

Name \_\_\_\_\_

# EET 1131 Lab #9

## Logic Families

### Equipment and Components

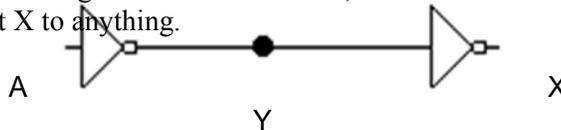
- Safety glasses
- Integrated Circuit: 7404 or 74LS04
- ETS-7000 Digital-Analog Training System
- Digital multimeter
- Quartus II software and Altera DE2-115 board

### Part 1. Measuring Operational Parameters

In the following steps you will measure some parameters for a 7404 or 74LS04 hex inverter chip. To get started, place a 7404 or 74LS04 on your breadboard, and provide your chip with power and ground in the usual way. *Make note of whether you have a 7404 or a 74LS04, since the datasheet values are different for these two chips.*

#### 1. Measuring Input Current

- According to the datasheet for your chip (7404 or 74LS04), what is the maximum current that flows into your inverter's input pin when that input is LOW? Record this value in the "Maximum" column of the table below. Be sure to include the proper unit.
- Connect two inverters together as shown below, with Point A wired to a data switch. Don't connect the output X to anything.



- Set the data switch so that Point Y (the input to the second inverter) is LOW.
- **If you don't know how to use a multimeter to measure current, ask me for help with this step.** Use a multimeter to measure the current at Point Y; in other words, the current flowing into the second inverter. Record this measured value in the table.

Data Table 1a. LOW Input Current

Maximum	Measured

- According to the datasheet, what is the maximum current that flows into an inverter's input pin when the input is HIGH? Record your answer in the "Maximum" column below.
- Set the data switch so that Point Y (the input to your second inverter) is HIGH.
- Use a multimeter to measure and record the current flowing into the second inverter.

Data Table 1b. HIGH Input Current

Maximum	Measured

Call me over to check your measurements. \_\_\_\_\_

## 2. Measuring Output Voltage

- According to the datasheet, what is the typical voltage on your inverter's output pin when the output is LOW? Record this value in the "Typical" column of the table below.
- Use the data switch to set the first inverter's output to LOW.
- If you don't know how to use a multimeter to measure voltage, ask me for help with this step. Use a multimeter to measure the voltage (relative to ground) on the first inverter's output pin. Record this measured value in the table.

Data Table 2a. LOW Output Voltage

Typical	Measured

- According to the datasheet, what is the typical voltage on your inverter's output pin when the output is HIGH? Record this value in the "Typical" column of the table below.
- Set the data switch so that your first inverter's output is HIGH. Measure and record the voltage (relative to ground) on the inverter's output pin.

Data Table 2b. HIGH Output Voltage

Typical	Measured

Call me over to check your measurements. \_\_\_\_\_

## 3. Measuring Propagation Delay

- According to the datasheet, what is the typical propagation delay through your inverter when the output is switching from a LOW to a HIGH? Record this value in the "Typical" column of the table below.
- Reconnect the first inverter's output to the second inverter's input, as in the drawing on page 1.
- Connect the first inverter's input to the trainer's TTL MODE socket instead of a data switch. Set the trainer's function generator controls to produce the highest frequency possible.
- Use an oscilloscope to display the waveform at Point Y on Channel 1, and the waveform at Point X on Channel 2.
- Set the oscilloscope's trigger controls to trigger on the rising edge of Channel 2.
- Use the SECONDS/DIVISION knob to "zoom" way in so that you can clearly see the time delay between Channel 1's falling edge and Channel 2's rising edge. Turn on the oscilloscope's cursors and measure and record this time delay.

Data Table 3a. LOW-to-HIGH Propagation Delay

Typical	Measured

- According to the datasheet, what is the typical propagation delay through your inverter when the output is switching from a HIGH to a LOW? Record this value in the “Typical” column of the table below.
- Set the oscilloscope’s trigger controls to trigger on the falling edge of Channel 2. Then measure and record the time between Channel 1’s rising edge and Channel 2’s falling edge.

Data Table 3b. HIGH-to-LOW Propagation Delay

Typical	Measured

- Call me over to check your measurements. \_\_\_\_\_

#### 4. Measuring Supply Current

- According to the datasheet, what is your chip’s typical supply current when all of its outputs are LOW? Record your answer in the “Typical” column of the table below.
- Disconnect your inverters from each other and from the TTL MODE socket. Then connect the input pins on your chip’s six inverters to six of the trainer’s data switches.
- Set the six switches so that all of the inverters’ outputs are LOW, but don’t connect these outputs to anything.
- **If you don’t know how to use a multimeter to measure current, ask me for help with this step.** Use a multimeter to measure the supply current flowing into your chip’s VCC pin from the trainer’s +5 V socket. Record your measured value in the table.

Data Table 4a. Supply Current with All Outputs LOW

Typical	Measured

- According to the datasheet, what is the chip’s typical supply current when all of its outputs are HIGH? Record your answer in the “Typical” column of the table below.
- Set the six switches so that all of your chip’s outputs are HIGH. Measure and record the chip’s supply current.

Data Table 4b. Supply Current with All Outputs HIGH

Typical	Measured

- Call me over to check your measurements. \_\_\_\_\_

## Part 2. A Decoder from Quartus II’s Library of Parameterized Modules

In Labs 7 and 8 you used the adder/subtractor and the comparator from Quartus II’s library of parameterized modules (LPM). Let’s do some more of the textbook’s examples and problems that use other components from the LPM.

1. Use Quartus II's New Project Wizard to create a new project named **prob\_c8\_9**. Remember to use this same name for your project's working directory.
2. Work through Example 8–22 on page 366 of the textbook. When you finish, call me over to check your simulation results.  

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3. Modify your design according to the directions in Problem C8–9 on page 382. When you finish, call me over to check your simulation results and your downloaded circuit.  

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### **Part 3. An LPM Multiplexer**

1. Close the previous project. Create a new project and working directory named **prob\_c8\_10**.
2. Work through Example 8–23 on page 367 of the textbook. When you finish, call me over to check your simulation results.  

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3. Modify your design according to the directions in Problem C8–10 on page 383 of the book. When you finish, call me over to check your simulation results.  

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### **Part 4. Review Questions.**

1. Did your inverter chip draw more supply current when all of the inverter outputs were HIGH or when they were all LOW? **Answer with a complete sentence, and justify your answer by citing measured values from Part 1 of this lab.**
2. Based on the datasheet's values, would you expect your inverter's output to switch faster when it switches from LOW to HIGH or when it switches from HIGH to LOW? Answer with a complete sentence, and justify your answer by citing datasheet values.
3. For a single inverter on your chip, did more current pass through the inverter's input pin when the input pin was HIGH or when it was LOW? Answer with a complete sentence, and justify your answer by citing measured values from Part 1 of this lab.