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TOUCHSYSTEMS

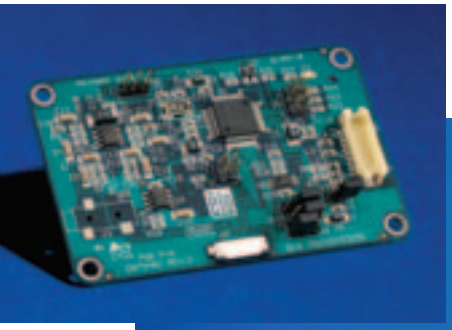
Acoustic Pulse Recognition (APR)

Breakthrough New Touch Technology
from Elo TouchSystems

www.elotouch.com

APR: Breakthrough New Touch Technology from Elo TouchSystems

Combines the best of other touch technologies



Features

- Optics and durability of pure glass
- Operation with finger, glove, pen, credit card
- Resistance to water, dust, grease
- No wear-out mechanism
- Operation even with scratches
- Excellent drag performance
- Sealability to NEMA 4/IP 65 standards
- One-time factory calibration—no drift
- Thin borders—only 5 mm
- True flat surface
- Small and large sizes
- Palm rejection for signature capture

Acoustic Pulse Recognition (APR) from Elo TouchSystems, the global leader in touch technology, is a completely new and unique way of sensing touches on a display. Elo TouchSystems is a unit of Tyco Electronics, the world's largest manufacturer of electrical and electronic components.

Consisting solely of a glass overlay mounted in front of the display, together with a small electronic controller board, Elo's APR technology provides a new set of benefits that have only been partially achieved before by other touch technologies.

Combines the Best of Other Touch Technologies

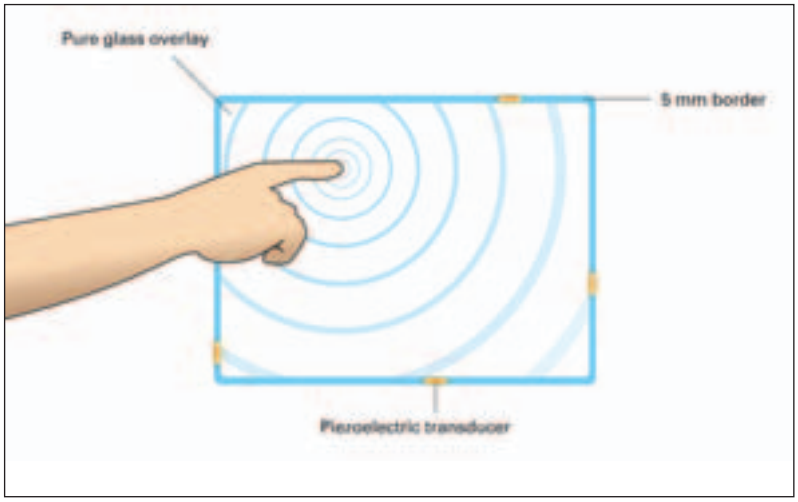
(See *Touch Technologies Explained* later in this document for more information.)

APR combines the ultimate in optical qualities, durability, and stability of surface acoustic wave (SAW) and infrared technologies with the excellent dragging properties of capacitive, along with the stylus, glove, and fingernail activation and low-cost advantages of resistive technology. In addition, APR is resistant to water and other contaminants on the screen, can be scaled from PDA to 42-inch displays, and provides palm rejection during signature capture.

As with many of the best inventions in history, APR works in a simple and elegant way—by recognizing the sound created when the glass is touched at a given position.

The key to the invention is that a touch at each position on the glass generates a unique sound. Four tiny transducers attached to the edges of the touchscreen glass pick up the sound of the touch. The sound is then digitized by the controller and compared to a list of prerecorded sounds for every position on the glass. The cursor position is instantly updated to the touch location. APR is designed to ignore extraneous and ambient sounds, as they do not match a stored sound profile.

APR differs from other attempts to recognize the position of touch with transducers or microphones, as it uses a simple table lookup method rather than requiring powerful and expensive signal processing hardware to attempt to calculate the touch location without any references. Therefore, APR is more cost-effective and not economically limited to very large displays.



From the Leaders in Touch Technology

Elo founders invented the touchscreen 35 years ago. It was a resistive touchscreen and to this day resistive technology has remained the world's most popular touch technology, found in devices from PDAs to industrial control equipment to point-of-sale (POS) terminals in restaurants everywhere. Elo's AccuTouch five-wire technology is the most widely respected brand in resistive touchscreens.

Elo continues to innovate, with the most active patents of any touch company and the world's largest offering of complete touchmonitors. In addition to resistive, today Elo offers all of the major touch technologies, including capacitive, infrared, and SAW—each optimized for specific applications and environments.

Now, with APR technology, Elo can offer a combination of benefits that has not been achieved before with any single touch technology.

Although APR is a new technology, in some ways it is very similar to a widely successful technology that has been shipping for 20 years—Elo's IntelliTouch surface wave. Both are acoustic technologies using a pure glass overlay with transducers attached. Whereas IntelliTouch transducers are both generating and receiving signals, in APR the transducers are only listening.

Because Elo is the leader in acoustic touch technology, with scientists and engineers already vastly experienced with the physics, materials, and manufacturing used in APR, Elo is firmly placed in a unique position to effectively bring APR to market.

Optical Qualities and Durability of Glass

Touch technologies always require an overlay over an LCD display to either sense the touch or protect the LCD from the touch.

Display manufacturers work hard to produce bright and true color images, so touchscreens should diminish the picture quality as little as possible. Unfortunately, an overlay over the display can potentially diminish picture quality in four ways: reducing light transmission, adding reflections, reducing clarity, and altering colors.

Glass is the preferred overlay material for optical reasons as well as for its hardness and durability.

- Pure glass has approximately 92% light transmission (per ASTM D1003), the highest achievable. By preserving brightness, it allows use of lower-cost LCD panels.
- The layers and coatings used in resistive and capacitive technology not only reduce light transmission, they also alter the original colors of the display. For many popular touch applications, such as medical instruments and digital photo kiosks, only pure glass is acceptable.
- Pure glass also minimizes reflections, as it has no layers or metallic coatings. Reflections can be tiring for long-time users, such as cashiers or casino game players, as well as an annoying distraction in public kiosks, whose displays are commonly angled toward overhead lights.
- Because reflections are already at a minimum with glass, aggressive antireflective coatings or antiglare diffusion techniques are not needed, thus preserving maximum clarity.

Glass is very hard to scratch, with a typical Mohs' hardness rating of 7H, compared to resistive screens with 3H or 4H ratings. Glass is also resistant to most chemicals and does not wear out like plastics. It is also stable, not deforming, expanding, or contracting with temperature changes.

Special vandal-resistant glass is also a possibility for applications in high-threat environments. Glass that is thicker, heat- or chemically strengthened, or even laminated can be used in place of ordinary glass.

For these reasons, Elo's surface-wave technology has become the top choice in public kiosks and self-service machines and is preferred by many others for applications including gaming and medical imaging.

APR technology has all the optical and durability-related benefits of surface-wave technology.

Choice of Stylus

If optical quality and ruggedness were the only issues, IntelliTouch touchscreens might be used in all touch applications. But for some applications, choice of stylus outweighs visual quality. An example is use in a restaurant by a cashier or waiter. Absolutely perfect picture quality and color purity are not necessary when displaying a menu on the screen, and a supervised employee is unlikely to vandalize the equipment.

What is more important is being able to touch the display with a pen, credit card, or ID card—as the workers may have dishes in the other hand—or to be able to touch small boxes along the bottom edge of the display where only a fingernail or pen will make contact. For these reasons, to date, resistive touchscreens have been the most popular technology used in retail, restaurant, and hospitality POS applications, in spite of having an outer plastic layer that degrades the optics and can wear out over time.

Recently, Elo's CarrollTouch next-generation infrared technology has been gaining market share in POS applications, as it can also work with a credit card, has no wear mechanism, and has a better picture quality than resistive.

In addition to the optical qualities and resistance to wear of glass, as with surface wave, APR technology can be activated with a finger, fingernail, pen or stylus, or credit card, as with resistive.

Contaminant Resistance

For some applications, the primary issue is not optics, durability, or stylus choice, but contaminant resistance. Here resistive and capacitive technologies have had the edge, as they continue to work with liquids and other contaminants on the screen, and they can be easily sealed. However, resistive still holds the lead over capacitive in restaurant, industrial, and medical applications, as it also works with gloves.

APR technology is resistant to contaminants on the screen such as liquids, dirt, ketchup, grease, and ultrasound gels, and it even works with scratches. It can also be sealed watertight to industrial standards, has the optical qualities of glass and like glass is resistant to cleaning and sterilizing chemicals, and can be activated with gloves and any stylus.

Stability

Touchscreens have a coordinate system independent from the underlying display. Mapping touches to the display position requires a conversion algorithm from one coordinate system to the other. The accuracy of this conversion depends on both the touch and video coordinate systems being stable. LCDs, unlike CRTs, have an inherent fixed display position. Some touch technologies, such as surface wave and infrared, also have a fixed coordinate system. Others, like capacitive and some low-cost resistive technologies, require calibration—even periodic recalibration over time—due to so-called "drift."

In all cases, it is preferable to have a touch technology that never needs calibration.

APR has a fixed coordinate system that never changes over time, position, or environmental changes. With APR, traditional touchscreen calibration can be eliminated from the application if the display size and position are fixed.

Fast and Sensitive

Touch technology should always be easy to touch and should respond to fast taps. APR does not miss touches of short duration as some other technologies do, because a short tap also generates a recognizable sound.

Most touch applications are simple "touch-and-go," designed for public users or employees with little training. Common PC techniques of double-clicking, scrolling, pull-down menus, and dragging are rarely used in touch applications, as they are not intuitive for all users. However, there are some technical applications in which these techniques are used, and gaming sometimes requires dragging. Capacitive is normally the best technology for dragging.

APR recognizes a quick tap and handles dragging very well, like capacitive. Unlike capacitive, APR allows dragging with both a finger and a stylus.

Touch-and-hold or drag-and-hold are currently not possible with APR, as no sounds are emitted in the hold position.

Simple Construction, Sealable, with Narrow Borders

Original Equipment Manufacturers (OEMs) look for touch technology components that are easy to integrate, besides meeting the basic touch characteristics required for their application as previously described. Touch components should not be affected by surrounding metal and should operate in environments with poor grounding. They should be sealable to NEMA 4/IP 65 standards with a variety of materials, including gaskets, glue, or RTV, and they must have the smallest possible outside dimensions. Ideally, the touchscreen panel should be no larger than the LCD panel itself. With LCD panel manufacturers continually reducing their outer border widths, touchscreen manufacturers have been challenged to reduce their border regions as well.

APR, as an acoustic technology, is not affected by surrounding metal or poor grounding. In addition, it may be sealed watertight with a variety of materials, and it has the narrowest borders of any overlay touch technology—a mere 5 mm, including sealing area.

Having narrow borders allows multiple LCD panels to be placed directly side by side, as is becoming increasingly common in medical, financial trading, and gaming applications.

Other APR Features

With APR, regions of the screen can be easily ignored, just by skipping those sections of the table of prerecorded sounds when scanning for a match. This allows features such as palm rejection for on-screen signatures, something either not easily achieved or impossible with most touch technologies.

APR may also be scaled cost-effectively, from very small PDA sizes to large displays such as 42-inch. Considering PDAs, for where cost is key, APR technology is fundamentally a piece of glass with transducers, plus hardware and software for acoustic digitizing and recognition—a configuration already present in today's powerful mobile phones.

For many applications in which exposed glass is unacceptable, such as in food processing or patient bedside applications, infrared has been the technology of choice. As with infrared frames, APR technology may also be applied to materials other than glass, such as acrylic.

The Future of APR

Over time, all technologies are improved and optimized and their cost reduced; this will be true for APR. Elo TouchSystems is initially launching APR technology directed at the retail and restaurant POS market, as its benefits clearly fit that important touch application.

At launch, several models of Elo's popular POS touchmonitors will be available for purchase with APR as an additional technology choice, with full production scheduled for year end 2006. These initially include the 1515L and 1529L touchmonitors, sealed against liquids to NEMA 4/IP 65 standards. The monitors will function under Windows XP with the included driver. Other drivers, including Linux drivers, are under development.

The combined benefits of APR—the choice of stylus and the splash and contaminant resistance of resistive technology, plus the pure glass optics and resistance to wear of infrared and surface-wave technologies, all integrated in fully sealed, attractive POS touchmonitors—will be just the beginning for this revolution in touch.

Touch Technologies Explained

Elo TouchSystems offers all of the major touch technologies.

Acoustic Pulse Recognition (APR)

The APR assembly comprises a glass display overlay or other rigid substrate, with four piezoelectric transducers mounted on the back surface. The transducers are mounted on two diagonally opposite corners out of the visible area and connected via a flex cable to a controller card.

The impact when the screen is touched, or the friction caused while dragging between a user's finger or stylus and the glass, creates an acoustic wave. The wave radiates away from the touch point, making its way to the transducers which produce electrical signals proportional to the acoustic waves. These signals are amplified in the controller card and then converted into a digital stream of data. The touch location is determined by comparing the data to a profile. APR is designed to reject ambient and extraneous sounds, as these do not match a stored sound profile.

IntelliTouch Surface Wave

The IntelliTouch surface acoustic wave (SAW) touchscreen consists of a glass overlay with transmitting and receiving piezoelectric transducers for the X and Y axes. The controller sends an electrical signal to the transmitting transducer, which converts the signal into ultrasonic waves within the surface of the glass. These waves are directed across the touchscreen by an array of reflectors. Reflectors on the opposite side gather and direct the waves to the receiving transducer, which reconverts them into an electrical signal. The process is repeated for each axis.

A touch absorbs a portion of the waves traveling across it. The received signals for X and Y are compared to the stored digital maps, the change recognized, and a coordinate calculated.

Variations include SecureTouch for increased vandal resistance, using 6 or 12mm tempered glass, and iTouch, in which surface waves travel directly within a CRT faceplate rather than through an added overlay.

AccuTouch Five-Wire Resistive

The AccuTouch five-wire resistive touchscreen consists of a glass panel with a resistive coating plus a coversheet with a conductive coating. The two layers are separated by tiny insulating dots.

When the screen is touched, the coversheet flexes to make electrical contact with the coating on the glass. The controller alternatively drives the X and Y axes on the glass layer with +5 V and reads the resulting voltage from the coversheet, which is the analog representation of the position touched.

AT4 Four-Wire Resistive

The AT4 four-wire resistive touchscreen has a similar construction to that of five-wire resistive. However, when the screen is touched, the controller alternately drives the coversheet with +5 V and reads the resulting voltage from the glass layer, then drives the glass layer and reads the voltage from the coversheet. Although it is particularly well suited to small size screens, the primary drawback of four-wire resistive is a shorter MTBF than five-wire.

Surface Capacitive

Elo surface capacitive technology consists of a uniform conductive coating on a glass panel. Electrodes around the panel's edge evenly distribute a low voltage across the conductive layer, creating a uniform electric field. A touch draws current from each corner. The controller measures the ratio of the current flow from the corners and calculates the touch location.

Projected Capacitive

Projected capacitive touchscreens consist of a sensor grid of micro-fine wires, laminated between two layers of protective glass. The assembly can be placed behind customer-installed materials, including vandal-resistant glass up to 18 mm thick. During a touch, capacitance forms between the finger and the sensor grid. The touch location is calculated from the changing electrical characteristics of the sensor grid.

CarrollTouch Infrared

The CarrollTouch high-resolution infrared (IR) technology uses a small frame around the display with surface-mounted LEDs and photoreceptors on opposite sides, hidden behind an IR-transparent bezel. The controller sequentially pulses the LEDs to create a scanning grid of IR light beams. A touch obstructs one or more of the beams in each axis, which identifies the X,Y coordinate.

Comparison of All Elo Touch Technologies

	Acoustic Pulse Recognition	Resistive		Surface Acoustic Wave (SAW)			Capacitive		Infrared
	APR	AT4 4-wire	AccuTouch 5-wire	IntelliTouch	SecureTouch	iTouch	Surface Capacitive	Projected Capacitive	CarrollTouch
Performance									
Speed	+++	+++	+++	+++	+++	+++	+++	−−	
Sensitivity	++			++	++	+++	+++		+++
Resolution	+++	+++	+++	+++	+++	+++	+++		+++
Accuracy	+++		+++	+++	+++	+++	−−	−−	+++
Calibration Stability	+++		+++	+++	+++	+++	−−		+++
Drag	+++					++	+++		+++
Z-axis	−−−	−−−	−−−	+++	+++	+++	−−−	−−−	−−−
Double Touch [1]	+++	−−	−−	+++	+++	+++	−−		
Parallax (lack of)						+++ [2]		−−	−− [3]
Input Flexibility									
Glove	++ [4]	+++	+++	+++	+++	+++	−−−	+++	+++ [4]
Fingernail	+++	+++	+++	−−−	−−−	−−−	−−−	−−	++
Credit Card	+++	+++	+++	−−−	−−−	−−−	−−−	−−−	++
Pen	+++	+++	+++	−−−	−−−	−−−	−−−	−−−	++
Signature Capture	+++	+++	+++	−−−	−−−	−−−	−−−	−−−	−−−
Handwriting Recognition	++	−−	−−	−−−	−−−	−−−	−−−	−−−	−−−
Optics									
Light Transmission	+++	−−	−−	+++	+++	+++ [5]	−−		+++
Reflection (lack of)	+++			+++	+++	+++ [5]	−−−		+++
Clarity	+++			+++	+++	+++			+++
Color Purity	+++	−−	−−	+++	+++	+++			+++

(Continued on next page)

Key	
+++	Best in category
++	Some advantage
	Neutral
−−	Perhaps not acceptable
−−−	Not possible, worst in category

Notes

1 −− = Incorrect (averaged) coordinate reported.
+++ = Simultaneous touches rejected; nearly simultaneous touches reported accurately.

2 Touch is closest to image, as there is no overlay.

3 Touch activates just before actual contact (1 mm).

4 Only technology recommended for metal gloves.

5 The utmost possible, as there is no overlay.

6 For LCDs only; plasma is not possible, due to EMI.

7 Special sealing materials required (Elo touchmonitors are watertight sealed).

8 Assuming proper materials are used.

9 Although splashing liquids are OK, extended rain and humidity exposure can lead to internal condensation.

10 Works with stationary water drops; excessive or moving water must be wiped away.

11 Polyester coversheet may yellow after years of exposure.

12 Required for food processing and some in-vehicle applications.

No guarantee of acceptability of the technology to the application is implied by this quick reference table.

	Acoustic Pulse Recognition	Resistive		Surface Acoustic Wave (SAW)			Capacitive		Infrared
	APR	AT4 4-wire	AccuTouch 5-wire	IntelliTouch	SecureTouch	iTouch	Surface Capacitive	Projected Capacitive	CarrollTouch
Mechanical									
Small Sizes (<10")	+++	+++	−−	−−	−−	−−		−−	−−
Large Sizes (>19")	+++	−−−	−−	+++	−−−		−− [6]		+++
Curved CRTs		−−−			−−−	+++		−−−	−−−
Ease of Integration	++	+++	+++	−−	−−	−−	++	−−	
Sealability	+++	+++	+++	−− [7]	−− [7]	−− [7]	+++	+++	+++
IP 65/NEMA 4	+++	+++	+++	−−−	−−−	−−−	+++	+++	+++
Electrical									
Controller Chip Available		+++	+++				+++		+++
Low Power/Battery Operation	TBD	+++							
Operation with Poor Ground	+++						−−−	−−−	
ESD	+++		+++	+++	+++	+++	−−		+++
EMI/RFI	+++	+++	+++	+++	+++	+++	−−	−−−	+++
Environmental									
Temperature	+++						+++	+++	+++
Humidity	+++							+++	+++
Shock/Vibration		+++	+++						+++
Altitude	++								+++
In-vehicle	TBD	++	++						+++
Chemical Resistance	+++	+++	+++				−−−	+++	+++
Scratch Resistance	+++			+++	+++	+++		+++ [8]	+++ [8]
Breakage Resistance					+++	+++		+++ [8]	+++ [8]
Safe Break Pattern		++	++		+++			+++	+++

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	APR	AT4 4-wire	AccuTouch 5-wire	IntelliTouch	SecureTouch	iTouch	Surface Capacitive	Projected Capacitive	CarrollTouch
Dust/Dirt	+++	+++	+++				+++	+++	– –
Liquids	++	+++	+++	– – [10]	– – [10]	– – [10]	+++	+++	– –
Rain	++	– – – [9]	– – – [9]	– – –	– – –	– – –		+++	– –
Snow		– – –	– – –	– – –	– – –	– – –	– –	+++	– –
Ice		– – –	– – –	– – –	– – –	– – –	– –	+++	– –
Ambient/UV Light	+++	– – [11]	– – [11]						
Fly on Screen	+++								– – –
Non-Glass Surface Possible[12]	+++	+++	+++					+++	+++
Works Through Other Materials	++	– – –	– – –	– – –	– – –	– – –	– – –	+++	
Durability/Wear	+++	– –	++	+++	+++	+++	++	+++	+++
Surrounding Metal	+++						– –	– –	
Reliability/ Warranty Length	+++	– – –		+++	+++				+++
Lowest Cost		+++				++		– –	– –

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Find out more about Elo's extensive range of touch solutions. Go to www.elotouch.com, or simply call the office nearest you.

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