About Mobile APR

Acoustic Pulse Recognition (APR) is an innovative technology from Elo TouchSystems that senses touch on the display by recognizing unique patterns of acoustic waves. Consisting of a glass overlay mounted in front of the display and proprietary electronics, APR technology delivers a distinctive set of benefits. It combines the desirable optics, durability and stability of surface acoustic wave (SAW) and infrared (IR) technologies with stylus, glove or fingernail activation and cost advantages found in resistive technology. In addition, APR works with water or other contaminants on the screen; it can be scaled from PDA to desktop-sized displays; and can effectively capture signatures written on the screen with any stylus.

Now, Tyco Electronics' Elo TouchSystems Mobile APR provides everything needed to integrate this new technology into mobile computing products.

elo TOUCHSYSTEMS

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Optics and Hardness of Glass

A mobile computing device with Mobile APR benefits from the APR glass overlay protecting the LCD display. In addition, the Mobile APR touch sensor's high light transmission and neutral coloration allow the choice of a cost-efficient display module and save power with reduced back-lighting requirements.

The Mobile APR touch sensor is an overlay of pure glass. The glass overlay has light transmission of approximately 92%, a relatively high value that preserves brightness and true color of the display image. Because it has no coatings or internal layers, the overlay minimizes reflections, eliminating the need for antireflective treatments. A light antiglare etch is applied to the touch sensor's front surface, which reduces glare without affecting display resolution.

While facilitating touch sensing, the Mobile APR overlay also protects the LCD display from the pressure and wear of a user's touch. Glass is resistant to scratching, with a hardness rating far higher than any plastic surface. Glass is mechanically stable—it won't deform, expand or contract over wide changes in temperature. It is resistant to many common chemicals and solvents, too.

Responds to Finger or Stylus

A mobile application needs to use a stylus for capturing handwritten input or for selecting small icons at the edge of the display. But on the go, a user frequently wants to activate the touchscreen with a finger or fingernail.

Mobile APR responds quickly and accurately to a pen, a pencil, a stylus or even the edge of a credit card—almost anything that makes a sound when striking the touchscreen. Mobile APR is also sensitive to the touch of a user's finger for either tapping or dragging.

Resistant to Contaminants

A product using Mobile APR must survive the rigors of the real world, where splashes, splatters and dirt are all too common. A Mobile APR touchscreen is not activated by standing water, and its sensitivity doesn't decrease when dirt builds up on the touch surface. As described above, Mobile APR's pure-glass sensor resists common solvents and chemicals.

Coordinate Linearity and Stability

In a mobile application, Mobile APR touch coordinates must align well to icons, buttons and "hot zones" on the display. The alignment should be accurate the first time the unit is turned on and the user shouldn't need to adjust it. Mobile APR produces stable, linear coordinate output without calibration, and no drift.

A touchscreen's coordinate system is independent of the underlying display. Mapping touches to display positions requires a mathematical conversion. The accuracy of this conversion depends on both the touch

and video coordinate systems being stable. LCD displays' coordinate locations are fixed due to their construction. Mobile APR touch coordinates are fixed because each APR touch sensor is characterized during its manufacture. The characterization is stored in memory that is part of the touch sensor. A Mobile APR touchscreen's coordinate locations don't change over time, positioning or due to the environment. The specifics of the mathematical conversion don't vary, and user calibration is eliminated.

Simple Construction, Sealable, with Narrow Borders

A mobile application must be small. Footprint space is at a premium and the Mobile APR touchscreen doesn't waste it. The Mobile APR touch sensor needs only a narrow border around the touch active area to accommodate backside conductive traces and small back mounted transducers.

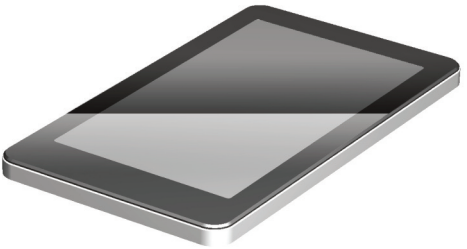

Figure 1: Zero-bezel (bezel-less)

Figure 2: Back-mounted

Mobile APR's "zero-bezel" capability can incorporate distinctive styling features in the end product. Because traces and transducers are hidden on the back—non-touch—surface of the Mobile APR sensor, the sensor itself may be integrated as part of the product enclosure. No bezel is needed to surround its outer edge.

Because Mobile APR employs acoustic sensing technology, it isn't affected by grounded or ungrounded metal in the surrounding enclosure. And, Mobile APR doesn't need to be electrically isolated from the display's front surface.

More Mobile APR Advantages

Modest power budget: Mobile APR is a passive sensing technology. It doesn't consume power by driving signals into the touch sensor. The Mobile APR circuitry uses system power only to receive signals picked up by the transducers and to correlate those signals to touch locations. Low power, fine-pitch CMOS circuitry with advanced DSP capability performs these functions.

Quick and responsive: A mobile computing device relies on click-to-select, cursor dragging and character recognition to control software programs. Mobile APR captures touches of short duration accurately, because a short tap generates a recognizable acoustic signature.

Scalable: Whether it's PDA or desktop-sized, a Mobile APR touch sensor doesn't change in complexity. It's still a piece of glass with four transducers mounted at the screen edges. Characterization of the sensor remains the same over a wide range of sizes. Thus, the same design scales to accommodate mobile and portable applications of many sizes.

How Mobile APR Works

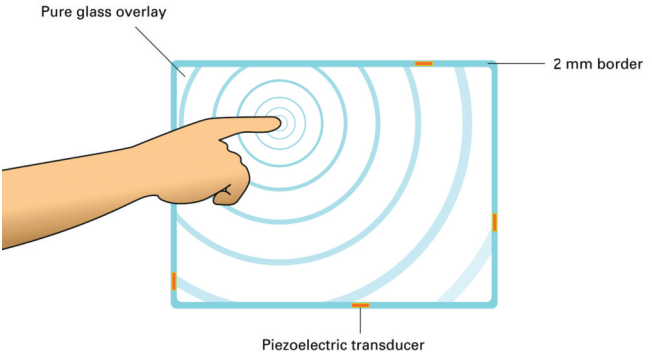

Figure 3: Operating principle

The Mobile APR sensor is a glass overlay with piezoelectric transducers mounted on its back surface. The transducers connect through a flex cable to the control electronics. In this kit, the electronics are integrated into the flex cable to produce a single touch sensing unit.

When a user touches the front surface of the glass, the impact of a tap or the friction of dragging create acoustic waves. From the touch location, the acoustic waves radiate outward, impinging on the transducers, which convert acoustic energy to electrical signals. The electronics compare specific components of the signals to a set of pre-recorded profiles associated with known positions on the screen. When the signal components align with components of a known position, the touch location is determined. Touch at locations between the pre-recorded profiles is detected as having components that are a mixture several known positions.

Mobile APR technology rejects common mode signals and plate vibrations caused by ambient sounds. It uses a comparatively simple table lookup method instead of the powerful, expensive signal processing hardware found in other acoustic-based technologies. Therefore, APR is cost-effective in small, portable applications as well as large displays.

Comparison of Mobile Technologies

CHARACTERISTICS	Analog Resistive	Projective Capacitive[1]	APR
Durability	○	●	●
Optical Performance	○	◡	◔
Stylus Performance	◡	○	●
Stable Calibration	○	●	●
Narrow Borders	◡	◔	●
Flush Surface	◡	●	●
Power Consumption	◔	◢	●
Multi-Touch	◡	●	◡
Substrate Independence	◡	●	◡
Cost	●	○	◔

[1] *Applies to both 1 & 2 layer Projective Capacitive solutions*

Typical APR Specifications

MECHANICAL	Input Method	Finger, finger nail, gloved hand, credit card, prosthetic or stylus activation
ELECTRICAL	Positional Accuracy	1% of full-scale max. error
	Resolution	Touch point density is based on controller resolution of 4096 x 4096
	Touch Activation	2 to 3 ounces (55 to 85 grams), typical
	Communication interface	Synchronous serial interface
OPTICAL	Light Transmission	92% ± 2%
ENVIRONMENTAL	Temperature	–20°C to 60°C, operating –40°C to 71°C, storage
	Relative Humidity Operating	90% RH at max 50°C for 240 hours, non-condensing
	Altitude	10,000 ft (3,048 m), operating 50,000 ft (15,240 m), storage
	Chemical Resistance	Touch activation area resists chemicals that do not attack glass such as: acetone, toluene, methyl ethyl ketone, isopropyl alcohol, methyl alcohol, ethyl acetate, ammonia based glass cleaners, gasoline, kerosene, vinegar
DURABILITY	Mohs' hardness rating	7
	Expected Life	No known wear-out mechanism, as there are no layers, coatings, or moving parts APR technology has been operationally tested to more than 50 million touches in one location without failure, using a stylus similar to a finger
WARRANTY	Touchscreen	10-year limited warranty
	Circuitry	5-year limited warranty

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