



The Future of Mobile Touch

Walker Mobile, LLC

October 2, 2007





Question

*What was the
most important event
in touch
in mobile displays
in 2007?*



Answer



The
Apple
iPhone

...and the
iPod touch



Photos courtesy of Apple



Why?

- ① The innovative user interface changed the perception of the value of touch
- ② The hardware brought projected-capacitive touch from a niche into the mainstream



A Quick Trip Through The Future Of Mobile Touch

- ❑ **The past:** Four-wire resistive touch
- ❑ **The future:** Projected-capacitive touch
 - ◆ Why did Apple choose it?
 - ◆ How does it work?
 - ◆ How is it implemented in the iPhone & iPod?
 - ◆ Who are the current suppliers?
 - ◆ What does the future look like?



The Past: 4-Wire Analog Resistive

❑ Dominant touch technology in mobile devices

- ❶ Lowest cost
- ❷ Readily available (50+ suppliers)
- ❸ Finger & stylus
- ❹ Other technologies aren't suitable
 - Projected capacitive – few suppliers; niche positioning
 - Surface capacitive – too sensitive to EMI
 - Infrared – too much projection above touch surface
 - Surface acoustic wave (SAW) – too sensitive to contamination
 - Optical – doesn't scale down to mobile size; too much projection
 - Bending wave – not available yet as a component
 - Force-sensing – not available yet; too sensitive to vibration
 - In-pixel – not available yet; light-sensing causes light loss

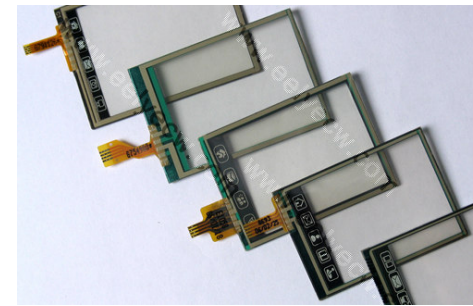


Photo courtesy of EELY

(pre-iPhone)



6/29/07: Projected-Capacitive Touch Enters The Mainstream

❑ Why did Apple choose projected capacitive?

- ① It supports multi-touch (required by the iPhone's user interface)
 - Only other current multi-touch technologies are IR & optical
- ② It eliminates resistive's two primary shortcomings
 - **Poor durability** – PET plastic top surface is easily damaged
 - **Low optical clarity** – 10% to 20% light loss
- ③ A high-capacity (30M units/year) supplier became available
 - TPK/Optera + Balda
- ④ It's a proven technology
 - Signature-capture
POS terminals, information kiosks, outdoor ATMs...

ExtremeTouch from
Touch International

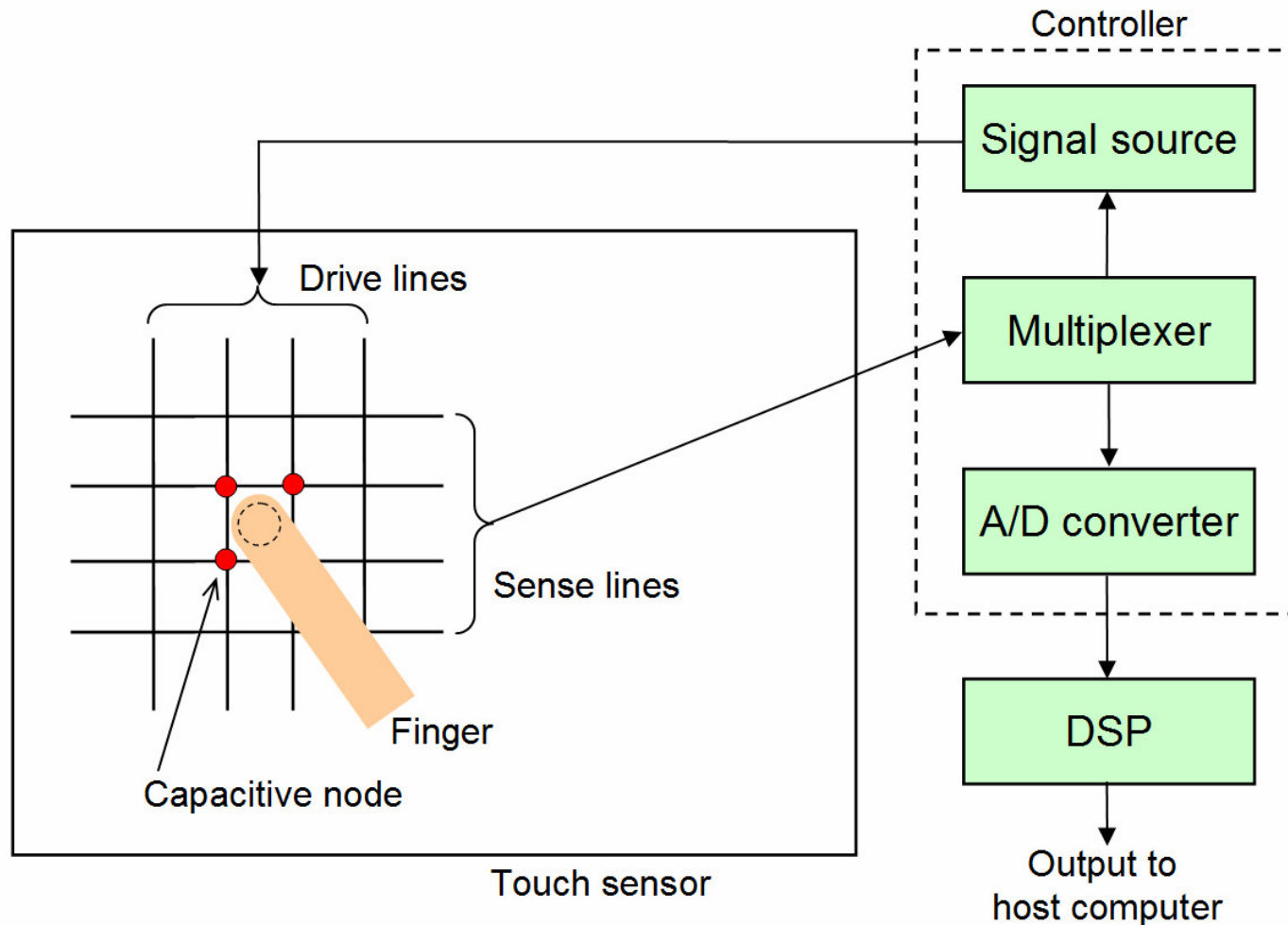


Omni 7100 MPD
Payment Terminal
from Verifone





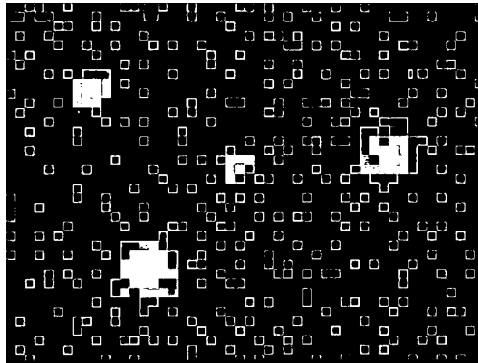
How The iPhone's Projected-Capacitive Touch Works



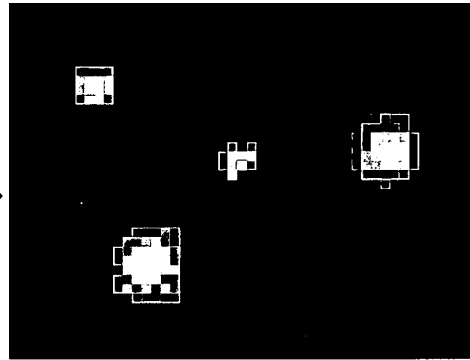


How The iPhone's Multi-Touch Works

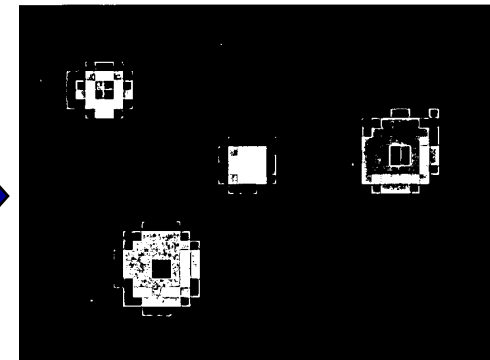
Raw data including noise



Filtered data

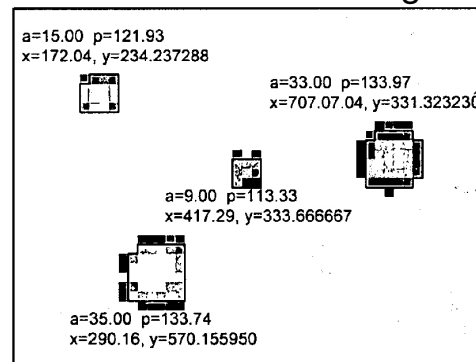


Gradient data

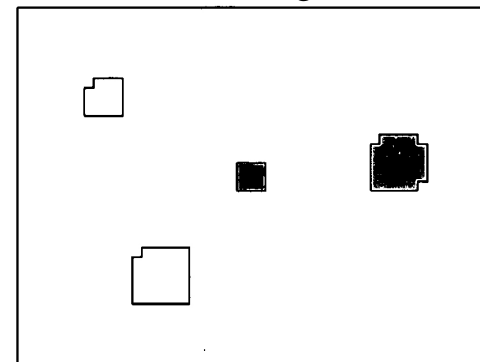


***“10 fingers,
2 palms
and
3 others”***

Coordinates of touch regions



Touch regions

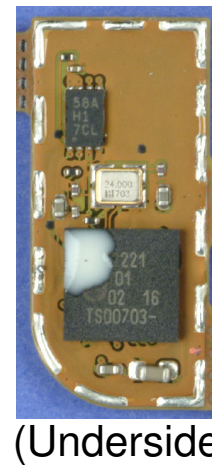
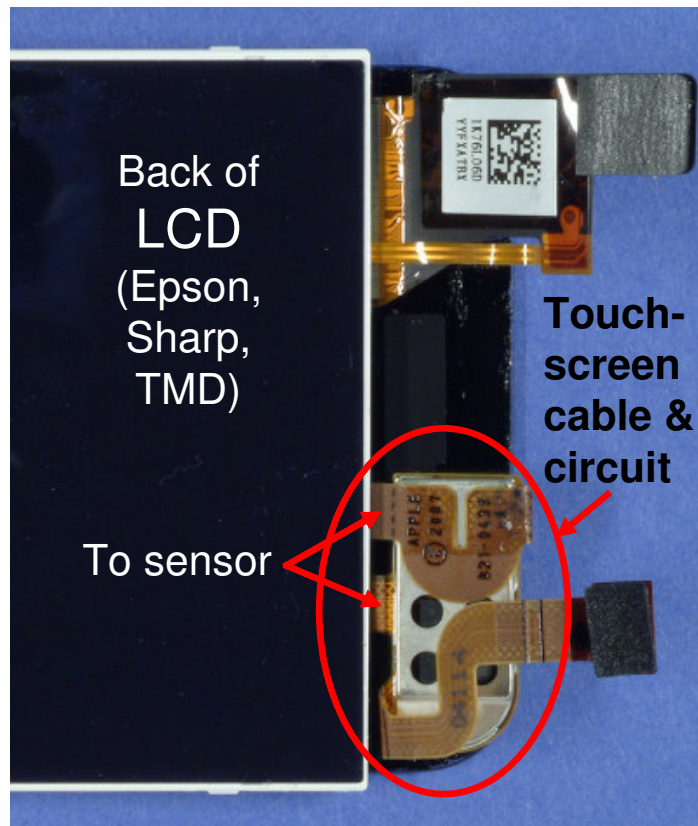


Images from Apple Patent Application #2006/0097991



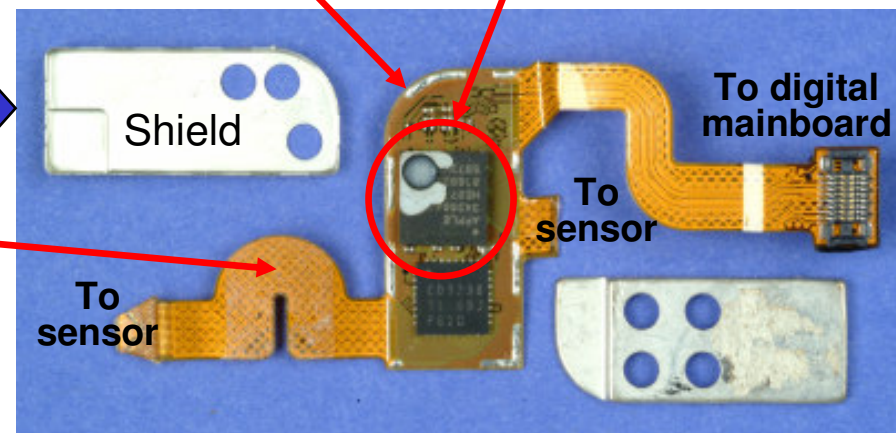
iPhone Touchscreen

Top surface (glass), sensor (glass) and LCD are laminated



NXP (Philips) ARM-7 DSP

Broadcom 1st-generation touchscreen controller



Photos courtesy of Portelligent (www.teardown.com)

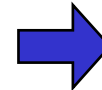


iPod Touch Touchscreen

Touch sensor
(glass) & top
surface (glass)
(laminated)

LCD (not
laminated)

Touch
sensor
cables



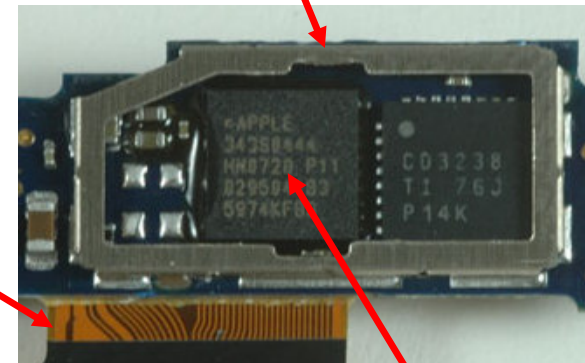
Battery

Touchscreen & WLAN
circuit boards (stacked)

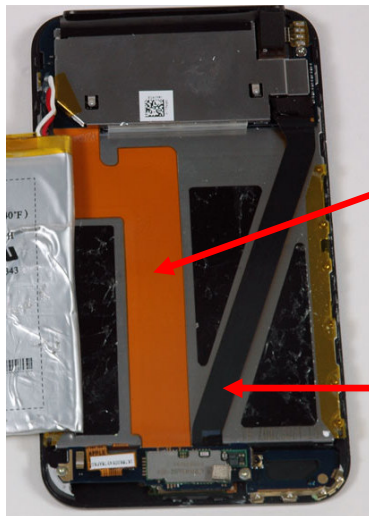


Touch-
screen
cable to
mainboard
(soldered)

LCD
cable



Broadcom 2nd-generation
touch controller (may include DSP)

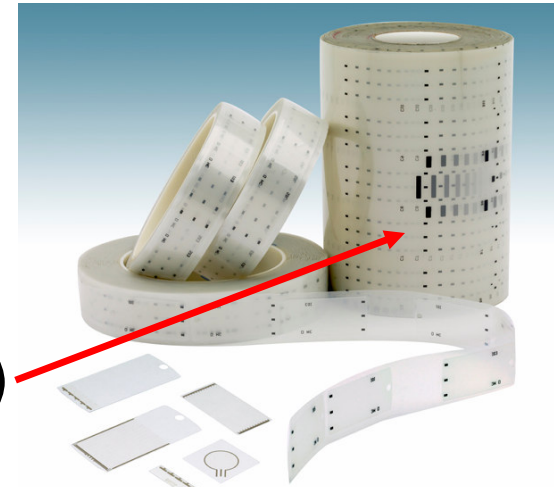


Photos courtesy of iFixit



Projected-Capacitive ITO Sensor Suppliers

- ❑ Balda/TPK/Optera – Apple iPhone
- ❑ Synaptics – LG Prada phone
- ❑ Wintek – Apple iPod touch ®
- ❑ 3M Flex Capacitive – shipping 750K sensors/month (roll-to-roll production)
- ❑ Sharp – Apple iPhone
- ❑ Optrex – Apple iPhone ®
- ❑ Innolux – building \$30M production facility (ship 1Q08?)
- ❑ Touch International – Verifone POS payment terminals
- ❑ N-trig (dual-mode touch & pen) – new Tablet PC (4Q)
- ❑ Others – e.g., Sony ® ...



Flex Capacitive photo courtesy of 3M

® = Rumor



Projected-Capacitive Controller Suppliers

- ❑ Broadcom – Apple iPhone & iPod touch
- ❑ Synaptics – LG Prada phone
- ❑ Wintek – unknown
- ❑ Elan Microelectronics – unknown (Innolux acquiring? ®)
- ❑ Cypress (PSoC) – unknown
- ❑ Quantum (QProx) – unknown ®
- ❑ N-trig (dual-mode touch & pen) – new Tablet PC (4Q)

Synaptics'
next-generation
phone concept
“Onyx”



® = Rumor



iSuppli's Forecast (6/07)

Total Market for Projected-Capacitive Touch

Projected Capacitive Touch Application/Market	2007 K Units	%	2009 K Units	%	2012 K Units	%
Mobile Phones	4,000	94.5	12,000	97.4	20,736	97.6
Retail	120	2.8	173	1.4	299	1.4
Industrial/Financial	35	0.9	46	0.4	69	0.3
Kiosk/POI	36	0.9	45	0.4	63	0.3
Medical/Healthcare	2	0	3	0	6	0.0
Other	40	0.9	48	0.4	64	0.3
Total Projected Capacitive	4,232	100%	12,315	100%	21,237	100%

1.5% market penetration

No impact outside of mobile phones

Touch Technologies in Mobile Phones

Mobile Phone Touch Technology	2007	2008	2009	2010	2011	2012
Projected Capacitive (M units)	4.0	10.0	12.0	14.4	17.3	20.7
	8%	17%	18%	19%	21%	23%
Resistive (M units)	46.0	49.0	54.3	58.2	62.0	65.7
	92%	82%	80%	78%	76%	73%
Other (M units)	0	1.0	1.5	2.0	2.8	3.8
	0%	1%	2%	3%	3%	4%
Total Mobile Phones with Touch	50M	60M	68M	75M	82M	90M

Resistive still dominant

6.5% market penetration

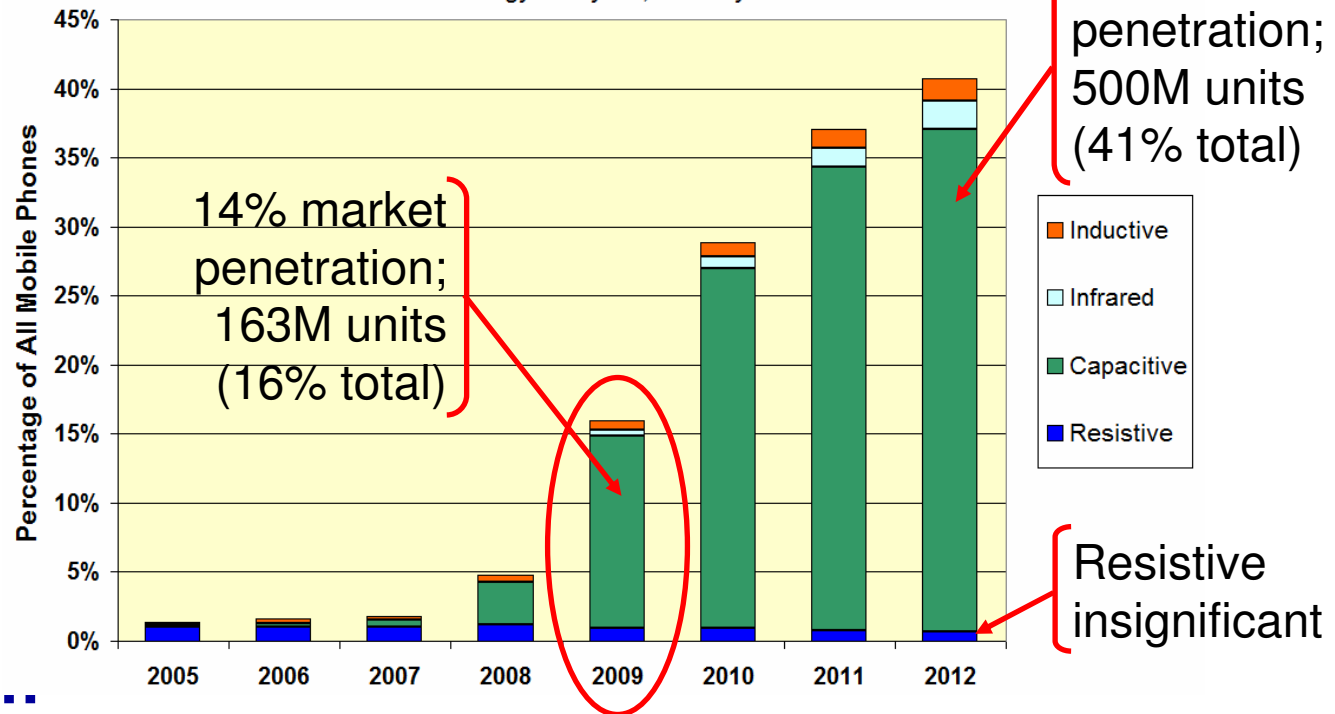
Forecast from iSuppli's "Touch Screens: The Right Touch for High Growth" report (2Q07)



Strategy Analytics' Forecast (1/07)

Penetration of Touch-Screen Technology into Mobile Phones

Source: Strategy Analytics, January



□ In 2009...

- ◆ 187M total touch-screen mobile phones (16% of all phones)
 - 163M (87%) will have capacitive touch-screens
 - ✓ Of the 163M, 115M (~70%) will be **touch-screen-only**, while 48M (~30%) will have both a **touch-screen and a keypad**



Walker Mobile's Forecast

Touch Technologies in Mobile Phones

Mobile Phone Touch Technology	2007	2008	2009
Projected Capacitive iPhone	3M	9M	18M
Top 5 OEMs	12M	25M	50M
Others	1M	2M	4M
Mobile Phones with Projected Capacitive	16M	36M	72M
Resistive	45M	50M	45M
Mobile Phones with Touch	61M	86M	117M
Percentage of Total Mobile Phones	5.8%	7.7%	9.9%

iSuppli
12M (1%)
vs.
Strategy
Analytics
163M (14%)

iSuppli 68M vs. Strategy Analytics 187M
(5.8%) (16%)



Why Just Mobile Phones?

- ❑ Walker Mobile predicts that projective-capacitive touch **will** penetrate other mobile devices (PND, PMP, PDA, MID, DSC, DVC, etc.)
 - ① Rapidly increasing number of suppliers
 - Few barriers to entry
 - ② Rapidly dropping cost
 - 3M's 2-inch, 2-layer PET sensor = \$2 to \$6, depending on volume
 - ③ Substantial user benefits
 - Very high durability (depending on the cover material)
 - No optical loss (longer battery life, higher contrast)
 - Multi-touch (depending on the controller)
 - ✗ User negatives
 - **No stylus**
 - ✓ This is the main reason resistive will maintain some market share, especially in Asia



In Closing...

- ❑ We've just barely scratched the surface of mobile touch
 - ◆ RPO's optical waveguide infrared touch (SID 2007)
 - ◆ Sharp's in-pixel light-sensing touch (sampling 9/07)
 - ◆ Samsung's in-pixel capacitive-sensing touch
 - ◆ Haptics in mobile displays
 - ◆ Mobile SAW from Fujitsu Labs
 - ◆ ITO-replacement materials
 - ◆ Increasing use of glass-glass resistive touch
 - ◆ Solutions for increased outdoor readability (hot topic!)
 - ◆ New touch start-ups – Integritouch, SiMa Systems, Stantum
 - ◆ N-trig's dual-mode pen & touch for Tablet PCs
 - ◆ And more...



Thank You!

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Appendix



Who Owns The IP?

- ❑ Does Apple own the IP on the use of projected capacitive with multi-touch on a mobile phone??
 - ◆ *The media seems to think so, but Walker Mobile doesn't!*
 - The form of projected capacitive that Apple is using has been in production by multiple companies for at least five years
 - Multi-touch was invented in the 1980s; the “pinch” gesture was in use long before the iPhone existed on paper
 - ◆ The touch-screen & gesture patents for which Apple has applied (but hasn't been granted yet) are largely a **PR exercise**



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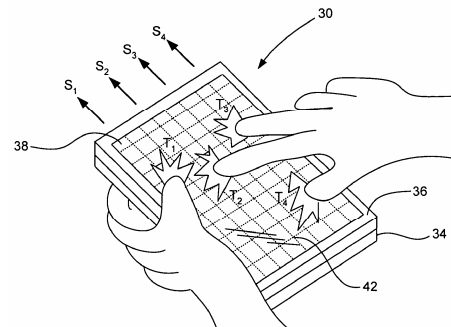
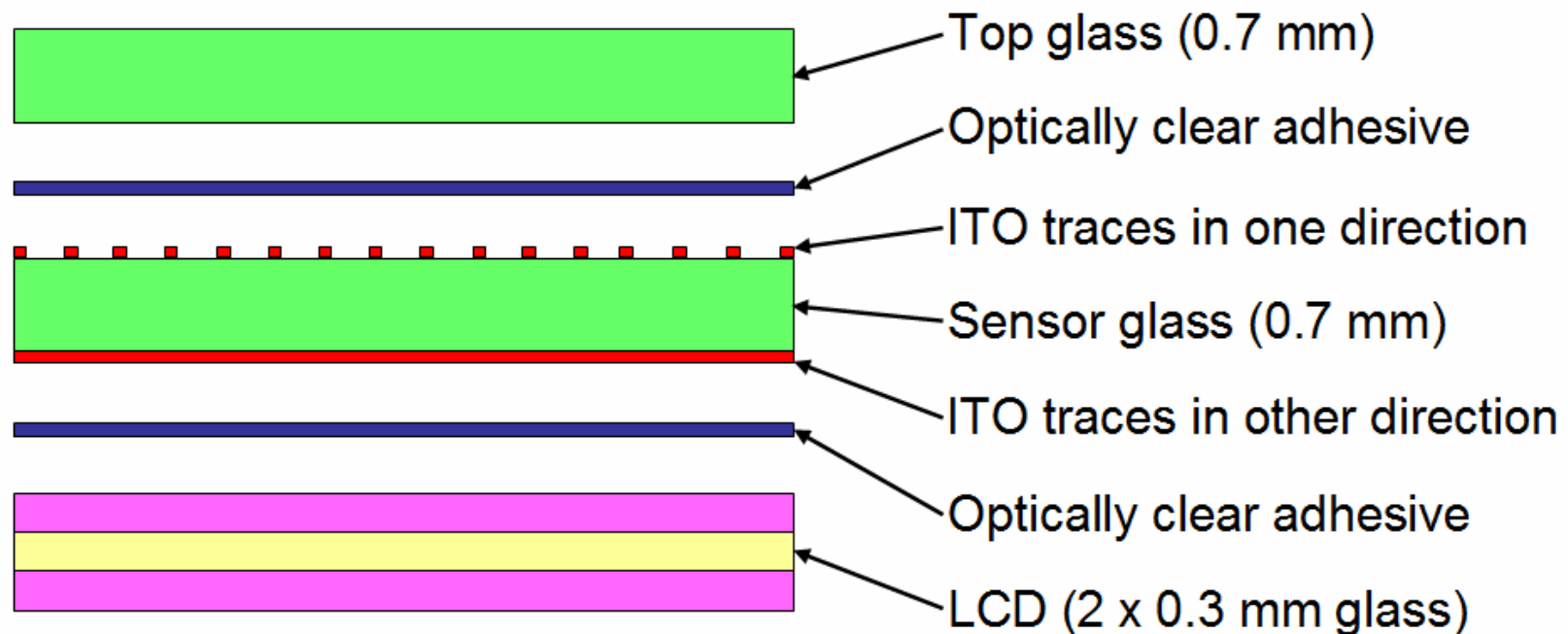


Illustration from Apple patent application



iPhone Touch Sensor Stack-Up



Measurements courtesy of Portelligent



Balda/TPK/Optera

