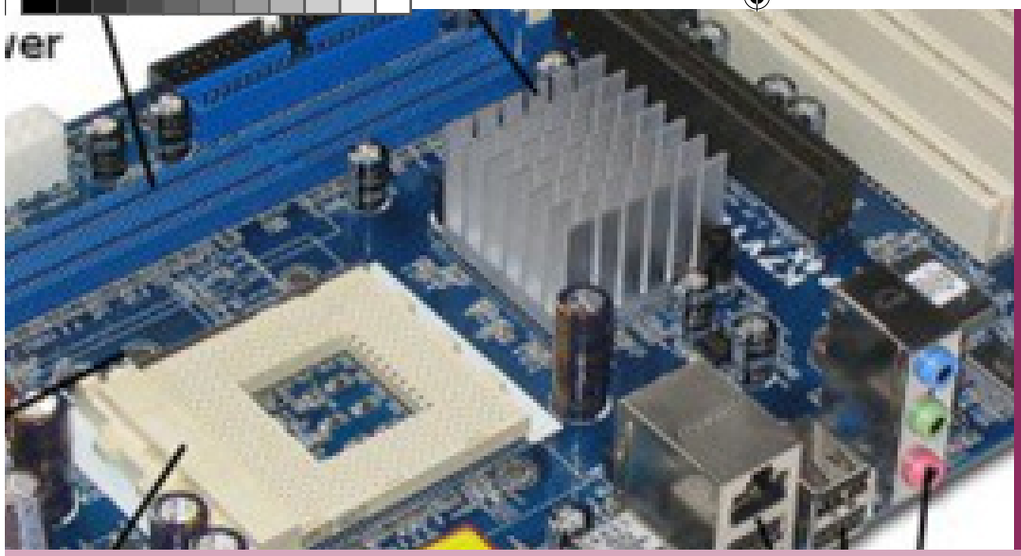

CHAPTER 9

Computer Hardware Techniques

LEARNING OBJECTIVE

In this chapter, the students can learn about the working principle and minor trouble shooting technique of the following

- Digital Computer
- Mother Board and Processor
- BIOS and Memory
- CMOS Battery and CPU clock
- Switches, Jumpers and Printers
- Networking and Embedded system
- Arduino Board and Raspberry Pi

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CONTENT

Introduction

We know today's world is dominated by digital devices, of which, the digital computer plays vital role in everybody's life. The computer becomes indispensible tool to perform all our routine, official and social works with greater accuracy and speed. Hence, it is highly essential to know about the technical features and also necessary fault rectification techniques of the computer. Basically, digital Computer consists of two broad classifications, such as hardware and software. Without the contribution of one other cannot function properly. Any action in the hardware is controlled by the software. Further, the software requires the hardware as a platform to execute the intended work. That mean, both hardware and software are inter-dependent. Hence, in this chapter, we are going to learn about digital computer's hardware, software and related fault rectifications.

9.1 MOTHER BOARD

The computer built around the main device called Central Processing Unit or simply CPU for performing all the tasks instructed by the user. The CPU is the prime part of the Mother Board, which has a sheet of plastic that holds all the circuitry to connect the various components of a computer system. Fig 9.1 shows the schematic diagram of the motherboard. It is populated with many crucial components of the computer including the central processing unit (CPU), memory and connectors for input and output devices. The base of the motherboard consists of a very firm sheet of non-conductive material, typically some-sort of rigid plastic. Thin layers of copper or aluminium foil, referred to as traces or tracks are printed onto this sheet. These tracks are very narrow and form the circuits between the various components. In addition to the circuits, a motherboard contains a number of sockets and slots to connect the other components. Other names for this central computer unit are system board, main-board, or printed wired board (PWB). The motherboard is sometimes shortened to Mobo.

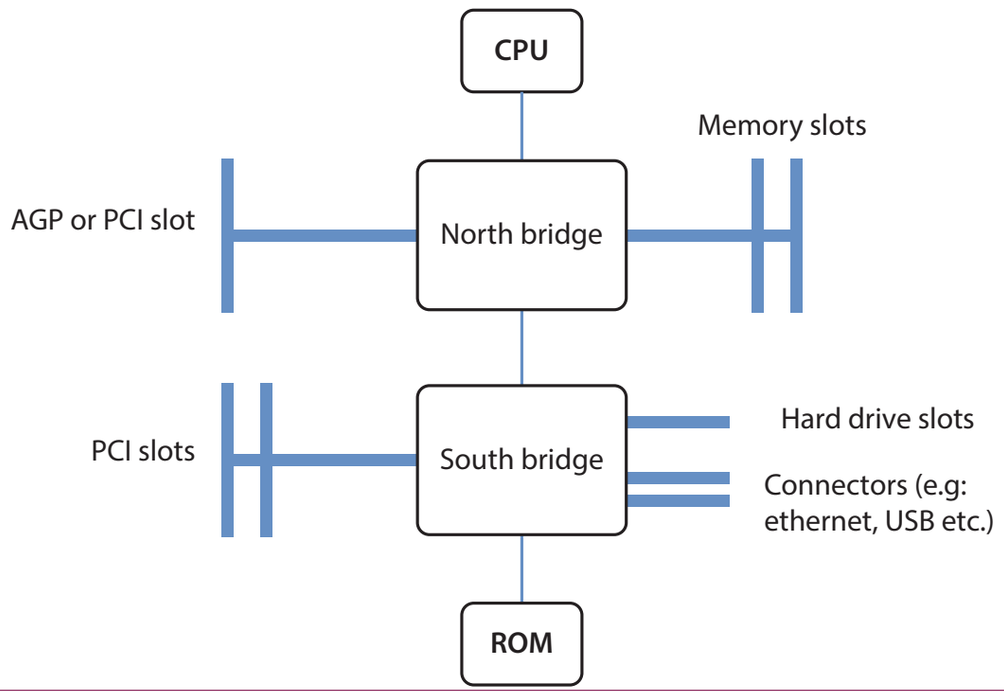

FIGURE 9.1 Schematic Diagram of Mother Board

Major Motherboard Components and their Functions

Numerous major components crucial for the functioning of the computer are attached to the motherboard. These include the processor, memory, and expansion slots. The motherboard connects directly or indirectly to every part of the PC. The type of motherboard installed in a PC has a great effect on a computer's system speed, functional and expansion capabilities. Fig 9.2 shows the view of the mother board.

Some of the more important parts and how the motherboard connects the various parts of a computer system are described as follows.

- A CPU socket - the actual CPU is directly soldered onto the socket. Since high speed CPU generates a lot of heat and hence there are heat sinks and mounting points for fans are provided right next to the CPU socket.
- A power connector to distribute power to the CPU and other components.
- Slots for the system's main memory, typically in the form of DRAM chips.
- A chip forms an interface between the CPU, the main memory and other components. On many types of motherboards, this is referred to as the Northbridge. This chip also contains a large heat sink.
- A second chip controls the input and output (I/O) functions. It is not connected directly to the CPU but to the Northbridge. This I/O controller is referred to as the Southbridge. The Northbridge and Southbridge combined together are referred as the chipset.
- Several connectors, which provide the physical interface between input and output devices and the motherboard, are handled by the Southbridge.
- Slots for one or more hard drives to store files. The most common types of slots are Integrated Drive Electronics (IDE) and Serial Advanced Technology Attachment (SATA).
- A Read-Only Memory (ROM) chip contains the firmware or start-up instructions for the computer system. This is also called as BIOS (Basic Input Output System).

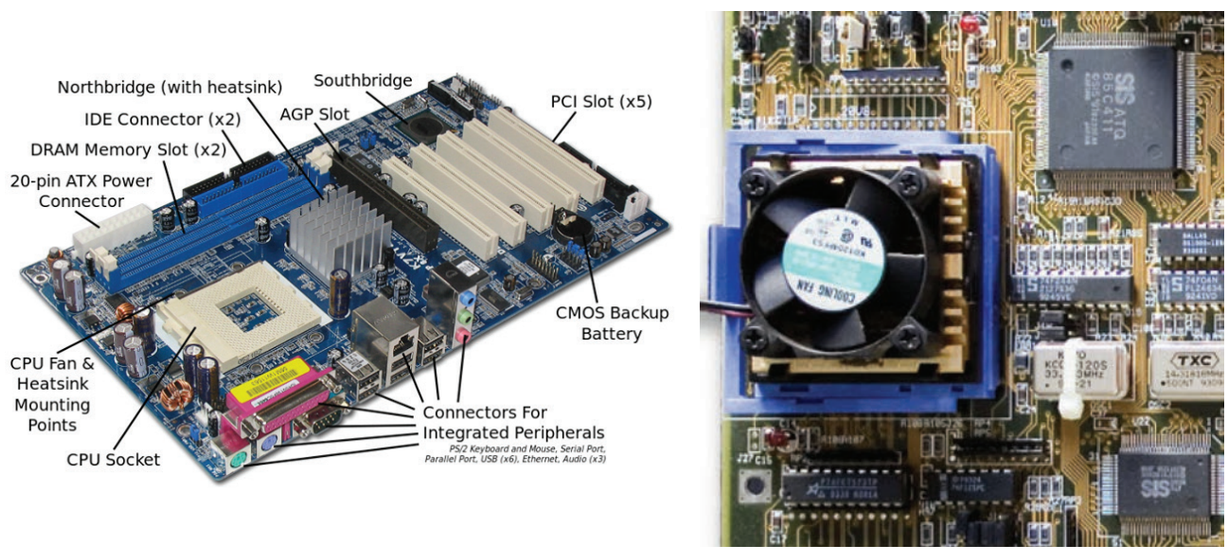

FIGURE 9.2 View of Mother Board with magnified view of the CPU

- A slot for a Video or Graphics Card (VGA) is used to connect the graphics card for communicating the information from CPU or any other device with the display. There are a number of different types of slots available, which includes the Accelerated Graphics Port (AGP) and Peripheral Component Interconnect Express (PCIE).
- Additional slots to connect hardware in the form of Peripheral Component Interconnect (PCI) devices.

9.1.1 Processor

A processor is an integrated electronic circuit that performs arithmetical, logical, input/output (I/O) and other basic instructions that are passed from an operating system (OS). The four primary functions of a processor are fetching, decoding, execution and write-back. Most other processes are dependent on the operations of a processor. Since this processor performs many more micro functions without committing any error, this single integrated chip is called as Microprocessor (µp). But, the µp is about two inches by two inches in size. This little chip is called Brain of the computer.

CPU (Central Processing Unit)

Central Processing Unit (CPU) is the heart and brain of the computer. It runs the Operating System and Application Software installed on the computer to do whatever the user wants to do. The µp handles most operations on a computer, but some operations are handled by specialized tools such as Graphics Processing Units (GPUs). µp is located on the motherboard. The µp gets very hot and therefore needs its own cooling system in the form of a heat sink and fan.

The various components of a µp and how they function mostly depend on the speed in which the computer works. The technological advancements in the chip design technology leads to processors having very high speed in the order of GHz. Presently, advanced PC has a 64-bit quad-core Intel i7 processor with 3.5 GHz speed. The µp has the following components viz.

- Arithmetic logic unit (ALU)
- Control unit (CU).
- Cache

Purpose of µp

The main purpose of a computer processor is to perform any sort of computations and logical functions assigned to the computer. Besides, managing the computer's memory, handling input from users, sending the output to display devices. Computer software is encoded in machine language, which is a numeric code that µp understand and process as a series of simple commands. µp do communicate with other devices installed on a computer, such as input and output devices and memory chips.

Common manufacturers of CPUs include Intel and AMD, which make processors for desktop and laptop computers. Qualcomm and ARM, which make chips designed mostly for smaller devices like smart phones and embedded tools. The processor chip is identified by the processor type and the manufacturer. This information is usually inscribed on the chip itself. For example, Intel 386, Advanced Micro Devices (AMD) 386, Cyrix 486, Apple note, etc.

Comparing *µp*

In addition to the brand name and model of a µp, there are stats that the user can compare different processing chips. The

most commonly cited statistic about a CPU is its clock speed, which refers to how many program instructions it can run in a second. Speed is typically measured in Mega-Hertz (MHz) or Giga-Hertz (GHz).

Another important measurement for comparing CPUs is the number of cores in the chip. A core is an independent processor within a processor that can run commands in parallel with other cores. There is a limit to how much software can be divided into units of commands that can run simultaneously, so adding additional cores increases the speed of the computer. But in general, µp with more cores run faster than those with fewer cores.

Depending on user needs, user may want to look at the power consumption of a particular µp. Faster processors sometimes use more energy than slower ones, but computers have become more efficient over time

The basic elements of a processor

- The Arithmetic Logic Unit (ALU), which carries out arithmetic and logic operations on the operands or instructions.
- A processor includes a control unit (CU) and measures the
  - Ability to process instructions at a given time.
  - Maximum number of bits/ instructions.
  - Relative clock speed.
- The floating point unit (FPU), also known as a math coprocessor or numeric coprocessor, a specialized coprocessor that manipulates numbers more quickly than the basic microprocessor circuitry can.
- Registers, which hold instructions and other data. Registers supply operands to the ALU and store the results of operations.
- L1 and L2 cache memory. Their inclusion in the CPU saves time compared to get data from random Access Memory (RAM).

Most processors today are multi-core, which means that the IC contains two or more processors for enhanced performance, reduced power consumption, more efficient and simultaneous processing of multiple tasks (see: parallel processing). Multi-core set-ups are similar to having multiple, separate processors installed in the same computer, but, the processors are actually plugged into the same socket and the connection between them is faster. It is responsible for fetching, decoding, and executing program instructions as well as performing mathematical and logical calculations.

9.2 Memory Unit

A memory is just like a human brain. It is used to store data and instructions. Computer memory is the storage space in the computer, where data is to be processed and instructions required for processing are stored. The memory is divided into large number of small parts called cells. Each location or cell has a unique address, which varies from zero to memory size minus one. For example, if the computer has 64 kilo-words, then the memory unit has 64 * 1024 = 65536 memory locations. The address of these locations varies from 0 to 65535 (65536 – 1).

Memory is primarily of three types

- Cache Memory
- Primary Memory/Main Memory
- Secondary Memory

9.2.1 Cache Memory

Cache memory is a very high-speed semiconductor memory which can speed up the μp. It acts as a buffer between the μp and the main memory. It is used to hold those parts of data and program which are most frequently used by the μp. The parts of data and programs are transferred from the disk to cache memory by the Operating System, from where the μp can access them.

- Cache memory is a small block of high-speed memory (RAM) that enhances performance by pre-loading information from the (relatively slow) main memory and passing it to the processor on demand.
- Most μps have an internal cache memory (built into the processor) which is referred to as Level 1 or primary cache memory. This can be supplemented by external cache memory fitted on the motherboard. This is the Level 2 or secondary cache. In modern computers, Levels 1 and 2 cache memories are built into the processor die. If a third cache is implemented outside the die, it is referred to as the Level 3 (L3) cache.

Advantages

The advantages of cache memory are

- Cache memory is faster than main memory.
- It consumes less access time as compared to main memory.
- It stores the program that can be executed within a short period of time.
- It stores data for temporary use.

Disadvantages

The disadvantages of cache memory are

- Cache memory has limited capacity.
- It is very expensive.

9.2.2 Primary Memory (Main Memory)

Basically Primary memory is classified into two broad categories.

1. ROM
2. RAM.

ROM

Normally, ROM family consists of ROM, PROM, EPROM and EEPROM. Among these many of the computer manufacturers use EPROM as the Booting IC.

EPROM memory holds only those instructions which are essential to make the computer get ready when it is switched on. The content of this memory cannot be altered or deleted. In case if it gets corrupted, the content of this particular memory can be erased by passing ultra-violet rays through the cavity provided on the top surface of the memory. Again this memory can be re-programmed by fixing this memory in the programming kit. The content of this memory is called as BIOS setup.

9.3 Basic Input/output System (BIOS)

BIOS stands for Basic Input/output System. BIOS is a set of instructions written in Assembly or HLL and the contents are "read-only" state. The memory consists of low-level software that controls the system hardware and acts as an interface between the operating system and the hardware. BIOS is also called device drivers, or just drivers. BIOS is essentially the link between the computer hardware and software in a system.

All motherboards include a small block of Read Only Memory (ROM) which is separated from the main system memory used for loading and running software.

On PCs, the BIOS contains all the code required to control the keyboard, display screen, disk drives, serial communications and a number of miscellaneous functions.

The system BIOS is a ROM chip on the motherboard used during the start-up routine (boot process) to check out the system and prepare to run the hardware. The BIOS is stored on a ROM chip because ROM retains information even when no power is being supplied to the computer.

BIOS (Basic Input Output System)

User might need to access BIOS to change how the device works or to assist in troubleshooting a problem. BIOS is responsible for the POST (Power On Self Test) and therefore makes it the very first software to run when a computer is started. The BIOS firmware is non-volatile, meaning that its settings are saved and recoverable even after power has been removed from the device.

BIOS instructs the computer on how to perform a number of basic functions such as booting and keyboard control. BIOS is also used to identify and configure the hardware in a computer such as the hard-drive, floppy-drive, optical-drive, CPU, memory, etc. The snapshot of the BIOS set-up is shown in Fig 9.3.

9.3.1 How to Access BIOS

The BIOS is accessed and configured through the BIOS Setup Utility. All available options in BIOS are configurable via the BIOS Setup Utility. BIOS is pre-

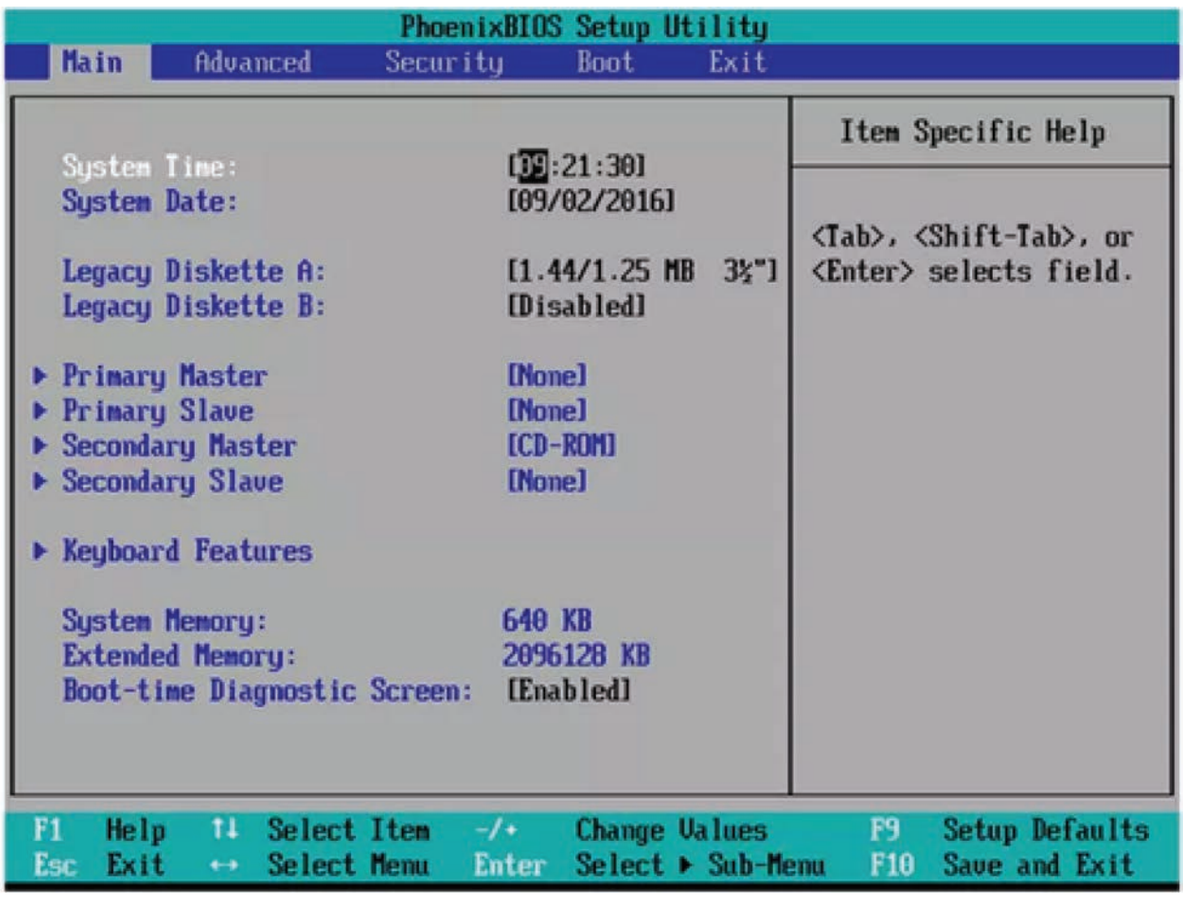

FIGURE 9.3 View of a BIOS set-up

installed when the computer is purchased (loaded by the manufacturer). The BIOS Setup Utility is accessed in various ways depending on the type of computer or motherboard make and model.

BIOS Availability

All modern computer motherboards contain BIOS software. BIOS access and configuration on PC systems is independent of any operating system because the BIOS is part of the motherboard hardware. It doesn't matter if a computer is running Windows 10, Windows 8, Windows 7, Windows Vista, Windows XP, Linux, Unix, or no operating system at all, i.e., the BIOS functions outside of the operating system environment and is no way dependent upon it. BIOS are manufactured by popular firmware companies such as, Phoenix Technologies, IBM, Dell, Gateway, American Megatrends (AMI), etc.

How to use BIOS

BIOS contains a number of hardware configuration options that can be changed through the setup utility. Saving these changes and restarting the computer applies the changes to the BIOS and alters the way BIOS instructs the hardware to function.

Before updating BIOS, it is important to know what version is currently running on the computer. There are multiple ways to do this, from checking in the Windows Registry to installing a third-party program that will display the BIOS version.

When configuring updates, it is extremely important that the computer not be shut down partway through or the update cancelled abruptly. This could brick the motherboard and render the computer unusable, making it difficult to regain functionality.

9.3.2 Characteristics of Main Memory

- These are semiconductor memories.
- It is known as the main memory.
- Usually volatile memory.
- Data is lost in case power is switched off.
- It is the working (live) memory of the computer.
- Faster than secondary memories.
- A computer cannot run without this primary memory.

9.4 Secondary Memory

This type of memory is also known as external memory or non-volatile. It is slower than the main memory. These are used for storing data/information, permanently. µp directly does not access these memories; instead they are accessed via input-output routines. Any part of the contents in the secondary memory is processed by transferring the content to the main memory. Then, only the µp can access it. For example, disk, CD-ROM, DVD, etc. Fig 9.4 shows the hard disk and its parts.

Characteristics of Secondary Memory

- The secondary memories are magnetic and optical disks.
- It is known as the backup memory.
- It is a non-volatile memory, i.e., data is permanently stored even if power is switched off.
- Computer may run without the secondary memory.
- Slower than primary memories.

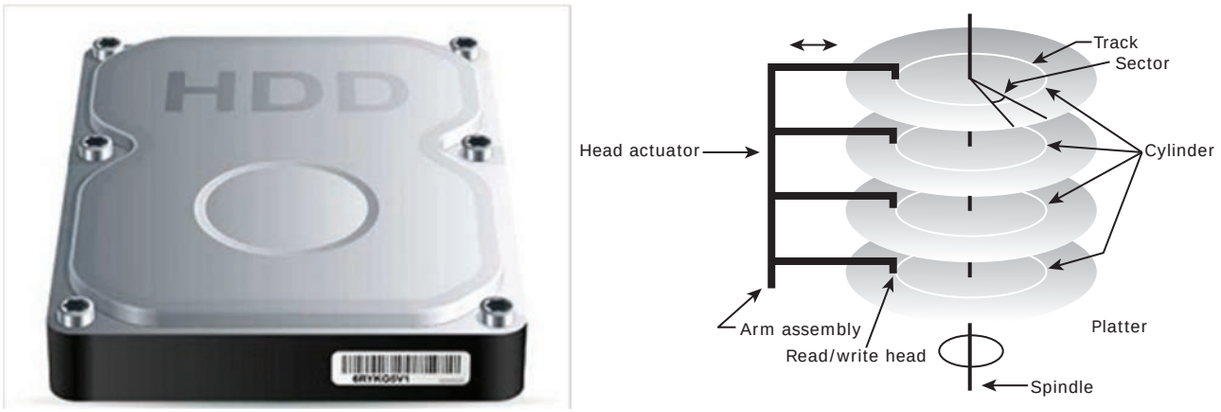

FIGURE 9.4 Outer-view and the parts of a Hard-disk

9.5 CMOS Battery

The CMOS battery is a Lithium-ion battery about the size of a coin. It can hold a charge for up to ten years before needing to be replaced. If the CMOS battery dies, the BIOS settings will reset to their defaults when the computer is turned off.

Motherboards also include a small separate block of memory made from CMOS RAM chips. It kept alive by a battery (known as a CMOS battery) even when the PC's power is off. This prevents reconfiguration when the PC is powered on.

Tip: If the user turn on the computer and notice that the hardware settings have changed, or that user system clock has reset to a date in the past (like January 1st, 1970), i.e., the CMOS battery is dead and needs to be replaced.

Some motherboards, including most modern ATX motherboards will continue to provide power to the CMOS, if the battery is replaced while the computer is powered on.

Warning: If the user wants to replace the CMOS battery, make sure to consult the motherboard documentation for the details and safety information. Visit the motherboard manufacturer's support website, if the user needs to download a new copy of the manual.

CMOS devices require very little power to operate. The CMOS RAM is used to store basic Information about the PC's configuration, for instance:

- Floppy disk and hard disk drive types
- Information about CPU
- RAM size
- Date and time
- Serial and parallel port information
- Plug and Play information
- Power Saving settings

The Expansion Buses

An expansion bus is an input/output pathway from the CPU to peripheral devices and it is typically made up of a series of slots on the motherboard in which the expansion boards (cards) are plugged. PCI is the most common expansion bus in a PC and other hardware platforms. Buses carry signals such as data, memory addresses, power, and control signals from component to component. Other types of buses include ISA and EISA.

Expansion buses enhance the PCs capabilities by allowing users to add missing features in their computers by slotting adapter cards into the expansion slots.

Chipsets

A chipset is a group of small circuits that coordinate the flow of data to and from a PC's main components. These main components include the CPU itself, the main memory, the secondary cache, and any devices interfaced on the buses. A chipset also controls data flow to and from hard disks and other devices connected to the IDE channels.

A computer has got two main chipsets:

- The Northbridge (also called the memory controller) is in charge of controlling transfers between the processor and the RAM, which is why it is located physically near the processor. It is sometimes called the GMCH, (Graphic and Memory Controller Hub).
- The Southbridge (also called the input/output controller or expansion controller) handles communications between slower peripheral devices. It is also called the ICH (I/O Controller Hub). The term "bridge" is generally used to designate a component which connects two buses.

9.6 CPU Clock

The CPU clock synchronizes the operation of all parts of the PC and provides the basic timing signal for the CPU. Using a quartz crystal, the CPU clock breathes life into the microprocessor by feeding it a constant flow of pulses.

For example, a 200 MHz CPU receives 200 million pulses per second from the clock. A 2 GHz CPU gets two billion pulses per second. Similarly, in any communications device, a clock may be used to synchronize the data transfer between the sender and the receiver. A "real-time clock," also called the "system clock," keeps track of the time of day and makes this data available to the software. A "time-sharing clock" interrupts the CPU at regular intervals and allows the operating system to divide its time between active users and/or applications.

9.7 Switches and Jumpers

- **DIP (Dual In-line Package)** switches are small electronic switches found on the circuit board that can be turned on or off just like a normal switch. They are very small and so are usually flipped with a pointed object, such as the tip of a screwdriver, a bent paper clip, or a pen top. Take care when cleaning near DIP switches, as some solvents may destroy them. Dip switches are obsolete and user will not find them in modern systems.
- **Jumper pins** are small protruding pins on the motherboard. A jumper cap or bridge is used to connect or short a pair of jumper pins. When the bridge is connected to any two pins, via a shorting link, it completes the circuit and a certain configuration has been achieved.
- **Jumper caps** are metal bridges that close an electrical circuit. Typically, a jumper consists of a plastic plug that fits over a pair of protruding pins. Jumpers are sometimes used to configure expansion boards. By placing a jumper plug over a different set of pins, user can change the board's parameters.

NOTE: User can check the jumper pins and jumper cap at the back of an IDE hard disk and a CD/DVD ROM/Writer.

9.8 Microprocessor

In order to understand the basic capabilities of the CPU, let us start our discussion with the basic fundamental component called

a microprocessor. A microprocessor is a very large scale integrating circuit in which number of functions are integrated and fabricated using Von Newman technology, i.e., it has no separate program and data memory. The first microprocessor was invented by Fair child semiconductors in the year 1959 and Intel released its first 4-bit microprocessor Intel 4004 in the year 1971. Then, 8-bit microprocessors were fabricated and released by many companies like Motorola (6800), Intel (8085) and Zilogs (Z80). Presently, several 16-bit, 32-bit and 64-bit microprocessors with added-functionalities were released to meet the requirements of the system viz., speed, features, compactness, adaptability towards network communication, etc. In this Section, we discuss about the features of Intel's 8085 microprocessor.

PIN Configuration of 8085

Fig 9.5 shows the pin diagram of 8085 Microprocessor and can be divided into the following seven groups.

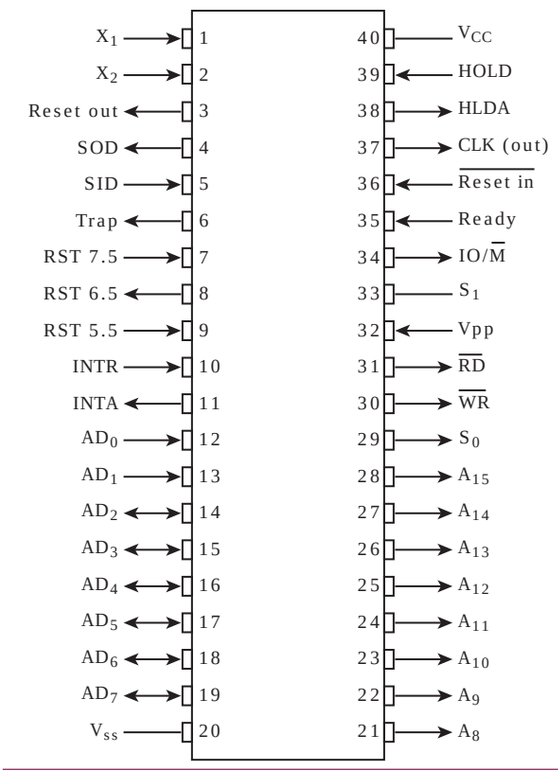

FIGURE 9.5 Pin diagram of 8085 microprocessor

Address bus

A15-A8, it carries the most significant 8-bits of the memory/IO addresses.

Data bus

AD7-AD0, it carries the least significant 8-bits of the address and data buses.

Control and status signals

These signals are used to identify the nature of operation. There are 3 control signals and 3 status signals.

The three control signals are RD, WR & ALE.

- **RD** – This signal indicates that the selected IO or memory device is to be read and is ready for accepting data available on the data bus.
- **WR** – This signal indicates that the data on the data bus is to be written into a selected memory or IO location.
- **ALE** – It is a positive going pulse generated when a new operation is started by the microprocessor. When the pulse goes high, it indicates that the information presented in the AD0-AD7 is the address information. When the pulse goes down it indicates that the information presented in the AD0-AD7 is data.

The three status signals are IO/M, S0 & S1.

IO/M

This signal is used to differentiate between IO and Memory operations, i.e. when it is high the signal indicates IO operation and when it is low then it indicates memory operation.

S1 & S0

These signals are used to identify the type of current operation.

Power supply

There are 2 power supply signals – VCC & VSS. VCC indicates +5 V power supply and VSS indicates ground signal.

Clock signals

There are 3 clock signals, i.e. X1, X2, CLK OUT.

- X1, X2 – A crystal is connected at these two pins and is used to set frequency of the internal clock generator. This frequency is internally divided by 2.
- CLK OUT – This signal is used as the system clock for devices connected with the microprocessor.

9.8.1 Interrupts & Externally Initiated Signals

Interrupts are the signals generated by external devices to request the microprocessor to perform a task. There are 5 interrupt signals, i.e. TRAP, RST 7.5, RST 6.5, RST 5.5, and INTR and their functionalities are listed below.

- **INTA** – It is an interrupt acknowledgment signal.
- **RESET IN** – It is used to reset the microprocessor by setting the program counter to zero.
- **RESET OUT** – It is used to reset all the connected devices when the microprocessor is reset.
- **READY** – It indicates that the device is ready to send or receive data. If READY is low, then the CPU has to wait for READY to go high.
- **HOLD** – It indicates that another master is requesting the use of the address and data buses.
- **HLDA (HOLD Acknowledge)** – It indicates that the CPU has received the HOLD request and it will relinquish the bus in the next clock cycle. HLDA is set to low after the HOLD signal is removed.

9.8.2 Serial I/O Signals

There are 2 serial signals, i.e. SID and SOD and these signals are used for serial communication.

- SOD (Serial Output Data line) – The output of SOD is set/reset as specified by the SIM instruction.
- SID (Serial Input Data line) – The data on this line is loaded into accumulator whenever a RIM instruction is executed.

9.9 Computer Ports

9.9.1 Input/Output Port

The term port is used in a number of places in computer terminology; an I/O port should not be confused with a physical port (connection) on the computer or network ports. Fig 9.6 illustrates the different ports available in a computer. A computer port is an interface or a point of connection between the computer and its peripheral devices. Some of the common peripherals are mouse, keyboard, monitor or display unit, printer, speaker, flash drive, etc. The main function of a computer port is to act as a point of attachment, where the cable from the peripheral can be plugged in and allows data to flow from and to the device.

There are two types of i/o ports.
1. Serial ports 2.Parallel ports.

1. **Serial ports:** A serial port is an interface through which peripherals can be connected using a serial protocol which involves the transmission of data one bit at a time over a single communication line.
2. **Parallel ports:** A parallel port is an interface through which the peripheral communicates with a computer in a parallel manner. DB-25 port is with parallel interface.

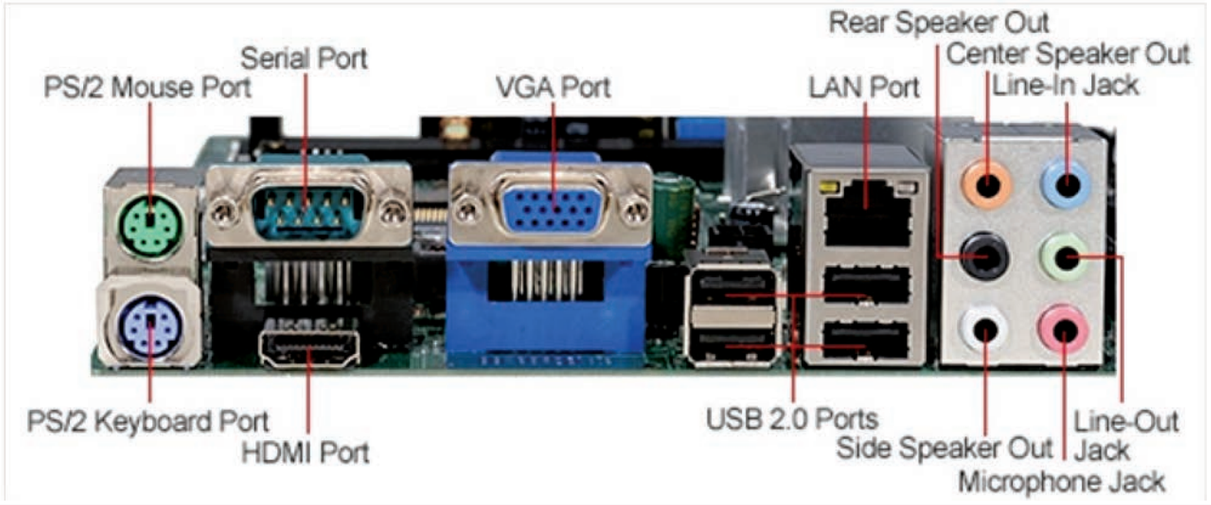

FIG 9.6 View of a port at the backside of the Computer

Let us see some other ports and Interfaces available in a computer.

1. **VGA Port:** VGA port is found in many computers, projectors, video cards and High Definition TVs. This connector is known as DE-15. VGA port is the main interface between computers and older CRT monitors. Even the modern LCD and LED monitors support VGA ports but the picture quality is reduced.
2. **Digital Video Interface (DVI):** DVI is a high speed digital interface between a display controller like a computer and a display device like a monitor. It was developed with an aim of transmitting lossless digital video signals and replace the analogue VGA technology.
3. **HDMI (High Definition Media Interface):** HDMI is a digital interface to connect High Definition and Ultra High Definition devices like Computer monitors, HDTVs, Blu-Ray players, gaming consoles, High Definition Cameras etc. HDMI can be used to carry uncompressed video and compressed or uncompressed audio signals. The HDMI port of type A is shown below.
4. **USB:** Universal Serial Bus (USB) replaced serial ports, parallel ports, PS/2 connectors, game ports and power chargers for portable devices.
5. **Input output system:** It is One of the important jobs of an Operating System is to manage various I/O devices including mouse, keyboards, touch pad, disk drives etc.
6. **Device Controllers:** Any device which is connected to the computer using a socket and plug to connect with each other. It communicates with CPU in binary. It contains a register and buffer which plays an important role in communication between input, output devices and CPU like a bridge.
7. **Device Driver:** It is a software which is an interface between OS and device controller. It tells the device Controller that how to control the I/O device. Device drivers are software modules that can be plugged into an OS to handle a particular device. Operating System takes help from device drivers to handle all I/O devices, Input Output Mechanism, Programmed I/O Interrupts, DMA (Direct memory

Access). The processor executes a program that gives it direct control of the I/O operation, including sensing device status, sending a read or write command, and transferring the data. When the processor issues a command to the I/O module, it must wait until the I/O operation is complete. If the processor is faster than the I/O module, this is wasteful of processor time.

8. **Programmed I/O:** I/O Commands to execute an I/O-related instruction, the processor issues an address, specifying the particular I/O module and external device and an I/O command. There are four types of I/O commands that an I/O module may receive when it is addressed by a processor: i) Control ii) Test iii) Read iv) Write. Let us discuss about these commands.

   i) **Control:** Used to activate a peripheral and tell it what to do. For example, a magnetic-tape unit may be instructed to rewind or to move forward one record.

   ii) Test: Used to test various status conditions associated with an I/O module and its peripherals. The processor will want to know that the peripheral of interest is powered on and available for use.

   iii) Read: Causes the I/O module to obtain an item of data from the peripheral and place it in an internal buffer. The processor can then obtain the data item by requesting that the I/O module place it on the data bus.

   iv) Write: Causes the I/O module to take an item of data (byte or word) from the data bus and later transmit that data item to the peripheral.

9. Interrupts: The problem with programmed I/O is that the processor has to wait a long time for the I/O module of concern to be ready for either reception or transmission of data. An alternative is for the processor to issue an I/O command to a module and then go on to do some other useful work. The I/O module will then interrupt the processor to request service when it is ready to exchange data with the processor. For input, the I/O module receives a READ command from the processor. The I/O module then proceeds to read data in from an associated peripheral. Once the data are in the module's data register, the module signals an interrupt to the processor over a control line. The module then waits until its data are requested by the processor. When the request is made, the module places its data on the data bus and is then ready for another I/O operation.

10. DMA (Direct Memory Access): Direct memory access (DMA) is a feature of computer systems that allows certain hardware subsystems to access main system memory (RAM), independent of the CPU. DMA involves an additional module on the system bus. The DMA uses the system bus to transfer the data to and from the memory only when the processor does not need it or it force the processor to suspend operation temporarily. When the processor wishes to read or write a block of data, it issues a command to the DMA module.

9.9.2 Difference Between Parallel Port & Serial Port

The main difference between a serial port and a parallel port is that a serial port transmits data one bit after another, while a parallel port transmits all 8 bits of a byte

in parallel. Thus, a parallel port transmits data much faster than a serial port. Computers have both serial and parallel ports along with newer technology called a USB (Universal Serial Bus) port.

9.9.3 Pin Configuration of Ports

Serial ports typically are 9-pin or 25-pin male connectors. The parallel port is a 25-pin female connector where the printer cable is interfaced. The ports COM1 and COM2 on the computer are serial ports and the LPT1 port is a parallel port. Each pin has a specific function such as transmit data, receive data, data terminal ready or auto-feed. Serial ports also refer to any port that is RS-232 (Recommended Standard 232) compliant in the telecommunications world.

9.9.4 Devices that use Serial Ports

The RS-232 standard is used by many different manufacturers of devices. Some common devices that use the serial port connection are flat screen monitors, GPS receivers, bar code scanners and satellite phones or modems.

9.9.5 Devices that use Parallel Ports

The parallel port is virtually synonymous with the printer port. Other devices that communicate with a parallel port are zip drives, scanners, joysticks, external hard drives and webcams. Today, the parallel port has been replaced by the new USB port for connecting these same devices to the computer.

9.9.6 UART

A UART (Universal Asynchronous Receiver/Transmitter) is a piece of hardware found inside the computer that translates data between parallel and serial ports. The UART takes the whole byte of data from the parallel port and transmits it serially, one bit after another. A device on the receiving end takes each bit and reassembles it back into a whole byte of parallel data. This technology makes use of a serial or parallel port configuration, but cannot be ascertained, i.e., a mute point.

9.9.7 USB

Universal Serial Bus, or USB, is a technological protocol developed in the 1990s to standardize connections between computers and the growing number of computer peripheral devices including cameras, external hard drives, memory sticks and audio-visual recorders. The USB protocol governs everything from the USB ports on the sides of most computers to the USB cables that connect the computer to USB-compliant devices like iPods, joysticks or keyboards. USB refers to the technology used a series of flat pins found in the connection headers that both transfer data and transmit electrical current to charge peripheral devices.

Difference between USB & Ethernet

USB stands for Universal Serial Bus. USB is used to connect peripheral devices to a computer. Ethernet, on the other hand, is a high-speed networking protocol. It is used primarily to connect local area networks (LANs). Ethernet can also be used to connect a DSL or cable modem to a computer. Fig 9.7 shows the USB and Ethernet connectors.

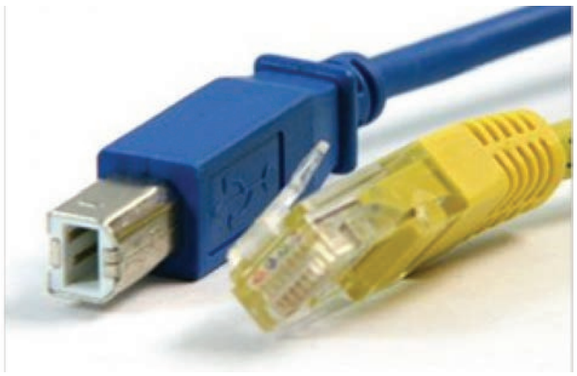

FIGURE 9.7 USB and Ethernet Connectors

Types

The USB 1.0 specification supported speeds up to 12 megabits per second (Mbps.) USB 2.0 supports speeds up to 480 Mbps. Ethernet supports three different speeds. The slowest operates at 10 Mbps. Fast Ethernet operates at 100 Mbps. The fastest type is Gigabit Ethernet, which transmits signals at 1000 Mbps.

Features

USB is compatible with plug and play devices. This means that when the user plugs-in a USB device, the device's drivers will begin to install automatically. When the user attaches a device to the computer by Ethernet, the user may have to install the drivers manually. If a CD is supplied with the device, place it in the CD-drive to install the software and configure the device. Some modems that connect by Ethernet require no drivers. However, the Internet Service Provider (ISP) will probably provide the software to configure the system to connect to the Internet.

Identification

A USB cable has metal connectors on both ends. The type "A" connector is flat and broad. This end will be connected to the computer. Many computers have USB ports available both on the front and on back. These can be identified by a trident symbol, which shows a medium-sized

TABLE 9.1 Comparison of Ports available in computers

	USB 3.1 Gen 2	USB 3.1 Gen 1 (USB 3.0)	USB 2.0	USB 1.1	Serial	Parallel
Industry Standard	Yes	Yes	Yes	Yes	Yes	No
Bandwidth	10 Gbps	5 Gbps	480 Mbps	12 Mbps	115 Kbps	115 KBps EPP/ECP - 3 MBps
Number of Devices	127 devices on a single USB bus	127 devices on a single USB bus	127 devices on a single USB bus	127 devices on a single USB bus	Limited to the number of ports available on the computer.	Limited to the number of ports available on the computer.
Bus Power	Yes, can provide up to 900 mA at 5V (Also USB Power Delivery)	Yes, can provide up to 900 mA at 5V (Also USB Power Delivery)	Yes, can provide up to 500 mA at 5V	Yes, can provide up to 500 mA at 5V	No	No
Cable Length Limit	Cable can be of any length as long as electrical spec is met. Practical max length is 1m.	Cable can be of any length as long as electrical spec is met. Practical max length is 3m.	5 m / 16 ft	5 m / 16 ft	3 m / 10 ft	1.8 m / 6 ft
Plug'n'Play	Yes	Yes	Yes	Yes	No	No
Hot Swapable	Yes	Yes	Yes	Yes	No	No

circle connected to three lines. One line ends in a square, one in a smaller circle and one in a triangle. The "B" connector connects to the device. This plug is keyed so that the user can't insert the device in the wrong way. Ethernet looks like a large telephone cable. It has a plastic tab on the end that will catch inside the plug when the user inserts it in back of the computer.

9.9.8 USB Vs Serial and Parallel

Table 9.1 lists the comparison between the various ports available in computers.

9.9.9 HDMI

HDMI is the short form of High Definition Multimedia Interface. HDMI is a connector and cable capable of transmitting high-quality and high-bandwidth streams of audio and video between devices. The HDMI technology is used with devices such as an HDTV, Projector, DVD player or Blu-ray player. Fig 9.10 shows the example of an HDMI interface cable and connector.

Specification of HDMI Cable

The HDMI standard was developed by multiple companies including Hitachi, Philips, Sony, and Toshiba. A single HDMI cable replaces the three composite audio/video cables, making it easier to connect two devices together for transmitting audio and video signals. HDMI is capable of transmitting standard, enhanced, and high-definition video signals, as well as up to 8-channels of digital audio signals.

The Different Lengths of HDMI Cables

The length of HDMI cables varies significantly. They can run from one foot to 50 feet, though it is not recommended for more than a 25 foot cable, as it may result in signal degradation or loss.

HDMI Ports

The HDMI ports are found either on the video card or motherboard on the back of the computer. It is important to note that not all computers and video cards have HDMI ports, but may have a Display Port, DVI, or VGA connector. Fig 9.8 shows some of these connectors with an example of the HDMI connector.

FIGURE 9.8 HDMI interface cable and connector

9.10 Printers

A computer printer is a device or an instrument that must be connected to a computer which allows users to print text and graphics on the plain papers. In some case they can be directly connected to digital camera for printing pictures without connecting to any computer.

Computer printer is one of the essential hardware, whether it is for a large company or for personal use. The usage of printer is depending upon the requirement of the company or individual person. For a big company they might print lots of paper or documents where as an individual need seldom.

There are different types and models of printers. The most commonly used computer printers are

1. **Inkjet Printer:** - Inkjet printers one of the user-friendly computer printers. It works by propelling variably-sized droplets of liquid or molten material (ink) onto almost any medium. They are the most common type of printer for the general consumer due to their low cost, high quality of output, capability of printing in glowing colour, and easy to use and handle.
2. **Laser Printer:** Laser printer uses LED-technology to obtain small particles of toner from a cartridge onto paper. They produce high quality text and graphics on plain paper. They are generally more economical to use than the ink of inkjet printers.
3. **Plotters Printer:** - Plotters printer is very different from others printers. Unlike other printer Pen Plotters print by moving a pen across the surface of a piece of paper. Plotters printer is the best way to produce colour high-resolution vector-based artwork, or very large drawings efficiently.
4. **Dot-matrix Printer:** - This printer is somehow like typewriting. They create characters by striking pins against an ink ribbon. Each pin makes a dot, and combinations of dots form characters and illustrations. The printing involves mechanical pressure, so these printers can create carbon copies and carbonless copies as well.
5. **Thermal Printer:** - Thermal printer is an inexpensive printer that works by pushing heated pins against heat-sensitive paper. Thermal printers are generally used in calculators and fax machines. Thermal printers print faster and more quietly than dot matrix printers. They are also more economical since their only consumable is the paper itself.

9.11 Computer Networking

Computer networking is an engineering discipline that aims to study and analyse the communication process among various computing devices or computer systems that are linked or networked together to exchange information and share resources.

Computer networking depends on the theoretical application and practical implementation of the fields like computer engineering, computer sciences, information technology and telecommunication.

A router, network card and protocols are the essential pillars upon which any network is built. Computer networks are the backbone of modern-day communication. Even public switched telephone networks are controlled by

computer systems; most telephonic services are also working with IP.

The increasing scope of communication has led to much advancement in the networking field and its relative industries like hardware, software manufacturing and integration. As a result, most households have access to one or more networks. There are three broad network types:

- **Local Area Network (LAN):** Used to serve a small number of people located in a small geographical space. Peer-to-peer or client server networking methods can be employed.
- **Wide Area Network (WAN):** Formed to connect a computer with its peripheral resources across a large geographical area.
- **Wireless Local Area Network (WLAN)/Wireless Wide Area Network (WWAN):** Formed without the use of wires or physical media to connect hosts with the server. The data is transferred over radio transceivers.

9.12 Embedded System

The word embedded implies that it lies inside the overall system, hidden from view, forming an integral part of the whole. An embedded system is a system whose principle function is not computational, but which is controlled by a computer embedded within it. Here the computer is nothing but the Micro Processor or Micro Controller. "Normally an Embedded System consists of a micro-controller, which is programmed and controlled by a software program. It is a reliable, real-time control system. It can work automatically or can be controlled by human or operated on diverse physical variables and in diverse environments. This is a cost-effective and sold competitively in the market.

Applications of Embedded System

Embedded systems are commonly found in consumer appliances, industrial, automotive, medical, commercial and military applications. Consumer electronics includes MP3 players, mobile phones, video game consoles, digital cameras, GPS receivers, and printers. Household appliances such as microwave ovens, washing machines and dishwashers include embedded systems to provide flexibility, efficiency and added-features.

Characteristics

The Characteristic of embedded System is,

1. The embedded systems are designed to do some specific task. (Whereas the general-purpose computer is designed for multiple tasks). Embedded systems are not always standalone devices. Many embedded systems consist of small parts within a larger device that serves a more general purpose.
2. System functions in real time. The tasks execute according to priorities. The system reacts to the events, interrupts in predetermined time interval and schedules responses according to priorities.
3. The program instructions written for embedded systems are referred to as firmware, and are stored in Read Only Memory (ROM) or Flash Memory chips. They run with limited computer hardware resources: little memory, small or non-existent keyboard or screen.
4. It has dedicated set of functions.
5. Complex dedicated –purpose algorithms.
6. Complex dedicated-purpose pre-programmed time constraints, to finish the different operations.

Examples are audio, video, data and network streams and events (e.g., Screen touch, switch ON, an external Input).

Embedded-system Constraints

An embedded system is designed by keeping the following three constrains in mind.

1. Available system memory
2. Available processor speed
3. The system needs to limit power because of continuous running. The program runs by managing power dissipation to minimum.

Besides, any embedded system design has few other constraints like performance, power, size and the design and manufacturing costs.

Processor Embedded into a System

The processor is the heart of the embedded system. The instructions, defined in the instruction set of a processor, arrange in a sequence in a program. The program executes in the sequence of their fetch from the memory. The processor has two essential units. Program Flow Control Unit (CU) and Execution Unit (EU). The processor runs the cycles of fetch-and-execution of a set of instructions.

A processor is present in one of the following forms:

1. Single VLSI (Very Large Scale Integrated) Chip.
2. A core in an ASIP (Application Specific Instruction-set Processor)
3. A core in an ASIC (Application Specific Integrated Circuit) or
4. A core in SoC (System-on-Chip)

(Core means a part of the functional circuit on to VLSI or VVLSI chip. System-on-Chip means a VLSI or VVLSI chip with all cores, software, digital and analog circuits of the system on one chip).

9.12.1 Microprocessor

A microprocessor is used as general-purpose processor when software is located in the external memory chip or secondary memory.

Examples

1. Starts from basic - Intel 8086 – a 32 bit processor, then 80386, 80486, Pentium series i.e.,586
2. Apple, Android and Backberry mobiles use 1.5 GHz dual core processors.
3. Many mobile handheld devices use ARM 9, ARM 10, ARM 11 processors.
4. Many Servers use SPARC family processors.

9.12.2 Microcontroller

A microcontroller is an integrated chip or core in VLSI or SoC. A Microcontroller has the processor memory and several other hardware units interfaced together and integrated in a single chip using Harvard architecture.

A microcontroller is used when a small or part of the embedded software has to be located in internal memory to perform task related to the on-chip functional units like interrupt-handler, port, timer, ADC, PWM, CAN controller, ZigBee or USB interfaces.

Some of the microcontroller chips widely used in embedded system are Intel 8051, 80251 versions, ATMEL mega series and Microchip PIC16F84 or 16C76 etc.

Presently, most of the embedded system components are available are dedicated cards with interfaces for

connected the input and output devices. In the following section we discuss about some of the famous embedded cards available in the market for designing purposes.

9.13 Arduino Board

Arduino Board consists of both a physical programmable circuit board called as a microcontroller and a piece of software or IDE (Integrated Development Environment) which can run on a computer. It is used to write and upload computer code (programme) to the physical board.

9.13.1 Arduino-UNO Board

The UNO is the best board to get started with electronics and coding (programme). This board gives good experience with the platform. The UNO is the most robust board to start the designs of interest. The UNO is the most used and documented board of the whole Arduino family. Fig 9.9 shows the completer Arduino Uno board.

Specifications

Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller. It can be simply connected to a computer with a USB cable or power it with an AC-to-DC adapter or battery to get started.

9.13.2 Software used in Arduino

"Uno" means "one" in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0. The Uno board and version 1.0 of

TABLE 9.2 Pin Description of Arduino UNO

Pin Category	Pin Name	Details
Power	Vin, 3.3V, 5V, GND	Vin: Input voltage to Arduino when using an external power source. 5V: Regulated power supply used to power microcontroller and other components on the board. 3.3V: 3.3V supply generated by on-board voltage regulator. Maximum current draw is 50mA. GND: ground pins.
Reset	Reset	Resets the microcontroller.
Analog Pins	A0 – A5	Used to provide analog input in the range of 0-5V
Input/Output Pins	Digital Pins 0 - 13	Can be used as input or output pins.
Serial	0(Rx), 1(Tx)	Used to receive and transmit TTL serial data.
External Interrupts	2, 3	To trigger an interrupt.
PWM	3, 5, 6, 9, 11	Provides 8-bit PWM output.
SPI	10 (SS), 11 (MOSI), 12 (MISO) and 13 (SCK)	Used for SPI communication.
Inbuilt LED	13	To turn on the inbuilt LED.
TWI	A4 (SDA), A5 (SCA)	Used for TWI communication.
AREF	AREF	To provide reference voltage for input voltage.

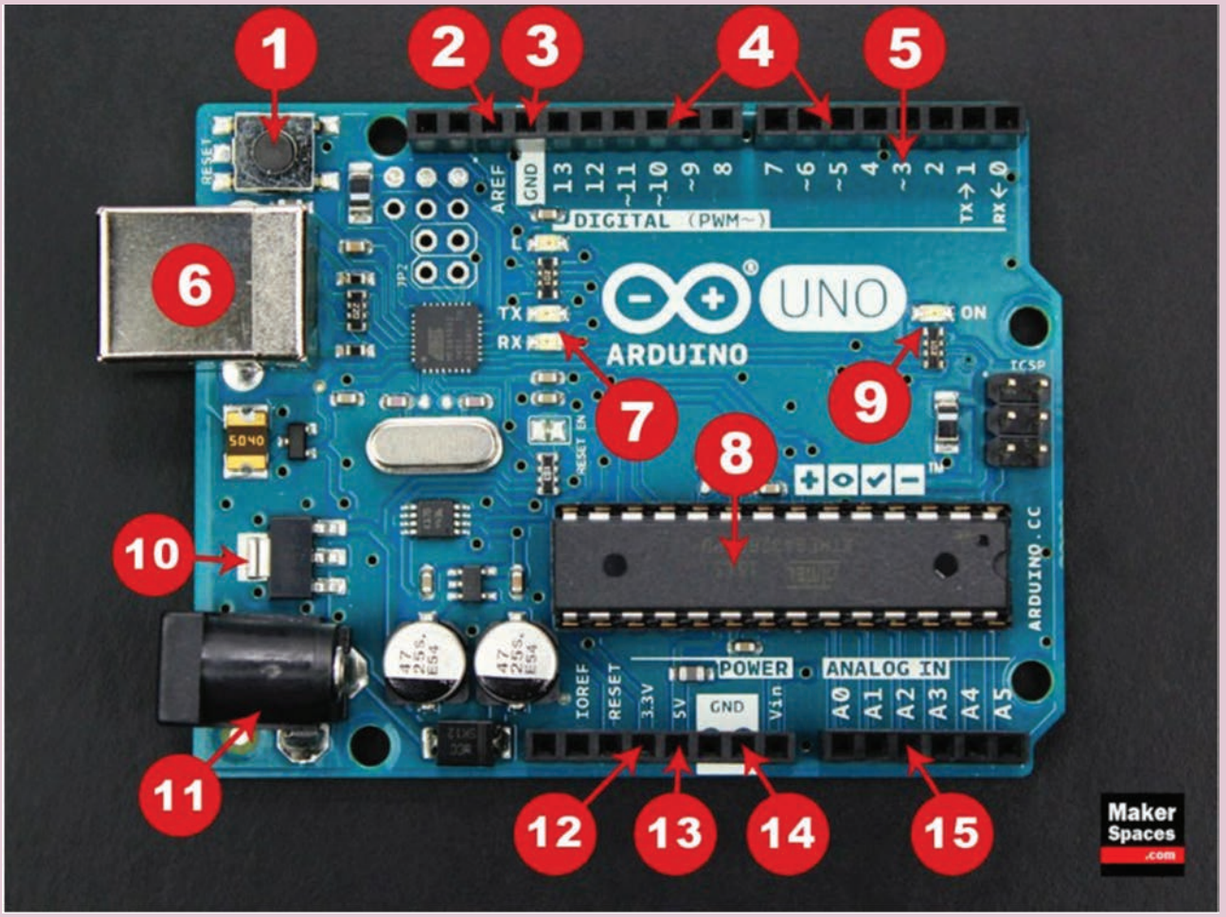

FIG 9.9 Pin diagram of Arduino UNO Board

Board Breakdown

Here are the components that make up an Arduino board and what each of their functions are.

1. **Reset Button** – This will restart any code that is loaded to the Arduino board
2. **AREF** – Stands for "Analog Reference" and is used to set an external reference voltage
3. **Ground Pin** – There are a few ground pins on the Arduino and they all work the same
4. **Digital Input/Output** – Pins 0-13 can be used for digital input or output
5. **PWM** – The pins marked with the (~) symbol can simulate analog output
6. **USB Connection** – Used for powering up your Arduino and uploading sketches
7. **TX/RX** – Transmit and receive data indication LEDs
8. **ATmega Microcontroller** – This is the brains and is where the programs are stored
9. **Power LED Indicator** – This LED lights up anytime the board is plugged in a power source
10. **Voltage Regulator** – This controls the amount of voltage going into the Arduino board
11. **DC Power Barrel Jack** – This is used for powering your Arduino with a power supply
12. **3.3V Pin** – This pin supplies 3.3 volts of power to your projects
13. **5V Pin** – This pin supplies 5 volts of power to your projects
14. **Ground Pins** – There are a few ground pins on the Arduino and they all work the same
15. **Analog Pins** – These pins can read the signal

Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform, for an extensive list of current, past or outdated boards. The pin descriptions of the Arduino Uno are summarized in Table 9.2. The pin configuration of Arduino Uno is shown in Fig 9.19.

Arduino IDE

For programming the Arduino, an integrated development environment called Arduino IDE is available, which can be downloaded from the company's website. The website provides numerous simple coding and designs.

Warnings

The Arduino Uno has a resettable poly-fuse that protects computer's USB ports from shorts and over-current. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500 mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

Power

The Arduino Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

External (non-USB) power can come either from an AC-to-DC adapter (wall-wart) or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the GND and Vin pin headers of the POWER connector.

Application of LED blink using Arduino Uno

To perform this application, open the LED blink example sketch: File > Examples >01.Basics > Blink as shown in Fig 9.10.

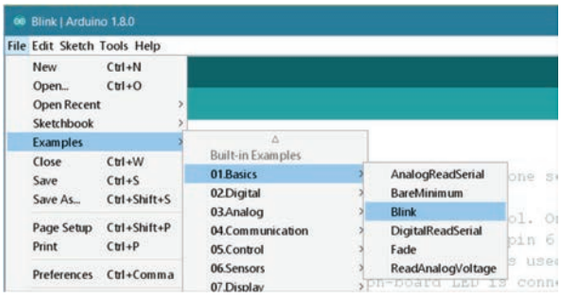

FIG 9.10 Screen showing LED blink application in Arduino Uno IDE

Then select the port by using the entry in the Tools > Board menu that corresponds to the Arduino or Genuino board as shown in Fig 9.11.

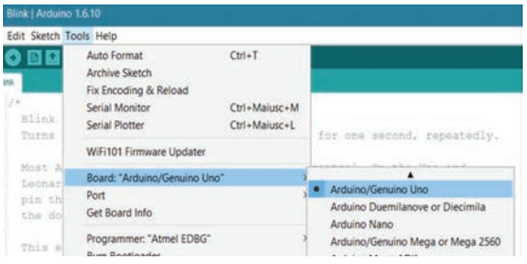

FIG 9.11 Selection of port available in Arduino Uno board

Then, the selection of the serial device of the board from the Tools menu as shown in Fig 9.12. This is likely to be COM3 or higher (COM1 and COM2 are usually reserved for hardware serial ports). To find out the ports available in the board, the user can disconnect the board and re-open the menu. Reconnect the board and select that serial port.

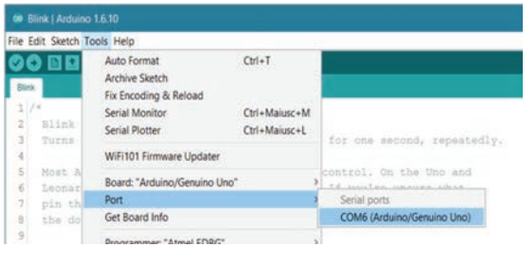

FIG 9.12 Serial port selection in Arduino Uno Board

Now, simply click the "Upload" button in the environment. Wait for a few seconds, the user can realize that the RX and TX LEDs are flashing as shown in Fig 9.13. If the upload is successful, the message "Done uploading." will appear in the status bar.

FIG 9.13 Snapshot of LED blinking

A few seconds after the upload finishes, the user can see the pin 13 (L) LED on the board start to blink (in orange).

9.14 Raspberry Pi

As like Arduino Board, yet another application board was developed in the United Kingdom by the company called Raspberry Pi Foundation. It consists of series of small single-board computers to promote teaching of basic computer science in schools and in developing countries. The original model became far more popular than anticipated, selling outside its target market for uses such as robotics. It does not include peripherals (such as keyboards and mice) and cases. However, some accessories have been included in several official and unofficial bundles.

9.14.1 Raspberry Board

Fig 9.14 & Fig 9.15 shows the Raspberry board. The features of this board are summarized below:

- **USB ports** — these are used to connect a mouse and keyboard. You can also connect other components, such as a USB drive.
- **SD card slot** — you can slot the SD card in here. This is where the operating system software and your files are stored.
- **Ethernet port** — this is used to connect the Raspberry Pi to a network with a

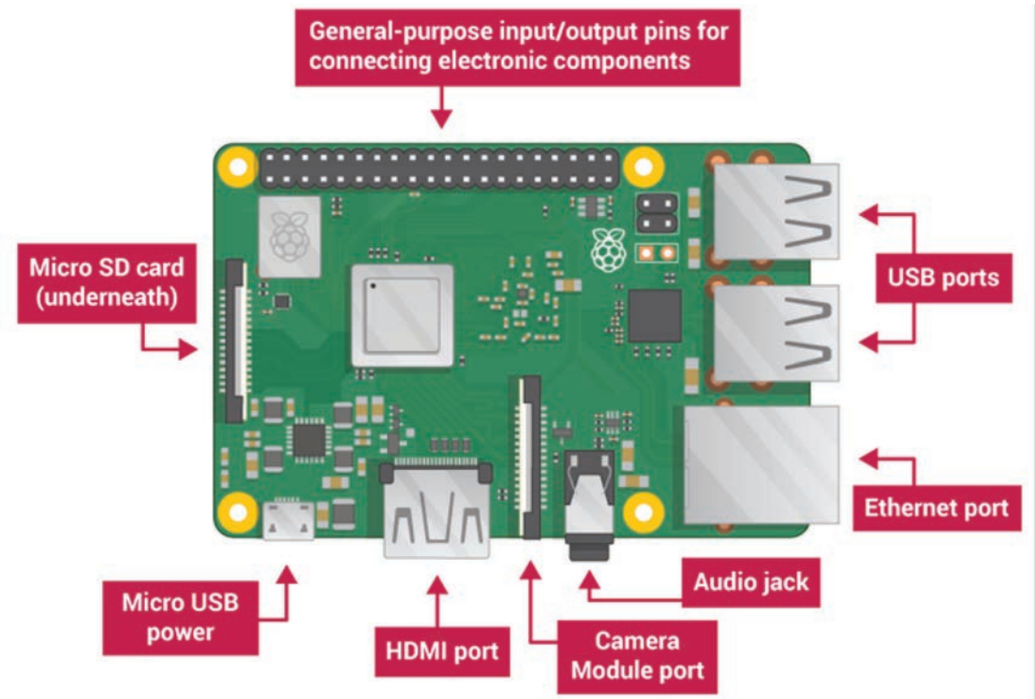

FIG 9.14 Raspberry board and its components

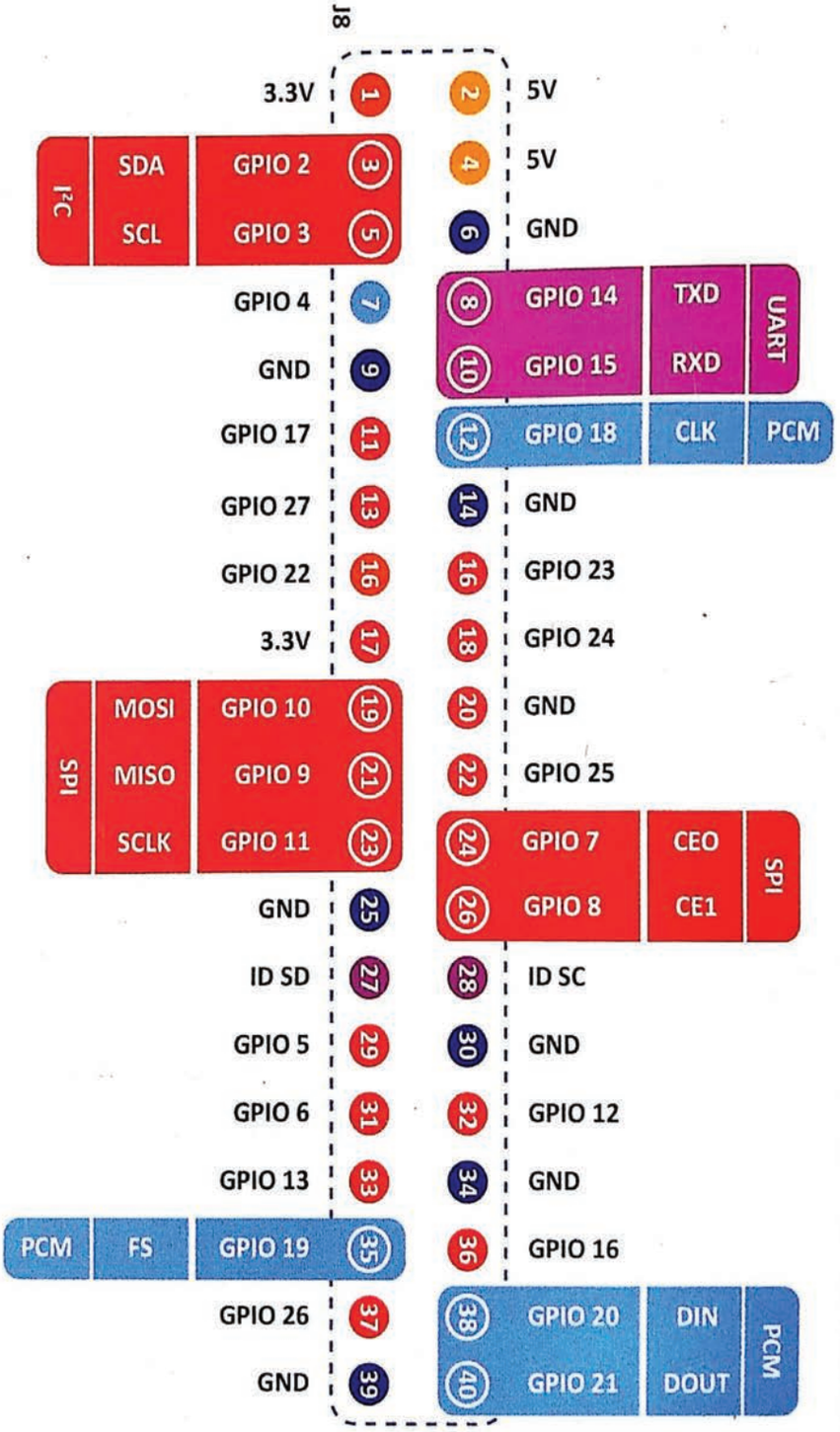

FIG 9.15 General purpose Input/Output Pins for connecting electronic compenents

cable. The Raspberry Pi can also connect to a network via wireless LAN.

- **Audio jack** — you can connect headphones or speakers here.
- **HDMI port** — this is where you connect the monitor (or projector) that you are using to display the output from the Raspberry Pi. If your monitor has speakers, you can also use them to hear sound.

- **Micro USB power connector** — this is where you connect a power supply. You should always do this last, after you have connected all your other components.
- **GPIO ports** — these allow you to connect electronic components such as LEDs and buttons to the Raspberry Pi.

9.14.2 Interfacing the Raspberry Pi

Let us connect the Raspberry Pi and get it operational by following the steps given below:

Check whether the Raspberry Pi already has an SD card in the slot at the underside, and if not, insert an SD card with Raspbian installed (via NOOBS) as shown in Fig 9.16.

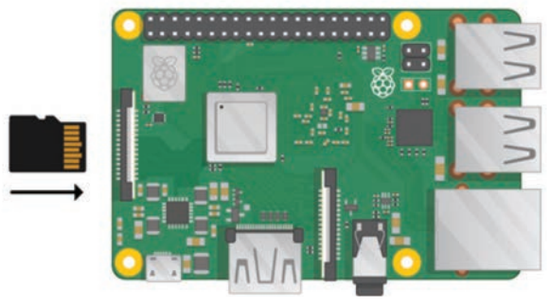

FIG 9.16 Check for SD card in Raspberry board

Then, find the USB connector for interfacing the mouse and connect the mouse to one of the USB port on the Raspberry Pi (it doesn't matter which one) as shown in Fig 9.17.

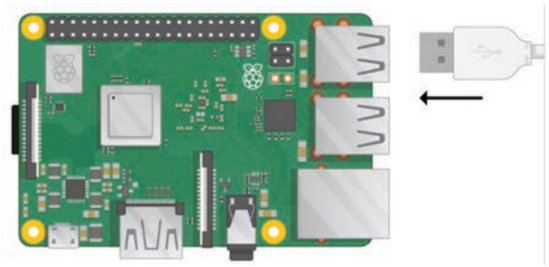

FIG 9.17 Connecting a mouse to the Raspberry board

Then, connect the keyboard in the same way as mouse as shown in Fig 9.18.

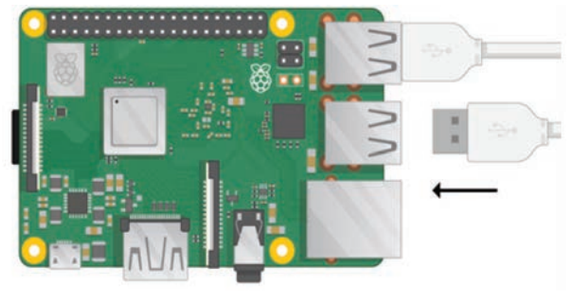

FIG 9.18 Interfacing of keyboard with Raspberry board

Then, look at the HDMI port on the Raspberry Pi (notice that it has a large flat side on top). Make sure the monitor is plugged into a power wall socket and turned on. Connect the monitor cable to the Pi's HDMI port — use an adapter if necessary as shown in Fig 9.19. Nothing will display yet. If the user wants to connect the Pi to the internet via Ethernet, use an Ethernet cable to connect the Ethernet port on the Raspberry Pi to an Ethernet socket on the wall or on the internet router. If WiFi is available, then there is no need to connect to the internet.

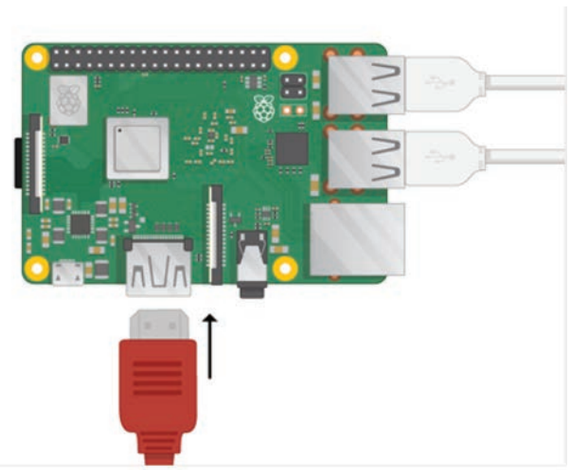

FIG 9.19 Monitor Interface with Raspberry Pi

Sound will come from the monitor if it has speakers or the user can connect headphones or speakers to the audio jack as shown in Fig 9.20.

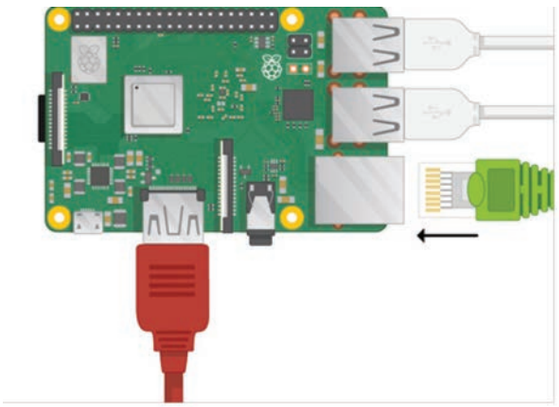

FIG 9.20 Interface the speakers with Raspberry Pi

Notice that the micro USB power port has a longer flat side on top. Plug the power supply into a socket and connect it to the micro USB power port as shown in Fig 9.21.

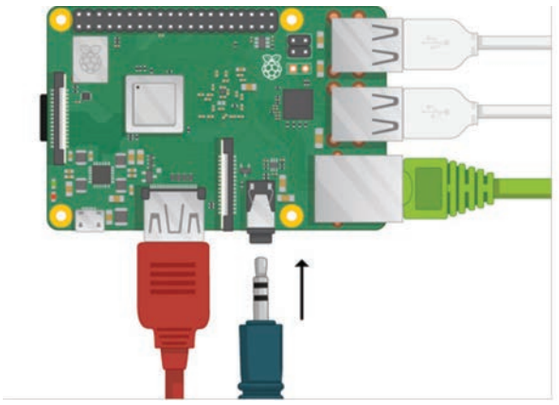

FIG 9.21 Interface with the Power supply

Finally, the user can see a red light on the Raspberry Pi and raspberries on the monitor.

The Pi will boot up into a graphical desktop.

Finish the setup

When you start your Raspberry Pi for the first time, the Welcome to Raspberry Pi application will pop up and guide you through the initial setup. The Raspberry Pi is a fantastic single-board computer, and its power and capabilities are very useful.

Installing Raspbian OS

The users must follow the instructions in the website to install the most common OS used on the Pi called Raspbian, which is a must-have for 99 out of 100 Pi projects. When the Pi boots, it will look for a specific boot file on the SD card and once that file has been found, it will begin to execute the code inside.

Python

The Raspberry Pi can be coded in a range of different languages, including Java and C++, but, arguably, the most flexible and easy language to use is Python. Programs written in Python can take half the time to write and half the amount of code to do the same task (when compared to languages such as C and C++). Of course, learning different languages is the best thing that any designer can do, but as a first language, Python is a good language to start with.

LEARNING OUTCOME

At the End of this chapter, the students would come to know the working principle and minor trouble shooting technique of the following

- Digital Computer
- Mother Board and Processor
- BIOS and Memory
- CMOS Battery and CPU clock
- Switches, Jumpers and Printers
- Networking and Embedded system
- Arduino Board and Raspberry Pi

GLOSSARY

µP	Microprocessor
Memory	Used to store data and instructions
BIOS	Basic Input and Output System
CMOS Battery	Complementary Metal Oxide Semiconductor Battery
Chipsets	Group of Small circuits
Northbridge	Internal Memory Controller
Southbridge	External Memory Controller
HDMI	High Definition Media Interface
USB	Universal Serial Bus
Arduino	Physical programmable circuit board called as microcontroller
Raspberry Pi	Mini Computer Board - having Mini Microprocessor and Microcontroller – best example for embedded system
Python	Computer language used to interface with Raspberry board

QUESTIONS

Part – A (1 Mark)

I Choose the best answer

1. The _____ is the prime part of the motherboard
   a. CPU b. ALU
   c. FPU d. None of the above
2. The mother board is sometimes shortened to _____
   a. CMOS B. MOBO
   c. BIOS D. None of the above
3. Brain of computer is _____
   a. Microprocessor
   b. Microcontroller
   c. Micro Connectors
   d. None of the above
4. L1 and L2 are _____
   a. Cache memory
   b. Secondary Memory
   c. UART
   d. None of the above
5. 2 GHz CPU gets _____ billion pulses per second
   a. Two b. One
   c. Three d. None of the above
6. There are _____ interrupt signals in 8085 microprocessors
   a. 9
   b. 5
   c. 3
   d. None of the above.
7. The analog signal voltage of arduino terminal is
   a. 3.3
   b. 5
   c. 9
   d. None of the above.
8. The digital signal voltage of arduino terminal is
   a. 3.3
   b. 5
   c. 9

d. None of the above.

9. The voltage received from the output source of arduino is

a. 3.3

b. 5

c. 9

d. None of the above.

10. ---------- is a good language to start with Raspberry Pi

a. Python

b.Java

c. C++

d. None of the above

Part – B (3 Marks)

II Answer the following

1. What is BIOS?
2. What is Micro Processor?
3. List out the characteristics of main Memory?
4. Explain- CMOS Battery?
5. Expand UART, USB, HDMI
6. What is Microcontroller?
7. Define embedded system
8. What is meant Arduino?
9. What is Raspberry Pi? ?
10. Explain Python?

Part – C (5 Marks)

III Explain the following questions

1. List out the advantages and disadvantages of Cache Memory?
2. Explain about switches and jumpers
3. Describe about input / output port
4. What is printer? Explain the types of printers

Part – D (10 Marks)

IV Answer the following questions in detail

1. Explain Mother Board components and their functions?
2. Explain the Memory Unit? List out it Advantages and Disadvantages?
3. Explain the Pin Diagram of Arduino UNO Board?

ANSWERS

1. (a) 2. (b) 3. (a) 4. (a) 5. (a) 6. (b) 7. (a) 8. (b) 9. (b) 10. (a)