Graphics Display Hardware

- Display technologies
  - CRT, LCD, etc.
- Drawing methods
  - Vector (random), raster
- Control circuitry
  - Scan generation, color, buffering

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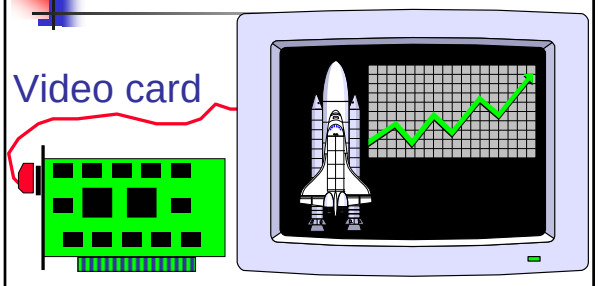
Video Display



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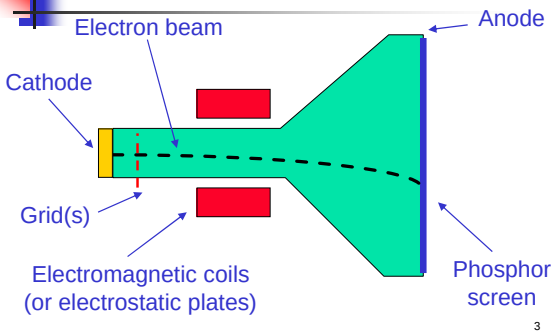
Cathode Ray Tube (CRT)



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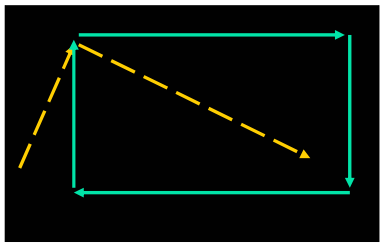
Vector (Random) Scanning



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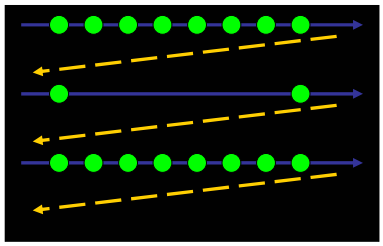
Raster Scanning



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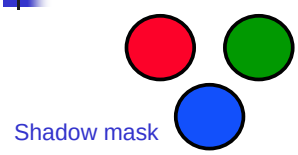
CRT Color Display



Trinitron

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Liquid Crystal Displays

- Controlled polarization
  - Voltage determines effect
  - Transmits or reflects light
- Drive mechanisms
  - Active - transistor per pixel
  - Passive - multiplexed
  - Speed, contrast differences

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Raster Scan System Design

- Frame buffer memory
  - Part of main memory (DMA)
  - Isolated (blanking interval access?)
  - Dual-port
- Video controller
  - Scan generator
  - Video shift register(s)

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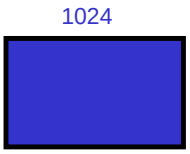
Video Display Timing Example



1024 * 768 = 786,432 pixels

What about interlace?

768 lines (+ blanking) = 900 lines (approx.)

If refresh rate = 70 Hz, 63K lines/s, 15.9 μs/line.

1024 pixels (+ blanking) = 1300 (approx.)

Pixel time = 12 ns, dot clock = 82 MHz?

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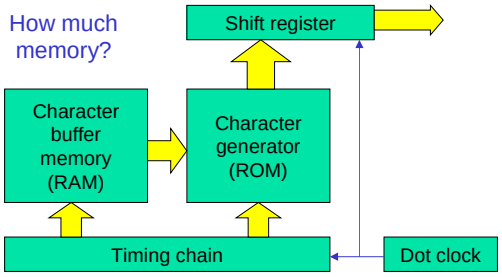
Text Display Systems

How much memory?



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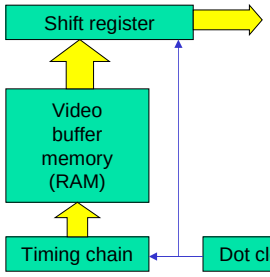
Graphics Display Systems

How much memory now?



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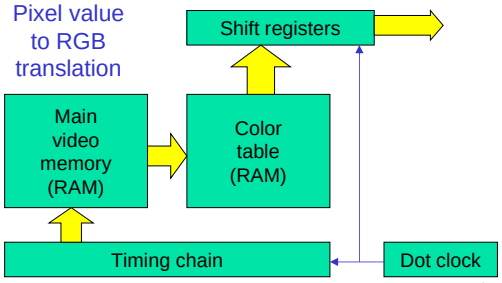
Color Lookup Table (Map)

Pixel value to RGB translation



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Video DAC

- Digital-to-analog converter
  - Gray-scale: one DAC
  - RGB: three DACs
- Converts binary to voltage
  - Must be fast
- With shift reg., color table?
  - RAMDAC

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Design Exercise

- Simple CRT display
  - Vertical frequency: 60 Hz
  - Active scan lines: 240 (of 256)
  - Active pixels/line: 384 (of 512)
  - Colors: 16 of 512 possible
- Design circuitry

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