



User Manual

DC brush motor controller

RS Stock No.: 717551

1. Product designation

Controller 717551 is an electronic device to operate and control DC brush motors with a maximum voltage of 24VDC and power under 1000W. The controller is designed to control torque, speed, direction, and the smooth start and stop of brush motors. The motor control is carried out by both internal regulators included in the design of the device and external ones, connected additionally. 717551 provides a motor overload protection function with regulation of the maximum permissible current supplied to the motor.

The controller performs the following functions:

- start and stop a DC brush 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;
- motor torque control;
- setting the value of acceleration and deceleration;
- protection of the motor against an overload with adjustment of peak current;
- indication of errors and operating modes of the controller;
- emergency stop function "HARD STOP" - the motor stops in case of opening of the electrical circuit of the protective circuit;
- control of the external electromagnetic motor brake;
- temperature protection of power stages;
- temperature protection of the brake circuit.

2. Technical characteristics

Table 1. Technical characteristics.

Power supply U_{sup}	12...24 VDC, stabilized
Permissible supply voltage range	8...29 VDC
Max. operation motor current	40 A
Maximum voltage across a motor	$0.99 \cdot U_{sup}$
Minimum non-zero voltage across a motor	$0.01 \cdot U_{sup}$
Current consumption	< 100 mA at a supply voltage of 24VDC
Internal output +5V:	
Voltage	4.5 - 4.5 VDC
Max. load current	50 mA
External brake control:	
Permissible working current of the brake connected to terminals BR+ / BR-	1 A
Brake response time	100 ms
Overcurrent protection:	
Hardware short-circuit protection	100A, 15 μ s
Motor phase current limit	set by customer, limitation range 5 - 40 A
Actuation time of motor phase current limiting	5 sec
Protection of an actuating mechanism:	
Emergency stop (HARD_STOP) - the motor stops immediately in case the protection circuit is broken.	

- brake circuit temperature rise

3. Control modes

The controller 717551 provides control of the motor speed or torque.

3.1. Motor speed control modes:

- internal potentiometer;
- external potentiometer with full resistance: 10 kOhm;
- analog signal 0 - 10 V (dead zone 0 ... 100 mV);
- analog signal -10 - +10 V (dead zone \pm 500 mV);
- analog signal 4 - 20 mA;
- PWM signal. PWM frequency: 16 kHz, 3.3 V. PWM duty cycle: 2% -100%.

Speed feedback is not provided.

3.2. Engine torque control modes:

- internal potentiometer;
- external potentiometer with full resistance: 10 kOhm;
- analog signal 0 - 10 V (dead zone 0...100 mV);
- analog signal -10 +10 V (dead zone \pm 500 mV);
- analog signal 4 - 20 mA;
- PWM signal. PWM frequency: 16 kHz, 3.3 V. PWM duty cycle: 2% -100%.

Torque stabilization without speed control, by instantaneous motor current.

The control mode and the type of control signal are selected using microswitches on the front panel of the controller (refer to section 6).

4. Construction

717551 is designed as a circuit plate with electronic elements, installed on a plate and covered with a case, indicating and control elements, and connection terminals on the board:

- Plastic housing designed for installation on a DIN rail.
- Circuit board with electronic components.
- Screw terminals for connecting wires: control lines, power supply, and motor.
- Front panel with controls and graphic symbols.

Front panel control elements:

- status LED;
- "START" button;
- "DIR" button;
- main speed setting potentiometer;
- second speed setting potentiometer;
- current setting potentiometer;
- microswitches group for selecting the start and reverse type (by level or by edge), selecting the "SPEED" speed control mode or the "TORQUE" torque control mode, selecting the stop mode with open or closed motor terminals, BRAKE signal inversion, and automatic brake application function.

5. Assembly and connection

Please, learn this manual carefully before connecting and assembling.

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

Set the required operating mode, type, and logic of control signals using microswitches SW1 – SW10 in accordance with section 6.1.

Installation must be performed by qualified personnel. The controller is designed for installation on a standard DIN rail 35 mm wide.

When selecting a power supply, consider the maximum power and starting current of the motor, as well as the operating mode, load type, and possible back EMF. When braking the motor, a voltage higher than the supply voltage may appear at the controller's power terminals. To prevent the power supply protection from tripping and damaging other devices connected to the same power bus, the controller can be connected in series via a power diode, or other means can be provided to prevent the line voltage from exceeding the permissible limit.

Attention: When connecting, observe the polarity of the power supply. Failure to observe the polarity, as well as exceeding the supply voltage, may damage the unit.

Due to high currents, it is recommended to locate the power supply in close proximity to the unit and use wires with a cross-section of 8.4 mm² (AWG-8). The power supply must provide a current 20% greater than the maximum possible current consumed during operation. Recommended length of supply wires depending on the peak current:

- no more than 100 cm for currents up to 10 A.
- no more than 50 cm for currents from 10 to 20 A.
- no more than 25 cm for currents from 20 to 40 A.

It is permissible to use one line of supply and phase terminals at a maximum current of up to 20 A. It is necessary to use both lines of supply and phase terminals at a maximum current of more than 20 A.

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

Connection order:

- 1) Make sure the power supply is turned off. Please, wire just when the power is off.
- 2) Connect the motor to the controller terminals A and B.
- 3) If necessary, connect external control circuits to the terminals: external speed or torque controller (potentiometer, analog signal source -10...+10V, 0...+10V, 4...20mA or PWM signal); external control signals "HARD STOP", "START/STOP", "DIR", "BR", "SPD2" to the corresponding terminals.
- 4) Connect the device to a power supply. The thickness of the connecting wires must correspond to the current consumed by the motor.
- 5) Use the control elements to pre-set working parameters by setting the speed, acceleration, and current potentiometers to the middle positions.
- 6) Turn the power on, check the operation, and perform fine-tuning using the control elements.

6. Operation

If necessary, before starting work, configure the controller operating parameters (control mode, speed, acceleration, current limitation) according to section 6.1.

During operation, the controller monitors abnormal situations. In case of error or alarm, the controller indicates the code with LED flashing – refer to section 6.7.

6.1. Setting up the controller and connecting control signals.

There is a group of microswitches SW1...SW10 on the front panel of the controller. These switches are intended for selecting the logic of start and reverse signals (by level or by edge), selecting the control mode - "SPEED" or "TORQUE", selecting the stop mode - with open or closed motor terminals, selecting brake polarity, and the automatic brake application function.

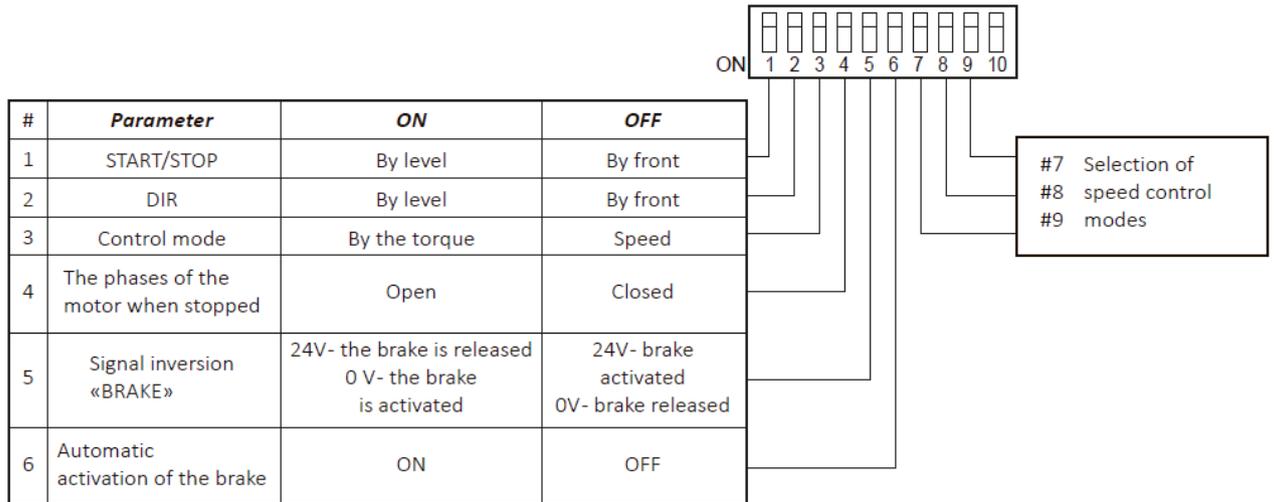


Fig. 2. Purpose of microswitches SW1 – SW10.

An example of connecting the controller with control from a built-in potentiometer is carried out according to the diagram in Fig. 3.

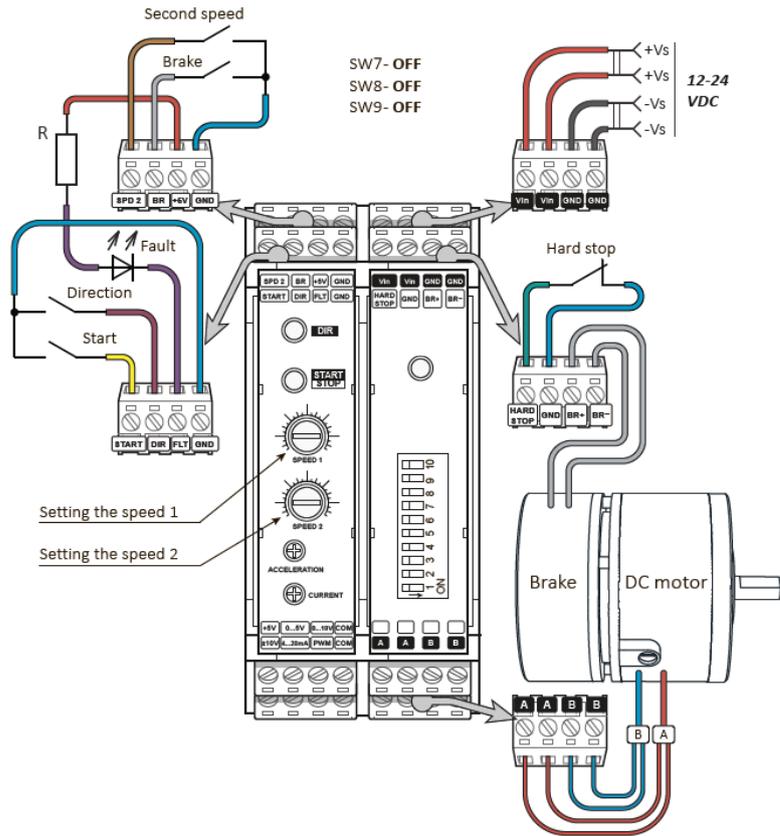


Fig. 3. Connection diagram for control with the built-in potentiometer.

The control signal type is set for the microswitches SW7, SW8, and SW9. Set the desired position of the microswitches and, if necessary, connect the external control signal according to the diagram in Fig. 4.

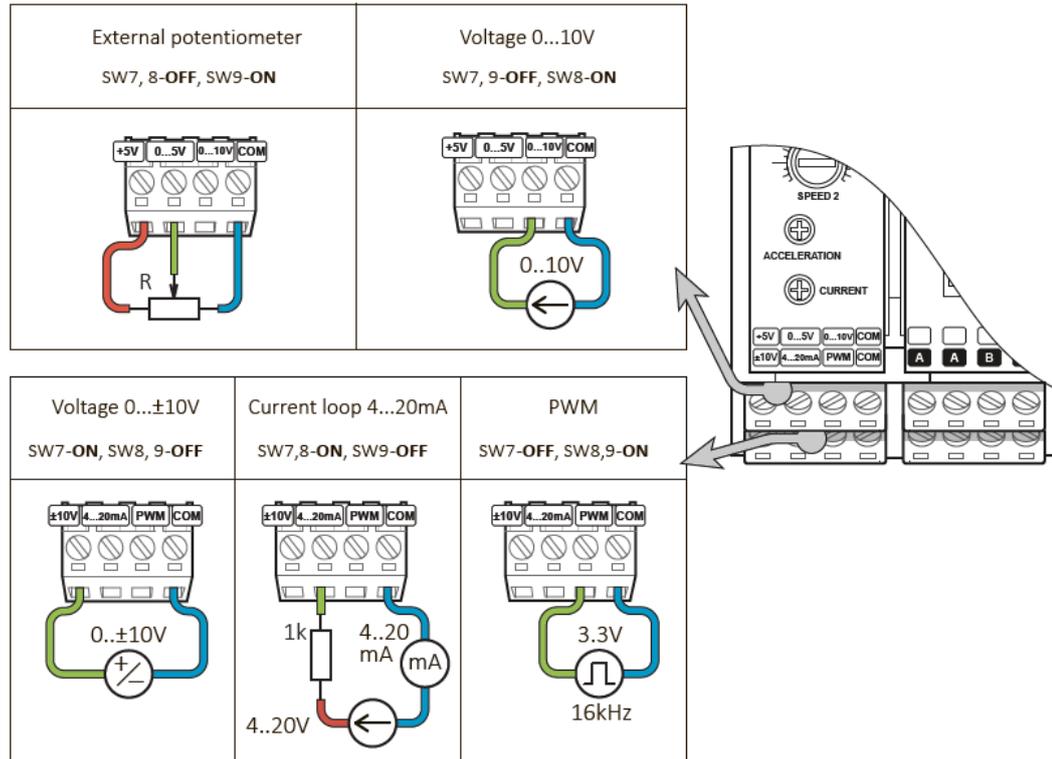


Fig. 4. Connecting external speed and torque control signals.

6.1.1. Selecting the operating mode - speed or torque control

Regulation of motor speed or torque with the controller 717551 is carried out with an analog signal. The control mode is selected using the SW3 microswitch on the front panel of the controller: SW3 = ON - speed control, SW3 = OFF - torque control.

Motor speed control (SW3 = OFF)

Speed setting is carried out with an analog signal. The type of the signal is selected with microswitches SW7, SW8, and SW9. Motor acceleration rate depends on the position of the built-in potentiometer "Acceleration". Speed stabilization is not provided.

Select the speed setting signal type according to the diagram in Fig. 4:

- internal potentiometer (SW7=OFF, SW8=OFF, SW9=OFF);
- external potentiometer with impedance: 10 kOhm (SW7=OFF, SW8=OFF, SW9=ON);
- analog signal 0 - 10 V (SW7=OFF, SW8=ON, SW9=OFF)
- analog signal -10 - +10 V (SW7=ON, SW8=OFF, SW9=OFF)
- analog signal 4 - 20 mA (SW7=ON, SW8=ON, SW9=OFF)
- PWM signal (SW7=OFF, SW8=ON, SW9=ON).

Built-in potentiometer. When controlling the speed with the built-in potentiometer "SPEED 1", no additional connections of the control signal are required. The extreme clockwise position corresponds to the maximum motor speed. The extreme counterclockwise position corresponds to stopping the motor. This control mode provides the possibility to set two speed values and switch between them by shorting the "SPD 2" input to the "GND" terminal. The second speed is set by the built-in potentiometer "SPEED 2".

External potentiometer. In case of controlling the speed with an external potentiometer, the maximum speed will correspond to the extreme position of the potentiometer, at which a

voltage of 4-5 V is applied to the "SPEED" input. The potentiometer position where 0V is applied to the "SPEED" input corresponds to the motor stopping. The potentiometer position where a voltage in the range of 0 to 50 mV is applied to the "SPEED" input is the dead zone. External potentiometer parameters: 10 kOhm.

Analog signal 0...10 V. In case of applying an external analog signal 0...10 V to the "SPEED" input, the maximum speed corresponds to a signal level of 10 V. A signal level of 0V corresponds to the motor stopping. The signal level range from 0 to 100 mV is the dead zone.

Analog signal 4...20 mA. When controlling the speed with an external current signal 4...20 mA, the maximum speed corresponds to a signal level of 20 mA. The motor stops at a signal level of 4 mA.

Analog signal -10...+10 V. When controlling the speed with a -10...+10 V analog signal, the maximum forward rotation speed corresponds to the +10V signal level, while the maximum reverse rotation speed corresponds to the -10V signal level. A signal level of 0V corresponds to the motor stop. The signal level range ± 500 mV is the dead zone.

PWM signal. When controlling the speed with a PWM signal with a frequency of 16 kHz, the minimum start speed corresponds to a duty cycle of 1%. The maximum speed corresponds to a duty cycle of 100%. The motor stops at a duty cycle of 0%.

Motor torque control (SW3 = ON)

In torque control mode, voltage is applied to the windings when the motor starts. The voltage gradually increases until the current reaches the set value.

Select the torque setting signal type according to the diagram in Fig. 4:

- internal potentiometer (SW7=OFF, SW8=OFF, SW9=OFF);
- external potentiometer with impedance: 10 kOhm (SW7=OFF, SW8=OFF, SW9=ON);
- analog signal 0 - 10 V (SW7=OFF, SW8=ON, SW9=OFF);
- analog signal -10 - +10 V (SW7=ON, SW8=OFF, SW9=OFF);
- analog signal 4 - 20 mA (SW7=ON, SW8=ON, SW9=OFF);
- PWM signal (SW7=OFF, SW8=ON, SW9=ON).

Built-in potentiometer. When controlling the torque with the built-in potentiometer "SPEED 1", no additional connections of the control signal are required. The extreme clockwise position corresponds to the maximum motor torque and motor current of 40A. The extreme counterclockwise position corresponds to the minimum torque and motor current of 5A.

External potentiometer. In case of controlling the torque with an external potentiometer, the maximum torque and motor current will correspond to the extreme position of the potentiometer, at which a voltage of 4-5 V is applied to the "SPEED" input. The potentiometer position where 0V is applied to the "SPEED" input corresponds to the minimum torque and motor current 0A. The potentiometer position where a voltage in the range of 0 to 50 mV is applied to the "SPEED" input is the dead zone. External potentiometer parameters: 10 kOhm.

Analog signal 0...10 V. In case of applying an external analog signal 0...10 V to the "SPEED" input, the maximum torque and motor current 40A corresponds to a signal level of 10 V. A signal level of 0V corresponds to the motor current 0A. The signal level range from 0 to 100 mV is the dead zone.

Analog signal 4...20 mA. When controlling the torque with an external current signal 4...20 mA, the maximum torque and current 40A corresponds to a signal level of 20 mA. The minimum torque and motor current of 5A corresponds to a signal level of 4 mA.

Analog signal -10...+10 V. When controlling the torque with a -10...+10 V analog signal, the maximum torque and current value 40A, and movement in the forward direction corresponds to the level of +10V. The maximum torque and current value 40A, and movement in the reverse direction corresponds to the level of -10V. The signal level range ± 500 mV is the dead zone.

PWM signal. When controlling the torque with a PWM signal with a frequency of 16 kHz, the maximum torque corresponds to a duty cycle of 100%. Duty cycle of 100% corresponds to a minimum motor current. When setting the minimum current value to 0A, the motor will brake at the speed set by the acceleration potentiometer.

6.1.2. Setting the motor acceleration

Use the built-in potentiometer "Acceleration" to set the acceleration and deceleration time. The extreme counterclockwise position corresponds to the maximum acceleration/deceleration time (minimum acceleration). The extreme clockwise position corresponds to the minimum acceleration/deceleration time (maximum acceleration). The acceleration time to maximum speed varies in the range from 0.5 to 5 seconds.

In the torque control mode, the acceleration potentiometer changes only the deceleration time.

Note: if, as a result of acceleration, the controller switches to the alarm state with the error code #2 (refer to Table 4), it is necessary to increase the acceleration time.

6.1.3. Setting the peak current limit

The internal potentiometer "Current" is used to set the peak power supplied to the motor. The extreme clockwise position corresponds to a motor current limit of 40 A, counterclockwise to a current limit of 5 A. When the limit is reached, if the current does not decrease within 5 seconds, an emergency stop of the motor (HARD STOP) is performed. The controller displays the HARD STOP error.

6.1.4 Motor stop method

By default, the controller uses the stop mode with the rotor closed on itself. Stopping with the rotor closed on itself allows the motor to stop rotating in a shorter period of time. It is possible to use the stop mode with the motor rotor open, the so-called "stop mode with open motor terminals". The mode is switched on by switch SW4 on the front panel: SW4 = ON - stop with open terminals, SW4 = OFF - stop with closed terminals.

6.2. Motor rotation control

After switching on the supply voltage, the device is ready for operation. The LED located on the board is continuously green.

Start/stop and reverse of the motor are carried out by external signals or by pressing buttons on the front panel of the controller. The buttons are activated when released, and external signals can be configured to be activated according to the front or level of the signal.

The controller can configure the logic for processing the control signals "START/STOP" and "DIR". The control signals are processed by a front or by a level, depending on the position of the microswitches SW1 (START/STOP signal) and SW2 (DIR) on the front panel (see the diagram in Fig. 2).

The OFF position of the microswitch determines the processing of the corresponding signal by a front, the ON position - by the signal level.

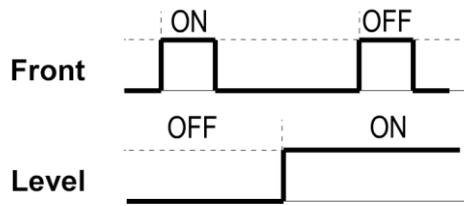


Fig. 5. Control signals START/STOP and DIR – front and level types.

6.2.1. Motor start/stop

The motor is started and stopped by the "START/STOP" 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 GND. The buttons on the front panel of the device, responsible for controlling the start and change of direction of the motor, operate when the button is released. Fig. 6 shows a diagram of the speed change when controlled by an external "START/STOP" signal by level (SW1 = ON) and a built-in button.

The logic of processing the "START/ STOP" signals under the following conditions:

External signal - **LEVEL**

Internal signal (button)- the **rear edge** of the signal

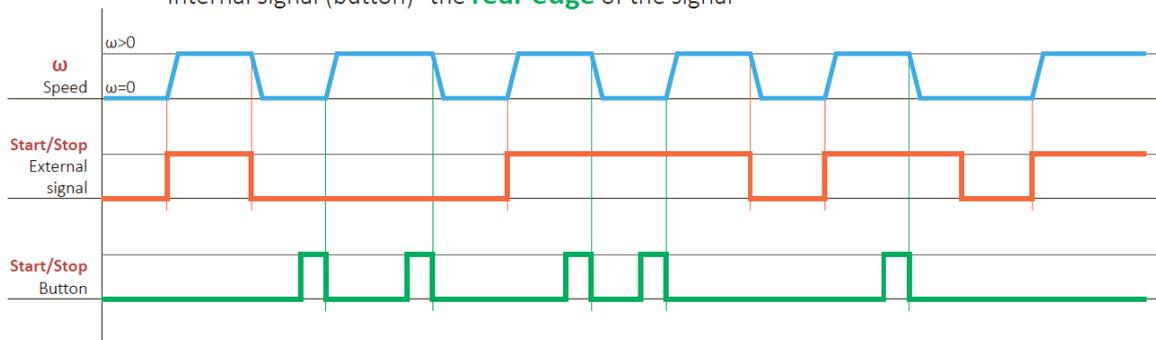


Fig. 6. Diagram of the coordinated operation of the external signal "START/STOP" and the built-in button.

6.2.2. Motor direction

The motor rotation direction is changed by the "DIR" button on the front panel of the controller or by an external signal, when the line connected to the "DIR" terminal is connected to the GND signal ground. In the -10...+10V control mode, the DIR button and the external DIR signal are not active. In this case, the direction of rotation is changed by changing the polarity of the voltage. Setting the external "DIR" signal is similar to the START/STOP signal - (see Fig. 2, Fig. 5). The DIR button and signal operate according to the OR logical circuit.

6.3. Alarm signal FAULT

If errors described in section 6.7 are detected, the FAULT output signal is triggered. The FLT output operates as follows: when an error occurs, the open-collector transistor switches the output to GND. Examples of connecting the error output signal are shown in Fig. 7 and Fig. 8.

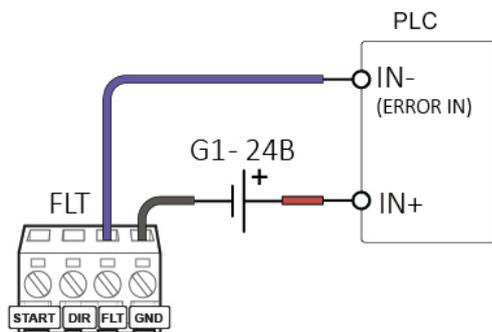


Fig. 7. Example of connecting to an external PLC.

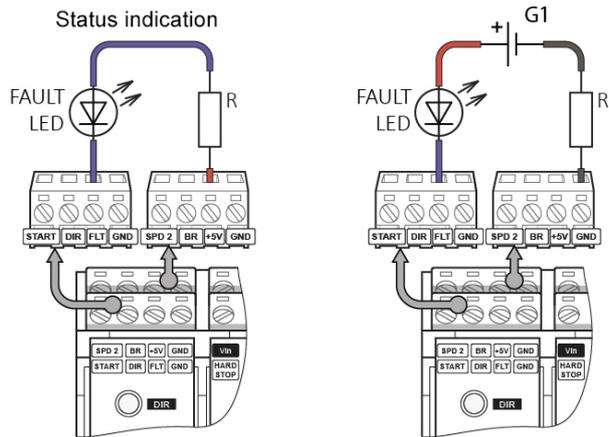


Fig. 8. Examples of connecting an indicator LED.

6.4. Emergency stop

The "HARD STOP" signal is used for the emergency stop of the motor. Operation is permitted when the HARD_STOP contact is closed to the GND signal ground. If the contact is disconnected, the controller switches to the emergency mode, the motor stops abruptly, and the corresponding error is indicated (refer to section 6.7).

Exit from the emergency mode is performed by switching off and then on the power supply.

6.5. Brake control

The controller provides the capability to control the motor's electromagnetic brake.

A normally closed brake holds the motor shaft when no voltage is applied to the brake. To release the motor rotor, power must be supplied to the brake. A normally open brake operates with the opposite logic—the shaft is locked when voltage is applied to the brake, and when voltage is not applied, the shaft rotates freely. The brake type is selected using microswitch SW5 on the front panel: SW5 = OFF - normally closed brake, SW5 = ON - normally open brake.

Brake control is available via the discrete "BRAKE" signal, as well as automatic braking. The control method is selected using microswitch SW6 on the front panel: SW6 = OFF - brake state controlled by the external "BRAKE" signal, SW6 = ON - automatic braking.

When controlling the brake using the external "BRAKE" signal (SW6 = OFF), voltage is applied or removed from the output terminals "BR+" and "BR-" depending on the brake type (SW5) and the state of the "BRAKE" signal.

Table 2. Brake control logic using external signal "BRAKE" (SW6 = OFF).

Brake inversion (SW5)	Signal «BRAKE»	State of brake connection output BR+\BR-
OFF	OFF	Vsup
OFF	ON	0
ON	OFF	0
ON	ON	Vsup

In automatic brake control mode (SW6 = ON), the brake is automatically applied when the motor stops and disengaged when the motor starts. In automatic brake control mode (SW6 = ON), the "BRAKE" signal is inactive.

Table 3. Control logic for automatic brake application (SW6 = ON).

Brake inversion (SW5)	Motor state	State of brake connection output BR+\BR-
OFF	OFF (stop)	0
OFF	ON (start)	Vsup
ON	OFF (stop)	Vsup
ON	ON (start)	0

6.6. Second speed

The controller can turn on a preset second speed. The second speed value is adjusted using the "SPEED 2" potentiometer. The second speed is turned on by closing the SECOND SPEED terminal to the GND signal ground. The function is only available in the speed control mode with the built-in potentiometer regulation (SW7=OFF, SW8=OFF, SW9=OFF).

6.7. Indication of operating modes and errors

The LED indicator on the front panel displays the controller state.

After applying the supply voltage in the normal mode:

- When the motor is off, the indicator lights up green constantly.
- When the motor is on, the indicator flashes green.

If the red LED lights up and remains lit during operation, this means that the maximum speed has been reached and further speed increase is impossible.

If an error is detected, the indicator displays the error code with a series of red flashes (Table 4).

Table 4. Status indication.

Error code	Indication	Description
0	Green on	Normal operation (motor off)
0	Green flashing	Normal operation (motor on)
0	Red on, no flashes	Normal operation (motor runs at maximum possible speed)
1	Single red flashes	Out of range of the internal 12V converter voltage
2	A series of 2 red flashes	Short circuit in the phase or motor current exceeds 100A
3	A series of 3 red flashes	Overheating of the internal braking circuit
4	A series of 4 red flashes	Overheating of the power stage

5	A series of 5 red flashes	Emergency stop of the motor (HARD_STOP)
6	A series of 6 red flashes	Test firmware version

Note: If a short circuit of the motor phases occurs or its current exceeds 100A for 15 μ s, the controller switches to emergency mode with the motor switched off and LED indication.

Note: If the controller switches to the alarm state with the error code #2 as a result of acceleration, it is necessary to increase the acceleration time.

7. Delivery in complete sets

DC brush motor controller 717551

1 pcs

8. Manufacturer information

RS Components 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.

9. Warranty

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

The manufacturer's sales department address:



RS Components Ltd, Birchington Rd, Corby, NN17 9RS, United Kingdom, rs-online.com

RS Components GmbH, Mainzer Landstrasse 180, 60327 Frankfurt/Main, Germany, rs-online.com