CpE 272 Digital Logic Laboratory

Lab 2

Programmable Logic Devices

Fall 2103

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09/3/13

**Introduction**

The main objective of this lab is to program a GAL chip and apply it as a decoder, so that it will display the correct digit on a seven segment LED display. This lab will also teach students how to use a program called wincupl to program the GAL chip.

**Part I**

**Experiment:**

The first task assigned to the group was to get the number 4 to display on the seven segment display.

**Methodology**

The first step taken by the group to solve this problem was to determine the segment of the seven segment display to be grounded. This was easily determined by listing out the segments that had to light up for the number 4 to be displayed and grounding them.

After this, the group placed the seven segment display and a resistor on the proto board, and then ran a wire from the +5v slot on the proto board directly to the seven segment LED display. To display the number 4, segments b, c, f and g. To do this, the group ran wires from the aforementioned segments on the LED display unto the resistor, and from the resistor to ground.

**Result**

All the segments grounded through the resistor lit up as the number 4 was displayed.

**Part II**

**Experiment**

This part of the lab required the group to write the logic expression for hexadecimal numbers listed 0 through 9 and A through F. This generated logic expression would then be used to program a GAL chip which in turn will be used to decode a four bit, so that the correct number will be displayed on the seven segment display.

**Methodology**

To accomplish this, the group determined which segment of the LED display needed to be grounded in order for the required hexadecimal number to light up. After determining the right segments to be grounded for each number, the group arranged the information in a table. The table can be seen below



Table 1

In the table above, W, X, Y and Z are inputs, a through g are outputs and the display column shows the number that will displayed on the seven segment display when the corresponding segments have been grounded. In the table a value of o means that a segment has been grounded, while a value of 1 means that a segment is powered.

The next step taken by the group was to use the information gathered in the table above to determine the logic expression for columns a through g. To do this, the group inspected the input values of every point along the columns that had a value of 1, and wrote down the values of the input in Wincupl code format.

**Result**

The logic expression found by the group is stated below

a = (!w&!x&!y&z)#(!w&x&!y&!z)#(w&!x&y&z)#(w&x&!y&z);

b = (!w&x&!y&z)#(!w&x&y&!z)#(w&!x&y&z)#(w&x&!y&!z)#(w&x&y&!z)# (w&x&y&z)

c = (!w&!x&y&!z)#(w&x&!y&!z)#(w&x&y&z);

d = (!w&!x&!y&z)#(!w&x&!y&!z)#(!w&x&y&z)#(w&!x&y&!z)#(w&x&y&!z)# (w&x&y&z);

e = (!w&!x&!y&z)#(!w&!x&y&z)#(!w&x&!y&!z)#(!w&x&!y&z)#(!w&x&y&z)#(w&!x&!y&z);

f = (!w&!x&!y&z)#(!w&!x&y&!z)#(!w&!x&y&z)#(!w&x&y&z)#(w&x&!y&z);

g = (!w&!x&!y&!z)#(!w&!x&!y&z)#(!w&x&y&z)#(w&x&!y&!z);

where **&-and**, **#-or** and **!-not**

**Part III**

**Experiment**

The final experiment of the lab was to insert the logic expressions that were found in part two into Wincupl, to compile the code and program a GAL chip.

**Methodology**

To do this, the group started a new file on the program Wincupl, filled all the initial required data such as name and device name, and defined the number of inputs and outputs as 4 and 7 respectively. The group defined its 4 inputs as w, x, y and z, and its 7 outputs as a, b, c, d, e, f, g. Next the group entered the logic expression derived in part II into Wincupl. The code was then saved as .pld file and compiled; afterwards the group ran the code and saved it as a .Jed file on a thumb drive. This .jed file was then taken to a computer, which was connected to a GAL programmer. The .jed file was loaded from the thumb drive unto the computer and from the computer unto the GAL programmer, which in turn programmed the GAL chip inserted in it.

Now the GAL chip was programmed and all that was left was to test it by connecting its inputs to switches and its outputs to the corresponding segments on the LED display. To test it, the group placed it, a resistor pack and the LED display on a proto board. Next the group sent 5v to the LED display, the Vcc pin on the chip and grounded the GAL chip at its 10th pin. Thereafter the first 4 inputs of the GAL chip were connected to switches; its 7 outputs were connected to the resistor pack and from the other end of the resistor pack to the corresponding segment of the display. Hence connections were made from output “a” on the chip, to the resistor, and then to segment “a” on the display, and this was done for all outputs.

**Result**

The connection was tested by trying all the possible switch value (on/off) combinations to display the corresponding value on the display. The group was able to get all numbers to display except for the number 3.

**Conclusion**

The group didn’t get all the desired numbers to be displayed, but this could be due to careless wiring or a faulty LED display. For the most part I have learned a lot from this lab. Now I know how to program a GAL chip using Wincupl, and I also know what a PLD is, and what it can be used for.

**Post Lab Questions**

Q1

* A common anode 7- segment display has to have its anodes connected to an upper voltage source
* While a common cathode 7 – segment display has to have its cathodes connected to a lower voltage source for its segments to light up.

Q2

* From the table: 0001111

**Lab 3 Pre Lab Questions**

Q1

* FPGA: Field Programmable Gate Array

Q2

* They are basically more convenient to use because one can work with them without having to use a breadboard or soldering iron.