ECEN 4856

LECTURE 6

MEMORY TYPE

BASIC ROM STRUCTURE

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

ROM

EEPROM OR FLASH

NOR FLASH ROM – ERASE OPERATION

NOR FLASH ROM – WRITE OPERATION
**NOR FLASH ROM – READ OPERATION**

![NOR Flash ROM Circuit](image)

**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 compared 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)**
  - Designed all the way from behavioral description to physical layout
  - Designs must be sent for expensive and time consuming fabrication in semiconductor foundry

- **FPGA (Field Programmable Gate Array)**
  - No physical layout design; design ends with a bitstream used to configure a device
  - 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