Filters and Other Touch Screen Enhancements

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This is a paper describing the EMI and Optics filters that are currently manufactured by Touch International.

INTRODUCTION

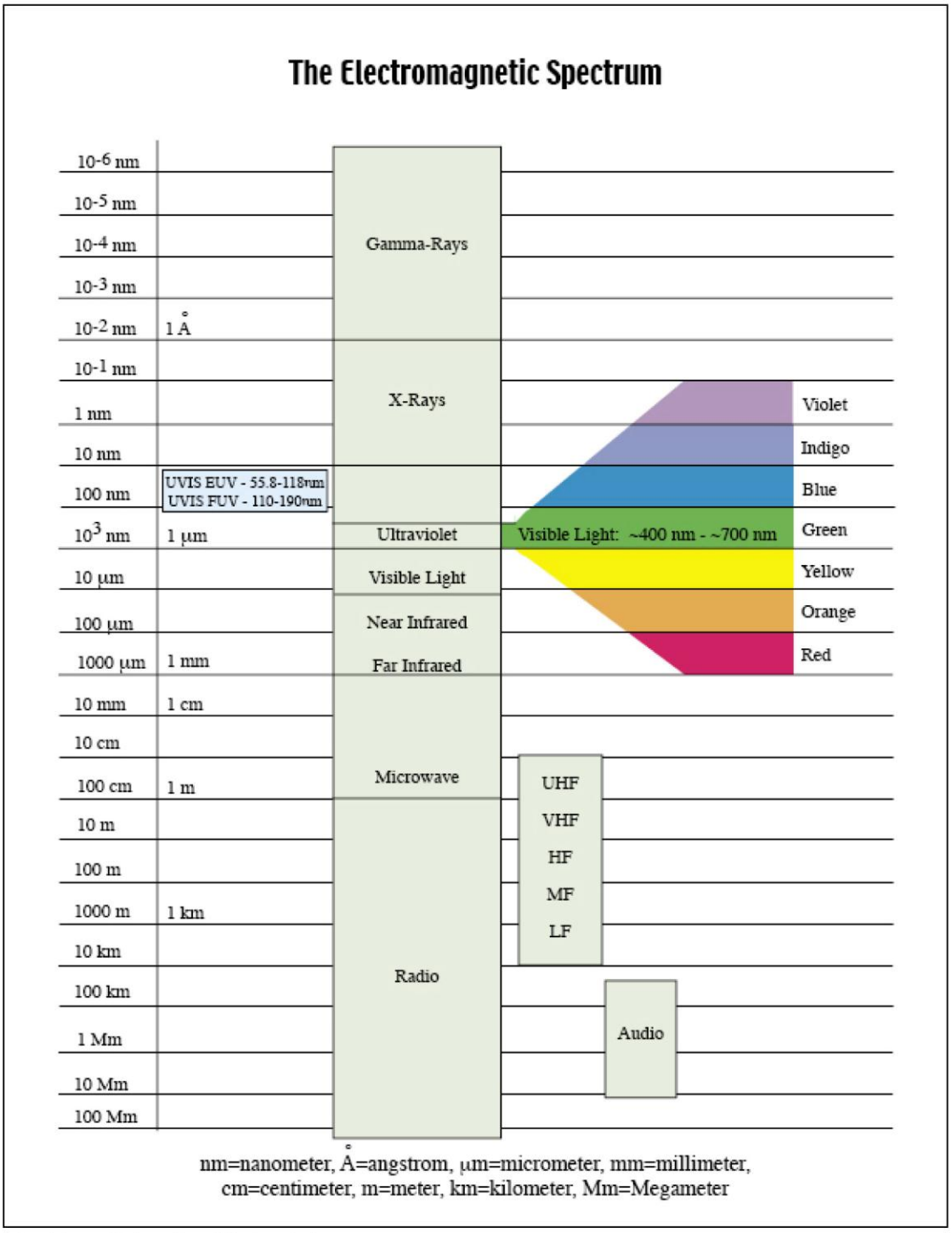
Touch International can incorporate a number of filters and light guides into the touch screens to meet a variety of customer needs. In addition, all of these transparent devices are available as non-touch filters. The filters fall into three general categories: 1) controlling electromagnetic interference (EMI), 2) optics to manipulate the physics of light, and 3) improvements to the environmental integrity of a display. Furthermore, most of these enhancements can be optically bonded to the face of the display, resulting in a significant increase in performance.

FILTERS FOR DISPLAYS

- EMI Filters -

Electromagnetic Interference Filters are designed to reduce emissions in the radio frequency (RF) range of the electromagnetic spectrum (see below). At the lowest levels of emissions, the U.S. Federal Communications Commission (FCC) and the Conformite Europeene (CE) in Europe, require manufacturers of electrical equipment to limit the levels of RF emission. The FCC has two categories: Class A for electrical equipment used in offices and Class B for home use, which is more restrictive and does not allow any interference with radio or television operations. At the extreme end of concern are so-called "Tempest" limits, which seek to stop enemies from scanning remote devices and conducting espionage. These are so restrictive one cannot even know what is needed to meet the filter requirements without high level security clearance. In between are filters, primarily for military or aerospace environments that seek to stop interference with navigation instruments or limit the ability of "enemy sniffers" to find and target a location.

Within the RF range, the filters can be tuned for specific frequencies, and the filter that is good at blocking one frequency, may be less effective for another. For this reason, Touch International offers two EMI filter types, low Ohm Indium Tin Oxide (ITO) and blackened mesh.



(chart from University of Nebraska)

- Resistive and Capacitive Touch Screen Filters –

The thin film ITO used in most touch screens will aid any device in meeting FCC Class A and Class B requirements. This is because the electronics attached to the touch screen act to "absorb" the EMI and ultimately "bleed" the noise to ground. Thus, a secondary benefit of resistive or capacitive touch screen is to act as a simple EMI filter.

- Low Ohm Thin Film -

Many RF emissions can be trapped by putting the EMI emitter (device) in a conductive box and connecting the box to ground. Using a low Ohm transparent conductor and connecting this to the EMI shield in the device's cabinet is similar to enclosing the device in a copper box. The transparent low Ohm conductor is the part of the "box" which sits over the display.

In the past, because of its low resistance, gold was used as the transparent thin film, but it had a number of problems, including a deep coloration of the display. Most recently Touch International has developed a low Ohm material called Indium Tin Oxide (ITO), which operates in the range of 4 Ohms per square, has a neutral color, and a light transmission of approximately 90%. Touch International uses silver bus bars for conductivity combined with copper conductive tape to achieve highly uniform EMI filters. Touch International offers .5, 2, 4, 8, 10, and 100 Ohm films, which can be exposed or sandwiched between two layers. The 10 Ohm thin film is ideal for medical, military, and aerospace markets.

- Mesh Filters –

A second, more effective method is to use a tarnished silver mesh that has 50 to 100 holes-per-inch, which typically has been bonded between two pieces of glass. The bonding process serves to hold the mesh flat so that it does not further disturb the optics. In addition, the bonding maintains the mesh holes at a uniform size, which is another requirement for shielding against EMI.

Although the science paradigm is beyond this white paper, the size and frequency of the holes and the high-conductivity of the silver mesh are excellent at stopping a certain range of emissions. The light transmission is good because nothing blocks the light passing through the holes. However, the mesh does block some small portion of the screen, and the resulting moiré effect can be a mild annoyance, though preferable to being discovered and attacked by the enemy forces.

- **Filters for Light Optics –**

These filters are for manipulating emissions in the 400 nm to 700 nm range, (visible light) and in the 700 nm to 1200 nm, (near infra-red or NIR). These filters mostly seek to manipulate the properties of light, which may include blocking or enhancing the radiation. Touch International offers a variety of finishes including polarizers, retarders, Broad-Band anti-reflective, and light control film for privacy purposes. Touch International filters have been used in POS, tablets, kiosks, aerospace, and hospital applications. Several of these will be described in the following sections.

- Privacy Filters -

Most users do not want to share everything on their computer screens. Having a child read the text on your laptop to all of the nearby passengers on an airplane might or might not be amusing. Having strangers read your PIN on an ATM from over your shoulder or from the side might be costly. Countries where there is a lot of text messaging on public transit vehicles think privacy filters are very important. Privacy filters stop off-axis viewing of the display.

The film is manufactured by creating chemical louvers that let the light come straight through, but block the light on either side so the image cannot be read.

- Contrast Enhancement -

Touch International can incorporate a wide variety of color filters into touch screens. For example, radar scopes fitted with touch screens have used a specific colors filter to adjust the apparent persistence of the phosphors. Some airline cockpits use LED displays, for which a neutral gray can enhance the ability to read the display. Night vision systems can make use of filters incorporated into the touch screen to block the NIR signature of the display.

- Anti-Reflective -

With the growing number of outdoor touch applications and with the advent of highly reflective (HR) LCDs, the production of touch screens using anti-reflective coatings is increasing. The amount of light which passes through a solid is impacted both by color absorption and the bending of light at the air/solid border. For example, a glass window passes about 92% of transmitted light; while color absorption is minimal, the changes in refractive index between the glass and air cause a reflection of about 4% at each surface (Fresnel reflection). One can see the impact of this phenomenon as a reflection from each surface.

Anti-reflective (AR) coatings are stacks of very thin films of chemicals coated onto the glass (or plastic) surface. When the film stack is properly designed, light entering the film stack undergoes constructive and destructive interference effects, resulting in an increase in light transmission and a decrease in reflectance. When the touch screen does not reflect as much light, the image behind the touch screen will be brighter and certainly more easily read. Reflected light is also reduced, so the impact is a significant improvement in display contrast. The design of these films requires careful attention to the material properties and thickness of each component. Creating anti-reflective coatings is an extremely precise process, which is very expensive and can easily make a touch screen 200 to 400 % more expensive than a standard touch screen. Today, all four surfaces-- the backside, two interior, and front-- can be AR treated, though any combination can also be selected in order to balance cost and performance. The fewer the surfaces treated, the lower the cost, but also the less reflection absorbed.

Until recently, the touch screen first surface (front) could not be treated with an anti-reflective coating. This was because the AR coatings are delicate (would not take the wear of millions of touches), and the thickness of the oil from a fingerprint altered the thickness of the coating and nullified the effect. However, the first generation of hard, fingerprint resistant AR coatings has recently become available. Because of the cost, AR coatings are used for fewer applications, such as those that would expose expensive instrumentation to outdoor or other high brightness environments.

- Anti-Glare Treatment -

Almost all touch screens put a silica (or other chemical) coating on the first surface to diffuse the reflective light and reduce the mirror effect. This is called an anti-glare coating, not to be confused with an anti-reflective coating. Anti-glare coatings are relatively inexpensive and enhance the scratch resistance of the touch screen. However, anti-glare coatings diffuse the image and consequently reduce the sharpness of the display image, reducing visual clarity.

The amount of diffusion is measured as gloss. Use of anti-glare coatings for applications in high brightness environments may result in undesirable light reflections which make the image unusable. Customer evaluations of the degree of anti-glare treatment that is beneficial are required before a final specification can be determined.

- Persistence Filters -

Traditional CRT-based radar systems use a combination of phosphors to achieve a usable “trail” in the radar image. This combination causes an initial bright flash of light followed by a longer decay component that defines the track of the target. This bright flash may be distracting to the controller, but can be largely eliminated by use of a

correctly selected color filter. Such filters are typically yellow to orange in visual coloration.

- Color Matching -
As more devices incorporate alphanumeric displays, designers can find that the color of each display is quite different. Color filters can be added to the touch screen which will adjust the color of the various displays so that they appear to have the same color.

OTHER ENHANCEMENTS TO DISPLAYS

Touch International offers a variety of other enhancements to the display community. These include enhancement of the luminance and/or contrast to the display and improving the environmental performance of the display.

- DBEF Filters -

Display Brightness Enhancement Film are micro prisms, formed onto a sheet, which collect and focus the display backlight into bright spots. This filter makes a display which is perceived to be brighter than the rating of the backlight.

- Flame Retardant -

Touch International has had success within the aerospace markets. One of the main requirements of this market is the FAR 25.853 vertical burn, which is when a cross section of a touch screen is exposed to flame and must self extinguish within 12 seconds or 60 seconds depending on its diagonal length. One of the main issues of concern is that the typical materials used in standard touch panes, tend to "wick," or continue to burn once ignited. The base material structures that Touch International can implement within a custom design have been formulated to pass the 12 and 60 second vertical burn test dictated by the FAA without deleterious effects to the light transmission rate.

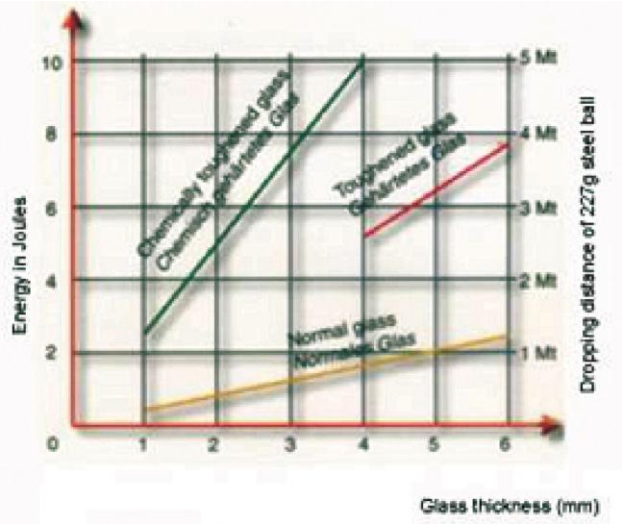
- Vandal Guard -

Many touch screens are used in unsupervised public access devices. There are rare occurrences in which bricks have been thrown at information terminals for buses, and even gunshots to gaming terminals. Standard soda lime glass, bathed and strengthened for up to 16 hours, generally comes in 3-4mm thickness but can be up to 6mm thick. Touch International produces a number of touch screens and replacement glass to address these problems (standard or tempered glass). The available options are listed below.

- Chemically Strengthened Glass -

Chemical strengthening is a process by which glass has small surface ions (sodium) replaced with big ones (potassium), and results in the surface of the glass being put into compression while the bulk of the glass is placed in tension. Because of this extra stress, the glass strength is up to fifteen times more resistant to breakage than that of standard float glass (chart from http://www.xinology.com/en/eg_cpml_temper-chemicalI.HTM).

Chemically strengthened glass can be produced in thicknesses between 0.5 mm and 12 mm (1/2″).



Graph comparing impact resistance

- Tempered Glass -

Tempered glass is about 2.5 times as strong as standard float glass. Tempered glass is made by heating the glass to near plastic state and then rapidly cooling it. Because this process requires the glass be moved on rollers to heat and cool both sides, minor ripples are often left in the glass which can be objectionable. However, much thicker glass (up to or beyond 19 mm) can be heat tempered, so a part with extremely high vandal resistance (even bullet proof) can be manufactured.

- Safety Glass -

Safety glass is made by autoclaving two surfaces together under extreme heat and pressure. Between the two (usually) glass layers is a material which holds the pieces

together so that if broken, sharp shards do not fly off and present a danger (thus "safety"). Both tempered and chemically strengthened glass can be used to give this product exceptional strength.

- Scratch Resistant Glass -

Some applications may require a surface which cannot be scratched or sand blasted. Touch International has three solutions.

Tin-Oxide Coatings

Tin-oxide is harder than glass and has up to 7H hardness. Crystals of tin-oxide are used in sanding abrasives. This is the same coating that is used in the large format capacitive glass. This product has a natural resistance to scratching.

Diamond Evaporative Coatings

A diamond-like substance can be deposited by chemical vapor deposition (CVD). When combined with an ion scrub, the resulting surface is almost as hard as diamond, the most scratch resistant material known. The material has a slight coloration, and is thin, but offers excellent scratch resistance.

Sapphire Glass

Sapphire glass is not glass, but rather a grown aluminum oxide crystal. Second to diamond in scratch resistance, this material is clearer and thicker than the carbon based diamond material. Sapphire glass is most commonly used on store scanners about which it is often said that the stainless steel bezel will scratch before the sapphire glass will. Large sizes of sapphire glass can become very expensive to produce, so this should only be used when absolutely necessary.

OPTICAL BONDING

Touch International is now able to provide the service of bonding the overlays described in this paper directly to the face of a display. Touch International offers options of UV-cured adhesives and thermally-cured silicone adhesives. Custom designs can be accommodated to meet your display needs.

About Touch International

Touch International is a leading provider of high-quality touch screen components manufactured for OEM's, Systems Integrators, and Value Added Resellers. Building on a legacy of integrity, reliability, quality, and technology expertise, Touch International makes it easy and affordable to integrate touch components into computer panels and displays.

If you would like additional information about touch screens or Touch International, please visit our web site at www.touchinternational.com or call us at 512.832.8292