

Over view of Microprocessor 8085 and its application

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Abstract: Microprocessor is a program controlled semiconductor device (IC), which fetches, decode and executes instructions. It is versatile in application and is flexible to some extent.

Nowadays, modern microprocessors can perform extremely sophisticated operations in areas such as meteorology, aviation, nuclear physics and engineering, and take up much less space as well as delivering superior performance Here is a brief review of microprocessor and its various application

Key words: Semi Conductor, Integrated Circuits, CPU, NMOS ,PMOS, VLSI

I. Introduction:

Microprocessor is derived from two words micro and processor. Micro means small, tiny and processor means which processes something. It is a single Very Large Scale of Integration (VLSI) chip that incorporates all functions of central processing unit (CPU) fabricated on a single Integrated Circuits (ICs) (1).Some other units like caches, pipelining, floating point processing arithmetic and superscaling units are additionally present in the microprocessor and that results in increasing speed of operation.8085,8086,8088 are some examples of microprocessors(2).

The technology used for microprocessor is N type metal oxide semiconductor(NMOS)(3). Basic operations of microprocessor are fetching instructions from memory ,decoding and executing them ie it takes data or operand from input device, perform arithmetic and logical operations and store results in required location or send result to output devices(1).Word size identifies the microprocessor.E.g. The microprocessor is an 8-bit microprocessor if Arithmetic and LogicUnit can perform 8- bit data operation at a time(4).

Examples:

Intel 4004	A 4 bit P type metal oxide semiconductor (PMOS) microprocessor
Intel 8085	8 bit NMOS microprocessor
Intel 8086	16 bit microprocessor
Intel 80386	32 bit microprocessor
Intel 's Itanium	64 EIPC(Explicitly Parallel Computing) processor.

The performance is described in terms of processor clock speed which is expressed in megahertz (MHz) or Gigahertz (GHz)(5). However this is not the only parameter for assessment in terms of performance of a microprocessor. Now a days Microprocessor designers are focusing on the latest silicon production processes and designs that minimize the size of microprocessor footprint, power consumption and heat generation. Other important facets of interest are microarchitecture optimization, multi- processing parallelism, reliability, designed-in security features, memory structure efficiency and better synergy between the hardware and accompanying software tools, such as compilers. The designers focus more attention on refining the efficiency of the software code rather than making the hardware responsible for dynamic optimization in order to enhance the ultimate system performance(6).

II. History:

Initially Microprocessor was designed by United States of America and BUSICOM of Japan in the year 1971 . The first Microprocessor Intel 4004,was a 4 bit P type Metal Oxide Semi Conductor (PMOS) Microprocessor.(3)Intel introduced two 8 bit microprocessors 8008 in the year 1972 and 8080 in 1973.2nd one was most popular microprocessor of the early 70s. 8080 was a NMOS microprocessor. NMOS microprocessor is popular than PMOSas NMOS technology are faster and provide higher density than that of PMOS. The enhanced version of 8080 was 8085 (1,7).Microprocessor 8085 was introduced by Intel in the year 1977 (8). The clock and controller of Intel 8080 were on separate chip and it utilizes two separate power supplies. So 8080 was not a complete CPU on a single chip .But Intel 8085 has its own clock and control circuit fabricated on a single chip (1). The model number "5" came from the fact that Intel 8085 requires only +5-volt(V) power supply by using depletion mode of transistors. This kind of chip requires a minimum of external units like RAM,ROM,8 bit latches etc(8).

III. Intel 8085 Microprocessor:

Intel 8085 is an 8-bit NMOS microprocessor. It is 40 pin IC, requires 3 MHz speed of operation and clock cycle is 320 ns. It has 80 instructions and 246 commands(9). 8-bit microprocessor is capable of addressing up to 64 K bytes (i.e. $2^{16} = 65536$ bytes) of memory.

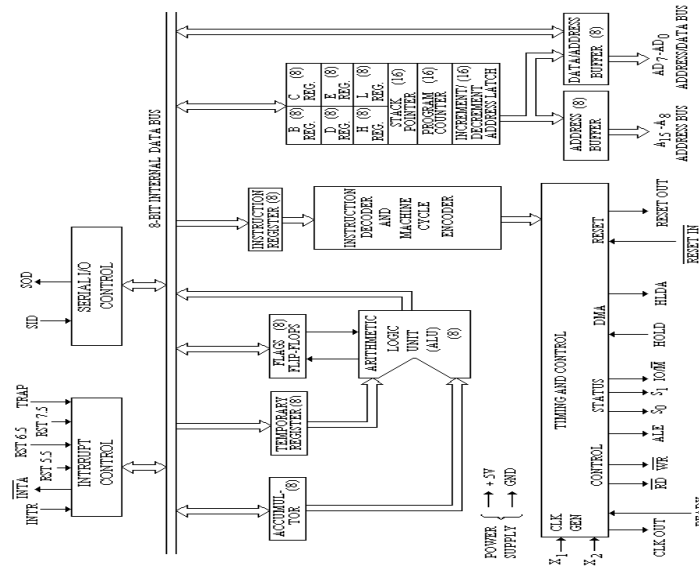


Fig 1: Block diagram of Microprocessor 8085 (1)

Components:

The five main functional components of 8085A microprocessor are given below:

- (A) Register Section (B) Arithmetic and Logic Unit (ALU) (C) Timing and Control Section (D) Interrupt Control Section (E) Serial Input / Output Control (1).

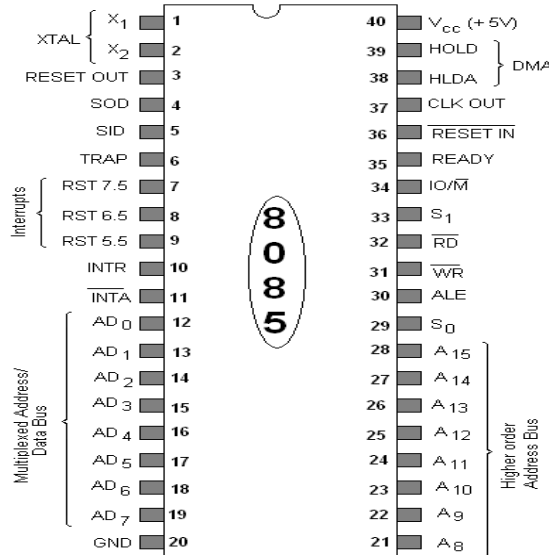


Fig 2: Pin Diagram of intel 8085 (1)

(A) REGISTER: Registers are temporary storage and used for manipulation of data and instructions (7). Intel 8085 microprocessor contains eight addressable 8-bit registers namely:

- (a) Accumulator (A register), (b) Flag register (PSW) (c) B register (d) C register (e) D register (f) E register (g) H register (h) L register (1)

General Purpose Registers: The 8085 Microprocessor has six 8-bit general purpose registers. They are B, C, D, E, H, L. They are called 16 bit registers when paired up as BC, DE and HL. Now they are called Register pair (rp). Again HL pair is used as memory pointer and it used to hold 16 bit address of a memory location (7). However, General Purpose Registers (GPRS) are limited as registers occupy more space on the Silicon chip (1).

Accumulator: The A register of 8085 is Accumulator, associate with Arithmetic and logic unit (ALU).It is used to store one of the data or operands of an arithmetic and logical operation.

Flag Register:There are five 8 bit flag registers. They show the status conditions after any arithmetic and logical operation. Therefore they are also called as Status register and PSW (Program Status word). The 5 Flag registers of Intel 8085 are: Carry Flag (CY), Auxiliary Carry Flag (AC), Parity Flag (P), Zero Flag (Z) and Sign Flag (S)(7)

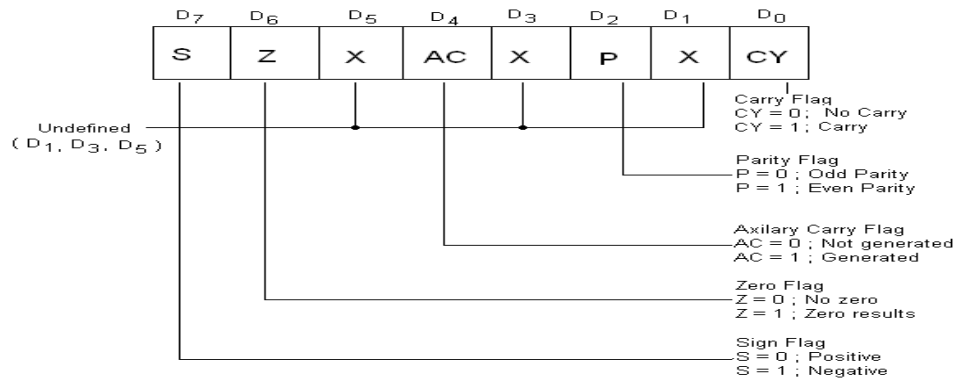


Fig 3: Program Status Word (2)

Carry Flag (CY): If there is a carry after any arithmetic and logical operation, then carry flag is set (1) otherwise reset (0)

Auxiliary Carry Flag (AC): If carry generated from bit 3 of PSW to bit 4 of PSW then AC is set (1) otherwise reset(0)

Parity Flag(P): parity Flag is set(1) if after arithmetic and logical operation result contains even no of 1's .If there is odd no of 1's then parity flag is reset(0)

Zero Flag(Z): Z flag is set(1) if the result of arithmetic and logical operation is zero(0).if there is non zero result,Z flag is reset(0) .

Sign Flag(S):If result of an arithmetic and logical operation is negative then S Flag is set(1).if result is positive then S Flag is reset(0) (7)

Ex: Add CC and C8

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11001100
+ 11001000
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110010100
    
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The result is nonzero,Z flag is reset(0)
 There is a carry from bit 7,C flag is set(1)
 There is a carry from bit 3 to bit 4,AC flag is set(1)
 There are 3 nos of 1s.P flag is reset(0)
 MSB of PSW is 1,S Flag is set(1) (7)

Program Counter(PC): Program Counter is 16 bit Special function register(SFR).It is used to store address or memory location of the next instruction to be executed.(7) . The PC is automatically updated after an instruction has been fetched by the processor. If instruction is one byte instruction, then PC will be updated by one. Similarly, for two and three byte instructions, PC will be updated by two and three respectively(1). For example; MOV A,B is one byte instruction. MVI A,06 is two byte instruction and LXI H,1200H is a 3 byte instruction .Here PC will be updated as PC=PC+1,PC=PC+2 and PC= PC+3 respectively.

Stack Pointer(SP): SP is 16 bit Special function register. Stack is a temporary location set aside by programmer to r/w the content of the other registers. SP takes the address of last used content of the stack. It works on LIFO(last in First out) principle.

Instruction Register(IR): IR is also 16 bit special Function Register, hold the opcode (operation code) of the instruction or command is being decoded and executed.(7)

(B).ARITHMETIC AND LOGIC UNIT (ALU): ALU performs arithmetic operations like addition,subtraction,multiplication ,division and logical operations like logical OR,logical AND,Exclusive OR, Exclusive NOR,complement, Clear, increment, decrement etc.(7) . ALU basically consists of accumulator (A), flag register (F) and a temporary register.

(C). TIMING AND CONTROL UNIT:This unit consists of the following sections:Instruction Register and Decoder&Control signals.

IV. Instruction Register and decoder:

CPU fetches an instruction from the memory for its execution. Length of the instruction can be 1-3 byte. The first byte contains the opcode of instruction which specifies the nature of operation like MOV,ADD,SUB etc. to be performed . If opcode is transferred to 8 bit IR through internal bus of processor

,becomes available at instruction decoder. The decoder is used for decoding the opcode and directs the control unit to produce the necessary control signals.(1)

Control Signals: Following are the various control signals

X1, X2 : X1,X2 are two input pins. They are connected to the externally connected quartz crystal. This oscillator drives an internal circuitry of the microprocessor for producing a suitable clock for the operation of microprocessor (7) .6.144MHz quartz crystal is used in this processor. This gives 3.072 MHz(half of the crystal frequency) clock frequency with 50% duty cycle (1).

CLK: CLK is a output pin and its clock period is about 320nsec (7).Output of the clock frequency is also available at CLK out terminal.

Address latch Enable(ALE):ALE is an output pin, used to enable address bus. When ALE is high ,bus functions as address bus and ALE is low,bus functions as data bus (10).

IO/M: It is a status signal and clearly indicates whether the address is for memory or I/O. When IO/M=1, address on the address bus for an I/O device. IO/M=0, address on the address bus for memory location.(7)

So,S1:So and S1 give various types of operation according to the following conditions:

So	S1	Operations
0	0	HALT
0	1	WRITE
1	0	READ
1	1	FETCH

RD: It is a low pin used to read memory and I/O device.

WR: It is a write pin used to write information on memory or I/O device.(7)

V. Hold and HLDA (HOLD acknowledgement)

These two signals are used for DMA (Direct Memory Access).DMA is a technique in which data transfer can be done without the intervention of microprocessor. It is a fastest data transfer scheme. When HOLD signal is high, CPU temporarily give up the use of buses and DMA operation starts up. HLDA signal is high means CPU has received the hold request. After completing data transfer, control is given to CPU by sending a HOLD signal (1)

Ready: It is an input pin used to indicate whether the peripheral is ready or not .If peripheral is ready,READY pin is high. If READY pin is low, Microprocessor waits till it goes high. (7)

RESET IN And RESET OUT: RESET is a low pin. When this pin is low ,CPU will reset the program counter,instruction register and other circuits. RESET OUT is a high pin. Data processing may begin when RESET IN=high and RESET out=LOW.(1)

VCC and VSS:Vcc for power supply ie +5 v power supply and Vss for ground.

(D) Interrupt Control:Interrupt means it breaks the continuity of an event. Intel 8085 has five interrupt sources. They are TRAP,RST 7.5,RST 6.5,RST 5.5 and INTR. Among them RST 7.5,RST 6.5,RST 5.5 are restart interrupts(7). Again Interrupts are divided into Maskable and Non-Maskable, Vectored and Non-Vectored, Edge Triggered and Level Triggered & Priority Based Interrupts

RST 7.5,RST 6.5,RST 5.5 and INTR are the Maskable interrupts which can be *enabled* or *disabled*. Enabling and Disabling is done by software instructions.

TRAP is a non-maskable interrupt which is always in enabled mode. It can never be disabled by software instruction.

Vectored Interrupts

The addresses to which program control goes:

Name	Vectored address
RST 7.5	003C H(7.5*0008 H)
RST 6.5	0034 H(6.5*0008H)
RST 5.5	002C H(5.5*0008 H)
TRAP	0024 H(4.5*0008H)

Absolute address is calculated by multiplying the RST value with 0008 H.

Non-Vectored Interrupts: INTR is a non-vectored interrupt i.e it don't have fixed memory location for transfer of control from normal execution.

Edge Triggered Interrupts: RST 7.5 is an edge triggered interrupt as it is triggered during the leading (positive) edge.

Level Triggered Interrupts: The interrupts which are triggered at high or low level are called level triggered interrupts. RST 6.5 ,RST 5.5,INTR are called level triggered interrupts as they are triggered at high or low level. TRAP is edge and level triggered interrupt.

Priority Based Interrupts

- Whenever there exists a simultaneous request at two or more pins then the pin with higher priority is selected by the microprocessor.
 - Priority is considered when there are simultaneous requests at two or more pins of the microprocessor.
- Priority of interrupts are(10):

INTERRUPT	PRIORITY
TRAP	1(Highest priority)
RST 7.5	2
RST 6.5	3
RST5.5	4
INTR	5(Lowest priority)

INTA :INTA is interrupt acknowledge. It is active low output pin.When INTR is low ,Microprocessor has acknowledged the INTR request(10).

Serial I/O Control: Serial input/output control circuit is used for data transmission. SID and SOD are two pins of this circuit(1)

SOD (Serial Output Data):

SOD takes 1 bit from Accumulator to serial port of 8085.It takes bit from MSB (8th position) of the Accumulator and 7th bit of Accumulator is transferred with the help of SIM (Set Interrupt Mask)instruction(10).

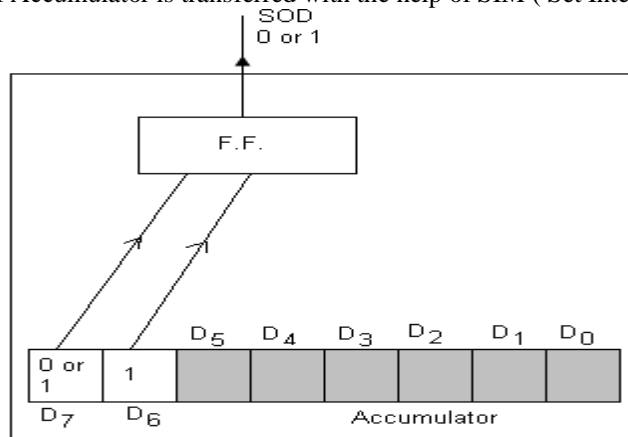


Fig 4: Function of Serial Output Data(1)

SID (Serial Input Data):

SID takes 1 bit input from serial port of 8085 to Accumulator.It stores the bit at MSB (8th position) of the Accumulator and bit 7 is transferred with the help of RIM (Read Interrupt Mask)instruction. (10)

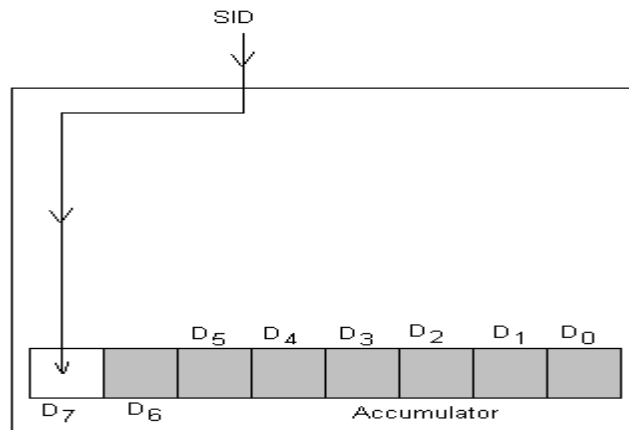


Fig 5: Function of SID (Serial Input Data) (1)

Data Bus and Address Bus: Intel 8085 has 8 bit data bus (D₀to D₇)and 16 bit address bus (A₀ to A₁₅).8 LSB of Address bus is multiplexed with 8 bit data bus to formAD₀ to AD₇.Their operation is such a way that at a particular moment they can be served as address bus and for another period of time they act as data bus.8 MSB of address bus (A₈ to A₁₅) is used for carrying addresses for memory and I/O device(7).

VI. Application:

Basically, Microprocessor is designed for small and dedicated applications. But gradually they are used in variety of applications from small household to large applications. They include day to day applicable equipments like gaming console, DVD players, television, tools of car, test instruments, light dimmers, smoke alarms, hi-fi audio visual components, credit card processing systems. It is used in communication systems like digital telephone sets, satellite communication system, radar system etc. It is also used in various medical devices like ECG (Electro cardiogram), EEG (Electro Encephalogram), Ultra sound machine, alcometer etc. Some applications require powerful low cost microprocessors and some having costly, complex one. Usually non programmable controls would require bulky, costly and complex implementation to obtain the results possible with microprocessor. One of the advantage of microprocessor is that it allows upgrading in performance with minimal redesign of the product and minimum production cost. Intel 8085 has a set of instructions like MOV, MVI, STA, ADD, DIV, JMP etc. Using these kind of instructions, microprocessor performs various operations like transfer of data, addition, subtraction, branching, storing etc. (6,8)

Microprocessor was used in personal computers like TRS-80 model 100 line used an OKI manufactured 80C85 (MSM80C85ARS). Several manufacturers are there for CMOS version of 80C85 of the NMOS/HMOS 8085 processor. Some manufacturers provide additional functionality by adding extra commands. During 1990s and 2000s, the Red-Hard version of 8085 has been in on-board instrument data processor for several NASA and ESA space physics missions and CRRES, POLAR, FAST, Cluster, HESSI, the Sojourner Mars Rover and THEMIS. During 1980s, swiss company SALA used 8085 and 8085-2 as the CPU for their PCA1 line of programmable logic controllers(8).

VII. Conclusion:

Microprocessor reduces cost of processing power, increases reliability focuses on real time applications and it is faster in speed also. It is used in smallest embedded system to largest main frames and super computers. Due to its wide varieties of uses it has revolutionized the human civilization.

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