Homework 4: Processor Description

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Summary:
All sixteen instructions should work, according to my knowledge. Sub circuits that I have created are as follows:

- 16BitRegister
- RegisterFile
- ALU
- InstructionDecode
- SignExtender
- Onebit
- Adder
- Subtractor
- Shiftright
- Shiftleft
- Zero
- Input

16BitRegister:
The 16 bit register takes in a 16 bit input value and outputs said value based on if the write-enable signal is turned on, and the clock has completed a cycle. There is also a reset input to reset the value back to 0.
Inputs: 16 bit input, clock, write enable, reset
Outputs: 16 bit output

RegisterFile:
The register file takes in three different three-bit inputs, one to dictate which first register to read from, which second register to read from, and which register to write the data onto. The register file also takes in a 16-bit data, which is the data that will actually be written onto the decided write register. Using 8 different 16 bit registers, the register file will write the input data onto its decided register, only if both the write enable have been turned on and the clock has been set, and using tri state buffers and two decoders, will output two different read data registers based on the three-bit input registers. These two read data registers will therefore become the RS and the RT.
Inputs: ReadReg1, ReadReg2, WriteReg, reset, data, RegWriteEnable, clk
Outputs: ReadData1 (RS), ReadData2(RT)

InstructionDecode:
The instruction decoder takes in the 16-bit instruction and breaks up the last four bits (12-15) also known as the opcode, into the instructions that correspond with the opcode. Based on the instruction, the decoder activates the control signals needed for the instruction, as well as breaks

up the rest of the instruction into its corresponding parts based off of which type of instruction it is (R, I or J).
Inputs: 16 bit Instruction
Outputs: shamt, RS, RT, RD, address, WE, ALUinB, rdst, rwd, DMwe, bne, blt, ioin, ioout, ALUop, j, jal

SignExtender:
The Sign extender takes in a 6-bit input and turns it into a 16-bit output by using the first five bits as the value, and then taking the sixth bit (the sign bit) and extending this bit into the rest of the 16 bits.
Input: 6 bit input
Output: 16 bit sign extended output

Onebit:
The one bit subcircuit takes two bits, A and B and adds them together.
Inputs: A, B, Cin
Outputs: cout, sum

Adder:
The adder takes in two 16 bit inputs, A and B, and using the 16 one bit sub circuits, adds the values together and outputs this added value.
Inputs: A, B
Outputs: result, ovf

Subtractor:
The subtractor takes in two 16 bit inputs, A and B, and using the 16 one bit sub circuits, subtracts the values and outputs this subtracted value.
Inputs: A, B
Outputs: result, ovf

Shiftright:
The shift right sub circuit takes in a 16 bit input and a 3 bit shamt, or shift amount, and using a lot of muxes, shifts the bits in the input to the right based on the value given in the shamt.
Inputs: 16 bit input, 3 bit shamt
Output: 16 bit output

Shiftleft:
The shift left sub circuit takes in a 16 bit input and a 3 bit shamt, or shift amount, and using a lot of muxes, shifts the bits in the input to the left based on the value given in the shamt.
Inputs: 16 bit input, 3 bit shamt
Output: 16 bit output

Zero:
The zero circuit takes in a 16 bit input and compares each value to 0; if any of these bits are not equal to zero, the output is 1. If instead the blt input is turned on, the zero circuit will compare

the 16th bit, or the sign bit, to 1, and if the 16th bit is 1, the input is therefore negative, and the output value is again 1.
Inputs: 16 bit input, blt
Output: 1 bit output

Input:
The input sub circuit takes in a 7-bit input and control signal and turns this into a 16 bit key output. If the control signal is turned on, bits 0-6 of the key will equal the corresponding bits from the data input, and 7-15 will equal 0, but if the control signal is not turned on, only the 7th bit of the key output will equal 1, and every other bit will equal 0.
Inputs: 7 bit data, one bit control signal
Output: 16 bit key