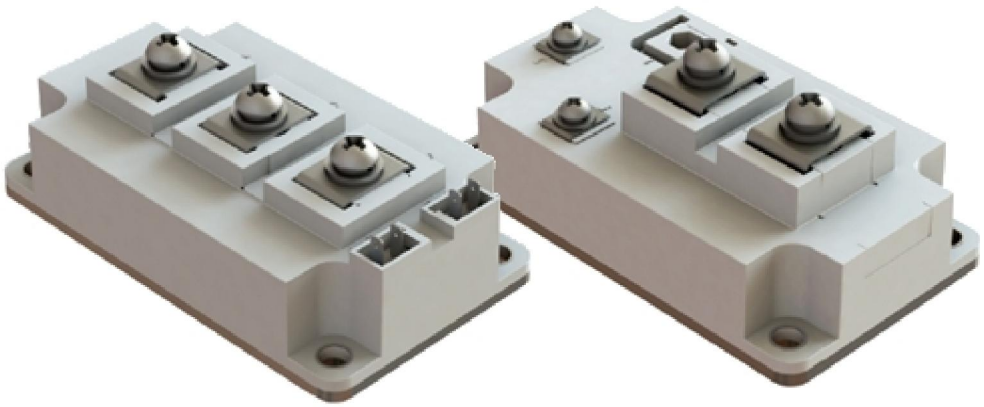
TRANSISTOR MODULES IGBT IN DESIGN VERSION E3-1, E3-2

USER'S MANUAL



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CONTENTS

1. APPLICATION AND PRODUCED MODULES

IGBT-modules in design versions «E3-1» and «E3-2» are assemblies IGBT-transistors and FRD-diodes are intended to commutate power loads as part of converters with a maximum peak voltage 600 V or 1200V and DC up to 600 A. IGBT-modules are presented with the following versions:

M9 – single switch shunted with reverse FRD. The module is produced with maximum DC 200,300,400, 600A and peak voltage 1200V.

M10 – low switch- series connected IGBT- transistor shunted with reverse FRD and series connected FRD(common collector-anode). The module is produced with maximum DC 300A and peak voltage 600 V and current 150,200,300,400A with peak voltage 1200V.

M11 – upper switch- series connected IGBT-transistor shunted with reverse FRD and series connected FRD(common emitter- cathode). The module is produced with maximum DC 300A and peak voltage 600V and current 150,200,300,400A with peak voltage 1200V.

M12 – two series connected IGBT-transistor (half-bridge) shunted with reverse FRDs. The module is produced with a number of maximum DC 200,300,400,600 A with peak voltage 1200V.

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.

Table1.1 – Produced IGBT-modules and and corresponding to them overall dimensions

Module type	Voltage, B	Current, A				
		150	200	300	400	600
M9	1200		Fig.6.1	Fig.6.1	Fig.6.1	Fig.6.1
M10	600			Fig.6.2		
	1200	Fig.6.2	Fig.6.2	Fig.6.2	Fig.6.2	
M11	600			Fig.6.2		
	1200	Fig.6.2	Fig.6.2	Fig.6.2	Fig.6.2	
M12	600		Fig.6.2	Fig.6.2	Fig.6.2	Fig.6.2
	1200	Fig.6.2	Fig.6.2	Fig.6.2	Fig.6.2	

On Figure 1.1 is shown modules name explanation.

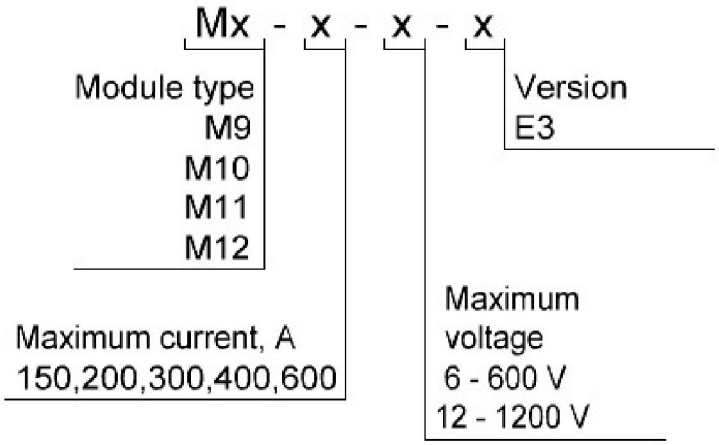

Figure 1.1 – Modules name explanation

For example, module M12-100-12-E3: a half-bridge with maximum permissible collector-emitter voltage 1200 V, maximum permissible DC 200 A with version «E3».

The modules are analogues of power modules produced by «Infineon» in accordance with Tables 1.2 – 1.4.

Table 1.2 – Conformity modules in housing «E3-2»

Class, V	Current,A	SEMIKRON	Infineon	"Electrum AV", CJSC
Single switch				
1200	200	SKM300GAL063D		M9-200-12
1200	300	SKM200GAL126D	FZ300R12KE3G	M9-300-12
1200	400	SKM200GAL12E4	FZ400R12KE3	M9-400-12
1200	600	SKM800GA126D	FZ600R12KE3	M9-600-12

Table 1.3 – Conformity modules in housing «E3-1»

Class, V	Current,A	SEMIKRON	Infineon	"Electrum AV", CJSC
Low switch				
600	300	SKM300GAL063D	FD300R06KE3	M10-300-6
Upper switch				
600	300	SKM300GAR063D		M11-300-6
Half-bridge				
600	200	SKM200GB063D	FF200R06KE3	M12-200-6
600	300	SKM300GB063D	FF300R06KE3	M12-300-6
600	400	SKM400GB066D	FF400R06KE3	M12-400-6
600	600	SKM600GB066D		M12-600-6

Table 1.4 – Conformity of 12 class modules in housing «E3-1»

Class, V	Current,A	SEMIKRON	Infineon	"Electrum AV", CJSC
Low switch				
1200	150	SKM200GAL126D		M10-150-12
1200	200	SKM200GAL12E4	FD200R12KE3	M10-200-12
1200	300	SKM300GAL12E4	FD300R12KE3	M10-300-12
1200	400	SKM400GAL12E4	FD400R12KE3	M10-400-12
Upper switch				
1200	150	SKM200GAR125D		M11-150-12
1200	200	SKM200GAR12E4	DF200R12KE3	M11-200-12
1200	300	SKM300GAR12E4	DF300R12KE3	M11-300-12
1200	400	SKM400GAR12E4	DF400R12KE3	M11-400-12
Half-bridge				
1200	150	SKM200GB126D	FF150R12KE3G	M12-150-12
1200	200	SKM300GB126D	FF200R12KE3	M12-200-12
1200	300	SKM400GB126D	FF300R12KE3	M12-300-12
1200	400	SKM600GB126D	FF400R12KE3	M12-400-12

2. GENERAL DESCRIPTION

In dependence on the module type the electrical circuits of the modules are different; on Figures 2.1 - 2.4 are represented possible variants of the modules circuits.

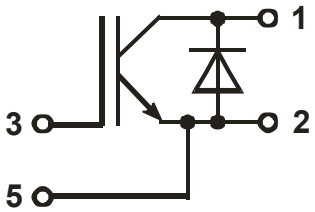

Figure 2.1 – Electrical circuit of the module M9

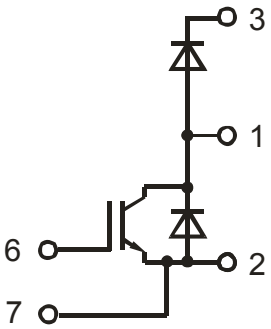

Figure 2.2 – Electrical circuit of the module M10

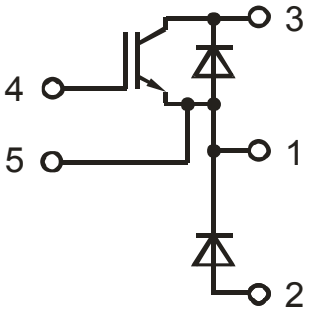

Figure 2.3 – Electrical circuit of the module M11

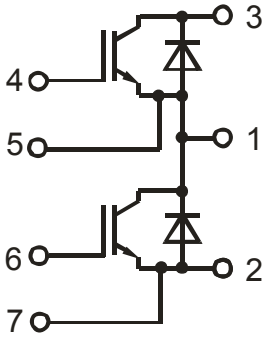

Figure 2.4- Electrical circuit of the module M12

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

3. BASIC PARAMETERS

Basic electrical parameters and maximum permissible parameters at temperature 25^0C are shown in Table 3.1.- 3.2

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

Parameter name, Unit	Symbol	Module maximum DC, A			
		200	300	400	600
Basic characteristics					
Collector-emitter breakdown (min), V	$V_{(BR)CES}$	600			
Power circuit DC voltage (max), V	V_{DC}	350			
Power circuit DC (max), A	I_{DC}	200	300	400	600
Junction-transistor housing thermal resistance (max), ºC/W	$R_{T(j-c)\,VT}$	0,15	0,15	0,1	0,06
Junction-diode housing thermal resistance (max), ºC/W	$R_{T(j-c)\,VD}$	0,25	0,25	0,2	0,12
Power dissipation (max), W	P_D	830	840	1250	2100
Circuit-isolation electrical 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	2,4	2,4
Collector leakage current (max), μA	I_{CES}	100	100	300	300
Dynamic characteristics					
Input capacitance (typical), pF	Cies	15000	18000	25000	42000
Output capacitance (typical), pF	Coes	1500	1500	2000	4000
Transfer capacitance (typical), pF	Cres	1000	1000	1500	3000
Switch-on delay time (max), ns	$t_{d(on)}$	300	150	150	250
Rise time (max), ns	t_r	150	80	80	120
Switch-off delay time (max), ns	$t_{d(off)}$	700	700	700	900
Fall time (max), ns	t_f	150	150	150	150
Switch-on loss energy (max), mJ	E_{ON}	20	25	30	70
Switch-off loss energy (max), mJ	E_{OFF}	30	35	60	150
Gate common charge (typical), nC	Q_G	1500	1800	1800	3000

Table 3.1 continuation

Reverse diode characteristics					
Direct voltage fall (typical), V	V_F	2,1	2,1	2,1	2,1
Direct diode current (max), A	I_F	200	300	400	600
Pulse diode current at t_{pul} = 1 ms (max), A	I_{FM}	600	900	1200	1800
Reverse recovery current (typical), A	I_{RR}	250	350	450	700
Recovery time (typical), ns	t_{RR}	300	250	300	300
Maximum permissible modes					
Collector-emitter voltage (max), V	V_{CES}	600			
Gate-emitter voltage (max), V	V_{GE}	+20			
Direct collector current at T_{amb} = 25 °C (max), A	I_C	240	350	500	700
Direct collector current at T_{amb} = 100 °C (max), A	I_C	200	300	400	600
Pulse collector current at t_{pul} = 1 ms (max), A	I_{CM}	600	900	1200	1800
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 DC, A**			
		150	**200**	**300**	**400**
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}	150	200	300	400
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VT}$	0,2	0,15	0,15	0,1
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VD}$	0,4	0,25	0,25	0,2
Power dissipation (max), W	P_D	625	830	840	1250
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	2,4
Collector leakage current (max), μA	I_{CES}	100	100	100	300
Dynamic characteristics					
Input capacitance (typical), pF	Cies	6000	15000	18000	25000
Output capacitance (typical), pF	Coes	450	1500	1500	2000
Transfer capacitance (typical), pF	Cres	300	1000	1000	1500
Switch-on delay time (max), ns	$t_{d(on)}$	200	300	150	150
Rise time (max), ns	t_r	200	150	80	80
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}	18	20	25	30
Switch-off loss energy (max), mJ	E_{OFF}	24	30	35	60
Common gate charge (typical), nC	Q_G	800	1500	1800	1800
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	150	200	300	400
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	450	600	900	1200
Reverse recovery current (typical), A	I_{RR}	125	250	350	450
Recovery time (typical), ns	t_{RR}	250	300	250	300
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	175	240	350	500
Collector DC at T = 100 °C (max), A	I_C	150	200	300	400
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	450	600	900	1200
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 M6 with torque (4 ± 0.5) N·m and the 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:	 40 (4)

- peak shock acceleration, m/s^2 (g); - shock acceleration duration, ms	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 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 passport if the consumer observes terms and conditions of storage, installation and operation, as well as guidance on the application specified in the passport.

Operating warranty is 2 years from the acceptance date, in the event of requalification – from the date of 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 no more than gamma-percent life, no less than10 years, when $\gamma = 90$ %.

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

6. OVERALL AND CONNECTING DIMENSIONS

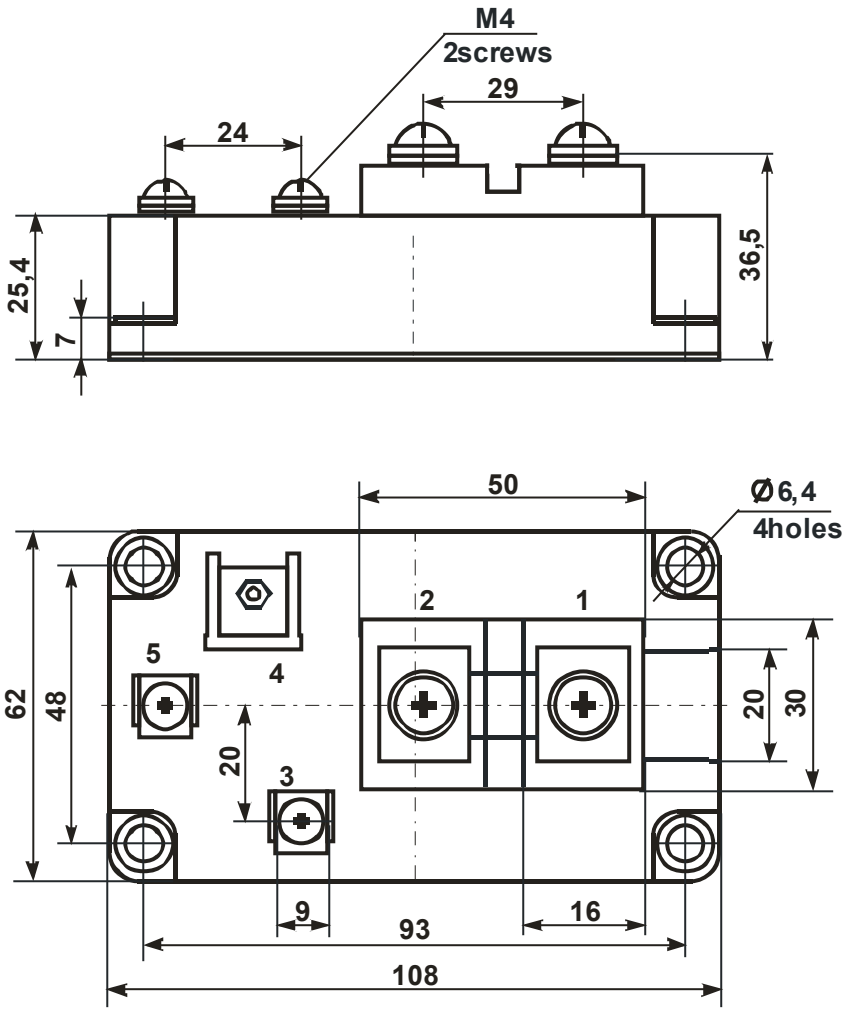

Figure 6.1- Overall dimensions of modules M9 (housing “E3-2”)

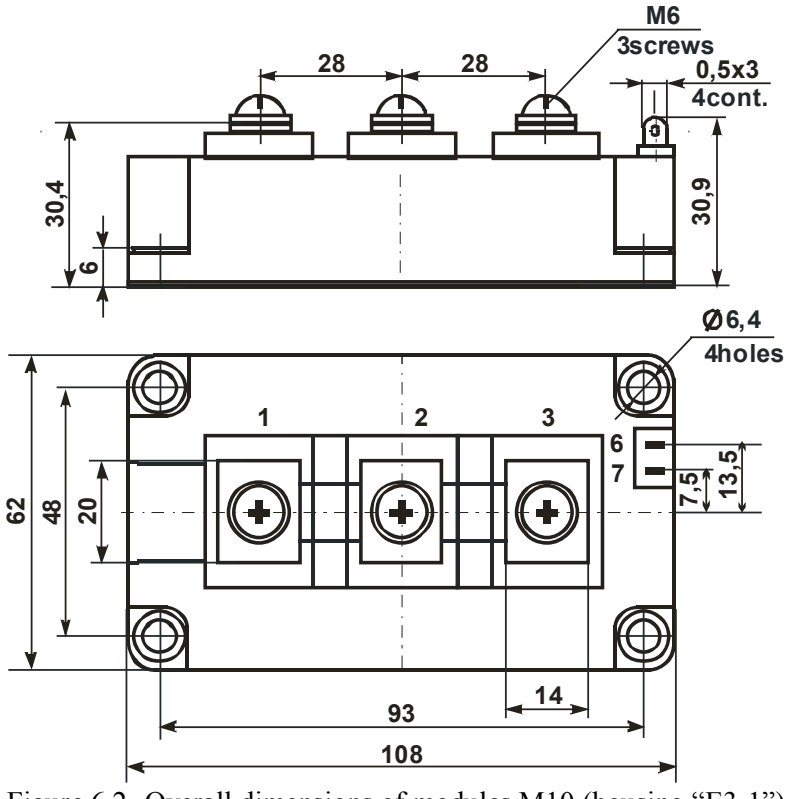

Figure 6.2- Overall dimensions of modules M10 (housing “E3-1”)

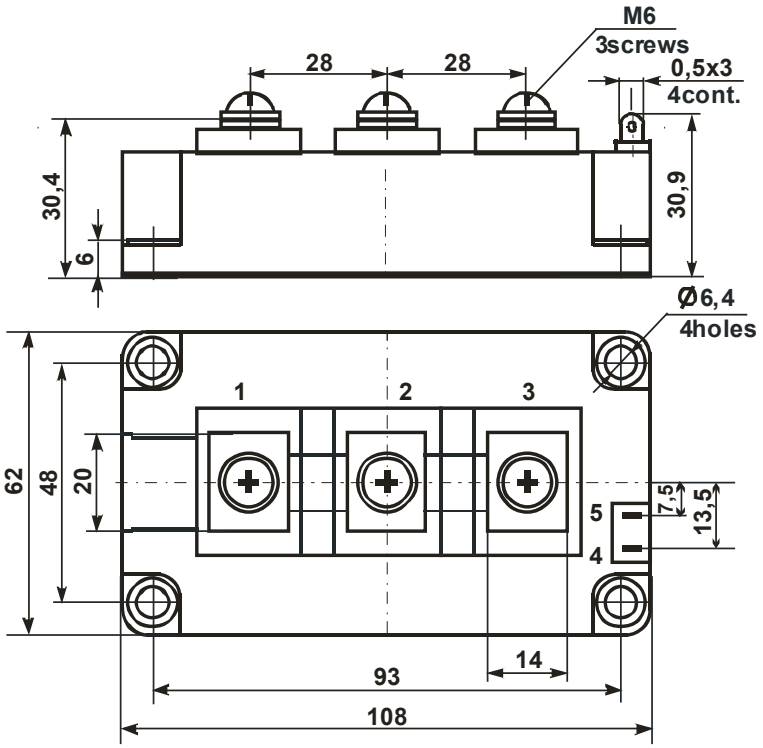

Figure 6.3- Overall dimensions of modules M11 (housing “E3-1”)

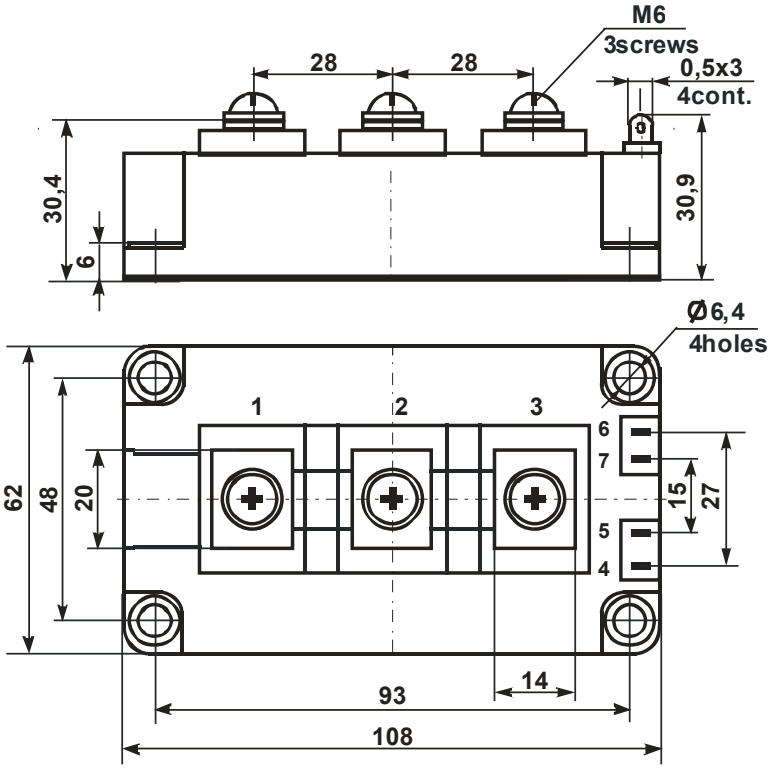

Figure 6.4- Overall dimensions of modules M12 (housing “E3-1”)

Precious metals are not contained.

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