Useful Digital Circuits

Combinatorial Circuits II

Derivation of logical expressions from truth tables

SOP (Sum Of Products) form:

- ➢Write an AND term for each input that produces a 1 output
  - Write the variable if its value is 1; complement otherwise
- ➢OR the AND terms to get the final expression

A	**B**	**C**	**F**	**Minterms**
0	0	0	0	
0	0	1	0	
0	1	0	0	
0	1	1	1	--> $\overline{A}BC$
1	0	0	0	
1	0	1	1	--> $A\overline{B}C$
1	1	0	1	--> $AB\overline{C}$
1	1	1	1	--> ABC

Sum of Minterms

$$F = \overline{A}BC + A\overline{B}C + AB\overline{C} + ABC$$

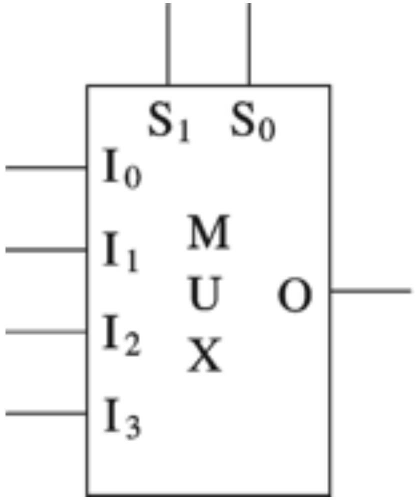
The POS form

The Product of Sums form is the **dual** of the **SOP** form.

A	B	C	F	Maxterms
0	0	0	0	(A+B+C)
0	0	1	0	(A+B+bar(C))
0	1	0	0	(A+ bar(B) +bar(C)
0	1	1	1	— — —
1	0	0	0	(bar(A) + B + C)
1	0	1	1	
1	1	0	1	
1	1	1	1	

The Multiplexer

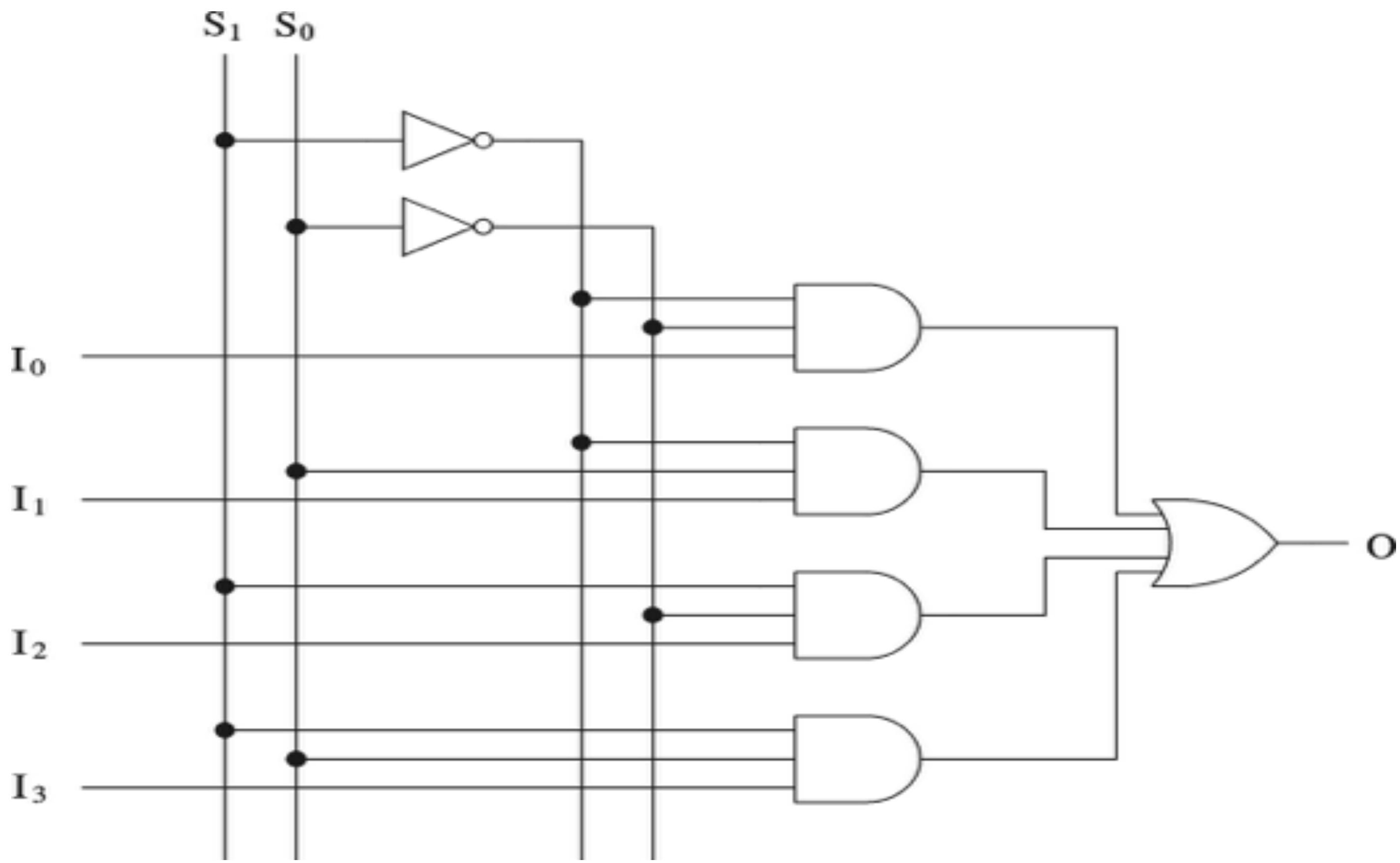
- Multiplexer
  - 2^n data inputs
  - n selection inputs
  - a single output



S_1	S_0	O
0	0	I_0
0	1	I_1
1	0	I_2
1	1	I_3

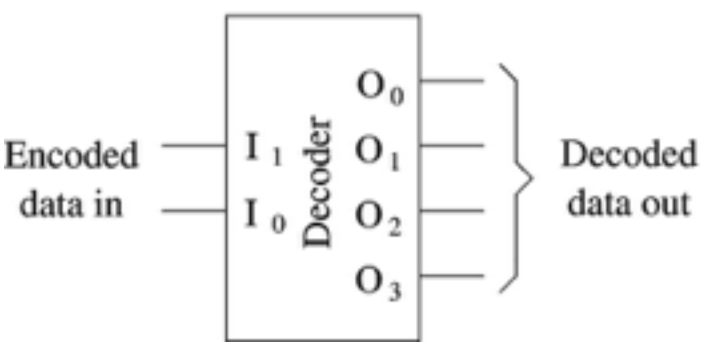
- Selection input determines the input that should be connected to the output

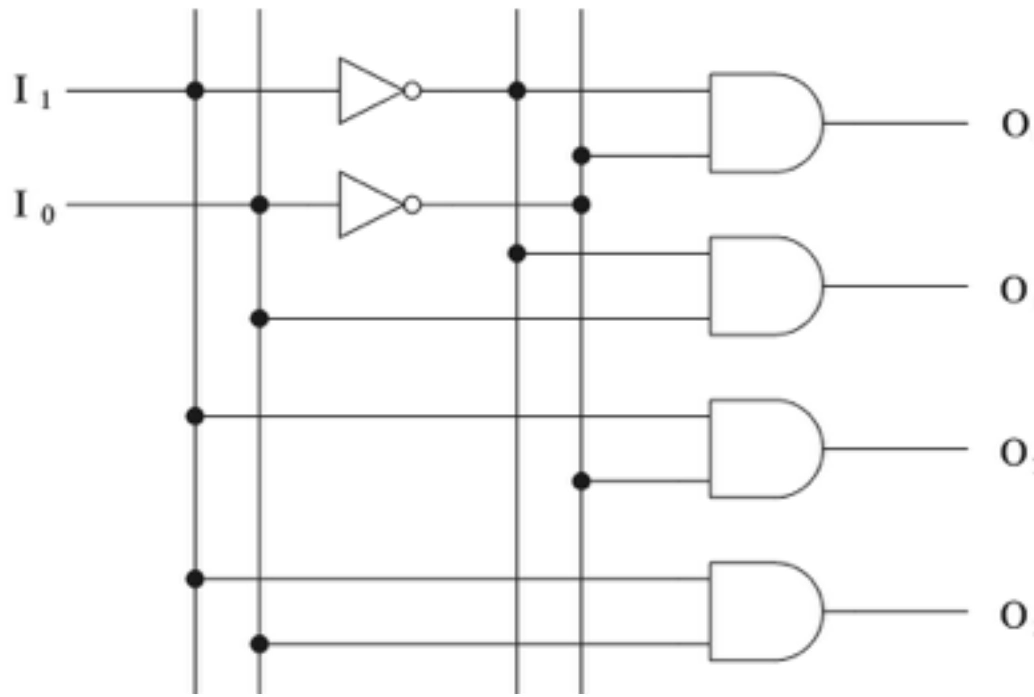
4 to 1 Mux Implementation



A decoder is a circuit that converts binary information from the n coded inputs to a maximum of 2^n unique o/p.

I_1	I_0	O_3	O_2	O_1	O_0
0	0	0	0	0	1
0	1	0	0	1	0
1	0	0	1	0	0
1	1	1	0	0	0





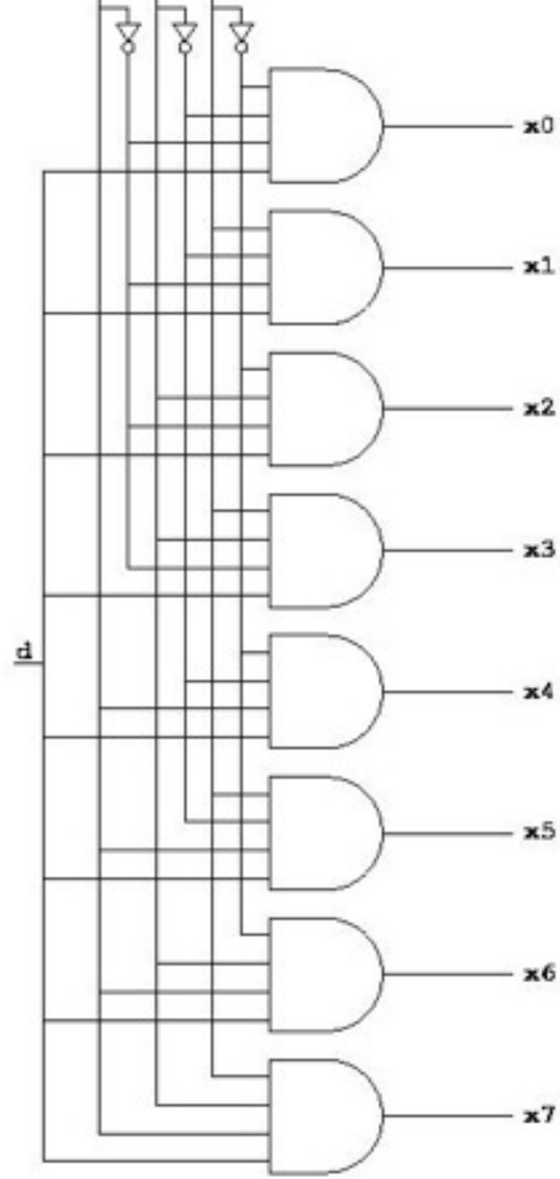
The Demux

- The inverse of the MUX; it has:

2^n outputs, 1 input and n selectors (addressing) terminals

a2	a1	a0	d	x7	x6	x5	x4	x3	x2	x1	x0
0	0	0	c	0	0	0	0	0	0	0	c
0	0	1	c	0	0	0	0	0	0	c	0
0	1	0	c	0	0	0	0	0	c	0	0
0	1	1	c	0	0	0	0	c	0	0	0
1	0	0	c	0	0	0	c	0	0	0	0
1	0	1	c	0	0	c	0	0	0	0	0
1	1	0	c	0	c	0	0	0	0	0	0
1	1	1	c	c	0	0	0	0	0	0	0

Used to send data from a single source to one of a number of destinations. Is also a universal gate.

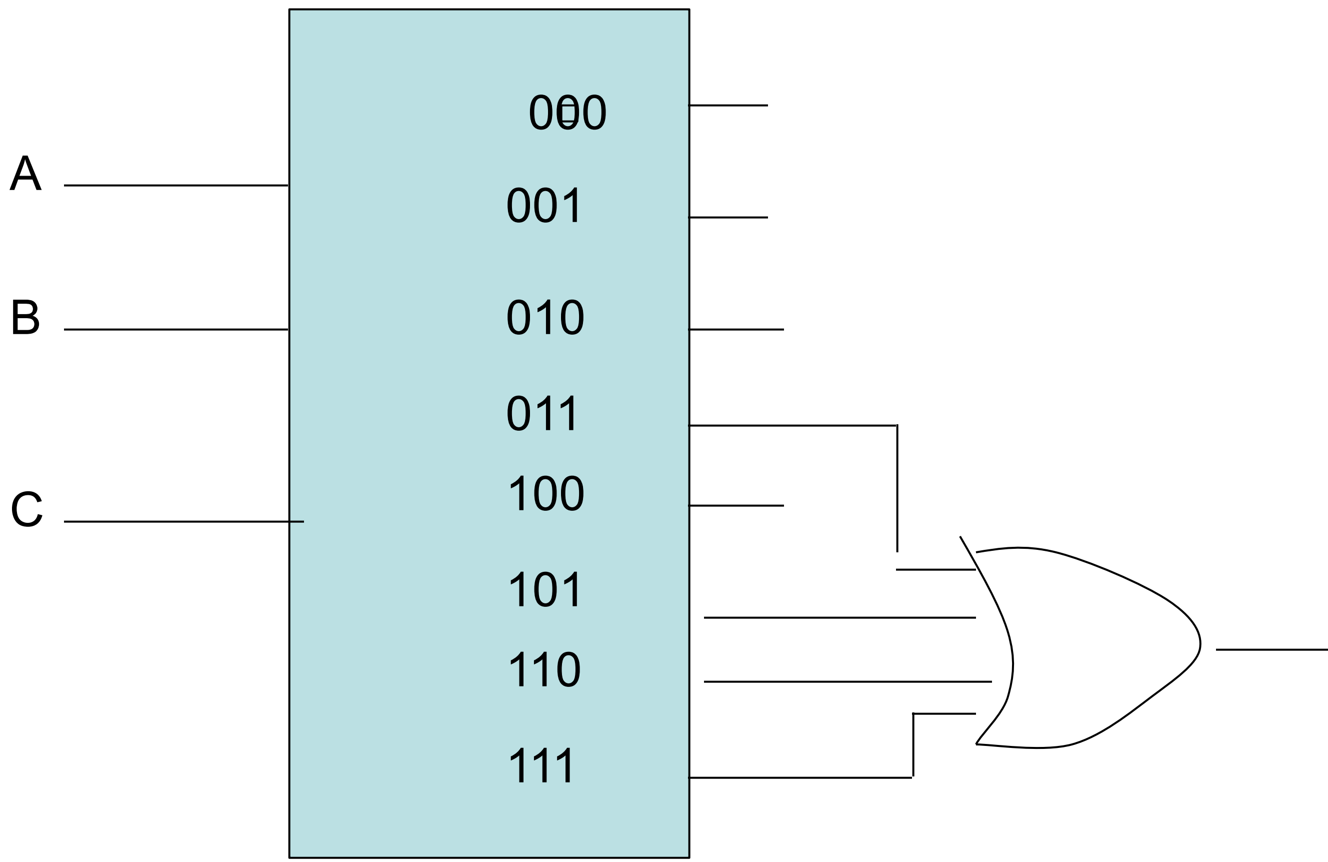


Decoder (contd.)

- Notice, that each o/p of the decoder is a minterm:
- $O_0 = \overline{I_2}\,\overline{I_1}$ $O_1 = \overline{I_2}\,I_1$ $O_2 = I_2\,\overline{I_1}$ & $O_3 = I_2\,I_1$
- Hence ANY B. Func. (which as we saw before, can be expressed as a sum of minterms) can be implemented with an (appropriate) decoder and OR gates.

Example:

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1



Implementing Combinatorial Circuits with a Mux

- Examine the logic circuit of a MUX and compare it to the decoder - the MUX is essentially a decoder with an OR gate putting together all the o/p's
- The minterms of the function are generated by the selector bits and selected by the I/p bits:
- There is a method for impl. an n-variable B. Func. with a MUX with (n-1) selector inputs: (once again the majority func)

A	B	C	F
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

Connect the first (n-1 = 2) varibles to Selector I/p
The remaining var. is used for the data I/ps
which will be C, ~~C,~~ 1 or 0.
Here when AB = 00, F = 0, so apply 0 to I/p 0
when AB = 01, F = C so apply C to I/p 1
when AB = 10, F = C so apply C to I/p 2
when AB = 11, F = 1, so apply 1 to I/p 3