**Lab 4: Introduction to Hardware Interfacing**

The main task of this lab is to have students code three subroutines that will take an input from the keyboard and display it on an LED array. Valid inputs include numbers (0-9) and all uppercase letters (A-Z).

In this lab, a GMC2288C 8X8 LED array would be used to display patterns and two 3X8 74LS138 decoders, two hex-input 74LS04 inverters, and eight 1kΩ resistors would be used on the breadboard. The Netburner board would have a 10 pin ribbon cable (buffer board) connected to it to prevent the output pins from the Netburner board from shorting. Pins P1-P3 of the buffer board correspond to the columns of the LED array with P1 being the least significant bit (LSB) and P3 being the most significant bit (MSB). Pins P4-P6 correspond to the rows with P4 being the LSB and P6 being the MSB. P8 is left unused while P9 is the ground pin and P10 is the power pin.

The software is the brains of the device where it takes in information, calculates the output and then sends it. The hardware helps us display what simple information we need, as well as inputting simple things. These two components work together to make lots of unique and useful tools such as displaying LEDs. The reason there are only 3 pins for the columns and rows to display an 8 by 8 array is because the software can translate 8 different states with only using 3 bits. The software itself is smart to only translate bounded values (keystrokes that can’t be displayed, or not stored), while it should give errors to values that are not bounded.

**Question**

*1. Why were the two 74LS138 decoders used in the circuit instead of directly connecting the pins to the array? Discuss how removing the decoders would affect the function of the LED array in the context of this lab.*

**Answer:**

The decoders were used to compact the amount of memory to display 0 to 7. Since using 3 pins made a total combination of 8 different states, it is perfect for translating 3 memory spaces to the pins. If we removed the decoders, we would have only one pin on and the rest off, which is inefficient memory wise because with 8 pins that can have up to 256 states.

**Flowcharts**

| Part A | Part B | Part C |
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