speed processing must process fast. [For a definition of 'deadline', refer to Section 4.6.] For embedded system software, a performance analysis during its design phase must also include the analysis of power dissipation during program execution and during standby. Good design must optimize the conflicting needs of low power dissipation and fast and efficient program execution.

1.3.2 Clock Oscillator Circuit and Clocking Unit (s)

After the power supply, the clock is the next important unit of a system. A processor needs a **clock oscillator** circuit. The clock controls the various clocking requirements of the CPU, of the system timers and the CPU machine cycles. The machine cycles are for

(i) fetching the codes and data from memory and then decoding and executing at the processor, and

(ii) transferring the results to memory.

The *clock* controls the time for executing an instruction. The clock circuit uses either a crystal (external to the processor) or a ceramic resonator (internally associated with the processor) or an external oscillator IC attached to the processor. (a) The crystal resonator gives the highest stability in frequency with temperature and drift in the circuit. The crystal in association with an appropriate resistance in parallel and a pair of series capacitance at both pins resonates at the frequency, which is either double or single times the crystal-frequency. Further, the crystal is kept as near as feasible to two pins of the processor. (b) The internal ceramic resonator, if available in a processor, saves the use of the external crystal and gives a reasonable though not very highly stable frequency. [A typical drift of the ceramic resonator is about ten minutes per month compared to the typical drift of 1 or 5 minutes per month of a crystal]. (c) The external IC-based clock oscillator has a significantly higher power dissipation compared to the internal processor-resonator. However, it provides a higher driving capability, which might be needed when the various circuits of embedded system are concurrently driven. For example, a multiprocessor system needs the clock circuit, which should give a high driving capability and enables control of all the processors concurrently.

For the processing unit(s), a highly stable oscillator is required and the processor clock-out signal provides the clock for synchronizing all the system units.

1.3.3 Real Time Clock (RTC) and Timers for Various Timing and Counting Needs of the System

A timer circuit suitably configured is the ***system-clock***, also called real-time clock (RTC). An RTC is used by the schedulers and for real-time programming. An RTC is designed as follows: Assume a processor generates a clock output every 0.5 µs. When a system timer is configured by a software instruction to issue timeout after 200 inputs from the processor clock outputs, then there are 10000 interrupts (ticks) each second. The RTC ticking rate is then 10 kHz and it interrupts every 100 µs. The RTC is also used to obtain software-controlled delays and time-outs.

More than one timer using the system clock (RTC) may be needed for the various timing and