ARM Instructions Worksheet #4

Addition and Subtraction

And their effect on the NZCV Flags in the CPSR register:

<table>
<thead>
<tr>
<th>N</th>
<th>Z</th>
<th>C</th>
<th>V</th>
<th>Q</th>
</tr>
</thead>
</table>

Prerequisite Reading: Chapter 5
Revised: March 26, 2020

Objectives: To use the web-based simulator (“CPUlator”) to better understand ...

1. That the flags are not affected unless the letter ‘S’ is appended to the instruction.
2. How the oVerflow flag (V) is affected as the result of a signed addition or a signed subtraction.
3. How the Carry flag (C) is affected as the result of an unsigned addition or an unsigned subtraction.
4. How to Zero flag (Z) and Negative flag (N) are affected as the result of an arithmetic operation.

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

```
syntax unified
.globl _start

_start:    MSR    APSR_nzcvq, 0  // *** EXECUTION STARTS HERE ***
0000004   LDR    R0, =0x40000001
0000008   ADD    R1, R0, R0
000000C   ADDS   R1, R0, R0
0000010   SUBS   R1, R0, R0
0000014   ADCS   R1, R1, 0
0000018   RSBS   R1, R0, 1

done:     B      done      // infinite loop

.end
```

What is left in R0 by the LDR at 0000000416?

- R0 (as unsigned decimal): 
- R0 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

What is in R1 and flags after ADD at 0000000816?

- R1 (as unsigned decimal): 
- R1 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

Unsigned Overflow? 
Signed Overflow?

What is in R1 and flags after ADDS at 0000000C16?

- R1 (as unsigned decimal): 
- R1 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

Unsigned Overflow? 
Signed Overflow?

What is in R1 and flags after SUBS at 0000001016?

- R1 (as unsigned decimal): 
- R1 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

Unsigned Overflow? 
Signed Overflow?

What is in R1 and flags after ADCS at 0000001416?

- R1 (as unsigned decimal): 
- R1 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

Unsigned Overflow? 
Signed Overflow?

What is in R1 and flags after RSBS at 0000001816?

- R1 (as unsigned decimal): 
- R1 (as signed decimal): 
- N: 
- Z: 
- C: 
- V: 

Unsigned Overflow? 
Signed Overflow?
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.

   **Note:** You can change the number format in the “Settings” window between hex, unsigned decimal and signed decimal as needed. It’s probably easiest to go through the instructions three times – once to get the unsigned decimal values, once to get the signed decimal values, and once to get the flag values (using hex format). Before each pass, press Ctrl-R to restart the simulation.

| Step 1: Press F2 exactly 2 times to execute the MSR, LDR pseudo-instruction (MOV) sequence |
| What is left in R0 by the LDR at 00000004₁₆? | R0 (as unsigned decimal) | R0 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |

| Step 2: Press F2 exactly once to execute the ADD R1, R0, R0 instruction. |
| What is in R1 and flags after ADD at 00000008₁₆? | R1 (as unsigned decimal) | R1 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |

| Step 3: Press F2 exactly once to execute the ADDS R1, R0, R0 instruction. |
| What is in R1 and flags after ADDS at 0000000C₁₆? | R1 (as unsigned decimal) | R1 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |

| Step 4: Press F2 exactly once to execute the SUBS R1, R0, R0 instruction. |
| What is in R1 and flags after SUBS at 00000010₁₆? | R1 (as unsigned decimal) | R1 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |

| Step 5: Press F2 exactly once to execute the ADCS R1, R1, 0 instruction. |
| What is in R1 and flags after ADCS at 00000014₁₆? | R1 (as unsigned decimal) | R1 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |

| Step 6: Press F2 exactly once to execute the RSBS R1, R1, 1 instruction. |
| What is in R1 and flags after RSBS at 00000018₁₆? | R1 (as unsigned decimal) | R1 (as signed decimal) | N | Z | C | V |
| Unsigned Overflow? | Signed Overflow? |