

## **8086 Memory Organizations**

### ***Physical Address / Real Address***

#### **SEGMENT : OFFSET CNCEPT**

The number of Address Bits depends on the amount of memory we want to handle, at maximum, a 16-bit processor can access memory of up to 64KB ( $2^{16}$ ). If we want to handle memories of more than 64KB we need additional bits.

In the 8086, all registers are 16 bits wide, but the address bus requires 20-bit wide. In order for an address of 20 bits in width to be composed in code, the CPU automatically combines the contents of two registers for all memory access. The two registers that combine to make up the 20-bit address are called generally Segment Registers and Offset Registers.

There are four Segment Registers (CS, SS, DS, and ES), and numerous other Offset Registers (AX, BX, CX, DX, IP, SP, BP, SI, & DI), and they combine in ways, to compose the 20-bit address.

### ***Some Basic Concepts:***

#### **1. Physical Address:**

It is the 20-bit address that actually put on the address bus (in 8086). It has a range of 00000<sub>h</sub> – FFFFF<sub>h</sub>. The physical address or real address refers to the actual position in the memory. It allows access to data in the main memory.

#### **2. Logical Address:**

A logical address or virtual address is used as a reference to access the physical address. Because the physical address cannot be accessed directly. The logical address consists of segment address and offset address.

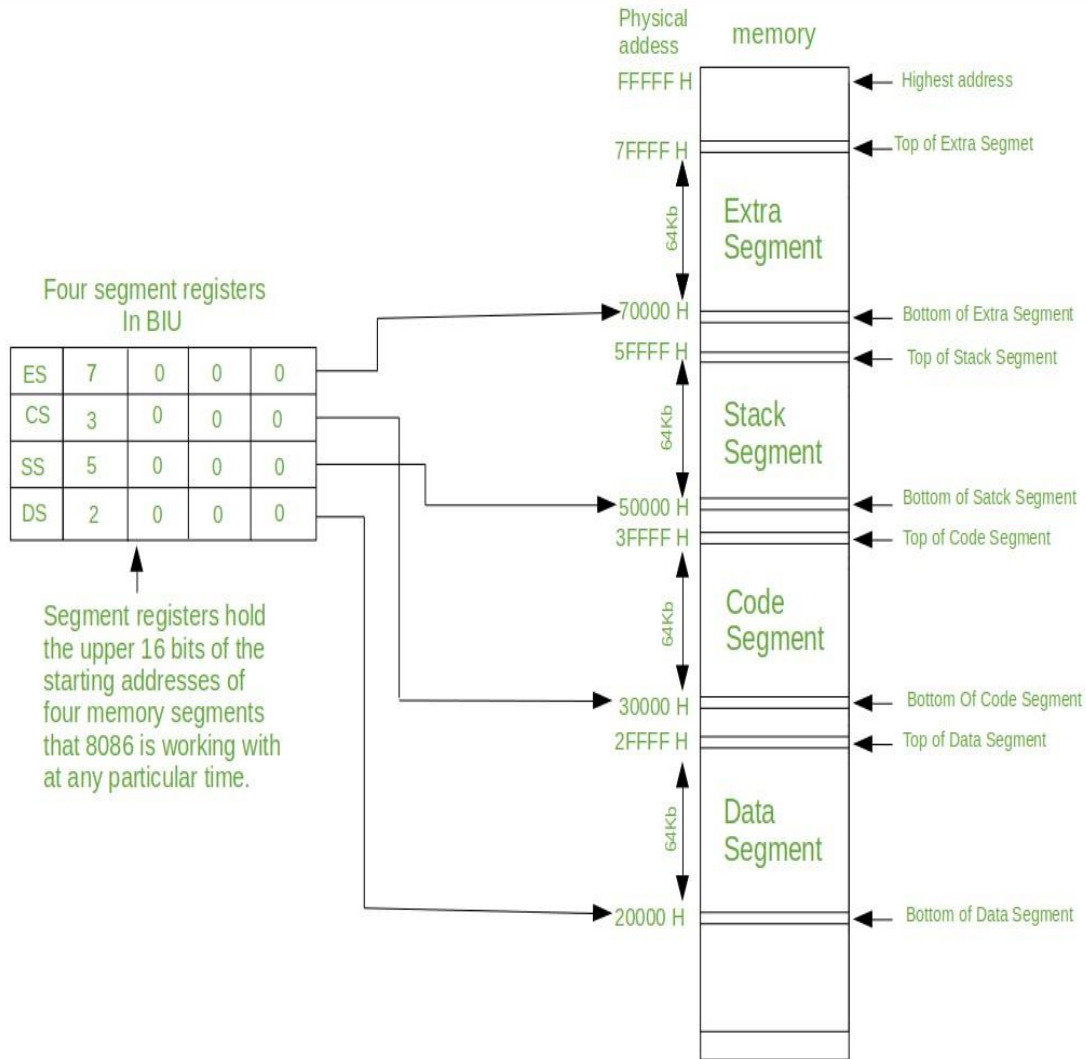
$$\text{Logical address} = \text{Segment addr} : \text{Offset addr}$$

#### **3. Segment Address:**

It is a 16-bit address of the segment block. The segment address, located within one of the segment registers, defines the beginning address of any 64K-byte memory segment.

#### **4. ▪ Offset Address :**

It is a location within 64K byte segment range. It has a range of 0000<sub>h</sub> – FFFF<sub>h</sub>



*Fig. Shows 8086 Memory Segmentation*

To express the 20-bit Physical-address of memory, Follow the steps below:

1. Multiply Segment register by 10<sub>h</sub> (or shift it to left by 4 bit).
2. Add it to the offset. (See Figure below)

**Remember:**

CS : IP

DS : SP  
SI

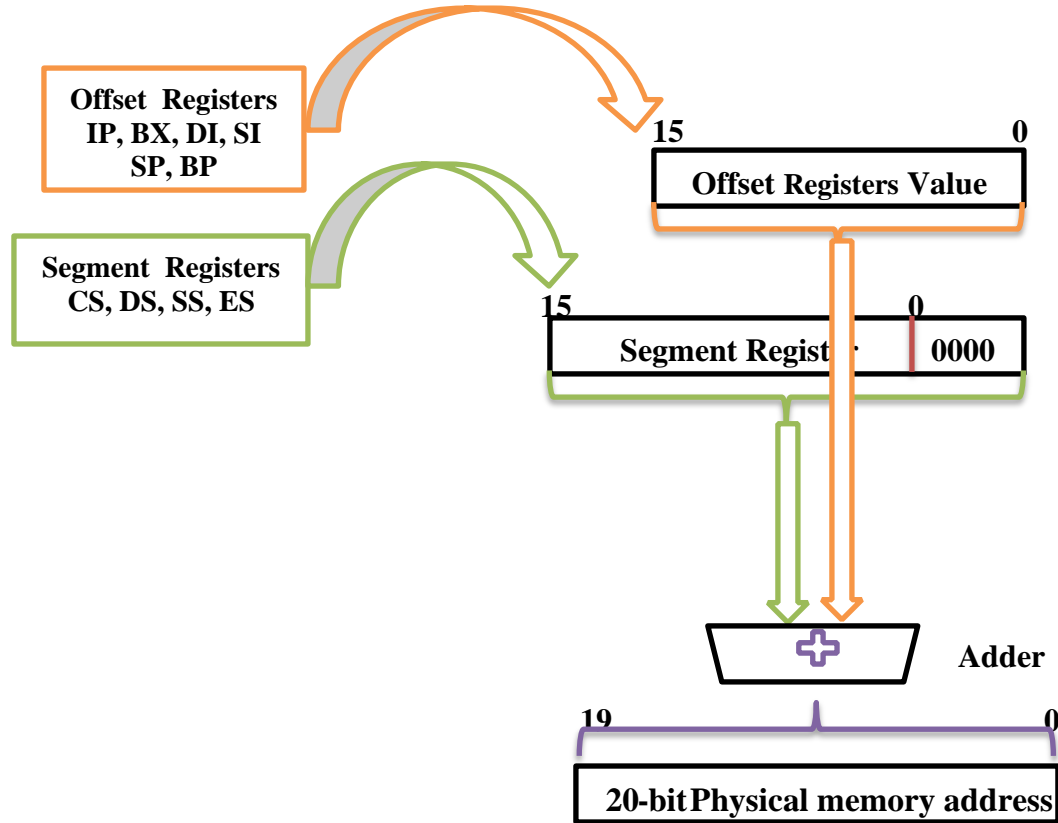
SS : SP  
BP

ES : DI

DI

This is performed automatically by the EU or CPU, and does not require any code to perform the address arithmetic.

Segment address indicates Segment Number, while Offset address indicates the location of byte or word within the segment.



*Figure Shows Physical Address And How To Calculate*

### **Addressing in Code Segment:**

To execute a program, the 8086 fetches the instructions from the Code Segment. The logical address of an instruction **consists** CS (Code Segment) and IP (instruction pointer). Logical Address in Code segment is **represented** by using segment address in CS register and Offset Address in IP register as follows:

General Formula of logical address :

**Segment addr. : Offset addr.**

Segment Address 16 bit      **CS : IP**      Offset Address 16 bit

### Example:

**Assume, CS register contains 2500<sub>h</sub> and IP register contains 95F3<sub>h</sub>.**

## What is the Logical Address in the Code Segment ?

**CS:IP  $\rightarrow$  2500:95F3**

**The 2500:95F3 means offset of 95F3 within Segment 2500**

Similarly, the SS (Stack Segment) register combines with the SP (Stack Pointer) Offset Register to access the stack.

**SS : SP      or      SS : BP**

### *Physical Address / Actual Address*

**The following operation illustrates the generation of 20-bit physical address from segment : offset pair 2222 : 118C**

**Sol:**

**Multiply Segment register by 10<sub>h</sub> (or shift it to left by 4 bit). 22220**

**Add it to the offset .**

118C

233AC

*physical address 20-bit*

### Example:

**Calculate from segment: offset pair, If SS = 24F6<sub>h</sub> and SP = 634A<sub>h</sub>, Show the:**

## 1- Logical Address

**SS:SP = 24F6 : 634A**

## 2- Offset Address

**SP = 634A**

### 3- Physical Address

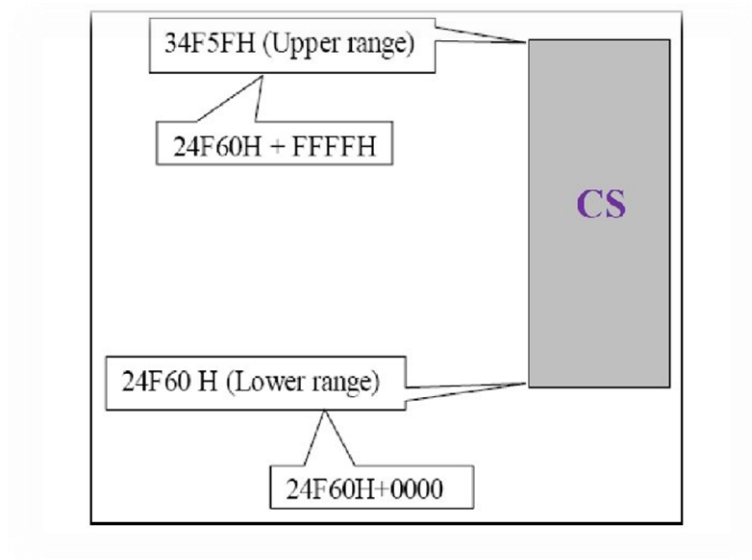
= **2B2AA** *physical address 20-bit*

#### 4- The Lower range of the Segment

**24F6 : 0000 => 24F60 + 0000 = 24F60**

## 5- The Upper range of the Segment

**24F6 : FFFF => 24F60 + FFFF = 34F5F**



*Figure Shows Lower / Upper range of the Segment*

**Example:**

Physical Address = 1278B, Code Segment = 1278, Find the Offset value & Logical Address?

**Sol:**

From:  $12780 + \text{Offset} = 1278B$

Offset = 000B

Logical Address = CS: IP = 1278 : 000B

**Location of Segments :**

**Segment 0** starts at address 0000:0000 = 00000<sub>h</sub> and ends at 0000:FFFF = 0FFFF<sub>h</sub>.

**Segment 1** starts at address 0001:0000 = 00010<sub>h</sub> and ends at 0001:FFFF = 1000F<sub>h</sub>.

**Segment 2**

**Segment 3** ..... etc.

