Hardware Manual

BD5/10 Brushless DC Motor Drive

Applied Motion Products

920-0065D
2/14/2014

Contents

Safety Instructions

Only qualified personnel are permitted to transport, assemble, commission, and maintain this equipment. Properly qualified personnel are persons who are familiar with the transport, assembly, installation, commissioning and operation of motors, and who have the appropriate qualifications for their jobs. The qualified personnel must know and observe the following standards and regulations:

IEC 364 resp. CENELEC HD 384 or DIN VDE 0100
IEC report 664 or DIN VDE 0110
National regulations for safety and accident prevention or VBG 4

To minimize the risk of potential safety problems, you should follow all applicable local and national codes that regulate the installation and operation of your equipment. These codes vary from area to area and it is your responsibility to determine which codes should be followed, and to verify that the equipment, installation, and operation are in compliance with the latest revision of these codes.

Equipment damage or serious injury to personnel can result from the failure to follow all applicable codes and standards. We do not guarantee the products described in this publication are suitable for your particular application, nor do we assume any responsibility for your product design, installation, or operation.

• Read all available documentation before assembly and commissioning. Incorrect handling of products in this manual can result in injury and damage to persons and machinery. Strictly adhere to the technical information on the installation requirements.

• It is vital to ensure that all system components are connected to earth ground. Electrical safety is impossible without a low-resistance earth connection.

• The BD5/10 contains electrostatically sensitive components that can be damaged by incorrect handling. Discharge yourself before touching the product. Avoid contact with high insulating materials (artificial fabrics, plastic film, etc.). Place the product on a conductive surface.

• During operation keep all covers attached, otherwise, there are deadly hazards that could possibility cause severe damage to health or the product.

• In operation, depending on the degree of enclosure protection, the product can have bare components that are live or have hot surfaces. Control and power cables can carry a high voltage even when the motor is not rotating.

• Never pull out or plug in the product while the system is live. There is a danger of electric arcing and danger to persons and contacts.

• After powering down the product, wait at least ten minutes before touching live sections of the equipment or undoing connections (e.g., contacts, screwed connections). Capacitors can store dangerous voltages for long

periods of time after power has been switched off. To be safe, measure the contact points with a meter before touching.

Be alert to the potential for personal injury. Follow the recommended precautions and safe operating practices. Safety notices in this manual provide important information. Read and be familiar with these instructions before attempting installation, operation, or maintenance. The purpose of this section is to alert users to possible safety hazards associated with this equipment and the precautions that need to be taken to reduce the risk of personal injury and damage to the equipment. Failure to observe these precautions could result in serious bodily injury, damage to the equipment, or operational difficulty.

Introduction

Thank you for selecting an Applied Motion Products BD Drive. We hope our dedication to performance, quality and economy will make your motion control project successful.

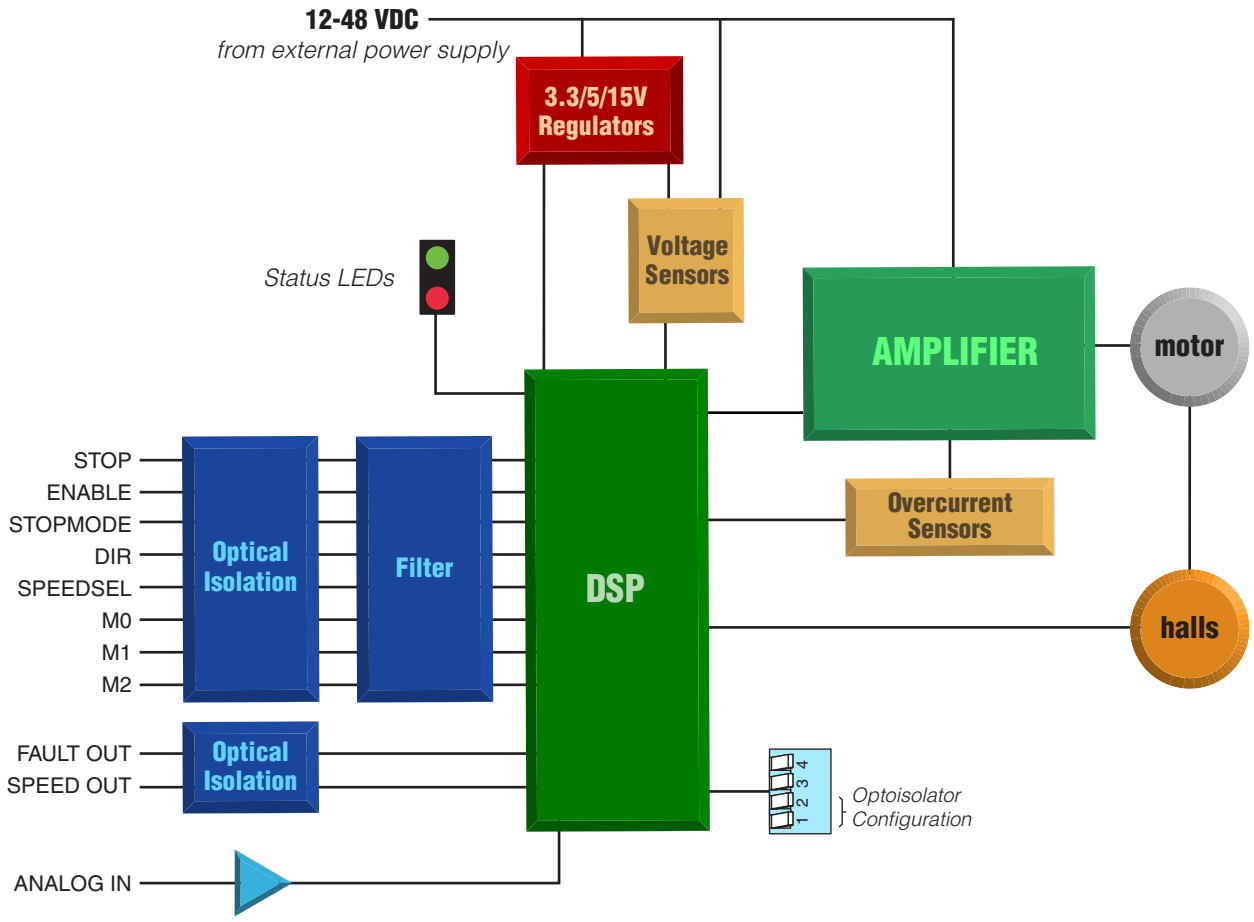
The BD5/10 is a DC powered brushless DC drive, with advanced control technology, excellent performance and ease of use.

If you have any questions or comments, please call Applied Motion Products Customer Support: (800) 525-1609, or visit us online: www.applied-motion.com.

Features

- Velocity modes controlled via analog input, digital input or on board trimpot
- 0 - 4500 rpm continuous, 5000rpm peak.
- Acceleration rate set by on board trimpot.
- Power supply: 12-48VDC
- Current output:
  - BD5-G1-AH 1.75Arms cont/3.5Arms peak (5 sec max)
  - BD5-G2-AH 3.5Arms cont/7Arms peak (5 sec max)
  - BD5-G3-AH 6.25Arms cont/12.5Arms peak (5 sec max)
  - BD5-H2-AH 3.2Arms cont/6.4Arms peak (5 sec max)
  - BD10-H4-AH 6.9Arms cont/13.8Arms peak (5 sec max)
  - BD10-H5-AH 4.5Arms cont/9.0Arms peak (5 sec max)
  - BD5-I6-AH 5.0Arms cont/10.0Arms peak (5 sec max)
  - BD10-I7-AH 10Arms cont/20Arms peak (5 sec max)
  - BD10-I8-AH 7.5Arms cont/15Arms peak (5 sec max)
- Motors Currently Offered:
  - BL030-H03-G, 42MM, 30W, 24V
  - BL060-H03-G, 42MM, 60W, 24V
  - BL090-H03-G, 42MM, 90W, 24V
  - BL060-H03-H, 57MM, 60W, 24V
  - BL120-H03-H, 57MM, 120W, 24V
  - BL180-H04-H, 57MM, 180W, 48V
  - BL100-H03-I, 80MM, 100W, 24V
  - BL200-H04-I, 80MM, 200W, 48V
  - BL300-H04-I, 80MM, 300W, 48V
- Protection against over voltage; under voltage; over temperature, short circuit(phase to phase, phase to ground), bad Hall signal
- Inputs & Outputs
  - one 0-5V analog input
  - eight 5-24V single-ended digital inputs, can be configured for sinking or sourcing
  - two differential digital outputs
  - all digital inputs and outputs are optically isolated
- Compact size: 100×65×30mm
- Available with nine performance matched, BLDC motors: 30 to 300 watts continuous output.
- CE pending and RoHS compliant

Block Diagram

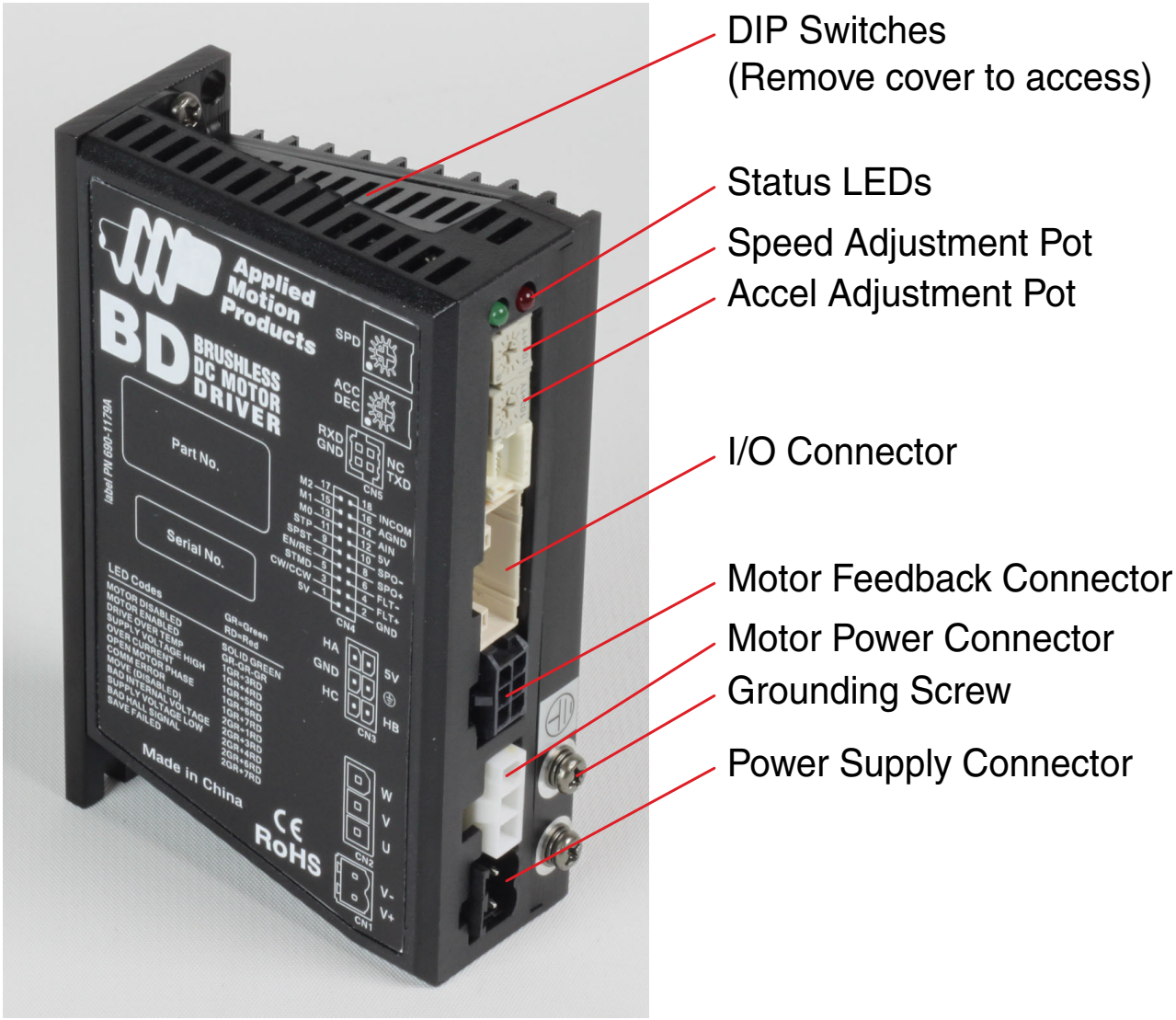


Getting Started

To use the drive model BD5/10, you should have the following:

- A DC power supply (12-48V)
- A compatible motor
- A small flat blade screwdriver for tightening the connectors. A screwdriver suitable for this purpose is included with your drive
- I/O cable connector

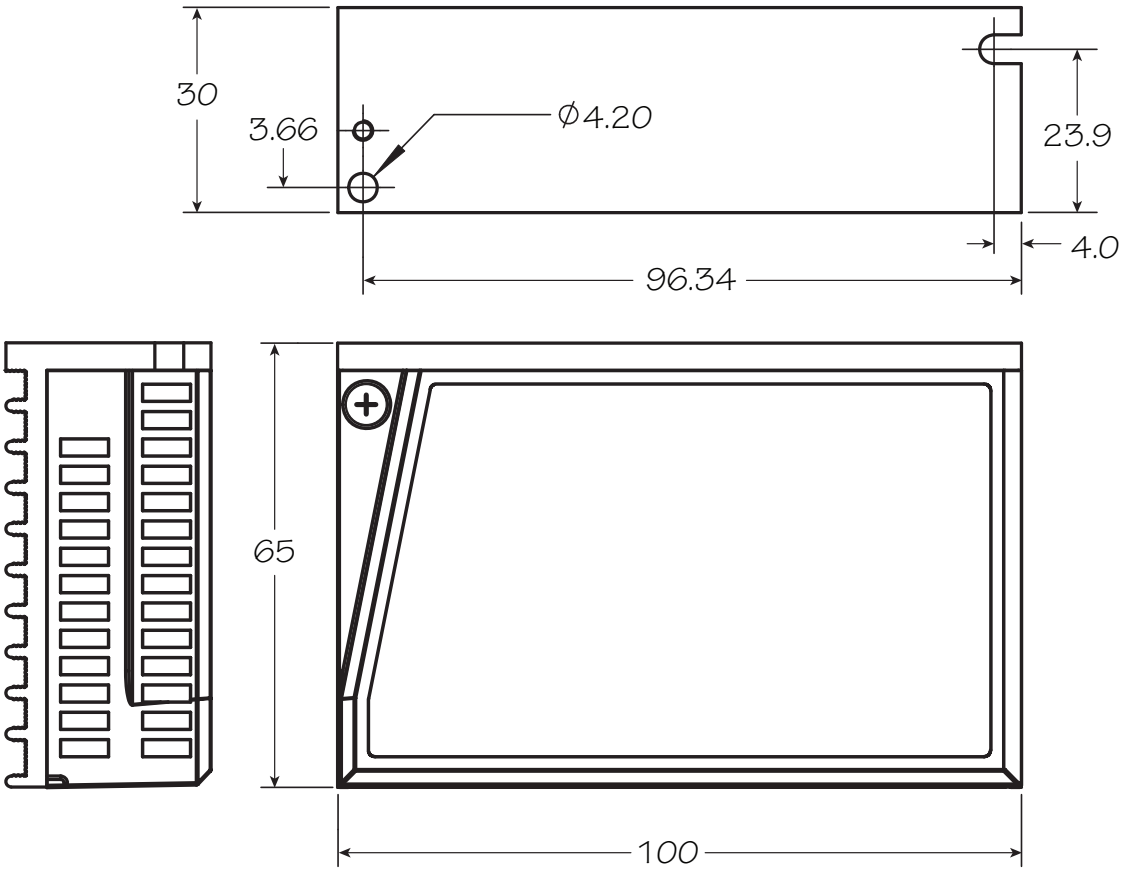
The photograph shows the location of important connection and adjustment points.
Please examine it now.



Drive Mounting

You can mount your drive on the narrow side of the chassis using #6 screws. The drive should be securely fastened to a smooth, flat metal surface that will help conduct heat away from the chassis. If this is not possible, then forced airflow from a fan may be required to prevent the drive from overheating.

- Never use your drive in a space where there is no air flow or where the ambient temperature exceeds 40°C.
- Never put the drive where it can get wet.
- Never allow metal or otherwise conductive particles near the drive.

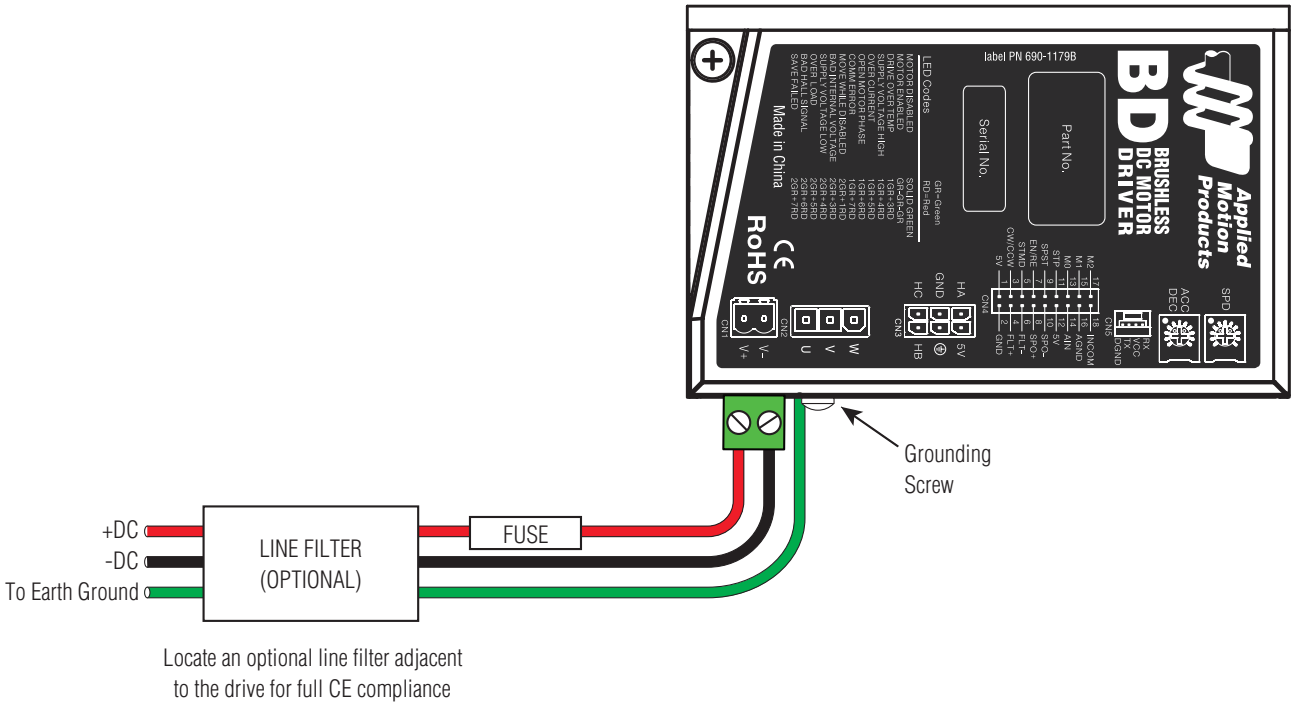


Dimensions are in millimeters

Connecting the Power Supply

The BD5/10 accepts a DC power supply voltage from 12 to 48V. Using the connector supplied and AWG16 or 18 wire, connect to the power supply as shown below:

Be careful not to reverse the wires. Reverse connection may destroy your drive.



Locate an optional line filter adjacent to the drive for full CE compliance

External (Line) Fuse Criteria

We recommend the Bussman ABC series of fast-blo, ceramic body fuses.

For all DC supply currents up to 9A (this includes peak values) use the ABC-12-R This is a 12A fast-blo ROHS fuse.

For all currents above 9A (this includes peak values) use the ABC-15-R. This is a 15 A fast-blo ROHS fuse.

The internal fuse is not user-replaceable, if tripped, the unit must be returned for repair.

Power Supply Voltage Requirement

Normal operating range: 12 to 48 VDC
Overvoltage shutdown: 62 VDC.
Undervoltage alarm: 8.5 VDC.
Undervoltage shutdown: 6 VDC.

Power Supply Current Requirement

To determine the size of the power supply you will need for your application, use one of the formulas below to calculate the rating of the power supply in Watts. Remember to use the peak torque value which typically occurs during acceleration. Note that these formulas include a 35% safety factor to account for the efficiency of the motor and drive.

For torque in oz-in and speed in rpm:
Rating of power supply in Watts = Torque * Speed / 1000

For torque in N-m and speed in rpm:
Rating of power supply in Watts = Torque * Speed / 7

Examples:

1. The application requires 35 oz-in maximum at a top speed of 1200 rpm.
   (35 oz-in) * (1200 rpm) / 1000 = 42 Watts
   Note: The PS50A24 power supply from Applied Motion is rated for 50 Watts and would be a good choice for this application.
2. The application requires 0.4N-m maximum at a top speed of 3600 rpm.
   (0.4 N-m) * (3600 rpm) / 7 = 206 Watts
   Note: The PS320A48 power supply from Applied Motion is rated for 320 Watts and would be a good choice for this application.

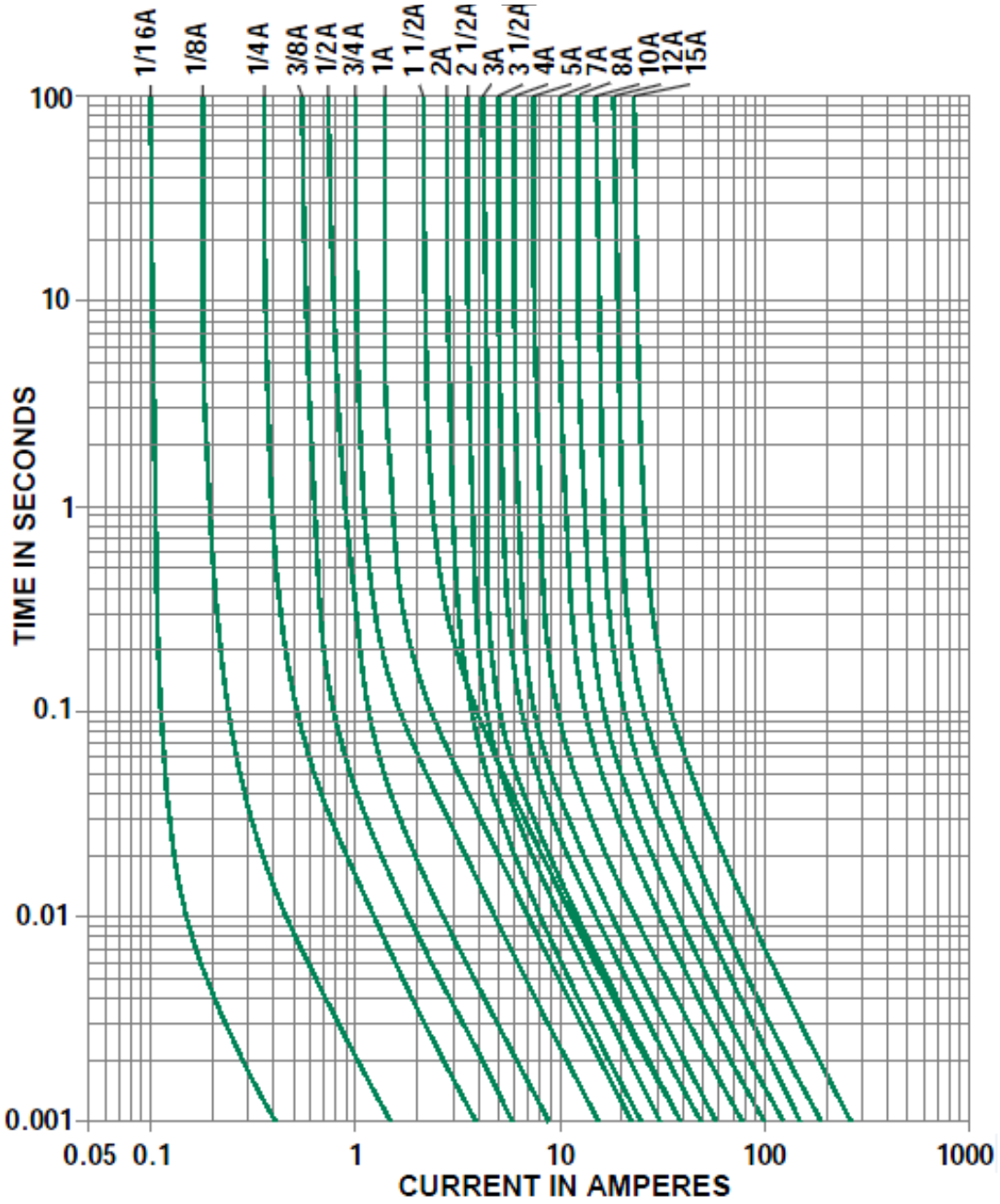
Applied Motion Products currently offers the following power supplies:

MOTOR	POWER- WATTS	POWER SUPPLY
BL030-H03-G	30	PS50A24
BL060-H03-G	60	PS150A24
BL090-H03-G	90	PS320A48
BL060-H03-H	60	PS150A24
BL120-H03-H	120	PS320A48
BL180-H04-H	180	PS320A48
BL100-H03-I	100	PS320A48
BL200-H04-I	200	PS320A48
BL300-H04-I	300	N/A

Current Inrush Limiting

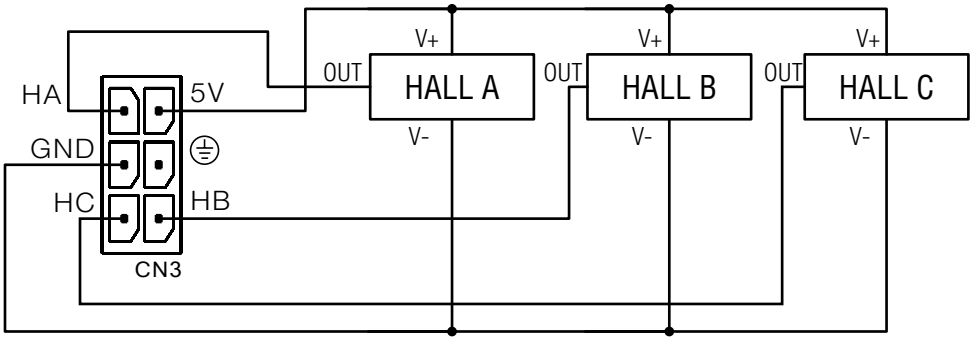
Power input to drive has no provision for current inrush limiting. Recommended operation is to use current limited power supplies.

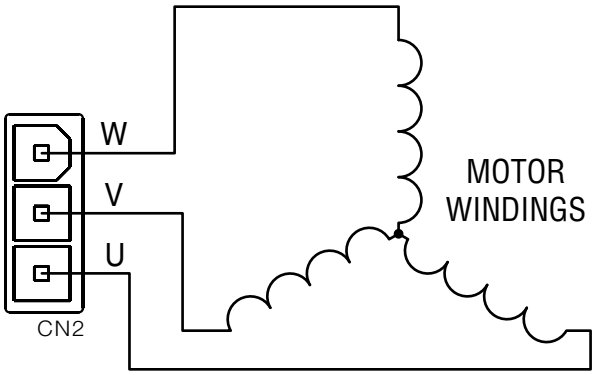
Power Input Fuse – an input fuse is incorporated into the drive to prevent catastrophic failure when the power supply is connected with reversed polarity. The internal fuse is a 15-Amp Fast-acting surface mount fuse type. This fuse must be replaced by our service technicians if it is tripped. An appropriate line fuse should be used for protection of the internal fuse, as shown on page 9.



Connecting the Motor

Never connect or disconnect the motor to the drive when the power is on. Insulate unused motor leads separately, and then secure. Never connect motors to ground or to a power supply.





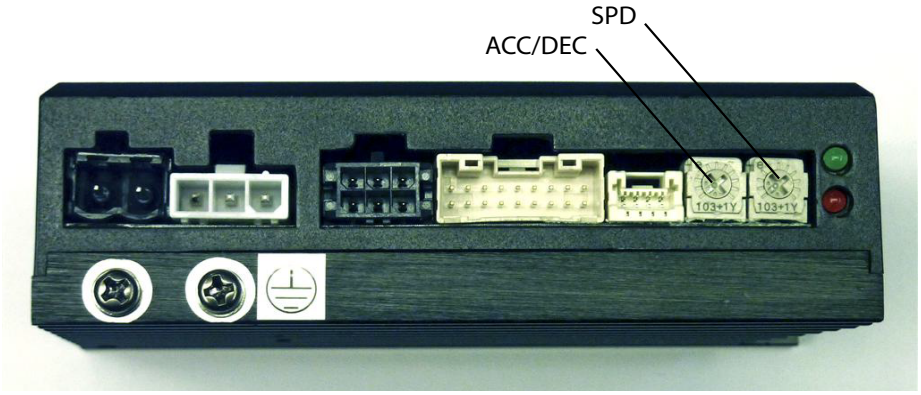
Trimpots

SPD

Used for adjusting the motor speed. Range is 0 to 4500 rpm and is active when pin 9 (SPST) is open.

ACC/DEC

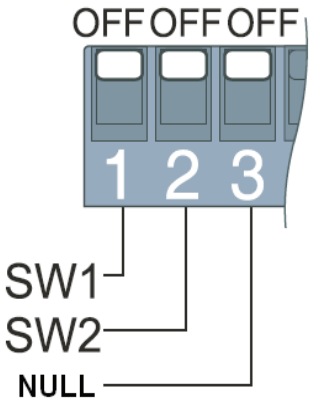
Used for adjusting the motor acceleration/deceleration rate. Range is 0 to 3000 rev/sec^2. Turn CW for shorter ramp times, i.e. faster accel/decel rates.

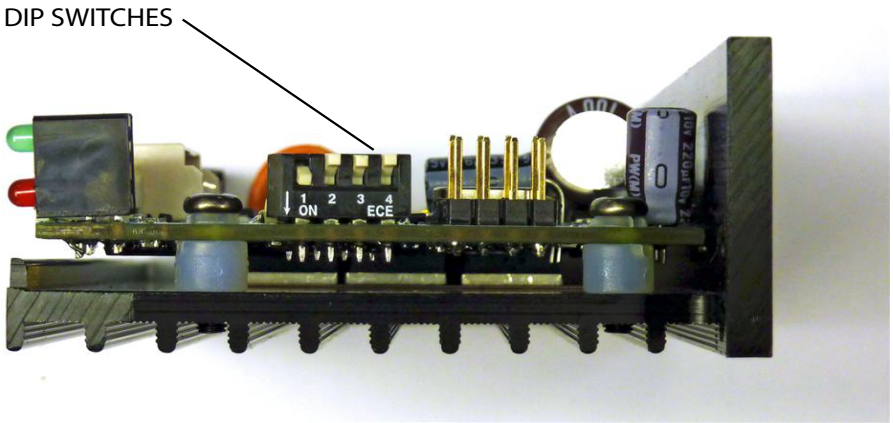


Dip Switches

Inside the BD drive are four switches that can be used to select whether internal or external power is applied to the optoisolator input circuits. There are four choices:

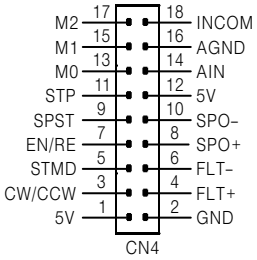
1. An external power supply +lead is applied to the INCOM terminal. Sinking signals must be used to control the inputs. Set DIP switches 1 and 2 to OFF. There is full optical isolation under this condition.
2. Sourcing signals are applied to the inputs. INCOM is connected to the GND of the external power supply. Also set DIP switches 1 and 2 to OFF. There is full optical isolation under this condition.
3. The internal 5V power supply is applied to INCOM. The inputs are driven with sinking signals connected to pin 2, the GND pin. Set DIP switch 1 to ON and DIP switch 2 to OFF.
4. The internal GND is applied to INCOM. Sourcing signals powered by pin 12 (+5V) are used to drive the inputs. Set DIP switches 1 and 2 to ON.





Inputs and Outputs

All inputs and outputs are available on one dual-row, 18-pin connector (2 mm pitch). See page 29 for mating connector recommendations. The pin-outs are as follows:



I/O Connector Pin Diagram

INPUT & OUTPUT TABLE

PIN NUM	SIGNAL TYPE	SIGNAL NAME	FUNCTION
		BASIC	BASIC
1	POWER SUPPLY	5V	The drive provides users with up to 50mA +5V supply
2		GND	External control signal GND
18		INCOM	External opto-coupler power input.
3	INPUT	CW/CCW	controls motor direction of rotation. open=CW.
5		STMD	Stop mode select
7		EN/RE	Motor enable/disable. It can be used for alarm reset as well.
9		SPST	Internal/external speed select
11		STP	Start/Stop command input. See next section for steps to test the motor using the internal voltage supply as a command source (SW1=ON; SW2=OFF).
13		M0	For multi-speed operation, the M0, M1, M2 signals are used in combination.
15		M1	
17		M2	
12	ANALOG INPUT	5V	Used to command speed when SPEED-SET input is closed. 5V = 4500 rpm
14		AIN	
16		AGND	
4	OUTPUT	FLT+	Fault output
6		FLT-	
8		SPO+	Output closes when motor reaches target speed +/- 200 rpm
10		SPO-	

Motor Test

- Ensure that DIP switch 1 is ON and 2 is OFF (to use internal power supply for I/O). Note, it may be necessary to remove the external cover to access the internal DIP switches. It may also be possible to access these switches by carefully reaching through the slots with the small screw driver that is included.
- Speed and accel/decel settings are controlled by on-board potentiometers, adjustable using the included screwdriver.
- Plug in both connectors of matching BL motor.
- Apply power to the drive.
- TESTING: To start the motor spinning, connect STP (pin11, black/white) to GND (pin2) and adjust the SPD pot to the desired speed. To reverse direction, connect CW/CCW (yellow) to GND (pin2).

Input/Output Connector Wire Colors

The signal names and colors used on the I/O cable provided with each drive are as shown below:

BD5/10 PIN	BD5/10 FUNC-TION	COLOR	COLOR CODE
1	5V	RED	
2	GND	BLK	
3	CW/CCW	YEL	
4	FLT+	GRN	
5	STMD	BLU	
6	FLT-	ORG	
7	EN/RE	GRY	
8	SPO+	VIO	
9	SPST	BRN	
10	SPO-	WHT	
11	STP	BLK/WHT	
12	5V	RED	
13	M0	YEL/WHT	
14	AIN	GRN/WHT	
15	M1	BLU/WHT	
16	AGND	BLK	
17	M2	RED/WHT	
18	INCOM	ORG/WHT	

Input Signals

Note: When working with inputs and outputs it is important to remember the designations "low" and "high". If current is flowing into or out of an input/output the logic state for that input/output is defined as low (or ON, or closed). If no current is flowing, or the input/output is not connected, the logic state is high (or OFF, or open).

CW/ CCW

Opening pin 3 will cause the motor to turn CW as viewed from the motor shaft. Closing pin 3 will cause the motor to turn CCW. The starting time is the time set by the acceleration potentiometer (ACC/DEC).

STMD (STOP-MODE)

When pin 5 is open, the motor will stop according to the deceleration set by the acc/dec potentiometer. When pin 5 is closed, it will stop the motor using electromagnetic braking (shorting the motor windings).

EN/RE (ENABLE/RESET)

When pin 7 is open, the motor will be energized. When pin 7 is closed, the motor will be disabled. Regardless of any other input status, pin 7 being closed has the highest priority, so that it can be used as an emergency stop.

SPST (SPEED SELECT)

Pin 9 open: Internal speed setting by SPD trimpot
Pin 9 closed: External signal setting by analog input

Multi-speed operation (M0,M1,M2)

9 preset speeds are selectable using SPST, M0, M1 and M2 inputs. (X = don't care)

SPST	M0	M1	M2	Speed (RPM)
CLOSED	OPEN	OPEN	OPEN	by analog input
OPEN	OPEN	OPEN	OPEN	by SPD trimpot
X	CLOSED	OPEN	OPEN	500
X	OPEN	CLOSED	OPEN	1000
X	CLOSED	CLOSED	OPEN	2000
X	OPEN	OPEN	CLOSED	3000
X	CLOSED	OPEN	CLOSED	3500
X	OPEN	CLOSED	CLOSED	4000
X	CLOSED	CLOSED	CLOSED	4500

STP (STOP)

Overrides all commands for motion and stops the motor using the method selected by the STMD input pin 5.

Analog Input (AIN)

A 0 to 5V analog input is provided for setting the motor speed. 5V = 4500 rpm. This speed is used when the M0, M1 and M2 inputs are open (OFF) and the SPST input is closed (ON).

Output Signals

FLT (FAULT)

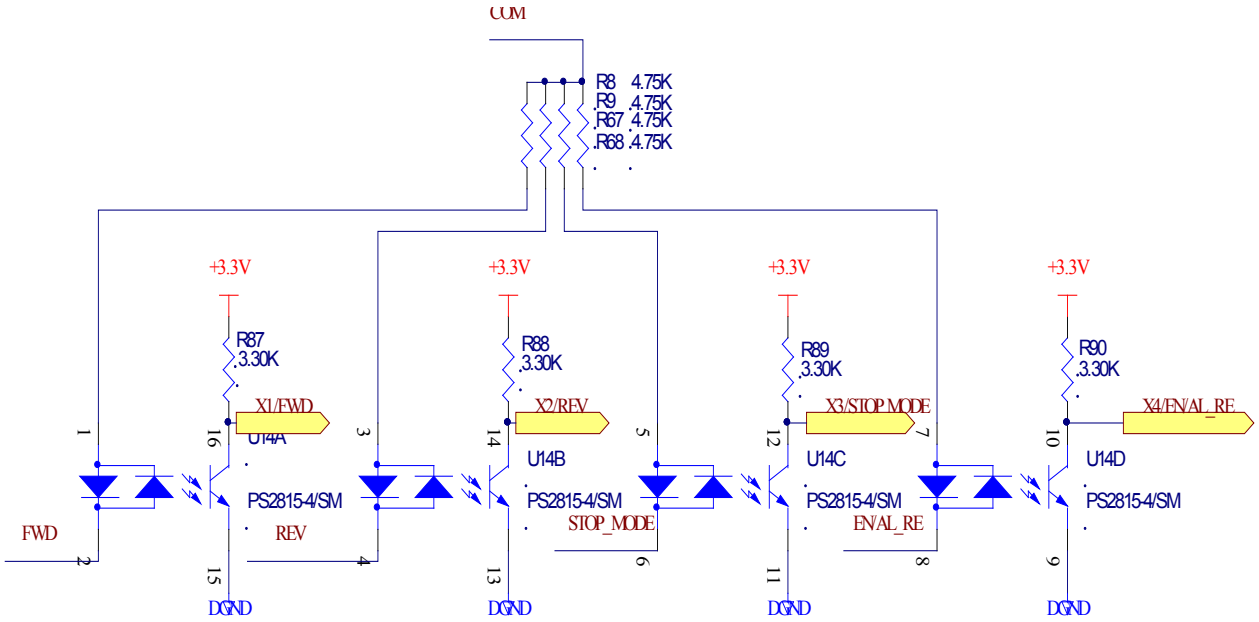
Closes for the following conditions: overtemperature, overcurrent, under voltage, overvoltage, internal voltage error.

SPO (SPEED OUT)

This output closes when the motor is within 200 rpm of the target speed..

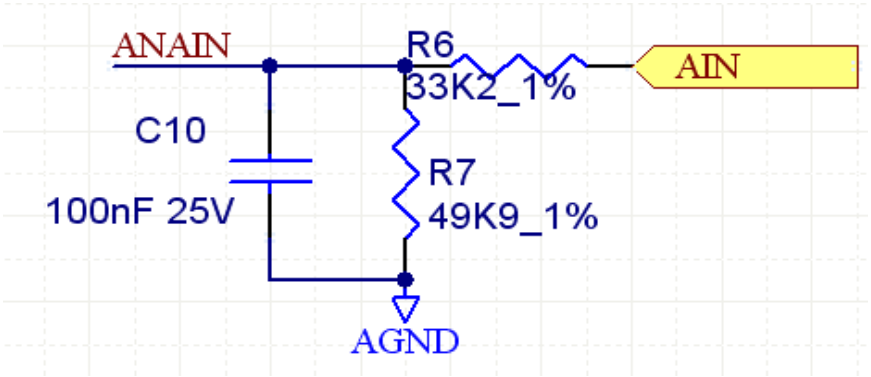
Digital Input Circuit

Eight 5-24 volt single-ended and optically Isolated sinking or sourcing inputs.

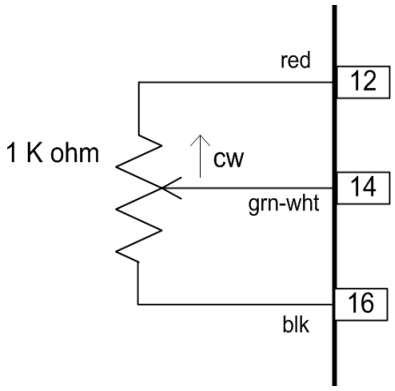


Analog Input Circuit

Allows an external speed potentiometer or analog signal to set speed. The input voltage range is 0 to 5VDC. Resolution is 12 bits.

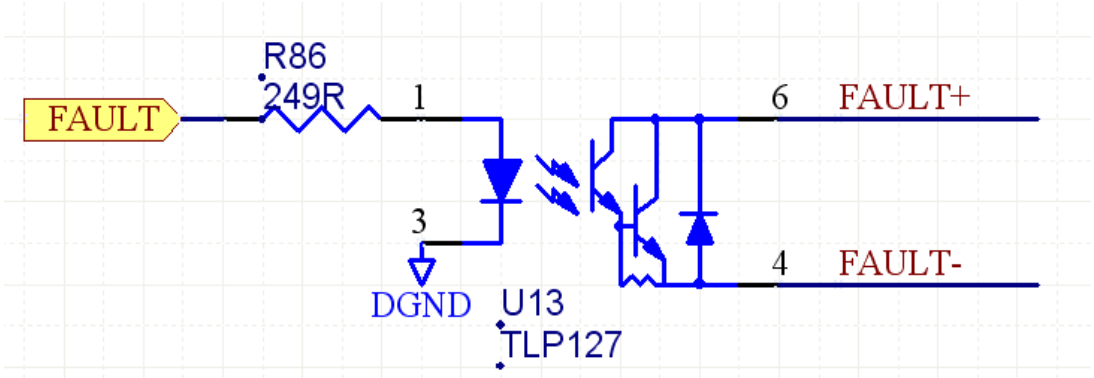


Wiring an External Speed Potentiometer



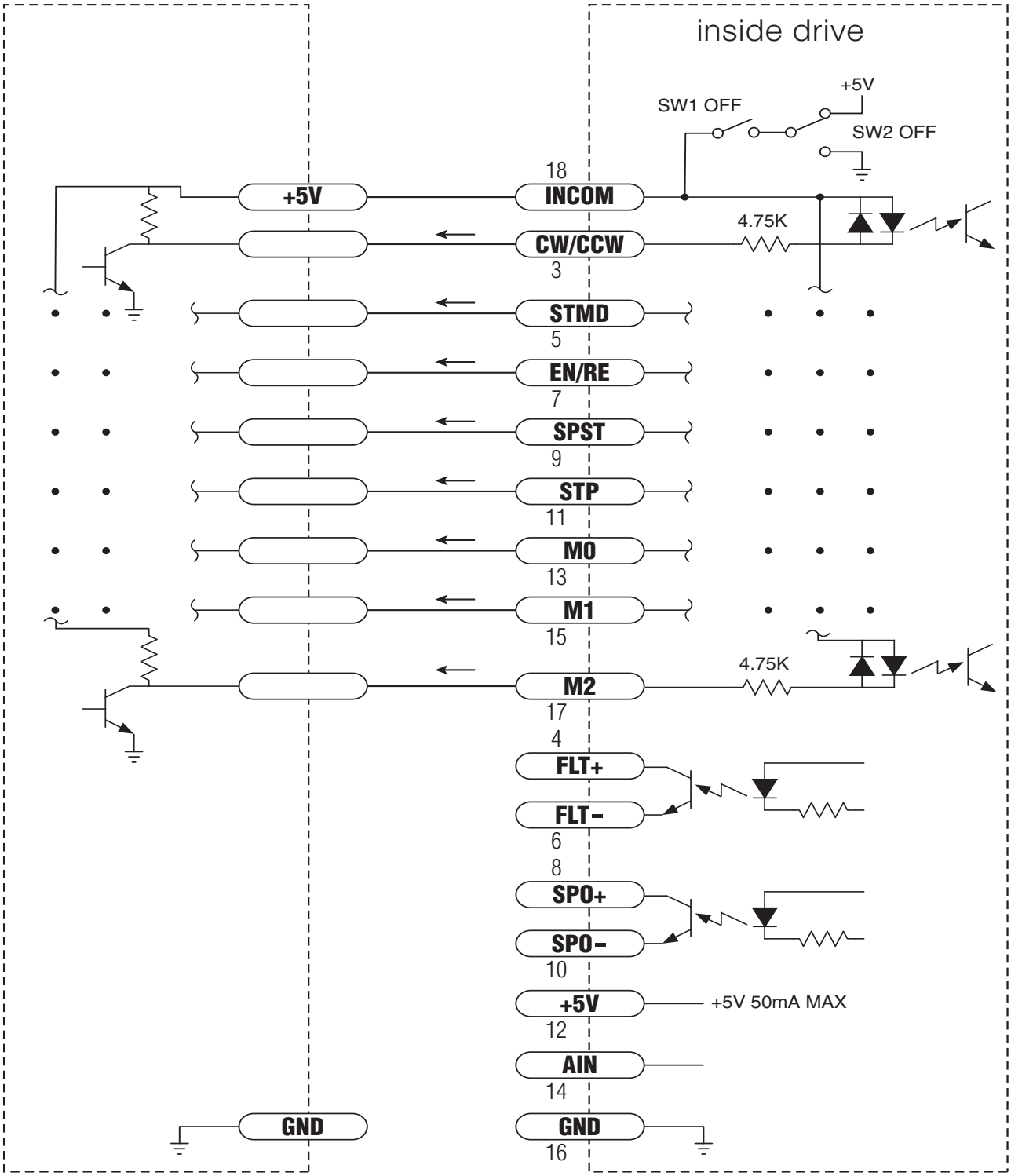
Digital Output Circuit

0 - 30 volt 80mA open collector, optically Isolated.

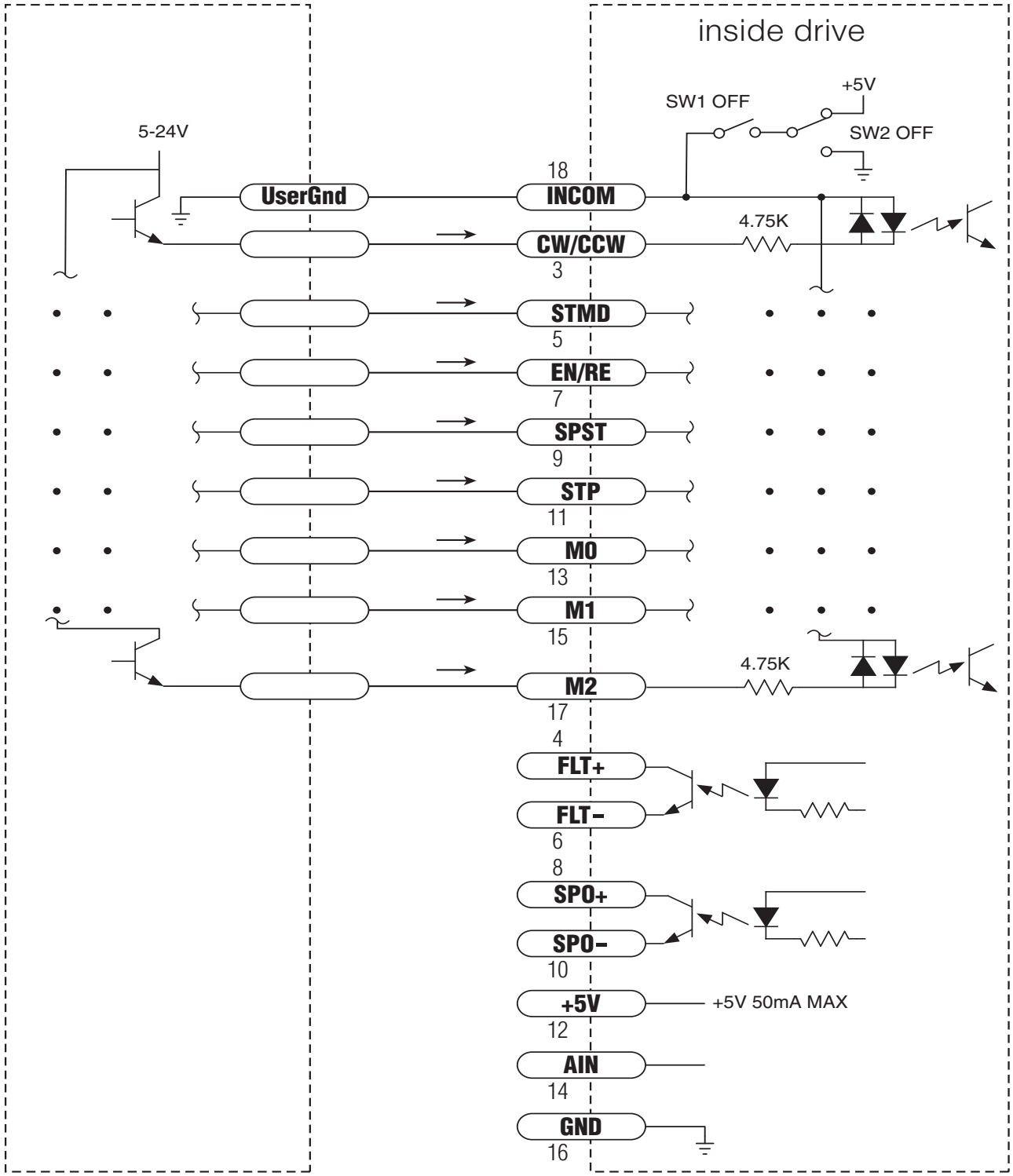


Connection diagrams:

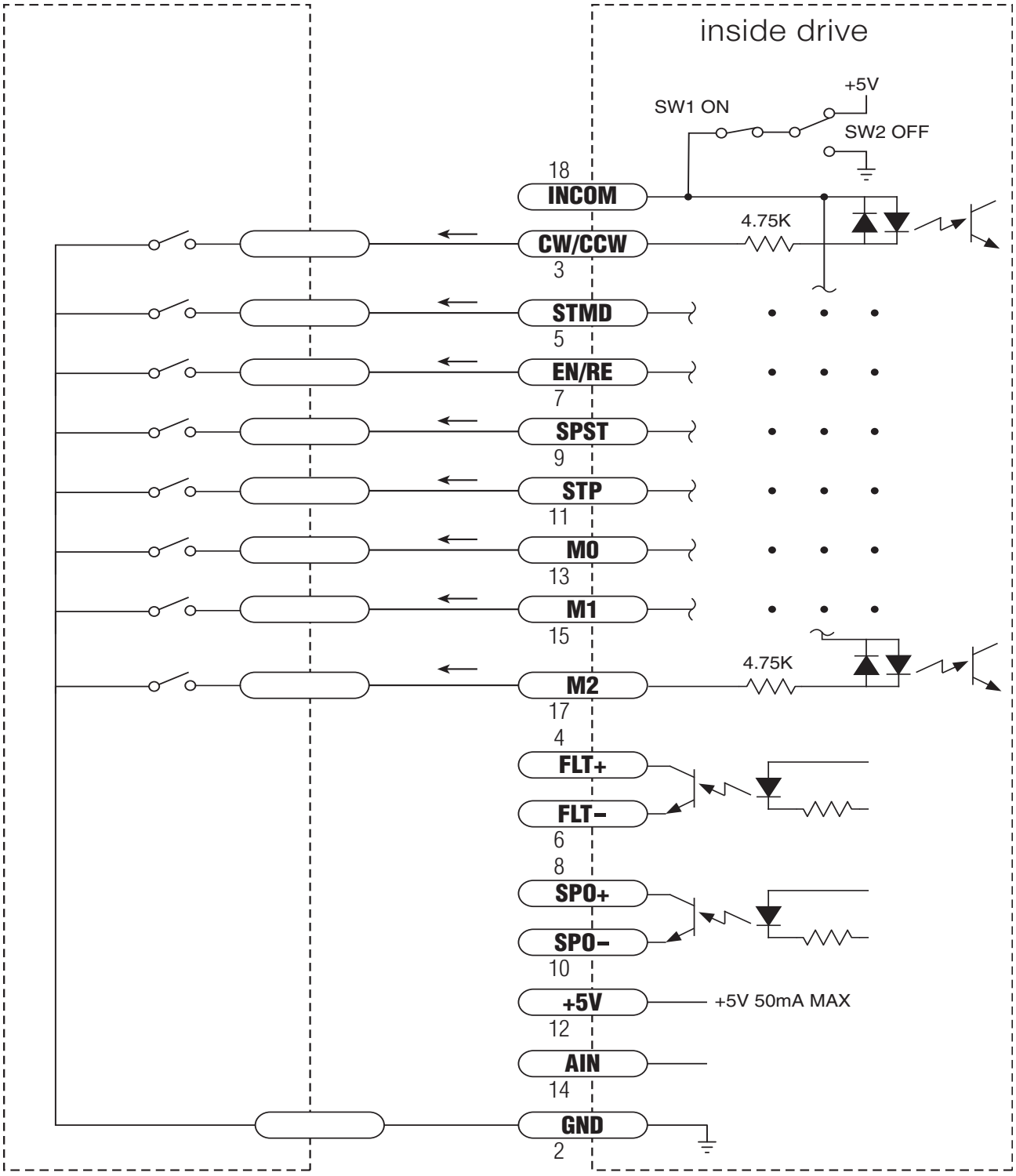
Control wiring for sinking signals with an external power source.:



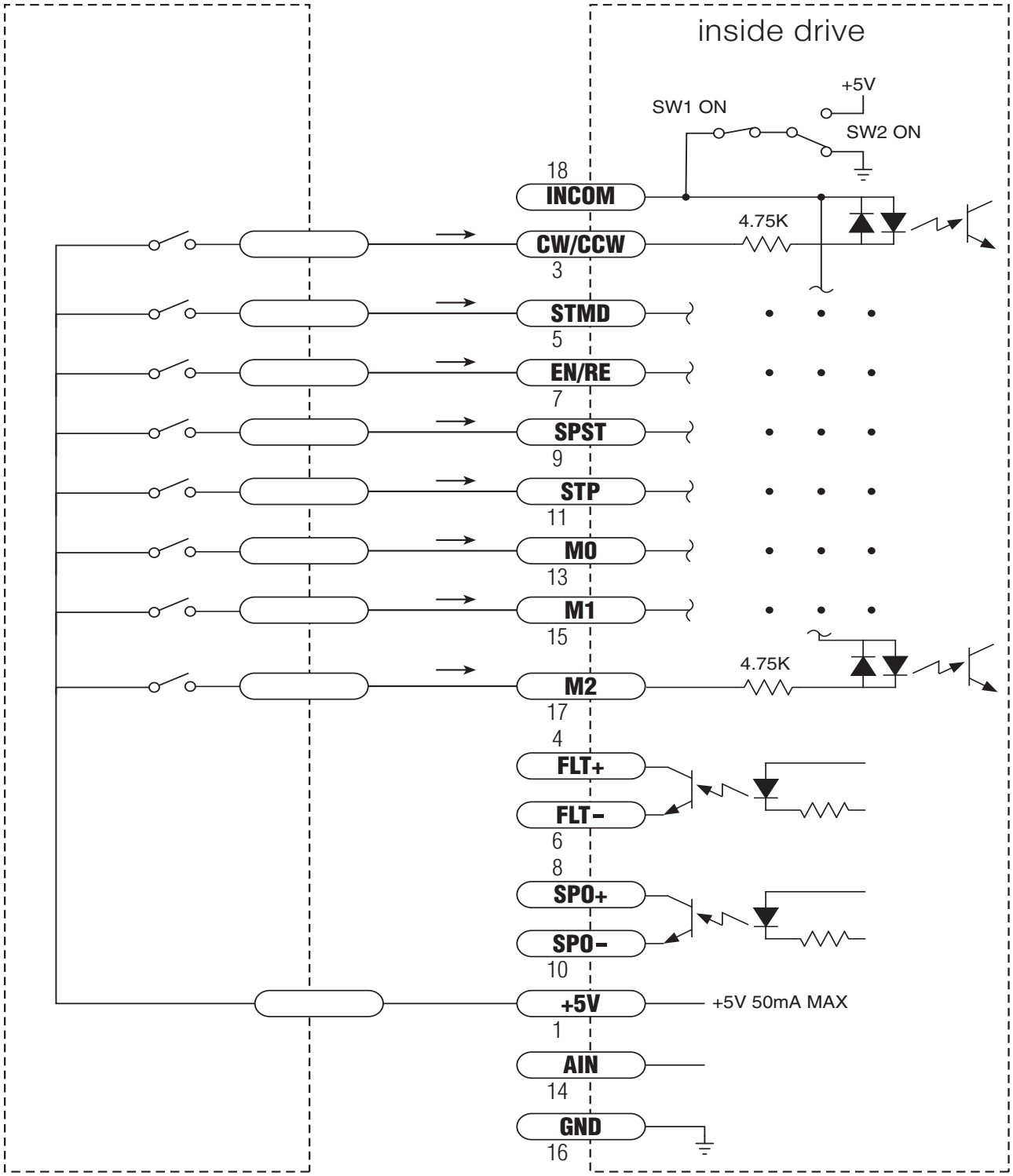
Control wiring for sourcing signals from an external power source:



Control wiring for sinking signals using the drives internal power supply:

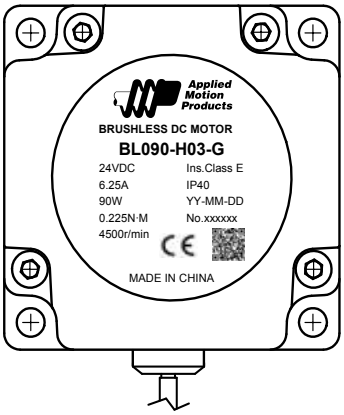


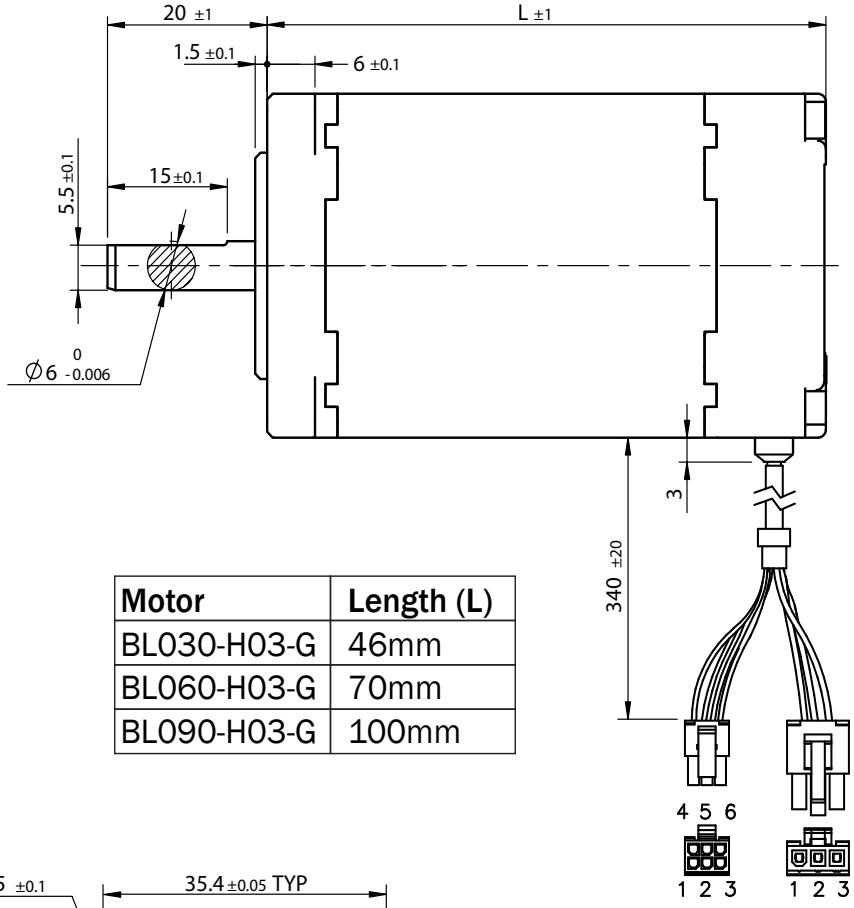
Control wiring for sourcing signals using the drives internal power supply:



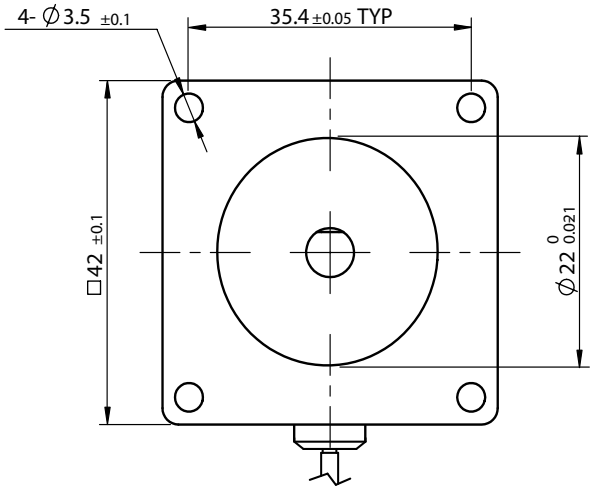
Reference Materials:

Motor Mechanical Outline - 42mm

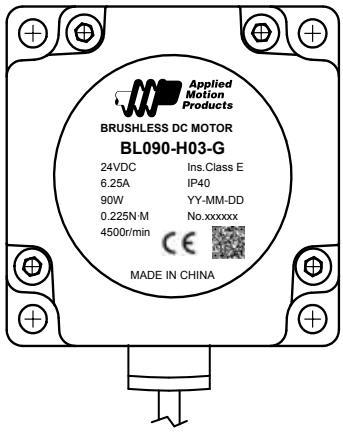


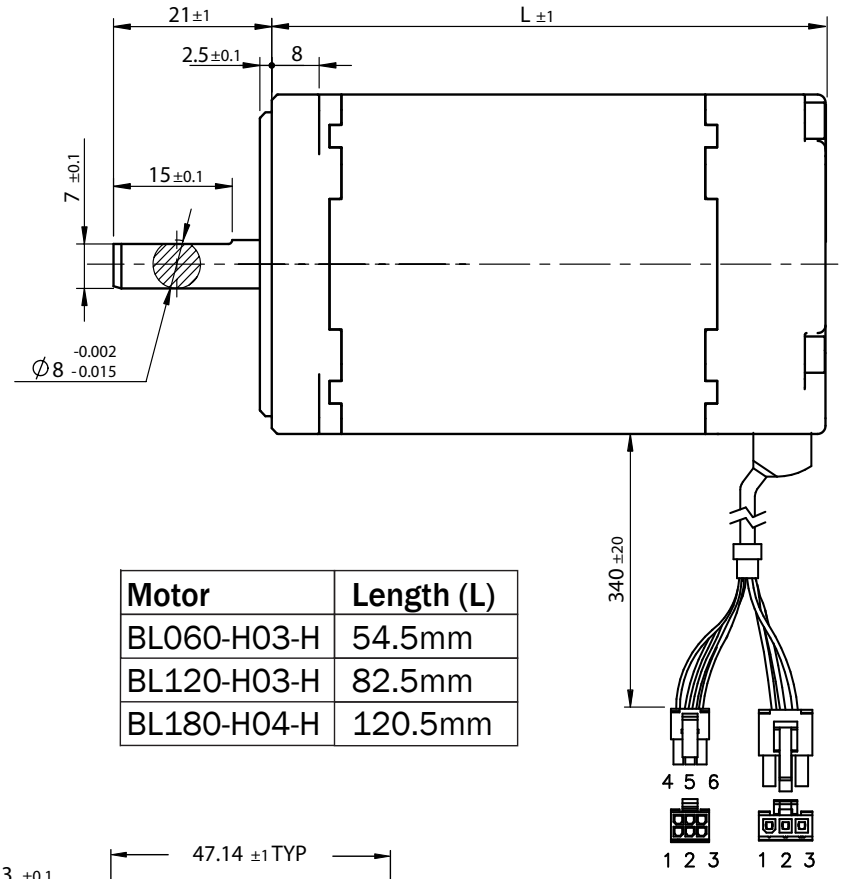


Motor	Length (L)
BL030-H03-G	46mm
BL060-H03-G	70mm
BL090-H03-G	100mm

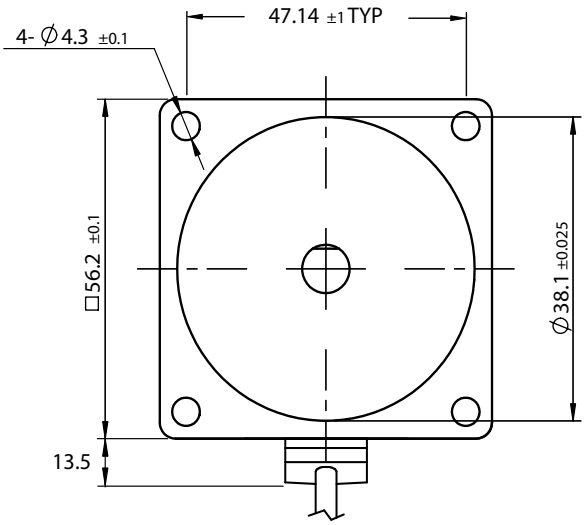


Motor Mechanical Outline - 57mm

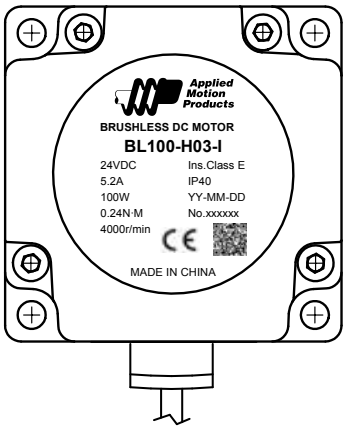


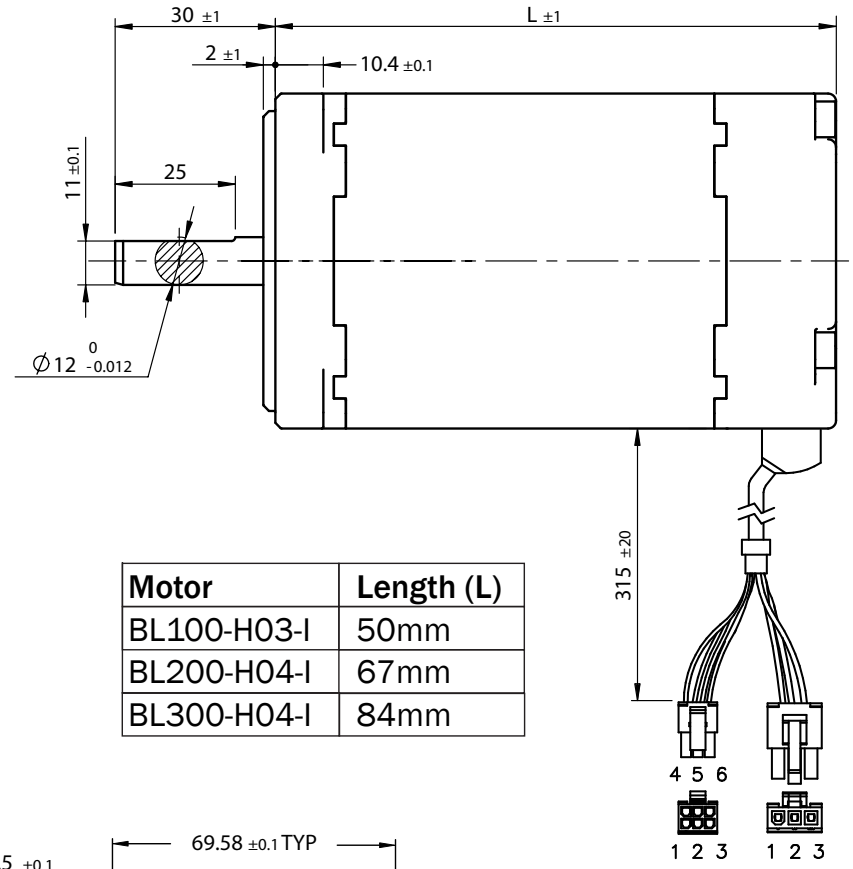


Motor	Length (L)
BL060-H03-H	54.5mm
BL120-H03-H	82.5mm
BL180-H04-H	120.5mm

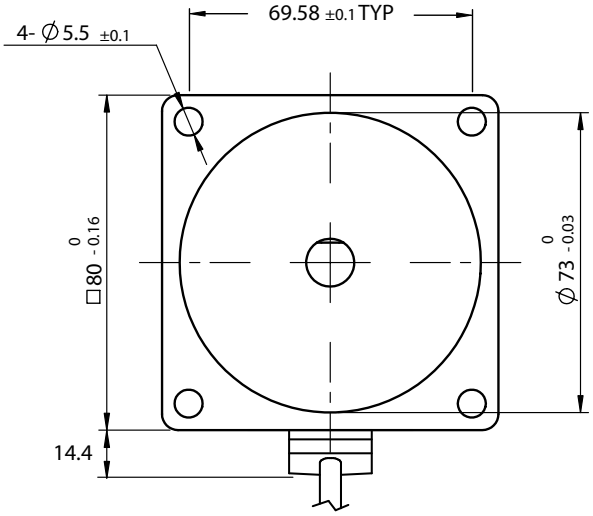


Motor Mechanical Outline - 80mm

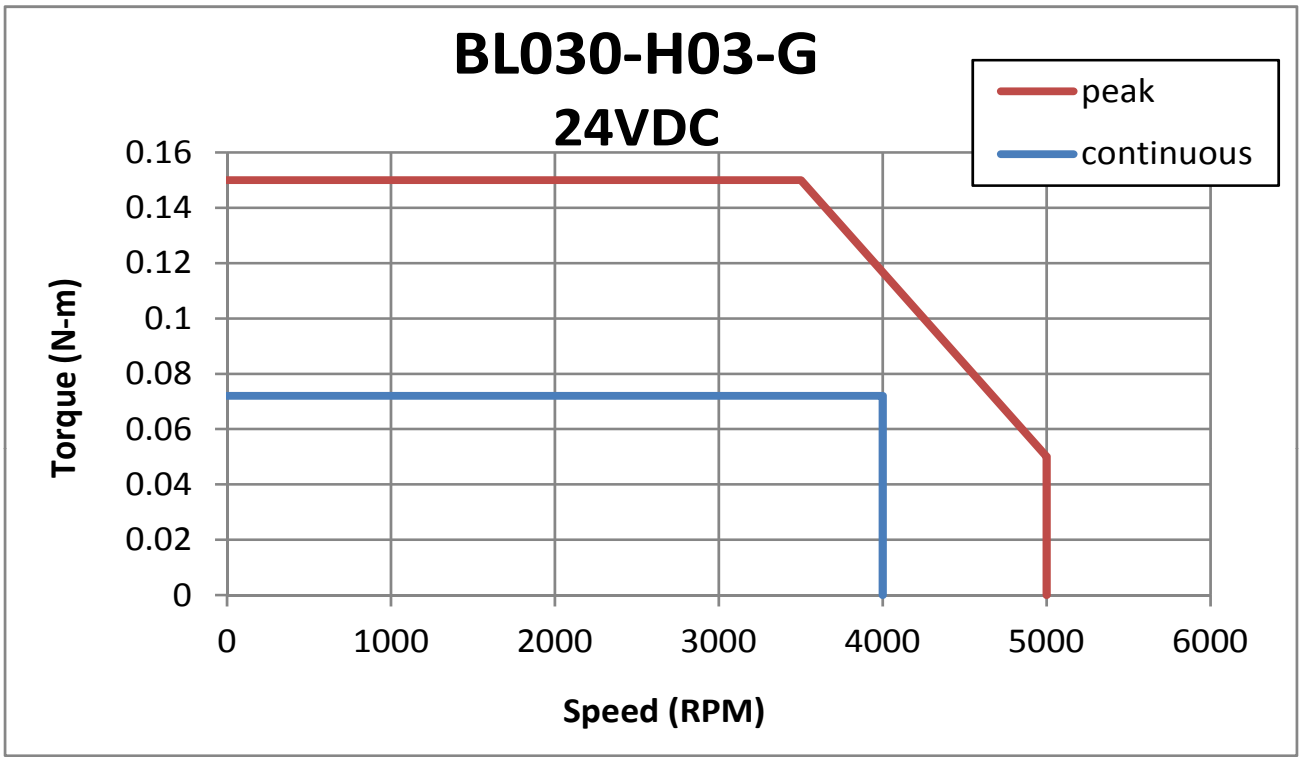




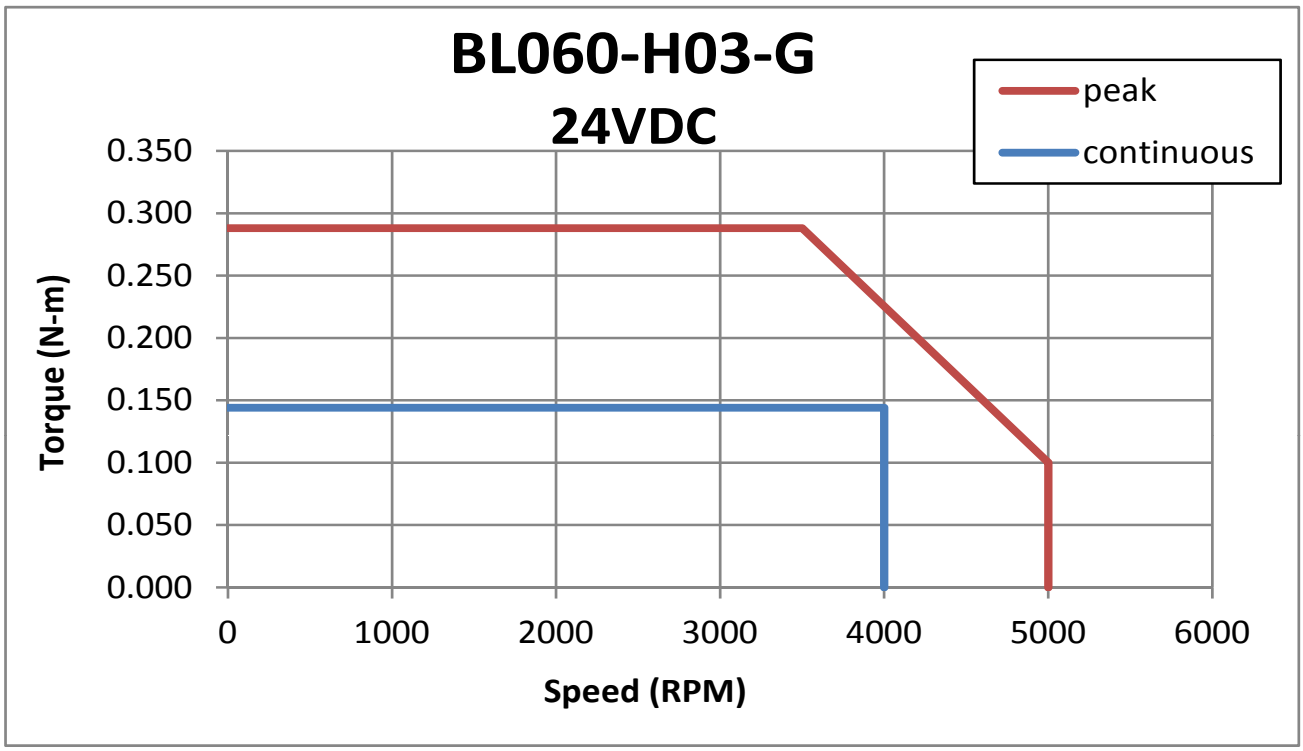
Motor	Length (L)
BL100-H03-I	50mm
BL200-H04-I	67mm
BL300-H04-I	84mm



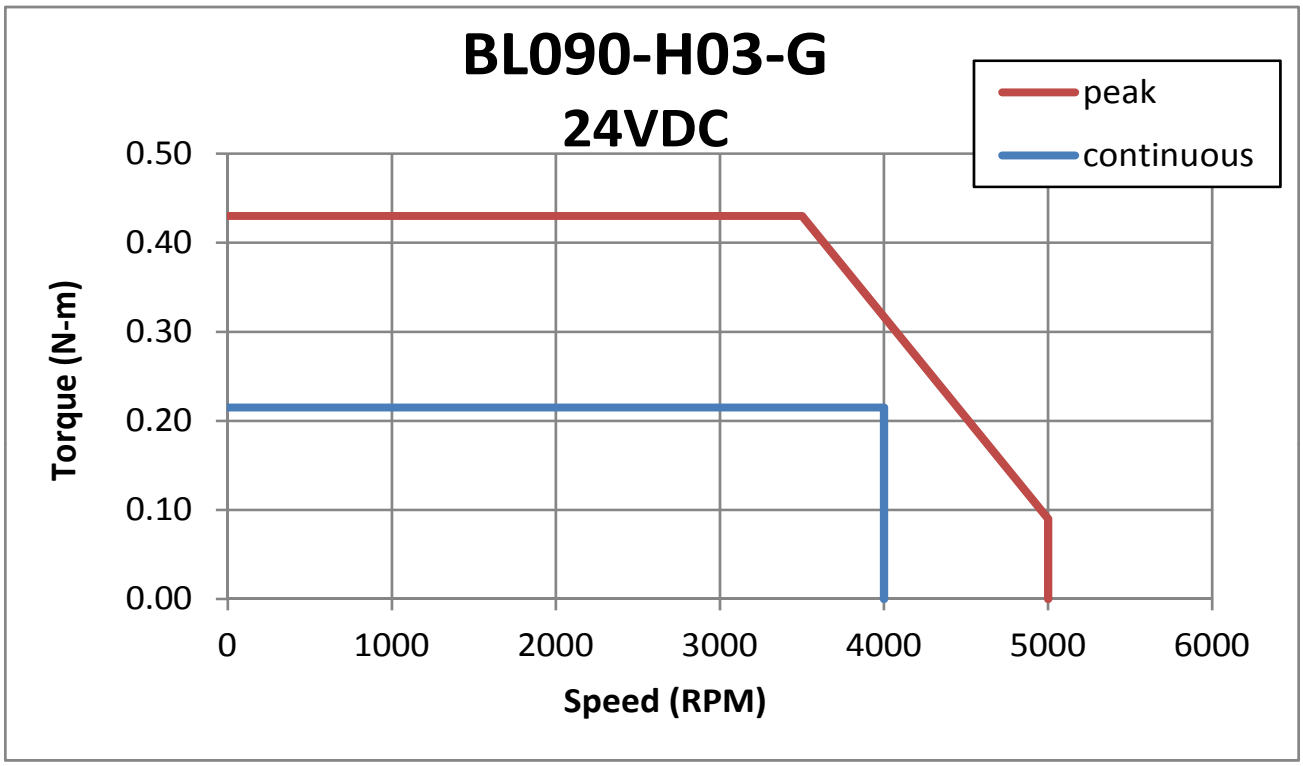
42mm BL030 Speed Torque Curve



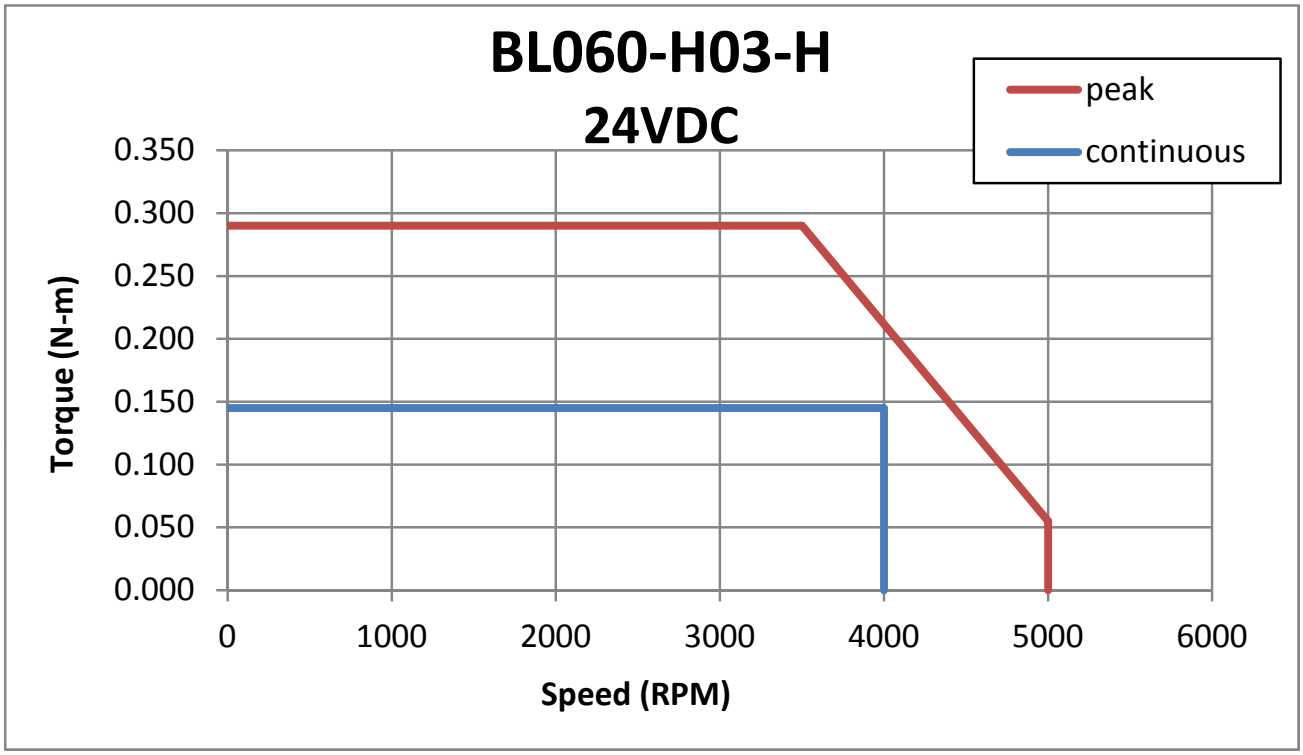
42mm BL060 Speed Torque Curve



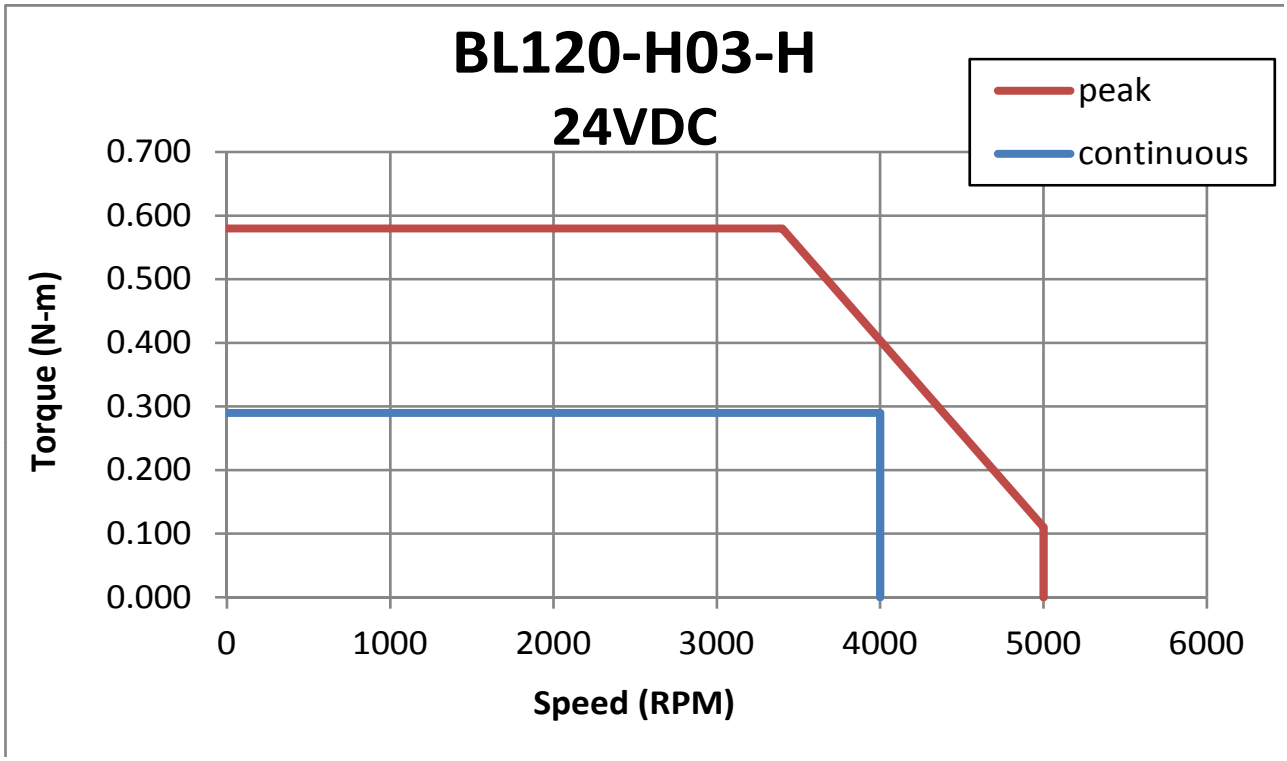
42mm BL090 Speed Torque Curve



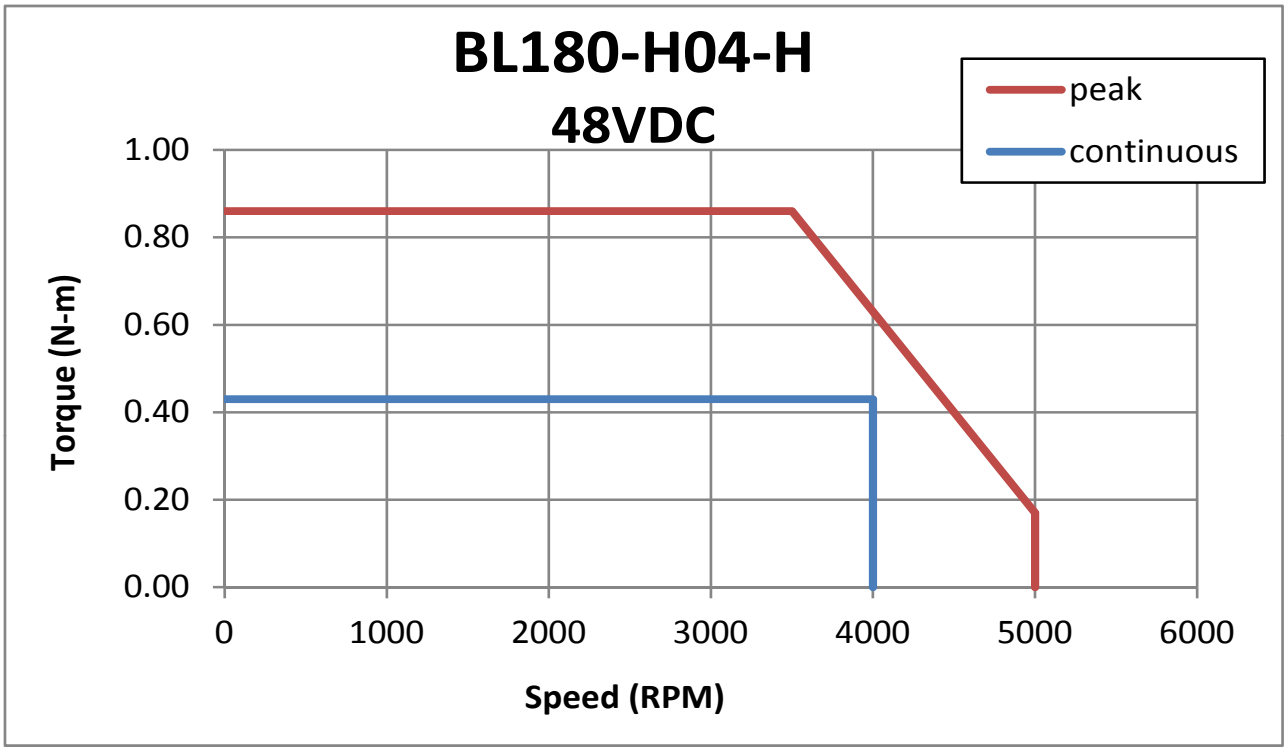
57mm BL060 Speed Torque Curve



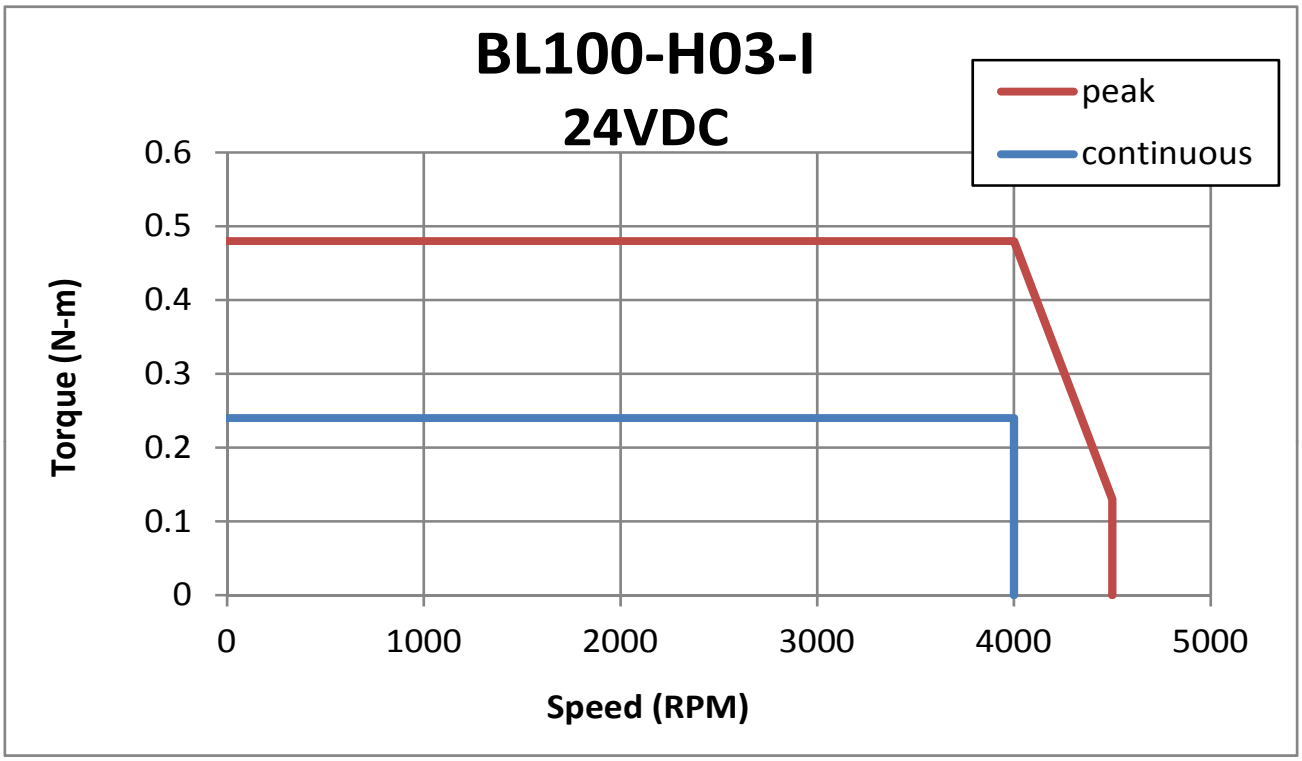
57mm BL120 Speed Torque Curve



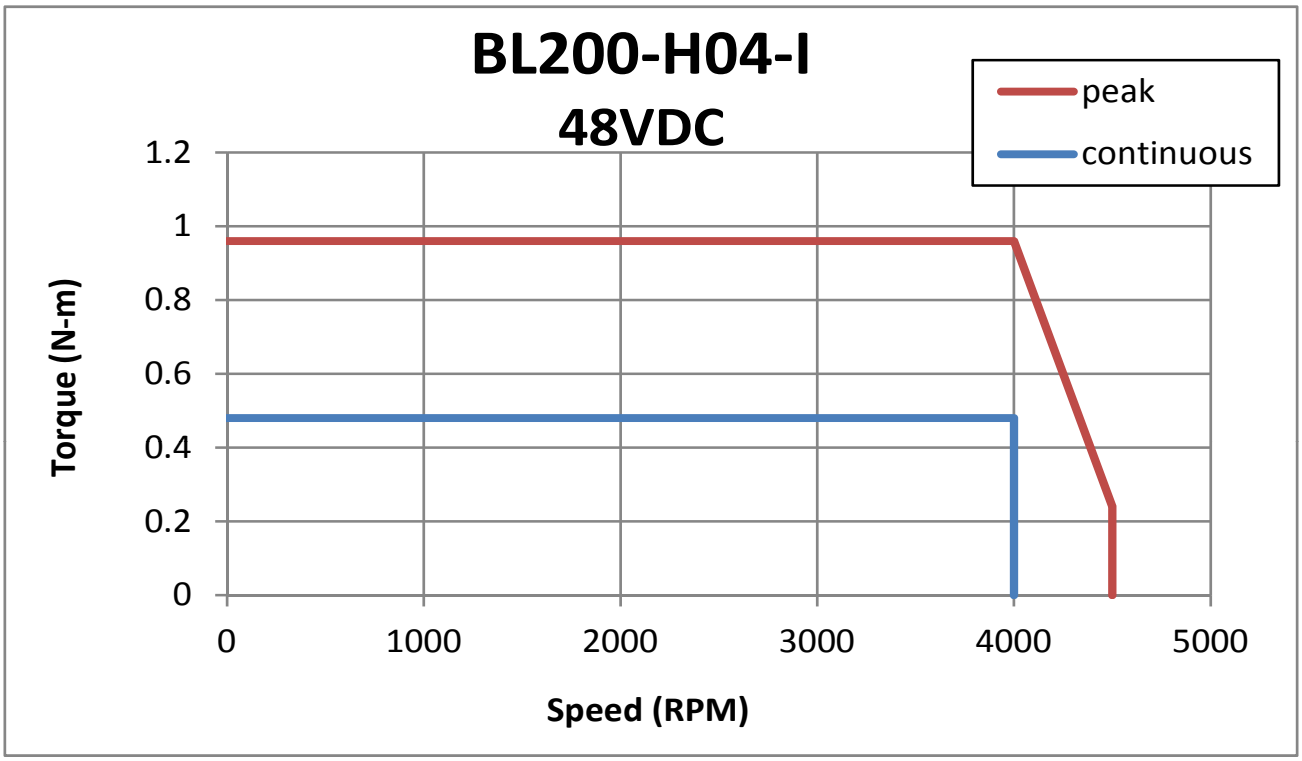
57mm BL180 Speed Torque Curve



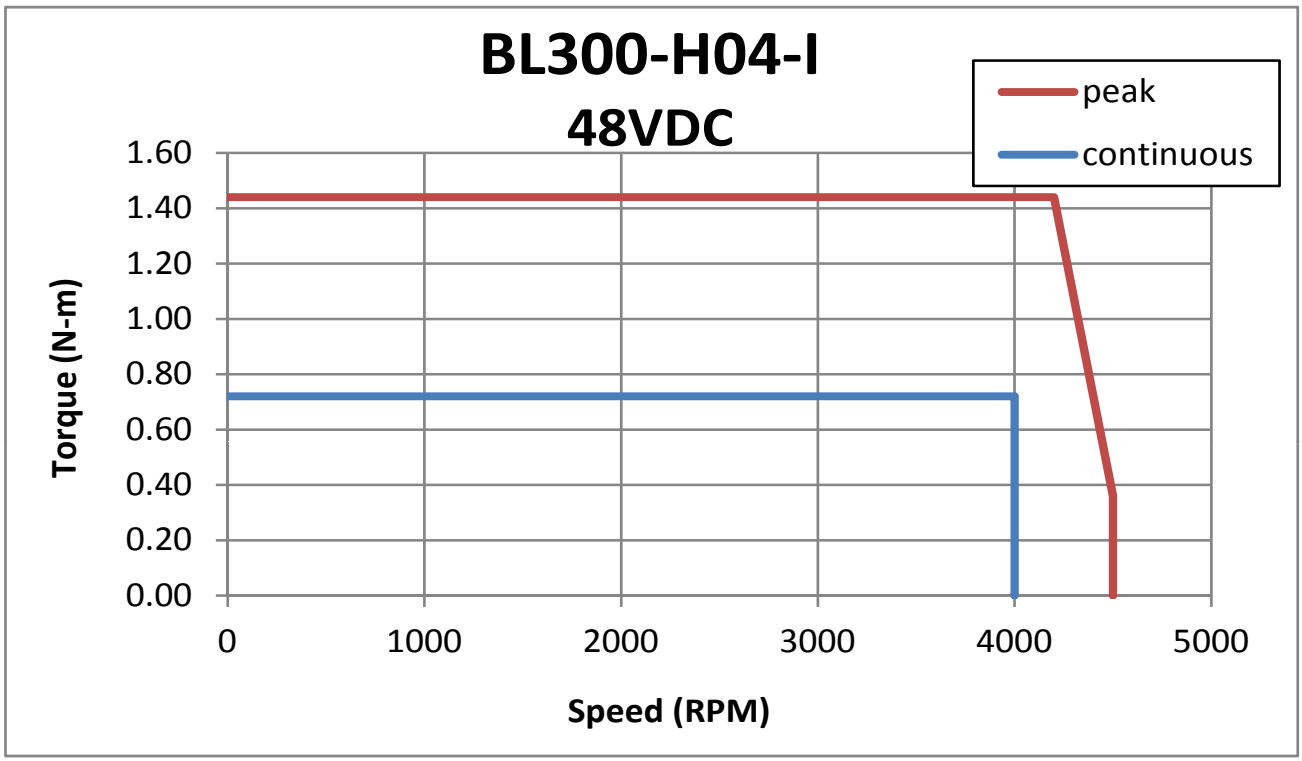
80mm BL100 Speed Torque Curve



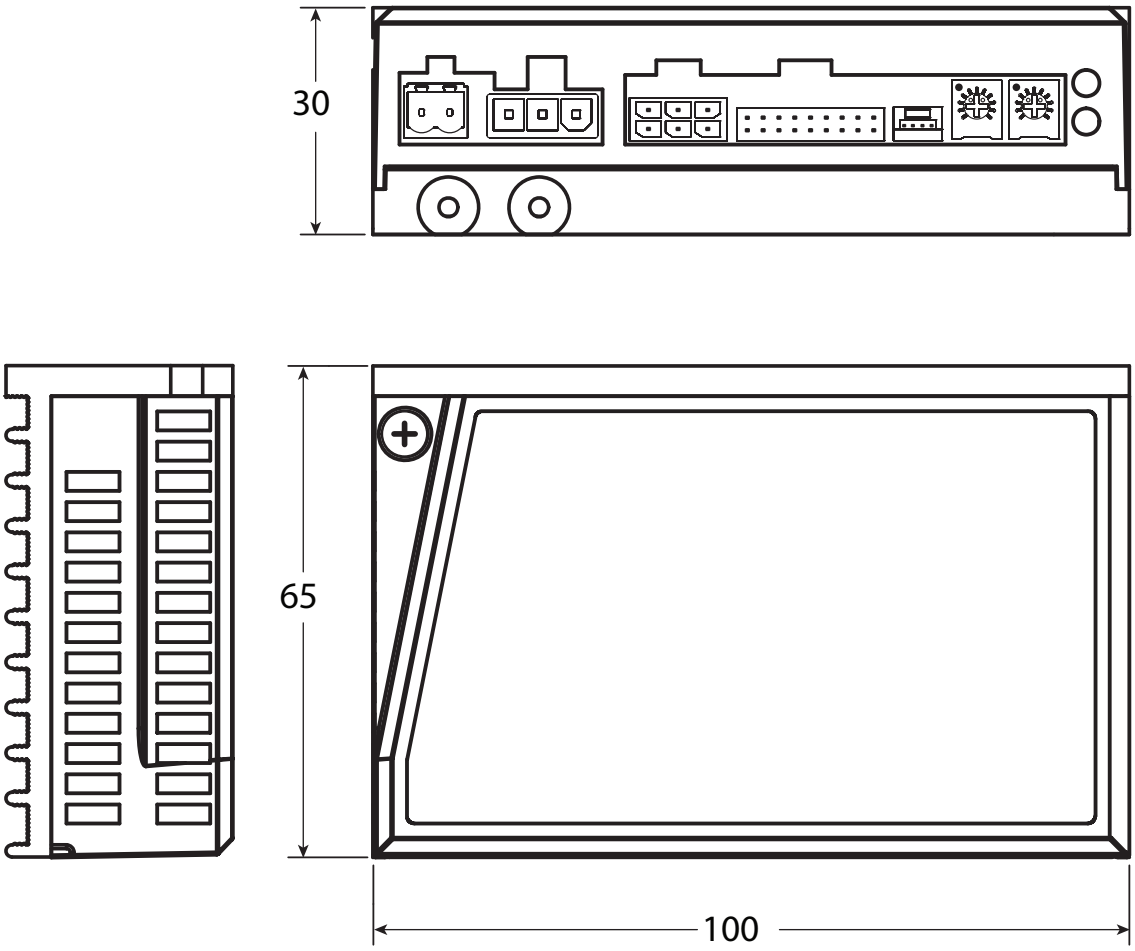
80mm BL200 Speed Torque Curve



80mm BL300 Speed Torque Curve



BD5/10 Drive Mechanical Outline



Dimensions are in millimeters

Technical Specifications - Drive

POWER AMPLIFIER:	
AMPLIFIER TYPE	Triple half bridge, 4 quadrant
CURRENT CONTROL	4 state PWM at 10 kHz
OUTPUT CURRENT	BD5/10-G1-AH: 1.75Arms cont, 3.5Arms peak (5 seconds max) BD5/10-G2-AH: 3.6Arms cont, 7.2Arms peak (5 seconds max) BD5/10-G3-AH: 6.25Arms cont, 12.5Arms peak (5 seconds max) BD5-H2-AH 3.2Arms cont, 6.4Arms peak (5 seconds max) BD10-H4-AH 6.9Arms cont, 13.8Arms peak (5 seconds max) BD10-H5-AH 4.5Arms cont, 9.0Arms peak (5 seconds max) BD5-I6-AH 5.0Arms cont, 10.0Arms peak (5 seconds max) BD10-I7-AH 10.0Arms cont, 20.0Arms peak (5 seconds max) BD10-I8-AH: 7.5Arms cont, 15Arms peak (5 seconds max)
POWER SUPPLY	External 12 - 48 VDC power supply required Under-voltage alarm: 8.5 VDC Over-voltage shutdown: 62 VDC
PROTECTION	Over-voltage, under-voltage, over-temp, motor/wiring shorts (phase-to-phase, phase-to-ground)
CONTROLLER:	
MODE OF OPERATION	Velocity control. Speed can be selected by digital input from on-board potentiometer, external analog signal, or 7 preset speeds. Accel/decel rate set by on-board potentiometer
DIGITAL INPUTS	Eight inputs, 5-24V, bidirectional (can be driven by sinking or sourcing signals) 2 kHz max freq response. Common terminal INCOM can be connected to an external power supply (5 to 24VDC) , or internally connected to 5V or GND (selected by internal DIP switches) CW/CCW: selects direction of motor shaft rotation STP: commands motor to stop quickly using electromagnetic braking EN/RE: applied/removes power from motor windings M0, M1, M2: selects one of seven preset speeds STMD: selects which mode of stopping is used SPST: selects whether speed is set by on-board pot or external analog signal
DIGITAL OUTPUTS	Two. 30V max, 80mA max, open collector, open emitter. FLT is a dedicated fault output. SPO: closes when motor is within 200 rpm of commanded speed
ANALOG INPUT	AIN referenced to AGND and 5V. Range = 0 to 5 VDC. Resolution = 12 bits. 5V = 4500 rpm
COMMUNICATION INTERFACE	RS-232 (for factory configuration only)

APPROVALS:	
AGENCY APPROVALS	RoHS CE PENDING
PHYSICAL:	
OPERATING TEMPERATURE	0 to 100°C (32 to 212°F) Internal temperature of the electronics section
AMBIENT TEMPERATURE	0 to 40°C (32 to 104°F) When mounted to a suitable heatsink
HUMIDITY	90% max, non-condensing
MASS	6.0 oz (170 g)

Technical Specifications - Motors

MODEL	Power	Rated Voltage	Rated Current		Rated Torque		Rotor Inertia	Mass	Torque Constant	Poles
	W cont	VDC	A cont	A peak	N-m cont	N-m peak	g-cm^2	g	mNm/A	
BL030-H03-G	30	24	1.75	3.5	0.065	0.13	38.8	320	37.3	6
BL060-H03-G	60	24	3.6	7.2	0.13	0.26	72	550	37.3	6
BL090-H03-G	90	24	6.25	12.5	0.225	0.45	114	830	37.3	6
BL060-H03-H	60	24	3.2	6.4	0.145	0.30	160	650	41.6	8
BL120-H03-H	120	24	6.9	13.8	0.29	0.60	293	1250	40.5	8
BL180-H04-H	180	48	4.5	9	0.48	0.96	471	1850	87.1	8
BL100-H03-I	100	24	5	10	0.24	0.48	380	900	46.5	8
BL200-H04-I	200	48	5.06	10.12	0.48	0.96	740	1560	95	8
BL300-H04-I	300	48	7.5	15.0	0.72	1.44	1080	2560	94.9	8

Specs common to all motors

Rated speed 4000 rpm
Max speed 42mm and 57mm 5000 rpm, 80mm 4500rpm
Phases: 3
Insulation class E
Ingress protection: IP40
Feedback: hall devices (3)

Mating Connectors and Accessories

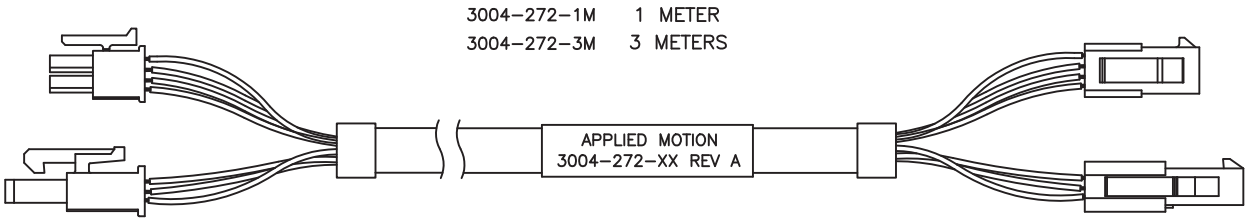
Mating Connectors

I/O: Housing: JST PUDP-18V-S. Crimp contacts: SPUD-001T-P0.5. Flying lead cable included with drive.
Power supply: PCD ELFP0221G (Phoenix Contact 1757019), included with drive.
Motor: Molex 39-01-2060 housing with Molex 39-00-0039 pins, included with motor.
Hall Signals: Molex 43025-0600 housing with Molex 43030-0001 pins, included with motor.

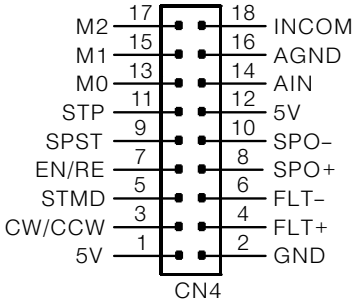
Accessories

Motor Extention Cable, 1 meter: 3004-272-1M
Motor Extension Cable, 3 meters: 3004-272-3M
Regeneration Clamp: RC-050.

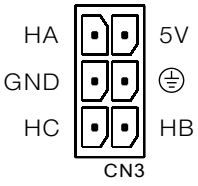
Model PSP-600-48 : We recommend a 600 watt 48 VDC power supply for use where 200 watt or 300 watt motors are used to their full capability or where many drives will be connected to one power supply.

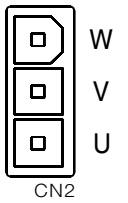


Connector Diagrams



I/O Connector





Motor Connectors

LED Error Codes

The BD drive includes red and green LEDs to indicate status. When the motor is enabled, the green LED flashes slowly. When the green LED is solid, the motor is disabled. Conditions and errors are indicated by combinations of red and green "flashes" as follows:

Code	Condition
solid green	no alarm, motor disabled
flashing green	no alarm, motor enabled
3 red, 1 green	(fault) drive over temp
3 red, 2 green	(fault) bad internal voltage
4 red, 1 green	(fault) supply voltage high
4 red, 2 green	(warning) supply voltage low
5 red, 1 green	(fault) over current
6 red, 1 green	(fault) open motor phase
5 red, 2 green	(warning) overload
7 red, 1 green	(warning) communication error
6 red, 2 green	(fault) bad Hall signal
7 red, 2 green	(warning) save failed

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