Computer architectures

Additional devices

Általános
INFORMATIKAI
Tanszék

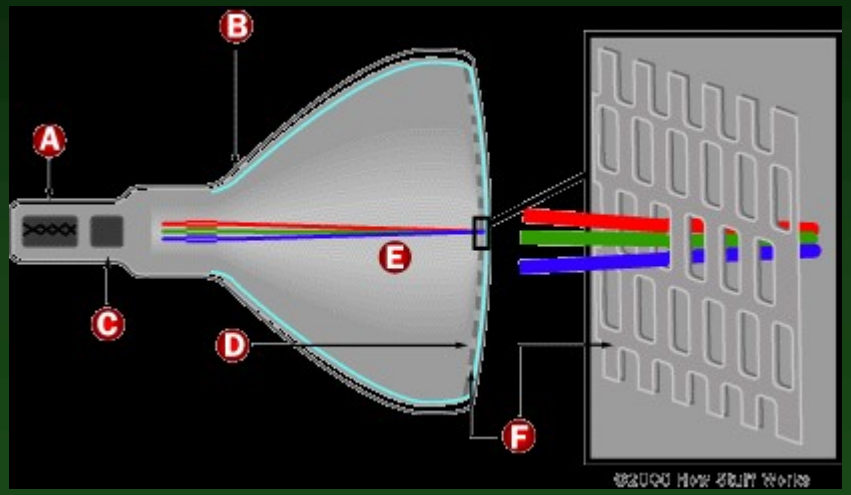
The program

- Terminals (classic, memory mapped)
- Other devices (printer, mouse, drawing machines, etc.)

Terminals

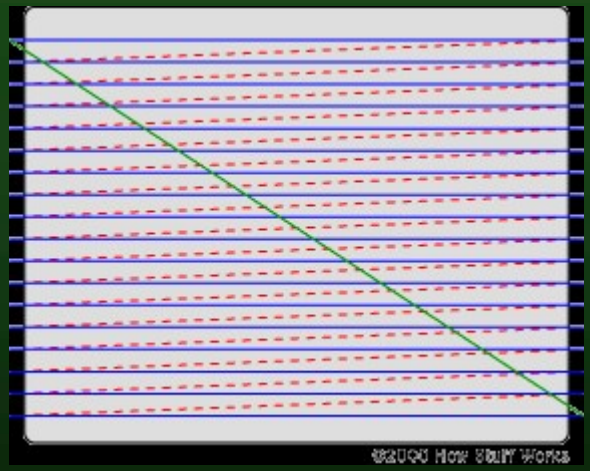
- Terminal equipment: display, keyboard, pointing device.
- The display: CRT or LCD.
- The operation of the CRT: based on the video signal of the picture, the phosphor layer is "scanned" with the electron beam of varying intensity from the picture tube. In the case of a color monitor, there are 3 phosphor layers, three electron beams running together but with different intensities. Color mixing.

CRT: Cathode Ray Tube



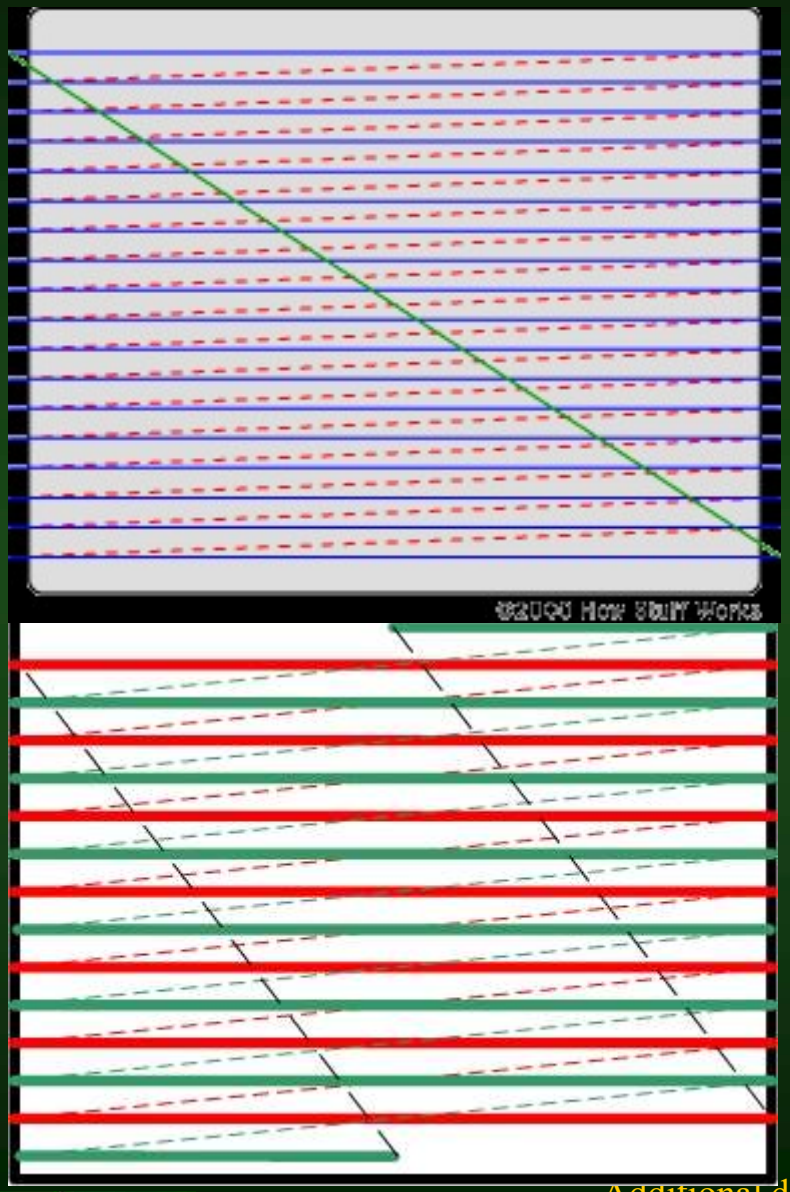
A. Cathode
B. Conductive coating
C. Anode
D. Phosphor layer on the screen
E. Electron beams
F. Shading mask

The deflecting coils create an electromagnetic field



Scan the screen

CRT: Interlaced video

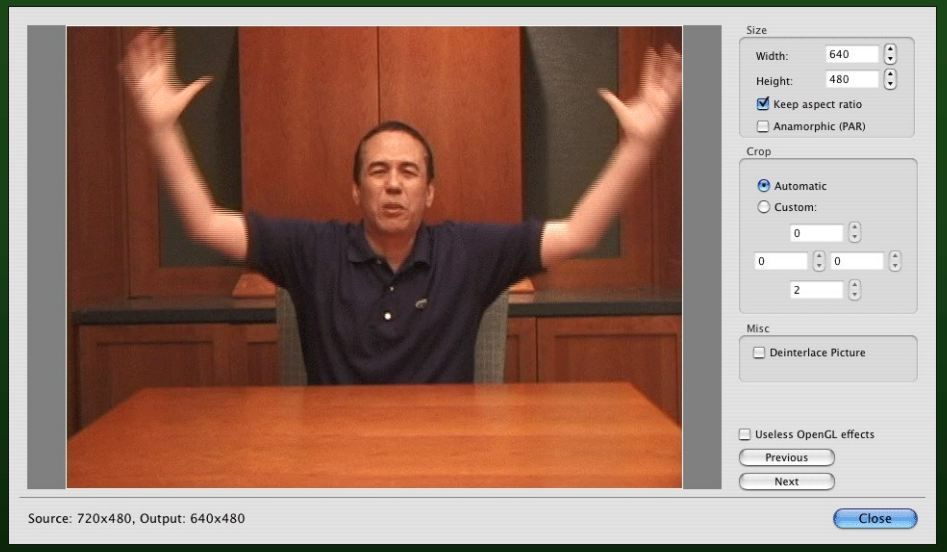


Interlace:

Double the refresh rate

Two consecutive images with lower resolution overlapped and offset with every second rows

Pal: 50/25Hz, NTSC: 60/30Hz



https://en.wikipedia.org/wiki/Interlaced_video

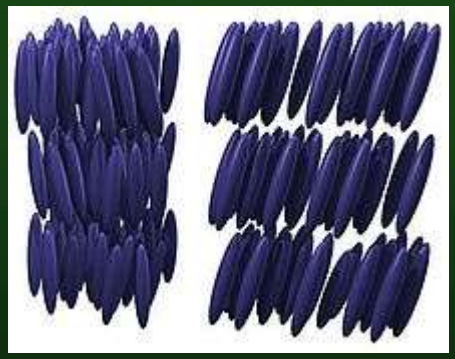
The CRT could be

- Vector graphics. Today only in special places (e.g. instruments).
- Raster graphics: memory cells with a bit width given to the pixels: they contain the color, intensity, etc. information. This is what the video works on.
- Question: where is the video memory? How can we write in it?

LCD image display

- **Under the influence of an electric field, certain crystals change their refractive properties (they rotate according to the crystal plane), thereby acting as a polarizing "filter".**
- **Raster graphics can be implemented: crystals of pixels divided into rows and columns can be “induced".**

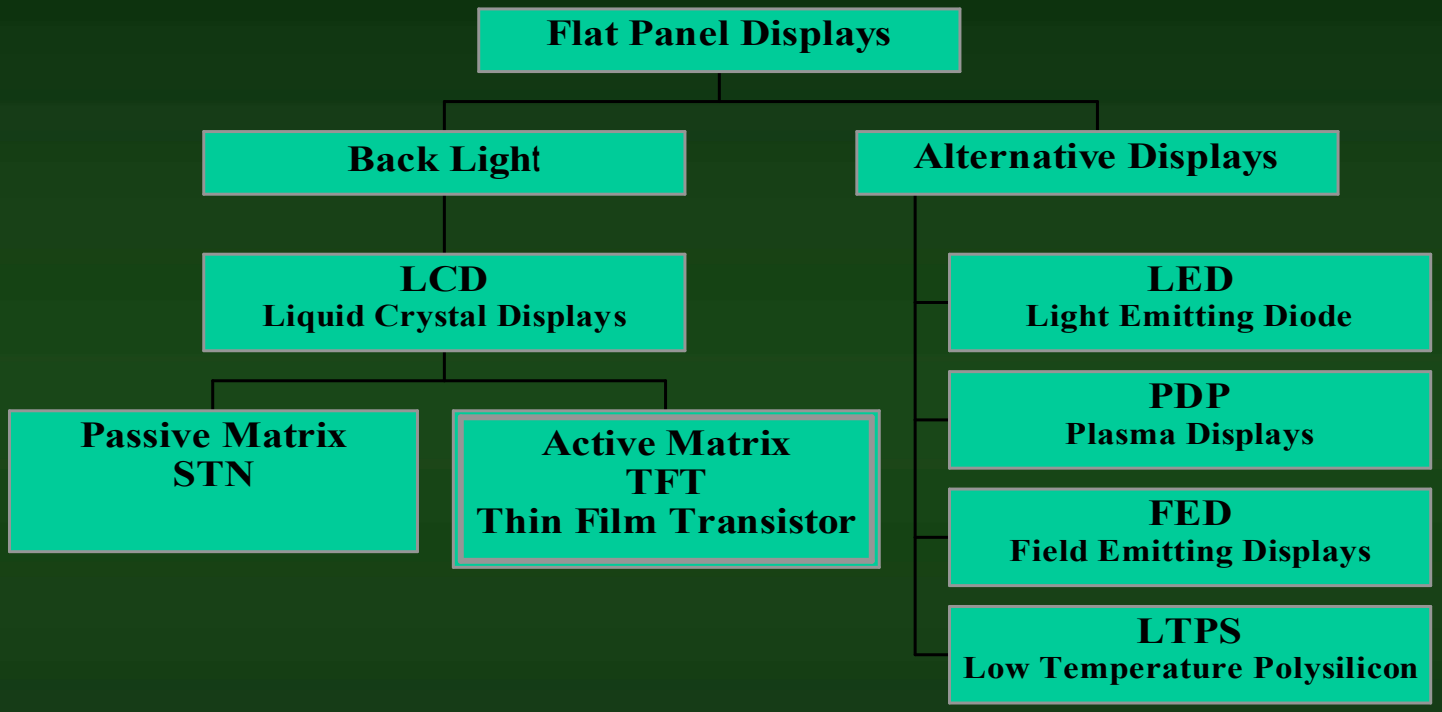
nematic - smectic



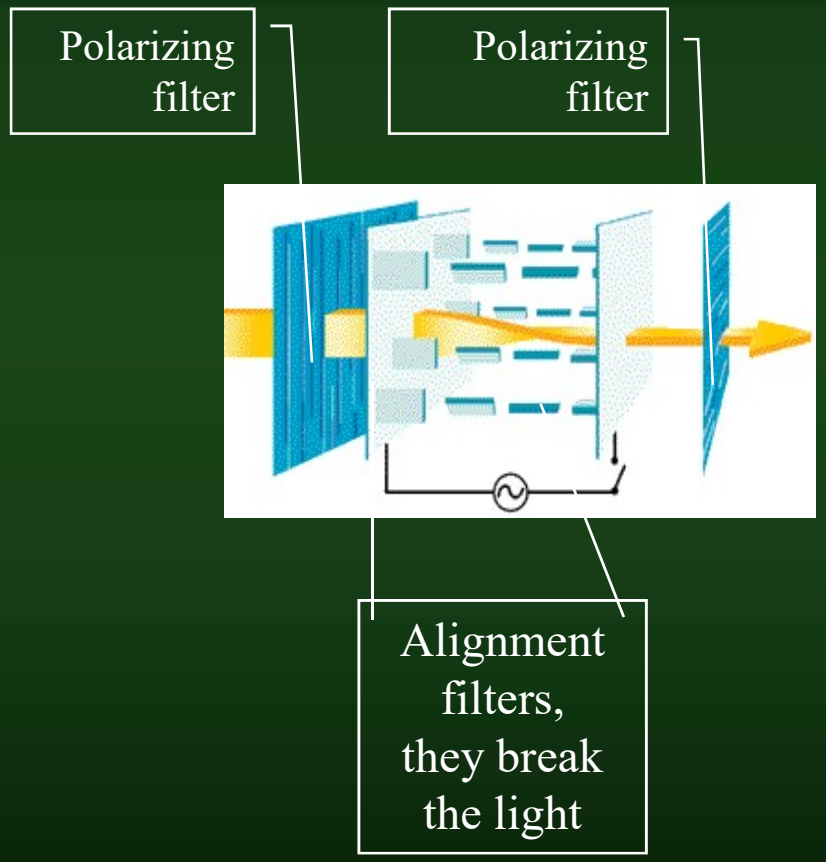
smectic phase (cold)

nematic phase (polarization)

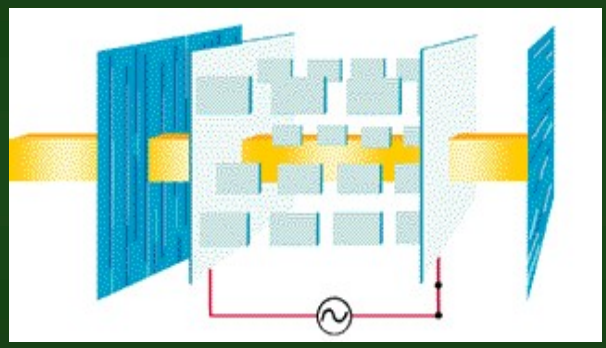
Flat Panel Displays



How does TFT work?



The voltage (electric field) on the alignment filters "twists" the liquid crystals ("nematic" near-liquid crystal phase), the transmitted light is absorbed by the second polarizing filter.

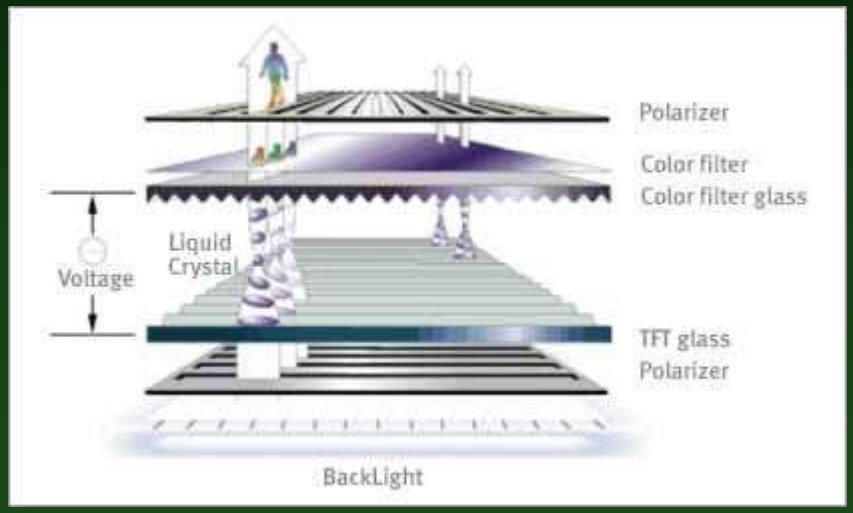


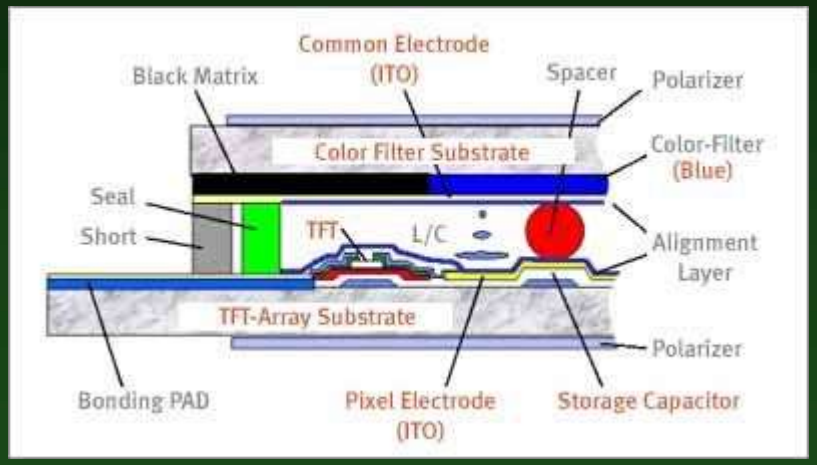
Of course, a combination of red-green-blue filters per pixel produces the true color

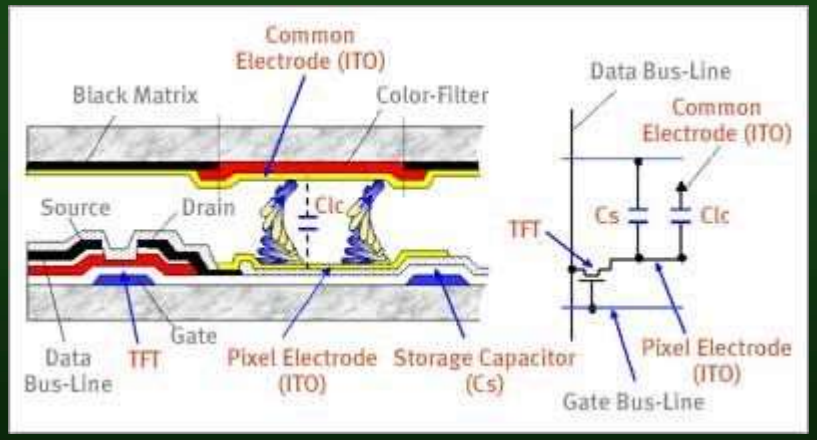
Technologies

- **Active matrix technology** (thin film transistors)
  - At the junctions of columns and rows, the cell (corresponding to a pixel): transistor- condenser pair (on the glass)
  - Addressing a pixel row and column addressing, charging the selected capacitor: this induces the LCD pixel
- **Passive matrix**
  - Metal wire mesh for each pixel
  - This induction voltage reaches the LCDs
  - This is cheaper, and can be operated only with a lower frequency (that is why it is not used)

Twisted Nematic (TN) TFT LCD



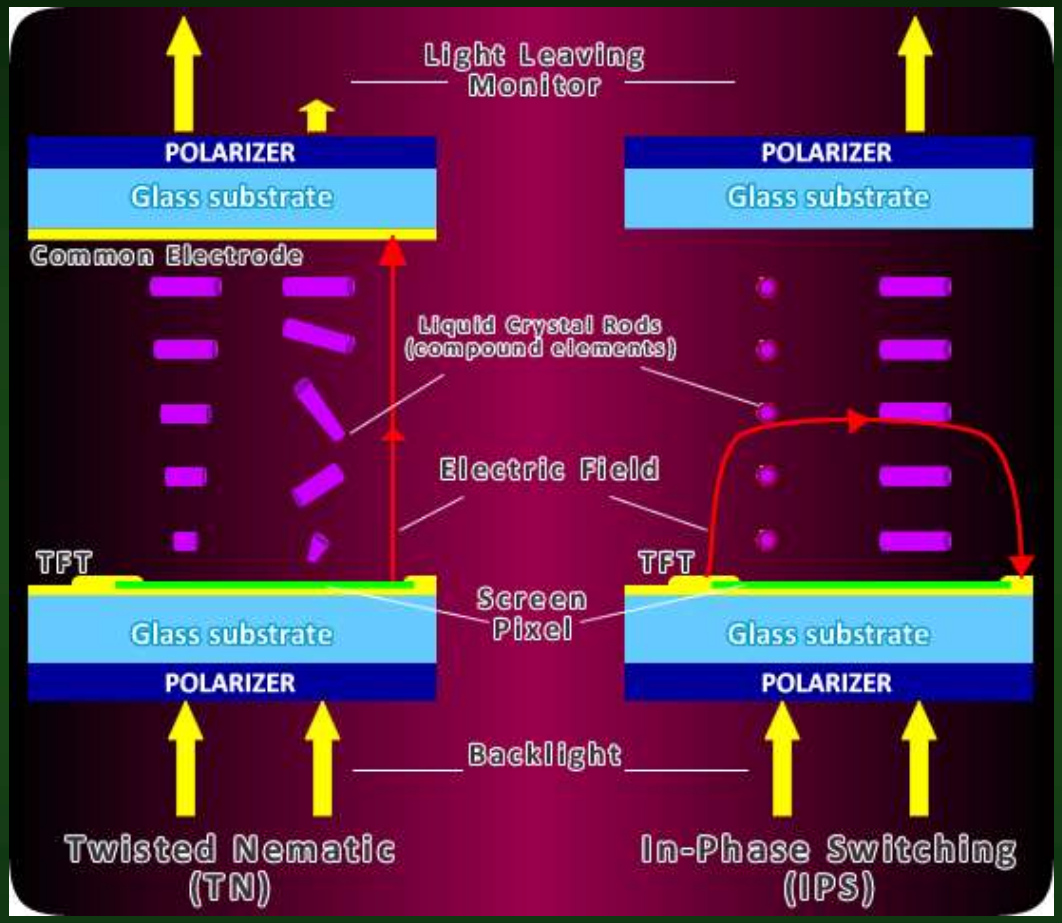




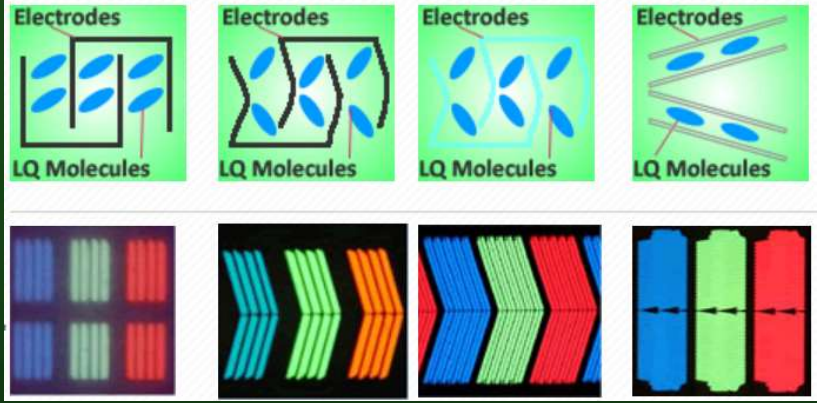
Cons:

- Small viewing angle
- The colors are not very good

In-Plane Switching (IPS) TFT LCD



IPS	S-IPS	AS-IPS	IPS-PRO
1996	1998	2002	2004
Wide viewing angle	Colour shift free	High transmittance	High contrast ratio
100	100	130	156
100	137	250	313



Two transistors instead of one,
less transparent space,
stronger backlight is needed

TFT characteristics

- **Viewing angle**: from which angle the picture is still good. 140-170º is acceptable.
- **Brightness:** given in cd/m^2 . 250-350 cd/m^2 is usual. 100 cd/m^2 is required for a cinema. (cd: Candella)
- **Contrast**: the ratio of white and black color intensity. A ratio of 450:1 – 600:1 is acceptable. Above 600:1, the improvement is barely noticeable.
- **Response time**: How long (ms) the pixel points change their color. 20-30 ms is already acceptable. A slower result is "ghosting".
- 15.1" TFT corresponds to 17" CRT
- **Native resolutions**:
  - 17”: 1024 * 768; 19”: 1280 * 1024; 20”: 1600 * 1200
  - 2K: 2560 x 1440, 4K: 3840 x 2160 pixels

TFT or (CRT) - OLED?

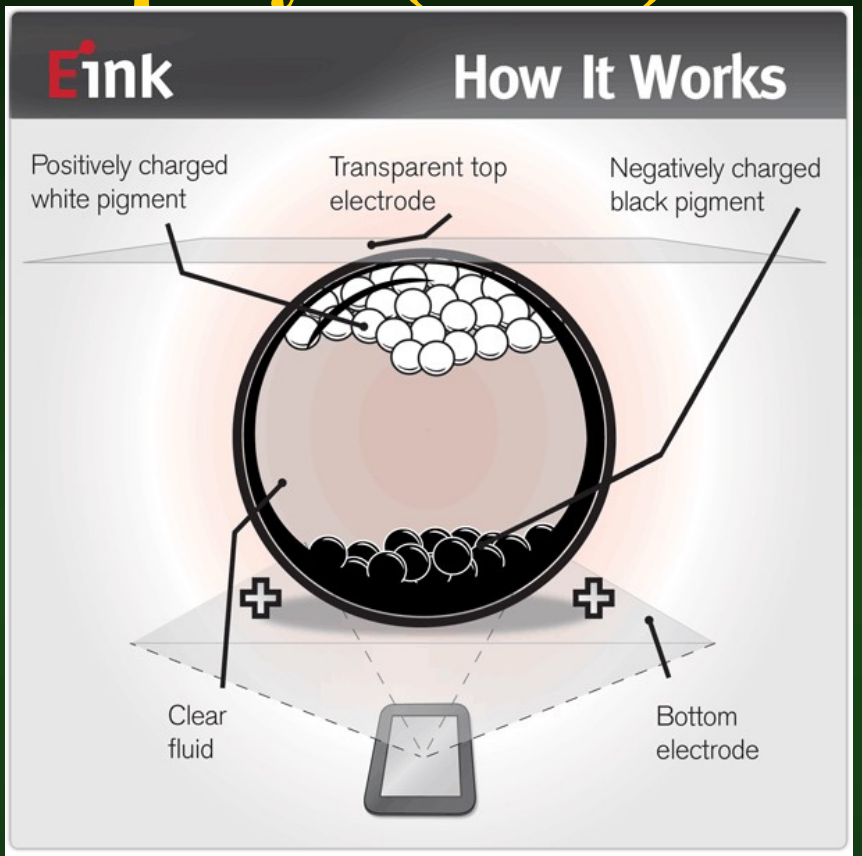
- TFT advantages
  - Lower current consumption
  - Smaller weight and size
  - Its controllability is better
  - Less strain on the eyes
- CRT Benefits (RIP)
  - Cheaper (was)
  - Better color fidelity and color display
  - Better response time (no ghosting)
  - Variable resolutions
  - Less vulnerable
- OLED
  - Organic Light-Emitting Diode
  - the electroluminescent layer is an organic semiconductor compound that lights up under the influence of an electric current
  - located between two electrodes
  - one electrode is transparent to allow light to escape

Organic Light-Emitting Diode (OLED)

- **Oled benefits**
  - Cheaper
  - It can be printed and produced more cheaply
  - Light and flexible support surfaces
  - Wider viewing angle, direct light emission
  - Energy efficient when black (dark image, 40% of LCD)
  - Fast, OLED 0.01 ms (LCD 2-8 ms)
- **OLED disadvantages**
  - Short lifespan (14,000 hours ~5 years if 8 hours/day) (LCD and LED 25,000-40,000 hours)
  - Problems with color balance - it ages quickly, burns in
  - Energy efficient, but when white (bright) image, 2-300% of LCD
  - UV sensitive

Electronic Paper Displays (EPD)

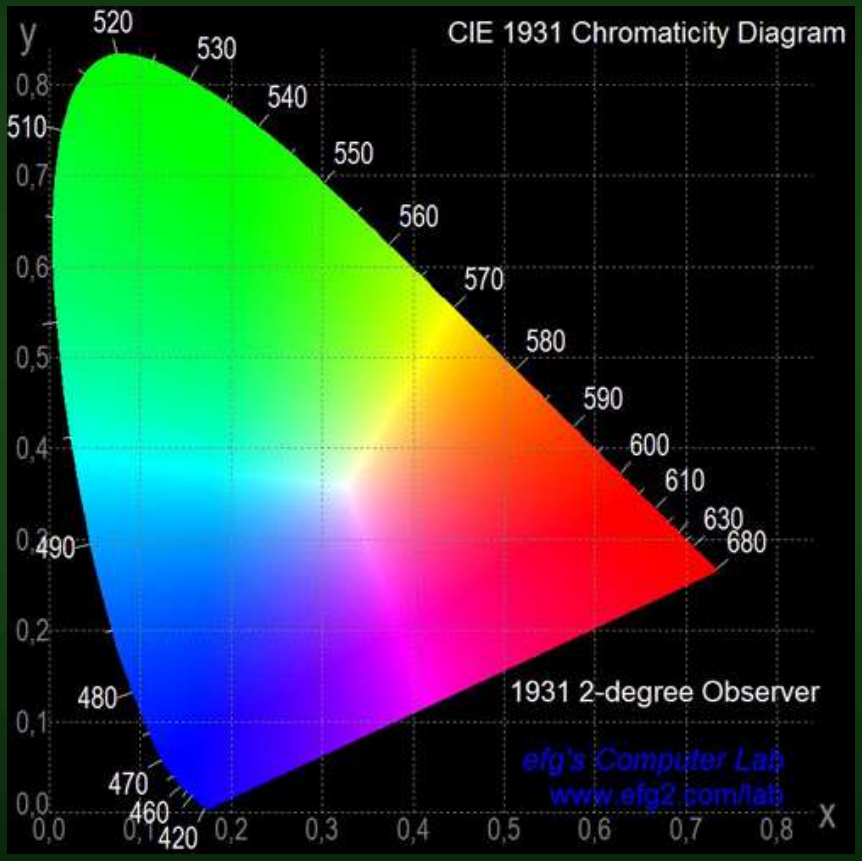
- **Bistable Display : Keeps** its state even without induction
- **Reflective Display :** Backlighting is not required (but it can be)
- **Microcapsules :** Positively (white) and negatively charged (black) particles float in a transparent liquid

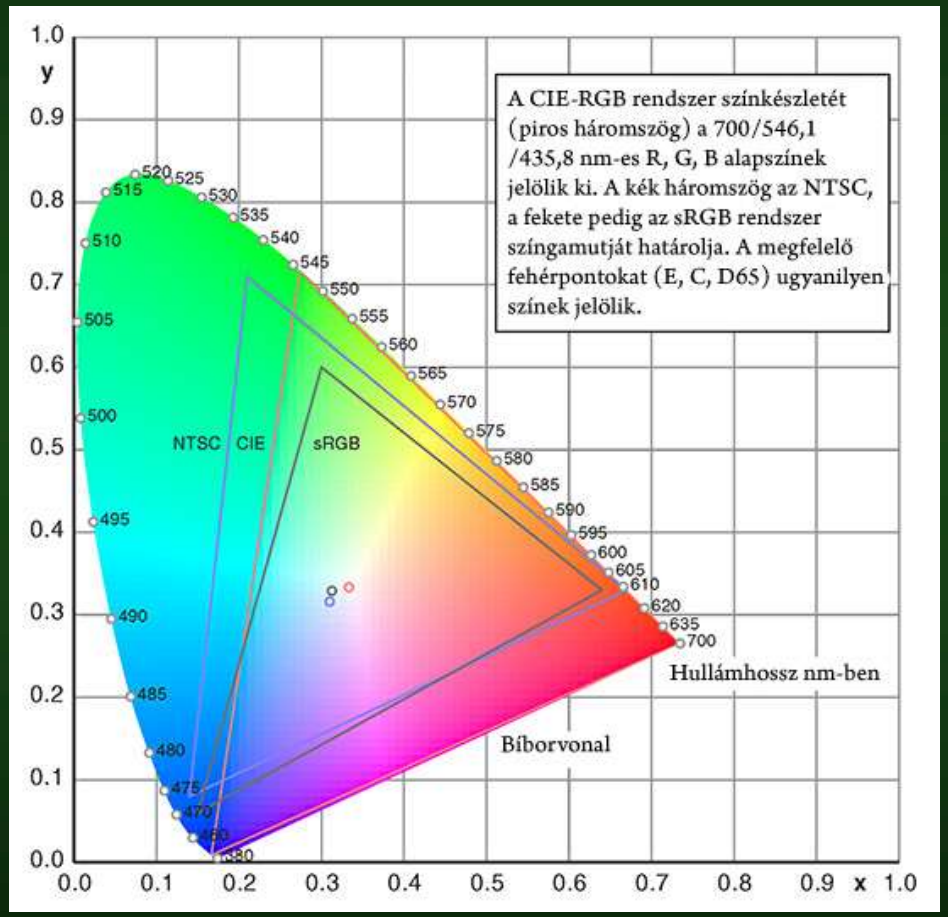


Electronic Ink is made up of millions of tiny microcapsules, about the diameter of a human hair. Each microcapsule contains positively charged white particles and negatively charged black particles suspended in a clear fluid.

Colors - color chart

CIE (Commission Internationale de L'Eclairage)

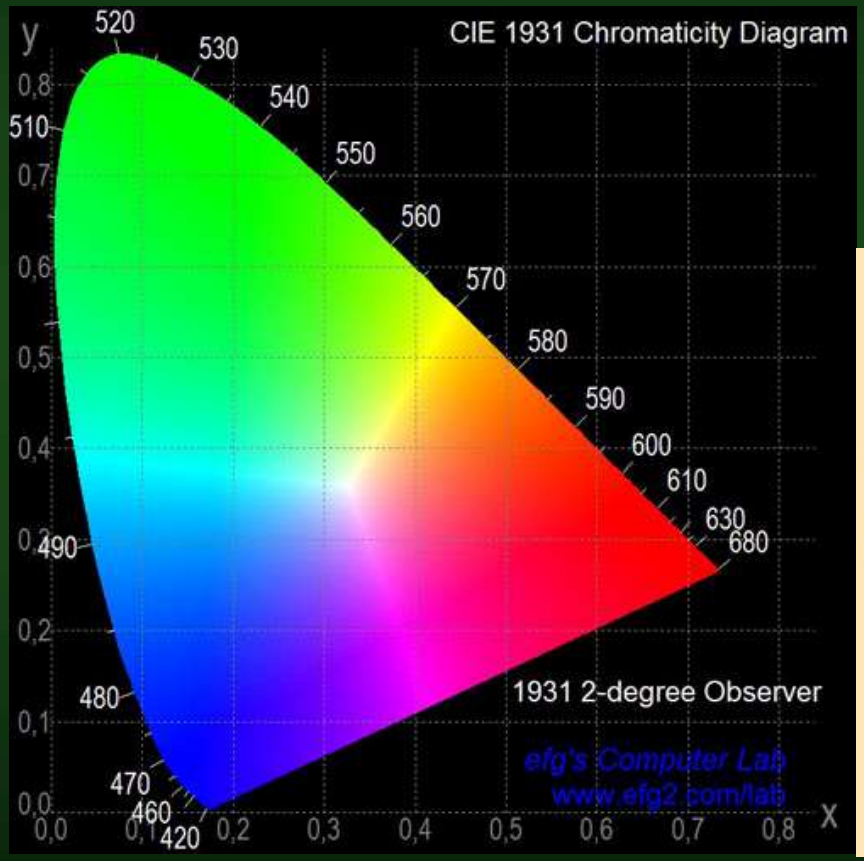




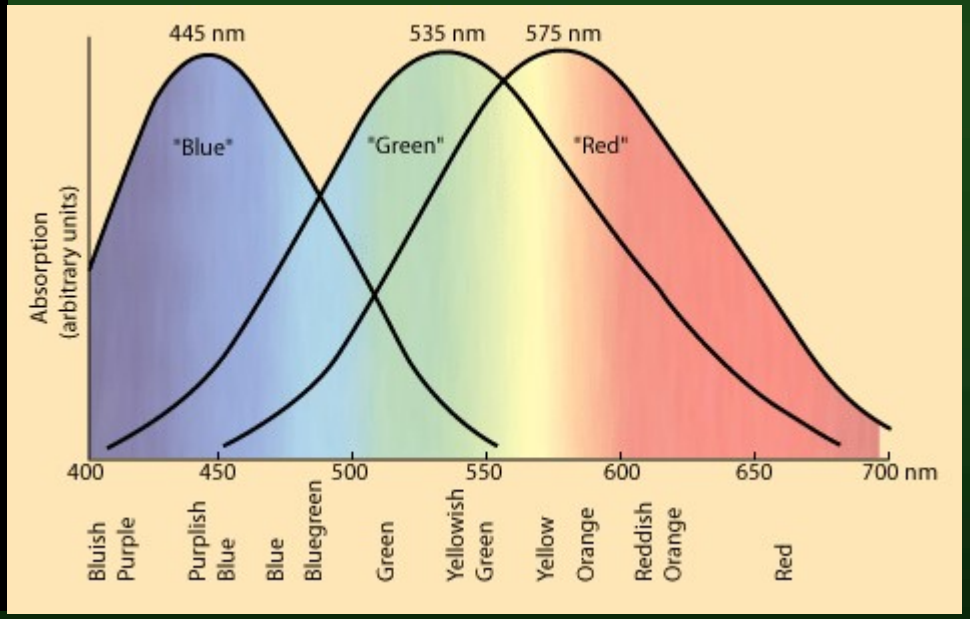
Purple line : mixed colors (not monochromatic)

Colors - color chart

CIE (Commission Internationale de L'Eclairage)



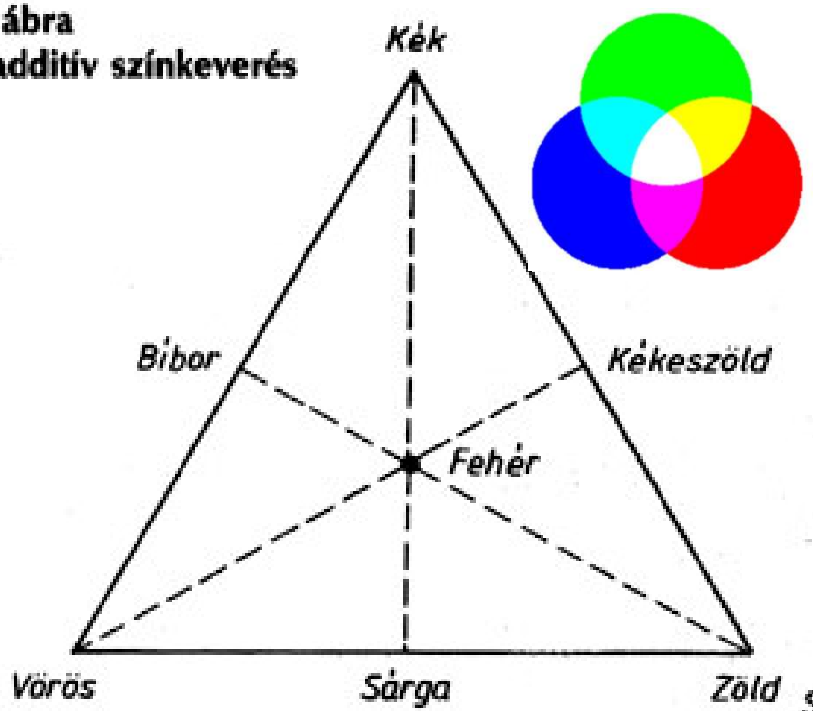
Cone cells: 64% red, 32% green and 2% blue sensitivity .

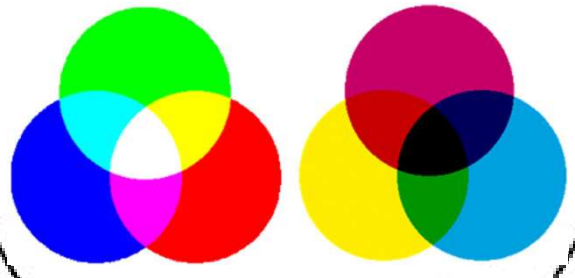


Purple line: mixed colors (not monochromatic)

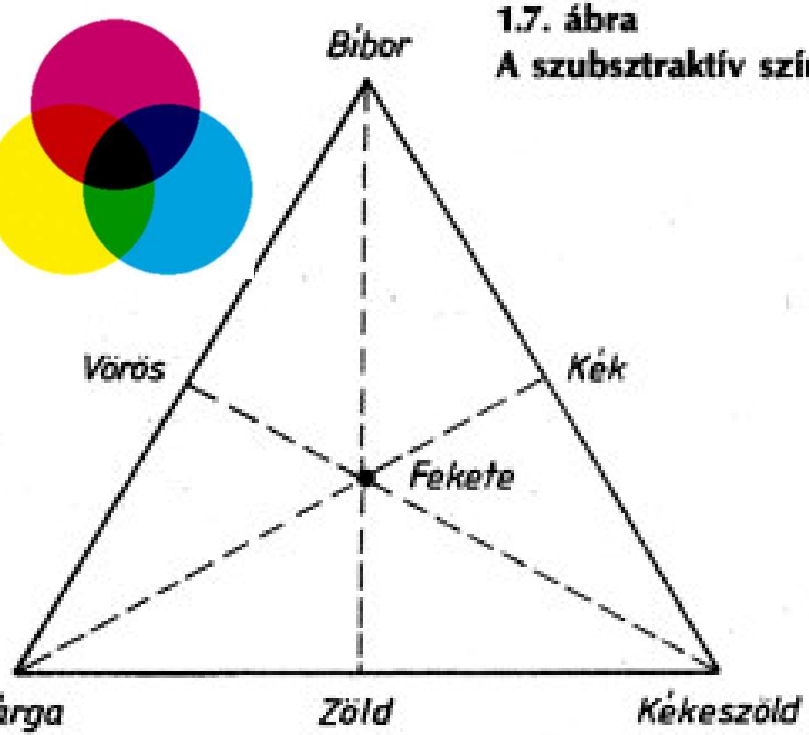
Colors - color mixing

1.6. ábra
Az additív színkeverés





1.7. ábra
A szubsztraktív színkeverés



R + G = Sárga
R + B = Bíbor
G + B = Kékeszöld
R + G + B = Fehér

Bíbor = Fehér – G
Kékeszöld = Fehér – R
Sárga = Fehér – B
Fekete = Fehér – R – G – B

Source: Barna Tamás: VIDEOTECHNIKA A GYAKORLATBAN (Műszaki Könyvkiadó, Budapest, 1988)

The "classic" terminals

- Their "own" video memory cannot be directly accessed by the host processor.
- They also handle a keyboard and pointing device.
- "Line" for the host controller: on this
  - bytes/character strings are transferred.
  - Bytes can be:
    - displayable pixels/characters,
    - control sequences (pointer positioning, color/intensity setting, etc.)
    - input lines.

The terminal standards

- They tell you what encoding is used,
- what is the coordinate system,
- what are the control sequences and how to react to them
- etc.
- Famous standards:
  - ANSI,
  - VT 100, VT 200, VT 300, VT 340, etc.

"Memory-mapped terminals"

- The video memory on the controller is directly accessible by the CPU (with move/in-out/load-store instructions).
- The video signal from the controller to the CRT, or directly to the LCD display.
- Several standards here too: VGA, SVGA, XGA, etc.
- Of course, the controller can also handle a keyboard and a pointer.
- Although video memory is available with machine instructions, control programming through IT operators and device drivers is recommended. Standard drivers (ANSI, VT 100, X11, etc.).

Typical standards and resolutions

Standard	Resolution	Typical use
XGA (Extended Graphics Array)	1024x768	15- and 17-inch CRT screens 15-inch LCD screens
SXGA (Super XGA)	1280x1024	15- and 17-inch CRT screens 17- and 19-inch LCD screens
UXGA (Ultra XGA)	1600x1200	19-, 20-, 21-inch CRT screens 20-inch LCD screens
QXGA (Quad XGA)	2048x1536	21-inch and larger CRT screens
WXGA (Wide XGA)	1280x800	Wide 15.4-inch laptop LCD displays
WSXGA+ (Wide SXGA plus)	1680x1050	Wide 20-inch LCD screens
WUXGA (Wide Ultra XGA)	1920x1200	Wide 22-inch and larger LCD screens

Full HD: 1080p (1920×1080) 16:9 – 2,073,600 (2M) pixels 2K horiz .

4K Ultra HD: 2160p (3840×2160) 16 : 9 - 8,294,400 (8M) pixels 4K

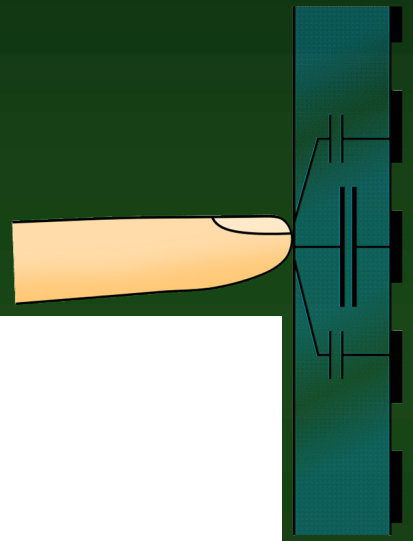
Typical standards and resolutions

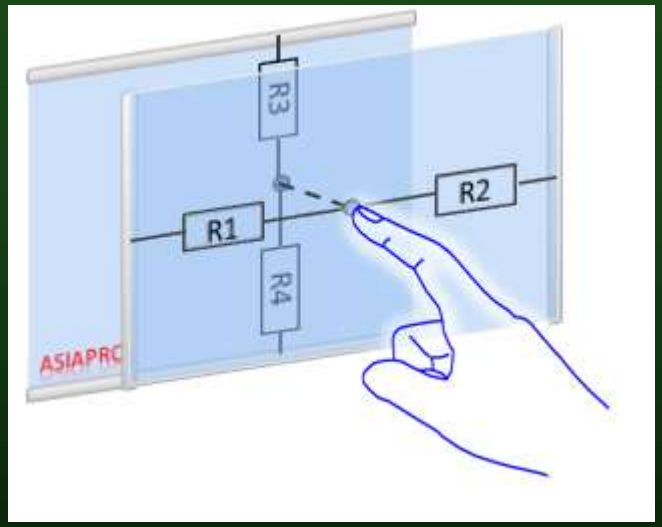
Standard	Resolution	Picture aspect ratio
1080p HD widescreen	1920×1080	16:9
1080p 4:3	1440×1080	4:3 / 8:6
Ultrawide HD	2560×1080	21:9
FullHD +	2160×1080	2:1 / 18:9
FHD+ (mobile)	2400×1080	2.2 :1 (40:18)
	1728×1080	16:10 / 8:5
	1620×1080	3:2 / 15:10

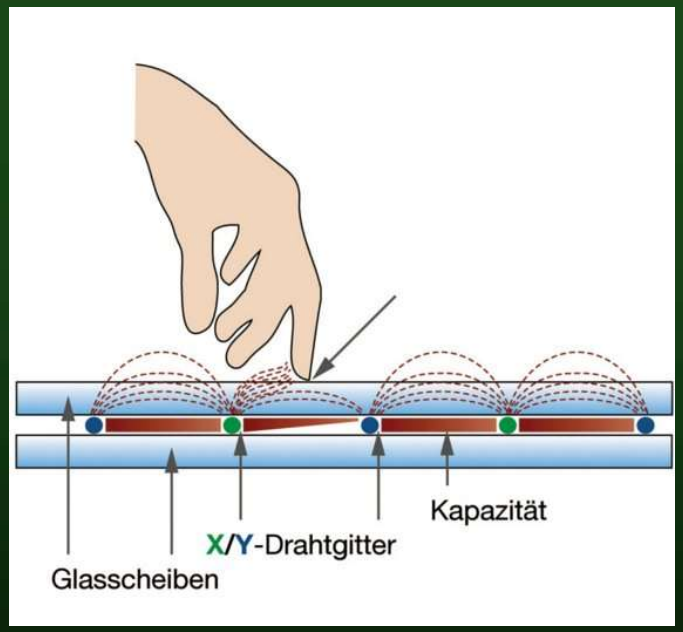
Full HD: 1080p (1920×1080) – 2073600 pixels 2M

Touch displays

- Touch on the screen surface should be detected.
- Possible technologies
  - With infrared sensors
  - Pressure sensor with resistors (Resistive)
  - Capacity change sensing

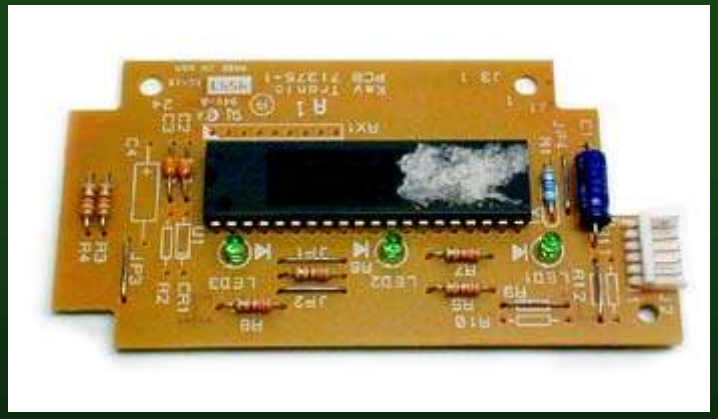






Keyboard

- Keygroups:
  - Basic QWERTY keys
  - Numeric keys
  - Function keys
  - Control keys
    - Home
    - End
    - Insert
    - Delete
    - Page Up
    - Page Down
    - Control (Ctrl)
    - Alternate (Alt)
    - Escape (Esc)



Keyboard control circuit

Keyboard

Dvorak fast typing

Keyboard

Dvorak fast typing

Keyboard controller

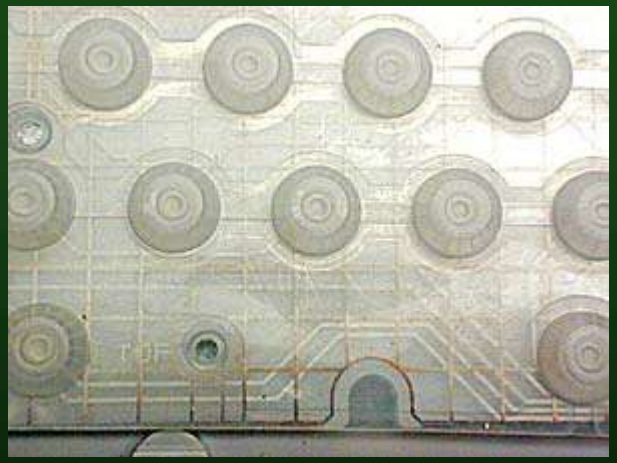
- State change (switching) detection
  - Which one? (keymatrix)
  - More than once? (bounce elimination)
    - Bounce: contact uncertainty, vibration in contact. To be decided, was it one push or more?
  - Repetitive (typematics)
    - Typematics: the electronics ensure that a key pressed for a long time gives a result as if it had been pressed many times: automatic repeated pressing.
  - It also affects: sensing key press (tactile, click)
    - Tactile detection: we like to feel that we have really pressed the key. Audio sensing as well: we like to hear a click that we have pressed the key...

Keyboard

- Press-release sensing technologies
  - Mechanical contact
  - Capacitive (expensive, long life)
    - There is no contact, the capacitance changes (thus the current flowing through) when pressed
  - Optical (light beam interruption)
    - Expensive, long-lived
  - Hall effect (permanent magnet approaches a crystal: it creates a changing electric field in it)

Keyboard, technologies

- **Rubber dome**
  - **Under the rubber dome is a carbon contact that closes a circuit. Common. The rubber cover protects (dirt, corrosion)**
  - **Relatively good tactile.**
  - **Cheap, widespread**



Keyboard, technologies

- Mechanical membrane
  - A bulge on the rubber sheet, a membrane underneath. Tactile perception of pressure is weak. For industrial equipment.
- Mechanical with metal touch
  - It's cheap, the click is good, good tactile sensation, it corrodes, it gets weaker in time
- Mechanical foam element
  - Conductive sponge foam is the contact. Good bounce, tactile

Keyboard, technologies

- **Cherry MX**

Gaote Black Switches
Tactile :NO
Clicky: NO
Actuation Force: 60g
50 million clicks lifecycle

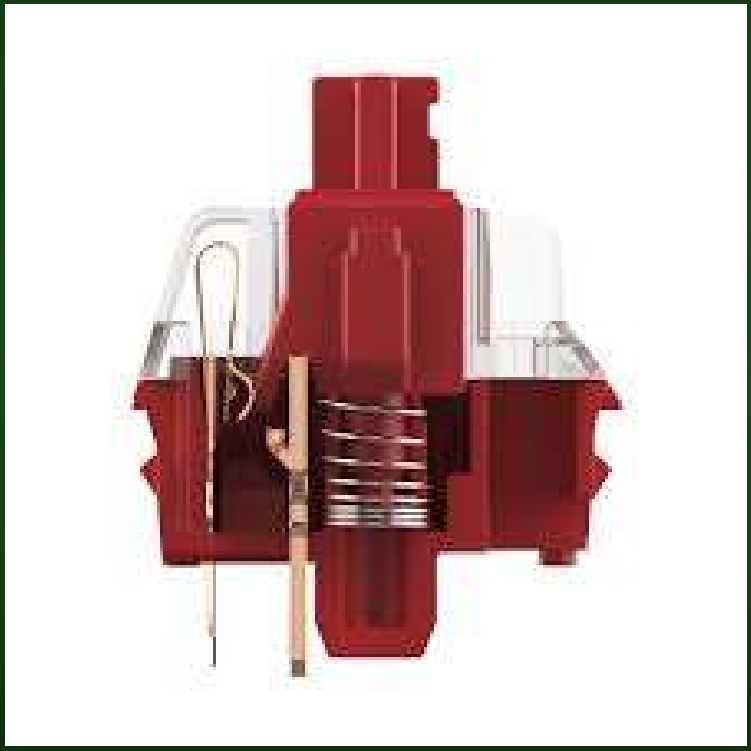
Gaote Red Switches
Tactile :NO
Clicky: NO
Actuation Force: 45g
50 million clicks lifecycle

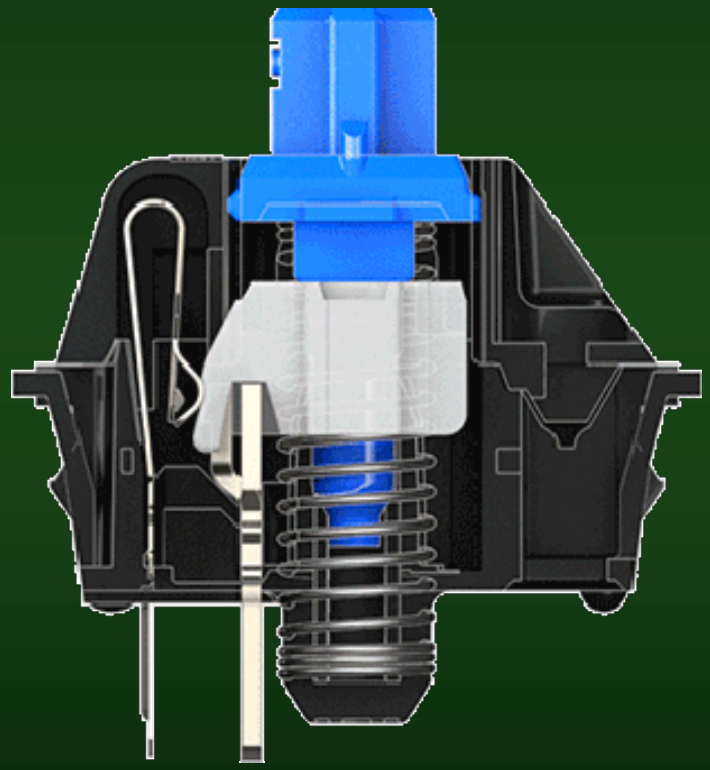
Gaote Brown Switches
Tactile: YES
Clicky: NO
Actuation Force: 45g
50 million clicks lifecycle

Gaote Blue Switches
Tactile :YES
Clicky: YES
Actuation Force: 50g
50 million clicks lifecycle

Keyboard, technologies

- **Cherry MX**





Connecting the keyboard

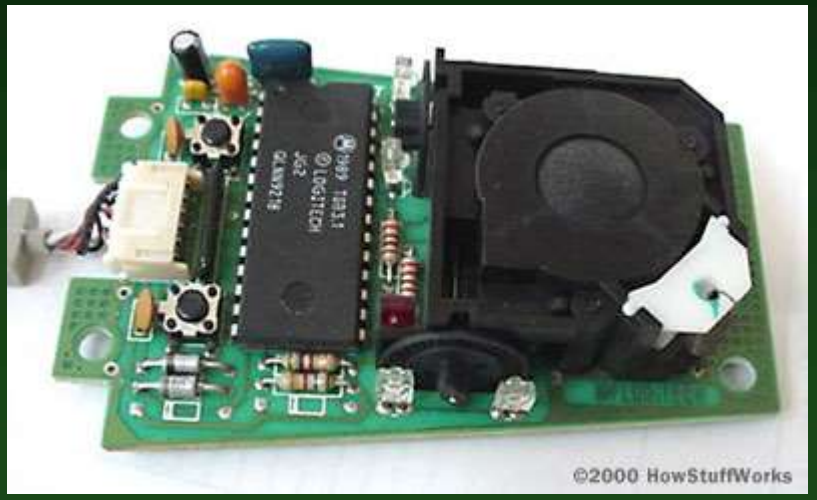
- Standards, opportunities
  - 5-pin DIN (Deutsche Industrie Norm) socket
  - 6-pin IBM PS/2 mion DIN connector
  - 4-pin USB connector
  - Internal connection for laptops
  - Radio, bluetooth connections

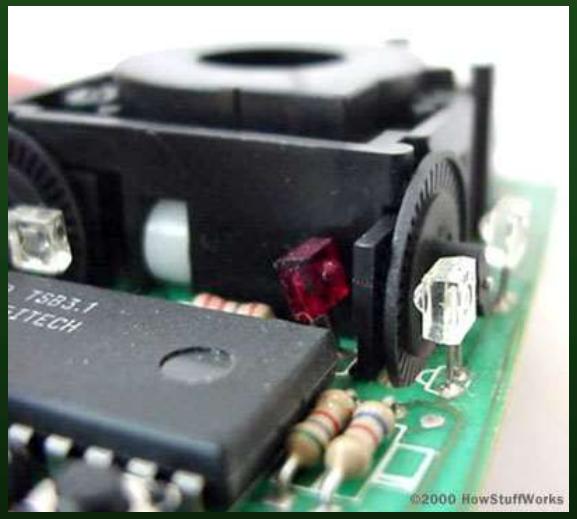
Pointers

- They weren't interesting at first
- Pointers in the 70s
  - Light pen
  - Tablet
  - Joy sticks
- In 1984, Apple added a mouse to the Mac
  - It's significantly cheaper
  - A pointer is indispensable for graphical user interfaces
  - Two-dimensional motion detection
  - Keystroke detection

The ball mouse

- Ball: the rolling of the ball divided into rotation around two axes.
- Measuring discs on axles.
  - It emits infrared LED light
  - An infrared sensor is used to "count" the light pulses (which are proportional to the angle of rotation, which is proportional to the displacement.
  - How are directions perceived?
- Advantages and disadvantages





Optical mice

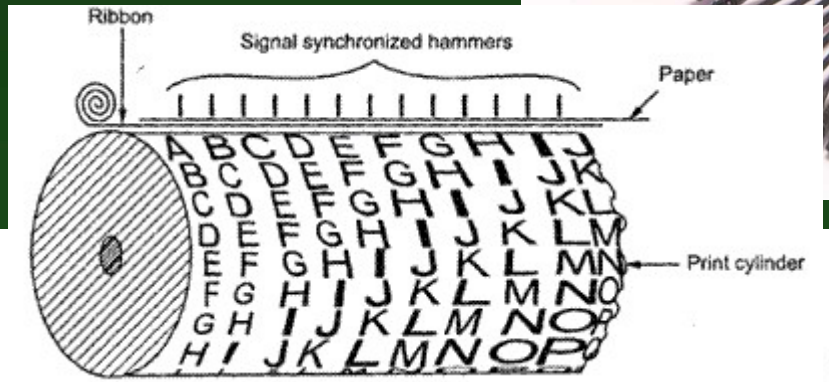
- Light emitting LED
  - (or a diode laser light)
- A sensor that detects light pulses reflected from the surface
  - (more recently, a metal-oxide semiconductor sensor that can detect the light reflection of many surfaces. It usually produces 16*16 or 32*32 pixel images).
- (Formerly) a special page (mouse pad), on which vertical and horizontal lines and notches are used to refract the reflected light (to produce pulses).
- The semiconductor sensor sends image samples to the mouse's processor (DSP: Digital Signal Processor), which determines the displacement of the image samples

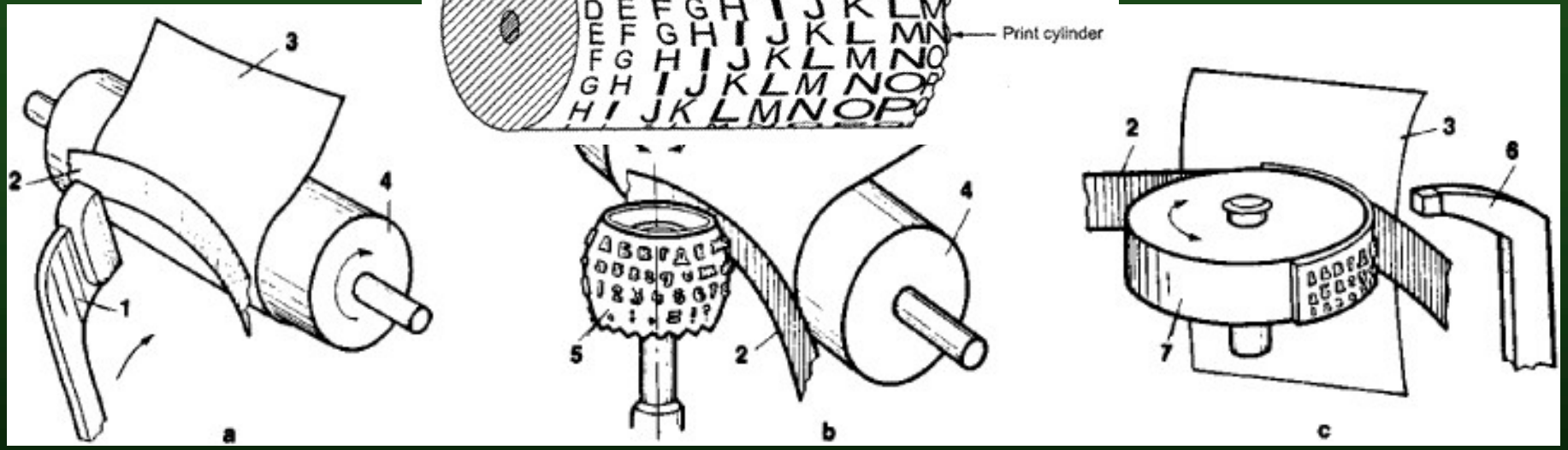
RF connection: Bluetooth

- One of the common radio frequency (RF) connections, approx. within 10 m (PAN: Personal Area Network)
- On the 2.4 GHz frequency (where 802.11 b/g wireless devices also work)
- Many HID (Human Interface Device) devices also use this protocol (PDA: Personal Digital Assistant, phone, headphones, etc.)
- It was named after the Danish king Harald Bluetooth (lived in the 900s, died in 986), in recognition of the important role played by Scandinavian people in IT

Printers

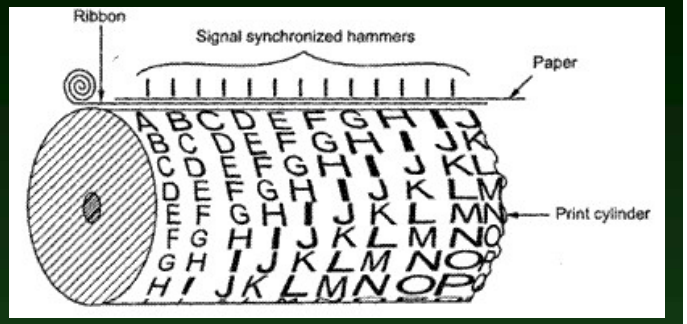
- **Impact type**
  - **Continuous ones (character bar, chain; letter wheel, ball head)**
  - **Dot matrix (pin matrix)**

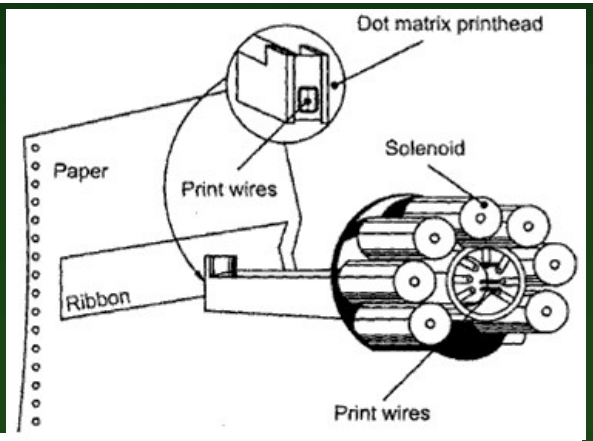


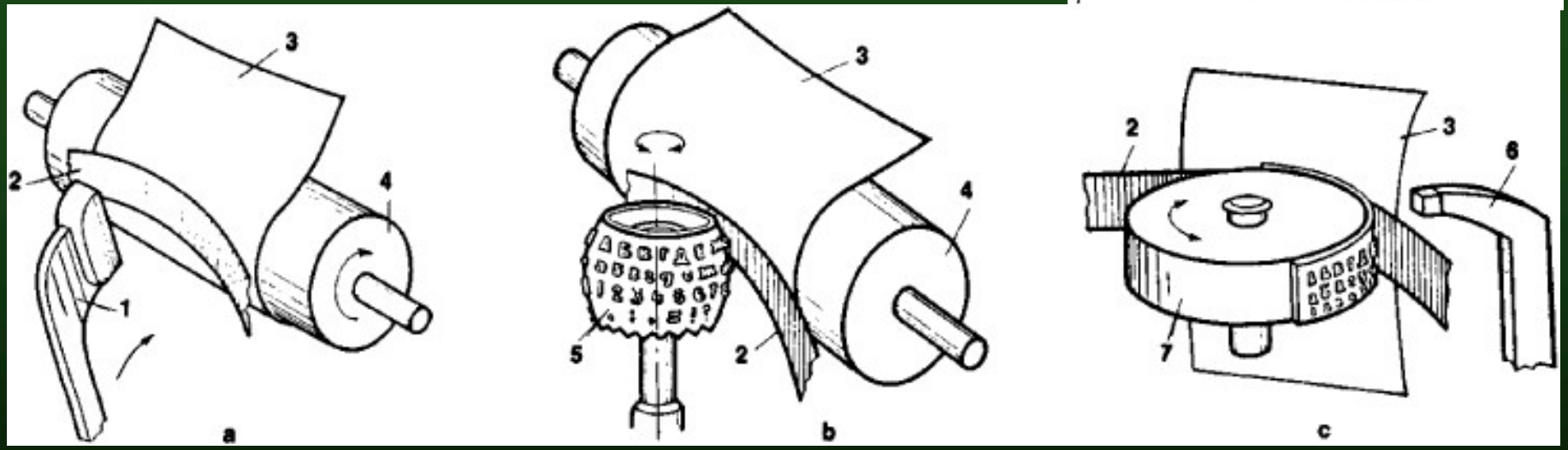


Printers

- **Impact type**
  - **Continuous ones (character bar, chain; head)**
  - **Dot matrix (pin matrix)**

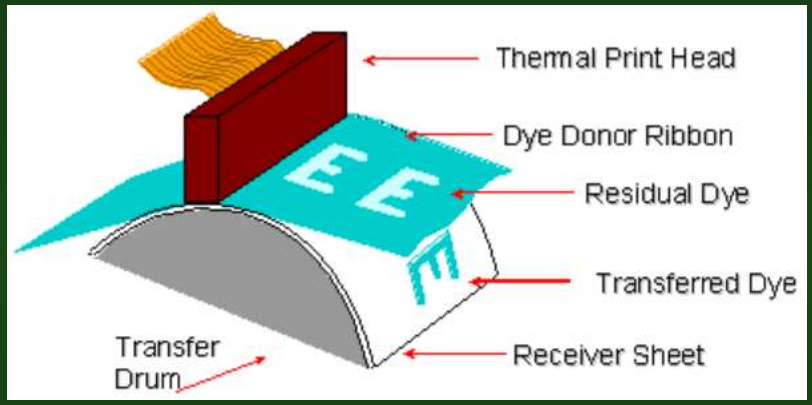






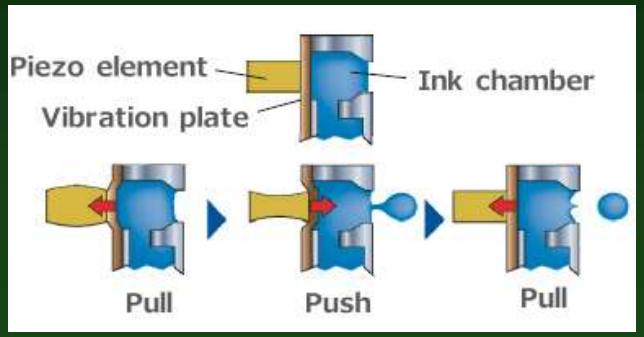
Printers

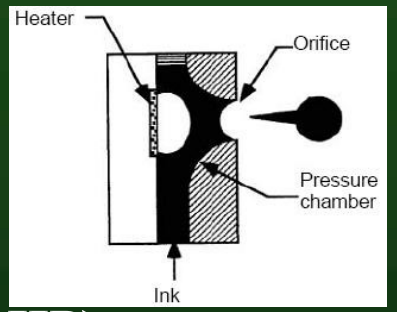
- Not impact type, dot matrix
  - Solid ink, dye sublimator, thermal wax, heat
  - inkjet,
  - electrostatic,
    - laser,
    - ion beam.



Inkjet printers

- Fine drops of ink from atomizers onto the paper.
  - 50-60 μm diameter, precise positioning
  - Capable of 1440x720 dpi (dot/inch)
  - Color blending for dots...
- Parts
  - Atomizers on the printhead (and ink tanks)
  - Print head moving stepping motor, stabilizer, time belt
  - Paper feeder, rollers, motor that moves them
  - Electronics, power
- The atomization
  - piezoelectric crystal is the pressure generator (Epson),
  - vapor bubble from ink (heating element glows) (Canon, HP)
  - continuous beam (similar to CRT: "acceleration, control, extinction" of electrostatically charged droplets).



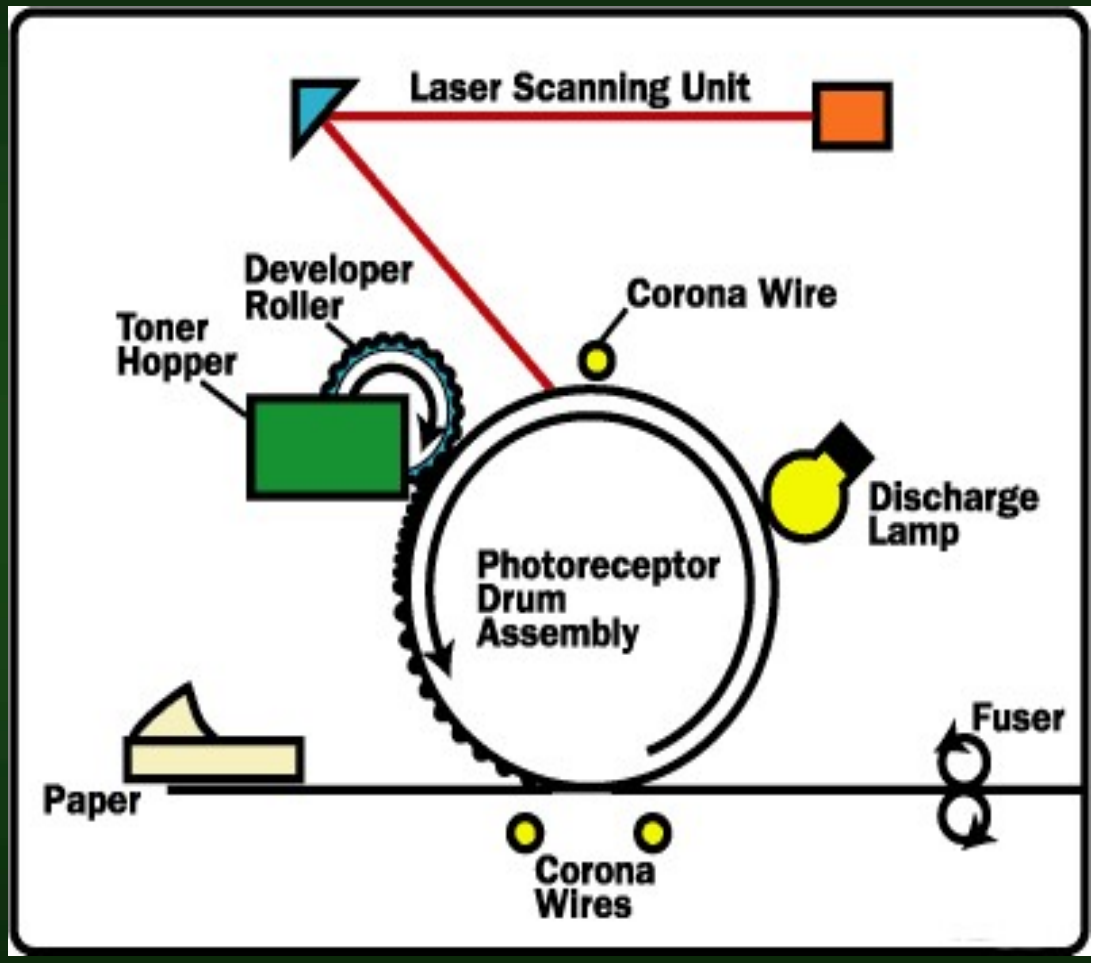


Electrostatic printers

- Homogeneously charged semiconductor drum, charge pattern formation with this light-ion beam.
- This attracts electrostatically charged paint,
- paint is applied to the paper by pressure/opposite charging from the drum,
- fixation on the paper (e.g. with heat),
- cleaning the drum.
- Laser: photosensitive selenium drum, ion beam: aluminum cylinder with a special semiconductor coating.

Laser printer

- CW gives the drum a positive charge
- The laser beam forms an electrostatic image on the drum
- Toner: pigment + plastic powder
- Transfer CW makes the paper strongly negatively charged
- Detach CW cancels paper charge
- Fuser: burns the ink onto the paper (Teflon heated rollers)
- The drum is discharged (residual paint powder is removed)



Drawing machines

- Vector graphics, for large sizes; movement on two axes, the pen can be moved with commands containing coordinate values.
- Pen change, pen up/down commands as well.
- Coordinate system switching, setting, zoom commands as well.
- The HPGL control language is famous.
- Drum plotter: one axis is the paper, the other is the pen.
- Flat plotter: the pen moves on both axes. More accurate, more expensive.

Computer architectures

More tools

End