SOS POLITICAL SCIENCE AND PUBLIC ADMINISTRATION

MBA FA 401

SUBJECT NAME: COMPUTER APPLICATION IN FINANCIAL ADMINISTRATION

TOPIC NAME: RANDOM ONLY MEMORY

ROM

Read Only Memory

Introduction

- **Read-only memory (ROM)** is a class of storage medium used in computers and other electronic devices. Data stored in ROM cannot be modified, or can be modified only slowly or with difficulty.
- Read Only Memories (ROM) or Programmable Read Only Memories (PROM) have:
  N input lines,
  M output lines, and
  2^N decoded minterms.
- Fixed AND array with 2^N outputs implementing all N-literal minterms.

- Programmable OR Array with M outputs lines to form up to M sum of minterm expressions.
- A program for a ROM or PROM is simply a multiple-output truth table
- If a 1 entry, a connection is made to the corresponding minterm for the corresponding output.
- If a 0, no connection is made

Can be viewed as a *memory* with the inputs as *addresses* of *data* (output values), hence ROM or PROM names!

Read only memory (ROM)

- ✓ROM holds programs and data **permanently** even when computer is switched off
- ✓Data can be read by the CPU in any order so ROM is also **direct access**
- ✓The contents of ROM are fixed at the time of manufacture
- ✓Stores a program called the **bootstrap loader** that helps start up the computer
- ✓Access time of between 10 and 50 nanoseconds

ROMS VS. RAMS

There are some important differences between ROM and RAM.

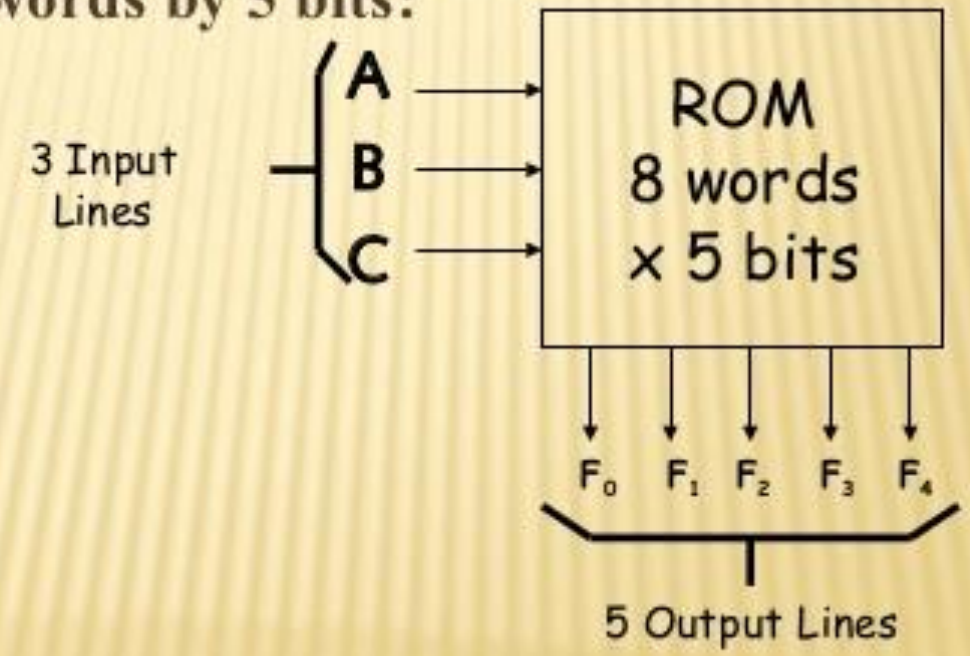
- ROMs are "non-volatile"—data is preserved even without power. On the other hand, RAM contents disappear once power is lost.
- ROMs require special (and slower) techniques for writing, so they're considered to be "read-only" devices.

Some newer types of ROMs do allow for easier writing, although the speeds still don't compare with regular RAMs.

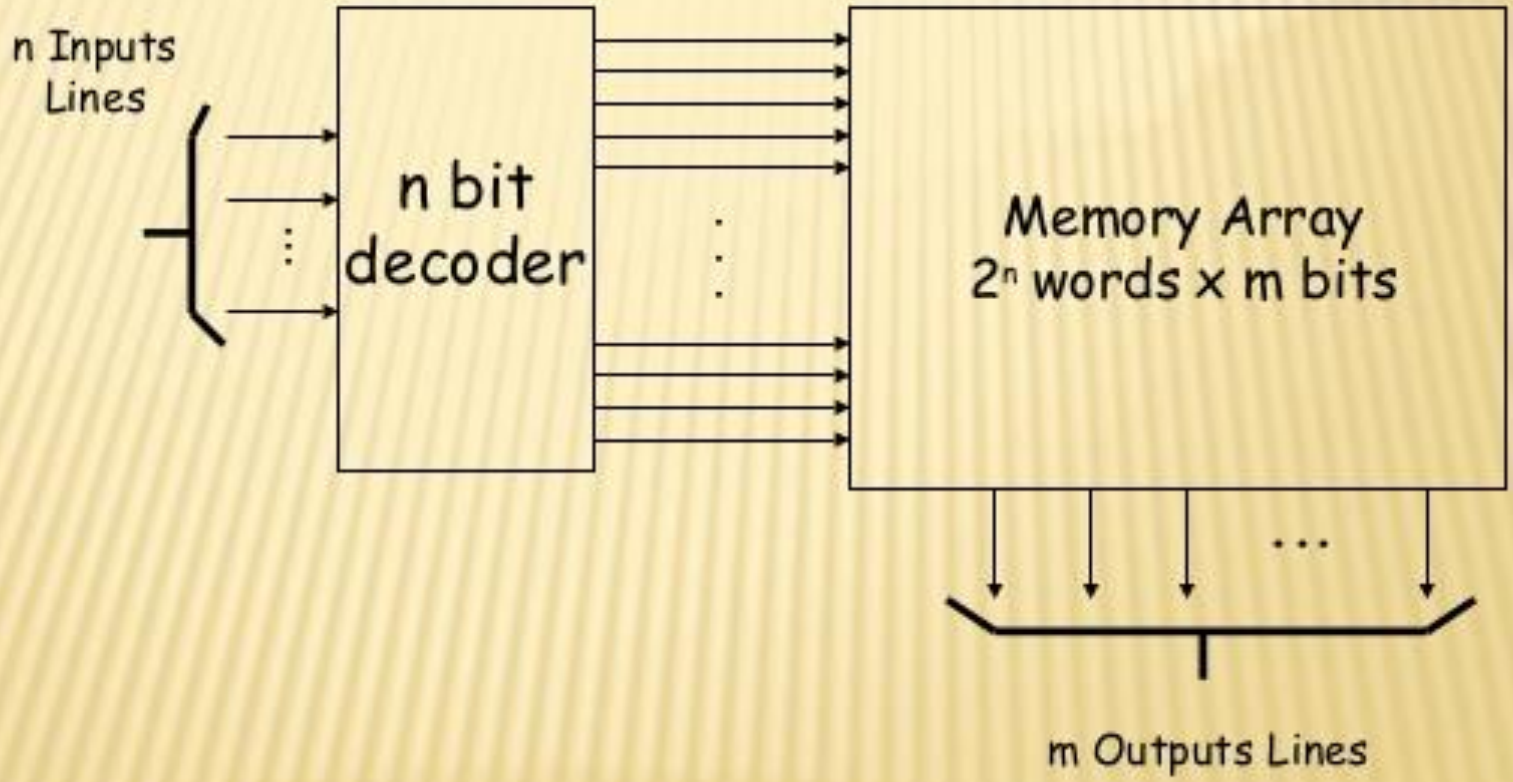
- MP3 players, digital cameras and other toys use CompactFlash, Secure Digital, or Memory Stick cards for non-volatile storage.
- Many devices allow you to upgrade programs stored in "flash ROM."

READ-ONLY MEMORY (ROM)

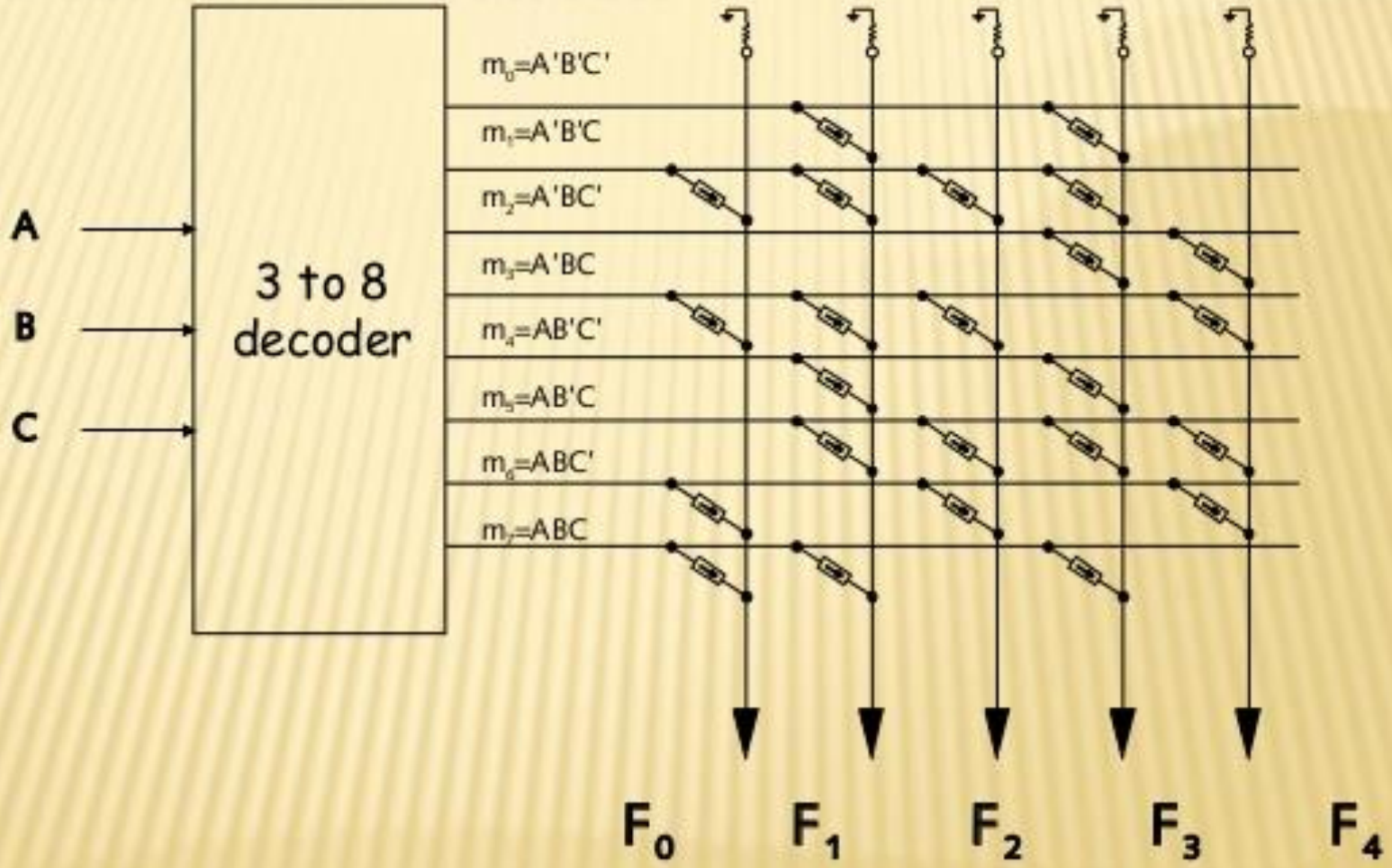
- N input bits
- 2^N words by M bits
- Implement M arbitrary functions of N variables
  - Example 8 words by 5 bits:



ROM INTERNAL STRUCTURE



ROM MEMORY ARRAY



ROM EXAMPLE

Specify a truth table for a ROM which implements:

F = AB + A′BC′

G = A′B′C + C′

H = AB′C′ + ABC′ + A′B′C

A	B	C	F	G	H
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

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0	1	0	1	1	0
0	1	1	0	0	0
1	0	0	0	1	1
1	0	1	0	0	0
1	1	0	1	1	1
1	1	1	1	0	0

Types of ROM

1. Programmable Read Only Memory (PROM)

- Empty of data when manufactured
- May be permanently programmed by the user

2. Erasable Programmable Read Only Memory (EPROM)

- Can be programmed, erased and reprogrammed
- The EPROM chip has a small window on top allowing it to be erased by shining ultra-violet light on it
- After reprogramming the window is covered to prevent new contents being erased
- Access time is around 45 – 90 nanoseconds

Types of ROM

3. Electrically Erasable Programmable Read Only Memory (EEPROM)

- Reprogrammed electrically **without** using ultraviolet light
- Must be removed from the computer and placed in a special machine to do this
- Access times between 45 and 200 nanoseconds

4. Flash ROM

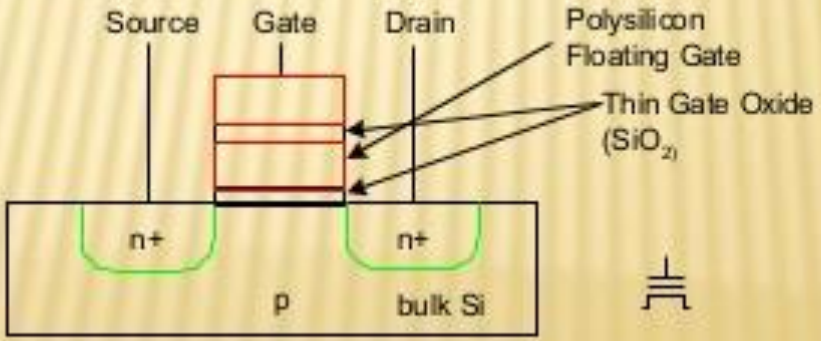
- Similar to EEPROM
- However, can be reprogrammed while still in the computer
- Easier to upgrade programs stored in Flash ROM
- Used to store programs in devices e.g. modems
- Access time is around 45 – 90 nanoseconds

PROM

One step up from the masked ROM is the PROM (programmable ROM), which is purchased in an unprogrammed state. If you were to look at the contents of an unprogrammed PROM, the data is made up entirely of 1's. The process of writing your data to the PROM involves a special piece of equipment called a device programmer. The device programmer writes data to the device one word at a time by applying an electrical charge to the input pins of the chip. Once a PROM has been programmed in this way, its contents can never be changed. If the code or data stored in the PROM must be changed, the current device must be discarded. As a result, PROMs are also known as one-time programmable (OTP) devices.

PROMS AND EPROMS

- Programmable ROMs
  - Build array with transistors at every site
  - Burn out fuses to disable unwanted transistors
- Electrically Programmable ROMs
  - Use floating gate to turn off unwanted transistors
  - EPROM, EEPROM, Flash



EPROM

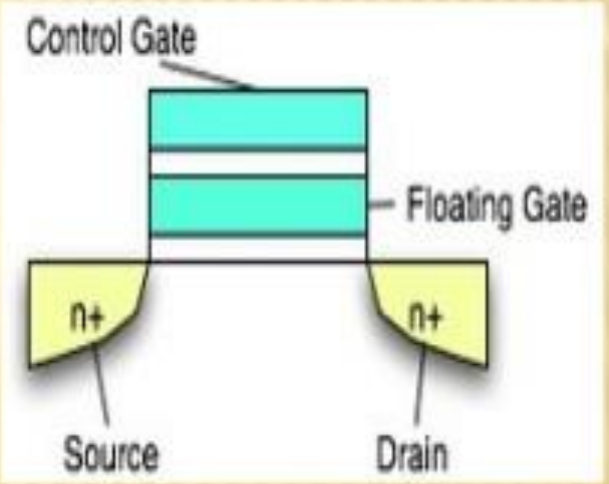
An EPROM (erasable-and-programmable ROM) is programmed in exactly the same manner as a PROM. However, EPROMs can be erased and reprogrammed repeatedly. To erase an EPROM, you simply expose the device to a strong source of ultraviolet light. (A window in the top of the device allows the light to reach the silicon.) By doing this, you essentially reset the entire chip to its initial-un-programmed-state. Though more expensive than PROMs, their ability to be reprogrammed makes EPROMs an essential part of the software development and testing process.

OPERATION

- Development of the EPROM memory cell started with investigation of faulty integrated circuits where the gate connections of transistors had broken. Stored charge on these isolated gates changed their properties. The EPROM was invented by Dov Frohman of Intel in 1971, who was awarded US patent 3660819 in 1972.
- Each storage location of an EPROM consists of a single field-effect transistor. Each field-effect transistor consists of a channel in the semiconductor body of the device. Source and drain contacts are made to regions at the end of the channel. An insulating layer of oxide is grown over the channel, then a conductive (silicon or aluminum) gate electrode is deposited, and a further thick layer of oxide is deposited over the gate electrode. The floating gate electrode has no connections to other parts of the integrated circuit and is completely insulated by the surrounding layers of oxide. A control gate electrode is deposited and further oxide covers it

To retrieve data from the EPROM, the address represented by the values at the address pins of the EPROM is decoded and used to connect one word (usually an 8-bit byte) of storage to the output buffer amplifiers. Each bit of the word is a 1 or 0, depending on the storage transistor being switched on or off, conducting or non-conducting.

The switching state of the field-effect transistor is controlled by the voltage on the control gate of the transistor. Presence of a voltage on this gate creates a conductive channel in the transistor, switching it on. In effect, the stored charge on the floating gate allows the threshold voltage of the transistor to be programmed.



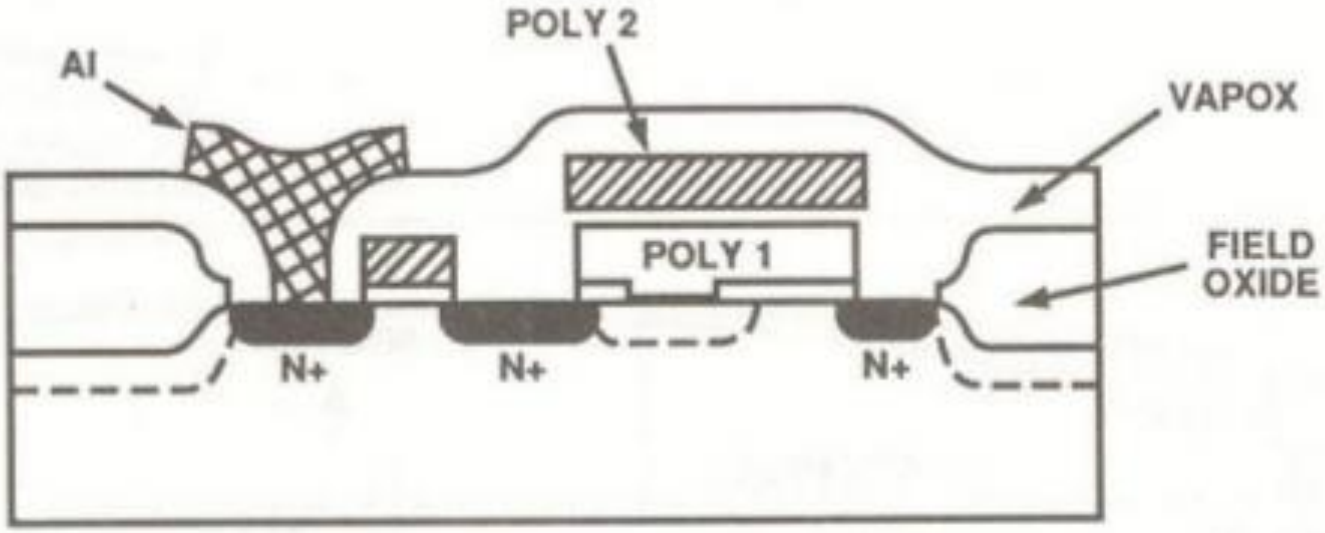
Storing data in the memory requires selecting a given address and applying a higher voltage to the transistors. This creates an avalanche discharge of electrons, which have enough energy to pass through the insulating oxide layer and accumulate on the gate electrode. When the high voltage is removed, the electrons are trapped on the electrode.[3] Because of the high insulation value of the silicon oxide surrounding the gate, the stored charge cannot readily leak away and the data can be retained for decades.

The programming process is not electrically reversible. To erase the data stored in the array of transistors, ultraviolet light is directed onto the die. Photons of the UV light cause ionization within the silicon oxide, which allow the stored charge on the floating gate to dissipate. Since the whole memory array is exposed, all the memory is erased at the same time. The process takes several minutes for UV lamps of convenient sizes; sunlight would erase a chip in weeks, and indoor fluorescent lighting over several years. Generally the EPROMs must be removed from equipment to be erased, since it's not usually practical to build in a UV lamp to erase parts in-circuit. The Electrically Erasable Programmable Read-Only Memory (EEPROM) was developed to provide an electrical erase function and has now mostly displaced ultraviolet-erased parts.

EEPROM

- **EEPROMS** are electrically-erasable-and-programmable. Internally, they are similar to EPROMs, but the erase operation is accomplished electrically, rather than by exposure to ultraviolet light. Any byte within an EEPROM may be erased and rewritten. Once written, the new data will remain in the device forever-or at least until it is electrically erased. The primary tradeoff for this improved functionality is higher cost, though write cycles are also significantly longer than writes to a RAM. So you wouldn't want to use an EEPROM for your main system memory.

EEPROM NMOS Memory Storage Device



EEPROM CMOS Memory Storage Device

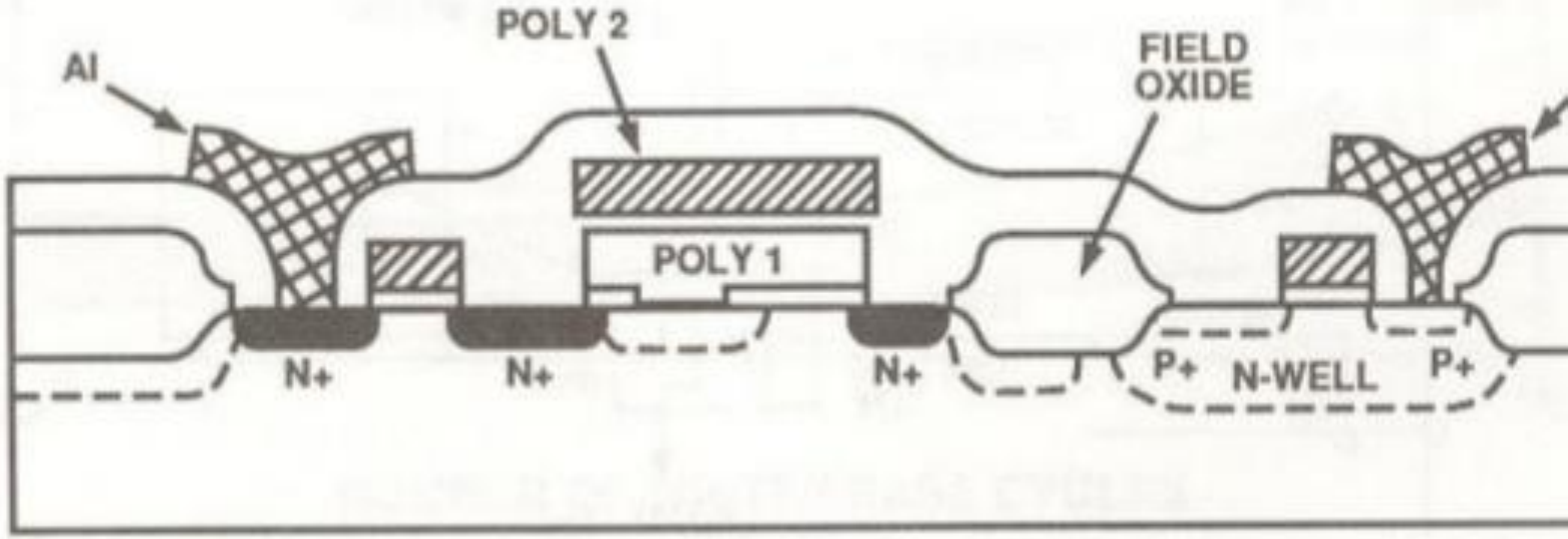


Figure 1. EEPROM Memory Storage

FLASH MEMORY (PRINCIPLES OF OPERATION)

- Flash memory stores information in an array of memory cells made from floating-gate transistors. In traditional single-level cell (SLC) devices, each cell stores only one bit of information. Some newer flash memory, known as multi-level cell (MLC) devices, including triple-level cell (TLC) devices, can store more than one bit per cell by choosing between multiple levels of electrical charge to apply to the floating gates of its cells.
- The floating gate may be conductive (typically polysilicon in most kinds of flash memory) or non-conductive (as in SONOS flash memory).

- **Flash memory** combines the best features of the memory devices described thus far. Flash memory devices are high density, low cost, nonvolatile, fast (to read, but not to write), and electrically reprogrammable. These advantages are overwhelming and, as a direct result, the use of flash memory has increased dramatically in embedded systems. From a software viewpoint, flash and EEPROM technologies are very similar. The major difference is that flash devices can only be erased one sector at a time, not byte-by-byte. Typical sector sizes are in the range 256 bytes to 16KB. Despite this disadvantage, flash is much more popular than EEPROM and is rapidly displacing many of the ROM devices as well.

Thank You