*University of Cincinnati  
Department of Electrical Engineering and Computing Systems*EECE 2060C – Digital Design, Lab room 806/808 Wednesday 2:30-5:30, Section# 005

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**Lab 2: Tire Pressure Indicator**

**Design Specification**  
 A car has a tire pressure sensor that outputs the tire pressure (assuming the car has only one tire) as a 3-bit binary number A, B, C. Create a digital circuit with three inputs A, B, C, and three outputs L (low), M (medium), and H (high). L is used to indicate low tire pressure, M is used to indicate medium tire pressure, while H is used to indicate high tire pressure. Output L generates logic 1 (and M and H generate logic 0) when the value of ABC is <= 2 (i.e., ABC = 000, 001, 010). Output M generates logic 1 (and L and H generate logic 0) when the value of ABC is smaller than 5 and greater than 2 (i.e., ABC = 011, 100). Output H generates logic 1 (and L and M generate logic 0) when the value of ABC is greater than 4 (i.e., ABC = 101, 110, 111). Input A, B, C by directly connecting them to Vdd or GND columns of the breadboard (because the lab kits do not include switches) and output L, M, H using LEDs.

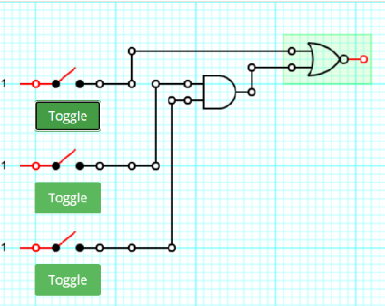
|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | **Inputs** | | | **Results** | | |
| **#** | **A** | **B** | **C** | **L** | **M** | **H** |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 2 | 0 | 1 | 0 | 1 | 0 | 0 |
| 3 | 0 | 1 | 1 | 0 | 1 | 0 |
| 4 | 1 | 0 | 0 | 0 | 1 | 0 |
| 5 | 1 | 0 | 1 | 0 | 0 | 1 |
| 6 | 1 | 1 | 0 | 0 | 0 | 1 |
| 7 | 1 | 1 | 1 | 0 | 0 | 1 |

**Task 1 – Breadboard Circuit Implementation**

Follow the design steps discussed in the classes. First, you design the truth table based on the design specification explained above. Second, based on the truth table, you generate switching expressions for outputs L, M, and H. Third, simplify the switching expressions as much as possible for outputs L, M, and H, using Boolean algebra you have learned so far. Fourth, convert the switching expressions into gate-level circuits. Finally, after approved by TA (by pre-lab design report), you implement the minimized switching expressions using gates (IC chips) on breadboard.

**Design**  
After reading the design specification I realized I could design a circuit for each part of the problem, is started with the low-pressure gate from the truth table and came up with a circuit below. This circuit has a formula of F = (A+(BC))\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Inputs** | | | **Outputs** |
| **A** | **B** | **C** | **L** |
| 0 | 0 | 0 | 1 |
| 0 | 0 | 1 | 1 |
| 0 | 1 | 0 | 1 |
| 0 | 1 | 1 | 0 |



**Test Cases/Truth Table**: Low-Pressure circuit and its expected output with this configuration.

This corelates directly to the design specification above for low pressure and inputs of ABC given to us. Then after creating this circuit, we can start to move onto the next part of the circuit, which was suggested as the high tire pressure sensor logic gates in the circuit The next circuit I have created shows our previous circuit and an addition of the inputs required for the high tire pressure circuit. Our formula for the circuit below shows only for the high tire pressure is F = ((B+C) A)\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Inputs** | | | **Outputs** |
| **A** | **B** | **C** | **H** |
| 1 | 0 | 0 | 0 |
| 1 | 0 | 1 | 1 |
| 1 | 1 | 0 | 1 |
| 1 | 1 | 1 | 1 |

Diagram, schematic

Description automatically generated

**Test Cases/Truth Table**: High-Pressure circuit and its expected output with this configuration.

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Now we Have a low tire Pressure and a high tire pressure added to our circuit, the next step is to use this circuit and combine this idea in a way to incorporate a low, medium, and high output. This next circuit has the formula as F = ((A+(BC))\* + ((B+C)A)\*)\*

|  |  |  |  |
| --- | --- | --- | --- |
| **Inputs** | | | **Outputs** |
| **A** | **B** | **C** | **M** |
| 0 | 1 | 0 | 0 |
| 0 | 1 | 1 | 1 |
| 1 | 0 | 0 | 1 |
| 1 | 0 | 1 | 0 |

Diagram, schematic

Description automatically generated

**Test Cases/Truth Table**: Low-Pressure circuit and its expected output with this configuration.

Now that we have a circuit and formulas for all the tire pressure, we can combine this circuit and simplify either the circuit or the number of literals in the formula. Our circuit formula is currently F = ((A+(BC))\* + ((B+C) A)\*)\*, we can minimize this circuit to make it more efficient. The Image below shows the minimization

Text, letter

Description automatically generated

**Test Cases**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Inputs** | | | **Expected Results** | | | **Actual Results** | | |
| **#** | **A** | **B** | **C** | **L** | **M** | **H** | **L** | **M** | **H** |
| 0 | 0 | 0 | 0 | 1 | 0 | 0 |  |  |  |
| 1 | 0 | 0 | 1 | 1 | 0 | 0 |  |  |  |
| 2 | 0 | 1 | 0 | 1 | 0 | 0 |  |  |  |
| 3 | 0 | 1 | 1 | 0 | 1 | 0 |  |  |  |
| 4 | 1 | 0 | 0 | 0 | 1 | 0 |  |  |  |
| 5 | 1 | 0 | 1 | 0 | 0 | 1 |  |  |  |
| 6 | 1 | 1 | 0 | 0 | 0 | 1 |  |  |  |
| 7 | 1 | 1 | 1 | 0 | 0 | 1 |  |  |  |

Time Taken/Hard copy

2 Hour, 30 minutes.

Signature: Date:

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