

# Chapter 14

## Memories

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December 8, 2015

# Memory

## Memory

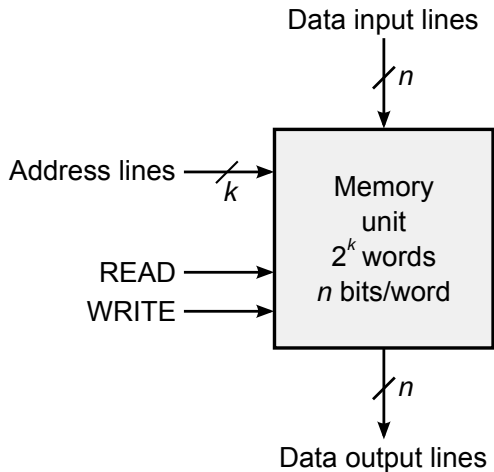
Memories are devices to which binary information is transferred for storage, and from which information is available for processing as needed

- RAM (Random Access Memory)
- ROM (Read-Only Memory)

# Memory

	<b>RAM</b>	<b>ROM</b>
<b>Stands for</b>	Random Access Memory	Read-Only Memory
<b>Use</b>	Stores currently active program and data	Stores the program required to initially boot the computer.
<b>Volatility</b>	Volatile: i.e. its contents are lost when the device is powered off.	Non-volatile: i.e. its contents are retained even when the device is powered off.
<b>Changeability</b>	Can be changed or deleted (read/write)	Cannot be changed (read-only)

# Memory Simplified

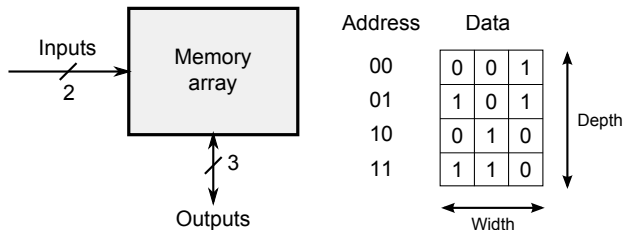


# Memory Simplified

## Memory Word

- A word is a group of bits transferred at the same time through  $n$  data lines.
- Location of each word (address) is identified by  $m$  address lines.
- Number of addresses is  $2^m$  numbered from 0 through  $2^m - 1$ .

## 4 × 3 Memory Array



- 4 × 3 memory means:
  - $m = 2 \rightarrow 2$  address lines
  - #locations =  $2^m = 4$
  - Addresses are 00, 01, 10 and 11 (0 thru  $2^2-1$ )
  - $n = 3 \rightarrow 3$  bits per location
  - #bits stored =  $4 \times 3 = 12$

# RAM Types

## SRAM – Static RAM

Store info in latches. Stored info stays until powered in cut off. Typically 4 to 6 transistors per bit.

## DRAM – Dynamic RAM

Stores info in capacitors. Capacitors need recharging by dedicated refresh circuit.

# Read/Write Memory Compared

$2^k \times n$  memory implemented as:

Register  
file



SRAM



DRAM



Type	Speed	Cost
Register file	Fastest	Most expensive
SRAM	Fast	Expensive
DRAM	Slow	Cheap



# ROM Types

<b>Acronym</b>	<b>Stands for</b>
<b>MROM</b>	Mask programmed Read-Only Memory
<b>PROM</b>	Programmable Read-Only Memory
<b>EPROM</b>	Erasable Programmable Read-Only Memory
<b>EEPROM</b>	Electrically-Erasable Programmable Read-Only Memory

# ROM Compared

Parameter	MROM	PROM	EPROM	EEPROM	Flash
Field-programmable		✓	✓	✓	✓
Reprogrammable			✓	✓	✓
Erasability level			Chip	Byte	Block
Erase Cycle			5-30 min	5-50 ms	>100 ms
Write Cycle	Weeks	Minutes	Minutes	1-10 ms	< 100 $\mu$ s
Programming site	Factory	Burner	Burner	In-system	In-system