SOSLID STATE POWER CONTROLLER
SSPC1

USER'S MANUAL

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1. APPLICATION AND FUNCTIONS

Solid state power controller (hereinafter module or SSPC1) designed to switch DC load current, for load protection and current overload protection of switching transistor (by criterion I^2t), for temperature protection and protection against inductive kicks in load circuit. The module includes control circuit and power circuit with galvanic decoupling from supply and control circuits.

SSPC1 will provide the following functions and capabilities:

- load current switching;

- load current control by value I^2t with load current protection;

- status signal delivery when exceeding load current permissible value;

- overheating protection of switching transistor;

- status signal delivery when controlled transistor overheating;

- collector-emitter overvoltage protection of controlled transistor (drain-source);

- status signal delivery by criterion $I \geq 0.3Inom$

2. PRODUCED MODULES

The SSPC1 is produced with different types of power assemblies (to different voltages and currents). The SSPC1 are produced to currents 2, 5, 10, 20, 30, 40 A and at 60, 100, 200, 400, 600 or 1200 V of power elements (module modification with corresponding current/voltage nominal is chosen in accordance with section 4). In module name the maximum permissible average value of long-term current is specified.

Maximum voltage, denoted in module name, will indicate maximum permissible collector-emitter voltage (drain-source) used in power transistor modules. Therewith the maximum switch voltage is lower than it is specified in the name (see Section 4).

SSPC1 are produced with two control options: modules with forward and inverse control inputs and modules with forward control input and reset input.

SSPC1 modules are produced for three different supply voltages of a built-in DC/DC converter – 15, 24, 27 V.

Figure 2.1 shows the SSPC1 modules name explanation.

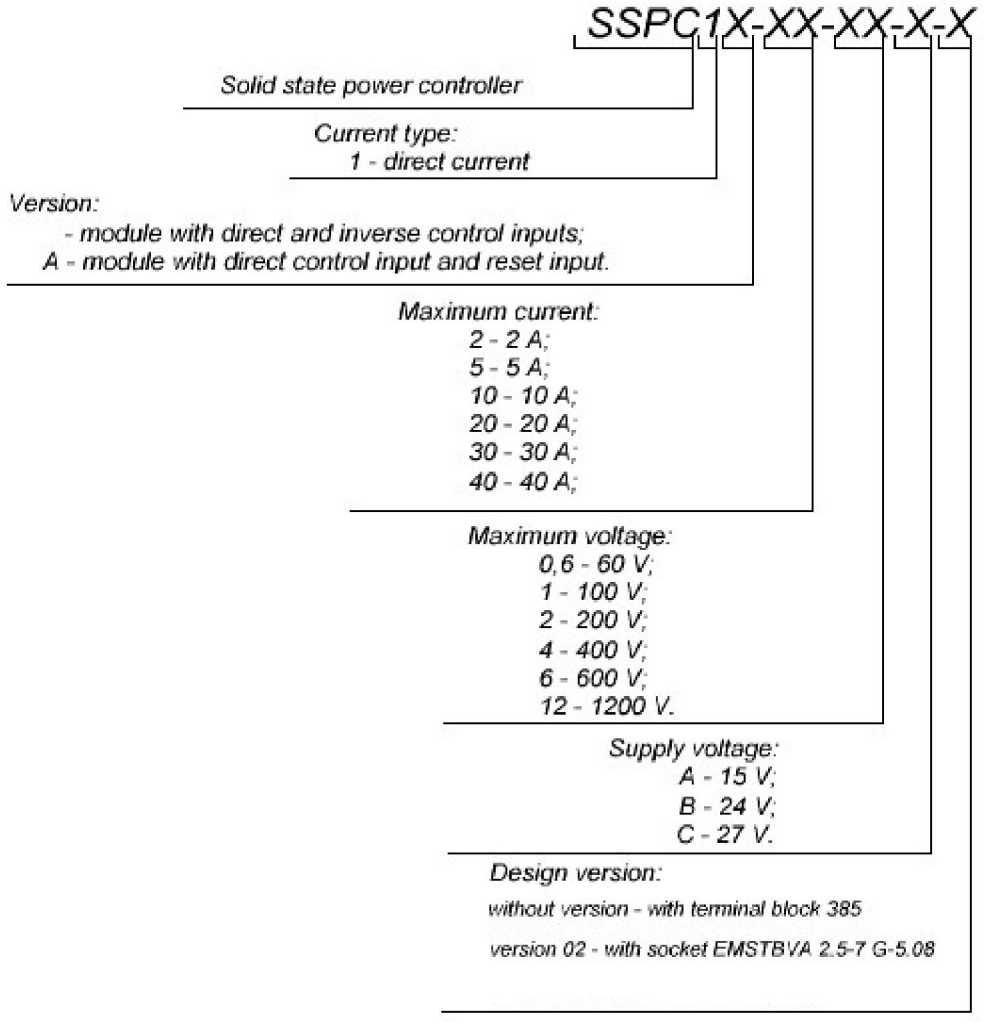


Figure 2.1 – Module name explanation

For example, module SSPC1-2-0,6-A – solid state power controller SSPC1 with direct and inverse control inputs, with maximum switching current 2 A, with maximum voltage of power elements 60 V, supply voltage 15 V.

3. GENERAL MODULE DESCRIPTION

The SSPC1 is an assembly of control circuit with power part including power switch transistors (MOSFET – for devices of 0,6, 1, 2, 4 class, IGBT for devices of 6 and 12 voltage class), current-measuring shunt and thermistor that are located on the radiator through insulating base.

Structure circuits of SSPC1 are given at Figures 3.1 and 3.2.

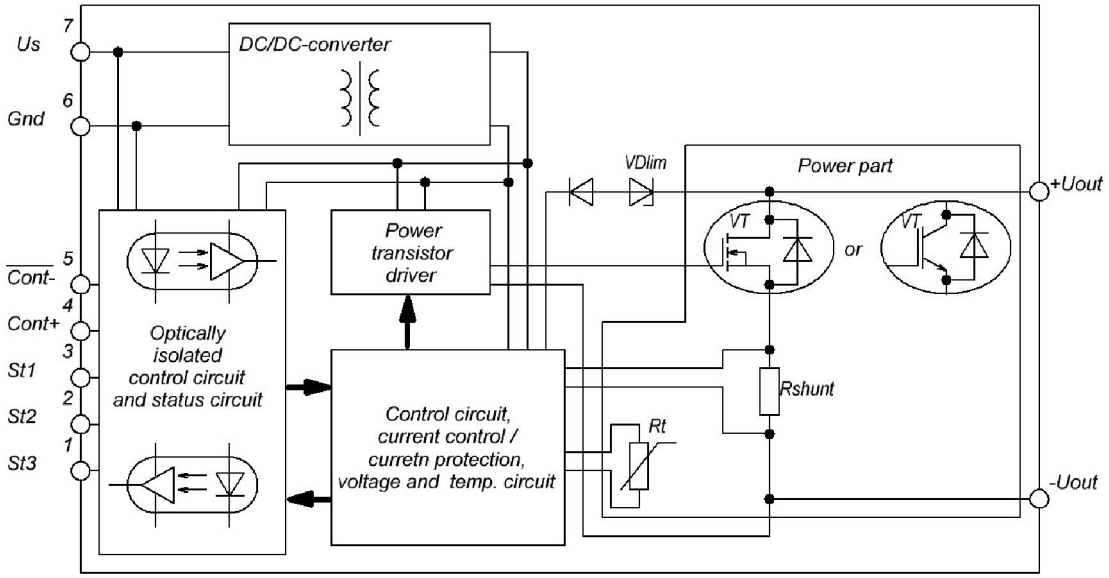


Figure 3.1 – Structural circuit of SSPC1-XX-XX-X-X

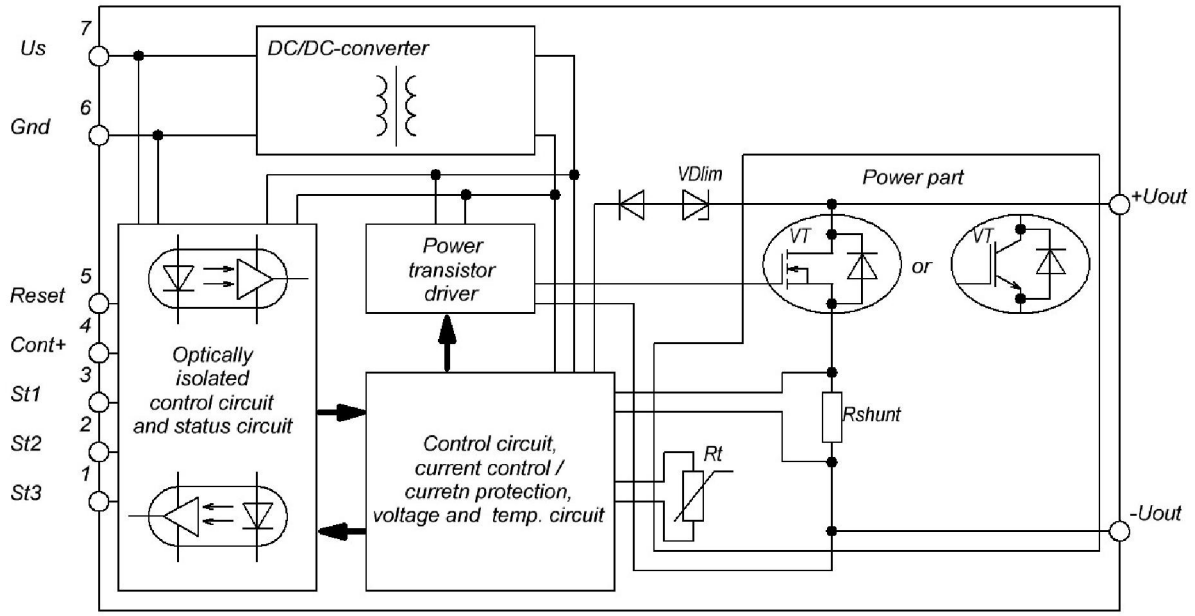


Figure 3.2 – Structural circuit of SSPC1A-XX-XX-X-X

Input supply contacts of a built-in DC/DC converter, connection contacts of control signals and reset signals, connection contacts of status signals are a push terminal of series 385, power output terminals thread contacts (ref. to overall drawings) or a plug FKC 2,5/7-ST-5,08. The output function is shown in Table 3.1.

Table 3.1 – Module outputs application

Contact #	Symbol	Application
7	Up	Positive output of built-in DC/DC converter
6	Gnd	Negative output of built-in DC/DC converter. Ground output for control signals, reset signals and status signals
5	$\overline{\text{Cont-}}$	Optically isolated inverse control input for module of series SSPC1-XX-XX-X-X
	Reset	Optically isolated input of external reset when current exceeding or short-circuit emergency for modules of series SSPC11A-XX-XX-X-X
4	Cont+	Optically isolated forward control input
3	St1	Optically isolated status signal (open collector) by value $I \geq 0.3\ I_{nom}$
2	St2	Optically isolated status signal (open collector) at load current exceeding or load SC
1	St3	Optically isolated status signal (open collector) at overheating of power cooler transistors
	+Uout	Power collector (drain) output of transistor for load connection
	-Uout	Power emitter (source) output of transistor for load connection

4. BASIC PARAMETERS

Basic electrical characteristics and maximum permissible electrical parameters SSPC1X-XX-XX-X-X at 25 ^{0}C are shown in Tables 4.1 - 4.7.

Table 4.1 – Basic and maximum permissible electrical characteristics of control circuits

Name	Unit	Value			Note
		min	typ.	max	
Supply parameters					
Supply voltage, U_{sup}	V	13.5	15	18	SSPC1X-XX-XX-A-X
		22	24	27	SSPC1X-XX-XX-B-X
		18	27	36	SSPC1X-XX-XX-C-X
Current consumption, I_{cons}	mA			150	
Control signals parameters					
«Low logic level» input signal, $U_{cont.off}$	V	-0.5		3	SSPC1X-XX-XX-A-X
		-0.5		6.5	SSPC1X-XX-XX-B-X
		-0.5		6.5	SSPC1X-XX-XX-C-X
«High logic level» input signal, $U_{cont.on}$	V	10	15		SSPC1X-XX-XX-A-X
		18	24	27	SSPC1X-XX-XX-B-X
		18	24	27	SSPC1X-XX-XX-C-X
Current of control inputs, I_{cont}	mA			1	«Cont+», «Cont-», «Reset»
Status signals parameters					
Maximum voltage of status signal output, Uout. ST	V			30	Open collector
Maximum current of status signal output, Iout. ST	mA			10	
Parameters of module functioning					
Delay time on/off of switching element, ton/off	µs			5	
Maximum switching frequency, f_{max}	kHz			30	
Turn-on current of status ST1			≥0.3Inom		
Turn-on current of status ST 2			≥1.1Inom		
Delay time of protection operation by criterion I ≥ 1.5Inom, t1	ms			4	
Delay time of protection operation by criterion I ≥ 3Inom, t2	ms			1.5	
Delay time of protection operation by criterion I ≥ 4Inom, t3	µs			10	
Protection operation temperature against overheating, Toff	ºC		90	100	
Protection block removal temperature against overheating , Ton	ºC	60		70	
Delay time on/off of status signal ST1, ton/off ST1	µs			5	I = 0.5Inom
Turn-on delay time of status signal ST2, ton/off ST2	µs			5	I = 3Inom
Turn-on delay time of status signal ST3, ton/off ST3	µs			5	
Insulation voltage between control circuits, power circuits and cooler, U_{isol}	V			1000	SSPC1X-XX-0,6-X-X SSPC1X-XX-1-X-X
				2000	SSPC1X-XX-2-X-X SSPC1X-XX-4-X-X
				4000	SSPC1X-XX-6-X-X SSPC1X-XX-12-X-X
Critical rate of change of output voltage, dU/dt	kV/µs			10	

Table 4.2 Basic and maximum permissible electrical parameters of power circuits for modules of 0,6 class (SSPC1X-XX-0,6-X)

Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, Ubv	V			60	
Maximum commutation direct voltage, U_{com}	V			31	
Limitation voltage of active protection, U_{lim}	V			48	
Leakage current of switching element, Iout.l.	μA			100	
Rated switching current, Inom	A			2	SSPC 1X-2-0,6-X-X
				5	SSPC 1X-5-0,6-X-X
				10	SSPC 1X-10-0,6-X-X
				20	SSPC 1X-20-0,6-X-X
				30	SSPC 1X-30-0,6-X-X
				40	SSPC 1X-40-0,6-X-X
Maximum pulse current, Ip.max.at t_p=10 ms	A			6	SSPC 1X-2-0,6-X-X
				15	SSPC 1X-5-0,6-X-X
				30	SSPC 1X-10-0,6-X-X
				60	SSPC 1X-20-0,6-X-X
				90	SSPC 1X-30-0,6-X-X
				120	SSPC 1X-40-0,6-X-X
Residual output resistance in on-state, U_{res}.	mΩ			30	SSPC 1X-2-0,6-X-X
				30	SSPC 1X-5-0,6-X-X
				30	SSPC 1X-10-0,6-X-X
				20	SSPC 1X-20-0,6-X-X
				20	SSPC 1X-30-0,6-X-X
				10	SSPC 1X-40-0,6-X-X
Thermal junction-cooler resistance, $R_{th\ j\text{-}c}$	ºC/W			2	SSPC 1X-2-0,6-X-X
				1	SSPC 1X-5-0,6-X-X
				1	SSPC 1X-10-0,6-X-X
				1	SSPC 1X-20-0,6-X-X
				0.8	SSPC 1X-30-0,6-X-X
				0.7	SSPC 1X-40-0,6-X-X
Thermal junction-ambient resistance, $R_{th\ j\text{-}a}$	ºC/W		10	12	

Table 4.3 – Basic and maximum permissible electrical parameters of power circuits for modules of 1-st class (SSPC1X-XX-1-X)

Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, Ubv	V			100	
Maximum commutation DC voltage, Ucom	V			48	
Limitation voltage of active protection, Ulim	V			78	
Leakage current of switching element, Iout.l.	μA			100	
Rated switching current, I_{nom}	A			2	SSPC 1X-2-1-X-X
				5	SSPC 1X-5-1-X-X
				10	SSPC 1X-10-1-X-X
				20	SSPC 1X-20-1-X-X
				30	SSPC 1X-30-1-X-X
				40	SSPC 1X-40-1-X-X
Maximum pulse current, Ip.max at t_p=10 ms	A			6	SSPC 1X-2-1-X-X
				15	SSPC 1X-5-1-X-X
				30	SSPC 1X-10-1-X-X
				60	SSPC 1X-20-1-X-X
				90	SSPC 1X-30-1-X-X
				120	SSPC 1X-40-1-X-X
Residual output resistance in on-state, U_{res}.	mΩ			120	SSPC 1X-2-1-X-X
				120	SSPC 1X-5-1-X-X
				60	SSPC 1X-10-1-X-X
				35	SSPC 1X-20-1-X-X
				20	SSPC 1X-30-1-X-X
				15	SSPC 1X-40-1-X-X
Thermal junction-cooler resistance, $R_{th\ j\text{-}c}$	ºC/W			2	SSPC 1X-2-1-X-X
				1	SSPC 1X-5-1-X-X
				1	SSPC 1X-10-1-X-X
				1	SSPC 1X-20-1-X-X
				0.8	SSPC 1X-30-1-X-X
				0.7	SSPC 1X-40-1-X-X
Thermal junction-ambient resistance, $R_{th\ j\text{-}a}$	ºC/W		10	12	

Table 4.4 – Basic and maximum permissible electrical parameters of power circuits for modules of 2-nd class (SSPC1X-XX-2-X)

Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, V_{DSS}	V			200	
Maximum commutation direct voltage, V_{DC}	V			100	
Limitation voltage of active protection, V_{AC}	V			150	
Leakage current of switching element, I_{DSS}	μA			100	
Rated switching current, I_{DC}	A			2	SSPC1X-2-2-X-X
				5	SSPC1X-5-2-X-X
				10	SSPC1X-10-2-X-X
				20	SSPC1X-20-2-X-X
				30	SSPC1X-30-2-X-X
				40	SSPC1X-40-2-X-X
Maximum pulse current, I_{DM} at t_{pul}=10 ms	A			6	SSPC1X-2-2-X-X
				15	SSPC1X-5-2-X-X
				30	SSPC1X-10-2-X-X
				60	SSPC1X-20-2-X-X
				90	SSPC1X-30-2-X-X
				120	SSPC1X-40-2-X-X
Residual output resistance in on-state, $R_{DS(on)}$	mΩ			200	SSPC1X-2-2-X-X
				200	SSPC1X-5-2-X-X
				100	SSPC1X-10-2-X-X
				50	SSPC1X-20-2-X-X
				30	SSPC1X-30-2-X-X
				20	SSPC1X-40-2-X-X
Thermal junction-cooler resistance, R_{thjc}	ºC/W			2	SSPC1X-2-2-X-X
				1	SSPC1X-5-2-X-X
				1	SSPC1X-10-2-X-X
				1	SSPC1X-20-2-X-X
				0.8	SSPC1X-30-2-X-X
				0.7	SSPC1X-40-2-X-X
Thermal junction-ambient resistance, R_{thja}	ºC/W		10	12	

Table 4.5 – Basic and maximum permissible electrical parameters of power circuits for modules of 4-th class (SSPC1X-XX-4-X)

Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, V_{DSS}	V			400	
Maximum commutation direct voltage, V_{DC}	V			180	
Limitation voltage of active protection, V_{AC}	V			350	
Leakage current of switching element, I_{DSS}	μA			100	
Rated switching current, I_{DC}	A			2	SSPC1X-2-4-X-X
				5	SSPC1X-5-4-X-X
				10	SSPC1X-10-4-X-X
Maximum pulse current, I_{DM} at t_{pul}=10 ms	A			6	SSPC1X-2-4-X-X
				15	SSPC1X-5-4-X-X
				30	SSPC1X-10-4-X-X
Residual output resistance in on-state, $R_{DS(on)}$	mΩ			600	SSPC1X-2-4-X-X
				300	SSPC1X-5-4-X-X
				220	SSPC1X-10-4-X-X
Thermal junction-cooler resistance, R_{thjc}	ºC/W			2	SSPC1X-2-4-X-X
				1	SSPC1X-5-4-X-X
				1	SSPCT1X-10-4-X-X
Thermal junction-ambient resistance, R_{thja}	ºC/W		10	12	

Table 4.6 – Basic and maximum permissible electrical parameters of power circuits for modules 6-th class (SSPC1X-XX-6-X)

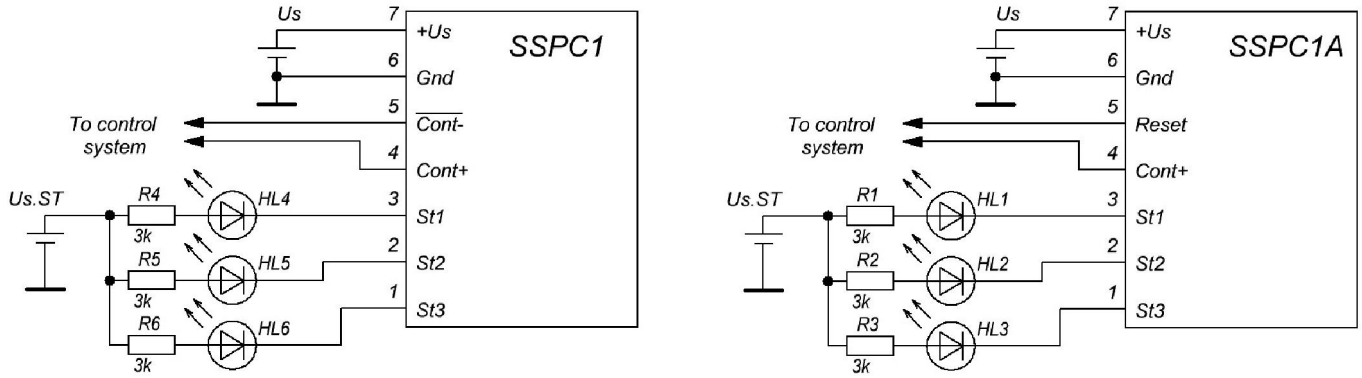
Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, V_{CES}	V			600	
Maximum commutation direct voltage, V_{DC}	V			280	
Limitation voltage of active protection, V_{AC}	V			450	
Leakage current of switching element, Ices	μA			100	
Rated switching current, I_{DC}	A			2	SSPC1X-2-6-X-X
				5	SSPC1X-5-6-X-X
				10	SSPC1X-10-6-X-X
				20	SSPC1X-20-6-X-X
				30	SSPC1X-30-6-X-X
				40	SSPC1X-40-6-X-X
Maximum pulse current, I_{CM} at t_{pul}=10 ms	A			6	SSPC1X-2-6-X-X
				15	SSPC1X-5-6-X-X
				30	SSPC1X-10-6-X-X
				60	SSPC1X-20-6-X-X
				90	SSPC1X-30-6-X-X
				120	SSPC1X-40-6-X-X
Residual output resistance, $V_{CE(on)}$	V		2.5	3.5	
Thermal junction-cooler resistance, R_{thjc}	ºC/W			2	SSPC1X-2-6-X-X
				1	SSPC1X-5-6-X-X
				1	SSPC1X-10-6-X-X
				1	SSPC1X-20-6-X-X
				0.8	SSPC1X-30-6-X-X
				0.7	SSPC1X-40-6-X-X
Thermal junction-ambient resistance, R_{thja}	ºC/W		10	12	

Table 4.7 – Basic and maximum permissible electrical parameters of power circuits for modules of 12-th class (SSPC1X-XX-12-X)

Name	Unit	Value			Note
		min	typ.	max	
Breakdown voltage of switching element, V_{CES}	V			1200	
Maximum commutation direct voltage, V_{DC}	V			540	
Limitation voltage of active protection, V_{AC}	V			800	
Leakage current of switching element, Ices	μA			100	
Rated switching current, I_{DC}	A			2	SSPC1X-2-12-X-X
				5	SSPC1X-5-12-X-X
				10	SSPC1X-10-12-X-X
				20	SSPC1X-20-12-X-X
				30	SSPC1X-30-12-X-X
				40	SSPC1X-40-12-X-X
Maximum pulse current, I_{CM} at t_{pul}=10 ms	A			6	SSPC1X-2-12-X-X
				15	SSPC1X-5-12-X-X
				30	SSPC1X-10-12-X-X
				60	SSPC1X-20-12-X-X
				90	SSPC1X-30-12-X-X
				120	SSPC1X-40-12-X-X
Residual output resistance, $V_{CE(on)}$	V		3	3.5	
Thermal junction-cooler resistance, R_{thjc}	ºC/W			2	SSPC1X-2-12-X-X
				1	SSPC1X-5-12-X-X
				1	SSPC1X-10-12-X-X
				1	SSPC1X-20-12-X-X
				0.8	SSPC1X-30-12-X-X
				0.7	SSPC1X-40-12-X-X
Thermal junction-ambient resistance, R_{thja}	ºC/W		10	12	

5. MODULE CONTROL

It is recommended the following modules switching circuits (see Fig. 5.1).



a) modules SSPC1-XX-XX-X-X b) modules SSPC1A-XX-XX-X-X

Figure 5.1 — Connection scheme of control circuits

The SSPC module status signals can be used both for signaling generation by means of LEDs and status signals forming for its further processing by module control scheme to realize control algorithm.

Modules operation of series SSPC1-XX-XX-X-X

The operation diagram of the series SSPC1-XX-XX-X-X is shown on Figure 5.2. When supplying to the input «Cont+» (Fig. 5.1) of logic unity state, to the «Cont-» input of logic zero state, according to the module states table (see Table 5.1) happens enabling of switching by the power voltage module and in the current starts flowing in the load circuit. The optically isolated state signal St1 switches when exceeding the current value flowing in the module, higher than $0.3I_{nom}$.

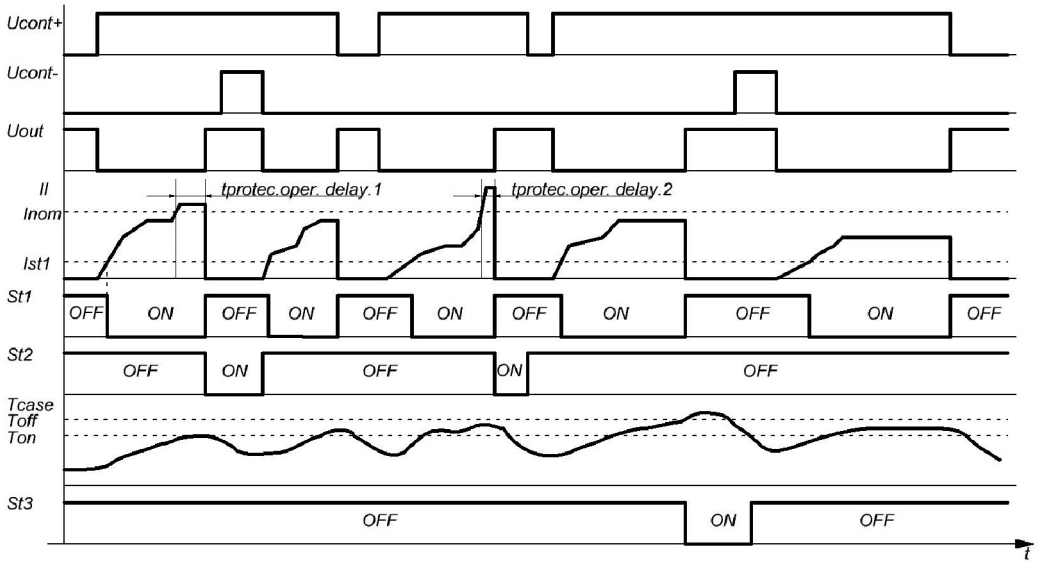


Figure 5.2 — Operation diagram of SSPC1

If the current value is higher than $1.1I_{nom}$ then occurs overload module protection operation or SC with protection operation delay; the value of $t_{prot.oper.del}$ depends on the module overload value in accordance with overload module characteristics shown on Fig. 5.4. On expiration of the time $t_{prot.oper.del}$, the module power transistors will be switched off, optically isolated status signal St2 is switched on.

Table 5.1 — States table of SSPC1-XX-XX-X-X

«Cont+»	«Cont-»	«St1»	«St2»	«St3»	Module state
«0»	«0»	«1»	«1»	«1»	«Off»
«0»	«1»	«1»	«1»	«1»	«Off»
«1»	«1»	«1»	«1»	«1»	«Off»
«1»	«0»	«1»	«1»	«1»	«On», current in load less than $0.3I_{nom}$
«1»	«0»	«0»	«1»	«1»	«On», current in load higher than $0.3I_{nom}$
«1»	«0»	«1»	«0»	«1»	«Off», overload or SC in load
«1»	«0»→«1»→«0»	«1»	«0»	«1»	«Internal reset», restart after current emergency
«1»→«0»→«1»	«0»	«1»	«0»	«1»	«Internal reset», restart after current emergency
«1»	«0»	«1»	«1»	«0»	«Off», overheat of power element
«1»	«0»→«1»→«0»	«1»	«1»	«0»	«Off», overheat of power element
«1»→«0»→«1»	«0»	«1»	«1»	«0»	«Off», overheat of power element

To remove the mode of SC emergency or overload and the module restart it is necessary to reset «Cont+» or «Cont-» signal. If the reasons of current exceeding or load SC are not eliminated then the current protection will repeat until the cause of current protection operation is eliminated.

If the cooler temperature exceeds the overheating protection operation temperature T_{off} equaled to 90…100 ºC, then the power module transistors will be switched off and optically isolated status signal St3 will be switched on. Current switching by module will be permitted at decreasing of the module radiator temperature less than the temperature value of overheating protection release T_{on} equaled to 60...70ºC. The control signal «Cont+» or «Cont-» reset will not lead to overheating blocking release before the radiator temperature decreases below the T_{on} value.

Modules operation of series SSPC1A-XX-XX-X-X

The operation diagram of the series SSPC1A-XX-XX-X-X is shown on Figure 5.3. When supplying the logic unity state to input «Cont+» according to the module's state table (see Table 5.2.) the switching of power voltage by the module will be permitted and the current starts flowing in the load circuit. If the current flowing in the module is more than $0.3I_{nom}$ then the optically isolated status signal St1 will be switched on.

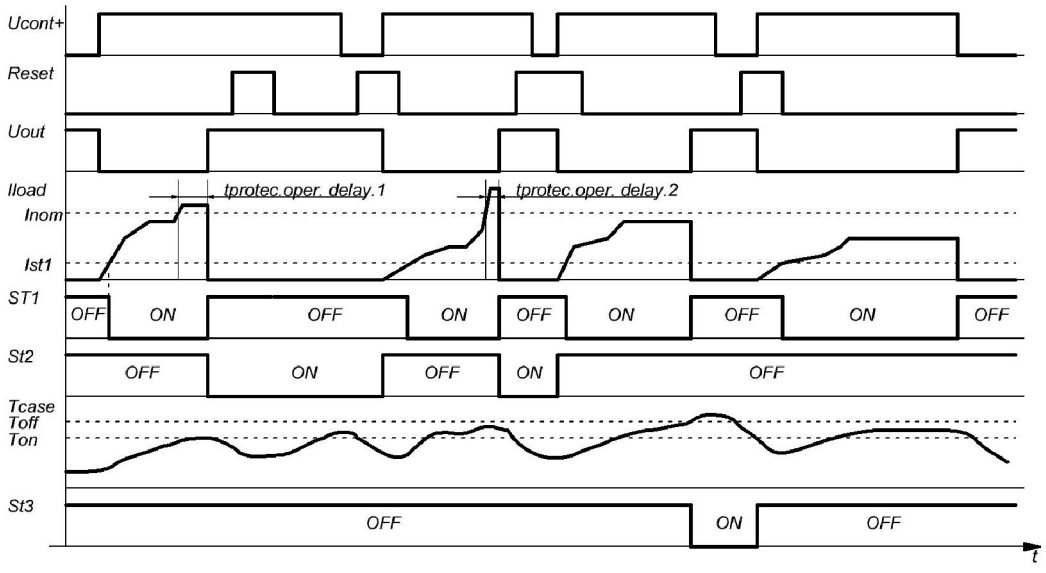


Figure 5.3 — Operation diagram of SSPC1A

If the current value exceeds $1.1I_{nom}$ then occurs overload module protection operation or SC with protection operation delay; the value of $t_{prot.oper.del}$ depends on the module overload value in accordance with the overload module characteristics shown on Fig. 5.4. On expiration of the time $t_{prot.oper.del}$, the module power transistors will be switched off, optically isolated status signal St2 is switched on.

Table 5.2 — States table of SSPC1A-XX-XX-XX-X-X

«Cont+»	«Reset»	«St1»	«St2»	«St3»	Module state
«0»	«0»	«1»	«1»	«1»	«Off»
«0»	«1»	«1»	«1»	«1»	«Off»
«1»	«0»	«1»	«1»	«1»	«On», current in load less than $0.3I_{nom}$
«1»	«0»	«0»	«1»	«1»	«On», current in load more than $0.3I_{nom}$
«1»	«0»	«1»	«0»	«1»	«Off», overload or SC in load
«1»→«0»→«1»	«0»	«1»	«0»	«1»	«Off», overload or SC in load
«1»	«0»	«1»	«1»	«0»	«Off», overheat of power element
«1»	«1»	«1»	«1»	«1»	«On», current in load less than $0.3I_{nom}$
«1»	«1»	«0»	«1»	«1»	«On», current in load more than $0.3I_{nom}$
«1»	«1»	«1»	«0»	«1»	«Off», overload or SC in load
«1»→«0»→«1»	«1»	«1»	«0»	«1»	«External reset», restart after current emergency
«1»	«1»	«1»	«1»	«0»	«Off», overheat of power element
«1»→«0»→«1»	«1»	«1»	«1»	«0»	«Off», overheat of power element

To remove the mode of overload emergency or SC in load it is necessary to set the logic unity state to the input “Reset” and to restart the module on input “Cont+”. If the reason of the current exceeding or load SC is not eliminated then the current protection will repeat until the cause of current protection operation is eliminated.

If the cooler temperature exceeds the overheating protection operation temperature T_{off} equaled to 90…100 ºC, then the power module transistors will be switched off and the optically isolated status signal St3 will be switched on. Current switching by the module will be enabled at decreasing of the module radiator temperature less than the temperature value of overheating protection release T_{on} equaled to 60...70ºC. The control signal «Cont+» or «Cont-» reset will not lead to overheating blocking release before the radiator temperature decreases below the T_{on} value.

Overload characteristics of the module of the series SSPC1 is shown at Figure 5.4. The module protection operation performed strictly in accordance with the overload characteristics: in the «Never trip» module state area the protection will not be active, in the «Always trip» module state area the overload or SC protection will be active.

The diagrams explaining the module current protection operation are shown on Figure 5.5. Several diagrams of the module protection operation depending on the current overload level are combined on each of the figures.

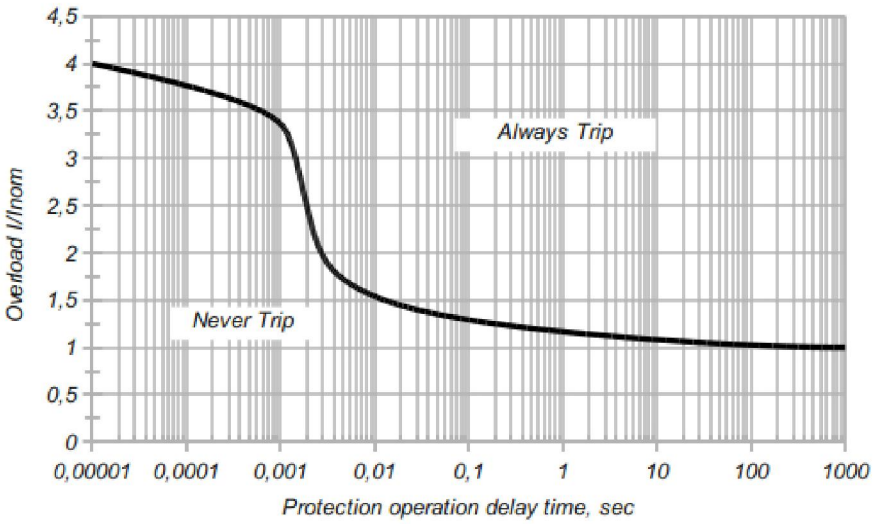


Figure 5.4 — Overload characteristics of SSPC1X-XX-XX-X-X

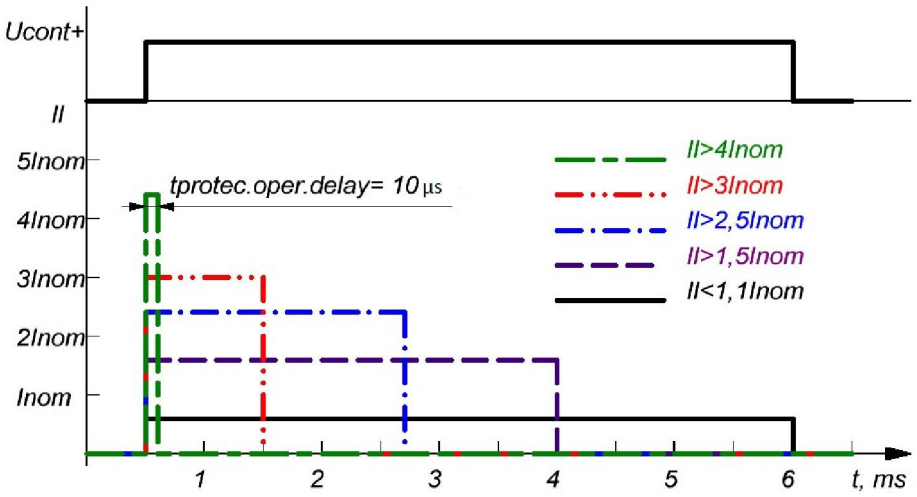


Figure 5.5 — Current protection operation diagram

6. POWER OUTPUTS

The following connection schemes of the module power circuits are recommended (Fig.6.1).

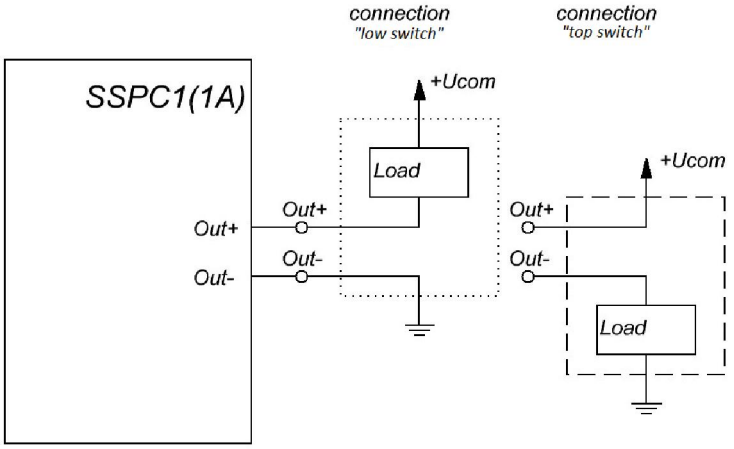


Fig. 6.1 — Connection of module power circuits

The power module part of series SSPC1 is designed in such a way that to withstand all overloads in the permissible range of the overload characteristics shown on Figures 5.4 without power transistors failure. It prevents therewith overheating and failure of the module itself and the connecting cables as well as it prevents flowing of the long-term current in the load which; the current is able to damage the load or load's components.

The SSPC1 module is provided with active limiting voltage protection that is realized using load shunting mechanism by means of a module power switch. Operation diagram of active limiting voltage protection is shown on Fig. 6.2. Switch overvoltage occurs when it is turned off because load which the module operates at has inductive nature. When achieving the voltage value U_{lim} on drain (collector) of power switch relative to source (emitter) the power transistor of the module series SSPC1 will open that prevents voltage increasing on power transistor drain up to U_{bv}; exceeding of U_{bv} can lead to breakdown of the power module part.

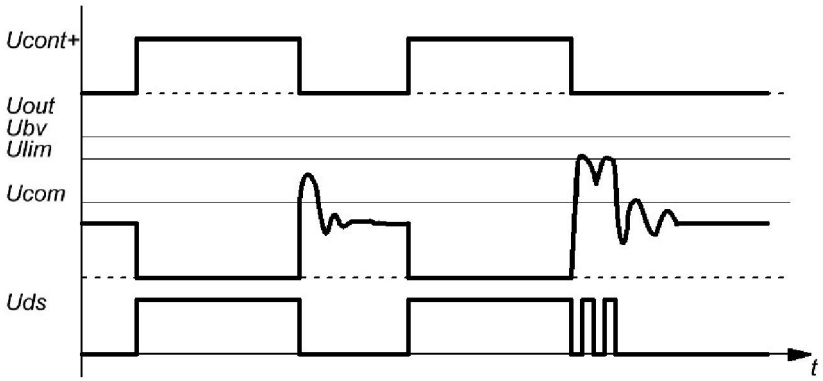


Figure 6.2 —Active protection operation of voltage limitation

7. INSTRUCTIONS FOR USE

Connection to module

The power circuit is mounted to the module using thread terminal. The nuts should tighten with torque (5±0.5) N·m, with obligatory installing of the flat and spring washers included in the package.

The power wires should be connected through the connectors having corrosion-resistant coat, purified from extraneous accretions. The screws should be tightened again in 8 days and in 6 weeks after commencement of the operation. After the screws' tightening the connection should be painted. Afterwards the tightening should be controlled at least once a half year.

The mounting of output contacts, error contacts and supply connection of built-in DC/DC converter is carried out by means of spring terminal blocks of series 385 or a plug FKC 2,5/7-ST-5,08.

When mounting and operating you should assume the measures of module protection against static electricity impact; when mounting the personnel must use the grounding bracelets and grounded low-voltage soldering irons with transformer supply.

Установка модуля

The module is mounted in the equipment to the cooler (chassis, installations magnet frame, metal plates, etc.) in any orientation by means of screws M3 with torque (5.0±0.5) N·m, with obligatory installation of the flat and spring washers. In equipment the module should be located in order to protect it against additional heat from neighboring elements. The planes of cooler ribs should be oriented in the direction of air flow.

The contact area of the cooler should have roughness not more than 2.5 μm and flatness tolerance– not more than 30 μm. The cooler surface should not have any rough edges, honeycombs. No extraneous particles should be between the module and cooler. To improve the heat balance the module installation to mounting area or cooler should be carried out using heat conducting pastes.

On mounting you should provide uniform pressure of the module's base to the cooler. For this purpose you should tighten all the screws uniformly in 2 – 4 motions by turns: first, located on one diagonal, then on the other one. Dismounting the module the screw tightening should be done in the reverse order.

Not earlier than in 3 hours after mounting the screws should be rotated to the end keeping the prescribed torque, because a part of the heat conducting paste under pressure will outflow and the fastening can be released.

You can install the several modules without additional insolating spacers, on condition that voltage between the outputs of different modules will not exceed the minimum value of isolation breakdown voltage of each of them or when the cooler is grounded.

Below you can see Table 7.2 for modules of kind SSPC1, loss power on it and necessary type of the cooler without additional blow-off.

Table 7.2 – Necessary dimensions of cooler for SSPC1 of different types T_{amb} = 25°C

Module name	Loss power at maximum load, max, W	Cooler type
SSPC1X-2-0,6-X-X	0.12	-
SSPC1X-5-0,6-X-X	0.75	-
SSPC1X-10-0,6-X-X	3	-
SSPC1X-20-0,6-X-X	8	HS271-50
SSPC1X-30-0,6-X-X	18	HS271-50
SSPC1X-40-0,6-X-X	16	HS271-50
SSPC1X-2-1-X-X	0.48	-
SSPC1X-5-1-X-X	3	-
SSPC1X-10-1-X-X	6	-
SSPC1X-20-1-X-X	14	HS271-50
SSPC1X-30-1-X-X	18	HS271-50
SSPC1X-40-1-X-X	24	HS271-50
SSPC1X-2-2-X-X	0.8	-
SSPC1X-5-2-X-X	5	-
SSPC1X-10-2-X-X	10	HS271-50
SSPC1X-20-2-X-X	-20	HS271-50
SSPC1X-30-2-X-X	27	HS271-50
SSPC1X-40-2-X-X	32	HS271-50

SSPC1X-2-4-X-X	2.4	-
SSPC1X-5-4-X-X	7.5	HS271-50
SSPC1X-10-4-X-X	22	HS271-50
SSPC1X-2-6-X-X	7	HS271-50
SSPC1X-5-6-X-X	17.5	HS271-50
SSPC1X-10-6-X-X	35	HS271-50
SSPC1X-20-6-X-X	70	HS271-110
SSPC1X-30-6-X-X	105	HS271-110
SSPC1X-40-6-X-X	140	HS271-150
SSPC1X-2-12-X-X	7	HS271-50
SSPC1X-5-12-X-X	17.5	HS271-50
SSPC1X-10-12-X-X	35	HS271-50
SSPC1X-20-12-X-X	70	HS271-110
SSPC1X-30-12-X-X	105	HS271-110
SSPC1X-40-12-X-X	140	HS271-150

For the module with loss power less than 7 W it is allowed their operation without installing to the cooler.

The smaller dimensions of the cooler are allowed if the module operates at load that is lower than the maximum one or if forced cooling is provided.

Service requirements

The module should be operated in conditions of exposure to mechanical loads in accordance with Table 7.3.

Table 7.3 – Exposure of mechanical loads

External exposure factor	External exposure factor value
Sinusoidal vibration: - acceleration, m/s^2 (g); - frequency, Hz	 150 (15) 0.5 - 100
Mechanical shock of repeated action : - peak impact acceleration , m/s^2 (g); - duration of impact acceleration, ms	 40 (4) 50
Linear acceleration, m/s^2 (g)	5000 (500)

The module should be operated in conditions of climatic loads exposure in accordance with Table 7.4.

Table 7.4 – Exposure of climatic loads

Climatic factor	Climatic factor value
Low temperature of environment: - operating, °C; - maximum, °C	 - 40 - 45
High temperature of environment: - operating, °C; - maximum, °C	 + 85 + 100
Relative humidity at temperature 35 °C non-condensing %, max	 98

Safe requirements

1. Operation with the module should be carried out only by qualified personnel.
2. Do not touch the power outputs if the supply voltage is fed.
3. Do not connect or disconnect wires and connectors while on the power circuit is energized.
4. Connect the oscilloscope probe only after removal of the power voltage and discharge of filter capacity.
5. If the radiator is not grounded, do not touch it, if the module is energized.
6. Do not touch the radiator or discharge resistance, because its temperature can be very high.
7. Do not spray the module with water and other liquids.

8. RELIABILITY REQUIREMENTS

Manufacturer guarantees quality conformance of modules when compliance by the consumer's storing, mounting and operating conditions, as well as application references specified in the user's manual.

The operating warranty is 2 years from the acceptance date, in the case of requalification – from the date of the requalification.

Reliability probability of the module 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.

9. OVERALL AND CONNECTING DIMENSIONS

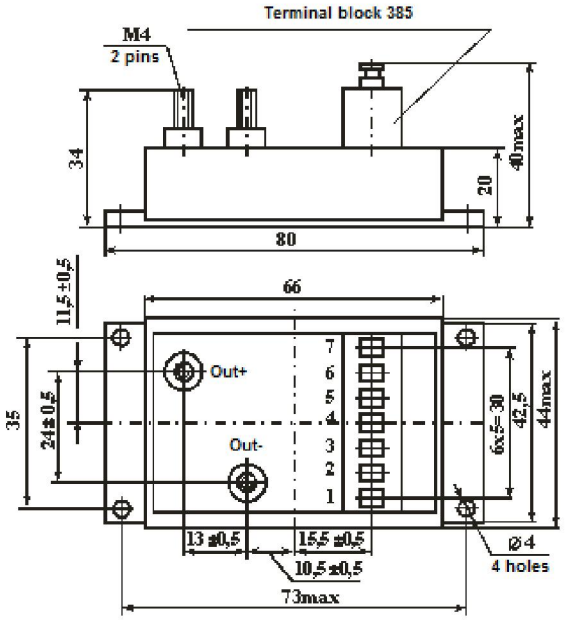


Fig. 9.1a – without version

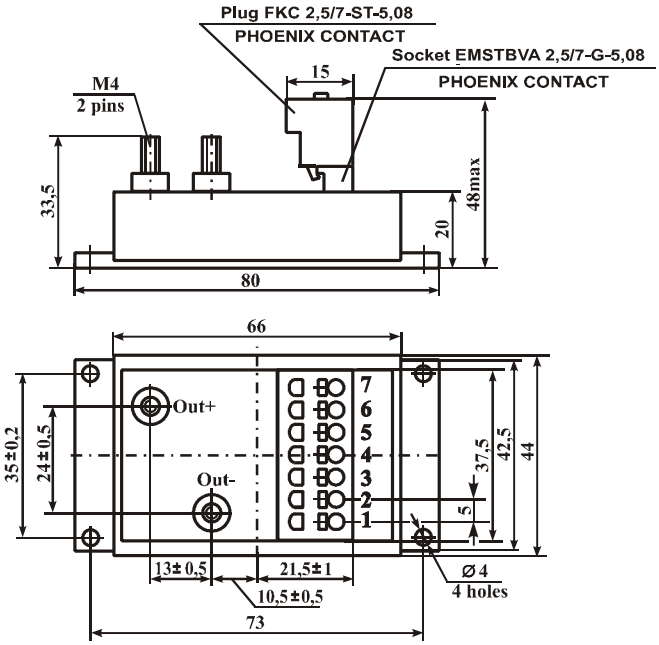


Fig. 9.1b – design version 02

Figure 9.1 – Overall and connecting dimensions

Precious metals are not contained.

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