

Laboratory Exercise 2

This is an exercise in designing combinational circuits that can perform binary-coded-decimal (BCD) addition and binary-to-decimal number conversion.

Part I

We wish to display on the 7-segment displays, *HEX3* to *HEX0*, the hexadecimal values set by the switches SW_{15-0} . Let the values denoted by SW_{15-12} , SW_{11-8} , SW_{7-4} and SW_{3-0} be displayed on *HEX3*, *HEX2*, *HEX1* and *HEX0*, respectively.

1. Create a new project which will be used to implement the desired circuit on the Altera DE2 board.
2. Write a VHDL file that provides the necessary functionality.
3. Include the VHDL file in your project and compile the project.
4. Assign the pins on the FPGA to connect to the switches and 7-segment displays, as indicated in the User Manual for the DE2 board.
5. Recompile the project and download the compiled circuit into the FPGA chip.
6. Test the functionality of your design by toggling the switches and observing the output display.

Part II

Design a circuit that can add two 2-digit BCD numbers as follows:

1. Use switches SW_{15-8} and SW_{7-0} to represent 2-digit BCD numbers *A* and *B*, respectively. The value of *A* should be displayed on the 7-segment displays *HEX7* and *HEX6*, while *B* should be on *HEX5* and *HEX4*. Write VHDL code to specify a circuit that generates $C = A + B$ and displays the sum, *C*, in the BCD form on the 7-segment displays *HEX2*, *HEX1* and *HEX0*.
2. Compile the designed circuit and simulate its functional behavior.
3. Make the necessary pin assignments and recompile the circuit.
4. Download the circuit into the FPGA chip.
5. Test your circuit by trying different values for numbers *A* and *B*.

Part III

Design a combinational circuit that converts a 6-bit binary number into a 2-digit decimal number represented in the BCD form. Use switches SW_{5-0} to input the binary number and 7-segment displays *HEX1* and *HEX0* to display the decimal number. Implement your circuit on the DE2 board and demonstrate its functionality.