Main Memory

Subject: Computer Organization & Architecture

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Main Memory

- The main memory is the central storage unit in a computer system.

- It is a relatively large and fast memory used to store programs and data during the computer operation.

- The technology used for the main memory is based on semiconductor integrated circuits.

- Integrated circuit RAM chips are available in two possible operating modes-static and dynamic

- The 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 unit.

- The dynamic RAM stores the binary information in the form of electric charges that are applied to capacitors.

- The capacitors are provided inside the chip by MOS transistors. The stored charge on the capacitors tend to discharge with time and the capacitors must be periodically recharged by refreshing the dynamic memory.

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- Refreshing is done by cycling through the words every few milliseconds to restore the decaying charge

- The dynamic RAM offers reduced power consumption and larger storage capacity in a single memory chip.

- The static RAM is easier to use and has shorted read and write cycles.

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

- Originally, RAM was used to refer to a random-access memory, but now it is used to designate a read/write memory to distinguish it from a read-only memory, although ROM is also random access.

- RAM is used for storing the bulk of the programs and data that are subject to change.

- ROM is used for storing programs that are permanently resident in the computer and for tables of constants that do not change in value one the production of the computer is completed.

- The ROM portion of main memory is needed for storing an initial program called a bootstrap loader.

- The bootstrap loader is a program whose function is to start the computer software operating when power is turned on.

- Since RAM is volatile, its contents are destroyed when power is turned off.

- The contents of ROM remain unchanged after power is turned off and on again.

- The startup of a computer consists of turning the power on and starting the execution of an initial program.

- Thus when power is turned on, the hardware of the computer sets the program counter to the first address of the bootstrap loader.

- The bootstrap program loads a portion of the operating system from disk to main memory and control is then transferred to the operating system, which prepares the computer fro general use.

- RAM and ROM chips are available in a variety of sizes.
- If the memory needed for the computer is larger than the capacity of one chip, it is necessary to combine a number of chips to form the required memory size.

RAM AND ROM CHIPS

- A RAM chip is better suited for communication with the CPU if it has one or more control inputs that select the chip only when needed.

- Another common feature is a bidirectional data bus that allows the transfer of data either from memory to CPU during a read operation or from CPU to memory during a write operation.

- A bidirectional bus can be constructed with three-state buffers.

- A three-state buffer output can be placed in one of three possible states: a signal equivalent to logic 1, a signal equivalent to logic 0, or a high-impedance state.
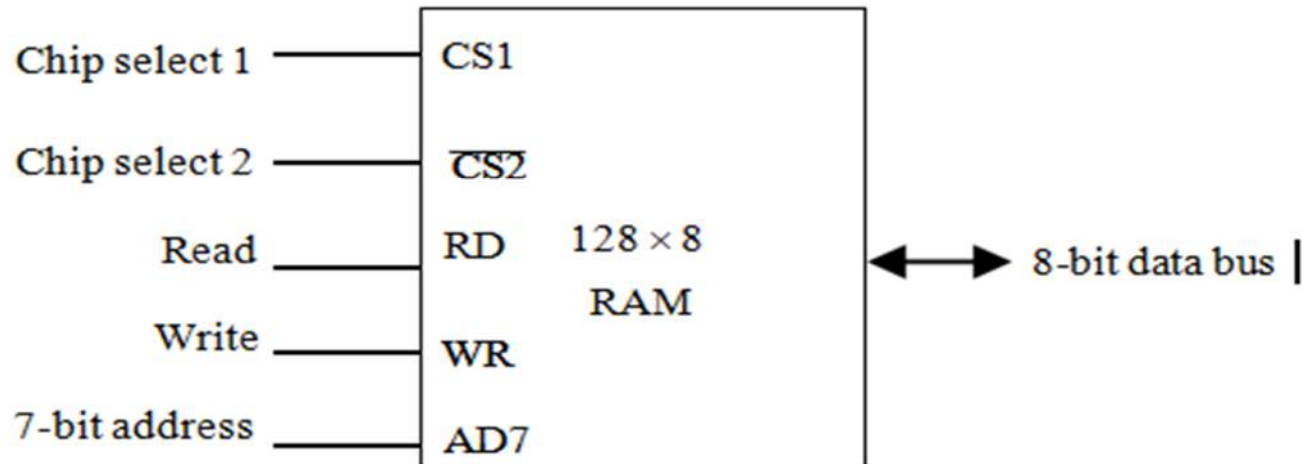
- The logic 1 and 0 are normal digital signals.
- The high-impedance state behaves like an open circuit, which means that the output does not carry a signal and has no logic significance.

Figure 7.2 Typical RAM chip.

(a) Block diagram

CSI	$\overline{CS2}$	RD	WR	Memory function	State of data bus
0	0	×	×	Inhibit	High-impedance
0	1	×	×	Inhibit	High-impedance
1	0	0	0	Inhibit	High-impedance
1	0	0	1	Write	Input data to RAM
1	0	1	×	Read	Output data from RAM
1	1	×	×	Inhibit	High-impedance

(b) Function table

- The capacity of the memory is 128 words of eight bits (one byte) per word.

- This requires a 7-bit address and an 8-bit bidirectional data bus.

- The 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 the microprocessor.

- The availability of more than one control input to select the chip facilitates the decoding of the address lines when multiple chips are used in the microcomputer.

- The read and write inputs are sometimes combined into one line labeled R/W. When the chip is selected, the two binary states in this line specify the two operations or read or write.

- The function table listed in Fig. 7-2(b) specifies the operation of the RAM chip.
- The unit is in operation only when $CSI = 1$ and $CS2 = 0$.
- The bar on top of the second select variable indicates that this input in enabled when it is equal to 0.
- If the chip select inputs are not enabled, or if they are enabled but the read but the read or write inputs are not enabled, the memory is inhibited and its data bus is in a high-impedance state.

- When SC1 = 1 and CS2= 0, the memory can be placed in a write or read mode.

- When the WR input is enabled, the memory stores a byte from the data bus into a location specified by the address input lines.

- When the RD input is enabled, the content of the selected byte is placed into the data bus.

- The RD and WR signals control the memory operation as well as the bus buffers associated with the bidirectional data bus.