POWER REGULATOR MODULE
M25M, M25T

USER'S MANUAL

5 Naugorskoe shosse, Orel, 302020, Russia Tel. +7(4862) 44-03-44, Fax +7(4862) 47-02-12
E-mail: mail@electrum-av.com

CONTENTS

1. APPLICATION AND FUNCTIONS

Module of power regulator with current protection (M25T) and without current protection (M25M) is intended to adjust the power of active load and active-inductive one in AC nets with voltage 220/380V. In the modules M25 (hereinafter – module) has been used a phase method to adjust the power in load; at this method changing of load power is carried out by changing by duration of pair open state of inverse-parallel thyristors, during a relevant half-period of the net voltage. The power value is adjusting with emitting of the control signal having a standard form (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 output power value from 0 to 100%. In the module is maintained a galvanic isolation of control circuits and power circuits.

The module maintains the following functions:

- commutation of alternating voltage;
- changing of output power by phase method;
- smooth start at supply switching on;
- protection against overcurrent (modules M25T);
- indication of current protection operation (modules M25T).

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

2. PRODUCED MODULES

By the control types the modules M25 are represented by the following versions:

A – maximum control signal amplitude corresponds to minimum output power;

B – maximum control signal amplitude corresponds to maximum output power;

By the control signal type by thyristors conductance angle (signal of input «Ctrl»):

1 – potential control 0…5 V;

2 – potential control 0…10 V;

3 – current control 4…20 mA;

4 – current control 0…5 mA;

5 – current control 0…20 mA;

Independently from the control type all the modules are produced with an amount of maximum output rms current 25,40,63,100,160,250 A, with peak voltage 1200 V.

On Figure 2.1 is shown modules' name explanation of series M25.

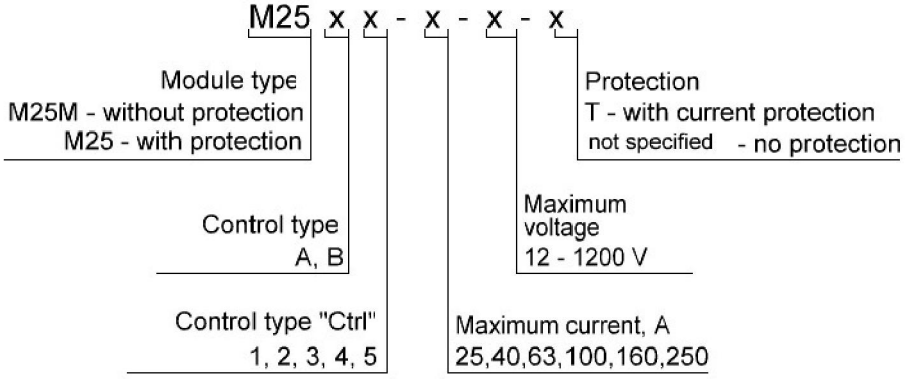


Figure 2.1 – Module's name explanation

For example, M25M-B1-100-12: a module without current protection with potential control 0…5 V, maximum control signal amplitude corresponds 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 M25M and M25T are an assembly of thyristors control circuit and power thyristors. The structural modules' circuits are represented on Figures 3.1 and 3.2.

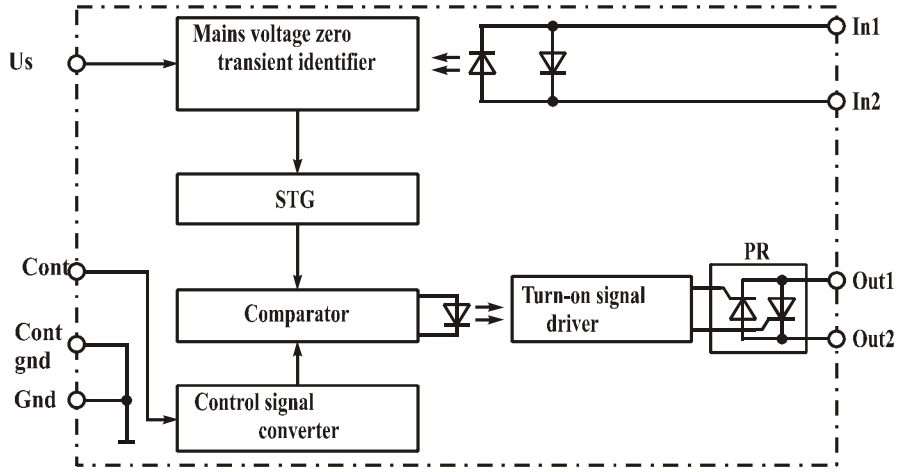


Figure 3.1 – Structural circuit of M25M

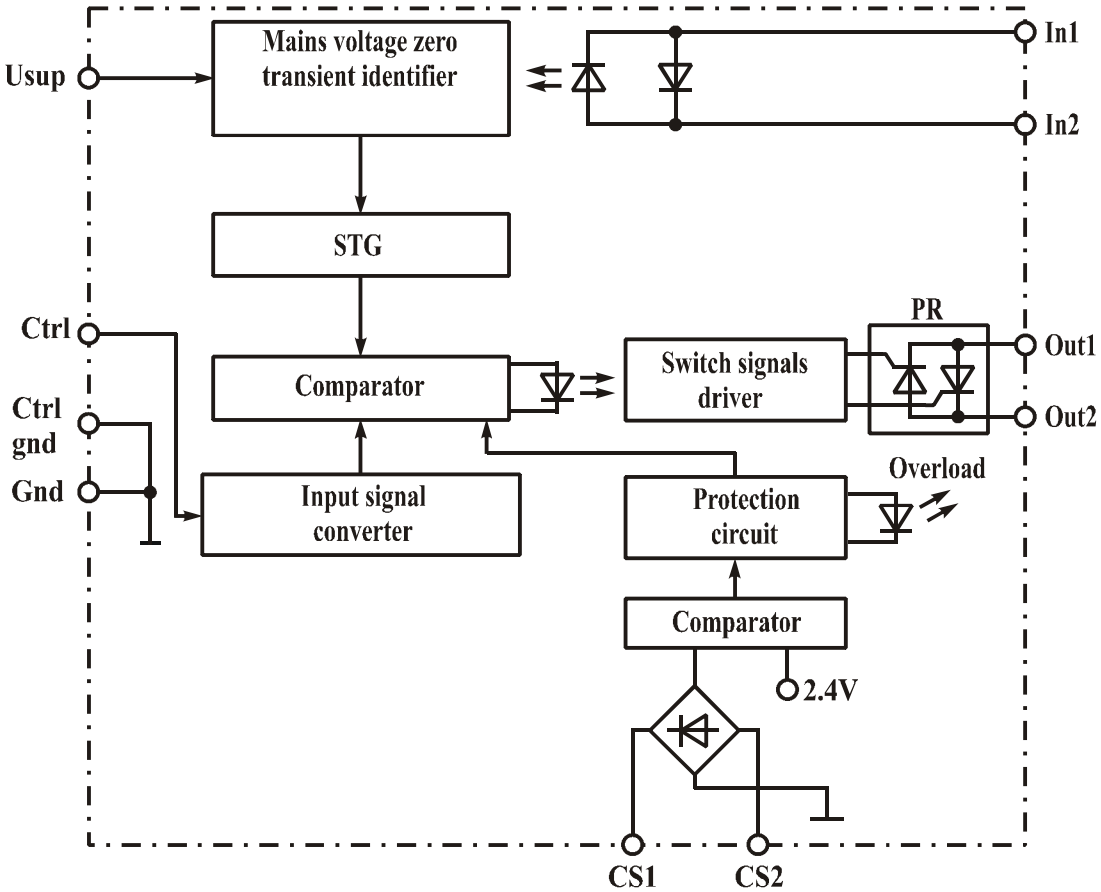


Figure 3.2 – Structural circuit of M25T

Power terminals - screwed terminal for screws M5, M6 or M8 (see overall drawings). The control socket is two rows of pin terminals. The application of the control socket outputs, power outputs and LED indication are represented in Table 3.1.

Table 3.1 – Назначение выводов модулей

Output #	Name	Application
5	In2	Outputs for net voltage control
6	In1	
7	CS2	Inputs for current sensor connection (connected only for M25T)
8	CS1	
9	Ctrl	Input of control signal
10	Ctrl gnd	«Minus» of control signal
11	U_{sup}	Output «plus» of module supply voltage
12	Gnd	Common «minus» of supply circuits
Power outputs	Out1, Out2	Power outputs of thyristor power regulator
LED	Overload	LED in red color for overcurrent indication of power circuit (only for M25T)

4. BASIC AND MAXIMUM PERMISSIBLE PARAMETERS

Basic electrical 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

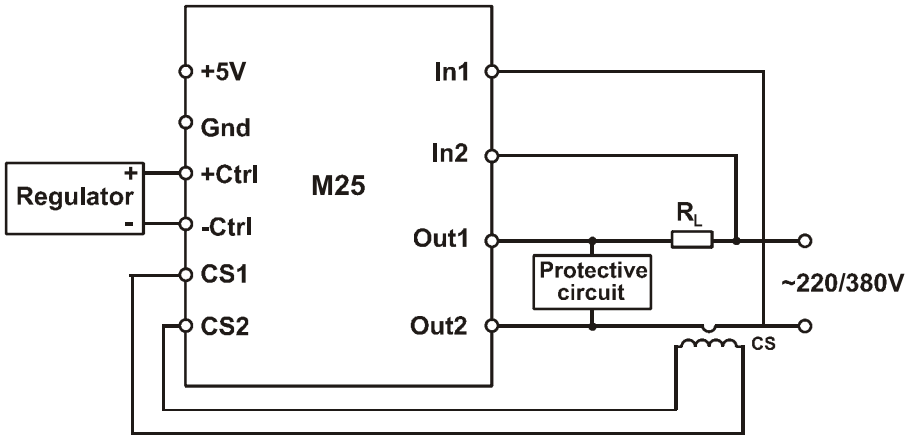
Parameter	Unit	Control type									
		A1	**A2**	**A3**	**A4**	**A5**	**B1**	**B2**	**B3**	**B4**	**B5**
Supply voltage (input «U_{sup}»)	V	5±0.5									
Input current consumption «U_{sup}», max	mA	30									
Current consumption of inputs «In1» and «In2», (U_{in} = ~380V), max	mA	7									
Peak voltage of inputs «In1» and «In2», (max)	V	±1200									
Value of control signal corr. 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
Value of control signal corr. 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
Resistance of control signal input circuit (min)	kΩ	≥10	≥10	-	-	-	≥10	≥10	-	-	-
Voltage on input «Ctrl», max	V	6	12	2	2	2	6	12	2	2	2
Duration of blocking in overcurrent mode for M25T (typical)	ms	200									
Insulation voltage power circuits / control circuits (DC, 1 minute)	V	4000									

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

Parameter name, Unit	Symbol	Maximum module current, A					
		25	**40**	**63**	**100**	**160**	**250**
Repetitive pulse voltage reverse / in off-state (max), V	V_{DRM} /V_{RRM}	±1200					
Commutating voltage (rms), V	$V_{O(RMS)}$	~ 200…430					
Commutating current (rms), (max), A	$I_{O(RMS)}$	25	40	63	100	160	250
Surge current in open state t=10 ms (max), A	I_{TSM}	200	300	750	1250	2000	3200
Repetitive pulse current in off-state / reverse current (max), mA	I_{DRM} / I_{RRM}	±0.6					
Pulse voltage in on-state at I = $I_{O(RMS)}$ (max), V	V_{TM}	1.5					
Extreme current rise rate in on-state (max), A/µs	$(di_T/dt)_{crit}$	160					
Extreme voltage rise rate in on-state (max), V/µs	$(du_d/dt)_{crit}$	500					
Thermal junction-base resistance (max), ºC/W	R_{thjc}	1	0.7	0.6	0.3	0.23	0.15
Protection operation current (typ.) for M25T, A	I_{CP}	35	56	89	141	226	353
Junction temperature (max), °C	T_J	125					
Electrical insulation strength of power circuits on housing (DC, 1 minute), V	V_{ISOL}	4000					

5. OPERATION AND MODULE CONTROL

Typical connection circuit of modules is represented on Figure 5.1



CS – current sensor CS 005.007-2 (Manufacturer CJSC «Energis», included in the package for M25T)

Figure 5.1 – Typical circuit of modules' connection M25T *

* - Connection circuit of the modules for M25M is similar, excluding: no connection of current sensor CS.

Besides Figure 5.1, possible connection circuits of the modules M25 in load circuit are shown on Figure 5.2.

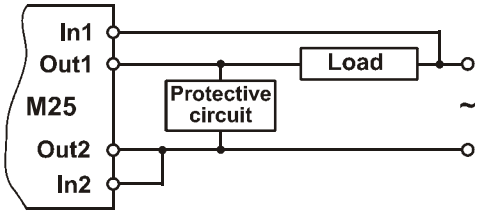


Figure 5.2 – Parallel connection of synchronizing circuit with load

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

Voltage zero transient identifier (VZTI) forms pulses during line voltage zero transient, which synchronize sawtooth generator (STG). In comparator (C) voltage STG and control signal voltage U_{cont} are compared, this signal is received from input signal converter circuit. When STG reaches the value U_{cont} a pulse will be generated that switches on the power rectifier (PR). Changing of control signal value leads to changing of equality moment between STG and U_{cont} and accordingly turn-on phase of PR. Thereby load power regulation will be reached.

The transformer is provided for smooth launch mode at initial turn-on and turn-on after overload, which eliminates transformer saturation and big initial inrush current.

The module M25T provides a protection against overload. When reaching of an instantaneous value load current I = 1.41 x $I_{O(RMS)}$ ($I_{O(RMS)}$ – depends on the version, see Table 4.2) the modules switches off; the indicator «Overload» lights. In 200 ms the protection is removed. If an emergency is not eliminated then the protection cycle is repeated again.

The control module is carried out using the following outputs:

«Usup». Output for connection «+» of control circuit supply voltage. The supply voltage should be 4.5…5.5 V; it is not allowed to be voltage pulsation more than the mentioned range. The current consumption for the input is not more than 30 mA.

«Gnd». Output for connection "-" of control circuit supply voltage.

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

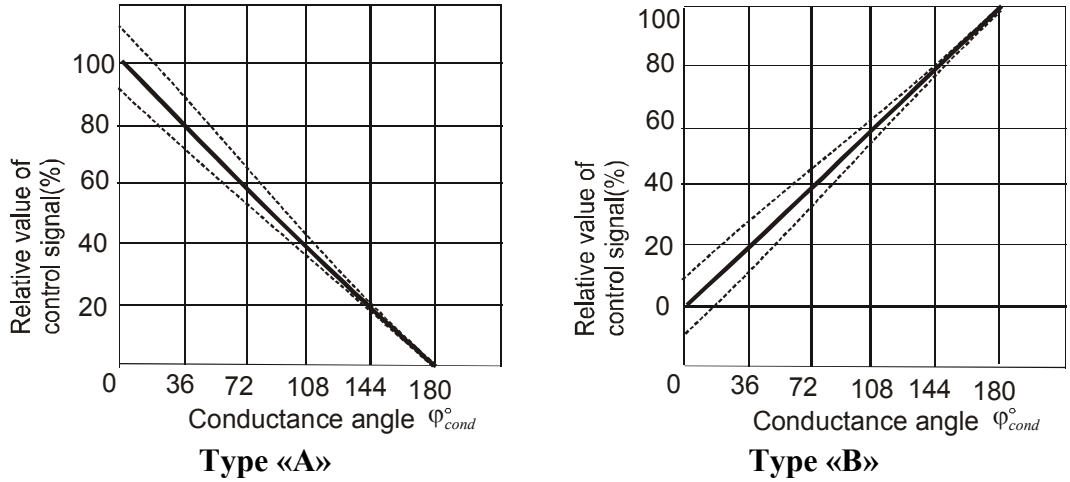


Figure 5.3 – Dependence of conductance angle versus value of control signal

«Ctrl.Gnd». General circuit output of thyristors' conductance angle setting.

«In1», «In2». Inputs for net voltage control. The inputs are intended to synchronize the control circuit with power circuit. The current consumption for the inputs «In1», «In2» does not exceed 7 mA.

«CS1», «CS2». Inputs for current sensor connection; the outputs are used for M25T only. When the inputs «CS1», «CS2» are not used then the current protection of the module M25T will be switched off. The supply package of the M25T includes current sensors D 005. 007-2 operating in the frequencies' range 50±1 Hz, with continuous current 5…250 A, with coefficient 1:2000.

Table 5.1 – Protection operation current on measuring terminals

Module current,A	25	40	63	100	160	250
Protection current, mA	17.5	28	44.5	70	113	177

Permissible deviation of protection operation current – is not more than ±5%. Avoid prolonged exceeding values (more than 10 s) with measuring current shown in Table 5.1.

When using the module as a part of power regulator of three-phase load the control circuits' connection should make in accordance with Figures 5.4 и 5.5.

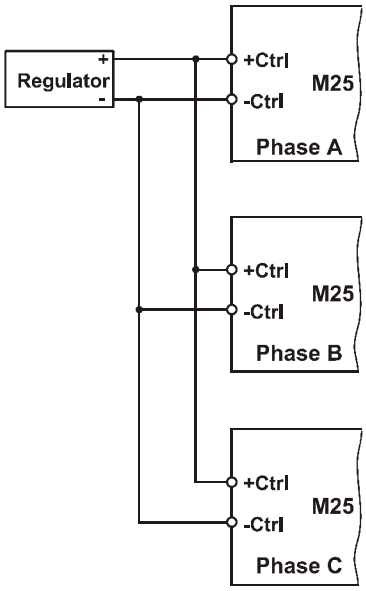


Figure 5.4 – Circuit of control circuit connection when using the module as a part of three-phase power regulator for groups:
A-1, A-2, B-1, B-2

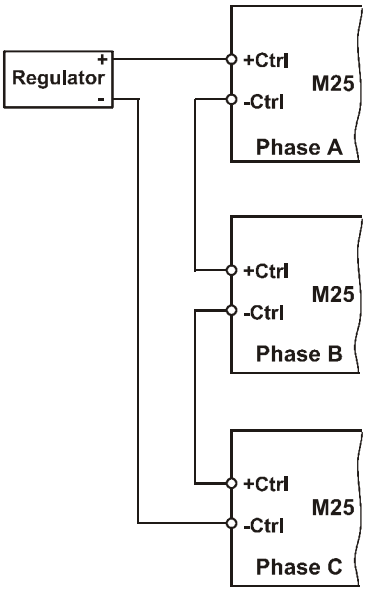


Figure 5.5 – Circuit of control circuit connection when using the module as a part of three-phase power regulator for groups:
A-3, A-4, A-5, B-3, B-4, B-5

Note – When connecting the control circuits in accordance with Figure 5.5 the module supply should be performed from three independent galvanic isolated power supplies.

Schematic examples of three-phase power regulators based on M25 are shown at Figures 5.6 and 5.7.

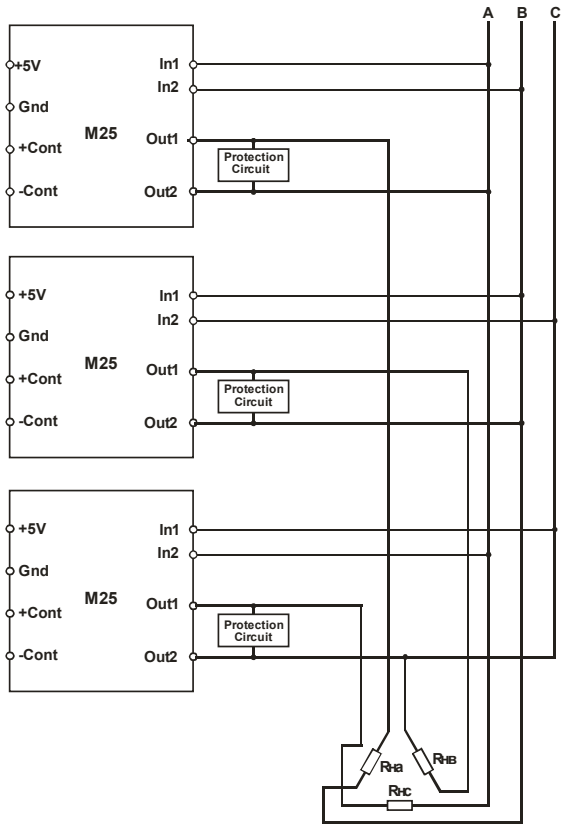


Figure 5.6 – Scheme's example of three-phase power regulator on M25 (open connection in «delta»)

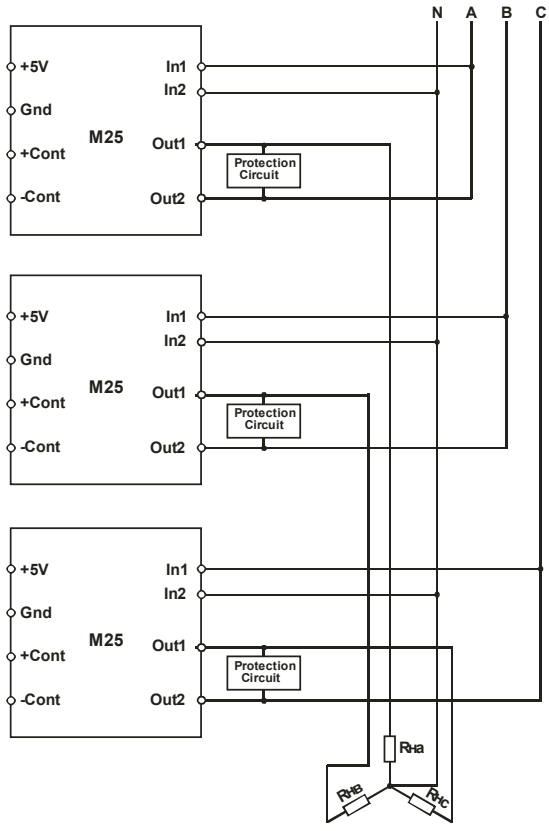


Figure 5.7 – Scheme's example of three-phase power regulator on M25 (connection in «wye» with output of neutral)

For protection of power modules thyristors against pulse surges in close proximity to the modules outputs it is necessary to install a protective circuit. Possible protective circuit scheme is shown on Figure 5.8.

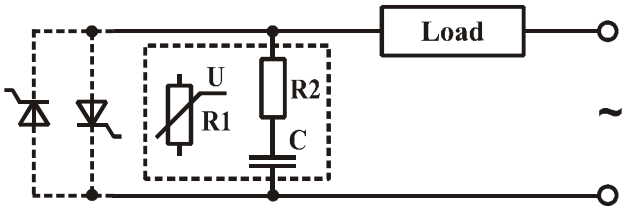


Figure 5.8 – Protective scheme of modules M25

For protection of the thyristors against overvoltage it is necessary to use varistors of kind: FNR; JVR with a nonlinearity factor more than 30 and dissipation energy 10…114 J, classified voltage 680…750 V – for net 380 V and 390…470 V – for net 220 V. It is necessary to note that the voltage on the varistor at the moment of overvoltage depends on the current on other conditions being equal. When commutating higher current, the use of the thyristors of 12-th class increases the product reliability but does not exclude to use the varistors.

To decrease the voltage rise rate (pulse noises in commutating net or voltage surges at break load circuit having inductive nature) is necessary to use a damping RC-circuit. The parameters of the protective RC-circuit for extreme commutating currents are shown on Table 5.2.

Table 5.2 – Parameters of protective RC-circuit

Module current	**25**	**40**	**63**	**100**	**160**	**250**
C, µF	0.039…0.043	0.043…0.100	0.100…0.130	0.180…0.200	0.300…0.390	0.470…0.510
R, Ω	36…43	22…36	18…22	10…12	6.2…8.2	3.6…3.9
P_R, W	0.5	0.5	1	2	2	10

6. OPERATION FOR USE

General requirements

Module operating is advisable when working average current value is not more than 80% from the module specified in the name 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 an electric circuit of equipment with use of the modules should be provided a fast-speed protection against invalid loads, short circuits and commutating overloads.

Module mounting

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

The contact area of the cooler should have roughness not more than 2.5 μm and flatness tolerance– not more than 30 μm. The cooler surface should not have any rough edges, honeycombs. There should not be extraneous particles between the module and the cooler. To improve the heat balance the module installation to mounting area or cooler should be carried out by instrumentality of heat conducting pastes or having similar heat conducting properties.

When mounting, you should provide uniform pressure of module housing to cooler. For this purpose you should tighten all screws uniform in 2 – 4 motions by turns: first, located on one diagonal, then on the other one. Disassembling the module the screw tightening should be done in the reverse order.

Not earlier than in 3 hours after mounting the screws should be rotated to the end, keeping the prescribed torque, because the part of heat conducting paste under pressure will outflow and the fastening can ease off.

You can install the several modules without additional insulating spacer to one cooler, on condition that voltage between outputs of different modules will not exceed the minimum value of isolation breakdown voltage of each of them or when the cooler is grounded.

Connection to module

Electric wires and cables will be connected to power contacts of the module by means of screws M5 and M6 with torque (4 ± 0.5) N·m or by means of bolts M8 with torque (5 ± 0.5) N·m and the washers that are supplied in the package.

The power wires should be connected by means of connectors with corrosion-inhibiting cover, which are purified of foreign layers. When screws (bolts) are tightened it is recommended to fasten the connection with paint. It is recommended to tighten screws (bolts) repeatedly in 8 days and in 6 weeks after commencement of operating. Afterwards tightening should be controlled at least once a half year.

The controlling module outputs are intended for mounting by means of soldering or split connectors. The permissible number of module outputs' re-soldering during electronic (assembly) edit is three. Outputs soldering should be performed at temperature not higher than (235±5) °C. Soldering duration is not longer than 3 sec.

When mounting and operating it is necessary to make protection measures against static electricity impact and overvoltage in gate circuit (when mounting the personnel should use a ground band and grounded low-voltage soldering irons with transformer supply).

Operation requirements

The module should be used under mechanical loads in accordance with Table 6.1.

Table 6.1 – Mechanic loads impacts

External exposure factor	External exposure factor value
Sinusoidal vibration: - acceleration, m/s^2 (g); - frequency, Hz	 150 (15) 0.5 - 100
Repeated mechanical shock:	

- peak shock acceleration, m/s^2 (g); - shock acceleration duration, ms	40 (4) 50
Linear acceleration, m/s^2 (g)	5000 (500)

The module should be used under climatic loads in accordance with Table 6.2.

Table 6.2 – Climatic loads impacts

Climatic factor	Climatic factor value
Low ambient temperature: - operating, °C; - maximum, °C	 - 40 - 45
High ambient temperature: - operating, °C; - maximum, °C	 + 85 + 100
Relative humidity at temperature 35 °C without moisture condensation, %, max	98

Safety 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.
3. Do not connect or disconnect wires and connectors while on the power circuit is 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. Avoid contacting to 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 if the consumer observes terms and conditions of storage, mounting and operation, as well as guidance on the application specified in the user's manual.

Operating warranty is 2 years from the acceptance date, in the case of requalification – from the date of the requalification.

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

Gamma-percent life must be no less than 50000 hours at $\gamma = 90$ %.

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

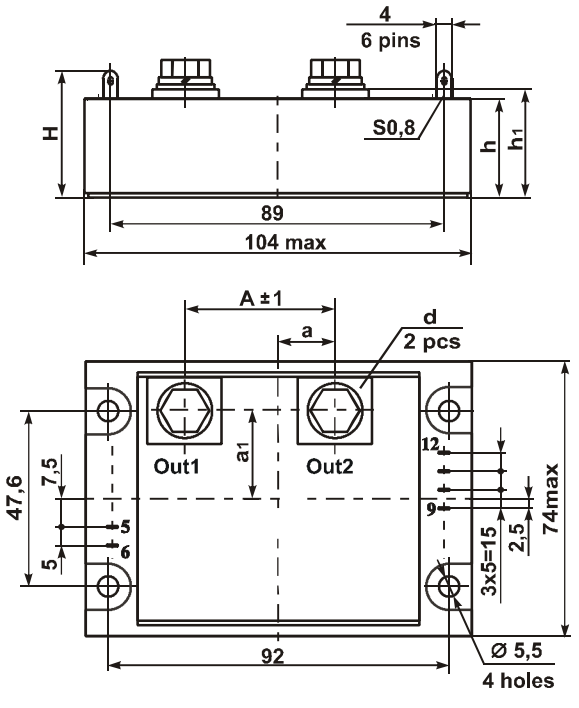


Figure 8.1 – Overall dimensions of modules M25M

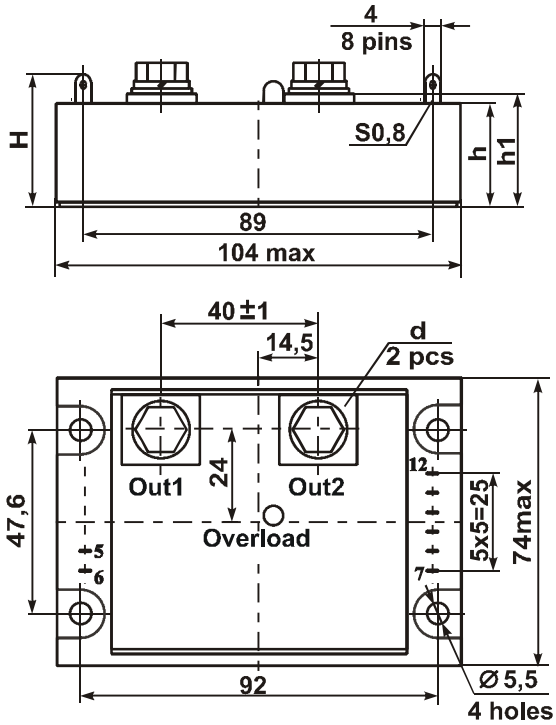


Figure 8.2 – Overall dimensions of modules M25T

Table 8.1 – Versions table of overall drawing of modules M25M and M25T

Module name	d	A, mm	a, mm	a_1, mm	h, mm	h_1, mm	H, mm
M25(M)-x-25-12(T)	Screw M5	54	27	21	27	29	35 max
M25(M)-x-40-12(T)	Screw M5	54	27	21	27	29	35 max
M25(M)-x-63-12(T)	Screw M5	54	27	21	27	29	35 max
M25(M)-x-100-12(T)	Screw M6	54	27	21	27	29	35 max
M25(M)-x-160-12(T)	Screw M6	40	20	24	27	29	35 max
M25(M)-x-250-12(T)	Bolt M8	40	14.5	24	27	29	35 max

Precious metals are not contained.

5 Naugorskoe shosse, Orel, 302020, Russia Tel. +7(4862) 44-03-44, Fax +7(4862) 47-02-12
E-mail: mail@electrum-av.com