

Touch screen highlights from the SID 2006 show floor

by Geoff Walker

The three most significant touch-related pieces of news at SID 2006 were (1) the large number of touch vendors exhibiting, (2) 3M Touch's absence, and (3) Elo TouchSystems' announcement of their new acoustic pulse recognition (APR) technology. There were a total of 20 touch-related vendors exhibiting a total of 10 technologies at SID this year (see table at the end of this article). That's considerably more than ever before. All 20 vendors are covered in this article in alphabetical order, except for Elo, which is a special case due to its significant new product announcement.

3M Touch

3M Optical Systems was exhibiting its Vikuiti product line in a large booth as usual, but the absence of 3M Touch from the booth was noticeable. As a result there were a large number of rumors about 3M Touch floating around the show. Instead of reporting these rumors, I went directly to the source and talked with a Communications Manager at 3M Touch. Here is the essence of what's happening at 3M Touch:

- It decided not to exhibit at SID 2006 because historically it hasn't been a good source of leads for them, and especially in an expensive venue such as San Francisco, it was difficult to justify the large investment required to exhibit. 3M Touch did conduct meetings with customers at an off-site location during SID.
- Organizationally, 3M Touch has been moved out from under Optical Systems and made a peer instead because there is less synergy between films and touch than there used to be. Sharing a booth with the Vikuiti product line was therefore not the automatic decision this year that it had been in past years.
- 3M Touch has decided to discontinue all its film-glass resistive touch screen products (the MicroTouch "FG" product line). The basic reason is that resistive technology has turned into a commodity with dozens of relatively undifferentiated suppliers worldwide, and 3M can no longer add significant value, achieve a substantial market share or make money in this market. This discontinuance includes 3M Touch's 5-wire resistive product line, which will cause 3M to lose the majority of its POS (point-of-sale) market share, especially in the food-service (glove-touch) segment. 3M will try to retain some of its POS share by applying capacitive technology where it fits.
- The company is continuing its film-film-glass resistive touch screen products (the MicroTouch "PL" product line) because it believes that 3M can continue to differentiate itself in this market segment.
- 3M Touch has discontinued its near field imaging (NFI, or projected capacitance) touch-screen products because of insufficient differentiation between 3M's NFI and ClearTek's capacitive-touch technologies, and because of insufficient business to justify the expense of upgrading the product line to meet RoHS.
- 3M is "downplaying" its dispersive signal technology (DST) that was announced with some fanfare at SID 2004. In September 2005, 3M announced that the first commercial availability of DST would be in 40-inch, touch-enabled, NEC LCD displays to be marketed as part of Richardson Electronics' "Pixielink" product line. Sometime in early 2006 the product disappeared from the Richardson Electronics' website. According to 3M, the product isn't dead, it's "still in the lab" and "not fully commercialized yet". Limited technology information is still on the 3M website (see <http://www.dsttouch.com>) but clearly the product isn't yet ready for prime time.
- Finally, 3M is not getting out of the touch business; the company is simply focusing its resources on capacitive technology where it can add the most value, achieve the largest market share and make money. Overall, it's really nothing more than a small part of a large corporation focusing more closely on what it does best.

Elo TouchSystems

In the author's opinion, Elo's APR touch technology is the most significant new announcement in the touch field in at least the last year (*see p4*). The remainder of this section looks a little deeper into the technology.

The APR sensor is a plain sheet of pure glass (92% transmissivity) with four piezoelectric transducers along the edges. The transducers are not located symmetrically, but instead are located approximately 60%, 70%, 80% and 90% of the way to each corner. The edge margin on the sensor is quite small, only 5 mm (including the sealing area); this makes the sensor well suitable for use in notebooks, LCD monitors and other products where there is a very small margin around the LCD. Sensor size can be from a couple of inches (cell phone or PDA size) up to around 42 inches.

The controller continually listens to the analog sound created by the sensor. When a touch creates a sound that exceeds a dynamic frequency-domain threshold, the controller filters it to remove known ambient non-touch sounds, then digitizes it and compares the sound with a list of pre-recorded sounds that are stored in flash memory on the controller. Each pre-recorded sound is about 100 ms long. Each location on the sensor generates a unique sound; when there's a match between a dynamic sound and a stored sound, the controller returns the touch coordinates of the stored sound. Since the controller spends most of its time listening and only does table look-ups rather than a lot of real-time calculations, the overall power consumption of APR is quite low, which makes it well-suited for use in mobile computers.

The key difference between 3M's dispersive signal technology (DST - *see above*) and APR is that DST dynamically tries to determine the location of each sound, while APR simply does a table look-up and ignores all sounds that don't match. This makes APR immune to ambient noise, while DST is sensitive to ambient noise. It also makes DST more power-hungry, since it uses more processing horsepower.

The key functional difference between SAW and APR is that, while both are acoustic, in SAW the transducers are both generating and receiving sounds and in APR the transducers are only listening. Again this goes to power consumption.

Palm rejection in signature-capture applications such as POS is difficult to achieve with most touch technologies; with APR it's a simple matter of skipping the sections of the pre-recorded sound table that are outside of the signature area. Performance specifications are comparable or better than resistive: accuracy is specified as 1% maximum, resolution is based on a controller resolution of 4096x4096, and touch activation force is 55-85 g.

The key benefits of APR combine (1) the choice of stylus and the splash and contaminant resistance of resistive with (2) the pure glass optics and resistance to wear of IR and SAW. The only negative to the technology is that you can't do touch-and-hold, drag-and-hold or "untouch" because no sound is made when the user is stationary (holding). Some of the lesser benefits include (1) works even with scratches, (2) excellent drag performance, (3) sealable to NEMA-4 and IP-65 standards, and (4) one-time calibration (no drift).

Because APR is a brand-new technology, Elo is being appropriately conservative about the rollout. Their plan is to ship APR starting in September 2006 in a few of their own touch monitors that are targeted at the retail and restaurant POS market. Then as they gain confidence in the technology and as manufacturing ramps up, they will enter full production by the first quarter of 2007.

A D Metro

A D Metro, based in the US, is known for its "Ultra" high-durability 5-wire resistive touch screen. It is created by laminating a 0.1 mm layer of glass on top of the PET (polyethylene) plastic top layer of a standard resistive touch screen. The result is a resistive touch screen that can be hit with a hammer (when used with a tempered glass substrate) or deeply scratched with a diamond-point glass cutter with no ill effects. Because it's still a resistive

touch screen, it can be used with fingers, gloves, stylus, or any object. It is unaffected by dirt, water or chemical contamination, and it can even operate submerged or completely frozen. A variant called the “Absolute Ultra” model uses a 12 mm polycarbonate substrate and is designed to meet the needs of explosion-proof equipment in the oil and gas industry. Basically, this is very cool stuff.

Curiously, even though the top surface is actually glass, the activation force is very close to that of a standard PET-surface touch screen – 85 grams. The only negative effect of the glass seems to be that when writing with a pen; the decreased radius of curvature (flexibility) of the top surface can cause electrical contact to be lost momentarily as the pen passes over a spacer dot. However, that’s relatively simple to compensate for in the driver.

The choice of the name “Ultra” turned out to be less than ideal for A D Metro. Because it’s such a common word and it’s not paired with any other word, the company was unable to trademark it. As a result, some competitors are using the same term as a generic description of rugged touch screens, and the media doesn’t always understand that “Ultra” is actually a product name.

Although their technology is clearly very interesting, it’s not actually new. When asked if A D Metro was showing anything new at this year’s SID, the booth person replied, “No, it’s the same stuff we’ve been hammering away at for the last three years.” In light of Ultra’s capabilities, “hammering” seems to be a very appropriate term...

Bergquist

Bergquist is a US-based, family-owned company specializing in thermally conductive interface materials. It also sells a line of highly customizable, high-quality, 5-wire resistive touch screens covering 3.9 to 23 inches (the widest range of 5-wire available). While they had a good range of product samples in their booth, they weren’t actually showing anything new.

Chi Lin Technology/Next Window

Chi Lin is a Taiwanese supplier of resistive touch screens and other materials to the display industry. It is part of the Chi Mei Group, which includes Chi Mei Optronics (CMO), the second-largest LCD manufacturer in Taiwan. Chi Lin wasn’t showing anything new in resistive touch screens in their booth. In fact they didn’t seem to have any clear differentiation other than their Chi Mei connection – which admittedly could have some value.

What was much more interesting in the Chi Lin booth was a sample of NextWindow’s optical touch screen (see <http://www.nextwindow.com>; Chi Lin is acting as an integrator for NextWindow). The 2400-series of products from NextWindow can be used with displays between 30 and 63 inches. While the light source is infrared, the sensing technology is camera-based which has some advantages over IR touch screens. The accuracy specification is given as +/- 2 mm over 90% of a 40-inch screen. Resolution reported by the USB interface is 32K x 32K points, although the actual number of touch points is only around 400K. The sample demonstrated full mouse functionality, including right-touch, click-and-drag, etc. Overall it was quite impressive.

DigiTech Systems

DigiTech is a Korean supplier of resistive and capacitive touch screens. DigiTech was featuring its newest product, the “TuffTouch” impact-resistant capacitive touch screen. It is created by laminating tempered glass to the back of their standard capacitive touch screen. Surface durability specifications are comparable to other capacitive products (more than Mohs 6 hardness, 250 million touches) but the laminated tempered glass provides a steel ball-drop specification of 0.5 kg at 1.3 M. The tradeoff is a total thickness of 6.5 mm and reduced transmittance (80%).

When asked who he competes with, Tommy Lee, the president of DigiTech, said the following: (1) mainly with Nissha in small resistive, (2) with many companies in large resistive, and (3) mainly with 3M in capacitive.

eGalax

eGalax is a six-year-old Taiwanese supplier of universal touch screen controllers. It is the dominant supplier of standalone controllers in the Asia market. Unlike Hampshire (*see below*), it is working on supporting IR and SAW in addition to resistive and capacitive. At SID its primary news was announcing formal support of SAW – although it's not on its website yet. One interesting factoid about eGalax is that it supplied the 4-wire resistive touch screen controller chip for every UMPC that's been announced so far. The eGalax booth person said that they are currently working on the Vista driver for that chip.

Fujitsu

Fujitsu is one of the major suppliers of resistive touch screens used in mobile devices. At SID, Fujitsu announced the availability of its conductive-polymer ITO replacement. This is fairly significant news, since there's quite a bit of activity in this area with the price of ITO rising so rapidly in recent years. Fujitsu has been developing this material for five or six years, so it's not exactly a flash in the pan.

Fujitsu showed several sample resistive touch screens made with the conductive polymer material. The key advantage of the conductive polymer is that it's much more flexible than ITO. This results in a 5x longer lifetime specification (250K pen touches instead of 50K pen touches). Currently Fujitsu expects the material to be priced at a slight premium over ITO due primarily to production inefficiencies, but in the long term it is expected to be lower cost than ITO. On the other hand, the coating process will be more difficult, since the material has a very low pH (only two or three). Fujitsu will initially only be using the material in custom touch screens, but after gaining some experience, it will begin using it in standard touch screens (although the initial sizes have not been decided yet).

The other product area that Fujitsu was highlighting at SID was its high-durability resistive touch screens. It showed two sample touch screens that had been through severe lifetime testing: continually writing a 9 x 10 mm Kanji character in the same location 150K times instead of the usual 50K times, with a pen pressure of 450 grams instead of the usual 250 grams. Both screens showed no visible degradation – pretty impressive performance! These touch screens are made of multiple layers of film on a plastic substrate (i.e. film-film-plastic construction). They're shatterproof, with an extended operating temperature range of -30C to +60C. Because of their specialized nature, there are no standard versions of these products – they're all customized.

Gunze

Gunze is a Japanese supplier of resistive touch screens; the company is either #1 or #2 in the market, depending on who you talk to. Their annual revenue is around \$800m, and it's 100% touch. Gunze was featuring its latest low-reflectivity touch screens at SID. These are touch screens that incorporate a circular polarizer and anti-reflection film to reduce reflections, which enables easier outdoor viewing. The traditional problem with this approach is that the polarizer absorbs a significant portion of the light coming from the display, which reduces the overall brightness. Gunze's latest design improves the transmissivity of the polarizer to 67%, which is a 13% improvement. Low-reflectivity touch screens are substantially more expensive than standard touch screens (typically about 3x); most of this is due to the addition of the low-volume/high-cost polarizer. The second-best way of creating a low-reflectivity touch screen is to use index-matching coatings on all four surfaces and omit the polarizer. While this doesn't work quite as well, the cost is only 2-2.5x that of a standard touch screen.

In their booth, Gunze was featuring products from Itronix, Motorola and Allen-Bradley (all US customers) that use Gunze touch screens. Although Gunze is a Japanese company, it has substantial manufacturing capability in the US. In fact, in the last year that capacity increased by 40%.

Hampshire

Hampshire makes high-performance, universal touch screen controllers. Its basic product positioning is that buying a touch screen controller separately from the sensor allows an OEM or systems integrator to insulate themselves

from vendor changes or single-source issues. It also allows switching between touch technologies without changing the driver software or controller hardware. Hampshire's controllers work with any manufacturer's sensor – they can auto-sense 4-, 5- or 8-wire resistive sensors, and they offer auto-sensing USB and RS-232 interfaces. At SID, Hampshire was featuring its newest product, a universal capacitive touch screen controller.

Hampshire is a relatively small company with annual revenues of less than \$10m and volumes of less than 1m units. Interestingly, 85% to 90% of their sales are of controller chips that are integrated into OEM products, rather than standalone controller boards.

Horizon Technology/General Touch

Horizon Technology is actually a distributor and systems integrator rather than a typical touch technology vendor. It designs and integrates a full range of standard and custom LCD solutions, including touch screens, sunlight readable displays, open-frame LCDs, etc. However, it is also the first company to offer 40 and 42-inch SAW (surface acoustic wave) touch screen displays in the US. Horizon acts as a distributor for General Touch, the leading Chinese manufacturer of SAW touch screens. Now that one of Elo's basic SAW patents has expired, an infusion of new SAW products is expected in the US market, and General Touch seems to be leading the charge.

The aisle-facing demo in the Horizon booth was a 40-inch LCD with a SAW touch screen integrated into the LCD's standard bezel, and it was very impressive. Interestingly, the sales person in the booth chose to focus on the general advantages of SAW over IR rather than on any of the specific characteristics of the General Touch SAW product.

Immersion

Immersion specializes in developing haptic (tactile and kinesthetic cue) technologies in a wide variety of devices, including gloves, exoskeletons, wheels, joysticks, pedals, mice, surgical simulators, cell-phone vibrators, and (of course) touch screens. Its demo at SID was focused around a touch screen that produced distinct "press and release" tactile feedback (accompanied by an audible clicking sound and a visual change in the button image) when an on-screen button was pressed. The tactile feedback is achieved by physically moving the touch-screen frame via a small actuator (solenoid). (*See SMK Technologies below for more information on how Immersion's haptic technology is being combined with SMK's touch screen technology.*)

IRTouch Systems

IR Touch Systems is a Chinese manufacturer specializing in infrared touch screens. It offers several varieties of add-on and integratable touch screens from 6 to 150 inches. Historically IR touch screens have not allowed multi-touch; IR Touch Systems' booth demonstration was primarily focused on a software (driver) implementation of multi-touch. They were using a CAD application to demo the capability. For example, the user could shrink, zoom or rotate an image by pointing one finger of each hand at each side of an image and moving his hands closer together, further apart or in a rotating motion.

It wasn't clear if this was just a demo done to attract attention at SID, or if it would actually be added to their products as a new capability. There was no sales literature or PR information available on the demo, and the booth person's English was rudimentary at best.

Northpoint Technologies

Northpoint is a small US-based supplier of resistive and capacitive touch screens. When asked what differentiates the company, the booth person at SID said, "It's a commodity business and we sell on price and reliability." Northpoint wasn't showing anything new at SID. However, the booth person said that they had recently developed their own SAW technology, but that they didn't want to go to the trouble of changing their booth graphics to support it. It's also not on their website.

Plastic Logic

Plastic Logic certainly isn't a supplier of touch screen technology, but they had an interesting concept demo in their booth. It was an E Ink flexible electrophoretic frontplane on top of a Plastic Logic flexible backplane, with a QWERTY keyboard overlay on top of the E Ink screen and a resistive touch screen underneath the flexible backplane. The upper layers were flexible enough so that typing on the overlay transmitted enough motion to activate the touch screen. Of course there wasn't any real tactile feedback from the flat keyboard, but this wasn't a product or even a prototype – it was just a concept to make one think about how flexible “electronic paper” screens and touch screens might be combined in the future. Interesting...

SMART Technologies

Smart Technologies launched its ID350 and ID370 “Symposium” interactive pen displays at SID this year. These two products are basically tablet monitors optimized for use in a meeting environment. The ID350 has a 15-inch XGA LCD, while the ID370 has a 17-inch SXGA LCD. What's interesting about these products is that they use a de-featured Wacom EMR digitizer instead of a capacitive or resistive touch screen. The normal “hover” function of the Wacom digitizer has been removed in these products. That means that from the user's perspective, these products work just like any standard touch screen. When you touch the pen to the screen, a click is registered or digital ink starts to flow, depending on what you're doing. The pen is tethered to the display not because it's electrically required (as it might be if the product used a capacitive touch screen) but just because it makes sense in a meeting environment. Since the pen contains electronics, losing the pen disables the display.

You might ask, why use EMR in this application if you're going to de-feature the technology? The answer appears to be (at least according to the booth person) that Smart OEMs use these products from Wacom, and of course Wacom is going to use its own technology. Smart was also displaying its interactive whiteboard products and the DT770 Symposium interactive pen display, both of which use optical touch screen technology, and neither is new.

SMK Electronics

SMK is a Japanese manufacturer of resistive and infrared touch screens. At SID it was showing an improved tactile-feedback resistive touch screen. The technology is a combination of SMK's “Force Feedback” self-vibrating touch screens and Immersion's “TouchSense” tactile, visual and auditory effects. The combination allows creating a wider variety of tactile effects than can be created with just SMK's technology alone. It's also possible to combine SMK's self-vibration capability with Immersion's electromagnetic actuator; this produces buttons that can both vibrate and give a feeling of z-axis motion when touched. For example, a touch speed control could be designed that not only seems to depress when touched, but also vibrates more or less strongly as the speed is varied.

The demo touch screen in the SMK booth contained a dozen or so buttons, each of which produced a different feeling when touched. SMK is planning to focus the combined technology on applications in the automotive, office equipment, appliance and white good, industrial control, kiosk, POS and aerospace markets. It's interesting to see how little mechanical movement is required to create tactile feedback – SMK's self-vibrating touch screen only moves three microns (peak-to-peak)!

Touch International

Touch International is a four-year-old, US-based company with resistive, capacitive, infrared and projected capacitive touch screen products. Their focus at SID was the last. The product, called “Digital Ink” (a name that's always bothered me), was actually introduced three years ago in July 2003. In the intervening years, the product seemed to get almost no traction. Now, finally, Touch International seems to have achieved a significant design win with VeriFone. Digital Ink is shipping in the VeriFone 7100 MPD (modular payment device, otherwise known as a POS terminal). The touch screen is implemented in a film-film format on top of the LCD and under a sheet of glass; this works well because it's projected capacitive. Functionally it's like the standard resistive touch screen that's used in most POS devices in that it can be used with a tethered pen or a finger – but yet the top surface is glass, not

PET, so it's far more durable and reliable (300 million touches in a single location), and it has inherently excellent palm rejection. It's also very high resolution (1000 dpi), although that's not required in the POS application. Finally, Touch International claims to be selling it at the price of 4-wire resistive! This seems like an ideal application for projected capacitive.

Touch International had a few other interesting things in their booth, one of which was a sample of a touch screen with an ITO index-matched coating on the back surface that acts as an EMI shield for in-flight, seat-back-mounted displays. When you think about it, 100+ LCD displays in an airplane can generate a substantial amount of interference, so the airlines are very strict about requiring EMI shielding for those displays. Incorporating an EMI shield into the back of a touch screen is simpler than trying to shield the front of the LCD. It just makes sense.

TouchKO/White Electronic Designs

TouchKO is a US-based supplier of resistive and projected capacitive touch screens. They didn't have their own booth at SID; instead, they were part of the White Electronic Designs booth. White was promoting its new Pro Series of Touch Tablet PCs. These products are created from the Motion Computing LS800 and LE1600 Tablet PCs. White removes the Wacom digitizer and adds TouchKO's 5-wire resistive touch screen. The touch screen is optically bonded to the Tablet PCs' LCDs using White's "Max-Vu" technology.

The resulting White products are slightly different from Motion's standard products in that (1) the LS800 isn't offered by Motion with a touch screen, although it is offered with optional optical bonding (what Motion calls "View Anywhere"), and (2) the LE1600 is offered with a resistive touch screen (as the model LE1600TS) but without an optical bonding option. These differences may seem very subtle, but the Motion/White relationship doesn't seem to be about product, it seems to be about distribution. White has a long history of selling memory chips, multi-chip modules and other hardware to the US military. It's likely that the cooperation between White and Motion is based on White's access to the military market.

During a conversation with a White executive at SID, there were also some hints dropped about future technology advances that could result from the White/TouchKO collaboration, such as a radical improvement in outdoor readability of touch-screen equipped mobile computers. The White executive indicated that the current White Tablet PC products were only the tip of the iceberg, that they were simply the first move in a much richer, long-term product plan. The *Touch Panel* certainly looks forward to seeing what may develop in this area, since outdoor readability of touch-screen equipped mobile computers has been an unsolved problem for many years.

Wacom

Wacom is the dominant supplier of electromagnetic resonance (EMR) digitizers. Wacom's technology is used in almost every Tablet PC. The only major brand that doesn't use it is Gateway; it uses the FinePoint Innovations digitizer (<http://www.finepointinnovations.com>). Wacom featured its new dual-mode Tablet PC digitizer at SID. First announced at WinHEC (the Windows Hardware Engineering Conference) in May, this capability allows a Tablet PC OEM to replace the LCD cover glass (the writing surface) with a resistive or capacitive touch screen without changing the controller. This provides a Tablet PC with both pen (digital ink) and finger-touch capabilities, support of which is one of the key new Tablet PC enhancements in Vista, the next major version of Windows. Wacom achieved this capability by enhancing the microprocessor on their controller card to also function as a touch-screen controller. It's fairly clever product positioning, since it allows the OEM to select and add the touch screen of their choice without changing anything substantial in the product.

Wacom also announced (in a very low-key way) the availability of digitizer sensors for tablet monitors in the range of 15 to 30 inch. This is desirable to support what should be a growing interest in tablet monitors once Vista starts shipping. However, because monitor LCD standards are much less widely accepted than Tablet PC LCD standards, Wacom is not offering any standard products in this category. Each sensor will be customized to the particular LCD display being used by the tablet monitor OEM.

Zytronic

Zytronic, based in the UK, is the dominant supplier of projected capacitive touch screens. Their touch screens are used in every Diebold and NCR ATM, and Elo resells Zytronic's touch screen under its own brand. Zytronic's sensor is created by cold-laminating ultra-fine copper wires onto a film, and then bonding the film to the back of a piece of glass or other touch surface. At SID, Zytronic was demonstrating their technology applied to the back of a large rear-projection screen. This created an interesting method of interacting with a game. Zytronic indicated that its technology could be applied to rear-projection screens as large as 100 inches. Although what was being demonstrated was basically a concept product, the booth person indicated that Zytronic intended to commercialize the idea.

The only other new capability that Zytronic announced at SID was the ability to use an off-sensor controller with their ATM-style touch screens. Apparently many of their current products use a controller that's integrated onto the sensor, and their customers are beginning to demand off-screen controllers such as are common with most other types of touch screens.

Vendor	Technologies	URL
A D Metro	C, R	http://www.admetro.com
Bergquist	R	http://www.bergquistcompany.com
Chi Lin Technology/ NextWindow	R, Opt	http://www.chilintech.com.tw http://www.nextwindow.com
DigiTech Systems	C, R	http://www.digitechsys.co.kr
EGalax	Cont	http://www.egalax.com.tw
Elo TouchSystems	APR, C, IR, PC, R, SAW	http://www.elotouch.com
Fujitsu	R	http://www.fcai.com
Gunze	R	http://www.gunzeusa.com
Hampshire	Cont	http://www.hampshirecompany.com
Horizon Technology/ General Touch	SAW	http://www.horizontechnology.com http://www.generaltouchus.com
Immersion	TF	http://www.immersion.com
IRTouch Systems	IR	http://www.irtouch.com
Northpoint Technologies	C, R	http://www.northpointech.com
Plastic Logic	(Concept Demo)	http://www.plasticlogic.com
Smart Technologies	Opt	http://www.smarttech.com
SMK Electronics	IR, R, TF	http://www.smkusa.com
Touch International	C, IR, PC, R	http://www.touchinternational.com
Touch KO/ White Electronic Designs	PC, R	http://www.touchko.com http://www.wedc.com
Wacom	EMR	http://www.wacom.com
Zytronic	PC	http://www.zytronic.co.uk
Touch Technology Abbreviations		
APR = Acoustic Pulse Recognition	Opt = Optical	
C = Capacitive	PC = Projected Capacitance	
Cont = Controller	R = Resistive	
EMR = Electromagnetic Resonance	SAW = Surface Acoustic Wave	
IR = Infrared	TF = Tactile Feedback	