SMART MOTOR DEVICES

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DC brush motor controller

BMD-12

manual
BMD.12.001

2024

1. Product designation

Controller BMD-12 is a miniature electronic device to operate and control DC brush motors with maximum voltage 24 VDC and power under 300 W. The device controls motor speed, compensates load and stabilizes the motor speed based on back EMF data. The controller is designed to be mounted on a panel. The controller is configured and additional parameters are displayed when connected to a PC via a USB Type-C connector.

2. Technical characteristics

Power supply voltage	12…24VDC
Own consumption current	<70 mA
Motor maximum continuous current	12 A
Peak motor current	14 A
Short circuit protection current	I_{lim}+ 5 A
Current limit adjustment range	0.5…12 A
Motor PWM frequency	18 kHz
Communication interface	USB

Environmental conditions:

- Ambient environment: non- corrosive, non-explosive,
- Humidity: 90% RH or less upon condition +25°C
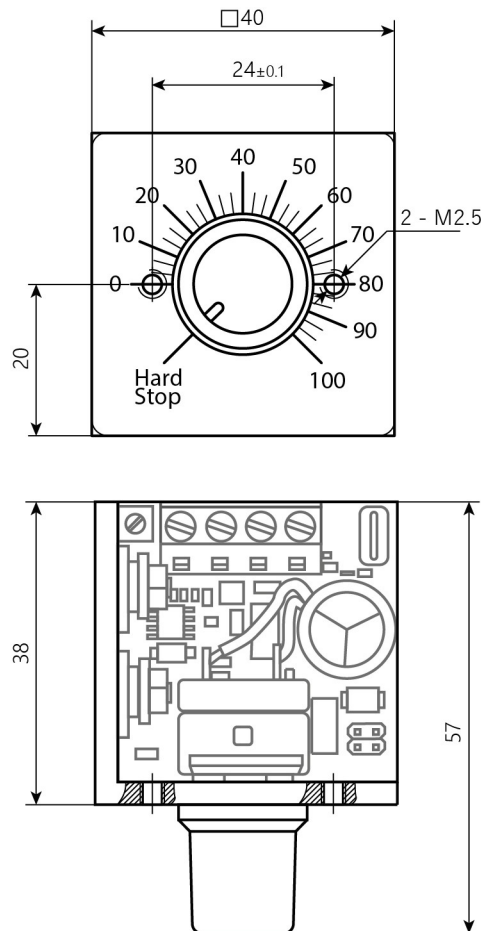- Condensation and freezing: none
- Ambient Temperature: 0…+40°C

Fig.1 Dimensions of BMD-12

3. Construction

BMD-12 is made in the form of a board with electronic components located on it. The controller body is a metal corner, allowing it to be fixed on the front panel of a device.
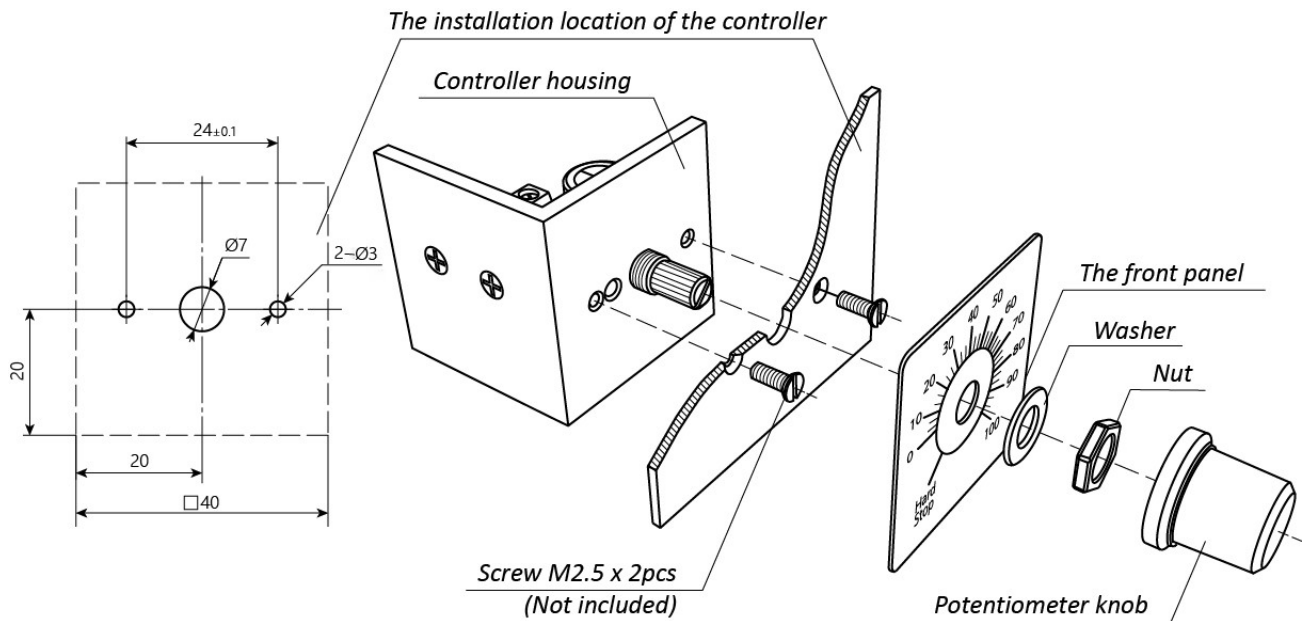

Fig.2 Constriction and installation of BMD-12

In addition to the electronic components, the board contains:
- screw terminals for connecting the power and motor connecting wires;
- potentiometer knob for adjusting the motor speed;
- adjustment scale on the front panel;
- LED indicator;
- potentiometer for limiting the maximum current;
- potentiometers for setting the maximum and minimum speed limits;
- USB Type-C connector for connecting the controller to a PC;

All motor operation parameters and motion control can also be performed by commands transmitted via USB interface.

4. Connection

It is prohibited to connect or disconnect the motor from the controller when the power is on. When connecting the controller, the polarity must be observed. Failure to observe the polarity, as well as excess supply voltage, leads to damage to the controller.

It is recommended that the power supply unit provide 20% more current than the maximum possible current consumed during operation.
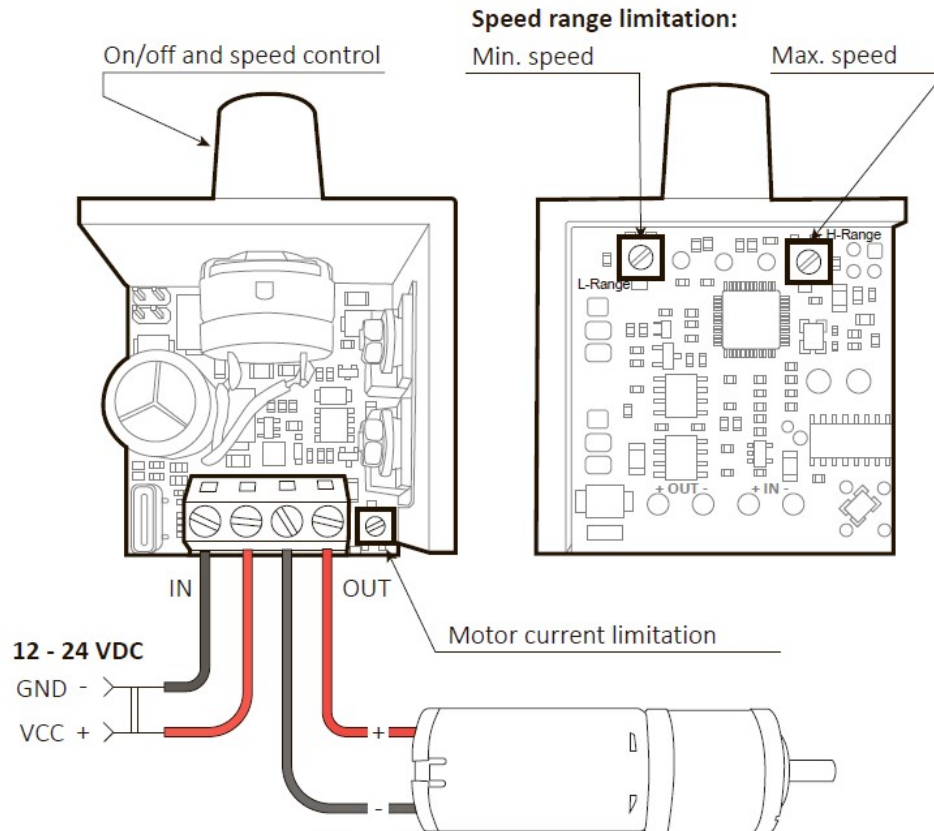
Fig.3. Connection

5. Usb connection and register map

To configure the operating parameters, monitor the status and transmit control commands, the controller is connected to the PC via USB (Type C). The Modbus ASCII protocol is used to read and write data. When connecting the device to the PC via USB, a virtual COM port is created. The following settings are used to transmit data:

- ID: 1
- Baud rate: 115200
- Parity: even
- Data bit: 7
- Stop bit: 1

5.1. Controller Status Registers

Address	Name	Description
		Input Registers
1000h	Supply Voltage	Supply voltage at the controller input, x10 mV
1001h	Motor Current	The current value of the current consumed by the motor, mA
1002h	Current Limit	Motor current limit value specified by a potentiometer, mA
1003h	Target BEMF	Target value of BEMF specified by a potentiometer or via the special register of the controller, x10 mV (Value is valid when 4001h = 1)
1004h	Set BEMF	The specified value of BEMF for the PID controller taking into account acceleration/ deceleration, x10 mV (Value is valid when 4001h = 1)
1005h	Measure BEMF	Measured current BEMF of the motor, x10 mV
1006h	Target Duty	PWM duty cycle, specified by a potentiometer or via the special register of the

Address	Name	Description
	Cycle	controller , % (Value is valid when 4001h = 0)
1007h	Current Duty Cycle	Current PWM duty cycle, %
	Discrete Inputs	
2000h	SC Error	Short circuit error flag
2001h	HARD STOP Active	Flag indicating that the controller is in HARD STOP mode
2002h	Current Limit Active	Flag indicating that motor current limitation is active

Registers 0x1000…0x2002 are read only.

5.2. Drive operation setup registers

Address	Name	Description
		Holding Registers
3000h	ACC	Acceleration, % from 5 s. 0 - movement without acceleration 10...100 – acceleration from the current speed to the specified speed from 0.5 s to 5 s, respectively
3001h	DEC	Deceleration, % from 5 s. 0 - movement without deceleration 10...100 – deceleration from the current speed to the specified speed from 0.5 s to 5 s, respectively
3002h	Const Speed BEMF	Constant BEMF (speed) value for the "Const Speed Mode" (register 4002h) and "Enable PID" (register 4001h) enabled
3003h	Const Speed DutyCycle	Constant duty cycle (speed) value for the "Const Speed Mode" (register 4002h) enabled and "Enable PID" (register 4001h) disabled
3004h	Kp (Proportional)	PID proportional gain
3006h	Ki (Integral)	PID integral gain
3008h	Kd (Differencial)	PID differential gain
300Ah	ADC Delay	BEMF analog-to-digital conversion delay, x 1.528 us. Allowed setting range 0...1310 (0...2 ms)
300Bh	ADC Frequency	Frequency of analog-to-digital conversion of BEMF, 2...50 Hz
300Ch	Derivative Threshold	First-order derivative threshold for filtering voltage spikes on the back EMF curve, x0.008V. It is selected experimentally for the motor type. The range of values is 1...500 (0.008V...4V).
300Dh	Integral Restriction	Limitation of the integral component of the PID controller, ±1...100% PWM Setting range: 1...100 (PWM + PWM/value) The higher the value, the faster the response to changes in the position of the speed potentiometer knob at the ends of the control range. The register does not require adjustment when the L-Range and H-Range speed limit potentiometers are correctly set.
300E	I-lim Mode	Current limiting options. 0 - current limiting is disabled (short circuit protection may be triggered at high starting currents) 1 - hardware limit of peak motor current 2 - software and hardware limit of motor current (lower current value can be set) The current value is set by the I-lim potentiometer, the set value is displayed in the register 1002h

300F	I-lim Kp (Proportional)	Software current limit PID proportional gain
3011	I-lim Ki (Integral)	Software current limit PID integral gain
3013	I-lim Kd (Differential)	Software current limit PID differential gain.
3015	Motor Current Measuring Mode	Possible values: 0 - measuring the motor current during the entire PWM period 1 - measuring the motor current during a PWM pulse When the controller operates with a motor with built-in spark-quenching capacitors, the value 0 should be written to this register.

Attention! Changing the PID controller coefficients is allowed only with a full understanding of the actions being performed. Abrupt changes of the coefficients values is not recommended.

0x300A - ADC Delay - The BEMF curve can be divided into 3 parts: 1 - a flat section near zero (does not contain useful information), 2 - a voltage increase curve, 3 – the target flat section, where the BEMF is measured. To exclude the first and partially second parts of the curve, a conversion delay is used. A value of this coefficient is selected experimentally for a used motor model. It is recommended to reduce this delay value for more accurate speed stabilization of small motors. And opposite – it is recommended to increase the value for large motor models.

0x300B - ADC Frequency - It is recommended to increase the frequency for more accurate speed stabilization of small motors. It is recommended to reduce the frequency for large motor models.

0x300D - Integral Restriction - Method for setting minimum limit values:

1) The controller must not be in HARD STOP mode
2) Set L-Range and H-Range speed potentiometers to minimum (CCW) position
3) With a motor connected, increase the L-Range the value of the register 1003h is slightly greater than the value of the register 1005h (the motor will not rotate if 1003h = 0).
4) Set the speed potentiometer to maximum, the motor will start to rotate at maximum speed.
5) Increase H-Range until the value of the register 1003h is slightly less than the value of the register 1005h (with 1003h greater than 1005h)
6) If necessary, L-Range and H-Range can be further increased

Address	Name	Description
		Coils
4000h	CLR SC Error	Setting the flag will result in an attempt to reset the short circuit error. The error will be reset if the causes of the error are eliminated.
4001h	Enable PID	Enabling the PID controller. 1 - Setting the flag enables the operation mode with speed stabilization based on BEMF (PID controller is turned on). The speed is set by a potentiometer or register 3002h. The values of the registers 1003h and 1004h are taken into account. 0 - Resetting the flag will disable the speed stabilization mode based on BEMF (PID controller is turned off). The speed is set by a potentiometer or the register 3003h.
4002h	Const Speed Mode Enable	Selecting the speed setting method. The bit is set - the speed is specified by a register. The bit is cleared - the speed is specified by a potentiometer.
4003h	Braking in HARD STOP mode	Selecting the braking method in HARD STOP mode. The bit is set - the motor terminals will be closed when braking in HARD STOP mode. The bit is cleared - when rotating in the forward direction - the motor terminals

		are open, when rotating in the opposite direction - closed
4004h	Set Default Settings	Setting the flag will reset the settings to factory values
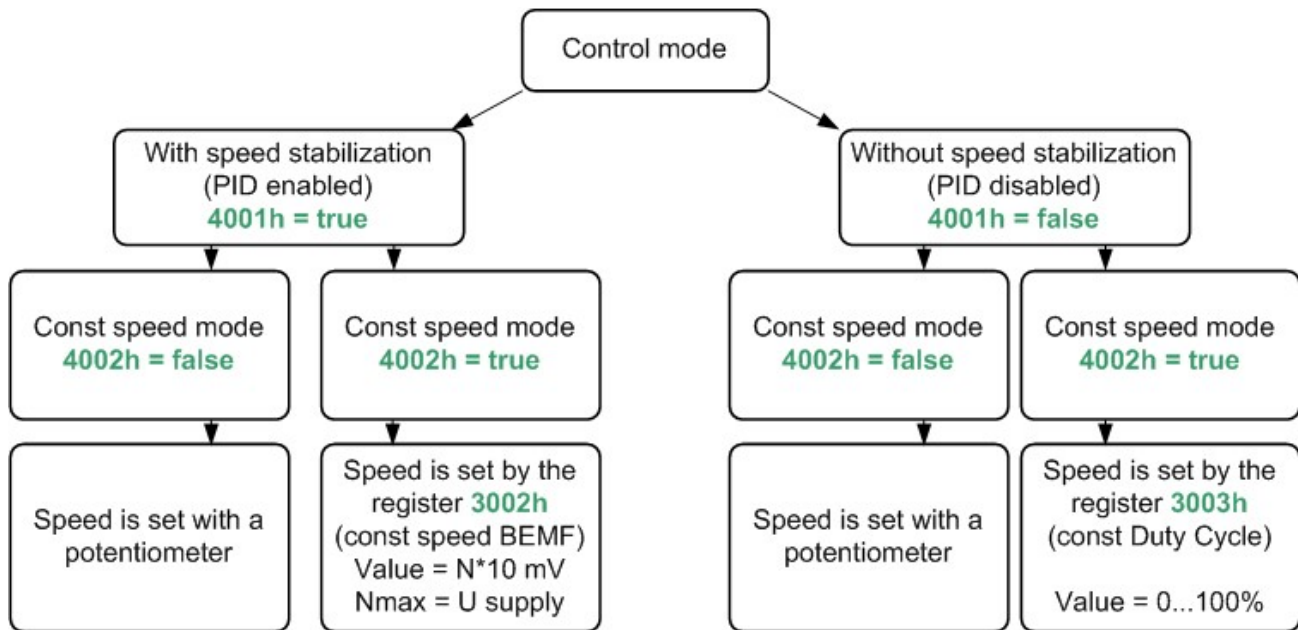
Fig.4 – setting registers for selecting speed source

6. Operation

1. Set the motor speed control potentiometer to the extreme left position until it clicks to prevent uncontrolled rotation.

2. Prepare the connection according to the section 4.

3. Turn on the power supply. The device is ready for operation. The LED located on the board should light continuously.

4. When starting for the first time, connect the controller to a PC using the USB Type-C connector to configure the parameters according to the section 5.

5. Configure the current limit with the potentiometer located on the controller board, monitoring the value in the register 1002h - Current Limit. Current limitation is enabled in the register 300E - I-lim Mode.

6. Configure acceleration and deceleration in the registers 3000h - ACC and 3001h - DEC.

7. Configure speed limits, if necessary, with the L-Range and H-Range potentiometers on the controller board. The L-Range potentiometer is responsible for the minimum speed value, the H-Range potentiometer is responsible for the maximum speed value.

Speed limit setting method to set the full speed control range of the motor (minimum speed is set with L-Range and maximum speed is set with H-Range potentiometers):

1) Set the potentiometers Speed, L-Range and H-Range to the minimum (CCW), but not HARD STOP position.

2) With the motor connected, increase the L-Range value until the value of the register 1003h is slightly greater than the value of the register 1005h and the motor starts to rotate.

3) Set the speed potentiometer to maximum, the motor starts to rotate at maximum speed.

4) Increase the H-Range until 1003h is slightly less than the value of 1005h.

5) The L-Range and H-Range values can be further increased if necessary.

If a short circuit of the motor phases occurs or motor current is exceeded the allowed value, the controller turns to an emergency mode, the motor is switched off, and LED indication.

The motor is controlled and can be stopped using the control knob on the front panel. In the extreme left position of the speed control potentiometer, the HARD STOP mode is activated.

7. Alarms indication

The controller provides LED indication of the operation state:

LED Indication	Description
Continuous red	Error. Short circuit of the motor windings.
Green blinking + red	Active current limiting (hardware and/or software)
Green blinking	Motor rotates. 1007h ≠ 0%
Continuous green	Motor stop 1007h = 0%

8. Delivery in complete sets

DC brush motor controller BMD-12   1 pcs

9. Warranty

Any repair or modifications are performed by the manufacturer or an authorized company.
The manufacturer guarantees the failure-free operation of the controller for 12 months since date of sale when the operation conditions are satisfied.

The manufacturer sales department address:
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Date of sale:

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