17.368 Data Conversion and Lab
Lab 3
Spring 2013

Analog to Digital Converter

Lab Report

See separate report form located on the course webpage. This form should be completed during the performance of this lab.

Objectives

1) To construct and operate an A/D Converter
2) To design and build a circuit which will sample an A/C input signal

Materials

General Material

☐	1	Breadboard
☐	1	6 V DC Supply
☐	1	Stepable voltage standard DC supply
☐	1	0 to 5 V Variable DC Supply
☐	2	Dual Power Supply (+15 V and –15 V)
☐	2	Oscillator or Function Generator for signal source
☐	1	Pulse Generator
☐	1	Voltmeter
☐	1	Oscilloscope

Analog-to-Digital Circuit

☐	1	National ADC0804 (8 bit μP Compatible Converter)
☐	1	LF398 Sample and Hold circuit
☐	1	100 pF Capacitor (101)
☐	1	150 pF Capacitor
☐	1	10 μF Capacitor (Tantalum)
☐	2	0.1 μF Capacitor (104)
☐	8	1.3 kΩ Resistors
☐	8	NSL5027 LEDs
☐	1	10 k ohm Resistors (Brown – Black – Orange)

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WARNINGS AND PRECAUTIONS

1) Never install or remove the components from an energized circuit

2) Do not construct circuits while energized

3) Follow electrical safety precautions

Background Information

None.

Pre-Lab Preparation

1. Download Lab # 2 from the course website. Read and understand the lab.

2. Download the complete Data Sheet for National Semiconductor ADC0804 A/D converter from the course web site

Procedure

Objective 1. BASIC A/D TESTER

a. Using the National Semiconductor Analog to Digital Converter in a 20 – pin dual in line package in the stand-alone mode with a 5-volt DC power supply and a 0 to 5-volt input.

b. Go to pages 23-24 section 3.0 "Testing the A/D Converter" of the ADC0804 Datasheet. (See download instructions above under Pre-Lab Preparation.)

c. Assemble the test circuit shown in Figure 1 of this lab (Datasheet Figure 9).

NOTE: THE CIRCUIT SHOWN IN FIGURE 1 WILL ALSO BE USED IN LAB # 4. SAVE TIME BY NOT DISASSEMBLING!

d. Connect the test circuit Vcc to the fixed +5 volt DC supply. Vref/2, pin 9 is an output, do not apply a voltage to this pin.

e. Connect the input pin to the variable plus DC supply and measure the voltage with the multimeter.

WARNING: Do not connect a voltage greater than +5 volts to this input.

Starting with 0 volts increase the voltage in ½ volt steps up to 5 volts. Start the scan Zero volts to +5 volts and note the output display. Make a table like the one on page 25 of the data sheet … decoding the Digital Output LEDs.

f. Now calculate the Vstep with:

$$V_{step} = \frac{V_{\max} - V_{\min}}{256}$$

Using a stepable voltage standard DC supply, check your Vstep and the table decoding the LEDs Output.

g. Calculate the frequency of the A/D Clock using the R – C values in the test circuit (see page 23 of the data sheet).

h. Measure this frequency with the O-scope.

i. Change the value of C and note the changes.

j. Input a slow AC signal (less than 1 Hz) between 0 and 5 volts and note the results.

Now increase the frequency and note the results. At what frequency will the A/D not be able to process the data?

k. From the data sheet find the following information:

1. What is the conversion time with the test circuit Clock frequency?
2. Determine the supply current used in the test circuit.
3. What is the max clock frequency that can be used?
4. Are the resistors selected for the LEDs in the test circuit the correct value? What would be an ideal value for these resistors? Now defend the value you selected.

5. What device would you add to the test circuit to make a better A/D converter (list at least two)?

OBJECTIVE 2. SAMPLE AN AC INPUT SIGNAL

a. Build the circuit "Sampling an AC Input Signal" shown in Figure 2 (see also page 16 of the datasheet). You will keep the A/D Basic Tester circuit and add the LF398 Sample and Hold chip from the last Lab (Lab #2). The DS005671 IC is not needed; just tie the input to the proper signal level. CH = 100pF

b. Apply a low frequency sine wave keeping in mind the voltage restrictions on the input when using a single +5 volt Vcc on the S/H and A/D chips. The TTL control signal is 0 to +5 volts. The active low pass filter is not needed for this experiment but is a good idea on a true design. Note output.

c. Change the frequency and note changes (this will require O-scope use).

d. Adjust the sample and conversion time and note changes.

1. Are your findings different or the same as Objective 1.j?

2. Did the S/H change anything?

SUMMARY:

This lab provided an introduction to the Analog to Digital converter.

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Lab Notebook Requirements:

1. Ensure that you have recorded all the data requested during the lab in your lab notebook as well as your lab report.

Lab Report:

1. Use template provided on the Class Web Site.

Lab Questions:

1. Contained within the lab.

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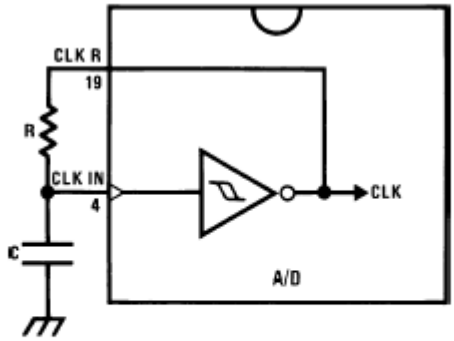
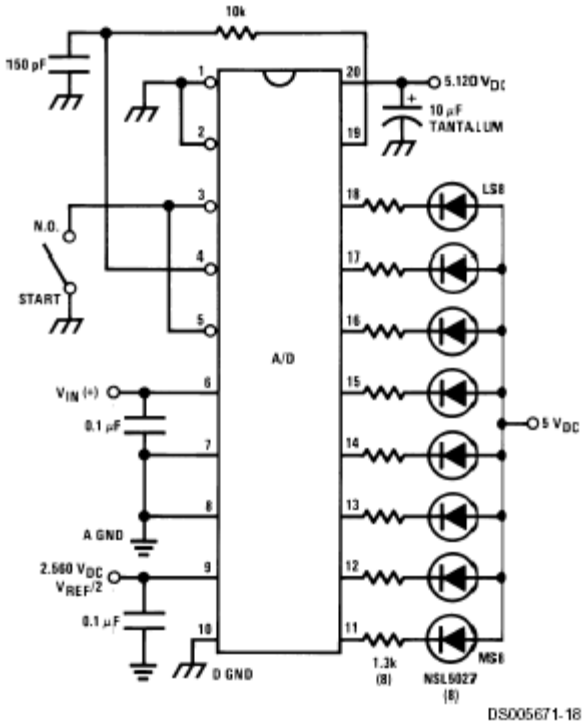
Figure 1 – Basic A/D Tester



$$f_{CLK} \cong \frac{1}{1.1\ RC}$$

$$R \cong 10\ k\Omega$$

Self-Clocking the A/D



Basic A/D Tester

Figure 2 – Sampling an AC Input Signal