

CS Section A - Components of a computer

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1 Describe the functions and interactions of main CPU components

The General Concepts

- The **central processing unit** (CPU) is the heart of a computer
CPU is responsible for executing instructions and processing data.
- **CU** (Control unit): Manages instruction execution, fetching, decoding, directing operations.
- **ALU** (Arithmetic Logic Unit): Performs calculations and logical operations on data
- **Registers**: Store data temporarily for quick access by the CPU.

1.1 CU, ALU and registers - The basic composition of a CPU

The **Control Unit**(CU) is responsible for the operation of the CPU - it controls the retrieval of instructions from the primary memory as well as the sequence of their execution. The CU is the **Conductor** of the CPU, orchestrating all operations, it:

- **Fetches**(Extracts) instructions from memory.
- **Decodes** instructions into understandable commands. (Translate machine code into assembly language)
- **Executes** instructions by coordinating with ALU and registers.
- **Manages** data flow between CPU components.

The **Arithmetic logic unit**(ALU) performs basic arithmetic, logical or input/output operations. The **Data** that needed to be processed by ALU is provided by **CU**.

- Performs **Arithmetic operations** (e.g. addition, subtraction...)
- Executes **Logical Operations** (e.g. AND, OR, XOR, NOT...)
- Handles **Comparisons** (e.g. Equal to, greater than, less than...)
- **Bitwise Operations** (e.g. shifting, masking)
- Essential for **Data processing and manipulation**

The **Registers** is a small *storage location* that can hold data. There are various types of registers, including the following:

- **IR (Instruction Register)**: Holds the current instruction.
- **PC (Program Counter)**: Stores the address of the next instruction.

- **MAR (Memory Address Register):** Holds the memory address for data access.
The **MAR** holds the memory address of the data to be used by the ALU, so that the ALU can retrieve the corresponding content from the memory and process them accordingly.
- **MDR (Memory Data Register):** Buffers data between CPU and memory
The **MDR** holds the data that is to be used by the ALU and then saved to the RAM. The MDR is **Closely related to MAR**.
- **ACC (Accumulator):** Stores intermediate results of *calculations*.

Extended Knowledge: Examples of data flow

1. Reading from Memory

- The CU *stores the address* in the MAR.
- Memory *locates* the data based on the address in the MAR.
- The data is *transferred* via the bus and stored in the MDR.
- The CU *moves the data* from the MDR to the target register or ALU.

2. Writing to Memory

- The CU *stores* the data in the MDR.
- The target address is *stored* in the MAR.
- Memory *receives* the data from the MDR based on the address in the MAR.