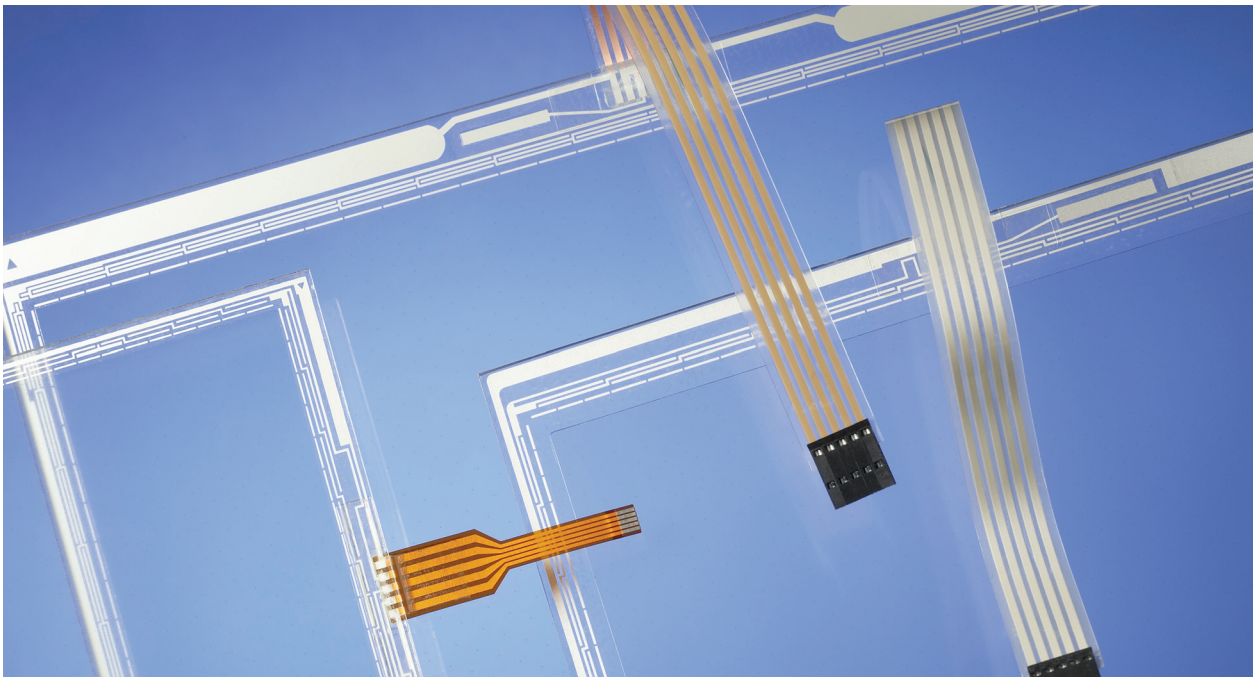
Bergquist Touch Screen

Technical Data

5-WIRE RESISTIVE

Reliable Performance For Harsh Environment Applications.



Benefits

- Durable, reliable performance for demanding, harsh-environment applications
- Rated at over 35 million activations
- Highly resistant to scratches, abrasions and external contaminants
- Patented optics for superior image clarity and brightness
- A wide variety of options available to match your design specifications

Bergquist 5-wire resistive analog touch screens are ideally suited for durable, reliable performance in a wide variety of demanding physical and harsh-environment applications. Unlike other resistive technologies that must use two opposing layers to create X- and Y- axis measurements, the Bergquist 5-wire utilizes the stable substrate of glass for both X- and Y- axis measurements.

Electrically, the 5-wire operates by supplying five volts to ground and toggling in both directions, thus supplying the X- and Y- measurements. The sense line, or fifth wire, is connected to the top film substrate. When the top layer is depressed, making contact with the base layer, it picks up the voltage data and carries it to the electronics. Because the top film is working only as a pick-up layer, it can tolerate resistance changes without impacting the reliability of the touch points' accuracy from the base layer.

It is for this reason the 5-wire is able to withstand temperature, humidity and mechanical stresses. As a result, 5-wire touch screens are specified at over 35 million activations versus a typical specification of 1 million activations for other types of resistive technologies.

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Bergquist Touch Screen

Technical Data

5-WIRE RESISTIVE

MECHANICAL	
Construction	Top Layer: 7 mil. hard coated polyester film with scratch-resistant, anti-glare or gloss finish on outer surfaces. Transparent conductive coating on inner surface Middle Layer: Near-invisible patented separator dots Bottom Layer: Glass substrate with uniform conductive coating
Cable & Connector	Flextail with a variety of 5-position Amp, Berg or ZIF connections available
Input Method	Finger, gloved hand, or stylus activation
Actuation Force	Stylus: <25 grams with plastic stylus with 0.039" radius Finger: <50 grams with 40 durometer, 0.375" spherical radius silicone finger Custom activation force available
ELECTRICAL	
Operating Voltage	2.5 V to 5V DC
Positional Accuracy	98.5% accuracy
Isolation	5 MΩ Isolation is the minimum resistance between traces that are not connected in the design when the touch screen is not deliberately activated
OPTICAL	*All values gained using BYK Gardner hazegard plus. Selection of film will determine final values.*
Transmittance	Glass <0.1" (2.54mm) thick: 89% ± 2 Glass ≥0.1" (2.54mm) thick: 87% ± 2
Haze & Clarity	Hardcoat 500303 — Haze 1%, Clarity 98%, Transmission 91% Hardcoat 500304 — Haze 1%, Clarity 98%, Transmission 85% Hardcoat 500269 — Haze 5%, Clarity 81-91%, Transmission 91% Hardcoat 500246 — Haze 8%, Clarity 80-91%, Transmission 85% Hardcoat 500293 — Haze 4%, Clarity 87-93%, Transmission 86%
ENVIRONMENTAL	
Operating	Temperature: -10° C to 50° C Relative Humidity: 90% RH at 35°C for 240 hours
Storage	Temperature: -40°C to 70° C Relative Humidity: 90% RH at 35°C for 240 hours
DURABILITY	
Point Activation	>35 million actuations. Life expectancy will vary depending on adjustments made to actuator type, dot pattern, durometer size, and force. Test conditions based on 0.375" spherical radius silicone finger with a 350g load at 2 touches per second.
Surface Hardness	4H per ASTM D3363-92
Chemical Resistance	Industrial chemicals: acetone, methylene chloride, methyl ethly ketone, isopropyl alcohol, hexane, turpentine, mineral spirits, unleaded gasoline, diesel fuel, motor oil, transmission fluid, antifreeze. Food service chemicals: vinegar, coffee, tea, grease, cooking oil, salt, plus most commercial cleaners including ammonia-based glass cleaner and laundry detergent
WARRANTY	
Touch Screen	5-year limited warranty, please see warranty for additional terms and conditions

U.S. Patents 5,736,688; 6,424,339; 6,559,835; 6,611,256
European Certificate 1233368

THE BERGQUIST COMPANY

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Bergquist Touch Screen

Design Flexibility

5-WIRE RESISTIVE

Options And Durability In A 5-Wire Resistive Analog Touch Screen.

Flexible Offerings

Bergquist combines the durability of 5-Wire resistive technology with flexible offerings to meet nearly any application requirement. Some of these options include:

- Large Range of Sizes From 3.9" to 23"
- Slim Perimeters
- Off Aspect Ratio Sizes
- Multiple Glass Options
- Variety of Top Film Options
- Wide Selection of Connectors
- Custom Flex Cables

Bergquist opens the door to a wide variety of design options. We allow you to build touch screens in dimensions and configurations that were previously precluded by technology or technique.

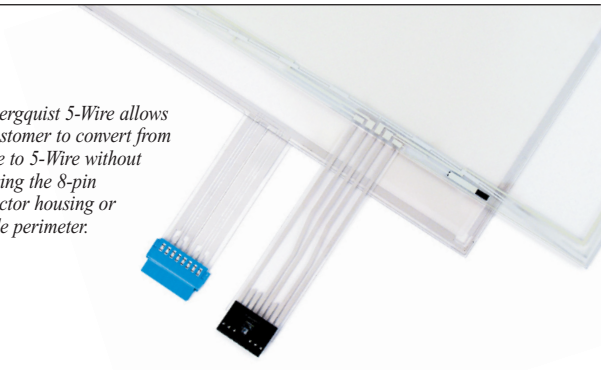
The touch screen overall dimensions are no longer determined by just standard sizes. You can specify the size to meet your application from 3.9" up to 23" in standard and off-ratio configurations.

Bergquist Touch Screen Options

SIZE	GLASS	TAIL DESIGN	FILM
Custom	Thickness	Length	Polished
Standard	Chemical Strengthening	Shape	Diffused
Off-Ratio	Single Strength	Connectors	Enhanced Polished or Diffused
Small Diagonal	Dimension	Center Spacing Pitch	Pen Input Device

Slim Perimeters

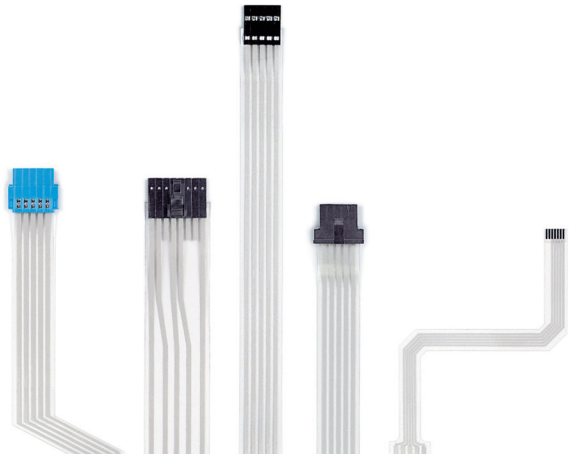
By offering some of the slimmest perimeters in the industry, our 5-Wire touchscreen design readily fits your application. It takes up less space and allows you to convert easily from 4 and 8-Wire into 5-Wire. Whether it is a new design or retrofit, our 5-Wire fits.



The Bergquist 5-Wire allows the customer to convert from 8-Wire to 5-Wire without changing the 8-pin connector housing or outside perimeter.

Flex Tail Interconnects

A comprehensive offering of flex tail interconnect solutions including: Berg, Amp, Zif with center pitch spacing from 0.039" (0.99mm) to 0.100" (2.54mm) in custom die cut shapes or standard lengths.



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Bergquist Touch Screen

Design Flexibility

5-WIRE RESISTIVE

With Bergquist, More Options Is Simply Our Point.

Film Options

Bergquist offers a wide variety of films to match your individual application. The film choice and best solution is dependent on your unique application which is why we work with you to understand your environment. Some of the items we take into account include: typical lighting conditions, brightness and type of display, viewing angle desired and, separation space from touch screen to display.

Our standard films come with a 4H rated hard coat, the toughest coating commercially available for touch screens today. Our conductive top films include pen input, polished, diffused, and several enhanced transmission types.

With a wide variety of films to select from, you'll be assured of the best solution for your application.

Bergquist Film Options

Type	Transmission	Haze	Clarity	Hardness
Enhanced Polished	**91%**	**1% ± .5%**	**98%**	**4H**
Polished	**85%**	**1% ± .5%**	**98%**	**4H**
Enhanced Diffused	**91%**	**5% ± 1.4%**	**81-91%**	**4H**
Diffused	**85%**	**5% ± 1.4%**	**81-91%**	**4H**
Pen Input Device	**86%**	**4.0% ± 1.5%**	**87-93%**	**4H**

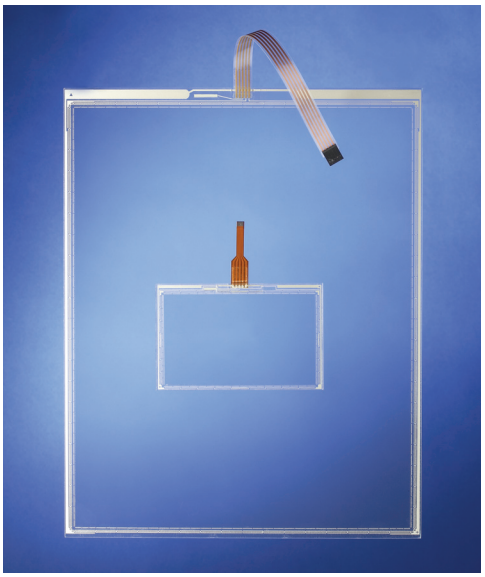
Size Offerings

The unique flexibility of the Bergquist 5-Wire pattern has changed the rules for 5-Wire size offerings. Where once 5-Wire was only offered in diagonal sizes over 6" and standard aspect ratios of 3:4, Bergquist 5-Wire sizes are available as small as 3.9" and as large as 23" in standard 3:4 aspect ratio as well as off aspect ratios.

Standard

- 3.9" LCD
- 5.7" LCD
- 6.4" LCD
- 8.4" LCD
- 10.4" LCD
- 12.1" LCD
- 13.3" LCD
- 14.1" LCD
- 15.0" LCD
- 15.1" LCD
- 16.8" LCD
- 18.1" LCD
- 19.2" LCD
- 20.2" LCD
- 23.0" LCD

Customized Sizes And Configurations Available



Large range of sizes from 3.9" to 23".

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Superior Optics, Robust Design

Resistive Touch Screen Versatility, Performance and Economy Without Sacrificing Clarity

Reduced Glare Improves Clarity

In a typical resistive touch screen, the dielectric separator dots used to isolate the conductive layers intensify veiling glare, the scattering of light transmitted through the touch screen. Veiling glare significantly reduces contrast and resolution, creating a visible haze that reduces clarity (see Figure 1).

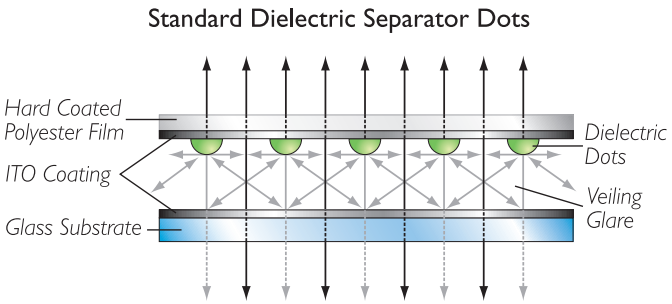


Figure 1

Bergquist 5-Wire resistive touch screens feature a patented configuration of dielectric separator dots that significantly reduce veiling glare. Color indexed to the 5-Wire's conductive coating, Bergquist's separator dots allow light to pass through the substrates with minimal veiling glare (see Figure 2). The result is an enhanced level of clarity and contrast that provides a sharper image for improved readability of text and graphics.

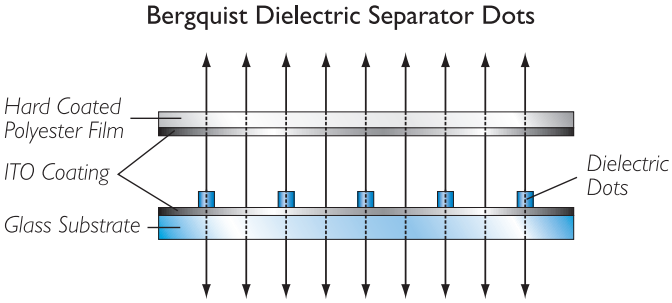


Figure 2

Durable Dots Make the Difference

Another key factor in the durability of Bergquist 5-Wire touch screens is the nature of the dielectric separator dots. Bergquist separator dots are applied to the surface of the glass, providing consistent, reliable performance. In contrast, (refer to Figure 3), some manufacturers' separator dots can be misshapen (A), deform during use (B), or fail completely under application pressure (C). Structural failure of the separator dots will significantly increase resistance thereby degrading electrical contact.

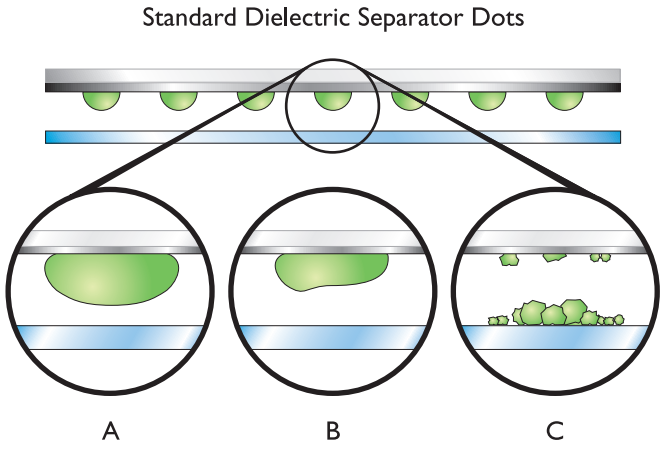


Figure 3

Bergquist Optical Clarity

Transmittance	Glass <0.1" (2.54mm) thick; 89% ± 2
	Glass ±0.1" (2.54mm) thick; 87% ± 2
Haze & Clarity	Hardcoat 500303 — Haze 1%, Clarity 98%, Transmission 91%
	Hardcoat 500304 — Haze 1%, Clarity 98%, Transmission 85%
	Hardcoat 500269 — Haze 5%, Clarity 81 - 91%, Transmission 91%
	Hardcoat 500246 — Haze 8%, Clarity 80 - 91%, Transmission 85%
	Hardcoat 500293 — Haze 4%, Clarity 87 - 93%, Transmission 86%
	Hardcoat 500294 — Haze 8.5%, Clarity 79 - 85%, Transmission 86%

NOTE: All values gained using BYK Gardner Hazegard Plus. Selection of film will determine final values.

U.S. Patents: 5,736,688; 6,424,339; 6,559,835; and 6,611,256.

Resistive Touch Screen Functionality: 4-Wire Versus 5-Wire Technology

Overview

All resistive touch screens use essentially the same voltage-driven operating principles. The electrically simplest way to produce a resistive touch screen is to utilize 4-wire technology. All 4-wire touch screens are constructed using two opposing, transparent and uniform high resistance conductive circuits onto which continuous low resistance bus bars are applied on two sides.

4-Wire Touch Screen Construction

The goal of a 4-wire circuit is to be able to produce two alternating linear voltage gradients in both the X and Y direction. Two circuits are used to alternately generate a voltage gradient and to measure the voltage that applies on the opposing circuit at the position where the two circuits are brought into contact.

To achieve this, the top circuit must consist of a flexible substrate uniformly coated with a clear conductive material. This circuit is then tightly suspended over a spacer layer that physically separates the flexible top from the ridged bottom circuit.

To generate a linear voltage gradient in one direction, the top circuit is coated with a uniform, electrically conductive yet transparent Indium Tin Oxide coating (ITO) coating. This relatively high resistance ceramic substrate is typically applied in a vacuum deposition process. A low resistance – typically silver – bus bar is applied on either side of the active area.

The bottom circuit utilizes a mirror image of the resistive coating that, in turn, is applied to a ridged material or a flexible material that is laminated to a ridged backer using an optically clear adhesive. The only difference is that the bottom circuit's bus bars are applied with a 90° offset to those of the top circuit. In other words, if the bus bars on the top circuit are applied to the left and right of the active area, the bus bars on the bottom circuit will be applied to the top and bottom.

How 4-Wire Touch Screens Work

In an assembled 4-wire touch sensor a voltage is applied to one bus bar on one of the two circuits while the opposing bus bar on the same circuit is grounded. This generates a linear voltage gradient from the drive voltage to ground, across the entire resistive surface of the circuit.

When the screen is touched, the top flexible circuit is depressed and makes contact with the bottom, stable circuit. At this point the voltage that applies at the touch location on the driven circuit will apply to the entire opposing circuit, where it is measured by an Analog to Digital Converter on the systems controller.

This voltage directly corresponds to the position in one axis. To obtain the second coordinate, the role of the two circuits is reversed. Now the circuit formerly used as the pick-off layer becomes the driven circuit and the opposing circuit is used as a pick off.

As the two voltage gradients are generated in X and Y direction, the second measurement will correspond to the second coordinate of the touch location.

Drawbacks of 4-Wire

Although a 4-wire screen works well in most consumer products or in applications where the screen is not exposed to any form of misuse or constant actuation, they will fail when exposed to prolonged actuation or in pen-input applications.

The primary reason for this is the inherent physical properties of the clear conductive coating. As mentioned earlier ITO is a ceramic and, when coated onto a flexible substrate, is therefore prone to crack if the base substrate is deformed.

The 4-wire system, however relies on linear voltage gradients that, in turn, require a conductive coating with uniform resistance properties in order to accurately determine a touch location. If the ITO coating is cracked, the properties of the flexible circuit will no longer allow for a linear voltage gradient to be generated and the screen therefore becomes non-linear.

This is especially the case for applications where touch screens are actuated numerous times in the same location (e.g. ENTER buttons or repeated actuations using a small radius tip, such as a stylus or screw driver).

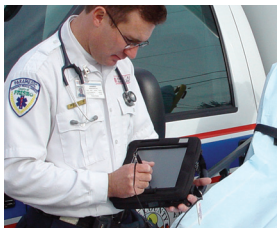
Another drawback of the 4-wire system is the fact that ITO on a flexible substrate is never fully oxidized. When exposed to heat and humidity the conductive coating will react with atmospheric oxygen and rise in resistance. As a result, a screen that was initially calibrated will drift, hence the touch location determined by the systems circuitry will be offset from the actual point of contact.

A good example of this problem is represented by PDAs that typically have to be re-calibrated every couple of months, especially when they are exposed to warm operating and storage conditions.

Continued ▶

The 5-Wire Advantage

In order to counteract these issues, a different operating concept was introduced: 5-wire technology. The idea is to produce a touch screen that works like a 4-wire system, only that both voltage gradients are produced on the stable substrate, almost exclusively glass. The advantage of glass versus any clear polymer (such as Polyester) is that glass can be coated with ITO yielding a fully oxidized coating that will not change in resistance and therefore is not prone to drift. In addition, glass is not hydroscopic and has a similar coefficient of expansion and contraction to ITO. Hence the material itself will not distort causing the ITO to crack.



Unlike 4-wire, the Bergquist 5-Wire is ideal for rugged, heavy usage applications.

It is technically not possible to simply apply 4 bus bars around the perimeter of the screen, as this would produce a short circuit. Instead, the bus bars are in essence broken up, producing a variety of resistor patterns in the perimeter of the screen. These individual elements form adjacent geometric shapes consisting of low resistance material that is screen printed directly onto the ITO substrate. The gaps between the shapes form individual resistors that allow a voltage applied to each corner of the resistor leg to uniformly drop from one electrode to the next.

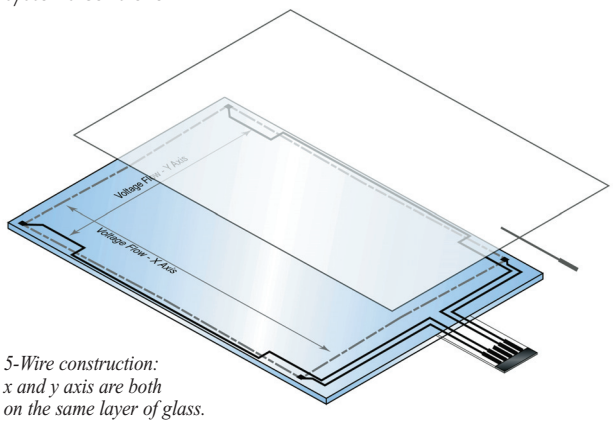
Driving 5-Wire Touch Screens

To drive a 5-wire screen, a voltage is applied to two adjacent corners of the resistor pattern while the two opposing corners are grounded. This generates a semi-linear voltage gradient across the entire surface of the screen in one axis.

The top film, which is connected to the 5th wire, is used only as a pick-off layer and, similar to a 4-wire touch screen, the voltage that applies at the point of actuation will apply to the entire top circuit, which corresponds directly to the point of actuation.

To determine the second coordinate, the role of two diagonally opposing corners is reversed. This generates a voltage gradient in a 90° offset direction. Again, the top circuit is used only as a voltage pick-off to take the measurement for the second touch coordinate. Because the top circuit is used only as a measuring circuit, it is not required to handle any current. This, in turn, does not require the transparent conductive coating to be of uniform resistance. Any cracks or fissures induced due to misuse or prolonged actuation therefore do not affect the screen's accuracy.

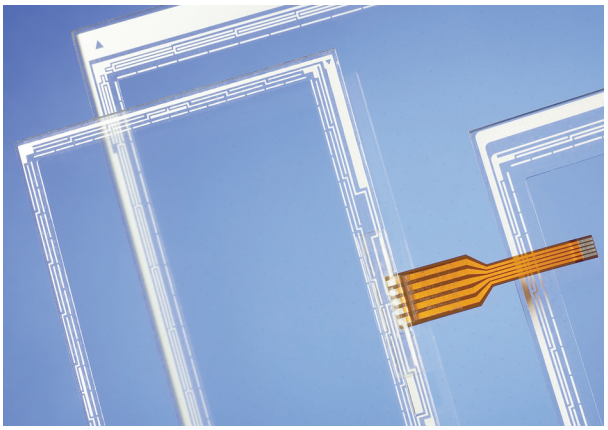
When the screen is touched, the top flexible circuit is depressed and makes contact with the bottom, stable circuit. At this point the voltage that applies at the touch location on the driven circuit will apply to the entire opposing circuit, where it is measured by an Analog to Digital Converter on the systems controller.



5-Wire construction: x and y axis are both on the same layer of glass.

This voltage directly corresponds to the position in one axis. To obtain the second coordinate, the role of the two circuits is reversed. Now the circuit formerly used as the pick-off layer becomes the driven circuit and the opposing circuit is used as a pick off.

As the two voltage gradients are generated in X and Y direction, the second measurement will correspond to the second coordinate of the touch location.



The Bergquist 5-Wire is resistant to normal chemical and environmental contamination such as dust, dirt and water droplets.

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Bergquist Touch Screen

Application Note

5-WIRE RESISTIVE

5-Wire Resistive Analog Touch Screens For Hand-Held Applications.

Hand-held devices are no longer a "disposable device." As hand-helds become an accepted tool for mainstream business, the demands placed on the touchscreen for reliability and optics have become increasingly important.

This 2.4" 5-wire touch screen is ideal for hand-held phone applications.

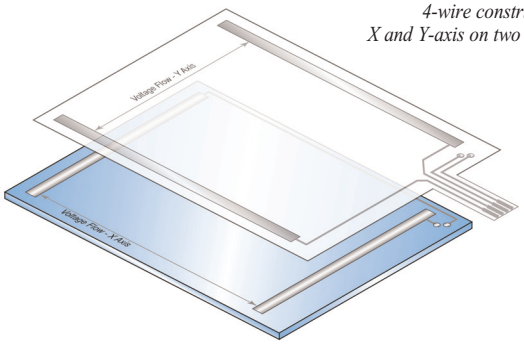
Resistive analog 4-wire touch screens have long been a successful touch screen user interface for hand-held devices, however mainstream industrial businesses such as warehousing, inventory control, retail, hospitality and medical applications have placed new demands on the interface pushing 4-wire resistive technology beyond its physical limit. This has prompted manufacturers to develop new and more rugged resistive touch screens for these harsh environment applications.

Resistive Analog 4-Wire Technology Construction and Functionality

The 4-wire consists of two opposing electrically conductive elements. The conductive material is typically ITO (Indium Tin Oxide) because of its transparent nature. There are two different ways to construct a 4-wire touch screen. One, using two flexible conductive films laminated to a glass or plastic backing. Two, using a flexible top conductive layer laminated to a conductive piece of glass. Most hand-held PDA constructions are built using the film/glass construction method.

Electrical Functionality of the 4-Wire

The X and Y-axis data points are derived using both conductive planes. In the first phase of data collection, the top conductive layer is electrically charged and the bottom conductive layer acts as the feedback sending raw voltage of the touch point to the electronics, deriving one-half of the full touch coordinate. In the second phase, the bottom layer is electrically charged and the top layer serves to send the voltage information to the electronics, completing the X and Y coordinate signal. Typically, low-cost 4-wire constructions built with a film/film type are rated at 100,000 activations and higher cost 4-wire film/glass constructions are rated at one million activations.



4-wire construction: X and Y-axis on two layers.

Reliability is the Key Limitation of a Four-Wire Touch Screen

In 4-wire touch screens, accuracy is affected with environmental changes, primarily shifts in humidity and temperature. The top film represents the X or Y-axis depending on the design. It is important that the resistance value remain stable on both axis after initial calibration. Because the top layer is made with polyester, this top sheet will expand and contract with changing conditions, thereby causing changes to the initial resistance values. This change results in what is known in the industry as "drift" to the touch point location, which diminishes the touch screen reliability. In addition, frequent flexing of the top layer upon single locations (such as on and off icons) can cause mechanical damage to the conductive coatings. This fracturing of the conductive coating changes the resistance values as well, and results in the need for frequent field recalibration or complete and permanent electrical failure of the touch screen. The benefits of a 4-wire are its widespread usage, which has helped keep the cost low and prompted numerous chip manufacturers to make electronics accessible and economical.

For Additional Info (800) 341-3533
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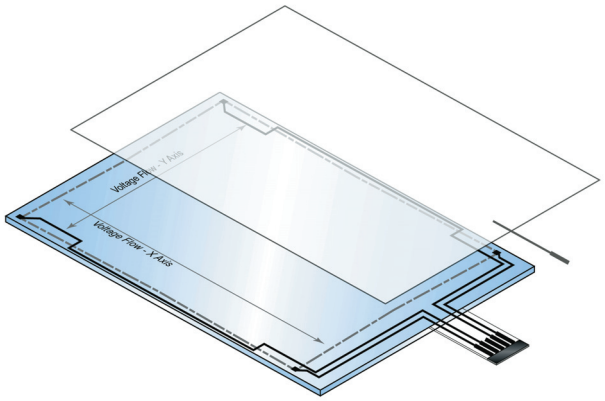
Alternative 5-Wire Resistive Technology for Hand-Held Devices

Resistive analog 5-wire touch screens are the most reliable resistive on the market today, but have never had the ability to be incorporated in a hand-held device until now. 5-wire has been the resistive analog solution for tough environment applications such as industrial control modules, POS applications and Kiosks for nearly 20 years, but has been limited to diagonal sizes of 6.4" or larger. This diagonal limitation prevented the technology from consideration in hand-held applications, which are typically 3.9" in diagonal or smaller. The following information describes 5-wire construction, functionality and its ability to now be incorporated into hand-held devices.

5-Wire Construction and Functionality

The mechanical layers that makeup a 5-wire construction are similar to that of a film/glass constructed 4-wire. The key difference between 4-wire and 5-wire is how they perform electrically. The 4-wire must use two layers to create X and Y-axis measurements. In contrast, the 5-wire utilizes the stable substrate of glass for both X and Y-axis measurements. 5-wire operates by supplying five volts to ground and toggling in both directions, thus supplying the necessary X and Y-axis measurements. The sense line or 5th wire is the top film substrate. When the top layer is depressed making contact with the base layer it picks up the voltage data and carries it to the electronics. Because the top film is working only as a pick up layer it can tolerate resistance changes without impacting the reliability of the touchpoints accuracy from the base layer. It is for this reason the 5-wire is able to withstand temperature, humidity and mechanical stresses. As a result, 5-wire manufacturers are able to specify their touch screens at 35 million activations.



5-wire construction: X and Y-axis on base layer of glass.

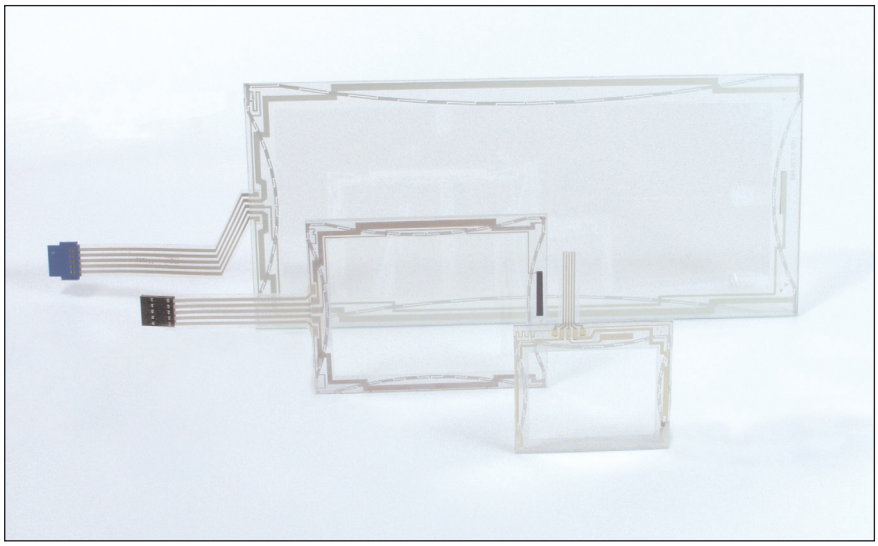
Barriers which prevented 5-Wire from being used in hand-held applications

Although the 5-wire has proven itself in the market to be reliable resistive analog solution for rugged applications, there were significant barriers that prevented its usage in hand-held devices. These barriers included the inability to linearize diagonals under 6.4", external electronic correction (NovRam), its wider perimeter and limited electronic accessibility in the marketplace. To help break down these barriers, The Bergquist Company has developed 5-wire drop in sizes for handheld devices and has recently developed a 2.4" diagonal for phone applications. The success of these smaller diagonals resides in Bergquists' patented linearity resistor network. This pattern is able to linearize small diagonals as well as off-ratio sizes (aspect ratio of 6:19). Off-ratio sizes are not only used in hand-held applications, but are of particular interest to the automotive industry where GPS and entertainment applications need the off-ratio dimensions. This linearization is first order, so no external correction electronics are necessary. Where OEMs were once bound to the touch screen manufacturer for their 5-wire electronics solutions this is no longer the case. Companies like Burr-Brown, Texas Instruments and Hampshire Company have made the electronics simple and accessible with "off the shelf", inexpensive electronic chip solutions for 5-wire.

5-Wire Optics

Resistive touch screen manufacturers are continuously working on improvements to enhance the optical performance of the touch screen. The 5-wire is uniquely suited for improvements in this area because the top conductive film does not require as many manufacturing-processing steps to complete. 5-wire can use nearly any conductive film, including polarized, anti-reflective, high-contrast, gloss and matte film offerings. This flexibility keeps 5-wire manufacturers consistently on the leading edge of optical performance. Bergquist has taken their optical performance a step further by significantly reducing the scattering of light within the touch screen itself. This is accomplished using a dot separator treatment that is closely color indexed to the conductive coating and changes the direction of light. Instead of scattering light, the dot separators allow the light to pass through the substrates. Manufacturers of hand-held devices are expanding into applications well beyond what was once considered the disposable consumer market. These include such rugged applications as, warehouse management, courier services, hospitality, retail, inventory control, healthcare and sales automation. These applications require not only durability, but optics that can enhance the display in all lighting conditions indoors and out. Expect to see more 5-wire touch screens filling these applications.

Right: *5-wire touch screen diagonals range from as small as 2.4 inch to as large as 23 inch. (Shown are 7 inches off-ratio, 3.9 inch and 2.4 inch sizes)*



Below: *Bergquist's patented dielectric dots (top) allow the light to pass through, reducing the scattering of light. Standard dielectric dots (bottom) bounce light from both conductive layers causing the "veiling light phenomenon" - light scattering.*