

Computer Organization and Architecture

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Lecture 08



Revision

Decoders

Decoder

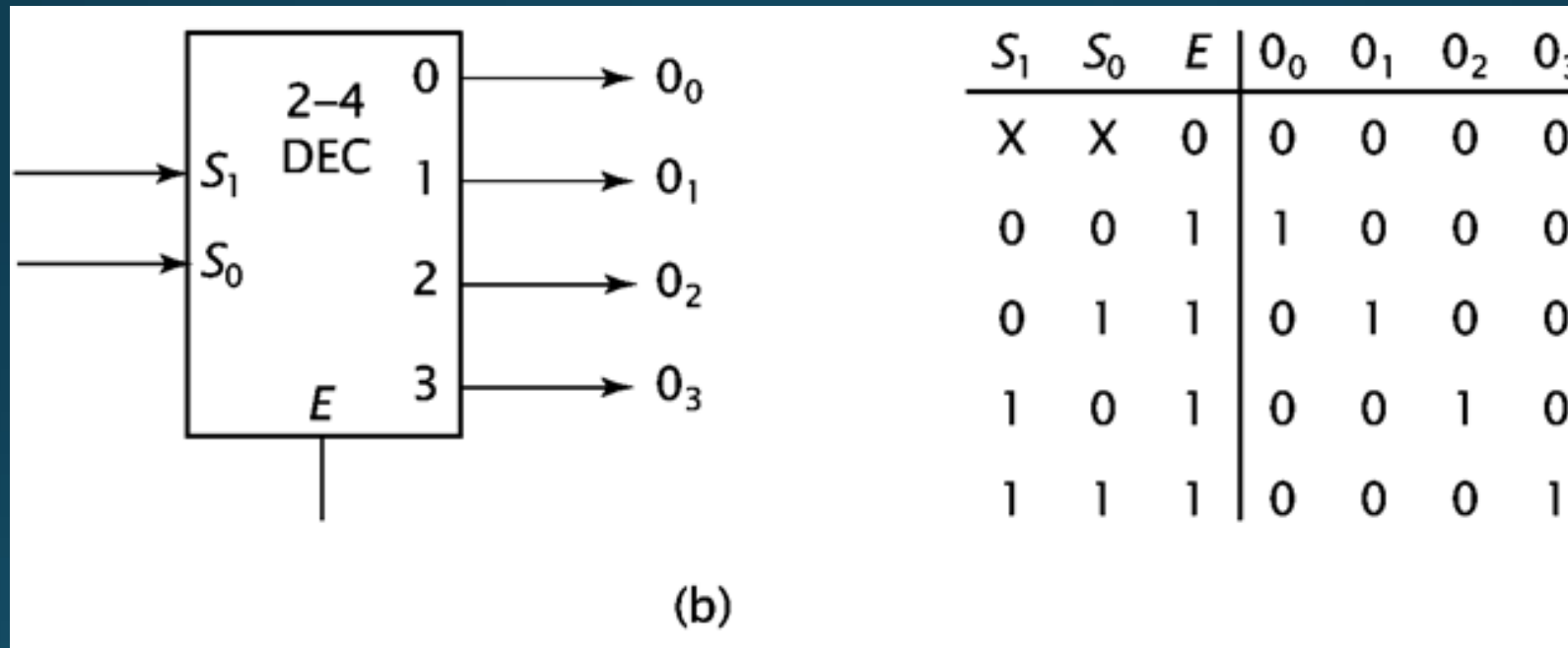
Accepts a value and decodes it

- Output corresponds to value of n inputs

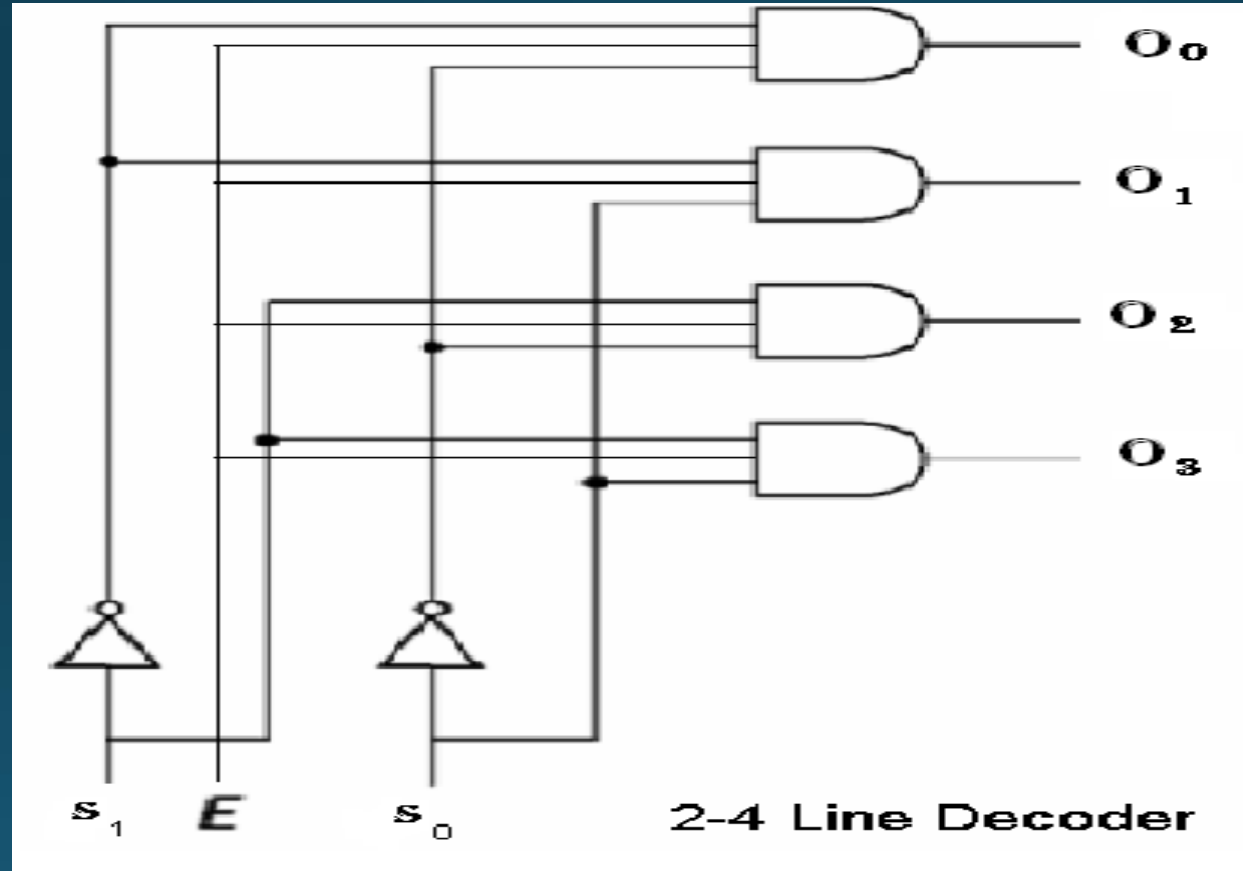
Consists of:

- Inputs (n)
- Outputs (2^n , numbered from $0 \rightarrow 2^n - 1$)
- Selectors / Enable (active high or active low)

2-to-4 Decoder



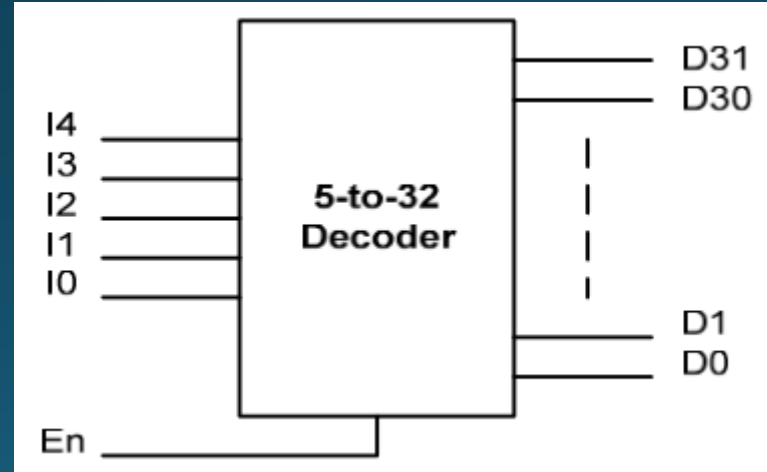
2-to-4 Decoder



Example on expansion decoder

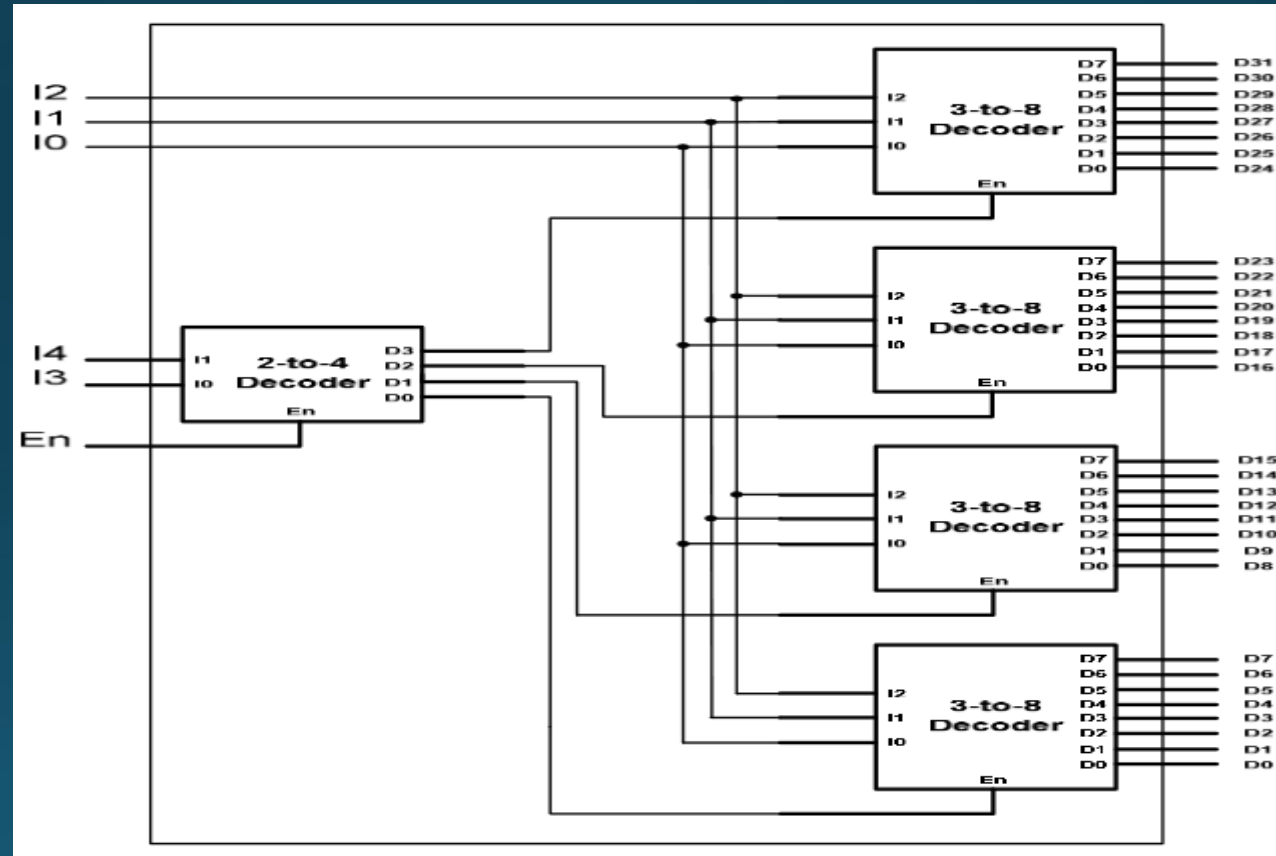
Construct a 5-to-32 decoder using only 2-to-4 decoders and 3-to-8 decoders (with enable).

We are going to make 5-to-32 decoder like the one shown below:



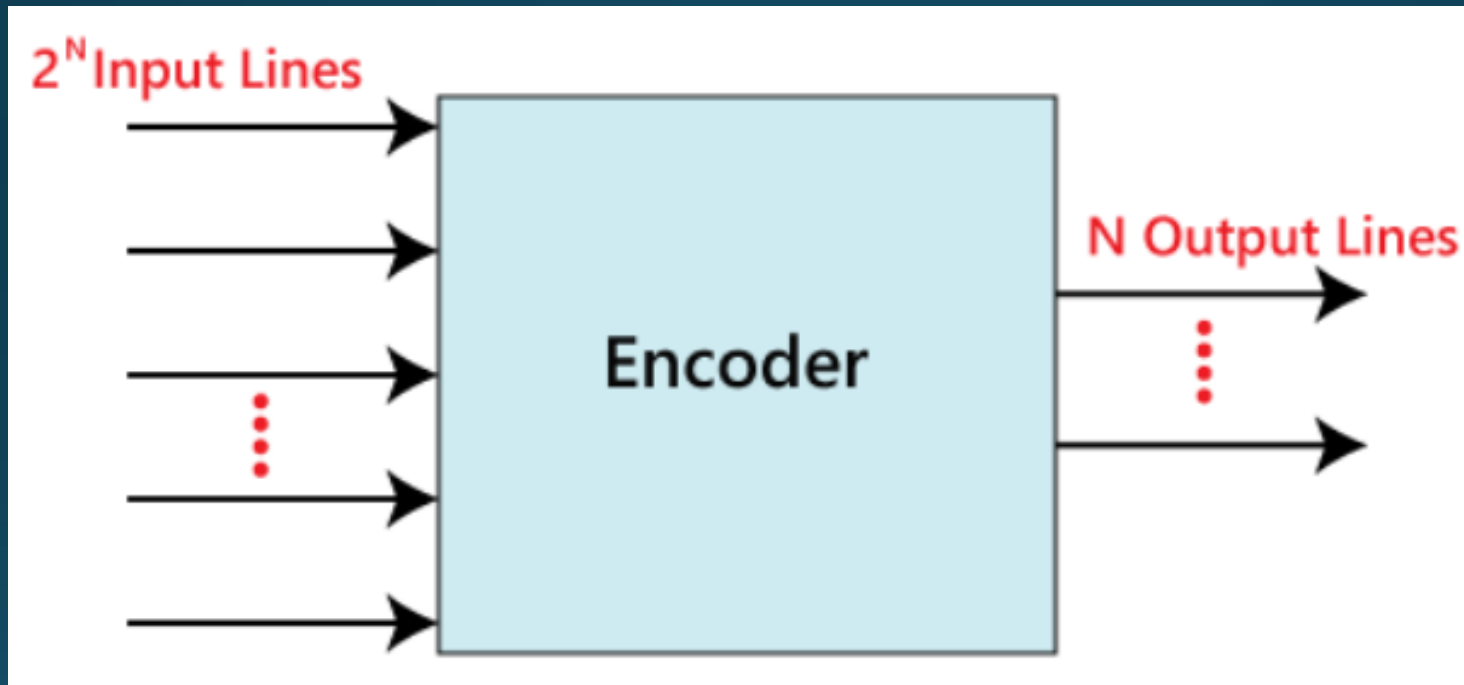
Example on expansion decoder

We need four 3-to-8 decoder for the last stage and one 2-to-4 decoder for selecting each of them at the first stage:



Encoders

Encoders

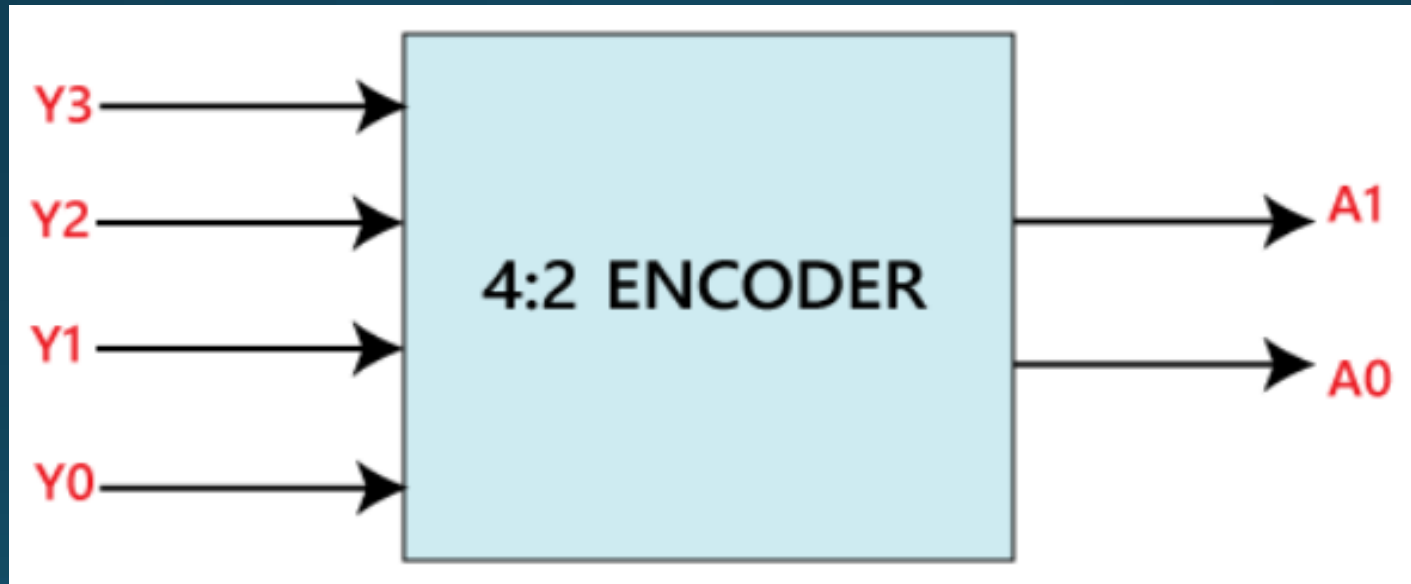


4-to-2 line Encoder

4 to 2 line Encoder

- In 4 to 2 line encoder, there are total of four inputs, i.e., Y_0 , Y_1 , Y_2 , and Y_3 , and two outputs, i.e., A_0 and A_1 . In 4-input lines, one input-line is set to true at a time to get the respective binary code in the output side. Below are the block diagram and the truth table of the 4 to 2 line encoder.

4 to 2 line Encoder



4 to 2 line Encoder

Truth Table:

INPUTS				OUTPUTS	
Y_3	Y_2	Y_1	Y_0	A_1	A_0
1	0	0	0	0	0
0	1	0	0	0	1
0	0	1	0	1	0
0	0	0	1	1	1

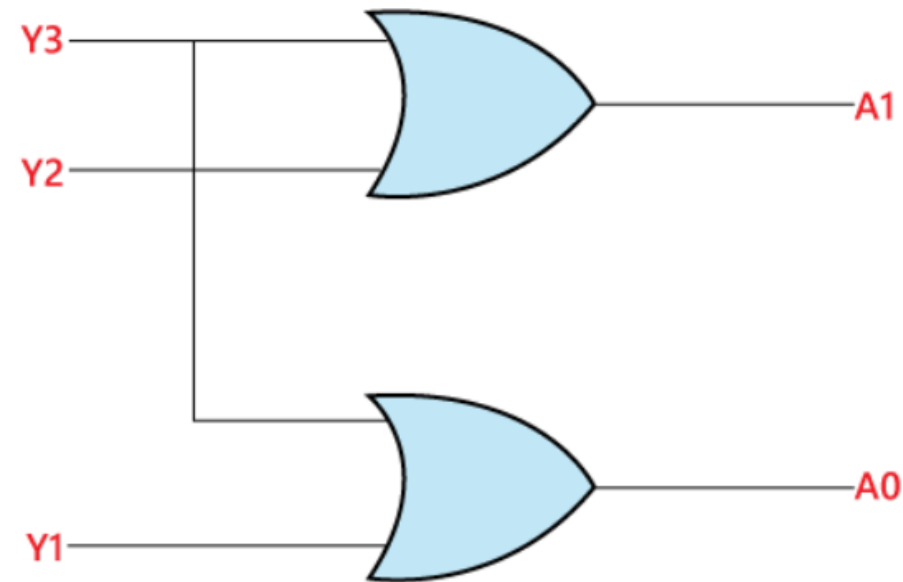
4 to 2 line Encoder

The logical expression of the term A_0 and A_1 is as follows:

$$A_1 = Y_3 + Y_2$$

$$A_0 = Y_3 + Y_1$$

Logical circuit of the above expressions is given below:



Encoder vs Decoder

Encoder vs Decoder

ENCODER	DECODER
Encoder circuit basically converts the applied information signal into a coded digital bit stream.	Decoder performs reverse operation and recovers the original information signal from the coded bits.
In case of encoder, the applied signal is the active signal input.	Decoder accepts coded binary data as its input.
The number of inputs accepted by an encoder is 2^n .	The number of input accepted by decoder is only n inputs.
The output lines for an <u>encoder</u> is n .	The output lines of an decoder is 2^n .

Encoder vs Decoder

ENCODER	DECODER
The encoder generates coded data bits as its output.	The decoder generates an active output signal in response to the coded data bits.
The operation performed is simple.	The operation performed is complex.
The encoder circuit is installed at the transmitting end.	The decoder circuit is installed at the receiving side.
OR gate is the basic logic element used in it.	AND gate along with NOT gate is the basic logic element used in it.

Digital Circuits Cont.

Digital Circuits Cont.

- **Multiplexer**
- **Demultiplexer**

Multiplexer / Demultiplexer

- The basic function of the Multiplexer (MUX).
- The typical application of a MUX.
- A 4-to-1 MUX designed with Small Scale Integration (SSI).
- A 4-to-1, 8-to-1, & 16-to-1 Medium Scale Integration (MSI) MUX.
- The basic function of the Demultiplexer (DEMUX).
- The typical application of a DEMUX.
- A 1-to-4 DEMUX design with Small Scale Integration (SSI).

Multiplexer (MUX)

What is a Multiplexer (MUX)?

- The term Multiplexer means many into one.
- Multiplexing is the process of transmitting a large number of information over a single line.
- A Digital Multiplexer (MUX) is a combinational Circuit that select one digital information from several sources and transmits the selected information on a single output line.
- A Multiplexer is also called a Data Selector.
- The Multiplexer has several data input line and a single output line.

What is a Multiplexer (MUX)?

- MUX directs one of the inputs to its output line by using a control bit word (*selection line*) to its *select lines*.
- Multiplexer contains the followings:
 - data inputs
 - selection inputs
 - a *single output*
- Selection input determines the input that should be connected to the output.
- The multiplexer acts like an electronic switch that selects one from different.

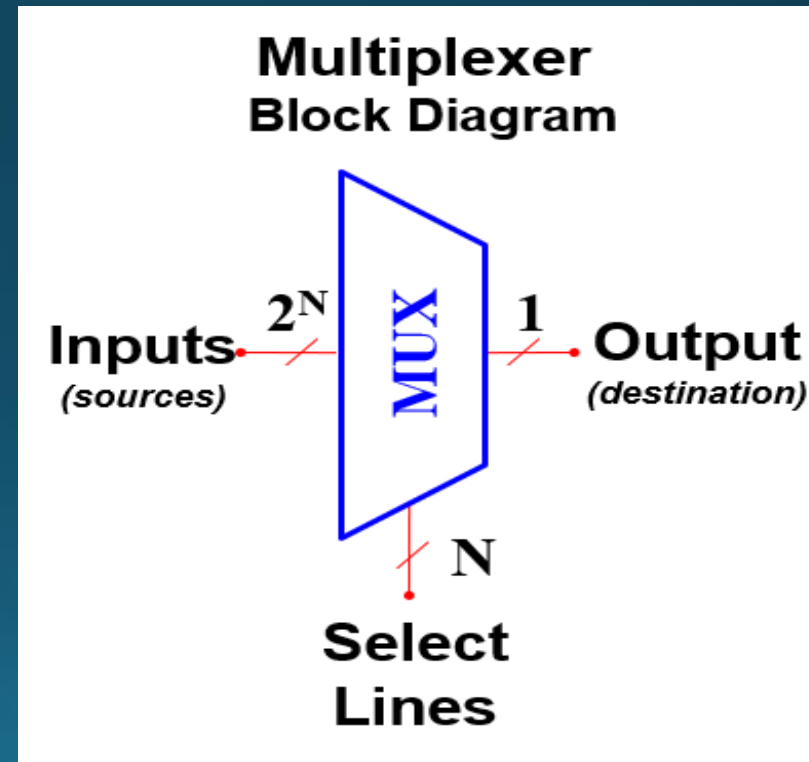
What is a Multiplexer (MUX)?

A MUX is a digital switch that has multiple inputs (sources) and a single output (destination).

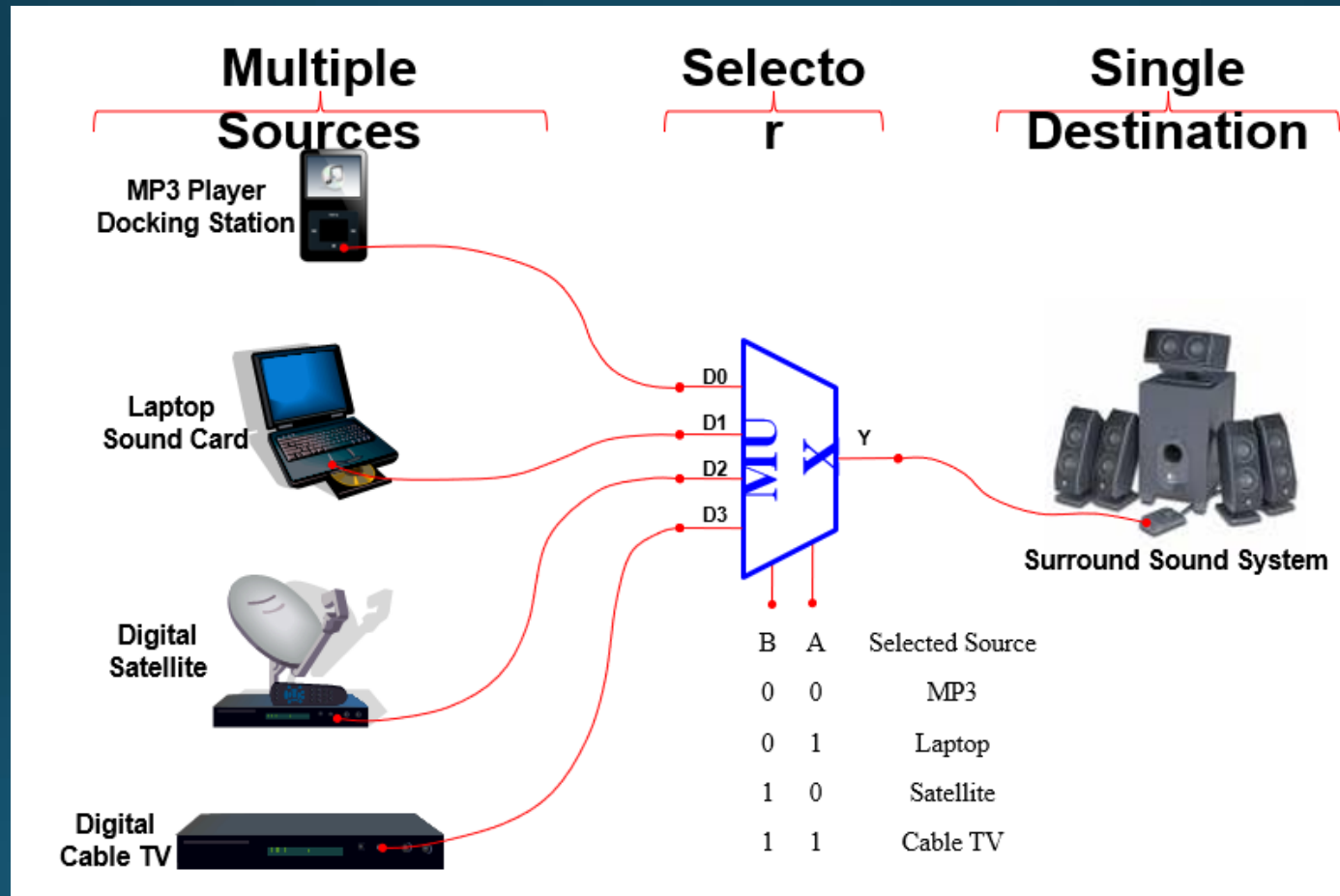
The select lines determine which input is connected to the output.

MUX Types

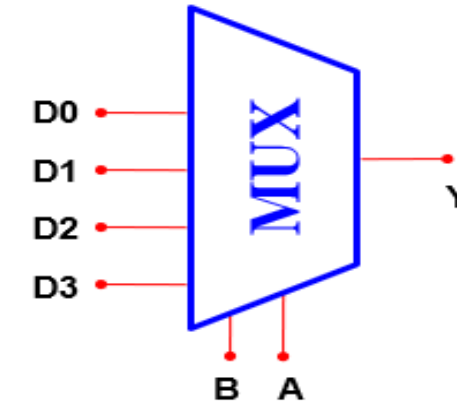
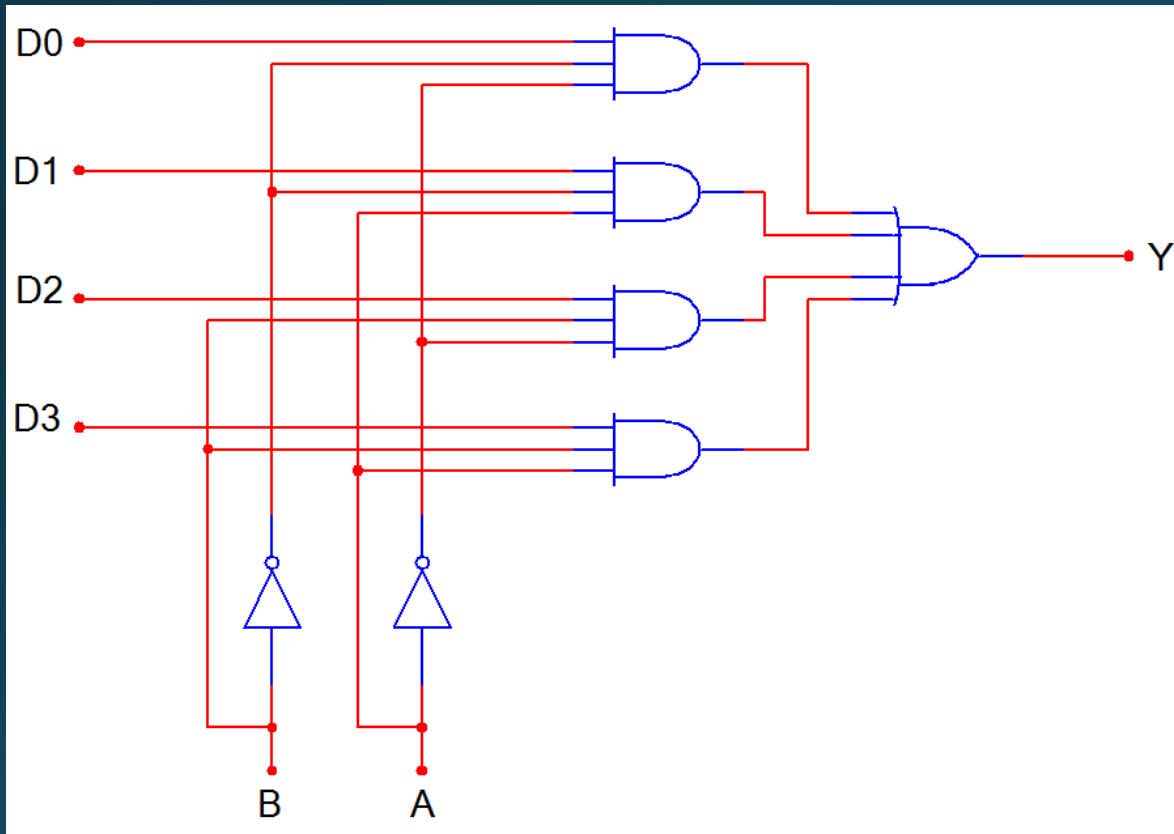
- 2-to-1 (1 select line)
- 4-to-1 (2 select lines)
- 8-to-1 (3 select lines)
- 16-to-1 (4 select lines)



Typical Application of a MUX



4-to-1 Multiplexer (MUX)



B	A	Y
0	0	D0
0	1	D1
1	0	D2
1	1	D3

DeMultiplexer (DEMUX)

What is a Demultiplexer (DEMUX)?

- The De-Multiplexer is a combinational logic circuit that performs the reverse operation of multiplexer (Several output lines, one input line).
- De -Multiplexer means one to many. A De-Multiplexer is a circuit with one input and many output. By applying control signal, we can steer any input to the output. Few types of De -Multiplexer are 1-to 2, 1-to-4, 1-to-8 and 1-to 16 De -Multiplexer .
- De-Multiplexer is the process of taking information from one input and transmitting the same over one of several outputs.

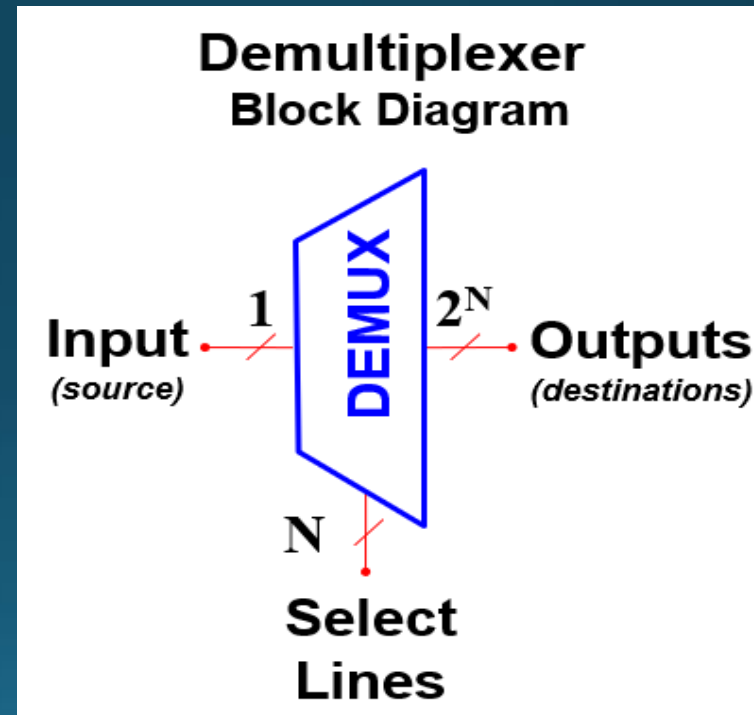
What is a Demultiplexer (DEMUX)?

A DEMUX is a digital switch with a single input (source) and a multiple outputs (destinations).

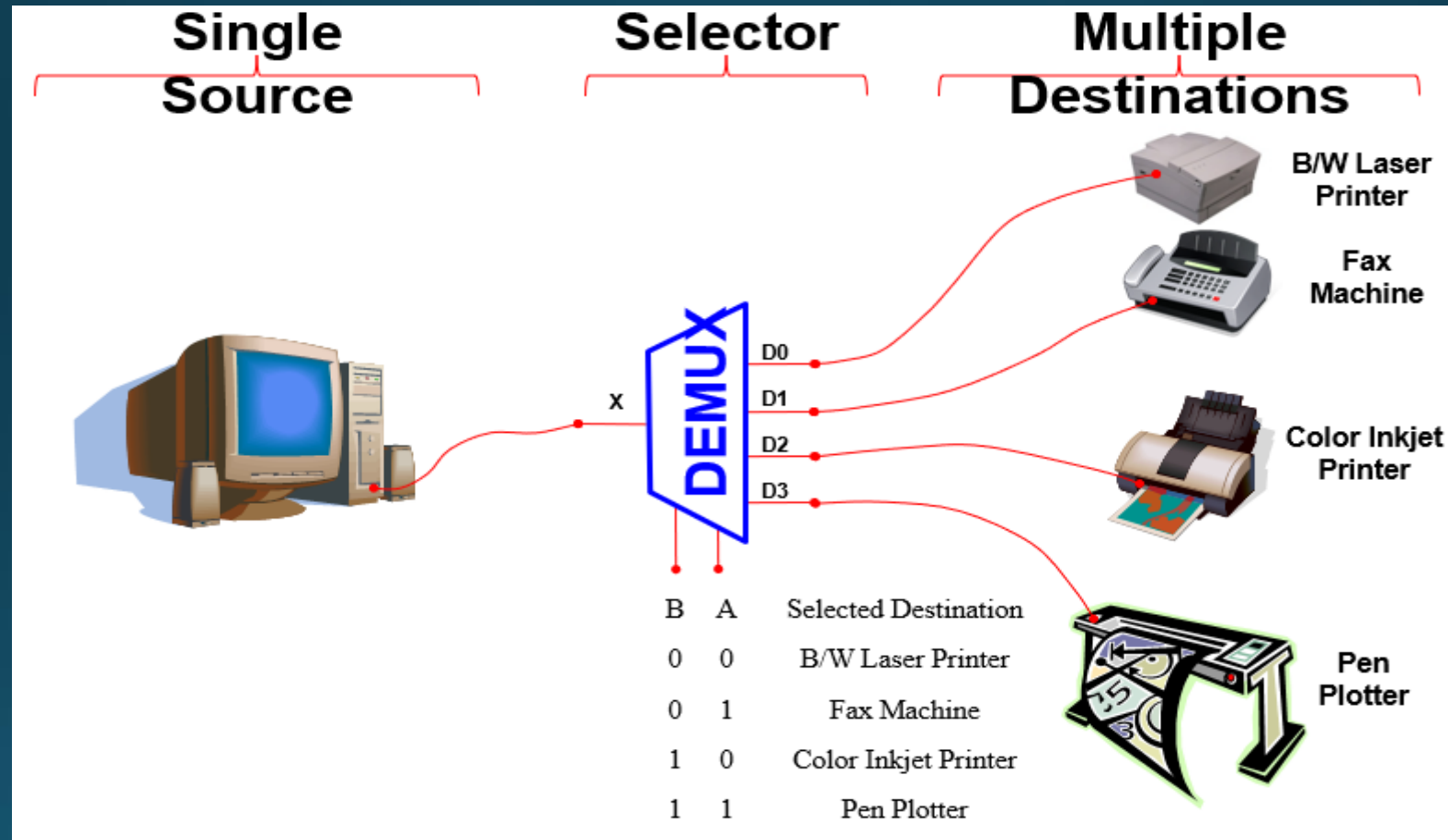
The select lines determine which output the input is connected to.

DEMUX Types

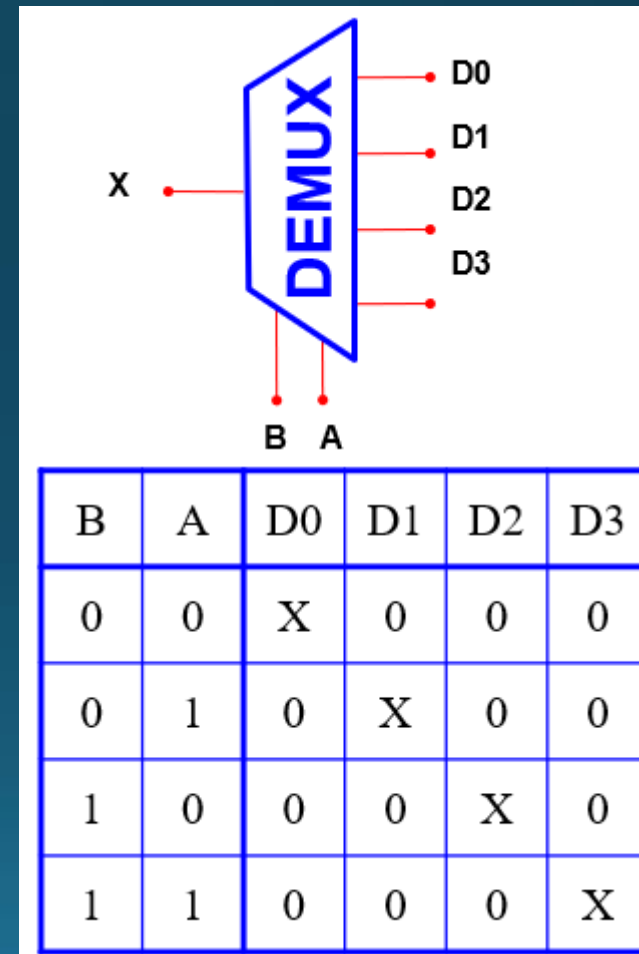
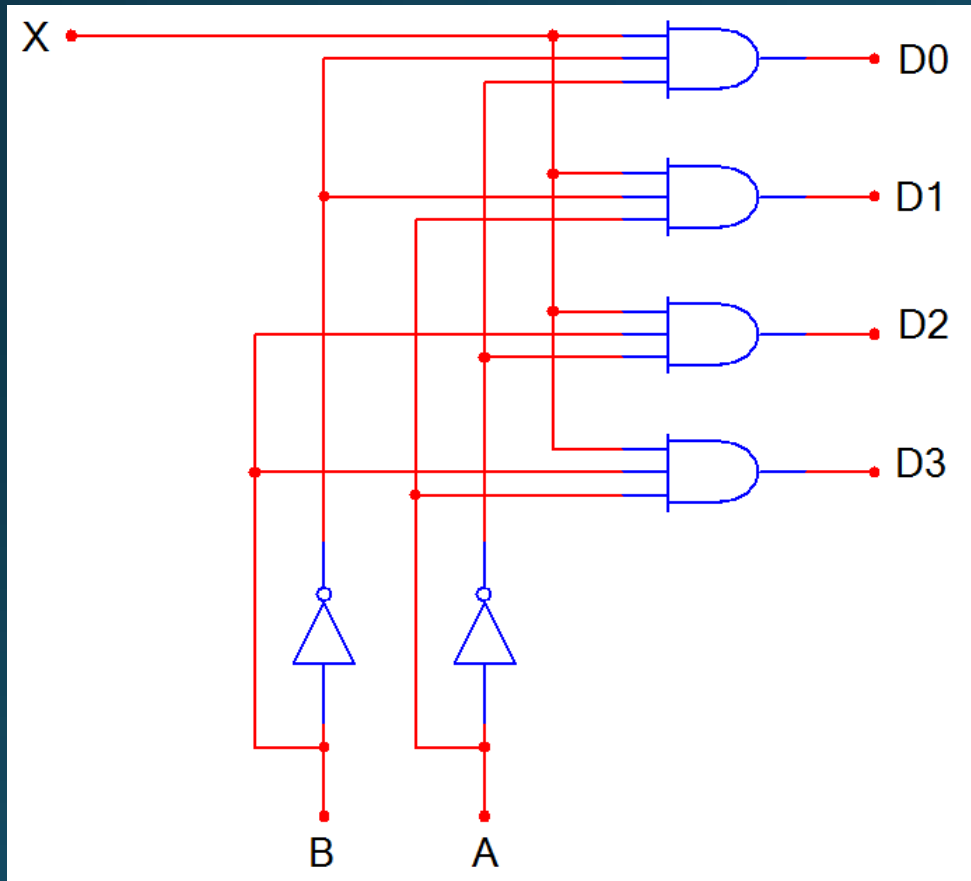
- 1-to-2 (1 select line)
- 1-to-4 (2 select lines)
- 1-to-8 (3 select lines)
- 1-to-16 (4 select lines)



Typical Application of a DEMUX



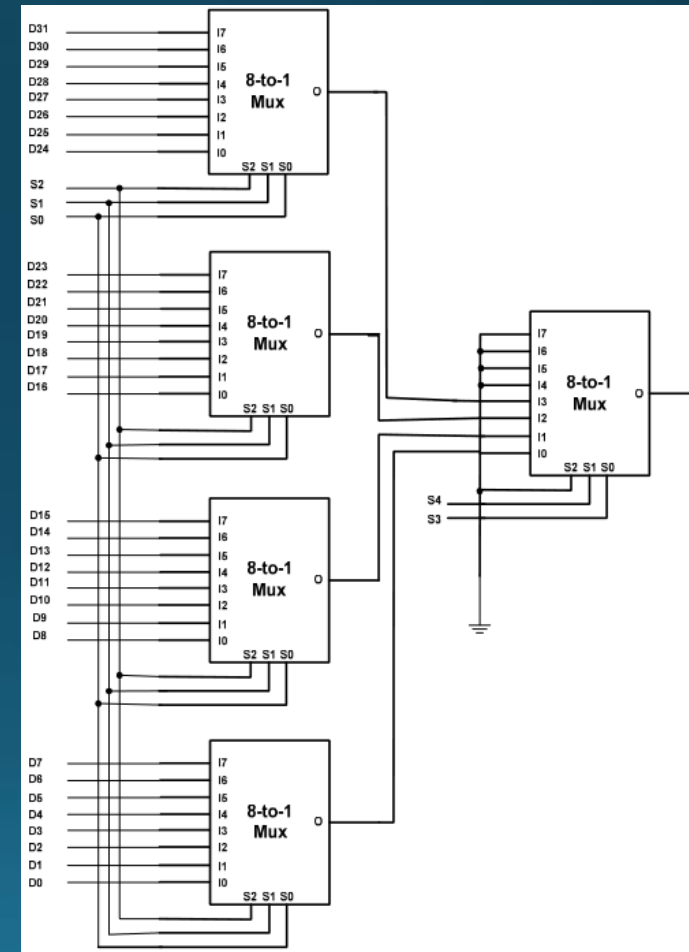
1-to-4 De-Multiplexer (DEMUX)



Example of expansion Multiplexer

Design a 32-to-1 multiplexer using only 8-to-1 multiplexer

We use four 8-to-1 in the first stage and another one to select between the output of the others:



MUX vs DeMUX

Difference between Multiplexer and Demultiplexer

Both multiplexer and demultiplexer are types of combinational digital circuit that are used in several large-scale digital systems. However, there are many differences between a multiplexer and a demultiplexer, which are highlighted in the following table

Difference between Multiplexer and Demultiplexer

Basis of Difference	Multiplexer	Demultiplexer
Definition	A multiplexer is a combinational digital circuit that takes multiple data inputs and provides only single output.	A demultiplexer is a combinational digital circuit that takes single input and provides multiple outputs.
Abbreviated name	The abbreviation used to represent the multiplexer is MUX.	The abbreviation used to represent the demultiplexer is DEMUX.
Input and output lines	Multiplexer has 2^n input lines and 1 output line. Where, n is the number of select lines.	Demultiplexer has 1 input line and 2^n output lines. Where, n is the number of select lines.
Also known as	Multiplexer is also known as a "data selector".	Demultiplexer is also known as "data distributor".

Difference between Multiplexer and Demultiplexer

Basis of Difference	Multiplexer	Demultiplexer
Operating principle	The operating principle of the multiplexer is "many to one".	The operating principle of a demultiplexer is "one to many".
Acts as	Multiplexer acts as a digital multi-position switch.	Demultiplexer acts as a digital circuit.
Conversion technique	A multiplexer performs parallel to serial conversion.	A demultiplexer performs serial to parallel conversion.
Function of control signal	In case of multiplexer, the function of control signal is to select a specific input that has to be transmitted at the output.	In demultiplexer, the function of control signal is to deliver the single input signal over the multiple output lines.

Difference between Multiplexer and Demultiplexer

Basis of Difference	Multiplexer	Demultiplexer
Examples	• Examples of some common multiplexers are – • 8:1 Multiplexer • 16:1 Multiplexer • 32:1 Multiplexer	• Some common demultiplexers are – • 1:2 Demultiplexer • 1:4 Demultiplexer • 1:8 Demultiplexer • 1:16 Demultiplexer
Practical importance	In practice, the multiplexer increases the efficiency of the communication system by enabling the data transmission using a single line.	In practice, the demultiplexer takes the output of a multiplexer and convert in its original form at the receiver end.

Difference between Multiplexer and Demultiplexer

Basis of Difference	Multiplexer	Demultiplexer
Usage in time-division multiplexing	A multiplexer is used at the transmitter end in the time-division multiplexing (TDM).	The demultiplexer is used at the receiver end in the time-division multiplexing.
Applications	The multiplexers are commonly used in communication systems, telephone networks, computer memories, etc.	The demultiplexers are used in communication systems, reconstruction of parallel data, ALU, etc.



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