

Microcontroller and Embedded Systems

MEMORY

- Memory is used to hold data and software for the processor
- DATA memory-----RAM:
- PROGRAM (Control store)memory-----ROM:

MEMORY

- None
- Mask ROM
- PROM
- EPROM
- EEPROM

MEMORY

- **None:**

8031 uses external ROM

I/O Ports are used to interface external memory

DATA Memory

Data memory can be classified into the following categories

- Bits
- Registers
- Variable RAM
- Program counter stack

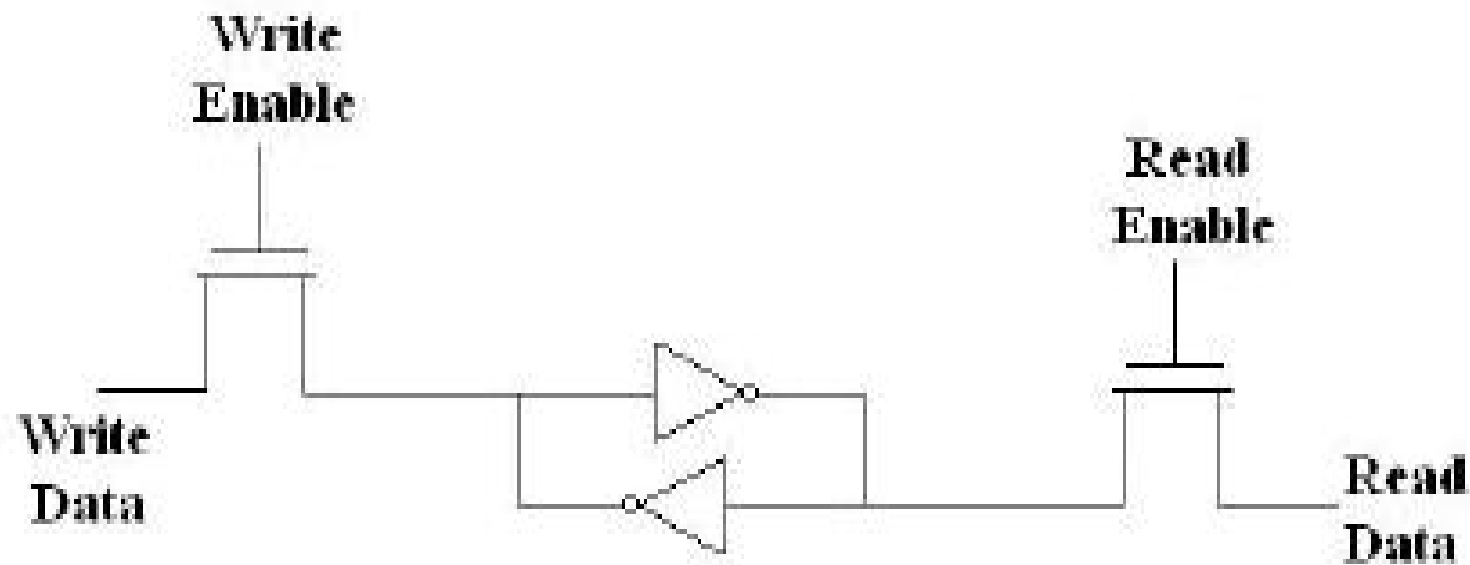
Microcontroller can have ability to perform manipulation of individual bits in certain registers (bit manipulation). This is a unique feature of a microcontroller, not available in a microprocessor.

Eight bits make a byte. Memory bytes are known as file registers.

Registers are some special RAM locations that can be accessed by the processor very easily.

RAM

- also called the working memory
- store data temporarily.
- Volatile & loses its contents when the system is switched off.
 - **SRAM**: STATIC RAM: Uses pairs of logic gates to store the data.
 1. Fastest form of RAM.
 2. Requires little external support circuitry & have relatively low power consumption.
 3. Main drawback is low capacity & more expensive than DRAM.
 4. **Cache memories** are implemented using SRAM.



SRAM memory cell equivalent

The figure of a single SRAM cell is shown above. This consists of two CMOS inverters connected back to front, so as to form a latch.

Processor stacks store/save the data in a simple way during program execution. Processor stack is a part of RAM area where the data is saved in a Last In First Out (LIFO) fashion just like a stack of paper on a table. Data is stored by executing a 'push' instruction and data is read out using a 'pop' instruction.

RAM Contd....

- ***DRAM***: It uses arrays of capacitors to hold individual bits of data.
- It can store charge for a short time depending upon the discharging time of the capacitor & hence require continuous refreshing by additional circuitry.
- They are the highest capacity devices

ROM

- nonvolatile memory.
- slower than RAM.
- Primary function of ROM is to hold the program or the code that needs to be present at the time of power on.
- ROM is fabricated from a large array of diodes. The process of loading software into the ROM is known as 'Burning' the ROM with the help of ROM burner. This is known as In System Programming (ISP) or In circuit Programming (ICP).

One time Programmable(OTP)

- ROM can be burned once only by the manufacturer. Also known as mask-programmable ROM e.g. computer firmware.

MASK ROM

Mask ROM: Some microcontrollers with ROM are programmed while they are still in the factory. This ROM is called Mask ROM. Since the microcontrollers with Mask ROM are used for specific application, there is no need to reprogram them. Some times, this type of manufacturing reduces the cost for bulk production.

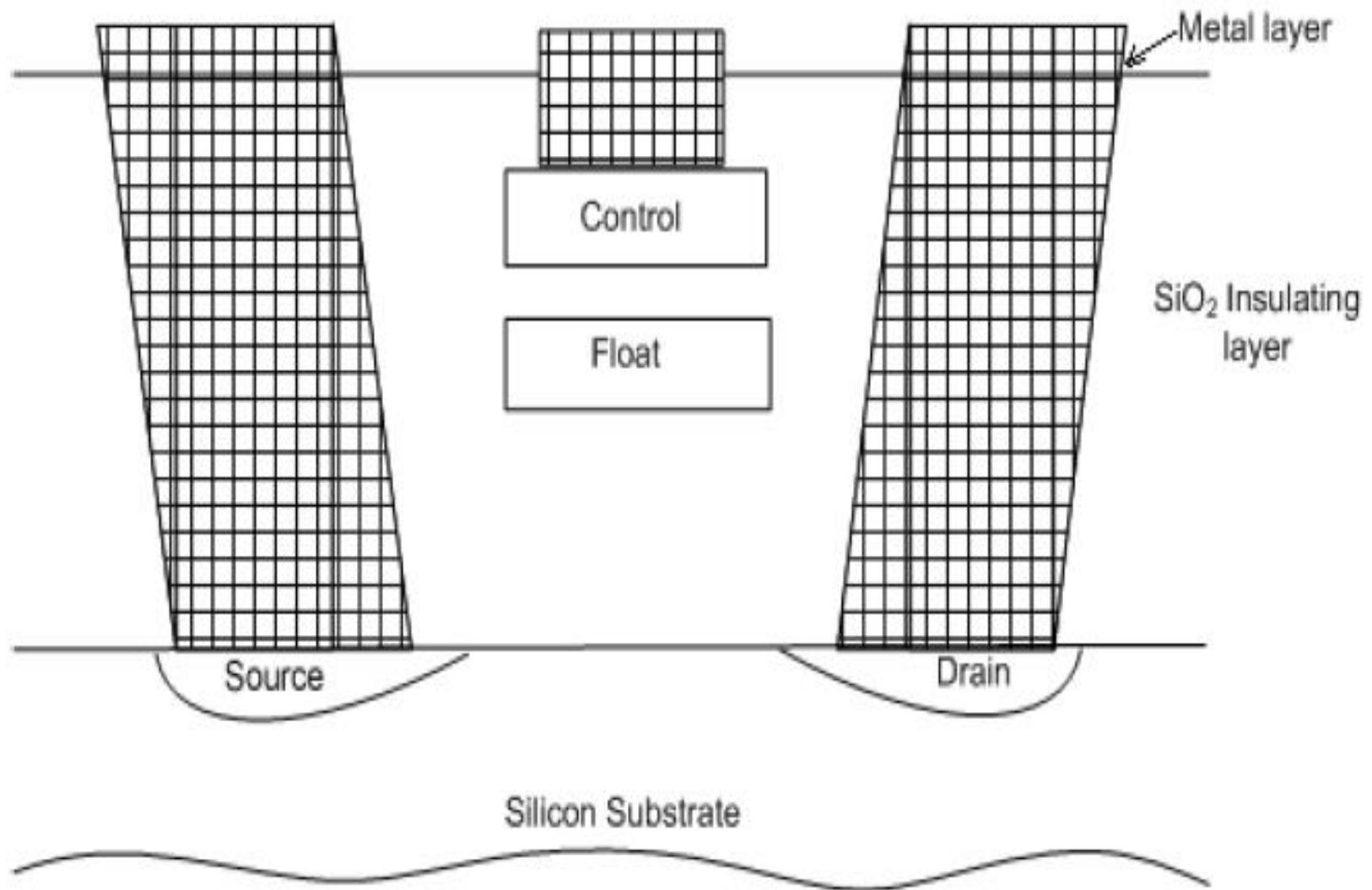
ERASEABLE PROGRAMMABLE ROM

- re- programmed.
- uses a modified MOS transistor with a floating gate that when uncharged does not effect the normal operation. However if it is subjected to (high) +12V, then a charge will move into the 2nd transistor which is stable (will last a decade).
- Reprogram by subjecting the cells to UV light via a ceramic window on top of the package. Wiping time takes about 20 minutes.

EPROM

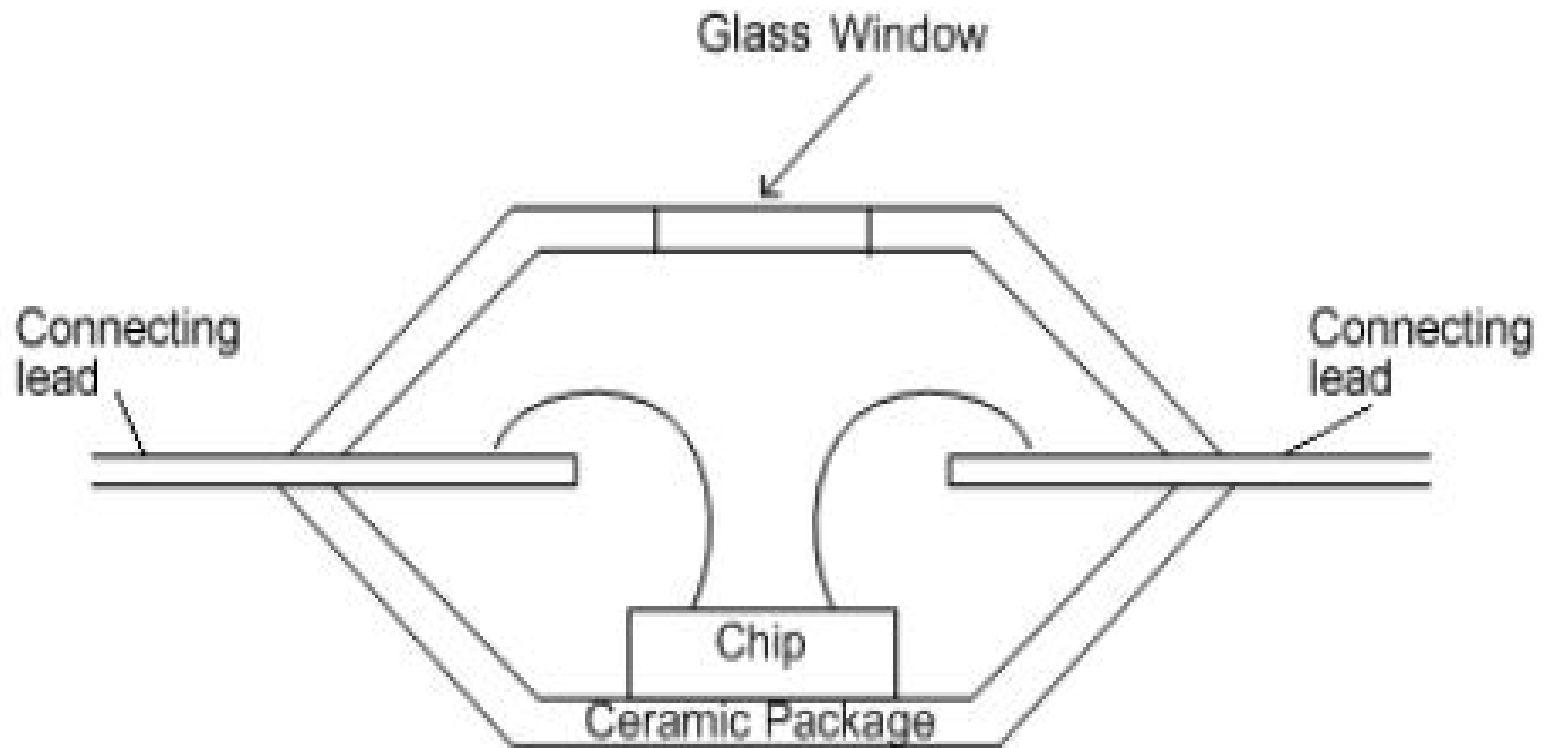
In the unprogrammed state, the 'float' does not have any charge and the MOSFET is in the OFF state. To program the cell, the 'control' above the 'float' is raised to a high enough potential such that a charge leaks to the float through SiO_2 insulating layer. Hence a channel is formed between 'Source' and 'Drain' in the silicon substrate and the MOSFET -- becomes 'ON'. The charge in the 'float' remains for a long time (typically over 30 years).

The charge can be removed by exposing the float to UV radiation. For UV erasable version, the packaging is done in a ceramic enclosure with a glass window.



Structure of an EPROM

UV Erasable PROM (EPROM)



UV erasable version of an **EPROM**

EEPROM or Electrically erasable proms

- EEPROMs are about 2.5 times larger than e proms, and are quicker to clear.
- FLASH proms are much quicker to erase (hence the name), and has the large capacity of standard ROM . They can be reprogrammed *while still on the circuit board* . Suitable for *easy upgrading* by the public of ROM chips in Modems and PCs.

Assignment No.11

- Classify different types of Memory available in Microcontroller.