16.480/16.552 Laboratory #1 Due: October 4, 2006

Embedded Controller

1. Introduction

The purpose of these laboratory assignments is for you to design the circuits and system components required to implement a lighting measurement system interfaced to a laboratory PC. The specific objective of this laboratory assignment is for you to start the design by creating circuits and systems needed to set up the embedded controller to be used to acquire data and provide system feedback based on this data.

2. Laboratory Procedure - Hardware

1. Using the schematics shown in the textbook in Figures 9-37a and 8-11 together with the components provided in your laboratory design kit, implement an 8088 minimum mode embedded system and memory interface. Be sure to read the sections on Program Storage Memory and System Clock in Sections 8.6 and 9.7 of the textbook. Your 2K code space will be at the top of the memory map.
   What is the physical address range of the code space?
   Which output of the 74LS138 is used to enable the EEPROM?
2. There will be two input sources to the 8088. The first input source is an Analog-to-Digital Converter (ADC). You will poll the ADC to acquire lighting data. The ADC will reside at address $FE000_{16}$ in physical memory. For now, attach an LED circuit to the corresponding output of the 74LS138 such that the LED illuminates when the output of the 74LS138 is active.
   Which output of the 74LS138 is used to enable the ADC?
3. The second input to the 8088 is an input port register. The register will be used to issue commands to the 8088 from a laboratory PC. The register will reside at address $FC000_{16}$ in physical memory. For now, attach an LED circuit to the corresponding output of the 74LS138 such that the LED illuminates when the output of the 74LS138 is active.
   Which output of the 74LS138 is used to enable the outputs of the input port register?
4. There will be two output sources from the 8088. The first output source is a First-In-First-Out (FIFO) memory element. The 8088 will store the acquired data in the FIFO for use by an external host computer. The FIFO will reside at address $FA000_{16}$ in physical memory. For now, attach an LED circuit to the corresponding output of the 74LS138 such that the LED illuminates when the output of the 74LS138 is active.
   Which output of the 74LS138 is used to enable the FIFO?
5. The second 8088 output source is a light bulb. The 8088 will turn the light bulb on and off. The light bulb will reside at address $F8000_{16}$ in physical memory. For now, attach an LED circuit to the corresponding output of the 74LS138 such that the LED illuminates when the output of the 74LS138 is active.
   Which output of the 74LS138 is used to enable the light bulb?
   What type of I/O are the ADC, input port register, FIFO, and light bulb?

3. Laboratory Procedure - Software

1. Put your 2K code space at the top of the memory map, i.e. from $FF800_{16}$ - $FFFFF_{16}$. See the documentation at "Resource" webpage for information on how to create the assembly code skeleton structure. Note that the resident, or actual code and data part of the file, must be less than 64K bytes, hence the "small" model. Also note that there must be no STACK segment.
   Demonstrate the operation of this program to your course instructor, TA, or LA.
2. Write an assembly language routine that initializes the system and then continuously performs the following sequence of operations:
   - Turn on the FIFO LED for approximately one second.
   - Turn off the FIFO LED and turn on the Input Port Register LED for approximately one second.
   - Turn off the Input Port Register and turn on the ADC LED for approximately one second.
   - Turn off the ADC LED and turn on the light bulb LED for approximately one second.
   - Turn off the light bulb LED.

   Which segment registers must be initialized and why?
   Exactly how long was each LED actually turned on?

   Demonstrate the operation of this program to your course instructor, TA, or LA.

4. Laboratory Report and Grading

Grading will be on:

- Hardware implementation and demonstration
- Circuit wiring neatness
- Software and software documentation
- Laboratory write-up

Include the following items in your laboratory report:

- Cover page with names and email addresses.
- Authorship page (who did what).
- Introduction detailing what the laboratory is trying to accomplish.
- A discussion of your circuits and programs.
- Clean-copy schematics for your hardware design.
- A discussion of your software implementation.
- Well commented program listings including the assembler map for the EEPROM.
- Conclusions regarding the laboratory.
- Sign-off sheet.