

University of Texas at El Paso
 Electrical and Computer Engineering Department
 EE 2169 –Laboratory for Digital Systems Design I

Lab #4 – Numeric Braille Printer

Logic circuits for digital systems may be combinational or sequential. A combinational circuit consists of logic gates whose outputs at any time are determined from only the present combination of inputs. A combinational circuit performs an operation that can be specified logically by a set of Boolean functions. A combinational circuit consists of an interconnection of logic gates. Combinational logic gates react to the values of the signals at their inputs and produce the value of the output signal, transforming binary information from the given input data to a required output data.

The following table shows the correspondence between the decimal numbers, their BCD representation, and Braille. (NOTE: Since Braille has “dots” there are two columns of dots, and there are two “dot positions” per column. That makes four “dot positions:” top of 1st column, top of 2nd column, bottom of 1st column, and bottom of 2nd column, which use the variables WXZY, respectively.

Number Digit	Input	Printer Output	
	A B C D	W Z	X Y
0	0 0 0 0	●	●
1	0 0 0 1	●	
2	0 0 1 0	●	
3	0 0 1 1	●	●
4	0 1 0 0	●	●
5	0 1 0 1	●	●
6	0 1 1 0	●	●
7	0 1 1 1	●	●
8	1 0 0 0	●	●
9	1 0 0 1	●	●

Pre-Lab

Represent a dot with a binary 1 and lack there of with a binary 0. Using a truth table and Karnaugh maps, write the Boolean expressions for each output (W, X, Z, & Y) in terms of the inputs (A, B, C, D). For the inputs 10 – 15 use *Don't Cares*. Write functions W and X in Sum of Products (SOP) form, while writing Y and Z as a Product of Sums (POS). Make sure you design the Braille printer using a **minimum** number of gates.

Lab

Implement the braille printer on the NI Digital Electronics FPGA Board using schematic capture in Xilinx ISE. Reference the *Xilinx ISE Basic Schematic Input Tutorial* and *Xilinx ISE Getting Started and iMPACT Tutorial* links on the Wiki Page to help you.

Assign each of the schematic inputs A,B,C,D to the switches SW3, SW2, SW1, SW0 on the board respectively. Assign the schematic outputs (W, X, Y, Z) to the LEDs on the seven segment display as shown in the figure below. Use the *Spartan 3E User Constraints File Template* for your design.

Verify your design using the table above. What happens when you input numbers 10 through 15?

