CSE1003 Digital Logic and Design
Module 4
Combinational Circuits II
L4

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Contents

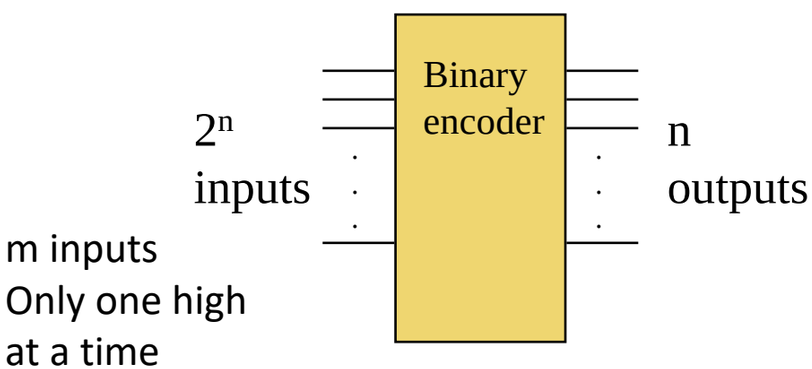
6 hrs

- Binary Parallel Adder - Look ahead carry
- Magnitude Comparator
- **Decoders**
- **Encoders**
- Multiplexers
- Demultiplexers

- CO4: Analyze the operation of medium complexity standard combinational circuits like the encoder, decoder, multiplexer, demultiplexer.

Encoders

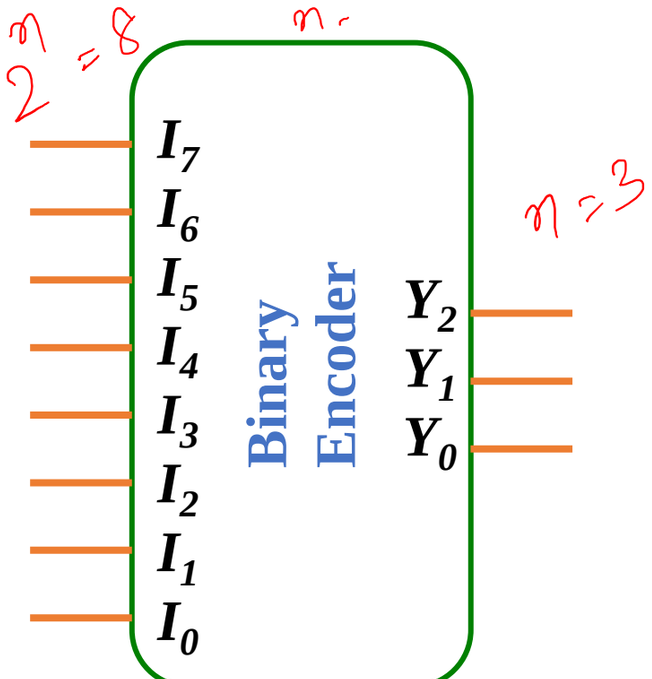
- An encoder is a combinational logic circuit that performs the inverse operation of a decoder.
- The process of converting various numbers (numerals, alphabets, special characters) into a binary format is called encoding.
- An encoder has 2^n (or fewer) input lines and *n* output lines.
- The opposite of the decoding process is called encoding, i.e. encoding is a process of converting familiar numbers or symbols into a coded format.
- Binary encoders
  - Converts one of 2^n inputs to an n-bit binary output
  - Useful for compressing data
  - Can be developed using AND/OR gates
- The simplest encoder is a 2^n-to-n binary encoder
  - One of 2^n inputs = 1
  - Output is an n-bit binary number
- Commonly used encoders
  - Octal-to-binary encoder
  - Decimal-to-BCD encoder
  - Hexadecimal-to-binary encoder



Block diagram of encoder

8-to-3 Binary Encoder or **Octal-to-Binary Encoder**

- Have eight input lines, each representing an octal digit, and three output lines representing the three-bit binary equivalent.
- At any one time, only one input line has a value of 1.

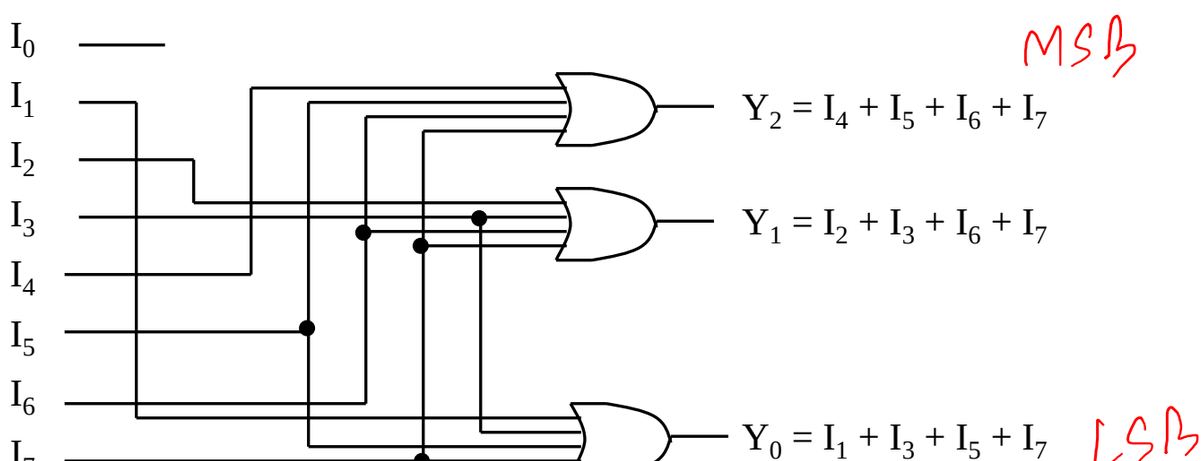


Block diagram of an octal to binary encoder

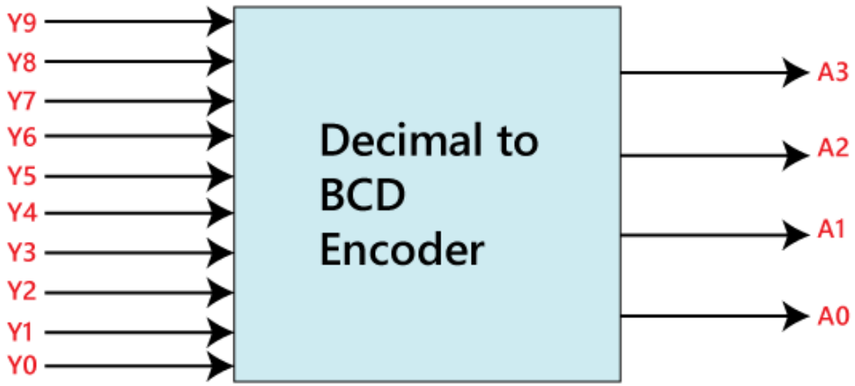
$$Y_2 = I_7 + I_6 + I_5 + I_4$$
$$Y_1 = I_7 + I_6 + I_3 + I_2$$
$$Y_0 = I_7 + I_5 + I_3 + I_1$$

Truth Table of an Octal to Binary Encoder

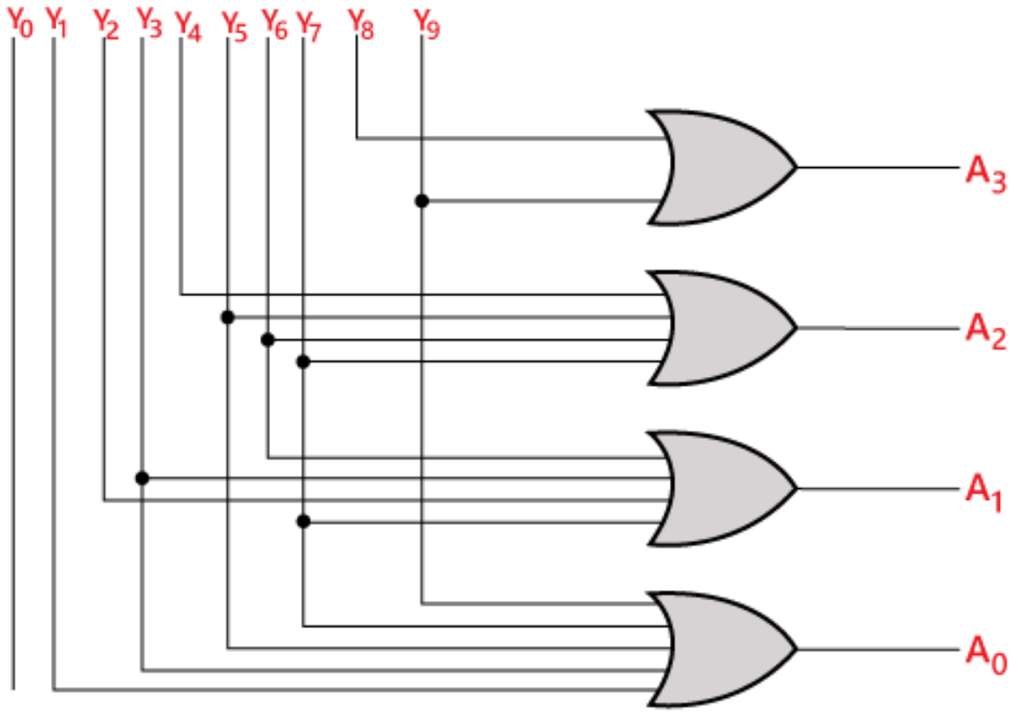
Inputs								Outputs		
I_0	I_1	I_2	I_3	I_4	I_5	I_6	I_7	Y_2	Y_1	Y_0
1	0	0	0	0	0	0	0	0	0	0
0	1	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	1	0	0	0	1	0	0
0	0	0	0	0	1	0	0	1	0	1
0	0	0	0	0	0	1	0	1	1	0
0	0	0	0	0	0	0	1	1	1	1



Decimal-to-BCD Encoder



INPUTS										OUTPUTS			
Y_9	Y_8	Y_7	Y_6	Y_5	Y_4	Y_3	Y_2	Y_1	Y_0	A_3	A_2	A_1	A_0
0	0	0	0	0	0	0	0	0	1	0	0	0	0
0	0	0	0	0	0	0	0	1	0	0	0	0	1
0	0	0	0	0	0	0	1	0	0	0	0	1	0
0	0	0	0	0	0	1	0	0	0	0	0	1	1
0	0	0	0	0	1	0	0	0	0	0	1	0	0
0	0	0	0	1	0	0	0	0	0	0	1	0	1
0	0	0	1	0	0	0	0	0	0	0	1	1	0
0	0	1	0	0	0	0	0	0	0	0	1	1	1
0	1	0	0	0	0	0	0	0	0	1	0	0	0
1	0	0	0	0	0	0	0	0	0	1	0	0	1



Logic diagram of decimal-to-BCD encoder

$$A_3 = Y_8 + Y_9$$
$$A_2 = Y_4 + Y_5 + Y_6 + Y_7$$
$$A_1 = Y_2 + Y_3 + Y_6 + Y_7$$
$$A_0 = Y_1 + Y_3 + Y_5 + Y_7 + Y_9$$

Priority Encoders

- A priority encoder generates a binary code corresponding to the number of the active input with highest priority (or, most often, the highest number).
- It can be used in the following applications:

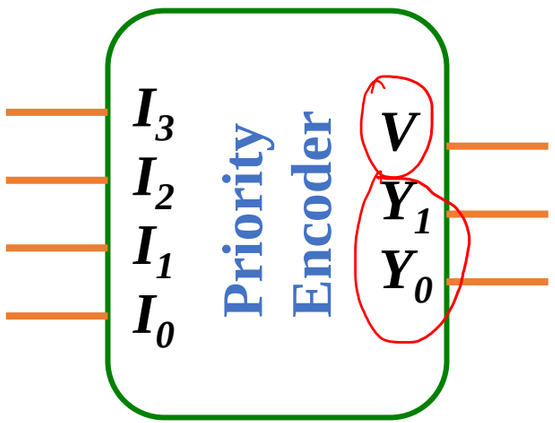
  – keyboard encoder: when several keys are pressed simultaneously, only the key with the highest number is taken into consideration;

  – unit processing interrupt requests in a microprocessor: in case of simultaneous interrupt requests, only the request with the highest priority is accepted.

Priority Encoders

4-to-2 line Priority Encoder

- the higher the subscript number, the higher the priority of the input.

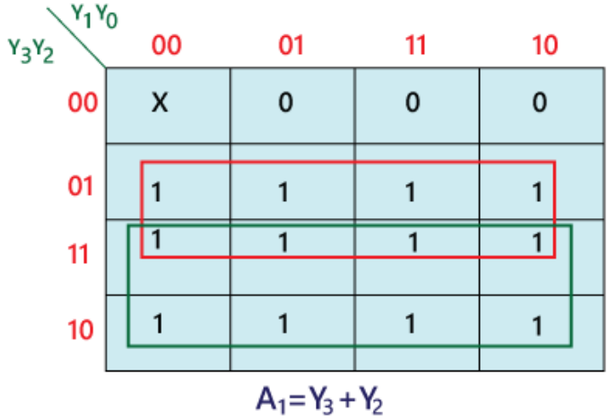


V - Valid bit indicator

V=1 more than 1 i/p lines goes High

V=0 when all i/ps are zero

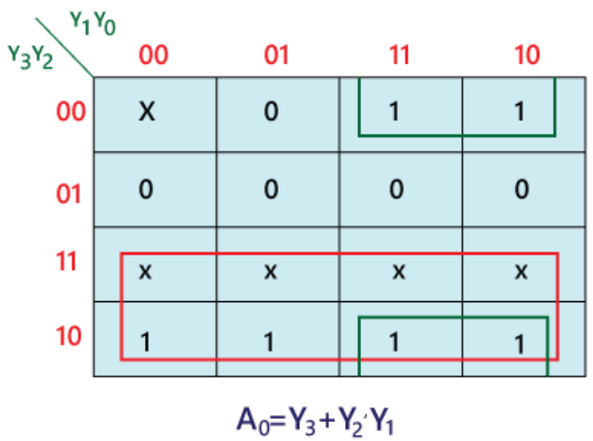
INPUTS				OUTPUTS		
Y_3	Y_2	Y_1	Y_0	A_1	A_0	V
0	0	0	0	X	x	0
0	0	0	1	0	0	1
0	0	1	X	0	1	1
0	1	x	X	1	0	1
1	X	x	X	1	1	1

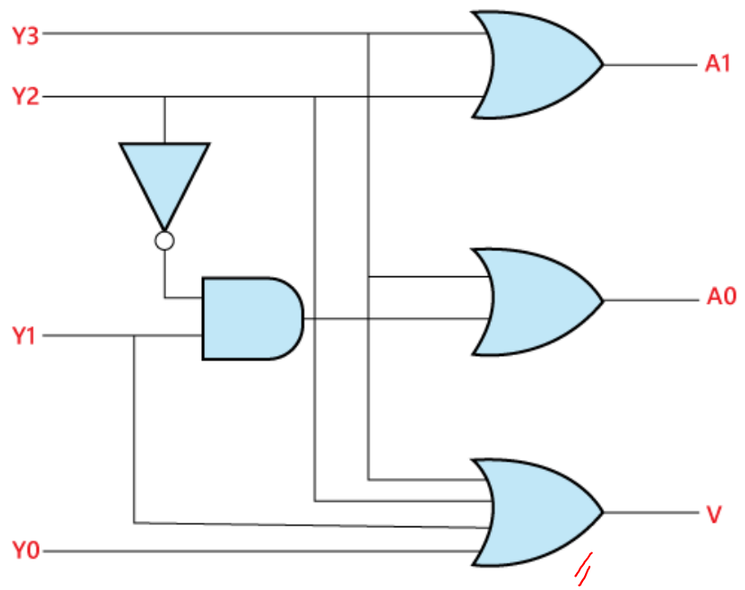


$A_1 = Y_3 + Y_2$

$A_0 = Y_3 + Y_2'.Y_1$

$V = Y_3 + Y_2 + Y_1 + Y_0$





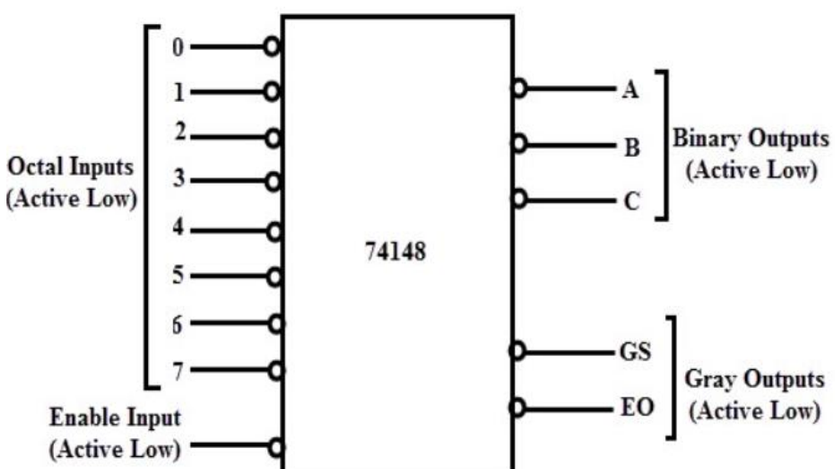
8-to-3 Priority Encoder

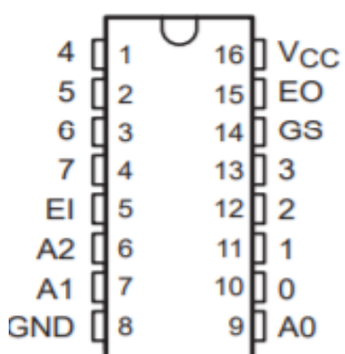
- What if more than one input line has a value of 1?
- Ignore "lower priority" inputs.

74148, 74LS148, and 74HC148 are all octal-to-binary priority encoders.

FUNCTION TABLE

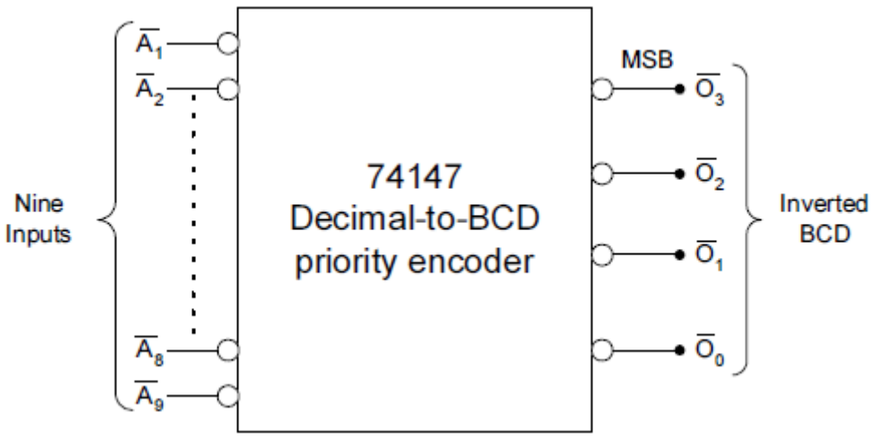
INPUTS									OUTPUTS				
EI	0	1	2	3	4	5	6	7	A2	A1	A0	GS	EO
H	X	X	X	X	X	X	X	X	H	H	H	H	H
L	H	H	H	H	H	H	H	H	H	H	H	H	L
L	X	X	X	X	X	X	X	L	L	L	L	L	H
L	X	X	X	X	X	X	L	H	L	L	H	L	H
L	X	X	X	X	X	L	H	H	L	H	L	L	H
L	X	X	X	X	L	H	H	H	L	H	H	L	H
L	X	X	X	L	H	H	H	H	H	L	L	L	H
L	X	X	L	H	H	H	H	H	H	L	H	L	H
L	X	L	H	H	H	H	H	H	H	H	L	L	H
L	L	H	H	H	H	H	H	H	H	H	H	L	H

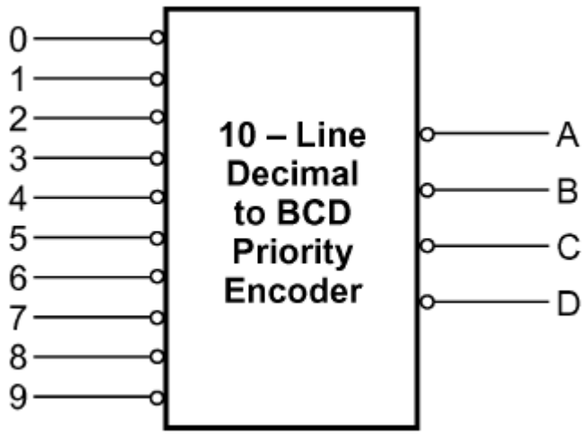




8-to-3 priority encoder IC 74148

Decimal-to-BCD Encoder



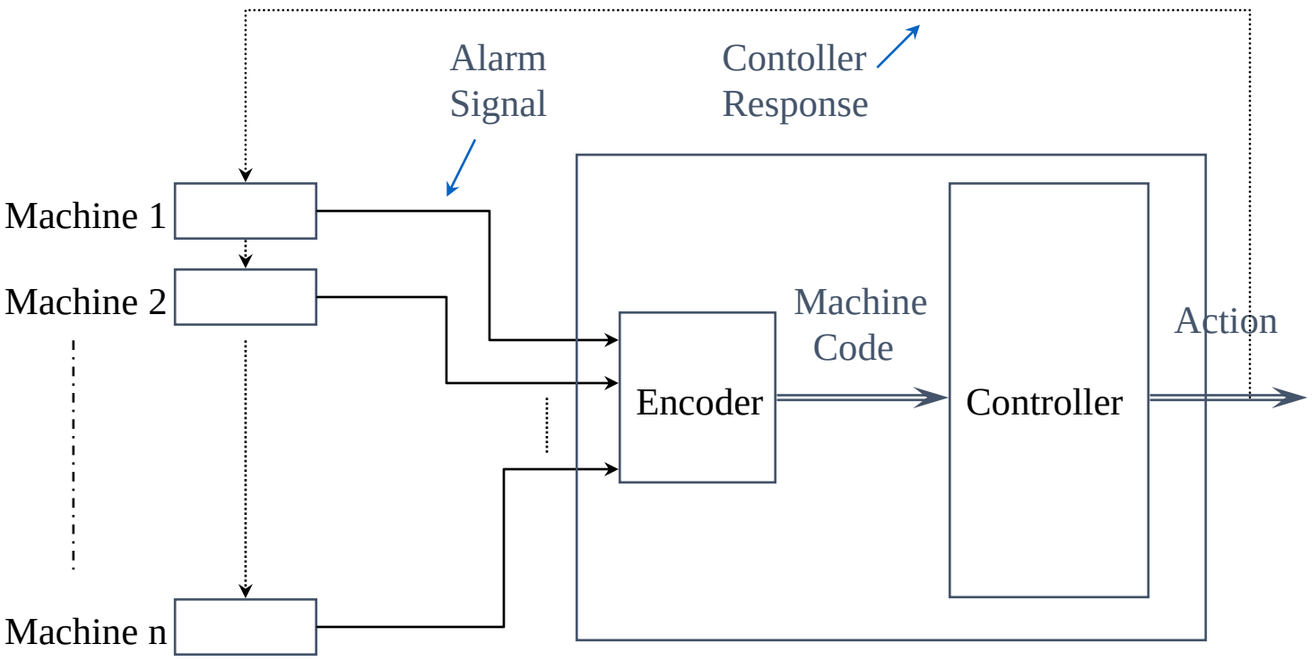


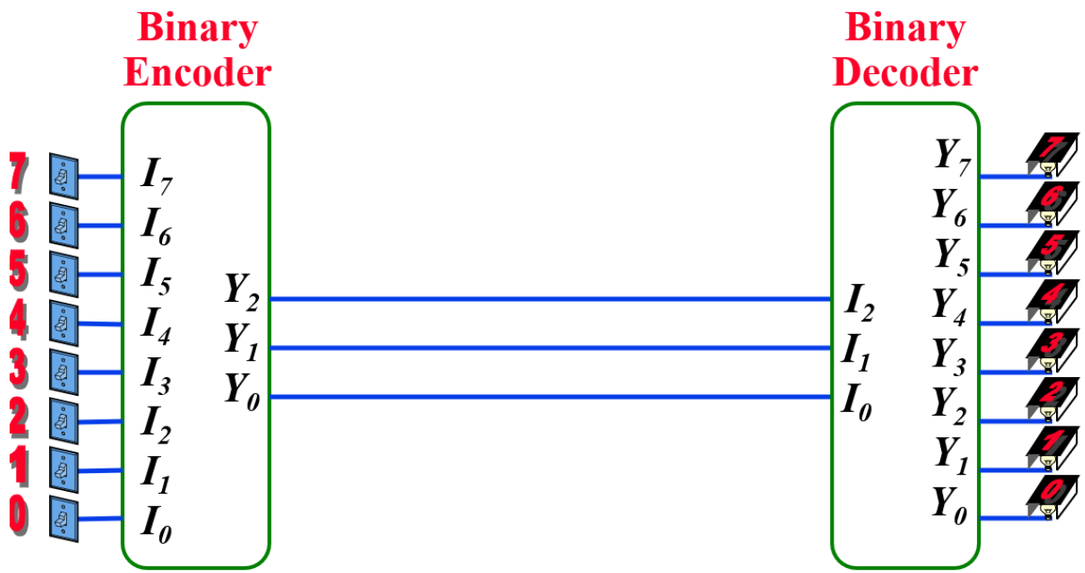
$\overline{A}_1$	$\overline{A}_2$	$\overline{A}_3$	$\overline{A}_4$	$\overline{A}_5$	$\overline{A}_6$	$\overline{A}_7$	$\overline{A}_8$	$\overline{A}_9$	$\overline{O}_3$	$\overline{O}_2$	$\overline{O}_1$	$\overline{O}_0$
1	1	1	1	1	1	1	1	1	1	1	1	1
X	X	X	X	X	X	X	X	0	0	1	1	0
X	X	X	X	X	X	X	0	1	0	1	1	1
X	X	X	X	X	X	0	1	1	1	0	0	0
X	X	X	X	X	0	1	1	1	1	0	0	1
X	X	X	X	0	1	1	1	1	1	0	1	0
X	X	X	0	1	1	1	1	1	1	0	1	1
X	X	0	1	1	1	1	1	1	1	1	0	0
X	0	1	1	1	1	1	1	1	1	1	0	1
0	1	1	1	1	1	1	1	1	1	1	1	0

Encoder Application (Monitoring Unit)

Encoder identifies the requester and encodes the value

Controller accepts digital inputs.





Encoder Applications

1. Keyboard encoder for computers
2. Optical encoders –linear or rotary
3. Interfacing peripherals to microprocessors
4. Audio/video coding and transmission