



DC BRUSHLESS MOTOR CONTROLLER BLD-20DIN

Manual

BLD.20.DIN.001

1. Product designation

Brushless controllers BLD-20DIN are electronic devices designed to operate and control brushless synchronous 3-phase DC motors with Hall encoder.

The controller performs the following functions:

- start and stop a motor with a button on the front panel or an external signal;
- change of direction of rotation of the motor by a button on the front panel or by an external signal;
- motor speed control using internal and external regulators;
- 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 control unit;
- dissipation of the energy generated by the motor during coasting or forced rotation using the built-in braking circuit;
- emergency stop "HARD STOP", function 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 characteristic

Controllers are designed to control speed, direction, smooth start and stop of brushless motors by input signals "START/STOP", "DIR" "HARD STOP", analog signal and potentiometers to control motor speed, acceleration and current limiting.

Table 1. Technical characteristic.

Model	BLD-20DIN
Power supply	24 – 48 VDC
Power supply protection	20 – 51 VDC
Rated current in motor phase	<20 A
Peak current limitation adjustment, A	1 – 20 A
Input resistance of SPEED input	20 kOhm
Input voltage range of SPEED input	0..5 VDC
Dimensions	120x100x25 mm

Dimensions of the controllers are shown on fig. 1

Connection scheme is shown on fig. 2

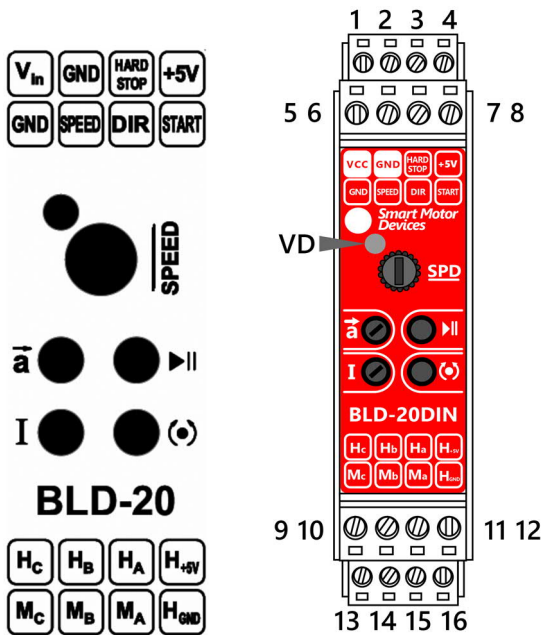
Environmental Conditions:

Ambient Temperature: 0...+50°C

Humidity: 90% RH or less upon condition +25°C

Condensation and freezing: none

Pressure: 650...800 mm of mercury



1. Power supply 24 – 48 VDC
2. Power supply GND
3. Emergency stop signal “HARD STOP
4. Output 5 VDC for external potentiometer
5. Signal GND
6. Analog signal input – for connection of an external speed regulation potentiometer
7. Signal “DIR” (clean contact)
8. Signal “START/STOP” (clean contact)
9. Hall sensor – phase C
10. Hall sensor – phase B
11. Hall sensor – phase A
12. Output for supply of Hall sensors
13. Motor phase C
14. Motor phase B
15. Motor phase A
16. GND of Hall sensors

SPEED – internal potentiometer for speed regulation

I – internal potentiometer for limiting of peak power

\bar{a} - internal potentiometer for adjusting of motor acceleration/deceleration

▶|| - “START/STOP” button

◉▶|| DIR” button

VD - LED indicator of operation mode

Fig. 2. Layout and assignment of terminals and control elements.

4. Assembly and connection

Please, learn this manual carefully before connection and assembly.

If it is necessary to change the operation logic of the control signals, before starting the installation, set the operation mode by setting jumpers in accordance with the section 5.1.

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

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

Due to high currents, it is recommended to locate the power supply in close proximity to the unit and use 3 mm² (AWG-8) wires. The power supply must provide 20% more current than the maximum possible consumed during operation. Recommended length of supply wires depends on the motor peak current:

- no more than 100 cm at currents up to 10 A.
- no more than 50 cm at currents from 10 to 20 A.

Connect the diagram is shown in fig. 3.

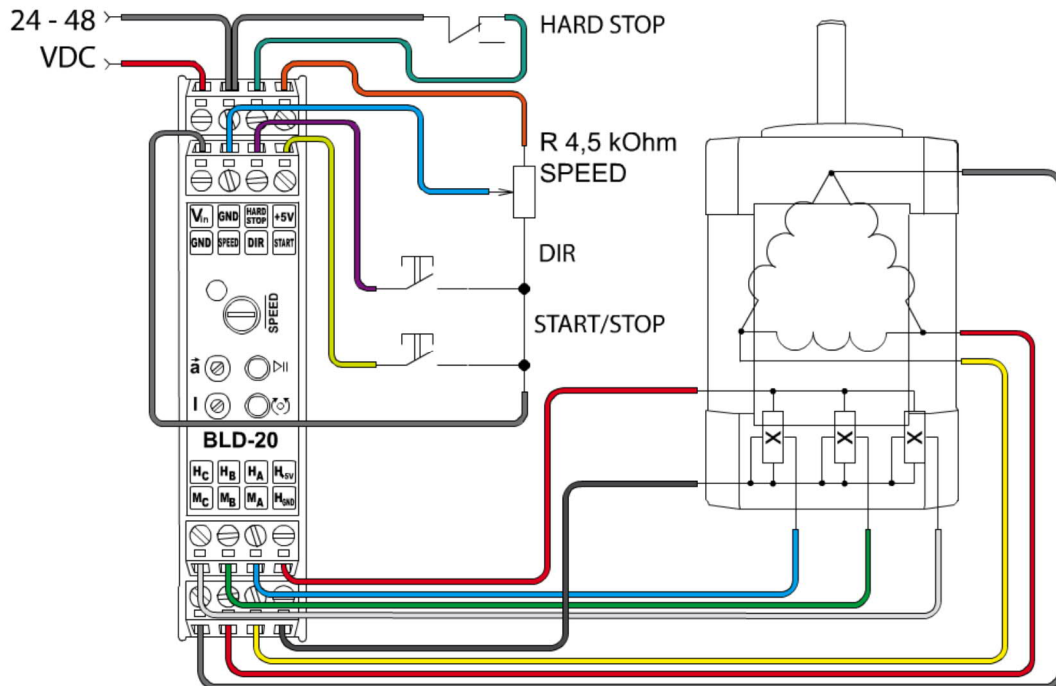


Fig.3 Connection diagram.

Follow the next instruction during connection:

1. Connect a motor to the controller according to the fig. 2 and 3. Motor phases must be connected to terminals 13 – 15. Hall sensors signals must be connected to terminals 9 – 11. GND of HALL sensors must be connected to the terminal 16, supply of HALL sensors signals must be connected to the terminal 12.
2. Connect external control elements according to the schemes in fig. 3:
 - type of external signals «START/STOP», «DIR», «HARD STOP» - clean contact;
 - full resistance of external potentiometer for speed control - approximately 4.5 KOhm.
3. Connect power supply to the contacts 1 and 2 according to the specification of the power supply unit. Input voltage range 24 – 48 VDC is allowed. The power supply unit should provide working voltage without voltage slump (choose power supply unit with ample of power). Connection wires should be suitable for the motor current, the recommendations are given above in this section.
4. Turn on the power, check the operation of the drive and make fine adjustments using the control elements. Parameter setting is described in the section 5.2.

Note: The HARD_STOP signal can be connected to the power ground terminal, simultaneous connection to the power and signal ground lines is not allowed.

Note: It is forbidden to apply power to signal ground. The internal signal ground circuit is not designed for high currents.

5. Operation

If necessary, before starting, set the operation mode of the input signals – refer to the section 5.1.

After switching power on, set the operating parameters such as speed, acceleration and maximum current limit according to the section section 5.2.

Further, during operation, the rotation of the motor is controlled in accordance with the section 5.3. The device performs control of emergency situations, with subsequent processing and display of the appeared error – refer to the section 5.5.

5.1. Input signals operating mode setting

Operation logic of the inputs "START/STOP" and "DIR" can be adjusted with the jumpers "START_PIN" and "DIR_PIN".

The "Start/Stop" button, located on the front panel of the controller, always operates on the edge, the logic of its



operation, unlike the logic of the control input "START/STOP", does not depend on the position of the jumper "START_PIN";

The "Reverse" button and the control input "DIR" duplicate each other. Their logic of operation is always the same. It is determined by the position of the "DIR_PIN" jumper.

By default, the controller comes with the following mode of operation configured:

Mode "b":

- ✓ START/STOP Start/stop the motor - according to the front edge of the signal
- ✓ DIR Rotation direction - according to the level of the signal

The signals operation logic can be changed to the next options:

Mode "a":

- ✓ START/STOP Start/stop the motor - according to the front edge of the signal
- ✓ DIR Rotation direction - according to the front edge of the signal

Mode "c":

- ✓ START/STOP Start/stop the motor - according to the level of the signal
- ✓ DIR Rotation direction - according to the level of the signal

Mode "d" - used to control actuators::

- ✓ START/STOP Forward start/stop the motor - according to the level of the signal
- ✓ DIR Backward start/stop the motor - according to the level of the signal

Jumpers «START_PIN» and «DIR_PIN» are located on the electronic board under the case of the controller.

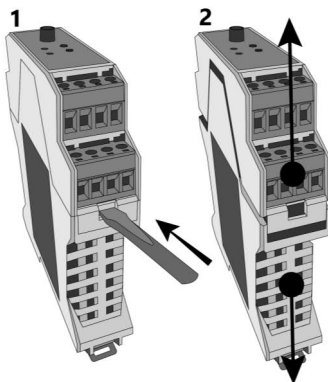


Fig. 4. Take off the case

To open the case:

- Turn off the power supply.
- Disconnect the terminals from the controller;
- Remove the controller from the DIN rail;
- Open the controller case as shown in the fig. 4:
 1. Press down on the latch with a flathead screwdriver on both sides;
 2. Pull the top and bottom of the case apart;
- Set the jumpers to the required position (fig.5.).
If the corresponding pair of contacts is closed by a jumper, then their state corresponds to the "ON". If there is no jumper, then the state of the contacts corresponds to the "OFF".



Fig. 5. Jumper contacts.

5.2. Setting operating parameters

5.2.1. Motor speed control

Choose the speed adjusting method:

- built-in "SPEED" potentiometer
- external potentiometer
- external signal source 0...5V.
- external PWM signal source

Internal potentiometer - additional connection isn't required. The clockwise end position corresponds to the maximum motor speed. The extreme position counterclockwise corresponds to the minimum speed.

External potentiometer - connect external potentiometer to the speed contacts 4 (+5V), 6 (SPEED) and 5 (GND). Minimum resistance of the potentiometer is related to maximum motor rotation speed. Increasing of the potentiometer resistance leads to motor speed decreasing. Recommended parameters of the external potentiometer: 2.2...4.7 kOhm.



Internal speed adjusting potentiometer should be turned to the end CCW position.

External signal 0...5V to the "SPEED" input – connect the signal contacts to the terminals 6 (SPEED) and 5 (GND). The maximum speed corresponds to a signal level of 5V, the minimum speed corresponds to a signal level 0V.

PWM signal - the motor speed is proportional to the effective voltage level applied to the SPEED input. Recommended PWM signal parameters: $F \geq 5$ kHz, amplitude 5V.

Note: when using the external input "SPEED", the built-in potentiometer must be turned to the extreme counter-clockwise position, because the speed will correspond to the signal level with the highest value.

5.2.2. Motor acceleration adjusting

Use the acceleration regulator \bar{a} to set the acceleration and deceleration times. The counter-clockwise end position corresponds to the maximum acceleration time (minimum acceleration). 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 the controller turns to an alarm state and indicates errors 1 or 2 (refer to the table 3) during accelerating, it is necessary to increase the acceleration time.

5.2.3. Limiting of motor current

The internal potentiometer I is used to set the maximum current applied to the motor. The clockwise end position corresponds to the maximum current supplied to the motor windings. The extreme counterclockwise position corresponds to the minimum current.

5.2.4. Parameter setting menu

Menu navigation and parameter setting is carried out using the Start/Stop and Reverse buttons. The parameter values are displayed by LED indication. Detailed instructions for working with the settings menu are given in the table 3.

The parameter number is selected by the appropriate number of short presses of the Start/Stop button, followed by fixing the selected menu item with the Reverse button.

The value of the selected parameter is set by the corresponding number of short presses of the Start / Stop button, followed by fixing the selected value with the Reverse button.

The display of the current value of the selected parameter is initiated by pressing and holding the Start/Stop button. The parameter value is indicated by the corresponding number of LED flashes.

If the number or parameter value is entered incorrectly, an error is displayed and the controller returns to the initial menu item for selecting the parameter number.

Table 2. Parameters to be adjusted.

№	Parameter	Setting range		Setting step*
		minimum	maximum	
1	FW version	Read only		
2	Maximum speed	1000 rpm	20000 rpm	1000 rpm
3	Inversion of direction	1 - off	2 - on	1
4	Hall sensors pulses number per revolution	1 p/rev	12 p/rev	1 p/rev

*Setting step corresponds to changing the value of the parameter with one press of the button and one blinking of the LED when the parameter is displayed.

FW version – read only parameter – during the indication, two series of LED flashes occur with a certain time interval. The number of blinks in the first series determines the major part of the firmware version, the second series determines the minor part.

Maximum speed - this parameter defines the maximum speed set by the internal potentiometer or external signal to the SPEED input.

Inversion of direction - this parameter is configured for the correct operation of the unit with different types of motors, depending on the correspondence between the direction of rotation of the rotor and the sequence of signals from the Hall sensors.

Note: it is possible to determine the need for inversion of direction by the following symptoms: when the rotation is started and the potentiometer is set to any speed above the minimum, the motor starts to rotate at the maximum speed (speed regulation is not possible), the indicator LED lights up red; when the potentiometer is set to the minimum



position, the motor stops abruptly. In this case, it is necessary to change the parameter in the settings menu - "Inversion of direction" (Table 2, parameter number 3). Instructions for setting parameters are given in the table. 3.

Hall sensors pulses number per revolution - this parameter is set in accordance with the characteristics of the motor model and is necessary for the correct measurement of the rotation speed.

Table 3. Instruction for settings menu

1 Preparation for work

External power is absent:

- 1a. Entering the settings menu.
 - 1.1. Set the built-in and external (if connected) speed control potentiometers to MIN position.
Remove the HARD STOP jumper.
 - 1.2. Press and hold the Start/Stop button.
 - 1.3. Apply power to the unit.

External power is present:

- 1b. Entering the settings menu.
 - 1.1. Set the built-in and external (if connected) speed control potentiometers to MIN position.
 - 1.2. Press and hold the Start/Stop button.
 - 1.3. Remove the HARD STOP jumper.

2 Entering the settings menu.

Hold the Start/Stop button until:

- 2.1. The error code indication stops.
- 2.2. The green LED indicator* turns on.
Release the Start/Stop button, the device enters the settings mode, and the LED turns off.

3 Selecting a parameter

- 3.1. Perform N short presses on the Start/Stop button, where N corresponds to the parameter number (refer to the table 2).
- 3.2. Confirm the selection with a short press of the Reverse button**.

4 Setting the parameter value

- 4.1. Perform N short presses on the Start/Stop button, where N corresponds to the parameter value.
- 4.2. Confirm the selection with a short press of the Reverse button**.

5 Requesting the parameter value

- 5.1. Press and hold the Start/Stop button.
- 5.2. Wait for the green LED indicator to turn on.
- 5.3. Release the Start/Stop button.
The parameter value indication will be made by a series of N green flashes, where N corresponds to the parameter value.

6 Exit from the Settings Menu

Exiting the settings menu can be done in one of the following ways:

- Turning the power Off/On.
- Holding down the Reverse button for a long time.
- Connecting the HARD STOP jumper.

Note:

* If there is no constant green light at this stage:

- If a cyclic error signal is indicated, repeat step 1.
- If the red LED is constantly ON - the Start/Stop button was released too early, it is need to press and hold the Start/Stop button again until the constant green indication is turned on in step 2.2.


** If there is a series of three fast red flashes on the display when trying to fix the indicator, it means that the N value was incorrectly entered. The controller returns to the initial state of selecting the parameter in step 3.


Note: Before starting the settings, make sure that nothing is connected to the Start and Dir inputs.

5.3. Motor rotation control

The controller is ready for operation after switching on the supply voltage. The LED indicator on the board should be solid green.

The controller has several options for processing the control signals "START / STOP" and "DIR", depending on the set operating mode. The inputs can be processed at the front edge or at the level of the signals, according to the settings (refer to the section 5.1).

Starting and stopping the motor is carried out by a button  on the front panel of the controller or by an external signal at the "START" input (when the signal line connected to the "START" terminal is closed to the signal ground, as shown in the diagram in fig. 3). Operation modes of the button and external signal "START/STOP" are given in the section 5.1. These control methods work according to the logical OR scheme, with the priority of external signals.

Switching the motor rotation direction is carried out by a button  on the front panel of the controller or by an external signal at the "DIR" input (when the signal line connected to the "DIR" terminal is closed to the signal ground, as



shown in the diagram in fig. 3). Operating modes of the button "DIR" and external signal "DIR" are given in the 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 operation mode is performed according to the signals level (refer to the section 5.1). The logic of the operation of the control signals "START/STOP" and "DIR" is shown in table. 4.

Table 4. Control signals in the actuator mode.

Control signal	State 1		State 2		State 3		
«START/STOP» (button/external signal)	ON	Forward rotation of the motor	OFF	Backward rotation of the motor	ON	OFF	Motor stop
«DIR» (button/external signal)	OFF		ON		ON	OFF	

5.4. 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 the ground contact. In the event of the contact is open, the controller switches to an emergency mode, a fast controlled braking of the motor occurs with an indication of the corresponding error (refer to the section 6).

Exit from the emergency mode is carried out by removing and restoring the power supply of the device.

6. Indication of operating modes and errors

LED on the front panel of the controller indicates the controller operation status. In case of normal operation the indicator is green. Green indicator blinks during motor operation (approx. 1 time per second). In case, if during operation the indicator turns to red and doesn't blink, it means the maximum torque is reached, speed stabilization impossible – for proper work choose a motor with more output power.

In case of alarms the indicator blinks green and red. The number of red blinks represents the alarm code (refer to the table 5).

Table 5. Alarms indication

Alarm code	Indication	Alarm
0	Solid green	Normal operation
0	Blinking green	Normal operation
1	Single red flashes	Input voltage range exceeded
2	Series of 2 red flashes	Short circuit in a motor phase
3	Series of 3 red flashes	Internal brake circuit overheating
4	Series of 4 red flashes	Internal power switches overheating
5	Series of 5 red flashes	Wrong motor connection
6	Series of 6 red flashes	Emergency stop
7	Series of 7 red flashes	Testing version of firmware

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 blinking.

Note: If the motor is not able to reach the set rotation speed with the given parameters (supply voltage and shaft load), the motor continues to rotate. At the same time, the red LED will blink.

Note: When errors 3 and 4 occur, the controller may require forced cooling.

7. Delivery in complete sets

The brushless motor controller BLD-20DIN
Manual BLD20.DIN.001.

1 pcs.
1 pcs.

8. List of changes to the firmware

FW Version 1.3

- Added the ability to set the maximum speed through the settings menu.

FW Version 1.4

- Added motor rotation direction control.
- The maximum current control algorithm has been changed. When the maximum current is reached and it is not possible to bring the motor to the set speed, no error will be initiated, the unit will continue to work at a speed below the set one.

FW Version 1.5

- Increased the number of configurable parameters through the settings menu.

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 – section 2.

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