TRANSISTOR MODULES IGBT
IN DESIGN VERSION E2

USER'S MANUAL

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

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This document is a user's manual with a description of characteristics of this product for which are warranted. All the products in the production process pass a complete set of electrical tests, which are performed twice, once before encapsulation, and then again after it. Tests carried out by "Electrum AV" are exhaustive and include 100% control at the final testing.

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If you need information about the product, which is not shown in this user's manual or which concerns the specific application of our product, please contact the sales office to the manager who is responsible for your enterprise.

Engineers "Electrum AV" have a lot of experience in the design, manufacture and application of powerful force devices and smart drivers and has already implemented a large number of individual decisions. If you need power modules and drivers that are not included in the package, as well as products with differences from the standard devices in specifications or design, please contact to our managers and specialists who will offer you best solution for your application.

"Electrum AV" reserves the right to make changes without notice in this document to improve the reliability, functionality and design improvement.

1. APPLICATION AND PRODUCED MODULES

IGBT-modules in design version «E2» are assemblies IGBT-transistors and FRD-diodes are intended to commutate power loads as part of converters with maximum peak voltage 600 V or 1200 V and DC up to 150 A. IGBT-modules are presented with the following versions:

M10 – lower switch – a series connected IGBT-transistor shunted with a reverse FRD and a series connected FRD (common collector-anode). The module is produced with maximum DC 75 A with peak voltage 600 V and a number of current 50,75,100,150 A with peak voltage 1200 V.

M11 – upper switch – series connected IGBT-transistor shunted with a reverse FRD and a series connected FRD (common emitter-cathode). The module is produced with maximum DC 75 A with peak voltage 600 V and DC 150 A with peak voltage 1200 V.

M12 – two series connected IGBT-transistor (half-bridge) shunted with reverse FRDs. The module is produced with a number of maximum DC 50,75,100,150 A with peak voltage 600 V or 1200 V.

In dependence on the current, the voltage and the version the modules are produced in designs that specified in Table 1.1. The modules are produced only in the versions where when crossing the module type line and the current column is specified the overall dimension corresponding to the version.

Table 1.1 – Produced IGBT-modules and corresponding to them overall dimensions

Module type	Voltage, V	Current, A			
		50	75	100	150
M10	600		Fig.6.1		
	1200	Fig.6.1	Fig.6.1	Fig.6.1	Fig.6.1
M11	600		Fig.6.1		
	1200				Fig.6.1
M12	600	Fig.6.1	Fig.6.1	Fig.6.1	Fig.6.1
	1200	Fig.6.1	Fig.6.1	Fig.6.1	Fig.6.1

On Figure 1.1 is shown modules name explanation.

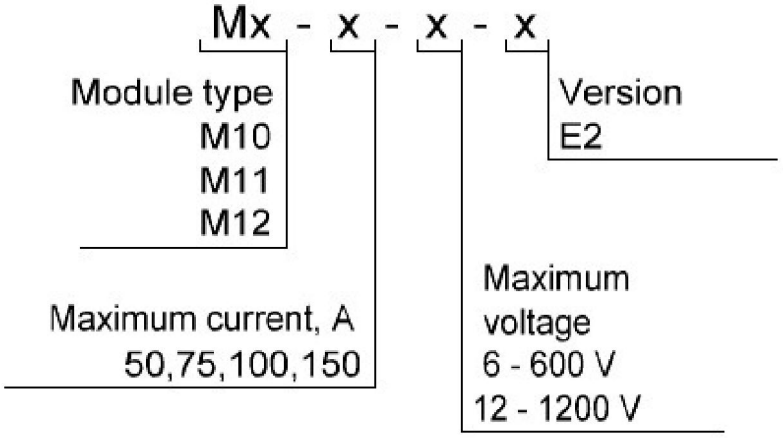

Figure 1.1 – Modules name explanation

For example, module M12-100-12-E2: a half-bridge with maximum permissible collector-emitter voltage 1200 V, maximum permissible DC 100 A with version «E2».

The modules are analogues of power modules produced by «Infineon» in accordance with Tables 1.2 – 1.3.

Table 1.2 – Conformity modules of 6-th class

Class, V	Current, A	SEMIKRON	Infineon	"Electrum AV", CJSC
Low switch				
600	75	SKM75GAL063D	-	M10-75-6-E2
Upper switch				
600	75	SKM75GAR12T4	-	M11-75-6-E2
Half-bridge				
600	50	SKM50GB063D	BSM50GB60DLC	M12-50-6-E2
600	75	SKM75GB063D	BSM75GB60DLC	M12-75-6-E2
600	100	SKM100GB063D	BSM100GB60DLC	M12-100-6-E2
600	150	SKM145GB063D	BSM150GB60DLC	M12-150-6-E2
600	200		BSM200GB60DLC	M12-200-6-E2

Table 1.3 – Conformity modules of 12-th class

Class, V	Current, A	SEMIKRON	Infineon	"Electrum AV", CJSC
Low switch				
1200	50	SKM50GAL12T4	-	M10-50-12-E2
1200	75	SKM100GAL123D	-	M10-75-12-E2
1200	100	SKM100GAL12T4	-	M10-100-12-E2
1200	150	SKM195GAL126D	FD150R12RT4	M10-150-12-E2
Upper switch				
1200	150	SKM150GAR12T4	DF150R12RT4	M11-150-12-E2
Half-bridge				
1200	50	SKM50GB12T4	FF50R12RT4	M12-50-12-E2
1200	75	SKM75GB12T4	FF75R12RT4	M12-75-12-E2
1200	100	SKM100GB12T4	FF100R12RT4	M12-100-12-E2
1200	150	SKM195GB126D	FF150R12RT4	M12-150-12-E2

2. GENERAL DESCRIPTION

In dependence on the module type the electrical circuits of the modules are different; on Figures 2.1 - 2.3 are represented possible variants of the modules circuits.

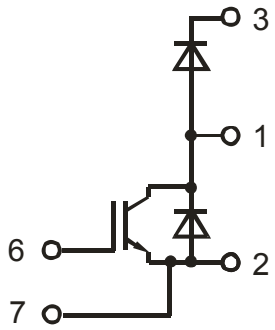

Figure 2.1 – Electrical circuit of modules M10

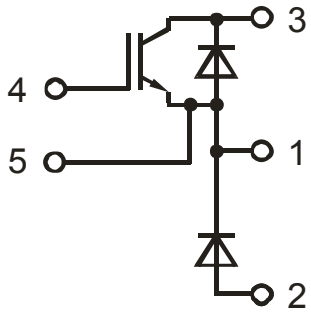

Figure 2.2 – Electrical circuit of modules M11

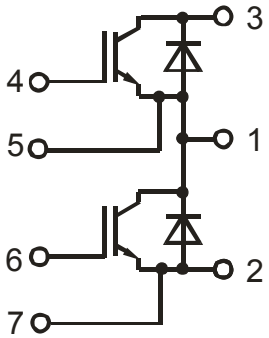

Figure 2.3 – Electrical circuit of modules M12

Attention! When transporting the gate and emitter must be short-circuited!

3. BASIC PARAMETERS

Basic electrical parameters and maximum permissible modules' parameters at temperature 25^0C are shown in Tables 3.1, 3.2.

Table 3.1 – Basic and maximum permissible parameters of modules of 6-th class

Parameter name, Unit	Symbol	Module maximum current, A			
		50	75	100	150
Basic characteristics					
Collector-emitter breakdown voltage (min), V	$V_{(BR)CES}$	600			
Power circuit direct voltage (max), V	V_{DC}	350			
Power circuit DC (max), A	I_{DC}	50	75	100	150
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VT}$	0.4	0.35	0.3	0.2
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VD}$	0.7	0.65	0.6	0.4
Power dissipation (max), W	P_D	300	360	420	625
Isolation strength (DC), V	V_{ISOL}	4000			
Static characteristics					
Gate-emitter threshold voltage, V	$V_{GE\,(th)}$	4.5…6.5	4.5…6.5	4.5…6.5	4.5…6.5
Gate leakage current (max), nA	I_{GES}	±500	±500	±500	±500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1.7	1.7	1.7	1.7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2.2	2.2	2.2	2.2
Collector leakage current (max), μA	I_{CES}	100	100	100	100
Dynamic characteristics					
Input capacitance (typical), pF	Cies	4000	4000	4500	6000
Output capacitance (typical), pF	Coes	250	250	300	450
Transfer capacitance (typical), pF	Cres	200	200	220	300
Switch-on delay time (max), ns	$t_{d(on)}$	150	150	150	200
Rise time (max), ns	t_r	80	80	80	200
Switch-off delay time (max), ns	$t_{d(off)}$	700	700	700	700
Fall time (max), ns	t_f	150	150	150	150
Switch-on loss energy (max), mJ	E_{ON}	5	5	5.5	18
Switch-off loss energy (max), mJ	E_{OFF}	7	7	7.6	24
Common gate charge (typical), nC	Q_G	400	500	600	800
Reverse diode characteristics					
Direct voltage fall (typical), V	V_F	2,1	2,1	2,1	2,1
Diode direct current (max), A	I_F	50	75	100	150
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	150	225	300	450
Reverse recovery current (typical), A	I_{RR}	50	50	75	125
Recovery time (typical), ns	t_{RR}	200	200	200	250
Maximum permissible modes					
Collector-emitter voltage (max), V	V_{CES}	600			
Gate-emitter voltage (max), V	V_{GE}	±20			
Collector DC at T = 25 °C (max), A	I_C	70	100	120	175
Collector DC at T = 100 °C (max), A	I_C	50	75	100	150
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	150	225	300	450
Junction temperature (max), ºC	Tj	150			

Table 3.2 – Basic and maximum permissible parameters of modules of 12-th class

Parameter name, Unit	Symbol	Module maximum current, A			
		50	75	100	150
Basic characteristics					
Collector-emitter breakdown voltage (min), V	$V_{(BR)CES}$	1200			
Power circuit direct voltage (max), V	V_{DC}	650			
Power circuit DC (max), A	I_{DC}	50	75	100	150
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VT}$	0.4	0.35	0.3	0.2
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VD}$	0.7	0.65	0.6	0.4
Power dissipation (max), W	P_D	300	360	420	625
Isolation strength (DC), V	V_{ISOL}	4000			
Static characteristics					
Gate-emitter threshold voltage, V	$V_{GE\,(th)}$	4.5…6.5	4.5…6.5	4.5…6.5	4.5…6.5
Gate leakage current (max), nA	I_{GES}	±500	±500	±500	±500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1.7	1.7	1.7	1.7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2.2	2.2	2.2	2.2
Collector leakage current (max), μA	I_{CES}	100	100	100	100
Dynamic characteristics					
Input capacitance (typical), pF	Cies	4000	4000	4500	6000
Output capacitance (typical), pF	Coes	250	250	300	450
Transfer capacitance (typical), pF	Cres	200	200	220	300
Switch-on delay time (max), ns	$t_{d(on)}$	150	150	150	200
Rise time (max), ns	t_r	80	80	80	200
Switch-off delay time (max), ns	$t_{d(off)}$	700	700	700	700
Fall time (max), ns	t_f	150	150	150	150
Switch-on loss energy (max), mJ	E_{ON}	5	5	5.5	18
Switch-off loss energy (max), mJ	E_{OFF}	7	7	7.6	24
Common gate charge (typical), nC	Q_G	400	500	600	800
Reverse diode characteristics					
Direct voltage fall (typical), V	V_F	2.1	2.1	2.1	2.1
Diode direct current (max), A	I_F	50	75	100	150
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	150	225	300	450
Reverse recovery current (typical), A	I_{RR}	50	50	75	125
Recovery time (typical), ns	t_{RR}	200	200	200	250
Maximum permissible modes					
Collector-emitter voltage (max), V	V_{CES}	1200			
Gate-emitter voltage (max), V	V_{GE}	±20			
Collector DC at T = 25 °C (max), A	I_C	70	100	120	175
Collector DC at T = 100 °C (max), A	I_C	50	75	100	150
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	150	225	300	450
Junction temperature (max), ºC	Tj	150			

4. INSTRUCTIONS FOR USE

General requirements

It is recommended to operate the module at operating value of average current not more than 80% from the mentioned in the name of the module and junction temperature not more than (70÷80)% from maximum one.

It is not allowed operating the modules in modes at simultaneous impacting two or more maximum permissible parameters' values.

In the electrical circuit of the equipment with use of the modules should be provided a fast-recovery protection against overloads, SCs and commutating overloads.

Module mounting

The module is mounted in the equipment to cooler (chassis, application housing, metal plates, etc.) in any orientation with screws M6 with 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 neighboring elements. The planes of 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. Cooler surface should not have any rough edges, honeycombs. There should not be extraneous particles between the module and 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 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 fail.

You can install the several modules without additional insolating 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 cooler is grounded.

Connection to module

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

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

When mounting and operating it is necessary to make protection measures against static electricity impact; on mounting the personnel should use the ground bands and grounded low-voltage soldering irons with transformer supply.

Operating requirements

Module should be used under mechanical loads in accordance with Table 4.1.

Table 4.1 – Mechanical loads impact

External exposure factor	External exposure factor value
Sinusoidal vibration: - acceleration, m/s^2 (g); - frequency, Hz	 150 (15) 0.5 - 100
Multiple-acting mechanic 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 4.2.

Table 4.2 – Climatic loads impact

Climatic factor	Climatic factor value
Reduced 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. Working with the module should only be performed by qualified personnel.
2. Do not touch the power terminals of the module when applying a voltage.
3. Do not connect or disconnect the wires and connectors while the power to the circuit module is applying a voltage.
4. Don't touch the module's radiator if it is not grounded and it's applied a voltage.
5. Don't touch the cooler and the module's housing in time its operation thereby their temperature can be very high.
6. Immediately turn off the power supply of the module if it discharges smoke, odor or abnormal noises, check if the module correctly connected.
7. It is not allowed penetrating water and other liquids to the module.

5. 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, installation 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 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 than10 years, at $\gamma = 90$ %.

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

6. OVERALL AND CONNECTING DIMENSIONS

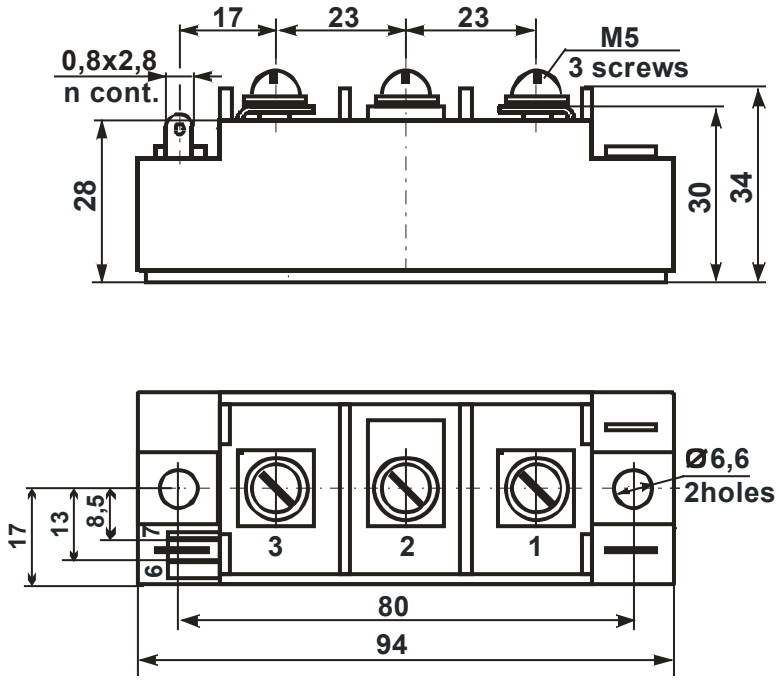

Figure 6.1 – Overall dimensions of modules M10 with version «E2»

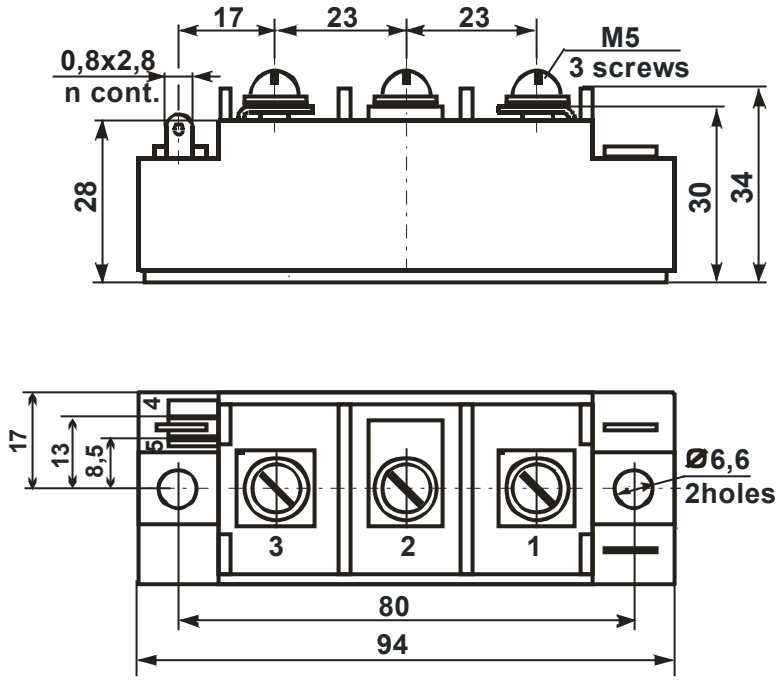

Figure 6.2 – Overall dimensions of modules M11 with version «E2»

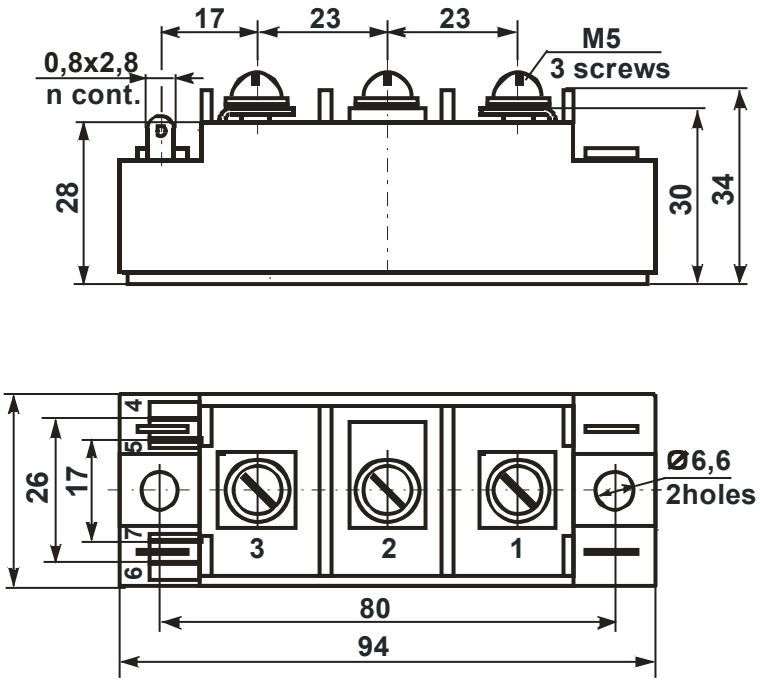

Figure 6.3 – Overall dimensions of modules M12 with version «E2»

Precious metals are not contained.

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