REGULATED RECTIFIER MODULES
MO30, MO30.1

USER'S MANUAL

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CONTENTS

1. APPLICATION AND FUNCTIONS

A module of three-phase (MO30) and single-phase (MO30.1) regulated rectifier (hereinafter – module) is intended to form from three-phase (single-phase) net voltage 50 or 400 Hz rectified pulse voltage that regulated by phase method. The value of the voltage is regulated by triggering a control signal of standard kind (0…5 V, 0…10 V, 4…20 mA, 0…5 mA, 0…20 mA); changing of the signal from minimum to maximum changes the value of rms value of the direct voltage in the range from 0 to 100%. In the module there is a galvanic isolation of control circuits and power circuits, also there is an inbuilt system of protection against overload.

The module maintains the following functions:

- rectifying of direct voltage;
- changing of direct voltage amplitude on input by phase method;
- smooth start when switching on the supply;
- protection against overcurrent;
- indication of being supply voltage and current protection operation.

The module maintains the operation from the AC net with linear voltage up to 430 V and maintains the control by load voltage with current consumption up to 250 A (rms).

2. PRODUCED MODULES

The modules are produced with different types of the power assemblies:

MO30 – the module intended for operation in the three-phase net; the module contains a controlled three-phase rectifier bridge. The modules are produced with an amount of maximum output rms current 63,100,160,250 A, with peak voltage 1200 V.

MO30.1 – the module intended for operation in the single-phase net; the module contains a controlled single-phase rectifier bridge. The modules are produced with an amount of maximum output rms current 63,100,160 A, with peak voltage 1200 V.

By control types the modules MO30 and MO30.1 are represented by the following versions:

A – maximum amplitude of the control signal corresponds to minimum rms on-load voltage;

B – maximum amplitude of the control signal corresponds to maximum rms on-load voltage.

By signal type for control by thyristors conductance angle (input signal «+Cont»):

1 – voltage control 0…5 V;

2 – voltage control 0…10 V;

3 – current control 4…20 mA;

4 – current control 0…5 mA;

5 – current control 4…20 mA;

On Figure 2.1 is shown the modules name explanation of series MO30.

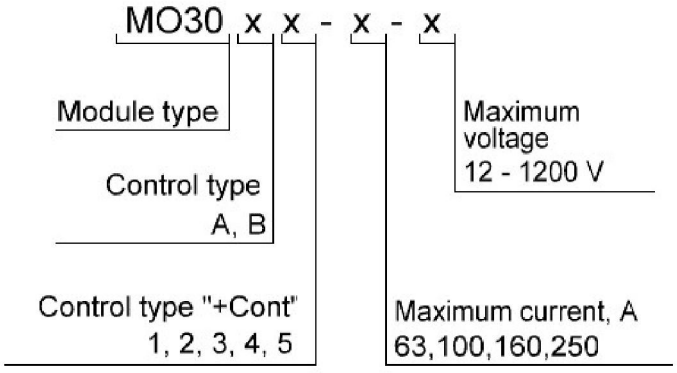

Figure 2.1 – Module name explanation

For example, MO30B1-100-12: a module with voltage control 0…5 V, maximum amplitude of control signal corresp. to maximum load voltage, with maximum rms load current 100 A and peak voltage of power circuit 1200 V.

3. GENERAL MODULE DESCRIPTION

The modules MO30 and MO30.1 are an assembly of thyristors control circuit and power thyristors. The structural circuits of the modules are represented on Figures 3.1 and 3.2

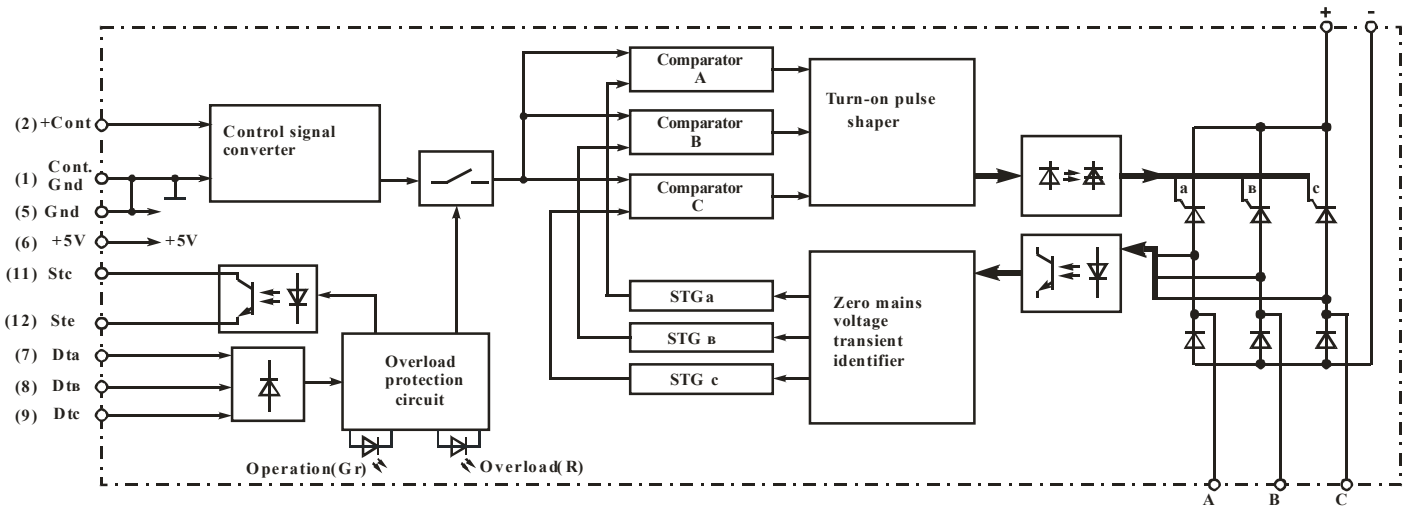

Figure 3.1 – Structural circuit MO30

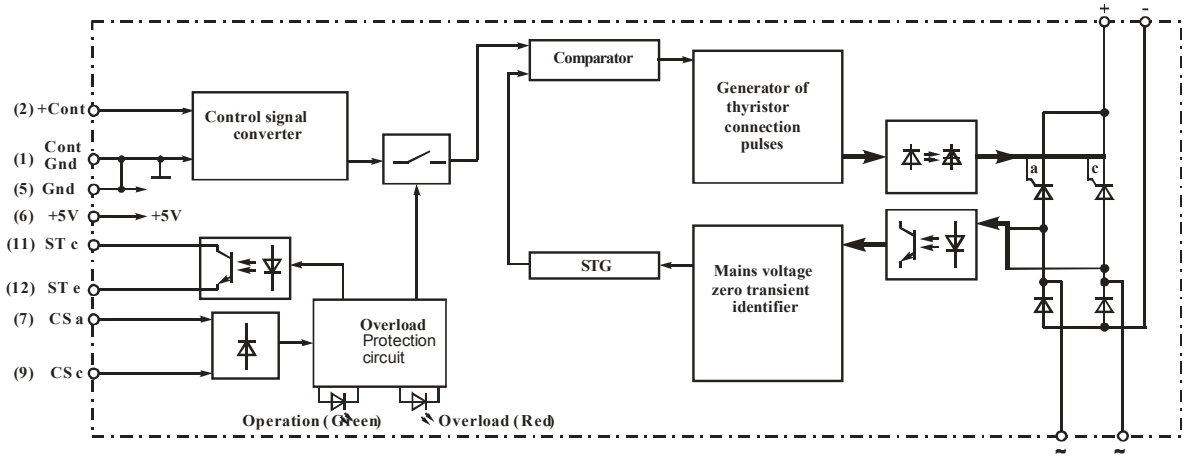

Figure 3.2 – Structural circuit MO30.1

The power contacts – thread ones for screws M5, M6 or M8 (see the overall drawings). The control socket is two rows of pin contacts. The output application of the control socket, power outputs and LED indication are represented in Table 3.1.

Table 3.1 – Application of modules' outputs

Output #	**Symbol**	**Application**
1	Cont. gnd	Control circuit outputs (adjustment of thyristors conductance angle)
2	+Cont	
5	Gnd	Outputs of supply circuit of control circuit
6	+5 V	
7	CSa	Input of current sensor of phase A
8	CSв	Input of current sensor of phase B (not involved for MO30.1)
9	CSc	Input of current sensor of phase C
11	Stc	Collector output of status signal transistor-former
12	Ste	Emitter output of status signal transistor-former
Power outputs	+, -	Outputs for load connection, «+» and «-»
	Pha, Phв, Phc	Inputs of phase A, B, C corres. to AC net
LEDs	Operation	Green LED for indication of control circuit supply voltage
	Overload	Red LED for indication of power circuit current load

4. BASIC MAXIMUM PERMISSIBLE PARAMETERS

Basic electric parameters and maximum permissible parameters of the modules at temperature 25^0C are represented in Tables 4.1 and 4.2.

Table 4.1 – Basic and maximum permissible parameters of control circuits

Parameter	Unit	Control type									
		A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**
Supply voltage	V	5±0.5									
Current consumption, max	mA	100									
Control signal value corresponding to minimum rms value of load voltage	V	5±0.5	10±1	-	-	-	0÷0.5	0÷1	-	-	-
	mA	-	-	20±2	5±0.5	20±2	-	-	4±0.4	0÷0.5	0÷2
Control signal value corresponding to maximum rms value of load voltage	V	0÷0.5	0÷1	-	-	-	5±0.5	10±1	-	-	-
	mA	-	-	4±0.4	0÷0.5	0÷2	-	-	20±2	5±0.5	20±2
Input circuit resistance of control signal, min	kΩ	≥10	≥10	-	-	-	≥10	≥10	-	-	-
Voltage between outputs «St_c», «St_e», max	V	50									
Load current of status output «Stc», «Ste», (max)	mA	20									
Blocking duration in overcurrent mode (typical)	ms	300									
Isolation voltage between control circuits and power circuits, (DC, 1 minute)	V	4000									

Table 4.2 – Basic and maximum permissible electric parameters of power circuits

Parameter name, unit	Symbol	Maximum module current, A			
		63	**100**	**160**	**250 ***
Repetitive pulse voltage: reverse / in off-state (max), V	V_{DRM} /V_{RRM}	1200			
Linear voltage (rms), V	$V_{O(RMS)}$	~ 100…430			
Output current (average value), (max), A	$I_{O\,(AV)}$	63	100	160	250
Surge current in on-state, t=10 ms (max), A	I_{TSM}	300	600	1200	1600
Repetitive pulse current in off-state / reverse current (max), mA	I_{DRM} / I_{RRM}	2			
Pulse voltage in on-state at I= $I_{O\,(AV)}$ (max), V	V_{TM}	1.65			
Extreme rise rate of current in on-state (max), A/μs	$(di_T/dt)_{crit}$	150			
Extreme rise rate of voltage in off-state (max), V/μs	$(du_d/dt)_{crit}$	1000			
Thermal junction-base resistance of each thyristor (max), ºC/W	$R_{thjc\ t}$	1.3	0.6	0.4	0.2
Protection operation current (typical), A	I_{CP}	63	100	160	250
Junction temperature (max), °C	T_J	125			
Electric insulation strength between power circuit and housing (DC, 1 minute), V	V_{ISOL}	4000			

* - only for MO30

5. MODULE O

PERATION AND CONTROL

Recommended circuits of modules' connection are represented on Figures 5.1 and 5.2.

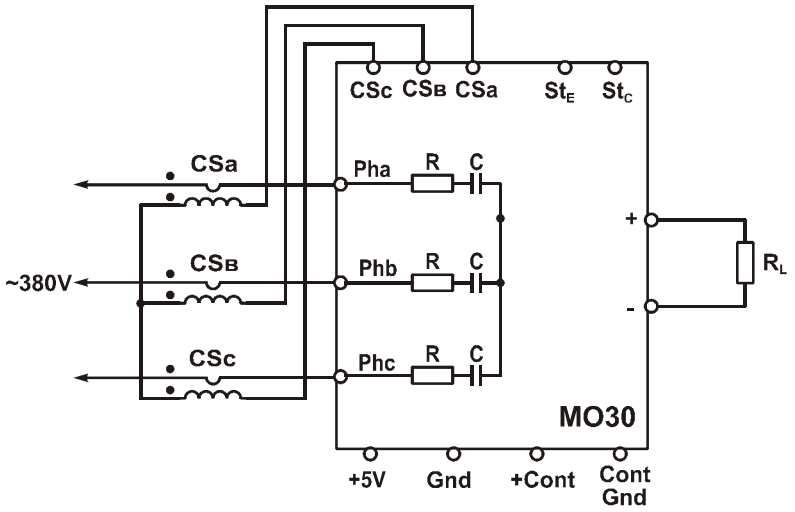

Figure 5.1 – Connection circuit of modules MO30

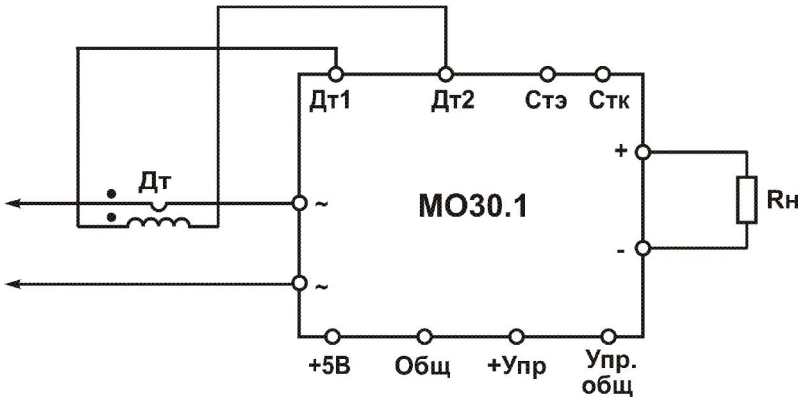

Figure 5.2 – Connection circuit of modules MO30.1

R = 10…27 Ω x 10 Ц; C = 0.33 μF x 1000 V
CSa, CSb, CSc – current sensor CS 005.007-2 (Manufacture CJSC «Energis», included in the package)

The module operates as follows (see Figures 3.1 and 3.2):

When supplying the supplying voltage of the control circuit the LED "Supply" lights up. When supplying the power supply voltage the control circuit provides smooth rise of load voltage, thus, decreasing the start currents amplitude.

Voltage zero transient identifier (VZTI) forms pulses in time of voltage zero transient; this pulses synchronize a sawtooth generator (STG). In comparator (C) voltage STG and control signal voltage U_{cont} are compared received from the input signal converter circuit. When the STG reaches the value $U_{cont, a}$ pulse of input thyristor connection is generated. Changing the control signal value, equality of STG and U_{cont} is varied and, accordingly, the thyristor connection phases. Thereby you reach regulation of thyristors opening angle and the root-mean-square load output voltage value.

When reaching the rms value of load current $I = I_{O(AV)}$ (see Table 4.2) the module is switched off. The indicator «Overload» lights up (red LED), the status transistor opens (output «Stc» respect to the output «Ste»). In 300 ms the protection is unsecured. If the emergency is not eliminated then the protection cycle will be repeated.

The module control is carried out using the following outputs:

«+5 V». Connection output «+» of the control circuit supply voltage. The supply voltage should be 4.5…5.5 V; it is not allowed to be any voltage ripples higher than the range. The current consumption for the input is not higher than 100 mA.

«Gnd». Connection output «-» of the control circuit supply voltage.

«+Cont». Output for setting of thyristors conductance angle. Depending on the control type («A» or «B») to maximum value of the control signal corresponds either thyristors closing (type «A») or complete opening (type «B»). Depending on the version 1,2,3,4,5 the control type signal is changed (0…5 V; 0…10 V; 0…5 mA; 0…20 mA; 4…20 mA). The dependence of thyristor conductance angle (during this time thyristors conduct current) versus relative value of the control signal for the control versions «A» and «B» is shown on Figure 5.3.

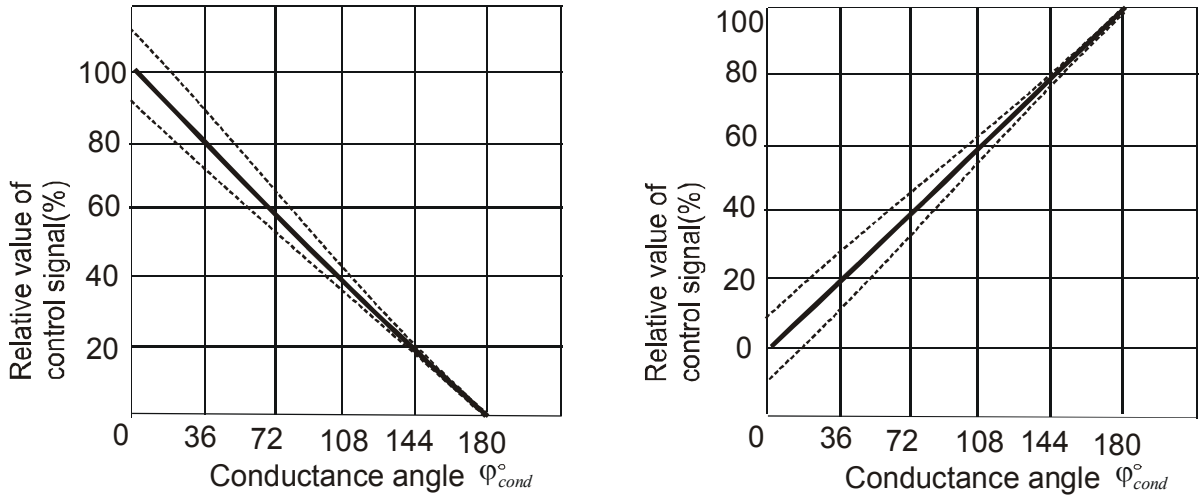

Figure 5.3 – Dependence of thyristors conductance angle versus control signal value

«Cont.gnd». Common output of thyristors conductance setting angle circuit.

«Stc», «Ste». Outputs of collector and emitter of relevant status transistor. Presence of power circuit overcurrent corresponds to transistor activation. The voltage between the outputs «Stc» and «Ste» should not exceed 50 V including ripple. The load current is no higher than 20 mA.

«CSa», «CSb», «CSc». Outputs for connection current sensors. For MO30.1 the output «CSb» is not involved. The package includes current sensors D 005. 007-2 operating in the frequency range 50±1 Hz, with continuous current 5…250 A (operating duration at double overload – no longer 600 sec); it is allowed to connect other sensors. Adjust the current sensors should be based on the fact that the current protection module operates with the following values of the current at the outputs «CSa», «CSb», «CSc» (Table 5.1).

Table 5.1 – Protection operation current at measuring outputs

Module current, A	63	100	160	250 *
Protection current, mA	32	50	80	125

* - only for MO30

Permissible deviation of protection operation current – no more than ±5%. It is not allowed to be long term excess (more than 10 sec) of the measuring current those values that specified in Table 5.1.

6. INSTRUCTIONS FOR USE

General requirements

Module operating is advisable when operating drain current value not more than 80% from specified in the name of the module and junction temperature not more than (70÷80)% from the maximum one.

Module operating is not allowed when simultaneous impact of two or more maximum permissible parameters.

In the electric circuit of equipment with use of modules should be provided a fast-acting protection against unallowable loads, short circuits and commutation overloads.

Module mounting

The module is mounted in the equipment to the cooler (chassis, frame systems, metal plates, etc providing thermal mode) in any orientation using screws M5 or M6 with torque (5±0.5) N·m, with obligatory installation of flat and spring washers. During installation the module should be positioned in such a way to protect it against additional heat from the neighboring elements. The planes of cooler ribs should be directed forward air flow.

The contact area of cooler should have roughness not more than 2.5 μm and non-flatness not more than 30 μm. The cooler surface should be without any rough edges, honeycombs. Between the module and the cooler should not be foreign particles. To improve the thermal balance the module installation to the mounting surface or cooler should be accomplished using heat conducting pastes.

During mounting it is necessary to provide uniformity of pressing the module base to the cooler. To that end, all the screws should be tightened evenly in two – four steps in turns: first, located on one diagonal, then on the other one. When module dismounting, the screws untwisting should be carried out in the reverse order.

Not sooner than in three hours after mounting the screws should be turned to the end keeping the given torque because a part of heat conducting paste under pressure outflows and fastening can be eased off.

It is allowed to install to one cooler several modules without additional insulating layers, on conditions that the voltage between outputs of different modules does not exceed the minimum voltage value of isolation breakdown voltage of each of them or when grounded cooler.

Connection to module

Connection of the electric conductors and cables to the power module terminals is carried out using screws M6 or M5 with torque (4±0.5) N·m, or using bolts M8 with torque (4±0.5) N·m and the washers, including in the package.

Power wires connection should be done by connectors, with corrosion-resistant coat, purified from extraneous layers. After screws tightening (bolts) is recommended fixing of connection with paint. It is recommended retightening the screws (bolts) in 8 days and in 6 weeks after commencement of the operation. Afterwards the tightening should be controlled at least one time a half year.

The controlled outputs are intended for mounting in the equipment by soldering or by demountable connectors. The permissible number of module outputs soldering during mounting (assembly) operations is 3. Output soldering should be carried out at temperature not higher than 235°C. Soldering duration is not longer than 3 sec.

When mounting and operation the module protective measures against static electricity should be taken; when mounting the personnel must use wrist strap and low-voltage soldering irons with power through the transformer.

Operation requirements

The module should only be used in exposure to mechanical loads in accordance to Table 6.1.

Table 6.1 – Impact of mechanical loads

External exposure factor	External exposure factor value
Sinusoidal vibration: - acceleration, m/s2 (g); - frequency, Hz	 150 (15) 0.5 - 100
Mechanical shock of repeated action : - peak impact acceleration , m/s2 (g); - duration of impact acceleration, ms	 40 (4) 50
Linear acceleration, m/s2 (g)	5000 (500)

The module should be used under the influence of climate stresses in accordance with Table 6.2

Table 6.2 – Climatic loads impact

Climatic factor	Value of climatic factor
Low temperature of environment: - operating, °C; - maximum, °C	 - 40 - 45
High temperature of environment: - operating, °C; - maximum, °C	 + 85 + 100
Relative humidity at temperature 35 °C non-condensing, %, max	98

Safe requirements

1. Operation with the module should be carried out only by qualified personnel.
2. Do not touch the module power outputs of the supply voltage applied, even if the engine is stopped.
3. Do not connect or disconnect wires and connectors while the power circuits are energized.
4. If the radiator is not grounded, do not touch it, if the module is filed by force feeding.
5. Do not touch the radiator or discharge resistance, because its temperature can be very high.
6. If the module is smoking, smelling or abnormal noising, immediately turn off the power and contact to the manufacturer.
7. Do not spray the module with water and other liquids.

7. RELIABILITY REQUIREMENTS

The manufacturer guarantees the quality of the module all the requirements of the user's manual passport if the consumer observes terms and conditions of storage, installation and operation, as well as guidance on the application specified in the user's manual.

Operating warranty is two years from the acceptance date, in case of requalification – from the date of the requalification.

Reliability probability of the module for 25000 hours must be at least 0.95.

Gamma percentage life ($T\gamma$) of module at $\gamma = 90\%$ in typical operation conditions should not be less than 50 000 hours within lifetime.

Gamma-percent service life of the modules, subject to cumulative operating time is not more than gamma-percent life, not less than 10 years, at $\gamma = 90$ %.

Gamma-percent storageability time of the modules, at $\gamma = 90$ % and storing – 10 years.

8. OVERALL AND CONNECTING DIMENSIONS

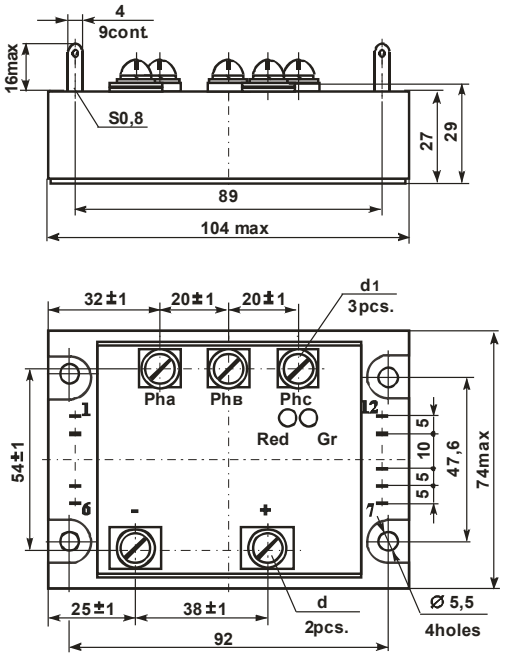

Figure 8.1 – Overall dimensions of modules MO30

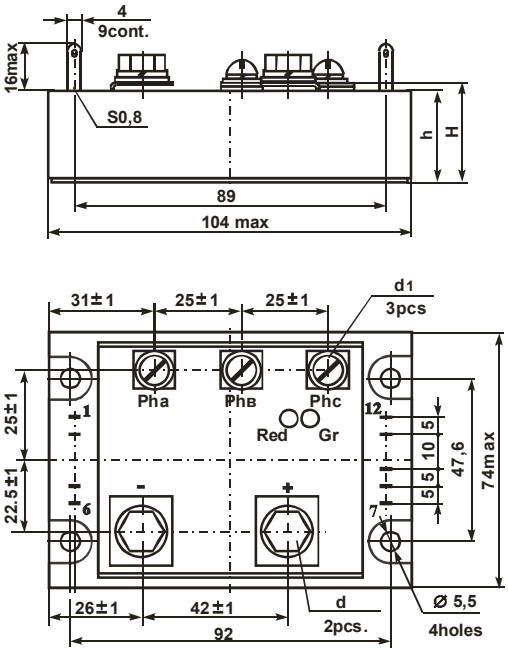

Figure 8.2 – Overall dimensions of modules MO30

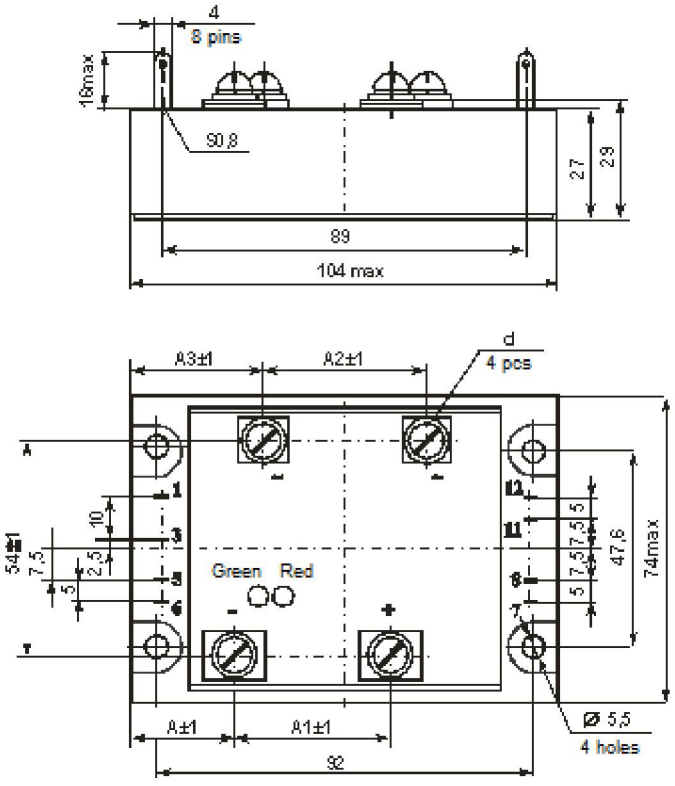

Figure 8.3 – Overall dimensions of modules MO30.1

Table 8.1 – Versions table of modules overall drawings MO30

Device symbol	Fig.	d	d_1	h, mm	H, mm
MO30-63-12	8.1	Screw M5	Screw M5	-	-
MO30-100-12	8.2	Screw M6	Screw M5	27	29
MO30-160-12	8.2	Screw M6	Screw M5	27	29
MO30-250-12	8.2	Bolt M8	Screw M6	29	31

Table 8.2 – Versions table of modules overall drawings MO30.1

Device symbol	Fig.	d	A, mm	A1, mm	A2, mm	A3, mm
MO30.1-63-12	8.3	Screw M5	25	38	40	32
MO30.1-100-12	8.3	Screw M6	26	42	50	31
MO30.1-160-12	8.3	Screw M6	26	42	50	31

Precious metals are not contained.

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