Introduction to 8086 Microprocessor (part 3)

Microprocessors and microcomputer-based system design
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>Chapter 3 section 3.1, 3.2, 3.3

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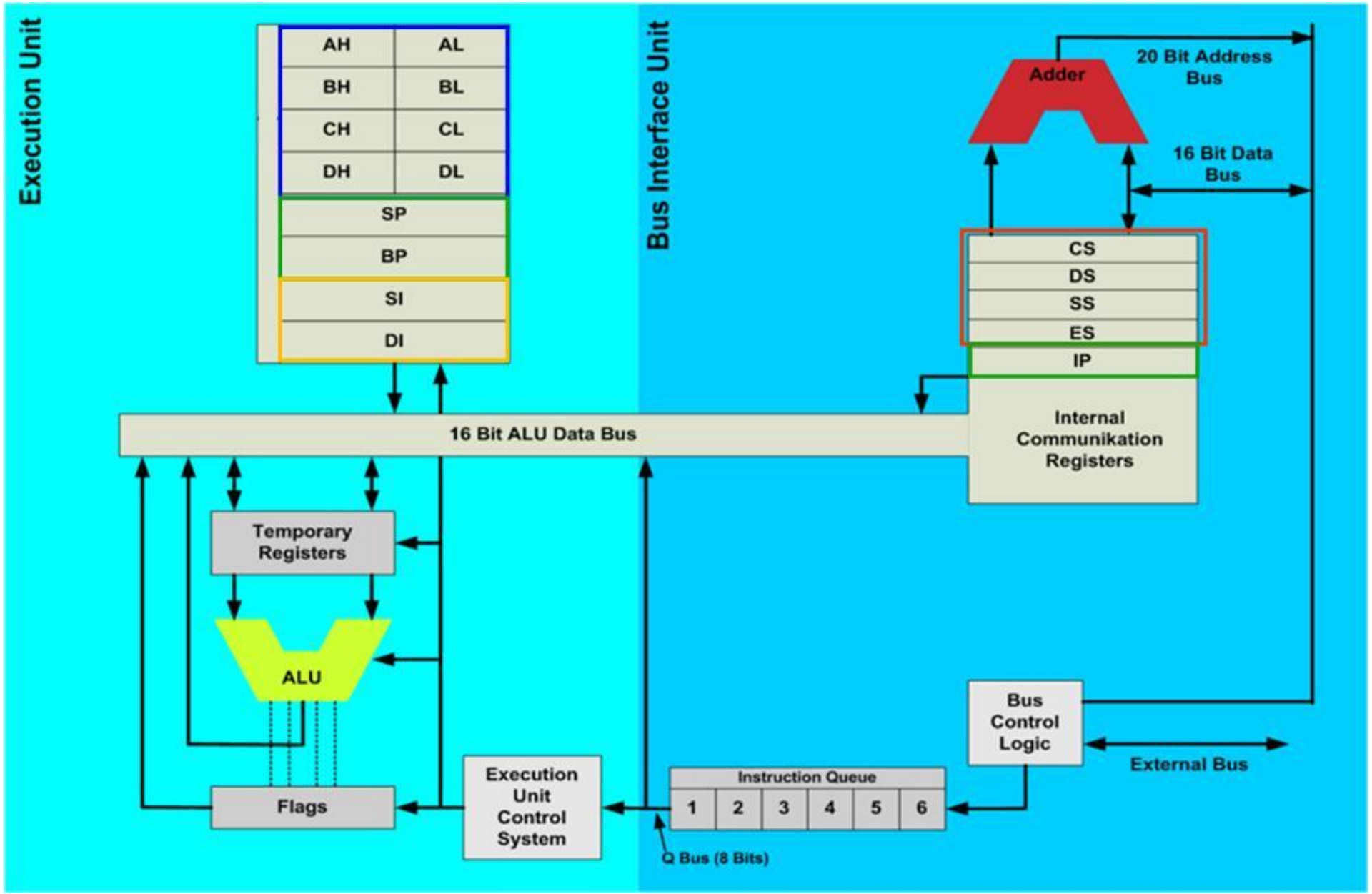
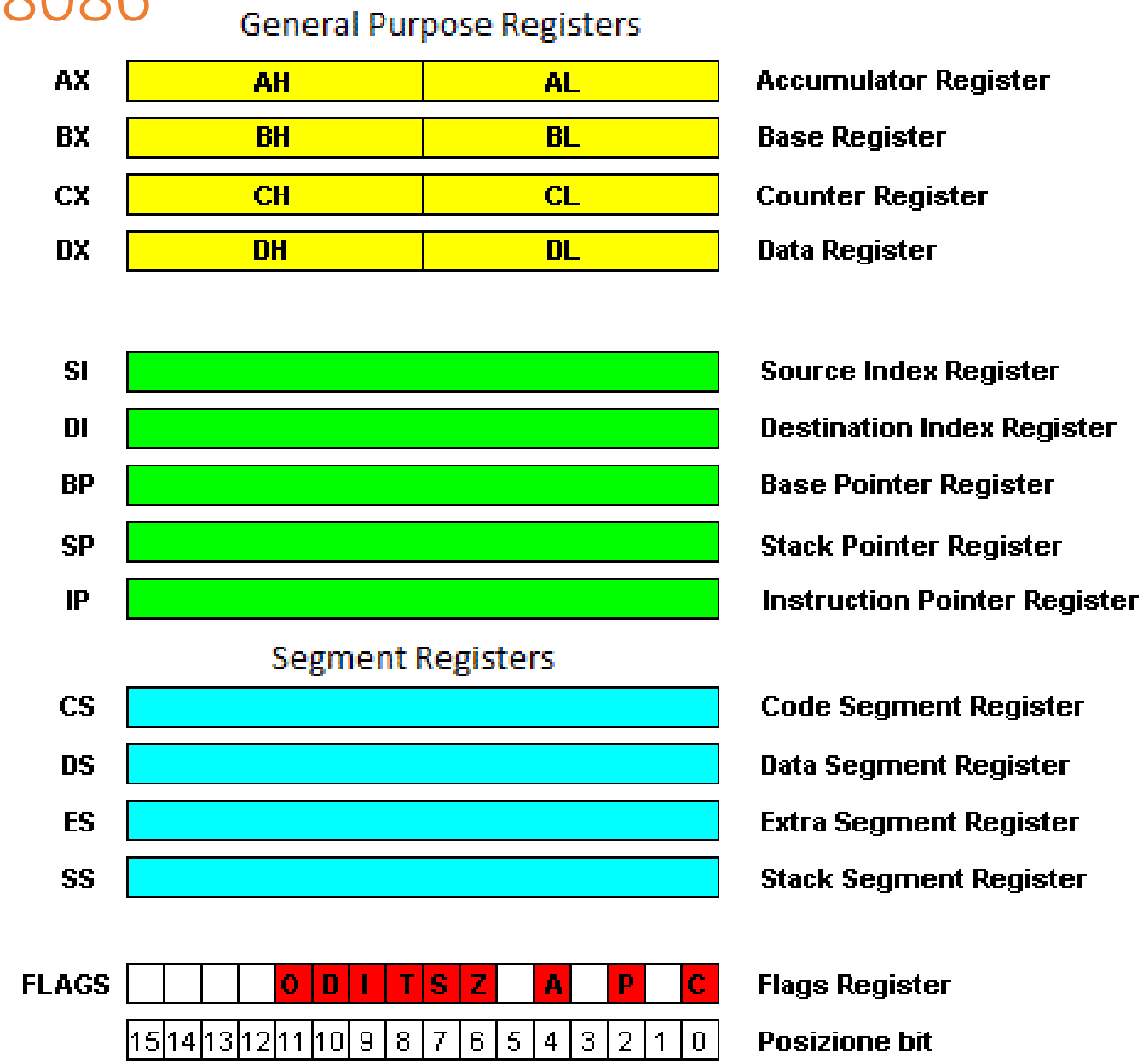
- Organization of. the 8086 Microprocessors Chapter 3 section 3.2
- FLAGS Register Chapter 5 section 5.1, 5.2, 5.3

8086 Internal Architecture



Registers in 8086



Description of Registers

- Registers
  - Data registers / General purpose register
    - Hold data for an operation to be performed
    - There are 4 data registers (AX, BX, CX, DX)
  - Address registers
    - Hold the address of an instruction or data element
    - Segment registers (CS, DS, ES, SS)
    - Pointer registers (SP, BP, IP)
    - Index registers (SI, DI)
  - Status register (FLAG Register)
    - Keeps the current status of the processor
- In total there are fourteen 16-bit registers in an 8086

Description of Data Registers

- Low and High bytes of the data registers can be accessed separately
  - AH, BH, CH, DH are the high bytes
  - AL, BL, CL, and DL are the low bytes
- Data Registers are general purpose registers but they also perform special functions

Description of Data Registers

- **AX**
  - –Accumulator Register
  - –Preferred register to use in arithmetic, logic and data transfer instructions because it generates the shortest Machine Language Code
  - –Must be used in multiplication and division operations
  - –Must also be used in I/O operations

Description of Data Registers

- **BX**
  - Base Register
  - Also serves as an address register
  - Used in array operations

- **CX**
  - Count register
  - Used as a loop counter
  - Used in shift and rotate operations

Description of Data Registers

- **DX**
  - Data register
  - Used in multiplication and division
  - Also used in I/O operations

Description of Address Registers

- **IP: Instruction Pointer**
  - Points to Next Instruction in code Memory.
- **SP: Stack pointer**
  - Pointer to the top of the stack.
- **BP: Base Pointer**
  - Used to point to the base of the stack.
- **SI & DI: Source and Destination Index register**
  - is required for string operation

Description of Address Registers

The memory of 8086 is divided into 4 segments namely

Code segment (program memory)

Data segment (data memory)

Stack segment (stack memory)

Extra segment (extra memory)

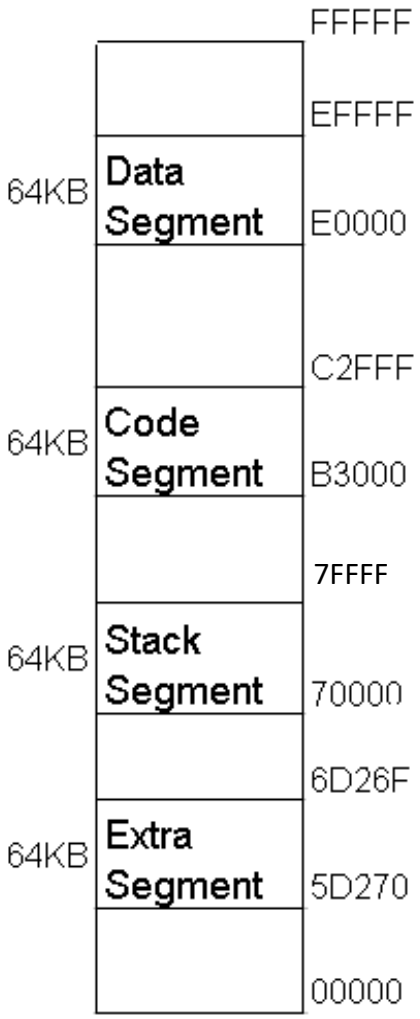
Segment Registers

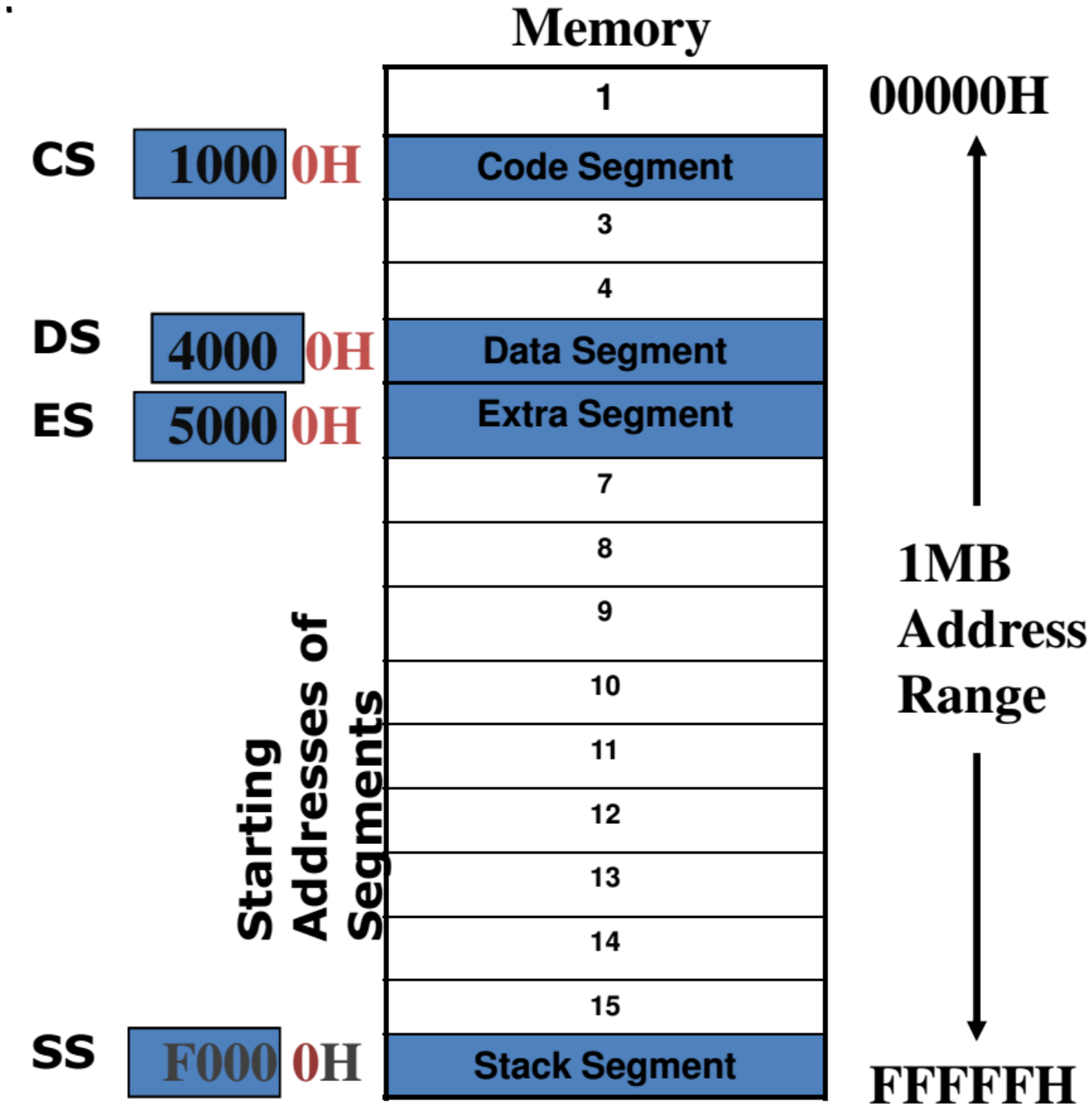
Segmented Memory

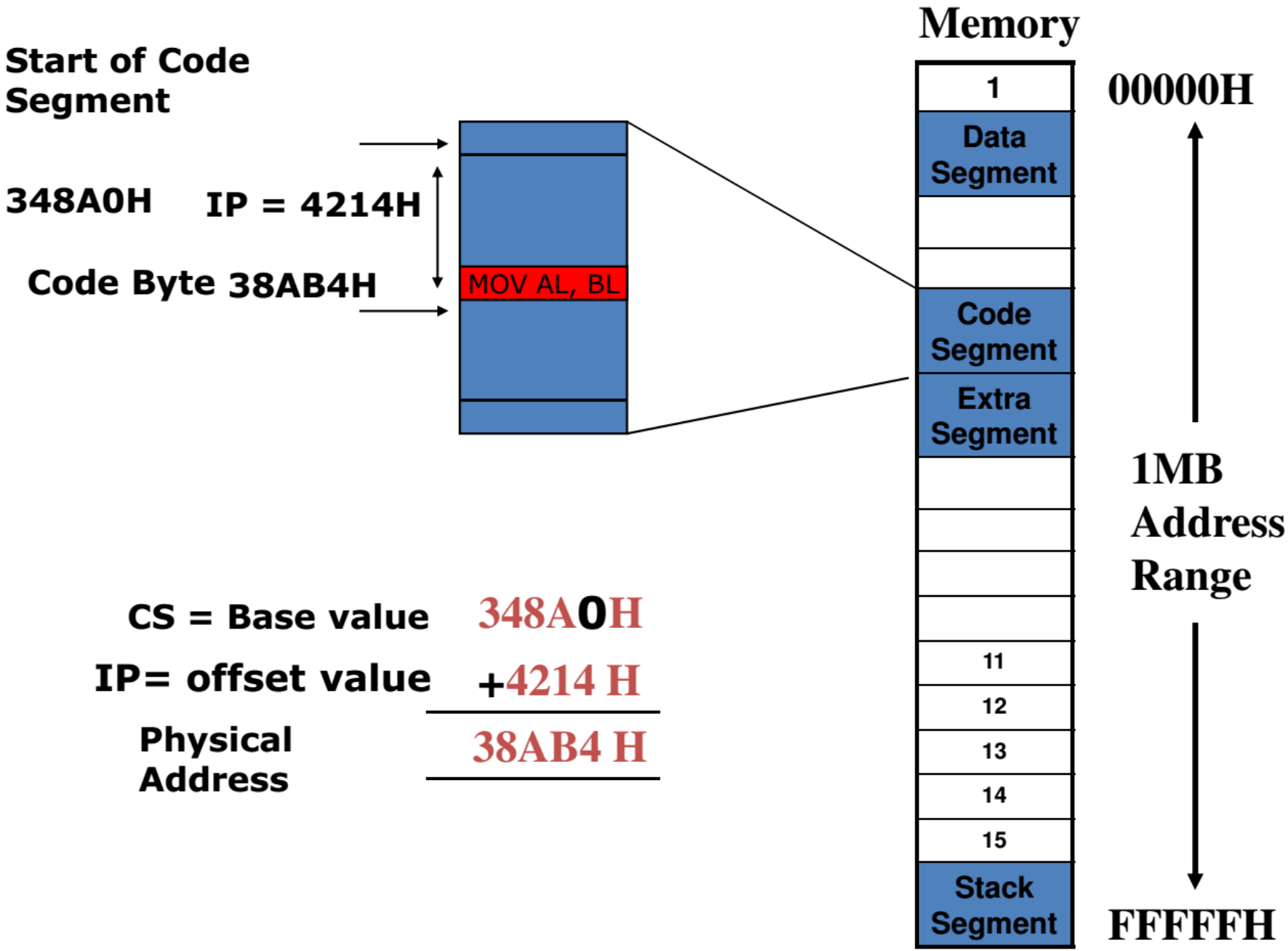
Within the 1 MB of memory, the 8086 defines 4, 64KB memory blocks.

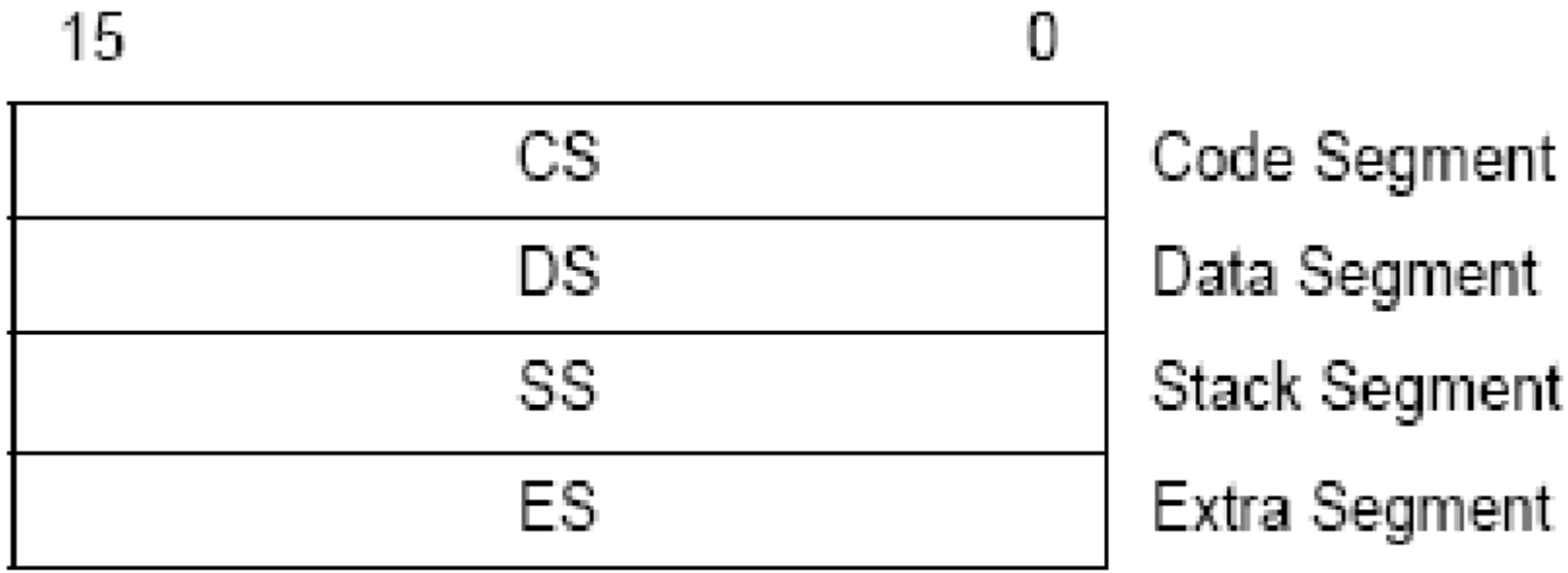
DS: E000	CS: B300
SS: 7000	ES: 5D27

The segment registers point to location 0 of each segment. (The base address)




Memory
1
00000H
CS
1000 0H
Code Segment
3
4
DS
4000 0H
Data Segment
ES
5000 0H
Extra Segment
7
8
9
10
11
12
13
14
15
Starting Addresses of Segments
1MB Address Range
SS
F000 0H
Stack Segment
FFFFFH


Start of Code Segment
348A0H
IP = 4214H
Code Byte 38AB4H
MOV AL, BL
Memory
1
Data Segment
Code Segment
Extra Segment
11
12
13
14
15
Stack Segment
00000H
1MB Address Range
FFFFFH
CS = Base value 348A0H
IP= offset value +4214 H
Physical Address 38AB4 H



Segment registers

Segment Registers

Code Segment (CS) register is a 16-bit register containing address of 64 KB segment with processor instructions.

Stack Segment (SS) register is a 16-bit register containing address of 64KB segment with program stack

Data Segment (DS) register is a 16-bit register containing address of 64KB segment with program data

Extra Segment (ES) register is a 16-bit register containing address of 64KB segment, usually with program data. This segment is also similar to data memory where additional data may be stored and maintained

Flag Register

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- section 5.1 The FLAG register
- Section 5.2 Overflow
- Section 5.3 How Instructions affect the Flags

Overflow

Direction

Interrupt enable

Trap

Sign

Zero

Auxiliary flag

Parity flag

Carry flag

6 are status flags

3 are control flag

Flag Register

- Status flag: The status flags reflect the result of an instruction executed by the processor.

- Control flag: The control flags enable or disable certain operations of the processor.

Flag Register Description (1)

- **SF** (sign) set to 1 when result is negative. When result is positive it is set to 0. This flag take the value of the most significant bit.
- **ZF** (zero) Indicates when the result of arithmetic or a comparison is zero. set to 1 when result is zero. For non zero result this flag is set to 0.
- **CF** (Carry) Set 1, if carry out of MSB.
- **AF** (auxiliary carry) Set 1, if carry out of bit 3 into bit 4.
- **PF** (parity) Set 1, if the number of 1 bits is even in the low-order byte of the result.

Flag Register Description (2)

- **OF** (overflow) set 1, if there is an arithmetic overflow for signed integer.
- **DF** (direction) Indicates left or right for moving or comparing string data.
- **IF** (interrupt) Indicates whether external interrupts are being processed or ignored.
- **TF** (trap) Permits operation of the processor in single step mode. Set (1) for step by step debugging.

Flag Register

- The next figure shows the bit definitions for the 16-bit flag register.
- Six of the flags are status indicators reflecting properties of the result of the last arithmetic or logical instruction
- 8086 flag word. DF, IF, and TF can be set or reset to control the operation of the processor

Flag Register

For more example read section 5.3

Example

AL=80H 7FH + 1 = 80H

CF=0 there is no carry out of bit 7

PF=0 odd number of ones

AF=1 There is carry out of bit 3 into bit 4

ZF=0 Result non-zero.

SF=1 Msb value is one (negative)

OF=1 The range of the signed integer is [0 to +127 & -1 to -128] (for 8-bit). Here the result is negative number but both inputs are positive number. Therefore, there is overflow.