

ITI1100 Section Z

Digital Systems I

Chapter 4:

Combinational Logic (4)

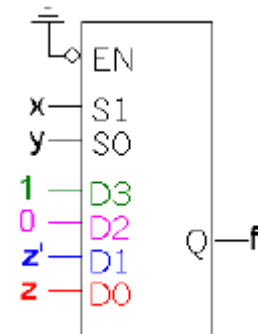
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Implementing Functions with Multiplexers (cont'd)

- More efficient way to implement $f(x,y,z) = \Sigma m(1,2,6,7)$ with just a **4-to-1 MUX**, instead of an **8-to-1 MUX** (i.e. **a function of n variables is to use an 2^{n-1} -to-1 MUX**), as follows:
 - Find the truth table for the function, and **group the rows into pairs**. Within each pair of rows, x and y are the same, so as if **f is a function of z only**
 - When $xy=00$, $f=z$
 - When $xy=01$, $f=z'$
 - When $xy=10$, $f=0$
 - When $xy=11$, $f=1$
 - Connect the first two input variables of the truth table (here, x and y) to the select bits $S1$ $S0$ of the 4-to-1 MUX**
 - Connect the equations above for $f(z)$ to the data inputs $D0$ - $D3$**

x	y	z	f
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	0
1	0	0	0
1	0	1	0
1	1	0	1
1	1	1	1

4x1 MUX

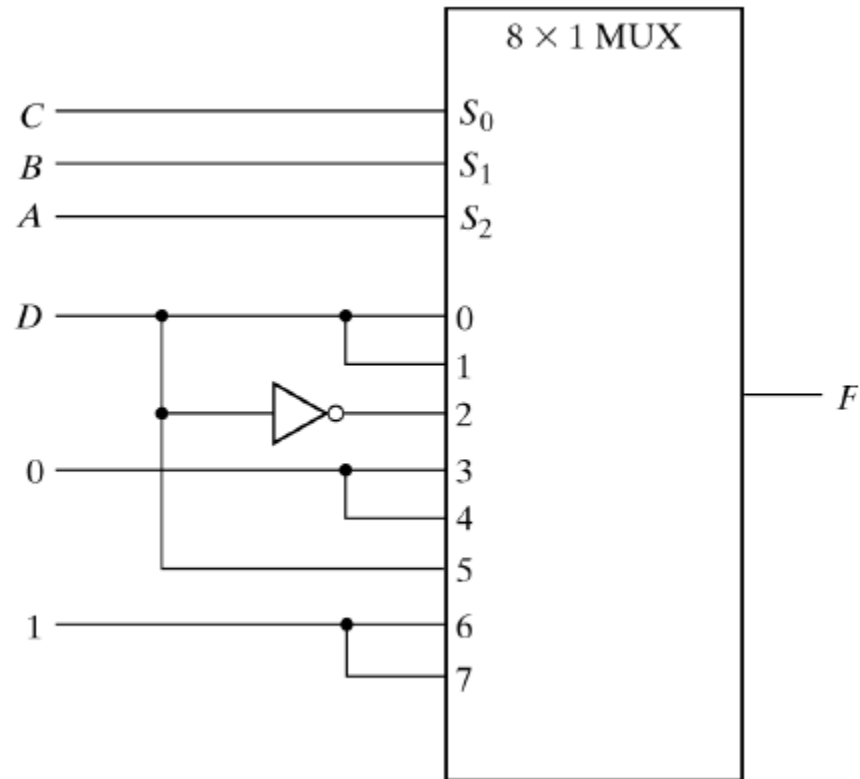


Implementing Functions with Multiplexers (cont'd)

- Example:** Implement the following Boolean function with a multiplexer $f(A,B,C,D) = \sum m(1,3,4,11, 12,13, 14,15)$

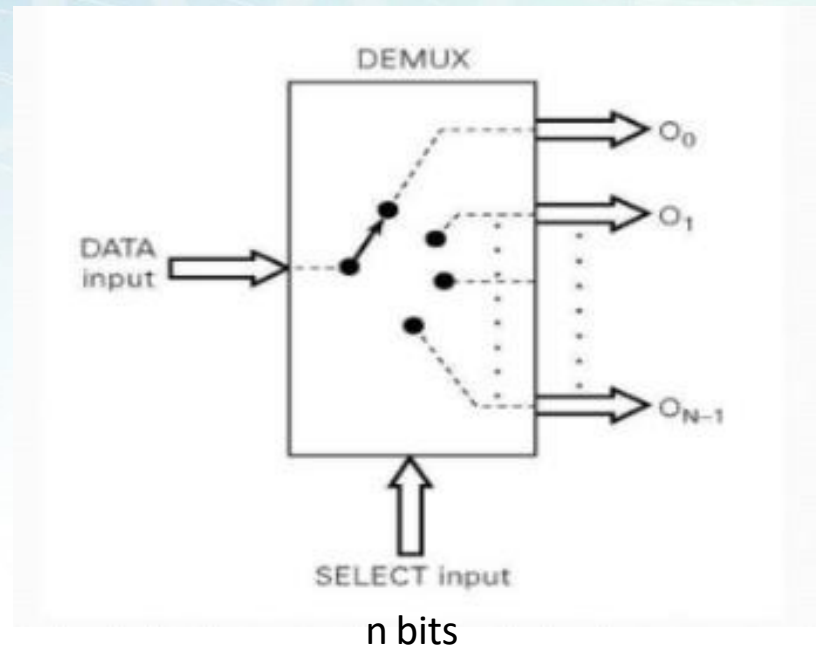
$2^{(4-1)}$ -to-1 MUX

A	B	C	D	F	
0	0	0	0	0	
0	0	0	1	1	$F = D$
0	0	1	0	0	$F = D$
0	0	1	1	1	
0	1	0	0	1	$F = D'$
0	1	0	1	0	
0	1	1	0	0	$F = 0$
0	1	1	1	0	$F = 0$
1	0	0	0	0	$F = 0$
1	0	0	1	0	
1	0	1	0	0	$F = D$
1	0	1	1	1	
1	1	0	0	1	$F = 1$
1	1	0	1	1	
1	1	1	0	1	$F = 1$
1	1	1	1	1	



Demultiplexer

- Demultiplexer (DEMUX or Data Distributor) **takes a single input** and **distributes it over one of the several 2^n outputs** according to the **state of the select variables**

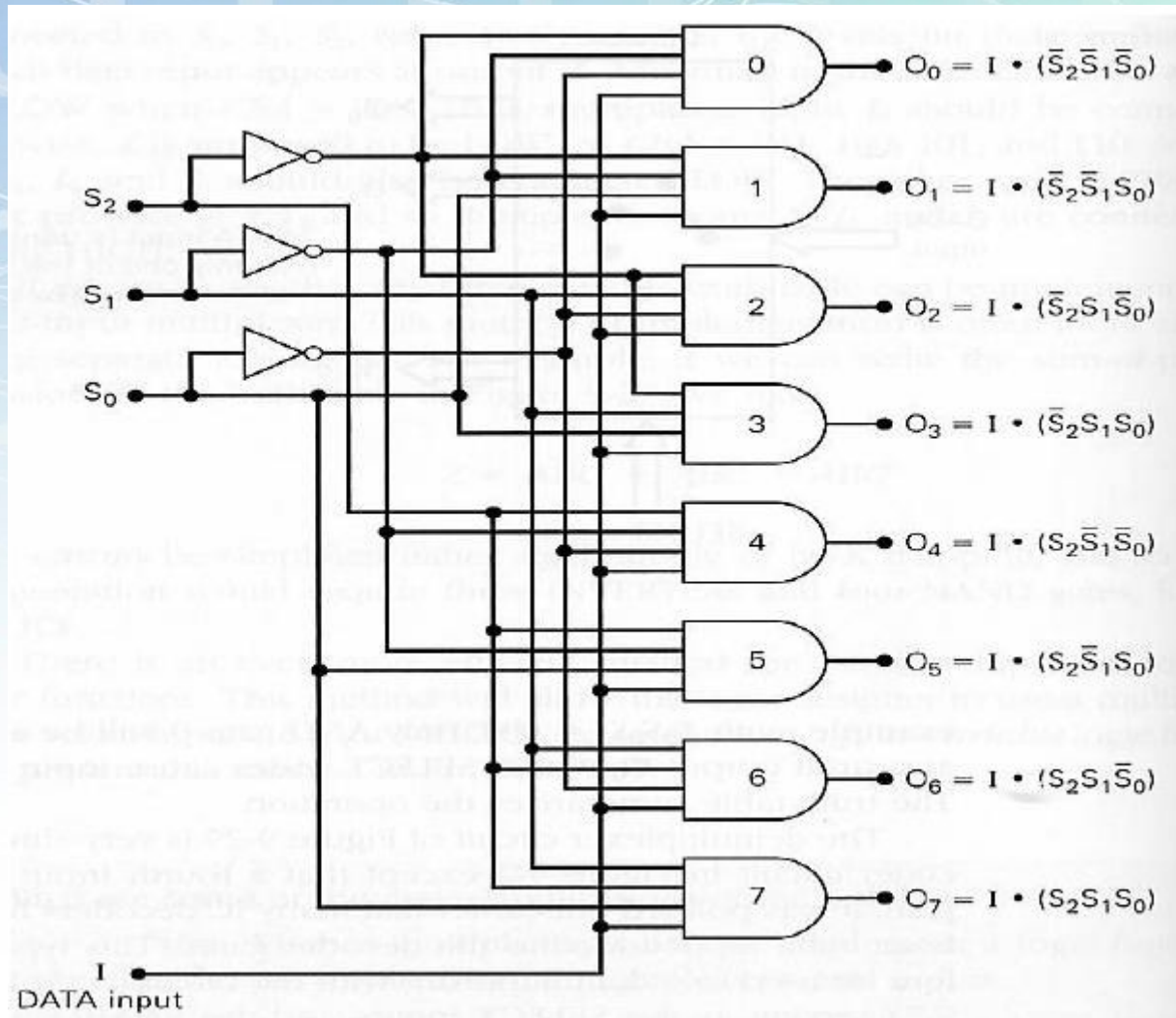


Demultiplexer (cont'd)

Function table of 1-to-8 DEMUX

SELECT code			OUTPUTS							
S ₂	S ₁	S ₀	O ₇	O ₆	O ₅	O ₄	O ₃	O ₂	O ₁	O ₀
0	0	0	0	0	0	0	0	0	0	1
0	0	1	0	0	0	0	0	0	1	0
0	1	0	0	0	0	0	0	1	0	0
0	1	1	0	0	0	0	1	0	0	0
1	0	0	0	0	0	1	0	0	0	0
1	0	1	0	0	1	0	0	0	0	0
1	1	0	0	1	0	0	0	0	0	0
1	1	1	1	0	0	0	0	0	0	0

Demultiplexer (cont'd)



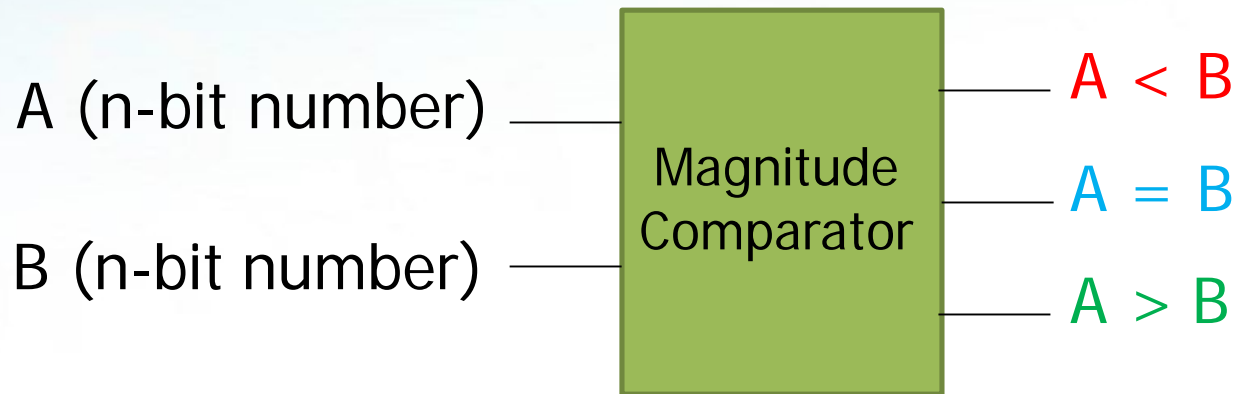
Magnitude Comparator

▪ The comparison of two numbers

- **Magnitude Comparator has three outputs**, one each for equality, $A = B$; greater than, $A > B$; and less than $A < B$

▪ Design Approaches

- **The truth table**
 - 2^{2n} entries; **too cumbersome for large n**
- Functions possess an **inherent regularity** which means that circuits can be designed by means of an **algorithm**



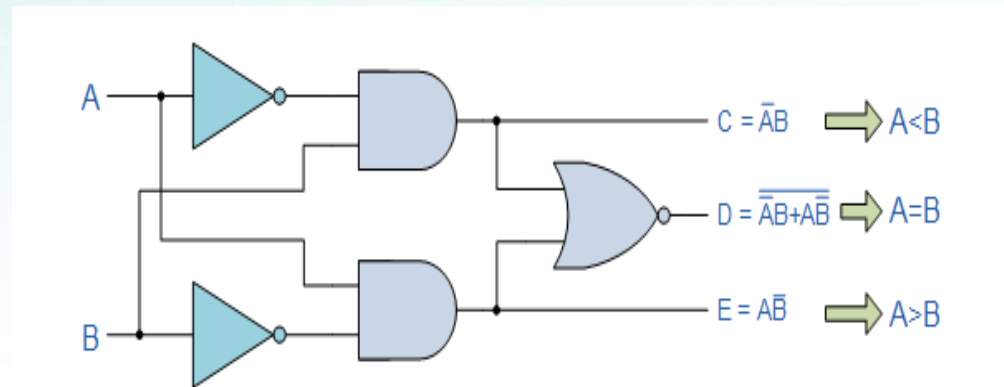
Magnitude Comparator (cont'd)

- **1-bit Digital Comparator:**

Digital Comparator Truth Table

Inputs		Outputs		
B	A	A > B	A = B	A < B
0	0	0	1	0
0	1	1	0	0
1	0	0	0	1
1	1	0	1	0

1-bit Digital Comparator Circuit



Magnitude Comparator (cont'd)

- **4-bit Digital Comparator:**
 - Number of the truth table has $2^{(2 \times 4)} = 2^8 = 256$ rows

