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}?

RO (as decimal signed)

8

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

RO (as decimal signed)

9

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

RO (as decimal signed)

7

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

RO (as decimal signed)

-7

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

RO (as decimal signed)

-9

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

RO (as decimal signed)

10

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

RO (as decimal signed)

21

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

RO (as decimal signed)

13

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

RO (as decimal signed)

14

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

RO (as decimal signed)

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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}?

RO (as decimal signed)

8

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

RO (as decimal signed)

9

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

RO (as decimal signed)

7

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

RO (as decimal signed)

-7

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

RO (as decimal signed)

-9

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

RO (as decimal signed)

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

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19