Javed Sir Lecture (Online); Course: Microprocessor; CSTE-3109; Session: 2017-18; Date: 10/04/2020

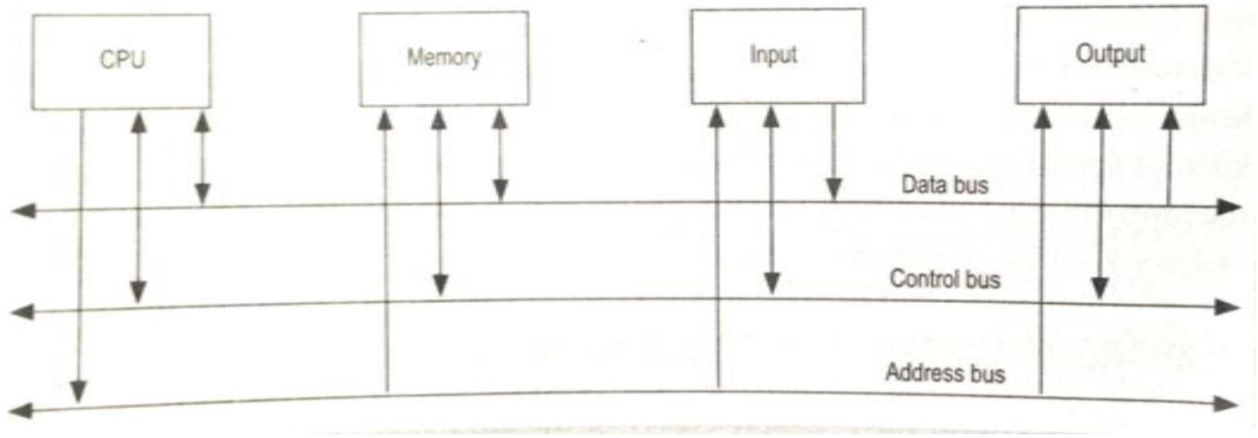

Fig.1 Microprocessor-based system

- **Bit**: A bit is a single binary digit.
- **Word**: A word refers to the basic data size or bit size that can be processed by the arithmetic and logic unit of the processor. A 16-bit binary number is called a word in a 16-bit processor.
- **Bus**: A bus is a group of wires/lines that carry similar information.
- **System Bus**: The system bus is a group of wires/lines used for communication between the microprocessor and peripherals.
- **Memory Word**: The number of bits that can be stored in a register or memory element is called a memory word.
- **Address Bus**: It carries the address, which is a unique binary pattern used to identify a memory location or an I/O port. For example, an eight-bit address bus has eight lines and thus it can address $2^8 = 256$ different locations. The locations in hexadecimal format can be written as 00H – FFH.
- **Data Bus**: The data bus is used to transfer data between memory and processor or between I/O device and processor. For example, an 8-bit processor will generally have an 8-bit data bus and a 16-bit processor will have 16-bit data bus.
- **Control Bus**: The control bus carry control signals, which consists of signals for selection of memory or I/O device from the given address, direction of data transfer and synchronization of data transfer in case of slow devices.

Functions of Control Unit of 8085:
Generates signals on data bus, address bus and control bus within microprocessor to carry out the instruction, which has been decoded. Typical buses and their timing are described as follows:

• *Data Bus*: Data bus carries data in binary form between microprocessor and other external units such as memory. It is used to transmit data i.e. information, results of arithmetic etc. between memory and the microprocessor. Data bus is bidirectional in nature. The data bus width of 8085 microprocessor is 8-bit i.e. 2^8 combination of binary digits and are typically identified as D0 – D7. Thus, size of the data bus determines what arithmetic can be done. If only 8-bit wide then largest number is 11111111 (255 in decimal). Therefore, larger numbers have to be broken down into chunks of 255. This slows microprocessor.

• *Address Bus*: The address bus carries addresses and is one-way bus from microprocessor to the memory or other devices. 8085 microprocessors contain 16-bit address bus and are generally identified as A0 - A15. The higher order address lines (A8 – A15) are unidirectional and the lower order lines (A0 – A7) are multiplexed (time-shared) with the eight data bits (D0 – D7) and hence, they are bidirectional.

• *Control Bus*: Control bus are various lines which have specific functions for coordinating and controlling microprocessor operations. The control bus carries control signals partly unidirectional and partly bidirectional. The following control and status signals are used by 8085 processor:

I. ALE (output): Address Latch Enable is a pulse that is provided when an address appears on the AD0 – AD7 lines, after which it becomes 0.

II. $\overline{RD}$ (active low output): The Read signal indicates that data are being read from the selected I/O or memory device and that they are available on the data bus.

III. $\overline{WR}$ (active low output): The Write signal indicates that data on the data bus are to be written into a selected memory or I/O location.

IV. $IO/\overline{M}$ (output): It is a signal that distinguished between a memory operation and an I/O operation. When $IO/\overline{M}$= 0 it is a memory operation and $IO/\overline{M}$ =1 it is an I/O operation.

V. S1 and S0 (output): These are status signals used to specify the type of operation being performed; they are listed in Table 1.

Table 1 Status signals and associated operations.

S1	S0	States
0	0	Halt
0	1	Write
1	0	Read
1	1	Fetch

Home Work (HW): Design the Functions of Control Unit of 8086, where Address buses=20 and Data buses=16.

Microprocessor Instruction- MOV

Assembly Language	*Size*	*Operation*
MOV BL,44	8-bits	Copies a 44 decimal (2CH) into BL
MOV AX,44H	16-bits	Copies a 0044H into AX
MOV SI,0	16-bits	Copies a 0000H into SI
MOV CH,100	8-bits	Copies a 100 decimal (64H) into CH
MOV AL,'A'	8-bits	Copies an ASCII A into AL
MOV AX,'AB'	16-bits	Copies an ASCII BA* into AX
MOV CL,11001110B	8-bits	Copies a 11001110 binary into CL
MOV EBX,12340000H	32-bits	Copies a 12340000H into EBX
MOV ESI,12	32-bits	Copies a 12 decimal into ESI
MOV EAX,100Y	32-bits	Copies a 100 binary into EAX

**Note:* This is not an error. The ASCII characters are stored as a BA, so care should be exercised when using a word-sized pair of ASCII characters.

Microprocessor Instruction- IN and OUT

Assembly Language	*Operation*
IN AL,p8	8-bits are input to AL from I/O port p8
IN AX,p8	16-bits are input to AX from I/O port p8
IN EAX,p8	32-bits are input to EAX from I/O port p8
IN AL,DX	8-bits are input to AL from I/O port DX
IN AX,DX	16-bits are input to AX from I/O port DX
IN EAX,DX	32-bits are input to EAX from I/O port DX
OUT p8,AL	8-bits are output from AL to I/O port p8
OUT p8,AX	16-bits are output from AX to I/O port p8
OUTp8,EAX	32-bits are output from EAX to I/O port p8
OUT DX,AL	8-bits are output from AL to I/O port DX
OUT DX,AX	16-bits are output from AX to I/O port DX
OUT DX,EAX	32-bits are output from EAX to I/O port DX

Note: p8 = an 8-bit I/O port number and DX = the 16-bit port address held in DX.

Addressing Mode (AM): Addressing mode is a technique by which CPU can select a particular address of memory location for READ or WRITE operation. By calculating Physical Address (PA), we can find out the particular address of memory location. AM refers to the way in which the operand of an instruction is specified. AM for 8086 instructions is divided into two categories:

1. Register Addressing modes
2. Memory Addressing modes

Register Address modes:

For Register Address modes, there are no PA calculations needed. Register Address modes are two types:

i. Register mode: In Register mode the operand of an instruction is placed in one of 8-bit or 16-bit general purpose registers. The data is in the register that is specified by the instruction.

Example: **MOV AX,CX** ; Move the contents (16-bit data) of CX register to AX register.
; is used for comments in Assembly Language instructions.

ii. Immediate addressing mode: In this mode, the 8-bit or 16-bit data is directly stored into the source operand of an instruction.

Example: **MOV Al,35H** ; Move the data 35H into Al register.
MOV AX,2A3BH ; Move the data 2A3BH into AX register.

Memory Addressing modes:

In this addressing mode, one operand (source or destination) of an instruction must be an address of a memory location, which will be calculated by PA.

PA calculation:

PA= [Segment]x10H + Offset
Where Segment= contents of CS/DS/SS/ES register.
Offset=Effective Address (EA)=Contents of 8-bit/16-bit values/IP/SP/BP/BX/SI/DI
Offset=Effective Address (EA)=
Contents of 8-bit/16-bit values (Displacement/variable) + contents of BX + contents of SI or DI.

Example: Offset/EA= [ARRAY] + [BX] + [SI] = 2AH + 5000H + 2000H = 702AH

There are five types of memory addressing modes:

i. Direct or Displacement mode: In this mode, the EA is directly given in the instruction.

Example: MOV AX,[DISP] ; Suppose, EA= DISP=002AH is moved into AX.
MOV AX,[0500] ; EA=0500H is moved into AX.

ii. Register Indirect mode: I this mode, the EA is in SI, DI or BX, which is calculated by PA.
PA= [DS]x10H+EA
Suppose, [DS]= 2000H and EA=[SI]=1200H
So, PA=21200H

Example: MOV AL,[SI]
; Calculated PA=21200H is the address of memory location, now the contents of memory location address (if [21200H]=02H) will be moved into AL. So, this a READ operation.

Solve the following Home Works (HW):

1. Write the name of addressing modes with comments of the following instructions:
   i). MOV AL,BL; ii). MOV DX,CX; iii). MOV AL,5AH; iv). MOV BX,25A9H; v). MOV DX,[ARRAY] and vi). MOV CL,[C8H]
2. Calculate the Physical Addresses with comments of the following instructions:
   i). MOV AL,[BX]; ii). MOV [DI],BL; where [DS]=5000H, [BX]=2A39H and [DI]=003BH