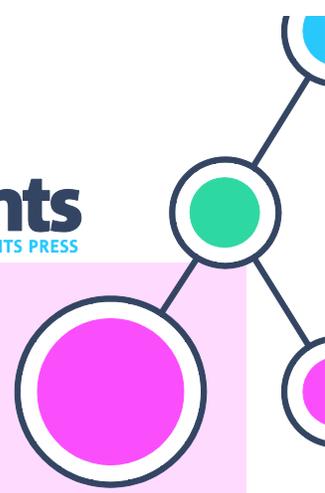


# DC Motor with myDAQ

## Core Concept Instructor Set

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### Learn It!

A DC motor takes an applied current and generates mechanical motion. This is accomplished by electromagnetic means, in which current generates a strong magnetic field turning the motor shaft. The DC motor included in this starter kit has a voltage range from 3.3 to 5 volts. Applying voltage will spin the motor shaft at a relatively high rotational speed. DC motors are used in a variety of devices, from

automotive starters to the vibration generator found in a common cell-phone.

In this exercise, you will learn how to connect and drive a very simple DC motor. The motor is driven by a simple digital signal, which turns the motor either entirely on or off.

### Build It!

DC Motors require a steady voltage with a relatively high current. For this reason you will use a transistor circuit to ground the motor, while supplying voltage via the myDAQ's onboard power port.

The low-voltage DC motor pictured here provides sufficient mechanical power to drive small fans or to spin lightweight objects. While the voltage is relatively low at 1.5 to 4.5 volts, the current can get as high as several hundred milliamps or even several amps in stall (blocked rotor) conditions. For this reason a power MOSFET transistor circuit is used as a motor driver.

### Creating an DC Motor Circuit

**Step 1:** Connect the DC Motor as indicated in the circuit diagram. The DC Motor circuit requires a triple transistor circuit. This allows the motor to be switched entirely on or off with no lagging changes in voltage, as supplying under voltage to the motor can be damaging to it.

**Step 2:** Open the DC Motor demo folder and the DC Motor project (DC Motor demo.vi). Open Motor Demo.vi. On the front panel there is a Boolean control for the motor's state, On or Off (Figure 1).

### Materials:

myDAQ

DC Motor

1N4001 general-purpose rectifier

TIP120 transistor

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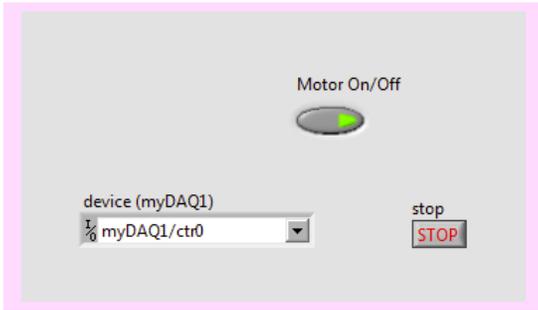


Figure 1: DC Motor Demo Front Panel

Step 3: Run the VI. Try switching the DIO state from Off to On, and see that the motor functions as expected.

**Guiding Questions:**

- The front panel control allows the user to select a motor state, on or off. Can you think of another way of doing this more rapidly? What might happen to the motor's speed was switched extremely rapidly?

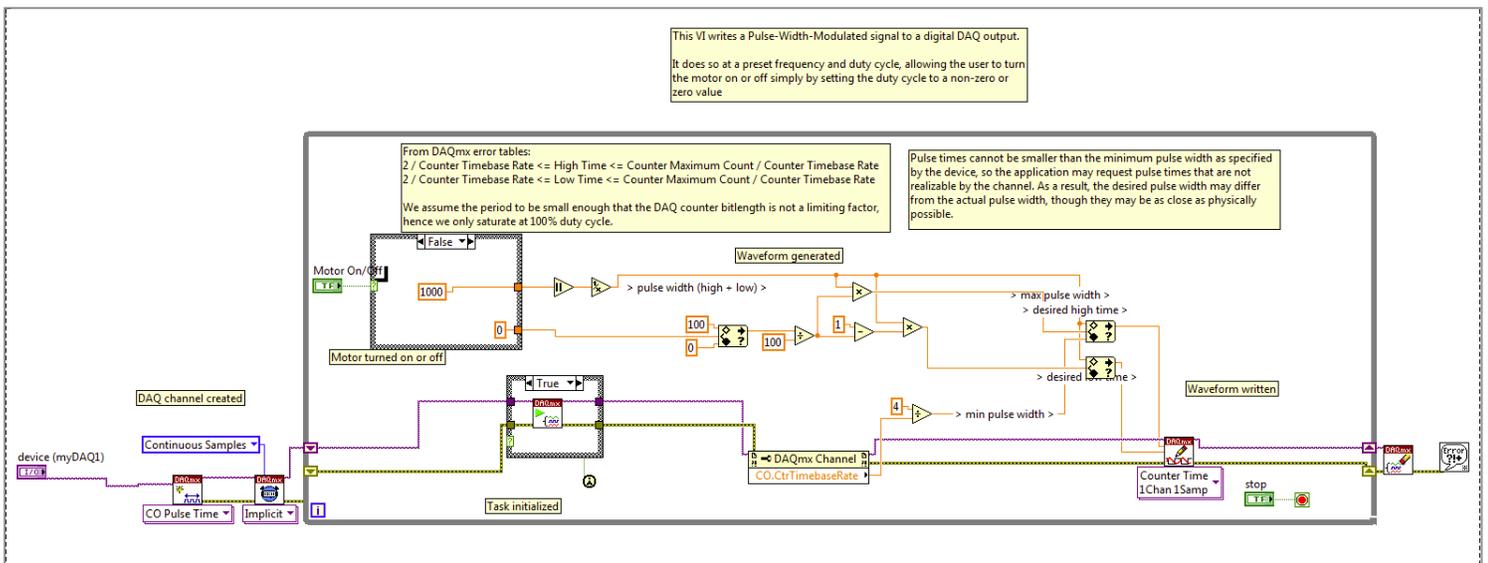
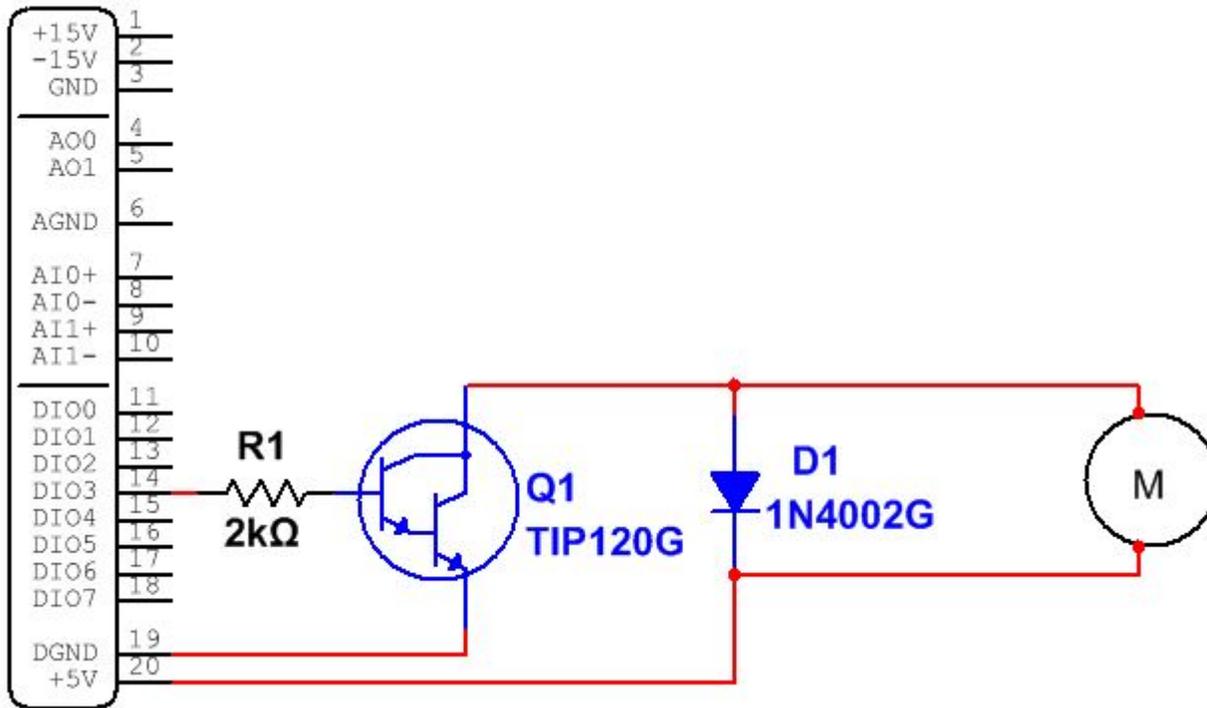


Figure 2: DC Motor Demo while loop with digital writing

Step 4: Examine the Block Diagram of the demo VI (Figure 2). The main body of the code runs within a while loop, so that the state can be updated indefinitely as the code runs.



DC Motor- Circuit Diagram

### Expand it!

- Add a Boolean front-panel control as a motor enable. Try using a Select node under the Programming | Comparison subpalette to set the duty cycle either to 0 or to the value of the front-panel duty cycle control.
- Create variable-speed motor operation as follows:
  - Replace the existing Digital Output Express VI with the PWM Express VI. Choose the PWM channel as B/PWM0, the same connector pin as B/DIO8 (pin 27). Choose the remaining dialog box options so that both frequency and duty cycle are available as inputs,
  - Create pointer slide front-panel controls for each; right-click on each control and choose "Visible items" and the "Digital display," and
  - Right-click on the frequency control, select "Scale" and then "Mapping," and choose "Logarithmic." Also, double-click the upper limit of your frequency control and enter "40000" and then similarly set the lower limit to "40."

Experiment with both the duty cycle and frequency. What frequency minimizes audible PWM noise and maximizes your ability to create very slow motor speeds? What do you notice about restarting the motor after it stops? If you have a DMM ammeter handy, you may wish to observe the motor current under various conditions including mechanical loading, free running, and start-up.

## Research it!

Study the video Motor Demo Walk-Through ([youtu.be/UCqFck0CLpc](https://youtu.be/UCqFck0CLpc), 1:56) to learn the design principles of Motor demo.

Study the video PWM Express VI ([youtu.be/mVN9jfwXleI](https://youtu.be/mVN9jfwXleI), 2:41) to learn how to use the PWM Express VI to create a pulse-width modulated square wave to provide variable-speed motor operation.

myRIO -

Study the video Motor Interfacing Theory ([youtu.be/C\\_22XZaL5TM](https://youtu.be/C_22XZaL5TM), 6:49) to learn more about the motor principles of operation and interface circuit design principles including: sizing the power transistor for motor current under various load conditions, importance of the rectifier to deal with back-emf voltage spiking, level-shifting circuit for 3.3-to-5 V, and required modification to connect the interface to the MSP connector with integral pull-down resistors.

DC motor:

[http://www.mabuchi-motor.co.jp/cgi-bin/catalog/e\\_catalog.cgi?CAT\\_ID=ff\\_180phsh](http://www.mabuchi-motor.co.jp/cgi-bin/catalog/e_catalog.cgi?CAT_ID=ff_180phsh)

1N4001 general-purpose rectifier:

<http://www.vishay.com/docs/88503/1n4001.pdf>

ZVN2110A n-channel enhancement-mode MOSFET:

<http://www.diodes.com/datasheets/ZVN2110A.pdf>

ZVP2110A p-channel enhancement-mode MOSFET:

<http://www.diodes.com/datasheets/ZVP2110A.pdf>

IRF510 n-channel enhancement-mode power MOSFET:

<http://www.vishay.com/docs/91015/sihf510.pdf>

Brushed DC Motor Fundamentals by Microchips Learn about DC motor principles of operation, drive circuits, direction control with an H-bridge, and speed control with Hall-effect sensors as feedback:

<http://ww1.microchip.com/downloads/en/AppNotes/00905B.pdf>