Making Industrial Touch A Reality

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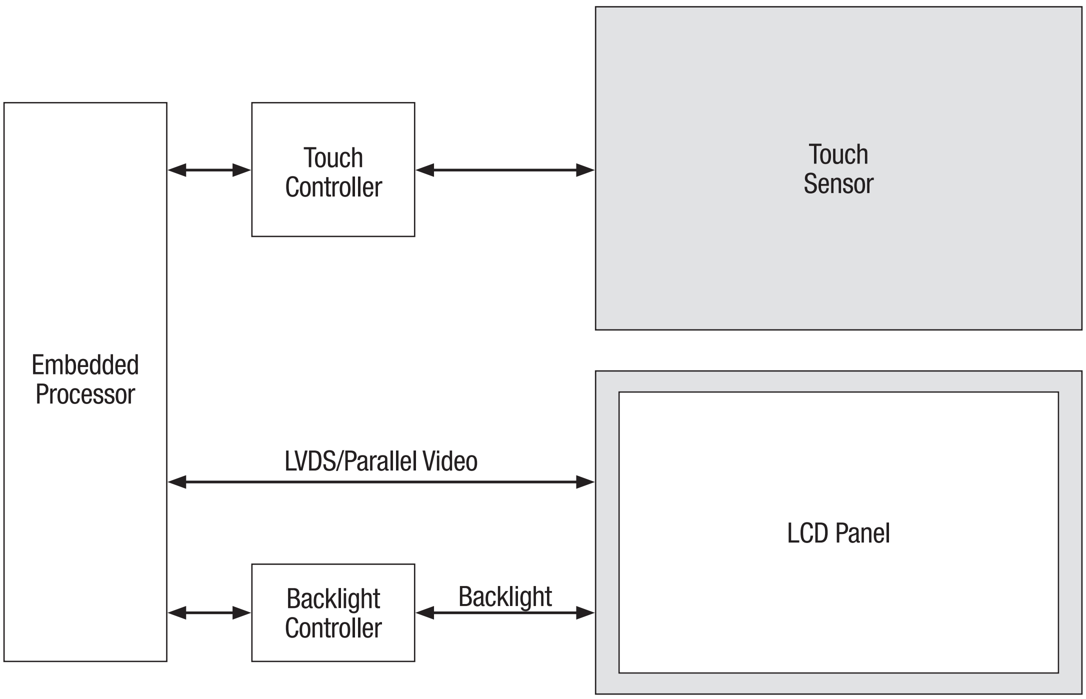
Touch screen interfaces are becoming the de-facto standard for today's consumer appliances, phones, and entertainment devices. From tablets and smartphones, to refrigerators and auto dashboards, consumers expect a touch-capable, interactive experience when interfacing with electronic equipment. Much of the interest is the result of a touch technology referred to as Projective Capacitive Touch, or PCAP. Unfortunately, this PCAP driven touch revolution has been lagging in the area of industrial displays. Environmental conditions, ruggedness, and lower unit volumes are limiting the availability and adoption of this promising technology in industrial applications. To help accelerate the implementation of industrial touch displays, Avnet Electronics Marketing continues to introduce industrial grade, PCAP Touch development kits. This article explains the challenges faced in creating an industrial PCAP touch display and the advantages the Avnet kits bring to the industrial design community.

Touch Display Basics

Touch displays have been around for a number of years. Prior to the introduction of Apple's® original iPhone® in 2007, the majority of touch displays were based on resistive touch technology, or to a lesser extent, infrared and surface acoustic wave. The iPhone ushered in the adoption of the newer projective capacitive touch technology, making it the must-have option for many designers. No matter what technology is used, the implementation of a touch display requires a complete system-level approach to the design. A typical touch system is made up of the LCD panel, a touch sensor overlay, a touch controller, a backlight controller, the embedded processor, and the software drivers and operating system. Figure 1 shows a typical block diagram for a touch system.

FIGURE 1. Touch Display System Block Diagram



In simple terms, resistive touch screens use two flexible sheets coated with a translucent resistive material, separated by a thin air gap. When a user applies pressure to the top layer with a finger or stylus, the resistive coatings come into contact with each other. Depending on the coating style, this contact either generates a matrix-like switch closure or an X-Y position location. The concept is straightforward, and a big advantage of resistive touch displays is the relative low cost of adding the touch sensor overlay and touch controller. Unfortunately, for many industrial applications, resistive touch solutions have critical shortcomings. Since the touch overlay needs to be flexible to detect the pressure applied from a finger or stylus, it tends to be soft and susceptible to scratches or damage. Because it is mechanical in nature, it can exhibit reliability issues over time due to repetitive use or miss-use. Cleaning the resistive overlay can present problems in certain medical applications where disinfectant or harsh chemicals are required. For today's higher resolution LCD panels, the resistive overlays can also degrade the optical clarity of the display.

PCAP Touch

Projective capacitive touch became main stream with the introduction of Apple's original iPhone. The technology behind PCAP is well documented and interesting, however it is really beyond the scope or need of this article. Basically, a PCAP sensor detects the change in capacitance caused by the presence of a conductor (a finger) as it nears the sensor. A PCAP touch sensor is built by coating indium tin oxide (ITO) onto a glass or plastic film substrate, then etching it with a proprietary pattern of individual sensor structures. The etched pattern depends upon the individual system design and varies by sensor manufacturer. From this process, the PCAP touch sensor is often referred to as the ITO.

Tightly coupled with the ITO is the PCAP touch controller. The PCAP controller has the critical function of sensing and measuring the capacitance changes in the ITO and translating this into meaningful user touch information. The controller runs software containing proprietary algorithms that are specially tuned to work with specific ITOs, screen sizes, and glass thicknesses - a glass overlay is added on top of the ITO as a protective layer for the ITO and LCD panel.

Industrial Touch Display Needs

PCAP touch displays have obviously proven themselves in the consumer world with the millions of smartphones and tablets being used daily. This same technology can also offer significant advantages to industrial grade display solutions. Most notably is the ruggedness and reliability that PCAP can offer over resistive touch. Unlike resistive touch where the sensor itself is exposed to the environment, a PCAP sensor (the ITO) typically has a glass overlay that protects the sensor. The glass overlay can offer not only protection from liquid, dust, and other harsh environmental factors, but can also act as a safety shield for the LCD panel against impact.

Given the acceptance of PCAP technology in the consumer world and the advantages it can bring to industrial applications, why has it been so slow to make its way into industrial solutions? There is no single answer for this, but rather a combination of factors that each present small roadblocks to its adoption.

1. **Cost –** There are many factors (screen size, unit volume, ruggedness, etc.) that drive the overall cost of a touch display, so it's difficult to quantify the overall cost adder for a PCAP verses a resistive touch solution. In general terms, a combined PCAP sensor and controller will be more expensive than a resistive sensor and controller. Unless there is a need to have the feature advantages PCAP offers, resistive touch tends to be a lower cost option.
2. **Volume –** Due to the custom design of the ITO sensor and the unique algorithm tuning of the PCAP controller, the design costs for each PCAP solution can run in the tens-of-thousands of dollars. The higher volumes of consumer applications allow the amortization of these development costs with minimal per unit cost impact. The lower volumes of industrial applications can make PCAP cost prohibitive.
3. **Water Rejection and Wet Finger Tracking –** By its nature, PCAP sensors are affected by the presence of liquid on the screen - liquid alters the capacitance seen by the sensor. Water rejection is the ability of the screen to reject false touches when liquid is on the screen. Wet finger tracking is the ability to accurately track a finger on the screen in the presence of a liquid. Many industrial applications require both of these, which can add extra cost and complexity to the PCAP design. Most consumer applications don't have these requirements.
4. **Gloved Operation –** Some industrial and medical applications require either leather or rubber glove operation. Gloves have no influence on resistive touch solutions, but can significantly influence the capacitance of a finger touch. If you try to use your smartphone or tablet with a leather glove, chances are it will not work.
5. **Impact Resistance –** Most consumer grade PCAP touch displays use a 1-2 mm thick glass overlay to protect the ITO and LCD panel. Industrial applications may need to meet more rigorous drop tests, such as UL6950, which ensures no screen breakage under certain test conditions. This drives industrial screens to use 4-5 mm thick glass, which can impact a finger's ability to influence the sensor capacitance since the finger is at a further distance from the actual sensor.

Put this all together and the slow adoption of industrial grade PCAP touch screen solutions is no surprise. Yet, the features and benefits PCAP has to offer over resistive and other touch technologies creates a desire and need for a viable option. This was the premise by which Avnet Electronics Marketing set out to develop a PCAP solution.

The PCAP Touch Display Kits

The Avnet Industrial PCAP Touch Display kit (Figure 2 and Figure 5) offers a custom developed industrial-grade PCAP touch controller and ITO sensor with a protective glass overlay, a 7-inch WVGA (800x480) LCD panel, and a LED backlight controller. The kit is intended for development and evaluation purposes, allowing designers to experiment and test the touch controller's performance in an embedded environment. There are two versions of the kit, one targeting the Freescale i.MX53 Quick Start Board kit (www.em.avnet.com/imx53), and the other designed for the Xilinx Zynq™-7000 AP SoC ZedBoard™ and MicroZed™ platforms (www.microzed.org/product/7-inch-zed-touch-display-kit). The Freescale kit uses a 24-bit parallel RGB data interface between the i.MX53 processor and the LCD panel, while the ZedBoard kit uses an LVDS display channel interface. Both implementations use an I²C connection between the processor and the PCAP touch controller. A display adapter card supports the LED backlight circuit and simplifies the cabling between all the display components. Custom cabling connects the embedded processor board with the display adapter card.

FIGURE 2. Freescale i.MX53 Quick Start Break-out with 7-inch LCD and PCAP Touch

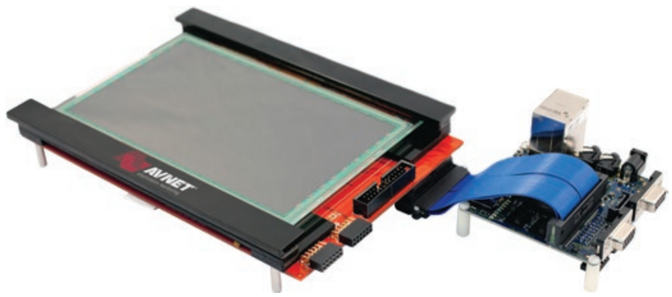
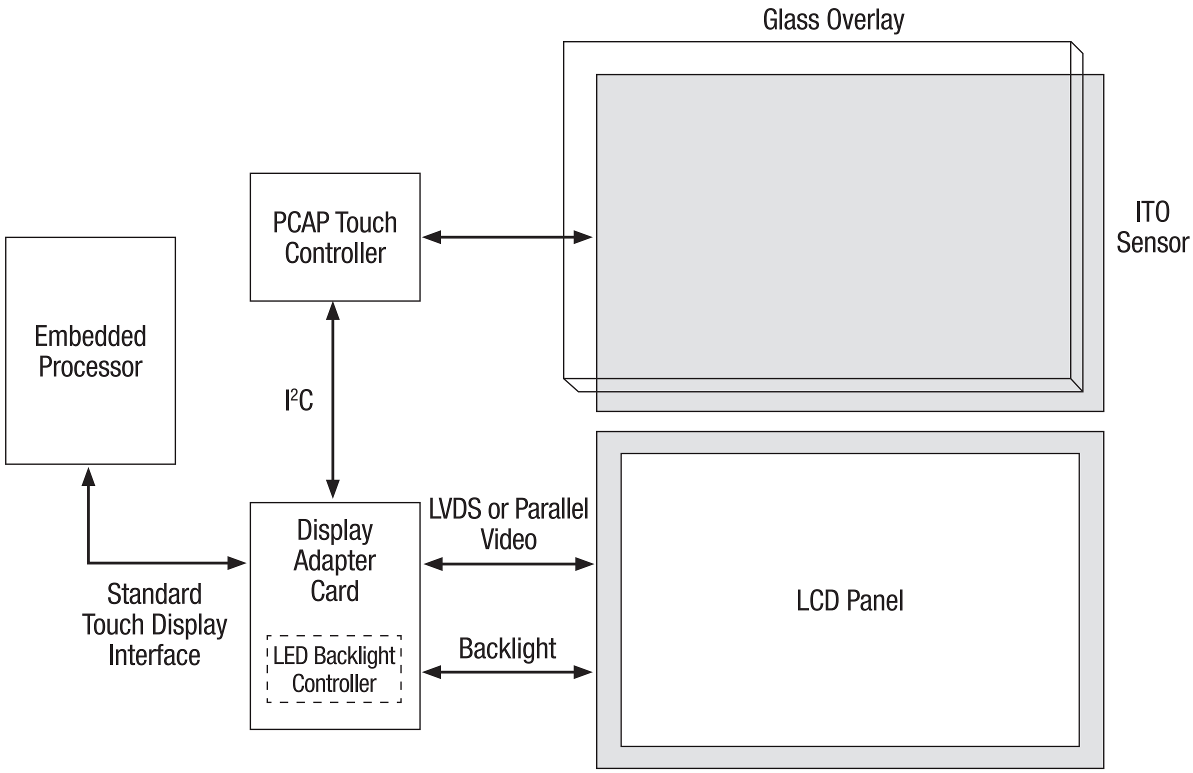


FIGURE 3. ZedBoard with 7-inch Zed Touch Display Kit

FIGURE 4. MicroZed (on I/O Carrier Card) with 7-inch Zed Touch Display Kit

FIGURE 5. Avnet Industrial PCAP Touch Display Kit Block Diagram



Avnet developed the kits with the help of Cypress Semiconductor, ClickTouch and DH Electronics. By pre-defining a given set of features, the ITO and touch controller were designed to address the mainstream requirements of typical industrial displays, yet still offer some level of end-user customization. Through the flexibility offered with Cypress' TrueTouch® technology, the PCAP controller has the ability to auto-tune, thereby supporting glass thicknesses from 0-6 mm, gloved operation, water rejection, wet finger tracking, and single finger touch. The kits are designed to work out-of-the box with the targeted processor (i.MX53 or Zynq), however, customization of the processor interface is possible with a re-spin of the display adapter card included in the kit. Avnet provides all PCB design files for the adapter card, making any re-spin a straight forward process.

Once a touch design has been verified using the display kit, Avnet can provide developers with a production ready, customized touch kit in volumes from hundreds of units to thousands of units. These custom kits include the user specified glass overlay, ITO sensor, PCAP controller, 7-inch LCD panel (parallel or LVDS), and user customized display adapter card with backlight controller. The integration the display adapter card provides, along with the embedded-friendly I^2C touch interface, makes the Avnet kit ideal over other off-the-shelf PCAP alternatives.

Industrial grade PCAP touch displays offer many advantages over previous generation touch technology. Avnet's Industrial PCAP Touch Display kits help bring this exciting technology to industrial designers through a semi-customizable, off-the-shelf development kit. The kits virtually eliminate the typical NRE, development time, and high volume requirements inherent with most PCAP touch solutions. With the barriers to entry removed, industrial applications can now enjoy the same user interface experience as their consumer counterparts. Move over iPhone, the industrial apps are on their way.

ABOUT THE AUTHOR

Jim Beneke is vice president of global technical marketing for the Electronics Marketing Group at Avnet, with responsibility for the worldwide technical programs and strategy supporting the company's design chain initiatives. Since 1994, Beneke has served in a variety of field and staff positions with Memec Insight, Memec, and Avnet. Prior to Memec's acquisition by Avnet, Beneke held North American and global technical marketing positions with Memec, beginning as a senior field applications engineer.

Prior to joining Memec, Beneke served three years in various design engineering and program management positions for Raytheon/E-Systems. Previously, he managed a design group and performed research and development for seven years at General Electric's Space Systems and Automated Systems divisions. Beneke holds a bachelor's degree in electrical engineering from Bucknell University and a master's degree in electrical engineering from Villanova University.

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