JUMO MEASUREMENT® AND CONTROL

Thyristor unit with analogue control

for wall mounting or mounting on rail to DIN EN 50 022

D 98.906

3.92/V 74209

Operating Instructions

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Contents

NOTE

All necessary settings and, where appropriate, alterations are described in these Operating Instructions.
If, however, any difficulties should arise during start-up please do not carry out any manipulations which are not permitted.
You could endanger your rights under the instrument warranty. Please contact the nearest office or the main factory.

1 DESCRIPTION

Thyristor units are used in all applications where large resistive and inductive loads have to be switched, as for example in industrial furnaces and in plastics processing.

The modular compact construction and the control through an analogue input signal make the JUMO thyristor units the ideal operating device for industrial power controls. The power unit consists of two thyristors connected in inverse parallel, the insulated heat sink and the control electronics.

The thyristor unit can be mounted directly on a wall by means of a mounting plate, or snapped onto a 35 mm rail.

Depending on the model, thyristor units operate either on the phase angle principle with adjustable current limitation, or on the burst firing principle. In burst firing operation the unit always switches complete sine waves, ensuring that there can be no d.c. component or reactive power. The control range can be restricted by attenuating the input signal, and a base load can be set through an external potentiometer. In burst firing operation a cost-saving circuit can be provided for a multi-phase load. In phase angle operation the phase angle set by the controller is approached slowly, starting from 180 degrees, in order to avoid a high rush-in current (soft start).

The thyristor units conform to VDE 0558 Part 1 and VDE 0160 Tab. 4. The unit has to be grounded in accordance with the requirements of the local power supply authority.

1.1 Type designation

Thyristor unit for analogue control

TYA . . .-110/1,. .,. . .		Thyristor unit for burst firing operation
TYA . . .-110/2,. .,. . .		Thyristor unit for phase angle control with soft start
020		control signal 0 - 20 mA
420		control signal 4 - 20 mA
010		control signal 0 - 10 V
005		control signal 0 - 5 V
-110		size 110 x 195 x 152 mm
	25	load current 25 A
	50	load current 50 A
	63	load current 63 A
	115	rated load voltage 115 V˙
	230	rated load voltage 230 V˙
	400	rated load voltage 400 V˙
	460	rated load voltage 460 V˙

˙ rated load voltage = voltage supply for control electronics

1.2 Extra Codes

1R alarm on part load failure (adjustable by trimmer) and also fuse failure through common relay contact and LED

1O as alarm 1R but via optocoupler

2 current limitation in phase angle operation with soft start

SP thyristor unit with P control for cost-saving circuit

1.3 Standard accessories

1 Mounting plate for wall mounting
1 Operating Instructions

1.4 Accessories

Replacement fuses	
32 A˙ for I_N=25 A	Stock No. 98097942
63 A˙ for I_N=50 A	Stock No. 98097943
80 A˙ for I_N=63 A	Stock No. 98097944

˙super-fast semiconductor fuse

Mounting set for rail mounting	Stock No. 98002730

1.5 Technical data

Circuit variants
- single-phase operation
- star circuit with accessible star point Mp
- open delta circuit
- cost-saving circuit (star or delta) for burst firing operation, available with Code SP

Control signal
Control by analogue d.c. current or voltage signal
Ri = 50 Ω approx. with current input
Ri = 100 kΩ approx. with voltage input
and manual control from external 5 kΩ potentiometer (additive to analogue input signal)

Input signal attenuation
adjustment range 100 - 20%

Operating modes
depending on model:
burst firing operation, zero switching, cycle time 400 msec (constant) or variable,
or phase angle operation with soft start

Load types
resistive loads in burst firing operation,
resistive and inductive loads in phase angle operation (inductive loads B = 1.2 Tesla max. and u_K = 6% min.)

Current limitation
In phase angle operation the load current can be set on a trimmer at the front within the range 10 - 100% I_{Load}. The limitation is based on the rms value of the load current.

Supply voltage
(control electronics)
a.c. 45 - 60 Hz 115 V +10% -20%
a.c. 45 - 60 Hz 230 V +15% -20%
a.c. 45 - 60 Hz 400 V +15% -20%
a.c. 45 - 60 Hz 460 V +15% -20%
(control voltage = nominal load voltage)

Voltage error
no error within the tolerance range of the supply voltage

Continuous load current I_{Load}
25 A for Type TYA...-110/1(2),25
50 A for Type TYA...-110/1(2),50
63 A for Type TYA...-110/1(2),63

Fuse
super-fast semiconductor fuse

Power losses P_{Loss}
= 1.5 V x I_{Load} (A) approx.

Cooling
by natural convection

Special features
firing pulse inhibit, base load setting possible by external potentiometer, blown fuse alarm through LED

Controls
normally U^2, to special order I^2 and P.
On energy-saving version (Code SP) both units with P control.

Protection circuit
RC protection circuit fitted as standard

Electrical connection
by screw terminals

Housing
black anodised heat sink with plastic covering for mounting either on 35 mm rail to DIN EN 50 022 or on mounting plate

Protection
IP00 to DIN 40 050,
protection against unintended contact through front cover;
heat sink carries no voltage

Permitted ambient temperature range
0 to 50°C
Permitted current reduced by 2% for each °C increased ambient temperature; ambient temperature must not exceed 60°C.

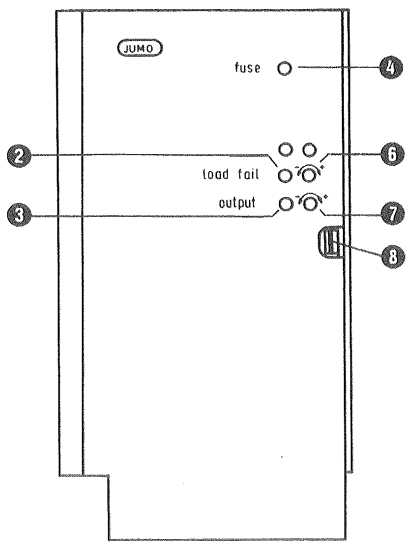
Permitted storage temperature range
-10 to +70°C

Operating position
vertical

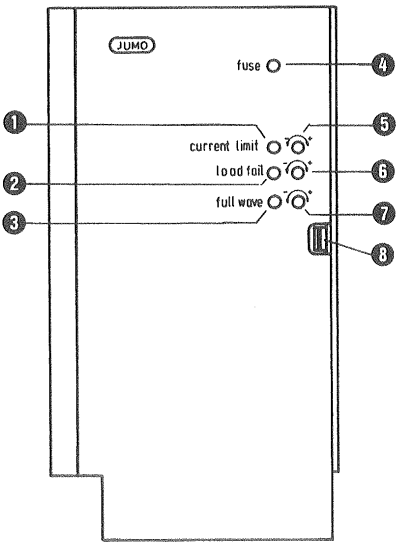
Climatic conditions
Class KWF to DIN 40 040, relative humidity 75% max. annual mean, no condensation

Weight
2.8 kg approx.

1.6 Indications and controls



TYA...-110/1



TYA...-110/2

1. Current limit indication LED on TYA...-110/2
2. Part load failure alarm LED
3. Output monitor on TYA...-110/1; full output indication LED on TYA...-110/2
4. Alarm LED on failure of semiconductor fuse
5. Adjustment of current limit in phase angle operation (only on TYA...-110/2 with Code 2)
6. Setting of response level for part load failure alarm
7. Adjustment of full output control
8. Release clip for opening the cover

2 INSTALLATION

2.1 Location and climatic conditions

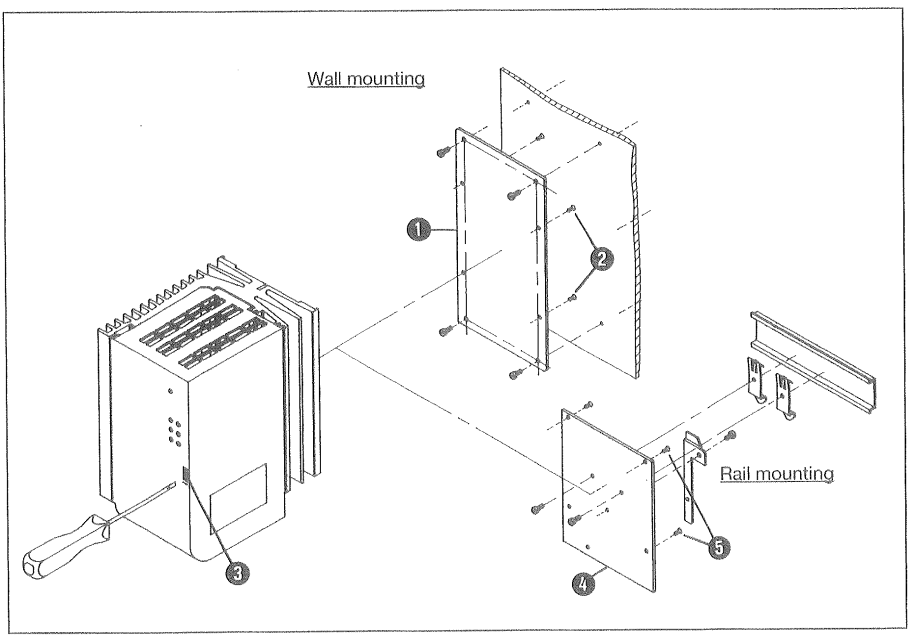
The location should as far as possible be free from shock and vibration. Electromagnetic fields, caused e.g. by motors, transformers etc., should be avoided. The ambient temperature at the location must be within 0 - 50°C at a relative humidity not exceeding 75%. Corrosive air or fumes have an unfavourable effect on the life of the thyristor unit.
To ensure satisfactory convective cooling the thyristor unit should be mounted vertically. When mounted in control cabinets it is important to ensure adequate ventilation. The distance from the floor should exceed 100 mm and the spacing from the ceiling should be larger than 150 mm.
The thyristor unit conforms to Protection IP 00 and has to be installed protected against contact (mounting in control cabinets).

2.2 Wall mounting

The aluminium mounting plate ❶ is secured to the heat sink with the screws ❷ supplied. Take off the front cover; push the retaining clip ❸ with a screwdriver in the direction of the arrow and lift off the cover towards the front.
The complete unit is then mounted on the wall with 4 screws.

2.3 Rail mounting

The mounting plate ❹ fitted with locating legs and locking lever is secured to the heat sink using the 4 screws ❺ provided.
The assembled unit is then snapped on to a rail to DIN EN 50 022 and locked in position with the lever.



3.1 Important notes on installation

The control wiring can be run in NYF wire inside the cabinet. Appropriate control circuit fuses (e.g. 2 A Type Neozed) have to be provided to protect the circuit.

Load circuit and control circuit should where possible be run separately.

The supply for the control electronics is connected to the terminals "L1" and "N/L2". Terminal "N/L2" has to be linked to "V" except when operating in an energy saving circuit.

Load circuit and control circuit must be on the same phase. Terminal "L1" must therefore be linked through a control circuit fuse (for circuit protection) to terminal "U1".

Switching-on sequence

If the control electronics is supplied from another circuit, both load and control circuit must be switched on simultaneously.

It is essential that the supply to the control electronics is not switched on before the load circuit supply.

This is particularly important when operating transformers and also resistive loads with a large ratio of hot-to-cold resistance.

Load connection

The thyristors are connected in series with the load. The terminal "U1" has to be linked to line 1 (L1). The load is connected between terminal "U2" and the neutral (N) or line 2 (L2 in the case of 380 V load voltage).

Control inputs

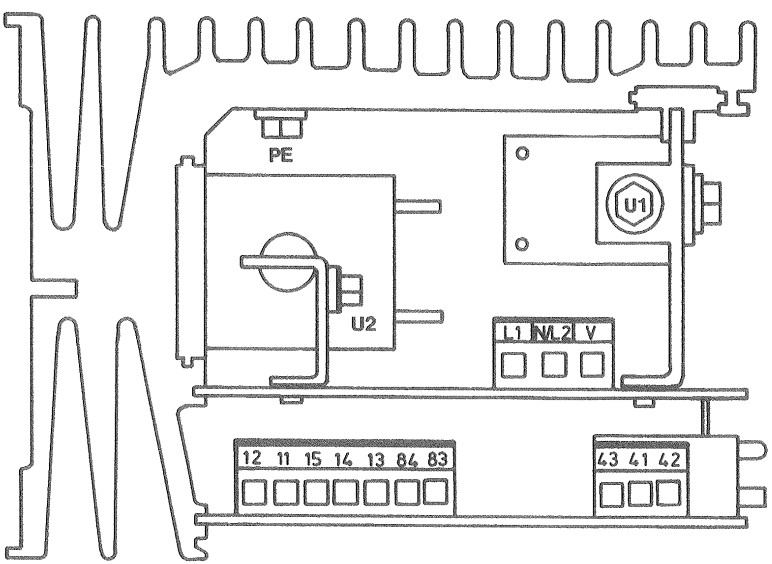
The two inputs to the thyristor unit are:
- terminals 11 and 12 controller signal input
- terminals 13, 14, 15 potentiometer input (manual control)

Both inputs can be used simultaneously. The potentiometer input is additive to the control signal input. The control inputs are isolated from the supply.

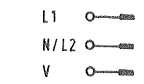
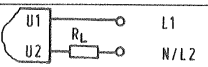
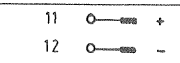
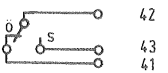
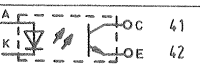
The firing pulse inhibit is described in Section 4 "Operation", the load failure output in Section 6 ("Special functions").

An isolating switch to VDE 0160/6.3.1 has to be connected in front of the thyristor unit. It is used to isolate the unit from the supply if any work is being carried out on it.

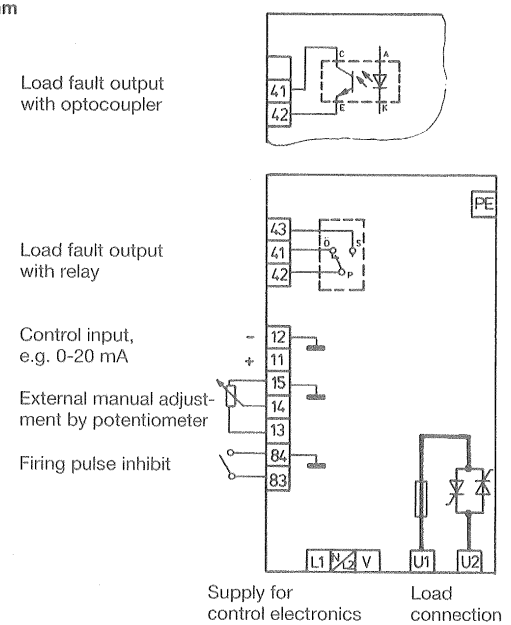
3.2 Connections



3.3 Connection list

Connection for	Terminals	Symbol
Supply for control electronics. Terminal V is linked to N/L2 except on cost-saving circuit	L1 N/L2 V	
Load connection	U1 U2	
Control input, e.g. 0 - 20 mA from controller output	11 + 12 - (⊥)	
External manual control by potentiometer (5 kΩ)	13 end 14 slider 15 start (⊥)	
Firing pulse inhibit input I_K = 0.15 mA approx.	83 84 (⊥)	
Load fail output with relay, rating 230 V a.c. 5 A resistive load	42 common 43 n.o. (closing) 41 n.c. (opening)	
Load fail output with optocoupler, $IU_{CE\,max}$ = 32 V	41 collector 42 emitter	

3.4 Connection diagram

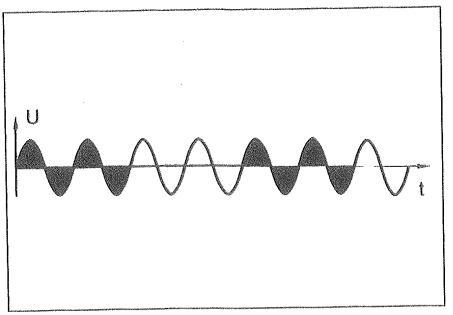


4 OPERATION

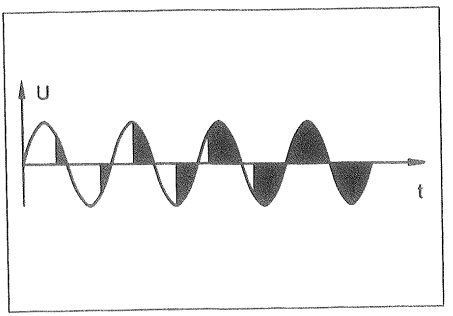
4.1 Operating modes

The thyristor unit operates with U^2 control in all operating modes. This means that voltage variations in the supply do not affect the power at the load.
Without this power compensation a supply voltage change of e.g. 10% would result in a power change of 21%.

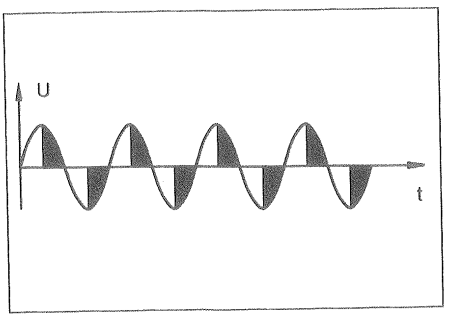
Burst firing operation
Power control by varying the number of complete sine waves passing through during each control cycle.
This operating mode is suitable for purely resistive loads whose cold resistance is similar to their hot resistance.
All switching takes place during passage through zero so that this operating mode is largely interference-free.
For adjustment of cycle time see Item 4.6.



Phase angle operation
Power control by varying the phase angle at which the thyristor fires. Suitable for resistive-inductive loads.
During the start-up phase the phase angle demanded by the controller is approached slowly (soft start) in order to avoid heavy in-rush currents.



Phase angle operation with current limitation (Code 2)
On loads whose cold resistance is much lower than their hot resistance (e.g. Kanthal Super heater bars) it is useful to employ current limitation.
Here the rms load current is limited through a suitable phase angle. The maximum permitted current can be set from the front. Details are given in Section 6 (Special Functions).



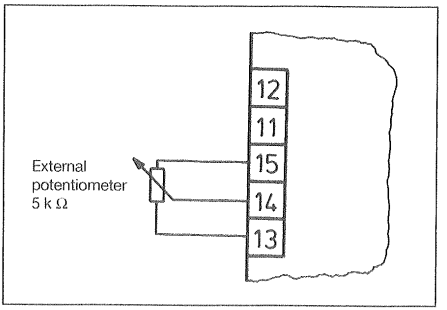
4.2 Controller signal matching.

Using the front trimmer "full wave" the thyristor unit can be adjusted both in burst-firing and in phase-angle operation so that it passes the full current at the maximum controller output signal.

Correct adjustment is achieved when, if the controller signal is at maximum, the green LED „full wave" lights up and the LED "Output" is no longer flashing (during burst-firing operation).

4.3 Base load selection

An external potentiometer can be used in conjunction with the front adjustment "full wave" (input signal attenuation) to set a base load level. For example, if a heater has to operate with 1/3 base load while the remaining 2/3 of the power is controlled by the controller, the procedure is as follows:
The attenuation of the controller signal has to be calculated; in this example it is 1 : 2/3 = 1.5. This factor is multiplied with the desired base load setting, here 1.5 x 1/3 = 0.5. The factor 0.5 means that the external potentiometer has to be set to 50% of its maximum scale range.
Then the full controller output signal is applied to the thyristor unit.
The trimmer "full wave" or "output" is now adjusted until the green LED lights up.

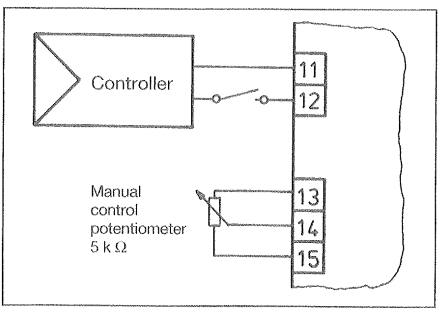


4.4 Firing pulse inhibit

Closing a contact between terminals 83 and 84 blocks the thyristor after the next current zero. This provides a simple means of switching large loads.
In order to isolate the system it is necessary however according to VDE regulations to provide a contactor or main switch before the thyristor unit.

4.5 Manual operation

The controller and potentiometer inputs are additive in their action. A change to manual operation can therefore be made by providing a switch in one of the control lines and then connecting the potentiometer in accordance with the diagram.
Purely manual operation is then possible when the switch is open.
When returning to the controller output signal the potentiometer should first be set to zero in order to avoid any unintended full output from the thyristor unit.

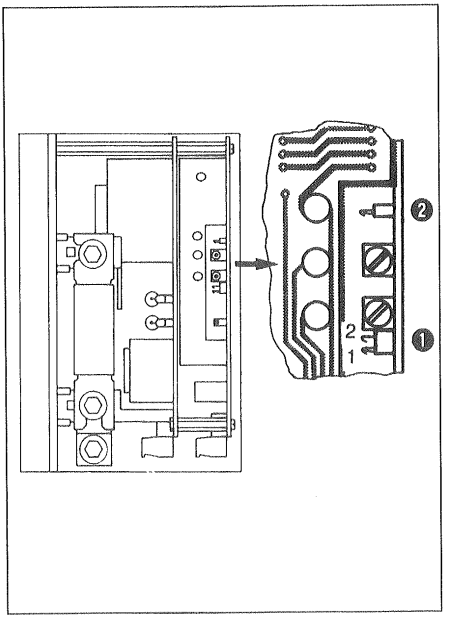


4.6 Adjusting the cycling rate in burst-firing operation

The cycling rate can be varied by means of the switch ❶. The switch is located underneath the cover next to the "Output" trimmer.

switch position 1: fixed cycle time (400 msec)
switch position 2: variable cycle time

Variable means that the unit always selects the fastest possible cycle time.



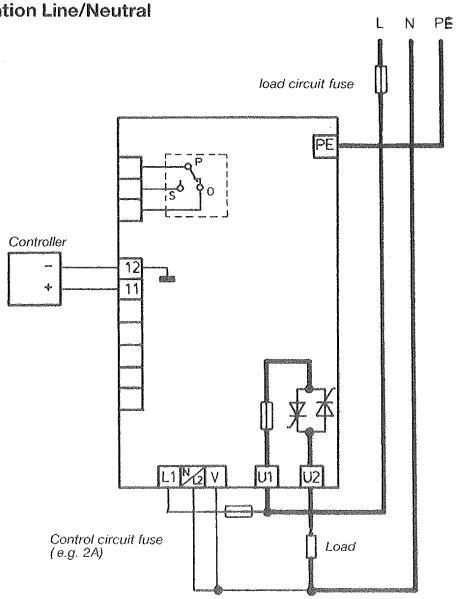
4.7 Cost-saving circuit (Code SP)

An cost-saving circuit with 2 thyristor units can be provided in burst firing operation only. Both units have to operate with P control for instrumentation reasons (determination of instantaneous power). Terminal "V" has to be connected to line L2. It is important to ensure clockwise field rotation (see Item 5.5).
The rated voltage of the thyristor units in both load circuit types must equal the line voltage.

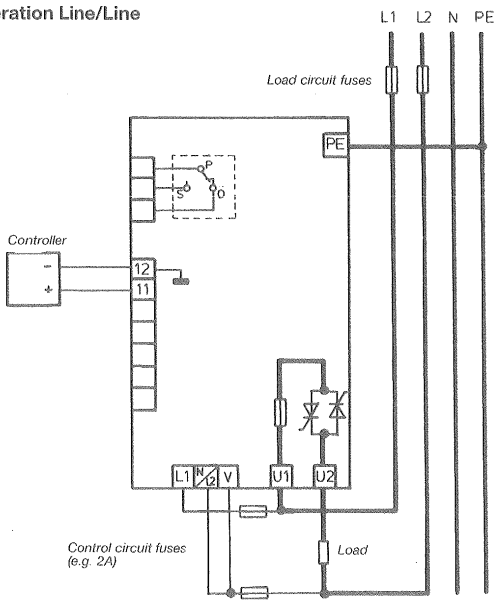
Switch ❶ must be set to position 1.
Switch ❷ must be closed.

This switch must be open in all operating modes other than the energy saving circuit.

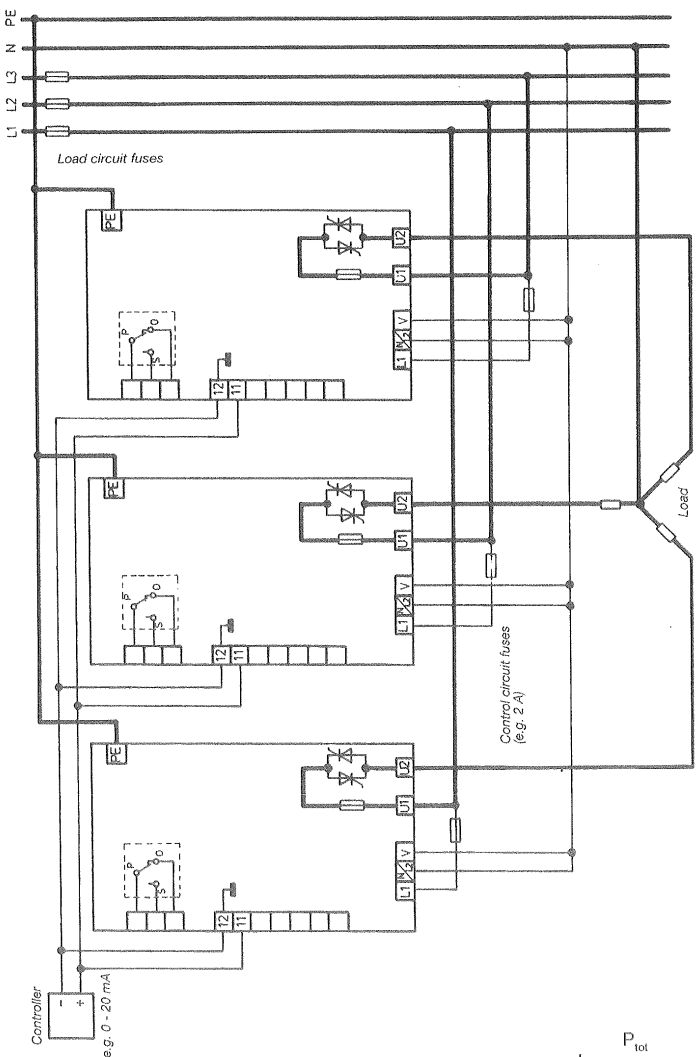
5.1 Single-phase operation Line/Neutral



5.2 Single-phase operation Line/Line



5.3 Star circuit with accessible star point



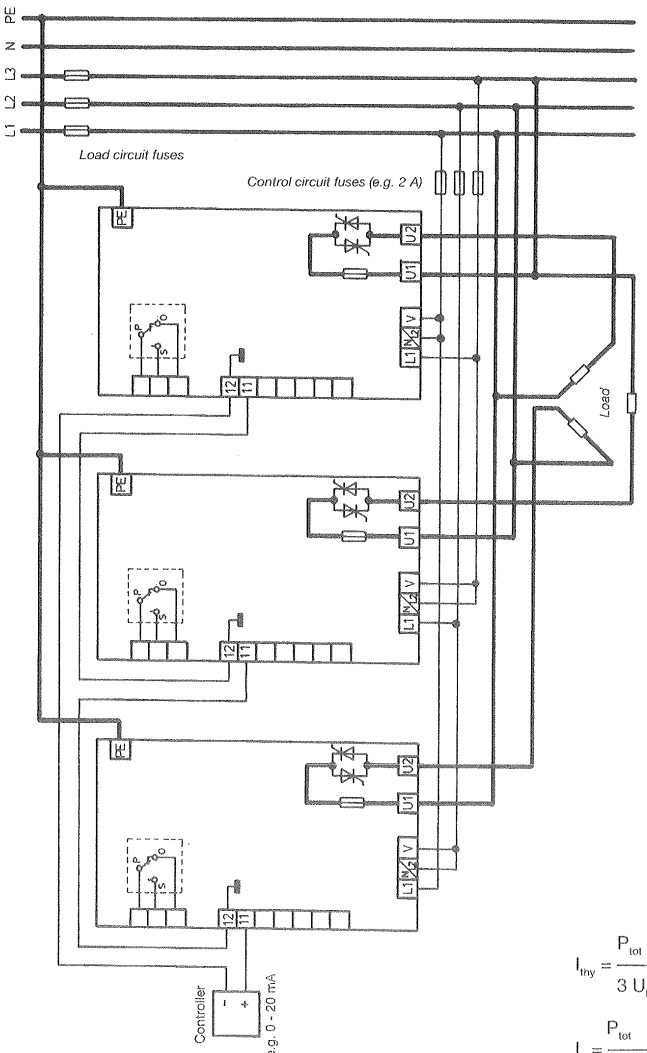
$$I_{thy} = \frac{P_{tot}}{3\ U_{ph}} = I_L$$

$$P_{max} = U_{ph} \cdot 3 \cdot I_N$$

P_{max} = max. possible power

I_N = thyristor unit nominal current

5.4 Open delta circuit



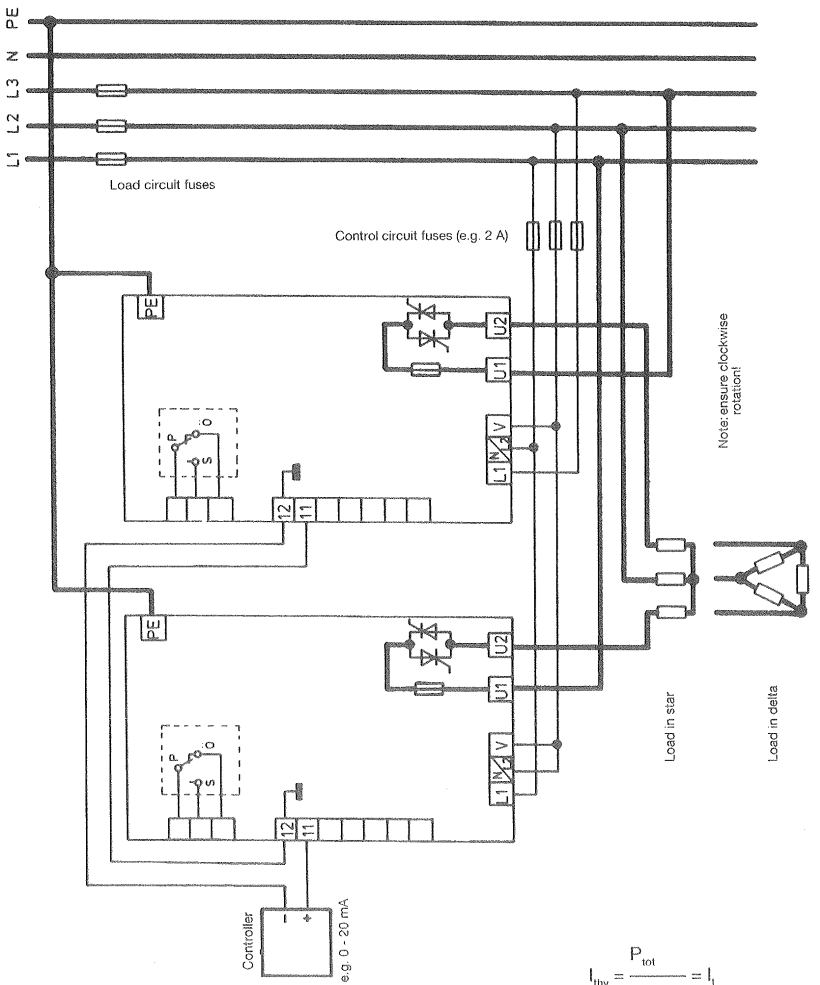
$$I_{thy} = \frac{P_{tot}}{3\,U_L}$$

$$I_L = \frac{P_{tot}}{\sqrt{3}\,U_L}$$

$$P_{max} = U_L \cdot 3 \cdot I_N$$

5.5 Cost-saving circuits (star or delta)

(only possible with burst firing operation)



6.1 Monitoring for load or part load failure (with Code 1R and 10)

Where several heaters of a load circuit are arranged in parallel it is possible to monitor for failure of a single heater.

Adjustment on single phase circuit or on circuit to Section 5.3 or 5.4:

The switching point of the load failure alarm is set on the front trimmer "load fail". The adjustment should be made when operating at full output. The monitoring circuit is set at the factory so that a failure of 50% of the nominal load is reported.

Setting takes place as follows: at the normal load current through the heater the "load fail" trimmer is turned clockwise until the yellow LED „load fail" lights up. Then lower the switching level by turning the trimmer anticlockwise. 1.5 turns correspond approximately to 10% of the thyristor unit nominal current.

A better method consists of simulating the fault on the load. With simulated load failure the trimmer is adjusted so that the yellow "load fail" ED just lights up.

The smallest current change which can be detected is about 10% of the nominal load current of one phase.

The alarm output can be either a floating contact (Code 1R) or an optocoupler output (Code 10). In case of load failure the relay is de-energised or the collector-emitter circuit of the optocoupler changes to a high resistance.

Adjustment on cost-saving circuit:

The smallest current change which can reliably be detected is about 25% of the nominal load current of one phase, since current changes by a factor of $\sqrt{3}/2 = 15\%$ approx. per phase can occur in normal operation due to the non-synchronised thyristor unit operation.

This 15% current change can be simulated by switching off the other thyristor using the firing circuit.

Adjustment of the minimum alarm threshold is made by leaving the load unchanged, switching of one thyristor with the firing inhibit and turning the "load fail" trimmer on the other thyristor anticlockwise until the "load fail" LED just goes out.

6.2 Phase ange control with current limitation (with Code 2)

Current limitation is available only with phase-angle operation.

The front trimmer "current limit" can be used to limit the RMS value of the load current within the range 10 - 100% of the thyristor unit nominal current. When the current limitation is activated the red LED "current limit" lights up. The limitation is achieved by limiting the maximum permitted firing point phase angle in such a way that the set RMS current is not exceeded.

7 ACTION ON FAULTS

The thyristor unit requires no maintenance.
In case of a fault the following points should be noted:

7.1 Checking the connections

(a) Is there both load voltage and supply voltage on the thyristor unit?
Check for correct phase
(see Item 3.1).

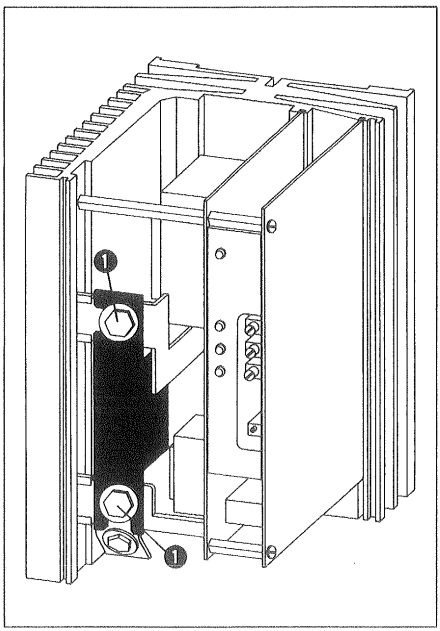
(b) Is the controller operating correctly?
The operation may be tested using the external manual potentiometer.

7.2 Changing the semiconductor fuse

When the red LED "fuse" lights up, this indicates that the semiconductor fuse has blown. This fuse protects the thyristors in case of a short-circuit and cuts out within a supply half-cycle in case of short-circuit.

First isolate the unit from the supply and remove the cover (after pushing the retaining clip in the direction of the arrow).
Then release the two hexagon fixing screws ❶ (10 mm a/f) of the fuse and remove the fuse.
If necessary check with a continuity tester.

Only original fuses must be used. On fitting other fuses the warranty becomes void.
(for replacement fuses see under accessories)



The circuit boards must be taken to be live at mains potential. Any work on the circuit must only be carried out after isolating the unit from the supply. In order to avoid danger to the operator, observe the regulations for working on live equipment (VDE 0100 Part 410).