TEXT BOOK:

Reference Book: – Ramesh S. Goankar, “Microprocessor Architecture, Programming and Applications with 8085”, 5th Edition, Prentice Hall

1.INTRODUCTION TO MICROPROCESSORS

A microprocessor is a multipurpose, programmable, clock driven, register based electronic device that reads binary instructions from a storage device called memory, accepts binary data as input, process data according to instructions and provides result as output.

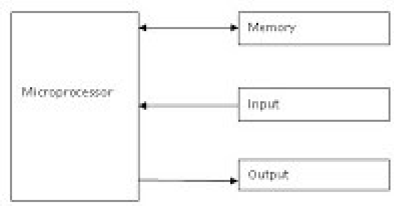

Fig. programmable device

A programmable machine can be represented with four components: microprocessor, memory, input and output as shown above.

MICROPROCESSOR AS A CPU [MPU]

Traditionally the computer is represented in the block diagram (a). The block diagram shows that the computer has four components: memory, input, output and Central processing unit [C.P.U], which consists of au and cu. The central processing unit [C.P.U] contains various register to store data; arithmetic logic unit [ALU] to perform arithmetic and logic operation, counters, instruction decoder etc. central processing unit [C.P.U] reads instruction from memory and perform the specified task. It communicates with I/O device to accept or send data. These devices are known as peripherals. Here, the central processing unit [C.P.U] is primary and central player.

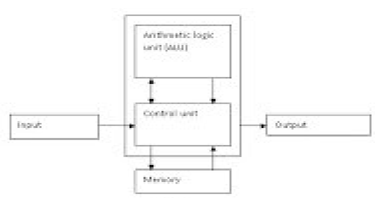

Fig. a

With the advent of integrate circuits [IC], the central processing unit [C.P.U] was build on a single chip known as microprocessor. Therefore, traditional central processing unit [C.P.U] has been replaced by microprocessor as shown in fig (b). A computer with a microprocessor as its central processing unit [C.P.U] is known as microcomputer. Microprocessor processing unit [M.P.U] implies a complete processing unit with necessary control units.

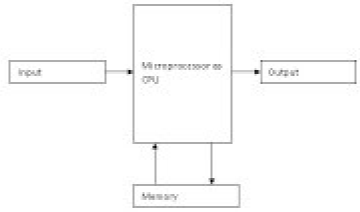

Fig b

The programming model consists of some segments of the arithmetic logic unit [ALU] and the registers. This model does not reflect the physical structure of the 8085 but includes the information that is critical in writing assembly language programs. The model includes six registers, one accumulator and one flag. In addition, it has two 16 bit registers, the stack pointer and the program counter.

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REGISTERS

The 8085 has six general purpose registers to store 8 bit data. These are identified as B, C, D, E, H, L. they can be combined as register pairs BC, DE, and HL, to perform 16 bit operations.

ACCUMULATOR

The acc is an 8 bit register that is part of the arithmetic logic unit [ALU]. This register is used to store 8 bit data and to perform arithmetic and logical operations. The result of the operation is stored in the accumulator and identified as A.

FLAGS

The arithmetic logic unit [ALU] includes 5 flip flops which are set or reset after an operation according to data conditions of the result in the accumulator and other registers. They are called zero (Z), carry (CY), sign(S), parity (P), and auxiliary carry (AC). The microprocessor used these flags to test data conditions.

PROGRAMCOUNTER

The microprocessor uses the PC register to sequence the execution of the instructions. The function of the pc is to point to the memory address from which the next byte is to be fetched. When a byte is being fetched, the pc is increased by one to point to the next memory location.

STACKPOINTER

The sp is also a 16 bit register used as a memory pointer. It points to a memory location in R/W memory, called the stack.

2.MICROPROCESSOR 8085

8085 is pronounced as "eighty-eighty-five" microprocessor. It is an 8-bit microprocessor designed by Intel in 1977 using NMOS technology.

It has the following configuration −

- 8-bit data bus
- 16-bit address bus, which can address upto 64KB
- A 16-bit program counter
- A 16-bit stack pointer
- Six 8-bit registers arranged in pairs: BC, DE, HL
- Requires +5V supply to operate at 3.2 MHZ single phase clock

It is used in washing machines, microwave ovens, mobile phones, etc.

8085 Microprocessor – Functional Units

8085 consists of the following functional units −

Accumulator

It is an 8-bit register used to perform arithmetic, logical, I/O & LOAD/STORE operations. It is connected to internal data bus & ALU.

Arithmetic and logic unit

As the name suggests, it performs arithmetic and logical operations like Addition, Subtraction, AND, OR, etc. on 8-bit data.

General purpose register

There are 6 general purpose registers in 8085 processor, i.e. B, C, D, E, H & L. Each register can hold 8-bit data.

These registers can work in pair to hold 16-bit data and their pairing combination is like B-C, D-E & H-L.

Program counter

It is a 16-bit register used to store the memory address location of the next instruction to be executed. Microprocessor increments the program whenever an instruction is being executed, so that the program counter points to the memory address of the next instruction that is going to be executed.

Stack pointer

It is also a 16-bit register works like stack, which is always incremented/decremented by 2 during push & pop operations.

Temporary register

It is an 8-bit register, which holds the temporary data of arithmetic and logical operations.

Flag register

It is an 8-bit register having five 1-bit flip-flops, which holds either 0 or 1 depending upon the result stored in the accumulator.

These are the set of 5 flip-flops −

- Sign (S)
- Zero (Z)
- Auxiliary Carry (AC)
- Parity (P)
- Carry (C)

Its bit position is shown in the following table −

D7	D6	D5	D4	D3	D2	D1	D0
S	Z		AC		P		CY

Instruction register and decoder

It is an 8-bit register. When an instruction is fetched from memory then it is stored in the Instruction register. Instruction decoder decodes the information present in the Instruction register.

Timing and control unit

It provides timing and control signal to the microprocessor to perform operations. Following are the timing and control signals, which control external and internal circuits −

- Control Signals: READY, RD', WR', ALE
- Status Signals: S0, S1, IO/M'
- DMA Signals: HOLD, HLDA
- RESET Signals: RESET IN, RESET OUT

Interrupt control

As the name suggests it controls the interrupts during a process. When a microprocessor is executing a main program and whenever an interrupt occurs, the microprocessor shifts the control from the main program to process the incoming request. After the request is completed, the control goes back to the main program.

There are 5 interrupt signals in 8085 microprocessor: INTR, RST 7.5, RST 6.5, RST 5.5, TRAP.

Serial Input/output control

It controls the serial data communication by using these two instructions: SID (Serial input data) and SOD (Serial output data).

Address buffer and address-data buffer

The content stored in the stack pointer and program counter is loaded into the address buffer and address-data buffer to communicate with the CPU. The memory and I/O chips are connected to these buses; the CPU can exchange the desired data with the memory and I/O chips.

Address bus and data bus

Data bus carries the data to be stored. It is bidirectional, whereas address bus carries the location to where it should be stored and it is unidirectional. It is used to transfer the data & Address I/O devices.

3.8085 Architecture

We have tried to depict the architecture of 8085 with this following image –

The pins of a 8085 microprocessor can be classified into seven groups −

Address bus

A15-A8, it carries the most significant 8-bits of memory/IO address.

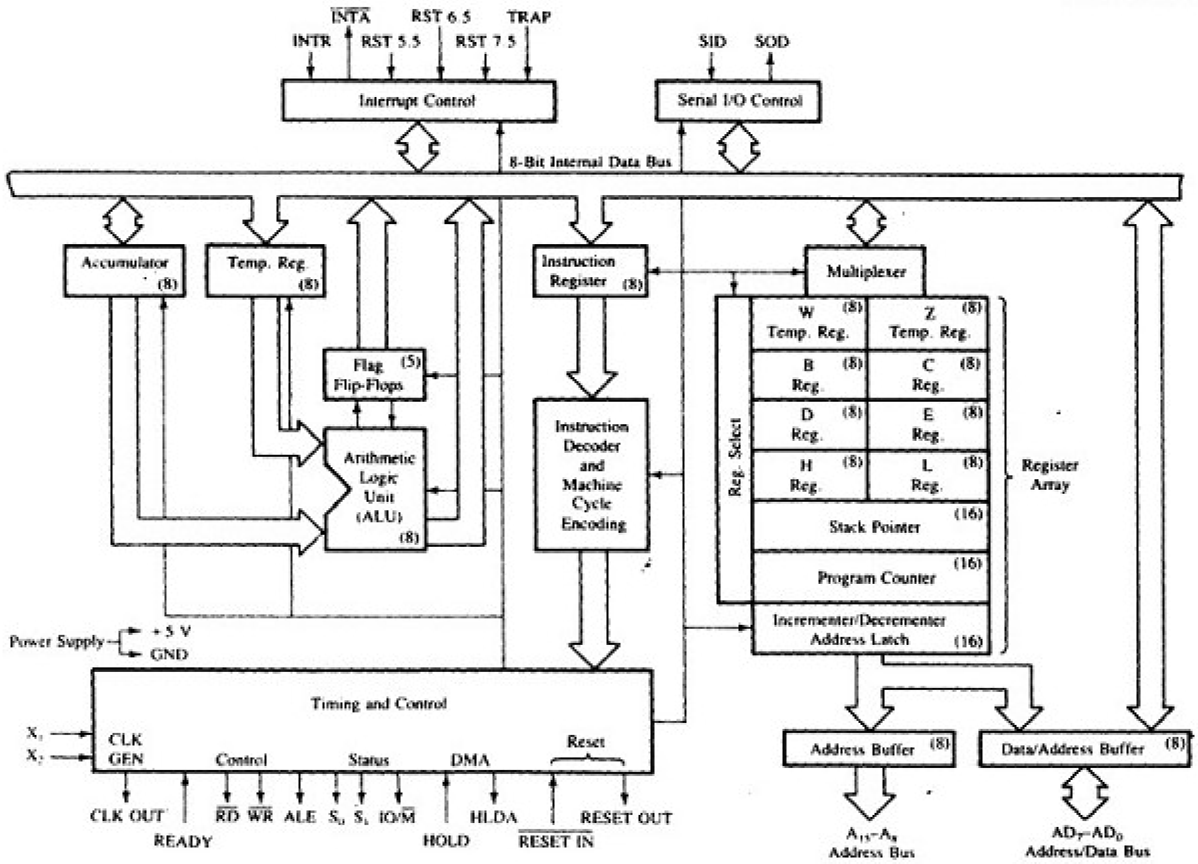
Data bus

AD7-AD0, it carries the least significant 8-bit address and data bus.

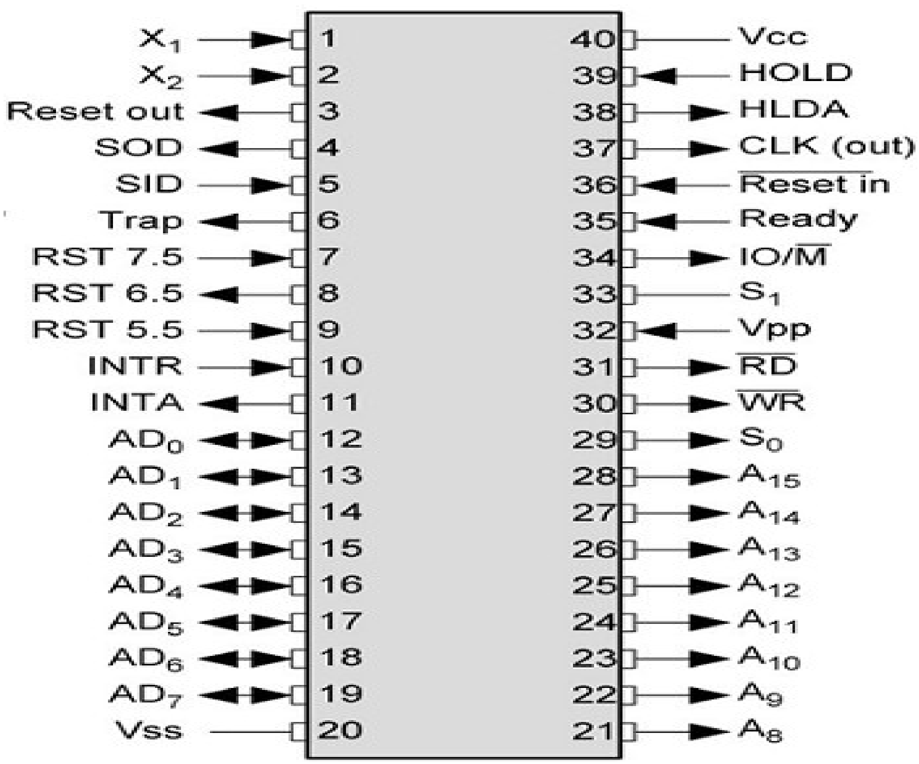
Control and status signals

These signals are used to identify the nature of operation. There are 3 control signal and 3 status signals.Three control signals are RD, WR & ALE.

- **RD** − This signal indicates that the selected IO or memory device is to be read and is ready for accepting data available on the data bus.
- **WR** − This signal indicates that the data on the data bus is to be written into a selected memory or IO location.



The following image depicts the pin diagram of 8085 Microprocessor −



- **ALE** − It is a positive going pulse generated when a new operation is started by the microprocessor. When the pulse goes high, it indicates address. When the pulse goes down it indicates data.

Three status signals are IO/M, S0 & S1.

IO/M

This signal is used to differentiate between IO and Memory operations, i.e. when it is high indicates IO operation and when it is low then it indicates memory operation.

S1 & S0

These signals are used to identify the type of current operation.

Power supply

There are 2 power supply signals − VCC & VSS. VCC indicates +5v power supply and VSS indicates ground signal.

Clock signals

There are 3 clock signals, i.e. X1, X2, CLK OUT.

- **X1, X2** − A crystal (RC, LC N/W) is connected at these two pins and is used to set frequency of the internal clock generator. This frequency is internally divided by 2.
- **CLK OUT** − This signal is used as the system clock for devices connected with the microprocessor.

Interrupts & externally initiated signals

Interrupts are the signals generated by external devices to request the microprocessor to perform a task. There are 5 interrupt signals, i.e. TRAP, RST 7.5, RST 6.5, RST 5.5, and INTR. We will discuss interrupts in detail in interrupts section.

- **INTA** − It is an interrupt acknowledgment signal.
- **RESET IN** − This signal is used to reset the microprocessor by setting the program counter to zero.
- **RESET OUT** − This signal is used to reset all the connected devices when the microprocessor is reset.
- **READY** − This signal indicates that the device is ready to send or receive data. If READY is low, then the CPU has to wait for READY to go high.

- **HOLD** − This signal indicates that another master is requesting the use of the address and data buses.
- **HLDA (HOLD Acknowledge)** − It indicates that the CPU has received the HOLD request and it will relinquish the bus in the next clock cycle. HLDA is set to low after the HOLD signal is removed.

Serial I/O signals

There are 2 serial signals, i.e. SID and SOD and these signals are used for serial communication.

- **SOD** (Serial output data line) − The output SOD is set/reset as specified by the SIM instruction.
- **SID** (Serial input data line) − The data on this line is loaded into accumulator whenever a RIM instruction is executed.

4.Instruction Set Classification

An **instruction** is a binary pattern designed inside a microprocessor to perform a specific function. The entire group of instructions, called the **instruction set**, determines what functions the microprocessor can perform. These instructions can be classified into the following five functional categories: data transfer (copy) operations, arithmetic operations, logical operations, branching operations, and machine-control operations.

1 Data Transfer Group

The data transfer instructions move data between registers or between memory and registers.

MOV	Move
MVI	Move Immediate
LDA	Load Accumulator Directly from Memory
STA	Store Accumulator Directly in Memory

LHLD Load H & L Registers Directly from Memory

SHLD Store H & L Registers Directly in Memory

An 'X' in the name of a data transfer instruction implies that it deals with a register pair (16-bits);

LXI Load Register Pair with Immediate data

LDAX Load Accumulator from Address in Register Pair

STAX Store Accumulator in Address in Register Pair

XCHG Exchange H & L with D & E

XTHL Exchange Top of Stack with H & L

2 Arithmetic Group

The arithmetic instructions add, subtract, increment, or decrement data in registers or memory.

ADD Add to Accumulator

ADI Add Immediate Data to Accumulator

ADC Add to Accumulator Using Carry Flag

ACI Add immediate data to Accumulator Using Carry

SUB Subtract from Accumulator

SUI Subtract Immediate Data from Accumulator

SBB Subtract from Accumulator Using Borrow (Carry) Flag

SBI Subtract Immediate from Accumulator Using Borrow (Carry) Flag

INR Increment Specified Byte by One

DCR Decrement Specified Byte by One

INX Increment Register Pair by One

DCX Decrement Register Pair by One

DAD Double Register Add; Add Content of Register

Pair to H & L Register Pair

3 Logical Group

This group performs logical (Boolean) operations on data in registers and memory and on condition flags. The logical AND, OR, and Exclusive OR instructions enable you to set specific bits in

the accumulator ON or OFF.

ANA Logical AND with Accumulator

ANI	Logical AND with Accumulator Using Immediate Data
ORA	Logical OR with Accumulator
OR	Logical OR with Accumulator Using Immediate Data
XRA	Exclusive Logical OR with Accumulator
XRI	Exclusive OR Using Immediate Data

The Compare instructions compare the content of an 8-bit value with the contents of the accumulator;

CMP	Compare
CPI	Compare Using Immediate Data

The rotate instructions shift the contents of the accumulator one bit position to the left or right:

RLC	Rotate Accumulator Left
RRC	Rotate Accumulator Right
RAL	Rotate Left Through Carry
RAR	Rotate Right Through Carry

Complement and carry flag instructions:

CMA	Complement Accumulator
CMC	Complement Carry Flag
STC	Set Carry Flag

4 Branch Group

The branching instructions alter normal sequential program flow, either unconditionally or conditionally. The unconditional branching instructions are as follows:

JMP	Jump
CALL	Call
RET	Return

Conditional branching instructions examine the status of one of four condition flags to determine whether the specified branch is to be executed. The conditions that may be specified are as follows:

NZ	Not Zero (Z = 0)
Z	Zero (Z = 1)
NC	No Carry (C = 0)

C	Carry (C = 1)
PO	Parity Odd (P = 0)
PE	Parity Even (P = 1)
P	Plus (S = 0)
M	Minus (S = 1)

Thus, the conditional branching instructions are specified as follows:

Jumps	Calls	Returns	
INC	CNC	RNC	(No Carry)
JNZ	CNZ	RNZ	(Not Zero)
JM	CM	RM	(Minus)
JP0	CPO	RPO	(Parity Odd)
JM	CM	RM	(Minus)
JPE	CPE	RPE	(Parity Even)
JP0	CPO	RPO	(Parity Odd)

Two other instructions can affect a branch by replacing the contents or the program counter:

PCHL	Move H & L to Program Counter
RST	Special Restart Instruction Used with Interrupts

5 Machine Control instructions

EI	Enable Interrupt System
DI	Disable Interrupt System
HLT	Halt
NOP	No Operation

6 Stack Instructions

The following instructions affect the Stack and/or Stack Pointer

PUSH	Push Two bytes of Data onto the Stack
POP	Pop Two Bytes of Data off the Stack
XTHL	Exchange Top of Stack with H & L
SPHL	Move content of H & L to Stack Pointer

7 I/0 instructions

IN	Initiate Input Operation
OUT	Initiate Output Operation

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5.8085 HARDWARE MODEL:

The hardware model in fig (a) shows two major segments. One segment includes arithmetic logic unit [ALU] and an 8 bit register called an accumulator, instruction decoder, and flags. The second segment shows 8 bit and 16 bit registers. Both segments are connected with various internal connections called an internal bus. The arithmetic and logic operations are performed in the arithmetic logic unit [ALU]. Results are stored in the accumulator, and flip-flops, called flags, are set or reset to reflect the results. There are 3 buses- a 16 bit unidirectional address bus, an 8 bit bidirectional data bus, and a control bus.

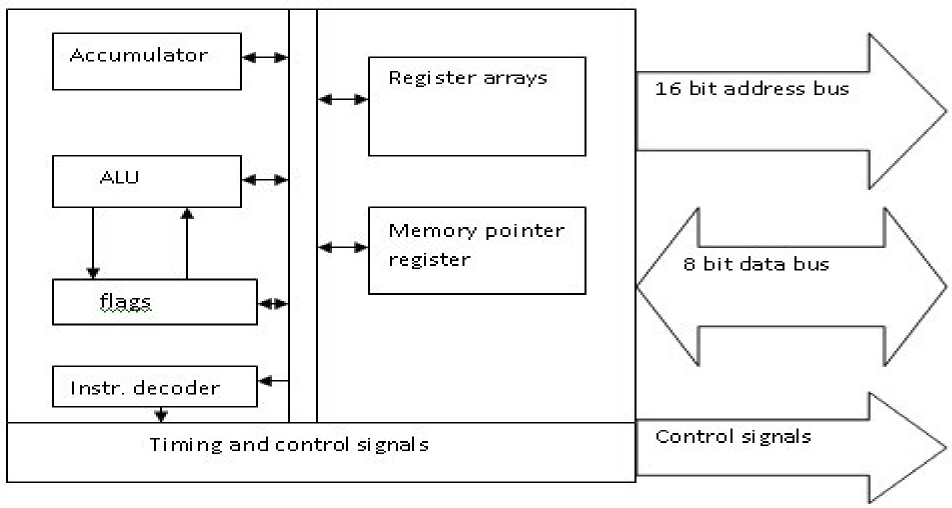
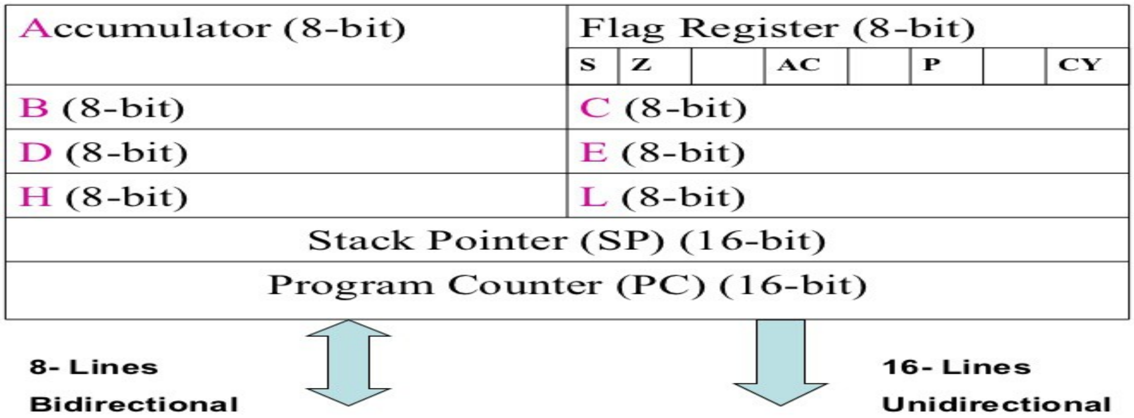


Fig. hardware model

A model is conceptual representation of a real object. It can take many forms such as text description; a drawing etc. similarly the microprocessor can be represented in terms of its hardware (physical electronic components) and programming model (information needed to write programs).

6.8085 programming model



The 8085 Programming Model

The 8085 programming model includes six registers, one accumulator, and one flag register, Figure. In addition, it has two 16-bit registers: the stack pointer and the program counter. They are described briefly as follows.

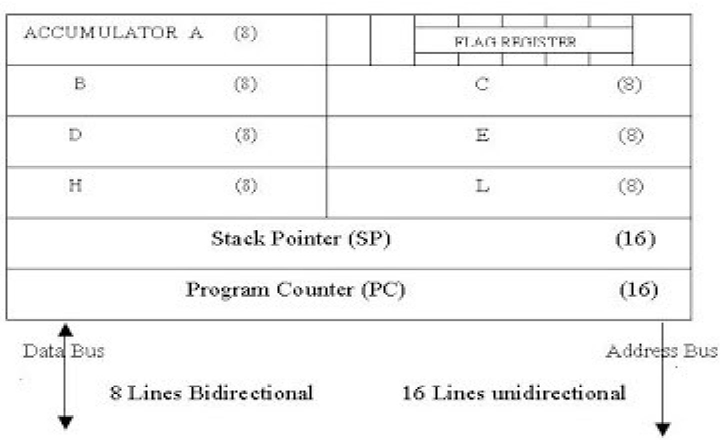
1.Six general purpose register

2.Accumulator register

3.Flag Register

4.Stack pointer

5.Program Pointer

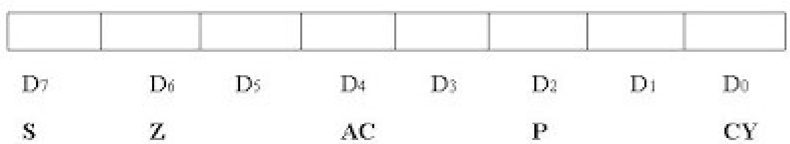


Register Diagram

Registers
The 8085 has six general-purpose registers to store 8-bit data; these are identified as B,C,D,E,H, and L as shown in the figure. They can be combined as register pairs - BC, DE, and HL - to perform some 16-bit operations. The programmer can use these registers to store or copy data into the registers by using data copy instructions.

Accumulator
The accumulator is an 8-bit register that is a part of arithmetic/logic unit (ALU). This register is used to store 8-bit data and to perform arithmetic and logical operations. The result of an operation is stored in the accumulator. The accumulator is also identified as register A.

Flags
The ALU includes five flip-flops, which are set or reset after an operation according to data conditions of the result in the accumulator and other registers. They are called Zero(Z), Carry (CY), Sign (S), Parity (P), and Auxiliary Carry (AC) flags; their bit positions in the flag register are shown in the Figure below. The most commonly used flags are Zero, Carry, and Sign. The microprocessor uses these flags to test data conditions.



Flags

For example, after an addition of two numbers, if the sum in the accumulator id larger than eight bits, the flip-flop uses to indicate a carry -- called the Carry flag (CY) -- is set to one. When an arithmetic operation results in zero, the flip-flop called the Zero(Z) flag is set to one. The first Figure shows an 8-bit register, called the flag register, adjacent to the accumulator. However, it is not used as a register; five bit positions out of eight are used to store the outputs of the five flip-flops. The flags are stored in the 8-bit register so that the programmer can examine these flags (data conditions) by accessing the register through an instruction.

ProgramCounter(PC)
This 16-bit register deals with sequencing the execution of instructions. This register is a memory pointer. Memory locations have 16-bit addresses, and that is why this is a 16-bit register. The microprocessor uses this register to sequence the execution of the instructions. The function of the program counter is to point to the memory address from which the next byte is to be fetched. When a byte (machine code) is being fetched, the program counter is incremented by one to point to the next memory location

Stack Pointer (SP)
The stack pointer is also a 16-bit register used as a memory pointer. It points to a memory location in R/W memory, called the stack. The beginning of the stack is defined by loading 16-bit address in the stack pointer.

7.INSTRUCTION AND DATA FORMATS

Intel 8085 is an 8-bit microprocessor. It handles 8-bit data at a time. One byte consists of 8-bits.A memory location for Intel 8085 microprocessor is designed to accumulate 8-bit data. If 16-bit data are to be stored, they are stored in consecutive memory locations. The address of memory location is 0f 16-bit i.e. 2 bytes.

The various techniques to specify data for instructions are:
(1) 8-bit or 16-bit data may be directly given in the instruction itself.

(2) The address of the memory location, I/O port or I/O device, where data resides, may be given in the instruction itself.

(3)In some instructions only one register is specified. The content of the specified register is one of the operand and other operand is the accumulator.

(4) Some instructions specify two registers. The contents of the registers are the required data.

Due to different ways of specifying data for instruction are not of same length.

So there are three types of instructions of Intel 8085:
(1)1-byte instruction
(2)2-byte instruction
(3)3-byte instruction

One-Byte instruction.
The content information regarding operands in the opcode itself .These are of one byte.

Ex-MOV A,B ; Move the content of register B to A

78H is opcode for MOV A,B. The binary form of opcode 78H is 01111000. The first two bit i.e. 01 for MOV operation; the next 3 bits i.e. 111 for register A and last 3 bits 000 are for register B.

Two-Byte instruction.
In case of two byte instruction the 1st byte of the instruction is opcode and 2nd byte is either data or address.Both bytes are stored in two consecutive memory locations.

Ex-MVI B,05; Move 05 to register B 06,05; MVI B,05 in the code form
Here in this case the 1st byte i.e. 06 is the opcode for MVI B and 2nd byte i.e. 05 is the data which is to be moved to register B.

Three-Byte instruction.
In case of three bytes instruction the 1st byte of instruction is opcode and 2nd and 3rd byte of instruction are either 16-bit data or 16-bit address.

They are stored in three consecutive memory locations.

Ex-LXI H, 2400H ; load H-L pair with 2400H
21,00,24; LXI H, 2400H in code form.Here 1st byte i.e. 21 is the opcode for instruction LXI H. The 2nd byte i.e. 00 is 8 LSBs of data which is loaded in to register L. The 3rd byte i.e. 24 is 8 MSBs of data which is loaded in to register H.

8.ADDRESSING MODES OF 8085:

Addressing mode: These are various techniques to specify data for instruction
a) Direct addressing mode
b) Register addressing mode
c) Register addressing mode
d) Immediate addressing mode
e) Implicit addressing mode.

a) Direct addressing mode:
In this addressing mode the address of the operand is given in the instruction.

Ex: STA 2000H
IN 02H

b) Register addressing mode:
In this addressing mode the operands are in the general purpose register. The opcode specify the address of the register and the operation to be Perform.

Ex: MOV A,B
ADD B

c) Register indirect addressing mode:
In this addressing mode the address of the operand is specify by a register pair.

Ex: MOV A,M
LDAX B

d) Immediate addressing mode:
In this addressing mode operand is specify within the instruction.

Ex: MVI A,05H // Move immediate data 05H to Accumulator.
LXI B,2030H

e) Implicit addressing mode:
This instruction operates on the content of the accumulator.They don't required operand address.

EX: CMA //Complement
HLT,RET

9.MICROPROCESSOR ARCHITECTURE

The microprocessor is the central processing unit or cpu of a micro computer. it is the heart of the Computer.

INTEL 8085:
It is an 8 bit Nmos microprocessor. It is an forty pin IC(integrated circuit) package fabricated on a single LSI (Large scale Integration) chip. It uses a single +5 volt dc.(Direct Current) supply for its operation. It clock speed is 3 mhz.It consists of 3 main sections.

1-Arithmetic Logic Unit (ALU)
2-Timing and control unit
3-Several Registers

Arithmetic Logic Unit:
It performs various arithmetic an logical operations like addition, substraction, logical an, xor, or, not, increment etc.

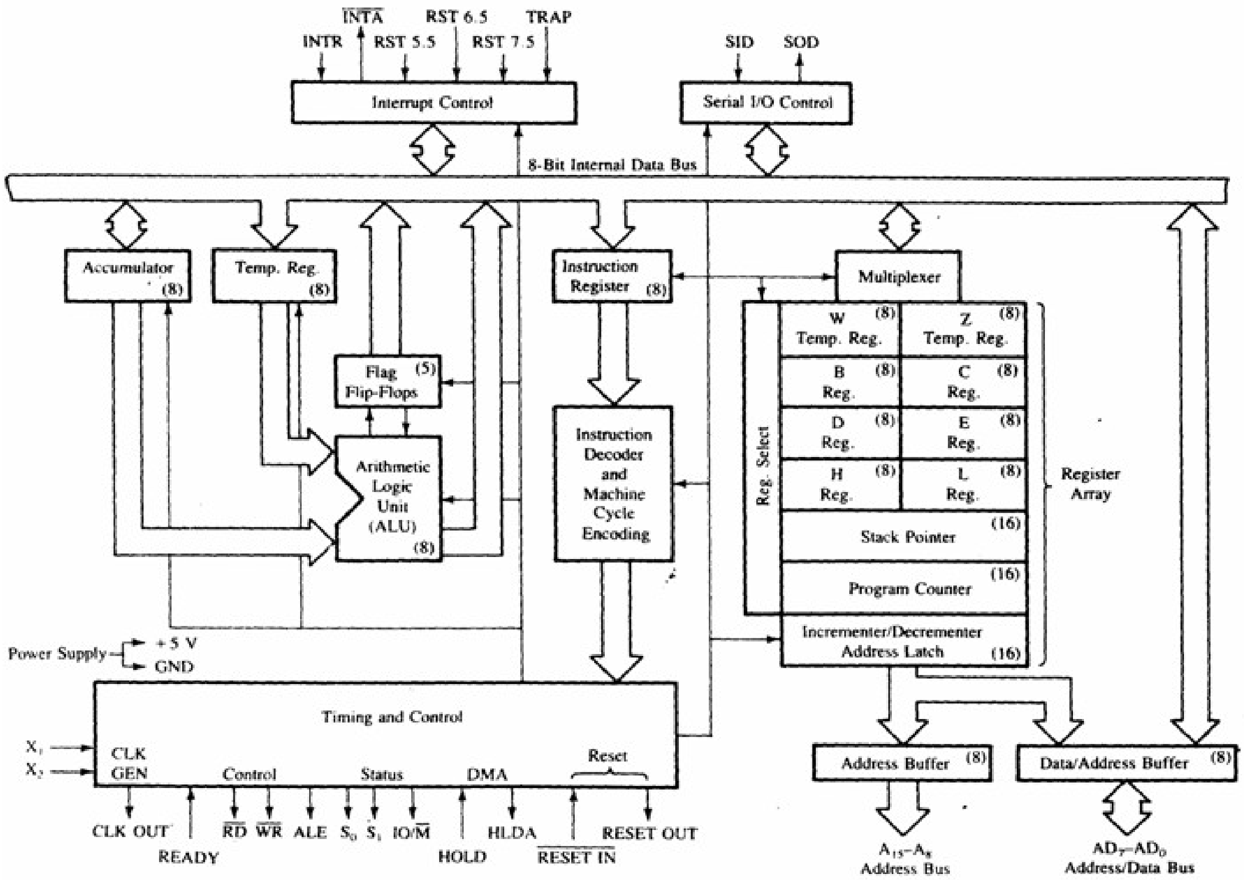
Timing and control unit:
It generates timing an control signals which are necessary for the execution of the instructions. It Controls the at flow between cpu an peripherals.

Several Registers:
Registers:-it is a collection of flip flops use to store a binary word.they is used by the microprocessor for the temporary storage and manipulation of data and instructions.

8085 has the following registers:
1-8 bit accumulator i.e. register A
2-6 8 bits general purpose registers i.e. B, C, D, E, H, and L
3-one 16 bit register i.e. stack pointer
4-16 bit Program counter, Status register, Temporary register, Instruction Register.

The register A holds the operands during program execution.
There are six 8 bits general purpose registers B,C,D,E,H,L are to handle 8 bit data. two 8 bit Registers can be combined. This is called register pair is used to as 16 bit address memory location register pair. Valid register pair of 8085 is BC, DE, HL

BLOCK DIAGRAM 8085



STACK POINTER:

Stack is a sequence of memory location defined by the programmer in LIFO function. That is last Element to be placed on the stack is first one is to removed .The stack pointer contain the address of the stack cup.

PROGRAM COUNTER:

It is the address of the next instructions to be executed.

INSTRUCTION REGISTER:

It holds a copy of the current instruction until it is decoded.

STATUS REGISTER:

It contains the status flags of 8085 microprocessor.

TEMPORARY REGISTER:

It is used to store intermediate results and for intermediate calculations.

STATUS FLAGS:

It is a set of 5 flip-flops

i. Carry Flag(Cs)

ii. Sign Flag(S)

iii. Zero Flag(Z)

iv. Parity Flag(P)

v. Auxilarity carry flag(Ac)

Carry Flag:

It holds carry out of the resulting from the execution of an arithmetic operation.If there is a carry from addition or a borrow from substraction or comparision,the carry flag is said to 1 ortherwise it is 0.

Sign Flag:

It is set to 1 if the MSB of the result of an arithemetic or logical operation is 1 ortherwise it is 0.

Zero Flag:

It is said to 1 if the result of an arithmetic or logical operation is zero.for non zero result,it is 0.

Parity Flag:

It is set to 1 when the the result of the operation contains even no.of 1& it is set to 0 if there are odd no.of 1.

Auxilary Carry Flag:

It holds carry from bit 3 to A resulting from the execution of an arithmetic operation.If there is a carry from bit 3 to 4,the AC flag is set to 1 ortherwise it is 0.

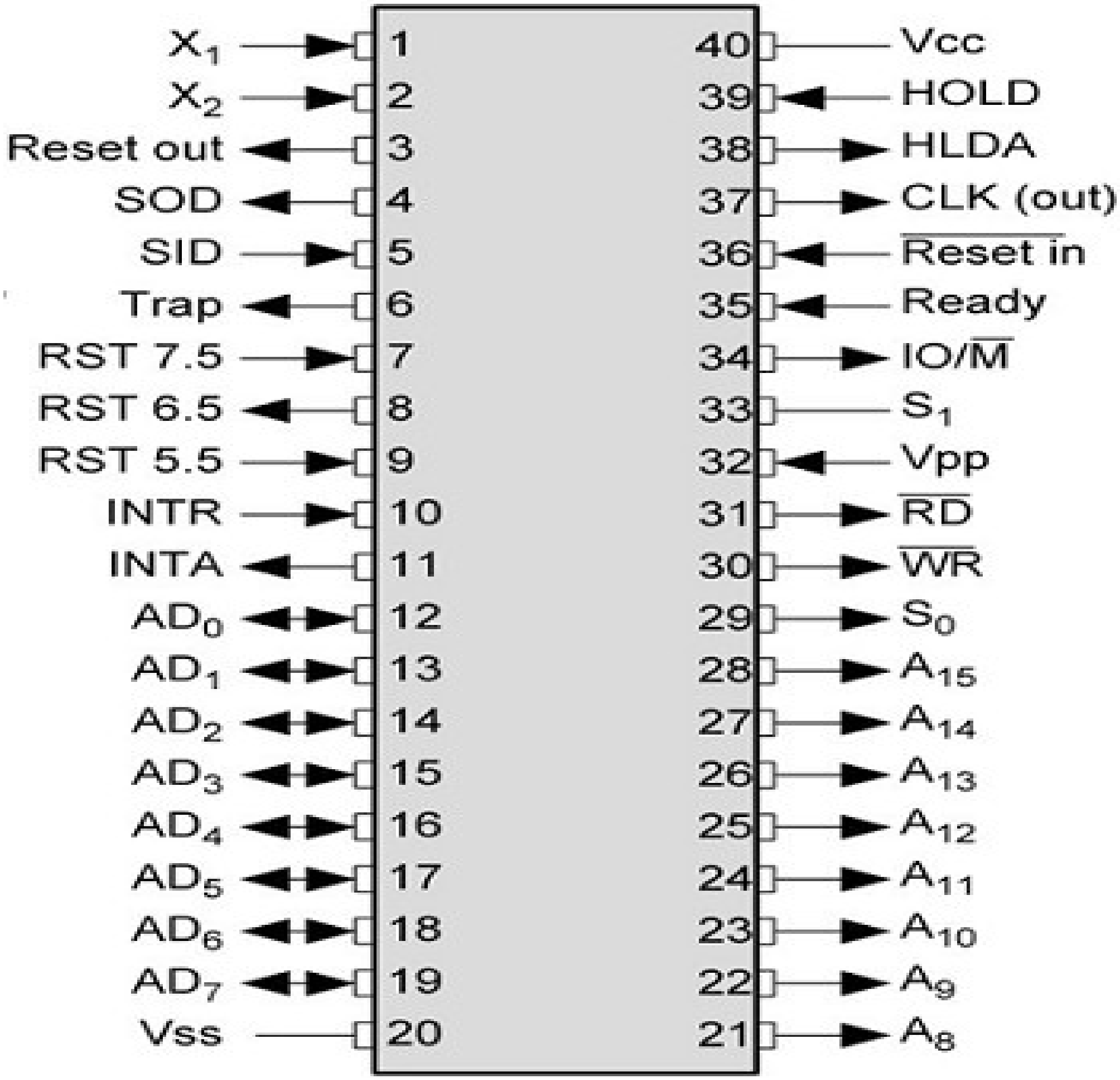
Program Status Word(PSW):

It is a combination of 8-bits where five bits indicates the 5 status flags & three bits are undefined. Psw and the accumulator treated as a 16 bit unit for stack operation.

BUS ORGANISATION:

INTEL 8085 is a 8 bit micro processor.its data bus is 8 bit wide .8 bit of data can be transmitted in parallel form. or to the microprocessor. Address bar is 16 bit wide as memory address are of 16 bit.8 msb is the address are transmitted by on A8-A15.8 LSB is is the address are transmitted by the data bus AD0-AD7.The address or data bus transmits data & address at different moments. it can transmits data or address at a time.

PIN DESCRIPTION OF 8085



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 that is 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/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 signal sent by the microprocessor to distinguish the various types of operation

Status code for Intel 8085

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

RD (output)-it is a signal to control READ operation .when it goes low the selected memory or I/O device is read.

WR(output)-it is a signal to control WRITE operation .when it goes low the data on the data bus is written into the selected memory or I/O operation.

READY(input)-it is used by the microprocessor to sense whether a peripheral is ready to transfer data or not .a slow peripheral may be connected to the microprocessor through READY line. if READY is high the peripheral is ready .if it is low the microprocessor waits till it goes high.

HOLD (input)-it indicates that another device is requesting for the use of the address and data bus. Having received a HOLD request the microprocessor relinquishes the use of the buses as soon as the current machine cycle is completed. Internal processing may continue. the processor regains the bus after the removal of the HOLD signal. when a HOLD is acknowledged .

HLDA (output)-it is a signal for HOLD acknowledgement. It indicates that the HOLD request has been received. after the removal of a HOLD request the HLDA goes low. the CPU takes over the buses half clock cycle after the HLDA goes low.

INTR (input)-it is an interrupt request signal. Among interrupts it has the lowest priority. An interrupt is used by io devices to transfer data to the microprocessor without wasting its time.

INTA (output)-it is an interrupt acknowledgement sent by the microprocessor after INTR is received.

RST5.5, RST6.5, RST 7.5(input)-these are interrupts. Signals are the restart interrupt, they causes an internal restart to be automatically inserted each of them of a programmable mask.

TRAP-TRAP has the highest priority. It is used in emergency situation. it is an non-mask able interrupt.Order of priority-

TRAP RST 7.5 RST 6.5 RST 5.5 INTR

When an interrupt is recognize the next instruction is executed from a fixed location in memory. A subroutine is executed which is called ISS(interrupt service subroutine).

RESET IN (input)-it resets the program counter to zero .it also resets interrupts enable that is an HLDA flip-flops.

RESETOUT (output)-it indicates that the CPU is being reset.

X1, X2 (input)-these are terminals to be connected to an external crystal oscillator which drives an internal circuitry of the microprocessor 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 integrated circuits.

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 (read interrupt mask) instruction is executed.

SOD (output)- it is data line for serial output. The 7th bit of the accumulator is output on sod line when sim instruction is executed.

INTERRUPTS ISS ADDRESS
TRAP 0024
RST 5.5 002C
RST 6.5 0034
RST 7.5 003C
Vcc-it is +5 volt dc supply.
Vss-it is the ground reference