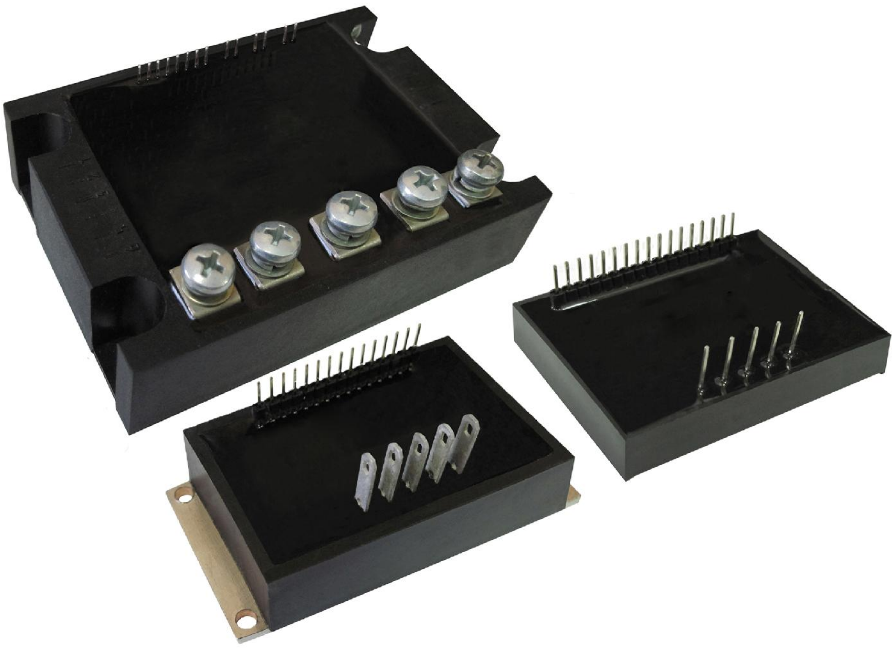
IGBT INVERTERS MODULES
M13A, M13B, M13C

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

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.

Any such warranty is provided only in accordance with the terms of the supply agreement (supply contract or other documents in accordance with applicable law). The information presented in this document does not provide warranties and liability of "Electrum AV" by the use of such information and the suitability of products for your equipment. The data contained in this document are intended exclusively for technically trained staff. You and your technical expert will have to evaluate the suitability of the product for the application and the completeness of the product data, in connection with this application.

Any products of “Electrum AV” are not permitted for the use in devices and life support systems and special equipment without the prior written consent of “Electrum AV”.

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-inverters are inverters assemblies based on IGBT-transistors and FRDs intended to commutate power loads as a part of converters with peak voltage up to 1200 V and average switch current up to 50 A. The IGBT-inverters are represented the following versions:

M13A – three-phase inverter in housing to mount it on cooler. The module is produced with maximum peak voltage 600 V or 1200 V with an amount of maximum average switch current 10,30,50 A.

M13MA – three-phase inverter in compact housing. The module is produced with maximum peak voltage 600 V and maximum average switch current 10 A.

M13A-PP4 – three-phase inverter in housing to mount it into PCB. The module is produced with maximum peak voltage 600 V and maximum average switch current 1 A.

M13B – two-phase inverter in housing to mount it on cooler. The module is produced with maximum peak voltage 600 V or 1200 V with an amount of maximum average switch current 10,30,50 A.

M13MB – two-phase inverter in compact housing. The module is produced with maximum peak voltage 600 B and maximum average switch current 10 A.

M13B-PP4 – two-phase inverter in housing to mount it into PCB. The module is produced with maximum peak voltage 600 V and maximum average switch current 1 A.

M13C – four skew half-bridges in housing to mount it on cooler. The module is produced with maximum peak voltage 600 V or 1200 V with an amount of maximum average switch current 10,30,50 A.

Depending on the current and version the IGBT-inverters are produced in the versions shown in Table 1.1. The modules are produced only in the versions where at crossing the voltage line and current column is specified the drawing of the overall drawing corresponding to the version.

Table 1.1 – Produced IGBT-inverters and overall drawings corresp. to them

Type	**Class**	**Maximum average current, A**			
		1	**10**	**30**	**50**
M13A	**6**		Fig. 6.1	Fig. 6.2	Fig. 6.2
	12		Fig. 6.1	Fig. 6.2	Fig. 6.2
M13B	**6**		Fig. 6.5	Fig. 6.6	Fig. 6.6
	12		Fig. 6.5	Fig. 6.6	Fig. 6.6
M13C	**6**		Fig. 6.9	Fig. 6.10	Fig. 6.10
	12		Fig. 6.9	Fig. 6.10	Fig. 6.10
M13MA	**6**		Fig. 6.3		
	12				
M13MB	**6**		Fig. 6.7		
	12				
M13A-PP4	**6**	Fig. 6.4			
	12				
M13B-PP4	**6**	Fig. 6.8			
	12				

On Figure 1.1 is shown modules' name explanation.

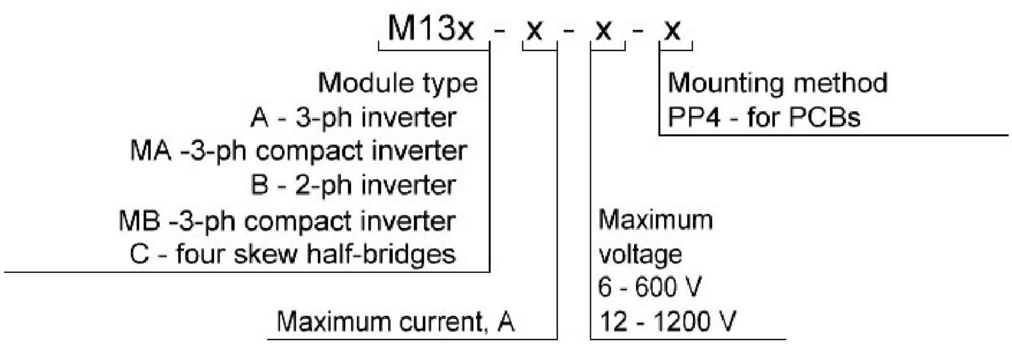


Figure 1.1 – Modules name explanation

For example, module M13MA-10-6: three-phase inverter in compact housing with maximum permissible collector-emitter voltage 600 V and maximum average switch current 10 A.

2. GENERAL DESCRIPTION

Depending on the module type and maximum average switch current the electric circuits of the modules are differed; on Figures 2.1 – 2.3 are shown all the possible variants of the IGBT-inverters' circuits.

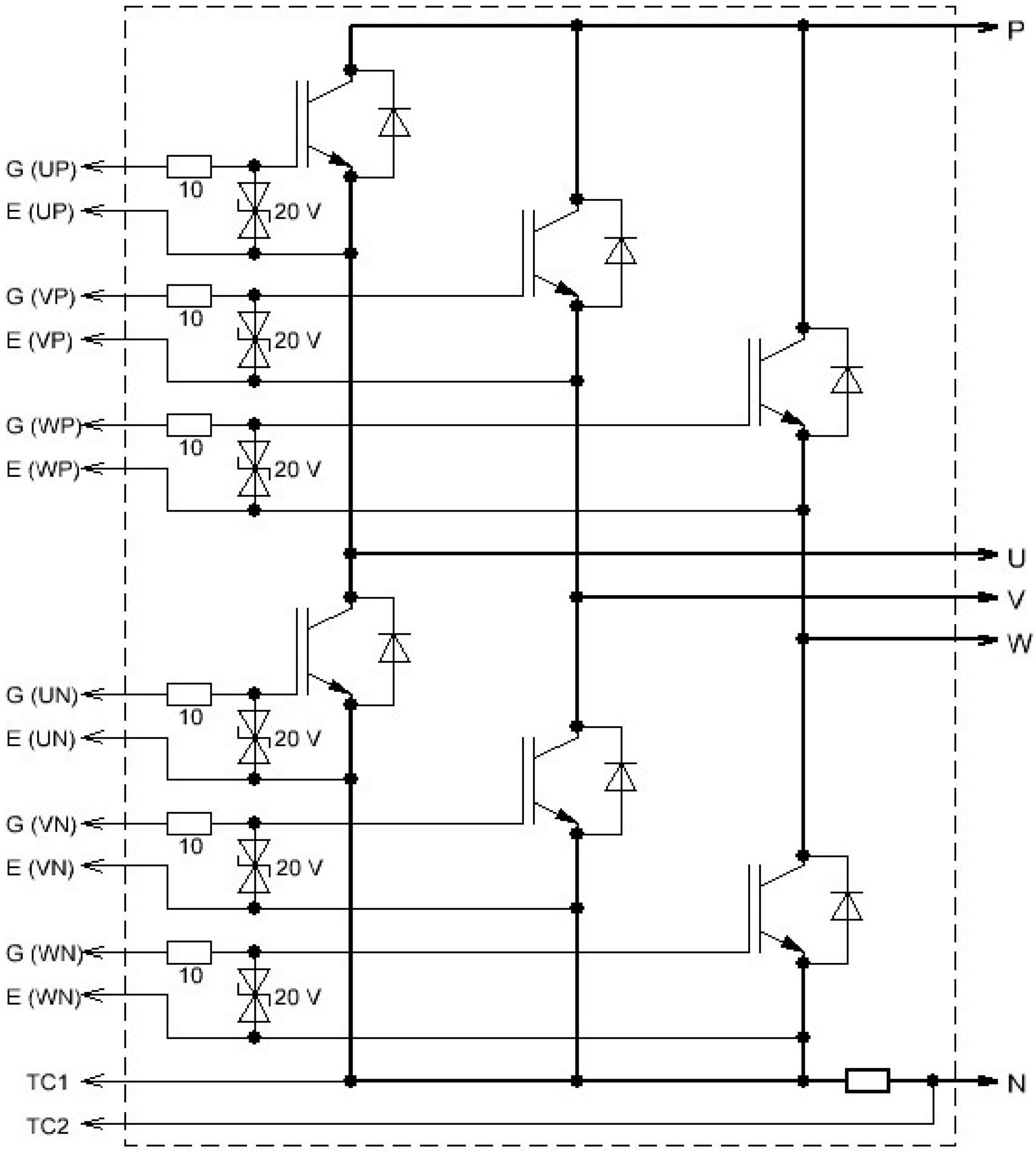


Figure 2.2 – Functional circuit M13 – three-phase inverter (type «A»)

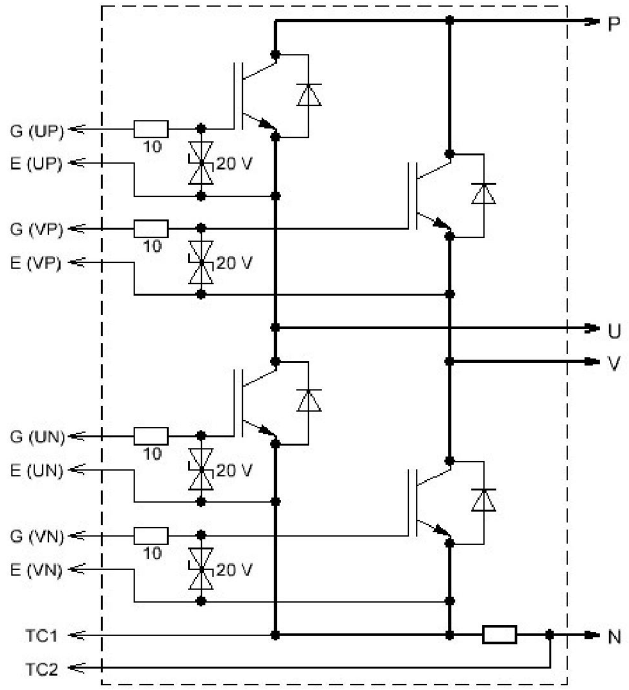


Figure 2.2 – Functional circuit
M13 – two-phase inverter (type «B»)

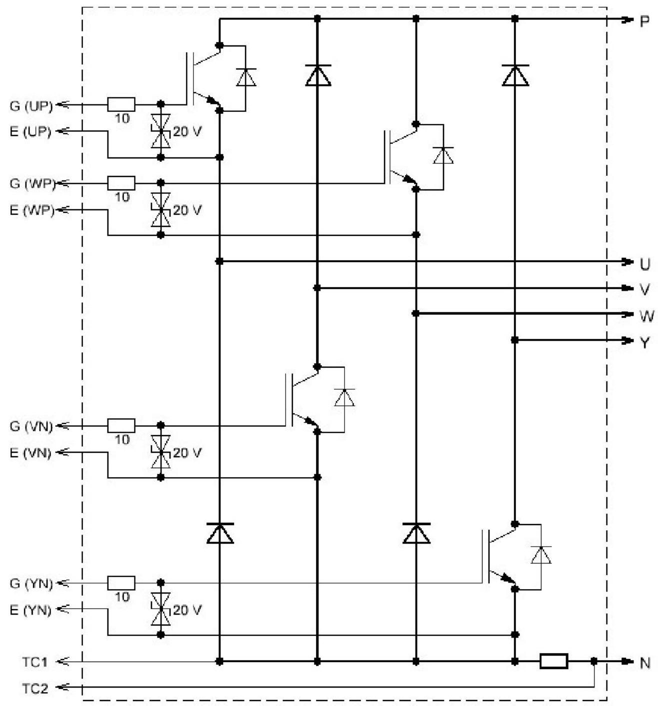


Figure 2.3 – Functional circuit
M13 – four skew half-bridges (type «C»)

For the all design versions of IGBT-inverters modules the control sockets are similar. The application of the outputs and their reference designator depending on the module circuit type is shown in Table 2.1.

Table 2.1 – Application and output numbering of modules M13

Contact	Outputs of type «A»	Outputs of type «B»	Outputs of type «C»	Application
1	TC1	TC1	TC1	Positive output of current-collecting resistor
2	TC2	TC2	TC2	Negative output of current-collecting resistor
3	-	-	-	Not involved
4	E (UP)	E (UP)	E (UP)	Emitter of upper switch of phase «U»
5	G (UP)	G (UP)	G (UP)	Gate of upper switch of phase «U»
6	-	-	-	Not involved
7	E (VP)	E (VP)	-	Emitter of upper switch of phase «V»
8	G (VP)	G (VP)	-	Gate of upper switch of phase «V»
9	-	-	-	Not involved
10	E (WP)	-	E (WP)	Emitter of upper switch of phase «W»
11	G (WP)	-	G (WP)	Gate of upper switch of phase «W»
12	-	-	-	Not involved
13	E (UN)	E (UN)	-	Emitter of lower switch of phase «U»
14	G (UN)	G (UN)	-	Gate of lower switch of phase «U»
15	E (VN)	E (VN)	E (VN)	Emitter of lower switch of phase «V»
16	G (VN)	G (VN)	G (VN)	Gate of lower switch of phase «V»
17	E (WN)	-	E (YN)	Emitter of lower switch of phase «W» («Y» for type «C»)
18	G (WN)	-	G (YN)	Gate of lower switch of phase «W» («Y» for type «C»)

3. BASIC PARAMETERS

The basic electric parameters and maximum permissible electric parameters of the modules at temperature 25^0C are shown in Tables 3.1 – 3.3.

Table 3.1 – Basic and maximum permissible electric parameters of each switch (diode) of modules IGBT-inverters of 6-th class

Parameter name, unit	Symbol	Maximum average switch current, A			
		1	10	30	50
Static characteristics					
Breakdown collector-emitter voltage (min), V	$V_{(BR)CES}$	600			
Power circuit direct voltage (max), V	V_{DC}	350			
Maximum average switch current (max), A	I_{DC}	1	10	30	50
Threshold gate-emitter voltage, V	$V_{GE\ (th)}$	3…6.5	3…6	3…6	4…6
Gate leakage current (max), nA	I_{GES}	±100			
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2.6	2.8	2.2	2.5
Collector leakage current (max), µA	I_{CES}	250	250	250	500
Dynamic characteristics					
Input capacitance (typical), pF	Cies	220	450	3200	4300
Output capacitance (typical), pF	Coes	29	61	370	395
Transfer capacitance (typical), pF	Cres	7.5	14	95	160
Switch-on delay time (max), ns	$t_{d(on)}$	49	54	63	72
Rise time (max), ns	t_r	28	34	49	32
Switch-off delay time (max), ns	$t_{d(off)}$	97	180	150	366
Fall time (max), ns	t_f	140	72	95	45
Switch-on energy (max), mJ	E_{on}	0.25	0.34	1.61	6.9
Switch-off energy (max), mJ	E_{off}	0.14	0.3	0.84	8.4
Common gate charge (typical), nC	Q_G	19	34	200	340
Diodes characteristics					
Direct voltage fall (max), V	V_F	1.8	1.7	1.7	2.1
Direct diode current at Ta=100 °C (max), A	I_F	4	7	25	60
Pulse diode current at t_{pul}=1 ms (max), A	I_{FM}	16	32	280	240
Reverse recovery current (typical), A	I_{RR}	1.9	2.5	4.5	50
Recovery time (typical), ns	t_{RR}	42	55	75	180
Maximum permissible modes					
Collector-emitter voltage (max), V	V_{CES}	600			
Gate-emitter voltage (max), V	V_{GE}	±20			
Collector DC at Ta=25 °C (max), A	I_C	9	16	52	105
Collector DC at Ta=100 °C (max), A	I_C	5	9	30	60
Collector pulse current at t_{pul}=1 ms (max), A	I_{CM}	18	32	104	240
Junction temperature (max), °C	Tj	150			

Table 3.2 – Basic and maximum permissible electric parameters of each switch (diode) of modules IGBT-inverters of 12-th class

Parameter name, unit	**Symbol**	**Maximum average switch current, A**		
		10	**30**	**50**
Static characteristics				
Breakdown collector-emitter voltage (min), V	$V_{(BR)CES}$	1200		
Power circuit direct voltage (max), V	V_{DC}	650		
Maximum average switch current (max), A	I_{DC}	10	30	50
Threshold gate-emitter voltage, V	$V_{GE\ (th)}$	3…6	4…6	4…6
Gate leakage current (max), nA	I_{GES}	$\pm$100		
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	4.2	3.4	2.5
Collector leakage current (max), μA	I_{CES}	250	500	500
Dynamic characteristics				
Input capacitance (typical), pF	Cies	800	4300	4300
Output capacitance (typical), pF	Coes	60	330	395
Transfer capacitance (typical), pF	Cres	14	160	160
Switch-on delay time (max), ns	$t_{d(on)}$	39	76	72
Rise time (max), ns	t_r	84	39	32
Switch-off delay time (max), ns	$t_{d(off)}$	220	332	366
Fall time (max), ns	t_f	90	25	45
Switch-on energy (max), mJ	E_{on}	0.95	2.3	6.9
Switch-off energy (max), mJ	E_{off}	1.15	3.0	8.4
Common gate charge (typical), nC	Q_G	53	165	340
Diodes characteristics				
Direct voltage fall (max), V	V_F	3.8	2.4	2.1
Direct diode current at Ta=100 °C (max), A	I_F	10	40	60
Pulse diode current at t_{pul}=1 ms (max), A	I_{FM}	40	160	240
Reverse recovery current (typical), A	I_{RR}	4.4	50	50
Recovery time (typical), ns	t_{RR}	76	180	180
Maximum permissible modes				
Collector-emitter voltage (max), V	V_{CES}	1200		
Gate-emitter voltage (max), V	V_{GE}	$\pm$20		
Collector DC at Ta=25 °C (max), A	I_C	20	80	105
Collector DC at Ta=100 °C (max), A	I_C	10	40	60
Collector pulse current at t_{pul}=1 ms (max), A	I_{CM}	40	160	240
Junction temperature (max), ºC	Tj	150		

Table 3.3 – Common parameters of IGBT-inverters modules

Parameter name, unit	Symbol	Maximum average switch current, A			
		1	10	30	50
Resistance of amperometric resistor (typical), mΩ	R_I	100	10	1	1
Thermal junction-base resistance of each transistor or diode (max), ºC/W	R_{thjc}	50	1.55	0.95	0.95
Dissipated power (max), W	P_D	10	400	1000	
Electric insulation circuit / housing strength (DC), V	V_{ISOL}	4000			

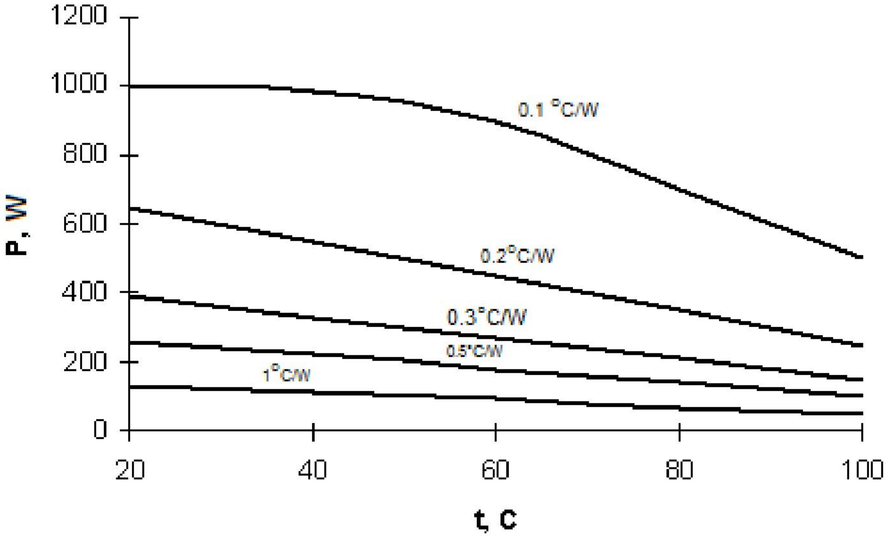


Figure 3.1 – Dependence of permissible loss power versus common thermal inverter resistance and temperature of metal module base

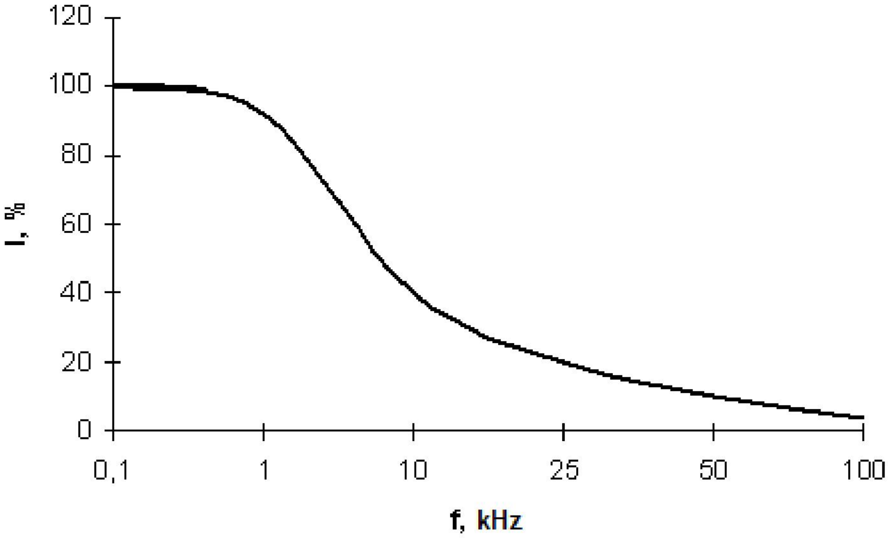


Figure 3.2 – Dependence of permissible average switch current (in percent from maximum permissible one) versus operating frequency

4. INSTRUCTIONS FOR USE

General requirements

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

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

In electric circuit of equipment with use of coolers should be provided a fast-acting protection against unallowable 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 using 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.

When mounting, you should provide uniform pressure of module housing to cooler. For this purpose you should tighten all the 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 be eased 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 should be connected to the 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 or M10 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-resistant coat, which are purified of foreign layers. When screws (bolts) are tightened it is recommended fastening the connection with paint. It is recommended tightening the screws (bolts) repeatedly in 8 days and in 6 weeks after commencement of operating. Afterwards the 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; 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 4.2.

Table 4.2 – 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 4.3.

Table 4.3 – 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

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.
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.

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, 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 γ = 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 γ = 90 %.

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

6. OVERALL AND CONNECTING DIMENSIONS

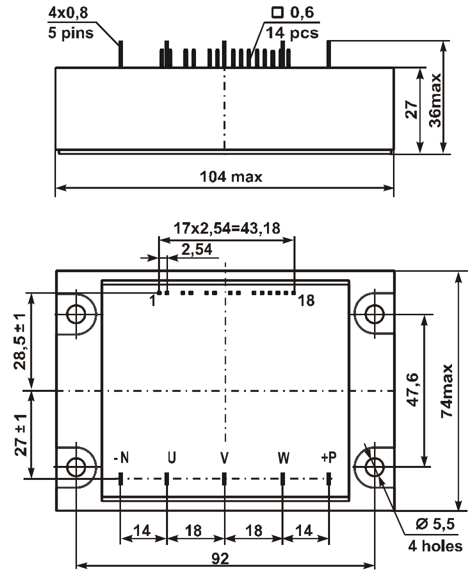


Figure 6.1 – Overall drawing of modules M13A-10-6(12)

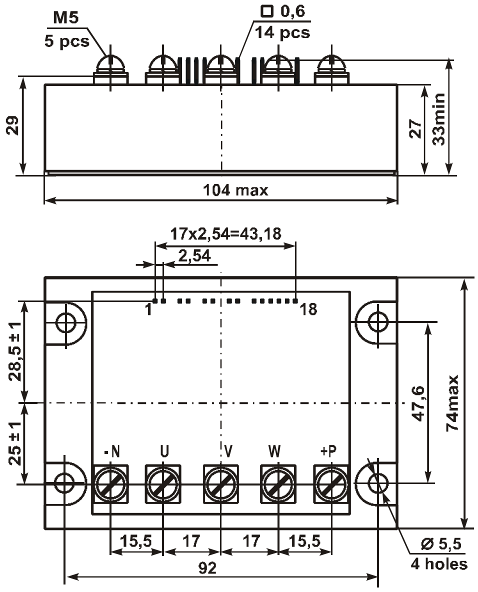


Figure 6.2 – Overall drawing of modules M13A-30(50,90)-6(12)

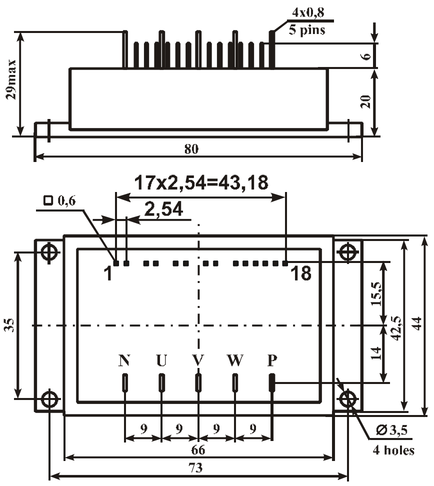


Figure 6.3 – Overall drawing of modules M13MA-10-6

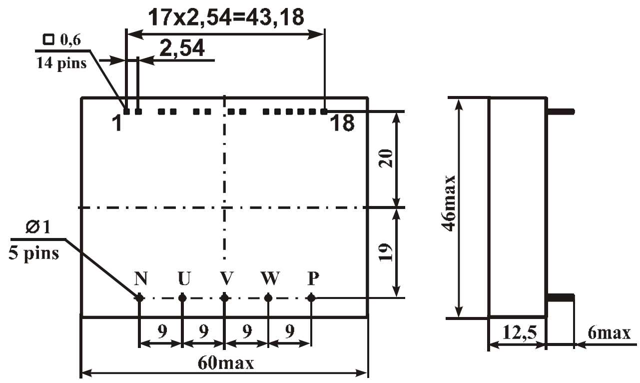


Figure 6.4 – Overall drawing of modules M13A-1-6-PP4

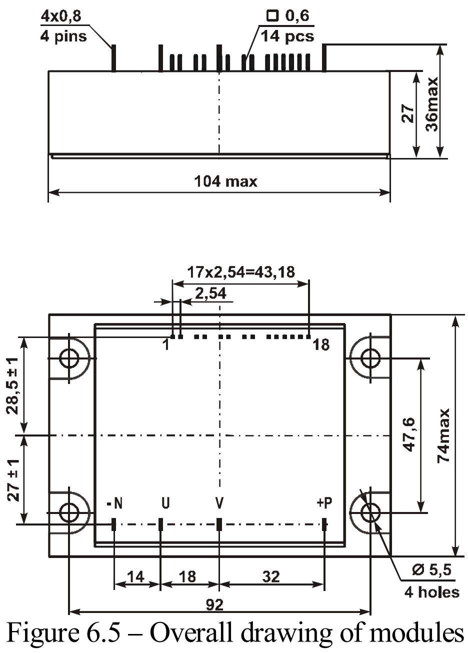


Figure 6.5 – Overall drawing of modules M13B-10-6(12)

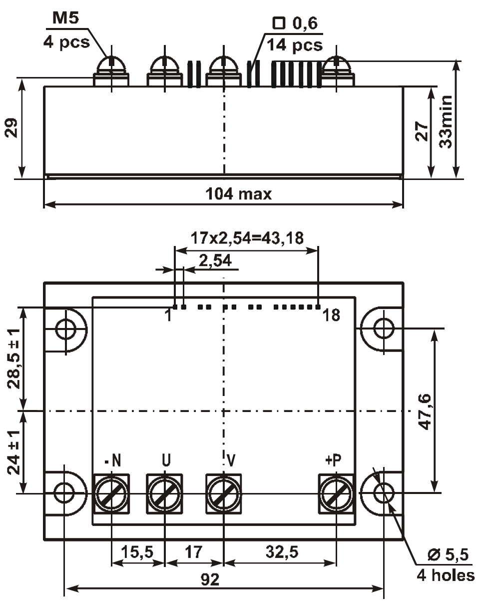


Figure 6.6 – Overall drawing of modules M13B-30(50,90)-6(12)

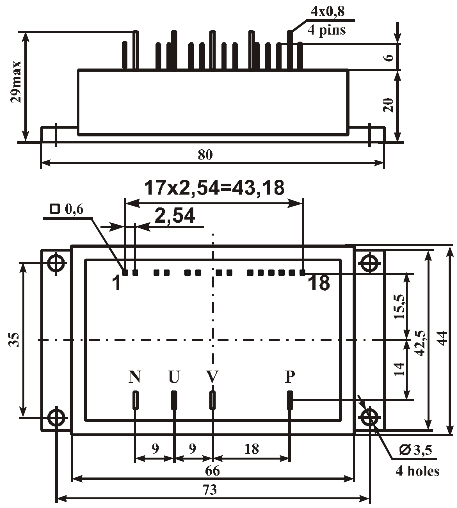


Figure 6.7 – Overall drawing of modules M13MB-10-6

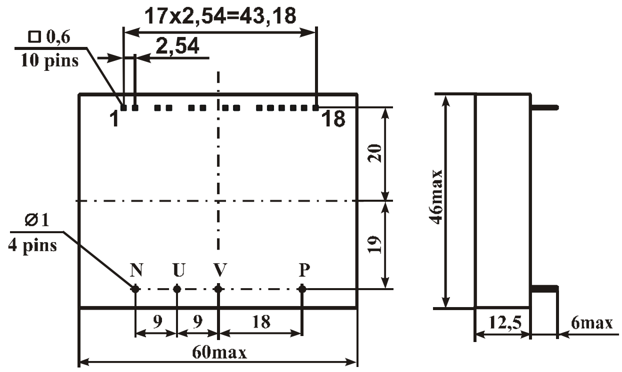


Figure 6.8 – Overall drawing of modules M13B-1-6-PP4

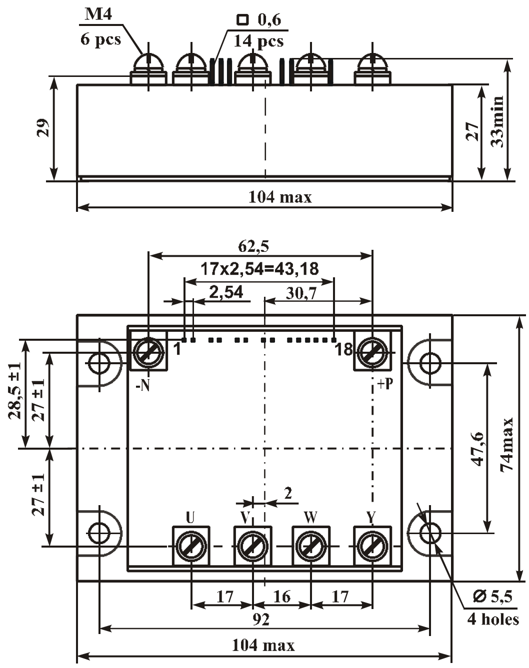


Figure 6.9 – Overall drawing of modules M13C-10-6(12)

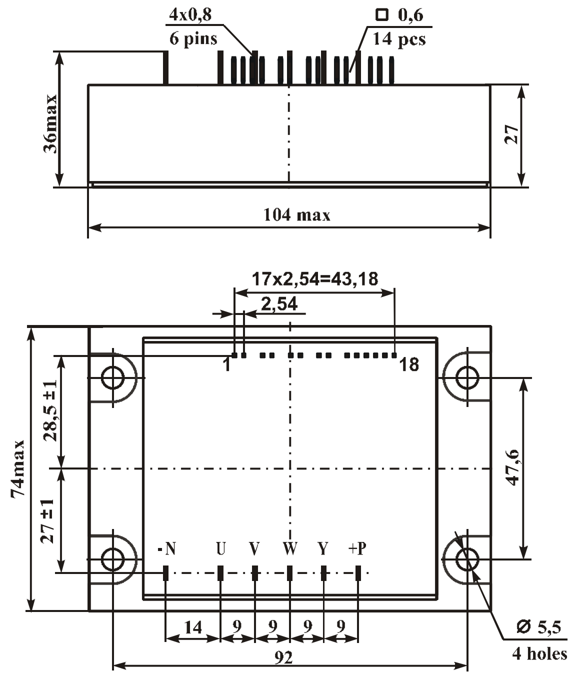


Figure 6.10 – Overall drawing of modules M13C-30(50,90)-6(12)

Precious metals are not contained.