

COA

Chapter 05: | Memory Expansion

Prof. Dr. Mostafa Elhosseini

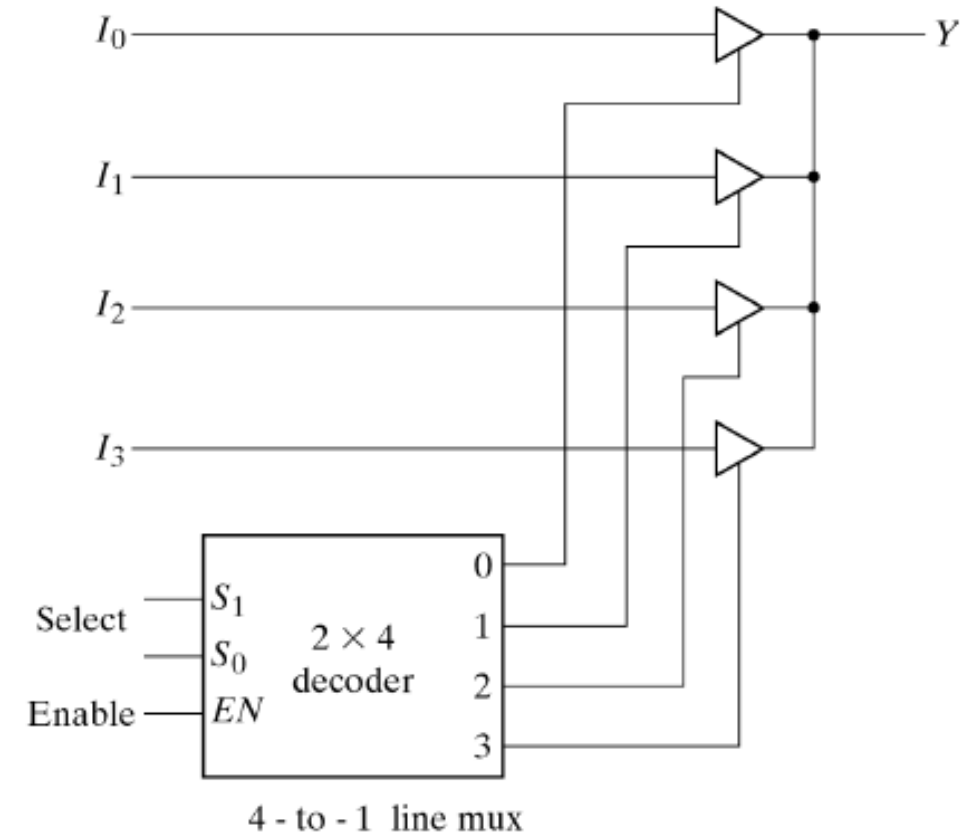
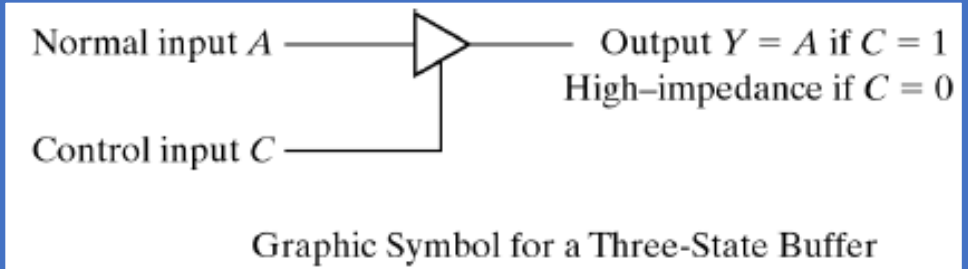
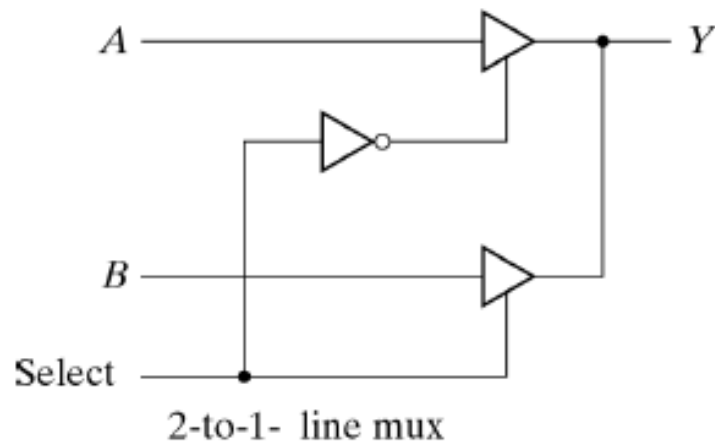
<https://youtube.com/drmelhosseini>

| AGENDA

- Chip Logic
- Chip Packaging
- Memory Expansion
 - word-length expansion
 - word-capacity expansion

Tri-state Buffer

- Three state:
 - 0 or 1 Boolean value
 - High impedance
- High impedance acts as if gate is disconnected



| Chip Logic

- Semiconductor **memory** comes in **packaged chips**
- Each **chip** contains an **array of memory cells**.
- One of the key design issues is the **number of bits** of data that may be read/written **at a time**
- Memory chip organization with a DRAM like ROM organization

Chip Logic

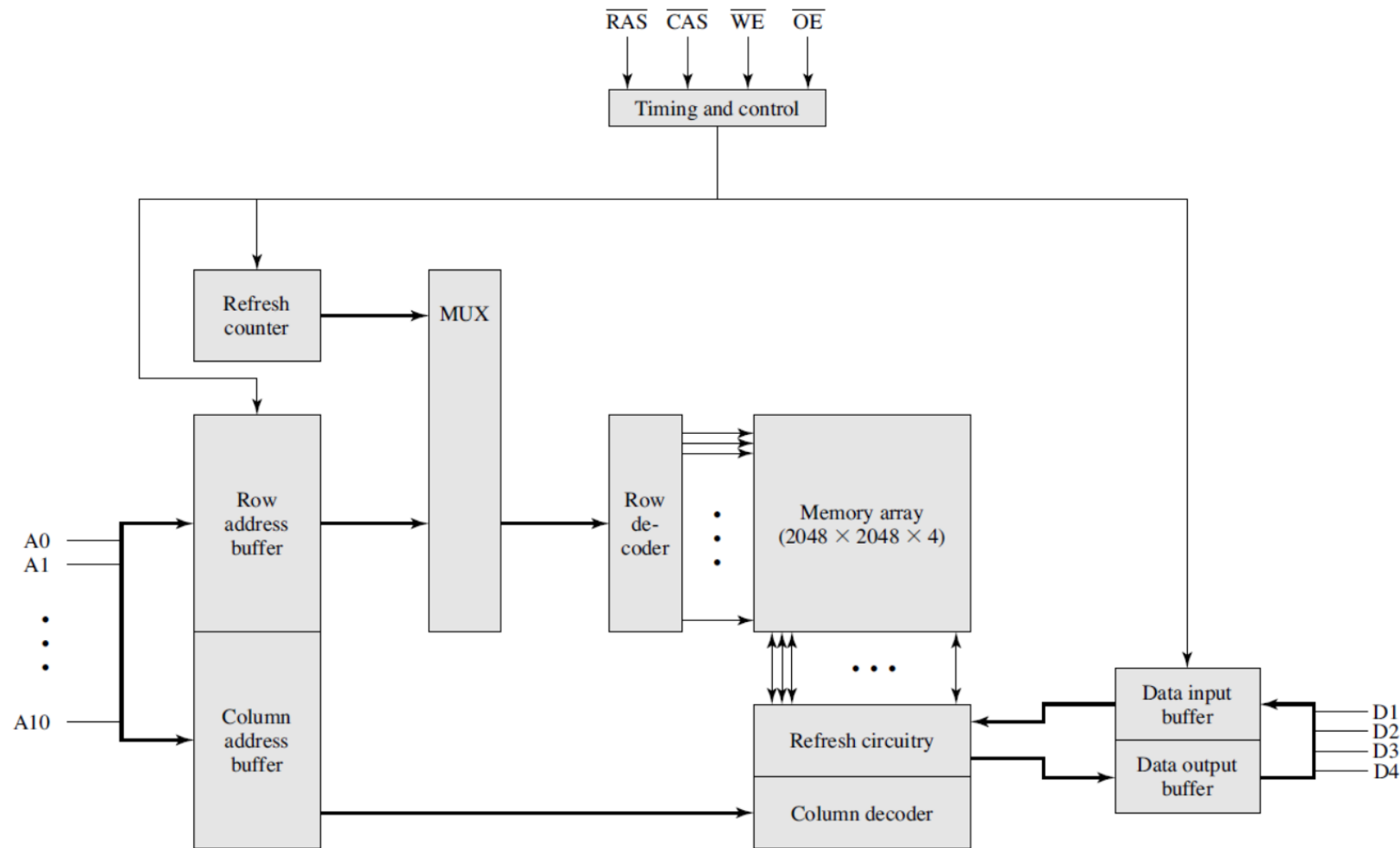
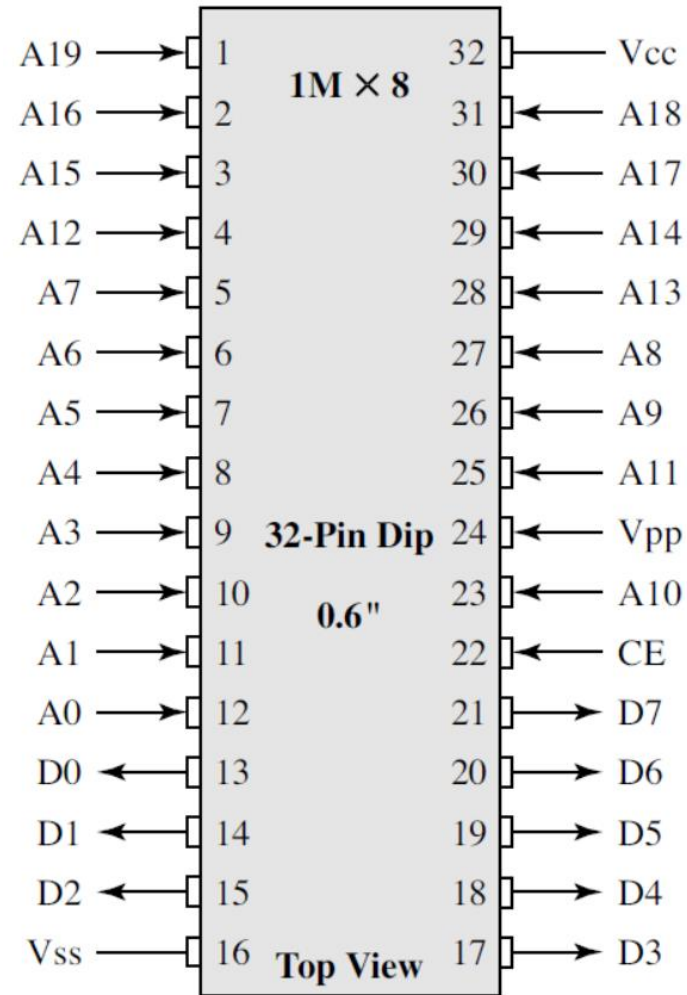


Figure 5.3 Typical 16 Megabit DRAM (4M x 4)

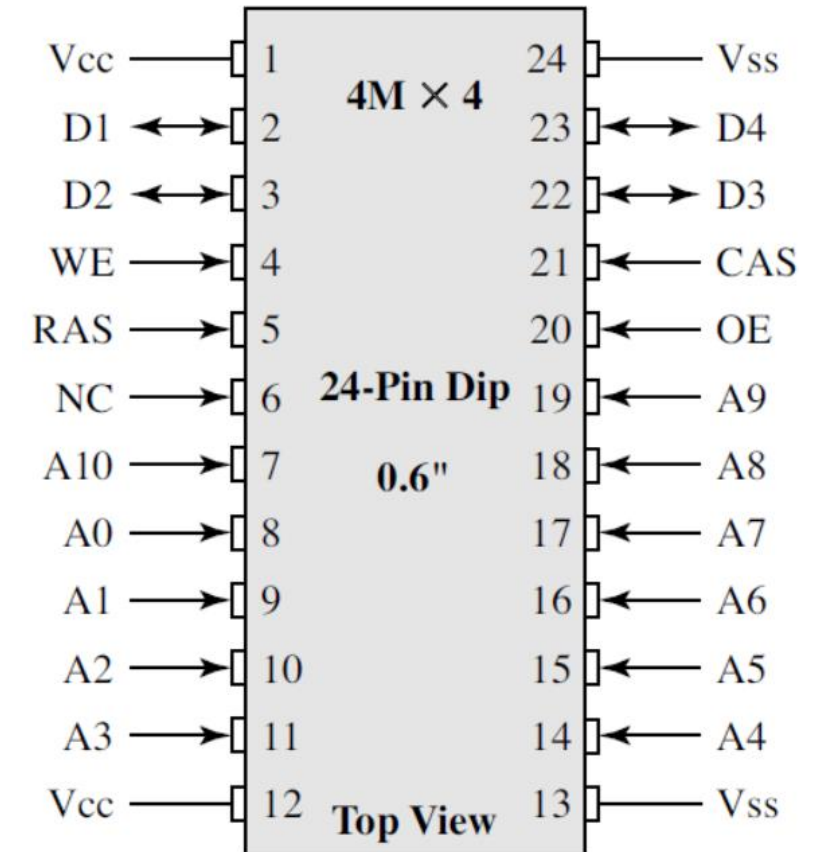
| Chip Packaging



(a) 8-Mbit EPROM

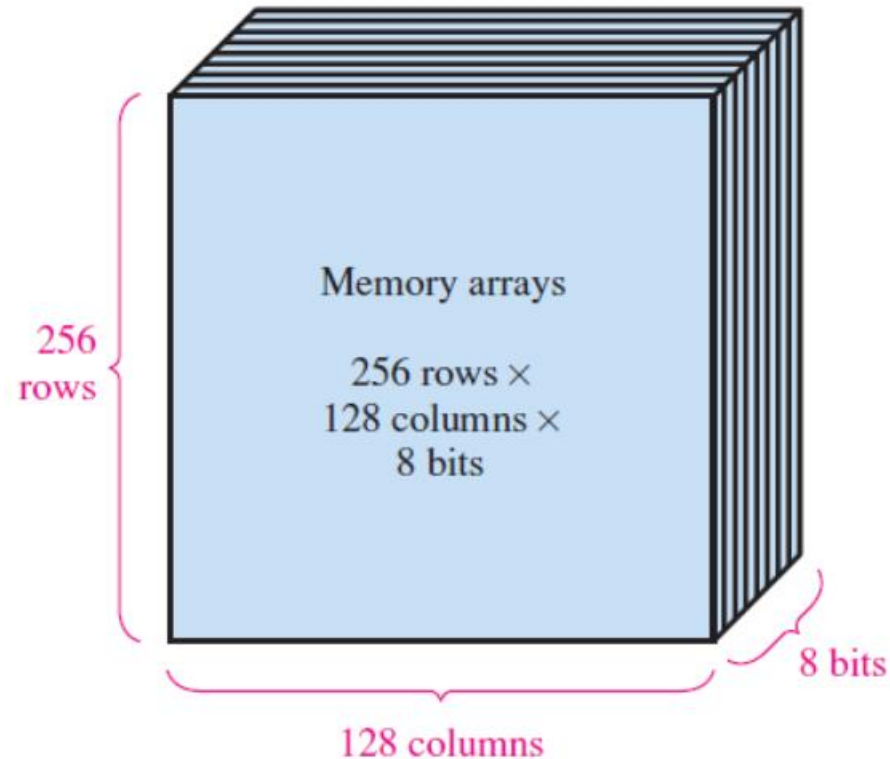
| Chip Packaging

- DRAM - 16-Mbit chip organized as $4M \times 4$
 - The data pins are input/output
- Address is **multiplexed**, only **11** address pins are needed to specify the **4M**
- no connect (**NC**) pin is provided so that there are an even number of pins

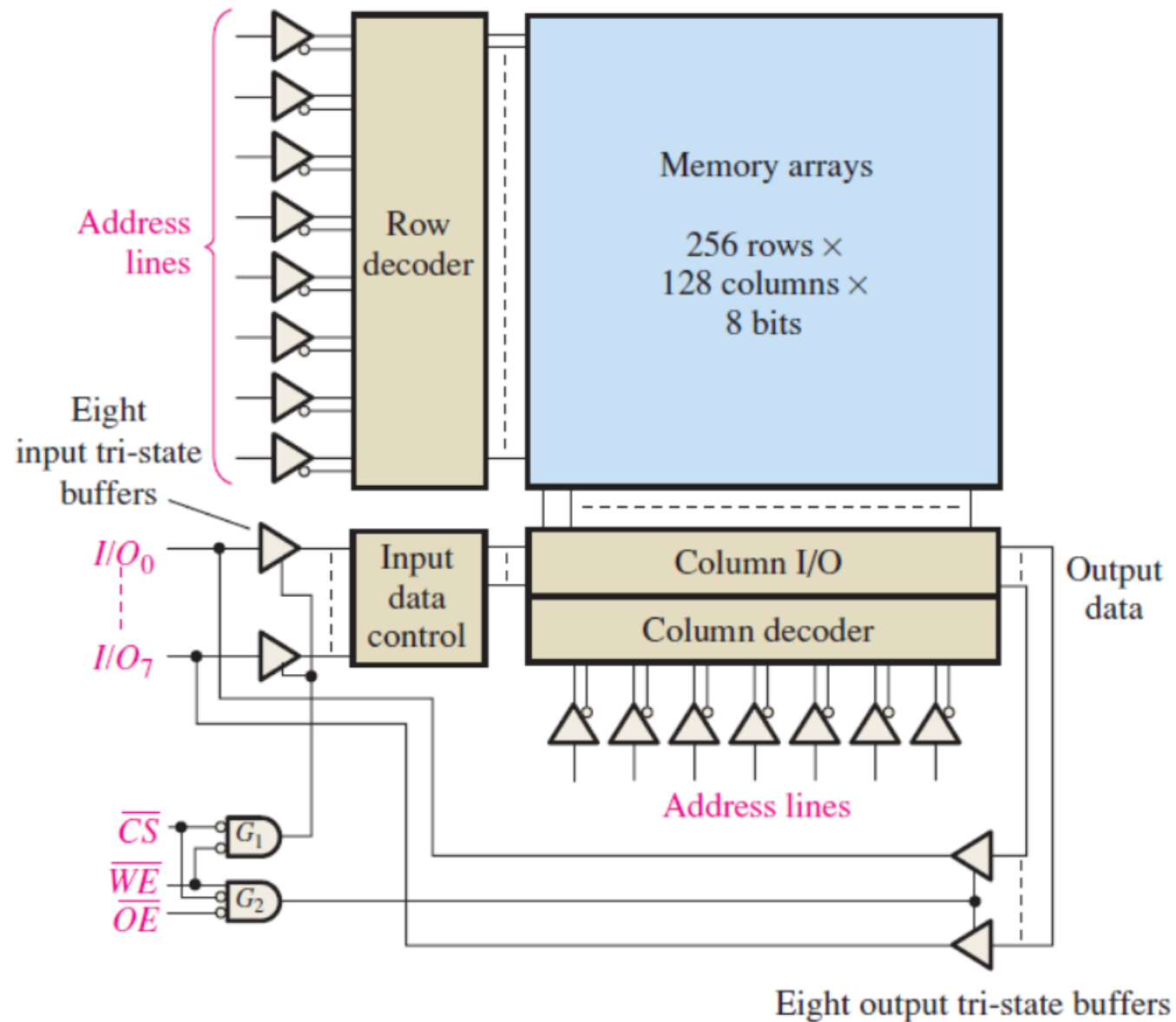


| Organization of a small $32k \times 8$ SRAM

- The memory cell array is arranged in 256 rows and 128 columns, each with 8 bits



| $32k \times 8$ SRAM



| Memory Expansion

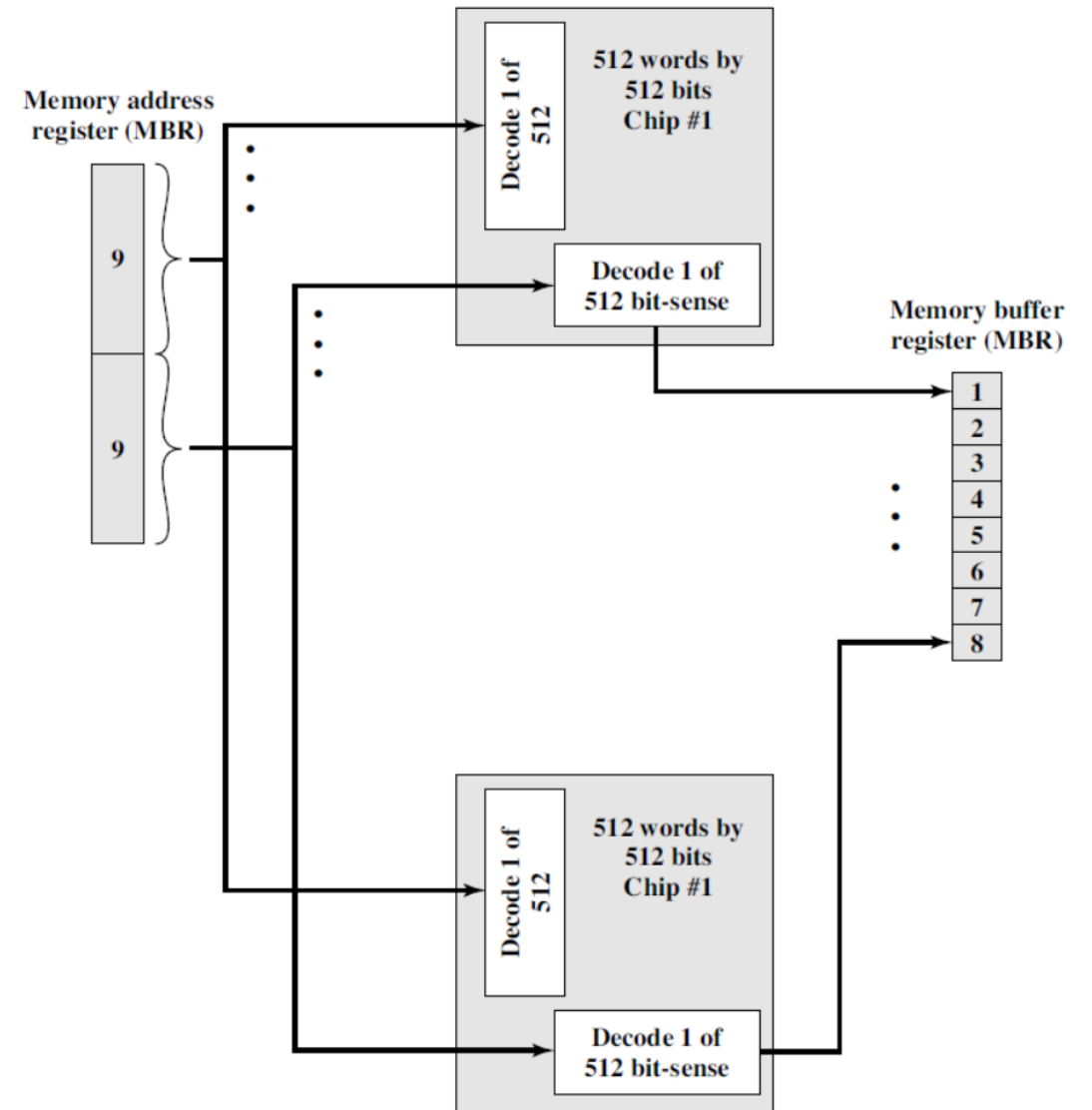


Figure 5.5 256-KByte Memory Organization

Memory Expansion

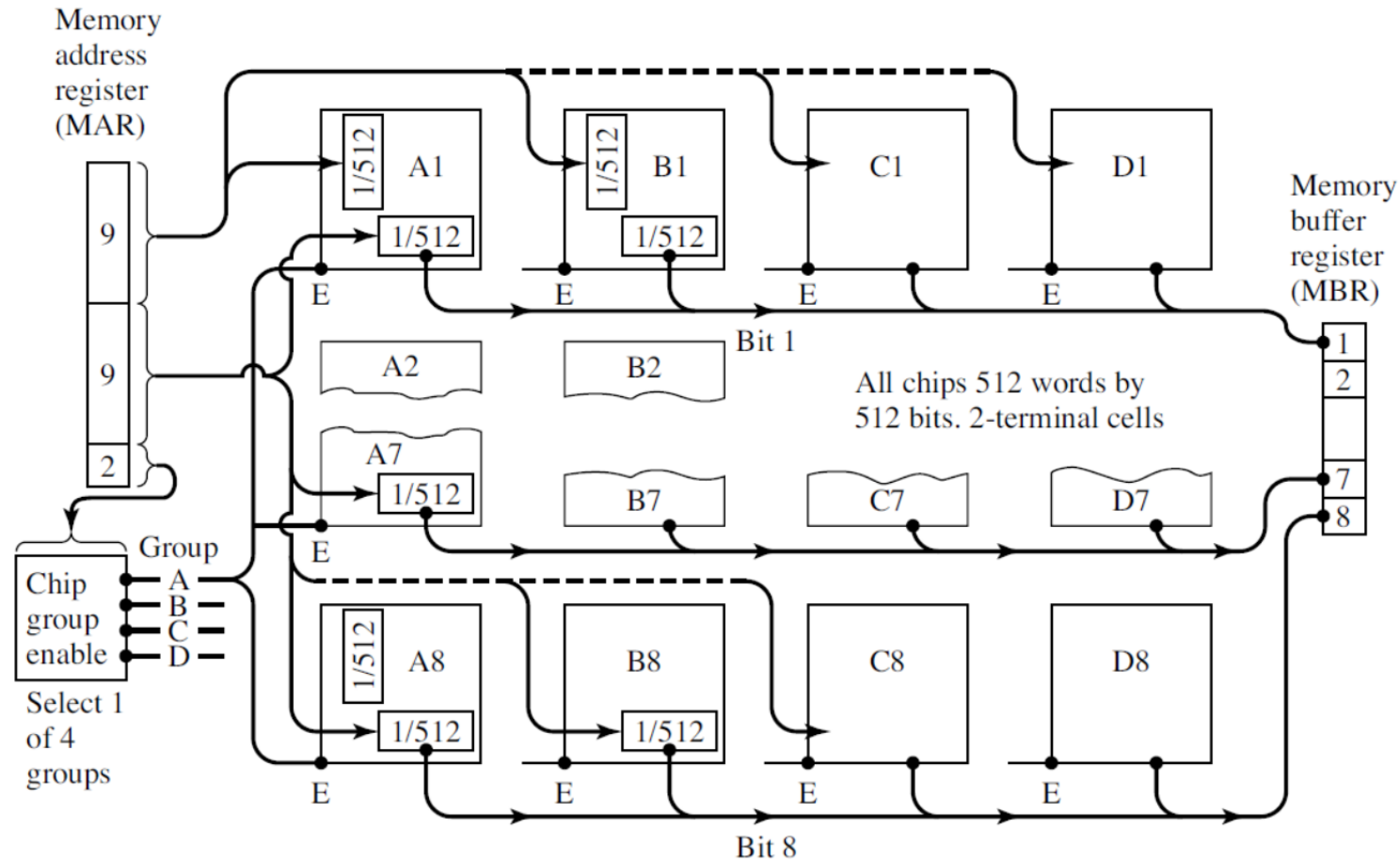


Figure 5.6 1-Mbyte Memory Organization

| Memory Expansion

■ Word-Length Expansion

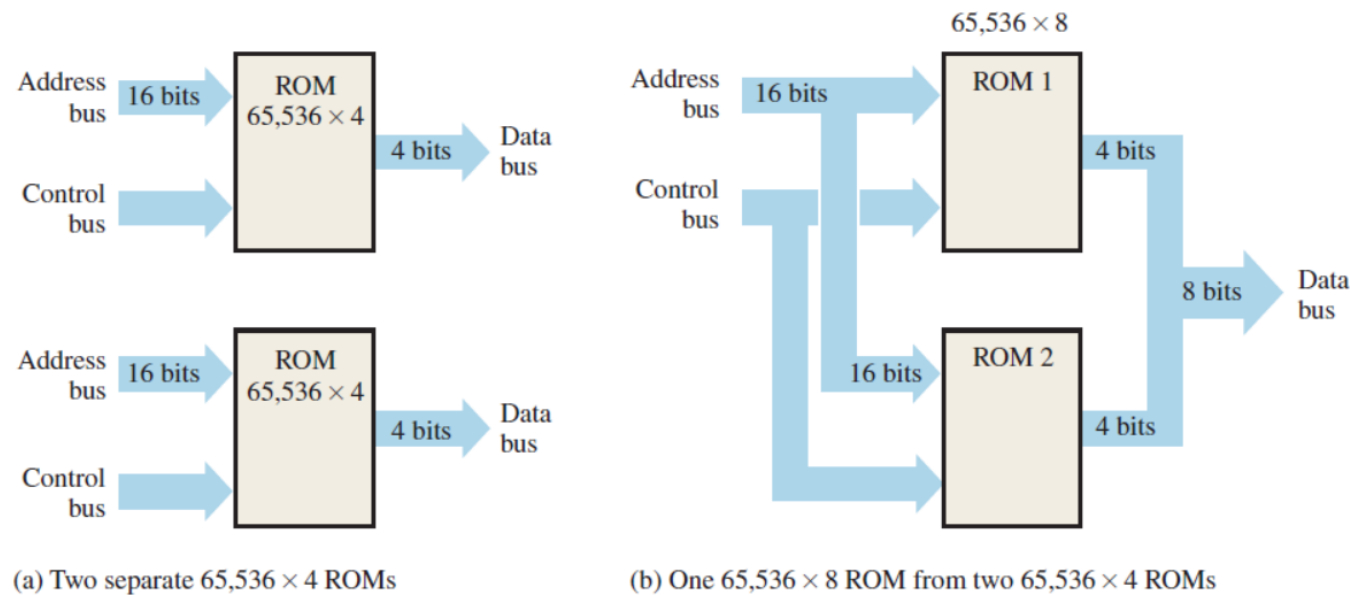
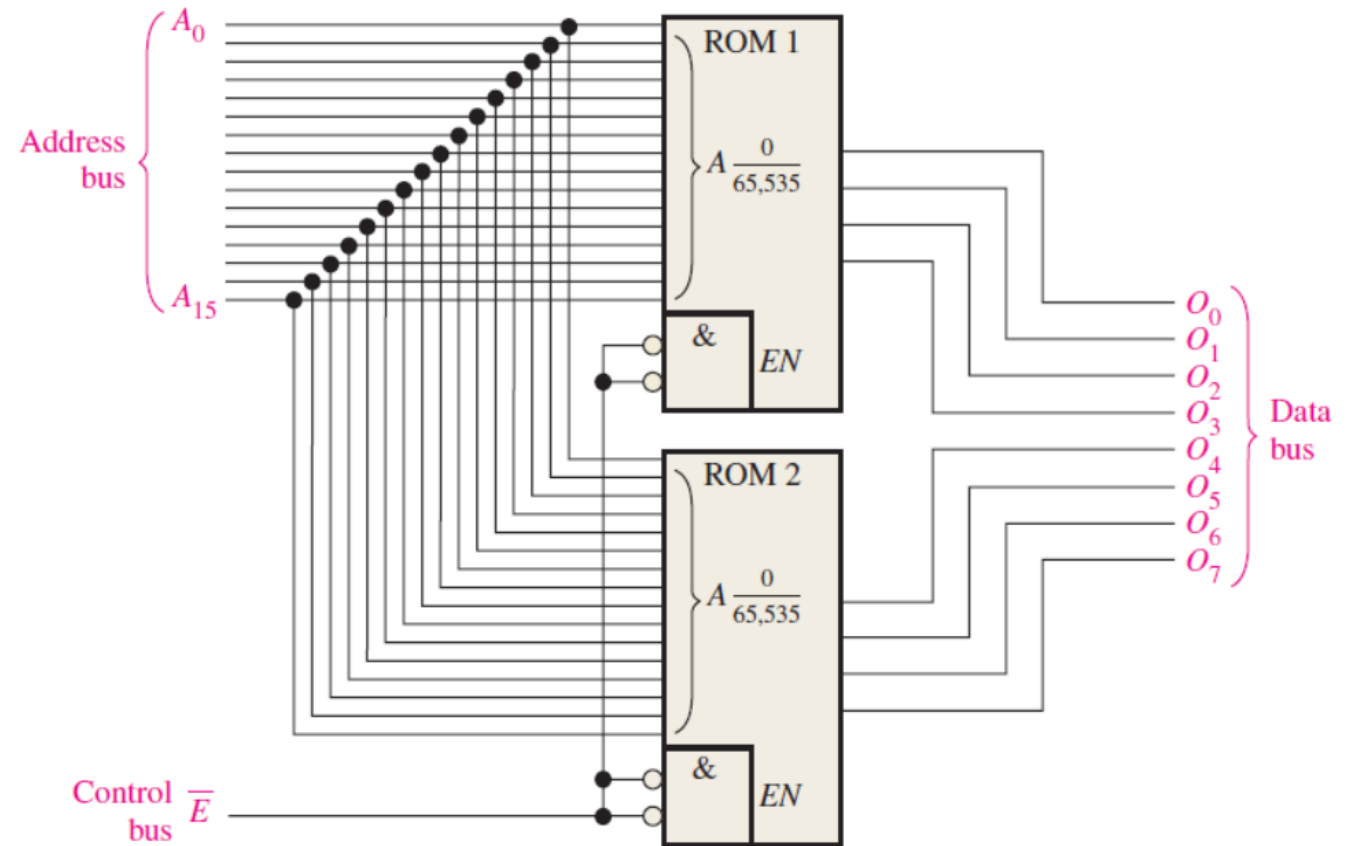
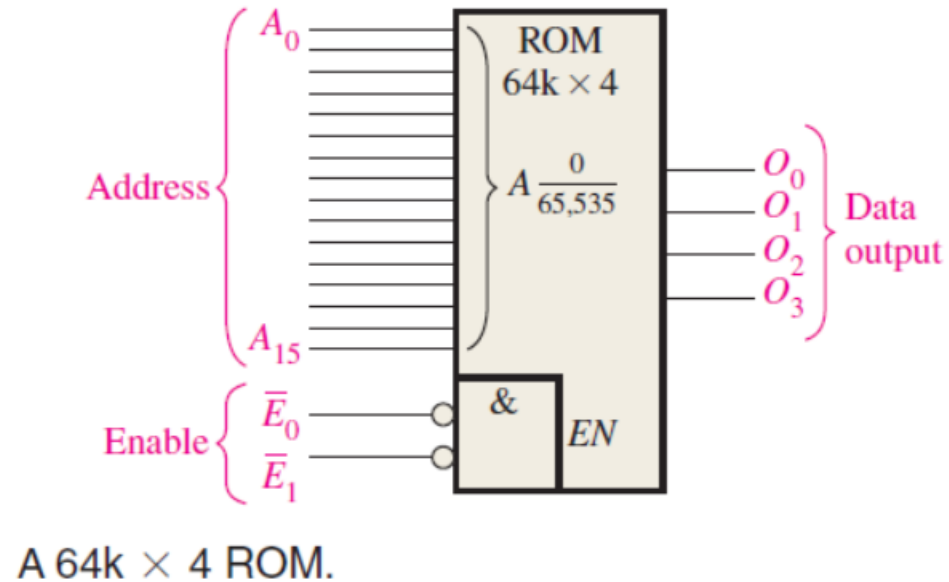


FIGURE 11-40 Expansion of two $65,536 \times 4$ ROMs into a $65,536 \times 8$ ROM to illustrate word-length expansion.

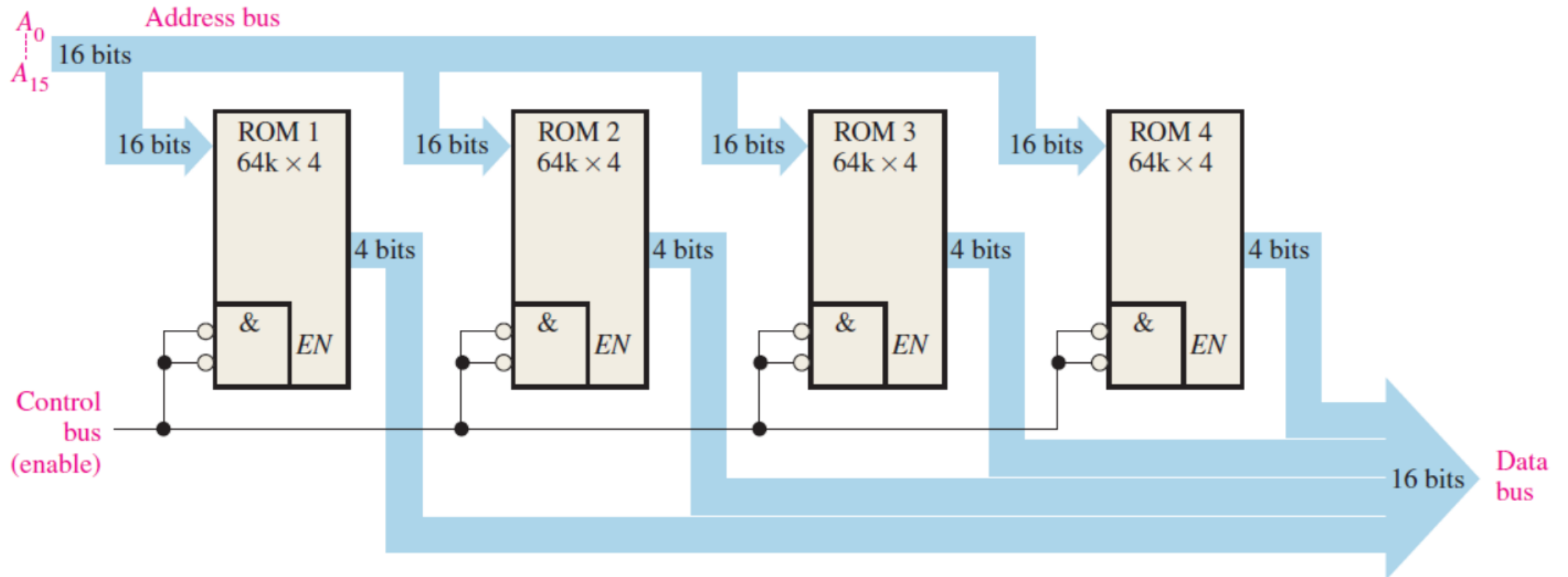
| Memory Expansion

■ Word-Length Expansion



Memory Expansion

■ Word-Length Expansion



| Memory Expansion

■ Word-Capacity Expansion

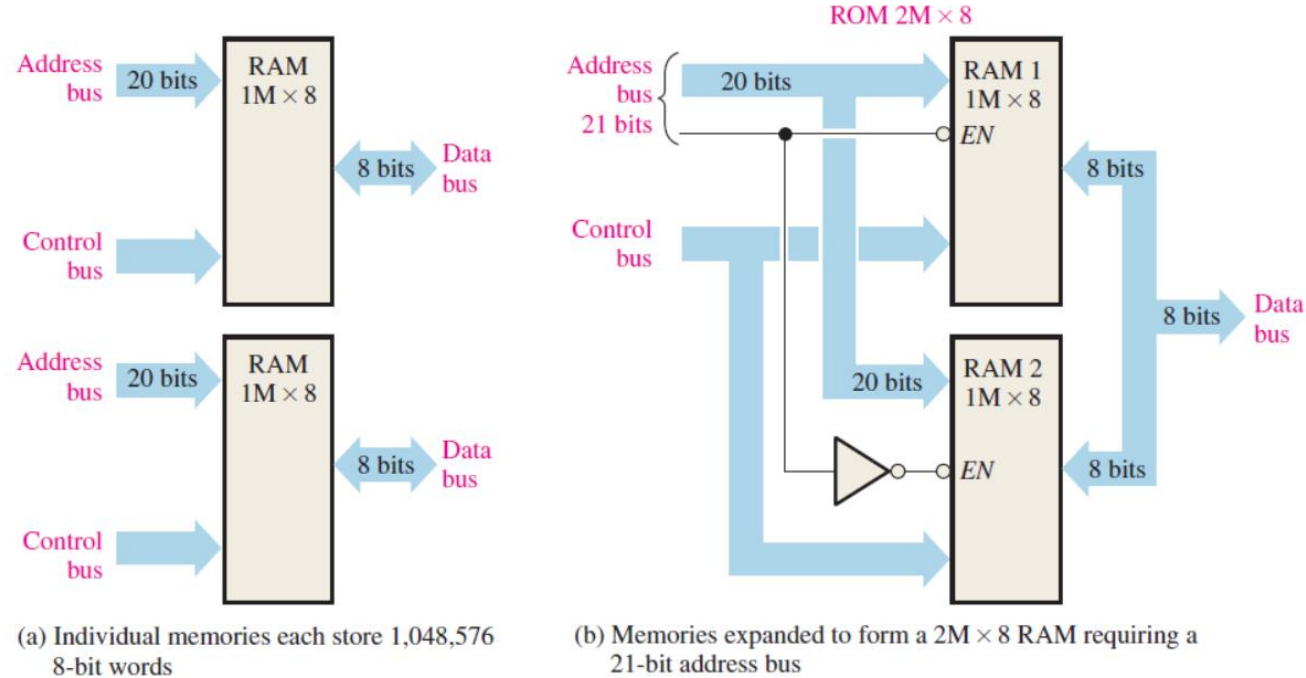


FIGURE 11-46 Illustration of word-capacity expansion.

| Memory Expansion

- **Word-Capacity Expansion:** Use $512k \times 4$ RAMs to implement a $1M \times 4$ memory

Memory Expansion

