BADJI MOKHTAR-ANNABA UNIVERSITY
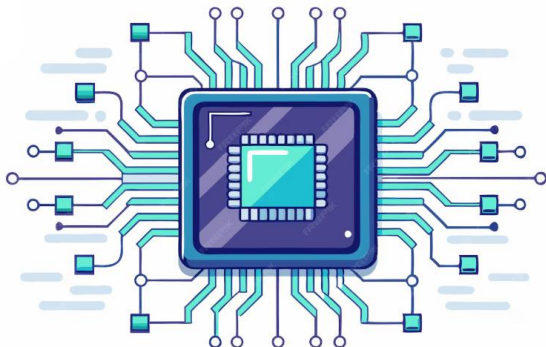**UNIVERSITE BADJI MOKHTAR-ANNABA**

جامعة باجي مختار-عنابة

Faculty of technology
Electronics departement
Microcontrollers and Microprocessors course

Chapter 3
Semiconductor Memory

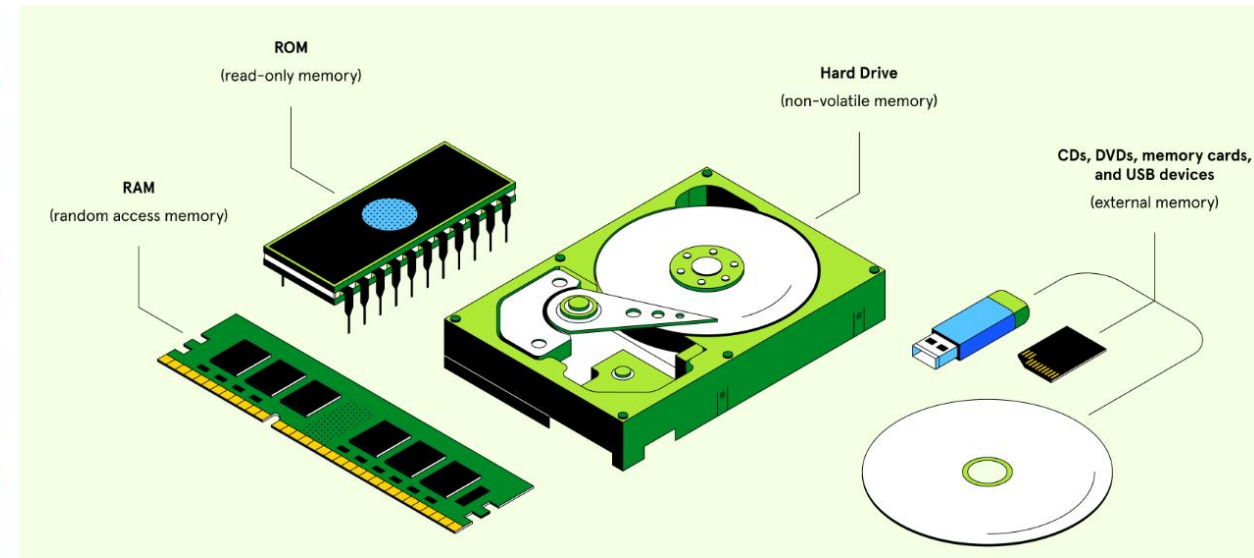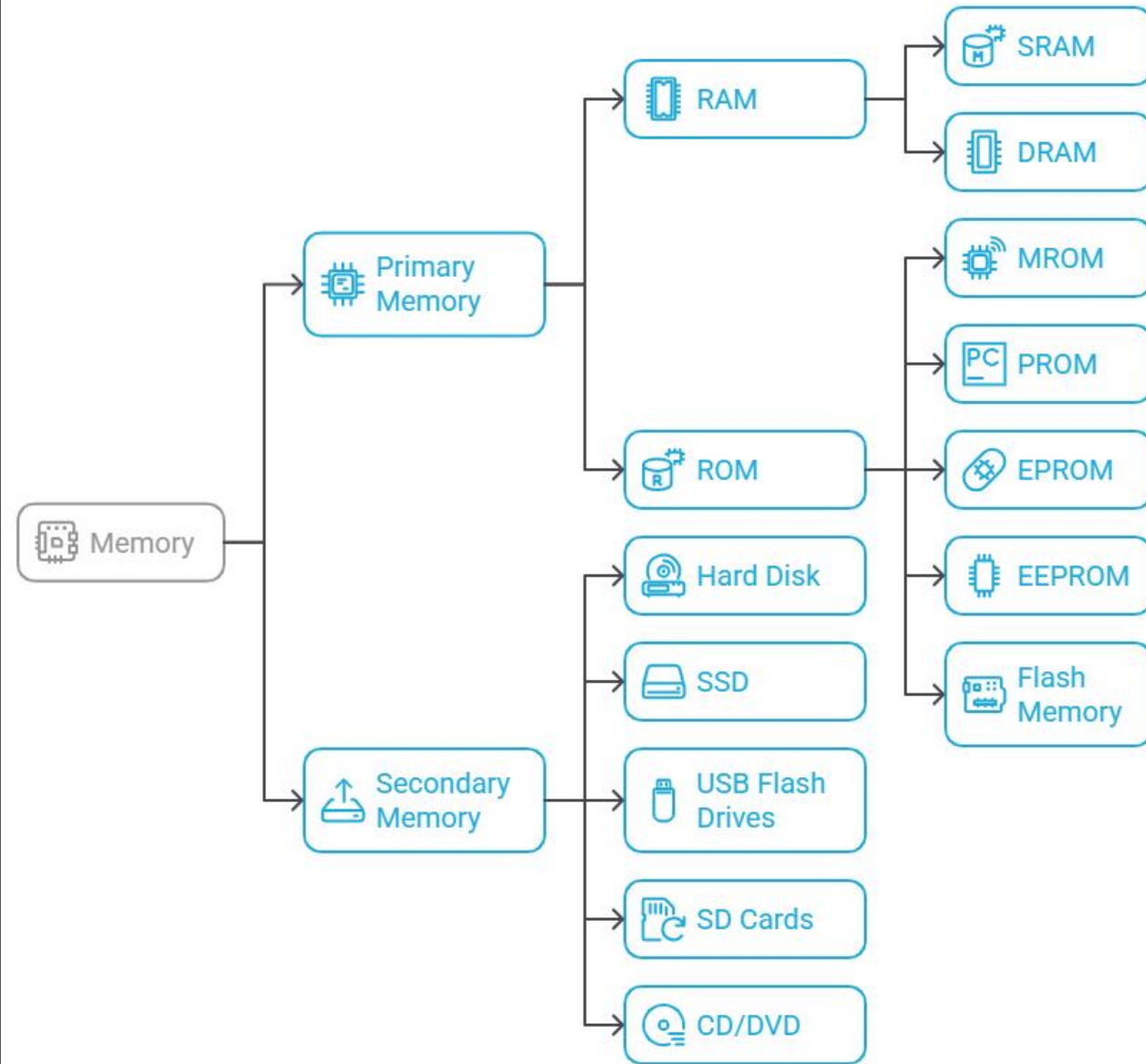Course 6/7

Teaching by
Dr. MERABTI Nardjes

L3 AUTO
Promotion : 2025/2026

What is Memory ?

Memory is electronic circuit that holds a place for instruction and data that a Microprocessor needs to reach quickly. It is the collection of storage units that store binary information in bits. The memory block is split into smaller components called cells. Every cell has a unique address for storing data in memory.

It stores data as electrical charges or logic states inside integrated circuits.

Memory Classification and Types

Memory

- Primary Memory
  - RAM
    - SRAM
    - DRAM
  - ROM
    - MROM
    - PROM
    - EPROM
    - EEPROM
    - Flash Memory
- Secondary Memory
  - Hard Disk
  - SSD
  - USB Flash Drives
  - SD Cards
  - CD/DVD

RAM
(random access memory)

ROM
(read-only memory)

Hard Drive
(non-volatile memory)

CDs, DVDs, memory cards, and USB devices
(external memory)

Made with Napkin

1. Primary Memory

This is the main type of memory in computer that communicates directly with the CPU, cache and auxiliary memory. It allows immediate access from temporary memory slots or other storage locations. This type of computer memory keeps data and programs when the process is active to use them.

When a program or data is activated for execution, the processor loads instructions from the secondary memory into the main memory and then starts execution. It is a volatile memory due to which any unsaved data is lost when a power cut occurs.

Primary memory is of two types: RAM and ROM.

- Volatile Memory **(**Loses its data when power is switched off)

a) **RAM (Random Access Memory):** RAM is a type of primary memory that temporarily holds data while a computer is operating. It allows fast access to data, ensuring the smooth functioning of applications and programs. However, the stored data is erased when the computer is turned off.

➢ **Static RAM (SRAM):** is a quicker and more dependable form of RAM that stores data using flip-flops, in contrast to Dynamic RAM (DRAM). It doesn't **require refreshing**, which results in faster access speeds. However, it tends to be costlier and consumes more power compared to DRAM.

➢ **Dynamic RAM (DRAM):** is a memory type that saves data in capacitors, which require regular refreshing to keep the stored information intact. It is slower than SRAM but more cost-effective, making it commonly used for system memory in computers. DRAM consumes less power than SRAM.

➤ Cache Memory

Cache memory is a small, rapid storage space near the CPU that is intended to store frequently accessed data for speedier access. Although it has a limited capacity, it speeds up processing by reducing the amount of time needed to obtain data from the main memory.
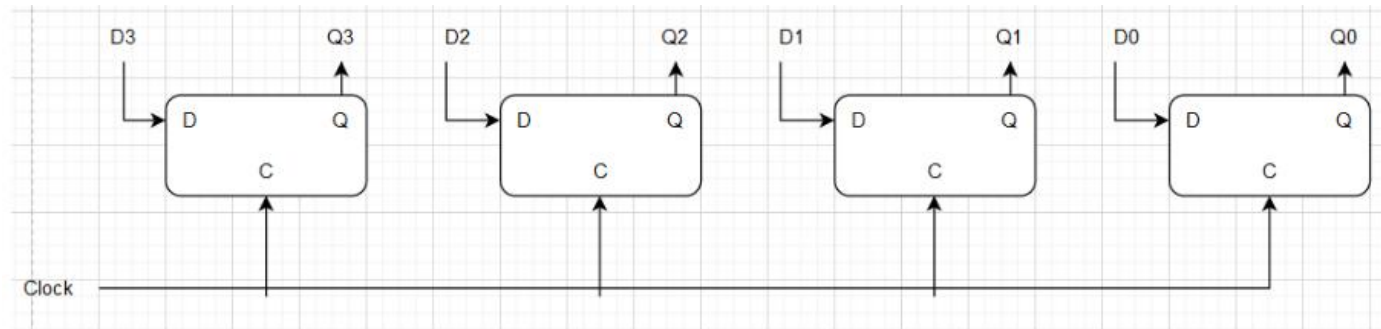
➤ Register Memory

Register memory is the fastest form of memory, situated directly within the CPU. It temporarily holds small amounts of data to facilitate rapid processing during computations and tasks. Registers are essential for executing instructions efficiently.

A Register is a group of flip-flops. Its basic functionality is to hold data within any digital system to make it available to the logic units for the computing process. However, it may also have additional capabilities.

The flip-flops in a register contain the binary data, whereas the logical gates control the data flow; In general, we have two major types of Registers: Serial and Parallel Load Registers
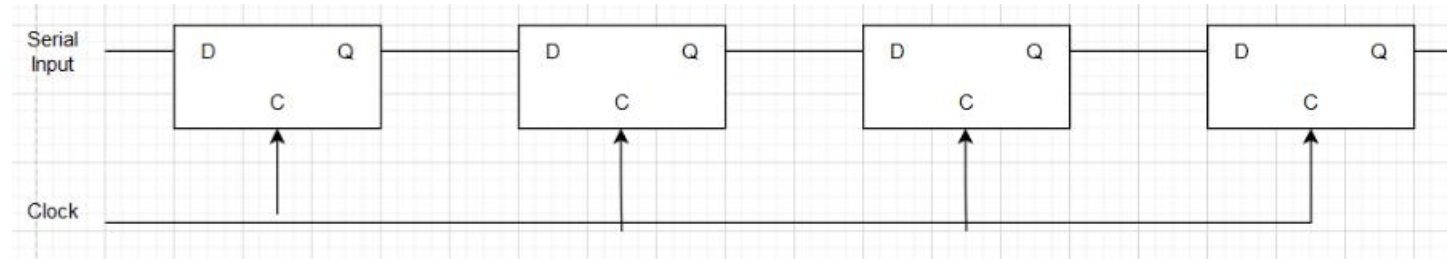
4 Bit register

4 Bit Parallel load register

- **Non-Volatile Memory :(** Keeps data even when power is off:

==a) ROM (Read-Only Memory):== ROM is a non-volatile memory that retains data even without power. It holds critical system information, like the startup instructions of a computer. Since ROM is read-only, its data cannot be easily altered.

➢ **Masked ROM (MROM):** Data that has been pre-programmed during the manufacturing process and cannot be altered later is known as masked ROM (MROM). It is typically used for storing fixed data, such as firmware, and cannot be modified once programmed.

➢ **Programmable ROM (PROM):** is a kind of ROM that, with the use of a specialized programming tool, enables data to be written once after production. Once data is programmed, it cannot be changed or erased.

➤ **Erasable Programmable ROM (EPROM):** One kind of ROM that can be cleaned and reprogrammed with ultraviolet (UV) radiation is called Erasable Programmable ROM (EPROM). It is often used for storing firmware that may need periodic updates, allowing new data to be written after erasure.

➤ **Electrically Erasable Programmable ROM (EEPROM):** Data can be deleted and reprogrammed using electrical impulses instead of UV light, thanks to a form of ROM called Electrically Erasable Programmable ROM (EEPROM). It offers the convenience of reprogramming without requiring physical exposure to light.

➤ **Flash ROM:** This type of ROM can be programmed or written in smaller units called sectors or block. It is used for transferring data between computer and digital devices.

Difference between RAM ROM memory

RAM	ROM
RAM is a volatile memory	ROM is a non-volatile memory
RAM is expensive compared to ROM	ROM is cheaper in comparison to RAM
Data in RAM can be modified, read, or erased.	Data in ROM can only be read.
RAM is a temporary storage	ROM is a permanent storage
Writing data on RAM is faster than ROM	Writing data on ROM is slower
RAM can be accessed by the CPU directly	The data of ROM needs to be transferred to RAM to give access to the CPU to its data.

2. Secondary memory: is a permanent type of storage used to keep large amounts of data and programs for long periods.

It is external to the CPU and cannot be accessed directly by it; access occurs through I/O controllers.

Secondary memory is commonly available as external storage devices, such as CDs, DVDs, and USB drives.

It is cheaper than primary memory but also slower; Includes:

✓ Hard Disk (HDD)

✓ SSD (Solid-State Drive)

✓ USB Flash Drives

✓ SD Cards

✓ CD/DVD

How Semiconductor Memory Works?

- Data stored as logic 0/1

- Address lines select which memory cell to read/write Control signals:

➢ CS (Chip Select): enables the memory chip

➢ RD (Read): enables reading operation

➢ WR (Write): enables writing operation
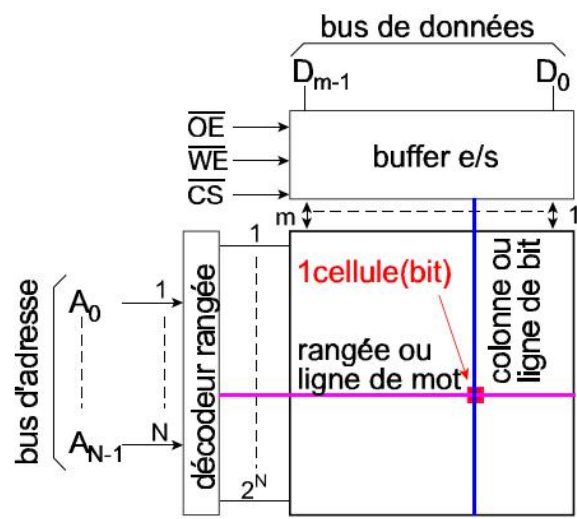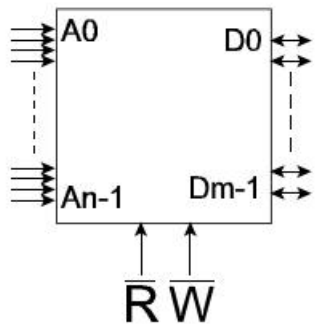
- Data lines carry 8-bit, 16-bit, or 32-bit words.
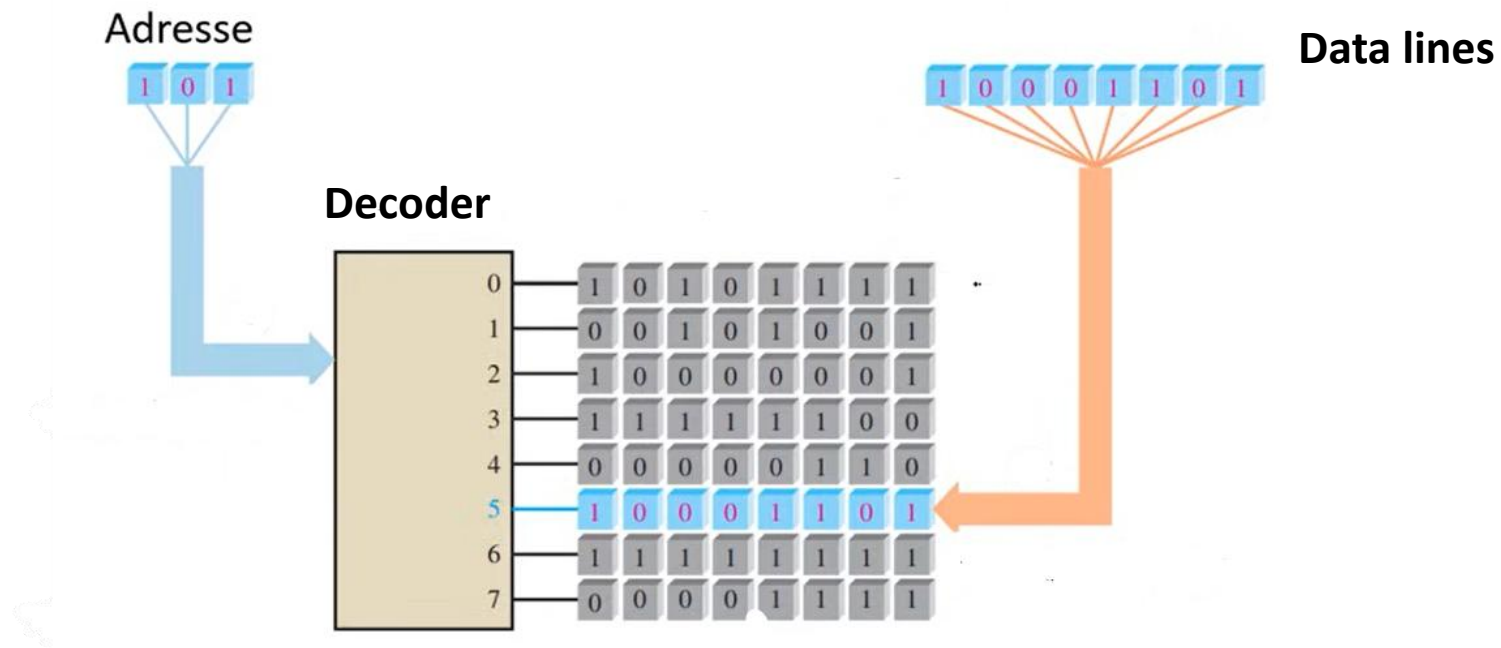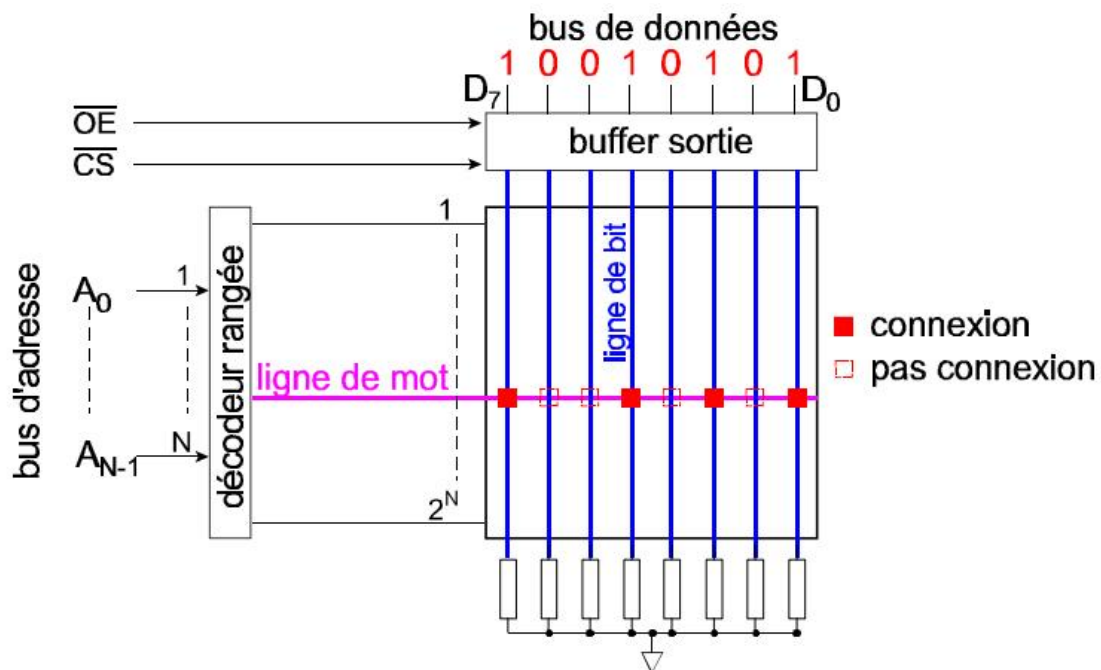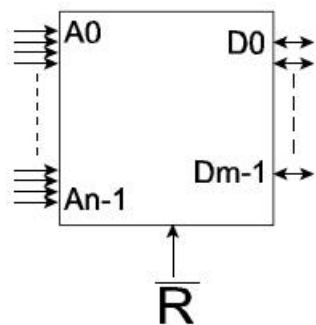
Block Diagram of a Memory :

A_0---A_{n-1} : Addres buses

D_0---D_{m-1} :Data buses

RAM

ROM

❖ Memory Expansion (Extension)

Memory expansion means increasing the total memory size of a system by adding multiple memory chips.

$$\text{Nbre of chips: } \frac{Total\ size}{size\ of\ a\ chip}$$

A) Expansion by Capacity (Address Expansion): Used to add more memory locations.

➢ Keep data bus the same

➢ Add more address space

➢ Use chip select (CS) signals with decoders

Example: we want Total memory = 8 KB with Two 4 KB (2 in Series → Each chip = 4 KB)Chip 1 occupies the first 4 KB [0000H – 0FFFH]; Chip 2 occupies the next 4 KB [1000H – 1FFFH]

We use **A12** as the selection line.
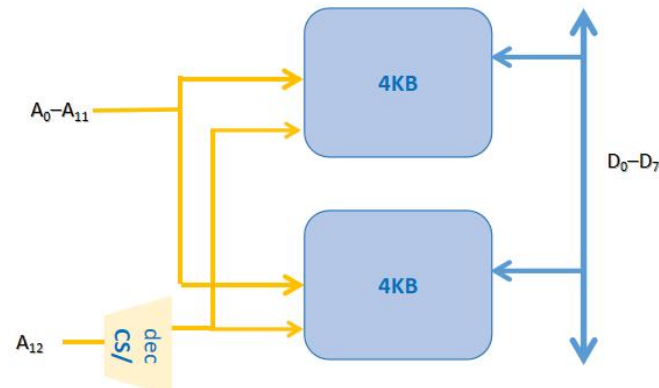
B) Expansion by Word Size (Data Expansion): Used to increase data width.

Both chips share:

➢ Same address lines

➢ Same control signals

But **different halves of the data bus.**

• **Example:**

To build 16K × 8, you combine:

One 16K × 4 chip → lower byte (D0–D3)

One 16K × 4 chip → higher byte (D4–D7)