Practical considerations for capacitive touchscreen system design (Part 1 of 2)

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As consumer mobile communication devices increasingly embrace digital and functional convergence, the need for intuitive and innovative user interface solutions becomes ever more important to device design. Projected-capacitance touchscreens, as part of a user-interface design, can help answer this challenge.

Designing a successful projected-capacitance touchscreen system requires careful consideration of the following aspects: device mechanical design, substrate selection and user interface design. Cost and technology tradeoffs are also useful to keep in mind at all stages of the assessment process.

Unlike resistive touchscreen technologies, projected-capacitance touchscreens are better designed to handle finger gesturing, in particular, multi-touch user input. Resistive technologies require finger pressure in order to cause the mechanical layers of the touchscreen to make electrical contact. This makes fluid finger sliding and gesture operations very cumbersome. In addition, the multi-layer mechanical assembly of a resistive touchscreen is prone to early wear-and-tear from repeated usage.

Multi-touch gestures enabled by projected-capacitance touchscreens include common variants such as pinching, zooming, two-finger scrolling and rotating. They enable fast and easy manipulating of data, content and user preferences. Portable gaming and text/email applications can also take advantage of multi-touch technology. Multi-touch all-points-addressable (APA) can precisely determines the coordinate location of each finger press in a multi-finger touch event.

Typing shift characters is simply a singular multi-touch event operation instead of having first to shift the character set and then typing the actual shift character. Multi-Touch also has broad applications in GPS navigation. Instead of entering starting and destination addresses, APA enables the selection of end-points right on the screen, making it much faster for people to get to where they want to be. Figure 1 illustrates some of the possibilities with multi-touch.
There are several keys questions to answer in order to evaluate a device's mechanical design.

1. **Is the cover lens (touch surface) flat or curved?**
It is generally recommended that capacitive touchscreen applications should be mounted on flat touch surfaces. Having a curved surface introduces some complications. In order to achieve a robust capacitive-sensing design, the transparent touch sensor must be laminated flush along the underside of the cover lens. Any air pockets or "bubbles" caused by lamination unevenness can result in decreased touch performance and impact the overall product aesthetics.

A curved cover lens restricts the choice of touch sensor substrates to PET (polyethylene terephthalate). The plastic sensor will be able to bend to fit the form-factor of the curved cover lens. If a curved cover lens must be used, it is recommended that the degree of curvature does not exceed 45° from the point of inflection. Having a much steeper curvature makes lamination much more challenging, and can damage the indium tin oxide (ITO) conductive patterning. As a result, production yield may be jeopardized.

Cheaper methods of lamination involving the use of pressure sensitive adhesives (PSA) may not be possible with a curved overlay. Instead, more costly UV-curing liquid polymer adhesives may need to be used to ensure greater lamination integrity. UV-curing adhesives are expensive because they are easy to use, thin, and possess very high optical qualities (greater than >95% transparency).

2. **What are the border widths of the cover lens' opaque in-active areas?**
For touchscreen sizes of under 4 inches (10 cm), the border widths of the cover lens that are adjacent to the side with the touch sensor tail should be no thinner than 3.0 mm and the side of the touch sensor tail should be no thinner than 10 mm. The required border space is used to hide the non-transparent silver traces linking the transparent ITO pattern to the control circuitry and the control circuitry itself. It may be possible to achieve thinner borders using glass-based substrates but the above guidelines are still recommended. **Figure 2** summarizes these guidelines.
3. What is the overlay/cover lens material?
The lens/overlay material and any decorative artwork within the touchscreen active area must not use any conductive materials. The use of a conductive material will shield the e-field of the capacitive sensors and drastically reduce the sensing performance. Cover lens should be 1.0 mm or less in thickness.

4. What is the distance between the bottom of the cover lens and the LCM?
As portable communication devices strive for slimmer profiles, it is important to consider the gap between the liquid crystal module (LCM) and the cover lens. There must be sufficient space to fit a thin touchscreen sensor as well as an air gap to protect the touch sensor from unwanted radiated EMI interference from the LCM. At least a 0.5 mm gap between the underside of the touch sensor substrate and the LCM is recommended.

5. How am I going to handle ESD?
In order to offer protection to electrostatic discharge (ESD) events on the touch surface, a low impedance path to ground must exist through the device. The touch sensor should be protected using a ground ring placed in the non-active border area of the cover lens. The ground ring could be a simple metal foil. It is necessary to ensure that there is a firm connection between the ground ring and device system ground.

(Part 2 of this article concludes with a discussion of mechanical, substrate, and yield issues, read it by clicking here.)

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