CS250 HW4

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November 7, 2017

1 Overview

All components of my Duke 250/16 processor work. The processor passes all tests in the available test suite and exhibits normal behavior in Logisim. Below, I'll explain the makeup of each subcomponent of the processor.

2 Component: Register

The register component is made up of 16 D flip-flops. It takes a clock value, reset signal and 16-bit integer as inputs and can be asynchronously reset or write-enabled.

3 Component: Register File

The register file component is composed of 8 registers. Three ofo the eight are "special" registers: register 0 permanently holds value 0 and cannot be written into; register 7 is advised to be used to hold the return address of the processor; register 6 is advised to be used as a stack pointer. No specific behavior is enforced for registers 6 and 7.

The register file takes as input the following: A clock value, a reset signal, a write enable signal, a 16-bit number (to be written into a register), a 3-bit destination register number (to signify where values should be written into) and two 3-bit register numbers (to identify registers to be read for value). It outputs two 16-bit numbers that are read from the two targeted input registers.

4 Component: 16-bit adder/subtractor

The 16-bit adder/subtractor adds or subtracts two 16-bit 2's complement integers. It was created by combining 16 1-bit adder components. It takes as input two 16-bit numbers and a 1-bit signal indicating whether it should perform addition or subtraction. It outputs a 16-bit 2's complement integer and an overflow signal.

5 Components: Right shifter/Left shifter

The right/left shifter components (separate) both shift a 16-bit input number left or right by up to 8 bits. Both components uses three combined layers of multiplexers to do so. As input, they take a 16-bit input number, plus a 3-bit shift amount number. They output a single 16-bit number.

6 Component: Arithmetic Logic Unit

The arithmetic logic unit (ALU) performs arithmetic and logical operations on inputs. Specifically, it can add numbers, subtract numbers, left/right shift numbers, *xor* two numbers or negate a number. The ALU takes an opcode signifyinig which operation to perform as input, as well as two 16-bit input numbers and an optional 3-bit shift amount. It always outputs a single 16-bit number.

7 Component: Sign Extender

The sign extender converts a 6-bit 2's complement number into a 16-bit 2's complement number. It does so by inputting a 6-bit number, setting the 5 least significant bits of the 16-bit output number equal to the 5 least significant bits of the 6-bit input number, and then padding the other 11 bits of the 16-bit output with the most significant bit of the input.

8 Component: Control

The control component activates certain signals based upon the operation the processor is performing. It takes a 4-bit opcode as input and emits 10 1-bit signals as output. The useful outputs signals are: Rwe (read-write enable), J (jump), BR (branch), DMWe (data memory write enable), IN (signifies input), OUT (signifies output), JAL (jump and link), Itp (i-type) and JR (jump return).