

# Selecting and Implementing H-Bridges in DC Motor Control

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Spring 2011

## **Abstract**

DC motors can be used in a number of applications that require automated movements. The DC motors can be used to lift objects too heavy for a person, move different wares to other locations, and has many other helpful uses. In most of these applications, variable speed of the DC motor and user control is desired. This can be accomplished through the use of H-bridges, a power supply, and a control signal.

## **Introduction**

The purpose of this application note is to instruct readers on the use of H-bridges in DC motor control. This will include guides to choosing and implementing H-bridges and a power supply to drive different motors. The application note will also discuss in detail, how the H-bridge works and what input signal is needed for DC motor control. An example will show how connect one H-Bridge to a DC Motor to control the speed and rotational direction.

## How an H-Bridge works

To better understand how an H-Bridge works, a simple schematic for an MOSFET H-Bridge is provided below:

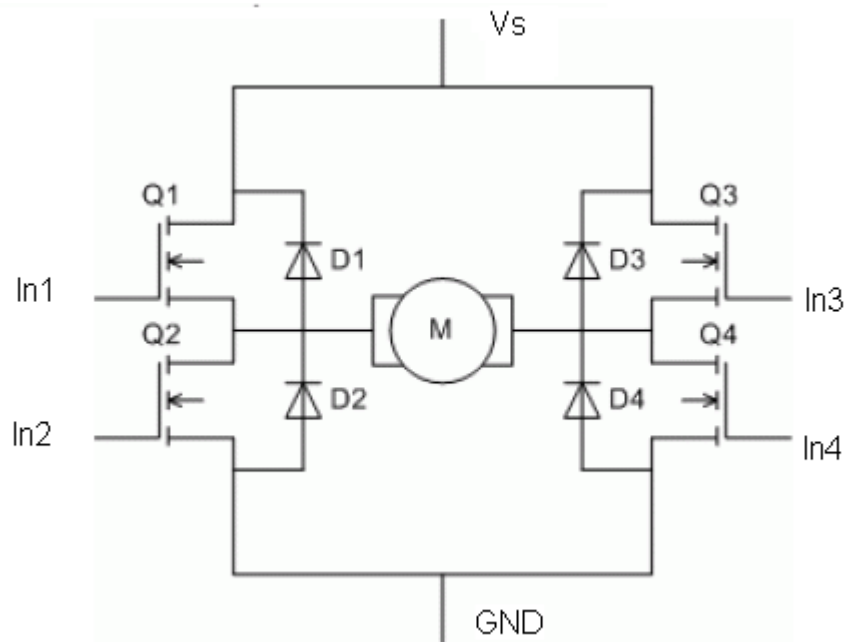


Figure 1 – MOSFET H-Bridge [1]

The MOSFETs of the H-Bridge act as switches which can be used to control the speed of the motor, as well as the rotational direction. If a pulse width modulation (PWM) signal is applied to In1 and logic high to In4, then the MOSFET switches would create a path from Vs to GND through the motor. This would make the motor rotate forward. By varying the duty cycle of the pulse width modulated signal at In1, the speed of the motor would change correspondingly. Likewise, if we applied the PWM signal to In3 and logic high to In2, the same would occur, with the exception that the rotational direction would be reversed. By using the PWM signal, we are essentially switching the motor on and off at a certain rate to control the speed. The diodes represented in the H-Bridge are called “fly back diodes.” These diodes provide a path for the current to dissipate when the motor switches from on to off. Since the

shaft of the motor itself is spinning, stopping the motor without those diodes in place, will cause a large spike in current that could potentially burn out the MOSFETs of the H-Bridge.

## Choosing an H-Bridge



Figure 2 – Pololu High Power Motor Driver [3]



Figure 3 – STMicroelectronics  
VN12SP30TR-E IC Driver Motor H-Bridge[2]

One of the keys to choosing an H-bridge is to determine what maximum current the DC motor being used will draw. The stall current, in which the motor needs to initially run, will need to be considered. The H-Bridge that is chosen will need to be rated to handle that much current, otherwise the integrated circuit will burn out. The Pololu High Power Motor Driver pictured in Figure 2 above is rated to draw 15 amps continuously without a heat sink and can handle the motor power supply between 5.5V and 30V. This is a good H-bridge for motors that are used in most projects. The H-bridge from STMicroelectronics is rated to draw 30A continuously and would apply to automotive applications of DC Motors. Since many projects will use motors that are either 12V -24V and draw upwards of 10A, the Pololu High Power Motor Driver will suffice for those projects.

## Selecting a Power Supply

There are many factors to consider when selecting a power supply for DC Motor control. An AC-to-DC power supply is needed to convert the 120Vac from the wall outlet to the desired voltage to drive the DC motor. Since many projects require that multiple DC motors run at the same time in parallel, the power supply needs to be able to supply enough current to run multiple DC motors. As an example, if we had 3 12V 8A DC motor, we would need a power supply that would be able to provide 12V and be able to draw at least 24A of current. Preferably, the supply current should be rated a couple of amps higher than that. Below are some figures of S-350-12 power supply that is rated to supply 29A of current. This power supply would be sufficient to drive those twelve volt DC motors.

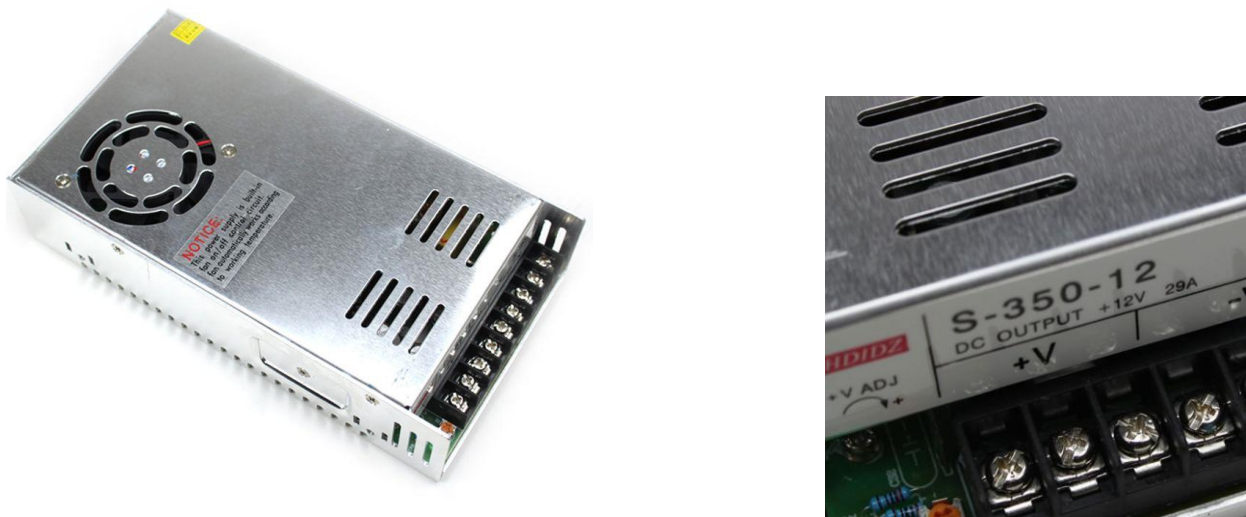


Figure 4 – Meanwell S-350-12 12V 29A Power Supply [4]

## Connecting the H-Bridge, Power Supply, and DC Motor

As an example, this section will instruct on how to connect the Pololu motor driver, Mean Well 12V 29A Power Supply, and a 12 DC Brushless motor together to achieve motor control. The first step is to attach a three prong plug to the power supply and set the switch on the supply to 120Vac. The line, neutral, and ground are used to connect the three prong wall plug as shown in the figure below:



Figure 5 - Power Supply with attached wall plug

The next step is to connect V+ of the power supply to the large V+ pad and V- to the large ground pad on the Pololu motor driver. The pads used on the Pololu motor can be seen below:

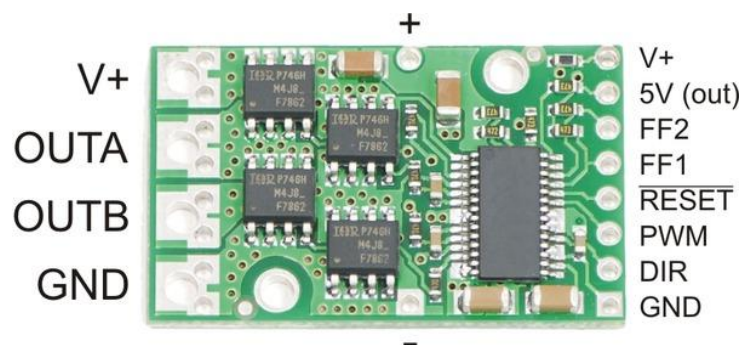


Figure 6 – Pad layout of Pololu motor driver [3]

The OUTA and OUTB pads on the H-Bridge motor driver are connected to the two terminals of the DC brushless motor. The PWM signal can be generated from either a microcontroller or a function generator and can be applied to the PWM pad on the motor driver pictured in Figure 6. The duty cycle of the PWM signal can be varied to control the speed of the motor.

The DIR pad controls the direction the motor rotates. In the Specifications listed, the minimum threshold voltage for logic high for the motor driver is 3.5V. However, testing the H-Bridge may reveal that the minimum threshold voltage for logic high is actually around 2.4V, which would make it compatible with a 3.3V output of a microcontroller such as the Arduino FIO without stepping up the voltage. There is also a 5V pin that can supply a few milliamps that can be used for IR interrupters.

## **Conclusion**

The use of H-Bridges in DC Motor control is simple and an easy way to control the direction and speed of a DC motor. The real challenge lies in choosing those Integrated circuits and power supply that are rated to handle the voltage and current the motor would draw.

## References

1. <http://robotechno.us/high-current-h-bridge-with-mosfet.html>
2. <http://search.digikey.com/scripts/DkSearch/dksus.dll?Detail&name=497-4501-2-ND>
3. <http://www.pololu.com/catalog/product/755/specs>
4. [http://cgi.ebay.com/12V-DC-30A-350W-Regulated-Switching-Power-Supply-MW-New-/260472178091?pt=LH\\_DefaultDomain\\_0&hash=item3ca55a05ab#shId](http://cgi.ebay.com/12V-DC-30A-350W-Regulated-Switching-Power-Supply-MW-New-/260472178091?pt=LH_DefaultDomain_0&hash=item3ca55a05ab#shId)