Matrix Multiplication

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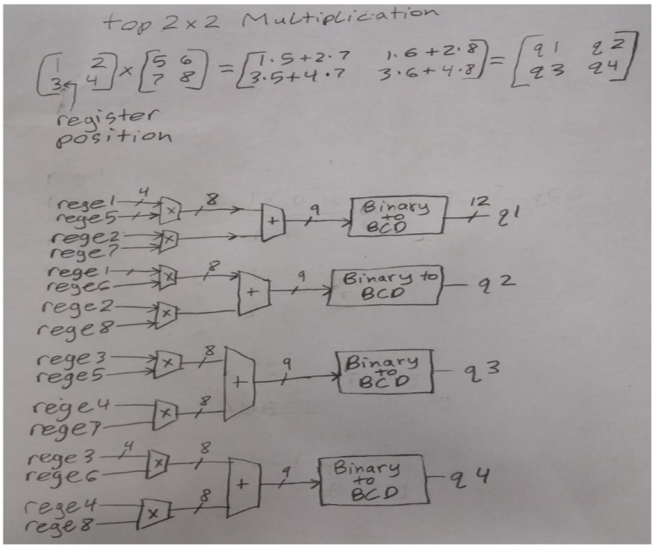
***Abstract*- In the following project we created a simple 2x2 and 3x3 matrix multiplier. The user can input 4 bit numbers that will be displayed on the seven segment display. The user will know where the answer is located on the matrix by the LED's displaying the position on the matrix.**

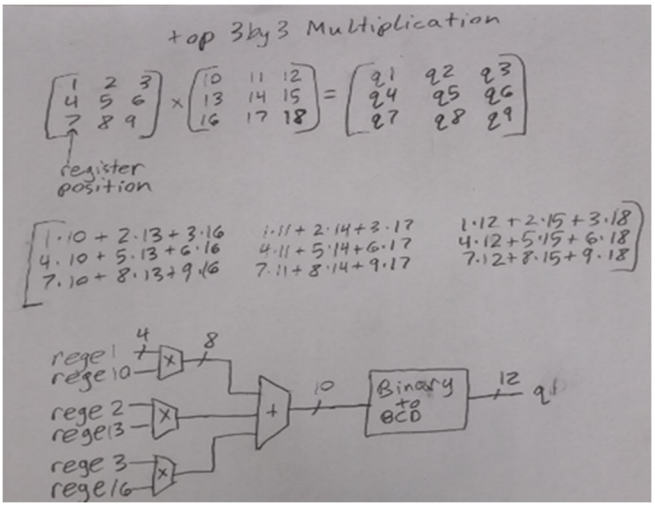
I. INTRODUCTION

For our ECE 378 we have decided to make a 2 x 2 matrix multiplier and a 3 x 3 matrix multiplier. A matrix multiplication is a binary operation that takes a pair of matrices, and produces another matrix. While a matrix are a rectangular array of numbers, expressions, or symbols that are arranged in rows and columns. The reason that we are creating this 2 x 2 matrix and a 3 x 3 matrix is because we wanted a faster way to solve a matrix multiplication problem, rather than solving it by hand. A few things that we learned in class that helped us create this project are using the finite state machine, used a decoder, registers, adders, multipliers, a UART output interface or the 7 segment display. We eventually ended up choosing to use just the seven segment display that was on the board.

II. METHODOLOGY

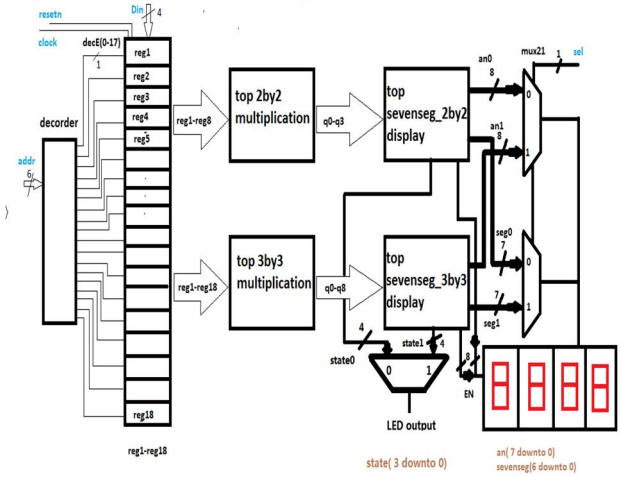
To begin we first had to figure out how the circuit would look and what we needed for it to work. One of the main things we thought hard about was whether to use either 4 bit or 8 bit numbers, and whether or not to use UART or the 7 segment display to output our results. Once we decided that we were going to use 4 bit numbers we started to draw out the circuit on paper, just so we visualize how it will look before we start to code it. So how it works is we have a 6 to 18 address decoder that will help the user right their desired input number into the matrix. From there the numbers begin to get put through multipliers and adders that finally get placed into a register that stores the answers. Where the answers will be converted from binary to BCD and then will be displayed on the seven segment display. The answer will then begin to be displayed as the user inputs their numbers into the matrix. As each number is shown on the seven segment display a LED will light up indicating what position that answer is on the matrix. For example if the answer is in quadrant 1 a single LED will be displayed, if the answer is in quadrant 2 two LED's will light up, and so forth for the rest of the answers. The same idea is used for the 3x3 matrix, but the board takes a sum of three products rather than 2 and produces a 10 bit number. Whereas the 2x2 matrix a 9 bit number is produced. Below are the combination circuits for the 2x2 matrix and the 3x3 matrix.



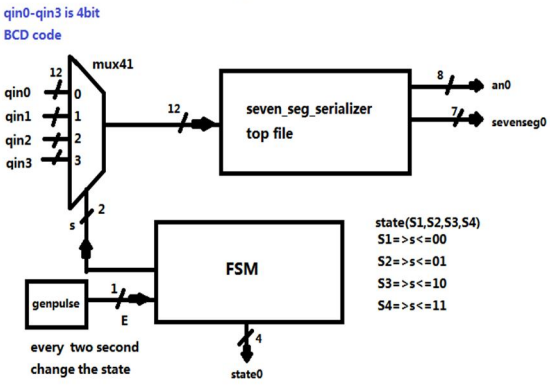


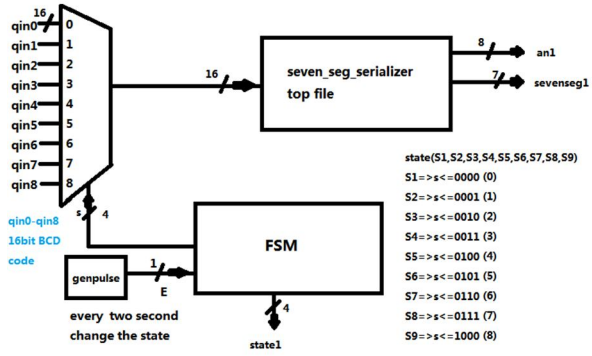
A. Problem and Soultion Section

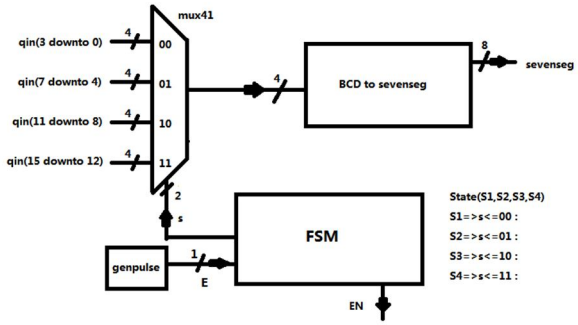
While creating this project a couple problems were found that caused us to be stuck or change up our multiplier a bit. The first one was trying to switch our output between the 2x2 and 3x3 matrices. What we had to do to fix this problem by creating three 2 to 1 multiplexer that will switch with the same selector switch between the 2x2 and the 3x3 matrix. How it was implanted is shown in the figure below.



Another issue that we had was figuring out how to implement the UART with our design. After days of trying to get the UART communication running with our matrix multiplier we decieded that it was not going to work out. Therefore we decided to scrap that idea and use the seven segement display and LED's. How we got the seven segement to work is by creating to functions for the seven segemnt display. The first one is to rotate the q output answer of the matrix with a two second delay and the second function is to rotate the actual number of the output answer very fast on the seven segement display so that the user does not see a delay in the answers. There is a top seven seg 2x2 file and a top seven seg 3x3 file that will rotate the ouput answer for the different positions of the matrix. Inside the top seven seg 2x2 file and a top seven seg 3x3 file there is a seven seg serializer file that will rotate the anode of the number on the seven segment display. The LED's will then light up to let the user know what postion the answer should be placed in. This is known as the state value in the diagrams below. Below are the pictures of the circuits that were created for the seven segment display. (From top to bottom in respective order; a top seven seg 2x2 file, a top seven seg 3x3 file, and Seven Seg Serializer)







III. Experimental Setup

What was used to help us create everything was the ISE Design Suite 14.7, from this we were able to code everything. Using the test bench we created several different scenarios and from there were able to create the time diagram. From the timing diagrams we were able to see if any mistakes were in our code or if the logic makes sense. Also we used some of the codes that was provided to us from Dr. Llamocca such as the registers, the seven seg serializer, the serial multiplier, and the full adder.

IV. Results

The results obtained from this project was how to create a serial multiplier, how to create a combinational 2x2 and 3x3 matrix multiplication combinational circuit. We also learned new and creative problem solving techniques such as how to create an interface for our project.

Conclusions

Overall the project was a success and everything went smoothly. We did have other ideas that would improve our project but could not implement. We wanted to decrease the amount of components used in our project by trying to make 2x2 matrix multiplication work on the 3x3 matrix multiplication combinational circuit. This would have dramatically decrease our components used in the project. We also wanted to try to make a serial matrix multipliers, instead of the parallel ones that were implemented.

References

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[2] "Transmitter." Wikipedia. Wikimedia Foundation. Web. 1 Apr. 2015. <http://en.wikipedia.org/wiki/Universal_asynchronous_receiver/transmitter>. I. S. Jacobs and C. P. Bean, “Fine particles, thin films and exchange anisotropy,” in Magnetism, vol. III, G. T. Rado and H. Suhl, Eds. New York: Academic, 1963, pp. 271–350.

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