THREE-PHASE POWER REGULATOR DRIVER
3phPRD-A1, 3phPRD -A2, 3phPRD -A3, 3phPRD -A4, 3phPRD -A5
3phPRD -B1, 3phPRD -B2, 3phPRD -B3, 3phPRD -B4, 3phPRD -B5

TECHNICAL DESCRIPTION

Three-phase power regulator driver 3phPRD (hereinafter – 3phPRD) is intended for controlling of thyristor module with three pairs of opposite-parallel connected thyristors with optoelectronic decoupling MO26D, three thyristor modules with two opposite connected thyristors with optoelectronic decoupling MO8D or six opto thyristors. It provides in common with them the building of three-phase power regulator.

The module uses phase method of power regulation in three-phase DC network, so change of AC load voltage effective value is performed by on state time change of one of opposite-parallel connected thyristors, during half-period of network frequency.

Action and functions of 3phPRD nodes are shown at Figure 1.

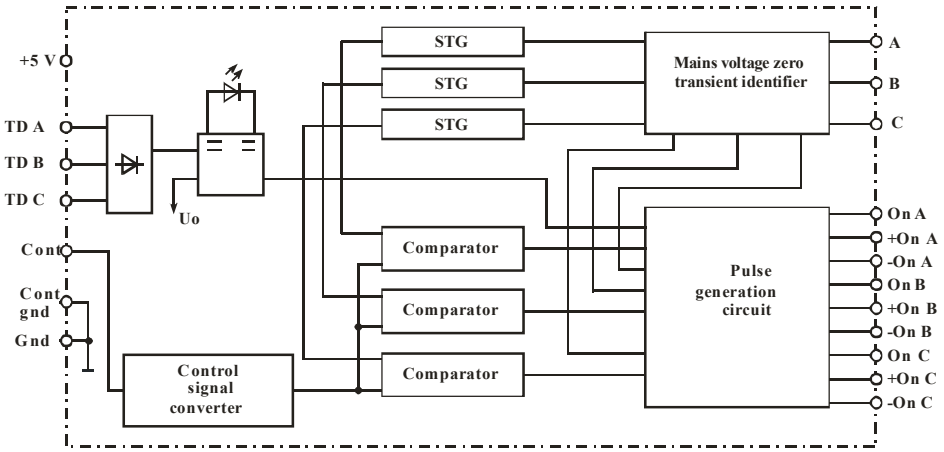


Figure 1 – 3phPRD functional circuit

Voltage zero transient identifier (VZTI) forms pulses during line voltage zero transient, which synchronize sawtooth generator (STG). In comparator (C) voltage STG and control signal voltage U_{cont} are compared, this signal is received from input signal converter circuit. When STG will reach value U_{cont}, pulse of input thyristor connection is generated. Changing the control signal value, equality of TVG and U_{cont} is varied and, accordingly, thyristor connection phase. Thereby you reach load voltage regulation.

The transformer is provided for smooth launch mode of supply turn-on and overload, which eliminates transformer big initial inrush current. The driver is provided for current inputs of current sensor connection that ensures modules' protection MO8D, MO26D or opto thyristors against overload. When instantaneous value of load current is reached Im= 1.41·Icom.rms 3phPRD will transfer into state "Overload", status LED changes section color from green to red, at thyristor control outputs the signals that correspond to zero load power are formed. In 300 ms protection will be removed. Section color of status LED becomes green, at thyristor control outputs the signals are formed that perform smooth launch from zero load power, which is determined by control signal value.

If emergency situation is not eliminated then the above described process continues until the failure is removed. There is a ten-position switch (0-9) under 3phPRD cover that allows setting necessary protection operation current when 3phPRD break-in. it is necessary to take off the 3phPRD cover and set the switch to the necessary position (when delivering to the consumer the switch is set to "0")

The driver is made in two versions for two protection operation current ranges in accordance with Table 4.

Functional purpose of outputs is shown in Table 1.

Table 1 – Functional purpose of 3phPRD outputs

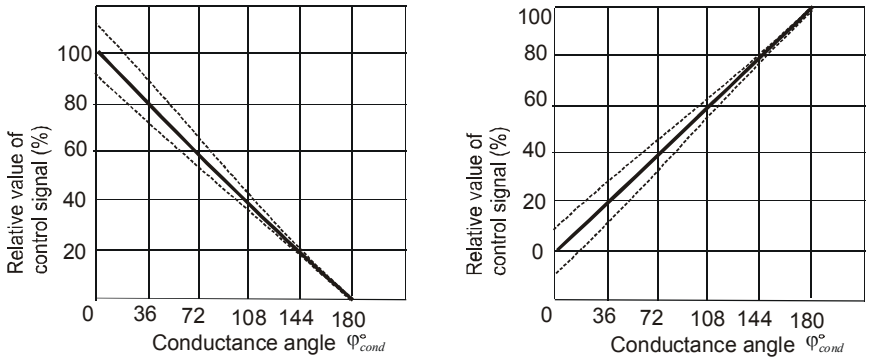
Connector	Outputs number	Symbol	Purpose
XS1	1	Cont.gnd	«Minus» of control signal
	2	Cont	Control signal input
	3	+5 V	Supply voltage +5 V
	4	Gnd (-5 V)	Ground «minus» of supply circuits

XS2	1	A	Phase inputs of AC power circuit
	2	B	
	3	C	
XS3	1	On.A	Connection output of phase A
	2	-On.A	Thyristor of negative half-wave connection input of phase A
	3	+On.A	Thyristor of positive half-wave connection input of phase A
	4	On.B	Connection output of phase B
	5	-On.B	Thyristor of negative half-wave connection input of phase B

XS3	6	+On.B	Thyristor of positive half-wave connection input of phase B
	7	On.C	Connection output of phase C
	8	-On.C	Thyristor of negative half-wave connection input of phase C
	9	+On.C	Thyristor of positive half-wave connection input of phase C
XS4	1	TD. A	Connection output of current sensor A
	2	TD. B	Connection output of current sensor B
	3	TD.C	Connection output of current sensor C

Allowable value of on state repetitive pulse voltage of power transistors is 1200 V, providing product reliability at over-voltage and depending on load characteristic.

Control signal converter depending on version 3phPRD, transforms control signal of five types (0…5 V; 0…10 V; 0…5 mA; 0…20mA; 4…20 mA) to signal «U_{cont}» for two types of control characteristic. Thyristor conductance angle (time, during which thyristors conduct current) versus relative value of control signal is shown at Figure 2.



A – 100% control signal corresponds to zero power;
B– 100% control signal corresponds to total power.

Figure 2 – Control characteristic types

Basic characteristic of input circuits are represented in Table 2. Basic characteristic of output circuits are represented in Table 3.

Table2 – Basic characteristic of input circuits

Characteristic name		Unit	Types of input circuits										Note
			A-1	A-2	A-3	A-4	A-5	B-1	B-2	B-3	B-4	B-5	
Basic electric characteristic													
1 Current consumption, Is, max		mA	120										U_s = 5 V
2 Input current «A», «B», «C» rms, Iin.rms		mA	7										U_{in} = ~380V
3 Control signal value when zero power		V	5±0.5	10±1	-	-	-	0÷0.5	0÷1	-	-	-	
		mA	-	-	20±2	5±0,5	20±2	-	-	4±0.4	0÷0.5	0÷2	
4 Control signal value at total power		V	0÷0.5	0÷1	-	-	-	5±0.5	10±1	-	-	-	
		mA	-	-	4±0.4	0÷0.5	0÷2	-	-	20±2	5±0.5	20±2	
5 Input circuit resistance of control signal, Rin		kΩ	≥10	≥10	-	-	-	≥10	≥10	-	-	-	
Maximum permissible values of basic characteristic													
1 Supply voltage, Us	min	V	4.5										
	max	V	5.5										
2 Input voltage «Cont», Uin	max	V	6	12	2	2	2	6	12	2	2	2	
3 Peak value of inputs «A», «B», «C», Uin.peak	max	V	1200										tp = 10 ms

4 Effective value of line voltage on inputs «A», «B», «C», Uin.lin	min	V	50	
	max		500	
5 4 Output pulse current, Iout. pul, min	min	A	1 10	$t_p \le 1$ ms $t_p \le 100$ μs

Table 3 – Maximum permissible values of output circuit characteristic

Characteristic name		Unit	Characteristic	Note
1 Output current «On.A», «-On.A», «+On.A», «-On.B», «+On.B», «On.B», «-On.C», «+On.C», «On.C», Iout	max	mA	100	
2 Operating temperature range, T_{oper}		°C	0…+80	

3phPRD overall drawing is shown at Figure 3.

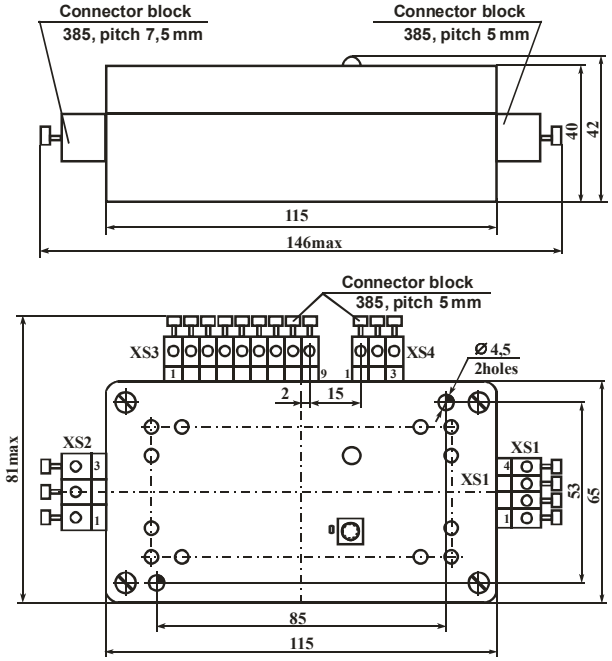


Figure3 – 3phPRD overall drawing

Notation: $\frac{\text{3phPRD}}{1} - \frac{\text{A}}{2} - \frac{1}{3} - \frac{\text{CP1}}{4}$

1 Name of three-phase power regulator driver
2 Control characteristic:
A – 100% control signal corresponds to zero power;
B – 100% control signal corresponds to total power.
3 Control signal type:
1 - 0…5 V;
2 - 0…10 V;
3 - 4…20 mA;
4 - 0…5 mA;
5 - 0…20 mA.
4 Current protection:
CP1 – over the range 20 to 200 A;
CP2 – over the range 200 to 380 A.

Application recommendations

3phPRD connection circuit to load circuit is represented at Figures 4 – 6.

3phPRD should be mounted as close as possible to the controlled bridge, but not to the cooler, which it is located on. When mounting it is not permitted to lay field line wires and controlled circuits in one bundle or common tube (housing). Avoid loops in connecting wires of control and supply circuits. Connecting control wires for noise immunity support should be made by twisted pairs.

Driver is commuted by current sensors with current transmission coefficient 1:2000. If the current sensors are different from the recommended ones you should ensure input current of inputs TD.A, TD.B and TD.C in accordance with Table 4.

Table 4

Switch position		0	1	2	3	4	5	6	7	8	9
Version I	Load protection operation current, A	20	40	60	80	100	120	140	160	180	200
	Input load protection operation current of inputs TDA, TD.B, TD.C, mA	14	28	42	56	70	84	98	112	126	140
Version II	Load protection operation current, A	200	220	240	260	280	300	320	340	360	380
	Input load protection operation current of inputs TD.A, TD.B, TD.C, mA	140	154	168	182	196	210	224	238	252	266

Attention! For correct functioning of driver protection and current protection it is necessary to follow strictly phase connection to the driver and winding connection polarity of current transformer (TD) in accordance with Figures 4, 5 and 6.

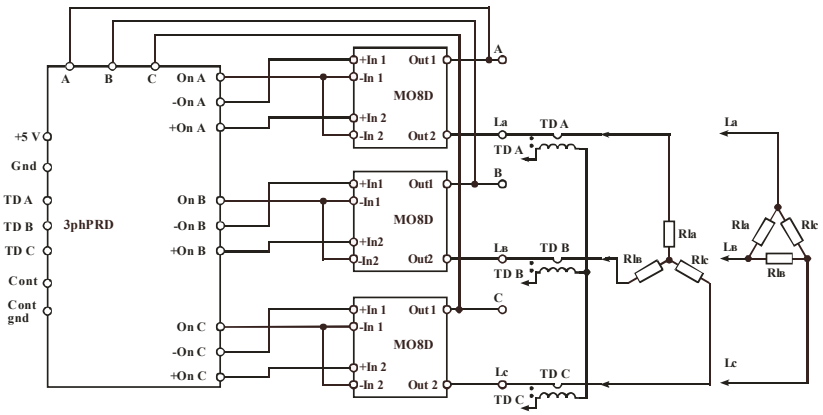


Figure 4 – Connection circuit to 3phPRD load together with three modules MO8D

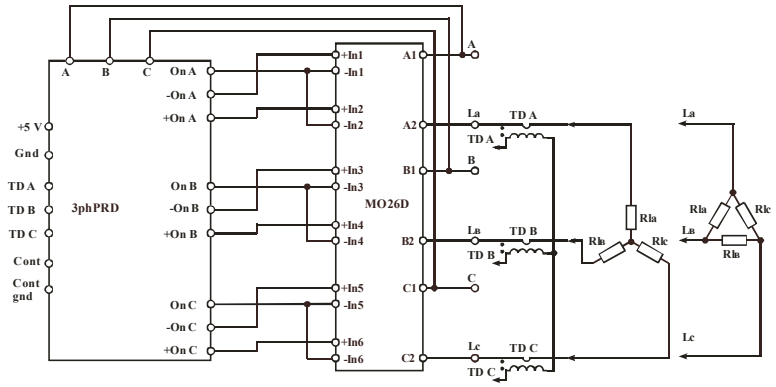
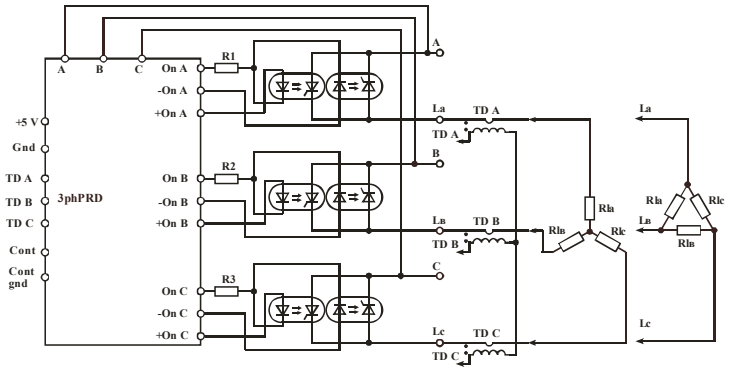


Figure 5 – Connection circuit to 3phPRD load in common with module MO26D



R1= R2= R3 and formula calculated $R = \frac{5}{I_{\Delta}}$, where I_{Δ} - LED current of optoelectronic coupler

Figure 6 – Connection circuit to 3phPRD load in common with six optothyristors

SUPPLY SET

1. Driver _____ _____ pcs
2. Current sensor 1:2000±2% _____ _____ pcs

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