8086 Flag Register

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CSE 341 Team
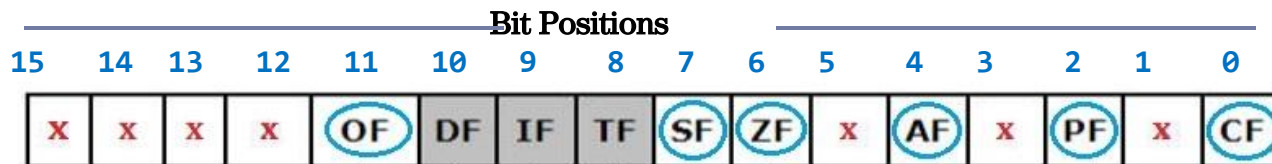
Lecture References:

- **Book:**

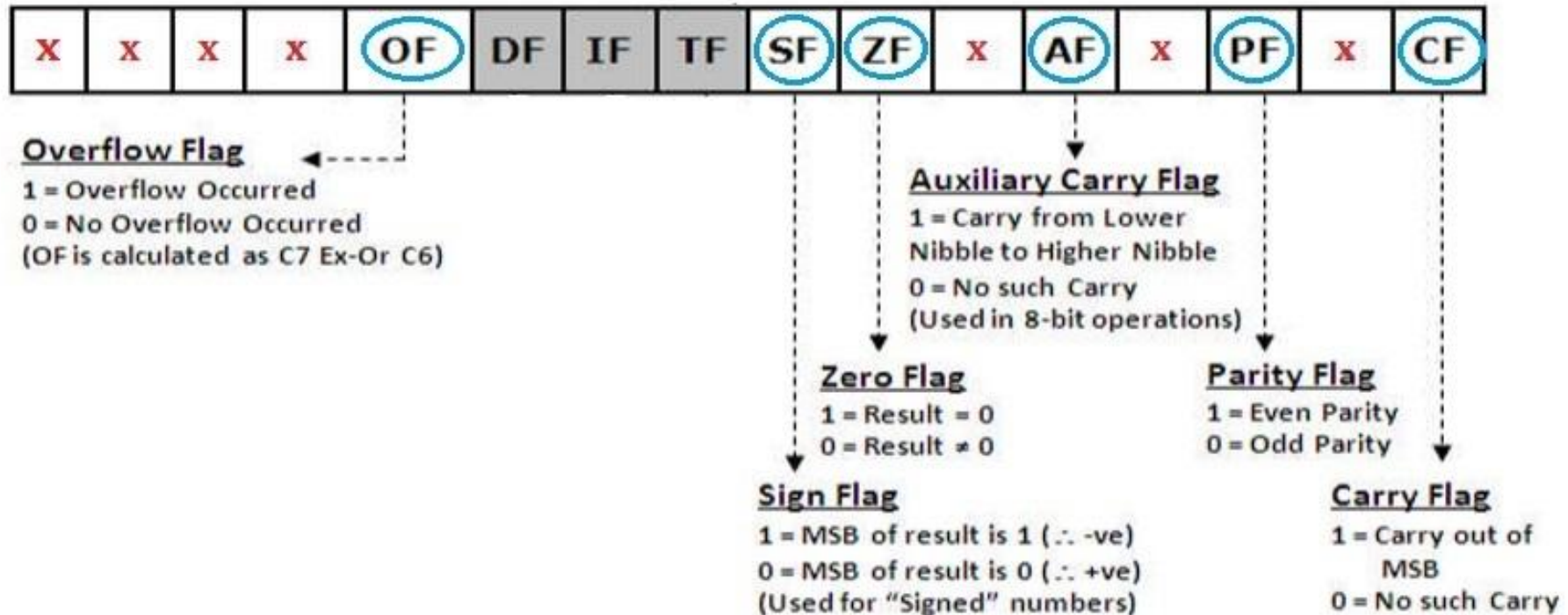 - *Microprocessors and Interfacing: Programming and Hardware, Chapter # 2,* **Author:** Douglas V. Hall

8086 Flag Register

- 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

Bit Positions

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
x	x	x	x	OF	DF	IF	TF	SF	ZF	x	AF	x	PF	x	CF

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Status Flags

x	x	x	x	OF	DF	IF	TF	SF	ZF	x	AF	x	PF	x	CF

Overflow Flag
1 = Overflow Occurred
0 = No Overflow Occurred
(OF is calculated as C7 Ex-Or C6)

Auxiliary Carry Flag
1 = Carry from Lower
Nibble to Higher Nibble
0 = No such Carry
(Used in 8-bit operations)

Zero Flag
1 = Result = 0
0 = Result ≠ 0

Parity Flag
1 = Even Parity
0 = Odd Parity

Sign Flag
1 = MSB of result is 1 (∴ -ve)
0 = MSB of result is 0 (∴ +ve)
(Used for "Signed" numbers)

Carry Flag
1 = Carry out of
MSB
0 = No such Carry

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

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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...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. **(Only check the lower 8 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.

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Status Flags

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

Carry   1   1   1

⬜ 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

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Status Flags

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**

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

Carry   1 1 1 1 1 1 1 1

☐ 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 0)

CF=I
Set because the answer has a carry

SF=0
Reset because the MSB is 0 indicating a positive answer

ZF=I
Set because the answer IS zero

PF=I
Set because the answer has an EVEN number of 1s

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Control Flags:

| x | x | x | x | OF | DF | IF | TF | SF | ZF | x | AF | x | PF | x | CF |

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

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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.

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Quiz: Status Flag Values?

- MOV AX, ABCDh

- MOV BX, 9876h

- ADD AX, BX

Thank You !!

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