Combinational Logic with LSI

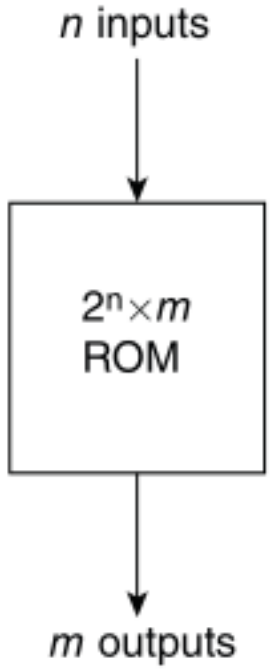
Logic Design of Digital Systems (300-1209) section 1

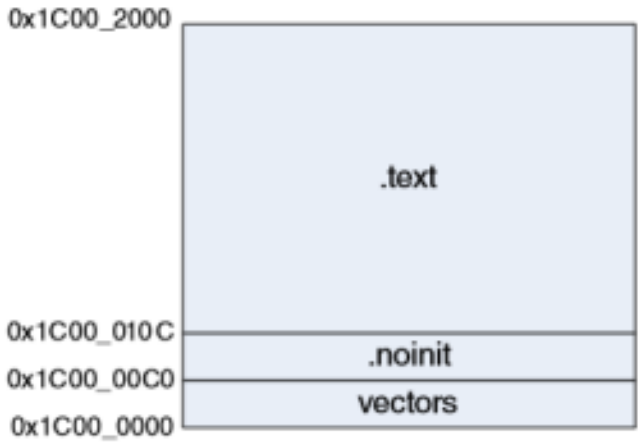
LECTURE 07

KRISADA PHROMSUTHIRAK

Read-Only Memory (ROM)

What is ROM? A ROM is essentially a memory (or storage) device in which a fixed set of binary information is stored. The memory from which we can only read but cannot write on it. The information is stored permanently in such memories during manufacture.

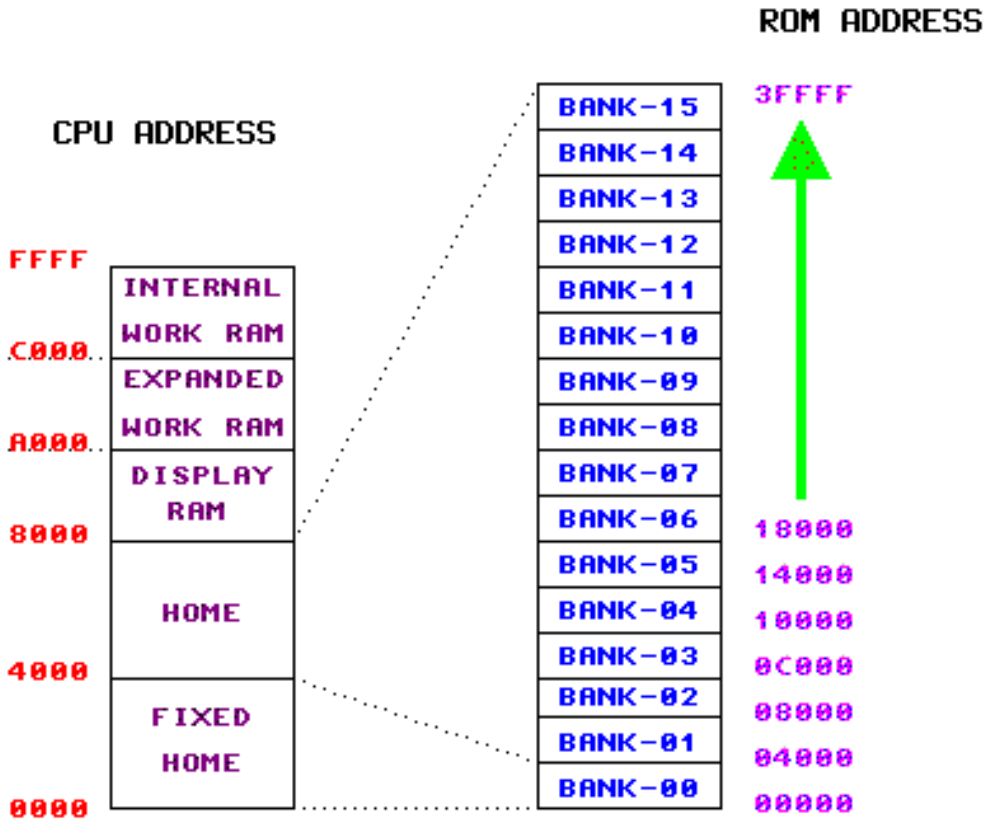




8KB of ROM

Memory Map

Read-Only Memory (ROM)



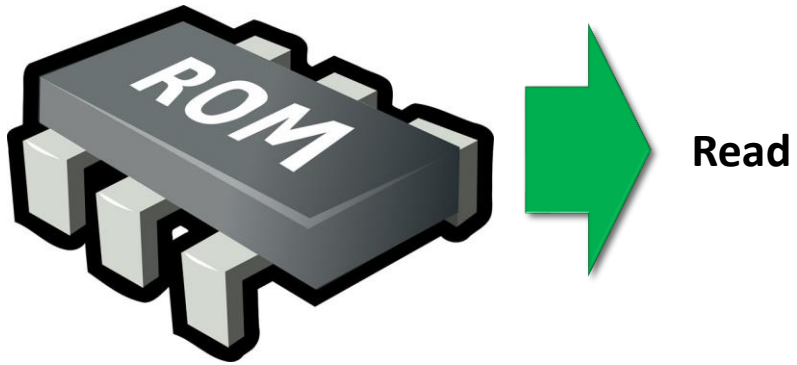
http://marc.rawer.de/Gameboy/

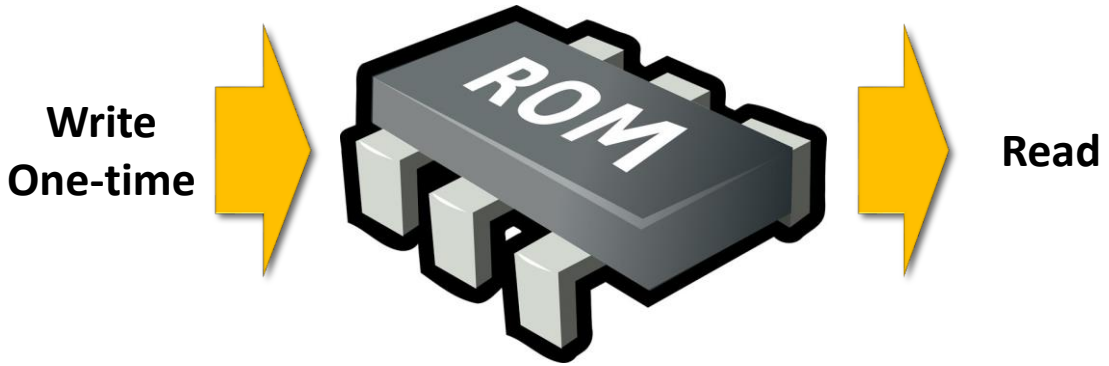
Read-Only Memory (ROM)

Various type of ROM

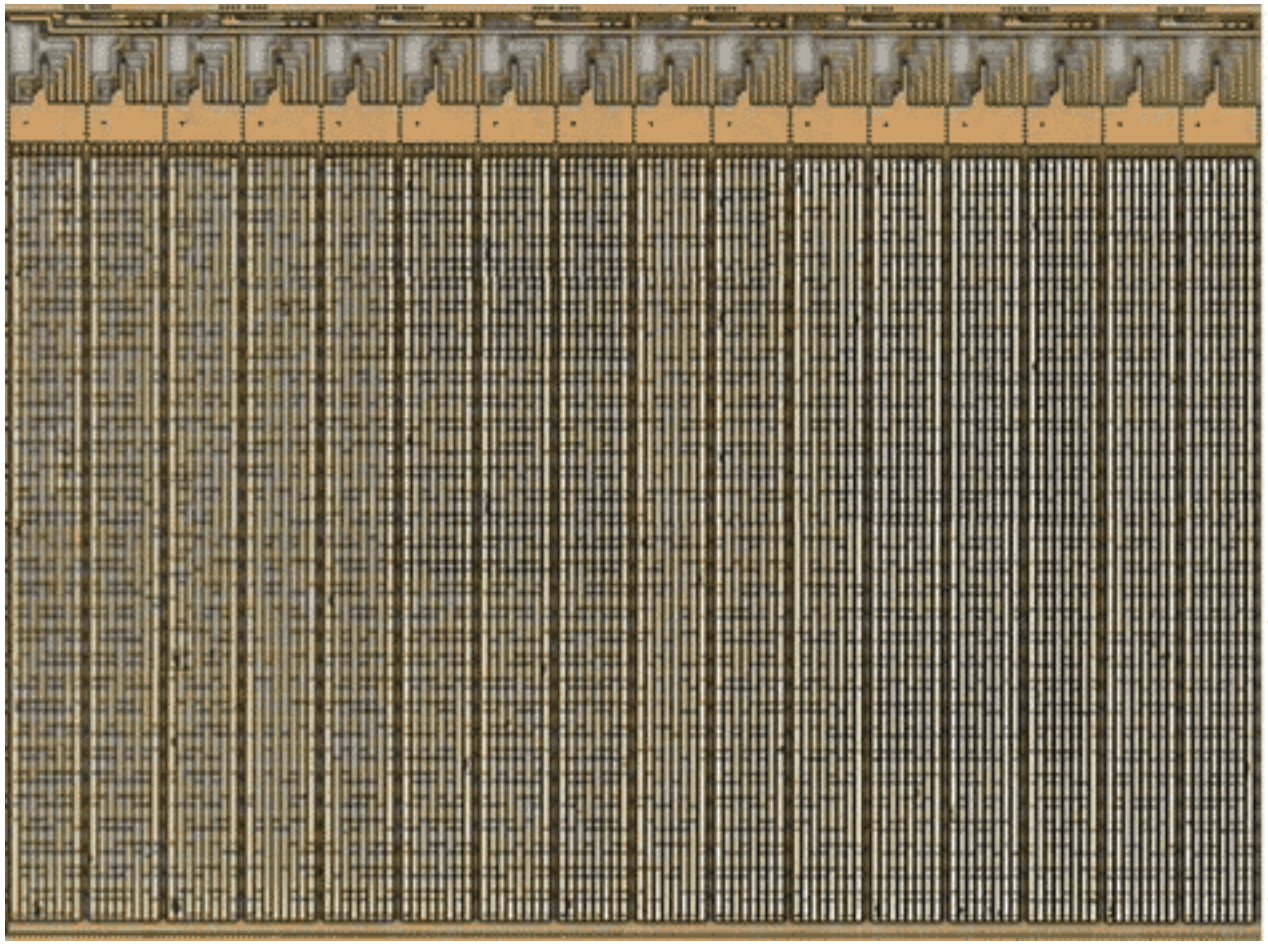
MROM (Masked ROM)
The very first ROMs were hard-wired devices that contained a preprogrammed set of data or instructions. These kind of ROMs are known as masked ROMs, which are inexpensive.

PROM (Programmable Read Only Memory)
PROM is read-only memory that can be modified only once by a user. The user buys a blank PROM and enters the desired contents using a PROM program. It can be programmed only once and is not erasable.

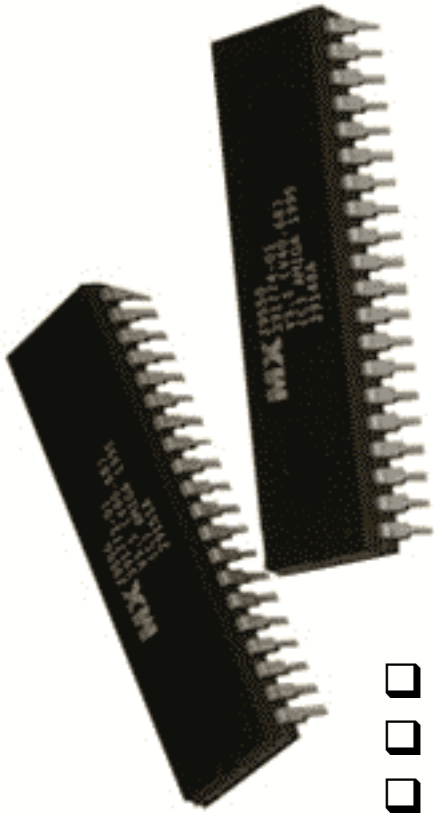




Read-Only Memory (ROM)



Mask Read Only Memory (MROM)



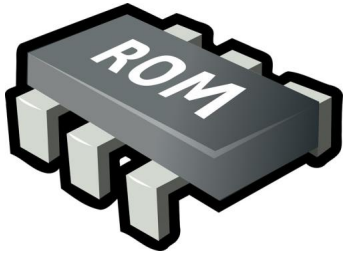
- Network Operating Systems.
- Server Operating Systems.
- Storing fonts for laser printers.
- Storing sound data in electronic musical instruments.

Read-Only Memory (ROM)

Various type of ROM

EPROM
(Erasable and Programmable Read Only Memory)
During programming, an electrical charge is trapped in an insulated gate region. EPROM can be erased by exposing it to ultra-violet light for a duration of up to 40 minutes. This exposure to ultraviolet light dissipates the charge

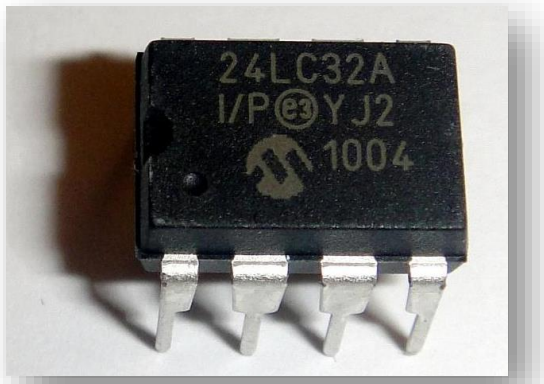
EEPROM
(Electrically Erasable and Programmable Read Only Memory)
EEPROM is programmed and erased electrically. It can be erased and reprogrammed about ten thousand times. Both erasing and programming take about 4 to 10 ms (millisecond).

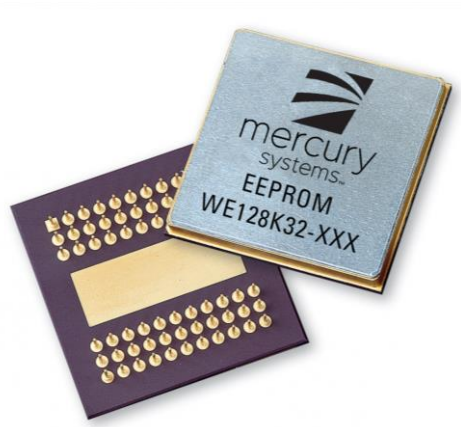


Write

Erase (with UV)

Read



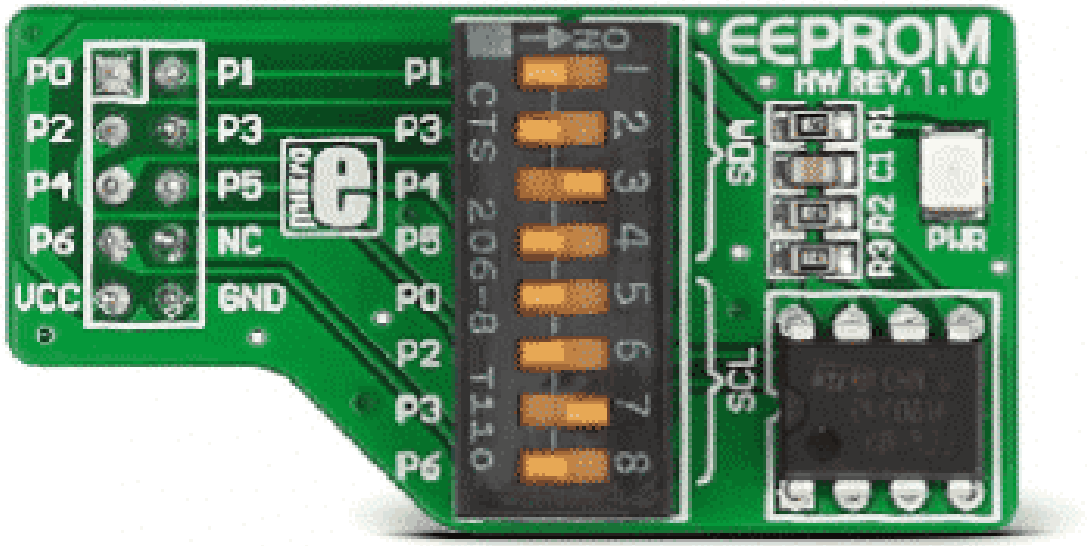


Read-Only Memory (ROM)

EPROM Chip

EPROM Eraser

Read-Only Memory (ROM)



EEPROM Chip

EEPROM Programmer

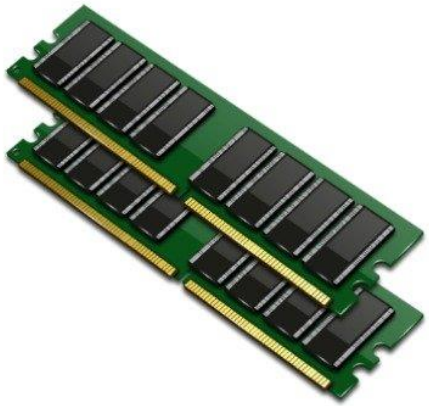
Read-Only Memory (ROM)

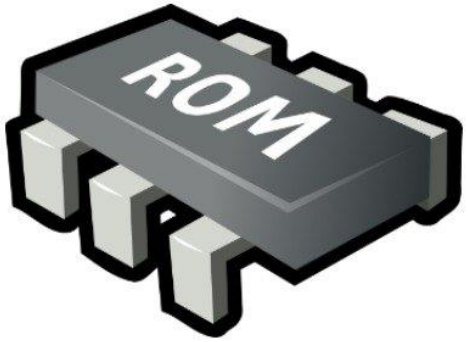
Advantages of ROM

- ❑ Cannot be accidentally changed
- ❑ Static and do not require refreshing
- ❑ Contents are always known and can be verified
- ❑ Cheaper than RAMs
- ❑ More reliable than RAMs
- ❑ Lower storage capacity than RAMs (4 – 6 MBs)

Random Access Memory (RAM)

- Use to hold data while program running
- When power off, all data will be wasted
- Ram has large storage limit





RAM Vs ROM

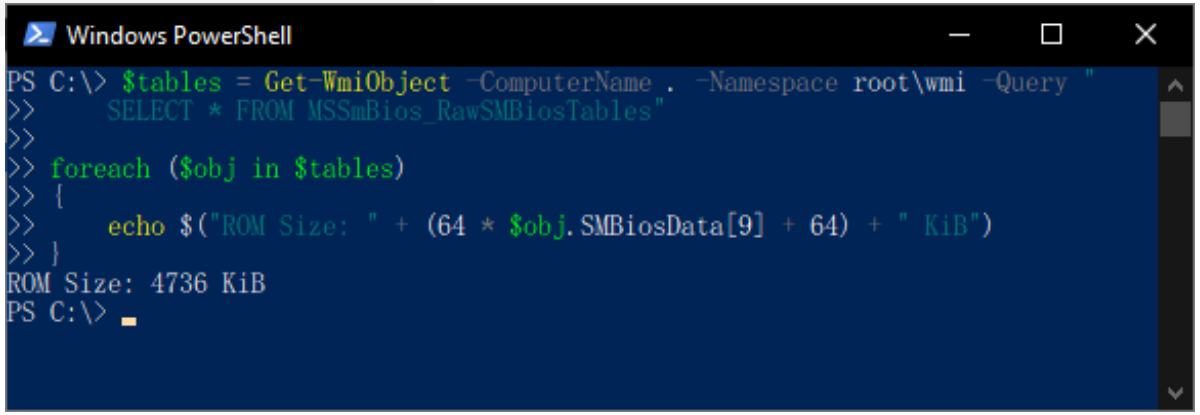
Read-Only Memory (ROM)

How can I find a ROM size of my Computer ?

PowerShell

```
$tables = Get-WmiObject -ComputerName . -Namespace root\wmi -Query "
    SELECT * FROM MSSmBios_RawSMBiosTables"

foreach ($obj in $tables)
{
    echo $("ROM Size: " + (64 * $obj.SMBiosData[9] + 64) + " KiB")
}
```

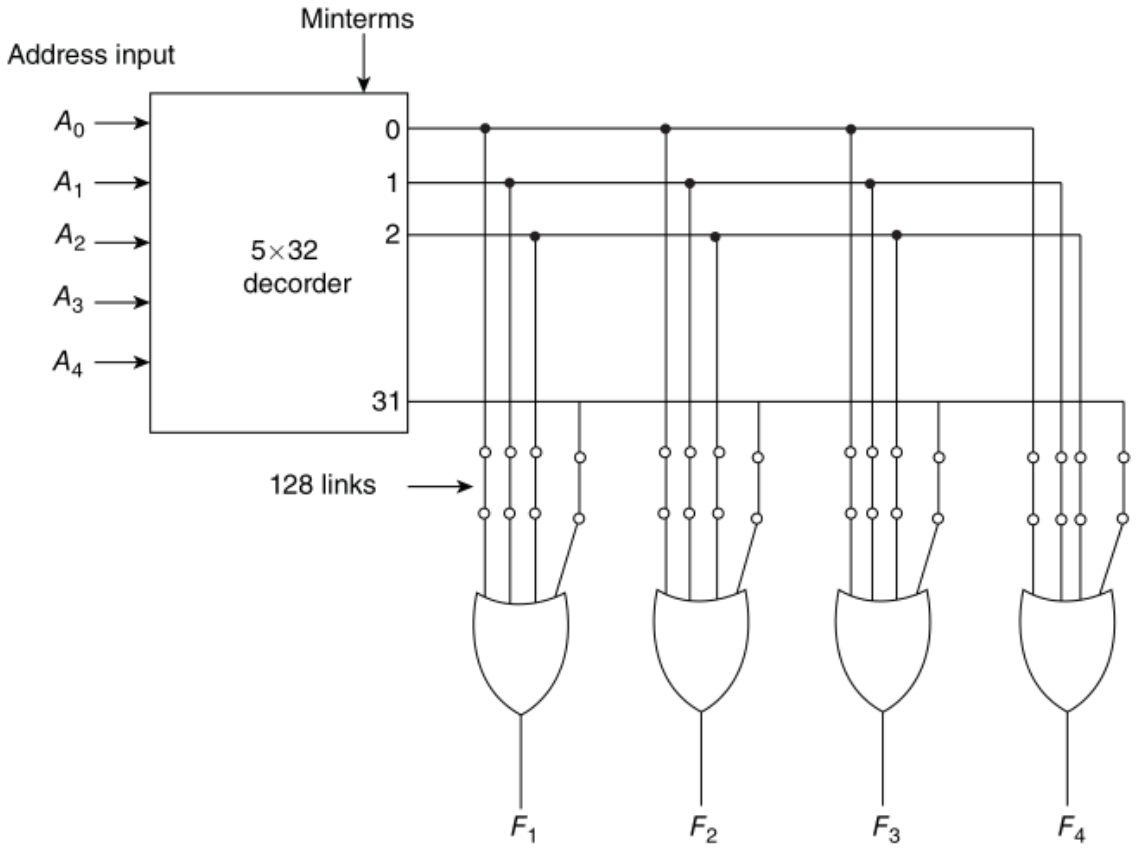


System Management BIOS (SMBIOS)

BIOS ➔ Basic Input Output System

Read-Only Memory (ROM)

Internally, the ROM is a combinational circuit with AND gates connected as a decoder and a number of OR gates equal to the number of outputs in the unit.



ROM definition in Symbol

Input : ตำแหน่งของกล่อง (Address)

Output : สิ่งที่อยู่ข้างในกล่อง (Data)

Read-Only Memory (ROM) : Review of Decoder

Read-Only Memory (ROM)

How to Programming the ROM

Example #1

A_1	A_0	F_1	F_2
0	0	0	1
0	1	1	0
1	0	1	1
1	1	1	0

Read-Only Memory (ROM)

Example #2: Design a combinational circuit using a ROM. The circuit accepts a 3-bit number and generates an output binary number equal to the square of the input number.

Read-Only Memory (ROM)

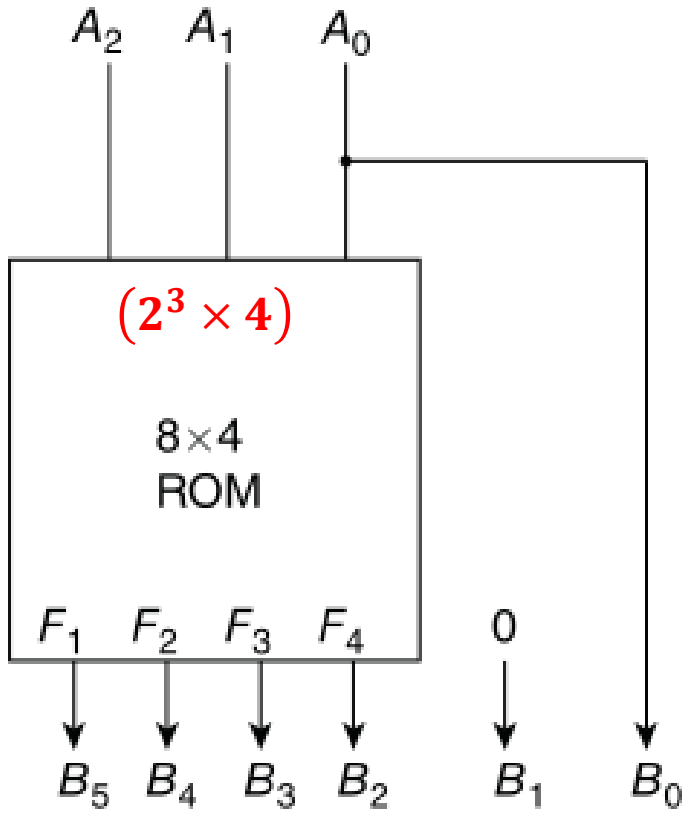
Example #2:

Read-Only Memory (ROM)

Example #2:

Read-Only Memory (ROM)

Example #2:



(a) Block diagram

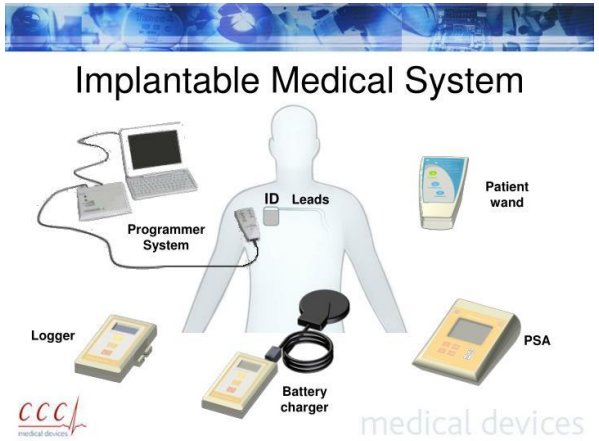
A_2	A_1	A_0	F_1	F_2	F_3	F_4
0	0	0	0	0	0	0
0	0	1	0	0	0	0
0	1	0	0	0	0	1
0	1	1	0	0	1	0
1	0	0	0	1	0	0
1	0	1	0	1	1	0
1	1	0	1	0	0	1
1	1	1	1	1	0	0

(b) ROM truth table

Read-Only Memory (ROM)

ROMs are widely used to implement complex combinational circuits directly from their truth tables. They have a wide variety of applications.

- ❑ Use ROM in Arithmetic functions such as multipliers
- ❑ Use ROM in Video game consoles
- ❑ Radio-Frequency Identification (RFID)tags.
- ❑ Implantable Medical devices.



Take a Break

REST YOUR MIND

Programmable Logic Array (PLA)

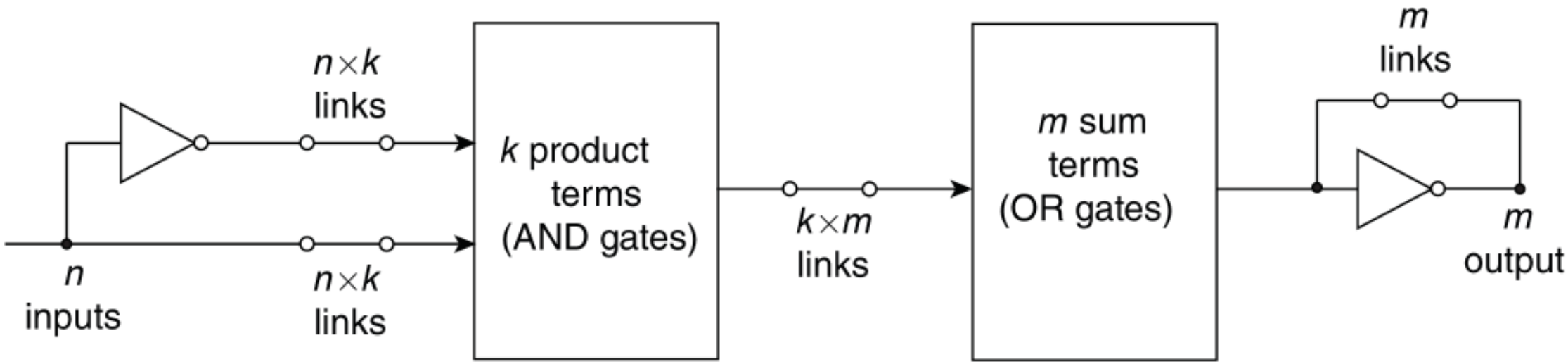
A combinational circuit may occasionally have don't-care conditions. When implemented with a ROM, a don't-care condition becomes an address input that will never occur. The words at the don't-care addresses need not be programmed and may be left in their original state (all 0's or all 1's). The result is that not all the bit patterns available in the ROM are used, which may be considered a **waste** of available equipment.

Comparison between ROM and PLA

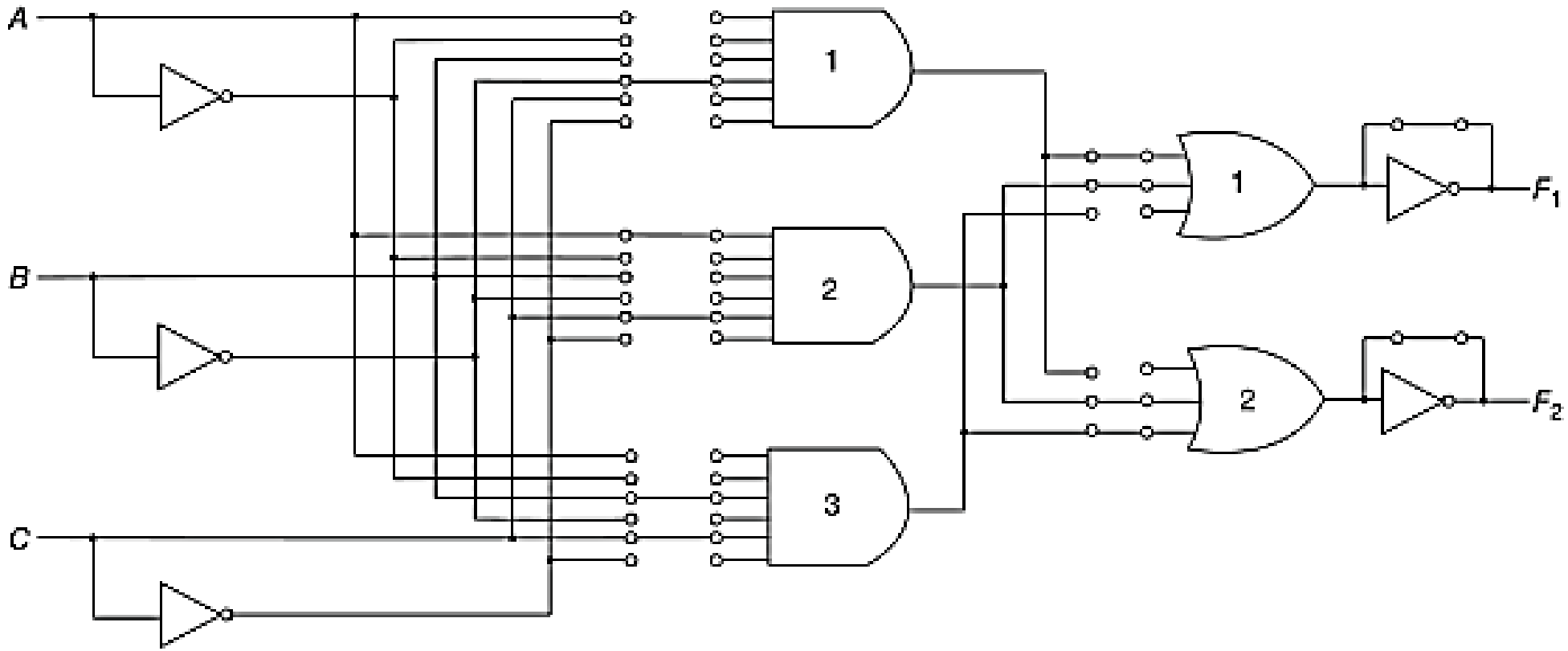
ROM has **fixed** AND gate array but **programmable** OR gate array

PLA has **programmable** AND gate array and **programmable** OR gate array

Programmable Logic Array (PLA)



Programmable Logic Array (PLA)



Programmable Logic Array (PLA)

Example #3: Implement the following Boolean function with PLA

$$F_1(A, B, C) = \sum(0,1,2,4)$$

$$F_2(A, B, C) = \sum(0,5,6,7)$$

Programmable Logic Array (PLA)

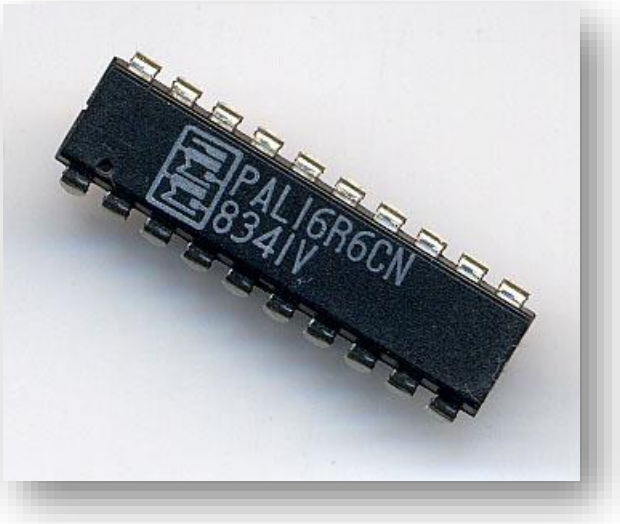
Example #3:

Programmable Array Logic (PAL)

This one is also a programmable logic device (PLD) like a Programmable Logic Array (PLA). Because only the AND array is programmable, it is easier to use but not flexible as compared to Programmable Logic Array (PLA).

Advantages of PAL:

- ❑ Low production cost as compared to PLA
- ❑ Highly secure
- ❑ High Reliability
- ❑ Low power required for working.



Comparison between ROM, PLA, and PAL

ROM has **fixed** AND gate array but **programmable** OR gate array

PLA has **programmable** AND gate array and **programmable** OR gate array

PAL has **programmable** AND gate array and **fixed** OR gate array

Programmable Array Logic (PAL)

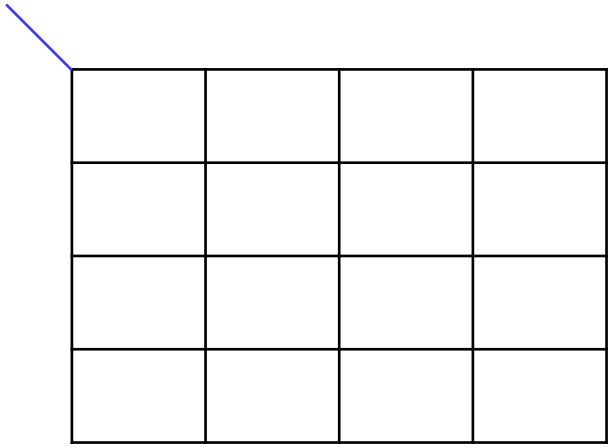
Example #4: Implement the following Boolean function with PLC

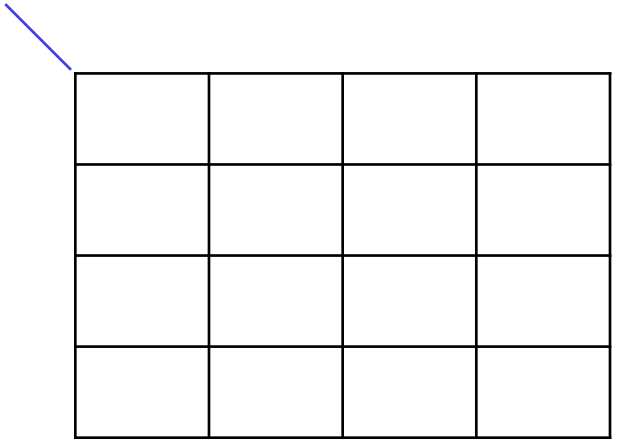
$$F_1(A,B,C,D) = \sum(2,12,13)$$

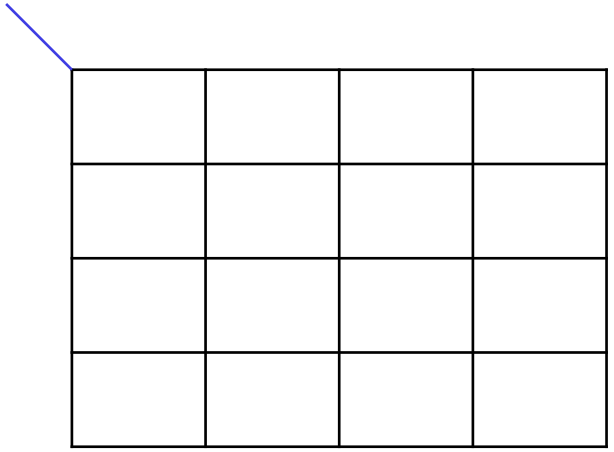
$$F_2(A,B,C,D) = \sum(7,8,9,10,11,12,13,14,15)$$

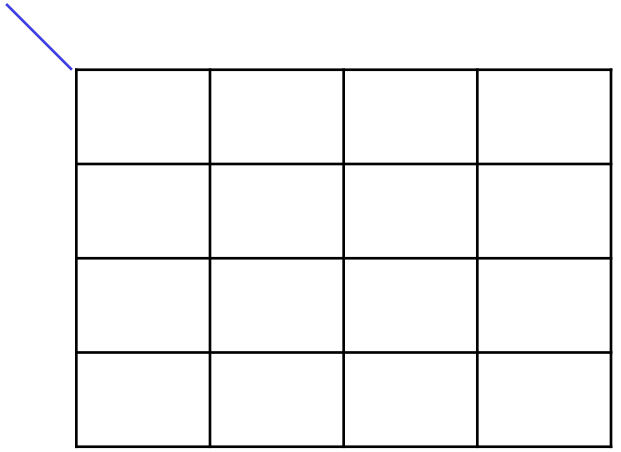
$$F_3(A,B,C,D) = \sum(0,2,3,4,5,6,7,8,10,11,15)$$

$$F_4(A,B,C,D) = \sum(1,2,8,12,13)$$







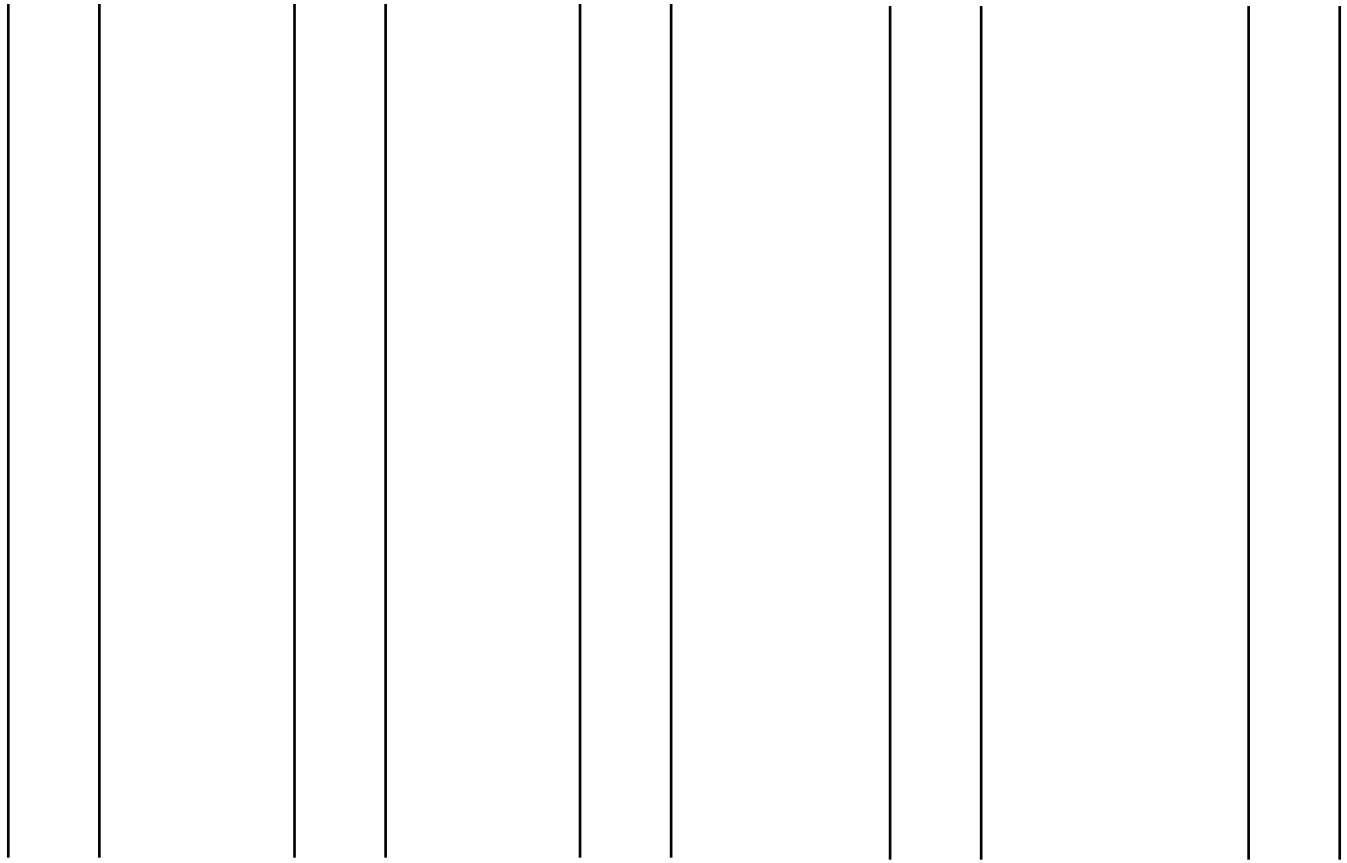


Programmable Array Logic (PAL)

Example #4:

Programmable Array Logic (PAL)

Example #4:




I have just three things to teach:
simplicity, patience, compassion. These
three are your greatest treasures.
Lao Tzu
quotefancy