

Bi-Directional Electric Motor Control

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There are two methods for controlling an electrical motor to spin in either direction. One method requires the ability to provide both positive and negative voltage to one of the motor terminals where the positive voltage will spin the motor in one direction while the negative voltage will spin it in the opposite direction. The other way to control the motor is to have circuitry built around the motor that will allow you to control which pin is set to receive a voltage and which pin will be grounded. A common method of implementing this circuitry is done using an H bridge. An H bridge consists of components that allow the pins of the motor to be change from receiving a voltage to be grounded. This can be implemented in multiple ways including but not limited to using inverters or transistors.

Using inverters the major factors that must be taken into effect is the amount of current being drawn by the motor and the method of input. If the motor will draw more current that the inverter can handle, which is very likely, you will need to connect multiple inverters in parallel to increase the current limitations. When connecting the inverters in parallel the forward current through the inverters is simply added, for example if you connect two inverters in parallel each capable of up to 10mA you will be able to draw up to 20mA from the parallel combination. It is necessary to have an identical parallel combination of inverters connected to both pins of the motor.

The other factor that must be considered is the input to the circuit. This can be done by either using two separate inputs which are controlled separately but must still be opposite of each other (i.e. one input is high and one input is low or ground) or it can be done using another inverter and a single input line. When using a single input line you must run that line both to one set of the group of inverters as well as to the input of the extra inverter then the output of the inverter must be connected to the opposite group of inverters. This ensures that the motor is always receiving a voltage on one pin and ground on the other but using this method does not allow the motor to be turned off unless the signal is altered such as using a pulse width modulated signal.

An alternative to using inverters is to use transistors; I will describe this method using MOSFET transistors. When using transistors it is necessary to again be aware of current and power necessities and be sure to choose a transistor that can provide appropriate levels of both. The methods of input for a transistor based H-bridge are very similar to those used with inverters. To better explain the input methods I will describe the H-bridge has having four MOSFETs, two p-type and two n-type configured with the two p-type MOSFETs on top and the n-type on bottom with the motor between four MOSFETs. The source of the P-type MOSFETs are connected to the voltage course while the drains of both the P-type and N-type are connected together and the source of the N-type are connected to ground. The motor is connected at the same point as the drains with one pin connected to each group of one P-type and one N-type MOSFET. For explanation purposes I will

number the MOSFETs in a clockwise order starting with the top left MOSFET, which results in the P-type being one and two and the N-type being three and four.

The input will be connected to the gate for all of the transistors but it must be done in such a way that numbers one and three receive the same signal while at the same time numbers two and four receive the opposite signal. This can again be done using the same methods as with the inverters simply using an inverter for one of the signals or it can be done using pulse width modulation. In the case of using transistors it is a better choice to use pulse width modulation which will allow a time delay to be built into the circuit operation to give a small amount of time, on the order of microseconds, for the MOSFETs to discharge when changing the direction of the motor and hence switching which set of transistors is active.

To control the time delay in the pulse width modulated signal some extra circuitry will be required which can be designed on a component basis like the H-bridge described above but it is easier and more reliable to purchase a FET driver circuit to handle this particular issue. An excellent alternative to designing an H-bridge from scratch and choosing the individual components is to buy an IC, which already contains the H-bridge, which meets the necessary specifications for the applications. When choosing this route there is also the option of purchasing an IC that not only has the required H-bridge but also the FET driver built in, greatly simplifying the design of the motor control circuitry.