

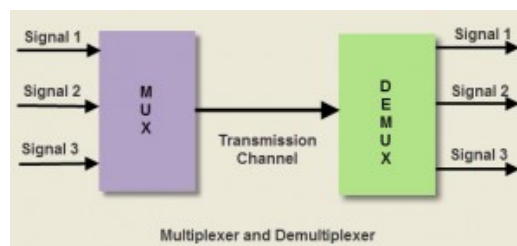
# Multiplexer and Demultiplexer : Types and Their Differences

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In large scale digital systems, a single line is required to carry on two or more digital signals – and of course! at a time, one signal can be placed on one line. But, what is required is a device that will allow us to select; and, the signal we wish to place on a common line, such a circuit is referred to as a multiplexer. The function of a multiplexer is to select the input of any 'n' input lines and feed that to one output line. The function of a demultiplexer is to inverse the function of the multiplexer. The shortcut forms of the multiplexer and demultiplexers are mux and demux. Some multiplexers perform both multiplexing and demultiplexing operations. The main function of the multiplexer is that it combines input signals, allows data compression, and shares a single transmission channel. This article gives an overview of multiplexer and demultiplexer.

## What are Multiplexer and Demultiplexer?

In-network transmission, both the multiplexer and demultiplexer are combinational circuits. A multiplexer selects an input from several inputs then it is transmitted in the form of a single line. An alternative name of the multiplexer is MUX or data selector. A demultiplexer uses one input signal and generates many. So it is known as Demux or data distributor.

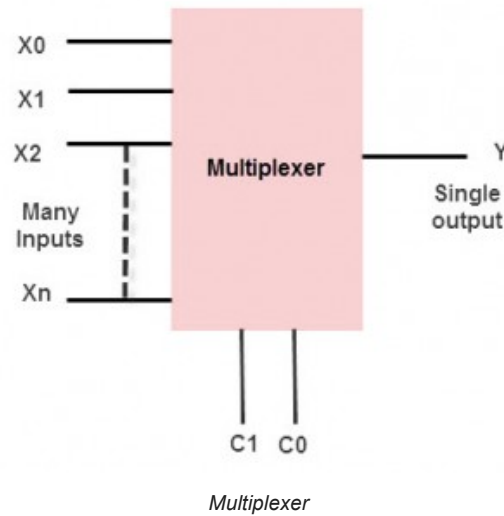


*Multiplexer and Demultiplexer*

## What is a Multiplexer?

The multiplexer is a device that has multiple inputs and single line output. The select lines determine which input is connected to the output, and also increase the amount of data that can be sent over a network within a certain time. It is also called a data selector.

The single-pole multi-position switch is a simple example of a non-electronic circuit of the multiplexer, and it is widely used in many **electronic circuits**. The multiplexer is used to perform high-speed switching and is constructed by **electronic components**.



Multiplexers are capable of handling both analog and **digital applications**. In analog applications, multiplexers are made up of relays and transistor switches, whereas in digital applications, the multiplexers are built from standard **logic gates**. When the multiplexer is used for digital applications, it is called a digital multiplexer.

## Multiplexer Types

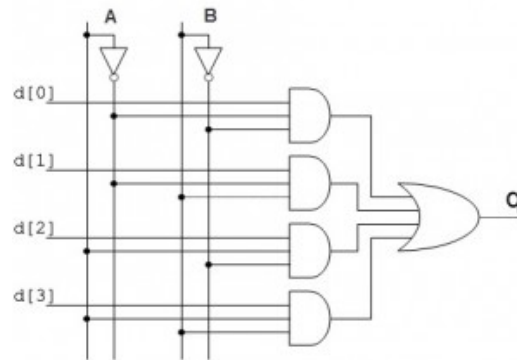
Multiplexers are classified into four types:



- 2-1 multiplexer ( 1select line)
- 4-1 multiplexer (2 select lines)
- 8-1 multiplexer(3 select lines)
- 16-1 multiplexer (4 select lines)

## 4-to-1 Multiplexer

The 4X1 multiplexer comprises 4-input bits, 1- output bit, and 2- control bits. The four input bits are namely 0, D1, D2, and D3, respectively; only one of the input bits is transmitted to the output. The o/p 'q' depends on the value of control input AB. The control bit AB decides which of the i/p data bit should transmit the output. The following figure shows the 4X1 multiplexer circuit diagram using AND gates. For example, when the control bits  $AB = 00$ , then the higher AND gates are allowed while remaining AND gates are restricted. Thus, data input D0 is transmitted to the output 'q'

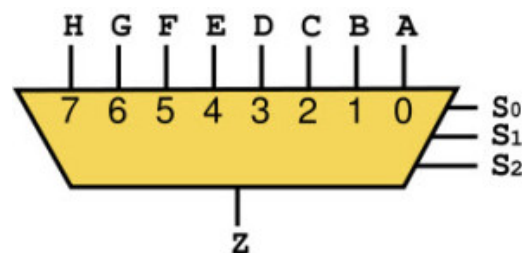


4X1 Mux

If the control input is changed to 11, then all gates are restricted except the bottom AND gate. In this case, D3 is transmitted to the output, and  $q = D0$ . If the control input is changed to  $AB = 11$ , all gates are disabled except the bottom AND gate. In this case, D3 is transmitted to the output, and  $q = D3$ . The best example of a 4X1 multiplexer is IC 74153. In this IC, the o/p is the same as the i/p. Another example of a 4X1 multiplexer is IC 45352. In this IC, the o/p is the compliment of the i/p

## 8-to-1 Multiplexer

The 8-to-1 multiplexer consists of 8 input lines, one output line, and 3 selection lines.

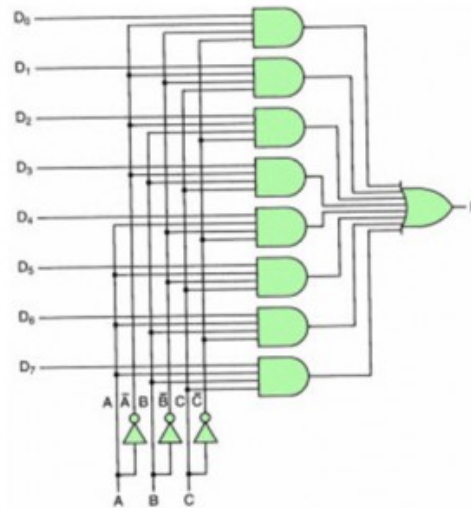


8-to-1 Mux

## 8-1 Multiplexer Circuit

For the combination of a selection input, the data line is connected to the output line. The circuit shown below is an 8\*1 multiplexer. The 8-to-1 multiplexer requires 8 AND gates, one OR gate, and 3 selection lines. As an input, the combination of selection inputs is giving to the AND gate with the corresponding input data lines.

In a similar fashion, all the AND gates are given connection. In this 8\*1 multiplexer, for any selection line input, one AND gate gives a value of 1 and the remaining all AND gates give 0. And, finally, by using OR gates, all the AND gates are added; and, this will be equal to the selected value.



*8-to-1 Mux Circuit*

## Advantages and Disadvantages of Multiplexer

The **advantages of multiplexer** include the following.

- In multiplexer, the usage of a number of wires can be decreased
- It reduces the cost as well as the complexity of the circuit
- The implementation of a number of combination circuits can be possible by using a multiplexer
- Mux doesn't require K-maps & simplification
- The multiplexer can make the transmission circuit less complex & economical
- The dissipation of heat is less because of the analog switching current which ranges from 10mA to 20mA.
- The multiplexer ability can be extended to switch audio signals, video signals, etc.
- The digital system reliability can be improved using a MUX as it decreases the number of exterior wired connections.
- MUX is used to implement several combinational circuits
- The logic design can be simplified through MUX

The **disadvantages of multiplexer** include the following.

- Additional delays required within switching ports & I/O signals which propagate throughout the multiplexer.
- The ports which can be utilized at the same time have limitations
- Switching ports can be handled by adding the complexity of firmware
- The controlling of multiplexer can be done by using additional I/O ports.

## **Applications of Multiplexers**

Multiplexers are used in various applications wherein multiple-data need to be transmitted by using a single line.

### **Communication System**

A **communication system** has both a communication network and a transmission system. By using a multiplexer, the **efficiency of the communication system** can be increased by allowing the transmission of data, such as audio and video data from different channels through single lines or cables.

### **Computer Memory**

Multiplexers are used in computer memory to maintain a huge amount of memory in the computers, and also to reduce the number of copper lines required to connect the memory to other parts of the computer.

### **Telephone Network**

In telephone networks, multiple audio signals are integrated on a single line of transmission with the help of a multiplexer.

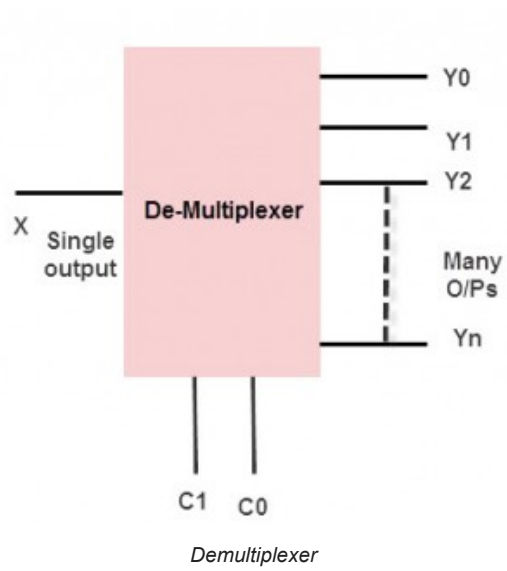
### **Transmission from the Computer System of a Satellite**

The multiplexer is used to transmit the data signals from the computer system of a spacecraft or a satellite to the ground system by **using a GSM satellite**.

## **What is Demultiplexer?**

De-multiplexer is also a device with one input and multiple output lines. It is used to send a signal to one of the many devices. The main difference between a multiplexer and a de-multiplexer is that a multiplexer

takes two or more signals and encodes them on a wire, whereas a de-multiplexer does reverse to what the multiplexer does.



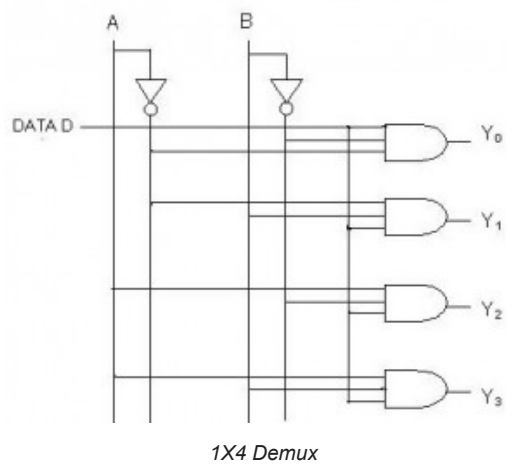
## Types of Demultiplexer

Demultiplexers are classified into four types

- 1-2 demultiplexer (1 select line)
- 1-4 demultiplexer (2 select lines)
- 1-8 demultiplexer (3 select lines)
- 1-16 demultiplexer (4 select lines)

### 1-4 Demultiplexer

The 1-to-4 demultiplexer comprises 1- input bit, 4-output bits, and control bits. The 1X4 demultiplexer circuit diagram is shown below.



The i/p bit is considered as Data D. This data bit is transmitted to the data bit of the o/p lines, which depends on the AB value and the control i/p.

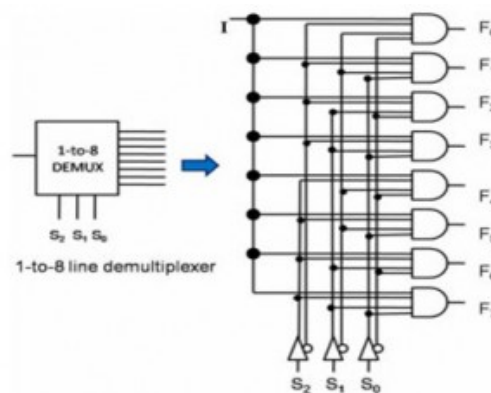
When the control i/p  $AB = 01$ , the upper second AND gate is permitted while the remaining AND gates are restricted. Thus, only data bit D is transmitted to the output, and  $Y1 = \text{Data}$ .

If the data bit D is low, the output Y1 is low. IF data bit D is high, the output Y1 is high. The value of the output Y1 depends upon the value of data bit D, the remaining outputs are in a low state.

If the control input changes to  $AB = 10$ , then all the gates are restricted except the third AND gate from the top. Then, data bit D is transmitted only to the output Y2; and,  $Y2 = \text{Data}$ . . The best example of 1X4 demultiplexer is IC 74155.

## 1-8 Demultiplexer

The demultiplexer is also called a data distributor as it requires one input, 3 selected lines, and 8 outputs. De-multiplexer takes one single input data line and then switches it to any one of the output lines. The 1-to-8 demultiplexer circuit diagram is shown below; it uses 8 AND gates for achieving the operation.



1-8 Demux Circuit

The input bit is considered as data D and it is transmitted to the output lines. This depends on the control input value of the AB. When  $AB = 01$ , the upper second gate F1 is enabled, while the remaining AND gates are disabled, and the data bit is transmitted to the output giving  $F1 = \text{data}$ . If D is low, the F1 is low, and if D is high, the F1 is high. So the value of the F1 depends on the value of D, and the remaining outputs are in the low state.

## Advantages and Disadvantages of Demultiplexer

The **advantages of demultiplexer** include the following.

- A demultiplexer or Demux is used to divide the mutual signals back into separate streams.
- The function of Demux is quite opposite to MUX.
- The Audio or Video signals transmission needs a combination of Mux and Demux.
- Demux is used as a decoder within the security systems of banking sectors.
- The communication system efficiency can be enhanced through the combination of Mux & Demux.

The **disadvantages of demultiplexer** include the following.

- Bandwidth wastage might happen
- Because of the synchronization of the signals, delays might take place

## Applications of Demultiplexer

Demultiplexers are used to connect a single source to multiple destinations. These applications include the following:

### Communication System

Mux and demux both are used in communication systems to carry out the process of data transmission. A De-multiplexer receives the output signals from the multiplexer and at the receiver end, it converts them back to the original form.

### Arithmetic Logic Unit

The output of the ALU is fed as an input to the De-multiplexer, and the output of the demultiplexer is connected to multiple registers. The output of the ALU can be stored in multiple registers.

### Serial to Parallel Converter

This converter is used to reconstruct parallel data. In this technique, serial data is given as an input to the De-multiplexer at a regular interval, and a counter is attached to the demultiplexer at the control input to detect the data signal at the output of the demultiplexer. When all data signals are stored, the output of the demux can be read out in parallel.

## Difference between Multiplexer and Demultiplexer

The main difference between multiplexer and demultiplexer is discussed below.

Multiplexer	Demultiplexer



A multiplexer (Mux) is a combinational circuit that uses several data inputs to generate a single output.	A demultiplexer (Demux) is also a combinational circuit that uses single input that can be directed throughout several outputs.
Multiplexer includes several inputs and the single output	Demultiplexer includes single input and several outputs
A multiplexer is a data selector	The demultiplexer is a data distributor
It is a digital switch	It is a digital circuit
It works on the principle of many to one	It works on the principle of one-to-many
The parallel to serial conversion is used in the multiplexer	The serial to parallel conversion is used in Demultiplexer
The multiplexer used in TDM (Time Division Multiplexing) is at the end of the transmitter	The demultiplexer used in TDM (Time Division Multiplexing) is at the end of the receiver
The multiplexer is called MUX	The demultiplexer is called Demux
It doesn't use any extra gates while designing	In this, additional gates are necessary while designing demux
In Multiplexer, control signals are used to choose the specific input that has to be sent at the output.	Demultiplexer uses the control signal to permit us to include several outputs.
The multiplexer is used to improve the efficiency of the communication system using transmission data like transmission of audio as well as video.	Demultiplexer gets the o/p signals from the Mux & changed them to the unique form at the end of the receiver.
The different types of multiplexers are 8-1 MUX, 16-1 MUX, and 32-1 MUX.	The different types of demultiplexers are 1-8 Demux, 1-16 Demux, 1-32 Demux.

In multiplexer, the set of selection lines are used to control the specific input

In demultiplexer, the selection of output line can be controlled through n-selection lines bit values.

## Key Difference between Multiplexer and Demultiplexer

The key differences between multiplexer and demultiplexer are discussed below.

- The combinational logic circuits like multiplexer and demultiplexer are used within communication systems however their function is accurately opposite to each other because one works on multiple inputs whereas the other works on only input.
- Multiplexer or Mux is an N-to-1 device whereas demultiplexer is a 1-to-N device.
- A multiplexer is used to convert several analog or digital signals into a single o/p signal through different control lines. These control lines can be determined by using this formula like  $2^n=r$  where 'r' is the no of i/p signals & 'n' is the no of required control lines.
- The data conversion method used in MUX is parallel to serial and it is not difficult to understand because it uses different inputs. However, DEMUX works quite reverse to MUX like a serial to parallel conversion. So, the number of outputs can be achieved in this case.
- A demultiplexer is used to convert one i/p signal to several. The number of control signals can be determined by using the same formula of MUX.
- Both the Mux and Demux are used to transmit the data over a network in less bandwidth. But multiplexer is used at the transmitter end whereas the Demux is used at the receiver end.