TRANSISTOR MODULES IGBT
IN DESIGN VERSIONS S4, S5

USER' MANUALS

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1. APPLICATION AND PRODUCED MODULES

IGBT-modules in design versions «S4», «S5» are assemblies IGBT-transistors and FRD-diodes are intended to commutate of power loads as part of converters with a maximum peak voltage up to 1200 V and DC up to 75 A. The IGBT-modules are presented with the following versions:

M13A – three-phase inverter. The module is produced with maximum DC 30 A, with peak voltage 600 V and a number of current 30, 50, 75 A, with peak voltage 1200 V.

M13A1 – three-phase inverter and three-phase bridge. The module is produced with a number of maximum DC 10,30 A and with peak voltage 600 V, and current 30 A with peak voltage 1200 V.

M13A2 – three-phase inverter and single-phase bridge. The module is produced with a number of maximum DC 10,30 A with peak voltage 600 V.

M13B – H-bridge. The module is produced with maximum DC 30 A with peak voltage 600 V.

M13D – three-level inverter. The module is produced with maximum DC 30 A with peak voltage 600 V and a number of current 30,50,75 A with peak voltage 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			
		10	30	50	75
M13A	600		Fig.6.1		
	1200		Fig.6.1	Fig.6.6	Fig.6.6
M13A1	600	Fig.6.2	Fig.6.2		
	1200		Fig.6.7		
M13A2	600	Fig.6.3	Fig.6.3		
	1200				
M13B	600		Fig.6.4		
	1200				
M13D	600		Fig.6.5		
	1200		Fig.6.8	Fig.6.8	Fig.6.8

On Figure 1.1 is shown modules name explanation.

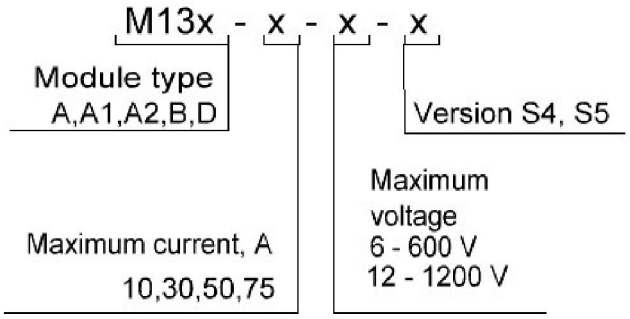

Figure 1.1 – Modules name explanation

For example, M13A-30-12-S4: three-phase inverter with maximum permissible collector-emitter voltage 1200 V, maximum permissible switch DC 30 A in version «S4».

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

Table 1.2 – Conformity modules in housing «S4», «S5»

Class, V	Current, A	Housing	Infineon	"Electrum AV", CJSC
Three-phase inverter (SixPACK)				
600	30	S4	FS30R06W1E3	M13A-30-6-S4
H-bridge (FourPACK)				
600	30	S4	F4-30R06W1E3	M13B-30-6-S4
Three-phase inverter and three-phase bridge (PIM 3-ph bridge)				
600	10	S4	FP10R06W1E3	M13A1-10-6-S4
600	30	S4	FP30R06W1E3	M13A1-10-6-S4
Three-phase inverter and single-phase bridge (PIM 1-ph bridge)				
600	10	S4	FB10R06W1E3	M13A2-10-6-S4
600	30	S4	FB30R06W1E3	M13A2-10-6-S4
Three-level inverter				
600	30	S4	F3L30R06W1E3_B11	M13D-30-6-S4
Three-phase inverter (SixPACK)				
1200	30	S4	FS25R12W1T4	M13A-30-12-S4
1200	50	S5	FS50R12W2T4	M13A-50-12-S5
1200	75	S5	FS75R12W2T4	M13A-75-12-S5
Three-phase inverter and three-phase bridge (PIM 3-ph bridge)				
1200	30	S5	FP35R12W2T4	M13A1-30-12-S5
Three-level inverter				
1200	30	S4		M13D-30-12-S4
1200	50	S5		M13D-50-12-S5
1200	75	S5		M13D-75-12-S5

2. GENERAL DESCRIPTION

In dependence on the module type the electrical circuits of the modules are different; on Figures 2.1 - 2.5 are represented possible variants of the modules circuits.

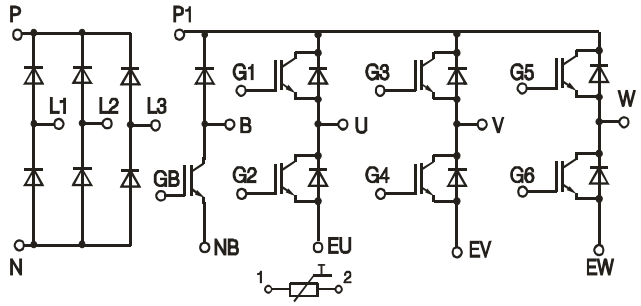

Figure 2.1 – Electrical circuit of modules M13A1 (draw of Fig. 6.2, Fig. 6.7)

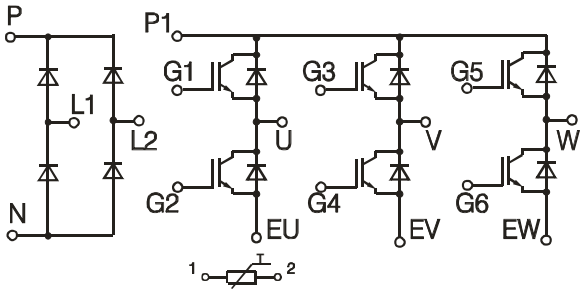

Figure 2.2 – Electrical circuit of modules M13A2 (draw of Fig. 6.3)

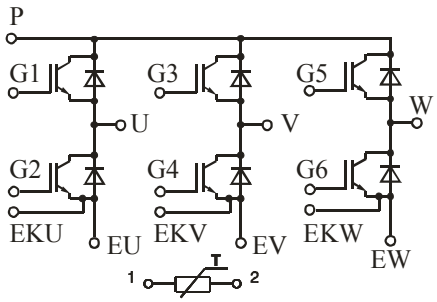

Figure 2.3 – Electrical circuit of modules M13A (draw of Fig. 6.1, Fig. 6.6)

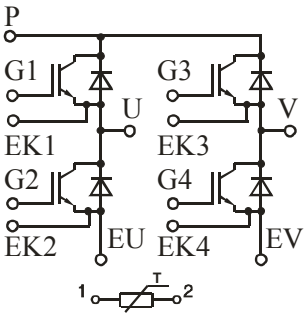

Figure 2.4 – Electrical circuit of modules M13B (draw of Fig. 6.4)

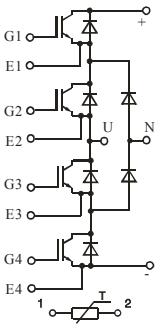

Figure 2.5 – Electrical circuit of modules M13D (draw of Fig. 6.5, Fig. 6.8)

Contacts' configurations on the module housing see in Section 6

3. BASIC PARAMETERS

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

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

Parameter name, Unit	Symbol	Module maximum DC, A	
		10	**30**
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}	10	30
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VT}$	1.8	0.45
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VD}$	4	0.7
Power dissipation (max), W	P_D	70	300
Isolation strength (DC), V	V_{ISOL}	4000	
Static characteristics			
Gate-emitter threshold voltage, V	$V_{GE\ (th)}$	4…6.5	3…6
Gate leakage current (max), nA	I_{GES}	$\pm$100	$\pm$200
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1.6	1.7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2.0	2.1
Collector leakage current (max), μA	I_{CES}	50	200
Dynamic characteristics			
Input capacitance (typical), pF	Cies	600	3500
Output capacitance (typical), pF	Coes	50	150
Transfer capacitance (typical), pF	Cres	20	100
Switch-on delay time (max), ns	$t_{d(on)}$	70	50
Rise time (max), ns	t_r	40	50
Switch-off delay time (max), ns	$t_{d(off)}$	200	400
Fall time (max), ns	t_f	50	100
Switch-on loss energy (max), mJ	E_{ON}	200	3
Switch-off loss energy (max), mJ	E_{OFF}	400	2
Common gate charge (typical), nC	Q_G	35	250
Reverse diode characteristics			
Direct voltage fall (typical), V	V_F	1.8	2.0
Diode direct current (max), A	I_F	10	30
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	30	90
Reverse recovery current (typical), A	I_{RR}	10	30
Recovery time (typical), ns	t_{RR}	200	200
Maximum permissible modes			
Collector-emitter voltage (max), V	V_{CES}	600	
Gate-emitter voltage (max), V	V_{GE}	$\pm$20	
Collector DC at T = 25 °C (max), A	I_C	16	50
Collector DC at T = 100 °C (max), A	I_C	10	30
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	30	90
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		
		30	50	75
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}	30	50	75
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VT}$	0.45	0.4	0.35
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VD}$	0.7	0.7	0.65
Power dissipation (max), W	P_D	300	300	360
Isolation strength (DC), V	V_{ISOL}	4000		
Static characteristics				
Gate-emitter threshold voltage, V	$V_{GE\ (th)}$	3…6	4,5…6,5	4,5…6,5
Gate leakage current (max), nA	I_{GES}	±200	±500	±500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1,7	1,7	1,7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2,1	2,2	2,2
Collector leakage current (max), μA	I_{CES}	200	100	100
Dynamic characteristics				
Input capacitance (typical), pF	Cies	3500	4000	4000
Output capacitance (typical), pF	Coes	150	250	250
Transfer capacitance (typical), pF	Cres	100	200	200
Switch-on delay time (max), ns	$t_{d(on)}$	50	150	150
Rise time (max), ns	t_r	50	80	80
Switch-off delay time (max), ns	$t_{d(off)}$	400	700	700
Fall time (max), ns	t_f	100	150	150
Switch-on loss energy (max), mJ	E_{ON}	3	5	5
Switch-off loss energy (max), mJ	E_{OFF}	2	7	7
Common gate charge (typical), nC	Q_G	250	400	500
Reverse diode characteristics				
Direct voltage fall (typical), V	V_F	2.0	2.1	2.1
Diode direct current (max), A	I_F	30	50	75
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	90	150	225
Reverse recovery current (typical), A	I_{RR}	30	50	50
Recovery time (typical), ns	t_{RR}	200	200	200
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	50	70	100
Collector DC at T = 100 °C (max), A	I_C	30	50	75
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	90	150	225
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 M4 with obligatory installation of flat and spring washers. The module should be located in such a way to protect it against additional heat from neighbor 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

Connecting of the electrical wires and cables to the power and controlled modules contacts is carried out by soldering. Permissible number of module outputs' re-soldering during electronic (assembly) operations 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. Operating 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

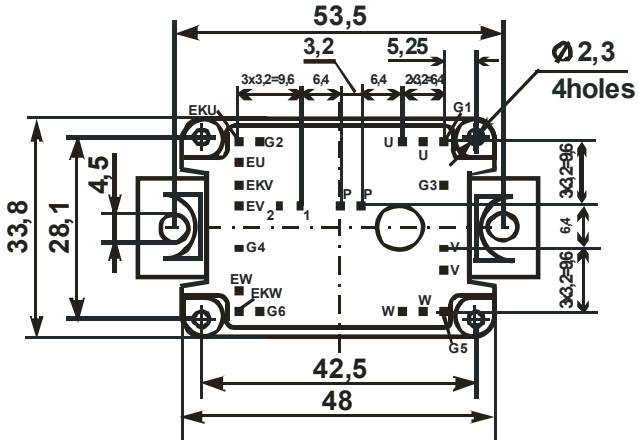

Figure 6.1 – Overall dimensions of modules M13A in version S4

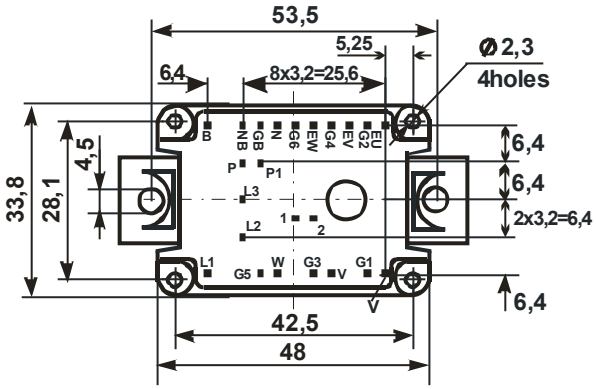

Figure 6.2 – Overall dimensions of modules M13A1 in version S4

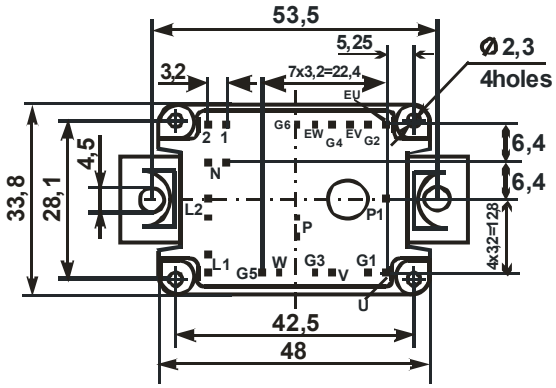

Figure 6.3 – Overall dimensions of modules M13A2 in version S4

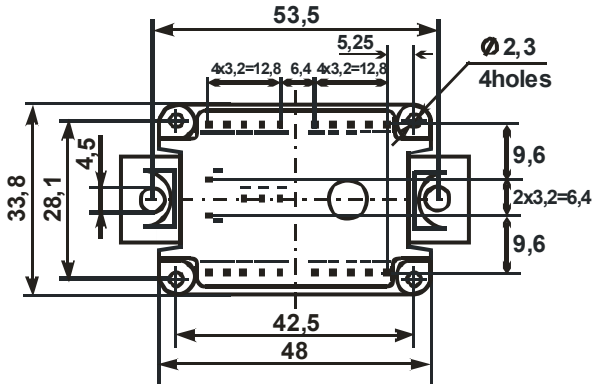

Figure 6.4 – Overall dimensions of modules M13B in version S4

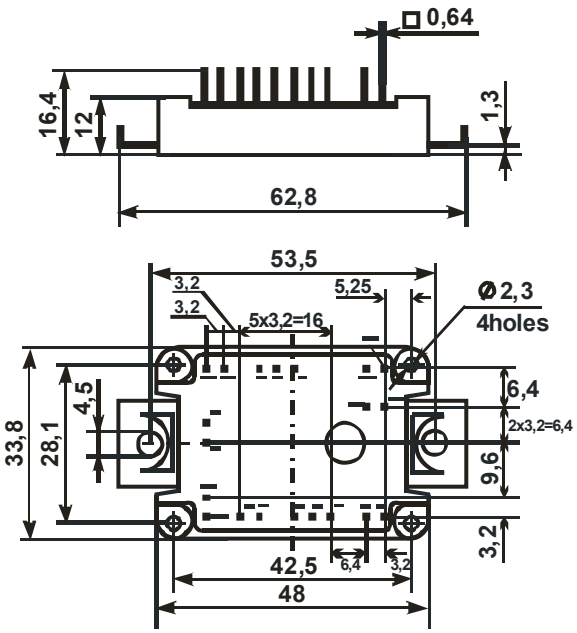

Figure 6.5 – Overall dimensions of modules M13D in version S4

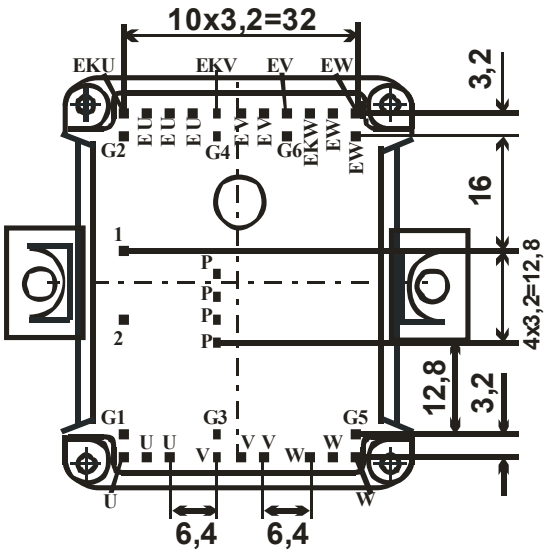

Figure 6.6 – Overall dimensions of modules M13A in version S5

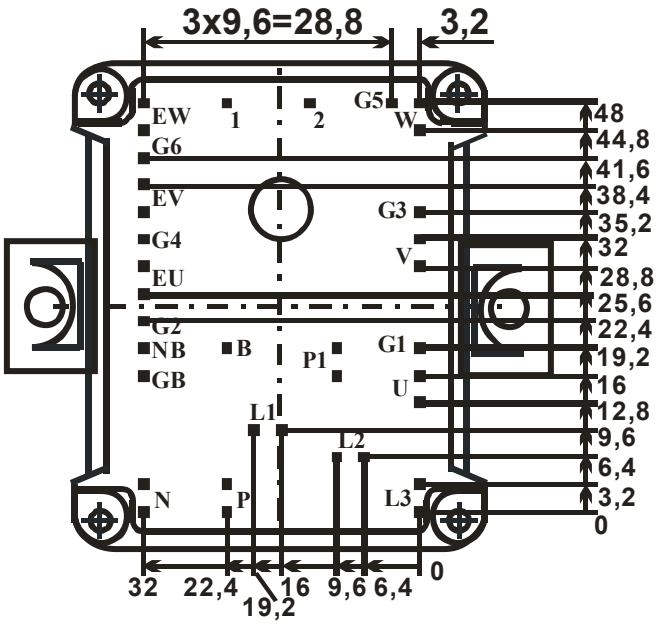

Figure 6.7 – Overall dimensions of modules M13A1 in version S5

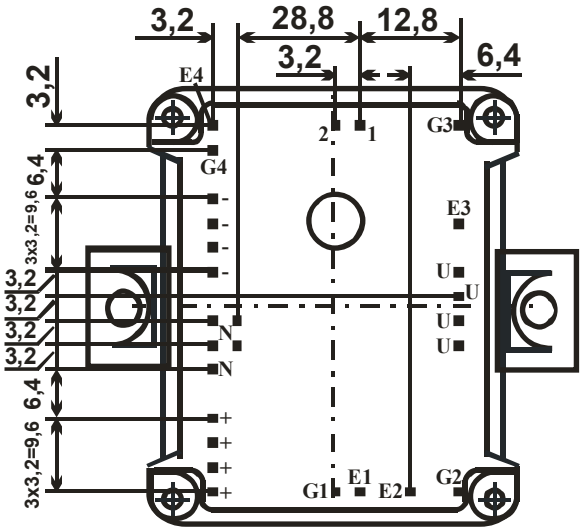

Figure 6.8 – Overall dimensions of modules M13D in version S5

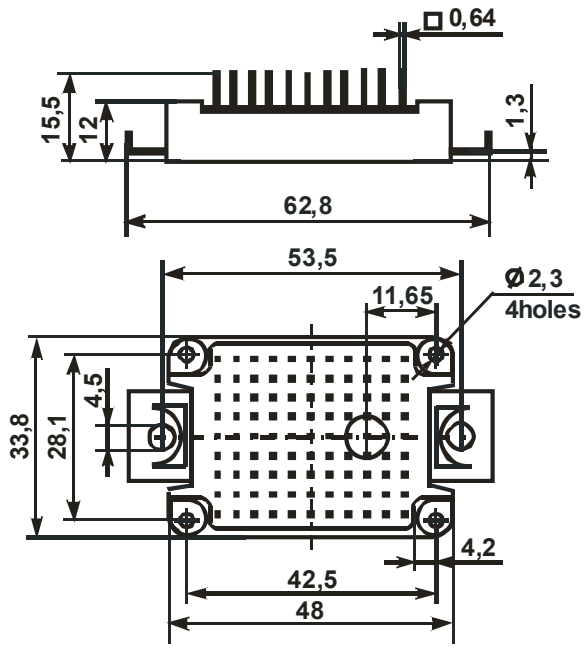

Figure 6.9 – General overall dimensions of modules S4

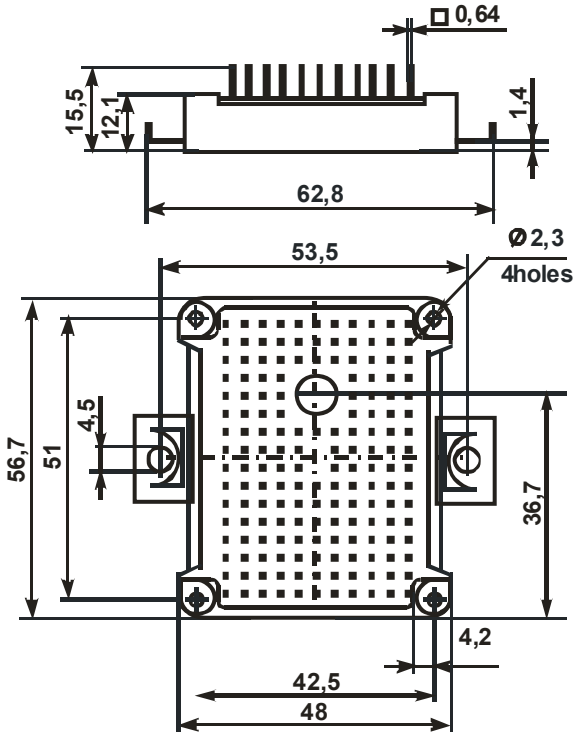

Figure 6.10 – General overall dimensions of modules S5

Precious metals are not contained.

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