Moisture & Water Tolerant Touchscreens for Industrial Applications

After revolutionizing the consumer electronics landscape, capacitive touchscreens are now having a similar impact on the industrial market. The features that make capacitive touchscreens so appealing for portable devices, such as fast response times, intuitive multitouch operation and light touch input are all attractive for industrial applications, and the flexibility of touchscreens compared to traditional controls mean that they could be used in a wide range of applications from monitoring food production lines to manufacturing process controls.

However, industrial applications also come with an additional set of performance requirements beyond those of consumer applications which must be addressed for a touchscreen to be suitable for an industrial setting. One of these key requirements is reliable operation in the presence of water or other contaminants on the screen. Without careful design, such contaminants can result in the screen becoming unresponsive or, in the worst case, lead to false inputs on the screen. In some applications this could be disastrous.

With a system level approach to touchscreen design and custom tuning of the finished module, water tolerance can be improved to levels which are appropriate for a wide range of industrial applications.

The problem with water

Handsets and tablets are carried everywhere and are exposed to different environments resulting in a high risk of contaminants (water and other) getting on the screen and causing issues with proper operation. In a consumer device this rarely results in anything other than a minor inconvenience – your phone may become temporarily unresponsive when exposed to rain, but, being a handheld device, it is easy to wipe clean and we would not be particularly troubled by this. In an industrial application things are very different, however. Say the touchscreen in question is on a built-in industrial monitor, controlling a production line, or a touchscreen in an operating theatre – in these conditions the contaminant on the screen is no longer a minor inconvenience but a significant potential hazard.

Why is water problematic for touchscreen operation

Projected capacitive touchscreens are composed of a matrix of electrodes which are charged to form a capacitive field. When a touch occurs on the screen the finger, being conductive, causes a change in capacitance at a particular location which is detected by the touchscreen controller and a touch is reported. However, fingers are not the only thing which can affect the capacitive field - water and other contaminants can alter the capacitive field causing false inputs which can lead to serious issues.

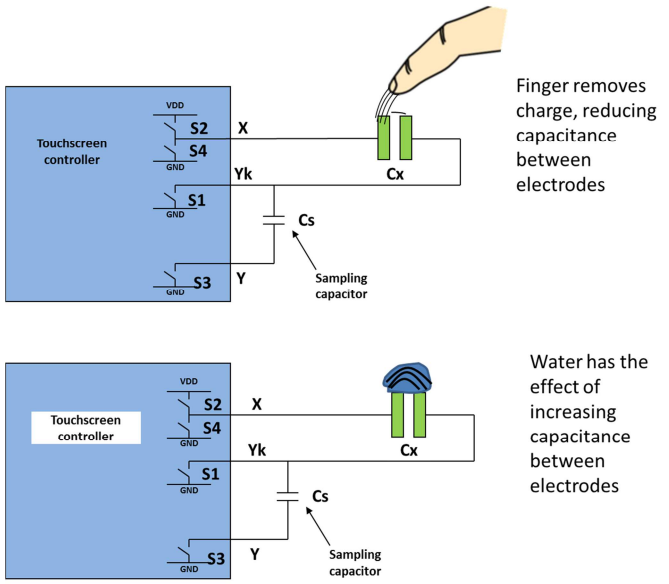
In order to address these issues and design robust touchscreens suitable for industrial applications, touchscreen module designers must cleverly combine and configure the latest capacitive touchscreen controllers with appropriate touch sensors. Below we review the main approaches to addressing the challenges of water in a leading edge industrial environment.

Capacitive touch technologies

There are two basic types of measurement method for capacitive touchscreens: self capacitance and mutual capacitance. These methods each have their advantages and as a result many touchscreen controllers support both concurrently.

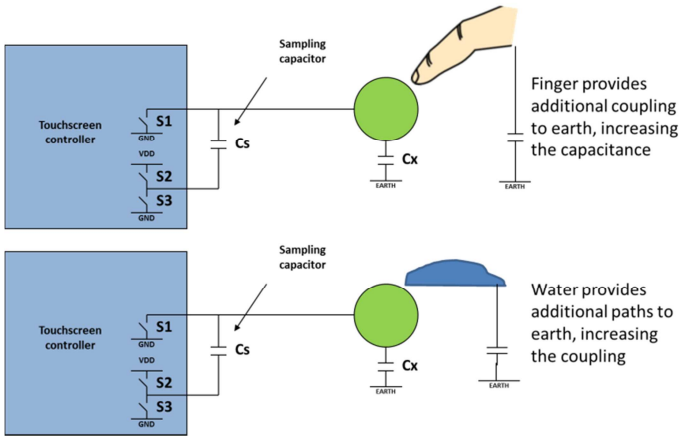
Mutual capacitance

The mutual capacitance measurement method is the technology that allows multiple touches to be detected on a screen simultaneously. Mutual capacitance works by detecting a **decrease** in coupling **between two electrodes** when a touch occurs. When there is a water droplet on the screen this behaves differently from a touch as it increases the coupling between the electrodes. This decrease in coupling is known as an anti-touch. It is possible to calibrate out this behaviour such that the effect of the water on the screen is ignored. However, if this is done and then the water is removed, the touchscreen will incorrectly identify a touch in this position which will remain until the screen is calibrated again.



Self capacitance

Self capacitance sensors operate by measuring the **increase** in coupling between the **electrode and ground** by any available path. Due to the fact that the sensing uses discrete electrodes it is not possible to uniquely identify multiple touch points, so self capacitance alone can't be used to implement the type of touchscreen including gestures that consumers are used to.



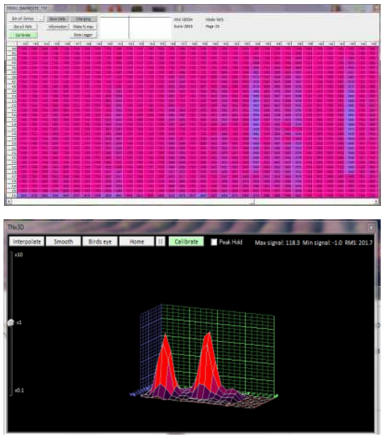
One significant advantage of self capacitance is that the region of touch sensitivity can be made to extend into the space directly above the sensor, which can be very useful if the user is likely to be wearing a thick glove which is often the case in industrial settings. Anything that increases the coupling to ground, such as a layer of water above the sensor, will push the sensor towards touch. This means that self capacitance sensors are quite sensitive to surface contamination, and a sudden splash of water on the screen could result in a false touch.

Mutual and self capacitance combined

Some of the latest approaches combine mutual and self capacitance in the same touchscreen. In this way it is possible to have the benefits of both technologies: true unlimited multitouch with mutual capacitance and the ability to sense touches away from the screen with self capacitance. Furthermore, by combining technologies it is also possible to use both measurement methods as a way of addressing issues relating to water contamination: by alternating the measurements and combining the output data algorithmically it is possible to determine if water is present and if water has subsequently been removed, increasing reliability in challenging situations.

Touch sensor considerations

Whilst using a combined measurement certainly improves moisture performance in some scenarios there are numerous other factors which come into play. For instance, on large screens combining the self and mutual capacitance measurement methods is not always easy, especially in electrically noisy surroundings, which is common for industrial settings. In environments where noise levels are likely to be high, touchscreens are usually designed to have narrow sensing electrodes, however, this is not entirely compatible with the self capacitance measurement method and so it is necessary to compromise on the design requirements appropriately.



When embarking on any touchscreen design it is essential understand the environment and requirements from the outset and this is particularly important in designs where reliability is paramount. Simulating the touchscreen stack and sensor design for the proposed environment can identify issues before initial samples are made, saving time and money and ensuring the best possible performance.

Future developments

Whilst there are steps which can be taken to make touchscreens more water tolerant there will always be challenging scenarios with contaminants on the screen. With innovations in touchscreen technology in terms of materials, stack ups and controllers we should expect to see incremental improvements over the next few years. Switching to ITO alternatives such as metal mesh brings challenges in terms of touchscreen pattern visibility but gives higher touch deltas which may be beneficial for dealing with moisture. Other enhancements such as adding support for pressure sensing to touchscreen designs will also help to identify valid touches on the screen, increasing reliability further.

The numerous advantages of capacitive touchscreen interfaces mean that we can expect to see them used in a wide range of industrial applications moving forward.

Author: Helen Francis – March 2015