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Project 6 : 4 -Function Calculator
Date: 11/07/2023

Abstract:

The purpose of this project is to use RAM to implement a stack-based calculator with basic arithmetic functions. The calculator utilizes a register (MBR) as both the display and the top of the stack. Its functionality is governed by three buttons: Capture for input, Enter to push values onto the stack, and Action to perform operations. The seven-segment displays the result.

Results:

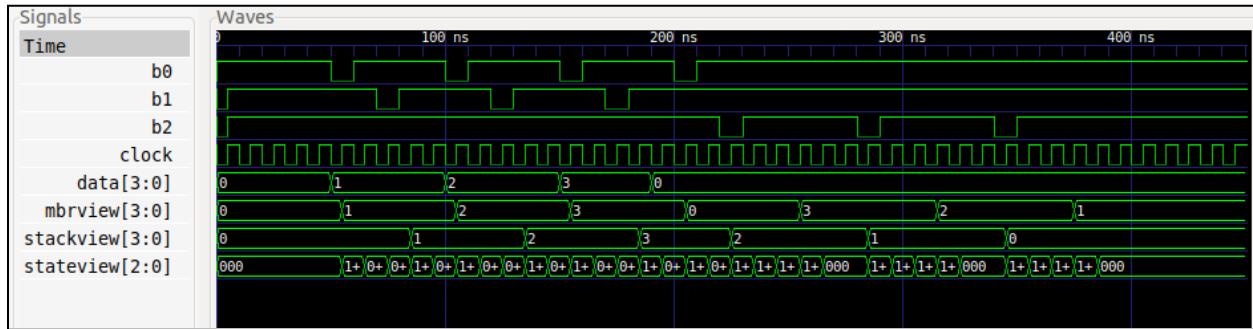


Figure 1: GTKwave for stacker

Description of the top-level design:

The main entity, named "calculator," is designed to function as a stack-based calculator and incorporates various elements. These include inputs like the clock, buttons (Capture, Enter, Action), operation switches, and data switches. Outputs consist of two seven-segment displays labeled as digit0 and digit1. The entity makes use of a RAM component created through the MegaWizard Plug-in Manager, with internal signals managing RAM control, stack pointer, memory buffer register (MBR), and state. A state machine supervises the calculator functions, with a reset condition triggered by specific button inputs. The integration of RAM and seven-segment display circuits facilitates the testing of mathematical expressions and sets of operations.

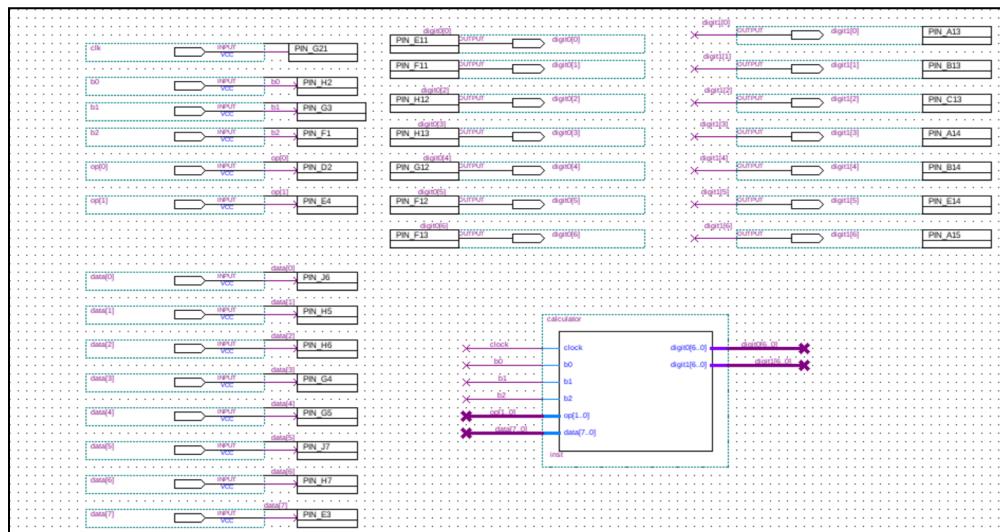


Figure 2: Bdf file for 4-function calculator

Video of circuit for all 4 operations

Addition: Example used = $5 + 1$

Subtraction: Example used = $8 - 2$

Multiplication: Example used = $2 * 3$

Division: Example used = $12/2$

I have attached the videos of all the four operations named **addition.mov**, **subtraction.mov**, **multiplication.mov**, and **division.mov**

Description of additional testing

I used the instructions provided in the project to do further testing to make sure the code was running properly.

The instruction has been outlined below. I worked out the instructions manually to make sure that it produced the right answer for each step of the instructions.

```
-- operations:  
-- mbr = 2  
-- push MBR  
-- mbr = 6  
-- push MBR  
-- mbr = 4  
-- push MBR  
-- mbr = 0  
-- pop 4, and MBR = 4-MBR = 4-0 = 4  
-- pop 6, and MBR = 6-MBR = 6-4 = 2  
-- pop 2, and MBR = 2+MBR = 2+2 = 4
```

Extensions

Expanding its functionality, I incorporated an additional arithmetic operation into the calculator—specifically, the exponential function, enabling it to perform power operations. Instead of merely describing the enhancement, please a video of how it works has been attached below. The showcased sequence of operations includes:

- $3^2 = 09$ (in hex)
- $4^2 = 10$ (in hex)

The video file labeled **extension.mov** shows this in action.

Acknowledgement

- Delanyo Nutakor
- Desmond Frimpong