DATA PROCESSING CIRUITS

MULTIPLEXER: ADVANTAGES AND APPLICATIONS:

The multiplexer is a combinational logic circuit designed to switch one of several input lines to a single common output line by the application of a control logic. The input has maximum of 2^N data Inputs (where N equals selection or control lines) and single output line.

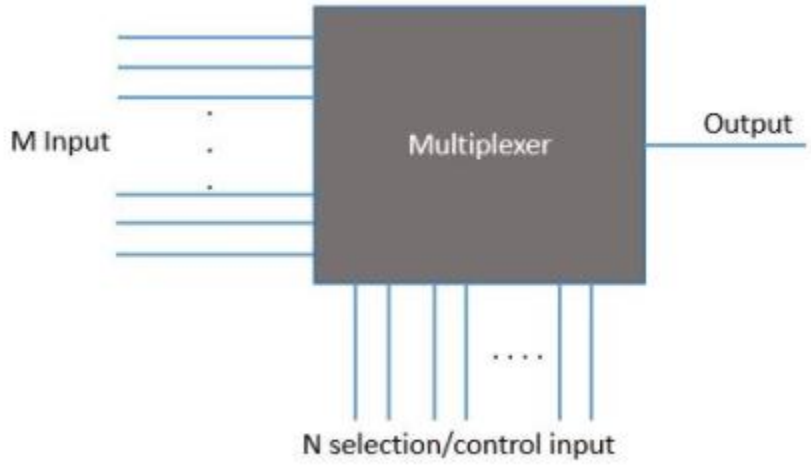


Fig. 1 Mux Block diagram

In short multiplexer is also known as mux or data selector or many to one circuit or universal logic circuit or parallel to serial circuit

the relation between selection/ control lines and input lines is given as $M=2^N$

In simple language are multiplexer is a circuit that selects only one input from multiple inputs

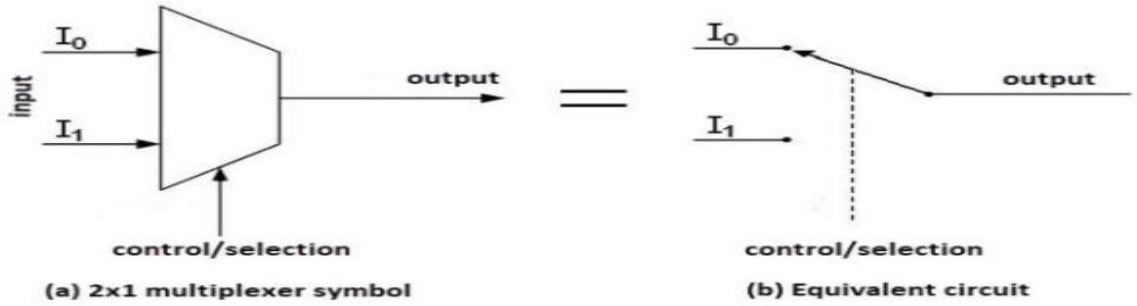


Fig.2 Multiplexer symbol

4 x 1 multiplexer

number of selection/control input, N = 2 (S_1 & S_0)

number of data inputs =2^N = 2^2 = 4 (I_3, I_2, I_1 & I_0)

number of output = 1 (Y)

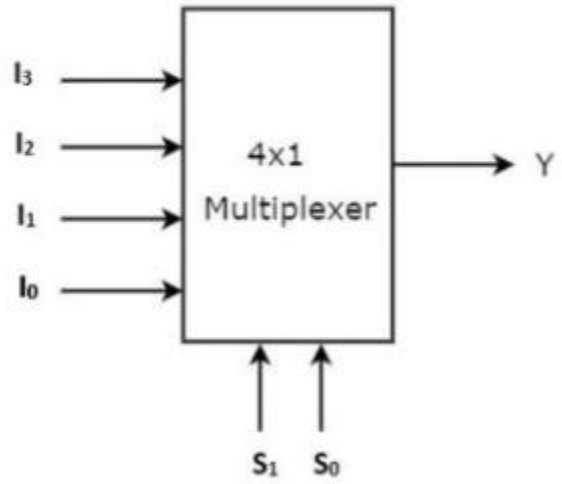


Fig. 2 4×1 Mux

One of these four inputs (I_3, I_2, I_1 & I_0) will be connected to the output (Y) based on the combination of inputs present at these two selection lines (S_1 & S_0). The truth table of 4×1 Mux is as follows.

Selection/Control Lines		Output
S_1	S_0	Y
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

As from Truth table, we can directly write the Boolean function for output, Y as

$$Y = \overline{S_0}\,\overline{S_1}\,I_0 + S_0\overline{S_1}\,I_1 + \overline{S_0}\,S_1\,I_2 + S_0S_1\,I_3$$

4×1 Mux can be implemented by using Inverters, AND gates & OR gate as shown in figure 3.

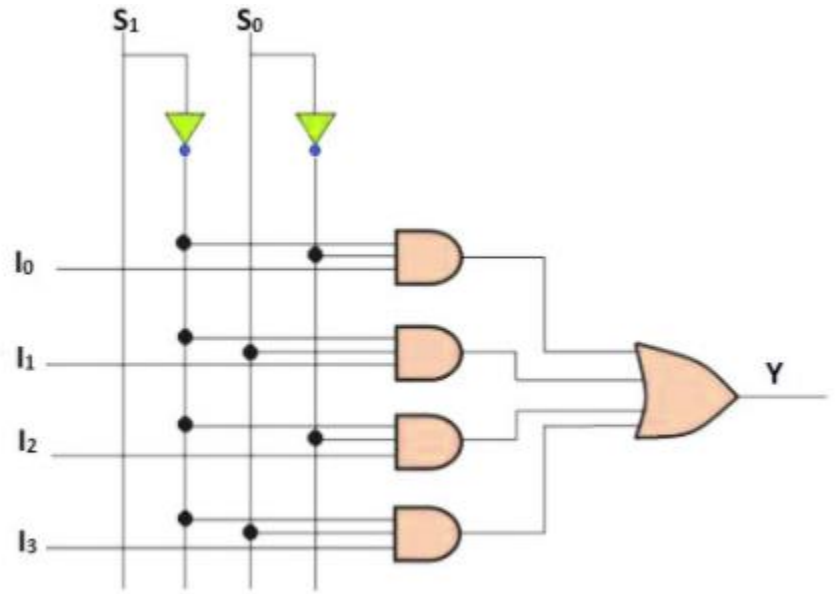


Fig. 3 Logic Diagram

Applications of multiplexer:

1. **Communication system:** a Max is implemented in this system to increase efficiency. using a single transmission line various types of data (audio ,video etc.)are transmitted at same instant .
2. **computer memory:** in a computer, the huge quantity of memory is implemented by means of Max .it also has an advantage of a reduction in the number of copper lines which are used for the connection of memory to other parts of the computer
3. **Computer system of a satellite transmission:** Mux is used for the data signals to be transmitted from space or computer system of a satellite to the earth by means of GPS.
4. **telephone network:** in a telephone network the multiple audio signals are brought into a single line and transmitted with the implementation of a mux. By this way, the numerous audio signals are made isolated and ultimately the recipient will receive the required audio signals

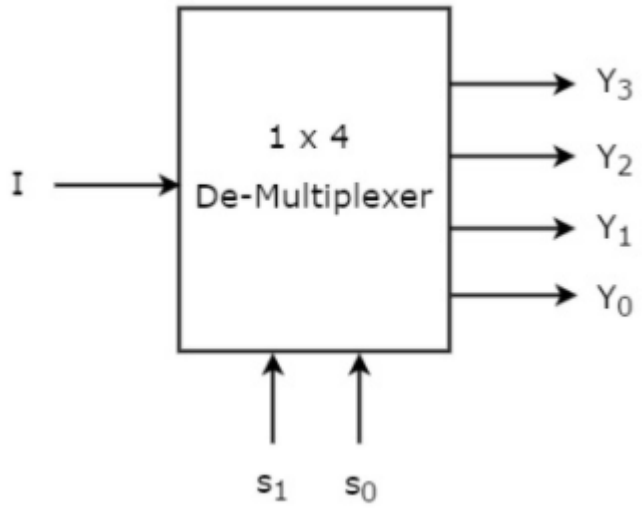
Advantages of multiplexers:

1. Max makes the transmission circuit economical and less complex.
2. analog switching current is low of the order 10 milliamperes to 20 milliamperes. due to such a low magnitude of current, the heat dissipation is very low.
3. the ability of mux to switch digital signals can be extended to switch to a video signal, what audio signal etc.

DEMULTIPLEXER:

is a combinational circuit that performs the reverse operation of Multiplexer. It has single input, ‘n’ selection lines and maximum of 2^n outputs. The input will be connected to one of these outputs based on the values of selection lines.

Since there are ‘n’ selection lines, there will be 2^n possible combinations of zeros and ones. So, each combination can select only one output. De-Multiplexer is also called as **De-Mux**.



The single input 'I' will be connected to one of the four outputs, Y_3 to Y_0 based on the values of selection lines s_1 & s0. The **Truth table** of 1x4 De-Multiplexer is shown below.

Selection Inputs		Outputs			
S_1	S_0	Y_3	Y_2	Y_1	Y_0
0	0	0	0	0	I
0	1	0	0	I	0
1	0	0	I	0	0
1	1	I	0	0	0

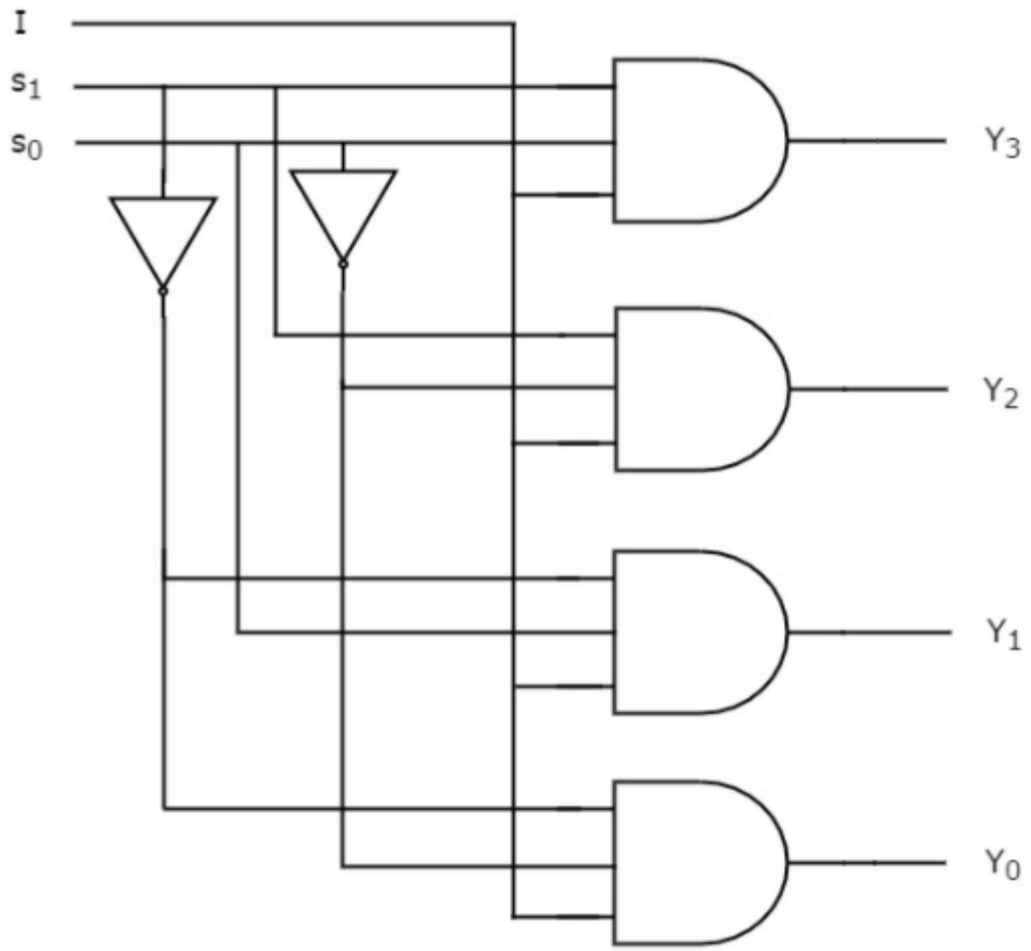
From the above Truth table, we can directly write the **Boolean functions** for each output as

$$Y_3 = s_1 s_0 I$$

$$Y_2 = s_1 s_0{}' I$$

$$Y_1 = s_1{}' s_0 I$$

$$Y_0 = s_1{}' s_0{}' I$$



DECODER:

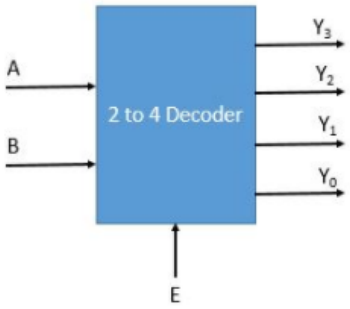
Decoder is a combinational circuit that has '**n**' input lines and maximum of 2^n output lines. One of these outputs will be **active High** based on the combination of inputs present, when the decoder is enabled. It means that Decoder detect a particular code. The output of the decoder are nothing but the **min terms** of '**n**' input variables (lines), when it is enabled.

A decoder is a combinational circuit which has many inputs and many outputs. It is used to convert binary data to other codes. Examples: binary to octal conversion using 3 to 8 decoder, BCD to decimal conversion using 4 to 10 decoder, binary to hexadecimal conversion using 4 to 16 decoder, etc.

→ 2 to 4 decoder is the minimum possible decoder.

2 to 4 Decoder

Let 2 to 4 decoder has two inputs A and B and four outputs Y_3, Y_2, Y_1, and Y_0. The block diagram of 2 to 4 decoder is shown in the following figure.



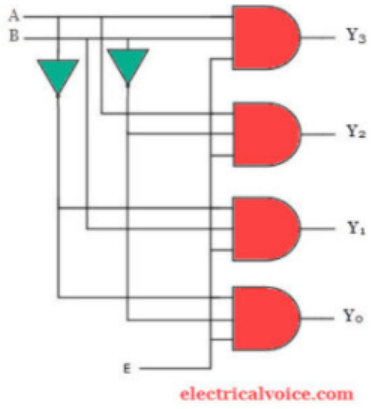
One of these four outputs will be '1' for each combination of inputs when enable E is '1'. The truth table of 2 to 4 decoder is shown below.

Input			Output			
Enable (E)	A	B	Y_3	Y_2	Y_1	Y_0
0	x	x	0	0	0	0
1	0	0	0	0	0	1
1	0	1	0	0	1	0
1	1	0	0	1	0	0
1	1	1	1	0	0	0

From truth table, we can write the Boolean functions (logical expressions) for each output as

$$Y_3 = ABE$$
$$Y_2 = A\overline{B}E$$
$$Y_1 = \overline{A}BE$$
$$Y_0 = \overline{A}\,\overline{B}E$$

Each output is having one product term. So, there are four product terms in total. We can implement these four product terms by using four AND gates having three inputs each and two inverters. The circuit diagram of 2 to 4 decoder is shown in the following figure.



Therefore, the outputs of 2 to 4 decoder are nothing but the min terms of two input variables A and B when enable E is equal to 1. If enable E is zero, then all the outputs of the decoder will be equal to zero.

Note:

1. The internal circuitry of decoder and demux are exactly same.

2. A decoder with enable input can function as a demultiplexer.

3. A 2 × 4 line decoder may acts like a 1:4 demux and vice-versa.

4. Decoder contains AND gates or NAND gates.

Decoder Applications

1. Decoders are used to input data to a specified output line as is done in addressing core memory where input data is to be stored in a specified memory location.

2. It is used in code conversions.

3. In high-performance memory systems, this decoder can be used to minimize the effects of system decoding.

4. It may also be used for data distribution i.e. demultiplexing.

5. Decoder is designed to be used in high-performance memory-decoding or data-routing applications requiring very short propagation delay times.

6. Decoders can be used as timing or sequencing signals to turn devices on or off at specific times, because when the decoder inputs come from a counter that is being continually pulsed, the decoder outputs will be activated sequentially.