EET364 Microcontroller Systems
OIT Portland West, Winter 2011
Lab Assignment #2 — Analog to Digital Converter
Due January 20

Objective:
The student will demonstrate the usage of the Analog to Digital Converter in the 68HCS12.

Equipment and Software needed:
- Everything you needed for Lab Assignment #1

General Instructions:
Note that Freescale Semiconductor refers to an Analog to Digital Converter as an "ATD" rather than the conventional "ADC." There are two ADCs in the microcontroller. We will restrict ourselves to the first ADC. An input voltage of 5 volts will generate ADC value 1023 while an input voltage of 0 volts will generate an ADC value of 0.

The Dragon12-Plus board has several devices connected to the ADC. There is a potentiometer giving an adjustable voltage input of 0 to 5 volts on PAD07 that can be used for static voltage measurement, there is a light sensor connected to PAD04, and there is a temperature sensor connected to PAD05. We will be using the potentiometer and temperature sensors in this assignment.

Program Design:
In this unit we will be measuring the voltage and temperature. The ADC must be configured with the SCAN bit set for continuous operation, the MULT bit set to measure from multiple pins, 3 conversions, and for 10 bit conversion. By starting with PAD05, we will be measuring the voltage of PAD05, PAD06 (which we will ignore), and PAD07. The three conversion readings will need to be processed in sequence when an interrupt occurs. Set the AFFC bit so that reading a result register will clear the SCF flag, allowing the next interrupt to occur. With this configuration, the ADC will run continuously, converting at the maximum rate, with an interrupt occurring every 3 conversions.

You need two variables. The unsigned word variable *voltage* is to store the potentiometer voltage in units of millivolts. The signed byte variable *temperature* is to store the temperature in degrees Celsius. For both variables, your interrupt routine will need to get the ADC measurement and convert to the correct units.

For the voltage we know that one unit of the ADC value is 5/1024 volts, or 5000/1024 millivolts. So to convert to millivolts we need to multiply the ADC value by 5000 and then divide by 1024. Use the EMUL and EDIV instruction pair to

accomplish this conversion. You can jump ahead to the chapter on Scaled Integer Arithmetic for more information.

For temperature, it is a bit more involved. We know we can multiply by 5000/1024 to get the voltage of the sensor in millivolts. Then the LM45 data sheet states that the voltage output is 10mV/degree. So we need to divide the voltage in millivolts by 10 to get the temperature. This means we can take the ADC value, multiply by 500 and divide by 1024 to get the temperature in degrees.

Don't forget to include the heartbeat code! The heartbeat light should continue to flash until the Abort button is pressed.

To turn in:

- Commented program listing
- Values in *voltage* when the potentiometer is fully counter-clockwise, midscale, and fully clockwise. If you have a voltmeter, measure the voltage and put that in your report as well.
- The value in *temperature*. If you have a room thermometer, provide its reading as well. If you can, try measuring the temperature outdoors or in your refrigerator for a second data point. Don’t try it in your oven, though!