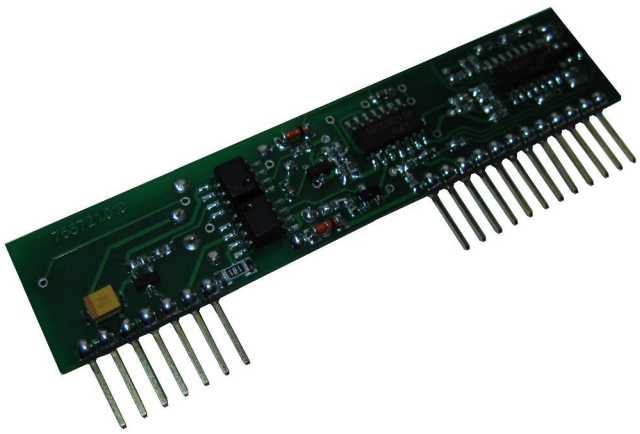
IGBT AND MOSFET TRANSISTORS DRIVER DM1120P-A, DM1120P-A1
ANALOGE OF VLA500-01

USER'S MANUAL



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CONTENTS

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1 OVERVIEW

A single-channel IGBT and MOSFET transistors driver that is intended for galvanically isolated control of power transistor with field control that has maximum permissible values of currents and voltages 600V/600 A, 1200V/400A, 1700V/400A. The driver has the inbuilt DC/DC converter and poses control signals sharpener amplifier by transistor gate with frequency up to 25 kHz. Driver is analogue to **VLA500-01** by Mitsubishi.

2 FUNCTIONAL DRIVER FEATURES

2.1 Driver provides the following management functions, control and protection of controlled transistor:

1 Transistor control according to control signals;
2 Forming of controlled transistor galvanically isolated barrier and cutoff voltages;
3 Voltage saturation control on the controlled transistor collector, its protection turn-off when leaving saturation state;
4 Providing of smooth driver transition from active state into inactive in case of an «emergency» situation (controlled transistor out from saturation state);
5 Control blocking in an «emergency»;
6 Protection activation delay adjustment at non-saturation;
7 Controlled transistor smooth emergency switching-off delay adjustment;
8 Signaling about emergency;

3 DIMENSIONAL DRAWING AND FUNCTIONAL DIAGRAM

3.1 Dimensional drawing is shown in the Figure 1, functional diagram is shown in the Figure 2, connection circuit is shown in Figure 3.

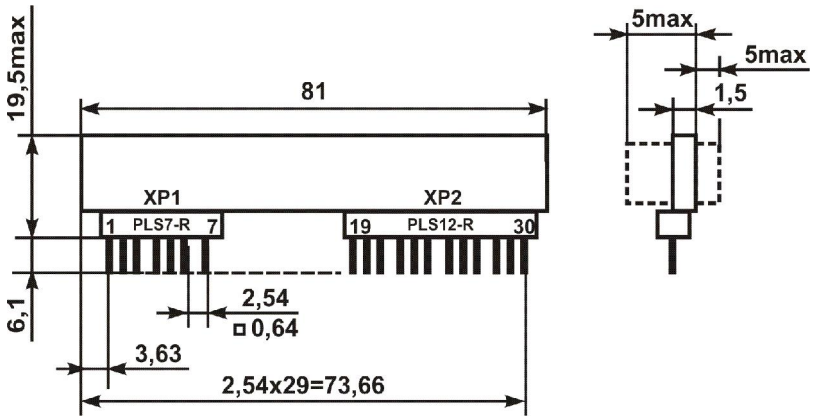

Figure 1 – Driver overall drawing

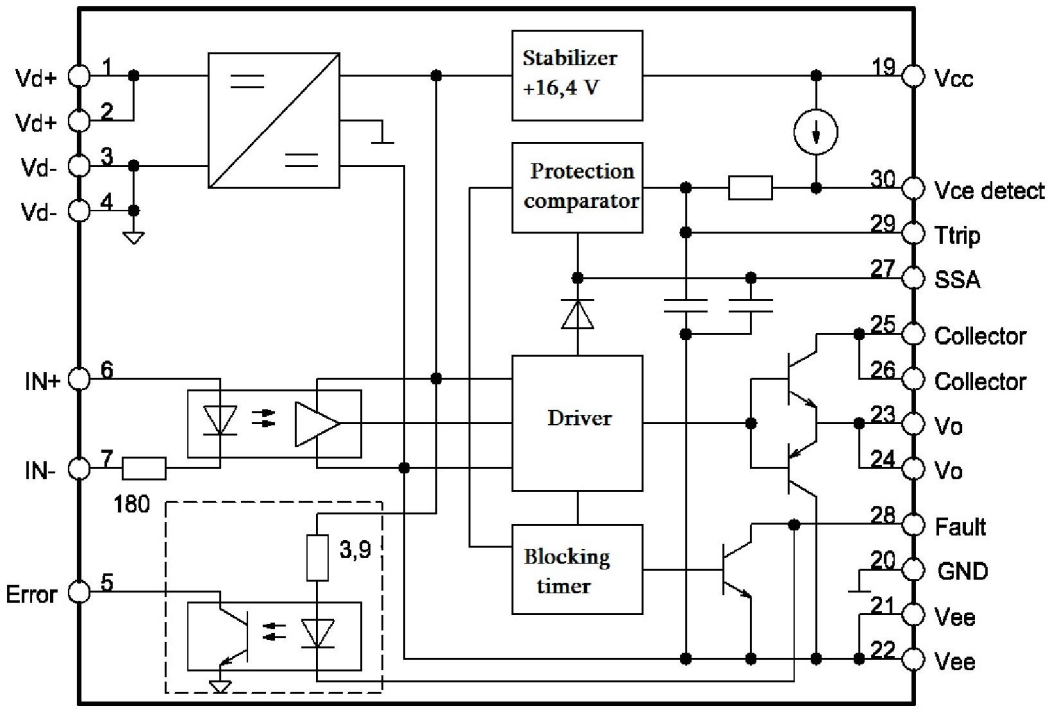

Figure 2 – Driver functional diagram

Block that is an exclusive part of DM1120P-A1 is shown by dashed line.

3.2 Driver outputs application is shown in Table 1.

Table 1 – Driver outputs purpose

Output	Symbol	Purpose
1	Vd+	Connection output «+» DC/DC converter supply
2		
3	Vd-	Connection output «-» DC/DC converter supply
4		
5	Error	Error signal output (open collector). Only DM1120P-A1 is used.
6	IN+	Input optocoupler LED anode
7	IN-	Input optocoupler LED cathode
17	-	Not active
18	-	Not active
19	Vcc	Output supply 16,4 V positive output
20	GND	Common output of output circuits; emitter connection output (source)
21	Vee	Negative output of output supply -10 V
22		
23	Vo	Controlled transistor connection gate output
24		
25	Collector	Driver output stage connection output of positive supply
26		
27	SSA	Capacitor connection output of smooth emergency turn-off duration adjustment
28	Fault	Error signal output (open collector)
29	Ttrip	Capacitor connection output of delay protection activation adjustment at non-saturation
30	Vce detect	Measuring collector, saturation voltage control output

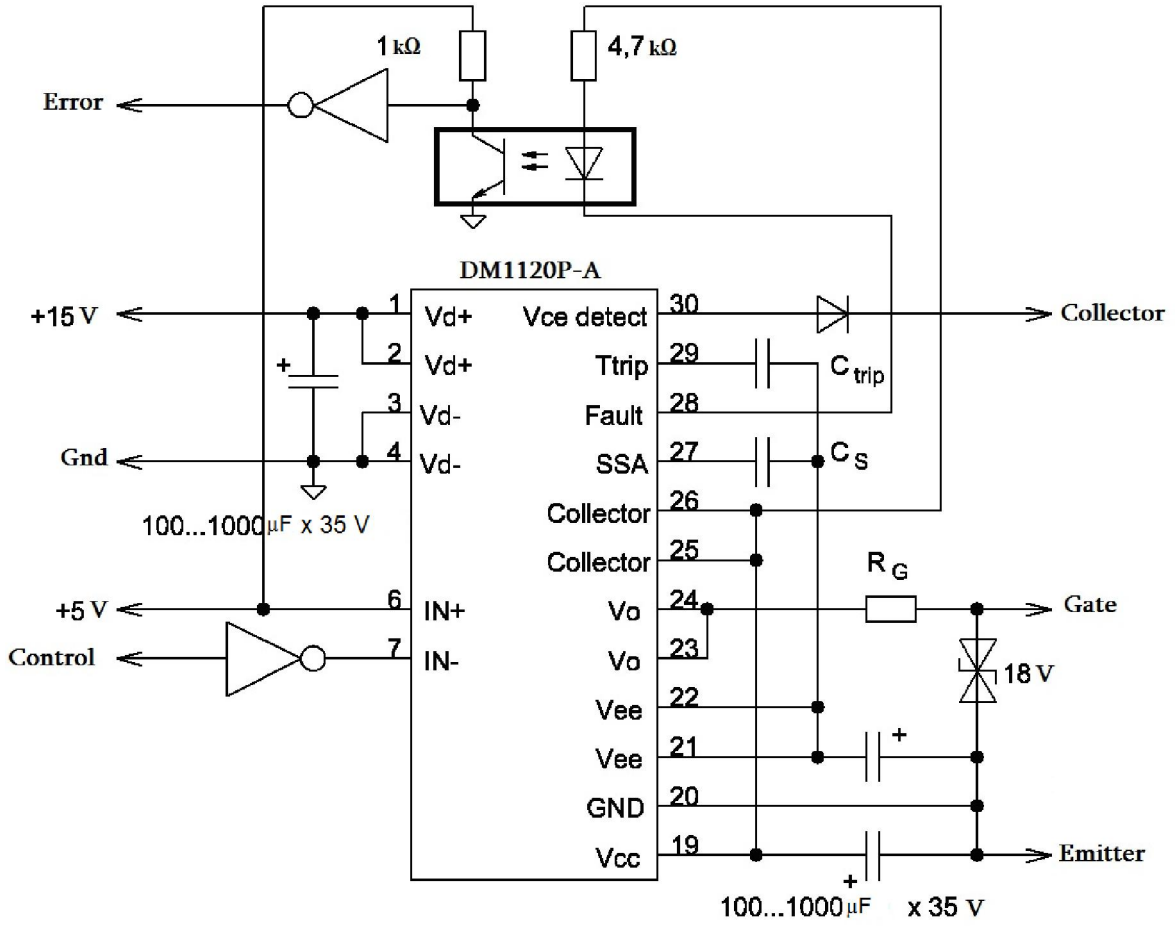

Figure 3 –Connection circuit of driver DM1120P-A

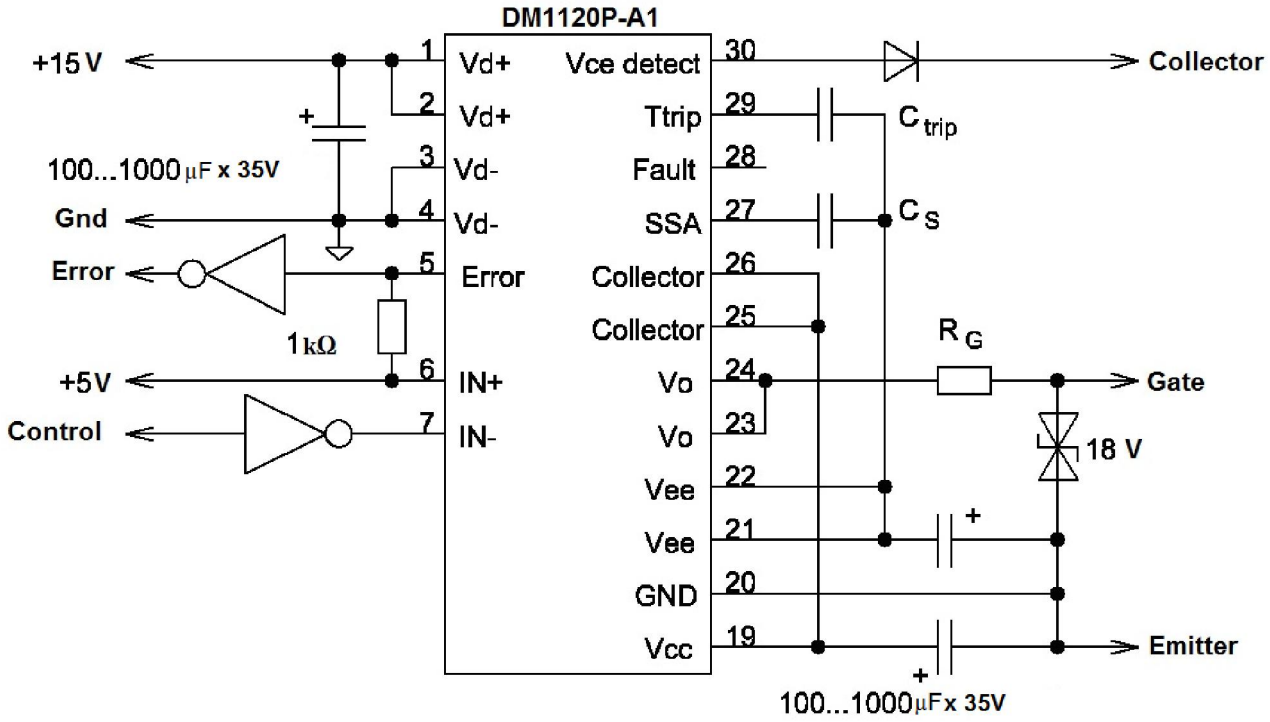

Figure 4 –connection circuit of driver DM1120P-A1

4 BASIC AND MAXIMUM PERMISSIBLE CHARACTERISTICS

Table 2 – Basic and maximum permissible characteristics (at T = 25 °C)

Characteristic	Symbol	Unit	Value			Notes
			min	type	max	
Supply characteristics						
Supply voltage	U_S	V	13.5	15	16.5	
No-load current consumption	I_S	mA		90	100	f = 0 Hz
Maximum current consumption	$I_{S\,max}$	mA			300	see Figure 5
Control inputs characteristics						
Optocoupler LED current that matches to controlled transistor switching on	$I_{IN\,ON}$	mA	5		20	
Optocoupler LED current that matches to controlled transistor switching off	$I_{IN\,OFF}$	mA	0		1.5	
Control current at Ucont=5 V	$I_{IN\,5V}$	mA		17		
Input resistance	R_{IN}	Ω		180		
Time characteristics						
Switching on/ switching off delay time between input and output	$t_{d\,on/off\,(in\text{-}out)}$	µs			1	
Maximum operation frequency	f_{max}	kHz			25	see Figure 6
Non-saturation protection operation delay	t_{trip}	µs	2	2.4	3	Set by customer see Figure 9
Transistor smooth emergency turn-off time	ts	µs	5	10	15	Set by customer see Figure 8
Controlled transistor dead time after emergency	t_{block}	ms	1	1.6	2	
Emergency signal turn-on delay time	$td_{(on\text{-}err)}$	µs		0.1	1	
Output characteristics						
Turn-on pulse current	$I_{Omax\,+}$	A	12			
Turn-off pulse current	$I_{Omax\,-}$	A			-12	
Positive output supply voltage	$U_{out\,+}$	V	15	17	18	In all range of permissible loads
Negative output supply voltage	$U_{out\,-}$	V	-5	10	-15	
Output average current	I_O	mA			130	
Output signal building-up period	t_r	ns			100	No-load
Output signal fall time	t_f	ns			150	
Maximum current on «Fault» and «Error» state outputs	$I_{F\,max}$	mA			10	
Maximum voltage on «Fault» and «Error» state output	$U_{F\,max}$	V			30	
Residual voltage at «Fault» and «Error» signal output	$U_{O\,F}$	V			1	at I_F = 10 mA
Voltage threshold on «Detect» measuring input that leads to emergency turn-off	U_{ms}^{Th}	V	9	10	11	With one protective diode
Isolation characteristics						
Insulation voltage between input and output	$U_{ISO(IN\text{-}OUT)}$	V			4000	DC, 1 minute
Output voltage variation at critical speed	dU/dt	kW/µs			20	
Exploitation and storage parameters						
Operating temperature range	T_A	°C	-40		+85	
Storing temperature	Ts	°C	-45		+100	

5 DRIVER OPERATION

Current feed higher then 5 mA to «IN» controlled inputs will lead to controlled transistor opening. Increasing of voltage fall in open state more then U_{MS}^{Th} during the time that exceeds t_{trip} will lead to protection activation at exceeding of voltage loss in open state (at current overload). Upon incurrence of «emergency» transistor that is connected by circuit with open collector («Fault» output for DM1120P-A and «Error» output for DM1120P-A1) will open. Reset of «emergency» will be activated through the t_{block} time by internal circuit of «emergency» reset and by the next closest one after the reset of «IN» control signal rising edge the controlled transistor will be opened. In case if reason of the «emergency» was not eradicated the protection operation will be repeated again.

Diagram explaining the driver operation is shown in the Figure 5.

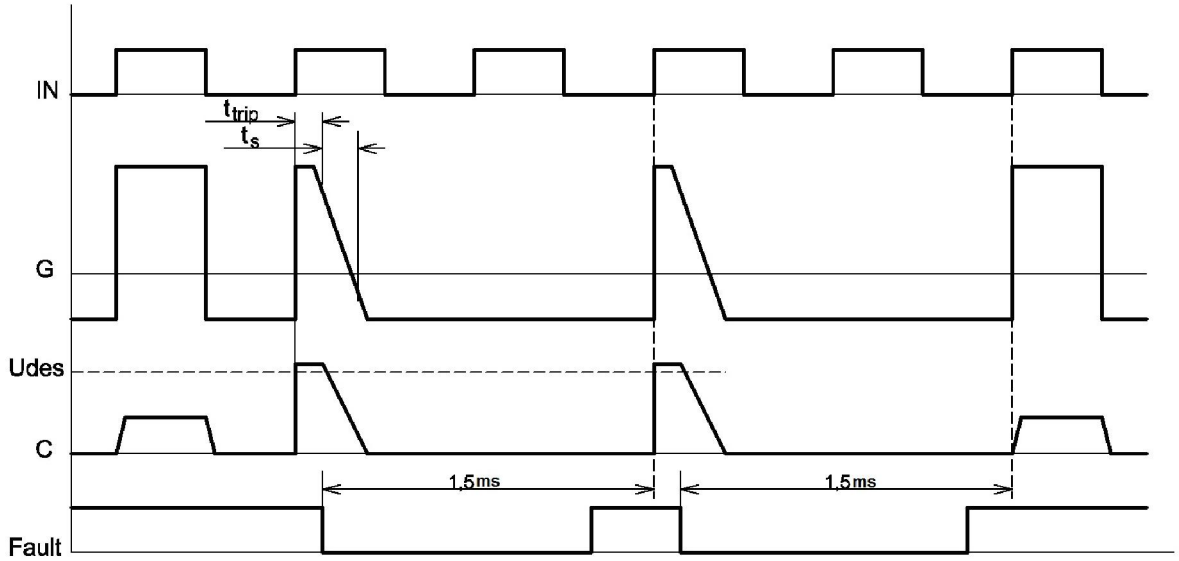

Figure 5 – Functional diagram of driver operation in «emergency»

6 DRIVER CONNECTION RECOMENDATIONS

IN+, IN- – control outputs. They represent LED outputs of input optocoupler (anode and cathode). Driver control is described in «Driver operation» paragraph.

Fault – output signaling about emergency appearance. Represents open collector of protection circuit transistor at controlled transistor non-saturation. Output is galvanically connected with output driver circuits; for state signal transmitting to galvanically isolated input driver circuit it is recommended to use optocoupler that is connected according to scheme in the Fig. 3. Output must not be used for DM1120P-A1.

Error – error that signals in an emergency occurrence; is used only for DM1120P-A1. It represents transistor open collector of protection circuit at controlled transistor non-saturation. Output is galvanically connected with input circuits of DC/DC driver converter.

Vd+, Vd- – DC/DC converter supply connection outputs. Current consumption must not exceed 300 mA otherwise driver can broken-down.

V_{CC} – DC/DC converter positive supply output. To this output comparatively the «ground» of output currents must be connected capacitor with capacity 100…1000 μF (see Fig. 3 and 4).

V_{EE} – DC/DC converter negative supply output. To this output comparatively the «ground» of output circuits necessary to connect capacitor with capacity 100…1000 μF (see Fig. 3 and 4).

GND – common of driver output circuits; controlled transistor emitter (source) connection output.

Collector – driver output stage connection output of positive supply. It is recommended as output stage positive supply of DC/DC converter by connecting of this output with Vcc output.

V_O – controlled transistor gate connection output. For driver output pulse current decreasing (and controlled transistor turn-on/off time) it is recommended to install gate resistor in the break between this output and gate; driver turn-on without gate resistor is acceptable. For protection of controlled transistor from overvoltage

on gate is recommended to install bilateral voltage limiter to nominal breakdown voltage of 18V between gate and emitter (source).

Vce detect – controlled transistor collector (source) connecting output. Output is intended for voltage fall control (non-saturation protection) on the transistor. Driver doesn't have built-in protection free-wheeling diode, installing of external free-wheeling diodes on the maximum reverse voltage is not less at 20% more then controlled transistor maximum permissible voltage.

The standard value of protection activation threshold is 10V with one free-wheeling diode. Protection activation threshold is regulated by installation of external elements (diodes and Zener diodes); from the maximum voltage (10V) the voltage fall is subtracted on the Zener diodes and diodes at current 4 mA. For example, if to set «Vce detect» Zener diodes consecutively (cathode to driver) with nominal stabilization voltage 3,3V and two diodes with voltage fall 0.7V on current 4 mA, then threshold protection activation will be equal 10-3.3-2x0.7=5.1V.

If the protection from current overvoltage of the controlled transistor is not necessary, this output should be shorted out to controlled transistor emitter (source).

SSA – capacitor connection output of smooth emergency turn-off duration adjustment, see Fig. 8.

T_{trip} – capacitor connection output of duration delay adjustment protection activation at non-saturation, see Figure 9.

7 GRAPHS EXPLANING DRIVER OPERATION

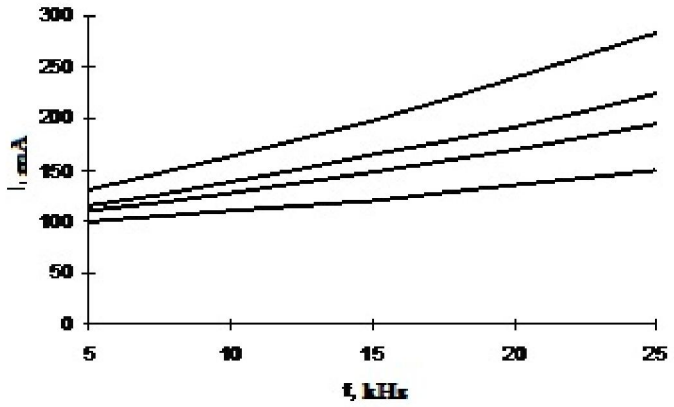

Figure 6 – Graph of current consumption dependence from control signal frequency under the load (with gate resistor 1 Ω) for gate capacities 10 nF, 25 nF, 50 nF, 100 nF

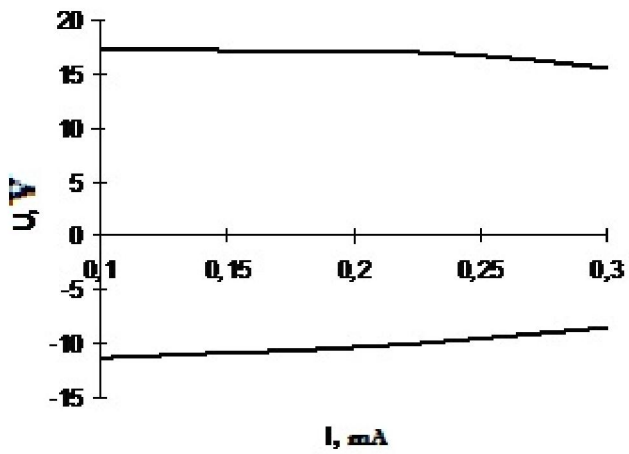

Figure 7 – graph of dependence voltage amplitude on the controlled transistor gate from driver current consumption

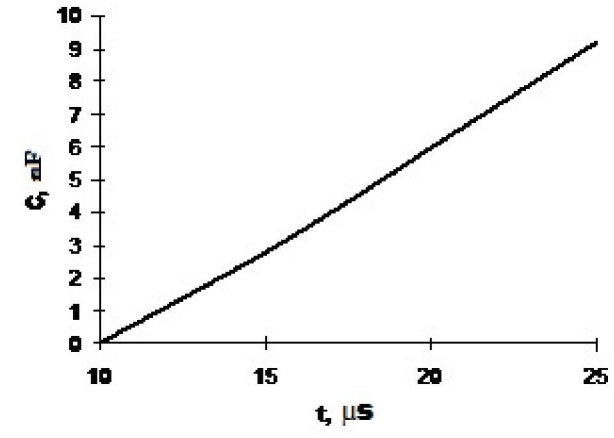

Figure 8 – Graph of smooth emergency turn-off dependence duration from capacity nominal Cs

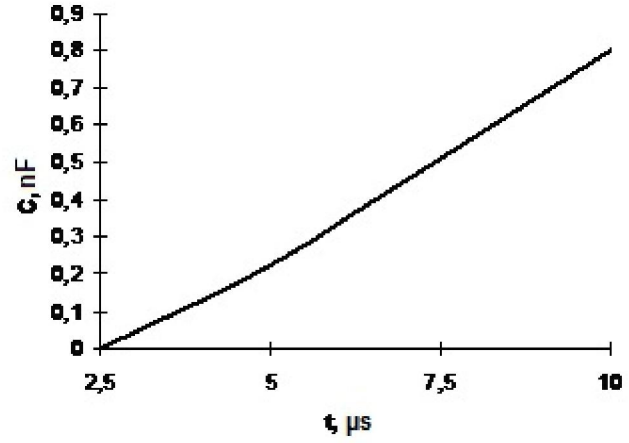

Figure 9 – Graph of dependence protection activation delay duration at non-saturation from capacity nominal Ctrip

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, м/s^2 (g)	150 (15)
Mechanical shock of single action:	
- shock acceleration peak value, м/s^2 (g);	40 (4)
- shock acceleration pulse length, мs	50

In technical reasonable cases, on request of concrete consumers, the drivers can be produced also for the other service conditions.

9.2 Tolerance requirements at climatic impacts.

Table 4 - Tolerance requirements to climatic impact factors

Climatic factor	Climatic factor value
Ambient reduced temperature:	
- operating, °C;	minus 40
- maximum, °C	minus 45
Ambient elevated temperature:	
- operating, °C;	+85
- maximum, °C	+100
Relative humidity at 35 °C without humidity, %, max	98
Ambient temperature changing, °C	from minus 45 to +100
Atmospheric decreased pressure, Pa(mm Hg)	86000 (650)
Atmospheric increased 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.