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Summarization of 8085 Microprocessor

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***Abstract* - Microprocessor is a small IC that can process data that is perform arithmetical and logical operation. It's a multipurpose, clock driven, register based, programmable electronic device which accepts digital or binary data as input, process it according to instruction stored in its memory and provides a result as output. Here is a brief overview of 8085 microprocessor architecture, its pin functions and its various applications.**

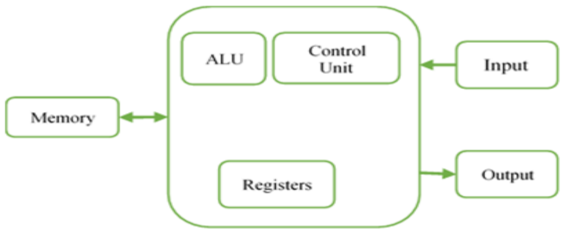
HISTORY OF MICROPROCESSOR

1st Generation of Microprocessor: In 1971, the first microprocessor Intel 4004 was invented that would run at a clock speed of 108 KHz. With only 4 bits as the word size, the 4004 could only represent signed numbers in the range -8 to +7, which is indeed very small. So, it was not really of practical use for arithmetic calculations. Used in controlling devices.
2nd Generation of Microprocessor: In 1972, the first 8-bit microprocessor Intel 8008 was evoluted. This was soon followed by Intel 8080, also an 8-bit microprocessor. Intel 8080 was the first commercially popular 8bit microprocessor. With 8 bits as the word size, it could represent signed numbers in the range of −128 to +127. This is also not a good enough range for performing arithmetic calculations. Thus, the 8080 also was used only for control applications. The 1976 Intel 8085 was introduced and is an 8-bit microprocessor. It is a 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. Some other microprocessors like 6800 from Motorola, Z-80 from Zilog were also Popular at this time.
3rd Generation of Microprocessor: Around 1978, Intel released 8086, the first 16-bit microprocessor. With 16-bit word size, it was possible to represent signed numbers in the range of −32,768 to +32,767, which is quite a decent range for performing arithmetic calculations. As such, this processor became very popular not only for control applications, but also for number crunching operations. Speeds of those processors were four times better than the 2nd generation processors.
4th Generation of Microprocessor: In the early 80s, Intel released the 32-bit processor, the Intel 80386. With 32-bit word size, it was possible to represent signed numbers in the range ±2×109, which is quite a large range for performing arithmetic calculations as such, this processor became very popular as the CPU in computers for number crunching operations.
5th Generation of Microprocessor: From 1995 to until now this generation has been bringing out high-performance and high-speed processors that make use of 64-bit processors like Pentium, AMD (Advance Micro Device) etc.
A microprocessor is also known as a central processing unit in which numbers of peripherals are fabricated on a single silicon chip. It has ALU (arithmetic and logic unit), a control unit, registers, bus systems and a clock to perform computational tasks. It reads the instruction from the memory and executes it line by line.

MICROPROCESSOR

It's a multipurpose, clock driven, register based, programmable electronic device which accepts digital or binary data as input, process it according to instruction stored in its memory and provides a result as output. Microprocessor as a programmable device, it means it can be instructed to perform given tasks within its capability.
It has three steps: Fetch, Decode and Execute. Fetch: An instruction is copied from the memory into the microprocessor, Decode: What operation the instruction is meant to do, Execute: Operation is performed. Application of Microprocessor are Mobile phones, digital watches, washing machine, computer, laptop, TV, multimeter, microwave oven, military weapons, etc.

COMPONENTS OF MICROPROCESSOR



ALU: Performs arithmetic and logical operations such as ADD, SUB, AND, OR etc.
Registers: It's a prominent part of the block diagram and the programming model of any microprocessor. The basic registers are Accumulator, PC, SP, general purpose register, memory address register, temporary data register. They are the small additional memory location which are used to store and transfer data. Used for temporary storage of instruction and data/address.

Accumulator: Major working register of microprocessor. Used to hold data for manipulation. Result of arithmetic and logical operations is stored in the accumulator. After execution of instruction original content of accumulator are lost because they are over written. It is used for data transfer between an I/O port and a memory location.

Temporary Register: To store 8-bit data. Identified as W and Z. These registers are not available to the user. They are internally used by the microprocessor.

General Purpose Registers: Used as simple storage area, they are mainly used to store immediate result of operation. They are identified as B, C, D, E, H and L are 8-bit general purpose registers or as 16-bit register pairs like B-C, D-E, and H-L to store and perform 16-bit operations. HL pair also functions as a data pointer or memory pointer.

Special Purpose Registers: Accumulator, Flag register, Program Counter (PC), Stack Pointer (SP) and Instruction Register.

Program Counter (PC): It points to the memory address from which next instruction(byte) is to be fetched. If PC is of 16 bit, it can address upto 64K (216) of memory. Before the execution of program, PC has to be loaded with valid memory address.

Stack Pointer (SP): It points to the next available location in the memory, called as stack.

Instruction Register: In the processor operation, the processor first fetches the opcode of instruction from memory (i.e place address on address bus and data on data bus). It then stores this opcode in a register called the instruction register.

Status/Flag Register: The ALU includes five flip-flops, which are set or reset after an operation according to data conditions of result in the accumulator. They are called as Zero (Z), Carry (CY), Sign (S), Parity (P), and Auxiliary Carry (AC) flags.

Z-Zero: The zero flag is set if the result is zero, otherwise it is reset.

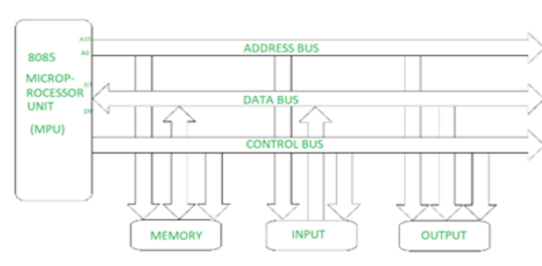
CY-Carry: If an arithmetic operation results in a carry, the carry flag is set otherwise it is reset.
S-Sign: The sign flag is set if bit D7 of the result is one, otherwise it is reset.

AC- Auxiliary Carry: In a BCD arithmetic operation, when a carry results from digit D3 and passes on to digit D4, the AC flag is set.

P-Parity: If the result has an even number of 1's, the parity flag is set. For odd number of 1's, the flag is reset.

Control Unit: Provides timing and control signals to all the operations. It controls and executes the flow of data between the microprocessor, memory and peripherals. It informs the ALU unit what operations are to be performed. It maintains the synchronization in operation of different parts of microprocessor.

MICROPROCESSOR SYSTEMS WITH BUS ORGANIZATION



Bus organization system of 8085 Microprocessor

The system bus is a communication path between the microprocessor and peripherals. Mainly MPU performs four operations: Memory Read: Reads data or instruction from memory. Memory write: Writes data or instruction into the memory. I/O Read: Accepts data from input device. I/O Write: Send data to the output device. All these operations are part of communication process between the MPU and peripheral devices (including memory).

To communicate with a peripheral, MPU needs to perform following steps: 1) Identify the peripherals or the memory location (with its address) 2) Transfer its binary information (Data or instruction) 3) Provide timing and control signals.

Address Bus: It is unidirectional bus (flows the bits in one direction from MPU to peripherals). MPU uses the address bus to perform the first function of identifying a peripheral or memory location. Each peripheral or memory location is identified by a binary number called an address and the address bus is used to carry a 16-bit address. Suppose 8085 MPU with 16 address line, that is it is capable of addressing, 216 = 65536 (64K) memory location.

Data bus: It is a group of 8, 16, 32 or more parallel signal lines used for data flow. These lines are bidirectional. Flows the data in both directions between MPU and memory and peripheral devices. It is used for transferring the bits or information. MPU can read data on this lines from memory as well as send data out of this lines to a memory location.

Control bus: It comprises of various single lines that carries synchronize signals. The MPU use such line for providing timing signals. MPU generates specific control signal for operation like MEMR, MEMW, I/O Read, I/O Write.

I/O WITH 8-BIT ADDRESSES (PERIPHERAL-MAPPED I/O OR I/O MAPPED I/O)

MPU uses 8 address lines to identify an input or an output device. This is known as peripheral-mapped I/O. Instruction used is IN and OUT with 8-bit address. 8-bit address line has 256 (28 combination) addresses. Thus MPU identifies 256 input device and 256 output devices with address ranging from 00H to FFH. Input device and output device are classified by the control signals. MPU uses I/O read control signal for input device and I/O write control signal for output device. Entire range of I/O addresses from 00H to FFH is known as I/O map and individual address are referred to as I/O device address or I/O port number.

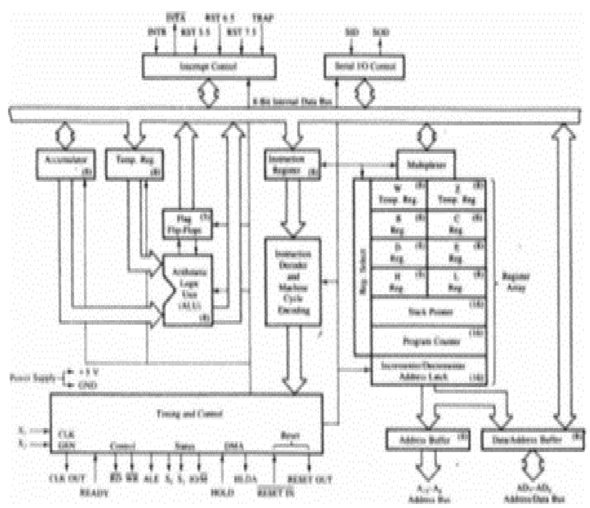
Steps for communicating with I/O devices:

1) MPU places an 8-bit address on the address bus, which is decoded by external decode logic.
2) MPU sends a control signals (I/O read or I/O write) and enables the I/O device.
3) Data are transferred using the data bus.

I/O WITH 16-BIT ADDRESSES (MEMORY-MAPPED I/O)

MPU uses 16 bit address lines to identify an input or an output device. I/O is connected as if it is a memory register. This is known as memory mapped I/O. 16-bit address line has 64 KB memory space (216 combination) addresses ranges from 0000 H to FFFF H. MPU uses memory control signal, memory read (MEMR) and memory write (MEMW). Instruction used for this is LDA, STA, etc.

8085 MICROPROCESSOR ARCHITECTURE



Divides into following groups:

Register group: Used for temporary storage of instruction and data/address.

Temporary Register: To store 8-bit data. Identified as W and Z. These registers are not available to the user. They are internally used by the microprocessor.

General Purpose Registers: To store 8-bit data. They are identified as B, C, D, E, H and L. They can be combined as register pairs: B-C, D-E, and H-L to store and perform 16-bit operations.

Special Purpose Registers: Accumulator, Flag register, Program Counter (PC), Stack Pointer (SP) and Instruction Register.

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

Program Counter (PC): This is a 16-bit register, which always points to the address of next instruction to be fetched.

Stack Pointer (SP): This is a 16-bit register that points to the next available location in the memory, called as stack.

Status/Flag Register: The ALU includes five flip-flops, which are set or reset after an operation according to data conditions of result in the accumulator. They are called as Zero (Z), Carry (CY), Sign (S), Parity (P), and Auxiliary Carry (AC) flags.

Z-Zero: The zero flag is set if the result is zero, otherwise it is reset. CY-Carry: If an arithmetic operation results in a carry, the carry flag is set otherwise it is reset. S-Sign: The sign flag is set if bit D7 of the result is one, otherwise it is reset. AC-Auxiliary Carry: In a BCD arithmetic operation, when a carry results from digit D3 and passes on to digit D4, the AC flag is set. P-Parity: If the result has an even number of 1's, the parity flag is set. For odd number of 1's, the flag is reset.

Instruction Register: Used to store the opcode of the instruction that is decoded and executed.

Arithmetic and logical section: This section includes the accumulator, the temporary register, the arithmetic logic circuits, and five flip-flops. The arithmetic logic unit(ALU) of 8085 performs addition, subtraction, increment, decrement and comparison arithmetic operation and logical operations such as AND, OR, exclusive-OR, complement. The temporary register is used to hold data during arithmetic logic operation. The result is stored in accumulator, and flags are set or reset according to result of operation. Register, ALU and five flag flip-flops.

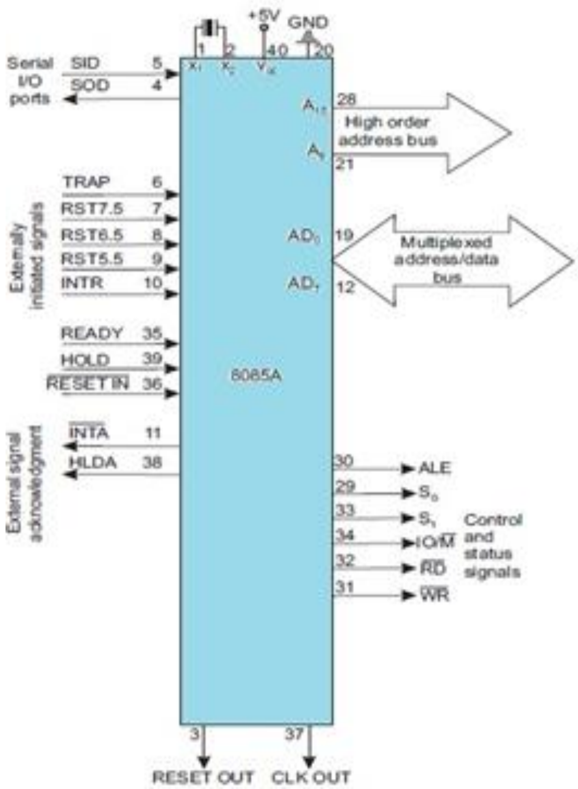
Instruction register, decoder and control group: The Instruction register is an 8-bit register that is part of the ALU. When an instruction is fetched from memory, the opcode of the instruction is loaded in the instruction register. Instruction Decoder accepts the opcode of instruction from Instruction register, decodes it and gives the information to control logic. The information includes what operation is to be performed, who is going to perform it, how many operation bytes the instruction contains etc. Based on the decoded information, timing and control unit provides control signals.

Address and Address/Data Buffers: Address Buffer is an 8-bit unidirectional buffer used for address lines. It is used to drive the higher order address bus(A8-A15). Address/Data Buffer is an 8-bit bidirectional buffer used for address and data. It is used to drive the lower order address and data bus(AD0-AD7). The Increment/Decrement Address Latch is used to increment or decrement address i.e. the contents of PC, HL, BC, DE and SP register.

Timing and control unit: The timing and control unit synchronizes all microprocessor operations with clock and generates control and status signals (RD, WR) for communication between microprocessor and peripherals. It controls all internal and external circuits in the microprocessor system. The microprocessor uses a quartz crystal (LC/RC circuit) to determine the clock frequency.

Interrupt control group: It's a mechanism by which an I/O device (Hardware interrupt) or an instruction (software interrupt) can suspend the normal execution of the processor and get it self-serviced is termed as interrupt. 8085 accepts different interrupt request inputs such as TRAP, RST 7.5, RST 6.5, RST 5.5 and INTR. INTA is used for Interrupt Acknowledgement.
Serial I/O control group: Used to transfer the data serially from microprocessor to I/O device and I/O device to Microprocessor. The serial output data (SOD) line is used to send data serially and serial input data (SID) line is used to receive the data serially. The data on these lines is accepted or transferred under software control by serial I/O control block.

8085 PIN FUNCTION



Power Supply & clock frequency:
i) Vcc: +5V power supply, ii) Vss: Ground Reference, iii) X1, X2: A Crystal or R-C or L-C network is connected to these two pins. The crystal frequency is internally divided by two to give the operating system frequency. So, to run the microprocessor at 3 MHz, a clock running at 6 MHz should be connected to the X1and X2 pins. fup = fcrystal/2 where, fup is microprocessor frequency and fcrystal is crystal frequency. iv) CLK OUT: This output clock pin is used to provide the clock signal for other devices. Its frequency is half the oscillator frequency.

Address Bus and Data bus:
i) Multiplexed Address/Data bus [AD7-AD0]: 8-bit data bus is multiplexed with lower half of 16-bit address bus. Bidirectional: They serve a dual purpose(Input/Output) used as lower order address as well as the data bus. In executing an instruction, during the 1st part of machine cycle: Used as lower order address bus. It can be a 8-bit memory address or I/O address. During remaining part of machine cycle, these lines are used as bidirectional data bus.
ii) Address bus (A8 to A15) Unidirectional, used for most significant 8 bits called the higher-order address bits.

Control and Status Signals: Two control signals (RD and WR). Three status signals (IO/M, S1 and S0) to identify nature of operation. One special signal(ALE) to indicate the beginning of operation.

ALE (Address Latch Enable): It occurs every time during the first clock cycle of the 8085 machine cycle operation. It is used to latch the low order address from multiplexed bus and generate a separate address (A7-A0). RD-Read (Active low control signal): It indicates that data must be read from selected memory location or I/O port via data bus. WR-Write (Active low control signal): It indicates that data on the data bus are to be written into a selected memory location or I/O port. IO/M: This is a status signal used to differentiate between I/O and memory operation. When it is high, it indicates an I/O operation. When it is low, it indicates a memory operation. SO, S1 (Output): These are status signals and identify various operations (Machine cycle like opcode fetch, MEMR, MEMW, IOR, IOW, Interrupt Acknowledgement)

Serial I/O Ports: i) SID: It is used to accept serial data bit by bit from the external device. ii) SOD: It is used to send serial data bit by bit to the external device.

Reset Signals: i) RESET IN (Input): When this goes low, the Program Counter is set to zero (0000H), the buses are tri-stated and microprocessor is reset. ii)

RESET OUT (Output): This indicates that 8085 is being reset. This can be used to reset other devices.

External Signals: i) HOLD (Input): It is an active high signal used in the direct transfer of data between a peripheral device and memory locations. This type of data transfer is called as direct memory access (DMA). It indicates that another master is requesting for use of address bus, data bus and control bus. ii) HLDA (Output): Hold Acknowledge This is an active high signal and acknowledges HOLD request.

Interrupts & Externally Initiated Signals:
i) INTR (Input): Interrupt Request. The INTR is used as a general purpose interrupt.
ii) INTA (Output): Interrupt Acknowledge This is an active low signal and is used to acknowledge an interrupt.

iii) RST 7.5, RST 6.5, and RST 5.5: Restart Interrupts (input): These three are hardware vectored interrupt signals. It transfers the program control to specific memory location.

iv) TRAP (Input): This is a non-maskable interrupt and has highest priority.

v) READY: It is used to sense whether a peripheral is ready or not for data transfer. If not the processor waits. It is used to synchronize slower peripherals to the microprocessor.

CONCLUSION

In our daily life, in each and every electronic system microprocessor is the brain of all devices which is inbuilt and which can process the data at faster speed. Microprocessor 8085 is one of the reliable, cost effective and faster speed processor.

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