SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19ECB202 – LINEAR AND DIGITAL CIRCUITS

II YEAR/ III SEMESTER

UNIT 5 – SEQUENTIAL CIRCUITS

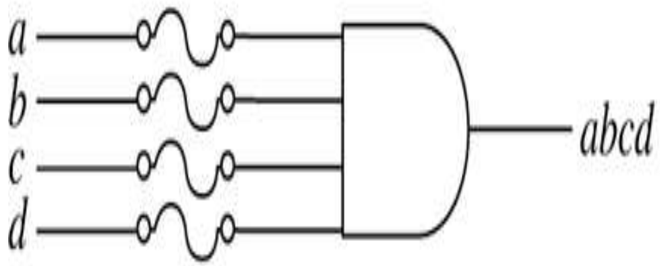
TOPIC 7 – Introduction to PLD implementation

Problem definition

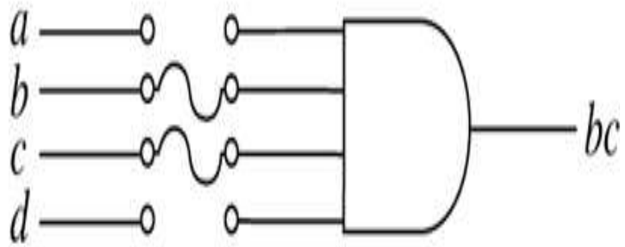
Device	AND-array	OR-array
PROM	Fixed	Programmable
PLA	Programmable	Programmable
PAL	Programmable	Fixed
GAL	Programmable	Fixed

- The differences between the first three categories are these:
  - 1. In a ROM, the input connection matrix is hardwired. The user can modify the output connection matrix.
  - In a PAL/GAL the output connection matrix is hardwired. The user can modify the input connection matrix.
  - In a PLA the user can modify both the input connection matrix and the output connection matrix.

Programming by blowing fuses.



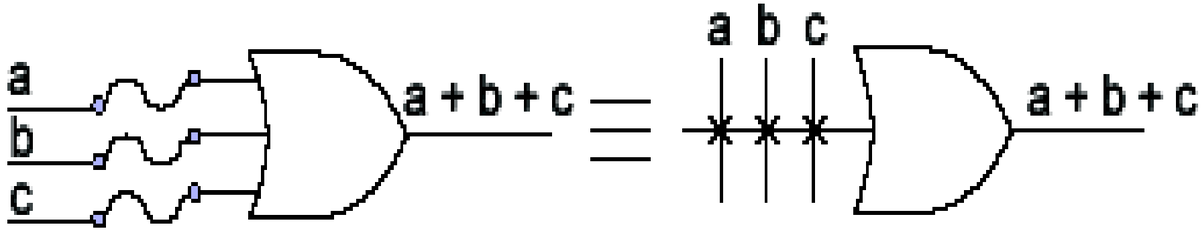
(a)



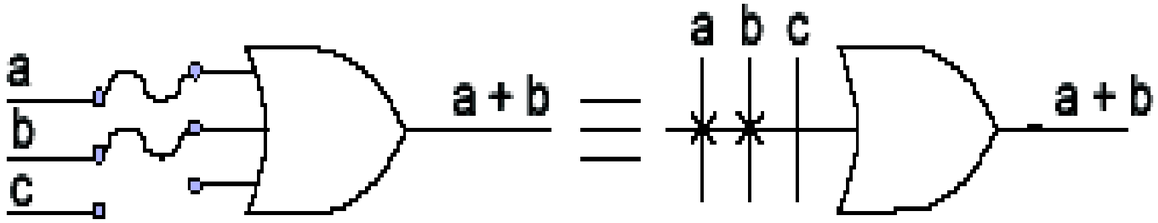
(b)

(*a*) Before programming. **(*b*) After programming.**

OR- PLD Implementation

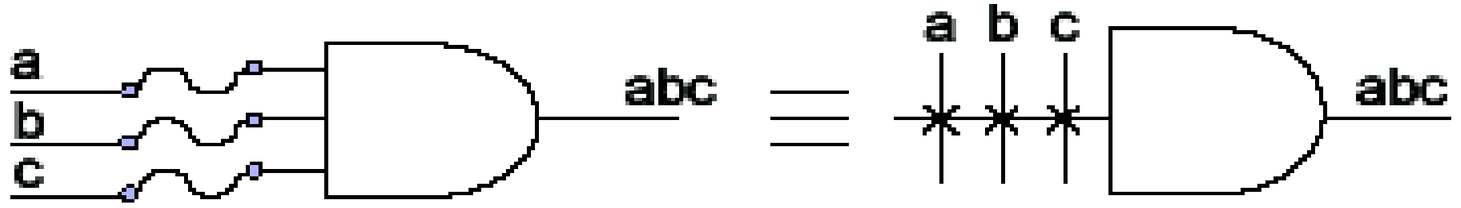


OR gate before programming

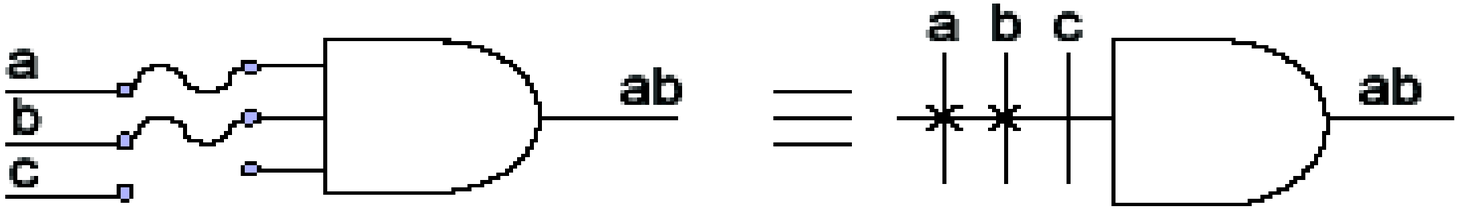


OR gate after programming

AND- PLD Implementation

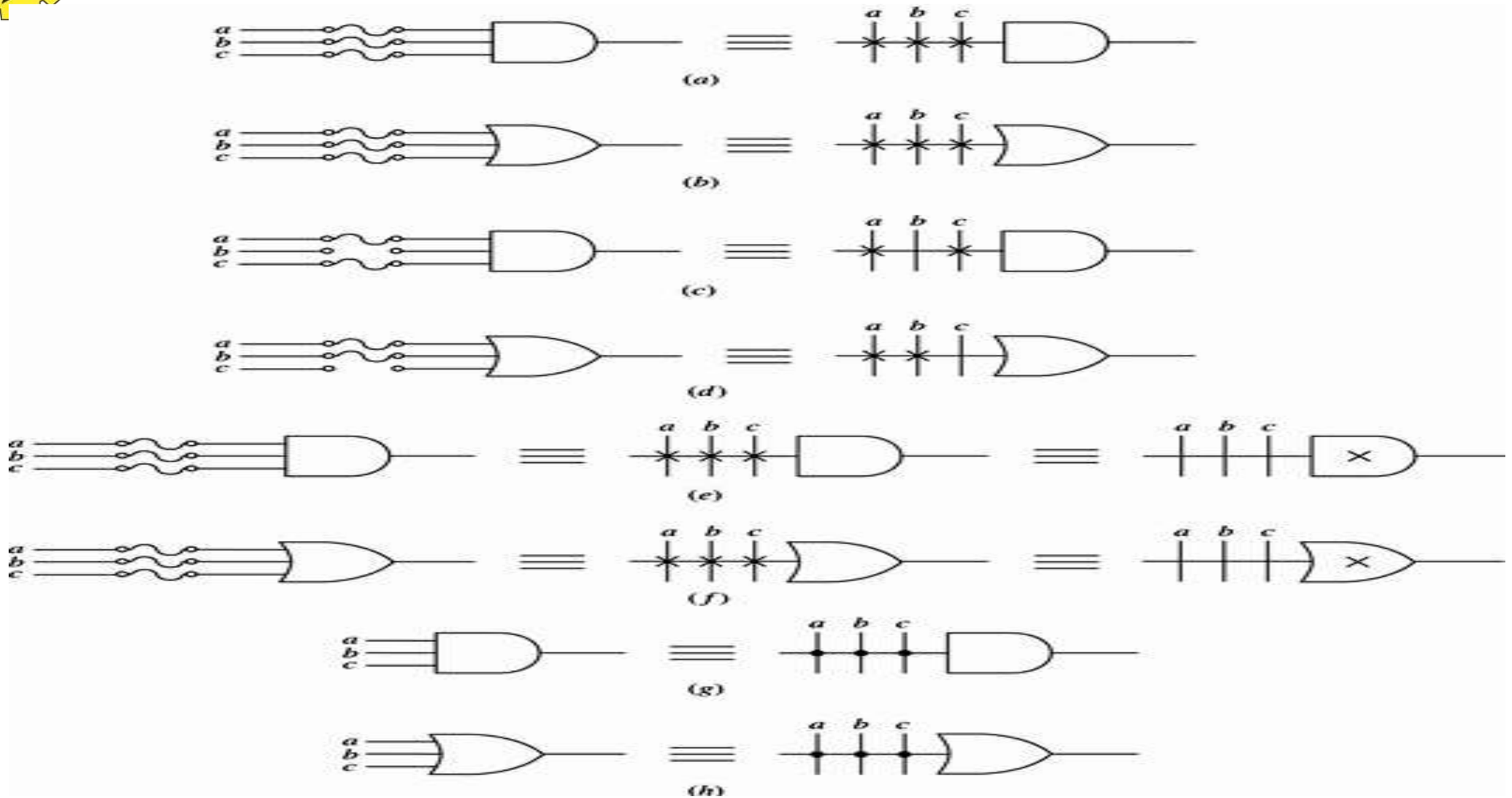


AND gate before programming

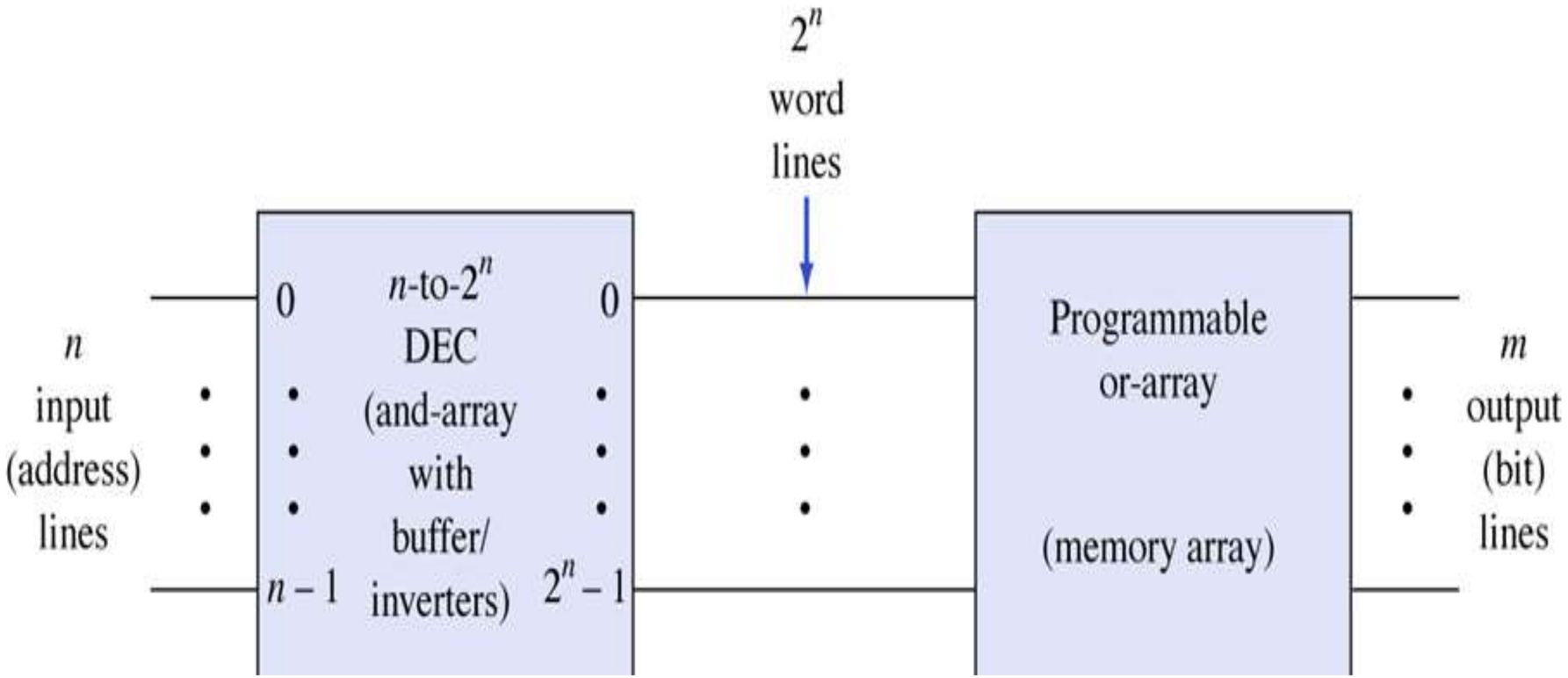


AND gate after programming

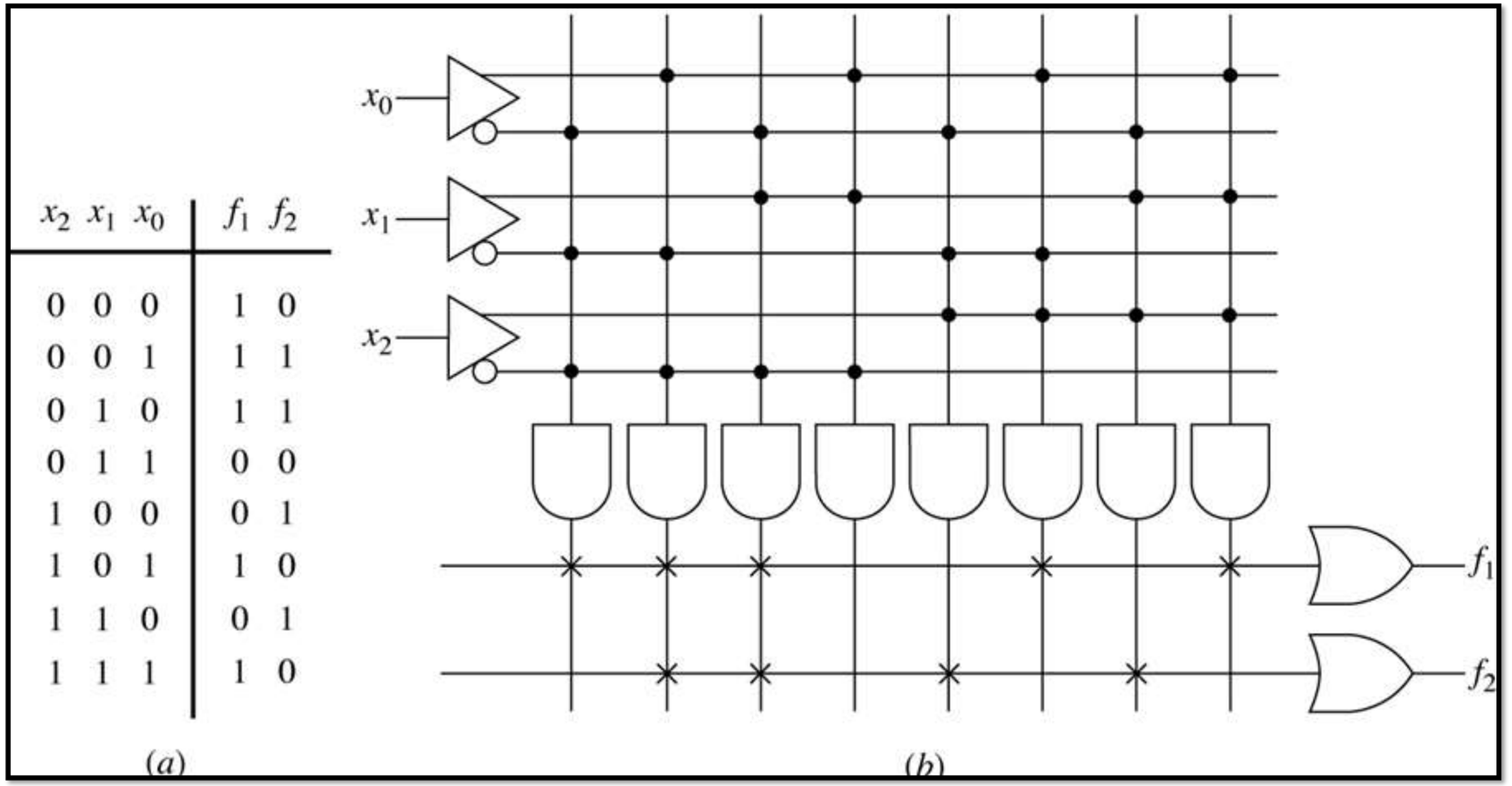
PLDs



PROM Notation



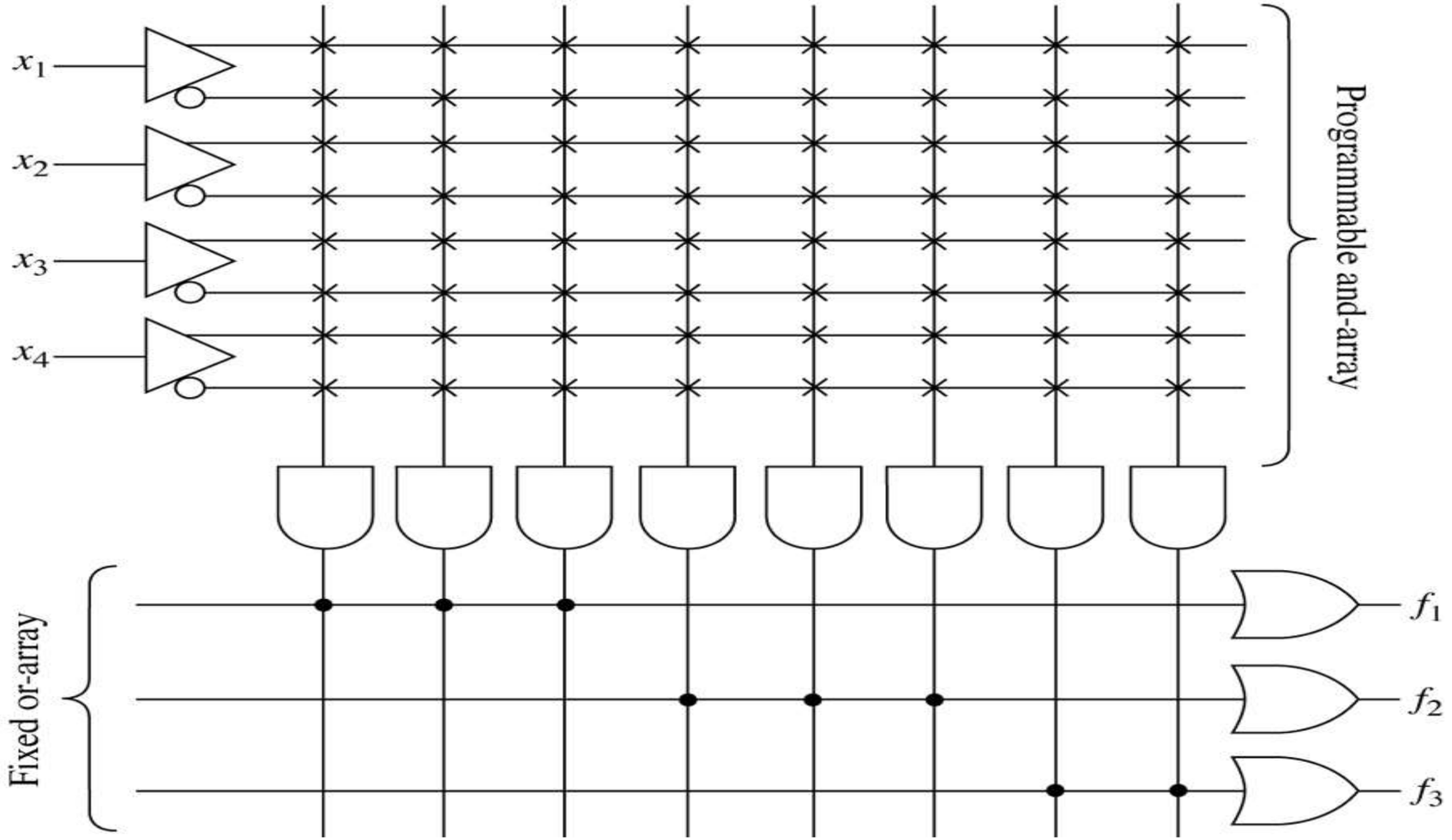
Using a PROM for logic design



x_2	x_1	x_0	f_1	f_2
0	0	0	1	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	0
1	0	0	0	1
1	0	1	1	0
1	1	0	0	1
1	1	1	1	0

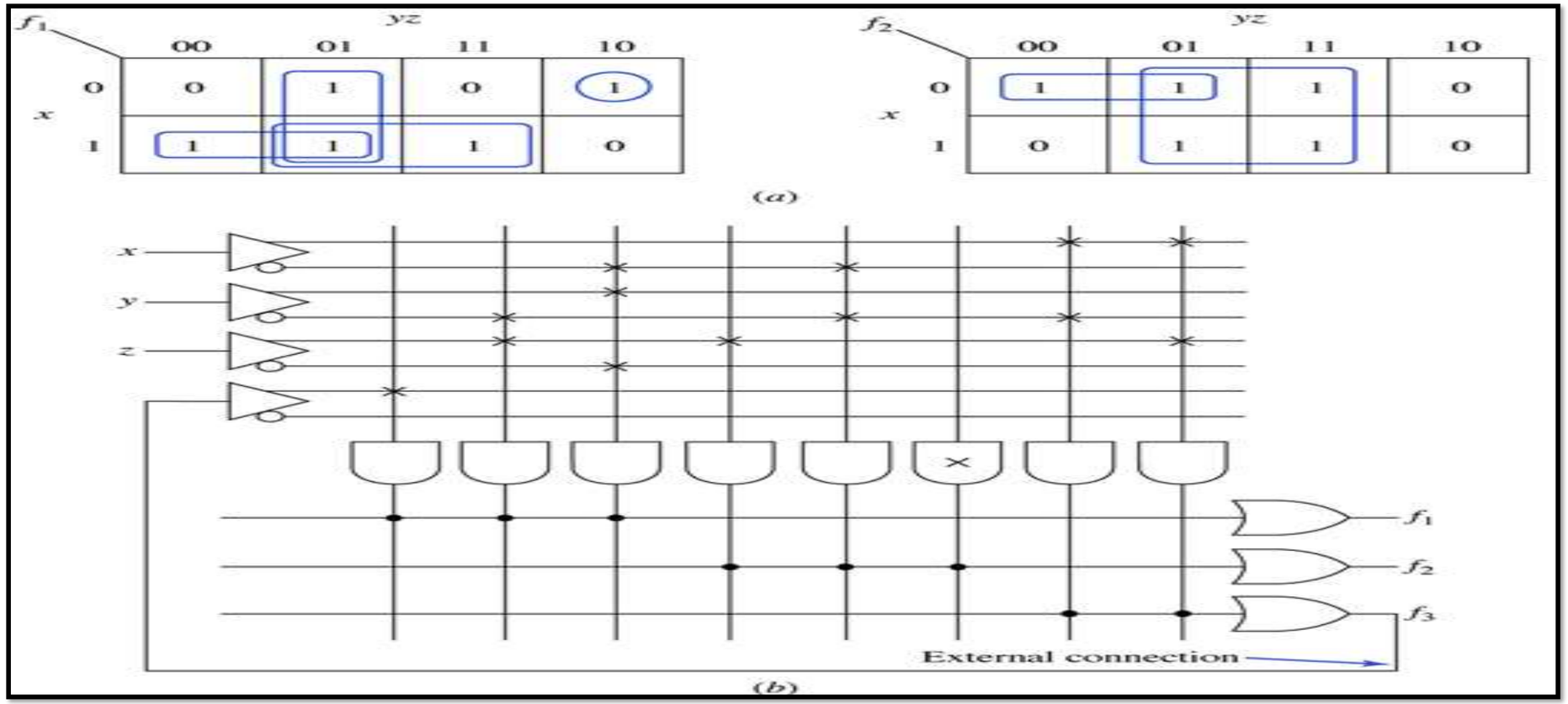
(*a*) Truth table. **(*b*) PROM realization.**

A simple four-input, three-output PAL device.



A simple four-input, three-output PAL device.

An example of using a PAL device to realize two Boolean functions.



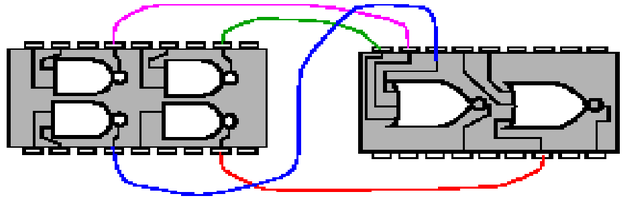
(*a*) Karnaugh maps. **(*b*) Realization.**

Constructing Digital Circuits

Hand Wired Circuits

Cirri 1970-85

- Make 2 to 4 silicon gates in a package.
- Connect with wires.

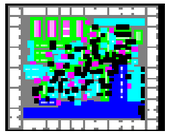


VLSI circuits

Start with a silicon wafer and make:

- the gates
- the interconnections on top

both made together.

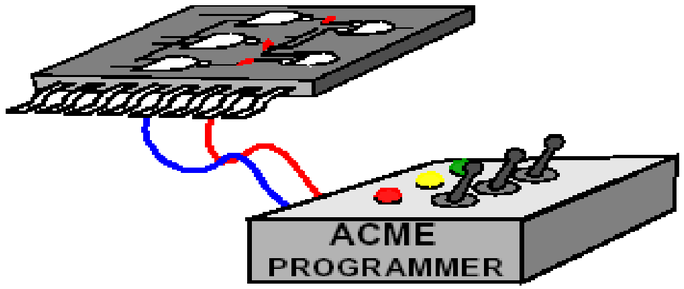


Field Programmable circuits

Start with a silicon wafer and make:

- gates with no connections.
- Make connections later using:

1) electrical means
   - blow fuses, grow anti fuses
   - use memory to hold connections
2) deposit metal lines on top of silicon.

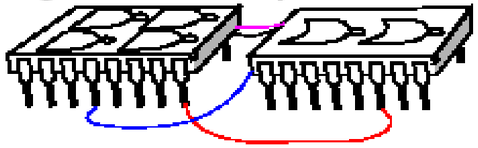


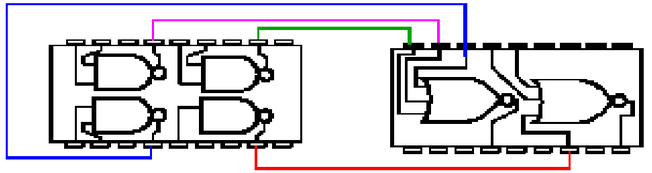
Micro Controllers

Programmable Logic

Different Ways of Connecting Logic

1. Connect Wires
   Few gates on a chip



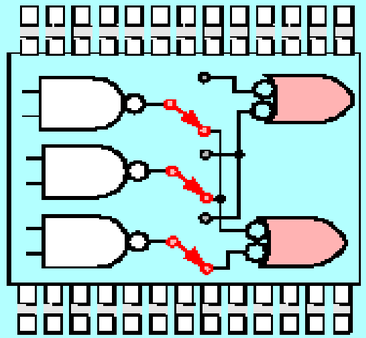


2. Electrically Programmable
   Many gates on a chip

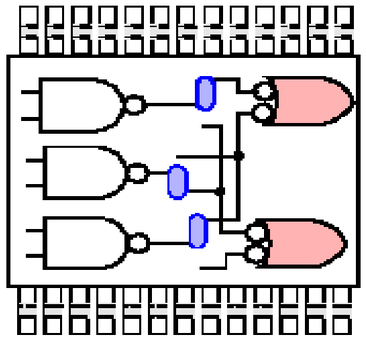
Electrically Controlled Switches

Fuses; blow to remove unwanted connections

Antifuses; grow to make connections

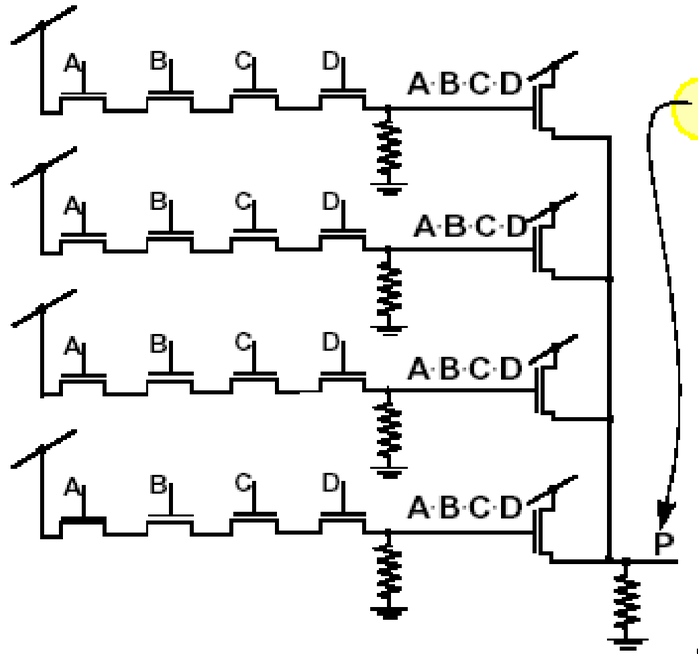


3. Mask Programmable
   Many gates on a chip



Metal blobs deposited over ends of wires to be connected

Array Logic



Combine the AND and OR logic

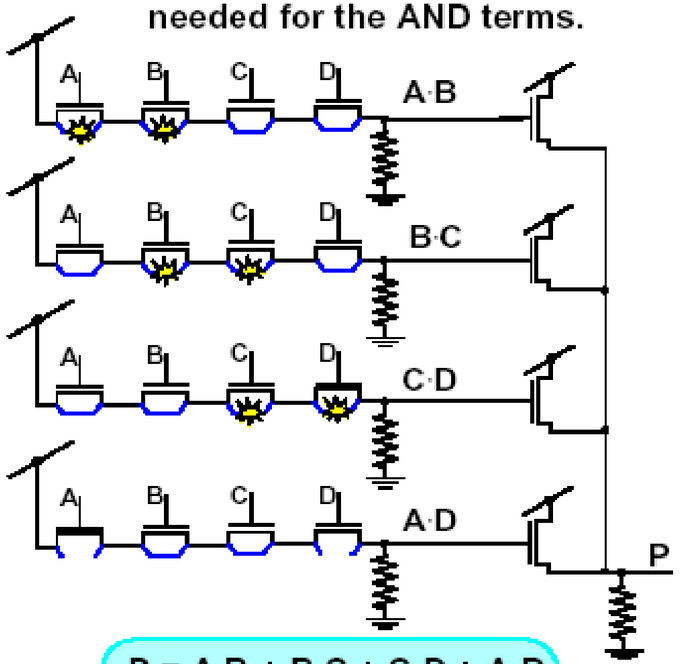
$$P = A \cdot B \cdot C \cdot D + A \cdot B \cdot C \cdot D + A \cdot B \cdot C \cdot D + A \cdot B \cdot C \cdot D$$

A Fuse Programmed Logic Array

Program the logic

Short all transistors with fuses.

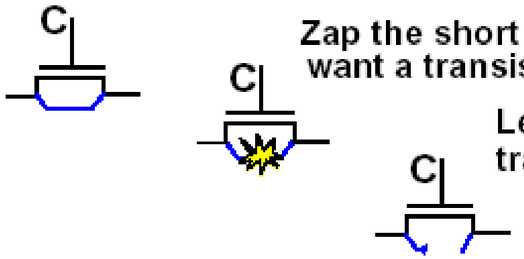
Remove shorts from transistors needed for the AND terms.



$$P = A \cdot B + B \cdot C + C \cdot D + A \cdot D$$

Fuse Programming

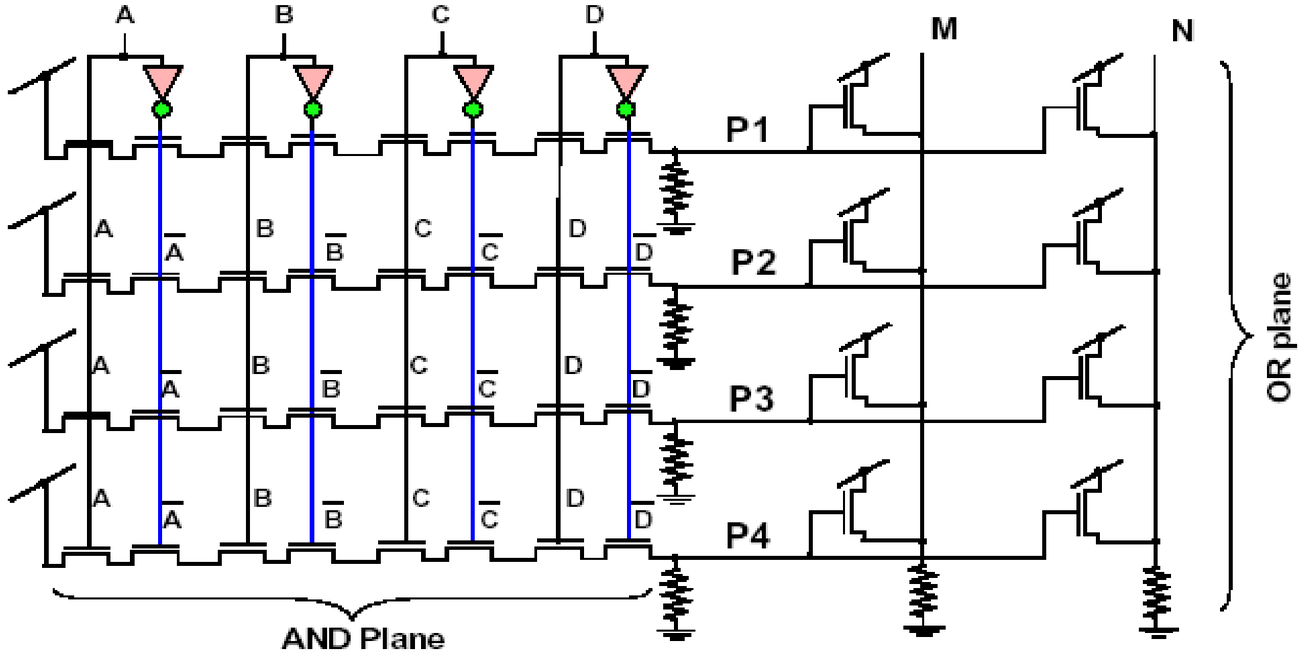
Start with all transistors shorted.



Zap the short where you want a transistor

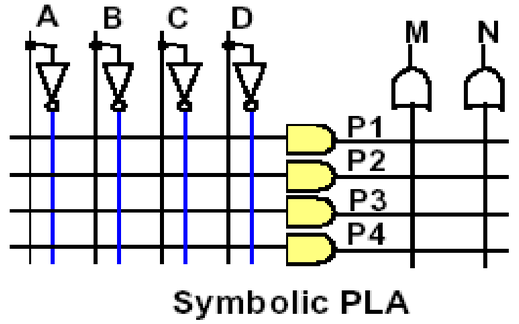
Leave a working transistor

Programmable Logic Array (PLA)



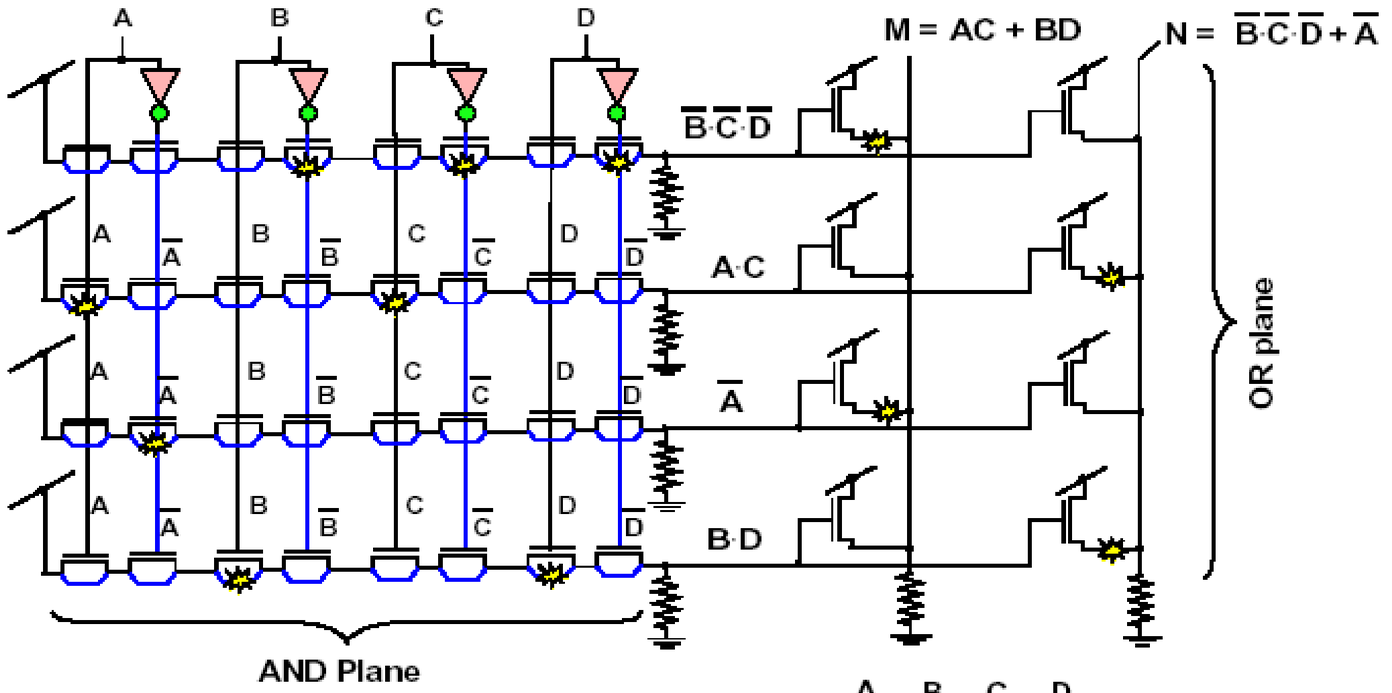
Two outputs M and N
Can implement two Σ of Π functions
with 4 inputs which includes x and $\bar{x}$
and with 4 product terms, P1, P2, P3 and P4.

Use the simple symbol for logic design



Symbolic PLA

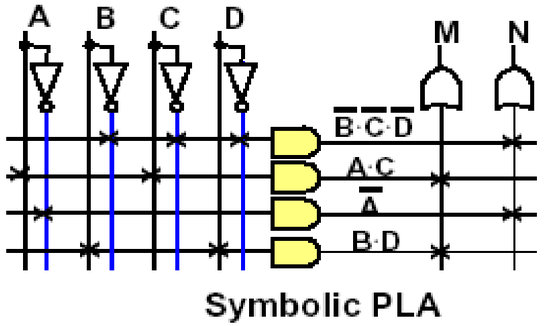
Programming the PLA



AND Plane
Blow fuses for letters you want in the AND term

OR Plane
Blow fuses to remove unwanted ORs

Symbolic PLA
Put an × where you want a connection



Symbolic PLA

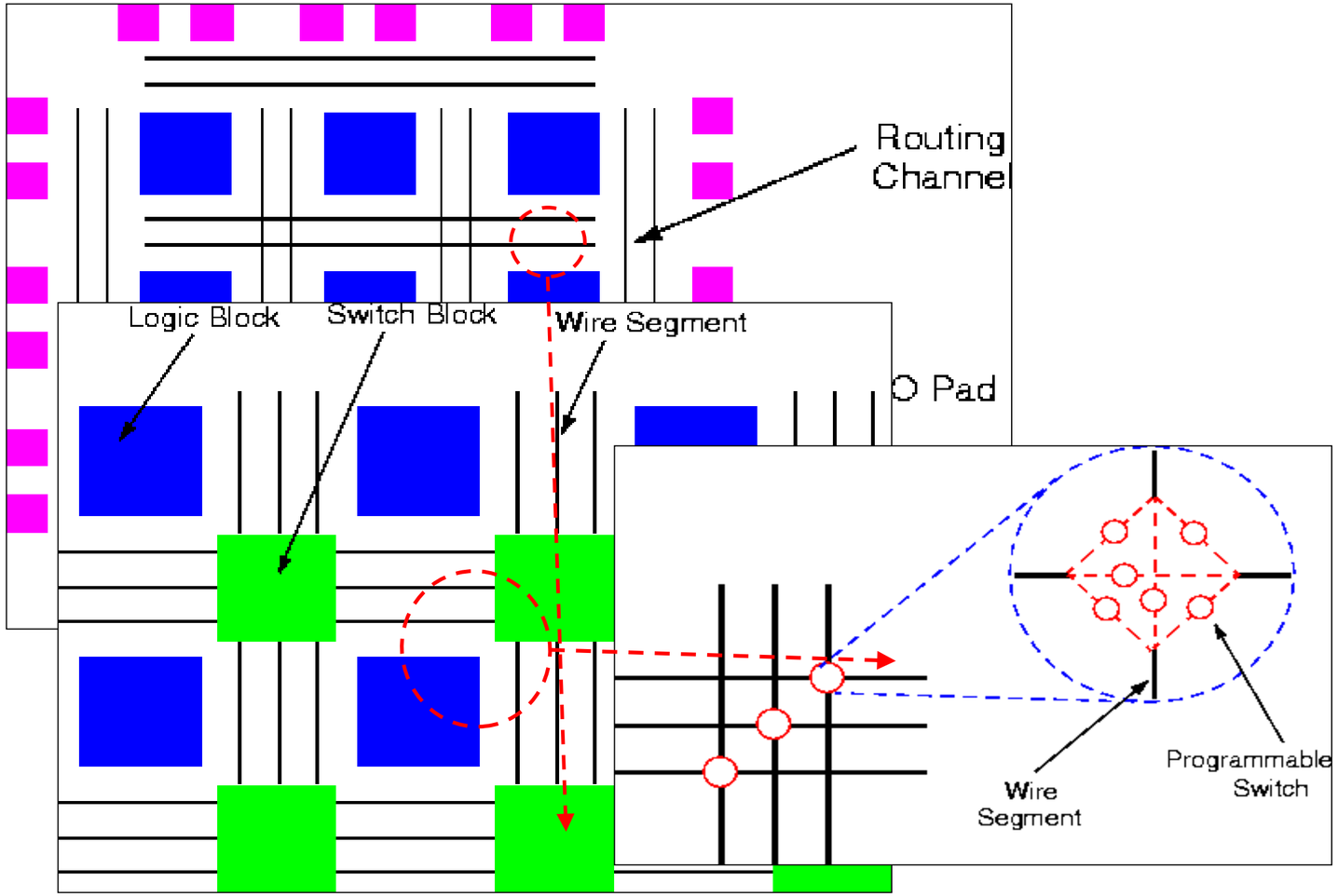
FPGA AND CPLD

1. FPGA - Field-Programmable Gate Array.
2. CPLD - Complex Programmable Logic Device
3. FPGA and CPLD is an advance PLD.
4. Support thousands of gate where as PLD only support hundreds of gates.

What is an FPGA?

- Before the advent of programmable logic, custom logic circuits were built at the board level using standard components, or at the gate level in expensive application-specific (custom) integrated circuits.
- FPGA is an integrated circuit that contains many (64 to over 10,000) identical logic cells that can be viewed as standard components. Each logic cell can independently take on any one of a limited set of personalities.
- Individual cells are interconnected by a matrix of wires and programmable switches.
- A user's design is implemented by specifying the simple logic function for each cell and selectively closing the switches in the interconnect matrix.
- Array of logic cells and interconnect form a fabric of basic building blocks for logic circuits. Complex designs are created by combining these basic blocks to create the desired circuit

What is an FPGA?



THANK YOU