8086 Flag Register

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Lecture References:
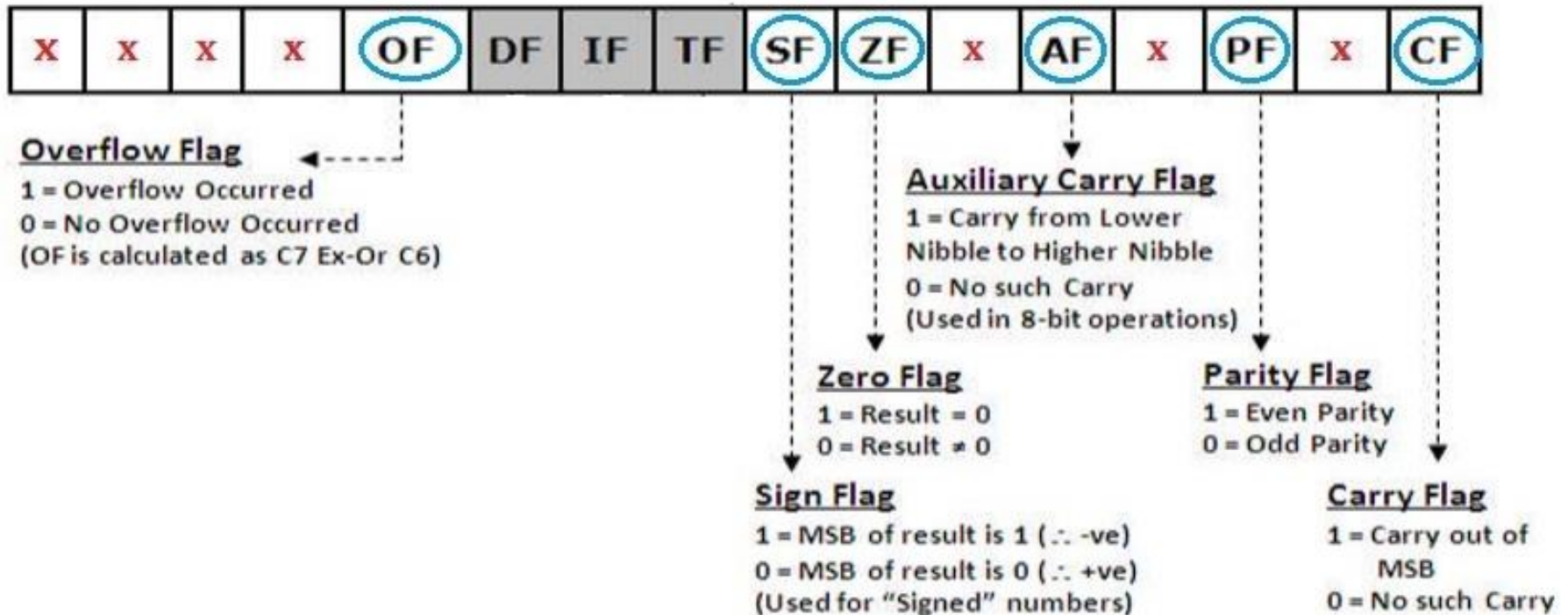
➢ **Book:**

  ➢ *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 0

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Status Flags

➢ **Carry Flag (CF) -** In case of addition, this flag is set if there is a carry out of the MSB. The carry flag also serves as a borrow flag for subtraction. In case of subtraction it is set when borrow is needed.

➢ **Parity Flag (PF) -** It is set to '1' when there is an even number of one bits in the last 8 bits of the result, and reset to '0' when there is odd number of one bits in the last 8 bits of the result.

➢ **Auxiliary Flag (AF) -** The flag is set to '1' when there is an overflow out of bit 3 i.e., carry from lower nibble to higher nibble (D3 bit to D4 bit)

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Status Flags

➢ **Zero Flag (ZF) -** set to '1' when result is zero. For non-zero result this flag is reset to '0'. The zero flag is also set if a certain register content becomes zero following an increment or decrement operation of that register.

➢ **Sign Flag (SF) -** After the execution of arithmetic or logical operations if the MSB of the result is 1, the sign bit is set to '1'. Sign bit 1 indicates the result is negative, otherwise it is positive.

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Status Flags

➤ **Overflow Flag (OF) -** The flag is set to '1' if result is out of range. For addition this flag is set when there is a carry into the MSB and no carry out of the MSB or vice-versa. For subtraction, it is set when the MSB needs a borrow and there is no borrow from the MSB or vice-versa.

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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

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   (ₓ 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

NB:
OF is **reset to 0** if:
- there is a **carry** from **the** 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** 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

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 0

CF=1
Set because the answer has a carry

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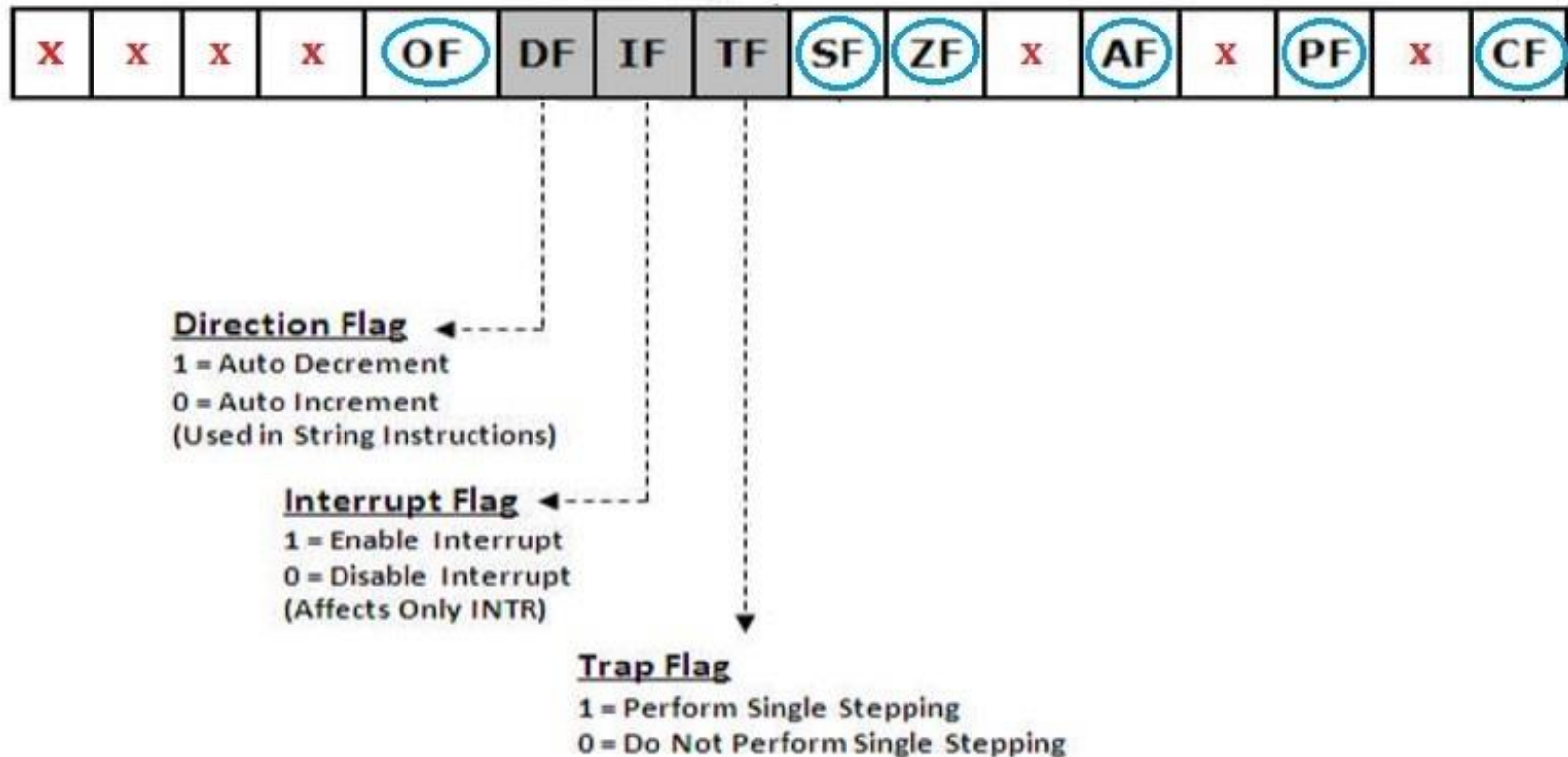Reset because the MSB is 0 indicating a positive answer

ZF=1
Set because the answer IS zero

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

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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 Flag (IF) -** It is used to allow/prohibit the interruption of a program. If set to '1', a certain type of interrupt (a maskable interrupt) can be recognized by the 8086; Otherwise these interrupts are ignored.

➢ **Direction Flag (DF) -** It is used with string instructions. If DF = 0, the string is processed from its beginning with the first element having the lowest address. Otherwise, the string is processed from the high address towards the low address.

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Practice 1:

- MOV AX, ABCDh

- MOV BX, 9876h

- ADD AX, BX

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Practice 2:

- MOV AX, 65D1h

- MOV BX, 2359h

- ADD AX, BX

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Practice 3:

- MOV AX, 6729h

- MOV BX, 354Ah

- SUB AX, BX

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Thank You!!

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