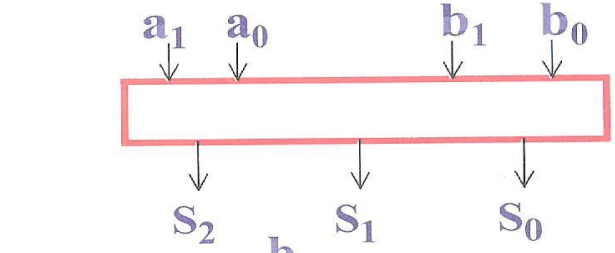
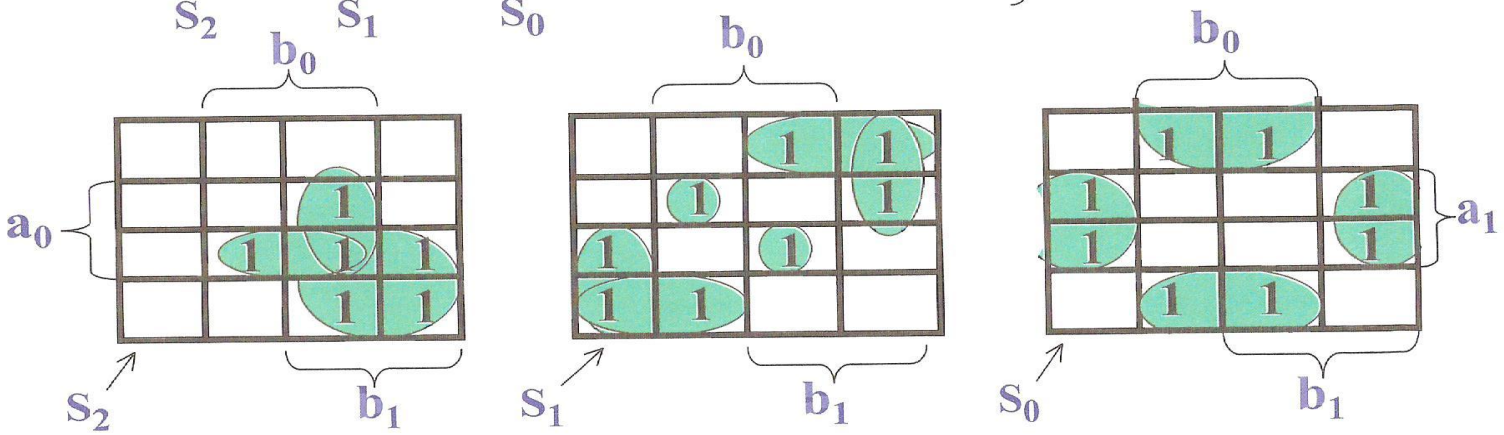
Three Logical Operations
Function 4

- 2-bit Parallel Adder (hard)

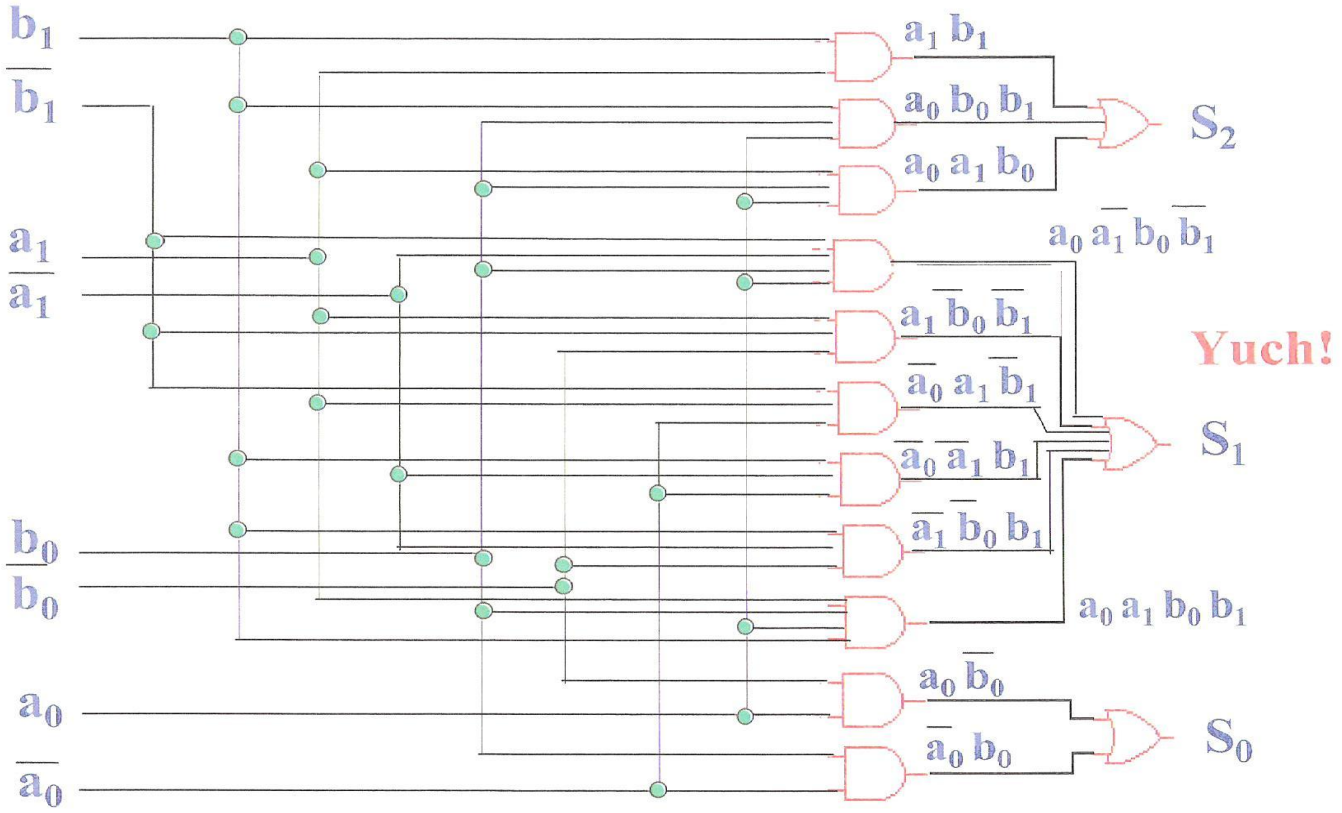


For example

$a_1a_0 = 10$
$b_1b_0 = 11$
$= S_2S_1S_0 = 101$

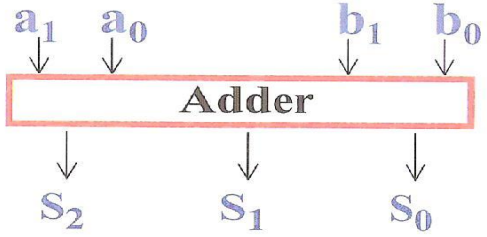


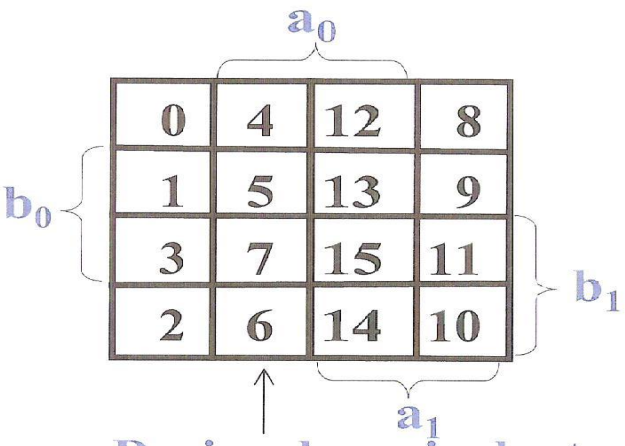
Three Logical Operations
Function 4



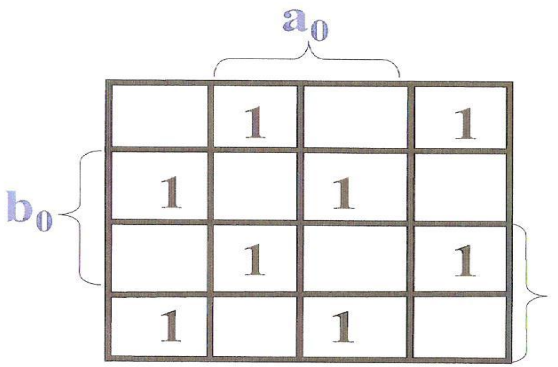
Three Logical Operations
Function 4

- Now return to



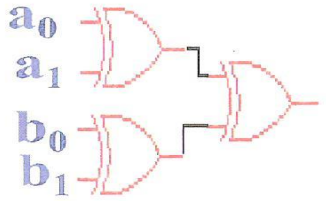


TT = BCD



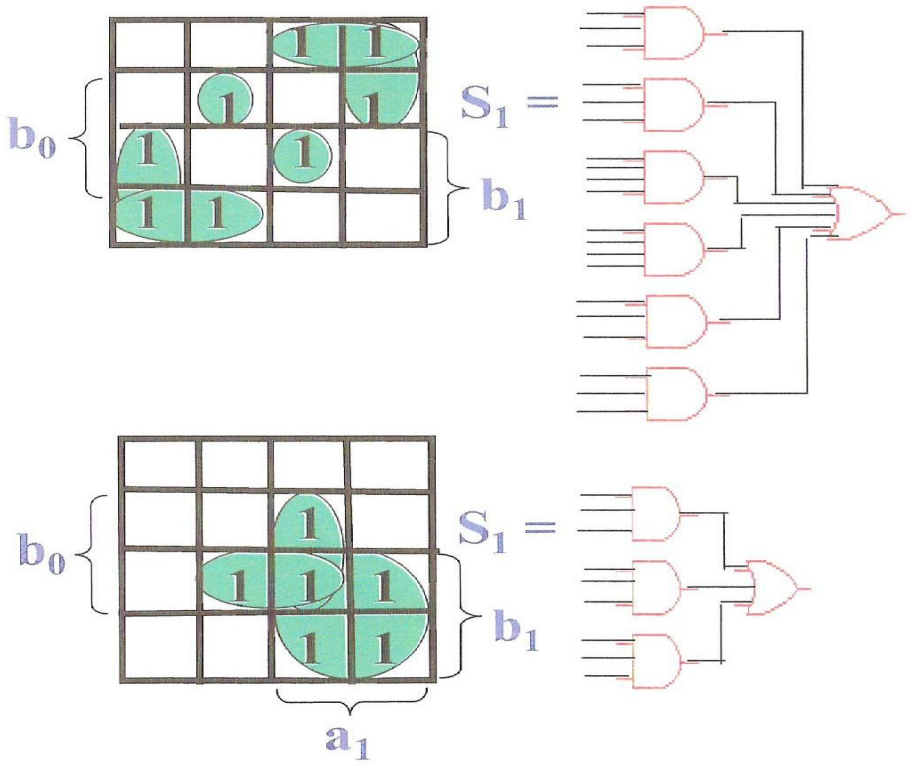
$S_0 = b_0 \oplus b_1 \oplus b_2 \oplus b_3$

All odd numbers



Three Logical Operations

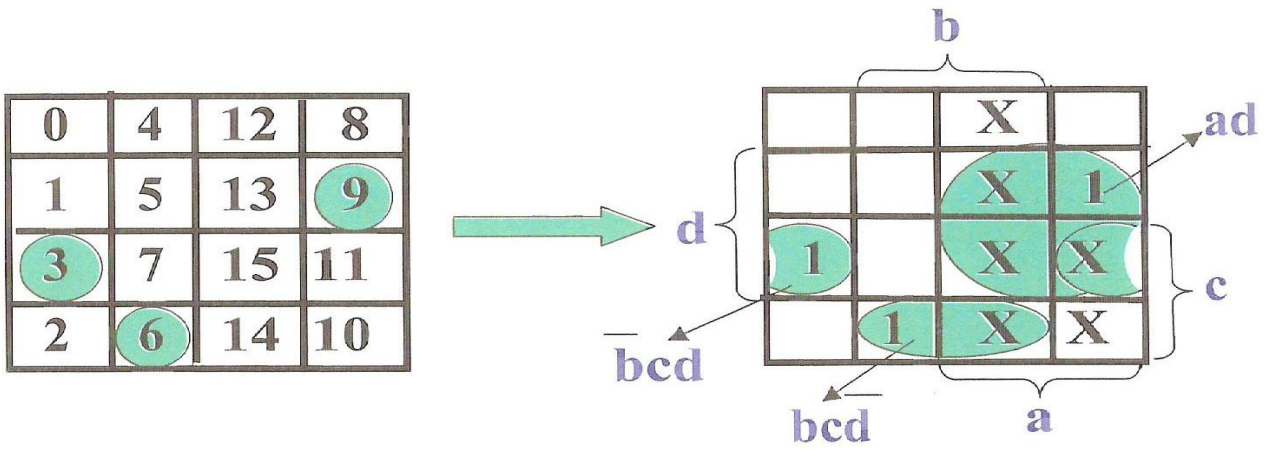
Function 4



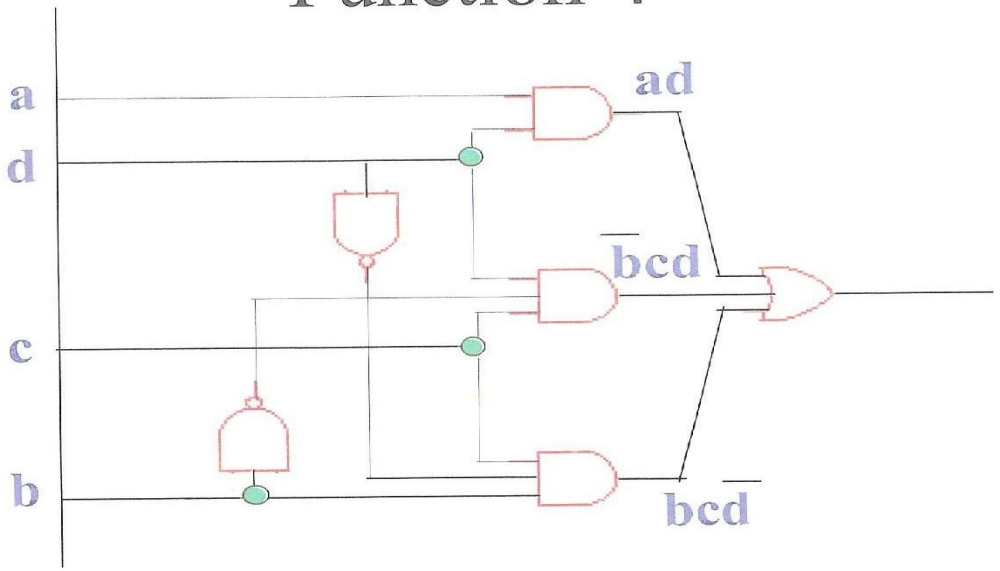
a_1	a_1	a_1	a_1	a_1	a_1	a_1
0	0	0	0	0	0	0
0	0	0	1	0	0	1
0	0	1	0	0	1	0
0	0	1	1	0	1	1
0	1	0	0	0	0	1
0	1	0	1	0	1	0
0	1	1	0	0	1	1
0	1	1	1	1	0	0
1	0	0	0	0	1	0
1	0	0	1	0	1	1
1	0	1	0	1	0	0
1	0	1	1	1	0	1
1	1	0	0	0	1	1
1	1	0	1	1	0	0
1	1	1	0	1	0	1
1	1	1	1	1	1	0

Three Logical Operations
Function 4

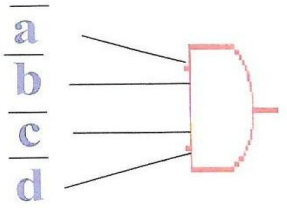
- Example Problem: with "Don't Cares"
  - **Which BCD (Binary Coded Decimal) integers are divisible by 3?**
  - **BCD means 4-bit code but 10-15 not allowed**



Three Logical Operations
Function 4

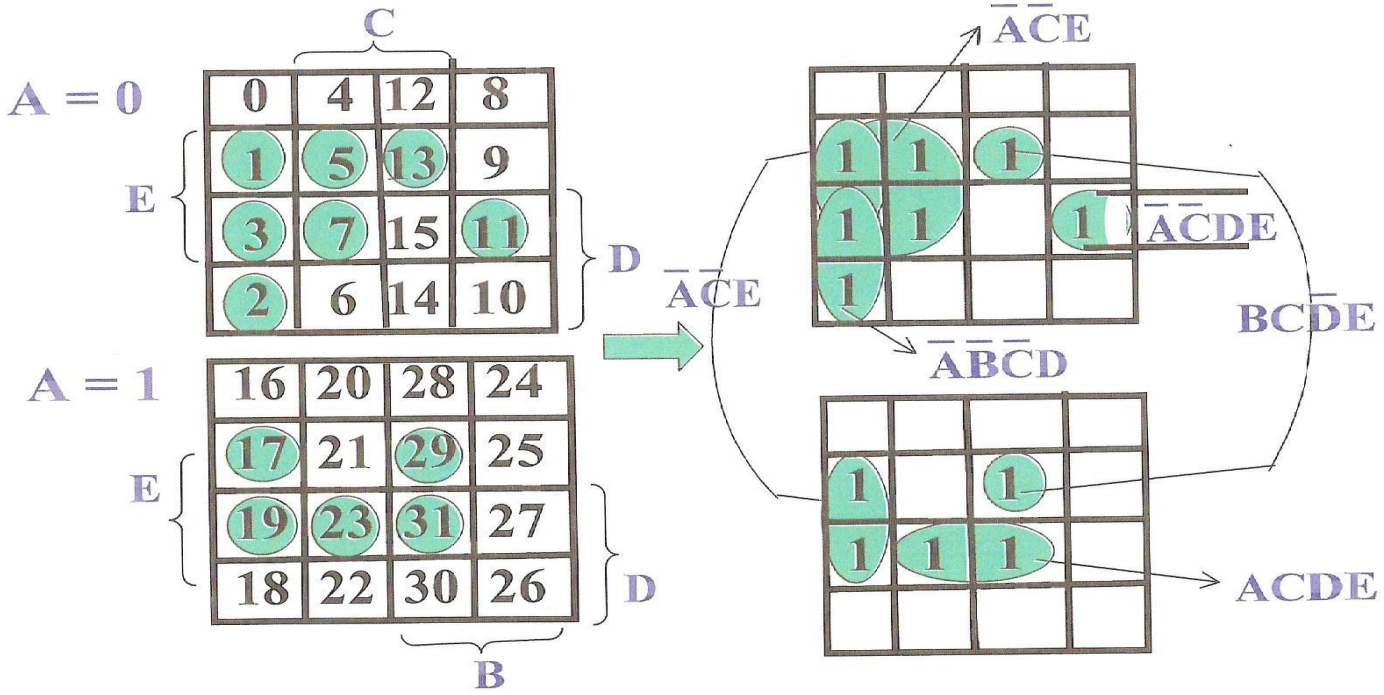


- Is 0 divisible by 3?
  - **If so, need another AND gate:**

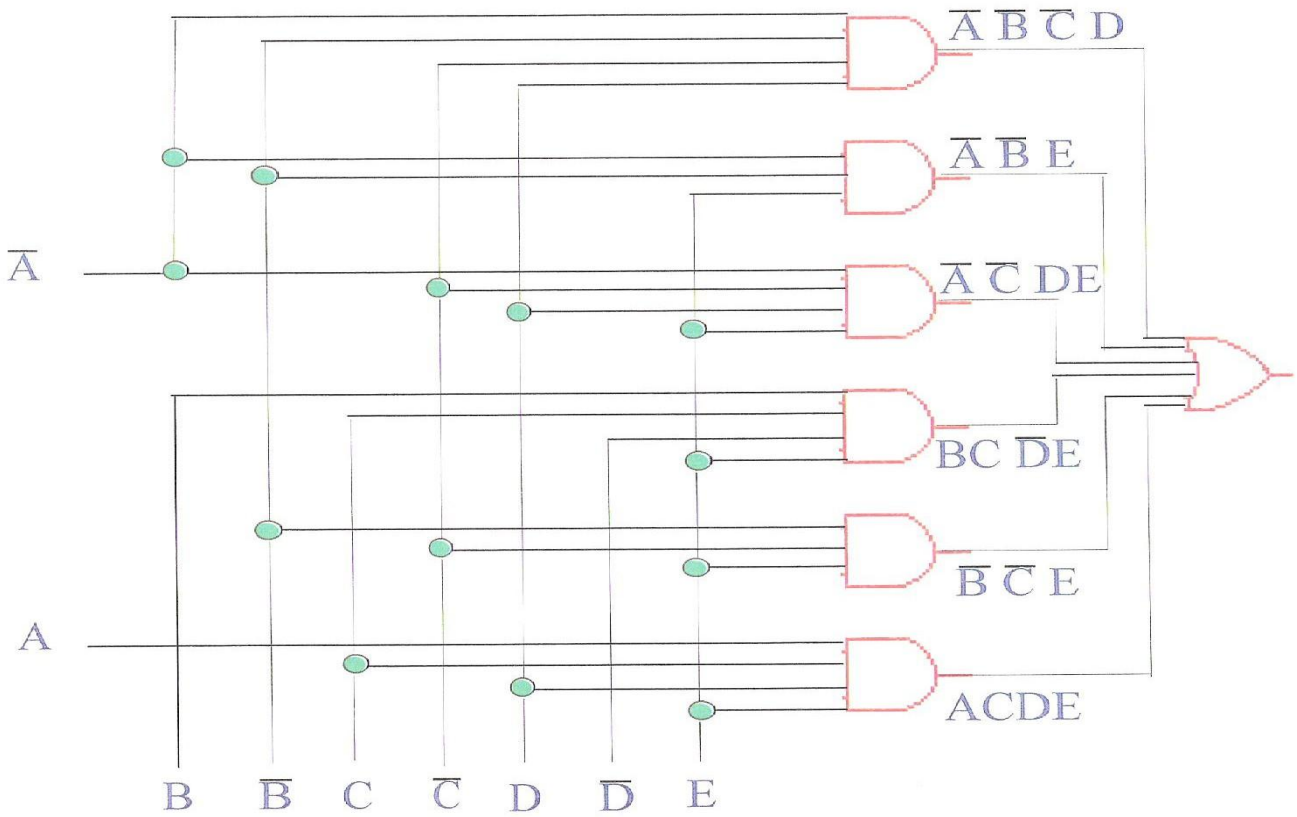


Three Logical Operations
Function 4

- Example Problem: (Very hard)
  - 5 bit Prime Number detector



Three Logical Operations
Function 4



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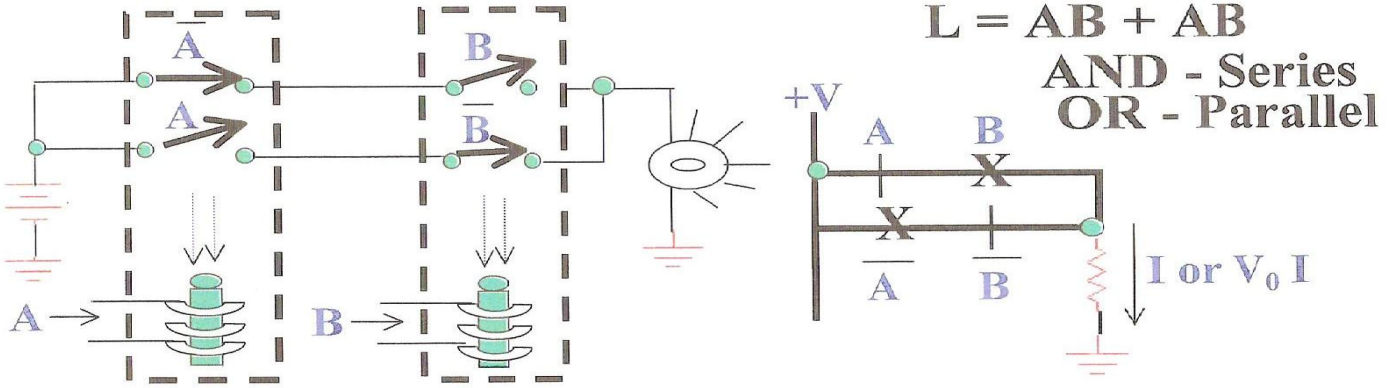
Switches and Relays

- 1. Switches & Relays
- 2. Bipolar Transistor Logic
- 3. FET ICs

Switch/Relay	A Normally Open Contact	$\overline{A}$ Normally Closed Contact
OFF/Released	0	1
ON/Operated	1	0



Switches and Relays

- "Transfer Contact"