

PololuHigh -PowerMotor Driver36v20CS

WWW.ROBOTIKHARDWARE.DE

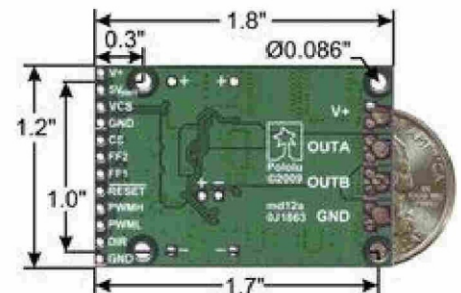
This discrete MOSFET H-bridge motor driver enables bidirectional control of one high-power DC brushed motor. The compact 1.8×1.2-inch board supports a wide 5.5 to 50 V voltage range and is efficient enough to deliver a continuous 20 A without a heat sink. This version outputs an analog voltage proportional to the motor current, and an extra control input allows for coasting in addition to the driving and braking offered by the other Pololu high-power motor drivers.

 [Compare all products in Pololu High -PowerMotor Drivers.](#)

Description Specifications (11) Pictures (4) Resources (3) FAQs (0)

Overview

The Pololu high-power motor driver is a discrete MOSFET H-bridge designed to drive large DC brushed motors. The H-bridge is made up of one N-channel MOSFET per leg, and most of the board's performance is determined by these MOSFETs (the rest of the board contains the circuitry to take user inputs and control the MOSFETs). The MOSFET datasheet is available under the "Resources" tab. The board has an absolute maximum voltage rating of 50 V; higher voltages can permanently destroy the motor driver. Under normal operating conditions, ripple voltage on the supply line can raise the maximum voltage to more than the average or intended voltage, so a safe maximum voltage is approximately 44 V.



Note: Battery voltages can be much higher than nominal voltages when they are charged, so the maximum battery voltage we recommend is 36 V unless appropriate measures are taken to limit the peak voltage.

The versatility of this driver makes it suitable for a large range of currents and voltages: it can deliver up to 20 A of continuous current with a board size of only 1.8" by 1.2" and no required heat sink. With the addition of a heat sink, it can drive a motor with up to about 32 A of continuous current. The module offers a simple interface that requires as few as two I/O lines while allowing for both sign-magnitude and locked-antiphase operation, and an optional third control input unique to this board allows for coasting. This board also features a [current-sensing circuit](#) that measures bidirectional motor current with a magnitude up to 30 A and outputs an analog voltage.

Integrated detection of various short-circuit conditions protects against common causes of catastrophic failure; however, please note that the board does not include reverse power protection or any over-current or over-temperature protection. We recommend you use the integrated current sensor to keep the driver from delivering more current than it can safely handle.

There are currently nine versions of the high -power motor driver, each with a different operating voltage and current range. The three CS versions have the same pinout, and the six non -CS versions have the same pinout. The following table provides a comparison of the high -power motor drivers:

Pololu high -power motor drivers		
Name	Max nominal battery voltage (V)	Max continuous current (A) w/o heat sink
<u>High -power motor driver 18v25 CS</u>	18	25
<u>High -power motor driver 18v25</u>	18	25
<u>High -power motor driver 18v15</u>	18	15
<u>High -power motor driver 24v23 CS</u>	28	23
<u>High -power motor driver 24v20</u>	28	20
<u>High -power motor driver 24v12</u>	28	12
<u>High -power motor driver 36v20CS</u>	36	20
<u>High -power motor driver 36v15</u>	36	15
<u>High -power motor driver 36v9</u>	36	9

Note: We also offer [motor controllers](#), with similar power characteristics and with high level interfaces that make them much easier to use.

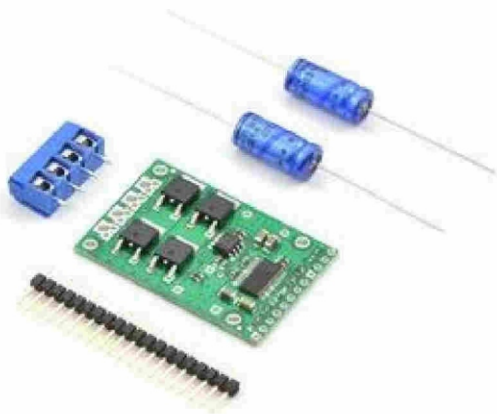
Using the Motor Driver

Connections

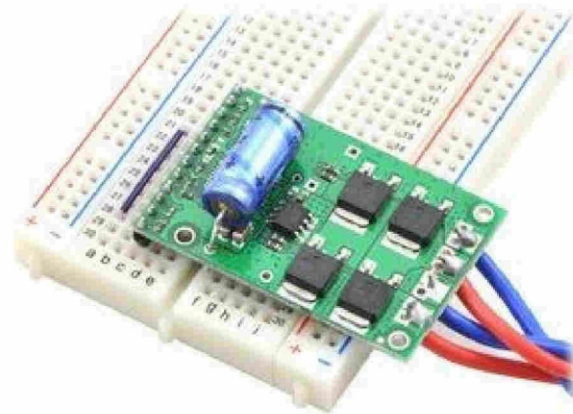
The motor and motor power connections are on one side of the board, and the control connections (5V logic) are on the other side. The motor supply should be capable of delivering the high current the motor will require, and a large capacitor should be installed between V+ and ground close to the motor driver to decrease electrical noise. Two axial capacitors are included and one or both can be installed by soldering them into the V+ and GND pins (labeled '+' and '-' on the bottom silkscreen) along the long edges of the board. Such installations are compact but might limit heat sinking options; also, depending on the power supply quality and motor characteristics, a larger capacitor might be required. There are two options for connecting to the high -power signals (V+, OUTA, OUTB, GND): large holes on 0.2" centers, which are compatible with the included terminal blocks, and pairs of 0.1" -spaced holes that can be used with perfboards, breadboards, and 0.1" connectors.

Warning: Take proper safety precautions when using high -power electronics. Make sure you know what you are doing when using high voltages or currents! During normal operation, this product can get **hot** enough to burn you. Take care when handling this product or other components connected to it.

The logic connections are designed to interface with 5V systems (5.5 V max); the minimum high input signal threshold is 3.5 V, so we do not recommend connecting this device directly to a 3.3 V controller. In a typical configuration, only PWMH and DIR are required, but PWML can be used to enable coasting if both PWML and PWMH are driven low. PWML is pulled high and PWMH is pulled low internally. The two fault flag pins (FF1 and FF2) can be monitored to detect problems (see the Fault Flag Table below for more details). The **RESET** pin, when held low, puts the driver into a low -power sleep mode and clears any latched fault flags. The V+ pin on the logic side of the board gives you access to monitor the motor's power supply or pass it on to low -current devices (it should not be used for high current). The board also provides a regulated 5V pin which can provide a few milliamps (this is typically insufficient for a whole control circuit but can be useful as a reference or for very low -power microcontrollers). This pin can be shorted to VCS to power the current sensor, or VCS can be supplied with 5 V externally. If the 5V output pin is used to power VCS, it should not be used for any other purpose as the current sensor will draw close to the limit of the current the 5V pin can supply. When the current sensor is powered by applying 5 V to VCS, the CS pin outputs 66 mV/A for currents between -30 and 30 A centered at 2.5 V (typical error is less than 1.5%).



Pololu high -power motor driver CS with included hardware.



Pololu high -power motor driver CS in a breadboard.

Motor Control Options

The motor driver can be used in several different modes:

- **Sign -magnitude(drive -brake):** With PWML disconnected or held high, apply a pulse -width -modulated(PWM) signal to the PWMH pin. The duty cycle of the PWM controls the speed of the motor and the DIR pin controls the direction. During the active (high) portion of the PWM, the motor outputs drive the motor by putting the full V+ voltage across the motor in the direction determined by the DIR pin; during the low portion of the PWM, the motor outputs brake the motor by shorting both motor terminals to ground. This means that the motor alternates between drive and brake at the PWM frequency with the percentage of the driving time determined by the duty cycle.
- **Sign -magnitude(drive -coast):** Connect the same PWM signal to both the PWMH and PWML pins. The duty cycle of the PWM controls the speed of the motor and the DIR pin controls the direction. During the active (high) portion of the PWM, the motor outputs drive the motor by putting the full V+ voltage across the motor in the direction determined by the DIR pin; during the low portion of the PWM, the motor outputs are disconnected and the motor is allowed to coast. This means that the motor alternates between drive and coast at the PWM frequency with the percentage of the driving time determined by the duty cycle. Drive -coast operation can draw less power than drive -brake operation, but drive -brake operation can produce a more linear relationship between duty cycle and motor speed.
- **Variable braking (brake -coast):** With PWMH disconnected or held low, apply a PWM signal to the PWML pin (the state of the DIR pin has no effect on this mode). During the active (high) portion of the PWM, the motor outputs brake the motor by shorting both motor terminals to ground; during the low portion of the PWM, the motor outputs are disconnected and the motor is allowed to coast. This means that the motor alternates between brake and coast at the PWM frequency with the percentage of the braking time determined by the duty cycle.
- **Locked -antiphase:** With PWML disconnected or held high and PWMH held high, apply a PWM signal to the DIR pin. In locked -antiphase operation, a low duty cycle drives the motor in one direction and a high duty cycle drives the motor in the other direction; a 50% duty cycle turns the motor off. A successful locked -antiphase implementation relies on the motor inductance and PWM switching frequency to smooth out the current (e.g. making the current zero in the 50% duty cycle case), so a high PWM frequency might be required.

Motor Driver Truth Table					
PWMH	PWML	DIR	OUTA	OUTB	Operation
H	H	L	GND	V+	Forward
H	H	H	V+	GND	Backward
L	H	X	GND	GND	Brake Low
H	L	X	V+	V+	Brake High
L	L	X	Z	Z	Coast

X = don't care (same for input H or L); Z = high impedance (outputs disconnected)

PWM Frequency

The motor driver supports PWM frequencies as high as 40 kHz, though higher frequencies result in higher switching losses in the motor driver. Also, the driver has a dead time (when the outputs are not driven) of approximately 3 μ s per cycle, so high duty cycles become unavailable at high frequencies. For example, at 40 kHz, the period is 25 μ s; if 3 μ s of that is taken up by the dead time, the maximum available duty cycle is 22/25, or 88%. (100% is always available, so gradually ramping the PWM input from 0 to 100% will result in the output ramping from 0 to 88%, staying at 88% for inputs of 88% through 99%, and then switching to 100%.)

Real-World Power Dissipation Considerations

The motor driver can tolerate peak currents in excess of 200 A. The peak current ratings are for quick transients (e.g. when a motor is first turned on), and the continuous rating of 20 A is dependent on various conditions, such as the ambient temperature. The main limitation comes from heating and power dissipation; therefore, at high currents, the motor driver will be extremely hot, and performance can be improved by adding heat sinks or otherwise cooling the board. The driver's printed circuit board is designed to draw heat out of the MOSFETs, but performance can be improved by adding a heat sink. The MOSFETs have a theoretical maximum continuous current of 90 A at 25°C, but dissipating enough heat to keep the MOSFET at this temperature is impractical for most applications; close to 35 A of continuous current should be achievable without too extravagant of a heat sink. For more information on power dissipation see the data sheet for the MOSFETs on the Resources tab.

Because there is no internal temperature limiting on the motor driver, the entire system should be designed to keep the load current below the 20 A limit. An easy way to achieve this is to select a motor with a stall current below that limit. However, because a good motor can have stall currents dozens of times higher than the typical operating current, motors with stall currents that are hundreds of amps can be used with this driver as long as the running current is kept low. For example, a motor with a 100 A stall current might run well at 10 A, leaving a safe margin for the current to double for several minutes at a time or to triple for several seconds. If the motor does stall completely for a prolonged period, however, the motor or driver are likely to burn out.

Warning: This motor driver has no over-current or over-temperature shut-off. Either condition can cause **permanent damage** to the motor driver. We recommend you use the current-sense output CS to monitor your current draw if your application will put the driver close to its limits of operation.

Fault Conditions

The motor driver can detect three different fault states, which are reported on the FF1 and FF2 pins. The detectable faults are short circuits on the output, under-voltage, and over-temperature. A short-circuit fault is latched, meaning the outputs will stay off and the fault flag will stay high, until the board is reset ($\overline{\text{RESET}}$ brought low). The under-voltage fault disables outputs but is not latched. The over-temperature fault provides a weak indication of the board being too hot, but it does not directly indicate the temperature of the MOSFETs, which are usually the first components to overheat. The fault flag operation is summarized below.

Flag State		Fault Description	Disable Outputs	Latched Until Reset
FF1	FF2			
L	L	No fault	No	No
L	H	Short Circuit	Yes	Yes
H	L	Over Temperature	No	No
H	H	Under Voltage	Yes	No