# Display devices.

A display device is an output device for presentation of information in visual or tactile form (the latter used for example in tactile electronic displays for blind people).

When the input information that is supplied has an electrical signal the display is called an electronic display.

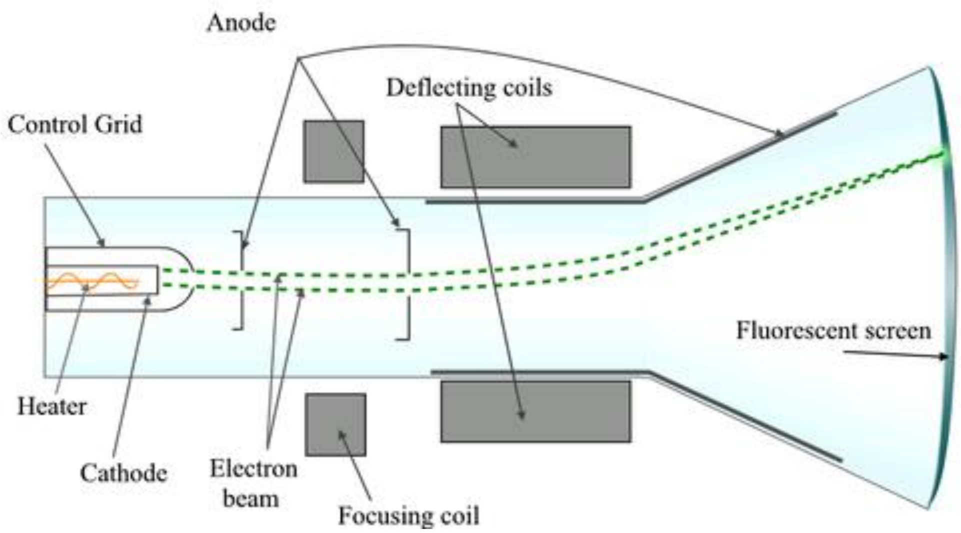
Common applications for electronic visual displays are television sets or computer monitors.

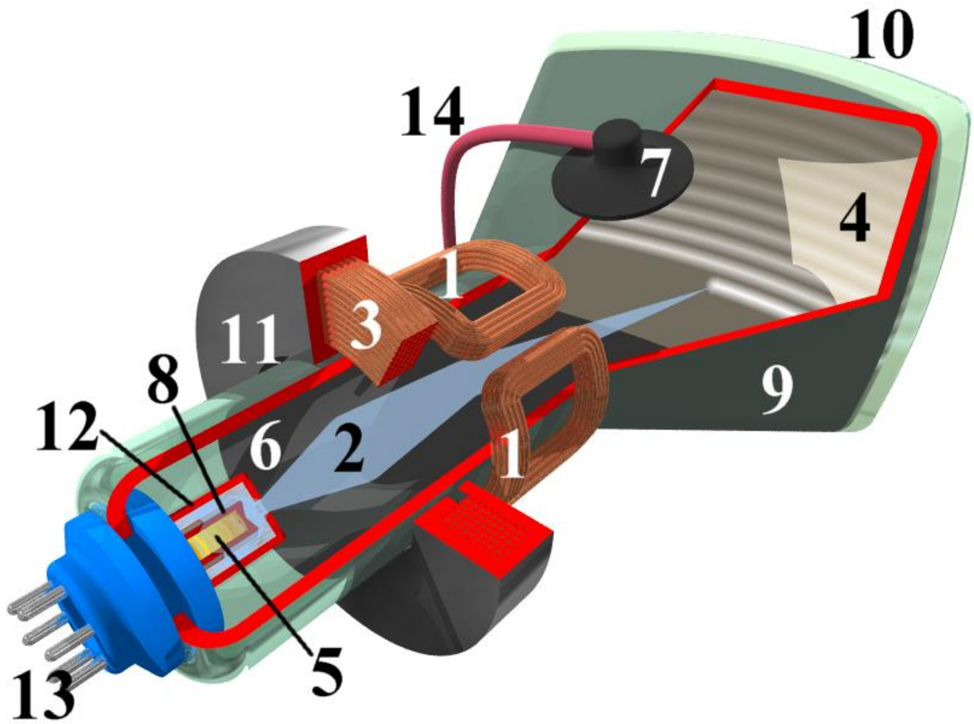
Electrically operated display devices have developed from electromechanical systems for display of text, up to all-electronic devices capable of full-motion 3D color graphic displays. Electromagnetic devices, using a solenoid coil to control a visible flag or flap, were the earliest type, and were used for text displays such as stock market prices and arrival/departure display times.

The cathode ray tube was the workhorse of text and video display technology for several decades until being displaced by plasma, liquid crystal (LCD), and solid-state devices such as thin-film transistors (TFTs), LEDs and OLEDs.

With the advent of metal–oxide–semiconductor field-effect transistors (MOSFETs), integrated circuit (IC) chips, microprocessors, and microelectronic devices, many more individual picture elements ("pixels") could be incorporated into one display device, allowing graphic displays and video.

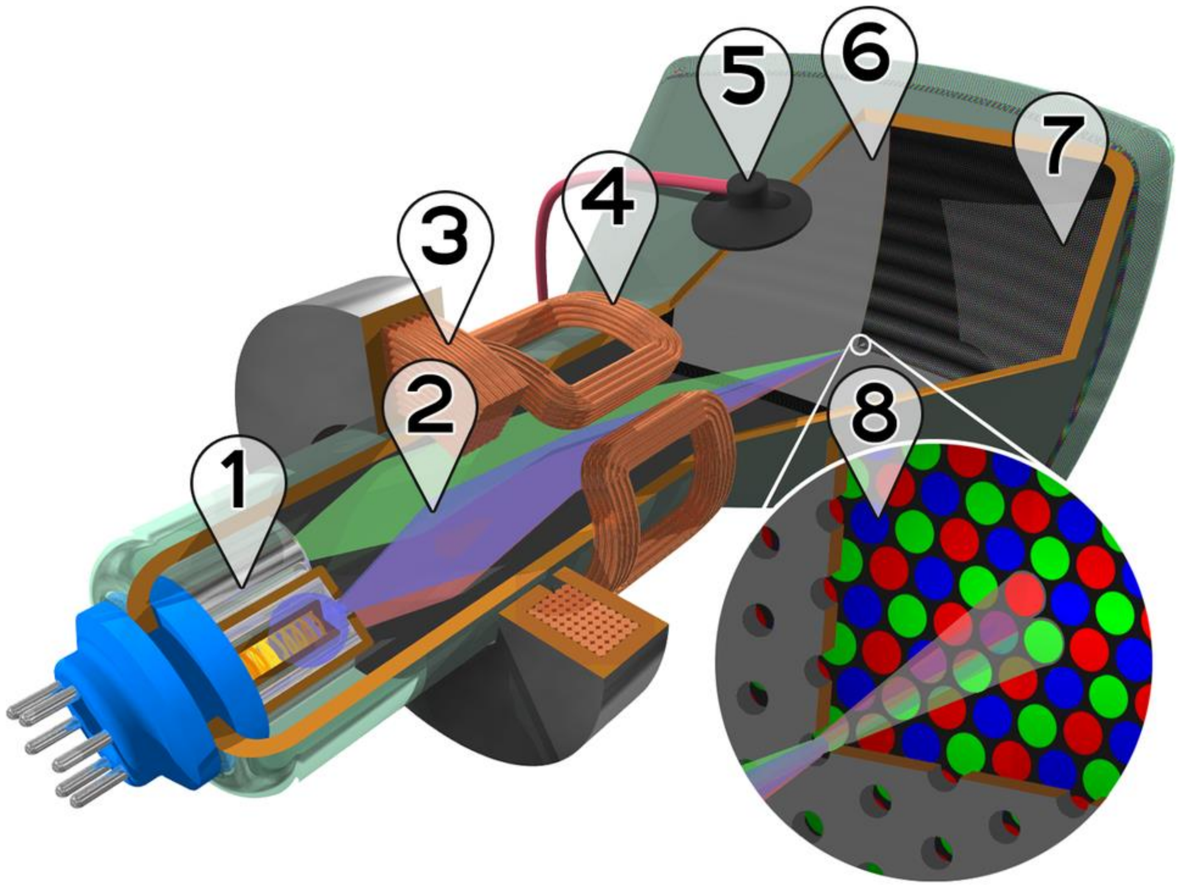
# Cathode Ray Tube (CRT)





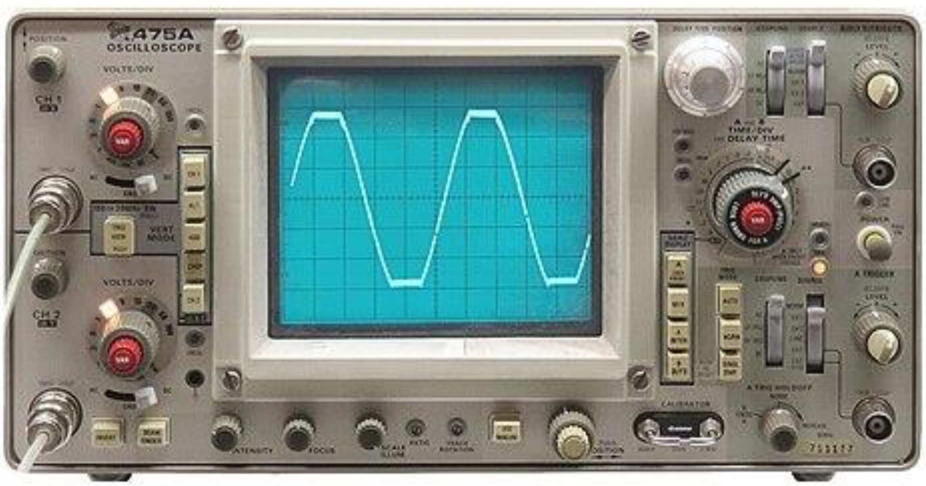

**Cutaway rendering of a monochrome CRT:**

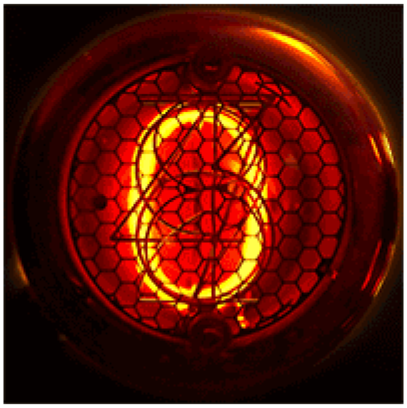
1. Deflection coils
2. Electron Beam and Electron Gun
3. Focusing coil
4. Phosphor layer on the inner side of the screen; emits light when struck by the electron beam
5. Filament for heating the cathode
6. Graphite layer on the inner side of the tube
7. Rubber or silicone gasket where the anode voltage wire enters the tube (anode cup)
8. Cathode
9. Air-tight glass body of the tube
10. Screen
11. Coils in yoke
12. Control electrode regulating the intensity of the electron beam and thereby the light emitted from the phosphor.
13. Contact pins for cathode, filament and control electrode.
14. Wire for anode high voltage.
15. The only visible differences are the single electron gun, the uniform white phosphor coating, and the lack of a shadow mask.




**Cutaway rendering of a color CRT:**

1. Three electron emitters (for red, green, and blue phosphor dots)
2. Electron Beams and Electron Guns
3. Focusing coils
4. Deflection coils
5. Connection for final anodes
6. Mask for separating beams for red, green, and blue part of the displayed image.
7. Phosphor layer (screen)with red, green, and blue zones
8. Close-up of the phosphor-coated inner side of the screen


475A
OSCILLOSCOPE
VOLTS/DIV
CH 1
CH 2
VERT MODE
TIME/DIV
DELAY TIME
INTENSITY
FOCUS
CALIBRATOR
POWER
LEVEL



Nixie tube display

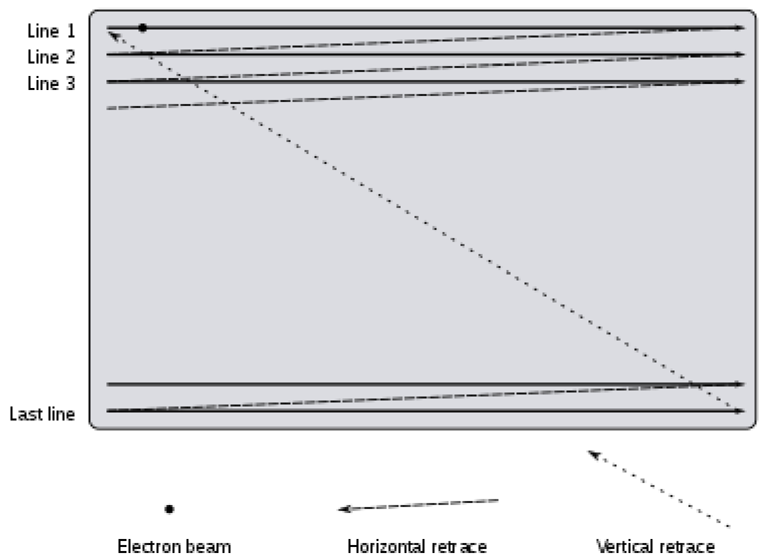

Flip-flap or disc display


LED display

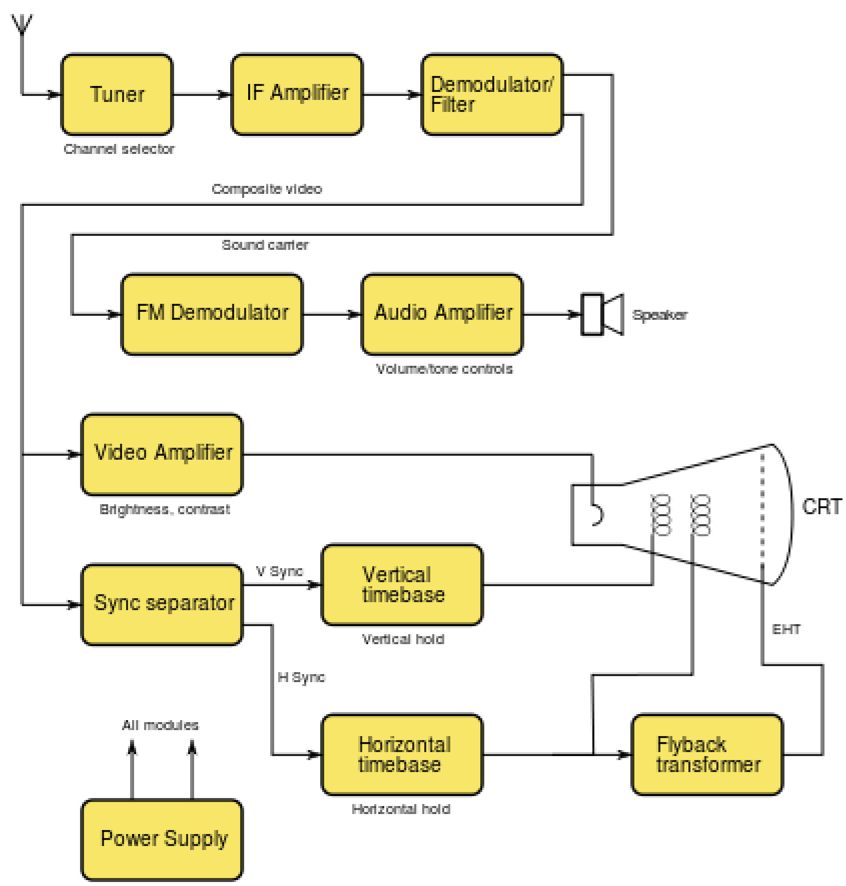
Organic display


Electronic paper

Electroluminescent display



Line 1
Line 2
Line 3
Last line
Electron beam
Horizontal retrace
Vertical retrace

Tuner
Channel selector
IF Amplifier
Demodulator/ Filter
Composite video
Sound carrier
FM Demodulator
Audio Amplifier
Volume/tone controls
Speaker
Video Amplifier
Brightness, contrast
CRT
Sync separator
V Sync
Vertical timebase
Vertical hold
EHT
H Sync
All modules
Horizontal timebase
Horizontal hold
Flyback transformer
Power Supply

The tuner is the object which, with the aid of an antenna, isolates the television signals received over the air. There are two types of tuners in analog television, VHF and UHF tuners. The VHF tuner selects the VHF television frequency. This consists of a 4 MHz video bandwidth and a 2 MHz audio bandwidth. It then amplifies the signal and converts it to a 45.75 MHz Intermediate Frequency (IF) amplitude-modulated video and a 41.25 MHz IF frequency-modulated audio carrier.

The IF amplifiers are centered at 44 MHz for optimal frequency transference of the audio and video carriers.[k] Like radio, television has automatic gain control (AGC). This controls the gain of the IF amplifier stages and the tuner.

The video amp and output amplifier is implemented using a pentode or a power transistor. The filter and demodulator separates the 45.75 MHz video from the 41.25 MHz audio then it simply uses a diode to detect the video signal. After the video detector, the video is amplified and sent to the sync separator and then to the picture tube.

The audio signal goes to a 4.5 MHz amplifier. This amplifier prepares the signal for the 4.5Mhz detector. It then goes through a 4.5 MHz IF transformer to the detector. In television, there are 2 ways of detecting FM signals. One way is by the ratio detector. This is simple but very hard to align. The next is a relatively simple detector. This is the quadrature detector. It was invented in 1954. The first tube designed for this purpose was the 6BN6 type. It is easy to align and simple in circuitry. It was such a good design that it is still being used today in the Integrated circuit form. After the detector, it goes to the audio amplifier.

Image synchronization is achieved by transmitting negative-going pulses.[l] The horizontal sync signal is a single short pulse that indicates the start of every line. Two-timing intervals are defined – the front porch between the end of the displayed video and the start of the sync pulse, and the back porch after the sync pulse and before the displayed video. These and the sync pulse itself are called the horizontal blanking (or retrace) interval and represent the time that the electron beam in the CRT is returning to the start of the next display line.

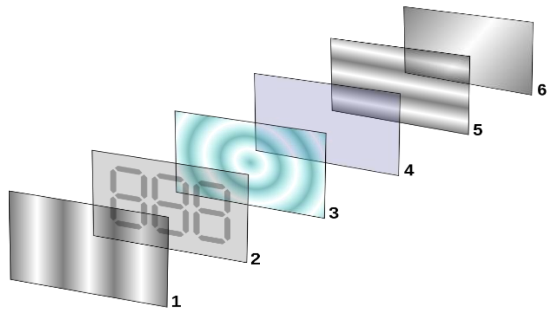
The vertical sync signal is a series of much longer pulses, indicating the start of a new field. The vertical sync pulses occupy the whole of line interval of a number of lines at the beginning and end of a scan; no picture information is transmitted during vertical retrace. The pulse sequence is designed to allow horizontal sync to continue during vertical retrace.[m]

A sync separator circuit detects the sync voltage levels and extracts and conditions signals that the horizontal and vertical oscillators can use to keep in sync with the video. It also forms the AGC voltage.

The horizontal and vertical oscillators form the raster on the CRT. They are driven by the sync separator. There are many ways to create these oscillators. The earliest is the thyratron oscillator. Although it is known to drift, it makes a perfect sawtooth wave. This sawtooth wave is so good that no linearity control is needed. This oscillator was designed for the electrostatic deflection CRTs but also found some use in electromagnetically deflected CRTs. The next oscillator developed was the blocking oscillator which uses a transformer to create a sawtooth wave. This was only used for a brief time period and never was very popular. Finally the multivibrator was probably the most successful. It needed more adjustment than the other oscillators, but it is very simple and effective. This oscillator was so popular that it was used from the early 1950s until today.

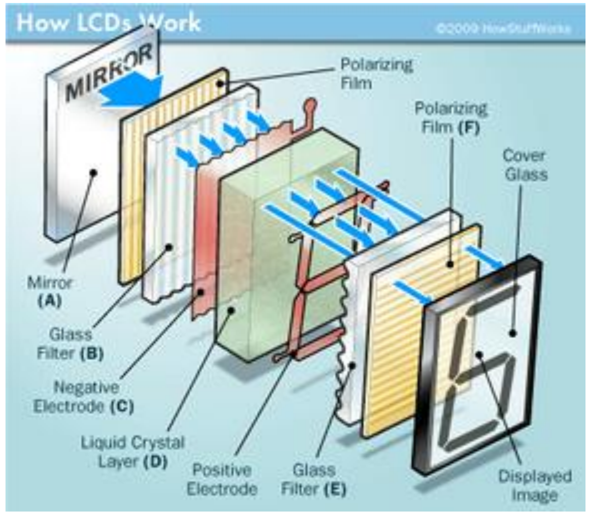
Two oscillator amplifiers are needed. The vertical amplifier directly drives the yoke. Since it operates at 50 or 60 Hz and drives an electromagnet, it is similar to an audio amplifier. Because of the rapid deflection required, the horizontal oscillator requires a high-power flyback transformer driven by a high-powered tube or transistor. Additional windings on this flyback transformer typically power other parts of the system.

LCD Display




The layers of a reflective twisted nematic liquid crystal display:

1. Polarizing filter film with a vertical axis to polarize light as it enters.
2. Glass substrate with ITO electrodes. The shapes of these electrodes will determine the shapes that will appear when the LCD is switched ON. Vertical ridges etched on the surface are smooth.
3. Twisted nematic liquid crystal.
4. Glass substrate with common electrode film (ITO) with horizontal ridges to line up with the horizontal filter.
5. Polarizing filter film with a horizontal axis to block/pass light.
6. Reflective surface to send light back to viewer. (In a backlit LCD, this layer is replaced or complemented with a light source.)




The LCD needed to do this job is very basic. It has a mirror (A) in back, which makes it reflective. Then, we add a piece of glass (B) with a polarizing film on the bottom side, and a common electrode plane (C) made of indium-tin oxide on top. A common electrode plane covers the entire area of the LCD. Above that is the layer of liquid crystal substance (D). Next comes another piece of glass (E) with an electrode in the shape of the rectangle on the bottom and, on top, another polarizing film (F), at a right angle to the first one.