Systemtechnik LEBER

The POWERCONTACT power controller series
Operating Manual
HP3201 Universal controller
Phase angle, Burst-Mode, Soft start, 50/60Hz
Analogue, digital and seriel control signals

Function, start-up and troubleshooting

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	Mederer	V1.1b (01.08.2008) text corrections

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Important!

Read the documentation carefully. Warranty claims will not be entertained in respect of damage resulting from a failure to observe the documentation. We shall accept no liability for secondary damages resulting from such nonobservance.

Safety instructions

Only persons capable of recognizing dangerous contact voltages and taking the necessary precautions may use the module or subassembly. Voltages exceeding 60 V DC or 42 V AC represent dangerous contact voltages.

Standard EN 60204-1 (VDE 0113) prescribes a number of checks to be performed and documented when the electrical equipment is integrated completely into the machine. Such checks must be performed and documented by a skilled electrician in accordance with regulation VBG 4 of the German institutions for statutory accident insurance.

Proper use

The module or subassembly is intended solely for use in industrial machinery or plant. Before this module or subassembly is put into service, a pre-engineering phase **must** be completed. Pre-engineering entails definition of the statutory provisions of the accident insurance institutions or competent bodies, such provisions forming the terms of reference for all technical solutions.

Where the machine or system is employed outside the Federal Republic of Germany, the statutory provisions applicable locally shall also be observed.

A permit must be obtained for our modules or subassemblies prior to export of the machine or installation to the USA or Canada.

This module/subassembly does not constitute a device in the context of the German Equipment Safety Act (Gerätesicherheitsgesetz). Rather, it forms a component intended for connection to other components to form a plant or machine. Proper use of the machine or plant is subject to the applicable statutory provisions. Planning, installation, commissioning, testing, maintenance and decommissioning of the machine or plant may be performed only by a skilled electrician or by a person who has received the requisite training. Information to this effect must be included in the instructions for use of the machine or plant, and attention drawn to it.

Improper use

The module/subassembly is not intended for the commercial market or for "end users". Direct or indirect export to the USA or Canada is not permitted without express authorization.

Table of contents

1 Description of the module

1.1 Applications

The module is designed for the universal supply of power to chiefly resistive loads and for inherent function monitoring. The control input can be an analogue control-signal 0 to 10VDC, a nominal 24V DC logic signal or a serial telegram (see TransDil-S5 or TransDil-S7). An input signal controls the power in phase angle control or burst firing with or without initial soft start. Jumpers can select the operation mode.

The module is normally mounted piggyback on a SSR and the SSR is normally mounted on a suitable heat sink and attached to a 35 mm DIN mounting rail by means of a clip.

1.2 Design

The module based on a random switching standard Solid-State-Relay in a well tried 'series 1' case and is therefore compatible with many other competitors (picture 5). Two screw-terminals X1 represent the main power-switch and a pluggable connector X2 are for auxiliary supplies, controlling and feedback.

There are six Jumpers for function select. A 7th Jumper changes the Alarm-Output from NO (normally open) to NC (normally closed). There is nothing to operate or to handle on the module. Four LED's indicators shows the status and error condition. They can be read at any time, even if the cover is mounted.

The module has a permanent monitoring function. It observes the load, the power, the wiring and the module itself. If there is any error, it reports an alarm by a red LED and an output signal.

For proper operation the Solid-State-Relay with the piggyback PCB has to be cooled. Therefore it must be mounted on a heat sink that is suitable for nominal current. The whole unit has to be installed in a cabinet in a way, that an ordinary convection or the air stream of a fan keeps down the air temperature under the specified limit.

A programmable micro controller defines the function. The controller is placed in an 18-pin socket.

1.3 Operation

The module will be controlled via X2 with auxiliary voltage, input and feedback signals. The screw terminals X1.1 and X1.2 represent the main switch and must be connected in series with the load.

Important! Whenever you change the setting of any Jumper 1 to 6, unplug connector X2, wait two seconds and plug it in. The Jumper settings get readed only once at 24V Power-Up. Jumper 7 can be changed at any time.

The 3 popular functions are:

1.3.1 Phase angle control

Phase-Angle-Control means, that similar to the control voltage of 0 to 10V DC each half wave of the main power will be delayed ignitioned within 10 to 0msec (50Hz). Because the main voltage is AC (sinusoidal), the control voltage of 0 to 10VDC causes a non linear relation of 0 to 100% load. Picture 9a shows the relation between input signal and respective load power.

Jumper 6 is open.

Then the module operates in phase angle control mode. This mode is mostly used in light applications. An analogue control signal from 0 to 10VDC at input X2.4 represent a set point within 0 to 100% and governs the firing phase angle of each half-wave of the load, thus providing a continuously variable load range of between 0 and 100%. A set point change at the input will be ramped to the load. Jumper 1 and 2 selects four different ramp speeds (0s / 0,5s / 1s / 2,5s for full range).

An extra input START (X2.5) enables the function. If START went OFF, the load is switched OFF at once. There is no soft stop.

1.3.2 Burst Firing

Burst Firing means that only full sine waves are switches to the load. Similar to the control voltage signal of 0 to 10V DC or 00h to FFh, a calculated ratio of switched and unswitched full sine waves govern the power in the load. The ratios can varie from 0/256 to 256/256. The actual ratio is shortened so, for example, a ratio of 128/256 (50%) is shortend down to 1/2, which means that 1 of 2 full waves will switch on.

Jumper 2 changes the setpoint range 0 to 100% between

Jumper 2 is open	=	1/256 to 256/256
Jumper 2 is closed	=	1/100 to 100/100.

Jumper 6 is closed.

Then the module operates in burst firing mode (see picture 8). This mode is mostly used in heat radiator applications.

Jumper 1 selects an initial phase angle controlled soft start for preheating the load.

Jumper 1 is open	=	no initial softstart
Jumper 1 is closed	=	initial softstart 0 to 100% in 0,5s.

An extra input START (X2.5) enables the function. If START went OFF, the load is switched OFF at once. There is no soft stop.

1.3.3 Zero cross switching

Jumper 5 and 6 are closed. Connect Input 2 (X2.5) permanent to GROUND.

Then the module operates as a standard zero cross switch with permanent monitoring function (see picture 8).

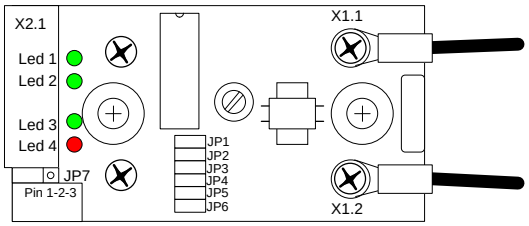
Remember! This module only operates proper mounted on a random switch SSR. If it is mounted on a zero cross SSR, the zero-cross-window of SSR and module tread on each othe's toe. Mostly it results in a module ALARM.

1.4 Technical data

Auxiliary supply (X2.1/2 and X2.3)	24VDC +/- 20%, Ripple lower than 1Vpp typ. 25mA in error free mode typ. 17mA in error mode
Input 1 (analogue)	0,0 – 10VDC, typ. 2,5mA (-2,0 to 16,0V for 10 seconds)
Input 1 (digital)	24VDC, typ. 2,5mA (-2 to 5VDC = OFF, 8 bis 32V = ON)
Input 2 (digital)	24VDC, typ. 2,5mA (-2 to 5VDC = OFF, 8 bis 32V = ON)
Alarm output	24VDC, max 100mA HIGH = OK LOW = fault
Main Voltage	180VAC to 500VAC
Line cycles	50 Hz +/-3 Hz or 60Hz +/-3 Hz
Main current	1,5 to 50A for PR4850-HP32xx- (see Derating) 1,5 to 90A für PR4890-HP32xx- (see Derating)
Ambient temperature	0°C to 60°C operation (see Derating) –20°C bis 80°C storage
Humidity	Non condensing
Ingress protection	IP10 (with cover)
Atmosphere	No corrosive
Dust	Pollution degree 1 to EN 50178 (VDE 0160) At high dust levels, the maintenance/service intervals must be reduced accordingly.
Altitude	max 2000m above sea level
EMC disturbance EMC sensitivity	The EMC requirements vary according to the application. The use of shielded control cables in accordance with the relevant recommendations is however advisable. In special cases, shielded power cables and the use of a dv/dt choke are recommended.
LEDs	LED 1 green indicates a setpoint >10% LED 2 green indicates enable LED 3 green indicates Onhas different uses LED 4 red indicates FAULT. 2 seconds OFF delay.
Screws X1	Enclosed
Connector X2	8-pole Connector, enclosed
Dim., weight (exclusive heatsink)	W x H x D 45mm x 105mm x 42mm 250gr

1.5 Jumper

The function and the controlling is determind by Jumper 1 to 6 (JP1 .to. JP6). Each change of any Jumper 1 to 6 needs unplug, two seconds wait and plug of X2. The Jumper settings get readed only once at 24V Power-Up.



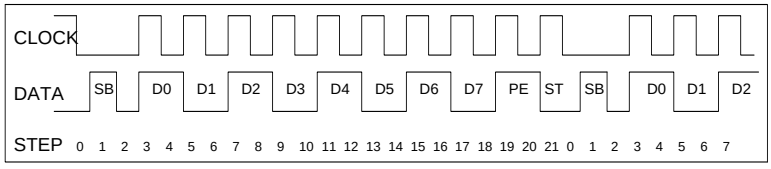
Picture 1: Position of Jumpers

JP1/JP2	(JP6=open)	open/open	->	no ramp (0s)
		closed./open	->	ramp ~ 0,5s
		open/closed.	->	ramp ~ 1s
		closed./closed.	->	ramp ~ 2,5s
JP1	(JP6=closed)	open	->	direct setpoint
		closed	->	if last setpoint was 0%, the next setpoint greater than 0% starts with a phase angle control soft-start within 0 to 100% in 0,5sec (pre-heat).
JP2	(JP6=closed)	open	->	ratio 1/256 .. 256/256
		closed	->	ratio 1/100 .. 100/100
JP3/JP4		open / open	->	automatic Line Cycles detection
		closed./ open	->	Line Cycles fix 50Hz
		open / closed.	->	Line Cycles fix 60Hz
		closed / closed	->	automatic Line Cycles detection
JP5		open	->	Control signal analogue 0V .to. 10VDC at X2.4
		closed	->	Control signal digital at X2.4 (TransDil)
JP6		open	->	Phase-Angle-Control
		closed	->	Burst Mode
JP7		1-2 position.	->	Error – potential free contact NC (normaly closed)
		2-3 position	->	Error – potential free contact NO (normaly open)

1.6 Seriel Set-Point Transmitting

If Jumper 5 is closed, the set points value has to be transmitted seriell instead of analogue. We recommend that a programmable logic controller (PLC) or a PC be employed for this purpose. The setpoint is transmitted by means of the SYSTRANS protocol. A software driver is available free of charge for the SIEMENS S5 and S7 series of PLCs. Users have to write their own drivers for other PLCs and for PCs.

Protocol handling is described as follows:



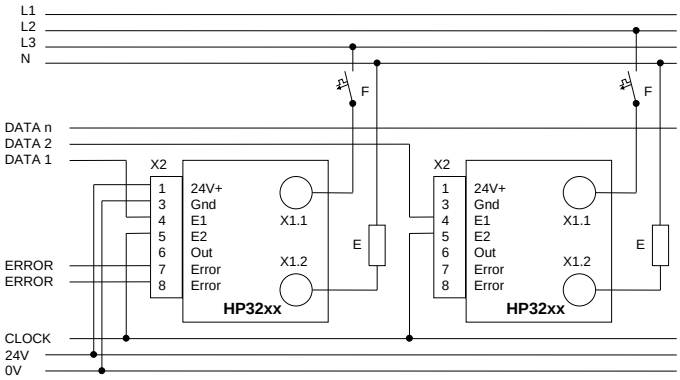
SB: Start bit / D0-D7: Data bits / PE: Parity EVEN / ST: Stop bit

Picture 2: Structure of a serial message employing the TRANSDIL protocol

- The data are read at each high-to-low clock change.
- Transmission of a byte begins with the LSB.
- Parity is EVEN.
- A parity bit must be followed by at least one stop bit.
- If the clock is LOW and the data line switches from LOW to HIGH and back to LOW, a start bit is recognized.
- The length of the message is 1 byte.
- The clock rate is not critical. Each step must have a length of at least 22 ms.
- The minimum setpoint value is 000d or 00h, corresponding to 000%.
- The maximum setpoint value is 255d or 0FFh., corresponding to 100% in Jumper 2 is open.
- The maximum setpoint value is 100d or 064h, corresponding to 100% in Jumper 2 is closed.

Formatiert: Nummerierung und Aufzählungszeichen

Important! There is no need for an extra or special serial communication interface in der PLC or PC system. Just one ordenary 24V digital output per channel as DATA plus one extra for the common CLOCK are used to do the job. Connect the DATA line at input 1 and the CLOCK line at input 2.



Picture 3: Setpoint transmitting via TransDil protokoll

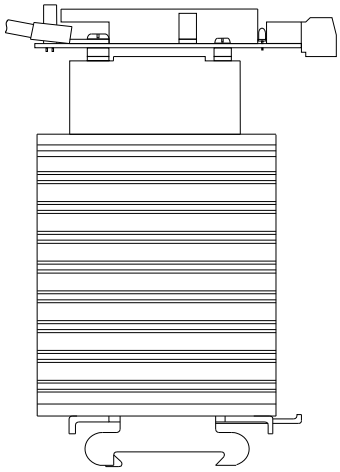
1.7 Terminal pin assignment

X2.1	24V DC Auxiliary voltage			intern connected to X10.2
X2.2	24V DC Auxiliary voltage			intern connected to X10.1
X2.3	Ground			
X2.4	Input 1	SETPOINT	(data)	0V .. 10V (analog) / 0V .. 24V (digital)
X2.5	Input 2	ENABLE	(clock)	0V .. 24V (digital)
X2.6	Error			0V .. 24V (digital)
X2.7,8	Error			potential free contact (NO or NC)
X1.1	Lastschalter			keine Polarität
X1.2	Lastschalter			keine Polarität

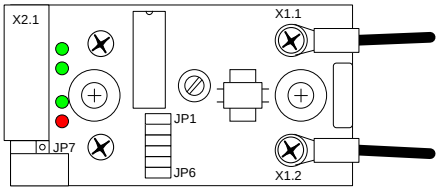
1.8 Ordering details

PR4850-HP3201-MS2	150-500VAC, 25A rated current	(see Derating)
PR4890-HP3201-MS2	150-500VAC, 45A rated current	(see Derating)
PR4890-HP3201-MS140V	150-500VAC, 60A rated current	(see Derating)

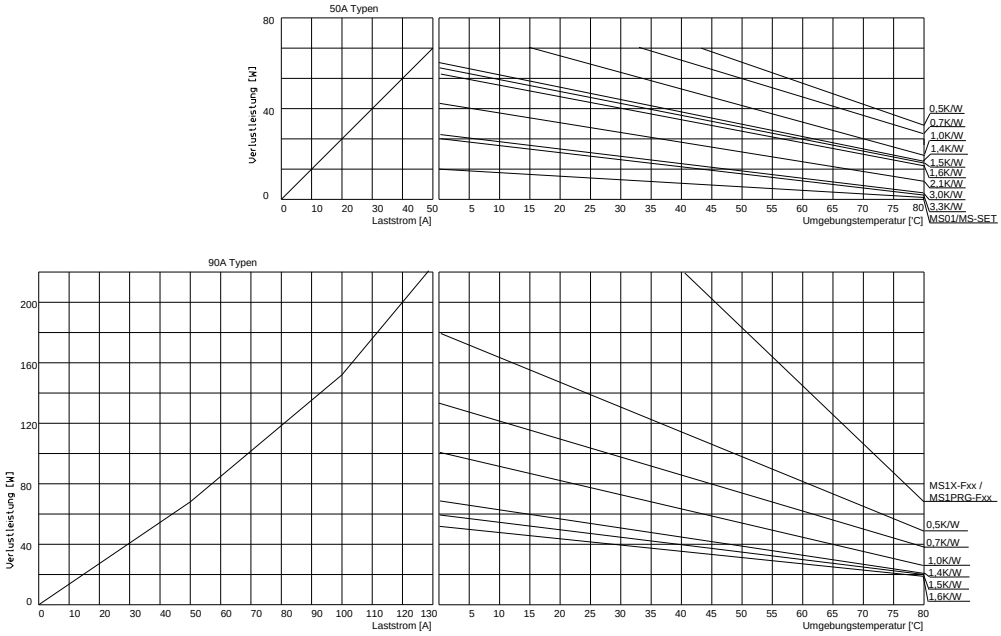
1.9 Drawings, diagrams



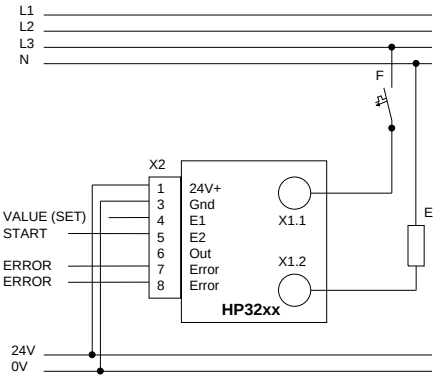
Picture 5: Example PR4890-MS140V-HP32xx



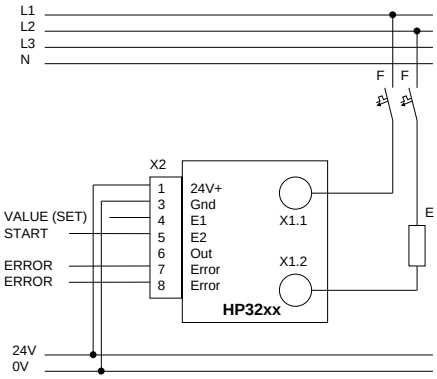
Picture 4; Terminal, Jumper und LEDs location



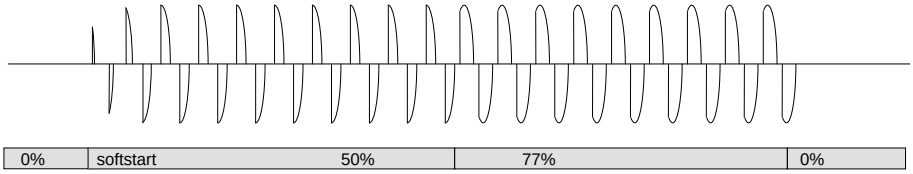
Picture 4: Derating diagramm



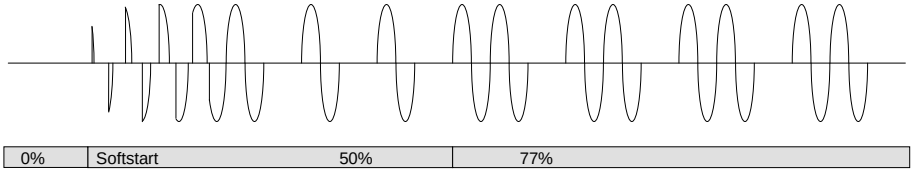
Picture 6 Typical 230VAC arrangement



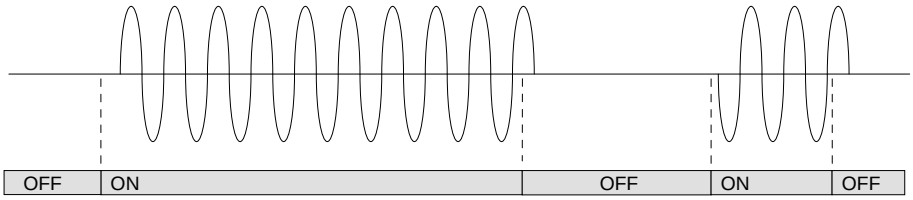
Picture 7 Typical 400VAC arrangement



Picture 8a Phase-angle-control



Picture 8b Burst-Mode with initial softstart



Picture 8c Zero Cross switching

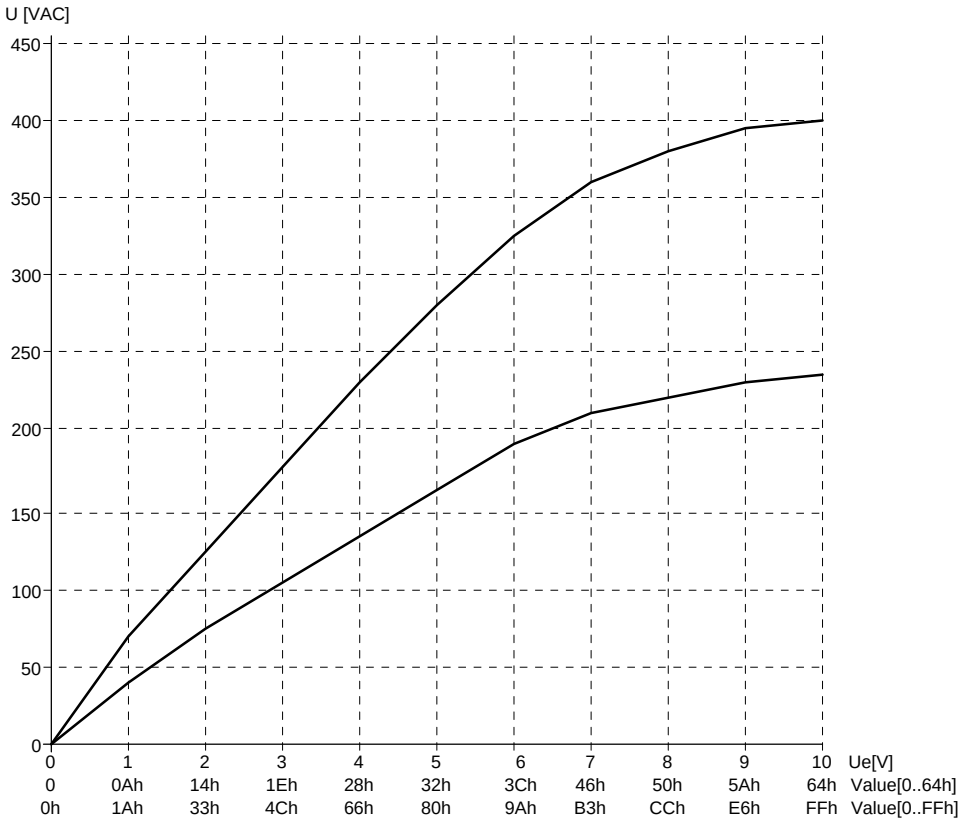


Bild 9a Effektive Lastspannung via Steuerspannung

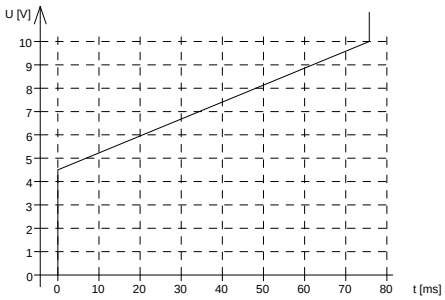


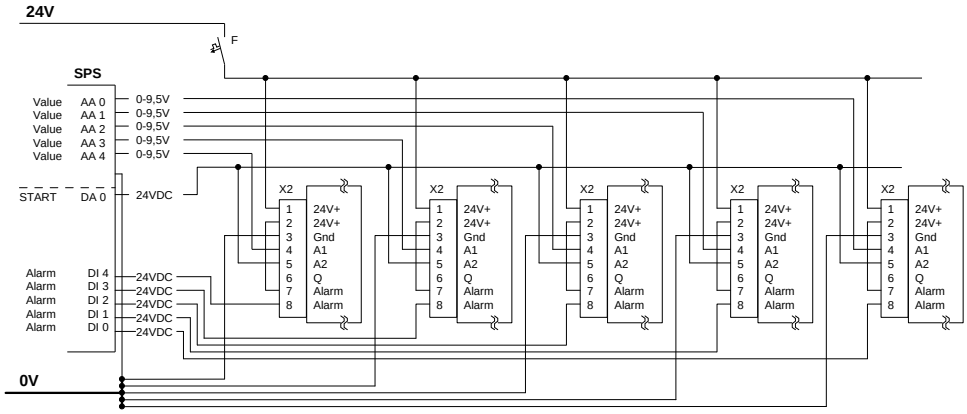
Bild 9 Ramp time as function of set point value

2 Installation

2.1 Connection of the X2 control cables

The control cables are connected by means of plug-in connector system X2.

The module has a common reference earth for both the auxiliary voltage, and the analogue signal. A low-impedance wiring arrangement as shown in Fig. 10 is therefore recommended.

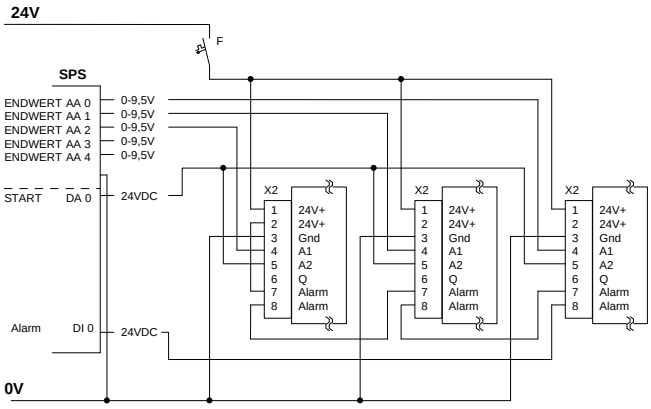


Picture 10 Wiring arrangement with individual error reading

Each ERROR signal is connected individually to the PLC or PC system. Connect Jumper JP7 as NC!

As can be seen in Fig. 10, the 24 V DC auxiliary voltage supply line must be protected by a 2 A fuse.

The use of shielded cables for the control lines is recommended.



Picture 10a Wiring arrangement with common error reading

As can be seen in Fig 10A, you can also connect all ERROR information in series to economize wiring and Inputs. Connect Jumper JP7 as NC too!

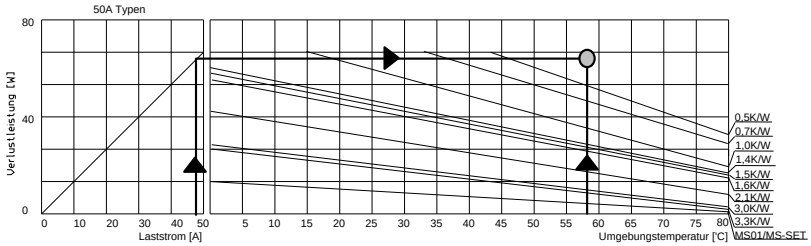
2.2 Installation of module

A suitable cooling arrangement must be provided which takes into account the rated current at which the module is to be operated. Refer to Fig. 3 for selection.

The following example illustrates use of the diagram for selection.

Rated current: 48 A
Ambient temperature: 58 °C

First determine the requisite cooling capacity for a 50 A PR4850.



Picture 11
Example: cooling capacity for an PR4850

The example in Fig. 11 shows that the minimum cooling capacity is determined by the intersection of the power dissipation and the ambient temperature. Any heat sink the characteristic of which runs to the right of the intersection may be employed. As can be seen from the diagram, a standard heat sink capable of supplying this cooling capacity by convection is not available.

The more powerful PR4890 module must therefore be employed. The requisite cooling capacity for this module is calculated as follows:

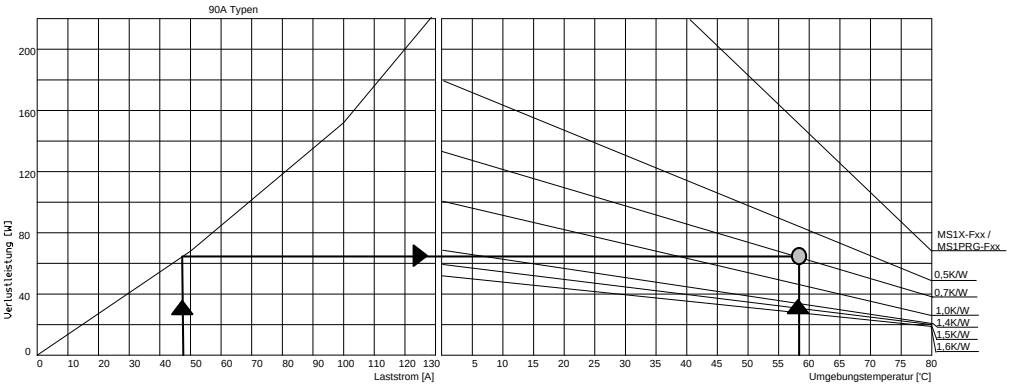


Fig. 12
Example: cooling capacity for an PR4890

In the example shown in Fig. 12, the characteristics intersect at 0,7 K/W. Any heat sink with a cooling capacity of 0.7 K/W or higher is therefore suitable for this application. An MS1 heat sink can therefore be selected from the range.

The module is mounted on the heat sink by means of DIN 7985 M4x10 screws. To improve thermal conduction, apply a thin continuous layer of P12 silicone heat transfer compound to the underside of the module. Fit a DIN 6798 serrated lock washer in order to secure the screw and to compensate for thermal expansion.

Remarks!

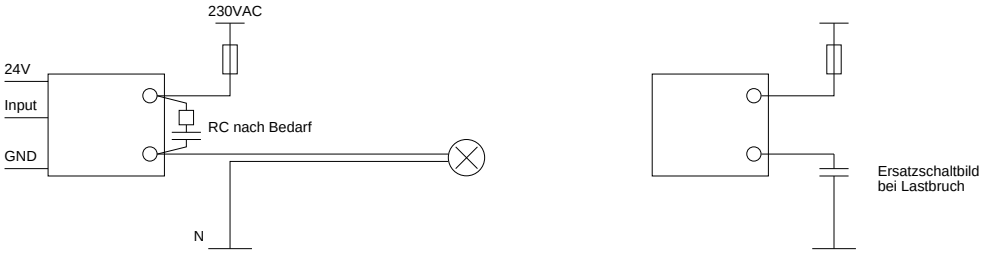
- Tighten the screw until the lock washer is just fully compressed.
- Before mounting the module on the heat sink, check that the mounting surfaces of module and heat sink are perfectly flat and free of dust.
- After mounting the module on the heat sink, install it in the cabinet, for example on a DIN 35 mm mounting rail, with the heat sink ribs vertical. Convection air must be able to flow freely through the cooling ribs.
- Should a number of modules be installed side-by-side in a cabinet, observe a spacing of at least 10mm between modules. The surface area available for cooling is otherwise reduced.

Complete kits, comprising a module ready-mounted on a heat sink with clip for attachment to a 35 mm DIN mounting rail, are available ex-works. Please ask for further details.

2.3 Connecting power cables

Terminate the load circuit cables with DIN 46234 or DIN 46237 ring tongue solderless connectors, and attach them to the X1 load terminals using the enclosed screws. When determining cable ratings, note that the temperature in the switchgear cabinet may exceed 55 °C, and that the temperature of the X1 load terminals may reach 100 °C under full load. If high-temperature cable is not used throughout, we recommend that an initial loop of cable be left exposed to the air outside the cable duct.

Particular attention must be paid to the wiring between the controller and the load. In a typical arrangement such as that shown in Fig. 7, routing the cables together gives rise to a parasitic capacitance, which becomes stronger with increasing cable length. Should the load fail, for example as a result of a circuit break, the capacitance may generate sufficient current over long cable lengths to simulate a fully functional load.



For this reason, the cable lengths indicated in Table 13 should not be exceeded. The cable lengths stated are based on a worst-case scenario, which assumes that the cables are laid as close as possible in the cable duct. Such unfavourably small intervals between cables do not occur in practice. These extreme values need be employed only where the controller and the load are connected by means of a three-core nx0.75 mm^2 cable.

Multi-conductor cables have a capacitance of 1.0 to 1.4 nF for every 10 m length.

If a 0.1uF/47 Ohm RC element is shunted across the controller, the module can detect all faults, with certain restrictions. Refer to the table below for details.

Tabel 13:

	Cable length	Capacitance	Remarks
230V	Up to 80 meters	8nF	Module detects all faults
230V	Up to 300 meters	10nF	Modul can not detect broken load. All other faults, such as fuse tripping and mains power failure, are detected
400V	Up to 50 meters	5nF	Module detects all faults
400V	Up to 100 meters	10nF	Modul can not detect broken load. All other faults, such as fuse tripping and mains power failure, are detected
230V mit RC 0,1/47	Up to 200 meters	20nF	Module detect broken load if the set point value is 0%. All other faults, such as fuse tripping and mains power failure, are detected at any set point value
400V mit RC 0,1/47	Up to 100 meters	10nF	Module detect broken load if the set point value is 0%. All other faults, such as fuse tripping and mains power failure, are detected at any set point value

2.4 Miscellaneous

- Control and load circuit cables must be laid in separate ducts.

- The wiring layout must be done in that way, that finally the cover plate can be mounted or clipped.

- Owing to the high temperature loading, we recommend that the complete wiring of the bay be screened by a polycarbonate panel in order to provide secure protection against contact with any high-temperature exposed cable loops, as required by the German UVV/VBG 4 accident prevention regulations.

- The fuses in the load circuit, as shown in Figs. 6 or 7, do not require separate monitoring. Should they trip, they are detected by the module, which signals a fault.

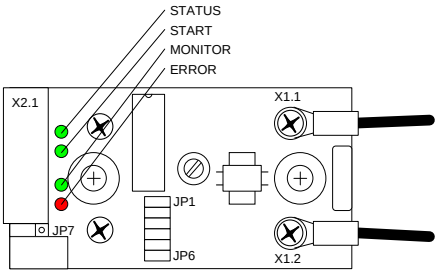
- If the load is a transformer with chiefly resistiv load, the transformer should never runs unloaded. A minimum load of 5% is recommended. The minimum load value can change within all the different modells of transformers.

- The design of the module employs the latest solid-state technology. The module therefore requires no maintenance. Check the module for dust deposits at regular intervals and clean it if necessary. Clean at more frequent intervals under more dusty conditions.

- Whenever you change the setting of any Jumper 1 to 6, unplug connector X2, wait two seconds and plug it in. The Jumper settings get readed only once at 24V Power-Up. Jumper 7 can be changed at any time.

3 Operation

The module has no controls. No operations need be performed on the module in normal operation.



LEDs are provided on the module for diagnostics purposes.

Error LED red

This LED signals that the module has detected a fault. When the fault has been eliminated, the LED drops out with a two-second delay.

STATUS LED green

This LED signals that the set point value is greater than 10%.
At analogue control it is > 1,0V
At seriell control it is > 0Ah (0..100) oder > 1Ah (0..255)

START LED green

This LED signals an active ENABLE signal at analogue control or the CLOCK signal at seriell control.

MONITOR LED green

This LED signals an switched ON SSR.

Note: When the 24 V supply is applied, the module performs a frequency check and selects either 50 or 60 Hz. Until mains voltage is applied, the module does not assume regular operation and the two green LEDs thus remain off, irrespective of the actual states on the inputs. The decision for 50Hz or 60Hz operation is based on the length of the 4th mains half-wave.

4 Maintenance and service

The design of the module employs the latest solid-state technology. The module therefore requires no maintenance. Check the module for dust deposits at regular intervals and clean it if necessary. Clean at more frequent intervals under more dusty conditions.

Note: Isolate the switchgear cabinet and the machine/plant prior to performing any maintenance or service work. A skilled electrician may only perform such work. Detailed regulations can be found in the latest edition of the German UVV – VBG4 accident prevention regulations.

The module requires no servicing. Return it to the manufacturer for testing if necessary.

5 Troubleshooting

Fault	Cause
Module not functioning; red LED permanently ON.	The module has detected a continuous fault. To locate the fault, ensure that no setpoint is being applied, or that the setpoint is 0%. 1. Measure the terminal voltage on X1.1 and X1.2. The voltage must be equal to the load voltage. If this is not the case, check the load circuit (loads, fuses, terminals) and wiring. The load voltage must always be greater than 180 V AC. The undervoltage trip cuts out below this value. 2. Measure the leakage current in the load circuit through the module. It should always be approaching 0.0 A AC (less than 5 mA) in the Off state. 3. Measure the current at the two ends of the load circuit. The level should be the same at both ends. If this is not the case, leakage current is being sunk at some point. 4. Check that the controller is located in the socket.
There is no function – the red LED is permanently OFF.	The module is probably not functioning. 1. Check the auxiliary voltage. It must be within the specified range. 2. Withdraw the plug and re-insert it after approx. 2 seconds. The red LED must come on for approx. 0.5 seconds when the plug is replaced. If it fails to come on, an internal fault has arisen. The module is functioning: 1. Check the setpoint. It should be grater than 0% to see any affect on the load. 2. As a function of the design, low setpoints generate a low number of double halve-waves. Under such conditions, a load may require some time to reach temperature. For this reason, increase the setpoint value and measure the load current.

Fault	Cause
Module functioning; red LED comes on intermittently	The module has detected an intermittent fault in the load circuit. A fault may have a number of causes: 1. Major disturbances influence whole half waves: half-waves which have already been fired are extinguished. 2. Reactive-power compensation equipment can also cause disturbances sufficiently great to impair function of the module. 3. Half-wave failure at the power supply utility or transformer substation. 4. The rated voltage is at the lower end of the tolerance range. 5. High-frequency transients are causing dv/dt-induced parasitic firing. 6. The module has an internal fault and is failing to fire properly.
Module functioning; the red LED comes on permanently after a certain time	The module requires a certain time before recognizing a fault: 1. If the module's temperature rises excessively, the undervoltage threshold rises dramatically. Although the load voltage may be within the tolerance, an undervoltage alarm may still be triggered under these conditions. 2. Impermissibly high supply voltage dips may occur when all modules are being operated at full load. Check the ratings.
The module is operating – but it is not possible to control the whole range of 0 to 100%	The module is reading a wrong setpoint value. 1. Check the load current on several setpoints, for example 10%, 20%, 50%, 80% and 100%. Check the results for any offsets or factors. 2. Check the operation mode. If the main power comes up after auxiliary voltage and the start of main power was very lousy, the module detected wrong a 60Hz application instead of a 50Hz operation. A new check is only made after restart auxiliary voltage.
Module functioning but overheats	Module cooling is unsatisfactory. 1. Check that the air temperature below the heat sink does not exceed that specified by the design calculation. 2. Check that the cooling ribs are clean and unobstructed. 3. Check that the module is mounted firmly, perfectly flat, and level on the heat sink by means of heat transfer compound. 4. Check that the load current does not exceed that specified by the design calculation.

6 Notes

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