ARM Instructions Worksheet #11

Constant Multiples

Prerequisite Reading: Chapter 7
Revised: May 11, 2020

Objectives: *To use the web-based simulator ("CPULator") to better understand …*

1. That multiplying by a constant requires two instructions – one to load a register with the constant followed by a MUL.
2. The use of a single addition or subtraction with shifting to compute N times a variable without multiplying.
3. The use of a two-instruction sequence to compute N times a variable in the same time as using a MUL.

To do offline: Answer the questions that follow the listing below. (Numbers at far left are memory addresses.)

```
                .global     _start
                .syntax     unified

00000000 _start:    LDR         R1,=1  // *** EXECUTION STARTS HERE ***

                // Creating multiples using 1 instruction (faster than MUL)

00000004            LSL         R0,R1,3
00000008            ADD         R0,R1,R1,LSL 3
0000000C            RSB         R0,R1,R1,LSL 3
00000010            SUB         R0,R1,R1,LSL 3
00000014            MVN         R0,R1,LSL 3

                // Creating multiples using 2 instructions (same time as MUL)

00000018            ADD         R0,R1,R1,LSL 2
0000001C            LSL         R0,R0,1

00000020            ADD         R0,R1,R1,LSL 2
00000024            ADD         R0,R1,R0,LSL 2

00000028            ADD         R0,R1,R1,LSL 4
0000002C            SUB         R0,R0,R1,LSL 2

00000030            RSB         R0,R1,R1,LSL 3
00000034            LSL         R0,R0,1

00000038            ADD         R0,R1,R1,LSL 2
0000003C            RSB         R0,R1,R0,LSL 2

00000040 done:      B           done  // Infinite loop

                .end
```

What is in register R0 after executing the LSL instruction at address 00000004_{16}?

R0 (as decimal signed)
8

What is in register R0 after executing the ADD instruction at address 00000008_{16}?

R0 (as decimal signed)
9

What is in register R0 after executing the RSB instruction at address $0000000C_{16}$?

R0 (as decimal signed)
7

What is in register R0 after executing the SUB instruction at address 00000010_{16}?

R0 (as decimal signed)
-7

What is in register R0 after executing the MVN instruction at address 00000014_{16}?

R0 (as decimal signed)
-9

What is in register R0 after executing the LSL instruction at address $0000001C_{16}$?

R0 (as decimal signed)
10

What is in register R0 after executing the ADD instruction at address 00000024_{16}?

R0 (as decimal signed)
21

What is in register R0 after executing the SUB instruction at address $0000002C_{16}$?

R0 (as decimal signed)
13

What is in register R0 after executing the LSL instruction at address 00000034_{16}?

R0 (as decimal signed)
14

What is in register R0 after executing the RSB instruction at address $0000003C_{16}$?

R0 (as decimal signed)
19

Getting ready: *Now use the simulator to collect the following information and compare to your earlier answers.*

1. Click here to open a browser for the ARM instruction simulator with pre-loaded code.
2. Change the number format in the "Settings" window to signed decimal.

Step 1: *Press F2 once per ARM instruction as needed to see what the simulator says for the following:*

What is in register R0 after executing the LSL instruction at address 00000004_{16}?

R0 (as decimal signed)
8

What is in register R0 after executing the ADD instruction at address 00000008_{16}?

R0 (as decimal signed)
9

What is in register R0 after executing the RSB instruction at address $0000000C_{16}$?

R0 (as decimal signed)
7

What is in register R0 after executing the SUB instruction at address 00000010_{16}?

R0 (as decimal signed)
-7

What is in register R0 after executing the MVN instruction at address 00000014_{16}?

R0 (as decimal signed)
-9

What is in register R0 after executing the LSL instruction at address $0000001C_{16}$?

R0 (as decimal signed)
10

What is in register R0 after executing the ADD instruction at address 00000024_{16}?

R0 (as decimal signed)
21

What is in register R0 after executing the SUB instruction at address $0000002C_{16}$?

R0 (as decimal signed)
13

What is in register R0 after executing the LSL instruction at address 00000034_{16}?

R0 (as decimal signed)
14

What is in register R0 after executing the RSB instruction at address $0000003C_{16}$?

R0 (as decimal signed)
19