IVALab Robot Electronics Lab Experiments: Intro

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I am not sure what you are comfortable with or not, so I have devised a series of small experiment to get to know the equipment for testing, the motor controller, and the motor encoder. I have also printed the spec sheets for all of the parts you'll be using or interfacing.

Part 1: Voltage Regulation. Let's start with the LM38T05 chip, which is a 5V regulator. Its job is to take in an input greater than 5 volts and output a fairly steady voltage around 5V. The spec sheet says how much above or below it may be. Can you find where?

Figure out what the different leads mean and sketch the basic circuit setup. Once you have the sketch, connect it up using the the breadboard to generate the 5V supply, using the AC/DC converter that is on the workbench. Verify that you know which lead is positive versus ground. Verify that you have indeed generated the 5V reference signal.

Unplug everything and clean up when done.

Part 2: Pulse Width Modulation on the Frequency Generator. OK, now that the supply voltage is working fine, we need to focus on the pulse width modulated signal (PWM signal) that will be output to the motor controller, and ultimately to the motor through the amplifier. You will need to turn on the oscilloscope and the function generateor. Connect the output of the function generator to the input of the oscilloscope. Program in a 1Khz signal that is 5V and 20% duty cycle. Vary the duty cycle up to 80% and see what happens on the oscilloscope. Adjust the waveform to be sawtooth instead of square wave.

Do you see properly on the oscilloscope? You may need to adjust the horizontal and vertical axes of the oscilloscope. Find the areas on the oscilloscope where it says ”horizontal” and ”vertical” and adjust accordingly. Play around with the waveform and its properties (frequency, aimplitude, duty cycle, ...). Get a feel for both the oscilloscope and the function generator.

Turn off when done.

Part 3: LEDs This continues on Experiment 2. Instead of just measuring the output of the function generator, connect the output to an LED. For the LED, it matters how the connections go and there is a current limit (otherwise they blow), so read up. Once you've got it and you've sketched the circuit, connect it up and verify that circuit. As you adjust the waveform duty cycle, you should get the LED to change brightness.

Part 4: Optoisolation. Here, the purpose is to learn how to connect optoisolators. Optoisolators are used to provide a consistent ground signal for a signal that is generated external to a given circuit. Look in the binder to find the documentation on optoisolators and identify which of the chips in the bags belong to optoisolators. Note that optoisolators are somehwat like LEDs in that current is expected to flow in a particular direction.

One role of an optoisolator is to transform a digital signal from one circuit, with its own ground, to a digital signal of another circuit. The voltage levels or the ground plane may differ between the two circuits, so the optoisolator does a little bit of digital translation.

Connect the optoisolators up to the function generator (on the input side) and have the new (output) reference come from the 5V regulator. You should get a 5V regulated square wave on the other end. Different optoisolators have different functional characteristics, so you may have to play around with the resistances to get it to work out properly. If you'd like, connect the output side to the LED as in Part 3.

Part 5: Motor Control. Look at the spec sheet for the LM18200/LM18201 Motor Controller. There is also a print-out specifying the pin-out. First come up with a sketch of the motor control circuit. Once done, proceed with forming the proposed circuit. To build the circuit, you may have to do a little soldering (the motor controller chip plus break-out pins need to be attached to a break-out board).

Attach the motor controller to the bread-board and connect the controller up. Start with the logic part and then connect up the supply voltage to the PWR and GND pins off to the side using the 12V battery, the fuse, and the switch. There is a small DC motor sitting around in the lab somwhere. Connect it up to the output of the motor controller through a resistor (about 100-1000 Ohms will do) and a small capacitor across the two motor leads.

Verify that the PWM output looks like the PWM input but with the voltage swing determined by the battery voltage (12V). Use the second input line to the oscilloscope and turn on the second input (hit the [2] button until the input appears on screen). Once this is done, turn off the battery supply using the switch. (have baby motor)

Part 6: Motor Control (ctd). Good, now connect a bigger motor V/GND pair up to the motor controller output (say the motors on the car). Set the circuit up as before, with everything powered off. Hopefully everything is OK, otherwise there will be trouble with the next step (you may want to check resistance across supply and ground). Turn on the battery supply using the switch and you should see the motor turn. By controlling the duty cycle, you can vary the speed of the motor. If you power off the circuit and change the digital logic to the motor controller you should be able to get it to spin the other way around.

When you are satisifed with the results, turn off the battery supply.

Part 7: Quadrature Encoders. Here, we will learn of one technique for measuring velocity of a spinning motor. The sensor device is called a quadrature encode. Look at the Acroname quadrature encoder spec sheet and related print-outs to see what's going on. Connect the 5V regulated voltage to the encoder as determined by the spec sheet. Turn on the second oscilloscope and get two input connectors for it. Attach the connectors to the CLK and DIR outputs.

Turn the wheel/encoder manually and verify that there is output. Now, using the motor controller setup, engage the wheels by turning on the battery supply once more and see what the encoder outputs are. Vary the duty cycle. What happens?

Part 8: Quadrature Encoder, Part 2. Once you have done all of the above, unplug all of the circuit except for the 5V regulated supply. Get the other encoder, the HEDS-5540, which is a three channel quadrature encoder. Check out its spec sheet and see what's going on. Connect it up as specified and see if you can read the output when you turn the encoder wheel using a paper clip or a pencil eraser.

OK, that's pretty much it for today. Now you should know how PWM works, what job the motor controller plays, and how encoders work. In a little bit, we'll try to hard-wire the electrical connections and program a micro-controller to do all of what you did manually. Then it can be put on the vehicle and controlled with little effort.