

LED Thermometer Lab

Summary: This exercise provides an introduction to temperature transducer measurement as well as data acquisition. The LED Thermometer Lab is designed as a laboratory or at-home experiment. Low Cost National Instruments Data Acquisition products are used to provide a power supply and measure data from a temperature sensor IC.

LED Thermometer Lab Using National Instruments Low Cost Data Acquisition

Introduction

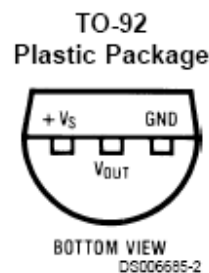
One common measurement that scientists and engineers like to make is temperature. For example, it may be necessary to record the temperature of a biology experiment, a heat testing chamber for electronics, or a jet engine.

In order to convert temperature information into electrical form, a transducer is needed. A temperature transducer is simply a sensor that will allow the user a mechanism to detect a temperature change (increasing or decreasing voltage, current, resistance, etc).

During this exercise, the experimenters will use the integrated circuit LM34CZ temperature sensor to output a linear, temperature dependent voltage. This voltage will be digitized by a Low Cost USB DAQ so that measurements can be taken on a computer. Finally, a LabVIEW virtual instrument (VI) will be created in order to visualize sampled data and control several LEDs.

Theory

One method to measure temperature involves using an integrated circuit transducer such as the LM34CZ. This IC will generate a voltage that is linearly proportional to the measured temperature. Compared to other measurement methods, ICs provide an extremely linear output with very little error. They are also one of the simplest temperature sensors to connect and use. Below are several views of the LM34CZ in a TO-92 package:



Subfigure 1.1: LM34CZ Sensor Subfigure 1.2: Sensor Pinout

Figure 1

As you can see, the LM34CZ is a three-terminal device. Two pins are used for power (+Vs and GND), while the third pin is used to output a temperature dependent voltage. Since the LM34CZ outputs a voltage that is linearly dependent with temperature, it is easy to compute measured temperature from sensor output voltage or vice versa. In fact, the LM34CZ ideally outputs exactly 10mV / deg F.

$$Temp (\text{deg } F) = V_{OUT} * 100$$

To visualize this relationship, a graph sensor output voltage vs. temperature can be plotted using LabVIEW:

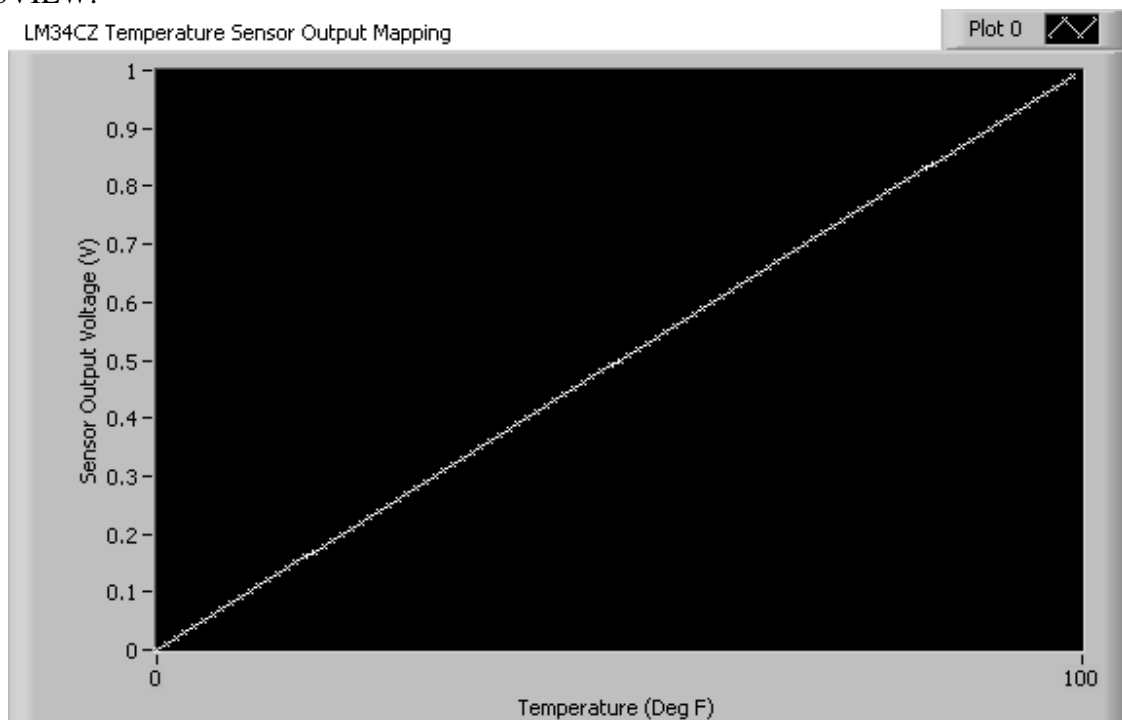


Figure 3: Output Voltage Vs. Temperature Data

Hardware and Software Required

1. (4) red LEDs
2. (4) 220 Ohm resistors
3. LM34CZ temperature sensor IC
4. National Instruments Low Cost USB DAQ
5. LabVIEW 8.0 software

Laboratory Exercise

During this exercise, the experimenter will construct an LED thermometer that resembles the following:

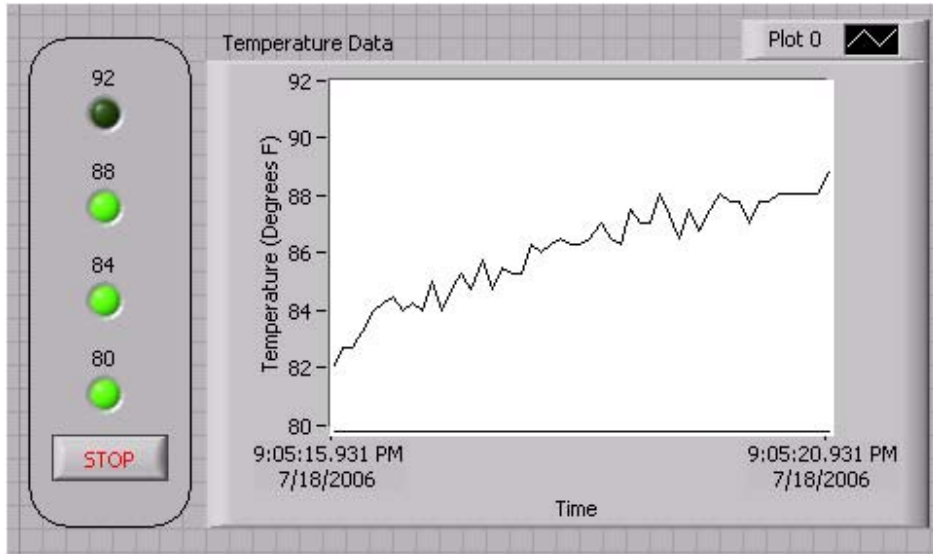


Figure 4: LED Thermometer Front Panel in LabVIEW

1) In order to create the LED thermometer output, Connect LEDs and resistors to the digital output lines of the Low Cost USB DAQ as shown below. Each LED will be programmed to light up when the temperature exceeds a certain threshold.

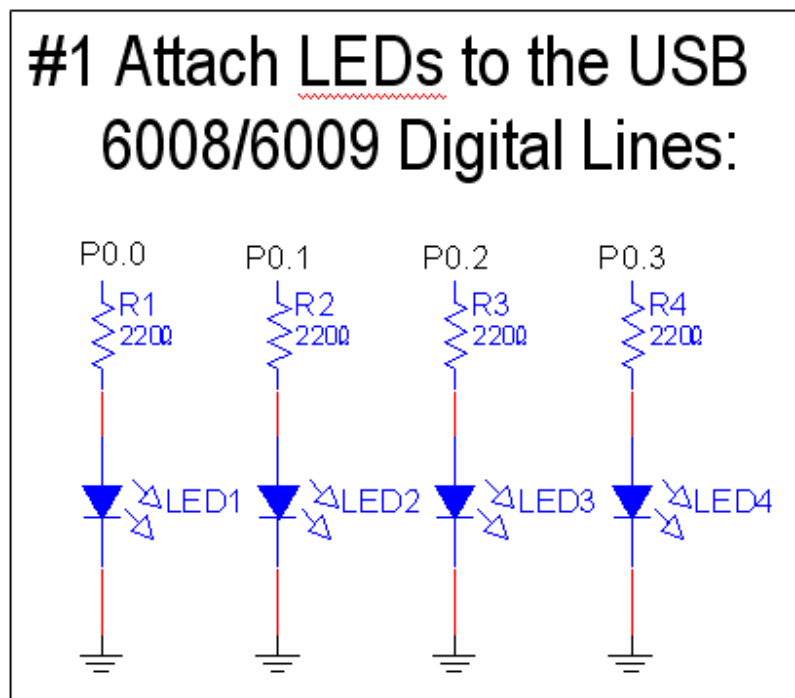


Figure 5: LED Connection Schematic

2) To measure the temperature, connect the LM34CZ IC to the Low Cost USB DAQ as shown below. Note that the +5V supply needed by the IC can be obtained directly from the National Instruments USB 6008 or 6009.

#2 Attach Temperature IC to the USB 6008/6009 AI 2+ Line:

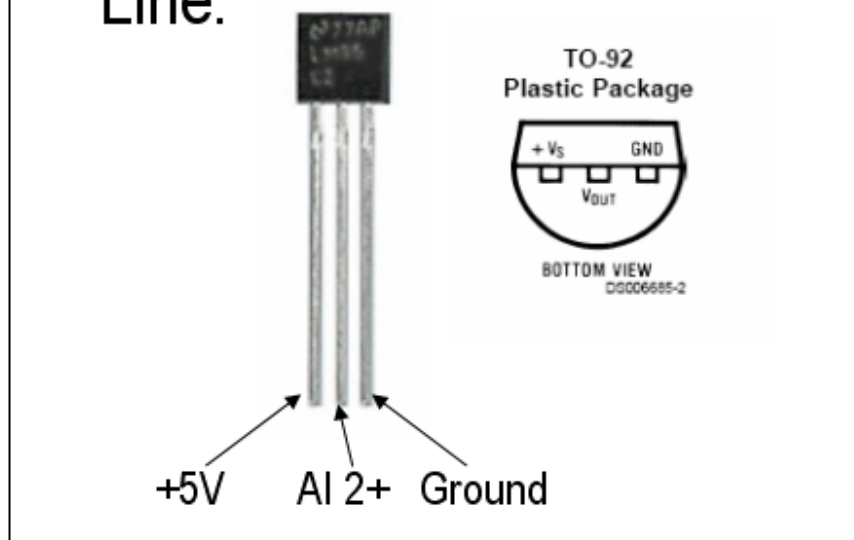


Figure 6: Temperature Sensor Schematic

3) Using the DAQ Assistant Express VI, create the following LabVIEW block diagram. In this virtual instrument (VI), temperature data is acquired using the Low Cost USB DAQ, scaled, and displayed on a chart. The temperature measurement is also compared with several thresholds. Once the temperature exceeds each threshold, a corresponding physical LED and front panel LED will light up.

4) Run the VI and adjust the threshold levels so that several LEDs light up. Warm up the temperature sensor by squeezing it with your fingers and observe the rise in measured temperature on the front panel chart. You have now succeeded in creating an LED thermometer