

MICROPROCESSOR BASICS AND MEMORY CONCEPTS

MICROPROCESSOR:-

It is a multipurpose, programmable logic device (an Integrated Circuit) that accepts binary data as input and processes data according to those binary instructions reads from a storage device called memory and provides results as output. The basic characteristics of microprocessor are :-

(i) **Instruction Set:-**

The possible operations a microprocessor can execute, is determined through its instruction set. For example, SIMP(Single Instruction and Multiple Processor) computer understands 10 instructions and any program written for it uses those 10 instructions in various ways.

(ii) **Word Size:-**

The numbers of bits processed in single instruction depend upon the word size of a microprocessor. The word size determines the amount of RAM memory that can be accessed. 32-bit processor means it has a word size of 32 bits.

(iii) **Clock Speed:-**

It is the speed at which a microprocessor executes instructions. It is also called **clock rate**. The faster the clock, the more instructions the microprocessor can execute per second. Clock speed is stated as MHz(Mega Hertz) or GHz(Giga Hertz).

Composition of Microprocessor

CPU its function and units as discussed in chapter 1.

MEMORY 1. (ROM) Read only Memory – stores preprogrammed instructions permanently for booting process, i/o process and other basic processes).

2.(RAM) Random Access Memory – fast temporary storage memory for storing program, applications and data which are currently used in system.

BUSES:- A collection of wires through which [data](#) is transmitted from one part of a [computer](#) to another. You can think of a bus as a highway on which data travels within a computer.

There are following three types of busses that perform these tasks:-

(i) **Address bus** is unidirectional bus which is responsible for carrying address of a memory location or an input/output port from CPU.

(ii) **Data Bus** is bidirectional bus which carries the actual data to and from memory location, to output ports and from input ports depending on architecture i. e. 16 bits or 32 bits or 64 bits. These are two types:-

(a) **Internal Data Bus** that operates only within the internal circuitry of the CPU, communicating among the registers and internal caches of memory that are part of the CPU chip's design.

(b) **External Data Bus** that connects a computer to Main Memory and peripheral devices via ports.

(iii) **Control Bus** is a bidirectional bus that carries control signals such as clock signals; interrupt signals (ready, halt etc.).

Input-output unit

1. Ports
2. Input devices same as chapter 1
3. Output devices same as chapter 2

Classification of Microprocessors:-

Microprocessors are classified :-

(i) By the width of the data format they process:-

This type of microprocessors depends upon the size of the internal registers and the word-size of the data-width they can process in one go. For example, 4-bit, 8-bit, 16-bit, 32-bit, 64-bit or 128-bit. **16 bit Microprocessor:** It indicates the width of the [registers](#). A 16-bit microprocessor can process data and [memory addresses](#) that are represented by 16 bits. Eg. 8086 processor

32 bit Microprocessor: It indicates the width of the [registers](#). A 32-bit microprocessor can process data and [memory addresses](#) that are represented by 32 bits. Eg. Intel 80386 processor, Intel 80486

64 bit Microprocessor: It indicates the width of the [registers](#); a special high-speed [storage](#) area within the [CPU](#). A 32-bit microprocessor can process data and [memory addresses](#) that are represented by 32 bits. Eg. Pentium dual core, core 2 duo.

128 bit Microprocessor: It indicates the width of the [registers](#). A 128-bit microprocessor can process data and [memory addresses](#) that are represented by 128 bits. Eg. Intel core i7

(ii) By their instruction set:-

(a) RISC (Reduced Instruction Set Computer) have the following characteristics:-

- Simple primitive instructions and addressing modes
- Instructions execute in one clock cycle
- Uniformed length instructions and fixed instruction format
- Hardwired control
- Instructions interface with memory via fixed mechanisms
- Complexity pushed to the compiler
- Supports fewer instructions
- For example, Pentium1, AMD K6, Intel P6 etc.

(b) CISC (Complex Instruction Set Computer) have the following characteristics:-

- Supports hundreds of instructions
- Richer instruction set, some simple, some very complex
- Instructions generally take more than 1 clock to execute
- Instructions of variable sizes
- For example, Intel 386, Intel 486, Pentium III, Pentium Pro etc.

(c) EPIC (Explicitly Parallel Instruction Computing) have the following characteristics:-

- It offers best of both above computers.
- It provides parallelism
- It does not use fixed width instructions rather as many as parallel as possible
- Programs must be written using sequential semantics with explicitly laid out parallelism

- Compiler should play the key role in designing the plan of execution and the architecture should provide the requisite support for it to do so successfully.

Memory Devices:-

Memory is an essential component of the computer system. A high speed memory is organized into words of fixed lengths. A memory is divided into N words where each word is assigned an address in the memory. Each word consists of same number of bits is called **word length**. A memory with 4096 locations with each location having 16 bits is called a 4096 word 16-bit memory or 4 K 16-bit memory (1K = 1024). Memory is divided into following categories:-

(i) **Main Memory or Primary Memory:-**

Programs and Data need to be in main memory in order to be executed or referenced. The main Memory can be divided into two parts:-

(a) RAM (Random Access Memory):-

It is a temporary memory or volatile memory whose data would be erased when the system has been shut down or when the power goes off.

The amount of time taken to produce data required from memory, from the start of access until the availability of data is called **memory access time**.

Dynamic RAM (DRAM):-

- It consists of a transistor and capacitor that's capable of storing an electric charge.
- A DRAM cell consists of only one transistor and capacitor per bit, it allows a DRAM chip to pack a large number of cells within the chip compared to SDRAM.
- The problem of a capacitor is that it starts losing the charge over a period of time, and can retain data for barely a thousandth of a second. Therefore, the memory controller needs to refresh the memory contents as many as thousand times a second, which is called **memory refreshing**.
- Uses a circuit that acts like a capacitor and an external refresh circuit must periodically read the data value and write it back again.
- Contents are constantly refreshed 1000 times per second
- Access time 60 – 70 nanoseconds
- High density (1 transistor/bit)
- Slower than SRAM

Static RAM:-

It consists of internal flip-flops that store the binary information. It take up more space for a given storage capacity than do dynamic RAMs. Static RAMs are used in specialized applications while dynamic RAMs are used in the primary storage sections of most computers. The static RAM is easier to use and has shorter read and write cycles compared to dynamic RAM.

- Doesn't need refreshing

- The miniature circuit contains many transistors that operate continuously
- Retains contents as long as power applied to the chip
- Access time around 10 nanoseconds
- Used for **cache** memory
- Also for **date and time** settings as powered by small battery
- Less dense (4-6 transistors/bit)

(a) **ROM (Read Only Memory):-**

It is the memory that performs the read only operation. It does not have write capability. There are various types of ROM given below:-

- **Programmable Read Only Memory (PROM)** is a ROM that can be programmed to record information using a facility known as PROM-programmer that information cannot be changed.
- **Erasable Programmable Read Only Memory (EPROM)** is another type of ROM that can be erased using **ultraviolet light (UPROM)** & **Electrically Alterable (EAPROM)** and the chip can be reprogrammed to record different information using a special PROM-program facility.
- **Electrically Erasable PROM (EEPROM)** is ROM that can be programmed and erased by electrical signals. Information loaded in this memory can be retained for many years without power supplied, when power is returned, the EEPROM memory can be used to replace the lost contents of the RAM memory and the microcomputer can continue working just as if nothing had happened.

(ii) **Cache Memory:-**

The Cache Memory is high speed memory available inside CPU in order to speed up access to data and instructions stored in RAM memory. 95% of the time the processor is working; it is accessing information from cache. When data is found in the cache, it is called a **cache hit**, and the effectiveness of a cache is judged by its hit rate. There are three types of cache memories:

- **Level 1 (L1) cache** is built inside the CPU package
- **Level 2 (L2) cache** is external to the CPU and reside on the motherboard.
- **Level 3 (L3) cache** is external to the CPU and reside on the motherboard.

Thus, when CPU needs some information, its order of memory checks or access as shown below:

(iii) **Secondary Memory:-**

These are also called Secondary Memory Devices or Storage Devices which are used to store large amount of data permanently. Some most common storage devices are:-

- **Floppy Disks or Diskette**
- **Hard Disks:-** These are the memories store information on one or more circular platters or disks which are continually spinning. These rotating disks are coated with a magnetic material and stacked with space between them. Information is recorded on the surface of rotating disks by magnetic heads as tiny magnetic spots. These heads are mounted on access arms. Information is recorded in bands. Each

band of information on a given disks is called a **track** i.e. the concentric circles on the magnetized surface of the magnetic disks **are known as tracks**. The tracks are commonly divided into invisible pie-shaped sections called **sectors**.

- **Compact Disks (CDs)**:- these are optical media storage capacity of upto 700 MB. There are three main types:-
 - (a) **CD-ROM (CD-Read Only Memory)** used only to store information and cannot be used to store data. Manufacturers use CDROMs to record information for the CD distribution e.g. encyclopedias, software, games, e-books etc.
 - (b) **CD-R (CD-Recordable)** can be written data only once and disk can't be erased.
 - (c) **CD-RW (CD-Rewritable)** is an erasable disk that you can write on multiple times.
- **Digital Video Disks (DVDs)** is an optical storage device that store information about 15 times as much information and transfer it to the computer about 20 times as fast as a CD-ROM. It is also called **Super Density disk (SD)**. It capable of storing 4.7 GB to 17 GB. There are three main types:-
 - (a) **DVD-ROM (DVD-Read Only Memory)**
 - (b) **DVD-R (DVD -Recordable)**
 - (c) **DVD-RW (DVD-Rewritable)**
- **Pen/Thumb Drives – Flash Memories (Solid State Storage)**
 - ✓ Used to record MP3 music files
 - ✓ Key chain hard drives
 - ✓ “Flash” – the memory cell is erased or reprogrammed in a single action or flash
 - ✓ Connects to a USB port
 - ✓ Has no moving parts unlike magnetic storage devices and no lasers are used unlike optical disks
 - ✓ Works similar to RAM, data retained while power is switched off.
 - ✓ Cheaper and size ranges from 2 GB to 32 GB
- **Blu-ray Disk (BD)** is an optical disc storage media format. Its main uses are high-definition video and data storage. It capable to hold 25 GB/50 GB almost six times the capacity of a dual layer DVD.

PORTS:-

- (i) **Serial Ports**:- these ports transfers data serially a bit at a time. As a result, the serial port needs only wire to transmit 8 bits. Serial ports are often known as communication (COM) ports or RS232C ports.
- (ii) **Parallel Ports**:- these ports can send or receive a byte (8-bit) at a time. It comes in the form of 25-pin female connector.
- (iii) **USB (Universal Serial Bus) Ports**:- To spare the user botheration of 8-pin, 25-pin, male, female connectors, the USB has been designed.

- (iv) **AGP Ports:-** it is used to connect to graphic card that provides high-speed video performance typically required in games and other multimedia applications.
- (v) **InfraRed Port (IR Port):-** It is a port, which sends and receives infrared signals from other devices. In this special form of radio transmission, a focused ray of light in the infrared frequency spectrum, measured in terahertz, or trillions of hertz (cycles per second). It is playing important role in wireless data communication.
- (vi) **Bluetooth** is a telecommunication industry specification that describes how mobile phones, computers and personal digital assistants (PDAs) can be easily interconnected using a short-range wireless connection. Connections can be point-to-point or multipoint. The maximum range is 10 meters.
- (vii) **PS-2 Port** stand for Personal System/2. It is an electronic receptacle or plug found on computers. It accepts a PS/2 cable (Female) with a mini-DIN connector (Male) and is most often used to plug in a keyboard or mouse. DIN stands for standards setting organization for Germany.
- (viii) **Firewire** is Apple Computer's version of a standard, IEEE 1394, High Performance Serial Bus, for connecting devices to your personal computer. It provides a single plug-and-socket connection on which upto 63 devices can be attached with data transfer speeds upto 800 Mbps(Megabits per second).