READ ONLY MEMORY

(ROM)

SYED HASAN SAEED

hasansaeedcontrol@gmail.com

https://shasansaeed.yolasite.com

ROM

- In ROM Binary information is stored permanently.
- Block diagram of ROM (size m x n) is shown in fig.1, where ‘m’ is the number of locations and ‘n’ is the number of bit words that can stored in each locations.

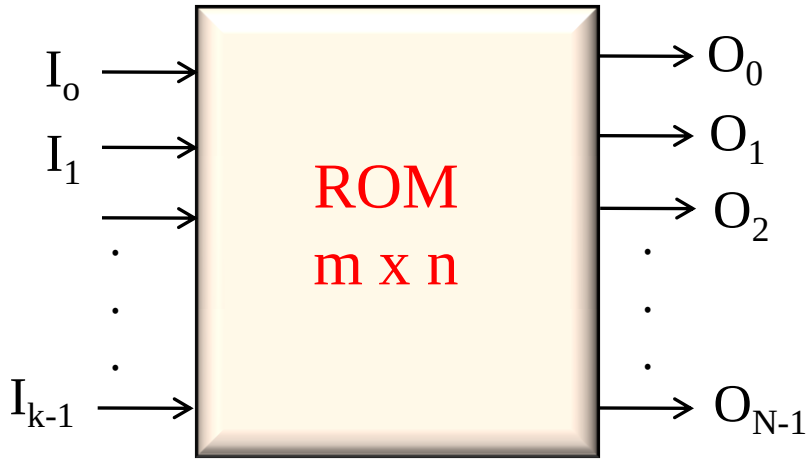

Fig. 1

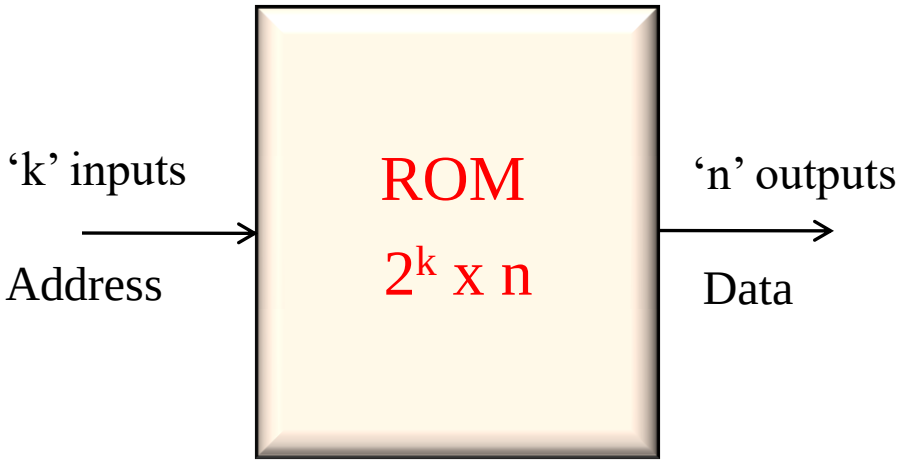

Fig. 2

ROM

- There are ‘k’ number of address lines to access ‘m’ locations.

$$m = 2^k$$

- ‘n’ is the data output lines. This gives the data bits of the stored word selected by the address.
- Therefore for implementation of ‘k’ variables and ‘n’ outputs then the size of ROM is represented by 2^k x n as shown in fig.2. this will generates all possible 2^k minterms.
- ROMs are designed only for reading the stored informations.
- ROM does not have write operation i.e user cannot write any information.
- ROM is used to store fixed information like instructions, look up tables etc.

ROM

- ROMs are programmed at the time of manufacturing.
- ROMs are costly.
- ROMs can be used for the implementation of combinational circuits

EXAMPLE 1

The following memory units are specified by the number of words times the number of bit per word. How many address lines and input-output data lines are required in each case.

(i) 4K x 16 (ii) 2G x 8 (iii) 16M x 32 (iv) 256K x 64

Reference: Moris Mano

Solution: (i) since, $1K=1024=2^{10}$

$4K=2^2 \times 2^{10}= 2^{12}$

4K x 16 can be written as 2^{12} x 16

Therefore, there are 12 address lines and 16 data lines.

Total input-output lines = 12+16=32

(ii) 2G x 8

$1\ G = 2^{30}$

$2G = 2 \times 2^{30} = 2^{31}$ *No. of Address line*

$2G \times 8 = 2^{31} * 8$

Therefore, there are 31 address lines and 8 data lines.

Total input-output lines = 31+8 =39

(iii) 16M x 32

1 M = 2^{20}

16M = 2^4 x 2^{20} = 2^{24}

16M x 32 can be written as

No. of Address line

16M x 32 = 2^{24} x 32

Therefore, there are 24 address lines and 32 data lines.

Total input-output lines = 24 + 32 = 56

(iv) 256K x 64

Since, 1K=1024 = 2^{10}

No. of Address line

256K = 2^8 x 2^{10} = 2^{18}

256K x 64 can be written as 2^{18} x 64

Therefore, there are 18 address lines and 64data lines.

Total input-output lines = 18 + 64 = 82

EXAMPLE 2: Give the number of bytes stored in the memories listed in example 1.

SOLUTION:

(i) 4K x 16

A byte is equivalent to 8 bits.

No. of 16 bit words = 4K= 4 * 1024 = 2^{12} = 4096

Memory Size = No. of words * word size = 4096 * 16 bit = 65536 bits

(Output is 16 i.e. 2 bytes)

Memory size =65536 / 8 = 8192 bytes = 8kB

(ii) 2G x 8

A byte is equivalent to 8 bits.

No. of 8 bit words = 2G = 2G = 2 x 2^{30} = 2^{31} = 2,147,483,648

Memory Size = No. of words * word size = 2,147,483,648 * 8 bit = 17179869184 bits

(Output is 8 i.e. 1 bytes)

Memory size = 17179869184 /8 = 2,147,483,648 =2GB

(iii) 16 M x 32

A byte is equivalent to 8 bits.

No. of 16 bit words = 2^4 x 2^{20} = 2^{24} = 16777216

Memory Size = No. of words * word size = 16777216 * 32 bit = 536870912 bits

(Output is 32 i.e. 4 bytes)

Memory size = 536870912 / 8 = 67108864 bytes = 64 MB

Alternate 1: 16M = 2^{24} 

16 M x 32 = 2^{24} * 4* 8 = 2^{24}* 2^2*8 = 2^{26} *8

No. of Bytes stored = 2^{26} = 67108864 bytes = 64 MB

Alternate 2: Memory Size = No. of words * word size

= 16 M * 4 B = 64 MB

(iv) 256K x 64

256K x 64

Memory Size = No. of words * word size

= 256 k * 8B

= 2048 kB = 2 MB

TYPES OF ROM

- Mask Programmed ROM (MROM)
- Programmable Read Only Memory (PROM)
- Erasable Programmable Read Only Memory (EPROM)
- E^2PROM

ADVANTAGES OF ROM

- Low Cost
- High Speed
- Flexibility in system designed
- ROM is non-volatile memory.

APPLICATIONS OF ROM

- It is used for the implementation of combinational circuits.
- It is used for the implementation of sequential circuits.
- Used for look up tables.
- Used for storage purpose of microprocessor program.
- It is suitable for the LSI manufacturing process.
- Used in function generators.

INTERNAL STRUCTURE OF ROM

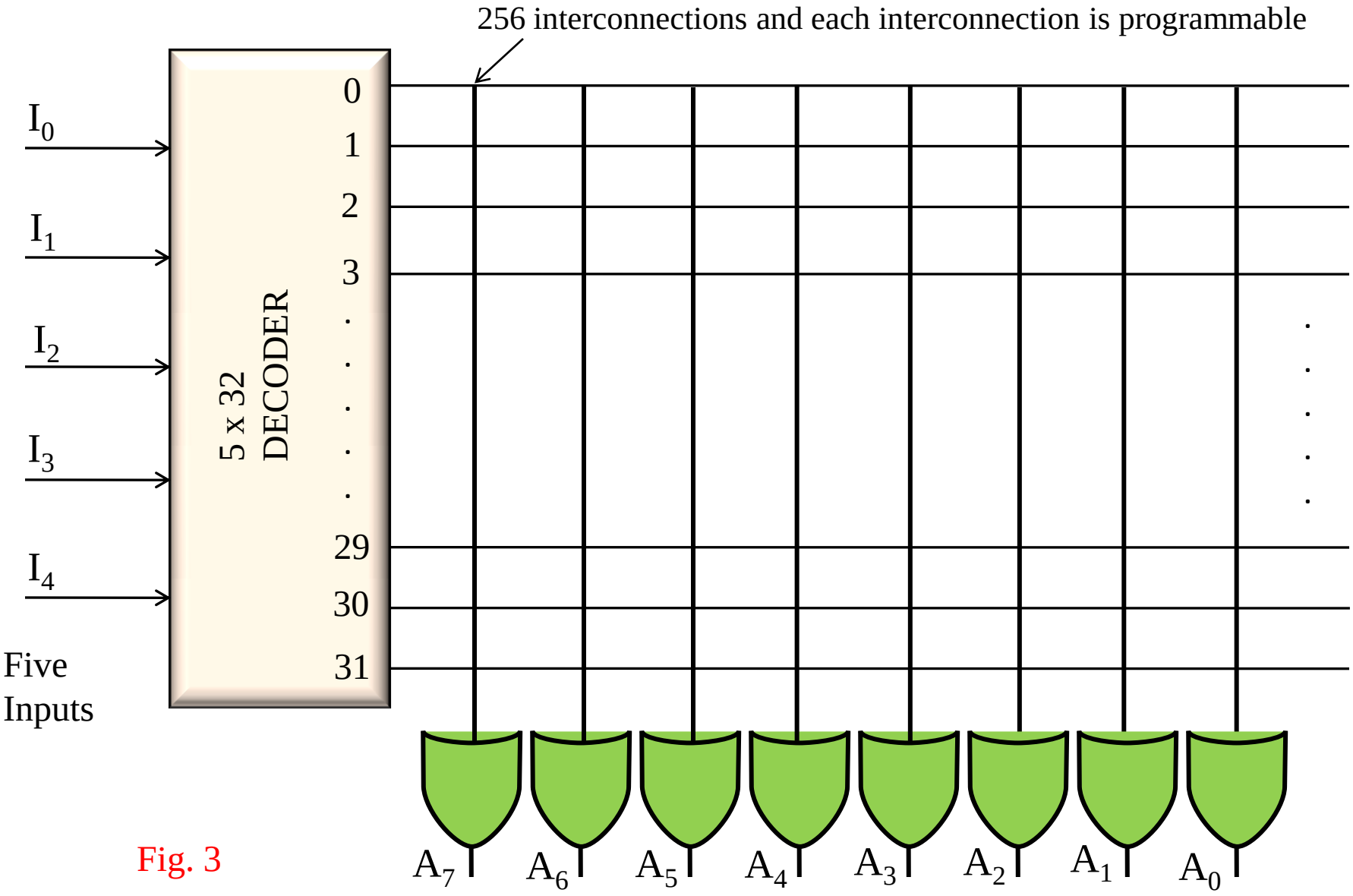

Fig. 3

EXAMPLE: Consider 32 x 8 ROM.

- It consists of 32 words of 8 bits each.
- To access 32 locations (addresses) there are 5 input lines (m =32, m= 2^5, k = 5) which forms the binary numbers equivalent to 0 to 31.
- Fig.5 shows the internal logic of a ROM.
- The five inputs are decoded into 32 different outputs with the help of a 5 x 32 decoder and each output of the decoder represent a memory address.
- The 32 outputs of the decoder are connected to each of the eight OR gates. It means that each OR gate having 32 inputs.

- There are 8 OR gates and each OR gate has 32 connections, therefore total internal connections will be 32 x 8 = 256

- In general '2^k x n' ROM will have 'k x 2^k' decoder and 'n' OR gates.

- Each OR gate has 2^k inputs, which are connected to each of the outputs of the decoder.

- All 256 intersections are programmable.
- A programmable connection between two lines is equivalent to a switch which is either turned ON or OFF. ON means two lines are connected with each other and OFF means two lines are not connected.
- ROM truth table is shown in fig.4
- Truth table shows that there are 5 inputs and 8 outputs.
- There are 32 locations (addresses) and each location stored 8 bits word.
- ‘0’ in truth table indicates there is no connection and ‘1’ indicates a connection.

TRUTH TABLE:

Location No.	Inputs					Outputs							
	I_4	I_3	I_2	I_1	I_0	A_7	A_6	A_5	A_4	A_3	A_2	A_1	A_0
0	0	0	0	0	0	1	0	0	1	0	0	1	1
1	0	0	0	0	1	0	0	0	1	1	1	0	1
2	0	0	0	1	0	1	0	1	1	0	0	0	1
3	0	0	0	1	1	1	0	0	0	1	1	1	0
⋮													
⋮													
29	1	1	1	0	1	1	0	0	0	1	0	1	0
30	1	1	1	1	0	0	1	1	1	0	0	0	1
31	1	1	1	1	1	0	1	1	0	0	0	1	1

Fig. 4

INTERNAL STRUCTURE OF 32 x 8 ROM

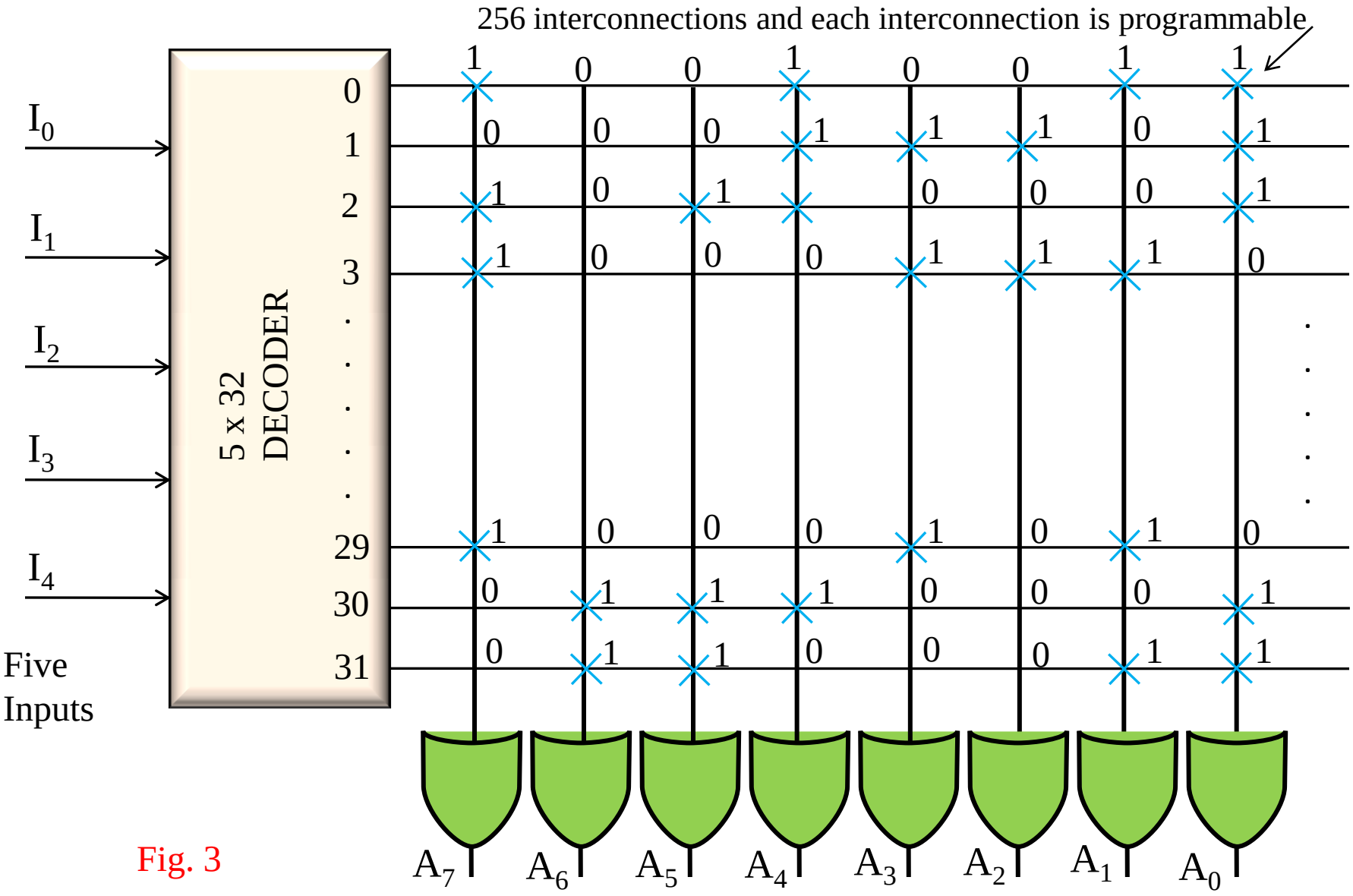

Fig. 3

THANK YOU