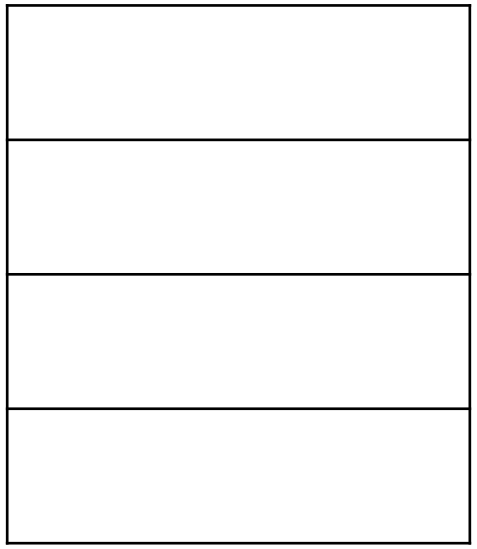
Memory Interfacing

Memory Basics

- Memory is generally divided into locations that store a fixed amount of data. (usually a byte)



- For the entire memory to be useable, the processor should be capable of generating a unique address for each location.

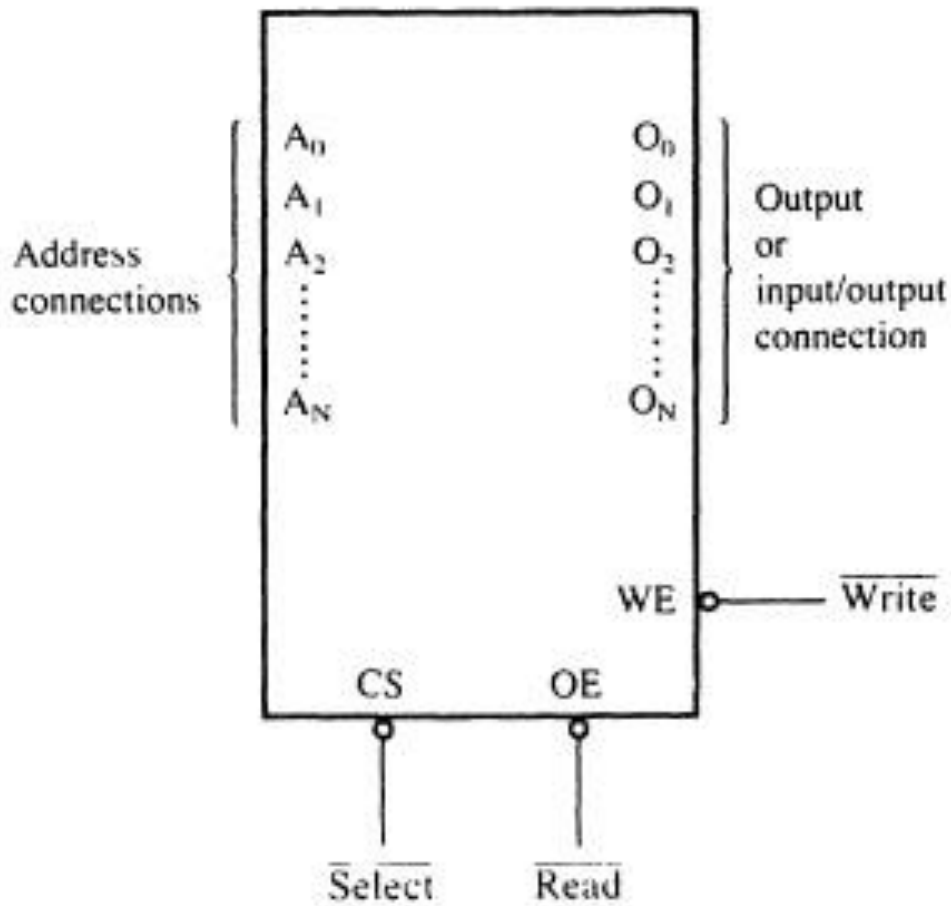
- The total number of unique addresses that can be generated by the processor is referred to as its address space.
- The size of the address space is limited by the width of the address bus by:

$$address\ space\ size = 2^n$$

Where *n* is the width of the address space.

- What do we really mean when we refer to a memory size of 1GB?

Memory connections



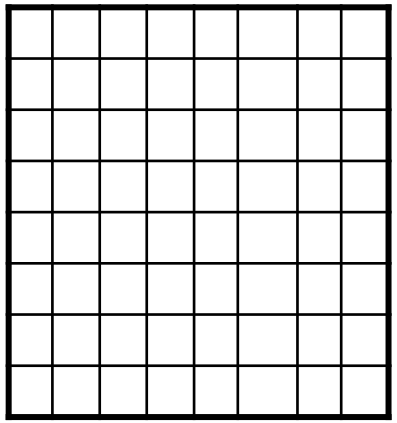
Address Connections

- All memory devices have address inputs that select a memory location within the memory device.
- They are usually labelled from A_0,the least significant address input to A_n, the most significant.
- A 1K device has 10 address pins; labelled $A_0 - A_9$.
- Memory addresses are usually represented in hexadecimal.
- Example: 400H represents 1K-bytes. *If a memory device is decoded to begin at address 1000H, and it is a 1K device, what is the address of the last memory location?*
- Others you should keep in mind: 1000H : 4K, 10000H : 64K, etc

Practical Application

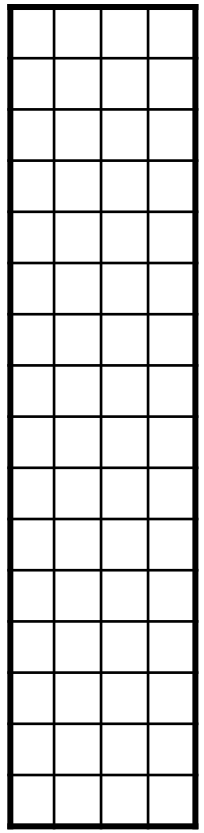
- Processors have a limit on how much memory they can make use of based on the address space.

Memory can be organized in different ways:



8 x 1 byte
or
8 x 8 bit

16 x 4 bit



64 x 1 bit

capacity of all these is 64 bits

Data Connections

- All memory devices have a set of data outputs or input/outputs. The figure in slide 4 has a set of common I/O pins.
- The data connections are the points at which data is entered for writing or extracted for reading.
- Data pins on memory devices are almost always labelled D_0 – D_7 for an 8-bit wide memory device. (Often called *byte-wide* memory)
- It is however possible to have 16-bits, 4-bits, or just 1-bit wide memory devices.

- Catalogue listings of memory devices often refer to memory locations times bits per location.
  - Example: 1K x 8, 16k x 1, etc.

- Memory devices are also classified according to the total bit capacity.
  - Example: 1K x 8 may be listed as 8K, 64K x 4 as 256K, etc

- Variations occur across manufacturers.

TEST YOUR UNDERSTANDING!

- Why is the data bus bi-directional?

- If a 32 bit microprocessor system is designed to access a memory system of total of 256 K bytes what is the data bus and the address bus lengths of the system.

Selection Connections

- Each memory device has an input that selects or enables the device.
  - (Refer again to image on Slide 4)

- This input is often called a chip select (CS or $\overline{CS}$) or chip enable (CE or $\overline{CE}$). It is sometimes simply referred to as a Select (S or $\bar{S}$) input.

- If this input is active the memory device performs a read or write. If it is inactive, the memory device is disabled.

Control Connections

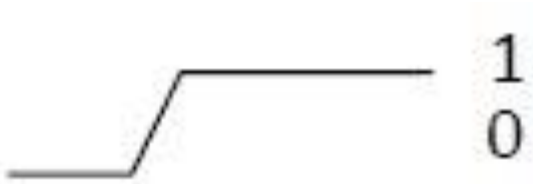
- All memory devices have some form of control input(s).
- This input determines what kind of action is performed on the device.
- A ROM usually has one control input, the output connection ($\overline{OE}$) or gate ($\bar{G}$) input. (Why?)
- A RAM device has one or two control inputs.
- If there exists only one control input it is usually labelled $R/\bar{W}$.
- If there are two control inputs, they are labelled $\overline{WE}$ or $\bar{W}$ and $\overline{OE}$ or $\bar{G}$

Read and Write Protocols

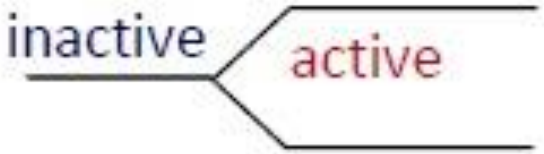
Timing Diagrams

- Most common method for describing a communication protocol is by the use of timing diagrams.
- On a timing diagram, time proceeds to the right on x-axis.
- A control signal is shown with a single line and may by low or high at some intervals.
- A signal may be active low (e.g., G', $\bar{G}$, or G_L).
- The term *assert* is used to indicate that the signal is made active and *deassert* means deactivated. Asserting G means set G=0.

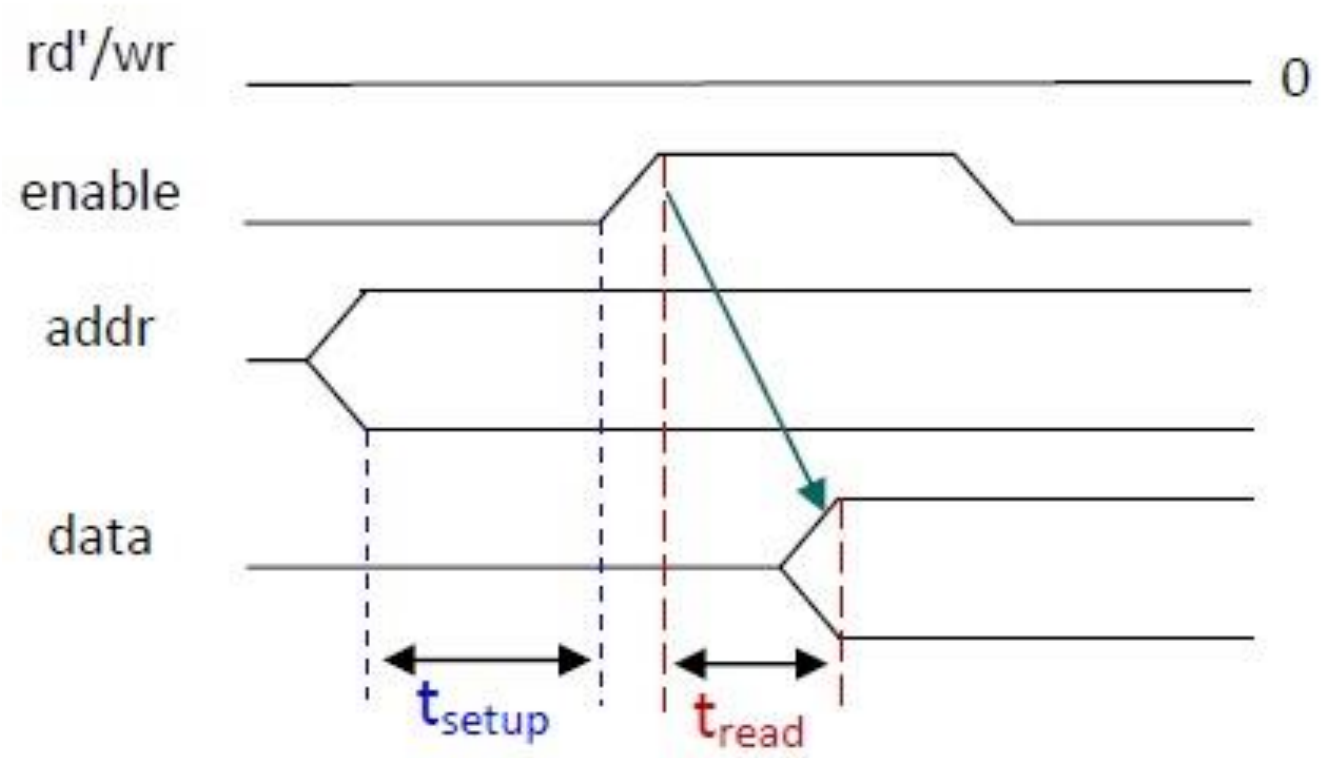
- Deassert for an active low signal:



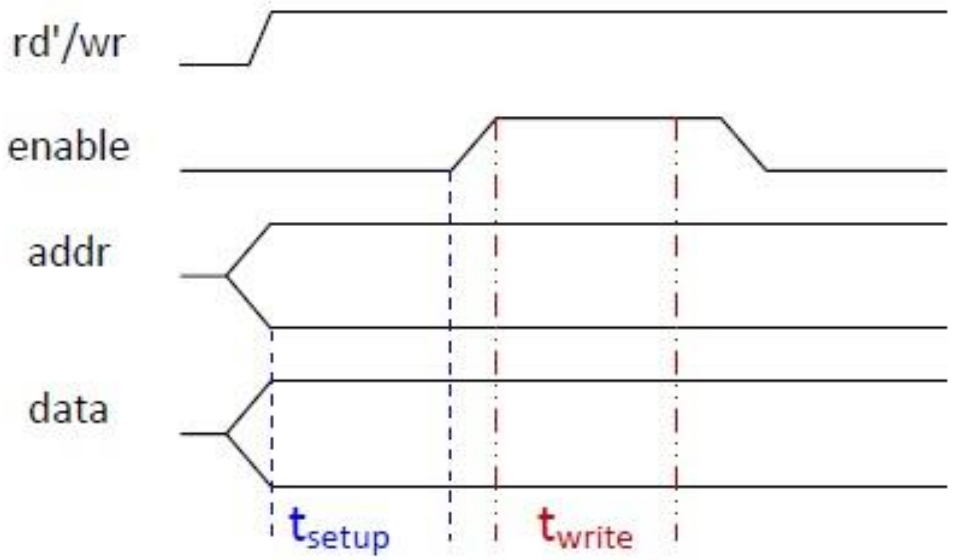
- Data signals on the other hand are usually represented by a single line when inactive and a ‘double’ line when active.



Read Protocol



Write Protocol



TEST YOUR UNDERSTANDING…

- Can you explain the difference between these three terms:
  - Setup time, read time, write time?

Assignment.

- Read about different types of memory systems in use in today's industry.
  - ROM, RAM, Disk, Cache, etc.