Lab 8: A digital temperature monitor.

Name: _____ Lab Partner: _____

Answers to pre-lab questions and a design of any circuits you will build or experiments you will perform must be turned in at the beginning of your lab. You may want to make a copy of the pre-lab for reference while you do the lab because you will not have the copy you turn in at the beginning. Make sure all the work you turn in is your own. I.E., do not copy other student's work (This applies to lab reports as well as pre-labs).

Overview

In this lab you will design and implement a temperature sensing and monitoring system. You will use an analog to digital converter to sample an analog temperature sensor. The ambient temperature is to be displayed on 7-segment displays to the user. Your circuit should alarm the user when a predefined temperature threshold is exceeded. The sensor (LM335z) and the ADC (ADC0804) are in your parts kit.

Pre-lab Questions

1. What is the temperature range of the LM335z? What voltage will the sensor read at the min, the max, and at room temperature?
2. What is the *resolution* of an analog to digital converter (ADC)? What is the analog input *range*?
3. What is the function of a digital to analog converter (DAC)? How does it compare to a pulse-width modulator?
4. How do we implement the A/D converter in free-running mode (continuous conversion)?
5. Given the schematic of Figure 2 (notably the RC circuit tied to pins 19 and 4), what is the designed frequency of the converter (see ADC0804 datasheet).

Experiment

Implement a circuit that measures temperature using the LM335z analog sensor from National Semiconductor (in you kit) and the ADC0804 analog to digital converter from Intersil, available in the lab. You may use the following circuit schematics (Figures 1,2 and 3) for reference. Your circuit should continuously display the absolute ambient temperature (from 32°F to 212°F) using three decimal digits on three 7-segment displays in degrees Fahrenheit.
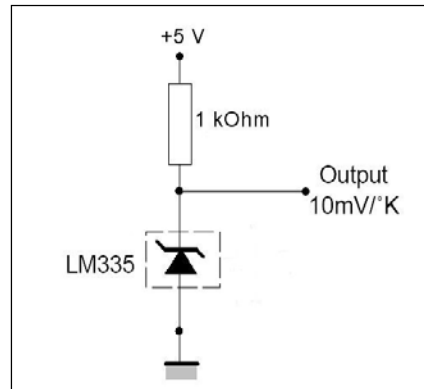
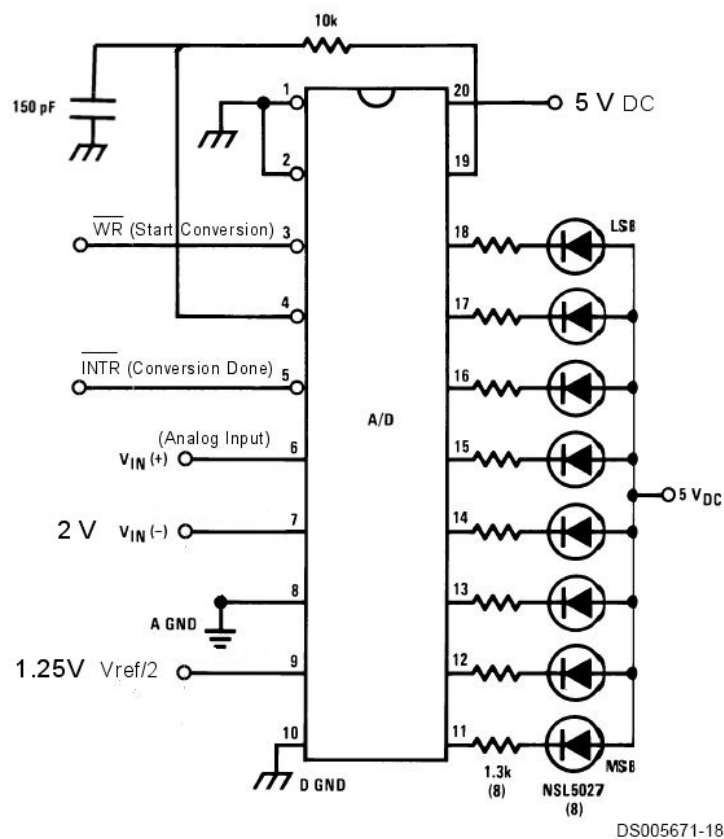**Figure 1: Basic LM335Z Temperature Sensor Circuit**

Figure 2: Suggested ADC0804 Circuit

Part 1: Wire a temperature sensing circuit and show the output voltage using a multi-meter.

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Part 2: Wire the ADC circuit using the output voltage of the temperature sensor in part 1 as the analog input to be digitized. Demonstrate the correct operation by showing the digital temperature reading on eight LEDs on your protoboards. The ADC may be used in free-running mode.

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Part 3: Implement your Verilog/FPGA circuit and show its correct operation by using 8 logic switches to simulate the ADC reading (hint: for this part and part 4 – display the 8 bit number on the leds, as well as on the seven-segment displays in decimal format).

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Part 4: Now put the whole circuit together and show the actual temperature sensor reading on the 7-segment displays.
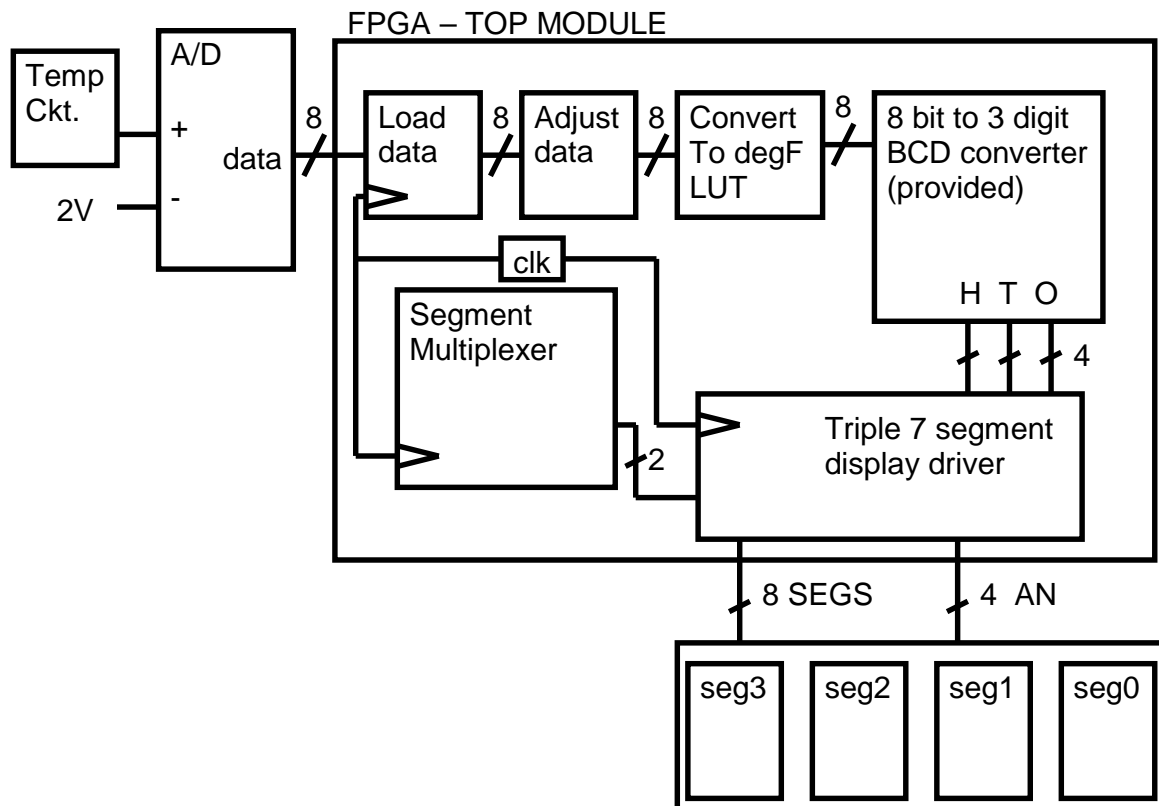
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Figure 3: Overview of entire design.