Main Memory

By Noor Kadhum

Architecture For 3rd Stage

Computer Science

In the first lecture, we learned about the first level in the hierarchy of memory - registers – they are the only type of memory that resides inside the processor .

This lecture is dedicated to the study of another level in the hierarchicy. The main memory is the central storage unit in computer. It is relatively large and fast memory used to store programs and data during the computer operation.

Random Access Memory(RAM)

Integrated circuit RAM chips are available in two possible operating modes:

1- Static RAM : consists essentially of internal flip-flops that store the binary information. The stored information remains valid as long as power is applied to the unit. The static RAM is easier to use and has shorter read and write cycles.

2- Dynamic RAM: stores the binary information in the form of electric charges that are applied to capacitors(متسعات). The capacitors are provided inside the chip by MOS

transistors. The charge on the capacitors tends to discharge with time and the capacitors must be periodically recharged by refreshing the dynamic memories. The dynamic RAM offers reduced power consumption and larger storage capacity in a single memory chip.

RAM was used to refer a Random Access Memory but it is use to designate a read / write memory to distinguish from read only memory (ROM).

Read Only Memory(ROM)

Most of main memory in a general purpose computer is made of RAM integrated circuit chips but a portion of the memory may be constructed with ROM chips.

ROM is needed for storing an initial program called bootstrap loader whose function is to start the computer software operating when the power is turned on .

The startup of computer consists of : Turning the power on and starting the initial program. thus when power is turned on the hardware of computer sets the program counter (PC) to the first address of the bootstrap loader.

The bootstrap program loads a portion of the operating system (OS) from disk to main memory and control is then transferred to OS which prepare the computer for general use.

Comparison between RAM and ROM

1- Both are random access memory.

2- RAM is used to store the programs and data that are subject to change. while ROM is used to store the programs that are permanently resident in the computer and for tables f constants that do not change in value once the production of computer is completed .

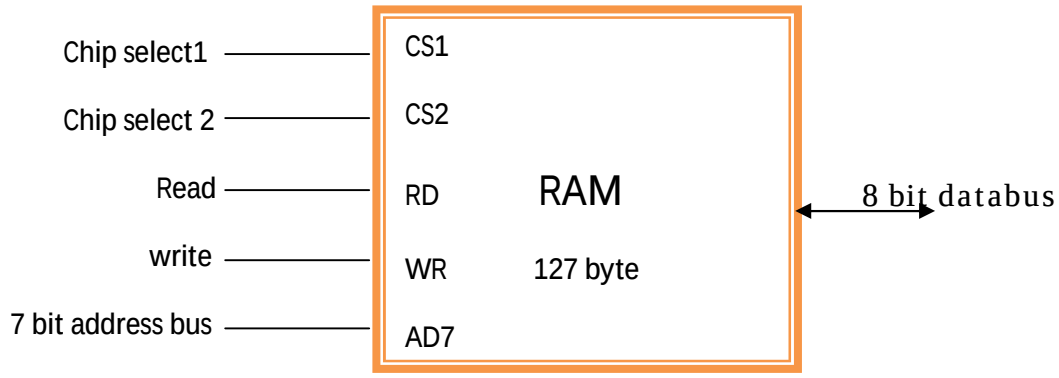
3- RAM is volatile, its contents are destroyed power is turned off. The contents of ROM remain unchanged after power in turned off and n again.

RAM and ROM chips

The block diagram of RAM chip is shown in the figure below. The capacity f the memory is 128 byte :

128= 2^7 **à** 7 bit address bus

Byte **à** 8 bit data bus (bidirectional)

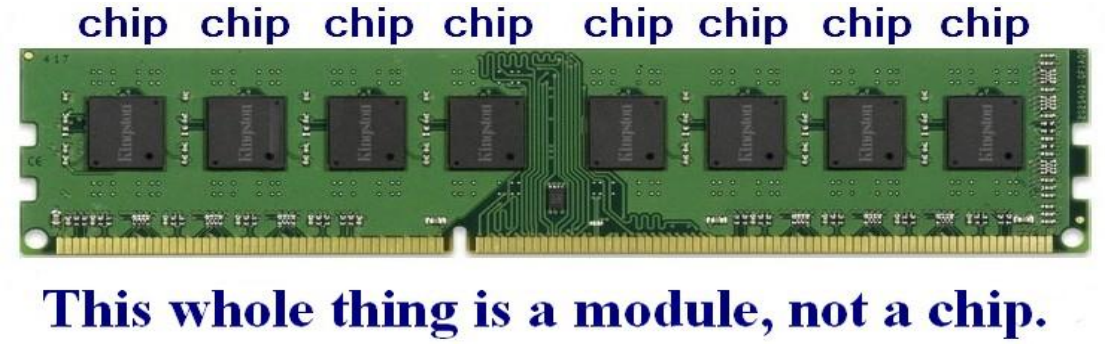


Read and write inputs specify the memory operation and the two chips select (CS) control inputs are for enabling the chip only when it is selected by CPU. the availability of more than

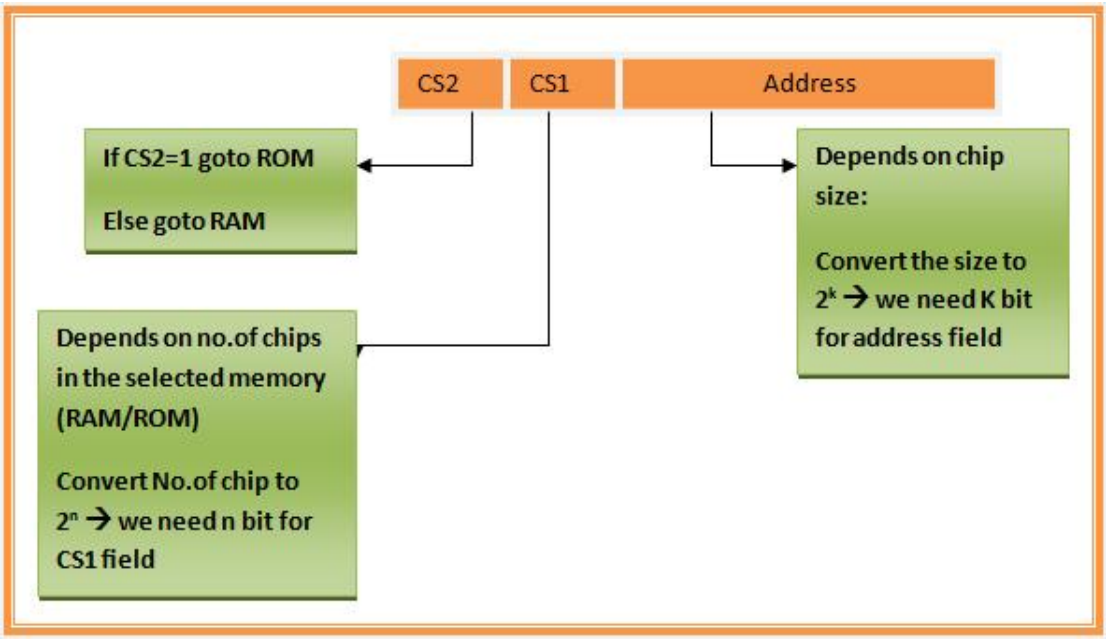
one control input to select the chip facilitates the decoding of the address when multiple chips are used in CPU.

ROM chip is organized externally in a similar manner. However, since ROM can only read, the data bus can only be in the output mode. Could you draw a ROM chip of 512byte?

Your answer:



The format of address with its translation will be :



Example: translate the following address:

0	01	0 000 011

Sol:

- The selected chip located within RAM because CS2=0
- The selected chip is : 1 because CS1=$(01)_2$ =$(1)_{10}$
- The selected address within chip is the address no.3 because the value of address field is $(0000011)_2$=$(3)_{10}$

Exercise:

Draw the address format for ROM consists of 1 chip of 512 B and the selected address is the third one.

Example: designing Main Memory:

Desingnate a M.M of 1KB consisting of chips of 128 byte (RAM) and single chip for ROM.

SOL:

a-Devide M.M size into two halves equally between RAM and ROM.

1KB= 2^{10} B

Size of ROM= Size of RAM = $2^{10}/2 = 2^9$= 512 byte

b-Compute the NO.of each chip :

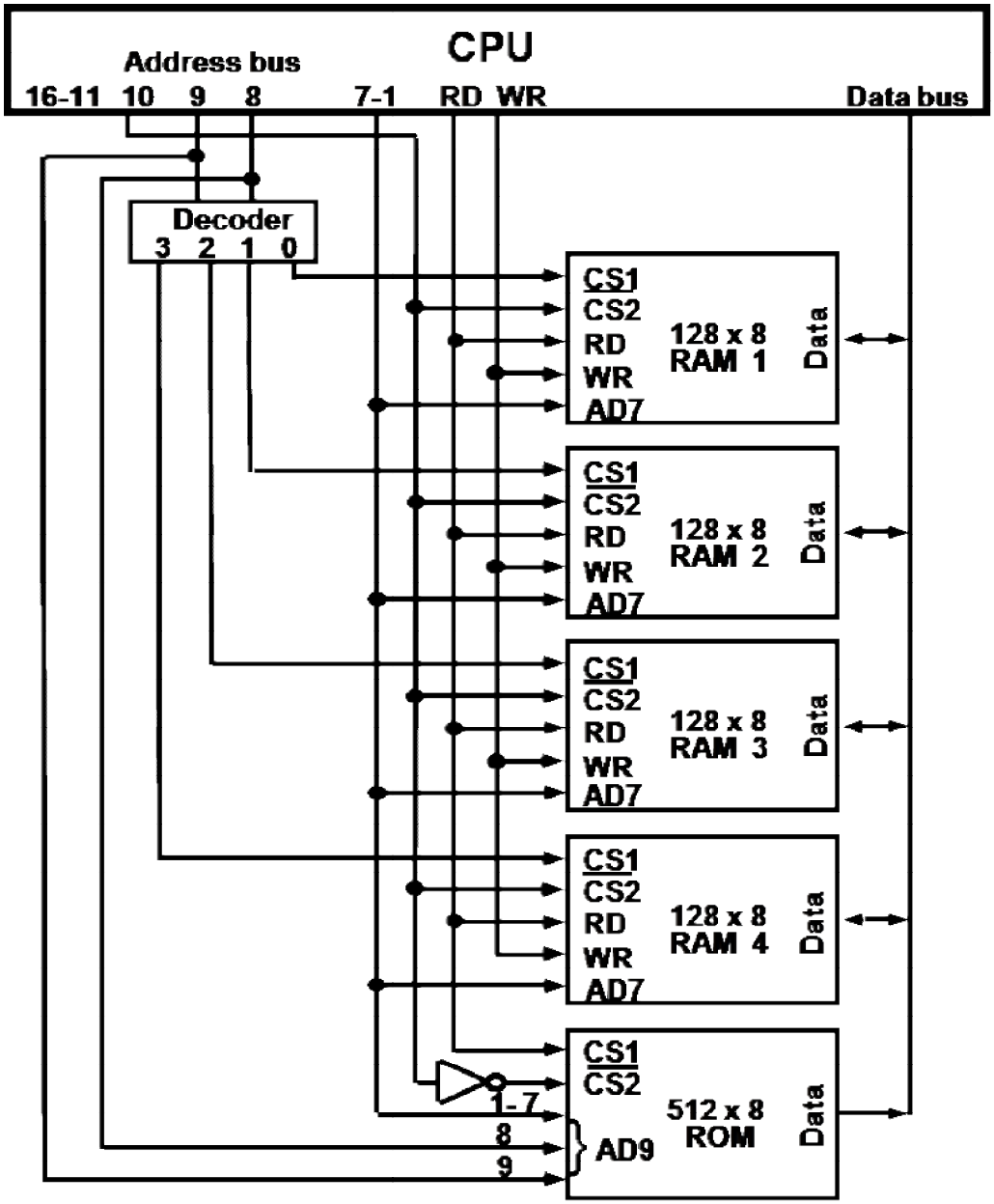
the no. of chip (RAM) = size of RAM/size of CHIP

= $2^9/2^7=2^2$=4 chips

The no. of chip (ROM) =1 (given).

M.M consists 5 chips as a whole [4chips (RAM) +1chip (ROM)],

The five chips of memory are connected to the CPU as shown below:



Decoders and multi chips

As we see in the previous example, the selection between RAM and ROM is achieved by CS2 bit. RAM has 4 chips the question is : How the computer knows the required chip?

This done by 2×4 decoder whose outputs go to CS1 inputs in each RAM chip:

CS1	Selected chip
0 0	RAM1
0 1	RAM2
1 0	RAM3
1 1	RAM4

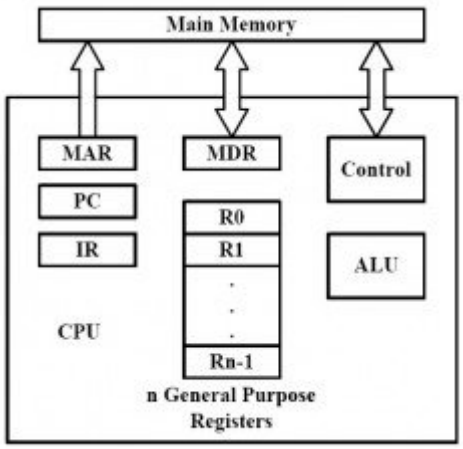
Note that RD and WR outputs from CPU are applied to the inputs of each RAM chip.ROM chip is connected with RD only.

Remember that the RAM connects directly with two registers in the CPU :

-MDR via bidirectional data bus .

- MAR via address buses

Offcourse M.M needs to contact with CU by control buses



Exercises

A-Suppose that:

- RAM consists of 8 chips with 128 byte for each.
- ROM consists of 2 chips, what is the size of each chip?
- Find the size of main memory based on your answers of the previous points.

B-The size of M.M=1MB. The size of RAM chip is equal to the size of ROM chip and equal to 1 KB. Find the no. of bits in each field in the address.

Next Lecture

The next clamshell we will learn about another kind of memories, the cache. See you next week, God willing,