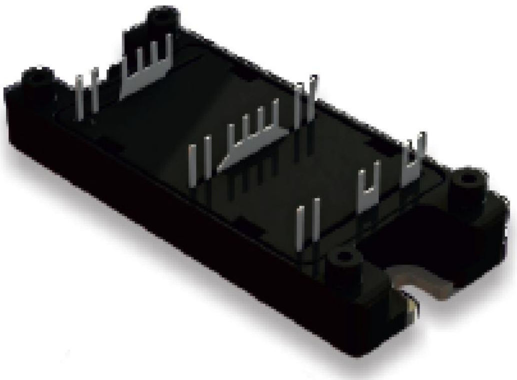
TRANSISTOR MODULES IGBT
IN DESIGN VERSIONS M2

USER'S MANUAL



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1. APPLICATION AND PRODUCED MODULES

IGBT-modules in design version «M2» are represented assemblies of IGBT-transistors and FRD-diodes that are intended for power loads commutation in complex of converters with maximum peak voltage up to 1700V and DC up to 300A. IGBT-modules are represented with the following versions:

M10 – lower switch. The module is produced with maximum DC 200,300 with peak voltage 600 V, and a number of current 50,75,100,150 A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M11 – upper switch. The module is produced with maximum DC 200,300 A with peak voltage 600 V, a number of current 50,75,100,150 A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M12 – two parallel connected IGBT-transistors (half bridge). The module is produced with maximum DC 200,300 A with peak voltage 600 V, a number of current 50,75,100,150 A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M12.1 – two parallel connected IGBT-transistors (common emitter). The module is produced with maximum DC 100,200 A with peak voltage 600 V, a number of current 50,75,100 A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M13B – H-bridge. The module is produced with maximum DC 100,150 A with peak voltage 600 V, a number of current 50,75,100 A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M13B1 – skew bridge. The module is produced with maximum DC 100,150 A with peak voltage 600 V, a number of current 50,75,100A with peak voltage 1200 V, current 50 A with peak voltage 1700 V.

M13E – H-bridge и chopper. The module is produced with maximum DC 50 A with peak voltage 600 V current 25 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	**Class**	**Current, A**						
		25	**50**	**75**	**100**	**150**	**200**	**300**
M10	**6**						Fig.6.1	Fig.6.1
	12		Fig.6.1	Fig.6.1	Fig.6.1	Fig.6.1		
	17		Fig.6.1					
M11	**6**						Fig.6.2	Fig.6.2
	12		Fig.6.2	Fig.6.2	Fig.6.2	Fig.6.2		
	17		Fig.6.2					
M12	**6**						Fig.6.3	Fig.6.3
	12		Fig.6.3	Fig.6.3	Fig.6.3	Fig.6.3		
	17		Fig.6.3					
M12.1	**6**				Fig.6.4		Fig.6.4	
	12		Fig.6.4	Fig.6.4	Fig.6.4			
	17		Fig.6.4					
M13B	**6**				Fig.6.5	Fig.6.5		
	12		Fig.6.5	Fig.6.5	Fig.6.5			
	17		Fig.6.5					
M13B1	**6**				Fig.6.6	Fig.6.6		
	12		Fig.6.6	Fig.6.6	Fig.6.6			
	17		Fig.6.6					
M13E	**6**		Fig.6.7					
	12	Fig.6.7						

On Figure 1.1 is shown modules name explanation.

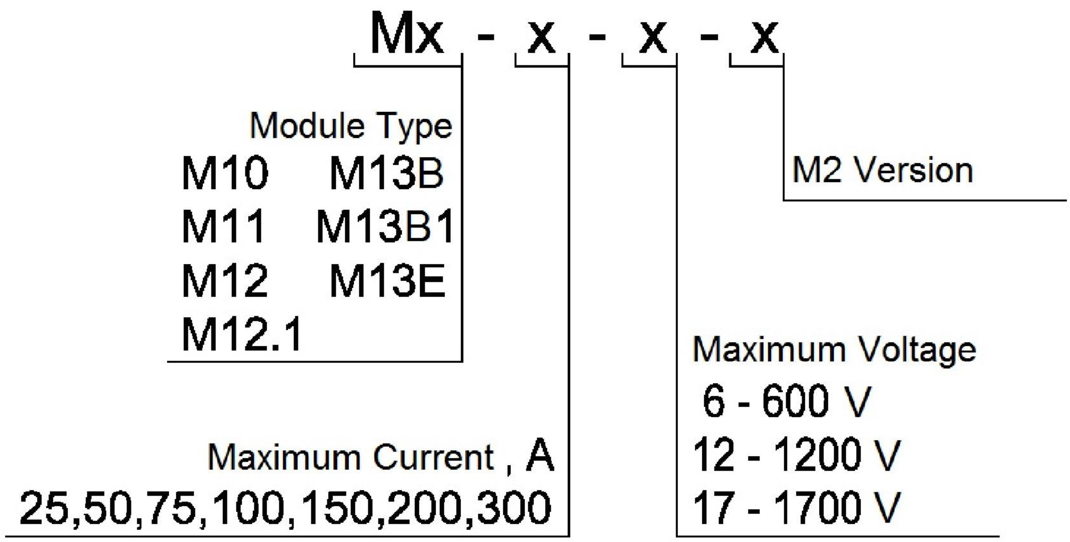

Figure 1.1 – Modules names explanation

For example, M12-100-12-M2: half bridge with maximum permissible voltage collector-emitter 1200 V, maximum permitted DC 100 A in version M2.

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

Table 1.2 – 6 class modules concordance

Class, V	**Current, A**	**Microsemi**	**Electum AV, CJSC**
Dual common sourse			
600	100	APTGT100DU60TG	M12.1-100-6-M2
600	200	APTGT200DU60TG	M12.1-200-6-M2
Lower switch			
600	200	APTGF180DA60TG	M10-200-6-M2
600	300	-	M10-300-6-M2
Upper switch			
600	200	APTGF180SK60TG	M11-200-6-M2
600	300	-	M11-300-6-M2
Half-bridge			
600	200	APTGF180A60TG	M12-200-6-M2
600	300	APTGT300A60TG	M12-300-6-M2
PFC + Full bridge			
600	50	APTGV50H60BG	M13E-50-6-M2
Full-bridge			
600	100	APTGT100H60TG	M13Б-100-6-M2
600	150	APTGT150H60TG	M13Б-150-6-M2
Asymmetrical bridge			
600	100	APTGT100DH60TG	M13Б1-100-6-M2
600	150	APTGT150H60TG	M13Б1-150-6-M2

Table 1.3 – 12 class modules concordance

Class, V	Current, A	Microsemi	Electrum AV, CJSC
Dual common sourse			
1200	50	APTGT50DU120TG	M12.1-50-12-M2
1200	75	APTGT75DU120TG	M12.1-75-12-M2
1200	100	APTGT100DU120TG	M12.1-100-12-M2
Lower switch			
1200	50	APTGT50DA120TG	M10-50-12-M2
1200	75	APTGT75DA120TG	M10-75-12-M2
1200	100	APTGF100DA120TG	M10-100-12-M2
1200	150	APTGF150DA120TG	M10-150-12-M2
Upper switch			
1200	50	APTGT50SK120TG	M11-50-12-M2
1200	75	APTGT75SK120TG	M11-75-12-M2
1200	100	APTGF100SK120TG	M11-100-12-M2
1200	150	APTGF150SK120TG	M11-150-12-M2
Half-bridge			
1200	50	-	M12-50-12-M2
1200	75	APTGT75A120TG	M12-75-12-M2
1200	100	APTGT100A120TG	M12-100-12-M2
1200	150	APTGF150A120TG	M12-150-12-M2
Full-bridge			
1200	50	APTGT50H120TG	M13B-50-12-M2
1200	75	APTGT75H120TG	M13B-50-12-M2
1200	100	-	M13B-100-12-M2
Asymmetrical bridge			
1200	50	APTGT50DH120TG	M13B.1-50-12-M2
1200	75	APTGT75DH120TG	M13B.1-75-12-M2
1200	100	APTGT75DH120TG	M13B.1-100-12-M2
PFC + Full bridge			
1200	25	APTGV50H120BG	M13E-25-12-M2

Table 1.4 – 17 class modules concordance

Class, V	Current, A	Microsemi	Electrum AV, CJSC
Dual common sourse			
1700	50	APTGT50DU170TG	M12.1-50-17-M2
Low switch			
1700	50	APTGT50DA170TG	M10-50-17-M2
Upper switch			
1700	50	APTGT50SK170TG	M11-50-17-M2
Half-bridge			
1700	50	-	M12-50-17-M2
Full-bridge			
1700	50	APTGT50H170TG	M13B-50-17-M2
Asymmetrical-bridge			
1700	50	APTGT50DH170TG	M13B.1-50-17-M2
PFC + Full bridge			
1700	50	APTGV50H170BG	M13E-25-17-M2

2. GENERAL DESCRIPTION

In dependence on the module type the electrical circuits of the modules are different; on Figures 2.1 – 2.7 are represented possible variants of IGBT-modules circuits in M2 version.

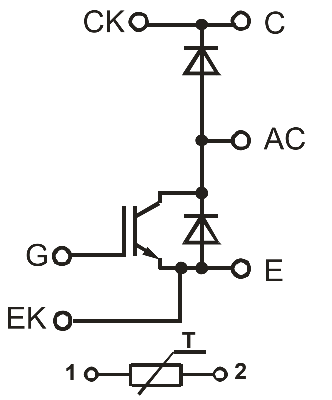

Figure 2.1 – Electrical circuit of modules M10

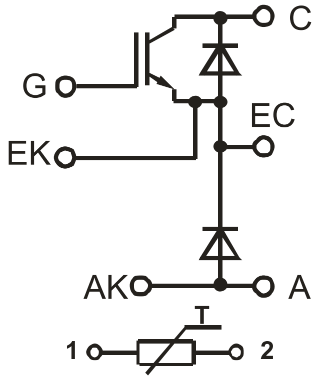

Figure 2.2 – Electrical circuit of modules M11

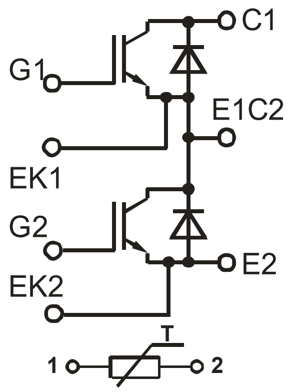

Figure 2.3 – Electrical circuit of modules M12

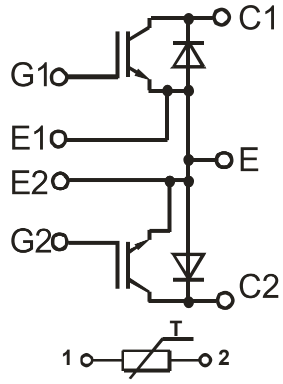

Figure 2.4 – Electrical circuit of modules M12.1

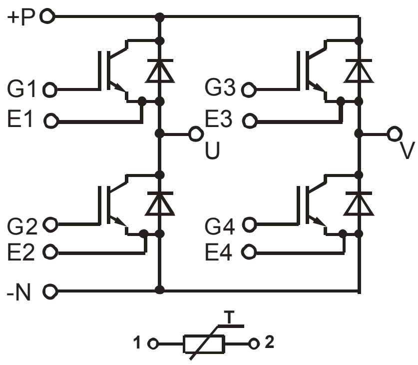

Figure 2.5 – Electrical circuit of modules M13B

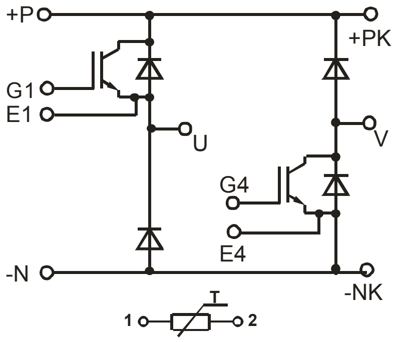

Figure 2.6 – Electrical circuit of modules M13B.1

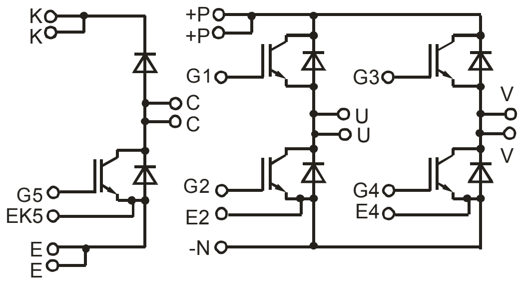

Figure 2.7 – Electrical circuit of modules M13E

Attention! When transporting 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 - 3.3.

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

Parameter name, Unit	Symbol	Module maximum DC, A				
		50	100	150	200	300
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	100	150	200	300
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j-c)\ VT}$	0.4	0.3	0.2	0.15	0.15
Junction-diode housing thermal resistance, ºC/W	$R_{T(j-c)\ VD}$	0.7	0.6	0.4	0.25	0.25
Power dissipation (max), W	P_D	300	420	625	830	840
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	4.5…6.5
Gate leakage current (max), nA	I_{GES}	$\pm$500	$\pm$500	$\pm$500	$\pm$500	$\pm$500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1.7	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	2.2
Collector leakage current (max), µA	I_{CES}	100	100	100	100	100
Dynamic characteristics						
Input capacitance (typical), pF	Cies	4000	4500	6000	15000	18000
Output capacitance (typical), pF	Coes	250	300	450	1500	1500
Transfer capacitance (typical), pF	Cres	200	220	300	1000	1000
Switch-on delay time (max), ns	$t_{d(on)}$	150	150	200	300	150
Rise time (max), ns	t_r	80	80	200	150	80
Switch-off delay time (max), ns	$t_{d(off)}$	700	700	700	700	700
Fall time (max), ns	t_f	150	150	150	150	150
Switch-on loss energy (max), mJ	E_{ON}	5	5.5	18	20	25
Switch-off loss energy (max), mJ	E_{OFF}	7	7.6	24	30	35
Common gate charge (typical), nC	Q_G	400	600	800	1500	1800
Reverse diode characteristics						
Direct voltage fall (typical), V	V_F	2.1	2.1	2.1	2.1	2.1
Diode direct current (max), A	I_F	50	100	150	200	300
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	150	300	450	600	900
Reverse recovery current (typical), A	I_{RR}	50	75	125	250	350
Recovery time (typical), ns	t_{RR}	200	200	250	300	250
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	70	120	175	240	350
Collector DC at T = 100 °C (max), A	I_C	50	100	150	200	300
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	150	300	450	600	900
Junction temperature (max), ºC	Tj	150				

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

Parameter name, Unit	Symbol	Module maximum DC, A				
		25	**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}	25	50	75	100	150
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VT}$	0.45	0.4	0.35	0.3	0.2
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\ VD}$	0.7	0.7	0.65	0.6	0.4
Power dissipation (max), W	P_D	300	300	360	420	625
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	4.5…6.5	4.5…6.5
Gate leakage current (max), nA	I_{GES}	±200	±500	±500	±500	±500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	1.7	1.7	1.7	1.7	1.7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	2.1	2.2	2.2	2.2	2.2
Collector leakage current (max), μA	I_{CES}	200	100	100	100	100
Dynamic characteristics						
Input capacitance (typical), pF	Cies	3500	4000	4000	4500	6000
Output capacitance (typical), pF	Coes	150	250	250	300	450
Transfer capacitance (typical), pF	Cres	100	200	200	220	300
Switch-on delay time (max), ns	$t_{d(on)}$	50	150	150	150	200
Rise time (max), ns	t_r	50	80	80	80	200
Switch-off delay time (max), ns	$t_{d(off)}$	400	700	700	700	700
Fall time (max), ns	t_f	100	150	150	150	150
Switch-on loss energy (max), mJ	E_{ON}	3	5	5	5.5	18
Switch-off loss energy (max), mJ	E_{OFF}	2	7	7	7.6	24
Common gate charge (typical), nC	Q_G	250	400	500	600	800
Reverse diode characteristics						
Direct voltage fall (typical), V	V_F	2.0	2.1	2.1	2.1	2.1
Diode direct current (max), A	I_F	30	50	75	100	150
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	90	150	225	300	450
Reverse recovery current (typical), A	I_{RR}	30	50	50	75	125
Recovery time (typical), ns	t_{RR}	200	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	50	70	100	120	175
Collector DC at T = 100 °C (max), A	I_C	30	50	75	100	150
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	90	150	225	300	450
Junction temperature (max), ºC	Tj	150				

Table 3.3 – Basic and maximum permissible parameters of modules of 12 class

Parameter name, Unit	Symbol	Module maximum DC, A
		50
Basic characteristics		
Collector-emitter breakdown voltage (min), V	$V_{(BR)CES}$	1700
Power circuit direct voltage (max), V	V_{DC}	950
Power circuit DC (max), A	I_{DC}	50
Junction-transistor housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VT}$	0.6
Junction-diode housing thermal resistance, ºC/W	$R_{T(j\text{-}c)\,VD}$	1.0
Power dissipation (max), W	P_D	210
Isolation strength (DC), V	V_{ISOL}	5000
Static characteristics		
Gate-emitter threshold voltage, V	$V_{GE\,(th)}$	2.5…6
Gate leakage current (max), nA	I_{GES}	±500
Collector-emitter saturation voltage (typical), V	$V_{CE(on)}$	2.7
Collector-emitter saturation voltage (max), V	$V_{CE(on)}$	3.2
Collector leakage current (max), µA	I_{CES}	50
Dynamic characteristics		
Input capacitance (typical), pF	Cies	3500
Output capacitance (typical), pF	Coes	300
Transfer capacitance (typical), pF	Cres	200
Switch-on delay time (max), ns	$t_{d(on)}$	170
Rise time (max), ns	t_r	50
Switch-off delay time (max), ns	$t_{d(off)}$	200
Fall time (max), ns	t_f	80
Switch-on loss energy (max), mJ	E_{ON}	16
Switch-off loss energy (max), mJ	E_{OFF}	10
Common gate charge (typical), nC	Q_G	375
Reverse diode characteristics		
Direct voltage fall (typical), V	V_F	2.2
Diode direct current (max), A	I_F	100
Diode pulse current at t_{pul} = 1 ms (max), A	I_{FM}	300
Reverse recovery current (typical), A	I_{RR}	50
Recovery time (typical), ns	t_{RR}	300
Maximum permissible modes		
Collector-emitter voltage (max), V	V_{CES}	1700
Gate-emitter voltage (max), V	V_{GE}	±20
Collector DC at T = 25 °C (max), A	I_C	55
Collector DC at T = 100 °C (max), A	I_C	50
Collector pulse current at t_{pul} = 1 ms (max), A	I_{CM}	150
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 the 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 M2.5 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

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. 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 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 requalification.

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

Gamma percentage life (Tγ) of module at γ = 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 γ = 90 %.

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

6. OVERALL AND CONNECTING DIMENSIONS

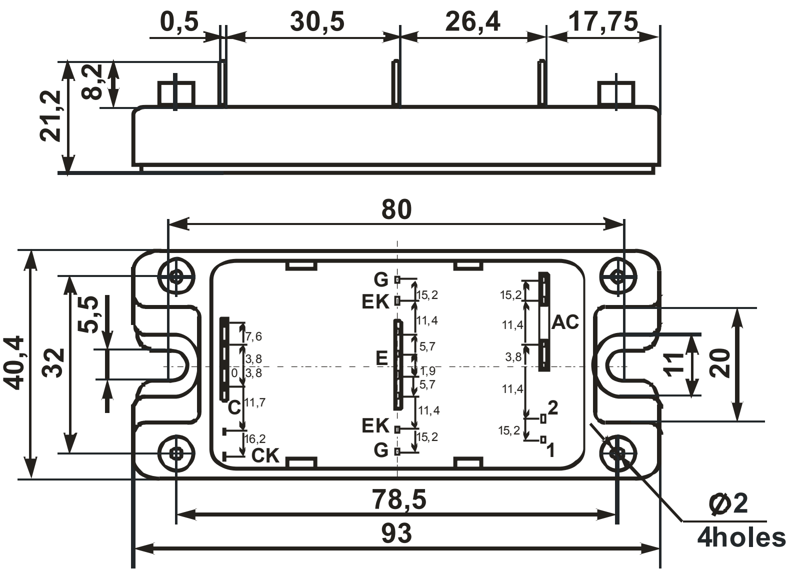

Figure 6.1 – Overall modules drawing M10

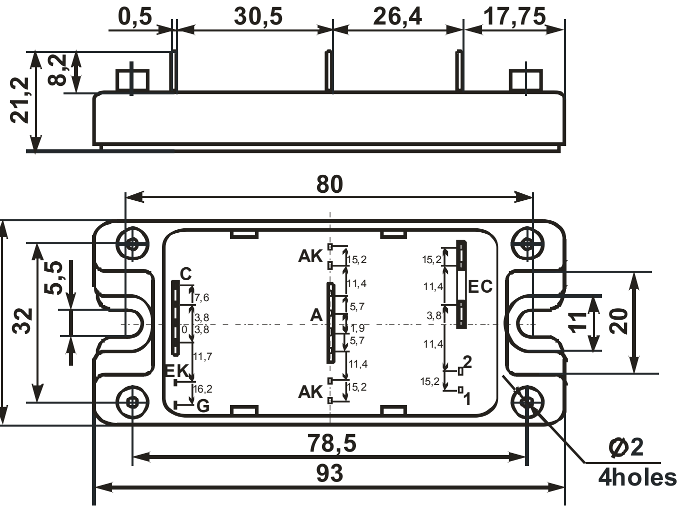

Figure 6.2 – Overall modules drawing M11

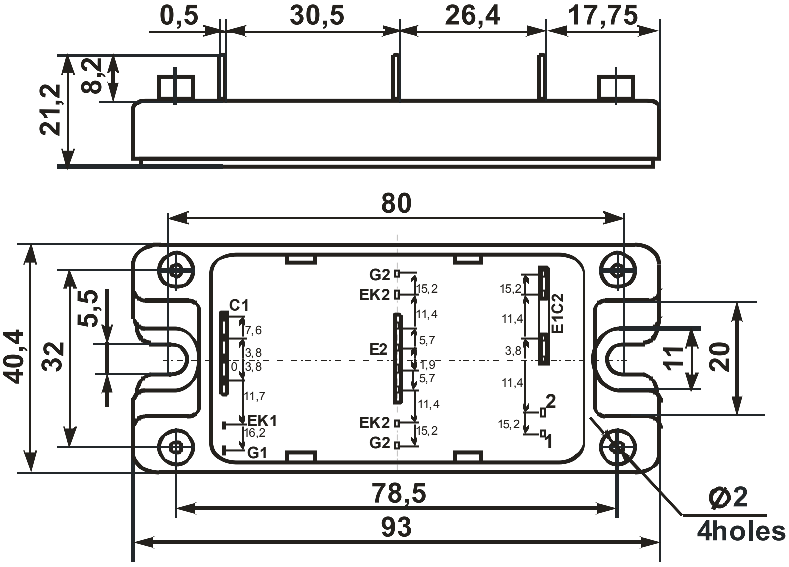

Figure 6.3 – Overall modules drawing M12

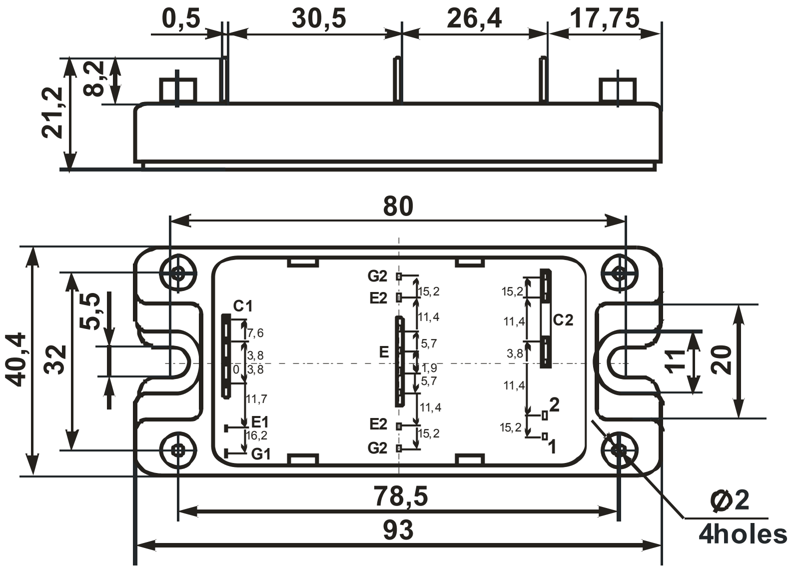

Figure 6.4 – Overall modules drawing M12.1

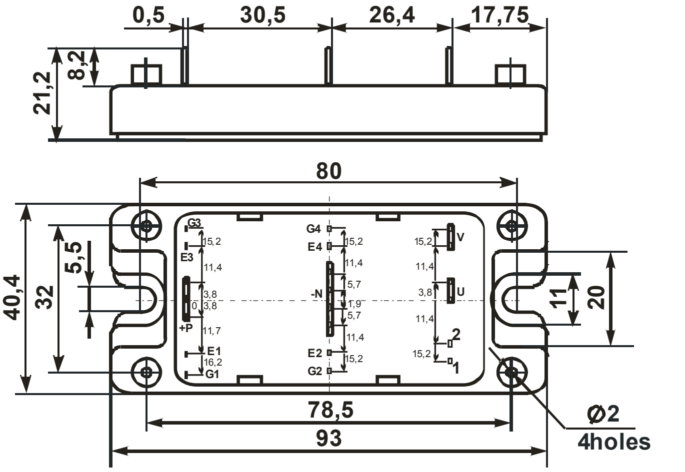

Figure 6.5 – Overall modules drawing M13B

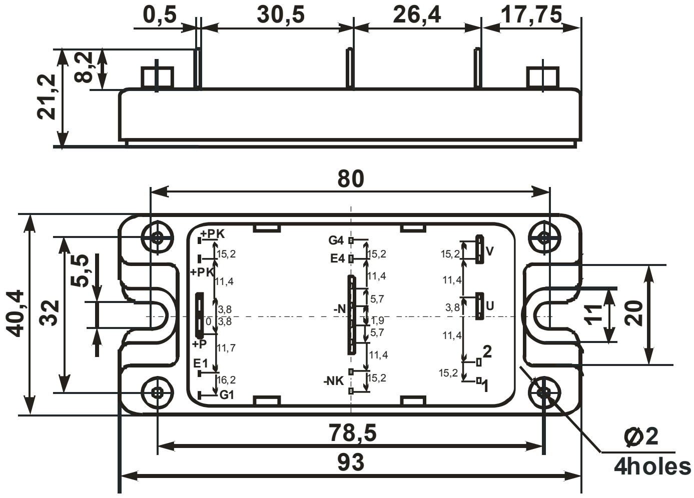

Figure 6.6 – Overall modules drawing M13B1

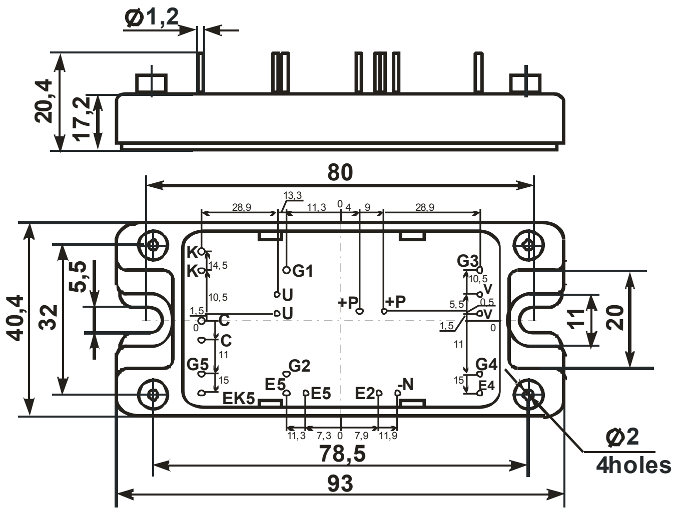

Figure 6.7 – Overall modules drawing M13E

Precious metals are not contained.

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