RAM - ROM PRESENTATION

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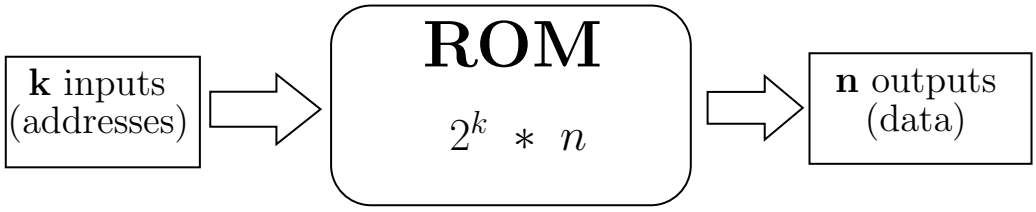
1 ROM

1.1 Definition

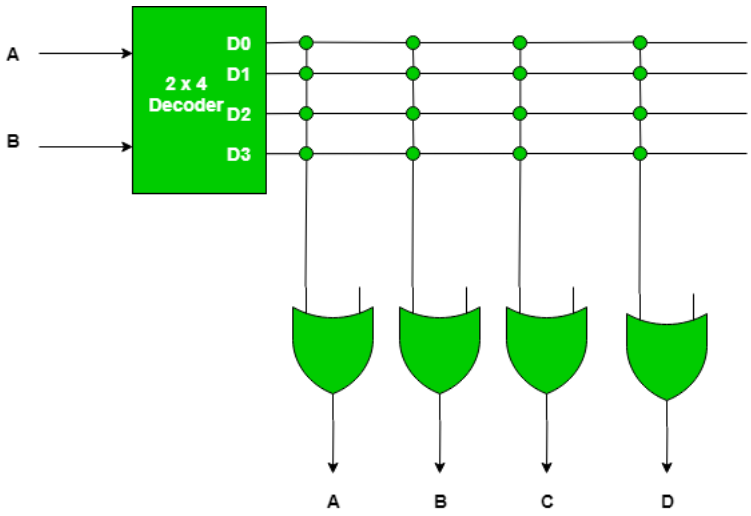
- **ROM**: stand for **Read-only Memory**.
- Primary memory unit of computer system along with RAM.
- Remain with the unit even when the system is powered off.

1.2 Structure

- **Block Structure**: Below is the block diagram of the Struture



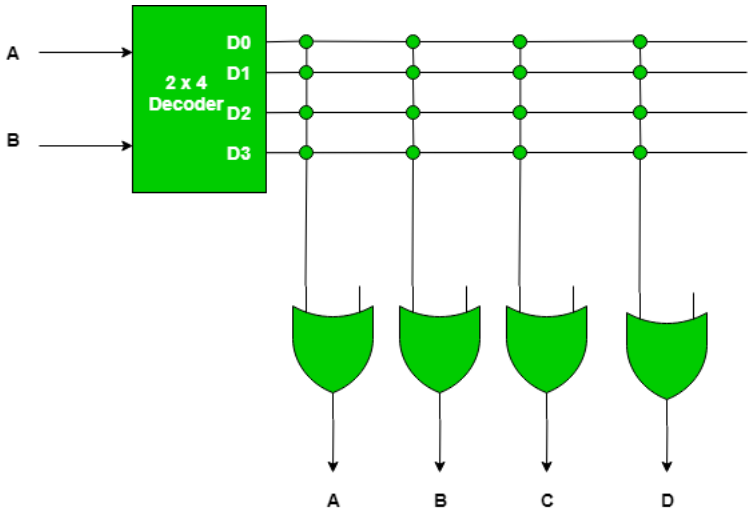
- It consist of **k** input lines and **n** output lines.
- **k** inputs are in binary form and is used to determine the addresses we want to access inside **ROM**.
- Since **k** inputs is in binary form, we can calculate the total addresses can be referred by the formula: 2^k.
- **n** is the number of bit information that contain in each address line $\Rightarrow$ the size of a **ROM** can be calculated by the formula: $2^k * n$.
- **Internal structure:**



- Consists of two components: **Decoder** and **Or gates**.

1.3 How it works ?

- Let's have a look again at the internal structure:



- The decoder will decode data from binary form to more known for like decimal.
- In ROM, the input to a decoder will be in binary form and the output will represent its decimal equivalent .
- All the OR gates present in the ROM will have outputs of the decoder as their input .
- All the intersections as shown in the internal structure diagram above can be programmed to meet our demand.

1.4 Classification

- **PROM**:
  - Stands for Programmable ROM.
  - Appear as a blank memory unit after manufacturing.
  - Can only be programed once, the data will be eternal.
  - Suitable for storing eternal data like sound in electronic devices or sound driver in organs...

- **EPROM**:
  - Stands for Erasable Programmable ROM.
  - An erasable version of PROM.
  - Erasing method: shortwave radiation under ultra violet light for the length of time.
  - Used to be used in old microcontrollers.

- **EEPROM**:
  - Stands for Electronic Erasable Programmable ROM.
  - A version of EPROM that the data inside can be erased by electronic, 1 byte at a time.
  - Erasing method: electrical signal, under ultraviolet light.
  - Mostly used for storing old computer BIOS.

- **Flash ROM**:
  - A better version of EEPROM, 512 bytes of data can be written or

erased at a time.
- Much faster than EEPROM.
- Mostly used for storing modern computer BIOS.

1.5 Programming the ROM

- To begin, we have to define what is the value at each address in the ROM. In this example, th following truth table will be use

Address	Value
00	0010
01	0011
10	0100
11	0101

- Here is the code for the following definition:

```
module rom_example(
    addr,
    data,
    clk,
);
    input [0:1] addr;
    input clk;
    output wire [0:3] data;
    reg [0:3]data_temp;
    reg [0:3]mem[0:3];

    always @(negedge clk)
    begin
        mem[0] = 4'b0010;
        mem[1] = 4'b0011;
        mem[2] = 4'b0100;
        mem[3] = 4'b0101;
        data_temp = mem[addr];
    end
    assign data = data_temp;

endmodule
```

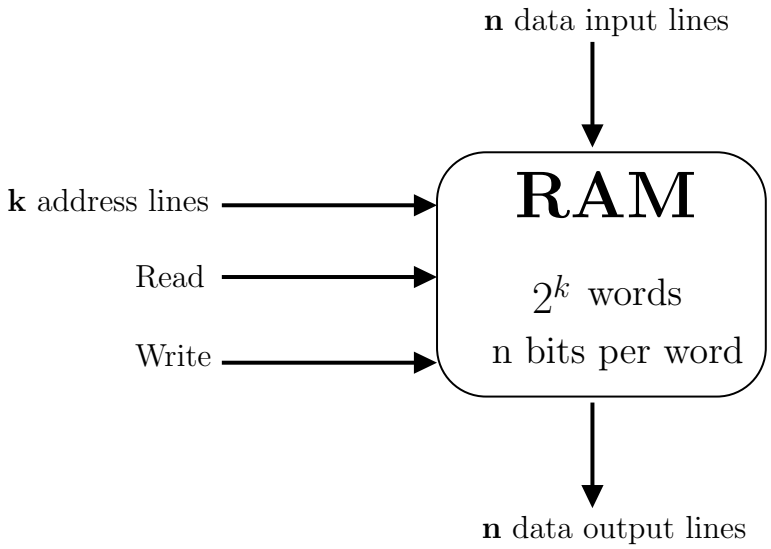
2 RAM

2.1 Definition

- **RAM** - short for "random access memory", **RAM** is used to read and write into memory.
- **RAM** stores files and data of programs that are currently being executed by CPU.
- **RAM** is a volatile memory as data loses when power is turned off.
- The more **RAM** you have, the better your computer will perform.

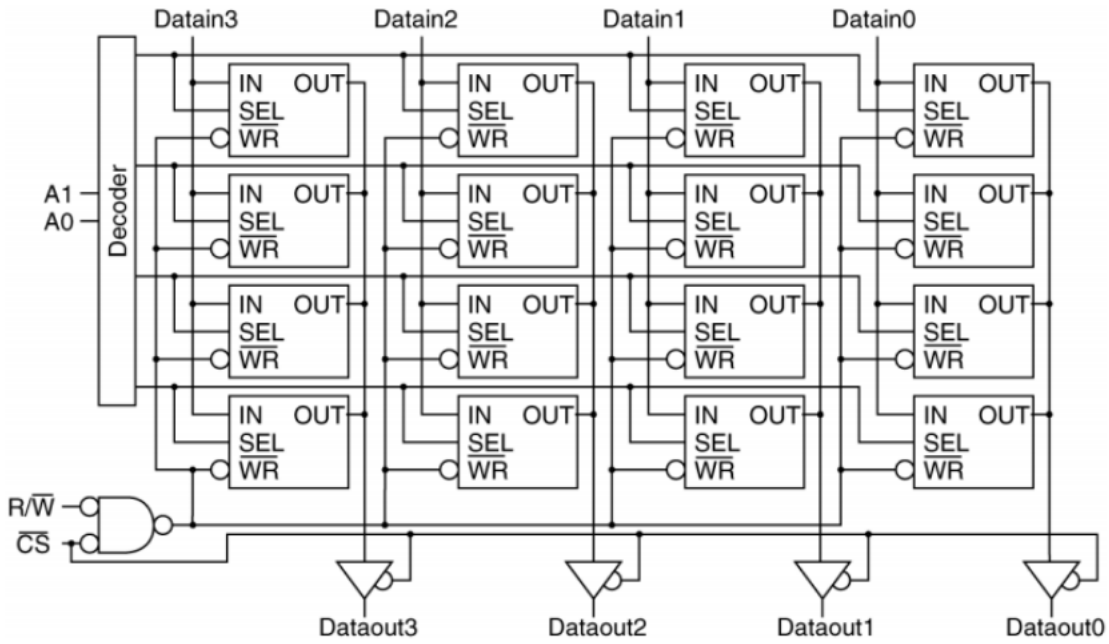
2.2 Structure

- **Block structure** - below is the block diagram of **RAM**:



- The n data input lines provide the information to be stored in memory.
- The n data output lines supply the information coming out of the chosen word among the 2^k available inside the memory.
- The two control inputs specify the direction of transfer desired.

- Internal structure of RAM:



2.3 How it works ?

RAM has 2 operations:

- Read function:
  - Apply the binary address of the desired word into the address lines.
  - Apply the data bits that must be stored in memory into the data input lines.
  - Activate the write input.

- Then the memory unit will then take the bits presently available in the input data lines and store them in the specified by the address lines.

- Write function: Specifies a transfer-in operation and the read function specifies a transfer-out operation, in detail:
  - Apply the binary address of the desired word into the address lines.
  - Activate the read input.

- Then the memory unit will then take the bits from the word that has been selected by the address and apply them into the output data lines. The content of the selected word does not change after reading.

2.4 Classification

RAM is further classified into two types: **SRAM** (Static Random Access Memory) and **DRAM** (Dynamic Random Access Memory)

- **Static RAM, or (SRAM)**:
  - Data is stored in transistors and requires a constant power flow.
  - Because of the continuous power, SRAM doesn't need to be refreshed to remember the data being stored.

- **Dynamic RAM, or (DRAM)**:
  - Data is stored by using a pair of transistor and capacitor which constitute a DRAM memory cell.
  - Capacitors that store data in DRAM gradually discharge energy, no energy means the data has been lost.

Summary of classification:

DRAM	SRAM
Constructed of tiny capacitors that leak electricity.	Constructed of circuits similar to D flip-flops.
Requires a recharge every few milliseconds to maintain its data	Hold its contents as long as power is available
Inexpensive.	Expensive.
Slower than SRAM.	Faster than DRAM.
Can store many bits per chip.	Can not store many bits per chip.
Uses less power.	Uses more power.
Generates less heat.	Generates more heat.
Used for main memory.	Used for cache.