Capacitive vs. Resistive Touchscreens: What Are the Differences?

Capacitive and resistive touchscreen devices are everywhere these days, but what's the difference and how do they work?

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Whenever you buy a touchscreen, it isn't always advertised whether it's a capacitive or a resistive touchscreen. Yet, touchscreens of both types are used throughout the electronics industry.

If you pay attention, you'll notice the difference between the two screens. In the case of capacitive touchscreens, such as on very expensive smartphones and tablets, are very responsive to the slightest touch. Meanwhile, resistive touchscreens may require more pressure, or the use of a stylus.

The reason each type of touchscreen responds so differently is the underlying technology.

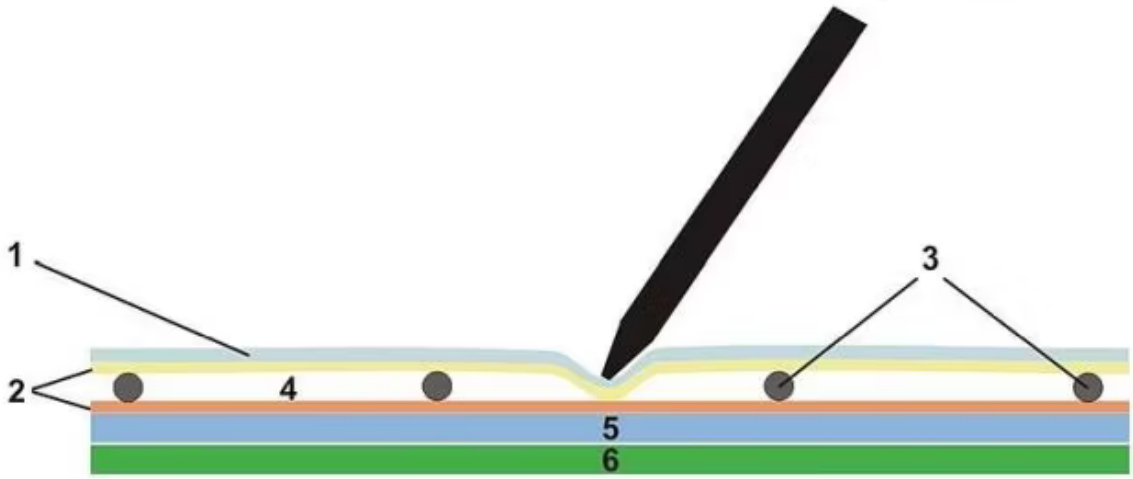
How Resistive Touchscreens Work

The resistive touchscreen has always been the most common type used in industrial electronics. This is mostly because they're cheaper to make and are easier to use in difficult environments.

The technology relies on resistance, meaning the pressure that's applied to the screen itself.

This type of touchscreen is created out of two very thin layers of material, separated by a thin gap. The top layer is typically some type of clear poly-carbonate material, while the bottom layer is made up of a rigid material. Manufacturers typically use PET film and glass for these layers.

Image credit: Szente/Wikimedia Commons



The upper and bottom layers are lined with conducting material like indium tin oxide (ITO). The conducting sides of each layer face one another.

Finally, spacers are placed in the thin gap between the two layers to prevent them from touching when the screen isn't in use.

The diagram above is a simple guide showing how this technology works.

- 1: The top, flexible poly-carbonate layer
- 2 & 3: Thin, conductive, indium tin oxide layers

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- 4: Spacer dots between the conductive layers
- 5: The rigid bottom layer, typically made of glass
- 6: Sensors that detect change of voltage when conductive layers touch

When you press your finger or a stylus against the screen, it creates a change in resistance (an increase in voltage). The sensor layer then detects this change, and the tablet or mobile phone processor calculates the coordinates of that change.

The 3 Types of Resistive Touchscreens

Resistive touchscreen technology relies on electrodes that layer a uniform voltage across the entire conductive area. This provides a specific voltage reading when an area of the two years make contact.

The type of resistive layout determines the durability and sensitivity of the entire circuit.

4-Wire Analog

In a 4-wire analog setup, both the top and bottom layers contain two electrodes called "bushbars".

These electrodes are oriented perpendicular to one another.

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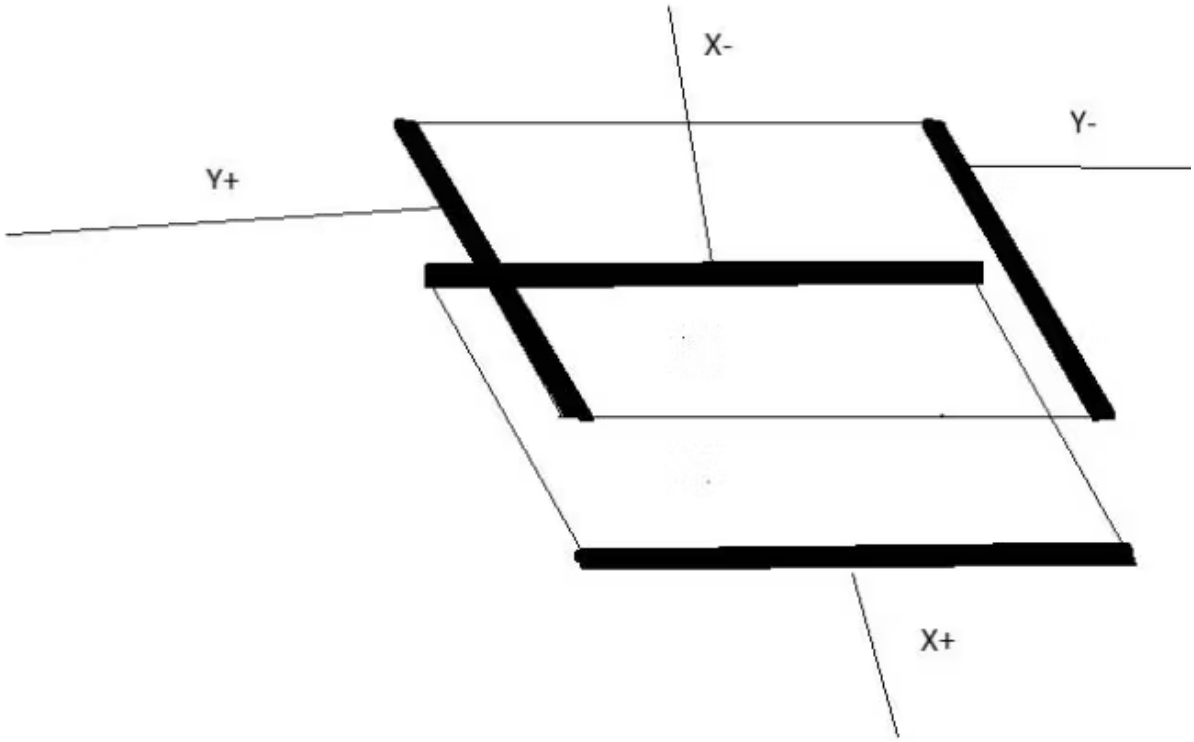

Electrodes on the top sheet are the positive and negative Y axis, while electrodes on the bottom are the positive and negative X axis.

Using this sort of electrical-coordinate setup, the mobile device can sense the coordinates where the two layers have come in contact.

5-Wire Analog

A 5-wire analog setup consists of four electrodes placed at each corner of the bottom layer. There are four wires that connect these electrodes together.

The fifth wire is the "sensing wire" embedded into the top layer.

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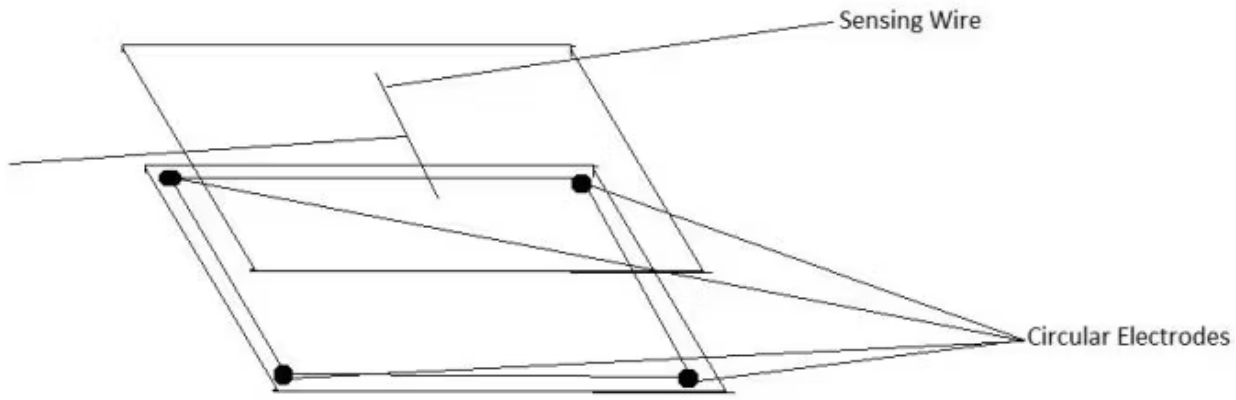

When your finger or stylus makes any area of the two layers touch, the sensing wire sends the voltage for the coordinates to the processor.

With fewer components and a simpler design, the 5-wire analog circuit is considered to be a bit more durable than other designs.

8-Wire Analog

The most sensitive resistive screen design is that of the 8-wire sensing circuit.

The layout is similar to the 4-wire analog, but each of the bar electrodes contain two wires. This introduces a bit of redundancy into the circuit.

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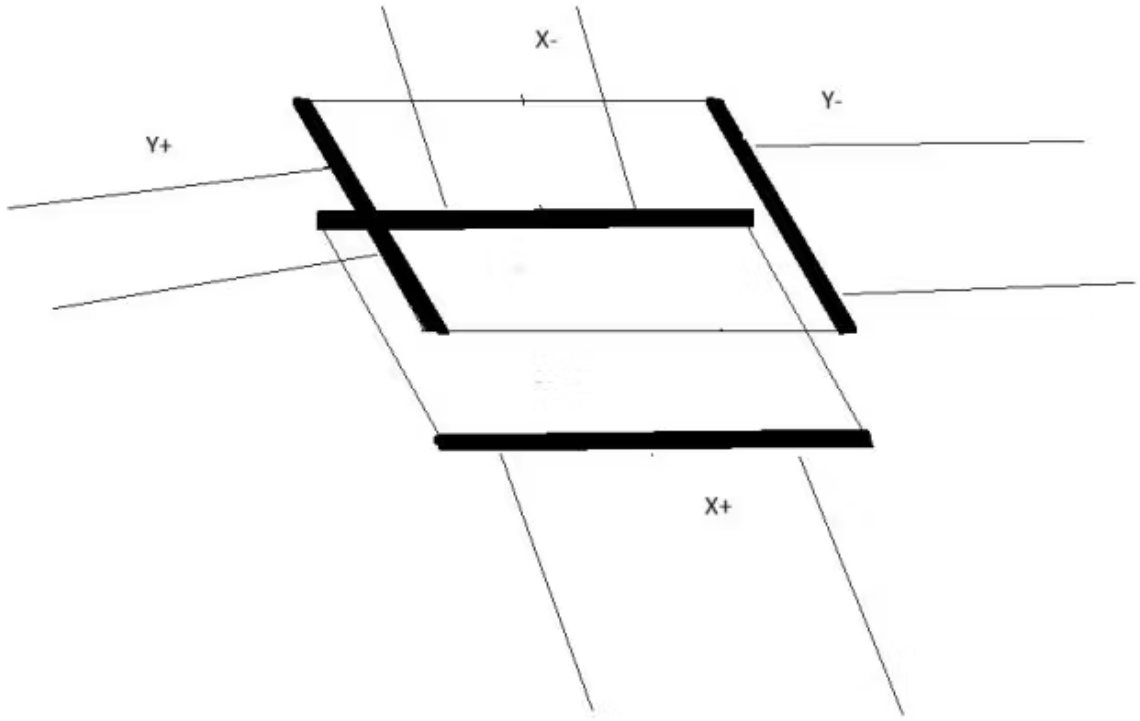

This is because even if one of the wire pairs loses resistance over time, the second wire provides a secondary signal to the processor.

This means that a more expensive resistive touchscreen with an 8-wire analog circuit will last longer. It also avoids the "drift" problems older phones used to have when trying to sense the location of your finger or stylus.

The Disadvantages of Resistive Touchscreens

Resistive touchscreens are meant to sense the location of one touch, and early generation touchscreens couldn't respond to two-finger pinch or zoom actions.

However, later generations saw some mobile device manufacturers introducing new algorithms and other tricks that allowed for two-finger touch features.

Some other limitations include:

- Less sensitive to light touch
- In many cases can't be used with gloves on
- Thick top layer creates less clarity for the display

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- The screen material is usually more easily scratched or damaged

In most cases such touchscreens are difficult or impossible to repair.

How Capacitive Touchscreens Work

Capacitive touchscreens were actually invented almost 10 years before the first resistive touchscreen. Nevertheless, today's capacitive touchscreens are highly accurate and respond instantly when lightly touched by a human finger. So how does it work?

As opposed to the resistive touchscreen, which relies on the mechanical pressure made by the finger or stylus, the capacitive touchscreen makes use of the fact that the human body is naturally conductive.

Capacitive screens are made of a transparent, conductive material---usually ITO---coated onto a glass material. It's the glass material that you touch with your finger.

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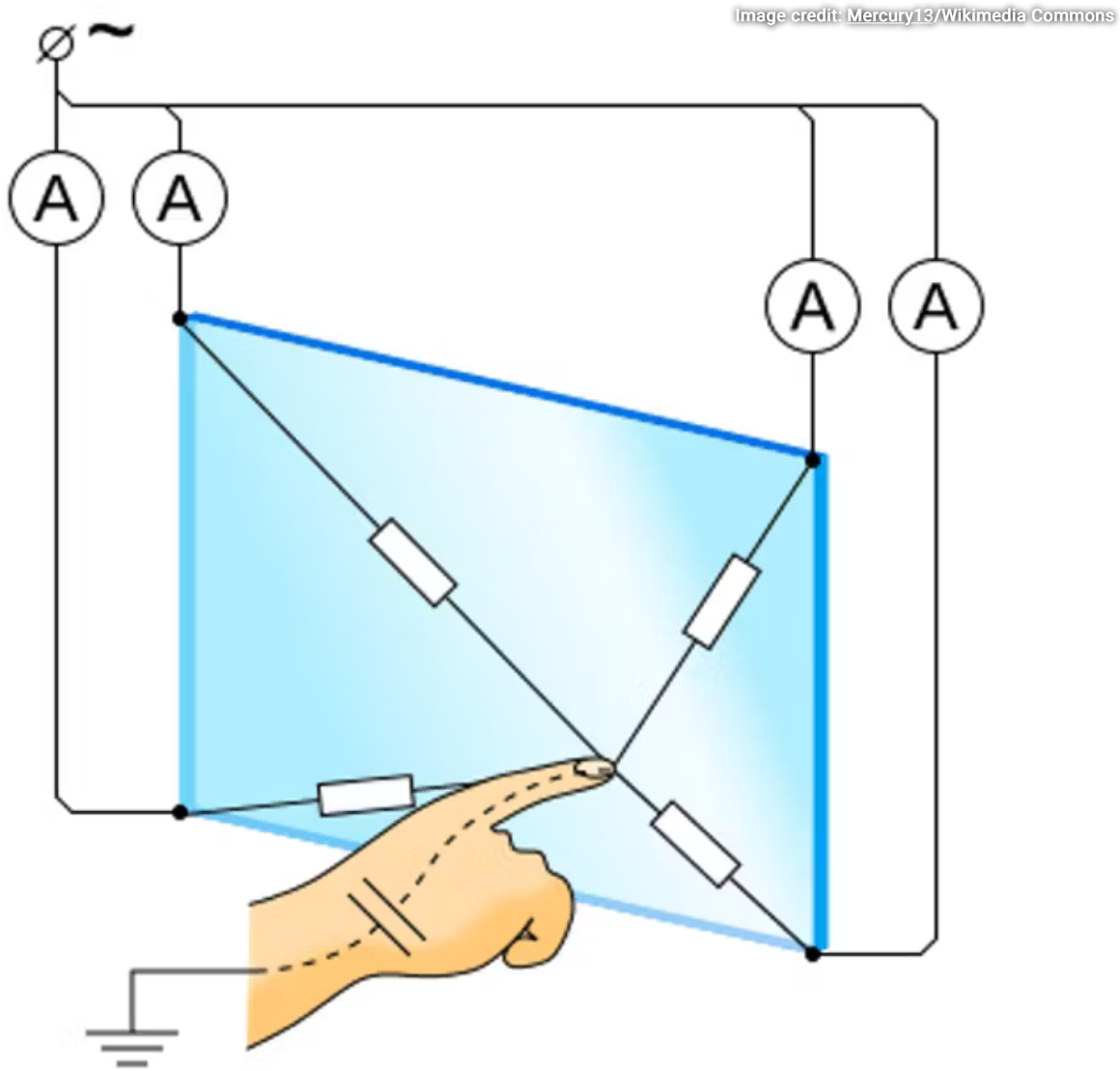

Surface Capacitive

In a surface capacitive setup, there are four electrodes placed at each corner of the touchscreen, which maintain a level voltage over the entire conductive layer.

When your conductive finger comes in contact with any part of the screen, it initiates current flow between those electrodes and your finger. Sensors positioned under the screen sense the change in voltage, and the location of that change.

Projected Capacitive

In a device that uses a projected capacitive setup, transparent electrodes are placed along the protective glass coating in a matrix formation.

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One line of electrodes (vertical) maintain a constant level of current when the screen isn't in use. Another line (horizontal) are triggered when your finger touches the screen and initiates current flow in that area of the screen.

The matrix formation creates an electrostatic field where the two lines intersect. This is one of the most sensitive types of touchscreens, and is how some phones can sense a finger touch even before you make contact with the screen itself.

Projected capacitive technology also allows you to use the touchscreen even when you're wearing thin gloves.

Resistive vs. Capacitive Touchscreens

Resistive touchscreen advantages include:

- Lower cost to manufacture
- Higher sensor resolution---you can tap small buttons easier with just your fingertips
- Fewer accidental touches
- Can sense any object touching the screen hard enough
- More resistant to the elements like heat and water

Capacitive touchscreen advantages include:

- More durable
- Sharper images with better contrast
- Provide multi-touch sensing
- More reliable---will even work when the screen cracks (until you replace the touchscreen)
- More sensitive to light touch

The choice to use a capacitive or resistive touchscreen depends largely on the application for the device.

How Touchscreens Are Used

Most devices with resistive screens are used in manufacturing, ATMs and kiosks, and medical devices. This is because in most industries the users need to wear gloves when

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using the touchscreens.

Capacitive screens are typically used in most consumer products like tablets, laptops, and smartphones.

If it weren't for cutting edge touchscreen technologies, we could never enjoy cool new applications like Opera's one-handed browsing for Android. The applications are only going to expand as the technology continues to be refined.

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