Resistive Touch Screen for Sunlight Readability

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There are many touchscreen technologies available in the market today. Truly sunlight readable touchscreens are not many. They are IR (infrared) touchscreen and SAW (surface acoustic wave) touchscreen. The principle operation of these two touchscreens are that IR touchscreen relies on infrared and SAW touchscreen relies on surface acoustic wave. Both touchscreens have no optical layer overlay on the display surface; therefore there is nothing between your eyes and the display elements. These two touchscreens, however, have drawbacks. See Table 1, page 3 for advantages and disadvantages. On the other hand, resistive touchscreen is most popular for indoor applications because of low-cost and high resolution and can use a pointed stylus for drawing fine lines. This write-up addresses the problems of resistive touchscreen for sunlight readability and methods to overcome these problems optically by examining its current technologies and means of improving its structure for sunlight readability.

Review Current Resistive Touchscreen Technology

Figure 1 is the glass-to-film, low-cost touchscreen. The two resistive layers of ITO (indium tin oxide) sandwiched together and separated by a ridged layer. This ridged layer reduces light transmission and optical clarity of the touchscreen. The film surface is prone to damage from scratches. Most current ITO layer design is around 15 angstrom thickness and has a resistance of 20 ohm/sq with an index of refraction of 2.0. In Figure 1, there are 5 interfaces marked asterisks. The upper most asterisk is the air to film interface, next is the ITO to ridged layer interface and so forth. These five interfaces create five layers of reflections. These reflections are undesirable for sunlight readability

Figure 2 is the glass-to-glass touchscreen and is an improvement of Figure 1. Notably is the replacement of the film by a glass layer. These provide two improvements. One, the top glass surface is more rugged for providing better scratches and chemicals resistant. As you can see, the improvements still have five interfaces marked with asterisks, which create five layers of undesirable reflections.

New Improved Resistive Touchscreen

Figure 3 is an improved glass-to-glass touchscreen of Figure 2. Figure 3 provides two important improvements. One is an anti-reflective and hydrophobic coating, which are deposited on the front surface, that facing the viewer. This layer provides an anti-reflective coating to minimize the reflection of the sun ray and the hydrophobic coating provides anti-finger print. Second improvement is to provide index matched ITO in two ITO layers. See Figure 3. The standard ITO has a refractive index of 2.0, same as those shown in Figures 1 and 2. The index matched ITO has the characteristics that the refractive index makes a gradual transition from 1.5 to 2.0. The 1.5 refractive index of the ITO interfaces with the refractive index of 1.5 of the glass. This eliminates the glass-to-ITO interface reflection. As a result, this arrangement provides minimum reflection except for the two interfaces between the index matched ITO and the air interface. These two interfaces have low reflection because of refractive index 1.5 of the is very close to the refractive index 2.0 of the ITO. This approach resulted in approximately 5 times lower reflection than the touchscreen of Figure 2.

Conclusion

This improved resistive touchscreen provides four important characteristics for sunlight readability, namely: low reflection, good optical clarity, high light transmission, which approaches 95%, and anti-finger print surface.

Resistive Touch Screen Structure for Sunlight Readability

(Figures 1 and 2 Conventional; Figure 3 Improved Version)

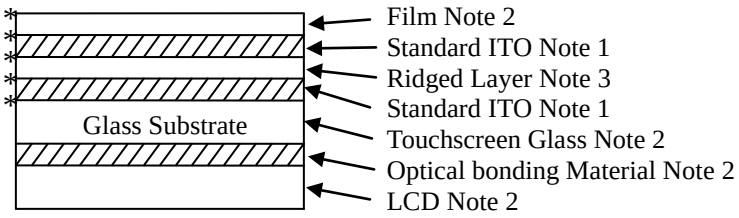

Figure 1 Conventional Glass-to-Film Resistive Touch Screen structure

* This interface produces reflection.

** This interface produces low reflection

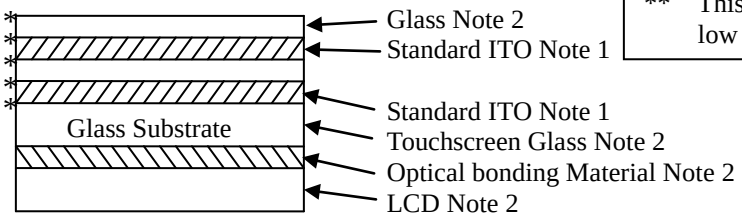

Figure 2 Conventional Glass-to-Glass Resistive Touch Screen structure

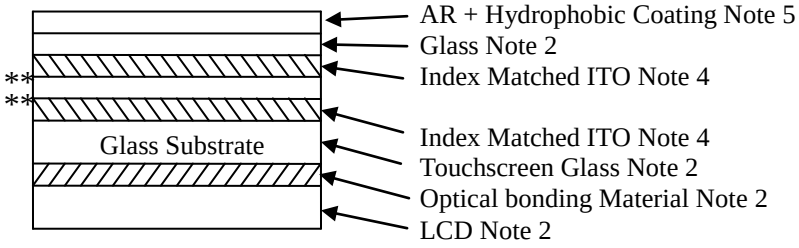

Figure 3 Index Matched Glass-to-Glass Resistive Touch Screen structure

Note 1 ITO index of refraction is 2.0.The resistance of ITO required for the touch screen operation.
Note 2 Index of refraction approximately 1.5.
Note 3 Index of refraction approximately 1.0 air.
Note 4 Index matched ITO. The index matched ITO has the characteristics that the refractive index makes a gradual transition from 1.5 to 2.0. The 1.5 refractive index of the ITO matches with the refractive index of 1.5 of the glass. This eliminates the glass-to-ITO interface reflection.
Note 5 This layer provides AR and anti-finger print coating.

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TABLE 1

Since all touchscreens are application dependent, following lists the advantages and disadvantages of five types of touchscreen.

	Advantage	Disadvantage
Glass-to-Film (Figure 1)	Low-Cost Draws fine lines	High reflection Prone to scratches and chemicals Poor optical clarity
Glass-to-Glass (Figure 2)	Draws fine lines Good light transmission and good optical clarity	Moderate expensive Increased thickness High reflection
Improved Glass-to Glass (Figure 3)	Draws fine lines Good light transmission; good optical clarity Low reflection, ideal for sunlight readable with anti-finger print coating.	Low cost can be achieved with good manufacturing process.
IR Touchscreen	Good transparency and durability No color distortion AR and anti-finger print coating are available (Note 1)	Moderate expensive Not easy to accommodate small sizes below 6.4". Can not draw fine lines Attract bugs on lighted screen at night time. Bugs sit on the lighted screen will interrupt IR beams causing touch screen to malfunction.
SAW Touchscreen	Good transparency and durability No color distortion AR and anti-finger print coating are available. Draws fine lines.	Moderate expensive Not suitable in applications where contaminants and moisture getting on the display.

Note 1. IR touchscreen has been successfully used in military display systems in harsh environmental conditions because of its rugged construction. Refer to website: www.irtouch.com for specifications and further detail.