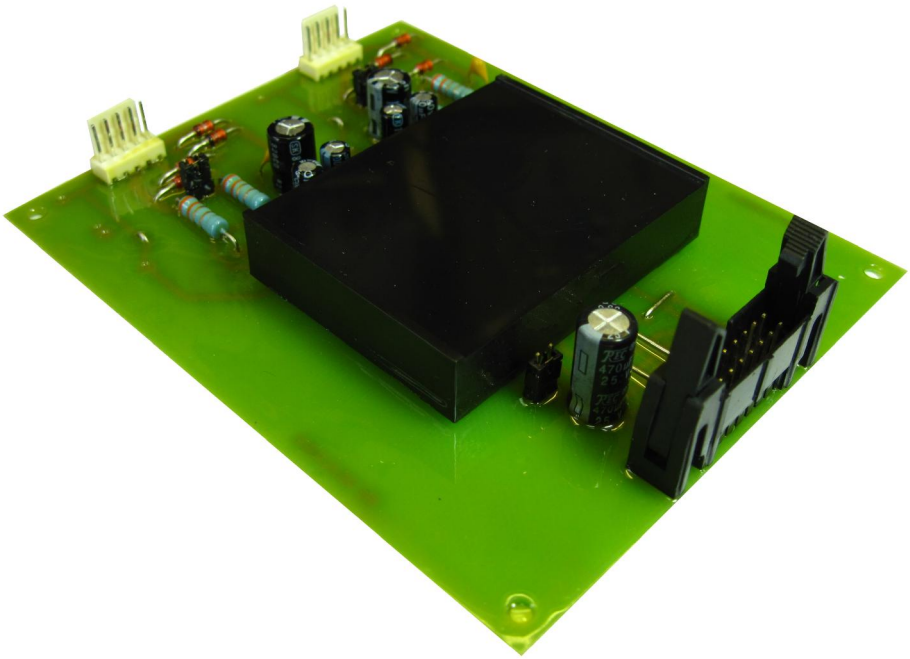
IGBT ANSD MOSFET TRANSISTOR DRIVER 2DR180P–B, 2DR180P–B1

USER'S MANUAL



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1 OVERVIEW

A two-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 built-in galvanic isolated DC-DC converter, providing necessary levels of enabling and blocking voltages on transistor gate.

2 DRIVER COMPOSITIONS

2.1 The driver – a circuit plate with installed a driver module (DM), performed in hermetic plastic housing, 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 controlled transistors gate;
5 Undervoltage and overvoltage protection circuit on controlled transistor gate;
6 Controlled transistor protection circuit against over-current.

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 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 Control block when an “emergency”
5 Emergency signaling;
6 Driver supply voltage control (built-in comparator) on DC-DC converter output;

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

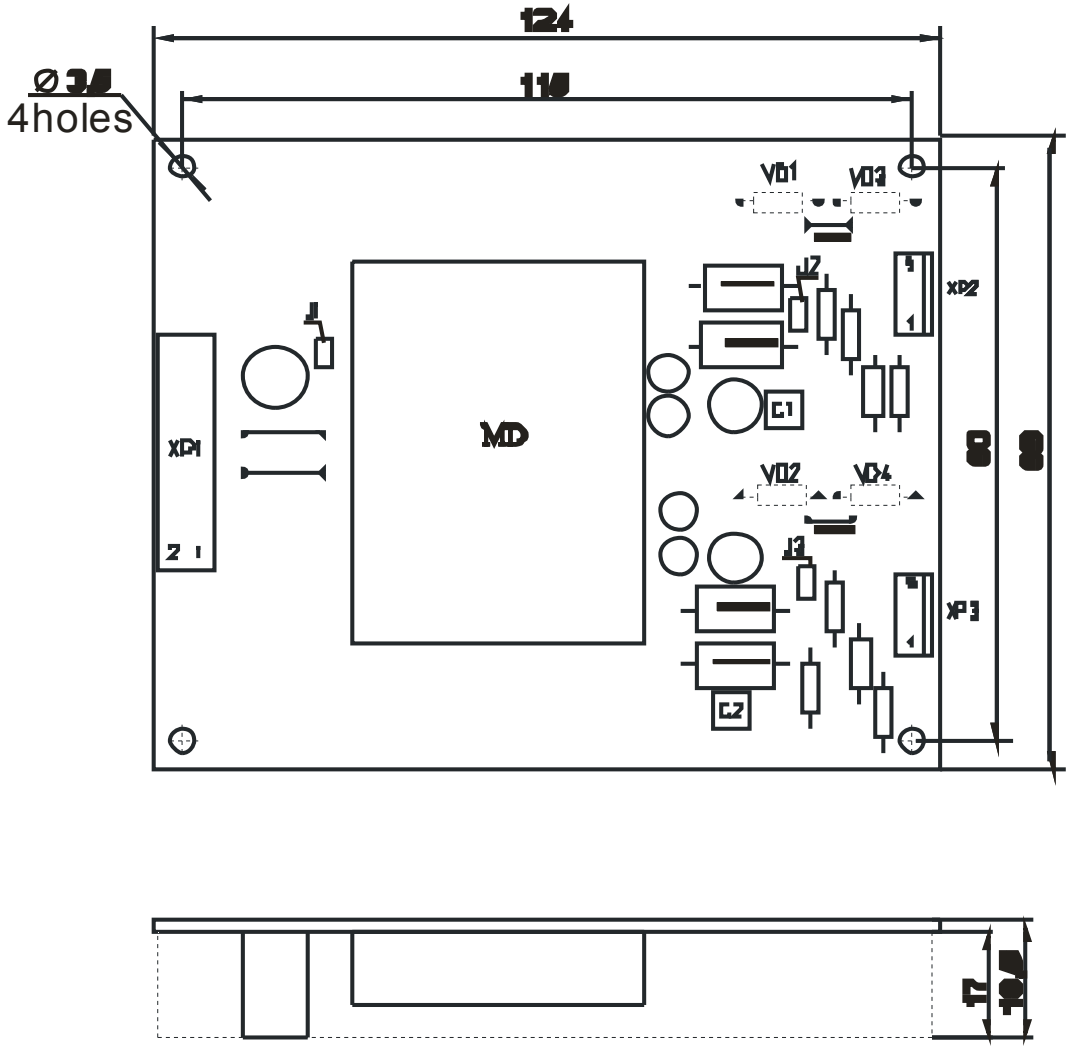


Figure 1 – Overall drawing

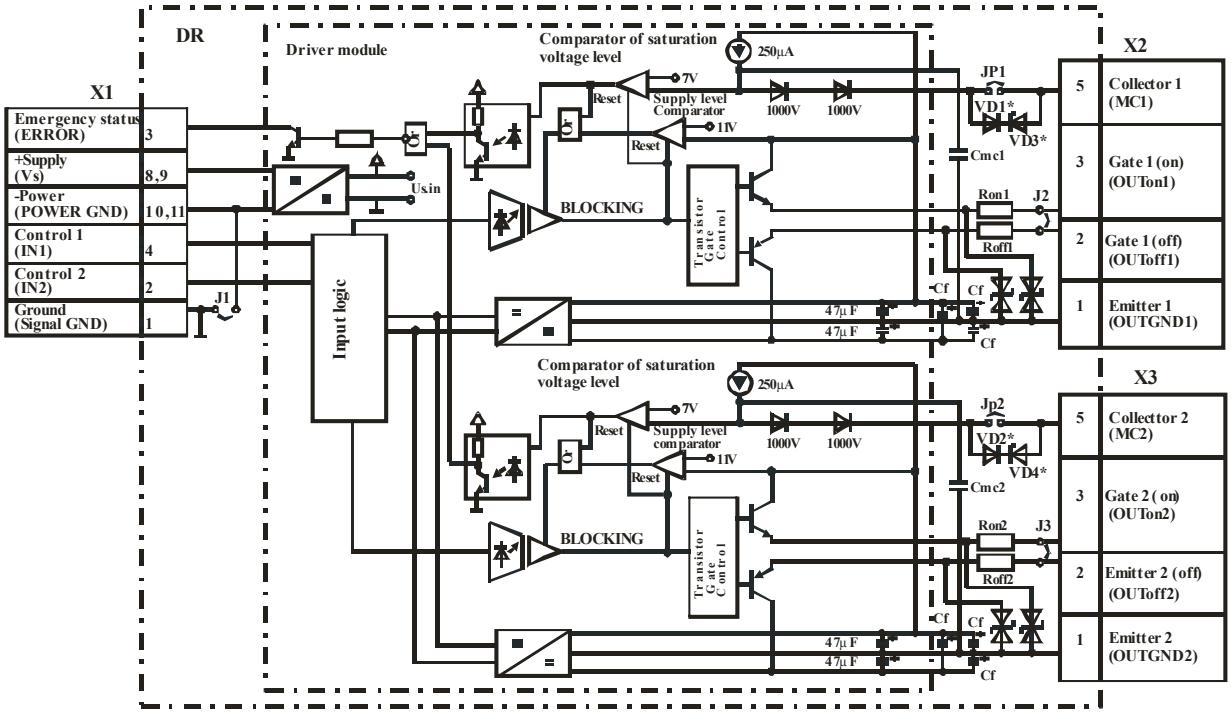


Figure 2– Driver functional and turn-on circuits

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

- Diodes VD1…VD4 are installed at the request of consumer

X1 – plug IDCC-14MS + socket IDC-14;

X2 – plug WF-M-5 + socket HU-F-5.

3.3 Outputs description is shown in Table 1.

Table 1 – Driver outputs description

Outputs	Output description	Symbol
X1.1	Ground signal output for controlling signal delivery	Signal GND
X1.2	Controlling input of channel 2	IN2
X1.3	Error signal output	$\overline{\text{ERROR}}$
X1.4	Controlling input of channel 1	IN1
X1.8, X1.9	Supply +15 V	Vs
X1.10, X1.11	Power ground	POWER GND
X2.1	Output signals ground output 1	OUTGND1
X2.2	Turn-off driver output of channel 1	OUToff1
X2.3	Turn-on driver output of channel 1	OUTon1
X2.5	Measuring collector – saturation voltage control circuit on controlled transistor of channel 1	MC1
X3.1	Output signals ground output 2	OUTGND 2
X3.2	Turn-off driver output of channel 2	OUToff2
X3.3	Turn-on driver output of channel 2	OUTon2
X3.5	Measuring collector – saturation voltage control circuit on controlled transistor of channel 2	MC2

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, see Figures 4 and 5
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	2DR180 P-B
			9	15	16.8	2DR180 P-B1
Low level input voltage	U_{IL}	V	-0.6	0	0.8	2DR180 P-B
			-0.6	0	2.4	2DR180 P-B1
Input resistance	R_{IN}	kΩ		2.0		2DR180 P-B
				5.9		2DR180 P-B1
Time characteristics						
Signal turn-on delay time between input and output	$t_{d\ on(in-out)}$	µs			0.5	See Figure 11
Signal turn-off delay time between input and output	$t_{d\ off\ (in-out)}$	µs			0.5	See Figure 11
Maximum operating frequency	f_{max}	kHz			50	No-load; See section 6 and Figure 4

Blocking time of fall voltage control on controlled open state transistor	t_{BLOCK1}	µs	5		20	Set by consumer; see section 6 and Figures 3 and 10
Blocking time of controlled transistor after “emergency”	t_{BLOCK2}	ms		70		See Figure 3
Transistor smooth emergency shutdown time	t_{off}	µs		6		See Figure 3
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 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; see section 6 and Figure 7
Mean output current	I_O	mA			160	To each channel
Output signal rise time	t_r	ns			150	No-load, see section 6 and Figures 6, 7and 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 мА
Threshold voltage on measure input MC causing emergency turn-off	U_{Mc}^{Th}	V		5.8		Without additional elements
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 inputs first and second channels	$U_{ISO(OUT1-OUT2)}$	V			2000	DC, 1 minute
Critical speed 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	

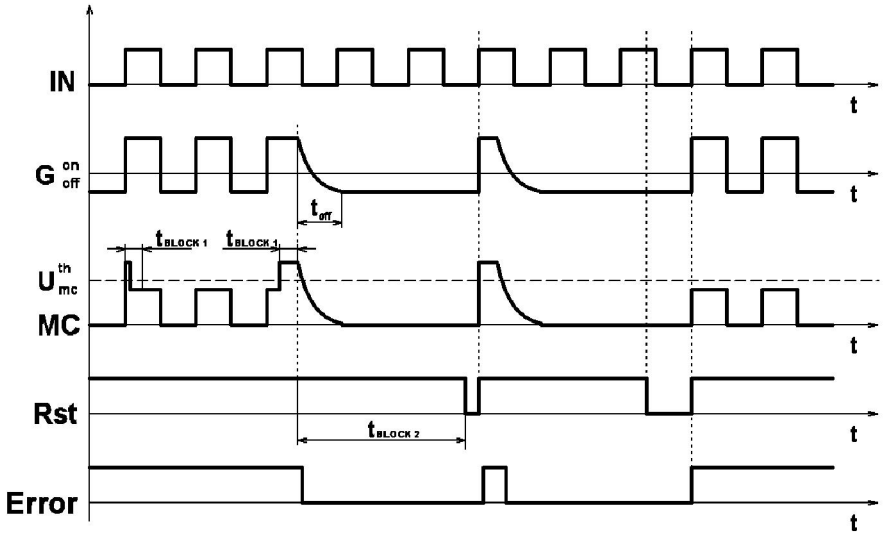
5 DRIVER OPERATION

Delivery of «log.1» to controlling input «IN1» or «IN2» 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), thereby the driver will block the operation of two channels. When an "emergency" the transistor will be opened 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. In the event when the emergency cause was not disposed then the protection cycle will be recurred.

Driver supply voltage decrease to protection operation threshold level from 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.

Both of controlled transistors will open when simultaneous delivery of «log. 1» to output «IN1» and «IN2» because the channels operate independently

Diagram explaining driver operation is shown at Figure 3.



R_{st} – Periodical internal signal of "emergency" reset

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

6 DRIVER CONNECTION RECOMENDATIONS

IN, IN2 – controlling inputs. 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 of supply voltage excess by control 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.

Error – output signaling about emergency. The output is transistor with open collector of protection circuit. Meanwhile the transistor will be open only when emergency because of power transistor current overload; when driver supply voltage decrease to level «U_{uvlo-}» transistors will be closed regardless of input control signals (the signals will recover when supply level corresponds to «U_{uvlo+}»), but error signaling in this case will not follow. It is not recommended to deliver voltage and current of values higher than maximum permissible including short-time on output "Error".

V_S – driver supply output. You must note that on decreasing of driver supply voltage DC/DC – converter output voltage will also decrease. Thereby if the supply is less than the allowable level then the input circuit can operate faultlessly but on gates of controllable transistors the voltage can drop to level «U_{uvlo-}» and transistor control will be faulty.

Maximum no-load current consumption on supply input is not more than 200 mA. When transistors connection the current consumption will increase by amount of gate recharge current and it can reach 750 mA (equal load for both channels). At higher current consumption DC/DC – converter can fail or when short-time excess of current consumption by 750 mA, output voltage of DC/DC – converter will decrease to unallowable level and undervoltage protection will operate, that will lead to faulty transistor control. In the event of non-uniformly distributed load the current consumption of one channel should not exceed 300mA (without control circuit consumption). Current consumption depends on controlling pulse ratio, gate input capacity and on gate resistors value (see Figures 4, 5). Thereby when driver service you must make correction for current consumption depending on transistors which the driver will operate on. Driver safe operation zone depending on gate capacity and frequency is shown at Figure 7.

MC1, MC2 – collector connection outputs (drain) of controlled transistor. The output is intended for voltage fall controlling (saturation protection) on transistor. Thereof the typical value of protection operation threshold is equal to 5.8 V (if the external elements are not installed and jumper JP1 and JP2 are installed) or 1 V with not installed jumpers. Protection operation threshold is regulated by the external elements (Zener diodes and diodes); the voltage fall of Zener diodes and diodes at 250 μA is deducted from maximum voltage (5.8 V). For instance, if you install the Zener diode sequentially with rated Zener breakdown of 3.3 V and two diodes with voltage fall 0.7 V at 250 μA, then protection operation threshold will be equal to 5.8-3.3-2x0.7=1.1 V.

In the case if current overload protection of controlled transistor is not required then «MC» output should be short-circuited to source (emitter) of corresponding channel

Condensers C_{mc1} , C_{mc2} – timing condensers of turn-off delay forming of corresponding controlled transistor when current overload. Protection operation delay is necessary to avoid malfunction of short-time inductive kicks. Thereby in case of emergency this delay time will be equal to "rerun pulse" continuance. To increase protection operation delay, it is recommended to install the condensers with nominal indicated at Figure 10. Initially installed capacity condenser is 100 pF that corresponds to delay continuance of 8 μs (typ.).

OUToff1, OUToff2, OUTon1, OUTon2 – outputs intended for connecting the controlled transistors gates.

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

Jumpers

JP1, JP2 – jumpers regulating saturation protection operation threshold of controlled transistors. With installed jumpers the saturation voltage protection operation threshold of transistor is U_{ms}^{Th} = 5.8 V. When there are not installed jumpers, protection operation threshold is equal to 1 V.

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

J1 – jumper combining «minus» of power and «ground» of driver control;

J2, J3 – jumper combining resistors Ron1 and Roff1, Ron2 and Roff2 for connection to the gate.

7 GRAPHICS EXPLAINING DRIVER OPERATION

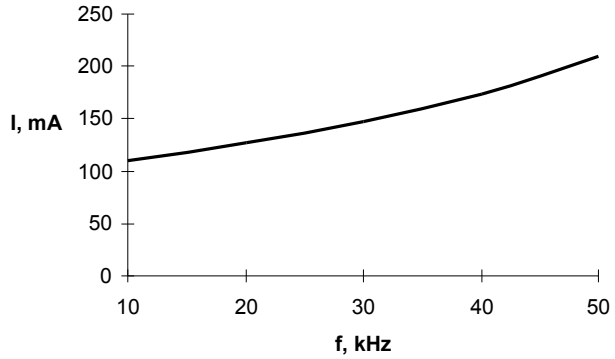


Figure 4 – Graph of driver current consumption versus no-load control signal frequency

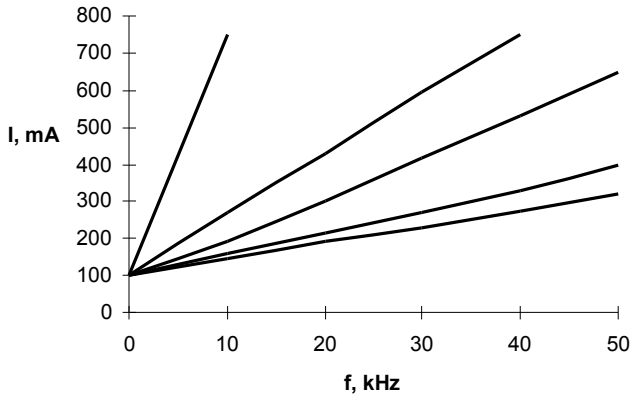


Figure 5 – Graph of current consumption versus signal frequency under load (with gate resistor 5Ω) for gate capacities 10 nF, 25 nF, 50 nF, 100 nF and 250 nF

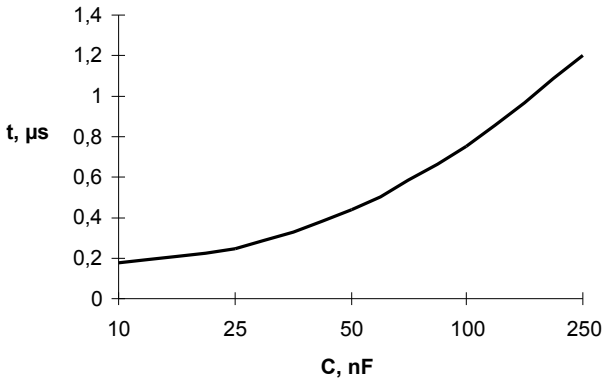


Figure 6 – Graph of acceleration time versus gate capacity (with gate resistor 5 Ω)

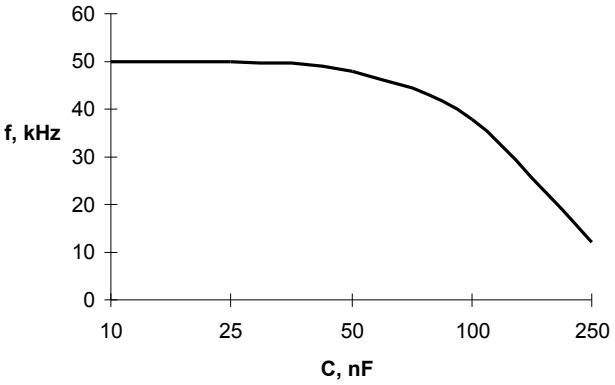


Figure 7 – Graph of driver safe operation zone (with gate resistor 5Ω)

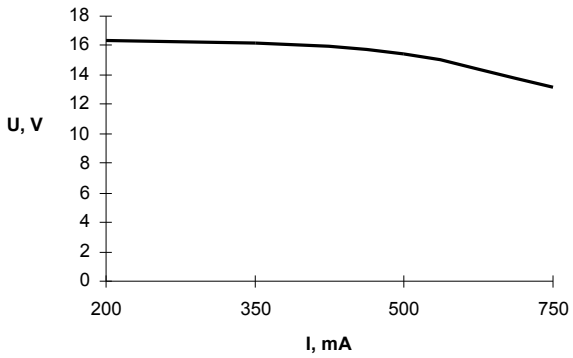


Figure 8 – Graph of transistor gate voltage versus current consumption

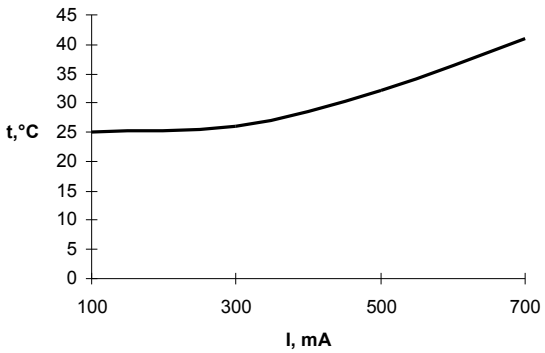


Figure 9 – Graph of driver housing temperature versus current consumption

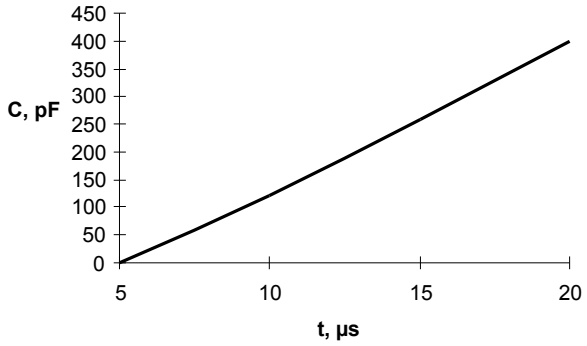


Figure 10 – Graph of delay continuance of saturation protection turn-on versus trimmer capacity

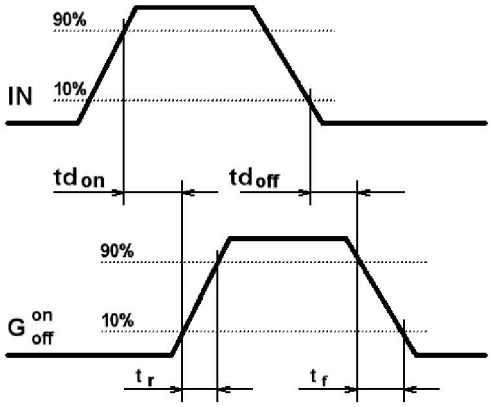


Figure 11 – Diagram explaining driver time characteristics
where IN – input control signal; G – signal on controlled transistor gate

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 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 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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