Decoders

Silicon Community Session - 1

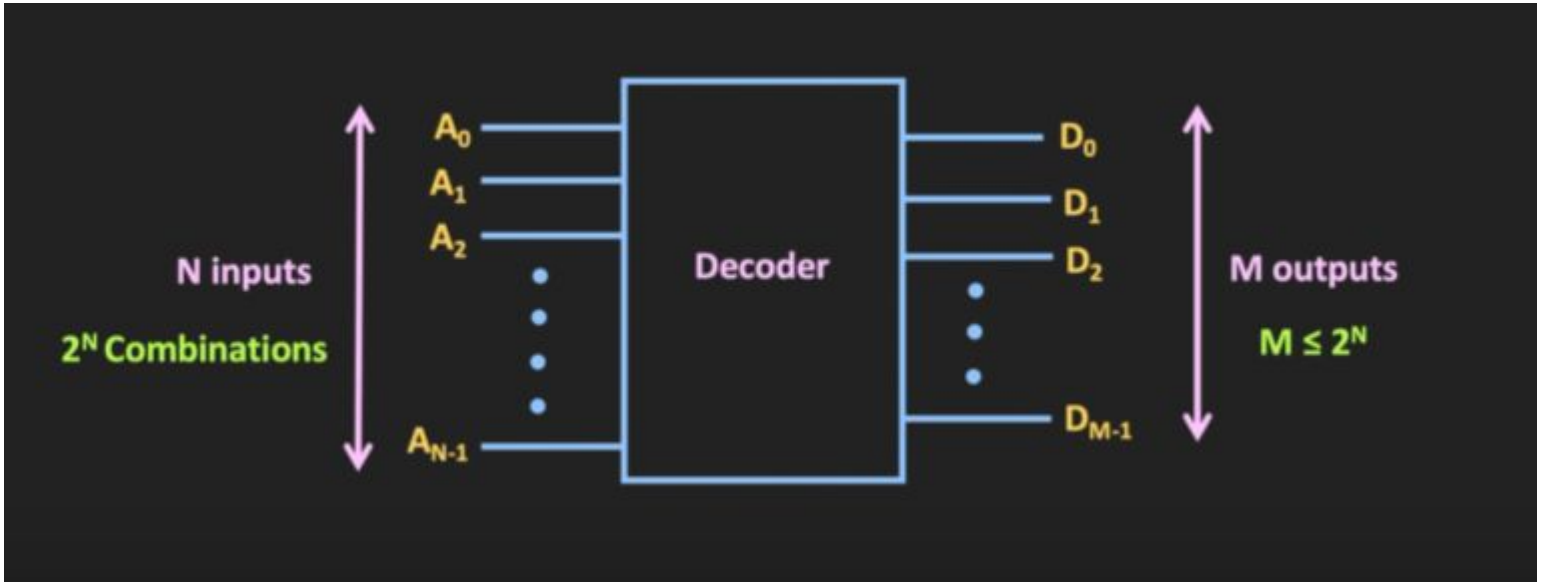
Introduction

The decoder is a combinational logic circuit that converts an input code into an output corresponding to a specific combination of signals.

Function: The primary function of a decoder is to enable the selection of a particular output line based on the input code. It takes an n-bit binary input and produces 2^n output lines, where only one output line is active (high) at a time, based on the input code.

Programmable Decoders: Some decoders can be programmed or configured to perform specific functions. Programmable decoders often use external programming inputs to set the desired input-output mapping.

NxM Decoder Block Diagram



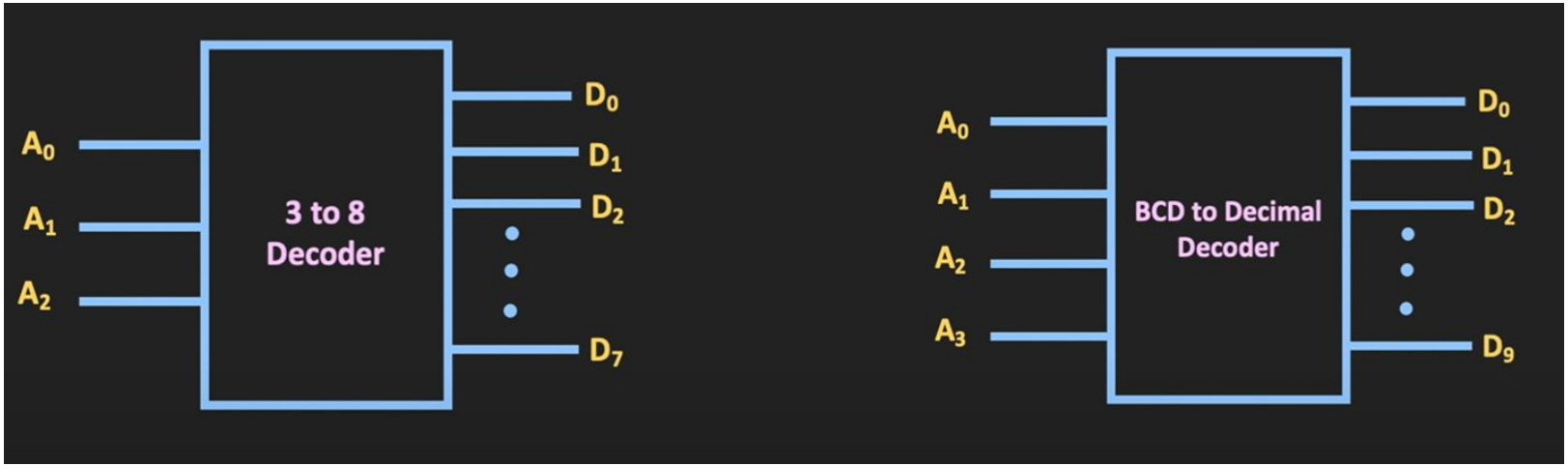
N inputs and number of outputs possible is less than or equal to 2^N

Decoder Application

Decoders are used in various applications, such as

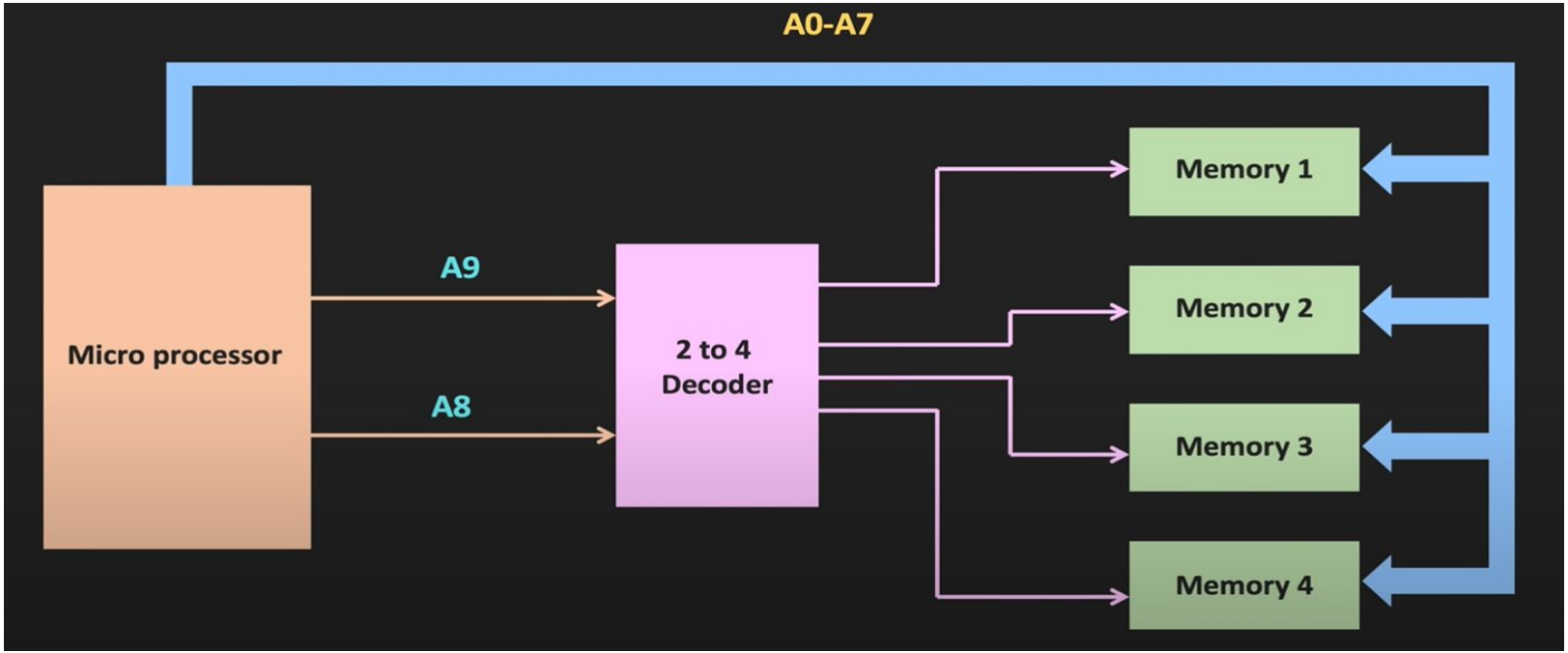
- **memory systems** to select a specific memory location based on an address
- **data multiplexing** to route data to the desired destination
- **digital display systems** to drive segment displays based on input codes.

Decoder Application - BCD on 7-segment display



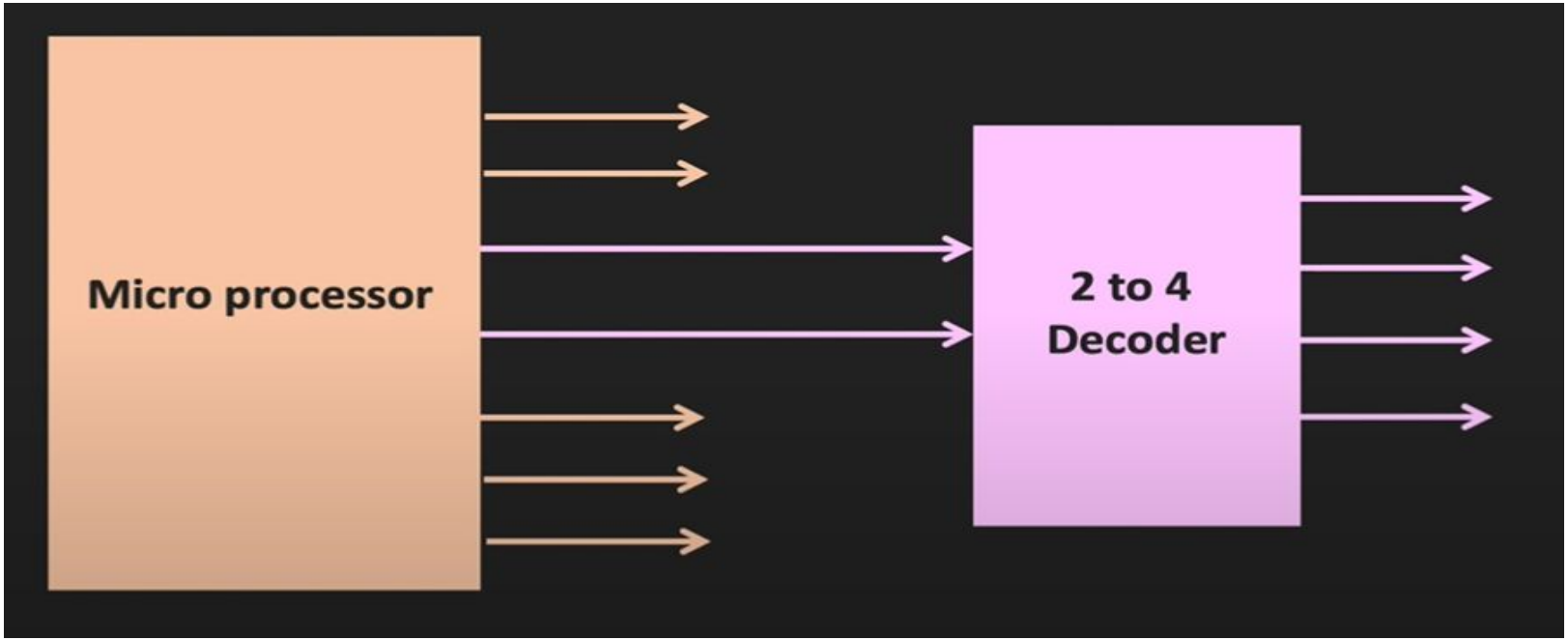
For example, let's say you have a 4-digit BCD number "1011". Connect each digit to the inputs of the BCD to 7-segment decoder, and then connect the decoder outputs to the segments of the 7-segment display. When you apply the BCD code, the decoder will activate the appropriate segments to display the decimal number "11" on the display.

Decoder Application - Address decoding



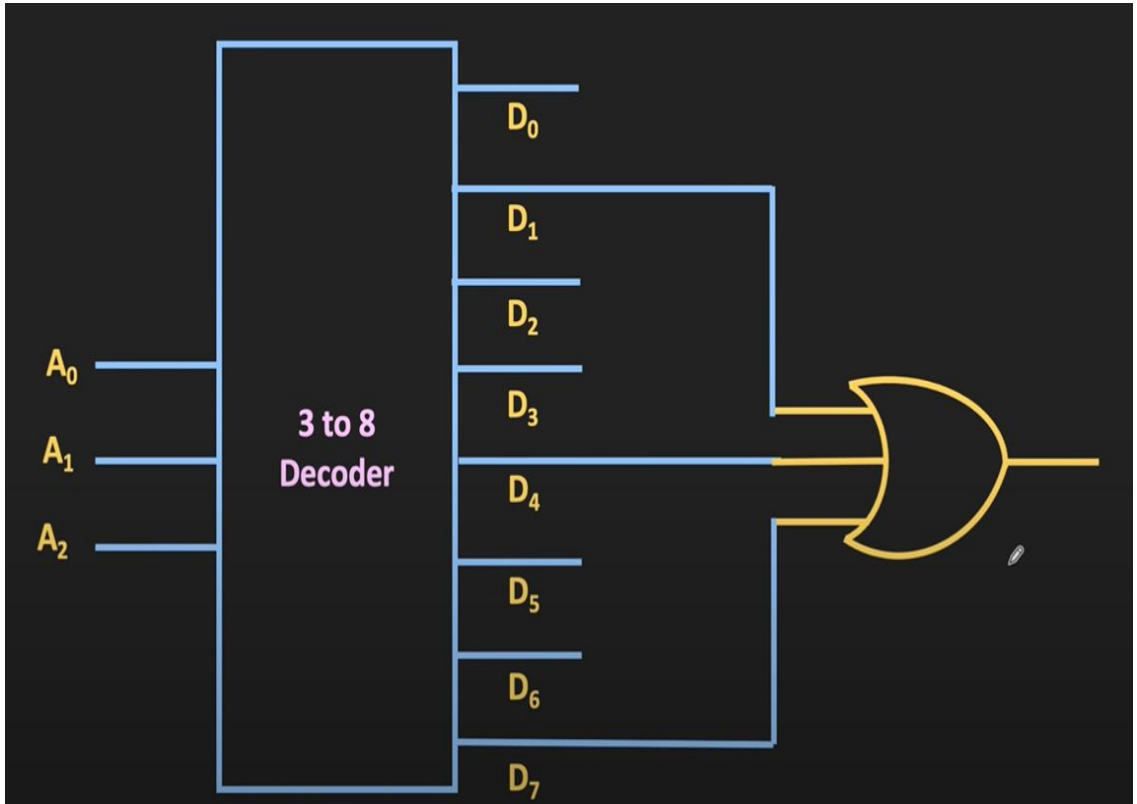
- **address decoding** in microprocessors to decode memory and I/O addresses

Decoder Application - Control signal Generation



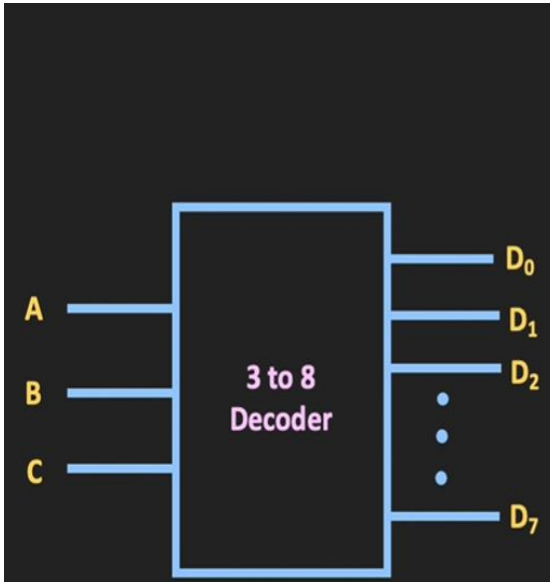
Based on the inputs from the processor, decoder will generate the control signals for the various tasks to be performed

Decoder Application - Logic circuit implementation



Implementation of circuits like half adder, full adder, subtractor etc can be implemented using the decoder

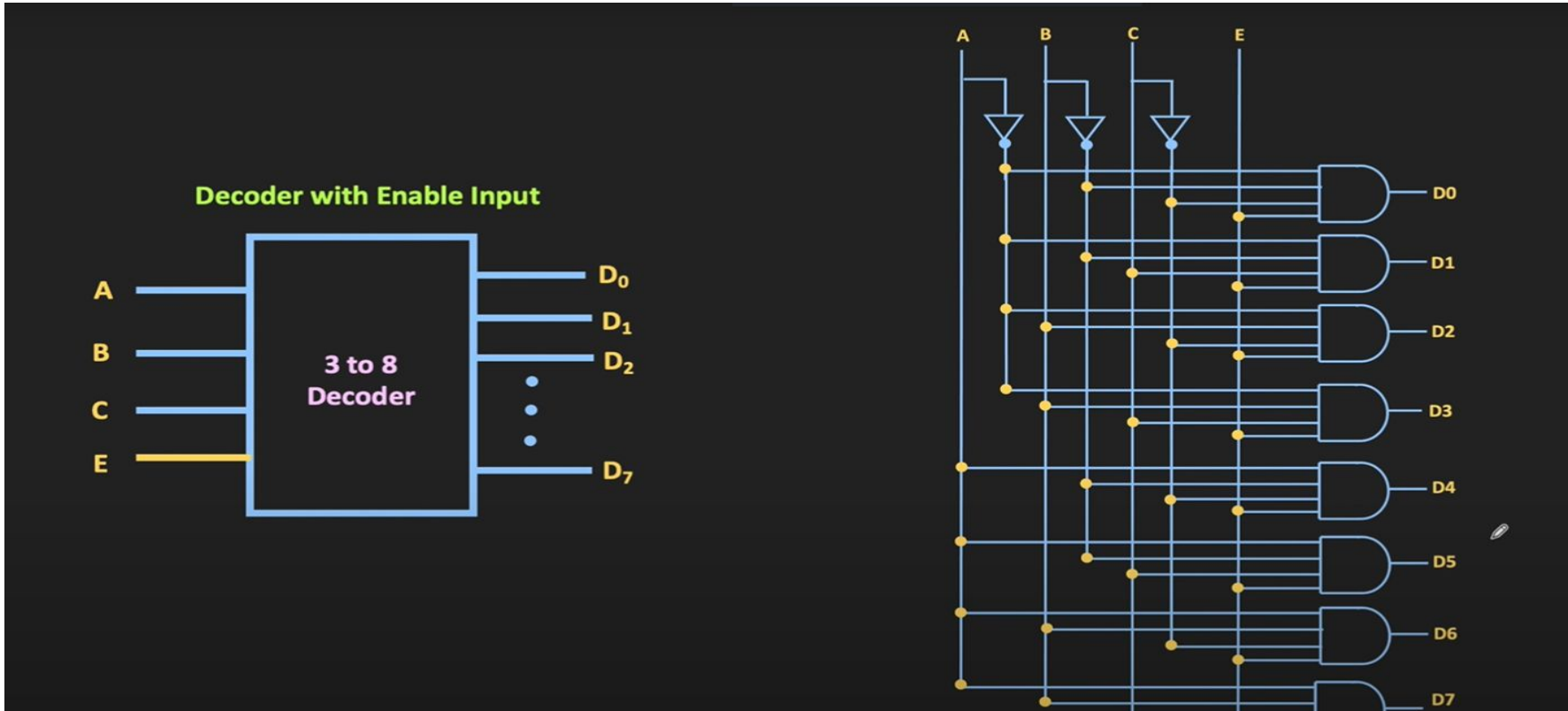
Decoder- Truth Table



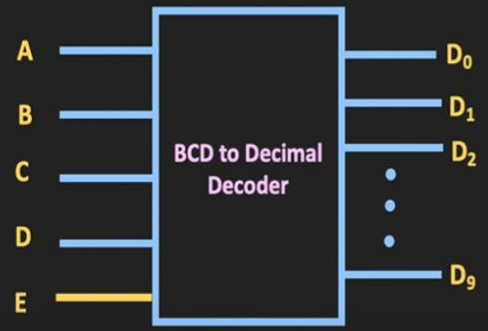
Truth Table

A	B	C	D0	D1	D2	D3	D4	D5	D6	D7
0	0	0	1	0	0	0	0	0	0	0
0	0	1	0	1	0	0	0	0	0	0
0	1	0	0	0	1	0	0	0	0	0
0	1	1	0	0	0	1	0	0	0	0
1	0	0	0	0	0	0	1	0	0	0
1	0	1	0	0	0	0	0	1	0	0
1	1	0	0	0	0	0	0	0	1	0
1	1	1	0	0	0	0	0	0	0	1

Decoder - circuit diagram



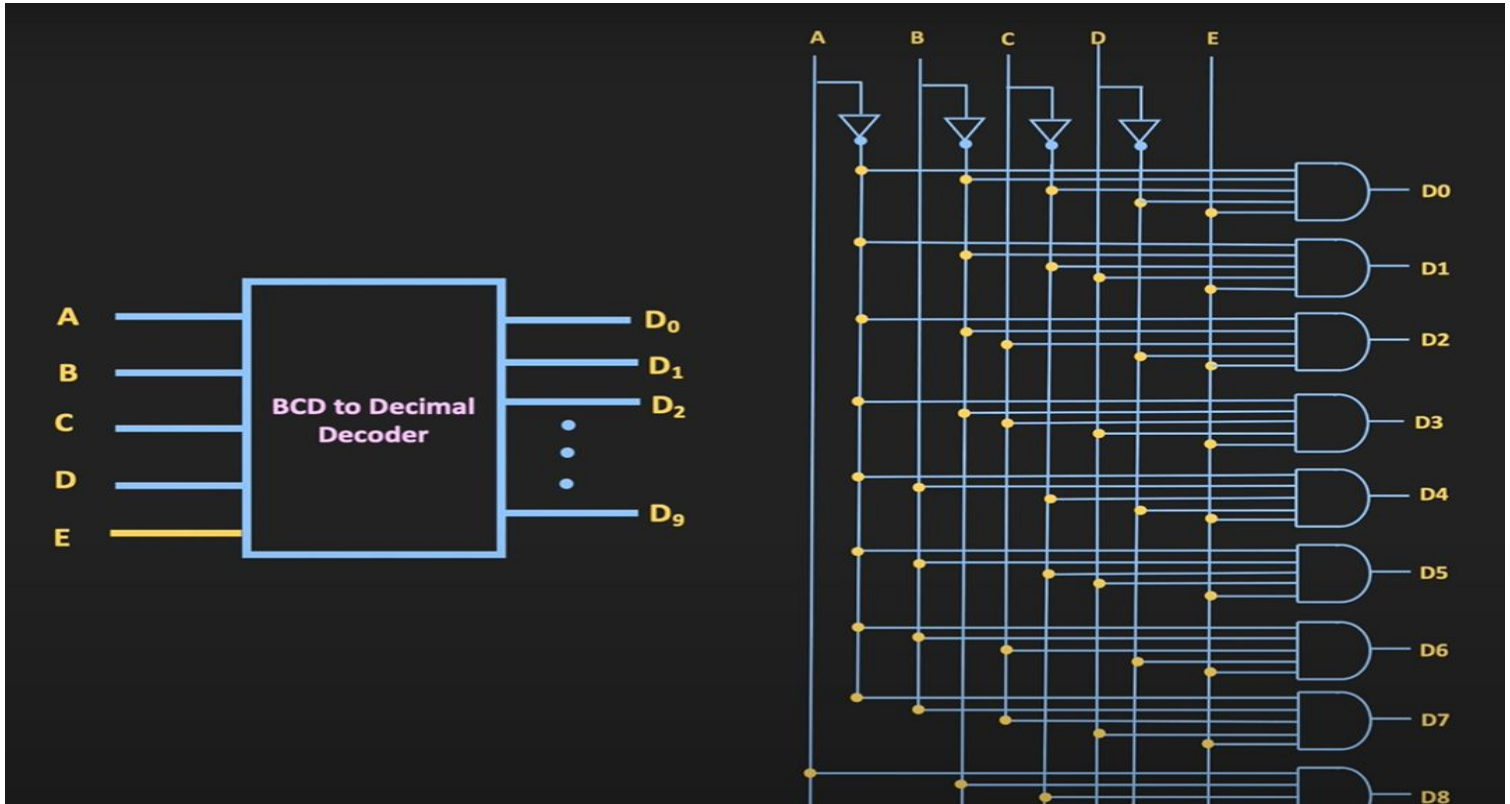
BCD to Decimal (Truth Table)



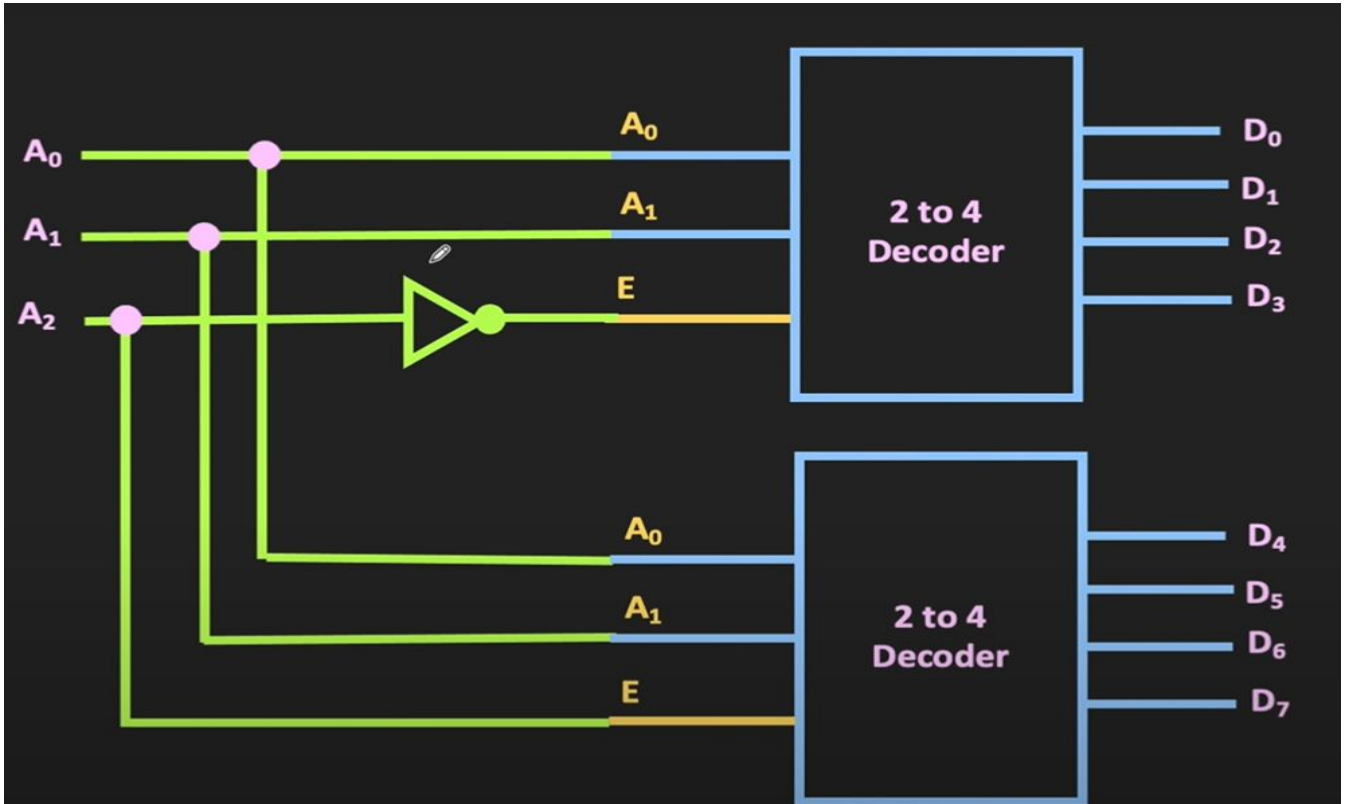
Truth Table

A	B	C	D	E	D0	D1	D2	D3	D4	D5	D6	D7	D8	D9
X	X	X	X	0	0	0	0	0	0	0	0	0	0	0
0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
0	0	0	1	1	0	1	0	0	0	0	0	0	0	0
0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
0	0	1	1	1	0	0	0	1	0	0	0	0	0	0
0	1	0	0	1	0	0	0	0	1	0	0	0	0	0
0	1	0	1	1	0	0	0	0	0	1	0	0	0	0
0	1	1	0	1	0	0	0	0	0	0	1	0	0	0
0	1	1	1	1	0	0	0	0	0	0	0	1	0	0
1	0	0	0	1	0	0	0	0	0	0	0	0	1	0
1	0	0	1	1	0	0	0	0	0	0	0	1	0	1

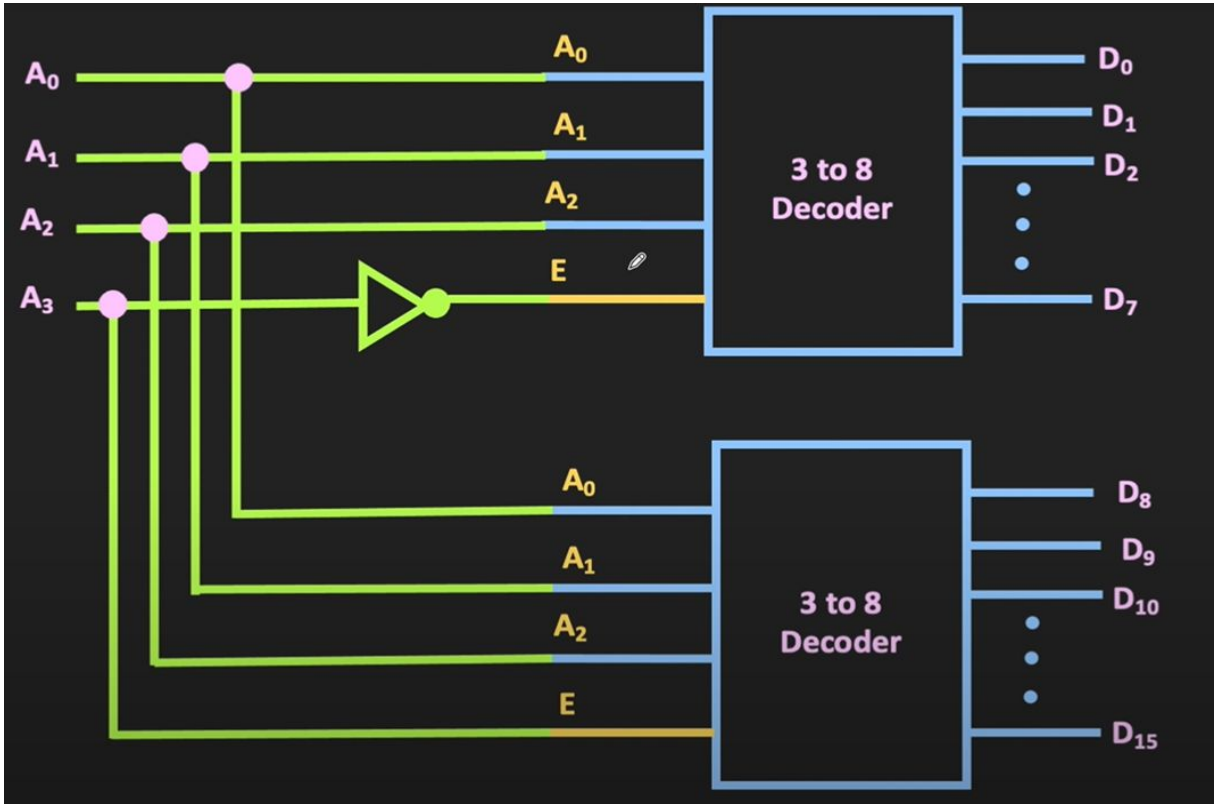
BCD to Decimal (Circuit Diagram)



3x8 Decoder using 2x4 Decoders

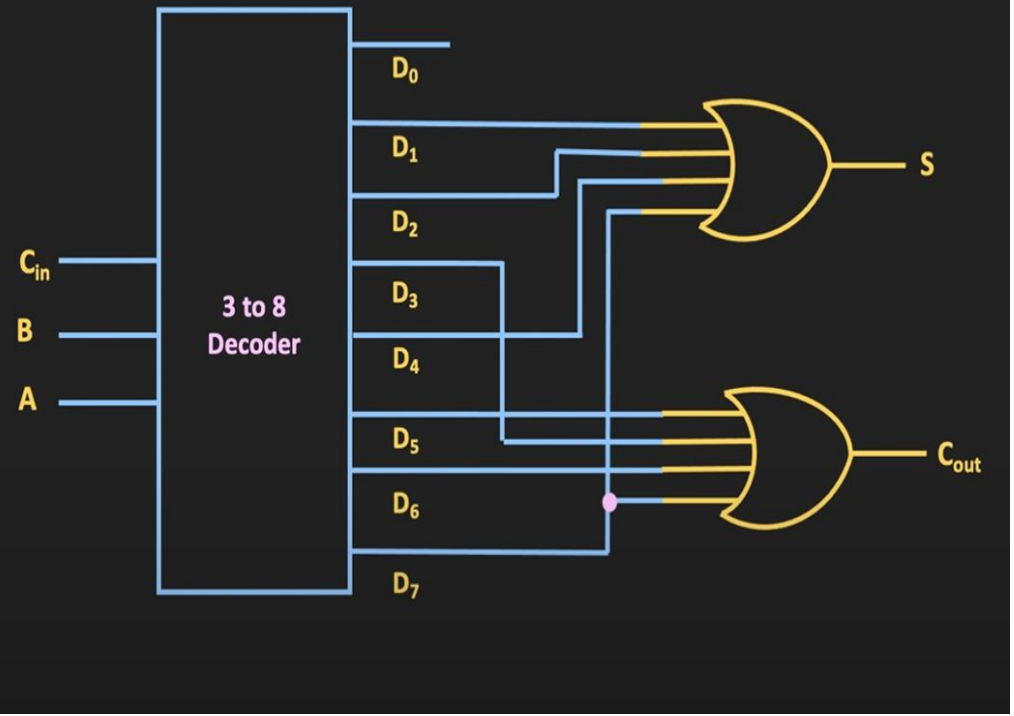


4x16 Decoder using 3x8 Decoder



Full adder using Decoders

A	B	C_{in}	Sum	C_{out}
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1



FAQs on Decoder (1)

Explain the concept of a multiplexer-based decoder. How does it differ from a regular decoder?

Answer: A multiplexer-based decoder is a decoder that uses multiplexers in its implementation. It differs from a regular decoder because it utilizes the data selector functionality of multiplexers to achieve the decoding operation. In a multiplexer-based decoder, the inputs of the multiplexers are the input code lines, and the select lines are derived from the input code. The outputs of the multiplexers correspond to the decoder output lines

Explain the concept of a decoder with a latched output. How is it different from a regular decoder?

Answer: A decoder with a latched output, also known as a latching decoder, retains its output state even when the input changes. It is different from a regular decoder, which produces output based solely on the current input. A latching decoder typically includes a latch or flip-flop connected to its output, allowing the output to be stored or "latched" until it is explicitly changed. This enables the output to remain stable even if the input changes or is removed. Latching decoders are commonly used in applications where the output needs to be held steady until a specific condition is met or a control signal is received.

FAQs on Decoder (2)

Discuss the concept of a "don't care" condition in decoder design. How can it be utilized?

Answer: In decoder design, a "don't care" condition refers to a specific combination of input values where the output is not relevant or can be either 0 or 1. It allows for more flexibility in the design and optimization of the decoder. A "don't care" condition can be utilized by simplifying the logic implementation, reducing the number of gates, and optimizing the circuit's overall complexity. It allows designers to ignore certain input combinations that do not require specific output behavior, leading to more efficient decoder designs.

Explain the concept of a decoder with an active-low output.

Answer: A decoder with an active-low output is a decoder in which the outputs are inverted or active-low. This means that the output lines are considered active or asserted when they are at a logic low state (0) and inactive or deasserted when they are at a logic high state (1). In other words, the output lines of the decoder are complemented compared to a regular decoder with active-high outputs.

FAQs on Decoder (3)

Explain the concept of a decoder with latched inputs. How does it differ from a regular decoder, and what are its advantages?

Answer: A decoder with latched inputs, also known as a latched decoder, has input lines that can be latched or stored using flip-flops. This allows the decoder to hold the input values even when the inputs change. In contrast, a regular decoder updates its output based solely on the current input. The advantage of using a latched decoder is that it allows the outputs to remain stable even if the input changes or is removed, providing better control over the output timing and stability. Latched decoders are commonly used in applications where the input values need to be held constant for a specific duration or until a certain condition is met.

FAQs on Decoder (4)

Discuss the concept of a programmable decoder. How can it be programmed or configured to perform different decoding functions?

Answer: A programmable decoder is a type of decoder that can be programmed or configured to perform different decoding functions based on the desired logic operation. It typically involves providing input signals or data that specify the desired decoding function or truth table. Programmable decoders can be implemented using programmable logic devices such as programmable array logic (PAL) or complex programmable logic devices (CPLDs). These devices can be reprogrammed or reconfigured using software or programming tools to change the decoder's behavior, allowing for versatile and flexible circuit design.

FAQs on Decoder (5)

Explain the concept of a decoder with a strobe input. How does the strobe input affect the operation of the decoder?

Answer: A decoder with a strobe input, also known as an enable input, allows the decoder to be enabled or disabled based on the state of the strobe input signal. When the strobe input is active, the decoder functions normally, decoding the input code and activating the corresponding output line. However, when the strobe input is inactive, the decoder is disabled, and none of the output lines are activated, regardless of the input code. The strobe input provides control over the decoder's operation, allowing it to be selectively enabled or disabled as needed.