8086 microprocessor internal registers

8086 consists of 13 register , All registers of size 16-bits

- Data registers (AX, BX, CX, and DX).
- *Segment registers* (CS, DS, SS, and ES).
- Instruction pointer (IP).
- Index registers (SI and DI).
- Pointer registers (BP and SP).
- Status register (SR) or (Flag register).

General Purpose Registers (data register) (Ax , BX , CX , DX)

AX register
(Accumulator)

used for all input/output operations some string operation and Arithmetic operations.

BX register
(base register)

used as an index to extend addressing it's also used for computation

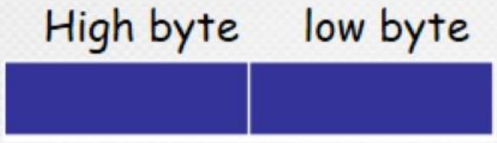
CX register
(count register)

used for controlling the number of times a loop is repeated contains the value by which bits are shifted it's also used for computations.

DX register
(data register)

Used for input/output operations. It use for multiply and divide operations

General Purpose Registers (data register) (Ax , BX , CX , DX)


High byte low byte

AX= 25F8
AL =F8
AH=25

BX =A5D

(0A5D)

BH= 0A
BL= 5D

AX	
AH	AL
BX	
BH	BL
CX	
CH	CL
DX	
DH	DL

A: Accumulator

B: Base reg.

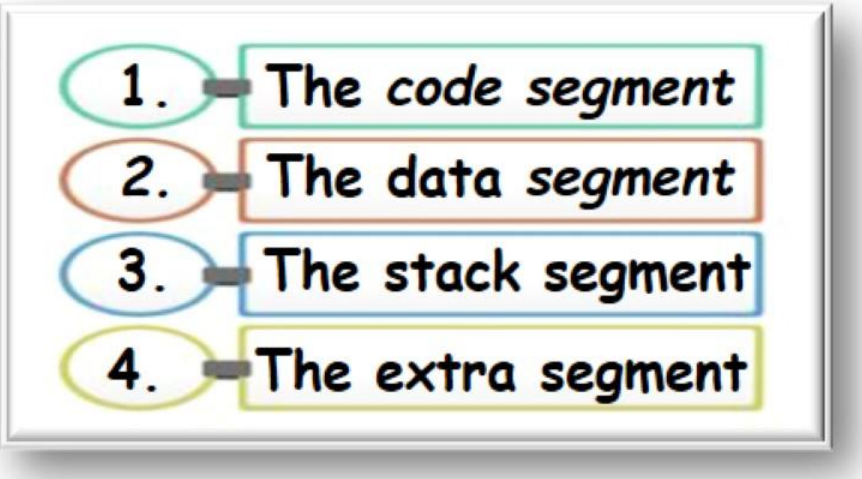
C: Counter reg.

D: Data reg.

- Each register can be **accessed as a byte or a word**.
- **The left most byte is a high-order 8 bits** of register and **the right most byte is the low-order 8bits.**

Segment Registers and Memory Segmentation

- Even though the 8086 has a 1Mbyte address space, **not all this memory can be active at one time.**
- The 1Mbytes of memory can be **partitioned into 64Kbyte** (65,536) **segments.**
- **A segment: represents an independently addressable unit of memory consisting of 64K consecutive byte-wide storage locations.**
- Each segment is assigned **a base address** that identifies its **starting point (its lowest address byte-storage location).**
- Only four segments can be active at a time



1. The *code* segment
2. The data segment
3. The stack segment
4. The extra segment

Size of segment=64kbyte

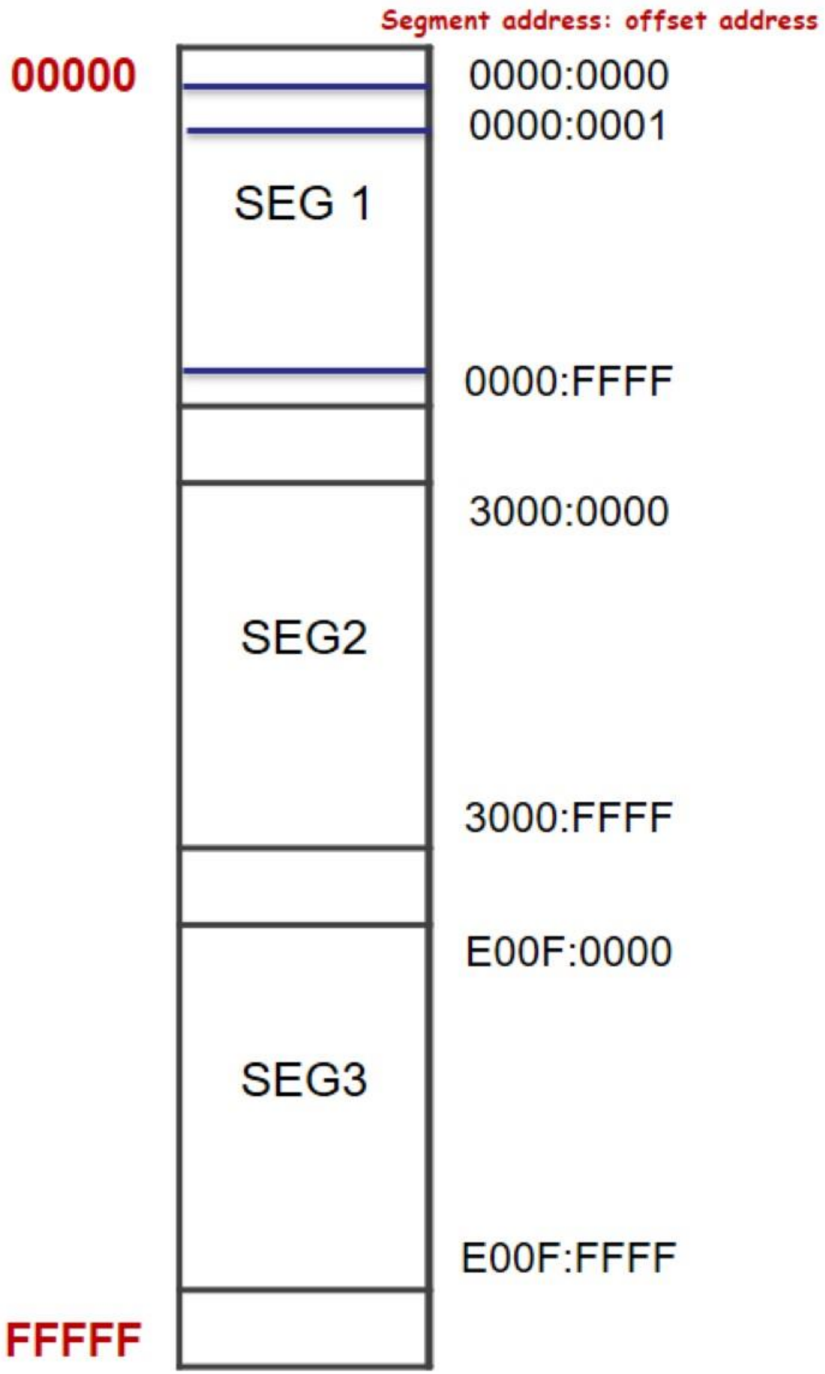
$$2^6 * 2^{10} = 2^{16}$$

Size of address in segment = 16 bits

0000

FFFF

Memory Segmentation



Segment Registers and Memory Segmentation

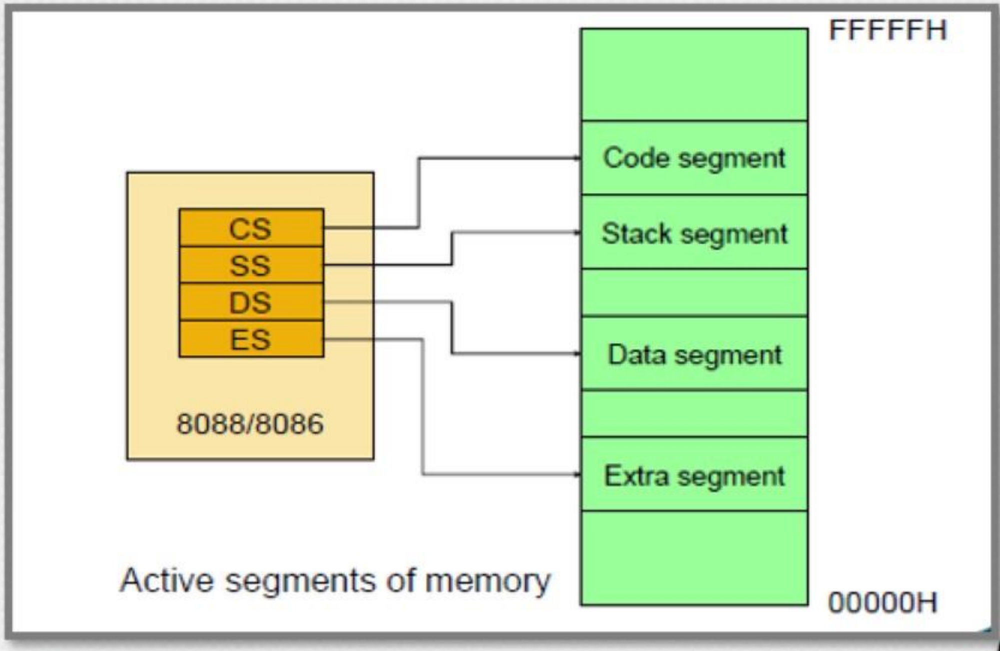
- Code Segment (CS) : holds the program instruction codes.
- Data Segment (DS) : stores data for the program.
- Stack Segment (SS) : used to store interrupt and subroutine return address.
- Extra segment (ES) : is an extra data segment.

The segments of memory that are active are identified by the values of addresses held in the 8086's four internal segment registers :

- Code segment register (CS)
- Data Segment Register (DS)
- Stack Segment Register (SS)
- Extra Segment Register (ES)

Each of these registers contains a **16-bit base address** that points to **the lowest addressed byte of the segment in memory.**

Segment Registers and Memory Segmentation



4 seg. active
4*64kbyte
=256kbyte

Four segments give a maximum of 256Kbytes of active memory. { 64Kbytes are for code (*program storage*), 64Kbytes are for a *stack*, and 128Kbytes are for *data storage* }

Logical and Physical addresses

Three types of addresses :

Physical Address

20 bits actually put on the address bus

Range:00000 → FFFFF

Offset Address

A location within a 64K byte segment

Range:0000 → FFFF

Logical Address

Consist of a segment value and offset address

SEGMENT VALUE: OFFSET ADDRESS

❖ The segment base address and offset address are 16 bit quantities.

❖ This is because all register and memory locations used in address calculations are always 16 bits long. However, the physical addresses that are used to access memory are 20 bits in length.

Pointer and Index registers

Instruction pointer (IP):

Is a 16 bit register contains the offset of the next instruction to be fetched from the current code segment instead of the actual address. Every time an instruction is fetch 88/86 updates the value of IP by incrementing it. (CS:IP)

Pointer and Index registers:

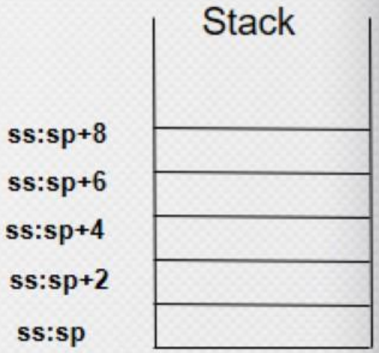
Pointer and index group is 16 bits Registers (**you cannot access the low or high bytes alone**). These Registers are used as memory pointer.

Pointer registers

Stack pointers (SP): represent the offset of the next stack location that is to be accessed.

(SS: SP): result a 20 bit address points to the top of the stack.

Base pointer (BP): The base pointer facilitates referencing of parameters. (Data and addresses passed via stack).



Pointer and Index registers

Index register

Source index (SI): is required for some string operations in this context the SI are associated with DS register. **(DS:SI)**

Destination index (DI): is required for some string operations in this context the DI are associated with ES register. **(ES:DI)**

Example:

```
MOV  SI,1000
MOV  AH,[SI]
```

What are the contents of register AH after the previous instructions is executed?

AH= 17

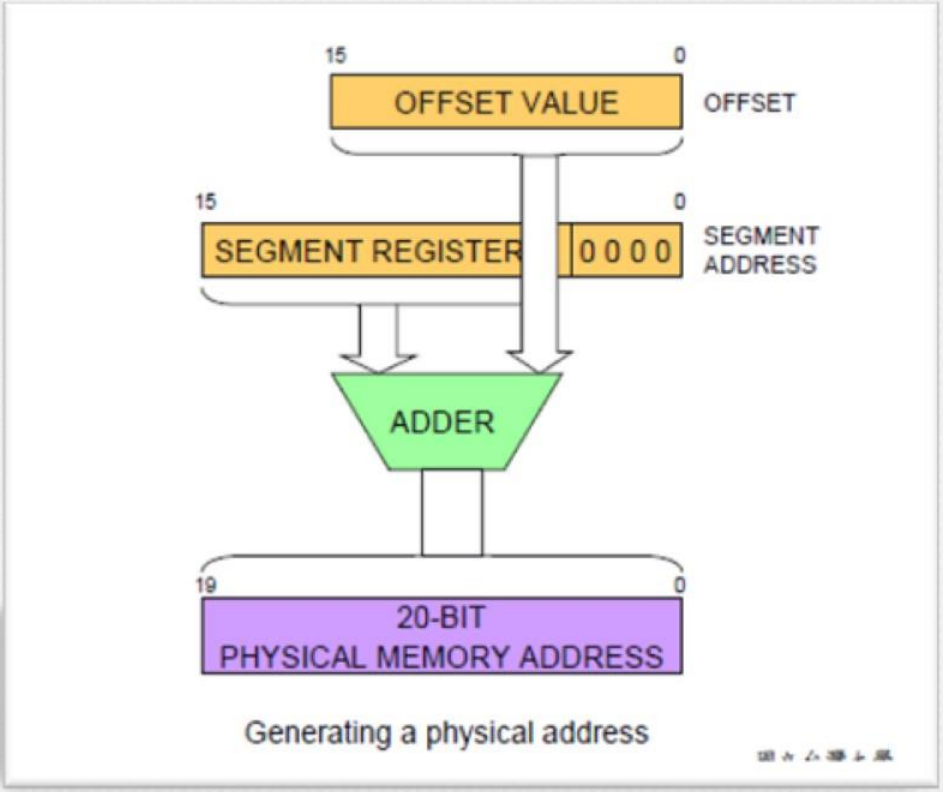
DS:1000	17	← DS:SI
DS: 1001	3A	
DS: 1002	26	

Summery (Offset registers for various segments)

Segment Register	CS	DS	ES	SS
Offset Register(s)	IP	SI DI BX	DI SI BX	SP BP

CS:IP
DS: SI , DS:BX , DS:DI
SS:BP

Convert Logical address to Physical addresses



Generating a physical address

Physical address (ph) = segment value * 10 + offset value

Examples

EXample1 :

find the physical address for each of the following logical addresses:

1. 1000: 5020
2. 1400: 1020
3. E90F: 2302
4. 1302: 2009
5. 08F0: 0200

1/ SEGMENT VALUE = 1000 , OFFSET ADDRESS = 5020

PH= Segment value *10 + OFFSET

10000+5020 = 15020

```
10000
 5020
-------
15020
```

3/

segment value =E90F offset = 2302

E90F*10 + 2302 = EB3F2

```
E90F0
 2302
------
EB3F2
```

Example2:

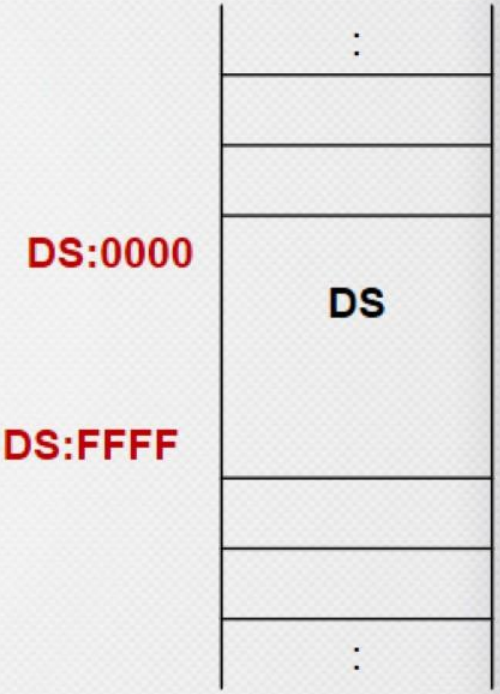
If DS=2567 and SI = 2341 find:

1. The logical address.
2. The offset address.
3. The physical address.
4. The lower address in data segment
5. The upper address in data segment.

الحل :

1. DS : SI (2567:2341) LOGICAL ADDRSS
2. 2341
3. PH= DS*10+ SI

   = 2567*10 + 2341= 25670 + 2341 = 279B1
4. DS: 0000 (2567:0000)
5. DS:FFFF (2567:FFFF)



Example3:

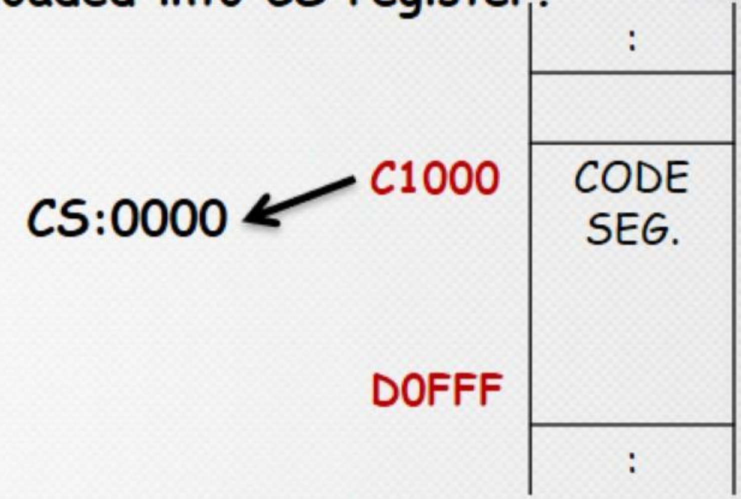
A code segment is to be located from physical address C1000 to D0FFF So, find the value that be loaded into CS register.

PH = SEG*10 + OFFSET

C1000 = CS*10 + 0000

C1000=CS*10

CS(CODE SEG. REG.)=C100



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Q1. If CS=F90E and IP = 3000 find:
1. The logical address.
2. The offset address.
3. The physical address.
4. The lower physical address in code segment
5. The upper physical address in code segment.

Q2. justify (علل)

Memory connected with 8086 is segmented?