

A Basic Overview of EMI Shielding Techniques & Concepts

Suppress noise in your electronics with these EMI shielding techniques, including some new shielding options from advanced electronic materials companies.

As modern electronics continue to run at higher speeds, high frequencies, and higher densities, electromagnetic interference (EMI) has become more difficult to address. Reduction of EMI in electronics design is sometimes seen as quite esoteric and is often overlooked by many designers. Designers may not realize they have EMI problems until a prototype is sent out for EMC testing, creating delays in production schedules and product launches as the design is debugged and reworked.

EMI problems can originate from multiple places in a PCB layout. The exact cause of an EMC testing failure can be a mystery without the right measurement equipment and some experience. As a result, designers will often try every possible PCB layout change until they manage to pass an EMC test, or they end up settling with bulky metal shielding applied to some components. However, there are some EMI shielding techniques that focus on the enclosure rather than the PCB layout. These more sophisticated solutions are being enabled by a range of advanced materials, which can eliminate failed board spins, redesigns, and production delays.

This whitepaper will serve as a basic introduction to these effective EMI shielding concepts and solutions.

■ The Need For EMI Shielding

All EMI shielding performs the same function: when an electronic device is placed inside some type of EMI shielding, the shielding helps prevent external electromagnetic radiation from inducing noise in the device. Shielding works both ways: if an electronic device emits excessive noise, shielding helps contain the emitted electromagnetic radiation and prevents it from interfering with an external device. EMI shielding can be made from a large conductor, or it can be an absorbing dielectric. The former tends to be more effective, but the latter has become a more viable option for compact low-cost electronics.

Any engineer that remembers their physics classes probably remembers a Faraday cage. Conductive EMI shielding is tied back to ground so that it provides the same effect as a Faraday cage. However, just like a Faraday cage, conductive shielding is bulky

■ Common EMI Reduction Techniques

Layout engineers have multiple tools at their disposal to combat conducted and radiated EMI. While there is no substitute for best practices



when creating a PCB layout, some EMI problems require specific solutions that fall in one of the following areas:

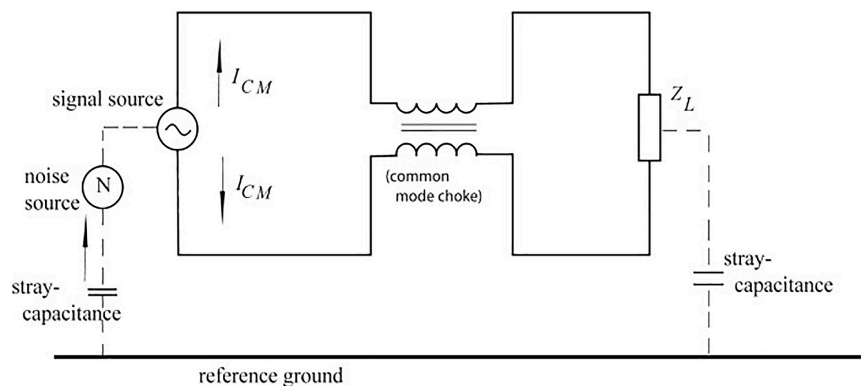
Circuit-level solutions generally target conducted EMI in specific frequency ranges or specific noise sources with filter circuits. Chokes are often used to remove common-mode or differential-mode noise in a number of systems as a standard practice, such as in MII routing in Ethernet and in power converters. If any radiated emissions induce noise currents into the system, a circuit-level solution is convenient for removing unwanted conduction currents in critical portions of the system.

Board-level solutions are arguably the most common ways to attack EMI. Via fences, gridding out the board with ground pour, guard traces, EMI shielding cans, and sophisticated electronic bandgap structures are all used to prevent reception of radiated EMI in a huge range of designs, including advanced high-speed digital systems and RF systems. On a PCB, it's difficult to find a designer who doesn't use copper pour to provide shielding and isolation between board sections.

Coatings, tapes, foams, and elastomers are also useful board-level solutions as these materials can act as absorbers, although they tend to be less common than other board-level methods. However, certain materials can provide broadband absorption at GHz frequencies, allowing problems like edge emission in modern mmWave devices to be addressed. Some recent research has also shown that conformal coatings can be used as absorbers that target board edge emissions.

Oftentimes, when a layout engineer encounters an EMC testing failure, they tend to throw every possible PCB layout change at the problem until it goes away. This can include everything from increasing layer counts with additional ground planes, high density via stitching, and re-routing signals on inner layers to try and solve the problem. These solutions are seen as cheaper than other solutions, yet they tend to be less effective, and a designer may end up settling on an enclosure solution to solve the problem.

Enclosure-level solutions are often a last resort that targets radiated emissions from the board. This generally involves placing a metal can within the enclosure and tying it to ground to provide shielding. While this is effective for radiated emissions, it can create a new EMI problem in the form of common-mode noise due to parasitic capacitance between grounds in the system. Common-mode chokes are then used to remove the coupled noise, but a choke can become susceptible to noise coupling via its winding capacitance if return paths in a nearby ground plane are not well-defined.



From the above EMI reduction techniques, it should be evident that comprehensive solutions that cover every EMI problem are difficult to find. A combination of methods is often required to ensure sufficient noise immunity and successful EMC testing. Today, innovative electronic materials companies are innovating new board-level and enclosure-level solutions to help shield, suppress, or absorb EMI in advanced electronics. These solutions can provide more flexible options should the typical PCB layout changes and enclosure shielding solutions fail to deliver results.

▪ Alternative Solutions

Circuit-level solutions are the standard practice for removing conducted EMI, but radiated EMI suppression does not have such simple solutions. The major challenges involved in providing shielding for radiated EMI without creating new noise problems are seen at the board and enclosure levels. Board-level solutions take time and experience to implement. Incorporating these into a PCB layout might spark a series of failed prototyping runs while experimenting with different solutions. Enclosure-level solutions are known to create new noise problems due to difficulty in implementing a clear grounding strategy, and the range of options for radiated EMI suppression from enclosures has typically been limited to Faraday cages.

This is where targeted solutions with shields of varying dimensions is a superior strategy for combating radiated EMI. As a leader in the advanced electronic materials industry, Laird Performance Materials produces a line of EMI shielding solutions that can be easily incorporated on an existing board and enclosure. In many cases, these materials can be applied directly to the noise source, allowing their usefulness to be assessed immediately. Additionally, they can be incorporated in volume

production without major modifications to the design. A brief overview of Laird's shielding material solutions are summarized in the table below:

		EMI Target
Surface-mount shielding	Available as one-piece or two-piece shielding cans that mount directly to the board.	Emissions from specific circuits or components
Grounding contacts	Metal and foal SMD contacts provide a low-impedance bridge across two ground regions inside an enclosure.	Emissions from ground loops
Gaskets	Available as foam or elastomer materials as well as metal gaskets, used to seal enclosure openings with low compression force.	Emissions from large to small openings in enclosures
Form in Place	Another class of shielding material that can be molded to compartmentalized surface irregularities.	Emissions from small openings requiring a molded seal

■ Laird Has Your Targeted EMI Solutions

Reducing EMI at the board and enclosure levels without compromising on form factor can be difficult without the right shielding components and materials. Instead of working through repeated changes to your enclosure or layout, take advantage of Laird's line of EMI shielding materials. Laird's flexible options let you create a custom solution that provides broadband EMI shielding without compromising form factor.

[Contact Laird](#) today to learn more.