BRUSHLESS DC COMMUTATOR MODULE BDCCM USER'S MANUAL

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CONTENTS

1 PURPOSE AND FUNCTIONS

Brushless DC commutator module (hereinafter – BDCCM or module) is intended for control signals of inverters transistor formation for DC commutator module control. BDCCM is designed on the basis of microelectronics, digital-to-analogue integral circuits and digital-to-analogue signals with in-built PWM-circuits processing controllers modern technologies achievements, digital-to-analogue integral circuits and controllers of digital and analogue signals processing with inbuilt PWM circuits. BDCCM has the following functions and abilities:

- Power inverter control signals converters;
- Controlled motor start/stop;
- Motor shaft rotation direction change;
- Speed regulation;
- Electro motor current overloads and SC protection;
- Current protection operating threshold regulation;
- Internal signalization about accident conditions;

BDCCM is characterized with operation simplicity and small size. BDCCM is produced in different control variants what enables to use the module for common industrial problems and private cases.

2 PRODUCED MODULES

BDCCM is produced in the different control types. Recommended modules connection circuits depending on the design are represented in Section 5.

Control types:

"A"- standard with PWM. Digital-to-analogue control with all standard controlled module connection terminal with in-built PWM- generator circuit.

"B"- simplified with PWM. Control variant with in-built PWM-generator circuit which enables to realize operation permission/ prohibition choice and motor shaft rotation direction choice by single switch what is convenient for the module use in lifting- traction mechanisms.

"C"- bipolar with PWM. Control with in-built PWM-generator circuit is realized using one input or with the help of digital-to-analogue converter or with the corresponding specifically connected variable resistor. Control voltage lies in the range -10...+10 V with braking range -0.5...+0.5 V. Rotation speed is defined by voltage amplitude and rotation voltage is defined by its polarity.

"D"- digital with PWM. The module contains PWM which enables to realize speed control with the help of digital code. The module can be controlled according to standard control circuit (type "A"); control variant choice is realized by presence or absence of jumper (see Section 5). There is an internal PWM- generator in the module.

"E"- standard without PWM. Control algorithm doesn't differ from type "A" despite the fact that the module doesn't contain PWM- generator. External connection of time-setting circuit for PWM- generator, feedback connection is needed for module operation. Modules variants without internal PWM- generator can be convenient for difficult private case solution and for specific speed feedback connections realization.

"F"- simplified without PWM

"G"- bipolar without PWM

"H"- digital without PWM.

For example, module BDCCM - C: brushless DC commutator module with control variant "C"

Modules variants are referred only to its control, output signals parameters (amplitude "log.1" and "log.0" and as well as load capacity) for all the modules are not changed.

3 GENERAL MODULE DESCRIPTION

BDCCM block scheme is shown at Figure 3.1.

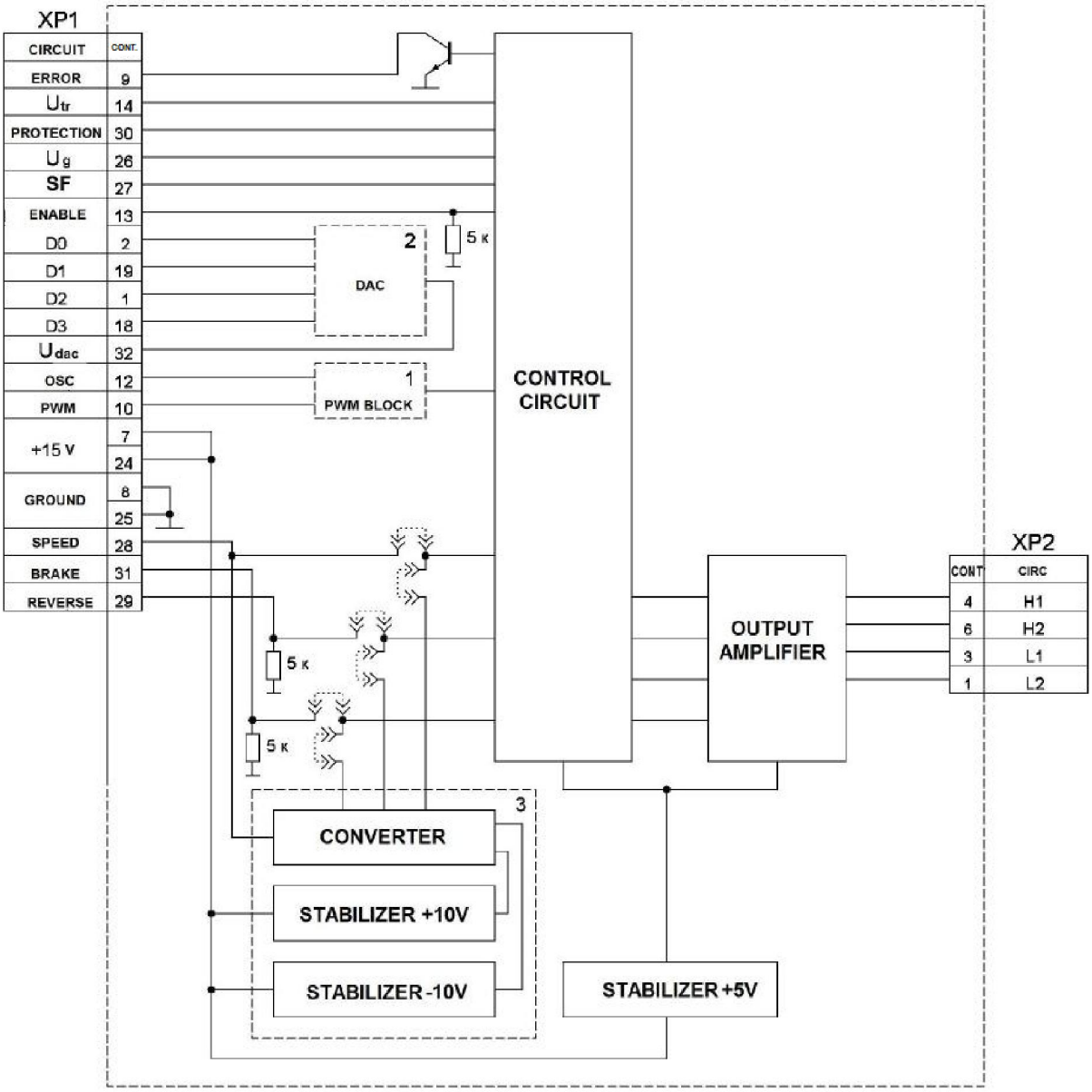

Figure 3.1 – BDCCM block scheme

«1» - internal PWM-generator circuit, that is installed for «A», «B», «C», «D» control types.

«2» - internal DAC that is installed for «D», «H» control types.

«3» - control circuit that is part of BDCCM for «C» and «G» control types (bipolar control).

XP1 connector is two lines of contacts PLS-15 with corresponding part of PBS-15 type. XP2 connector – one line of PLS-6 contacts. XP1 socket outputs purpose and purpose of power outputs are shown in Tables 3.1 and 3.2.

Table 3.1 –XP1 socket outputs purpose

Number	Symbol	Purpose	Control							
				B	C	D	E	F	G	H
1	D2	Second rate of speed control digital input	-	-	-	+	-	-	-	+
2	D0	Zero rate of digital speed control	-	-	-	+	-	-	-	+
3		Not involved								
4		Not involved								
5		Not involved								
6		Not involved								
7	+15V	Supply voltage output	+	+	+	+	+	+	+	+
8	Ground	Ground	+	+	+	+	+	+	+	+
9	Error	Output of module operating disable signal	+	+	+	+	+	+	+	+
10	PWM	PWM commutator inverting input	-	-	-	-	+	+	+	+
11		Not involved								
12	Osc.	Connection input of PWM generator timing elements	-	-	-	-	+	+	+	+
13	Enable	Enable and disable input of module operation	+	+	+	+	+	+	+	+
14	U_{tr}	Transfer voltage source	+	+	+	+	+	+	+	+
15		Not involved								
16	D3	Third rate of speed control digital input	-	-	-	+	-	-	-	+
17	D1	First rate of speed control digital input	-	-	-	+	-	-	-	+
18		Not involved								
19		Not involved								
20		Not involved								
21		Not involved								
22	+15V	Supply voltage output	+	+	+	+	+	+	+	+
23	Ground	Ground	+	+	+	+	+	+	+	+
24		Not involved								
25	FB	Input of speed feedback	-	-	-	-	+	+	+	+
26	Speed	Motor shaft rotation speed control input	+	+	+	+	+	+	+	+
27	Reverse	Motor shaft rotation control input	+	+	-	+	+	+	-	+
28		Not involved								
29	Braking	Braking input	+	+	-	+	+	+	-	+
30	U_{dac}	Output of speed digital control	-	-	-	+	-	-	-	+

Table 3.2 –XP2 socket outputs purpose

Number of contact	Symbol	Purpose
1	L3	Control output of phase 2 lower switch
2		Not involved
3	L1	Control output of phase 1 lower switch
4	H1	Control output of phase 1 upper switch
5		Not involved
6	H2	Control output of phase 2 upper switch

For convenience of control circuits connection at Figure 3.2 is shown schematic look of BDCCM module XP1 socket.

15					10									1
	U_{tr}	Enable	Osc		PWM	Error	Ground	+15V					D0	D2
U_{dac}	Braking		Reverse	Speed	SF		Ground	+15V					D1	D3
30					25									16

Figure 3.2 – Appearance of XP1 socket.

4 BASIC CHARACTERISTICS

Basic electric characteristics and maximum allowable electric characteristics of the modules BDCCM at 25 ^{0}C are represented in Tables 4.1

Table 4.1 – Basic and maximum permissible electric parameters

Function	Unit	Rate			Note
		min	type	min	
Supply characteristics					
Supply Voltage	V	13.5		16.5	
Current Consumption	mA			100	U_c=15 V
Input characteristics					
Current Consumption at Inputs	mA	0.1		1	
Control Voltages Range	V	-0.3		5.2	
Low Level Input Voltage	V	-0.3		0.5	For logic inputs
High Level Input Voltage	V	2.4		5.2	For logic inputs
Voltage Relevant to braking	V		1.2		
Voltage Relevant to maximum speed	V		4.5		
PWM generator characteristics					
PWM Generator Frequency	kHz	15		25	
Maximum Saw Tooth Voltage	V	4.2		4.6	
Minimum Peak Saw Tooth Voltage	V	1.0		1.2	
Output parameters					
Maximum Voltage at «Error» Output	V			20	
Maximum Current at «Error» Output	mA			20	
Output «Error» Delay Activation	μs			2	
Low Level Voltage at Outputs H1, H2, L1, L2	V	-0.3		0.5	
High Level Voltage at Outputs H1, H2, L1, L2	V	2.4		4.7	
Maximum Output current at outputs H1, H2, L1, L2	mA			10	
Voltage at Output «U_{tr}»	V	6.25	6.5	6.75	Without load
Maximum Load Current at Output «U_{tr}»	mA			10	

5 MODULE CONTROL

In dependence on the module control type we recommend the following turn-on circuits (Fig.5.1 – 5.4).

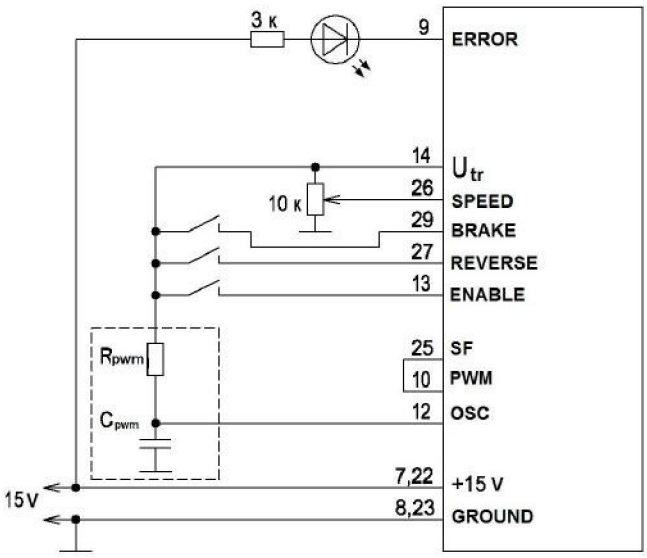

Figure 5.1 – Turn-on circuits of control circuits of BDCCM «A» and «E»

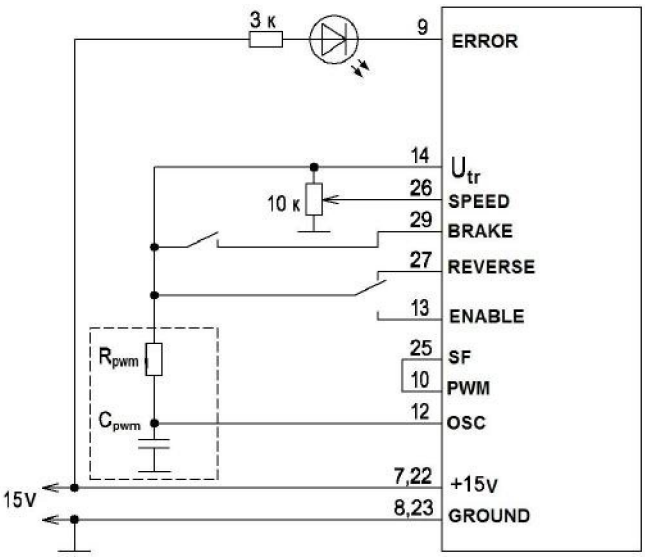

Figure 5.2 – Turn-on circuits of control circuits of BDCCM «B» and «F»

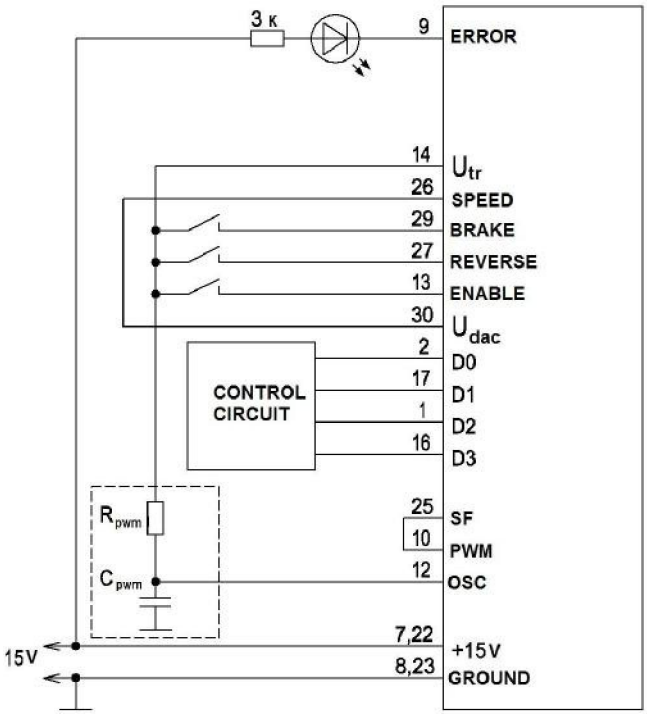

Figure 5.3 – Turn-on circuits of control circuits of BDCCM «E» and «G»

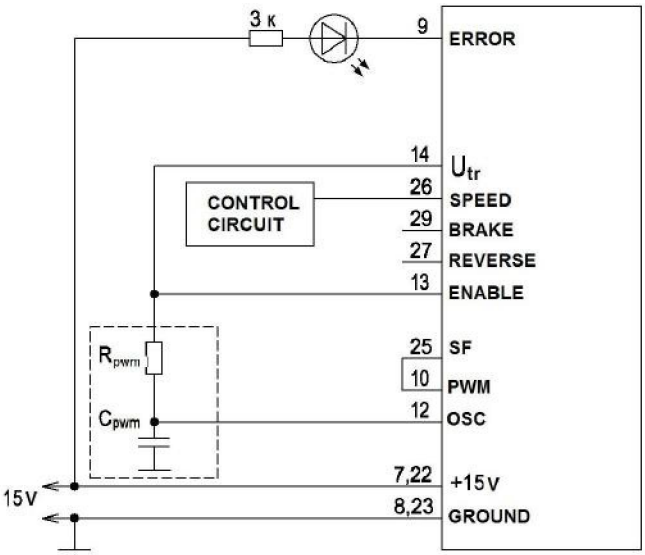

Figure 5.4 – Turn-on circuits of control circuits of BDCCM «C» and «H»

Circuit part is marked by dotted line that is necessary for modules turn-on without in built PWM generator («E», «F», «G», «H» types). For the modules with inbuilt PWM-generator the marked outputs should not be activated.

At Figure 5.2 is shown the connection circuit of the module with «B» or «F» control type with common switcher to «Reverse» and «Enable». Module operation disabling will be only in case of switch opening with the both contacts. «B» and «F» control types also can be controlled by circuits of «A» and «E» types.

It is allowed using a TTL-level logical control instead of the switches.

Motor control by BDCCM provides by the following outputs:

«Enable». TTL-level input that indicates enable or disable for control circuits operating. «Log.1» is relevant to enable, «Log.0» is relevant to disable. At operation disable the «Error» output transistor will be opened (see table 1).

«Braking». TTL-level input that turn-on or turn-off braking mode. Will be no braking If «Log.0». At sending of «Log.1» to current input all low inverter transistors will be opened and motor will change to a mode dynamic braking (see table 5.1).

«Reverse». TTL-level input that vector motor shaft rotation direction. Rotation changing provides by switching of module phases upper transistors. At switching of rotation direction is recommended firstly to send braking signal (or to take off «Enable» signal to stop motor by runout) as when braking by connection at opposition the motor can fall out.

«Speed». Motor shaft rotation speed running. Controlling range is between 1,5...4,5 V. Dependence of motor shaft rotation speed from voltage at input «Speed» is shown t Fig. 5.5 and 5.6 (for «C» and «G» control types) .

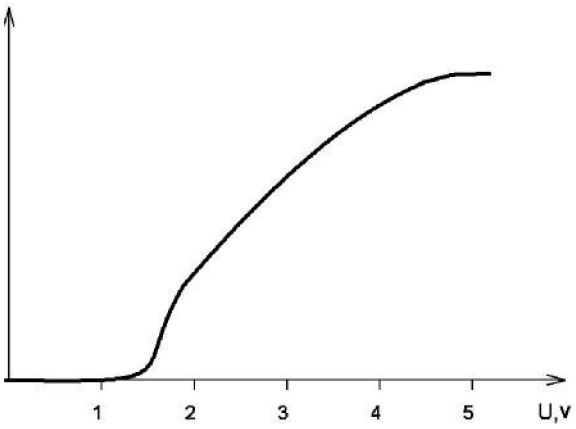

Figure 5.5 – Dependence of motor shaft rotation speed from voltage at output «Speed»

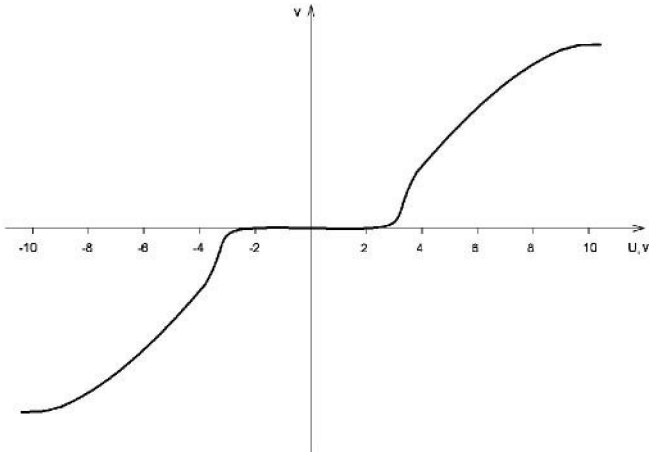

Figure 5.6 – Dependence of motor shaft rotation speed from voltage at output «Speed» for «C» and «G» control types.

For «C» и «G» types the motor control is provided only by the output «Speed»; the outputs «Reverse» and «Brake» are not used. The output «Enable» can be connected to «U_{tr}» when current output will not influence to module operation. If to connect «Enable» output to «U_{tr}» with switch, the control by current output will be provided the same way as for different control types.

Motor rotation direction is chosen on the assumption of signal at «Speed» output, braking mode (all lower switches are open) that is relevant to voltage of - 0.5...+ 0.5 V, rotation speed is regulated by voltage level (10...+10 V). Diagram that explains module operation with «C» and «G» control types that is shown at Fig. 5.7.

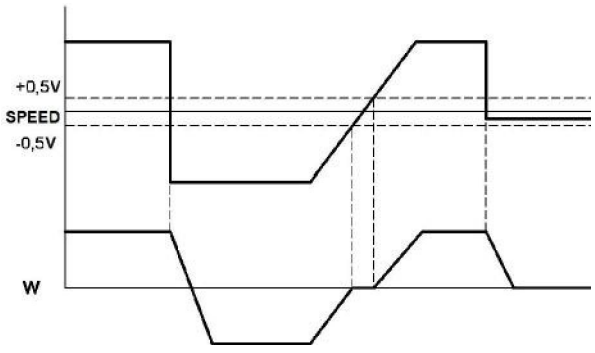

Figure 5.7 – Module control by «C» and «G» control types

Below there is table with module states at control by DC collector motor.

Table 5.1 – Modules state types at controlling of collector DC motor.

Inputs			Protection	Outputs			Note
				Ph1	Ph2	Error 2	
Reverse	Enable	Brake					
1	1	0	0	1	0	1	p.1
0	1	0	0	0	1	1	p.1
X	1	1	0	0	0	1	p.2
X	0	1	0	0	0	0	p.3
X	0	0	0	-	-	0	p.4
X	1	0	1	-	-	0	p.5

p.1	At «Ph1» outputs («L1» and «H1» outputs), «Ph2» («L2» and «H2» outputs) high level (1) means connection to «+», low level (0) – connection to «–» (common minus).
p.2	At high level (1) at «Enable» and «Brake» inputs – «Ph1», «Ph2» outputs are connected to «-» (common minus), motor winding outputs are closed, braking electromagnetic force (dynamic braking) is created by this.
p.3	If at input «Enable» the low level (0), and at input «Brake» - high level (1), outputs «Ph1», «Ph2» are in the mode of dynamic braking; is built by circuit with open collector the «Error» output has active low level (0).
p.4	If at «Enable» and «Brake» inputs are low level (0) - «Ph1», «Ph2» outputs are turned-off; at output «Error» is low level (0).
p.5	At current level (that is consumed from external source) is higher predetermined limit – outputs «Ph1», «Ph2» are turned-off; at output «Error» is low level (0).

Where X is any output state.

«Error». Output that signals about module operation disable («log.0» at outputs «Enable» or «log.1» at «Protection» output), that is a transistor open collector of protection circuits. Note for this output operation is shown in Table 5.1.

«Utv». Transfer voltage source output (6.5V+5%) with maximum output current of 10 mA. Take care when connecting current output to avoid current overload or short circuit because module can fall out in such case.

«+15V». Module supply input with current consumption 40...80 mA (in dependence from control type from ambient temperature) without external load.

«PWM» and **«FB».** Motor shaft speed rotation stabilization inputs. The outputs are used only for «E», «F», «G», «H» control types; for «A», «B», «C» и «D» feedback is set in the module circuit and cannot be adjusted. If the feedback is not required the current outputs should be connected (Fig. 5.1 – 5.4). Module usage variant in feedback closed loop mode is shown at Fig. 5.8. Pulse signal that similar to speed level (tachometer signal), can be received from any sensor (optic one, Hall one, etc.) with signal level (0...6.5)V.

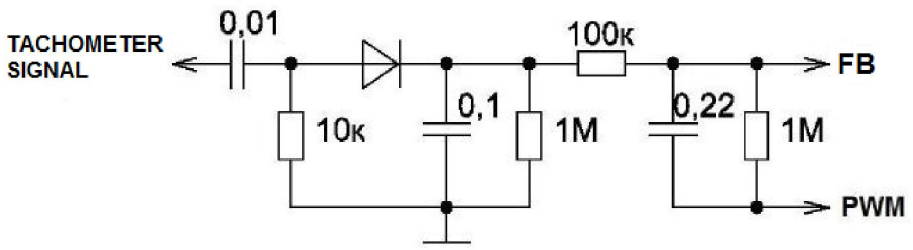

Figure 5.8 – Feedback connection circuit by speed

Feedback deep and correctness of its work at different motor shaft rotation speed must be regulated by capacitor proportion 0.01 μF and resistor of 10 kΩ or capacitor proportion of 0.22 μF and resistor of 100 kΩ.

«Osc.». The input that is intended for connection of time-setting circuit for the inbuilt PWM-generator. Recommended connection circuit of current input is shown at Fig. 5.1 – 5.4. Frequency that is set by the external

RC-circuit must be in the ranges 15...50 kHz. Frequency dependence versus resistor nominal and capacitor is shown at Figure 5.9.

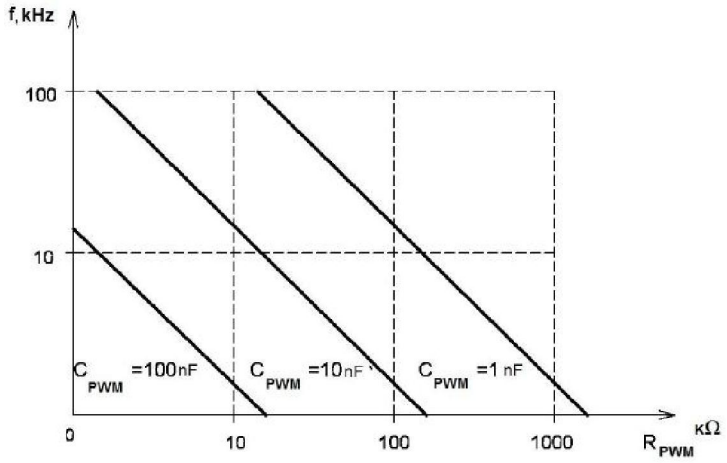

Figure 5.9 – Dependence PWM frequency versus nominal R_{pwm} and C_{pwm}

To receive more linear character of motor shaft rotation speed changing from voltage control that is recommended to install a current source 0.5 ... 5 mA instead of R_{pwm} resistor in dependence from the required PWM frequency.

Output is used only for «E», «F», «G», «H» control types.

«D0», «D1», «D2», «D3». TTL-level inputs of internal DAC. Motor shaft rotation frequency will be changed from combination of 1.5V at DAC output (output «U_{dac}») up to combination corresponding to 4.5V. The outputs are used only for «D» and «H» control types.

«U_{dac}». Internal DAC output. To connect control with DAC is necessary to connect output with «Speed» output as it is shown at Fig. 5.3. Input code value is changed from 0000 to 1001; it leads to step changing of speed level from 0% up to 90% preliminarily by 10%. Input code values from 1010 to 1111 correspond to 100% speed level.

Input is used only for «D» and «H» control types.

«L1», «L2», «L3», «H1», «H2», «H3». Module control circuits outputs of TTL-level module with load possibility up to 10 mA to one output.

6 SERVICE INSTRUCTIONS

The module is intended for exploitation without a cooler.

The module should only be used in exposure to mechanical loads in accordance with Table 6.

Table 6.1 – Impact of mechanical loads.

External exposure factor	External exposure factor value
Sinusoidal vibration: - acceleration, m/s2 (g); - frequency, Hz	 100 (10) 1 - 500
Mechanical shock of repeated action : - peak impact acceleration , m/s2 (g); - duration of impact acceleration, ms	 400 (40) 0.1 – 2.0
Linear acceleration, m/s2 (g)	5000 (500)

The module should be used under the influence of climate stresses in accordance with Table 6.2

Table 6.2 – Climatic loads impact

Climatic factor	Value of climatic factor
Low temperature of environment: - operating, °C; - maximum, °C	 - 40 - 45

High temperature of environment: - operating, °C; - absolute, °C	 + 85 + 100
Relative humidity at temperature 35 °C non-condensing %, max	98

Module outputs are intended for mounting to printed board by soldering or by bolt connector. Maximum number of resoldering during assembly operations is 3. Soldering of outputs must be done at temperature not higher than 235°C. Soldering process duration is not more than 3 seconds.

During its mounting and exploitation is necessary to protect module from impact of static voltage; during mounting is necessary to use grounding strap and grounding low voltage soldering machines with supply through transformer.

7 RELIABILITY SPECIFICATIONS

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 γ = 90 %.

Gamma-percent service life of the modules, subject to cumulative operating time is no more than gamma-percent life, no less than10 years, when γ = 90 %.

Gamma-percent storage-ability time of the modules, when γ = 90 % and storing – 10 years.

8 OVERALL AND CONNECTING DIMENSIONS

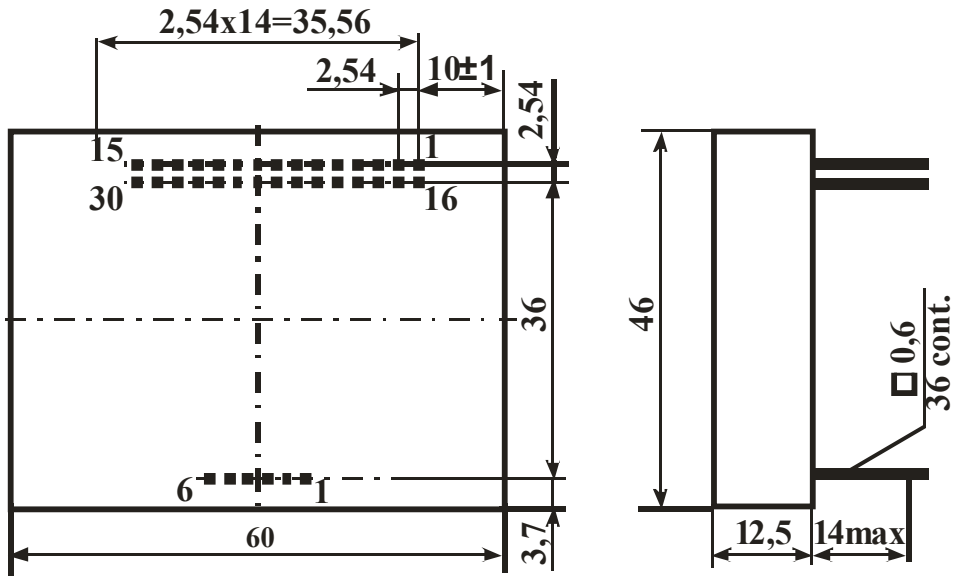

Figure 8.1 – – Overall dimensions of BDCCM

Precious metals are not contained.

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