

Addition and Subtraction

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Book Chapter

- “Assembly Language for x86 Processors”
- Author “Kip R. Irvine”
- 6th Edition
- Chapter 4
 - Section 4.2

Outline

- INC and DEC Instructions
- ADD Instruction
- SUB Instruction
- NEG Instruction
- FLAGS affected by Addition and Subtraction

INC and DEC Instructions (1/2)

- INC instruction increments 1 in a single operand
- DEC instruction decrements 1 from a single operand
- Syntax is
 - INC reg/mem
 - DEC reg/mem
- Flags affected
 - OF, SF, ZF, AF, PF

INC and DEC Instructions (2/2)

```
.data
```

```
a DB 10h
```

```
.code
```

```
INC a
```

a = 11h

```
MOV al, a
```

```
DEC al
```

al = 10h

ADD Instruction

- Adds a source operand into a destination operand
- Both operands must have the same size
- Sum is stored in the destination operand
- Syntax is `ADD dest, src`
- Flags affected
 - CF, ZF, SF, OF, AF, PF

SUB Instruction

- Subtracts a source operand from a destination operand
- Both operands must have the same size
- Result is stored in the destination operand
- Syntax is `SUB dest, src`
- Flags affected
 - CF, ZF, SF, OF, AF, PF

NEG Instruction

- Reverses the sign of a number by taking its 2's complement
- Syntax is
 - NEG reg
 - NEG mem
- Flags affected
 - CF, ZF, SF, OF, AF, PF

Flags Affected by Addition and Subtraction

- Status flags reflect the outcome of an arithmetic or logic instruction
 - ... based on the contents of destination operand
- Essential flags are
 - ZF: set when destination operand equals zero
 - SF: set when destination operand is negative
 - CF: set when unsigned value if out of range
 - OF: set when signed value if out of range
- **MOV instruction never affects the flags**

Zero Flag (ZF)

- ZF is set when the result of an operation produces zero in the destination operand

```
MOV al, 1          ;no flag affected
SUB al, 1          ;al=0 → ZF=1
MOV bl, 0FFh       ;no flag affected
INC bl             ;bl=0 → ZF=1
INC bl             ;bl=1 → ZF=0
```

- Remember that
 - A flag is **set** when it equals 1
 - A flag is **clear** when it equals 0

Sign Flag (SF)

- SF is set when destination operand is –ve
- SF is clear when destination is +ve

```
MOV  al, 0      ;no flag affected
SUB  al, 1      ;al=-1 → SF=1
ADD  al, 2      ;al=1 → SF=0
```

Carry Flag (CF)

- CF is set when result of an arithmetic operation generates an unsigned value that cannot fit into destination operand

```
MOV al, 0FFh ;no flag affected  
ADD al, 1    ;al=00h → CF=1
```

```
MOV al, 0    ;no flag affected  
SUB al, 1    ;al=0FFh → CF=1
```

Overflow Flag (OF) (1/2)

- OF is set when the result of a signed arithmetic operation overflows or underflows the destination operand

```
MOV al, +127 ;no flag affected  
ADD al, 1    ;al=?? → OF=1
```

```
MOV al, -128 ;no flag affected  
SUB al, 1    ;al=?? → OF=1
```

Overflow Flag (OF) (2/2)

- When adding two integers, remember that OF is only set when
 - Two positive operands are added and their sum is negative
 - Two negative operands are added and their sum is positive