

- Condition Code Flag interpretation

ELEC2041

Microprocessors and Interfacing

Lecture 7: Number Systems – II Extras

<http://webct.edtec.unsw.edu.au/>

March 2005

Saeid Nooshabadi

saeid@unsw.edu.au

Review: int and unsigned int in C

- With N bits we can represent 2^N different Numbers:

- 2^N numbers 0 to $2^N - 1$:Only zero and Positive numbers
- 2^N numbers $-2^{N/2}$ to 0 to $2^{N/2} - 1$: Both Negative and positive numbers in 2's Complement

0000	0	0
0001	1	1
0010	2	2
0011	3	3
0100	4	4
0101	5	5
0110	6	6
0111	7	7
1000	8	-8
1001	9	-7
1010	10	-6
1011	11	-5
1100	12	-4
1101	13	-3
1110	14	-2
1111	15	-1

Is 1000 > 0110 ?

1000 > 0110 if only +ve representation used

1000 < 0110 if both +ve and -ve representation in 2's complement used

Review: Condition Flags

Flags	Arithmetic Instruction
Negative (N='1')	Bit 31 of the result has been set Indicates a negative number in signed operations
Zero (Z='1')	Result of operation was zero
Carry (C='1')	Result was greater than 32 bits
oVerflow (V='1')	Result was greater than 31 bits Indicates a possible corruption of the sign bit in signed numbers

312827

NZCV

unused

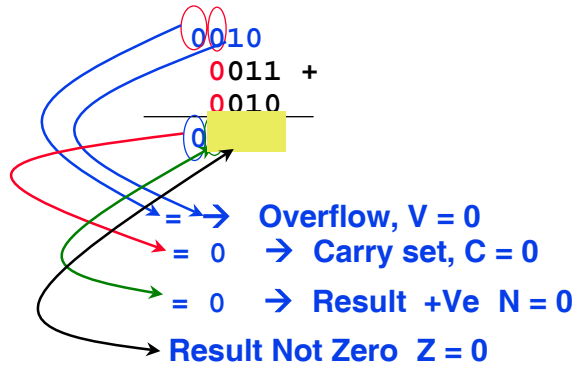
87654

IFTmode

0

Experimentation with Condition Flags (#1/5)

Indicate the changes in **N, Z, C, V** flags for the following arithmetic operations: (Assume 4 bit-numbers)



Signed interpretation: $3 + 2 = 5$. The number is within the range of -8 to +7. **No overflow (V)**

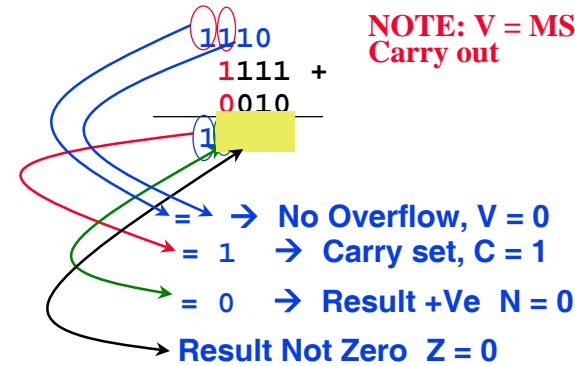
Unsigned interpretation: $3 + 2 = 5$. The number is within the range of 0 to +15. **Carry NotSet, NoOverflow (C)**

ELEC2041 lec06-numbers-II-extras.5

Saeid Nooshabadi

Experimentation with Condition Flags (#2/5)

Indicate the changes in **N, Z, C, V** flags for the following arithmetic operations: (Assume 4 bit-numbers)



NOTE: V = MSB Carry In (XOR) MSB Carry out

Signed interpretation: $-1 + 2 = 1$. The number is within the range of -8 to +7. **No overflow (V)**

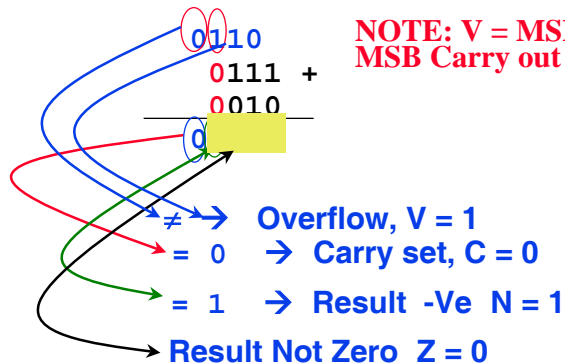
Unsigned interpretation: $15 + 2 = 17$. The number is out of the range of 0 to +15. **Carry Set, Overflow (C)**

ELEC2041 lec06-numbers-II-extras.6

Saeid Nooshabadi

Experimentation with Condition Flags (#3/5)

Indicate the changes in **N, Z, C, V** flags for the following arithmetic operations: (Assume 4 bit-numbers)



NOTE: V = MSB Carry In (XOR) MSB Carry out

Signed interpretation: $7 + 2 = 9$. The number is out of the range of -8 to +7. **overflow (V)**

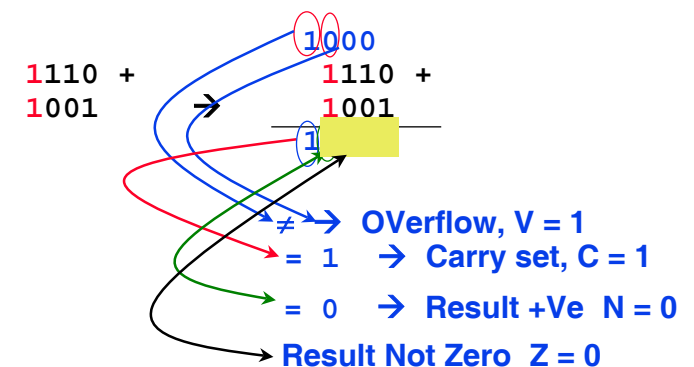
Unsigned interpretation: $7 + 2 = 9$. The number is within the range of 0 to +15. **Carry NotSet, NoOverflow (C)**

ELEC2041 lec06-numbers-II-extras.7

Saeid Nooshabadi

Experimentation with Condition Flags (#4/5)

Indicate the changes in **N, Z, C, V** flags for the following arithmetic operations: (Assume 4 bit-numbers)



Signed interpretation: $-2 - 7 = -2 + (-7) = -9$. The number is out of the range of -8 to +7. **overflow (V)**

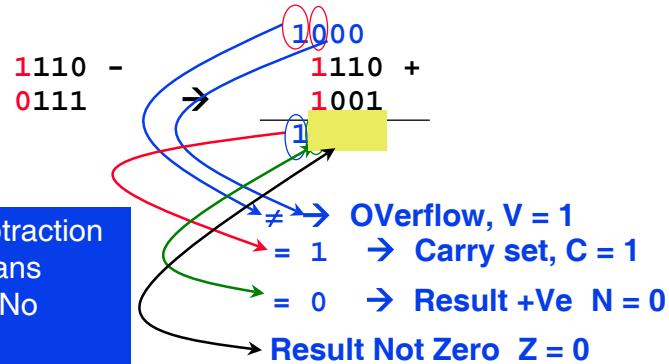
Unsigned interpretation: $14 + 9 = 23$. The number is out of the range of 0 to +15. **Carry Set, Overflow (C)**

ELEC2041 lec06-numbers-II-extras.8

Saeid Nooshabadi

Experimentation with Condition Flags (#5/5)

Indicate the changes in **N**, **Z**, **C**, **V** flags for the following arithmetic operations: (Assume 4 bit-numbers)



Note: For Subtraction
Carry Set means
No Overflow (No
Borrow)

Signed interpretation: $-2 - 7 = -2 + (-7) = -9$. The number is out of the range of -8 to $+7$. **oVerflow (V)**

Unsigned interpretation: $14 - 7 = 7$. The number is within the range of 0 to $+15$. **Carry Set, NoOverflow (C)**

Signed /Unsigned Overflow Summary

Signed Arithmetic overflow Condition:

oVerflow flag V = 0 **NO OVERFLOW**

oVerflow flag V = 1 **OVERFLOW**

NOTE: V = MSB Carry In (XOR) MSB Carry out

UnSigned Arithmetic overflow Condition:

Addition:

(Carry flag C = 0) **NO OVERFLOW**

(Carry flag C = 1) **OVERFLOW**

Subtraction:

(Carry flag C = 0) **OVERFLOW**

(Carry flag C = 1) **NO OVERFLOW**