ECE 385

EXPERIMENT #1

Introductory Experiment

I. OBJECTIVE

This experiment is intended primarily to be an introduction to the ECE 385 Laboratory and equipment. The equipment introduced in this experiment includes the student lab kit, the lab station I/O boards, the Agilent MSO6032A oscilloscope and the Hewlett Packard 33120A pulse generator.

II. INTRODUCTION

A discussion of the theory behind Experiment 1 can be found in the General Guide, parts IV (Design Techniques, GG.22) and VI (Debugging Outside the Lab, GG.29). If you have the opportunity, you should read these sections before coming to lab. If not, you should read these sections after lab. Though the lab portion of Experiment 1 may be completed without reading these sections, understanding of these concepts is critical to both completing the Experiment 1 report and succeeding in the course in general.

III. PRE-LAB

A. Complete the design of the circuit shown in the General Guide, Figure 16 (GG.25) (add pin numbers, chip placement, and I/O assignments). You will be able to find the pin assignments for the chips in the Data Sheets provided on the Lab 1 webpage on the course website. Document the circuit as a circuit logic diagram (with pin numbers assigned and ports interconnected) and in a layout sheet (blank sheets provided at the back of the lab manual.) Drive the three inputs A, B, and C from I/O board switches. **The I/O board switches are debounced – no modifications are necessary**. Also, display the three inputs and the output on LEDs. Note that the I/O boards contain LEDs and drivers; to display a signal, simply hook it directly to the appropriate I/O board ribbon cable connection. Not all groups may observe static hazards (why?) If you do not observe a static hazard, chain an odd number of inverters together in place of the single inverter from Figure 16 **or** add a small

capacitor to the output of the inverter until you observe a glitch. Why does the hazard appear when you do this?

B. Redesign the circuit of part A to eliminate all static-1 hazards (glitches) at the output. (For a discussion on glitches, see General Guide part IV – "Design Techniques", "Delays and Glitches" section GG.22-25). Again document the circuit as a separate logic diagram and in the same layout sheet (only one layout sheet per lab, but you should include all circuits.) Build the circuit, drive all inputs from I/O board switches, and display the output on an LED. This circuit should be built independently of the circuit from part A; the two may share inputs, but both should be built from scratch.

Demo Points Breakdown:

The first lab does not have any in-lab demo points. However, results will need to be contained within the lab report.

IV. LAB

1. Unit test each integrated circuit (chip) required for this lab. Since all the chips used in this lab are combinational logic, you may simply verify that each gate within the chip individually implements the truth table as expected. You should also verify that the output for each chip is within the expected noise margin (check the data-sheet for specifics). This means that there should be no ambiguous voltage levels (those which are not clearly logical 0 or logical 1). Ambiguous voltages indicate either a wiring problem (e.g. a bus conflict) or a faulty chip. This should be standard practice with all TTL labs.

2. Test the circuit of part A of the pre-lab by applying all possible input combinations using the three switches. Complete a truth table of the output as a function of the three inputs.

3. Disconnect the switch going to input B of the circuit in part A. After setting both inputs A and C high, drive input B with a 1 MHz, 0 to 5 volt square wave from the pulse generator. **WARNING: You should always check the output of the pulse generator on the oscilloscope before connecting it to the circuit. Doing this will greatly reduce the chance of your circuit being smoked by mistake.**

Display input B on one channel of the scope and the circuit output on the other channel. Note that displaying the input is necessary to provide a frame of reference for the output waveform. With the input displayed, it can be seen how the output of the circuit is changing in response to various signals. Save the waveforms (using a USB or Agilent's screen capturing software on the PC); pay particular attention to the relation between the two waves and the timing. Make sure that voltage and time scales are clearly indicated.

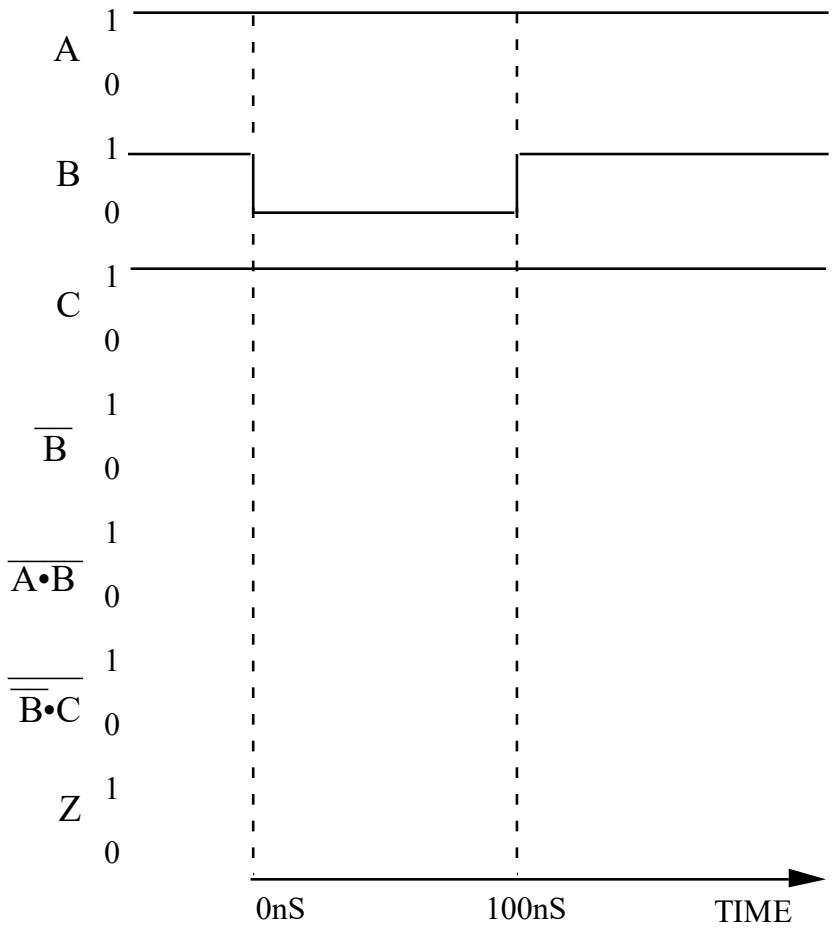
4. Using the three input switches, test the circuit in part B of the pre-lab. Complete a truth table of the output. Does it respond like the circuit of part A? Next, disconnect the switch from input B and hook the pulse generator to input B. With inputs A and C high, observe input B and the circuit output on the oscilloscope. Describe and save the output and explain any differences between it and the results obtained in part 2. Consider the following question and explain: for the circuit of part A of the pre-lab, at which edge (rising/falling) of the input B are we more likely to observe a glitch at the output?

V. POST-LAB

1.) Given that the guaranteed minimum propagation delay of a 7400 is 0ns and that its guaranteed maximum delay time is 20ns, complete the timing diagram below for the circuit of part A. (See GG.23 if you are not sure how to proceed.)

1.4

TIMING DIAGRAM



How long does it take the output Z to stabilize on the falling edge of B (in ns)? How long does it take on the rising edge (in ns)? Are there any potential glitches in the output, Z? If so, explain what makes these glitches occur.

2.) Explain how and why the debouncer circuit given in General Guide Figure 17 (GG.32) works. Specifically, what makes it behave like a switch and how the ill effect of mechanical contact bounces is eliminated?

VI. REPORT

For lab report, you should hand in the following:

- An introduction;
- Written description of the operation of circuits from both parts of the pre-lab;

- One (1) component layout sheet, with the package layout of all circuits (DO NOT draw the interconnections! Refer to GG.20 for the proper documentation);
- Circuit diagrams for all circuits (pre-lab part A and B are two separate circuits);
- Documentation from all parts of the lab. This includes but not limited to a truth table for the circuit of pre-lab part A, answers to the questions posed in the pre-lab, a truth table for the circuit of pre-lab part B, an oscilloscope printout from lab part 2, and an oscilloscope printout for lab part 3;
- Answers to all post-lab questions;
- Answers to questions from the General Guide (GG.6, GG.29);
- A conclusion regarding what worked and what didn't, with explanations of any possible causes and the potential remedies.

Note: This lab report is an **individual report**, not a group report. Each person in the lab must hand in his/her own lab report; lab partners can work together but should not hand in copies of the same work. This means that oscilloscope traces may be shared, but answers to the questions should be in each partner's own words. Combined lab reports will begin at Experiment #2.

VII. HOMEWORK

Design a portable I/O board using circuits like those described in the General Guide, section VI (pages GG.29-32). This board will be used for debugging circuits outside of the laboratory and should therefore be built as carefully as possible. The board should include at least two (2) debounced switches (the four SPDT switches are mounted in a Dual Inline Package (DIP)) and two (2) LEDs. Drive the LEDs using the 7404 or 7406 open collector hex inverter chip from the lab kit. The 7406 is preferred because you will unlikely use open collector outputs elsewhere in your designs. Remember to include a separate current limiting resistor for each of the LED circuits! The I/O board must fit on a single socket strip; equivalent to one of the five columns (A, B, C, D, or E) on the lab kit protoboard (see GG.10) as you will not be required to disassemble this portion of the protoboard in between labs.

Begin building the portable I/O board as soon as possible. It is easier to test the board using the facilities of the lab, so proceed as far as possible on Experiment #2 in the remaining lab time.