Experiment 03

Objectives

Simulate and implement the 4-bit adder on the PYNQ Z2 board and display the 2-digit decimal sum on two seven-segment displays

Apparatus

Vivado Design Suite, PYNQ Z2 board, Breadboard, two 7-segment displays, RPI module, jumper cables

Procedure

A.   Verilog modules

Refer to the module hierarchical structure shown in Fig. 1.

Step 1: Use the Verilog modules of full adder, 4-bit adder created in the previous experiment, and create new modules to convert the binary sum to decimal and extract the ten's and unit's place. You may also explore the pattern-based module for 7-segment display in this experiment, instead of the logical expression-based module created in earlier experiments.

Step 2: Create BCD code corresponding to each digit and generate a 7-segment pattern using the BCD-to-Seven Segment Decoder.

Step 3: Create a testbench (as a new simulation source) to display the addition, extracted decimal digits, and corresponding 7-segment patterns for at least six combinations.

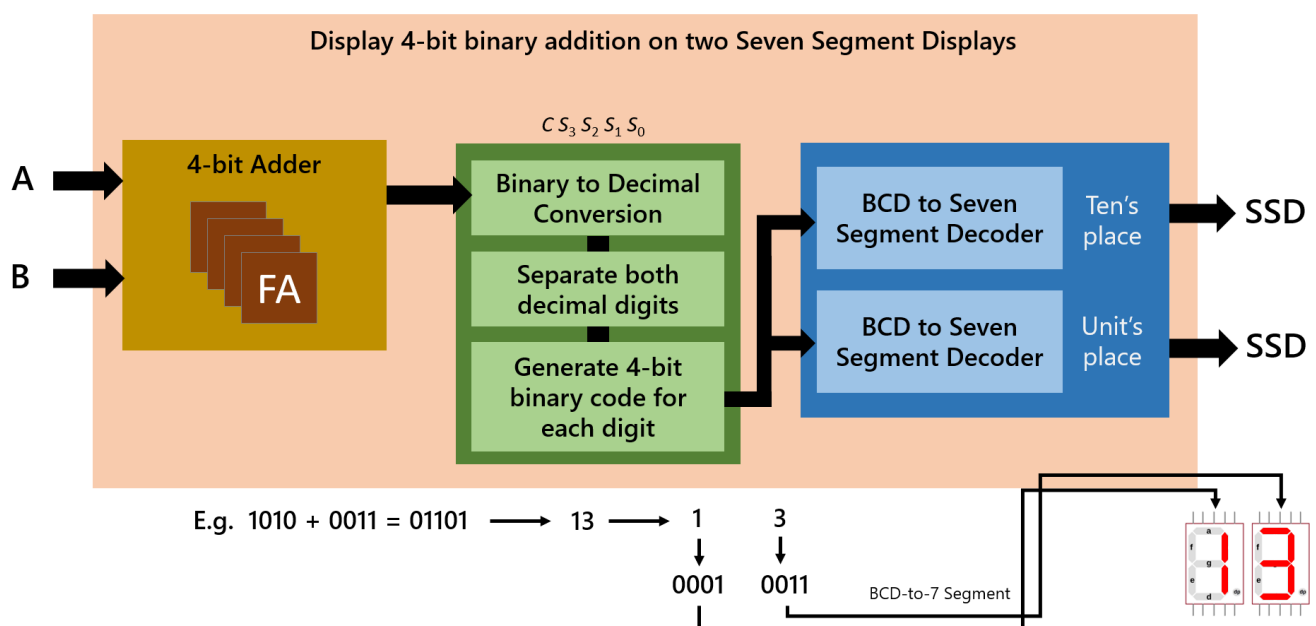**Insert the timing diagram (simulation results) in your report.**

Figure 1 Module structure

B.   Circuit

Refer to Fig. 2 for the circuit of the design.

Step 1: Use the slide switches on the RPI module to provide the 4-bit inputs, *A* and *B*. Use the following mapping {SWH, SWG, SWF, SWE} = $A_3A_2A_1A_0$ and {SWD, SWC, SWB, SWA} = $B_3B_2B_1B_0$.

Step 2: Use both Pmod A and Pmod B to individually connect the two seven segment displays, corresponding to the ten's place and the unit's place. Let Pmod A be connected to unit's place SSD and Pmod B to the ten's place SSD. (Refer to the pin configuration of the Pmod and SSDs from the previous experiments).
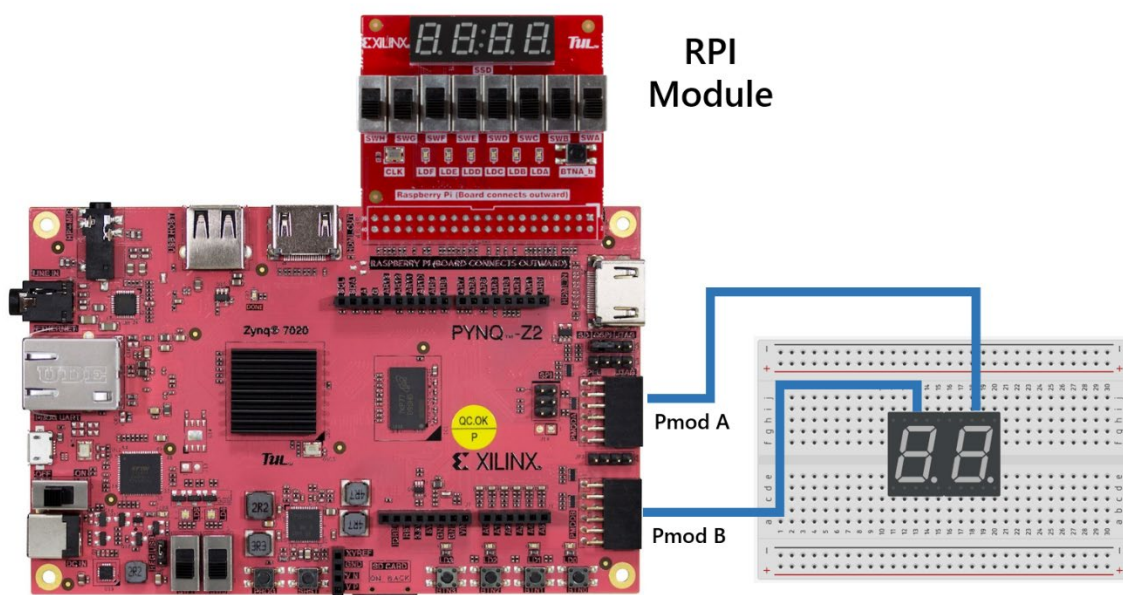

Figure 2 Circuit Schematic of the connections

Step 3: Update the XDC file of the RPI module with the input ports (eight switches) and the XDC file of the PYNQ Z2 board with the output ports (Pmod *A* and *B*).

Step 4: Generate the bitstream and program the device with the generated stream.

Step 5: Verify the display with all combinations of inputs.

Record the video showing the input/output ports and seven segment outputs for at least fifteen combinations of inputs.

Online Reference

R. Chouhan, *Displaying decimal sum on two 7-segment display* (https://youtu.be/YOXONtyZShg)