Calculator

- Data processing device that carries out logic and arithmetic operations.

- Accepts data from a small keyboard, performs the arithmetic and logical calculation and show the result on LCD or LED.

- Programs are stored in ROM, data stored in RAM.

Features

- Interface easily with keyboards and displays.

- Handle decimal digits as units.

- Execute the standard program stored in ROM

- Mathematical functions

- Low cost, small size and low power consumption.

Von-Neumann Architecture

- Known as "**stored program concept**" and was developed by John Von Neumann.

- Computer could get instruction by reading them from memory and a program could be set or altered by setting the values of a portion of memory.

| Program and Data Memory | ← Address Bus — | ALU |
| | ↔ Data Bus ↔ | Program Control Unit |
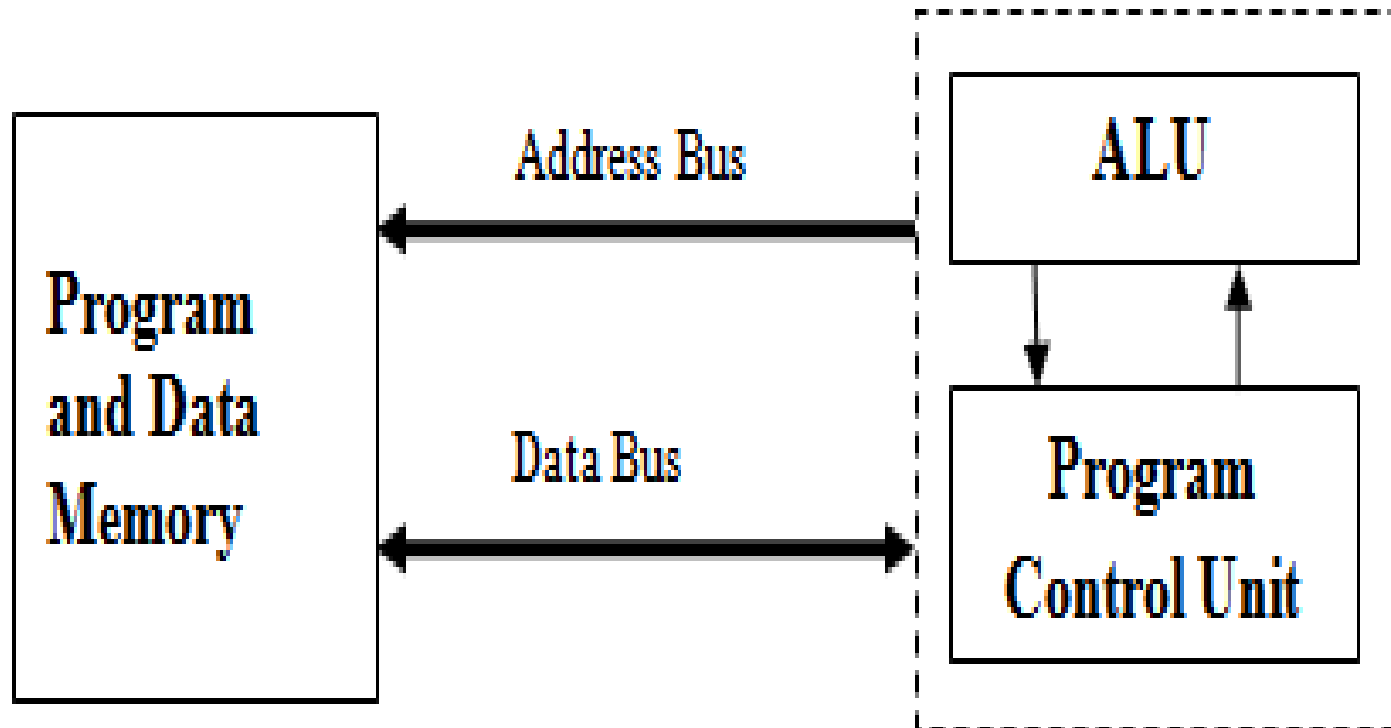
Von-Neumann Architecture

- Uses a single memory to hold both the instruction and data.

- Such machines are also known as **stored program computer**.

- ALU is capable of performing arithmetic and logical operations on binary data.

- The memory of the Neumann's machine consists of 1000 storage location called **words**, each capable of storing 40 bits.

- Each number is represented by sign bit and 39-bit value.

- Control unit provides the timing and control signals to all the operations.

- The storage location of the control unit and ALU are called register.

1. **Memory Address Register (MAR):** located in the CPU, connected to the address lines. Specifies the address in memory.

2. **Memory Buffer Register (MBR):** Located in the CPU, connected to the data lines. Acts as an interface between the CPU and memory.

- **Instruction Register (IR):** When the instruction is fetched from the memory, it is loaded in the instruction register.

- **Program Control (PC):** Contains the address of next byte to be fetched from the memory. The main purpose is to sequence the execution of the program.

- The contents of the program counter are copied to the memory address register before an instruction is fetched from memory.

- When the instruction is fetched, the control unit updates the program counter to point to the next instruction which is to be fetched.

- The Accumulator (AC) and the Multiplier-Quotient (MQ) are employed to temporarily hold the operands and result of ALU operations.

- E.g., the result of multiplying the two 40-bit numbers is 80-bit number, the most significant 40 bit are stored in AC and the least significant in MQ.

Harvard Architecture
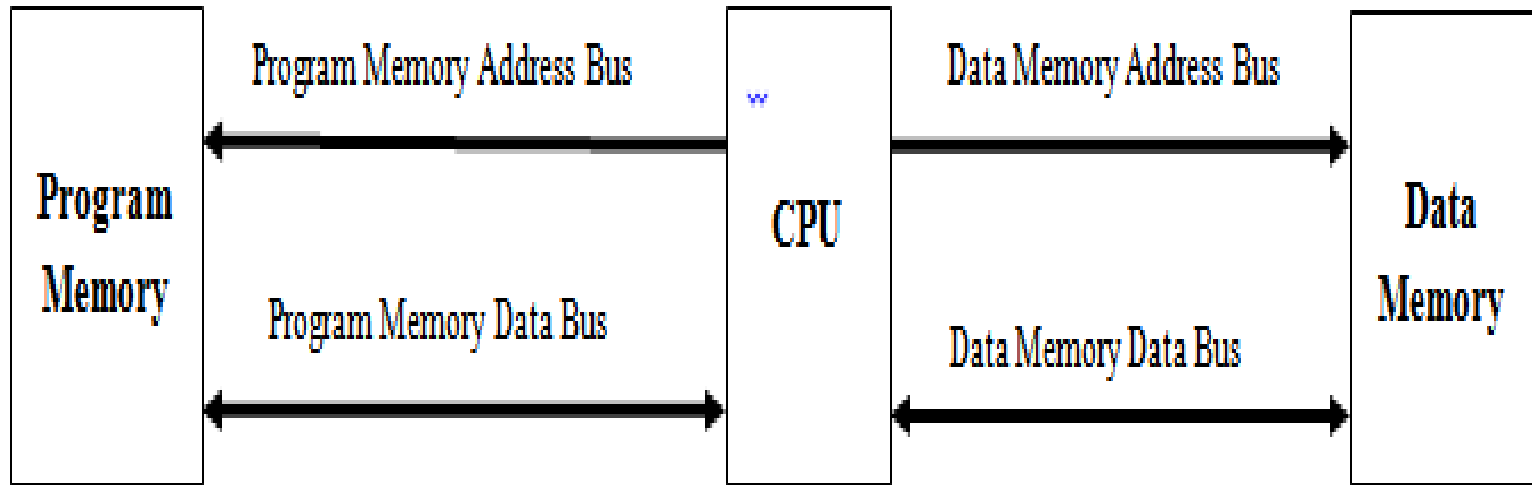
Harvard Architecture

- Consists of separate memory for program and data.
- Each memory has its own address and data buses.
- Both the instruction and data can be fetched from memory concurrently.

- Consists of separate data and address buses for program and data memory.

- Hence it requires separate block of RAM chip.

- The data memory address bus carries the memory address of data whereas program memory address bus carries the memory address of the instruction.

- Similarly, program memory data bus carries the instruction and data memory data bus carries the data required to perform the operations.

Microprocessor

- A μP is a programmable, clock driven electronic device, designed with registers, flip-flops & timing elements that reads binary instruction from a storage device called memory, accept binary data as input and process data according to those instruction and provide the results as output.

- It has a set of instructions, designed to manipulate data and communicate.

- It can be programmed to perform specific task by selecting necessary instruction from its set.

- It reads one instruction at a time, matches it with instruction set and performs the data manipulation as indicated by the instruction.

- Thus µP can fetch instruction from memory, decode and execute them, perform arithmetic and logical operations, accept data from input and send results to the output device.
- The CPU of computer consists of an ALU, CU and memory.

- If all these components can be organized on a single silicon chip by means of LSI, VLSI technology, then such structure is called µP.

- So the microprocessor is CPU in a single chip.