CSE P567 - Winter 2010   Name_____

Lab 8 – Motor Driver and Sensor Interface

You should complete the first 3 parts in Lab (by 9:30PM), and the rest as a homework assignment, which you will demo in the next Lab. There will be a small (10%) penalty for late turnin.

Overview

There is one more setup that you will need to finish the final project, and you should do this setup before you leave the lab today so that you can work on the homework before the next lab. In this setup, you will interface your Arduino to an electric motor and a phototransistor that will allow you to monitor the speed of the motor. You should construct and test this interface before the end of the lab – you may need to do this before you finish Lab 7. If so, it may require you to move things around a little on your protoboard so that they fit.

Part 0 – Complete Lab 7

Complete all parts of Lab 7 and get signed off by the TA.

Part 1 – Connect the Motor

First, you will construct a drive circuit for the electric motor. Running a motor takes a considerable amount of current, especially when it is starting up, so we can't use the ATmega328 to drive it directly. Instead we will use transistors to amplify the current provided by the output pins of the ATmega328 so that it can be used to drive the motor. The ULN2003 chip includes seven input/output pairs (in the next lab you will be driving **two** motors, but for now, you only need to drive one). Take a look at the datasheet for the ULN2003 and notice the diode that is connected between each output and the common pin.

When a motor is turned on, it acts like a wire with little resistance and will thus pull lots of current. When it is running at constant speed, there is a "back-voltage" generated by the motor, which increases the effective resistance and reduces the current requirements. Increasing the load on the motor decreases this back-voltage and increases the current. When the motor decelerates quickly, this back-voltage can spike, causing the voltage on the input to the motor to rise above Vdd, which can damage the driver. These chips thus include a diode that dumps current straight to the power supply, effectively bypassing the driver transistor and keeping the voltage on the transistor output at a reasonable level.

Connect the motor to the driver chip as shown in the following diagram. You should use an output pin that can be driven using an analog output (PWM) to drive the motor. You may want to solder the wires to the motor.

Test the motor by using the pin in digital output mode. Make sure that it goes at full speed when turned on, and stops when turned off.
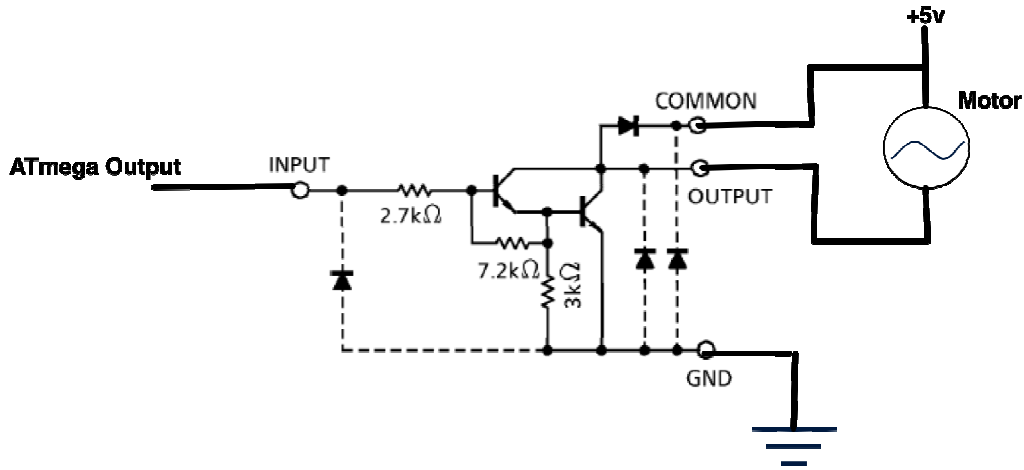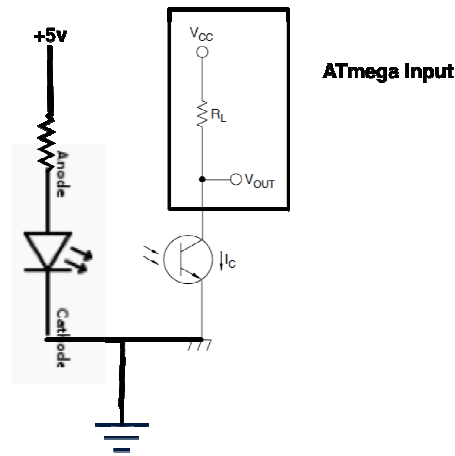

Motor Circuit Checkoff_____TA

Part 2 – Phototransistor - Motor Speed Sensor

Our motors are connected to a disk with black and white sections that are used to sense the speed of the motor using a phototransistor sensor. This comprises an LED that shines a light on the disk and a phototransistor that senses the reflected light, producing a 1-bit signal, which is 1 or 0 depending on whether it senses a light or dark sector. Connect the LED using a 150 ohm resistor. Connect the phototransistor output to an ATmega input, where the 20k pullup transistor of the ATmega is used for the pullup transistor shown in the figure.

Test that your sensor works using an oscilloscope to display the output signal while your motor is running.

Sensor Circuit Checkoff_____TA

Part 3 – Direct Motor Control

Write a program that drives the motor speed based on commands from the serial monitor. Entering a number beween 0 and 100 should drive the motor at a speed of 0% to 100% of maximum speed. We will use a PWM output to vary the effective voltage of the output. The inertia of the motor will act as a low-pass filter, effectively turning the PWM waveform into an analog value. We could also use a resistor-capacitor circuit as a filter and generate an analog voltage directly.

Motor Driver/potentiometer Circuit Checkoff_____TA

Part 4 – Motor Speed Sensor

Now, add code to your program that measures the motor speed in RPM and prints this value to the Serial Monitor. There are several different ways to do this – it is up to you to decide which one to use.

Sensor Circuit Demo_____TA