Selecting & Integrating Touchscreens

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Agenda

❑ Introduction (3)

❑ How the mainstream touch technologies work (13)

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❑ Conclusions (1)

When you see this racecar…

It means we're going to race through these 18 pages so we can cover 54 content pages in 45 minutes!

Included Touch Technologies

❏ **Mainstream (95% of 2007 units)**

   ✦ Analog resistive

   ✦ Surface capacitive

   ✦ Surface acoustic wave (SAW)

   ✦ Infrared (IR)

Excluded
Touch Technologies

❑ **Emerging (5% of 2007 units)**

✦ Projected capacitive (ITO-based & wire-based)

✦ Camera-based optical (e.g., from NextWindow)

✦ Acoustic pulse recognition (APR, from Elo)

✦ Dispersive signal technology (DST, from 3M)

✦ Waveguide infrared (from RPO)

✦ Force-sensing (from QSI)

✦ LCD in-cell (optical, capacitive & resistive, from LCD companies)

❑ **Other**

✦ Haptics (e.g., VibeTonz from Immersion, used in cellphones)

✦ Active digitizers (e.g., from Wacom, used in Tablet PCs)

✦ Opaque touch (e.g., from Cypress, used for control surfaces)

Touchscreen Market (2007)

Technology	2007					
	Mobile		Stationary		TOTAL	
	Revenue	Units	Revenue	Units	Revenue	Units
Resistive	$920M	75M	$440M	12M	$1,360M	87M
Surface capacitive	0	0	$150M	1.5M	$150M	1.5M
Surface acoustic wave	0	0	$80M	1.3M	$80M	1.3M
Infrared	0	0	$70M	0.8M	$70M	0.8M
Mainstream	**$920M**	**75M**	**$740M**	**15.6M**	**$1,660M**	**90.6M**
Emerging	$80M	4M	$70M	0.9M	$150M	4.9M
TOTAL	**$1,000M**	**79M**	**$810M**	**16.5M**	**$1,810M**	**95.5M**

	Revenue	Units
Mobile	55%	83%
Stationary	45%	17%
TOTAL	**100%**	**100%**

	Revenue	Units
Mainstream	92%	95%
Emerging	8%	5%
TOTAL	**100%**	**100%**

Market size estimates are based on iSuppli and Elo TouchSystems data

How the Mainstream Touch Technologies Work
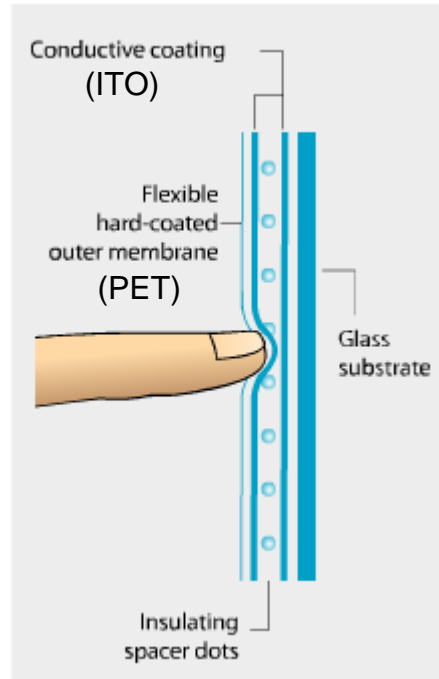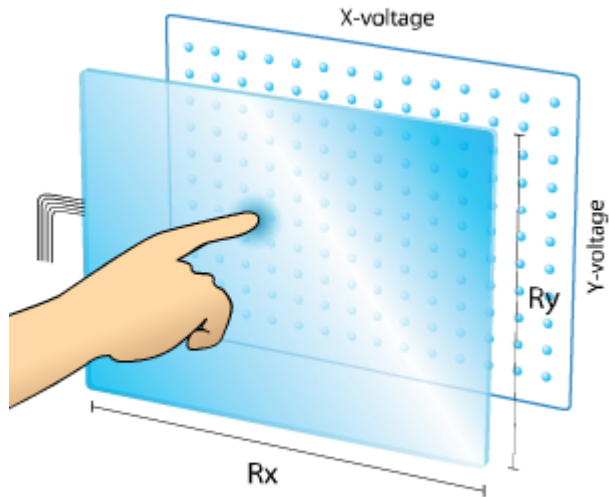
Photo courtesy of Engadget

Analog Resistive

Conductive coating (ITO)

Flexible hard-coated outer membrane (PET)

X-voltage

Y-voltage

Rx

Ry

Glass substrate

Insulating spacer dots

Illustrations courtesy of Elo TouchSystems

Illustration courtesy of Bergquist

Analog Resistive…2

❑ **Types**

✦ 4-wire (low cost, shorter life) is common in mobile devices

✦ 5-wire (higher cost, longer life) is common in stationary devices

❑ **Constructions**

✦ <u>PET + Glass</u> (previous illustration) is the most common

✦ <u>PET + PET</u> is the thinnest; sometimes used in cellphones

✦ <u>Glass + Glass</u> is the most durable; gaining share in automotive

✦ Film + film + PET, others…

❑ **Options**

✦ Surface treatments (AG, AR, AS), rugged substrate, dual-force touch, high-transmissivity, surface armoring, others…

Illustration courtesy of Schott

Analog Resistive…3

❑ **Size range**
  ✦ 2" to ~26"

❑ **Major applications**
  ✦ Mobile devices
  ✦ Point of sale (POS) terminals

❑ **2007 market share**
  ✦ 75% of revenue
  ✦ 91% of units

❑ **Selected suppliers**
  ✦ Elo TouchSystems, Fujitsu, Gunze, Touch International…
  ✦ 50+ suppliers worldwide
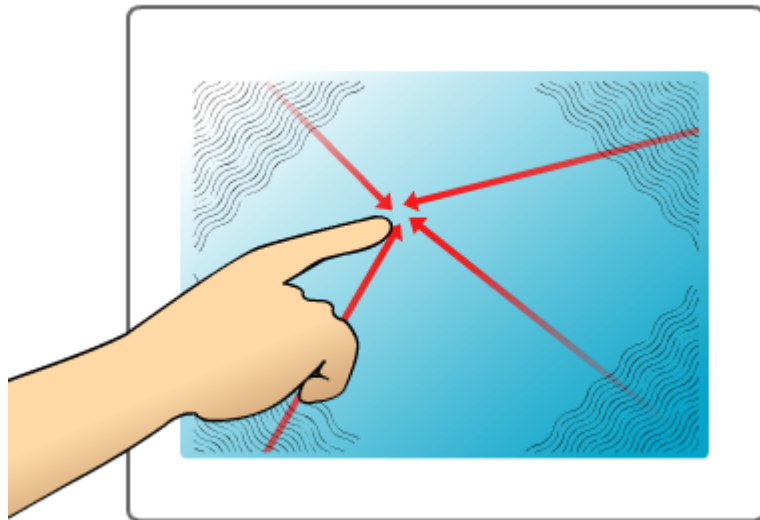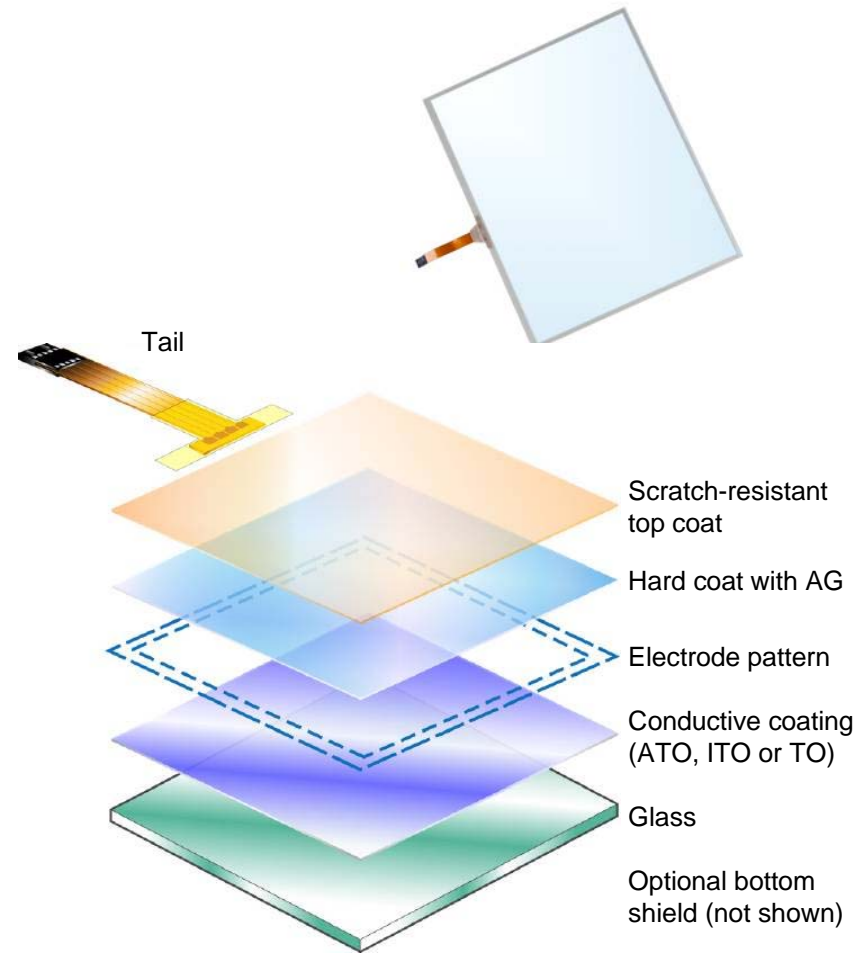
Illustration courtesy of 3M

Surface Capacitive

Tail

Scratch-resistant
top coat

Hard coat with AG

Electrode pattern

Conductive coating
(ATO, ITO or TO)

Glass

Optional bottom
shield (not shown)

Illustration courtesy of Elo TouchSystems

Illustrations courtesy of 3M

Surface Capacitive...2

- ❏ **Size range**
  - ✦ 6" to 32"
- ❏ **Major applications**
  - ✦ Gaming
  - ✦ Kiosks
  - ✦ ATMs
- ❏ **2007 market share**
  - ✦ 8% of revenue
  - ✦ 2% of units
- ❏ **Selected suppliers**
  - ✦ 3M, DigiTech, Elo TouchSystems
  - ✦ 16+ suppliers worldwide

Illustrations courtesy of 3M

Illustration courtesy of Kodak

Surface Acoustic Wave

Glass substrate

Y- axis transmitting transducer

Y- axis receiving transducer

X- axis receiving transducer

X- axis transmitting transducer

Edge of Active Area

Array of reflectors (45°)

Rayleigh wave
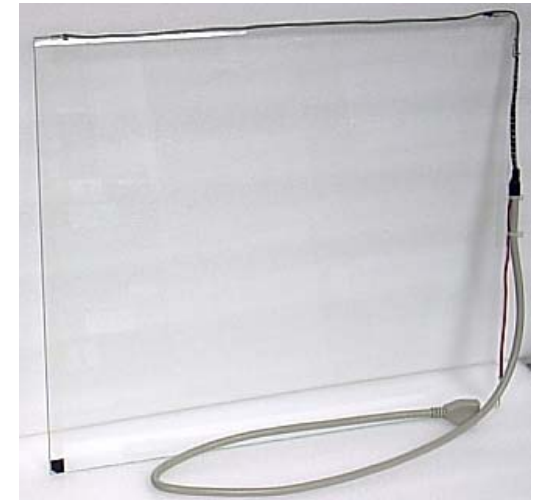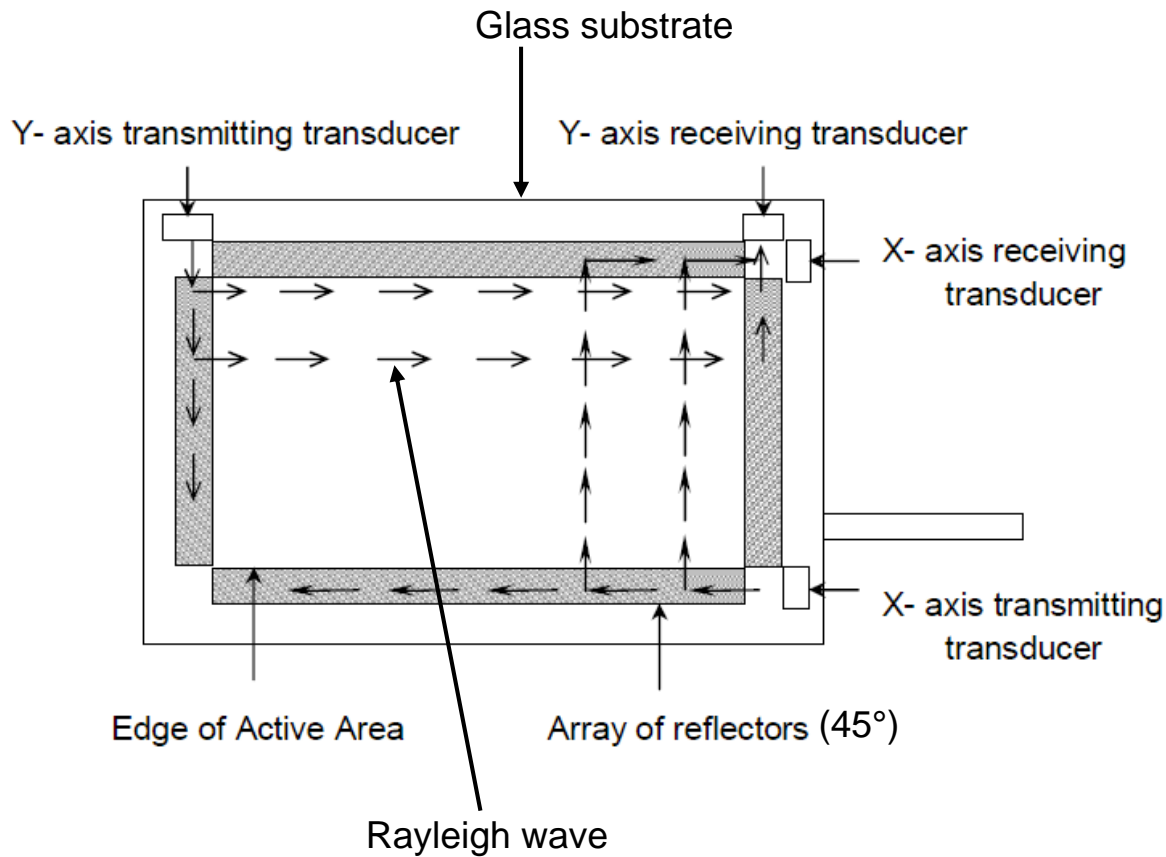
Illustrations courtesy of Onetouch (left) and A-Touch (right)

Surface Acoustic Wave…2

- ❑ **Size range**
  - ✦ 8" to 50"
- ❑ **Major applications**
  - ✦ Kiosks
  - ✦ Gaming & entertainment
- ❑ **2007 market share**
  - ✦ 4% of revenue
  - ✦ 1% of units
- ❑ **Selected suppliers**
  - ✦ Elo TouchSystems, General Touch
  - ✦ 10+ suppliers worldwide

Photo courtesy of Euro Kiosks Network

Infrared

Photo courtesy of IBM
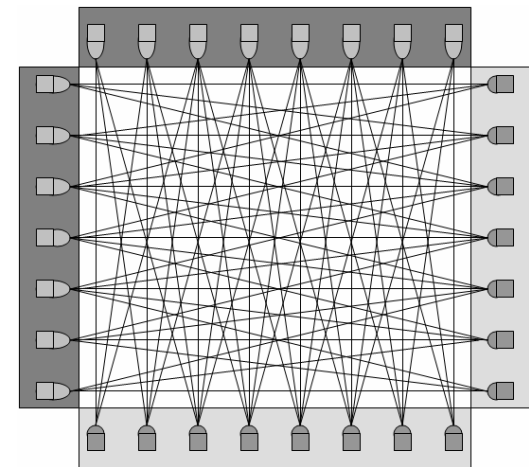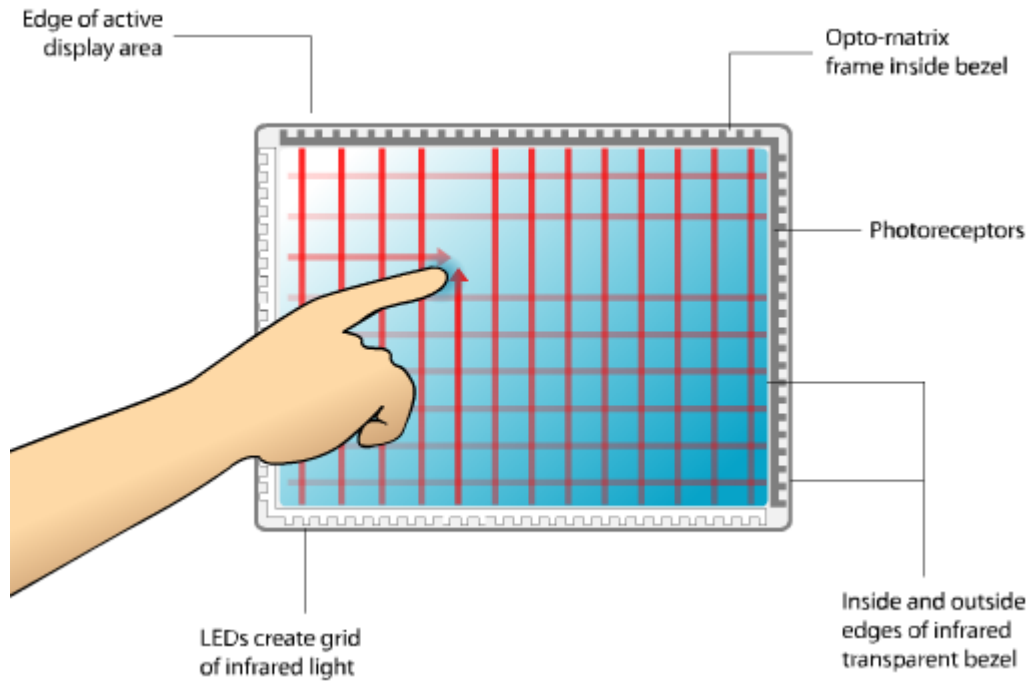
Illustrations courtesy of Elo TouchSystems

Infrared…2

- ❑ **Size range**
  - ✦ 8" to 150"
- ❑ **Major applications**
  - ✦ Kiosks
  - ✦ Point-of-sale
  - ✦ Large displays
- ❑ **2007 market share**
  - ✦ 4% of revenue
  - ✦ 1% of units
- ❑ **Selected suppliers**
  - ✦ Elo Touch, IR Touch
  - ✦ 16+ suppliers worldwide

50" plasma display with infrared touchscreen from Netrax

How to Select a Mainstream Touch Technology

Methodology

❑ Focus on **functionality & characteristics** rather than technical product specifications

✦ User interaction with the touch application is the key factor

❑ Select the technology based on usage, application and environmental needs, with the realization that…

> *There's no perfect touch technology that meets all requirements*

Input Models

❏ **Finger-only**
- ✦ Use for selecting large features with finger
- ✦ Usage with gloves must be considered

❏ **Finger + available objects**
- ✦ Use for selecting large or small features with many common objects used as a "stylus"

❏ **Stylus-only**
- ✦ Use for selecting small features with a stylus and for other functions such as handwriting recognition
- ✦ A special stylus may or may not be acceptable
- ✦ Palm rejection is advantageous
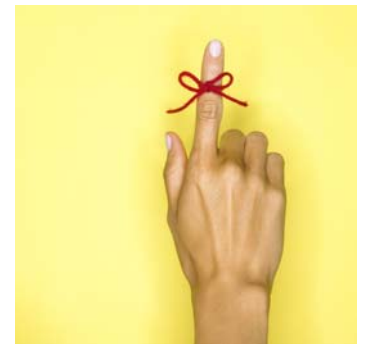
Optional-Use Applications

- ❏ **Kiosks**
  - ✦ Point-of-information (POI)
  - ✦ Merchandising
  - ✦ Tourism & museums
  - ✦ Gift registries
  - ✦ Digital photo printing
- ❏ **Ticketing & vending**
- ❏ **Financial**
- ❏ **Transportation**
- ❏ **Gaming & amusement**

- ❏ **Telecommunication**
  - ✦ Web phones
  - ✦ Internet terminals
- ❏ **Outdoor**
  - ✦ Gas pumps
  - ✦ ATMs
  - ✦ Outdoor vending machines
  - ✦ Store window applications

Required-Use Applications

- ❑ **Point-of-sale (POS)**
    - ✦ Restaurants
    - ✦ Hospitality
    - ✦ Post offices
- ❑ **Industrial/process control**
- ❑ **Medical equipment**
- ❑ **Office equipment**
    - ✦ Time clocks
    - ✦ Copiers
- ❑ **Retail**
- ❑ **Automotive**
    - ✦ Navigation
    - ✦ Diagnostic systems
- ❑ **Personal mobile device**

Photo courtesy of Engadget

Some Examples of Market Needs

❑ General

- ✦ Easy employee training
- ✦ Fast, simple transactions
- ✦ Rugged, durable, reliable
- ✦ Watertight seal
- ✦ Small footprint & floor space

❑ POS

- ✦ Any stylus (credit card, fingernail,etc.)
- ✦ Works when wet

❑ Medical

- ✦ Gloves
- ✦ Easy to sterilize

❑ Industrial

- ✦ Gloves
- ✦ Fast alarm acknowledgements
- ✦ Wash-down
- ✦ Specific agency approvals
  - ● NEMA 4; IP 65
    - ✔ High-pressure hose
  - ● NEMA 12: IP54
    - ✔ Dust-proof, splash-proof
  - ● Factory Mutual (FM)
    - ✔ Intrinsically safe
- ✦ No glass in food processing

Functionality & Characteristics

- Ambient light sensitivity
- Calibration stability
- Controller chip
- Cost
- Curved substrate
- Debris/contamination
- Design
- Drag performance
- Durability
- Ease of integration
- Flush surface
- Handwriting recognition
- HID interface
- Hover

- Lifetime/MTBF
- Mobile/handheld
- Multi-touch
- Non-glass substrate
- Object size recognition
- Optical clarity
- Reliable light touch
- Scratch resistance
- Sealability
- Screen size
- Stylus independence
- Vandal resistance
- Weather resistance
- Z-axis measurement

Anticipate undiscovered needs!

Characteristics & Scoring...1

Characteristic	Resistive (4-wire)	Resistive (5-wire)	Surface Capacitive	Surface Acoustic Wave	Infrared
Ambient light sensitivity	5	5	5	5	3
Calibration stabilty	2	4	3	5	5
Controller chip	5	5	5	5	5
Cost	5	5	3	3	1
Flexible substrate	0	0	0	0	0
Debris/contamination	5	5	4	1	2
Drag performance	3	3	5	2	3
Durability	1	3	4	5	5
Ease of integration	5	5	1	3	3
Handwriting recognition	4	4	1	1	1
Hover	0	0	0	0	3
Lifetime/MTBF	2	3	4	5	4
Mobile/handheld use	5	3	0	0	0

0 = Not applicable
1 = Least appropriate
5 = Most appropriate

✦ *Weight & rank based on relevance to the application*

✦ *There will be trade-offs!*

WALKER MOBILE

0 = Not applicable
1 = Least appropriate
5 = Most appropriate

Characteristic	Resistive (4-wire)	Resistive (5-wire)	Surface Capacitive	Surface Acoustic Wave	Infrared
Multi-touch	0	0	0	4	5
Non-glass substrate	2	2	0	0	5
Optical clarity	1	1	3	5	5
Reliable light touch	3	3	4	2	5
Scratch resistance	1	3	2	5	5
Sealability	4	4	4	2	5
Size >50"	0	0	0	3	5
Size 30" - 50"	0	0	1	4	4
Size 12" - 28"	3	4	5	5	5
Size 2" - 10"	5	3	2	2	1
Stylus flexibility	4	4	1	3	4
Vandal resistance	1	3	4	5	5

✦ *Weight & rank based on relevance to the application*

✦ *There will be trade-offs!*

4 & 5-Wire Resistive…1

❑ **Advantages**

✦ Size range:
- 4-wire: 2" – 15"
- 5-wire: 6" – 26"

✦ Can be activated with any device or stylus

✦ Highly resistant to screen contaminates

✦ Sealability (NEMA)

✦ Low power-consumption (4-wire)

✦ Multiple vendors for screen, controller & chip solution

✦ Lowest-cost solution (4-wire)
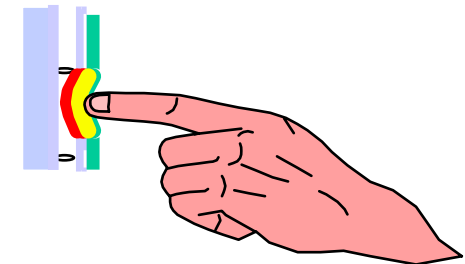
4 & 5-Wire Resistive…2

❑ **Considerations**

✦ More widely used than any other touch technology

✦ Lower durability compared to other technologies, especially considering cosmetic wear

✦ Poorer transmittance and overall optical quality due to plastic overlay and multiple layers

✦ May require periodic recalibration (4-wire)
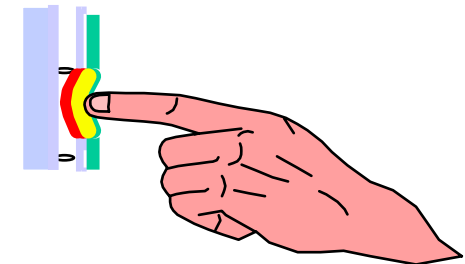
Surface Capacitive

❏ **Advantages**

- ✦ Size range: 6" - 32"
- ✦ More durable than resistive (no PET)
- ✦ Higher light transmission than resistive (fewer layers)
- ✦ Highly sensitive (touch & drag)
- ✦ Liquids & common contaminants don't impede performance

❏ **Considerations**

- ✦ Accepts input only from finger (or a tethered conductive stylus)
- ✦ Susceptible to electromagnetic interference (EMI)
- ✦ Accuracy may be affected by environment
- ✦ May require periodic calibration
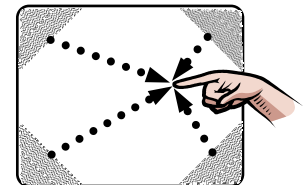
Surface Acoustic Wave (SAW)

❑ Advantages

- ✦ Size range: 8" to 50"
- ✦ Very high transmittance
- ✦ Very high durability
  - ● No wear mechanism; functions even with scratches
- ✦ Finger, gloved hand or soft stylus activation
- ✦ Available with tempered or chemically strengthened (CS) glass

❑ Considerations

- ✦ Sealing is challenging
- ✦ Requires "soft" input device
- ✦ Surface obstructions or water can cause a false touch
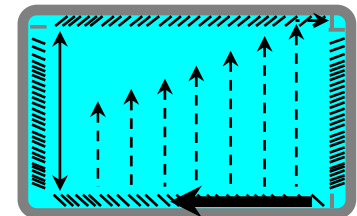
Infrared (IR)

❏ Advantages

- ✦ Size range: 8" to 150"
- ✦ Can be activated with almost any device
- ✦ Very high transmittance
- ✦ Very high durability
  - No wear mechanism
- ✦ Sealability (NEMA)
- ✦ With acrylic substrate, sole solution for glass-free applications

❏ Considerations

- ✦ Lower resolution than other technologies
- ✦ Surface obstructions or "hover" can cause a false touch
- ✦ Industrial design (bulkiest bezel)
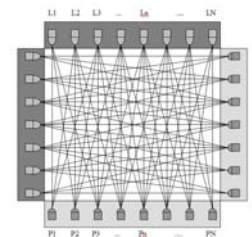
Summary

❑ Know your users

❑ Weight & rank touch technology characteristics based on their relevance in the application

❑ Understand the trade-offs

❑ Recognize that touch technology is constantly changing – what a vendor said last year may not be true today

Customization & Integration

Custom vs. Standard

❑ **Standard products**

✦ Off-the-shelf, inventory part number

✦ No NRE (Non-Recurring Engineering) fees

✦ Low or no minimum quantity requirements

✦ Less expensive on a per unit basis

❑ **Custom products**

✦ Customer-specific request

● *Purchaser bears responsibility for defining requirements*

✦ Longer leadtimes

✦ NRE fees can range from $2,000 - $10,000 (supplier-dependent)

✦ Minimum quantities often required

✦ Typically more expensive on a per-unit basis

✦ Single-source limitation

✦ Ownership and control

General Considerations

❑ **For any touchscreen**

(Includes resistive, surface capacitive,
projected capacitive & surface acoustic wave)

✦ Cable exit location

✦ Cable length

✦ Size and aspect ratio
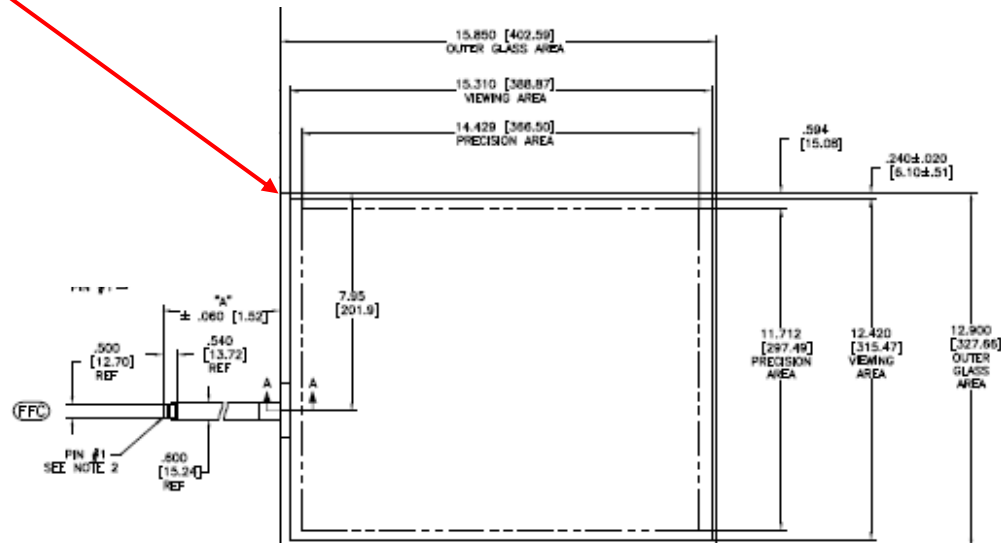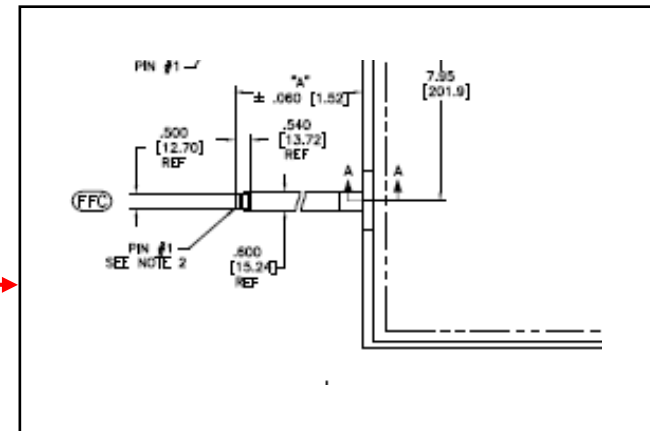
Custom Product Specifics…1

❏ **Resistive**

✦ EMI shielding

✦ Gaskets

✦ Graphics

✦ Palm rejection

✦ Extended touch life

✦ Membrane switches

✦ High light transmission

✦ Product differentiation

- Branding, logos, company colors, etc.

Custom Product

Resistive ITO films on top sheet and bottom layer

PET topsheet

Adjust spacer dots to accommodate palm rejection

Glass substrate

Finger or stylus flexes top sheet to make electrical contact

Spacer dots

Spacers along edges
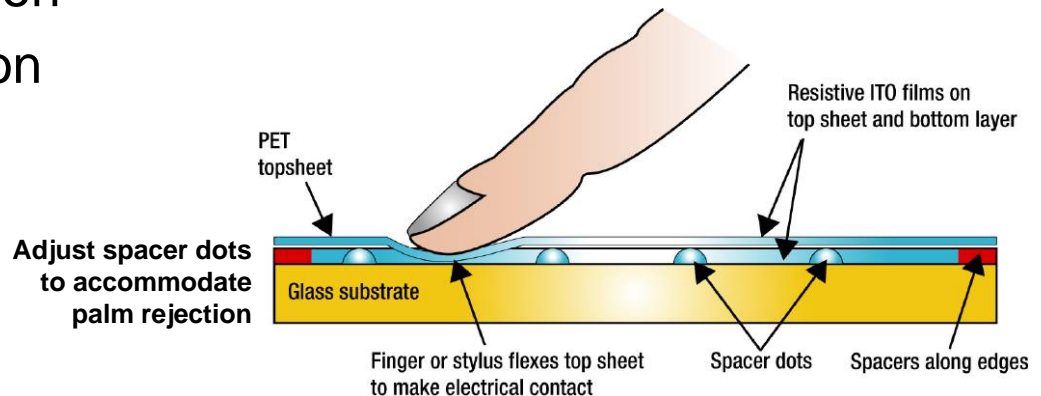
Custom Product Specifics…2

❑ **Resistive** *(continued)*
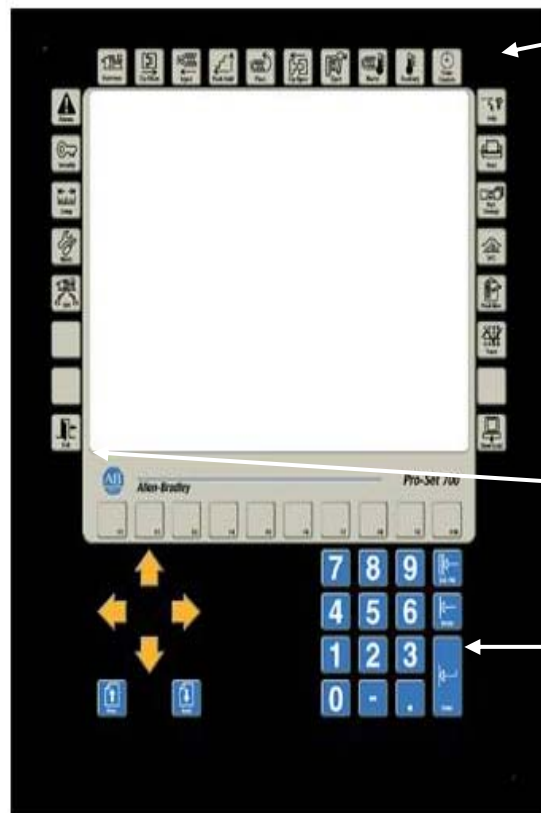
Silk-screened graphics

Brand with logos or product names

Membrane switches
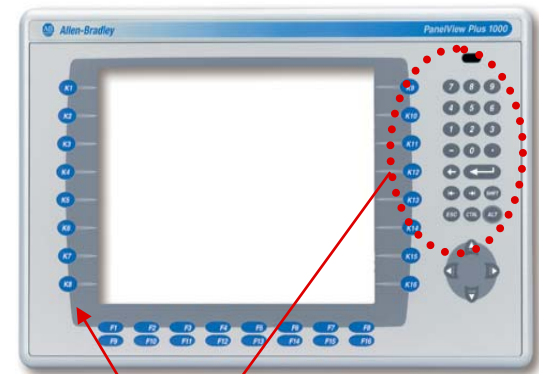
Discrete switches

Custom Product Specifics…3

❑ **Surface capacitive**

✦ Impact resistant

✦ Privacy viewing

✦ Tethered pen

✦ Rear shield

✦ Anti-glare (AG) coating

Impact resistant
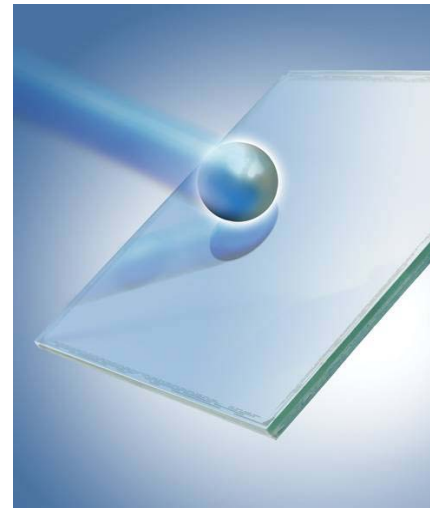
Laminated privacy film
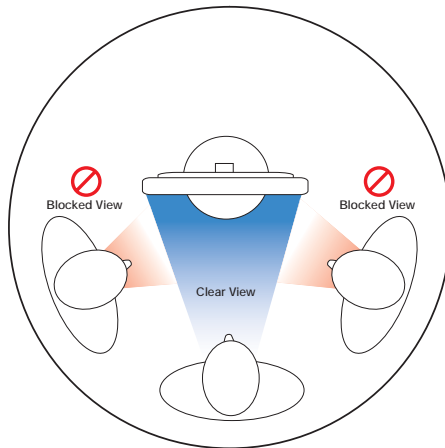
Tethered pen
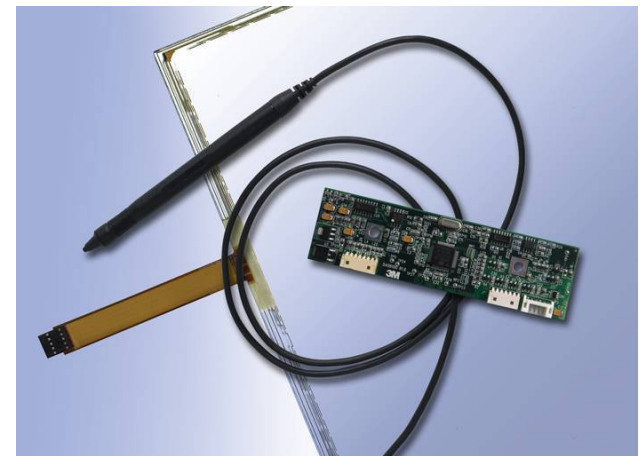
Custom Product Specifics…4

❑ **Surface acoustic wave**
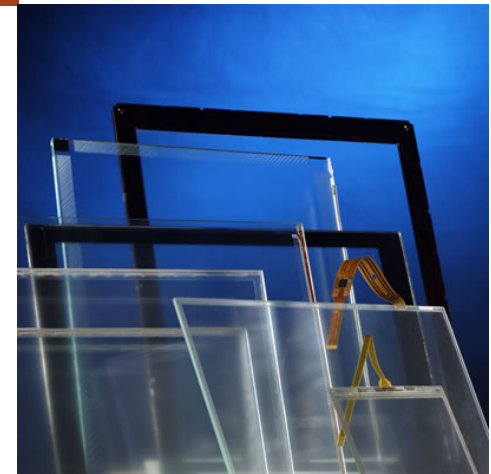
✦ Ruggedized

✦ Privacy viewing

✦ Special coatings

Laminated privacy film

Blocked View   Blocked View

Clear View
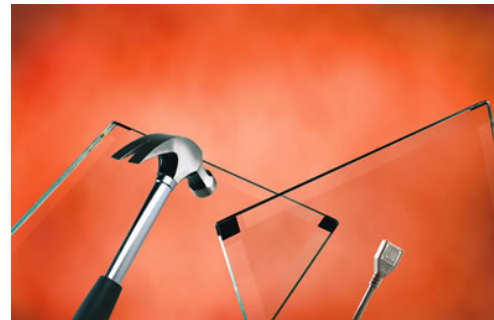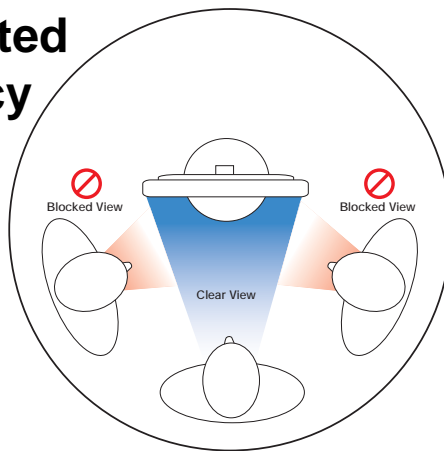
Ruggedized touch

➡ Tempering

➡ Chemical strengthening

Custom Product Specifics…5

❑ **Infrared**

✦ Ruggedized

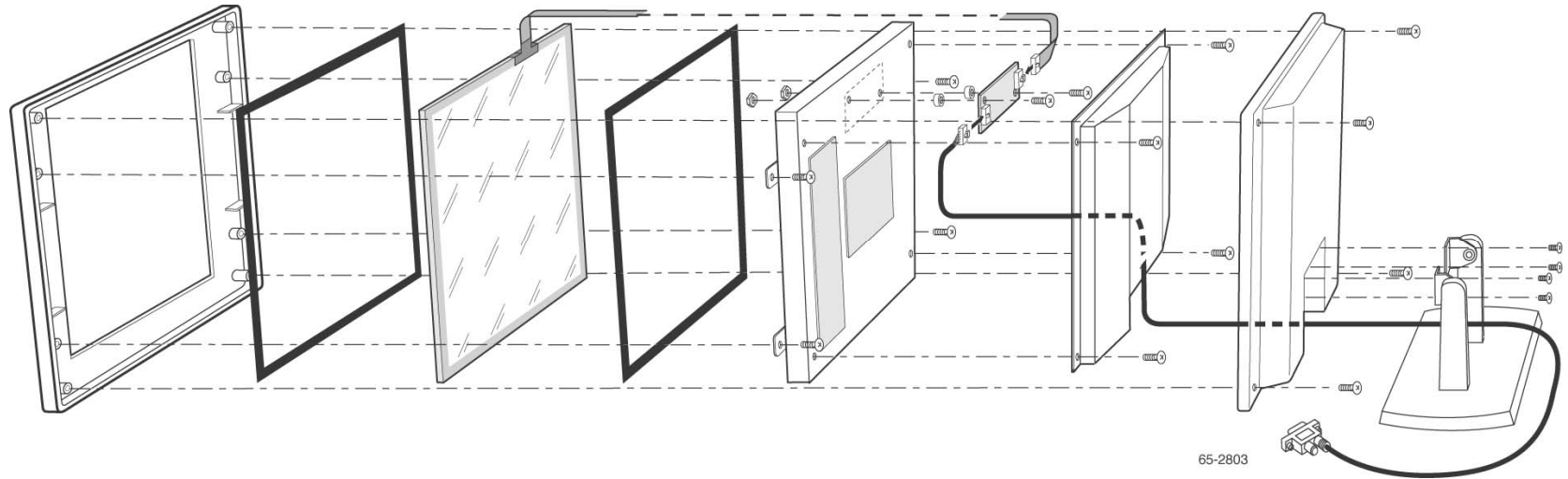✦ Sunlight immunity

✦ The "Grasshopper Problem"

Integration

Touch system includes touch sensor, controller and software
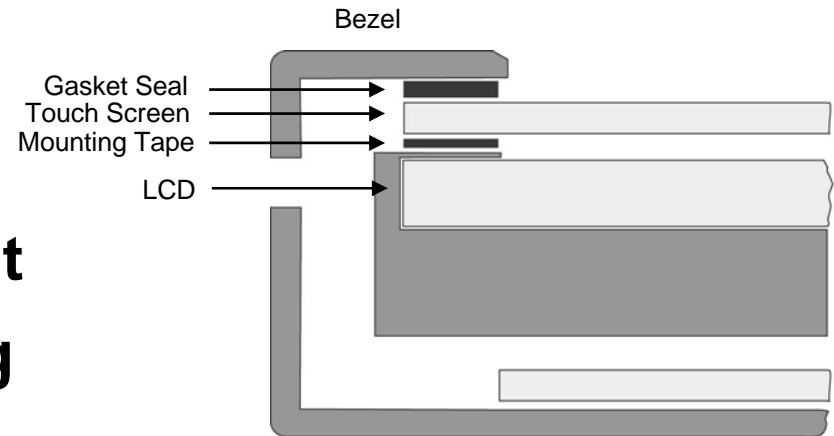
Sensor and controller
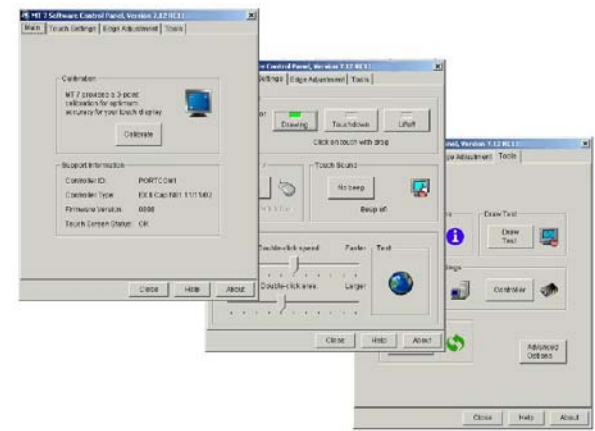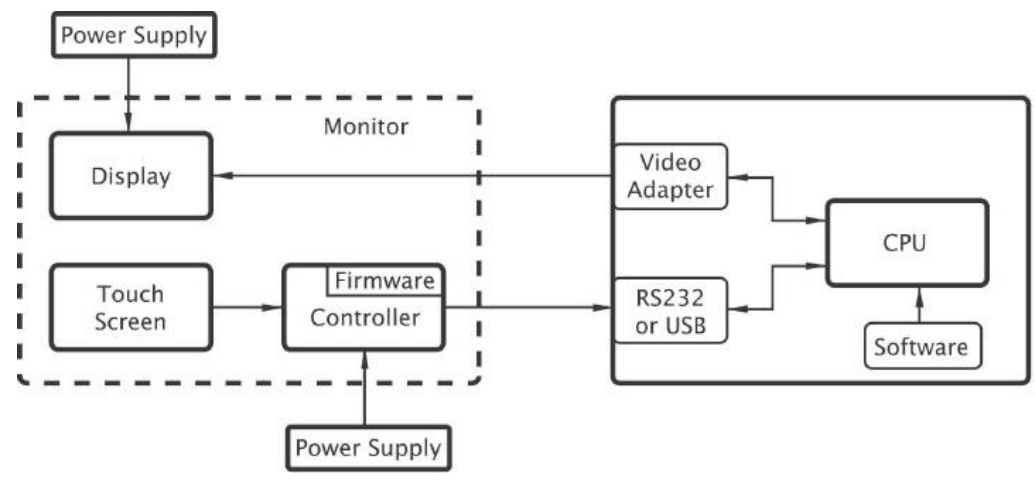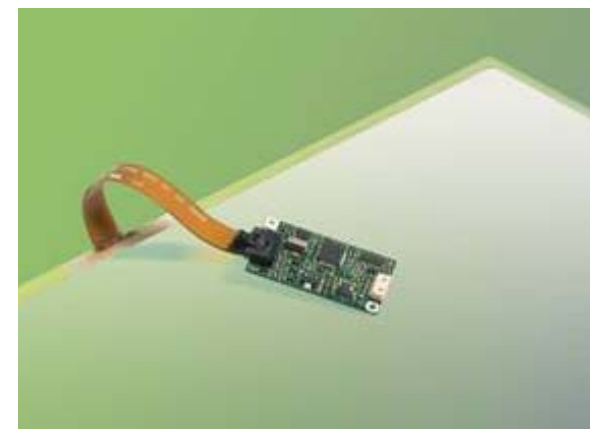
Software drivers
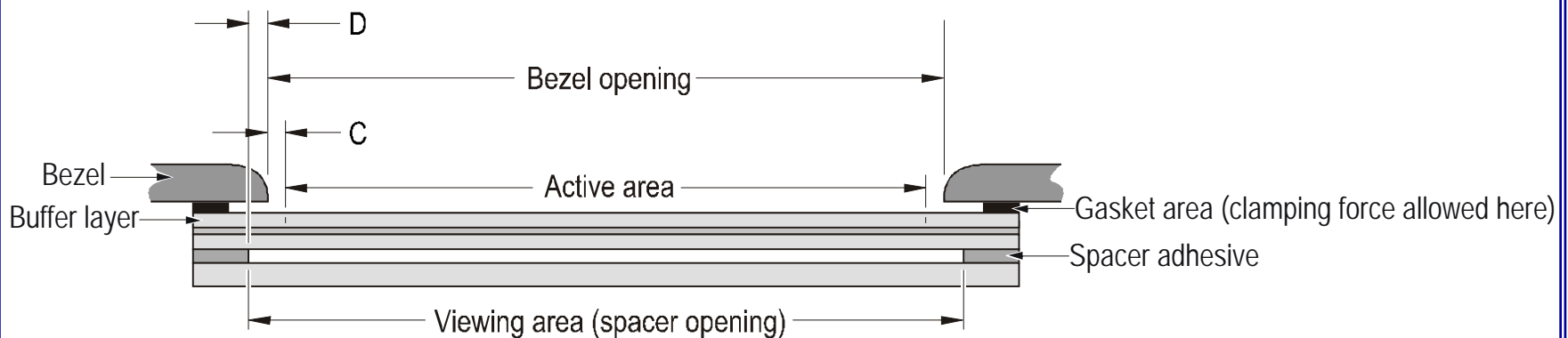
Substrate Technology Integration Basics

65-2803

❏ **Touch screen fit**

❏ **Gasket seal**

❏ **Touchscreen alignment**

❏ **Touchscreen mounting**

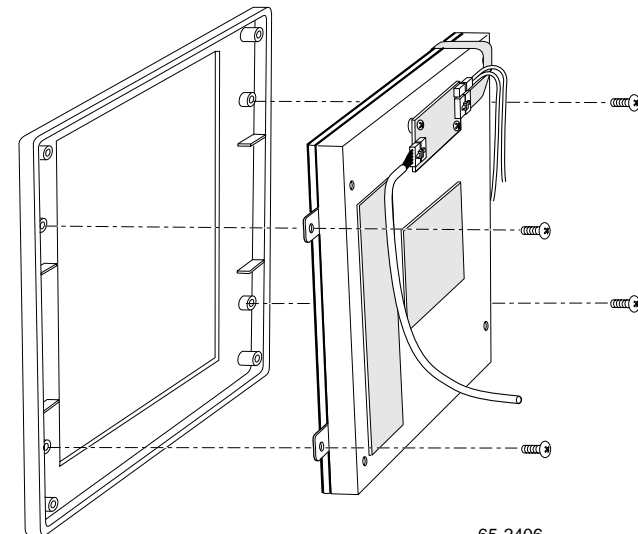Bezel

Gasket Seal
Touch Screen
Mounting Tape

LCD

65-2814

Sample Resistive Integration Considerations

❑ Alignment or registration of the bezel and gasket to the touchscreen is critical

❑ Bezel pressure exerted on the active area of the touch screen causes a constant-touch condition

  ✦ Apply gasket material to the non-active portion of the touchscreen to guard against false touch activation

D

Bezel opening

C

Bezel

Buffer layer

Active area

Gasket area (clamping force allowed here)

Spacer adhesive

Viewing area (spacer opening)

Sample Surface Capacitive Integration Considerations

❑ For touchscreens without a rear shield, ensure that the touchscreen is fixed into position and has no movement

❑ Metal bezel (includes bezels with conductive paint)

✦ Ensure that the bezel is secure and does not move

✦ Ensure that the bezel is grounded

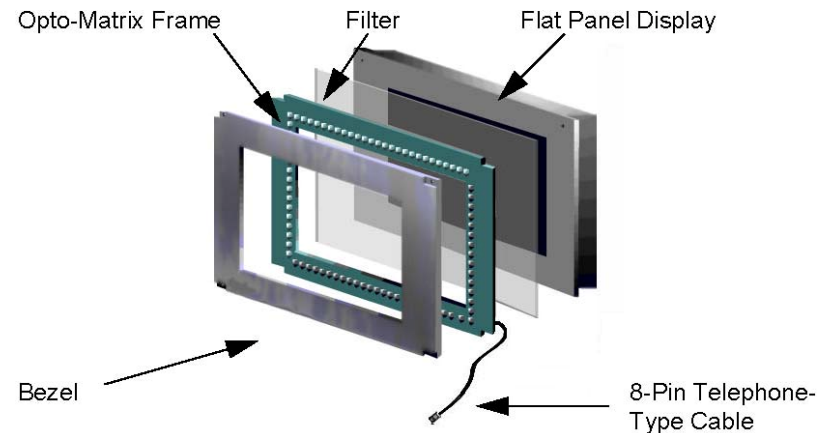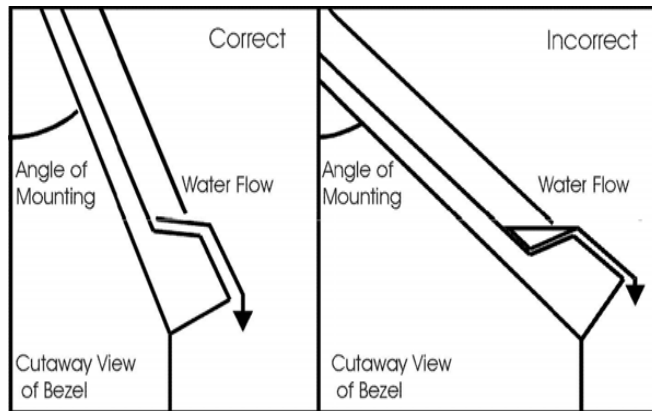✦ Ensure that the bezel does not come into direct contact with the touchscreen

65-2406

Sample SAW Integration Considerations

❑ Ensure there is sufficient room in the display to allow for the piezoelectric transducers and wires

❑ Bezel to touchscreen sealing

✦ Select a gasket material that will not attenuate the SAW signal (e.g., a closed-cell polyolefin-based foam)

✦ Position the gasket material within the active area of the touchscreen

✦ The gasket material should not contact the reflector array border pattern

✦ Bezel pressure exerted on the active area of the touchscreen may affect performance
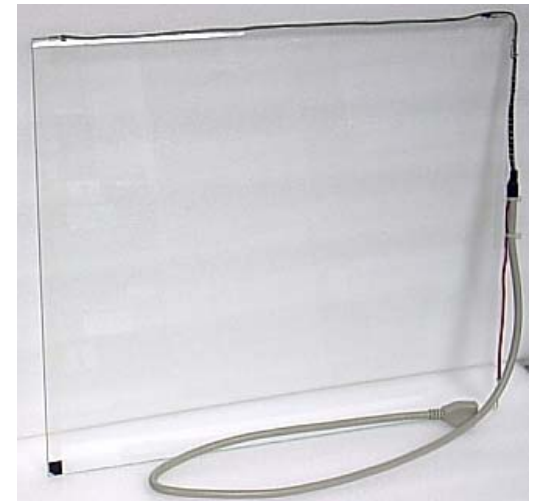
Sample Infrared Integration Considerations

❏ Mount the infrared bezel assembly at an angle to prevent liquid collection

❏ Select the bezel-sealing material to avoid particulate buildup on the IR LEDs and phototransistors
   ✦ Polyester, urethane and silicone are recommended

Correct | Incorrect

Angle of Mounting | Water Flow | Angle of Mounting | Water Flow

Cutaway View of Bezel | Cutaway View of Bezel

Opto-Matrix Frame | Filter | Flat Panel Display

Bezel

8-Pin Telephone-Type Cable

Controller vs. Chipset Considerations

❑ Chipset

- ✦ Longer design and qualification cycle
- ✦ Design flexibility
- ✦ Extended support requirements
- ✦ Supply-chain management
- ✦ Cost-effective solution
- ✦ Reduced space requirement
- ✦ Minimum order requirements

❑ Controller board

- ✦ Shorter design and qualification cycle
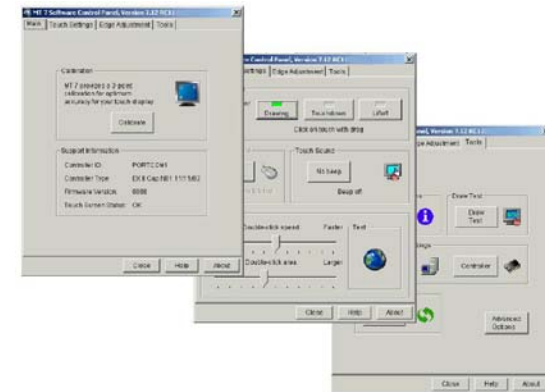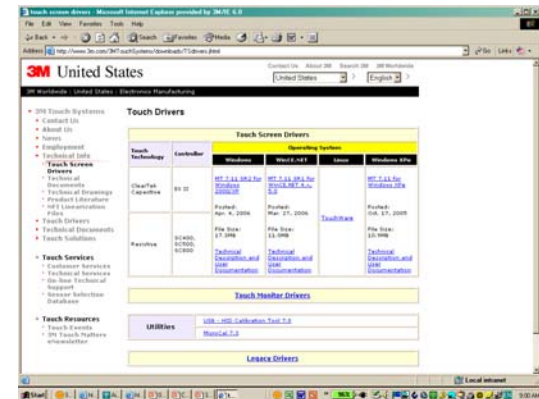- ✦ Complete touch solution
- ✦ Proven field usage

Software

- ❏ **Touchscreen software drivers**
  - ✦ Windows 2000, XP, Vista, XPe, CE
  - ✦ Linux support
  - ✦ Custom
- ❏ **Control panel**
- ❏ **Calibration**
- ❏ **Utilities and diagnostic tools**

Summary

❑ Custom vs. standard product selection

❑ Consider the complete touch system

❑ Understand the relationship between product specifications and integration requirements

❑ Look at the total cost of ownership
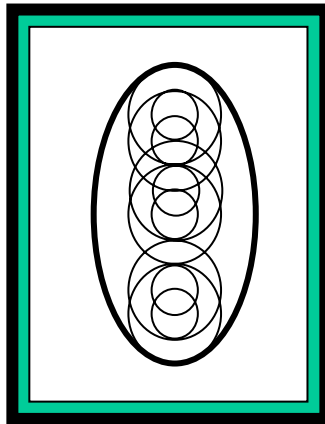
Testing Plans & Methods

Testing Plans & Methods…1

❑ **Reference:** The usage-model you developed initially

✦ Form & methods of interaction

✦ Use environment

❑ **Test model**

✦ Component & system test

❑ **Test parameters**

✦ Normal & extreme use conditions

❑ **Test development**

✦ Experience, vendor information & customer expectations

❑ **Test environment**

✦ Lab testing vs. real-world testing

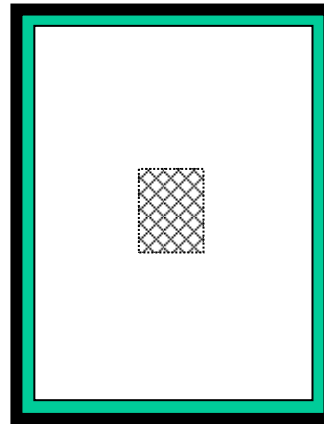✦ Replicate user interactions, including error & illogical states

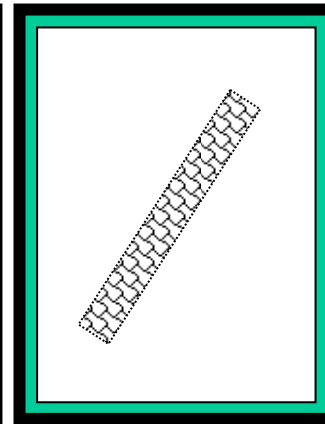# Testing Plans & Methods…2

❑ **Testing: Resistive**

✦ Signature-capture

✦ Edge-scrolling performance

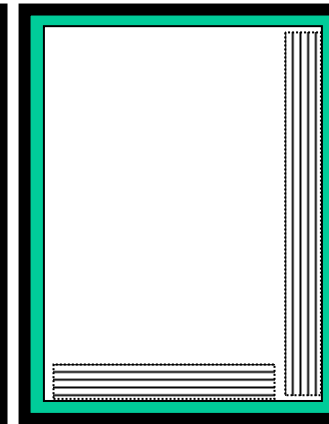✦ Surface wear (Taber wheel, Mohs pick)

Overlapping Circles   Character Writing   Signature Simulation   Edge Sliding

Testing Plans & Methods…3

❑ **Testing: Surface capacitive**
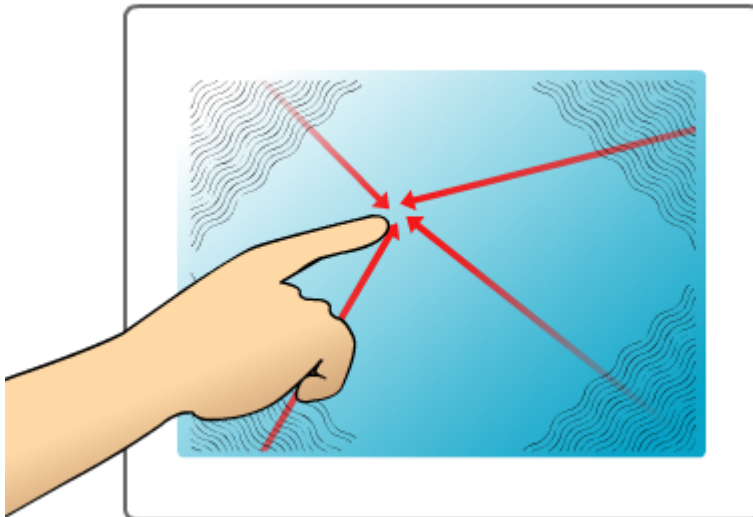
✦ Positive actuation

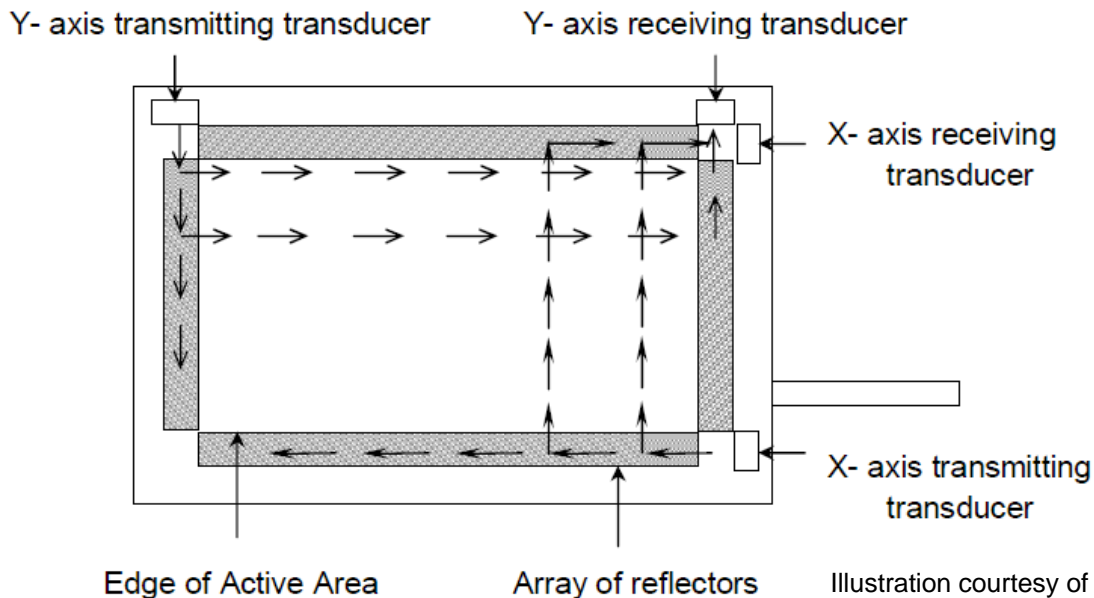✦ Surface wear (Mohs pick)

Illustration courtesy of Elo TouchSystems

Illustration courtesy of 3M

Testing: Surface acoustic wave

- Sealed applications need to be tested for compression effects
- Use OEM diagnostic tools to test and optimize performance

Y- axis transmitting transducer   Y- axis receiving transducer

X- axis receiving transducer

X- axis transmitting transducer

Edge of Active Area   Array of reflectors   Illustration courtesy of Onetouch

❑ Testing: Infrared

✦ Use OEM diagnostic tools to test beam interaction
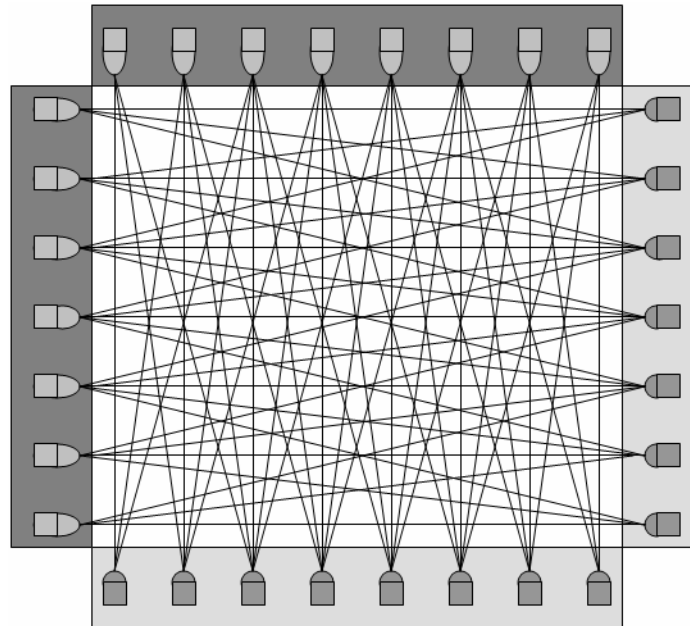

Illustration courtesy of Elo TouchSystems

Purchasing Components

Purchasing Components…1

❑ **Establish your needs**

  ✦ Estimated annual usage (EAU)

  ✦ Schedule steps: Prototype (EVT), DVT, pilot (PVT), production

❑ **Purchasing route:** Who's buying your parts?

  ✦ OEM, integrator, VAD, CM/CEM

❑ **Identify purchasing locations for each step**

❑ **Quantification**

  ✦ Establish economic purchase quantities

  ✦ Identify needs for each phase and best purchasing route

Purchasing Components…2

❑ **Common purchasing issues**

✦ Which path? OEM-direct, distribution, or other

✦ Longevity of supply: Custom vs. standard

✦ Risk issues

❑ **Vendor qualification**

✦ Location, integrator support, vendor support, financials, RMAs, References, documentation, enhancements, failure rate, etc.

Conclusions

Avoiding Mistakes

- ❑ Know your user: *The most critical item*
- ❑ Design is a team effort: ID, EE, ME, SW, Support
- ❑ Test for the unexpected: Your users will…
- ❑ Test the whole design: HW, SW, UI, ease of use
- ❑ Test the system: Timely response to input is crucial
- ❑ Set customer expectation level: No surprises
- ❑ Warranty support vs. product life: Understand it
- ❑ Serviceability: Has to be designed in from the start
- ❑ Customer applications: Training and support are key
- ❑ Expect the unexpected: Be prepared
- ❑ Touch is always evolving: Keep informed

Thank You!