Microprocessor Components

A microprocessor is an integrated circuit that functions as the CPU (Central Processing Unit) of a computer. It consists of several essential components:

1. Registers

Registers are small, high-speed storage units inside the CPU. They temporarily hold data, addresses, and instructions during execution.

Types of Registers:

- General Purpose Registers (GPRs) – Used for storing temporary data and intermediate results. (e.g.B,C,D,E,H,L)
- Accumulator (A) – Used for arithmetic and logic operations.
- Special Purpose Registers (SPRs) – Control CPU operations. Examples include:
    - Program Counter (PC) – Holds the address of the next instruction.
    - Instruction Register (IR) – Holds the current instruction.
    - Memory Address Register (MAR) – Stores the address to be accessed in memory.
    - Memory Data Register (MDR) – Stores data read from or written to memory.

2. Arithmetic Logic Unit (ALU)

The ALU performs arithmetic operations (addition, subtraction, multiplication, division) and logical operations (AND, OR, XOR, NOT, comparisons).

Operations of the ALU:

- Arithmetic: ADD, SUB, INC, DEC
- Logical: AND, OR, XOR, NOT
- Bitwise Operations: Shift Left (SHL), Shift Right (SHR)

The ALU operates under the control of the Control Unit, taking inputs from registers and outputting the result back to registers or memory.

3. Control Unit & Timing Unit

The Control Unit (CU) manages instruction execution by generating control signals. It ensures data moves correctly between registers, memory, and the ALU.

Functions of the Control Unit:

- Fetching instructions from memory.
- Decoding instructions.
- Sending signals to execute instructions (via control signals).
- Handling the timing of operations using the system clock.

The Timing Unit synchronizes operations using clock pulses. Each instruction execution is divided into machine cycles and T-states (clock cycles).

System Buses

A bus is a set of parallel wires that transfer data between CPU, memory, and peripherals.

Types of Buses:

1. Data Bus – Transfers actual data (e.g., 8-bit in Intel 8085).
2. Address Bus – Carries memory addresses to identify locations (e.g., 16-bit in Intel 8085).
3. Control Bus – Carries control signals (e.g., Read/Write, Interrupt, Clock).

Microprocessor Systems with Bus Organization

A microprocessor system consists of:

1. CPU – Executes instructions (ALU, Registers, Control Unit).
2. Memory – Stores instructions and data (RAM, ROM).
3. I/O Devices – Input (keyboard), Output (monitor), Storage (hard disk).
4. Buses – Enable communication between components.
5.

In a bus organization, all components share a common communication pathway, with the CPU controlling access to memory and peripherals.

SAP 1	SAP 2
Data Bus is 8-bit	Data Bus is 16-bit
PC is 4-bit.	PC is 16-bit.
It does not have hexadecimal keyboard encoder.	It has hexadecimal keyboard encoder.
It has single input.	It has two input ports.
MAR receives 4-bit address from PC.	MAR receives 16-bit address from PC.
It does not have ROM.	It has 2 KB ROM.
It has 16 Byte memory.	It has 62 KB memory.
It does not have MDR.	It has MDR.
It has only adder/subtractor.	It has ALU.
It does not have flag.	It has 2 flags.
It does not have temporary register.	It has temporary register.
It has single register (B).	It has 2 registers (B and C).
It has single output port.	It has 2 output ports.
It has 5 instruction sets.	It has 42 instruction sets.

8085 Microprocessor Architecture

8085 Microprocessor Architecture

The Intel 8085 is an 8-bit, general-purpose microprocessor designed for various computing applications. It consists of multiple functional units that work together for data processing, memory operations, and control execution.

Registers in 8085 Microprocessor

General-Purpose Registers

The 8085 microprocessor has six general-purpose registers, each 8-bit wide:

- B, C, D, E, H, and L
- These registers can be paired to form 16-bit register pairs:
    - BC register pair
    - DE register pair
    - HL register pair (commonly used to store memory addresses)

Special-Purpose Registers

Program Counter (PC)

- 16-bit register that holds the address of the next instruction to be executed.
- Automatically increments after fetching each instruction.
- Used to execute instructions sequentially.

Stack Pointer (SP)

- 16-bit register used to manage the stack in memory.
- The stack stores temporary data, subroutine addresses, and return addresses.
- Works with PUSH, POP, and CALL instructions.

Instruction Register

- 8-bit register that holds the current instruction being executed.
- Used for instruction decoding before execution.

Flag Register (Status Register)

- 8-bit register that holds the status of operations performed by the ALU.
- It consists of five important flags:
    - Carry Flag (CY) – Set when an arithmetic operation generates a carry.
    - Zero Flag (Z) – Set when the result of an operation is zero.
    - Sign Flag (S) – Set if the result is negative (MSB = 1).
    - Parity Flag (P) – Set if the result has an even number of 1s.
    - Auxiliary Carry Flag (AC) – Used in BCD arithmetic operations.

Accumulator (A Register)

- An 8-bit register connected to the ALU.
- Stores the results of arithmetic and logical operations.
- Plays a central role in data transfer and I/O operations.

Temporary Register (wz)

- 8-bit register used during arithmetic and logical operations internally.
- Not accessible to the programmer.

Instruction Decoder

- Decodes the instruction fetched from memory.
- Determines the operation to be performed.

Arithmetic and Logic Unit (ALU)

- Performs arithmetic operations (addition, subtraction, increment, decrement).
- Performs logical operations (AND, OR, XOR, NOT).
- Supports bit-shifting operations.

Buses in 8085 Microprocessor

Address Bus

- 16-bit unidirectional bus (carries addresses only in one direction).
- Used to address memory locations (up to 65,536 locations (64KB)).

Data Bus

- 8-bit bidirectional bus (carries data in both directions).
- Transfers data between the microprocessor, memory, and I/O devices.

Control Bus

- A set of control signals that coordinate the operations of the microprocessor.
- Important control signals:
    - Read (RD) – Fetches data from memory/I/O.
    - Write (WR) – Writes data to memory/I/O.
    - Interrupt (INTR, TRAP, RST 7.5, RST 6.5, RST 5.5) – Used to handle external requests.
    - Reset (RESET) – Resets the microprocessor.

Execution Cycle in 8085

Instruction Fetching

- The Program Counter (PC) provides the memory address of the next instruction.
- The instruction is fetched from memory and placed in the Instruction Register.
- The PC increments to point to the next instruction.

Instruction Decoding & Execution

- The Instruction Decoder decodes the instruction.
- The Timing and Control Unit sends necessary control signals.
- The instruction is executed using ALU, registers, and memory.

Interrupt Handling

- If an interrupt occurs, the microprocessor pauses execution.
- The Interrupt Service Routine (ISR) is executed.
- Once completed, normal execution resumes.

Memory and Stack Operations

Stack Operations

- The stack is a reserved section in memory used for storing temporary data.
- The Stack Pointer (SP) keeps track of the top of the stack.
- Operations performed on the stack:
    - PUSH – Saves register data to the stack.
    - POP – Restores data from the stack.
    - CALL & RET – Used for function calls.

Interrupts in 8085 Microprocessor

Interrupt	Type	Priority	Usage
TRAP	Non-maskable	Highest	Emergency shutdown, power failure
RST 7.5	Maskable	High	Software-based interrupt
RST 6.5	Maskable	Medium	Peripheral device interrupts
RST 5.5	Maskable	Low	Peripheral device interrupts
INTR	Maskable	Lowest	General-purpose interrupt

Interrupts temporarily pause execution to handle urgent tasks.

Serial Communication in 8085

8085 allows serial data transfer using special Serial Input/Output (I/O) pins:

- SID (Serial Input Data) – Used to receive serial data.
- SOD (Serial Output Data) – Used to send serial data.

These signals help in interfacing external devices like sensors, displays, and communication modules.

Timing and Control Unit

- The Timing and Control Unit coordinates the execution of instructions.
- It generates control signals for memory, I/O, and ALU operations.
- Main control signals:
    - ALE (Address Latch Enable) – Helps in using the multiplexed address/data bus.
    - Control Signals – RD, WR, RESET.
    - DMA Signals – Used for Direct Memory Access operations.

8085 Microprocessor Pin Functions

1. Power Supply & Clock Signals

- Vcc (Pin 1) → +5V power supply
- Vss (Pin 40) → Ground (0V)
- X1, X2 (Pins 2, 39) → External crystal oscillator input
- CLK (Pin 3) → Provides the clock signal for the system
- CLK OUT (Pin 38) → Used for clocking external devices

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2. Address & Data Bus

- Address Bus (A0 – A15, Pins 18–23) → 16-bit unidirectional bus to access memory and I/O.
- Data Bus (D0 – D7, Pins 10–17) → 8-bit bidirectional bus for data transfer.

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3. Control & Status Signals

- ALE (Pin 29) → Address Latch Enable (separates address & data bus)
- IO/M' (Pin 26) → Distinguishes memory (0) from I/O (1) operations
- RD' (Pin 34) → Read signal (active low)
- WR' (Pin 33) → Write signal (active low)

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4. Interrupt Signals

- INTR (Pin 25) → Interrupt Request
- INTA' (Pin 24) → Interrupt Acknowledge
- RST 5.5 (Pin 23), RST 6.5 (Pin 22), RST 7.5 (Pin 21) → Restart Interrupts
- TRAP (Not shown, but important) → Highest priority interrupt

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5. Direct Memory Access (DMA) Signals

- HOLD (Pin 30) → Requests control of system buses
- HLDA (Pin 31) → Acknowledges HOLD request

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6. Serial I/O Ports

- SID (Pin 5) → Serial Input Data
- SOD (Pin 36) → Serial Output Data

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7. Reset Signals

- RESET IN' (Pin 4) → Resets the microprocessor (active low)
- RESET OUT (Pin 37) → Indicates MPU is resetting other devices

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