

# Touchscreens, tablets and digitizers

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# Touchscreen technology

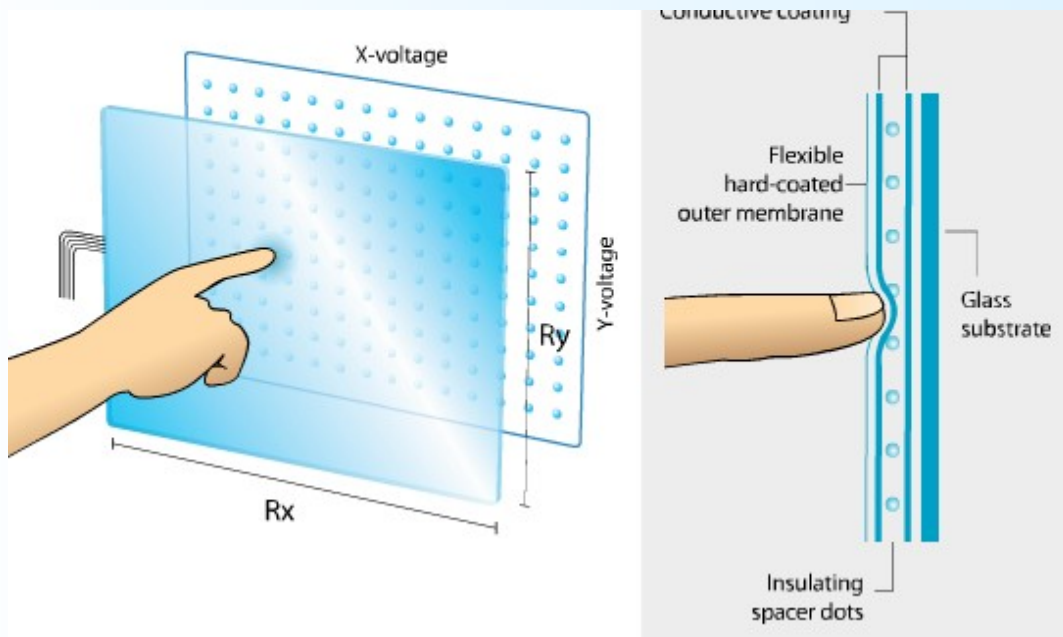
1965 *Johnson* – created device with wires, sensitive to the touch of a finger, on the face of a CRT

1971 *Hurst* – made first resistive touchscreen

- Resistive
- Capacitive
- Surface acoustic wave
- Infrared
- APR (Acoustic pulse recognition)

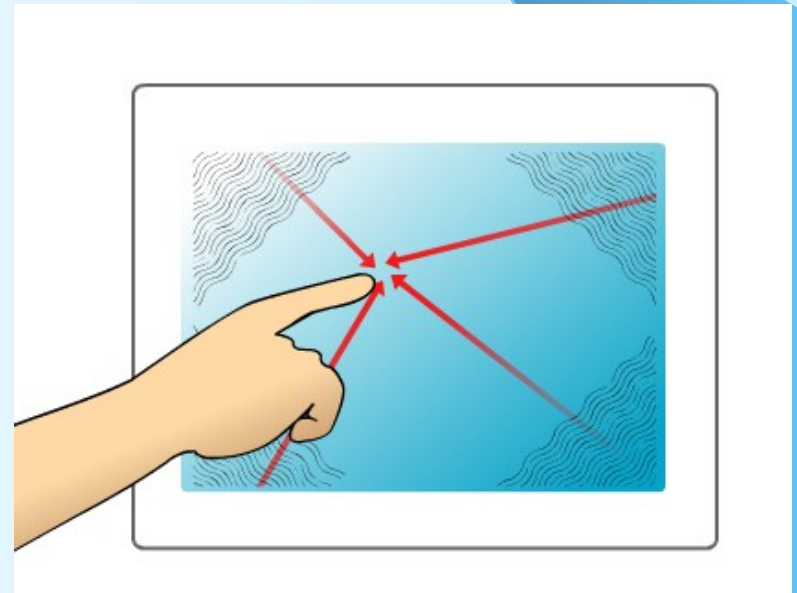
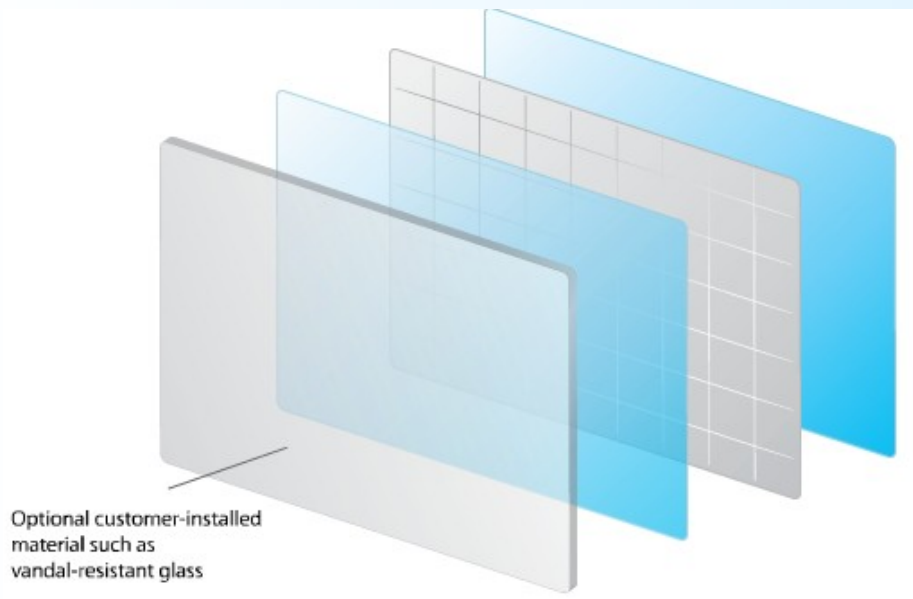
# Resistive touchscreens

- It consists of two conductive layers separated by an insulator. The first one is conductive without resistance, the second one has a specific resistance and it is continuously powered by a current.
- When touching, both layers are joined together. An electric current appears on the conductive layer. First, the voltage for the  $x$ -axis, then for  $y$ -axis is measured. This is done several times and the average is calculated.



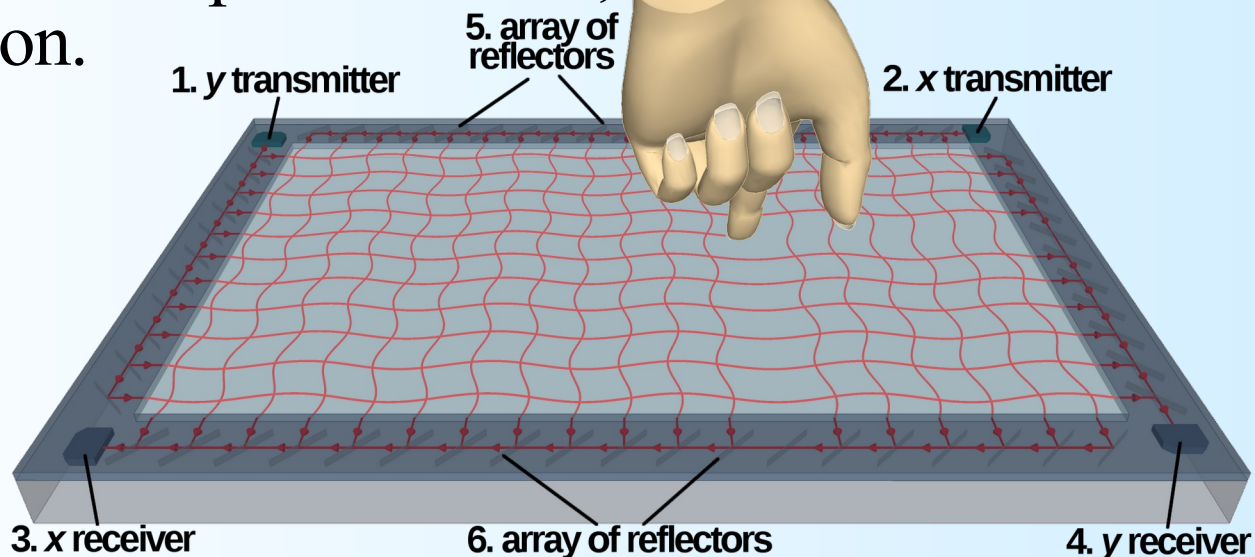
# Capacitive touchscreens

- There are two technologies – projected and surface.
- Projected contains a layer of sensors arranged in the grid.
- Surface has 4 sensors placed on the four corners.
- Ratio of the electrical current flowing from the four corners is measured to detect the touched point.



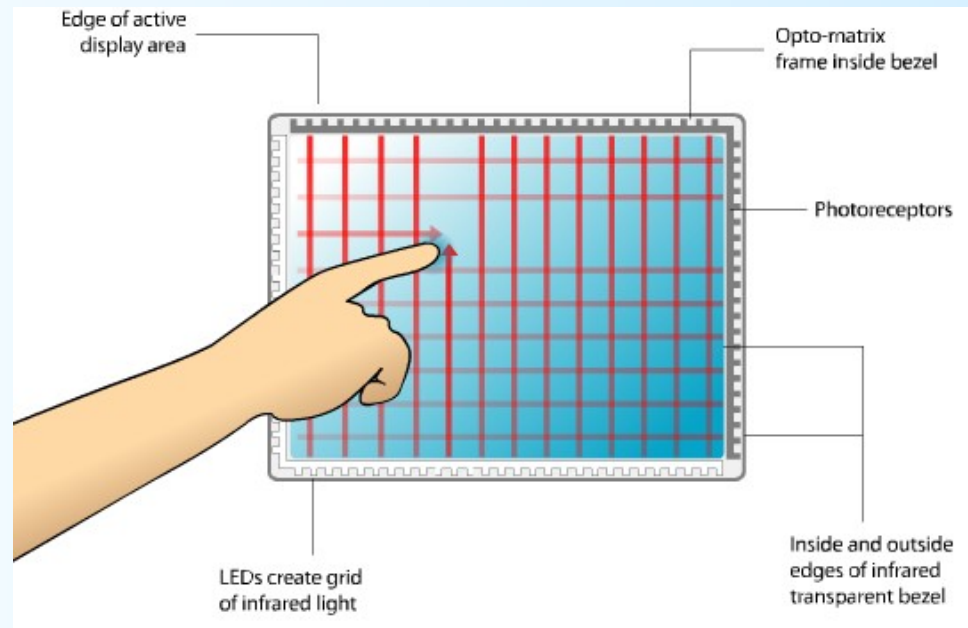
# Surface acoustic wave touchscreens

- Ultrasonic waves propagate from the transmitter through the array of the reflectors and are scattered throughout the screen. Using another array, they are then directed to the receiver.
- After touch, the wave is absorbed, and will not be received by the receiver. The sensor will recognize which route was touched, and locate the touched point.
- To determine the touch coordinate, it is necessary to carry out the entire process twice; first for  $x$  and then for  $y$  direction.



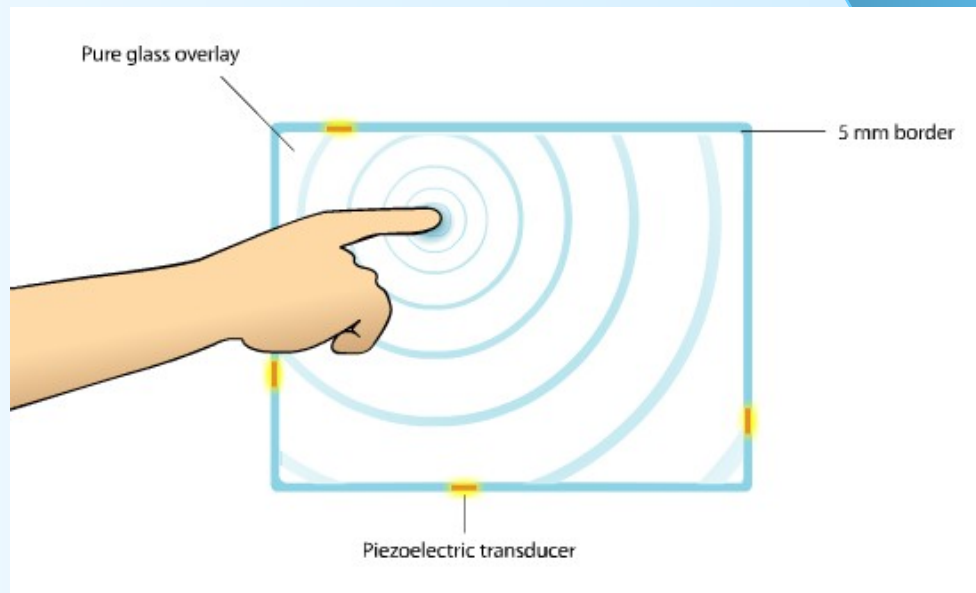
# Infrared touchscreens

- The infrared LEDs (transmitters) and the phototransistors (receivers) are located on the sides of the display.
- When touched, one or more beams are interrupted, and hardware detects the absence of light on the specific phototransistors.
- Based on this information, coordinates  $x$  and  $y$  are determined.



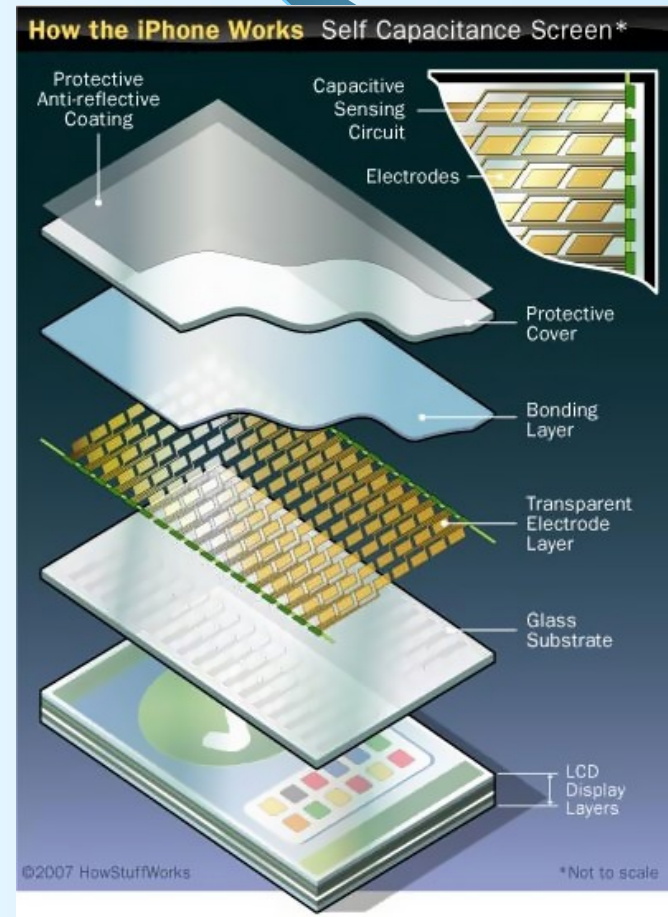
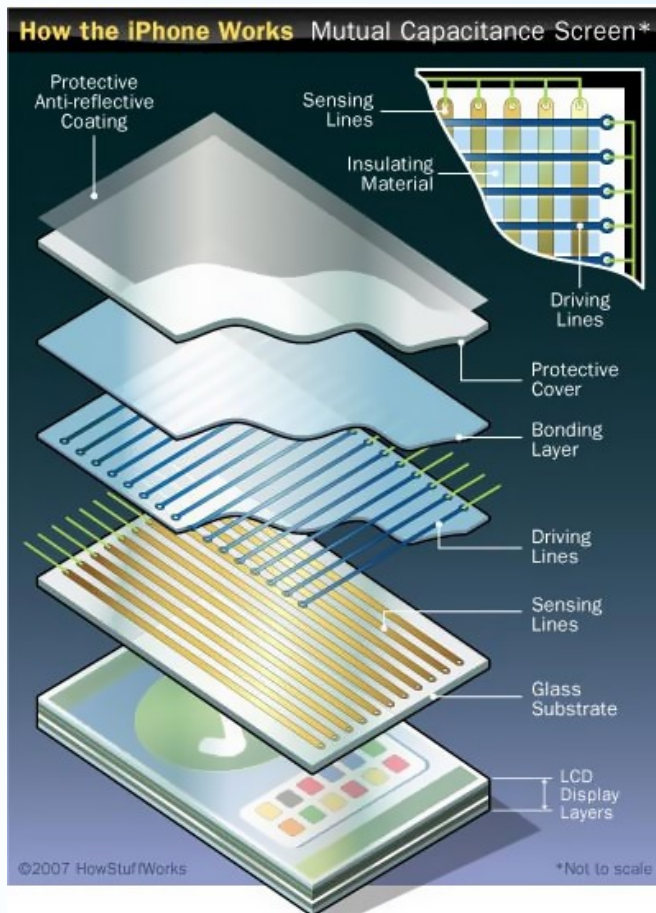
# APR touchscreen

- This system uses 3 or more piezoelectric sensors. These sensors change sound waves (created by changing the mechanical energy of touch) to an electrical signal that is further digitized.
- The system compares this signal with the “database” of stored waveforms (patterns) for each touch point.
- If it finds the same pattern, it can determine the exact position of the touch.



# Multitouch technology

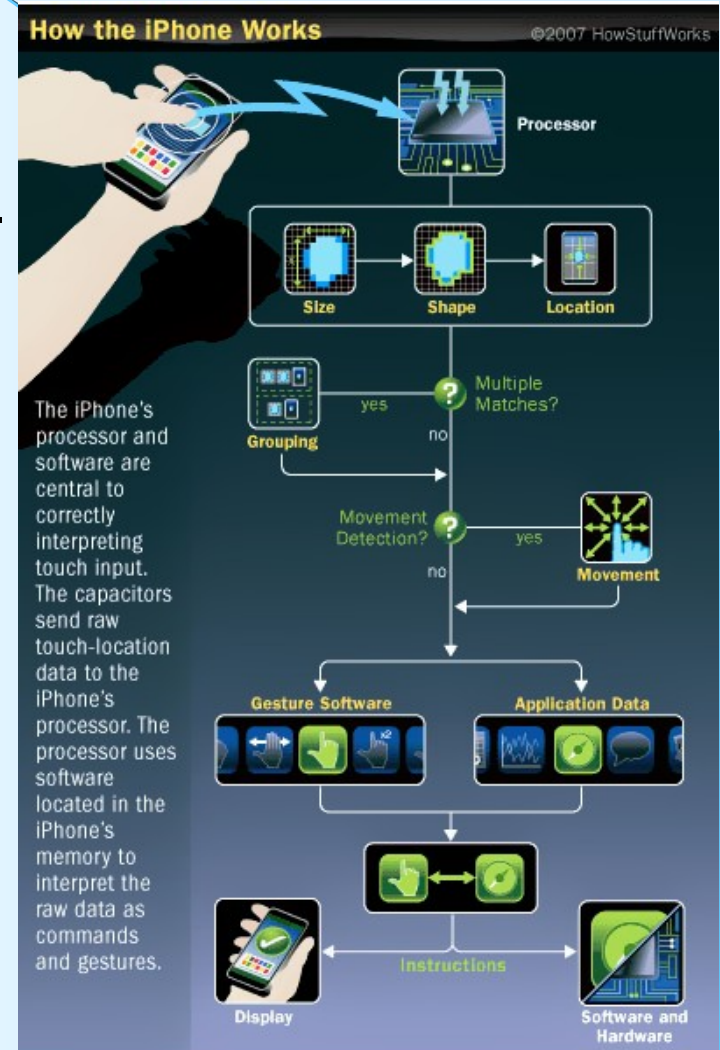
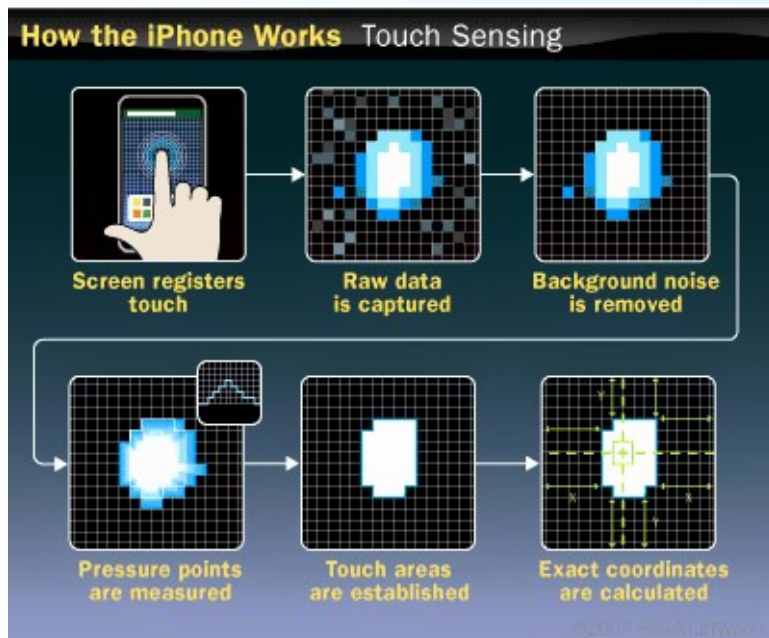
- iPhone uses capacitive technology.
- The first generation used two-layer conductor technology, the second used a block of electrodes located in the grid.





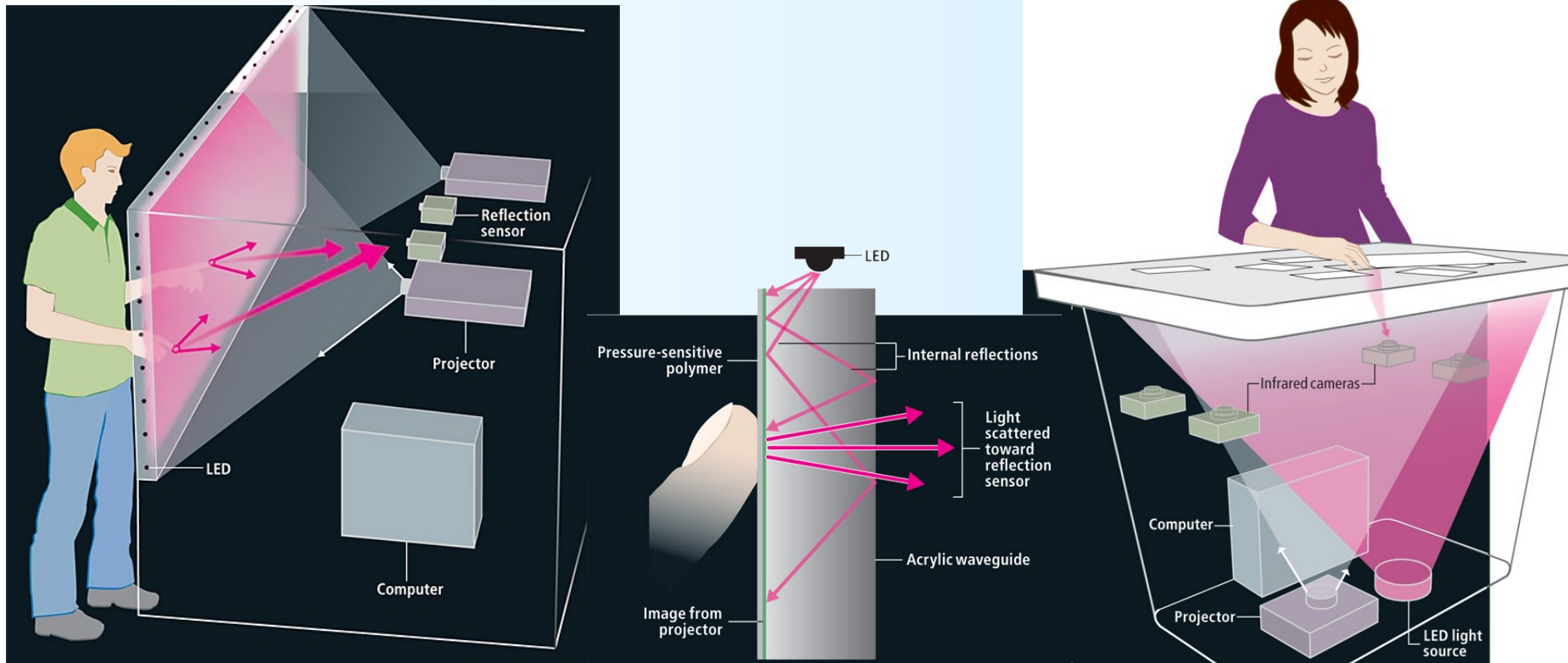
# Multitouch technology

- When touching, the position, size and shape of the touch point is obtained.
- The software then performs the appropriate action based on the nature of the touch and the specific application.



# Multitouch technology

- Projection touch panels use one or more LED light sources.
- The light beam is reflected to the sensors when touched.
- They are also capable of responding to the force of touch.



# Using touchscreens

- PDA – Personal digital assistants
- Laptops
- Mobile phones
- GPS navigation
- Information displays



# Comparison of touchscreen technologies

	Resistive	SAW(M)	Capacitive Surface	Capacitive Projected	Infrared	APR
Sensitivity	0	+	0	+	+	+
Resolution	+	+	0	+	+	+
Accuracy	+	+	-	-	+	+
Transparency	0	+	0	0	+	+
Resistance	0	+	0	+	+	0
Price	+	0	0	0	-	0

# Tablets technology

1956 *Rand Corporation* – created first digitizer.

- Passive – the stylus is not powered
- Active – the stylus is powered (e.g. battery)
- Electromagnetic induction and magnetostrictive
- EMR (Electro-Magnetic Resonance)
- Sound wave, acoustic
- Capacitive
- Resistive

# Electromagnetic induction

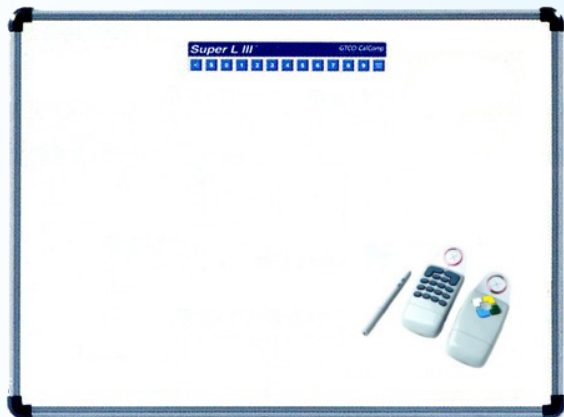
They use the principle of electromagnetic induction.

- A small coil is located in the sensing head, and a grid of conductors in the work surface.
- The coil in the sensing head is affected by the electric current and a magnetic field is created. This field induces the voltage on the specific wires.
- The position of the sensing head is determined by the voltage on the individual wires.
- In the second technology, the each wire is gradually influenced by the electric current (each for a short time). This action is repeatedly performed separately for both  $x$  and  $y$  directions.
- In the coil of sensing head, the electrical current is generated by electromagnetic induction. The device recognizes which wires have just been powered and calculates the corresponding coordinates.

# Magnetostriction technology

The principle is based on the elastic mechanical deformation of the magnetic material that is affected by the magnetic field.

- Magnetic conductors of the work surface are gradually influenced by the magnetic field of the electromagnetic coil. Then, a “deformation wave” propagating at a speed of 5 km/s is formed in the conductors.
- At the moment the wave passes near the sensor containing the coil, it induces electrical voltage in it.
- The value of the corresponding coordinate is determined by the time between the transmitted pulse on the wire and its detection in the sensor.



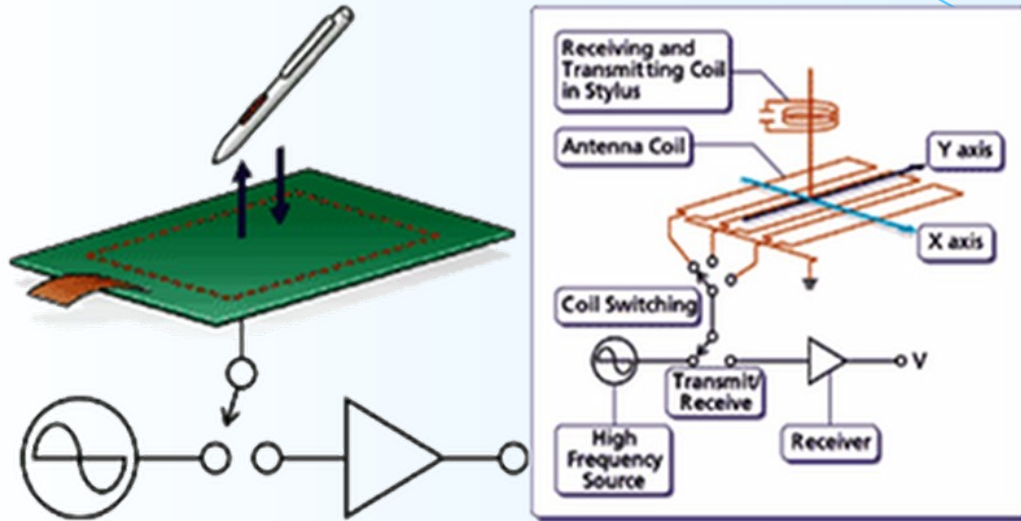
# Electromagnetic resonance

This technology was patented by *Wacom*. Allows you to use a stylus without power or connection to a laptop.

- The tablet's work surface contains a sensor that alternately acts as a transmitter and receiver.
- The electromagnetic signal stimulates oscillation in the coil-and-capacitor resonant circuit in the pen.
- The resonant circuit in the pen's tip supplies the power and serves as transmitter too.
- The received signal goes through the modulator to stylus chip. The information of the pressure sensor and of the side switch are sent back to the modulator which in turn sends a signal to the resonant circuit in the tip. The tablet picks up the information in the pen's tip in order to determine position, pressure, and other information.



# Electromagnetic resonance



# Sound wave technology

- This technology is based on the measurement of the time that elapses until the generated sound pulse (ultrasound) from the sound pen reaches the membrane of the microphones located in the corners of the scanning area.
- For measuring accuracy, up to 4 microphones are used in 3D tablets instead of three microphones.



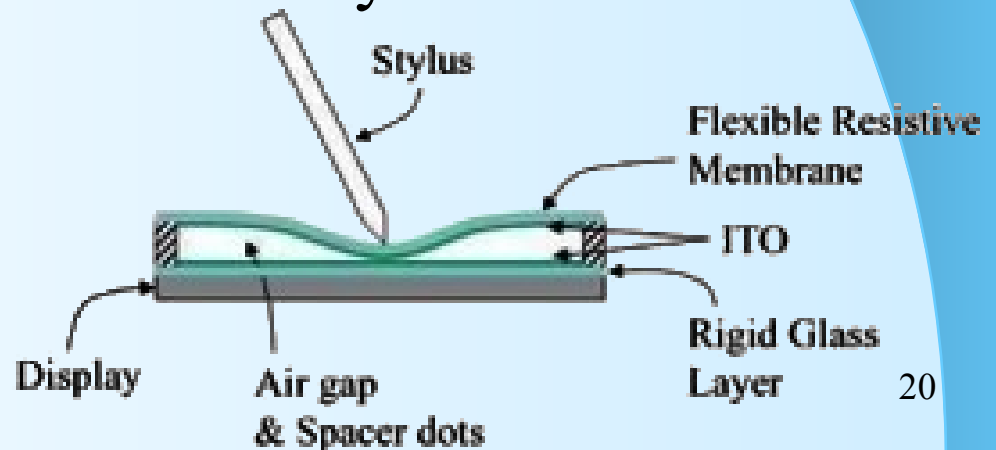
# Capacitive technology

- The work surface is made of a thin film on which electrically conductive shapes are placed in both  $x$  and  $y$  directions.
- Above this grid of conductors moves the sensor, which capacitively receives impulses.
- As soon as the sensor receives a pulse, the device detects which wires have been powered. From these data, it is then possible to determine point coordinates.

# Resistive technology

They work on the same principle as resistive touchscreens.

- It contains two conductive layers, one of which has a specific resistance. This layer is, on the one side, powered by a voltage which, due to the resistance, drops towards the second.
- The current is applied in both the  $x$ -axis and the  $y$ -direction.
- When touching, both layers are joined together. An electric current appears on the conductive layer.



# Use of digitizers and tablets

## Tablets:

- Common – PDA, tablet PC
- Computer graphics, art

## Digitizers:

- CAD
- Cartography and geography

