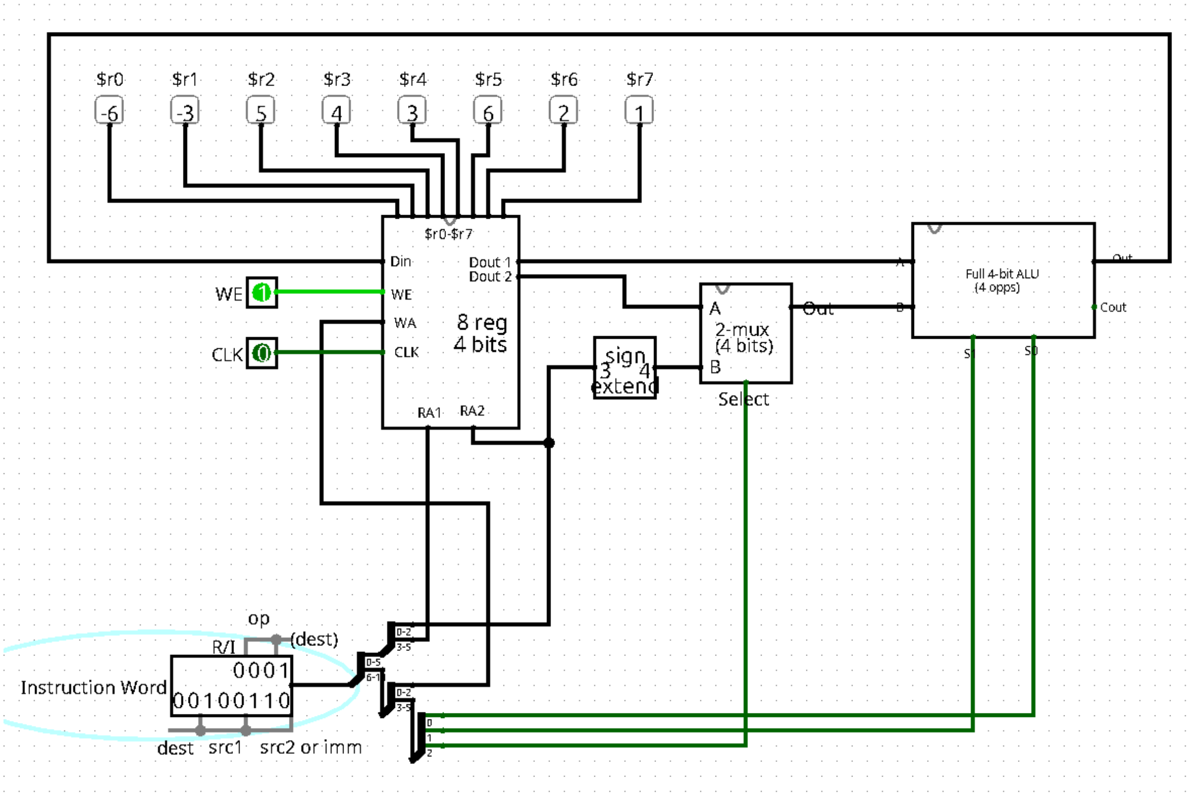
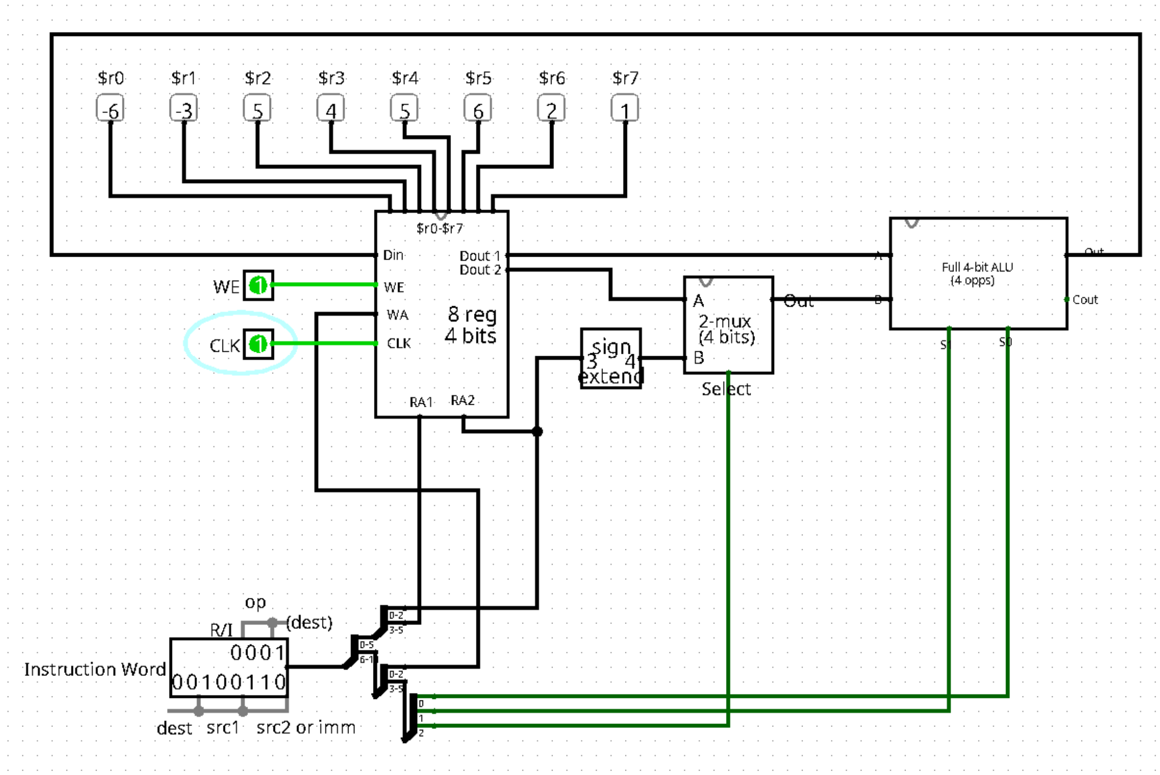
Lab 3

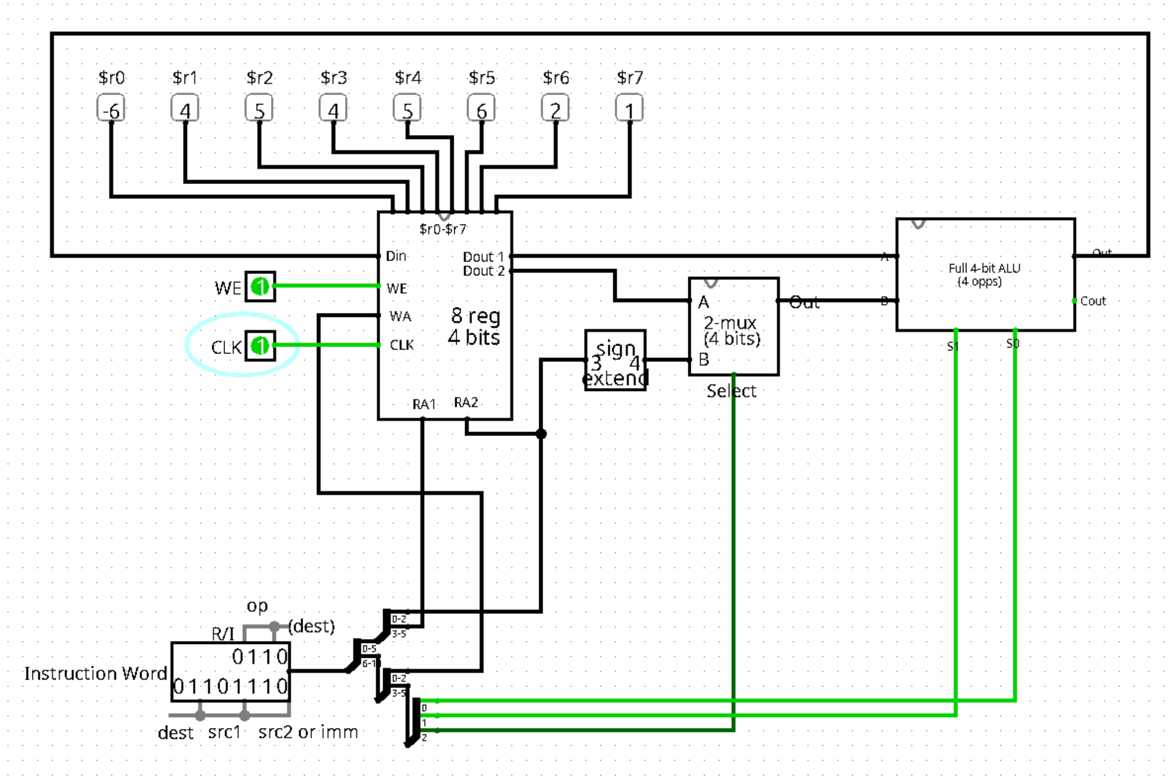
This processor implements a 12-bit instruction set architecture with support for both register-register and register-immediate operations, where the instruction word is divided into four fields: The 12 bit signifies if a register or immediate is being used. The bits 11 and 10 are the 2-bit operation codes for the ALU. The bits 9-7 are a 3-bit destination register address. The bits 6-4 are a 3-bit first source register address. Finally, the bits 3-1 are a 3-bit second source address or the immediate number. The operation code specifying the ALU operation (00=ADD, 01=SUB, 10=AND, 11=OR). The destination and first source fields each specify one of eight registers ($r0-$r7), while the final field serves as either the second source register or a 3-bit signed immediate value (range -4 to +3) that is sign-extended to 4 bits before entering the ALU.

Initial State: ADD $r4 $r4 $r6

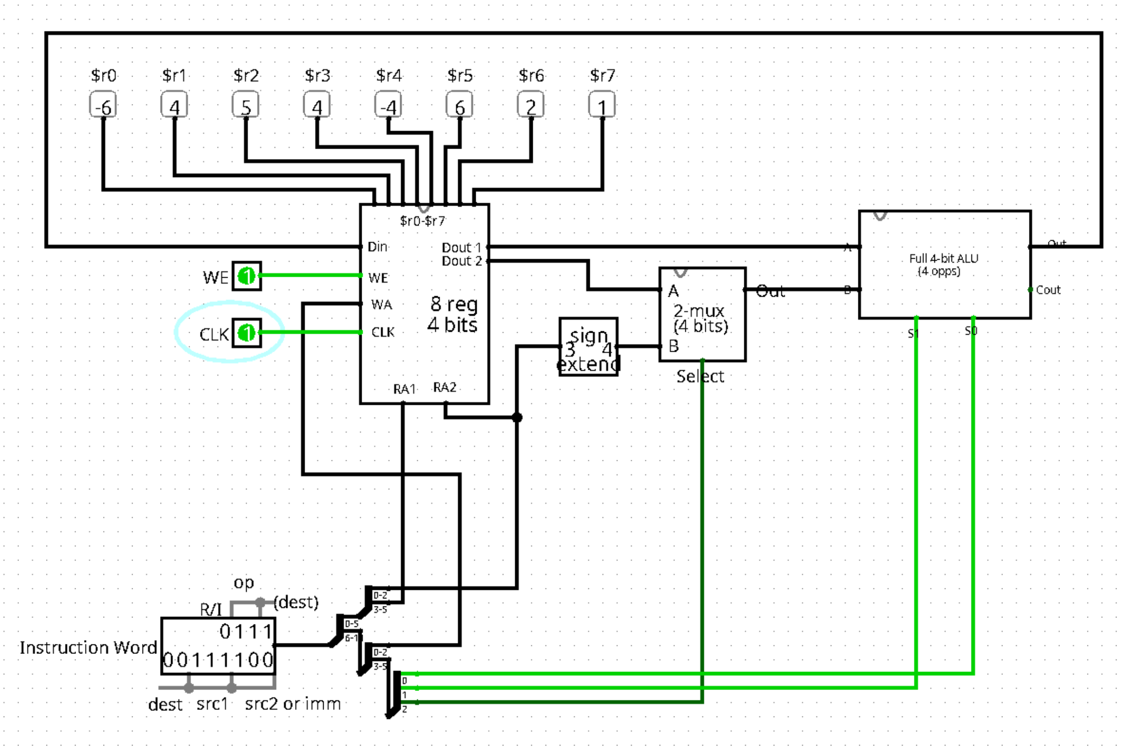



$r0
$r1
$r2
$r3
$r4
$r5
$r6
$r7
-6
-3
5
4
5
6
2
1
$r0-$r7
Din
Dout 1
Dout 2
WE
WA
CLK
8 reg
4 bits
RA1
RA2
WE
CLK
sign
3 4
extend
A
2-mux
(4 bits)
B
Out
Select
Full 4-bit ALU
(4 opps)
A
B
Out
Cout
S1
S0
op
R/I
(dest)
Instruction Word
0001
00100110
dest
src1
src2 or imm

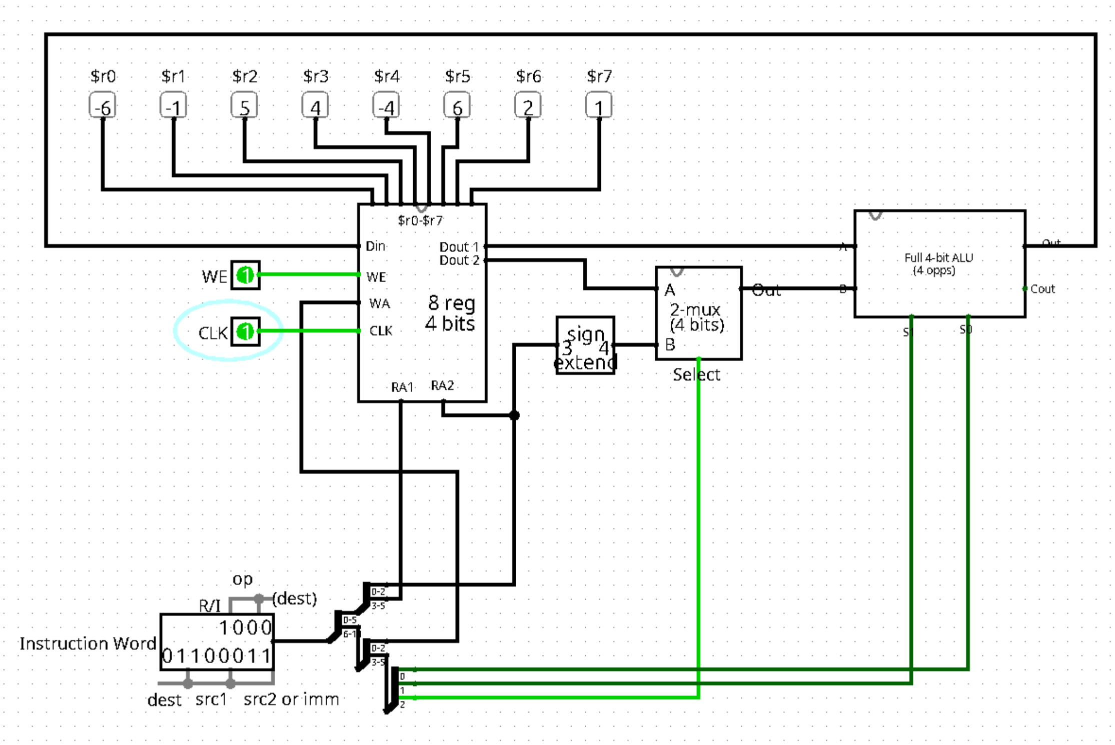
SUB $r1 $r5 $r6


$r0
$r1
$r2
$r3
$r4
$r5
$r6
$r7
-6
4
5
4
5
6
2
1
$r0-$r7
Din
Dout 1
Dout 2
WE
WA
CLK
8 reg
4 bits
RA1
RA2
WE
CLK
sign
3 4
extend
A
2-mux
(4 bits)
B
Out
Select
Full 4-bit ALU
(4 opps)
A
B
Out
Cout
S1
S0
op
R/I
(dest)
Instruction Word
0110
01101110
dest
src1
src2 or imm

SUB $r4 $r7 $r4



ADDi $r1 $r4 3



1. The missing bit is from the RA2 section of the instruction word because there are 8 registers. 8 registers require only 3 input bits so the instruction word uses 3 bits for RA2 but since it is also used for the immediate, we use a bit extender.
2. The largest immediate value you can put is 111 since there are only 3 bits to be used so the largest decimal number for the immediate is 7.
3. The lowest is 0 for the same logic as stated above.
4. It is only 8 out of the the 16 numbers that the immediate could possibly be since it is a 4-bit ALU, so a bit extender that could add a zero or a 1 could give us the full 16 decimal number that we could use for the immediate