



8086 Flag Register

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Lecture References:

▣ **Book:**

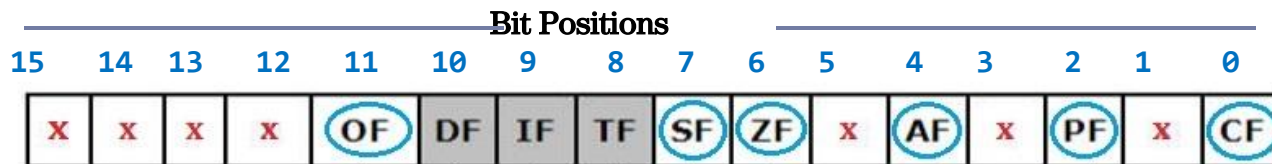
- ▣ *Microprocessors and Interfacing: Programming and Hardware,*
*Chapter # 2, **Author:** Douglas V. Hall*

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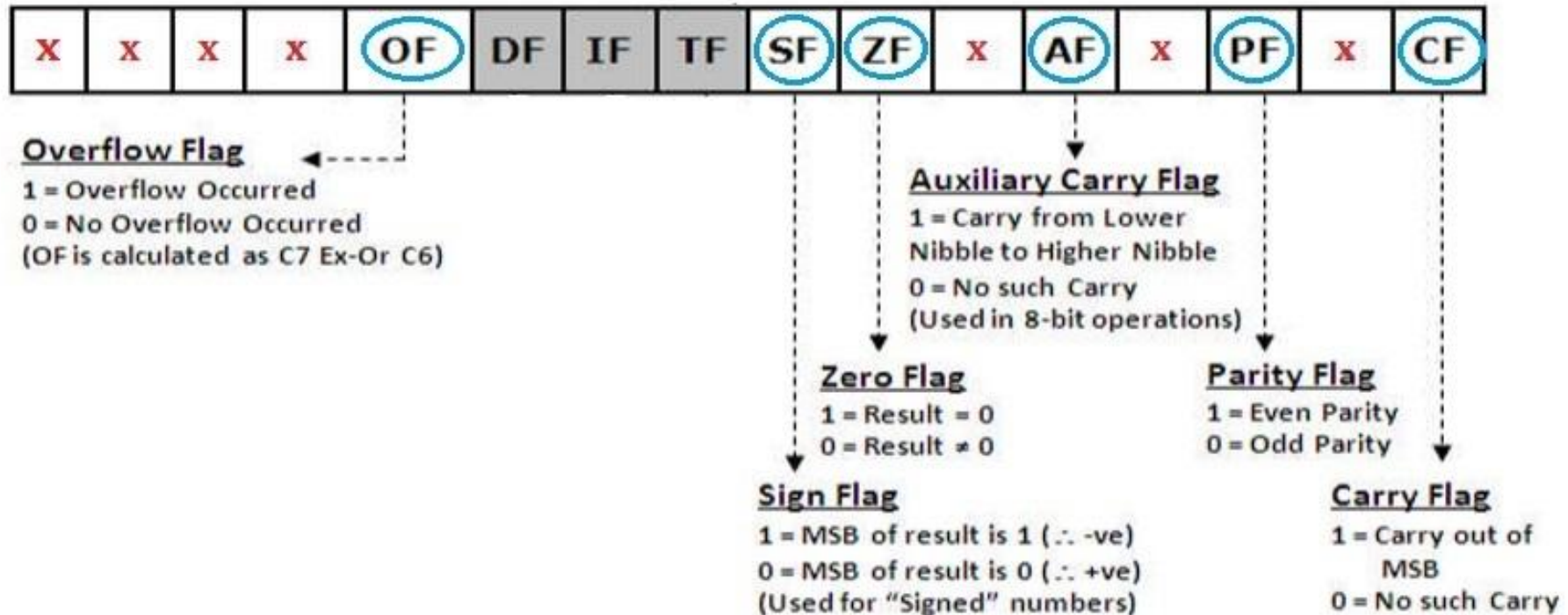
□ 16-Bit register

- **7 bits are undefined/unused (marked by red x in the figure below)**
- **6 status/condition flags (marked by blue circles)**
- **3 control flags (those in grey boxes)**

- The condition flags are set (1) or reset (0) depending on the result of an arithmetic/logical operation.
- Control flags control the operations of the CPU



Status Flags



Flags are useful in programming e.g. when writing conditions such as:

- If answer is zero, do ... else // zero flag comes in hand here
- If answer is less than zero, do ... else // sign flag can be used here

Status Flags

- ▣ **Carry Flag (CF)** - is set to '1' when there is an unsigned overflow. E.g. when you add bytes $255 + 1$ (result is not in range $0 \dots 255$). When there is no overflow this flag is reset to 0.
- ▣ **Parity Flag (PF)** - set to '1' when there is even number of one bits in result, and reset to '0' when there is odd number of one bits.
- ▣ **Auxiliary Flag (AF)** - set to '1' when there is an unsigned overflow for low nibble (4 bits).

Status Flags

- ▣ **Zero Flag (ZF)** - set to '1' when result is zero. For non-zero result this flag is reset to '0'.
- ▣ **Sign Flag (SF)** - set to '1' when result is negative. When result is positive it is reset to '0'. (This flag takes the value of the most significant bit).
- ▣ **Overflow Flag (OF)** - set to '1' when there is a signed overflow. For example, when you add bytes $100 + 50$.

Status Flags

NB:

OF is set to 1 if there is a carry from:

- the 7th bit to the 8th bit ONLY or
- from the 8th bit to the 9th bit ONLY

If there is a carry from the 7th bit to the 8th bit and from the 8th bit to the 9th bit at THE SAME TIME then OF = 0

OF=1

Set because there is a carry from the 7th bit to the 8th bit ONLY

AF=0

Reset because there is NO carry from the lower nibble to the upper nibble

MOV AL, 50h (0 1 0 1 0 0 0 0)

MOV BL, 32h (0 0 1 1 0 0 1 0)

ADD AL, BL (1 0 0 0 0 0 1 0)

CF=0

Reset because the answer has NO carry

SF=1

Set because the MSB is 1 indicating a negative answer

ZF=0

Reset because the answer is NOT zero

PF=1

Set because the answer has an EVEN number of 1s

Status Flags

NB:

OF is reset to 0 if:

- there is a carry from the 7th bit to the 8th bit and from the 8th bit to the 9th bit at THE SAME TIME or
- there is NO carry from the 7th bit to the 8th bit and from the 8th bit to the 9th bit at THE SAME TIME

OF=0

Reset because there is a carry from the 7th bit to the 8th bit and from the 8th bit to the 9th bit at THE SAME TIME

Carry

1 1 1 1 1 1 1 1

AF=1

Set because there IS a carry from the lower nibble to the upper nibble

□ MOV AL, FFh

1 1 1 1 1 1 1 1

□ MOV BL, 01h

0 0 0 0 0 0 0 1

□ ADD AL, BL

1 0 0 0 0 0 0 0

CF=1

Set because the answer has a carry

SF=0

Reset because the MSB is 0 indicating a positive answer

ZF=1

Set because the answer IS zero

PF=1

Set because the answer has an EVEN number of 1s

Control Flags:



Direction Flag ←
 1 = Auto Decrement
 0 = Auto Increment
 (Used in String Instructions)

Interrupt Flag ←
 1 = Enable Interrupt
 0 = Disable Interrupt
 (Affects Only INTR)

Trap Flag
 1 = Perform Single Stepping
 0 = Do Not Perform Single Stepping

Control Flags:

- ❑ **Trap Flag (TF)** - Used for on-chip single-step debugging.
- ❑ **Interrupt enable Flag (IF)** - when this flag is set to '1' CPU reacts to interrupts from external devices.
- ❑ **Direction Flag (DF)** - this flag is used by some instructions to process data chains, when this flag is set to '0' - the processing is done forward, when this flag is set to '1' the processing is done backward.

Quiz: Status Flag Values?

- MOV AX, ABCDh
- MOV BX, 9876h
- ADD AX, BX

Thank You !!

