Name (Last, First) ____

UNIVERSITY OF CALIFORNIA

College of Engineering
Electrical Engineering and Computer Sciences Department

EECS 145M: Microcomputer Interfacing Laboratory

Spring Midterm #1 (Closed book- calculators OK)
Wednesday, February 21, 1996

PROBLEM 1 (25 points)

You have just tested an 8-bit D/A circuit by making measurements of its output glitches. Your measurements show that after all possible changes in input bit patterns at time t, the output glitch begins no earlier than t + 10 ns and is essentially gone after t + 30 ns. The output ranges from V_1 = 0 volts to V_{255} = 2.55 volts.

You decide to design and build a circuit that does the following:

- Uses the D/A converter, but suppresses output glitches by sensing changes in the input and using a sample and hold amplifier.
- Has accurate conversion at 0 Hz.

You have available the following components:

1 A digital circuit that has 8 inputs and one output (normally low). If the input bits change at time t, the output goes high from (t + 5 ns) to (t + 5 ns + t_d). You can choose the value of t_d.

2 A sample-and-hold amplifier with an analog input, and analog output, and a digital control line. When the control line is low, the analog output $V_0(t)$ is equal to the analog input $V_1(t)$. When the control line is made high at time t_h, the analog output is initially held at $V_1(t_h)$, but with an output droop of 100 mV per second.

Do the following:

a. (12 points) Draw a block diagram of your circuit design, showing and labeling all essential components and connections.

PROBLEM 1 (continued)

b. (13 points) Briefly describe the operation of your circuit after a change in input.

PROBLEM 2 (50 points)

You are to design a system able to meet the following considerations:

1 Measures the frequency f of a sinewave $V(t) = V_0 \sin(2\pi f t)$

2 Makes a new measurement every second

(Hint: Use the event timing measurement technique of Lab Exercise 2)

You are provided with the following components:

1 A computer with C compiler, similar to the one used in the 145M lab. Inportb and outportb commands each take 1 µs- assume that all other C program commands are essentially instantaneous.

2 A counter/timer circuit at port address 1, containing a single 32-bit counter/timer is set to take its input from a 1 MHz clock.

All four bytes in the counter can be set to zero using the program command

```
outportb(1,0);
```

The four bytes i1 (least significant byte) to i4 (most significant byte) can be latched and read using the following program commands:

```
outportb(1,1);
i1 = inportb(1);
i2 = inportb(1);
i3 = inportb(1);
i4 = inportb(1);
```

3 An 8-bit parallel input port (similar to the one used in Lab 3) at port address 2. It is set to operate in transparent mode so that the byte value b on the external lines can be read at any time using the program command:

```
b = inportb(2);
```

4 An analog comparator (two analog inputs, one digital output)

PROBLEM 2 (continued)

Do the following:

a. (12 points) Draw a block diagram of your system, showing and labeling all essential components and connections.

b. (14 points) List the steps in the operation of your system during a 1s measurement period. Include both hardware events and program code as needed. ("Legal" C code not required- just describe what each program command needs to do.)

PROBLEM 2 (continued)

c. (8 points) Draw a timing diagram for the important signals.

d. (8 points) What are the minimum and maximum frequencies that your system can measure? (Show work)

e. (8 points) At the minimum and maximum frequencies, what are the uncertainties in the measurements?

(Hint: You do not need to use the formal error propagation formula, just consider the range of measured values for a fixed input frequency)

PROBLEM 3 (25 points)

Interface an analog data conversion circuit (Figure 1) to the digital input port of a microcomputer (similar to the one you used in Lab Exercise 3).

The analog data conversion circuit has the following features:

- S/H input
- A/D conversion is started with a low-to-high edge
- A/D conversion complete is signaled with a high-to-low edge (and reset to high with the next A/D start conversion edge)

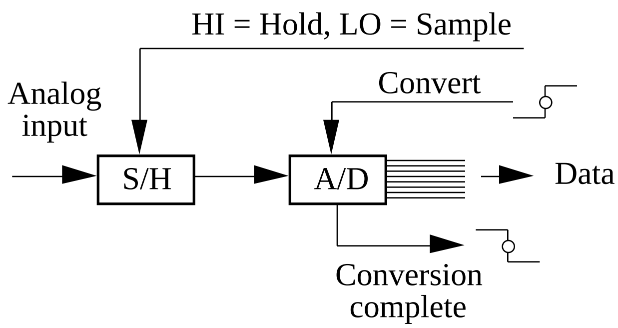

Figure 1 Analog data conversion circuit, using a sample and hold amplifier and an A/D converter.

The digital input port has the following features:

- When $\overline{\text{BI HOLD}}$ is high, the input registers are equal to the input lines.
- When $\overline{\text{BI HOLD}}$ is low, the input registers are held constant, regardless of input.
- An output line BI CTS can be set high or low by program control
- A status register BI STROBE can be set high or low by an external circuit and its logic state read by the program

a. (12 points) Draw a block diagram of your circuit design, showing and labeling all essential components and connections.

PROBLEM 3 (continued)

b. (13 points) Assuming that the program initiates analog data acquisition, describe the sequence of steps that occur, including handshaking.