Combinatorial Circuits III

The Half Adder, the Full Adder,
the DeMux, the Encoder

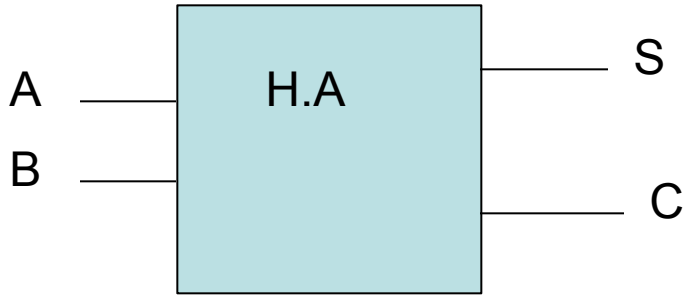
How do you add 2 bits?

A B	S C
0 0	0 0
0 1	1 0
1 0	1 0
1 1	0 1

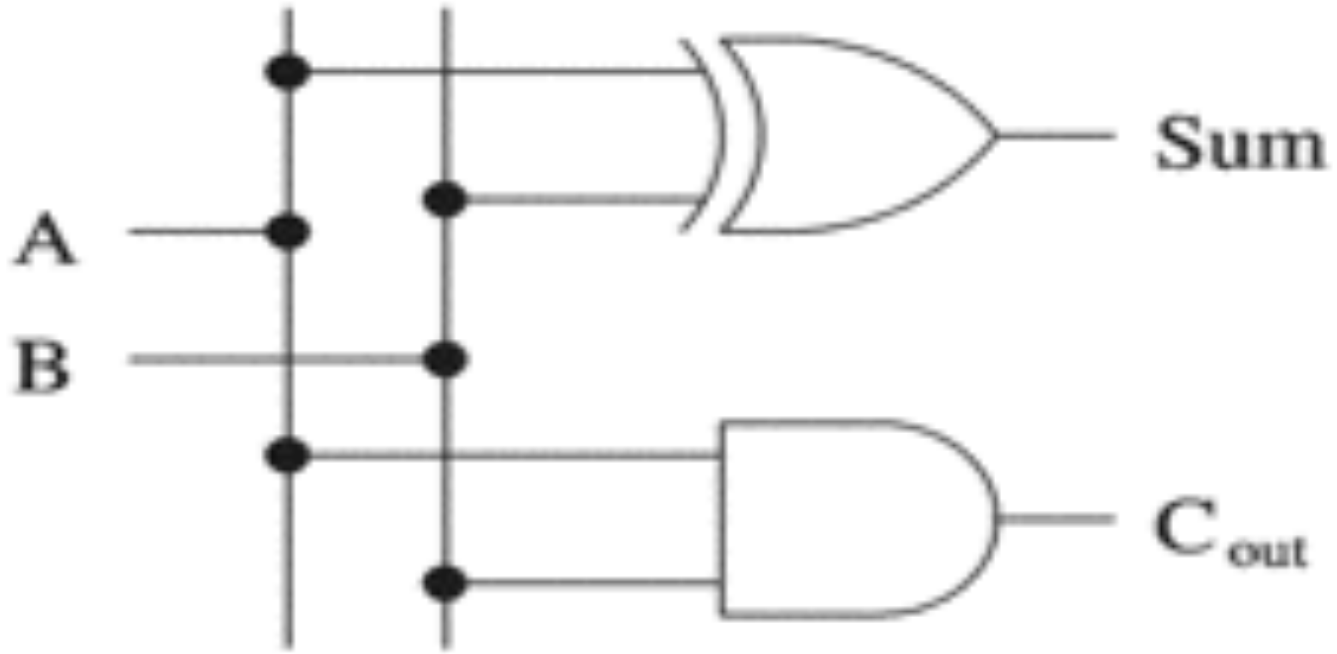
S =

C =

Why ``Half''?

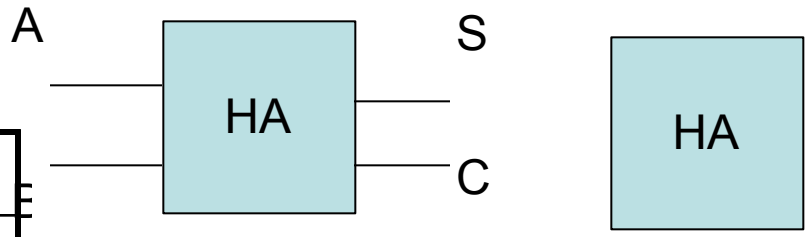


The Half Adder



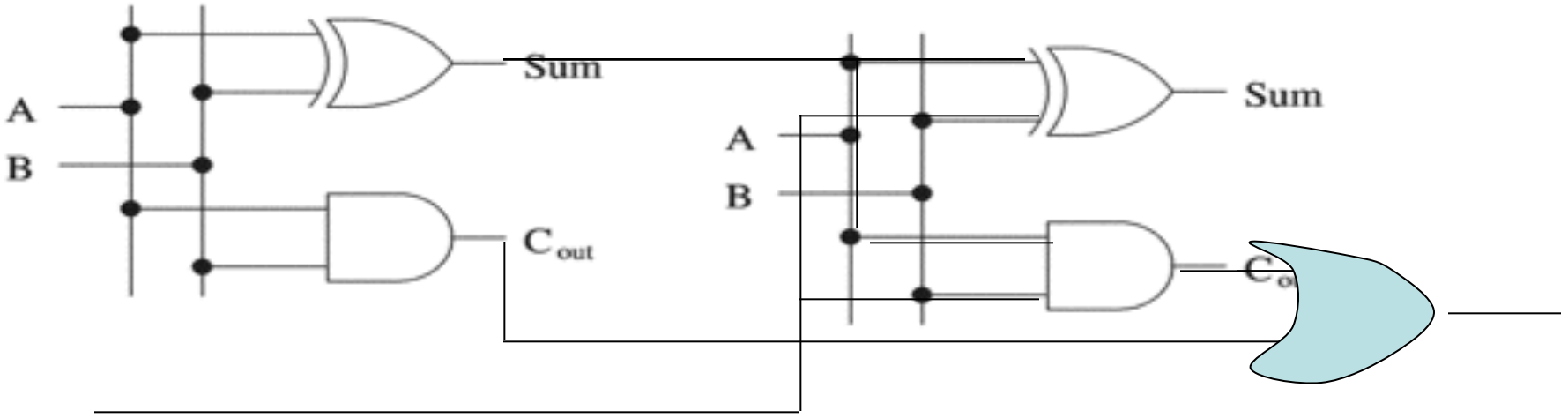
The Full Adder

- Truth table
- Sum =
- C_out =



Cin	A	B	S	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

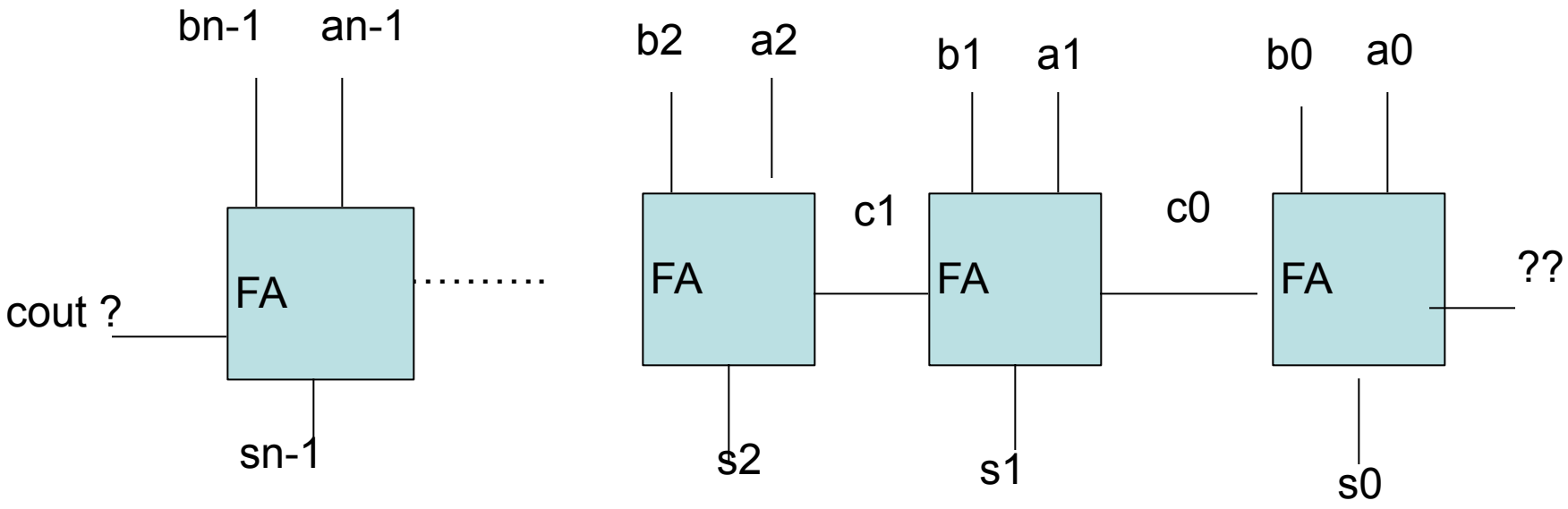
Full Adder



The n-bit Ripple Carry Adder

$a = a_{n-1} \ldots\ldots a_2 a_1 a_0$

$+b = b_{n-1} \ldots\ldots b_2 b_1 b_0$



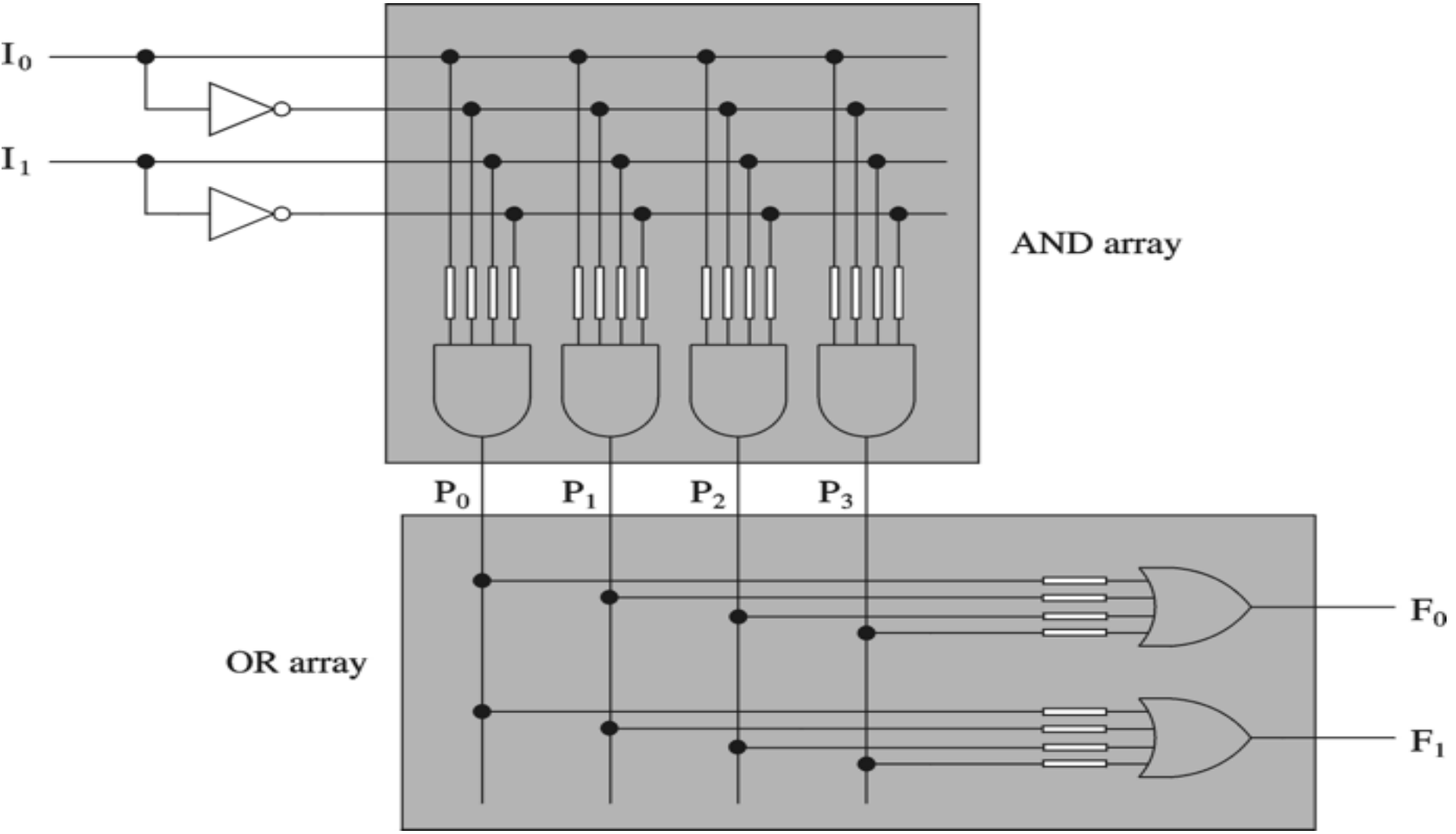
Ripple–Carry Adders (contd.)

- Ripple-carry adders can be slow
  - Delay proportional to number of bits added
- Carry lookahead adders
  - Eliminate the delay of ripple-carry adders -
  - Impl. carry in 2 parts: Gi = Ai.Bi & Pi = Ai xor Bi
  - then C_{i+1} = Gi + Pi.Ci etc.
  - Carry-ins are generated independently
    - $C_0 = A_0 B_0$
    - $C_1 = A_0 B_0 A_1 + A_0 B_0 B_1 + A_1 B_1$
    - . . .
  - Requires complex circuits
  - Usually, a combination carry lookahead and ripple-carry techniques are used

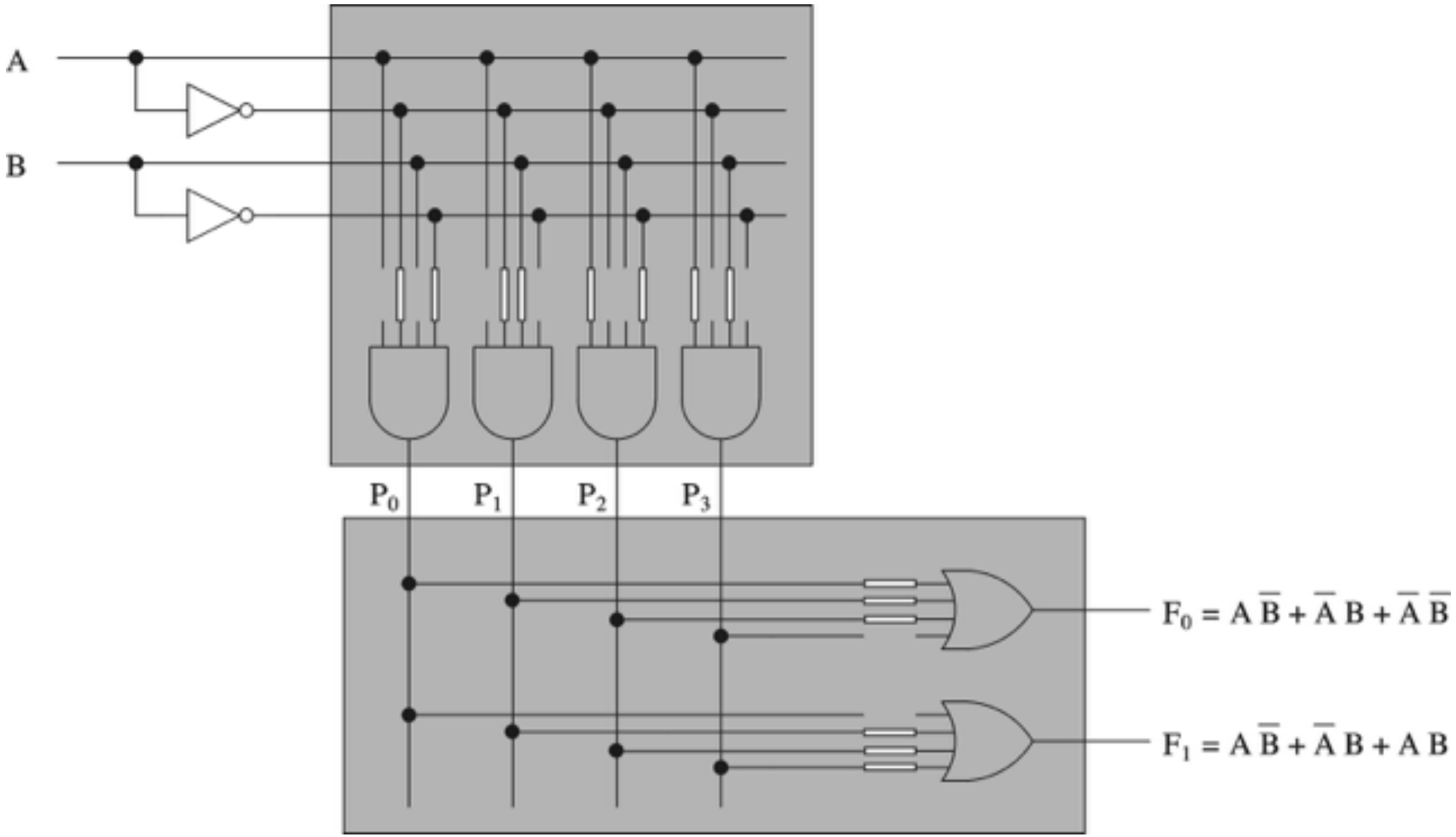
Practical Devices: Programmable Logic Arrays

- PLAs (also fPGA: field P Gate A)
  - Implement sum-of-product expressions
    - No need to simplify the logical expressions
  - Take *N* inputs and produce *M* outputs
    - Each input represents a logical variable
    - Each output represents a logical function output
  - Internally uses
    - An AND array
      - Each AND gate receives 2*N* inputs
        - » *N* inputs and their complements
    - An OR array

A 2 i/p 2 o/p PLA



Implementation of Boolean Functions using PLAs



Encoder/ Priority encoder

- A 2^n to n device that delivers the binary index of a bit pattern.
- Trouble with straight encoder.
- Hence:
- The MSB has highest priority etc.
- Used when multiple devices use the same resource. Each device is granted a priority that is used to resolve any conflicts.

- (circuit in class)

Table for a priority encoder

x_3	x_2	x_1	x_0	y_1	y_0
1	x	x	x	1	1
0	1	x	x	1	0
0	0	1	x	0	1
0	0	0	x	0	0