Digital Design Lab
EEN 315 Section 3G

Project #2
Four-Bit Multiplier

Group #2
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April 7, 2014

Abstract

The purpose of designing a Four-Bit multiplier is to introduce the idea of designing arithmetic circuits, understanding the advantages of register storage, help to understand control logic, and introduce idea of programmable logic. The multiplier is implemented using 4 bit registers to store the multiplicand and muliplier, a 4:1 multiplexer to choose the current bit for the multiplicand, AND gate to implement the addition of the multiplier and current bit, and a full adder with shift register to keep total sum and to shift the current total. Upon creating the block diagram in Quartus, the circuit performed as expected, correctly multiplying the two numbers together. The results of this lab show that logic used by humans to implement arithmetic functions can be accurately modeled using integrated circuits and logic components.

Overview

Arithmetic circuit design is one of the main implementations for digital design, as these circuits were the original purpose for computers. This lab introduces these circuits, along with the idea of storing data in registers.

Objectives

The idea of control logic is introduced in this lab, where user input determines the function of the circuit. The other concepts introduced in this lab were storing data in registers, and designing arithmetic circuits.

Equipment

Description	Chip Number	Quantity
4 bit register	74194	2
4:1 Mux		1
AND gates		4
Full Adder	7483	1
Shift Register	74198	1
4 bit counter	74163	1

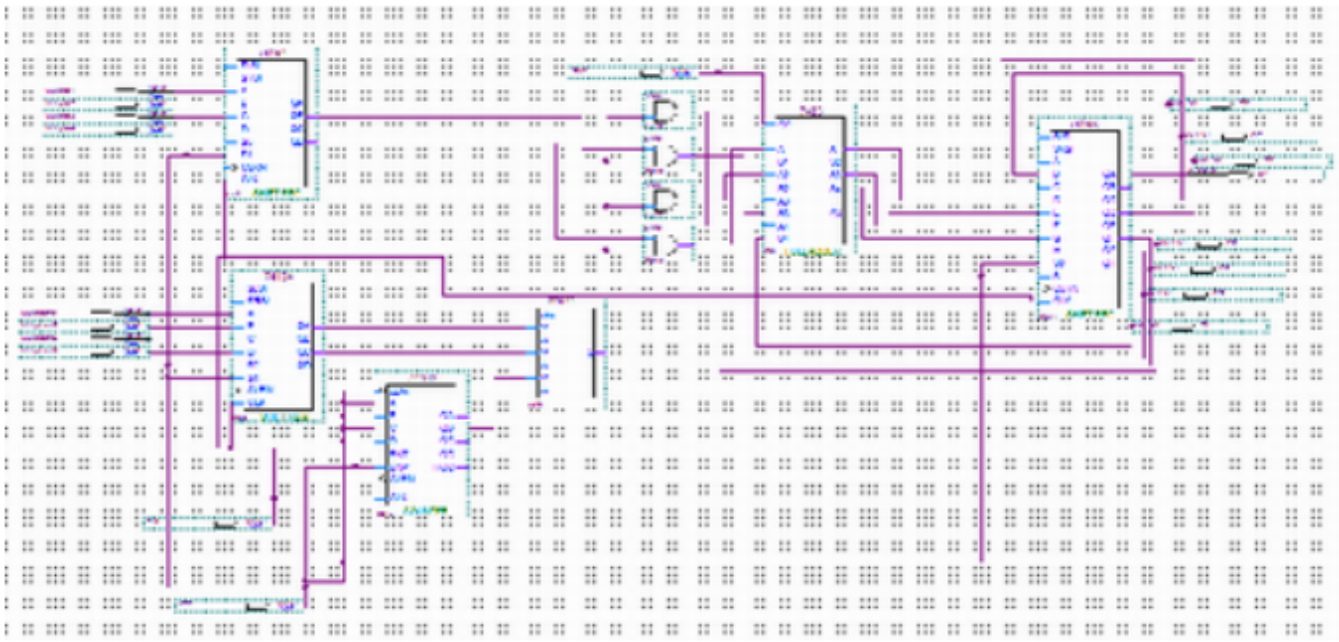
Description

The first step of the project was to become familiar with how the full-adder chip functioned. The inputs were addressed by using two shift register chips for the multiplier and multiplicand. Next, the multiplicand output and counter output were used in a 4:1 multiplexer chip which chose which of the bits of the multiplicand was to be used. This output was then ANDed with the multiplier.

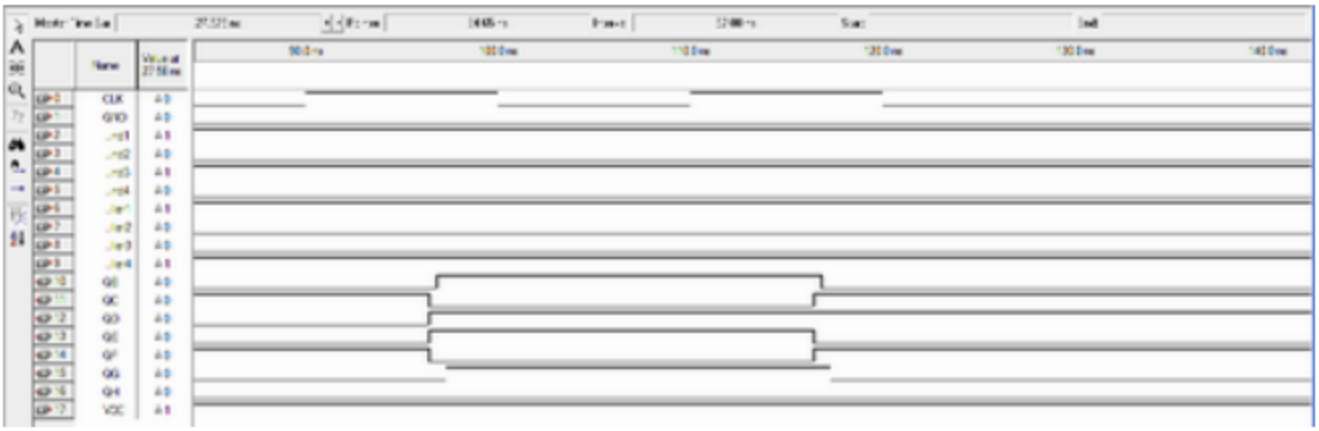
The outputs of the AND gates were then sent to the full adder. The outputs of the adders were then sent to the least significant bits of the shift register. One part of the shift and add occured each clock cycle, so the correct output occurred after 4 cycles.

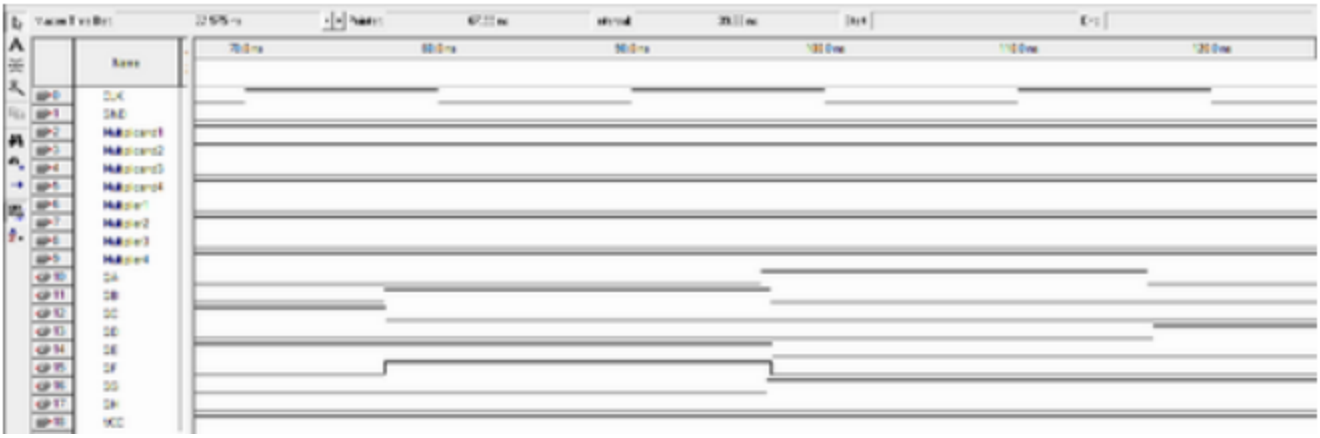
Last, the circuit was simulated on Quartus and then on the DE2 board. This required forming pin connections between inputs and outputs in the simulation and linking them to switches and LEDs on the board.

Complete Logic Diagram



Results and Simulations





Conclusion

This project served as an implementation of all the concepts we have learned in this class this semester. Basic logic concepts such as gates were included, as well as flip flops, multiplexers, and counters. The project also demonstrated how larger scale design can be done through software, and how large scale systems are made up of basic components which are within our understanding. It also shows how hardware boards can be used to more easily debug and visualize a project, and how many different boards could have used for the project depending on the purpose.