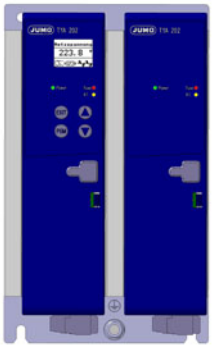
JUMO TYA 202

Thyristor power controller in a three-phase economy circuit



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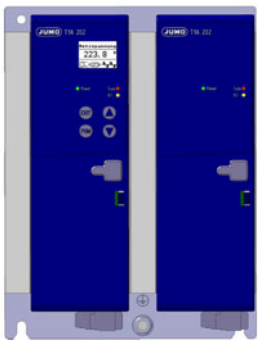

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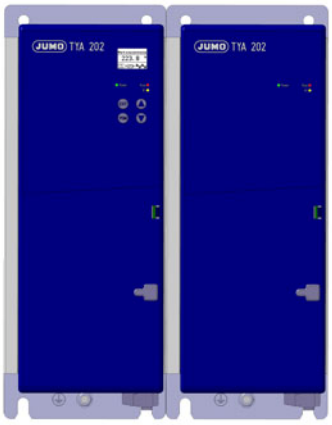

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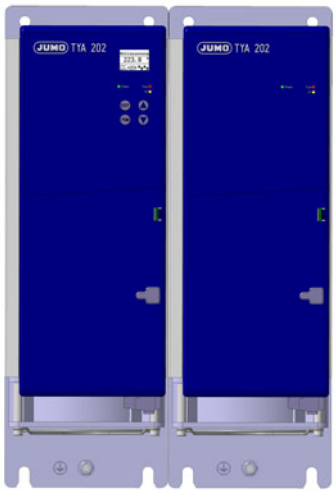

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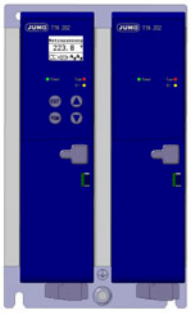


709062/8-01-32

709062/8-01-020

Operating Manual

70906200T90Z001K000

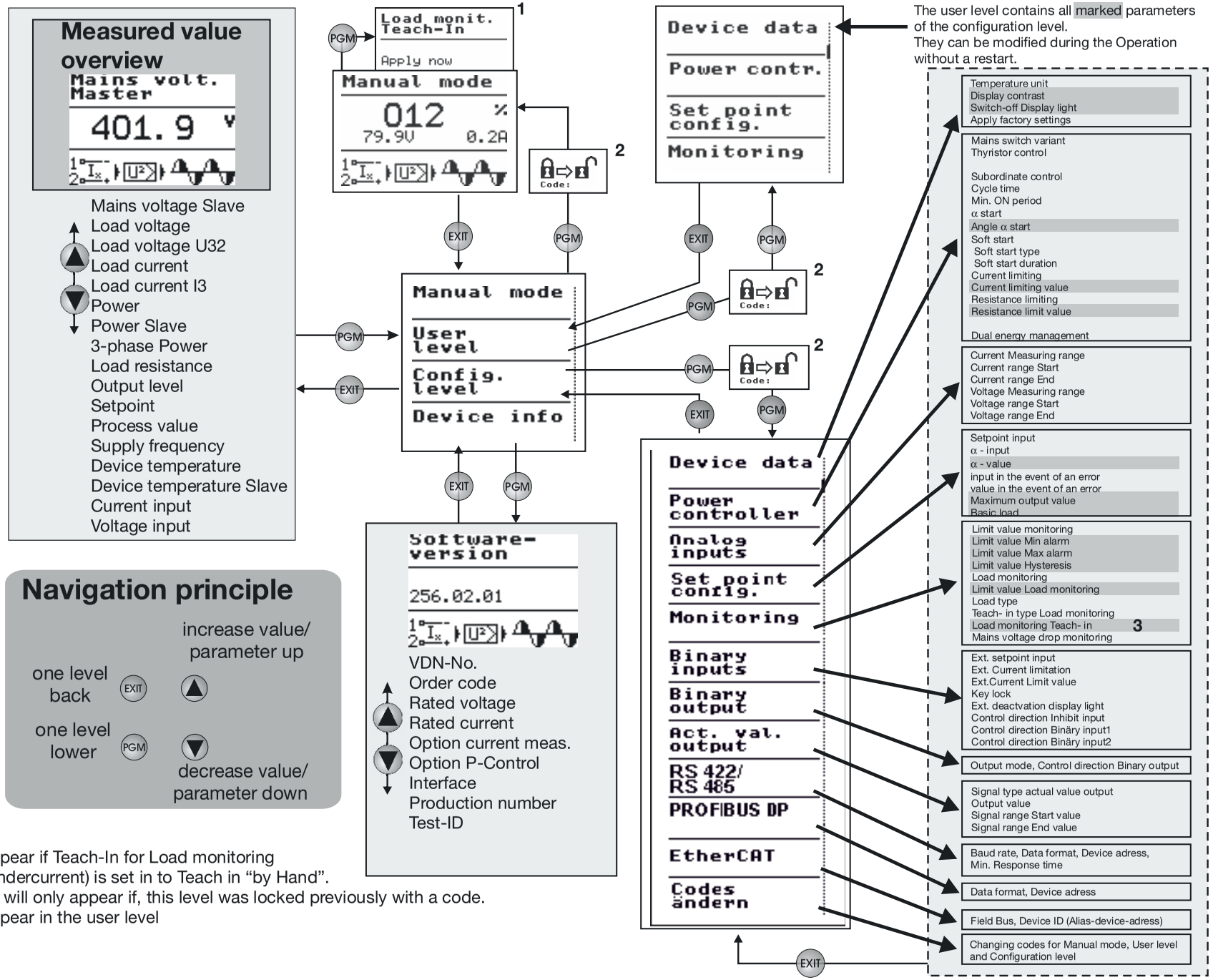
JUMO

V3.01/EN/00561073

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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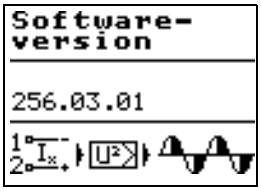
1.1 Editorial

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 ➔Power controller ➔Operating mode — 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

709062	TYA 202 Thyristor Power Controller in Three-phase Economy Circuit

(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

(8) Extra code

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

(1)		(2)		(3)		(4)		(5)		(6)		(7)		(8)	
	/		-		-		-		-		-		/		**Order code**
709062	/	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)

b. Enables energy meter

Note:
Subordinate control loop U, U^2, code 100: enables voltage control
Subordinate control loop I^2, code 010: enables voltage control, current control, partial load failure detection, dual energy management, current limiting, and energy meter function
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 function

At a load current of 250 A, observe voltage supply for fan!
⇨ Chapter 3.2.4 "Typ 709062/X-0X-250-XXX-XXX-XX-25X"

1.3.1 Scope of delivery

1 operating manual
1 thyristor power controller in the version ordered
1:1 patch cable

1.3.2 Accessories

Item	**Part no.**
Setup program 709061 TYA 201 (can also be run for TYA 202 power controllers)	00544869
USB cable A-connector B-connector 3 m	00506252
Installation kits:	
Installation kit for DIN rail 20 A TYA 202	00555172
Installation kit for DIN rail 32 A TYA 202	00555527
Installation kit for DIN rail 50 A TYA 202	00600097

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 202 represents the consistent development of JUMO power controller technology. It switches ohmic-inductive loads using a three-phase current economy circuit in star-delta three-phase operation. The microprocessor-controlled power controller displays all parameters in an LCD display with background lighting. It can be operated using the 4 keys at the front.

Application

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

Mounting

Thyristor power controllers up to a load current of 32 A can either be 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 TYA 202 works in burst-firing operation. In burst-firing operation, the first half-wave can be optimally cut with an adjustable phase angle so that transformer loads can also be operated.
It is possible to specify a base load or, depending on the device type, to set current limiting or resistance limitation for the load.
To avoid high starting currents, a soft start can be set.

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. Fluctuations 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 - only for industrial use Industrial requirement
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)	709062/X-XX-020-... Load current 20 A
	UL 508 (Category NRNT) C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709062/X-XX-032... 709062/X-XX-050... 709062/X-XX-100... 709062/X-XX-150... 709062/X-XX-200... 709062/X-XX-250... Load current 32 to 250 A
Can be used for electrical 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 application, it must be ensured that the fuse for the supply protection of the control electronics is 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.

Master/slave 1:1 patch cable

Prior to startup, the enclosed 1:1 patch cable must be inserted into the master's X8 socket and connected to the slave device's X8 socket.

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 protection conductor is not a component of the supply cable 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 (rated 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 setpoint specification 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.
The ground terminals X2_2/11 **or** X2_1/6 of the master and slave must be connected to one another.

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 cooling body of the master and slave device 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.

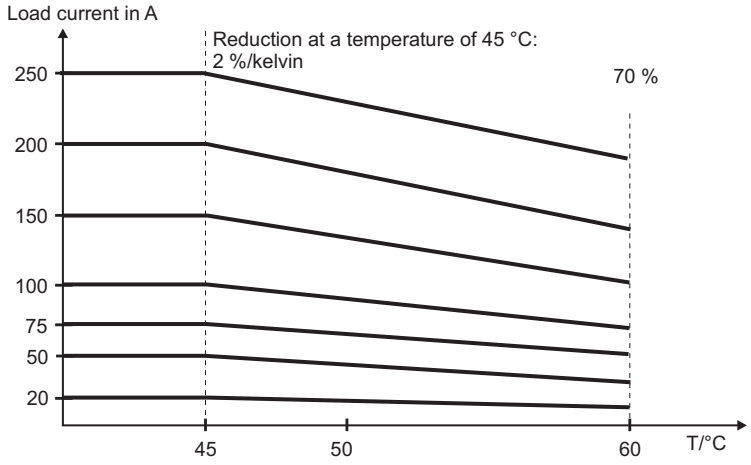
The control electronics of the thyristor power controller comply with the EMC requirements of EN 61326.

However, 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:

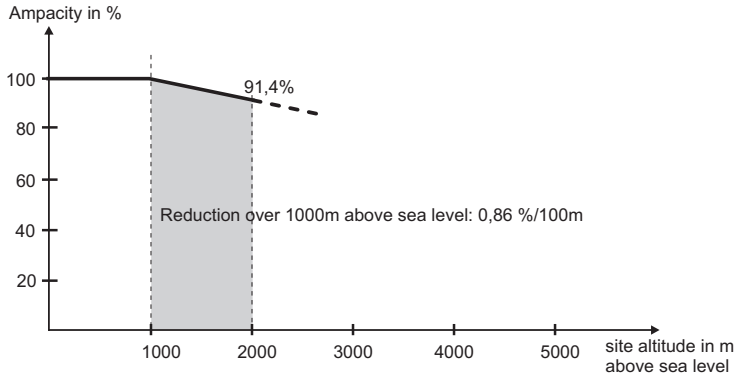
In the event of operation at maximum load current over an extended period, the heat sink and its surroundings heat up.
For this reason, at ambient temperatures above 45 °C, the maximum load current must be reduced as shown in the image, as the thyristor module could otherwise be destroyed.
The master or slave 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 load current 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 current is completely switched off.

⇨ Chapter 8 "Error messages and alarms"

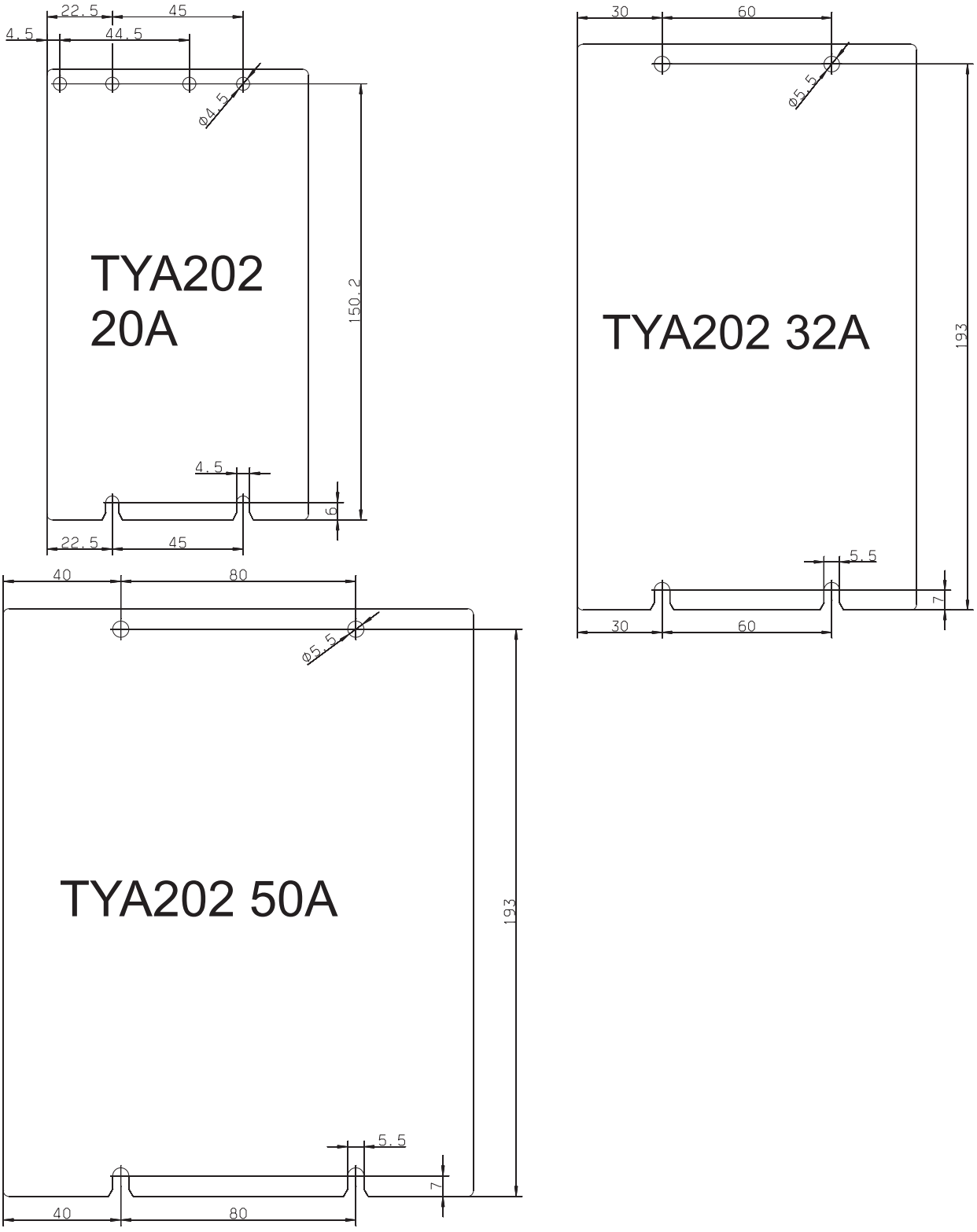
Site altitude

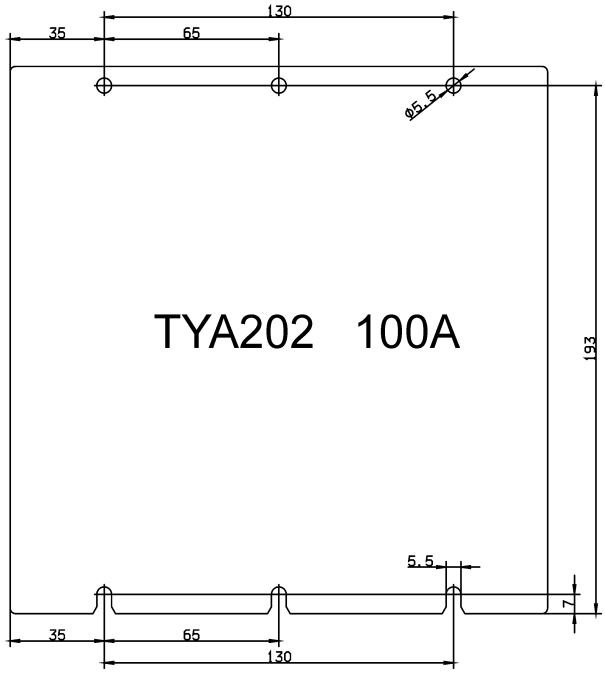
In the case of air cooling, it must be noted that the effectiveness of the cooling is reduced as the site altitude increases. As a result, the ampacity of the thyristor power controller decreases with such a cooler as the site altitude increases, as shown in the diagram.



2.1.4 Wall mounting with screws (default)

Power controllers with a load current between 20 and 50 A are affixed to a fire-proof control cabinet wall with 4 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 6 screws.

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TYA202 100A
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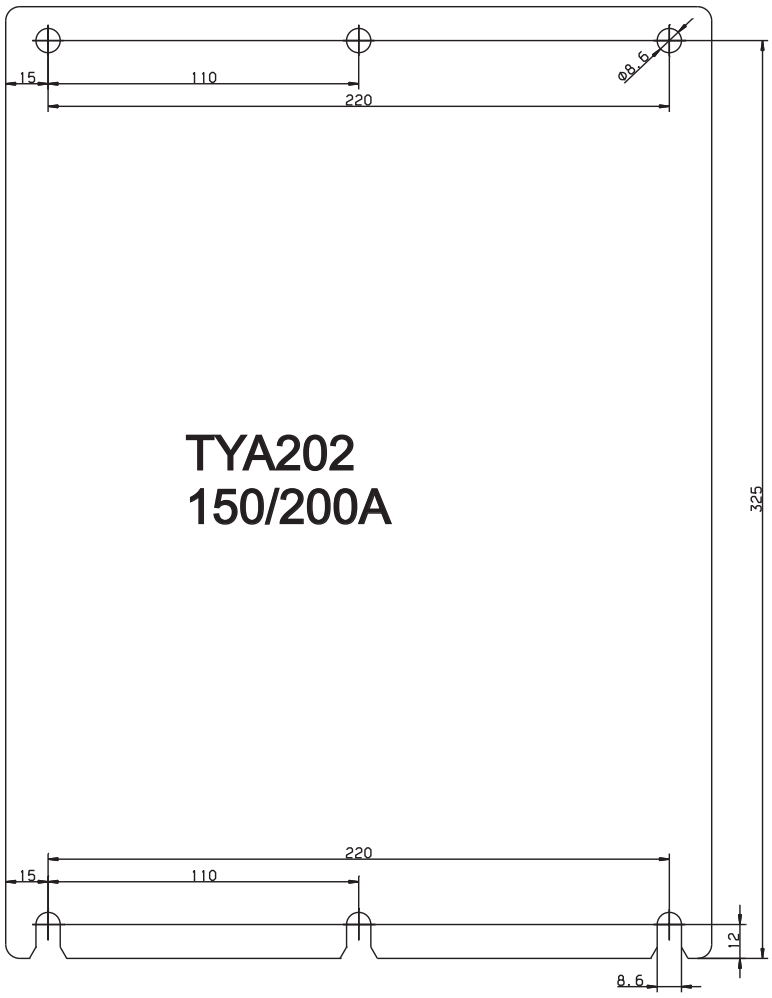
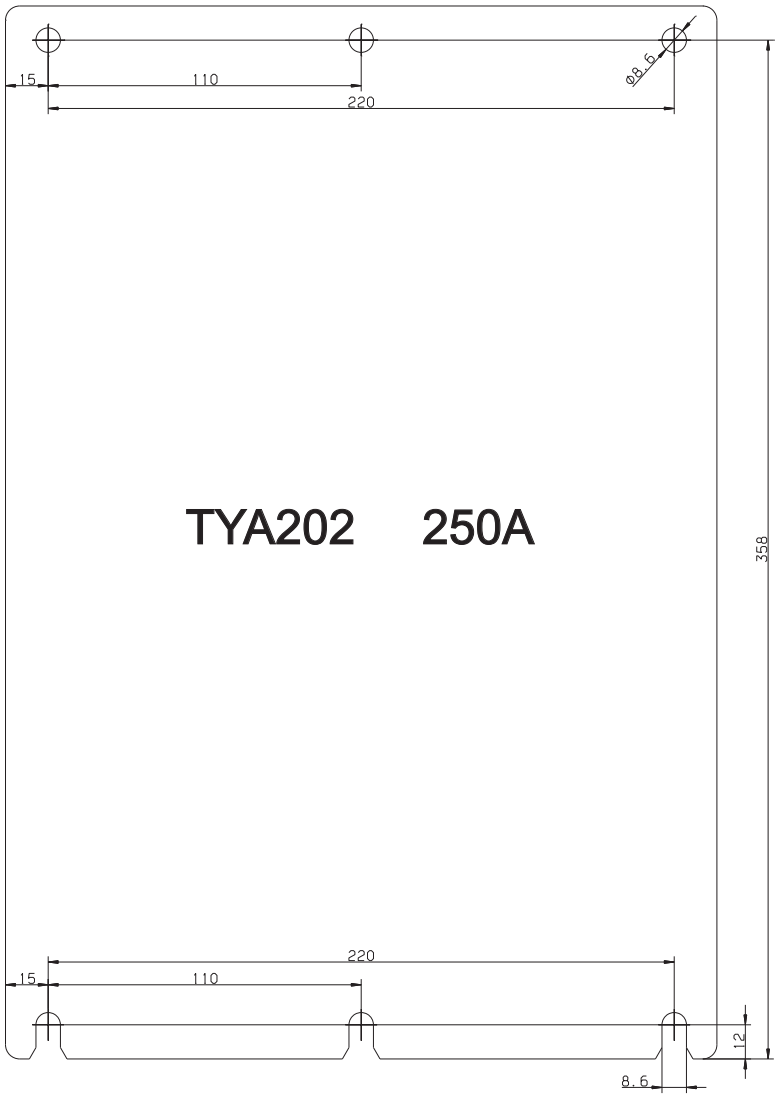
130


15
110
220
Ø8.6
TYA202
150/200A
325
220
15
110
12
8.6


15
110
220
ø8.6
TYA202 250A
358
220
15
110
12
8.6

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.

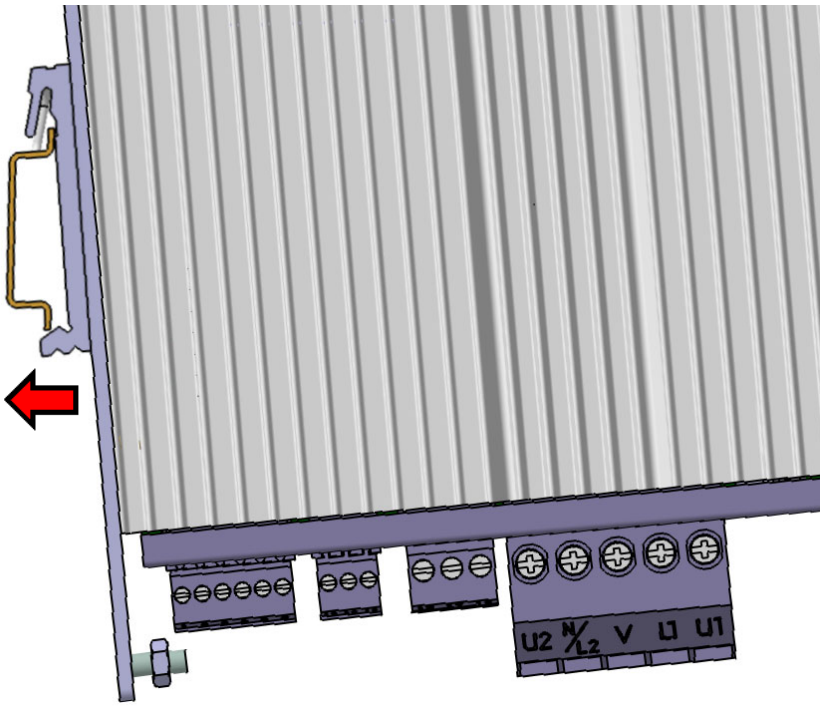
Integrated fan for 250 A power controller:
The intake air at the ventilation grid of the fan may not exceed a maximum inlet air temperature of 35 °C. Ensure that the inlet air for the built-in fans can be taken in from below and escape at the top without obstruction!

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 1.3.3 "General accessories"

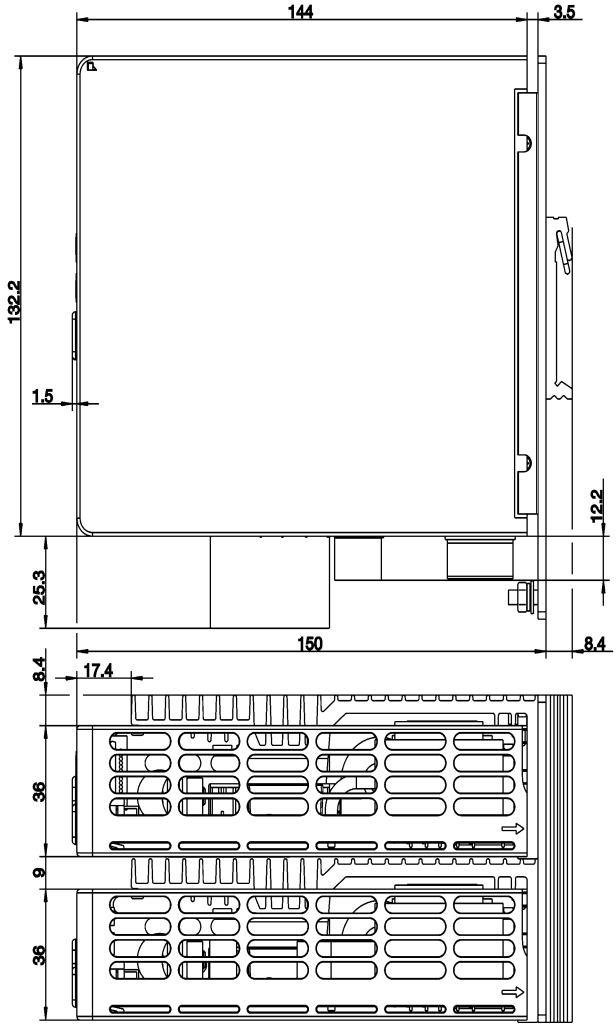
✱ Hook the spring saddle into the DIN rail from above.

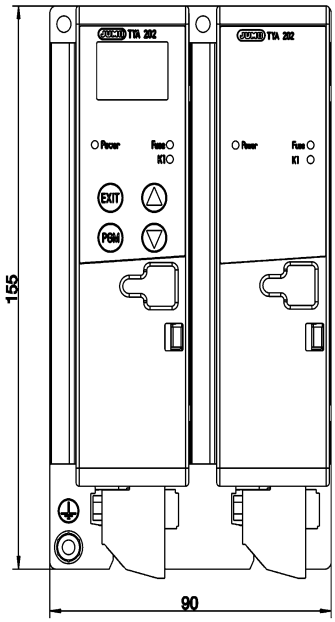


✱ Swivel the power controller downward until the lug engages with the DIN rail with an audible click.

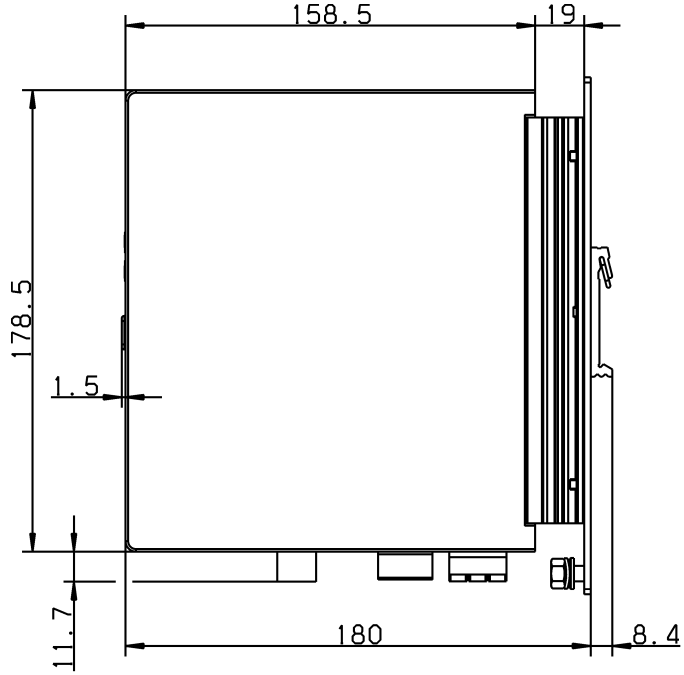
2.2 Dimensions

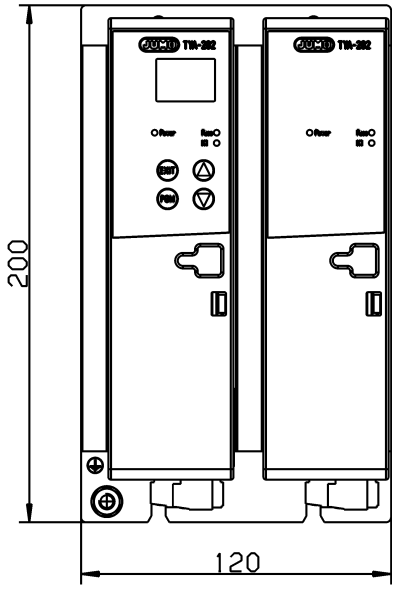
2.2.1 Type 709062/X-0X-020-XXX-XXX-XX-25X

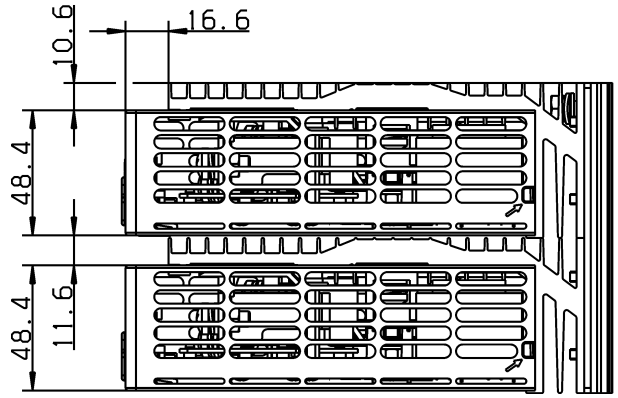




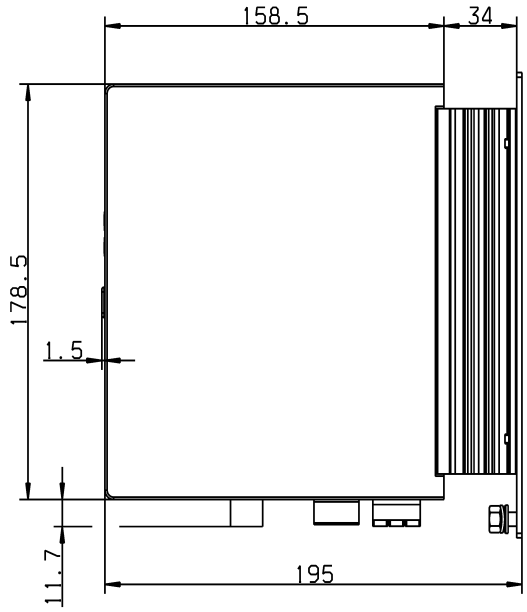
2.2.2 Type 709062/X-0X-032-XXX-XXX-XX-25X

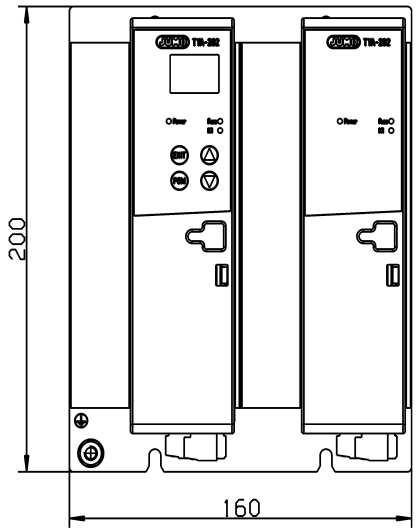


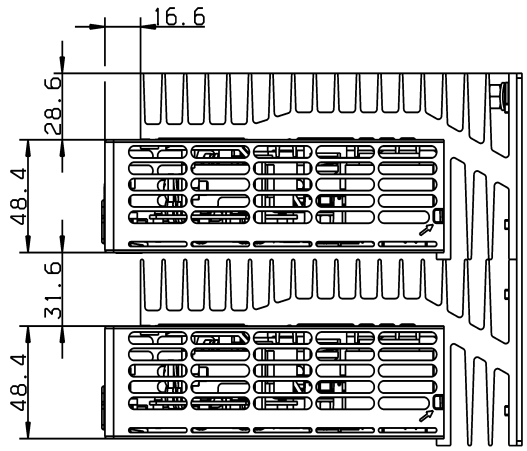




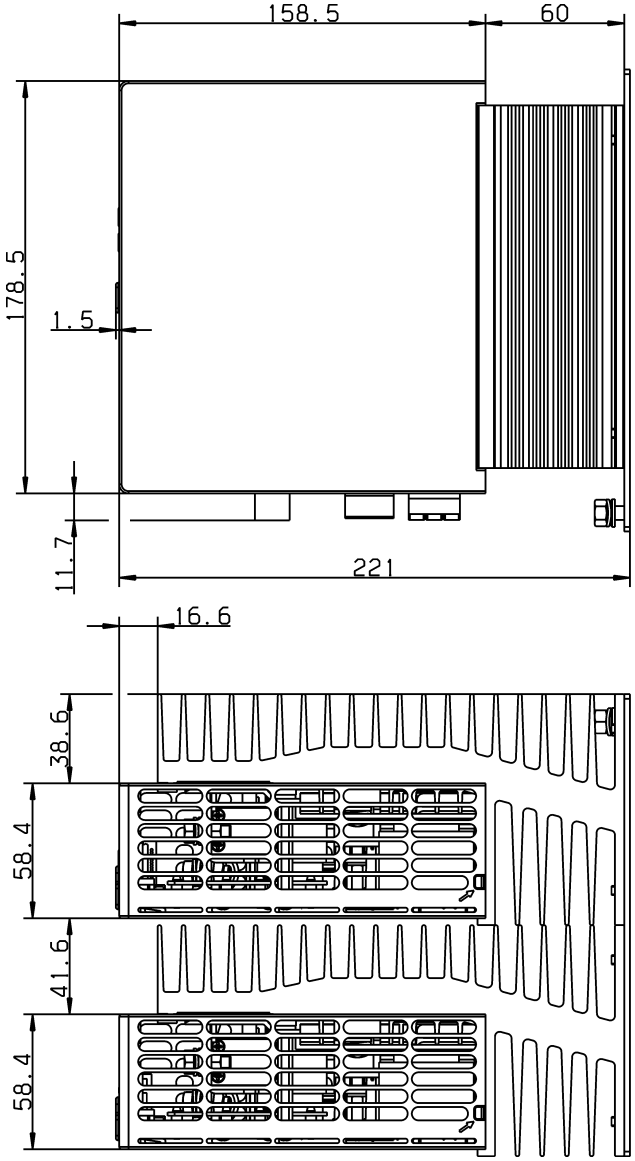
2.2.3 Type 709062/X-0X-050-XXX-XXX-XX-25X

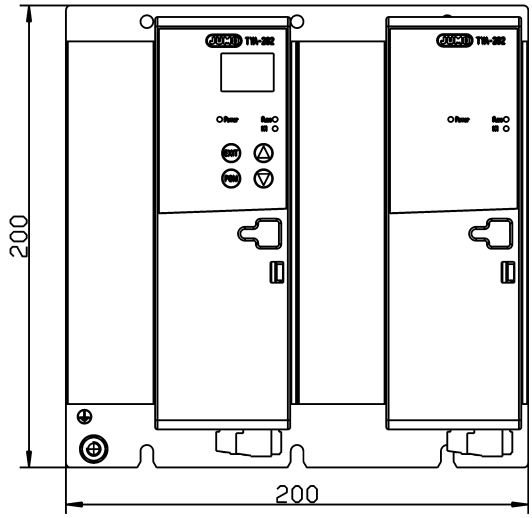




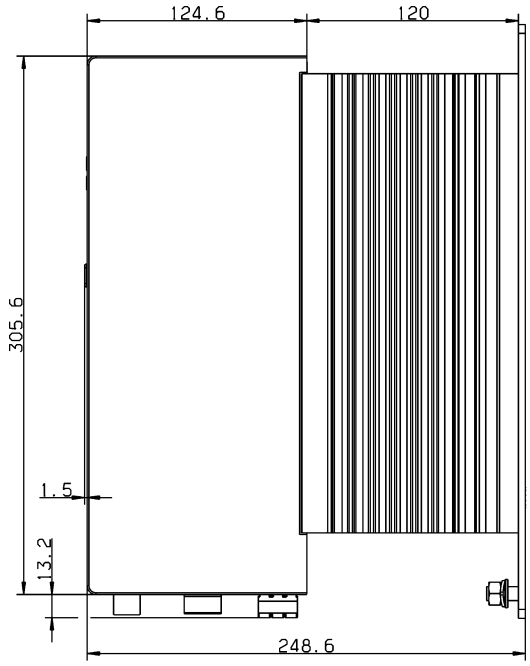


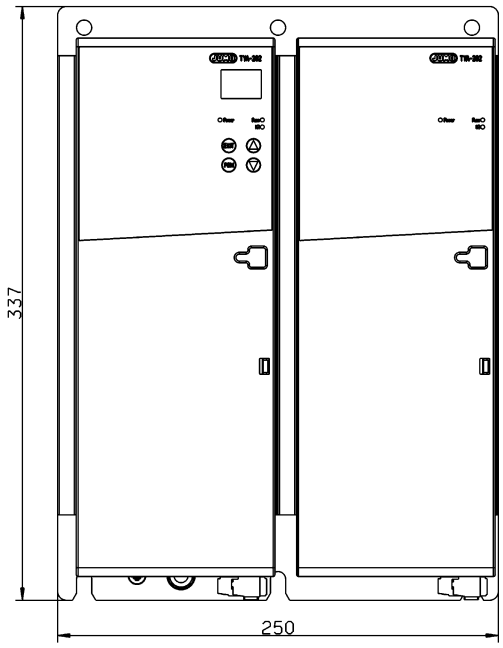
2.2.4 Type 709062/X-0X-100-XXX-XXX-XX-25X

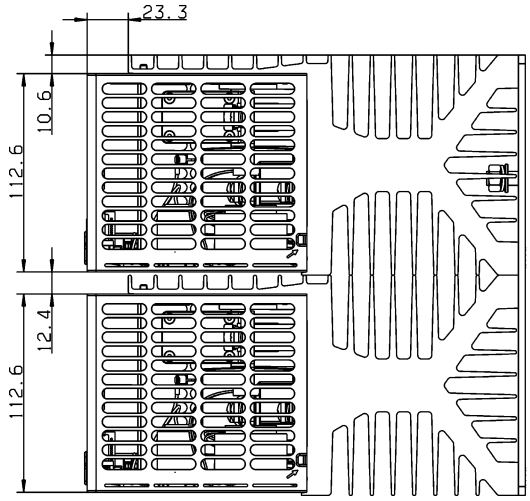




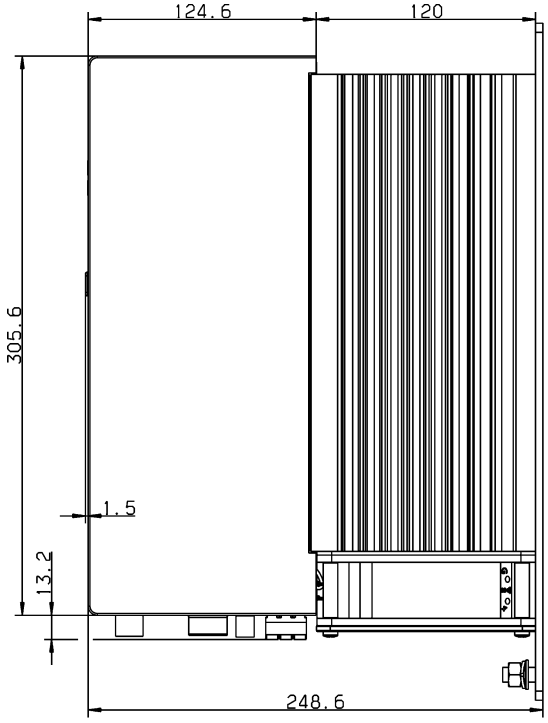
2.2.5 Type 709062/X-0X-150-XXX-XXX-XX-25X
Type 709062/X-0X-200-XXX-XXX-XX-25X

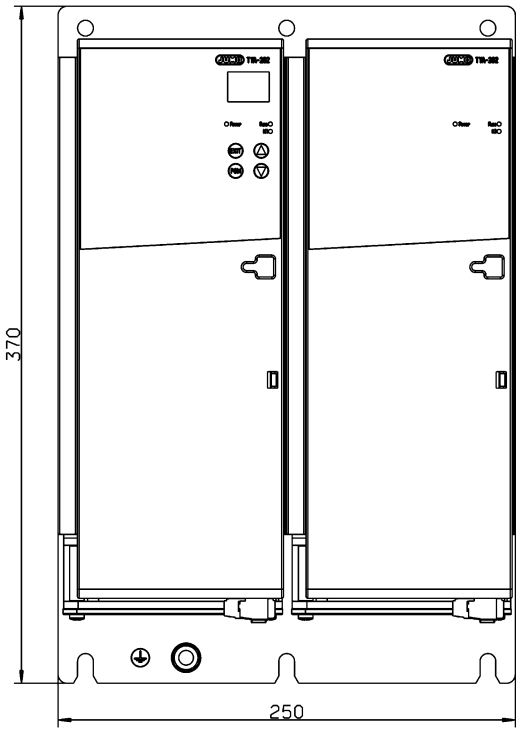


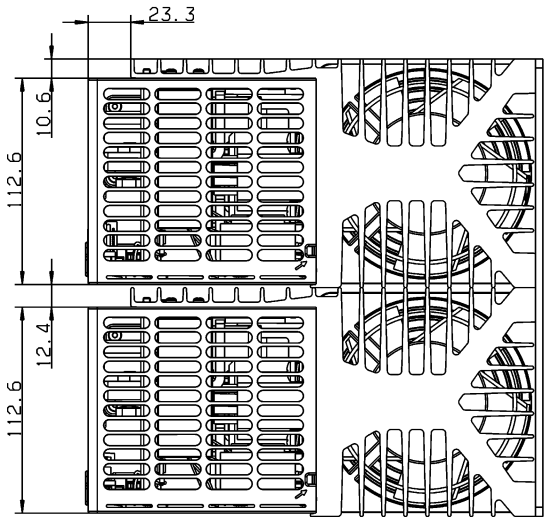




2.2.6 Type 709062/X-0X-250-XXX-XXX-XX-25X







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.

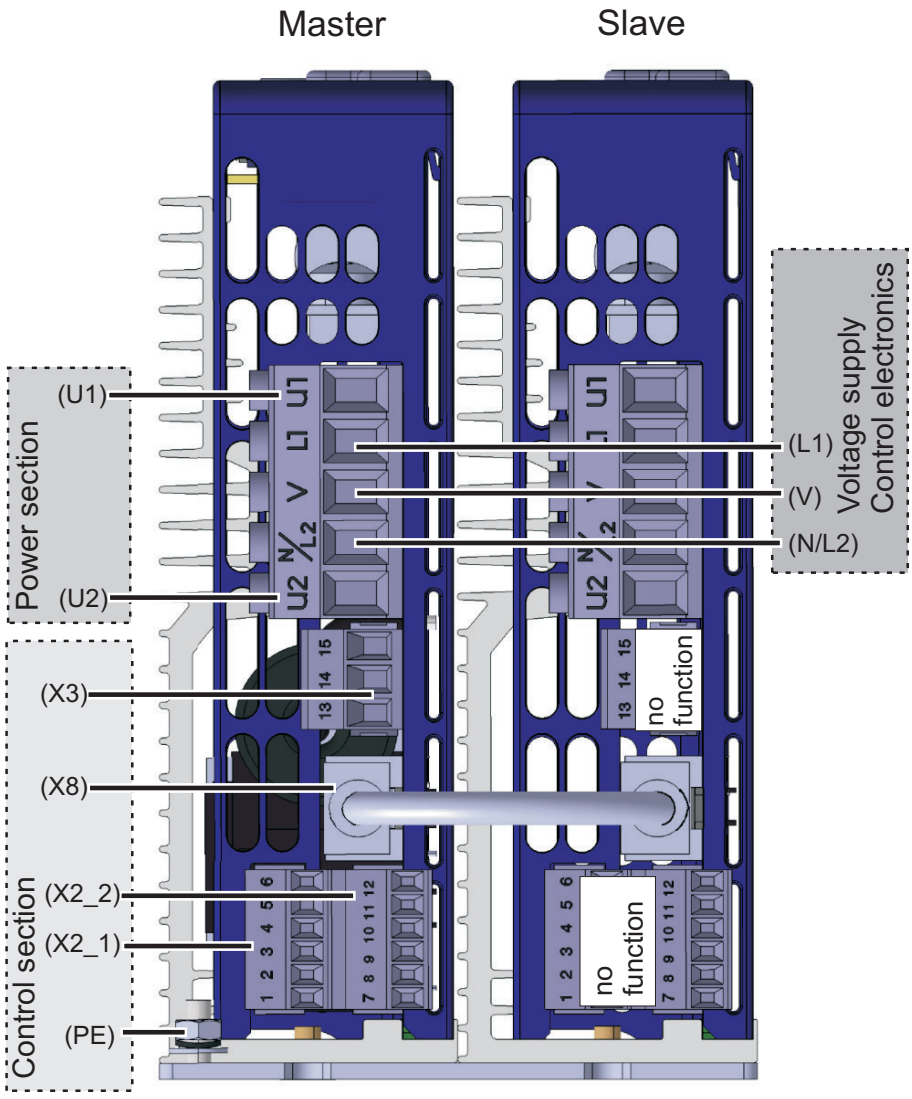
All **screw terminals supplied ex works must be inserted and screwed tight during operation!**

3.1 Plug-in screw terminals with 20 A

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

3.1.1 Type 709062/X-0X-20-XXX-XXX-XX-25X

The device with a load current of 20 A is connected via pluggable 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	0.5-2.5 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

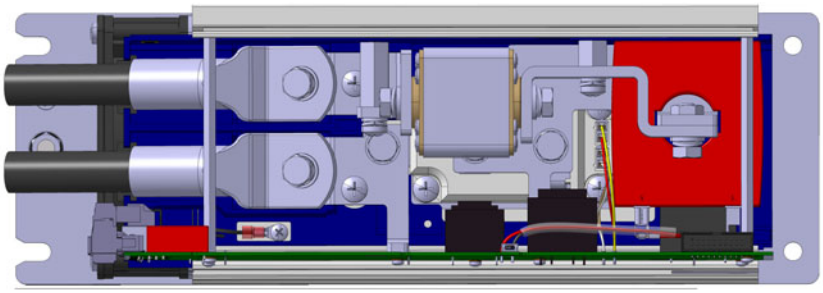
Master-slave connection

Terminal	Connection for
RJ 45 socket X8	Master-slave The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation (X8 connection to slave).

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



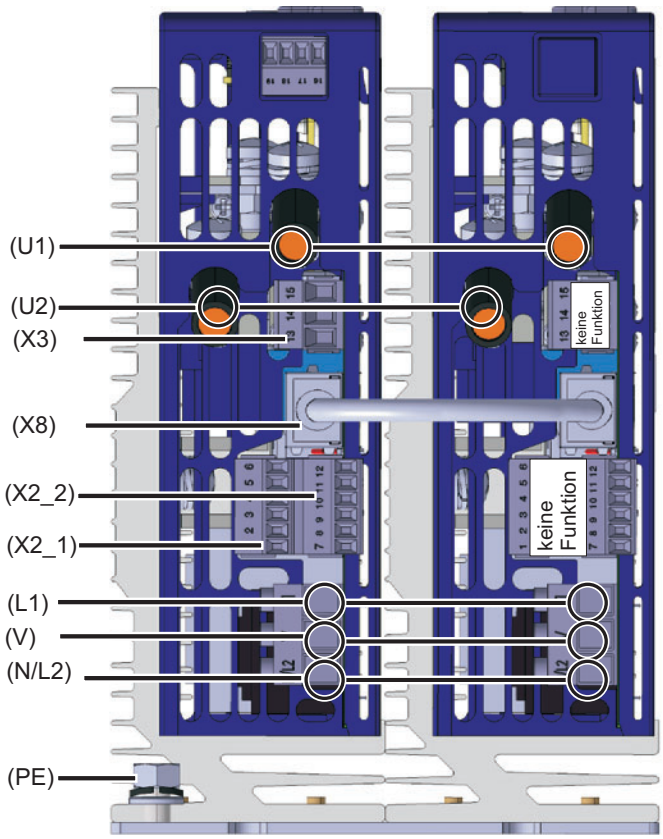
3.2.1 Type 709063/X-0X-032-XXX-XXX-XX-25X
Type 709063/X-0X-050-XXX-XXX-XX-25X

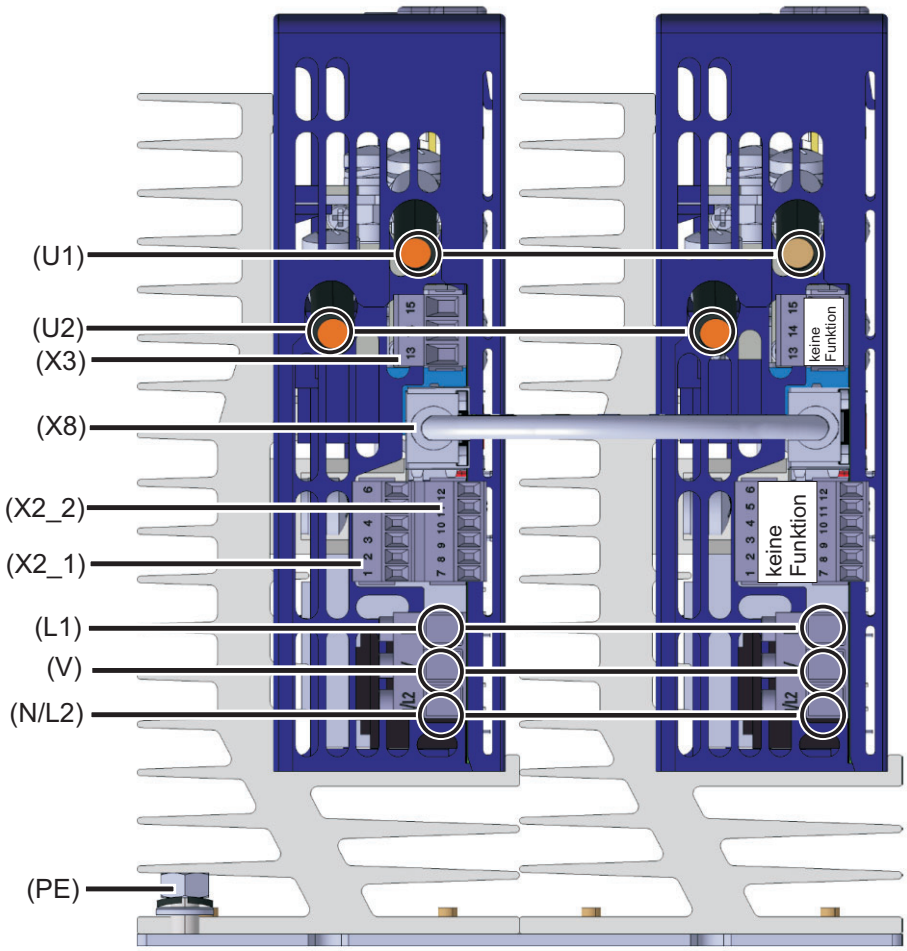
Devices with a load current of 32 A and 50 A are equipped with plug-in screw terminals in the control section and cable lugs in the power section.

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	0.5 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

Master-slave connection

Terminal	Connection for
RJ 45 socket X8	Master-slave The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation (X8 connection to slave).




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

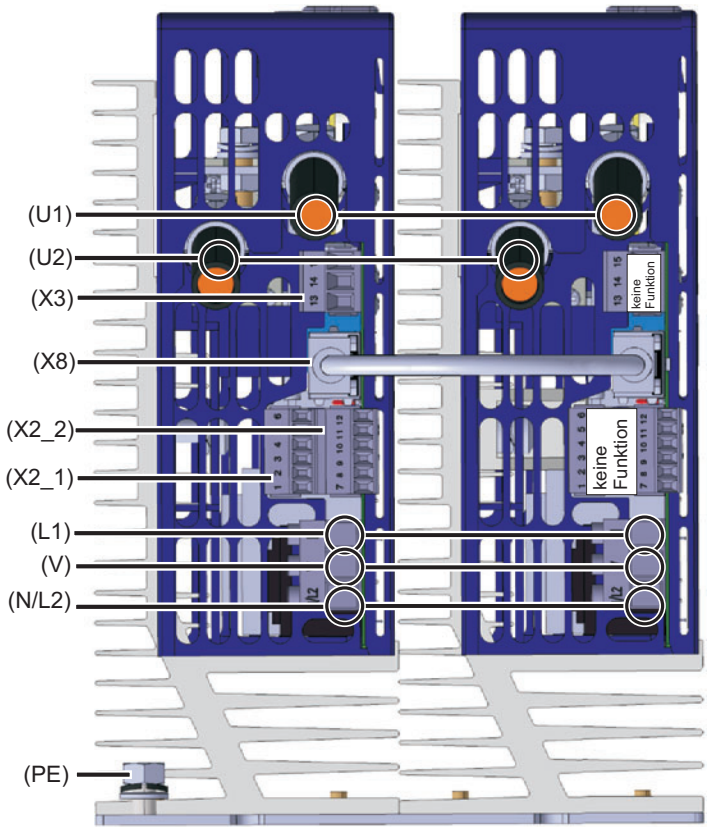
3.2.2 Type 709062/X-0X-100-XXX-XXX-XX-25X

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	0.5 to 2.5 mm^2	0.5 Nm
U2, U1	M6 hex-headed screws, width across flats 10 mm	16 to 50 mm^2	5 Nm
For applications according to UL, only 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

Master-slave connection

Terminal	Connection for
RJ 45 socket X8	Master-slave The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation (X8 connection to slave).



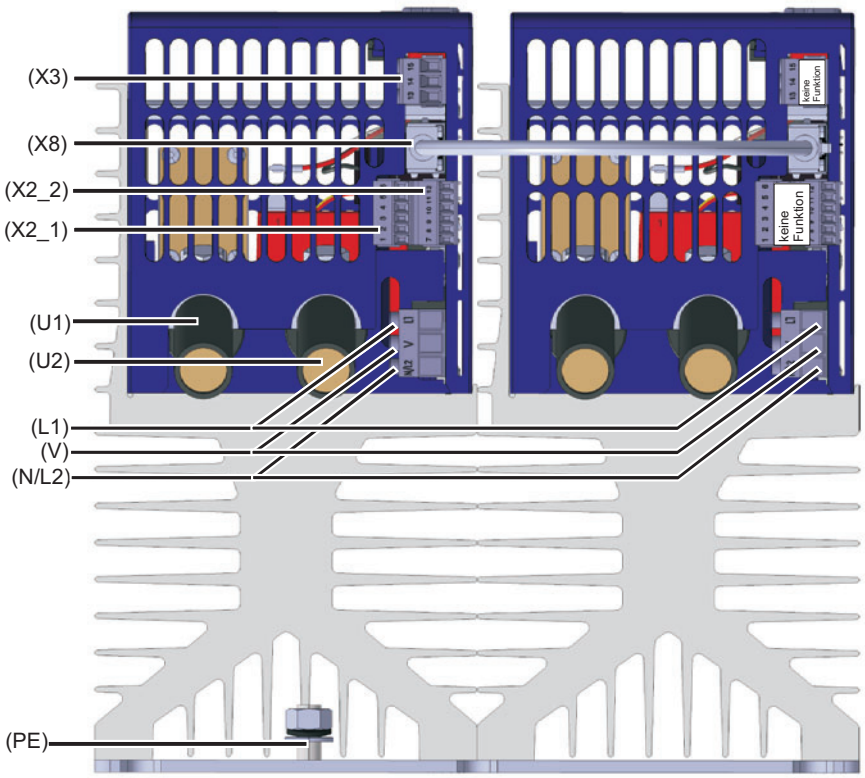
3.2.3 Type 709062/X-0X-150-XXX-XXX-XX-25X
Type 709062/X-0X-200-XXX-XXX-XX-25X

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	0.5 to 2.5 mm^2	0.5 Nm
U2, U1	M8 hex-headed screws, width across flats 13 mm	95 to 150 mm^2	12 Nm
For applications according to UL, only 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	M8 setscrew with hexagon nut, width across flats 13 mm	Cable lug hole: 8 mm	12 Nm

Master-slave connection

Terminal	Connection for
RJ 45 socket X8	Master-slave The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation (X8 connection to slave).



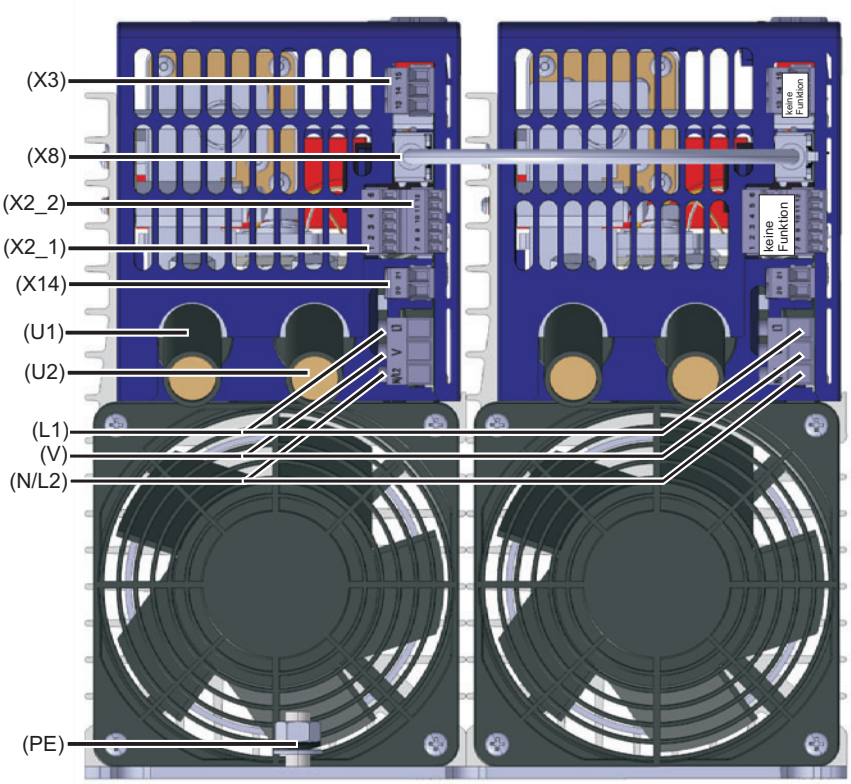
3.2.4 Type 709062/X-0X-250-XXX-XXX-XX-25X

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	0.5 to 2.5 mm^2	0.5 Nm
U2, U1	M8 hex-headed screws, width across flats 13 mm	95 to 150 mm^2	12 Nm
For applications according to UL, only 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	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

Master-slave connection

Terminal	Connection for
RJ 45 socket X8	Master-slave The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation (X8 connection to slave).



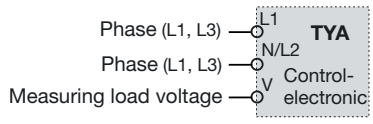
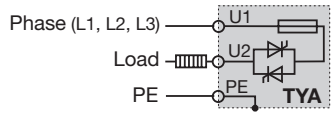
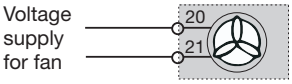
3 Electrical connection

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.

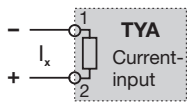
Voltage supply for fan

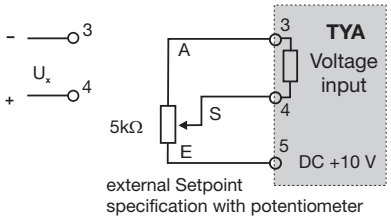
Mains voltage on the power controller	**Tolerances**	**Fan specifications**
Mains voltage AC 24 V	-20 ... +15 %, 48 ... 63 Hz	AC 24V/2x30 VA
Mains voltage AC 42 V	-20 ... +15 %, 48 ... 63 Hz	
Mains voltage AC 115 V	-15 ... +10%, 48 ... 63 Hz	AC 115V/2x30 VA
Mains voltage AC 230 V	-15 ... +10%, 48 ... 63 Hz	AC 230V/2x30 VA
Mains voltage AC 265 V		
Mains voltage AC 400 V		
Mains voltage AC 460 V		
Mains voltage AC 500 V		

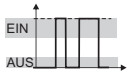
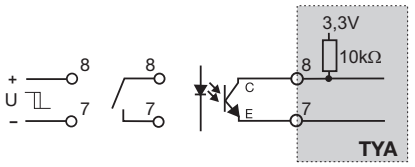
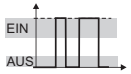
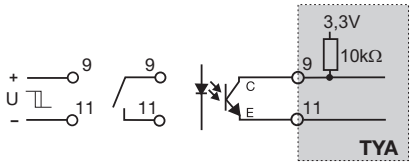
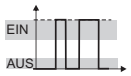
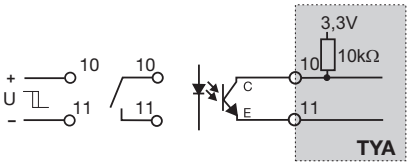
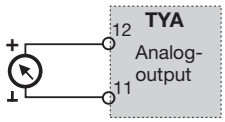
3.3 Connection diagram

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

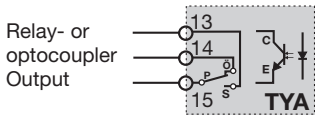
Control section

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	
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
The ground terminals X2_2/11 **or** X2_1/6 of the master and slave must be connected to one another.		
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 master only)"	12 11 (GND)	

Fault signal output

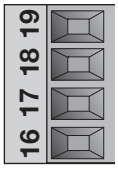
Connection for	screw terminal X3	Connection side Device side
Relay or optocoupler	13 N/O contact or collector	
	14 N/C contact	
	15 pole or emitter	

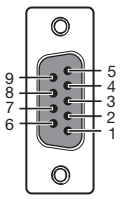
Master-slave connection

Terminal	Connection for
RJ 45 socket X8	The 1:1 patch cable (included in scope of delivery) must be plugged in for correct operation between the master and slave (X8 connection to slave).

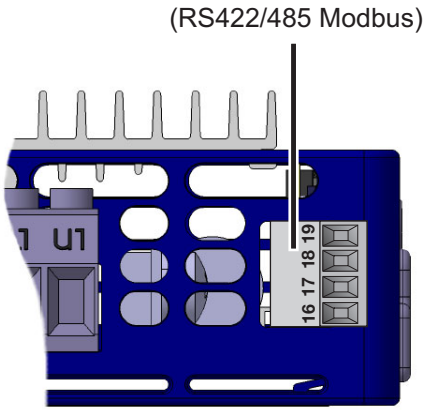
3 Electrical connection

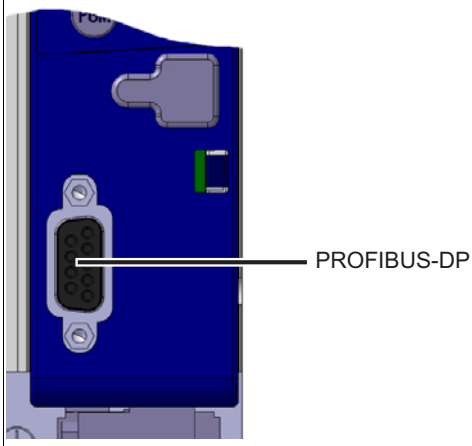
Interfaces

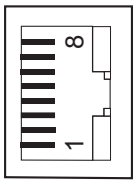
Connection	Modbus		RS422	RS485
Plug-in screw terminals on the bottom of the housing	19		TxD (-)	RxD/TxD B(-)
	18		TxD (+)	RxD/TxD A(+)
	17		RxD (-)	-
	16		RxD (+)	-

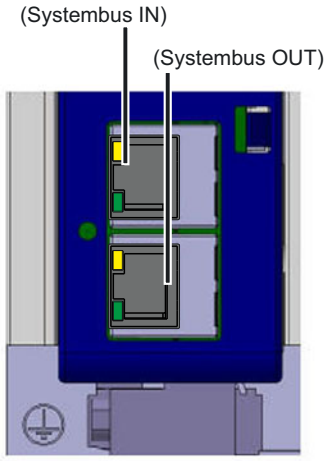
Connection	PROFIBUS-DP	
SUB-D socket 9-pin (on the front)	3 A(+)	
	8 B(-)	
	6 VCC	
	5 GND	
	Shield	

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





Connection	JUMO mTRON T system bus 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 Three-phase economic circuit Master-Slave for resistive loads in star-, delta connection or transformer loads (resistive-induktive)

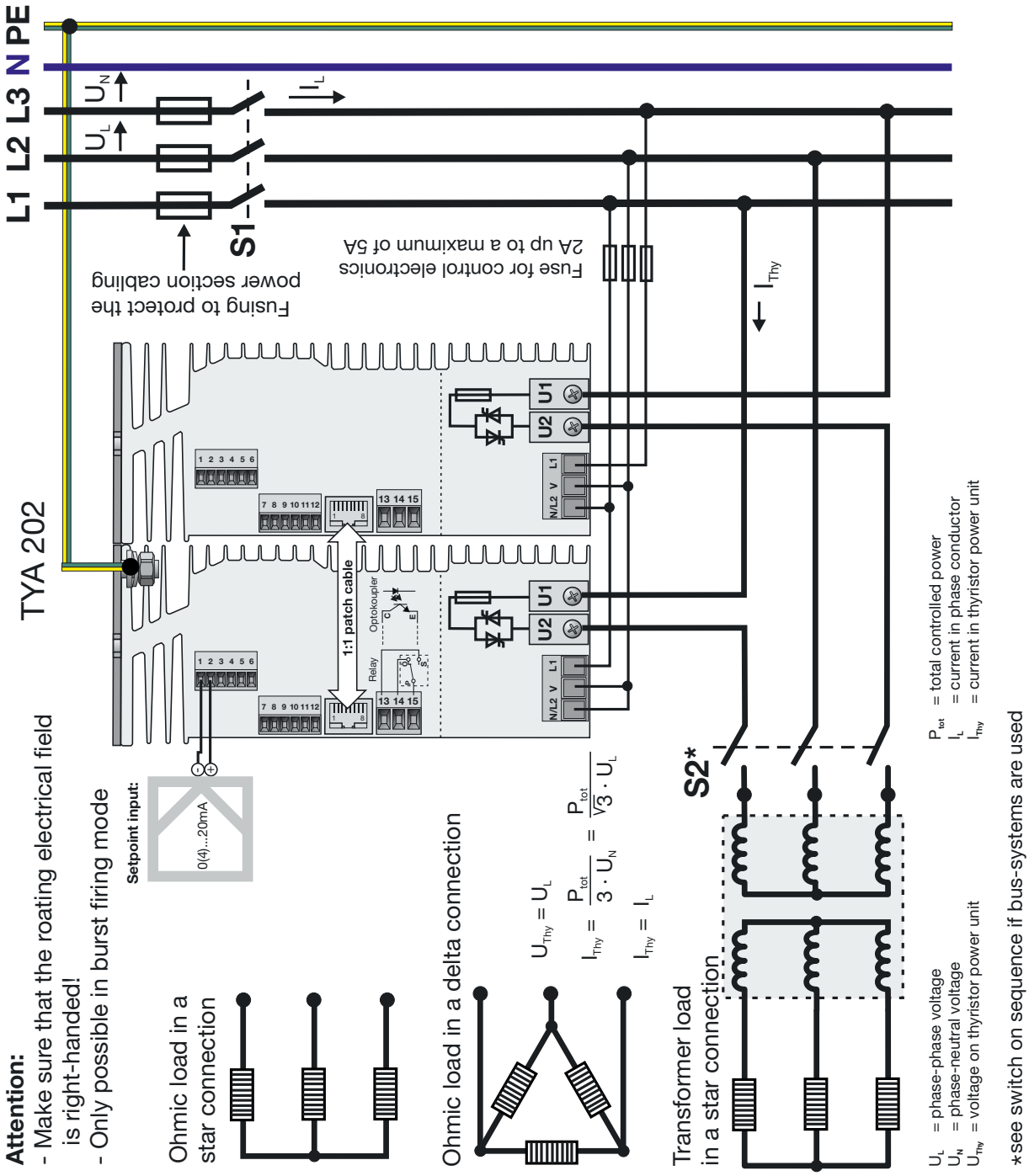
Prerequisite

To facilitate master-slave operation, the devices must have the same order code and the same device software version.
The two devices are connected by means of a 1:1 patch cable (max. length of 30 cm).

The image shows the wiring of a TYA 202, which is available ex works as a fully assembled and configured unit, and behaves exactly like two single TYA 201 devices in master-slave operation.

Operating mode

In the standard version, the master-slave economy circuit operates with a U^2 control. 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 drive transformer loads. In combination with the fixed cycle time and the U^2 control, high voltage consistency of the individual load resistances can be achieved.



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**.

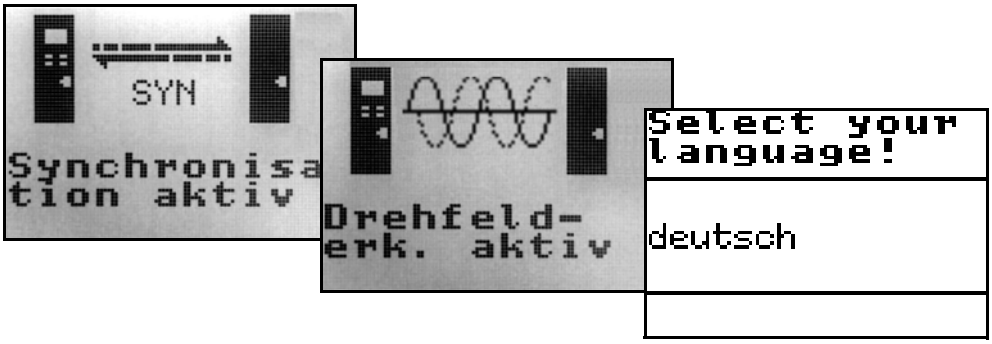
⇨ Chapter 3.2.4 "Type 709062/X-0X-250-XXX-XXX-XX-25X"

4.1 Display after switching on the device

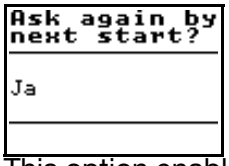
Hourglass and national language selection

Initially, as soon as the voltage supply is switched on, the Power LED is permanently lit in green and an hourglass appears on the display. The master is then synchronized with the slave devices and rotary field detection is carried out. If everything is wired correctly, the power controller shows a national language selection 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".

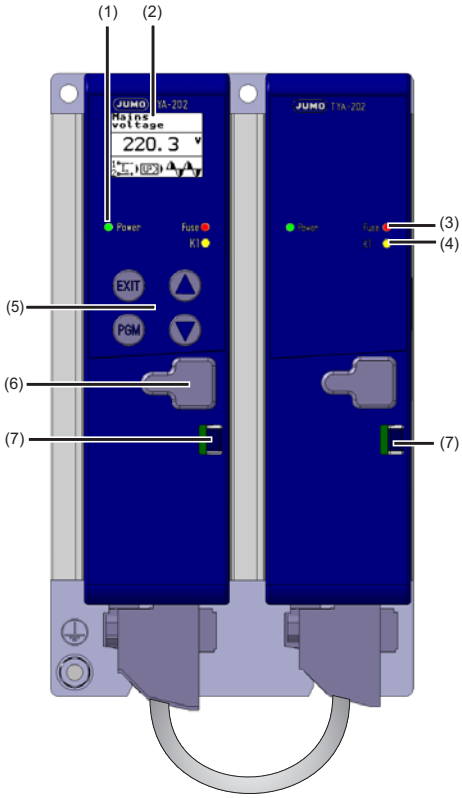
Error messages

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 "Was tun, wenn ..."	
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	Fuse LED (red) is lit in the event of a defective semiconductor fuse on the corresponding power controller.	
4	K1 LED (yellow) fault indicator	
5	**Keys:** Increase value / previous parameter Decrease value / next parameter Cancel / one level back Programming / one level forward	
6	USB setup interface Configuration is performed on the left device and transferred automatically to the right device via the patch cable.	
7	Spring clip to release the plastic housing ⇨ Chapter 8.2 "Defekte Halbleitersicherung austauschen"	

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

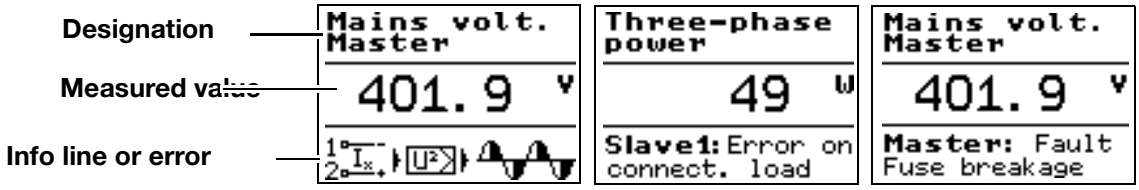
This information is also displayed in the diagnosis window for the setup program.

⇨ Chapter 7 "Setup program"

4.1.2 Appearance of measured values

Overview of measured values

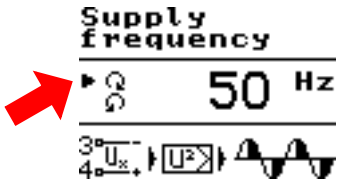
At this level, the description of the measured value is displayed in the top line, and the numerical value together with the unit is displayed in the middle.



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 "Fehlermeldungen und Alarme"

Mains frequency

In this window, the rotary field direction is shown alongside the supply frequency. The small triangle indicates the corresponding direction of rotation.



Meaning of the symbols in the info line

Input signal		Subordinate control loop		Operating mode load output	
	Voltage		None		
	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
Master mains voltage	Effective value of the mains voltage – measured on the master between the L1 and N/L2 terminals	V
Mains voltage Slave	Effective value of the mains voltage – measured on the slave between the L1 and N/L2 terminals	V

Master4 load voltage	Effective value of the supply voltage U12 - measured on the master between the V and U2 terminals	V
Load voltage Slave [4]	Effective value of the supply voltage U31 - measured on the slave between the V and U2 terminals	V
Master[1, 4] load current	Effective value of the load current I1 measured from the master	A
Load current Slave[1, 4]	Effective value of the load current I3 measured from the slave	A
Master [1, 4] power	Effective power measured from the master	W or kW
Power Slave [1, 4]	Effective power measured from the slave	W or kW
Three-phase current [1.4]	Overall effective power (total effective power contributed by master and slave)	W or kW
Master[1, 4] load resistance	Effective resistance measured from the master	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
Master device temperature	Currently measured temperature inside the master power controller	°C or °F
Slave device temperature	Currently measured temperature inside the slave power controller	°C or °F
Current input	Measured value of the current input – measured on the master power controller between terminals 1 and 2 on X2_1	mA
Voltage input	Measured value of the voltage input – measured on the master power controller between terminals 3 and 4 on X2_1	V

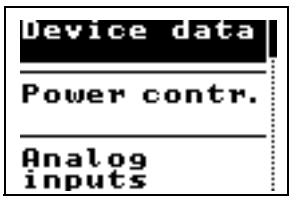
[1.] Is only displayed if the current transformer is fitted (option I^2- / I- or P control)
[2.] Is not displayed if the subordinate control loop is switched off
[3.] Is only displayed for phase-angle operation
[4.] Is not displayed in half-wave control operating mode

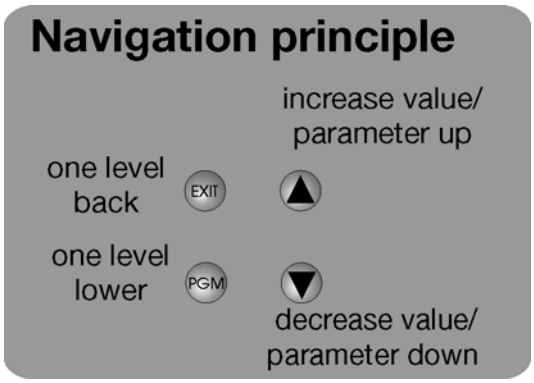
4.1.4 Appearance in the configuration level

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.

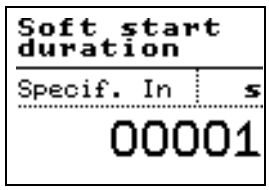
Navigation





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.

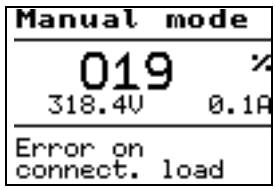
4.1.5 Appearance of error messages and special statuses

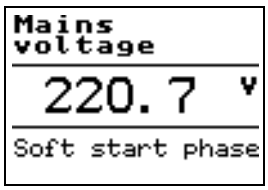
Cyclical appearance

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

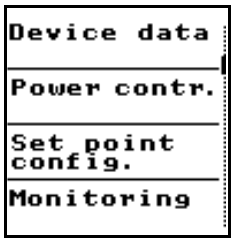




4 Operation

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"

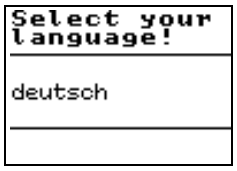
During ongoing operation, the power controller can be adapted to the plant and optimized.

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

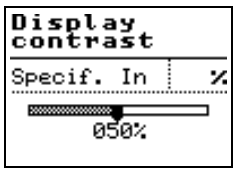
Editing a parameter

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.

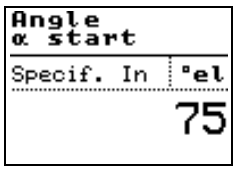
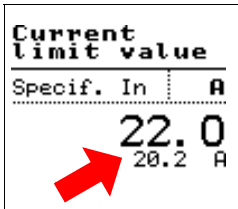
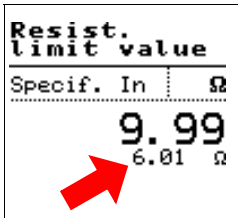


0...**50**...100 %	50 % is set per default.

0000 to 1440 min	0000 minutes are set per default, which means the display is not switched off.

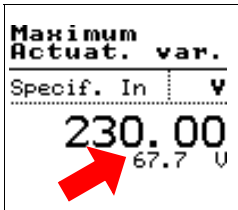
■ / **bold** = default setting

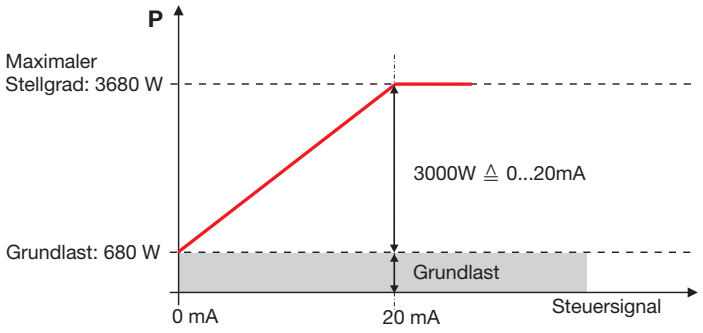
4.2.2 Power controller

	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. The current is limited in the master branch. 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. The resistance value is measured in the master branch. Resistance cannot be measured directly in the three-phase current economy circuit. However, the current resistance measured at a working point can be used as a resistance limit value. ⇨ Chapter 5.1.2 "Power controller" ⇨ Chapter 6.6 "Resistance limitation (r-control)"

■ / **bold** = default setting

4.2.3 Setpoint value configuration

	Value range	Description
 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 measurands in the master branch are measured. The displayed value depends on the "Subordinate control loop" setting: U^2 und U: display in V (linked value) (example: 0... **400**...460 V) P: display in kW **(three-phase power/2)** (example: 0... **6.90**...10.35 kW) 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**... 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	In the case of **continuous** thyristor control via the analog input, the base load at the measuring range start (e.g. 0 mA) can be varied **during operation**. **Note:** This setting is only available if Power controller ➔Thyristor control ➔Continuous (power controller) is set. The unit depends on the setting for subordinate control loop and device type: - With voltage: **0** to 100 % of max. load voltage (e.g. **0 V**) **(linked value)** - With current: **0** ... 100% of max. load current (e.g. **0 A**) - With power: **0** to ... 100 % of power (e.g. **0 W**) **(three-phase power/2)** - None: **0** to 100 % of output level (e.g. **0 %**) The measurands in the master branch are measured. ⇨ Chapter 1.3 "Order details" 

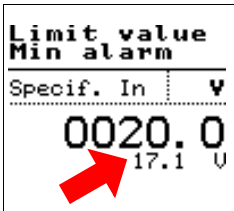
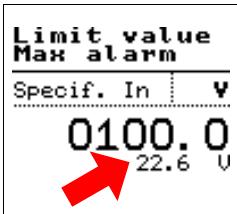
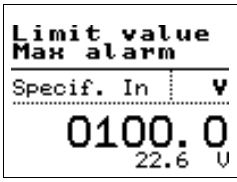
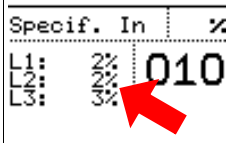
■ / **bold** = default setting

4.2.4 Monitoring

The value to be monitored can be adjusted.

⇨ Chapter 5.1.5 "Überwachungen"

The load voltage was used in this example.

	Value range	Your setting:
 Current measured value	**0** ... 9999.9	The **absolute** minimum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. The measurands in the master branch are measured. ⇨ Chapter 5.1.5 "Monitoring" Example: If the voltage falls below 20 V, an alarm is issued.
 Current measured value	0 ... **9999.9**	The **absolute** maximum limit values for load voltage, load current, power, resistance, mains voltage, or device temperature can be monitored. The measurands in the master branch are measured. ⇨ Chapter 5.1.5 "Monitoring" Example: If the voltage exceeds 100 V, an alarm is issued.
	0 ...**1** ... 9999.9	The **switching differential** at the minimum or maximum limit value
 Current deviation from Teach-In i.e. if it exceeds 0 % the load has become higher-impedance; if it is below 0 %, the load has become lower-impedance	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 deviations from the Teach-In value in all three phases, it is possible to check how, for example, the resistance change behaves over the entire setting range. The load monitoring limit value can then be adjusted accordingly. Guide values for the identification of load errors: ⇨ Chapter 6.1 "Erkennung von Lastfehlern"

■ / **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

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.

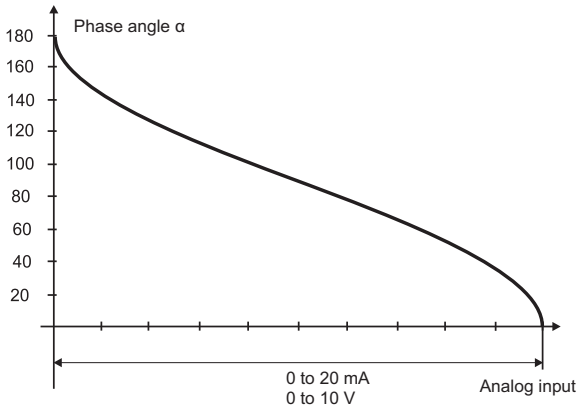
■ / **bold** = default setting

5.1.2 Power controller

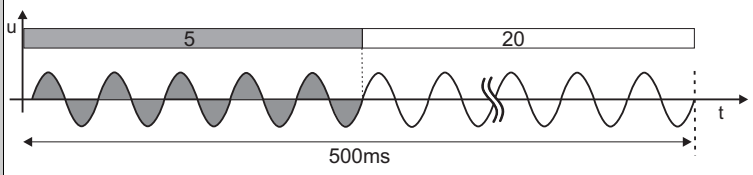
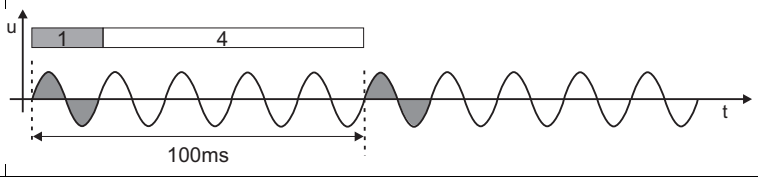
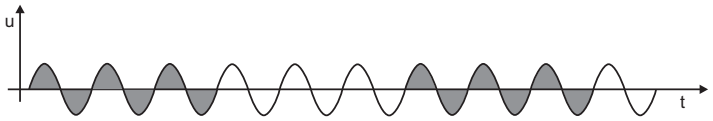
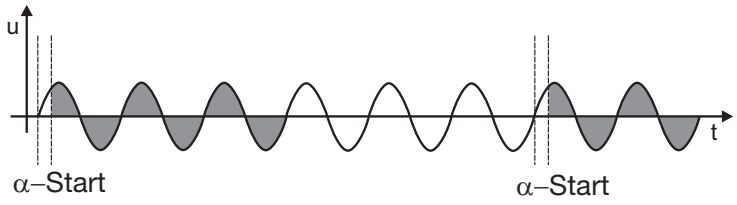
Settings for the switching behavior of the power controller in the plant

	Value / settings	Description
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.

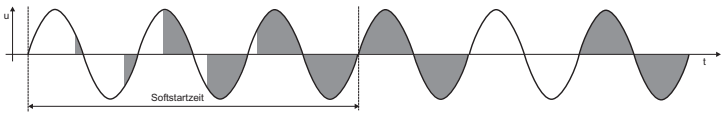
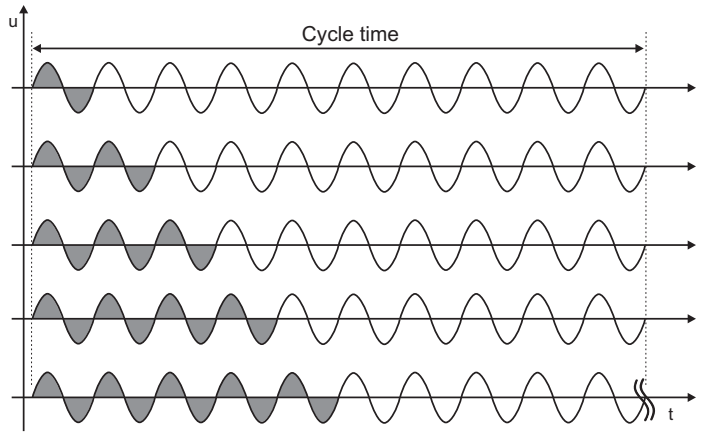
■ / **bold** = default setting

	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 The load voltage, load current, or power measured by the **master** are always applied as the **actual value** for the subordinate control loop.
	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. 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. For an output level of 20 %, this means 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. For example, at an output level of 50 % and the fastest possible cycle time, three sine waves are switched on and three 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 per default
	Yes	"Yes" means that a soft start with phase-angle control or burst-firing is performed after power ON.

■ / **bold** = default setting

	Value / settings	Description
Soft start type	With phase-angle control	This parameter only appears if soft start is set to "Yes". 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 soft start duration 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** ... 65535s	Specifies the duration of the soft start. **Note:** Due to the system, when current limiting is switched on, the soft start duration is at least 4 s, even if a shorter time is configured as the soft start duration.
Current limiting	No	No current limiting
	Yes	Current limiting is implemented via phase-angle control. In this case, the load current from the master is monitored on the basis of the set current limit value. Only phase control angles that do not cause the current limit value to be exceeded are permitted. It is also possible to activate an **external current limit value** via a digital input. Chapter 5.1.6 "Digital inputs"

■ / **bold** = default setting

	Value / settings	Description
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 set. 22 A can be selected. ⇨ Chapter 1.3 "Order details" **Note:** The value must exceed 10 % of the maximum power controller current (i.e. > 2 A in the case of 709062/X-01-020...)
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 set resistance limit value is not exceeded, if the load current is **> 5% of the power controller's nominal current.** For phase-angle operation, the limitation is implemented through the phase control angle α. For burst-firing operation, the limitation is implemented through the ON/OFF ratio of the sine waves. ⇨ Chapter 6.6 "Widerstandsbegrenzung (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.
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[1] to be configured in such a way that they do not simultaneously draw power from the mains at small output levels. This prevents current peaks. ⇨ Chapter 6.4 "Dual energy management"
	Device1	
	Device2	

The master-slave group type 709062 is regarded as "one" device.

■ / **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 ... 20 mA	This setting specifies which current standard signal is connected. ⇨ Chapter 3.3 "Connection diagram"
	4 ... 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 ... 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 ... 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

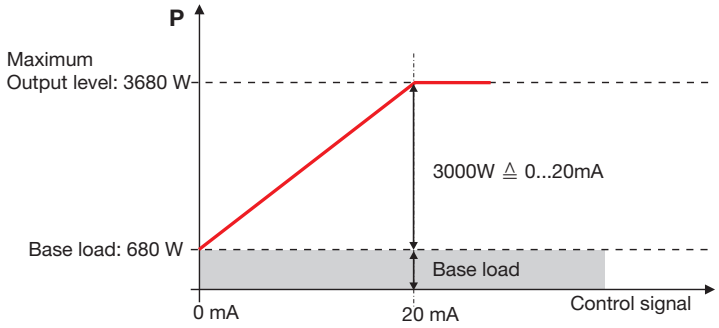
[1.] **Inverting analog inputs:**
If, for example, the current measuring range start is set to 20 mA and the current measuring range end is set to 0 mA, the power controller is switched off at 20 mA and switched on at 0 mA.

5.1.4 Setpoint value configuration

This setting determines which analog input specifies the setpoint value, how high the base load is, and which replacement value should be applied in the event of a fault.

	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 r 100 % and open r 0 % (for control direction set per default).
	Digital input2 	
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.
	Last value	The last valid value is used per default.
	Voltage input or current input	Depending on which input is set for the setpoint specification, the second input – which is still free – appears at this point. If an error (e.g. wire break) now occurs at the current input which is set per default for the setpoint specification, 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 in the master branch 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: input in V **(linked value)** (example: 0... **400**...460 V) - P: input in W **(three-phase power/2)** (example: 0... **4600** to 5290 W) - I^2 and I: entry in A (example: 0 to **20** A) None: entry in % (example: 0 to **100 %**)

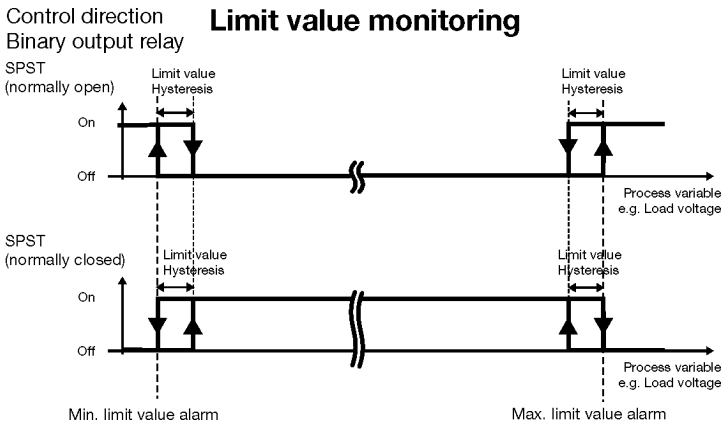
Base load

0... 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**) **(linked value)** - With current: **0** ... 100% of max. load current (e.g. **0 A**) - With power: **0** to ... 100 % of power (e.g. **0 W**) **(three-phase power/2)** - None: **0** to 100 % of output level (e.g. **0 %**) The measurands in the master branch are measured. 

■ / **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.  The limit values are monitored in the master and in the slave and, if the limit value is breached, the corresponding error message is shown in the info line at the bottom of the display (e.g. "Slave2:Limit val. MinVal reached") **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** ... 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 ... **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 ...**1** ... 9999.9	Switching differential at the upper and lower limit of the monitoring range
>Load monitoring	None	The load is not monitored.
	Undercurrent Overcurrent	**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 6.1 "Erkennung von Lastfehlern"
		Note: This setting is only available if **load monitoring** has been set to undercurrent or overcurrent.
Limit value load monitoring	0...**10** ... 100 %	**Partial load failure** or **partial load short circuit**: This setting specifies the percentage by which the load current 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 **at the operating 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 binary 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 "Error messages and alarms"

■ / **bold** = default setting

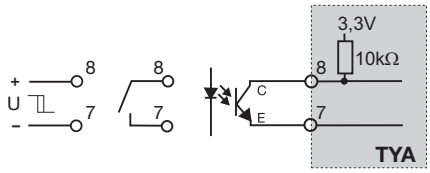
5.1.6 Digital inputs

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:

* Use the PGM key to switch to the configuration level ➔ Digital inputs

	Value / settings	Description
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	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.
	Current input	
	Value, adjustable	
Value when toggling	0% ...100 %	**Note:** This parameter is available only if **"Value, adjustable"** is selected for setpoint specification when toggling.
Ext. current limiting		This function can only be set if the following presettings have been made: 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, "Binary input 1" is set here, when the binary input is closed, the current limit value set under "Power controller ➔Current limit value" is overwritten and the "**External current limit value**" (further down in the table) becomes effective.
	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
External 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 set. 22 A can be selected. ⇨ Chapter 1.3 "Order details"

■ / **bold** = default setting

	Value / settings	Description
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 "Anschlussplan"
	Open, load ON	Per default: Inhibit input open, power controller supplies power. Inhibit input closed, power controller does not supply power. 
	Open, load OFF	
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"

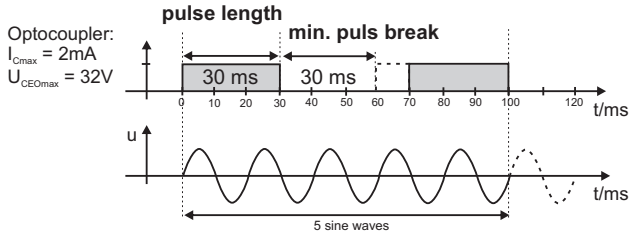
The control direction is used to select the switching behavior of the relay and determine whether, in the event of an error message, it should switch on (error message via N/O contact) or drop out (error message via **N/C contact**). In the optocoupler, the control direction determines whether the collector-emitter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

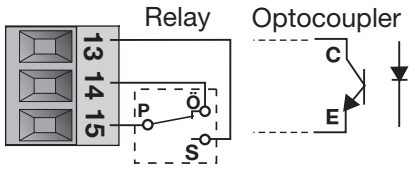
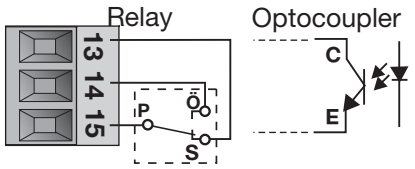
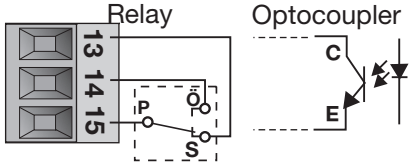
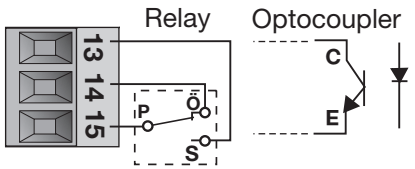
⇨ Chapter 1.3 "Bestellangaben"

✱ 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 ... 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 ... 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 ... 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	**Normally Open 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 14 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 
	Normally Closed 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 ... 20 mA	The actual value output outputs the "Value to be output" in the form of a current signal.
	4 to 20 mA	
	0 ... 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 ... 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. 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** ... 9999.9	Lower limit for the "Value to be output**"**
Signal range end value	0 ... **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** ...255	
Min. response time	**0 ... 500 ms**	

■ / **bold** = default setting

5.1.10 PROFIBUS-DP

Interface parameters for PROFIBUS-DP (see separate manual)

	Value / settings	Description
Device address	1 ...**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**, **operating level**, and **configuration level** to protect them from unauthorized access.

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

■ / **bold** = default setting

5.2 Configuration example

Requirements

Mains voltage on the power controller 400 V

Load voltage 230 V

9 heating elements each with 1 kW

Star connection with isolated star points

Load current: 9000 W/(3 x 230 V) = 13 A

Temperature coefficient TC = 1

Subordinate control loop: U^2

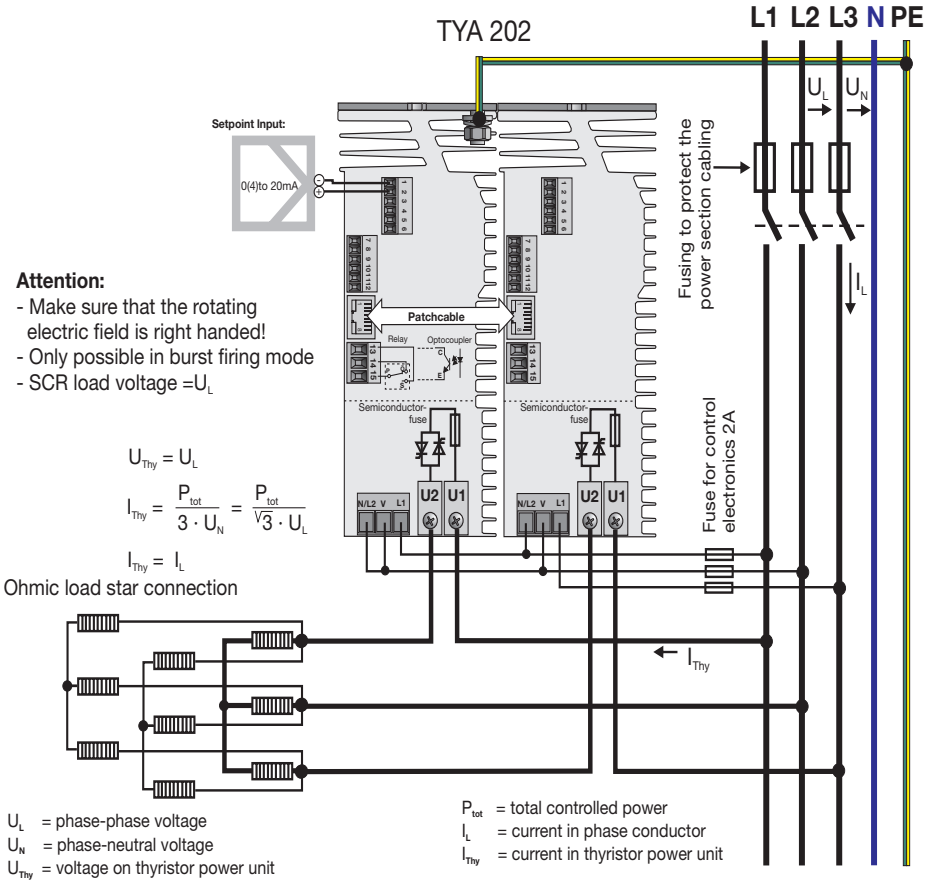
Base load: 0 %; maximum output level 100 %

Setpoint specification via standard signal of 0 to 20 mA.

These requirements are sufficient for the following power controllers:

Device type

709062/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.

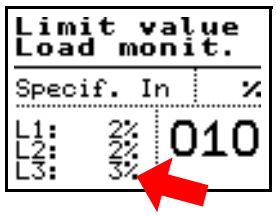
Overcurrent This function is used for several heating elements connected in series that are to be monitored for short circuits.

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.

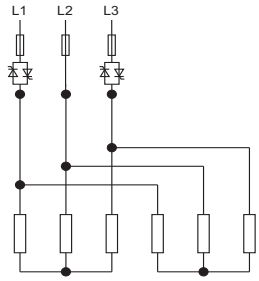
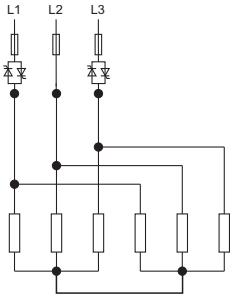
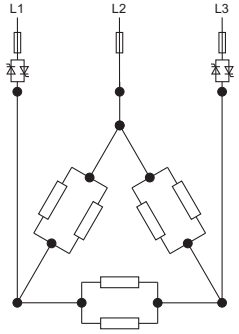
For heating elements with a high positive or negative temperature coefficient, a suitable limit value must be determined independently. The values in % given below (see arrow) are used for this purpose.
A value in % is displayed for each of the three phases, which represents the current deviation from the Teach-In values as a percentage. Access this window via Operating level ➔ Monitoring ➔ Limit value load monit.



☞ These values can be used to find out in what phase a load error occurred. If a load break occurs in phase L3, for example, the value in % exceeds the set limit value (10 % in the table).

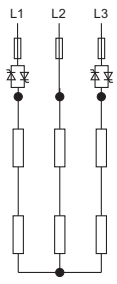
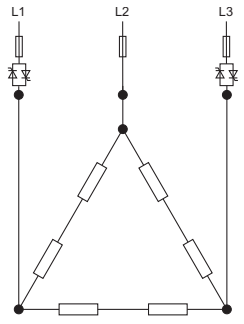
For heating elements with a temperature coefficient TC ≈ 1, the limit value can be taken directly from the following tables:

Undercurrent

Number of heating elements	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 %
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	Star connection without neutral conductor	Delta connection
6	-	-
5	10 %	-
4	10 %	10 %
3	14 %	13 %
2	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 for later operation are recorded precisely, only perform the Teach-In at a load current of at least 20 % of the nominal 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 later operation are recorded precisely, the Teach-In is only performed in phase angle control 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 "Automatically 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 most recently detected Teach-In values are deleted again. After another power ON, the power controller resumes automatic Teach-In detection.

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.

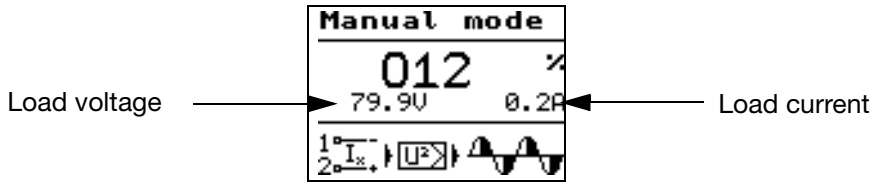
6.2.1 Setpoint specification in manual mode

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.

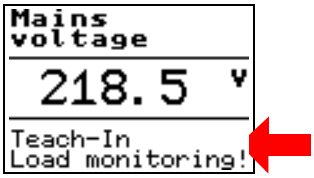
⇨ Configuration level See "Teach-In type load monitoring" on page 63.

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.

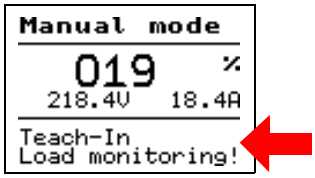


6.2.3 Performing Teach-In in manual mode

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

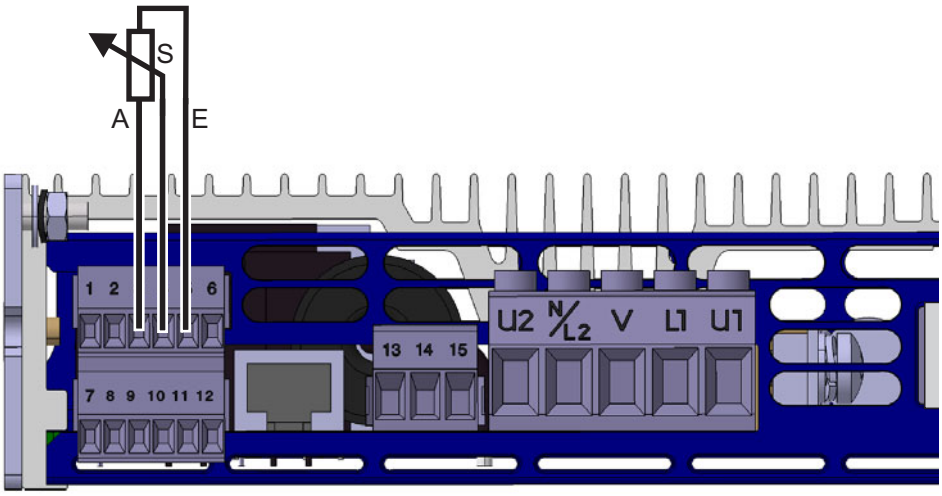
* Press the PGM key and the following message will appear:

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

6.3 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 config. ➔ Setpoint specification ➔ 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 master-slave 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 %).

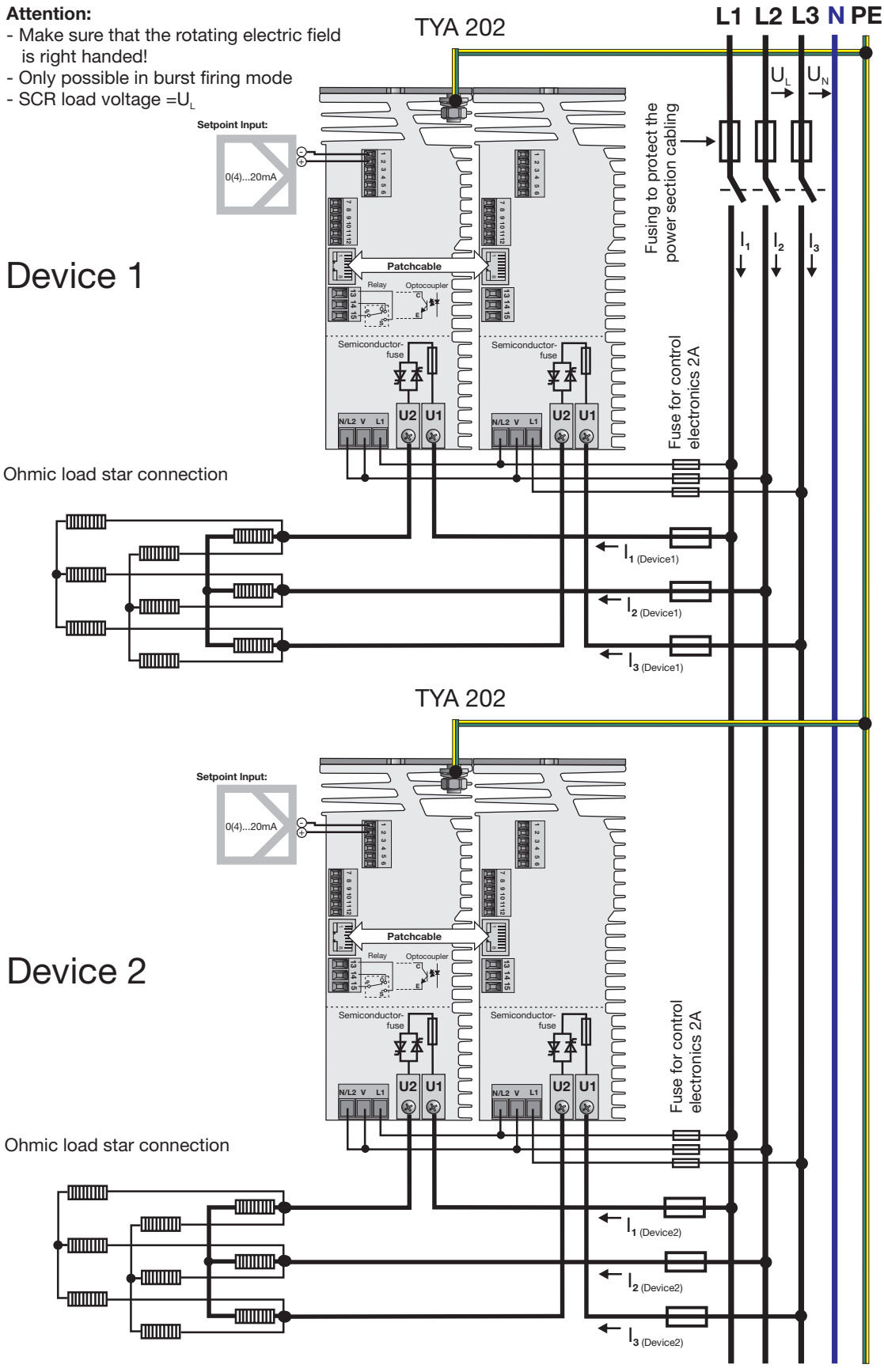
More than 2 power controllers

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

Prerequisites

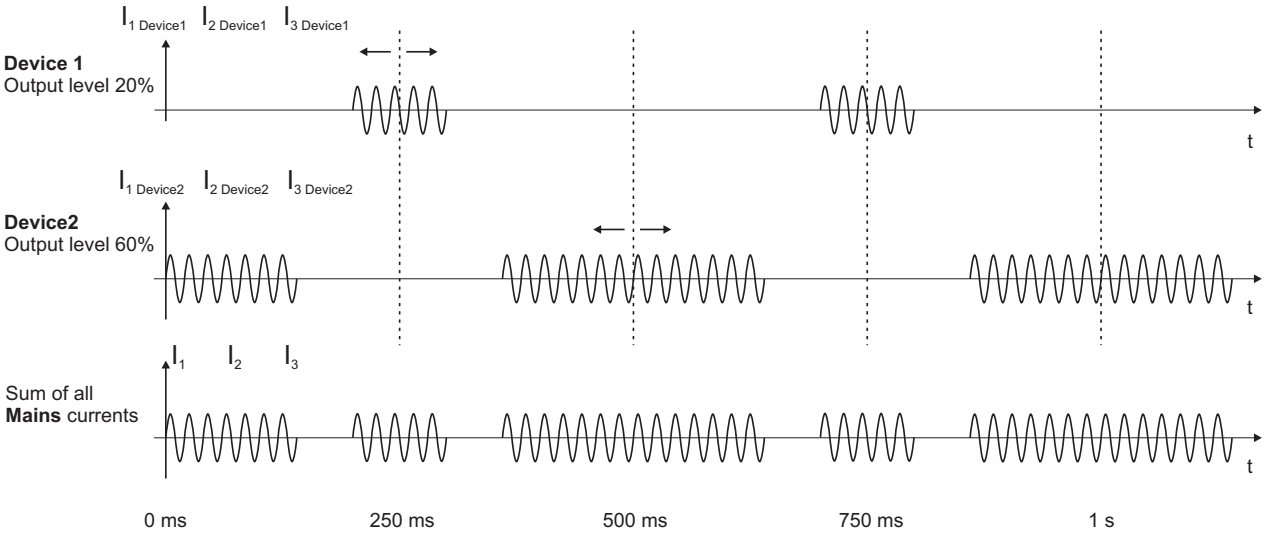
- The 2 master-slave devices must be wired identically as shown in the following image.
- The control electronics and the load circuit must have the same phase
- Synchronize both master-slave devices in a group by switching them on simultaneously
- **Burst-firing operation** must be configured
- The cycle time must be set to **500 ms (fixed)**
- In each group, one master-slave device must be configured as **Device1** and the other master-slave device as **Device2**.

Attention:
- Make sure that the rotating electric field is right handed!
- Only possible in burst firing mode
- SCR load voltage =U_L



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 current level in the network is not started until the total output level exceeds 100 %.

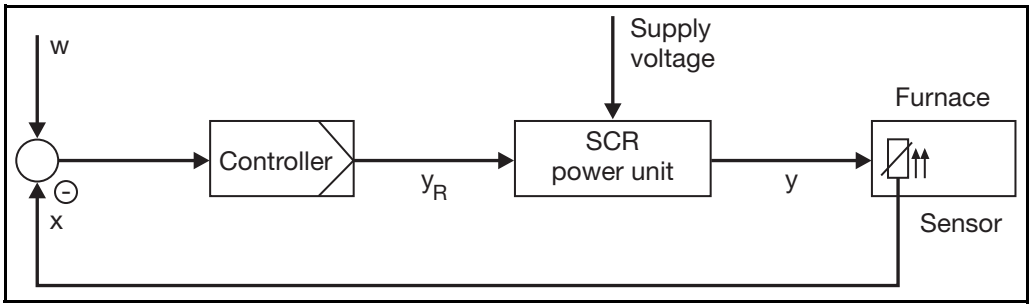
If one power controller performs a restart when the configuration level is exited, it no longer operates synchronously with the others. All master-slave devices have to be switched on again simultaneously via a joint main switch!



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 an **thyristor power controller** using **phase angle control**, this means that it alters the firing angle over the range from 180° to 0°, corresponding to a controller output level of 0 to 100 %. 100 %
- 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 to 100 %

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 %.

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

$P230_V$: Power in the load resistance at a mains voltage U of 230 V

ΔP: Power reduction resulting from reduced supply voltage

R: Resistance of the load

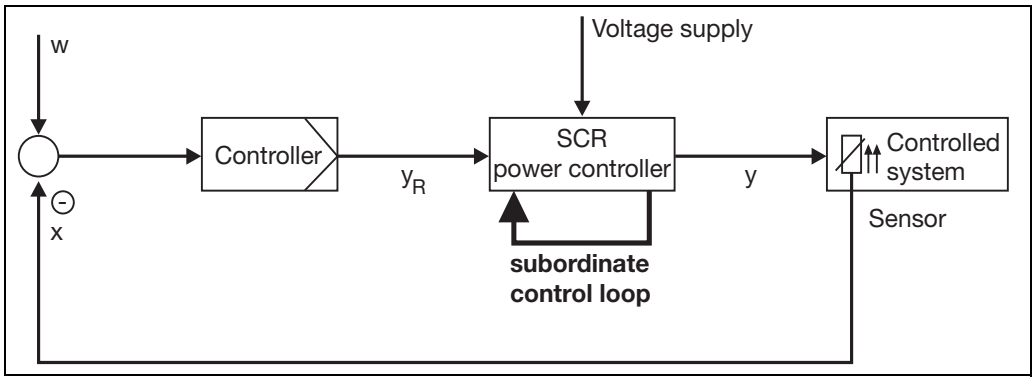
This 19 % reduction in the energy being fed in means that the **furnace temperature falls.**

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

The power controller recognizes the deviation through the relatively slow response 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 Pl_{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 in such a manner that the square of the load voltage is proportional to the signal input (e.g. 0 to 20 mA) to the controller. 20 mA).

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

Combining equations 5 and 4, we can see that the power in the load resis-

tance is proportional to the input signal to the power controller.

$$P_{Last} \sim \text{Eingangssignal des Leistungsstellers (0 ... 20 mA)} \quad (6)$$

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.

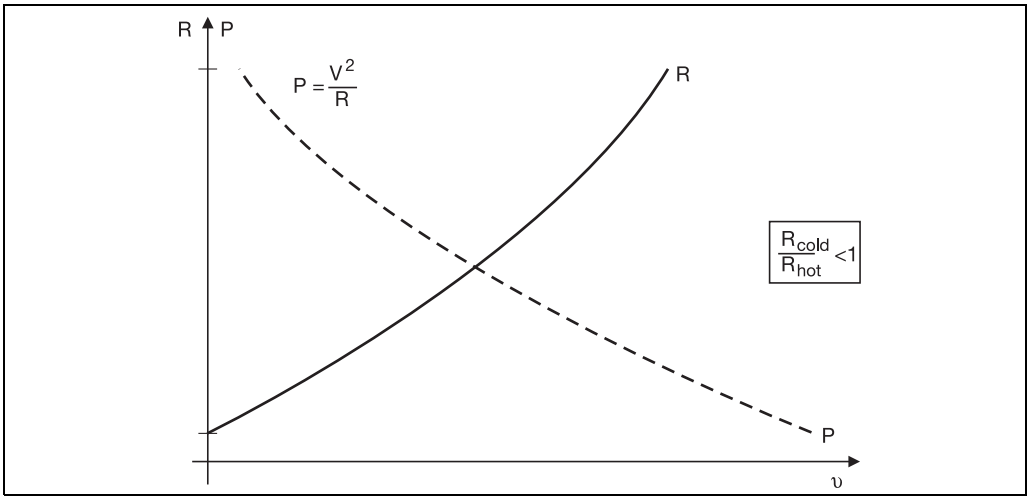


Figure 1: Heating element with a positive TC

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 ris-

es 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.

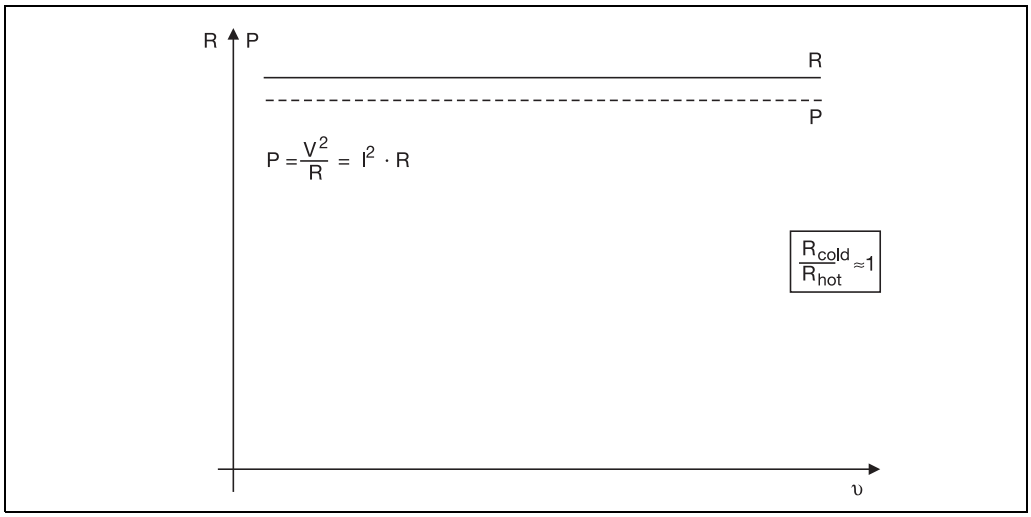


Figure 2: Heating element with TC ≈ 1

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.

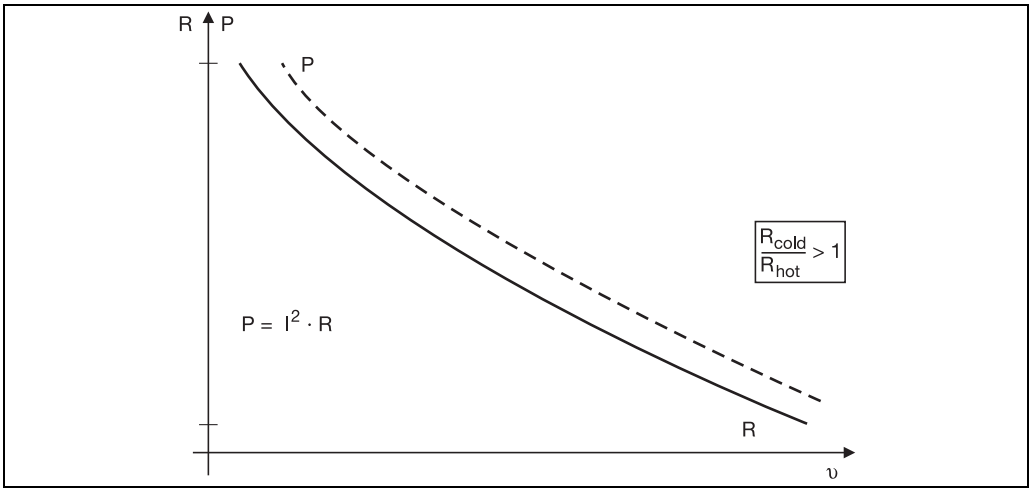


Figure 3: Heating element with a negative TC

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).

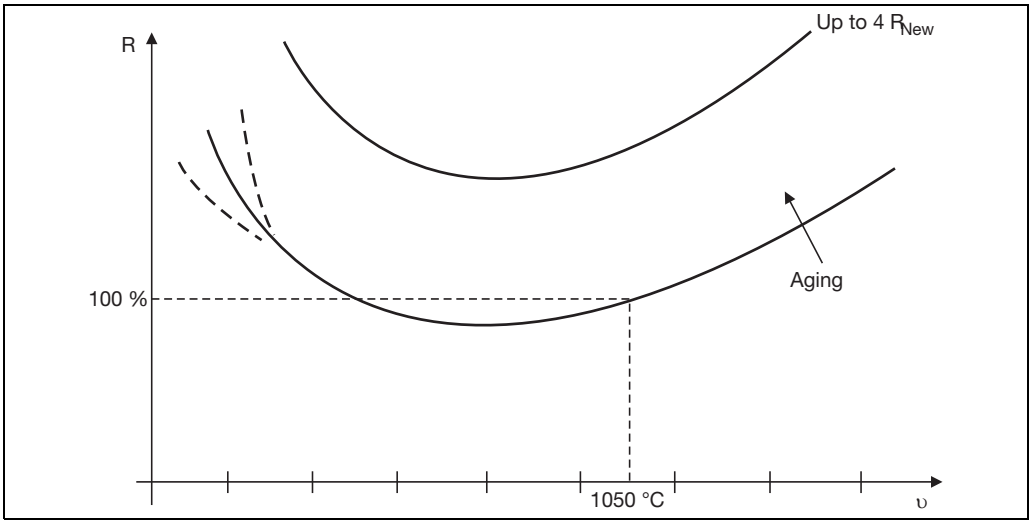


Figure 4: Resistance changes for silicon carbide

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:

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

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**	
Burst-firing operation	**X**				
Burst-firing operation with α start	**X**				**X**
Burst-firing operation with current limiting		**X**	**X**	**X**	
Subordinate control loop					
U^2	**X**	**X**			**X**
I^2			**X**		**X**
P				**X**	**X**

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.

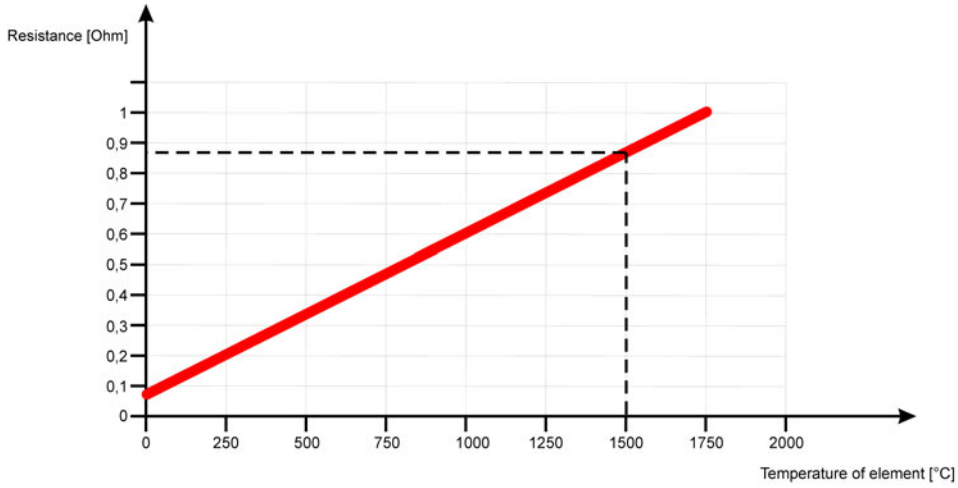
Function

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 Special device functions

6.7 Current limiting

Current limiting is only possible for power controllers with load current measurement; in other words, subordinate control **I,I²** (code 010 in the order code), or **P** (code 001 in the order code) must be selected in the order details.

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

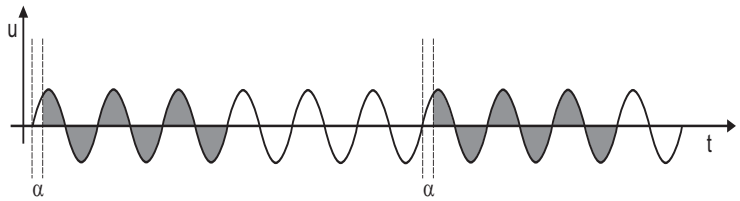
Current limiting is not activated.

⇨ Chapter 5.1.2 "Power controller"

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-angle control of the first half-wave.
The factory setting is an angle of 70 °el. (electrical). This value can be adjusted at 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 binary 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 "Überwachungen"

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
- Master/slave data line interruption
- Master/slave synchronization failure
- Setup of data transfer to the device
- Device temperature greater than 115 °C
- Rotary field error
- Short-term supply drops > 10 % within a half-wave

⇨ Chapter 5.1.5 "Monitoring"

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 Special device functions

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

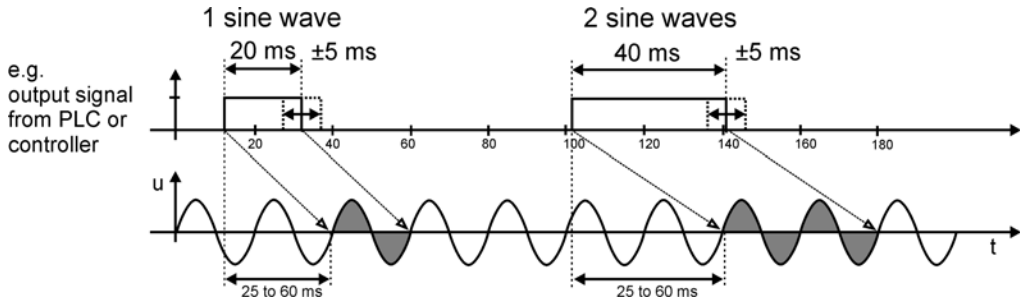
The full power is switched by closing the digital input. If this is too high for the case at hand (e.g. in the case of quick heat-up processes), the output power can be reduced by cutting all sine waves ("α input").

⇨ Chapter 5.1.4 "Setpoint value configuration"

Time behavior

If only short pulse packages with a precisely defined number of sine wave cycles are to be switched, the binary 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

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.

For configuration of the power controller it is sufficient to insert the USB cable into the master 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

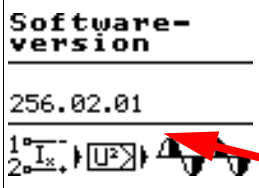
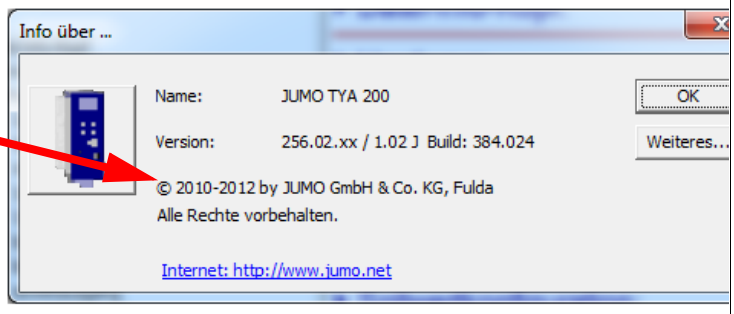
If several users are managed on one computer, make sure that the user who is logged in is the person who will be working with the program later.
The user must have administrator rights for installing the software. After installation, the rights can be restricted again.

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!

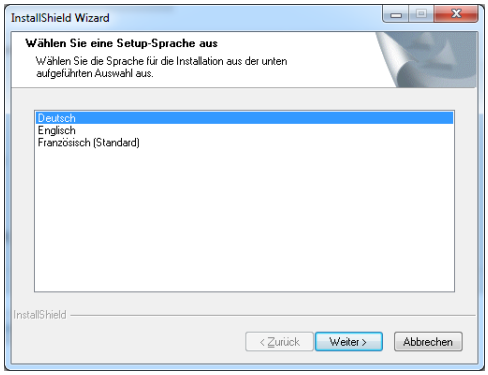
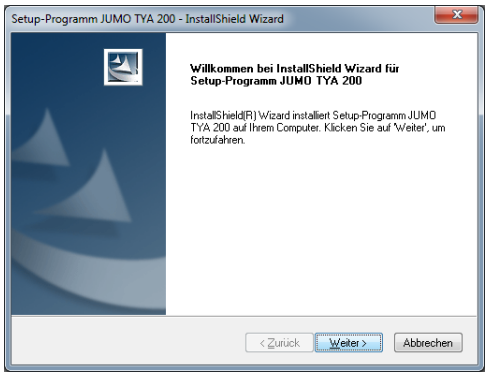
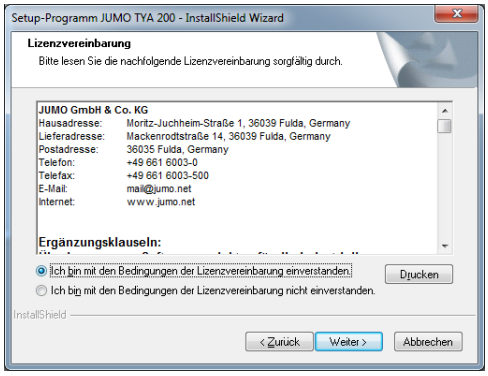
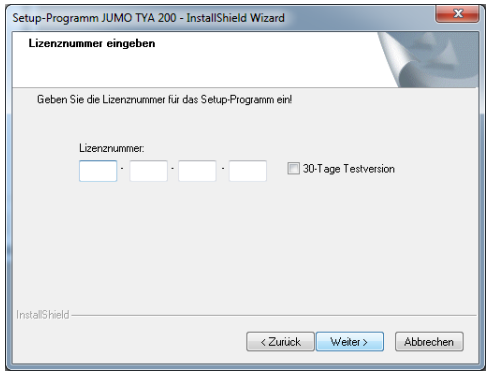
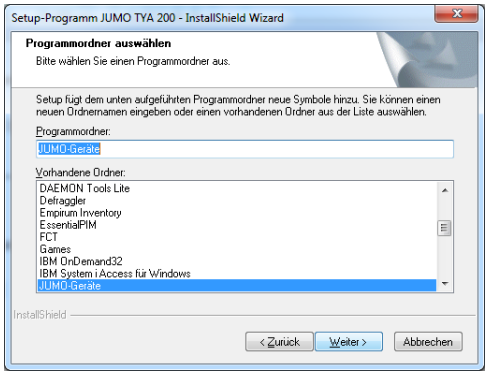
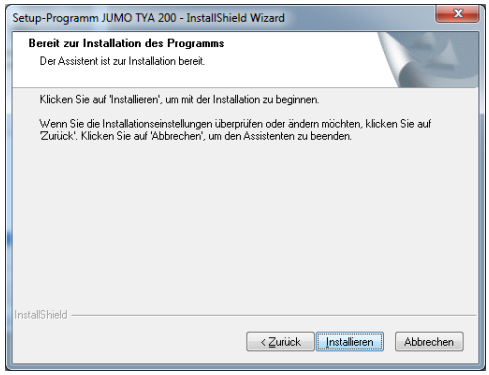
* After switching on the device, press PGM
  The device software version is shown in the Device info menu.
* Click "Info" in the setup program menu bar

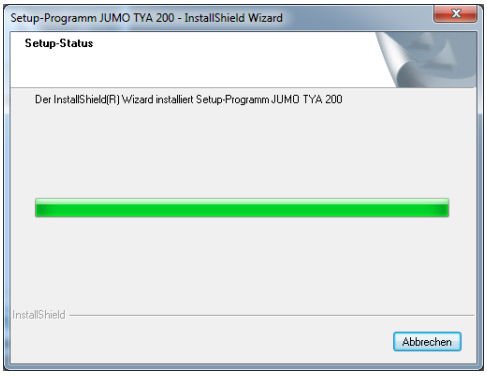
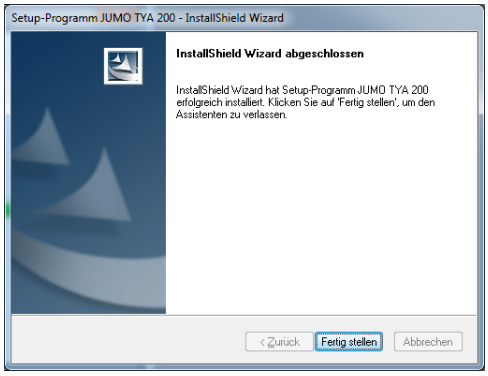
On the device	In the setup program
	

7 Setup program

7.3 Installation

✱ Install the setup program

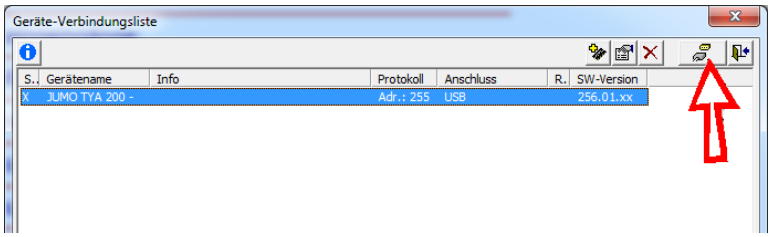
Installation steps	Appearance on the PC screen	
	1 	2 
Enter license number	3 	4 
	5 	6 

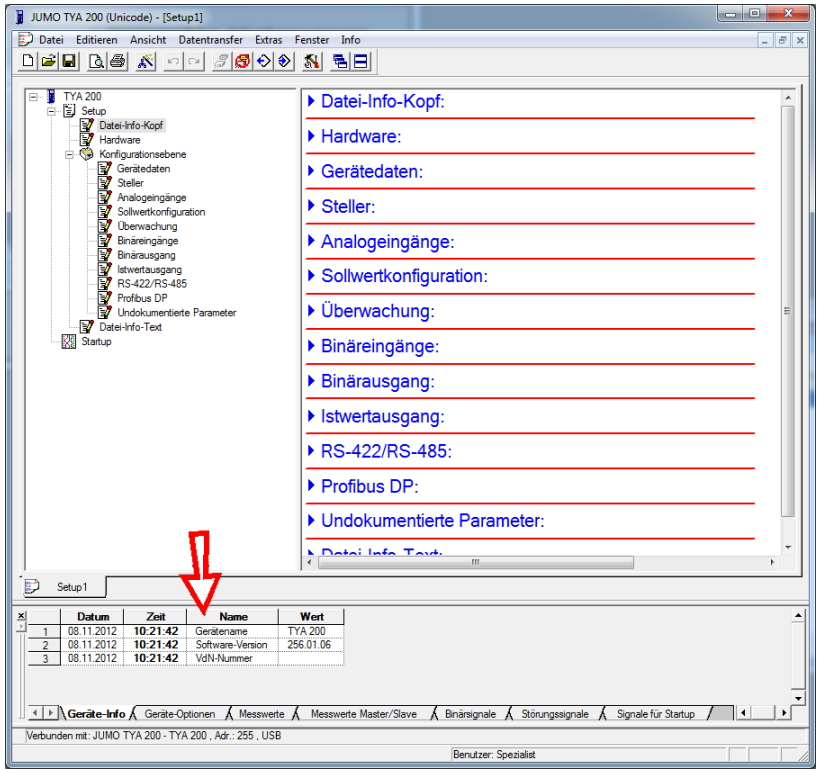
Installation steps	Appearance on the PC screen	
Installation complete	7 	8 
Launch setup program	9 	

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.

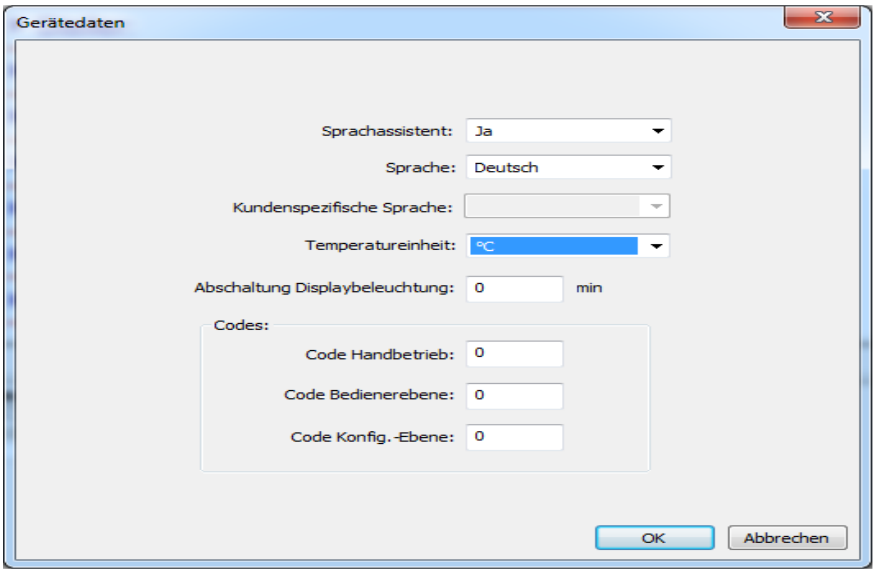
7.5 Forgotten the code?

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

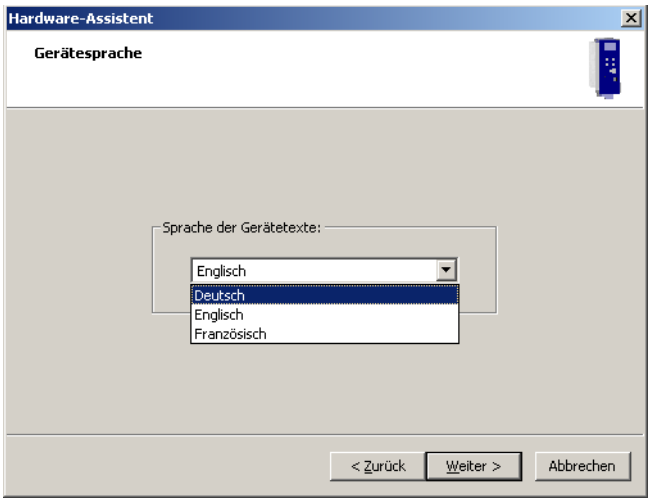
* Enter a new code
* Perform a *Data transfer* ➔ *to the device*
  After the setup data transfer, the device performs a restart and the codes are activated.

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 assistant 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

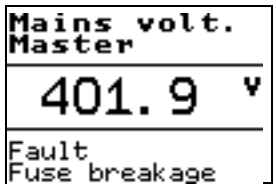
The device now restarts and texts will appear on the display in the desired national language.

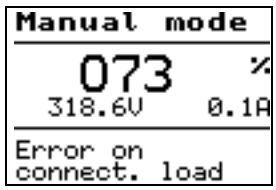
Cyclical appearance

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 8 "Error messages and alarms"

Examples





Error message	Cause	Remedy
Master: Limit val.MinVal reached	The value has dropped below the set limit value for the min. alarm	check why limit value has dropped below
Slave: Limit val.MinVal reached		
Master: Limit val. MaxVal reached	The set limit value for the max. alarm has been exceeded	check why limit value has been exceeded
Slave: Limit val. MaxVal reached		
	The following Error Messages are recognized seperately for Master or Slave	
Master: Fault at connected load	Break or short-circuit of a load resistor. ⇨ Chapter 6.1 "Detection of load faults"	Replace defective heating elements.
Master: 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
	4. Thyristor in the master power controller defective (only with three-phase economy circuit where nominal voltage < 230 V)	The device must be returned to JUMO for repair. ✱ Return the device
Master: Malfunction Thyristor failure	1. Thyristor defective 2. Fuse failure (only in operating states in which it is not possible to clearly distinguish between thyristor failure and fuse failure)	Check fuse If the fuse is not defective, this relates to a thyristor failure: The device must be returned to JUMO for repair. ✱ Return the device

8 Error messages and alarms

Error message	Cause	Remedy
Master: 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
Master: Caution! High temperature	Device temperature is higher than 100 °C (Excess temperature)	- Ensure adequate ventilation - Reduce load current - Use power controller with higher maximum load current
Master: Limit. active high temp.	Device temperature is higher than 105 °C Device is too hot, power is reduced! (Limited power due to excess temperature)	- Ensure adequate ventilation - Reduce load current - Use power controller with higher maximum load current
Master: Mains volt. 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 "Bestellangaben"
Master: Mains volt. 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 "Bestellangaben"
Master: Tempor. mains drop	Dangerous temporary equal proportion for transformer loads has been detected. ⇨ Chapter 5.1.5 "Monitoring"	Ensure stable mains supply.
Master-slave rotary field error	Counterclockwise rotary field has been detected	⇨ Chapter 3.4.1 "Drehstrom Sparschaltung Master-Slave für ohmsche Lasten in Stern-, Dreieckschaltung oder Trafolasten (ohmsch-induktiv)"
Master-slave wiring is wrong.	Wiring fault has been detected	
Rotary field detection failed	Rotary field detection not possible	- Check connection ⇨ Chapter 3.3 "Anschlussplan" - Eliminate mains disturbances
Wire break Current input	Input current for the set measuring range outside the valid range.	- Check wiring for wire breaks and reverse polarity. - Check upstream devices (controllers)
Wire break Voltage input	Input current for the set measuring range outside the valid range.	- Check wiring for wire breaks and reverse polarity. - Check upstream devices (controllers)
Malfunction Bus error	No connection to the Profibus master	Check wiring and master device (PLC).

Error message	Cause	Remedy
Master-slave Error in comm.	Error in the data transfer between master and slave	Check data connection of the 1:1 patch cable
Data cable faulty	Communication between master and slave interrupted.	Check the 1:1 patch cables and replace if necessary
Synchronization failed	Slave device switched off or communication between master and slave interrupted	Check data connection of the 1:1 patch cable or voltage supply

Teach-In load monitoring!	Reminder that "manual" Teach-In has been configured but not yet executed.	Perform Teach-In ⇨ Chapter 6.1 "Erkennung von Lastfehlern"
Slave: Limit val. Min-Val reached	The value has fallen below the selected limit value for the min. alarm at the slave	Check why the value has fallen below the limit value.
Slave: Limit val. Max-Val reached	The selected limit value for the max. alarm has been exceeded at the slave	Check why the limit value has been exceeded.
Slave: fault at connected load	Break or short-circuit of a load resistor. ⇨ Chapter 6.1 "Detection of load faults"	Replace defective heating elements.
Slave: 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
Slave: thyristor breakage	1. Thyristor defective 2. Fuse failure (only in operating states in which it is not possible to clearly distinguish between thyristor failure and fuse failure)	Check fuse If the fuse is not defective, this relates to a thyristor failure: The device must be returned to JUMO for repair. ✱ Return the device
Slave: thyristor short circuit	Thyristor defective	The device must be returned to JUMO for repair. ✱ Return the device
Slave: Caution! High temp.	Device temperature is higher than 100 °C (Excess temperature)	- Ensure adequate ventilation - Reduce load current - Use power controller with higher maximum load current
Slave: limit. active high temp.	Device temperature is higher than 105 °C Device too hot! Power is reduced. (Limited power due to excess temperature)	- Ensure adequate ventilation - Reduce load current - Use power controller with higher maximum load current
Slave: supply volt. 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 "Bestellangaben"

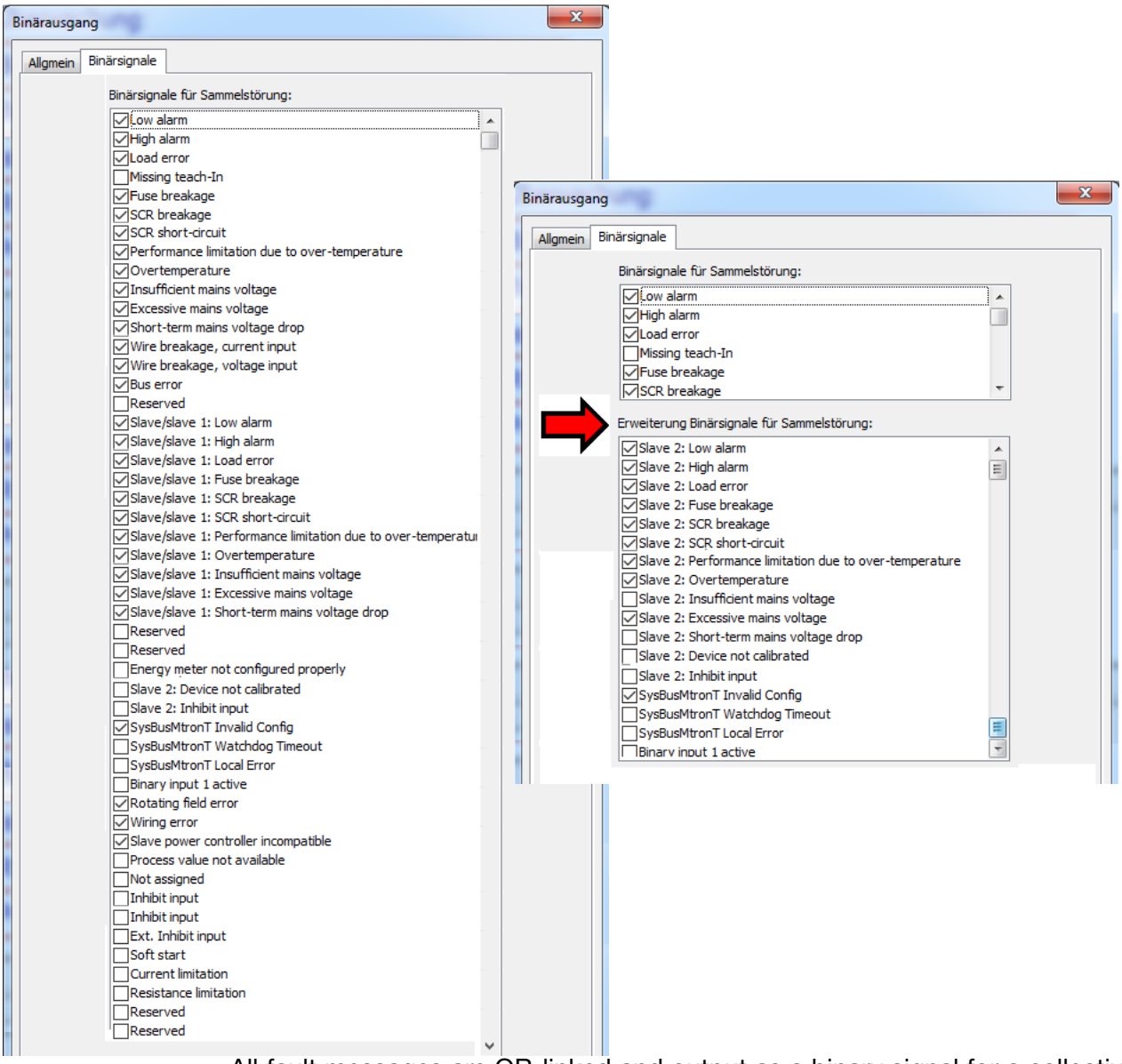
8 Error messages and alarms

Error message	Cause	Remedy
Slave: supply volt. 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 "Bestellangaben"
Slave: Temp. mains drop	Dangerous temporary equal proportion for transformer loads has been detected. ⇨ Chapter 5.1.5 "Monitoring"	Ensure stable mains supply.
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 "Anschlussplan" 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 display appears until the soft start period has elapsed.	⇨ Chapter 5.1.2 "Steller" -> Softstartdauer
Current limiting active	The required output level causes an excessive load current and is limited to the set value.	⇨ Chapter 5.1.2 "Steller" -> Strombegrenzung
Resistance limiting active	The desired output level leads to current/voltage values that are limited to the set load resistance value. The output level is limited to the admissible resistance to prevent the heating element from overheating.	⇨ Chapter 5.1.2 "Steller" -> Widerstandsbegrenzung

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 Error messages and alarms

8.2 Replacing a defective semiconductor fuse

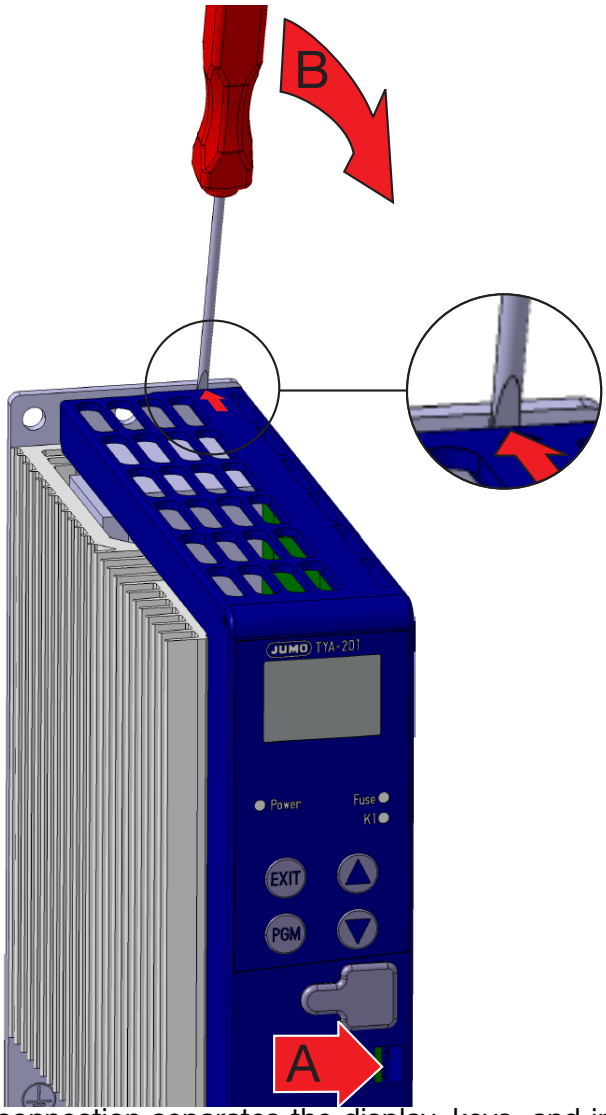
Opening the housing

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 "Anschlussplan"
* 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).



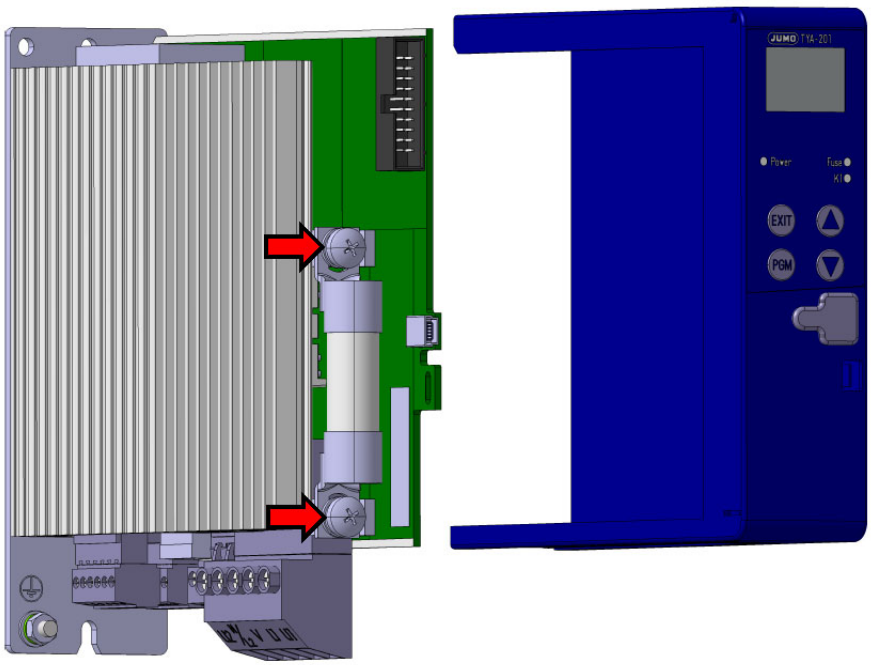
A plug connection separates the display, keys, and interface from the power section and you will be able to see the semiconductor fuse.

8.2.1 Accessories: semiconductor fuses

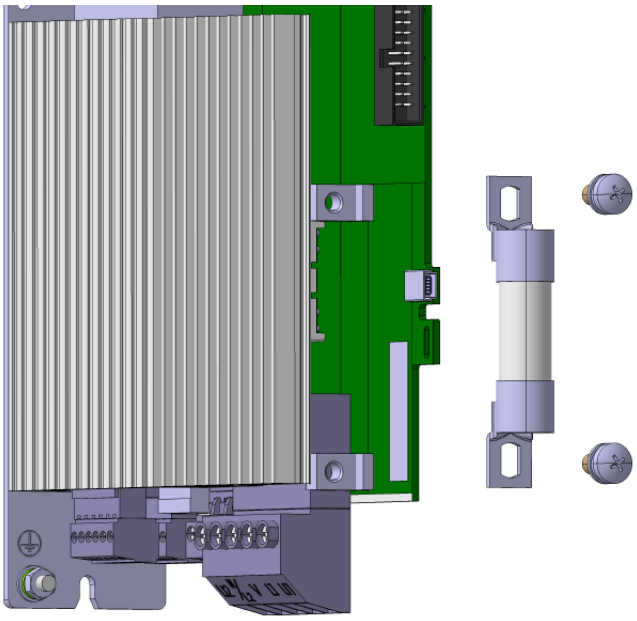
The design of the semiconductor fuse differs according to the device type.

Power controller type	Tripping current	Screws	Tightening torque	Sales no.
20 A	Tripping current: 40 A	Recessed head	3 Nm	70/00513108
32 A	Tripping current: 80 A	Recessed head	5 Nm	70/00068011
50 A	Tripping current: 80 A	Recessed head	5 Nm	70/00068011
100 A	Tripping current: 160 A	Hex-headed, width across flats 10 mm	5 Nm	70/00081801
150 A	Tripping current: 350 A	Hex-headed, width across flats 13 mm	12 Nm	70/00083318
200 A	Tripping current: 550 A	Hex-headed, width across flats 13 mm	12 Nm	70/00371964
250 A	Tripping current: 550 A	Hex-headed, width across flats 13 mm	12 Nm	70/00371964

8.2.2 Semi-conductor fuses type 709062/X-0X-20...

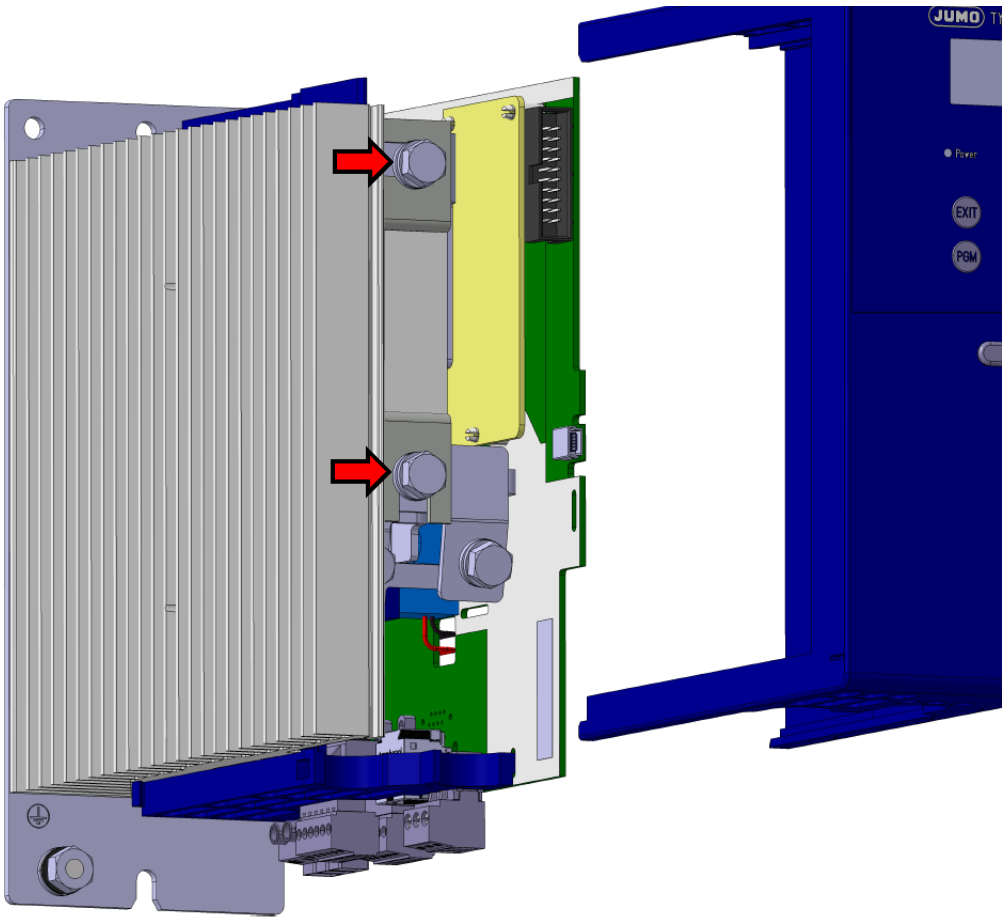


✱ Undo 2 recessed head screws

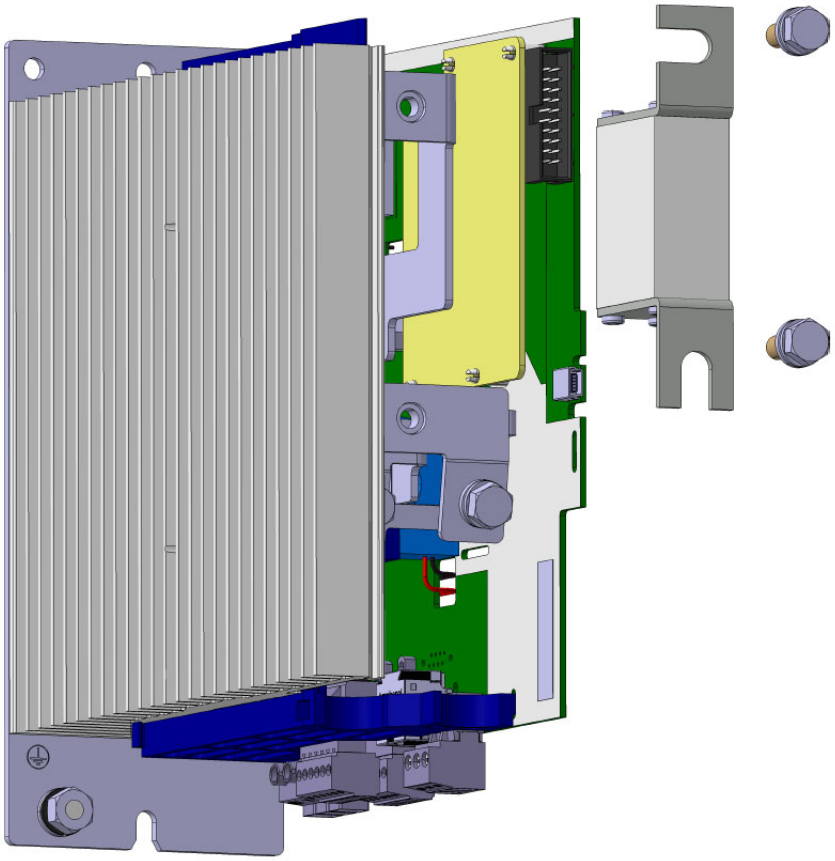


* Replace the defective semiconductor fuse with a new one.
* Tighten the screws with the specified tightening torque

8.2.3 Semi-conductor fuses type 709062/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.

8 Error messages and alarms

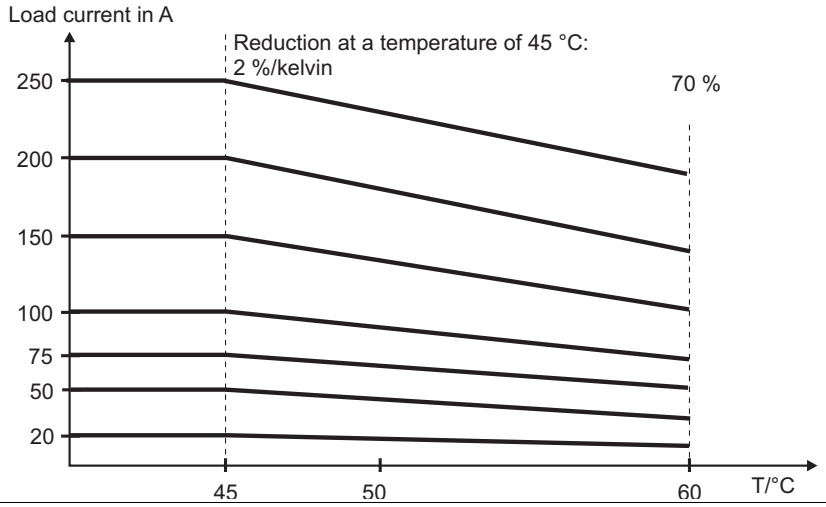
What is happening?	Cause / remedy	Info
Green Power LED is flashing	- Display switch-off active ✱ Press any key	⇨ Chapter 5.1.1 "Device data"
Power controller is not producing any output power even though the green Power LED is lit and a setpoint value has been set.	- Parameters have been changed in the 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 "Electrical connection"
	- 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 61.
	- Thyristor short circuit	⇨ Chapter 8 "Error messages and alarms"

9 What to do, if ...

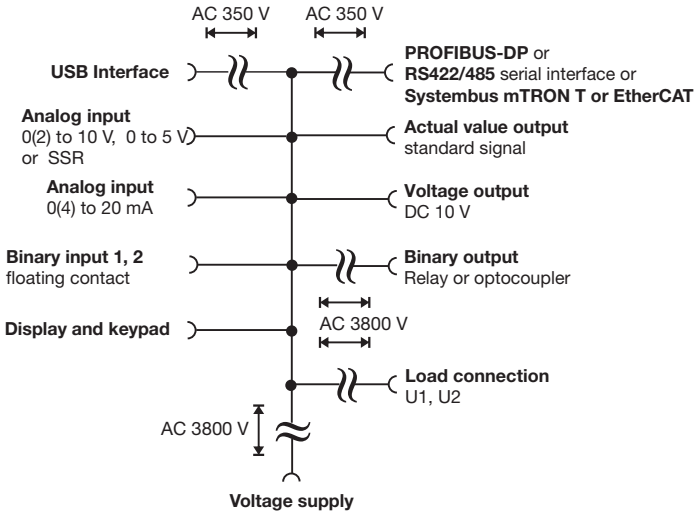
What is happening?	Cause / remedy	Info
Power controller is not producing full power even though the setpoint value is set to 100 %	- Current limiting active ✱ Check settings	⇨ See "Current limiting" on page 57.
	- Half-wave control set (half power) ✱ Change to burst-firing operation	

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

Code	Voltage supply for control electronics = Mains voltage	Fan specifications Type 709062/X-0X-250...
024	AC 24V -20%...+15%, 48 ...63 Hz	AC 24V/2×30VA
042	AC 42V -20%...+15%, 48 ...63 Hz	AC 24V/2×30VA
115	AC 115V -20%...+15%, 48 ...63 Hz	AC 115V/2×30VA
230	AC 230V -20%...+15%, 48 ...63 Hz	AC 230V/2×30VA
265	AC 265V -20%...+15%, 48 ...63 Hz	AC 230V/2×30VA
400	AC 400V -20%...+15%, 48 ...63 Hz	AC 230V/2×30VA
460	AC 460V -20%...+15%, 48 ...63 Hz	AC 230V/2×30VA
500	AC 500V -20%...+15%, 48 ...63 Hz	AC 230V/2×30VA
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. 40 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 (master only)

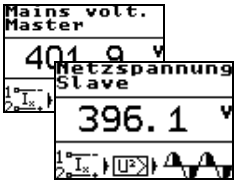
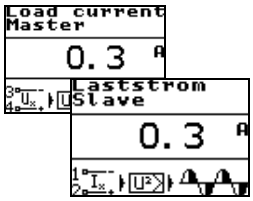
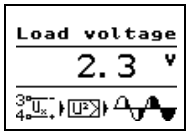
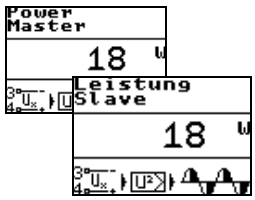
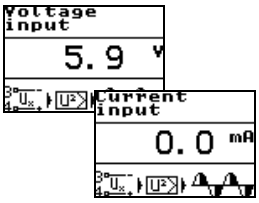
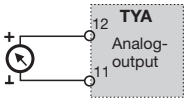
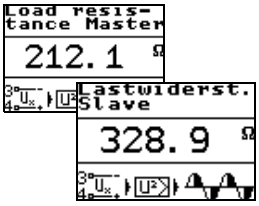
Current	0 (4) to 20 mA R_i = 50 Ω
voltage	0 (2) to 10 V R_i = 25 kΩ
	0 (1) to 5 V R_i = 25 kΩ

10.4 Analog output (actual value output master only)

analog output	Switched off as standard. I_{max} = 20 mA with 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 with 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.

<table>
<tr>
<td>Mains voltage: ±2.5 %
 
</td>
<td>Load current: ±1 %
 
</td>
<td>Load voltage: ±1 %
 
</td>
<td>Power: ±2 %
 
</td>
<td></td>
</tr>
<tr>
<td>Analog input
Voltage/current: ±1 %
 
</td>
<td>Analog output
Voltage/current: ±1 %
 
</td>
<td>Load resistance: ±2 %
(For resistive load)
 
</td>
<td></td>
<td></td>
</tr>
</table>

10.5 Digital inputs

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

10.6 Digital output (fault signal output master only)

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 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	- Three-phase economy circuit in master slave operation
Operating modes	- Burst-firing operation for resistive or transformer load
Special features	- Dual energy management - Soft start with pulse groups
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 709062/X -0X-020... Control and load leads are connected via screw terminals. From type 709062/X -0X-032... Control cables 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 709062/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 "Zulässiger Laststrom in Abhängigkeit von der Umgebungstemperatur und der Aufstellhöhe"
Permissible storage temperature range	-30 to +70 °C (1K5 according to EN 60721-3-1)
Altitude	≤ 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

<table>
<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 709062/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 ... +15 %, 48 ... 63 Hz</td><td rowspan="2">AC 24 V/2x30 VA</td></tr>
<tr><td>Mains voltage AC 42 V</td><td>-20 ... +15 %, 48 ... 63 Hz</td></tr>
<tr><td>Mains voltage AC 115 V</td><td>-15 ... +10 %, 48 ... 63 Hz</td><td>AC 115 V/2x30 VA</td></tr>
<tr><td>Mains voltage AC 230 V</td><td rowspan="5">-15 ... +10 %, 48 ... 63 Hz</td><td rowspan="5">AC 230 V/2x30 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 supply current circuit and SELV circuits
For type 709062/X -0X-020...
12.7 mm between supply current circuit and SELV circuits
From type 709062/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 = 2x (20 W + 1.3 V x 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. 2.2 kg
Load current 32 A approx. 4.2 kg
Load current 50 A approx. 5.4 kg
Load current 100 A approx. 7.6 kg
Load current 150 A approx. 17 kg
Load current 200 A approx. 19 kg
Load current 250 A approx. 20.4 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)	709062/X-XX-020-... Load current 20 A
			UL 508 (Category NRNT) C22.2 NO. 14-10 Industrial Control Equipment (Category NRNT7)	709062/X-XX-032... 709062/X-XX-050... 709062/X-XX-100... 709062/X-XX-150... 709062/X-XX-200... 709062/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

部件名称 Product group: 709062	 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

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