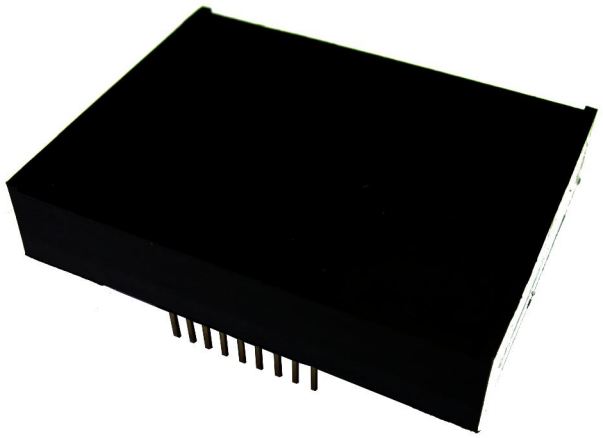
IGBT DRIVER AND MOSFET TRANSISTORS
2DM1180P-B

USER'S MANUAL



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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.

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1 OVERVIEW

Two-channel driver of powerful transistors with independent drive (hereinafter – driver) is intended for galvanic isolated controlling of two powerful transistors with field drive (MOSFET or IGBT) with maximum permissible voltage up to 1700 V. The driver is an amplifier – generator of transistor gates control signals with frequency up to 100 kHz. The driver contains built-in galvanic isolated DC/DC-converter, providing requisite levels of unlocking and locking voltages on transistor gate.

2 COMPOSITION AND FUNCTIONAL DRIVER FEATURES

2.1 The driver is made in hermetic plastic package with compound-filling.

2.2 The driver contains the following functional assemblies:

1 Driver supply voltage stabilizer with protection against false turn-on polarity;
2 Built-in DC-DC converter with stabilization of unlocking and locking voltage levels on gates of controlled transistors;
3 Input logics;
4 Drive circuit of controlled transistor gates;
5 Protection circuit against under-voltage and over-voltage of controlled transistors gate;
6 Protection circuit of controlled transistors against current overload.

2.3 The driver provides the following drive functions, control and protection functions of controlled transistor:

1 Saturation voltage control on collector of controlled transistor, its protective disconnection when leaving the saturation state;
2 Protective turn-off threshold regulation of saturation voltage;
3 Smooth driver junction from active state to inactive one when an “emergency” situation (leaving of controlled transistor of saturation mode);
4 Control block when an “emergency”;
5 Emergency alarm;
6 Turn-on/off time regulation of controlled transistor by resistors resistance changing in output circuit (Ron, Roff);
7 Driver supply voltages’ control (built-in comparators) on output of DC-DC converter.

3 OVERALL DRAWING AND FUNCTIONAL CIRCUIT

3.1 Overall drawing is shown at Figure 1, functional circuit and driver turn-on circuit are represented at Figure 2.

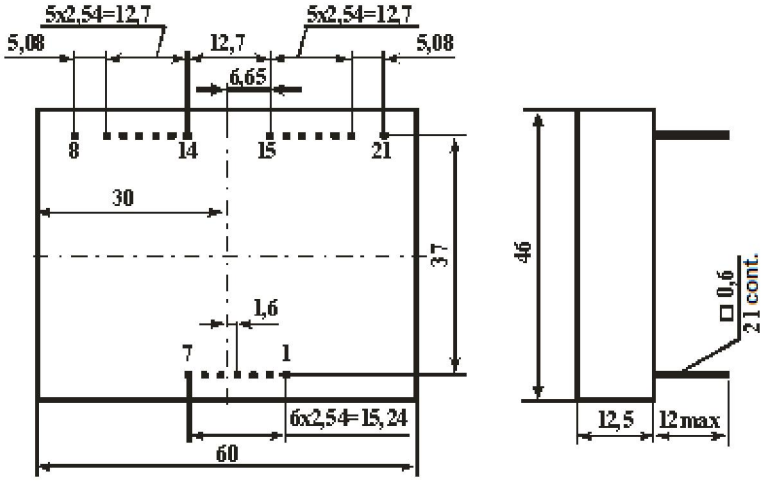


Figure 1 – Overall driver drawing

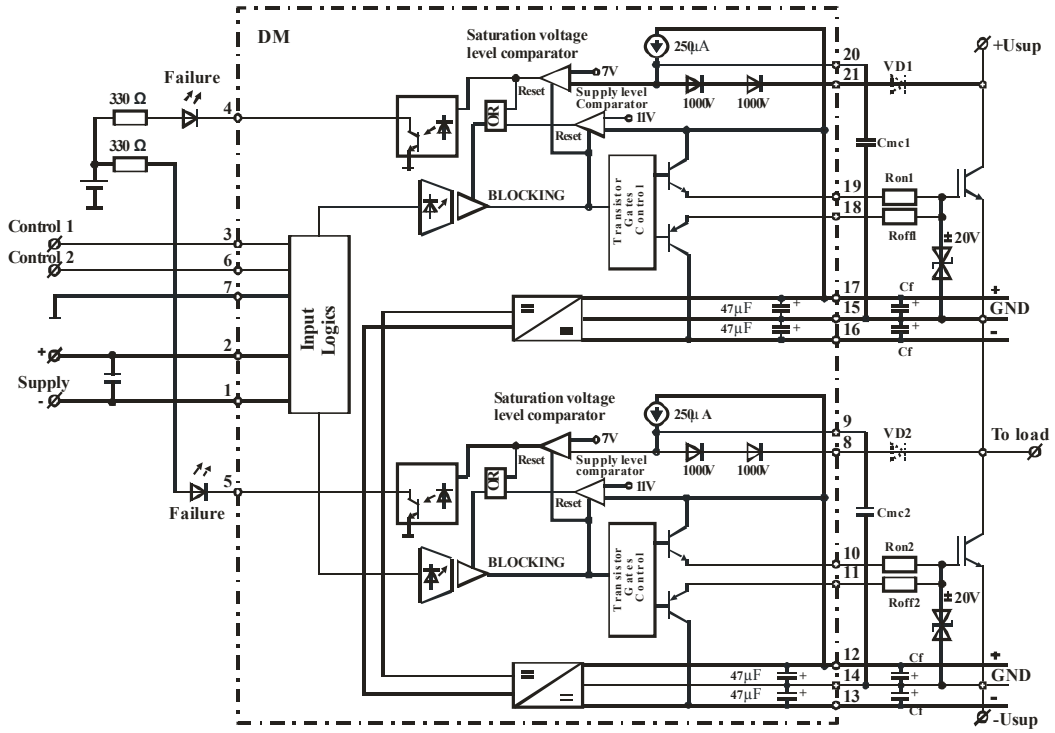


Figure 2– Functional circuit and driver turn-on circuit

3.2 Outputs description is shown in Table 1.

Table 1 – Driver outputs description

Outputs	Outputs description	Symbol
1	Driver power ground	Power GND
2	Supply +15 V	Vs
3	Controlling input of channel 1	IN1
4	Error signal output of channel 1	ERROR1
5	Error signal output of channel 2	ERROR2
6	Controlling input of channel 2	IN2
7	Ground signaling output for delivery of controlling signal	Signal GND

Continuation of Table 1

Outputs	Outputs description	Symbol
8	Measuring collector – saturation voltage control circuit on controlled transistor of channel 2	MC2
9	Output of turn-on delay setup of saturation voltage protection of controlled transistor of channel 2	MCR2
10	Driver output with turn-on time setup of channel 2	OUTon2
11	Driver output with turn-off time setup of channel 2	OUToff2
12	Positive supply output of DC-DC converter of channel 2	Uon2
13	Negative supply output of DC-DC converter of channel 2	Uoff2
14	Ground output of output signals of channel 2	OUT GND2
15	Ground output of output signals of channel 1	OUT GND1
16	Negative supply output of DC-DC converter of channel 1	Uoff1
17	Positive supply output of DC-DC converter of channel 1	Uon1
18	Driver output with turn-off time setup of channel 1	OUToff1
19	Driver output with turn-on time setup of channel 1	OUTon1
20	Output of turn-on delay setup of saturation voltage protection of controlled transistor of channel 1	MCR1
21	Measuring collector – saturation voltage control circuit on controlled transistor of channel 1	MC1

4 BASIC AND MAXIMUM PERMISSIBLE CHARACTERISTICS

Table 2 – Basic and maximum permissible characteristics (at T = 25 °C)

Characteristic	Symbol	Unit	Value			Notes
			min	type	max	
DC/DC block characteristics						
Supply rated voltage	U_S	V	13.5	15	16.5	
Maximum current consumption	I_S	mA		80	120	f = 0 Hz, ref. to Figures 5 and 6
Power of built-in supply source of output driver module part	P_{DC-DC}	W	3			for every channel
Voltage monitor characteristics						
Turn-off threshold	U_{UVLO+}	V		11		DC-DC output
Turn-on threshold	U_{UVLO-}	V		12		
Control inputs characteristics						
High level input voltage	U_{IH}	V	3	5	5.6	
Low level input voltage	U_{IL}	V	-0.6	0	0.8	
Input resistance	R_{IN}	kΩ		2.0		
Time characteristics						
Signal turn-on delay time between input and output	$t_{d\ on(in-out)}$	µs			0.5	ref. to Figure 10
Signal turn-off delay time between input and output	$t_{d\ off\ (in-out)}$	µs			0.5	ref. to Figure 10
Maximum operating frequency	f_{max}	kHz			100	No load; see section 6
Block time of fall voltage control on controlled open state transistor	t_{BLOCK1}	µs	2			Set by consumer; see section 6, Figure 9
Block time of controlled transistor after “emergency”	t_{BLOCK2}	ms		70		
Time of smooth emergency shutdown of controlled transistor	t_{off}	µs		1.5		

Turn-on delay time of emergency signal	$td_{(on\text{-}err)}$	µs			2	
Output characteristics						
High level output voltage	U_{OH}	V	+12	+15	+18	In all range of allowable loads
Low level output voltage	U_{OL}	V	-8	-10	-12	In all range of allowable loads
Maximum output pulse switch-on current	$I_{Omax\ on}$	A	+18	20		Set by consumer; see Figure 8
Maximum output pulse switch-off current	$I_{Omax\ off}$	A		-22	-18	
Mean output current	I_O	mA			130	for every channel
Output signal rise time	t_r	ns			150	No load
Output signal fall time	t_f	ns			150	
Maximum current of status output «Error»	$I_{ERR\ max}$	mA			20	
Maximum voltage of status output «Error»	$U_{ERR\ max}$	V			30	
Residual voltage on signal output «Error»	$U_{O\ ERR}$	V	0	0.3	0.7	at I_{ERR} = 20 mA
Threshold voltage on measure input MC that causes emergency turn-off	U_{ms}^{Th}	V			6	without additional elements
Isolation characteristics						
Maximum permissible reverse voltage on output «MC»	$U_{R(MC)}$	V			2000	
Isolation voltage between input and output of DC	$U_{ISO(IN\text{-}OUT)}$	V			4000	DC, 1 minute
Isolation voltage between outputs of first and second channels of DC	$U_{ISO(OUT1\text{-}OUT2)}$	V			4000	DC, 1 minute
Critical rate of voltage changing on output	$(dU/dt)_{cr}$	kV/µs			20	
Service and storage characteristics						
Operating temperature range	T_A	°C	-45		+85	
Storing temperature	Ts	°C	-60		+100	
Controlled transistor characteristics						
Maximum permissible voltage of controlled transistor	U_{CE} (U_{DS})	V			1700	

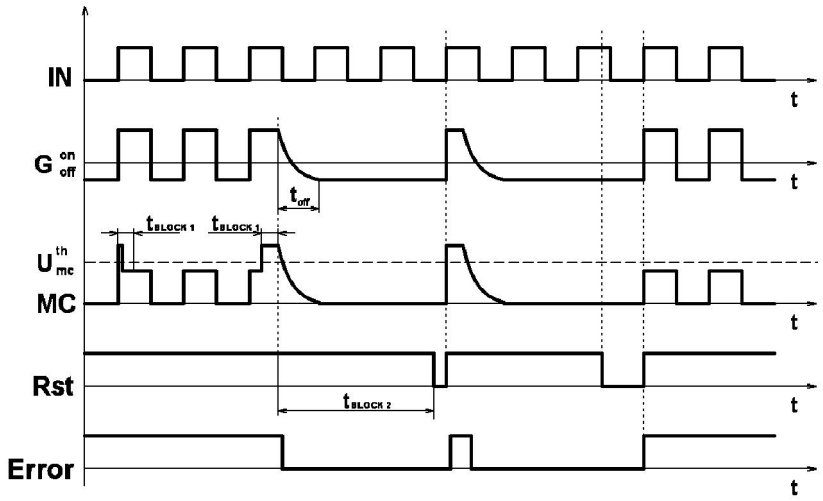
5 DRIVER OPERATION

Delivery of «log.1» on controlling input «IN1» or «IN2» will lead to opening of controlled transistor. Open state voltage fall increasing more than by U_{ms}^{Th} per time, exceeding t_{BLOCK1}, will lead to protection operation of open state voltage fall increasing (when current overload). When “emergency” the transistor will open that is connected in accordance with the circuit with open collector (output «Error1» and «Error2»). In 70 ms emergency reset by internal circuit of “emergency” reset will be performed and on front edge of control signal «IN» controlled transistor will be opened. In the case when the emergency cause was not disposed then the protection cycle will recur.

Driver supply voltage decrease to protection operation threshold level against driver supply undervoltage «U_{uvlo-}» will lead to closing of controlled transistor regardless of input control signals. Control signals will be recovered on protection operation threshold against driver supply undervoltage «U_{uvlo+}». There is not an error signal on output «Error» when protection operation against supply undervoltage.

Control block will not occur when simultaneous delivery of “log.1” to outputs «IN1» and «IN2» because the drivers operate independently.

Diagram explaining the driver operation in “emergency” mode is shown at Figures 3. Thereby operation of any channel in emergency mode will occur regardless the other channel; an emergency on one of the channels will not affect the operation of the other channel.



R_{st} – Periodic internal reset signal «Emergency»

Figure 3 – Functional diagram of driver operation at «emergency»

6 DRIVER CONNECTION RECOMENDATIONS

IN1, IN2 – Controlling inputs. Driver control is described in section “Driver operation”. When delivering of controlling voltage you must note that reverse protective diodes are set on control inputs. If control voltage exceeds supply voltage more than by 0.6 then output current consumption will be increased and the driver can fail by a considerable excess of supply voltage.

Error1, Error2 – outputs signaling about emergency of corresponding channel. Outputs are open transistors’ collectors of protection circuits. Meanwhile transistor will open only when emergency that caused with current overload of powerful transistor; when driver supply voltage decrease to level «U_{uvlo-}» transistors will be closed regardless the input control signals (signals will recover when supply level corresponds to «U_{uvlo+}»), but error signaling in this case will not occur.

It is not recommended to apply to output «Error» voltage and current of values higher than maximum permissible including short-term.

V_S – driver supply output. You must note that on decreasing of driver supply voltage DC/DC-converter output voltage is also reduced. Thereby if supply is lower than the permissible level then input circuit can operate properly, but on controlled transistors gates the voltage can fall to level «U_{uvlo-}» and transistor control will be faulty.

Maximum no-load current consumption on supply input is 120 mA. When transistors connection the current consumption will increase by value of gate recharge current and it can reach 550 mA (equal load for both channels). At higher current consumption DC/DC – converter can fail, or, when short-time current consumption increasing in 750 mA, output voltage of DC/DC – converter will be decreased to unallowable level and undervoltage protection will operate, that will lead to faulty transistor driving. If the load is distributed unevenly through the channels than current consumption of one channel must not exceed 300 mA (except consumption by control circuit). Current consumption depends on control signal frequency, gate capacitance and gate resistors values (see Figures 4 and 5). Thereby, when driver exploitation you must make a correction for current consumption subject to transistors, which the driver will work on. Safe operation area of the driver versus gate capacitance and frequency is shown at Figure 7.

MC1, MC2 – collector connection outputs **(**drain) of controlled transistor. Outputs are intended for voltage fall controlling (saturation protection) on the transistor. Meanwhile maximum protection operation threshold value is equal to 5.8 V (if the external elements are not set). Protection operation threshold is regulated by external elements (Zener diodes and diodes); voltage fall on Zener diodes and diodes at current 250 μA is deducted from the maximum voltage (5.8 V). For instance, if Zener diode with rated Zener voltage 3.3 V and two diodes with voltage fall 0.7 V at current 250 μA are set sequentially (ref. to recommended connection circuit at Figure 2), then protection operation threshold will be equal to 5.8-3.3-2x0.7=1.1 V.

If current overload protection of controlled transistor is not required then the output MC should be short-circuited to source (emitter) of corresponding channel.

MCR1, MCR2 – connection outputs of timing turn-off delay capacitance of corresponding controlled transistor at current overload. Protection operation delay is necessary to avoid malfunction of short-time inductive kicks. Thereby this delay duration will be equal to "rerun pulse" duration when an emergency. To increase protection operation delay it is recommended to install the capacitors with nominal showed at Figure 10. If delay increase is not required this output should be disconnected; it is not recommended to connect it with "ground" output.

OUToff1, OUToff2, OUTon1, OUTon2 – outputs meant for connection of controlled transistors gates. The recommended connection circuit is shown at Figure 2. Voltage limiter should be set with rated breakdown voltage not less than 16 V and not more than maximum-permissible gate voltage. It is recommended the limiter with rated breakdown voltage 18 V. It is allowed to install the Zener diodes with corresponding rated Zener breakdown. If the controlled transistor is installed at a remote distance from the driver, then the limiter should install directly to transistor.

Gate resistors (Ron1, Ron2, Roff1 and Roff2) are necessary for maximum pulse current decreasing. It's not recommended to install the resistors with nominal less than 1 Ω. It is allowed to install the resistors with different nominal, for instance, for turn-off duration increasing of controlled transistor to decrease voltage amplitude of inductive kicks.

7 GRAPHICS EXPLAINING DRIVER OPERATION

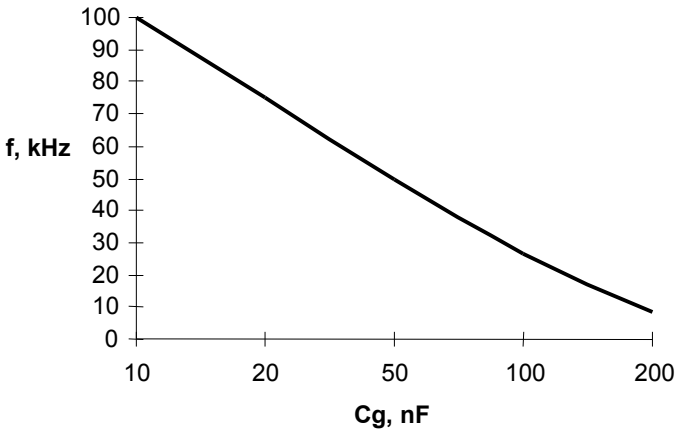


Figure 5 – Graph of driver safe operation depending on frequency and gate capacitance (with gate resistor 1 Ω)

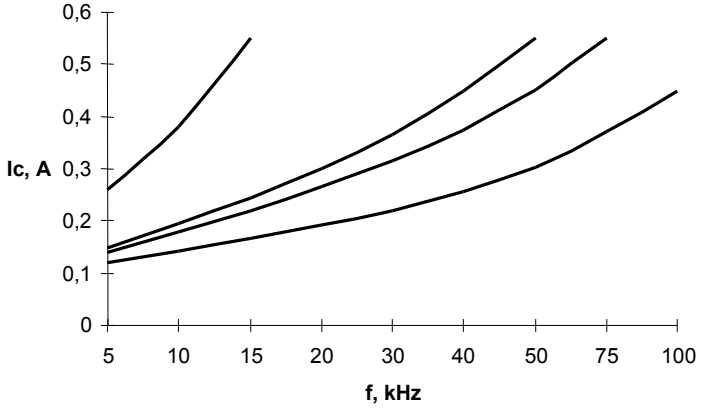


Figure 6 – Graph of current consumption versus signal frequency under load (with gate resistor 1Ω) for gate capacities 10 nF, 25 nF, 50 nF, 100 nF

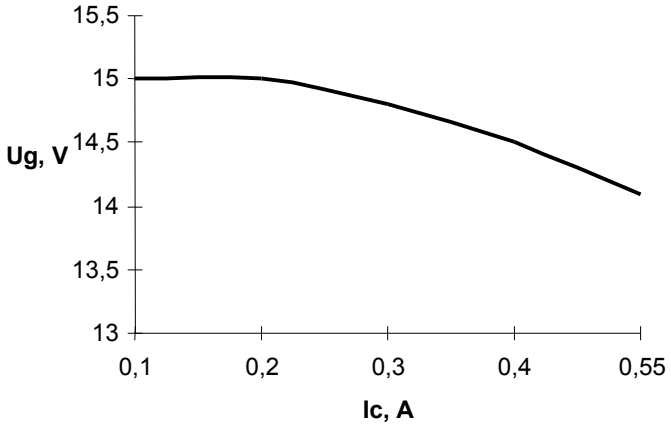


Figure 7 – Graph of transistor gate voltage versus current consumption

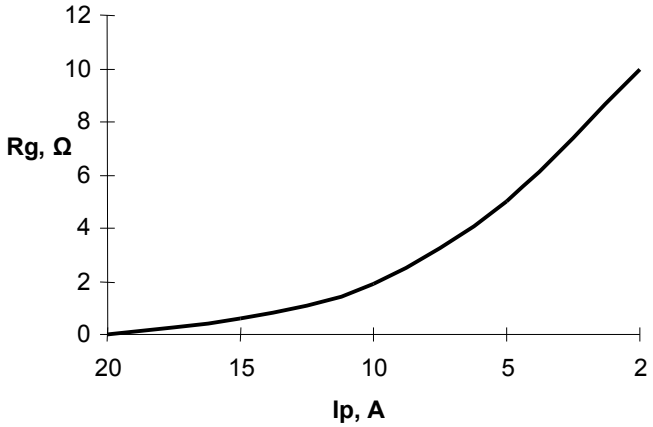


Figure 8 – Graph of output pulse current dependence versus gate resistors nominal

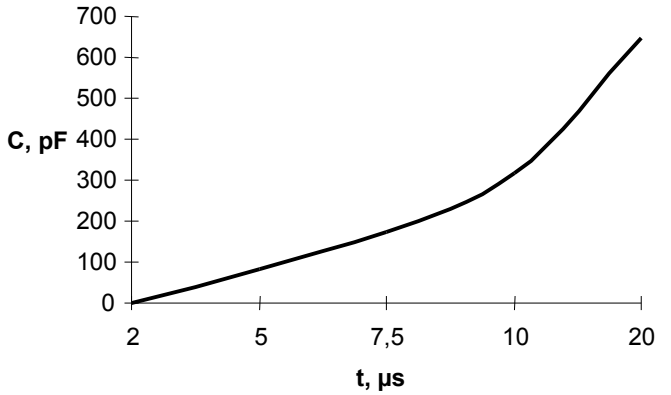


Figure 9 – Graph of duration dependence on delay saturation protection versus trimmer capacitance nominal C_{mc}

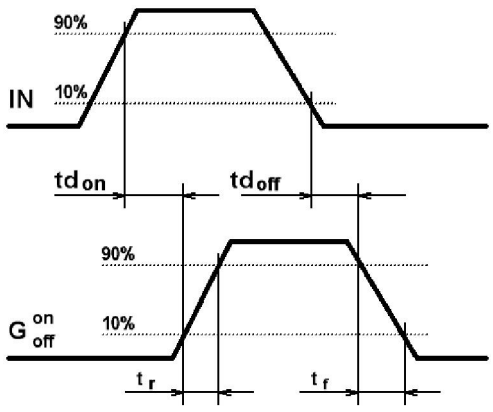


Figure 10 – Diagram explaining driver time parameters
Where IN – input control signal; G – signal of controlled transistor gate

8 INFORMATION ABOUT PRECIOUS METALS

Precious metals are not contained.

9 SERVICE RECOMMENDATIONS

9.1 Tolerance requirements at mechanical impacts

Mechanical impacts for drivers in accordance with qualifying standards of controlled power transistors are shown in Table 3.

Table 3 – Drivers tolerance requirements to mechanical impact factors

External exposure factor	External exposure factor value
Sinusoidal vibration:	
- frequency range, Hz;	0.5 - 100
- acceleration amplitude, m/s^2 (g)	150 (15)
Mechanical shock of single action:	
- peak shock acceleration, m/s^2 (g);	40 (4)
- pulse duration of shock acceleration, ms	50

9.2 Tolerance requirements at climatic impacts.

Climatic impacts in accordance with qualifying standards of controlled power transistors are shown in Table 4.

Table 4 -Tolerance requirements to climatic impact factors

Climatic factor	Climatic factor value
Lower ambient temperature:	
- operating, °C;	minus 45
- maximum, °C	minus 60
Higher ambient temperature:	
- operating, °C;	+85
- maximum, °C	+100
Relative humidity with temperature 35 °C without moisture condensation, %, max	98
Ambient temperature change, °C	from minus 60 to +100
Lower atmospheric pressure, Pa (mm Hg)	86000 (650)
Higher atmospheric pressure, Pa (mm Hg)	106000 (800)

10 RELIABILITY SPECIFICATIONS

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 not be less than 50000 hours by $\gamma = 90$ %.

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 $\gamma = 90$ %.

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