JUMO IGBT Power Converter

70A with amplitude control

B 70.9050.0
Operating Manual

02.08 /00379884

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2.1 Preface

Please read this operating manual before commissioning the instrument.
Keep the operating manual in a place accessible to all users at all times.
Your comments are appreciated and can serve to improve this operating manual.

Phone: ++49 (0) 6 61 60 03-7 27
Fax: ++49 (0) 6 61 60 03-5 08

Please ensure that only the choke recommended by JUMO is connected!

Should difficulties arise during start-up, please do not carry out any unauthorized manipulations. This could lead to you losing your warranty rights!

Please contact the nearest subsidiary or the head office.

Service hotline

For technical questions
Phone support in Germany:
Phone: +49 (0)661 6003-300 or -653 or -899
Fax: +49 (0)661 6003-881729
E-mail: service@jumo.net

Austria:
Phone: +43 1 610610
Fax: +43 1 6106140
E-mail: info@jumo.at

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

Electrostatic charge

When accessing the inner parts of the unit, please observe the regulations according to DIN EN 61340-5-1 and DIN EN 61340-5-2 „Protection of electrostatic sensitive devices“. Only use **ESD** packaging for transport.

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

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

2.2 Typographical conventions

2.2.1 Warning signs

Danger

This symbol is used when there may be **danger to personnel** if the instructions are ignored or not followed correctly!

Caution:

This symbol is used when there may be **damage to equipment or data** if the instructions are ignored or not followed correctly!

ESD

This symbol is used where special care is required when handling **components liable to damage through electrostatic discharge**.

2.2.2 Note signs

Note

This symbol is used when your **special attention** is drawn to a remark.

Reference

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

Footnote

abc[1]

Footnotes are remarks that **refer to specific points** in the text. Footnotes consist of two parts:
A marker in the text and the foot note text itself.
The markers in the text are arranged as continuous superscript numbers.

2.2.3 Performing an action

Action instruction

* Plug in the connector

This symbol indicates that an **action to be performed** is described. The individual steps are marked by this asterisk.

Vital text

This text contains important information, and it is vital that you read it before going any further.

2 Introduction

2.3 Order details

The nameplate is glued onto the right panel of the housing.

				(1)	**Basic version**
			709050/81		IGBT power converter 70A (max. load voltage 120V) Standard version
			709050/91		Customer-specific version
				(2)	**Voltage supply to the control section**
x			11		115V AC +15/-20%, 48 ... 63Hz (only for 115V AC in the power section)
	x	x	12		230V AC +15/-20%, 48 ... 63Hz
				(3)	**Voltage supply to power section**
x			115		115V AC +15/-20%, 48 ... 63Hz
	x		230		230V AC +15/-20%, 48 ... 63Hz
		x	400		400V AC +15/-20%, 48 ... 63Hz
				(4)	Load voltage
x	x	x	020		20V DC ⎓
x	x	x	060		60V DC ⎓
x	x	x	090		90V DC ⎓
	x	x	120		120V DC ⎓
			150		150V DC ⎓
			210		210V DC ⎓
			270		270V DC ⎓
			380		380V DC ⎓
				(5)	**Load current**
x	x	x	070		70A DC ⎓
				(6)	**Extra code for fault signal output**
x	x	x	252		Relay (changeover contact) 3A
x	x	x	257		Optocoupler

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Order code	____ -	__ -	__ -	__ -	__ -	__
Order example	709050/81 -	12 -	230 -	060 -	070 /	252

2.3.1 Standard accessories

1 Operating Manual

2.3.2 Accessories

Choke: L = 0.6mH/I_N = 75A, protection rating IP 10, as per EN 60 529

Dimensions	Connection cross-section	Tightening torque for screw terminals	Weight	Sales No.
Diameter: 155 mm Height: 135 mm Diameter of fixing hole: 10.4 mm	Via screw terminals up to max. 4...25 mm^2	max. 4...4.5 Nm	approx. 7.5 kgs	70/00392474

EMC filter

For voltage supply to power section					
Nominal voltage, nominal current	Dimensions (L x W x H)	Tightening torque for screw terminals	Weight	Permissible ambient temperature	Sales No.
115V/250V/440V AC, I_{Nom} = 16A	(255 x 60 x 130) mm	0.6 ... 0.8 Nm	approx. 4kgs	40°C	70/00399527
115V/250V/440V AC, I_{Nom} = 20A	(289 x 70 x 140) mm	1.5 ... 1.8 Nm	approx. 5.5 kgs	40°C	70/00438775
115V/250V/440V AC, I_{Nom} = 32A	(324 x 90 x 160) mm	1.5 ... 1.8 Nm	approx. 9.5kgs	40°C	70/00409831
115V/250V/440V AC, I_{Nom} = 63A	(380 x 117 x 190) mm	2 ... 2.3 Nm	approx. 17kgs	40°C	70/00409990
115V/250V/440V AC, I_{Nom} = 100A	(445 x 150 x 220) mm	6 ... 8 Nm	approx. 26 kgs	40°C	70/00431997
For voltage supply to the control section					
115V/250V AC, I_{Nom} = 1A	80 x 45 x 30 mm	-	approx. 120g	40°C	70/00413620

2 Introduction

2.4 Brief description

Instrument

The JUMO IPC is a IGBT power converter for controlling heater loads that previously required a transformer (either a variable transformer or a combination of transformer and thyristor power unit).
Its function is that of an electronic transformer with a pulsed DC output.

Advantages

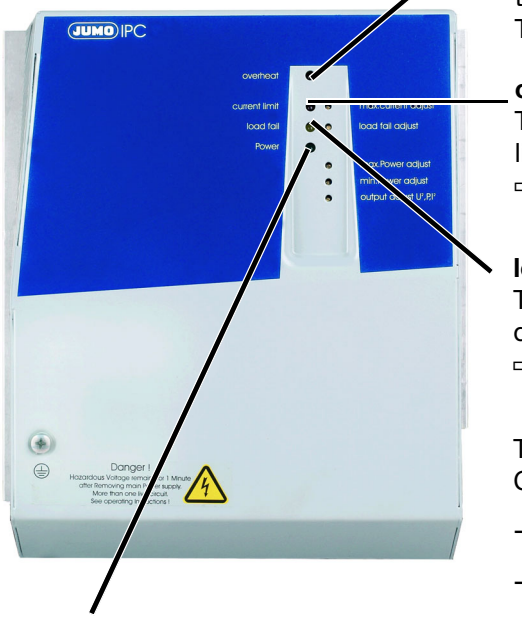
It combines the advantages of a conventional variable transformer, such as amplitude control which is the sinusoidal current loading, with the advantages of a thyristor power switch, such as current limiting, load monitoring, subordinate control action, etc.

There is no electrical isolation between the voltage supply and the load voltage.

Application

This power converter is employed wherever large resistive loads need to be switched and no electrical isolation is required between the supply voltage and the load voltage. Thanks to the amplitude control (the current drawn from the supply is always sinusoidal), synchronous clock controls (as for burst-firing operation) and power-factor compensation networks (for the reactive power resulting from phase-control) are no longer required.

2.5 Interpretation of the LEDs



overheat
This LED lights up if the maximum permitted temperature is exceeded. The instrument remains disconnected until the temperature has fallen below the limit value again.
The load fail LED is lit at the same time.

current limit
This LED lights up if the converter is working at the current limit.
⇨ Chapter 5.11 „Setting the current limit (max. current adjust)“

load fail
This LED lights up if a total or partial load failure has been detected.
⇨ Chapter 5.12 „Total and partial load failure monitoring (load fail adjust)“

This LED lights up if the fault signal relay has dropped out
Causes:

- Overheat
- Safety cut-out in the load circuit (semiconductor failure, semiconductor short)

Power
This LED indicates that the control section is connected to the voltage supply.
It does **not** indicate the status of the power section!

3.1 Important notes on installation

Safety regulations

- The choice of cable, the installation and the electrical connection of the instrument must conform to the requirements of VDE 0100 "Regulations on the Installation of Power Circuits with Nominal Voltages below 1000 V AC" or the appropriate local regulations.
- The electrical connection must only be carried out by qualified personnel.
- An isolation switch as per VDE0160/6.3.1 must be wired between the supply and the converter to be able to disconnect the converter from the voltage supply prior to starting internal work.

Caution!
The converter has 2 power supplies (to the control section and to the power section). Disconnect both supplies (all poles) prior to starting work on the converter.

Allow 1 minute to elapse after switching off prior to starting work on the converter, since potentially fatal voltages could be present in the converter interior and at the terminals.

- Inside the converter, safety gaps meet the requirements for double insulation.
  When installing the connecting cable, ensure that the cables are fitted according to regulations and that the safety gaps are maintained.

Electrical supply types

The IPC is suitable for operation with TN and TT supply networks.

✱ Carry out installation in accordance with EN 50178.

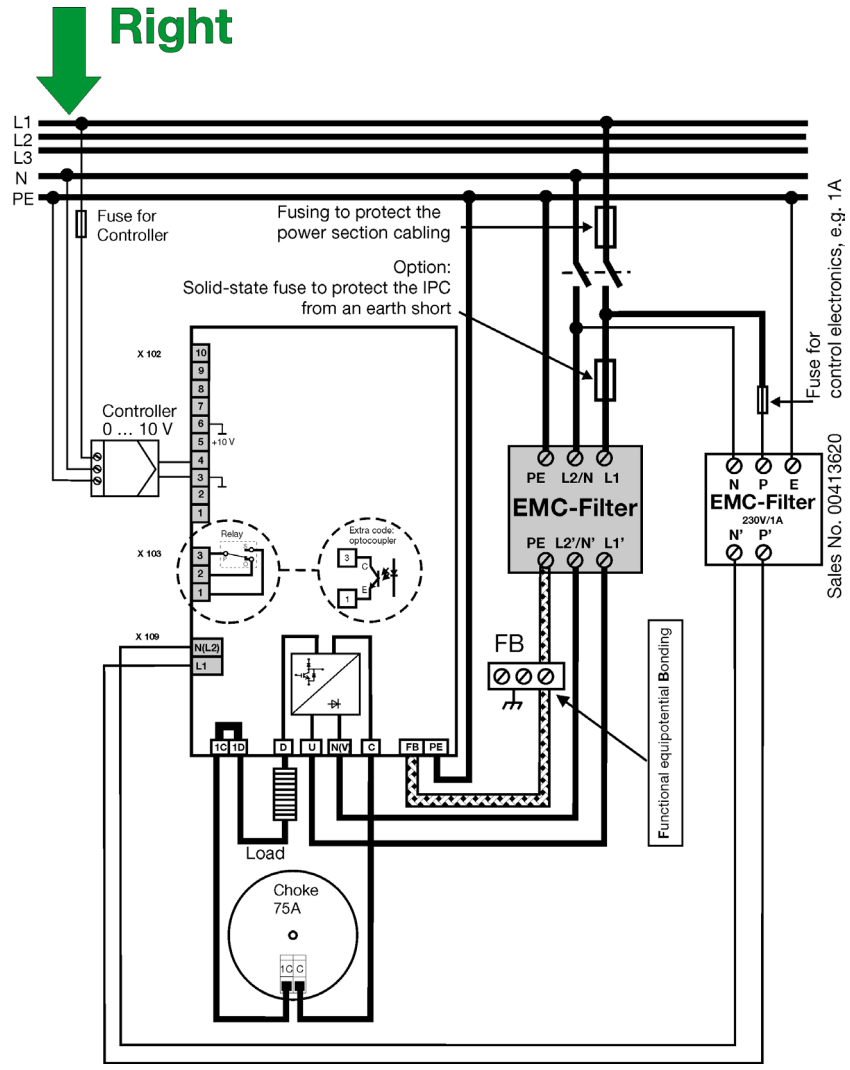
Fuse protection

- Fuse protection in accordance with the VDE regulations must be installed for the voltage supply to the power section. The supply protection can also be achieved by a circuit-breaker in the supply lead. This must be dimensioned for the power consumption of the power converter and the rated current of the downstream EMC filter.
- To protect the IPC in the event of a short, additionally provide fuse protection for the supply lead in the power section by a semiconductor fuse.
  Select <2000 A^2s as the I^2t value of the
  semiconductor fuse for type 70.9050/X1-XX-XXX-XXX-070/XXX.
  Provide an appropriate control circuit fuse for **control section lead protection**. The control section consumes approx. 50 VA.

3.1.1 Correctly wire all components

EMC filter

The IPC may only be used in conjunction with a suitable filter (accessories). If a different filter is used, it must be of equal or better characteristics. Otherwise, inductive voltages may be introduced into the supply network. We decline any liability for damage caused as a result.



The EMC filters may only be used for interference suppression of the IPC power converter. Other devices, such as controllers, power supplies etc. must be suppressed, where necessary, with their own EMC filters. Do not wire these devices in parallel to the IPC power converter on the load side of the EMC filter.

The earth leakage current of the IPC power converter with a filter wired into the supply lead is less than 3 mA. If the load conditions result in an earth leakage current greater than 3.5 mA, a fixed supply connection is required as a protection against hazardous potentials (also see EN 50178).

Electromagnetic compatibility conforms to the standards and regulations cited in the technical data.

⇨ Chapter 6 „Technical data“

✱ Load wiring (thick) and cables for control inputs (thin) should be routed separately, if possible.

Positioning of the choke

* The choke should be installed close to the converter.

Connection

* Check the data given on the nameplate (voltage supply to the control section, voltage supply to the power section, load voltage and load current) against the system data.

⇨ Chapter 2.3 „Order details“

* Check the adaptation of the setpoint inputs.
* Check the switch settings.

PE connection/ FB connection

* Provide a direct connection between the PE of the IPC and the PE of the supply network. Connect to the PE terminal of the IPC.
* If necessary, interference emission of the IPC can also be minimised by a function equipotential bonding. The function equipotential bonding is connected to the FB terminal of the IPC.

⇨ Chapter 3.1.1 „Correctly wire all components“

Choke connection

* The choke is connected to terminals C and 1C.

Voltage supply

* Connect the voltage supply to the control section to terminals L1 and N(L2) (X109).
* Connect the voltage supply of the power section to terminals U and N(V).

An isolation switch as per VDE 0160/5.3.1 must be wired between the supply and the converter to be able to disconnect the converter (all poles) from the voltage supply prior to starting internal work!

The connection must only be carried out by qualified personnel!

Load connection

* The load is connected to terminals D and 1D.
* The cable between the load and the IPC should be as short as possible and not exceed 50 m.

Control inputs

The terminal strip for control connections (inputs and outputs) have been laid out for safe isolation from the supply. 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.

Switch-on sequence

The voltage supplies to the control section and to the power section must be switched on simultaneously.

Under no circumstances may the voltage supply to the control section be switched on before the load voltage. This is especially important when driving resistive loads that have a high hot/cold resistance ratio.

3.2 Filtering and interference suppression

System

Compliance with the EMC standards can only be achieved through additional EMC measures. These include:

- a supply filter in the voltage supply
- a shielded cable for the voltage supply
- a shielded cable to the load
- Functional equipotential bonding

Compliance with the EMC standards must be tested for the overall system.

Construction

To keep interference emission through conducted and radiated interference below the permissible levels defined in CISPR 16-1 and CISPR 16-2, constructive measures must be taken in the installation and wiring stages in addition to supply input filtering. Poor earth connection or shielding of the EMC filter will reduce the effectiveness of the interference suppression measures.

The following points should be noted in order to achieve good configuration for EMC purposes:

* All metallic components of the converter or cabinet must be well bonded for HF currents over a large surface area.
* The EMC filter should be installed close to the IPC, if possible, on a common metal plate. Route cables for control inputs and signal cables as far apart from each other as possible, and use shielded cables.
* If possible, do not route power cables in the same cable duct as control or signal cables.
* The cable between the load and the IPC should be as short as possible and not exceed 50 m.

Earthing

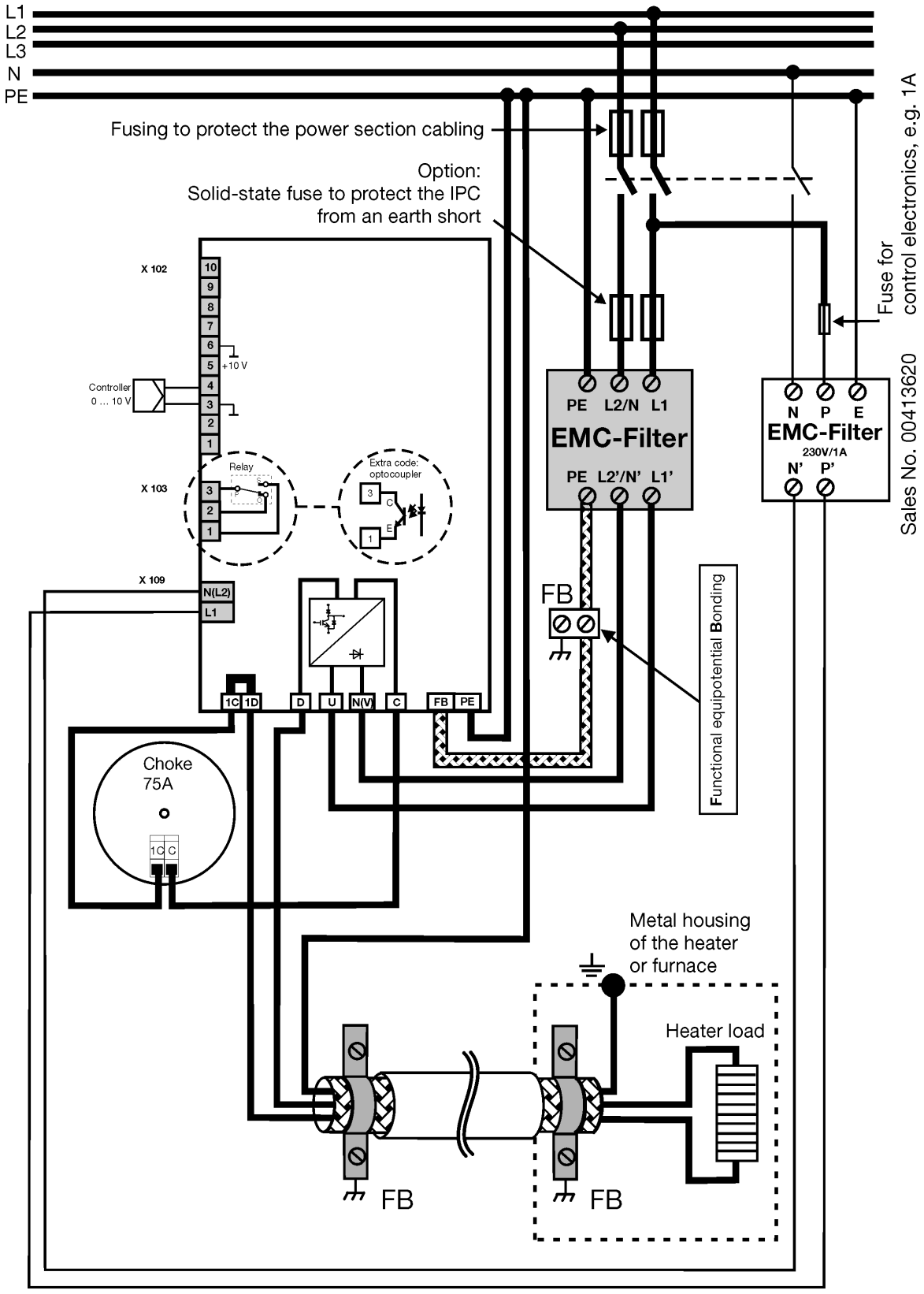
The base plate, the supply filter and the shielding of the supply cable must be earthed to a star point using HF braiding.

Choosing a suitable cable

- If the cable between the filter and the IPC is longer than 300 mm, we recommend to use a shielded cable with the shielding earthed at both ends. Route cables inside the switch cabinet as close as possible to grounded surfaces, otherwise they can act as antennae and radiate interference.
- To achieve a good shielding effect for the cable, only use cables that have shielding made with tinned or nickel-plated copper braiding. The coverage of the shielding should be at least 70%; the lay angle should be 90°. Screens made of steel braiding are not suitable. Earth the shielding of the load cable on both ends.
- The shielding of the control inputs must only be earthed at one end. If potential differences exist, install an additional equipotential bonding conductor.

EVC compliant design

The user/owner is responsible for the specific application complying with the EMC directive. A configuration meeting EMC requirements is illustrated in the diagram below for type 709050/X1-12-400-XXX-070/XXX with a **Phase / Phase** connection.



3.3 Ambient conditions

Misuse

The instrument is not suitable for use in areas with an explosion hazard (Ex areas).

Mounting site

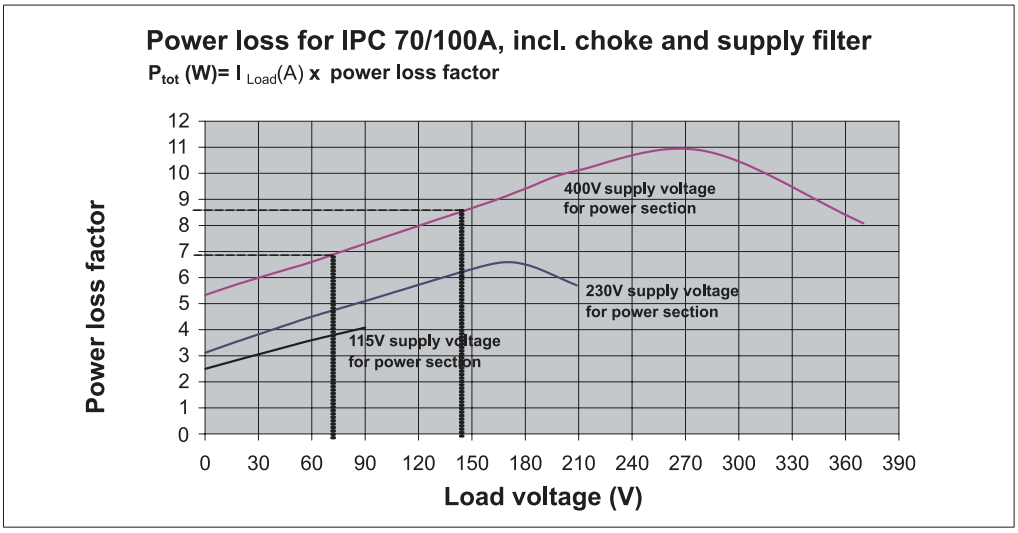
The installation site should be free from vibration, dust and corrosive media.

Climatic conditions

- Relative humidity: 5...85 % no condensation (3K3 as per EN 60721)
- Max. air inlet temperature 35°C
- Ambient temperature range: 5 ... 40 °C (3K3 as per EN 60721)
- Storage temperature range: -10...70 °C

Power loss

Power loss occurs in the form of thermal discharge at the cooling body of the power converter, at the EMC filter and choke and has to be discharged at the place of installation (e.g. in the switch cabinet) in accordance with the climatic conditions.



Example of the Molybdenum Disilicide heating elements

IPC type: **709050/81-12-400-120-070/252**
Load voltage = 120V
Load current = 70A
Voltage supply to the power section = 400V

Resistive loads and Molybdenum Disilicide heating elements:

Heating element data: Load voltage = 110V; load current = 65A

✱ Determine the max. load voltage actually taken (e.g. 110V) and find the point intersecting with the curve for the voltage supply in the power section. The Y axis shows the attendant power loss factor of, e.g., 7.8.

The power loss (W) is obtained by multiplying this power loss factor by the load current (e.g. 65A)
that flows at max. load voltage (e.g. 110V) through the load resistor

Power loss = 65(A) x power loss factor

Power loss = 65(A) x 7.8 = **507W**

Example of the SIC heating elements

IPC type: **709050/91-12-400-120-070/252**
Load voltage = 120V
Load current = 70A
Voltage supply to the power section = 400V
P control, P = 4200W

SIC heating elements

SIC heating element data: new: 60V/70A, old 120V/35A; P = 4200W

* Determine the maximum load voltage actually taken (e.g. 60V) of the **new** SIC heating element and find the point intersecting with the curve for the voltage supply in the power section. The Y axis shows the attendant power loss factor of, e.g., 6.6.

The power loss (W) is obtained by multiplying this power loss factor by the load current (e.g. 70A)
that flows at max. load voltage (e.g. 60V) through the **new** SIC heating element

Power loss = 70(A) x power loss factor

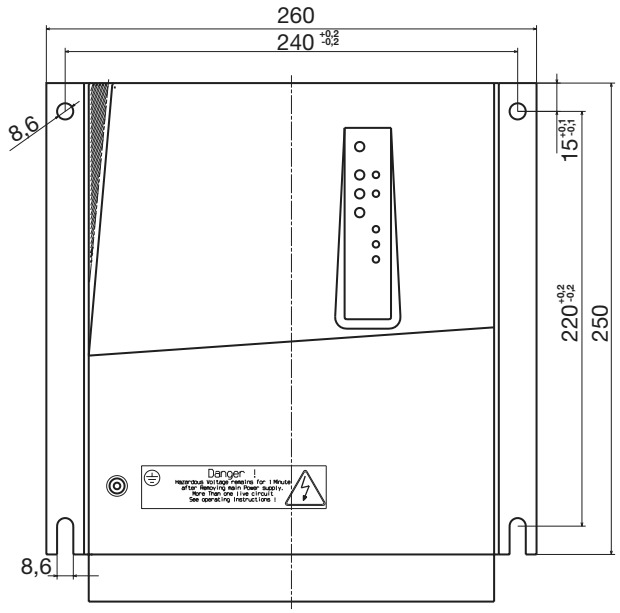
Power loss =70(A) x 6.6 = **462W**

Wall fixing

* Use 4 bolts to fix the converter vertically on a heat resistant switch cabinet back panel.

The temperature of the air drawn in through the ventilation grille must not exceed 35° C. Ensure that the inlet air of the built-in ventilator can escape freely at the top and bottom!

Dimensions **Type 709050/X1-XX-XXX-XXX-070/XXX**



Caution! Hot cooling body!

The cooling body can reach very high temperatures during operation!

3.4 Spacings

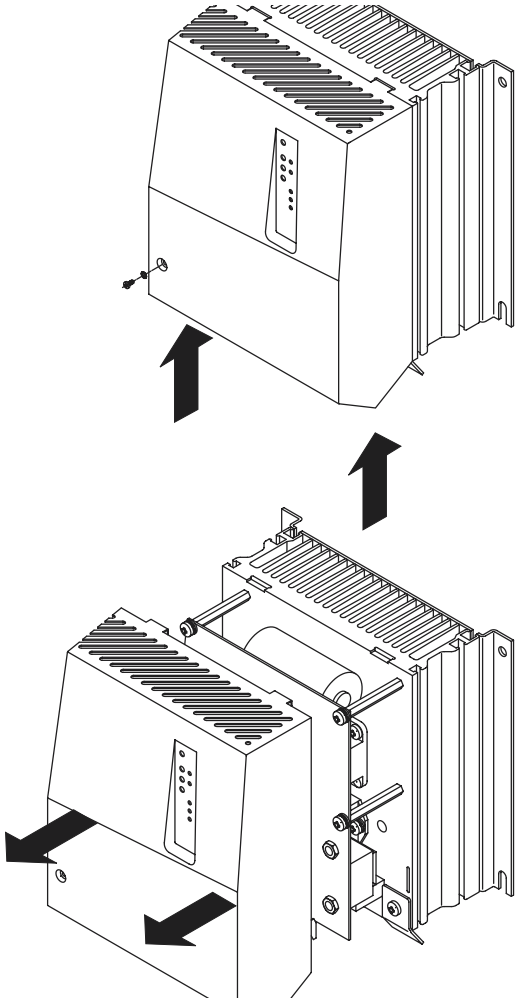
* Allow a clearance of 10 cm from the floor.
* Allow a clearance of 15 cm from the ceiling.
* When fitted next to each other, no spacing between the units is required.

3.4.1 Opening the housing

Caution!
The converter has 2 power supplies (to the control section and to the power section). Disconnect both supplies (all poles) prior to starting work on the converter.

Allow 1 minute to elapse after switching off prior to starting work on the converter, since potentially fatal voltages could be present in the converter interior and at the terminals.

* Disconnect the built-in converter from the voltage supply on all poles
* Undo the bolt on the bottom left
* Push the housing cover upward and pull off to the front



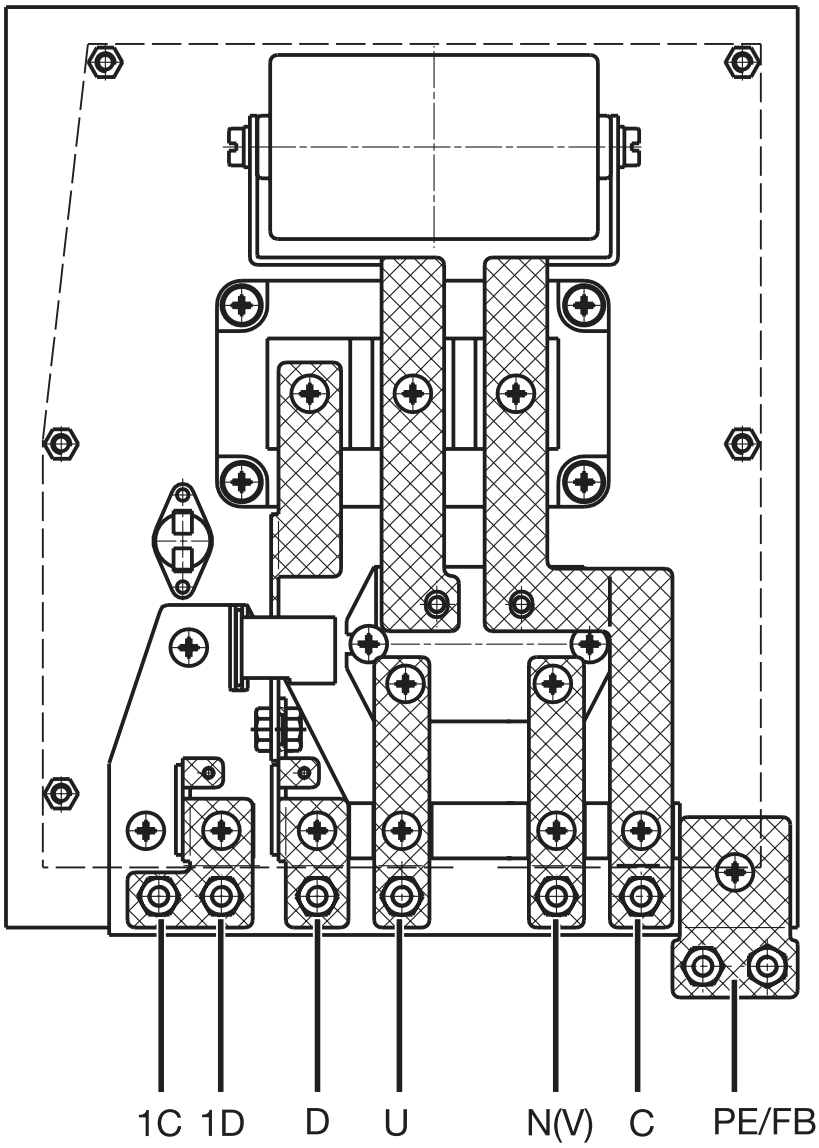
4.1 Screw connections in the power section

Tool

- Screwdriver
- Open jaw spanner, width across flats 10mm

The electrical connection must only be carried out by qualified personnel!

✱ Disconnect the system from the electrical supply on all poles.

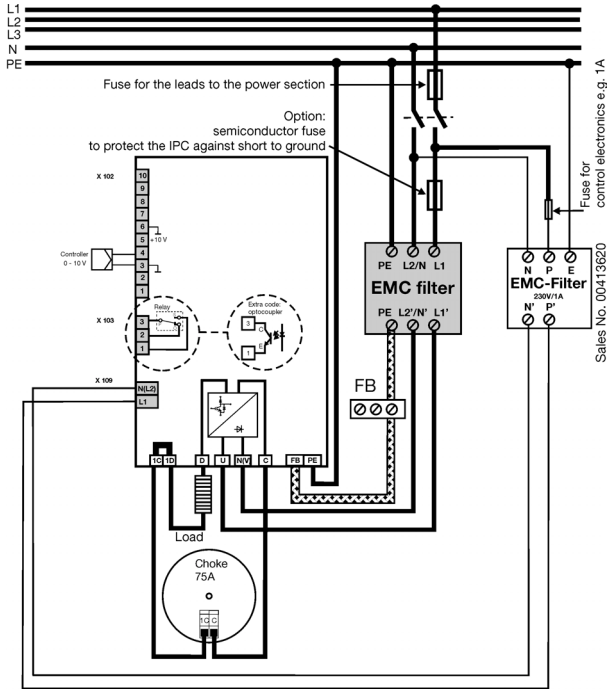


✱ Make the connections to the screw terminals only with cables that have a suitable cross-section and are fitted with cable lugs.
Maximum tightening torque 15 Nm.

4 Electrical connection

Phase / N

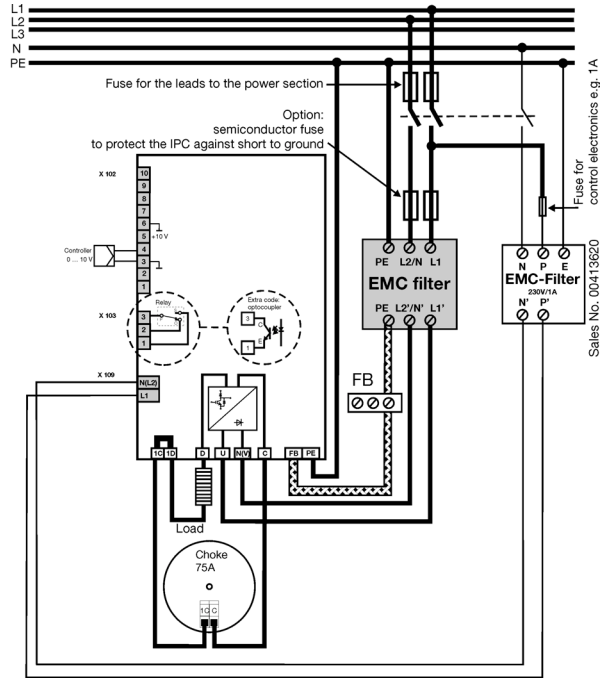
The diagram shows the wiring for single-phase operation **Phase / N** for type 709050/X1-11-115-XXX-070/XXX and type 709050/X1-12-230-XXX-070/XXX.



⇨ Required I^2t value of the semiconductor fuse Chapter 3.1 „Important notes on installation“ Page 11

Phase / Phase

The diagram shows the wiring for single-phase operation **Phase / Phase** for type 709050/X1-12-400-XXX-070/XXX.



⇨ Required I^2t value of the semiconductor fuse Chapter 3.1 „Important notes on installation“ Page 11

4.1.1 Suitable cables and cross-sections

PE conductor

The cross-section of the PE conductor must be at least as large as the cross-section of the voltage supply conductors to the power section. If the protective earth (PE) conductor is not part of the supply cable or its sheathing, the chosen conductor must have a cross-section of at least 2.5 mm^2 (if mechanically protected) or at least $4mm^2$ (if the PE conductor is not mechanically protected).

⇨ see VDE 0100 Part 540

Control section

The screw terminals for the voltage supply to the control section are laid out for a conductor cross-section between 0.5 and 2.5 mm^2 . The minimum conductor cross-section must not be less than 0.5^2 mm. Fusing of the cable must correspond to the selected conductor cross-section.

Power consumption is approx. 50 VA.

Power section

The minimum conductor cross-section chosen must be adequate for the maximum load current. The connection is made to the copper busbars of the converter by means of cable lugs and a screw connector.
We recommend the use of a shielded cable to reduce EMC interference emission.

The cable cross-section in the load and choke circuits must not be smaller than the cross-section of the supply leads to the power section!

Calculation formula

$$I_{Supply} = \frac{\text{maximum load power consumption}}{\text{Voltage supply to power section}} + 2A$$

Example

$$I_{Supply} = \frac{3000\ W\ (\text{heater load})}{230V\ (\text{voltage supply to the power section})} + 2A =$$

$$I_{Supply} = 13A + 2A = 15A$$

4.1.2 Electrical isolation

The control section, including the inputs and outputs, as well as all operator controls have been laid out for connection to SELV circuits.

There is no electrical isolation between the voltage supply of the power section and the load.

Ensure that the metal housing of the oven or combustion chamber is properly earthed.

⇨ Chapter 3.2 „Filtering and interference suppression“ Installation must comply with EVC requirements.

4.1.3 Use of residual current protection devices

The converter is equipped with an internal input rectifier. A short to the housing can result in a residual DC current that blocks the tripping of the conventional residual current protection device. For this reason, any RCD used must be an „all-current sensitive“ version of Type B.
When defining the trip current for the RCD, the leakage currents of the EMC filter caused by the Y capacitors (<3mA) as well as the capacitive currents from the cable shielding have to be taken into account.

See also EN 50178 (VDE 0160):

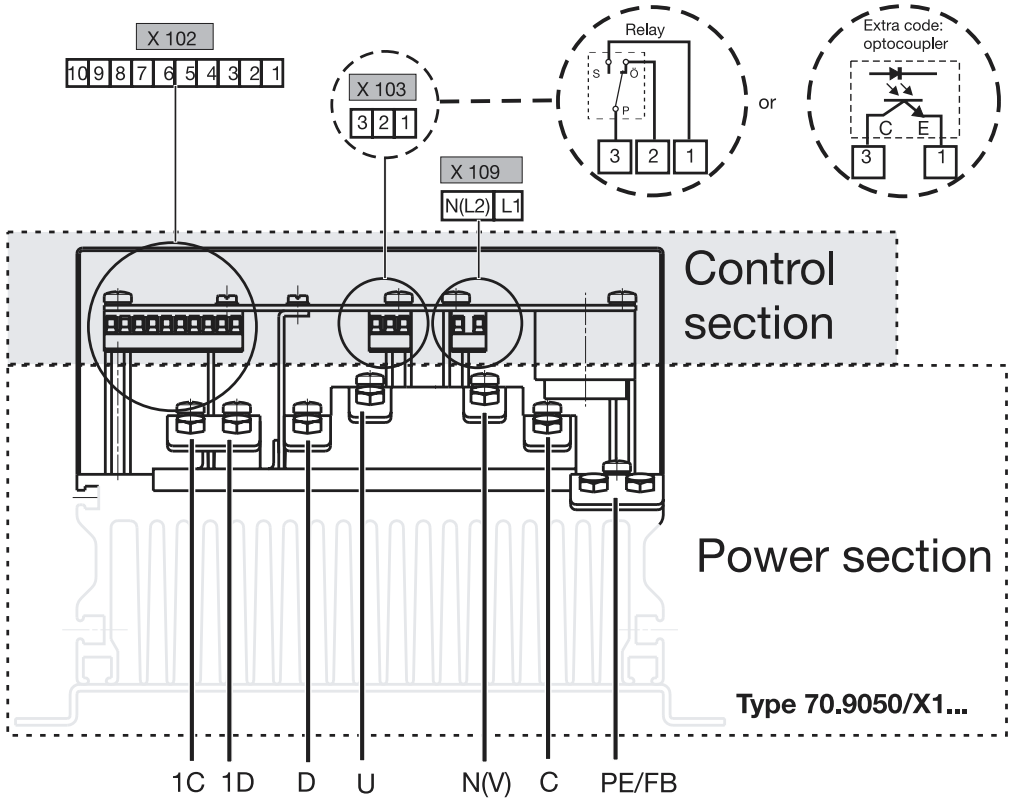
Protection of electrical equipment through residual current protection devices.

4.1.4 Wiring of the screw terminals

Position

The following diagram shows the position of the screw connections in the power section, the screw terminals on the PCB as well as the general connection arrangement.

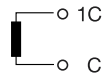
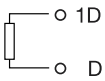
Only tighten the green screw terminals in the control section with a tightening torque of 0.5 to 0.6 Nm!

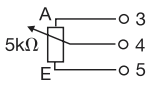
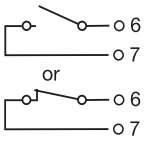


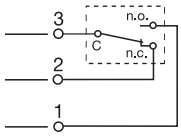
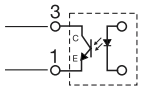
	Connection for	terminal screw X109	Detail
→	Voltage supply Control section	L1 N (L2)	L1 — o L1 N (L2) — o N (L2)

	Connection for	Screw connections in the power section	Detail
→	Voltage supply to power section	U N(V)	L1 — o U N (L2) — o N (V)
	Protective earth	PE	PE — o PE
	Functional equipotential bonding ⇨ Chapter 3.1.1 „Correctly wire all components“	FB	FB — o FB

4 Electrical connection

	Choke connection	1C C	
	Load connection	1D + D -	

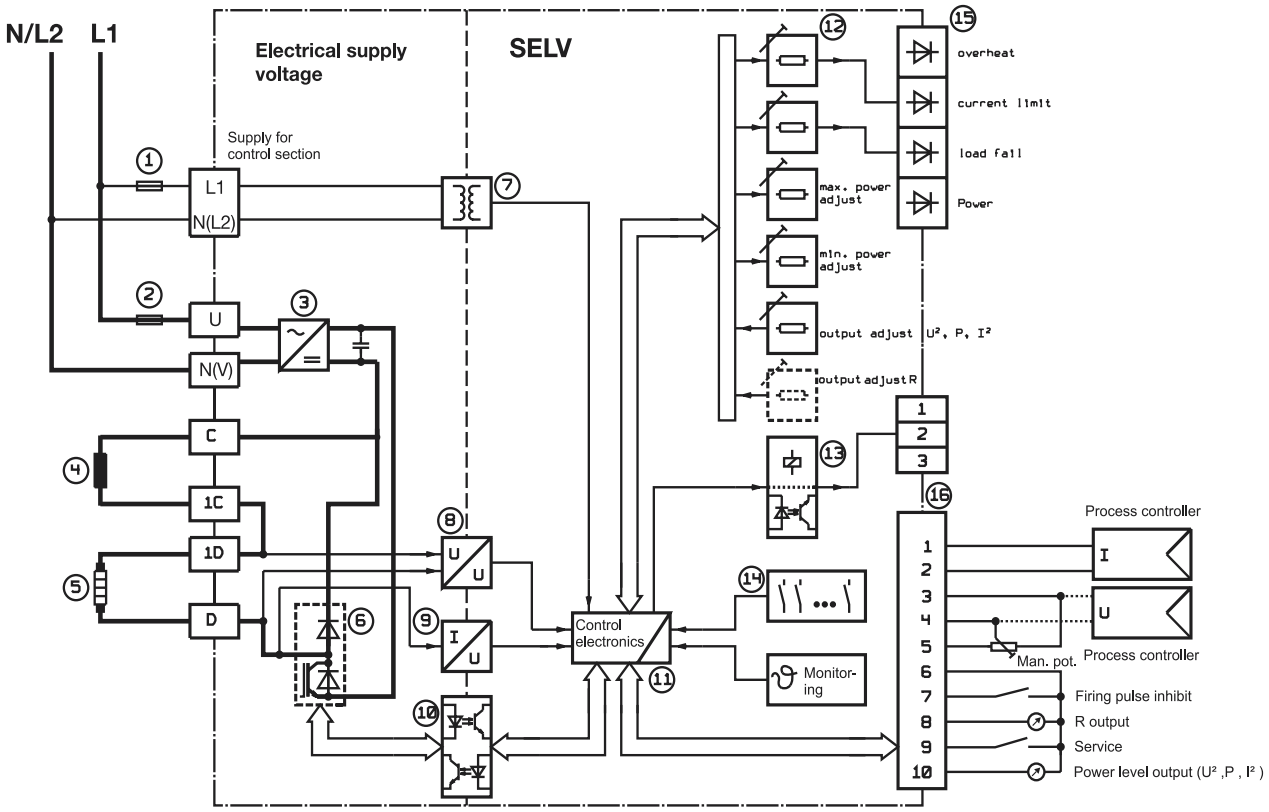
	Connection for	terminal screw X102	Detail
	Current input (differential input)	1- 2+	
	Voltage input (ground-referenced)	3 ground 4+	
	External manual adjustment Potentiometer 5 kΩ	3 Start (ground) 4 slider 5 end (+10V)	
	Firing pulse inhibit (inhibit input) I_K approx. 1mA (break or make contact)	6 ground 7+	
	Output level 0 to 10V (U^2, P, I^2) I_{max} approx. 2mA	10+ 6 ground	
	Resistance output 0 to 5 V (R) I_{max} approx. 2mA	8 + 6 ground	

	Connection for	Screw terminal X103	Detail
	Load fault output with relay contact rating 230V AC/3A resistive load relay drops out at fault	1 make contact 2 break contact 3 common	
	Load fault output with optocoupler Ic $_{max}$ = 2mA $U_{CEO\ max}$ = 32 V	3 collector 1 emitter	

5.1 Operating principle

The JUMO IPC can be used wherever a transformer was previously used to reduce the voltage level.
It functions as an electronic transformer that produces a pulsed DC output.

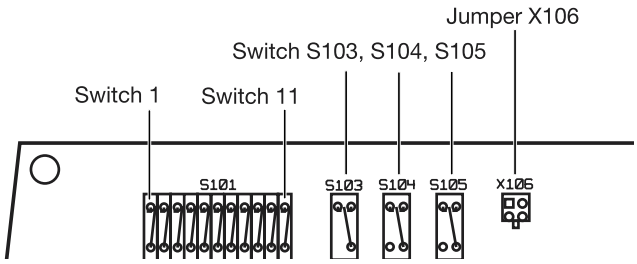
Block diagram

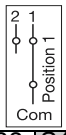
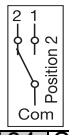


① Control section supply fuse
② Power section supply fuse
③ Rectifier
④ Inductor
⑤ Load
⑥ IGBT module
⑦ Supply for control electronics
⑧ Voltage transformer
⑨ Current transformer
⑩ Electrical isolation for control circuits
⑪ Control electronics
⑫ Adjustment trimmers
⑬ Fault signal output via relay or optocoupler
⑭ Configuration switches
⑮ LED indicators
⑯ Manipulating variable setting, control inputs, actual power level outputs

5 Settings

5.2 Setting switches and jumpers



Switch position															
Switch number S101	1	2	3	4	5	6	7	8	9	10	11	S103	S104	S105	X106
Factory setting	1	0	0	0	0	1	1	0	1	0	1	1	1	1	
User setting															
Subordinate control loop															
U^2	1	0	0												
P	0	1	0												
I^2	0	0	1												
Actual value output															
U^2				1	0	0									
P				0	1	0									
I^2				0	0	1									
Load voltage matching U_L															
$U_L \geq 75\%\ U_{L\ Nom}$							1								
$U_L < 75\%\ U_{L\ Nom}$							0								
Control input															
0...20mA								0	1				1		
4...20 mA								0	0				2		
0...10V								0	1				1		
2...10V								0	0				2		
0...5V								1	1				1		
1...5V								1	0				2		
Process dependent load reduction															
inactive (ex-factory)										0					
active										1					
Internal signal matching to heater element															
standard, tungsten, Molybdenum												1			
Disilicide heating element															
silicon carbide heating element												2			
Firing pulse inhibit															
external contact is a "make" contact														1	
external contact is a "break" contact														2	
Base load setting															
no base load											1				
Base load 0 ... 100%											0				
Partial load failure															
underload detection															
overload detection															

5.3 Subordinate control loop

Subordinate control lops are primarily used to eliminate or compensate for external disturbances, such as fluctuations in the supply voltage and alterations in resistance that have a negative effect on the operation of the control loop.

Factory setting A subordinate U^2 control loop has been set, but P or I^2 control loops are also possible.

Control type	**Internal switch S101**			**Application**
	S1	S2	S3	
U^2	1	0	0	- positive TC, Molybdenum Disilicide
				- R ≈ constant - brightness controls
P	0	1	0	- temperature dependent TC
I^2	0	0	1	- negative TC

■ factory setting

5.4 Load voltage adjustment

Switch S101-7 can be used to adjust the load voltage.
If the max. load voltage required is less than 75% of the load voltage $U_{L\ Nom}$ as per type code, then S 101-7 must be opened.

If the maximum required load voltage is 75% or more of the nominal load voltage $U_{L\ Nom}$ as per type code, then S 101-7 must be closed.

Factory setting S101-7 is closed.

5.5 Control inputs

The internal switches S8, S9 and S104 are used to adapt the converter to the available control signal (controller output signal).
The voltage and current inputs are separated from one another. The current inputs (+,-) are arranged as differential inputs, i.e. they can have a maximum common mode voltage of 7V with respect to the common ground potential (⊥). If the current and voltage inputs are used at the same time, their effect will be cumulative.

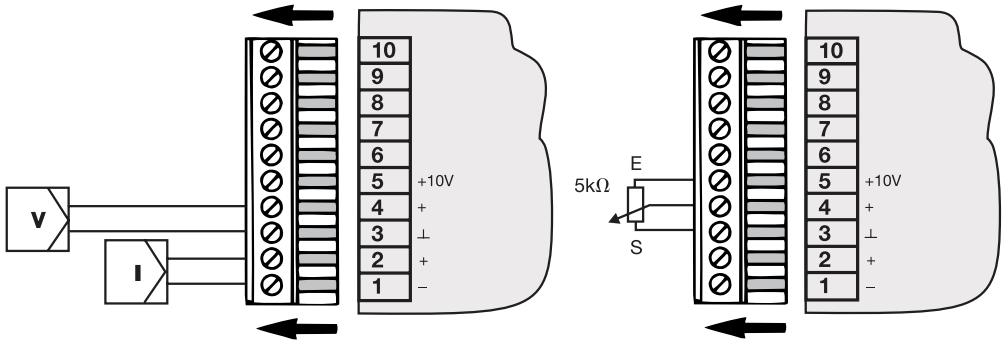
Control signal		**Internal switches**		
Signal start	Signal end	S8	S9	S104
0 mA	20 mA	0	1	1
4 mA	20 mA	0	0	2
0 V	10 V	0	1	1
2 V	10 V	0	0	2
0 V	5 V	1	1	1
1 V	5 V	1	0	2

■ factory setting

Analog control inputs

The converter can be controlled through the following signals (continuous power control):

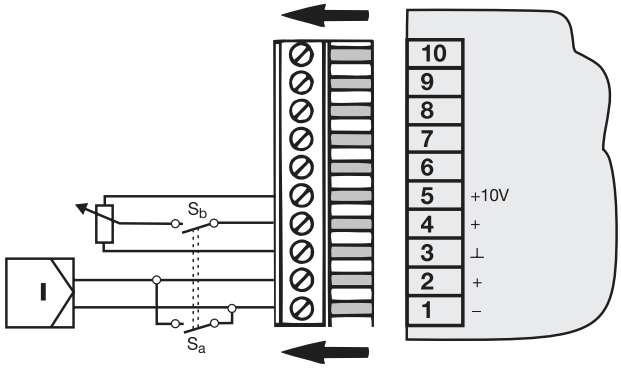
- voltage signal (terminals 3, 4)
- current signal (terminals 1, 2)
- 5-kΩ potentiometer (terminals 3, 4, 5)
  For this purpose, a 10 V source is provided on terminal 5.
  (switch settings are as for a 0 ... 10 V signal)



5.5.1 Combination of external potentiometer and electronic controller

Controller with current output

The voltage input (terminals 3, 4) in conjunction with the internal 10 V source and a 5 kΩ potentiometer is used as a manual control input.

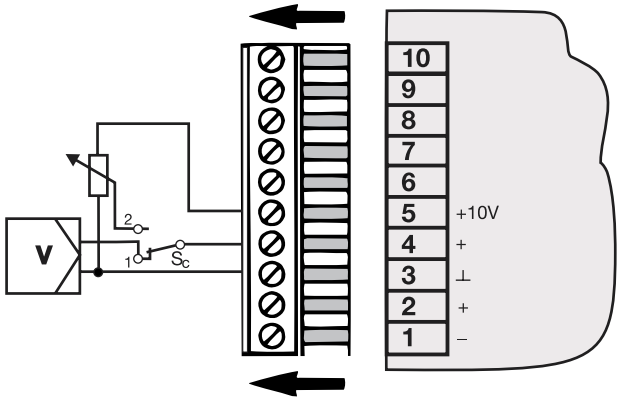


Switch	S_a	S_b
Automatic mode	open	open
Manual mode	closed	closed

☞ To prevent unintended oversteering when switching over to the manual mode, S_a should be mechanically linked to S_b. Otherwise both signals will briefly cumulate.

Controller with voltage output

Only the voltage input of the converter is used. Manual operation requires a 5 kΩ potentiometer connected to terminals 3 and 5.



Switch	S_{ca}
Automatic mode	Position 1
Manual mode	Position 2

5 Settings

5.6 Firing pulse inhibit

The firing pulse inhibit function provides a simple way of switching to high power levels.

In order to be able to disconnect a system from the supply voltage, a circuit-breaker or main switch for all-pole disconnection must be wired into the supply feed!

A contact between connections 6 and 7 can be used to switch off the load. The external contact can be a make or break contact, depending on the position of S105.

External contact	Internal switch S105	Response
Make (a)	Position 1	The Load is permanently switched off when the contact is closed
Break (b)	Position 2	The Load is permanently switched off when the contact is open

■ Factory setting

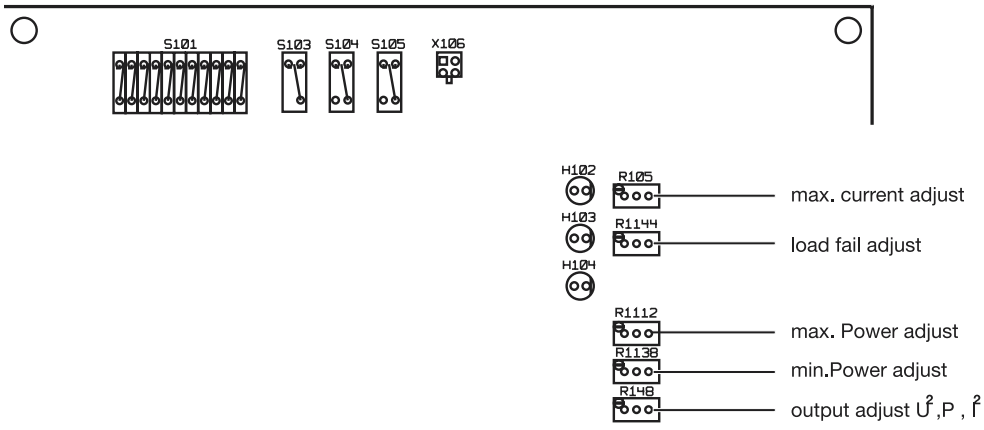
Factory setting S105 is in position 1

5.7 Resistance output

When the converter is operating within rated limits, the resistance output has a voltage of 4 ... 5 V.

5.8 Trimmer settings

The converter has 5 trimmers that can be adjusted by inserting a screwdriver blade (maximum blade width: 2 mm) through openings in the housing.



5.9 Control input adjustment (max. Power adjust)

The „max. Power adjust“ trimmer at the front can be used to adapt the power output of the converter to the maximum output signal of the controller connected before.

Action	Response
Turn the „max. Power adjust“ trimmer clockwise	more power
Turn the „max. Power adjust“ trimmer counter-clockwise	less power

Factory setting The trimmer is adjusted such that maximum load voltage is produced at nominal voltage and a 100 % controller output signal.
(U^2 control is the factory setting for the subordinate control loop).

5.9.1 Setting for maximum power (max. Power adjust)

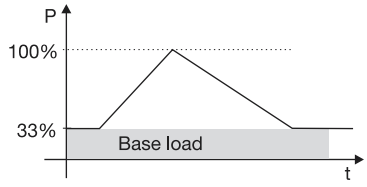
* Apply the maximum controller output signal
* Turn the „max. Power adjust“ trimmer clockwise or counter-clockwise until the required power is achieved.
* Turning the „max. Power adjust“ trimmer clockwise will increase the maximum power output.
* Take care that the red „current limit“ LED remains off, otherwise the circuit is operating in current limiting (max. current adjust), which leaves turning the trimmer clockwise without effect (power output will not increase).

5.9.2 Input signal attenuation

* Turning the „max. Power adjust“ trimmer counter-clockwise will decrease the maximum power output of the converter.

5.10 Setting the base load (min. Power adjust)

Base load setting Open switch S11 to be able to set a base load.
Turning the „min. Power adjust“ trimmer clockwise will increase the base load setting.
The settable range covers the complete range from 0 to 100%.



Example: A heating system is operated with a base load set to 1/3. The remaining 2/3 of the power are regulated by the controller.

5 Settings

5.11 Setting the current limit (max. current adjust)

* The front „max. current adjust“ trimmer can be used to limit the rms value of the load current over a range of 10 to 100 % of the rated converter current.
  1.5 clockwise turns correspond to increasing the response threshold by approx. 10 % of the rated converter current.

Action	Response
Turn the „max. current adjust“ trimmer clockwise 	The current limit will increase
Turn the „max. current adjust“ trimmer counter-clockwise 	The current limit will reduce

Correct measurement

A **true-rms meter** must be used for measuring voltage, power or current, because the load current is pulsating DC.
A meter calibrated for alternating current (AC) and sinusoidal waveforms will produce false readings!

The red „current limit“ LED is on when current limiting is active.

Factory setting The trimmer is set to the maximum rated current.

5.12 Total and partial load failure monitoring (load fail adjust)

If the load resistance changes during operation, this will be detected by the partial load monitoring and indicated through the signal output.
The response threshold can be adjusted by the „load fail adjust“ trimmer on the front panel (load fail adjust) between 20 and 100 % of the rated converter current.

The smallest change in resistance that can be detected is 5 % of the nominal load resistance.

Factory setting The trimmer is set to approx. 20 %.

The signal output provided is a floating contact or an optocoupler, depending on the extra (type) code.

Type: relay

709050 / X1 - XX - XXX - XXX - 070 / 252

Type: optocoupler

709050 / X1 - XX - XXX - XXX - 070 / 257

In the case of a load fault, the floating contact drops out, or the collector-emitter path of the optocoupler goes high-resistance.

The signal output is also active if the maximum temperature of the converter is exceeded (overheat) or if the safety cut-out in the power section has been triggered.

⇨ Chapter 7 „Troubleshooting“

Jumper setting	Response
	Underload detection
	Overload detection

■ factory setting

☞ The total and partial load failure monitoring (underload) also allows overload monitoring. For this purpose, both jumpers on the pin strip X106 must be turned through 90°.

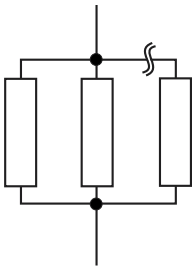
⇨ Chapter 5.2 „Setting switches and jumpers“

5.12.1 Setting the load fault indication

☞ The partial load setting must be made after the current limit has been set. If the current limit setting is changed, this will also affect the setting of the partial load fault detection.
This must be corrected accordingly, if necessary.

* Connect the load
* Provide a full control signal (e.G. 20 mA at the control input)
* Adjust the „load fail adjust“ trimmer such that the yellow „load fail“ LED just extinguishes.
  - Turn clockwise = LED lights up
  - Turn counter-clockwise = LED extinguishes
* If necessary, continue turning counter-clockwise to reduce the activation threshold. 1.5 turns of the potentiometer change the load current by approx. 10 % of the converter rated current.

Alternative setting option: To simulate a load fail, adjust the „load fail adjust“ trimmer such that the yellow „load fail“ LED lights up.



The smallest change in resistance that can be detected is 5 % of the nominal load resistance.

5.12.2 Safety cut-out in the power section

A safety cut-out occurs in the event of a defect in the choke or in the semiconductor power module; the output voltage between terminals D and 1D is switched off.

However, terminals D and 1D may still carry dangerous voltage from the supply. They are not electrically isolated from the supply!

This state is indicated by the „load fail“ LED, and the fault signal relay drops out.
This safety cut-out remains activated even when the fault has been remedied. It can only be reset by disconnecting the voltage supply.

* Switch the device off briefly, and then on again

If in the event of a fault the semiconductor module goes low-resistance, it is possible to produce the full voltage supply of the power section for the consumer (load).

To safely disconnect the resulting overload and to protect the load, provide a cut-out in the supply cable in the form of a CMC (Q) automatic cut-out or a semiconductor fuse in addition to the protection circuit-breaker. An automatic cut-out combining both functions can be used in the power section to cut out the voltage supply.

5.13 Adjusting the output level signal (output adjust U^2, P , I^2)

In the factory settings, the output level signal corresponds to the I^2 signal at the output of the converter. It is thus proportional to the power in the load (R=constant).

However, setting P or U^2 instead of the I^2 signals is also possible

⇨ Chapter 5.2 „Setting switches and jumpers“

Power level output	**Internal switches**		
	S4	**S5**	**S6**
U^2	1	0	0
P	0	1	0
I^2	0	0	1

Output adjust U^2, P, I^2

The output level signal provides a voltage in the range of 0 to 10V (corresponding to 0 to 100% of the variable being measured). The trimmer „output adjust U^2, P , I^2 “ on the front panel can be used to set the required end value:

Action	**Response**
Turn „output adjust U^2, P , I^2 “ trimmer clockwise 	End value increases
Turn „output adjust U^2, P , I^2 “ trimmer counter-clockwise 	End value reduces

5.14 Process dependent load reduction

Switch S101-10 can be used to activate the process dependent load reduction. The load is reduced depending on the resistance value R when operating Molybdenum Disilicide heating elements. When the converter is operating within rated limited, the load reduction amounts to approx. 10 %. This must be taken into consideration when the converter operates outside its rated limits (nominal voltage and current).

5 Settings

6.1 Voltage supply

Voltage supply Power section	115V AC +15%/-20% 48 ... 63Hz 230V AC +15%/-20% 48 … 63Hz 400V AC +15%/-20% 48 … 63Hz
Voltage supply Control section	115V AC +15%/-20% 48 ... 63Hz, 50VA (only with 115V AC in the power section) 230V AC +15%/-20% 48 … 63Hz, 50 VA
Power consumption, control section	approx. 50 VA
Load voltage $U_{L\ rms}$	20 V DC, 60 V, 90V, 120 V ⎓≂
Load current $U_{L\ rms}$	70A DC ⎓≂
Load type	Resistive loads
Effect on the supply network	Additional interference suppression measures allow to meet limit valuesas per EN 61 326.

6.2 Control

Control signal	0 (4) … 20mA R_i = 50 Ω 0 (2) … 10V R_i = 25kΩ 0 (1) … 5V R_i = 12kΩ Manual control through an external 5 kΩ potentiometer
Input signal attenuation	Adjustment range 100 to 20%
Base load setting	0 ... 100 %

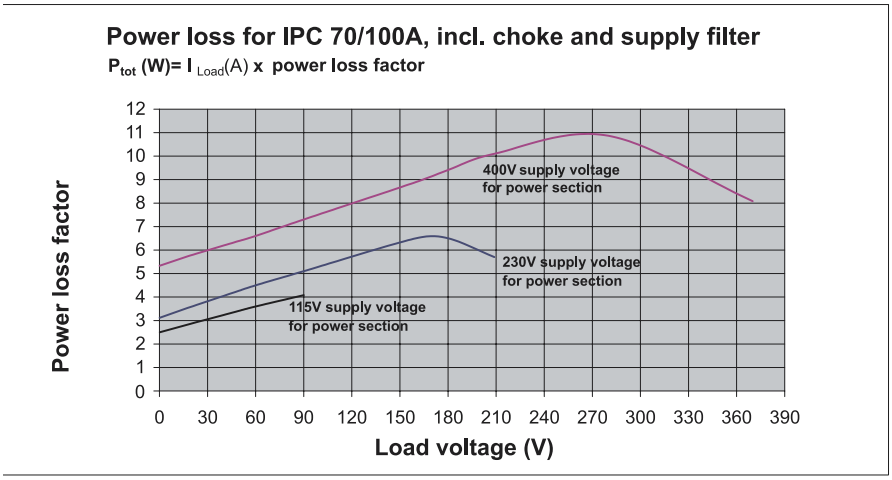
6.3 Fault signal output

Relay (changeover contact) without contact suppression	150000 switching actions at a contact rating of 3A/230V 50Hz (resistive load)
Optocoupler output	I_{Cmax} = 2mA, U_{CEOmax} = 32V

6.4 General characteristics

Circuit variants	Single-phase operation
Operating modes	Amplitude control
Subordinate control	As standard: free choice between U^2-, P-, I^2 control via internal switches
Current limiting	In operation, the load current can be set in the range of 10 … 100% I_N by a trimmer on the front panel. This limits the rms-value of the load current.
Partial load failure	20 ... 100% of nominal current
Power level output	As standard: free choice between U^2-, P-, or I^2 signal via internal switches, adjustable 0 … 5V to 0 … 10V , $I_{max} \approx$ 2mA, offset deviation: ≤ ±5%

6 Technical data

Power loss P_{tot} (W)	Power loss occurs in the form of thermal discharge at the cooling body of the power converter, at the EMC filter and choke. ⇨ Chapter 3.3 „Umgebungsbedingungen“ 
Control accuracy	The regulation will eliminate supply voltage variations within the tolerances range (+15%/-20%) with an accuracy of ±0.5 %
Electrical connection	Control leads via plug-in screw terminals for conductor cross sections 0.5 … 2.5mm^2 In the power section via cable lugs.
protection rating	IP00 as per EN 60 529, the cooling body is connected to PE
Protection class	Protection class I, with isolated control circuitry for connection to SELV circuits
Permissible ambient temperature range	5 … 40°C (3K3 as per EN 60721-3-3)
Permissible storage temperature range	-10 … +70°C (1K3 as per EN 60 721-3-1)
Cooling	forced convection, maximum inlet air temperature 35°C
Climatic conditions	Rel. humidity ≤ 5 to 85 % annual average, no condensation 3K3 as per EN 60721
Installation position	vertical
Operating conditions	The converter is designed as a built-in device as per EN 50178 Pollution degree 2, overvoltage category Ü III
Test voltage	as per EN 50178
Creepage distances	Control section to load circuit ≥ 5.5 mm Control section to housing ≥ 5.5 mm The converter can be connected to SELV circuits. SELV = Separate Extra Low Voltage (safe low voltage)
Housing	Metal housing
Weight	approx. 9 kgs

6.5 Choke data

Type:	Dimensions	Connection cross section	Connection, Tightening torque	Weight	Sales No.
L = 0.6 mH / I_N = 75A protection rating IP 10 as per EN 60529	Choke diameter: 155 mm Height: 135 mm Diameter of fixing hole: 10.4 mm	4...25 mm^2	Via screw terminals, max. 4...4.5 Nm	approx. 7.5 kgs	70/00392474

6.6 EMC filter

For voltage supply to power section						
Nominal voltage, Nominal current	Dimensions (length x width x height)	Connection cross-section	Tightening torque	Weight	Permissible ambient temperature	Sales No.
115V/250V/440V AC, I_{Nom} = 16A	(255 x 60 x 130) mm	0.25...4 mm^2	0.6 ... 0.8 Nm	approx. 4 kgs	40°C	70/00399527
115V/250V/440V AC, I_{Nom} = 20A	(289 x 70 x 140) mm	0.5...10 mm^2	1.5 ... 1.8 Nm	approx. 5.5 kgs	40°C	70/00438775
115V/250V/440V AC, I_{Nom} = 32A	(324 x 90 x 160) mm	0.5...10 mm^2	1.5 ... 1.8 Nm	approx. 9.5 kgs	40°C	70/00409831
115V/250V/440V AC, I_{Nom} = 63A	(380 x 117 x 190) mm	0.5...16 mm^2	2 ... 2.3 Nm	approx. 17 kgs	40°C	70/00409990
For voltage supply to the control section						
115V/250V AC, I_{Nom} = 1A	(80 x 45 x 30) mm	via tab connector 6.3 x 0.8mm	-	approx. 120 g	40°C	70/00413620

6 Technical data

What is happening?	Cause / Remedy	Information
Green power LED does not light up	- Voltage supply to control section not connected	⇨ Chapter 4 „Electrical connection“
IPC is not producing any output power although green power LED is lit and a setpoint value set.	- Voltage supply to power section not connected	⇨ Chapter 4.1 „Screw connections in the power section“
	- Analog control input not connected correctly	⇨ Chapter 4.1.4 „Wiring of the screw terminals“
	- Switch positions for control input S 101/8 and 9 set incorrectly	⇨ Chapter 5.5 „Control inputs“
	✱ Check switch for firing pulse inhibit S 105	⇨ Chapter 5.6 „Firing pulse inhibit“
	- Load break - Load short circuit (current-limit LED is lit) ✱ Check load and load connections	
IPC is not producing any output power although green power LED is lit, a setpoint value is set and the load fail LED is lit.	- Load break - Load short circuit (current-limit LED is lit at the same time) ✱ Check load and load connections	
	- Safety cut-out in the power section	⇨ Chapter 5.12.2 „Safety cut-out in the power section“
IPC is not producing any output power although green power LED is lit, a setpoint value is set and the overheat LED is lit.	- Overtemperature disconnection	⇨ Chapter 3.3 „Ambient conditions“
IPC does not produce full power, although setpoint is set to 100%	- Switch positions for control input S 101/8 and 9 set incorrectly	⇨ Chapter 5.5 „Control inputs“
	- Control input (max. Power adjust) is not turned clockwise to the stop ✱ Check adjustment	⇨ Chapter 5.9 „Control input adjustment (max. Power adjust)“
	- Current limiting active (when the red current-limit LED is lit) ✱ Turn the „max. current adjust“ trimmer clockwise	⇨ Chapter 5.11 „Setting the current limit (max. current adjust)“
	- Process-dependent power limiting active ✱ Check switch S 101/10	⇨ Chapter 5.2 „Setting switches and jumpers“
	✱ Check switch S 103	
	✱ Check switch S 101/7	

7 Troubleshooting

What is happening?	Cause / Remedy	Information
IPC is producing power, although no setpoint value is set	- Check switches S 101/ 8 and 9 for control input	⇨ Chapter 5.5 „Control inputs“
	- Base load setting (max. Power adjust) is not turned counter-clockwise to the stop ✱ Check switch S 101/11	⇨ Chapter 5.10 „Setting the base load (min. Power adjust)“
Overheat LED is lit	- Insufficient supply of fresh air - Inlet air temperature > 35°C - Ventilator defective or ventilation grille soiled.	⇨ Chapter 3.3 „Ambient conditions“

7 Troubleshooting

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