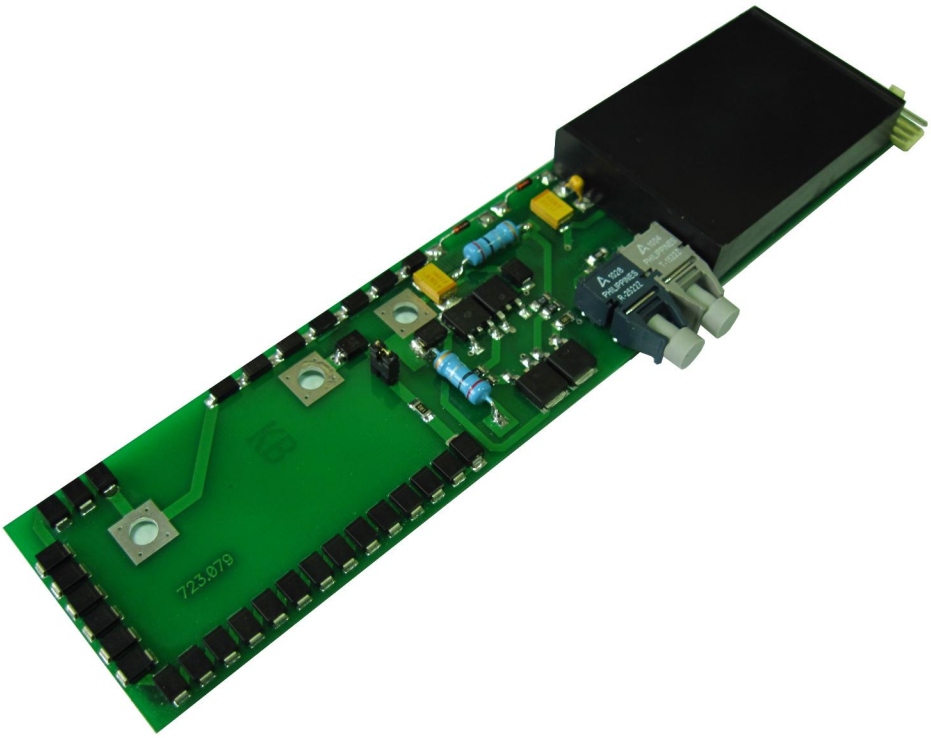
IGBT AND MOSFET TRANSISTOR DRIVER DR1280P–BF-12, DR1280 P–BF -17, DR1280 P–BF -25, DR1280 P–BF -33, DR1280 P–BF -45, DR1280 P–BF -65 ANALOGUE OF 1SP0635, 1SD536F2, 1SD418F2.

USER'S MANUAL



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CONTENTS

1 OVERVIEW

A two-channel driver of powerful transistors with field drive (MOSFET or IGBT) (hereinafter – driver) is intended for dependant galvanic isolated control of two power transistors with maximum permissible voltage up to 6500 V. 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. The driver is an analogue of **1SP0635, 1SD535F2, 1SD536F2, 1SD418F2, 1SD312F2** in structure and function.

2 DRIVER COMPOSITION

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

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 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 driving functions, controlling and protecting functions of controlled transistor:

1 Saturation voltage control on collector-emitter of controlled transistor, its protective disconnection when saturation state output;
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 signaling;
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.

3.2 Overall drawing is shown at Figure 1, functional driver scheme is represented at Figure 2.

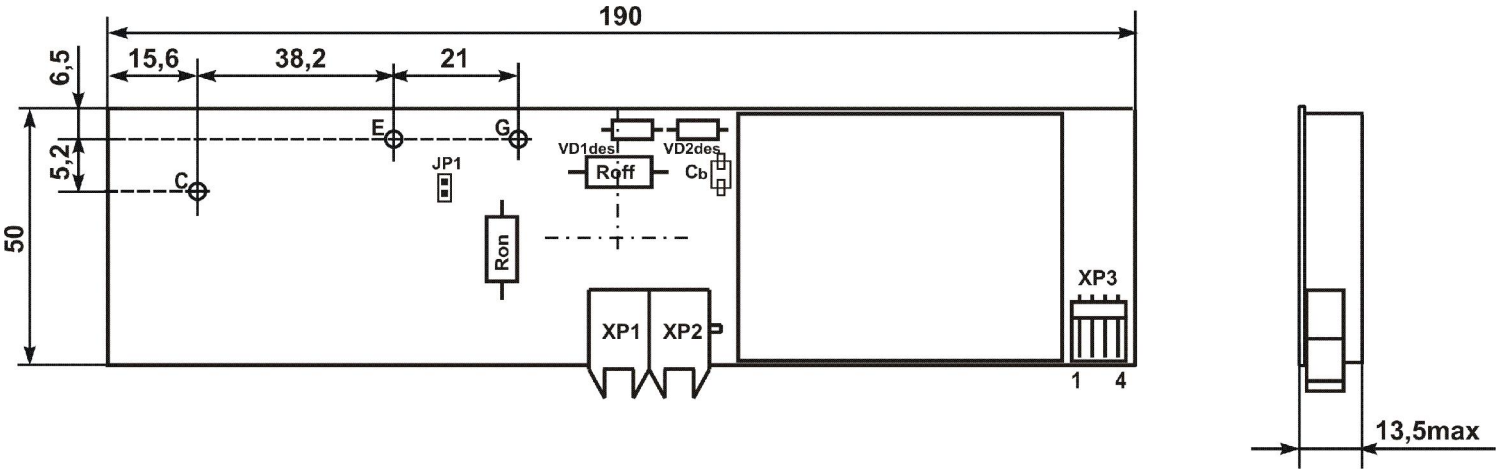


Figure 1 – Overall driver drawing

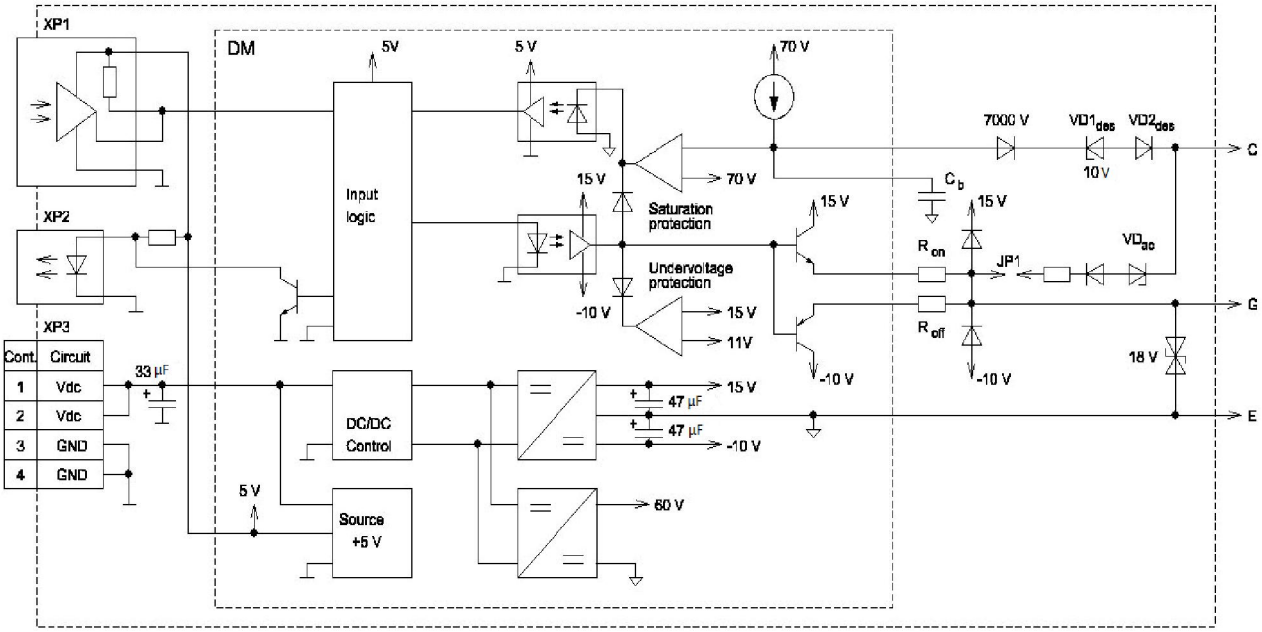


Figure 2– Functional driver circuit

XP1 – receiver HFBR-2522
XP2 – signal transmitter HFBR-1522
XP3 – plug CWF-4R; mate - socket HU-4R

3.3 Output function is given in Table 1.

Table 1 – Output function of XP3 connector

Output	Symbol	Function
1	Vdc	Supply +15 V
2	Vdc	Supply +15 V
3	GND	Ground of supply circuit
4	GND	Ground of supply circuit

4 BASIC AND MAXIMUM PERMISSIBLE PARAMETERS

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

Parameter	Symbol	Unit	Value			Note
			min	type	max	
DC/DC block parameters						
Supply voltage	U_S	V	13.5	15	16.5	
Idle running current consumption	I_S	mA		100	120	F_{cont} = 0 Hz
Maximum current consumption	$I_{S\,max}$	mA			500	Under load ref. to Fig. 5 and 6
Power of built-in supply source of output driver module part	P_{DC-DC}	W	6			
Voltage monitor characteristics						
Turn-on threshold	U_{UVLO-}	V		11		DC-DC output
Turn-off threshold	U_{UVLO+}	V		12		
Control input characteristics						
Wavelength that used when delivering and receiving signal	λ	nm		660		
Time characteristics						
Turn-on/off delivery time of input-output	$t_{d\,(in-out)}$	μs			0.5	ref. to Figure 9
Maximum operating frequency	f_{max}	kHz			50	No-load; ref. to Figure 5 and 6
Delay time of de-saturation protection operation	t_{BLOCK1}	μs	5			Setup by consumer; ref. to Figure 8
Block time of controlled transistor after “emergency”	t_{BLOCK2}	s		1		
Smooth emergency shutdown time of controlled transistor	t_{off}	μs		3		
Turn-on delay time of emergency signal	$t_{d(on-err)}$	μs			3	
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	
Maximum output pulse turn-on current	$I_{Omax\,on}$	A	+28	+31		Set by consumer; ref. to Figure 8
Maximum output pulse turn-off current	$I_{Omax\,off}$	A		-31	-28	
Average output current	I_O	mA			200	
Output signal rise and fall time	$t_{r\,(f)}$	ns			150	ref. to Figure 9
Saturation voltage corresponding to de-saturation voltage operation	$^{Th}U_{ms}$	V		65	70	Set by consumer
Status signal transmitter distance	L_{err}	m	25			

Isolation characteristics						
Maximum permissible reverse collector voltage	U_C	V			7000	
Isolation voltage between input and output of DC (1 minute, DC)	$U_{ISO(IN-OUT)}$	V			4000	DR1280P-BF-12 DR1280P-BF-17
					7500	DR1280P-BF-25 DR1280P-BF-33
					10000	DR1280P-BF-45
					12000	DR1280P-BF-65
Critical rate of voltage change on output	$(dU/dt)_{cr}$	kV/ μs			20	
Overvoltage protection characteristics						
Protection operation voltage against collector-emitter overvoltage of controlled transistor (ref. to Figure 12)	U_{AC}	V		800		DR1280P-BF -12
				1200		DR1280P-BF -17
				1600		DR1280P-BF -25
				2400		DR1280P-BF -33
				3200		DR1280P-BF -45
				4400		DR1280P-BF -65
Controlled transistor parameter						
Maximum permissible voltage of controlled transistor	U_{CE} (U_{DS})	V			1200	DR1280P-BF -12
					1700	DR1280P-BF -17
					2500	DR1280P-BF -25
					3300	DR1280P-BF -33
					4500	DR1280P-BF -45
					6500	DR1280P-BF -65
Service and storage characteristics						
Operating temperature range	T_A	°C	-45		+85	
Storing temperature	Ts	°C	-60		+100	

5 DRIVER OPERATION

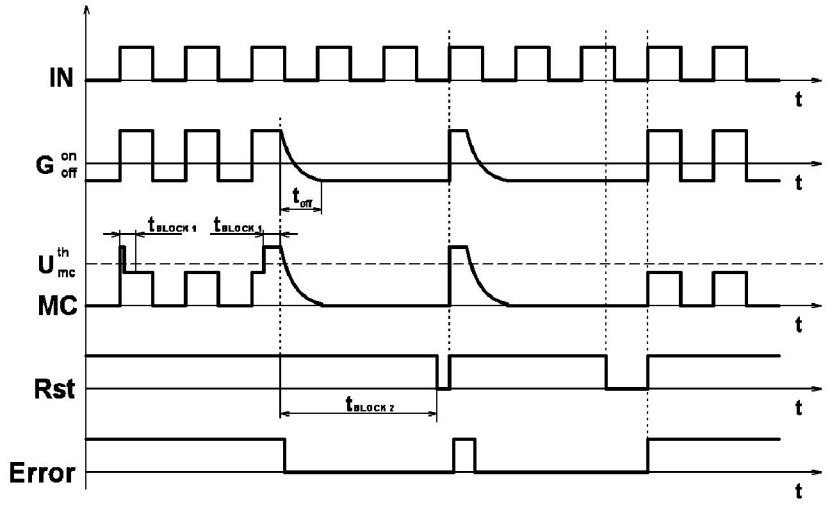
Delivery of light pulse to control signal receiver XP1 will lead to opening of controlled transistor. Open state voltage fall increase by more than U_{ms}^{Th} per time, exceeding t_{BLOCK1}, will lead to protection operation of open state voltage fall increasing (when current overload). When “emergency” LED of XP2 transmitter stops lighting. In 1 sec there will be emergency reset by internal circuit of emergency reset and controlled transistor will open on rising edge of control signal. In the event when the emergency cause was not disposed then the protection cycle will be recurred.

Overvoltage protection will operate with installed jumper JP1 if the output “Collector” voltage will exceed U_{ac}, ref. to Figure 10.

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 that used when delivering and receiving signal is equal to 660 ns.

Status transmitter XP2. Microcircuit forms the light signal about driver operation mode. There is 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 decrease 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 correctly 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 120 mA. When transistors are connected the current consumption increases by value of gate recharge current and it can reach 0.5 A.

At higher current consumption DC/DC – converter can fail, or, when short-time increase of current consumption by 0.5 A, 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 6). Thereby, when using the driver you must make a correction for current consumption according to the transistors, which the driver will work on. Safe operation area of the driver versus gate capacitance and frequency is shown at Figure 5.

G – output meant for gate connection of controlled transistor.

Gate resistors (Ron, Roff) are necessary for decreasing of maximum pulse current. Gate resistors are installed with resistance of 0 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. The dependence of output pulse current on the nominal of gate resistors is represented at Figure 8. Initially, the resistors 0.2 Ω are installed that corresponds to the maximum pulse current.

C – collector connection output of controlled transistor. The output is intended for voltage fall controlling (saturation protection) on the transistor. Maximum value of protection operation threshold is equal to 65 V (typ). Thereby initially the Zener diode VD1des and VD2des with voltage drop 10V are installed, that is initially the protection threshold is 55 V (typ.).

Protection operation threshold is regulated by installing the diode (Zener diode) VD1des and VD2des.

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

E – emitter connection output of controlled transistor.

Diodes VD1des and VD2des – diodes (Zener diodes) that adjust the protection operation threshold on non-saturation: Zener diode and diode voltage drop at 1 mA is deducted from maximum voltage (65V).

For example, if you install the Zener diode with nominal stabilized voltage 20 V and diode with voltage fall 0.7 V at 3 mA then the protection operation threshold will be equal to 65-20-0.7 = 44.3 V.

Capacitor C_b – delay setting capacity of protection operation on non-saturation, ref. to Fig. 8. Initially the capacity of 100 pF is set on the driver that corresponds to the operation delay 7.5 μs.

Jumper JP1. Jumper that connects collector-emitter overvoltage protection of controlled transistor.

7 DRIVER CONNECTION RECOMMENDATIONS

In order that the driver may be analogue to the plug-n-play CT-Concept Driver for the special module it is recommended to adjust DR1280P-BF in compliance with CT-Concept Driver. You should adhere to the following technique when setting up the driver:

1. Disconnect CT Concept driver from the module, connect DC voltage sources between collector and emitter outputs, control gate signal.
2. Measuring protection operation voltage by smooth rising of voltage at the sources that imitate transistor saturation voltage.
3. Relative to protection operation threshold you should increase the voltage twice and measure non-saturation protection operation delay.
4. Reset "Emergency" mode, set up the frequency of control signal 0.1…1 kHz, connect RC-chain (resistor to gate) between gate and emitter with nominal 0.1 Ω/ 1μF (non-polar condenser). Connect the driver and measuring resistor voltage drop (measurement of pulse driver current).
5. Set up DR1280P-BF in compliance with the characteristics of CT Concept driver, notably:
- set up non-saturation protection operation voltage by trimming diodes VD1des and VD2des;
- set up protection operation delay time by capacitor Cb in compliance with Figure 8;
- set up output pulse current by resistor Rg on(off) in compliance with Figure 7.
6. Measure the received parameter of DR1280P-BF similarly to the CT Concept driver test, be assured in their equivalent.
7. Connect the driver to the power module and be sure that the converter operates by analogy with the variant of CT-Concept driver.

8 GRAPHS EXPLAINING DRIVER OPERATION

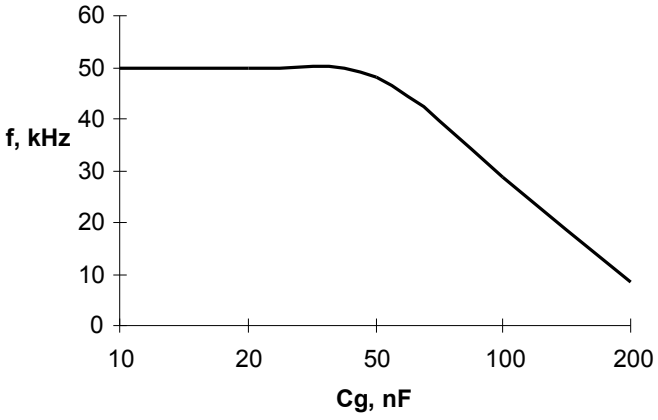


Figure 5 – Graph of safe operation area versus frequency and gate capacity (with gate resistor 1 Ω)

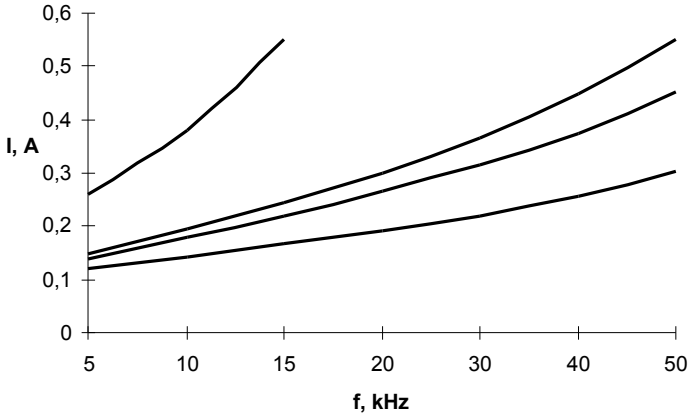


Figure 6 – Dependence of current consumption on load signal frequency (with gate resistor 1 Ω) For gate capacities 10 nF, 25 nF, 50 nF, 100 nF

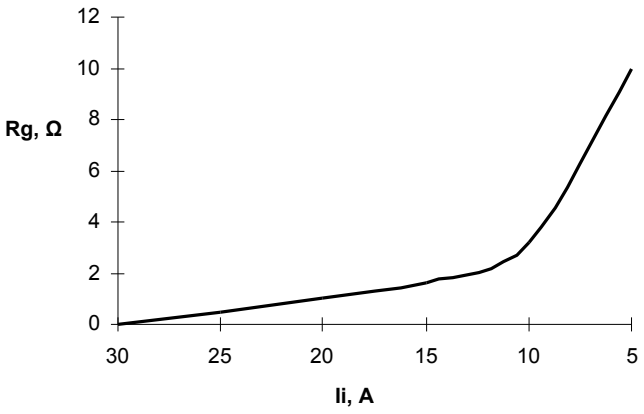


Figure 7 – Dependence of output pulse current on the gate resistor nominal

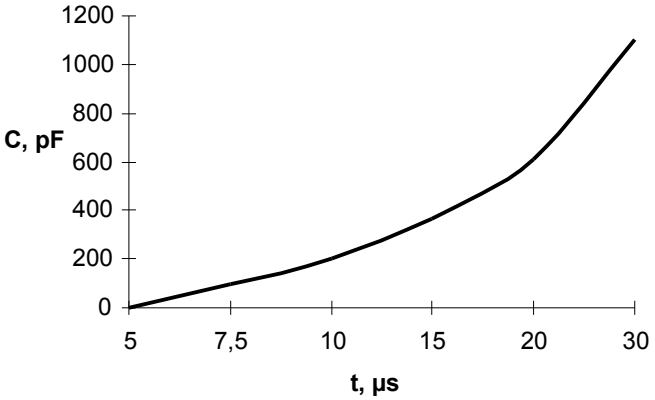


Figure 8 – Dependence of turn-on delay duration of non-saturation protection on the nominal of trimming capacity C_b

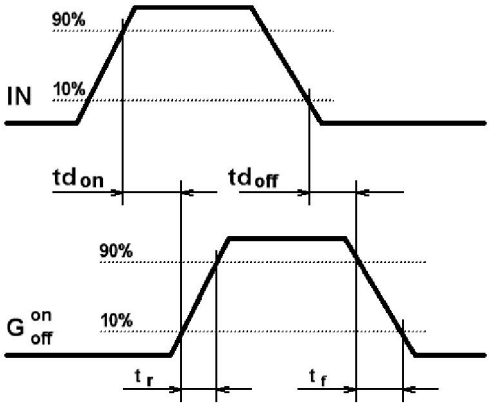


Figure 9 – Diagram explaining time characteristics
where IN – input control signal; G – gate signal of controlled transistor

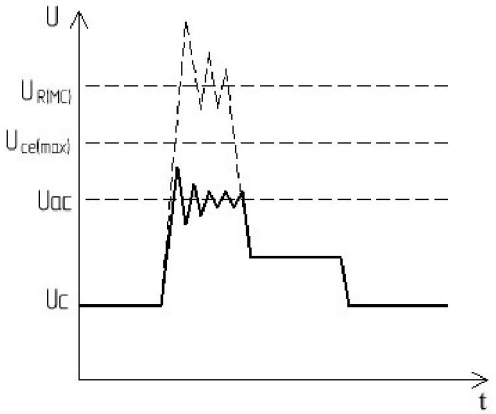


Figure 10 – Graph of driver operation when protection operation against collector-emitter overvoltage of controlled transistor
where Uac –overvoltage protection operation voltage; Ur(mc) – maximum permissible reverse voltage on driver collector output, Uce(mc) – collector-emitter powerful transistor maximum voltage

9 INFORMATION ABOUT PRECIOUS METALS

Precious metals are not contained.

10 SERVICE RECOMMENDATIONS

10.1 Resistance 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

10.2 Resistance 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)

11 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 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.