0445	1
-W6	Network cable			Patchcord UTP 5e 0,5m		PRO0491	1
-W7	Flexible cable			OW 3x1		EPW0005	3
-W8	Control cable			LIYY 3x0,5		EPW0052	5
-W9	Control cable			LIYY 3x0,5		EPW0052	5
-W10	Control cable			LIYY 3x0,5		EPW0052	5
-W17	Network cable			Patchcord UTP 5e 3m		PRO0490	1
-W18	Flexible cable			OW 3x1		EPW0005	3
-W19	Flexible cable			OW 3x1		EPW0005	3
-W20	Flexible cable			OW 3x1		EPW0005	3
-W21	Flexible cable			OW 3x1		EPW0005	3
-X1	Rail terminal block		Cabur	GPM95		ECE0379	4
-X2	Rail terminal block		Cabur	CBD4		ECE0381	3
-X2	Rail terminal block		Cabur	CBD2		ECE0376	8
-X2	PE rail terminal block		Cabur	TE2		ECE0275	4
-X2	PE rail terminal block		Cabur	TE4		ECE0380	1
-X3	Rail terminal block		Cabur	CBD2		ECE0376	8
-X3	PE rail terminal block		Cabur	TE2		ECE0275	1
-X4	Rail terminal block		Cabur	CBD2		ECE0376	44

Plan of terminals

		Terminal block X1						
Sort of connector	Connector type	Target ID	Connection	Terminal	Bridge	Target ID	Connection	Position
Rail terminal block	GPM95	-F1	1	1		L1		/4.0
Rail terminal block	GPM95	-F1	3	2		L2		/4.1
Rail terminal block	GPM95	-F1	5	3		L3		/4.1
Rail terminal block	GPM95	-PE		4		PE		/4.1

Plan of terminals

		Terminal block X2						
Sort of connector	Connector type	Target ID	Connection	Terminal	Bridge	Target ID	Connection	Position
Rail terminal block	CBD4	-M2	U1	1		-KM1	T1	/4.0
Rail terminal block	CBD4	-M2	V1	2		-KM1	T2	/4.1
Rail terminal block	CBD4	-M2	W1	3		-KM1	T3	/4.1
PE rail terminal block	TE4	-M2	PE	4		-PE		/4.1
Rail terminal block	CBD2	-Y1	x1	5		-K2	14	/14.2
Rail terminal block	CBD2	-KM1	A2	6		-Y1	x2	/14.2
PE rail terminal block	TE2	-Y1	PE	7		-PE		/14.2
Rail terminal block	CBD2	-Y2	x1	8		-K3	14	/14.3
Rail terminal block	CBD2			9		-Y2	x2	/14.3
PE rail terminal block	TE2	-Y2	PE	10		-PE		/14.4
Rail terminal block	CBD2	-Y3	x1	11				/14.5
Rail terminal block	CBD2			12		-Y3	x2	/14.5
PE rail terminal block	TE2	-Y3	PE	13		-PE		/14.5
Rail terminal block	CBD2	-Y4	x1	14		-K4	24	/14.6
Rail terminal block	CBD2			15		-Y4	x2	/14.6
PE rail terminal block	TE2	-Y4	PE	16		-PE		/14.6

Plan of terminals

		Terminal block X3						
Sort of connector	Connector type	Target ID	Connection	Terminal	Bridge	Target ID	Connection	Position
Rail terminal block	CBD2	-S1	1	1		-A1	L1	/4.4
Rail terminal block	CBD2	-T4	1	2		-S1	2	/4.4
Rail terminal block	CBD2	-S1	1	3		-A1	L2	/4.4
Rail terminal block	CBD2	-T4	3	4		-S1	2	/4.4
Rail terminal block	CBD2	-S1	1	5		-T5-X132	9	/4.4
Rail terminal block	CBD2	-T5-STO_A	24V	6		-S1	2	/4.4
Rail terminal block	CBD2	-A7	-X80:1	7		-A6	1	/13.7
Rail terminal block	CBD2	-A7	-X80:2	8		-A6	2	/13.8
PE rail terminal block	TE2	-A7	-X80	9		-PE		/13.8

Plan of terminals

		Terminal block X4						
Sort of connector	Connector type	Target ID	Connection	Terminal	Bridge	Target ID	Connection	Position
Rail terminal block	CBD2	-B7		1		-F2	13	/8.4
Rail terminal block	CBD2	-A3	-X10:11	2		-B7		/8.4
Rail terminal block	CBD2	-U1		3				/8.4
Rail terminal block	CBD2	-A3	-X10:12	4		-U1		/8.4
Rail terminal block	CBD2			5				/8.5
Rail terminal block	CBD2	-A3	-X10:13	6				/8.5
Rail terminal block	CBD2			7				/8.5
Rail terminal block	CBD2	-A3	-X10:14	8				/8.5
Rail terminal block	CBD2			9				/8.6
Rail terminal block	CBD2	-A3	-X11:2	10				/8.6
Rail terminal block	CBD2			11		-A3	-X11:1	/8.6
Rail terminal block	CBD2			12		-A3	-X12:1	/8.7
Rail terminal block	CBD2	-A3	-X11:3	13				/8.7
Rail terminal block	CBD2			14		-K1	A2	/8.7
Rail terminal block	CBD2	-A4	-X10:1	15		-T1	1	/10.3
Rail terminal block	CBD2	-A4	-X10:4	16		-T1	2	/10.3
Rail terminal block	CBD2			17		-T2	1	/10.4
Rail terminal block	CBD2	-A4	-X10:6	18		-T2	2	/10.4
Rail terminal block	CBD2			19		-T3	1	/10.6
Rail terminal block	CBD2	-A4	-X11:4	20		-T3	2	/10.6
Rail terminal block	CBD2	-A5	-X10:1	21				/10.7
Rail terminal block	CBD2	-A4	-X11:6	22				/10.7
Rail terminal block	CBD2	-A5	-X10:6	23		-B1		/11.3
Rail terminal block	CBD2	-A5	-X10:7	24		-B1		/11.3
Rail terminal block	CBD2	-A5	-X10:10	25		-B2		/11.4
Rail terminal block	CBD2	-A5	-X10:11	26		-B2		/11.5
Rail terminal block	CBD2	-A5	-X11:6	27		-B3		/11.6
Rail terminal block	CBD2	-A5	-X11:7	28		-B3		/11.6
Rail terminal block	CBD2	-A5	-X11:10	29		-B4		/11.8
Rail terminal block	CBD2	-A5	-X11:11	30		-B4		/11.8
Rail terminal block	CBD2	-A5	-X12:6	31		-B5		/12.2
Rail terminal block	CBD2	-A5	-X12:7	32		-B5		/12.2
Rail terminal block	CBD2	-A5	-X12:10	33		-B6		/12.4
Rail terminal block	CBD2	-A5	-X12:11	34		-B6		/12.4
Rail terminal block	CBD2	-A5	-X13:6	35				/12.5

Plan of terminals

		Terminal block X4						
Sort of connector	Connector type	Target ID	Connection	Terminal	Bridge	Target ID	Connection	Position
Rail terminal block	CBD2	-A5	-X13:7	36				/12.6
Rail terminal block	CBD2	-A5	-X13:10	37				/12.7
Rail terminal block	CBD2	-A5	-X13:11	38				/12.7
Rail terminal block	CBD2			39		-K5	14	/14.7
Rail terminal block	CBD2			40		-K5	12	/14.7
Rail terminal block	CBD2			41		-K5	11	/14.7
Rail terminal block	CBD2			42		-K6	14	/14.8
Rail terminal block	CBD2			43		-K6	12	/14.8
Rail terminal block	CBD2			44		-K6	11	/14.8