Keep In "Touch" With EMI Solutions For Today's Displays

Dec 13, 2010 2:47 PM, By Jeff McCutcheon, 3M Electronics

MOBILE DEV&DESIGN

Designers can take advantage of materials such as transparent conductor films, shielding tapes, and absorbers to enhance touch-sensor display performance.

The evolution of the touch-sensor display continues to challenge engineers to wring out higher performance at cost-effective levels. According to the path set forward by your marketing team, success for the next-generation device depends on three key factors:

- A projected-capacitive (PROCAP) touch display
- A faster processor for faster data rates
- Improved antenna performance to ensure success in the field

The PROCAP display is designed by making an array or grid pattern that utilizes a conductive material (e.g., indium tin oxide, or ITO) on an optically clear substrate. The grid pattern design can vary significantly for a given device.

To ensure a timely design solution to meet each of the design goals, it's imperative to understand that each of these goals depends on a robust electromagnetic interference (EMI) set of solutions. Otherwise, the touch will not display, the added speed will be lost to higher error rates, and improved antenna performance can fade with time.

PROCAP Touch Sensor Display

Step one begins with the PROCAP touch display. Designers select this type of display interface for many reasons, including multi-touch capability, speed, sensitivity, and overall functionality. Other options exist, such as resistive touch sensor displays, both acoustic and optical, but each comes up a little short in one of the desired areas directed by the marketing team.

An effective PROCAP sensor may face many integration challenges. For instance, it's a "conductive circuit" that can appear to look like an antenna, can be in close proximity to other electrical devices, and/or can be located near metal surfaces, all of which could impact the PROCAP sensor's performance. The sensor is susceptible to EMI and other common effects associated with a more classical review of printed-circuit-board (PCB) layout of circuit traces.

The PROCAP sensor is a powered grid that's constantly being measured for extremely slight variations in a voltage. The "desired" voltage changes occur when a finger or stylus comes within a "capacitive influence distance" from the PROCAP sensor grid. The "capacitive touch" leads to a capacitance-localized impact, which leads to a voltage change detected by the circuit electronics, and then to an acknowledged "touch" and associated software command action (Fig. 1).

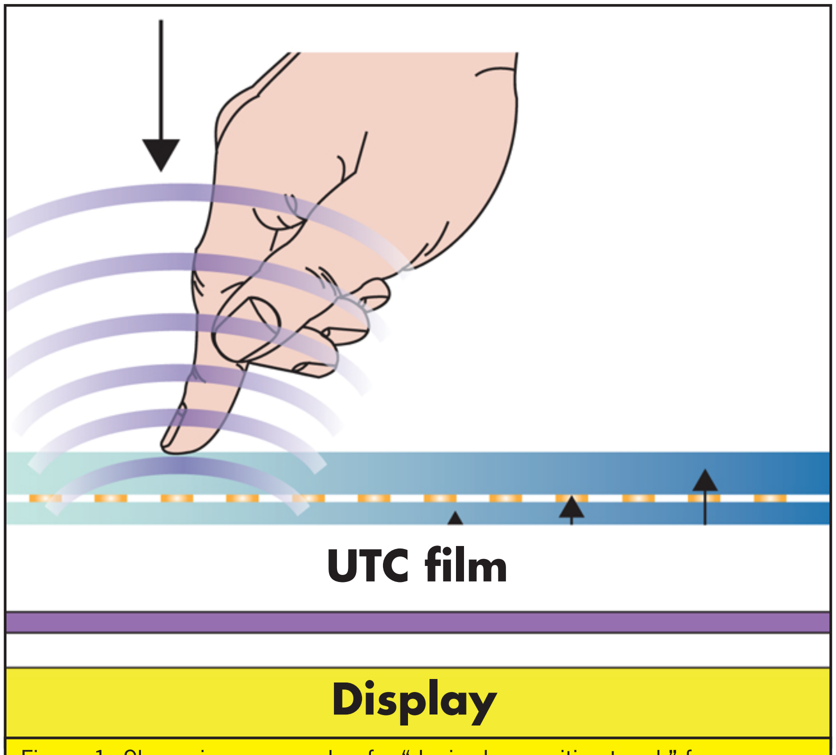


Figure 1. Shown is an example of a "desired capacitive touch" for a projected capacitive touch sensor.

The circuit doesn't know the source of the voltage change. Therefore, any "unwanted touch" or effect from an EMI source or a "capacitive- or impedance-changing influence" within or external to a device can create an undesired response. Even more importantly, it can lead to a design solution that requires a less responsive PROCAP sensor device to minimize the impact of the undesired influence. The optimized PROCAP sensor integration design doesn't compromise performance, but minimizes the environmental influences on the PROCAP sensor. Solutions to optimize the PROCAP sensor include the integration of three key material sets:

Unpatterned transparent conductors (UTCs):To reduce the effect of internal-device-generated EMI noise on the PROCAP sensor, the use of second-generation UTCs (SG-UTCs) for EMI shielding is recommended. SG-UTC films are placed between the display and the PROCAP sensor, which is the common EMI noise source direction (Fig. 2). These films are transparent PET films with a conductive coating that's been optimized not only for EMI shielding, but also for color, haze, and reflection characteristics. SG-UTCs are designed to offer excellent performance for PROCAP sensor designs.

PROCAP sensor E-field normalization and guard layer for PROCAP sensor optimization:Second-generation patterned transparent conductor (SG-PTC) films or SG-UTC films can offer "E-field normalization" of the PROCAP sensor by using either film in the display stack near the sensor. SG-PTC films can also be used in the PROCAP sensor to replace the ITO-based sensor design.

Looking at it more closely, the PROCAP sensor can have areas that are "electrically far or near" from other conducting surfaces (metal frame, bezel edges). Thus, the capacitance or inductance can vary across the PROCAP sensor. SG-UTC or SG-PTC can be used as an E-field normalization film or "guard" layer that modestly interacts with the PROCAP sensor array and unifies circuit performance across the sensor. It's similar to metal layers that are used near flat flex cables to influence circuit impedance levels to optimize performance. Reduced variability of the PROCAP sensor due to environmental capacitance or inductance improves response and sensitivity. It also helps further simplify software and hardware integration.

SG-PTC films, which are patterned per a PROCAP sensor X-Y grid design, offer the potential for lower resistance traces along with excellent transparency versus comparable ITO sensor designs. SG-PTC sensor design could offer a lower RC time constant, enabling a faster sensor, particularly in display sizes of eight inches or more. The SG-PTC can also deliver improved flexibility and a narrower interconnect width versus a typical ITO-based touch sensor.

On top of that, SG-UTC and SG-PTC films reduce electrostatic discharge (ESD) for the display. The edges or perimeter of a design may allow ESD to "spark around or past" a bezel edge and enter the device, leading to potential ESD damage. SG-PTC or SG-UTC films lie below the bezel, but in front of the display and other electronics, potentially providing a path for the ESD to travel away from the more sensitive electronics of the device.

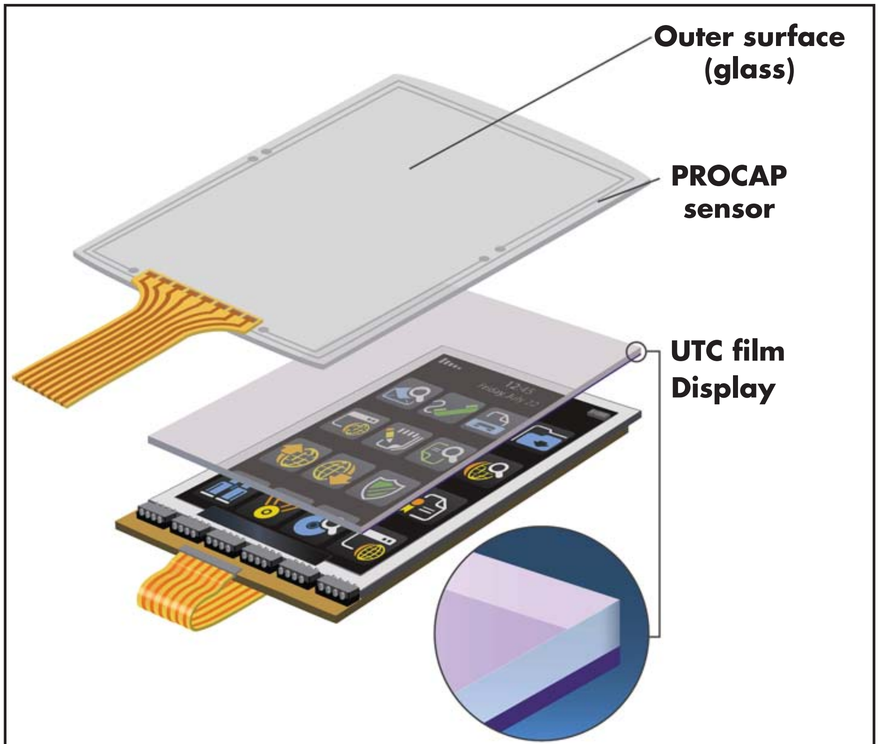


Figure 2. In a typical projected-capacitive-touch sensor assembly, the unpatterned transparent conductor (UTC) film is inserted between the sensor and display.

EMI shielding or EMI absorbers to reduce internal EMI noise sources: EMI shielding foil, such as copper-foil EMI shielding tapes, could be used to minimize EMI noise leakage. Often, though, an even better solution is to employ EMI absorbers. Absorbers help reduce the EMI noise from a chip or signal line. They convert the EMI energy to a negligible amount of heat as they reduce the EMI energy from the source. Absorbers come with an adhesive backing so ease of application is ensured in the assembly.

Processor Speed

So, what exactly will a faster processor achieve? First, it translates into higher frequencies throughout the entire system design, leading to overall lower signal-to-noise ratios (SNRs). Second, lower SNR means that EMI

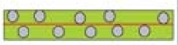
Pictorial design	Thickness (μm)	Z or XYZ conductivity (based on 3M test method)	Features, advantages, and benefits
	50	Z	Z-axis, standard adhesion acrylic adhesive, silver conductive filler
	50	XYZ	XYZ, "bond line gap/slit" EMI shielding for high-frequency, low-contact resistance to stainless steel; improved contact R conformance
	66	XYZ	XYZ, double-coated aluminum foil, medium adhesion acrylic adhesive, nickel conductive filler
	50	XYZ	XYZ, non-woven conductive scrim, low-contact resistance to stainless steel, higher adhesion acrylic adhesive

Figure 3. Several electrically conductive adhesive transfer-tape solutions are available, coming in at different price points to meet application needs.

noise levels must be reduced, or error rates will increase in point A to point B communication within a device.

The higher frequencies lead to the need for improved EMI shielding solutions. Compact, low-profile designs, with IC devices in closer proximity to each other and within the enclosed EMI environment, raise important design issues. Not only must designers deal with the EMI electric field, but the magnetic field associated with EMI also may become a greater concern in geometry-based, "near-field" conditions.

Specific EMI issues can be related to:

- New EMI leakage paths in Faraday cage designs, which can occur due to higher frequencies (i.e., smaller slots)
- RF noise radiated from surfaces within a device caused by electrical bias along a surface or structure; RF bias noise isn't an issue with higher SNRs of lower frequen cies, but it becomes a problem with lower SNR of higher frequencies
- Proximity of a noise source to a data-flex transmission line
- Higher-density data-transmission lines and associated crosstalk

A lower-EMI environment can be accomplished with improved EMI reflective shielding materials, such as the latest generation of copper-foil tapes. These tapes are thinner and work well at higher frequencies, while allowing for lower-profile solutions.

Also, a new generation of conductive fabric solutions laminated with a conductive adhesive improves conformability, puncture resistance, ease of use, and a tailored EMI shielding level based on composition. They include, for example, high-performance products based on a silver-plated fabric, or conductive fabric tape that uses a lower-cost nickel-plated fabric

EMI reflective shielding solutions are now being complemented with EMI absorbing materials in enclosures that experience near-field EMI (Fig. 4). These absorbing materials act like "acoustic absorbers," much like ceiling tiles or carpet in an acoustically loud room. By reducing the noise level, the desired signal-speaker can be more easily understood with fewer errors or requests to retransmit the information.

The performance of the absorbing materials is generally related to the product's permeability (the material's level of interaction with the electromagnetic field of the EMI), thickness of the absorber, geometric placement, and area covered. To determine the best material for your environment, start with a high-performance absorber, with maximum thickness and largest area allowed, to establish a baseline of potential performance.

High-performance absorbers feature high permeability, leading to excellent EMI noise reduction. However, more economical lower-permeability absorbers may meet the required effective performance levels, too. Test for those after establishing the baseline performance of peak potential and see if they meet the minimum specification. It's best to establish absorbers highest performance impact first, because it may allow for other design changes once a new EMI reduction is demonstrated.

As frequencies climb, the need arises for reduced device internal bias through improved internal assembly grounding methods. Lower contact resistance can improve Faraday cage performance to seal any leaks via slits or slots established by ground points. Lower electrical bias in a system helps minimize internal radiated RF signals generated on the system structures, and it can impact the

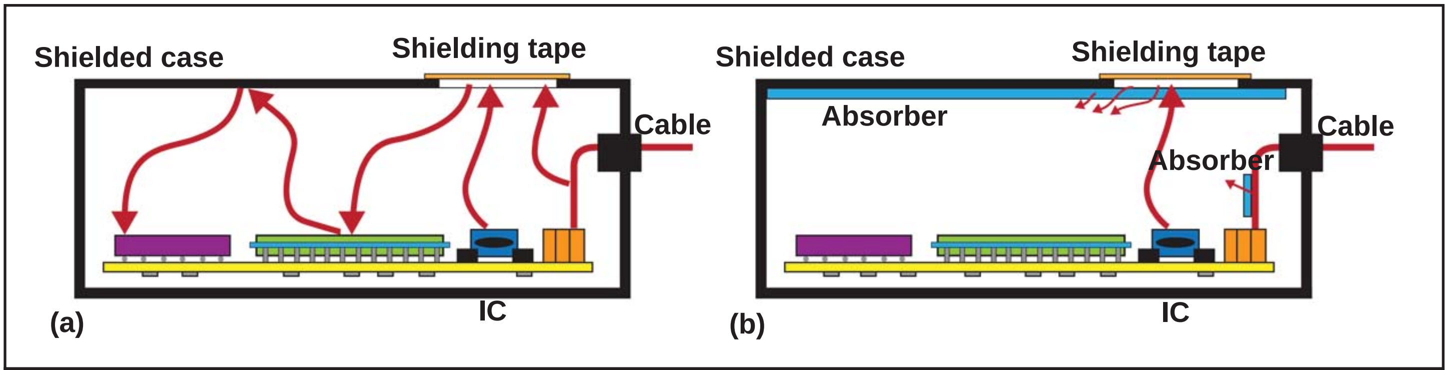


Figure 4. These two enclosure designs can combat EMI, one using shielding tapes (a) and the other using shielding tapes complemented by absorbers (b).

SNR of the data transmitted via a flexible circuit. Improved grounding and inherent EMI shielding may even be needed throughout an adhesive bond line thickness to reduce EMI escaping or entering the system due to higher frequencies now able to pass through a bond line thickness gap or slit.

Electrically conductive adhesive transfer tapes (ECATTs) offer solutions to improving device grounding (Fig. 5). Such products can be used to enhance and/or replace traditional methods of grounding with screws, clips, or compression fit designs. The conductive portion of the ECATT may affect adhesion, grounding resistance level, shock and vibration performance, reliability with environmental aging, EMI shielding in the bond line, rework, and surface contact conformance. Therefore, each application must be scrutinized to determine which ECATT product best meets the end user's grounding and EMI shielding design goals.

Antenna Performance

Though antennas can be complex designs, they're relatively basic in concept. Antennae collect electromagnetic energy and deliver it to a device to interpret the signal. Thus, SNR becomes important. The better the SNR, the easier it is for the electronics to determine the true signal intent with fewer errors.

Consequently, reducing the noise levels will improve the SNR and simplify the antenna design. The designer's only job in this scenario is to reduce noise. The key is to understand that the noise is typically associated with internal device bias and/or eddy currents in metal surfaces, which leads to radiated RF signals that are noise to the antenna,

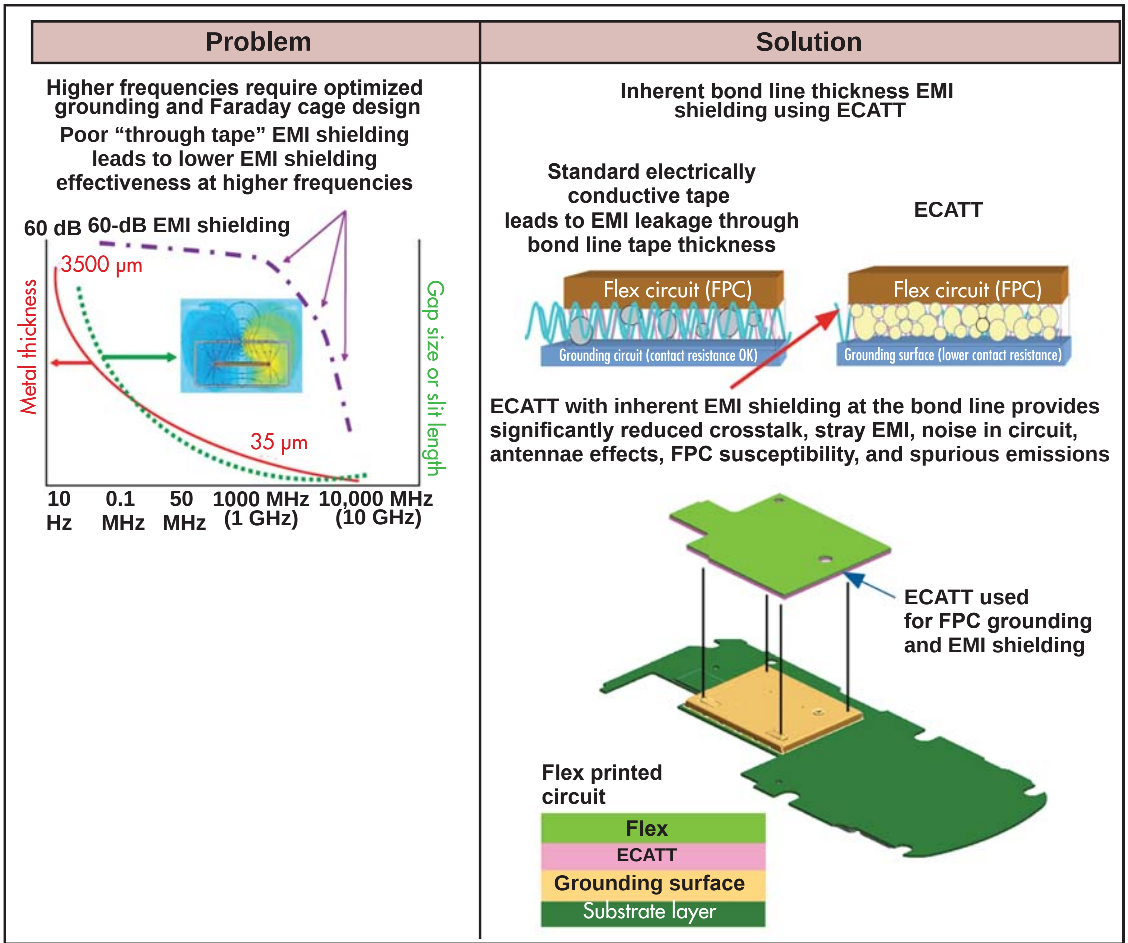


Figure 5. Highly filled, electrically conductive adhesive transfer tapes (ECATTs) help reduce crosstalk, spurious EMI, and signal degradation.

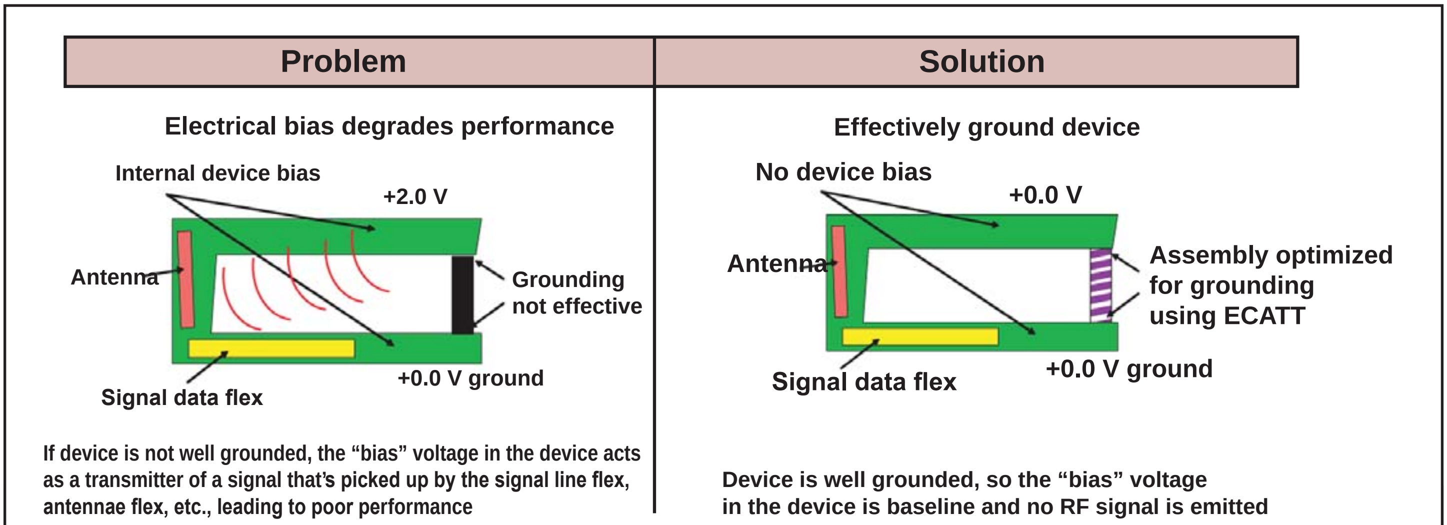


Figure 6. Reducing a device's internal electrical bias improves antenna performance and sensitivity.

lowering the SNR (Fig. 6). The desire is to have the antenna in an "EMI quiet" location so it can listen effectively to the desired signal with a high SNR.

Some ECATT solutions offer the opportunity to improve a system's grounding, reduce internal bias, and lower radiated RF signal noise. The ECATTs can be used alone or with other mechanical fasteners to optimize the grounding solution—not only for the initial design, but more importantly also for the longer-term use of a device.

The latter is particularly beneficial, because shock, vibration, coefficient of thermal expansion (CTE) mismatch, corrosion of contact points, rubbing, debris, and other factors can all lead to changing internal contact resistance. Internal bias thus increases, leading to reduced antenna performance with time and usage of the device. The ECATT can potentially reduce these problems, avoiding any significant degradation in antenna performance over the long term.

Create A Thermal/EMI Hybrid

EMI in the latest higher-frequency systems has opened the door to new thermal and EMI hybrid material solutions. Requests for multifunctional material solutions have certain manufacturers now combining a thermal interface material pad with an EMI absorber. ECATTs are being made with enhanced thermal conductivity to provide bond line gap EMI shielding, plus electrical and thermal connection performance between substrates.

Jeff McCutcheon is a senior technical specialist at 3M responsible for technical and application support for the 3M EMI & Thermal Materials solutions to the electronics marketplace. He has been with 3M for 17 years. Previously, he worked for various electronics companies such as Seagate Technology working on components used in hard-disk drives. He holds a BS in engineering from the University of Minnesota. He can be contacted at jeffmccutcheon@mmm.com.