The Rugged Environment and Touch Screens

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There are a variety of environmental factors that could potentially impact one's optimal choice of touch technology. This paper provides an overview of potential concerns that the buyer should consider if the touch application is to be used outside a benign office environment.

Temperature

Moderate temperature changes do not have any impact on touch screens. In fact, extreme temperature changes have more impact on the touch electronics than they do on the sensors. The manifestation of most high or low temperature extremes on the touch electronics is drift (the touch point does not appear under the finger). The impact is primarily associated with the analog electronics, especially the A to D converter, and for applications that anticipate these temperature extremes, the use of ceramic or high temperature parts can help abate potential drift. In the vast majority of applications, however, there is no need to be concerned.

The most temperature sensitive type of touch screens are those that are associated with acoustic technology, such as Surface Acoustic Wave (SAW). Typically, acoustic sensors will incorporate an auto calibration into its operating cycle, using a known point or measuring a deviation from the initial calibration in the non-touch phase.

Resistive sensors fall into three general categories, known as three, four, and five-wire touch technologies.

Three-wire resistive sensors, now rarely produced, use onboard diodes that are somewhat sensitive to high temperatures. A 30ºF degree change in temperature from the calibration position will typically show a 2% shift.

Four-wire resistive sensors are the most susceptible to increased temperature changes. Four-wire sensors are typically stable throughout their operating temperature ranges. However, when the upper end temperature is exceeded, sensors can exhibit as much as a 4% drift. This is because changing the temperature will change the bulk resistance of the transparent thin film, and thereby alter the voltage that is used to generate the coordinate. Worse, one axis may exhibit a different percent drift from the other.

Adding resistive conductive paths to the touch screen can minimize drift due to higher temperature swings. These paths, which can also be used for auto calibration, turn a four-wire touch screen into an "8-wire" touch screen. Extra feedback traces require edge distance around the perimeter of the sensor. An 8-wire touch screen uses sensing voltages to maintain accuracy under changing initial system values and will go so far as to auto-compensate with the appropriate electronics.

Five-wire sensors are almost immune to temperature shifts due to their ratio-metric nature. However, resistive controllers can be damaged by extreme temperature environments. Conductive materials that spend extended time periods in harsh environments experience issues because ink gets released from the films.

Capacitive touch screens are also ratio-metric, and while the controller temperature is more sensitive to temperature, the touch sensor is mostly immune.

Most touch screens can be functionally damaged by storage temperatures below –40ºF. Resistive touch sensors can be cosmetically damaged by temperatures that are below –40ºF. This is because the top layer of plastic can contract and stretch, and when the touch screen is returned to operating temperature, it may be “puffy”. Acoustic and capacitive sensors can experience a breakdown in the materials used to manufacture the product. While all of these products have survived –40ºF and below, there is always a risk that damage might occur. Other than controlling the environment, there is nothing that can be done to mitigate the risks.

All plastic touch screens (unbreakable) are typically sensitive to temperatures above 185ºF (85ºC). This is because the adhesive systems can create small bubbles that, while, not damaging to the electrical performance, may affect the optics.

Altitude
Touch screens are not generally affected by altitude. Resistive touch screens can be manufactured with or without vents. Typically resistive touch screens are manufactured without vents. Ventless resistive touch screens are not affected within the normal altitude testing. Vented touch screens are used when the touch screen has to meet extreme rapid decompression requirements testing (primarily for aerospace applications). Vents are essentially gaps which are built into the touch screen. Vents allow the air between the layers to equalize.

Ultraviolet Light
All touch screens are somewhat susceptible to long periods of ultraviolet light. In practice, however, this almost never occurs. Outdoor applications which expose the anti-glare hard coats (in the case of acoustic and capacitive) and the plastics (in the case of resistive) to intense sunlight, can “yellow” over time. There are special UV inhibiting coated materials that can be use to minimize the yellowing affect from ultraviolet rays.

Special Light Conditions
There are a variety of lighting conditions, including night vision and bright sunlight that are handled differently by each of the touch technologies. By far the biggest issue is the use of touch screens in high bright automotive applications. This is because the instrument, usually a global positioning system (GPS), is generally fix-mounted and unlike a PDA, cannot be tilted to a non-reflective angle. While acoustic and capacitive reflect less light than resistive, neither of these is well adapted to mobile applications. Therefore, special anti-reflective materials must be incorporated into a resistive touch screen to meet these sunlight readable needs. Additionally, light enhancement filters can be used to increase the brightness, while a green tinted film is used for night-readable applications.

Shock and Vibration

Shock damage, primarily due to impact from an attempt to break the touch screen, affects all current touch technologies. In practice, other than personal digital assistant (PDA) applications, there is relatively little shock damage and ordinarily standard touch screens will pass all UL breakage tests. Materials can be selected to meet durability requirements for all applications, up to (and including) the use of bullet-proof glass.

Currently, plastic touch screens are the exclusive domain of resistive touch technology. Plastic is the best choice where breakage and shattering are not an option. The most common contemporary touch application that exemplifies this requirement is in-flight entertainment systems. The automotive industry is a rapidly growing area for touch applications. The automotive environment combines the elements of shock, vibration, and temperature for touch screens.

Since acoustic touch screens are the most susceptible to vibration, they are not the first choice for mobile or vehicle applications. Capacitive and resistive sensors are generally immune to vibration problems, but capacitive does not always work reliably in mobile applications where vibrations are the greatest. Resistive film on glass (FG) and glass on glass (GG) touch panels are suitable for automotive use, however film on glass is the most common due to its ability to handle temperature fluctuation and the cost is low compared to other technologies. With the right gasketing or bezeling vibration and shock can be accounted for in any resistive touch panel design. Because of the glass substrate used in capacitive construction, a ruggedized resistive touch panel is the best technology where constant vibrations are likely.

Humidity and Liquids

Acoustic touch screens are most affected by humidity; condensed liquids, in fact, it can cause this type of touch screen to fail and thus they are generally not selected for outdoor applications. Resistive touch screens are the only type that can continue to operate in, and after, saltwater immersion tests as they are NEMA sealable; Nema 4, 12, and IP65.

Resistive and capacitive touch screens are also resistant to such liquid contaminants as coffee, tea, vinegar, juice, and soda.

Highly Corrosive Environments

Capacitive touch screens are the most susceptible to the types of air quality found in highly acidic environments. For example, steel mills; this is because the first surface of the touch screen is composed of a “leaky” silica overcoat on an acid-susceptible transparent thin film. Eventually, either strong acids or bases, passing through small holes in the protective silica overcoat, will ruin the touch screen. Both resistive and acoustic panels are largely immune, though resistive panels must be specified to have no vent. For all technologies, gold flashed connectors should be specified where a harsh environment is anticipated because gold is more resistant to corrosion than the standard tin-lead terminations.