

Display Technology

▶ Images stolen from various locations on the web...

Cathode Ray Tube

The diagram illustrates the basic structure of a Cathode Ray Tube (CRT). It shows a vacuum tube with a curved neck. At the rear, a Cathode is connected to a High Voltage source (indicated by a '+' sign). An Anode is positioned further forward. The tube is labeled 'Cathode Ray Tube' and 'Fluorescent Screen' at the front. A small copyright notice '© 2008 IBM' is visible at the bottom right.

Cathode Ray Tube

This detailed diagram shows the internal components of a CRT. From left to right: a Heater is connected to the Cathode. A Control Grid is located just behind the cathode. The Electron beam travels through the tube, passing through a Focusing coil and then Deflecting coils. The beam terminates at the Anode, which is connected to a high voltage source. The beam eventually strikes the Fluorescent screen at the front of the tube.

Raster Scanning

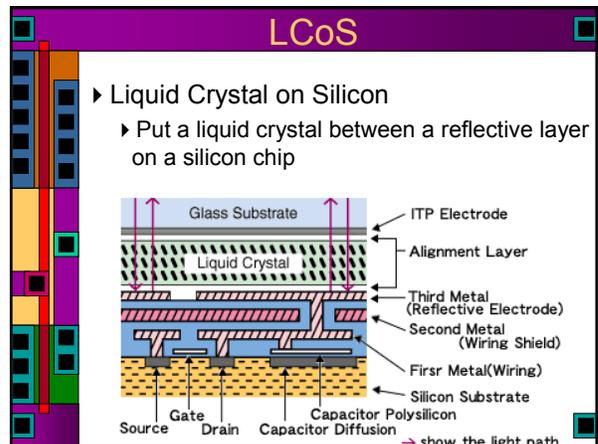
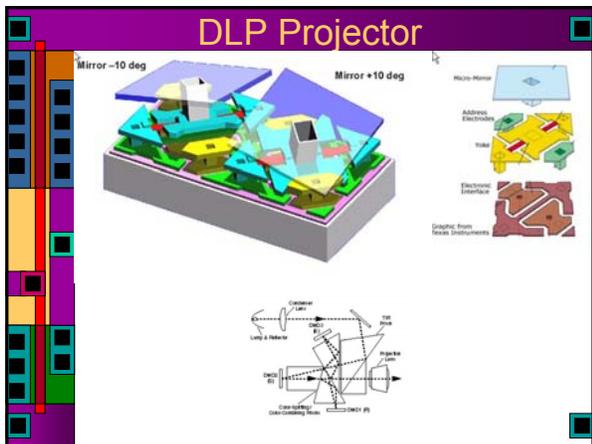
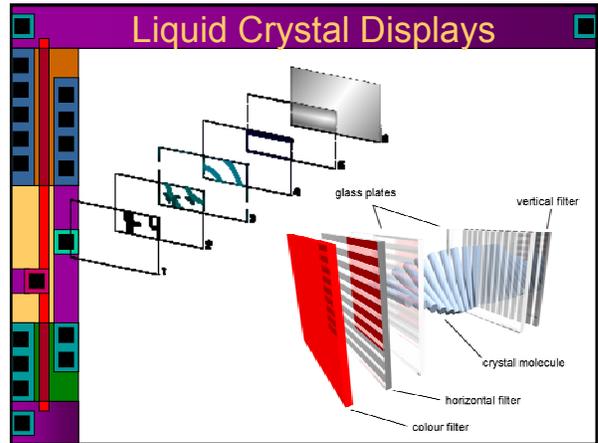
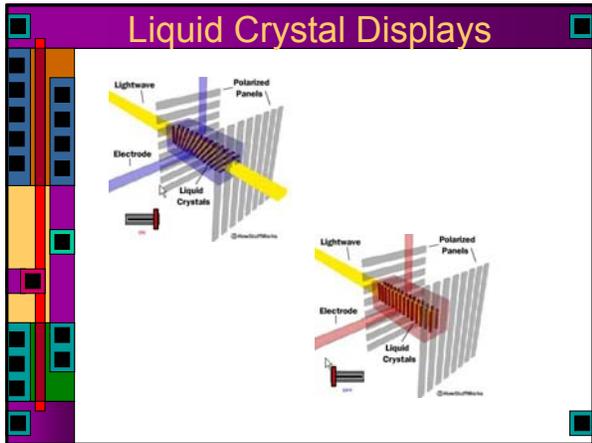
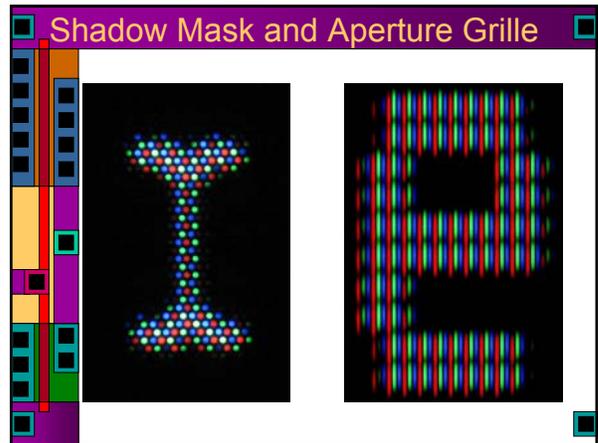
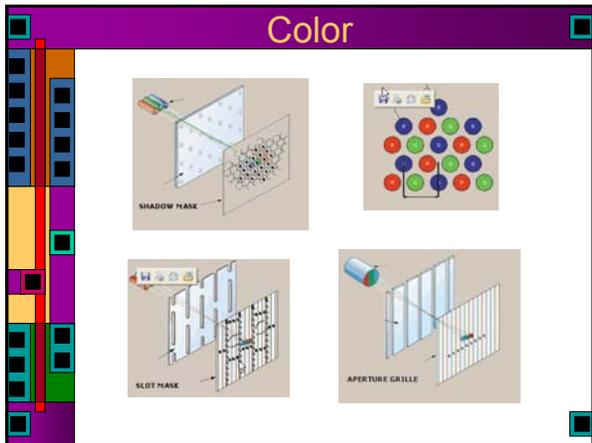
The diagram illustrates the raster scanning process. It shows a rectangular area representing the screen. Horizontal lines represent the lines of the image being scanned. A diagonal line represents the path of the electron beam as it scans across the screen from top to bottom, line by line.

Electron Gun

This block contains three images related to an electron gun. The top image is a photograph of a complete electron gun assembly. The middle image is a photograph of a disassembled electron gun, showing its cylindrical metal housing. The bottom image is a schematic diagram of an electron gun, showing the cathode, control grid, and anode, with an electron beam being emitted from the cathode.

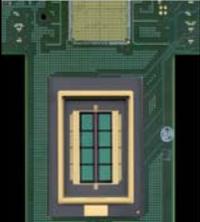
Beam Steering Coils

This block contains three photographs showing beam steering coils. The top image shows a coil assembly with a label '10000'. The middle image shows a similar coil assembly with a label '10000'. The bottom image shows a coil assembly with a label '10000'. These are likely the deflection coils used to steer the electron beam in a CRT.

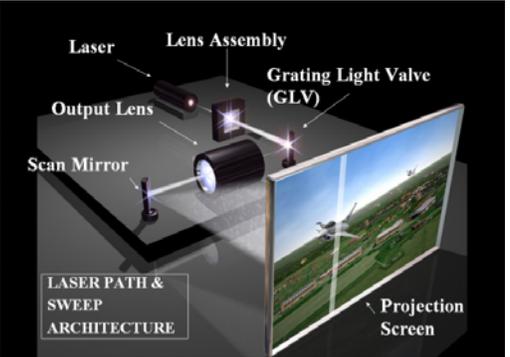


Grating Light Valve (GLS)

- ▶ lots (8000 currently) of micro ribbons that can bend slightly
 - ▶ Make them reflective
 - ▶ The bends make a diffraction grating that controls how much light where
 - ▶ Scan it with a laser for high light output
 - ▶ 4000 pixel wide frame ever 60Hz



Grating Light Valve (GLS)



LASER PATH & SWEEP ARCHITECTURE

Digistar 3 Dome Projector



VGA

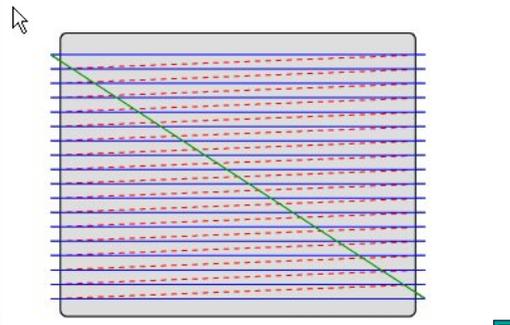
- ▶ Stands for Video Graphics Array
- ▶ A standard defined by IBM back in 1987
 - ▶ 640 x 480 pixels
 - ▶ Now superseded by much higher resolution standards...
- ▶ Also means a specific analog connector
 - ▶ 15-pin D-subminiature VGA connector

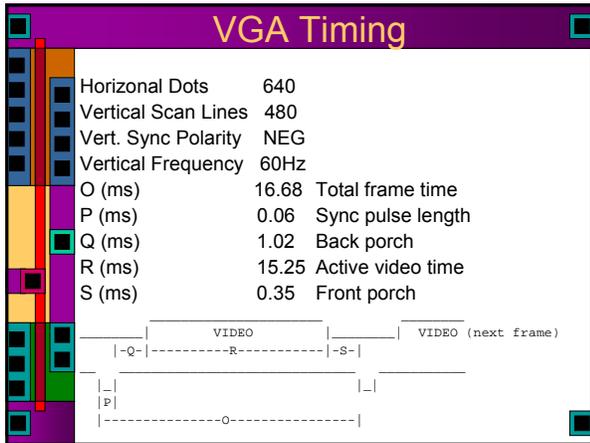
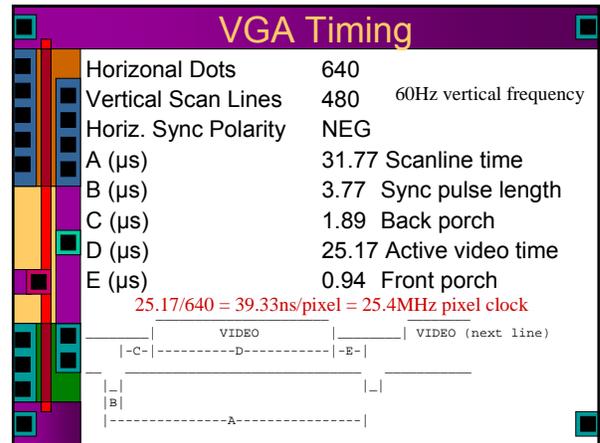
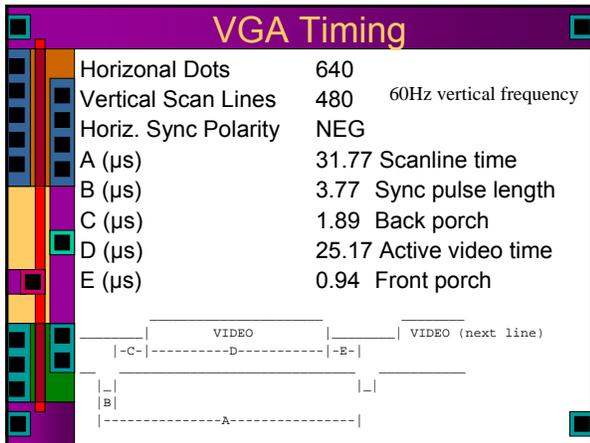
VGA Connector



1: Red out	6: Red return (ground)	11: Monitor ID 0 in
2: Green out	7: Green return (ground)	12: Monitor ID 1 in or data from display
3: Blue out	8: Blue return (ground)	13: Horizontal Sync
4: Unused	9: Unused	14: Vertical Sync
5: Ground	10: Sync return (ground)	15: Monitor ID 3 in or data clock

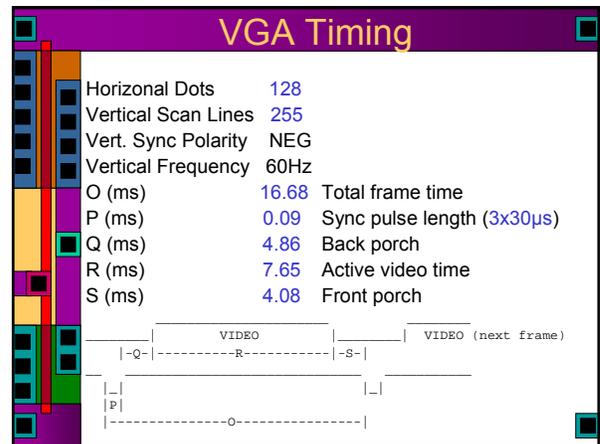
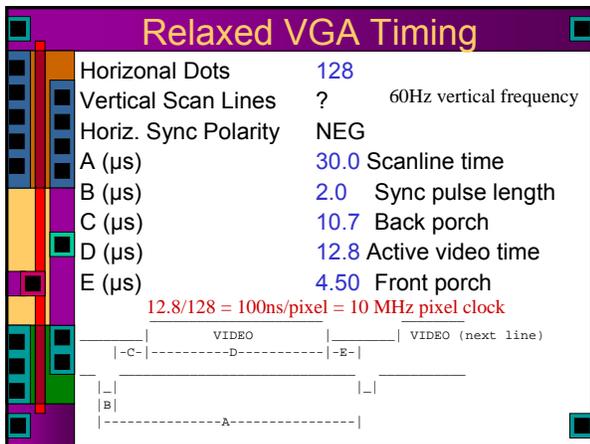
Raster Scanning





Relaxed VGA Timing

- ▶ This all sounds pretty strict and exact...
- ▶ It's not really... The only things a VGA monitor really cares about are:
 - ▶ **Hsync**
 - ▶ **Vsync**
 - ▶ **Actually, all it cares about is the falling edge of those pulses!**
 - ▶ The beam will retrace whenever you tell it to
 - ▶ It's up to you to make sure that the video signal is 0v when you are not painting (i.e. retracing)



VGA Voltage Levels

- ▶ Voltages on R, G, and B determine the color
 - ▶ Analog range from 0v (off) to +0.7v (on)
 - ▶ But, our pads produce 0-5v outputs!

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 - ▶ For B&W output, just tie RGB together and let 0v=black and 5v=white
 - ▶ overdrives the input amps, but won't really hurt anything
 - ▶ For color you can drive R, G, B separately
 - ▶ Of course, this is only 8 colors (including black and white)
 - ▶ Requires storing three bits at each pixel location

More colors

- ▶ More colors means more bits stored per pixel
- ▶ Also means D/A conversion to 0 to 0.7v range

More Colors (Xess)

What to Display?

- ▶ You need data to display on the screen...
 - ▶ Brute force: put it all in a giant ram that has the same resolution as your screen and just walk through the RAM as you paint the screen
 - ▶ More clever: Fill a row buffer with data for a scan line
 - ▶ Multi-level: Fill a (smaller) row buffer with pointers to glyphs that are stored in another RAM/ROM
- ▶ Just keep track of where the beam is and where your data is...

CharROM

