Cpr E 281 LAB06

ELECTRICAL AND COMPUTER ENGINEERING

IOWA STATE UNIVERSITY

# Programming the DE2-115 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 DE2-115 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.

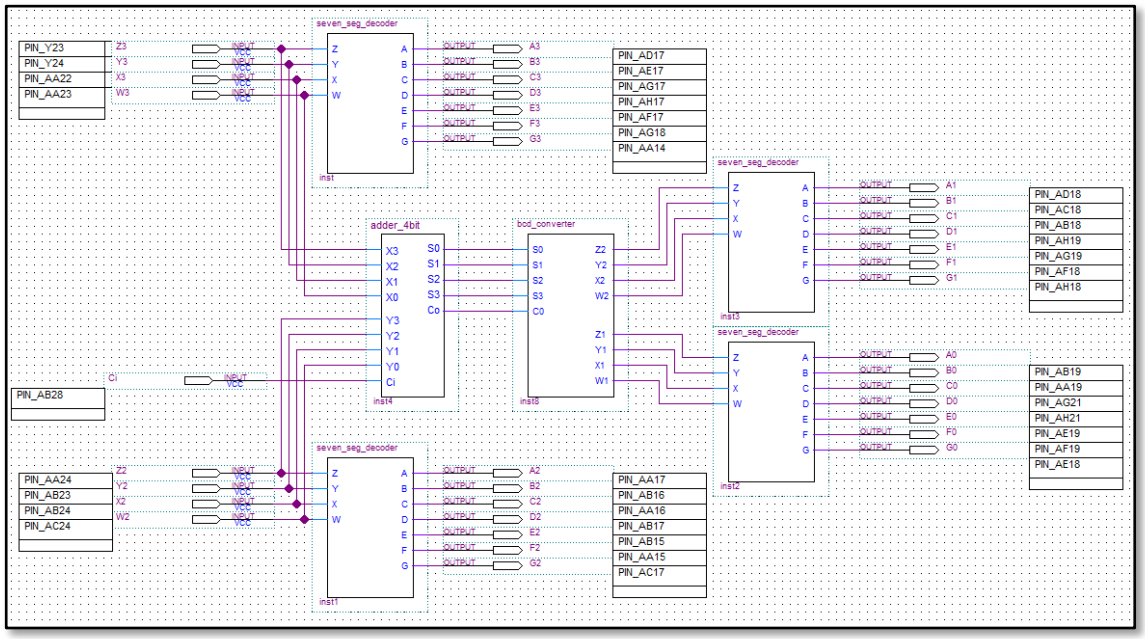


**Figure 1: Adder with BCD Display**

## 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 Prime 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 Notepad++. Select the pin information and copy it as shown in **Figure 2**.

```
set_global_assignment -name PARTITION_FITTER_PRESERVATION_LEVEL PLACEME
set_global_assignment -name PARTITION_COLOR 16764057 -section_id Top
set_location_assignment PIN_AB19 -to A0
set_location_assignment PIN_AA19 -to B0
set_location_assignment PIN_AG21 -to C0
set_location_assignment PIN_AH21 -to D0
set_location_assignment PIN_AE19 -to E0
set_location_assignment PIN_AF19 -to F0
set_location_assignment PIN_AE18 -to G0
set_location_assignment PIN_AC27 -to W0
set_location_assignment PIN_AD27 -to X0
set_location_assignment PIN_AB27 -to Y0
set_location_assignment PIN_AC26 -to Z0
set_location_assignment PIN_AD18 -to A1
set_location_assignment PIN_AC18 -to B1
set_location_assignment PIN_AB18 -to C1
set_location_assignment PIN_AH19 -to D1
set_location_assignment PIN_AG19 -to E1
set_location_assignment PIN_AF18 -to F1
set_location_assignment PIN_AH18 -to G1
set_location_assignment PIN_AD26 -to W1
set_location_assignment PIN_AB26 -to X1
set_location_assignment PIN_AC25 -to Y1
set_location_assignment PIN_AB25 -to Z1
set_location_assignment PIN_AC24 -to W2
set_location_assignment PIN_AB24 -to X2
set_location_assignment PIN_AB23 -to Y2
set_location_assignment PIN_AA24 -to Z2
set_location_assignment PIN_AA17 -to A2
set_location_assignment PIN_AB16 -to B2
set_location_assignment PIN_AA16 -to C2
set_location_assignment PIN_AB17 -to D2
set_location_assignment PIN_AB15 -to E2
set_location_assignment PIN_AA15 -to F2
set_location_assignment PIN_AC17 -to G2
set_location_assignment PIN_AD17 -to A3
set_location_assignment PIN_AE17 -to B3
set_location_assignment PIN_AG17 -to C3
set_location_assignment PIN_AH17 -to D3
set_location_assignment PIN_AF17 -to E3
set_location_assignment PIN_AG18 -to F3
set_location_assignment PIN_AA14 -to G3
set_location_assignment PIN_AA23 -to W3
set_location_assignment PIN_AA22 -to X3
set_location_assignment PIN_Y24 -to Y3
set_location_assignment PIN_Y23 -to Z3
set_instance_assignment -name PARTITION_HIERARCHY root_partition -to |
```

**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" *C0*, 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 Prime. Log off the computer, power down the DE2-115 board, and hand in your answer sheet to your TA. **Don't forget to write down your name and your lab section number**.