

Programming the DE2 Board to Perform Binary Addition

PRELAB!

Read the entire lab, and **complete** the prelab questions (Q1-Q4) on the answer sheet **before** coming to the laboratory.

1.0 Objective

In Lab 05, we created a circuit to display a 4-bit digital input (set on a set of toggle switches) onto a 7-segment display. In this lab we will perform addition of two 4-bit binary inputs and display the answer in decimal onto two 7-segment displays. (*NOTE: All binary numbers in this lab are in unsigned representation.*)

2.0 Setup

Refer to **Figure 1**. We will use the toggle switches available on the DE2 board to provide two 4-bit inputs. Each set of four switches represents one binary number. The inputs are wired to a block that adds the two numbers together. The result is processed to convert the results into two decimal digits (binary coded decimal or BCD representation is used for this purpose). For example, if we add number 7 (binary 0111) and number 5 (binary 0101), the result is 12, and it is displayed as two decimal digits 1 and a 2 after converting the result into two decimal digits using the module BCD_converter block. The two decimal digits are fed to their respective 7-segment display. The two 4-bit inputs are also displayed using two 7-segment displays.

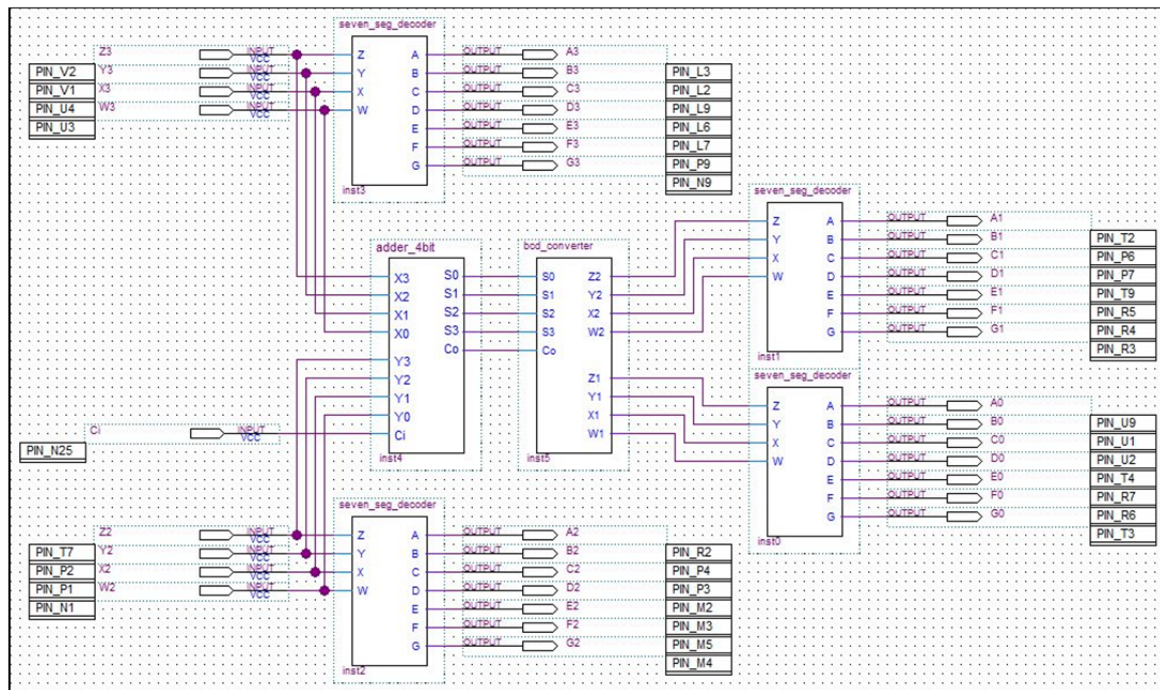


Figure 1: Adder with BCD Display

3.0 The Design

3.1 The 7-Segment Code Converter (seven_seg_decoder)

Use the 4-bit input 7-bit output seven segment decoder from Lab05 to display the 4-bit number onto a 7-segment display. Copy the *.bsf* and *.v* files for the symbol you want to use into your project folder.

NOTE: Recall from the last lab that it was tedious to create and assign all inputs and outputs. Therefore, rather than adding new symbols in the same way you add any new component, it is easier to copy the work you already have done and reuse it.

To do this, just open your *lab5step1.bdf* file. Select all of the components and wires. Then simply copy (Ctrl+c) them. Then in your current design simply paste (Ctrl+v) them. It is important that you copied the *.bsf* and corresponding *.v* file to your project directory so that your design will compile. Compile your design once and fix any errors you might have before copying over the pin assignments.

Quartus II stores the pin assignments in a *.qsf* file. Go to your lab5step1 directory and open the *lab5step1.qsf* file with a text editor such as WordPad. Select the pin information and copy it as shown in **Figure 2**.

```
"Root Region"
set_global_assignment -name STRATIX_DEVICE_IO_STANDARD "3.3-V
LVTTL"
set_location_assignment PIN_V2 -to Z3
set_location_assignment PIN_V1 -to Y3
set_location_assignment PIN_U4 -to X3
set_location_assignment PIN_U3 -to W3
set_location_assignment PIN_I7 -to Z2
set_location_assignment PIN_P2 -to Y2
set_location_assignment PIN_P1 -to X2
set_location_assignment PIN_M1 -to W2
set_location_assignment PIN_A13 -to Z1
set_location_assignment PIN_B13 -to Y1
set_location_assignment PIN_C13 -to X1
set_location_assignment PIN_AD13 -to W1
set_location_assignment PIN_AD13 -to Z0
set_location_assignment PIN_AF14 -to Y0
set_location_assignment PIN_AE14 -to X0
set_location_assignment PIN_P25 -to W0
set_location_assignment PIN_N9 -to G3
set_location_assignment PIN_P9 -to F3
set_location_assignment PIN_L7 -to E3
set_location_assignment PIN_L6 -to D3
set_location_assignment PIN_L9 -to C3
set_location_assignment PIN_L2 -to B3
set_location_assignment PIN_L3 -to A3
set_location_assignment PIN_M4 -to G2
set_location_assignment PIN_M5 -to F2
set_location_assignment PIN_M3 -to E2
set_location_assignment PIN_M2 -to D2
set_location_assignment PIN_P3 -to C2
set_location_assignment PIN_P4 -to B2
set_location_assignment PIN_R2 -to A2
set_location_assignment PIN_R3 -to G1
set_location_assignment PIN_R4 -to F1
set_location_assignment PIN_R5 -to E1
set_location_assignment PIN_I9 -to D1
set_location_assignment PIN_P7 -to C1
set_location_assignment PIN_P6 -to B1
set_location_assignment PIN_I2 -to A1
set_location_assignment PIN_I3 -to G0
set_location_assignment PIN_R6 -to F0
set_location_assignment PIN_R7 -to E0
set_location_assignment PIN_T4 -to D0
set_location_assignment PIN_U2 -to C0
set_location_assignment PIN_U1 -to B0
set_location_assignment PIN_U9 -to A0
set_global_assignment -name MIO_CFG
"C:/altera/projects/Lab05/lab5aten1/lab5aten1.dof"
```

Figure 2: lab5step1 Pin Information

Next go to your Lab06 project directory and open the *.qsf* file there in a text editor. Paste the pin assignment information into the end of the file and save it. Then compile your design again. Now you are ready to modify your design by adding the last two components.

3.2 The 4-bit Adder

In this lab, you will a 4-bit adder that you have not implemented yet. It is provided to you. Download *full_adder.bdf* and *adder_4bit.bdf*, as well as their respective *.bsf* files, to your Lab06 directory from the files provided in your lab assignment folder. The full adder is used by the 4-bit adder to do the addition. The function of this block is to add two 4-bit numbers. Its output is a 4-bit number and a “carry-out bit” *CO*, or in other words, a five-bit number. The “carry-in bit” *Ci*, is assigned to SW0.

3.3 Binary Coded Decimal Converter

This block converts the adder output into two decimal digits, each of which is represented using 4-bits, and thus produces eight outputs for the two 7-segment displays. This block is created using verilog as part of *Prelab Q4*.

3.4 Test the BCD Adder

Perform the additions you carried out in the prelab to test your circuit. Demonstrate your design to your TA.

5.0 Complete

You are done with this lab. Ensure that all files are closed and then exit Quartus II. Log off the computer, and hand in your answer sheet to your TA. **Don't forget to write down your name and your lab section number.**