DawarTouch®

Ruggedize Your Touch Panel

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Sustaining Quality,
Exceeding Expectations

DawarTouch®

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Introduction

Projected capacitive (PCAP) touch panels continue to make inroads into embedded markets like industrial controls, marine navigation, casino gaming, oil field maintenance, and other heavy use markets. The product demands of these markets tend to be very different from consumer products. A consumer product is designed for a life span of 2 to 3 years; an embedded product life span is 5 to 10 years or more. A consumer product tends to be thin and light; an embedded product tends be heavier and more rugged. A consumer product has a thin, light weight cover lens; an embedded product has a thicker, impact resistant cover lens. There are also EMI and environmental differences between the two types of products (*Table 1*).

	Consumer	Industrial
Life span	2-3 years	5-10 years or more
Size	Smaller, usually hand held	Larger, often wall powered
Cover lens	Thin, light, and inexpensive	Thicker, impact resistant, additional films and treatments
Radiated emission and susceptibility	Minimal, charger noise is biggest problem	Can be stringent depending on market (e.g., aviation)
Environmental requirements	Nominal temperature and humidity	Extreme temperature and humidity, possibly even immersion

Table 1

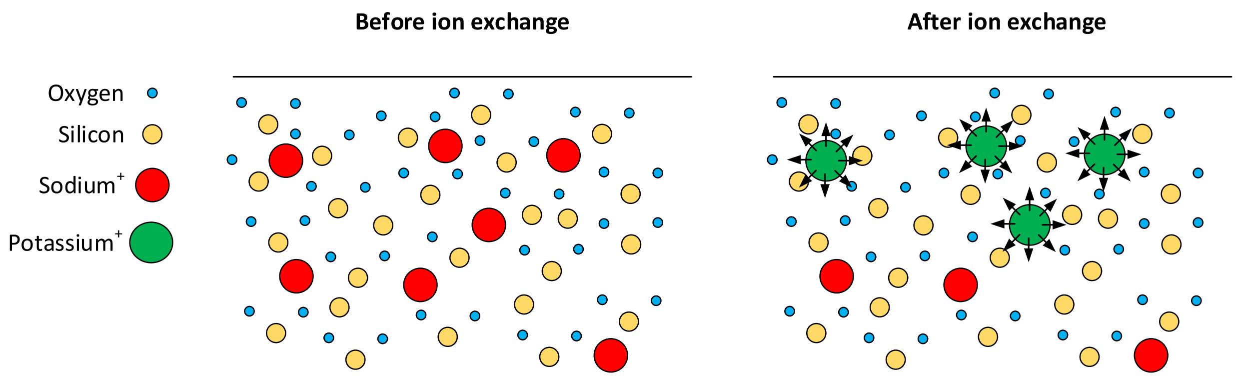
Most importantly, an industrial product very often requires customized tuning for EMC requirements, electrical noise, safety standards, and extreme environments. These differences are important factors to consider when integrating a PCAP touch panel into an embedded design. In this article we'll discuss some of the design considerations involved in ruggedizing a touch panel design.

Cover Lens

The cover lens is the most important part of the design for a ruggedized product. The first consideration is the material. Cover lenses can be standard (a.k.a. soda lime) glass, chemically strengthened glass, aluminosilicate glass (e.g., Gorilla® Glass, Dragontrail™, etc.), or plastic (e.g., PMMA). All of these options are available in a variety of thicknesses. There are industry standard thickness for the different types of glass. While custom thicknesses are possible, they are difficult to justify with volumes typical in the industrial market.

Most ruggedized applications will require that the product pass drop tests and/or impact tests. Impact testing normally involves dropping a steel ball into the center of a display from up to 1.5 meters above the display. Hand held products will also often need to survive multiple drops to a concrete floor. One way to help pass these tests is to increase the strength and breakage resistance of the cover lens by chemically strengthening the glass.

Chemically strengthened glass is created by placing standard glass in a bath containing potassium salt. When heated to a high temperature, potassium ions in the bath exchange places with sodium ions in the glass. The potassium ions are larger than the sodium ions they replace. This compression closes micro fractures in the glass surface, which helps prevent breakage by eliminating stress points where cracks can start. This compression in the glass also results in a hardened surface (*Figure 1*).



Soda lime glass contains randomized chains of silicon oxides and additional trace elements including sodium ions.

Larger potassium ions replace the smaller sodium ions near the surface, creating internal tension.

Figure 1

The strength of glass is measured by a Modulas of Rupture (MoR) test. In this test a glass sample is put under a bending stress until it yields. Generally, chemically strengthened soda lime glass will have a MoR of about 4X the MoR of non-strengthened plain soda lime glass. Aluminosilicate glass would have a MoR of about 10X that of plain soda lime glass. Another interesting thing is what happens after the glass is damaged. Scratches in the surface of glass can become propagation points for cracks to start. The harder the glass surface, the less likely it is that surface damage such as scratches will occur. Given a plain soda lime glass sample and a chemically strengthened soda lime glass sample that each have a small scratch applied to them, the chemically strengthened glass out performs the soda lime glass. A piece of aluminosilicate glass, which undergoes a similar ion exchange process, out performs chemically strengthened glass. This is true as long as the scratch does not go past the depth of the ion exchange layer. If a scratch exceeds that depth (about 50µm in chemically strengthened glass, and about 100µm in aluminosilicate glass), then the glass will fail at about the same stress level as standard soda lime glass. If your product has a breakage or impact requirement, then it most likely will require a chemically strengthened soda lime or aluminosilicate glass cover lens.

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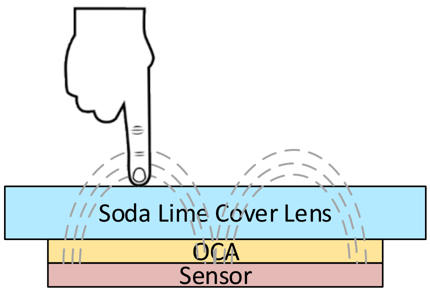
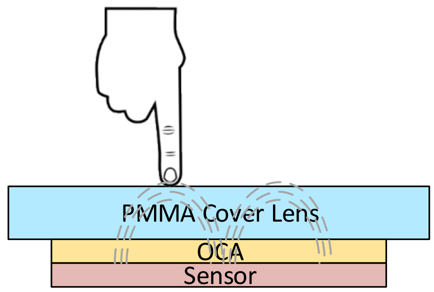
Even after being chemically strengthened, glass will still break under the right amount of stress, and the broken glass shards can be dangerous. Some products require impact tests that are not allowed to produce any glass shards. This is a difficult test to pass with any kind of glass. Heat tempered glass, like the kind used in automobile windshields, might be an option as it does not have sharp edges when it breaks. However, tempered glass thicknesses are limited to about 3mm and greater and the cost is often too expensive for low to medium volume designs.

Once glass breaks, it is going to shard, regardless of whether it is chemically strengthened or not. Anti-splinter films can be applied to the top layer to capture the glass shards, but these may not be effective depending on the impact test requirements. If broken glass is a safety concern, then a plastic cover lens may be required. Typically this would be an acrylic like PMMA. The downside of using any kind of acrylic material is that acrylics have a much lower dielectric constant than glass. What this means is that the electric field generated by the touch panel will not extend as far, reducing the sensitivity of the touch panel. If an acrylic cover lens is required, the touch panel design may have to be altered to ensure good performance (*Figure 2*).



Electric field through 2mm glass cover lens



Electric field through 2mm PMMA cover lens

Figure 2

Other important factors to consider when specifying the cover lens are the various coatings and films that are available. If the product is being used outside, then an anti-glare finish may be needed. If the product will be used in a marine environment, then a hydrophobic (i.e., water repellant) coating may be needed. There are a variety of other coatings, films, etchings, etc. that can address particular requirements for a product. Once the touch panel partner understands the environment in which the device will be used, they can recommend the appropriate cover lens enhancements.

Adhesives

The touch panel is typically bonded to the cover lens with an optically clear adhesive (OCA). This adhesive is a thin layer similar to double sided transparent tape. The OCA may also be used to bond interior layers of the touch panel (*Figure 3*).

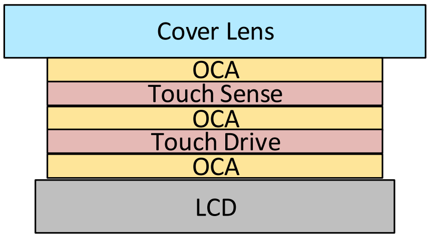


Figure 3

The adhesive may have a polyester carrier or may have no carrier at all (this is also known as no-base OCA). If the product is going to be used outside, the polyester substrate of the OCA can create issues. The problem is that when the light from the display's backlight passes through the polarizer in the display, then through the polyester substrate, and then through polarized sunglasses which may be worn by someone using the product outdoors, a colorful prism-like pattern called birefringence can occur (*Figure 4*).

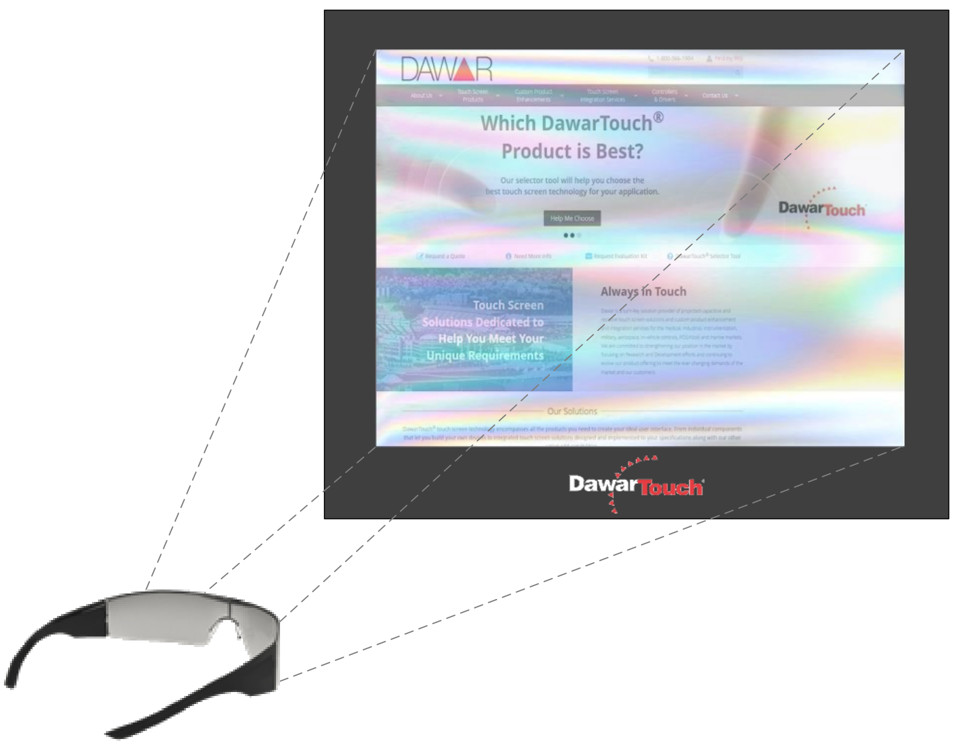
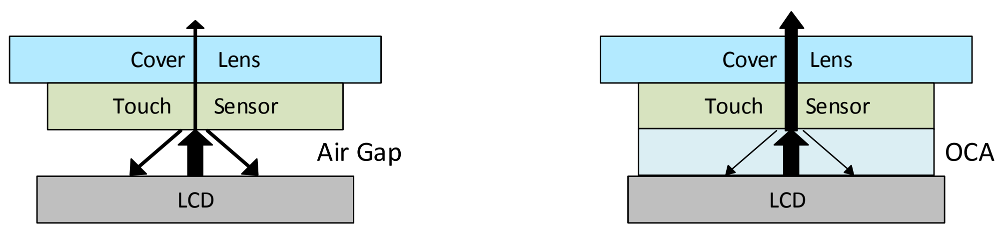


Figure 4

This rainbow pattern can be very distracting to the user and may even obscure parts of the display. The only way to avoid this is to not use birefringent materials like polyester in the touch panel construction. It is very important to tell your touch panel partner if the design is going to be used outside so they can avoid using materials that create birefringence.

The adhesive layer from the touch sensor to the display is also very important. While it is possible to use a gasket around the perimeter to bond the display to the touch sensor, this is not recommended for ruggedized designs. A better alternative is to use an OCA to bond the touch sensor to the display. This could be a dry bond OCA similar to the OCA used in the internal touch sensor layers, or it could be a liquid OCA material, commonly referred to as LOCA. The liquid bond agent may be cured using a variety of techniques. The most effective liquid adhesives are cured using a dual process that includes self-curing. In a dual cure process, the main curing is done with something like UV light. The secondary self-curing ensures that areas of the OCA that are difficult for manufacturing processes to access, for example between the touch panel's FPC and the cover lens, are still cured. Without the secondary self-cure process, the liquid OCA may not be fully cured in some of the harder to access areas, and may leak over time.

The primary benefit of using an OCA for the touch sensor to display bond layer is improved optical performance. Light is refracted and reflected anytime it crosses a boundary between two different types of materials. A layer of air between the display and the touch sensor refracts and reflects a significant portion of the light. This results in less light from the backlight reaching the user. It also creates parallax making it difficult to tell where icons actually are on the screen. Using an optical adhesive between the display and the touch sensor removes most of the parallax and increases the amount of light that reaches the user. Specifying an OCA layer between the display and the touch sensor may improve the optical performance to the point where the backlight can be set to a lower level, saving power. It may even be possible to select a display with a less powerful backlight which can be a significant cost savings (*Figure 5*).



A significant portion of the backlight is internally reflected within the air gap layer.

Most of the backlight makes it to the user, resulting in a brighter image

Figure 5

The second benefit to using an OCA layer between the display and the touch sensor is improved impact resistance. Every OCA layer in the stack up acts as a shock absorber. Adding OCA at the bottom of the stack increases the overall shock absorption of the display module as a whole. This effect is even more important when using glass sensor layers. With an air gap, the sensor glass may deflect enough to cause a break in the glass. An OCA layer can stop the sensor glass from flexing enough to break.

Integration

The final factor to consider is how the touch panel assembly mounts in the enclosure. Typically the touch panel and display assembly is either front loaded into a recess in the bezel or rear loaded from behind the bezel. In either case a gasket material is used to bond the two assemblies together. Many ruggedized products have sealing requirements for water, dirt, and other particulates that must be kept out of the enclosure. Selecting the correct gasket material for a particular assembly can be difficult. There are many different options for gaskets including tapes, foams, form-in-place liquids, etc. This is another area where a touch panel vendor with experience in ruggedizing touch panel designs can be very helpful. Gaskets can also provide shock absorption which assists in passing stringent impact tests. The touch panel designer should be able to assist in selecting the best gasket based on impact requirements. In some cases the product may even be required to pass a submersion test. For these products selecting the optimal mechanical design for the touch sensor to enclosure interface is critical. The touch panel manufacturer's mechanical engineers must be available to work closely with the customer in selecting the best adhesives, gaskets, and overall mechanical design for the touch sensor and the enclosure.

Conclusion

Ruggedizing a touch panel requires a complete understanding of the environment in which it will be used, the tests it will be subjected to, and the optical requirements of the market. A successful touch panel project requires close collaboration between the engineering teams of the touch panel provider and the end user. When choosing a touch panel design partner for a ruggedized product, it is important to select a partner that understands these issues and can offer a variety of options that best fits your needs.

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