



Embedded Systems Design

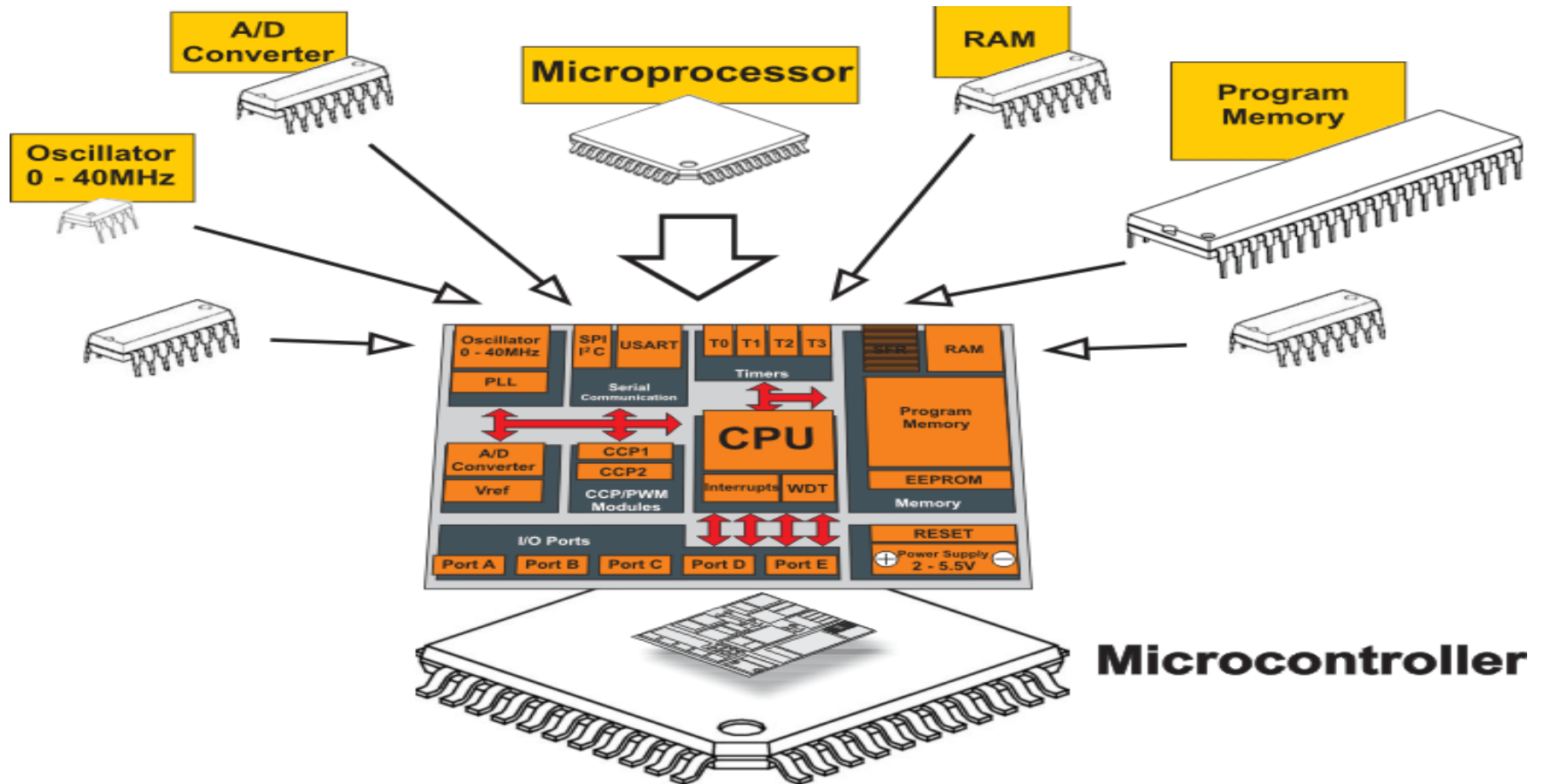
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Lecture 2

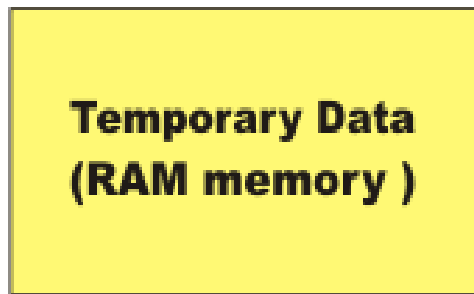
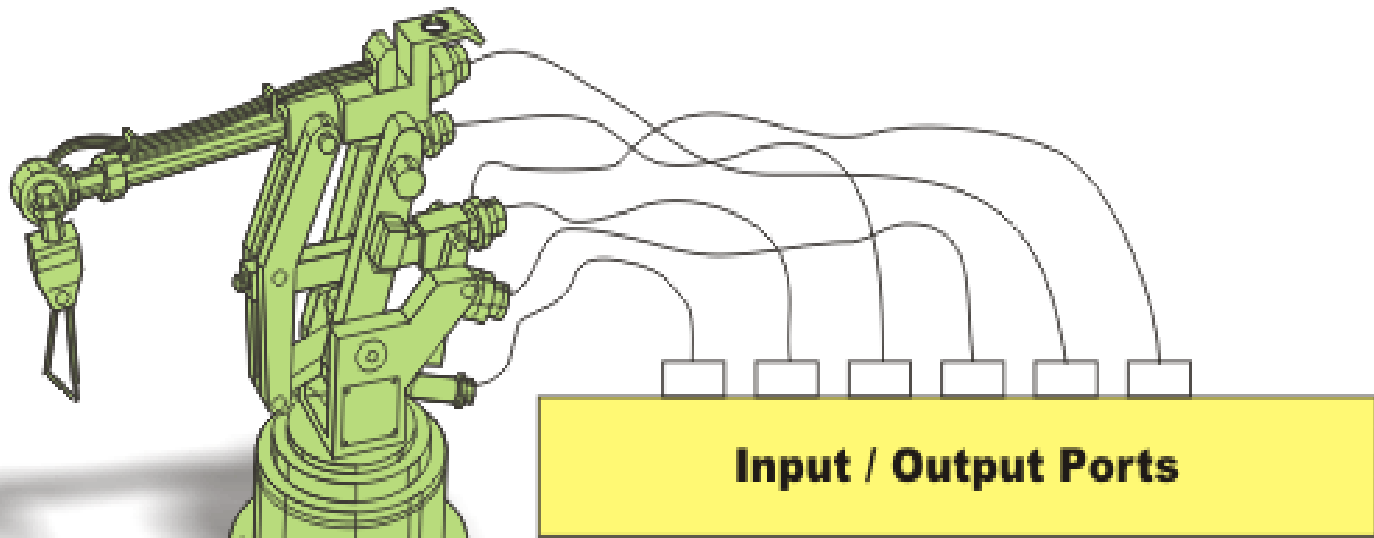
Introduction to Microcontrollers

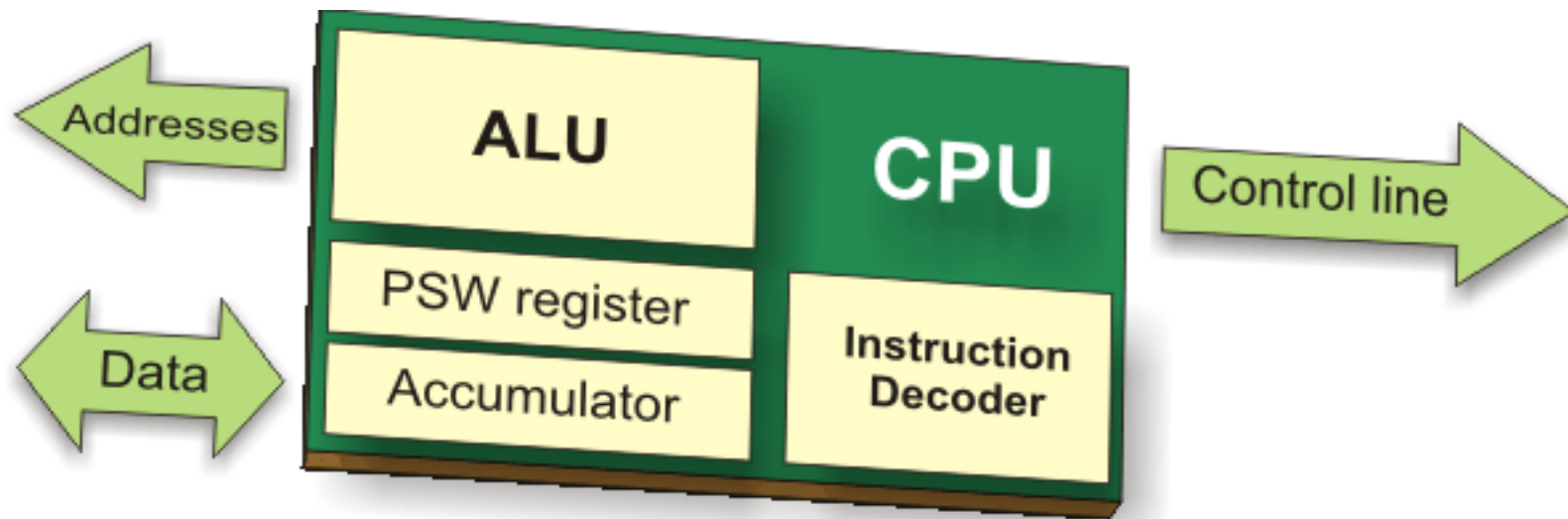
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The MC is designed to be all of that in one. No other external components are needed for its application because all necessary circuits belong to peripherals are already built in it. It saves time and space needed to design a device.



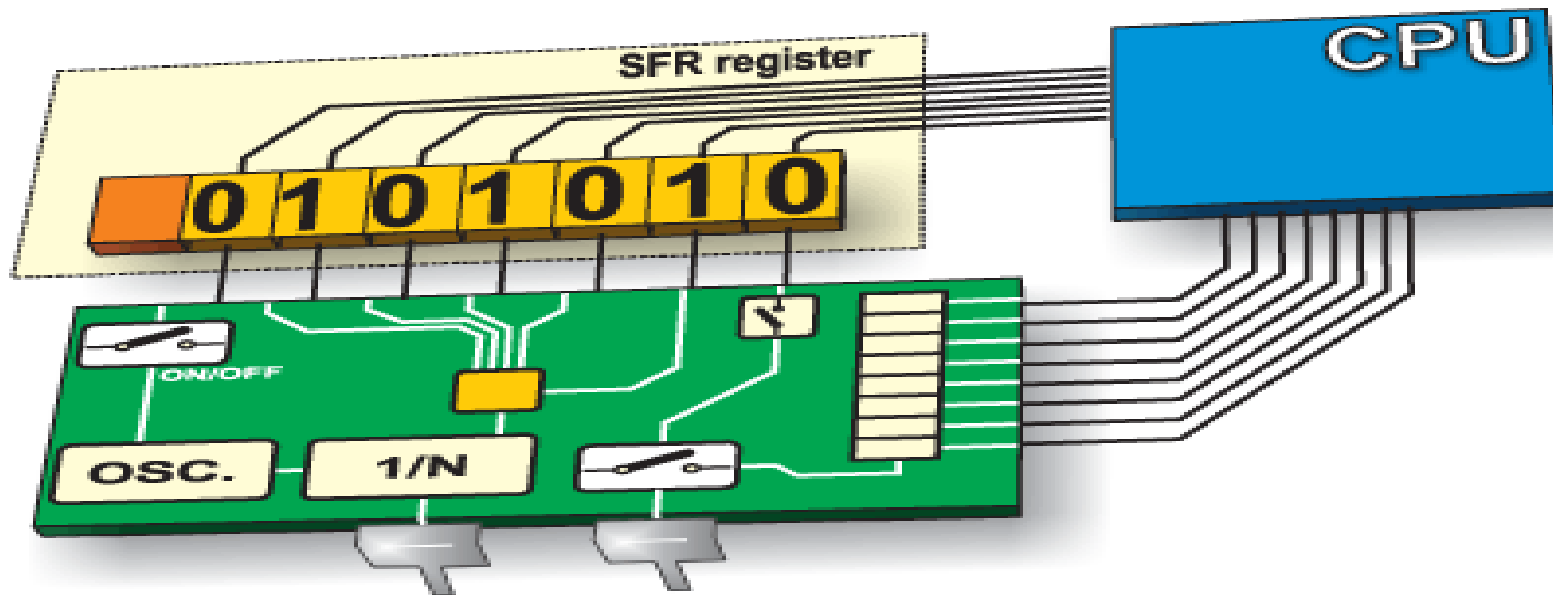
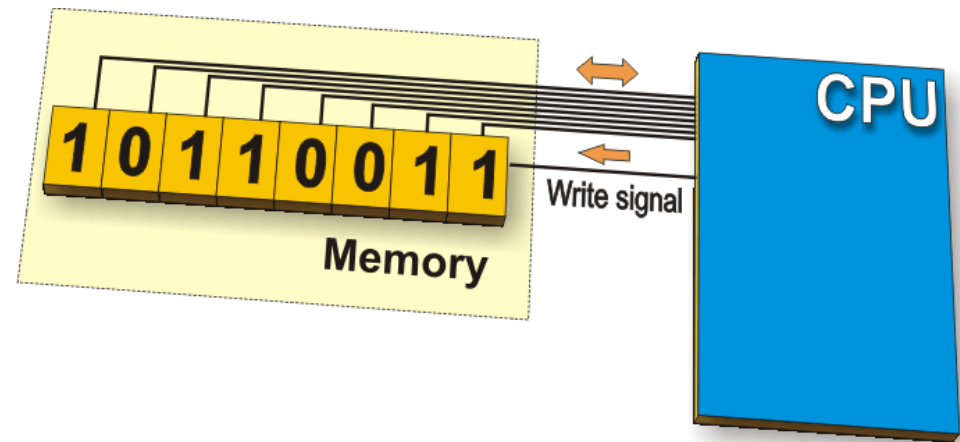


CENTRAL PROCESSOR UNIT (CPU)

- This unit monitors and controls all processes within the MC. It consists of several subunits:
- **Instruction Decoder:** to decode program instructions and run other circuits.
- **Arithmetical Logical Unit (ALU):** to perform all mathematical and logical operations upon data.
- **Accumulator (Working Reg):** is an SFR closely related to the operation of the ALU. One of the SFRs, called a *Status Register (PSW)*, is closely related to the accumulator. It shows at any given time the 'status' of a number stored in the accumulator.

Registers:

In addition to registers which do not have any special and predetermined function, every microcontroller has a number of registers (SFR) whose function is predetermined by the manufacturer.



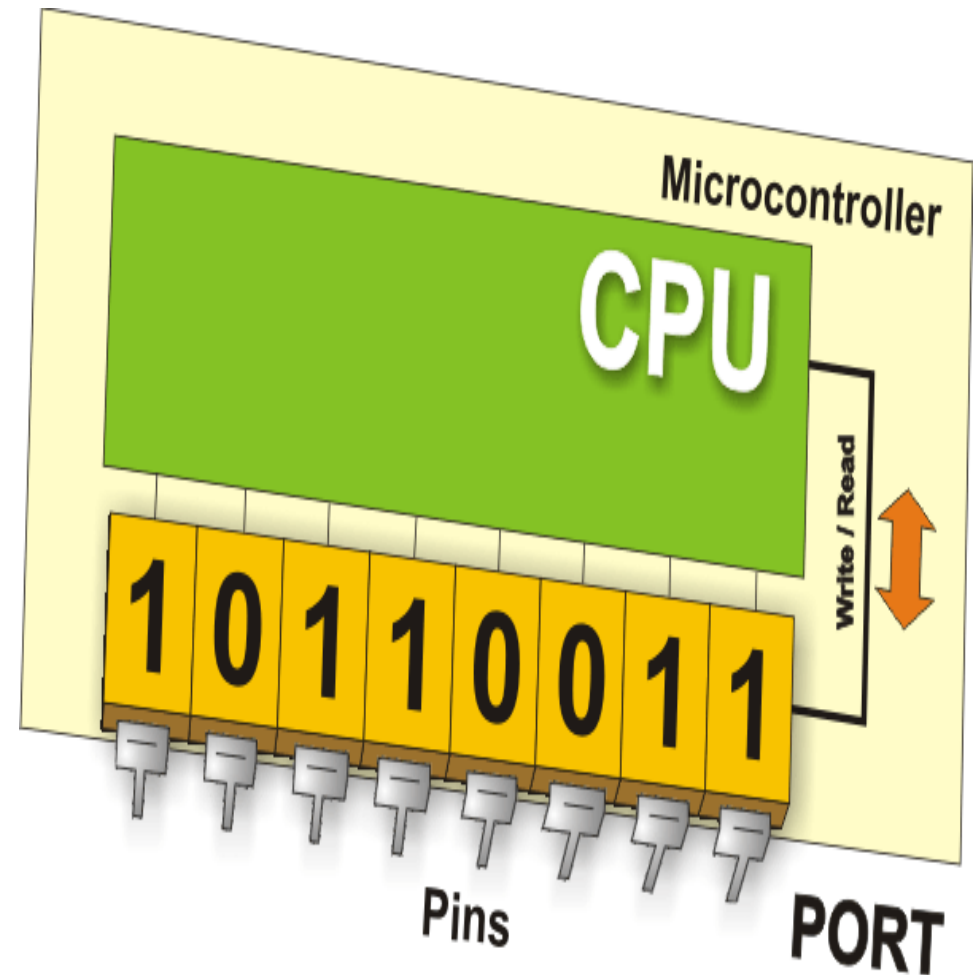
Input/Output Pins:

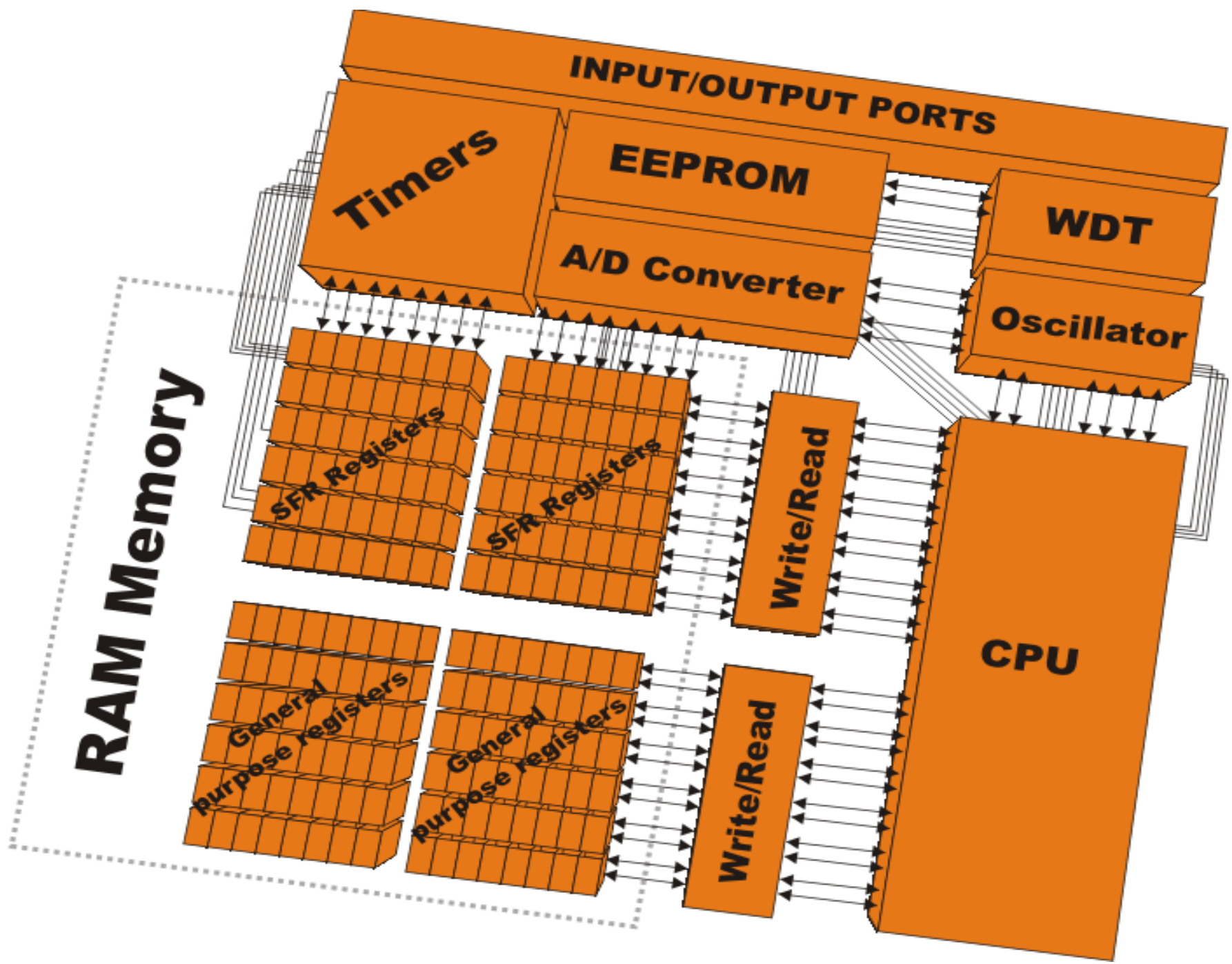
In order to make the MC useful, it has to be connected to additional peripherals.

Each MC has one or more registers (called ports) connected to the MC pins.

Each I/O port is usually under control of the specialized SFR.

For example, by writing logic one to a bit of the control register (SFR), the appropriate port pin is automatically configured as an input.





RAM Memory

INPUT/OUTPUT PORTS

Timers

EEPROM

A/D Converter

WDT

Oscillator

SFR Registers

SFR Registers

Write/Read

CPU

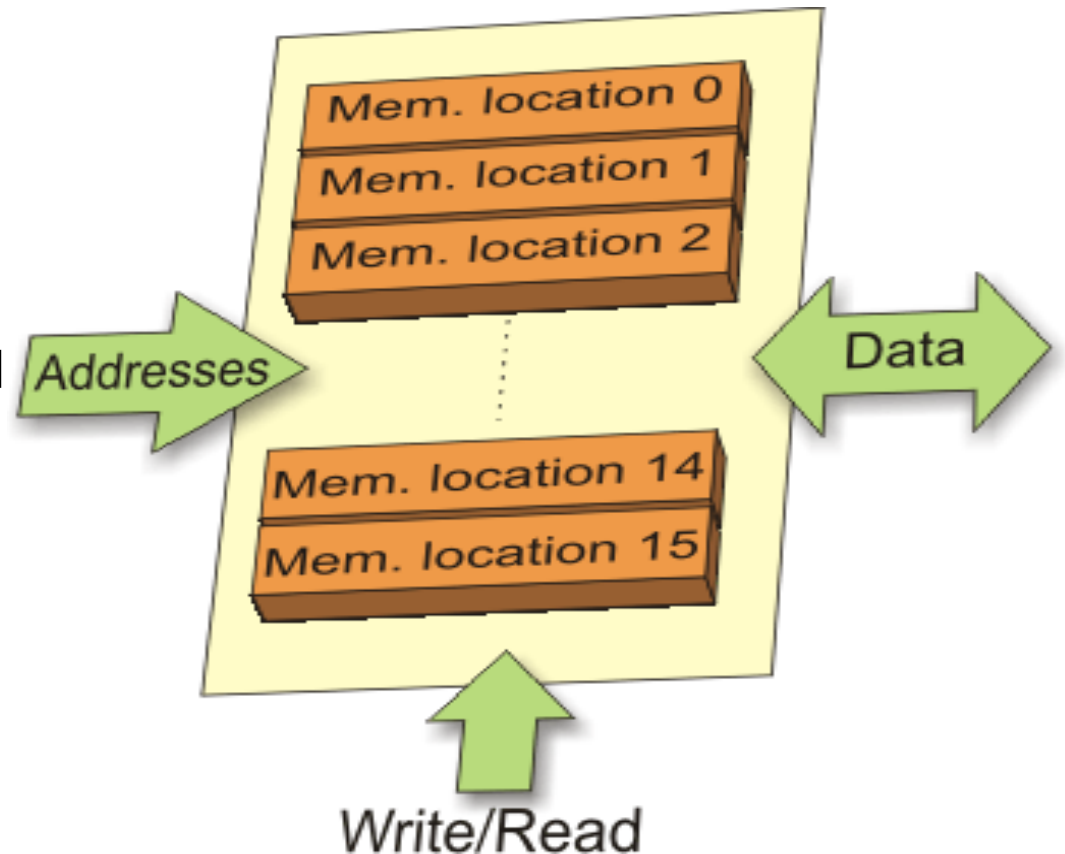
General purpose registers

General purpose registers

Write/Read

MEMORY UNIT

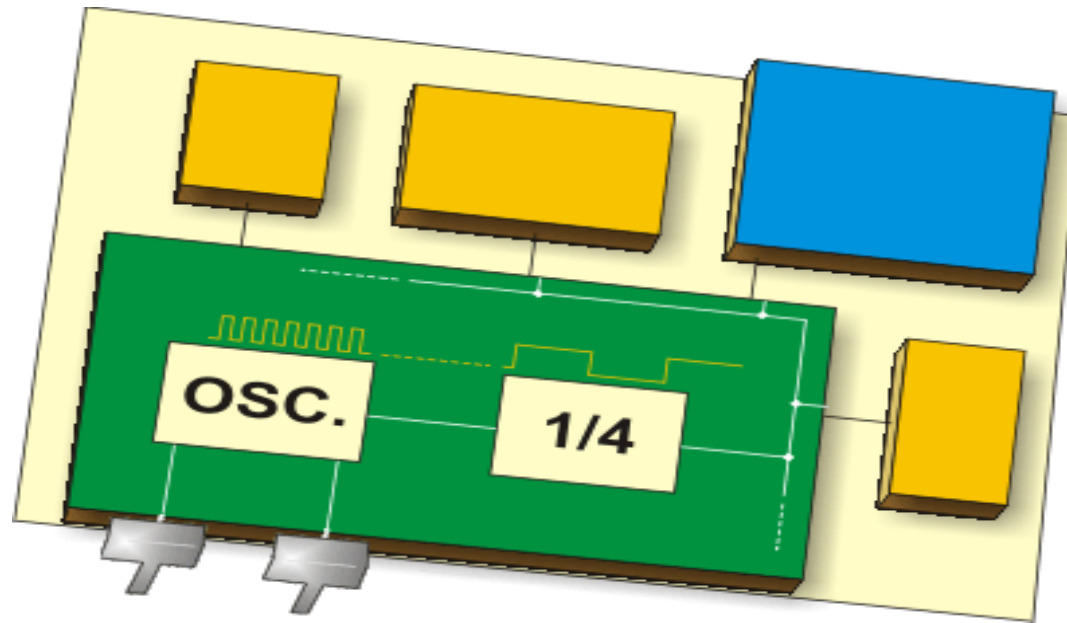
- Memory is part of the MC used for data storage.
- There are several types of memory within the MC: RAM, ROM, PROM, EPROM, EEPROM, Flash Memory.



Flash Memory:

The content of this memory can be written and cleared practically an unlimited number of times.

MCs with Flash ROM are ideal for learning, experimentation and small-scale production.

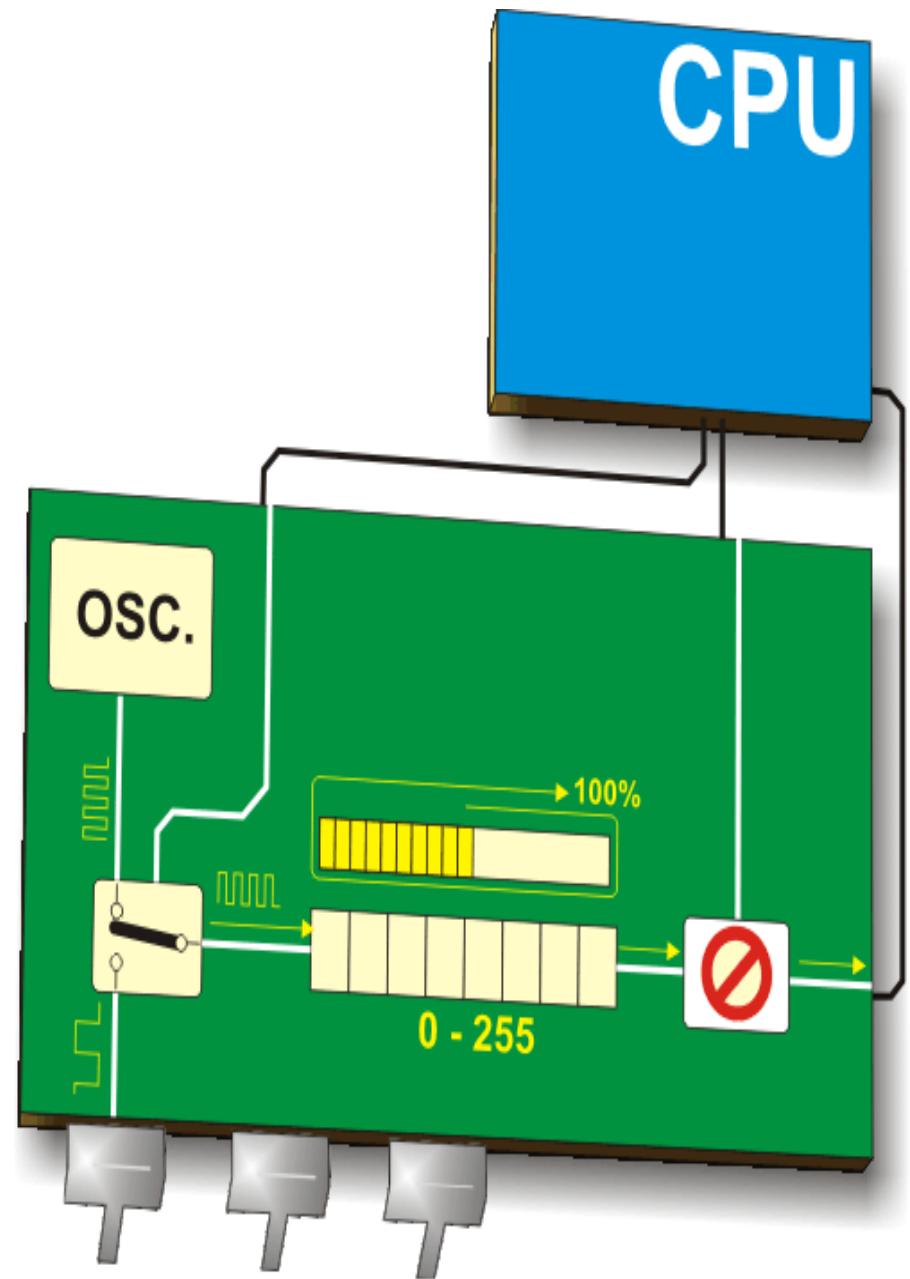


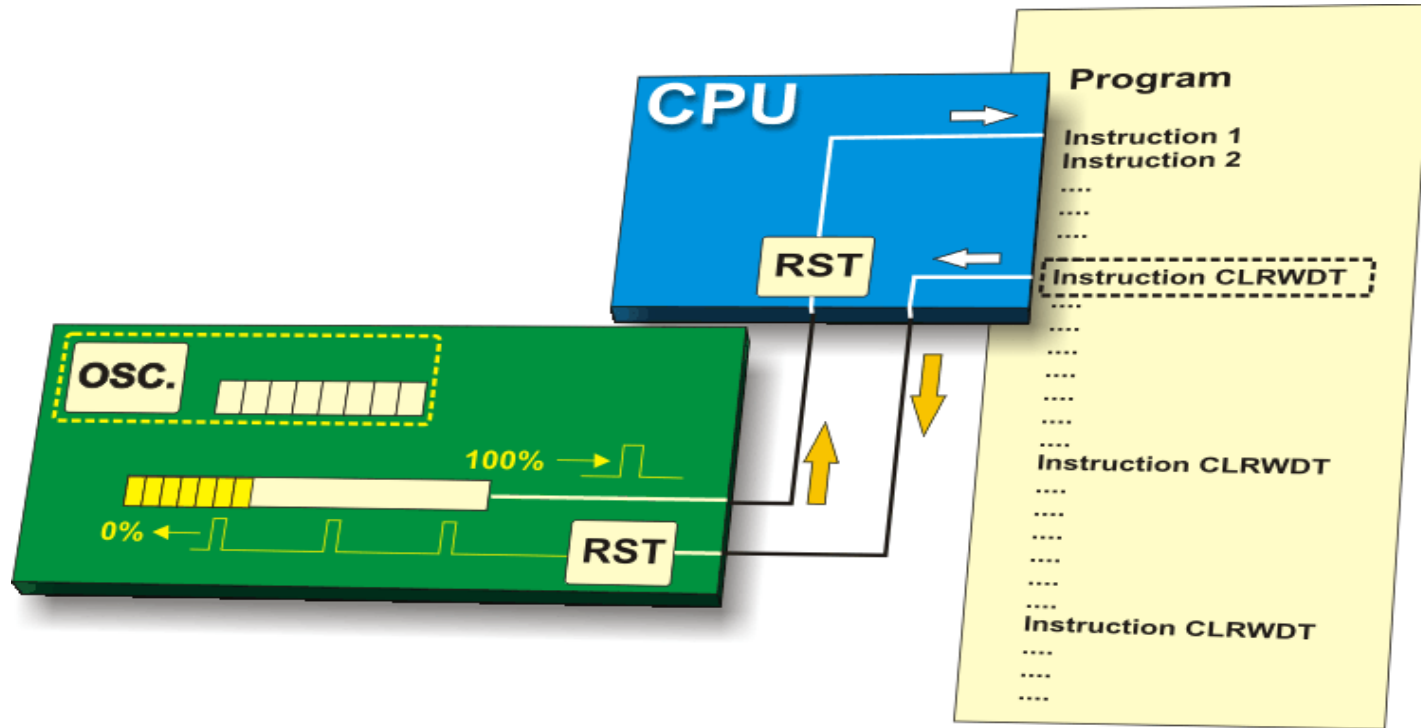
OSCILLATOR

- Pulses generated by the oscillator enable synchronous operation of all circuits within the MC.
- The oscillator is usually configured so as to use quartz crystal or ceramic resonator for frequency stability, but it can also operate as a stand-alone circuit (RC oscillator).
- It is important to say that instructions are not executed at the rate imposed by the oscillator itself, but several times slower.

Timer/Counter:

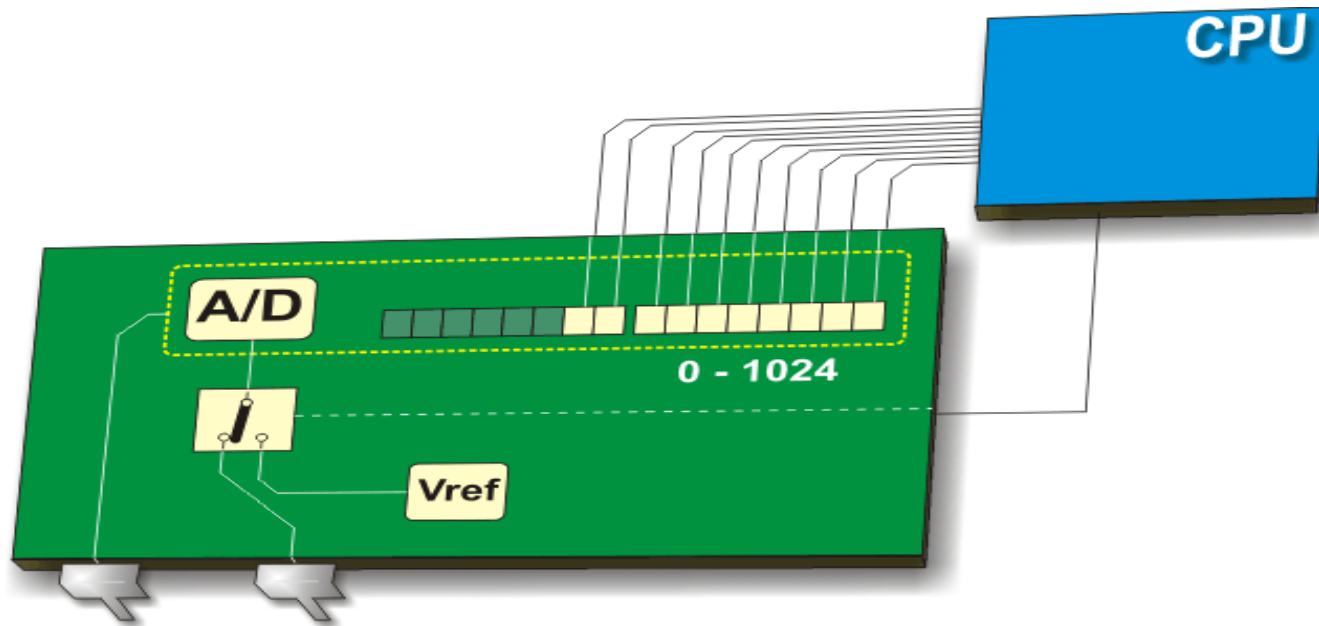
- If it is necessary to measure time between two events, it is sufficient to count up pulses generated by this oscillator. This is exactly what the timer does.
- If the timer receives pulses from the MC input pin, then it turns into a counter.





WATCHDOG TIMER (WDT):

- A WDT is a timer connected to a completely separate RC oscillator within the microcontroller.
- If the watchdog timer is enabled, every time it counts up to the maximum value, the microcontroller reset occurs and the program execution starts from the first instruction. The point is to prevent this from happening by using a specific command.



A/D CONVERTER:

- External signals are usually analog signals different from those the MC understands (ones and zeros) and have to be converted.
- An analogue to digital converter is an electronic circuit which converts continuous signals to discrete digital numbers.
- This circuit converts an analogue value into a binary number and passes it to the CPU for further processing. This module is therefore used for input pin voltage measurement (analogue value).