MDC300-120151 Series
120VAC, 15A Brushless Controller

User's Guide

PHASE C
PHASE B
PHASE A
MTR GND

HALL POWER
HALL A
HALL B
HALL C
HALL GND

PG OUT (C)
PG OUT (E)
DIRECTION +
DIRECTION -
FREEWHEEL +
FREEWHEEL -
RUN/STOP +
RUN/STOP -
FAULT OUT (C)
FAULT OUT (E)
ANALOG VIN +
ANALOG VIN -

EGND
NEUTRAL
LINE (HOT)

MDC300-120151

MDC300-120151 Driver Features

- Peak Current Limit Setting from 5.0 to 15.0 Amps
- Internal/External Potentiometer or Voltage Input Speed Control
- On-board Potentiometer Ramp Up/Down Adjustment
- Single Input Speed and Direction Control (Auto-Direction)
- 2-Quadrant Operation
- Hall Sensor Feedback
- Constant Velocity Mode Option
- Short Circuit Protection
- Requires 85-135 VAC
- Speed Out
- Fault Out
- Run/Stop, Freewheel and Direction Inputs
- Optically Isolated Inputs and Outputs
- Dual Mounting Option
- Detachable, Screw Type Terminal Blocks for the Logic Inputs/Outputs and Motor Phases
- Covered, Screw Type Barrier Strip for the Power Input

General Description

The MDC300-120151 Driver is designed to drive DC brushless motors at currents of up to 15A peak and 170VDC. 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 notifies the user. If the fault latch is enabled and an error occurs, the fault output goes low 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 optional external potentiometer or voltage input can be used to control the speed voltage input as well. The direction of the motor can be preset by the direction control input. The speed and direction can also be controlled by the external voltage speed input when the Auto-Direction mode is chosen. Other inputs to the drive include a run/stop and a motor freewheel input. An onboard potentiometer sets the ramp up/down profile from standstill. The run/stop input overrides all other inputs into the driver.

Electrical Specifications

Item	Min	Typ	Max	Units
Input Voltage (Power)	85	120	135	VAC
Input Voltage (Power)	120	170	191	VDC
Phase Output Current	3.5		10.6	A (RMS)
Phase Output Current	5		15	A (Peak)
Input Voltage (Inputs)	3.5		24	VDC
Chopping Frequency	23	25	27	kHz
Operating Temperature	0		70	C
External Speed Voltage	-6		6	VDC

Table 1: MDC300-120301 electrical specifications

Hi-Pot Rating (10 seconds):

Line to Ground 850VAC, 10mA

Pin Descriptions

The inputs on the MDC300-120151 are optically isolated with the anode (+) and cathode (-) both brought out to the user. With no current going through the Direction, Freewheel, and Run/Stop opto-diodes, the input is considered high. To enable the motor to Run, current must go through the Run/Stop input opto-diode. To Freewheel (remove energy from the motor) the motor, current must go through the Freewheel input opto-diode. To enable an input, a minimum of 1.0 mA needs to be sourced or synced through the opto-diode. To enable an input, apply a DC voltage source of +3.5VDC to +24VDC across the two inputs of the opto-diode. If sourcing current into the inputs, then all three cathodes (-) should be tied together and grounded. If sinking current, then all three anodes (+) should be tied together to the +voltage. The isolated external Speed Voltage Input must be an analog voltage from 0VDC to +/-5VDC. The PG Out and Fault output on the MDC300-120151 are an opto-decoupled open collector output.

Speed Output: (TB1, Pin 1 and 2)

An opto-decoupled open collector output 50% duty cycle square wave 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. Care must be taken not to pass more than 50mA through this transistor.
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)

Motor Direction (TB1 - pins 3 and 4)

The motor direction feature allows the changing of the rotation of the motor. This input should not be changed while maximum speed 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.

Motor Freewheel (TB1 - pins 5 and 6)

The motor freewheel feature allows the de-energizing of the motor phases. A high (open) 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 (TB1 - pins 7 and 8)

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.

Fault Output: (TB1, Pin 9 and 10)

To use the fault output, FLT LATCH switch (Switch Panel 1, Switch 2) must be in the ON position. When normal operation occurs, this output will conduct current into the emitter. Care must be taken not to pass more than 50mA through this transistor.

Analog Vin: (TB1, Pin 11 and 12)

To control the speed of the motor with an external DC voltage, INT/EXT SPD switch (Switch Panel 1, Switch 1) must be on ON Position.

Dip Switch Panel 1 Settings

Function	Switch 1	Switch 2	Switch 3	Switch 4	Switch 5
Internal Speed Control (On board speed potentiometer)	Off	---	---	---	---
External Speed Control (TB1 - Pins 11 & 12)	On	---	---	---	---
Fault Latching	---	On	---	---	---
Fault Cycle by Cycle	---	Off	---	---	---
Ramp 1 profile 1 (set by Ramp Pot)	---	---	On	---	---
Ramp 1 profile 2 (set by Ramp Pot)	---	---	Off	---	---
Direction control via Direction Opto-input	---	---	---	Off	---
Direction Control via Speed Voltage Polarity	---	---	---	On	---
60° Hall Sensor Spacing	---	---	---	---	Off
120° Hall Sensor Spacing	---	---	---	---	On

Dip Switch Panel 1: Speed Adjustment, Over Current, and Ramp settings

Internal/External Speed Control (Switch Panel 1 - Switch 1)
There are two ways to set the speed on this drive:
1. Use the on board potentiometer. To use the on board potentiometer, set INT/EXT SPD switch (Switch Panel 1- Switch 1) to the 'off' position (default). The speed is adjusted by setting the onboard speed potentiometer.
2. The second way is to use an external source. To use an external 10K potentiometer or external voltage set INT/EXT SPD switch (Switch Panel 1- Swtich 1) to the 'on' position.

When INT/EXT SPD switch (Switch Panel 1- Switch 1) in the OFF Position:
The onboard speed potentiometer is used to control the speed of the motor. The motor speed increases as the potentiometer is set from 0% - 100%.

When INT/EXT SPD switch (Switch Panel 1 - Switch 1) in the ON Position:
Either an external speed analog voltage or an external potentiometer can be used to set the motor speed. For an external voltage, apply a +/- voltage on TB1 - pin 11 and the return on TB1 - pin 12. The motor speed increases as the voltage is set from 0.1VDC to +5VDC or -0.1VDC to -5VDC. A -5VDC to +5VDC voltage span cay be used to change the speed and direction of the motor (*see Auto Direction (Switch Panel 1 - Switch 4).* The motor will be stopped with an external speed analog voltage from -0.1VDC to 0.1VDC.

For an external potentiometer, connect the POT WIPER to TB1 - pin 11, POT (-) to TB1 - pin 12, and POT (+) to an external +/-5V supply.

Fault Latch (Switch Panel 1 - Switch 2)
Over current protection can be provided by means of a over current latch function by setting the 'FLT LATCH' switch, Switch Panel 1 - Switch 2 to the "on" position. If a motor current level exceeding the current limit set by the internal current limit potentiometer is produced, an over current latch is activated, shutting off the output and turning the fault output high (logic "1"). This driver is equipped with a FAULT LED and Fault-out output to alert the user of the following conditions. To reset the MDC300-120301 driver from a latched condition, power down, allow 30 seconds for power to dissipate, then power up. To diseable the fault latch, set FLT LATCH switch to the "off" position and the driver will have a cycle by cycle current limiting protection.

Motor Ramp Up/Down (Switch panel 1 - Switch 3)

Ramp Set on Switch Panel 1 - Switch 3 set to the ON position, the motor will have the following zero RPM to max open loop speed ramp times:

RAMP POT %	Ramp up/down time
100	3.2 sec
75	2.4 sec
50	1.6 sec
25	0.8 sec
0	0 sec

Ramp Profile 1

Ramp Set on Switch Panel 1 - Switch 3 set to the OFF position, the motor will have the following zero RPM to max open loop speed ramp times:

RAMP POT %	Ramp up/down time
100	1.6 sec
75	1.2 sec
50	0.8 sec
25	0.4 sec
0	0 sec

Ramp Profile 2

Auto Direction (Switch Panel 1 - Switch 4)

When AUTO DIRECTION switch (Switch Panel 1, Switch 4) in the OFF Position (default):
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.
When AUTO DIRECTION switch (Switch Panel 1, Switch 4) in the ON Position:
A 0 to +5V speed voltage signal at TB1 - pins 11 & 12 causes the motor to turn in the CW direction, while a 0 to -5V speed voltage causes the motor to turn in the CCW direction. With Switch Panel 1 Switch 4 in the ON position, the Direction inputs TB1-pin 3 (Direction +) should be left open AND TB1-pin 4 (Direction -) should be tied to TB1-pin 12 (Analog VIN -). INT/EXT SPD switch (Switch Panel 1 - Switch 1) needs to be set to the ON Position.

Hall Sensor Spacing (Switch Panel 1 - Switch 5)

60° Hall Sensor Spacing when Switch Panel 1 - Switch 5 is set to the OFF position.
120° Hall Sensor Spacing when Switch Panel 1 - Switch 5 is set to the ON position.

Dip Switch Panel 2 Settings (Closed loop settings)

Function	Switch 1	Switch 2	Switch 3	Switch 4
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 Producy (Ready to Ship)	On	Off	Off	Off

Dip Switch Panel 2: Open Loop and Closed Loop. If Closed Loop selected, Closed Loop compensation switches must be set according to motor speed desired.

Open Loop/Closed Loop Constant Velocity Mode (Switch Panel 2 - Switch 1-4)
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. In Open Loop operation, the greater the load, typically the speed of the motor decreases. 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 must be in the 'on' position.

To operate Closed Loop, the O/C LOOP switch (Switch Panel 2, Switch 1) must be in the 'off' position and the CLADJ potentiometer (R3) and CLADJ dip switches (Switch Panel 2, Switch 2-4) must be set to optimize the driver for each motor and application. The Closed Loop adjustments are needed for faster and slower motor operation, within the restrictions of the motor rated speed. The adjustments provide a direct duty cycle to the driver with repect to the required motor speed.

The tables shown on the next page are the Closed Loop potentiometer and dip switch settings for each motor. These setting are calid for the rated motor voltage listed on the following tables. These adjustments will set the maximum running speed of the internal/external speed potentiometer or the 5VDC voltage set to the motors maximum running speed. Motor operation at slower speeds may also be attained. For the slower speed, the pulse width of the duty cycle can be increased by adjusting the CL POT towards 100% and switching 'off' CL3, CL2, and CL1 one after another, until the desired motor speed is achieved. The motor speed can be monitored by measuring the pulse rate of PG OUT (TB1 pin 1 and 2).

If using a non-Anaheim Automation DC Motor.
1. Start by making sure the Open/Closed loop (Switch Panel 2, Switch 1) setting is toggled 'on'.
2. Set the closed loop switches CL1, CL2, and CL3 on the 'on' position.
3. Set CLADJ POT to 0%.
4. Adjust the internal speed pot or external speed pot to 100% The motor at this time should be running at its maximum speed.
5. Turn the Open/Closed loop setting Dip Switch Panel 2, Switch 1 'off'.
6. Decrease 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 7.

CL1	CL2	CL3	Duty Cycle Setting
On	On	On	Max
Off	On	On	
On	Off	On	
Off	Off	On	
On	On	Off	
Off	On	Off	
On	Off	Off	
Off	Off	Off	Min

Table 2: CL gain adjust decremented settings

7. Slowly rotate CLADJPOT 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 CLADJPOT to 0%. Increase the closed loop gain incrementally by setting CL1, CL2, CL3 with respect to the desired top motor speed and re-tune CLADJPOT, as described in step 4 and step 5.

4-pole motors

Motor	CL1	CL2	CL3	CL POT	MAX SPD (RPM)	MIN SPD (RPM)
BLWS235D-160V-3000 BLWS235S-160V-3000	Off	Off	On	80%	3000	270

Table 3: Closed Loop Operation Motor Settings @ rated motor voltages

8-pole motors

Motor	CL1	CL2	CL3	CL POT	MAX SPD (RPM)	MIN SPD (RPM)
BLY342D-160V-3000 BLY342S-160V-3000	Off	On	On	50%	3000	250
BLY343D-160V-3000 BLY343S-160V-3000	Off	On	On	50%	3000	250
BLY344D-160V-3000 BLY344S-160V-3000	Off	On	On	50%	3000	250

Table 4: Closed Loop Operation Motor Settings @ rated motor voltages

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 connection a motor for the first time, connect the hall sensor wires (5 of them) to the driver. **DO NOT CONNECT THE PHASE WIRES YET.** Turn on power and rotate the motor by hand. If the RED FAULT LED comes on, the hall sensor wires are incorrectly wired. If the RED FAULT LED does not come on then the hall sensor 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, closed loop setting (if closed loop is used) 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..

Hall Sensor Power Output:
5V @ 30mA maximum. Typical current draw from hall sensors is 20mA.
All three Hall Sensors inputs are pulled up through 20K ohm resistors.

Terminal Block Descriptions

Pin #	Description
1	PG OUT(collector
2	PG OUT(emitter)
3	Direction (+)
4	Direction (-)
5	Freewheel (+)
6	Freewheel (-)
7	Run/Stop (+)
8	Run/Stop (-)
9	Fault Out (collector)
10	Fault Out (emitter)
11	Speed Voltage (+)
12	Speed Voltage (-)

TB1: Opto-isolated Control Inputs and Outputs

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

TB2: Motor Hall Terminals

Pin #	Description
1	Phase A
2	Phase B
3	Phase C

TB3: Motor Phase Terminals

Pin #	Description
1	AC Hot
2	AC Neutral
3	EARTH GND (must be connected)

TB4:AC Voltage In Terminals

Dip Switch Descriptions

Switch#	Description
1	INT/EXT SPEED
2	FLT LATCH
3	RAMP
4	AUTO DIRECTION
5	60/120

Switch Panel 1: Dip Switch

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

Switch Panel 2: Dip Switch

Fault Protection

The MDC300-120151 is equipped with a FAULT LED and Fault-out output to alert the user of the following conditions. :

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

A Fault latch function is available by setting the 'FLT LATCH' dip switch (Switch Panel 1, SW2) to the "on" position. If Fault latchis selected and a fault occurs, the driver shuts off the output and turns the fault output open (logic "1"). To reset the MDC300-120151 driver from a latched condition, power down, allow 30 seconds for power to dissipate, then power up.

Heating Considerations

The temperature of the heat sink should never be allowed to rise above 70° Celsius. If necessary, mount the unit to an additional heat sink or air should be blown across the heat sink to maintain suitable temperatures.
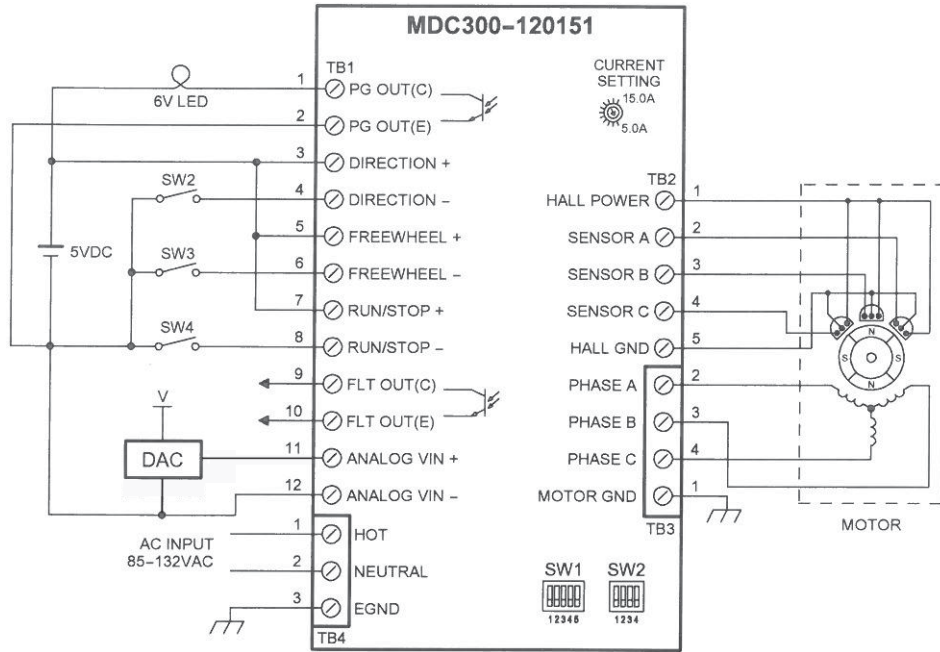
Typical Hookup Drawing
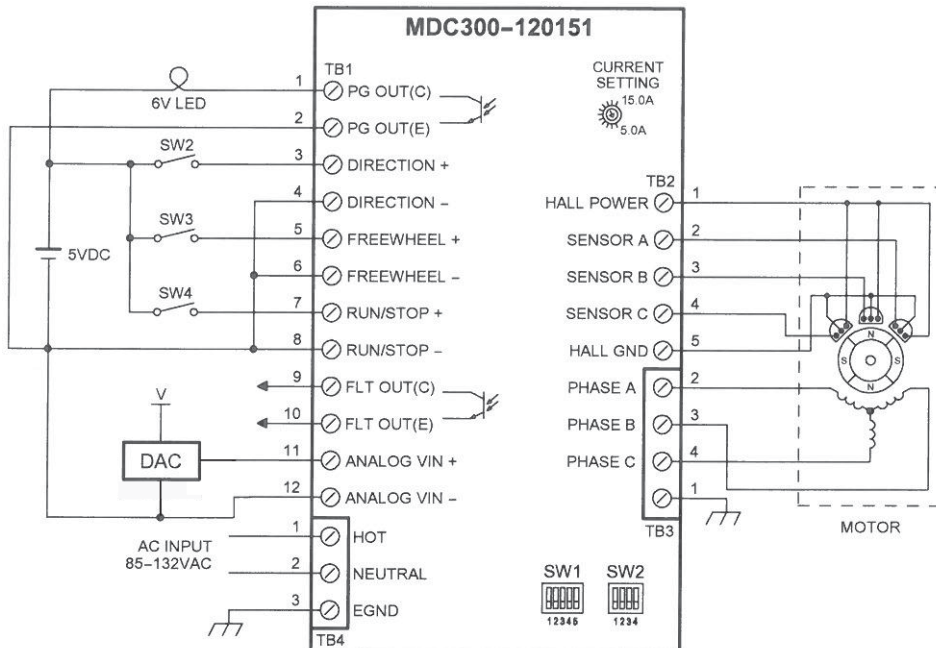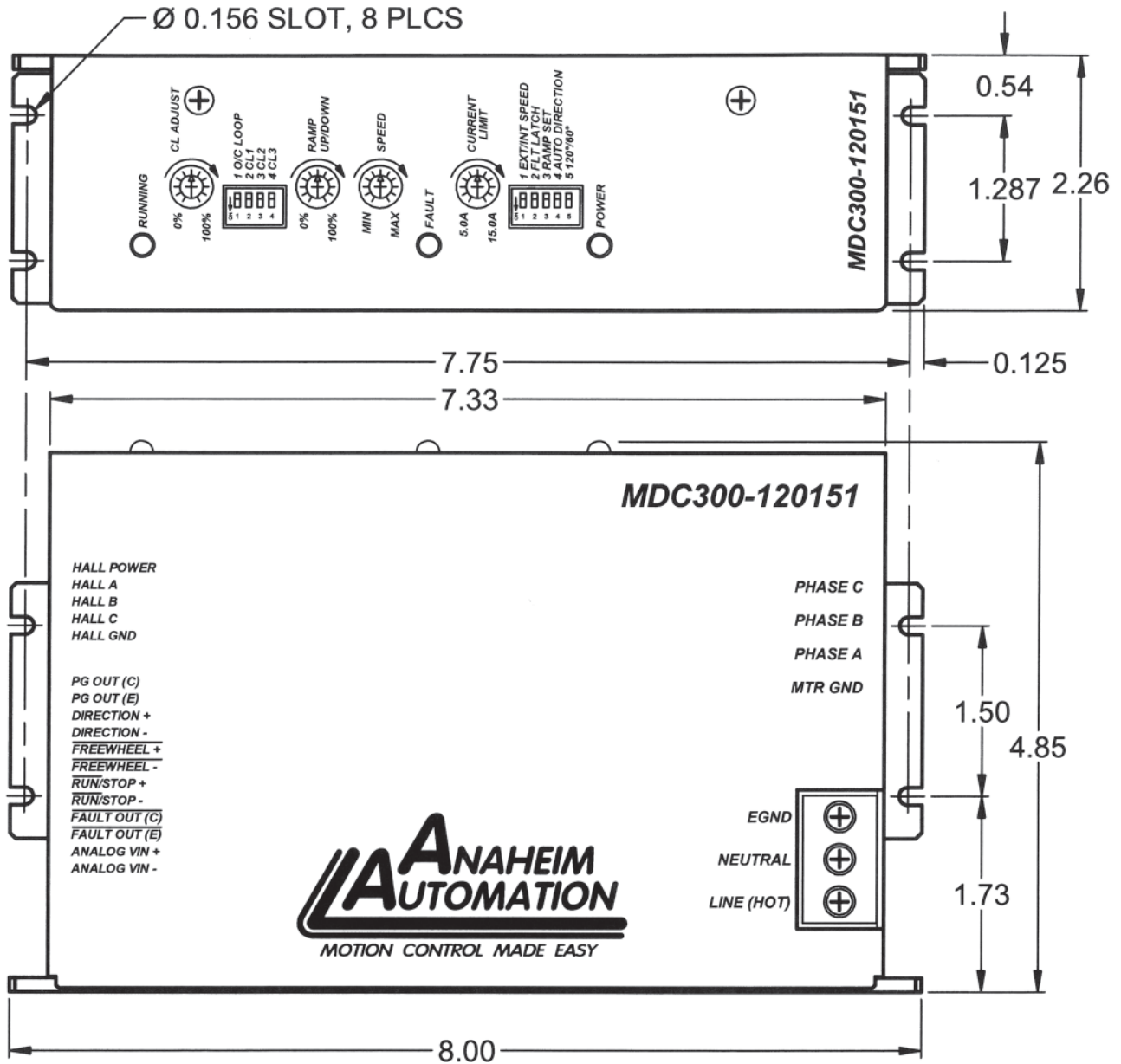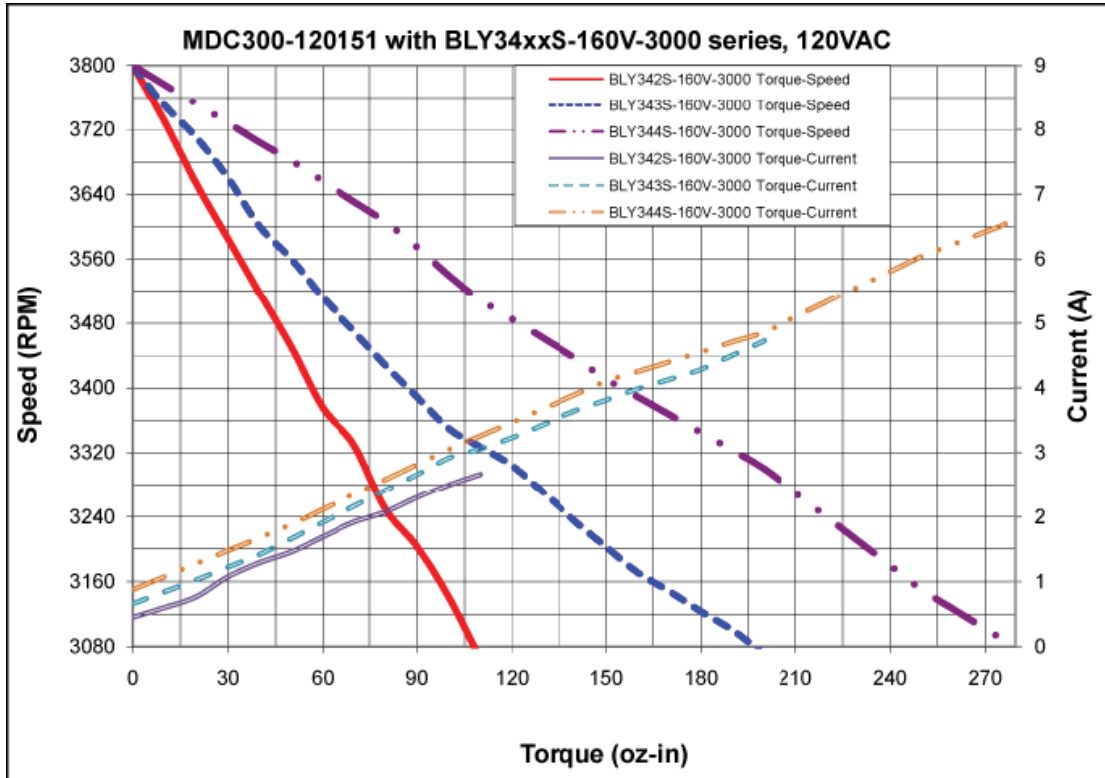

Figure 1: Hook up for current sinking inputs

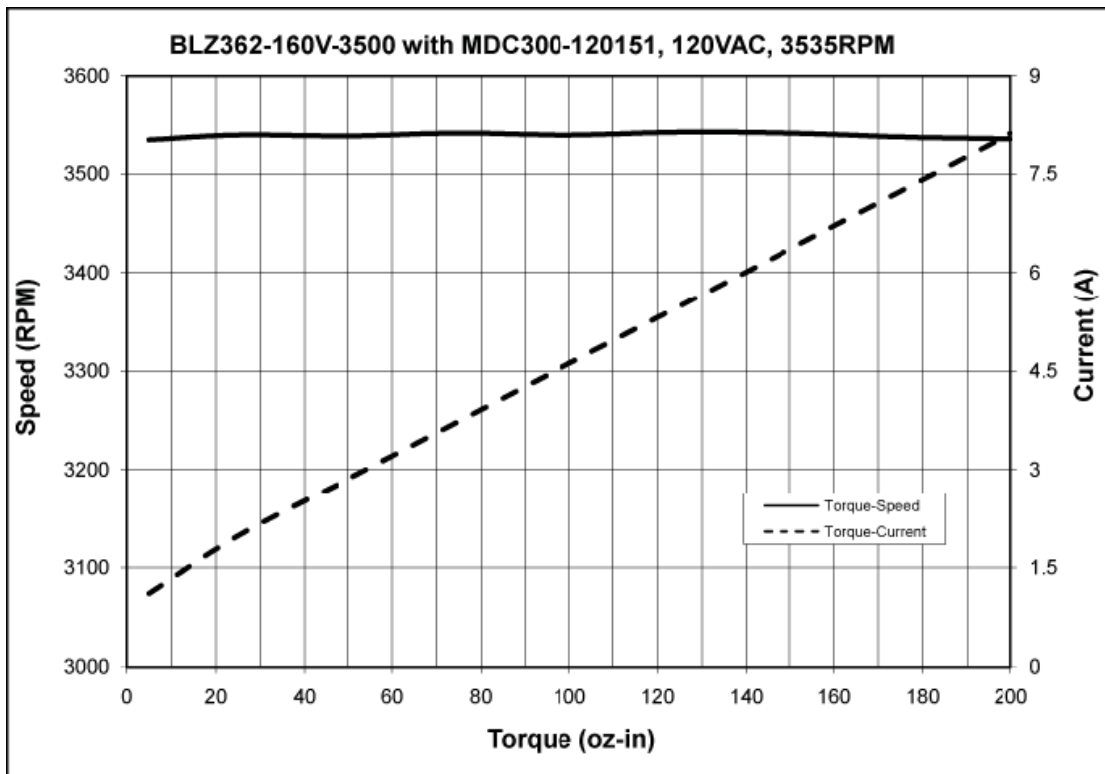Figure 2: Hook up for current sourcing inputs

Dimensions

Ø 0.156 SLOT, 8 PLCS

Top view:
- RUNNING
- CL ADJUST — 0% / 100%
- 1 O/C LOOP / 2 CL1 / 3 CL2 / 4 CL3
- RAMP UP/DOWN
- SPEED — MIN / MAX
- FAULT
- CURRENT LIMIT — 5.0A / 15.0A
- 1 EXT/INT SPEED / 2 FLT LATCH / 3 RAMP SET / 4 AUTO DIRECTION / 5 120°/60°
- POWER

MDC300-120151

Dimensions: 0.54, 1.287, 2.26, 7.75, 7.33, 0.125

Front view labels (left):
- HALL POWER
- HALL A
- HALL B
- HALL C
- HALL GND
- PG OUT (C)
- PG OUT (E)
- DIRECTION +
- DIRECTION -
- FREEWHEEL +
- FREEWHEEL -
- RUN/STOP +
- RUN/STOP -
- FAULT OUT (C)
- FAULT OUT (E)
- ANALOG VIN +
- ANALOG VIN -

MDC300-120151

Front view labels (right):
- PHASE C
- PHASE B
- PHASE A
- MTR GND
- EGND
- NEUTRAL
- LINE (HOT)

ANAHEIM AUTOMATION
MOTION CONTROL MADE EASY

Dimensions: 1.50, 4.85, 1.73, 8.00

Weight = 4.5lbs

Open Loop Torque Speed Curve

MDC300-120151 with BLY34xxS-160V-3000 series, 120VAC

Legend:
- BLY342S-160V-3000 Torque-Speed
- BLY343S-160V-3000 Torque-Speed
- BLY344S-160V-3000 Torque-Speed
- BLY342S-160V-3000 Torque-Current
- BLY343S-160V-3000 Torque-Current
- BLY344S-160V-3000 Torque-Current

Close Loop Torque Speed Curve

BLZ362-160V-3500 with MDC300-120151, 120VAC, 3535RPM

Legend:
- Torque-Speed
- Torque-Current

Troubleshooting

Problem	Suggested Things to Test
Red Fault LED on at Power Up	Verify if Motor Halls, Power, and GND are not either disconnected or miswired.
	Verify if Motor Phases are not either disconnected or miswired.
	Verify that the Hall Sensor Spacing switch (SW1 - POS. 5) is properly set for the motor used.
	If a heavy load is present at power up, verify current limit setting is set appropriately and current latch (SW2 - POS. 2) is not set to the ON position.
	Verify the Motor Hall Power is not overloaded. This occurs when other external circuitry other than the motor halls is using this voltage reference for power, i.e. motor encoder.
	Verify the Freewheel input is not sinking or sourcing any current through the opto-diode.
Motor does not run	Check if Red Fault LED is on.
	Verify if Motor Halls, Power, and GND are not either disconnected or miswired.
	Verify if Motor Phases are not either disconnected or miswired.
	Verify the Run/Stop input is sinking or sourcing current through the opto-diode.
	Verify the on-board/external speed setting is correct on SW1, pin 1 is correct.
	Verify on-board or external speed adjustment not at 0VDC or 0%
	If a Closed-Loop operation is required, verify the Closed-Loop settings are correct for the motor used.
Motor runs erratic, at high temperature (above 70°C), or incorrect speed	Verify if Motor Halls, Power, and GND are not either disconnected or miswired.
	Verify Motor Phases are not either disconnected or miswired.
	Verify the on-board/external speed setting is correct on SW1, pin 1 is correct.
	Verify the Freewheel input is not intermittently sinking or sourcing any current through the opto-diode.
	Verify the Run/Stop input is not intermittently losing any current sinking or sourcing through the opto-diode.
	Verify that nothing is connected to the Direction inputs when the Auto Direction mode is selected.
	If a Closed-Loop operation is required, verify the Closed-Loop settings are correct for the motor used.
	Verify there are no large variations in the motor bus voltage by monitoring the voltage input when open-loop operation is used.
	Verify the motor is not damaged by trying another motor with the driver.

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Anaheim Automation will repair or replace at its' option, any product which has been found to be defective and is within the warranty period, provided that the item is shipped freight prepaid, with previous authorization (RMA#) to Anaheim Automation's plant in Anaheim, California.

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.

ANAHEIM AUTOMATION