17.368 Data Conversion and Lab
Lab 2
Fall 2013

Sample and Hold Amplifiers

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 a Sample and Hold circuit using the LF398
2) To measure DROOP RATE and GAIN ERROR
3) To construct and operate a 1 Bit A/D Converter

Materials

General Material

☐ 1	Breadboard	
☐ 2	Dual Power Supply (+15 V and –15 V)	
☐ 2	Oscillator or Function Generator for signal source	
☐ 1	Pulse Generator	
☐ 1	Voltmeter	
☐ 1	Oscilloscope	

Sample and Hold Circuit

☐ 1	741 Linear IC		
☐ 1	LF398 Sample and Hold circuit		
☐ 1	10 pF Capacitor	(10)	smallest
☐ 1	100 pF Capacitor	(101)	↓
☐ 1	0.001 μF Capacitor	(102)	
☐ 1	0.01 μF Capacitor	(103)	
☐ 1	0.1 μF Capacitor	(104)	
☐ 1	1.0 μF Capacitor	(105)	largest
☐ 3	10 k ohm Resistors	(Brown – Black – Orange)	
☐ 1	10 k ohm Potentiometers		

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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

The purpose of the Sample-and-Hold amplifier is to freeze an analog voltage of the instant the Hold command is issued and make that analog voltage available for an extended period of time allowing for A/D converter and other applications to utilize the stored voltage.

Pre-Lab Preparation

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

2. Download LF398 Data Sheet from the course Webpage

Procedure

Objective 1. SAMPLE AND HOLD

a. Assemble the circuit shown in Figure 1. Values are as follows:

V+ = 15 volts (Use dual power supply)
V- = -15 volts (Use dual power supply)
C_h = 100 pF

b. Apply a 5 Vpp Sine wave of 10 Hz to the Analog input. Use the Oscillator or Function Generator for the signal source. NOTE: Analog input frequency can range from 10 Hz to 5 KHz. Record the actual value used.

c. Apply a 5 Vpp differentiated square wave of 2 KHz to the sample and holding time signal, by using a Pulse Generator.

d. Record the actual sample and holding time duty cycle (frequency). Make note of the output signal. Compare the input signal to that of the output.

e. Change the sample and holding time (duty cycle). Make note of the output signal changes as the duty cycle changes.

f. Repeat Step 1.d. with an Analog input frequency of 100 Hz.

g. Repeat Step 1.d. with an Analog input frequency of 1 KHz.

OBJECTIVE 2. DROOP RATE AND GAIN ERROR

a. Assemble the circuit shown in figure 1. Values are as follows:

V+ = 15 volts (Use dual power supply)
V- = -15 volts (Use dual power supply)
C_h = 10 pF

b. Let the analog input = 1 VDC from a DC power supply (be sure to disconnect the function generator).

c. Measure the output (Vo) with a DC voltmeter while the 5 Vpp 2 kHz differentiated square wave is clocking the LF398 IC.

d. Disconnect the clock input, and observe Vo on a DC voltmeter for 60 seconds. Record Vo at the end of 60 seconds.

e. Calculate the droop rate in volts/sec.

TABLE 1 DROOP RATE					
C_h (Hold Capacitor)		Voltage Start	Voltage Comp		Droop Rate (Calculated)
10 pF					
100 pF					
0.001 μF					
0.01 μF					
0.1 μF					
1.0 μF					

f. Repeat Steps 2.b. through Step 2.e. by replacing C_h with the different values for the hold capacitor as indicated in TABLE 1. Record the output droop rate for each capacitor used.

g. Using the same circuit, Figure 1, with C_h= 0.001μF, observe the output transient at start of sample mode. (Sample rate: 8kHz)

h. Test for Gain Error (input vs output). Compare with data sheet values. Gain error is calculated as follows:

$$GAINERROR = \frac{V_{OUT} - V_{IN}}{V_{IN}} * 100\%$$

OBJECTIVE 3. 1 BIT A/D CONVERTER

a. Assemble the circuit shown in Figure 2. Values are as follows:

V+ = 15 volts (Use dual power supply)
V- = -15 volts (Use dual power supply)
C_h = 100 pF

b. Apply a 5 Vpp Sine wave of 1 KHz to the Analog input. Apply a 5 Vpp differentiated square wave of 2 KHz to the sample and holding time signal, by using a Pulse Generator. Set the comparator to 70% of the sampled signal. Output will be high (digital 1) when input signal reaches the reference voltage on the 741 output.

SUMMARY:

This lab provided an introduction to the Sample-and-Hold amplifier. The Sample-and-Hold amplifier freezes an analog voltage at the instant the Hold command is issued and makes that analog voltage available for an extended period of time allowing for A/D converter and other applications to utilize the voltage.

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. None

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Figure 1 – Sample and Hold Circuit

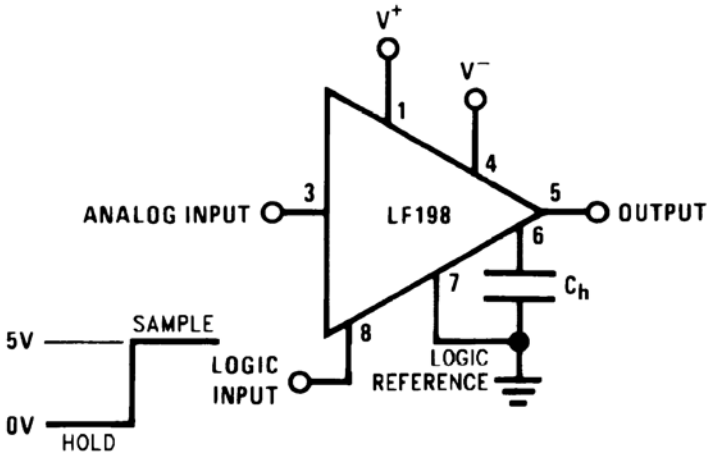

Figure 2 – One (1) Bit A/D Converter