

2. Touch Screen Theory

Touchscreens are everywhere: they are embedded in phones, office equipment, speakers, digital photo frames, TV control buttons, remote controls, GPS systems, automotive keyless entry, and medical monitoring equipment. As a component, they have reached into every industry, every product type, every size, and every application at every price point. In fact, if a product has an LCD or buttons, a designer somewhere is probably evaluating how that product, too, can implement touchscreen technology. As with any technology, there are many different ways to implementation approaches, many promises of performance, and many different technical considerations when designing a touchscreen.

A touchscreen is an electronic device most of the time part of visual display that can detect the presence and location of a touch within the display area. The term generally refers to touching the display of the device with a finger or hand. Touchscreens can also sense other passive objects, such as a stylus. Touchscreen is common in devices such as all-in-one computers, tablet computers, and smartphones.

The touchscreen has two main attributes. First, it enables one to interact directly with what is displayed, rather than indirectly with a cursor controlled by a mouse or touchpad. Secondly, it lets one do so without requiring any intermediate device that would need to be held in the hand. Such displays can be attached to computers, or to networks as terminals. They also play a prominent role in the design of digital appliances such as the personal digital assistant (PDA), satellite navigation devices, mobile phones, and video games

TYPES:

There are a variety of touchscreen technologies.

1. Resistive Touch Screen:

A resistive touchscreen panel is composed of several layers, the most important of which are two thin, electrically conductive layers separated by a narrow gap. When an object, such as a finger, presses down on a point on the panel's outer surface the two metallic layers become connected at that point: the panel then behaves as a pair of voltage dividers with connected outputs. This causes a change in the electrical current, which is registered as a touch event and sent to the controller for processing.

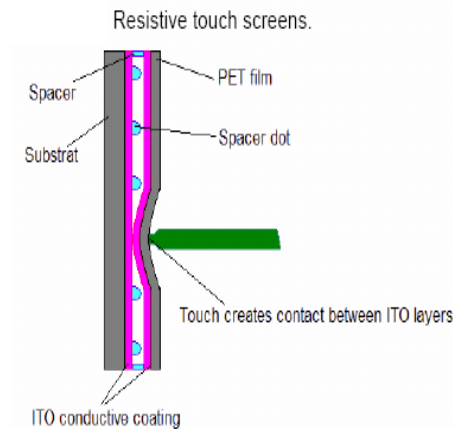


Figure: Resistive TouchScreen

There are various resistive touchscreens available like 4wire, 5wire, 6wire, 8wires touchscreen in various sizes, Most popular one is 4wire and 5wire touch screen.

2. Capacitive Touch Screens:

A capacitive touchscreen panel is one which consists of an insulator such as glass, coated with a transparent conductor such as indium tin oxide (ITO). As the human body is also an electrical conductor, touching the surface of the screen results in a distortion of the screen's electrostatic field, measurable as a change in capacitance. Different technologies may be used to determine the location of the touch. The location is then sent to the controller for processing. Unlike a resistive touchscreen, one cannot use a capacitive touchscreen through most types type of electrically insulating material, such as gloves; one requires a special capacitive stylus, or a special-application glove with finger tips that generate static electricity. This disadvantage especially affects usability in consumer electronics, such as touch tablet PCs and capacitive smartphones.

In most basic technology, only one side of the insulator is coated with a conductive layer. A small voltage is applied to the layer, resulting in a uniform electrostatic field. When a conductor, such as a human finger, touches the uncoated surface, a capacitor is dynamically formed. The sensor's controller can determine the location of the touch indirectly from the change in the capacitance as measured from the four corners of the panel. As it has no moving parts, it is moderately durable but has limited resolution, is prone to false signals from parasitic capacitive coupling, and needs calibration during manufacture. It is therefore most often used in simple applications such as industrial controls and kiosks.

For newer mobile phones advance technologies like projected capacitance and mutual capacitance (for MultiTouch Sensing) is used.

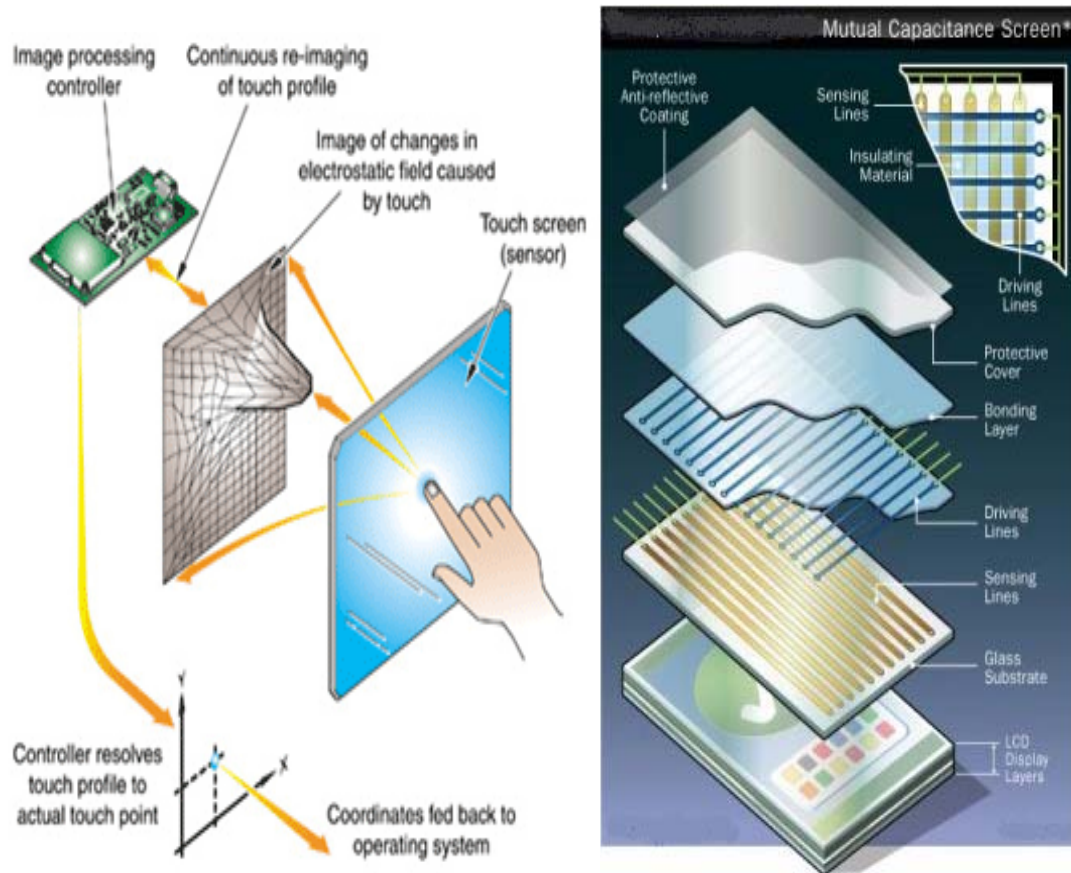


Figure: Capacitive Touch Screen

3. Surface acoustic wave:

Surface acoustic wave (SAW) technology uses ultrasonic waves that pass over the touchscreen panel. When the panel is touched, a portion of the wave is absorbed. This change in the ultrasonic waves registers the position of the touch event and sends this information to the controller for processing. Surface wave touchscreen panels can be damaged by outside elements. Contaminants on the surface can also interfere with the functionality of the touchscreen.

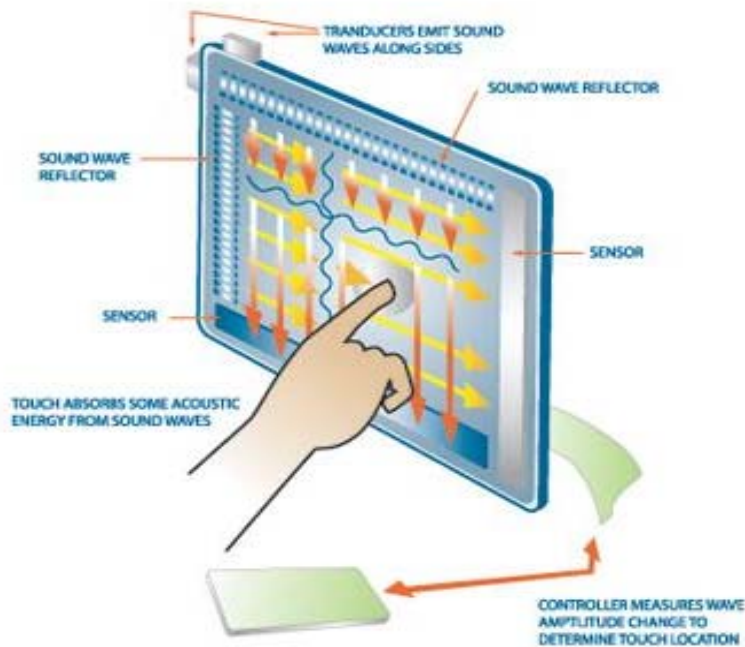


Figure: SAW (Surface acoustic wave) Touch Screen

4. Infrared Touchscreen

An infrared touchscreen uses an array of X-Y infrared LED and photo detector pairs around the edges of the screen to detect a disruption in the pattern of LED beams. These LED beams cross each other in vertical and horizontal patterns. This helps the sensors pick up the exact location of the touch.

A major benefit of such a system is that it can detect essentially any input including a finger, gloved finger, stylus or pen. It is generally used in outdoor applications and point of sale systems which can't rely on a conductor (such as a bare finger) to activate the touchscreen.

Unlike capacitive touchscreens, infrared touchscreens do not require any patterning on the glass which increases durability and optical clarity of the overall system.

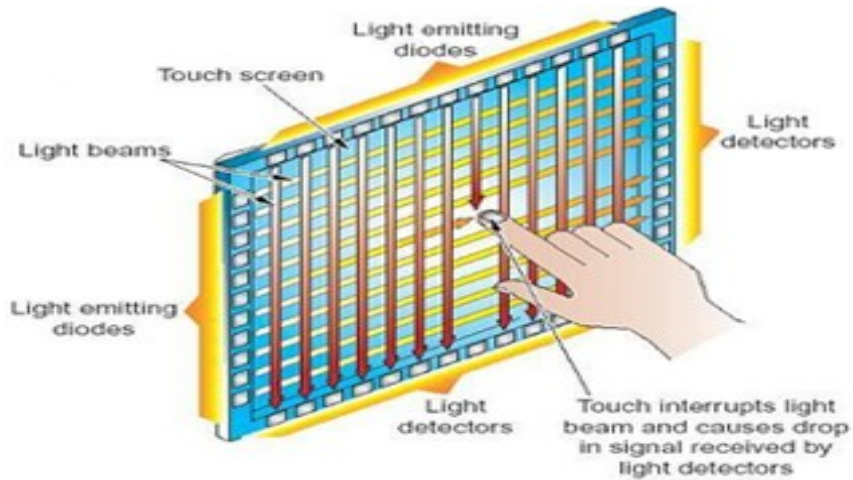


Figure: Infrared Touch Screen

Now it's time to compare all above touchscreens:

Technology	4-Wire Resistive	Surface Acoustic Wave	Infrared	Capacitive
Durability	3 year	5 Year	5 Year	2 Year
Stability	High	Higher	High	Ok
Transparency	Bad	Good	Good	Ok
Installation	Built-in /Onwall	Built-in/Onwall	Onwall	Built-in
Touch	Anything	Finger/Pen	Finger/Pen	Conductive
Response time	<10ms	10ms	<20ms	<15ms
Following Speed	Good	Low	Good	Good
Waterproof	Good	Ok	Ok	Good

4 Wire Resistive Touch Screen

In our project we are going to use 4 wire Resistive touchscreens. Resistive 4- and 5-wire touch systems belong to the most popular and most common touch screen technologies. Their market share is about 75%, mainly due to their low costs and simple interface electronics. Resistive System can be found in various mobile applications including PDAs and Smartphones.

Advantages in using Resistive touch screens:

- Resistive touchscreens are easily available as most of mobiles and other portable devices use this kind of touchscreen
- Interfacing to resistive touch screens is easier compared to other touch screens.
- Resistive touchscreens are cheaper compared to other input devices.

Construction of Resistive Touch screen:

A resistive touch screen consists of at least three layers: A flexible membrane made from PET film is suspended over a rigid substrate made from glass or acrylic. Both surfaces are coated with a transparent conductive film like ITO (Indium tin oxide). The conductive ITO layers are kept apart by an insulating spacer along the edges, and by spacer dots on the inner surface of the two ITO layers. In this way there will be no electrical connection unless pressure is applied to the top sheet (PET film).

When the PET film is pressed down, the two resistive surfaces meet. The position of this meeting (a touch) can be read by a touch screen controller circuit.

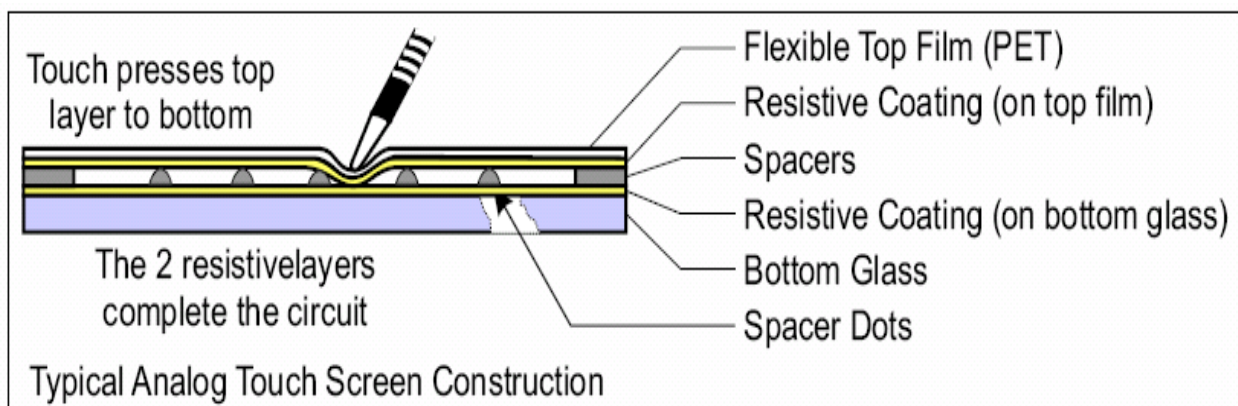


Figure: Construction of 4 Wire Resistive Touch screen.

Before going to understand how to measure x and y position first we have to understand how connections are made in top and bottom layer and coating configuration.

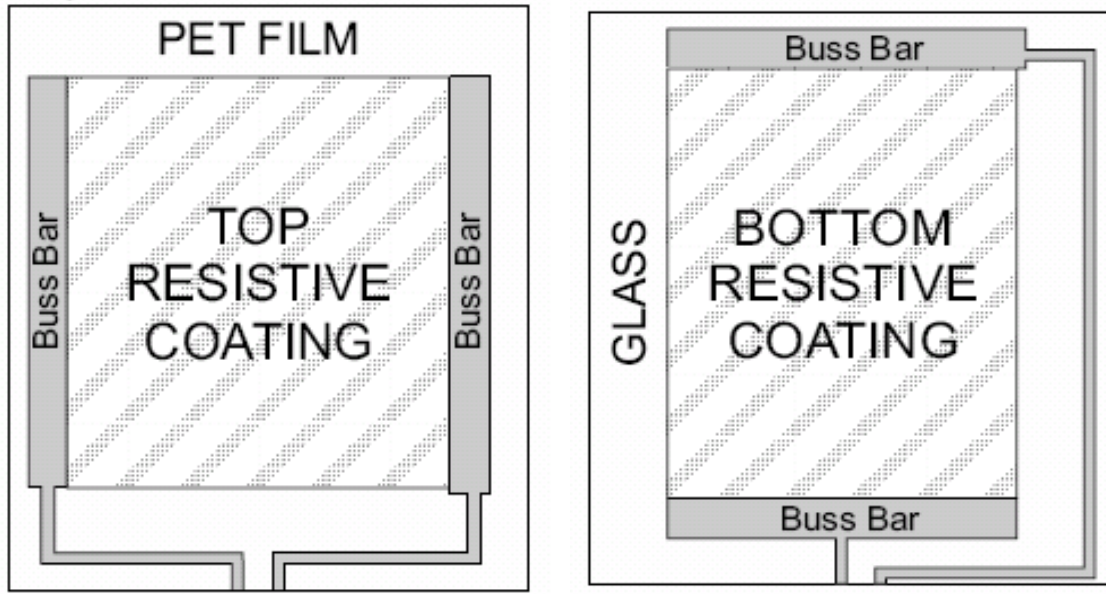
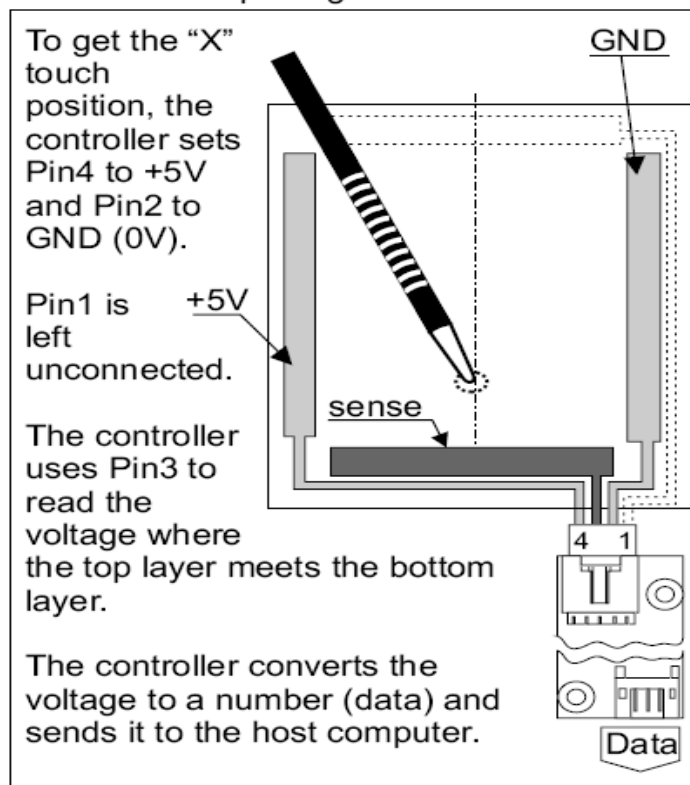


Figure: Coating of both layer and connection to outside of touch screen.

Measuring X and Y Position:

Now we will understand how to measure X and Y position by providing correct connections to different layers.

Capturing the "X" Touch



Circuit for X position sensing

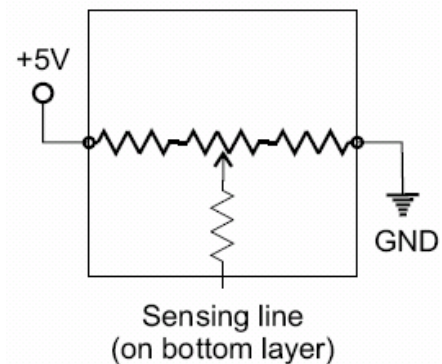


Figure: Measuring X position
Capturing the "Y" Touch

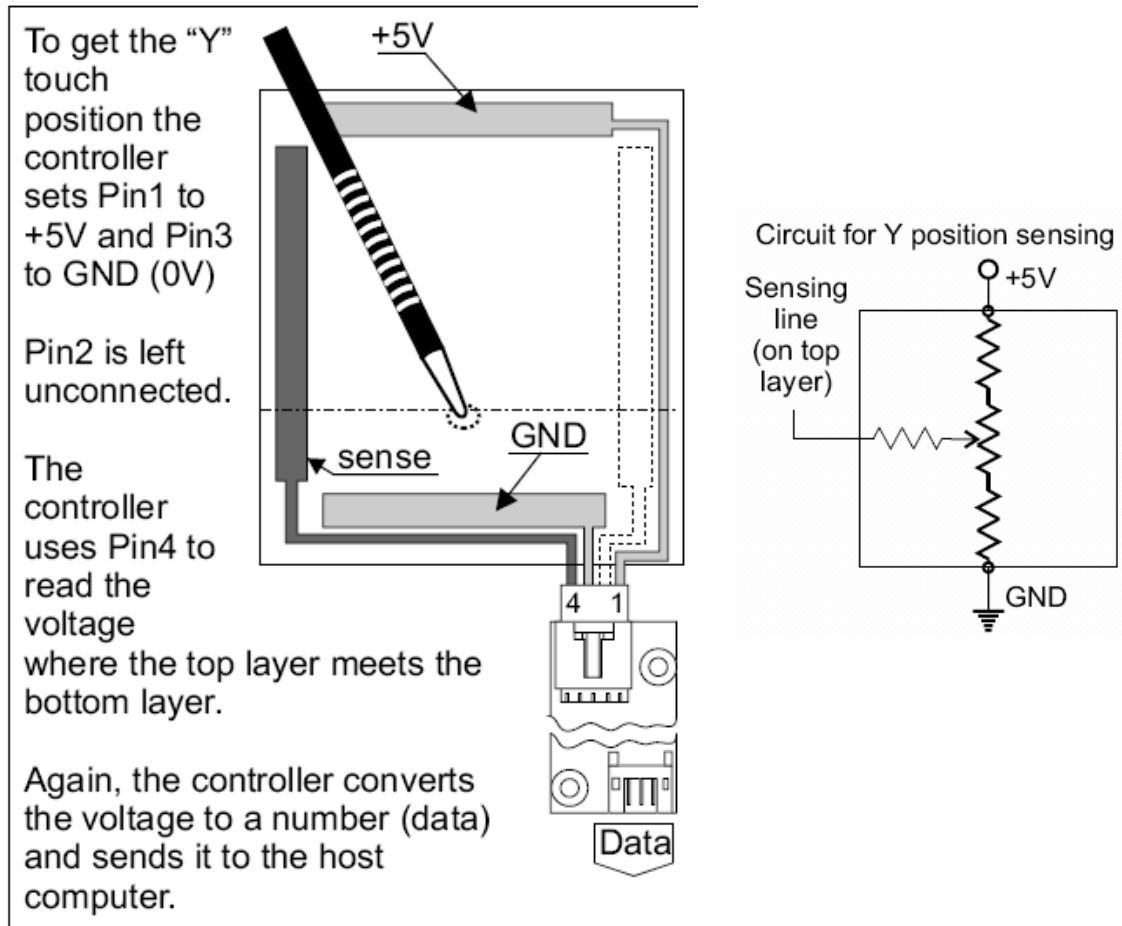


Figure: Measuring Y position.

After understanding above two procedures we have concluded following table for connections for x any y position measurement.

	X+ (Pin1)	Y- (Pin 2)	X- (Pin3)	Y+ (Pin4)
X Position	+5V	NC	GND	X o/p
Y Position	NC	GND	Y o/p	+5V

Basically we are getting voltages at pin 3 and 4 corresponding to Y position and X position, which we have to convert to digital values and find out the position, which can be used for further processing.