IGBT AND MOSFET TRANSISTOR DRIVER
DR1300P–BF-12-L(P); DR1300P–BF-17-L(P)*

USER'S MANUAL

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CONTENTS

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1 OVERVIEW

A single-channel driver of powerful transistors with independent drive (hereinafter – driver) is intended for galvanic isolated controlling of fiber line by powerful IGBT transistor of type CM1000DU – 34NF with maximum permissible voltage up to 1700 V or by analogue in structure module at current to 2500A. The driver is an amplifier – generator of transistor gates control signals with frequency up to 50 kHz. The driver contains built-in galvanic isolated DC/DC-converter providing requisite levels of unlocking and locking voltages on transistor gate.

2 DRIVER COMPOSITION

2.1 The driver is a printed-circuit board with set driver module on it (DM), made in hermetic plastic housing, necessary tuning element and connectors for connection of controlled transistors and control signals.

2.2 The driver contains the following functional units:

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 undervoltage and overvoltage on controlled transistors gate;
6 Protection circuit of controlled transistors against current overload.

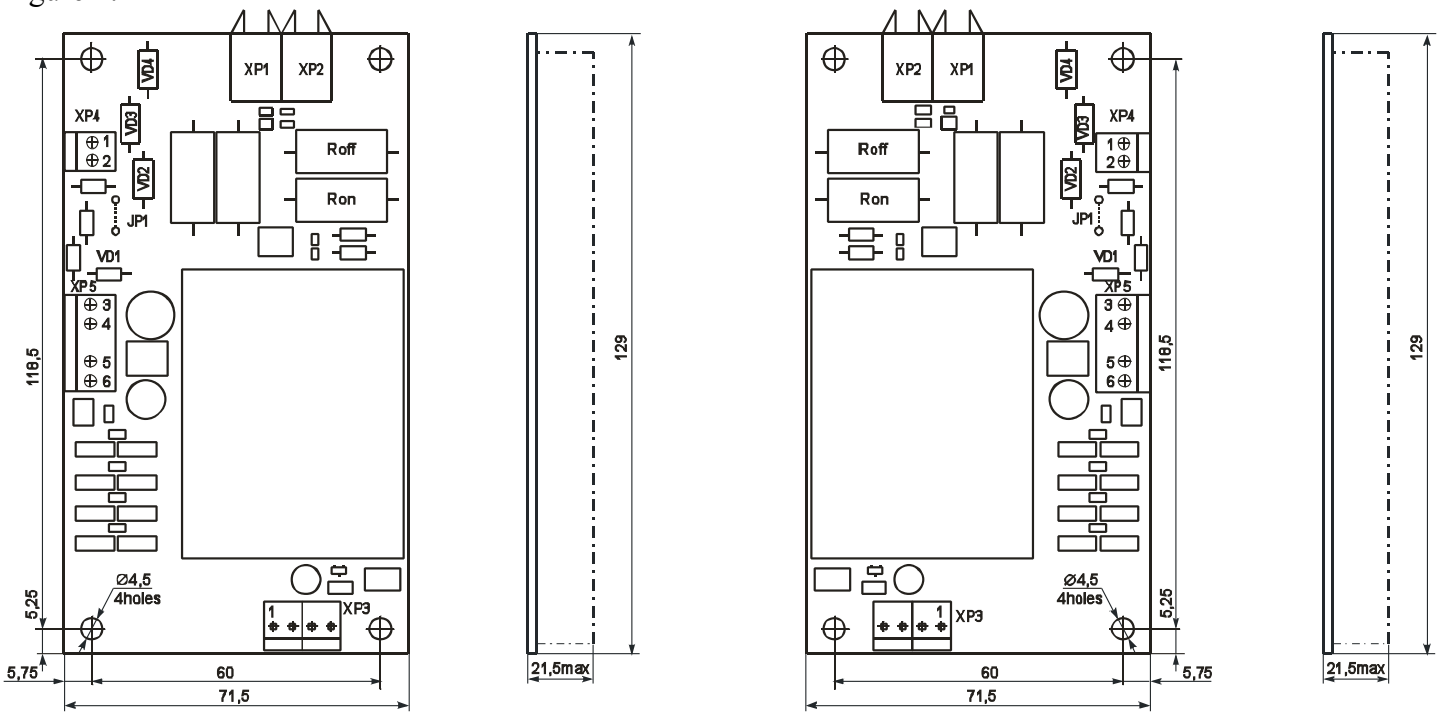
3 FUNCTIONAL DRIVER FEATURES

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

1 Saturation voltage control on collector-emitter of controlled transistor, its protective disconnection when removing the saturation state;
2 Threshold regulation of protective turn-off on saturation voltage;
3 Smooth driver junction from active state to inactive one when an “emergency” (output of controlled transistor from saturation mode);
4 Control block when an “emergency”;
5 Emergency alarm;
6 Turn-on/off time regulation of controlled transistor by resistors resistance change in output circuit (Ron, Roff);
7 Driver supply voltage control (built-in comparators) on output of DC-DC converter;
8 Active protection of controlled transistor against overvoltage during load commutation of inductive nature or when emergency.

* When delivering to the consumer the indexes “L” and “P” in the description is not specified.

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



DR1300P–BF-L DR1300P–BF-P

Figure 1 – Overall and connecting driver dimensions

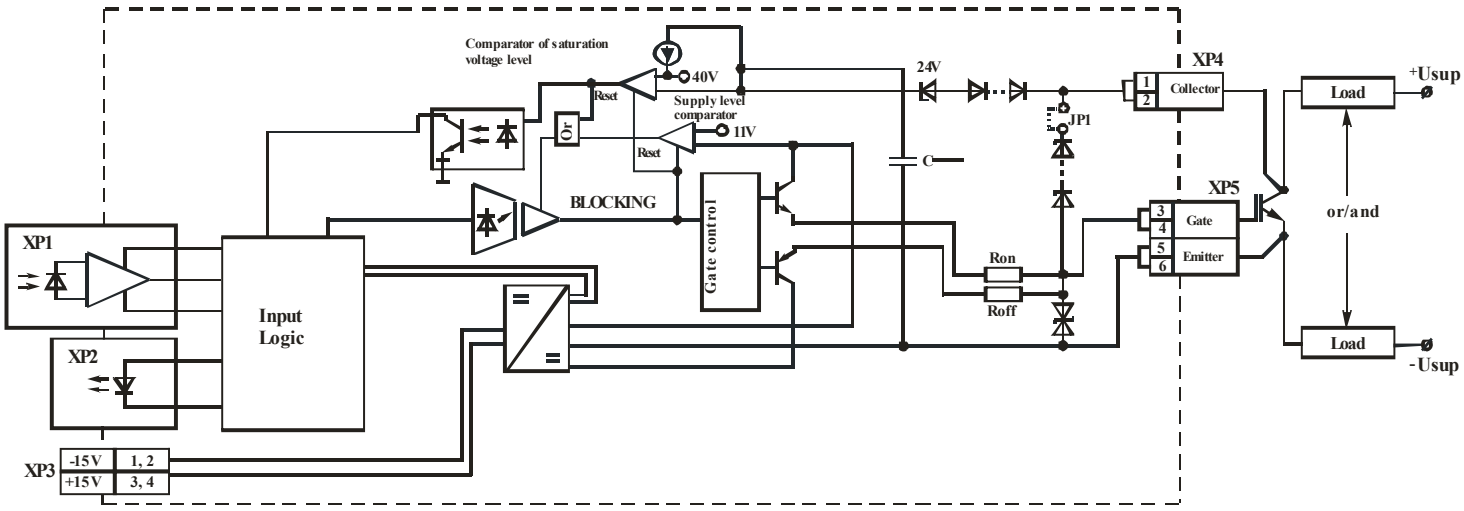


Figure 2 – Functional electronic diagram

3.3 Outputs description is shown in Table 1.

Table 1 – Outputs and driver contact points

Connector	Output description	Output or contact point number	Connector type
XP1	Control signal receiver	-	HFBR-2522
XP2	Status transmitter	-	HFBR-1522
XP3	-15V	1, 2	PWL-4
	+15V	3, 4	
XP4	Collector	1, 2	PWL-2*
XP5	Gate	3, 4	PWL-5*
	Emitter	5, 6	
Driver delivery without connectors is possible (on consumer's request)			

4 BASIC AND MAXIMUM PERMISSIBLE CHARACTERISTICS

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

Characteristic	Symbol	Unit	Value			Note
			min	type	max	
DC/DC block characteristics						
Supply rated voltage	U_S	V	13.5	15	16.5	
Maximum current consumption	I_S	mA			250	No-load, ref. to Figure 4 and 5
Power of built-in supply source of output driver module part	P_{DC-DC}	W	10			
Voltage monitor characteristics						
Turn-off threshold	U_{UVLO+}	V		11		DC-DC output
Turn-on threshold	U_{UVLO-}	V		12		
Control input characteristics						
Wavelength, used when signal delivery and reception	λ	nm		660		
Time characteristics						
Signal turn-on delay time between input and output	$t_{d\ on(in-out)}$	µs			1	ref. to Figure 10
Signal turn-off delay time between input and output	$t_{d\ off\ (in-out)}$	µs			1	ref. to Figure 10
Maximum operating frequency	f_{max}	kHz			50	No-load; ref. to section 6 and Figure 7
Block time of fall voltage control on controlled open state transistor	t_{BLOCK1}	µs	3		30	Set by consumer; ref. to section 6 and Figure 3 and 12
Block time of controlled transistor after “emergency”	t_{BLOCK2}	ms		280		ref. to Figure 3
Transistor smooth emergency shutdown time	t_{off}	µs		6		ref. to Figure 3
Turn-on delay time of emergency signal	$t_{d(on-err)}$	µs			2	
Output characteristics						
High level output voltage	U_{OH}	V	+14	+16	+19	In all range of allowable loads
Low level output voltage	U_{OL}	V	-7.5	-6	-4	In all range of allowable loads
Maximum output pulse current	I_{Omax}	A	-30		+30	Set by consumer; ref. to section 6
Mean output current	I_O	A			0.75	
Output signal rise time	t_r	ns			150	No-load, ref. to section 6
Output signal fall time	t_f	ns			150	No-load, ref. to section 6
Threshold voltage on measure input “Collector” causing emergency turn-off	U_{Mc}^{Th}	V		13		Without additional elements

Continuance of table 2

Characteristic	Symbol	Unit	Value			Note
			min	type	max	
«Active protection» operation voltage	U_{ac}	V		800		DR1300P-BF-12
				1200		DR1300P-BF-17
Isolation characteristics						
Maximum permissible reverse voltage on output "Collector"	$U_{R(MC)}$	V			3000	
Isolation voltage between input and output of DC (1 minute, DC)	$U_{ISO(IN-OUT)}$	V			7000	1 minute, DC
Critical rate of voltage change 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

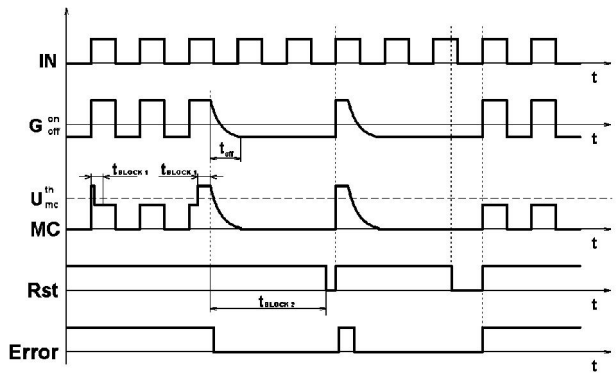
Delivery of light pulse to control signal receiver XP1 will lead to opening of controlled transistor. Open state voltage fall increase by more than U_{ms}^{Th} per time, exceeding t_{BLOCK1}, will lead to protection operation of open state voltage fall increasing (when current overload). When "emergency" LED of XP2 transmitter stops lighting. In 280 ms there will be emergency reset by internal circuit of emergency reset and controlled transistor will open on rising edge of control signal. In the case if the emergency cause was not disposed then the protection cycle will be recurred.

Over-voltage protection will operate with set jumper JP1 if output "Collector" voltage exceeds U_{ac}, ref. to Figure 11.

Driver supply voltage decrease that leads to output voltage decrease to protection operation threshold level against driver supply undervoltage «Uuvlo-» will entail closing of controlled transistor regardless of input control signals.

The control signals will recover when supply voltage increases to value that provide output voltage at protection operation threshold level against driver supply undervoltage «Uuvlo+». The error signal on the transmitter XP2 will not occur when protection operation against supply undervoltage.

The diagram explaining driver operation is shown at Figure 3.



IN – input signal

Rst – Periodical internal signal of "emergency" reset

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

6 DRIVER CONNECTION RECOMENDATIONS

Control signal receiver XP1. Converter microcircuit of light pulses into logic control signals. Wavelength used when signal delivery and reception is equal to 660 ns.

Status transmitter XP2. Microcircuit forms the light signal about driver operation mode. There is a light signal of transmitter output when normal driver operation. Transmitter will shut down only when emergency caused by powerful transistor current overload; when driver supply voltage decreases to level «Uuvlo-» transistors will be closed regardless of input control signals (signals will recover when the supply level corresponds to «Uuvlo+»), but error signaling in this case will not occur.

XP3 – driver supply connection outputs. You must note that on driver supply voltage decreasing the DC/DC – converter output voltage is also reduced. Thereby, if the supply is lower than the permissible level then input circuit can operate correct but the voltage on controlled transistor gates can fall to level «Uuvlo-» and transistor control will be faulty.

Maximum no-load current consumption on supply input is not more than 250 mA. When transistors are connected then the current consumption increases by value of gate recharge current and can reach 0.8 mA. At higher current consumption DC/DC – converter can fail, or, when short-time increase of current consumption by 0.8 mA, DC/DC – converter output voltage will decrease to unallowable level and undervoltage protection will operate, that will lead to faulty transistor drive. Current consumption depends on control signal frequency, gate capacitance and gate resistors values (ref. to Figures 5). Thereby, when the driver operating you must make a correction for current consumption subject to transistors which the driver will operate on. Safe operation area of the driver versus gate capacitance and frequency is shown at Figure 7.

Collector – collector connection output of controlled transistor. The output is intended for voltage fall controlling (saturation protection) on the transistor. Typical value of protection operation threshold is equal to 13 V (if external elements are not installed). Protection operation threshold is regulated by the external elements (Zener diodes and diodes); voltage fall on Zener diodes and diodes is deducted from maximum voltage (13V) at 250 μA. For instance, if Zener diode VD1 with rated Zener breakdown of 10 V and two diodes VD2 and VD3 with voltage fall 0.7 V at current 250 μA will be installed sequentially to outputs “Collector” then protection operation threshold will be equal to 13-10-2*0.7=1.6 V.

If current overload of controlled transistor is not required then the collector outputs should be short-circuited to emitter.

Gate – output, meant for gate connection of controlled transistor. The recommended connection circuit is shown at Figure 2.

Gate resistors (Ron, Roff) are necessary for decrease of maximum pulse current. Gate resistors are installed with resistance of 1 Ω. It is allowed to install the resistors with different nominal, for instance, for turn-off width increase of controlled transistor to decrease voltage amplitude of inductive kicks.

Jumper JP1. If there is a jumper then active driver protection against collector voltage surges when inductive load commutation switches on. The level of active protection operation is shown in Table 2, ref. to Figure 2 and Figure 11.

If there is any need to change the jumper JP1 you should use the method of hand soldering by electric soldering iron with solder stick temperature (245 ± 15) °C using solder alloy and resin flux. In case of rosin-core solder and soldering paste use there is no any necessary in additional fluxing.

C_{BLOCK} – block time trimming capacitance of voltage fall control on controlled open state transistor, ref. to Figure 12. Initially the capacitance 100 pF is set on the drivers.

7 GRAPHS EXPLAINING DRIVER OPERATION

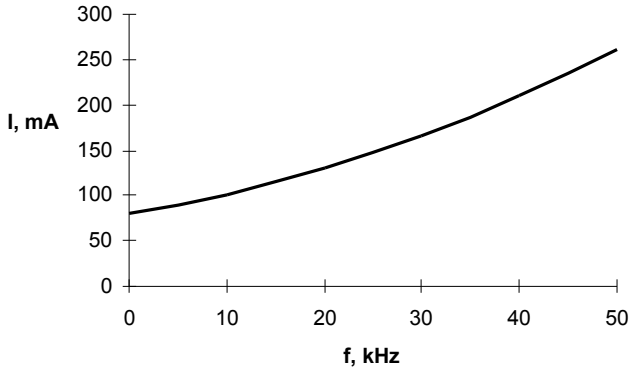


Figure 4 – Graph of driver current consumption versus no-load control signal frequency

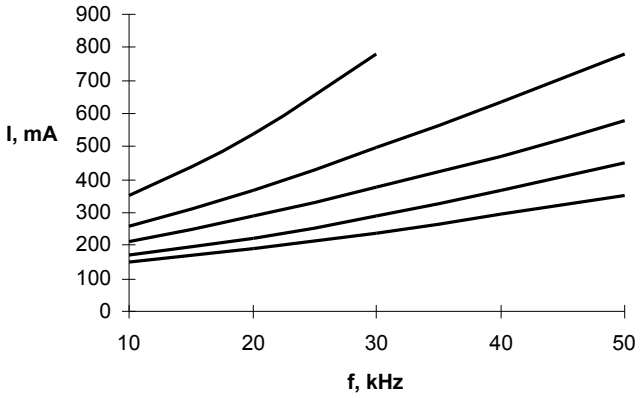


Figure 5 – Graph of current consumption versus signal frequency under load (with gate resistor 5Ω) for gate capacities 10nF, 25 nF, 50 nF, 100 nF and 250 nF

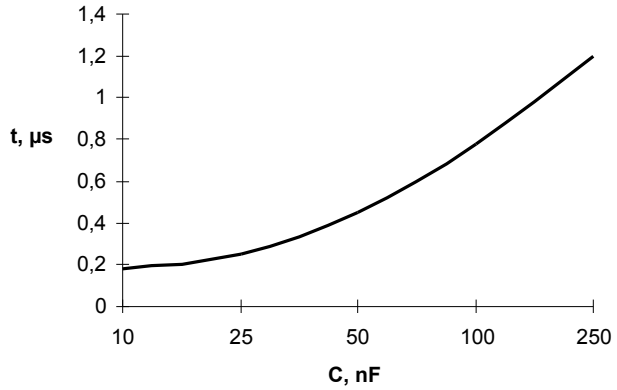


Figure 6 – Graph of rise/fall time versus gate capacity (with gate resistor 5Ω)

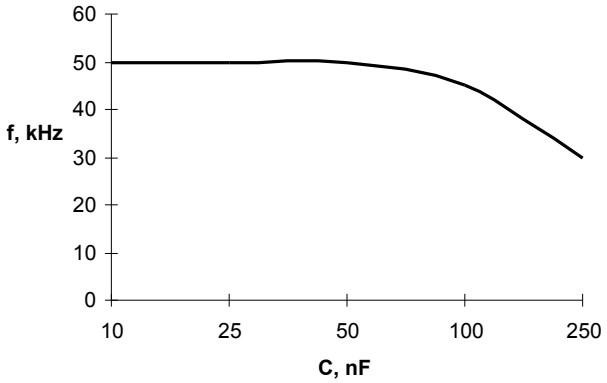


Figure 7 – Graph of driver safe operation zone (with gate resistor 5 Ω)

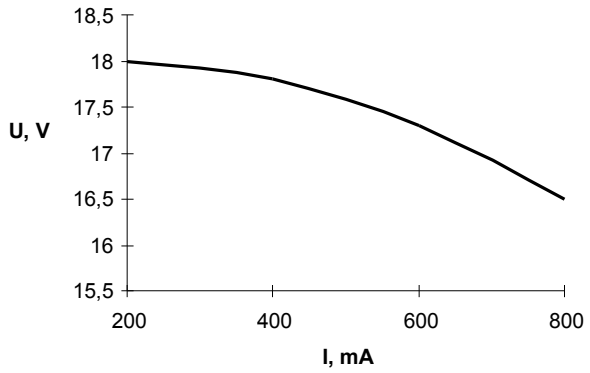


Figure 8 – Graph of transistor gate voltage versus current consumption

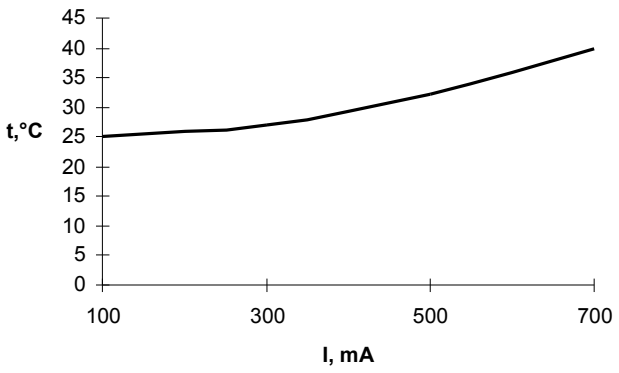


Figure 9 – Graph of driver housing temperature versus current consumption

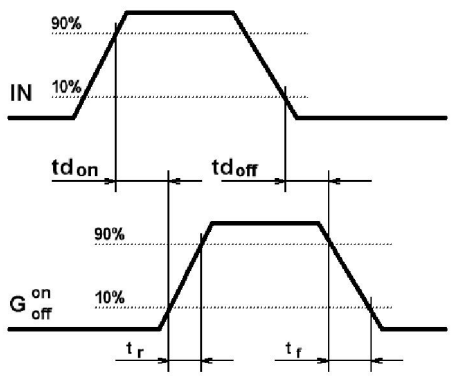


Figure10 – Diagram explaining time driver characteristics
where IN – input control signal;
G – signal on controlled transistor gate

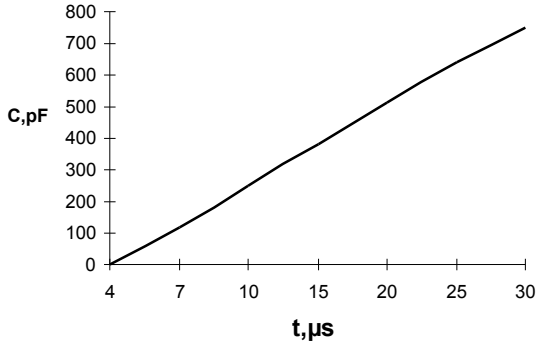


Figure 12 – Saturation protection turn-on delay width versus trimming capacitance

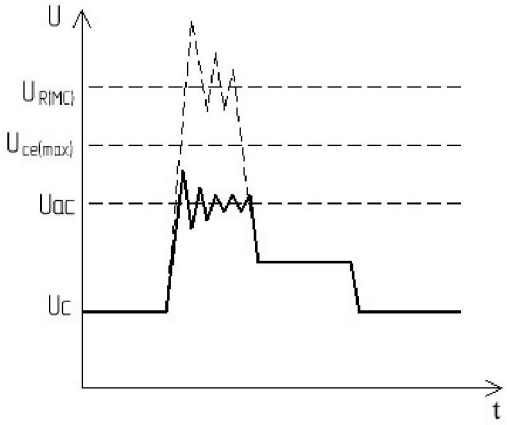


Figure 11 – Graph of driver operation when active protection operation

where Uac – maximum permissible voltage of controlled transistor (active protection operation voltage);
Uc – collector voltage of controlled transistor, Ur(mc) – maximum permissible reverse voltage on output «Collector», Uce(max) – maximum permissible collector-emitter voltage of powerful transistor.

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 factors	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; - maximum, °C	 minus 45 nus 60
Higher ambient temperature: - operating, °C; - maximum, °C	 +85 +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 be not 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 than10 years, at $\gamma = 90$ %.

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

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