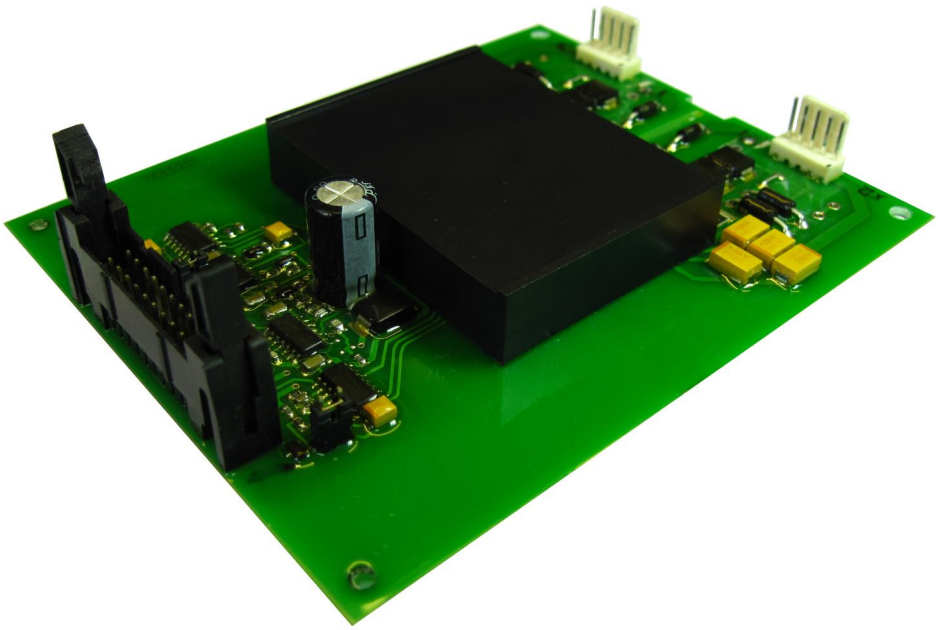
IGBT AND MOSFET TRANSISTOR DRIVERS
DRF280P–B-12, DRF280P–B1-12, DRF280P–B-17, DRF280P–B1-17

USER'S MANUAL



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CONTENTS

1 OVERVIEW

A fast two-channel driver of powerful transistors with field control (MOSFET or IGBT) (hereinafter – driver) is intended for dependent or independent galvanic isolated control of two powerful transistors with maximum permissible voltage up to 1700 V. The driver is an amplifier – control signal shaper of transistors gate with up to 200 kHz. The driver contains built-in galvanic isolated DC-DC-converter providing requisite levels that unlock and lock gate voltage of the transistor.

2 DRIVER COMPOSITION

The driver – a circuit plate with installed driver module (DM), performed in hermetic plastic housing, necessary tuning elements and connectors for connection of controlled transistor and control signals.

2.1 Driver contains the following functional parts:

1 Driver supply voltage stabilizer with protection against faulty turn-on polarity;
2 Build-in DC-DC converter with stabilization of enabling and blocking voltage level on controlled transistors gates;
3 Input logics;
4 Control circuit of controlled transistors gates;
5 Protection circuit against undervoltage on controlled transistor gates.
6 Protection circuit of controlled transistors against current overload;
7 Protection circuit of controlled transistor against over-voltage in collector-emitter circuit

3 FUNCTIONAL DRIVER FEATURES

The driver provides the following driving, controlling and protecting functions of controlled transistor:

1 Saturation voltage control on controlled transistor collector, its protective turn-off 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” (controlled transistor output from saturation mode);
4 Turn-on regulation – controlled transistor turn-on by resistors resistance change in output circuit (Ron, Roff).
5 Voltage control of driver supply (built-in comparator) on DC-DC converter output;
6 Control block when an “emergency”;
7 Block against simultaneous turn-on of upper and lower arms;
8 Turn-on/off delay of upper and lower arms;
9 Emergency signaling;
10 The possibility of external control by restart when an “emergency”;
11 Transistor protection against over-voltage in collector-emitter circuit.

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

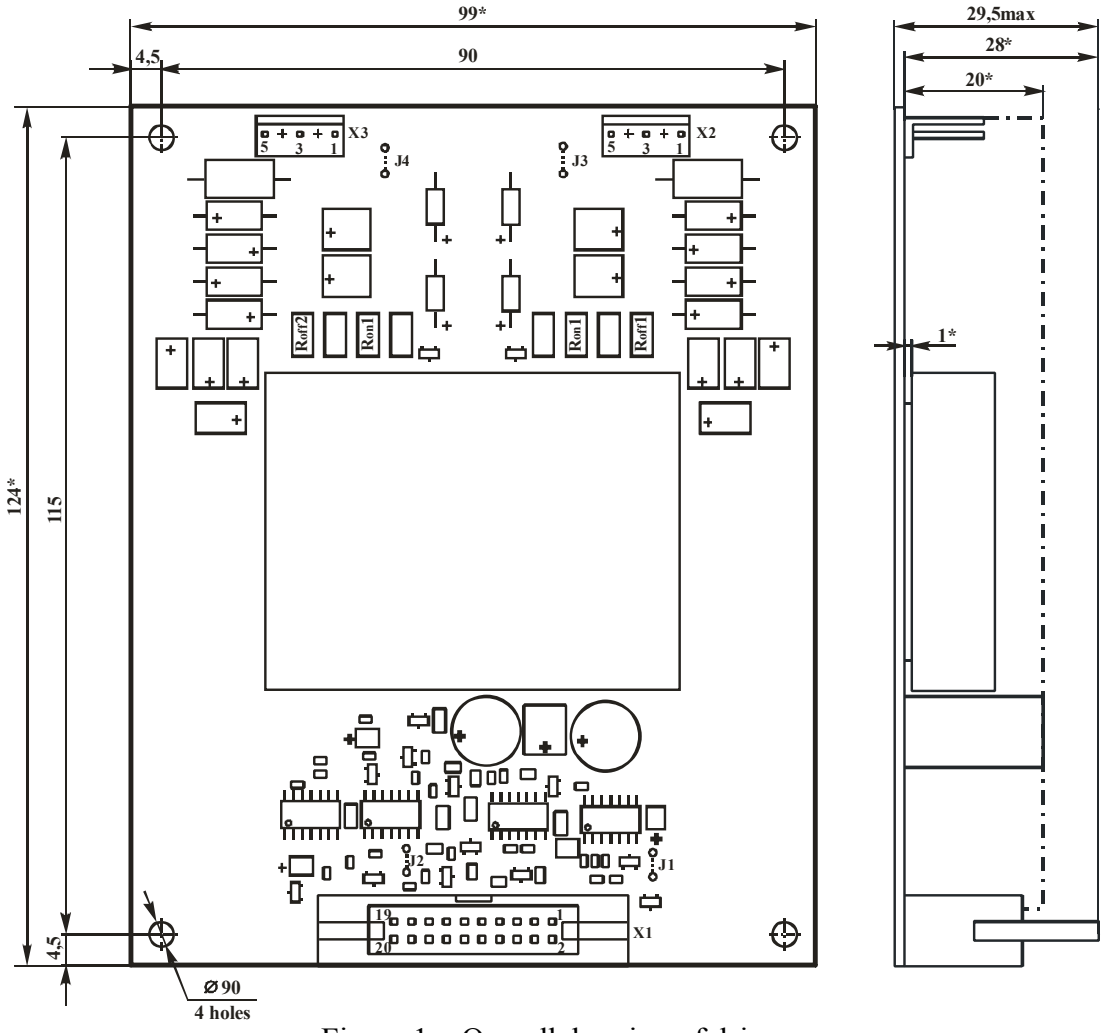


Figure 1 – Overall drawing of driver

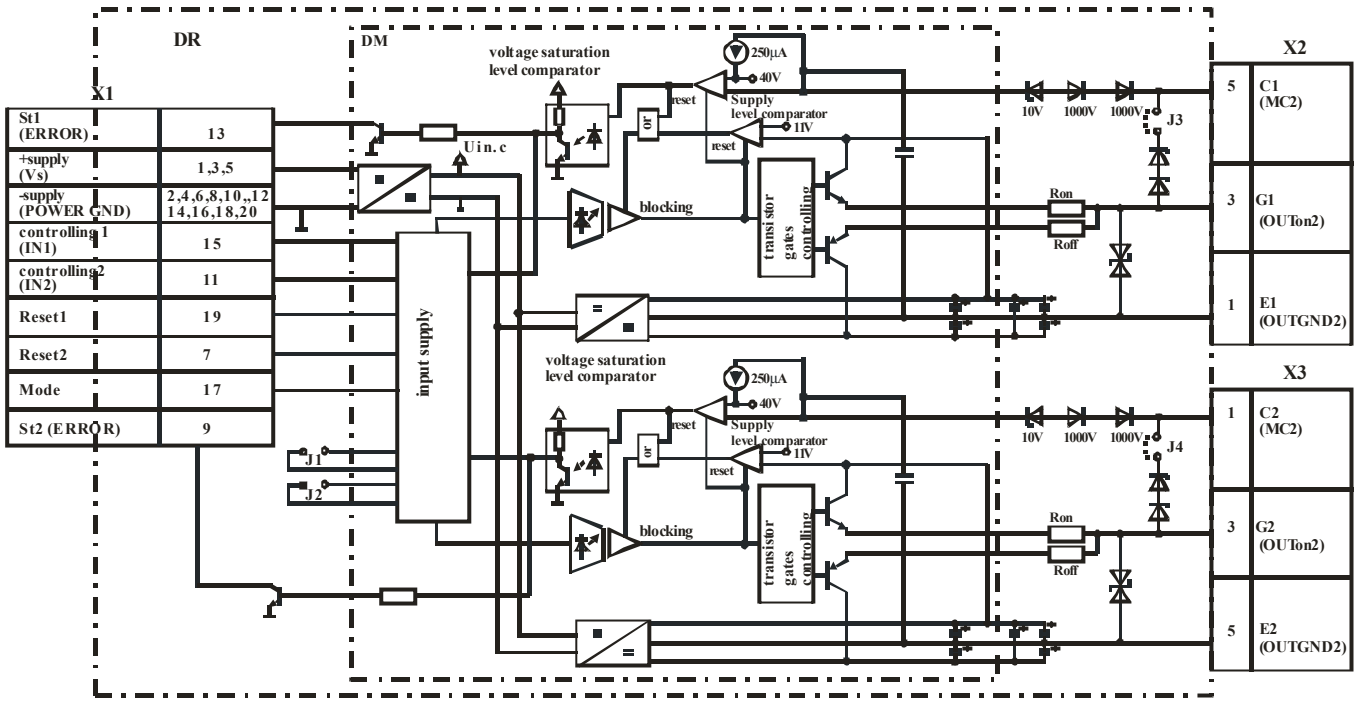


Figure 2– Functional circuit and driver turn-on circuit

Note – Outputs description in accordance with conditionally graphic symbols in electric circuits is shown in the brackets.

Connector type X1: plug IDCC-20MS + socket IDC-20;

Connector type X2, X3: plug WF-M-5 + socket HU-F-5.

Table 1 – Outputs description

Con-nector	Outputs	Outputs description	Symbol
X1	1, 3, 5	Supply +15 V	Vs
	2,4,6,8,10,12, 14,16,18,20	Ground supply and control outputs	POWER GND
	9	Error signal output of second channel (open collector)	St2
	11	Controlling input (channel 2)	IN2
	13	Error signal output of first channel (open collector)	St1
	15	Controlling input (channel 1)	IN1
	17	Input of operation mode choice	Mode
	7	Reset (channel 2)	Reset2
	19	Reset (channel1)	Reset1
X2	1	Ground output of output signals of first channel	E1
	3	Driver output of first channel with turn-on/off time setting	G1
	5	Measuring collector – saturation voltage control circuit on controlled transistor (channel 1)	C1
X3	1	Output signals ground output of second channel	E2
	3	Driver output of second channel with turn-on/off time setting	G2
	5	Measuring collector – saturation voltage control circuit on controlled transistor (channel 2)	C2

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			200	f = 0 Hz, refer to Figures 5 and 6
Power of built-in supply source of output driver module part	P_{DC-DC}	W	4			For each channel
Voltage monitor characteristics						
Turn-off threshold	U_{UVLO+}	V		11		DC-DC output
Turn-on threshold	U_{UVLO-}	V		12		DC-DC output
Control input characteristics						
High level input voltage	U_{IH}	V	3	5	5.6	DRF280P-B
			9	15	16.8	DRF280P-B1
Low level input voltage	U_{IL}	V	-0.6	0	0.8	DRF280P-B
			-0.6	0	2.4	DRF280P-B1
Input resistance	R_{IN}	kΩ		2.0		DRF280P-B
				5.9		DRF280P-B1
Time characteristics						
Signal turn-on delay time between input and output	$t_{d\ on(in-out)}$	µs			0.75	Refer to Figure 11
Signal turn-off delay time between input and output	$t_{d\ off\ (in-out)}$	µs			0.5	Refer to Figure 11
Maximum operating frequency	f_{max}	kHz			200	No-load; Ref. to Figure 6 and Figures 6, 8
Block time of fall voltage control on controlled open state transistor	t_{BLOCK1}	µs		1.5		

Continuation of Table 2

Characteristic	Symbol	Unit	Value			Note
			min	type	max	
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	$td_{(on-err)}$	µs			2	
«Dead time» between signals changes on first and second channels outputs	t_{TD}	µs	0.2	0.25	0.3	
Output characteristics						
High level output voltage	U_{OH}	V	+14	+16	+19	In all range of permissible loads
Low level output voltage	U_{OL}	V	-7.5	-6	-4	In all range of permissible loads
Maximum output pulse current	I_{Omax}	A	-8		+8	Set by consumer; ref. section 6
Mean output current	I_O	mA			160	For each channel
Output signal rise time	t_r	ns			150	No-load, ref. section 6 and Figures 7, 11
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	with I_{ERR} = 20 mA
Threshold voltage on measure input MC causing emergency turn-off	U_{Mc}^{Th}	V		10		Without additional elements
Active protection voltage	Uac	V			800	DRF280 P-B(B1)-12
					1200	DRF280 P-B(B1)-17
Isolation characteristics						
Maximum permissible reverse voltage on output «MC»	$U_{R(MC)}$	V			2000	
Isolation voltage between input and output	$U_{ISO(IN-OUT)}$	V			4000	DC, 1 minute
Isolation voltage between input and output of first and second channels	$U_{ISO(OUT1-OUT2)}$	V			2000	DC, 1 minute
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	

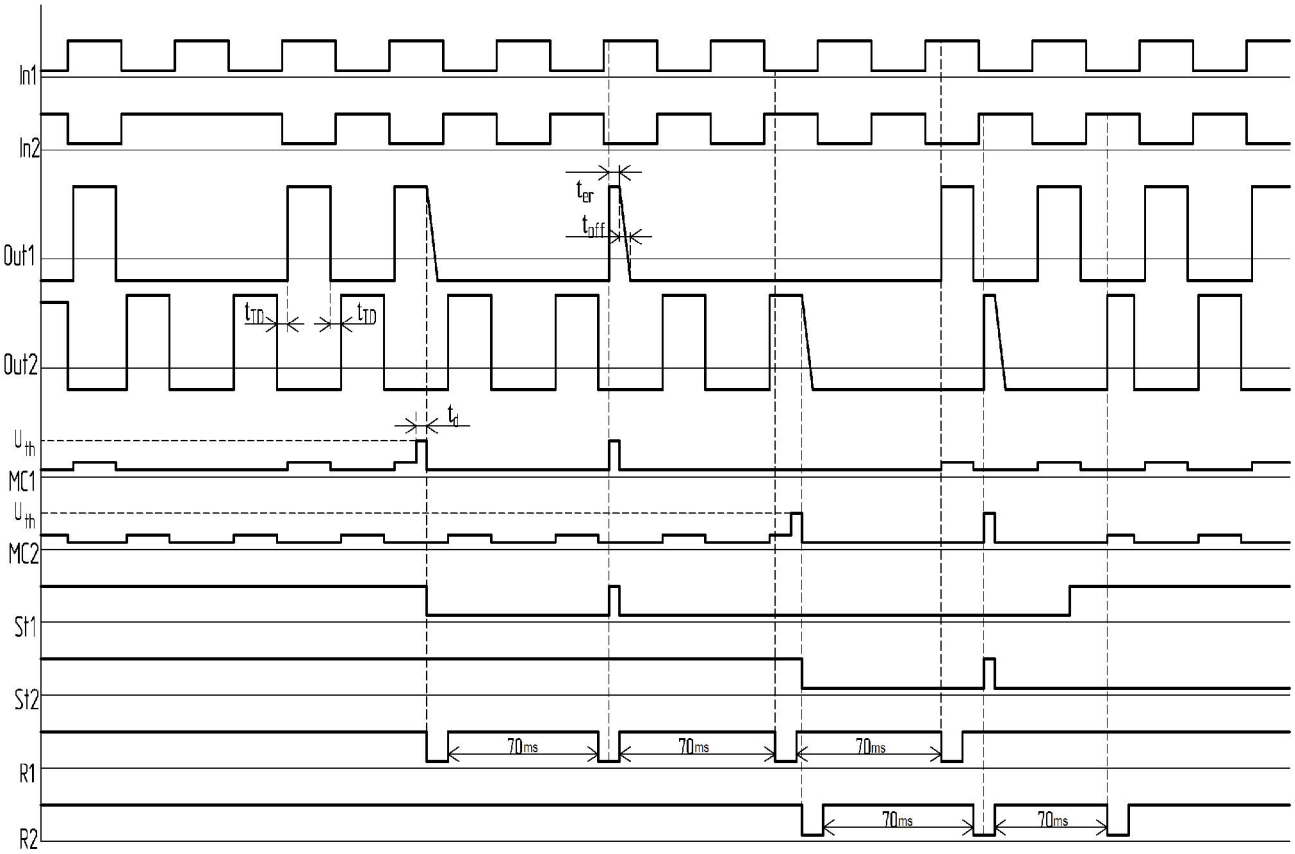
5 DRIVER OPERATION

Delivery of «log.1» on controlling input «IN1» or «IN2» will lead to opening of controlled transistor. Open state voltage fall increasing 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” the transistor will open that is connected in accordance with the circuit with open collector (output «Error»). In 70 ms emergency reset will be performed by internal circuit of emergency reset and on rising edge of control signal «IN» the controlled transistor will be opened. If 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 close the controlled transistor regardless of input control signals. Control signals will recover 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 will be blocked and controlled transistors will be closed if there is “log.1” on output “Mode” and on simultaneous delivery of “log. 1” to outputs «IN1» and «IN2», thereby error signaling on output «Error» does not arise.

The diagrams explaining driver operation is shown at Figures 3 and 4.



where R1 and R2 –internal rerun signals of corresponding channels in a mode «Emergency».

Figure 3 – Driver operation graph with internal rerun

Figure 4 – Graph of driver operation with use of output «Reset»

6 DRIVER CONNECTION RECOMENDATIONS

In1, In2 - Control inputs of powerful transistors. Meanwhile «log.1» corresponds to transistor turn-on; «log.0» corresponds to turn-off. It is not recommended to use the driver with frequency of controlling signals less than 50 kHz because in this case rerun failures in emergency mode are possible.

Mode - Output is intended for driver mode selecting. If output "Mode" is not connected then the driver operates with dependent turn-on of channels with switching "dead time" and simultaneous turn-on lock of top and lower arms that is when delivery of identical signals to inputs «In1» and «In2» locking voltage can occur on transistor gate.

The channels operate independently when short-circuited output «Mode» to ground; it is allowed any combination of control signals.

Reset1, Reset2 – outputs intended for emergency mode drop of driver operation. These outputs should be used only with removed jumpers J1 or J2 in accordance to that, on which channel external reset is used; if «Reset» is used with installed jumpers then driver operation failures in emergency mode are possible. On using of external reset drive at one of the channels it is allowed to keep internal re-drop to another channel.

Outputs operate independently, when there is emergency only at one channel, the second channel will operate in normal mode. When outputs Reset1 and Reset2 are connected then emergency of one of the channels will prohibit operation of the second channel. In this mode with independent operation of the channels the reset can occur simultaneous (that is the both powerful transistors can open simultaneous), when dependent operation the simultaneous opening of both transistors can not occur; re-drop will occur only on the channel on which input there is "log.1".

The reset corresponds to «log.0». With a constant presence of «log.0» the reset will occur automatically in every 70 ms (ref. to the diagram explaining driver operation).

St1, St2 - outputs that signal to emergency, they are open transistors collectors of protection circuit. Meanwhile transistor will open only when emergency caused by current overload of powerful transistors; when driver supply voltage decrease to level «U_{uvlo-}» transistors will be closed regardless of input control signals (signals will recover if supply level corresponds to «U_{uvlo+}») but error signaling will not follow in this case.

Outputs «St1» and «St2» operate independently. Error signaling will be only for the channel where the emergency occurred, including dependent channel operation mode.

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

Maximum no-load current consumption on supply input is 250 mA. When transistors connecting the current consumption will increase by value of gate recharge current and it can reach 750 mA. At higher current

consumption DC/DC – converter can fail, or, when short-time current consumption increase to 750 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 and 6). Thereby, when using the driver 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 8.

C1, C2 – collector connection outputs (drain) of controlled transistor. Outputs are intended for voltage fall controlling (saturation protection) on transistor. Thereby typical value of protection operation threshold is equal to 10 V. If current overload protection of controlled transistor is not required, then output C should be short-circuited to source (emitter) of corresponding channel.

G1, G2 – outputs intended for connecting of controlled transistors gates.

Gate resistors (Ron1, Ron2, Roff1and Roff2) are necessary for decrease of maximum pulse current. It is 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-on width increase of controlled transistor to decrease voltage amplitude of inductive surges.

Jumpers

J1, J2 – jumpers connecting internal re-drop circuits in emergency mode (ref. to operation description of outputs Reset)

J3, J4 – jumpers connecting protection against collector-emitter voltage of controlled transistors. Protection operation is represented at Figure 12.

7 GRAPHICS EXPLAINING DRIVER OPERATION

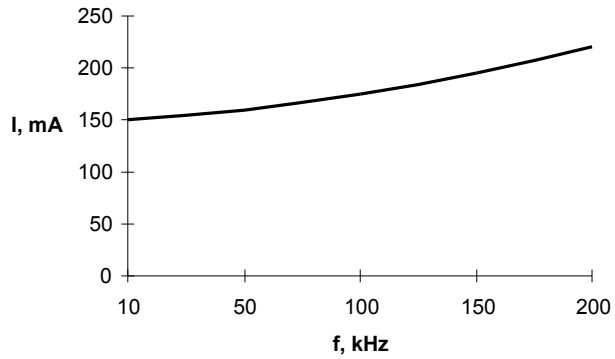


Figure 5 – Graph of driver current consumption versus no-load control signal frequency

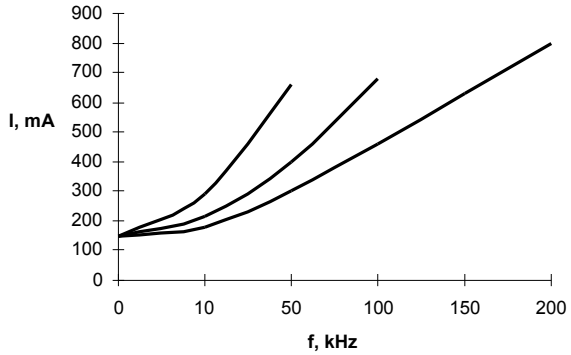


Figure 6 – Graph of current consumption versus signal frequency under load (with gate resistor 5Ω) for gate capacities 10nF, 25 nF, 50 nF

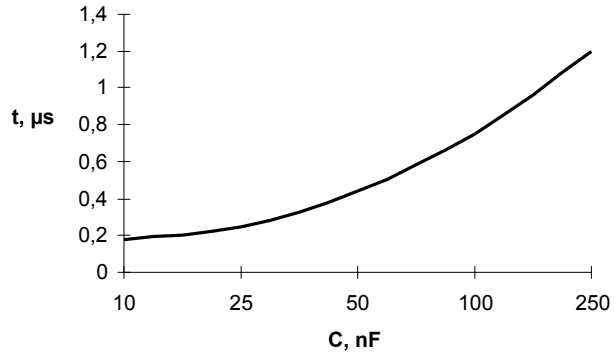


Figure 7 – Graph of acceleration time versus gate capacity (with gate resistor 5 Ω)

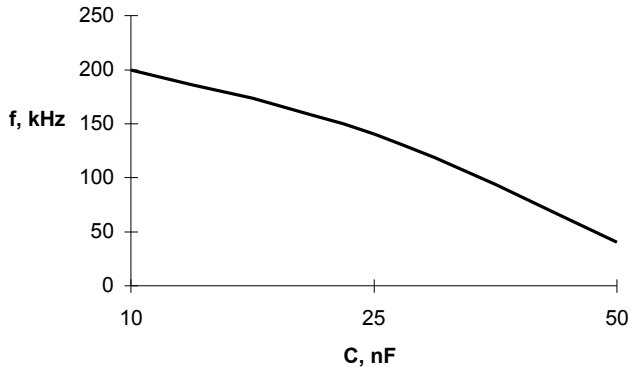


Figure 8 – Graph of driver safe operation area (with gate resistor 5Ω)

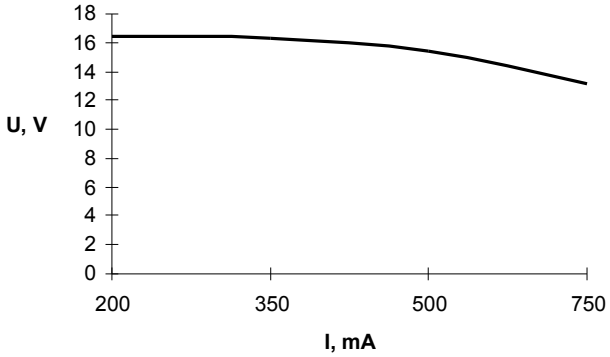


Figure 9 – Graph of transistor gate voltage versus current consumption

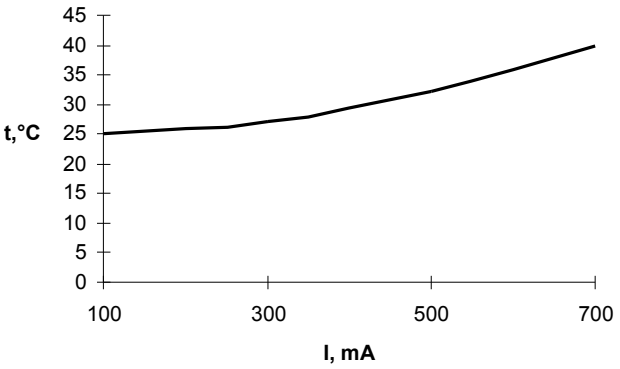


Figure 10 – Graph of driver housing temperature versus current consumption

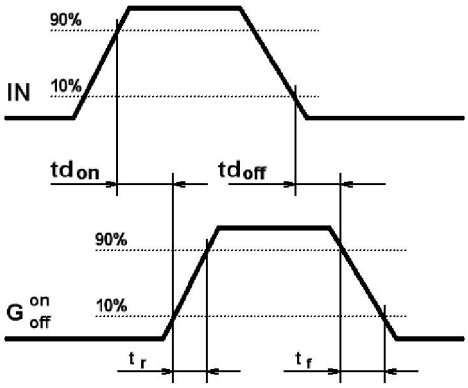


Figure 11 – Diagram explaining driver time characteristics
where IN – input control signal;
G – signal of controlled transistor gate

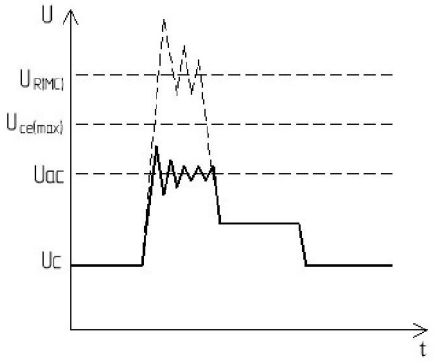


Figure 12 – Graph of driver operation when active protection operation
where Uac – maximum permissible voltage of controlled transistor (active protection operation voltage); Uc – collector voltage of controlled transistor, Ur(mc) – maximum permissible reverse voltage on output «MC», Uce(max) – maximum 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;	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 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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