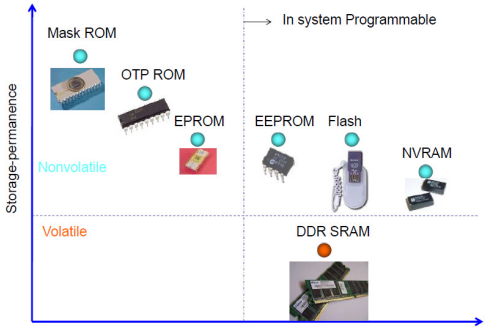
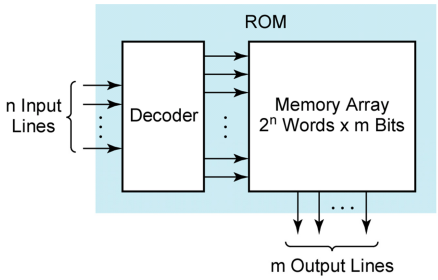
ECEN 4856

LECTURE 6

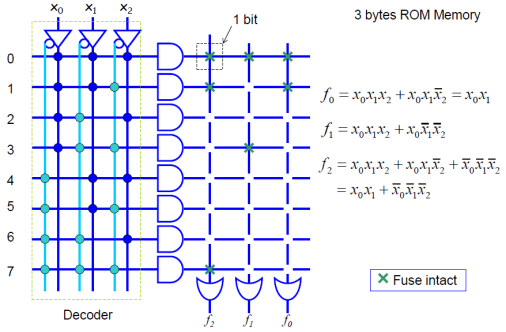
MEMORY TYPE



BASIC ROM STRUCTURE



ROM – FIXED AND & OR GATES



$f_0 = x_0x_1x_2 + x_0x_1\bar{x}_2 = x_0x_1$

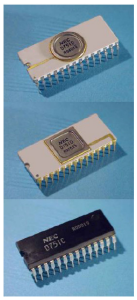
$f_1 = x_0x_1x_2 + x_0\bar{x}_1\bar{x}_2$

$f_2 = x_0x_1x_2 + x_0x_1\bar{x}_2 + \bar{x}_0\bar{x}_1\bar{x}_2$
$= x_0x_1 + \bar{x}_0\bar{x}_1\bar{x}_2$

MASK ROM (MROM)

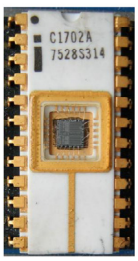
NEC uPD751

- Data bus width 4-bit
- White/Tin CerDIP, round lid, 28 tin leads
- The uPD751 ran at a clock speed was 1.0MHz (Single phase)
- 2500 transistors, N-Channel MOS process.
- Manufactured in 1971
- Expensive to setup, while cheaper if produced in large volume



ERASABLE PROGRAMMABLE READ-ONLY MEMORY (EPROM)

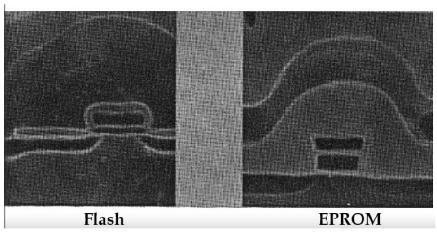
- The first INTEL EPROM, the 1702 (1971), 256 Bytes, 1 MHz
- EPROMs are easily recognizable by the transparent quartz window on top of the package,
- Through the window, the silicon chip can be seen
- The window also permits UV light during erasing.



ELECTRICALLY ERASABLE PROGRAMMABLE READ-ONLY MEMORY (EEPROM)

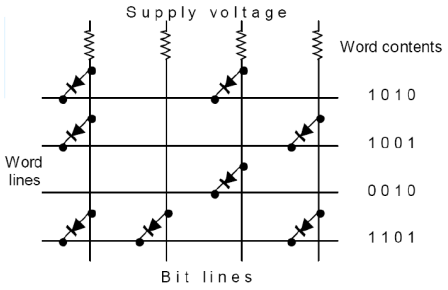
- The M24M01 supports 100 kHz and 400 kHz clock frequencies, in full compliance with the I2C specification
- 1.8V to 5.5V supply-voltage
- Organized as 128-Kbits x 8,
- Fast Write time of 256 Bytes in less than 5ms.
- Improved input noise filtering protects against spurious Write operations in electrically noisy environments.
- Data retention is more than 40 years
- Write Endurance of more than 1 million Write cycles.
- The operating temperature range is -40 to +85 degrees C.

CROSS SECTIONS OF THE NON-VOLATILE MEMORIES

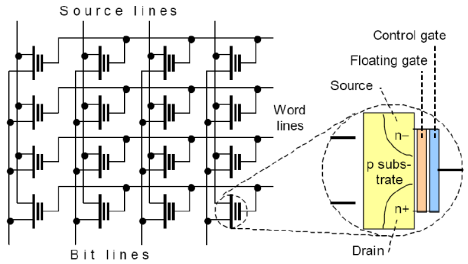


Source: intel

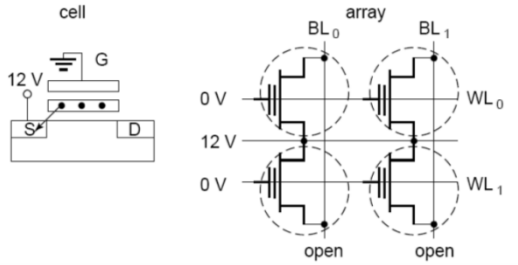
ROM



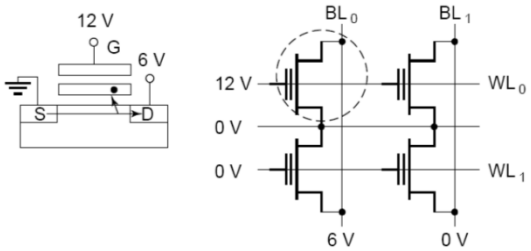
EEPROM OR FLASH



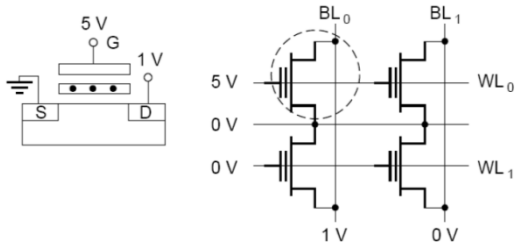
NOR FLASH ROM – ERASE OPERATION



NOR FLASH ROM – WRITE OPERATION



NOR FLASH ROM – READ OPERATION



RAM (RANDOM ACCESS MEMORY)

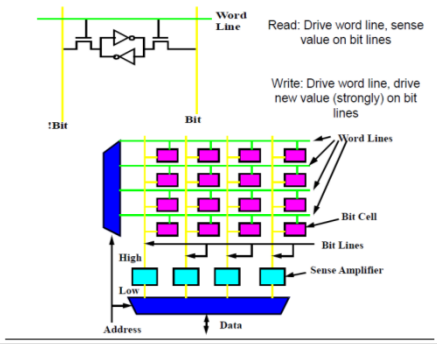
Random Access Memory

- Two main types: Static RAM (SRAM) and Dynamic RAM (DRAM)
  - Differences lie in how bits are stored
  - Other types: Flash RAM, SDRAM, Video RAM, FERAM

Computer Compatibility Desktop memory
Memory Size 2GB (pair of 1GB DIMMs)
Type of Memory PC2-5300 DDR2
240-pin DDR dual in-line memory modules (DIMMs)
Operates at up to 667MHz

RAM (RANDOM ACCESS MEMORY)

- **Static random access memory (SRAM)**
  - Operates like a collection of latches
  - Once value is written, it is guaranteed to remain in the memory as long as power is applied
  - Generally expensive
  - Used **inside processors** (like the Pentium D)
  - Faster compares to the DRAM
- **Dynamic random access memory (DRAM)**
  - Generally, simpler internal design than SRAM
  - Requires data to be rewritten (refreshed), otherwise data is lost
  - Often hold larger amount of data than SRAM
  - Longer access times than SRAM
  - Used as **main memory** in computer systems



OTHER RAM TYPES

- Video RAM
  - Optimized for high-speed regular accesses to frame buffer
- SDRAM
  - Uses clocked organization to pipeline for speed
- Flash RAM
  - Non-volatile (holds data without power)
- FERAM (NVRAM)
  - Uses magnetic technology (similar to hard disk) to store data
    - Holds value when power off
    - Capacity, access time similar to RAM (hard disks take ms)
- Nanotech RAMs
  - Molecular electronics, carbon nanotubes
  - Nowhere near ready for prime time

FPGA ON-CHIP MEMORY

ASIC Application Specific Integrated Circuit	FPGA Field Programmable Gate Array
• designed all the way from behavioral description to physical layout	• no physical layout design; design ends with a bitstream used to configure a device
• designs must be sent for expensive and time consuming fabrication in semiconductor foundry	• **bought off the shelf and reconfigured by designers themselves**

RELATIVE MEMORY SIZES AND USE

- SRAM is primarily a fast, but expensive, solution
- DRAM is primarily a pretty fast, but cheaper (dense) solution
- FERAM is a non-volatile, expensive, special solution
- Block Select RAM is embedded SRAM on Xilinx FPGAs