Lab 2: Other Logical Building Blocks and the Design Process.

Name: _____Lab Partner: _____

Answers to pre-lab questions and a design of any circuits you will build or experiments you will perform must be turned in at the beginning of your lab. You may want to make a copy of the pre-lab for reference while you do the lab because you will not have the copy you turn in at the beginning. Make sure all the work you turn in is your own. Do not copy other student's work (This applies to lab reports as well as pre-labs).

Pre-lab Questions

1. Design a 16:1 multiplexer using 4:1 multiplexers.
2. Show how to implement the following function with a 4 to 1 multiplexer:

   $f(W,X,Y,Z) = \sum m(0,2,3,9,10,14)$

3. Draw a block-level diagram of how you will wire the 74148 priority encoder for this lab. Make sure to label all of the inputs and outputs.
4. Design the custom code converter (work with your lab partner) to be used in this lab. First, design the circuit using standard logic operators and gates (and, or, not) and convert to a 2 input NAND circuit (7400s). Then design the circuit using a quad 2:1 Multiplexer (74157) and 2 input NAND chips (7400) for the extra logic.

Experiments

Modern aircraft are amazingly complex systems, and in general the more complex a system the less reliable it is (an unwanted feature on an aircraft). One way that this is handled is via redundancy (i.e. critical system components have spares). Imagine you are building a redundant fault detector circuit for an airplane that monitors the most serious fault modes (the master fault detector circuitry may be much more complex, but assume it has already been designed and hence we can ignore). The fault detector circuit monitors the status of various sensors in the aircraft while it is operating and reports the information to the pilot via a simple 7 segment display. Your circuit is connected to sensors that monitor four conditions: Engine fault; Fire; Cabin Pressure; and Bird Impact. Each sensor outputs a high (logic 1) signal when everything is ok and a low (logic 0) signal when it detects a problem (Negative Logic). The output is connected to a display that can display only one condition at a time. This circuit can be broken into two pieces.

I. Fault Detector

Design and implement a circuit using TTL parts (74148 or equivalent) to convert the output from the sensors to a two bit code, c_1c_0. Your circuit should also output an overall

status signal, ERR_L, that is at a logic level 1 when nothing is wrong (all sensors output high) and low when something is wrong (any sensor outputs a low).

If two things fail at the same time, your circuit should output the code for the most serious condition, ignoring less serious conditions. Obviously, an engine fault is the most serious condition. A Fire on the aircraft is the second most serious condition. Cabin Pressure is also serious condition (but not as serious as the other two). A Bird Impact, the lowest priority input, can lead to loss of flight control surfaces or fuselage damage. Be sure to specify which code (binary – two bit value) your circuit outputs for each condition (Engine, Fire, Cabin Pressure, and Bird Impact). Since this is a redundant system, these most important conditions are the only ones that are monitored and the display is a simple 7 segment display (hence the need for priority in condition display).
Demonstrate your circuit to your instructors and get a signature.

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II. Output Display

Using a seven segment display (available in the lab) design and implement an output display circuit for the failure detector you built in the previous part. Each of the segments in the seven segment display is a separate LED. The dual seven segment display (provided in class) uses a common-anode configuration (all the anodes are internally tied together) to reduce the number of pins in the package. In this lab, we will only use one of the seven-segment displays (leave the other unconnected). A data sheet for the display we will use has been attached to the handout for class. The LEDs in your seven segment display have about a 0.9 V voltage drop. Do not forget to use suitable resistors to limit the amount of current the gate sinks. Be sure to document how you selected the resistors in your lab report. The table below shows how what the display should look like for each of the outputs from your failure detector circuit above.

ERR_L	C_1	C_0	Error Condition	7 Segment Output
0	0	0	Engine Fault	E
0	0	1	Fire	F
0	1	0	Cabin Pressure	C
0	1	1	Bird Impact	b
1	X	X	No Error	No display

You should be able to generate the outputs to drive the seven segment LED display with just two or three TTL chips, the 7 segment display, and the necessary resistors. Connect your failure detector to the output circuit and demonstrate the whole circuit to your TA.

Demonstrate your circuit to your instructors and get a signature.

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