Microcontroller

A **microcontroller** is a small and low-cost microcomputer, which is designed to perform the specific tasks of embedded systems like displaying microwave's information, receiving remote signals, etc.

The general microcontroller consists of the processor, the memory (RAM, ROM, EPROM), Serial ports, peripherals (timers, counters), etc.

Difference between Microprocessor and Microcontroller

The following table highlights the differences between a microprocessor and a microcontroller −

Microcontroller	Microprocessor
Microcontrollers are used to execute a single task within an application.	Microprocessors are used for big applications.
Its designing and hardware cost is low.	Its designing and hardware cost is high.
Easy to replace.	Not so easy to replace.
It is built with CMOS technology, which requires less power to operate.	Its power consumption is high because it has to control the entire system.
It consists of CPU, RAM, ROM, I/O ports.	It doesn't consist of RAM, ROM, I/O ports. It uses its pins to interface to peripheral devices.

Types of Microcontrollers

Microcontrollers are divided into various categories based on memory, architecture, bits and instruction sets. Following is the list of their types −

Bit

Based on bit configuration, the microcontroller is further divided into three categories.

- **8-bit microcontroller** − This type of microcontroller is used to execute arithmetic and logical operations like addition, subtraction, multiplication division, etc. For example, Intel 8031 and 8051 are 8 bits microcontroller.
- **16-bit microcontroller** − This type of microcontroller is used to perform arithmetic and logical operations where higher accuracy and performance is required. For example, Intel 8096 is a 16-bit microcontroller.
- **32-bit microcontroller** − This type of microcontroller is generally used in automatically controlled appliances like automatic operational machines, medical appliances, etc.

Memory

Based on the memory configuration, the microcontroller is further divided into two categories.

- **External memory microcontroller** − This type of microcontroller is designed in such a way that they do not have a program memory on the chip. Hence, it is named as external memory microcontroller. For example: Intel 8031 microcontroller.
- **Embedded memory microcontroller** − This type of microcontroller is designed in such a way that the microcontroller has all programs and data memory, counters and timers, interrupts, I/O ports are embedded on the chip. For example: Intel 8051 microcontroller.

Instruction Set

Based on the instruction set configuration, the microcontroller is further divided into two categories.

- **CISC** − CISC stands for complex instruction set computer. It allows the user to insert a single instruction as an alternative to many simple instructions.
- **RISC** − RISC stands for Reduced Instruction Set Computers. It reduces the operational time by shortening the clock cycle per instruction.

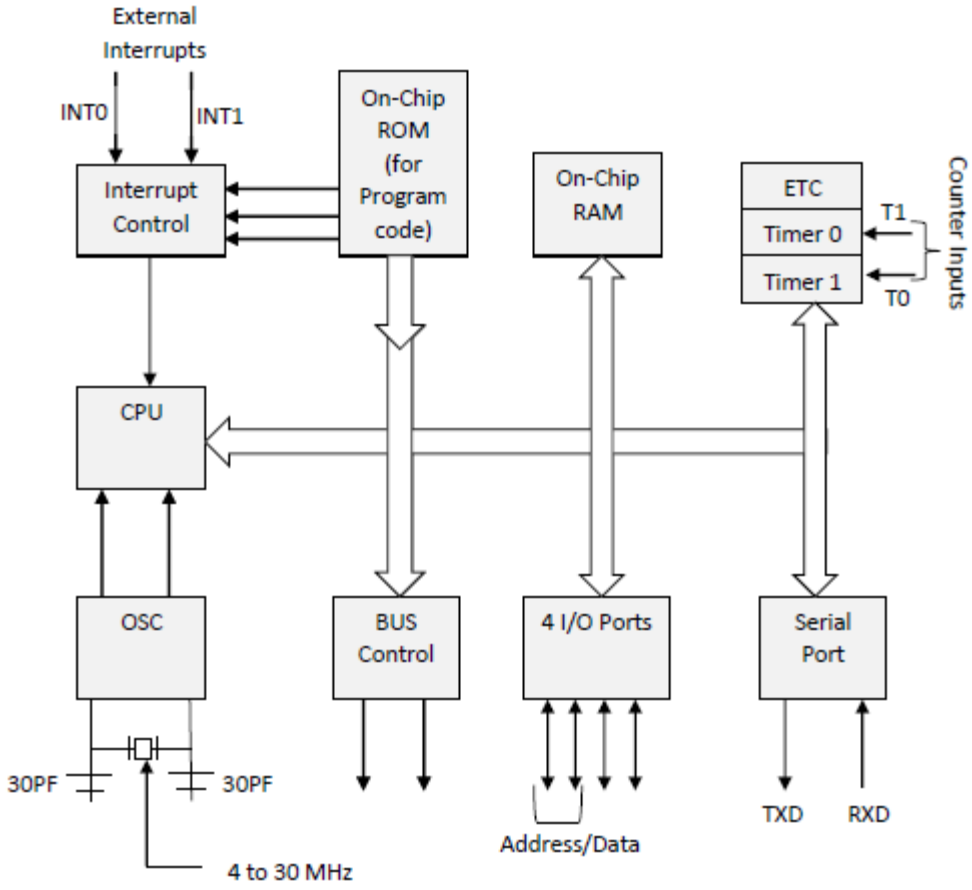
Applications of Microcontrollers

Microcontrollers are widely used in various different devices such as −

- Light sensing and controlling devices like LED.
- Temperature sensing and controlling devices like microwave oven, chimneys.
- Fire detection and safety devices like Fire alarm.
- Measuring devices like Volt Meter.

8051 microcontrollers is designed by Intel in 1981. It is an 8-bit microcontroller. It is built with 40 pins DIP (dual inline package), 4kb of ROM storage and 128 bytes of RAM storage, two 16-bit timers. It consists of are four parallel 8-bit ports, which are programmable as well as addressable as per the requirement. An on-chip crystal oscillator is integrated in the microcontroller having crystal frequency of 12 MHz.

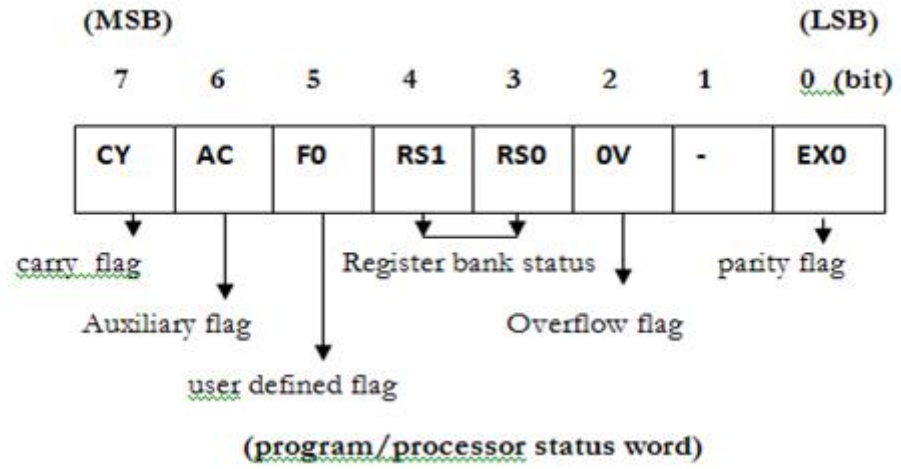
- In the following diagram, the system bus connects all the support devices to the CPU. The system bus consists of an 8-bit data bus, a 16-bit address bus and bus control signals. All other devices like program memory, ports, data memory, serial interface, interrupt control, timers, and the CPU are all interfaced together through the system bus.



PSW

The program status word (PSW) register is an 8-bit register, it is also referred to as the flag register the PSW register is 8-bit wide only 6-bit of it are used by the 8051, the two unused bits are user definable flags, four of the flags are called conditional flags, meaning that they indicate some conditions that results after an instruction is

executed, these four are CY(carry), AC(auxiliary carry), P(parity) and OV(overflow) the bits PSW.3 and PSW.4 are designated as RS0 and RS1 register selection bit and are used to change the bank register.



RS 1	RS 0	Register Bank
1	0	Register bank 0
0	1	Register bank 1
1	0	Register bank 2
1	1	Register bank 3

CY (carry flag):

- This flag is set whenever there is a carry out from the D.7 bit
- This flag bit is affected after 8-bit addition or subtraction

- It can also be set to 1 or 0 directly by an instruction such as " SET BC" and "CLRC"

AC (Auxiliary flag):

- If there is a carry from D3 to D4 during ADD or SUB operation this bit is set otherwise it is cleared
- This flag is used by instruction that perform BCD (binary coded decimal) arithmetic

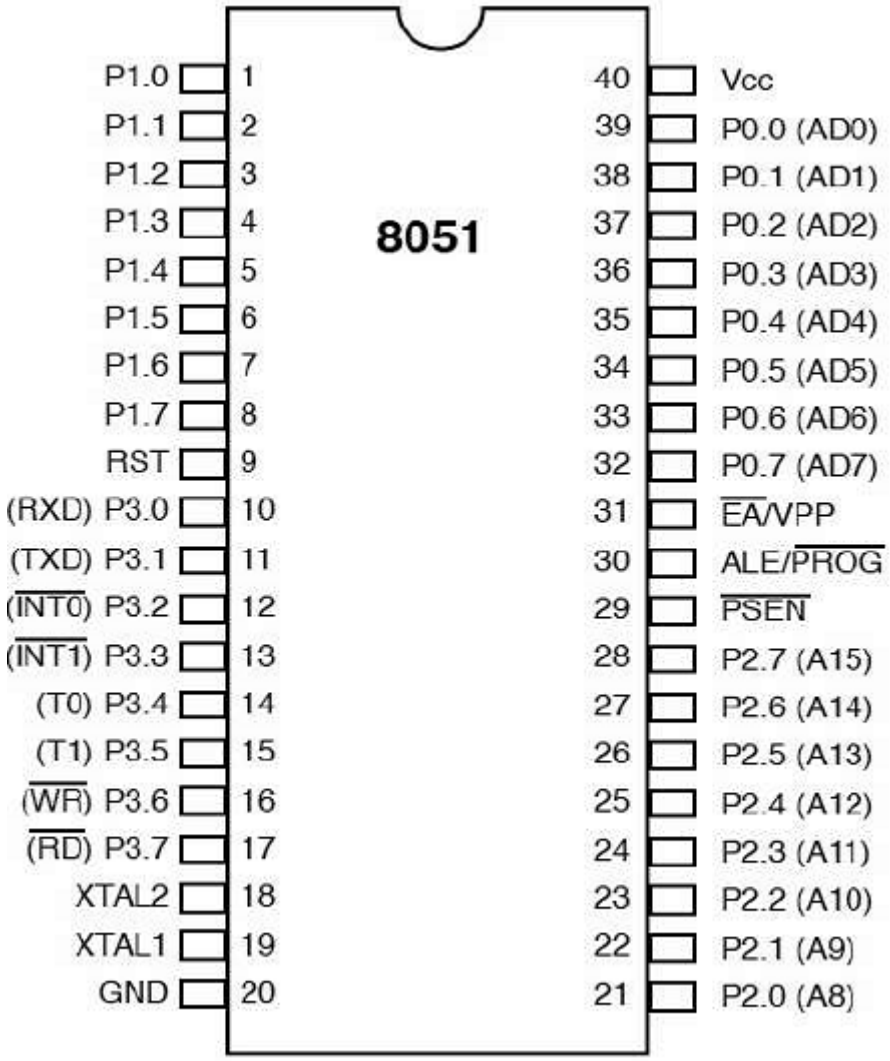
P (parity flag):

- The parity flag reflects the number of 1's in the A (accumulator) register only
- if the A register contains an odd number of 1's then p=1 therefore p=0 if A has an even number 1's.

OV (overflow flag):

- This flag is set whenever the result of a signed number operation is too large causing the high order bit to overflow into the sign bit
- the carry flag is used to detect error in unsigned arithmetic operations
- the overflow flag is only used to detect error in signed arithmetic operations.

The pin diagram of 8051 microcontroller looks as follows −



- **Pins 1 to 8** − These pins are known as Port 1. This port doesn't serve any other functions. It is internally pulled up, bi-directional I/O port.
- **Pin 9** − It is a RESET pin, which is used to reset the microcontroller to its initial values.
- **Pins 10 to 17** − These pins are known as Port 3. This port serves some functions like interrupts, timer input, control signals, serial communication signals RxD and TxD, etc.

- **Pins 18 & 19** − These pins are used for interfacing an external crystal to get the system clock.
- **Pin 20** − This pin provides the power supply to the circuit.
- **Pins 21 to 28** − These pins are known as Port 2. It serves as I/O port. Higher order address bus signals are also multiplexed using this port.
- **Pin 29** − This is PSEN pin which stands for Program Store Enable. It is used to read a signal from the external program memory.
- **Pin 30** − This is EA pin which stands for External Access input. It is used to enable/disable the external memory interfacing.
- **Pin 31** − This is ALE pin which stands for Address Latch Enable. It is used to demultiplex the address-data signal of port.
- **Pins 32 to 39** − These pins are known as Port 0. It serves as I/O port. Lower order address and data bus signals are multiplexed using this port.
- **Pin 40** − This pin is used to provide power supply to the circuit.