Department of Electrical Engineering
Columbia University
EE E3082. Digital Electronics Laboratory
Laboratory 3. A/D and D/A converters

Note: The chips you are using in this lab are very sensitive to damage from electrostatic discharge. Please use a ground strap.

Introduction: While most signal processing and computation is done with information coded in digital form, the world is analog and digital-to-analog (D/A) and analog-to-digital (A/D) converters are an important interface.

Goals: In this lab, you will:

1. Plot the transfer function of an LSI A/D converter chip.
2. Use an A/D converter to design a simple digital voltmeter.
3. Combine an A/D and D/A for reconstruction and to understand the effects of aliasing.

In this lab, we will make sure of the TLC0820 A/D converter chip. This is an 8-bit successive-approximation ADC.

P Configure the ADC as shown in Fig. 1. In this mode, once the ADC is done with one conversion, it will set the digital outputs and immediately begin the next conversion. To ensure proper start-up on power up, you may need to "momentarily ground" $\overline{RD}$.

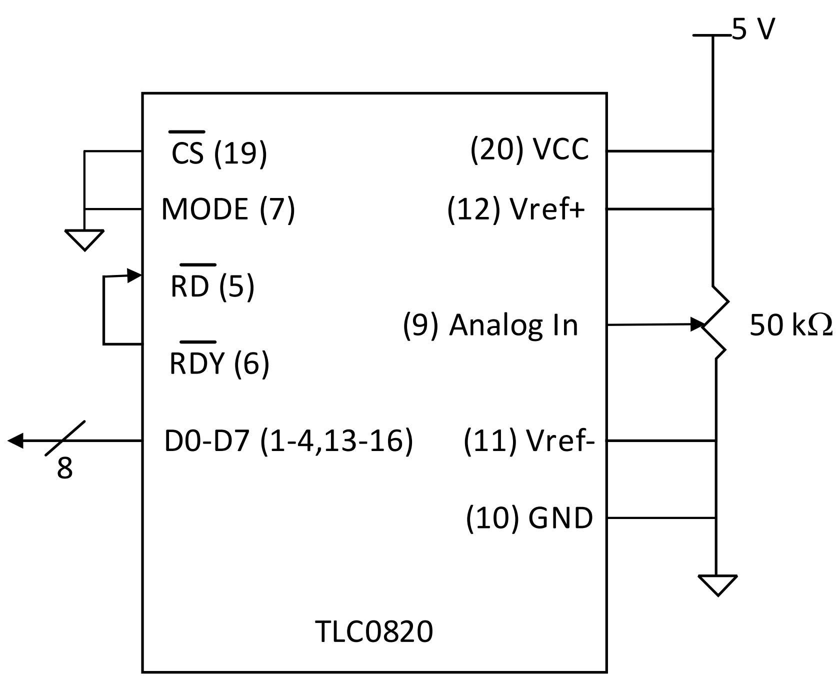

Figure 1. ADC operating in "free-running" mode

Q1

Measure the conversion time by measuring the period of the waveform at pin 6. Does the conversion time depend on the value of the voltage being converted?

D1

Modify the circuit of Fig. 1 to construct a two-digit octal voltmeter that operates between 0 and 5 V. Your circuit should output an octal number between 00_8 and 77_8, equivalent to a decimal number between 0_{10} and 63_{10}; 77_8 corresponds to the maximum input voltage (V_{ref}). Record 5 pairs of data, each consisting of an input voltage and the corresponding octal output, and show in your lab report that the displayed output is correct. Please submit a complete schematic and a brief explanation of the circuit.

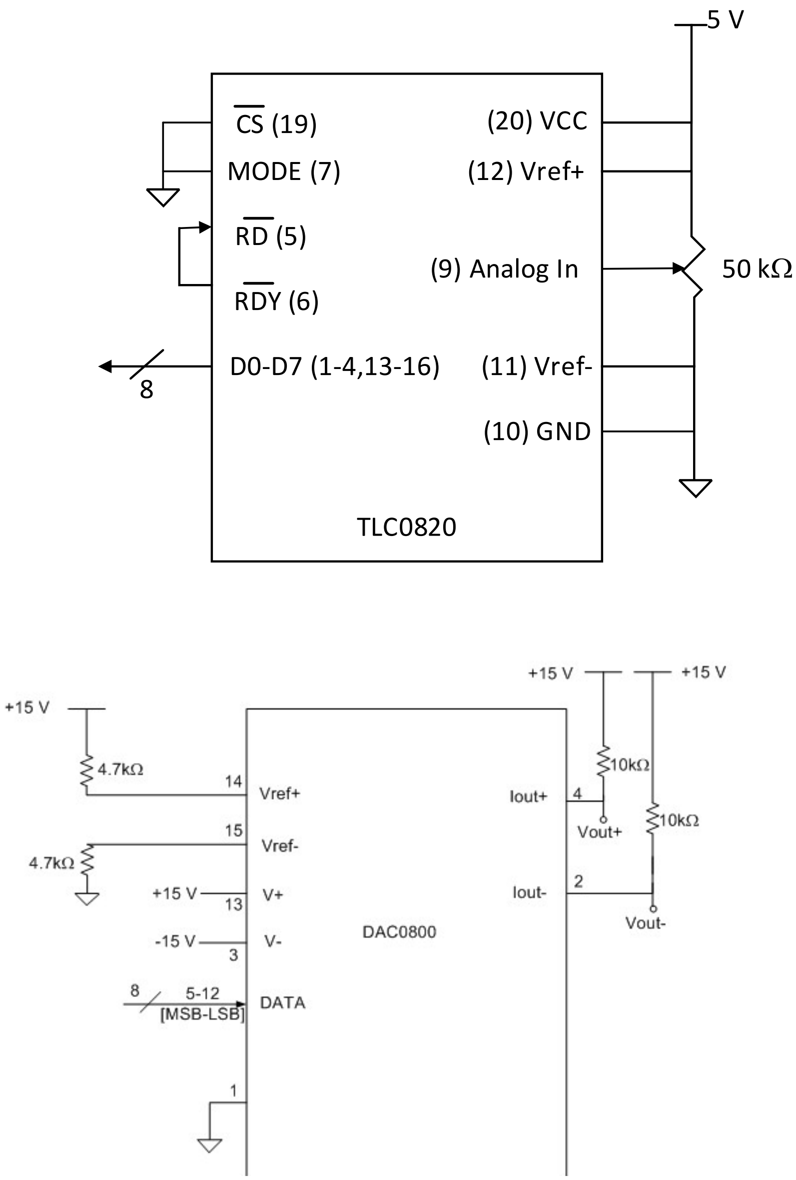

Figure 2. A/D followed by D/A reconstruction.

P Using a DAC0800 chip, construct the circuit of Fig. 2 which converts an analog signal into digital form and then reconstructs the analog signal. Connect the scope to the DAC output; specifically, connect both Vout- and Vout+ to the scope. Apply a 100 Hz, 1 V peak-to-peak sine wave operating around a 2.5 V offset to the ADC input.

Q2 Recording the DAC output for several different amplitudes and frequencies. What happens to the DAC output when the input frequency exceeds the Nyquist frequency ($f_s/2$)? (f_s is the sampling rate.) At frequencies well above the sampling rate, you will notice significant lower frequency content at the output, an effect known as aliasing. As a result, the input must generally also be low-pass filtered (anti-aliasing filter).