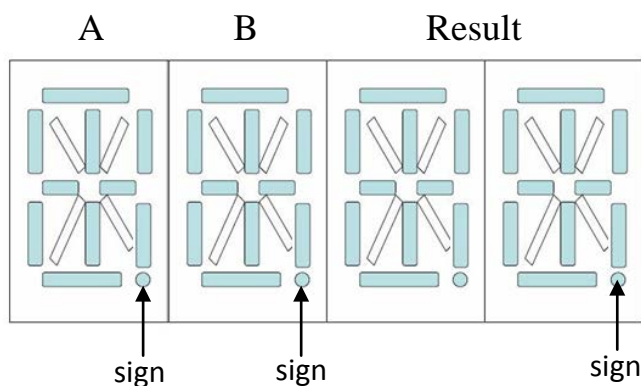# Lab 7: Adder/Subtractor

Due: April 16, 2015

Objective

➢ To design and implement an adder/subtractor on the demo board

Action Items

1. In this lab you have to design an adder/subtractor module and implement it on the demo board. The adder/subtratcor takes two 4-bit 2's complement numbers A and B (whose ranges are -8 ~ 7 in decimal) and calculates the result of A+B or A-B, depending on which button (the add button or the sub button) is pushed. If the add button is pushed, the adder/subtractor performs the addition. If the sub button is pushed, the subtraction is performed. At any time, only one or none of the two buttons is pushed. Your design should show the decimal values of A and B on the two leftmost seven-segment display, and the decimal value of the result on the two rightmost seven-segment displays (see the following figure). In addition, the dot segment should light up when the number being displayed is a negative number.

The adder/subtractor has the following input and output ports:
input clk, reset, add, sub;
input   [3:0] COLUMN;
output [3:0] ROW, DIGIT;
output [8:0] DISPLAY;

More details about the I/O signals of the design are given below.

- **clk**: Clock signal (which is connected to the FPGA pin **R10).**
- **reset**: Asynchronous negative trigger reset (which is the pushbutton **S3** connected to the FPGA pin **P3)**. When enabled, the numbers being shown on the seven-segment displays are all set to 0.
- **add**: When the button (which is the pushbutton **S2** connected to the FPGA pin **P4)** is pushed, the addition is performed.
- **sub**: When the button (which is the pushbutton **S1** connected to the FPGA pin **N3**) is pushed, the subtraction is performed.
- **COLUMN**: Column signals which are connected to the FPGA pins J3, J1, H2,H1.
- **ROW**: Row signals which are connected to the FPGA pins K2, K1, L4,L3.
- **DISPLAY**: Signal to show the decimal values of A, B, and the result on the 7-segment displays.
- **DIGIT**: Signal to enable one 7-segment display.

Use the 4x4 keyboard to set up the values of A and B by pressing two keys sequentially. The keys 0 ~ 7 represent the decimal numbers 0 ~ 7, respectively, and the keys 8 ~ F stand for the decimal numbers -8 ~ -1, respectively. Once the add or sub button is pushed, the result has to be updated and displayed accordingly. To respecify the values of A and B, the reset needs to be triggered at least once. Also, you have to use a debouncer to filter out bouncing pulses for the keyboard and each pushbutton used in this lab. The figure on the next page illustrates some example operations.
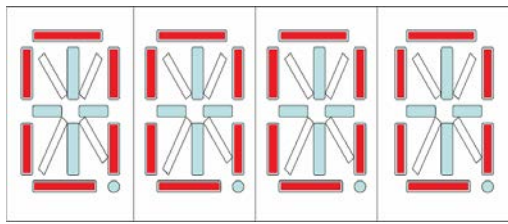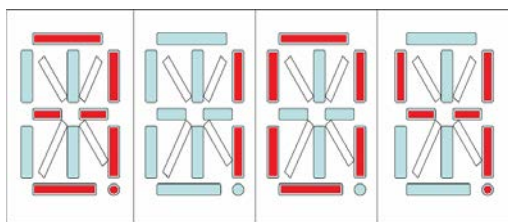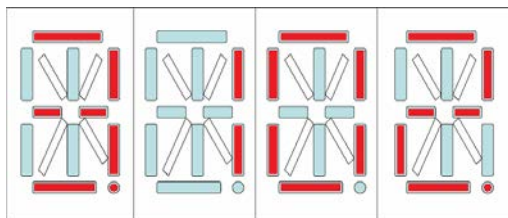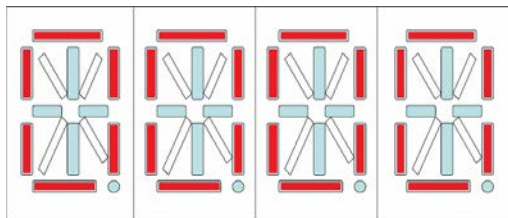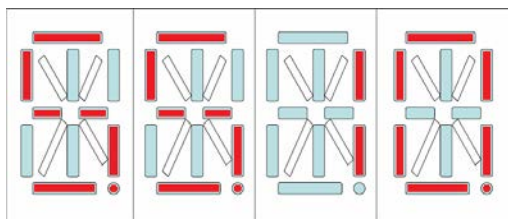
press RESET

⇩
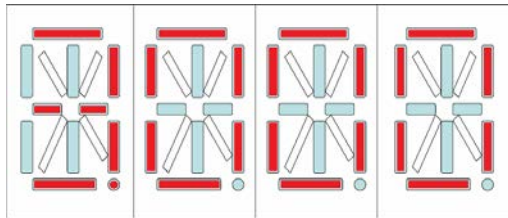
press D

⇩
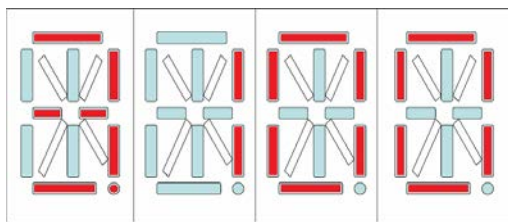
press 1

⇩

press sub

⇩

press add

⇩

press RESET

⇩

press B, press B, and press add