Introduction :-

The microprocessor is one of the most important components of a digital computer. It acts as the brain of a computer system. computer are of two types : digital computers and analog signals, processes analog computer. A digital computer makes processing of numbers. Today the works like analysis and simulation are done using digital computers. As we see the computer all are digital computers. Analog computers have specific applications. We we use the digital computer.

"A digital computer is a programmable machine". Its main components are : CPU (central processing unit), memory, input device and output device.

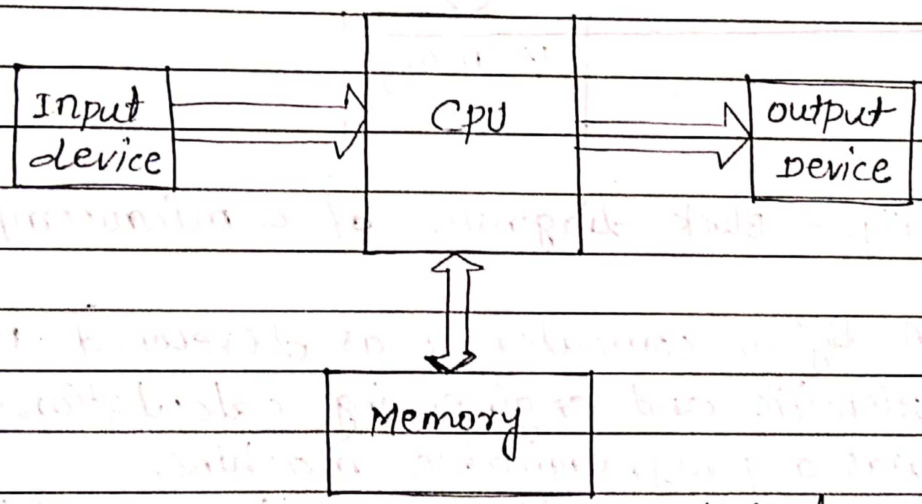


fig. - Block diagram of a digital computer

Input device :- It is used to feed programs and data to the computer
eg. mouse, keyboard

output device :- It displays or prints programs, data and/or results according to the instruction given to the computer.
eg. printer, monitor.

CPU :- It executes instructions. The central processing unit built on a single IC is called "microprocessor". A digital computer in which one microprocessor has been provided to act as a CPU, is called "microcomputer." A desktop computer and portable computers like laptop, notebook, palmtop etc. contain one microprocessor to act as a CPU. therefore they are microcomputer.

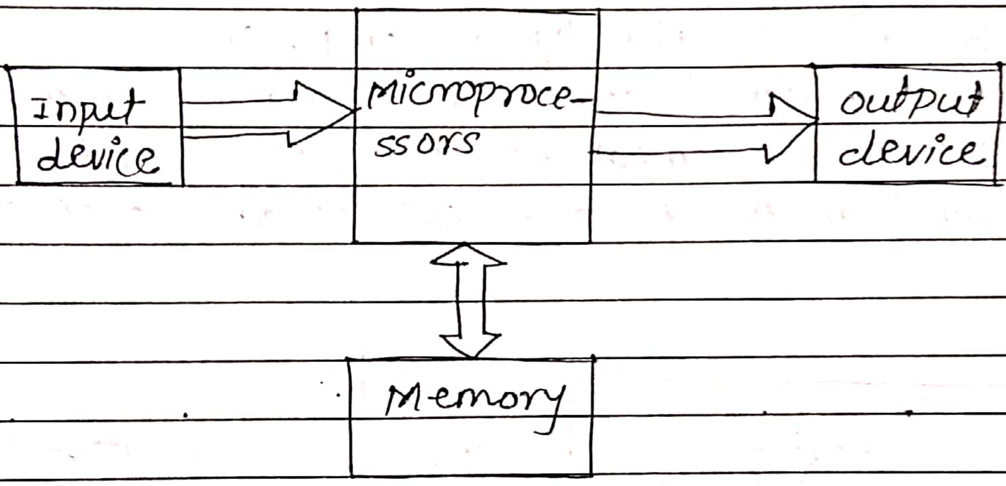


fig. - Block diagram of a microcomputer

A digital computer was developed for complex scientific and engineering calculations and it was a programmable machine.

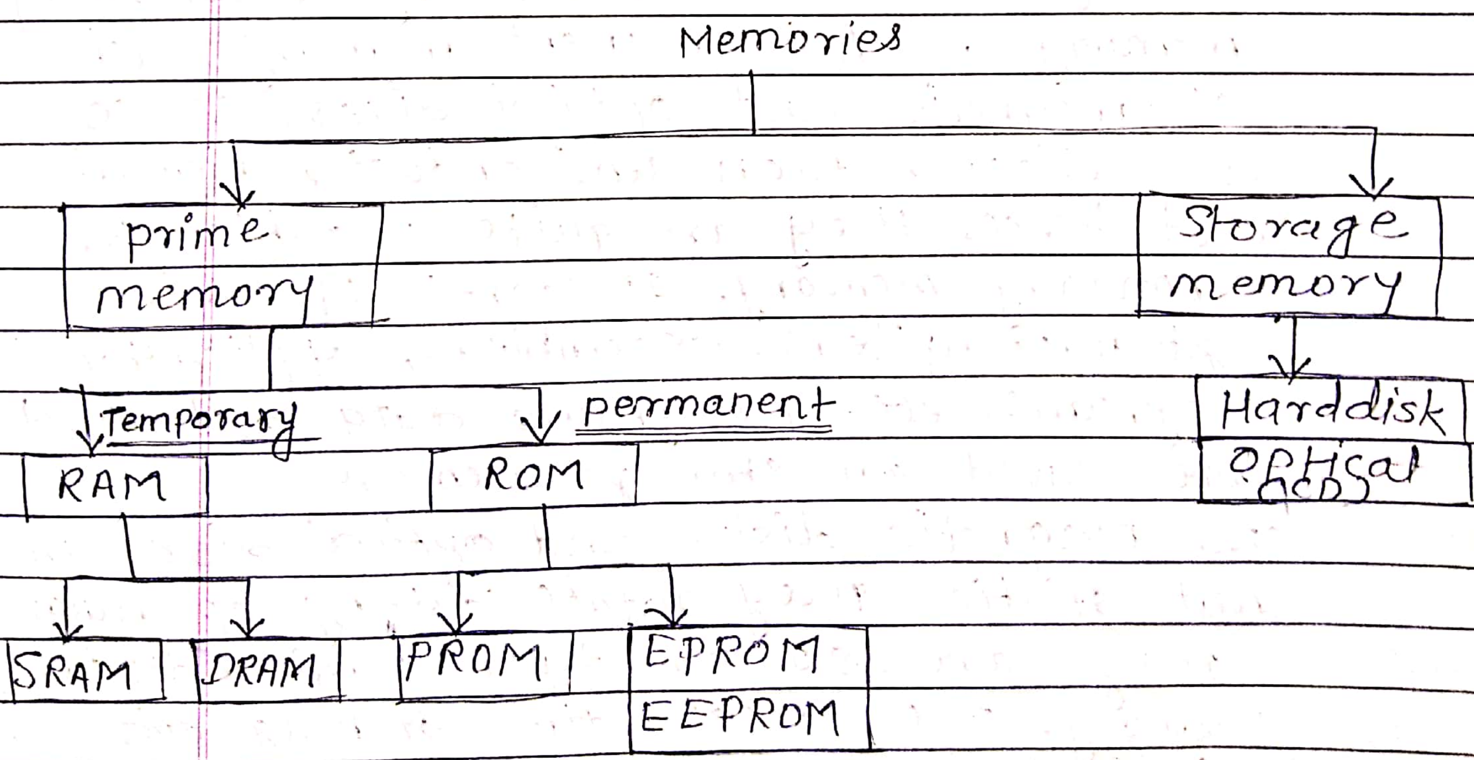
"programmable computing machine."

computer also used for a number of non-computing work such as automatic control of industrial equipment, to control process, to measure physical and electrical quantities, to process text, graphics and image; to store information, to display information, to transmit information from one place to another, to receive information.

"A computer defined as programmable machine which can make calculations; manipulate, measure, store and display information; control process, equipment, machine and appliances transmit and receive information."

Memory :- It is a storage device. It stores programs, data and result.
Memory is an essential component of a digital computer. It is needed to store programs, data and results.

There are three types of memory devices on the basis of different technologies
1) semiconductor memory
2) magnetic memory
3) optical memory



Prime Memory: This is the memory the microprocessor uses in executing and storing programs. This memory should be able to respond fast enough to keep up with the execution speed of the μP. If memory is slow, the CPU has to wait for data and instructions. This will reduce the processing speed of the computer. Semiconductor memories are used ~~for~~ to match the speed of the CPU, which is directly connected to the CPU.

Semiconductor memory is a static device. It is faster, smaller in size and lighter in weight; and consumes less power compared to other types of memory devices.

Storage memory (secondary or auxiliary memory): A permanent memory such as magnetic and optical disks. These are cheaper than semiconductor memories and hence they are quite suitable for secondary memory. It stores operating system, compilers, assemblers, application programs, etc. programs, data and results are saved on storage memory.

The magnetic disks and optical disks are not static. They rotate during operation. They are slower than semiconductor memory. The access time of magnetic disks is about 5-10 ms. The access time of optical disks is about 80 ms.

Page:
Date: / /

semiconductor memory :-
There are two main types of semiconductor memory : RAM and ROM

RAM: The abbreviation RAM stands for Random Access Memory. In RAM any memory location can be accessed in a random way without going through any other location. The access time is 10ns and is same for each and every memory location. since information can be written into or read from RAMS, they are used as read/write memory of a computer system. Therefore also called as read/write memory.

RAM is a volatile memory. It stores information as long as power is supplied to it. Its contents are lost when power supply is switched off or interrupted.

Two types of RAM as follows:-

SRAM (static RAM) :- This memory is made up of Flip-Flops, and it stores the bit as a voltage. Each memory cell requires six transistors; therefore, the memory chip has low density but high speed. This memory is more expensive and consumes more power than the Dynamic memory described in the next paragraph. In high speed processors, SRAM known as cache memory is included on the processor chip. ~~I~~ access time is 10 ns.

Date: / /

DRAM (Dynamic RAM) :-
This memory is made up of MOS transistor gates, and it stores the bit as a charge, on a capacitor. The advantages of dynamic memory are that it has high density because of only one transistor per memory cell. and low power consumption and is cheaper that SRAM. The disadvantage is that charge on capacitor leaks away in very short time; therefore, stored information needs to be read and written again every few miliseconds. This is called refreshing the memory, and it requires extra circuitry, adding to the cost of the system.
In comparison to the processor speed, the DRAM is too slow. Access time is about 50 ns.

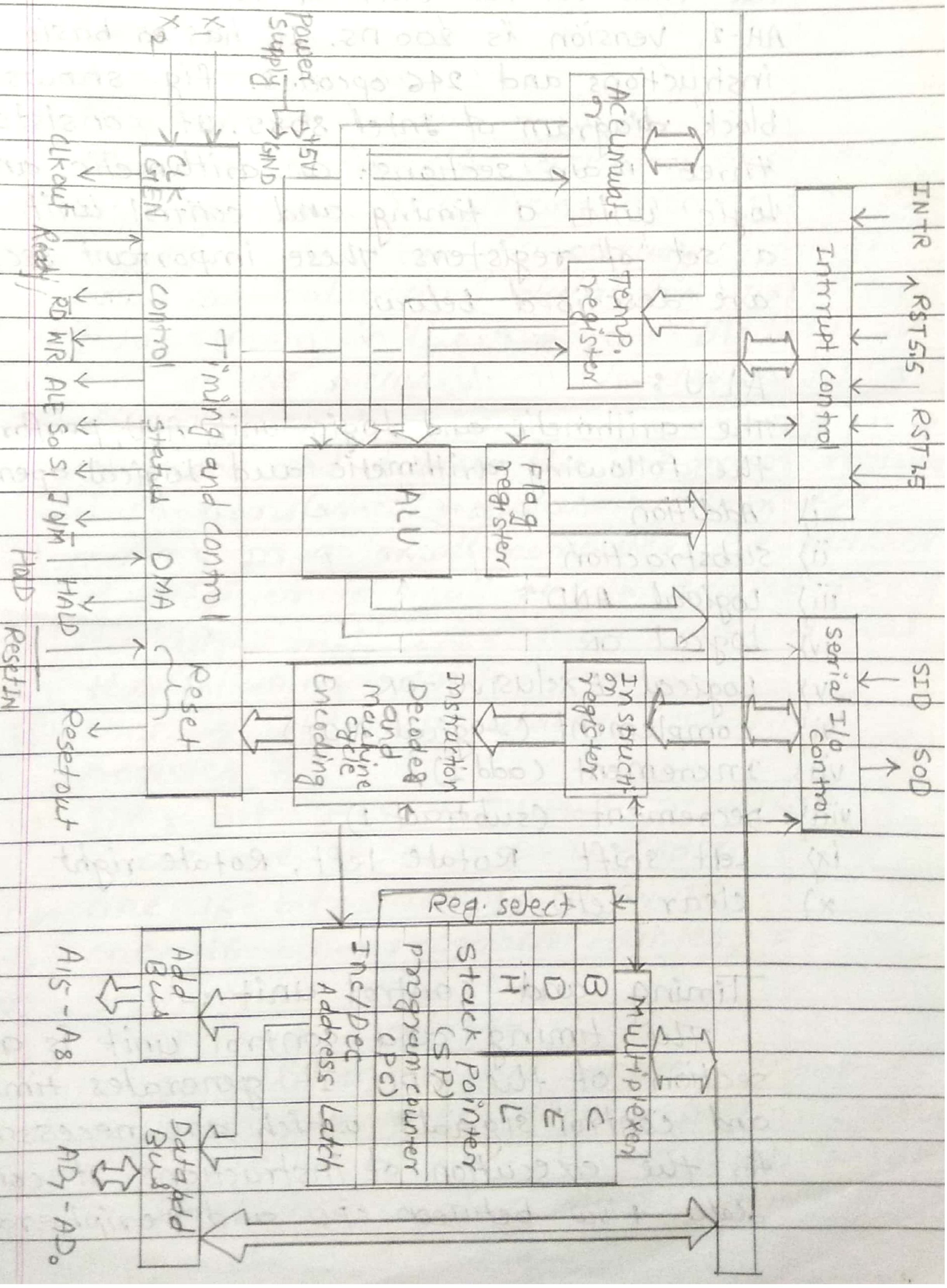
ROM (Read only Memory) : A ROM is a non-volatile memory. It stores information permanently. Its contents are not lost when its power ~~sy~~ supply is switched off. It is not accessible to user, and hence he can not write anything into it. ROM is used to store permanent (fixed) programs. It is used to store initializing programs of a computer, microcodes of a CISC processor, supervisory programs (monitor) of a microprocessor-kit, fixed programs in microcontrollers, etc. Its contents are written at the time of its IC fabrication. It is cost-effective for high-volume production because of high cost of preparing a mask needed for writing the desired contents into the ROM. It is simple, cheap and dense. It uses one-transistor memory cell.

PROM (programmable ROM): A PROM is a programmable ROM. The user can write a program, data or any other kind of information permanently into a PROM. PROMs are only once programmable i.e. the user can write his program/data into a PROM only once. A special equipment called PROM programmer is required for writing programs into a PROM. A PROM programmer is provided on standard microprocessor-kit. Universal PROM programmer is also available which is more powerful and provide greater facilities, and accepts a variety of PROMs.

EPROM: An EPROM is an erasable PROM Its contents can be erased and it can be reprogrammed more than once. To erase its contents it is exposed to high intensity short wave ultraviolet light for about 20 minutes. To facilitate exposure of ultraviolet light the EPROM chips are packed in a package which has transparent window. The ultraviolet light having wavelength of 2537 Å is used is available for erasing the contents of an EPROM. An equipment with ultraviolet source called EPROM eraser is available for this purpose. The entire contents are erased in this process. Another disadvantage of this technique of erasure is that the EPROM chip has to be taken out of the system board and placed in an EPROM eraser's chamber. EPROMs are cheap and reliable. Hence, they are widely used. EPROMs are used to store programs, data or any other kind of information which are permanent but need updating. The programs which are at development stage, are also stored in EPROM because they are to be modified many times. EPROMs are far more economical than PROMs because they can be reused. It uses one transistor memory cell and hence it has high density.

EEPROM or E^2PROM: EEPROMS are electrically erasable PROMS. They are also called EAROM (Electrically Alterable ROM). They need not be removed from the system board for erasure. EEPROM is byte erasable. So selective erasure of its contents is possible. Its contents can be erased and programmed on the system board itself very easily on byte by byte basis. Its disadvantage is that different voltages are required for erasing and 5 volts for read operation. It uses complex memory cell structure and therefore, it has low density. It has also high cost and lower reliability. It is used in certain applications, where byte - alterability is needed.

Block diagram of Intel 8085 :-



Date : / /

Features of Intel 8085 :-

Intel 8085 is an 8-bit, NMOS microprocessor. It is a 40 pin I.C. package fabricated on a single LSI chip. The Intel 8085 uses a single +5Vd.c. supply for its operation. Its clock speed is about 3 MHz. The clock cycle is of 320 ns. The time for the clock of the Intel 8085 AH-2, version is 200 ns. It has 80 basic instructions and 246 opcodes. fig. shows the block diagram of Intel 8085. It consists of three main sections: an arithmetic and logic unit, a timing and control unit and a set of registers. These important sections are described below.

ALU :-

The arithmetic and logic unit, ALU, performs the following arithmetic and logical operations:-

i) Addition
ii) Substraction
iii) Logical AND
iv) Logical OR
v) Logical Exclusive-OR
vi) complement (Logical NOT)
vii) Increment (add 1)
viii) Decrement (subtract 1)
ix) Left shift, Rotate left, Rotate right
x) clear etc.

Timing and control unit :-

The timing and control unit is a section of the CPU. It generates timing and control signals which are necessary for the execution of instructions. It controls data flow between CPU and peripherals (including memory). It provides status, control and timing signals which are required for the operation of memory and I/O devices. It controls the entire operations of the microprocessor and peripherals connected to it. Thus it is seen that the control unit of the CPU acts as the brain of the computer system.

Registers :-

The fig. shows the various registers of Intel 8085. Registers are used by the microprocessor for temporary storage and manipulation of data and instructions. Data remain in the registers till they are sent to the memory or I/O devices. In a large computer the number of registers is more and hence the program requires less transfer of data to/from the memory. In a small computer the number of register is small due to limited size of the chip. Intel 8085 microprocessor has the following registers:

i) one 8-bit accumulator (ACC) i.e register A
ii) Six 8-bit general purpose registers. These are B, C, D, E, H and L
iii) one 16-bit stack pointer, SP
iv) one 16-bit program counter, PC
v) Instruction register
vi) Temporary register

In addition to the above mentioned registers the 8085 microprocessor contains a set of five Flip-Flops which serve as flags (or status flags). A flag (or status flag) is a flip-flop which indicates some condition which arises after the execution of an arithmetic or logical instruction.

Accumulator (ACC) :-
The accumulator is an 8-bit register associated with the ALU. The register 'A' in the 8085 is an accumulator. It is used to hold one of the operands of an arithmetic or logical operation. It serves as one input to the ALU. The other operand for an arithmetic or logical operation may be stored either in the memory or in one of the general-purpose registers. The final result of an arithmetic or logical operation is placed in the accumulator.
But in some typical or exceptional cases, there are some logical instructions which need only one operand. It is held in the accumulator. The result is placed in the accumulator. Such instructions do not require any other register or memory location because there is no other operand. There is one typical instruction DAD rp, for 16-bit addition for which one of the 16-bit operands is kept in H-L pair and the other in the B-C or D-E pair. The result is placed in the H-L pair.

General-purpose Registers :-
The 8085 microprocessor contains six 8-bit general-purpose registers. They are : B, C, D, E, H and L register. To hold 16-bit data a combination of two 8-bit

registers is known as a register-pair. The valid register pairs in the 8085 are: B-C, D-E and H-L. The programmer can not form a register-pair by selecting any two registers of his choice. The H-L pair is used to act as memory pointer and for this purpose it holds the 16-bit address of a memory location. The general-purpose registers and the accumulator are accessible to programmer. He can store data in these registers during writing his program.

Program counter (PC) :-

It is a 16-bit special-purpose register. It is used to hold the memory address of the next instruction to be executed. It keeps the track of memory addresses of the instructions in a program while they are being executed. The microprocessor increments the content of the program counter during the execution of an instruction so that it points to the address of the next instruction in the program at the end of the execution of an instruction.

Stack pointer (SP) :-

It is a 16-bit special function register. The stack is a sequence of memory locations set aside by a programmer to store/retrieve the contents of accumulator, flags, program counter and general-purpose registers during the execution of a program. Any portion of the memory can be used as stack. Since the stack works on LIFO (last-in-first-out)-

principle, its operation is faster compared normal store / retrieve of memory locations. During the execution of a program sometimes it becomes necessary to save the contents of some registers which are needed for some other operations in the subsequent steps of the program. The contents of such registers are saved in the stack. Then the registers are used for some other operations. After completing the needed operations the contents which were saved in the stack are brought back to the registers. The contents of only those registers are saved, which are needed in the later part of the program. The stack pointer (SP) controls addressing of the stack. The SP holds the address of the top element of data stored in the stack.

The stack is defined and the stack pointer is initialized by the programmer at the beginning of a program which needs stack operation. Stack is also used by the microprocessor. for example, it stores the contents of program counter when it jumps to a subroutine using CALL instruction. ~~stack has~~.

Instruction Register :-

The instruction register holds the opcode (operation code or instruction code) of the instruction which is being decoded and executed.

Temporary Register :-

It is an 8-bit register associated with

the ALU. It holds data during an arithmetic / logical operation. It is used by the microprocessor. It is not accessible to programmer.

Flags :-

The Intel 8085 microprocessor contains five Flip-Flops to serve as status flags. The Flip-Flops are set or reset according to the conditions which arise during an arithmetic or logical operation.

The five status flags of Intel 8085 are:

i) carry flag (CS)
ii) parity flag (P)
iii) Auxiliary carry flag (AC)
iv) zero flag (z)
v) sign flag (s)

If a flip-flop for a particular flag is set, it indicates 1. when it is reset, it indicates 0.

Carry flag (CS) :-

After the execution of an arithmetic instruction if a carry is produced, the carry flag CS is set to 1, otherwise it is 0. The carry flag is set or reset in case of addition as well as substraction. After the addition of two 8-bit numbers, if the sum is larger than 8 bits, a carry is produced; and the carry flag is set to 1. In case of substraction, if borrow occurs, the carry flag is set to 1. The carry flag holds carry out of the most significant bit resulting from the execution of an arithmetic operation.

Page :
Date : / /

parity flag (P). :-
The parity status flag p is set to 1, if the result of an arithmetic or logical operation contains even number of 1s. It is reset i.e. it is 0, if the result contains odd number of 1s.

Auxiliary carry flag (AC).
The auxiliary carry flag AC holds carry out of the bit number 3 to the bit number 4 resulting from the execution of an arithmetic operation. The counting of bits starts from 0, and hence, the Bit No. 3 is actually the fourth bit from the least significant bit.

Zero Flag (Z) :-
The zero status flag Z is set to 1, if the result of an arithmetic or logical operation is 0. If the result is not zero, the flag is set to 0.

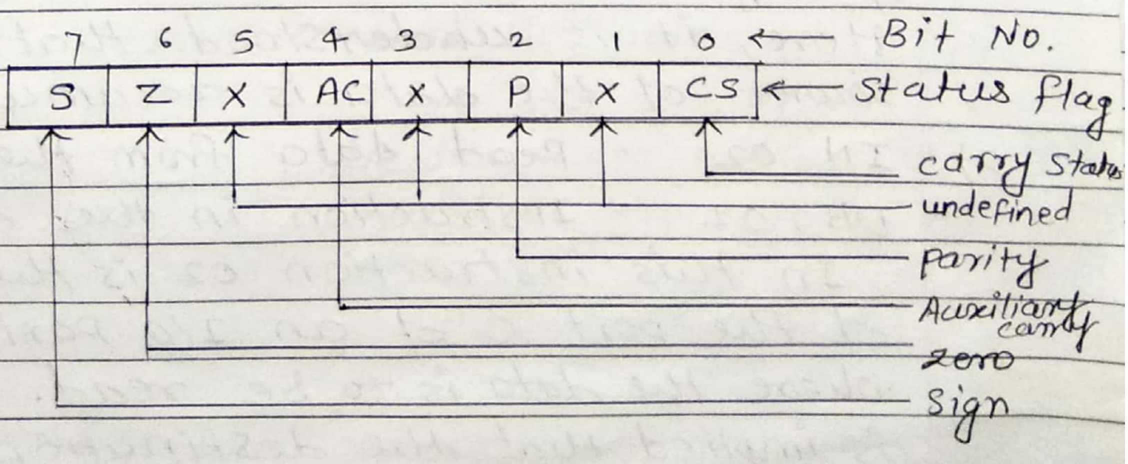
sign flag (S) :-
The sign flag S is set to 1, if the result of an arithmetic or logical operation is negative. If the result is positive, the sign flag is set to 0.

PSW :-
five bits indicate the five status flags and three bits are undefined. The combination of three 8 bits is called program status word (PSW). psw and the accumulator are treated as a 16-bit unit for stack operation.

Data and Address Bus:-

The Intel 8085 is an 8-bit microprocessor. Its data bus is 8-bit wide and hence, 8-bit of data can be transmitted in parallel from or to the microprocessor. The Intel 8085 requires a 16-bit wide address bus as the memory address are of 16-bits. The 8 most significant bits of the address are transmitted by the address bus, A-bus (Pins A_8 to A_{15}). The 8 least significant bits of the address are transmitted by address/data bus, AD-bus (pins $AD_0 - AD_7$). The address/data bus transmits data and address at different moments. At a particular moment it transmits either data or address. Thus the AD-bus operates in time shared mode. This techuique is known as multiplexing. first of all 16-bit memory address is transmitted by the microprocessor; the 8 MSBs of the address on the A-bus and the 8 LSBs of the address on AD-bus. Each memory location contains 1 byte of data.

Status flags of Intel 8085:-



pin configuration :-

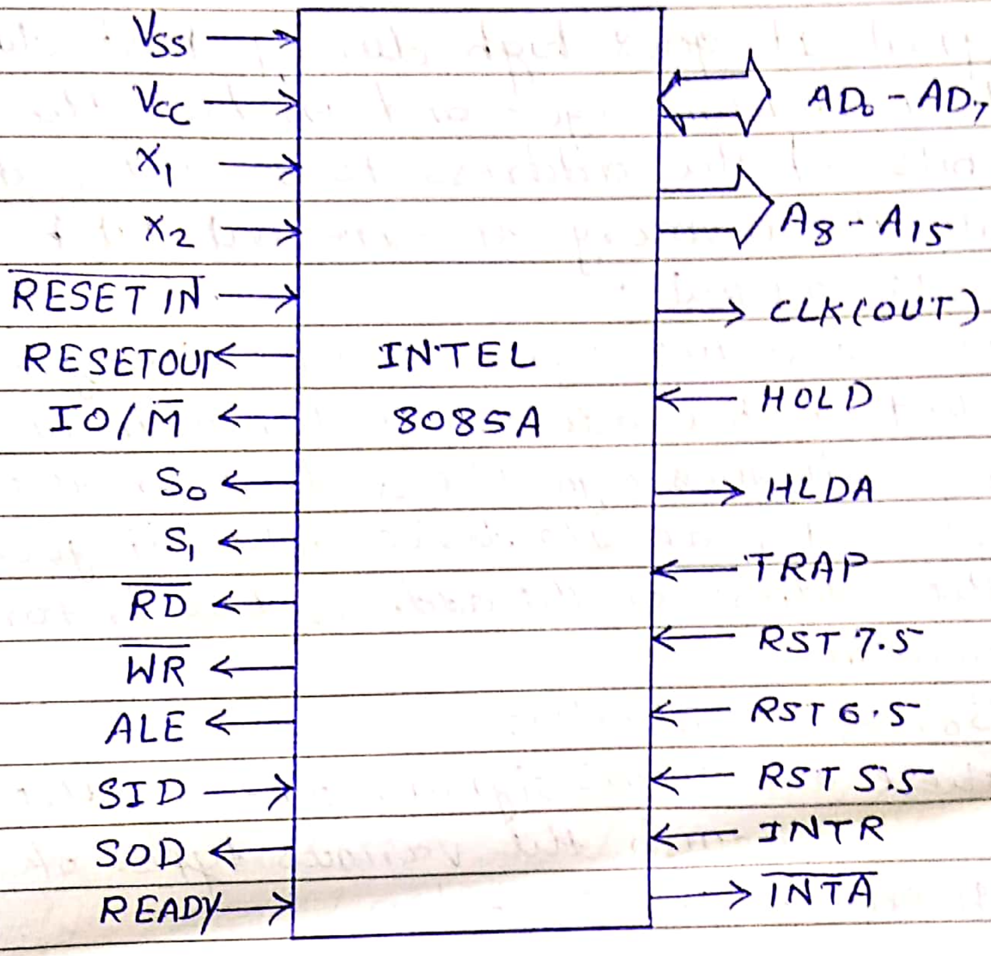


Fig. shows the schematic diagram of Intel 8085. The description of various pins are as follows:

$A_8 - A_{15}$ (output) :
These are address bus and are used for the most significant bits of the memory address or 8 bits of I/O address.

$AD_0 - AD_7$ (input/output) :
These are time multiplexed address/data bus i.e. they serve dual purpose. They are used for the least significant 8 bits of the memory address or I/O address during the first clock cycle of a machine cycle. Again they are

used for data during second and third clock cycles.

ALE (output): It is an address latch enable signal. It goes high during first clock cycle of a machine cycle and enables the lower 8 bits of the address to be latched either into the memory or external latch.

IO/$\overline{M}$ (output):
It is a status signal which distinguishes whether the address is for memory or I/O. when it goes high the address on the address bus is for an I/O device. when it goes low the address on the address bus is for a memory location.

S_0, S_1 (output):
These are status signals sent by the microprocessor to distinguish the various types of operation given in table below

S_1	S_0	operations
0	0	HALT
0	1	WRITE
1	0	READ
1	1	FETCH

$\overline{RD}$ (output):
When microprocessor reads data or codes from a memory location or an input device, it is called READ operation. $\overline{RD}$ is a signal sent by the µP to the memory / input device to control READ operation. when it goes low, the selected memory or input device is read.

$\overline{WR}$ (output) :- When microprocessor sends data to a memory location or an output device, it is called WRITE operation. $\overline{WR}$ is a signal sent by the microprocessor to the memory/output device to control write operation. When it goes low, the data which is on the data bus, is written into the selected memory or sent to the output device.

READY (input) :-
It is a signal sent by an input or output device to the µP. This signal indicates that the input or output device is ready to send or receive data. The µP examine READY signal before data transfer operation is performed. A slow input or output device is connected to the microprocessor through READY line. When READY is high, it indicates that the input or output device is ready to send or receive data. when READY is low, the microprocessor waits till Ready becomes high.

HOLD (input): when another device of the computer system, requires address and data buses for data transfer, it sends HOLD signal to the microprocessor. After receiving the HOLD request, the µP sends out a HLDA (HOLD acknowledge) signal to the device. Then the µP leaves the control over the buses as soon as the current machine cycle is completed. Internal processing may continue. The microprocessor regains the control over the buses after the HOLD signal is removed.

HLDA (output): It is a HOLD acknowlege signal sent out by the microprocessor after receiving the HOLD signal. It is sent to the device which has issued the HOLD signal. After the removal of the HOLD signal, the HLDA goes low, and thereafter the µp takes over the buses.

INTR (input): It is an interrupt signal sent by an external device to the µP. Through this line an external device informs µP that it is ready to transfer data or to initiate certain operation. The 8085 µP has 5 interrupt lines. The INTR is one of them. When it goes high, the µp suspends the execution of its normal sequence of instructions. After completing the current instruction at hand, it attends the interrupting device. The µp issues an interrupt acknowledge signal $\overline{INTA}$. Then it transfers data or takes any other action as required.

$\overline{INTA}$ (output): It is an interrupt acknowledge signal issued by the µP after receiving an interrupt request from an external device. It is a low active signal.

RST 5.5, 6.5, 7.5 and TRAP (inputs):- These are interrupts. when an interrupt is recognised the next instruction is executed from a fixed location in the memory is given below.

Line	location from which next instruction is picked up
TRAP	0024
RST 5.5	002C
RST 6.5	0034
RST 7.5	003C

RST 7.5, RST 6.5 and RST 5.5 are the restart interrupts. Each of them has a programmable mask, The TRAP has the highest priority among interrupts. It is a nonmaskable interrupt. It is unaffected by any mask or interrupt enable. The order of priority of interrupts is as follows:

TRAP (highest priority)
RST 7.5
RST 6.5
RST 5.5
INTR (lowest priority)

RESET IN (input) :- It resets the program counter to zero. It also resets interrupt enable and HLDA flip-flop. It does not affect any other flag or register except the instruction register.

RESET OUT (output) :-
It indicates that the CPU is being reset.

X_1, X_2 (input) :-
These are terminals to be connected to an external crystal oscillator which drives an internal circuitry of the MP to produce a suitable clock for the operation of microprocessor.

CLK (output) :- It is a clock output for user, which can be used for other digital ICs. Its frequency is same at which processor operates

SID (input) :-
It is data line for serial input. The data on this line is loaded into the 7th

bit of the accumulator when RIM instruction is executed.

SOD :- (output)
It is a data line for serial output. The 7th bit of the accumulator is output on SOD line when SIM instruction is executed

- Vcc +5 volts supply
- Vss ground reference.