STEP-BY-STEP LCD TFT TOUCHSCREEN DESIGN

Developing A Touch-Integrated Flat Panel Display System

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Touch screen interfaces are a popular choice for industrial and commercial computer systems. This technology eliminates the need for a keyboard or traditional mouse, offering instead a simple, direct interaction with graphical icons that represent the specific tasks at hand. In industrial applications, this helps keep plant-floor operators focused on the application and can be used by most operators regardless of their computer skills. Key to the successful application of touch screens is selecting the right technology and addressing the steps necessary to integrate them into a flat panel display system. Increasingly, this is being done by system integrators who can design and attach touch screens to a manufacturer's standard LCD, eliminating the need for a customer clean room. A completely integrated touch kit includes the controller, interface cables and LCD. Customization is typically available for precise fit and function per the customer's specifications. This is particularly useful if the system designer is new to or inexperienced with touch panels (see Figure 1). The following steps outline the development of a touch-integrated flat panel display system.

Figure 1. This integrated touch screen system incorporates a rugged space-saving enclosure and is scalable to accommodate display sizes from 12.1" to 19".

Step 1. DEFINE THE APPLICATION

The first step is to define the application. Questions to consider are as follows. Where is the flat panel touch-integrated display system being used? Is it an industrial control or machine automation system? Is it a medical

application? Is it a Point-of-Sale (POS) or Point-of-Information (POI) system? Is it an information or self-service kiosk? Is it a digital signage application? Is the display system indoor or outdoor? Is it being used in a rugged environment? What is the operating temperature range required? Will it be used in a wide range of ambient environments? How will the touch capability be integrated?

Touch screen panels can be directly bonded to the front surface of the LCD, affixed to the display's bezel, or be installed via a mechanical mounting scheme for easy replacement if damaged. A direct bond or bezel mounted touch sensor requires a special clean room environment, and in the case of the bonded sensor, specialized application equipment and highly trained installation personnel. A mechanically mounted touch sensor is a touch screen input device that is designed to mount on the outside of a display device and is held in place by a physical device such as brackets or pressure gasketing material. The external touch screen is less invasive and is used when replacing the sensor in the field or at a repair depot. The touch screen controller's power requirements also need to be taken into consideration, as many will need a 5V or 12V DC voltage to operate properly (see Figure 2).

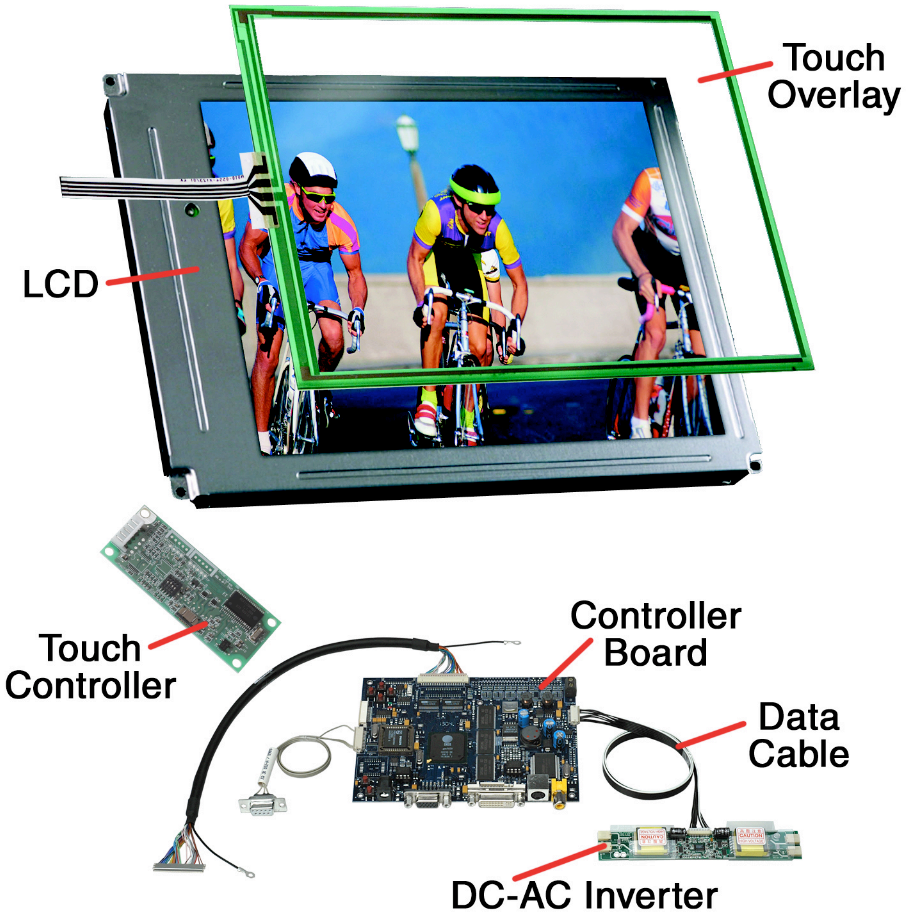

Figure 2. The major components of a touch screen system utilizing an externally mounted touch panel.

2. ESTABLISH TOUCH PANEL CRITERIA

Important performance specifications to consider when integrating touch screen displays are the number of touch points, actuation force, LCD pixel pitch, desired response time, operating life (number of touches), and touch resolution. Complete LCD display and bezel dimensions are required as well as the type of LCD that will be used, e.g., passive matrix or active matrix TFT LCD, followed by several additional criteria as follows. Does it require anti-glare or anti-reflective properties? Are high brightness or transflective properties required for daylight readability? Brightness required for daylight readability is generally 600 cd/m^2 (nits) or higher, depending on what other properties are involved, such as anti-reflective surface treatments, which are commonly supplied by the manufacturers or value-added integrators of most LCDs today. Does the display require glass bonding for vandal-proof outdoor public environments? What is the relative importance of price, performance, quality and long-term availability? Other parameters to consider include external connections, mounting options and environmental operating parameters.

3. SELECT THE TOUCH SCREEN TECHNOLOGY

Once you make a decision to go with a touch screen interface, the next step is to determine which touch screen technology is best. Technologies include resistive overlay, capacitive overlay, scanning infrared, or SAW (Surface Acoustic Wave). A comparison chart is shown in Table 1. Factors to consider include:

- operating environment
- optical performance
- LCD size
- degree of transmissivity or transparency
- desired lifetime
- degree of scratch and damage resistance
- degree of calibration stability
- choice of finger or stylus touch (will the finger operation be gloved?)
- anti-reflective treatment (for high ambient light conditions)
- cost of the touch panel and controller

	Resistive Overlay	Capacitive Overlay	Scanning Infra Red	Surface Acoustic Wave
Resolution	4096 x 4096 typical	1024 x 1024 typical	0.25" Physical, 0.125" logical.	0.030"
Transmissivity	70-80% typical. 90% Available from Craft Data	85-92%	100%	92%
Activation & Response	Tactile activation. No parallax. 18-40 msec.	Tactile activation. No parallax. 15-25 msec.	Proximity activation. Small parallax. 18-40 msec.	Tactile activation. No parallax. 53-59 msec.
Stylus Type	No stylus limitation	Requires conductive stylus	Any stylus with minimum diameter 5/16"	Requires soft energy absorbing stylus
Drift & Calibration	Minor long term drift. Simple calibration	Minor drift. Simple calibration	Not subject to drift	Not subject to drift
Integration	Invasive	Invasive	Non-invasive	Invasive
Reliability	2 Million touches per point. Controller approx 100K Hrs. MTBF	20 Million touches per point. Controller approx 150K Hrs. MTBF	140,000 Hrs. MTBF	Sensor 50 Million touches per point. Controller 100K Hrs. MTBF
Durability	Front film can be damaged with improper use. Glass subject to breakage with impact.	Glass can be broken with severe shock or impact.	No overlay to break. No exposed parts.	Glass can be broken with severe shock or impact.
Moisture Resistance	NEMA 4 or 12	NEMA 4 or 12	NEMA 4 or 12	NEMA 12
Dust & Dirt Resistance	Not affected	Moderate accumulation tolerated	Excessive accumulation may affect performance	Excessive accumulation may affect performance
Chemical Resistance	Only chemicals which attack polyester should not be used	Not affected by general purpose cleaning agents	Only chemicals which attack polycarbonates should not be used	Not affected by general purpose cleaning agents
Vibration & Shock Resistance	Vibration resistant. Glass susceptible to shock. Mounting method determines	Vibration resistant. Glass susceptible to severe shock	Very resistant to vibration & shock	Vibration resistant. Glass susceptible to severe shock
Ambient Light	Not affected	Not affected	Best products use compensation circuits	Not affected
Temperature, Humidity & Altitude	0-50 deg. C. 0-95% non-condensing. Alt. 15,000ft (4,500 m)	0-70 deg. C. 0-95% non-condensing. Alt.30,000 ft. (9,000 m)	0-55 deg. C. 0-95% non-condensing. Alt10,000 ft (3,000m) over full temperature range	0-50 deg. C. 95% non-condensing. Altitude not specified

Table 1. A comparison chart of touch screen technologies.

A resistive touch panel is produced by sandwiching together ITO (Indium Tin Oxide) coated glass and PET film (Poly Ethylene Terephthalate). This process is illustrated in Figure 3. The glass provides mechanical stability and the PET provides a flexible medium through which the two parts connect. Microdot spacers, printed onto the glass, separate the layers and enable precise feature control via dot size, height and density. (Dot density determines the operation method from low-density finger to higher density pen operation touch panels.)

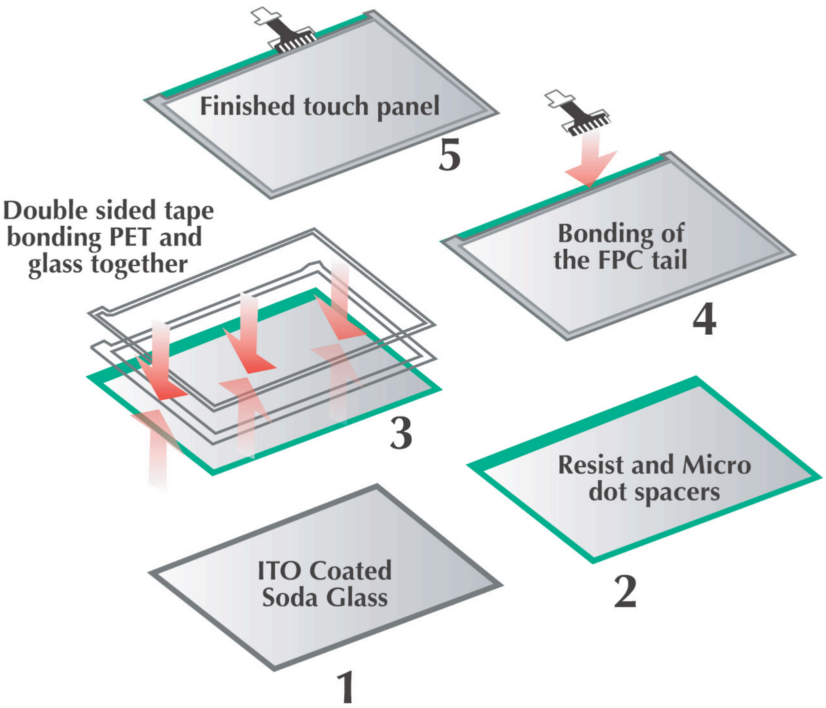

Figure 3. A resistive touch panel is produced by sandwiching together Indium Tin Oxide coated glass and Poly Ethylene Terephthalate film.

Resistive is the most popular form of touch screen technology in applications ranging from industrial to consumer. This pressure-sensitive technology is multi-functional and one of the most cost-effective and easy-to-use of the touch technologies. Resistive touch panels are generally more affordable but the light transmission levels they provide are typically limited to a high end of 86% (although higher is available), and the front surface of the resistive layer can be damaged by sharp objects and harsh chemicals. Resistive touch panels are not affected by outside elements such as dust or water and, because they can be sealed to NEMA 4/4X standards, most of the major human-machine interface (HMI) manufacturers have adopted this technology. An example is a 12.1" diagonal active matrix LCD with 400cd brightness, SVGA resolution, LVDS interface and high contrast ratio used in a medical application involving patient monitoring and medical device control. For this application, a 4-wire resistive touch sensor was integrated to the display to meet the requirement that the touch interface work with a gloved hand with no external pointing device.

LCDs utilizing surface acoustic wave technology, like resistive panels, can utilize any type of pointing device, such as a finger or stylus. SAW provides excellent scratch and damage resistance and superior drift-free calibration stability, as well as a high level of light transmission (92%). It's nearly impossible to physically wear out this touch screen. SAW touch screen technology is widely used in gaming, office automation and indoor self-service kiosk (e.g., ATM) applications. A downside to SAW technology is that it is highly susceptible to contamination from dirt, dust and other particulates. In a kiosk-type application open to the public, there are additional contamination threats--rain, snow or some external object stuck to the screen (such as a wad of chewing gum)--can negatively impact the performance of the touch operation by interrupting the acoustic wave pattern on the front of the touch sensor.

Capacitive technology makes use of a glass substrate with a tin oxide coating that is charged with a slight electrical current. When a conductive stylus or finger touches the surface, it creates a capacitive coupling that causes a current draw at that point. The X and Y coordinates can then be determined by the touch screen controller. The glass substrate of a capacitive touch screen is highly resistant to scratching, is highly transmissive, and the touch-screen system can be built to NEMA 4/4X standards. One drawback with this technology for industrial applications and clean room environments is that, because it requires a conductive pointing device of some sort, gloved fingers or non-conductive pointing devices will not activate the system.

Scanning Infrared (also known as I/R Touch) technology uses infrared emitter-collector pairs to project an invisible grid of light a small distance above the surface of the screen. When a beam is interrupted, the absence of the signal at the collector is detected and converted to an X/Y touch coordinate. See Figure 4 for an illustration of how this technology works. Scanning infrared touch technology is commonly used in kiosk, gaming, retail, healthcare and industrial human-machine interface (HMI) applications. It is very rugged and unaffected by dirt, water and other contaminants, making it ideal for kiosk displays that are outdoors and open to the public; and it has no calibration drift. However, it is limited as to how small a point area it can detect, which poses a problem in applications such as point-of-sale (POS) that require signature capture, which demands a very high resolution. The resolution provided by scanning infrared touch technology doesn't really have the accuracy required to prevent pixilation or distortion of the signature as it switches from one beam to the next.

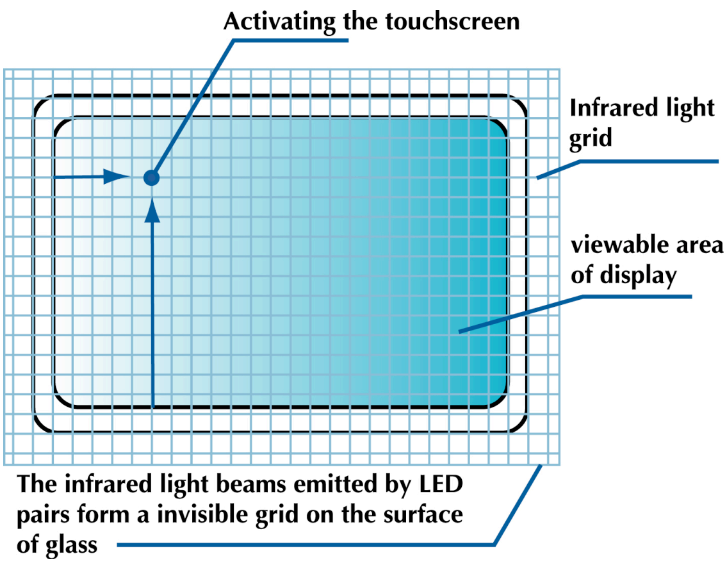

Figure 4. An illustration of how scanning infrared technology works.

4. SELECT THE CONTROLLER BOARD

Factors to consider when selecting the controller board are as follows. What kind of interface is being used to connect the touch controller to the CPU on the computer motherboard?

- Serial (RS-232)
- USB
- PS/2

If the touch controller and touch sensor are going to be some distance away from the host computer, this will affect the choice of interface. For example, a serial interface can accommodate distances up to 50′, whereas USB interfaces are generally limited to a distance of approximately 16′. However, touch controllers with serial interfaces have to be powered externally, requiring a 5V or 12V DC power supply. Controllers with USB interfaces, on the other hand, are self-powered directly from the USB port on the host computer system.

5. SELECT THE ENCLOSURE

There are a number of factors to consider when packaging the touch panel and touch controller together with the LCD, LCD controller, and associated components. The most important factor is selecting the right enclosure. Does it need to be sealed? Does it need to be NEMA or IP rated? What about possible contaminants such as chemicals, or extremes of heat and cold?

CONCLUSION

If you are designing a touch-integrated flat panel display system yourself, this article should be both insightful and useful as a resource for future reference. Often short on engineering resources to accomplish this in-house, most companies choose to utilize a value-added solutions integrator with many years of experience in displays and associated sub-systems who have the resources and expertise to put all these components together into a perfectly functioning system. Working closely with your design engineers, the end result should be a touch-integrated solution that meets or exceeds your product specifications. If you need a display system with touch controller, serial communication, matching backlight inverter and all associated interface cabling for direct mounting to the LCD display, a systems integrator who specializes in display systems can help you choose the right LCD and LCD controller, as well as making sure that all the proper components are integrated together into one seamless touch- integrated display system.

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