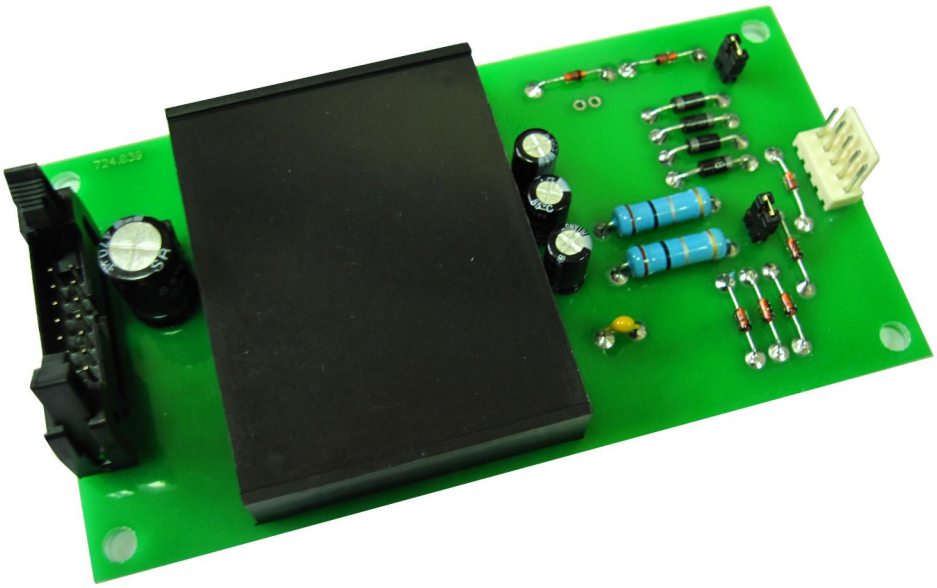
# IGBT AND MOSFET TRANSISTORS DRIVER
# DRA180P–B-12; DRA180P–B1-12; DRA180P–B-17; DRA180P–B1-17
# DRA180P–B-25; DRA180P–B1-25; DRA180P–B-33; DRA180P–B1-33

## USER'S MANUAL



5 Naugorskoe highway, Orel, 302020, Russia  Tel. +7(4862) 44-03-44, Fax +7(4862) 47-02-12
E-mail: mail@electrum-av.com

**CONTENTS**



This document is a user's manual with a description of characteristics of this product for which are warranted. All the products in the production process pass a complete set of electrical tests, which are performed twice, once before encapsulation, and then again after it. Tests carried out by "Electrum AV" are exhaustive and include 100% control at the final testing.

Any such warranty is provided only in accordance with the terms of the supply agreement (supply contract or other documents in accordance with applicable law). The information presented in this document does not provide warranties and liability of "Electrum AV" by the use of such information and the suitability of products for your equipment. The data contained in this document are intended exclusively for technically trained staff. You and your technical expert will have to evaluate the suitability of the product for the application and the completeness of the product data, in connection with this application.

Any products of "Electrum AV" are not permitted for the use in devices and life support systems and special equipment without the prior written consent of "Electrum AV".

If you need information about the product, which is not shown in this user's manual or which concerns the specific application of our product, please contact the sales office to the manager who is responsible for your enterprise.

Engineers "Electrum AV" have a lot of experience in the design, manufacture and application of powerful force devices and smart drivers and has already implemented a large number of individual decisions. If you need power modules and drivers that are not included in the package, as well as products with differences from the standard devices in specifications or design, please contact to our managers and specialists who will offer you best solution for your application.

"Electrum AV" reserves the right to make changes without notice in this document to improve the reliability, functionality and design improvement.

## 1 OVERVIEW

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 built-in galvanic isolated DC-DC converter providing necessary levels of enabling and disabling transistor gate voltage.

## 2 DRIVER COMPOSITION

2.1 The driver – a circuit plate with installed driver module (DM), performed in a 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 control circuit gate;
5. Under-voltage and excess voltage protection circuit on controlled transistor gate;
6. Controlled transistor protection circuit against over-current.
7. Controlled transistor protection circuit against overvoltage in collector-emitter circuit

## 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 emergency (controlled transistor output from saturation mode);
4 Control block when “emergency”
5 Emergency signaling;
6 Turn-on/off time regulation of controlled transistor by means of resistors resistance change in output circuit (Ron, Roff);
7 Driver supply voltage control (built-in comparator) on output of DC/DC-converter;
8 Controlled transistor overvoltage protection 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.

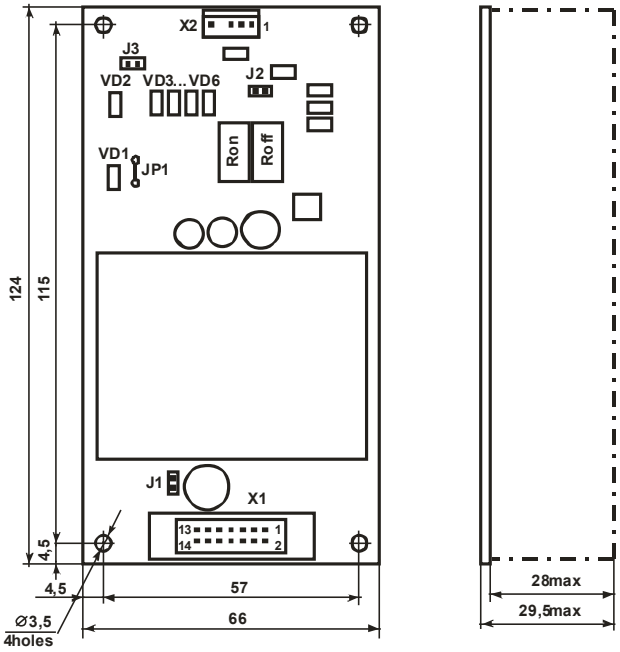



Figure 1 – Overall drawing

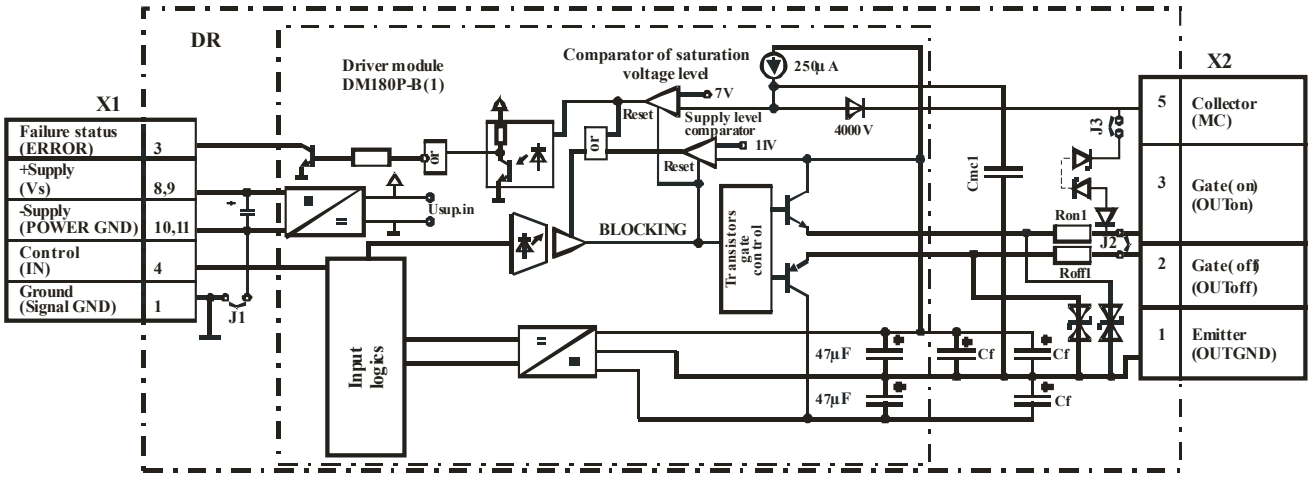



Figure 2– Driver functional and turn-on circuits

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

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 |
| X1.3 | Error signal output | $\overline{\text{ERROR}}$ |
| X1.4 | Controlling input | IN |
| X1.8, 1.9 | Supply +15 V | Vs |
| X1.10, 11 | Power ground | POWER GND |
| X2.1 | Output signals ground output | OUTGND |
| X2.2 | Turn-off driver output | OUToff |
| X2.3 | Turn-on driver output | OUTon |
| X2.5 | Measuring collector – saturation voltage control circuit on controlled transistor | MC |

## 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 | | | 100 | f = 0 Hz, see Figures 4 and 5 |
| Power of built-in supply source of output driver module part | $P_{DC-DC}$ | W | 4 | | | |
| **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 | DRA180P-B |
| | | | 9 | 15 | 16.8 | DRA180P-B1 |
| Low level input voltage | $U_{IL}$ | V | -0.6 | 0 | 0.8 | DRA180P-B |
| | | | -0.6 | 0 | 2.4 | DRA180P-B1 |
| Input resistance | $R_{IN}$ | kΩ | | 2.0 | | DRA180P-B |
| | | | | 5.9 | | DRA180P-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 Figures 4, 5 |
| Block time of fall voltage control on controlled open state transistor | $t_{BLOCK1}$ | µs | 5 | | 20 | set by consumer; see section 6 and Figure 10 |
| Block 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 | $t_{d(on-err)}$ | 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 |
| Mean output current | $I_O$ | mA | | | 160 | |

Continuation of the Table 2

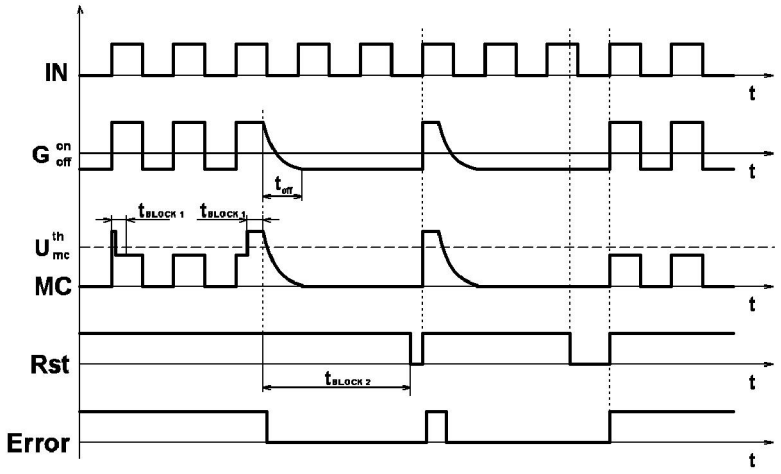
| Characteristic | Symbol | Unit | Value | | | Note |
|---|---|---|---|---|---|---|
| | | | min | typ. | max | |
| Output signal rise time | $t_r$ | ns | | | 150 | no-load, see section 6 and Figure 6 |
| Output signal fall time | $t_f$ | ns | | | 150 | no-load, see section 6 and Figure 6 |
| Maximum 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 | $U_{мс}^{Th}$ | V | | 5.8 | | without additional elements |
| Protection operation voltage on collector-emitter overvoltage (see Figure 12) | $U_{ac}$ | V | | 800 | | DRA180P-B(1)-12 |
| | | | | 1600 | | DRA180P-B(1)-17 |
| | | | | 2400 | | DRA180P-B(1)-25 |
| | | | | 3200 | | DRA180P-B(1)-33 |
| **Isolation characteristics** | | | | | | |
| Maximum permissible reverse voltage on output «MC» | $U_{R(MC)}$ | V | | | 2000 | DRA180P-B(1)-12 |
| | | | | | 2000 | DRA180P-B(1)-17 |
| | | | | | 3000 | DRA180P-B(1)-25 |
| | | | | | 4000 | DRA180P-B(1)-33 |
| Isolation voltage between input and output (DC, 1 min) | $U_{ISO(IN-OUT)}$ | V | | | 4000 | DRA180P-B(1)-12 |
| | | | | | 4000 | DRA180P-B(1)-17 |
| | | | | | 7500 | DRA180P-B(1)-25 |
| | | | | | 7500 | DRA180P-B(1)-33 |
| 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 | | | 1200 | DRA180P-B(1)-12 |
| | | | | | 1700 | DRA180P-B(1)-17 |
| | | | | | 2500 | DRA180P-B(1)-25 |
| | | | | | 3300 | DRA180P-B(1)-33 |

## 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 «Error»). In 70 ms emergency reset by internal circuit of emergency reset will be performed and controlled transistor will be opened on front edge of control signal «IN». 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 «Uuvlo-» 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 «Uuvlo+». There is not an error signal on output «Error» at protection operation against supply undervoltage.

Diagram explaining driver operation is shown at Figure 3.




Rst – Periodical internal signal of "emergency" reset

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

## 6 DRIVER CONNECTION RECOMENDATIONS

**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 set on control inputs. As a result if control voltage exceeds supply voltage by more than 0.6 V, then current consumption on inputs will be increased and with considerable increase of supply voltage the driver can fail.

**Error** – output signaling about emergency. The output is transistor open collector of protection circuit. Meanwhile the transistor will open 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 the 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 when driver supply voltage decrease output voltage of DC/DC – converter is decreased. Thereby if the supply is less of the allowable level than the input circuit can operate faultlessly but on gates of controllable transistors the voltage can drop up to level «Uuvlo-» and transistor control will be faulty.

Maximum no-load current consumption on supply input is 100 mA. When transistors connection the current consumption increases by amount of gate recharge current and can reach 450 mA (350 mA of output current). At higher current consumption DC/DC – converter can fail or when short-term current consumption excess in 450 mA, DC/DC – converter output voltage will decrease to unallowable level and under-voltage 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 4, 5). Thereby using driver 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 7.

**MC –** collector connection output (drain) of controlled transistor. The output is intended for voltage fall control (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 is installed) or 1 V with not installed jumpers. Protection operation threshold is regulated by installing of external elements (Zener diodes and diodes); the voltage drop on Zener diodes and diodes at current 250 μA is deducted from maximum voltage (5.8 V). For instance, if you install the Zener diodes sequentially with rated Zener breakdown 3.3 V and two diodes with voltage drop 0.7 V at current 250 μA, than protection operation threshold will be equal to 5.8-3.3-2*0.7=1.1 V.

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

**Смс –** timing capacity connection output of controlled transistor turn-off delay when current overload. Protection operation delay is necessary to avoid malfunctions at short-time inductive kicks. Thereof this delay duration will be equal to "rerun impulse" continuance in case of emergency. For protection operation delay increase it is recommended to install the condensers with values showed at Figure 10. Initially the condenser of capacity 100 pF is installed that corresponds to delay continuance 8 μs (typ.).

**OUToff, OUTon –** outputs intended for connection of controlled transistor gate. Gate resistors (Ron, Roff) are necessary for maximum pulse current decrease. It is not recommended to install the resistors with values less than 1 Ω. It is allowed the resistors installation of different values, for instance, for increase of controlled transistor turn-off continuance to decrease voltage amplitude of inductive surges.

**Jumpers**

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

J2 – jumper merges resistors Ron and Roff for connection to the gate.

J3 – jumper connecting overvoltage protection («active protection») in collector-emitter circuit (see Figure 12).

## 7 GRAPHS EXPLAINING DRIVER OPERATION

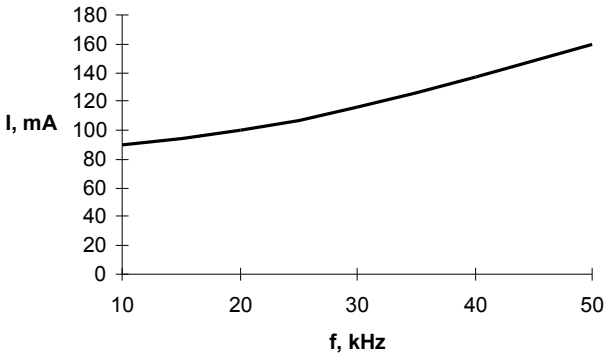



Figure 4 – Graph of driver current consumption versus no-load control signal frequency

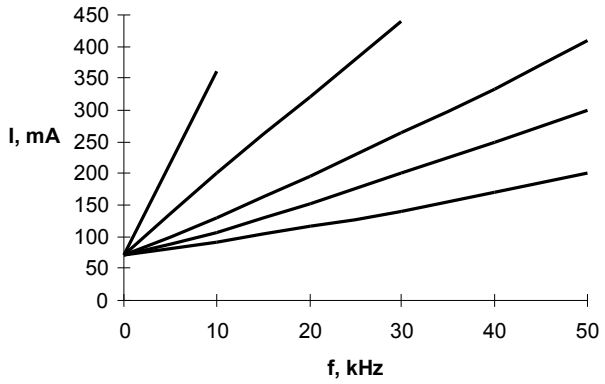



Figure 5 – Graph of current consumption versus signal frequency under load (with gate resistor 5Ω) for gate capacities 10nF, 25 nF, 50 nF, 100 nF and 250 nF

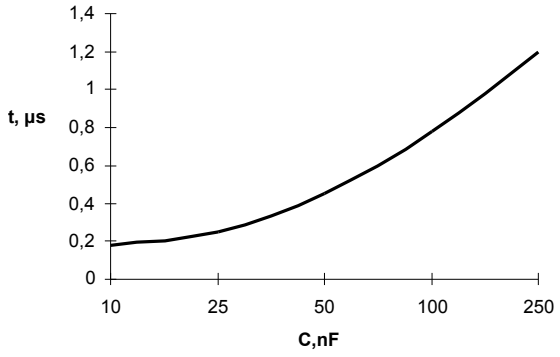



Figure 6 – Graph of acceleration time versus gate capacity (with gate resistor 5 Ω)

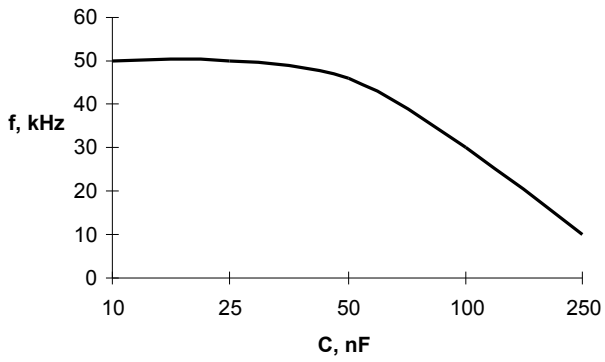



Figure 7 – Graph of driver safe operation zone (with gate resistor 5 Ω)

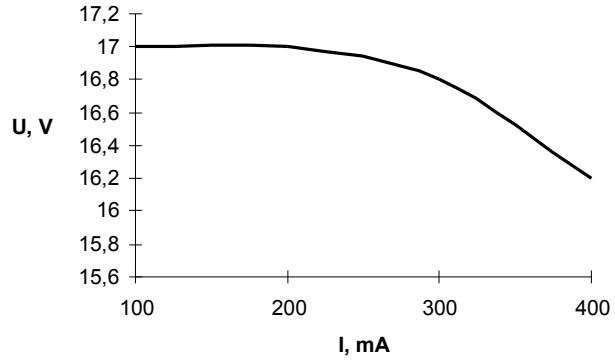



Figure 8 – Graph of transistor gate voltage versus current consumption

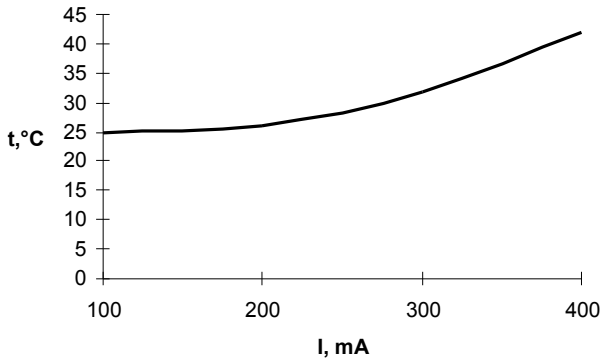



Figure 9 – Graph of driver housing temperature versus current consumption

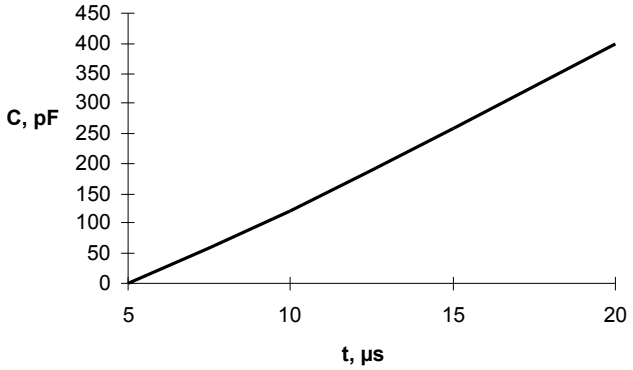



Figure 10 – Graph of delay continuance of saturation protection turn-on versus trimmer capacity

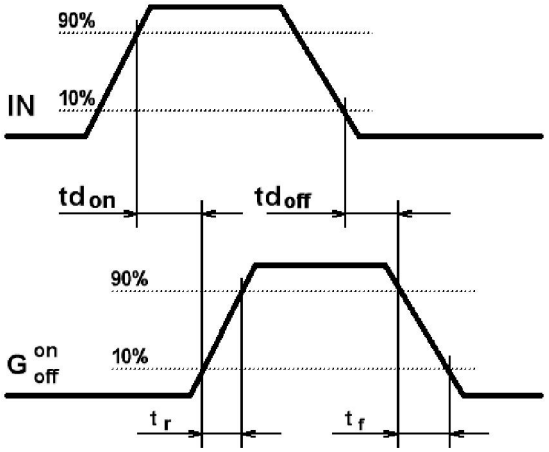
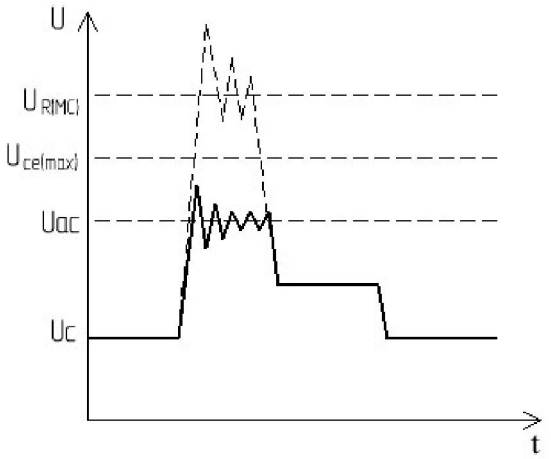



Figure 11 – Diagram explaining driver time characteristics
where IN – input control signal; G – signal on controlled transistor gate




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

Figure 13 – Driver operating schedule when active protection operating

## 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 drivers for 25000 hours must be at least 0.95.

Gamma-percent life must be no 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.

**5 Naugorskoe highway, Orel, 302020, Russia Tel. +7(4862) 44-03-44, Fax +7(4862) 47-02-12**
**E-mail: mail@electrum-av.com**