A BRIEF STUDY OF MICROPROCESSOR 8085

Subodh Kumar Sharma

Department of Physics S. S. V. College Hapur, U.P.-245101

Email: subodhphysicsccs@gmail.com

Abstract;

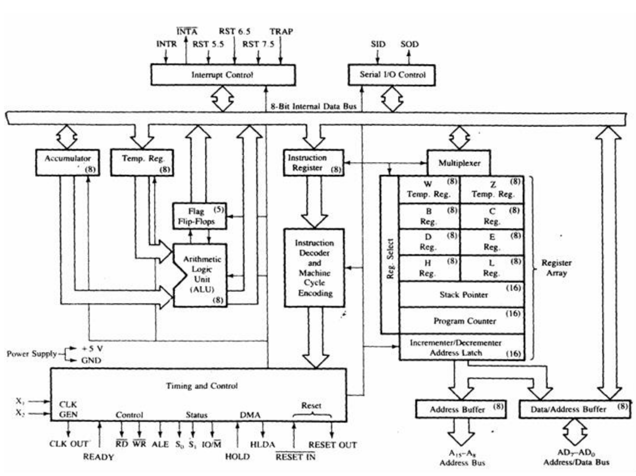
Microprocessor is an electronic chip that functions as the central processing unit of a computer. All processors are using the basic concept of stored program execution. Program or instructions are stored sequentially in the memory. Every microprocessor has its own associated set of instructions. Instruction set for microprocessor is in two forms one in mnemonic, which is comparatively easy to understand and the other is binary machine code.

I. Introduction

The Intel 8085 is an 8-bit microprocessor produced by Intel and introduced in 1976. It is software-binary compatible with the more-famous Intel 8080 with only two minor instructions added to support its added interrupt and serial input/output features. However, it requires less support circuitry, allowing simpler and less expensive microcomputer systems to be built. When we hear the word microprocessor then what comes to our mind is a small IC that can process data i.e.- perform arithmetic and logical operations. Microprocessor reads the instructions from memory and executes it line by line. As we know that all of this operation is performed generally all of this operation is done by the ALU unit in Microprocessor

A. Architecture Diagram of 8085 Microprocessor

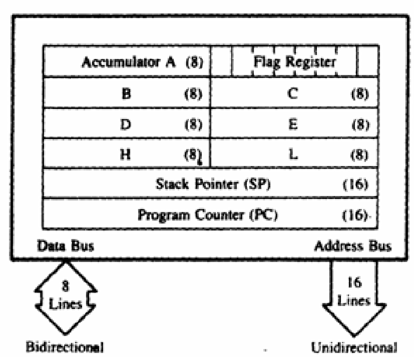
This is the functional block diagram of the 8085 Microprocessor.



1.Accumulator:-It is a 8-bit register which is used to perform arithmetical and logical operation. It stores the output of any operation. It also works as registers for i/o accesses.

2.Temporary Register:-It is a 8-bit register which is used to hold the data on which the acumulator is computing operation. It is also called as operand register because it provides operands to ALU.

3.Registers:-These are general purposes registers. Microprocessor consists 6 general purpose registers of 8-bit each named as B,C,D,E,H and L. Generally theses registers are not used for storing the data permanently. It carries the 8-bits data. These are used only during the execution of the instructions. These registers can also be used to carry the 16 bits data by making the pair of 2 registers. The valid register pairs available are BC,DE HL. We can not use other pairs except BC,DE and HL. These registers are programmed by user.



4.ALU:-ALU performs the arithmetic operations and logical operation. Flag Registers:-It consists of 5 flip flop which changes its status according to the result stored in an accumulator. It is also known as status registers. It is connected to the ALU.

The bit position of the flip flop in flag register is:

D_7	D_6	D_5	D_4	D_3	D_2	D_1	D_0
S	Z		AC		P		CY

All of the five flip flop set and reset according to the stored result in the accumulator.

i. **Sign**- If D7 of the result is 1 then sign flag is set otherwise reset. As we know that a number on the D7 always decides the sign of the number. If D7 is 1: the number is negative.

if D7 is 0: the number is positive.

ii. **Zeros(Z)-**If the result stored in an accumulator is zero then this flip flop is set otherwise it is reset.

iii. **Auxiliary carry(AC)-**If any carry goes from D3 to D4 in the output then it is set otherwise it is reset.

iv. **Parity(P)-**If the no of 1's is even in the output stored in the accumulator then it is set otherwise it is reset for the odd.

v. **Carry(C)-**If the result stored in an accumulator generates a carry in its final output then it is set otherwise it is reset.

5. **Instruction registers(IR)**:-It is a 8-bit register. When an instruction is fetched from memory then it is stored in this register.

6. **Instruction Decoder:**- Instruction decoder identifies the instructions. It takes the informations from instruction register and decodes the instruction to be performed.

7. **Program Counter:**-It is a 16 bit register used as memory pointer. It stores the memory address of the next instruction to be executed. So we can say that this register is used to sequencing the program. Generally the memory has 16 bit addresses so that it has 16 bit memory.

The program counter is set to 0000H.

8. **Stack Pointer:-**It is also a 16 bit register used as memory pointer. It points to the memory location called stack. Generally stack is a reserved portion of memory where information can be stores or taken back together.

9. **Timing and Control Unit:-**It provides timing and control signal to the microprocessor to perform the various operation. It has three control signals. It controls all external and internal circuits. It operates with reference to clock signal. It synchronizes all the data transfers.

There are three control signal:

i. **ALE-** Arithmetic Latch Enable, It provides control signal to synchronize the components of microprocessor.

ii. **RD-** This is active low used for reading operation.

iii. **WR-**This is active low used for writing operation.

There are three status signal used in microprocessor S0, S1 and IO/M. It changes its status according the provided input to these pins.

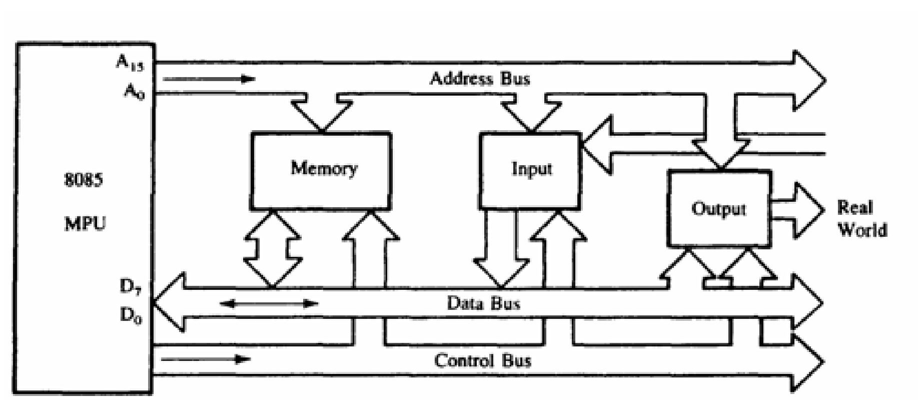
IO/M(Active Low)	S1	S2	Data Bus Status(Output)
0	0	0	Halt
0	0	1	Memory WRITE
0	1	0	Memory READ
1	0	1	IO WRITE
1	1	0	IO READ
0	1	1	Opcode fetch
1	1	1	Interrupt acknowledge

10. **Serial Input Output Control**-There are two pins in this unit. This unit is used for serial data communication.

i. **Interrupt Unit**-There are 6 interrupt pins in this unit. Generally an external hardware is connected to these pins. These pins provide interrupt signal sent by external hardware to microprocessor and microprocessor sends acknowledgement for receiving the interrupt signal. Generally INTA is used for acknowledgement.

ii. **Register Section**:-Many registers has been used in microprocessor. It consists of PIPO(Parallel Input Parallel Output) register.

B. Bus Structure Of 8085 Microprocessor



1.Address Bus:-Generally, Microprocessor has 16 bit address bus. The bus over which the CPU sends out the address of the memory location is known as Address bus. The address bus carries the address of memory location to be written or to be read from.

The address bus is unidirectional. It means bits flowing occur only in one direction, only from microprocessor to peripheral devices.

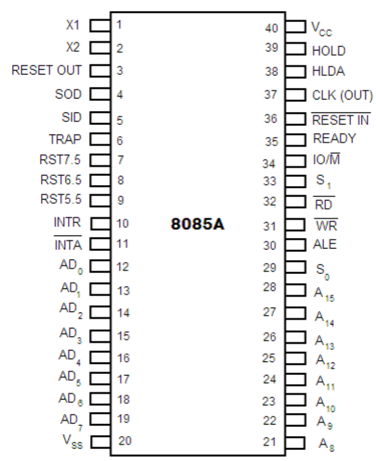
We can find that how much memory location it can use the formula 2^ N. where N is the number of bits used for address lines.

Here, 2^16 = 65536bytes or 64Kb

So we can say that it can access up to 64 kb memory location.

2.Data Bus:-8085 Microprocessor has 8 bit data bus. So it can be used to carry the 8 bit data starting from 00000000H(00H) to 11111111H(FFH). Here 'H' tells the Hexadecimal Number. It is bidirectional. These lines are used for data flowing in both direction means data can be transferred or can be received through these lines. The data bus also connects the I/O ports and CPU. The largest number that can appear on the data bus is 11111111. It has 8 parallel lines of data bus. So it can access up to 2^8 = 256 databus lines.
3.Control Bus:-The control bus is used for sending control signals to the memory and I/O devices. The CPU sends control signal on the controlbus to enable the outputs of addressed memory devices or I/O port devices.

C. Pin Diagram and Pin description of 8085



8085 is a 40 pin IC, The signals from the pins can be grouped as follows

1. **Power supply and Clock frequency signals** Vcc: + 5 volt power supply Vss: Ground X1, X2 : Crystal or R/C network or LC network connections to set the frequency of internal clock generator. The frequency is internally divided by two. Since the basic operating timing frequency is 3 MHz, a 6 MHz crystal is connected externally. CLK (output)-Clock Output is used as the system clock for peripheral and devices interfaced with the microprocessor.

2. **Address Bus:** A8 - A15: It carries the most significant 8 bits of the memory address or the 8 bits of the I/O address.
3. Data bus: AD0 - AD7 (input/output; 3-state) These multiplexed set of lines used to carry the lower order 8 bit address as well as data bus. During the opcode fetch operation, in the first clock cycle, the lines deliver the lower

order address A0 - A7.In the subsequent IO / memory, read / write clock cycle the lines are used as data bus. The CPU may read or write out data through these lines.

D. Control and Status signals:

ALE (output) - Address Latch Enable. It is an output signal used to give information of AD0-AD7 contents. It is a positive going pulse generated when a new operation is started by up. When pulse goes high it indicates that AD0-AD7 is address. When it is low it indicates that the contents are data.

RD (output 3-state, active low) Read memory or IO device. This indicates that the selected memory location or I/O device is to be read and that the data bus is ready for accepting data from the memory or I/O device

WR (output 3-state, active low) Write memory or IO device. This indicates that the data on the data bus is to be written into the selected memory location or I/Device.

IO/M (output) - Select memory or an IO device this status signal indicates that the read / write operation relates to whether the memory or I/O device. It goes high to indicate an I/O operation. It goes low for memory operations.

E. Status Signals:

S1: S2:
It is used to know the type of current operation of the microprocessor.

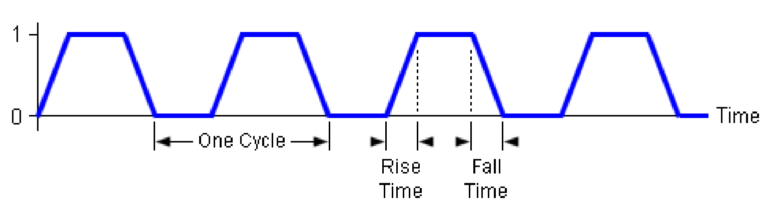
IO/M	**S1**	**S0**	**OPERATION**
0	1	1	Opcode fetch
0	1	0	Memory read
0	0	1	Memory write
1	1	0	I/O read
1	0	1	I/O write
1	1	0	Interrupt acknowledge
Z	0	1	Halt
Z	x	x	Hold
Z	x	x	Reset

F. **Interrupts and Externally initiated operations:** They are the signals initiated by an external device to request the microprocessor to do a particular task or work. There are five hardware interrupts called,TRAP,RST7.5,RST6.5,RST5,INTA .On receipt of an interrupt, the microprocessor acknowledges the interrupt by the active low INTA (Interrupt Acknowledge) signal. Reset In (input, active low) This signal is used to reset the microprocessor. The program counter inside the microprocessor is set to zero. The buses are tri-stated. Reset Out indicates CPU is being reset. Used to reset all the connected devices when the microprocessor is reset.

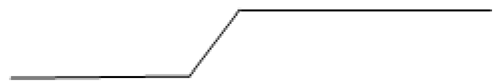
G. **Direct Memory Access (DMA): Tri state devices:** When two or more devices are connected to a common bus, to prevent the devices from interfering with each other, the tristate gates are used to disconnect all devices except the one that is communicating at a given instant. The CPU controls the data transfer operation between memory and I/O device. Direct Memory Access operation is used for large volume data transfer between memory and an I/O device directly. The CPU is disabled by tri-stating its buses and the transfer is effected directly by external control circuits. HOLD signal is generated by the DMA controller circuit. On receipt of this signal, the microprocessor acknowledges the request by sending out HLDA signal and leaves out the control of the buses. After the HLDA signal the DMA controller starts the direct transfer of data. READY Memory and I/O devices will have slower response compared to microprocessors. Before completing the present job such a slow peripheral may not be able to handle further data or control signal from CPU. The processor sets the READY signal after completing the present job to access the data. The microprocessor enters into WAIT state while the READY pin is disabled.

H. Representation of signals in Timing Diagram Of 8085

1. **Clock Signals:-**As we know that the microprocessor operates with reference to clock signals provided to it. At pins X1 and X2 we provide clock signals and this frequency is divided by two. This frequency is called as the operating frequency.



2. **Single Line Signal:-**The status of single line will be either LOW or HIGH. But the change from one state to another state is not possible in zero time.



3. **Multiple Line Signals:-**In Microprocessor we have multiple lines. These signals are also called as bus signals. If a single line changes occur then we have to show a crossing to indicate change in contents.

I. Instruction Set An instruction is a binary pattern designed inside a microprocessor to perform a specific function. Each instruction is represented by 8 bit binary value.

Types of instruction set:

1) Data transfer instructions:

Instructions, which are used to transfer data from one register to another register, from memory to register or register to memory, come under this group. Examples are: MOV, MVI, LXI, LDA, STA etc. When an instruction of data transfer group is executed, data is transferred from the source to the destination without altering the contents of the source. For example, when MOV A, B is executed the content of the register B is copied into the register A, and the content of register B remains unaltered. Similarly, when LDA 2500 is executed the content of the memory location 2500 is loaded into the accumulator. But the content of the memory location 2500 remains unaltered

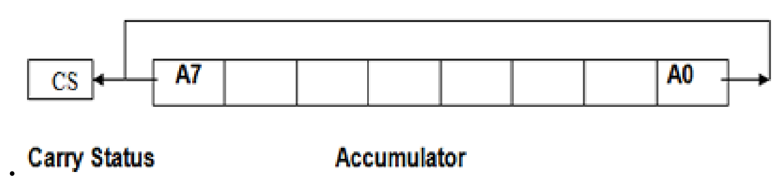
2) Arithmatic instructions:

The instructions of this group perform arithmetic operations such as addition, subtraction; increment or decrement of the content of a register or memory.

3) Logical instructions:

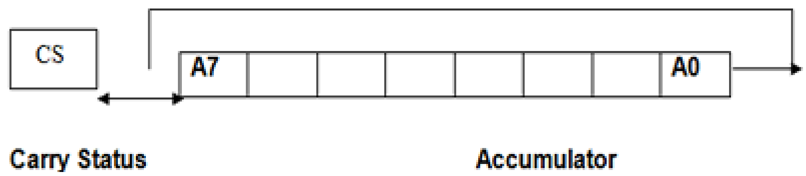
The Instructions under this group perform logical operation such as AND, OR, compare, rotate etc.

RLC (Rotate accumulator left) [An+1] <-- [An], [A0] <-- [A7],[CS] <-- [A7]



The content of the accumulator is rotated left by one bit. The seventh bit of the accumulator is moved to carry bit as well as to the zero bit of the accumulator. Only CS flag is affected.

RRC. (Rotate accumulator right) [A7] <-- [A0], [CS] <-- [A0], [An] <-- [An+1].



The content of the accumulator is rotated right by one bit. The zero bit of the accumulator is moved to the seventh bit as well as to carry bit. Only CS flag is affected.

RAL. (Rotate accumulator left through carry) [An+1] <-- [An], [CS] <-- [A7], [A0] <-- [CS].

RAR. (Rotate accumulator right through carry) [An] <-- [An+1], [CS] <-- [A0], [A7] <-- [CS].

4) Branching Instructions:

This group includes the instructions for conditional and unconditional jump, subroutine call and return, and restart.

5). Stack, I/O and Machine control instructions:

1. N port-address. (Input to accumulator from I/O port) [A] <-- [Port]
2. OUT port-address (Output from accumulator to I/O port) [Port] <-- [A]
3. PUSH rp (Push the content of register pair to stack)
4. PUSH PSW (PUSH Processor Status Word)
5. POP rp (Pop the content of register pair, which was saved, from the stack)
6. POP PSW (Pop Processor Status Word)
7. HLT (Halt)
8. XTHL (Exchange stack-top with H-L)
9. SPHL (Move the contents of H-L pair to stack pointer)
10. EI (Enable Interrupts)
11. DI (Disable Interrupts)
12. SIM (Set Interrupt Masks)
13. RIM (Read Interrupt Masks)
14. NOP (No Operation).

II. Programming model

The processor has seven 8-bit registers accessible to the programmer, named A, B, C, D, E, H, and L, where A is also known as the accumulator. The other six registers can be used as independent byte-registers or as three 16-bit register pairs, BC, DE, and HL, depending on the particular instruction. Some instructions use HL as a 16-bit accumulator. As in the 8080, the contents of the memory address pointed to by HL can be accessed as pseudo register M. It also has a 16-bit program counter and a 16-bit stack pointer to memory. Instructions such as PUSH PSW, POP PSW affect the Program Status Word. The accumulator stores the results of arithmetic and logical operations, and the flags register bits are set or cleared according to the results of these operations. The sign flag is set if the result has a negative sign. The auxiliary or half carry flag is set if a carry-over from bit 3 to bit 4 occurred. The parity flag is set according to the parity of the accumulator. The zero flag is set if the result of the operation was 0. Lastly, the carry flag is set if a carry-over from bit 7 of the accumulator occurred.

III. Applications

For the extensive use of 8085 in various applications, the microprocessor is provided with an instruction set consisting of various instructions such as MOV, ADD, SUB, JMP, etc. These instructions are written in the form of a program which is used to perform various operations such as branching, addition, subtraction, bitwise logical, and bit shift operations. More complex operations and other arithmetic operations must be implemented in software. For example, multiplication is implemented using a multiplication algorithm. The 8085 processor was used in a few early personal computers, for example, the TRS-80 Model 100 line used an OKI manufactured 80C85. The CMOS version 80C85 of the NMOS/HMOS 8085 processor has several manufacturers. In the Soviet Union, an 80C85 clone was developed under the designation IM18121VM85A which in 2016 was still in production. Some manufacturers provide variants with additional functions such as additional instructions. Thread version of the 8085 has been in on-board instrument data processors for several NASA and ESA space physics missions in the 1990s and early 2000s, including CRRES, Polar, FAST, Cluster, HESSI, the Sojourner Mars Rover, and THEMIS. The Swiss company SAIA used the 8085 and the 8085-2 as the CPUs of their PCA1 line of programmable logic controllers during the 1980s. Pro-Log Corp. put the 8085 and supporting hardware on an STD Bus format card containing CPU, RAM, sockets for ROM/EPROM, I/O and external bus interfaces. The included Instruction Set Reference Card uses entirely different mnemonics for the Intel 8085 CPU, as the product was a direct competitor to Intel's Multi bus card offerings.

References:

1. http://www.intel.com/pressroom/kits/quickrefyr.htm#1976
2. The history of the microcomputer-invention and evolution, S Mazor - Proceedings of the IEEE, 1995
3. "MCS-80/85 Family User's Manual", 1983
4. Dehnhardt, Wolfgang; M. Sorensen, Villy (January 1979). "Unspecified 8085 op codes enhance programming". Electronics. McGraw-Hill: 144–145. ISSN 0013-5070.
5. Microprocessor system M1821, Novosibirsk: AO NZPP. Retrieved 31 May 2016.
6. Mitra, Jubin. "8085 Simulator Manual".
7. Win85 project homepage
8. William Stallings Computer Organization and Architecture: Designing for Performance 8th Ed. Prentice Hall, 2009 ISBN 0-13-607373-5
9. Abhishek Yadav Microprocessor 8085, 8086 Firewall Media, 2008 ISBN 81-318-0356-2
10. Ramesh Gaonkar Microprocessor Architecture, Programming and Applications with the 8085 Penram International Publishing ISBN 81-87972-09-2
11. Bill Detwiler Tandy TRS-80 Model 100 Teardown Tech Republic, 2011 Web