

Lab 11: Control System

November 30, 2008

In this lab you will design a simple control system that reacts to an input signal and produces a desired behavior based on this signal. For example, if you are trying to control the temperature of a computer, you will need to measure the temperature, and if the temperature is above a certain value, turn on a fan to cool it off. If the temperature drops below a certain value, turn off the fan. Hence, you control the temperature of the computer using an input signal (temperature) through an output signal controlling the fan.

The control system that you will design is going to be implemented on the computer that you build previously. Since the computer is a digital system, it can't handle continuous signals, neither in time nor in value as that requires infinitely fast computer as well as infinite precision to represent the infinite possibilities of the values of the input signal. Therefore, we need to sample the input signal, i.e., pick only fixed points in time rather than all time. We also need to digitize those sampled values and represent them by finite binary values. This process is accomplished using an analog-to-digital converter (ADC).

Figure 1 is an example of sampling and digitizing of a continuous signal. First, the signal value is captured at a fixed point in time, then this value will be approximated to the closest digital level available. In this case, each value is represented using only 3 bits and therefore there is only 8 different digital values as opposed to the infinite values that can be represented by the continuous signal.

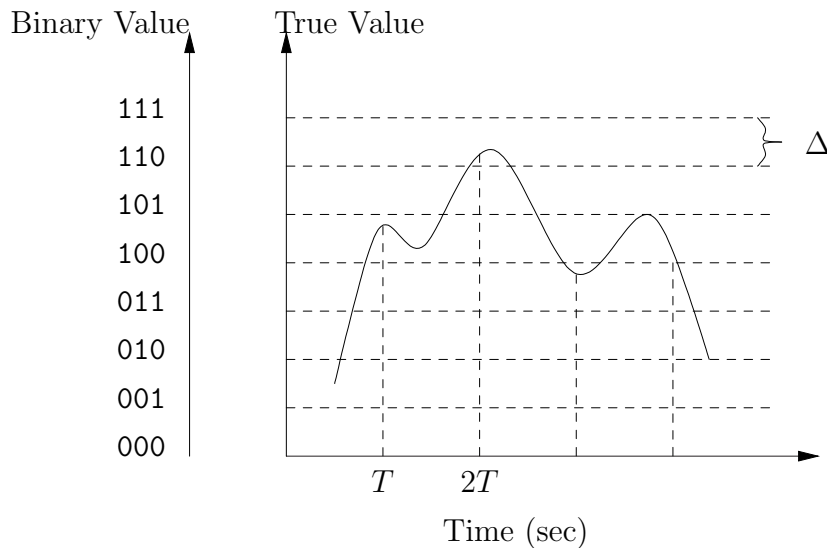


Figure 1: Sampling and digitizing of a continuous signal

1 Lab

1. If your ADC is 8-bits, how many digital levels do you have? What is the resolution of this ADC if it operates in the range of 0-5V, e.g. looking at Figure 1, what is Δ in volts?. If the input is 2.5V, what is the output?
2. Build the circuit shown in Figure 2.
 Make sure to have separate buses for the analog ground and the digital ground (See Figure 3). Then connect them at a single point on your board. Otherwise, there will be noise on the analog signals due to the fast switching of the digital portion of the chip.
3. Use a variable pot to control the input to the ADC. Connect the output to the LEDs on your protoboard. Verify that it works properly.
4. Design a computer program that takes in the value for the ADC and if it is greater than 2.5V then output a 1, otherwise output a 0.
5. Implement your control system and verify its operation in hardware as shown in Figure 4.

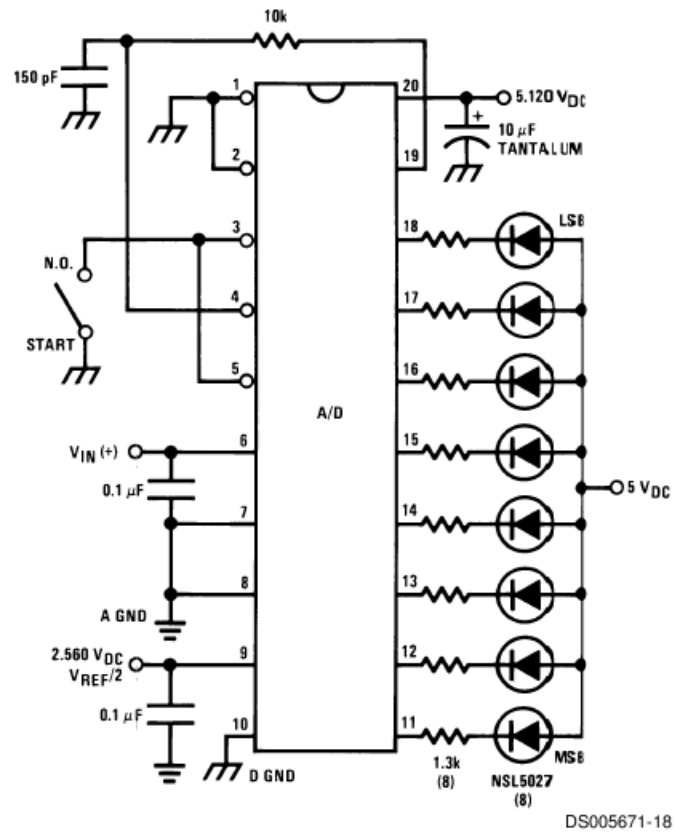


Figure 2: ADC0804 Tester



Figure 3: Analog and digital ground symbols

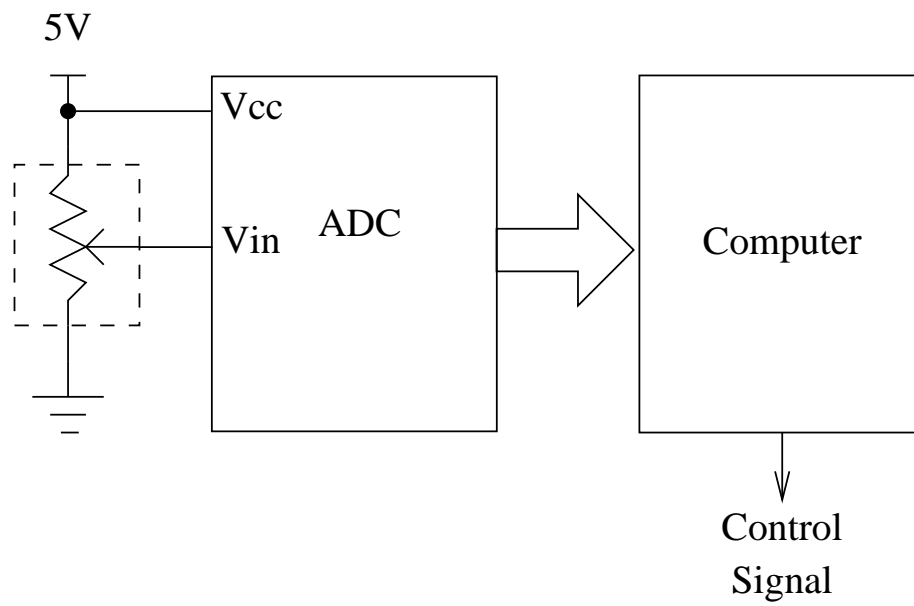


Figure 4: System overview with the variable resistor represents the variable output of a temperature sensor.