DELD

Unit-6

Introduction to Computer Architecture

6.1 Introduction to Ideal Microprocessor – Data Bus, Address Bus, Control Bus.

- It is a controlling unit that is fabricated on a small chip.
- It is capable to perform arithmetic logic operations and communicate with various devices connected to it.
- It comprises of an ALU (Arithmetic Logic Unit), MU (Memory unit) and CU (Control unit).
- It also consists of register array with registers named as B, C, D, E, H, L and ACC.

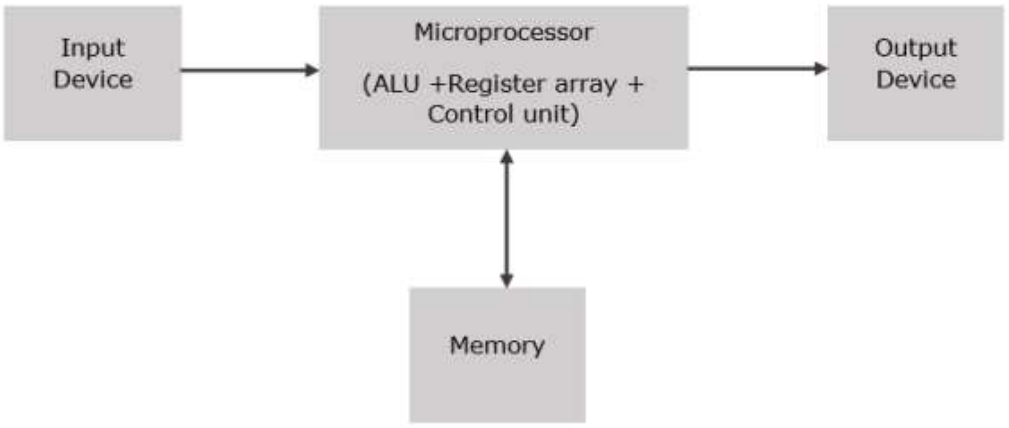


Fig.: Basic block diagram of microprocessor (ref 1)

Basic functions of microprocessor

- Accumulator

It is an 8-bit register used for performing all arithmetical and logical operations. It is also used to load and store data.

- Arithmetic and logic unit

It performs all arithmetical and logical operations like add, subtract, AND, OR etc.

- General purpose register

There are 6 General purpose registers and they are B, C, D, E, H and L. Each of them can hold 8 bit of data. They can also work in pair known as register pairs and they are H-L, B-C and D-E.

- Program counter (PC)

It is a 16 bit register. It is used to store data, memory information etc. whenever memory is incremented, the PC then points to the next location.

- Stack pointer (SP)

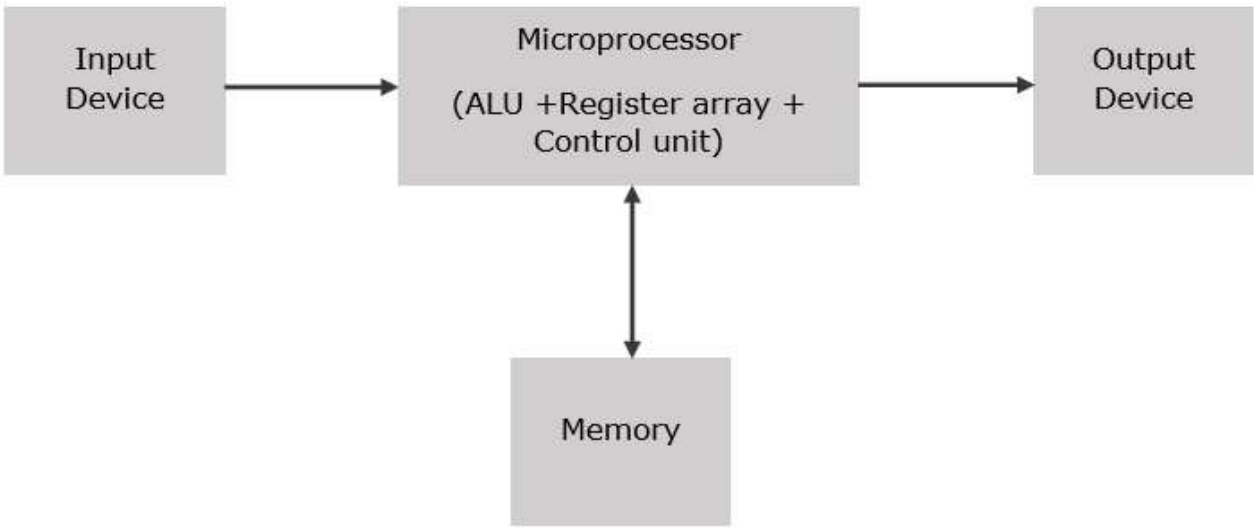
It is a 16 bit register. It always points to stack which can be incremented or decremented by PUSH and POP instruction.

- Temporary register

It is an 8 bit register which is used to store temporary information of the ALU.

- Flag register

It is an 8 bit register.



Here, Sign (S), Zero (Z), Auxiliary Carry (AC), Parity (P),Carry (C) bit.

- Instruction register and decoder

It is an 8-bit register. It stores an instruction that is fetched from memory. It decodes the information present inside it.

- Timing and control unit

It provides timing and control signal to the microprocessor to perform various operations. Following are the signals that controls the external and internal circuits are:

Control Signals: READY, RD', WR', ALE

Status Signals: S0, S1, IO/M'

DMA Signals: HOLD, HLDA

RESET Signals: RESET IN, RESET OUT D7

- Interrupt control

It controls the interrupts during a process. When a microprocessor is executing a main program and if 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 types of interrupts: INTR, RST 7.5, RST 6.5, RST 5.5 and TRAP.

- Serial input/output control

It controls the serial data communication in the microprocessor by using two instructions namely SID (Serial input data) and SOD (Serial output data).

- Address and data bus

Data bus carries the data required to be stored. It is bidirectional. Address bus carries the location to where the data should be stored and it is unidirectional. It is used to transfer the data & address.

System Bus

- The system bus comprises of two types of bus:

  - Address bus

    It is a 16-bit bus in which A15-A8, it carries the most significant 8-bits of memory/IO address and AD7-AD0 are multiplexed with data lines that carries the least significant bits of the address.

    As its length is 16 Bit, it ranges from 0000 H to FFFF H, where H denotes Hexadecimal. The microprocessor 8085 can transfer a maximum of 16 bit address which means it can address 65, 536 different memory location.

  - Data bus

    It is an 8-bit bus which is multiplexed with the address lines AD7-AD0. It carries data and also the least significant 8-bit address.

    Its length is 8 Bit which ranges from 00 H to FF H where H denotes Hexadecimal.

  - Control Bus

    It is used to send control signals to all the associated peripherals. It is used to process data. Some of the control signals are:

    Memory read

    Memory write

    I/O read

    I/O Write

    Opcode fetch

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

Fig.: System Bus (ref 1)

6.2 Microprocessor based Systems – Basic Operation, Microprocessor operation, Block Diagram of Microprocessor

Basic operations of microprocessor

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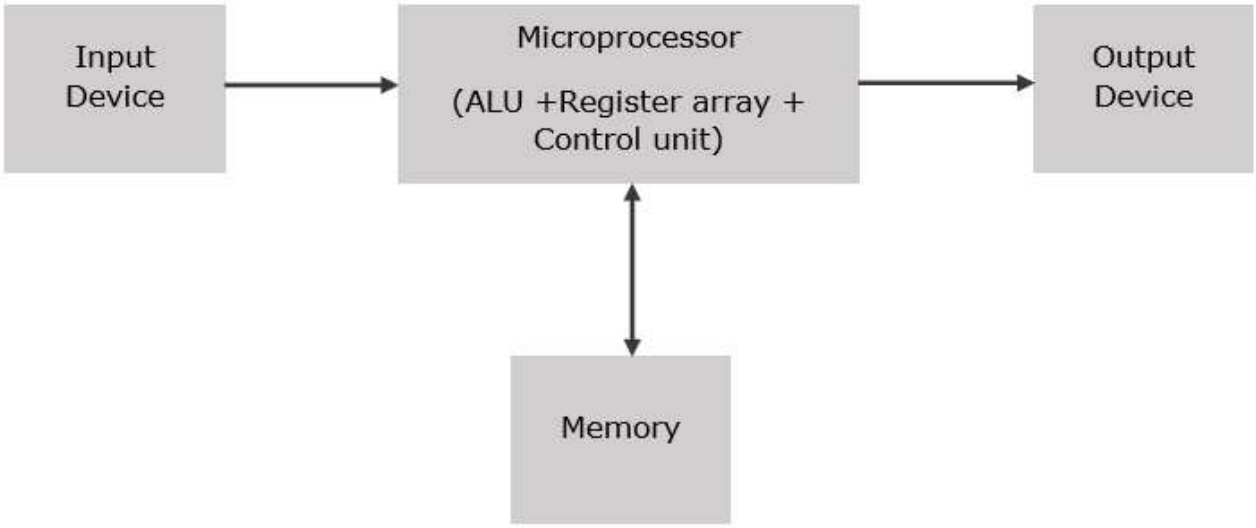

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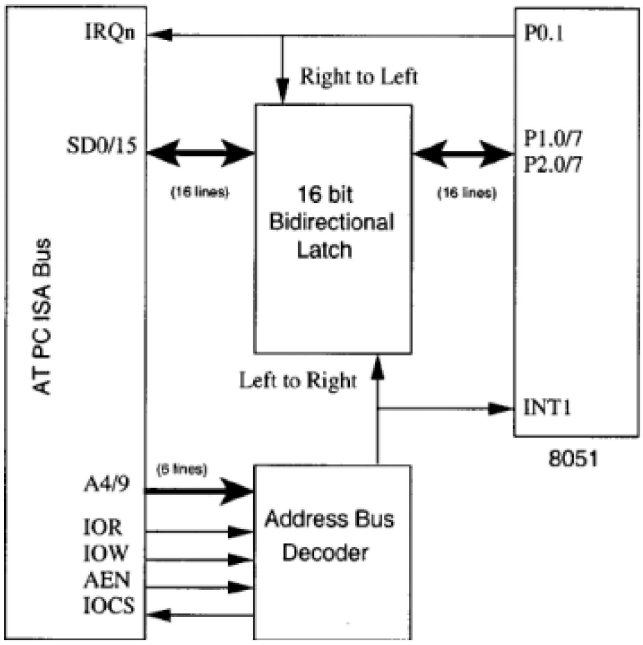


6.3 Functional Units of Microprocessor – ALU using IC 74181, 4-bit Multiplier circuit using ALU and shift registers.

ALU using IC 74181

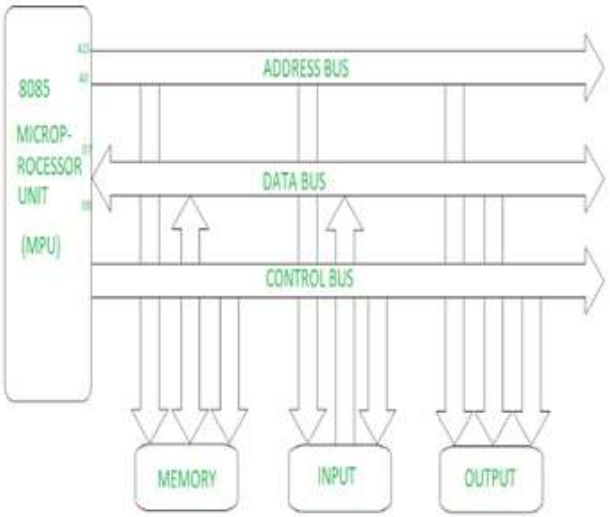
The SN54/74LS181 is a 4-bit Arithmetic Logic Unit (ALU) which can perform all the possible 16 logic, operations on two variables and a variety of arithmetic operations.

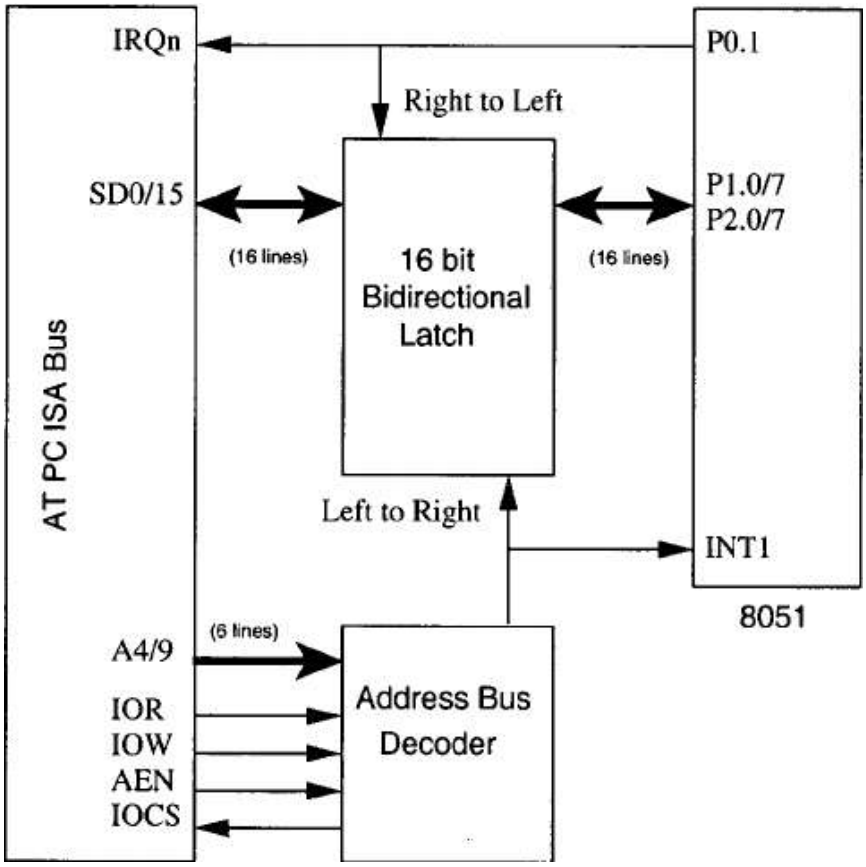
• Provides 16 Arithmetic Operations Add, Subtract, Compare, Double, Plus Twelve Other Arithmetic Operations

• Provides all 16 Logic Operations of Two Variables Exclusive — OR, Compare, AND, NAND, OR, NOR, Plus Ten other Logic Operations

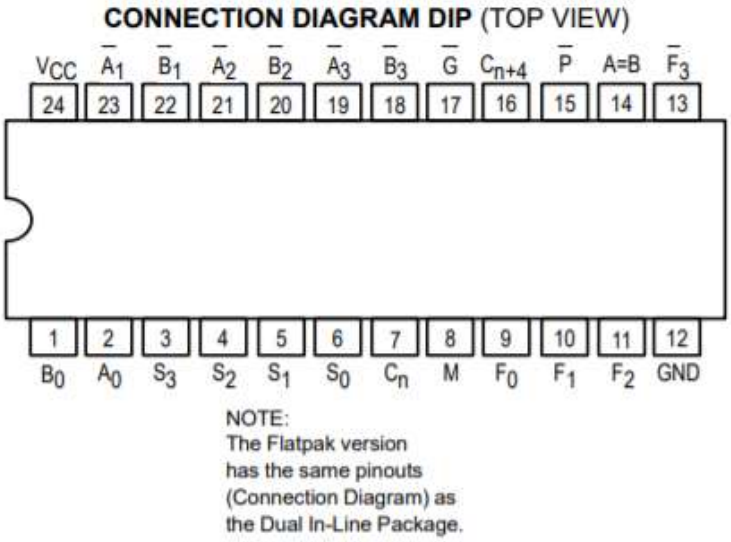
• Full Lookahead for High Speed Arithmetic Operation on Long Words

• Input Clamp Diodes





4-bit Multiplier circuit using ALU and shift registers

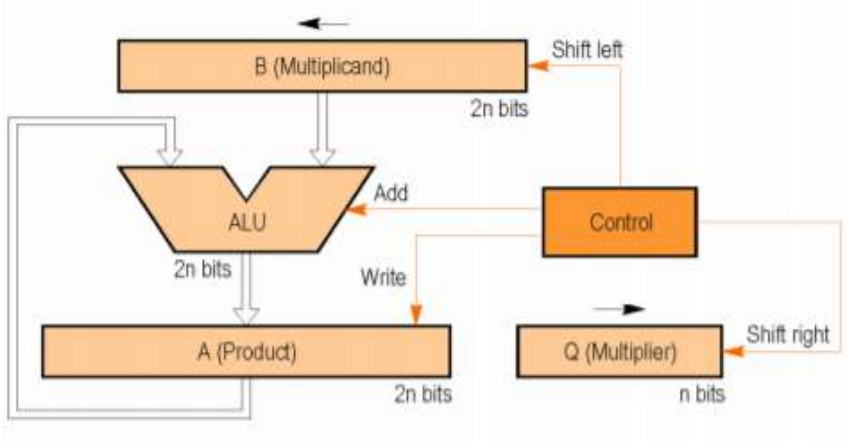


Shift-and-add multiplication is similar to the multiplication performed by paper and pencil. This method adds the multiplicand X to itself Y times, where Y denotes the multiplier. To multiply two numbers by paper and pencil, the algorithm is to take the digits of the multiplier one at a time from right to left, multiplying the multiplicand by a single digit of the multiplier and placing the intermediate product in the appropriate positions to the left of the earlier results. As an example, consider the multiplication of two unsigned 4-bit numbers, 8 (1000) and 9 (1001).

PIN NAMES		LOADING (Note a)	
		HIGH	LOW
$\overline{A}_0-\overline{A}_3, \overline{B}_0-\overline{B}_3$	Operand (Active LOW) Inputs	1.5 U.L.	0.75 U.L.
S_0-S_3	Function — Select Inputs	2.0 U.L.	1.0 U.L.
M	Mode Control Input	0.5 U.L.	0.25 U.L.
$\overline{C}_n$	Carry Input	2.5 U.L.	1.25 U.L.
$\overline{F}_0-\overline{F}_3$	Function (Active LOW) Outputs	10 U.L.	5 (2.5) U.L.
$\overline{A=B}$	Comparator Output	Open Collector	5 (2.5) U.L.
G	Carry Generator (Active LOW) Output	10 U.L.	10 U.L.
$\overline{P}$	Carry Propagate (Active LOW) Output	10 U.L.	5 U.L.
C_{n+4}	Carry Output	10 U.L.	5 (2.5) U.L.

In the case of binary multiplication, since the digits are 0 and 1, each step of the multiplication is simple. If the multiplier digit is 1, a copy of the multiplicand (1 × multiplicand) is placed in the proper positions; if the multiplier digit is 0, a number of 0 digits (0 × multiplicand) are placed in the proper positions.

6.4 Memory Organization and Operations



- There are two types of memory organization.
- They are **linear addressing** and **segmented addressing**.
- In linear addressing, the available memory space is present for the processor to be used in one linear array.
- In the segmented addressing, the memory space is divided into "**chunks**" known as segments and is termed as segmented memory.
- In 8086, the **available memory space is 1Mbytes**.
- This memory is further divided into number of logical segments.
- **Each segment is 64 K bytes in size** and is addressed by one of the segment registers.
- The 16-bit contents of the segment register give starting or the base address of a particular segment. An offset address is needed for addressing of a specific memory location within a segment. It is 16-bit wide and is provided by one of the index register.

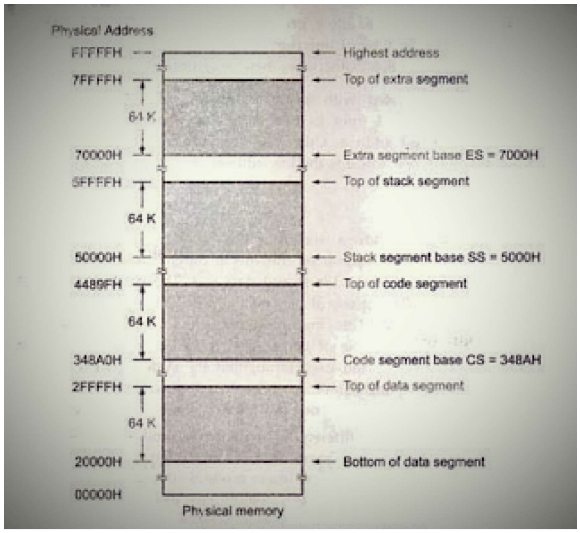


Fig.: Memory Segmentation

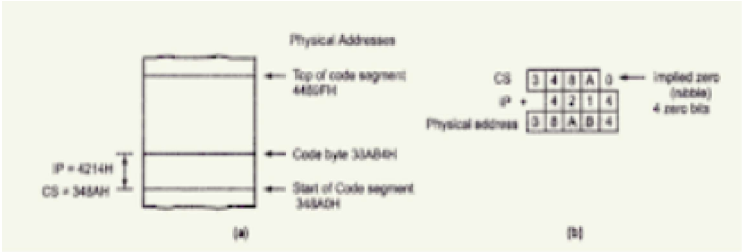


Fig.: 20-bit address generation

6.5 Digital circuit using decoder and registers for memory operations.

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Multiplicand          1000 ×
Multiplier            1001
                      1000
                     0000
                    0000
                   1000
Product           1001000
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Reference Books:

1. John Yarbrough, —Digital Logic Applications and Design, Cengage Learning, ISBN – 13: 978-81-315-0058-3

2. D. Leach, Malvino, Saha, —Digital Principles and Applications‖, Tata McGraw Hill, ISBN – 13:978-0-07-014170-4.

3. Anil Maini, —Digital Electronics: Principles and Integrated Circuits‖, Wiley India Ltd, ISBN:978-81-265-1466-3.

4. Norman B & Bradley, —Digital Logic Design Principles, Wiley India Ltd, ISBN:978-81-265-1258