Integration of Hardware and Firmware

The process of embedding firmware into the hardware (or target board) is discussed by the concept known as integration of hardware and firmware. Design engineers refer this process as "Embedding Intelligence" to the product. Usually, the availability of built in code memory will depend on the type of embedded processor / controller used in the target board. In the case of a non-operating system based embedded products,

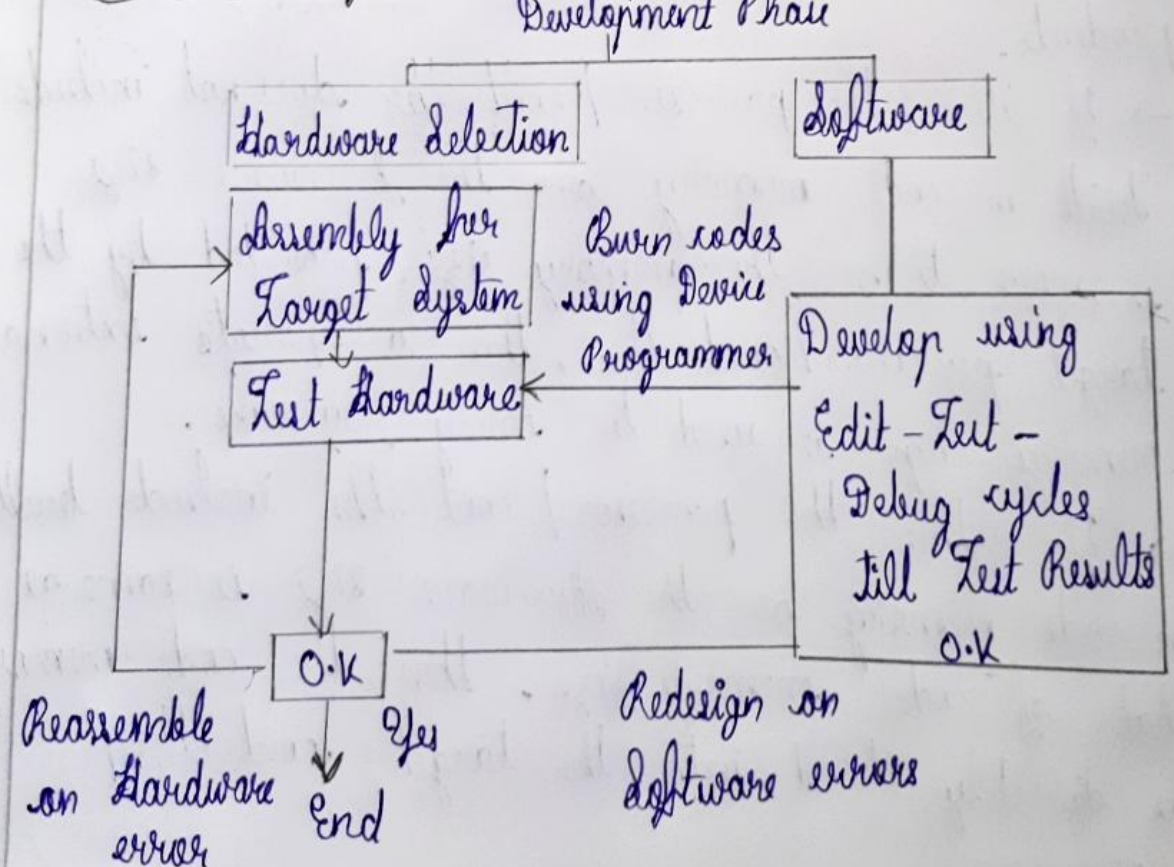
→ If either the processor / controller does not include built in code memory or the firmware size is more than the memory size provided by the target processor / controller, then a separate external memory chip is used to carry firmware.

→ If either the processor / controller include built in code memory or the firmware size is same as that of code memory size, then the code memory is directly stored into the target controller / processor.

Generally, there are several techniques for embedding firmware into the target board. The frequently used firmware embedding technique for a non-operating system based embedded system and an operating system based embedded system are,

→ Out of circuit programming
→ In system programming
→ In Application programming
→ Use of factory programmed chip

Embedded Software Development Process



The above figure shows the development process of an embedded system.

Approaches during Edit - Test - Debug cycle

- Using a Target system
- Using an emulator for Target system
- Using Target Processor and IDE
- Using a simulator for Hardware
- Using IDE or Prototyping Tool

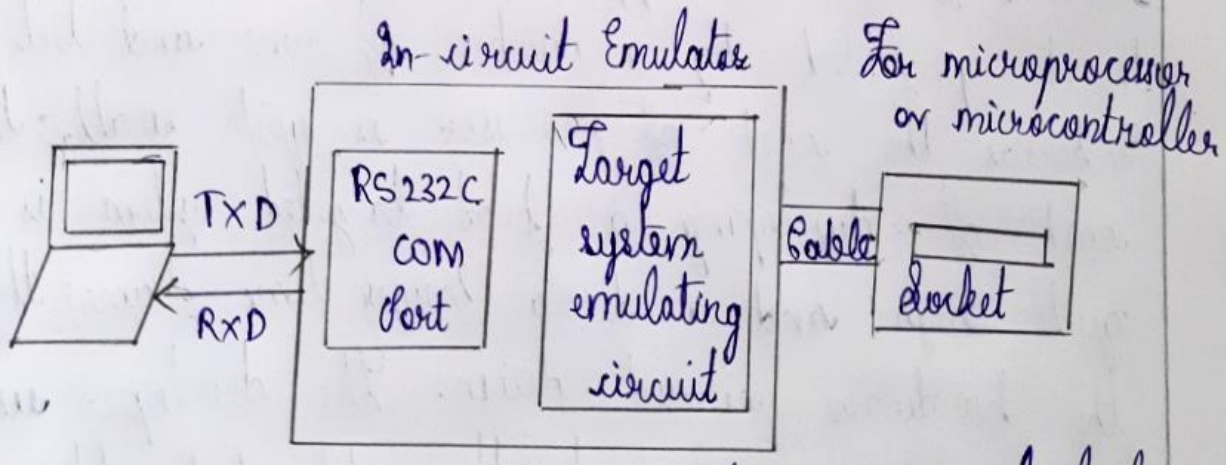
The above figure shows the edit - test - debug cycle during implementation phase of the development phases. Whereas the processor part once chosen remains fixed, the application software codes have to be perfected by a number of runs and tests. Whereas the cost of processor is quite small, the cost of developing a final targeted system is quite high and needs a larger time frame than the hardware circuit design. The developer uses four main approaches to the edit- test- debug cycles.

→ An IDE or prototype tool.

→ A simulator without any hardware.
→ Processor only at the target system and uses an in between ICE (in circuit emulator)
→ Target system at the last stage

ICE (In circuit emulator)

A circuit which replaces the microprocessor in target system is referred as In Circuit Emulator (ICE). It offers more flexibility to build several applications on a single system by avoiding multiple targeted system testing. The below figure shows the basic arrangement of an in circuit emulator,



ICE functions independently providing a serial link from PC to it. In ICE, a connection is made

to the host system via, a serial link for the purpose of debugging. In the development phase of embedded system, the ICE emulates several models of a microcontroller family with the help of remaining target circuit. In circuit emulator includes the following components. They are,

→ Emulator pod with a ribbon cable. This provides a connection between a processor or microcontroller socket and the ICE.

→ A cable that provides a connection the ICE and COM RS232C port of computer.

Debugging Tools

The following are the different types of hardware debugging tools :-

→ In-Circuit Emulator (ICE) :- It is a hardware device, which is usually used for debugging the software of an embedded system. An emulator takes place of a microprocessor in a target circuit. It is used to monitor and modify the internal registers,

memory, variables and caches etc. It consists of an overlay memory used for simulating ROM.

→ ROM Emulator:- This tool simulates ROM by replacing the ROM with cables connected to RAM (dual port). It serves as an intermediate hardware device which is connected to the target and host using different ports.

→ Background Debug mode:- It is also known as chip debugging. It creates breakpoints to stop the execution of any software. It provides facility to read and write the I/O ports, RAM and registers. It allows the observation of software execution in real time.

→ Oscilloscope:- It is an analog device that is mainly used to measure the exact voltage of a signal with respect to any given time. It is used for the verification of circuit functioning.

→ Ohmmeter:- It is a device that is used to measure resistance between any two points on a circuit. It is the cheapest hardware debugging tool.

→ Voltmeter:- This device is used to measure the voltages between any two points on a circuit. It can also be used to determine whether power is available in circuits ship. It is relatively cheap.

→ Multimeter:- Multimeter is mainly used for measuring the voltage and electrical resistance. The working of multimeter is similar to that of ohmmeter and voltmeter.

→ Logic Analyzer:- It helps in simultaneous capturing and tracking of multiple signals and prepare a graph for them. It operates on timing mode and state mode. It determines any changes in I/O ports. It is processor independent. It is an expensive hardware debugging tool.