

★ Computer Architecture: Input/Output Organisation:-

In this tutorial we will learn about how input and output is handled in a computer system.

★ Input/Output subsystem:-

The I/O subsystem of a computer provides an efficient mode of communication between the central system and the outside environment. It handles all the input-output operations of the computer system.

★ Peripheral Devices:-

Input or output devices that are connected to computer are called peripheral devices. These devices are designed to read information into or out of the memory unit upon command from the CPU and are considered to be the part of computer system. These devices are also called peripherals.

For example: keyboards, display units and printers are common peripheral devices.

There are three types of peripherals:

1- Input peripherals :-

allows information user input, from the outside world to the computer. Example: Keyboard, Mouse etc.

2- Output peripherals :-

allows information output, from the computer to the outside world. Example: Printer, Monitor etc.

3- Input-Output peripherals :-

allows both input (from outside world to computer) as well as, output (from computer to the outside world). Example: Touch screen etc.

* Interfaces :-

Interface is a shared boundary between two separate components of the computer system which can be used to attach two or more components to the system for communication purpose.

There are two types of Interface :-

- 1- CPU Interface.
- 2- I/O Interface.

Input - Output Interface :-

Peripherals connected to a computer need special communication links for interfacing with CPU. In computer system, there are special hardware components b/w the CPU and peripherals to control or manage the input-output transfers. These components are called input-output interface units because they provide communication links b/w processor bus and peripherals. They provide a method for transferring information b/w internal system and input-output devices.

* Modes of I/O Data Transfer :-

Data transfer between the central unit and I/O devices can be handled in generally three types of modes which are given below :-

- 1- Programmed I/O
- 2- Interrupt Initialed I/O
- 3- Direct Memory Access.

1★ Programmed I/O :-

Programmed I/O instructions are the result of I/O instructions written in computer program. Each data item transfer is initiated by the instruction in the program.

Usually, the program controls data transfer to and from CPU and peripheral.

Transferring data under programmed

I/O requires constant monitoring of the peripherals by the CPU.

2- Interrupt Initialed I/O :-

In the programmed I/O method the CPU stays in the program loop until the I/O unit indicates that it is ready for data transfer. This is time consuming processor because it keeps the processor busy needlessly.

This problem can be overcome by using interrupt initialed I/O.

In this when the interface determines that the peripheral is ready for data transfer, it generates an interrupt. After receiving the interrupt signal, the CPU stops the task which it is processing and service the I/O transfer and then returns back to its previous processing task.

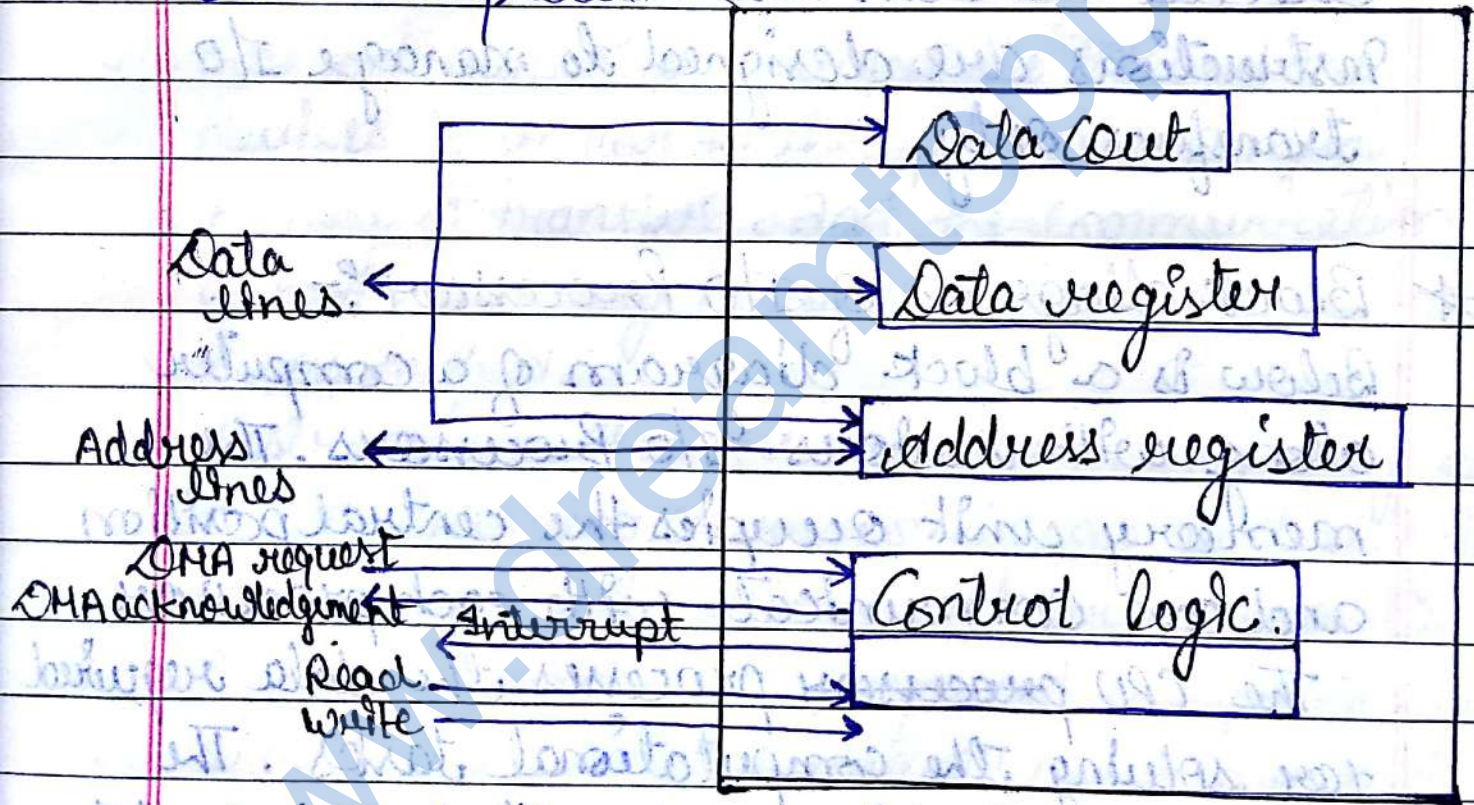
3- Direct Memory Access :-

Removing the CPU from the path and letting the peripheral device manage the memory buses directly would improve the speed of transfer. This technique is known as DMA.

In this, the interface transfer data to and from the memory through memory bus. A DMA controller manages to transfer data b/w peripherals and memory unit.

Many hardware system use DMA, such as disk drive controllers, graphic cards, network cards and sound

Cards etc. It is also used for Intra chip, data transfer in multicore processors. In DMA, CPU would initiate the transfer, do other operations while the transfer is in progress and receive an interrupt from the DMA controller when the transfer has been completed.



(Block diagram of DMA)

★ Computer architecture :-

Input/output processor :-

An input-output processor (IOP) is a processor with direct memory access capability.

In this, the computer system is divided into a memory unit and no. of processor. Each IOP controls and manage the input-output tasks. The IOP is similar to CPU except the it handles only the details of I/O processing. The IOP can fetch and execute its own instructions. These IOP instructions are designed to manage I/O transfers only.

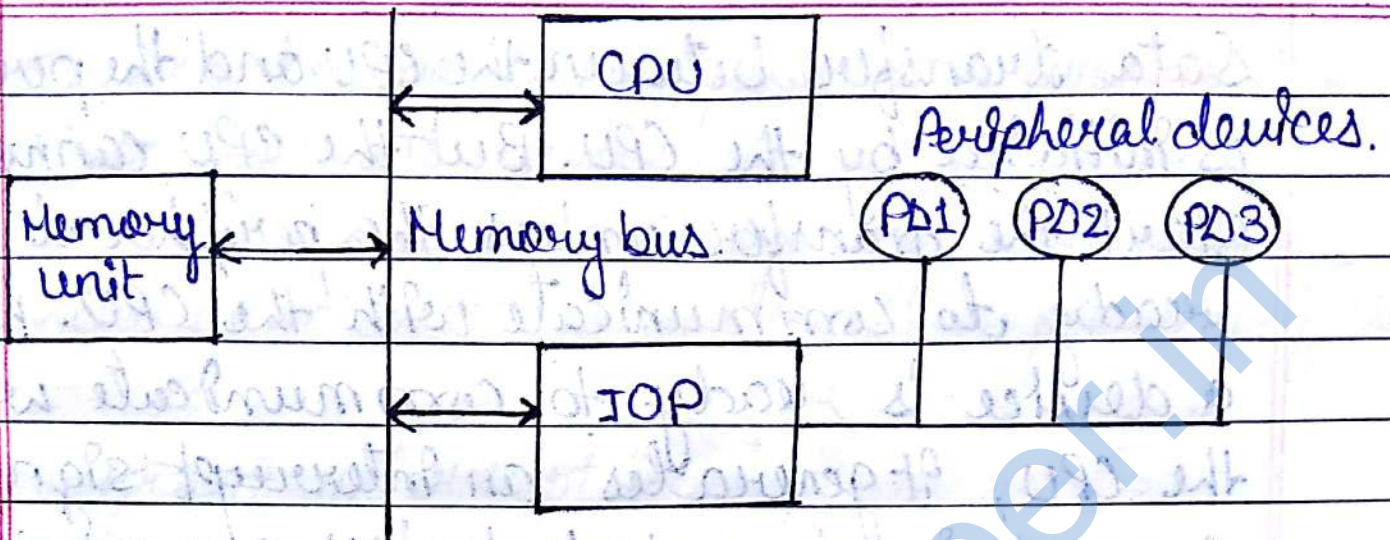
* Block diagram of I/O Processor:-

Below is a block diagram of a computer along with various I/O processors. The memory unit occupies the central position and can communicate with each processor.

The CPU processor processes the data required for solving the computational tasks. The IOP provides a path for transfer of data between peripherals and memory. The CPU assigns the tasks of initial the I/O program.

~~The Input~~

The IOP operates independent from CPU and transfer data between peripherals and memory.



The communication between the IOP and the devices is similar to that program control method of transfer. And the communication with the memory is similar to the direct memory access method.

Instructions that are read from memory by an IOP are also called commands to distinguish them from instructions that are read by CPU. Commands are prepared by programmers and are stored in memory. Command words make the program for IOP. CPU informs the IOP where to find the commands in memory.

A. Computer Architecture ? Interrupts ? -

Data transfer between the CPU and the peripherals is initiated by the CPU. But the CPU cannot start the transfer unless the peripheral is ready to communicate with the CPU. When a device is ready to communicate with the CPU, it generates an interrupt signal. A no. of input-output devices are attached to the computer and each device is able to generate an interrupt request.

The main job of the interrupt system is to identify the source of the interrupt.

● Priority Interrupt :-

A priority interrupt is a system which decides the priority at which various devices, which generates the interrupt signal at the same time, will be serviced by the CPU.

The system has authority to decide which conditions are allowed to interrupt the CPU, while some other interrupt is being serviced. Generally, devices with high speed transfer such as magnetic disks are given high priority and slow devices

Such as keyboards are given low priority. When two or more devices interrupt the computer simultaneously, the computer services devices with the high priority first.

* Types of Interrupt :-

* Serial Data Communication :-

● Data communication processor :-

A data communication processor is an I/O processor that distributes and collects data from numerous remote terminals connected through telephone and other communication lines to the computer. It is a specialized I/O processor designed to communicate with data communication networks.

Such a communication network consists of variety of devices such as printers, display devices, digital sensors etc. serving many users at once. The data communication with CPU and memory in the same manner as any I/O processor does.

• What is Modem?

In a data Communication Network, the remote terminals are connected to the data commⁿ processor through telephone lines or other wires. Such telephone lines are specially designed for voice communication and computers use them to communicate in digital signals, therefore some conversion is required.

These conversions are called modem (modulator-demodulator).

A modem converts digital signal into audio tones to be transmitted over telephone lines and also converts audio tones into digital signal for machine use.

★ Modes of Transmission :-

Data can be transmitted b/w 2 points by three different modes:

1- Simplex :-

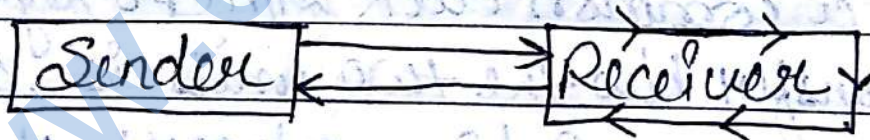
A simplex line carries information in one direction only. In this mode receiver cannot communicate with the sender.

to indicate the occurrence of errors that means only sender can send data but receiver cannot. For example: Radio and Television Broadcasting.



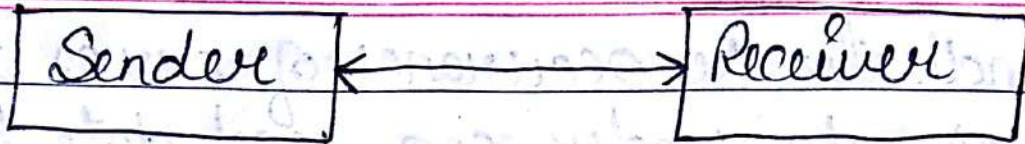
2- Half Duplex:-

In half duplex mode, system is capable of transmitting data in both directions but data can be transmitted in one direction only at a time. A pair of wires is needed for this mode. For example: Walkie-Talkie.



3- Full Duplex:-

In this mode data can be send and received in both directions simultaneously. In this four wire link is used. For example: video calling, Audio calling etc.



★ Asynchronous Data Transfer

We know, the internal operations in individual unit of digital system are synchronized by means of clock pulse, means clock pulse is given to all registers within a unit, and all data transfer among internal registers occur simultaneously during occurrence of clock pulse. Now, suppose any two units of digital system are designed ~~for~~ independently such as CPU I/O Interface.

And if the registers in the interface (I/O interface) share a common clock with CPU registers,

then transfer b/w the two units is said to be synchronous. But in most cases, the internal timing in each unit is independent from

each other in such a way that each uses its own private clock for its internal registers. In that case, the two units are

said to be asynchronous to each other, and if data transfer occurs b/w them this data transfer is said to be

Asynchronous data Transfer.

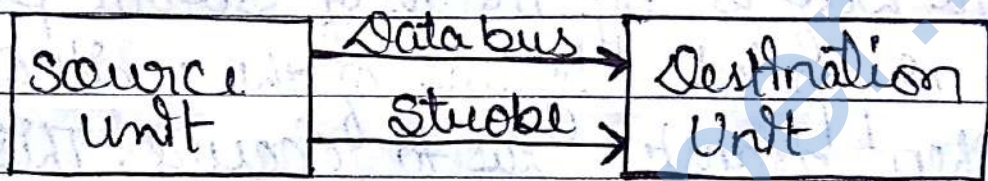
This asynchronous way of data transfer can be achieved by two methods:-

- 1- One way is by means of strobe pulse which is supplied by one of the units of other unit when transfer has to occur. This method is known as "Strobe Control."
- 2- Another method commonly used is to accompany each data item being transferred with a control signal that indicates the presence of data in the bus. The unit receiving the data item responds with another signal to acknowledge receipt of the data. This method of data transfer b/w two independent units is said to be "Handshaking".

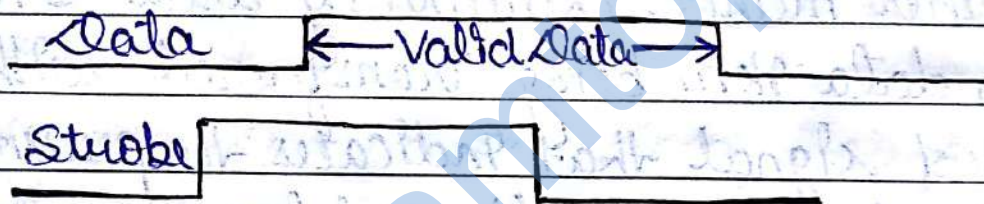
1- Strobe Control :-

The Strobe control method of asynchronous data transfer employs a single control line to time each transfer. The control line is also known as strobe and it may be achieved either by source or destination, depending on which initiates transfer.

- Source initiated strobe for data transfer. The block diagram and timing diagram of strobe initiated by source unit is shown in figure below:



(a) Block Diagram.

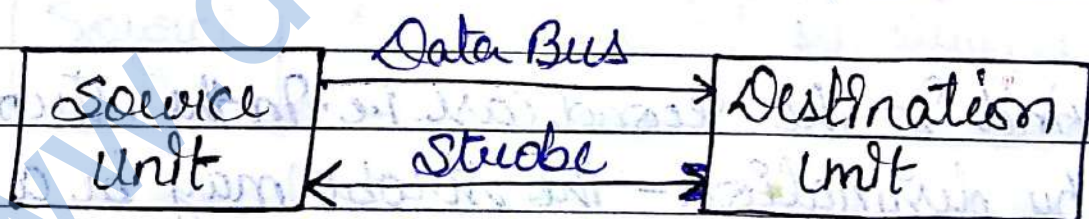


(b) Timing Diagram.

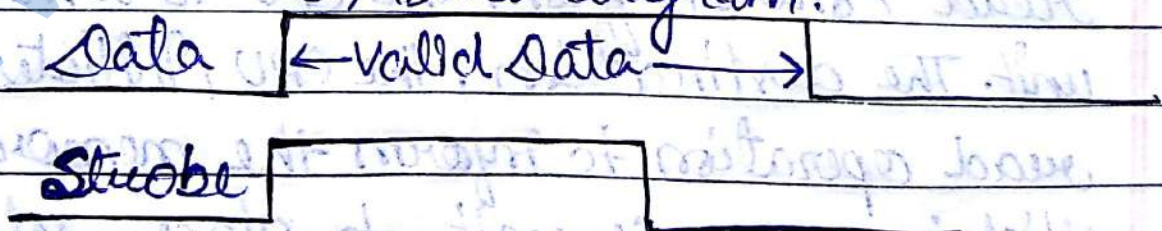
In block diagram we see that strobe is initiated by source, and as shown in timing diagram, the source unit first places the data on the data bus. After a brief delay to ensure that the data settle to a steady value, the source activates a strobe pulse. The information on data bus and strobe control signal remain in the active state for a sufficient period of time to allow.

destination unit to receive the data. Actually, the destination unit, uses a falling edge of strobe control to transfer the contents of data bus to one of its internal registers. The source removes the data from the data bus after it disables its strobe unit pulse. New valid data will be available only after the strobe is enabled again.

- Destination-Initiated strobe for data transfer. The block diagram and timing diagram of strobe initiated by destination is shown in figures below:



(a) Block diagram.



(b) Timing diagram.

In block diagram, we see that, the strobe initiated by destination, and as shown in timing diagram the destination unit first activates the strobe pulse, informing the source to provide the data.

✓ Now, actually in computer, in the first case means in strobe initiated by source - the strobe may be a memory-write control signal from the CPU to a memory unit. The source, CPU places the word on the data bus and informs the memory unit, which is the destination, that is a write operation.

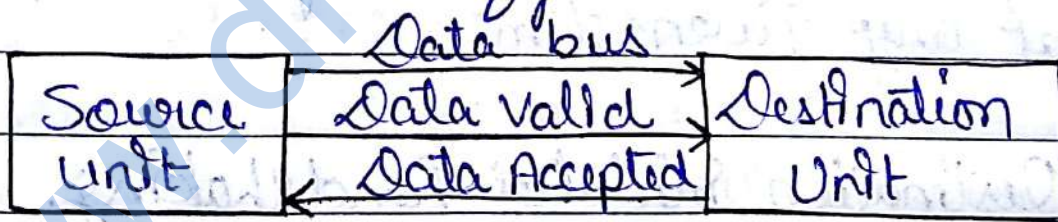
✓ And in the second case i.e. in the strobe initiated by destination - the strobe may be a memory read control from the CPU to a memory unit. The destination, the CPU, initiates the read operation to inform the memory, which is a source unit, to place selected word into the data bus.

2- Handshaking ?

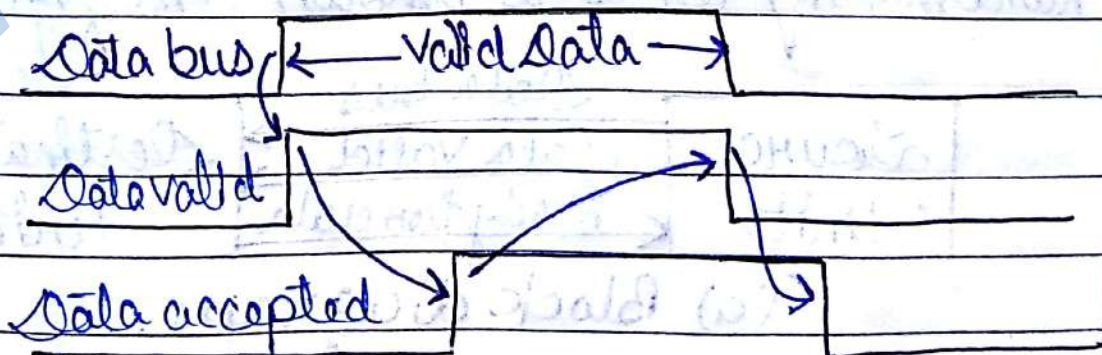
The disadvantage of Strobe method is that source unit that initiates the transfer has no way of knowing whether the destination has actually received the data that was placed in the bus. Similarly, a destination unit that initiates the transfer has no way of knowing whether the source unit has actually placed data on the bus.

• Source Initiated Handshaking

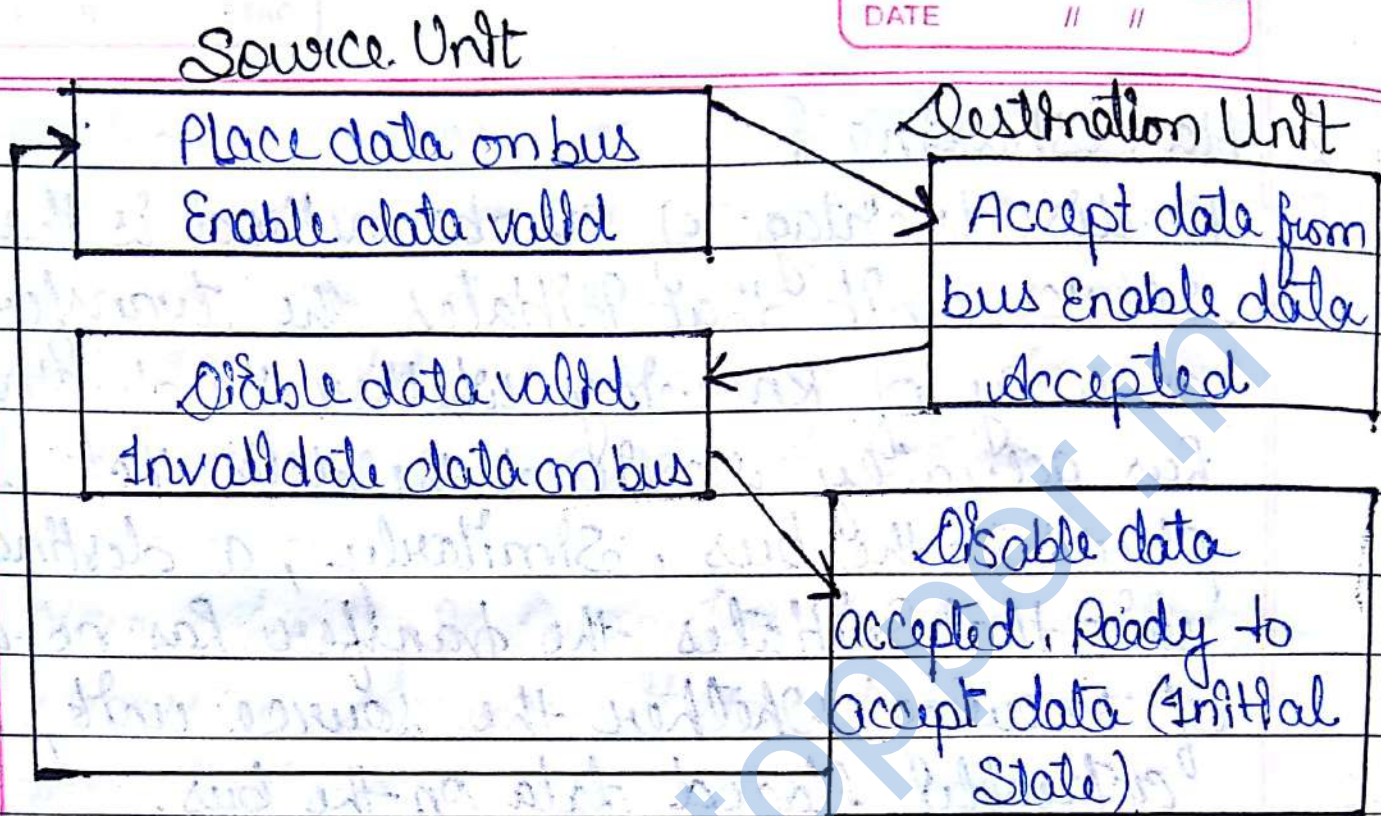
The source initiated transfer using handshaking lines is shown in figure below:



(a) Block diagram.



(b) Timing diagram.

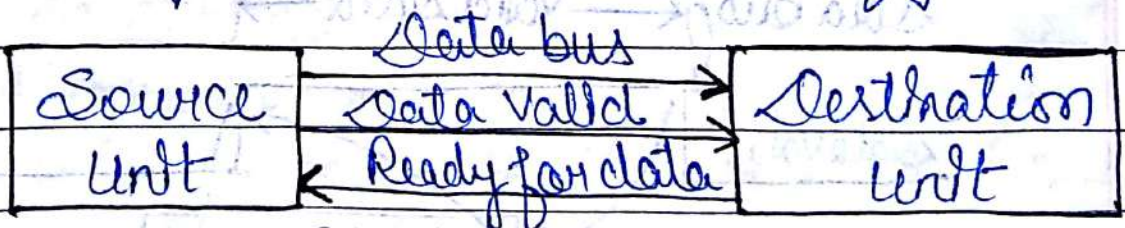


(C) Sequence Diagram (sequence of events)

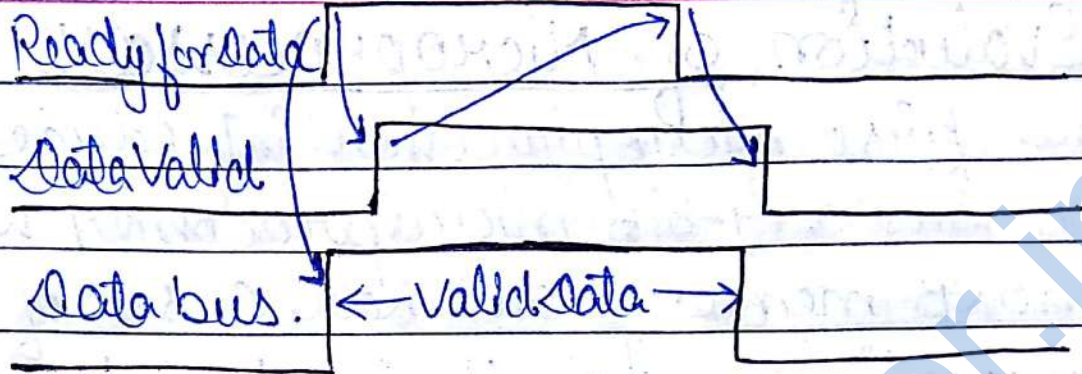
This sequence of events described in its sequence diagram, which shows the above sequence in which the system is present, at any given time.

● Destination Initiated handshaking.

The destination initiated transfer using handshaking lines is shown in figure below:



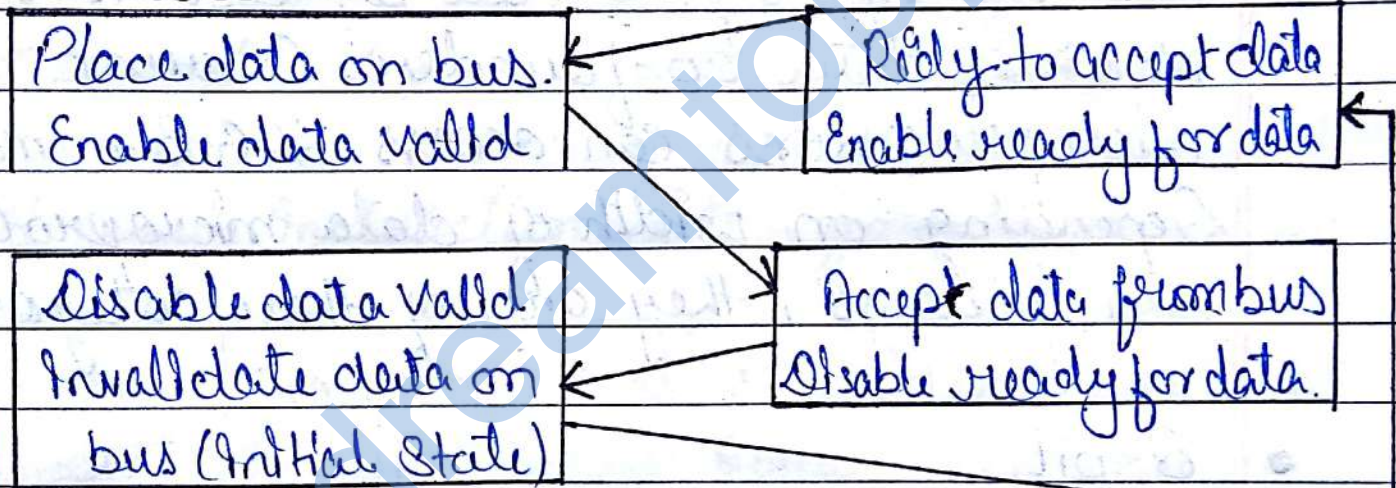
(a) Block diagram.



(b) Timing Data

Source unit

Destination Unit



(c) Sequence Diagram (Sequence of event)

The sequence of event in it are shown in its sequence diagram and timing relationship b/w signals is shown in its timing diagram.