

UNIT VI: ECE 213

PLD devices

Programmable Logic Devices

- An IC that contains large numbers of gates, flip-flops, etc. that can be configured by the user to perform different functions is called a Programmable Logic Device (PLD).
- The internal logic gates and/or connections of PLDs can be changed/configured by a programming process.
- One of the simplest programming technologies is to use fuses.
- In the original state of the device, all the fuses are intact.
- Programming the device involves blowing those fuses along the paths that must be removed in order to obtain the particular configuration of the desired logic function.

Advantages of using PLDs:

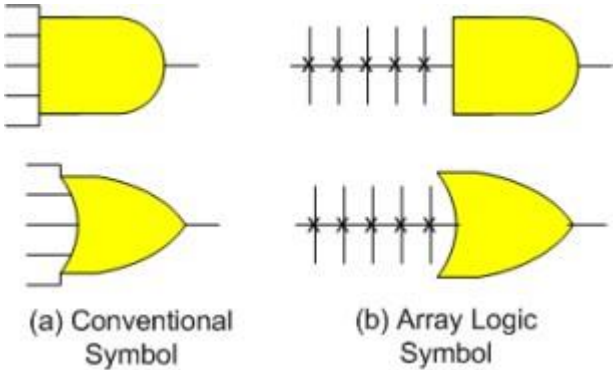
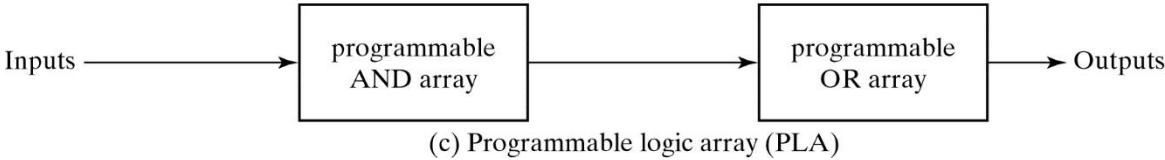
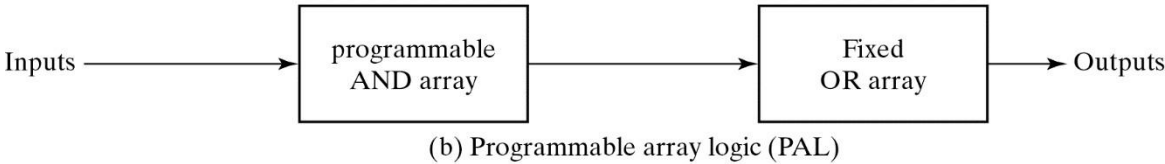
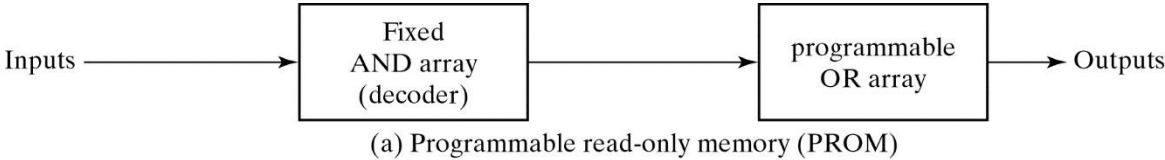
Less board space, faster, lower power requirements (i.e., smaller power supplies), less costly assembly processes, higher reliability (fewer ICs and circuit connections means easier troubleshooting), and availability of design software.

Types of PLDs

1. SPLDs (Simple Programmable Logic Devices)
 - ❑ ROM (Read-Only Memory)
 - ❑ PLA (Programmable Logic Array)
 - ❑ PAL (Programmable Array Logic)
 - ❑ GAL (Generic Array Logic)
2. CPLD (Complex Programmable Logic Device)
3. FPGA (Field-Programmable Gate Array)

PLDs are typically built with an array of AND gates (AND-array) and an array of OR gates (OR-array).

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



The PLA has programmable connections for both AND and OR arrays. So it is the most flexible type of PLD.

MCQ

PLA contains _____

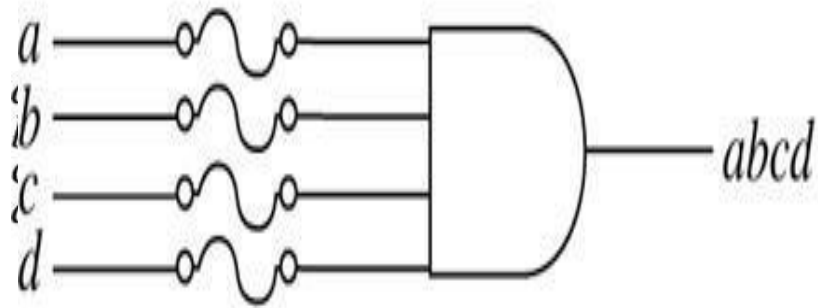
- a) AND and OR arrays
- b) NAND and OR arrays
- c) NOT and AND arrays
- d) NOR and OR arrays

MCQ

The difference between a PAL & a PLA is _____ .

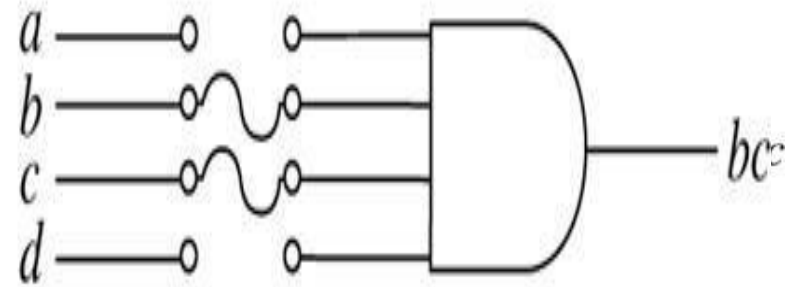
- a) PALs and PLAs are the same thing
- b) The PLA has a programmable OR plane and a programmable AND plane, while the PAL only has a programmable AND plane
- c) The PAL has a programmable OR plane and a programmable AND plane, while the PLA only has a programmable AND plane
- d) The PAL has more possible product terms than the PLA

Programming By Blowing Fuses



(a)

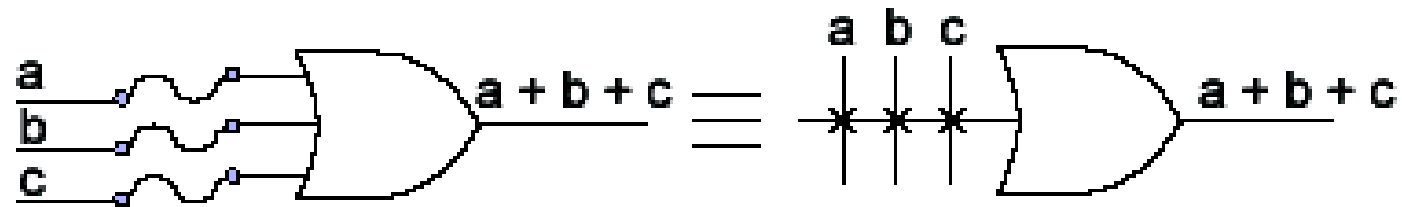
(a) Before programming.



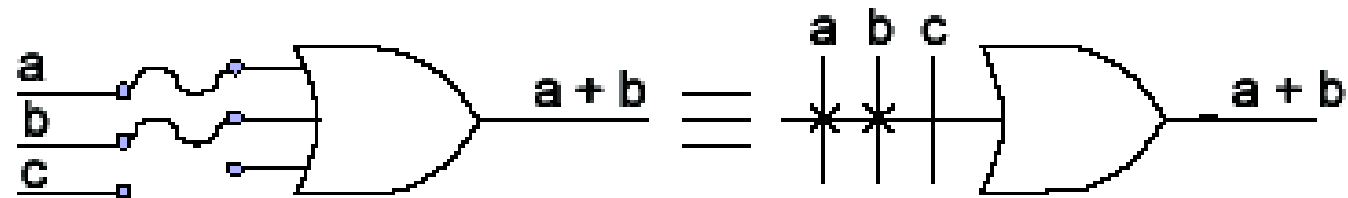
(b)

(b) After programming.

OR-PLD Notation

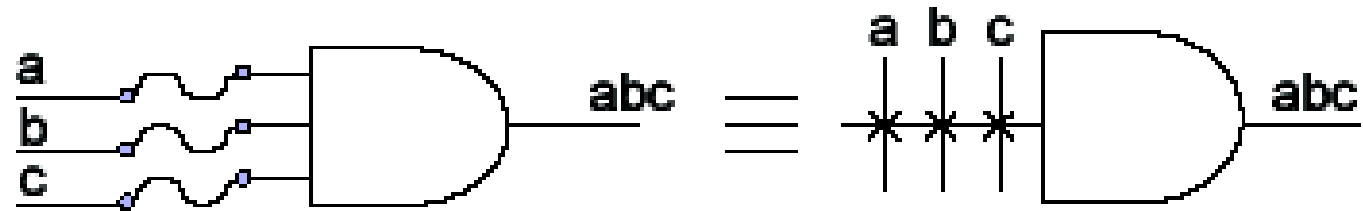


OR gate before programming

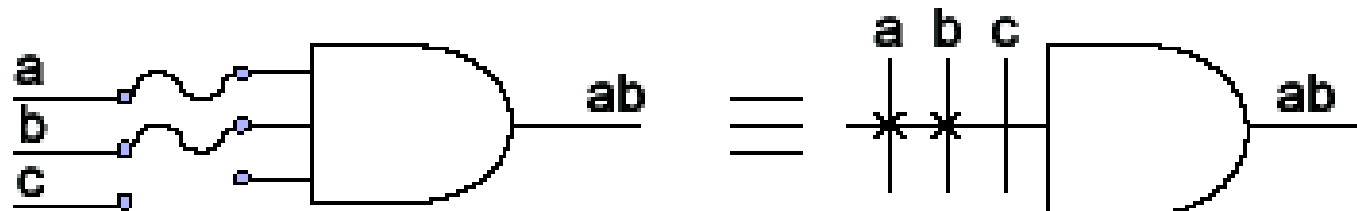


OR gate after programming

AND-PLD Notation



AND gate before programming



AND gate after programming

Read-Only Memory

- A block diagram of a ROM is shown below. It consists of k address inputs and n data outputs.
- The number of words in a ROM is determined from the fact that k address input lines are needed to specify 2^k words.

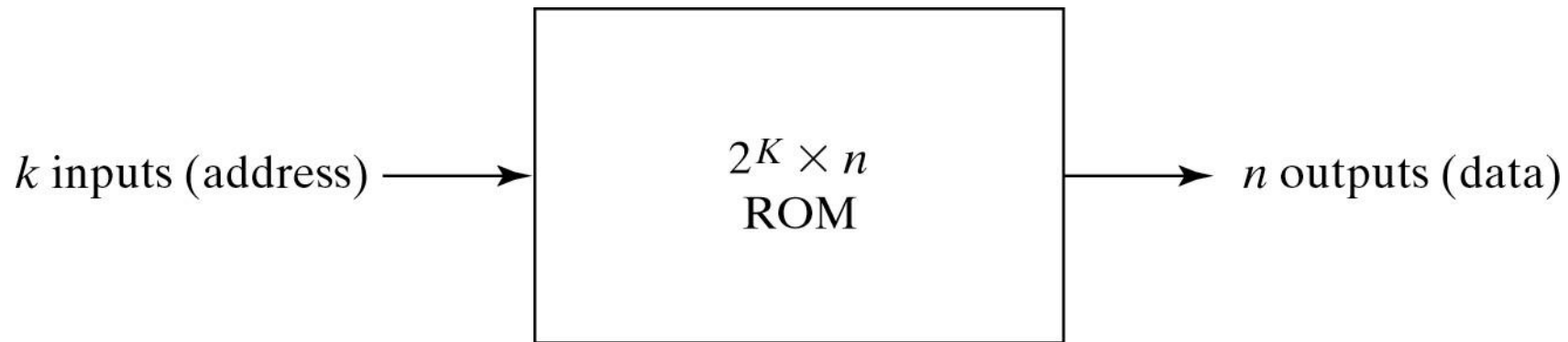


Fig. 7-9 ROM Block Diagram

Construction of ROM

- Each output of the decoder represents a memory address.
- Each OR gate must be considered as having 32 inputs.
- A $2^k \times n$ ROM will have an internal $k \times 2^k$ decoder and n OR gates.

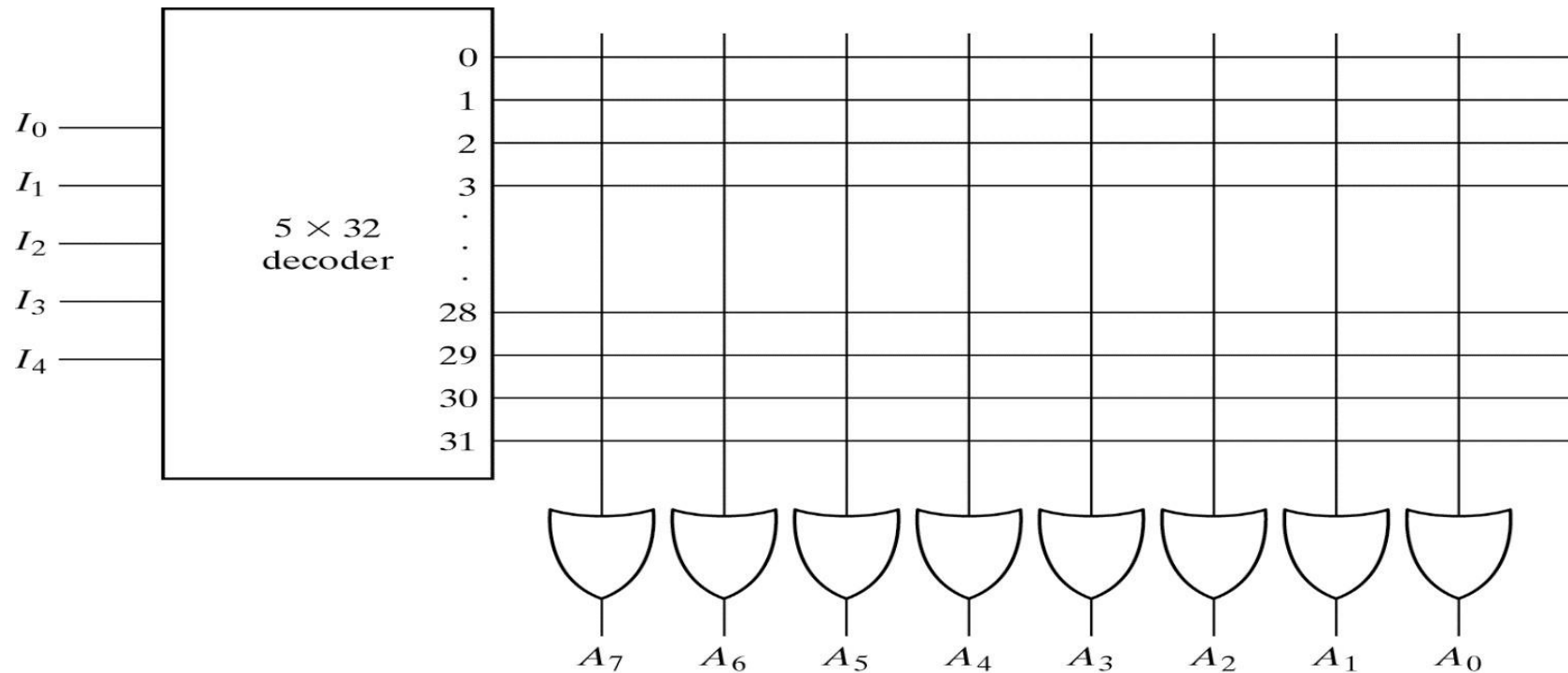


Fig. 7-10 Internal Logic of a 32×8 ROM

Truth table of ROM

- A programmable connection between to lines is logically equivalent to a switch that can be altered to either be close or open.
- Intersection between two lines is sometimes called a cross- point.

Table 7-3
ROM Truth Table (Partial)

Inputs					Outputs							
I4	I3	I2	I1	I0	A7	A6	A5	A4	A3	A2	A1	A0
0	0	0	0	0	1	0	1	1	0	1	1	0
0	0	0	0	1	0	0	0	1	1	1	0	1
0	0	0	1	0	1	1	0	0	0	1	0	1
0	0	0	1	1	1	0	1	1	0	0	1	0
		⋮					⋮					
1	1	1	0	0	0	0	0	0	1	0	0	1
1	1	1	0	1	1	1	1	0	0	0	1	0
1	1	1	1	0	0	1	0	0	1	0	1	0
1	1	1	1	1	0	0	1	1	0	0	1	1

Programming the ROM

In Table 7-3, 0 → no connection

1 → connection

Address 3 = 10110010 is permanent storage using fuse link

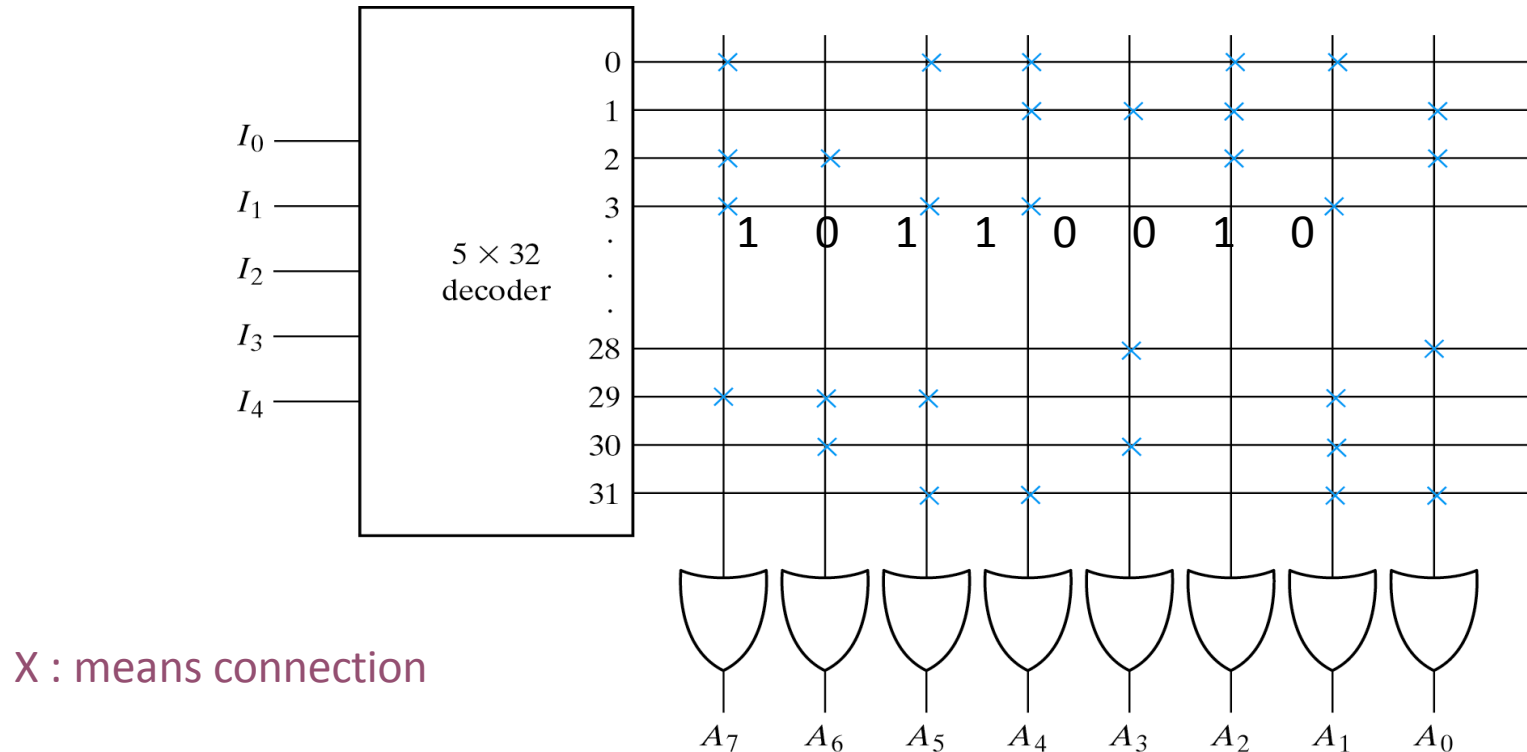
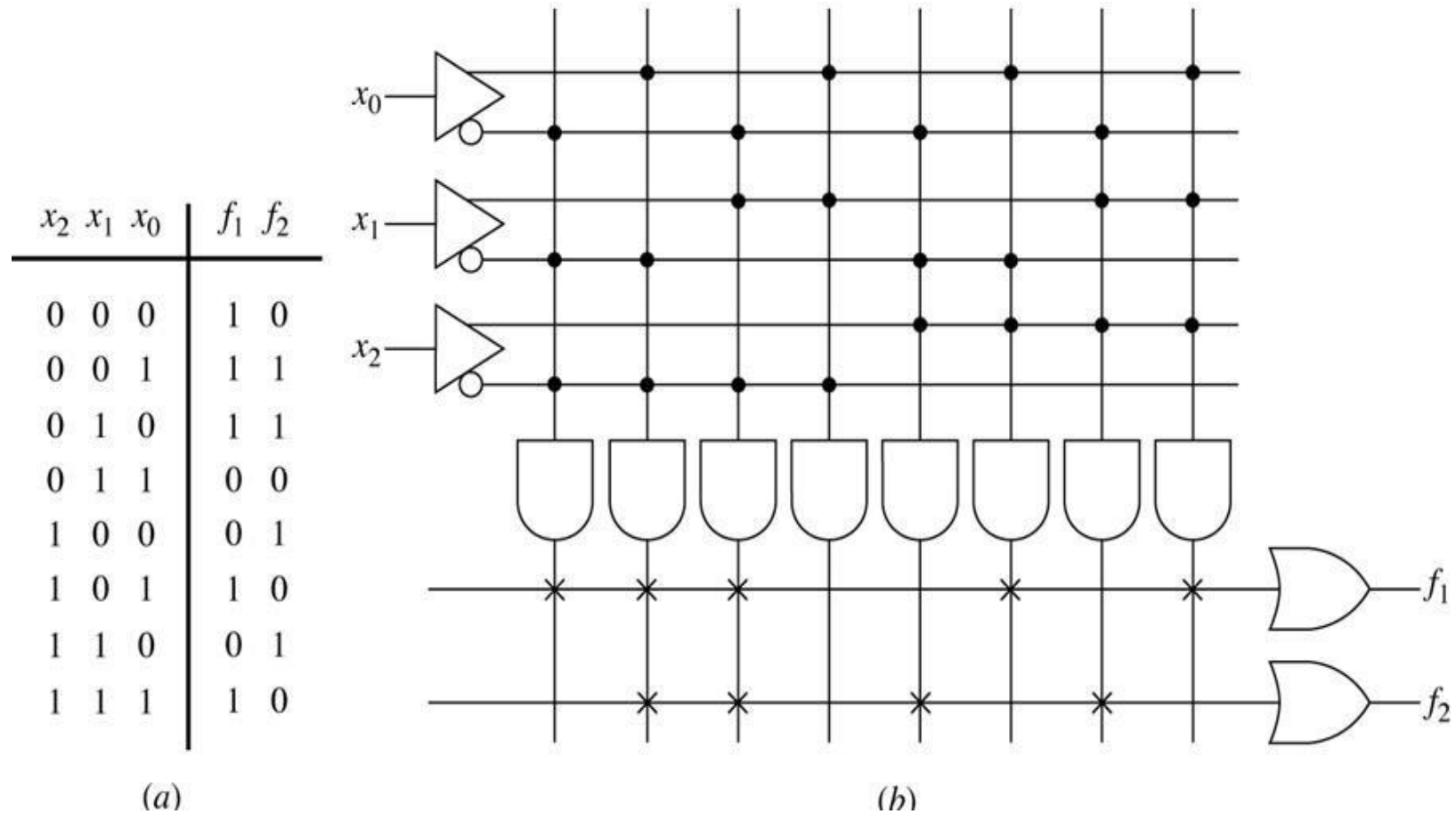


Fig. 7-11 Programming the ROM According to Table 7-3

Using a PROM for logic design



(a) Truth table.

(b) PROM realization.

MCQ

Which of the following best describes the fusible-link PROM?

- a) Manufacturer-programmable, reprogrammable
- b) Manufacturer-programmable, one-time programmable
- c) User-programmable, reprogrammable
- d) User-programmable, one-time programmable

MCQ

What is a fusing process?

- a) It is a process by which data is passed to the memory
- b) It is a process by which data is read through the memory
- c) It is a process by which programs are burnout to the diode/transistors
- d) It is a process by which data is fetched through the memory

Example

: implement the following Boolean functions using PROM.

$$A(X, Y, Z) = \sum m(5, 6, 7)$$

$$B(X, Y, Z) = \sum m(3, 5, 6, 7)$$

