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# MDC151-050301 Series
# 50V, 30A Brushless DC Controller

## User's Guide




ANAHEIM AUTOMATION

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## MDC151-050301 Driver Features

- Maximum Current Limit Setting from 10.0-30.0 Amps (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 - 50VDC
- Speed Out
- Fault Out
- Run/Stop, Freewheel and Direction
- Selectable Ramp Up
- TTL-CMOS Compatible Inputs
- Compact Size (6.25” x 3.28” x 1.65”)
- Dual Mounting Option
- Screw Type Terminal Blocks

## General Description

The MDC151-050301 driver is designed to drive DC brushless motors at currents of up to 30A (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. Other inputs to the drive include a run/stop and a motor freewheel 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 an over current latch function by setting the ‘FLT LATCH’ dip switch. 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. This driver is equipped with a FAULT LED to alert 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 voltage.

## Power Supply

| Part # | Description |
|---|---|
| PSA24V2.7A | DC Power Supply 24VDC at 2.7 Amps |
| PSA40V4A | DC Power Supply 40VDC at 4 Amps |
| PSA40V8A | DC Power Supply 40VDC at 8 Amps |



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## Specifications

### Control Inputs: (TB1, Pins 1-3)

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

### Vcontrol: (TB1, Pin 4)

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 10.0 - 30.0 amperes per phase maximum operating peak current
(5.0 - 15.0 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



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## Hall Sensor Power Output:

6.25V @ 30mA maximum. Typical current draw from hall sensor is 20mA.
All three Hall Sensor inputs are pulled up through 20K ohm resistors.

## 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 hte CLADJ POT (R3) and CLADJ dip switches (SW2, pin 2-4) must be set to optimize the driver for each application.

If using an Anaheim Automation DC Brushless motor, the tables shown on the next page are the Close Loop potentiometer and dip switch settings for each motor. The regulated speed of the motor is then controlled by adjusting the internal or external speed pot. The motor speed can be monitored by measuring the pulse rate of PG OUT (TB3 - pin 1).

If using a non-Anaheim Automation DC Motor.

1. Start with setting the closed loop switches CL1, CL2, and CL3 on the 'on' position.
2. Set CLADJPOT 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 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.



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# 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<br>BLWS231S-36V-4000 | On | Off | On | 65% | 4010 | 550 |
| BLWS232D-36V-4000<br>BLWS232S-36V-4000 | On | Off | On | 65% | 4010 | 550 |
| BLWS233S-36V-4000 | On | Off | On | 65% | 4010 | 550 |
| BLWS234D-36V-4000<br>BLWS234S-36V-4000 | On | Off | On | 65% | 4010 | 550 |
| BLWS235-36V-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 |
| BLY172D-24V-4000<br>BLY172S-24V-4000 | On | On | On | 80% | 4000 | 250 |
| BLY173D-24V-4000 | On | On | On | 80% | 4000 | 250 |
| BLY174D-24V-4000<br>BLY174S-24V-4000 | On | On | On | 80% | 4000 | 250 |
| BLY341D-48V-3200<br>BLY341S-48V-3200 | Off | On | On | 40% | 3200 | 250 |
| BLY342D-24V-3000 | Off | On | On | 40% | 3000 | 250 |
| BLY342D-30V-3000<br>BLY342D-30V-3000 | Off | On | On | 40% | 3000 | 250 |
| BLY342D-48V-3200<br>BLY342S-48V-3200 | Off | On | On | 30% | 3200 | 250 |
| BLY343D-48V-3200<br>BLY343S-48V-3200 | Off | On | On | 30% | 3200 | 250 |
| BLY343S-30V-3000 | Off | On | On | 40% | 3000 | 250 |
| BLY344D-48V-3200<br>BLY344S-48V-3200 | Off | On | On | 30% | 3200 | 250 |
| BLZ362S-36V-3500 | Off | On | On | 10% | 3500 | 330 |
| BLZ362S-160V-3500 | Off | On | On | 10% | 3500 | 330 |
| BLZ482S-160V-3500 | Off | On | On | 10% | 3500 | 330 |
| BLZ242S-24V-3500 | Off | On | On | 10% | 3500 | 330 |



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## 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.



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## Terminal and Dip Switch 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 | PG OUT |
| 2 | Direction |
| 3 | Freewheel |
| 4 | Run/Stop |
| 5 | Fault Out |
| 6 | VControl |
| 7 | GND |

TB3: Control Inputs and Outputs

| SW # | Description |
|---|---|
| 1 | INT/EXT SPEED |
| 2 | FLT LATCH |
| 3 | RAMP 1 |
| 4 | RAMP 2 |
| 5 | 60/120 |

SW1: Dip Switch

| SW # | Description |
|---|---|
| 1 | O/C LOOP |
| 2 | CL1 |
| 3 | CL2 |
| 4 | CL3 |

SW2: Dip Switch

## Dip Switch Settings

| Function | 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



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## Dip Switch Settings (cont.)

| Function | SW1 | SW2 | SW3 | SW4 | SW5 |
|---|---|---|---|---|---|
| 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 | Off |

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

## Motor Freewheel

The motor freewheel feature allows 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.

## Speed Adjust Setting

There are three ways to set the speed on this drive. One is to use the on-board or external potentiometer. To others is to use an external voltage. To use the on-board potentiometer, set INT/EXT SPD switch to the off position (default). To use the external 10K 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 Vcontrol (TB3 - pin 6) with respect to GND (TB3 - pin 7). If an external potentiometer is used to control the speed of the motor, connect the pot wiper to Vcontrol (TB3 - pin 6), the positive end of the potentiometer to Hall Power (TB1 - pin 1) and the negative end to GND (TB3 - pin 7).

The maximum voltage that can be placed on Vcontrol 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 Vcontrol input.



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## Speed Output

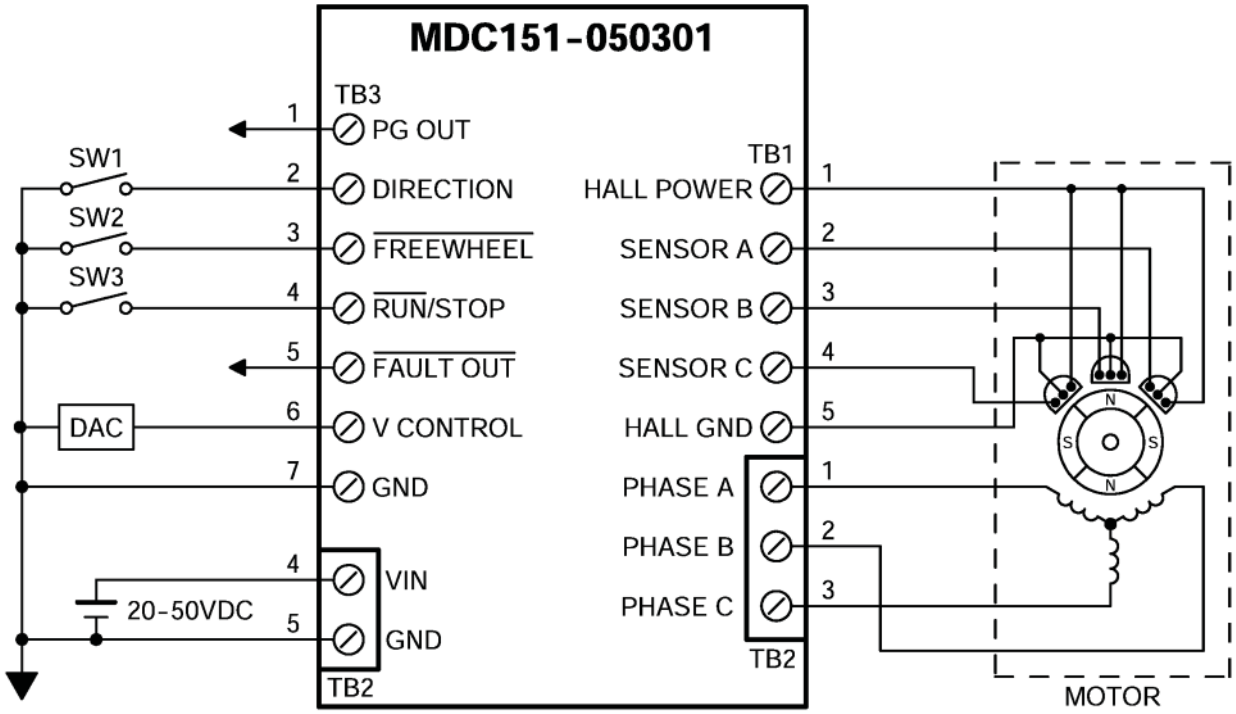
The PG OUT terminal (TB3 - pin 1) is used to determine the speed of the motor shaft. A 5V signal pulse out is shown at a rate of 4 pulses for 1 revolution of an 8-pole motor, 3 pulses for 1 revolution of a 6-pole motor, and 2 pulses for 1 revolution of a 4-pole motor.

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

## Heating Considerations

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.

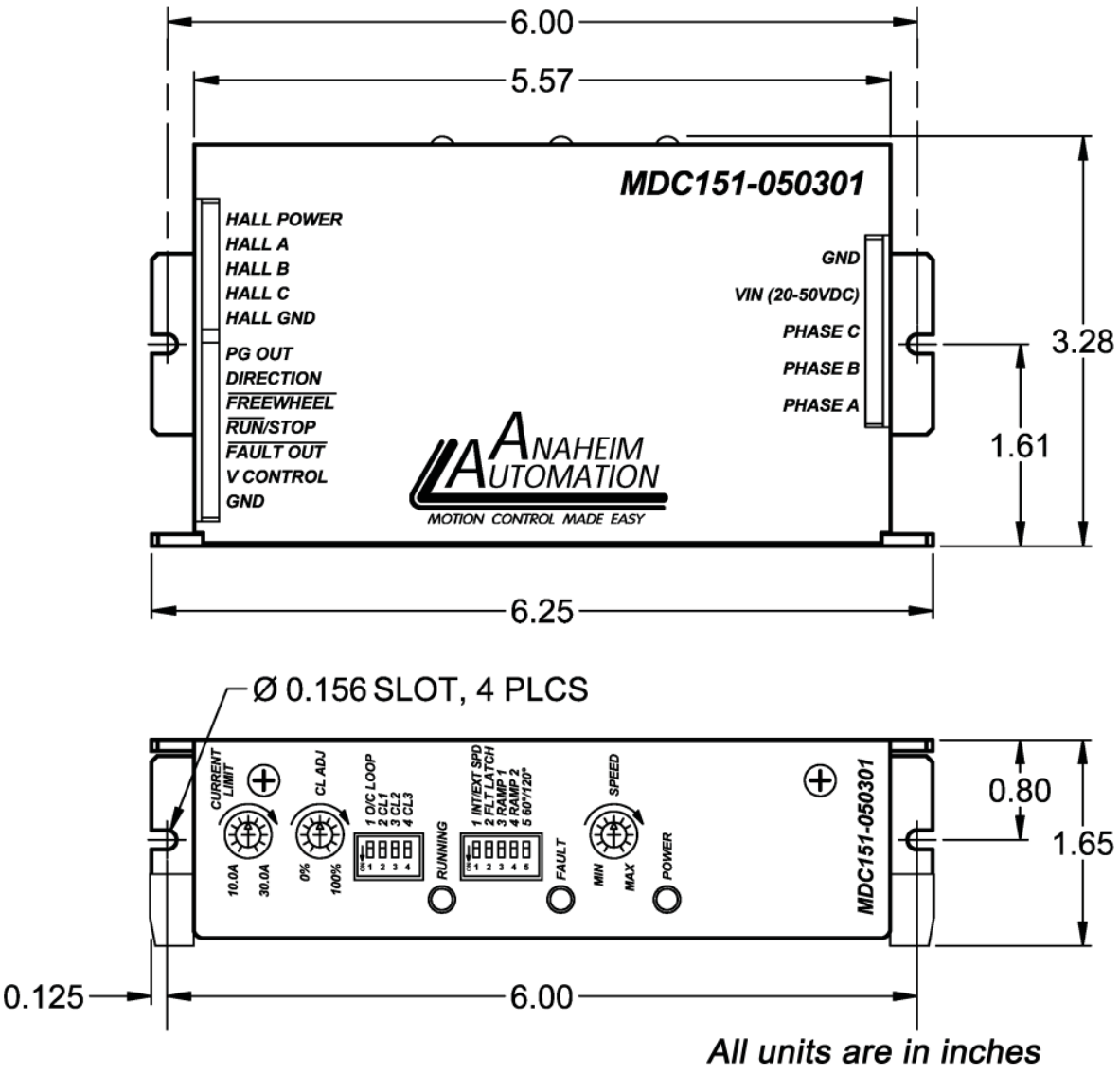
## Typical Wiring Diagram






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## Dimensions






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