



**SMART MOTOR DEVICES**

<https://www.smd.ee>

**DC brush motor controller**

**BMD-20DIN**

*manual*

**BMD.20.DIN.V2.001**

**2022**



## 1. Product designation

Controller BMD-20DIN ver.2 is electronic device to operate and control DC brush motors with maximum voltage 24VDC and power under 480W. The controller is designed to control speed, direction, smooth start and stop of brush motors. BMD-20DIN ver.2 provides the function of precise adjustable motor overcurrent protection.

The controller performs the following functions:

- start and stop a dc brush motor motor with a button on the front panel or with an external signal;
- change of rotation direction of the motor by a button on the front panel or by an external signal;
- motor speed control;
- setting the value of acceleration and deceleration;
- protection of the motor against an overload with adjustment of value of peak current;
- indication of errors and operating modes of the controller;
- dissipation of the energy generated by the motor during coasting or forced rotation using the built-in braking circuit;
- emergency stop of the engine "HARD STOP", function of safe stop Safe Stop 1, in case of opening of the electrical circuit of the protective circuit;
- temperature protection of power stages;
- temperature protection of the brake circuit.

## 2. Technical characteristics

Power supply	12...24 VDC, stabilized
Permissible supply voltage range	8...30 VDC
Max. operation motor current	20 A
Maximum voltage across a motor	$0.99 \cdot U_{sup}$
Minimum non-zero voltage across a motor	$0.01 \cdot U_{sup}$
<b>Overcurrent protection:</b>	
Hardware short-circuit protection	30A, 15 $\mu$ s
Motor phase current limit	set by customer, limitation range 0.1 – 20 A
Actuation time of motor phase current limiting	5 sec
<b>Protection of an actuating mechanism:</b>	
SS1 – Safe Stop 1. Emergency stop (HARD_STOP) - the motor stops immediately in case the protection circuit is broken	
<b>Thermal protection:</b>	
output stage temperature rise	
brake circuit temperature rise	
<b>Speed regulation:</b>	
Speed regulation methods	Analog current or voltage signal, internal or external potentiometer, PWM regulation
SPEED input voltage range (for analog voltage signal)	-10...+10 VDC; 0...5 VDC
Analog current signal	4...20 mA;
Input impedance of SPEED input, kOhm	20
Impedance of external potentiometer	2.2...4.7 kOhm
PWM signal frequency	50 Hz
Pulse duration of the PWM signal	544...2400 mks
<b>Input signals "DIRECTION" and "START/STOP"</b>	
Type	clean contact;
Max. closed contact resistance	4.7 kOhm
Max. current	,5 mA

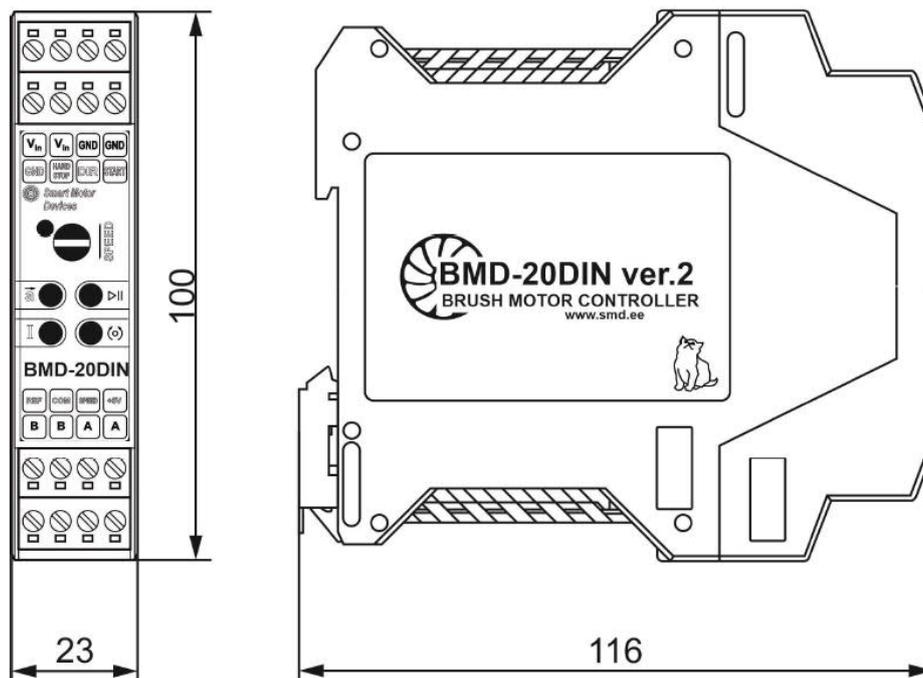


Fig.1 Dimensions of BMD-20DIN

Environmental conditions:

- Ambient environment: non- corrosive, non-explosive,
- Humidity: 90% RH or less upon condition +25°C
- Condensation and freezing: none
- Pressure: 650...800 mm of mercury.
- Ambient Temperature: 0...+50°C

### 3. Construction and control elements

BMD-20DIN ver.2 is designed as circuit plate with electronics elements, installed on a plate and covered with a case. Besides electronic components, there are indicating and control elements and connection terminals on the board:

- terminal screws for power supply, motor windings and control circuit connection;
- "START/STOP" and "REVERSE" buttons;
- Internal preset potentiometers to adjust motor speed "SPEED", acceleration/deceleration "a" and motor current limit "I".
- LED for indication of the controller status.

To adjust motor speed internal potentiometer "SPEED" and analog input "SPEED" (0..5V, -10..+10V, 4..20mA) are provided. To adjust acceleration and reversing deceleration internal potentiometer "a" is provided. To change the direction input and button "DIR" are intended. To start or stop motion button and input "START/STOP" are intended. Adjustment of a threshold of operation of protection 0.1 ... 20A is carried out by a potentiometer of "CURRENT ADJUST" and terminal «Vref».

Terminals for connecting external lines:

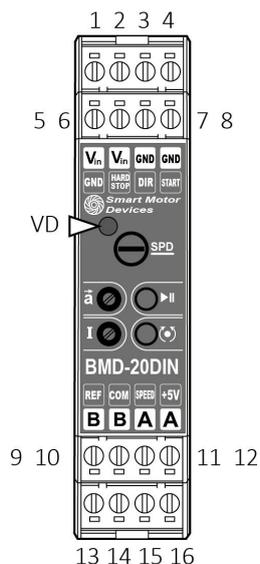


Fig.2. Layout and assignment of terminals and controls

1. (VCC) Power supply from 12 to 24 VDC.
2. (VCC) Power supply from 12 to 24 VDC.
3. (GND) Power supply GND
4. (GND) Power supply GND
5. (GND) Signal GND
6. (HARD STOP) Emergency stop signal input
7. (DIR) Direction signal input
8. (START) Motor START/STOP signal input
9. (REF) Reference voltage for motor peak current setting
- 10.(GND) Signal GND
11. (SPEED) Analog speed control input
12. (+5V) 5V output for connection of an external potentiometer
13. (B) Motor connection terminal
- 14.(B) Motor connection terminal
- 15.(A) Motor connection terminal
- 16.(A) Motor connection terminal

Control elements:

- SPD – built-in speed control potentiometer
- I – motor peak current adjusting potentiometer
- $\bar{a}$  - acceleration control potentiometer
- ▶|| - start/stop button "START/STOP"
- ⊙ - button reverse "DIR"

Indication:

- VD - LED indicator of device operation mode

#### 4. Principle of work

Regulation of speed and the direction of rotation of the engine is carried out by change of size and polarity of voltage. This change is provided with turning on of the engine in the bridge scheme on the transistor keys operated by the PWM.

The PWM-generator is executed on the microcontroller. Except the PWM-regulator the microcontroller carries out functions of measurement of values of the operating entrances, provisions of regulators, calculation of speed, acceleration and braking according to the built-in program.

#### 5. Assembly and connection

Please, learn this manual carefully before connection and assembly.

Before starting work, choose one of speed control methods: internal or external potentiometer, analog voltage signal 0...5V or -10...+10V, analog current signal 4...20mA or PWM signal. Setting the speed control mode is carried out by jumpers M1-M3. Refer to the figures 4 – 9 to set jumpers M1-M3.

Set jumpers DIR\_PIN and START\_PIN according to the needed logic of START/STOP and DIR signals. Please, refer to the section 5.1.

Please, wire just when power is off. Do not attempt to change wiring while the power is ON.

##### 5.1. Setting the operating mode of the control signals Start/Stop and Reverse

By default, the unit comes with the following mode of logic signals START/STOP and DIR:

Mode - "b":

- START/STOP start and stop - operates according rising edge of the signal
- DIR reverse – operates according to the signal level at the input

If necessary, the default mode of operation can be changed:

Mode - "a":

- START/STOP start and stop - operates according rising edge of the signal
- DIR reverse – operates according to the rising edge of the signal



### Mode - "c":

- START/STOP start and stop - operates according to the signal level at the input
- DIR reverse – operates according to the signal level at the input

### Mode - "d" is used to control the actuators:

- Start/stop move at the forward direction - operates according to the signal level at the input
- Reverse move at the backward direction - operates according to the signal level at the input

The signals logic is set using the jumpers "START\_PIN" and "DIR\_PIN" installed on the electronic board of the controller under the case (Fig. 3 and fig.4).

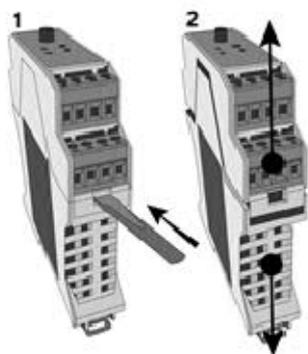


Fig.3. Taking of the case of the controller.

### To set jumpers:

- Disconnect the terminals from the controller;
- Open the housing as shown in figure 3;
- Press down on the latch with a flathead screwdriver on both sides;
- Pull the top and bottom of the case apart;
- Set the jumpers to the required position (fig.4).

If the corresponding pair of contacts is closed by a jumper, then their state corresponds to the "ON" value. If there is no jumper, then the state of the contacts corresponds to the value "OFF".



Fig. 4. Jumper contacts

The operation logic of the control signals "START/STOP" and "DIR" and the corresponding position of the jumpers "START\_PIN" and "DIR\_PIN" are shown in Figures 5-8.

Switch off the power supply before setting.

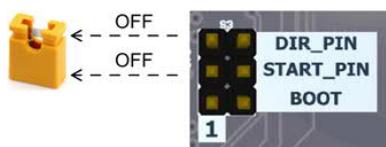
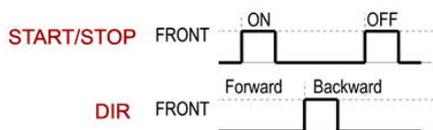


Fig.5. Mode - "a"

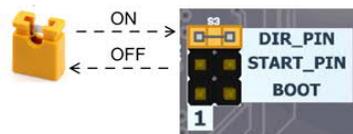
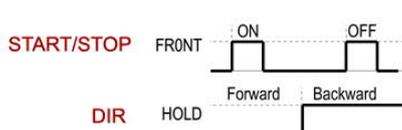


Fig.6. Mode - "b"

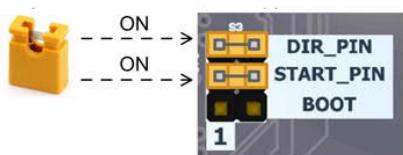
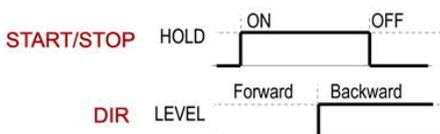


Fig.7. Mode - "c"

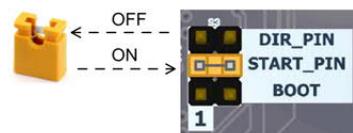
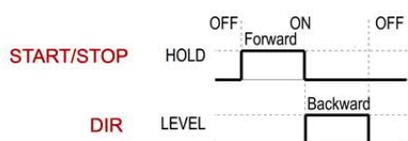


Fig.8. Mode - "d"



### 5.2. Connection

Please, provide a reliable contact in connection terminals. During wiring, please, observe the polarity and wire management.

- 1) Make sure the power supply is turned off. Please, wire just when power is off.
- 2) Connect the motor to the controller terminals A and B. The connection scheme is shown on figure 9.

**IMPORTANT:** due to high current it is strongly recommended to place a power supply in direct proximity to the controller BMD-20DIN ver.2. It is obligatory to use wire cross-section 3 mm<sup>2</sup> (AWG-8). The power supply must be able to provide the current 20% higher than a maximum possible current consumption while in operation. Recommended wire length: no longer than 100 cm for current up to 10A; no longer than 50 cm for current from 10A to 20A.

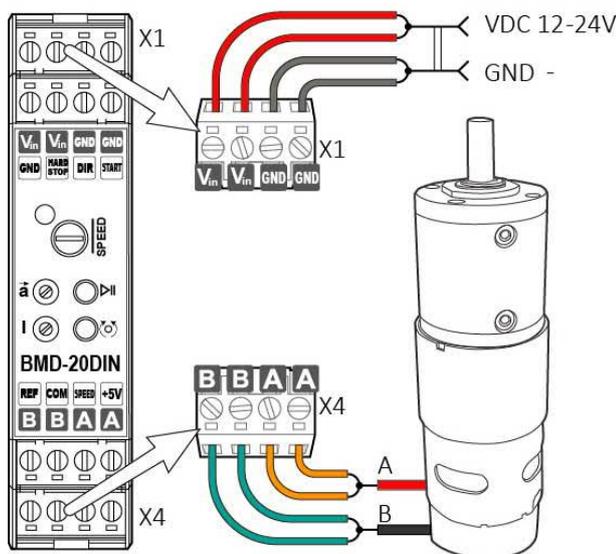


Fig.9. BMD-20DIN ver.2 connection scheme (motor and power supply connection.)

- 3) Connect the control elements to the controller according to chosen speed adjusting method as shown in the figures 10 – 15.

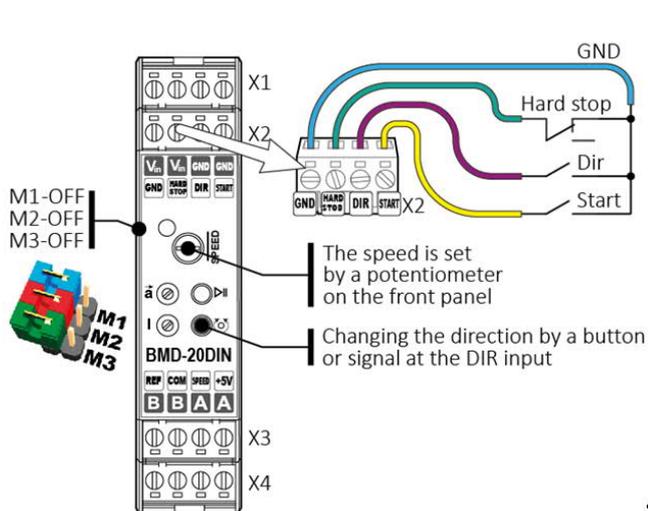


Fig.10. Speed control with internal potentiometer.  
Additional connection isn't required.

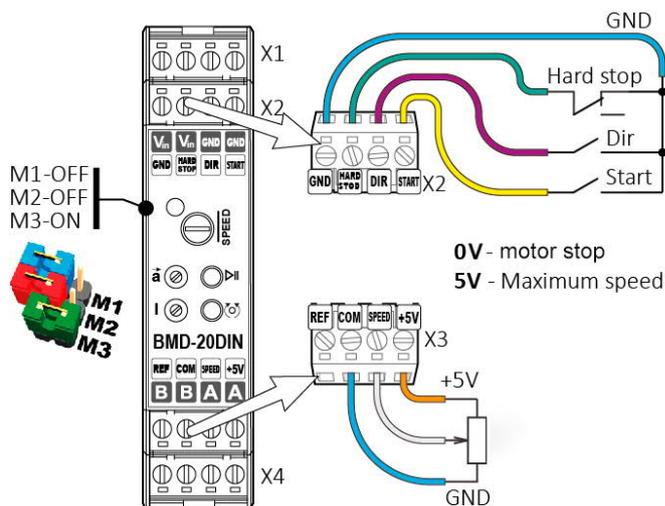


Fig.11. Connection for speed control with external potentiometer.

Connect the external potentiometer to the contacts "SPEED", "COM" and "+5V". The internal potentiometer "SPEED" should be turned to the end left position

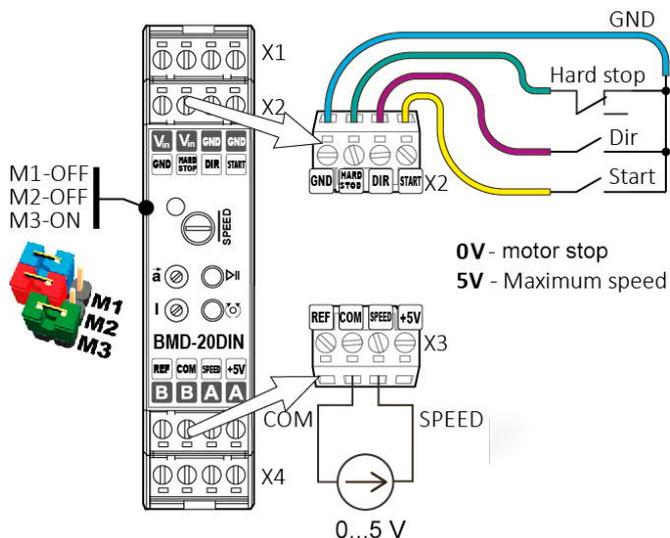


Fig. 12. Connection for speed control with analog signal 0..5V.

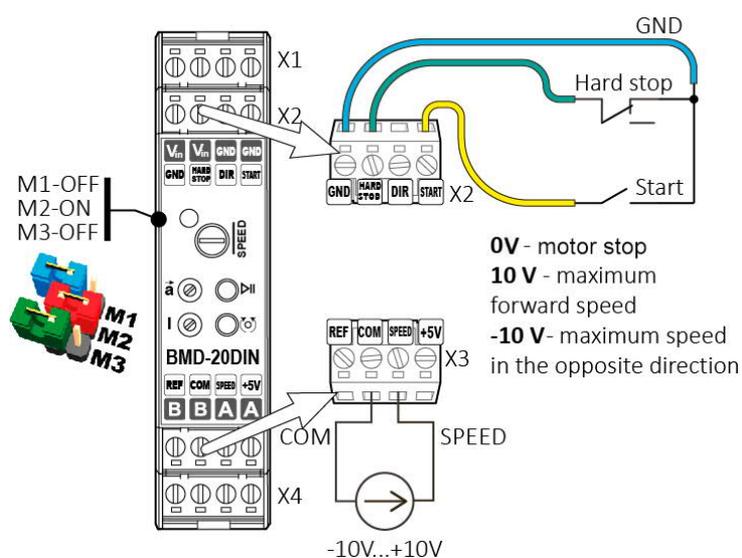


Fig. 13. Connection for speed control with analog signal -10..+10V.

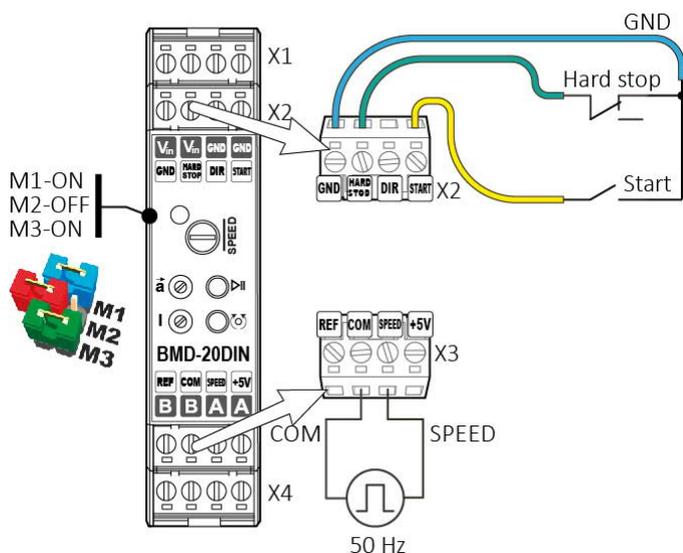


Fig. 14. Connection for speed control with PWM signal

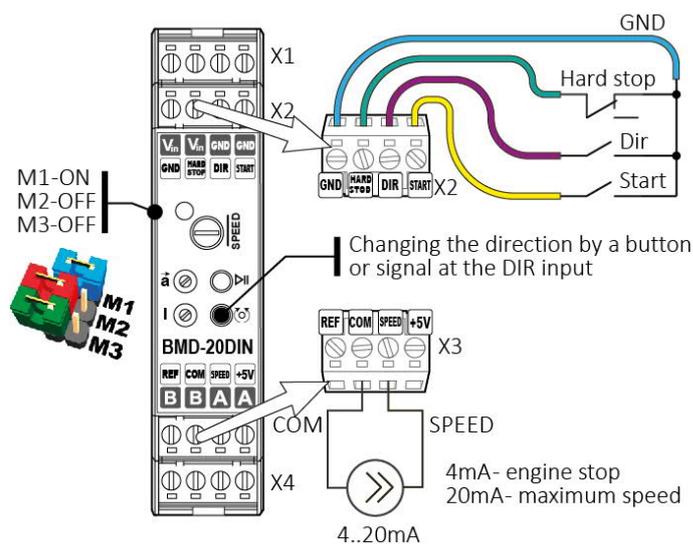


Fig. 15. Connection for speed control with analog signal 4..20 mA

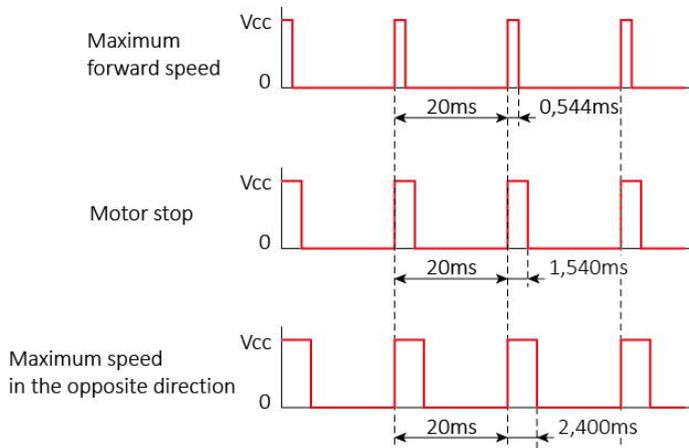


Fig. 16. Oscillogram of the PWM control signal.



- 4) If needed, connect control elements to the "START/STOP" and "DIR" contacts. These inputs are clean contact.
- 5) Connect power supply to the controller contacts according to the fig.9: "+" of the power supply to the terminal "Vin", "-" of the power supply to the terminal "GND". Wire cross-section should be suitable to the motor current consumption. We recommend using wire cross-section 3 mm<sup>2</sup> (AWG-8). Ground the power supply unit.

## 6. Operating parameters and motor control

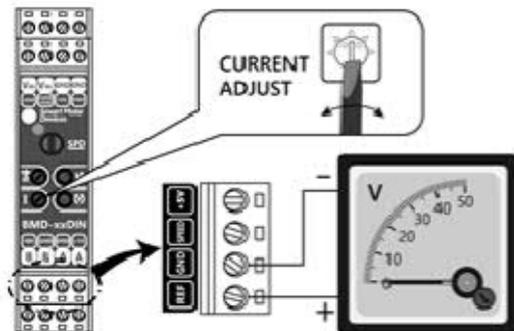
### 6.1. Motor current limitation

To set the value of the peak power supplied to the motor, the internal potentiometer **I** is used. The extreme position clockwise corresponds to the maximum current supplied to the motor windings, counterclockwise - the minimum current.

Set the speed and acceleration controls to the leftmost (counterclockwise) position corresponding to their minimum values.

Connect a voltmeter to the terminals "GND" and "Vref" to measure the reference voltage (Fig. 17).

Using the CURRENT ADJUST potentiometer, set the value of the maximum current consumed by the motor using a voltmeter. The calculation of the maximum current  $I_{lim}$  is carried out according to the following formula:



$$I_{lim} = I_{lim(min)} + (I_{lim(max)} - I_{lim(min)}) \times (V_{ref} / 3.3)$$

$I_{lim}$  – motor current limit value

$$I_{lim(min)} = 0.1A \dots I_{lim(max)} = 20A \text{ for BMD-20DIN ver.2;}$$

$$I_{lim(min)} = 1A \dots I_{lim(max)} = 60A \text{ for BMD-40DIN;}$$

$V_{ref}$  – voltage measured between terminals GND and REF

Fig.17. Connecting a voltmeter to set the maximum motor current.

### 6.2. Motor speed control

When control the speed with the built-in "SPEED" potentiometer, no additional connections are required. The clockwise end position corresponds to the maximum motor speed. The extreme position counterclockwise corresponds to the minimum speed.

In the case of speed control by an external potentiometer, the maximum speed corresponds to the extreme position of the potentiometer, at which a voltage of 5V is applied to the "SPEED" input. The minimum speed will correspond to the position of the potentiometer, at which 0V will be applied to the "SPEED" input. External potentiometer parameters: 2.2...4.7 kOhm.

In the case of applying an external signal 0 ... 5V to the "SPEED" input, the maximum speed corresponds to a signal level of 5V. The minimum speed level is 0V.

When controlling the speed with a current signal of 4 ... 20mA, the maximum speed corresponds to a signal level of 20mA. The minimum speed level is 4 mA.

When controlling the speed with a signal -10 ... +10V, the minimum speed (motor stop) corresponds to the signal level 0V. The maximum forward speed is +10V. The maximum reverse speed is -10V.

When controlling the speed with a PWM signal with a frequency of 50Hz, the minimum speed (motor stop) corresponds to a pulse duration of 1540  $\mu$ s. The maximum forward speed corresponds to a pulse width of 544  $\mu$ s. The maximum reverse speed corresponds to a pulse duration of 2400  $\mu$ s.

### 6.3. Acceleration

Use the acceleration control potentiometer ( $\bar{a}$  -) to set the acceleration and deceleration times. The counter-clockwise end position corresponds to the maximum acceleration time (minimum acceleration value). The clockwise end position



corresponds to the minimum acceleration time (maximum acceleration). The acceleration time to maximum speed varies in the range from 1 to 20 seconds.

Note: If, as a result of overclocking, the unit turns off with errors codes 1 and 2 (refer to the section 7), it is necessary to increase the acceleration time.

### 6.4. Start, stop and reverse

The device is ready to work after switching on the supply voltage. The LED on the board should glow solid green.

This controller has several options for processing the control signals "START / STOP" and "DIR". The processing of control signals is carried out at the rising edge or at the level of signal, depending on the settings – refer to the section 5.1.

#### Motor start/stop

Starting and stopping the motor is carried out by the button ► on the front panel of the controller or by an external signal, when the line connected to the "START" terminal is closed to the signal ground. Or by an external control signal applied to the "SPEED" input.

Operation modes of the button and external signal "START/STOP" are given in section 5.1. These control methods work according to the logical OR scheme, with the priority of external signals.

#### Changing the direction of rotation of the motor shaft

The motor rotation direction is switched by the button ↻ on the front panel of the controller or by an external signal, when the line connected to the DIR terminal is closed to the signal ground. Or by an external control signal applied to the "SPEED" input.

Operating modes of the button "DIR" and external signal "DIR" are given in section 5.1. These control methods work according to the logical OR scheme.

#### Actuator mode

Processing of the control signals "START/STOP" and "DIR" in the actuator mode is carried out according to the level (section 5.1.). The logic of operation of the control signals "START/STOP" and "DIR" is shown in the table below.

Control signal	Motor runs, forward direction	Motor runs, backward direction	Motor stop	
«START/STOP» (button or external signal)	ON	OFF	ON	OFF
«DIR» (button or external signal)	OFF	ON	ON	OFF

#### Emergency stop

The HARD STOP signal is used to stop the motor in case of an emergency. Operation is enabled when the contact is closed to ground. In case of disconnection, the controller goes into emergency mode, the motor stops abruptly with the indication of the corresponding error (refer to the section 7).

Exit from the emergency mode is carried out by removing and restoring the supply voltage.

## 7. Indication of operating modes and errors

The LED indicator on the front panel displays the status of the controller. After applying the supply voltage in normal mode the indicator is constantly lit green, when the motor is turned off. When the motor is on, the indicator flashes green with a period of approximately 1 second.

If during operation the red LED lights up and stays on, it means that the engine torque is exceeded. In this situation, it is not possible to maintain the set rotation speed, select a motor with a large torque.

If errors are found, the indicator displays the error code with a series of red flashes (see table below).



### LED errors indication

Error code	Indication	Description
0	Lit green	Regular operation (motor off)
0	Flashing green	Regular operation (motor on)
1	Single flashes of red	Out of voltage range of the internal converter
2	Series of 2 red flashes	Short circuit in phase
3	Series of 3 red flashes	Overheating of the internal braking circuit
4	Series of 4 red flashes	Overheating of power switches
5	Series of 5 red flashes	Motor connection error
6	Series of 6 red flashes	Emergency stop (HARD_STOP)

**Note:** If a short circuit of the motor phases occurs or its current exceeds 30 A for 15  $\mu$ s, the unit switches to emergency mode, the motor turned off and LED indicates the alarm.

**Note:** When the maximum motor current value set by the CURRENT ADJUST potentiometer is reached, the motor continues to rotate without exceeding this value, while the red LED is flashing.

### 8. Delivery in complete sets

DC brush motor controller BMD-20DIN ver.2

1 pcs

### 9. Manufacturer information

Smart Motor Devices adheres to the line of continuous development and reserves the right to make changes and improvements in the design and software of the product without prior notice.

The information contained in this manual is subject to change at any time and without prior notice.

### 10. 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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url: <https://smd.ee>

Date of sale:

Last modified: 28.04.2023