

# Silencer® Series Brushless Controllers

**BDO-Q2-40-05 (40 V, 5 A)**  
2-quadrant speed controller for brushless motors



## Instruction Manual

### GENERAL

- The BDO-Q2-40-05 controller is a 2-quadrant speed controller for electronically commutating three-phase brushless motors with Hall sensors which are offset at 120 electrical degrees.
- The speed of the motor is set by either an internal or an external potentiometer.
- The maximum constant current can be adjusted via an on-board potentiometer.
- The direction of rotation of the motor can be preset by the **Direction** control input. The controller output stage can be activated and deactivated by the **Brake** control input and the **Disable** control input.
- The controller is safeguarded against heat overload by an internal thermal cutoff.
- The controller output stage has been constructed using POWER-MOSFET technology, resulting in very high efficiency. With a maximum constant current of 5 A, the motor voltage is reduced by a maximum 4 V.

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COMPONENTS GROUP

# SPECIFICATIONS

ELECTRICAL DATA	BDO-Q2-40-05
Operating voltage <b>-+input and Gnd</b> Residual voltage < 5 %	12 - 40 VDC
Maximum constant current (adjustable) • Without additional cooling surfaces (free convection) • With additional convection (< 1.8 K / W)	0.5 - 3.5 A 0.5 - 5.0 A
Peak current limitation (cycle by cycle)	10.0 A
Supply voltage for Hall sensors	6 V / 20 mA

## INPUTS

- Direction of rotation – (**REV**) open collector / TTL / CMOS / switch
- Brake - (**BRAKE**) open collector / TTL / CMOS / switch
- Disable output stage – (**DIS**) open collector / TTL / CMOS / switch

## TEMPERATURE RANGE

Storage -104 to 185°F (-40 to +85°C)  
Operation -50 to 113°F (-10 to +45°C)

## MOISTURE RANGE

20 to 80% non-condensed

## MECHANICAL DATA

Weight - 4.37 oz (124 g)  
Dimensions - (L x W x H) - 3.54 x 1.97 x 1.18 in (90 x 50 x 30 mm)  
Mounting - 4 x M4 with a distance between holes of 3.15 x 1.18 in (80 x 30 mm)

## ASSEMBLY NOTE

Optimum heat dissipation is achieved by mounting the BDO-Q2-40-05 controller on a heat sink, and through the use of a thermal conduction paste.

For longer distances between the motor and the control unit, > 12 in (30 cm), shielded cables should be used for the sensor cable and the motor cable.

## SAFETY NOTE

Operating voltages > 40 VDC or cross-connection of the + Input and Gnd inputs will destroy the BDO-Q2-40-05 controller and will void the product warranty.

Unauthorized opening and improper repairs will put the user in danger and will void the product warranty.

If the BDO-Q2-40-05 controller is brought from a cold environment into the operating environment, there can be condensation. Wait until the controller has reached the ambient temperature of the operating environment, and is absolutely dry before it is put into operation.

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TERMINATION TABLE		
Terminal #	Nomenclature	Description
1	REV	Reverse Motor Direction
2	GND	Signal Ground
3	SV	External Speed Input
4	+6 V	Reference Voltage for Control Inputs
5	GND	Supply Voltage - Ground
6	+INPUT	Supply Voltage - Positive
7	DIS	Controller Disable Input
8	BRAKE	Controller Brake Input
9	S1	Hall Switch #1
10	S2	Hall Switch #2
11	S3	Hall Switch #3
12	VCC	Hall Switch Supply Voltage
13	GND	Hall Switch Ground
14	ØB	Motor Phase B
15	ØC	Motor Phase C
16	ØA	Motor Phase A

### CONTROL INPUTS

Control inputs 1 (Reverse), 7 (Disable) and 8 (Brake) can be enabled either by an external switch, an open collector transistor, or by means of TTL / CMOS components. This connection is made to 2 (Gnd).

Control input	Input open or high level	Input on Gnd or low level
Rev	Turning to the right (CCW)	Turning to the left (CW)
Dis	Controller active	Controller inactive
*Brake	Controller inactive	Controller active

\*Note: If the **Brake** input is not used, please jumper between 8 (Brake) and 2 (Gnd).

### SELECTING MOTOR DIRECTION-OF-ROTATION

Reversing the direction of motor rotation is easily accomplished. Using a switch, relay contact, or simply a jumper wire, connect the terminal labeled **Rev.** to the terminal labeled **Gnd.**

Note: Do not reverse motor direction while the motor is rotating. The controller is not designed for instantaneous reversing.

### SPEED CONTROL

Motor speed may be controlled via one of the following three methods (see page 4 and 5 for detail instructions):

1. On-Board Speed Potentiometer
2. External Speed Potentiometer – (Recommend 10k – 10 Turn Precision Potentiometer)
3. External Control Voltage

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The following is a procedure for using each of the speed control methods mentioned on page 3.

### 1. On-Board Speed Potentiometer

- A. Place a jumper from terminal labeled **GND** to terminal labeled **SV**.
- B. Rotate the trimpot labeled **Speed** fully **CW**.
- C. Rotate the trimpot labeled **nmax** fully **CW**.
- D. Apply the operating input voltage across **+ Input** and **Gnd**, being careful to observe polarity.  
**Do not apply an incremental input voltage, but rather a single step voltage.**
- E. Motor should now be running at full speed. Measure and record speed.
- F. Slowly rotate the **nmax** trimpot **CCW** until the motor speed decreases slightly, then slowly rotate the trimpot back **CW** until the motor is once again running at full speed (see value recorded in step **E**).
- G. The **nmax** trimpot is now “tuned” to the motor currently connected to the controller and will not require readjustment unless a different motor is connected to the controller, or the level of the input voltage is changed.
- H. Motor speed may now be varied by using the **Speed** trimpot.

### 2. External Speed Potentiometer (Optional)

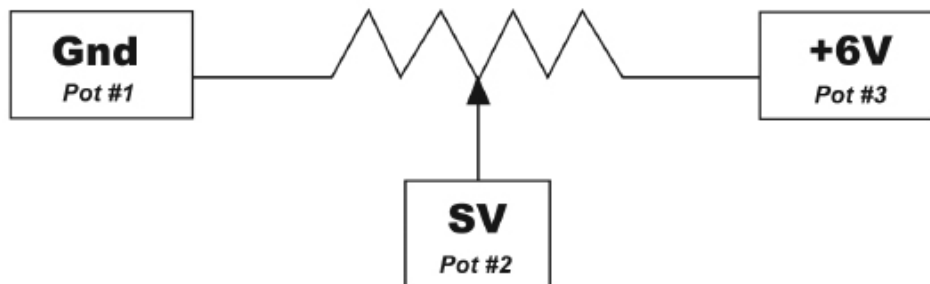
**NOTE: See Figure 1 for connection diagram for External Speed Potentiometer.**

- A. Rotate the **External Speed Potentiometer** fully **CCW**.
- B. Rotate the trimpot labeled **Speed** fully **CCW**.
- C. Rotate the trimpot labeled **nmax** fully **CW**.
- D. Apply the operating input voltage across **+ Input** and **GND**, being careful to observe polarity.  
**Do not apply an incremental input voltage, but rather a single step voltage.**
- E. Motor should now be running at full speed. Measure and record speed.
- F. Slowly rotate the **nmax** trimpot **CCW** until the motor speed decreases slightly, then slowly rotate the trimpot back **CW** until the motor is once again running at full speed (see value recorded in step **E**).
- G. The **nmax** trimpot is now “tuned” to the motor currently connected to the controller and will not require readjustment unless a different motor is connected to the controller, or the level of the input voltage is changed.
- H. Motor speed may now be varied by using the **External Speed Potentiometer**.

**Note:** Pot #1 = Potentiometer Terminal #1, Pot #2 = Potentiometer #2, Pot #3 = Potentiometer Terminal #3

Figure 1

### Connection Diagram for External Speed Potentiometer



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### 3. External Voltage Control (Optional)

By applying a DC voltage between 3 (SV) and 2 (Gnd), the following conditions are observed:

- A. 0 to 0.5 volts – **speed = 0.**
- B. 0.5 to 5.0 volts – **speed range in control operation.**
- C. 5.0 to 10.0 volts – **no pulse-width-operation-control works in simple commutation mode.**
- D. On-board speed potentiometer must be set fully **CCW**.

**Note:** Some power supplies used to supply this external voltage may contain large amounts of ripple. If speed control is **unstable**, please install a **10µF electrolytic capacitor** across 9 (Spd) and 8 (Gnd). **BE SURE TO OBSERVE POLARITY WHEN INSTALLING THIS CAPACITOR; 9=Positive, 8=Gnd.**

## CURRENT LIMITING

Current limiting is available via the on-board current potentiometer. The settings are as follows:

**Fully CCW** – maximum setting

**Fully CW** – minimum setting

## FUSING

Proper overcurrent protection (fusing) is required for the protection of this controller. We recommend a **5 amp – 120 volt – non-time delay** fuse. This fuse should be connected in series with the **+ Input** line going to the controller.

**Note: Considerations regarding the power supply:**

Output voltage: **> 12 V and < 40V** with a residual voltage of **< 5%**

Output Current: corresponding to the necessary torque and possible reserves for acceleration

**Note: Procedure for calculating the necessary minimum supply voltage:**

Default: Torque  $M_B$  [mNm]  
Operating speed  $n_B$  [min<sup>-1</sup>]  
Rated voltage of the motor  $U_N$  [V]  
Idling speed with  $U_N$   $n_0$  [min<sup>-1</sup>]  
Characteristic curve slope  $\frac{\Delta n}{\Delta M}$  [min<sup>-1</sup> mNm]

Result: 
$$V_{cc} = \frac{U_N}{n_0} * (n_B + \frac{\Delta n}{\Delta M} * M_B) + 4V$$

## HOOK-UP PROCEDURE

1. Connect motor connections (**φA, B, and C**).
2. Connect Hall sensors (**S1, S2, and S3**), as well as the Hall voltage supply (**V<sub>cc</sub> and Gnd**) of Hall sensors.
3. Connect the control inputs according to the requirements (**Rev., Dis., and Brake**).
4. Connect the supply voltage (**+ input and gnd**).
5. Set up the speed control for the controller (**depending upon which method of speed control is used - see Speed Control**).
6. After completion of step #5, speed control is now active.
7. Set the maximum current via the on-board speed potentiometer (**current**).

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