



# SNS COLLEGE OF TECHNOLOGY

Coimbatore-35  
An Autonomous Institution



Accredited by NBA – AICTE and Accredited by NAAC – UGC with ‘A+’ Grade  
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

## DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

### 19ECB231 –DIGITAL ELECTRONICS

II YEAR/<sub>1</sub> III SEMESTER

#### UNIT 5 – SEQUENTIAL CIRCUITS

TOPIC 7 – Introduction to PLD implementation



## Problem definition

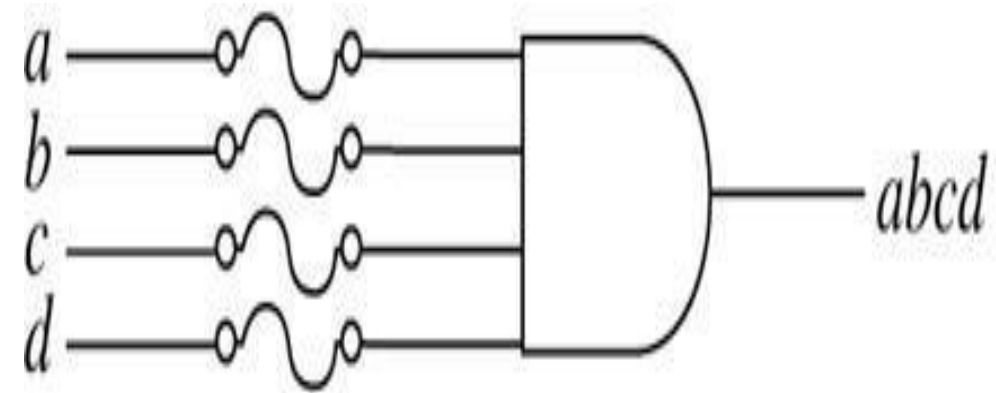


Device	AND-array	OR-array
PROM	Fixed	Programmable
PLA	Programmable	Programmable
PAL	Programmable	Fixed
GAL	Programmable	Fixed

- 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.

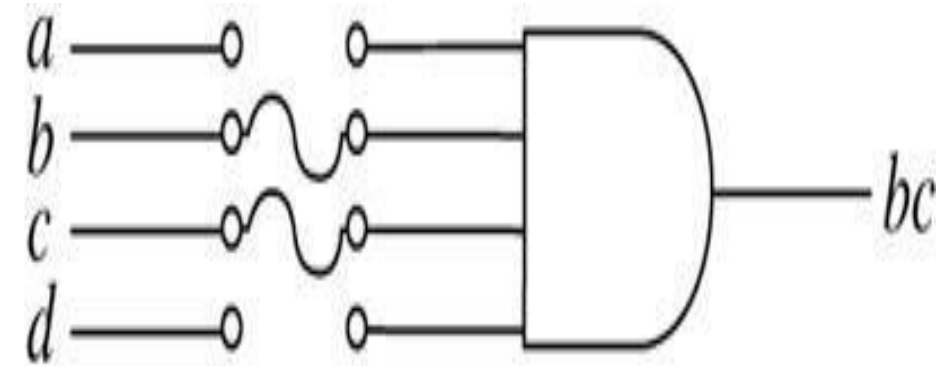


# Programming by blowing fuses.



(a)

**(a) Before programming.**

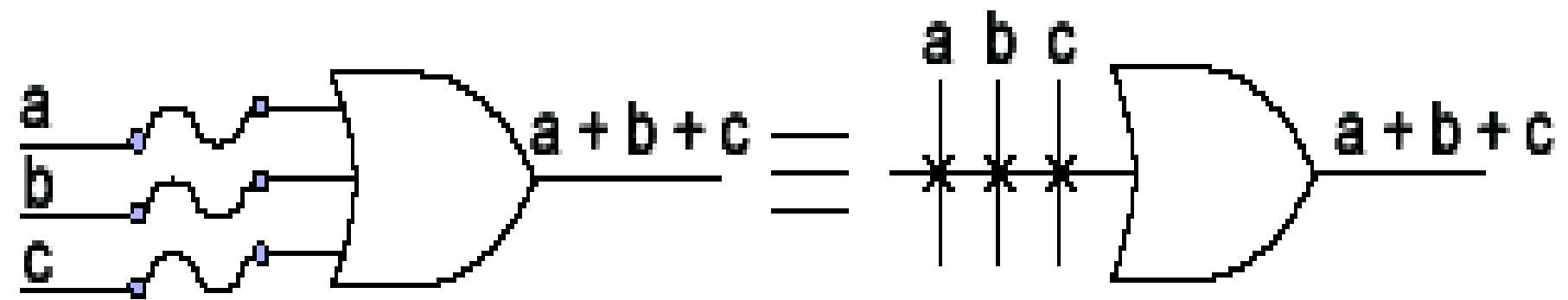


(b)

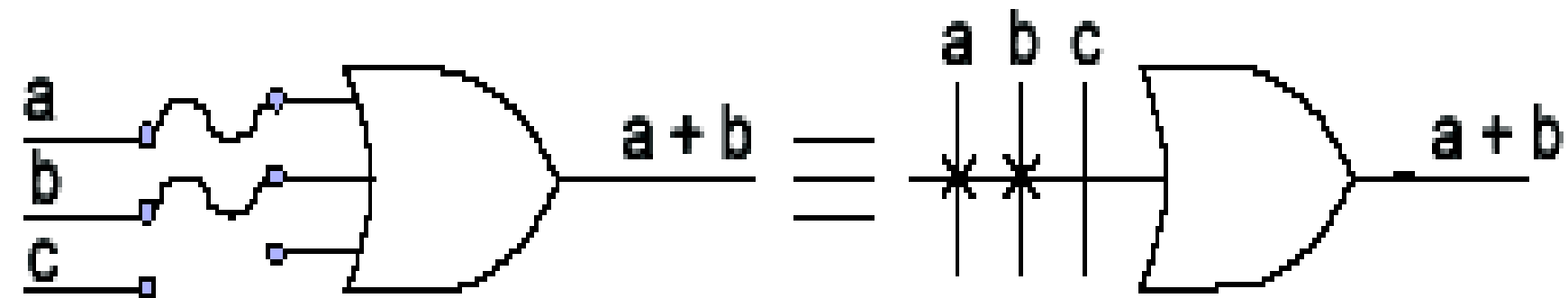
**(b) After programming.**



# OR- PLD Implementation



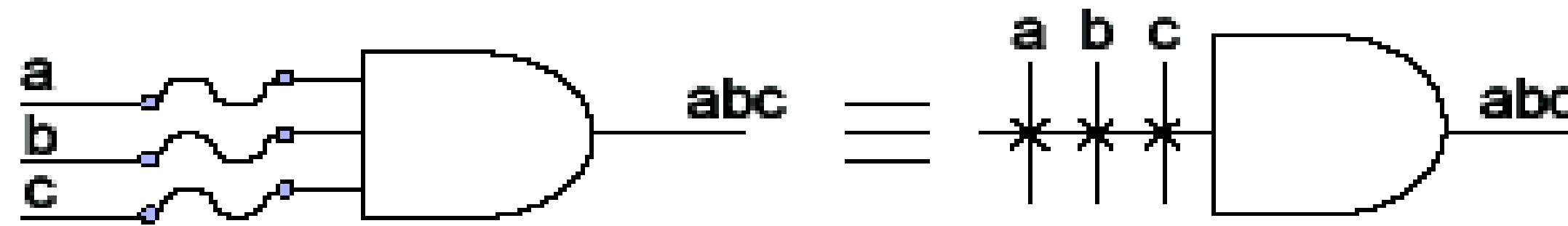
OR gate before programming



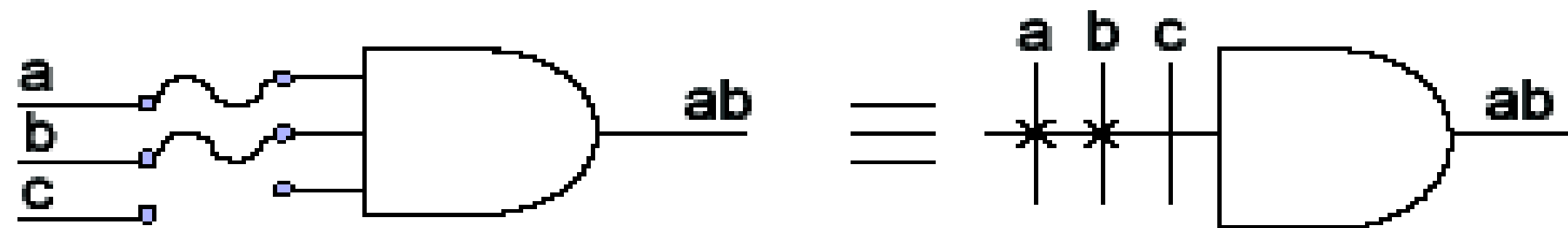
OR gate after programming



# AND- PLD Implementation



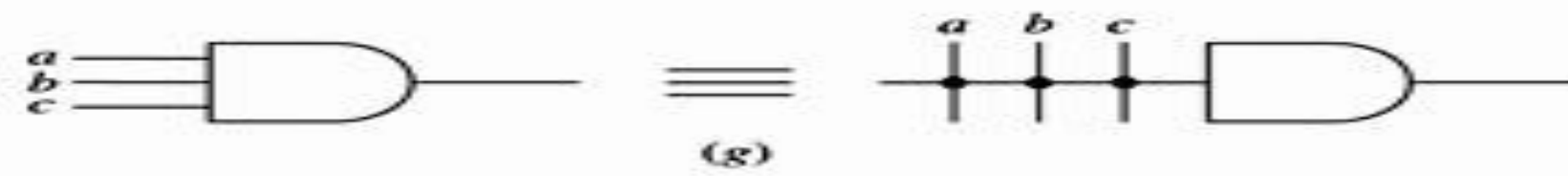
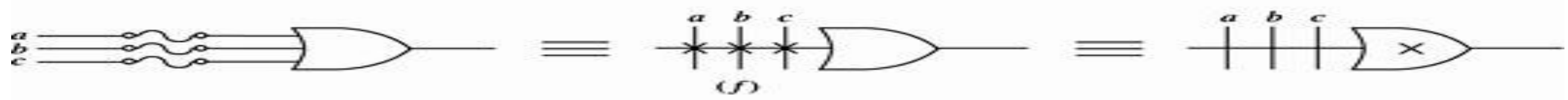
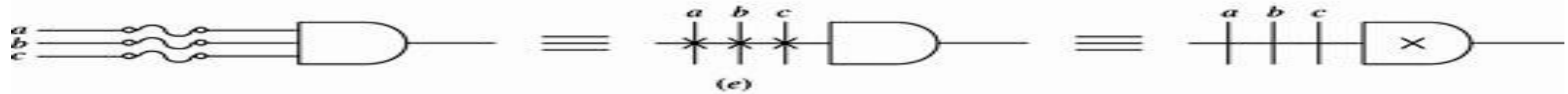
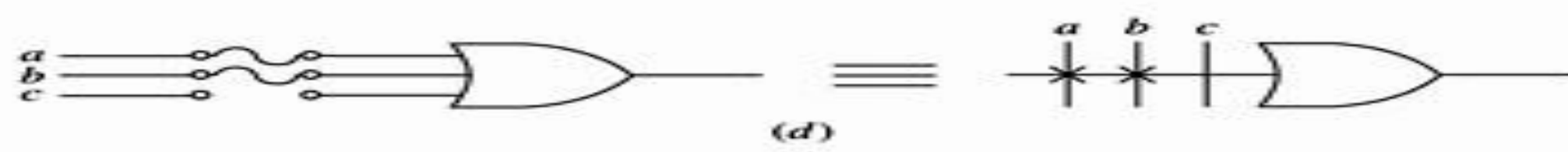
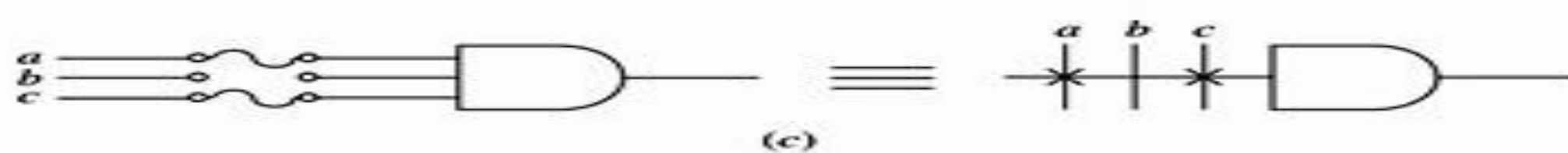
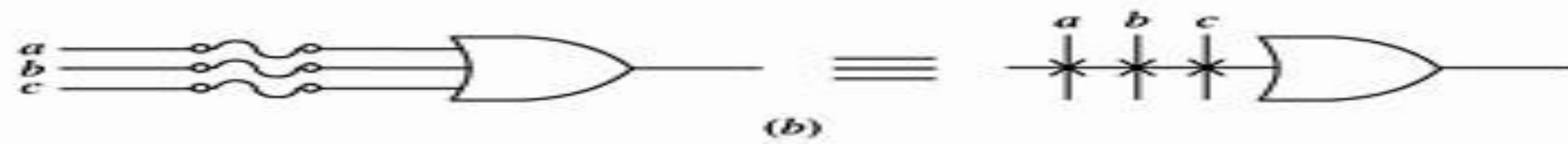
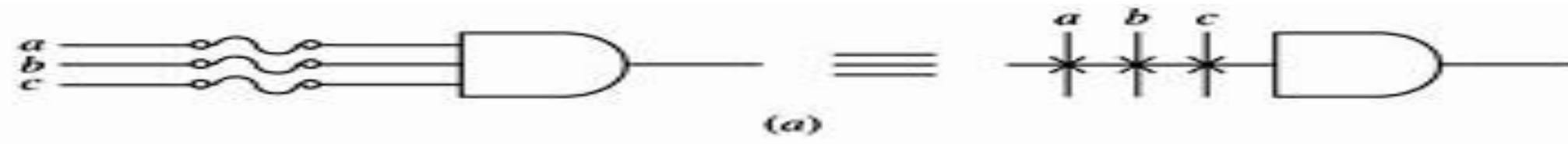
**AND gate before programming**



**AND gate after programming**

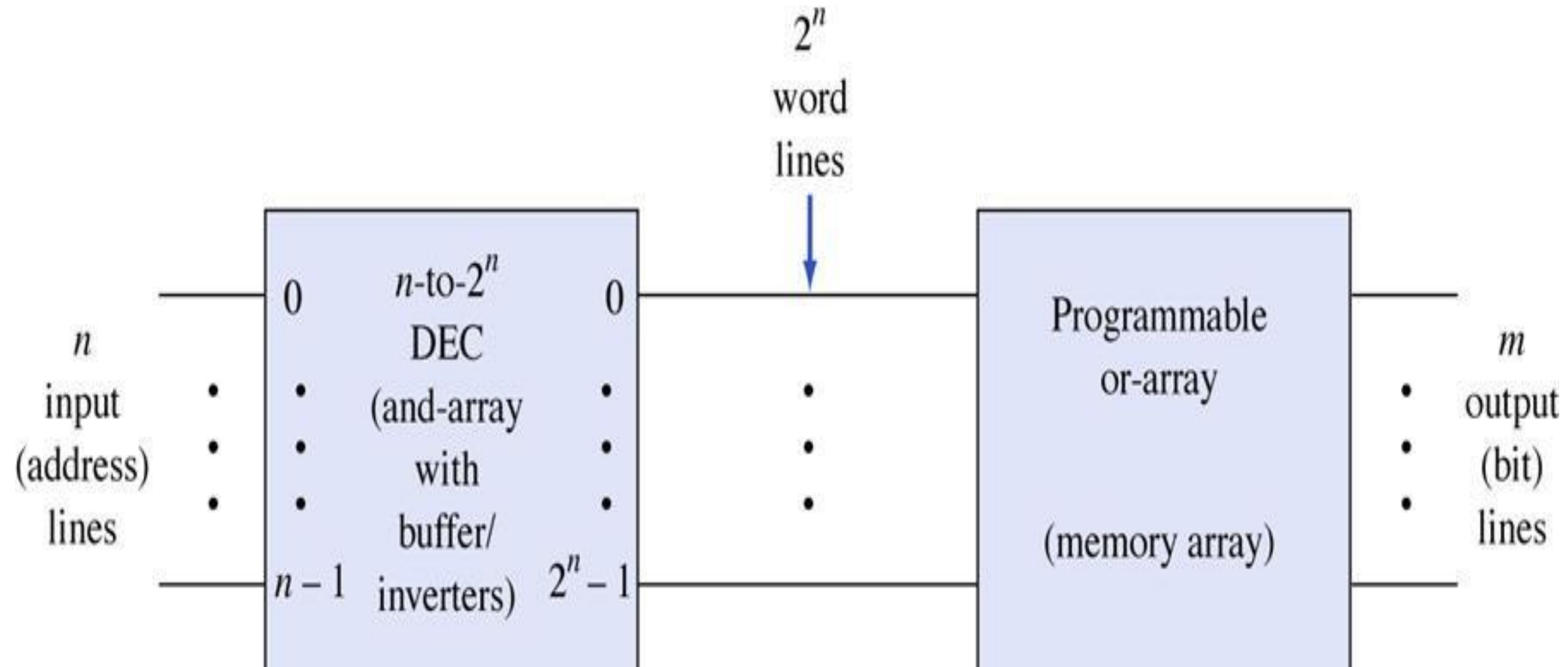


# PLDs



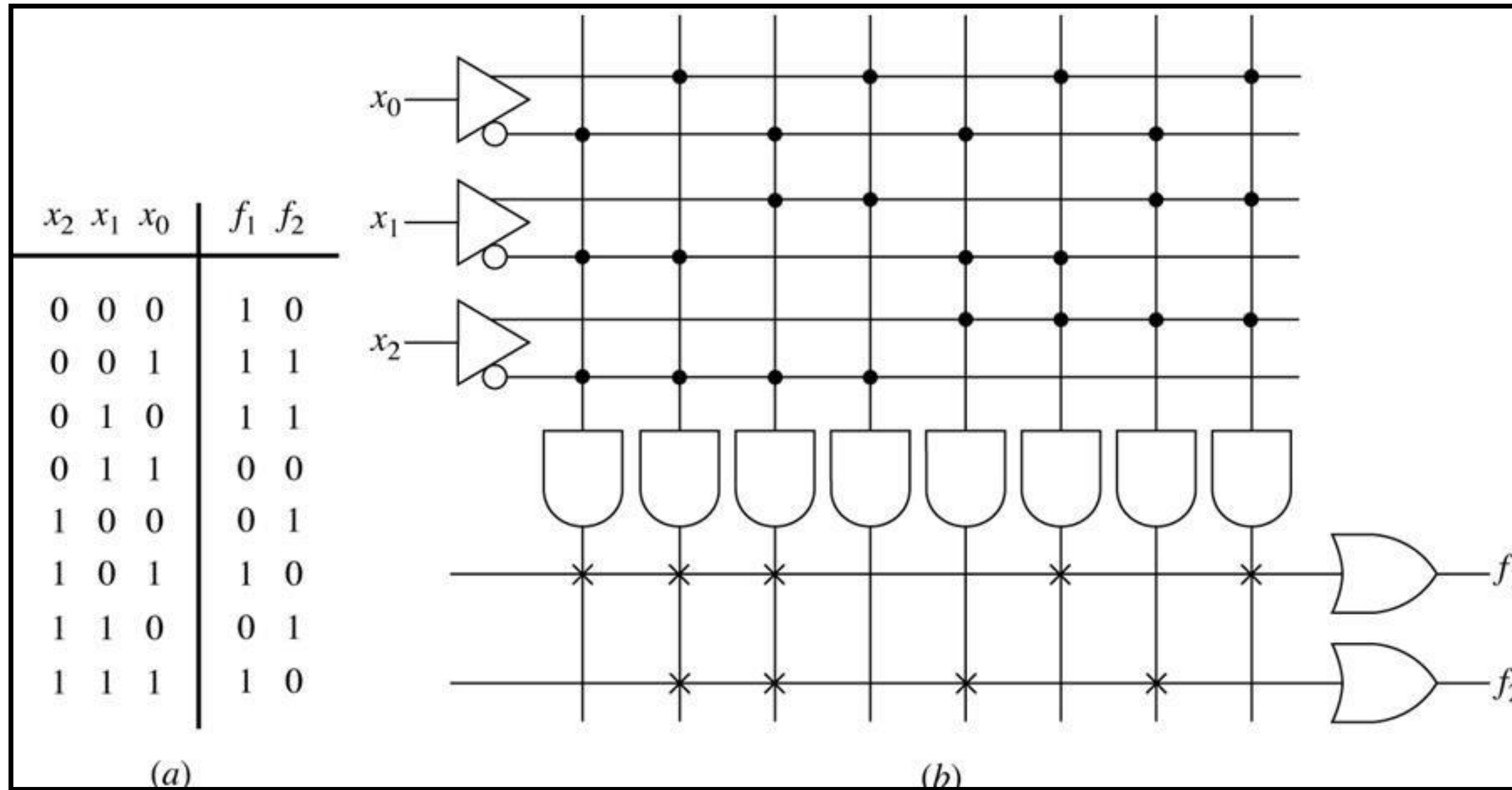


# PROM Notation





# Using a PROM for logic design



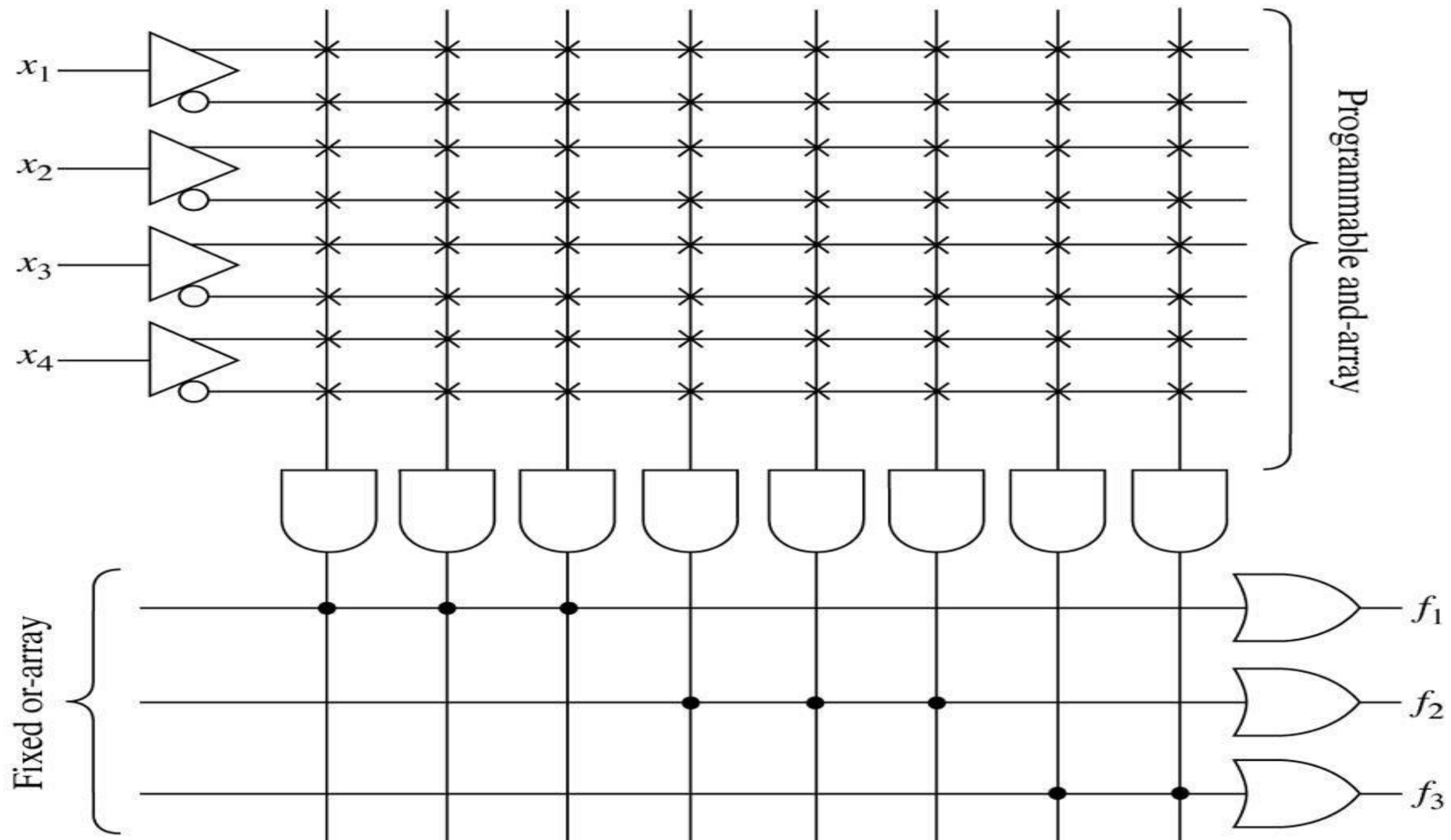
(a) Truth table.

(b) PROM realization.





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

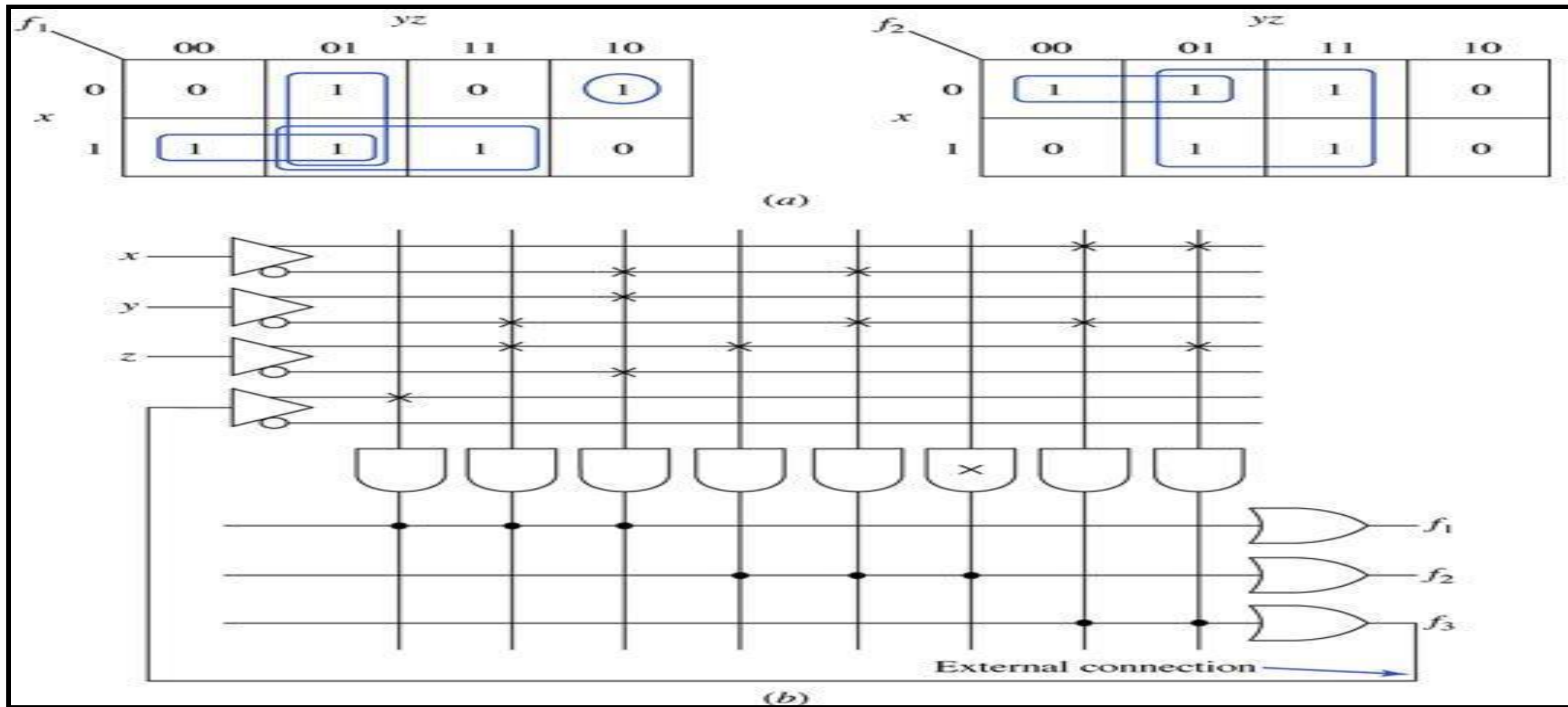




# A simple four-input, three-output PAL device.



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



(a) Karnaugh maps.

(b) Realization.

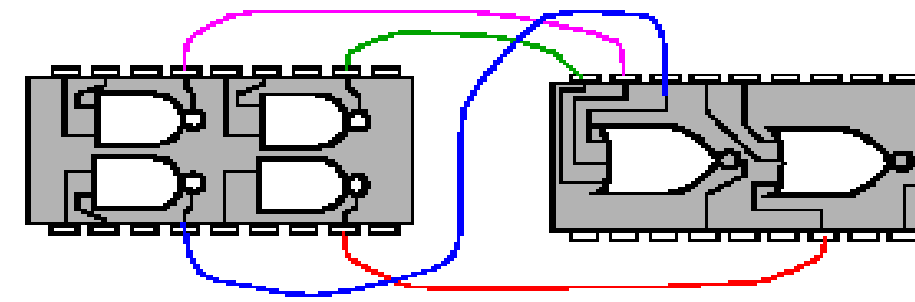


## Constructing Digital Circuits

### Hand Wired Circuits

Cirri 1970-85

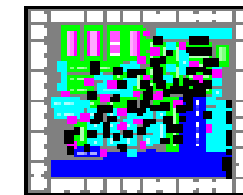
- Make 2 to 4 silicon gates in a package.
- Connect with wires.



### VLSI circuits

Start with a silicon wafer and make:

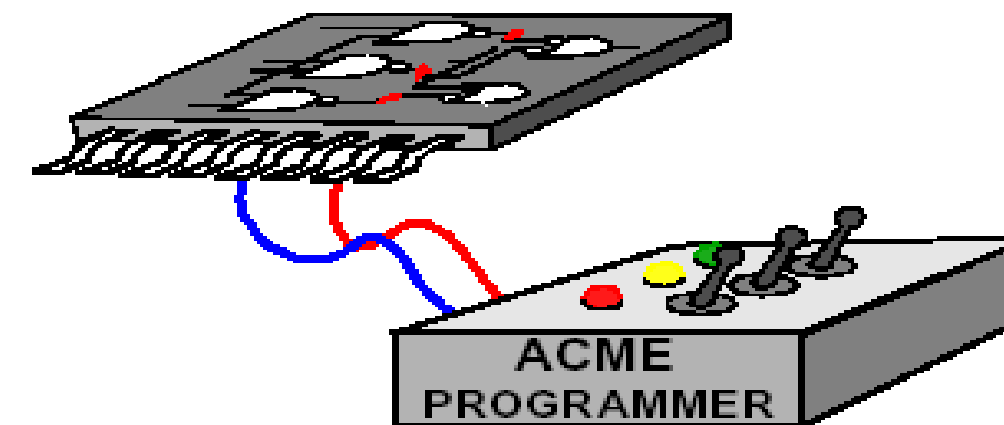
- the gates
- the interconnections on top both made together.



### 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.



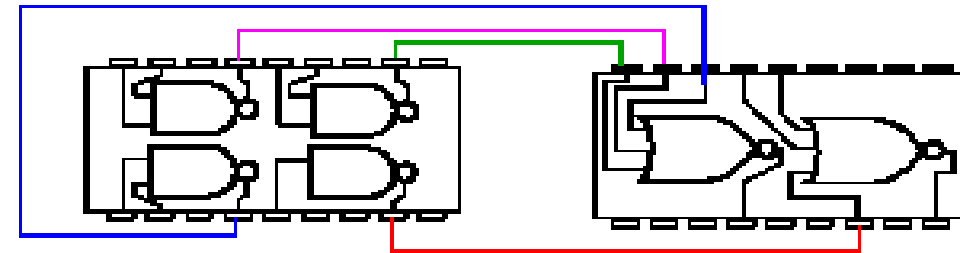
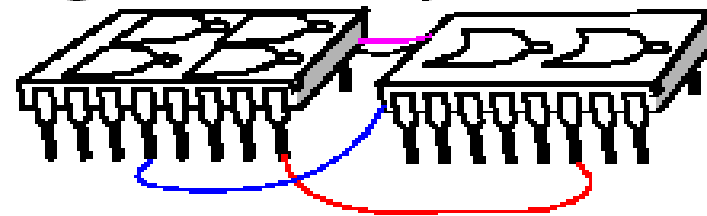
### Micro Controllers



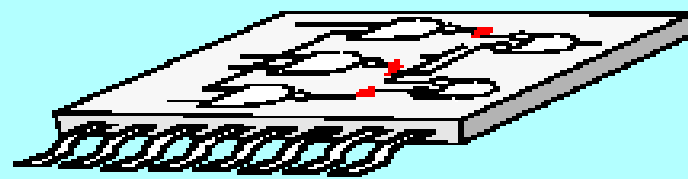
## Programmable Logic

### Different Ways of Connecting Logic

1. Connect Wires  
Few gates on a chip



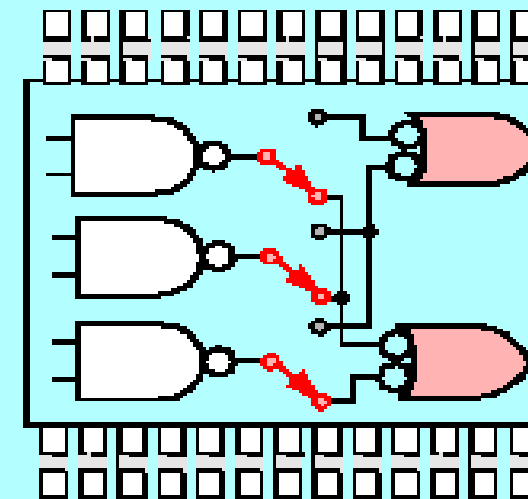
2. Electrically Programmable  
Many gates on a chip



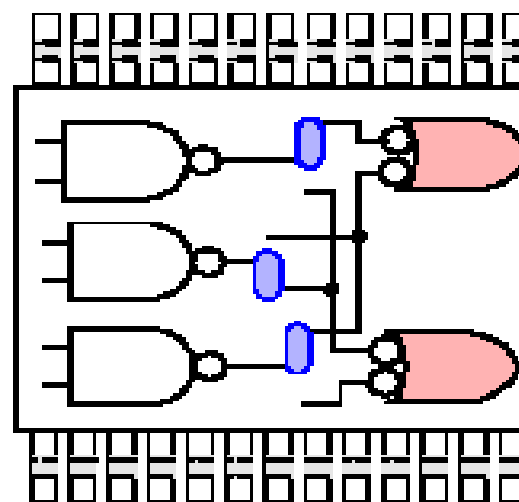
Electrically Controlled Switches

Fuses; blow to remove unwanted connections

Antifuses; grow to make connections



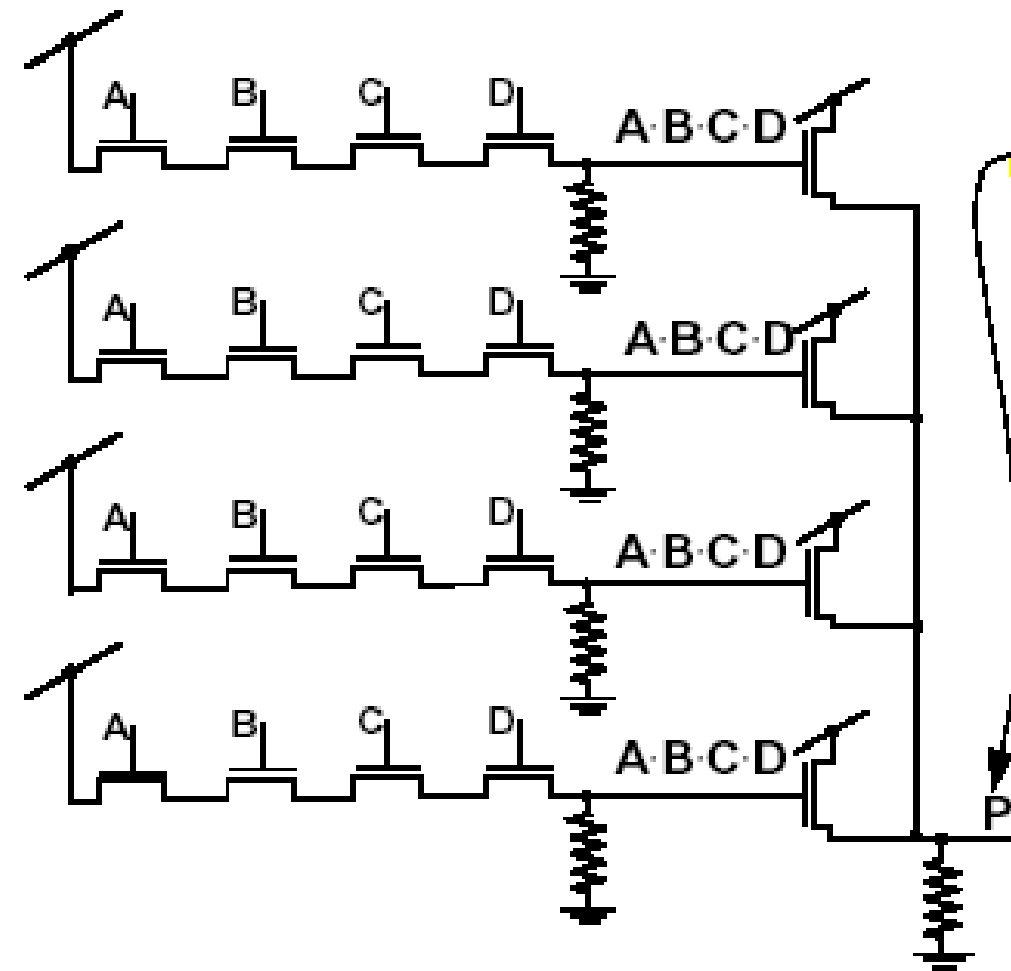
3. Mask Programmable  
Many gates on a chip



Metal blobs deposited over ends of wires to be connected



## Array Logic

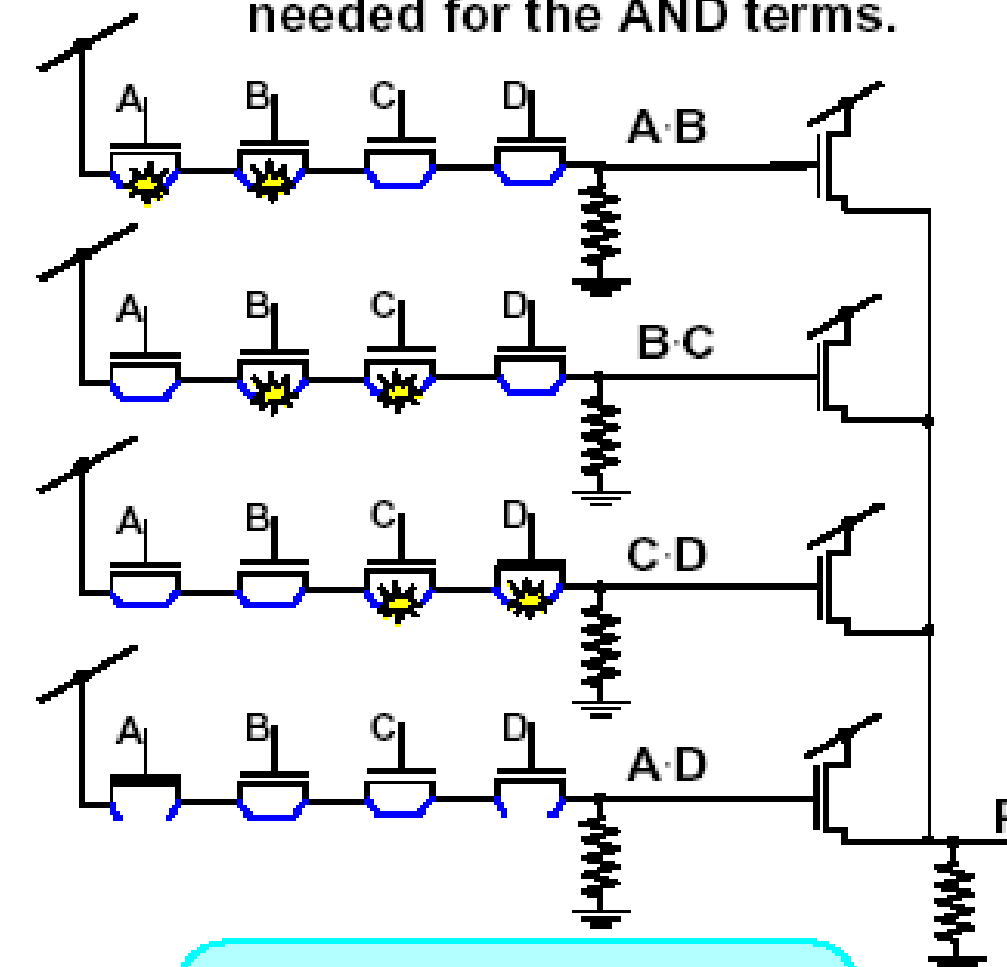


Combine the AND and OR logic

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

## A Fuse Programmed Logic Array

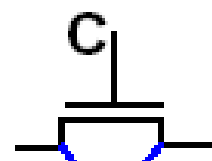
Program the logic  
Short all transistors with fuses.  
Remove shorts from transistors  
needed for the AND terms.



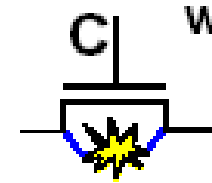
$$P = A \cdot B + B \cdot C + C \cdot D + A \cdot D$$

## Fuse Programming

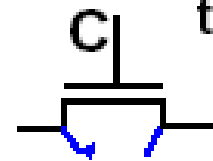
Start with all transistors shorted.



Zap the short where you  
want a transistor

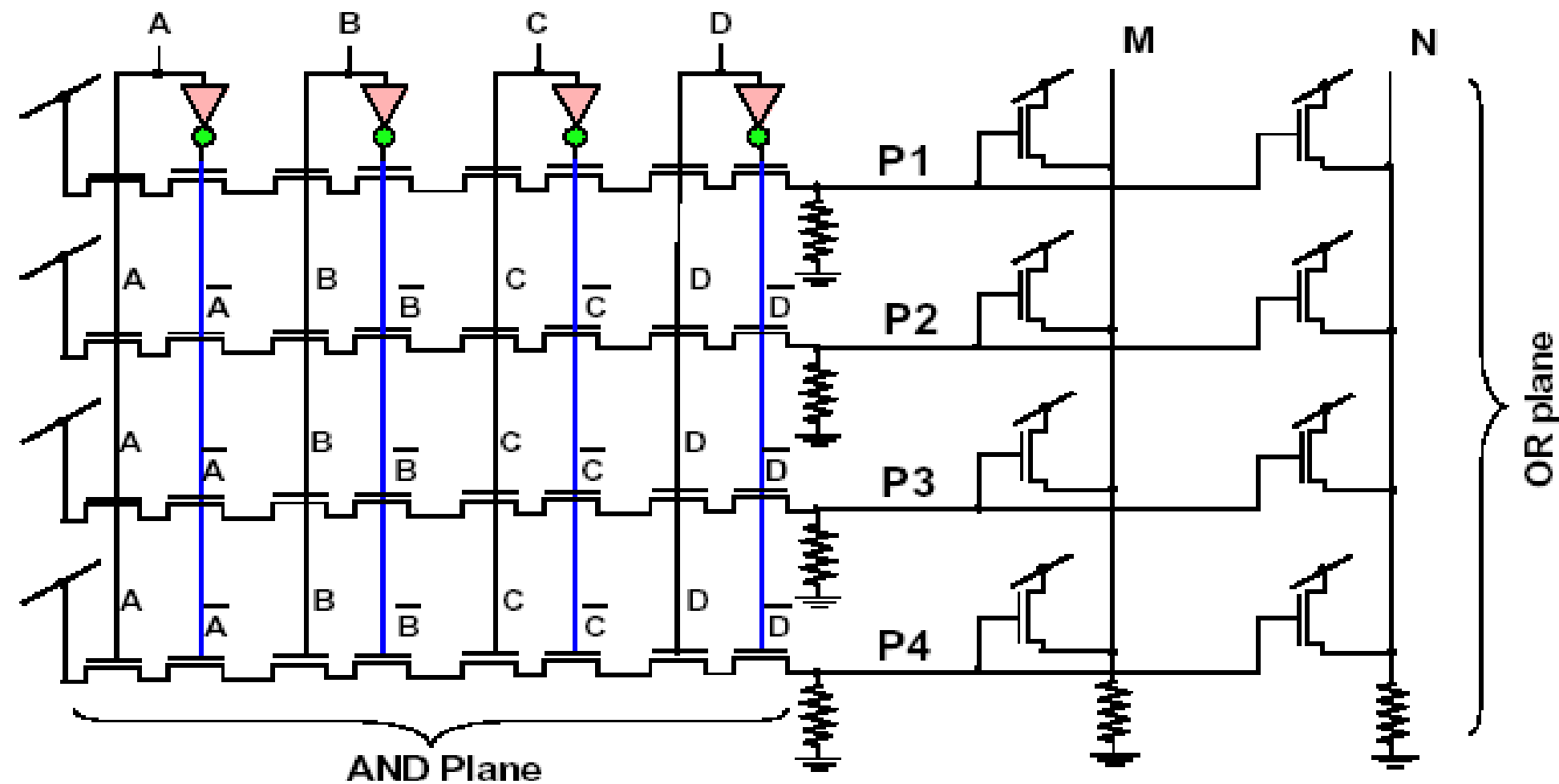


Leave a working  
transistor



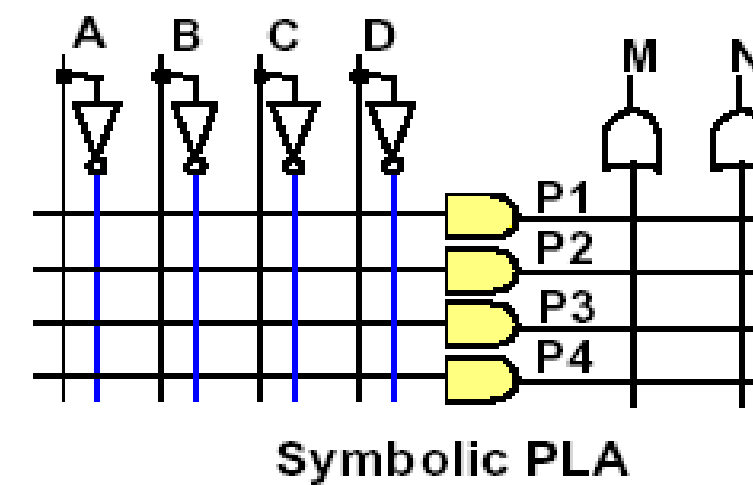


## Programmable Logic Array (PLA)



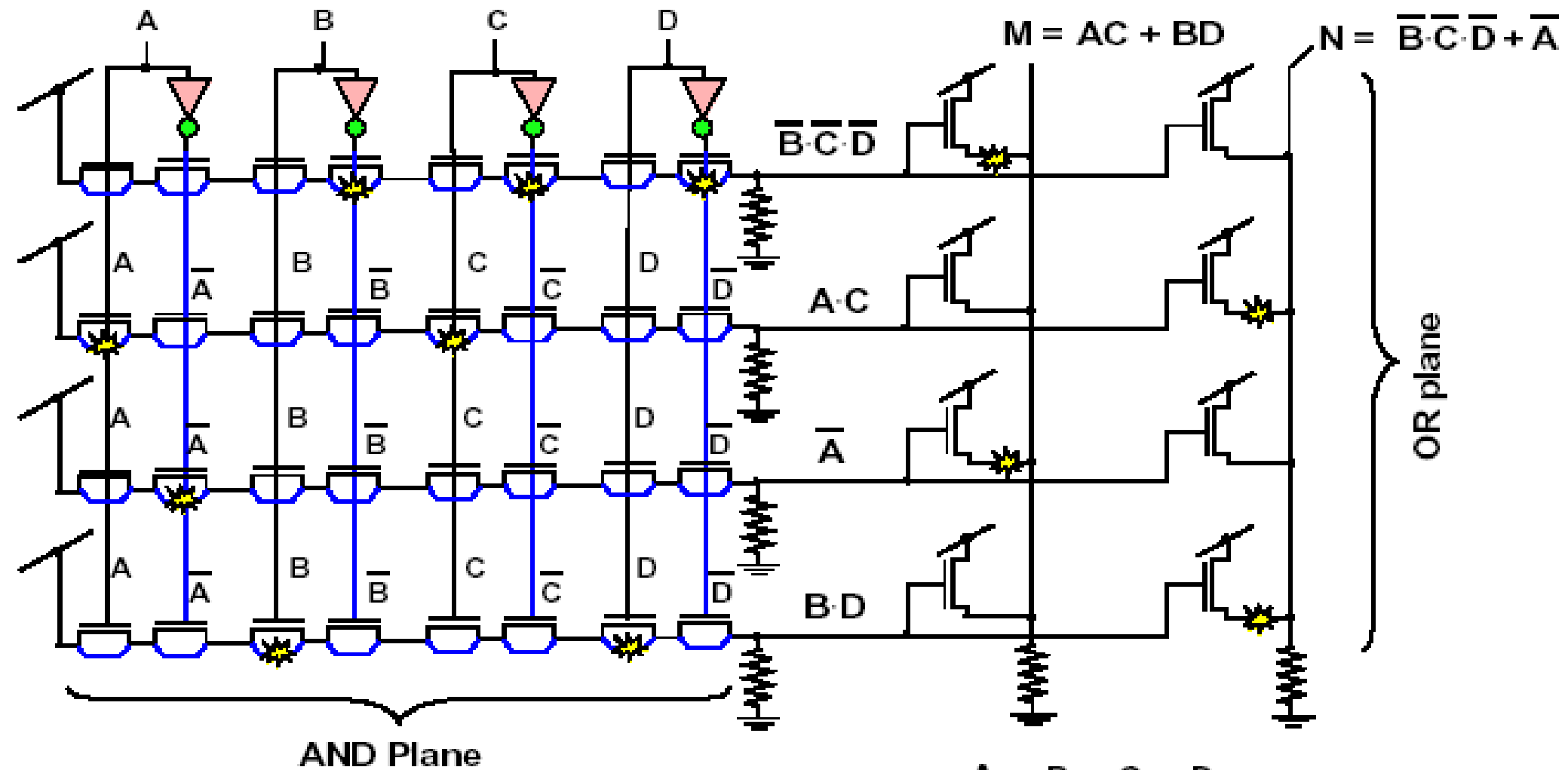
Two outputs M and N  
 Can implement two  $\Sigma$  of  $\Pi$  functions  
 with 4 inputs which includes  $x$  and  $\bar{x}$   
 and with 4 product terms, P1, P2, P3 and P4.

Use the simple symbol for logic design





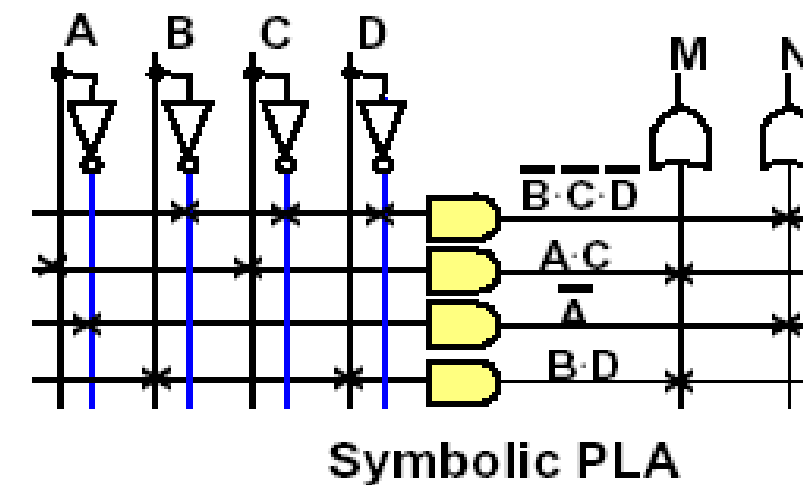
## Programming the PLA



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

**OR Plane**  
Blow fuses to remove unwanted ORs

**Symbolic PLA**  
Put an  $\times$  where you want a connection





## 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.





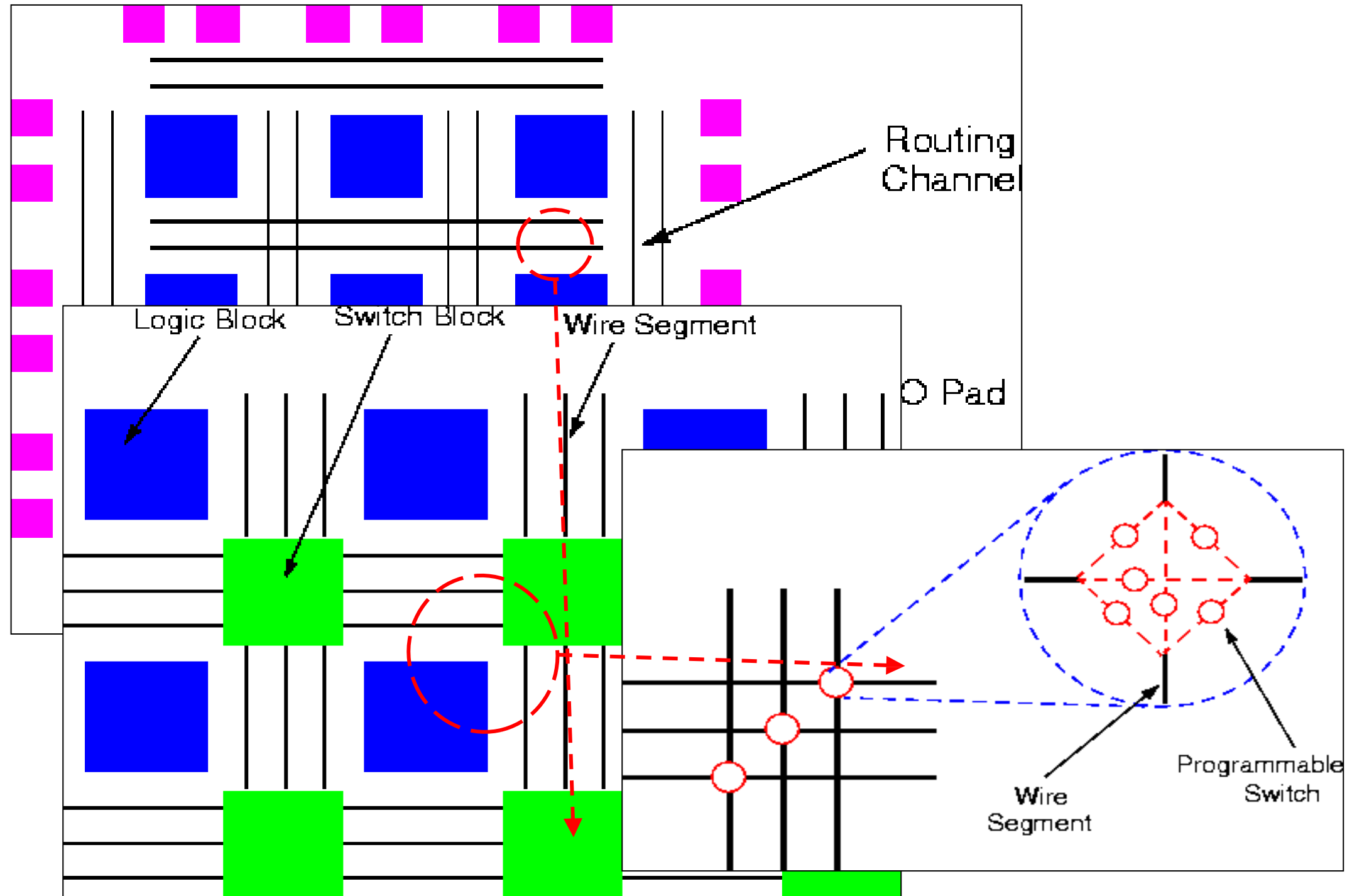
## What is an FPGA?



- 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