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 Computer Systems Final Project  
 Fall 2022  
**UNIT TESTINGS**

This file contains:

- Screenshots of ASM files for each new instruction for each edge case
- Screenshots of simulator running asm file to check the registers BEFORE and AFTER instruction is run
- Screenshots of hexadecimal values of the new instructions converted into machine code (each instruction = a line in asm file (program) = a hexadecimal value outputted by lc3.f)

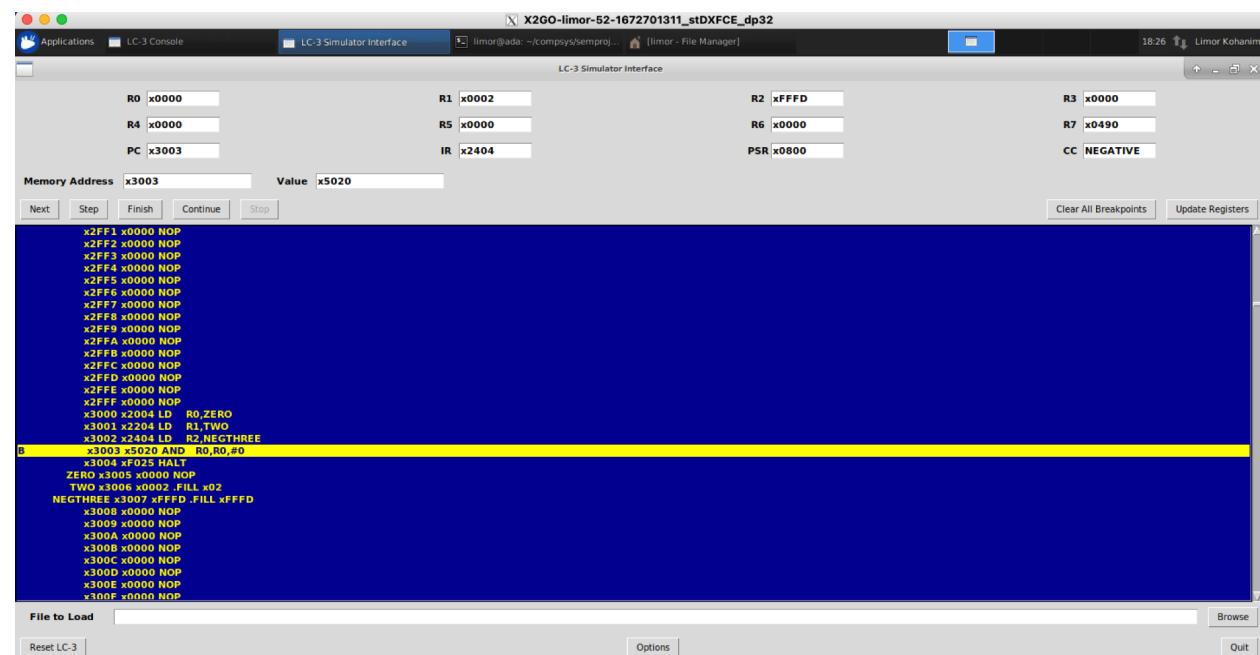
### **test RST: R**

#### R format

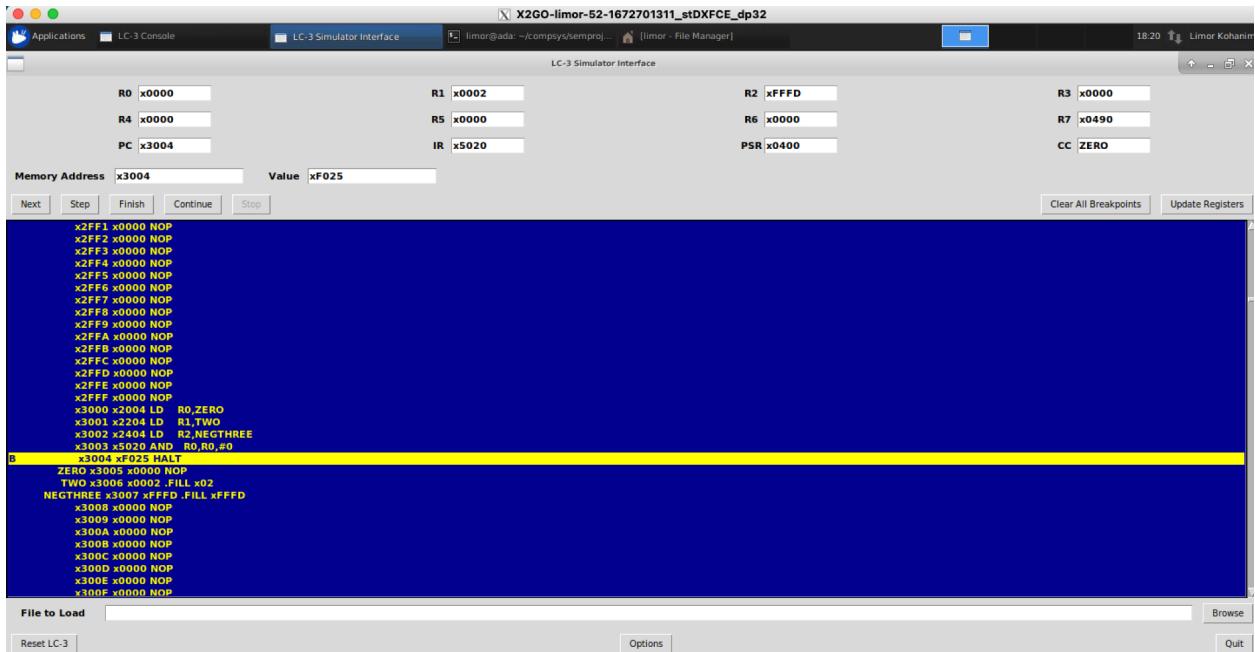
**RST R0** ; before instruction R0 is 0 after R0 is 0

```
compsys > semproj > lc3tools > RST_test.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5
6 RST R0
7
8 HALT
9 ;
10 ZERO .FILL x0000
11 TWO .FILL x0002
12 NEGTHREE .FILL xFFFFD
13 ;
14 .END
15
16
```

#### BEFORE INSTRUCTION



## AFTER INSTRUCTION



## HEX vals of instructions in this last edge case

```

● Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as RST_test.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2004
the current instruction's hexadecimal value is x2204
the current instruction's hexadecimal value is x2404
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffd
0 errors found in second pass.
○ Limor@ada:~/compsys/sempproj/lc3tools$ █

```

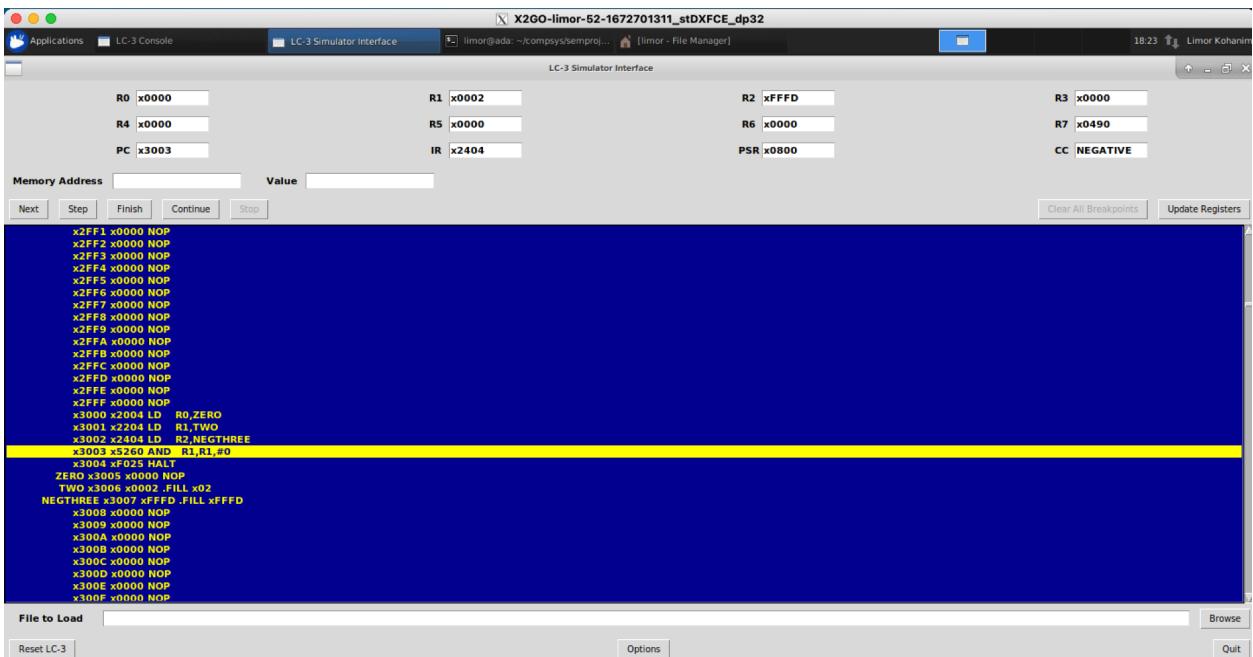
RST R1 ; before instruction R1 is 2 after R1 is 0

```

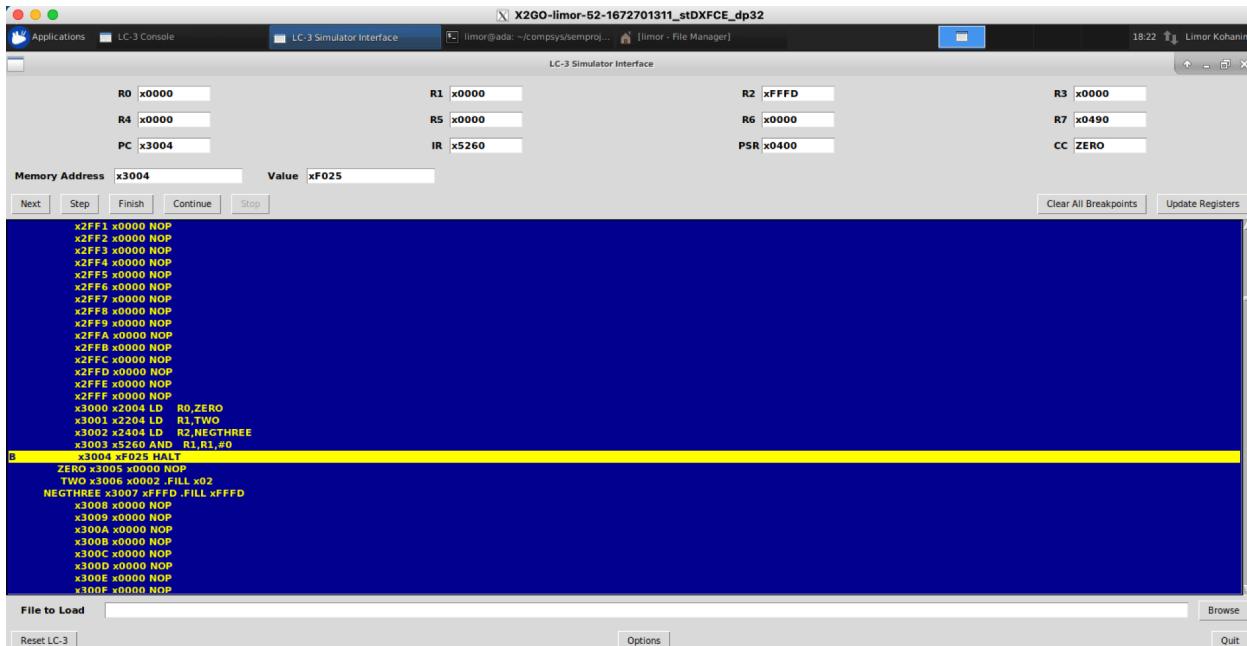
compsys > semproj > lc3tools > asm RST_test1.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5
6 RST R1
7
8 HALT
9 ;
10 ZERO .FILL x0000
11 TWO .FILL x0002
12 NEGTHREE .FILL xFFFD
13 ;
14 .END
15

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```

● Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as RST_test1.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2004
the current instruction's hexadecimal value is x2204
the current instruction's hexadecimal value is x2404
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
0 errors found in second pass.
○ Limor@ada:~/compsys/sempproj/lc3tools$ █

```

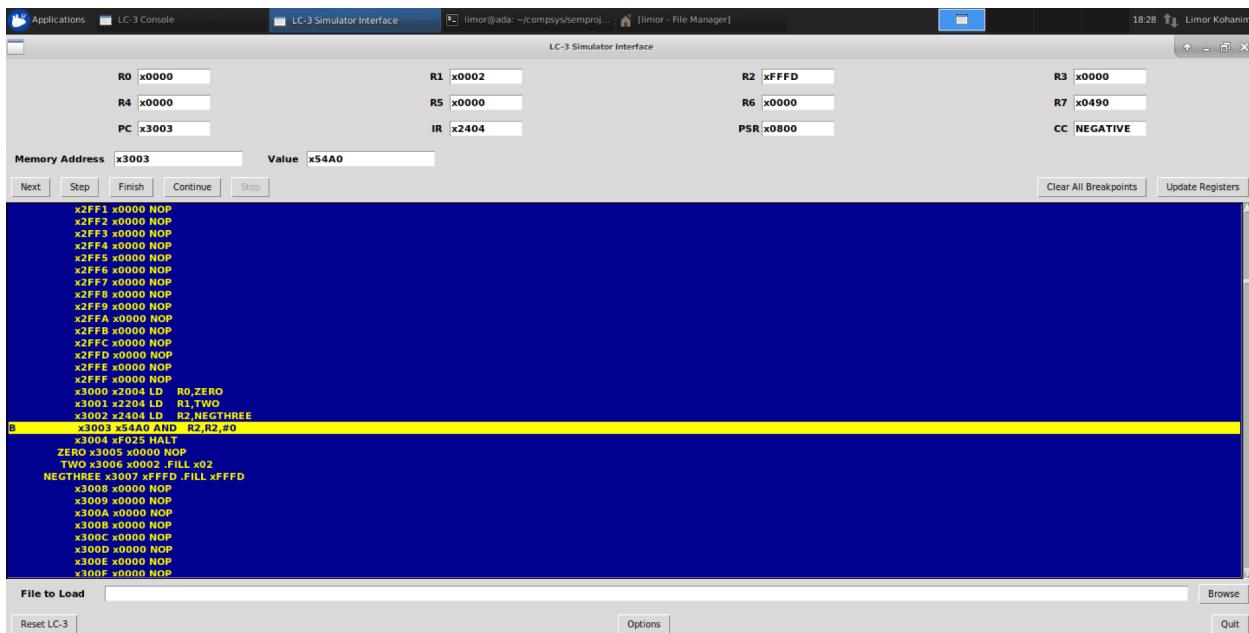
**RST R2** ; before instruction R2 is -3 after R2 is 0

```

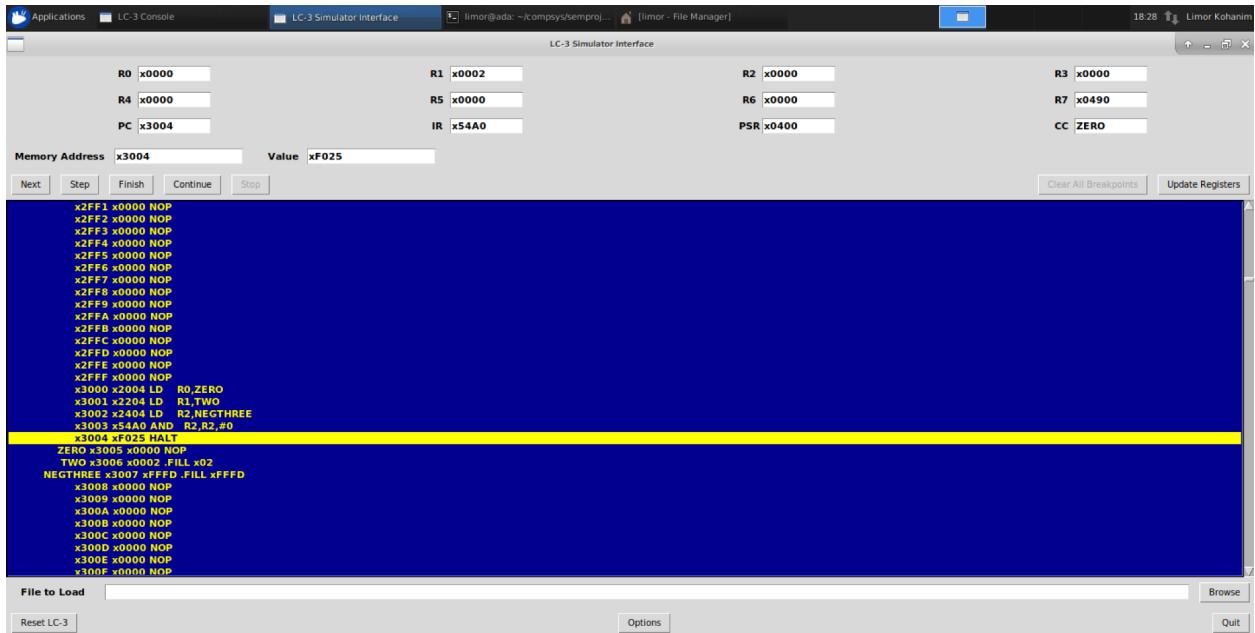
compsys > semproj > lc3tools > RST_test2.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5
6 RST R2
7
8 HALT
9 ;
10 ZERO .FILL x0000
11 TWO .FILL x0002
12 NEGTHREE .FILL xFFFD
13 ;
14 .END
15

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```
● Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as RST_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2004
the current instruction's hexadecimal value is x2204
the current instruction's hexadecimal value is x2404
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
0 errors found in second pass.
○ Limor@ada:~/compsys/sempproj/lc3tools$
```

### **test SUB: RRI, RRR**

#### RRI format

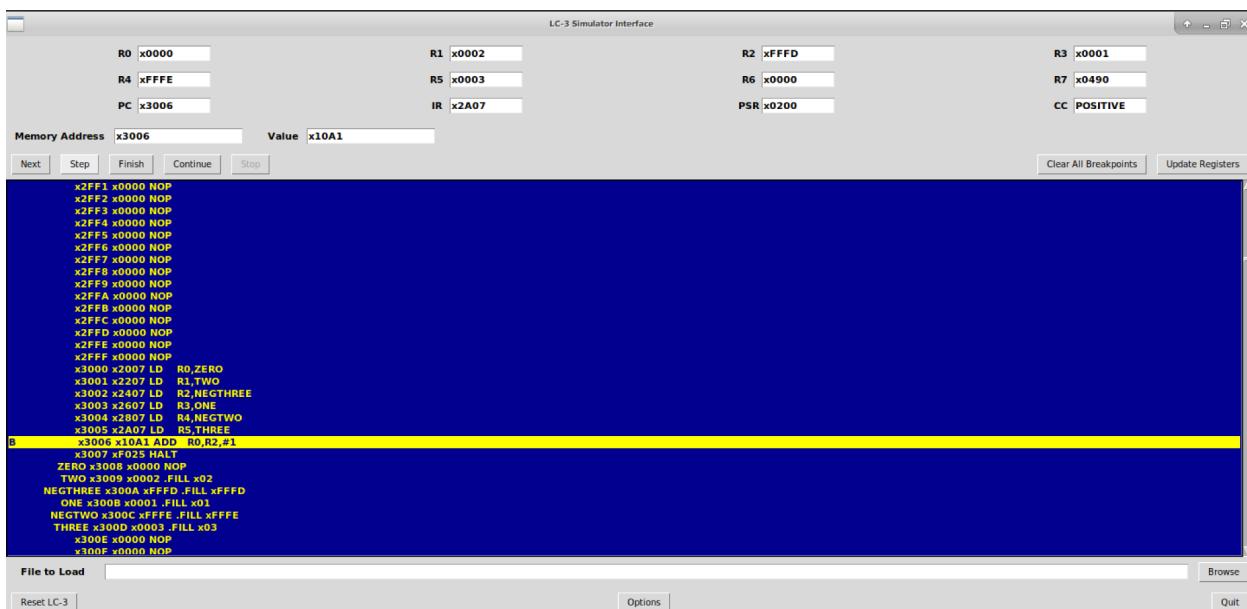
**SUB R0 negative negative**

```

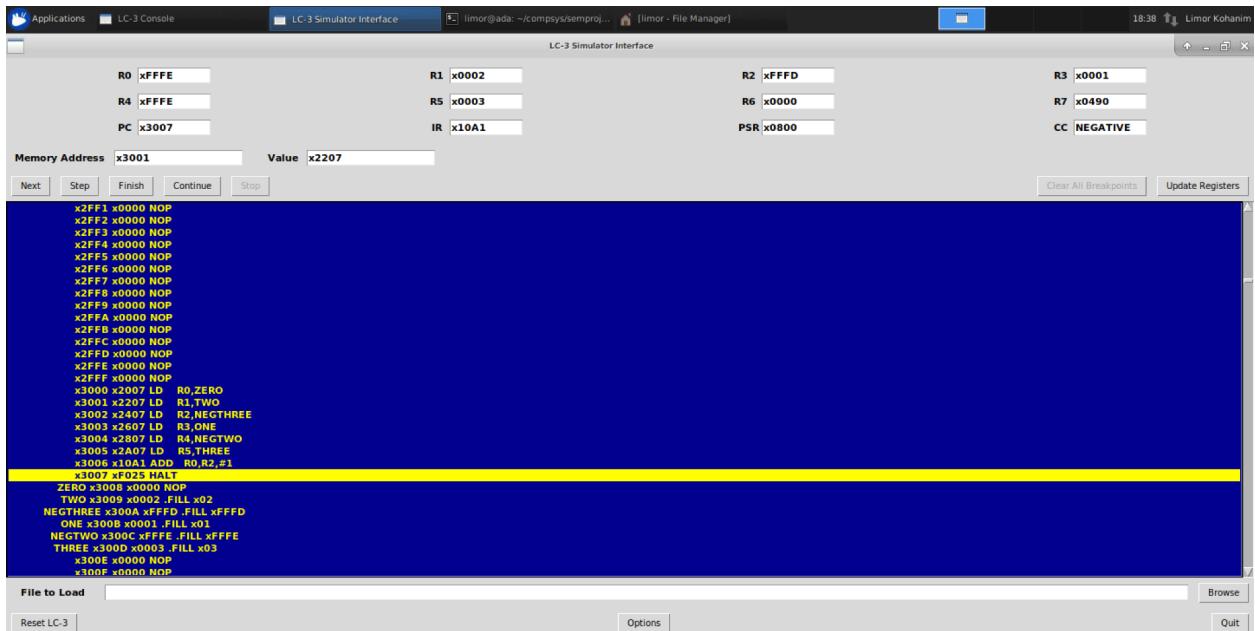
compsys > semproj > lc3tools > SUB_test.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTwo
7 LD R5, THREE
8
9 SUB R0, R2, #-1
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTwo .FILL xFFFE
18 THREE .FILL x0003
19 ;
20 ;
21 .END
22

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

- **Limor@ada:~/compsys/sempproj/lc3tools\$ ./lc3as SUB\_test.asm**

```

STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2007
the current instruction's hexadecimal value is x2207
the current instruction's hexadecimal value is x2407
the current instruction's hexadecimal value is x2607
the current instruction's hexadecimal value is x2807
the current instruction's hexadecimal value is x2a07
the current instruction's hexadecimal value is x10a1
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xfffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.

```
- **limor@ada:~/compsys/sempproj/lc3tools\$**

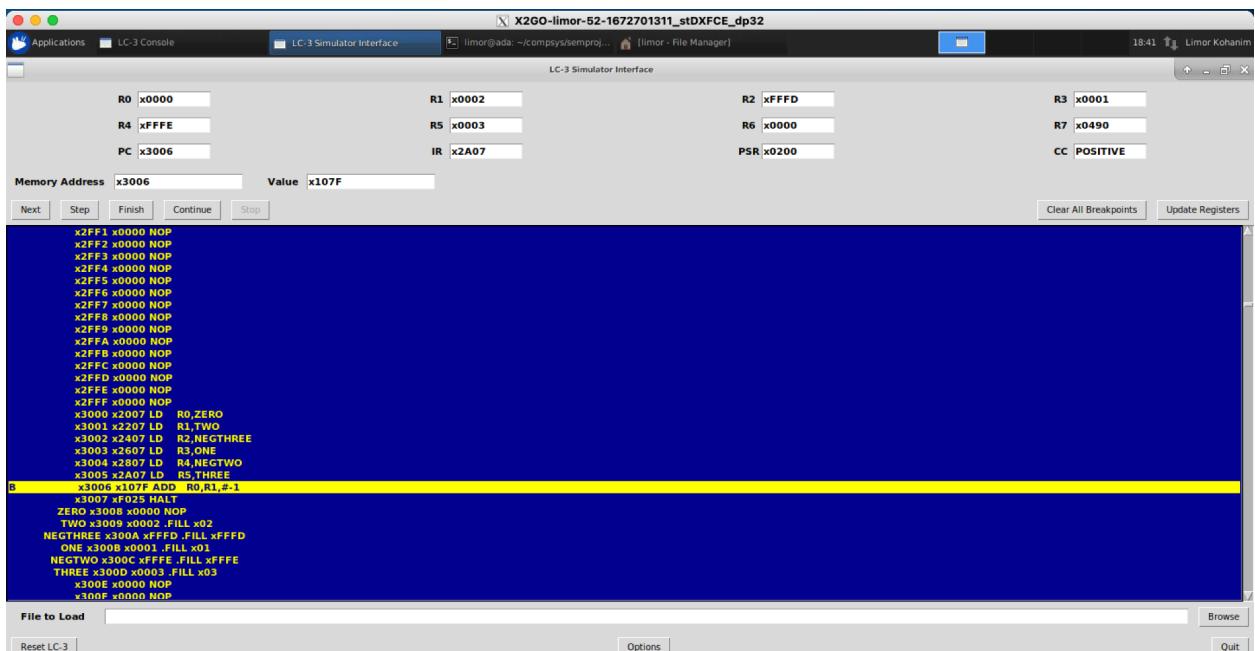
**SUB R0 positive positive**

```

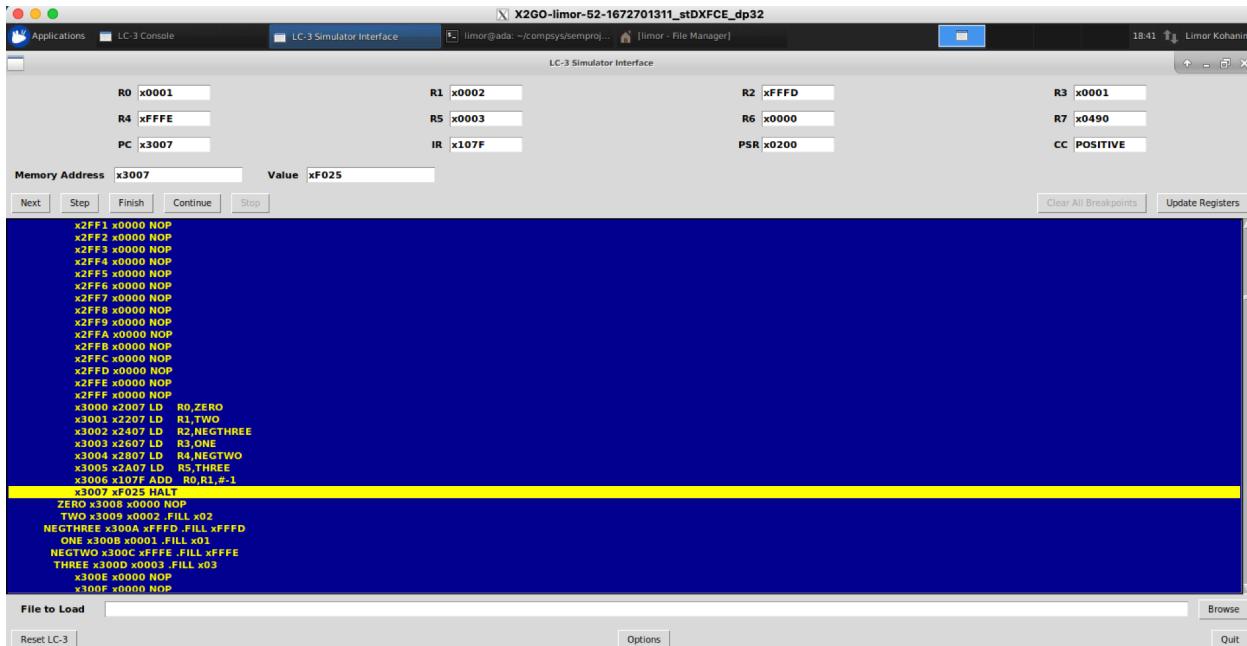
compsys > semproj > lc3tools > SUB_test1.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R1, #1
10 HALT
11 ;
12 ZERO .FILL x0000
13 TWO .FILL x0002
14 NEGTHREE .FILL xFFFD
15 ONE .FILL x0001
16 NEGTWO .FILL xFFFFE
17 THREE .FILL x0003
18 ;
19 .
20 .END
21

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

- `limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SUB_test1.asm`

STARTING PASS 1  
0 errors found in first pass.  
STARTING PASS 2  
the current instruction's hexadecimal value is x3000  
the current instruction's hexadecimal value is x2007  
the current instruction's hexadecimal value is x2207  
the current instruction's hexadecimal value is x2407  
the current instruction's hexadecimal value is x2607  
the current instruction's hexadecimal value is x2807  
the current instruction's hexadecimal value is x2a07  
the current instruction's hexadecimal value is x107f  
the current instruction's hexadecimal value is xf025  
the current instruction's hexadecimal value is x0  
the current instruction's hexadecimal value is x2  
the current instruction's hexadecimal value is xffffd  
the current instruction's hexadecimal value is x1  
the current instruction's hexadecimal value is xffffe  
the current instruction's hexadecimal value is x3  
0 errors found in second pass.
- `limor@ada:~/compsys/semproj/lc3tools$`

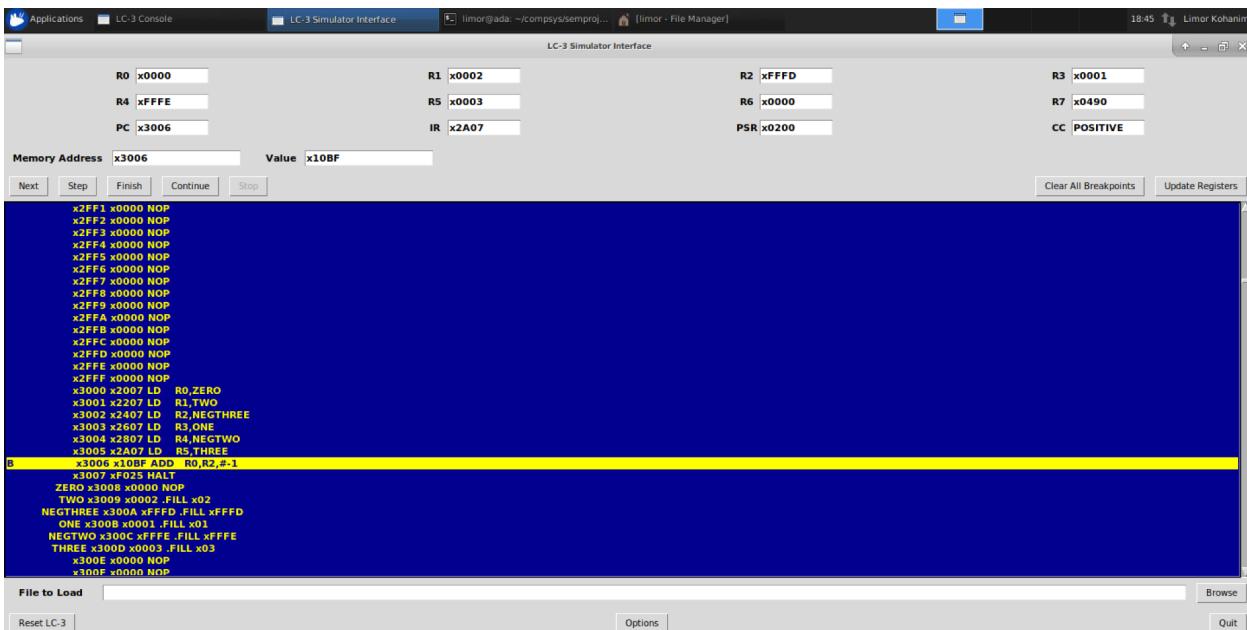
**SUB R0 negative positive**

```

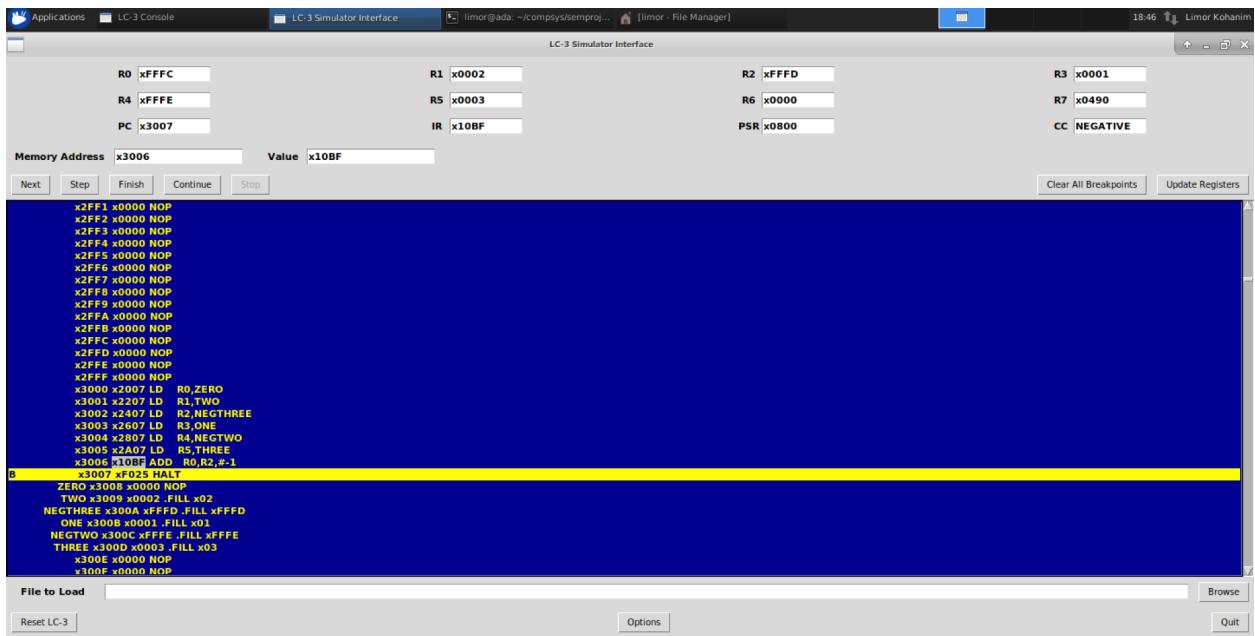
compsys > semproj > lc3tools > SUB_test2.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R2, #1
10 HALT
11 ;
12 ZERO .FILL x0000
13 TWO .FILL x0002
14 NEGTHREE .FILL xFFFD
15 ONE .FILL x0001
16 NEGTWO .FILL xFFFF
17 THREE .FILL x0003
18 ;
19 .
20 .END
21
22

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```

● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as SUB_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2007
the current instruction's hexadecimal value is x2207
the current instruction's hexadecimal value is x2407
the current instruction's hexadecimal value is x2607
the current instruction's hexadecimal value is x2807
the current instruction's hexadecimal value is x2a07
the current instruction's hexadecimal value is x10bf
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/sempproj/lc3tools$ █

```

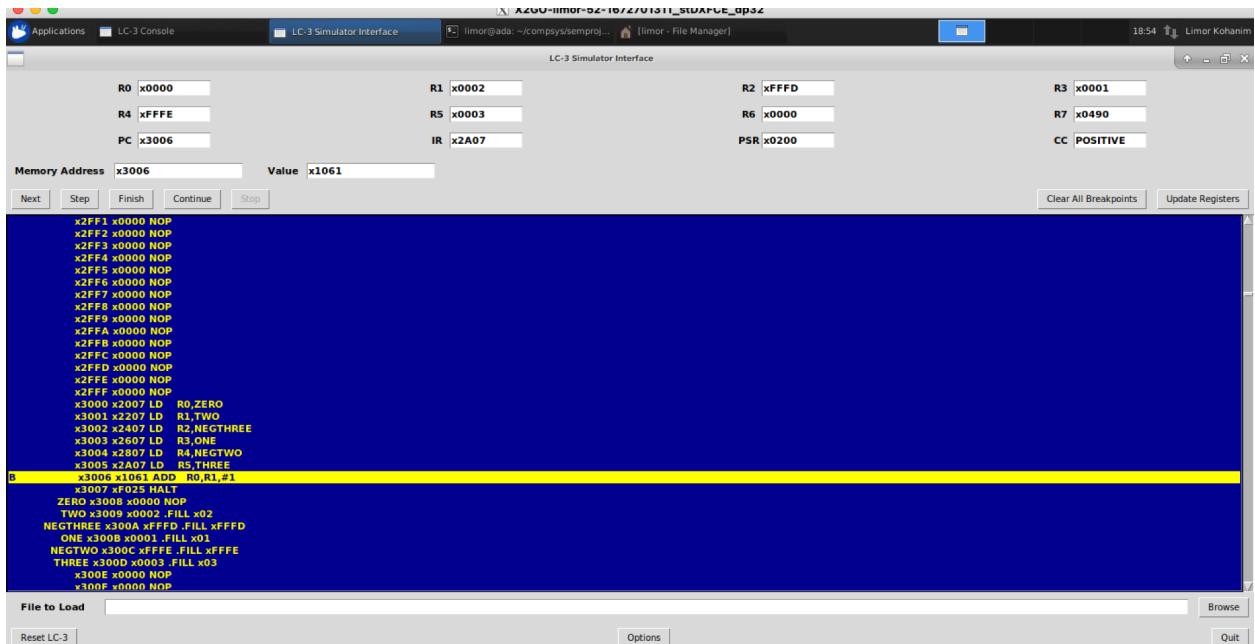
### SUB R0 positive negative

```

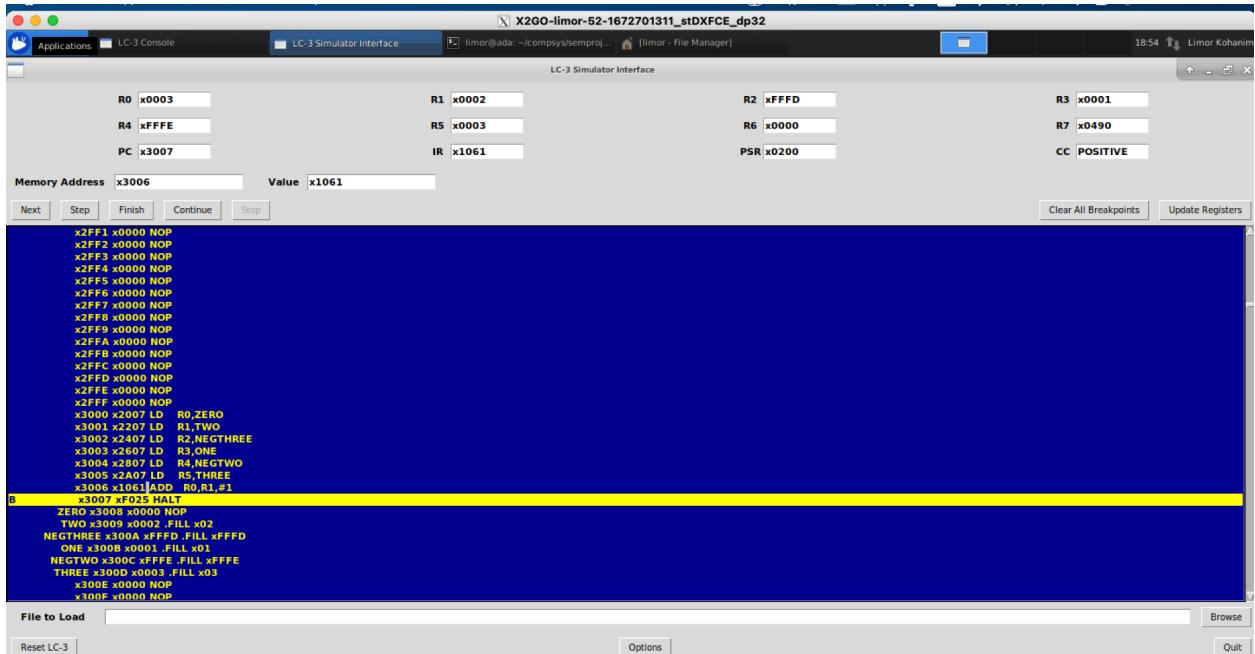
compsys > semproj > lc3tools > ASM SUB_test3.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R1, #-1
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22
23

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```
limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as SUB_test3.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2007
the current instruction's hexadecimal value is x2207
the current instruction's hexadecimal value is x2407
the current instruction's hexadecimal value is x2607
the current instruction's hexadecimal value is x2807
the current instruction's hexadecimal value is x2a07
the current instruction's hexadecimal value is x1061
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
limor@ada:~/compsys/sempproj/lc3tools$
```

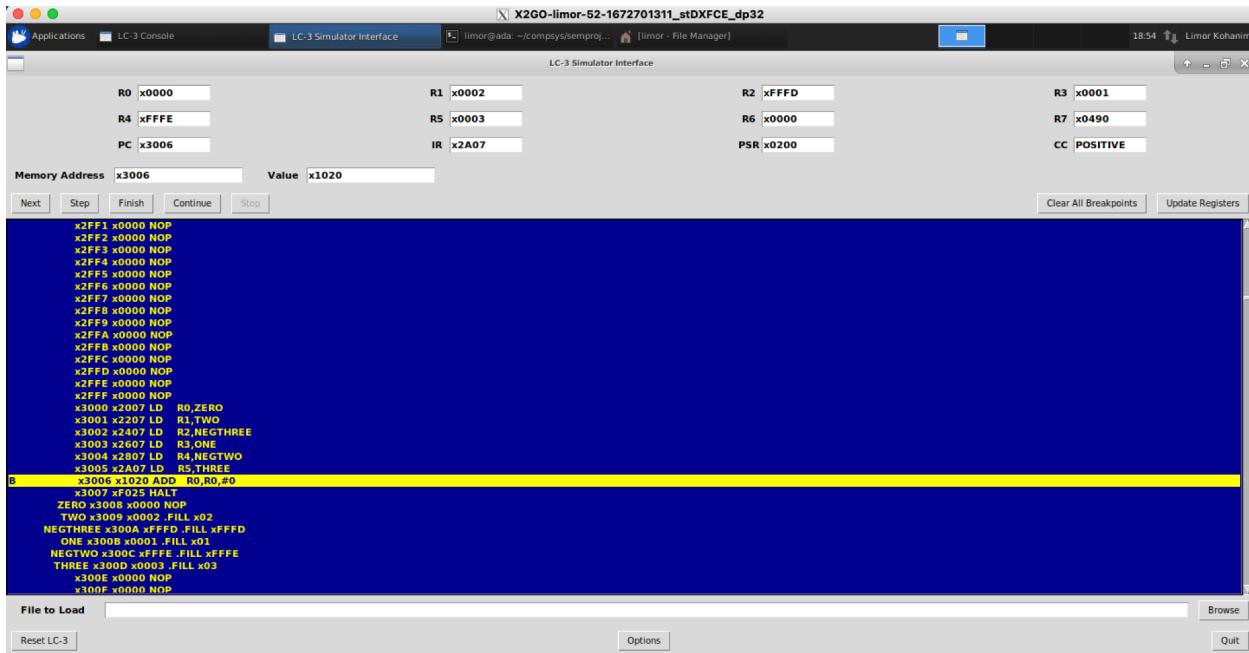
**SUB R0 0 0**

```

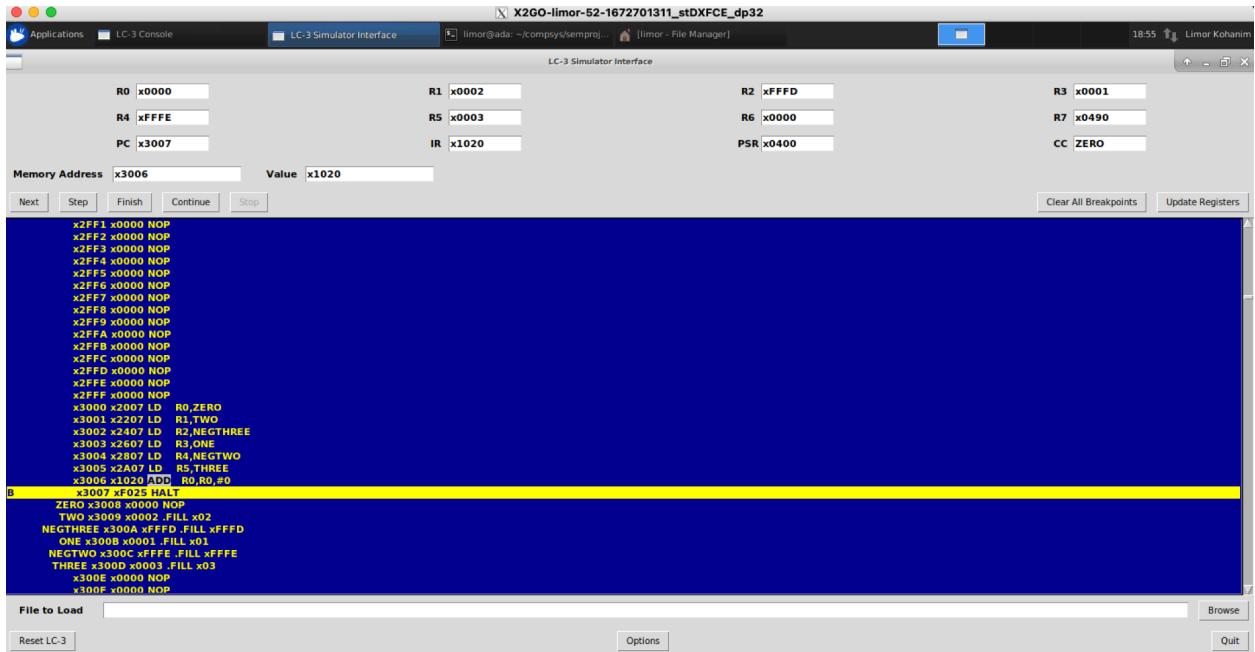
compsys> semproj > lc3tools > SUB_test4.asm
1    LD      R0, ZERO
2    LD      R1, TWO
3    LD      R2, NEGTHREE
4    LD      R3, ONE
5    LD      R4, NEGTWO
6    LD      R5, THREE
7
8    SUB R0, R0, #0
10
11
12    HALT
13    ;
14    ZERO     .FILL   x0000
15    TWO      .FILL   x0002
16    NEGTHREE .FILL   xFFFD
17    ONE      .FILL   x0001
18    NEGTWO   .FILL   xFFE
19    THREE    .FILL   x0003
20    ;
21    .END

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```

● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SUB_test4.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2007
the current instruction's hexadecimal value is x2207
the current instruction's hexadecimal value is x2407
the current instruction's hexadecimal value is x2607
the current instruction's hexadecimal value is x2807
the current instruction's hexadecimal value is x2a07
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xfffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/semproj/lc3tools$ █

```

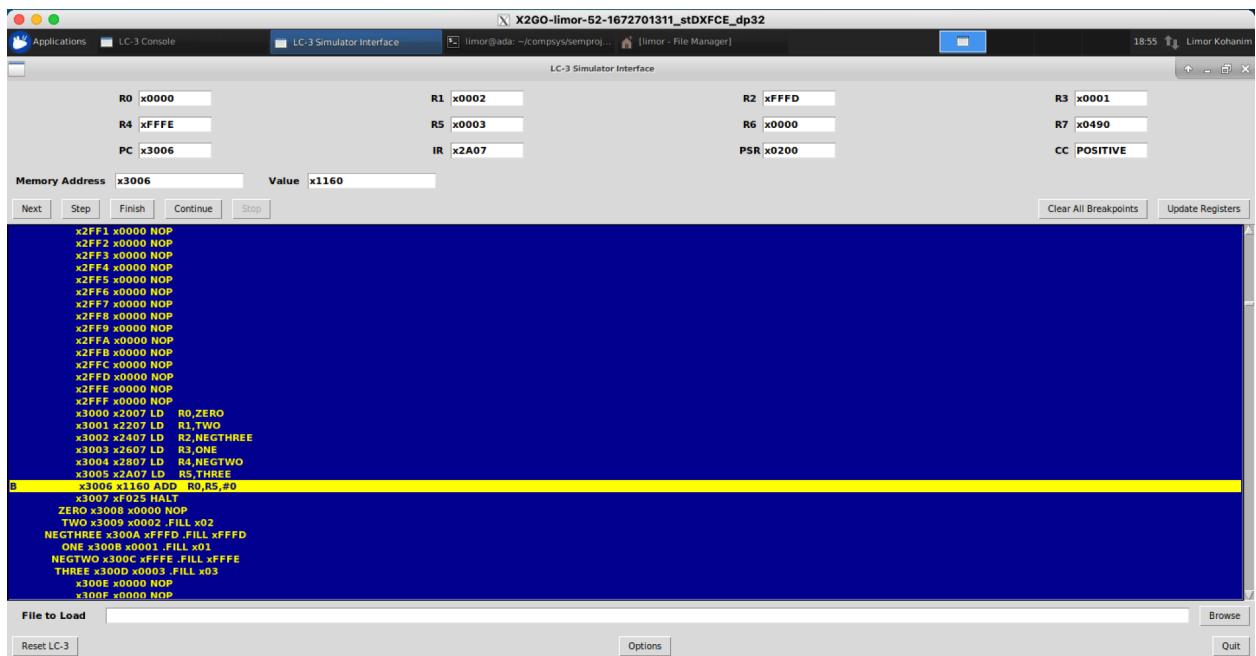
SUB R0 # 0

```

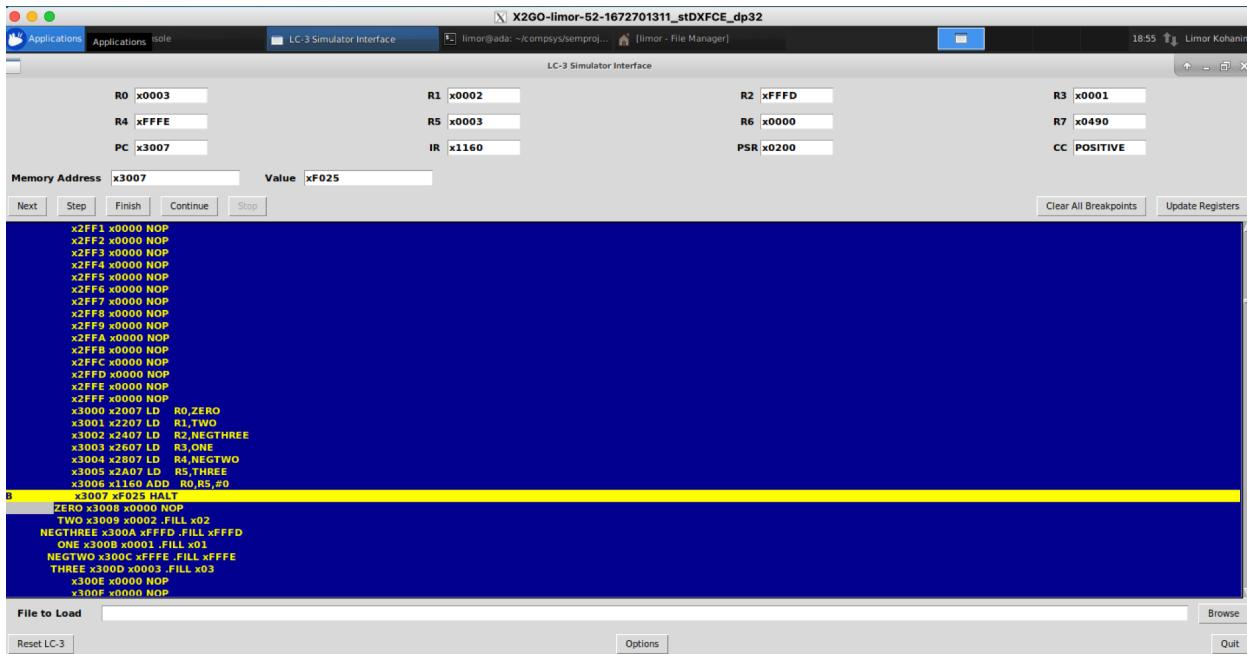
compsys > semproj > lc3tools > ASM SUB_test5.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R5, #0
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFE
18 THREE .FILL x0003
19 ;
20 .
21 .END
22

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

- **limor@ada:~/compsys/semproj/lc3tools\$ ./lc3as SUB\_test5.asm**

STARTING PASS 1  
0 errors found in first pass.  
STARTING PASS 2  
the current instruction's hexadecimal value is x3000  
the current instruction's hexadecimal value is x2007  
the current instruction's hexadecimal value is x2207  
the current instruction's hexadecimal value is x2407  
the current instruction's hexadecimal value is x2607  
the current instruction's hexadecimal value is x2807  
the current instruction's hexadecimal value is x2a07  
the current instruction's hexadecimal value is x1160  
the current instruction's hexadecimal value is xf025  
the current instruction's hexadecimal value is x0  
the current instruction's hexadecimal value is x2  
the current instruction's hexadecimal value is xfffd  
the current instruction's hexadecimal value is x1  
the current instruction's hexadecimal value is xfffe  
the current instruction's hexadecimal value is x3  
0 errors found in second pass.
- **limor@ada:~/compsys/semproj/lc3tools\$**

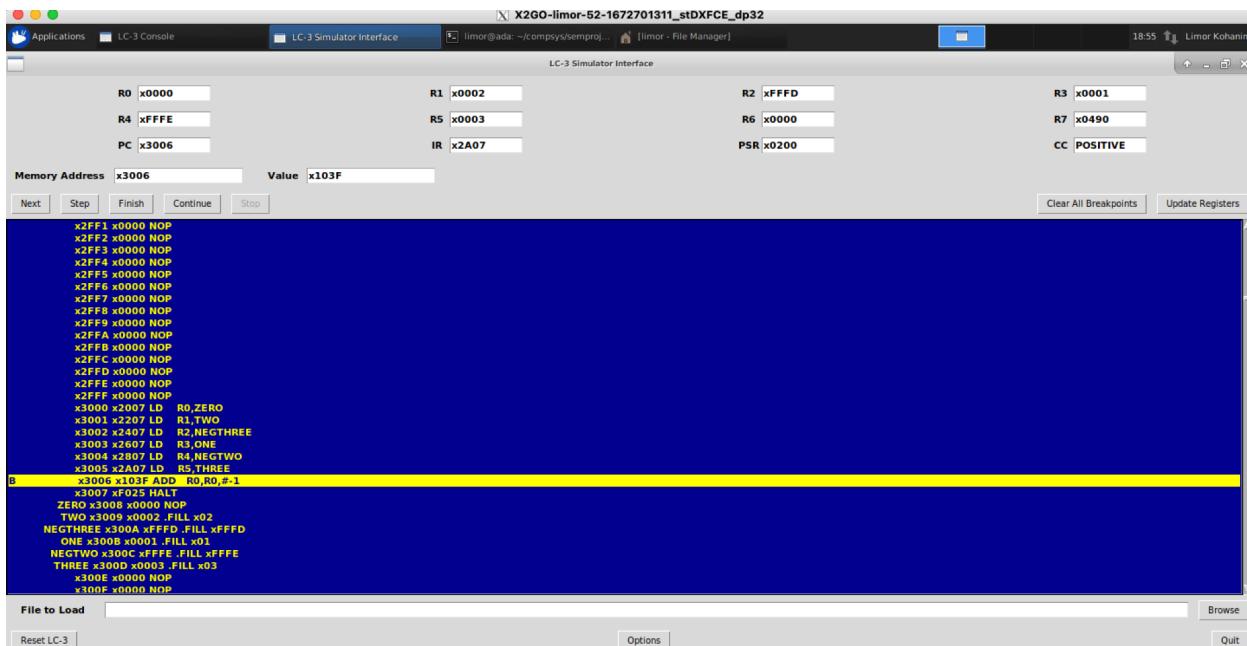
**SUB R0 0 #**

```

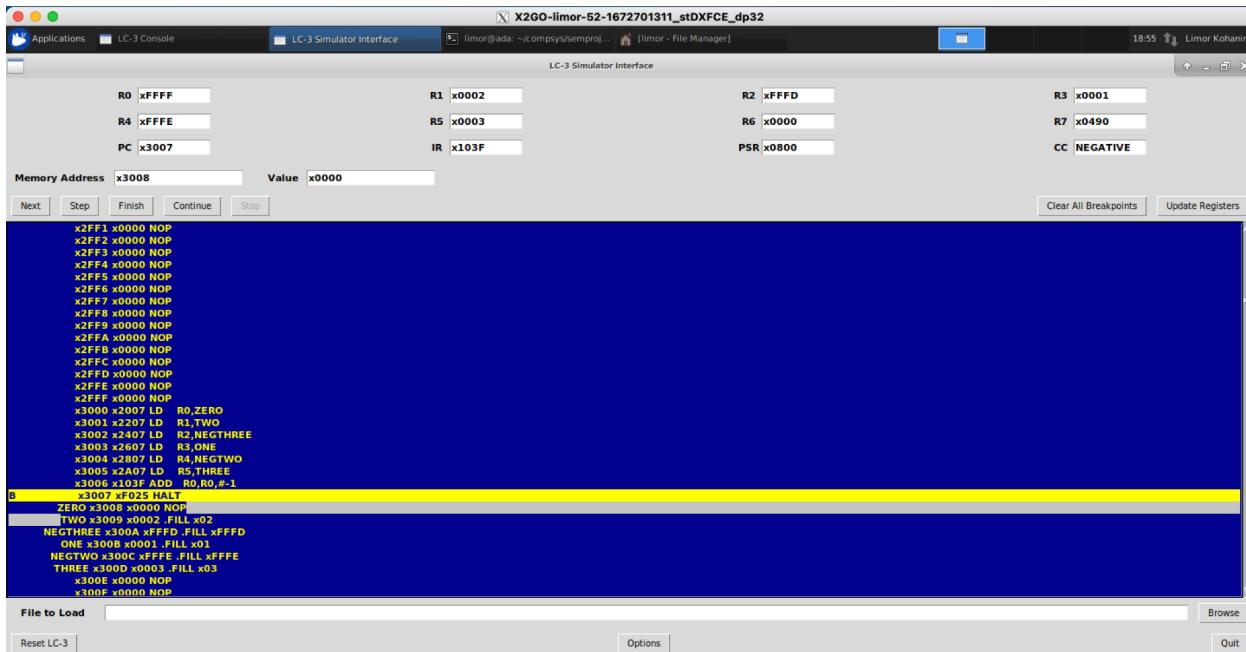
compsys > semproj > lc3tools > SUB_test6.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R0, #1
10
11
12 HALT
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFFF
19 THREE .FILL x0003
20 ;
21 .END
22

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

- Limor@ada:~/compsys/semproj/lc3tools\$ ./lc3as SUB\_test6.asm

```

STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2007
the current instruction's hexadecimal value is x2207
the current instruction's hexadecimal value is x2407
the current instruction's hexadecimal value is x2607
the current instruction's hexadecimal value is x2807
the current instruction's hexadecimal value is x2a07
the current instruction's hexadecimal value is x103f
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.

```

- Limor@ada:~/compsys/semproj/lc3tools\$

RRR format: R0 = 0, R1 = positive number, R2, negative number

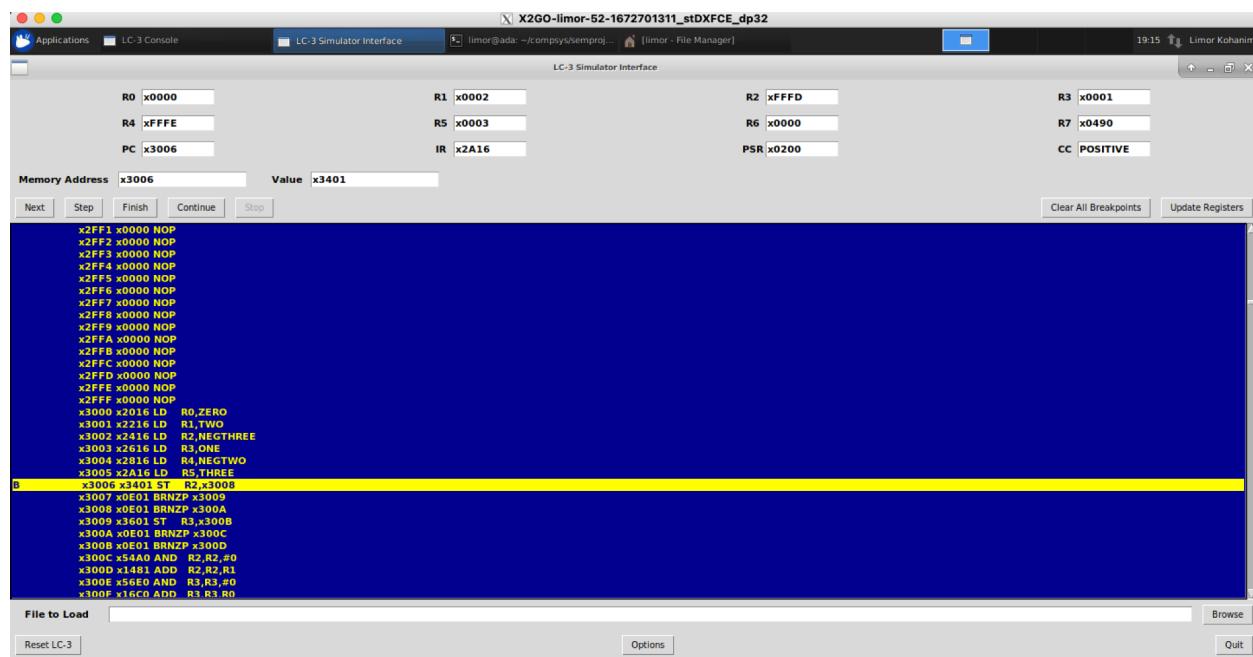
**SUB R1 R1 R0**

```

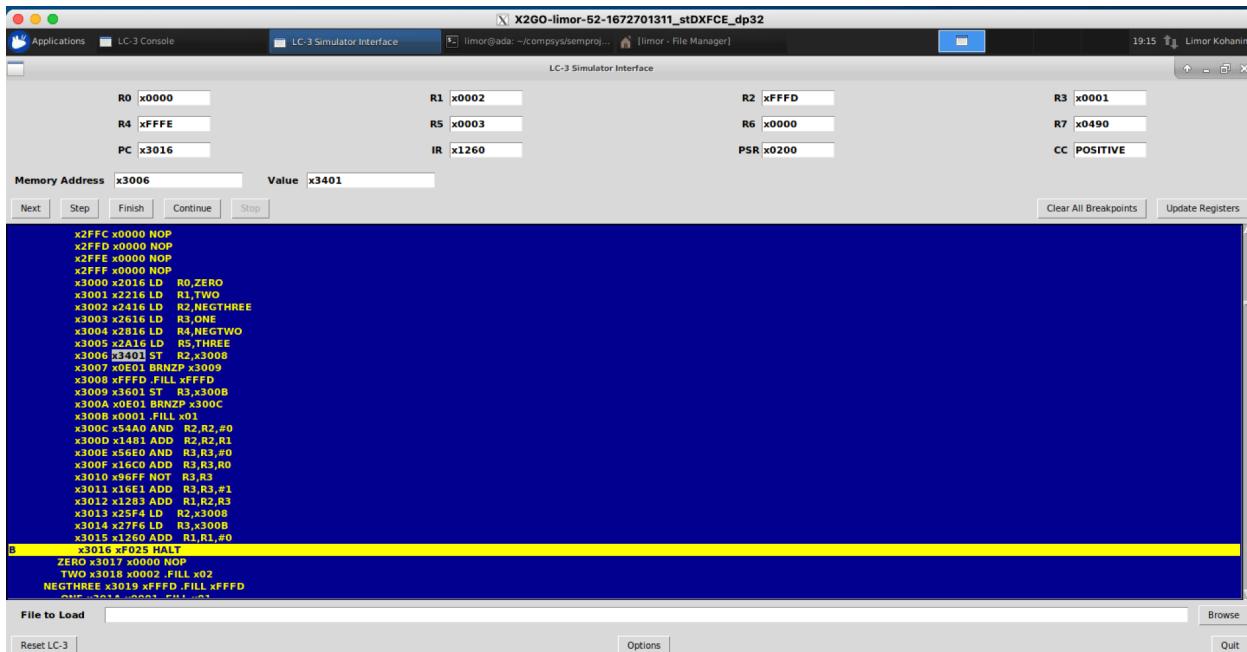
mpsys > semproj > lc3tools > ASM SUB_test7.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R1, R1, R0
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFE
18 THREE .FILL x0003
19 ;
20 .END

```

## BEFORE instruction



## AFTER instruction



## HEX vals of instructions in this last edge case

```

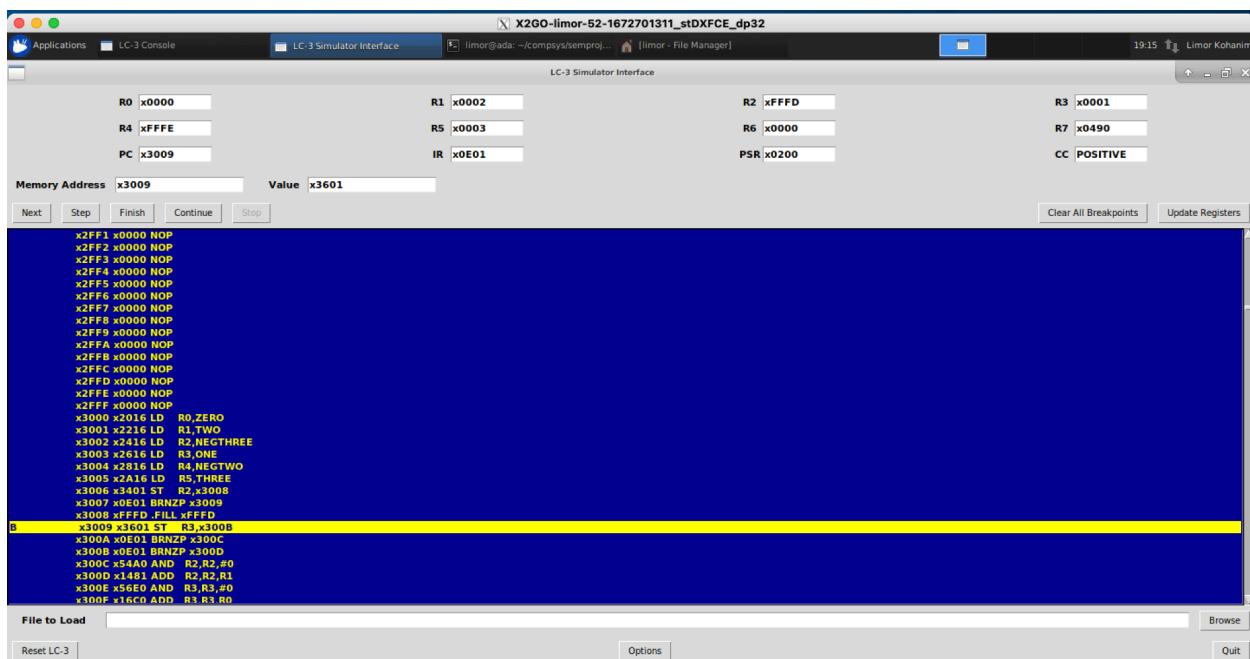
● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as SUB_test7.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2016
the current instruction's hexadecimal value is x2216
the current instruction's hexadecimal value is x2416
the current instruction's hexadecimal value is x2616
the current instruction's hexadecimal value is x2816
the current instruction's hexadecimal value is x2a16
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c0
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x1283
the current instruction's hexadecimal value is x25f4
the current instruction's hexadecimal value is x27f6
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xfffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/sempproj/lc3tools$ 

```

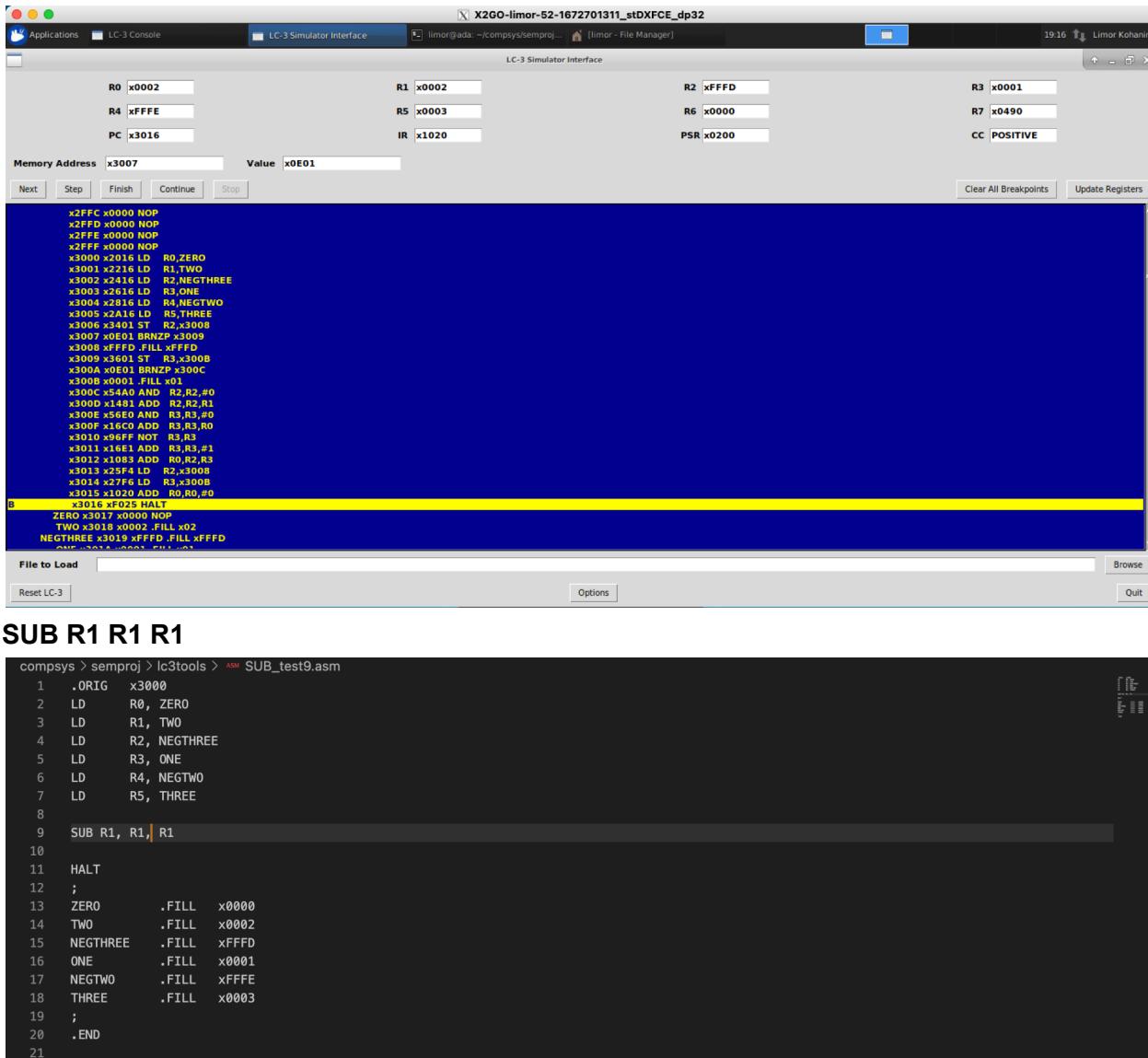
## SUB R0 R1 R0

```
compsys > semproj > lc3tools > ASM SUB_test8.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R1, R0
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFFE
18 THREE .FILL x0003
19 ;
20 .END
21
22
```

## BEFORE instruction



## AFTER instruction



## SUB R1 R1 R1

```

compsys > semproj > lc3tools > SUB_test9.asm
1  .ORIG  x3000
2  LD    R0, ZERO
3  LD    R1, TWO
4  LD    R2, NEGTHREE
5  LD    R3, ONE
6  LD    R4, NEGTHREE
7  LD    R5, THREE
8
9  SUB  R1, R1|R1
10
11 HALT
12 ;
13 ZERO   .FILL  x0000
14 TWO    .FILL  x0002
15 NEGTHREE .FILL  xFFFD
16 ONE    .FILL  x0001
17 NEGTHREE .FILL  xFFFE
18 THREE  .FILL  x0003
19 ;
20 .END
21

```

BEFORE instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

Memory Address x3006 Value x3001

Registers:

R0	x0000
R4	xFFFE
PC	x3006
R1	x0002
R5	x0003
IR	x2A16
R2	xFFFF
R6	x0000
PSR	x0200
R3	x0001
R7	x0490
CC	POSITIVE

Buttons: Next, Step, Finish, Continue, Stop, Clear All Breakpoints, Update Registers

```

x2FF1 x0000 NOP
x2FF2 x0000 NOP
x2FF3 x0000 NOP
x2FF4 x0000 NOP
x2FF5 x0000 NOP
x2FF6 x0000 NOP
x2FF7 x0000 NOP
x2FF8 x0000 NOP
x2FF9 x0000 NOP
x2FFA x0000 NOP
x2FFB x0000 NOP
x2FFC x0000 NOP
x2FFD x0000 NOP
x2FFE x0000 NOP
x3000 x2016 LD R0,ZERO
x3001 x2216 LD R1,TWO
x3002 x2416 LD R2,NEGTHREE
x3003 x2616 LD R3,ONE
x3004 x2816 LD R4,NEG TWO
x3005 x2A16 LD R5,THREE
x3006 x2C16 LD R6,NEG ONE
x3007 x0E01 BRNZP x3009
x3008 x0E01 BRNZP x300A
x3009 x3401 ST R2,x300B
x300A x0E01 BRNZP x300C
x300B x0E01 BRNZP x300D
x300C x1001 ADD R0,R0,#0
x300D x1001 ADD R0,R0,#1
x300E x54A0 AND R2,R2,#0
x300F x1481 ADD R2,R2,#1

```

File to Load: [Browse] Options Reset LC-3 Quit

## AFTER instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

Memory Address x3006 Value x3001

Registers:

R0	x0000
R4	xFFFE
PC	x3016
R1	x0000
R5	x0003
IR	x1260
R2	xFFFF
R6	x0000
PSR	x0400
R3	x0001
R7	x0490
CC	ZERO

Buttons: Next, Step, Finish, Continue, Stop, Clear All Breakpoints, Update Registers

```

x2FFC x0000 NOP
x2FFD x0000 NOP
x2FFE x0000 NOP
x3000 x2016 LD R0,ZERO
x3001 x2216 LD R1,TWO
x3002 x2416 LD R2,NEGTHREE
x3003 x2616 LD R3,ONE
x3004 x2816 LD R4,NEG TWO
x3005 x2A16 LD R5,THREE
x3006 x3001 ST R0,x300B
x3007 x0E01 BRNZP x3009
x3008 x0000 NOP
x3009 x3401 ST R2,x300B
x300A x0E01 BRNZP x300C
x300B x1001 ADD R0,R0,#0
x300D x1001 ADD R0,R0,#1
x300E x54A0 AND R2,R2,#0
x300F x1481 ADD R2,R2,#1
x3010 x94BF NOT R2,R2
x3011 x14A1 ADD R2,R2,#1
x3012 x1202 ADD R1,R1
x3013 x1203 ADD R1,R1
x3014 x25F6 LD R2,x300B
x3015 x1260 ADD R1,R1,#0
B x3016 xF025 HALT
ZERO x3017 x0000 NOP
TWO x3018 x0002 .FILL x02
NEGTHREE x3019xFFFF .FILL xFFFF

```

File to Load: [Browse] Options Reset LC-3 Quit

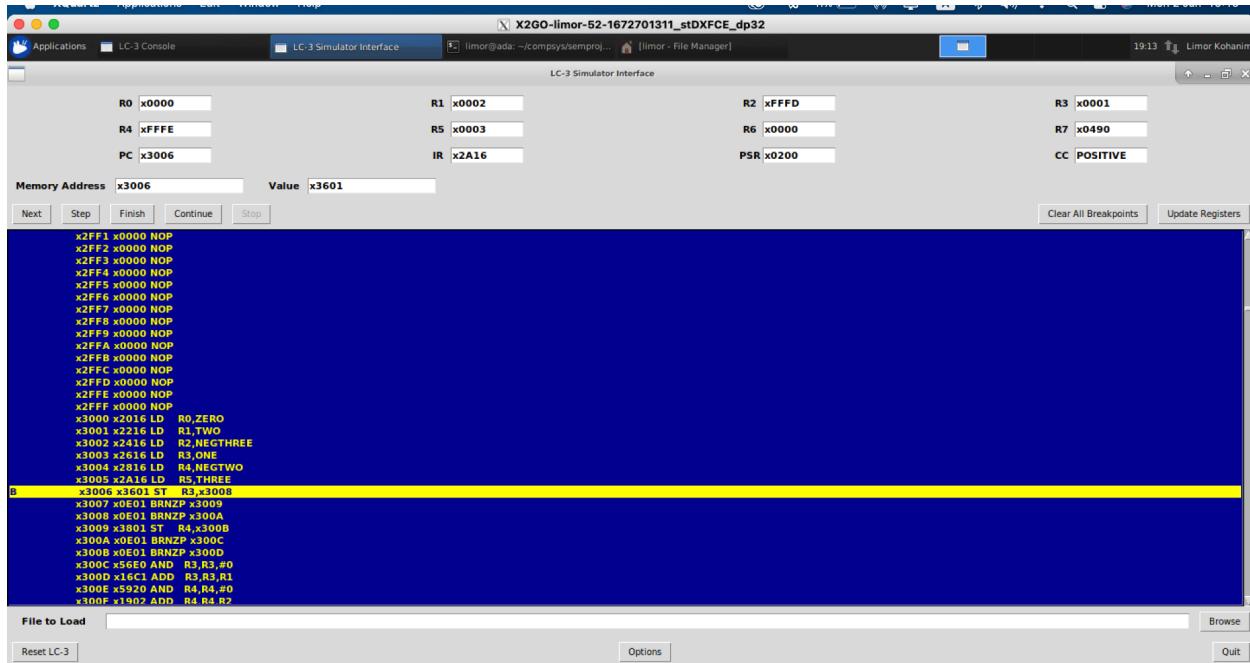
## SUB R0 R1 R2 (positive - negative)

```

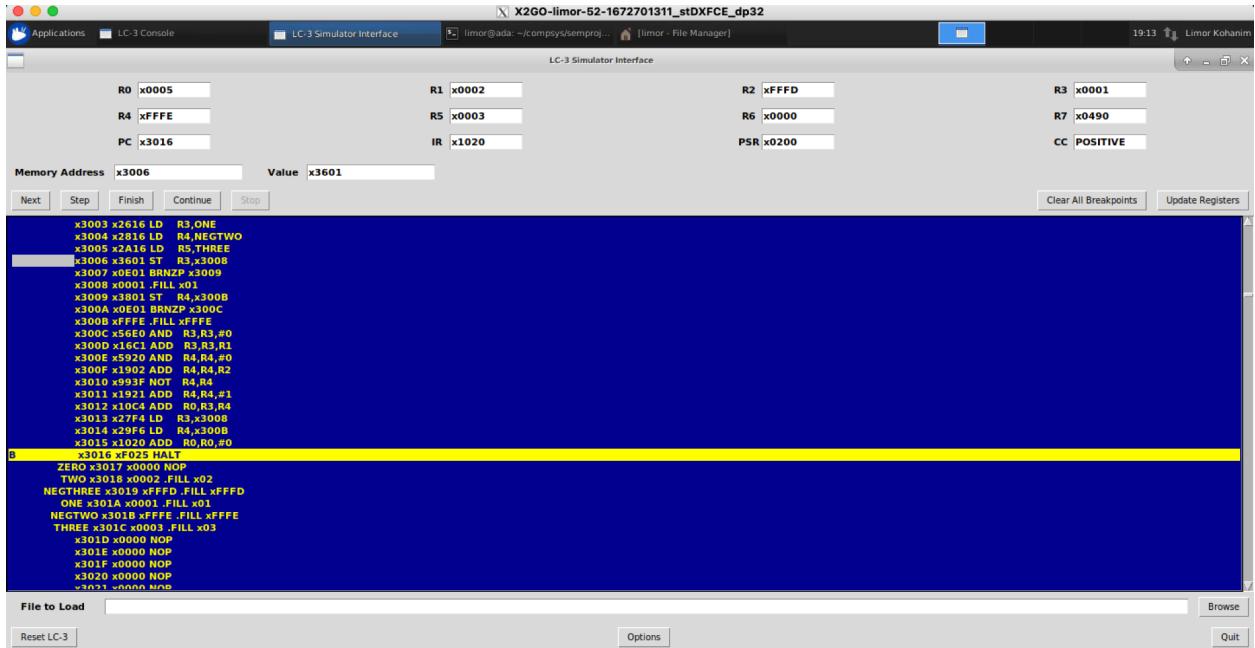
compsys > semproj > lc3tools > SUB_test10.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SUB R0, R1, R2
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFFE
18 THREE .FILL x0003
19 ;
20 .END
21
22

```

## BEFORE instruction



## AFTER instruction



## SUB R2, R2, R1 (negative - positive)

```

compsys > semproj > lc3tools > ASM SUB_test11.asm
1   .ORIG x3000
2   LD    R0, ZERO
3   LD    R1, TWO
4   LD    R2, NEGTHREE
5   LD    R3, ONE
6   LD    R4, NEGTHREE
7   LD    R5, THREE
8
9   SUB R2, R2, R1
10
11  HALT
12 ;
13  ZERO    .FILL x0000
14  TWO     .FILL x0002
15  NEGTHREE .FILL xFFFD
16  ONE     .FILL x0001
17  NEGTHREE .FILL xFFFE
18  THREE   .FILL x0003
19 ;
20 .END
21
22

```

BEFORE instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

limor@ada: ~/compsys/semprog... Limor - File Manager] 19:12 Limor Kohanim

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 xFFFD	R3 x0001
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x3006	IR x2A16	PSR x0200	CC POSITIVE

Memory Address x3006 Value x3001

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x2FF1 x0000 NOP
x2FF2 x0000 NOP
x2FF3 x0000 NOP
x2FF4 x0000 NOP
x2FF5 x0000 NOP
x2FF6 x0000 NOP
x2FF7 x0000 NOP
x2FF8 x0000 NOP
x2FF9 x0000 NOP
x2FFA x0000 NOP
x2FFB x0000 NOP
x2FFC x0000 NOP
x2FFD x0000 NOP
x2FFE x0000 NOP
x2FFF x0000 NOP
x3000 x2016 LD R0,ZERO
x3001 x2216 LD R1,TWO
x3002 x2416 LD R2,NEGTHREE
x3003 x2616 LD R3,ONE
x3004 x2816 LD R4,NEGTHREE
x3005 x2A16 LD R5,THREE
x3006 x3001 ST R0,x3008
x3007 x0E01 BRNZP x3009
x3008 x0E01 BRNZP x300A
x3009 x3601 ST R3,x300B
x300A x0E01 BRNZP x300C
x300B x0E01 BRNZP x300D
x300C x5020 AND R0,R0,#0
x300D x1002 ADD R0,R0,R2
x300E x56E0 ADD R3,R3,#2
x300F x16C1 ADD R3,R3,R1

```

B x3006 x3001 ST R0,x3008

File to Load Browse Options Reset LC-3 Quit

AFTER instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

limor@ada: ~/compsys/semprog... Limor - File Manager] 19:12 Limor Kohanim

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 xFFFB	R3 x0001
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x3016	IR x14A0	PSR x0800	CC NEGATIVE

Memory Address x3006 Value x3001

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x2FFC x0000 NOP
x2FFD x0000 NOP
x2FF1 x0000 NOP
x2FF2 x0000 NOP
x3000 x2016 LD R0,ZERO
x3001 x2216 LD R1,TWO
x3002 x2416 LD R2,NEGTHREE
x3003 x2616 LD R3,ONE
x3004 x2816 LD R4,NEGTHREE
x3005 x2A16 LD R5,THREE
x3006 x3601 ST R3,x300B
x3007 x0E01 BRNZP x3009
x3008 x0000 NOP
x3009 x3601 ST R3,x300B
x300A x0E01 BRNZP x300C
x300B x0001 FILL x01
x300C x5020 AND R0,R0,#0
x300D x1002 ADD R0,R0,R2
x300E x56E0 AND R3,R3,#0
x300F x16C1 ADD R3,R3,R1
x3010 x96FF NOT R3,R3
x3011 x16E1 ADD R3,R3,#1
x3012 x1403 ADD R2,R0,R3
x3013 x21F4 LD R0,x3008
x3014 x27F6 LD R3,x300B
x3015 x0000 FILL R0,R2,R0
B x3016 xF02 HALT
ZERO x3017 x0000 NOP
TWO x3018 x0002 FILL x02
NEGTHREE x3019 xFFFD FILL xFFFD
ONE x301A x0001 FILL x01

```

B x3016 xF02 HALT

File to Load Browse Options Reset LC-3 Quit

HEX vals of instructions in this last edge case

```

● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SUB_test11.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2016
the current instruction's hexadecimal value is x2216
the current instruction's hexadecimal value is x2416
the current instruction's hexadecimal value is x2616
the current instruction's hexadecimal value is x2816
the current instruction's hexadecimal value is x2a16
the current instruction's hexadecimal value is x3001
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x1403
the current instruction's hexadecimal value is x21f4
the current instruction's hexadecimal value is x27f6
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/semproj/lc3tools$ █

```

## test MLT: RRI, RRR

; R0 = 0, R1 = positive number, R2, negative number

RRI

**MLT R0, R0, #0**

**0 \* 0**

```

compsys > semproj > lc3tools > ASH MLT_test.asm
1   .ORIG  x3000
2   LD    R0, ZERO
3   LD    R1, TWO
4   LD    R2, NEGTHREE
5   LD    R3, ONE
6   LD    R4, NEGTwo
7   LD    R5, THREE
8
9   MLT R0, R0, #0
10
11
12 HALT
13 ;
14 ZERO    .FILL  x0000
15 TWO     .FILL  x0002
16 NEGTHREE .FILL  xFFFD
17 ONE     .FILL  x0001
18 NEGTwo  .FILL  xFFE
19 THREE   .FILL  x0003
20 ;
21 .END
22

```

BEFORE instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 xFFFD	R3 x0001
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x3006	IR x2A2B	PSR x0200	CC POSITIVE

Memory Address x3006 Value x3201

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x2F1 x0000 NOP
x2F2 x0000 NOP
x2F3 x0000 NOP
x2F4 x0000 NOP
x2F5 x0000 NOP
x2F6 x0000 NOP
x2F7 x0000 NOP
x2F8 x0000 NOP
x2F9 x0000 NOP
x2FA x0000 NOP
x2FB x0000 NOP
x2FC x0000 NOP
x2FD x0000 NOP
x2FE x0000 NOP
x2FF x0000 NOP
x3000 x2028 LD R0,ZERO
x3001 x222B LD R1,TWO
x3002 x242B LD R2,NEGTHREE
x3003 x262B LD R3,ONE
x3004 x282B LD R4,NEGTWO
x3005 x2A2B LD R5,THREE
B x3006 x3201 ST R1,x3008
x3007 xE01 BRNZP x3009
x3008 xE01 BRNZP x300A
x3009 x3401 ST R2,x300B
x300A xE01 BRNZP x300C
x300B x3601 ST R3,x300D
x300C x3601 ST R3,x300E
x300D xE01 BRNZP x300F
x300E xE01 BRNZP x3010
x300F x760 AND R1 R1 #0

```

File to Load Browse Options Quit

Reset LC-3

## AFTER instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 xFFFD	R3 xFFFD
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x302B	IR x1020	PSR x0400	CC ZERO

Memory Address x302B Value xF025

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x3015 x940F NOT R2,R2
x3016 x14A1 ADD R2,R2,#1
x3017 x1260 ADD R1,R1,#0
x3018 x0602 BRNZP x301B
x3019 x920F NOT R1,R1
x301A x1601 ADD R1,R1,#1
x301B x56E0 AND R3,R3,#0
x301C x14A0 ADD R2,R2,#0
x301D x0403 BRZ x3021
x301E x16C1 ADD R3,R3,R1
x301F x140F ADD R2,R2,#-1
x3020 x03FD BRP x301E
x3021 x1020 ADD R0,R0,#0
x3022 x35E8 LD R2,x300B
x3023 x1020 ADD R0,R0,#0
x3024 x0802 BRN x3027
x3025 x96FF NOT R3,R3
x3026 x16E1 ADD R3,R3,#1
x3027 x5020 AND R0,R0,#0
x3028 x37E1 ADD R0,R0,#0
x3029 x37E1 LD R3,x300B
x302A x1020 ADD R0,R0,#0
B x302B xF025 HALT
ZERO x302C x0000 NOP
TWO x302D x0002 .FILL x02
NEGTHREE x302E xFFFD .FILL xFFFD
ONE x302F x0001 .FILL x01
NEGTHREE x3030 xFFFF .FILL xFFFF
THREE x3031 x0003 .FILL x03
x3032 x0000 NOP
x3033 x0000 NOP

```

File to Load Browse Options Quit

Reset LC-3

## HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as MLT_test.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1240
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x14bf
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x23e6
the current instruction's hexadecimal value is x25e8
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is x802
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1003
the current instruction's hexadecimal value is x27e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

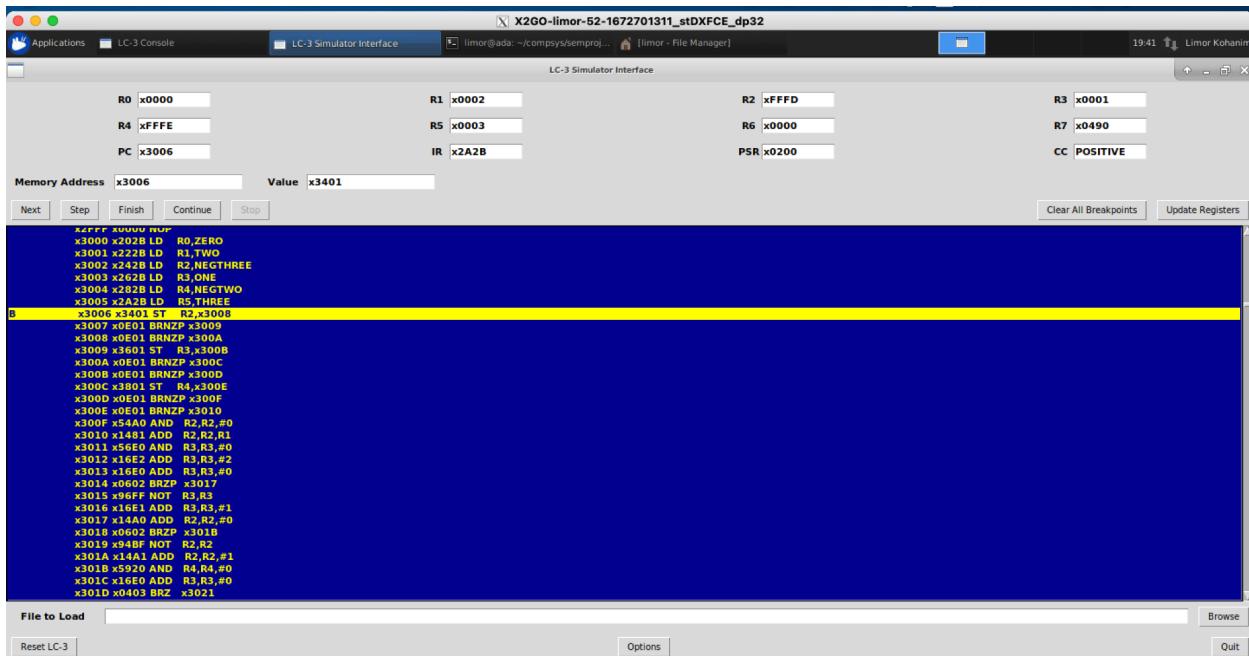
```
○ limor@ada:~/compsys/semproj/lc3tools$
```

MLT R0, R1, #positivenum

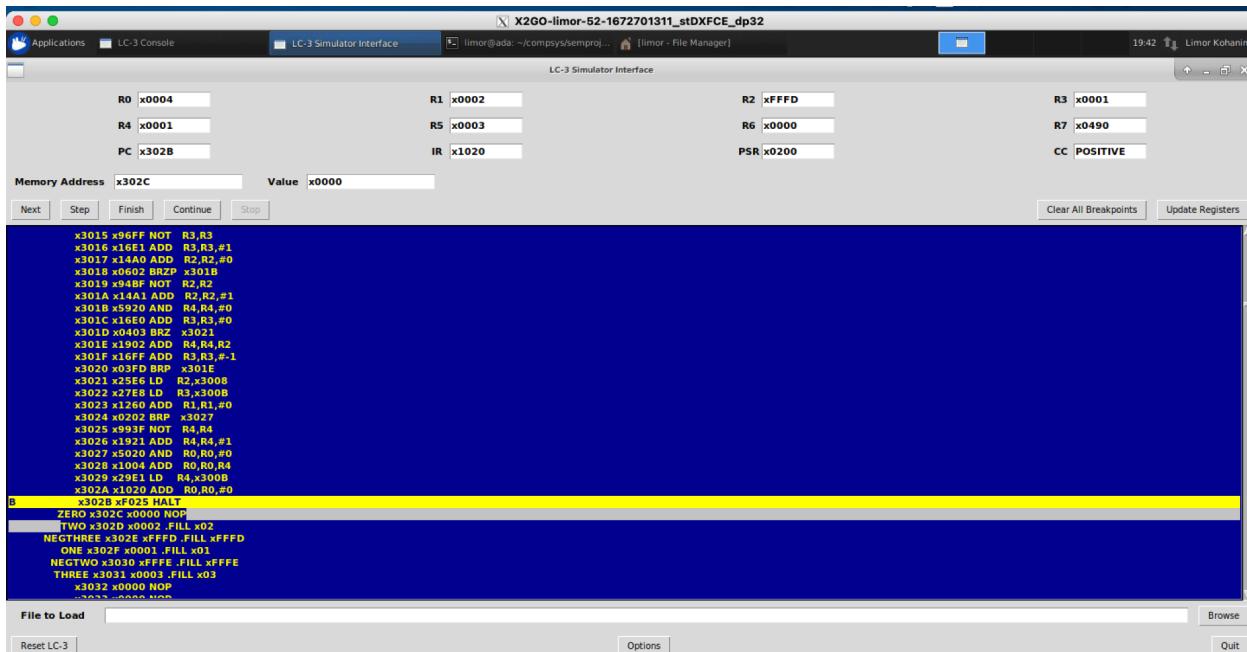
positive \* positive

```
compsys > semproj > lc3tools > ASM MLT_test1.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R0, R1, #2
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFE
18 THREE .FILL x0003
19 ;
20 .
21 .END
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

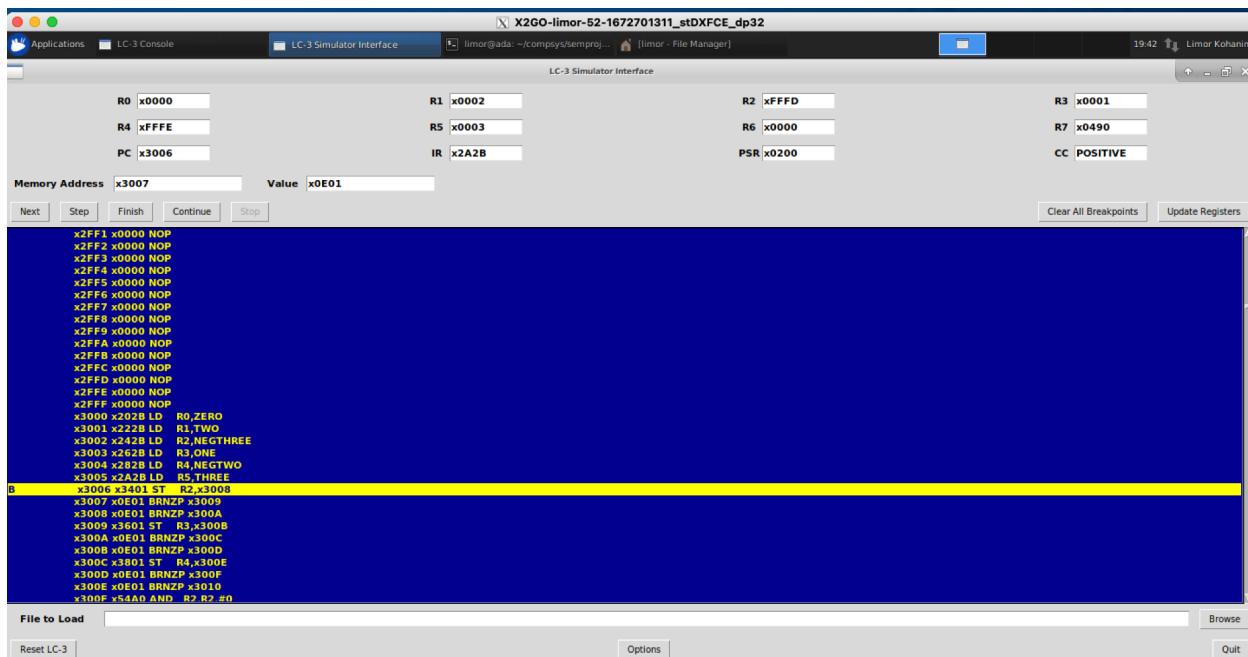
```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as MLT_test1.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16e2
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1902
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x25e6
the current instruction's hexadecimal value is x27e8
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x202
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1004
the current instruction's hexadecimal value is x29e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

MLT R0, R1, #negativenum

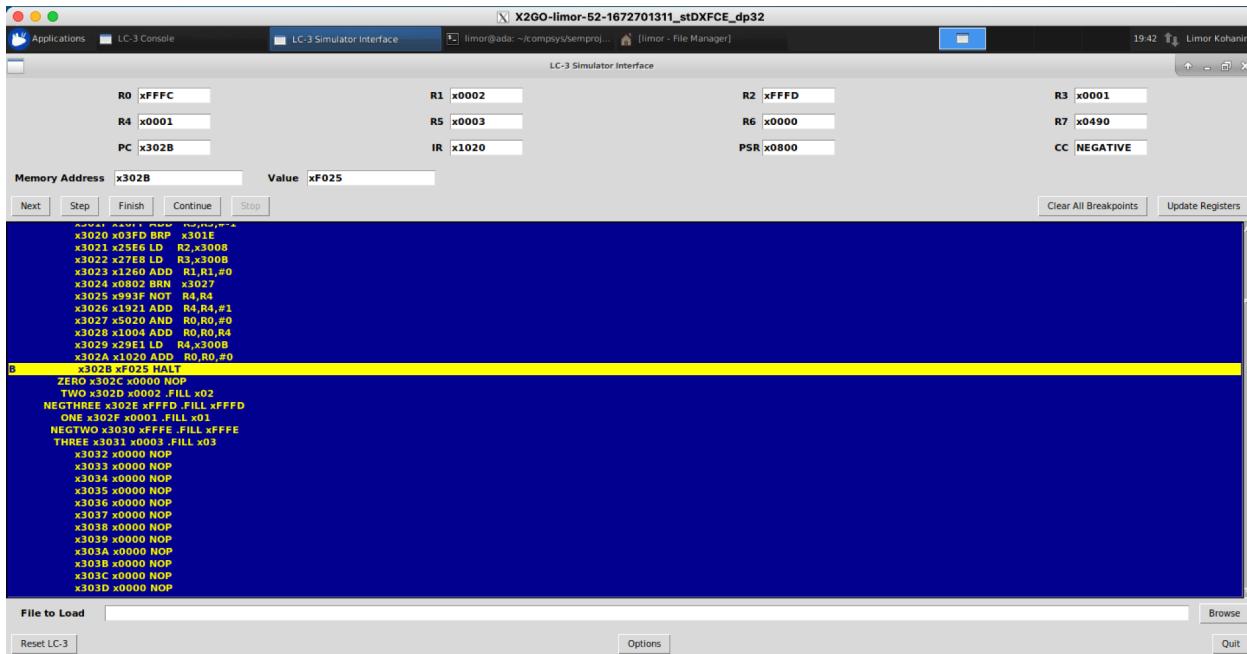
positive \* negative

```
compsys > semproj > lc3tools > x86 MLT_test2.asm
1 .ORIG X3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R0, R1, #-2
10
11 HALT
12 ;
13 ZERO .FILL X0000
14 TWO .FILL X0002
15 NEGTHREE .FILL XFFFFD
16 ONE .FILL X0001
17 NEGTWO .FILL XFFFE
18 THREE .FILL X0003
19 ;
20 ;
21 .END
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```
limor@ada:~/compsys/semproj/lc3tools$ ./lc3as MLT_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16fe
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1902
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x25e6
the current instruction's hexadecimal value is x27e8
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x802
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1004
the current instruction's hexadecimal value is x29e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

```
limor@ada:~/compsys/semproj/lc3tools$
```

**MLT R0, R1, #0**

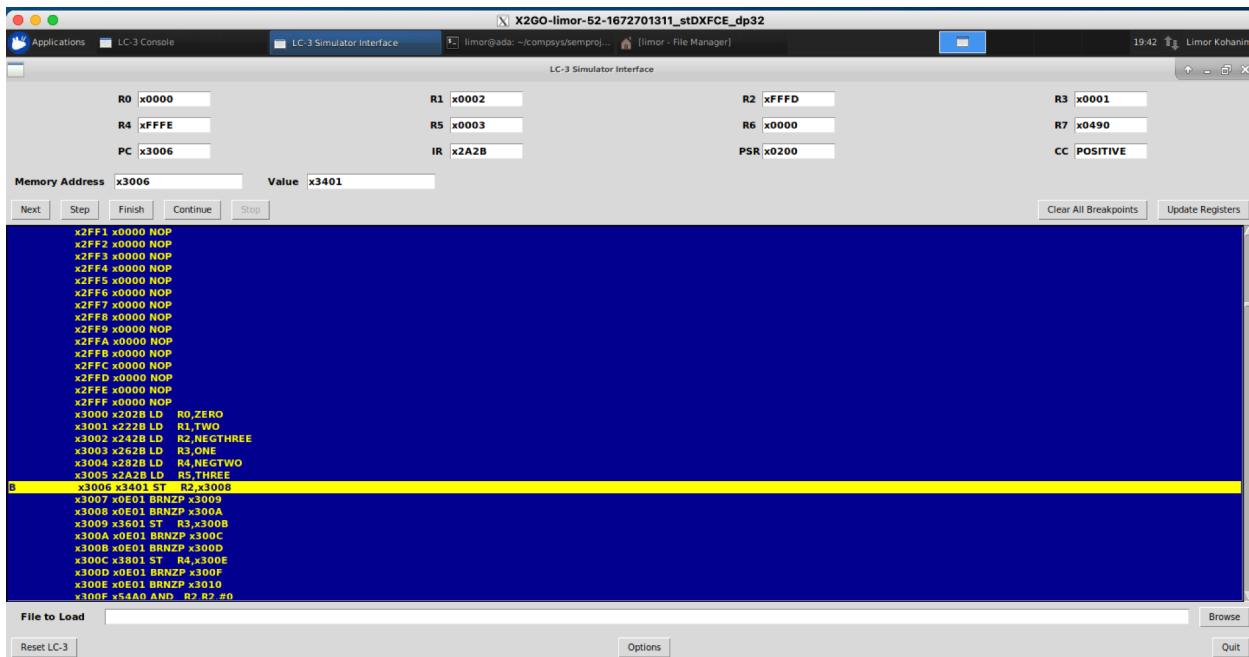
**positive \* 0**

```

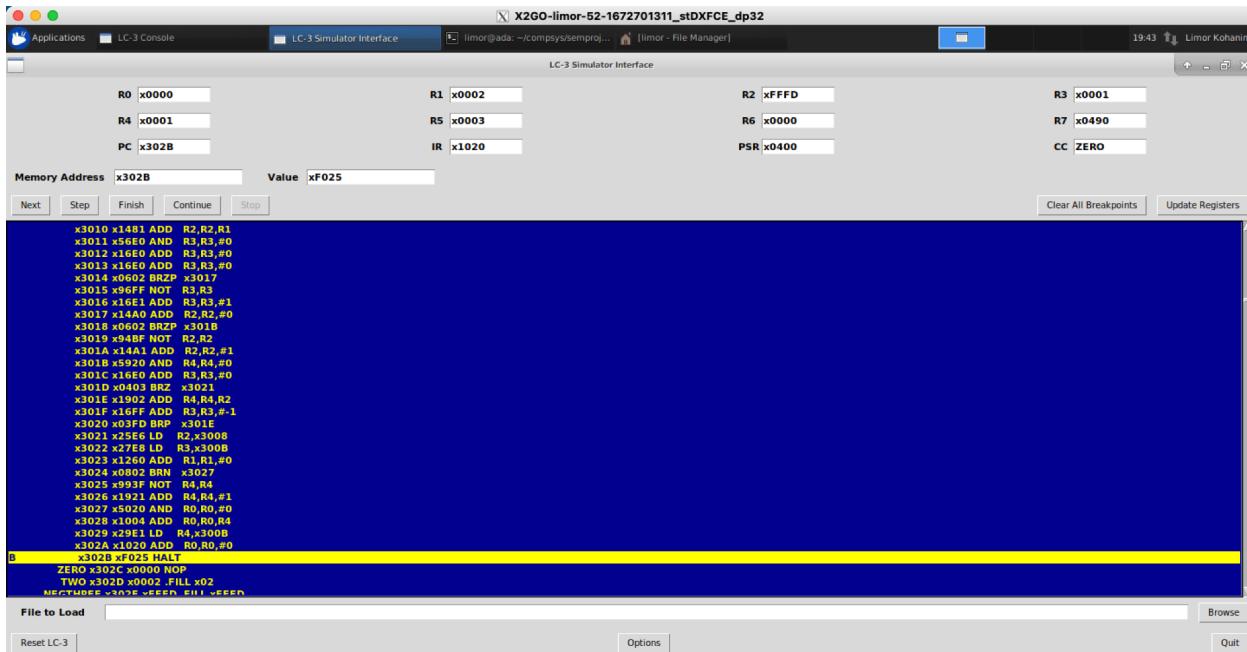
compsys > semproj > lc3tools > asm MLT_test3.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTwo
7 LD R5, THREE
8
9 MLT R0, R1, #0
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTwo .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as MLT_test3.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1902
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x25e6
the current instruction's hexadecimal value is x27e8
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x802
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1004
the current instruction's hexadecimal value is x29e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

**MLT R0, R2, #positivenum**

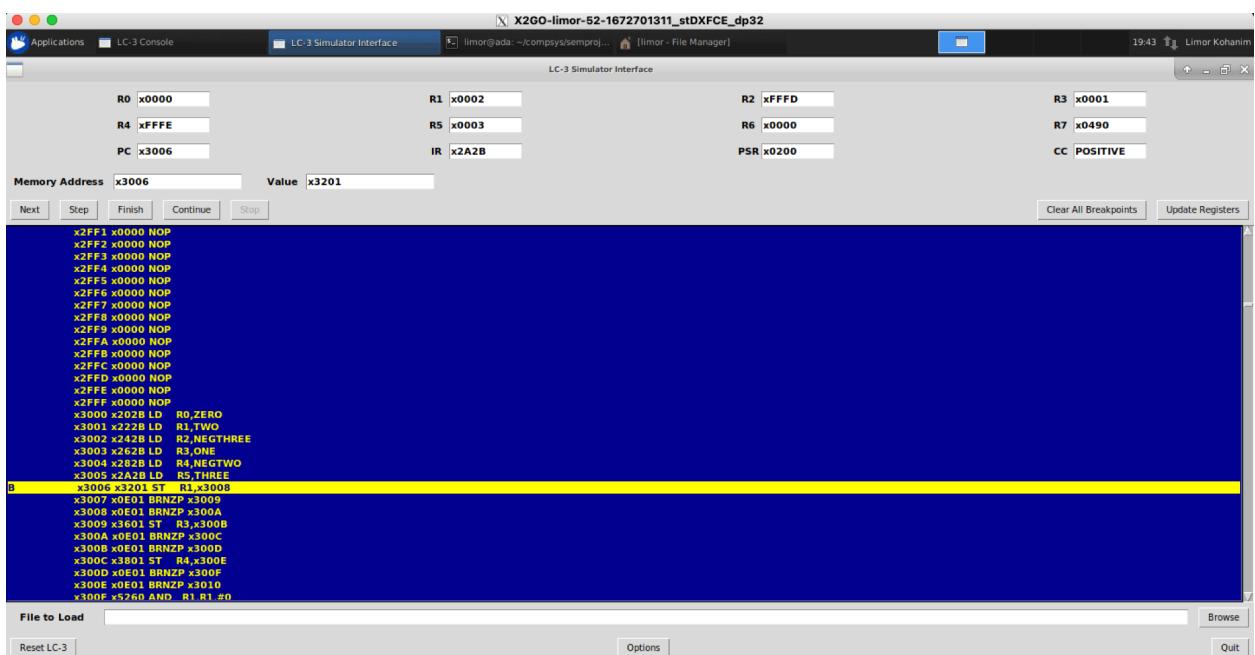
**negative \* positive**

```

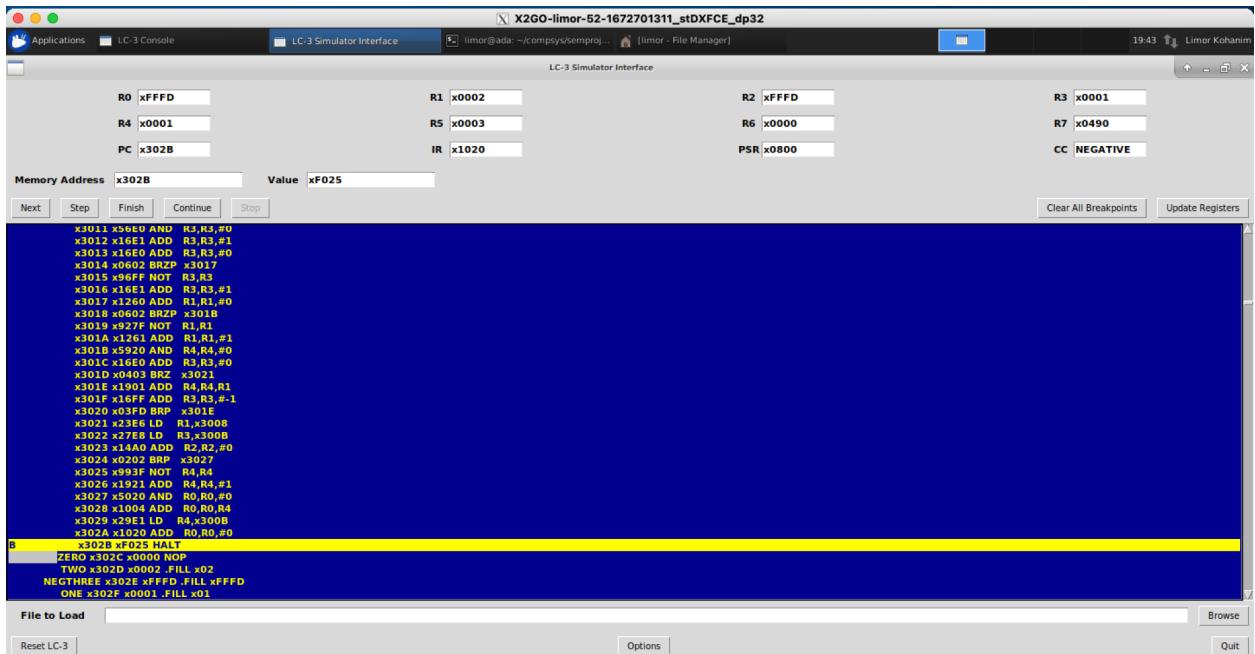
compsys > semproj > lc3tools > asm MLT_test4.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R0, R2, #1
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFE
18 THREE .FILL x0003
19 ;
20
21 .END

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```
Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as MLT_test4.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1901
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x23e6
the current instruction's hexadecimal value is x27e8
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x202
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1004
the current instruction's hexadecimal value is x29e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
Limor@ada:~/compsys/sempproj/lc3tools$
```

MLT R0, R2, #negativenum

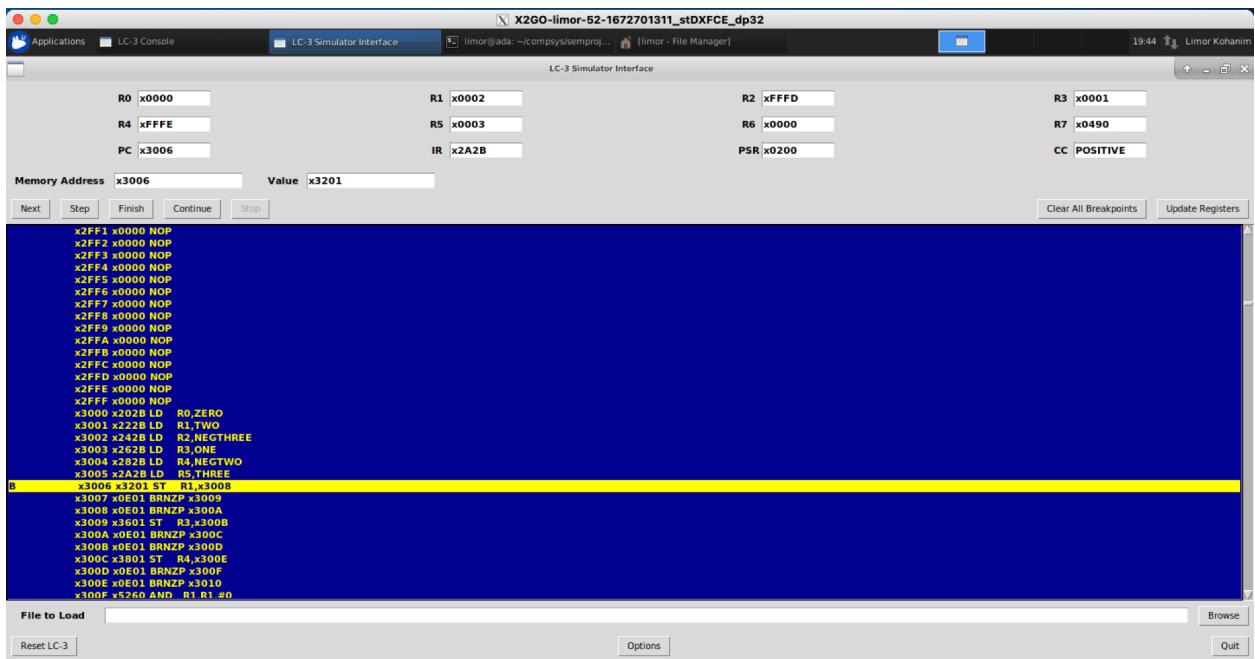
negative \* negative

```

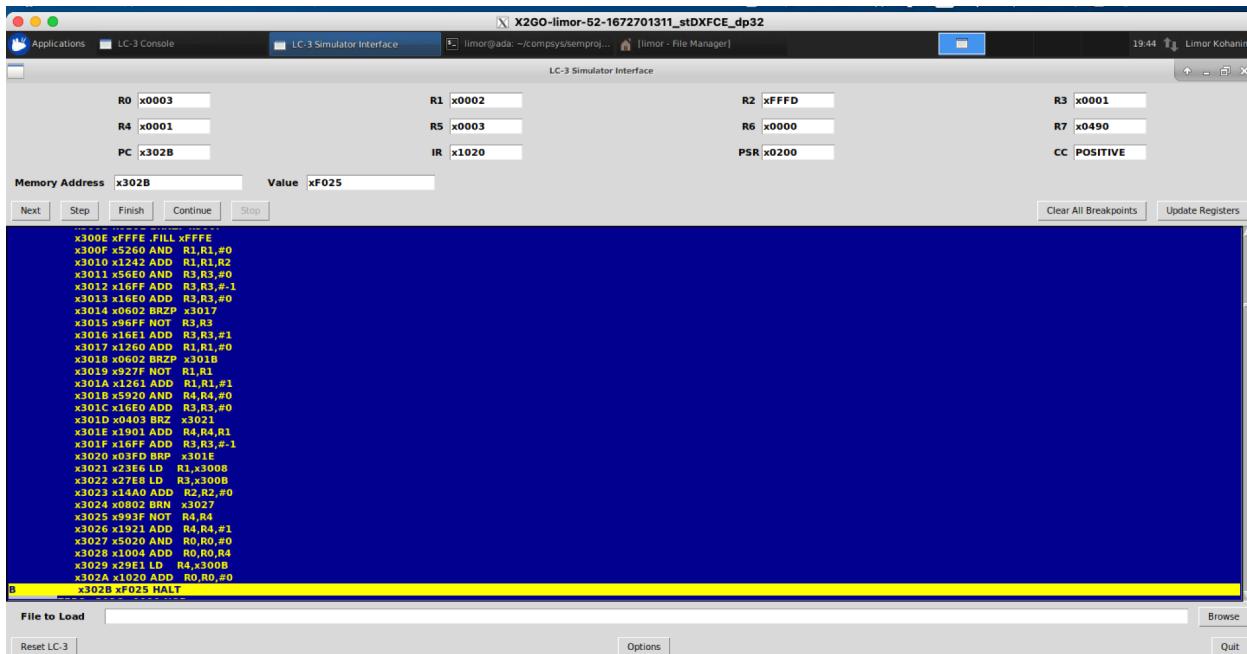
compsys > semproj > lc3tools > asm MLT_test5.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R0, R2, #-1
10
11
12 HALT
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

## BEFORE instruction



## AFTER instruction



## HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as MLT_test5.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1901
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x23e6
the current instruction's hexadecimal value is x27e8
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x802
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1004
the current instruction's hexadecimal value is x29e1
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

```
○ limor@ada:~/compsys/sempproj/lc3tools$
```

MLT R2, R2, #0

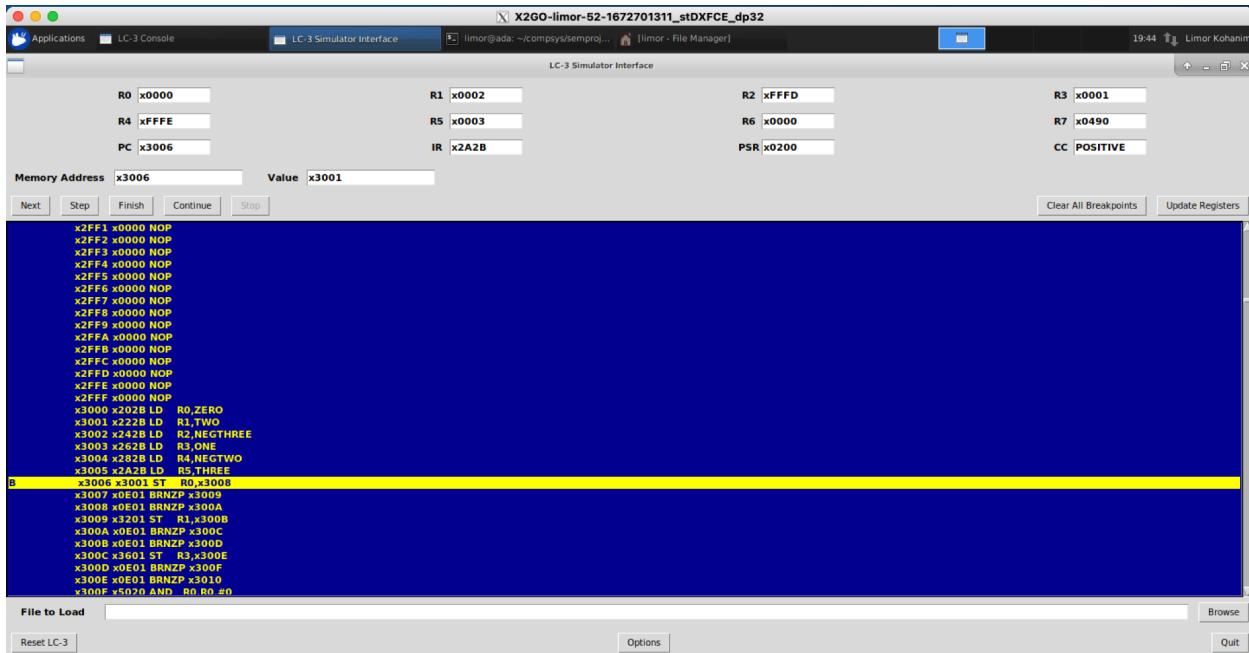
negative \* 0

```

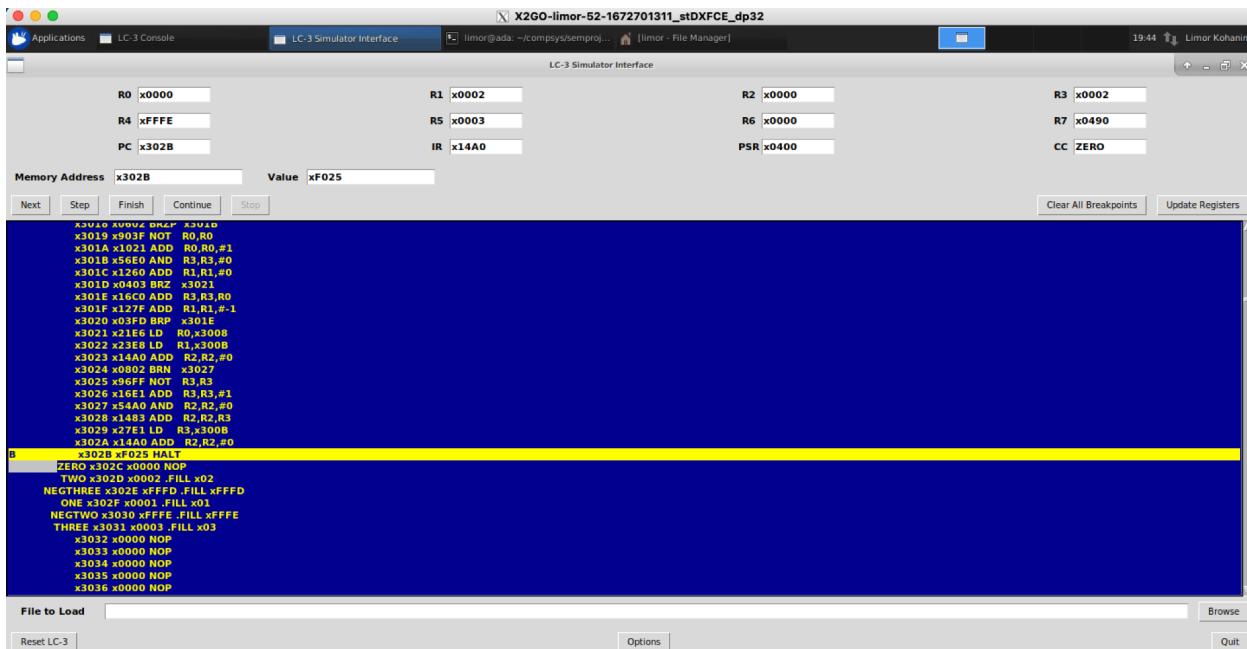
compsys > semproj > lc3tools > asm MLT_test6.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R2, R2, #0
10
11 HALT
12 ;
13 ; 
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

### BEFORE instruction



### AFTER instruction



## HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as MLT_test6.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x202b
the current instruction's hexadecimal value is x222b
the current instruction's hexadecimal value is x242b
the current instruction's hexadecimal value is x262b
the current instruction's hexadecimal value is x282b
the current instruction's hexadecimal value is x2a2b
the current instruction's hexadecimal value is x3001
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x16c0
the current instruction's hexadecimal value is x127f
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x21e6
the current instruction's hexadecimal value is x23e8
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x802
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1483
the current instruction's hexadecimal value is x27e1
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

```
● limor@ada:~/compsys/semproj/lc3tools$
```

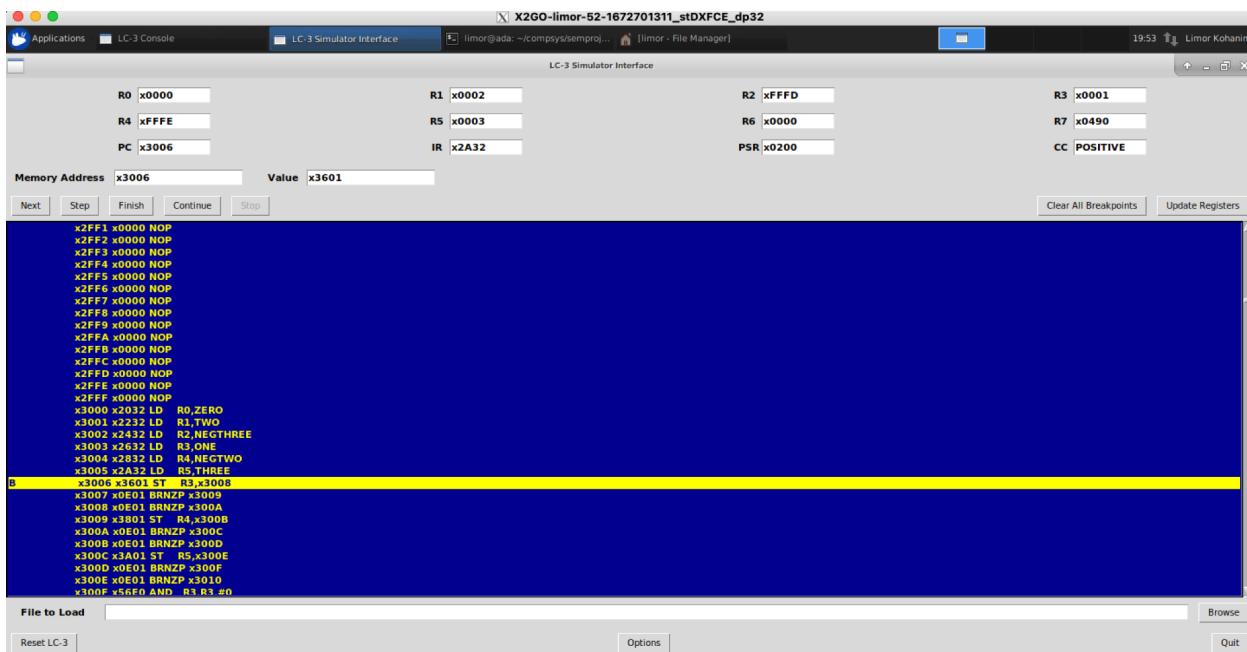
RRR

## MLT R0, R1, R2

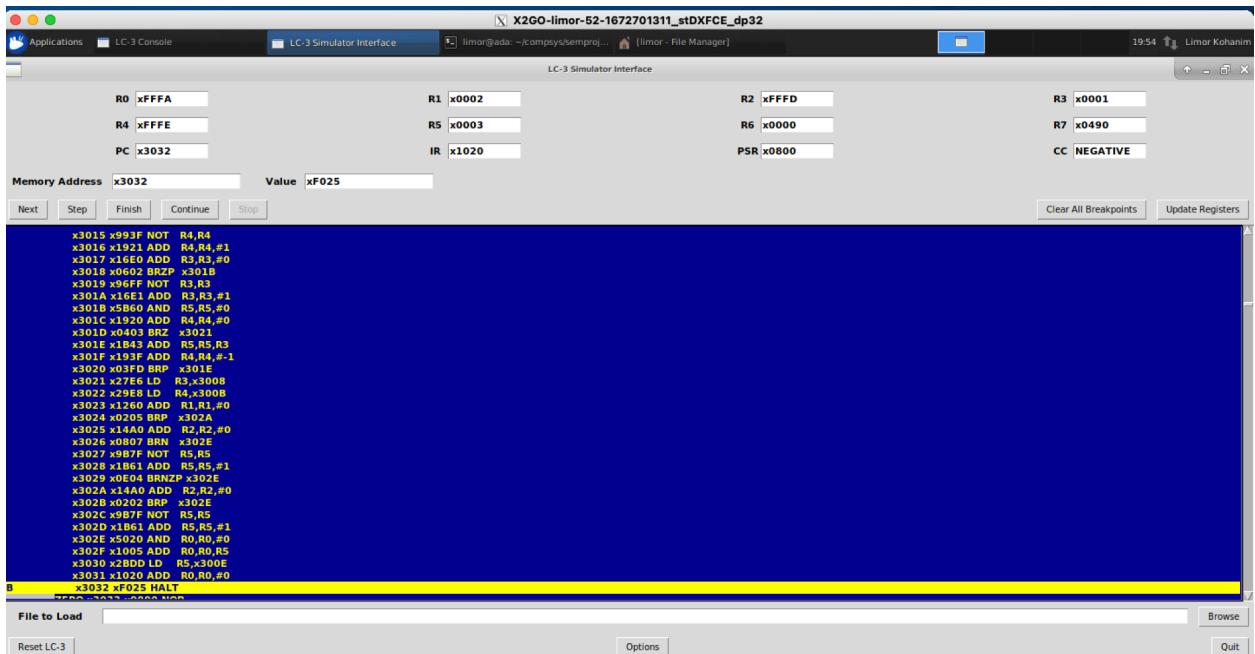
positive \* negative

```
compsys > semproj > lc3tools > asm MLT_test7.asm
1   .ORIG  x3000
2   LD    R0, ZERO
3   LD    R1, TWO
4   LD    R2, NEGTHREE
5   LD    R3, ONE
6   LD    R4, NEGTWO
7   LD    R5, THREE
8
9   MLT  R0, R1, R2
10
11  HALT
12  ;
13  ZERO     .FILL  x0000
14  TWO      .FILL  x0002
15  NEGTHREE .FILL  xFFFD
16  ONE      .FILL  x0001
17  NEGTWO   .FILL  xFFE
18  THREE    .FILL  x0003
19
20  ;
21  .END
22
23
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as MLT_test7.asm
```

```
STARTING PASS 1
```

```
0 errors found in first pass.
```

```
STARTING PASS 2
```

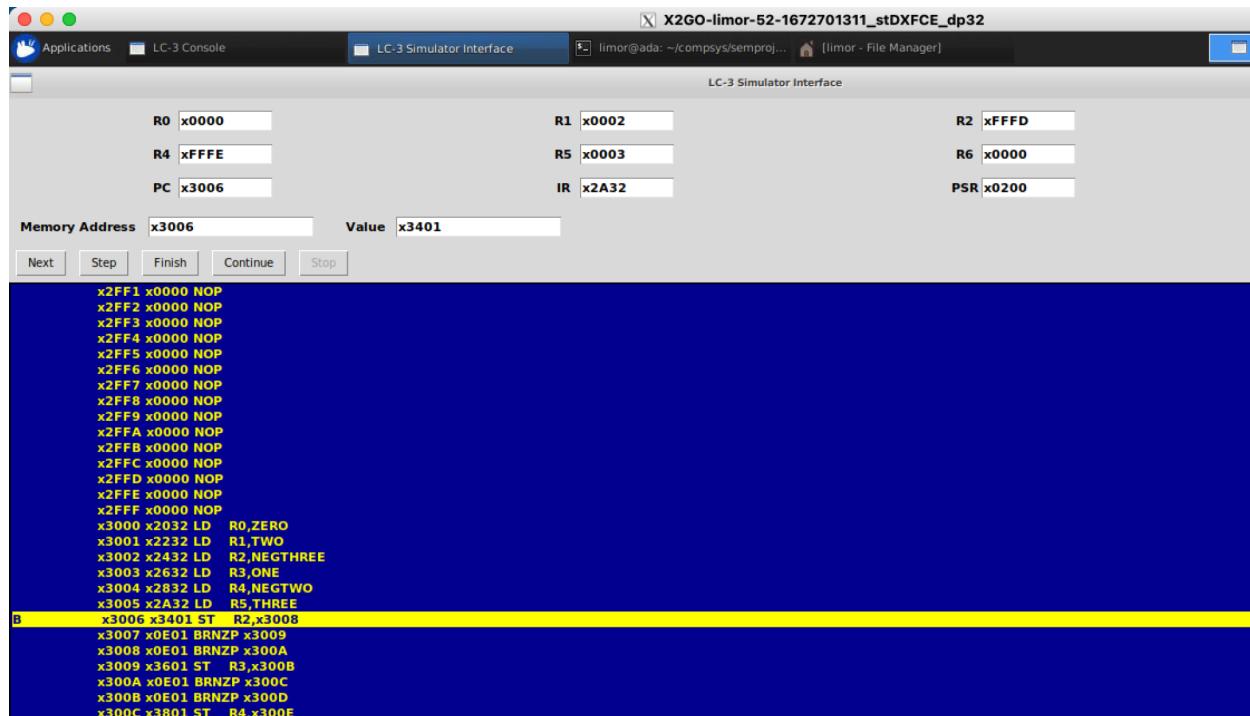
```
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2032
the current instruction's hexadecimal value is x2232
the current instruction's hexadecimal value is x2432
the current instruction's hexadecimal value is x2632
the current instruction's hexadecimal value is x2832
the current instruction's hexadecimal value is x2a32
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3a01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x1902
the current instruction's hexadecimal value is x1920
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x1921
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x5b60
the current instruction's hexadecimal value is x1920
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1b43
the current instruction's hexadecimal value is x193f
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x27e6
the current instruction's hexadecimal value is x29e8
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x205
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x807
the current instruction's hexadecimal value is x9b7f
the current instruction's hexadecimal value is x1b61
the current instruction's hexadecimal value is xe04
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x202
the current instruction's hexadecimal value is x9b7f
the current instruction's hexadecimal value is x1b61
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1005
the current instruction's hexadecimal value is x2bdd
the current instruction's hexadecimal value is x1020
```

## MLT R0, R0, R1

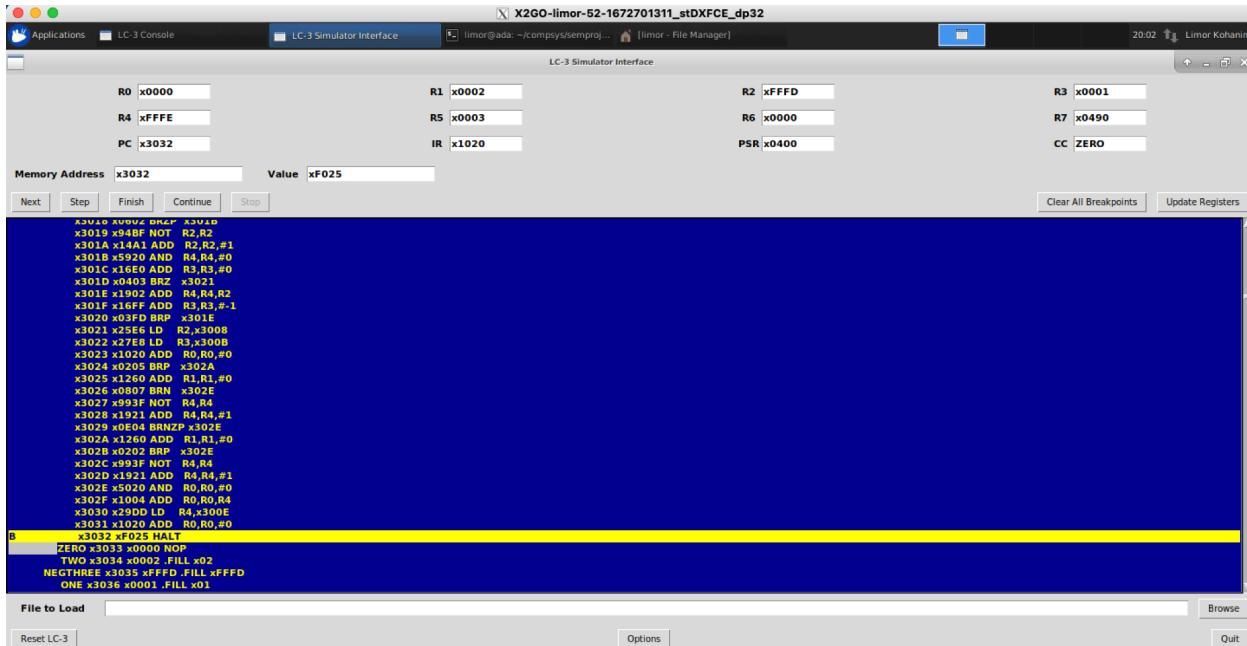
zero \* positive

```
compsys > semproj > lc3tools > MLT_test8.asm
1    .ORIG    X3000
2    LD      R0, ZERO
3    LD      R1, TWO
4    LD      R2, NEGTHREE
5    LD      R3, ONE
6    LD      R4, NEGTWO
7    LD      R5, THREE
8
9    MLT    R0, R0, R1
10
11   HALT
12   ;
13   ZERO     .FILL  x0000
14   TWO      .FILL  x0002
15   NEGTHREE .FILL  xFFFD
16   ONE      .FILL  x0001
17   NEGTWO   .FILL  xFFFE
18   THREE    .FILL  x0003
19   ;
20   ;
21   .END
```

BEFORE instruction



AFTER instruction



MLT R0, R1, R0

positive \* zero

```

compsys > semproj > lc3tools > .asm MLT_test9.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R0, R1, R0
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFF
17 ONE .FILL x0001
18 NEGTWO .FILL xFFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

BEFORE instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

Memory Address x3006 Value x3401

Registers:

R0	x0000
R4	xFFFE
PC	x3006
R1	x0002
R5	x0003
IR	x2A32
R2	xFFFF
R6	x0000
PSR	x0200
R3	x0001
R7	x0490
CC	POSITIVE

Buttons: Next, Step, Finish, Continue, Stop, Clear All Breakpoints, Update Registers

```

x2F1 x0000 NOP
x2F2 x0000 NOP
x2F3 x0000 NOP
x2F4 x0000 NOP
x2F5 x0000 NOP
x2F6 x0000 NOP
x2F7 x0000 NOP
x2F8 x0000 NOP
x2F9 x0000 NOP
x2FA x0000 NOP
x2FB x0000 NOP
x2FC x0000 NOP
x2FD x0000 NOP
x2FE x0000 NOP
x2FF x0000 NOP
x3000 x2032 LD R0,ZERO
x3001 x2232 LD R1,TWO
x3002 x432 LD R2,NEGTHREE
x3003 x2632 LD R3,ONE
x3004 x2A32 LD R4,NEGWTWO
x3005 x2A32 LD R5,THREE
x3006 x2A32 LD R6,FOUR
x3007 xE01 BRNZP x3009
x3008 xE01 BRNZP x300A
x3009 xE01 ST R3,x300B
x300A xE01 BRNZP x300C
x300B xE01 BRNZP x300D
x300C xE01 BRNZP x300E
x300D xE01 BRNZP x300F
x300E xE01 BRNZP x3010
x300F x4AA AND R2,R2,#0

```

File to Load: [Browse] [Reset LC-3] Options [Quit]

AFTER instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

Memory Address x3032 Value xF025

Registers:

R0	x0000
R4	xFFFE
PC	x3032
R1	x0002
R5	x0003
IR	x1020
R2	xFFFF
R6	x0000
PSR	x0400
R3	x0001
R7	x0490
CC	ZERO

Buttons: Next, Step, Finish, Continue, Stop, Clear All Breakpoints, Update Registers

```

x3027 x993F NOT R4,R4
x3028 x1921 ADD R4,R4,#1
x3029 x1020 ADD R0,R0,#0
x302B x0202 BRP x302E
x302C x993F NOT R4,R4
x302D x1921 ADD R4,R4,#1
x302E x5020 AND R0,R0,#0
x302F x1004 ADD R0,R0,R4
x3030 x1000 ADD R4,x300E
x3031 x1000 ADD R0,R0,#0
x3032 xF025 HALT
ZERO x3033 x0000 NOP
TWO x3034 x0002 .FILL x02
NEGTHREE x3035 xFFF.FILL xFFF
ONE x3036 x0001 .FILL x01
NEGWTWO x3037 xFFFE .FILL xFFFE
THREE x3038 x0003 .FILL x03
x3039 x0000 NOP
x303A x0000 NOP
x303B x0000 NOP
x303C x0000 NOP
x303D x0000 NOP
x303E x0000 NOP
x303F x0000 NOP
x3040 x0000 NOP
x3041 x0000 NOP
x3042 x0000 NOP
x3043 x0000 NOP
x3044 x0000 NOP

```

File to Load: [Browse] [Reset LC-3] Options [Quit]

MLT R1, R1, R1

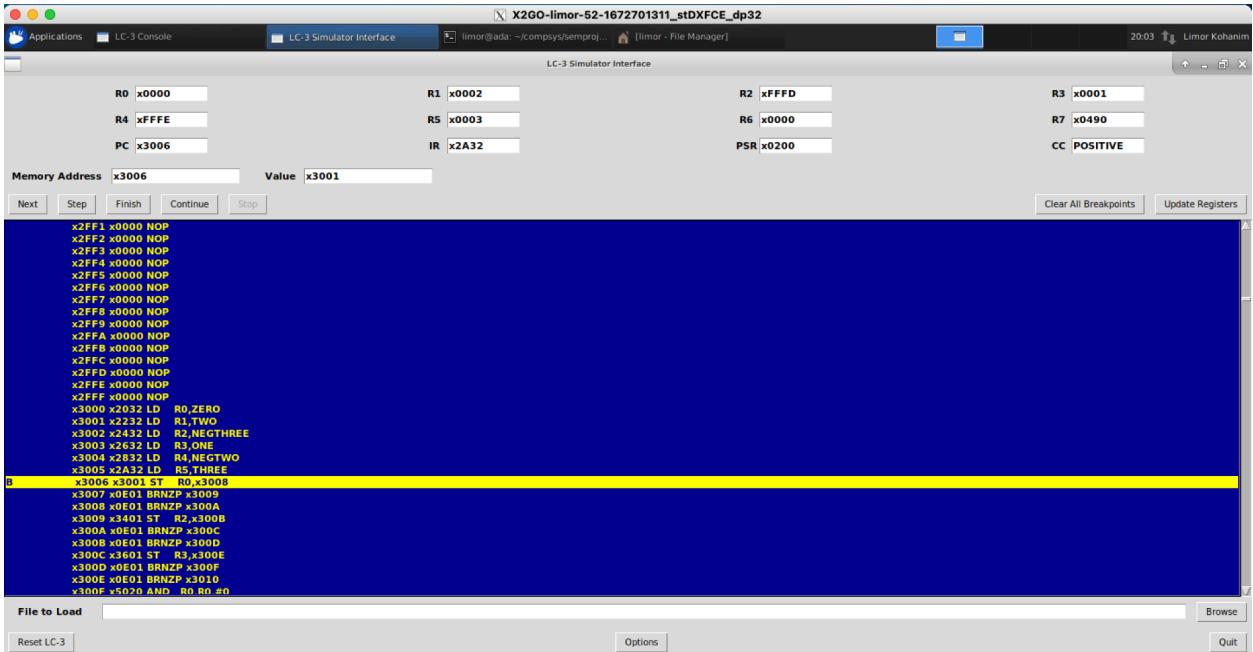
positive \* positive

```

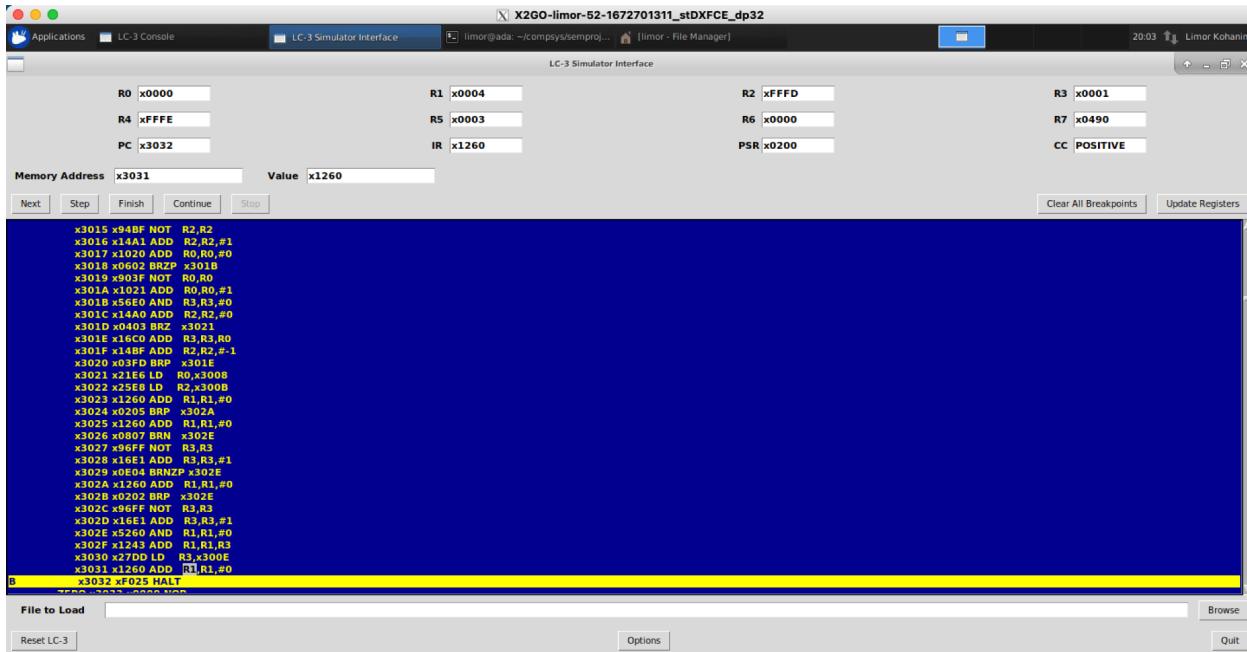
compsys > semproj > lc3tools > MLT_test10.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGtwo
7 LD R5, THREE
8
9 MLT R1, R1, R1
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGtwo .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

BEFORE instruction



AFTER instruction



## MLT R2, R2, R2

**negative \* negative**

```
compsys > semproj > lc3tools > ash MLT_test11.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 MLT R2, R2, R2
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFFF
19 THREE .FILL x0003
20 ;
21 .END
```

BEFORE instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

limor@ada:~/compsys/semproj... limor - File Manager

20:03 Limor Kohanim

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 xFFFD	R3 x0001
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x3006	IR x2A32	PSR x0200	CC POSITIVE

Memory Address x3006 Value x3001

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x2FF8 x0000 NOP
x2FF9 x0000 NOP
x2FA x0000 NOP
x2FB x0000 NOP
x2FC x0000 NOP
x2FD x0000 NOP
x2FE x0000 NOP
x2FF x0000 NOP
x3000 x2032 LD R0,ZERO
x3001 x2232 LD R1,TWO
x3002 x2432 LD R2,NEGTHREE
x3003 x2632 LD R3,ONE
x3004 x2832 LD R4,TWO
x3005 x2A32 LD R5,THREE
x3006 x3003 ST R0,x3008
x3007 x0E01 BRNZP x3009
x3008 x0E01 BRNZP x300A
x3009 x3201 ST R1,x300B
x300A x0E01 BRNZP x300C
x300B x0E01 BRNZP x300D
x300C x0E01 BRNZP x300E
x300D x0E01 BRNZP x300F
x300E x0E01 BRNZP x3010
x300F x5020 AND R0,R0,#0
x3010 x1002 ADD R0,R0,R2
x3011 x5260 AND R1,R1,#0
x3012 x1242 ADD R1,R1,R2
x3013 x96FF NOT R1,R1,#0
x3014 x0602 BRZP x3017
x3015 x927F NOT R1,R1
x3016 x1261 ADD R1,R1,#1

```

File to Load Browse

Reset LC-3 Options Quit

AFTER instruction

X2GO-limor-52-1672701311\_stDXFCE\_dp32

LC-3 Simulator Interface

limor@ada:~/compsys/semproj... limor - File Manager

20:03 Limor Kohanim

LC-3 Simulator Interface

R0 x0000	R1 x0002	R2 x0009	R3 x0001
R4 xFFE	R5 x0003	R6 x0000	R7 x0490
PC x3032	IR x14A0	PSR x0200	CC POSITIVE

Memory Address x3032 Value xF025

Next Step Finish Continue Stop Clear All Breakpoints Update Registers

```

x3010 x0002 BRNZP x3014
x3019 x903F NOT R0,R0
x301A x1021 ADD R0,R0,#1
x301B x5600 AND R0,R3,#0
x301C x1600 ADD R1,R1,#0
x301D x0403 BRZ x3021
x301E x16C0 ADD R3,R3,R0
x301F x127F ADD R1,R1,#1
x3020 x03FD BRP x301E
x3021 x21E6 LD R0,x3008
x3022 x14A0 ADD R1,x3008
x3023 x04A0 ADD R1,R2,#0
x3024 x0205 BRP x302A
x3025 x14A0 ADD R2,R2,#0
x3026 x0807 BRN x302E
x3027 x96FF NOT R3,R3
x3028 x16E1 ADD R3,R3,#1
x3029 x0E04 BRNZP x302E
x302A x14A0 ADD R0,R2,#0
x302B x04A0 ADD R0,R2,#0
x302C x96FF NOT R3,R3
x302D x16E1 ADD R3,R3,#1
x302E x54A0 AND R2,R2,#0
x302F x14B3 ADD R2,R2,R3
x3030 x27DD LD R3,x300E
x3031 x14A0 ADD R2,R2,#0
x3032 x04A0 ADD R2,R2,#0
ZERO x3033 x0000 NOP
TWO x3034 x0002 .FILL x02
NEGTHREE x3035 xFFFF .FILL xFFFF
ONE x3036 x0001 .FILL x01

```

File to Load Browse

Reset LC-3 Options Quit

HEX vals of instructions in this last edge case

● **limor@ada:~/compsys/semproj/lc3tools\$ ./lc3as MLT\_test11.asm**

```
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2032
the current instruction's hexadecimal value is x2232
the current instruction's hexadecimal value is x2432
the current instruction's hexadecimal value is x2632
the current instruction's hexadecimal value is x2832
the current instruction's hexadecimal value is x2a32
the current instruction's hexadecimal value is x3001
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x16c0
the current instruction's hexadecimal value is x127f
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x21e6
the current instruction's hexadecimal value is x23e8
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x205
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x807
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is xe04
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x202
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1483
the current instruction's hexadecimal value is x27dd
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
```

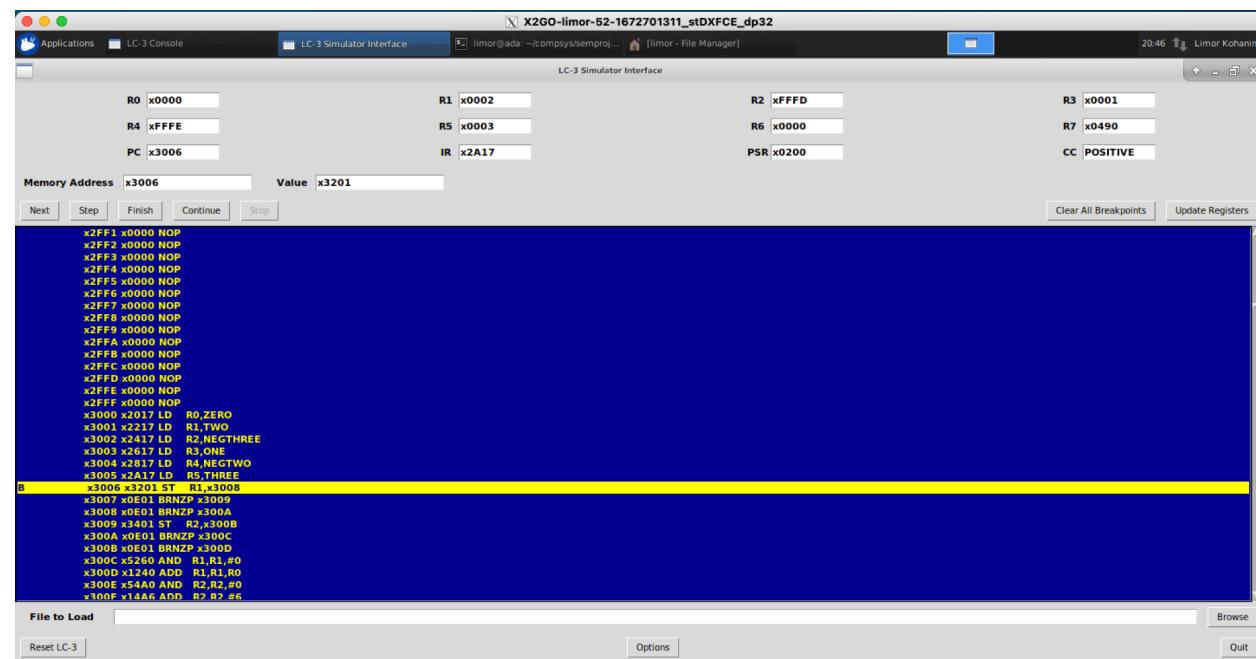
## test OR: RRI, RRR

### RRI

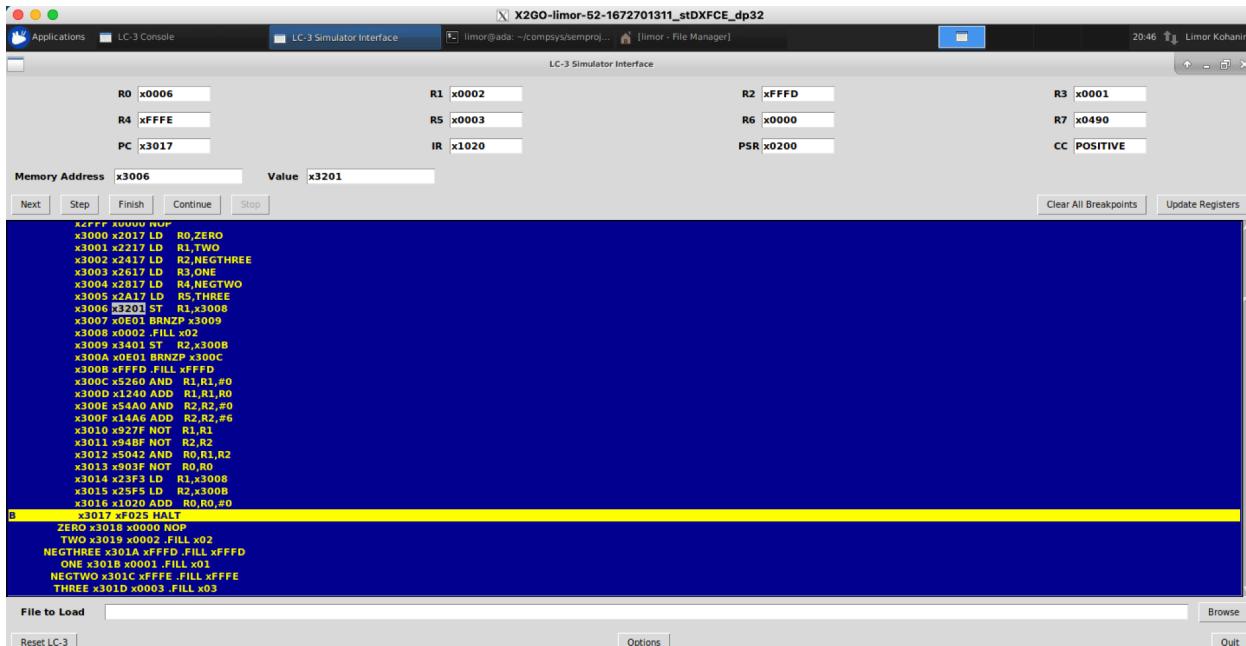
OR R0, R0, # ; zero OR val is a positive number

```
compsys > semproj > lc3tools > OR_test.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OR R0, R0, #0
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFE
18 THREE .FILL x0003
19 ;
20 .
21 .END
22
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```

● Limor@ada:~/compsys/semproj/lc3tools$ ./lc3as OR_test.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2017
the current instruction's hexadecimal value is x2217
the current instruction's hexadecimal value is x2417
the current instruction's hexadecimal value is x2617
the current instruction's hexadecimal value is x2817
the current instruction's hexadecimal value is x2A17
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1240
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x14a6
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x5042
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x23f3
the current instruction's hexadecimal value is x25f5
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xfffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ Limor@ada:~/compsys/semproj/lc3tools$ 

```

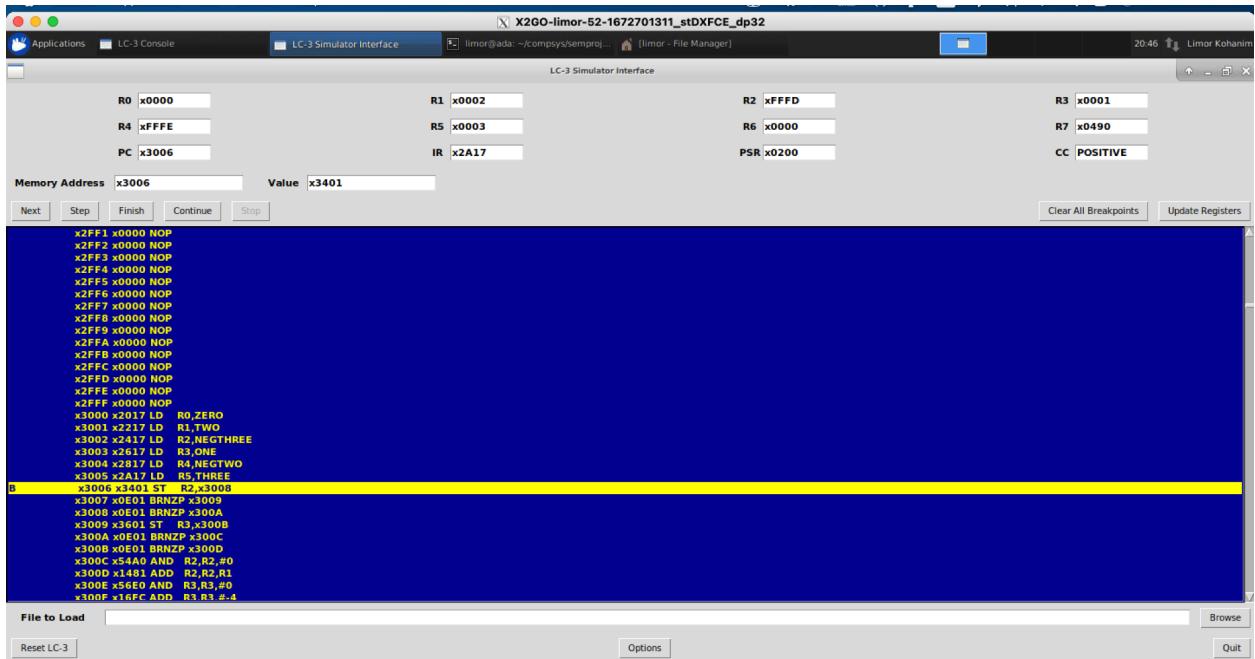
OR R0, R1, #    ; positive OR val is a negative number

```

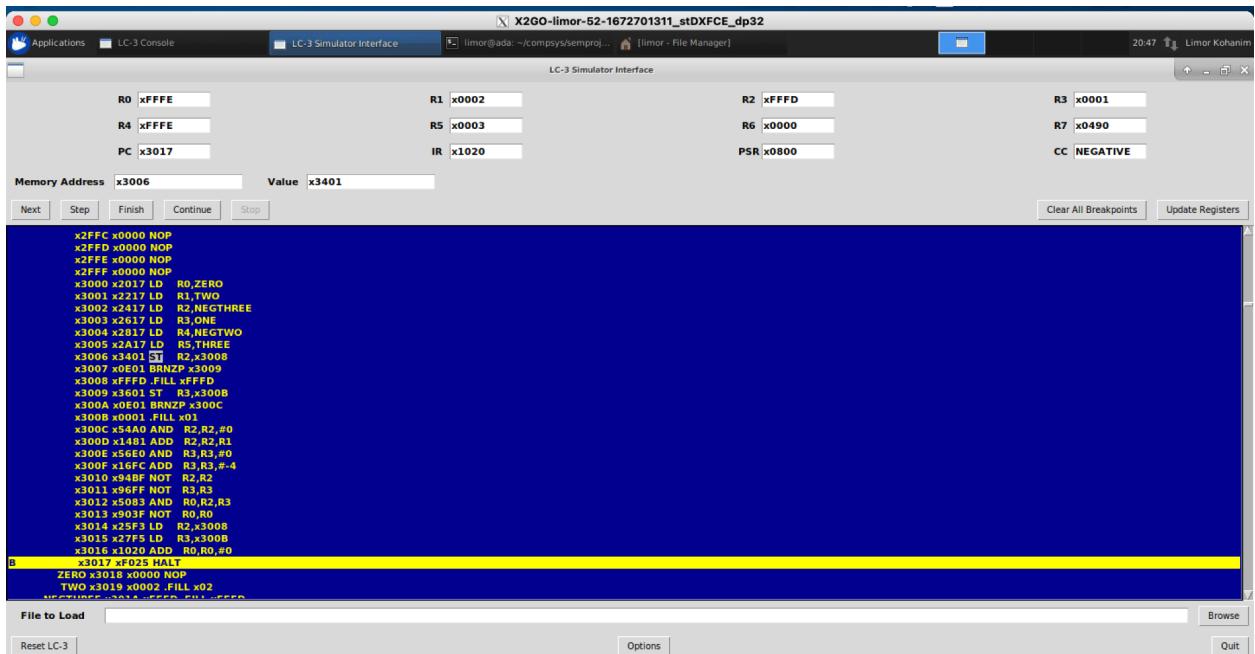
compsys > semproj > lc3tools > OR_test1.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OR R0, R1, #-4
10
11
12 HALT
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFFFE
19 THREE .FILL x0003
20 ;
21 .END
22
23

```

BEFORE instruction



AFTER instruction



## HEX vals of instructions in this last edge case

- Limor@ada:~/compsys/semproj/lc3tools\$ ./lc3as OR\_test1.asm  
STARTING PASS 1  
0 errors found in first pass.  
STARTING PASS 2  
the current instruction's hexadecimal value is x3000  
the current instruction's hexadecimal value is x2017  
the current instruction's hexadecimal value is x2217  
the current instruction's hexadecimal value is x2417  
the current instruction's hexadecimal value is x2617  
the current instruction's hexadecimal value is x2817  
the current instruction's hexadecimal value is x2a17  
the current instruction's hexadecimal value is x3401  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is x3601  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is x54a0  
the current instruction's hexadecimal value is x1481  
the current instruction's hexadecimal value is x56e0  
the current instruction's hexadecimal value is x16fc  
the current instruction's hexadecimal value is x94bf  
the current instruction's hexadecimal value is x96ff  
the current instruction's hexadecimal value is x5083  
the current instruction's hexadecimal value is x903f  
the current instruction's hexadecimal value is x25f3  
the current instruction's hexadecimal value is x27f5  
the current instruction's hexadecimal value is x1020  
the current instruction's hexadecimal value is xf025  
the current instruction's hexadecimal value is x0  
the current instruction's hexadecimal value is x2  
the current instruction's hexadecimal value is xffffd  
the current instruction's hexadecimal value is x1  
the current instruction's hexadecimal value is xffffe  
the current instruction's hexadecimal value is x3  
0 errors found in second pass.
- Limor@ada:~/compsys/semproj/lc3tools\$

RRR

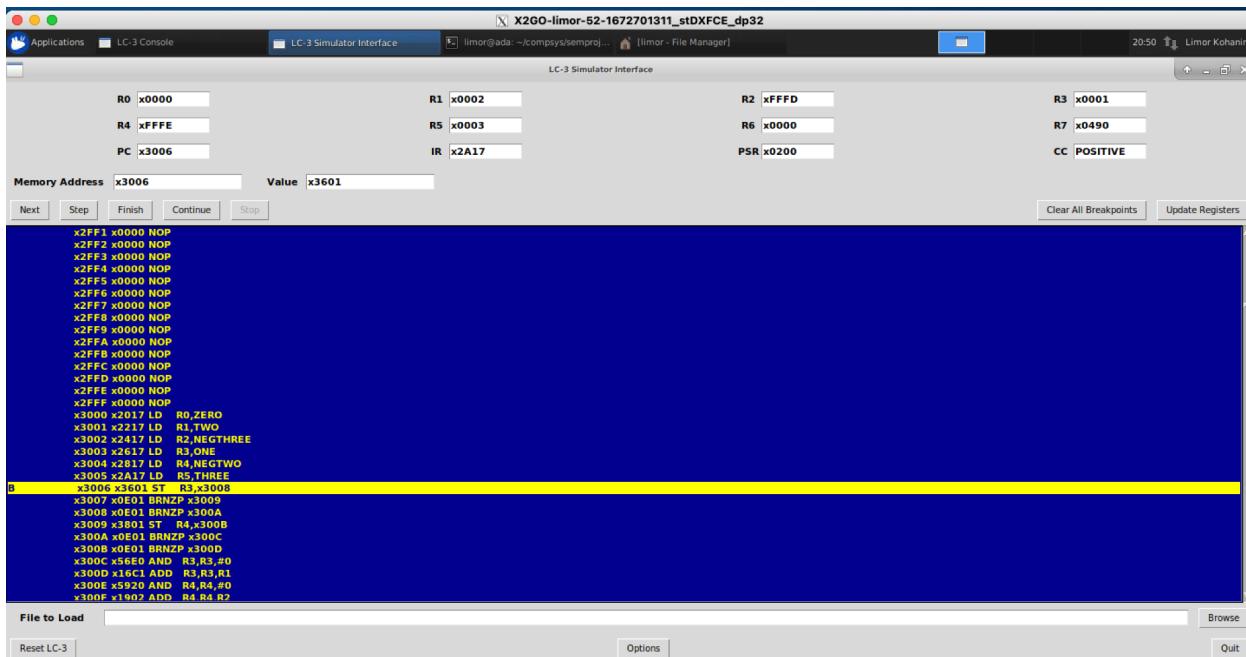
; R0 = 0, R1 = positive number, R2, negative number  
OR R0, R1, R2

```

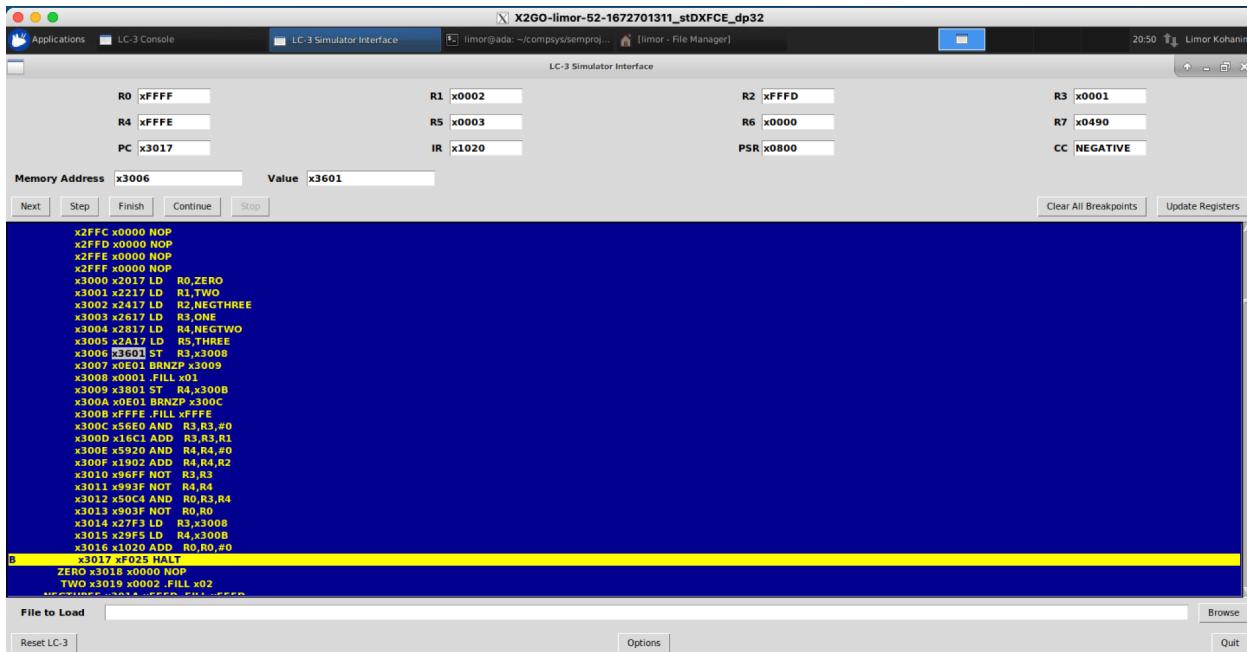
compsys > semproj > lc3tools > asm OR_test2.asm
1    .ORIG  x3000
2    LD      R0, ZERO
3    LD      R1, TWO
4    LD      R2, NEGTHREE
5    LD      R3, ONE
6    LD      R4, NEGTWO
7    LD      R5, THREE
8
9    OR R0, R1, R2
10
11
12 HALT
13 ;
14 ZERO     .FILL   x0000
15 TWO      .FILL   x0002
16 NEGTHREE .FILL   xFFFD
17 ONE      .FILL   x0001
18 NEGTWO   .FILL   xFFE
19 THREE    .FILL   x0003
20 ;
21 .END
22
23

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```

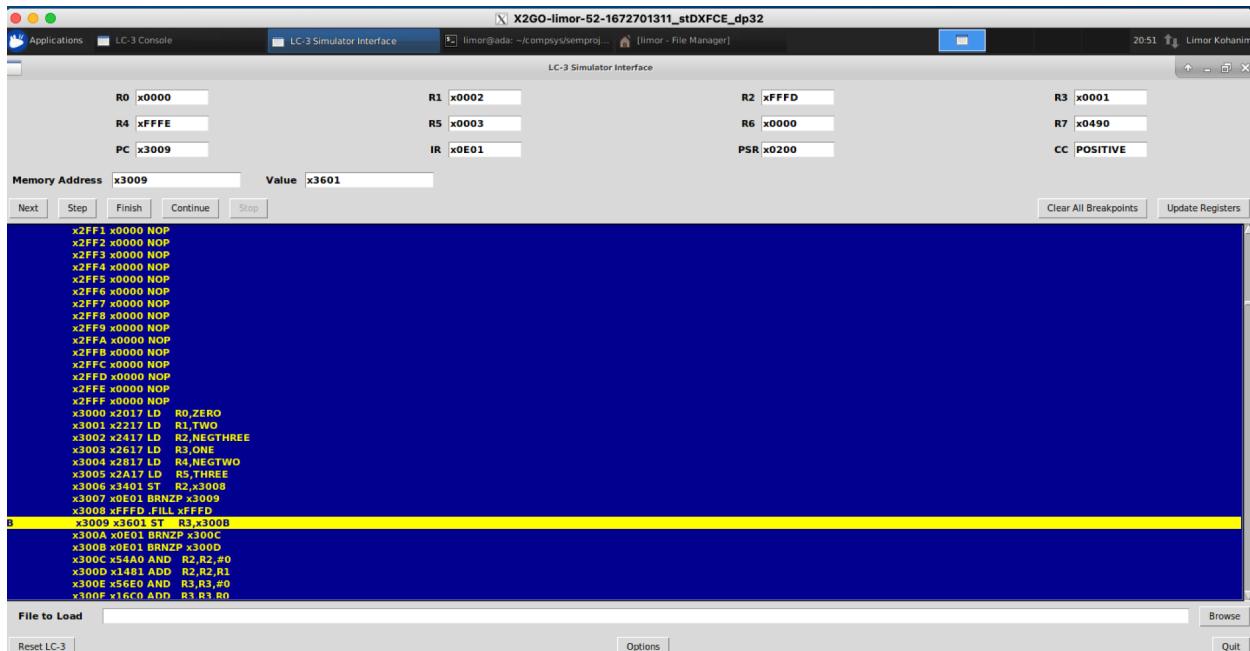
> limor@ada:~/compsys/semproj/lc3tools$ ./lc3as OR_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2017
the current instruction's hexadecimal value is x2217
the current instruction's hexadecimal value is x2417
the current instruction's hexadecimal value is x2617
the current instruction's hexadecimal value is x2817
the current instruction's hexadecimal value is x2a17
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3801
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x5920
the current instruction's hexadecimal value is x1902
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x993f
the current instruction's hexadecimal value is x50c4
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x27f3
the current instruction's hexadecimal value is x29f5
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.

```

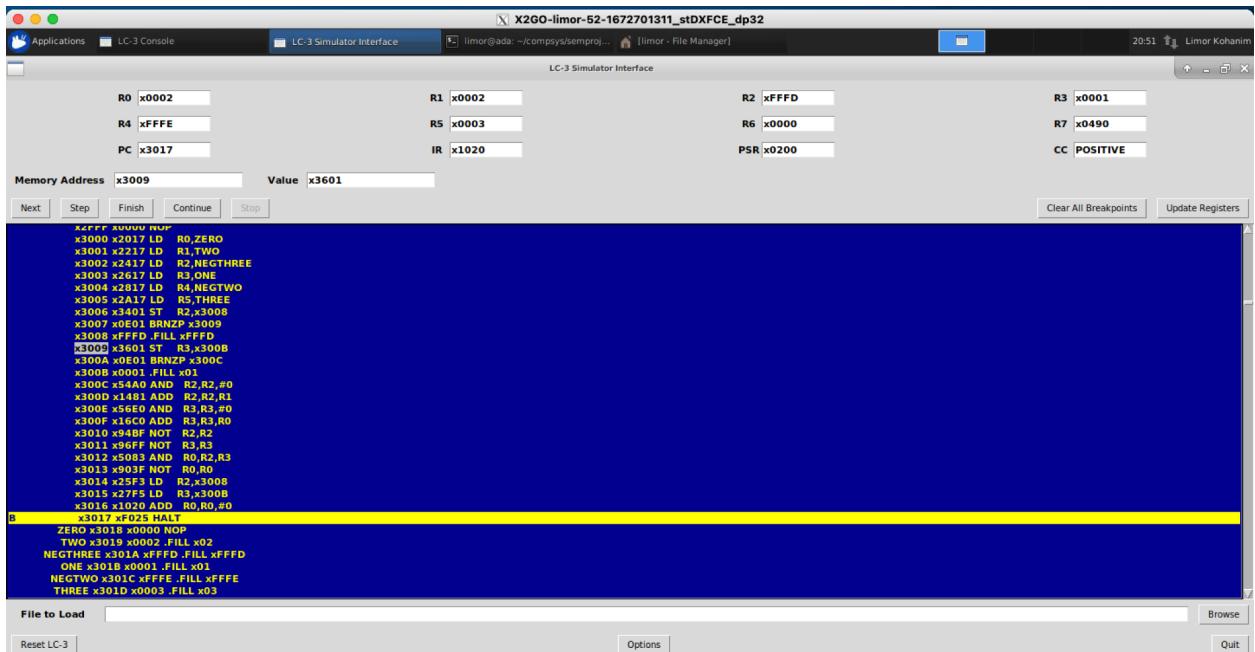
## OR R0, R1, R0

```
compsys > semproj > lc3tools > OR_test3.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OR R0, R1, R0
10
11 HALT
12 ;
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .
22 .END
```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

```
limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as OR_test3.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2017
the current instruction's hexadecimal value is x2217
the current instruction's hexadecimal value is x2417
the current instruction's hexadecimal value is x2617
the current instruction's hexadecimal value is x2817
the current instruction's hexadecimal value is x2a17
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c0
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x5083
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x25f3
the current instruction's hexadecimal value is x27f5
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

```
limor@ada:~/compsys/sempproj/lc3tools$
```

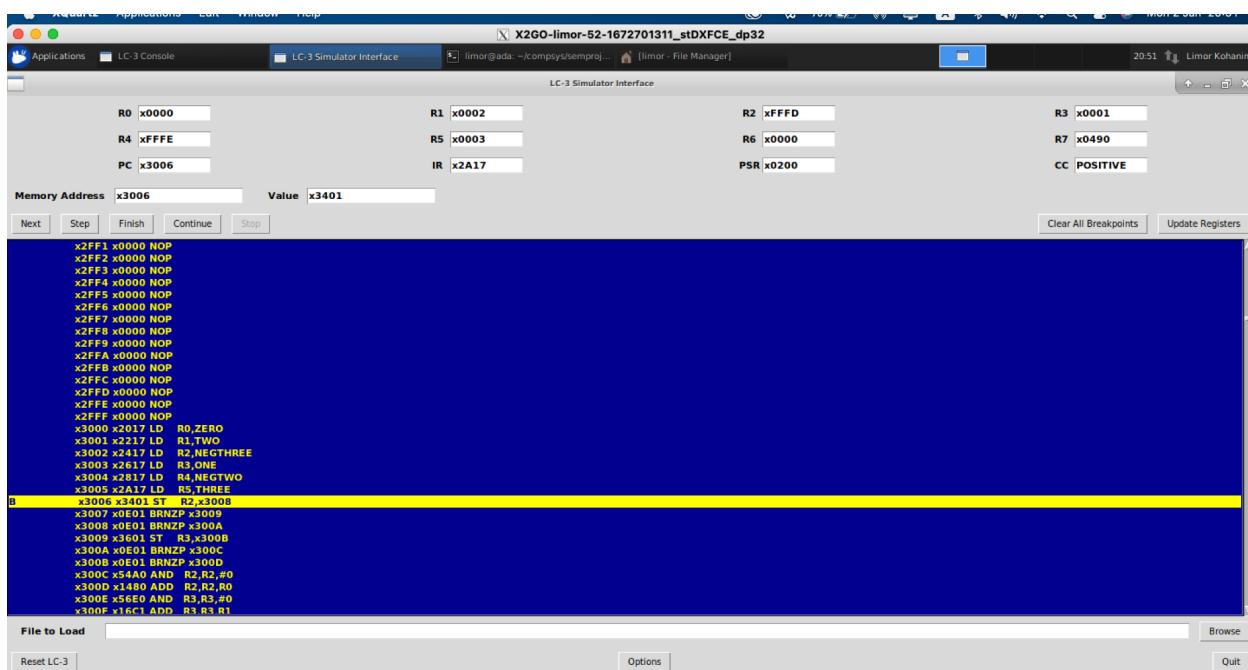
OR R0, R0, R1

```

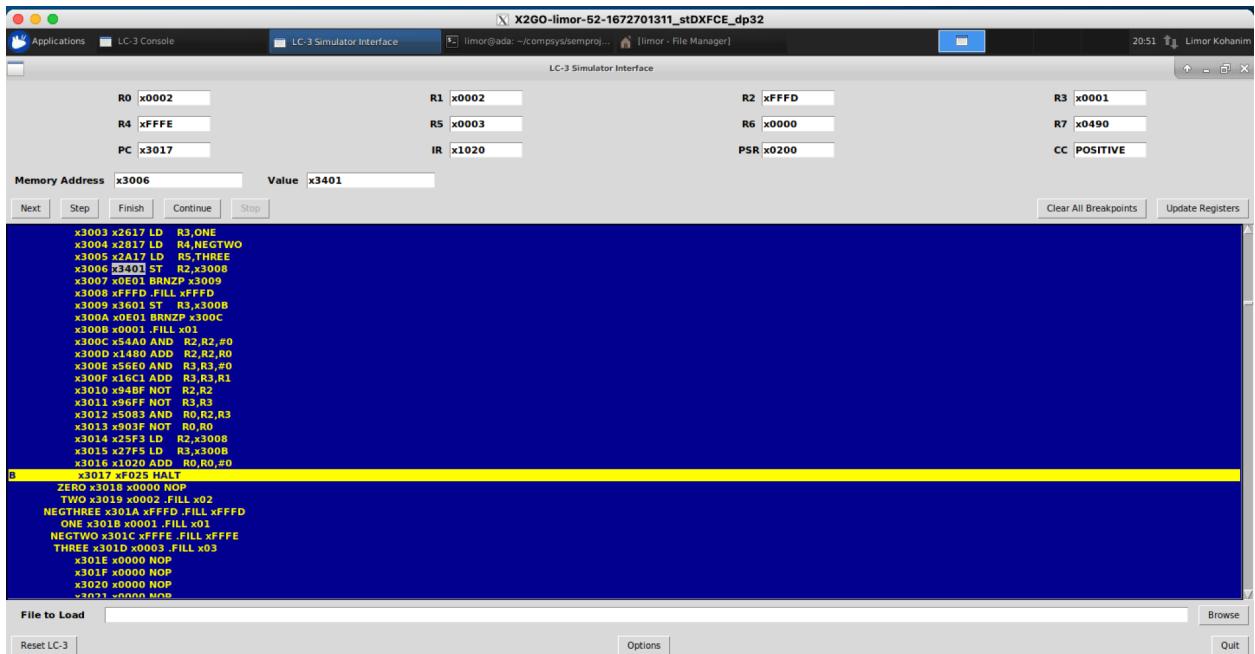
compsys > semproj > lc3tools > OR_test4.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OR R0, R0, R1
10 HALT
11 ;
12 ZERO .FILL x0000
13 TWO .FILL x0002
14 NEGTHREE .FILL xFFFD
15 ONE .FILL x0001
16 NEGTWO .FILL xFFE
17 THREE .FILL x0003
18 ;
19 .
20 .END
21
22

```

## BEFORE instruction



## AFTER instruction



## HEX vals of instructions in this last edge case

```
▶ Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as OR_test4.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2017
the current instruction's hexadecimal value is x2217
the current instruction's hexadecimal value is x2417
the current instruction's hexadecimal value is x2617
the current instruction's hexadecimal value is x2817
the current instruction's hexadecimal value is x2a17
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1480
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x5083
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x25f3
the current instruction's hexadecimal value is x27f5
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
▶ Limor@ada:~/compsys/sempproj/lc3tools$ █
```

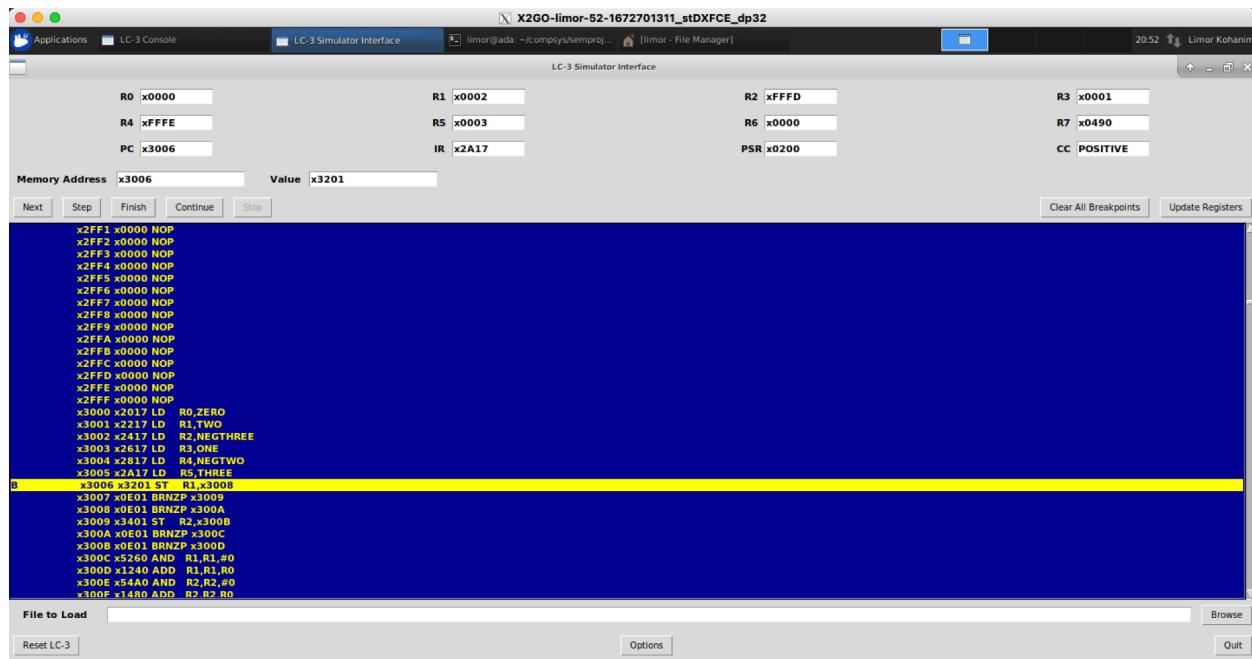
**OR R0, R0, R0**

```

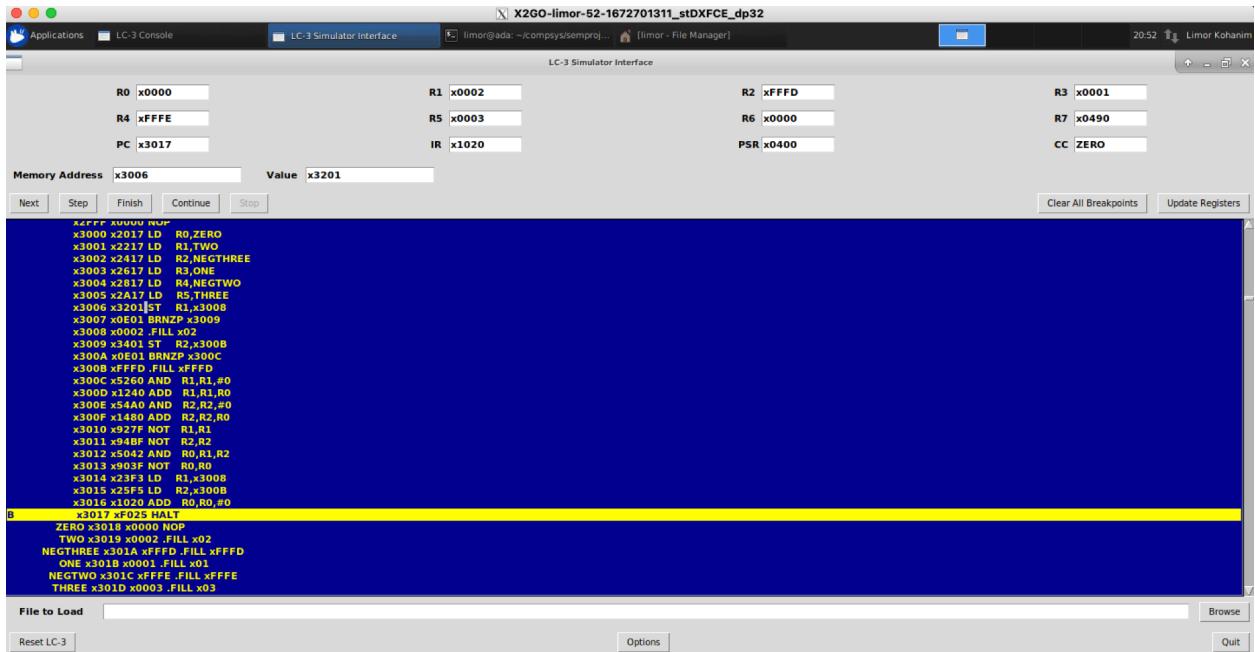
compsys > semproj > lc3tools > asm OR_test5.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OR R0, R0, R0
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFE
18 THREE .FILL x0003
19 ;
20 .END
21
22

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

- **limor@ada:~/compsys/sempproj/lc3tools\$ ./lc3as OR\_test5.asm**  
STARTING PASS 1  
0 errors found in first pass.  
STARTING PASS 2  
the current instruction's hexadecimal value is x3000  
the current instruction's hexadecimal value is x2017  
the current instruction's hexadecimal value is x2217  
the current instruction's hexadecimal value is x2417  
the current instruction's hexadecimal value is x2617  
the current instruction's hexadecimal value is x2817  
the current instruction's hexadecimal value is x2a17  
the current instruction's hexadecimal value is x3201  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is x3401  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is xe01  
the current instruction's hexadecimal value is x5260  
the current instruction's hexadecimal value is x1240  
the current instruction's hexadecimal value is x54a0  
the current instruction's hexadecimal value is x1480  
the current instruction's hexadecimal value is x927f  
the current instruction's hexadecimal value is x94bf  
the current instruction's hexadecimal value is x5042  
the current instruction's hexadecimal value is x903f  
the current instruction's hexadecimal value is x23f3  
the current instruction's hexadecimal value is x25f5  
the current instruction's hexadecimal value is x1020  
the current instruction's hexadecimal value is xf025  
the current instruction's hexadecimal value is x0  
the current instruction's hexadecimal value is x2  
the current instruction's hexadecimal value is xffffd  
the current instruction's hexadecimal value is x1  
the current instruction's hexadecimal value is xffffe  
the current instruction's hexadecimal value is x3  
0 errors found in second pass.
- **limor@ada:~/compsys/sempproj/lc3tools\$ █**

### test ABS: RR

RR

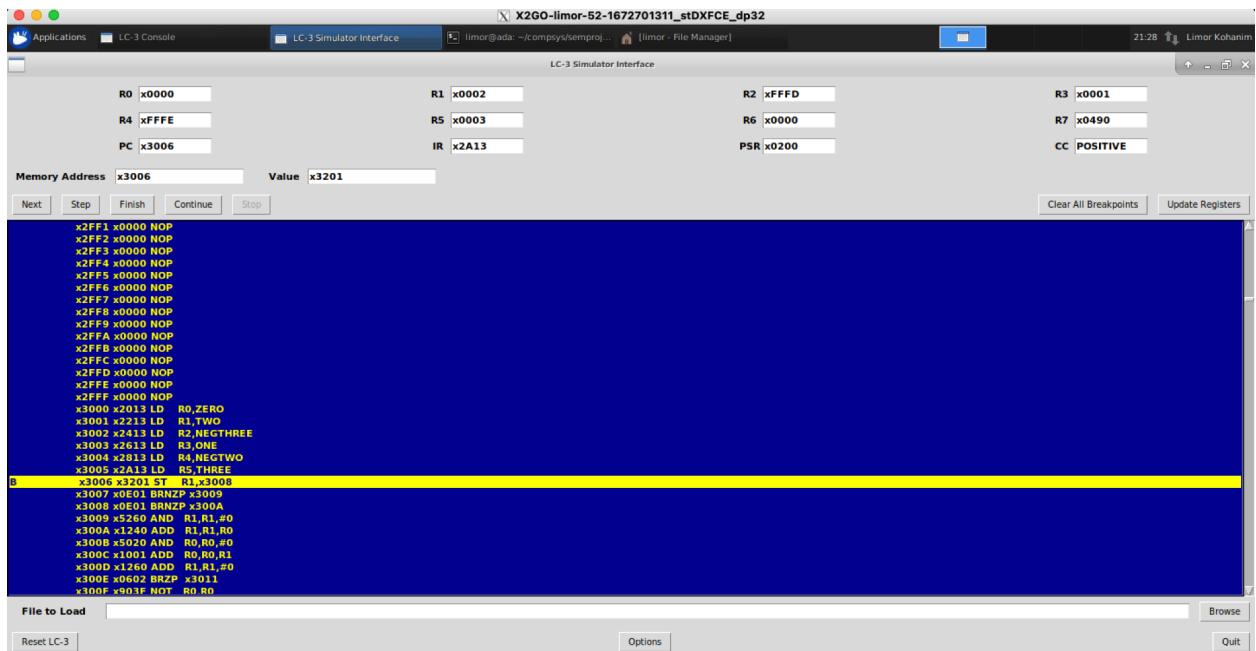
**ABS R0, R0 ;R0 = zero**

```

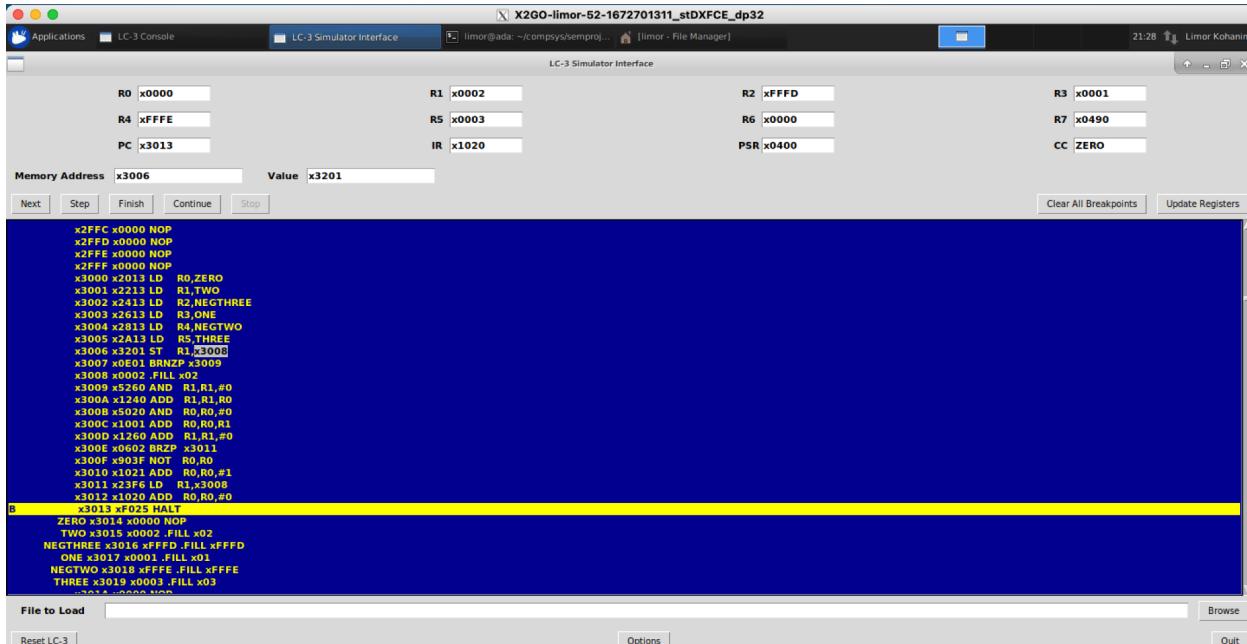
compsys > semproj > lc3tools > asm ABS_test.asm
1   .ORIG  x3000
2   LD      R0, ZERO
3   LD      R1, TWO
4   LD      R2, NEGTHREE
5   LD      R3, ONE
6   LD      R4, NEGTWO
7   LD      R5, THREE
8
9   ABS R0, R0    ;R0 = zero
10
11 HALT
12 ;|_
13 ZERO    .FILL  x0000
14 TWO     .FILL  x0002
15 NEGTHREE .FILL  xFFFD
16 ONE     .FILL  x0001
17 NEGTWO  .FILL  xFFFE
18 THREE   .FILL  x0003
19 ;
20 .END
21

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```

limor@ada:~/compsys/semproj/lc3tools$ ./lc3as ABS_test.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2013
the current instruction's hexadecimal value is x2213
the current instruction's hexadecimal value is x2413
the current instruction's hexadecimal value is x2613
the current instruction's hexadecimal value is x2813
the current instruction's hexadecimal value is x2a13
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1240
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1001
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x23f6
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xfffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
limor@ada:~/compsys/semproj/lc3tools$ 

```

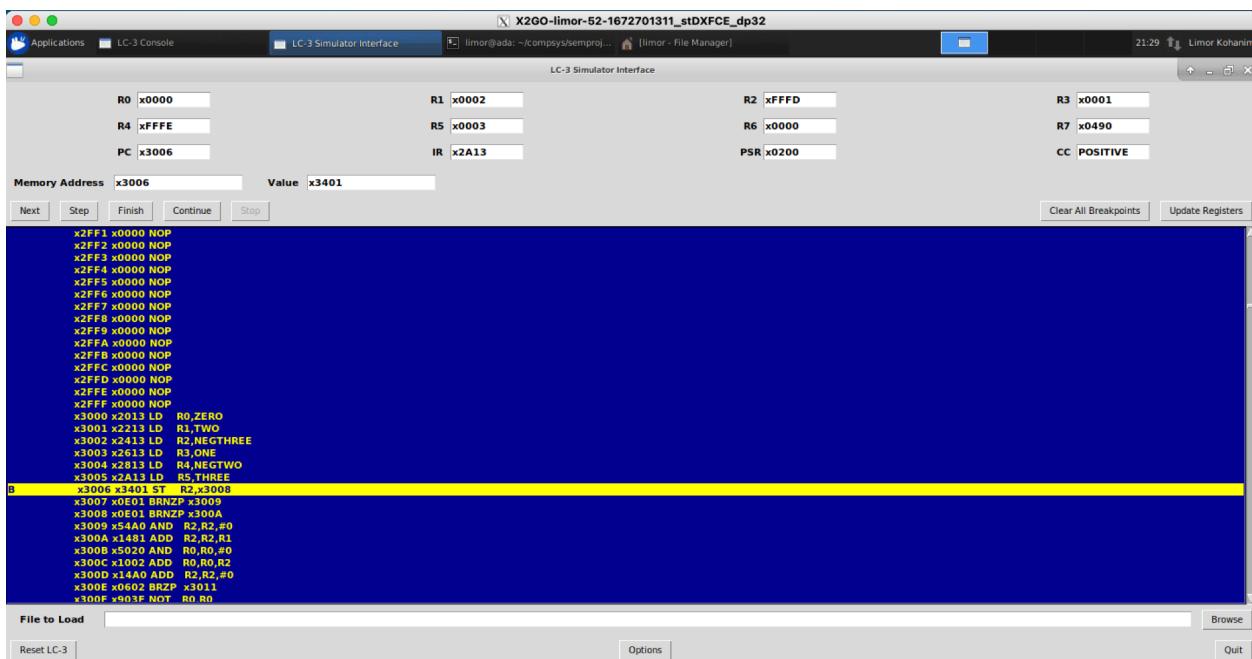
**ABS R0, R1 ;R1 = positive number**

```

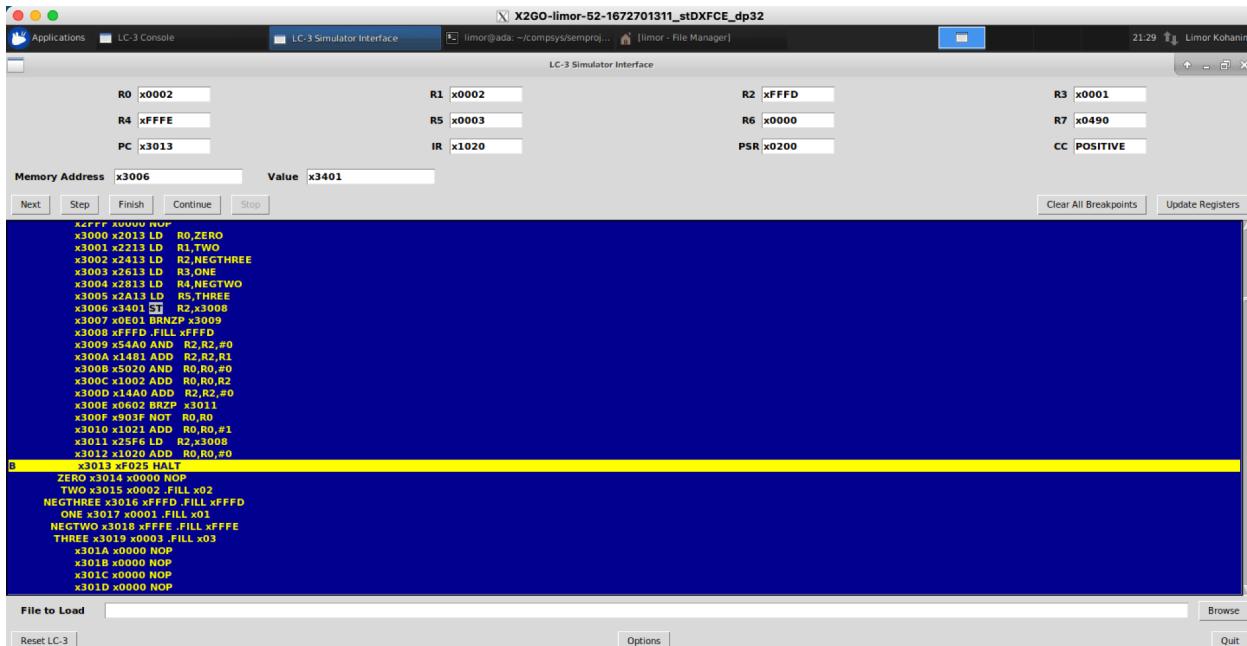
compsys > semproj > lc3tools > ASM ABS_test1.asm
1    .ORIG  x3000
2    LD      R0, ZERO
3    LD      R1, TWO
4    LD      R2, NEGTHREE
5    LD      R3, ONE
6    LD      R4, NEGTWO
7    LD      R5, THREE
8
9    ABS R0, R1 ;R1 = positive number
10   HALT
11   ;
12   ;
13   ZERO     .FILL  x0000
14   TWO      .FILL  x0002
15   NEGTHREE .FILL  xFFFD
16   ONE      .FILL  x0001
17   NEGTWO   .FILL  xFFFE
18   THREE    .FILL  x0003
19   ;
20   .END
21

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as ABS_test1.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2013
the current instruction's hexadecimal value is x2213
the current instruction's hexadecimal value is x2413
the current instruction's hexadecimal value is x2613
the current instruction's hexadecimal value is x2813
the current instruction's hexadecimal value is x2a13
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x25f6
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/sempproj/lc3tools$
```

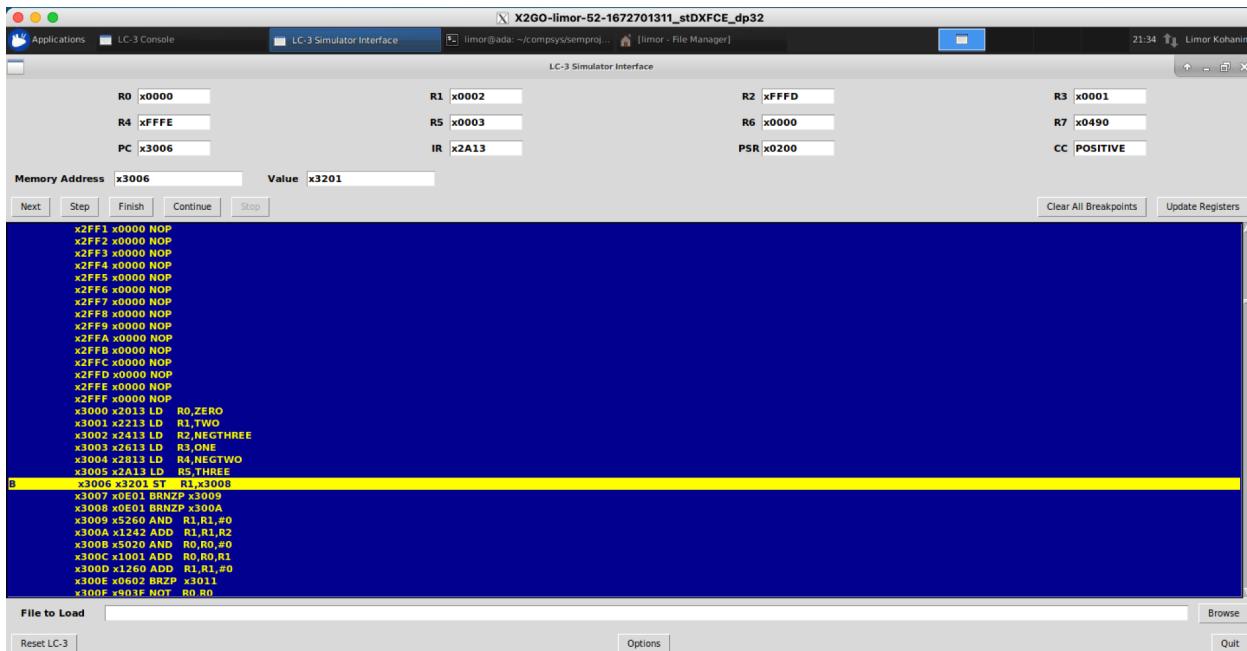
**ABS R0, R2 ;R2 = negative number**

```

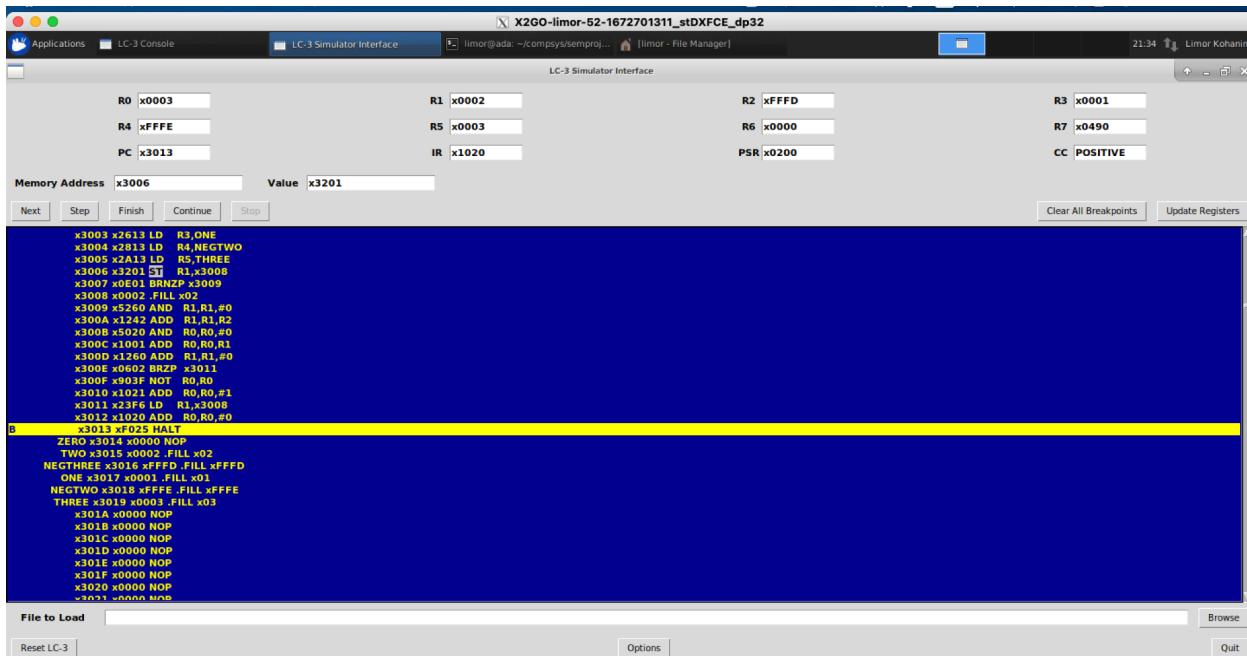
compsys > semproj > lc3tools > ASM ABS_test2.asm
1    .ORIG    X3000
2    LD      R0, ZERO
3    LD      R1, TWO
4    LD      R2, NEGTHREE
5    LD      R3, ONE
6    LD      R4, NEGTWO
7    LD      R5, THREE
8
9    ABS R0, R2 ;R2 = negative number
10
11
12   HALT
13   ;
14   ZERO     .FILL  x0000
15   TWO      .FILL  x0002
16   NEGTHREE .FILL  xFFFD
17   ONE      .FILL  x0001
18   NEGTWO   .FILL  xFFE
19   THREE    .FILL  x0003
20   ;
21   .END

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as ABS_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2013
the current instruction's hexadecimal value is x2213
the current instruction's hexadecimal value is x2413
the current instruction's hexadecimal value is x2613
the current instruction's hexadecimal value is x2813
the current instruction's hexadecimal value is x2a13
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1001
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x23f6
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
● limor@ada:~/compsys/sempproj/lc3tools$ █
```

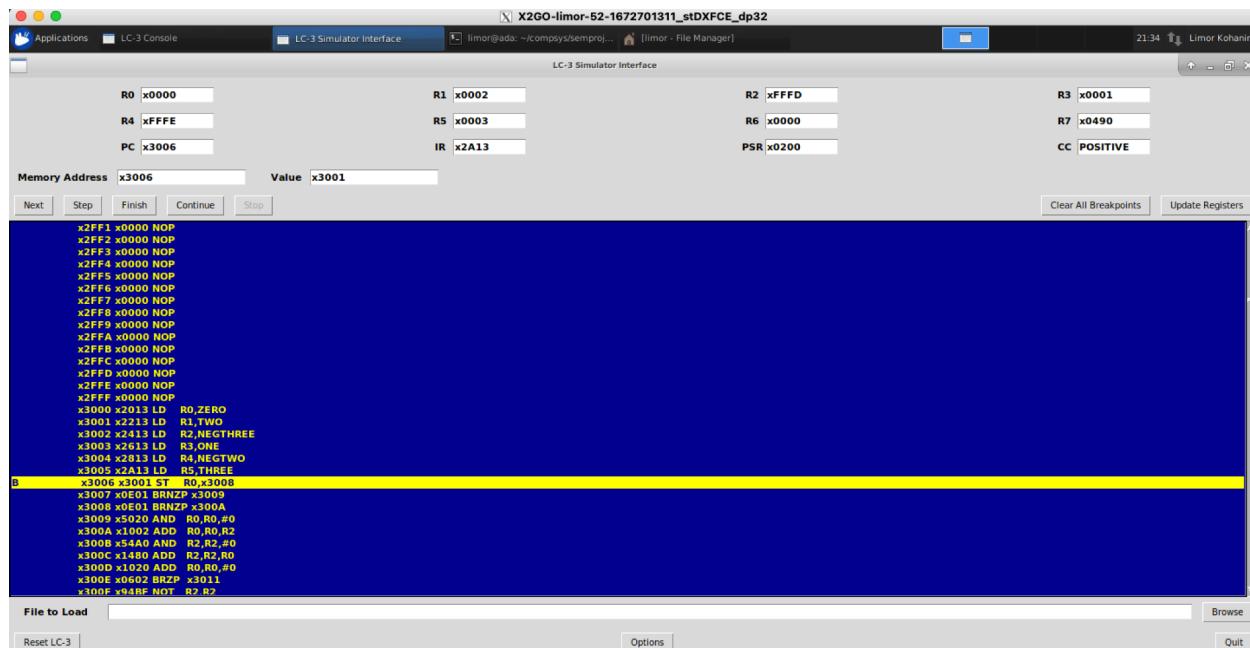
**ABS R2, R2 ;R2 = any number**

```

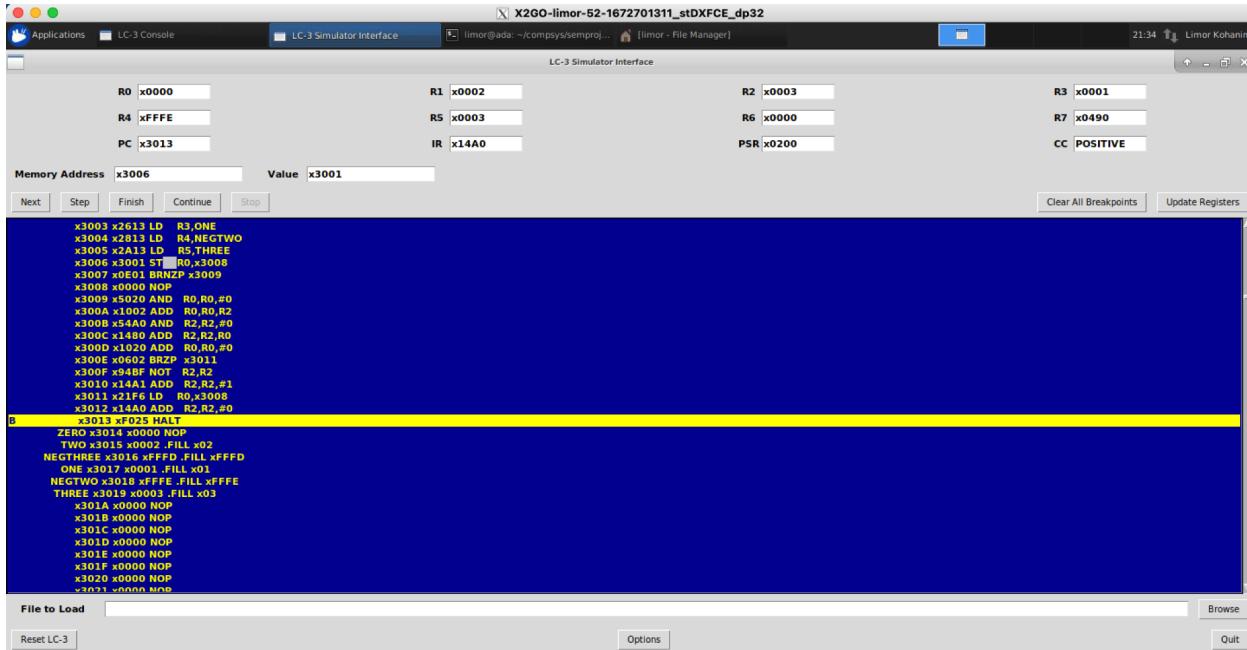
compsys > semproj > lc3tools > ASM ABS_test3.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 ABS R2, R2 ;R2 = any number
10
11
12 HALT
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFE
19 THREE .FILL x0003
20 ;
21 .END
22

```

## BEFORE instruction



## AFTER instruction



### HEX vals of instructions in this last edge case

- **limor@ada:~/compsys/sempproj/lc3tools\$ ./lc3as ABS\_test3.asm**

```

STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2013
the current instruction's hexadecimal value is x2213
the current instruction's hexadecimal value is x2413
the current instruction's hexadecimal value is x2613
the current instruction's hexadecimal value is x2813
the current instruction's hexadecimal value is x2a13
the current instruction's hexadecimal value is x3001
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1480
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is x602
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x21f6
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.

```
- **limor@ada:~/compsys/sempproj/lc3tools\$ █**

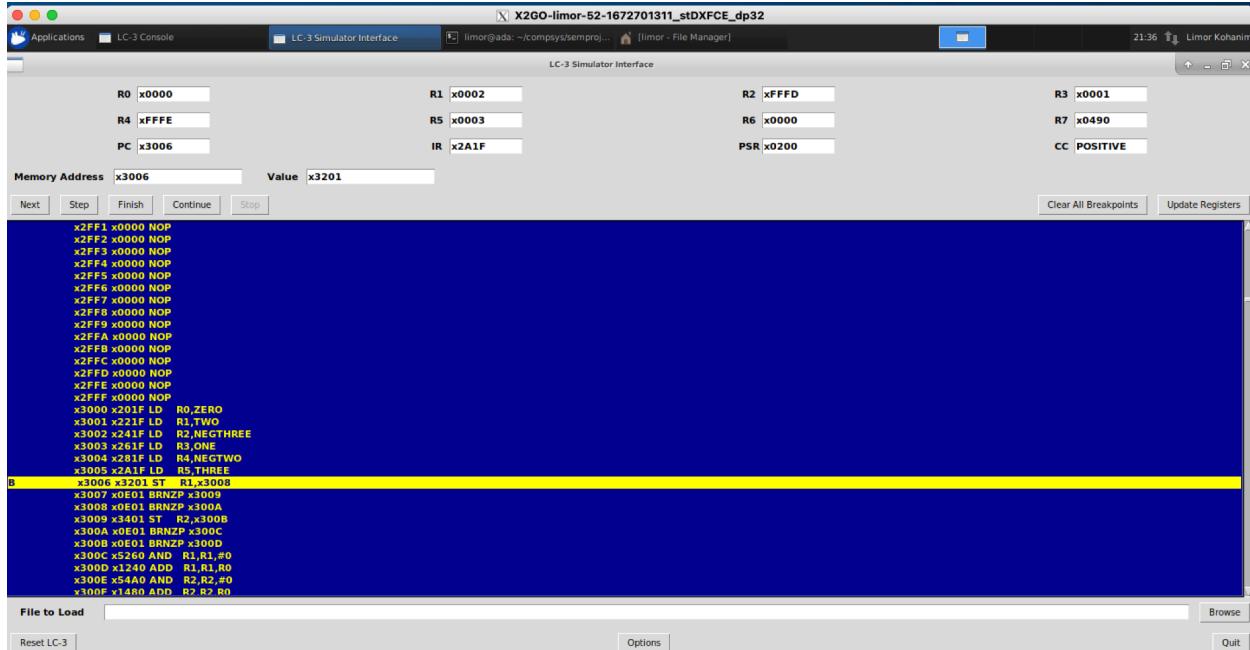
## test SQ: RR

RR

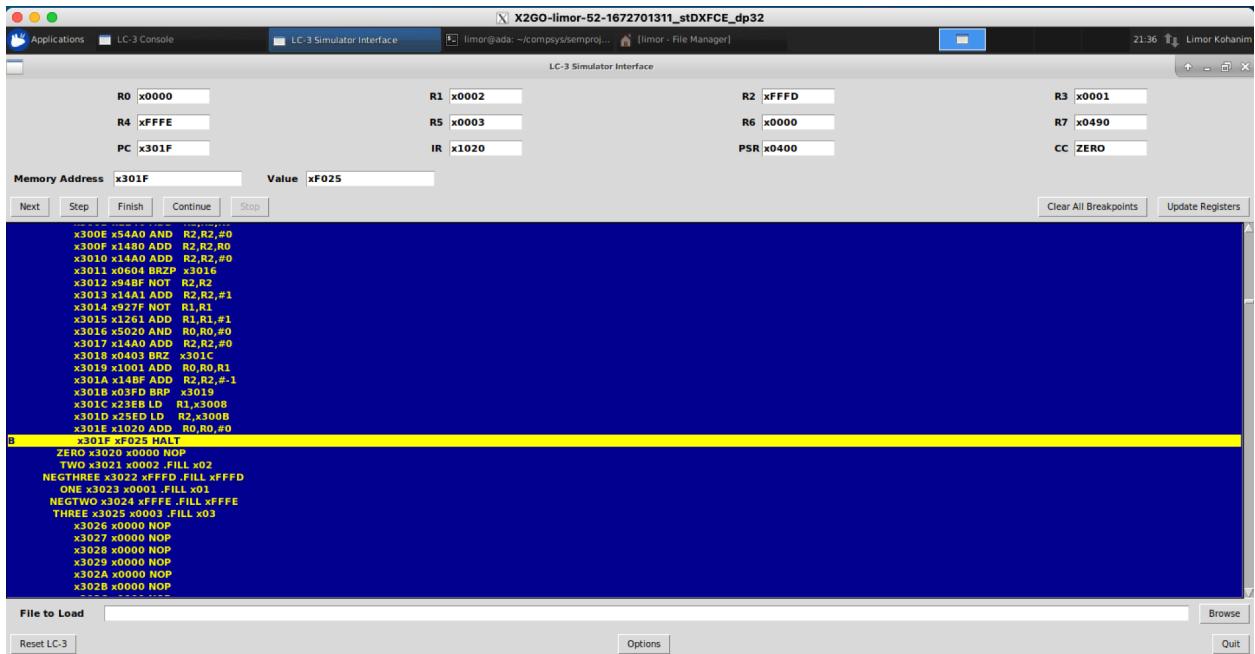
SQ R0, R0 ;R0 = zero

```
compsys > semproj > lc3tools > asm SQ_test.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SQ R0, R0 ;R0 = zero
10 HALT
11 ;
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFFE
18 THREE .FILL x0003
19 ;
20 .END
21
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SQ_test.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x201f
the current instruction's hexadecimal value is x221f
the current instruction's hexadecimal value is x241f
the current instruction's hexadecimal value is x261f
the current instruction's hexadecimal value is x281f
the current instruction's hexadecimal value is x2a1f
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1240
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1480
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x604
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1001
the current instruction's hexadecimal value is x14bf
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x23eb
the current instruction's hexadecimal value is x25ed
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xfffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

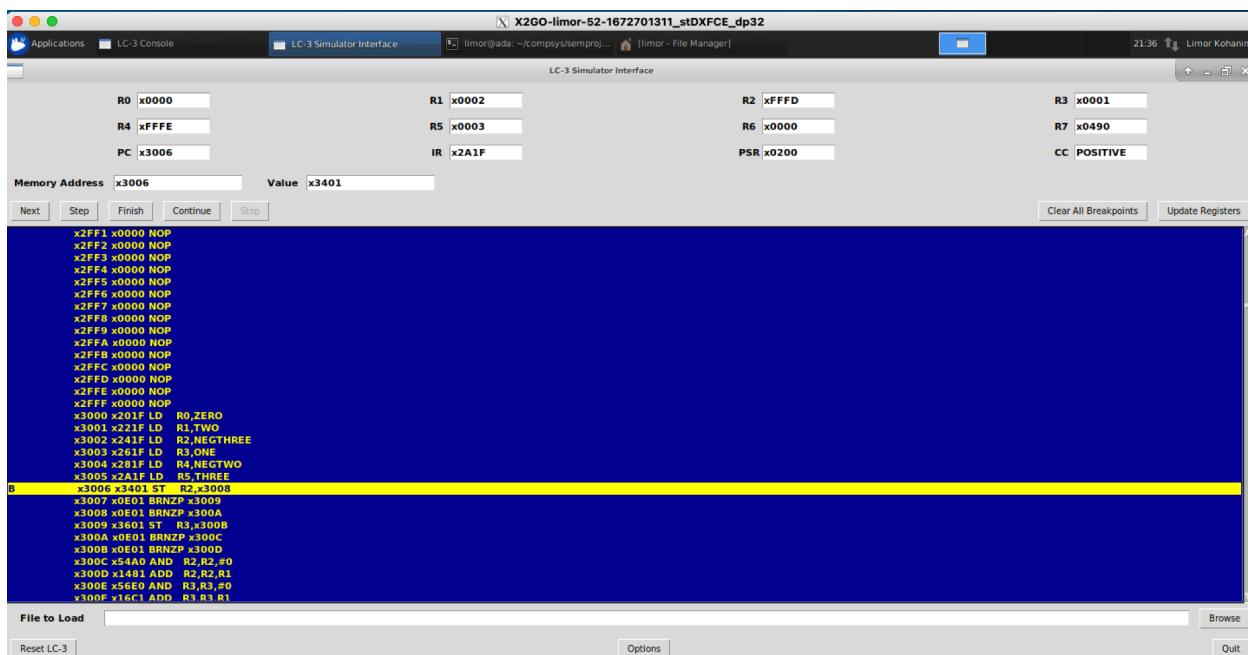
SQ R0, R1 ;R1 = positive number

```

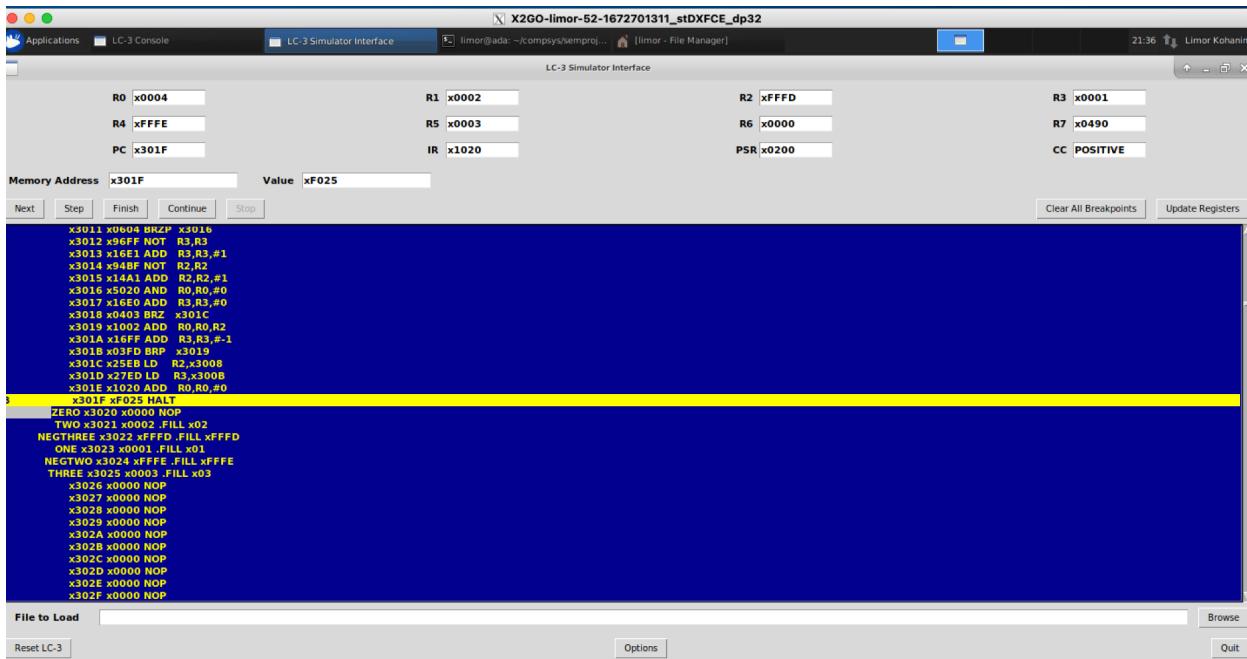
compsys > semproj > lc3tools > ASM SQ_test1.asm
1    .ORIG   x3000
2    LD      R0, ZERO
3    LD      R1, TWO
4    LD      R2, NEGTHREE
5    LD      R3, ONE
6    LD      R4, NEGTWO
7    LD      R5, THREE
8
9    SQ R0, R1 ;R1 = positive number
10
11   HALT
12   ;
13   ZERO    .FILL   x0000
14   TWO     .FILL   x0002
15   NEGTHREE .FILL   xFFFFD
16   ONE     .FILL   x0001
17   NEGTWO  .FILL   xFFFE
18   THREE   .FILL   x0003
19   ;
20   .END
21

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SQ_test1.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x201f
the current instruction's hexadecimal value is x221f
the current instruction's hexadecimal value is x241f
the current instruction's hexadecimal value is x261f
the current instruction's hexadecimal value is x281f
the current instruction's hexadecimal value is x2a1f
the current instruction's hexadecimal value is x3401
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1481
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c1
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x604
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x94bf
the current instruction's hexadecimal value is x14a1
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x25eb
the current instruction's hexadecimal value is x27ed
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

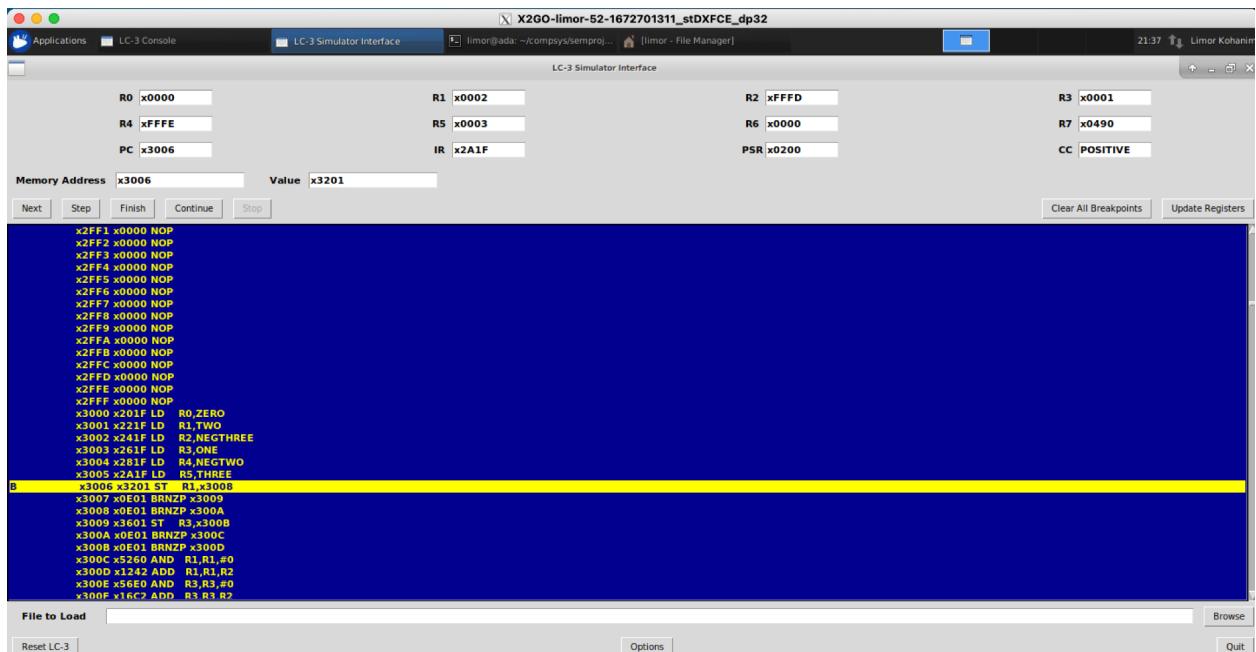
SQ R0, R2 ;R2 = negative number

```

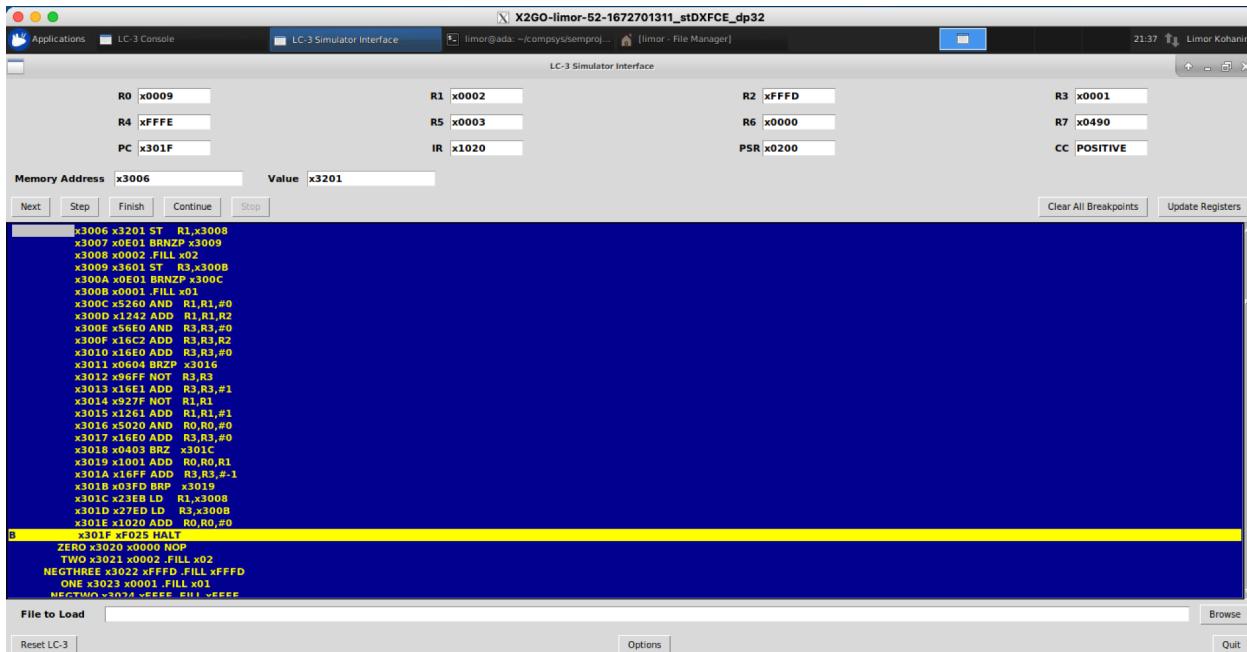
compsys > semproj > lc3tools > ASM SQ_test2.asm
1   .ORIG  x3000
2   LD      R0, ZERO
3   LD      R1, TWO
4   LD      R2, NEGTHREE
5   LD      R3, ONE
6   LD      R4, NEGTWO
7   LD      R5, THREE
8
9   SQ R0, R2    ;R2 = negative number
10
11  HALT
12  ;
13  ZERO     .FILL  x0000
14  TWO      .FILL  x0002
15  NEGTHREE .FILL  xFFFD
16  ONE      .FILL  x0001
17  NEGTWO   .FILL  xFFE
18  THREE    .FILL  x0003
19  ;
20  .END

```

### BEFORE instruction



### AFTER instruction



**HEX vals of instructions in this last edge case**

```
● Limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as SQ_test2.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x201f
the current instruction's hexadecimal value is x221f
the current instruction's hexadecimal value is x241f
the current instruction's hexadecimal value is x261f
the current instruction's hexadecimal value is x281f
the current instruction's hexadecimal value is x2a1f
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3601
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x56e0
the current instruction's hexadecimal value is x16c2
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x604
the current instruction's hexadecimal value is x96ff
the current instruction's hexadecimal value is x16e1
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x16e0
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1001
the current instruction's hexadecimal value is x16ff
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x23eb
the current instruction's hexadecimal value is x27ed
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ Limor@ada:~/compsys/sempproj/lc3tools$ █
```

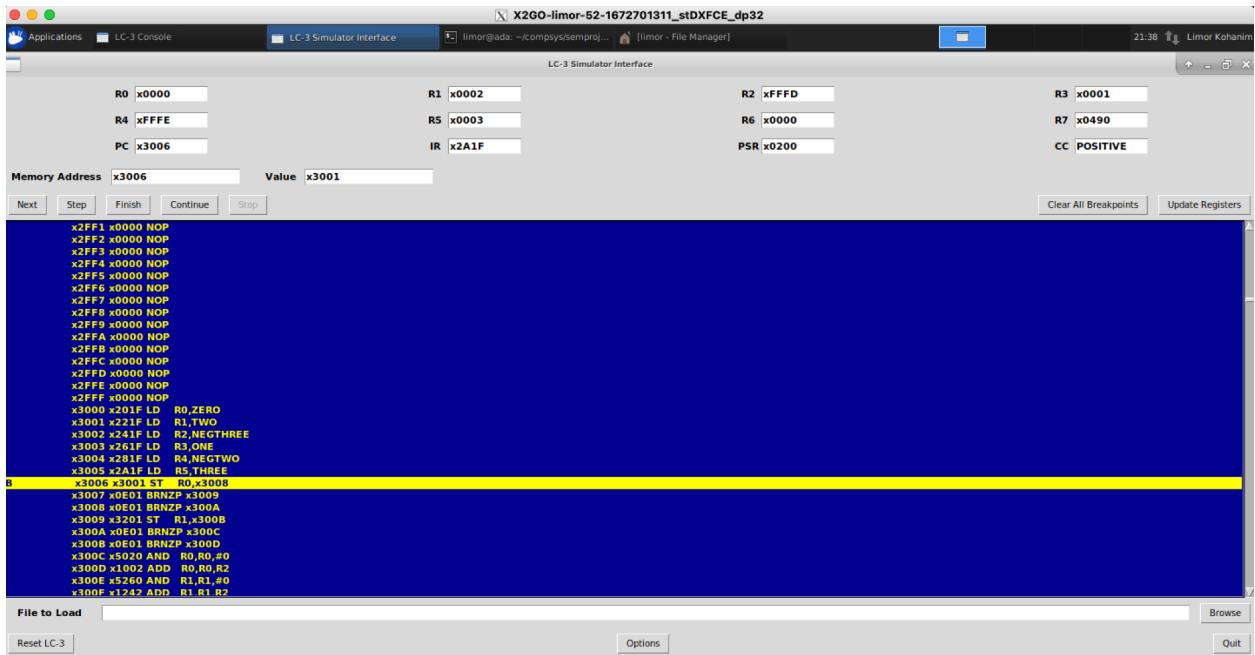
**SQ R2, R2 ;R1 = any number**

```

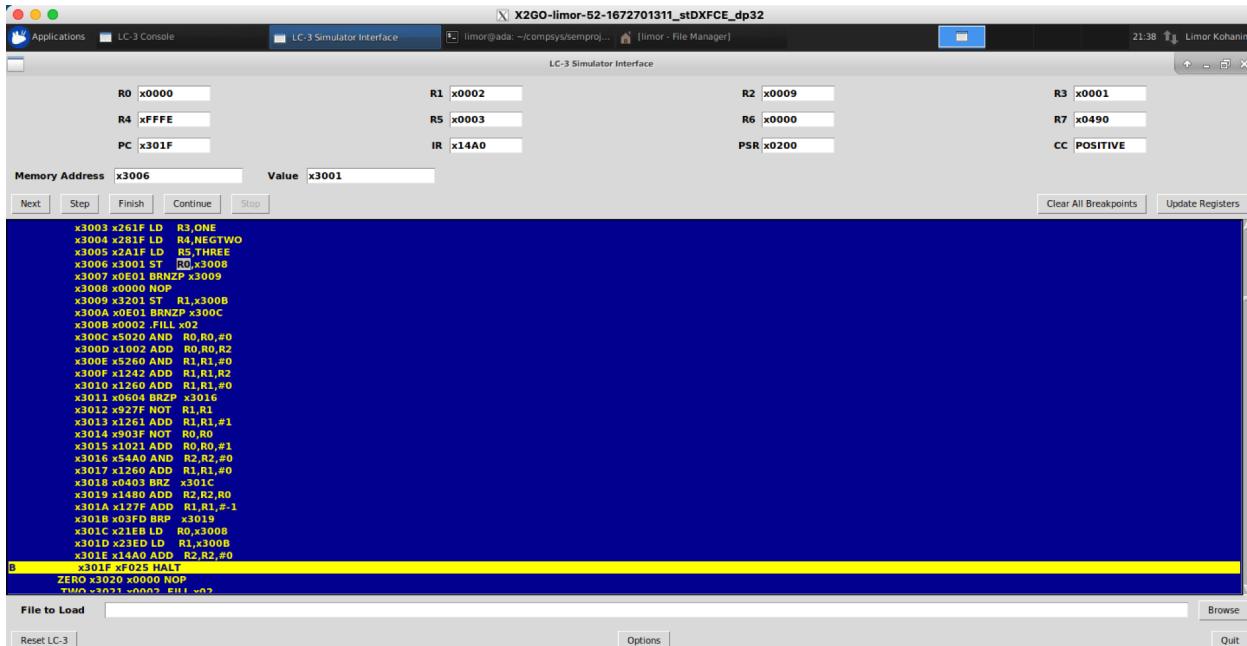
compsys > semproj > lc3tools > asm SQ_test3.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 SQ R2, R2 ;R2 = any number
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFE
18 THREE .FILL x0003
19 ;
20 .END
21

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```
● limor@ada:~/compsys/semproj/lc3tools$ ./lc3as SQ_test3.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x201f
the current instruction's hexadecimal value is x221f
the current instruction's hexadecimal value is x241f
the current instruction's hexadecimal value is x261f
the current instruction's hexadecimal value is x281f
the current instruction's hexadecimal value is x2a1f
the current instruction's hexadecimal value is x3001
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x3201
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is xe01
the current instruction's hexadecimal value is x5020
the current instruction's hexadecimal value is x1002
the current instruction's hexadecimal value is x5260
the current instruction's hexadecimal value is x1242
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x604
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x54a0
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is x403
the current instruction's hexadecimal value is x1480
the current instruction's hexadecimal value is x127f
the current instruction's hexadecimal value is x3fd
the current instruction's hexadecimal value is x21eb
the current instruction's hexadecimal value is x23ed
the current instruction's hexadecimal value is x14a0
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```

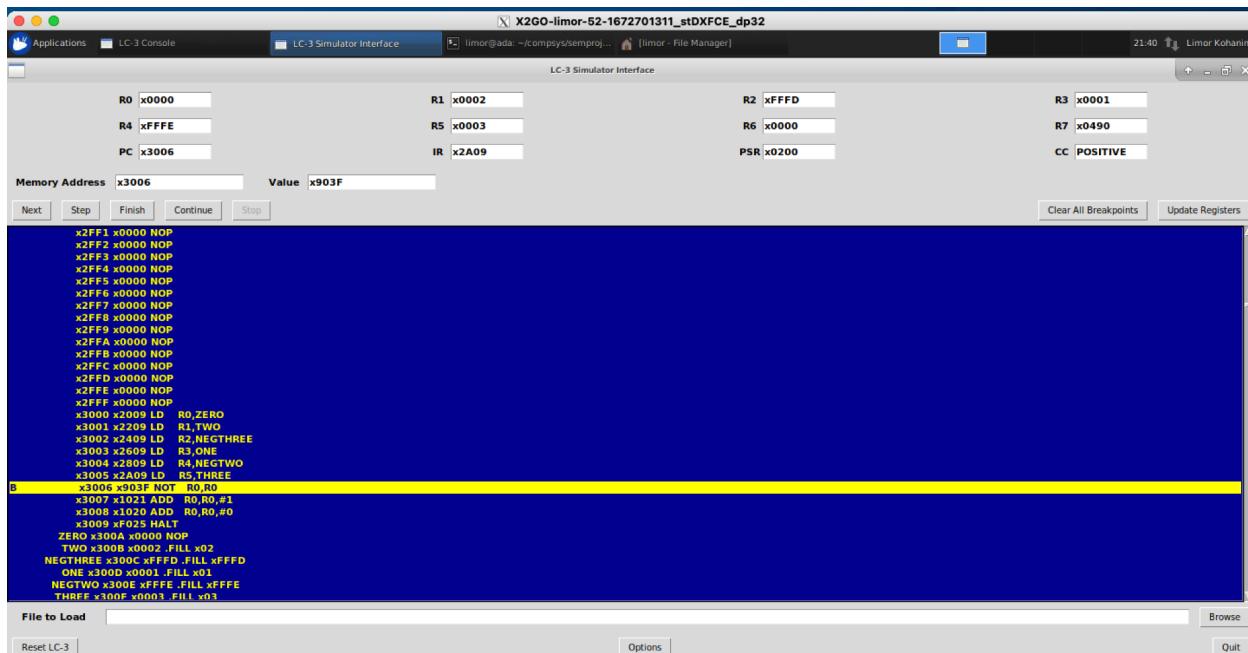
## test OPP: R format only

R

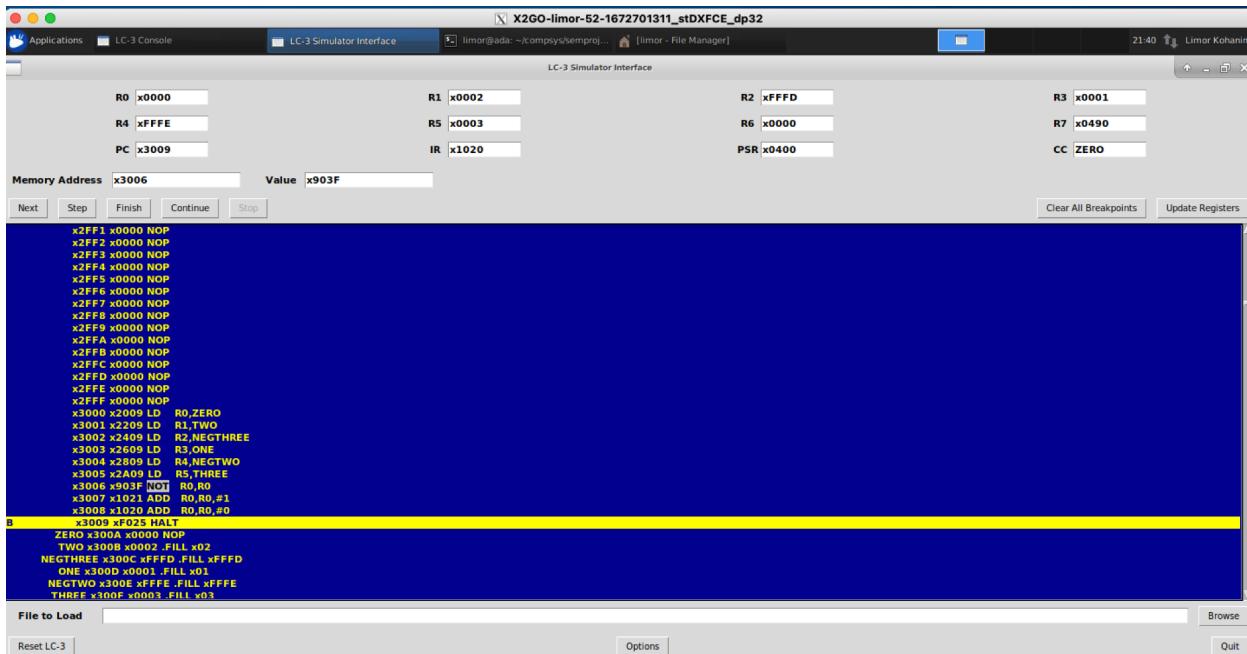
OPP R0 ; R0 = 0

```
compsys > semproj > lc3tools > asm OPP_test.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OPP R0 ; R0 = 0
10
11
12 HALT
13 ;
14 ZERO .FILL x0000
15 TWO .FILL x0002
16 NEGTHREE .FILL xFFFD
17 ONE .FILL x0001
18 NEGTWO .FILL xFFFFE
19 THREE .FILL x0003
20 ;
21 .END
22
```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

- **limor@ada:~/compsys/sempproj/lc3tools\$ ./lc3as OPP\_test.asm**

```
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2009
the current instruction's hexadecimal value is x2209
the current instruction's hexadecimal value is x2409
the current instruction's hexadecimal value is x2609
the current instruction's hexadecimal value is x2809
the current instruction's hexadecimal value is x2a09
the current instruction's hexadecimal value is x903f
the current instruction's hexadecimal value is x1021
the current instruction's hexadecimal value is x1020
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
```
- **limor@ada:~/compsys/sempproj/lc3tools\$**

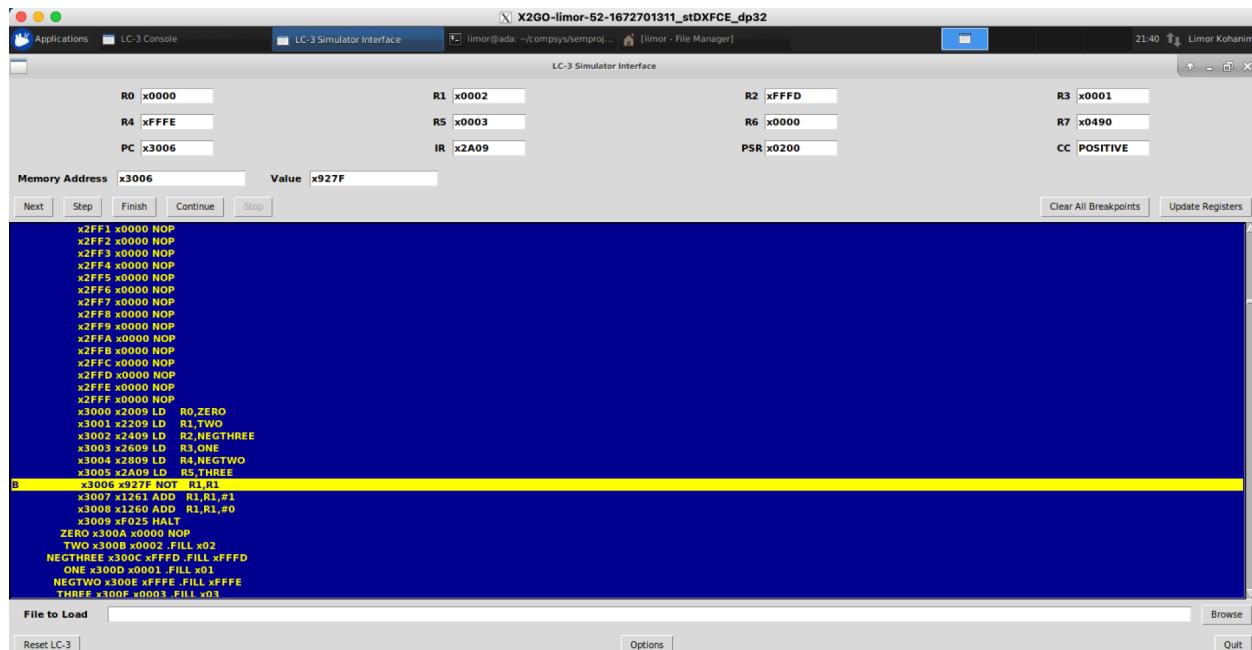
**OPP R1 ; R1 = positive number**

```

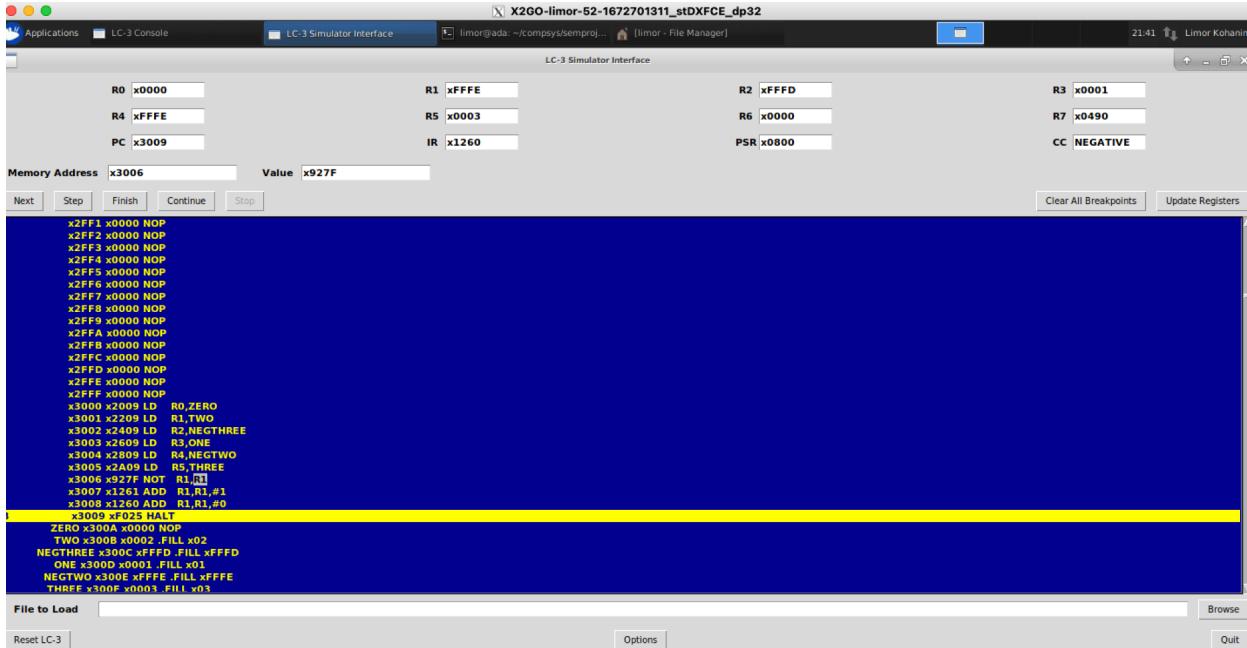
compsys > semproj > lc3tools > OPP_test1.asm
1   .ORIG  x3000
2   LD      R0, ZERO
3   LD      R1, TWO
4   LD      R2, NEGTHREE
5   LD      R3, ONE
6   LD      R4, NEGTWO
7   LD      R5, THREE
8
9   OPP R1 ; R1 = positive number
10
11
12  HALT
13 ;
14  ZERO     .FILL  x0000
15  TWO      .FILL  x0002
16  NEGTHREE .FILL  xFFFD
17  ONE      .FILL  x0001
18  NEGTWO   .FILL  xFFFFE
19  THREE    .FILL  x0003
20 ;
21 .END
22

```

### BEFORE instruction



### AFTER instruction



### HEX vals of instructions in this last edge case

```

● limor@ada:~/compsys/sempproj/lc3tools$ ./lc3as OPP_test1.asm
STARTING PASS 1
0 errors found in first pass.
STARTING PASS 2
the current instruction's hexadecimal value is x3000
the current instruction's hexadecimal value is x2009
the current instruction's hexadecimal value is x2209
the current instruction's hexadecimal value is x2409
the current instruction's hexadecimal value is x2609
the current instruction's hexadecimal value is x2809
the current instruction's hexadecimal value is x2a09
the current instruction's hexadecimal value is x927f
the current instruction's hexadecimal value is x1261
the current instruction's hexadecimal value is x1260
the current instruction's hexadecimal value is xf025
the current instruction's hexadecimal value is x0
the current instruction's hexadecimal value is x2
the current instruction's hexadecimal value is xffffd
the current instruction's hexadecimal value is x1
the current instruction's hexadecimal value is xffffe
the current instruction's hexadecimal value is x3
0 errors found in second pass.
○ limor@ada:~/compsys/sempproj/lc3tools$ 

```

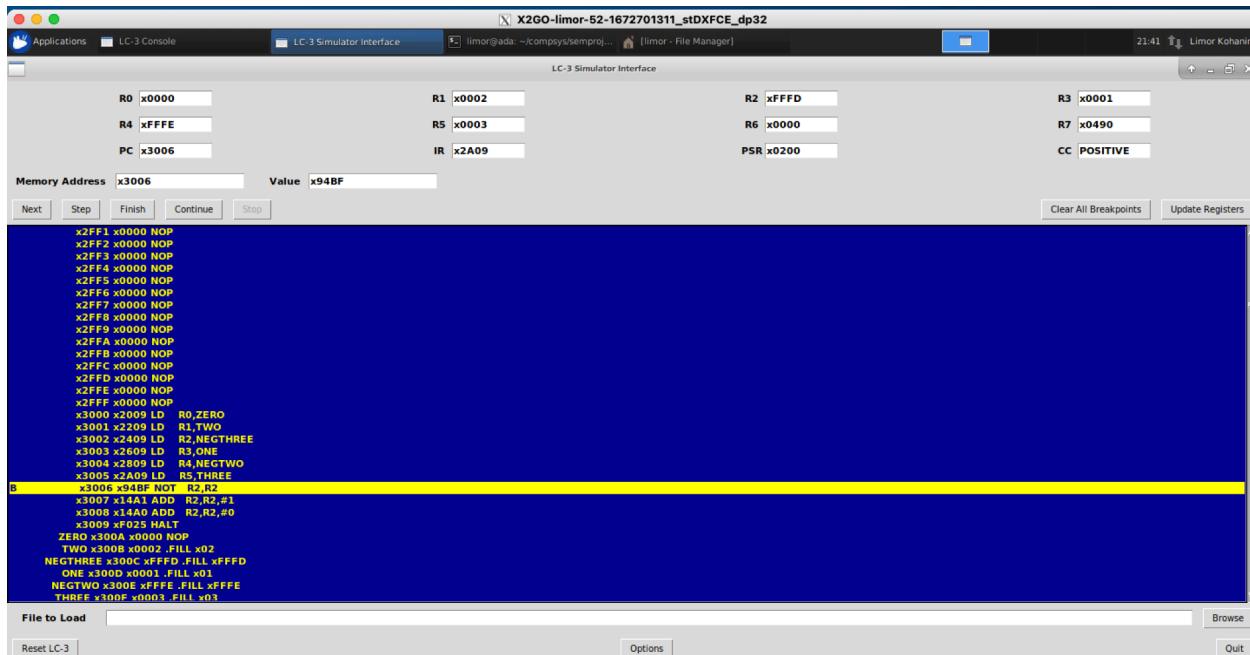
OPP R2 ; R2 = negative number

```

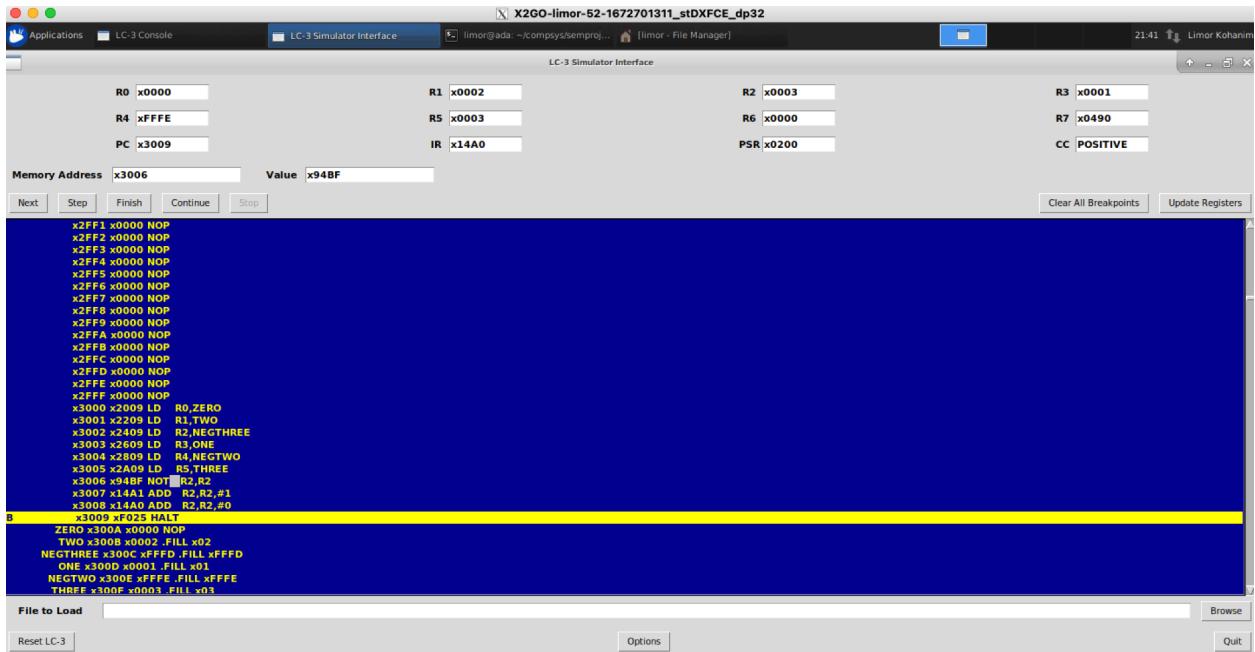
compsys > semproj > lc3tools > asm OPP_test2.asm
1 .ORIG x3000
2 LD R0, ZERO
3 LD R1, TWO
4 LD R2, NEGTHREE
5 LD R3, ONE
6 LD R4, NEGTWO
7 LD R5, THREE
8
9 OPP R2 ; R2 = negative number
10
11 HALT
12 ;
13 ZERO .FILL x0000
14 TWO .FILL x0002
15 NEGTHREE .FILL xFFFD
16 ONE .FILL x0001
17 NEGTWO .FILL xFFFE
18 THREE .FILL x0003
19 ;
20 .END

```

BEFORE instruction



AFTER instruction



### HEX vals of instructions in this last edge case

- **limor@ada:~/compsys/sempproj/lc3tools\$ ./lc3as OPP\_test2.asm**

STARTING PASS 1  
0 errors found in first pass.

STARTING PASS 2  
the current instruction's hexadecimal value is x3000  
the current instruction's hexadecimal value is x2009  
the current instruction's hexadecimal value is x2209  
the current instruction's hexadecimal value is x2409  
the current instruction's hexadecimal value is x2609  
the current instruction's hexadecimal value is x2809  
the current instruction's hexadecimal value is x2a09  
the current instruction's hexadecimal value is x94bf  
the current instruction's hexadecimal value is x14a1  
the current instruction's hexadecimal value is x14a0  
the current instruction's hexadecimal value is xf025  
the current instruction's hexadecimal value is x0  
the current instruction's hexadecimal value is x2  
the current instruction's hexadecimal value is xffffd  
the current instruction's hexadecimal value is x1  
the current instruction's hexadecimal value is xffffe  
the current instruction's hexadecimal value is x3  
0 errors found in second pass.
- **limor@ada:~/compsys/sempproj/lc3tools\$**