

8086 Architecture

11.1 Introduction

- A microprocessor is a semiconductor chip that implements the central processor of a computer. The microprocessor works as a brain of a computer. It consists of an arithmetic and logic unit (ALU) and a control unit.
- The microprocessors are usually characterised by speed, word length, architecture and instruction set.
- This central processing unit built into single chip is called as Microprocessor. In this chapter we will study features of 8086, detailed architecture of INTEL'S 8086 microprocessor and pin configuration.

11.1.1 Comparison of 8085 and 8086

Q. Give Comparison between 8085 and 8086.

Sr. No.	Parameter	8085	8086
1.	Size	It is an 8 bit Microprocessor	It is 16 bit Microprocessor
2.	Address Bus	Its address bus is of 16 bits	Its address bus is of 20 bits
3.	Memory	It can access upto $2^{16} = 65,536$ bytes i.e. 64 Kbytes of memory	It can access upto $2^{20} = 1,048,576$ bytes i.e. 1 MB of memory
4.	Instruction Queue	It does not have an instruction queue.	It has a 6 byte instruction queue
5.	Pipelining	It does not support pipelined architecture	It supports 2 stage pipelined architecture.
6.	Multiprocessor Support	It does not have multiprocessing support.	It supports multiprocessing. It has compatibility with further processors like Intel 80386, 80486 and Pentium.
7.	I/Os	It can address $2^8 = 256$ I/Os.	It can address $2^{16} = 65,536$ I/Os.
8.	Coprocessor Interface	It does not have coprocessor interface.	It has coprocessor interface. Coprocessor 8087 can be interfaced with 8086.
9.	Arithmetic support	It only supports integer and decimal arithmetic.	It supports integer, decimal and ASCII arithmetic.

Sr. No.	Parameter	8085	8086
10.	Multiplication and Division	It does not have instruction that computes the multiplication and division operation.	It supports instructions that compute the multiplication and division operation.
11.	Check speed	It operates on 3 MHz, 5 MHz or 6 MHz. i.e. it operates on low clock speed.	It operates on 5 MHz, 8 MHz or 10 MHz. i.e. it operates on high clock speed.
12.	External Hardware	It requires less external hardware.	It requires more external hardware.
13.	Operating modes	It supports single operating mode.	It supports two different operating modes : maximum mode and minimum mode.
14.	Addressing modes	It supports 5 addressing modes.	It supports the addressing modes supported by microprocessor 8085. It also supports some additional addressing modes.
15.	Cost	Its cost is low.	Its cost is high.
16.	Multiplexed pins	It has very few multiplexed pins.	It has number of multiplexed pins than 8085.
17.	Memory Segmentation	The memory spaces not segmented.	The memory space is segmented.
18.	Interrupts	8085 provides 8 software vectored interrupts and five hardware interrupts.	8086 has 256 software vectored interrupts and 2 hardware interrupts.

11.2 Features of 8086

The features of a processor can be divided into three broad groups viz. basic features, special features and miscellaneous features.

11.2.1 Basic Features of 8086

- Processor size
- Address bus size for memory
- Speed of processor
- Address bus size for I/O

- (1) It is a 16-bit processor. This implies that
- (a) It has a 16-bit ALU that can perform 16-bit operation simultaneously.
 - (b) It has 16-bit registers and internal data bus.
 - (c) It has 16-bit external data bus.

- (2) It has three versions based on the basis of frequency of operation.
- (i) 8086 \rightarrow 5 MHz.
 - (ii) 8086-2 \rightarrow 8 MHz.
 - (iii) 8086-1 \rightarrow 10 MHz.

Q. What is memory addressing capacity of 8086 ?

- (3) 8086 has 20-bit address lines to access memory, hence it can access $2^{20} = 1 \text{ MB}$ memory locations
- (4) It has 16-bit address lines to access I/O devices, hence it can access $2^{16} = 2^6 \times 2^{10} = 64 \times 1 \text{ K} = 64 \text{ K I/O locations}$

11.2.2 Special Features

Q. Explain how throughput of 8086 microprocessor is increased.

- 8086 is a pipelined processor
- 8086 can operate in 2 modes
- 8086 uses memory banks
- 8086 uses memory segmentation

1) 8086 is a pipelined processor

- o It uses a two stage pipelining i.e. **Fetch stage** that pre-fetches up to 6 bytes of instructions stores them in the queue and **Execute stage** that executes these instructions.
- o Pipelining improves the performance of the processor i.e. the operations are faster.

2) 8086 can operate in 2 modes.

- a **Minimum mode** \rightarrow A system with only 1 processor i.e. 8086.
- b **Maximum mode** \rightarrow A system with 8086 and other processors like 8087-(Math Co-processor), 8089-(IO processor) or multiple 8086 processors

3) 8086 uses memory banks

- o The 8086 uses a memory banking system i.e. the entire data is not stored sequentially in a single memory of 1 MB but the memory is divided into two banks of 512KB each.
- o The banks are called Lower bank (or even bank, because it stores the data bytes at even locations i.e. 0, 2, 4....) & Higher Bank (or odd bank, because it stores the data bytes at odd locations i.e. 1, 3, 5...).
- o The benefit of this is that 16-bit data can be accessed in a single access even though the memory chip can store only 8-bit at a location

4) 8086 uses memory segmentation

- o A 16-bit address in an instruction or a 16-bit address in a register can access a memory location, although 8086 has 20 address lines. This is made possible using the concept of Segmentation that divides the memory into logical components.
- o Here the memory is divided into 16 segments of a capacity of $2^{16} (= 65536 \text{ B} = 64 \text{ KB})$ each and is used as: Code, Stack, Data and Extra Segment.

11.2.3 Miscellaneous Features

- Interrupts
- Instruction set
- Registers
- Data size for ALU

- (1) It has 256 vectored interrupts : There are also non-vectored interrupts in 8086 but they are routed to one of these interrupts.
- (2) It has 14, 16-bit registers.
- (3) It has a powerful instruction set, that supports multiply and divide operations also (These operations were not possible in the processors earlier to 8086).
- (4) 8086 can perform operations on bit, byte (8-bit), word (16-bit) or a string (block of data) types of data.

11.3 8086 Internal Architecture

Q. Draw and explain the architecture of 8086.

- Before talking about programming, we need to discuss the special features and internal architecture of Intel 8086. Fig. 11.3.1 shows the block schematic of the internal structure of Intel 8086.

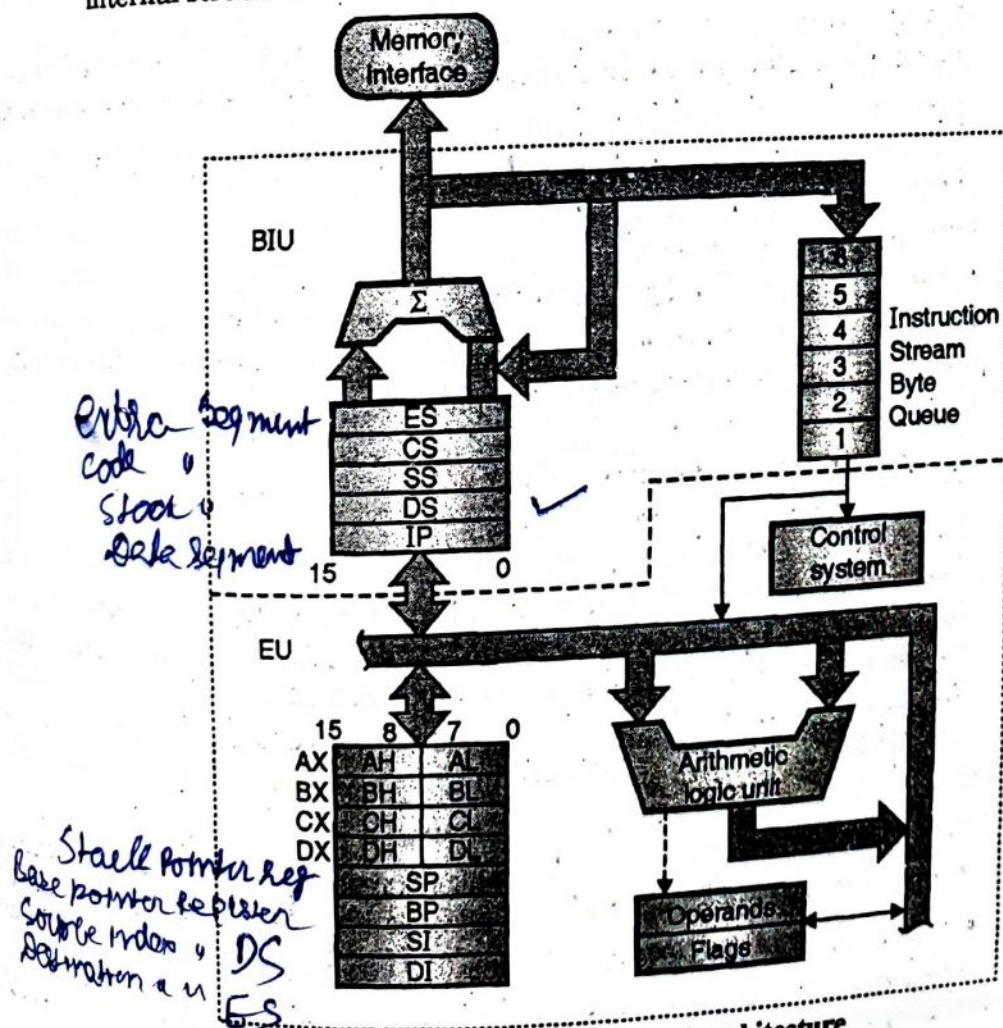


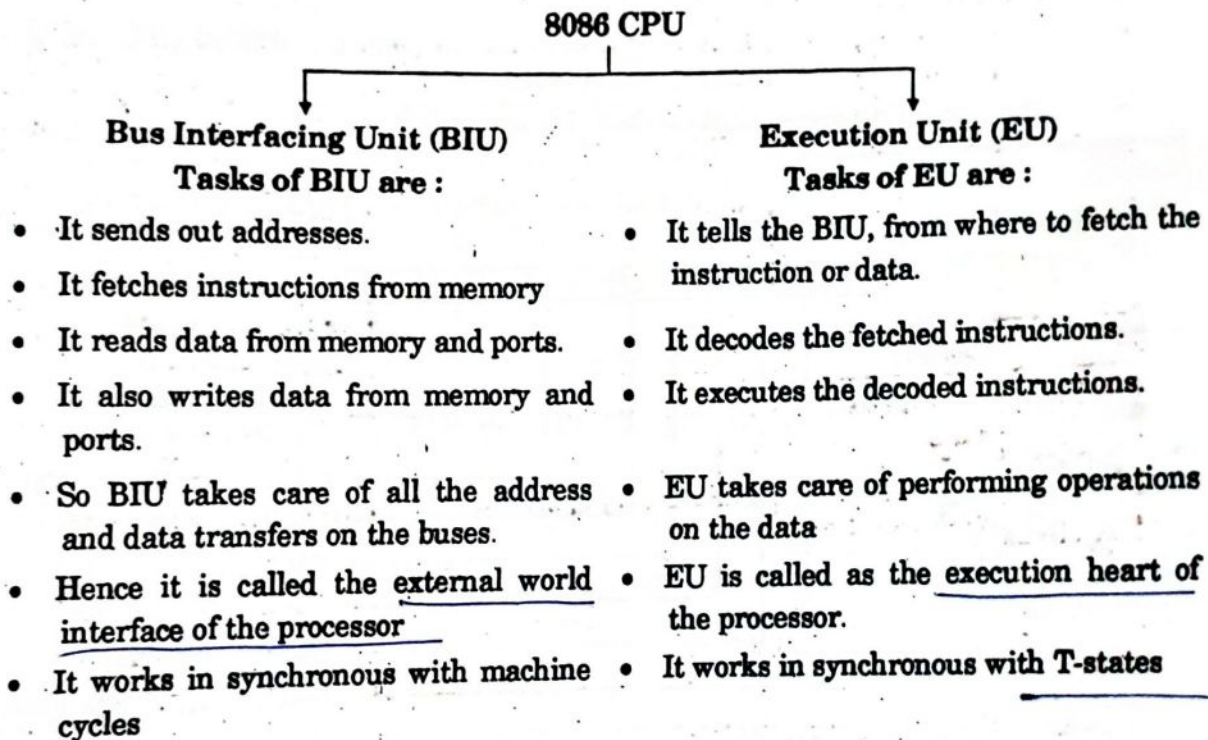
Fig. 11.3.1 : 8086 internal architecture

- As shown in Fig. 11.3.1, the 8086 CPU is divided into two units viz :

✓ The bus interfacing unit (BIU) • The execution unit (EU). 40

These two units are completely independent of each other and they share the work of CPU. Such a work division speeds up the processing and reduces the processing time. This is called as pipelining.

The work of 8086 CPU is divided between BIU and EU in the following manner.



11.4 The Execution Unit (EU)

Main function of EU is decoding and execution of the instructions. In order to carry out its tasks it has the following units :

- | | |
|-------------------------------|-------------------------------|
| • Arithmetic Logic Unit (ALU) | • Flag Register. |
| • General Purpose Registers. | • Control Unit |
| • Decoder | • Pointer and Index Registers |

11.4.1 Arithmetic Logic Unit (ALU)

- The ALU in the EU is a 16 bit unit i.e. it can perform 16-bit operation simultaneously.
- It is capable of performing a variety of arithmetic and logic operations such as add, subtract, AND, OR, NOT, EX-OR, increment, decrement, shift etc.