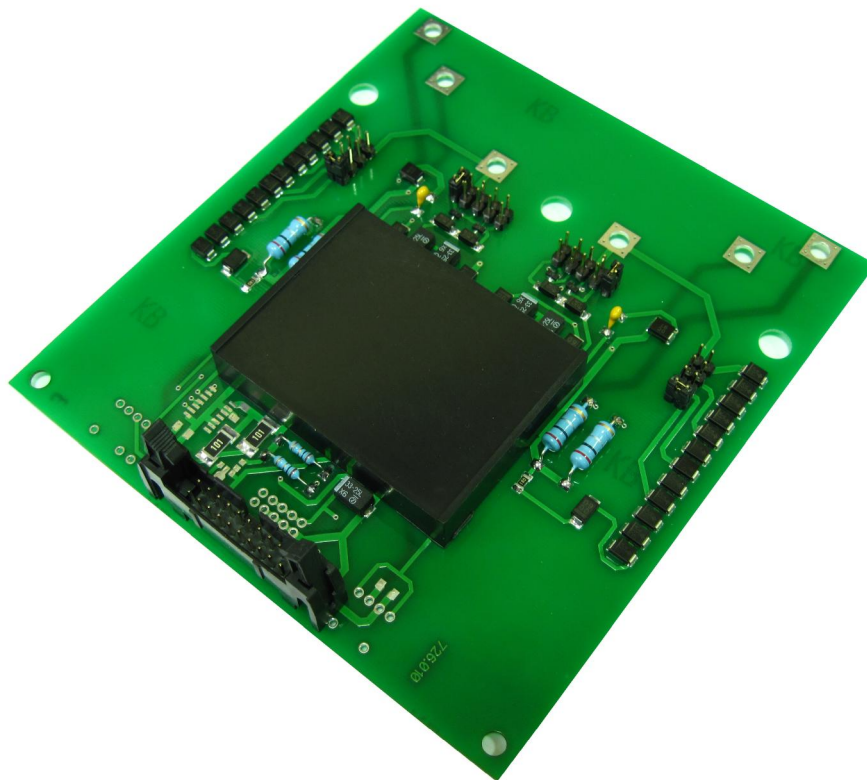




**TRANSISTOR IGBT AND MOSFET DRIVER DR2180P-B5  
ANALOGUE OF 2SB315A**

**USER'S MANUAL**



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## 1 OVERVIEW

A double-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 3300 V. The driver is an amplifier – generator of transistor gates control signals with frequency up to 100 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 **2SB315A** in structure and function.

## 2 DRIVER COMPOSITIONS

2.1 The driver is a printed-circuit board with installed driver module on it (DM), made in hermetic plastic housing, 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 drive functions, control and protection functions of controlled transistor:

- 1 Collector saturation voltage control of controlled transistor, its protective disconnection when saturation state output;
- 2 Protective turn-off threshold regulation on saturation voltage;
- 3 Soft 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 alarm;
- 6 On/off time regulation of controlled transistor by means of change of resistor resistance in output circuit (Ron, Roff);
- 7 Block of simultaneous turn-on of upper and lower arm;
- 8 Switching delay of upper and lower arm;
- 9 Switching delay regulation of upper and lower arm;
- 10 Driver supply voltage control (built-in comparators) on DC/DC converter output.

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

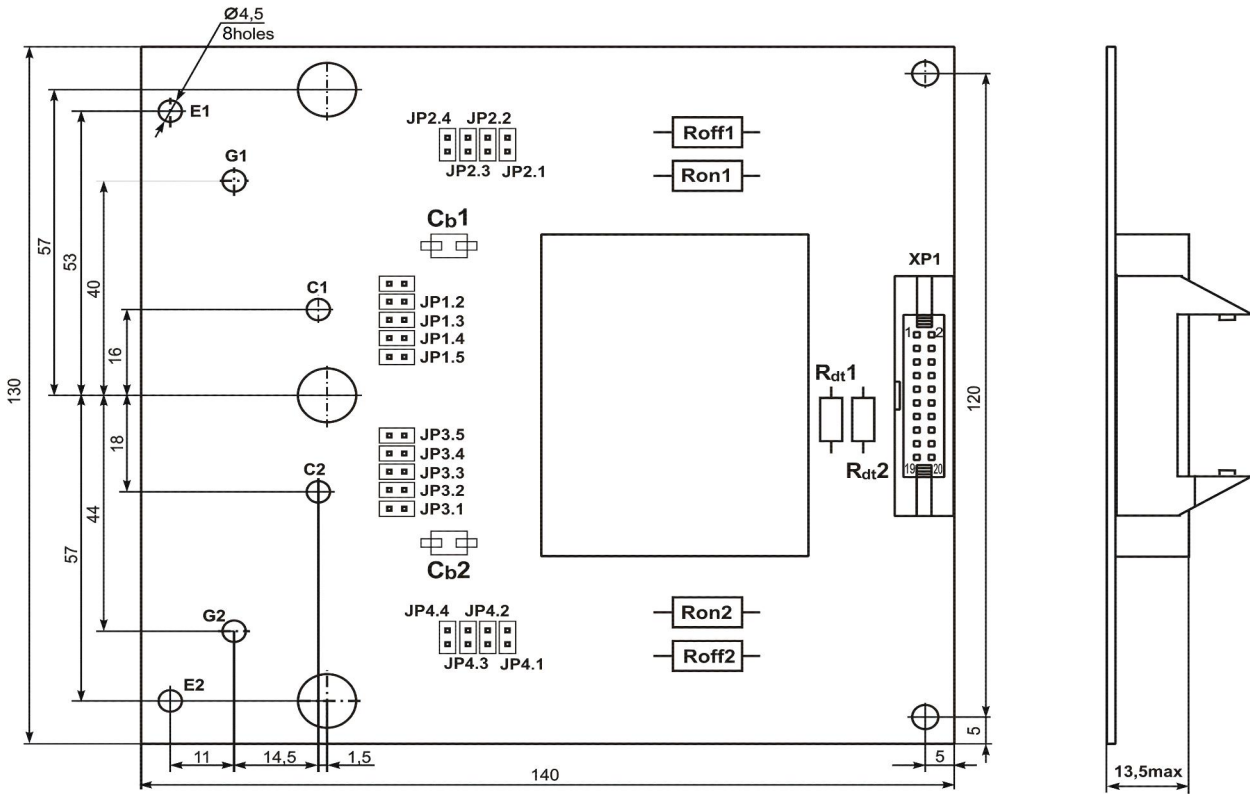


Figure 1 – Overall drawing

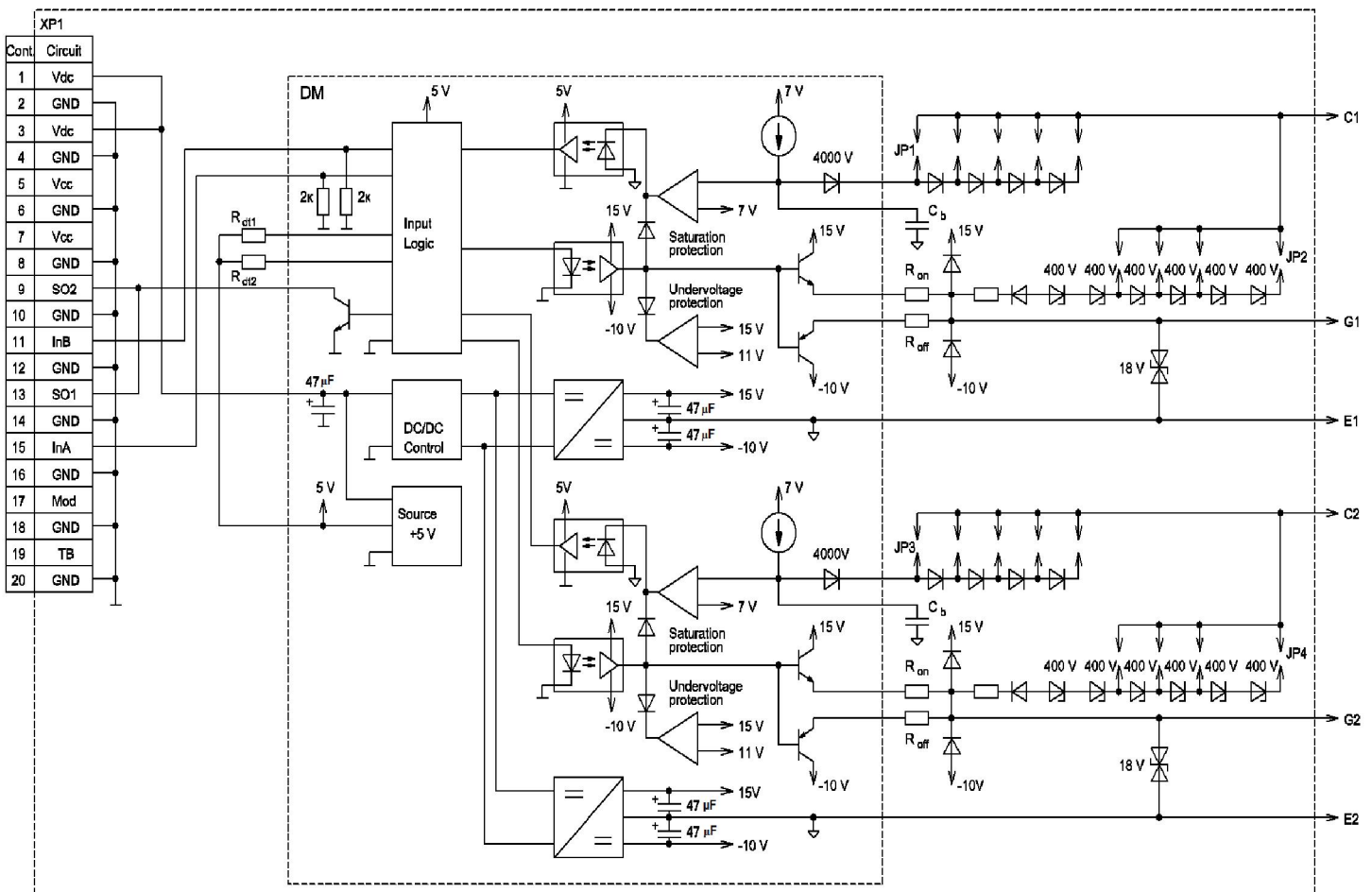


Figure 2– Functional driver circuit and turn-on circuit  
XP1 – plug IDCC-20MR; mate - socket IDC-20

3.3 Output function is given in Table 1.

Table 1 – Output function of XP1

| Output No. | Function | Symbol  |
|------------|----------|---|
| 1          | Vdc      | Supply +15 V                                  |
| 2          | GND      | Ground of power circuits and control circuits |
| 3          | Vdc      | Supply +15 V                                  |
| 4          | GND      | Ground of power circuits and control circuits |
| 5          | -        | Not involved                                  |
| 6          | GND      | Ground of power circuits and control circuits |
| 7          | -        | Not involved                                  |
| 8          | GND      | Ground of power circuits and control circuits |
| 9          | SO2      | Error output (open collector)                 |
| 10         | GND      | Ground of power circuits and control circuits |
| 11         | INb      | Control input of channel 2                    |
| 12         | GND      | Ground of power circuits and control circuits |
| 13         | SO1      | Error output (open collector)                 |
| 14         | GND      | Ground of power circuits and control circuits |
| 15         | INa      | Control input of channel 1                    |
| 16         | GND      | Ground of power circuits and control circuits |
| 17         | -        | Not involved                                  |
| 18         | GND      | Ground of power circuits and control circuits |
| 19         | -        | Not involved                                  |
| 20         | GND      | Ground of power circuits and control circuits |

#### 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  |                                       |
| <b>DC/DC block characteristics</b>  |                |            |       |      |      |                                       |
| Supply voltage  | $U_S$          | V          | 13.5  | 15   | 16.5 |                                       |
| Off-load current consumption  | $I_S$          | mA         |       | 80   | 120  | $F_{cont} = 0$ Hz                     |
| Maximum current consumption   | $I_{Smax}$     | mA         |       |      | 550  | Under load<br>Ref. to Figures 5 and 6 |
| Power of built-in power supply of output part                             | $P_{DC-DC}$    | W          | 3     |      |      | For each channel                      |
| <b>Voltage monitor characteristics</b>                                    |                |            |       |      |      |                                       |
| Protection turn-on threshold  | $U_{UVLO-}$    | V          |       | 11   |      | DC-DC output                          |
| Protection turn-off threshold   | $U_{UVLO+}$    | V          |       | 12   |      |                                       |
| <b>Control input characteristics</b>                                      |                |            |       |      |      |                                       |
| High level input voltage  | $U_{IH}$       | V          | 3     | 5    | 5.6  |                                       |
| Low level input voltage   | $U_{IL}$       | V          | -0.6  | 0    | 0.8  |                                       |
| Input resistance  | $R_{IN}$       | k $\Omega$ |       | 2    |      |                                       |
| <b>Time characteristics</b>   |                |            |       |      |      |                                       |
| Turn-on/off delay time input-output                                       | $t_d$ (in-out) | V          |       |      | 0.5  | ref. to Figure 11                     |
| «Dead time» between signal changes of the first and second output channel | $t_{TD}$       | V          | 2     |      |      | Set by consumer;<br>ref. to Figure 10 |
| Maximum operating frequency   | $f_{max}$      | k $\Omega$ |       |      | 100  | No-load;<br>ref. to Figure 5 and 6    |
| Non-saturation protection operation                                       | $t_{BLOCK1}$   | $\mu$ s    | 2     |      |      | Set by consumer;                      |

|   |                      |             |     |      |      |                                   |
|---|----------------------|-------------|-----|------|------|-----------------------------------|
| delay time  |                      |             |     |      |      | ref. to Figure 9                  |
| Lock time of controlled transistor after “Emergency”  | $t_{BLOCK2}$         | ms          |     | 70   |      |                                   |
| Soft emergency shutdown time of controlled transistor   | $t_{off}$            | $\mu s$     |     | 1,5  |      |                                   |
| Emergency turn-on delay time  | $t_{d(on-err)}$      | $\mu s$     |     |      | 2    |                                   |
| <b>Output characteristics</b>   |                      |             |     |      |      |                                   |
| High level output voltage   | $U_{OH}$             | V           | +12 | +15  | +18  | In all range of permissible loads |
| Low level output voltage  | $U_{OL}$             | V           | -8  | -10  | -12  |                                   |
| Maximum output pulse on current   | $I_{Omax\ on}$       | A           | +18 | 20   |      | Set by consumer; ref. to Figure 8 |
| Maximum output pulse off current  | $I_{Omax\ off}$      | A           |     | -22  | -18  |                                   |
| Average output current  | $I_O$                | mA          |     |      | 130  | To each channel                   |
| Rise and fall time of output signal   | $t_r(f)$             | ns          |     |      | 150  | ref. to Figure 11                 |
| Maximum current of “Emergency” output   | $I_{ERR\ max}$       | mA          |     |      | 20   |                                   |
| Maximum voltage of “Emergency” output   | $U_{ERR\ max}$       | V           |     |      | 20   |                                   |
| Residual voltage of “Emergency” output  | $U_{OERR}$           | V           |     | 0.3  | 0.7  | at $I_{ERR} = 20\ mA$             |
| Saturation voltage that corresponds to non-saturation protection operation                                      | $U_{MC}^{Th}$        | V           |     |      | 5.0  | Set by consumer, ref. to Table 3  |
| <b>Insulation characteristics</b>   |                      |             |     |      |      |                                   |
| Maximum permissible reverse collector voltage   | $U_C$                | V           |     |      | 4000 |                                   |
| Insulation voltage between input and output   | $U_{ISO(IN-OUT)}$    | V           |     |      | 7500 | DC, 1 minute                      |
| Insulation voltage between output of the first and second channel   | $U_{ISO(OUT1-OUT2)}$ | V           |     |      | 4000 | DC, 1 minute                      |
| Critical rate of output voltage change  | $(dU/dt)_{cr}$       | kW/ $\mu s$ |     |      | 20   |                                   |
| <b>Protection characteristics against overvoltage</b>   |                      |             |     |      |      |                                   |
| Protection operation voltage against collector-emitter overvoltage of controlled transistor (ref. to Figure 12) | $U_{AC}$             | V           |     | 800  |      | JP2(4).1 installed                |
|   |                      |             |     | 1200 |      | JP2(4).2 installed                |
|   |                      |             |     | 1600 |      | JP2(4).3 installed                |
|   |                      |             |     | 2400 |      | JP2(4).4 installed                |
| <b>Characteristics of controlled transistor</b>   |                      |             |     |      |      |                                   |
| Maximum permissible voltage of controlled transistor  | $U_{CE} (U_{DS})$    | V           |     |      | 3300 |                                   |
| <b>Service and storage characteristics</b>  |                      |             |     |      |      |                                   |
| Operating temperature range   | $T_A$                | $^{\circ}C$ | -45 |      | +85  |                                   |
| Storing temperature   | $T_S$                | $^{\circ}C$ | -60 |      | +100 |                                   |

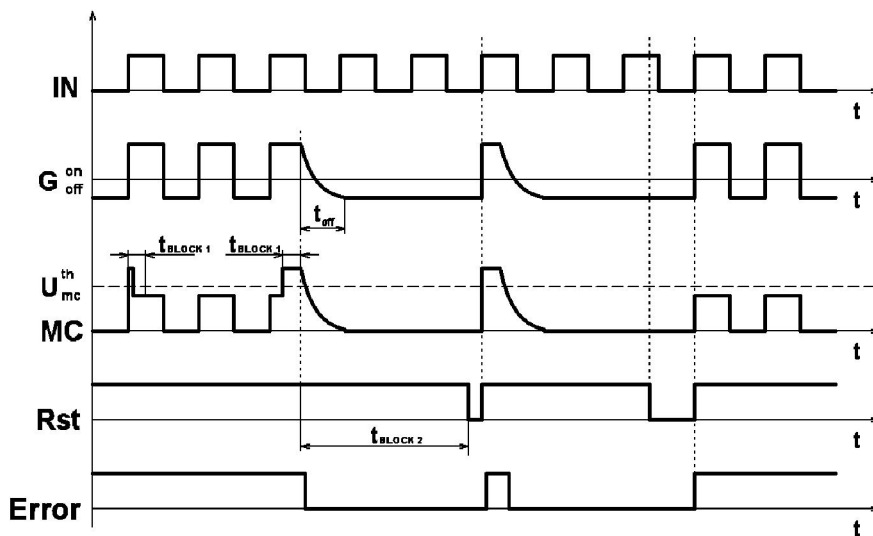
## 5 DRIVER OPERATION

Delivery of «log.1» on controlling input «INa» или «INb» will lead to opening of controlled transistor. Open state voltage fall increasing by more than  $U_{mc}^{Th}$  per time, exceeding  $t_{BLOCK1}$ , will lead to protection operation of open state voltage fall increasing (non-saturation protection). When “emergency” the transistor connected in accordance with the circuit with open collector («SO1» и «SO2») will open. 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 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 «SO» output when protection operation against supply undervoltage.

The simultaneous delivery of “log. 1” to outputs «INa» and «INb» will lead to control block and controlled transistors will be closed, thereby error signaling on «SO» output does not arise. When temperature protection operating the driver operation will be blocked until module temperature is lower than the operation temperature by 100% thereby there is no an emergency signal.

Diagrams explaining driver operation is shown at Figures 3 and 4.



Rst – Periodical internal signal of “emergency” reset

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

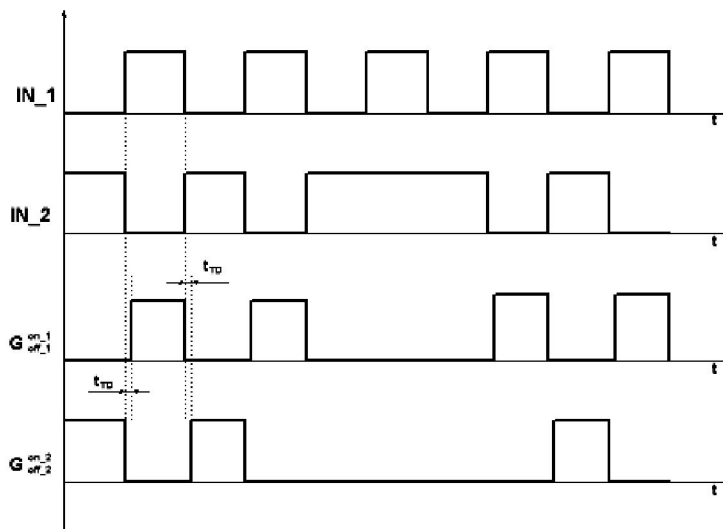


Figure 4 – Functional diagram of driver operation

## 6 DRIVER CONNECTION RECOMENDATIONS

**INa, INb** – 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 be increased and with considerable increase of supply voltage the driver can fail. If the driver should be controlled by the level «log.1» of amplitude 15 V then it is recommended to connect resistors 3.9...4.3 k $\Omega$  serially.

**SO1, SO2** – outputs signaling about emergency. The outputs are a transistor with open collector of protection circuit. Therewith transistor will open only when emergency caused by current overload of power transistor; if driver supply voltage is decreased to level « $U_{uvlo}$ » the transistors will be closed regardless of input control signals (signals will be recovered when reaching of supply level that corresponds to « $U_{uvlo+}$ »), but “Error” signaling in this case will not occur. There won't be alarm too when simultaneous delivering of signals corresponding to «log.1» to controlled inputs, though output transistor will be closed.

It is not recommended to apply to these outputs the voltage and current which are higher than the maximum permissible including short-time.

**Vdc** – driver supply input. You should note that when driver supply voltage decreases, the output voltage of DC/DC – converter will be also decreased. Therewith if the supply is lower than the permissible level the input circuit can operate regularly but the voltage on gates of controlled transistor can drop to level « $U_{uvlo}$ » and transistor control will be false.

Maximum no-load current consumption on supply input is 120 mA. When transistors connecting the current consumption will increase by value of gate recharge current and can reach 550 mA (equal load to both channel). At higher current consumption DC/DC – converter can fail, or, on short-time current consumption increasing by 550 mA, output voltage of DC/DC – converter will decrease to unallowable level and undervoltage protection will operate that will lead to faulty transistor drive. If the channel load is assigned irregularly then current consumption by one channel should not exceed 250 mA. Current consumption depends on control signal frequency, gate capacitance and gate resistors values as well as on input gate capacitance (ref. to Figure 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 5.

**GND** – ground of control circuits and supply circuits; thereby control circuit does not have a galvanic isolation with DC/DC-converter input.

**Resistors Rdt1, Rdt2** – timing resistor of switching delay setting of the first and second channel. Actually resistors regulate turn-on delay time thereby when resistor installing with diverse nominal the switching delay of leading edge of controlled pulses of the first and second channel will be different.

If there is no need for increasing of switching delay time, then you shall install the jumpers instead of resistors. The dependence of delay time on the resistor nominal is shown at Figure 10. Initially the resistors of 1  $\Omega$  nominal are installed that corresponds to minimum “dead time” (2  $\mu$ s).

**Capacitor Cb1, Cb2** – timing turn-off delay capacitor of corresponding controlled transistor at current overload. Protection operation delay is necessary to avoid the maloperation of short-time inductive kicks and of turn-on transient process. Thereby the delay duration will be equal to “rerun pulse” duration in case of emergency. To increase protection operation delay you are recommended to install the capacitors with nominal shown at Figure 9. Initially the capacitors of 100 pF capacitance are installed that corresponds to delay time 5 $\mu$ s (typ.).

**G1, G2** – outputs for gates connection of controlled transistors.

Gate resistors (Ron1, Ron2, Roff1 and Roff2) are necessary for maximum pulse current decrease. Resistor installing with any nominal is allowed, including 0  $\Omega$ . Resistor installing with different nominal is also allowed; for instance, in order to increase turn-on time of controlled transistor purposely to decrease voltage amplitude of inductive kicks. Output pulse current versus gate resistor nominal is shown at Figure 8.

Initially the resistors of 0.2  $\Omega$  are installed that corresponds to maximum pulse current.

**C1, C2** – collector (drain) connection output of controlled transistor. The outputs are intended for voltage fall controlling (saturation protection) on transistor. Thereby maximum value of protection operation threshold is 5.0 V. Protection operation threshold is regulated by jumper (JP1, JP3) position.

If there is no any need for current overload protection then output «C» should be short-circuited to emitter output of corresponding channel.

**E1, E2** – emitter connection outputs of controlled transistor.



## Jumpers

**JP1, JP3** – jumpers that regulate non-saturation protection operation threshold of controlled transistors.

Protection operation voltage versus installed jumper is represented in Table 3. If none of jumpers are installed then the driver will be in an emergency mode.

Table 3 – Non-saturation protection threshold versus installed jumper

| Jumper of channel 1 | Jumper of channel 2 | Protection threshold, V (typ.) |
|---------------------|---------------------|--------------------------------|
| JP1.1               | JP3.1               | 3.0                            |
| JP1.2               | JP3.2               | 3.5                            |
| JP1.3               | JP3.3               | 4.0                            |
| JP1.4               | JP3.4               | 4.5                            |
| JP1.5               | JP3.5               | 5.0                            |

**JP2, JP4** – jumpers that connect collector-emitter overvoltage protection of controlled transistor of channel 1 and 2 accordingly. Thereby operate voltage 800 V corresponds to JP2(4).1 position, voltage 1200 V corresponds to JP2(4).2 position, voltage 1600 V corresponds to JP2(4).3 position, voltage 2400 V corresponds to JP2(4).4 position.

## 7 DRIVER ADJUSTMENT RECOMMENDATIONS

In order to create the driver that is an analogue to the plug-n-play 2SB315A Driver for the special module it is recommended to adjust DR2180P-B5 in compliance with 2SB315A. You should adhere to the following technique when driver setting:

1. Disconnect 2SB315A driver from the module, connect the direct voltage sources between collector and emitter outputs, control gates signal.

2. Signal and measure “dead time” on switching (level 0 V);

3. Measuring protection operation voltage by smooth rising of voltage at the sources that imitate transistor saturation voltage.

4. Relative to protection operation threshold you should increase the voltage twice and measure de-saturation protection operation delay.

5. 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  $\Omega$ / 1 $\mu$ F (non-polar condenser). Connect the driver and measure resistor voltage drop (measurement of pulse driver current).

6. Set up DR2180P-B5 in compliance with the characteristics of 2SB315A driver, notably:

- set up “dead time” by Rdt resistors in compliance with the Figure 10;

- set up non-saturation protection operate voltage by jumpers JP1, JP3 in compliance with Table 3;

- set up protection operate delay time by capacitor C<sub>b</sub> in compliance with Figure 9;

- set up output pulse current by resistor R<sub>g</sub> on(off) in compliance with Figure 8.

7. Measure the received parameter of DR2180P-B5 similarly to 2SB315A driver test, be assured in their equivalent.

8. Connect the driver to the power module and be sure that the converter operates by analogy to the variant of 2SB315A driver.

## 8 GRAPHS EXPLAINING DRIVER OPERATION

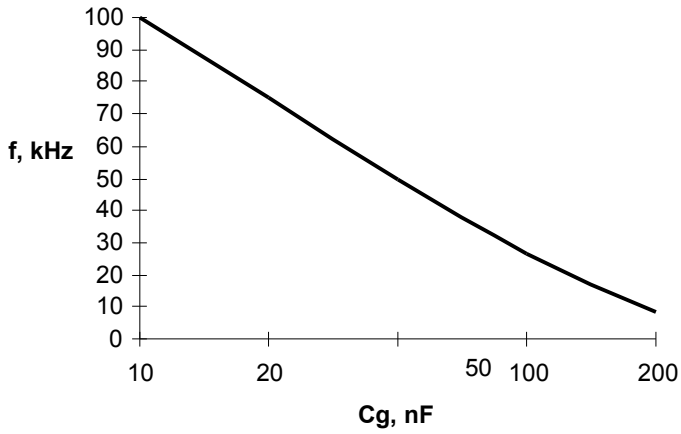


Figure 5 – Safe operation area versus frequency and gate capacitance (with gate resistor 1  $\Omega$ )

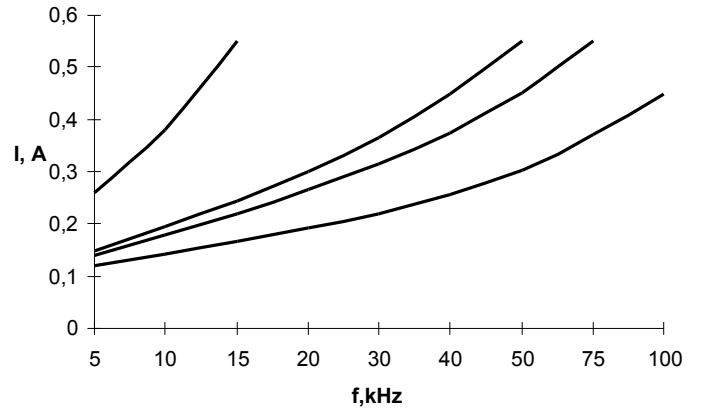


Figure 6 – Current consumption versus signal frequency under load (with gate resistor 1  $\Omega$ )  
For gate capacitance 10 nF, 25 nF, 50 nF, 100 nF

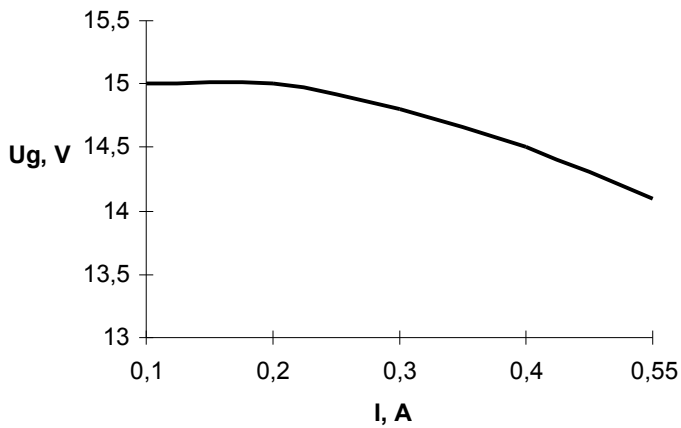


Figure 7 – Transistor gate voltage versus current consumption

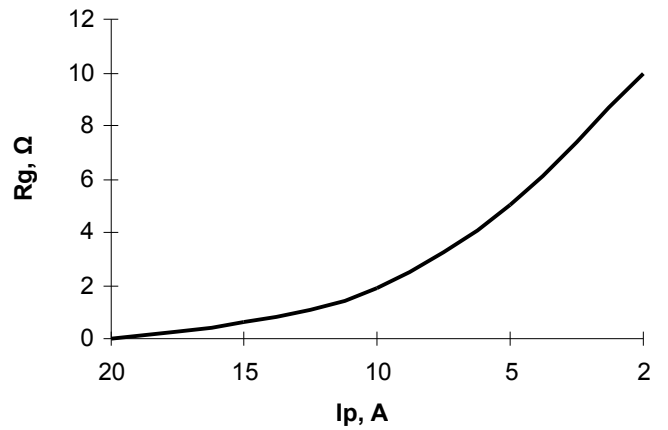


Figure 8 – Output pulse current versus gate resistor nominal

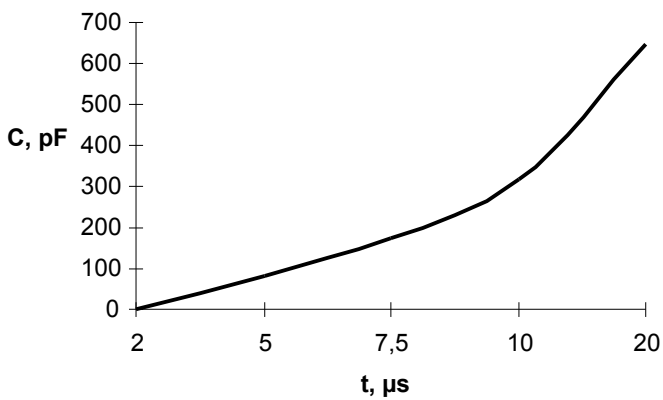


Figure 9 – Turn-on delay time of saturation voltage versus trimming capacitance  $C_b$  nominal

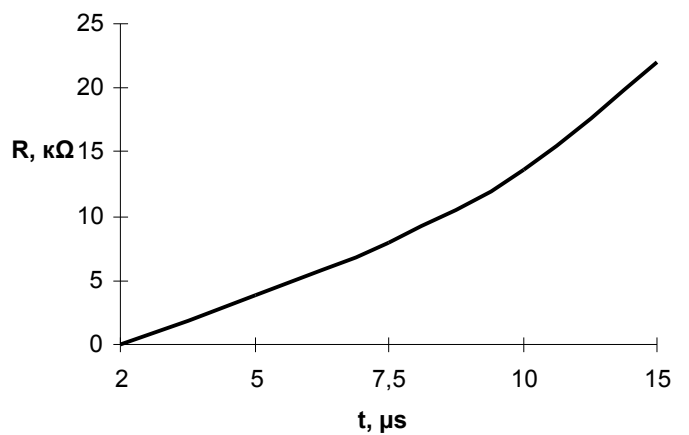


Figure 10 – “Dead time” duration versus trimming resistor  $R_{dt}$  nominal

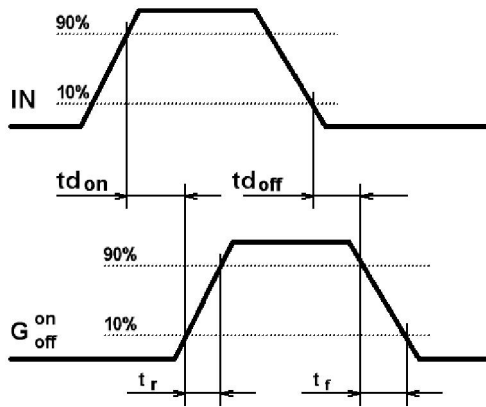


Figure 11 – Diagram explaining timing driver characteristics where IN – input control signal; G – gate signal of controlled transistor

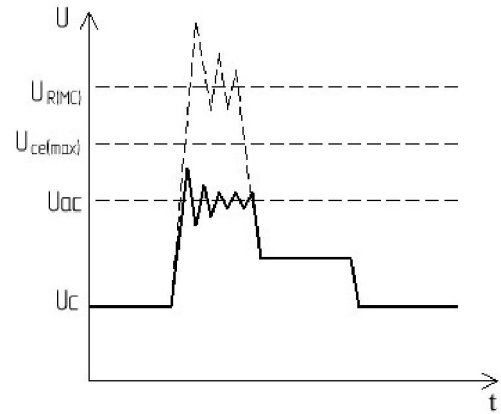


Figure 12 – Driver operation when collector-emitter overvoltage protection operate of controlled transistor where  $U_{ac}$  – protection operate voltage against overvoltage;  $U_{ce(max)}$  – max. collector-emitter voltage of power transistor,  $U_{r(mc)}$  – max. reverse voltage on collector output

## 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 4.

Table 4 – Drivers resistance 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                             |

## 10.2 Resistance requirements at climatic impacts

Table 5 - Resistance requirements to climatic impact factors

| Climatic factor   | Climatic factor value |
|---|-----------------------|
| Lower ambient temperature:<br>- operating, °C;<br>- maximum, °C                   | minus 45<br>minus 60  |
| Higher ambient temperature:<br>- operating, °C;<br>- maximum, °C                  | +85<br>+100           |
| Relative humidity with temperature 35 °C without<br>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 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 than 10 years, at  $\gamma = 90\%$ .

Gamma-percent storageability time of the modules, at  $\gamma = 90\%$  and storing – 10 years.

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