MDC151-0501001
50V @ 100A Brushless DC Controller

User's Guide



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MDC151-0501001 Driver Features

- Maximum Current Limit Setting from 50.0 - 100.0Amps (peak)
- Internal or External Potentiometer Speed Control
- 0V to 5V External Voltage Speed Control
- 2-Quadrant Operation
- Hall Sensor Feedback
- Constant Velocity Mode
- Short Circuit Protection
- Requires 20-50 VDC
- Speed Out
- Fault Out
- Run/Stop, Freewheel and Direction Inputs
- Selectable Ramp Up
- TTL-CMOS Compatible Inputs
- Detachable, Screw Type Terminal Blocks

General Description

The MDC151-0501001 driver is designed to drive DC brushless motors at currents of up to 100A (peak) and 50V. Using hall sensor feedback, a constant velocity mode can be selected. The driver is protected against over-current (cycle-by-cycle or latched), hall sensor error and under voltage. When an error occurs, a fault light and a fault output are turned on to notify the user. Included on the driver is an internal potentiometer to control the maximum phase current allowed into the motor and an internal potentiometer to control the speed of the motor. An external voltage (0-5VDC) can be used to control the speed as well. The direction of the motor can be preset by the direction control input. When using the run/stop input, there are three ramp up profiles from standstill to select from. The run/stop input overrides all other inputs into the driver.

Fault Protection

Over-current protection can be provided by means of a over-current latch function by setting the 'FLT LATCH' dip switch on. If a motor current level exceeding the current limit set by the internal or external current limit potentiometer is produced, an over-current latch is activated, shutting off the output. When a fault is detected, the driver turns off the motor current, the red FAULT LED alerts the user a fault occurred and the Fault Output (TB3 - Pin 5) goes low. The Fault Output is disabled, logic '1' output, when the 'FLT LATCH' dip switch is in the off position and disabled. This Fault protection alerts the user of the following conditions:

1. Invalid Sensor Input Code
2. Over-current. The driver is equipped with cycle-by-cycle current limiting or over-current latch.
3. Undervoltage Lockout activation at 9.1VDC for the input voltage and 4.5VDC for Hall Sensor

Fault Output

The Fault Output is only active when the Fault Latch is enabled, setting the 'FLT LATCH' dip switch on. The TTL level Fault Output indicates an over-current or failure in the motor/driver operation. The Fault Output is normally at a TTL logic level 1. If a fault occurs, the Fault Output will go to a TTL logic level 0.

Specifications

Control Inputs: (TB3, Pins 2-4)
TTL-CMOS Compatible
Logic “0” = 0-0.8VDC
Logic “1” = OPEN
All three inputs (run/stop, freewheel, and direction) are pulled up through 20k ohm resistors.

Direction Control: (TB3, Pin 2)
Logic “1” (open) - Clockwise
Logic “0” - Counterclockwise

Freewheel: (TB3, Pin 3)
Logic “1” (open) - Motor is Enabled
Logic “0” - Motor is de-energized and will coast

Run/Stop: (TB3, Pin 4)
Logic “1” (open) - Motor will not run and if running will come to a hard stop
Logic “0” - Motor will run and will accelerate according to ramp dip switch setting

V Control: (TB3, Pin 6)
To control the speed of the motor with an external DC voltage, INT/EXT SPD switch (SW1-POS1) must be switched to the ON position.
0VDC (min) - 5VDC (max)

Control Outputs: (TB3, Pin 1 and 5)
TTL-CMOS Compatible
These outputs are able to sink 50mA.

Speed Output: (TB3, Pin 1)
A 5V signal pulse out is available at a rate of 4 pulses for 1 revolution of an 8-pole motor, 3 pulses for 1 revolution of a 6-pole motor, and 2 pulses for 1 revolution of a 4-pole motor.
8-pole motor RPM = 15 * PG OUT (in Hz)
6-pole motor RPM = 20 * PG OUT (in Hz)
4-pole motor RPM = 30 * PG OUT (in Hz)

Fault Output: (TB3, Pin 5)
Logic “1” (5V out) - Status good, normal operation.
Logic “0” - One of the three fault conditions listed in the ‘Fault Protection’ section has occurred. When a fault is detected, the Fault Output (pin 5) goes low.

Output Current Rating:
Adjustable 50.0 - 100.0 amperes per phase maximum operating peak current
(25.0 - 50.0 amperes per phase maximum operating continuous current)

Power Requirements: (TB2, Pins 4 and 5)
20VDC (min) - 50VDC (max)

Operating Temperature:
Heat Sink: 0° - 70° C

Specifications

Hall Sensor Power Output:

6.25V @ 30mA maximum. Typical current draw from hall sensors is 20mA. All three Hall Sensor inputs are pulled up through 20K ohm resistors.
The external speed control potentiometer must be 10K Ohms.

Open-loop/Closed-loop (Constant Velocity Mode)

The driver can either be set for Open-loop or Closed-loop operation. Open-loop operation is used for applications where the speed of the motor needs to change according to the load. Closed-loop operation is used for applications where speed regulation is needed. Under closed-loop operation, the speed is regulated despite changes to the load and the power supply voltage.

To operate Open-loop, the O/C LOOP switch (SW2, pin 1) must be in the 'on' position.

To operate Closed-loop, the O/C LOOP switch (SW2, pin 1) must be in the 'off' position and the CLADJ POT and CLADJ dip switches (SW2, pin 2-4) must be set to optimize the driver for each application.

If using an Anaheim Automation brushless DC motor:

1. Start with setting the closed-loop switches CL1, CL2, and CL3 on the 'ON' position.
2. Set CLADJ POT to 0%.
3. Adjust the internal speed pot or external speed pot to 100%. The motor at this time should be running at its maximum speed.
4. Increase the closed-loop gain by switching CL1, CL2, and CL3 incrementally one stage until the motor speed dips below the maximum speed. Set the switches up one stage to the position before the motor dips below the maximum speed and proceed to step 5.

CL1	CL2	CL3	CL Gain
On	On	On	Min
Off	On	On	
On	Off	On	
Off	Off	On	
On	On	Off	
Off	On	Off	
On	Off	Off	
Off	Off	Off	Max

5. Slowly rotate CLADJ POT toward 100% until the motor speed slightly begins to decrease. At this point, the motor closed-loop adjustments are set.
   *If a slower top motor speed is desired, set CLADJ POT to 0%. Increase the closed-loop gain incrementally by setting CL1, CL2, CL3 with respect to the desired top motor speed and re-tune CLADJ POT, as described in step 4 and step 5.

Anaheim Automation Motor Closed-loop Settings

4-Pole Motors

Motor	CL1	CL2	CL3	CL POT	MAX SPD (RPM)	MIN SPD (RPM)
BLWR110S-15V-8000	On	On	On	80%	8000	500
BLWR111S-24V-10000	On	On	On	50%	10050	825
BLWR112S-24V-3700	On	Off	On	100%	3735	450
BLWR231D-36V-4000	On	Off	On	65%	4010	550
BLWR232D-36V-4000	On	Off	On	65%	4010	550
BLWR233D-36V-4000	On	Off	On	65%	4010	550
BLWR234D-36V-4000	On	Off	On	65%	4010	550
BLWR235D-36V-4000	On	Off	On	65%	4010	550
BLWR232S-24V-1350	Off	Off	Off	0%	1600	200
BLWS231D-36V-4000 BLWS231S-36V-4000	On	Off	On	65%	4010	550
BLWS232D-36V-4000 BLWS232S-36V-4000	On	Off	On	65%	4010	550
BLWS233S-36V-4000	On	Off	On	65%	4010	550
BLWS234D-36V-4000 BLWS234S-36V-4000	On	Off	On	65%	4010	550
BLWS235S-36V-4000	On	Off	On	65%	4010	550

8-Pole Motors

Motor	CL1	CL2	CL3	CL POT	MAX SPD (RPM)	MIN SPD (RPM)
BLY171S-17V-8000	On	On	On	0%	7500	500
BLY172S-17V-9500	On	On	On	0%	9000	500
BLY171S-24V-4000	On	On	On	80%	4000	250
BLY172S/D-24V-4000	On	On	On	80%	4000	250
BLY173D-24V-4000	On	On	On	80%	4000	250
BLY174S/D-24V-4000	On	On	On	80%	4000	250
BLY341S/D-48V-3200	Off	On	On	40%	3200	250
BLY342D-24V-3000	Off	On	On	40%	3000	250
BLY342S/D-30V-3000	Off	On	On	40%	3000	250
BLY342S/D-48V-3200	Off	On	On	30%	3200	250
BLY343S/D-48V-3200	Off	On	On	30%	3200	250
BLY343S-30V-3000	Off	On	On	40%	3000	250
BLY344S/D-48V-3200	Off	On	On	30%	3200	250

Commutation Sequence

	Step					
	1	2	3	4	5	6
Phase A	+	Z	-	-	Z	+
Phase B	Z	+	+	Z	-	-
Phase C	-	-	Z	+	+	Z
Hall A	1	1	0	0	0	1
Hall B	0	1	1	1	0	0
Hall C	0	0	0	1	1	1

120° Hall Spacing Sequence Forward

	Step					
	1	2	3	4	5	6
Phase A	-	Z	+	+	Z	-
Phase B	Z	-	-	Z	+	+
Phase C	+	+	Z	-	-	Z
Hall A	1	1	0	0	0	1
Hall B	0	1	1	1	0	0
Hall C	0	0	0	1	1	1

120° Hall Spacing Sequence Reverse

	Step					
	1	2	3	4	5	6
Phase A	+	Z	-	-	Z	+
Phase B	Z	+	+	Z	-	-
Phase C	-	-	Z	+	+	Z
Hall A	1	1	1	0	0	0
Hall B	0	1	1	1	0	0
Hall C	0	0	1	1	1	0

60° Hall Spacing Sequence Forward

	Step					
	1	2	3	4	5	6
Phase A	-	Z	+	+	Z	-
Phase B	Z	-	-	Z	+	+
Phase C	+	+	Z	-	-	Z
Hall A	1	1	1	0	0	0
Hall B	0	1	1	1	0	0
Hall C	0	0	1	1	1	0

60° Hall Spacing Sequence Reverse

+ = Top Transistor ON, Bottom Transistor OFF, Current flows into this wire
- = Top Transistor OFF, Bottom Transistor ON, Current flows out of this wire
Z = Top Transistor OFF, Bottom Transistor OFF, No current into or out of this wire (High Impedance)

Motor Connection

Refer to the hookup diagram for typical driver applications. When connecting a motor for the first time, connect the hall sensor wires (5 of them) to the driver. **DO NOT CONNECT THE PHASES YET.** Turn on power and rotate the motor by hand. If the RED FAULT LED comes on, the hall phases are incorrectly wired. If the RED FAULT LED does not come on then the hall wires are connected correctly. Power the unit down and proceed to connect the motor phases. If the motor does not run or runs erratically, power down and check the speed potentiometer and make sure the phases are connected correctly. There are six different ways to connect the phase wires, and normally only two will allow the motor to rotate, but only one is correct. If the direction of the motor is changed and the no-load current of the motor is approximately the same and the motor runs smoothly in both directions, then the phase wires are correct. The wiring of the motor phases should be separated from the hall and input connections to not allow a possible source of interference.

Terminal Block Descriptions

Pin #	Description
1	Hall Sensor Power
2	Hall Sensor A
3	Hall Sensor B
4	Hall Sensor C
5	Hall Sensor Ground

TB1: Motor Hall Terminals

Pin #	Description
1	Phase A
2	Phase B
3	Phase C
4	VIN
5	GND

TB2: Power and Motor Phase Terminals

Pin #	Description
1	Phase A
2	Phase B
3	Phase C
4	VIN
5	GND
6	V Control
7	GND

TB3: Control Inputs and Outputs

Dip Switch Descriptions

POS	Description
1	INT/EXT SPEED
2	FLT LATCH
3	RAMP 1
4	RAMP 2
5	60/120

SW1: Dip Switch

POS	Description
1	O/C LOOP
2	CL1
3	CL2
4	CL3

SW2: Dip Switch

Motor	SW1	SW2	SW3	SW4	SW5
Internal Speed Control (R46)	Off	---	---	---	---
External Speed Control (TB3 Pin 6)	On	---	---	---	---
Over-current Latching	---	On	---	---	---
Over-current Cycle by Cycle	---	Off	---	---	---
Ramp Profile 1 (4 Sec)	---	---	Off	Off	---
Ramp Profile 2 (2 Sec)	---	---	Off	On	---
Ramp Profile 3 (1 Sec)	---	---	On	Off	---
Ramp Profile 4 (500mSec)	---	---	On	On	---
60° Hall Sensor Spacing	---	---	---	---	Off
120° Hall Sensor Spacing	---	---	---	---	On
Standard Product (Ready to Ship)	Off	Off	Off	Off	On

SW1: Speed Adjustment, Over-current, and Ramp settings

Motor	SW1	SW2	SW3	SW4
Constant Speed Mode (Closed-loop)	Off	---	---	---
Voltage Controlled Speed Mode (Open-loop)	On	---	---	---
Closed-loop Compensation 1	---	---	---	---
Closed-loop Compensation 2	---	---	---	---
Closed-loop Compensation 3	---	---	---	---
Standard Product (Ready to Ship)	On	Off	Off	Off

SW2: Open-loop and Closed-loop. If Closed-loop is selected, Closed-loop compensation switches must be set according to motor speed desired.

Motor Freewheel

The motor freewheel feature allows for the de-energizing of the motor phases. A high (open) input at this input causes the motor to run at the given speed, while a low at this input causes the motor to coast to a stop.

Motor Run/Stop

The motor run/stop feature allows the stopping of a motor by shorting out the bottom drives of the three phases. A low at this input allows the motor to run, while a high (open) input does not allow motor operation and if operating causes rapid deceleration.

Motor Direction

The motor direction feature allows the changing of the rotation of the motor. This input should not be changed while motion is in progress. A high (open) input causes the motor to turn in the CW direction, while a low at this input causes the motor to turn in the CCW direction.

Note: Avoid changing the direction of rotation when the motor is already running in any one direction.

The following instructions must be followed to prevent permanent drive failure due to over-current conditions that exist in dynamic direction reversals of the motor:

1. Stop the motor by removing the grounding signal on the RUN/STOP input
2. Wait for at least 500mS
3. Change the direction with the DIRECTION input
4. Run the motor by grounding the RUN/STOP input

Speed Adjust Setting

There are three ways to set the speed on this drive. One is to use the on board. The others are to use a remote external potentiometer or an external 0-5VDC voltage. The use the on board potentiometer, set INT/EXT SPD switch to the off position (default). To use the external potentiometer or external 0V to 5V voltage speed setting, set INT/EXT SPD switch to the on position. If a voltage is used to control the speed of the motor, the 0V to 5V voltage can be tied on V-Control (TB3 - pin 6) with respect to GND (TB3 - pin 7). If an external potentiometer is used to control speed of the motor, connect the pot wiper to V-Control (TB3 - pin 6), the positive end of the potentiometer to Hall Power (TB1 - pin 1) and the negative end to GND (TB3 - pin 7).

A ramp up profile at start up would alleviate excessive current draw from the power supply. When the motor is rapidly accelerated from standstill, current drawn from the power supply can measure up to ten times the rated motor current. This startup current spike can shutdown power supplies by tripping the power supply's current limit.

A ramp down profile from max operating speeds would alleviate any back emf generated. When the motor is rapidly decelerated or stopped from high speed, the motor phase advances and this "returned energy" voltage appears on the drive's power supply pins. Returned energy voltages seen at the input pins in excess of 50V will damage the driver.

The maximum and minimum ramp times are determined per application. Both the ramp up and ramp down speeds can be controlled by SW1 (positions 3 and 4) and the use of an external controller connected to V-Control.

The maximum voltage that can be placed on V-Control is 15V. A voltage exceeding 15V may cause damage to the driver. If a voltage other than 0V to 5V is needed to control the speed of the motor, contact Anaheim Automation for custom tuning of the V-Control input.

Speed Output

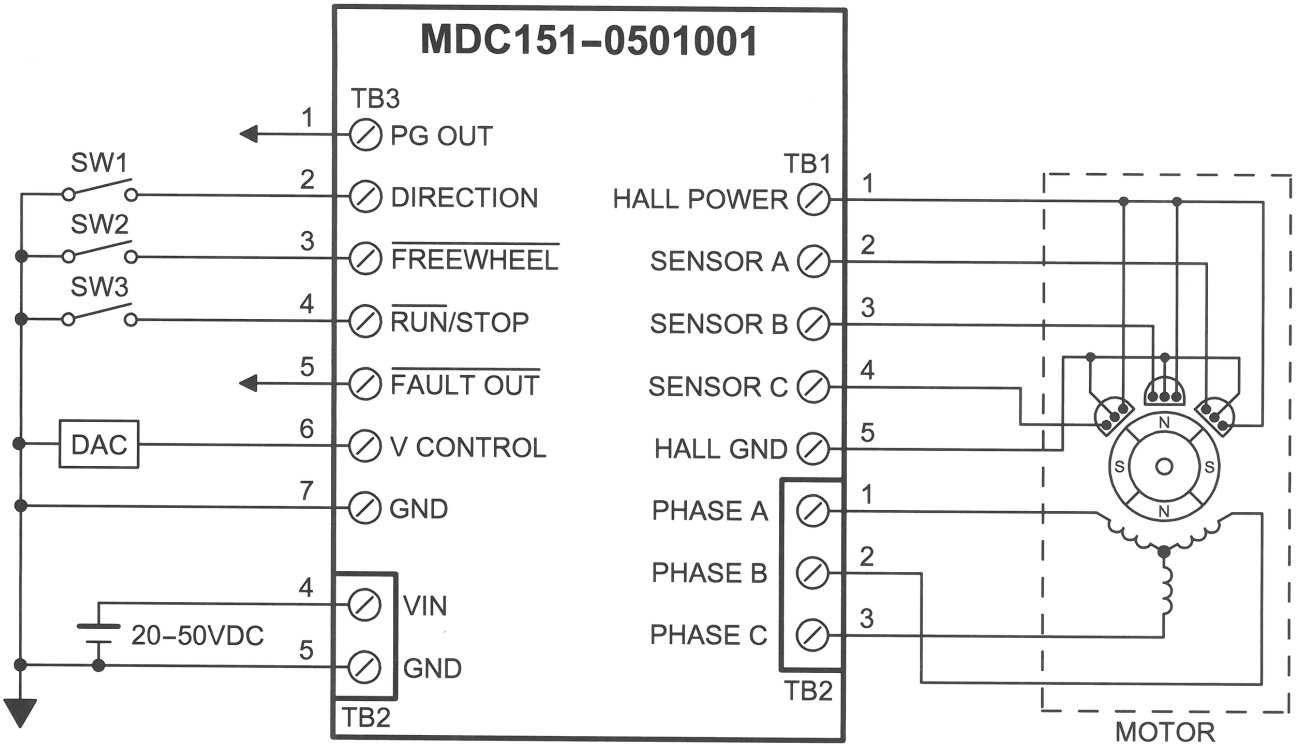
The PG OUT terminal (TB3 - pin 1) is used to determine the speed of the motor shaft. A 5V signal pulse out is shown at a rate of 4 pulses for 1 revolution of an 8-pole motor, 3 pulses for 1 revolution of a 6-pole motor, and 2 pulses for 1 revolution of a 4-pole motor.

# Poles	RPM
8	15 * PG OUT (in Hz)
6	20 * PG OUT (in Hz)
4	30 * PG OUT (in Hz)

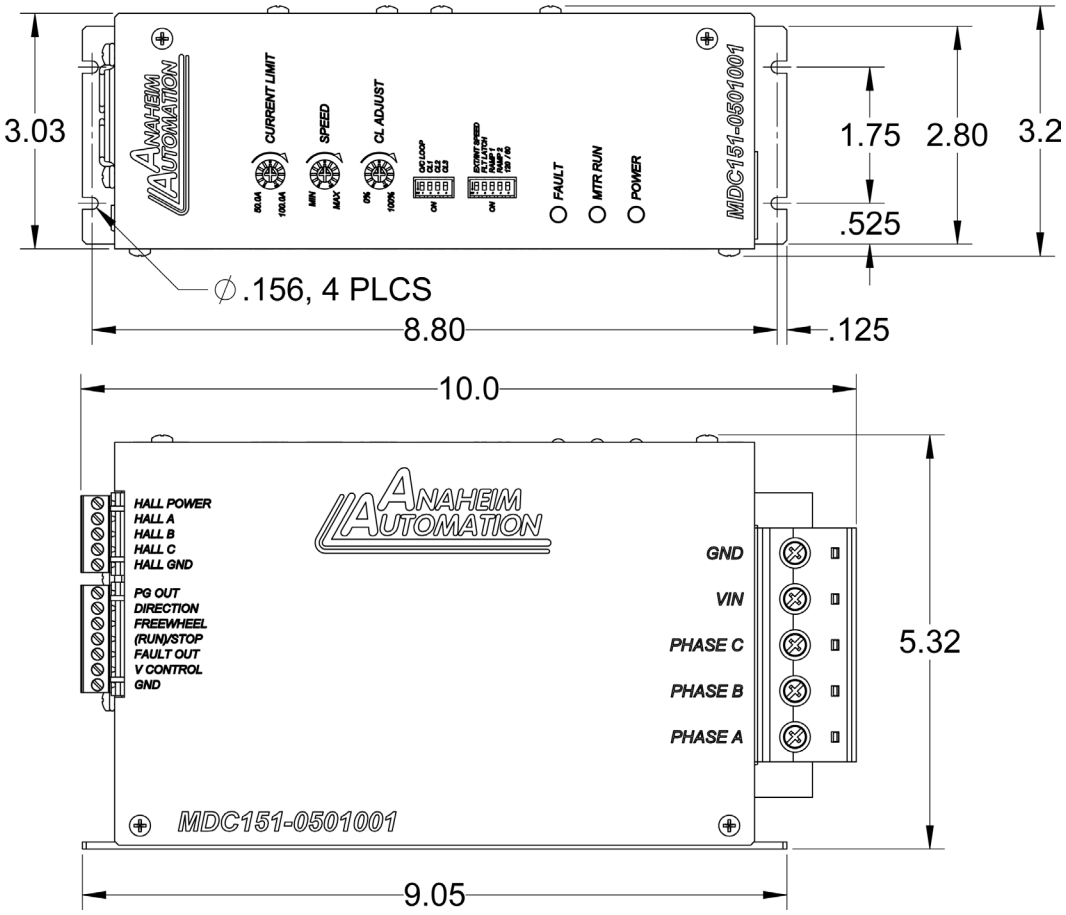
Heating Considerations

Temperature of the heat sink should never be allowed to rise above 70 degrees Celsius. If necessary, mount the unit to an additional heat sink or air should be blown across the heat sink to maintain suitable temperatures.

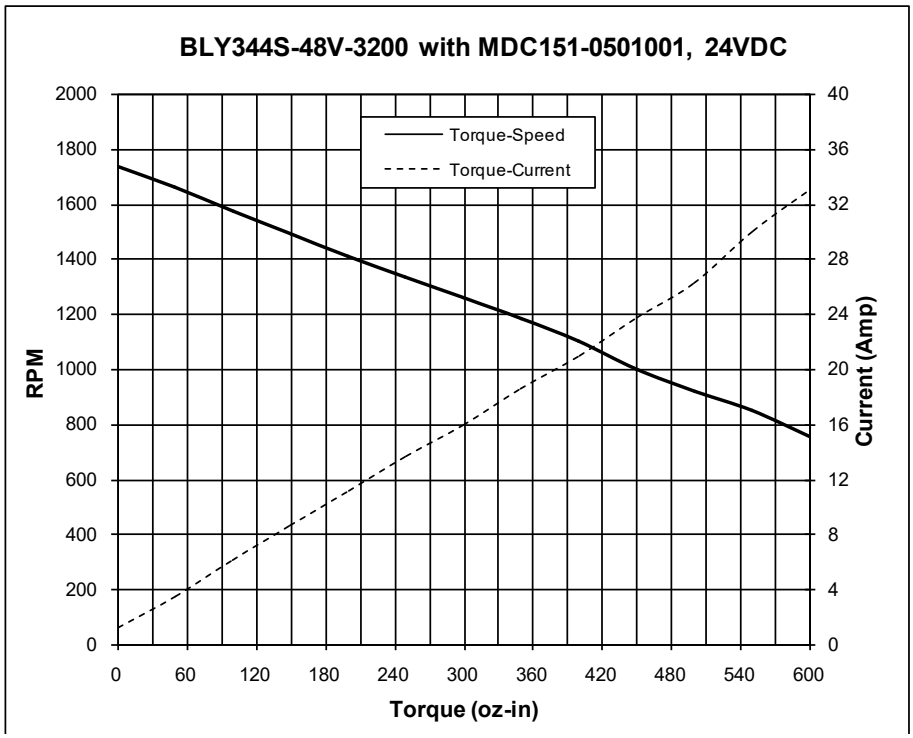
Typical Hookup Drawing



Dimensions



Torque Curve



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TECHNICAL SUPPORT
If you should require technical support or if you have problems using any of the equipment covered by this manual, please read the manual completely to see if it will answer the questions you have. If you need assistance beyond what this manual can provide, contact your Local Distributor where you purchased the unit, or contact the factory direct.