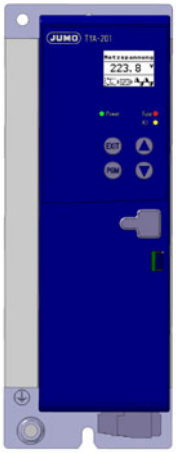
JUMO TYA 201

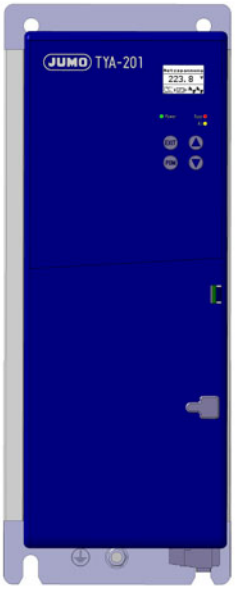
Single-Phase Thyristor Power Controller

709061/8-01-032

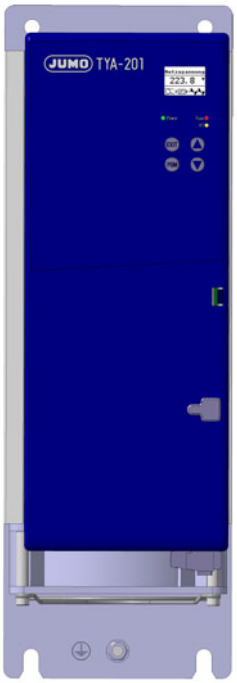
709061/8-01-050



709061/8-01-100



709061/8-01-150
709061/8-01-200



709061/8-01-250

709061/8-01-020

Operating Manual

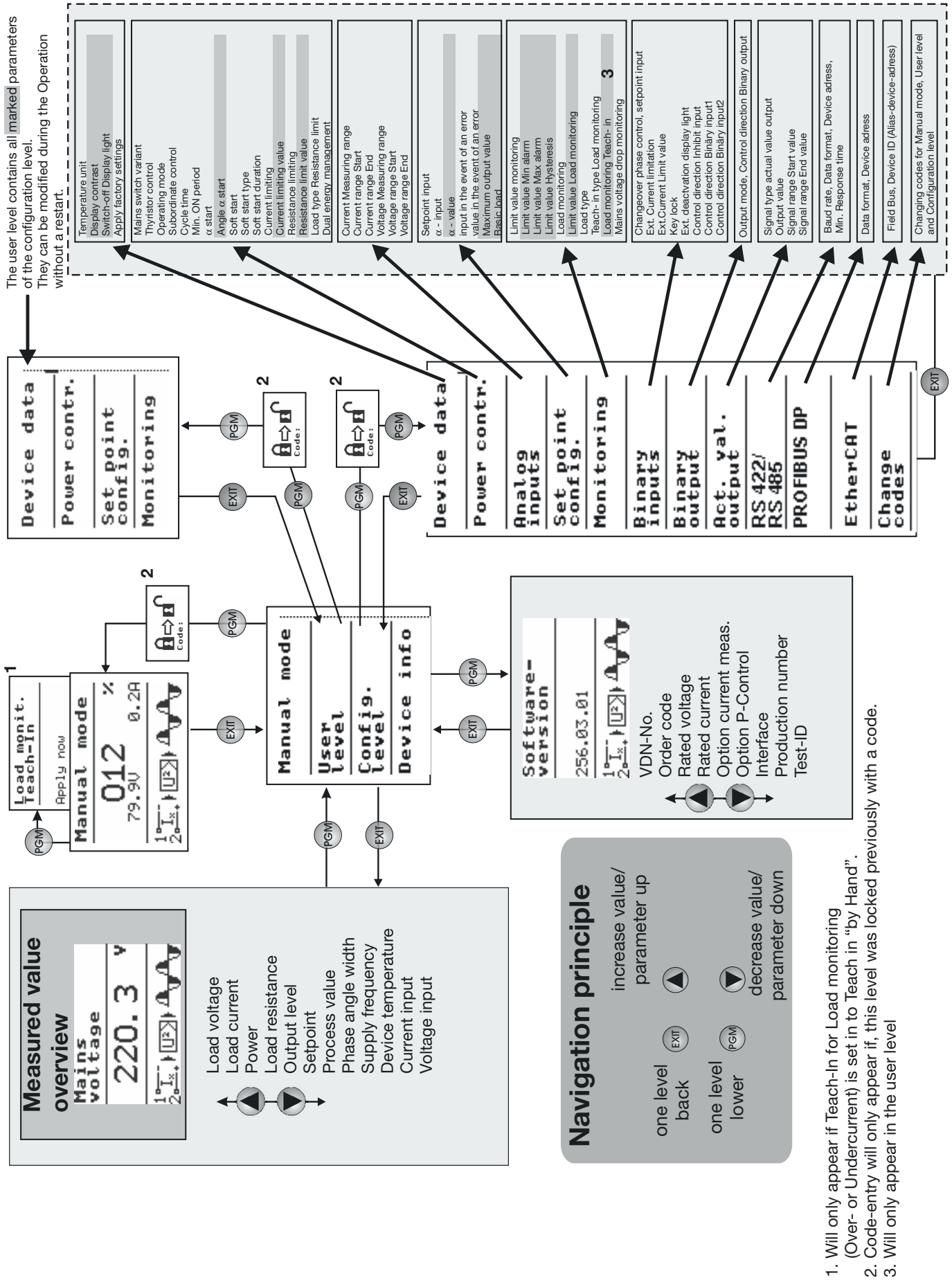
70906100T90Z001K000

V4.00/EN/00561071

All parameter settings are described in detail in the chapter "Configuration".

This operating overview shows all possible parameters of the device series.

Depending on the order specifications or current configuration, any parameters that are not required are hidden.



1. Will only appear if Teach-In for Load monitoring (Over- or Undercurrent) is set in to Teach in "by Hand".
2. Code-entry will only appear if, this level was locked previously with a code.
3. Will only appear in the user level

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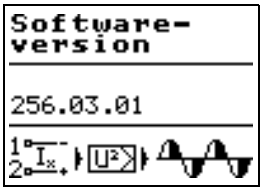
1.1 Preface

Read this operating manual before putting the device into service.

This operating manual is valid from **device software version** [256.03.01].



Keep the operating manual in a place that is accessible to all users at all times.

Your comments are appreciated and may assist us in improving this operating manual.

Phone: +49 661 6003-727
Fax: +49 661 6003-508

The power controller produces the power that is needed at the analog input or in manual mode. Safety systems independent of the power controller must be installed. They should safely switch off the subsequent heating process in the event of excess temperatures.

The power controller may only be operated using original JUMO semiconductor fuses.
In the event of replacement, please check that the correct spare part has been used.

All necessary settings are described in this operating manual.
Manipulations not described in the operating manual or expressly forbidden will jeopardize your warranty rights.
If you have any problems, please contact the nearest branch office or the head office.

Service hotline

For technical questions
Phone support in Germany:
Phone: +49 661 6003-9135
Fax: +49 661 6003-881899
Email: service@jumo.net

Austria:
Phone: +43 1 610610
Fax: +43 1 6106140
Email: info@jumo.at

Switzerland:
Phone: +41 1 928 24 44
Fax: +41 1 928 24 48
Email: info@jumo.ch

1 Introduction

When accessing the inner parts of the device and returning device plug-in units, modules, or components, please observe the regulations according to DIN EN 61340-5-1 and DIN EN 61340-5-2 "Protection of electronic devices from electrostatic phenomena". Use only **ESD** packaging for shipment.

Please note that we cannot accept any liability for damage caused by ESD.

ESD=**E**lectro**s**tatic **D**ischarge

1.2 Typographical conventions

1.2.1 Warning symbols

Caution

This character is used if **personal injury** may result from failure to follow instructions correctly or not at all!

Warning

This symbol is used when **damage to devices or data** may result from failure to follow instructions correctly or not at all!

ESD

This character is used if precautionary measures must be taken when handling **electrostatically sensitive components**.

Dangerous voltage

This symbol is used if dangerous voltages will cause an electric shock in the event of contact with live parts.

Hot surface, fire hazard

This symbol is used if burns can result from touching a hot surface.

Do not install any heat-sensitive components or devices close to the power controller.

1.2.2 Note symbols

Note

This symbol is used to draw your attention to a **particular issue**.

Reference

This symbol refers to **further information** in other manuals, chapters, or sections.

Footnote

abc[1] Footnotes are remarks that **refer to** specific parts of the text. Footnotes consist of two parts:
An identification marking in the text, and the footnote text itself.
The markers in the text are arranged as continuous superscript numbers.

1.2.3 Performing an action

Action instruction

✱ Plug in the connector — This symbol marks the description of a **required action**. The individual steps are marked by this asterisk

Vital text

READ THE DOCUMENTATION!

This symbol, which is attached to the device, indicates that the associated **device documentation must be observed**. This is necessary in order to recognize the nature of the potential danger and take the necessary measures to prevent it.

Command sequence

Config. level ➔ Operating mode — Power controller ➔ — Small arrows between words are designed to make it easier to find parameters in the configuration level.

1.2.4 Display types

Keys

Keys are displayed as symbols or text.
Key combinations are represented by a plus sign.

1 Introduction

1.3 Order details

The nameplate is affixed to the right-hand side of the housing.

(1) Basic type

709061	TYA 201 single-phase thyristor power controller

(2) Version

8	Standard with default settings
9	Customer-specific programming according to specifications

(3) National language of device texts

01	German (default setting)
02	English
03	French

(4) Load current

020	AC 20 A
032	AC 32 A
050	AC 50 A
100	AC 100 A
150	AC 150 A
200	AC 200 A
250	AC 250 A

(5) Subordinate control loop (see note below)

100	**U, U ^{2}**
010	**I, I ^{2}** (can be set to U, U^2)
001	**P** (can be set to I, I^2 or U, U^2)

(6) Mains voltage[a]

024	AC 24 V	-20 ... +15 %, 48 ... 63 Hz
042	AC 42 V	-20 ... +15 %, 48 ... 63 Hz
115	AC 115 V	-20 ... +15 %, 48 ... 63 Hz
230	AC 230 V	-20 ... +15 %, 48 ... 63 Hz
265	AC 265 V	-20 ... +15 %, 48 ... 63 Hz
400	AC 400 V	-20 ... +15 %, 48 ... 63 Hz
460	AC 460 V	-20 ... +15 %, 48 ... 63 Hz
500	AC 500 V	-20 ... +15 %, 48 ... 63 Hz

(7) Interface

00	None
54	RS485/422
64	PROFIBUS-DP
84	EtherCAT/JUMO mTRON T system interface

(8) Extra code

252	Relay (changeover contact) 3 A
257	Optocoupler[b]

(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	/		-		-		-		-		-		/		**Order code**
709061	/	8	-	01	-	100	-	100	-	400	-	00	/	252	**Order example**

a. Mains voltage = Voltage supply for control electronics (always select **phase voltage** L1-L2 from the three-phase system for free-running economy circuits)

b. Enables energy meter

Note:
Subordinate control loop U2, code 100: voltage control
Subordinate control loop I2, code 010: enables voltage control, current control, partial load failure detection, dual energy management and current limiting, and energy meter
Subordinate control loop P, code 001: enables voltage control, current control, power control, partial load failure detection, dual energy management, current limiting, r-control and energy meter

At a load current of 250 A, observe voltage supply for fan!

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"

1.3.1 Scope of delivery

1 operating manual
1 thyristor power controller in the version ordered

1.3.2 Accessories

Item	Part no.
Setup program 709061 (TYA 201)	00544869
USB cable A-connector B-connector 3 m	00506252
Installation kits:	
Installation kit for DIN rail 20 A TYA 201	00555169
Installation kit for DIN rail 32 A TYA 201	00555526
Installation kit for DIN rail 50 A TYA 201	00600095

1.3.3 General accessories

Semiconductor fuses

A semiconductor fuse is fitted in the power controller to protect the thyristor module. The "Fuse LED" lights up red in the event of a fault.

⇨ Chapter 8.2 "Replacing a defective semiconductor fuse"

Item	Load current $I_{nom.} = I_N$	Part no.
Super fast semiconductor fuse 40 A	I_N = 20 A	00513108
Super fast semiconductor fuse 80 A	I_N = 32 A	00068011
Super fast semiconductor fuse 80 A	I_N = 50 A	00068011
Super fast semiconductor fuse 160 A	I_N = 100 A	00081801
Super fast semiconductor fuse 350 A	I_N = 150 A	00083318
Super fast semiconductor fuse 550 A	I_N = 200 A	00371964
Super fast semiconductor fuse 550 A	I_N = 250 A	00371964

1 Introduction

1.4 Brief description

Device

The JUMO TYA 201 is an enhancement to JUMO power controller technology. The microprocessor-controlled power controller shows all parameters on a display with background lighting and is operated using 4 keys at the front.

Application

Thyristor power controllers are used where larger resistive and inductive loads have to be switched (e.g. in industrial furnace construction and plastics processing). The thyristor power controller consists of two anti-parallel switched thyristors, the insulted heat sink, and the control electronics.

Mounting

All thyristor power controllers up to a load current of 32 A can be either clipped to a 35 mm mounting rail or fitted to the wall on a mounting plate. Devices with a load current greater than 32 A can only be mounted on the wall.

Operating modes

The keypad or setup program is used to select the phase-angle operation mode with adjustable current limiting, burst-firing operation, or half-wave operation.
In burst-firing mode, the phase angle of the first half-wave can be cut so that transformer loads can also be operated. In phase-angle operation mode, the phase angle specified by the controller is slowly reduced, starting from 180 degrees, in order to avoid high inrush currents (soft start).
Users are able to specify a base load or, depending on the device type, select current limiting or resistance limitation for the load.

Load types

All resistive loads through to inductive loads are permitted.In the case of transformer loads, the nominal induction of 1.2 tesla must not be exceeded (value is 1.45 T in the case of mains overvoltage).

Subordinate control loop

Depending on the device type, U, U^2, I, I^2, or P controls are available as subordinate control loops. Variations in the mains voltage therefore have no effect on the control-loop regulation during operation.

Standards

The thyristor power controllers comply with VDE 0160 5.5.1.3 (5/88) and VDE 0106 Part 100 (3/83). The devices must be grounded as specified by the responsible energy supplier.

Advantages

- Teach-In function for the detection of partial load failure
- Network load optimization through dual energy management
- Transmission of the setup data is possible even without voltage supply to the device (power supply via USB port)
- Energy meter

1.5 Standards, approvals, and conformity

Device properties are inspected on the basis of the Low Voltage Directive DIN EN 50178.
The EMC Directive is inspected on the basis of DIN EN 61326-1.

	Standard
Electrical connection	DIN VDE 0100
Protection type IP20 built-in devices	DIN EN 60529
Climatic ambient conditions	Class 3K3
Air temperature and rel. humidity	DIN EN 60721-3-3
Storage temperature class 1K5	DIN EN 60721-3-1
Operating conditions Pollution degree Overvoltage category	DIN EN 50178 2 III
Test voltages	DIN EN 50178
Residual current circuit breaker	DIN EN 50178
Electromagnetic compatibility Interference emission Interference immunity	DIN EN 61326-1 Class A- For industrial applications only Industrial requirements
Mechanical tests: Vibration test 3M2 Toppling test class 2M1	 DIN EN 60068-2-6, DIN EN 60721-3-3 DIN EN 60068-2-31, DIN EN 60721-3-2
Labels, identification marking	DIN EN 50178, DIN EN 61010-1

Approvals	**Standard**	**Type**
c UL us LISTED	UL 508 (Category NRNT), pollution degree 2 C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709061/X-XX-020-... Load current 20 A
	UL 508 (Category NRNT) C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709061/X-XX-032... 709061/X-XX-050... 709061/X-XX-100... 709061/X-XX-150... 709061/X-XX-200... 709061/X-XX-250... Load current 32 to 250 A
Can be used for current circuits with a short-circuit current capacity of ≤ 100 kA (the admissible mains voltage must correspond to the nominal voltage of the thyristor controller). For plant protection, a fuse up to class RK5 may be used.		

CE conformity	Low Voltage Directives 2006/95/EC Marking Directives 93/68/EEC EMC Directives 2004/108/EC	

Conformity	**Standard**
RoHS	2002/95/EC

1 Introduction

2.1 Important installation notes

Safety regulations

- The choice of cable material, the installation, and the electrical connection of the device must conform to the requirements of VDE 0100 "Regulations on the Installation of Power Circuits with Nominal Voltages below AC 1000 V" or the appropriate local regulations.
- The electrical connection must only be carried out by qualified personnel.
- An isolating switch should be wired between the voltage supply and the device to be able to disconnect the device from the voltage supply on all poles prior to accessing the inner parts of the device.
- Inside the device, safety clearances meet the requirements for double insulation.
  When mounting the connecting cable, ensure that the cables are fitted according to regulations and that the safety clearances are maintained.

Fuse protection

- Fuse protection of the voltage supply in accordance with the VDE regulations must be installed when wiring the voltage supply in the power section. The supply can also be protected with a circuit-breaker in the supply lead. The circuit-breaker must correspond to the power consumption of the power controller.
- The connecting cables used for the terminals U1, U2, N/L2, V, and L1 must have an electric strength of AC 500 V.
- For UL applications, the fuse for the supply protection of the control electronics must be between 2 A and a maximum of 5 A. This also applies to the fan connection.
- A semiconductor fuse is installed to protect the power controller in the event of a ground fault. In the event of a defect, these may only be replaced with original JUMO semiconductor fuses.

⇨ Chapter 8.2 "Replacing a defective semiconductor fuse"

Wiring

Control cables (SELV potential) must be routed so that they are isolated from cables with mains voltage potential. For supply protection, fuses (e.g. 2 A, Neozed type) must also be installed in the control circuit.

PE connection

* A direct protection conductor connection must be provided between the power controller and the PE conductor of the supply network. Connection takes place at the PE connection terminal.

The cross section of the PE conductor must be at least as large as the cross section of the voltage supply cables in the power section. In the event that the protective conductor is not a component of the supply lead or its encasement, the selected conductor cross section may not be less than 2.5 mm^2 (for mechanical protection) or not less than 4 mm^2 (if the protection conductor is not protected mechanically).

⇨ See VDE 0100 Part 540

Check

* That the data on the nameplate (mains voltage, load current) corresponds to the data for the plant.
* That the rotary electrical field has clockwise phasing if the economy circuit configuration is used.
* That the configuration of the analog inputs, for example, corresponds to the wiring.
* The analog input for the default setpoint specification in "Master-slave operation" only needs to be connected to the master. The slave receives its information via the 1:1 patch cable.
  However, the slave power controller can be disconnected separately by means of its own inhibit input.

Load connection

* The electronic switch (2 anti-parallel thyristors) is located between the U1 and U2 terminals.
* Where possible, load cables and cables for control inputs should be routed so that they are isolated.
* Connect the mains voltage - thyristor power controller - load in accordance with the connection diagram and check.

Phasing

The voltage supply of the control electronics and the load voltage must have the same phase.

Control inputs

The terminal strips for control connections (inputs and outputs) have been laid out for safe isolation from the mains voltage (SELV). To prevent the safe isolation from being impaired, ensure that all connected current circuits are also safely isolated. The required auxiliary supplies must be SELV voltages.

2.1.1 Environmental conditions

Incorrect use

The device is not suitable for installation in potentially explosive areas.

Mounting site

The power controller must be installed in a fire-proof control cabinet.
The cabinet should be vibration-free, free from aggressive media, and free from dust to prevent the ventilation slots from becoming blocked.

Climatic conditions

- Relative humidity: 5 to 85 %, no condensation (3K3 according to EN 60721)
- Ambient temperature range: 0 to 45 °C (3K3 according to EN 60721-3-3)
- Storage temperature range: -30 to +70 °C class 1K5

Avoid additional sources of heat

- Ensure that the ambient temperature at the installation site is not increased by other sources of heat or heat accumulation.
- Do not mount the power controller too close to the heating process (furnace)
- Avoid direct sunlight.

Power loss

Occurs as waste heat on the power controller's heat sink and must be dissipated at the mounting site (e.g. in the control cabinet) in accordance with the climatic conditions.

2.1.2 Filtering and interference suppression

To prevent radio-frequency interference, generated with a soft start in phase-angle operation for example, electrical apparatus and plants must have interference suppression implemented.

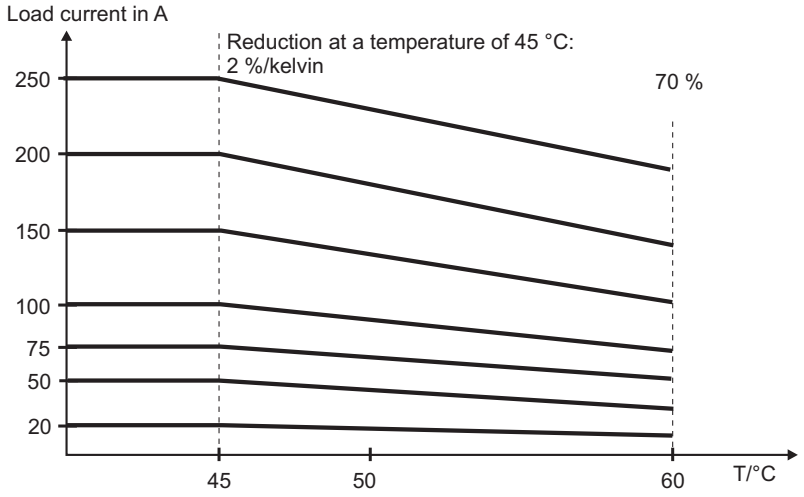
The control electronics of the thyristor power controller comply with the EMC requirements of EN 61326.

However, electrical modules such as thyristor power controllers do not have any purpose by themselves. They only serve as a component function within a plant.
Where applicable, the power controllers's entire load circuit must also have suitable interference suppression filters fitted by the plant provider.

There are a number of specialist companies that provide appropriate ranges of interference suppression filters to deal with any interference problems. These filters are normally supplied as complete modules that are ready to be connected.

2.1.3 Admissible load current depending on the ambient temperature and the site altitude

Ambient temperature



Destruction through overheating:

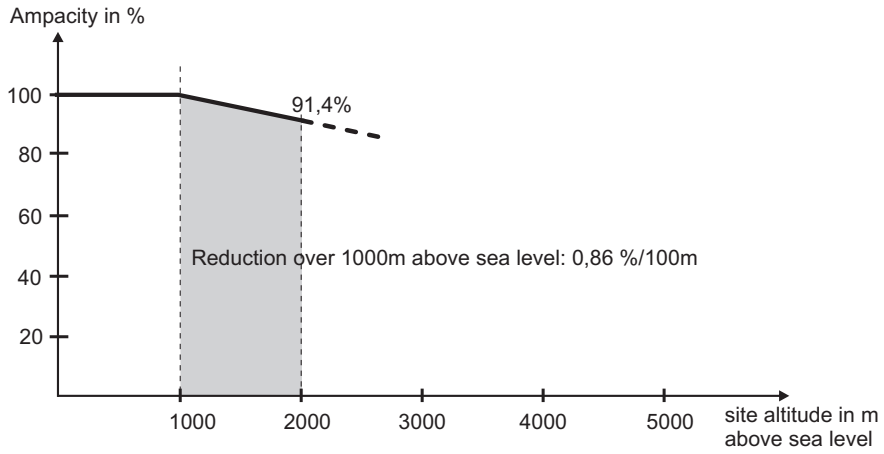
In the event of operation at maximum load current over an extended period, the heat sink and its surroundings heat up.
For this reason, at ambient temperatures above 45 °C, the maximum load current must be reduced as shown in the image, as the thyristor module would otherwise be destroyed.
The device temperature shown on the display may not exceed 100 °C.

At a device temperature of >100 °C, the message "Warning - high temperature" is displayed.
At a device temperature of >105 °C, the output level is gradually reduced by 10 % of the nominal current each time the temperature increases by one degree.
At a device temperature of >115 °C, the power controller is completely switched off.

⇨ Chapter 8 "Error messages and alarms"

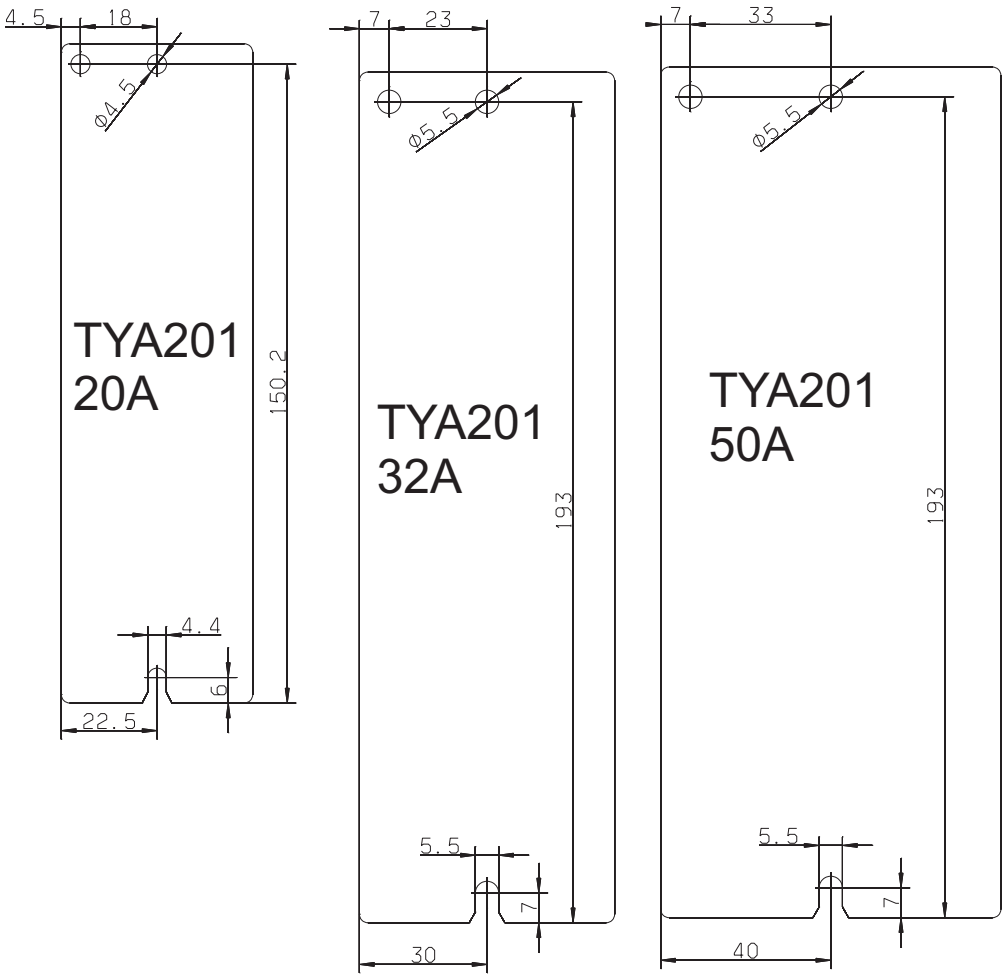
Site altitude

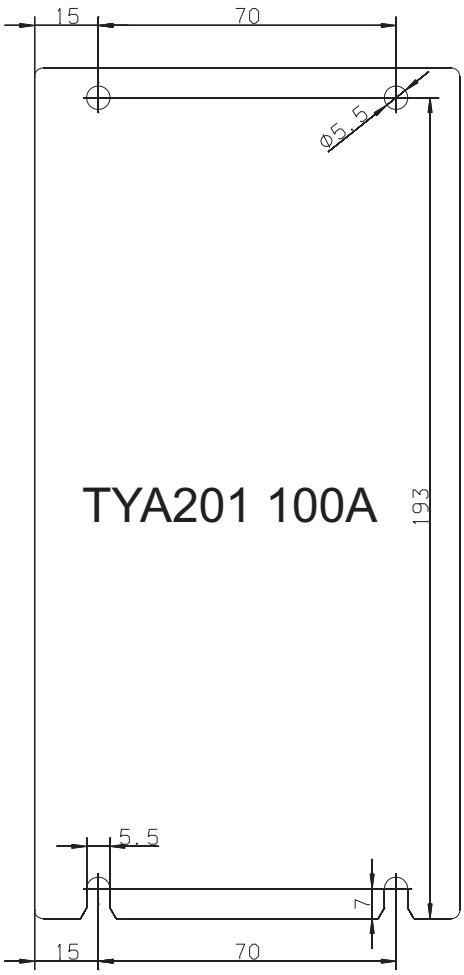
In the case of air cooling, it must be noted that the effectiveness of the cooling is reduced as the site altitude increases. As a result, the ampacity of the thyristor power controller decreases with such a cooler as the site altitude increases, as shown in the diagram.



2.1.4 Wall mounting with screws (default)

Power controllers with a load current between 20 and 50 A are affixed to a fireproof control cabinet wall with 2 screws. The left-hand hole is more easily accessible in the upper section.
Power controllers with a load current between 100 and 250 A are affixed with 4 screws.




15
70
Ø5.5
TYA201 100A
193
5.5
7
15
70


15
95
Ø8.6
TYA201 150/200A
325
8.6
12
15
95


15
95
Ø8.6
TYA201 250A
358
8.6
12
15
95

Hot surface

During operation, the power controller heats up to a maximum of 110 °C, depending on the load.
Ensure that the lamellae of the heat sink are vertically aligned to allow the heat to be dissipated through natural convection.

Fire hazard:

Do not install any heat-sensitive components or devices close to the power controller.

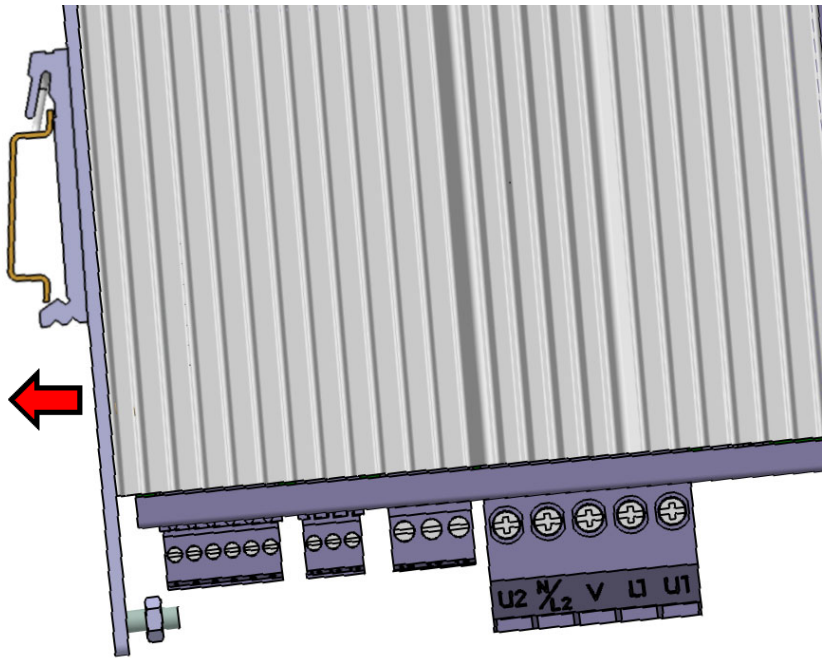
Integrated fan for 250 A power controller:
The intake air at the fan's ventilation grid may not exceed a maximum inlet air temperature of 35 °C. Ensure that the intake air for the integrated fans can be taken in from below and escape at the top without obstruction!

2.1.5 Mounting on DIN rail (accessories)

Power controllers up to 50 A can be affixed to a DIN rail using the corresponding accessories.

⇨ Chapter 1.3.2 "Accessories"

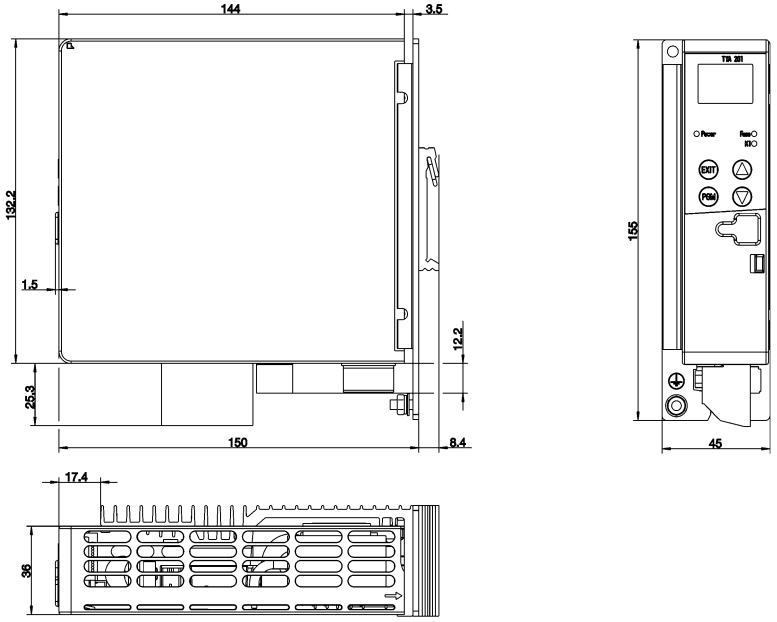
✱ Hook the spring saddle into the DIN rail from above.



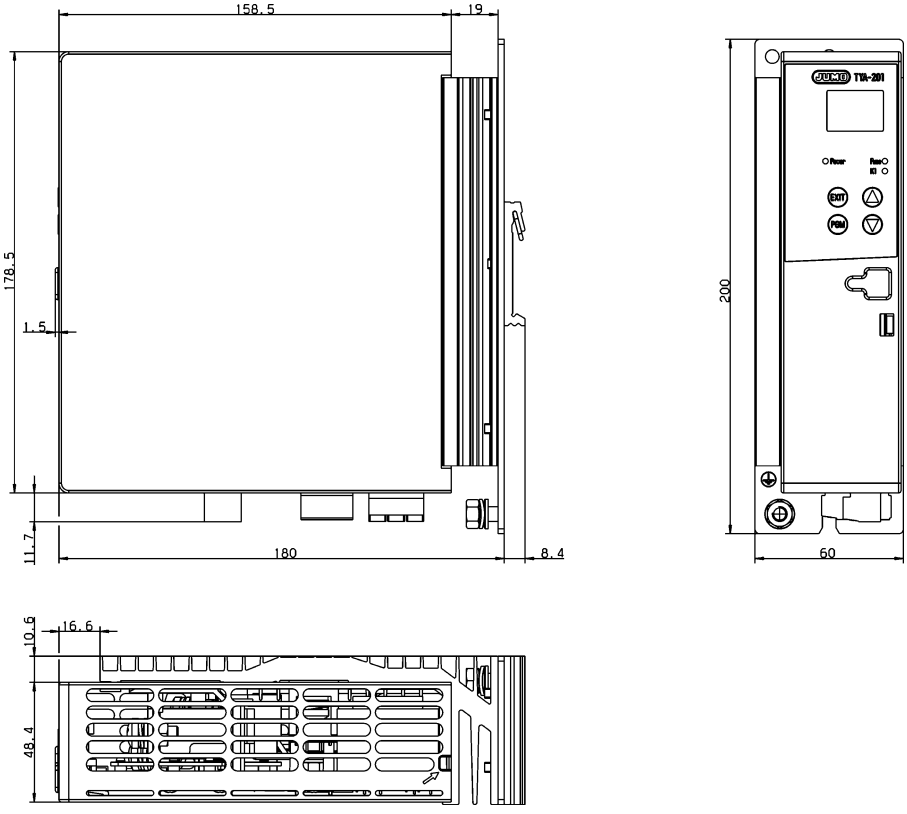
✱ Swivel the power controller downward until the lug engages with the DIN rail with an audible click.

2.2 Dimensions

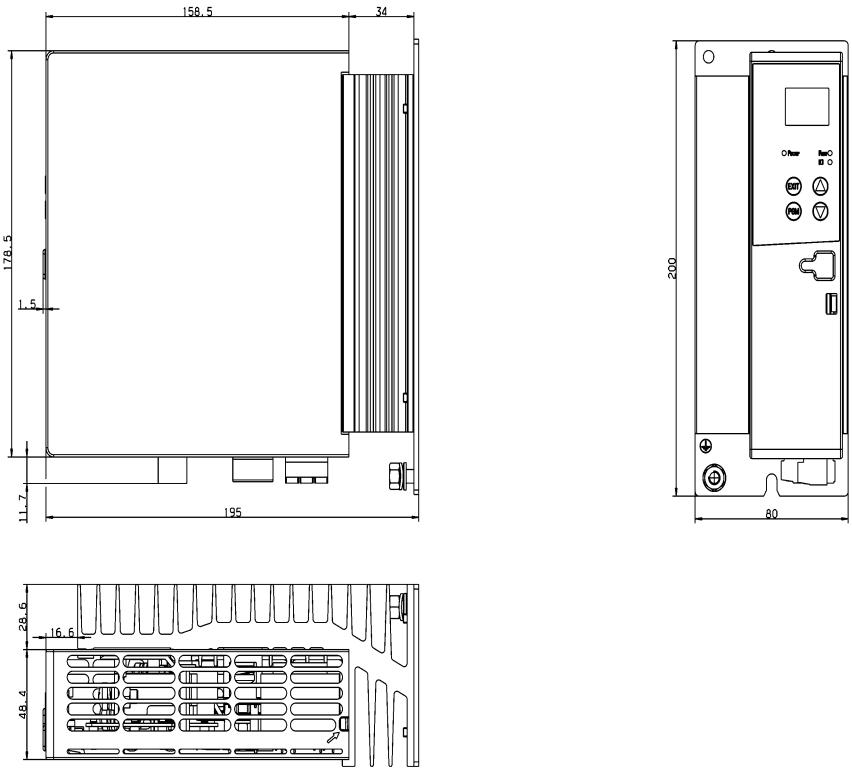
2.2.1 Type 709061/X-0X-020-XXX-XXX-XX-25X



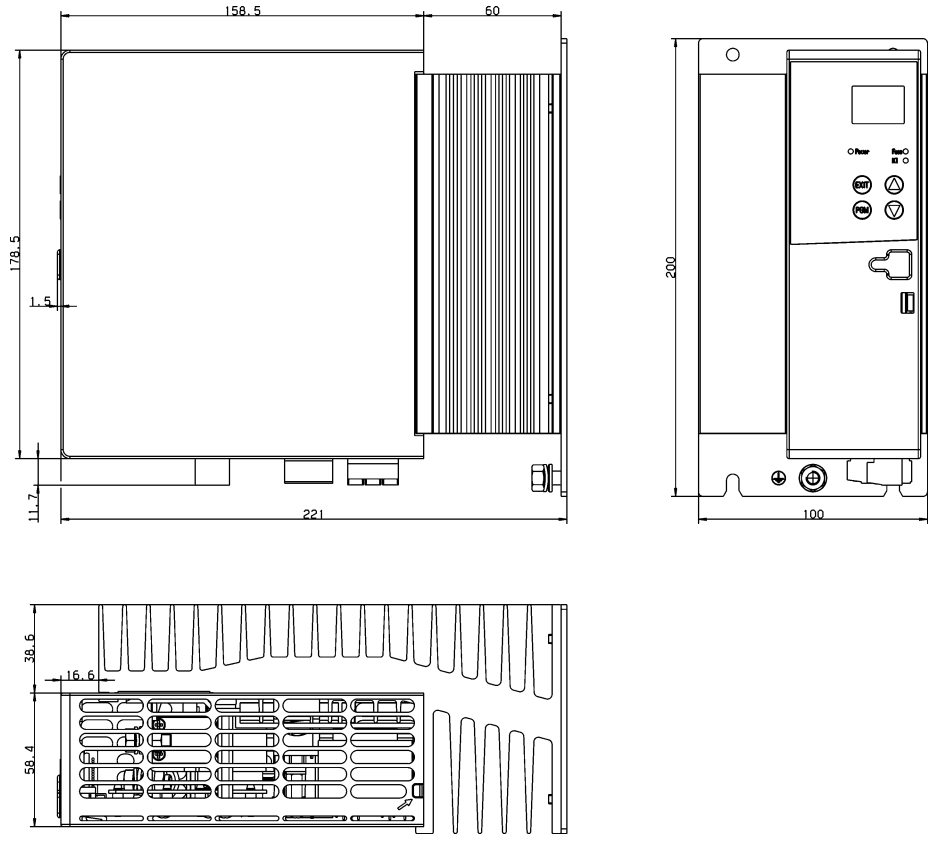
2.2.2 Type 709061/X-0X-032-XXX-XXX-XX-25X



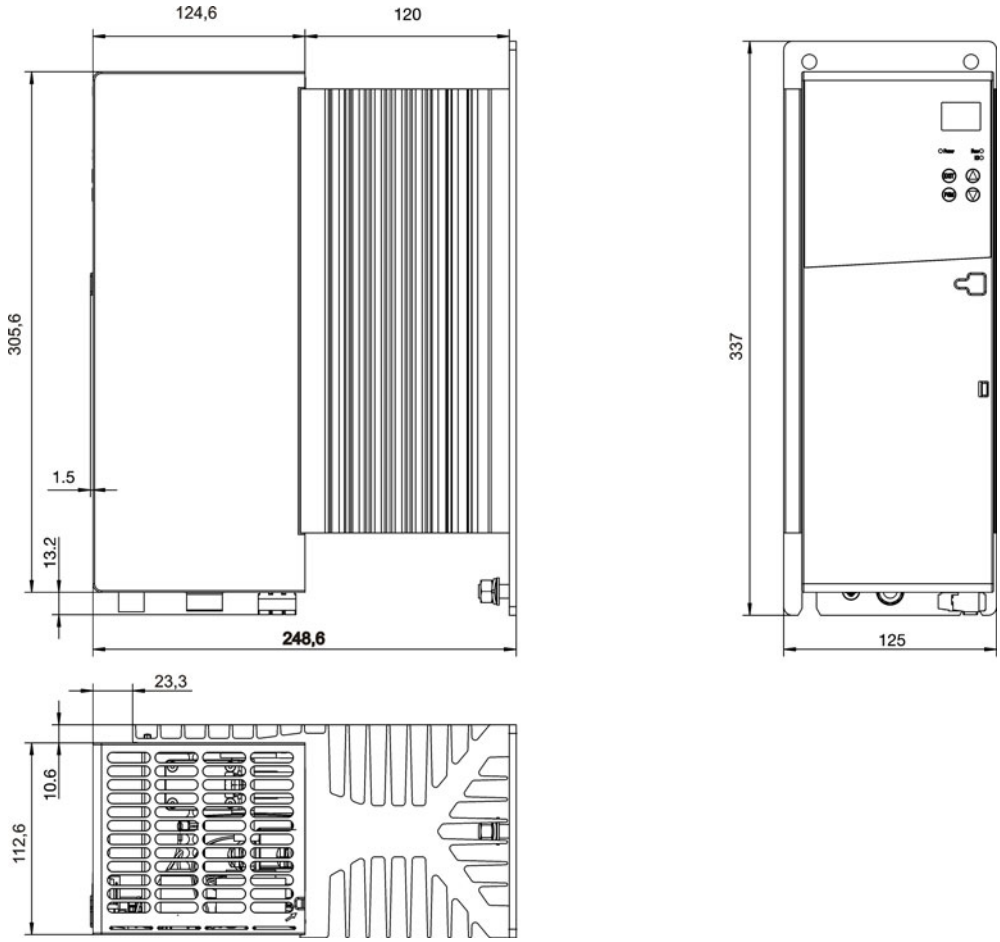
2.2.3 Type 709061/X-0X-050-XXX-XXX-XX-25X



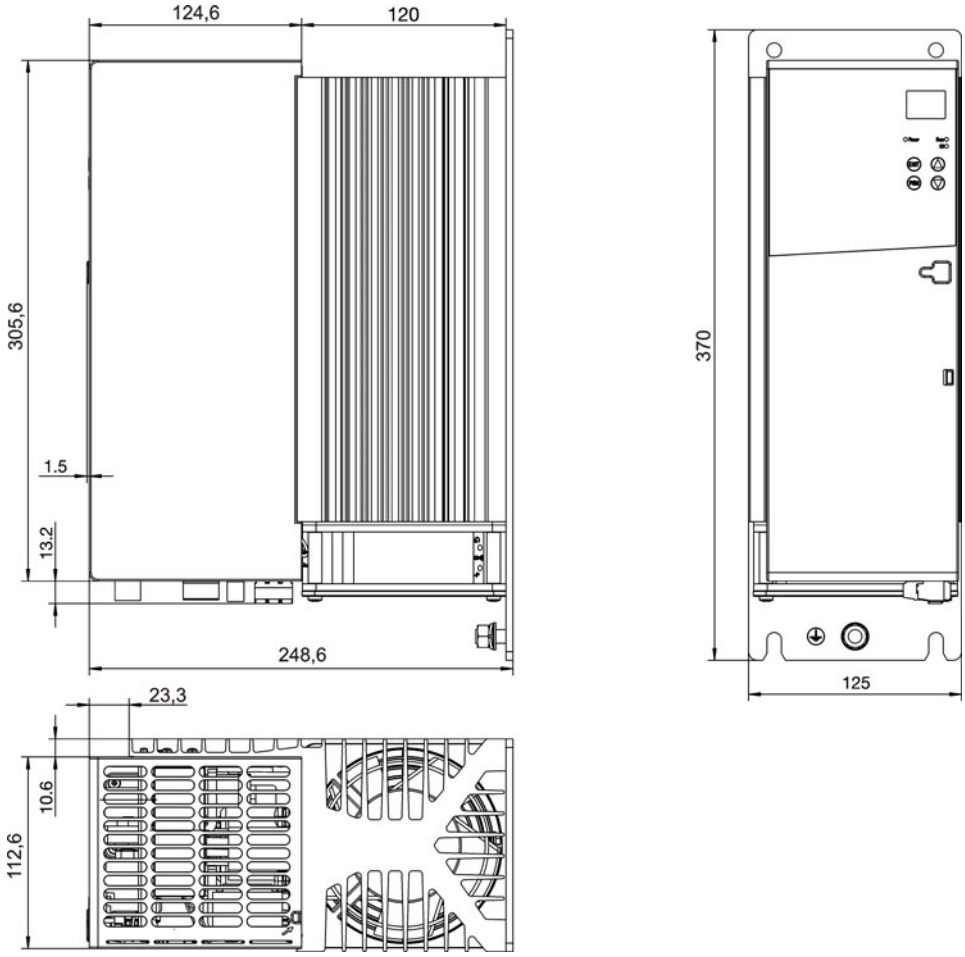
2.2.4 Type 709061/X-0X-100-XXX-XXX-XX-25X



2.2.5 Type 709061/X-0X-150-XXX-XXX-XX-25X
Type 709061/X-0X-200-XXX-XXX-XX-25X



2.2.6 Type 709061/X-0X-250-XXX-XXX-XX-25X



2.2.7 Clearances (all types)

- Allow a clearance of 10 cm from the floor.
- Allow a clearance of 15 cm from the ceiling.
- When fitted next to each other, no spacing between the devices is required.

Dangerous voltage

The electrical connection must only be carried out by qualified personnel! Dangerous voltages will cause an electric shock in the event of contact with live parts!

✱ Disconnect the plant from the mains voltage on all poles.

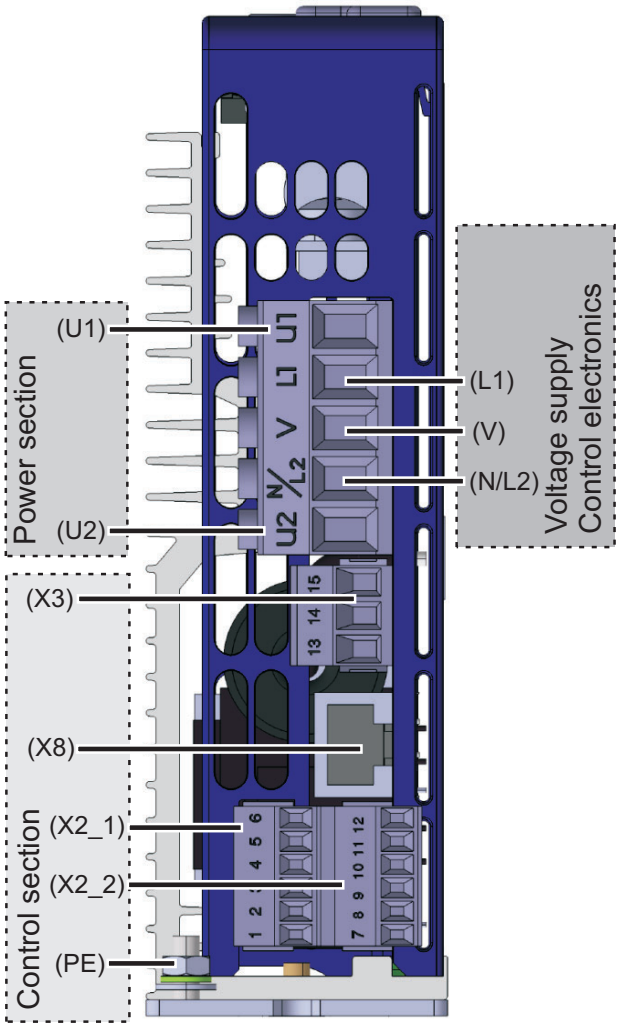
All **screw terminals supplied ex works must be inserted and screwed tight during operation!**

3.1 Plug-in screw terminals with 20 A

Tools - Flat-blade screwdriver, blade width 2, 3, and 5 mm

3.1.1 Type 709061/X-0X-20-XXX-XXX-XX-25X

The device with a load current of 20 A is connected via plug-in screw terminals.

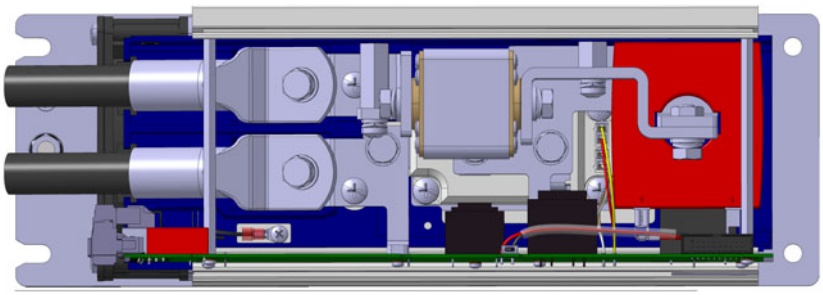


Terminal	Version	Conductor cross section	Maximum tightening torque
X2_1 and X2_2	Slotted screws, blade width 2 mm	0.2-1.5 mm^2	0.25 Nm
X3	Slotted screws, blade width 3 mm	0.2-2.5 mm^2	0.5 Nm
U2, N/L2, V, L1, U1	Slotted screws, blade width 5 mm	0.5-6 mm^2	0.6 Nm
For applications according to UL, only 60 °C or 60 °C / 75 °C copper conductors may be used!			
Ground terminal PE	M4 setscrew with hexagon nut Width across flats 7 mm	Cable lug with hole: 4 mm	3 Nm

3.2 Cable lugs and plug-in screw terminals as of 32 A

Tools

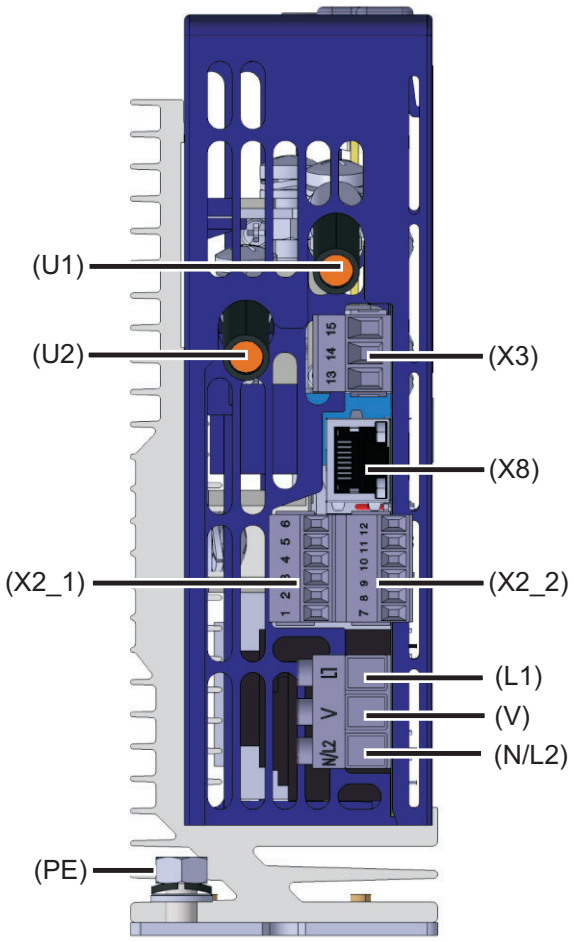
- Flat-blade screwdriver, blade width 2, 3, and 5 mm
- Ring or open-end wrench, width across flats 7, 10, 13 mm

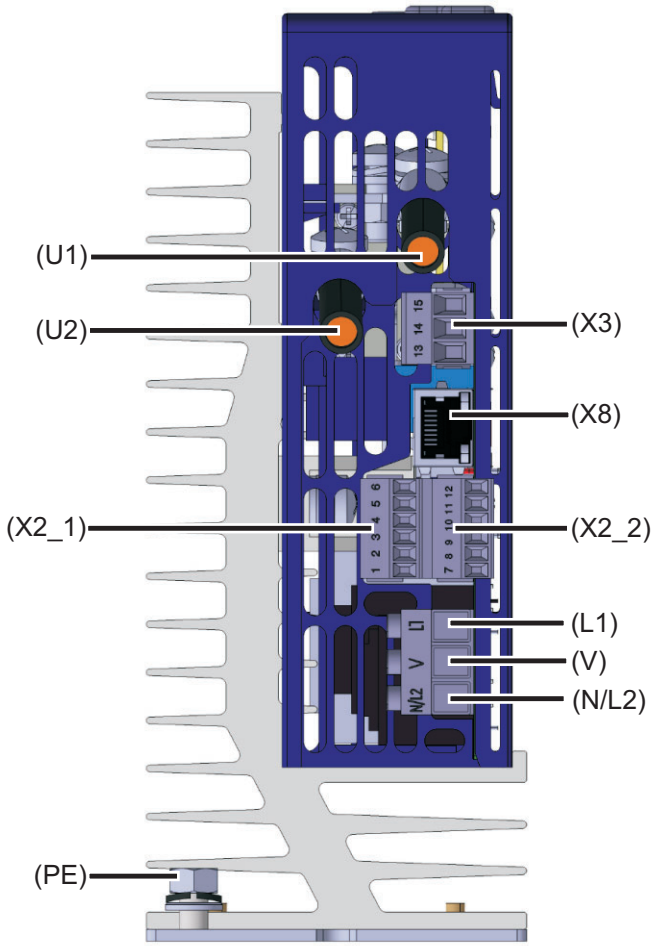


3.2.1 Type 709063/X-0X-032-XXX-XXX-XX-25X
Type 709063/X-0X-050-XXX-XXX-XX-25X

Devices with a load current of 32 A and 50 A are equipped with plug-in screw terminals in the control section and cable lugs in the power section.

Terminal	Version	Conductor cross section	Maximum tightening torque
X2_1 and X2_2	Slotted screws, blade width 2 mm	0.2 to 1.5 mm^2	0.25 Nm
X3	Slotted screws, blade width 3 mm	0.2 to 2.5 mm^2	0.5 Nm
U2, U1	M6 recessed head screws	6 to 25 mm^2	5 Nm
For applications according to UL, only 60 °C or 60 °C/75 °C copper conductors may be used!			
N/L2, V, L1	Slotted screws, blade width 3 mm	0.5 to 4 mm^2 or (0.5 to 2.5 mm^2 with ferrule) For UL AWG 20-12)	0.5 Nm
Ground terminal PE	M6 setscrew with hexagon nut Width across flats 10 mm	Cable lug hole: 6 mm	5 Nm

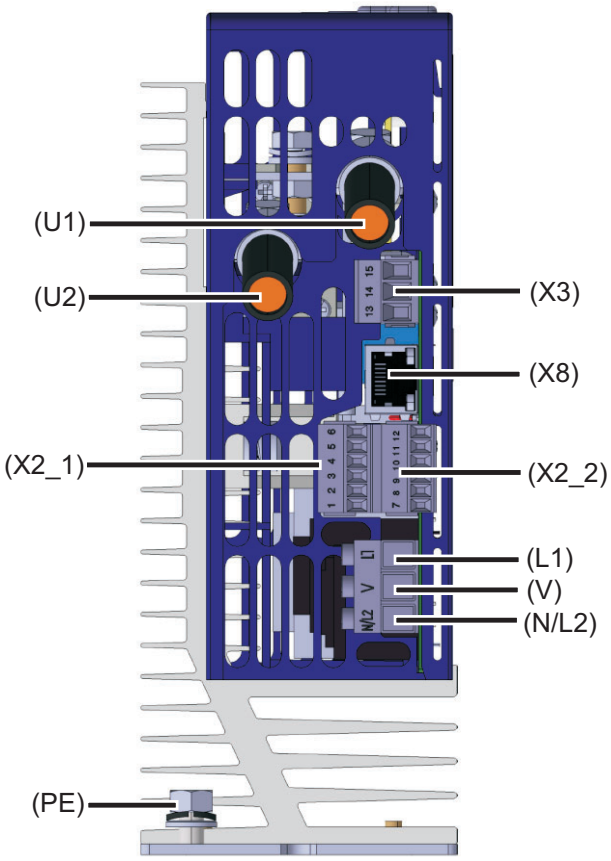



(U1)
(U2)
(X3)
(X8)
(X2_1)
(X2_2)
(L1)
(V)
(N/L2)
(PE)
L1
V
N/L2

3.2.2 Type 709061/X-0X-100-XXX-XXX-XX-25X

Devices with a load current of 100 A are equipped with plug-in screw terminals in the control section and cable lugs in the power section.

Terminal	Version	Conductor cross section	Maximum tightening torque
X2_1 and X2_2	Slotted screws, blade width 2 mm	0.2 to 1.5 mm^2	0.25 Nm
X3	Slotted screws, blade width 3 mm	0.2 to 2.5 mm^2	0.5 Nm
U2, U1	M6 hexagon screws, width across flats 10 mm	16 to 50 mm^2	5 Nm
For UL applications, use only 75 °C copper conductors!			
N/L2, V, L1	Slotted screws, blade width 3 mm	0.5 to 4 mm^2 or (0.5 to 2.5 mm^2 with ferrule) (for UL application AWG 20-12)	0.5 Nm
Ground terminal PE	M6 setscrew with hexagon nut Width across flats 10 mm	Cable lug hole: 6 mm	5 Nm



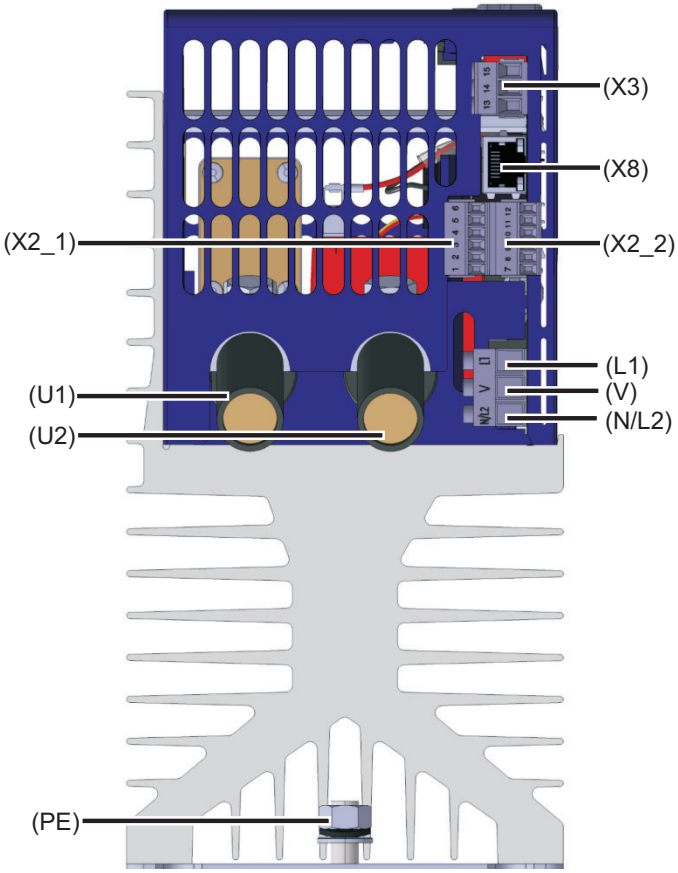
3.2.3 Type 709061/X-0X-150-XXX-XXX-XX-25X
Type 709061/X-0X-200-XXX-XXX-XX-25X

Devices with a load current of 150 A are equipped with plug-in screw terminals in the control section and cable lugs in the power section.

Terminal	Version	Conductor cross section	Maximum tightening torque
X2_1 and X2_2	Slotted screws, blade width 2 mm	0.2 to 1.5 mm^2	0.25 Nm
X3	Slotted screws, blade width 3 mm	0.2 to 2.5 mm^2	0.5 Nm
U2, U1	M8 hexagon screws, width across flats 13 mm	95 to 150 mm^2	12 Nm
For UL applications, use only 75 °C copper conductors!			
N/L2, V, L1	Slotted screws, blade width 3 mm	0.5 to 4 mm^2 or (0.5 to 2.5 mm^2 with ferrule) (for UL application AWG 20-12)	0.5 Nm
Ground terminal PE	M8 setscrew with hexagon nut, width across flats 13 mm	Cable lug hole: 8 mm	12 Nm

Interfaces

The connection for Modbus, RS422/485 is located on the front panel.

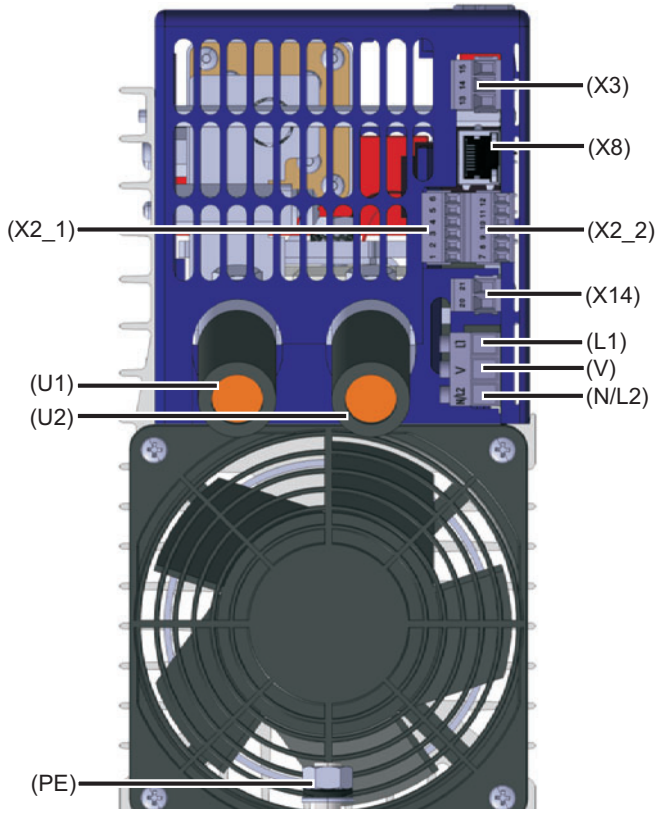


3.2.4 Type 709061/X-0X-250-XXX-XXX-XX-25X

Devices with a load current of 200 to 250 A are equipped with plug-in screw terminals in the control section and cable lugs in the power section.

Terminal	Version	Conductor cross section	Maximum tightening torque
X2_1 and X2_2	Slotted screws, blade width 2 mm	0.2 to 1.5 mm^2	0.25 Nm
X3	Slotted screws, blade width 3 mm	0.2 to 2.5 mm^2	0.5 Nm
U2, U1	M8 hexagon screws, width across flats 13 mm	95 to 150 mm^2	12 Nm
For UL applications, use only 75 °C copper conductors!			
N/L2, V, L1	Slotted screws, blade width 3 mm	0.5 to 4 mm^2 or (0.5 to 2.5 mm^2 with ferrule) (for UL application AWG 20-12)	0.5 Nm
Ground terminal PE	M8 setscrew with hexagon nut, width across flats 13 mm	Cable lug hole: 8 mm	12 Nm
Fan X14	Slotted screws, blade width 3 mm	0.5 to 2.5 mm^2	0.5 Nm

Interfaces The connection for Modbus, RS422/485 is located on the front panel



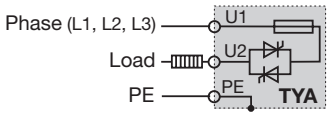
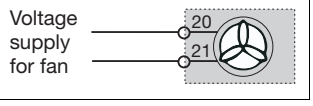
3 Electrical connection

Depending on the mains voltage, the fan terminal X14 must be supplied with the voltage specified below.
The lead protection must be between **2 A and a maximum of 5 A**.
The fan is temperature-controlled, switches on automatically when the device temperature reaches 85 °C, and remains in operation until the device temperature falls below 70 °C.

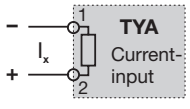
Voltage supply for fan

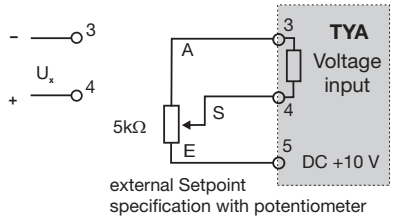
Mains voltage on the power controller	**Tolerances**	**Fan specifications**
Mains voltage AC 24 V	-20 ... +15 %, 48 ... 63 Hz	AC 24 V/30 VA
Mains voltage AC 42 V	-20 ... +15 %, 48 ... 63 Hz	
Mains voltage AC 115 V	-15 ... +10 %, 48 ... 63 Hz	AC 115 V/30 VA
Mains voltage AC 230 V	-15 ... +10 %, 48 ... 63 Hz	AC 230 V/30 VA
Mains voltage AC 265 V		
Mains voltage AC 400 V		
Mains voltage AC 460 V		
Mains voltage AC 500 V		

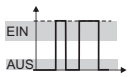
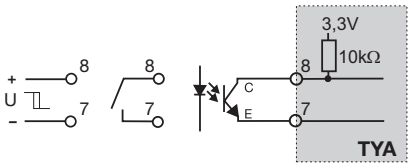
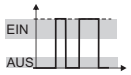
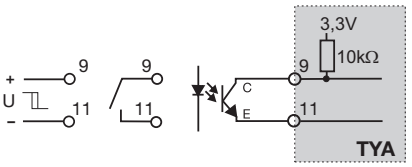
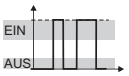
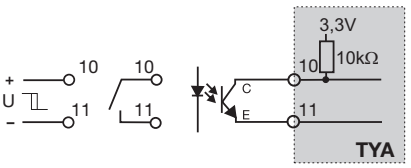
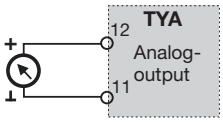
3.3 Connection diagram

Connection for	**screw terminals**	**screw terminal X2_1**
Voltage supply for **control electronics** (Corresponds to the mains voltage of the ordered device type)	L1 N/L2 V	1 2
Load connection in the **power section** and protective conductor connection	U1 U2 PE	
Fan X14	20, 21 (only for load current of 250 A)	

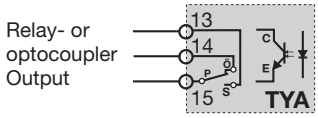
Control section

Connection for	**screw terminal X2_1**	**Connection side Device side**
Setpoint specification for current input	1 2	

Setpoint specification for voltage input (surge proof up to max. DC +32 V)	3 (GND) (for continous control) 4	 external Setpoint specification with potentiometer
Binary input SPS 0/24 V ON logical „1“ = DC +5...32 V OFF logical „0“ = DC 0...< 5 V	3 (GND) (for SPS-Logic signals) 4	
Output DC 10 V fixed voltage (max. +10 V, 2 mA)	5	
Ground potential	6 (GND)	

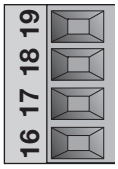
Connection for	**screw terminal X2_2**	**Connection side Device side**
Firing pulse inhibit  ON logical "1" = DC +2 to 32 V OFF logical "0" = DC 0 to +0.8 V	8 (not for SPS-Logic signals) 7 (GND)	
Digital input1  ON logical "1" = DC +2 to 32 V OFF logical "0" = DC 0 to +0.8 V	9 (not for SPS-Logic signals) 11 (GND)	
Digital input2  ON logical "1" = DC +2 to 32 V OFF logical "0" = DC 0 to +0.8 V	10 (not for SPS-Logic signals) 11 (GND)	
GND	7, 11	Ground potential
analog output Various internal controller variables can be output as a standard signal of 0(4) to 20 mA, 0(2) to 10 V, and 0(1) to 5 V. ⇨ Chapter 10.4 "Analog output (actual value output)"	12 11 (GND)	

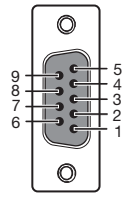
Fault signal output

Connection for	**screw terminal X3**	**Connection side Device side**
Relay or optocoupler	13 N/O contact or collector	
	14 N/C contact	
	15 pole or emitter	

3 Electrical connection

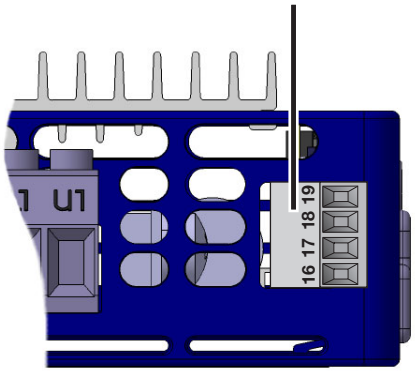
Interfaces

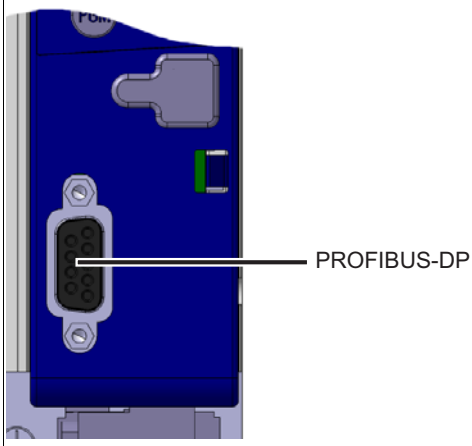
Connection	Modbus		RS422	RS485
Plug-in screw terminals on the bottom of the housing	19		TxD (-)	RxD/TxD B(-)
	18		TxD (+)	RxD/TxD A(+)
	17		RxD (-)	-
	16		RxD (+)	-

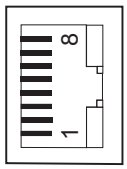
Connection	PROFIBUS-DP	
SUB-D socket 9-pin (on the front)	3 A(+)	
	8 B(-)	
	6 VCC	
	5 GND	
	Shield	

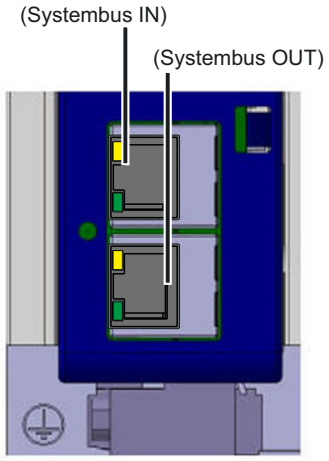
The shield of the Modbus cables must be routed to ground potential (PE)!

(RS422/485 Modbus)





Connection	System Bus JUMO mTRON T or EtherCAT conf. tested		
2 RJ-45 sockets (on the front)		1 TX+	Transmission data +
		2 TX-	Transmission data -
		3 RX+	Received data +
		6 RX-	Received data -



3.4 Switch-on sequence

Observe the general switch-on sequence

The **S2** switch is not required if no bus system is used.
The control section and power section are switched on simultaneously via switch **S1**.

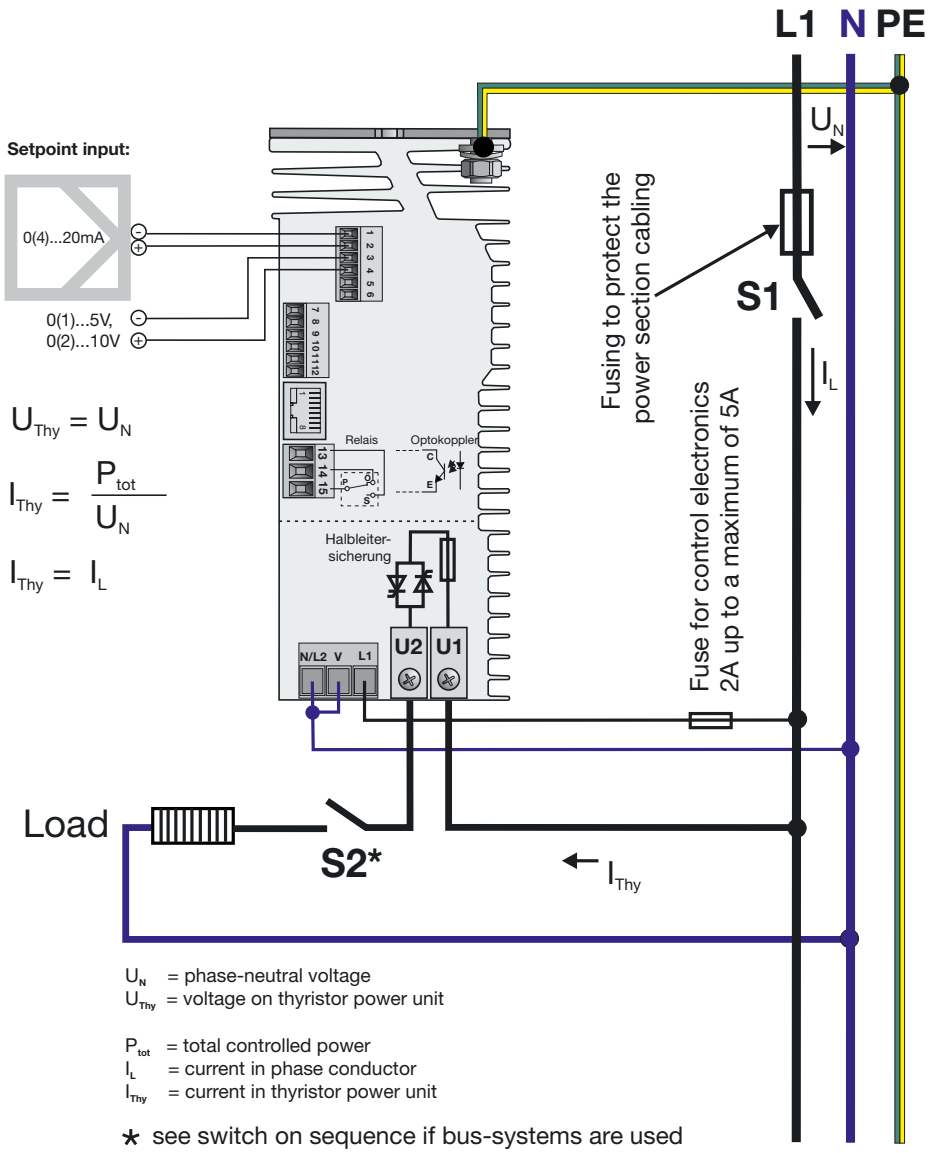
This is particularly important for the operation of transformer loads and resistance loads with a
high temperature coefficient (TC >> 1). This makes sure the necessary load start functions (soft start, current limiting, etc.) are activated accordingly.

Switch-on sequence when using bus systems

When using a bus system, the control section and power section are switched on via **S1** and **S2**.
The TYA's control section must remain connected to the mains voltage at all times (e.g. S1 permanently connected) to maintain the flield-bus communication.
S2 is used to activate the load.
In the event of transformer loads or loads with a large temperature coefficient (TC >> 1), the controller output must be blocked using the inhibit function prior to opening **S2**. After closing **S2**, the controller output must be reactivated via the inhibit function.

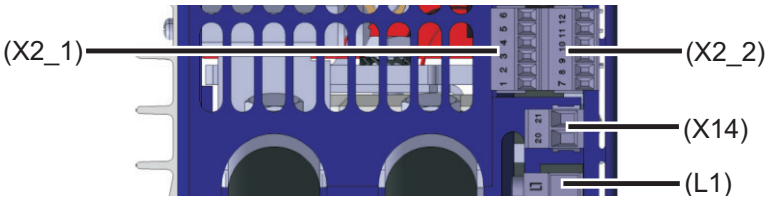
3.4.1 Single-phase operation: phase / N

This circuit example can only be applied in TN-Systems. In TT-Systems additionally the neural conductor has to be switched with S1 and S2.

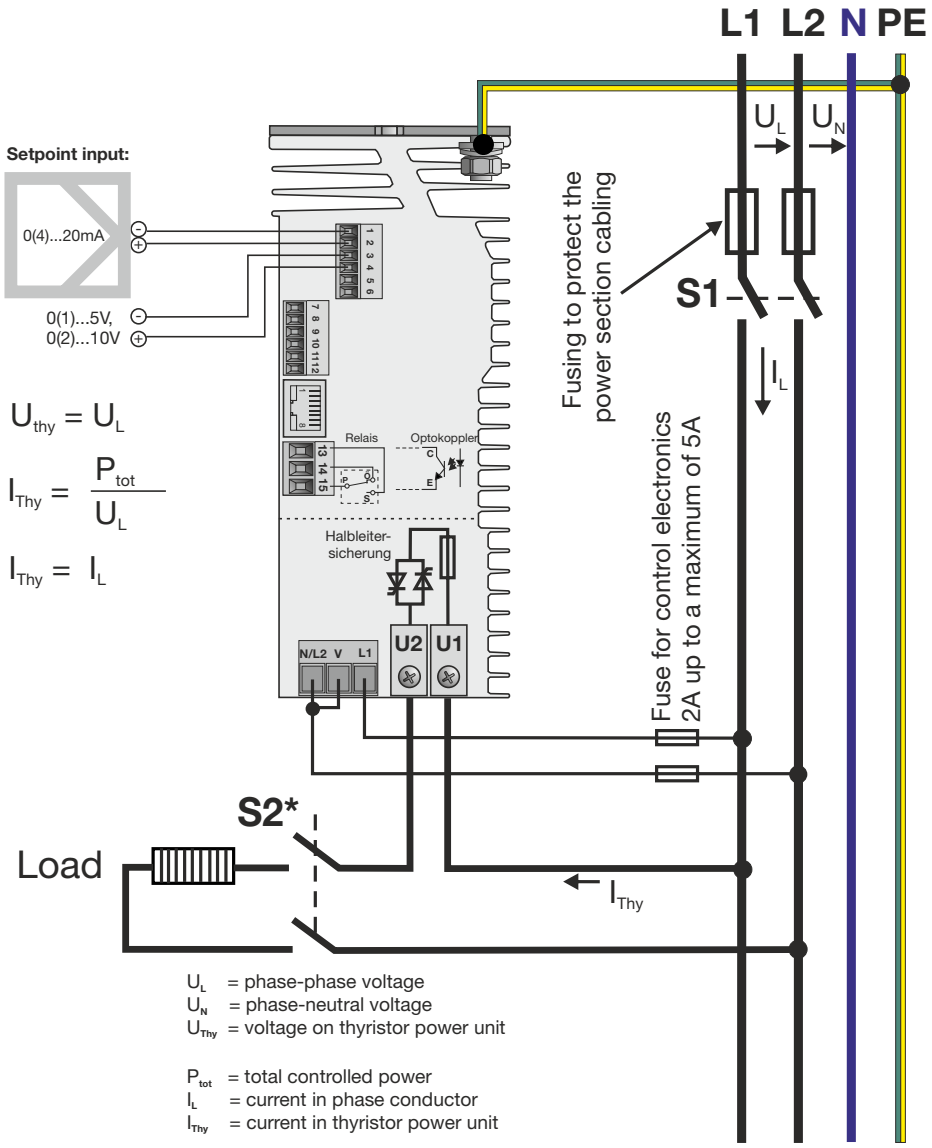


In the case of power controllers with a load current of 250 A, the fan terminal X14 must also be supplied with the specified voltage!
The lead protection must be between **2 A and a maximum of 5 A**.

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"

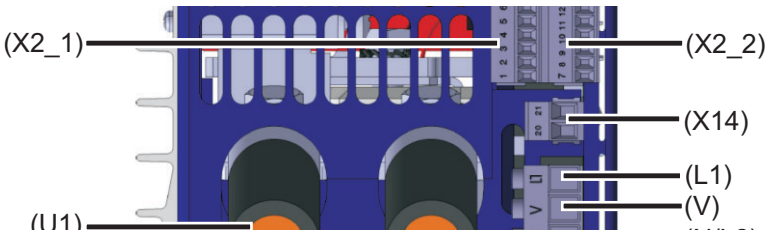


3.4.2 Single-phase operation: phase / phase



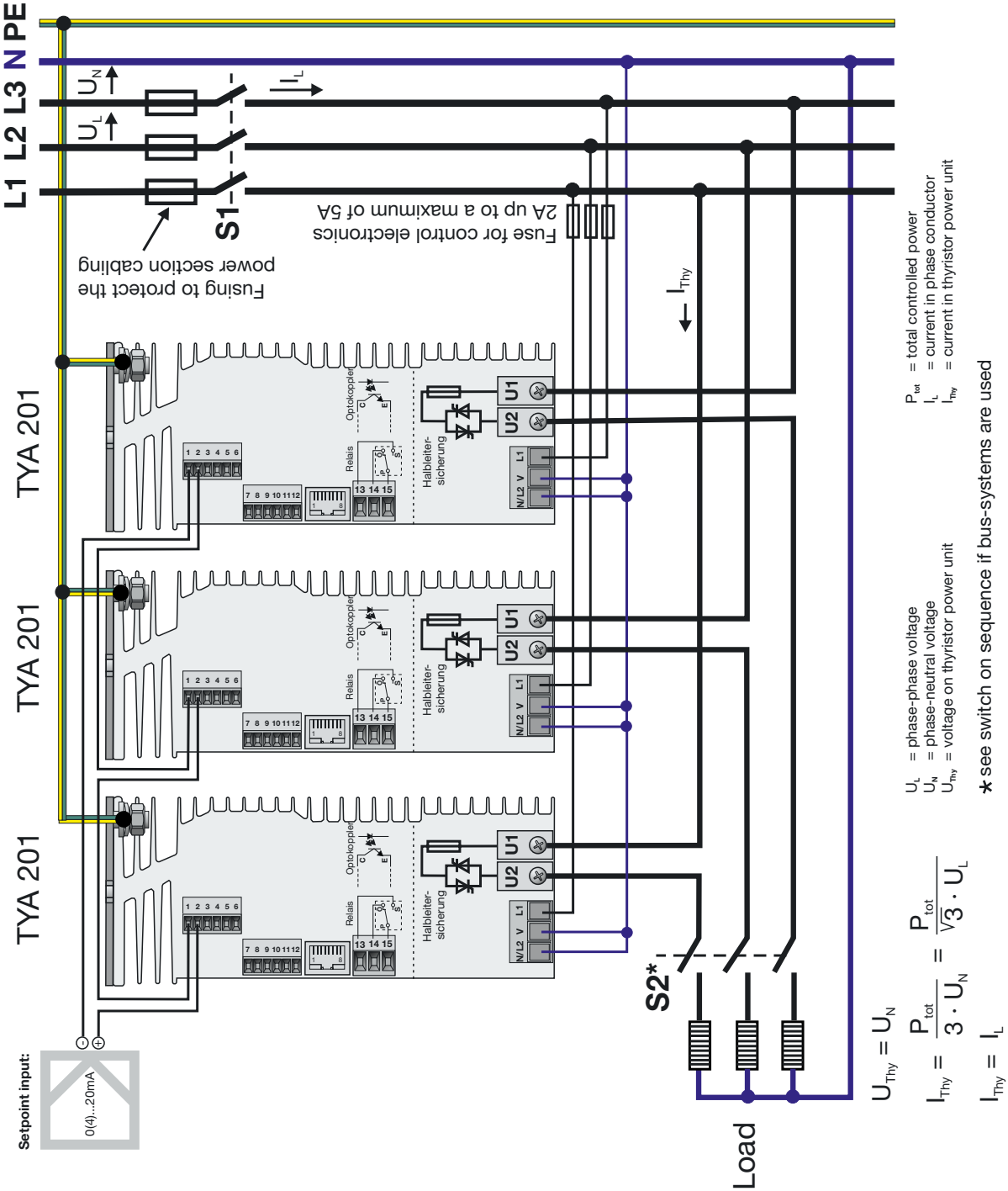
In the case of power controllers with a load current of 250 A, the fan terminal X14 must also be supplied with the specified voltage!
The lead protection must be between **2 A and a maximum of 5 A**.

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"



3.4.3 Star connection with accessible star point (N)

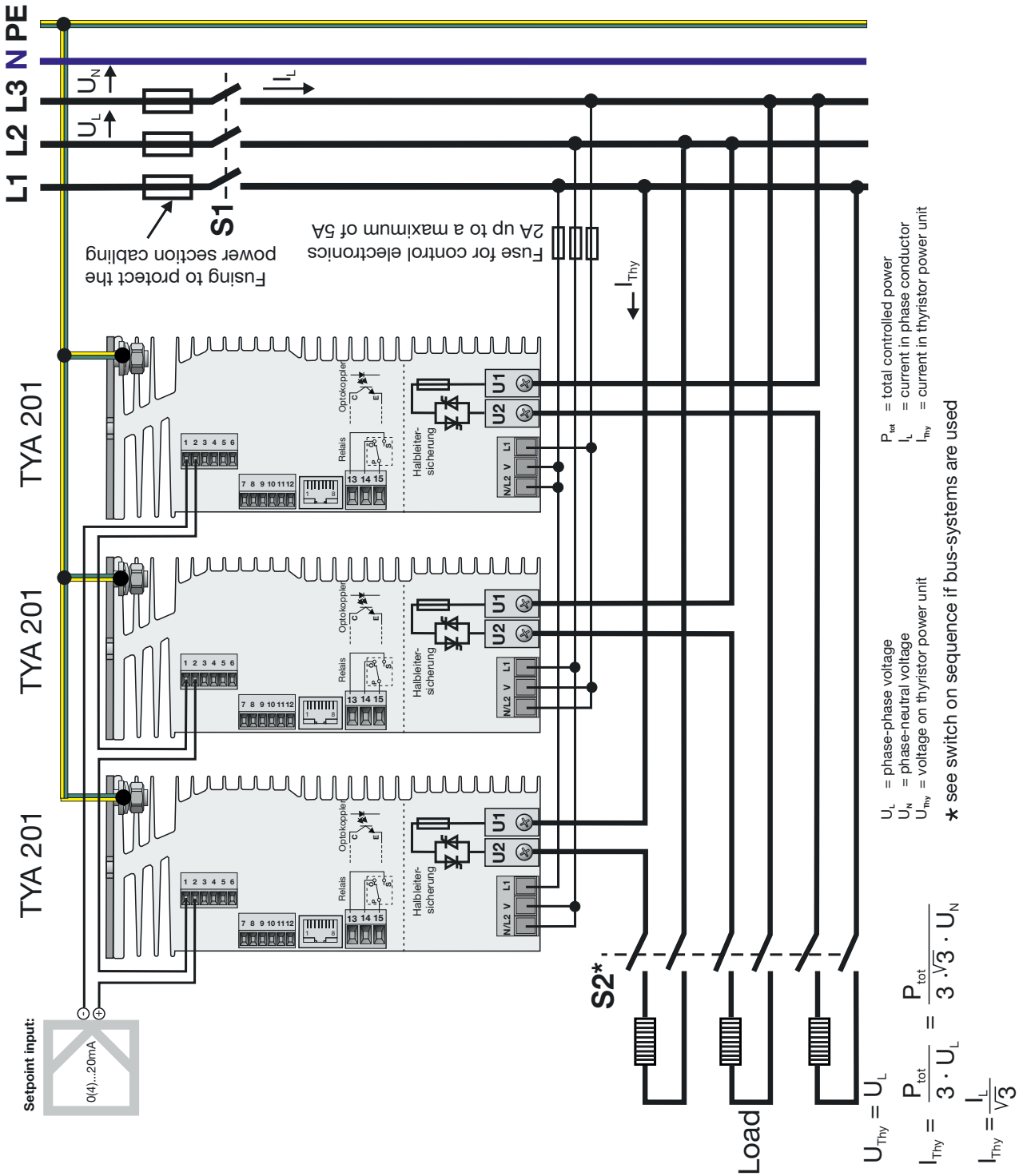
This circuit example can only be applied in TN-Systems. In TT-Systems additionally the neural conductor has to be switched with S1 and S2.



In the case of power controllers with a load current of 250 A, the fan terminal X14 must also be supplied with the specified voltage!
The lead protection must be between **2 A and a maximum of 5 A**.

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"

3.4.4 Open delta connection (six-wire connection)



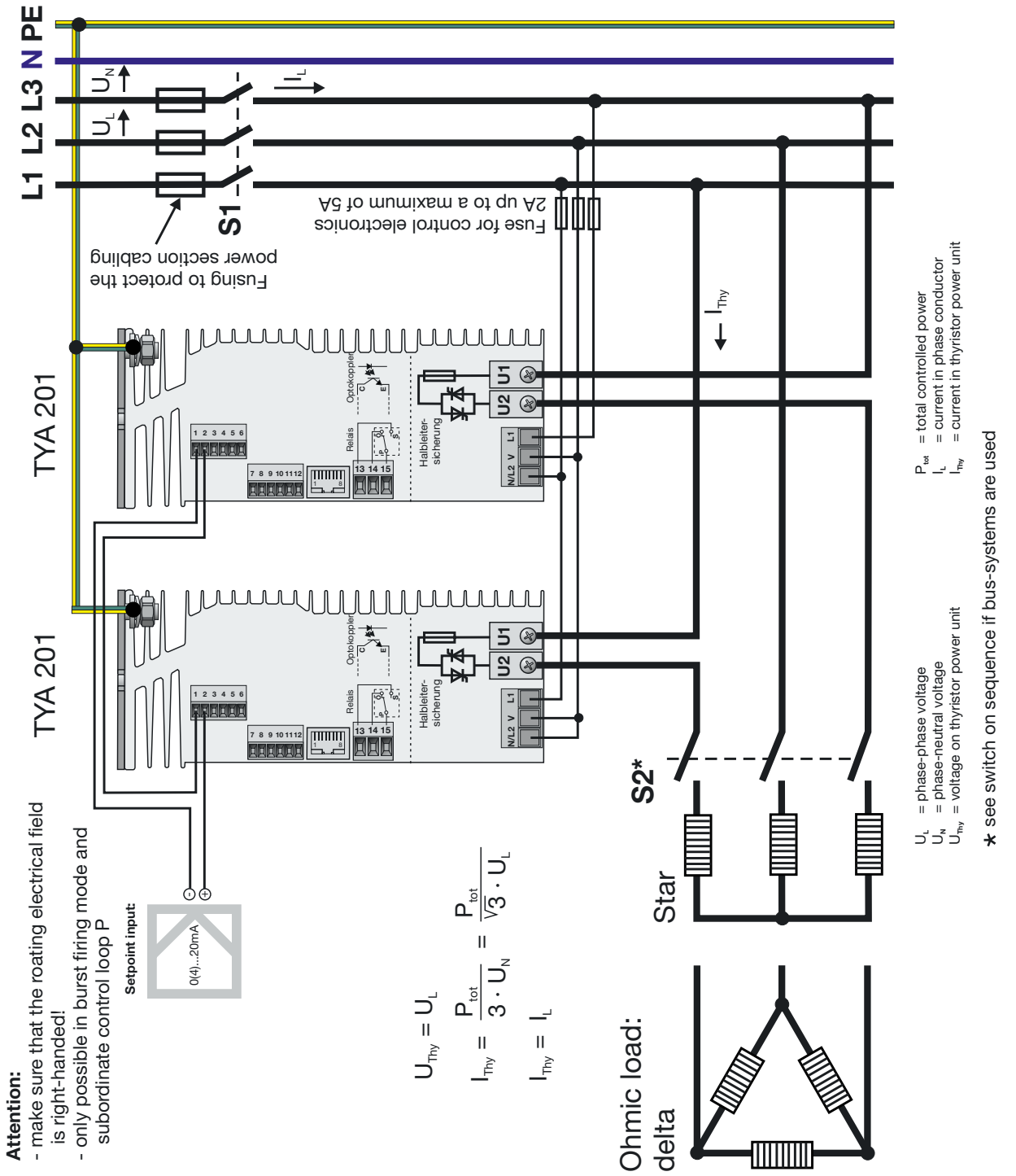
In the case of power controllers with a load current of 250 A, the fan terminal X14 must also be supplied with the specified voltage!
The lead protection must be between **2 A and a maximum of 5 A**.

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"

3 Electrical connection

3.4.5 Free-running economy circuit with purely resistive loads

No master-slave connection is needed for this electrical circuit.



In the case of power controllers with a load current of 250 A, the fan terminal X14 must also be supplied with the specified voltage!
The lead protection must be between **2 A and a maximum of 5 A**.

⇨ Chapter 3.2.4 "Type 709061/X-0X-250-XXX-XXX-XX-25X"

Advantages

The free-running economy circuit has the advantage that, on average, the supply voltage is subject to less impact stresses (asynchronous switching).
Both power controllers operate independently of each other and control the required 3-phase power precisely.

Even a possible partial load failure will not necessarily have an effect on the temperature stability of the control loop.

709061/X-XX-XXX-001-XXX-XX-XXX (code 001) is required in the order code for both power controllers.

3.4.6 Master-slave 3-phase current economy circuit for resistive loads in star/ delta connections, or transformer loads (resistive-inductive)

Important information:

The master-slave 3-phase current economy circuit is achieved with **version TYA 202 type 709062**.

The control electronics of the master power controller assume the actual power control function, and drive the slave power controller in synchronization.

This makes it possible to operate transformer loads.

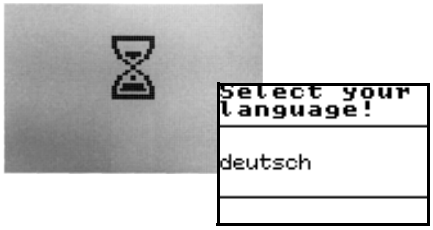
3 Electrical connection

4.1 Display after switching on the device

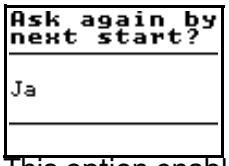
Hourglass and national language selection

As soon as the voltage supply is switched on, the Power LED first lights up permanently in green and an hourglass briefly appears on the display. The power controller then shows a range of language options on the display.

Select the national language and confirm your selection with PGM .



Language wizard



This option enables you to select whether the language wizard should be reactivated the next time the device is started.

Select "Yes" or "No", press PGM .

Measured values then appear on the device.

⇨ Chapter 4.1.2 "Appearance of measured values".

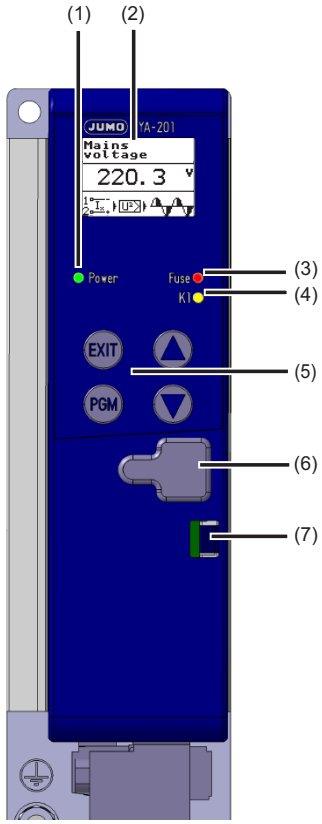
Error messages

The following chapter explains the error messages that may appear in the info line at the bottom of the screen:

Chapter 8 "Error messages and alarms"

4 Operation

4.1.1 Display and control elements

Legend	Comment	Diagram
1	The Power LED (green) lights up permanently when the voltage supply is connected. Flashes at regular intervals if the display lighting is switched off. ⇨ Chapter 9 "What to do, if ..."	
2	Display (96 x 64 pixels) with white background lighting. The information line at the bottom of the display shows the current settings and error messages.	
3	The Fuse LED (red) lights up if the semiconductor fuse is defective	
4	K1 LED (yellow) fault indicator	
5	**Keys:** ▲ Increase value / previous parameter ▼ Decrease value / next parameter EXIT Cancel / one level back PGM Programming / one level forward	
6	USB setup interface	
7	Spring clip to release the plastic housing ⇨ Chapter 8.2 "Replacing a defective semiconductor fuse"	

▲ and ▼ can be used to view the current measured values such as currents, actual voltage values, load resistance setpoint value, device temperature, and power.

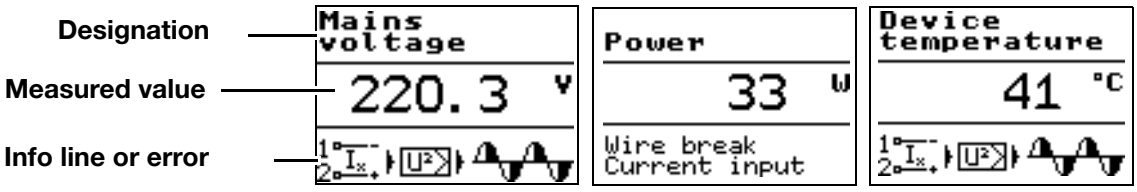
This information is also displayed in the diagnosis window for the setup program.

⇨ Chapter 7 "Setup program"

4.1.2 Appearance of measured values

Overview of measured values

At this level, the description of the measured value is displayed in the top line, and the numerical value together with the unit is displayed in the middle.



The info line shows the selected input (with terminal designation), the active subordinate control loop, and the operating mode.
It is also used to display temporary states (e.g. error messages).
⇨ Chapter 8 "Error messages and alarms"

Meaning of the symbols in the info line

Input signal		Subordinate control loop		Operating mode load output	
	Voltage		None		Phase-angle control
	Current		U^2		Soft start with phase-angle control
	Interface		I^2		Burst-firing operation
	Digital input1		U		Burst-firing operation with α start
	Digital input2		I		Half-wave control
	Input signal incorrectly configured		P		General logic
			Logic (switch)		Logic with α start
			Invalid control configured		Logic with α input
					Logic with α start and α input
					Firing pulse inhibit

4.1.3 Meaning of the displayed measured values

Measured value	Meaning	Unit
Mains voltage	Effective value of the measured mains voltage (Measured between the L1 and N/L2 terminals)	V
Load voltage[4]	Effective value of the measured load voltage (Measured between the V and U2 terminals)	V
Load current[1, 4]	Effective value of the measured load current	A
Power[1, 4]	Measured effective power	W or kW
Load resistance [1, 4]	Measured effective resistance	Ω
Output level[4]	Output value of the subordinate control loop	%
Setpoint value	Effective setpoint value for the subordinate control loop (with calculated base load and max. output level)	%
Actual value[2, 4]	Measured value as a percentage of the active control variable U^2, U, I^2, I, or P	%
Phase control angle[3, 4]	Currently output phase control angle	°el
Mains frequency	Currently measured mains frequency	Hz
Device temperature	Currently measured temperature inside the power controller	°C or °F
Current input	Measured value for the power controller's current input (Measured between terminals 1 and 2 on X2_1)	mA
Voltage input	Measured value for the power controller's voltage input (Measured between terminals 3 and 4 on X2_1)	V

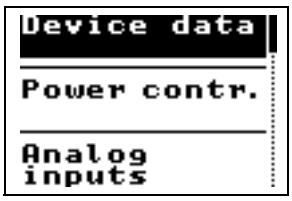
1. Is only displayed if the current transformer is fitted (option I^2- / I- or P control)
2. Is not displayed if the subordinate control loop is switched off
3. Is only displayed for phase-angle operation
4. Is not displayed in half-wave control operating mode

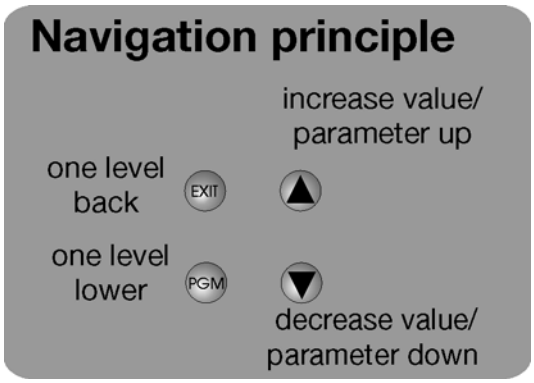
4.1.4 Appearance in the configuration level

Scroll bar

The entry highlighted in black is selected and contains further parameters. If there are more than three entries in one level, a scroll bar that shows the current position in the menu appears.

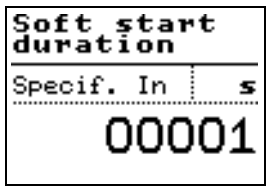
Navigation

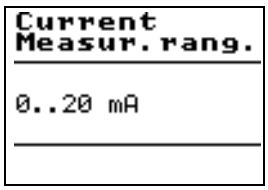




Numerical entry or selection

Once you have reached the required parameter, the ▲ or ▼ key can be used to enter a numerical value or to select a parameter.





* Save the setting using PGM.

If you do not wish to apply the value, the entry can be canceled by selecting EXIT.

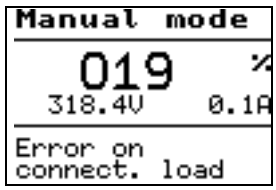
4.1.5 Appearance of error messages and special statuses

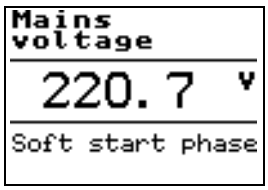
Cyclical appearance

The symbols for input, subordinate control loop, and operating mode are displayed alternately in the info line together with error messages or information about special statuses.

⇨ Chapter 8 "Error messages and alarms"

Examples

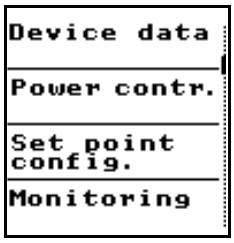




4 Operation

4.2 Operating level

All parameters for the maximum device extension level are listed in the following tables. Depending on the order details (see nameplate or device information) or the current configuration, parameters that are not required are hidden.



Here you will find the parameters that can be modified **during ongoing operation**.
They can be accessed without a password per default, but can also be protected with a 4-digit code if necessary.

⇨ Chapter 5.1.12 "Changing codes"

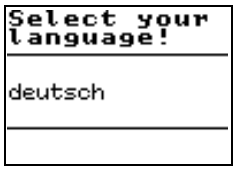
During ongoing operation, the power controller can be adapted to the plant and optimized.

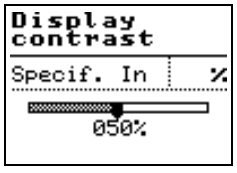
* In the measured value overview, press the PGM key
* Select the operating level and press PGM again

Editing a parameter

The changes are effective **immediately**.
Once the correct setting (e.g. for display contrast) has been found, the parameter can be stored by pressing PGM .
If you do not wish to apply the value, the entry can be canceled by pressing EXIT .

4.2.1 Device data

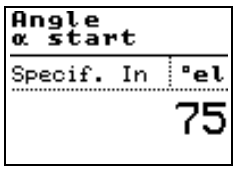
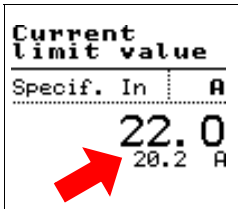
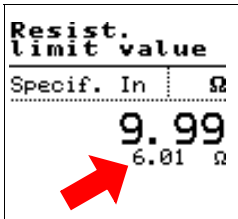




Value range	Description
deutsch english francais National language4	German (deutsch), English, and French (francais) are permanently stored in the device 1 additional national language can be subsequently loaded via Setup.
0...**50**...100 %	50 % is set per default.
0000 to 1440 min	0000 minutes are set per default, which means the display is not switched off.

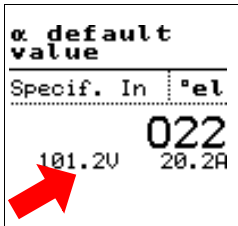
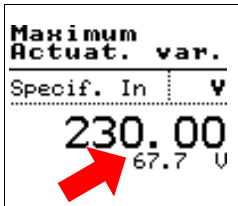
■ / **bold** = default setting

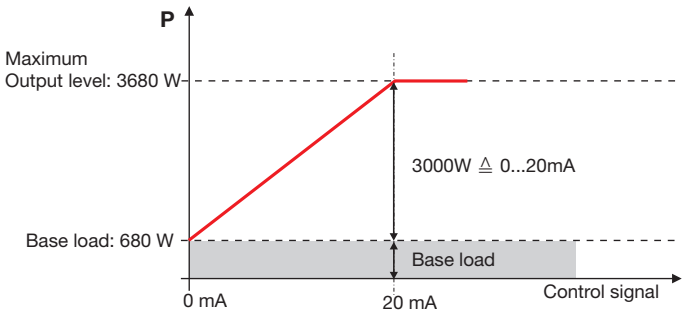
4.2.2 Power controller

	Value range	Description
	0 to **75** to 90° el	75° el is set per default. If "α start" is set to "No" in the configuration, this window is not displayed and α start is set to 0° el.
 Current load current	10 % to **max. load current for the device type** +10 %	**Current limiting:** It is possible to modify the current limit value in phase-angle operation mode during operation. This window is not displayed if "Current limiting" is set to "No" in the configuration.
 Current resistance	0 to **999.99** Ω	**Resistance limitation:** Indirect temperature limit for a heating element with a positive temperature coefficient.

■ / **bold** = default setting

4.2.3 Setpoint value configuration

	Value range	Description
 Current load voltage and current	**0** to 180 °el	In **logic operation**, the phase angle of each sine wave can be varied. This means that excessive electrical impact stresses on the load can be prevented.
 Current load voltage	0 to $\mathbf{U_{nom.}}$ to 1.15 $U_{nom.}$ of the load voltage, 0 to $\mathbf{P_{nom.}}$ to 1.15 $P_{nom.}$ of the power 0 to $\mathbf{I_{nom.}}$ of the max. load current 0 to **100** % of the output level	In the case of **continuous** thyristor control via the analog input, the maximum actuating variable at the measuring range end (e.g. 20 mA) can be varied during operation. The displayed value depends on the "Subordinate control loop" setting: U^2 and U: display in V (example: 0 to **230** to 264.5 V) P: display in W (example: 0 to **4600** to 5290 W) I^2 and I: display in A (example: 0 to **20** A) None: display in % (example: 0 to **100** %)

Basic load Specif. In V 000.00 30.1 V Current load voltage	**0** to U_{nom} of the load voltage, **0** to P_{nom} of the power **0** to $I_{nom.}$ of the max. load current **0** to 100 % of the output level	**Note:** This setting is only available if Power controller ➔ Thyristor control ➔ Continuous (power controller) is selected. The **unit** depends on the setting for the subordinate control loop and device type: ⇨ Chapter 1.3 "Order details" - With voltage: **0** to 100% of max. load voltage (e.g. **0 V**) - With current: **0** to 100% of max. load current (e.g. **0 A**) - With power: **0** to 100% of power (e.g. **0 W**) - None: **0** to 100 % of output level (e.g. **0 %**) **Note:** The following applies when selecting the maximum actuating variable for **free-running economy circuits**: - Each power controller regulates **half** the three-phase power during P-control 

■ / **bold** = default setting

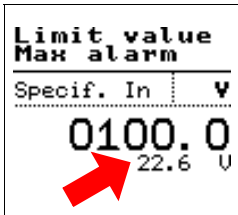
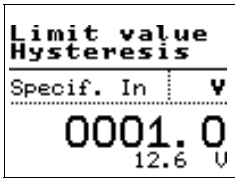
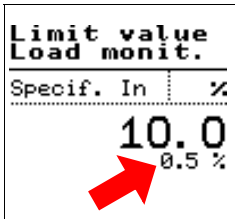
4.2.4 Monitoring

The value to be monitored can be adjusted.

⇨ Chapter 5.1.5 "Monitoring"

The load voltage was used in this example.

	Value range	Description
Limit value Min alarm Specif. In V 0020.0 17.1 V Current measured value	**0** to 9999.9	The **absolute** minimum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. ⇨ Chapter 5.1.5 "Monitoring" Example: An alarm is triggered if the voltage falls below 20 V.

 Current measured value	0 to **9999.9**	The **absolute** maximum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. ⇨ Chapter 5.1.5 "Monitoring" Example: An alarm is triggered if the voltage exceeds 100 V.
	0 ...**1** ... 9999.9	The **switching differential** at the minimum or maximum limit value
 Current deviation from teach-in. i.e. at > 0 % the load has become more high-resistance; at < 0 % the load is more low-resistance	0...**10**...100 %	**Partial load failure** or **partial load short circuit**: The monitoring value for the **percentage** of change to the load is selected (undercurrent or overcurrent). ⇨ Chapter 5.1.5 "Monitoring" By displaying the current deviation from the teach-in value, it is possible to check whether, for example, an output level-dependent resistance modification is present.

■ / **bold** = default setting

		This function is not configured per default. This window only appears if the following setting has been selected in the configuration level: * Press the PGM key to switch to the **configuration level** * Set Monitoring ➔ Teach-In type load monit. ➔ Manual * Press the PGM key The "Manual teach-in" function is now configured. * Change to the **operating level** ➔ Monitoring ➔ Load monit. Teach-In * Press the PGM key A screen now appears asking whether the state should be applied now. If so: * Press the PGM key to apply the current load state as the OK state. A change in the load (load error) will be evaluated by the device on the basis of this state.

■ / **bold** = default setting

4 Operation

5.1 Configuration level

The configuration level contains parameters for configuring the power controller.
If the parameters at this level are modified during operation, the power controller is locked (inhibit function) as a result. It does not provide any power in this state.

When exiting the configuration level with the EXIT key, the power controller continues operation with the modified parameters.

This level can be locked with a password.
However, no password is set per default.

☞ **All parameters** for the maximum device extension level are listed in the following tables. Depending on the device version (see nameplate) or configuration, parameters that are not required are hidden.

The configuration level can be accessed from the overview of measured values by pressing the following keys:

* In the measured value overview, press the PGM key
* Select the configuration level and press PGM

The parameters are combined in the following groups, which are explained in detail as sub-chapters in the tables on the following pages.

Parameter groups

Device data	⇨ Chapter 5.1.1 "Device data"
Power contr.	⇨ Chapter 5.1.2 "Power controller"
Analog inputs	⇨ Chapter 5.1.3 "Analog inputs"
Set point config.	etc.
Monitoring	
Binary inputs	
Binary output	
Act. val. output	
RS 422/ RS 485	⇨ see Chapter 5.1.9 "RS422/485"
PROFIBUS DP	⇨ see Chapter 5.1.10 "PROFIBUS-DP"
EtherCAT	⇨ see Chapter 5.1.11 "EtherCAT"
Change codes	

5.1.1 Device data

Basic settings for display and temperature unit.

	Value / settings	Description
Language wizard active	Yes	A query appears when the device is started, asking which national language is to be used to display the subsequent operation.
	No	No query appears
National language	German	
	English	
	French	
	Setup	Spanish is added to Setup per default. Spanish can be replaced with other national languages if needs be.
Temperature unit	°C	Defines the unit for the displayed temperatures, such as the device temperature.
	°F	
Display contrast	0...**50**...100 %	Bright/dark contrast setting
Switch-off Display lighting	**0000** to 1440 min	The background lighting for the display switches off once the selected number of minutes has passed. Power LED (green) flashes. 0000 means: lighting is always switched on
Apply default settings	Apply now?	The default settings are restored if the PGM key is pressed.

■ / **bold** = default setting

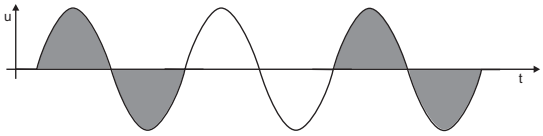
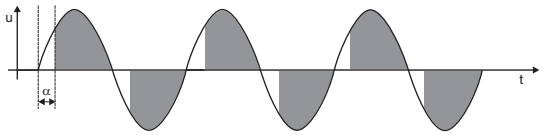
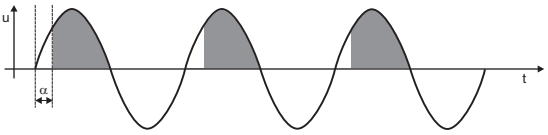
5.1.2 Power controller

Settings for the switching behavior of the power controller in the plant

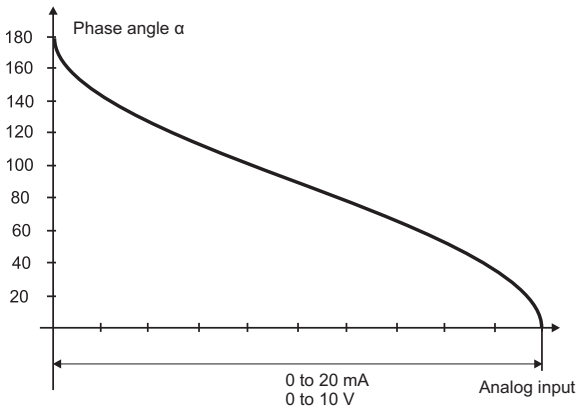
	Value / settings	Description
Mains switching variant	Single-phase operation	⇨ Chapter 3.4 "Switch-on sequence" or Chapter 3.4.2 "Single-phase operation: phase / phase"
	Free-running economy circuit	**Note:** - Check for clockwise phasing - Only possible with P-control (code 001 in order code) ⇨ Chapter 3.4.5 "Free-running economy circuit with purely resistive loads"
Thyristor control	Continuous (power controller)	The power controller provides the power for the load continuously according to the setpoint specification.
	Logic (switch)	**Note:** Subordinate control loop cannot be modified! The power controller acts like a switch and provides the power by either switching ON or OFF.

■ / **bold** = default setting

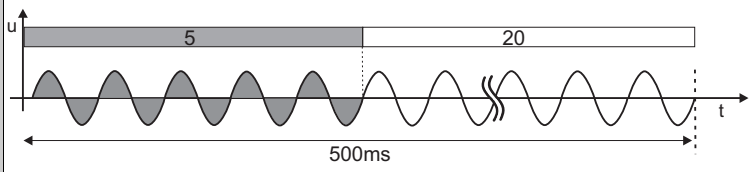
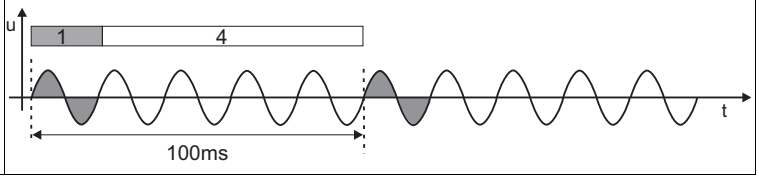
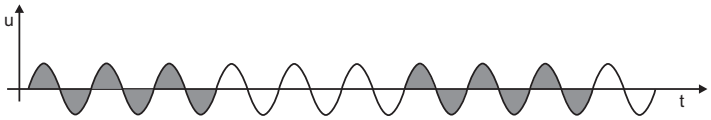
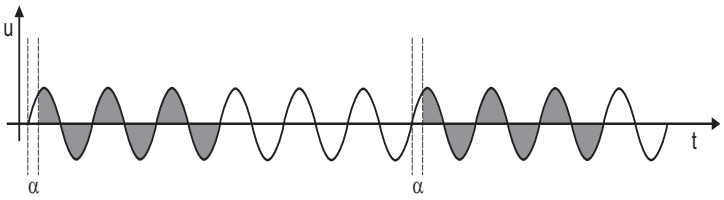
Operating mode
(Is displayed in the info line in the measured value overview level)

Value / settings	Description
Burst-firing mode	- For slow control loops - For free-running economy circuit - Low EMC interference through zero-voltage switching - No reactive power is generated 
Phase-angle control	- For fast control loops, such as lighting controls - No flickering 
Half-wave control	**Note:** Subordinate control loop cannot be modified! The half-wave control operating mode is only compatible with single-phase power controller operation. It is a special type of phase-angle operation mode used, for example, for vibrating magnets. In half-wave control, one thyristor branch remains permanently locked so that only the positive half-wave is allowed to pass through. The specified setpoint value is converted to a phase control angle of 180 °el. to 0 °el. In this operating mode, neither load voltage nor load current can be measured, which makes a subordinate control loop impossible. 

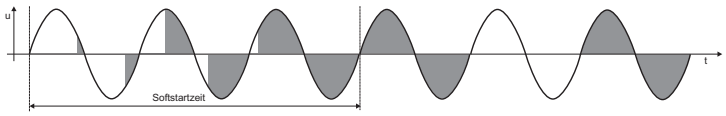
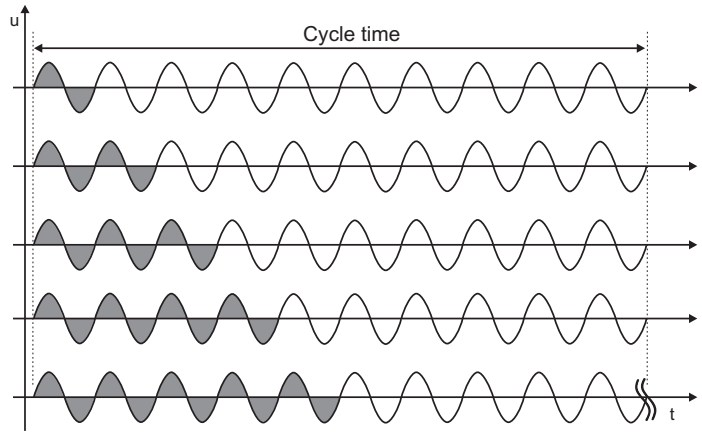
■ / **bold** = default setting

	Value / settings	Description
Subordinate control loop	**U^2**, U, I^2, I, P     	**Note:** The subordinate control loop only appears for: Power controller ➔ Thyristor control ➔ Continuous (power controller). Subordinate control loops are used to eliminate or compensate for external disturbances, such as mains voltage fluctuations and changes in load resistance, that would have a negative effect on the control process. The **U** setting is used when the load voltage should be linear to the setpoint specification. The **I** setting is used when the load current should be linear to the setpoint specification. The following subordinate control loops have proven advantageous for heating elements that do not have linear temperature behavior or that are subject to aging: **U^2** is used for: - Positive temperature coefficient, molybdenum disilicide - If R ≈ is constant - Brightness controls. **I^2** is used for: - Negative temperature coefficient (TC) **P** is used for: - Temperature-dependent temperature coefficient - Free-running economy circuit - General applications - SIC load with automatic aging compensation
	Switched off 	The diagram shows how the phase angle is specified via a standard signal without a subordinate control loop. 

■ / **bold** = default setting

	Value / settings	Description
Cycle time	Fixed (500 ms) (For slow heating elements)	**Note:** This setting is only available in burst-firing operation mode. For example, for a fixed period of 500 ms, 5 sine waves are switched on and 20 switched off at an output level of 20 %. 
	Fastest possible (For quick-response heating elements)	The cycle time is variable with this setting. At the required output level, the device attempts to find the shortest possible cycle time for full sine waves. At an output level of 20 %, this relates to one sine wave ON and four sine waves OFF. 
Min. ON period	None	
	3 full sine waves	Dependent on the cycle time setting. At least three full sine waves are always let through. At an output level of 50 % and with the fastest possible cycle time, 3 sine waves are switched on and 3 switched off.  **Note:** Particularly suitable for the control of transformer loads
α **start**	No	**Note:** This setting is available in continuous burst-firing operation mode and in logic operation. No: for resistive load Yes: for transformer loads If set to "Yes", the first half-wave of each pulse group is cut with the set phase control angle α. 
	Yes	
α **start angle**	0 to **75** to 90° el	Phase control angle for α start
Soft start	No	This setting determines the starting behavior of the power controller after power ON and is deactivated ex works.

■ / **bold** = default setting

	Value / settings	Description
	Yes	"Yes" means that a soft start with phase-angle control or burst-firing is performed after power ON.
Soft start type	With phase-angle control	This parameter only appears if soft start is set to "Yes". Soft start type "With phase-angle control" is available in phase-angle operation and in burst-firing operation. **Phase-angle operation:** Starting from 180 °, the phase control angle α is steadily reduced until the correct phase angle for the default setpoint value is reached. **Burst-firing operation:** Starting from 180°, the phase control angle α is steadily reduced until a full wave has passed through. This ends the soft start and the device switches to burst-firing operation.  **Note:** If the output level is reduced to 0 % for longer than 8 seconds, a soft start is initiated again as soon as the output level is increased once more. If current limiting is activated during the soft start phase, the duration of the soft start is extended because the phase control angle cannot be reduced further during current limiting.
	With burst firing	This setting is available in burst-firing operation mode with a fixed cycle time and with the fastest possible cycle time. During the soft start time, the ON/OFF ratio is increased from 0 to a maximum of 100 %. 
Soft start duration	**1** to 65535 s	Specifies the duration of the soft start. **Note:** Due to the system, the soft start duration is at least 4 s when current limiting is switched on, even if a shorter time is configured as the soft start duration.

■ / **bold** = default setting

	Value / settings	Description
Current limiting	No	No current limiting
	Yes	Current limiting is implemented via phase-angle control. In this case, the load current is monitored on the basis of the selected current limit value and only the phase control angles that do not cause the current limit value to be exceeded are permitted. If burst-firing operation is active, current limiting only operates during the soft start that is realized via time-limited phase angle control. It is also possible to activate an **external current limit value** via a digital input. ⇨ Chapter 5.1.6 "Digital inputs"
Current limit value	10 % to **max. load current** +10 % **of the device type**	Varies depending on the device type. For 20 A power controllers, 2 to 22 A can be selected. ⇨ Chapter 1.3 "Order details"
Resistance limitation		**Note:** Resistance limitation is only possible in the case of power controllers with integrated subordinate control loop P (code 001 in the order code).
	No	No limitation through load resistance
	Yes	The load resistance is monitored to ensure the selected resistance limit value is not exceeded if the load current is **> 5% of the power controller's nominal current**. For phase-angle control, limitation is implemented through the phase control angle α. For burst-firing operation, limitation is implemented through the ON/OFF ratio of the sine waves. ⇨ Chapter 6.6 "Resistance limitation (r-control)"
Resistance limit value	0 to **999.99** Ω	If the load resistance exceeds this value, it is limited by phase-angle control or limitation of the switched sine waves.
Load type resistance limitation		**Note:** This parameter only appears in the phase-angle control operating mode.
	Resistive load	This setting is to be used for purely resistive loads.
	Transformer load	This setting is only to be used for a resistive load via a transformer.
Dual energy management	Switched off	This parameter only appears with the following settings: Cycle time: fixed (500 ms), Operating mode: burst-firing operation. This setting allows 2 devices to be configured so that they do not simultaneously draw power from the mains voltage at small output levels. This prevents current peaks. ⇨ Chapter 6.4 "Dual energy management"
	Device1	
	Device2	

■ / **bold** = default setting

5.1.3 Analog inputs

The power controller has a voltage input and a current input.
These inputs (setpoint specification) specify the output to be provided by the power controller at the load output.

In most cases, this signal is sent as a standard signal from an electronic controller or PLC and is adjusted with these settings.

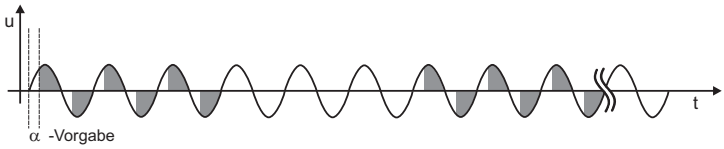
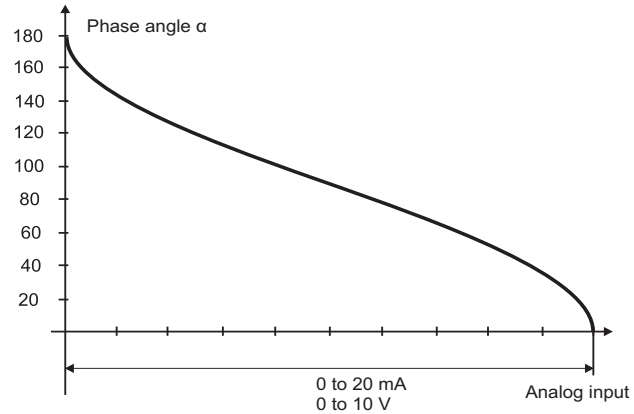
	Value / settings	Description
Current measuring range	0 to 20 mA	This setting specifies which current standard signal is connected. ⇨ Chapter 3.3 "Connection diagram"
	4 to 20 mA	
	Customer-specific[1]	
Current measuring range, start	**0** to 20 mA	**Note:** This parameter only appears if "Customer specific" is set for the current measuring range (see above)!
Current measuring range, end	0 to **20** mA	**Note:** This parameter only appears if "Customer specific" is set for the current measuring range (see above)!
Voltage measuring range	0 to 10 V	This setting specifies which voltage standard signal is connected. ⇨ Chapter 3.3 "Connection diagram"
	2 to 10 V	
	0 to 5 V	
	1 to 5 V	
	Customer-specific[1]	
Voltage measuring range, start	**0** to 10 V	**Note:** This parameter only appears if "Customer specific" is set for the voltage measuring range (see above)!
Voltage measuring range, end	0 to **10** V	**Note:** This parameter only appears if "Customer specific" is set for the voltage measuring range (see above)!

■ / **bold** = default setting

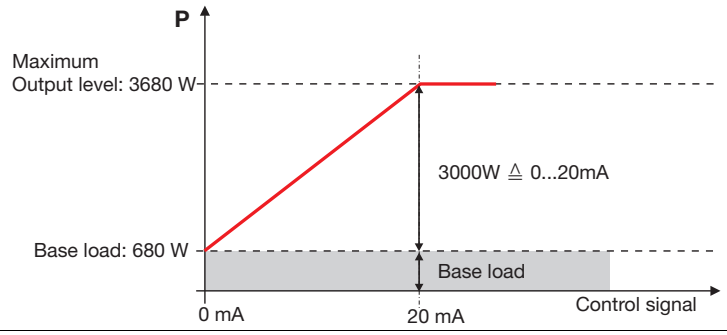
[1] **Inverting analog inputs:**
If, for example, the current measuring range start is set to 20 mA and the current measuring range end is set to 0 mA, the power controller is switched off at 20 mA and switched on at 0 mA.

5.1.4 Setpoint value configuration

This setting determines which input specifies the setpoint value, how high the base load is, and which alternative value should be applied in the event of an error.

	Value / settings	Description
Setpoint specification	Current input 	This setting specifies which analog input supplies the setpoint value for the power output. **Note:** These inputs can also be used for logic operation. ⇨ For switching level, see Chapter 10.7 "General specifications"
	Voltage input 	
	Via interface 	Means that the setpoint value for the power output is provided via an interface.
	Digital input1 	**Note:** This setting is only available if Power controller ➔ Thyristor control ➔ Logic (switch) is selected. In this case, the power controller is controlled in the same way as a solid-state relay (SSR) via digital input 1 or 2: contact: closed ➔ 100 % and open ➔ 0 % (for control direction default setting).
	Digital input2 	
α **input**	This setting is only available if Power controller ➔ Thyristor control ➔ **Logic** (switch) is selected. This setting specifies which signal the α input should control or whether it should be fixed. The "α input" value is a phase angle with which all sine waves are cut to limit the power. Not to be confused with the value for α **start!** 	
	No input	No phase angle is specified (full sine waves)
	Voltage input or current input	This standard signal specifies the phase angle as shown in the diagram. 
	Value, adjustable	The phase angle is entered as "α input value".
	Via interface	The phase angle is specified via an interface.
α **input value**	**0** to 180 °el	This is the phase angle if "Value, adjustable" has been selected under α **input**.

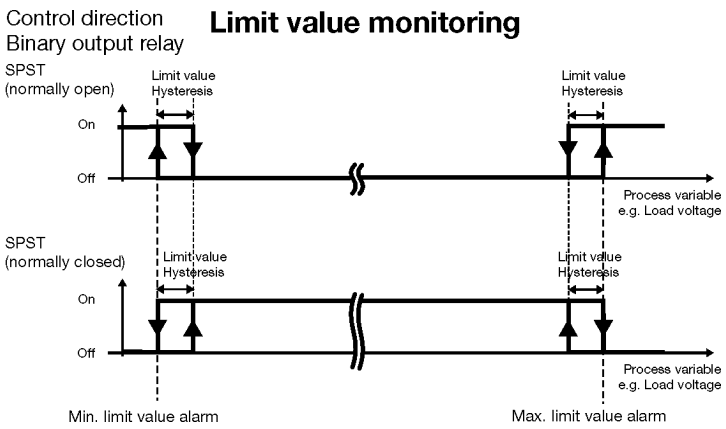
Input in the event of an error		Current, voltage, and interface input are monitored for errors (wire breaks or bus errors). This setting specifies which replacement value the power controller should use if the setpoint specification is incorrect. The last valid value is used per default.
	Last value	
	Voltage input or current input	If, for example, an error (e.g. wire break) now occurs at the current input that is selected for the default setpoint value, the power controller uses the value at the voltage input.
	Value, adjustable	This means that the "**Value in the event of an error**" is used.
Value in the event of an error	000.0	This value is used in the event of an error.
Maximum actuating variable	0 to **$U_{nom.}$** to 1.15 $U_{nom.}$ of the load voltage, 0 to **$P_{nom.}$** to 1.15 $P_{nom.}$ of the power 0 to **$I_{nom.}$** of the max. load current 0 to **100** % of the output level	In the case of **continuous** thyristor control via the analog input, the maximum actuating variable at the measuring range end (e.g. 20 mA) can be varied during operation. **Note:** This setting is only available if Power controller ➔ Thyristor control ➔ Continuous (power controller) is selected. The unit depends on the setting for subordinate control loop and device type: - U^2 and U: entry in V (Example: 0 to **230** to 264.5 V) - P: entry in W (example: 0 to **4600** to 5290 W) - I^2 and I: entry in A (example: 0 to **20** A) None: entry in % (example: 0 to **100 %**) **Note:** The following applies when selecting the maximum actuating variable for **free-running economy circuits**: - Each power controller regulates **half** the three-phase power during P-control

Base load	**0** to U_{nom} of the load voltage, **0** to P_{nom} of the power **0** to $I_{nom.}$ of the max. load current **0** to 100 % of the output level	**Note:** This setting is only available if Power controller ➔ Thyristor control ➔ Continuous (power controller) is selected. The **unit** depends on the setting for subordinate control loop and device type: ⇨ Chapter 1.3 "Order details" - With voltage: **0** to 100% of max. load voltage (e.g. **0 V**) - With current: **0** to 100% of max. load current (e.g. **0 A**) - With power: **0** to 100% of power (e.g. **0 W**) - None: **0** to 100 % of output level (e.g. **0 %**) **Note:** The following applies when selecting the maximum actuating variable for **free-running economy circuits**: - Each power controller regulates **half** the three-phase power during P-control 

■ / **bold** = default setting

5.1.5 Monitoring

This allows an internal measurand to be monitored for compliance with limit values.
Depending on the switching behavior, an overrange or underrange is output at the digital output (option: relay or optocoupler).

	Value / settings	Description
> Limit value monitoring	Switched off	No monitoring
	Load voltage Load current Power (in W) Power (in kW) Resistance Mains voltage Device temperature	These measurands can be monitored and are dependent on the ordered device type.  **Note:** If Power controller -> Thyristor control -> Logic (switch) and Monitoring -> Limit value monitoring -> Load voltage, load current, power (in W), or power (in kW) is selected, the limit value monitoring only operates in the periods in which the thyristors have been fired. If the thyristors are blocked, as a general rule, the min. and max. alarms are switched off.
Min. limit value alarm	**0** to 9999.9	The **absolute** minimum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. If the measurand falls below this value, an error message appears at the bottom of the display and the yellow K1 LED lights up. Depending on the set control direction, the digital output switches as shown in the diagram. The unit of the limit value corresponds to the measurand to be monitored.
Max. limit value alarm	0 to **9999.9**	The **absolute** maximum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. If the measurand exceeds this value, an error message appears at the bottom of the display and the yellow K1 LED lights up. Depending on the set control direction, the digital output switches as shown in the diagram. The unit of the limit value corresponds to the measurand to be monitored.

Limit value hysteresis	0 to **1** to 9999.9	Switching differential at the upper and lower limit of the monitoring range

>Load monitoring	None	The load is not monitored.
	Undercurrent	**Note:** This parameter is only available if the device type is equipped with an I, I^2, or P subordinate control loop and the current can therefore be measured. ⇨ Chapter 6 "Special device functions"
	Overcurrent	
		Note: This setting is only available if **load monitoring** has been set to undercurrent or overcurrent.
Limit value load monitoring	0 to **10** to 100 %	**Partial load failure** or **partial load short circuit**: This setting specifies the percentage by which the load resistance must have decreased or increased for a load error to be triggered.
Load type load monitoring	Standard	Default setting (suitable for most load types)
	Infrared radiator (short-wave)	Especially suitable for short-wave infrared radiators
Teach-In type load monitoring	Automatic, once	The Teach-In value is automatically determined once after each power ON. ⇨ Chapter 6.1.1 "Teach-In"
	Manual	Teach-in can be performed **in manual mode** or in the **operator level**. ⇨ Chapter 6.2.2 "Configuring Teach-In (prerequisite for Teach-In in manual mode)" ⇨ Chapter 4.2.4 "Monitoring"
	Automatic, cyclical	Teach-In is performed cyclically at a time interval of 1 minute.
>Mains voltage drop monitoring	No	No monitoring
	Yes	If the effective values of the analyzed half-waves are more than 10 % apart, an alarm message is displayed and the digital output for the collective alarm switches depending on the set control direction. Immediate firing pulse inhibit prevents the connected transformer loads from destroying the semiconductor fuse due to a DC component. If there are no further mains voltage drops, the firing pulse inhibit is removed and the power controller continues operation (e.g. with a soft start).
>Control loop monitoring	No	No monitoring
	Yes	Control loop monitoring is used mostly for monitoring SIC heating elements. It uses a binary signal to indicate when the power required by the setpoint specification can no longer be reached with the load present, potentially due to aging of the heating elements. This error is shown in the info line when the actual value of the subordinate control loop is smaller than the required setpoint value for an uninterrupted period of 15 minutes. ⇨ Chapter 8 "Fehlermeldungen und Alarme"

■ / **bold** = default setting

5.1.6 Digital inputs

There are 2 digital inputs and one additional digital input for firing pulse inhibit available, to which a potential-free contact can be connected.
The following functions can be triggered with digital input 1 and 2:

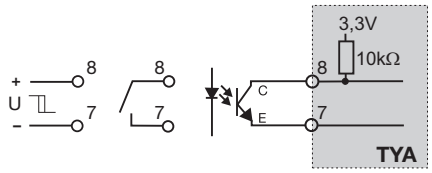
✱ Switch to the configuration level ➔ Binary inputs using the PGM key

	Value / settings	Description
Toggling the operating mode to phase-angle control		**Note:** The toggling to phase-angle operation mode is only possible if ➔ Power controller ➔ Operating mode ➔ Burst firing mode has been selected in the configuration level.
	Switched off	No toggling
	Digital input1	Toggling is controlled by digital input1
	Digital input2	Toggling is controlled by digital input2
	Ext. digital input1	Toggling is controlled via an interface
	Ext. digital input2	Toggling is controlled via an interface
External toggling of setpoint specification	Switched off	No external toggling of setpoint specification
	Digital input1	Toggling is controlled by digital input1
	Digital input2	Toggling is controlled by digital input2
	Ext. digital input1	Toggling is controlled via an interface
	Ext. digital input2	Toggling is controlled via an interface
Setpoint specification when toggling	Voltage input Current input Value, adjustable	Selects the source that is used to specify the setpoint value when external toggling of the setpoint specification is activated. **Note:** The only analog inputs that are available here are those that have **not yet** been populated by a setpoint specification, for example.
Value when toggling	0% to 100 %	**Note:** This parameter is available only if **"Value, adjustable"** is selected for setpoint specification when toggling.

■ / **bold** = default setting

	Value / settings	Description
Ext. current limiting		**Note:** This function can only be selected with the following presettings: Option 1: Power controller ➔ Operating mode ➔ Phase angle control and Power controller ➔ Current limiting ➔ Yes Option 2: Power controller ➔ Operating mode ➔ Pulse groups Power controller ➔ Soft start ➔ Yes Power controller ➔ Current limiting ➔ Yes If, for example, "Digital input 1" is selected here, the "**External current limit value**" (further down in the table) takes effect when the digital input is closed instead of the current limit value selected under "Power controller rCurrent limit value".
	Switched off	No ext. current limiting
	Digital input1	Ext. current limiting is controlled by digital input1
	Digital input2	Ext. current limiting is controlled by digital input2
	Ext. digital input1	Ext. current limiting is controlled via an interface
	Ext. digital input2	Ext. current limiting is controlled via an interface
Ext. current limit value	10 % to **max. load current of the device** +10 %	**Note:** This parameter is only available if a digital input is selected for ext. current limiting. The max. load current varies depending on the device type. For 20 A power controllers, 2 to 22 A can be selected. ⇨ Chapter 1.3 "Order details"
Key lock	Switched off	No key lock
	Digital input1	Key lock is controlled by digital input1
	Digital input2	Key lock is controlled by digital input2
	Ext. digital input1	Key lock is controlled via an interface
	Ext. digital input2	Key lock is controlled via an interface
External switch-off of display lighting	Switched off	No external switch-off, i.e. the background lighting behaves according to the configuration in Chapter 5.1.1
	Digital input1	Switch-off is controlled by digital input1
	Digital input2	Switch-off is controlled by digital input2
	Ext. digital input1	Switch-off is controlled via an interface
	Ext. digital input2	Switch-off is controlled via an interface
Inhibit input control direction		The firing pulse inhibit can be triggered when the switching contact is closed or open. ⇨ Chapter 3.3 "Connection diagram"

■ / **bold** = default setting

	Value / settings	Description
	Open, load ON	Per default:
	Open, load OFF	Inhibit input open, power controller supplies power. Inhibit input closed, power controller does not supply power. 
Control direction, digital input1	Open, inactive	The function for digital input1 can be triggered when the switching contact is open or closed.
	Open, active	
Control direction, digital input2	Open, inactive	The function for digital input2 can be triggered when the switching contact is open or closed.
	Open, active	

■ / **bold** = default setting

5.1.7 Digital output

The digital output consists of a relay or an optocoupler, depending on the order code.
With the digital output, it is possible to choose between the output mode **"collective fault transmitter", "energy meter"**, and **"Interf. signal".**

⇨ Chapter 8.1 "Binärsignal für Sammelstörung"

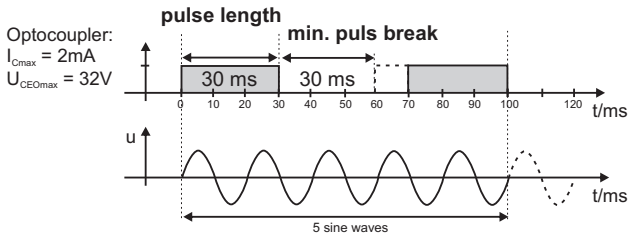
The control direction is used to select the switching behavior of the relay and determine whether, in the event of an error message, it should switch on (error message via N/O contact) or drop out (error message via **N/C contact**). In the optocoupler, the control direction determines whether the collector-emitter loop should be conductive or **high-impedance** in the event of an error message.

The energy meter function can only be activated if extra code 257 optocoupler is integrated into the device.

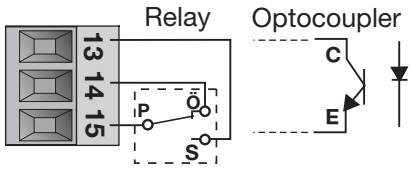
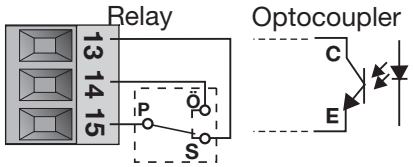
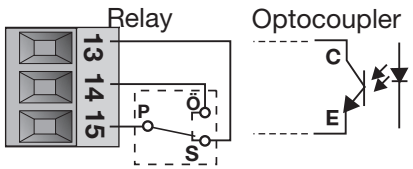
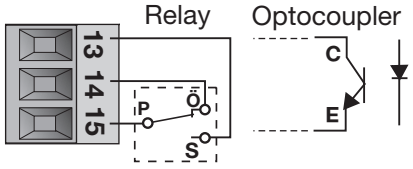
⇨ Chapter 1.3 "Bestellangaben"

✱ Use the PGM key to switch to the configuration level ➔ Digital output

Output mode

Value / settings	Description
Collective fault transmitter	The digital output switches if a collective fault occurs on the device. This can be configured as an "N/C contact" or as an "N/O contact" (see below). The K1 LEDs on the master, slave1, and slave2 also light up in the event of a fault.
Energy meter	The digital output functions as an energy meter and emits pulses depending on the energy consumed. If a collective fault signal occurs in energy meter mode, the K1 LED lights up yellow at all points simultaneously. 
Pulses per kWh: 1 to 10000	Specifies how many **pulses per kWh** are to be emitted. Select this value so that the **maximum power (power controller nominal power)** can also be shown.
Pulse length: 30 to 2000 ms	Specifies how long the high phase of the pulse should be. (Value is rounded up internally by the device to a multiple of the half-wave length of the mains voltage)
Min. pulse interval: 30 to 2000 ms	Specifies the minimum period for which the signal must be at Low until a new pulse is emitted. (Value is rounded up internally by the device to a multiple of the half-wave length of the mains voltage)
Interf. signal	The digital output is controlled via an interface

■ / **bold** = default setting

	Value / settings	Description
Control direction, digital output	**N/O contact**	No error message or energy meter pulse OFF or signal via interface is logically 0 "Low": Switching behavior: 14 and 15 pole and N/C contact closed or 13 and 15 optocoupler collector-emitter loop high-impedance  **Error message** present or energy meter pulse ON or signal via interface is logically 1 "High": Switching behavior: 13 and 15 pole and **N/O contact closed** or 13 and 15 optocoupler collector-emitter loop low-impedance 
	N/C contact	No error message or energy meter pulse OFF or signal via interface is logically 0 "Low": Switching behavior: 13 and 15 pole and N/O contact closed or 13 and 15 optocoupler collector-emitter loop low-impedance  **Error message** present or energy meter pulse ON or signal via interface is logically 1 "High": Switching behavior: 14 and 15 pole and N/C contact closed or 13 and 15 optocoupler collector-emitter loop high-impedance 

■ / **bold** = default setting

5.1.8 Analog output

The actual value output is an analog output at which different internal values can be output as a standard signal.

	Value / settings	Description
Signal type, actual value output		This setting specifies the standard signal that should be output at the actual value output.
	Switched off	The actual value output does not issue a signal.
	0 to 20 mA	The actual value output outputs the "Value to be output" in the form of a current signal.
	4 to 20 mA	
	0 to 10 V	The actual value output outputs the "Value to be output" in the form of a voltage signal.
	2 to 10 V	
	0 to 5 V	
	1 to 5 V	
Value to be output		This setting specifies the value that should be output at the actual value output.
	Load voltage	**Example:** The load voltage can vary between 0 and 500 V depending on the device type. As the default setting for the signal range is 0 to 9999.9, the end value must be adjusted to 500.0 to make use of the full signal range. The following must be observed for master-slave switching: These measured values are determined in the master branch. **Exception:** When selecting the power (in W or kW), the three-phase power is output at the actual value output. **Note:** Load voltage^2 = load voltage squared
	Load voltage^2	
	Load current	
	Load current^2	
	Power (in W)	
	Power (in kW)	
	Resistance	
	Mains voltage	
	Device temperature	
	Setpoint value	
Signal range start value	**0** to 9999.9	Lower limit for the "Value to be output**"**
Signal range end value	0 to **9999.9**	Upper limit for the "Value to be output**"**

■ / **bold** = default setting

5.1.9 RS422/485

Interface parameters for RS422/485 (see interface description B709061.2)

	Value / settings	Description
Baud rate	9600	
	19200	
	38400	
Data format	8-1-none	Data bits-stop bits-parity check
	8-1-odd	
	8-1-even	
	8-2-none	
Device address	**1** to 255	
Min. response time	**0 to 500ms**	

■ / **bold** = default setting

5.1.10 PROFIBUS-DP

Interface parameters for PROFIBUS-DP (see separate manual)

	Value / settings	Description
Device address	1 to **125**	If "0" is set as the device address, the bus fault error message is not displayed.
Data format	**Motorola®,** Intel®	

■ / **bold** = default setting

5.1.11 EtherCAT

For communication with EtherCAT see documentation 70906108T92Z000K000.

For communication with the JUMO mTRON T automation system, see documentation 70500153T90...

	Value / settings	Description
Fieldbus	**ECAT Conf. tested** SB JUMO mTRON T	To connect TwinCAT or other EtherCAT Master To connect JUMO mTRON T automation system
Device ID (Alias-Adr.)	**0** ... 65535 **0** ...99	in case of EtherCAT in case of Systembus JUMO mTRON T If several TYA-20X devices are located in the JUMO mTRON T system bus or EtherCAT, the user can identify each individual device by entering various alias device addresses.

■ / **bold** = default setting

5.1.12 Changing codes

Here, it is possible to assign passwords (4-digit numeric codes) for **manual mode**, **operator level**, and **configuration level** to protect them from unauthorized access.

	Value / settings	Description
Code, manual mode	**0000** to 9999	0000 means: no inhibit 9999 means: level is hidden
Code, operator level	**0000** to 9999	0000 means: no inhibit 9999 means: level is hidden
Code, config. level	**0000** to 9999	0000 means: no inhibit

■ / **bold** = default setting

5.2 Configuration example

Requirements

Mains voltage 400 V

3 heating elements each with 1 kW connected in parallel

Load current: 3000 W/400 V = 7.5 A

Temperature coefficient TC = 1

Operating mode: phase-angle control

Subordinate control loop: U^2

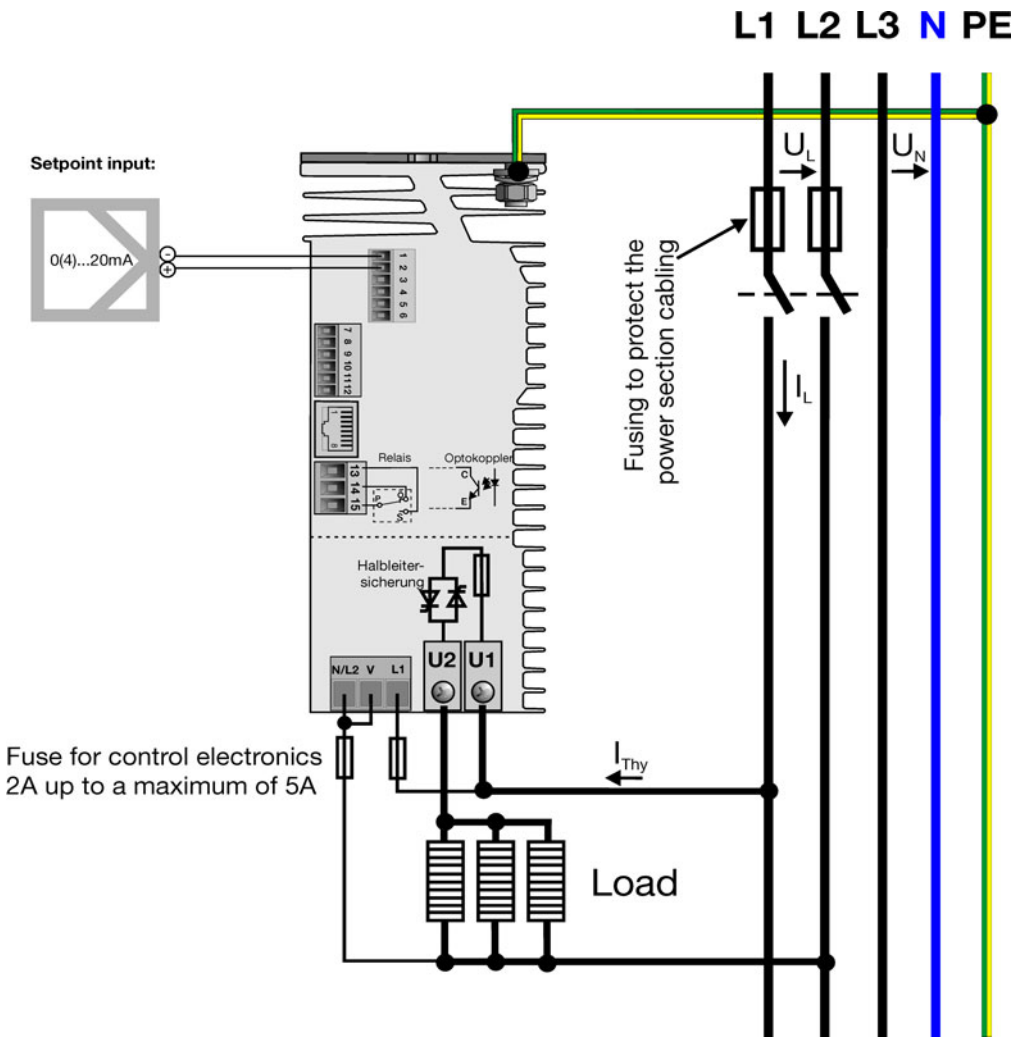
Base load: 0 %; maximum output level 100 %

Setpoint specification via standard signal of 0 to 20 mA.

The following power controller is selected for this requirement:

Device type

709061/X-01-020-100-400-00/252



5 Configuration

6.1 Detection of load faults

The load monitoring function detects the percentage change of the load resistance. The function can also detect and signal a load failure, partial load failure, or a partial load short circuit.

Undercurrent This function is used for one or more heating elements connected in parallel that are to be monitored for failure.

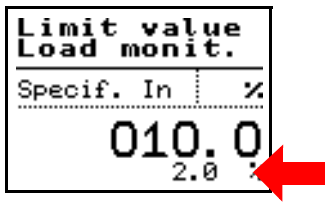
Overcurrent This function is used for several heating elements connected in series that are to be monitored for short circuits.

Function This function not only takes the decreasing or increasing load current into consideration but also includes the load voltage in the monitoring process.

The plant's correct load ratios are saved during Teach-In.
Based on this state, the load changes are continuously monitored irrespective of the required output level. In the event of a failure or short circuit of a heating element, the load current increases or decreases. This is detected by the load monitor and a load fault is signaled.

Limit value A limit value must be entered as a % in the configuration or operating level for load monitoring. This limit value depends upon the number of heating elements connected in parallel or in series.

For heating elements with a high positive or negative temperature coefficient, a suitable limit value must be determined independently. The % value shown below (see arrow) can be used as an aid for this.
This value represents the current deviation from the teach-in value. If the value is > 0 %, the load has become more high-resistance; if the value is < 0 %, it has become more low-resistance. This window can be accessed via Operator level➔Monitoring ➔Limit value load monit.

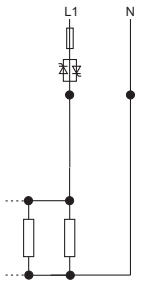
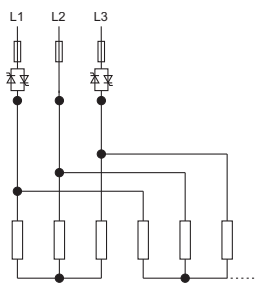
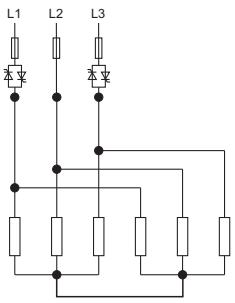
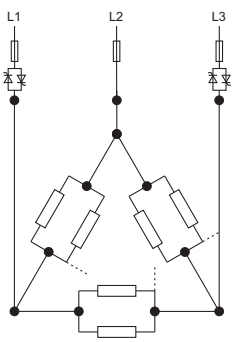


For heating elements with a temperature coefficient TC ≈ 1, the limit value can be taken directly from the following tables:

Undercurrent

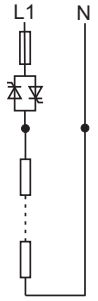
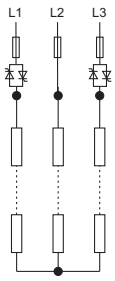
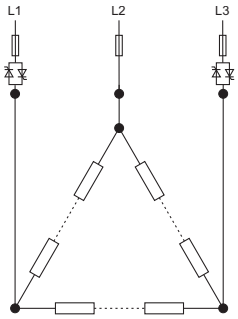
Number of heating elements	Single-phase operation	Star connection with separate star points without neutral conductor	Star connection with common star points without neutral conductor	Delta connection
5	10 %		-	-
4	13 %		10 %	-
3	17 %		13 %	10 %

6 Special device functions

Number of heating elements	Single-phase operation	Star connection with separate star points without neutral conductor	Star connection with common star points without neutral conductor	Delta connection
2	25 %		20 %	12 %
1	50 %		50 %	21 %
Example: 2 heating elements				

The specifications in **%** refer to **load resistance changes**

Overcurrent

Number of heating elements	Single-phase operation	Star connection without neutral conductor	Delta connection
6	10 %	-	-
5	13 %	10 %	-
4	17 %	10 %	10 %
3	25 %	14 %	13 %
2	50 %	25 %	26 %
Example for 2 heating elements			

The specifications in % refer to **load resistance changes**

☞ As a general rule, load monitoring does not yet take place during the soft start phase (which can last for an extended period due to active current limiting) as the standard working range of the load has not yet been reached. Teach-In cannot yet be performed in this phase either.

6.1.1 Teach-In

Depending on the configuration of the parameter "Load monit. Teach-In", Teach-In (i.e. determination of the load measured values in the OK state) is either performed once automatically after power ON or automatically and cyclically, repeatedly every minute, or manually.

"Manual" teach-in

For "Manual Teach-In", the power controller must be told once after the operating point has been reached that it is now to perform the Teach-In.
This can be performed in the operating level or in manual mode.

⇨ Chapter 4.2.4 "Monitoring"

⇨ Chapter 6.2.2 "Configuring Teach-In (prerequisite for Teach-In in manual mode)"

In this variant of Teach-In, the Teach-In values are then permanently saved. Teach-In does not need to be performed again when the power controller is switched off and on again.
Teach-In can be repeated whenever necessary. The old Teach-In values are then overwritten by the new ones.
The Teach-In values are only deleted if the load monitoring Teach-In parameter is explicitly configured to "Manual Teach-In" or when the default setting is applied. Teach-In is not affected when other parameters are reconfigured.

☞ From software version 256.01.08, the determined Teach-In values are also transferred when the setup data of one power controller is transferred to another.

If "Manual Teach-In" has been configured but no Teach-In has been conducted, the message "Teach-In load monitoring!" appears on the display as a reminder.Manual Teach-In can only be performed on the device itself, not via the setup program.

☞ To ensure that the load ratios are recorded precisely for later operation, only perform the Teach-In process at a load current of at least 20 % of the rated value!

Teach-in "Automatically (once)"

"Automatically once" means that the Teach-In values are temporarily saved after each power ON.
This setting is suitable only for heating elements with a temperature coefficient TC ≈ 1.
When the power controller is disconnected from the mains voltage, the Teach-In values are deleted again. After another power ON, load monitoring therefore remains inactive until a new Teach-In process is performed.To ensure that the load ratios for are recorded precisely for later operation, Teach-In is only performed in phase-angle operation mode with at least 30 % of the output level. (In burst-firing operation mode, this restriction is not needed because a sufficiently high current always flows when the thyristor is fired. In this case, Teach-In is always performed shortly after a power ON or – if configured – after the completion of the soft start.)

Teach-in "Automatic (cyclically)"

"Automatically (cyclically)" means that the Teach-In values are temporarily saved again at intervals of 1 minute. This setting is particularly suitable for SIC heating elements as in this case the resistance in the load point changes with time due to aging.
When the power controller is disconnected from the mains voltage, the Teach-In values detected last are deleted and recalculated once mains voltage supply has returned.

6.2 Manual mode

In this case, the setpoint value can be manually preset in % without the need for external wiring via the analog input.

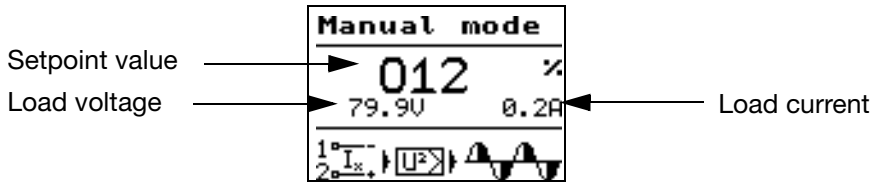
6.2.1 Setpoint specification in manual mode

Starting

Manual mode, as set per default, can be accessed without entering a code.

* Press the PGM key once (selection menu)
* Press the PGM key again (manual mode)
* Use the ▲ or ▼ key to increase or decrease the setpoint value

The changes become effective immediately at the load output and are indicated on the display.



☞ The setpoint value for manual mode is not saved in the event of a power failure!

6.2.2 Configuring Teach-In (prerequisite for Teach-In in manual mode)

The Teach-In function records the current/voltage ratio of a load in the OK state.
This function is not configured per default.

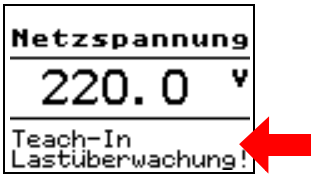
⇨ Configuration level See "Teach-In type load monitoring" on page 69.

Configuring "manual" Teach-In

The power controller is in the "Measured value overview" level.

* Press the PGM key
* Config. level ➔Monitoring ➔Load monitoring ➔Undercurrent or overcurrent ➔Teach-in type load monit. ➔Set to "manual"
* Press the PGM key
* Press the EXIT key twice

If Teach-In is being performed for the first time, the message "Teach-In load monitoring" appears in the bottom line of the display.

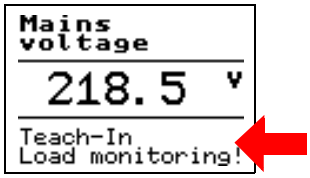


6.2.3 Performing Teach-In in manual mode

The power controller is in the "Measured value overview" level.

* Press the PGM key twice to return to **manual mode**.

If Teach-In is being performed for the first time, the message "Teach-In load monitoring" now appears in the bottom line of the display.



* Press the PGM key and the following message will appear:

* Press the PGM key to apply the current load state as the OK state.

A change in the load (load error) will be evaluated by the device on the basis of this state.

Repeating Teach-In

Teach-In can be repeated any number of times in manual mode

* Press the PGM key and the following message will appear:

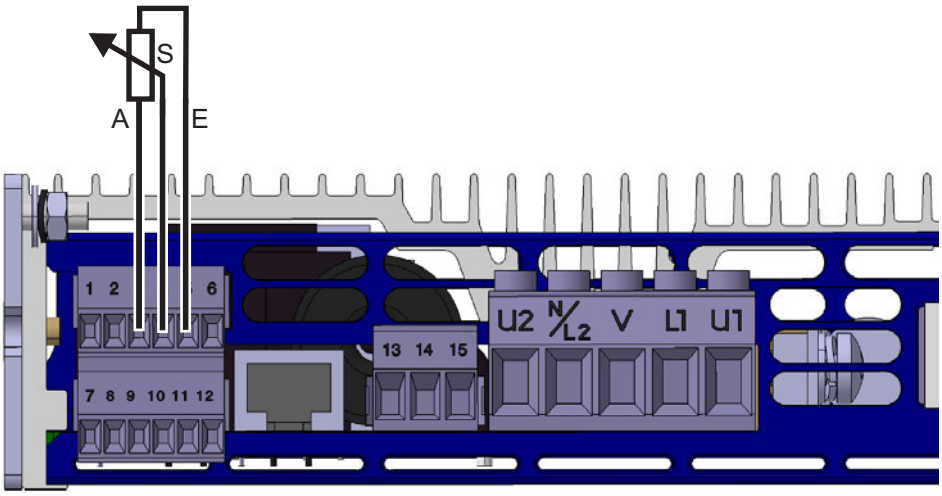
* Press the PGM key to apply the current load state as the OK state.

6 Special device functions

6.3 Setpoint specification via potentiometer

For this, a 5 kΩ potentiometer is connected to the voltage input.

It is supplied with DC 10 V at terminal 5 of the power controller.



* Configuration level ➔ Analog inputs ➔ Set voltage measuring range 0 to 10 V
* Configuration level ➔ Setpoint value config. ➔ Default setpoint value ➔ Set voltage input

Now the power controller power is preset via the external potentiometer.

6.4 Dual energy management

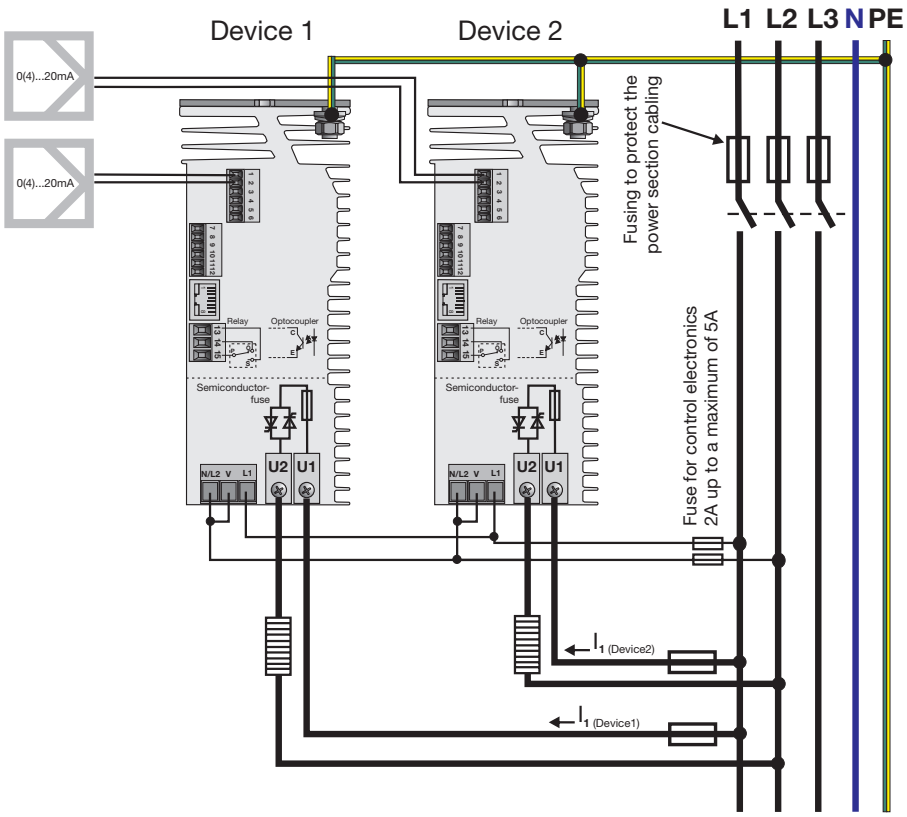
This allows setpoint values of up to 50 % each to be preset on 2 power controllers without causing current peaks in the network when they are switched on simultaneously.
No current peaks are caused in the network even if the setpoint values are asymmetrically distributed (e.g. 30 % and 70 %).

More than 2 power controllers

If more than 2 power controllers are required in a plant, they must be divided into 2 groups.
The "Dual energy management" parameter (Device1 and Device2) has to be selected in each group.

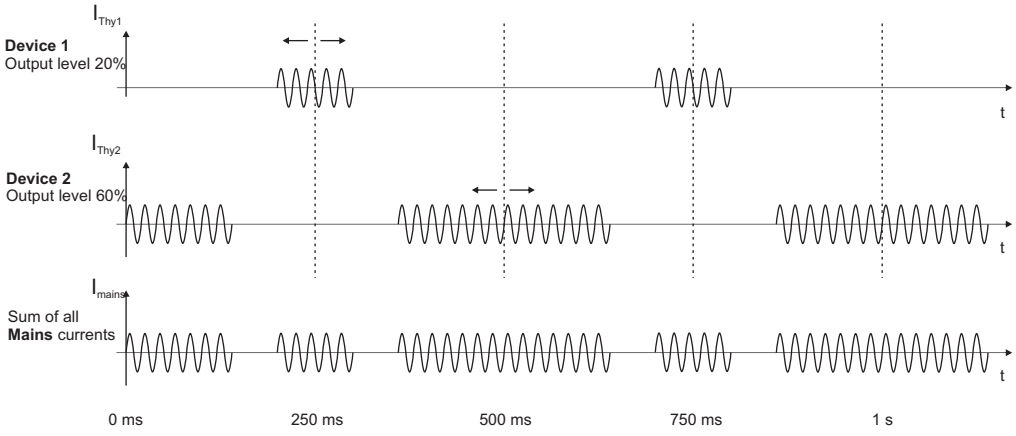
Prerequisites

- Both devices must be connected to the same phase
- The control electronics and the load circuit must have the same phase
- Synchronize both devices by switching them on simultaneously
- **Burst-firing operation** must be configured
- The cycle time must be set to **500 ms (fixed)**
- In each group, one TYA201 power controller must be configured as **Device1** and the other TYA201 power controller as **Device2**.



The two power controllers switch on at different times. Starting from the dashed lines, the dispersion of energy takes place symmetrically to the left and right (see arrows). For as long as the total output level of the two devices is below 100 %, two device currents in a single phase are prevented from overlapping. The next power level in the network is not started until the **total output level** exceeds 100 %.

If one power controller performs a restart when the configuration level is exited, it no longer operates synchronously with the others. All power controllers have to be switched on again simultaneously via a joint main switch!

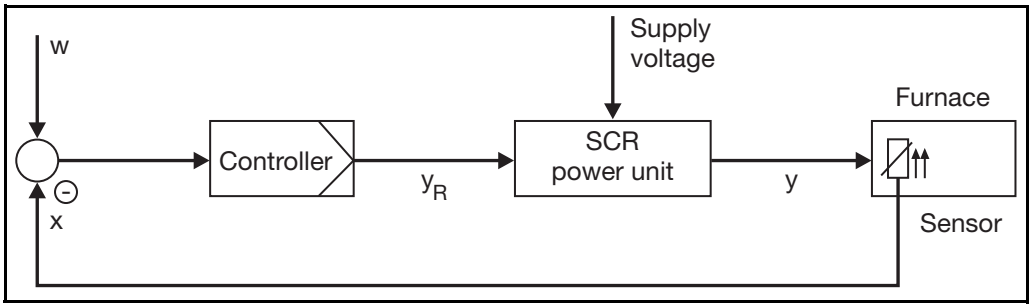


6 Special device functions

6.5 Subordinate control loop

Subordinate control loops are used to eliminate or compensate for external disturbances, such as mains voltage fluctuations and changes in load resistance, that would have a negative effect on the control process.

6.5.1 Closed control loop without subordinate control



Example Furnace/kiln control system

The electrical voltage supply is connected to the power controller. The controller derives the output level y_R from the difference between the set value (w) for the furnace temperature and the actual value (x) which is acquired by a sensor inside the furnace. The controller output level can range from 0 to100 % and is output at the output of the controller as a standard signal, for example, 0 to10 V. The output level signal is fed to the power controller.

The task of the power controller is to feed energy to the heating elements in the furnace, proportional to the controller output level:

- For a **thyristor power controller** using **phase-angle operation**, this means that it alters the firing angle over the range from 180° to 0°, corresponding to a controller output level of 0 to100 %
- If the **thyristor power controller** is in **burst-firing operation mode**, it increases the duty cycle T from 0 to100 %, corresponding to a controller output level of 0 to100 %

If the mains voltage drops from AC 230 V to AC 207 V (-10 %) at controller output level YR, the power fed to the furnace is reduced by 19 %.

$$P_{230V} - \Delta P = \frac{(U - 0,1U)^2}{R} = \frac{(0,9U)^2}{R} = 0,81 \bullet P_{230\,V} \qquad (2)$$

P_{230V}: Power in the load resistance at a supply voltage U of 230 V

ΔP: Power reduction resulting from reduced supply voltage

R: Resistance of the load

This 19 % reduction in the energy being fed in means that the **furnace temperature falls.**

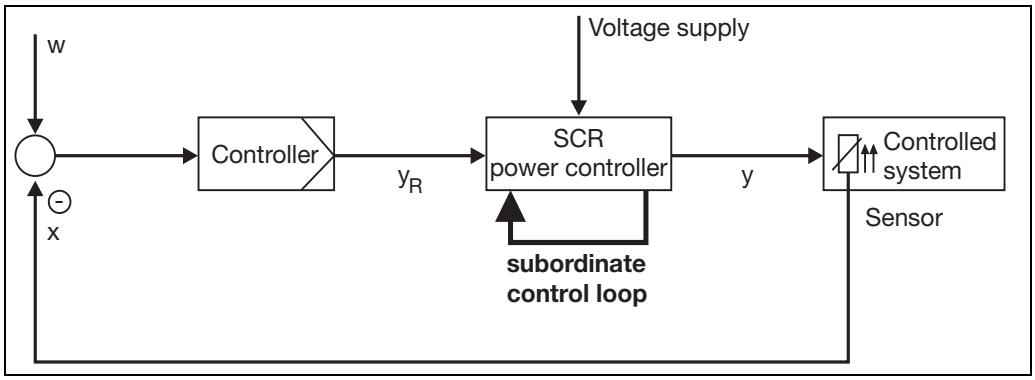
Disadvantage: **A continuing constant temperature is no longer assured.**

The power controller recognizes the deviation through the relatively slow re-

sponse of the temperature control loop and increases its output level (y_R) until the furnace reaches the original temperature (250 °C) again.

6.5.2 Closed control loop with subordinate control

To avoid power variations caused by mains voltage fluctuations, a **subordinate control loop** is built into the power controllers. The subordinate control loop immediately counterbalances any fluctuations in the amount of supplied power. This means that the power controller always provides a power level at the output (y) that is proportional to its input signal (y_R). The principle of an subordinate control loop is shown in Figure .



A distinction is made between U^2, I^2, and P control loops. V^2 control is used in most applications. There are, however, some applications where an I^2 or P control has advantageous control-loop characteristics (requires recording of the current in the power controller).
The three different types of subordinate control are described in the following chapters.

U^2 control

Considering the power PI_{oad} in a resistive load, we know that it is determined by the voltage on the load, U_{load} and the resistance of load, R, as follows:

$$P_{Last} = \frac{U_{Last}^{\ 2}}{R} \qquad (3)$$

Equation 3 shows that, for a constant load resistance, the power in this resistance is proportional to V_{load}^2.

$$P_{Last} \sim U_{Last}^{\ 2} \qquad (4)$$

A power controller with a U^2 control will regulate so that the square of the load voltage is proportional to the signal input (e.g. 0 to 20 mA) to the controller.

$$U_{Last}^{\ 2} \sim \text{Eingangssignal des Leistungsstellers} \qquad (5)$$

Combining equations 5 and 4, we can see that the power in the load resistance is proportional to the input signal to the power controller.

P_{Last} ~ Eingangssignal des Leistungsstellers (0 ... 20 mA) (6)

Heating elements that have a positive temperature coefficient (TC) (i.e. where the **electrical resistance increases with increasing temperature)** are usually driven by a power controller that incorporates a subordinate control loop (**U^2 control**) (Figure 1).

These are resistive materials such as

- Kanthal Super
- Tungsten
- Molybdenum
- Platinum
- Quartz radiators

Their cold resistance is substantially lower than their resistance when hot (by a factor of 6 to 16). These heating elements are usually run at temperatures above 1000 °C.

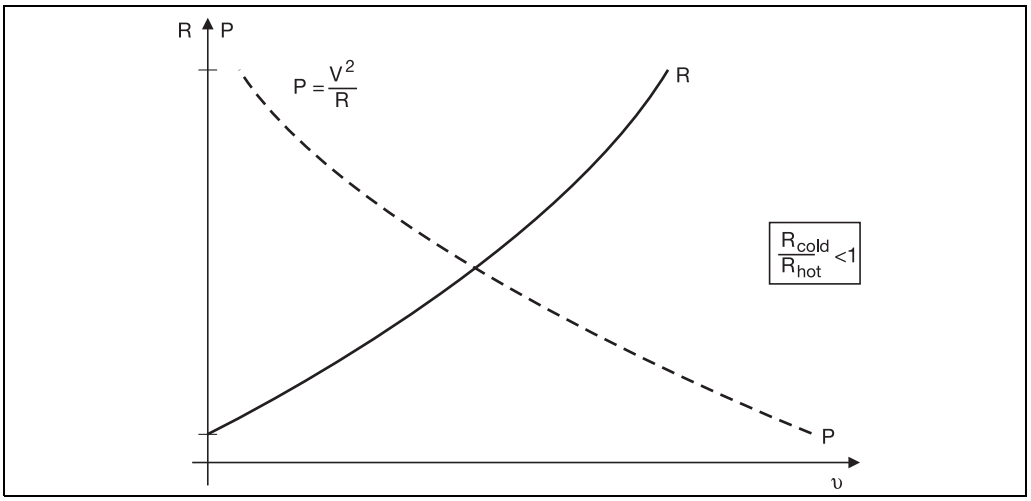


Figure 1: Heating element with a positive TC

Power controllers need current limiting for the starting phase. The constant current and the increasing resistance mean that, initially, the power in the heating element increases in proportion to R, since the power $P = I^2 \cdot R$.

When the current falls below the preset limit value, current limiting is no longer effective, and the power unit operates with the underlying V^2 control, i.e. if the resistance continues to increase, the power fed to the heater elements falls, since the voltage is held constant:
$P_{load} = \frac{U_{Last}^2}{R}$ automatically becomes smaller.

This effect supports the complete control loop. As the furnace temperature rises towards the setpoint value, the power fed to the furnace is reduced (at the same load voltage level). This means that the power controller alone is able to slow the approach to the setpoint value. This damps out any tendency to overshoot the final temperature.

Other applications for U^2 control are:

- In lighting systems: in this case, the intensity of the lighting is proportional to U^2.
- Some resistance materials have a TC that is close to 1. These include heating elements made from nickel/chrome, constantan, etc. This does not place any special demands on the thyristor power controller (e.g. current limiting). The resistance characteristic for a heater element with a TC ≈ 1 is shown in Figure 2.

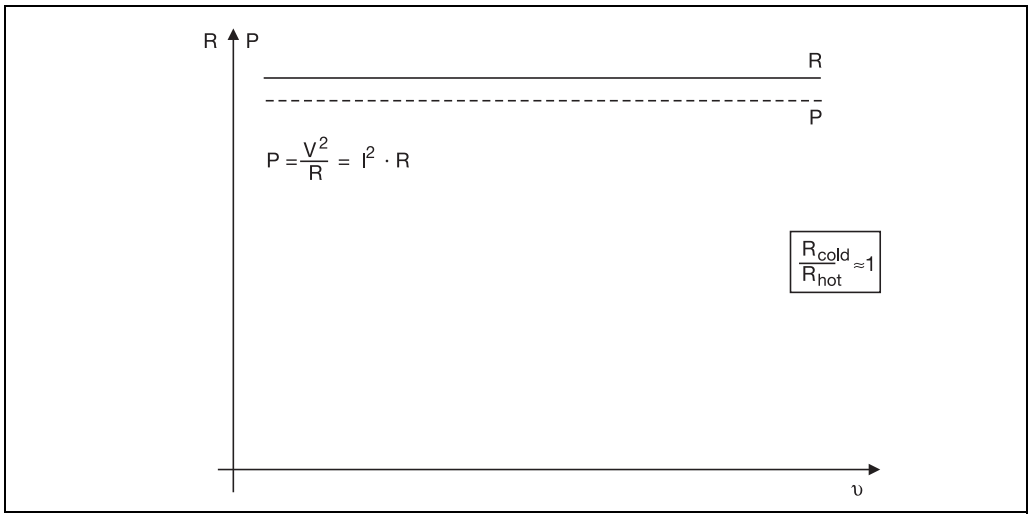


Figure 2: Heating element with TC ≈ 1

I^2 control

Current control (I^2 control) is advantageous for heater elements with a negative TC, where the electrical resistance becomes smaller as the temperature increases (Figure 3).

This behavior is exhibited by non-metallic materials such as graphite or molten glass. Molten glass is not usually heated by heating elements but by letting a current flow through the melt, so that the electrical energy is converted directly into heat in the molten material. The current is applied through electrodes.

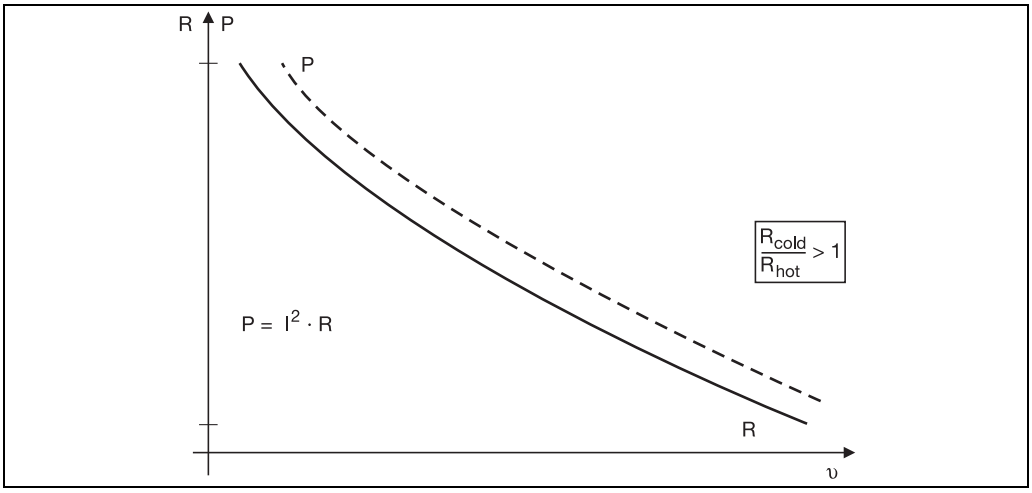


Figure 3: Heating element with a negative TC

Looking at the power equation $P = I^2 \cdot R$, we can see that an I^2 control has the same regulatory effect on the power as already described for the U^2 control. This means that, by regulating a constant current while the temperature rises, the power in the process is automatically reduced as the resistance falls.

P control

Power control (P control) is a continuous regulation of the product U · I, the power. In this case, there is a precise linear relationship between the output power and the level of the signal input (e.g. 0 to 20 mA) to the thyristor power controller.

A typical application of this type of subordinate control loop is for regulating heater elements which are subject to long-term drift combined with a temperature-dependent resistance, as is the case with silicon carbide elements (Figure 4).

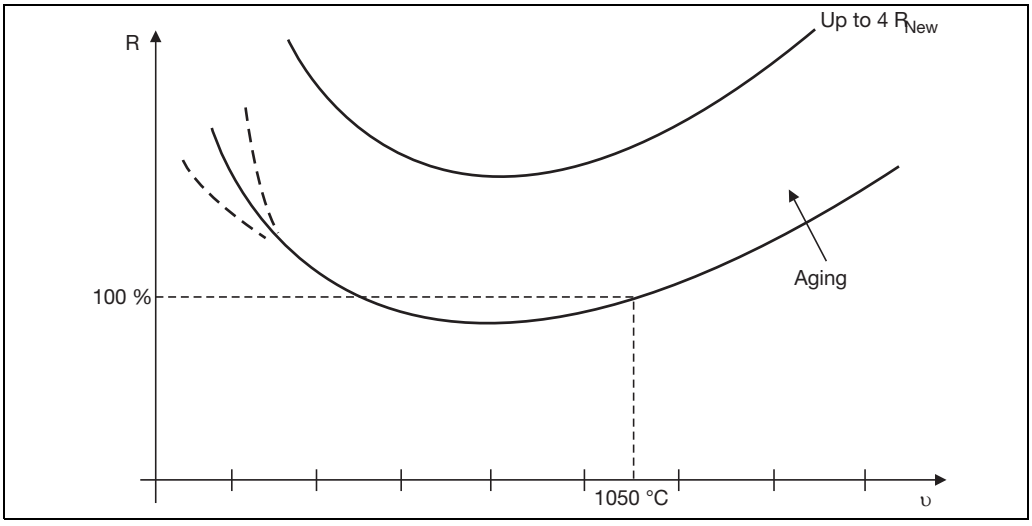


Figure 4: Resistance changes for silicon carbide

Silicon carbide heating elements have a nominal resistance that can increase by a factor of 4 over the long term. So when dimensioning a system it is necessary to adapt the power controller to produce twice the power for the heating elements. This doubles the current for the thyristor power controller.

Old = old state of the heating element $R_{New} = \frac{R_{Alt}}{4}$

New = new condition of the heating element

The relationship is illustrated by the following formula:

$$P_{Neu} = U_{Neu} \bullet I_{Neu} = \boxed{\frac{U_{Alt}}{2} \bullet 2I_{Alt}} = U_{Alt} \bullet I_{Alt} = P_{Alt} \quad (12)$$

P control is also used for free-running economy circuits running off a 3-phase supply network.

Which operating mode is suitable for which load?

Operating mode	**Resistive load**				**Inductive load**
	TC constant	**TC positive**	**TC negative**	**Long-term aging**	
Phase-angle control	**X**				**X**
Phase angle control with current limiting		**X**	**X**	**X**	
Burst-firing operation	**X**				
Burst-firing operation with α start	**X**				**X**
Burst-firing operation and current limiting		**X**	**X**	**X**	
Subordinate control loop					
U^2	**X**	**X**			**X**
I^2			**X**		**X**
P				**X**	**X**

6 Special device functions

6.6 Resistance limitation (r-control)

This is only possible in power controllers with current and voltage measurement that are fitted with subordinate control P (Code 001 in the order code) and only functions for load resistors with a positive temperature coefficient.

In three-phase economy circuits, no direct resistance limitation is possible because the individual resistance value is not recorded. However, the limiting function itself can be applied.

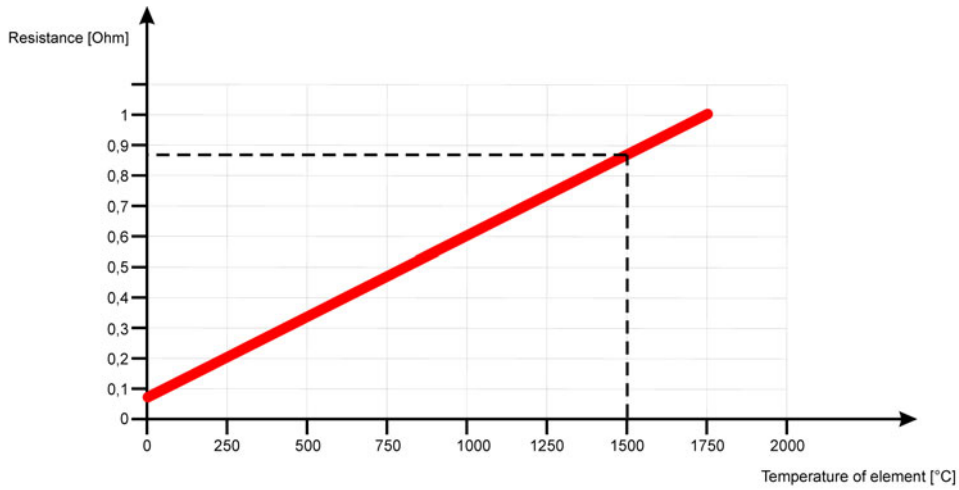
Function

It operates both in burst-firing operation and phase-angle operation.
If the current measured value for resistance exceeds the resistance limit, it is limited by phase-angle control or limitation of the switched sine waves.

Limitation of the power

The resistance limitation parameter can be used to activate limitation of the power output depending on the resistance value R when operating molybdenum disilicide heating elements in order to prevent overheating of the heating element in the upper temperature range. By measuring the resistance of the heating elements it is possible to assign a precise heating element temperature.

If the load resistance exceeds this value, it is limited by phase-angle control or limitation of the switched sine waves.
This protects the heating element from overheating.



6.7 Current limiting

Current limiting is only possible for power controllers with load current measurement, i.e. in the order details, subordinate control **I, I^2** (code 010 in the order code), or **P** (code 001 in the order code) must be selected.

Current limiting is implemented via phase-angle control. It therefore only operates permanently in phase-angle operation mode.
If burst-firing operation is active, current limiting only operates in the soft start phase if "With phase angle control" is selected as the soft start type.

In a three-phase economy circuit, only the current in the strand of the master power controller is limited to the configured value. As a result of the economy circuit, significantly greater load currents can flow in the other two phases.

Function

Current limiting prevents overcurrents in the load current circuit. It limits the load current independently of the load resistance and the setpoint value to the required current limit value by enlarging the phase control angle, if necessary.

Current limiting is unavoidable for heating elements with a high positive temperature coefficient, such as Kanthal-Super, for example. Without current limiting, the load current would accept inadmissibly high values when such heating elements are in a cold state.

Default setting

Current limiting is not activated.

If necessary, current limiting must be switched on in the configuration level.

⇨ Chapter 5.1.2 "Power controller"

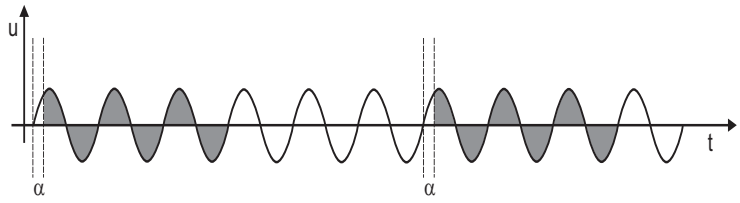
The current limit value can be adjusted both in the configuration level or in the operator level. In the operator level, it can be adjusted during operation.

6 Special device functions

6.8 α start

Default setting The phase-angle control of the first half-wave (α start) is not activated.

For transformer loads, the thyristor power controllers operate in continuous burst-firing mode and in logic operation with phase control of the first half-wave.
The factory setting is an angle of 70 °el. (electrical). This value can be adjusted in the configuration level or operator level within the range of 0 to 90 °el.



6.9 Monitoring of the mains voltage drop

If the effective values of the analyzed half-waves are more than 10 % apart, an alarm message is displayed and the digital output for the collective alarm switches depending on the set control direction.Immediate firing pulse inhibit prevents the connected transformer loads from destroying the semiconductor fuse due to a DC component.If there are no further mains voltage drops, the firing pulse inhibit is removed and the power controller continues operation (e.g. with a soft start).

Default setting Monitoring is not activated.

⇨ Chapter 5.1.5 "Monitoring"

6.10 Firing pulse inhibit

The inhibit function serves to protect the thyristor power controller and the connected devices.

Internal The thyristor output is locked during:

- Device switch-on (during the startup procedure)
- Changes in the configuration level
- Insufficient or excessive voltage supply
- Setup of data transfer to the device
- Device temperature greater than 115 °C
- Short-term supply drops > 10 % within a half-wave
  ⇨Chapter 6.9 "Monitoring of the mains voltage drop"

External Via the "Inhibit" digital input

⇨ Chapter 3.3 "Connection diagram"

Alternatively, the thyristor output can also be switched off via the PROFIBUS, RS422/485 interfaces.

6.11 Thyristor control logic (switch)

Operating mode

If the power controller is set to ➔Thyristor control ➔Logic (switch), the power controller operates as an electronic switch.
For as long as the configured digital or analog input is closed, the thyristors are fired in zero crossing of the mains voltage and are only locked again when the digital or analog input is opened.

Transformer loads

In the case of transformer loads, the first mains voltage half-wave of each pulse group must be cut. This can take place by configuring α **start** and entering **a value**.

⇨ Chapter 5.1.2 "Power controller"

The phase control angle for each first half-wave can be selected between 0 and 90°.

α input

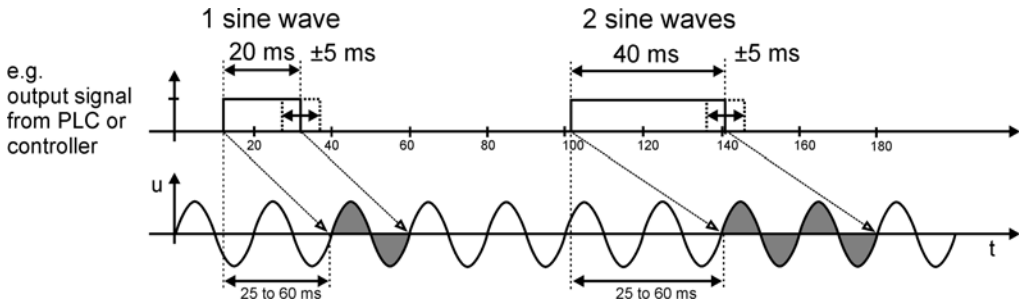
The full power is switched by closing the digital input. If this is too high for the case at hand (e.g. in the case of quick heat-up processes), the output power can be reduced by cutting all sine waves ("α input").

⇨ Chapter 5.1.4 "Setpoint value configuration"

Time behavior

If only short pulse packages with a defined number of sine wave cycles should be switched, the digital input (control direction "Open inactive") must be controlled via an optocoupler and the following timing must be observed:

Example for mains frequency of 50 Hz



The power controller requires an internal processing time and does not switch until the next zero crossing occurs. This results in a delay of 25 to 60 ms (see arrows) between the binary signal and the switching operation of the sine wave cycle.

Formula (50 Hz)

Binary signal length for n sine wave cycles = (n • 20 ms) ±5 ms

If the binary signal is, for example, 48 ms long and therefore calculated longer than for two sine wave cycles, it may be the case that the power controller switches two or even three sine wave cycles.

Formula (60 Hz)

Binary signal length for n sine wave cycles = (n • 16.6 ms) ±5 ms

6 Special device functions

The setup program enables all data for the device to be configured conveniently on a PC so that it can then be transferred to the device.

To configure the power controller, all you need to do is insert the USB cable into the power controller and connect it to the PC.

The configuration data is applied as soon as the device is switched on.

7.1 Hardware

- 500 MB hard disk space
- 512 MB RAM

7.2 Compatible operating systems

- Microsoft® Windows® 2000/XP/Vista
- Windows® 7 32-bit
- Windows® 7 64-bit

Users

If several users are managed on one computer, make sure that the user who is logged in is the person who will be working with the program later.
The user must have administrator rights for installing the software. After installation, the rights can be restricted again.

Failure to observe this information means that correct and complete installation cannot be guaranteed!

Software versions

The software versions for the device and the setup program must be compatible. An error message will appear if this is not the case!

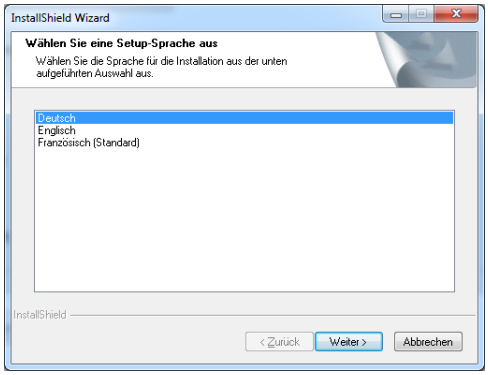
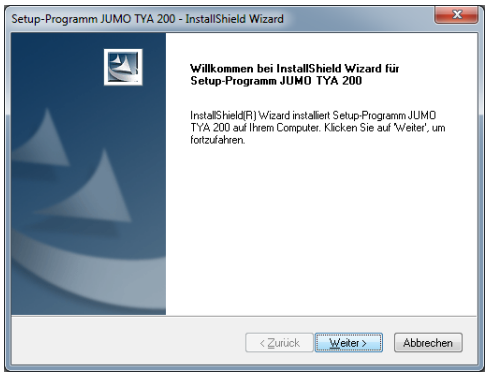
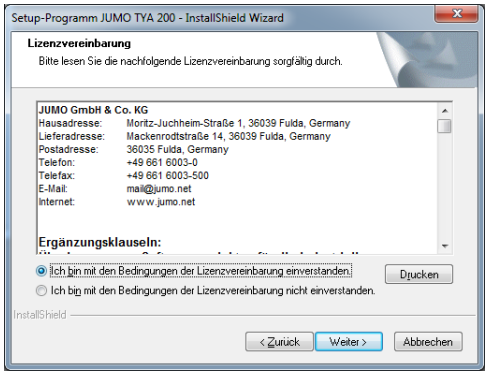
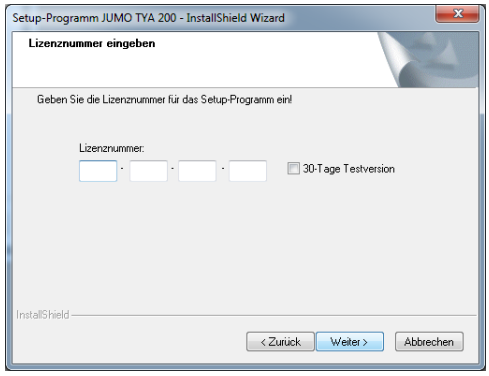
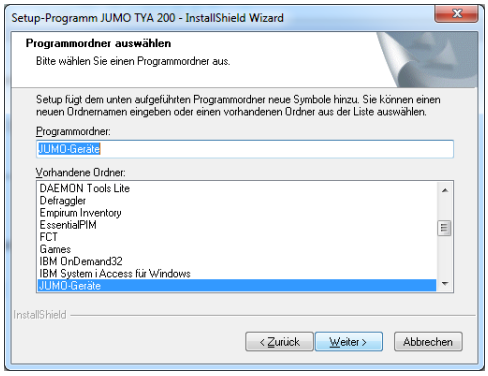
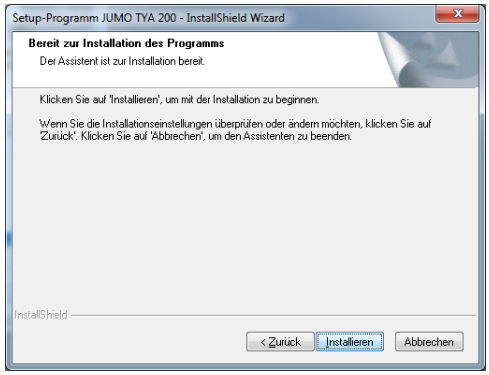
* After switching on the device, press PGM
  The device software version is shown in the Device info menu.
* Click "Info" in the setup program menu bar

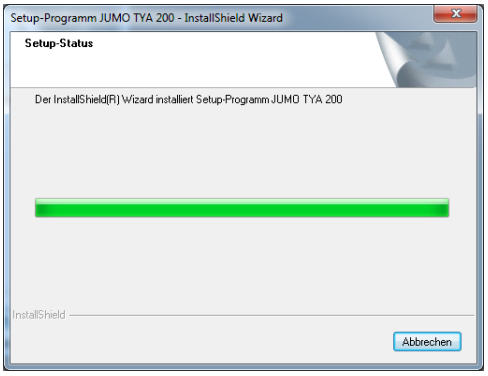
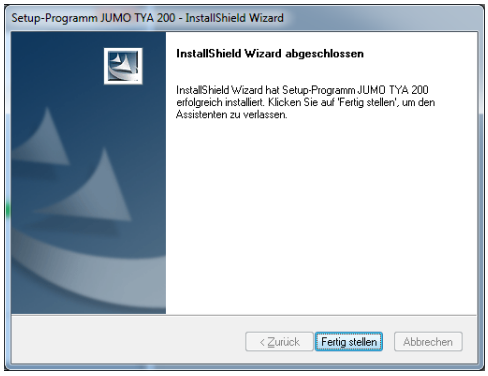
On the device	In the setup program
	

7 Setup program

7.3 Installation

✱ Install the setup program

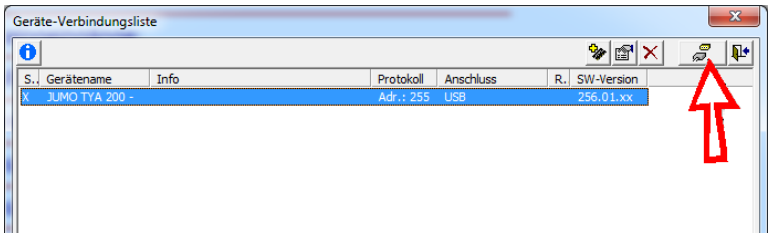
Installation steps	Appearance on the PC screen	
	1 	2 
Enter license number	3 	4 
	5 	6 

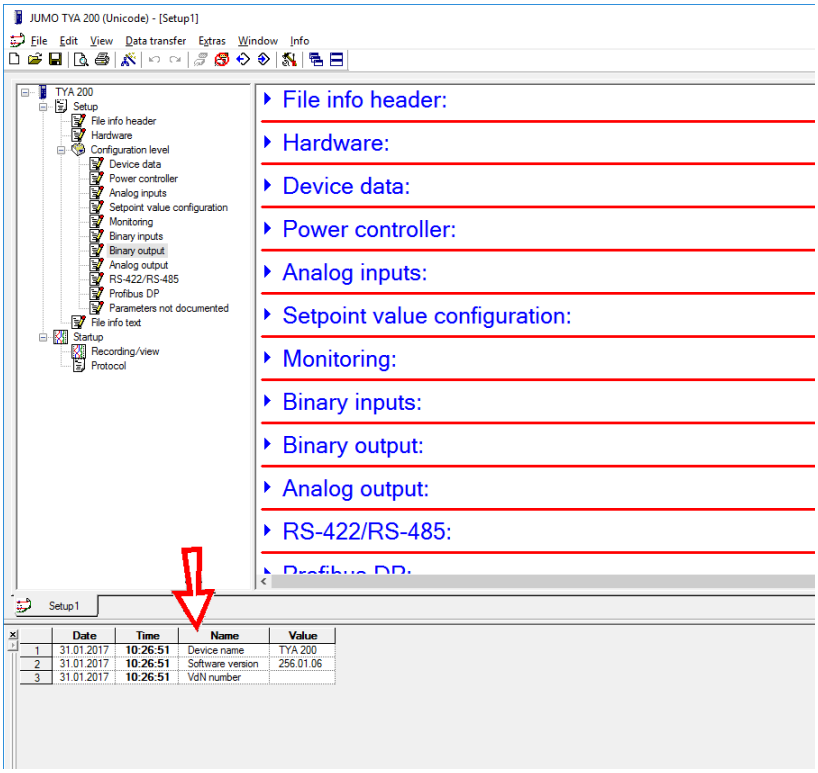
Installation steps	Appearance on the PC screen	
Installation complete	7 	8 
Launch setup program	9 	

7 Setup program

7.4 Program start

* Start the setup program using the Windows® Start menu
* Connect the socket of the power controller to a USB socket on the PC using the supplied USB cable
* Click *Connect* in the menu bar





Diagnostics

The diagnosis window appears at the bottom of the screen and shows the device info and the current measurement data. The connection has been established.

The power controller supplies no power while setup data is being transferred "to the device". The device restarts after the transmission.

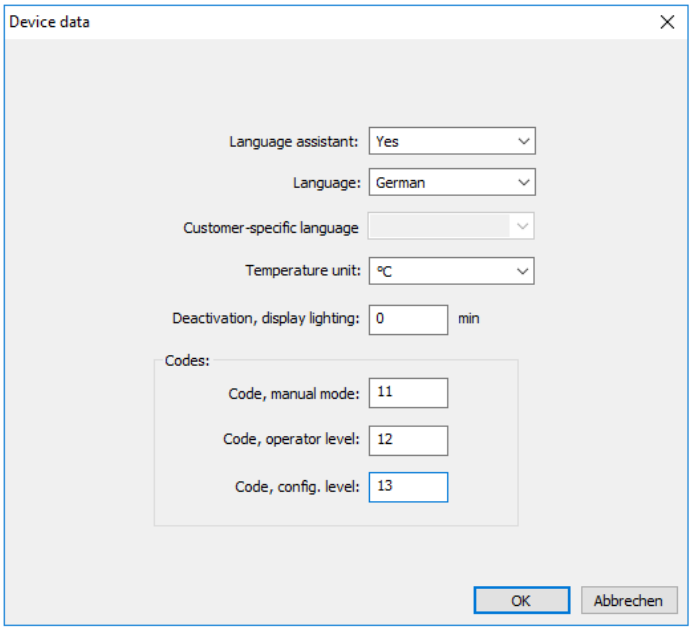
7.5 Forgotten the code?

If you have forgotten your password, you can extract the device data or enter a new code word via the setup program.

Extracting set-up data

* Perform a *Data transfer* ➔ *From the device*

The extracted codes are visible in the Device data menu.



Entering new codes

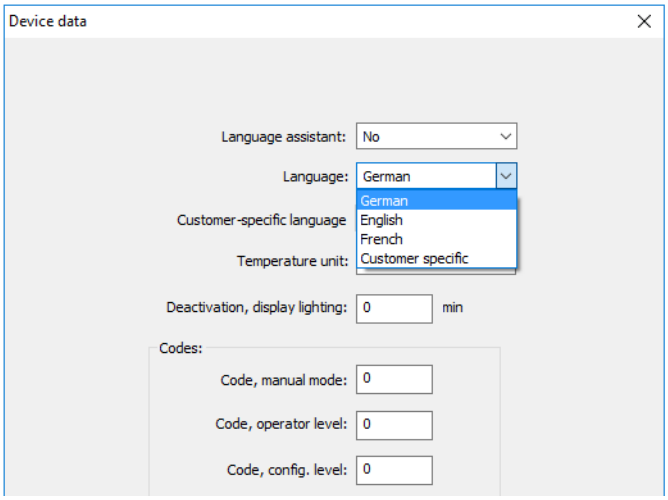
* Enter a new code
* Perform a *Data transfer* ➔ *To the device*
  After transferring the setup data, the device restarts and the codes are activated.

7 Setup program

7.6 Changing the language of the device texts

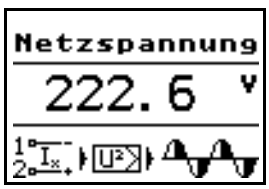
The default national language is specified in the order details. Only one national language can be transmitted to the device with the setup program.

* Connect the device to the PC using the USB cable
* Start the setup program
* Perform a *Data transfer* ➔ *from the device*
* *Edit* ➔*Execute hardware* and the hardware wizard will start
* Click *Automatic detection* and the dialog for the device language will appear.



* Select the desired national language
* Continue in the hardware wizard by clicking *Continue* until it is completed The device texts in the selected national language can now be found in the setup file.
* Perform a *Data transfer* ➔*To the device*
* Save the setup file and wait until the data transmission has been successfully completed

The device now restarts and texts will appear on the display in the desired national language.

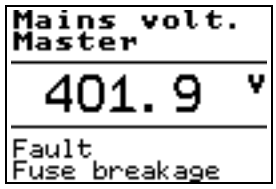


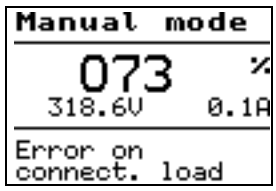
Cyclical appearance

The symbols for input, subordinate control loop, and operating mode are displayed alternately in the info line together with error messages or information about special statuses.

⇨ Chapter 4.1.2 "Appearance of measured values"

Examples





Error message	Cause	Remedy
Limit value monit. Min. value reached	The value has dropped below the set limit value for the min. alarm	-
Limit value monit. Max. value reached	The set limit value for the max. alarm has been exceeded	-
Fault at connected load	Break or short-circuit of a load resistor. ⇨ Chapter 6 "Special device functions"	Replace defective heating elements.
Malfunction Blown fuse (red LED fuse is lit)	1. Semiconductor fuse defective	⇨ Chapter 8.2 "Replacing a defective semiconductor fuse"
	2. No voltage at terminal U1	- Check wiring - Check the wire fuse for the load circuit
	3. The voltage supply for the control electronics L1/N does not have the same phase angle as the load circuit U1/U2.	Check wiring
Malfunction thyristor breakage	Thyristor defective	The device must be returned to JUMO for repair. ✱ Return the device
Thyristor short circuit	Thyristor defective **Note:** Monitoring only works when the load resistance is so low that at least 10 % of the power controller nominal current is flowing.	The device must be returned to JUMO for repair. ✱ Return the device
Caution! High temperature	Device temperature is higher than 100 °C (Excess temperature)	- Ensure adequate ventilation or provide for additional cooling - Reduce load current - Use power controller with higher maximum load current

8 Error messages and alarms

Error message	Cause	Remedy
Limiting active high temperature	Device temperature is higher than 105 °C. Device is too hot, output level is reduced! (Limited power due to excess temperature)	- Ensure adequate ventilation or provide for additional cooling - Reduce load current - Use power controller with higher maximum load current
Mains voltage is too low	Mains voltage is not within specified tolerance range ⇨ Chapter 10.1 "Voltage supply, Fan specifications for 250A, load current"	Check nominal voltage of the device type ⇨ Chapter 1.3 "Order details"
Mains voltage is too high	Mains voltage is not within specified tolerance range Chapter 10.1 "Voltage supply, Fan specifications for 250A, load current"	Check nominal voltage of the device type Chapter 1.3 "Order details"
Temporary drop in mains voltage	Dangerous temporary equal proportion for transformer loads has been detected. ⇨ Chapter 5.1.5 "Monitoring"	Ensure stable mains supply.
Teach-In load monitoring!	Reminder that "manual" Teach-In has been configured but not yet executed.	Perform Teach-In ⇨ Chapter 6 "Special device functions"
Inhibit by inhibit input	A firing pulse inhibit has been triggered via a potential-free contact. No power from the power controller.	⇨ Chapter 3.3 "Connection diagram" Open contact between terminal 7 and 8 at screw terminal X_2.
Inhibit by ext. inhibit	The firing pulse inhibit has been triggered via an interface.	⇨ Interface manual "Ext. inhibit"
Soft start phase	This message appears in the display until the soft start has been completed.	⇨ Chapter 5.1.2 "Power controller" -> Soft start duration
Current limiting active	The required output level causes an excessive load current and is limited to the set value.	⇨ Chapter 5.1.2 "Power controller" "Current limiting" on page 63
Resistance limitation active	The desired output level leads to current/voltage values that exceed the set load resistance. The output level is limited to the admissible resistance to prevent overheating.	⇨ Chapter 5.1.2 "Power controller" -> Resistance limit value

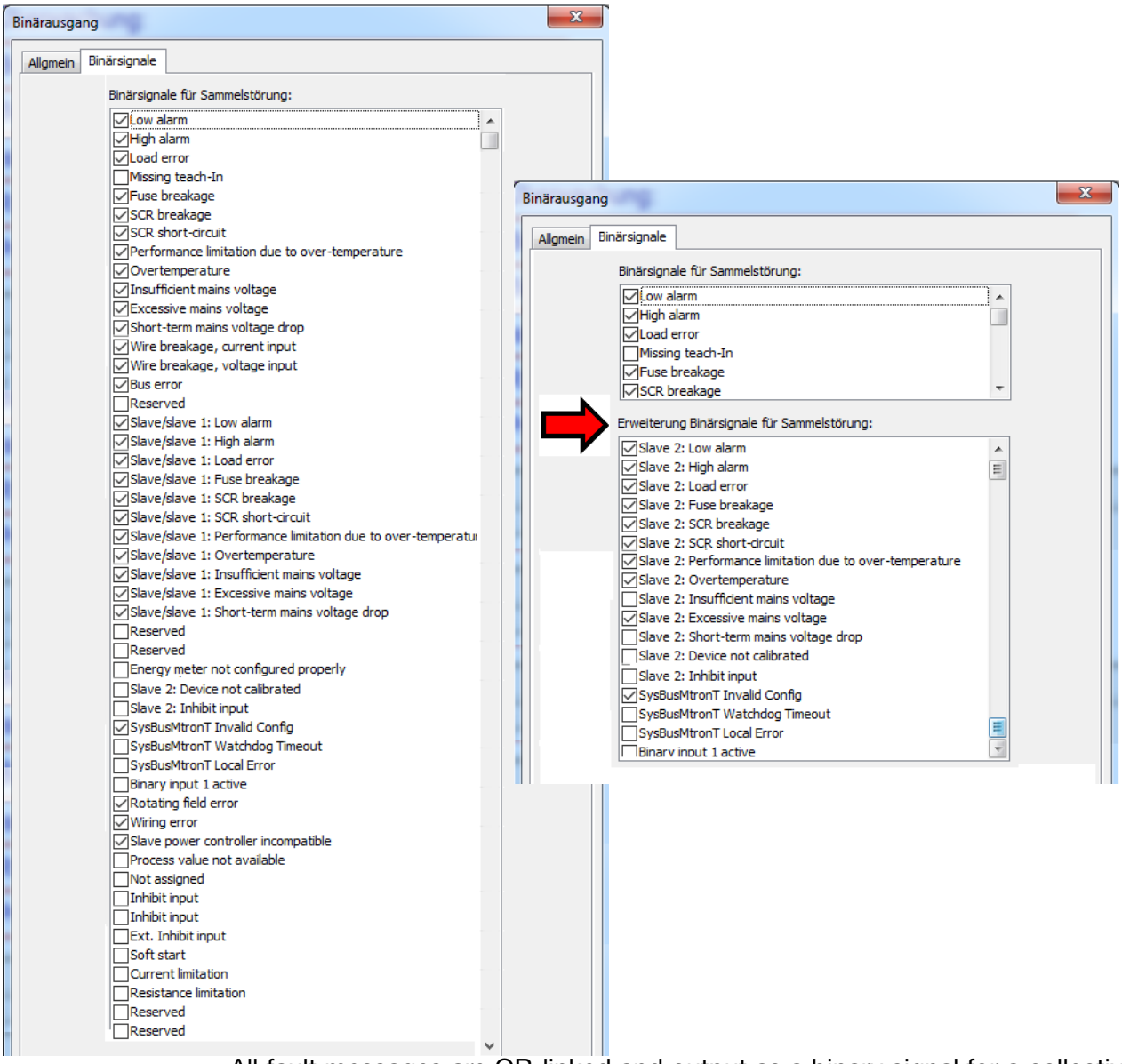
Error message	Cause	Remedy
Wire break Current input	Input current is out of the configured valid-range.	- check wiring for break or polarity reversal - check the signal output of connected devices (contoller)
Wire break Voltage input	Input voltage is out of the configured valid-range.	- check wiring for break or polarity reversal - check the signal output of connected devices (contoller)
Fault Bus error Busfehler	No connection to the Modbus-, Profibus- bzw. EtherCAT-Networkk	check wiring of Master device (SPS)
EtherCAT: InvalConfig	Wrong EtherCAT configuration	check EtherCAT configuration
EtherCAT: PdoWdTimeout	EtherCAT watchdog timeout e.g. not connected Ethernet cable	check EtherCAT wiring
EtherCAT: LocalError	Internal Error	✱ contact JUMO Service
Setpoint not reachable	This Message will be displayed if the applied setpoint cannot reach the requested power on the load.	⇨ Chapter 5.1.5 "Monitoring" -> >Control loop monitoring
Energy meter misconfigured	- Sum of **Pulse length** and **min. pulse interval** is too big - Value for **Pulses per kWh** is too big	⇨ Chapter 5.1.7 "Digital output" -> Output mode

8 Error messages and alarms

8.1 Binary signal for collective fault

This signal is used for controlling the digital output and LED K1, and can also be read out from the power controller via the interfaces.

You can use the setup program to configure which events (alarm and error messages) are to be grouped together as a binary signal for a collective fault.



All fault messages are OR-linked and output as a binary signal for a collective fault on the relay output or optocoupler.

In addition, LED K1 lights up yellow.

This alarm can switch a relay at the binary output.

⇨ Chapter 5.1.7 "Digital output"

8.2 Replacing a defective semiconductor fuse

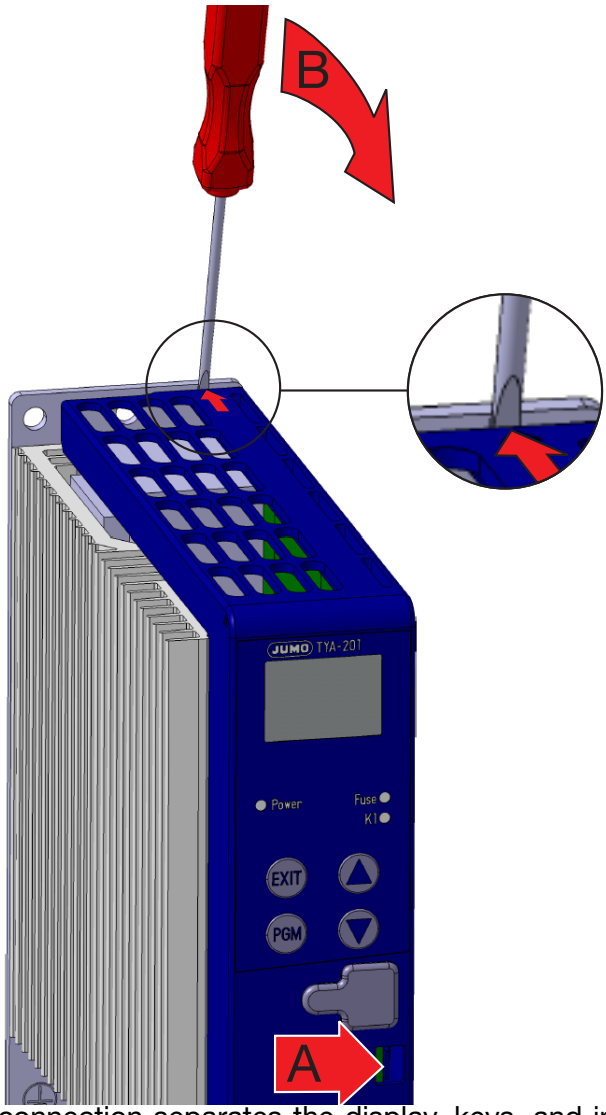
Opening the housing

Caution! Risk of burns!
The device's heat sink can heat up during operation.

The current device temperature is shown on the display.

⇨ Operating overview (on the first cover page)

* Disconnect the built-in device from the voltage supply on all poles
⇨ Chapter 3.3 "Connection diagram"
* Check that the device is isolated (green Power LED must not be lit)
* Press spring clip (A) to the right and lever up the plastic housing (at the point marked with an arrow) using a screwdriver (B).



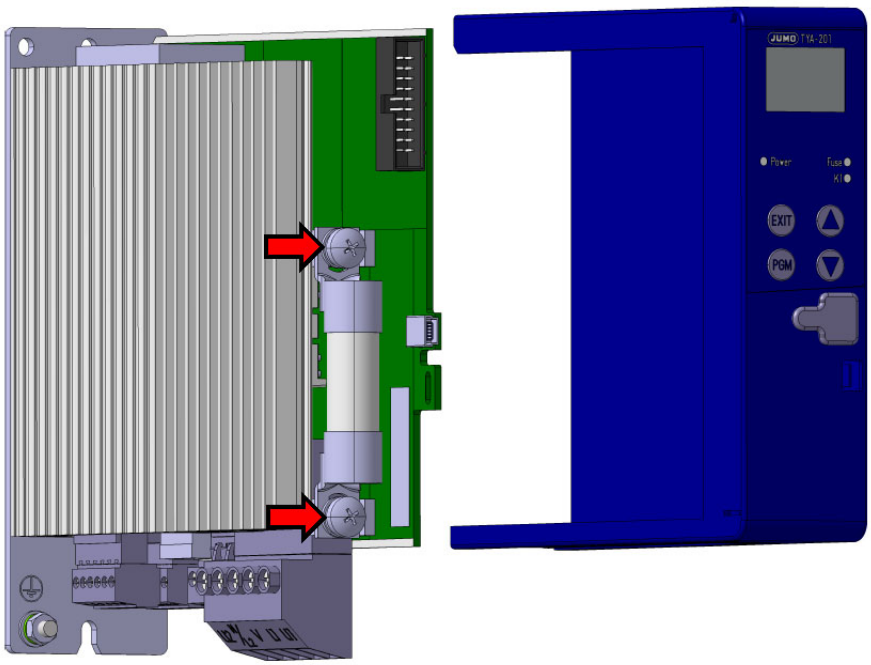
A plug connection separates the display, keys, and interface from the power section and you will be able to see the semiconductor fuse.

8.2.1 Accessories: semiconductor fuses

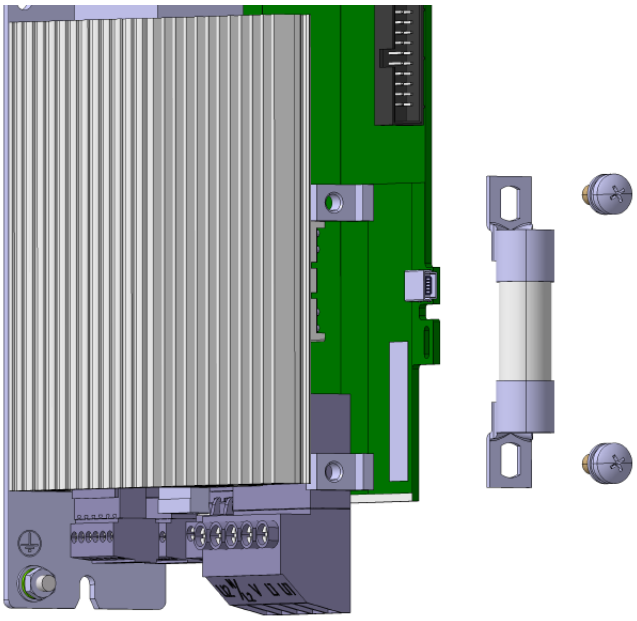
The design of the semiconductor fuse differs according to the device type.

Power controller type	Tripping current	Screws	Tightening torque	Part no.
20 A	Tripping current: 40 A	Recessed head	3 Nm	00513108
32 A	Tripping current: 80 A	Recessed head	5 Nm	00068011
50 A	Tripping current: 80 A	Recessed head	5 Nm	00068011
100 A	Tripping current: 160 A	Hex-headed, width across flats 10 mm	5 Nm	00081801
150 A	Tripping current: 350 A	Hex-headed, width across flats 13 mm	12 Nm	00083318
200 A	Tripping current: 550 A	Hex-headed, width across flats 13 mm	12 Nm	00371964
250 A	Tripping current: 550 A	Hex-headed, width across flats 13 mm	12 Nm	00371964

8.2.2 Semiconductor fuses type 709061/X-0X-20...

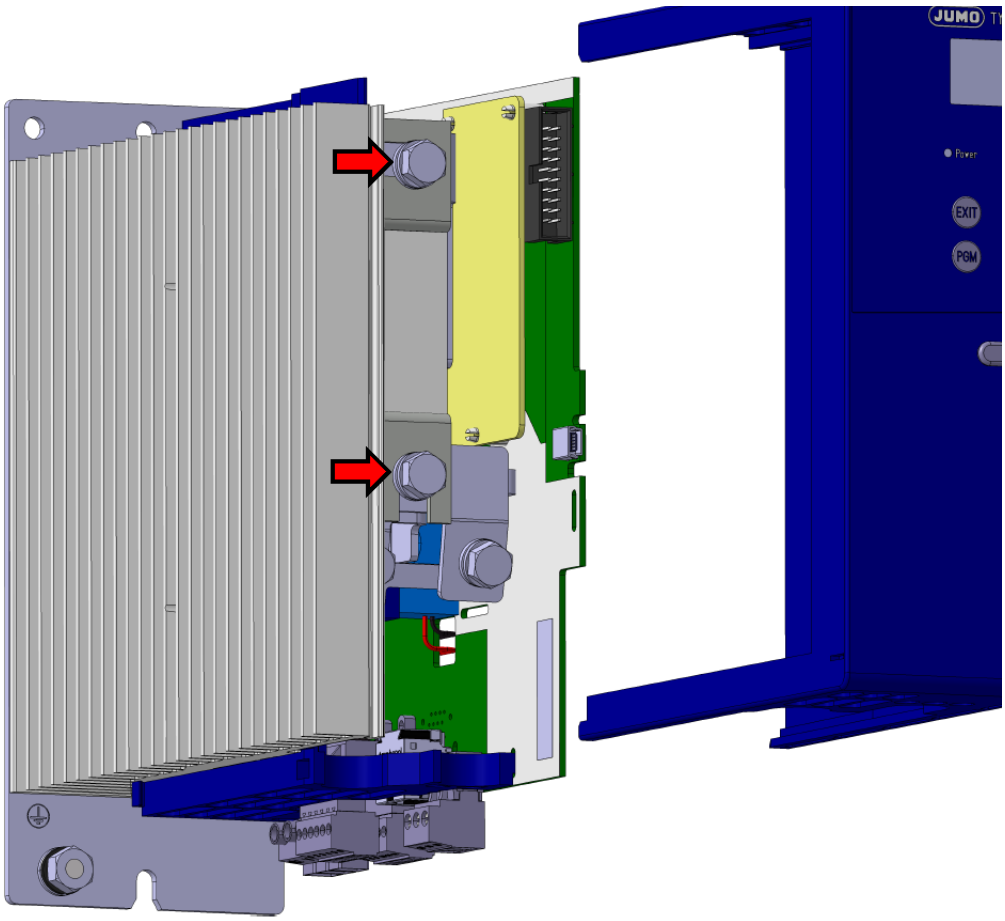


✱ Undo 2 recessed head screws

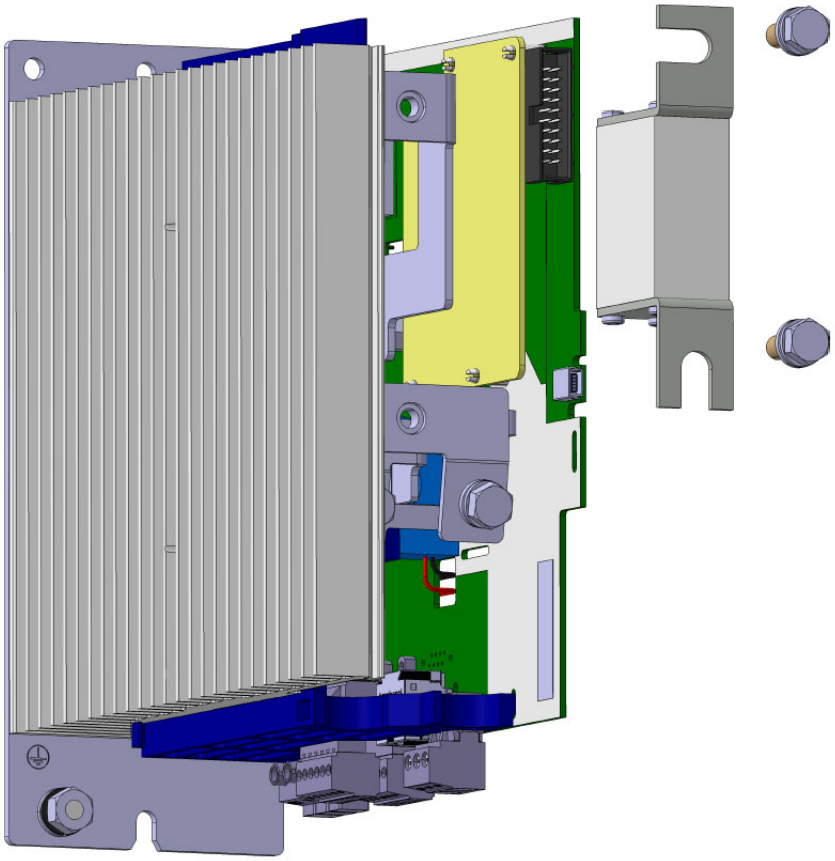


* Replace the defective semiconductor fuse with a new one.
* Tighten the screws with the specified tightening torque

8.2.3 Semiconductor fuses type 709061/X-0X-32...



* Undo 2 hex-headed screws



* Replace the defective semiconductor fuse with a new one.
* Tighten the screws with the specified tightening torque

Reassembling the housing

* Push the plastic housing back into the guide rails until the spring clip engages.

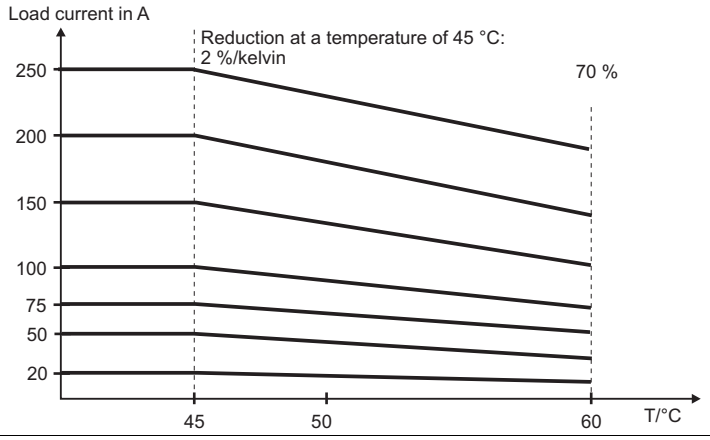
What is happening?	Cause / remedy	Info
Green Power LED is flashing	- Display switch-off active ✱ Press any key	⇨ Chapter 5.1.1 "Device data"
Power controller is not producing any output power even though the green Power LED is lit and a setpoint value has been set.	- Parameters have been changed in the configuration level but not completed. ✱ Leave the configuration level by pressing EXIT and wait for a restart.	-
	- Wire break at the analog input or incorrect analog input wiring	⇨ Chapter 3.3 "Connection diagram"
	- Setpoint value configuration incorrectly configured, e.g. set via interface.	⇨ Chapter 5.1.4 "Setpoint value configuration"
	- Input for firing pulse inhibit active A padlock symbol is shown as the operating mode in the info line. Undo connection between screw terminal 7 and 8 at terminal X2_2.	⇨ Chapter 4.1.2 "Appearance of measured values"
	- Load break ✱ Check load and load connections	⇨ Chapter 8 "Error messages and alarms"
Fuse LED is lit	- Semiconductor fuse defective due to short circuit in power section ✱ Remedy short circuit in the load or load circuit ✱ Fit a new semiconductor fuse	⇨ Chapter 8.2 "Replacing a defective semiconductor fuse"
Power controller is producing power even though no setpoint value (output level) is specified by the controller.	- Configuration problem: Controller output signal set to 4 to 20 mA and current set to 0 to 20 mA at analog input of power controller. ✱ Check configuration and select same standard signals for the controller and power controller.	⇨ Chapter 5.1.3 "Analog inputs" ⇨ Chapter 5.1.4 "Setpoint value configuration"
	- Power controller in manual mode ✱ Exit manual mode by pressing EXIT	⇨ Chapter 6.2 "Manual mode"
	- Base load settings selected ✱ Check settings for base load settings	⇨ See "Base load" on page 67.
	- Thyristor short circuit	⇨ Chapter 8 "Error messages and alarms"

9 What to do, if ...

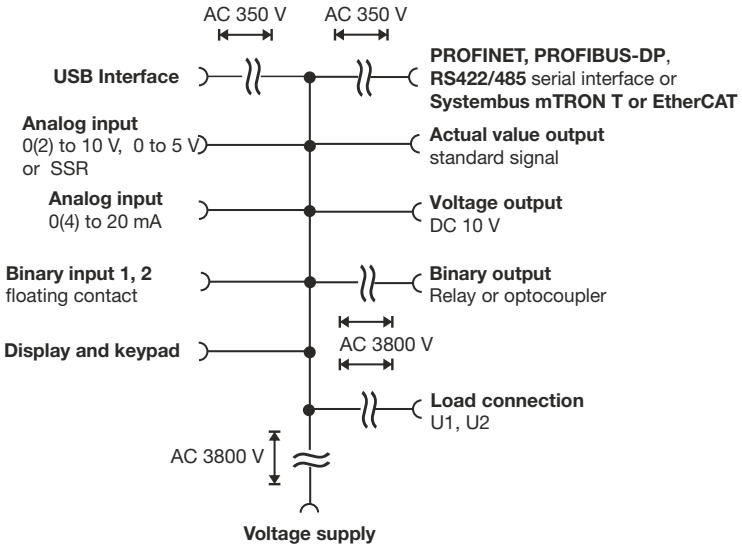
What is happening?	Cause / remedy	Info
Power controller is not producing full power even though the setpoint value is set to 100 %	- Current limiting active ✱ Check settings	⇨ See "Current limiting" on page 63.
	- Half-wave control set (half power) ✱ Change to burst-firing operation mode or phase-angle control	⇨ See "Operating mode" on page 59.

10.1 Voltage supply, Fan specifications for 250A, load current

Code	Voltage supply for control electronics = max. load voltage	Fan specifications Type 709061/X-0X-250...
024	AC 24V -20%...+15%, 48 ...63 Hz	AC 24V/30VA
042	AC 42V -20%...+15%, 48 ...63 Hz	AC 24V/30VA
115	AC 115V -20%...+15%, 48 ...63 Hz	AC 115V/30VA
230	AC 230V -20%...+15%, 48 ...63 Hz	AC 230V/30VA
265	AC 265V -20%...+15%, 48 ...63 Hz	AC 230V/30VA
400	AC 400V -20%...+15%, 48 ...63 Hz	AC 230V/30VA
460	AC 460V -20%...+15%, 48 ...63 Hz	AC 230V/30VA
500	AC 500V -20%...+15%, 48 ...63 Hz	AC 230V/30VA
Load current $I_{L\ rms}$	AC 20, 32, 50, 100, 150, 200, 250A	
Load type	Resistive and resistive/inductive loads	
Control section power consumption	max. 20 VA	

Admissible load current depending on the ambient temperature	
Load type	Resistive and resistive/inductive loads

10.2 Galvanic isolation



10 Technical data

10.3 Analog inputs

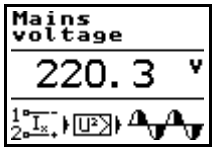
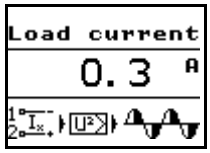
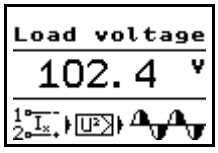
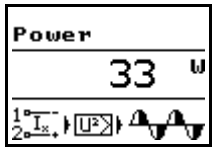
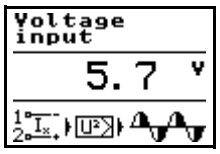
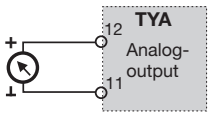
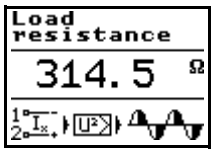
Current	0 (4) to 20 mA R_i = 50 Ω
Voltage	0 (2) to 10 V R_i = 25 kΩ
	0 (1) to 5 V R_i = 25 kΩ

10.4 Analog output (actual value output)

Analog output	Switched off as standard. I_{max} = 20 mA for standard signal voltage: 0 to 10 V, 2 to 10 V, 0 to 5 V up to 1 to 5 V. Burden max. 500 Ω for standard signal current: 0 to 20 mA up to 4 to 20 mA Depending on the device type, various internal measurands such as load current, load voltage, or power can be output.

10.4.1 Display and measuring accuracy

All specifications refer to the power controller nominal data.

Mains voltage: ±2.5 % 	**Load current:** ±1 % 	**Load voltage:** ±1 % 	**Power:** ±2 % 	
Analog input **Voltage/current:** ±1 % 	**Analog output** **Voltage/current:** ±1 % 	**Load resistance:** ±2 % (For resistive load) 		

10.5 Digital inputs

Digital input 1	For connection to potential-free contact
Digital input 2	

10.6 Digital output (fault signal output)

Relay (changeover contact) without contact protection circuit	30,000 switching operations at a switching capacity of AC 230 V / 3 A (1.5 A), 50 Hz, B300 (UL 508)
Optocoupler output	I_{Cmax} = 2 mA, U_{CEOmax} = 32 V

10.7 General specifications

Thyristor control:	**Setpoint specification current input** (Can carry current up to 25 mA)	**Setpoint specification voltage input** (Surge proof up to max. DC 32 V**)**	**Setpoint specification digital input1, 2** (Surge proof up to max. DC 32 V**)**	**Via interface**
Continuous	The power controller provides the power for the load continuously depending on the configured setpoint specification.		-	Possible
Logic (Solid state relay SSR)	The power controller acts like a switch and switches the load ON and OFF. The switching threshold is always in the middle of the configured current/voltage range At 4 to 20 mA, it is 12 mA; at 0 to 10 V, it is 5 V.		OFF logical "0" = 0 to +0.8 V; ON logical "1" = +2 to 3.3 V	Possible

Circuit options	- Single-phase operation - Star connection with accessible star point - Open delta connection (6-wire connection) - Free-running economy circuit (star or delta), only with subordinate P control in burst-firing operation - Three-phase economy circuit in master slave operation
Operating modes	- Phase-angle control for resistive and transformer loads with soft start - Burst-firing operation for resistive or transformer load
Special features	- Free-running economy circuit for resistive loads - Dual energy management (only for I^2 and P control) - Half-wave control - Soft start with pulse groups - R control (only for P control)
Load types	All resistive loads through to inductive loads are permitted. In the case of transformer loads, the nominal induction of 1.2 tesla must not be exceeded (value is 1.45 T in the case of mains overvoltage).
Subordinate control loop	U^2 set as standard Can be freely switched over to U, I, I^2, P control depending on device type
Electrical connection	For type 709061/X -0X-020... Control and load leads are connected via screw terminals. From type 709061/X -0X-032... Control leads are connected via screw terminals and load leads via cable lugs DIN 46235 and DIN 46234 or tubular cable lugs.
Operating conditions	The power controller is designed as a built-in device according to: EN 50178, pollution degree 2, overvoltage category Ü III
Electromagnetic compatibility	According to DIN 61326-1 Interference emission: Class B Interference immunity: to industrial requirements
Protection type	All device types IP20 according to EN 60529
Protection rating	Protection rating I, with isolated control circuitry for connection to SELV circuits
Admissible ambient temperature range	40 °C with forced air cooling using fan for type 709061/X-0X-250... 0 to 45 °C with natural air cooling (extended temperature range class 3K3 according to EN 60721-3-3) At higher temperatures, operation with reduced type current is possible. (From 45 °C with type current -2 %/°C) ⇨ Chapter 2.1.3 "Admissible load current depending on the ambient temperature and the site altitude"
Permissible storage temperature range	-30 to +70 °C (restricted temperature range 1K5 according to EN 60721-3-1)

10 Technical data

<table>
<tr><td>Altitude</td><td>≤ 2000 m above MSL
Caution: At site altitudes > 1000 m above MSL, the ampacity of the power controller decreases by 0.86 % per 100 m</td></tr>
<tr><td>Cooling</td><td>- Natural convection up to a load current of 200 A
- From 250 A of load current, forced convection
- At installation heights over 1000 m, the ampacity of the power controller decreases
⇨ Chapter 2.1.3 "Admissible load current depending on the ambient temperature and the site altitude"</td></tr>
<tr><td>Fans (only for type 709061/X-0X-250...)</td><td>Depending on the mains voltage of the power controller, the fan terminal X14 must be supplied with the voltage specified below.
The lead protection must be between 2 A and a maximum of 5 A.
The fan is temperature-controlled, switches on automatically when the device temperature reaches 85 °C, and remains in operation until the device temperature falls below 70 °C.
<table>
<tr><th>Mains voltage of the power controller</th><th>Tolerances</th><th>Fan specifications</th></tr>
<tr><td>Mains voltage AC 24 V</td><td>-20 to +15 %, 48 to 63 Hz</td><td rowspan="2">AC 24 V/30 VA</td></tr>
<tr><td>Mains voltage AC 42 V</td><td>-20 to +15 %, 48 to 63 Hz</td></tr>
<tr><td>Mains voltage AC 115 V</td><td>-15 to +10 %, 48 to 63 Hz</td><td>AC 115 V/30 VA</td></tr>
<tr><td>Mains voltage AC 230 V</td><td rowspan="5">-15 to +10 %, 48 to 63 Hz</td><td rowspan="5">AC 230 V/30 VA</td></tr>
<tr><td>Mains voltage AC 265 V</td></tr>
<tr><td>Mains voltage AC 400 V</td></tr>
<tr><td>Mains voltage AC 460 V</td></tr>
<tr><td>Mains voltage AC 500 V</td></tr>
</table></td></tr>
<tr><td>Resistance to climatic conditions</td><td>Rel. humidity ≤ 85 % annual average, no condensation 3K3 according to EN 60721</td></tr>
<tr><td>Installation position</td><td>Vertical</td></tr>
<tr><td>Test voltage</td><td>According to EN 50178 Tab. 18</td></tr>
<tr><td>Creepage distances</td><td>8 mm between mains voltage circuit and SELV circuits
For type 709061/X -0X-020...
12.7 mm between mains voltage circuit and SELV circuits
From type 709061/X -0X-032...
SELV = Separate Extra Low Voltage (safe low voltage)</td></tr>
<tr><td>Housing</td><td>Plastic, flammability class UL94 V0, color: cobalt blue RAL 5013</td></tr>
<tr><td>Power loss</td><td>The power loss can be calculated using the following empirical formula:
$P_V = 20\ W + 1.3\ V \times I_{Load}\ A$</td></tr>
<tr><td>Maximum temperature of the heat sink</td><td>110 °C</td></tr>
<tr><td>Weight</td><td>Load current 20 A approx. 1.1 kg
Load current 32 A approx. 2.1 kg
Load current 50 A approx. 2.7 kg
Load current 100 A approx. 3.8 kg
Load current 150 A approx. 8.5 kg
Load current 200 A approx. 9.5 kg
Load current 250 A approx. 10.2 kg</td></tr>
<tr><td>Standard accessories</td><td>1 operating manual</td></tr>
</table>

10.8 Approvals / approval marks

Approval mark	Test facility	Certificates / certification numbers	Inspection basis	Valid for type
c UL us LISTED	Underwriters Laboratories	E223137	UL 508 (Category NRNT), pollution degree 2 C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709061/X-XX-020-... Load current 20 A
			UL 508 (Category NRNT) C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709061/X-XX-032... 709061/X-XX-050... 709061/X-XX-100... 709061/X-XX-150... 709061/X-XX-200... 709061/X-XX-250... Load current 32 to 250 A

Lead protection for the control electronics	2 A up to max. 5 A, conductor cross section maximum AWG 20-12

10 Technical data

11.1 UL

CERTIFICATE OF COMPLIANCE

Certificate Number	20160609-E223137
Report Reference	E223137-20140218
Issue Date	2016-JUNE-09
Issued to:	JUMO GMBH & CO KG MORITZ-JUCHHEIM-STRASSE 1 36039 FULDA GERMANY
This is to certify that representative samples of	SWITCHES, INDUSTRIAL CONTROL See addendum page
	Have been investigated by UL in accordance with the Standard(s) indicated on this Certificate.
Standard(s) for Safety:	UL 508 & C22.2 No. 14-13 - Industrial Control Equipment
Additional Information:	See the UL Online Certifications Directory at www.ul.com/database for additional information

Only those products bearing the UL Certification Mark should be considered as being covered by UL's Certification and Follow-Up Service.

Look for the UL Certification Mark on the product.

Bruce Mahrenholz, Director North American Certification Program

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CERTIFICATE OF COMPLIANCE

Certificate Number	20160609-E223137
Report Reference	E223137-20140218
Issue Date	2016-JUNE-09

This is to certify that representative samples of the product as specified on this certificate were tested according to the current UL requirements.

Industrial Control Switches, open types, Cat. Nos. 709061 / 709062 or 709063 /, followed by 8 or 9, followed by - 01, - 02 or - 03, followed by - 020, - 032, - 050, - 100, - 150, - 200 or - 250, followed by - 100, - 010 or - 001, followed by - 024, - 042, - 115, - 230, - 265, - 400, - 460 or - 500, followed by - two digits, followed by / 252 or / 257.

Bruce Mahrenholz, Director North American Certification Program

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11.2 China RoHS

部件名称 Product group: 709061	 有毒有害物质或元素 Hazardous substances					
	铅（Pb）	汞（Hg）	镉（Cd）	六价铬（Cr(VI)）	多溴联苯（PBB）	多溴二苯醚（PBDE）
外壳 Housing (Gehäuse)	X	○	○	○	○	○
过程连接 Process connection (Prozessanschluss)	○	○	○	○	○	○
-螺母 Nut (Mutter)	○	○	○	○	○	○
螺钉 Screw (Schraube)	○	○	○	○	○	○

本表格依据 SJ/T 11364-2014**的规定编制。**
(This table is prepared in accordance with the provisions of SJ/T 11364-2014.)
O：**表示**该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下。
(O: Indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirement of GB/T 26572.)
X：**表示**该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求。
(X: Indicates that said hazardous substance contained in one of the homogeneous materials used for this part is above the limit requirement of GB/T 26572.)

11 Certificates

JUMO GmbH & Co. KG
Street address:
Moritz-Juchheim-Straße 1
36039 Fulda, Germany
Delivery address:
Mackenrodtstraße 14
36039 Fulda, Germany
Postal address:
36035 Fulda, Germany
Phone: +49 661 6003-0
Fax: +49 661 6003-607
Email: mail@jumo.net
Internet: www.jumo.net

JUMO Instrument Co. Ltd.
JUMO House
Temple Bank, Riverway
Harlow, Essex, CM20 2DY, UK
Phone: +44 1279 63 55 33
Fax: +44 1279 62 50 29
Email: sales@jumo.co.uk
Internet: www.jumo.co.uk

JUMO Process Control, Inc.
6724 Joy Road
East Syracuse, NY 13057, USA

Phone: +1 315 437 5866
Fax: +1 315 437 5860
Email: info.us@jumo.net
Internet: www.jumousa.com