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1/7/2007

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Memory



Computer Memory



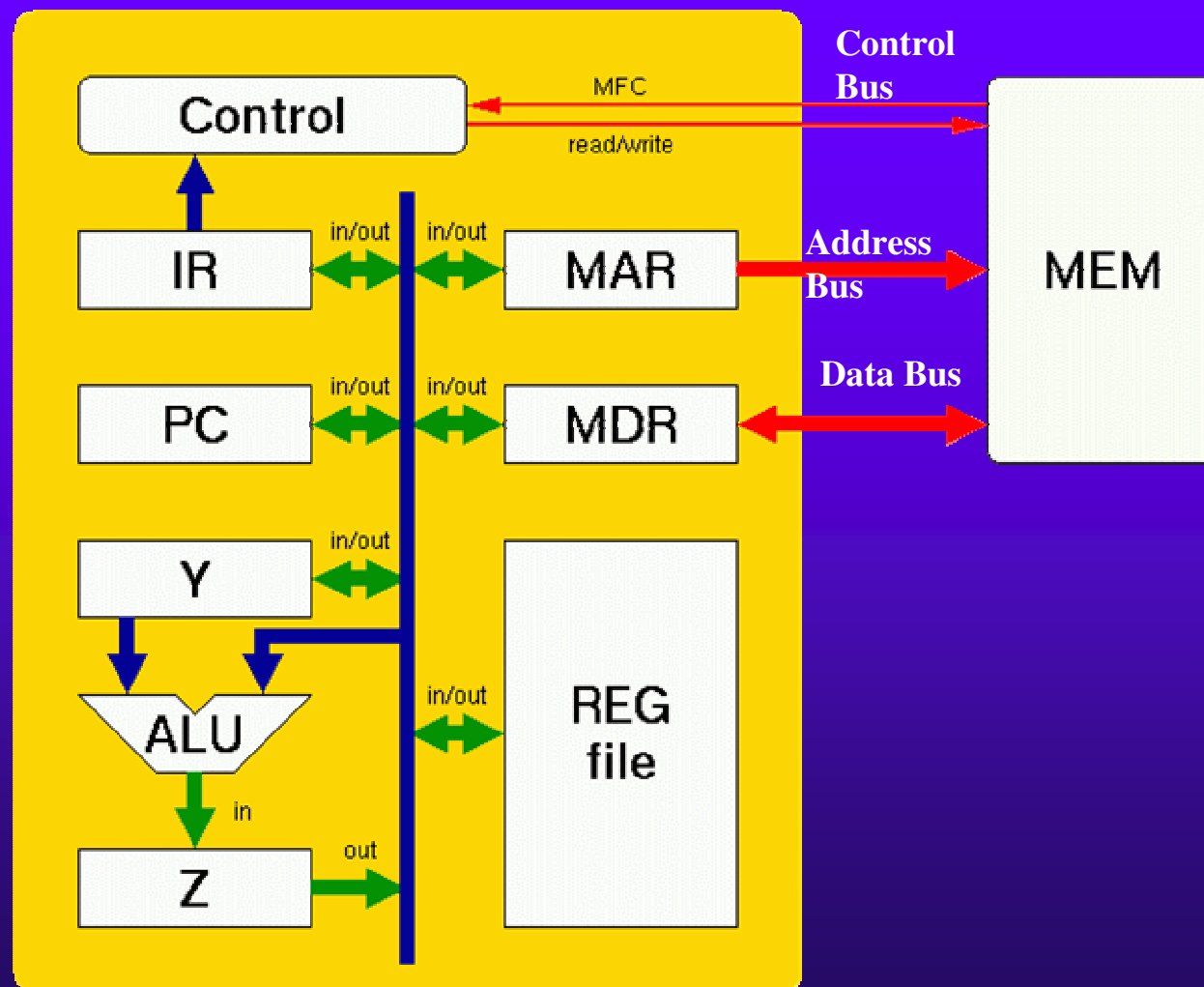
- What are the different types of memory used in computer?
- RAM
- ROM
- Cache
- Dynamic RAM
- Static RAM
- Flash memory
- Memory Sticks
- Virtual memory
- Video memory
- BIOS

Other Devices

- What are the other Devices which use memory?
- Cell phones
- PDAs
- Game consoles
- Car radios
- VCRs
- TVs



CPU and Memory



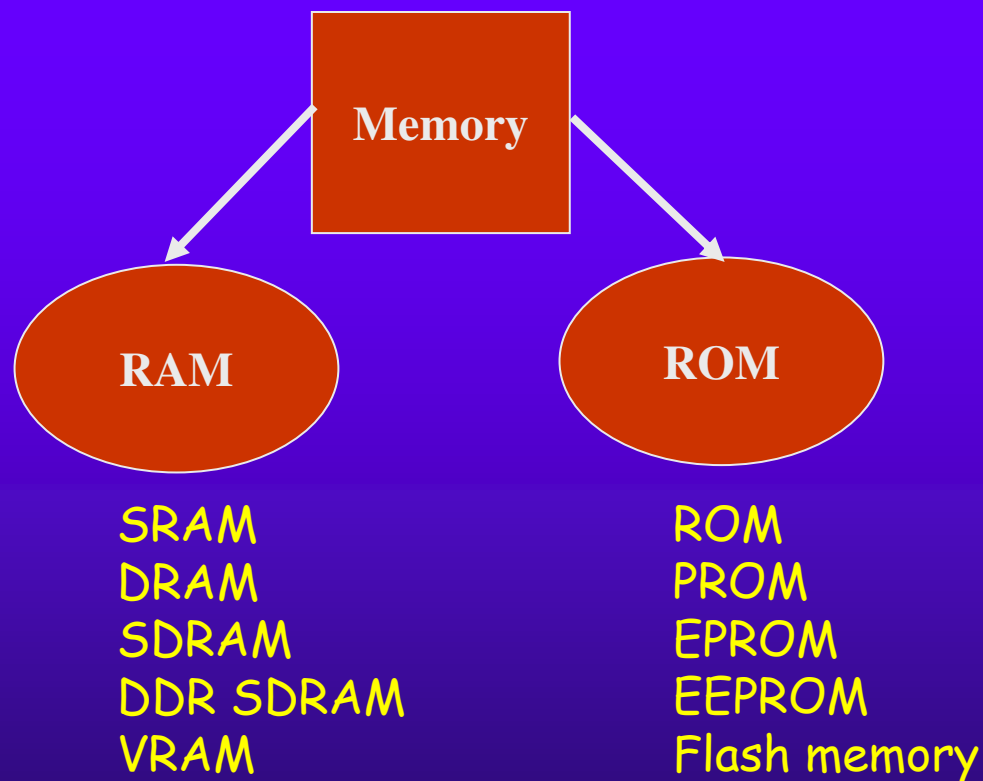
MAR and MDR

- The address to select a particular memory location is usually specified in binary form and is placed in a register called memory address register (MAR).
- The output of the memory address register drives the address bus.
- This output is used to select a memory location or in some cases, to select an input/output port.
- The memory address register is combined with a decoder logic to make the memory addressing task simpler.
- The data to be read from the memory or to be written in the memory is placed in a register called memory data register (MDR).

IR and PC

- Instruction Register contains the instruction to be executed.
- The instruction is loaded into IR from Memory through MDR
- Program Counter points to the address of the next instruction to be fetched from Memory

Memory Chips



RAM

- The best known form of computer memory is Random access memory (RAM)
- You can access any memory cell directly if you know the row and column that intersect at that cell.

Types of RAM

- What are the different types of RAM?
- SRAM
- DRAM
- SDRAM
- DDR SDRAM
- VRAM

Brief Notes on Types of RAM

- **SRAM (Static Random Access Memory)**
 - uses multiple transistors, typically four to six, for each memory cell made of flip flop.
 - It is used primarily for cache.
- **DRAM (Dynamic Random Access Memory)**
 - Has memory cells with a paired transistor and capacitor requiring constant refreshing
 - Used as computer memory



Brief Notes on Types of RAM

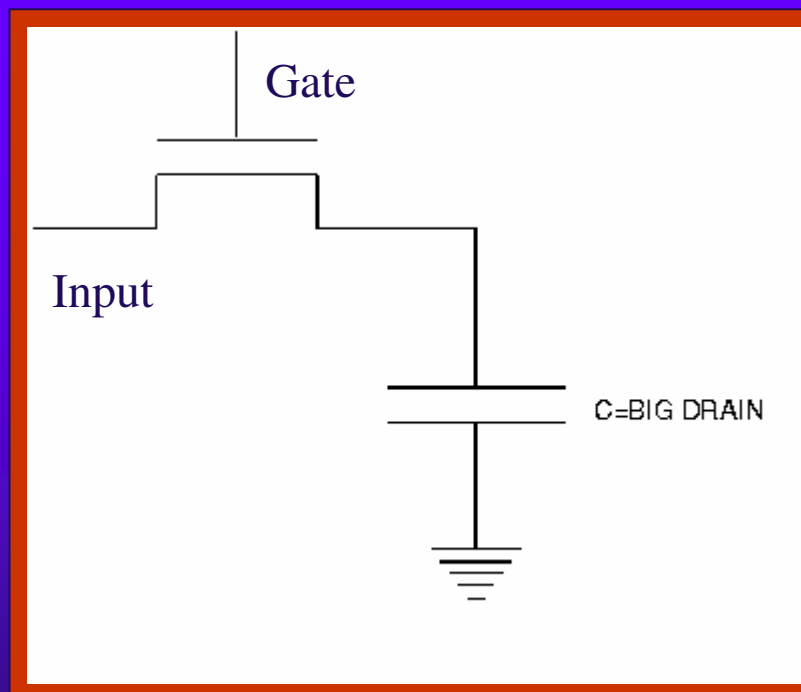
- **SDRAM (Synchronous dynamic random access memory)**
 - It does burst by staying on the row containing the requested bit and moving rapidly through the columns, reading each bit as it goes.
 - The idea is that most of the time the data needed by the CPU will be in sequence.
 - SDRAM is the most common form in desktops today.
 - Maximum transfer rate to L2 cache is approximately 528 MBps.
- **DDR SDRAM (Double data rate synchronous dynamic RAM)**
 - It is just like SDRAM except that it has higher bandwidth, meaning greater speed.
 - Maximum transfer rate to L2 cache is approximately 1,064 MBps (for DDR SDRAM 133 MHz).



Brief Notes on Types of RAM

- **VRAM: VideoRAM**
 - Also known as **multiport dynamic random access memory (MPDRAM)**
 - A type of RAM used specifically for video adapters or 3-D accelerators.
 - The "multiport" part comes from the fact that VRAM normally has two independent access ports instead of one, allowing the CPU and graphics processor to access the RAM simultaneously.
 - VRAM is located on the graphics card

DRAM Cell

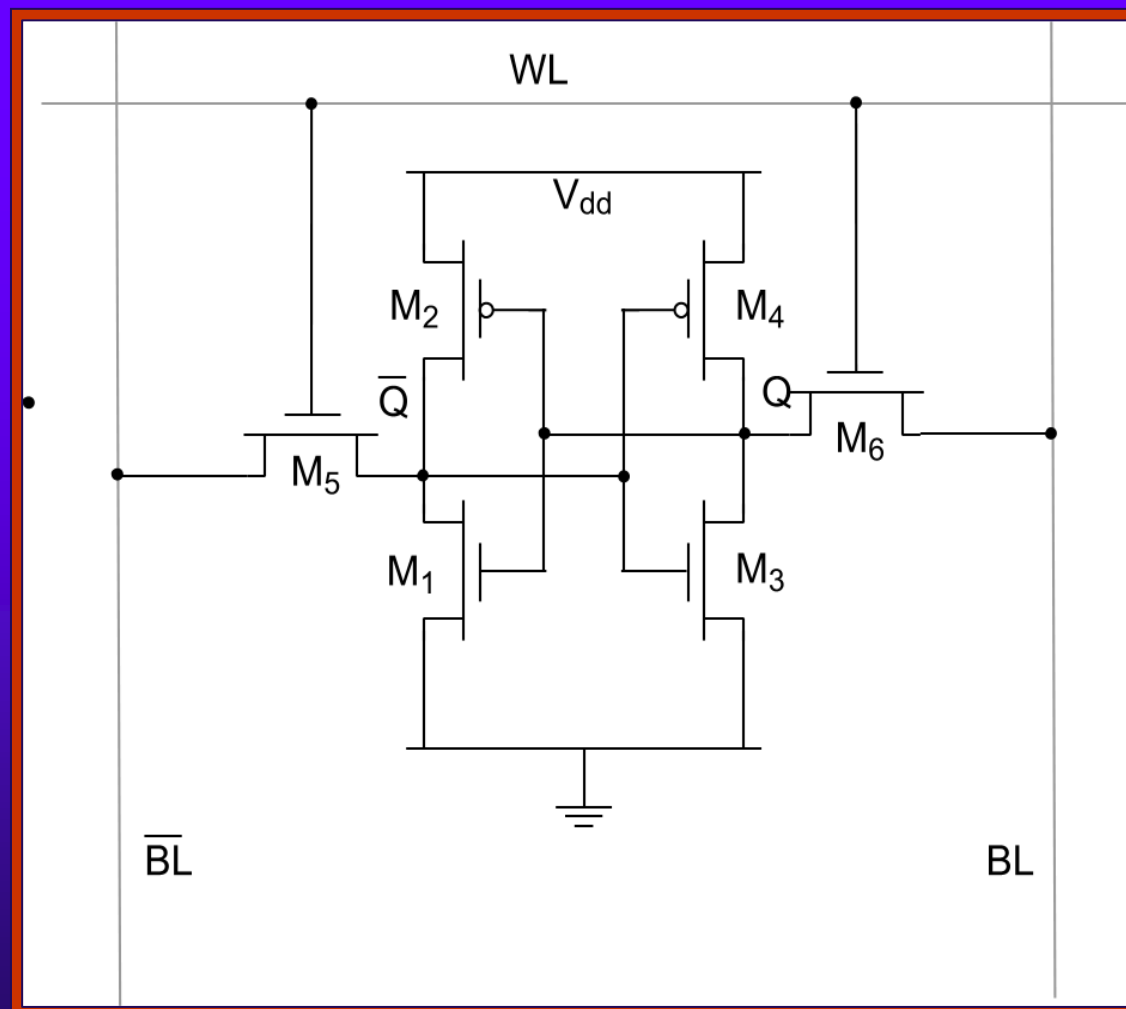


DRAM



- A transistor and a capacitor are paired to create a memory cell, which represents a single bit of data.
- The capacitor holds the bit of information -- 0 or 1
- The transistor acts as a switch that lets the control circuitry on the memory chip read the capacitor or change its state.
- A capacitor cell - Leaky bucket filled with electrons
- CPU or the memory controller has to recharge all of the capacitors holding a 1 before they discharge.
- The memory controller reads the memory and then writes it right back.
- This refresh operation happens automatically thousands of times per second.
- This refresh operation is where dynamic RAM gets its name. Dynamic RAM has to be dynamically refreshed all of the time or it forgets what it is holding.
- The downside of all of this refreshing is that it takes time and slows down the memory.

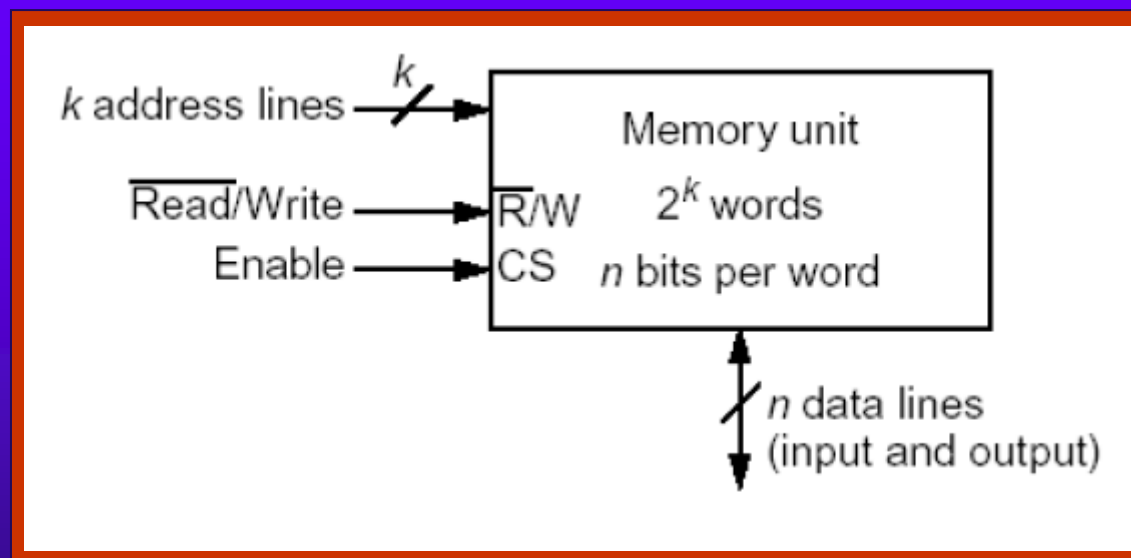
SRAM Cell



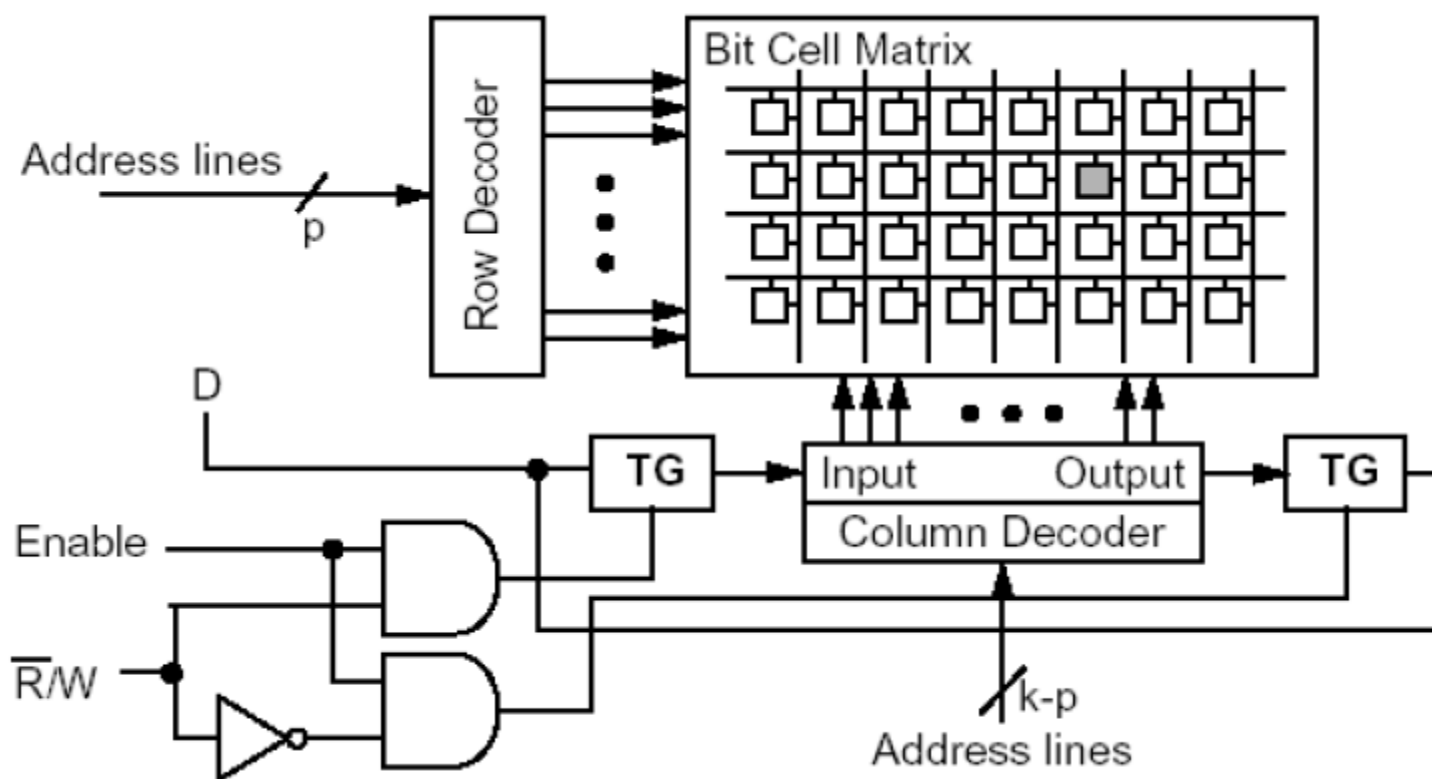
SRAM

- Flip-flop holds each bit of memory
- A flip-flop for a memory cell takes minimum four or six transistors along with some wiring, but never has to be refreshed.
- So Static RAM is significantly faster than dynamic RAM.
- As it has more parts, a static memory cell takes up a lot more space on a chip and hence less memory per chip, and expensive.
- Static RAM is fast and expensive, and dynamic RAM is less expensive and slower.
- So static RAM is used to create the CPU's speed-sensitive cache, while dynamic RAM forms the larger system RAM space.

Memory Unit



Memory Unit Control Lines





Hexadecimal to Binary

- Simply replace each hexadecimal digit by the corresponding four bit binary number
- $9F2_{16}$ ($0x9F2$)
- $= 9 \quad F \quad 2$
- $= 1001 \quad 1111 \quad 0010$
- $= 100111110010_2$



Binary to Hexadecimal

- Simply break the binary number into groups of four bits from LSB
- Convert each group into the appropriate hexadecimal digit
- $1110100110_2 = 0011 \ 1010 \ 0110$
- $= 3 \quad A \quad 6$
- $= 3A6_{16} (0x3A6)$



Size of Memory



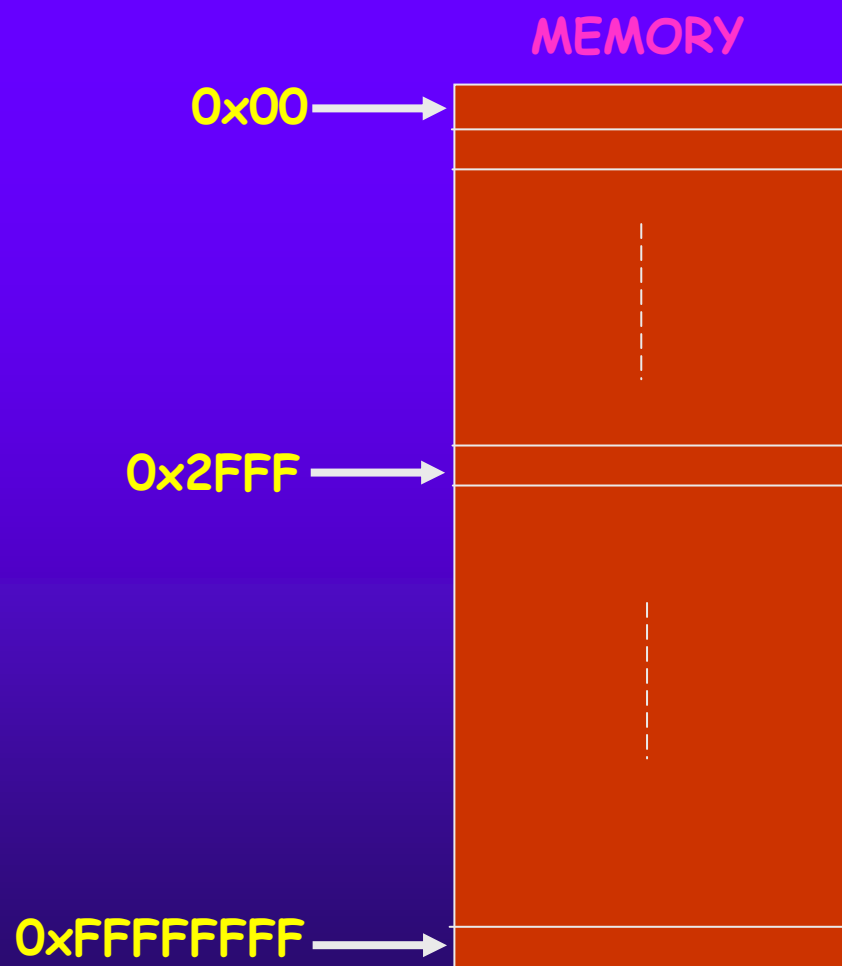
- 1 byte is 8-bits
- How many bits in 1 nibble?
- 4-bits
- $1 \text{ KB} = 2^{10} \text{ bytes} = 1024 \text{ bytes}$
- What is 10 KB?
- $10 * 1024 = 10240 \text{ bytes}$
- $1 \text{ MB} = 2^{20} \text{ bytes} = 1024 * 1024 \text{ bytes}$
- $1 \text{ GB} = 2^{30} \text{ bytes}$
- What is the size of the Memory if the address ranges from 0x00 to 0xFF?
- Size of the Memory usually means the number of data bytes the Memory can hold
- In general if the Address is an n-bit value then the size of the Memory is 2^n bytes or we can also say that the Memory will hold 2^n bytes
- If the address ranges from 0x0 to 0xFFF, then what will be the size of the memory?

Width of Memory

- Number of bits in one address location of the Memory
- It can be either 8/16/18/24/36 or more bits
- When we say size of the Memory it is Width (no. of bits) x Depth (no. of locations)



What is the size of this memory?



Types of ROM

- What are the Types of ROM?
- ROM
- PROM
- EPROM
- EEPROM
- Flash memory

ROM - General Concept

- Data stored in these chips is **nonvolatile** -- it is not lost when power is removed.
- Data stored in these chips is either **unchangeable** or requires a special operation to change

ROM

- Similar to RAM, ROM chips contain a grid of columns and rows.
- Where the columns and rows intersect, ROM chips are fundamentally different from RAM chips.
- ROM uses a diodes, Transistors, Fuses etc. to connect the lines if the value is 1.
- If the value is 0, then the lines are not connected at all.



ROM Risks

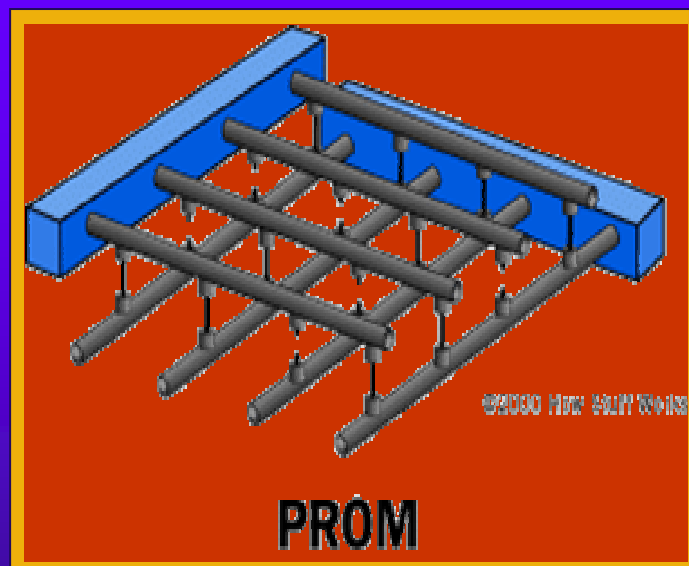
- ROM chip programming - perfect and complete
- Cannot reprogram or rewrite.
- If it is incorrect, or the data needs to be updated, ROM is discarded.
- Creating the original template for a ROM chip - laborious process full of trial and error.
- Once the template is completed, then very cheap.
- Use very little power, are extremely reliable and, in the case of most small electronic devices, contain all the necessary programming to control the device.

ROM Applications

- Handheld consoles like the Game Boy Advance and Nintendo DS continue using ROM cartridges
- BIOS or a boot-loader for a computer is often stored in ROM
- Networking or graphics card implements some basic functionality through software contained on a ROM chip.
- Storing software for embedded systems operating in physically demanding environments

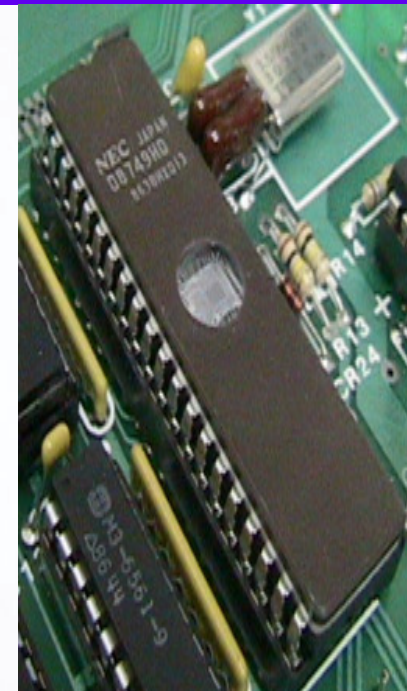
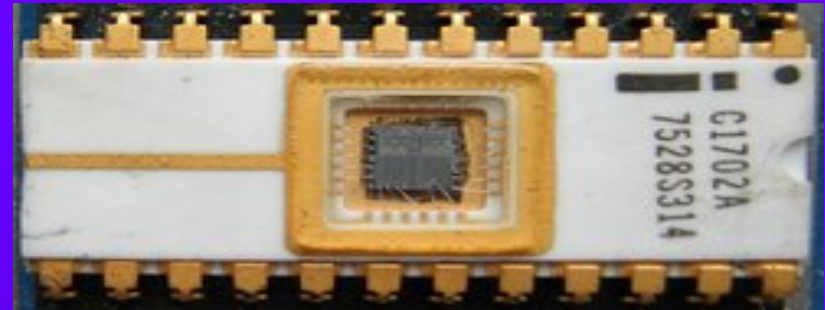
PROM

- Intersection of a column and row in a PROM chip has a **fuse** connecting them.
- Since all the cells have a fuse, the initial (**blank**) state of a PROM chip is all 1s.
- To change the value of a cell to 0, use a programmer to send a specific amount of current to the cell.
- The higher voltage breaks the connection between the column and row by **burning out the fuse**. This process is known as **burning the PROM**.

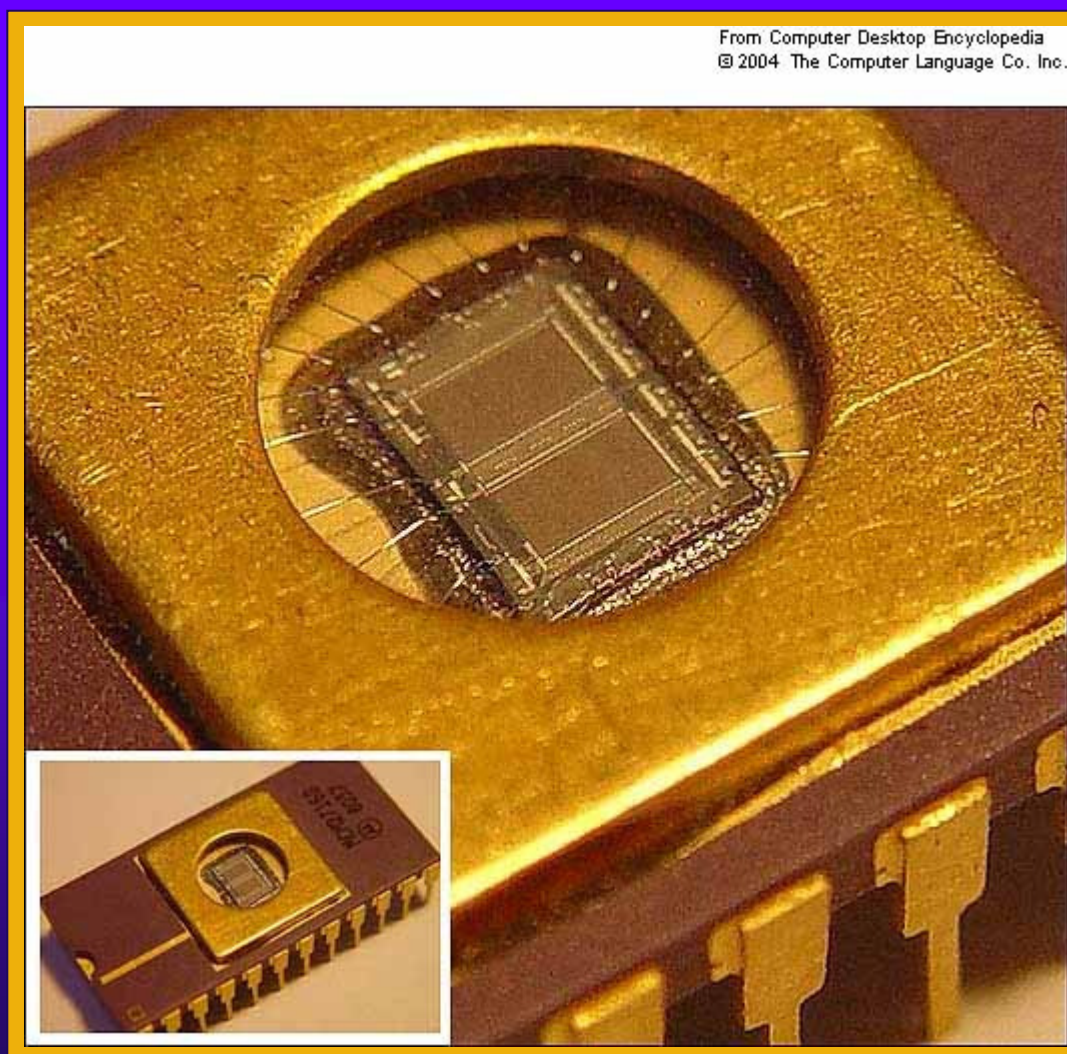


EPROM

- EPROM chips can be rewritten many times.
- Erasing an EPROM requires a special tool that emits a certain frequency of ultraviolet (UV) light.
- EPROMs are configured using an EPROM programmer that provides voltage at specified levels depending on the type of EPROM used.

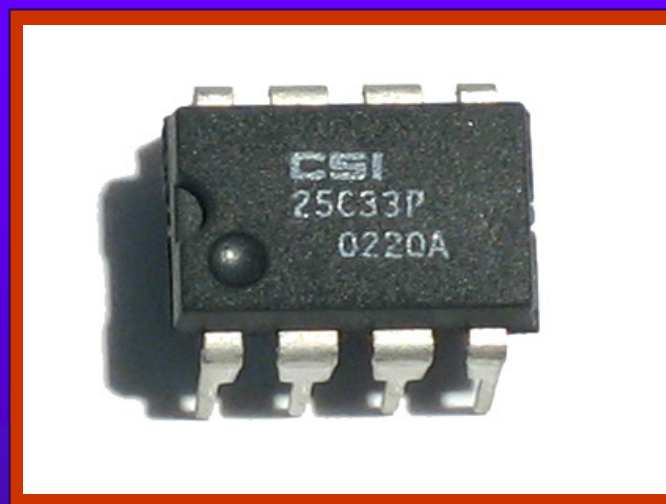


Another EPROM



EEPROM

- Similar to EPROM, but electricity is used for erasing instead of UV radiation.
- This eliminates the need of a window in the chip.
- EEPROMs are changed 1 byte at a time, which makes them versatile but slow.
- That is to erase a particular data; the entire data need not be erased.
- EEPROM is widely used in TV, Set-Top Box(STB), DVD, Audio MP3, camcorders, cameras and home appliance.



EEPROM for I²C

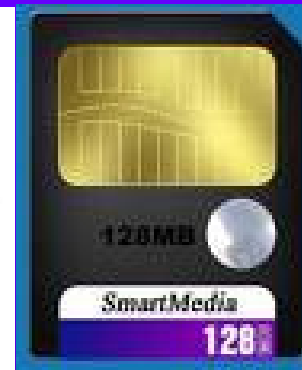


Flash Memory

- Flash memory, a type of EEPROM that uses in-circuit wiring to erase by applying an electrical field to the entire chip or to predetermined sections of the chip called blocks.
- Flash memory works much faster than traditional EEPROMs
- It writes data in chunks, usually 512 bytes in size, instead of 1 byte at a time

Flash Memory Examples

- Computer's BIOS chip
- CompactFlash (most often found in digital cameras)
- SmartMedia (most often found in digital cameras)
- Memory Stick (most often found in digital cameras)
- PCMCIA Type I and Type II memory cards (used as solid-state disks in laptops)
- Memory cards for video game consoles





Q & A



Thank you