40 Amp Digital Bidirectional PWM Motor Controller with Regenerative Braking
BIDIR-340-DR

The BIDIR-340-DR is a fully solid-state motor controller that allows you to control the speed and direction of a brushed DC motor using a potentiometer, a 0-5V voltage level, push buttons or logic pulses. Logic DIR and BRAKE inputs control motor direction and braking. Automatic current limiting protects the controller and motor from overload conditions. Regenerative Braking recharges batteries when the motor slows down. Adjustable soft-start ramps up the speed of the motor when starting and reversing to limit stress to mechanical linkages and power supplies. A high efficiency full H-bridge allows for minimal power loss while delivering up to 40 amps at 60 volts to the motor.

Features:

- Forward / Reverse Control
- Regenerative Braking
- Braking input (full brake)
- Logic Direction Input
- Logic Enable Input
- 60 Volts maximum input voltage
- 40 Amps maximum continuous current
- Separate Regeneration and Acceleration Current Limits
- 5k potentiometer or 0-5V control
- Microcontroller input option
- Push button speed control option
- Adjustable Soft Start Ramp
- Over-temperature protection
- Potentiometer Fault protection
- LED status indicator
- Low ESR, long-life filter capacitors

Absolute Maximum Ratings:

Parameter	Max	Units
Continuous Output Current	40	A
Continuous Input Voltage	65	V
Instantaneous Input Voltage (t<0.1 s)	70	V

Warning – operating at or above the absolute maximum ratings may damage your controller or your equipment under control.

Operating Parameters:

Parameter	Min	Typical	Max	Units
Input Voltage	12	24	60	V
Continuous Output Current	--	--	40*	A
Digital Logic Input Low Level	0	--	1.5	V
Digital Logic Input High Level	3.5	--	5	V
Digital Logic Input Current	-0.2	--	1	mA
Digital Input Capacitance	--	0.1	--	uF
Digital Pulse Frequency (UP, DN lines)	0	--	500	Hz
Analog Voltage Input	0.0	--	5.0	V
Analog Voltage Input Current	0.0	0.05	0.1	mA
Potentiometer Total Resistance	4	5	6	kΩ
Soft Start from Disabled Mode, Ramp Rate**	10	100	--	% / s
PWM Frequency	18	19	20	kHz
Quiescent Current Drain at 24 V	75	100	120	mA
Temperature	-40	25	+60	°C

* Internally limited
** When soft-start is enabled.

Terminal Block Pinout:

Pin Label	Function	Active H/L
P-	Lower pin of potentiometer (GND)	--
CN/D	Wiper of potentiometer or Digital Decrease Speed Input	--
P+	Upper pin of potentiometer (5V)	--
DIR	Direction Input	L = forward H = reverse
BRK	Brake Input	H = brake mode L = normal mode
GND	Signal Ground	
EN	PWM output enable (internal pull-down)	H = enable L = disable
UP	Digital Increase Speed Input	

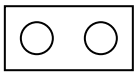
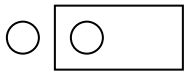
Power Connections:

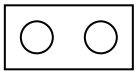
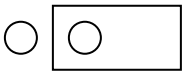
Pin Label	Function	Active H/L
MOTOR -	Negative output to motor	--
MOTOR +	Positive output to motor	--
GND	Ground from power supply	--
V+	Positive Power Supply	--

Modes of Operation:

The BIDIR-340-DR can be operated in analog or digital mode. The jumper labeled A/D is used to select between analog and digital input modes. Jumper PB is used to select between pulsed digital speed selection (microcontroller mode) and push button mode.

Table 1: Jumper Configuration

	Jumper Label	Position	Function
	A/D	Closed	Potentiometer (Analog Mode)
	A/D	Open	Digital Mode

	PB	Closed	Pulsed Digital (Microcontroller Mode)
	PB	Open	Push Button Mode

Note: All jumper setting changes take effect at power-up. Power down the board before changing the jumper settings.

Analog Mode:

When the board is configured for Analog Operation, a varying voltage (0 – 5 V) level is converted to the pulse width at the output (0 – 100%). A 5 k potentiometer may be used for speed control.

There is a built-in dead-band for potentiometer operation that sets the duty cycle to:
0% for any voltage level < 0.10 V.
100% for any voltage level > 4.90 V.

This dead-band along with digital filtering ensures smooth and reliable operation.

A 0-5 volt signal can also be used to control the output power. Connect the 0-5V signal into the D/CN terminal, and the signal ground to the GND terminal. Connect a 4.7k resistor between the P+ and P- terminals to bypass the missing potentiometer detection circuitry.

Digital Mode:

There are two ways to operate in digital mode: Microcontroller Mode and Push-Button Mode.

Microcontroller Mode:

In microcontroller mode, the UP and DN inputs are used to control the duty cycle. For every rising edge of the UP [DN] line, the output pulse width is increased [decreased] by approximately 0.8%. Once the pulse width reaches 0%, any further inputs on the DN line have no effect. Similarly, when the pulse width reaches 100%, any further inputs on the UP line have no effect.

Push-Button Mode:

In push-button mode, the UP and DN inputs are designed for interfacing to push buttons. When the UP line is brought LOW, the duty cycle is continuously increased at a rate of ~ 33% per second. Similarly, when the DN line is brought low, the duty cycle is decreased at a rate of ~ 33% per second. Any additional increase [decrease] after the pulse width has reached 100% [0%] will have no effect on the output.

Automatic digital de-bouncing of the inputs is implemented in continuous mode.

In both digital modes, a 4.7k resistor must be installed between P+ and P- to bypass the potentiometer fault circuitry.

Output Enable:

The output is disabled by default and the EN pin is internally pulled down. Bringing the EN pin low immediately brings the PWM output to 0%, allowing the motor to coast. Bringing the pin high re-enables the PWM output at the previous duty cycle.

Direction:

A switch can be connected between the DIR input and P+ to reverse the direction of the motor. Alternatively, a 5V signal applied to the DIR input will also reverse the motor. While reversing quickly is supported, rapid switching of directions without braking first could result in excessively high currents that may shorten the life of the controller.

Full Brake:

A switch can be connected between the BRK input and P+ to cause the motor to brake by shorting the motor terminals together. Alternatively, a 5V signal applied to the BRK input will cause the motor to brake. The PWM level does not affect braking intensity - braking is always set to 100% when activated through this pin.

Regenerative Braking:

Regenerative Braking Must Be Used with a Battery Power Supply.

When the motor is spinning and is commanded to slow down to a lower speed through the potentiometer, 0-5V signal, or digital lines, the motor slows down and the excess energy from the motor is captured and returned to the power supply bus.

Please note that this feature must be used with a battery powered supply. Do not use with an electronic power supply. Without a battery to absorb the returned current, the supply voltage will rise to a very high level, possibly causing damage to the controller, power supply, and/or other devices connected to the same supply. If you are not using a battery power supply or do not need regenerative braking, please see BIDIR-340-D (no regen).

This mode is controlled solely through the regular analog or UP/DN inputs. The BRK line is only used for 100% brake level, and does not recapture any energy.

Regenerative braking automatically shuts off when the bus voltage exceeds the safe voltage level of 65 volts.

Current Limiting:

Two onboard potentiometers control the current available to the motor. The ACCEL pot controls current during motor acceleration, and the REGEN pot controls the reverse current going into the battery system during regeneration. The maximum current for each potentiometer is 40 amps.

Soft Start:

When soft-start is enabled, the output is automatically ramped up to the set PWM level at a rate of determined by the onboard potentiometer labeled "SS" when the controller is switched from disabled to enabled. Soft-start is also activated when the direction is switched while the motor is running. This reduces the stress placed on power supplies and mechanical linkages as the motor comes back up to speed. To disable soft-start, turn the SS potentiometer all the way counter-clockwise.

The soft-start adjustment is read during startup. If you have changed the soft-start setting, power down the controller and reapply power for the change to take effect.

LED Status Indicators:

During normal operation, the GREEN status LED blinks slowly. During current limiting operation, the RED status LED will light.

Over-Temperature Protection:

In the event the controller overheats, the controller will shut down until the temperature drops. The maximum H-bridge chip temperature is 150°C. During normal operation, the chips should never reach this temperature. The onboard cooling fan will activate to cool down the controller well before this limit is reached.

Application Notes:

Ensure that the controller is wired correctly before applying power. Always turn off the power supply before making any changes to the wiring. A fuse and switch must be wired in series with the positive power supply lead for safe operation.

This controller is not reverse polarity protected. Reversing the battery leads will cause permanent damage and void your warranty.

Regenerative braking is not to be used as the sole method of braking. There are many ways that regenerative braking could stop working, such as over voltage, excessive regenerative current, disconnected battery cable, etc. Thus, a mechanical brake is required in situations where braking is necessary.

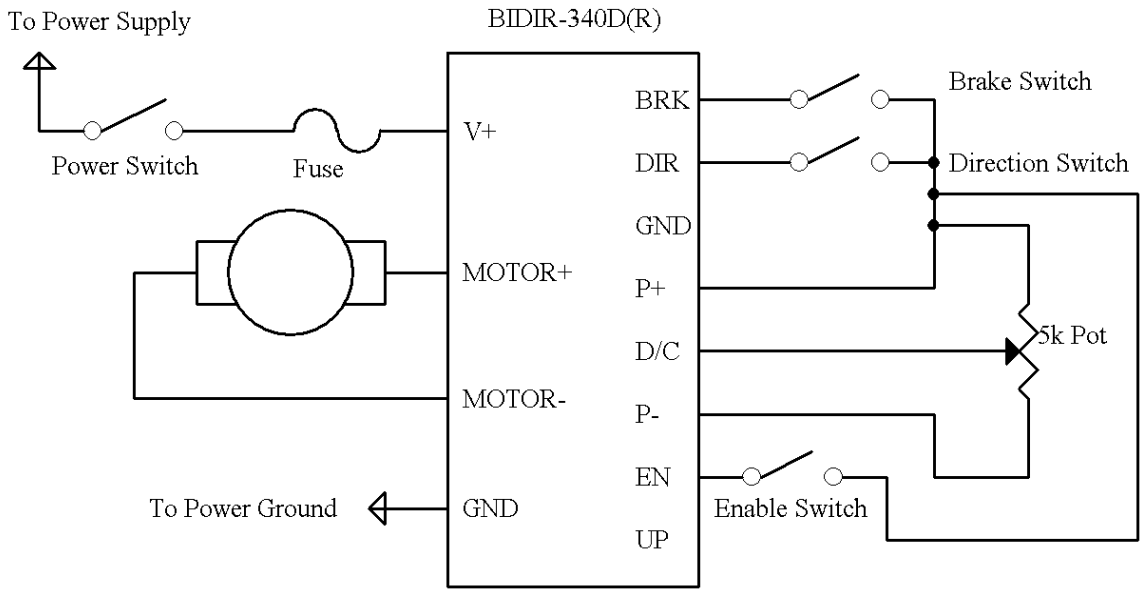
PWM controllers switch currents at high frequencies to vary the average power to the load. This switching can cause undesirable RF interference. To minimize such interference, it is recommended to twist the input V+ and Ground wire pair as well as the M+ and M- wire pair.

Ensure that the controller has adequate air flow for proper cooling. If installed into an enclosure, an exhaust fan may be necessary.

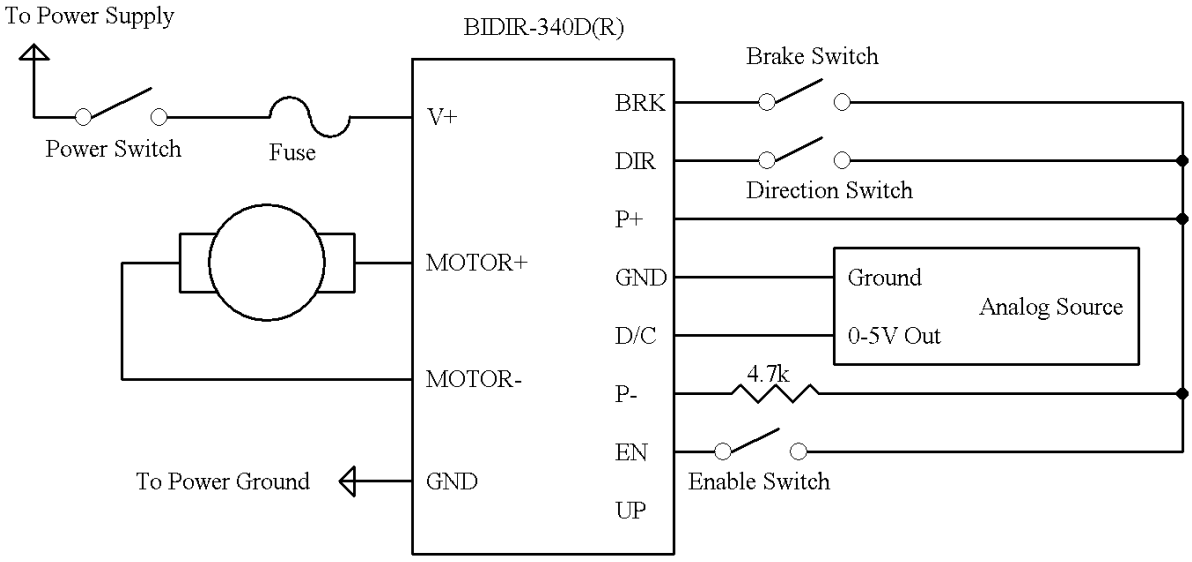
Use the shortest possible wiring between the load and controller, and between the controller and the power source. Ensure that the cables carrying the load current are adequately sized.

The control lines should be as short as possible. If the control lines are longer than 6 inches, twisted pair wiring should be used.

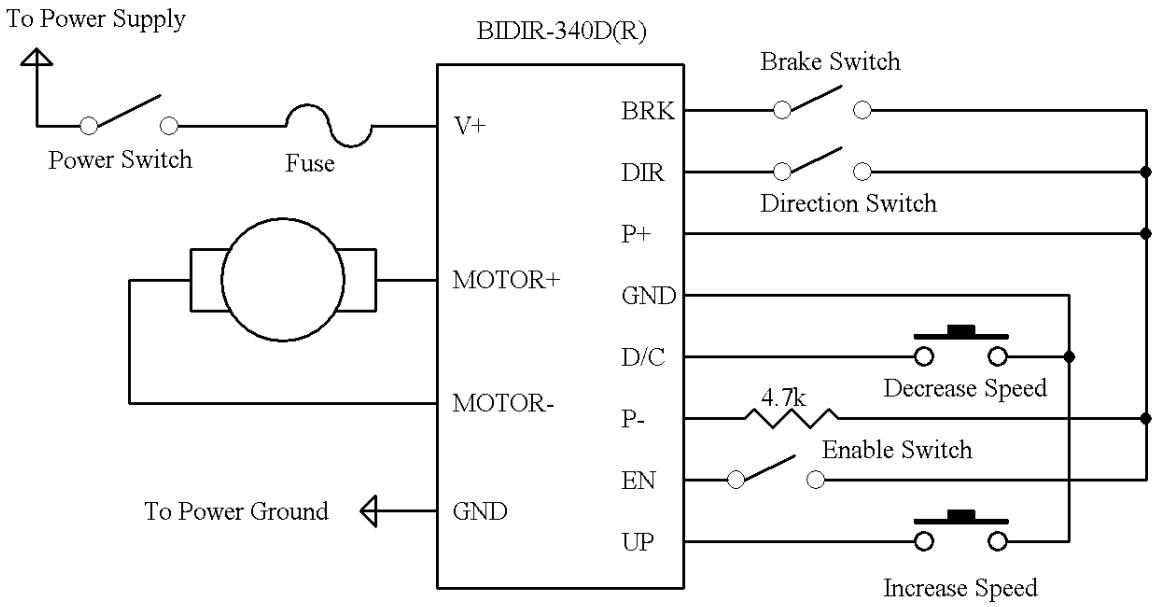
Typical Connections – Potentiometer Control Mode:



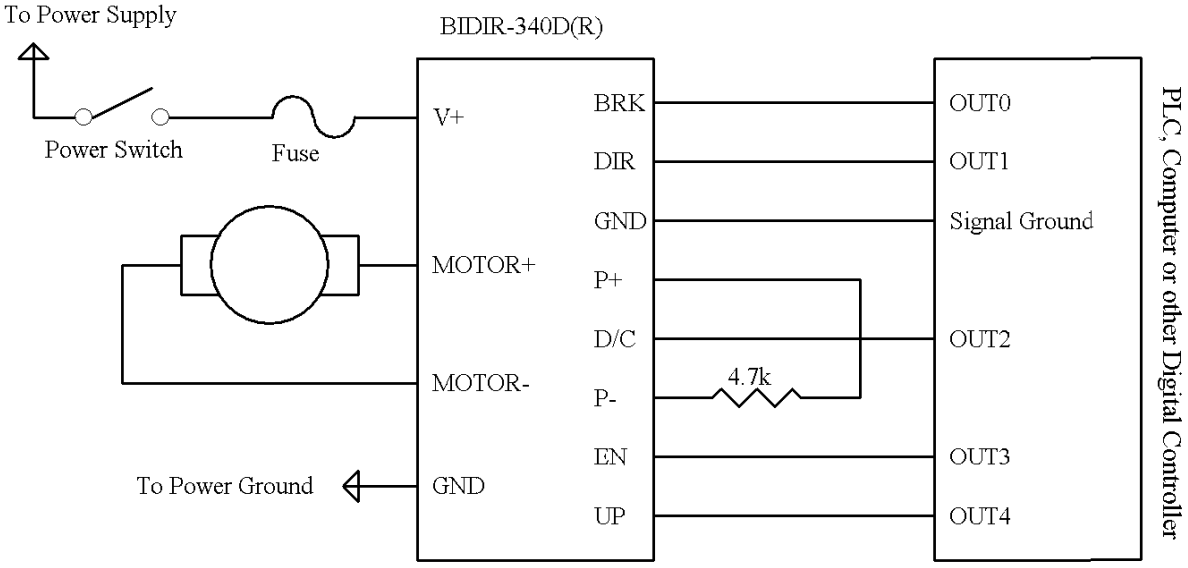
Typical Connections – Analog 0-5V Control Mode:



Typical Connections – Push Button Mode:



Typical Connections – Microcontroller Mode:



90-Day Limited Warranty:

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