Session 5

The Processor Status and the Flags Register

OBJECTIVES:

- Students will be make familiar with the FLAGS register
- They will learn how to determine overflow and the reasons behind overflow occurrence.
- Students will learn how instructions affect the flags.

The FLAGS Register

In 8086, the processor state is implemented as nine individual bits called flags. Each decision made by 8086 is based on the values of these flags. The flags are placed in the FLAGS register. The other bits have no significance.

Two types of flags: Status flags and control flags.

Status flags reflect the result of a computation. They are located in bits 0, 2, 4, 6, 7 and 11.

Control flags enable or disable certain operations of the processor. They are located in bits 8,9 and 10.

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

Bit	Name	Symbol
0	Carry Flag	CF
2	Parity Flag	PF
4	Auxiliary Carry Flag	AF
6	Zero Flag	ZF
7	Sign Flag	SF
11	Overflow Flag	OF
8	Trap Flag	TF
9	Interrupt Flag	IF
10	Direction Flag	DF

Status Flag

Control Flag

The Status Flags

Carry Flag (CF):

CF = 1 if there is a carry out in the MSB on addition, if there is a borrow into the MSB on subtraction, otherwise CF = 0. It is also affected by shift and rotate instructions.

Parity Flag (PF):

PF = 1 if the low byte of a result has even parity. PF = 0 if the low byte of a result has odd parity.

Auxiliary Carry Flag (AF):

AF = 1 if there is a carry out from 3rd bit on addition or a borrow into 3rd bit on subtraction, otherwise AF = 0. AF is used in BCD operations.

Zero Flag (ZF):

ZF = 1 for a zero result. ZF = 0 for a non-zero result.

Sign Flag (SF):

SF = 1 if the MSB of a result is 1 that means the result is negative. SF = 0 if the MSB of a result is 0 that means the result is positive.

Overflow Flag (OF):

OF = 1 if signed overflow occurred. Otherwise OF = 0.

Overflow

The range of signed numbers that can be represented by a 16-bit word is -32768 to 32767 and 8-bit byte is -128 to 127. The range of unsigned numbers that can be represented by a 16-bit word is 0 to 65535 and 8-bit byte is 0 to 255. If the result of an operation falls out of these range, then overflow occurs and the truncated result that is saved will be incorrect. When we perform an arithmetic operation such as addition there are four possible outcomes:

- No overflow
- Signed overflow only
- Unsigned overflow only
- Both signed and unsigned overflows

Example of Unsigned Overflow Only

Suppose AX contains FFFFh (-1), BX contains 0001h (1). Add the contents of AX and BX.

	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
+	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

If it is an unsigned interpretation the correct answer 10000h = 65535 but this is out of range for a word operation. A 1 is carried out of the MSB and the answer stored in AX is 0000h which is wrong so unsigned overflow occurs. But signed overflow does not occur as the stored answer is correct as a signed number.

Example of Signed Overflow Only

Suppose AX contains 7FFFh (32767), BX contains 7FFFh (32767). Add the contents of AX and BX

	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
+	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0

If it is a signed interpretation the answer is FFFEh = -2 but this incorrect as the result should be 65534. So signed overflow occurs. The unsigned interpretation of FFFEh is 65534, which is the right answer. So unsigned overflow does not occur.

Overflow Indicates by Processor

- The processor sets OF = 1 for signed overflow
- The processor sets CF = 1 for unsigned overflow

Overflow Occur Determination by Processor

- Unsigned overflow

  On addition when there is a carry out in the MSB. This means the result is larger than the biggest unsigned number. On subtraction when there is a borrow in the MSB. This means the correct answer is smaller than 0.