LAB 6
USING ELECTRONIC MULTIPLEXERS AND DECODERS TO DESIGN COMBINATIONAL LOGIC

OVERVIEW:
A digital multiplexer is a binary controlled digital signal switch with many inputs, and one output selected by several digital control lines. A 74LS151 has eight inputs that can be individually selected by three select lines. The output is connected to the input line selected by the binary value on the three select lines. If the three select lines are all zeros, then input line "0" is selected and connected to the output line.

A 74LS138 decoder is similar in nature but works this way: one input line (that is normally tied low) is routed to one of eight output lines. The output is selected by three select lines: S2, S1, & S0. Unselected output lines are normally high, so the selected output goes low when the input line is tied low.

Both the multiplexer and the decoder can be used to synthesize combinational logic circuits. In this laboratory experiment, you will realize a three input variable truth table design, first using conventional AND-OR or NAND-NAND logic. Then you will use a 74LS151 multiplexer, and finally a 74LS138 decoder and several AND gates.

MATERIALS:
1. Circuit design trainer with three data switches, solderless bread board, +5vdc power supply, and one indicator led.
2. Misc. Lengths of telephone wire cut and stripped back 1/4" on each end.
3. Qty. 1 - 74 LS151 8 to 1 multiplexer.
4. Qty. 1 – 47LS138 1 of 8 decoder.
5. The appropriate AND, OR, or NAND gates to realize your classic design of the circuit.

PROCEDURE:
1. Find the devices in your digital laboratory parts kit.
2. Given the truth table below, write the unsimplified Boolean algebra expression for the "1" terms in the truth table.
3. Draw a general logic gate schematic of the unsimplified circuit.

4. Use a three variable Karnaugh map, and try to simplify the expression.

5. Build and test your simplified design using AND-OR, or NAND-NAND logic gates. Demonstrate that it realizes the truth table outputs as you change the inputs.

6. Observe the 74LS151 multiplexer design below. Everything has been done for you, except to decide which of the inputs tie to the +5VDC wire, and which of the inputs tie to the ground wire. Draw the correct connections. Hint: The input connections should put a "1" on the inputs that correspond to the "1"s in the truth table, and the other inputs should be tied low.

7. Build and test your design, and verify that for any given input combination, you output the truth table "x" value.

8. Observe the decoder design using the 74LS138 and the 74LS08 AND gates. Again, everything has been done for you except to assign the pin connections from the 74LS138 outputs to the 74LS08 inputs. In this design, you are grouping the "0"s. If any of the AND gate inputs go to zero, the output "x" goes to zero.

9. Build the 74LS138 decoder and 74LS08 AND gate version of the "0" logic realization of the truth table. Make your connections as you think they should go. In this design, you are trying to get the output "x" to go to zero when the truth table goes to zero.

10. Test and verify that your 74LS138 design outputs exactly what the truth table indicates it should for "x" for every combination of select inputs, A B C.
FIGURE 6.1: The three variable input truth table and Karnaugh map

FIGURE 6.2: The 74LS151 multiplexer version of the combinational logic design
FIGURE 6.3: The 74LS138 decoder version of the inverse logic design of the truth table