IGBT AND MOSFET TRANSISTORS DRIVER DR1480P–B(B1)

USER'S MANUAL

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1 OVERVIEW

A single-channel driver of powerful transistors with field control (hereinafter – driver) is intended for galvanic isolated control of powerful transistors with field control (MOSFET or IGBT) with maximum permissible voltage up to 1700 V. The driver is an amplifier-former of transistors gate control signals with frequency up to 50 kHz. The driver includes a built-in galvanic isolated DC-DC converter, providing necessary levels of enabling and blocking voltages on transistor gate.

2 DRIVER COMPOSITION

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

2.2 Driver contains the following functional parts:

1 Supply voltage stabilizer of driver with protection against abnormal 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 control circuit gate;
5 Under-voltage and excess voltage protection circuit on controlled transistor gate;
6 Controlled transistor protection circuit against overcurrent.

3 FUNCTIONAL DRIVER FEATURES

3.1 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 leaving saturation state;
2 Threshold regulation of protective turn-off on saturation voltage;
3 Smooth driver junction from active state to inactive one when “emergency” (controlled transistor output from saturation mode);
4 Emergency signaling;
5 Driver supply voltage control (built-in comparator)

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

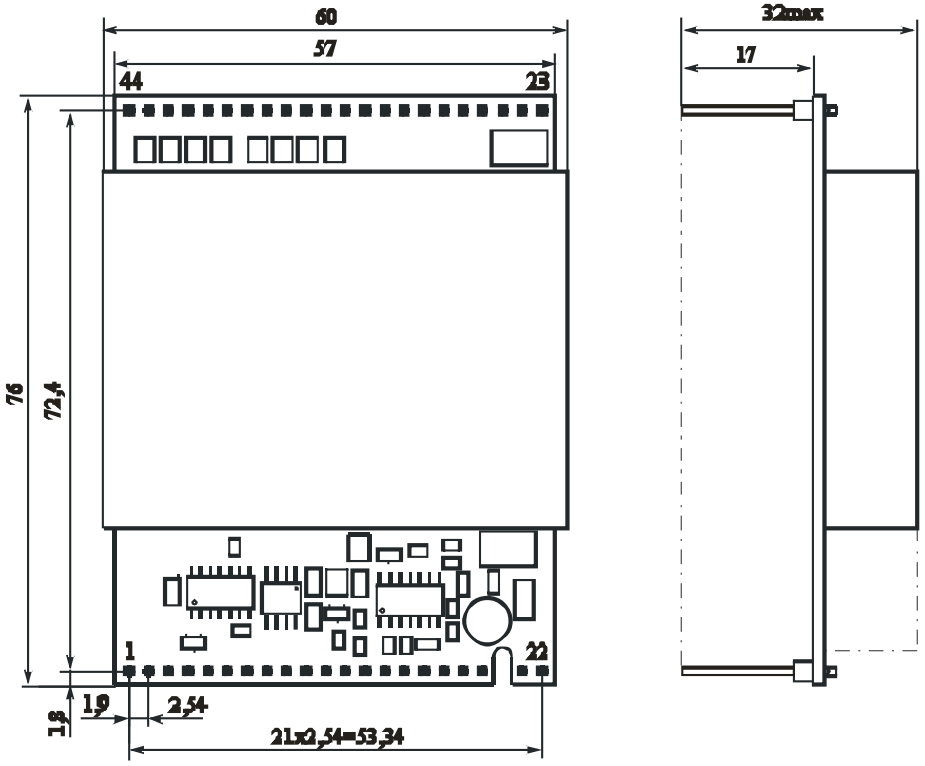

Figure1 – Overall drawing

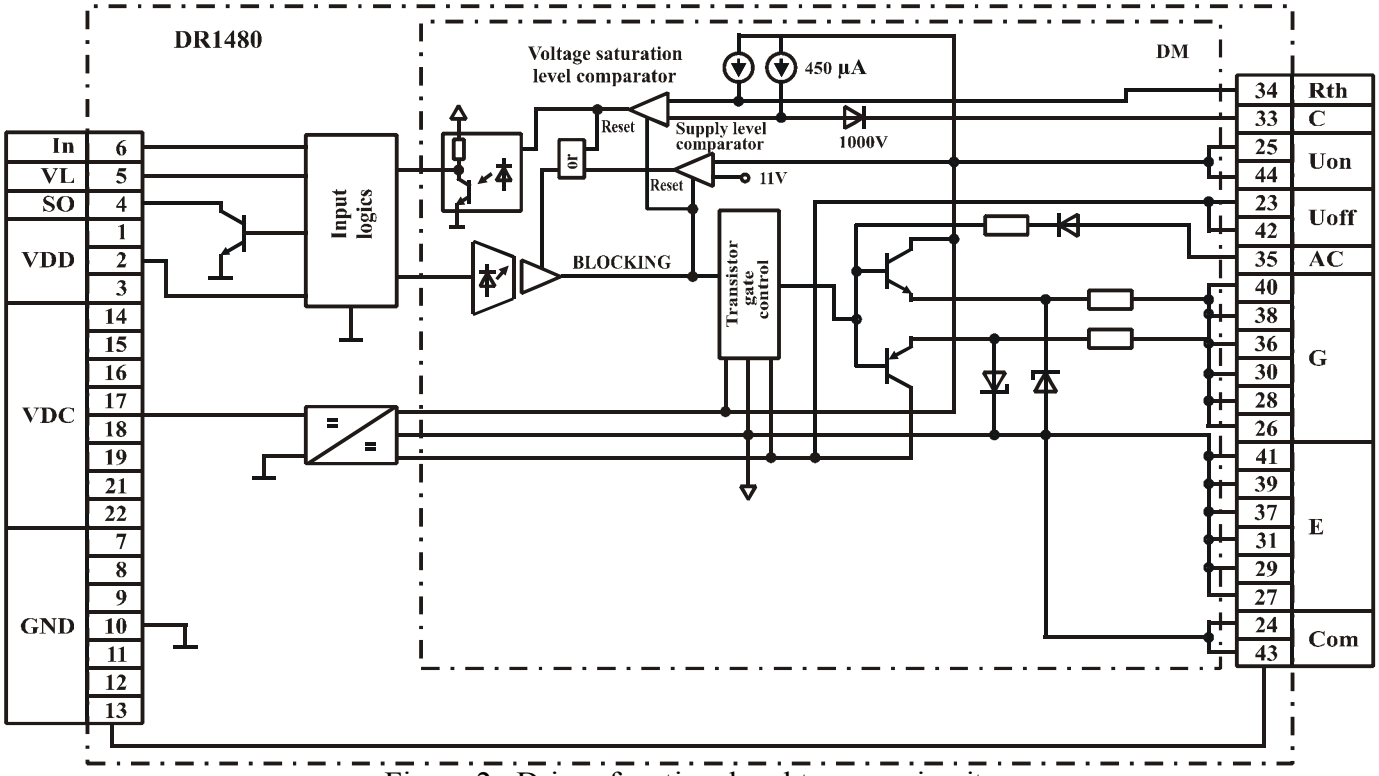

Figure 2– Driver functional and turn-on circuits

3.3 Outputs description is shown in Table 1.

Table 1 – Description of driver outputs

Output number	Output description	Symbol
1, 2, 3	Supply +15V	VDD
4	Status output	SO
5	Emergency state drop input	VL
6	Controlling input	In
7 – 13	Ground	GND
14 – 19, 21, 22	Supply +15V	VDC
20	Not involved	-
23, 42	Turn-off voltage (-7 V)	VNEG
24, 43	Ground	COM
25, 44	Turn-on voltage (+18 V)	VPOS
26, 28, 30, 36, 38, 40	Gate	G
27, 29, 31, 37, 39, 41	Emitter	E
32	Not involved	-
33	Collector (measure input)	C
34	Setup resistor of saturation protection operation threshold	R_{th}
35	Over-voltage protection input in collector-emitter circuit	AC

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 on input VDC	I_S	mA			100	f = 0 Hz, see Figures 11 and 12
Maximum current consumption on input VDD	I_S	mA			50	
Power of built-in supply source of output driver module part	P_{DC-DC}	W	10			
Voltage monitor characteristics						
Off threshold	U_{UVLO+}	V		11		DC-DC output
On threshold	U_{UVLO-}	V		12		DC-DC output
Control inputs characteristics						
High level input voltage	U_{IH}	V	9	15	16.8	
Low level input voltage	U_{IL}	V	-0.6	0	2.4	
Входное сопротивление	R_{IN}	kΩ		5.9		
Time characteristics						
Signal turn-on delay time between input and output	$t_{d\ on(in-out)}$	µs			0.5	See Figure 20
Signal turn-off delay time between input and output	$t_{d\ off\ (in-out)}$	µs			0.5	See Figure 20
Maximum operating frequency	f_{max}	kHz			50	No-load; See section 6 and Figures 11, 12
Block time of fall voltage control on	t_{BLOCK1}	µs		4		Set by consumer;

controlled open state transistor						see section 6 and Figures 17
Transistor smooth emergency shut-down time	t_{off}	µs		4		
Turn-on delay time of emergency signal	$td_{(on-err)}$	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	-48		+48	
Mean output current	I_O	mA			750	
Output signal time rise	t_r	ns			150	No-load, see section 6 and Figures 13, 10
Output signal time fall	t_f	ns			150	No-load, see section 6 and Figures 10, 13
Maximum current of status output «SO»	$I_{ERR\ max}$	mA			20	
Maximum voltage of status output «SO»	$U_{ERR\ max}$	V			30	
Residual voltage on signal output «SO»	$U_{O\ ERR}$	V	0	0.3	0.7	with I_{ERR} = 20 mA
Threshold voltage on measuring input C calling emergency turn-off	$^{Th}U_{ms}$	V			15	Set by consumer, see Figure 18
Isolation characteristics						
Maximum permissible reverse voltage on output «MC»	$U_{R(MC)}$	V			1000	Without additional diodes
Isolation voltage between input and output	$U_{ISO(IN-OUT)}$	V			4000	DC, 1 minute
Critical speed of voltage change on output	$(dU/dt)_{cr}$	kV/ µs			20	
Service and storage characteristics						
Working 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 «IN» leads 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 be opened connected in accordance with the circuit with open collector (output «SO»). Emergency drop occurs when delivering of “log. 1” to drop input “VL”

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 recover on protection operation threshold against driver supply undervoltage «U_{uvlo+}». There is not an error signal on output «SO» when protection operation against supply undervoltage.

Elementary connection circuit of driver inputs and diagram of its operation are shown at Figure 3 and 4.

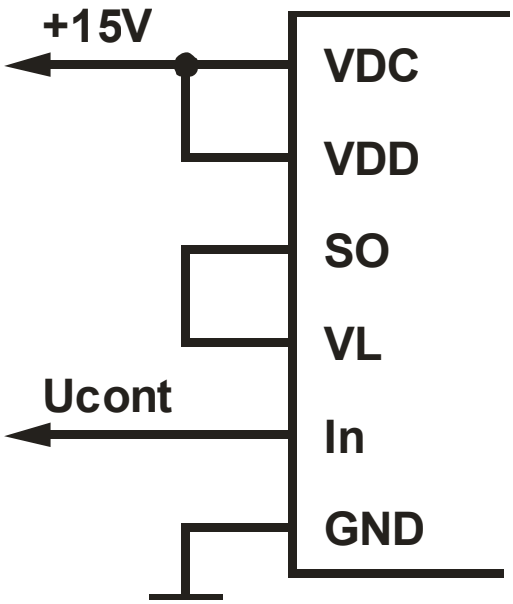

Figure 3 – Driver connection circuit to control circuits

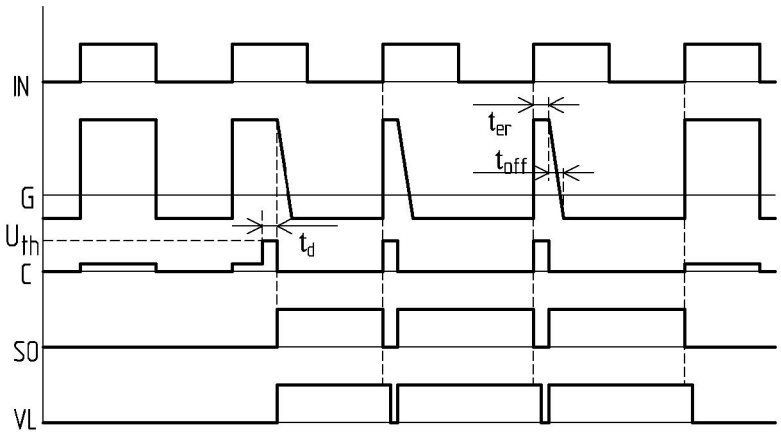

Figure 4 – Driver operation diagram connected according to the circuit of Figure 3

In the case if external drop control is necessary then it is recommended the circuit represented at Figure 5, then driver operation diagram will be correspond to the diagram showed at Figure 6.

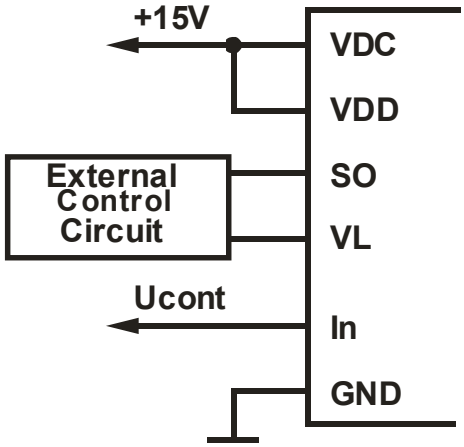

Figure 5 –Driver connection circuit to control circuits with external rerun

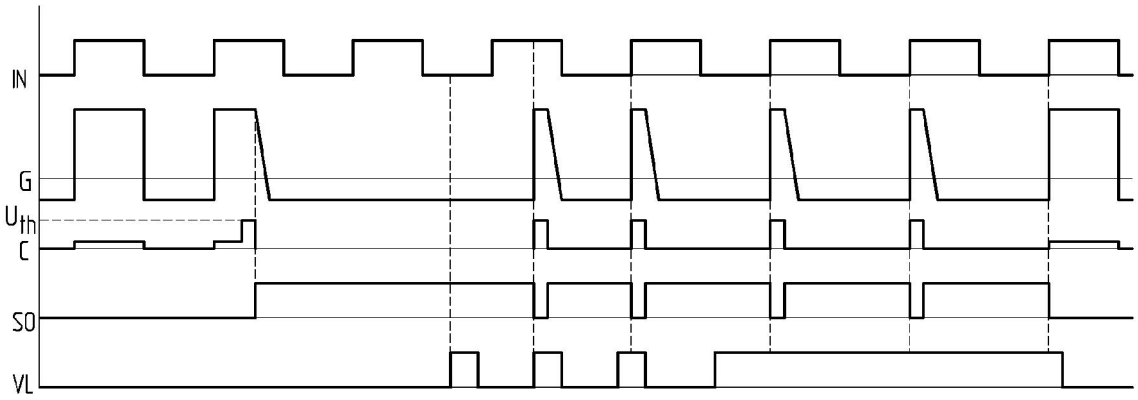

Figure 6 – Driver operation diagram connected according to the circuit of Figure 5

If the rerun by pulses with frequency different from control pulses repetition frequency is required then the connection circuit at Figure 7 is recommended.

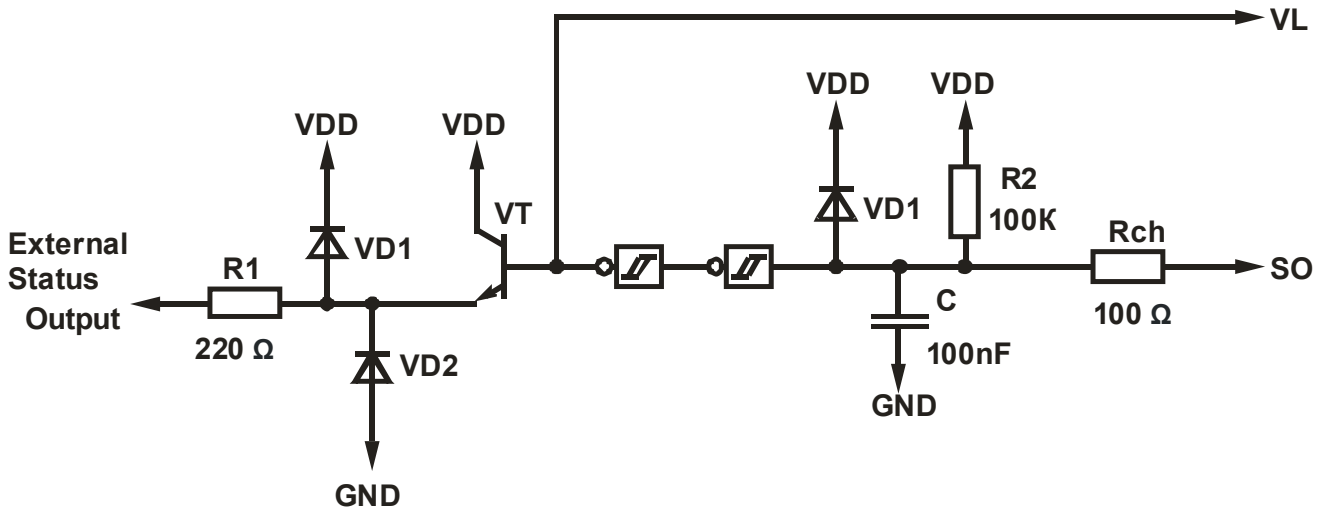

Figure 7 – connection circuit of external periodic rerun

In this case the pause duration between re-drop pulses of the driver is adjusted by condenser C (on the circuit – 100 nF); pause duration versus condenser nominal with charging resistor R2 of nominal 100 kΩ is shown at Figure 19.

6 DRIVER CONNECTION RECOMMENDATIONS

IN – controlling input. Driver control is described in section «Driver operation». When delivering of controlling voltage you must note that the protective reverse diodes are installed on control inputs. As a result if control voltage exceeds supply voltage by more than 0.6 V then current consumption on inputs will increase and with considerable increase of supply voltage the driver can fail.

SO – output signaling about emergency. The output is transistor open collector of protection circuit. Meanwhile the transistor will be opened only when emergency because of power transistor current overload; when driver supply voltage decrease to level «Uuvlo-» transistors will be closed regardless of input control signals (the signals will recover when supply level will correspond to «Uuvlo+») but error signaling in this case will not follow.

VL – emergency mode reset input. The reset is carried out by delivery of «log.1».

VDD – driver control circuit supply input. The current consumption on this input must not exceed 50 mA in all modes of driver operation.

VDC – DC/DC – driver converter supply input. You must take into account that DC/DC converter output voltage will be decreased when reducing of driver supply voltage. Thereby if the supply is lower than the permissible level then the input circuit will operate correct but the voltage on the controlled transistors gates can drop to level «Uuvlo-» and transistor control will be faulty.

Maximum no-load current consumption on supply input is 100 mA. When transistors connecting the current consumption will increase by amount of gate recharge current and it can reach 800 mA (750 mA of output current). At higher current consumption DC/DC – converter can fail or when short-term current consumption excess in 800 mA, output voltage of DC/DC – converter will decrease to unallowable level and undervoltage protection will operate that will lead to faulty transistor control. Current consumption depends on controlling pulse ratio, gate input capacity and on gate resistors value (see Figures 11, 12). Thereby when driver service you must note current consumption correction depending on transistors which the driver will operate on. Driver safe operation zone depending on gate capacity and frequency is shown at Figure 14.

C – collector connection output (drain) of controlled transistor. The output is intended for voltage drop controlling (saturation protection) on the transistor. The recommended connection circuit is shown at Figure 8.

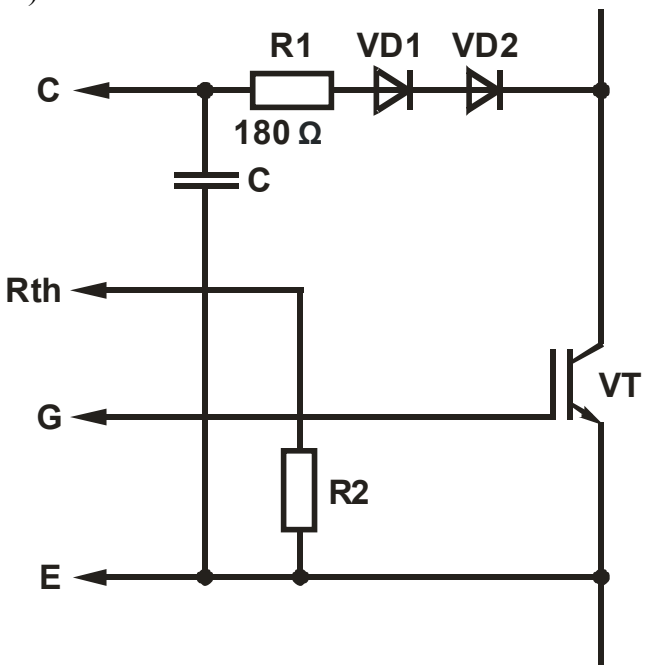

Figure 8 –Circuit of driver connection and its protection circuits to the controlled power transistor

VD1 and VD2 diodes are necessary for protection of driver measure circuit against overvoltage. It is recommended to install the diodes with maximum reverse voltage not less than by 30% exceeding maximum collector-emitter voltage of controlled transistor. The condenser «C» is necessary for increase of saturation protection operation delay; the nominal of this condenser should be chosen in terms of Figure 17.

In the case if current overload protection of controlled transistor is not required, then the output «C» should be short-circuited to output «E» (emitter).

R_{th} – resistor connection for threshold protection operation adjusting on saturation (see Figure 8). If output «R_{th}» is not involved then the protection operation threshold will be equal to 15 V. Saturation protection operation voltage versus resistor R2 nominal (Figure 8) is shown at Figure 18.

G – outputs intended for connecting of controlled transistor gate.

AC – protection operation input of controlled transistor against overvoltage in collector-emitter circuit («active protection»). The recommended connection circuit is shown at Figure 9; driver operating schedule with connected active protection is shown at Figure 10.

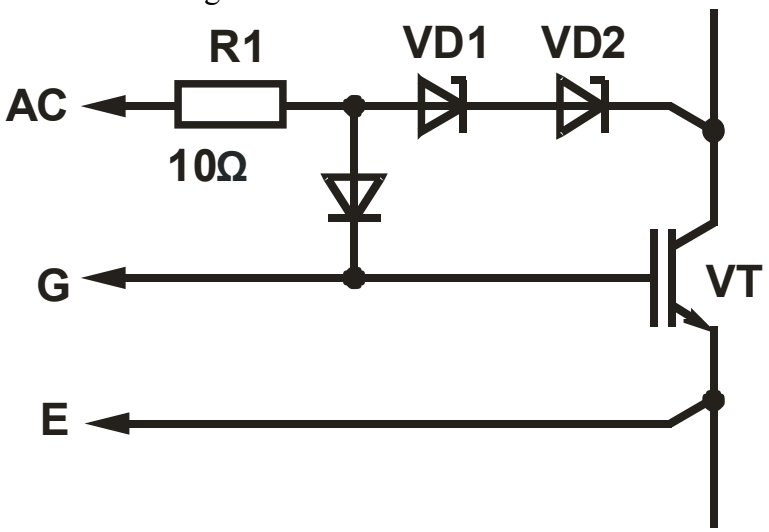

Figure 9 – Active protection connection circuit

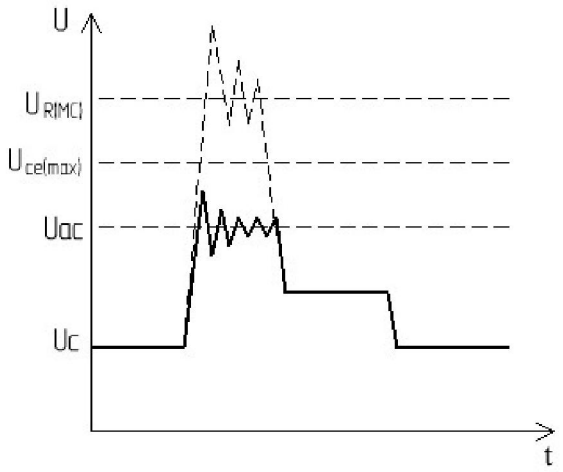

Figure10 – Driver operating scheme when active protection operating

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

VD1 and VD2 Zener diodes should be chosen in terms of required voltage level of emission limitation in power circuit. Zener diodes power should be not less 1.5 W.

7 GRAPHS EXPLAINING DRIVER OPERATION

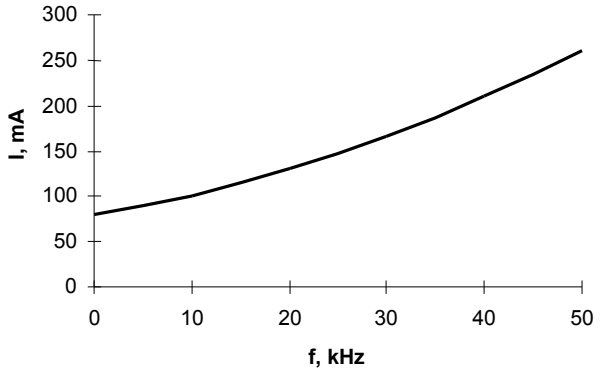

Figure 11 – Driver current consumption on input VDC versus no-load control signal frequency

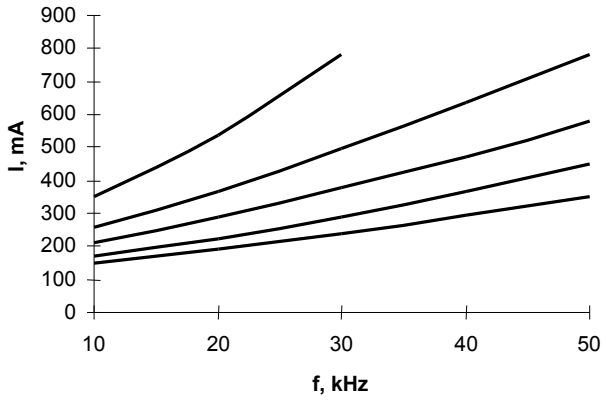

Figure 12 – Current consumption versus signal frequency under load (with gate resistor 5 Ω)

For gate capacities 10 nF, 25 nF, 50 nF, 100 nF and 250 nF

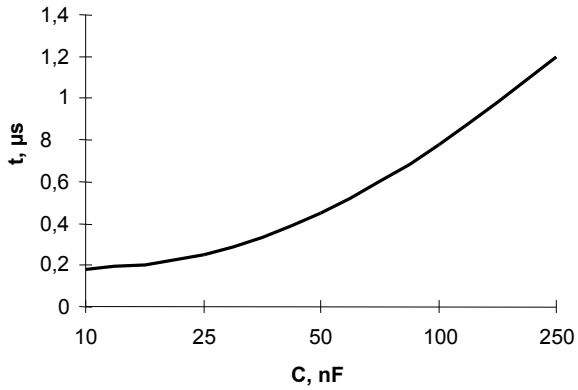

Figure13 – Graph of acceleration time versus gate capacity (with gate resistor 5 Ω)

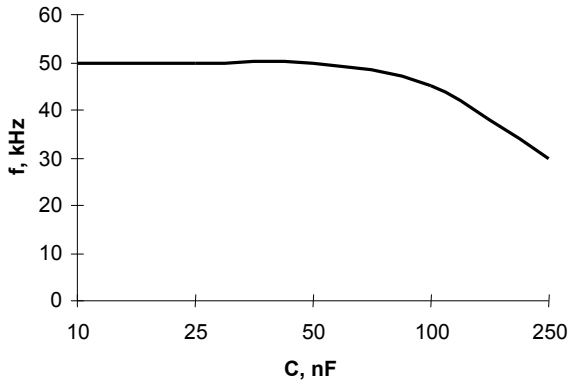

Figure 14 – Graph of driver safe operation zone (with gate resistor 5 Ω)

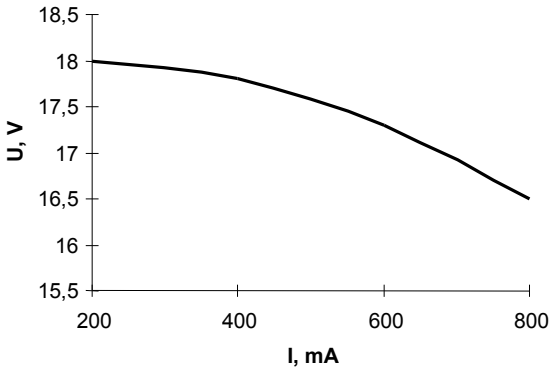

Figure 15 – Graph of transistor gate voltage versus current consumption

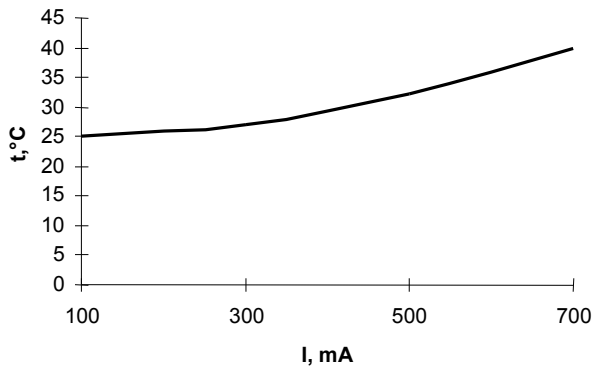

Figure 16 – Graph of driver housing temperature versus current consumption

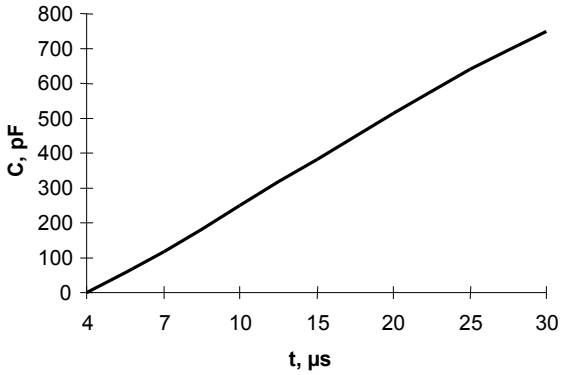

Figure 17 – Graph of delay continuance of saturation protection turn-on versus trimmer capacity

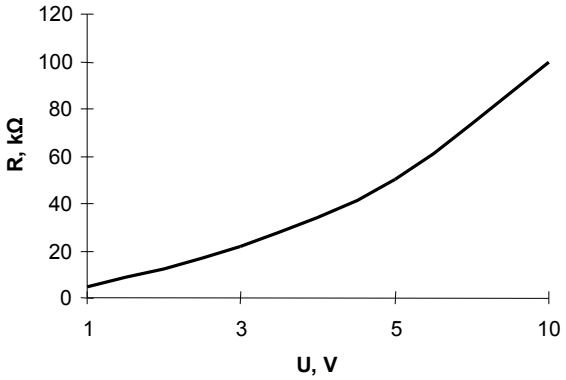

Figure 18 – Saturation protection operation voltage versus trimming resistor value (with one consistently connected diode)

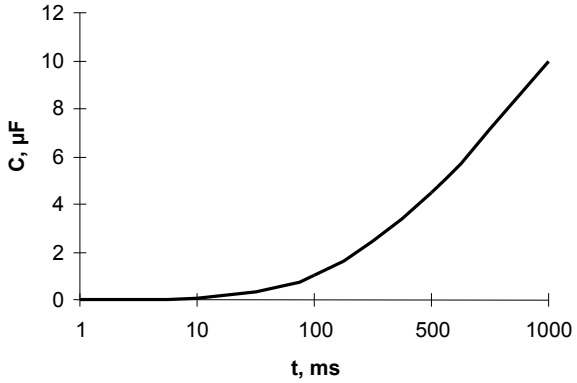

Figure 19 – Pause continuance among drop versus trimming condenser nominal

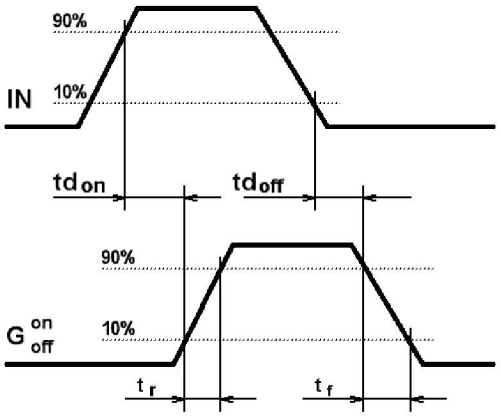

Figure 20 – Diagram explaining driver time characteristics
where IN – input control signal; G – signal on controlled transistor gate

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 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 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, 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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