ECED3901 Lab #1: Motors and Motor Controllers

Lab Day: May 25, 2015

Lab Due: June 1, 2015 @ 12:30 PM - Submitted via BBLearn Website (PDF files only), OR printed files in 3901 Mail-Slot at ECED Office

Lab Objective

The goals of this lab are to:

1. Explore what happens when an inductive load is driven, and what happens when you add a diode.
2. Learn how to solder a simple motor driver together.
3. Explore drive signals for an H-Bridge motor driver.
4. Explore PWM for an H-bridge motor driver (if time/equipment permits).

Assumptions:

1. You are familiar with DC motor basics and drive electronics. You should review
    a. Lecture notes from the May 21, 2015 Lecture
    b. Dr. Gregson's Workshop Manual (available on BBLearn)

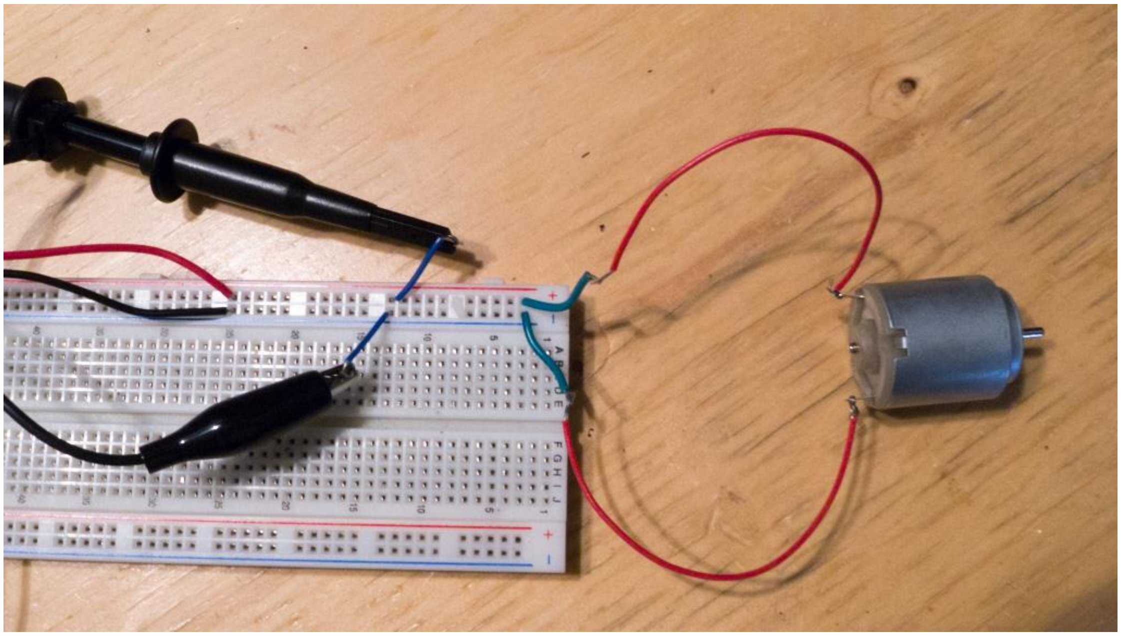
2. You are familiar with oscilloscope operation. This will be required for **every lab** in this course, so if you are unfamiliar please review a guide such as at https://learn.sparkfun.com/tutorials/how-to-use-an-oscilloscope

Part 1: Exploring Inductive Loads

1. Configure the oscilloscope for a large vertical scale (greater than 10V/div), and fairly slow horizontal scale (of around 1 mS/div)

2. Connect the oscilloscope across the motor terminals

3. Drive the motor with 5V from a lab power supply – the following shows an example of the complete setup:



4. Remove the power supply and attempt to capture a large negative spike

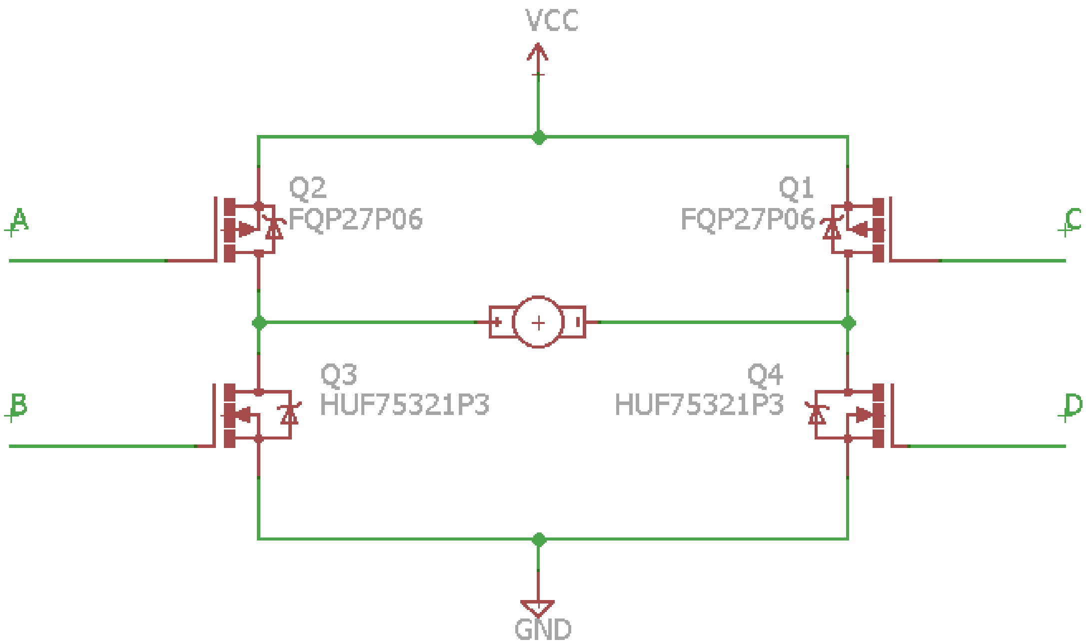
    a. Hint: Capturing this will require you to set the oscilloscope **Trigger Level**, which is the voltage at which the oscilloscope will capture the waveform. You will also need to use either **Triggered** or **Single-Shot** mode, which wait for the specific trigger conditions you set.

5. Capture either a screen-shot of the oscilloscope, or take a photo of the screen (i.e. with your phone), or carefully sketch the waveform (with units in your graph). Include this graph in your lab report.

6. Add a diode across the motor terminals, and repeat the experiment. You should see the magnitude of the inductive spike greatly reduced. Again include the resulting waveform in your lab report.

Part 2: Building a H-Bridge

A standard H-Bridge circuit is given below:

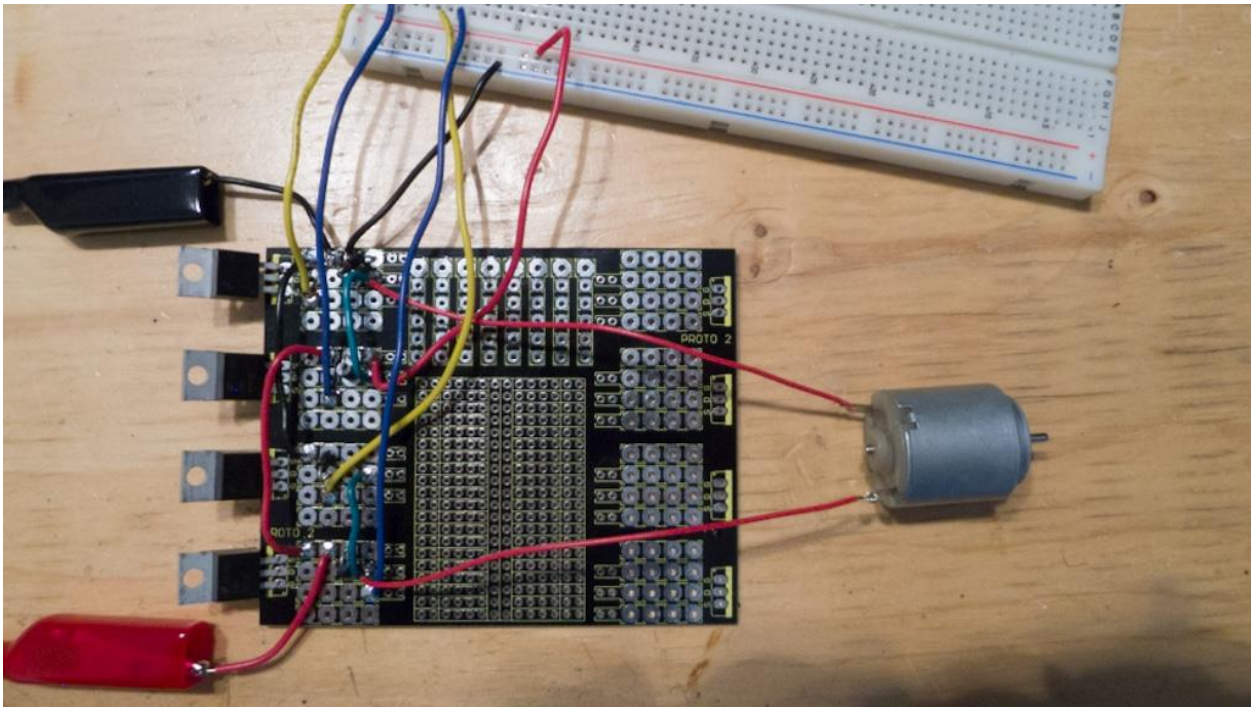


The datasheets are posted in BBLearn, or two links are given below:

1. FQP27P06: https://www.fairchildsemi.com/datasheets/FQ/FQP27P06.pdf
2. HUF74321P3: http://ecee.colorado.edu/ecen4517/components/parts/HUF75321P3.pdf

Looking at the devices, you should see a *portion* of the part numbers to differentiate them. For example one will say **27P06** which is the first device, the other might have the sequence **75321P**. You may have to consult the datasheets to determine the mapping between schematic symbol above and pin number.

Build up this circuit, and wire the outputs A/B/C/D to a breadboard. Also wire the VCC and GND connections to a breadboard. See the following example build:



Part 3: Driving a H-Bridge

WARNING: You will be driving an H-Bridge circuit with both allowed and invalid inputs. For certain "disallowed" inputs the MOSFETs may **GET VERY HOT**, or if the current limit is set incorrectly it could **EMIT SMOKE.** These can both be dangerous to you, so perform this lab with caution.

1. Set your power supply to **5 V**, and set the current limit to **200 mA** (i.e. **0.2 A**). <u>It is CRITICAL you set a current limit for this lab – if you do not know how to perform this **please ask a TA, technician, or instructor.**</u>

2. Fill in the following table of ALLOWED input values. Where an input is marked as 'H' it means connect the line to VCC, and where it is marked as 'L' it means connect the line to GND.

   The 'Current' column indicates the current consumed by the device, you can use the display on the power supply to give an approximate indication.

A	B	C	D	Current	Motor Direction/Note
H	L	H	L		
H	H	L	L		
L	L	H	H		
H	H	H	H		

3. Fill in the following table of DISALLOWED input values. Where an input is marked as ‘H’ it means connect the line to VCC, and where it is marked as ‘L’ it means connect the line to GND. When marked as ‘FLOAT’ it means to disconnect it entirely (not to VCC or GND).

   The MOSFETs may heat up during these tests, be careful!

A	B	C	D	Current	Motor Direction/Note
L	H	H	L		
FLOAT	FLOAT	FLOAT	FLOAT		

4. Connect the following inputs **in sequence**, note what happens when you float the ‘B’ input (i.e. you remove it from the breadboard). Touch it to L and note what happens.

A	B	C	D	Current	Motor Direction/Note
H	L	H	L		
H	H	L	L		
H	FLOAT	L	L		

5. Configure the function generator on your bench for a 1 kHz square wave, 5V peak-to-peak, and 2.5V offset. This should be a square wave from 0 to 5V. Feed this into **input B** (that was previously floating).

   Adjust the operating frequency over the range 500 Hz to 20 kHz, and observe what happens.

   You can adjust the duty cycle on the function generator in your lab, perform this, and observe what happens to the motor speed. Try several different duty cycles – for example 10%, 50%, and 100%.You can use the oscilloscope to better understand the waveform.

Lab Questions / Report Requirements

A standard lab report (as described on ECED3901 BBLearn site) is required. This lab report does not need to duplicate material such as the procedure already recorded here. Be sure to include:

1. Screen shots of the waveforms for the motor response when:
   a. No diode across terminals, and power turns off
   b. Diode across terminals, and power turns off

2. Photograph of your assembled H-Bridge driver

3. Completed tables for steps Part 3 - 2,3,4.

4. Answers to the questions listed below (in a section called ‘discussion’):

Questions:

1. What happened to the motor response when the diode is added?

2. What happens in the H-Bridge for some of the ‘disallowed’ drive signals?

3. What happened when you floated the input to the MOSFET? How can we ensure that if the input is floating the motor driver turns off instead?

4. What did you note about different drive frequencies and duty cycles on your motor speed / sound?