

Unit 5

Micro-Controllers

Microcontroller

- An embedded microcontroller is a chip which is a computer processor with all its support functions (clocking and reset), memory, and I/O built into the device.
- A single chip computer or A CPU with all the peripherals like RAM, ROM, I/O, Timers, ADCs, etc on the same chip.

FEATURES OF Microcontroller

- useful for small computing tasks.
- adequate for many control and monitoring application.
- packaging(RAM,ROM,Timers on-chip).
- Less power consumption.
- Easily upgradable.
- Cost per unit is less.

TYPES OF ARCHITECTURES

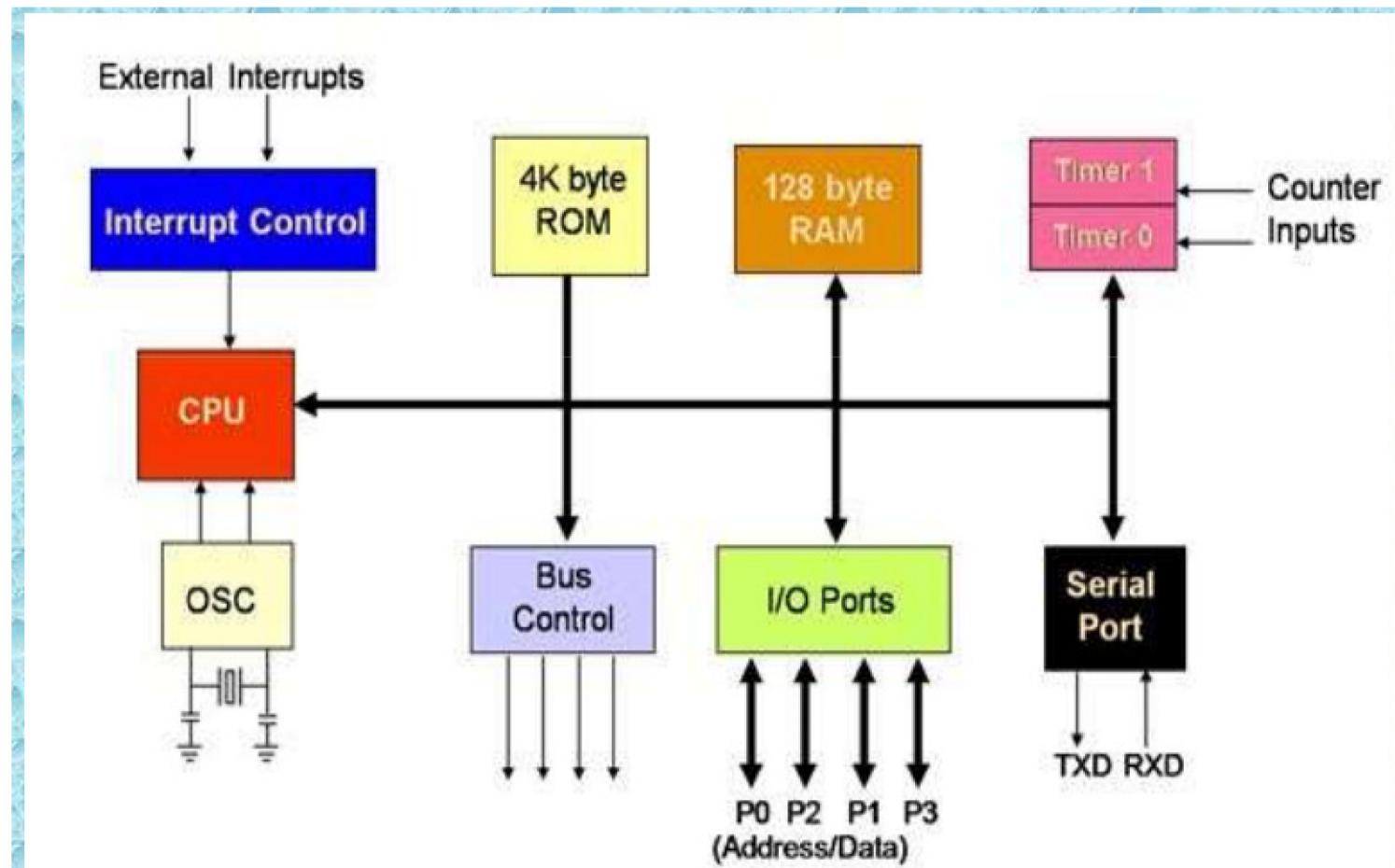
1) Von-Neumann Architecture

- only one bus.
- used for both data transfer and instruction fetches.
- cannot be performed at same time.

2) Harvard Architecture

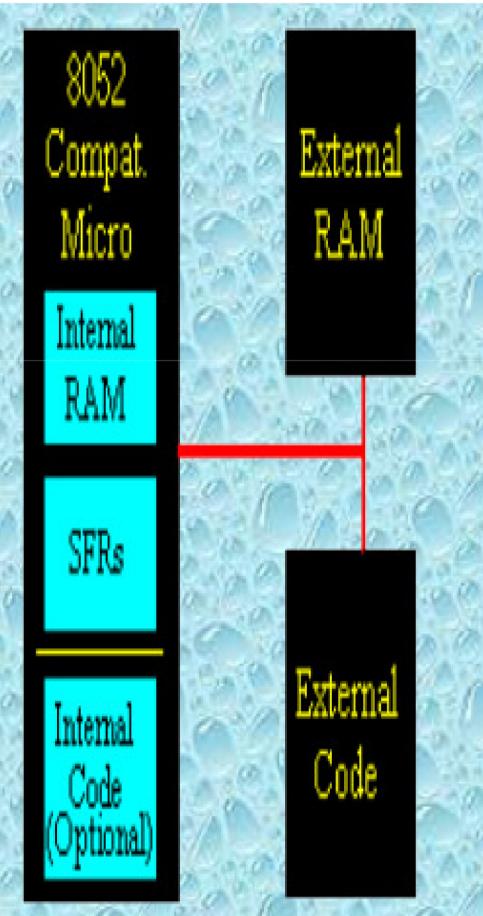
- Separate data and instruction buses.
- Transfers to be performed simultaneously on both buses.

Architecture of 8051 Microcontroller



MEMORY ORGANISATION OF 8051

- *Code Memory.*
- *External RAM.*
- *On-Chip Memory.*
- *Internal RAM.*
- *Special Function Register.*



MEMORY ORGANISATION OF 8051

- Code Memory
 - holds the actual 8051 program.
 - limited to 64K.
 - may be both internal or external.
- External RAM
 - slow accessing speed.
 - it gains in quantity.
 - limited to 64K.

MEMORY ORGANISATION OF 8051

- On-Chip Memory
 - It refers to that memory that physically exists on the microcontroller itself.
 - Two types
 - a) Internal RAM.
 - b) SFR(Special Function Register.)
 - Total 256 bytes.
 - Equal memory for RAM and SFR i,e 128bytes.

Applications

- Home
 - Appliances, intercom, telephones, security systems, garage door openers, answering machines, fax machines, TVs, cable TV tuner, VCR, camcorder, remote controls, video games, cellular phones, musical instruments, sewing machines, lighting control, paging, camera, pinball machines, toys, exercise equipment.
- Office
 - Telephones, security systems, fax machines, microwave, copier, laser printer, color printer, paging.
- Auto
 - Navigation system, engine control, air bag, ABS, instrumentation, security system, transmission control, entertainment, climate control, cellular phone, keyless entry.

Basics of Embedded System and their Applications

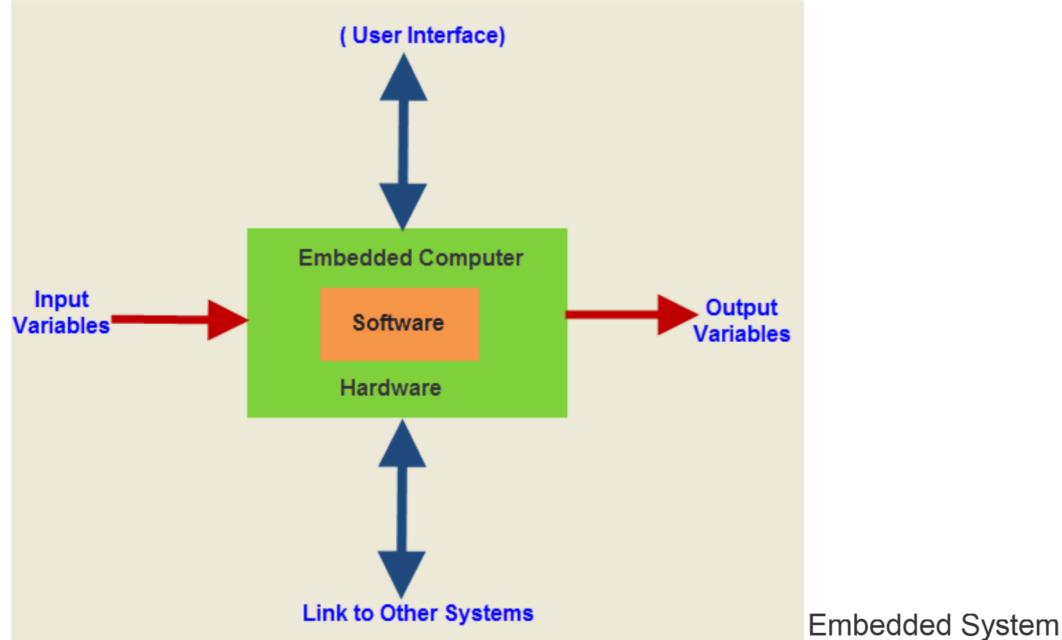
Definition 1- An embedded system is an electronic system that has a software and is embedded in computer hardware. It is programmable or non-programmable depending on the application. An Embedded system is defined as a way of working, organizing, performing single or multiple tasks according to a set of rules. In an embedded system, all the units assemble and work together according to the program. Examples of embedded systems include numerous products such as microwave ovens, washing machine, printers, automobiles, cameras, etc. These systems use microprocessors, microcontrollers as well as processors like DSPs. This article gives an overview of what is an embedded system and types of embedded system.

The important characteristics of an embedded systems are speed, size, power, reliability, accuracy, adaptability. Therefore, when the embedded system performs the operations at high speed, then it can be used for real-time applications. The Size of the system and power consumption should be very low, then the system can be easily adaptable for different situations.

Definition 2- An embedded system is integration of hardware and software, the software used in the embedded system is set of instructions which is termed as a program. The microprocessors or microcontrollers used in the hardware circuits of embedded systems are programmed to perform specific tasks by following the set of instructions. These programs are primarily written using any programming software like Proteus or Lab-view using any programming languages such as C or C++ or embedded C. Then, the program is dumped into the microprocessors or microcontrollers that are used in the embedded system circuits.

Definition 3- An embedded system is one kind of a computer system mainly designed to perform several tasks like to access, process, store and also control the data in various electronics-based systems. Embedded systems are a combination of hardware and software where software is usually known as firmware that is embedded into the hardware. One of its most important characteristics of these systems is, it gives the o/p within the time limits. Embedded systems support to make the work more perfect and convenient. So, we frequently use embedded systems in simple and complex devices too. The applications of embedded systems mainly involve in our real life for several devices like microwave, calculators, TV remote control, home security and neighborhood traffic control systems, etc. An Embedded system is a combination of computer hardware and software. As with any electronic system, this system requires a hardware platform and that is built with a microprocessor

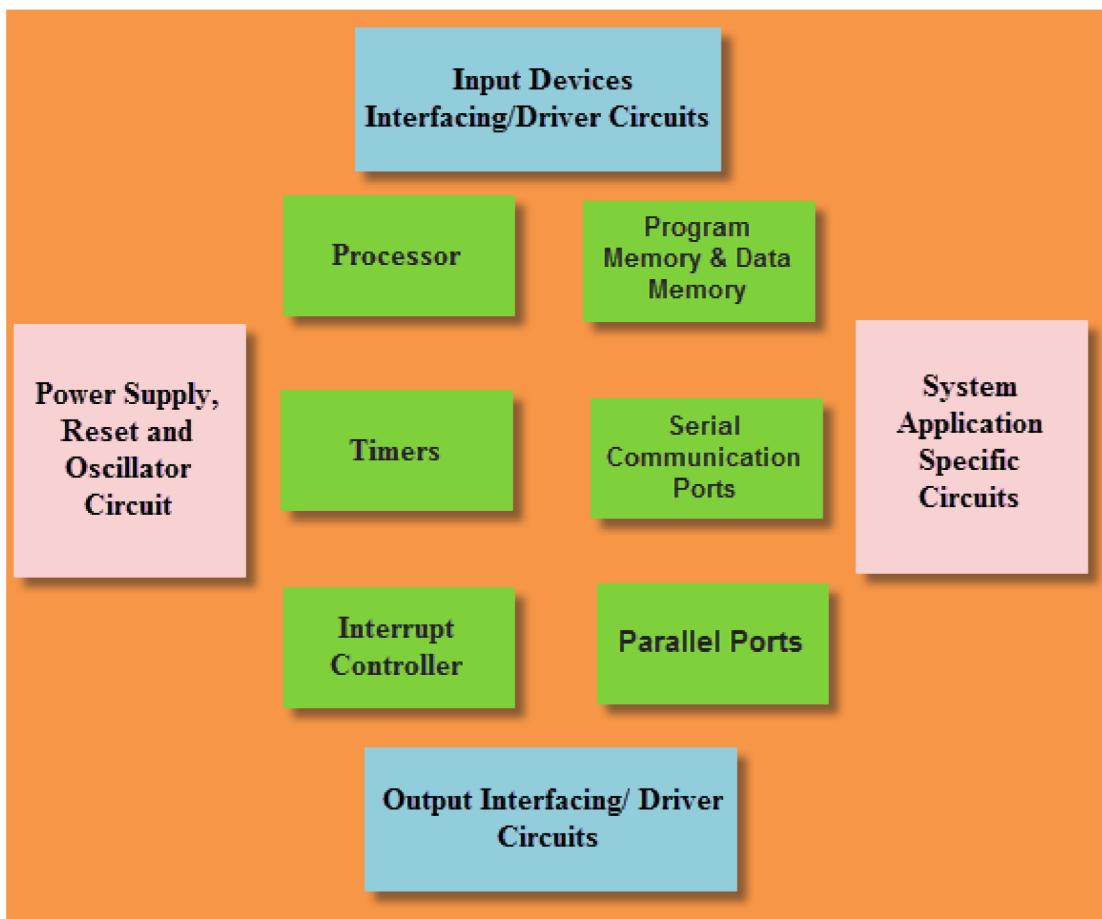
or [microcontroller](#). The Embedded system hardware includes elements like user interface, Input/Output interfaces, display and memory, etc. Generally, an embedded system comprises power supply, processor, memory, timers, serial communication ports and system application specific circuits.



Embedded System Basics

The embedded system basics are the combination of embedded system hardware and embedded system software.

An embedded system is basically an electronic system that can be programmed or non-programmed to operate, organize, and perform single or multiple tasks based on the application. In the real time embedded systems, all the assembled units work together based on the program or set of rules or code embedded into the microcontroller.



Embedded System Block Diagram

Embedded System Hardware

An embedded system uses a hardware platform to perform the operation. Hardware of the embedded system is assembled with a microprocessor/microcontroller. It has the elements such as input/output interfaces, memory, user interface and the display unit.

The software of an embedded system is written to execute a particular function. It is normally written in a high-level setup and then compiled down to offer code that can be stuck within a non-volatile memory in the hardware. An embedded system software is intended to keep in view of the following three limits

Convenience of system memory

Convenience of processor's speed

When the embedded system runs constantly, there is a necessity to limit power dissipation for actions like run, stop and wake up.

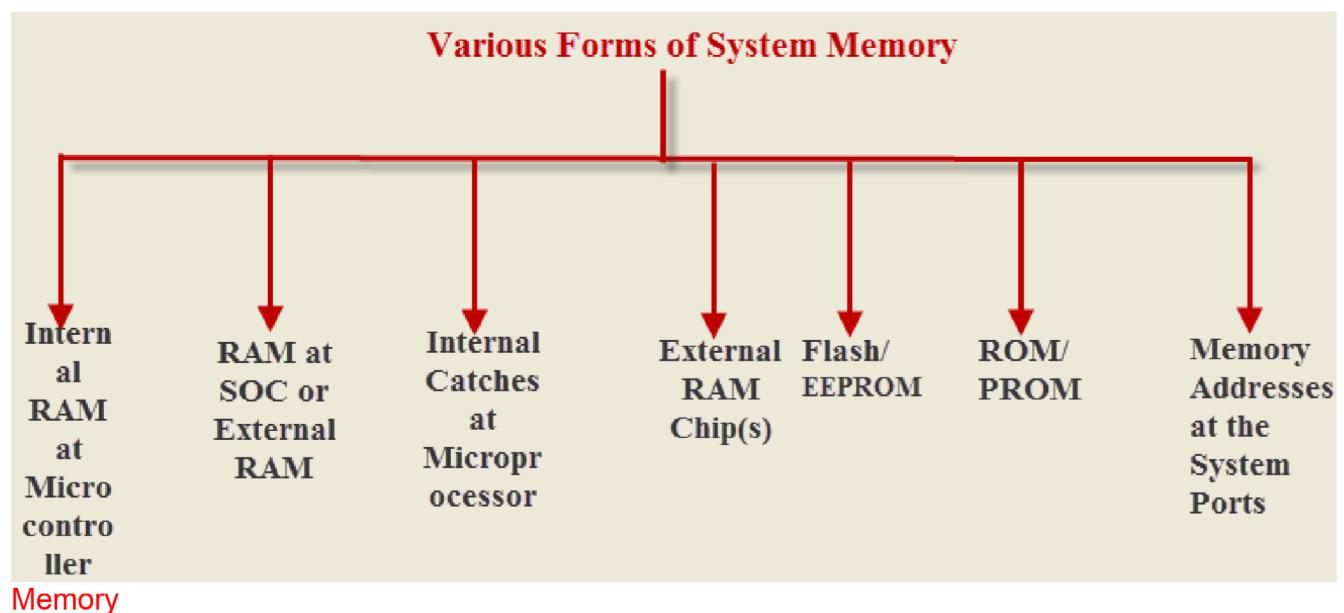
RTOS (Real Time Operating System)

A system which is essential to finish its task and send its service on time, then only it said to be a real time operating system. RTOS controls the application software and affords a device to allow the processor run. It is responsible for managing the different hardware resources of a personal computer and also host applications which run on the PC.

This operating system is specially designed to run various applications with an exact timing and a huge amount of consistency. Particularly, this can be significant in measurement & industrial automation systems where a delay of a program could cause a safety hazard.

Memory and Processors

The different kinds of processors used in an embedded system include Digital Signal Processor (DSP), microprocessor, RISC processor, microcontroller, ASSP processor, ASIP processor, and ARM processor. The different types of memories of an embedded system are given in the below chart.



Embedded System Characteristics

- Generally, an embedded system executes a particular operation and does the similar continually. For instance: A pager is constantly functioning as a pager.
- It must perform fast enough and consume less power to increase battery life.
- Several embedded systems should constantly react to changes in the system and also calculate particular results in real time without any delay. For instance, a car cruise controller; it continuously displays and responds to speed & brake sensors. It must calculate acceleration/de-accelerations frequently in a limited time; a delayed computation can consequence in letdown to control the car.
- It must be based on a microcontroller or microprocessor based.
- It must require a memory, as its software generally inserts in ROM. It does not require any secondary memories in the PC.
- It must need connected peripherals to attach input & output devices.
- An Embedded system is inbuilt with hardware and software where the hardware is used for security and performance and Software is used for more flexibility and features.

Classification of Embedded System

- a. Small Scale Embedded system
- b. Medium Scale Embedded system
- c. Sophisticated Embedded system

Small Scale Embedded system

System designed using 8 bit microcontrollers using 8051 or 1 bit microcontroller like 80196.

Hardware and software have very low complexity.

Battery operated

Coding is done in 'C' language.

Having small program and data memory.

Application are like Electronic watch, Temperature measurement, Automatioc Chocolate Vending Machine.

Medium Scale Embedded system

These types of embedded systems design with a single or 16 or 32 bit microcontroller, RISCs or DSPs

Hardware and software complexity is high.

Must have an operating system like RTOS.

Examples are Pagers, ATM Machine, FAX Machine

Sophisticated Embedded system

Use high end microcontrollers

Hardware and software complexity are very high.

Design tools are complicated and costly

Use RTOS for Specific applications

Memory requirement is more

Exp- Smart phones and Multimedia system.

Embedded System Applications

The applications of an embedded system basics include smart cards, computer networking, satellites, telecommunications, digital consumer electronics, missiles, etc.



- Embedded systems in automobiles include motor control, cruise control, body safety, engine safety, robotics in an assembly line, car multimedia, car entertainment, E-commerce access, mobiles etc.
 - Embedded systems in telecommunications include networking, mobile computing, and wireless communications, etc.
 - Embedded systems in smart cards include banking, telephone and security systems.
 - Embedded Systems in satellites and missiles include defense, communication, and aerospace
 - Embedded systems in computer networking & peripherals include image processing, networking systems, printers, network cards, monitors and displays

- Embedded Systems in digital consumer electronics include set-top boxes, DVDs, high definition TVs and digital cameras

Thus, this is all about the basics of embedded system basics and applications. We all know that embedded systems are extremely fabulous systems that play a vital role in many applications like equipment, industrial instrumentation, etc.

Difference Between 8086,80286,80386,80486

Description	8086	80286	80386	80486
Data bus	16	16	32	32
Address Bus	20	24	32	32
	Address and Data Lines are MULTIPLEXED		Address and Data Lines are NOT MULTIPLEXED	
Physical Address	1 MB	16 MB	4 GB	4 GB
Speed	8 MHz	8 MHz	50 MHz	66 MHz
Internal data word	16 Bits	16 Bits	32 Bits	32 Bits
Math Co-processor	8087 External	80287 External	80387 External	Internal

Difference Between 8086,80286,80386,80486

Description	8086	80286	80386	80486
Memory Management	External	Internal	Internal	Internal
Instruction cache	*****	*****	16 Bytes External	32 Bytes External
Data Cache	*****	*****	256 Bytes External	8KB Bytes External
FLAGS	O-D-I-T-S-Z-AF-P-C	12 NT-IOP-IOP are New	14 RF-VM are New	15 AC New
Segments	CS,DS,SS,ES	CS,DS,SS,ES	FS,GS are New	FS,GS are New
Offset Registers	SI,DI,BX	SI,DI,BX	Any Registers	Any Registers
Registers	AX,BX,CX,DX, SI,DI,SP,BP,IP (8,16)	AX,BX,CX,DX,SI,DI ,SP,BP,IP (8,16)	EAX,EBX,ECX,E DX,ESI,EDI,ESP, EBP,EIP (8,16,32)	EAX,EBX,ECX, EDX,ESI,EDI, ESP,EBP,EIP (8,16,32)

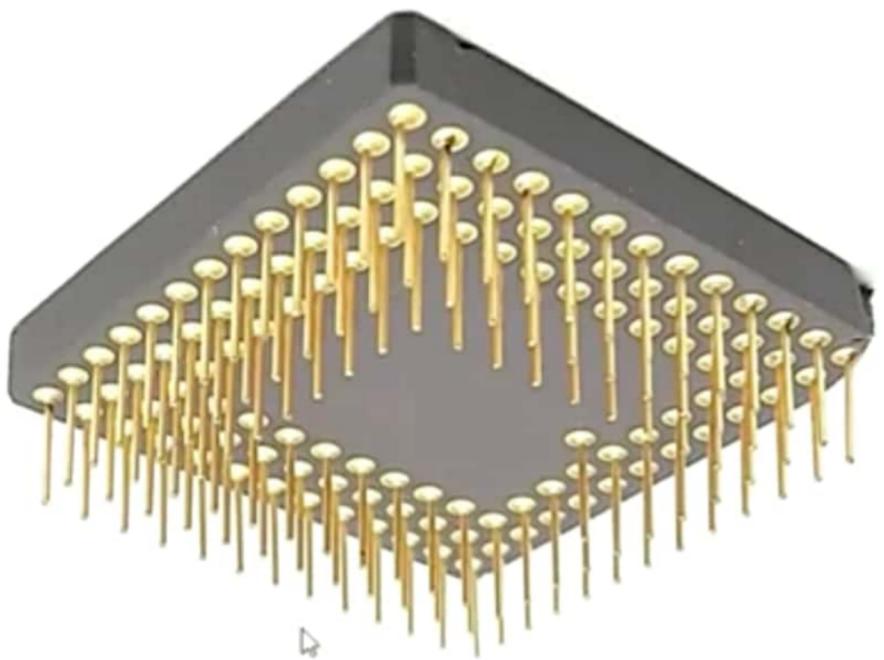
DIP (Dual in Line Package)



Flat Package



PGA (Pin Grid Array)



Unit 5

Intel 80186, Intel 80286,
Intel 80386,
Intel 80486 Microprocessor

INTEL 80186

- It is 16-bit Microprocessor
- The CPU is 8 MHz Processor
- The size of Address Bus is 20-bit and size of data Bus is 16-bit as 80186 Processor.
- It has similar addressing modes as 8086.
- The registers are similar as 8086.
- Flag registers are also similar as 8086.
- It has 68-pin I.C. package.
- It has two times greater throughput than standard 8086.
- It has same set of instruction as 8086 have.
- It has some additional instructions also.

INTEL 80186

- It has enhanced execution and bus interface unit.
- It is used for industrial applications.
- It can Address 1MB of Memory as 8086.
- It has additional on chip circuits like clock generator, programmable memory, programmable interrupt controller, 2 independent high speed DMA channel, 3 programmable 16-bit timers and local bus controller.
- So 80186 can be described as integrated peripherals.
- Its improved versions are 80C186, 80C186XL.

INTEL 80286

- It is 16-bit Microprocessor
- The size of Address Bus is 24-bit and size of data Bus is 16-bit as 8086 Processor.
- Its Clock speed varies from 8Mhz to 12.5 MHz.
- It has 68-pin of I.C. Package.
- It has similar addressing modes as 8086.
- The registers are similar as 8086.
- Flag registers are also similar as 8086.
- It is specially designed for multi user and multi tasking system.
- It has same set of instruction as 8086 have.
- It has some additional instructions also.

INTEL 80286

- It has a memory management capability.
- It supports virtual memory and operating system.
- It can address upto 16MB of Physical memory and 1 GB of virtual memory.
- It has non multiplexed data and address bus.
- It is available in PLCC(Plastic leaded chip carrier), Ceramic LCC (Leadless chip carrier) and PGA (pin Grid Array).

INTEL 80386

- It is 32-bit microprocessor.
- Its contains complete memory management unit on chip.
- It has total 129 instructions.
- It is available in three versions 80386 SX,SL and DX.
- The DX version has 32 bit data bus but SX and SL version have 16-bit wide data bus.
- It can address (DX Version) 4GB of physical memory and 64 TB of Virtual Memory.
- It Support paging Concept.
- It is available on 25,33 and 40 MHz clock.
- It's processing speed is 3-5 MIPS.
- It is 132 pin IC.