Standard Issue Calculator

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Abstract*— The goal for this project is implementing a standard issue calculator using the Nexys A7 100t board's interface. One will input two numbers using the on board switches and enable a desired math operation. The provided inputs and computed output will all be displayed/tracked by the seven segment display. This project is both a combinational (math operation is independent of time) and sequential circuit (seven segment display relies on the input present at a particular instant).

I. Introduction

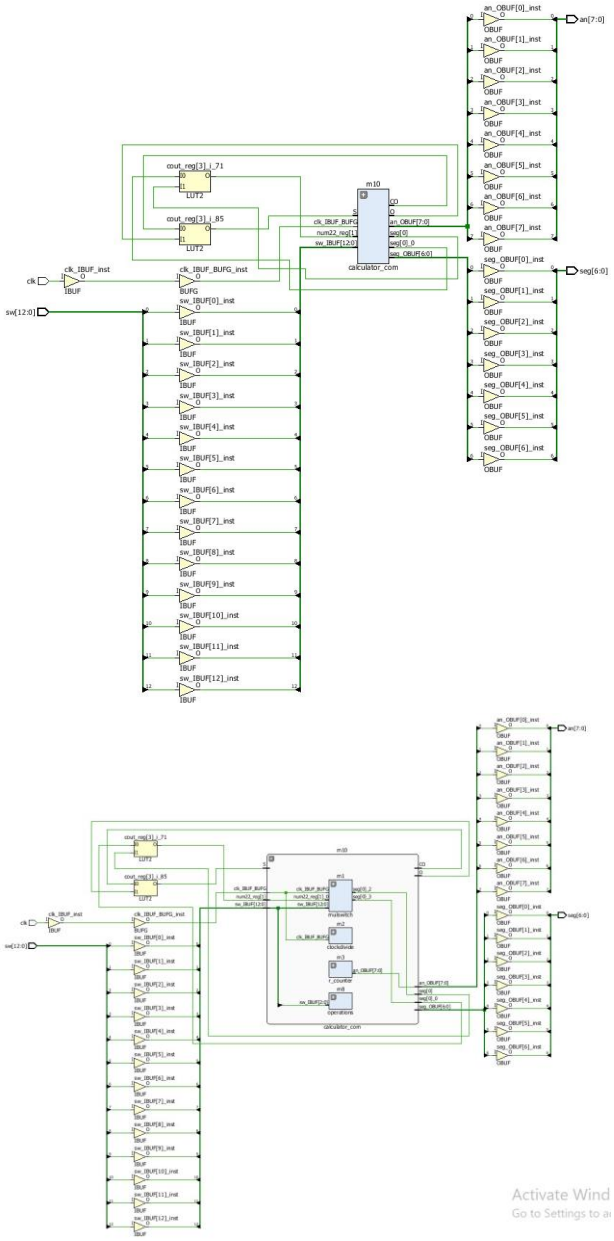
As we reached the end of the semester we were tasked to incorporate a bit of everything we learned from past assignments into this final project. Implementing a calculator using the Nexys a7 100t board allows us to hit each criteria. Overall this project will be able to conduct addition, subtraction, multiplication as well as division for two inputted numbers. The seven segment display will track in real time what our input is and what the result is based on desired math operation. We were also able to unite combinational and sequential circuits to make this project a reality.

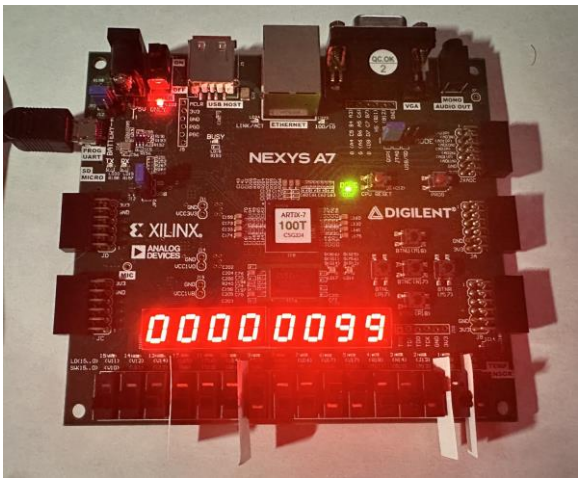
II. Background and Preliminaries

Additional research was conducted such as knowing the board's internal clock, limitations, which switches we could use and what we could ignore [1]. We studied our previous Array multiplier and exhaustive self checking testbench labs as a reference point[3][4]. Without their respective lab manuals being able to implement the calculator would not be possible. This was the first time we used the seven segment display therefore additional information was a must [2]. Several modules must be written correctly and mapped precisely in the xdc file for this project to be successful.

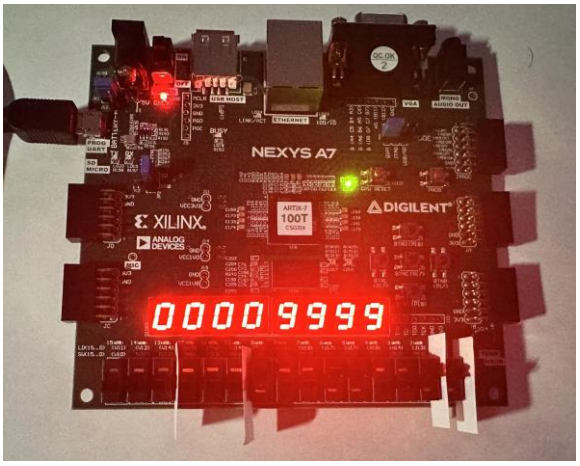
III. Implementation

Each module is important and structured such that it allows our calculator to function. The mulswitch module is in charge of allowing the user to input two different numbers onto the seven segment display. Two modules clockdivide and r_counter help with our timing in order to write onto the display. Because we are using the display we had to create the anode_control and segment7 modules to generate the results on the seven segment display. bcd_control stores our numbers in decimal so the user understands the interface a lot better. We also need a bin_to_bcd module in order to switch inputs so the board can read them with just the switches. Lately our operations module is in charge of which math operation we will be in and its respective output. SW[12] is division, SW[11] is subtraction, SW[10] is addition and SW[11]+SW[10] is multiplication. The first number is written when SW[1] is set to 0, our second number is stored when SW[0] is set to 1. SW[2]-[9] are used to input the actual numbers we want; this portion is coded in BCD so we can only input numbers 1-9 in the ones place and 1-9 in the tens place. Lastly SW[0] is wired to be our reset button. The combinational portion of our circuit revolves around the mathematical computation of our two provided inputs. Once the combinational circuit computes the desired output, we then use the board's built in clock to display said output and input on the seven segment display hence the sequential portion of our circuit. As for the seven segment display it will be divided into two parts, the left four segments will be in charge of displaying the computed output of the calculator. The right four segments will be divided into two parts to display our two inputs. We decided to put all our components into one module to prevent things from getting too messy. Once we connected all the modules together to the top_module, we connected the constraints file to our top_module.



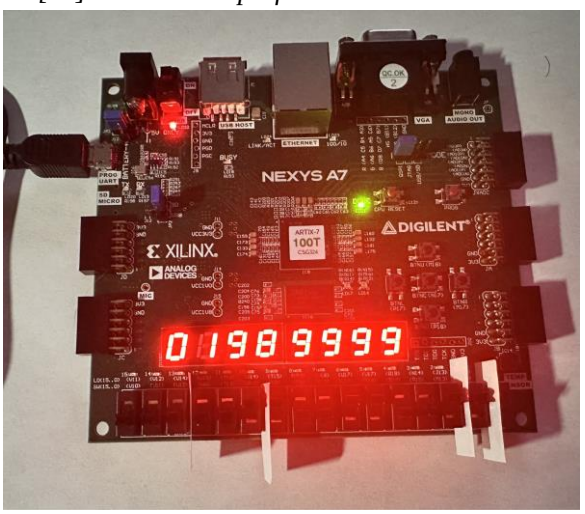


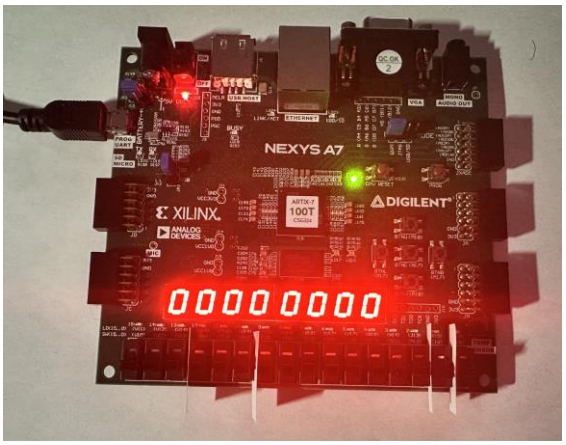
SW[1] is 0, SW[2]-[9] display number 99



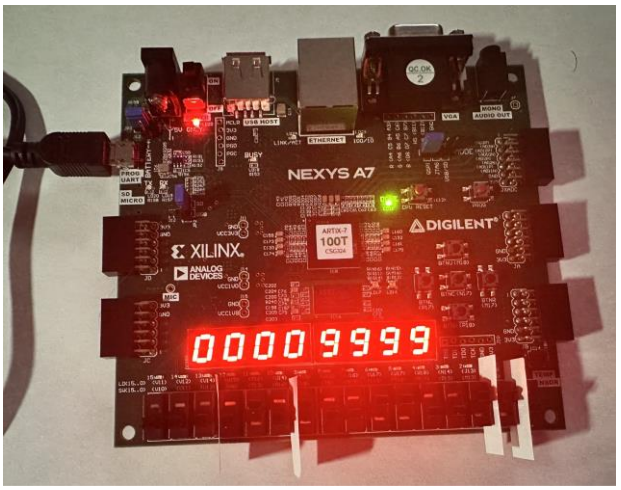
SW[1] is 1, SW[2]-[9] also display number 99

SW[10] active so we perform addition

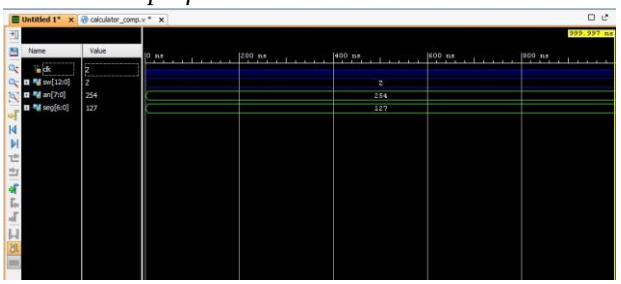




Default

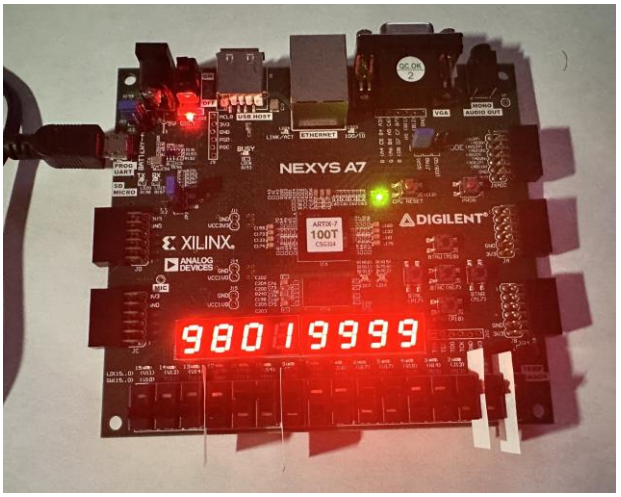


SW[11] active so we perform subtraction



IV. Evaluation

Our project's results are exactly what we expect them to be: a standard issue calculator using the Nexys a7 100t interface. When we input our two numbers we can cycle between addition, subtraction, multiplication and division. The seven segment display shows us what numbers are being inputted

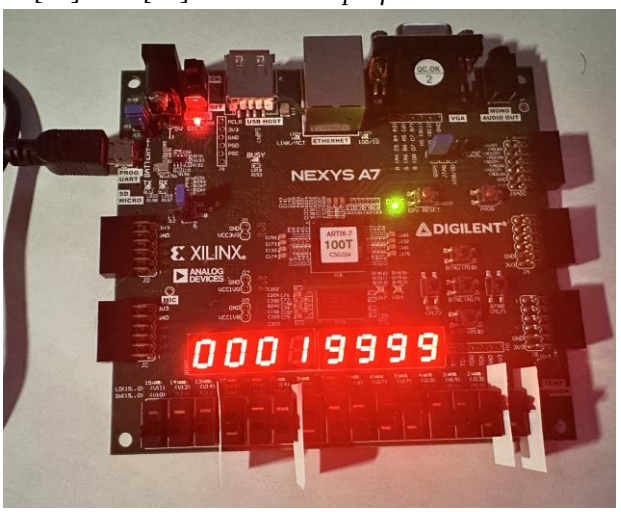


SW[12] active so we perform multiplication and the desired output right next to it simultaneously. The use of multiple modules in one helps keep the material organized and easy to follow along.

V. Conclusion

Learning about the different capabilities of the Nexys a7 100t board and how versatile it is was absolutely daunting. Being able to correctly map our internal logic with our hardware was incredibly difficult, as well as using its interface to display desired output. Although we could have organized our modules a bit nicer, the project ran smoothly and as intended. Asking a lot of questions and the collaborative work environment made this project a lot easier which would otherwise be impossible.

SW[10]&SW[11] active so we perform division



References

[1]*digilent.com. (n.d.). Nexys A7 Reference Manual Digilent Reference. [online] Available at: https://digilent.com/reference/programmable-logic /nexys-a7/reference-manual.*

[2]*ManualsLib. (n.d.). Seven-Segment Display - Nexys A7 Reference Manual [Page 20]. [online] Available at: https://www.manualslib.com/manual/1581461/Ne xys-A7.html?page=20 [Accessed 6 Dec. 2022].*

[3] https://bbcsulb.desire2learn.com/d2l/le/content/878075/view C ontent/10105777/View

[4] https://bbcsulb.desire2learn.com/d2l/le/content/878075/viewCont ent/10131343/V