Solving EMI Challenges: Choosing an EMI Material

A Guide to Materials and How to Rectify EMI Issues

Overview

Electromagnetic Interference (EMI) is an issue in all electronics that can often be mitigated during the design process. But what happens when you find an EMI issue too late and your design is already set? This article discusses how to address EMI challenges found during testing post-design, including a guide to the various materials utilized in these solutions. This knowledge can save you costly redesigns and vastly improve customer satisfaction.

WHAT IS EMI?

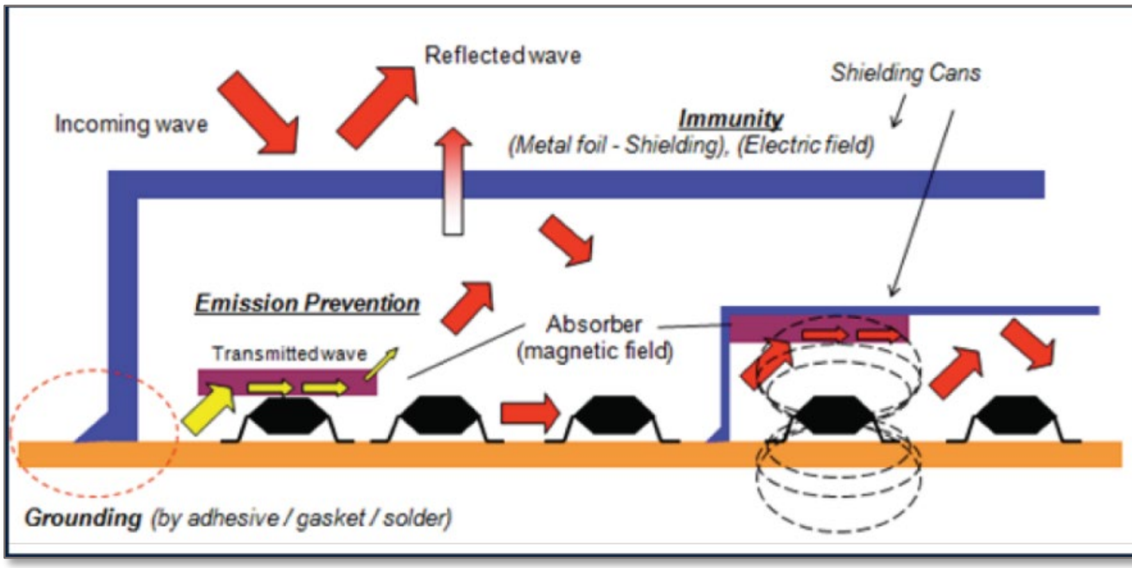
Electromagnetic Interference (EMI), sometimes called Radio-Frequency Interference (RFI), is a disturbance (either permanent or transient) in an electrical signal caused by an electric or magnetic source. This interference hinders the way devices function as they must be able to process electrical signals in order to operate. By disturbing these signals, EMI can cause degradation of circuit performance, increased error rates and data loss, performance interruptions, or complete device failure.

EMI sources range from surrounding electronic devices to power supplies, or even environmental factors such as lightning or the sun. As integrated and multifunctional devices become standard in homes, public, and businesses, each device can cause others in close proximity to experience EMI issues. For innovation and quality to continue to improve, all EMI issues must be properly addressed.

For more on EMI, designing your application to mitigate EMI from the start, and testing protocols for EMI, see Boyd's article: EMI/RFI Considerations & Choosing Your Solution: A Guide for Designing to Prevent EMI and How to Fix it Post-Design.

IDENTIFYING POST-DESIGN EMI ISSUES

When an EMI concern is identified after the design phase is complete, there are still several options for resolving the issue. Adding new, efficient components designed to control or negate specific EMI issues utilizing specialized engineered materials is often an affordable and timely solution. The first step is to identify the exact cause of the interference.



Major EMI Material Installation – illustration of EMI material Solutions

Grounding

A grounding check is the simplest and most common diagnostic tool for identifying EMI noise. When performing a ground check, keep in mind that the grounding is relative to the application, not ideal conditions. For instance, an aerospace application may be grounded differently than a home use device.

To address grounding issues, you will want to avoid creating “bias” voltage that can act as a signal transmitter by inserting an electrically conductive component that acts as an interconnect to optimize grounding. You have several material types to choose for this component such as a conductive foam, adhesive, polymer, or a fabric-over-foam.

Shielding

Once the EMI is identified as a shielding issue, the most common solution is to isolate “noise” from external sources (immunity) or internal radiation (emission) that influence data transmission and avoid radiation leakage from poor installation of the shielding material. Appropriate shielding materials include conductive foams, conductive pads, metal enclosures, metal foils, metalized cloths, or even conductive glue or epoxy. The ideal solution will depend on the dimensions available, performance requirements, and other design specifications.

Absorber Lamination

If EMI noise persists once grounding and/or shielding solutions have been investigated or introduced, absorber materials are the next solution to evaluate. To select the proper absorber material, it is critical to understand the frequency range causing the noise. Electric noise suppression sheets, magnetic materials, or a combination of both are common EMI absorber materials.

KEY CHARACTERISTICS TO HELP IDENTIFY THE BEST MATERIAL

Lower Surface Resistance (Ω/sq.) / Lower Contact Resistance (Ω/in^2)

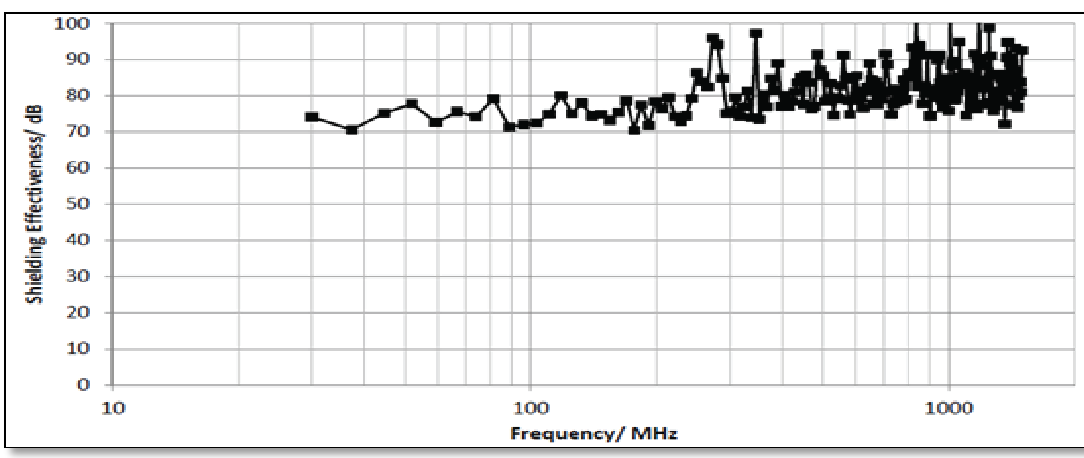
This critical measurement shows grounding performance in ohm/in^2. Contact area will affect conductivity performance. The same material with a larger contact area will offer better grounding performance. If higher performance is required but larger contact area is not available, a higher conductivity material may be needed to achieve improved grounding performance.

The unit for surface resistance is ohm/sq. and this is not related to the contact area size nor does contact area size correlate to performance. A product with a larger footprint will not have higher performance. Contact resistance is the measure of Z-axis resistance.

Better Shielding Capability (dB)

A shielding enclosure is often a preferred way to provide immunity or prevent emission internally. Material shielding effectiveness is measured according to ASTM D4935.

Interpreting Shielding Effectiveness Data – The lowest point in the data offers the least protection:



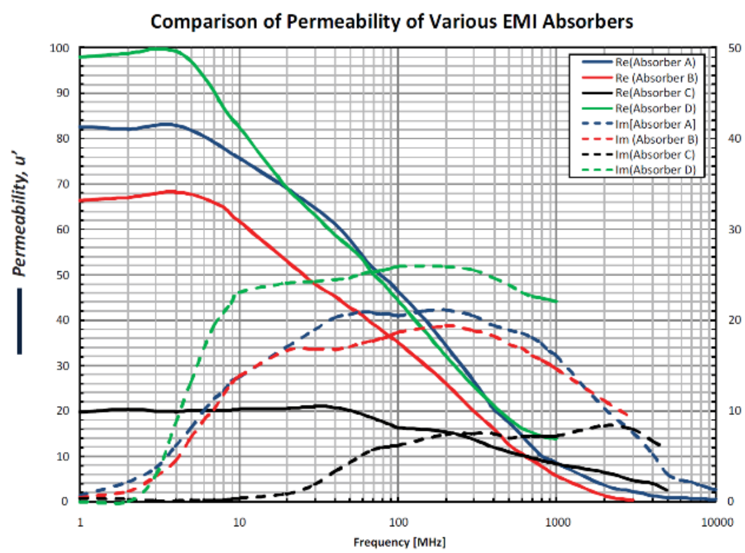
Devices with a higher shielding effect will experience less signal loss. Generally shielding in thinner materials is lower than thicker materials.

Proper Frequency Range Absorber for EMI Noise Absorption (permeability u', u")

EMI absorbers eliminate undesirable radiation that could interfere with a system's operation. Absorbers can be used externally to reduce the reflection from or transmission to devices and can be used internally to reduce oscillations caused by cavity resonance (enclosed space).

Absorbers most often consist of a filler material inside a material matrix. Filler materials consist of one or more components that absorb radiated noise. To choose the appropriate absorber, you must test permeability at the specific frequency level causing the EMI performance issue. See the table below, the material that correlates to the performance requirements is the correct material.

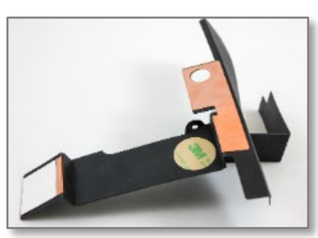
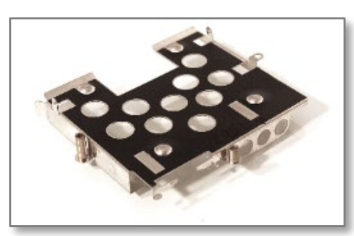
Select a higher u' permeability with lower u" (magnetic loss) after the problem frequency range has been identified (e.g. GSM working at 600 - 800MHz, Wi-Fi working frequency at 2.4GHz). A thicker absorber has better absorption capability if the space is available.



T***o learn more about the characteristics to help identify the best material to utilize, read Boyd's article: EMI/RFI Considerations & Choosing Your Solution: A Guide for Designing to Prevent EMI and How to Fix it Post-Design.***

UNDERSTANDING COMMON EMI MATERIALS

When choosing the solution to address your EMI challenges, it is important to understand your material options and their uses and benefits. There is no standard solution for EMI as it varies by cause, frequency, use, and application requirements. The wrong material may not resolve the disturbance, and it might even cause a whole new set of challenges. This is a quick guide to material types and when they may be a viable option to consider.


Shielding Solutions & Materials

EMI/RFI Shielding solutions balance electrical conductivity, dielectric permittivity, magnetic permittivity, and physical geometry to inhibit the transmission of EMI/RFI. Generally, shielding first deflects electromagnetic waves with reflective surfaces which then heats the shield, making moderate electrical and thermal conductivity important characteristics of an EMI/RFI Shield.

POPULAR METALS FOR EMI SHIELDING

Aluminum
- High Conductivity
- High Strength-to-Weight Ratio
- Non-Ferrous

Copper
- High Conductivity
- Solderable
- Non-Ferrous

Copper Alloy 770/Nickel Silver
- Corrosion Resistant
- Solderable
- Permeability of 1
- Non-Magnetic

Tin Plated Steel
- Tin Plating enables Soldering
- Low Cost
- Ideal for kHz to Lower GHz Range

POPULAR SHIELDING SOLUTIONS

Tapes

Electrically conductive tapes are a cost-effective way to mitigate EMI shielding and grounding issues. Tapes are lightweight, require little space and can provide additional shielding in the bond line gap for high frequency attenuation and more stable contact resistance. Tapes can also offer static charge drainage to eliminate static charge build-up.

Tapes can be made up of metal foils, fabric, and fabric and foil variations in order to meet application specifications and to benefit device performance in addition to EMI shielding.

Fabric Over Foam & Boyd's LectroShield Gasketing

Precision converted conductive fabric over foam enables reliable gasketing and shielding with a wide range of options and increased design flexibility. These solutions include material options that can perform in extreme temperatures, offer flame resistance, are abrasion resistant, and have varying compression to enable lighter solutions and additional cushioning or stiffness.

Foil and foam EMI solutions

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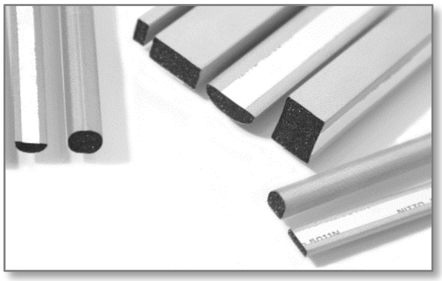
Boyd's LectroShield is designed for environments with high electronics density such as data centers and telecommunications, and can be integrated with pressure sensitive adhesives and release liners to enable faster assembly and streamline manufacturing.



Cores

- Urethane
- Thermoplastic Elastomer

Fabrics

- Nickel/Copper (Ni/Cu)
- Tin/Copper (Sn/Cu)

Pressure Sensitive Adhesive Options

- Non-conductive Tapes
- Conductive Tapes
- Non-Flammable Adhesive Tapes

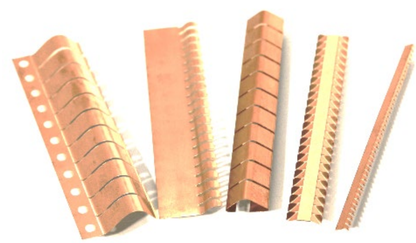
Flame Resistance Available
UL94 V0 or UL94 HB

Conductive Elastomers

Electrically conductive elastomers are ideal for applications that require sealing as well as shielding. Elastomers can be utilized in a wide range of operating temperatures, are available in a variety of filler materials that offer their own benefits and offer excellent mechanical properties.

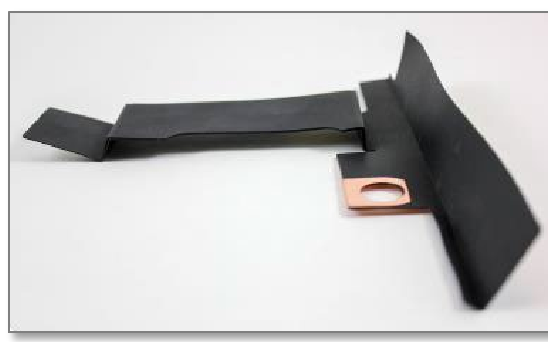
Fingerstock Gaskets

Fingerstock are lightweight, thin strip metal gaskets that are used in a wide range of applications including enclosure EMI shielding. These gaskets offer cost-efficient design flexibility without necessitating fully custom design work as they are available in a wide range of options. These options include variable dimensions, mounting, and plating types.



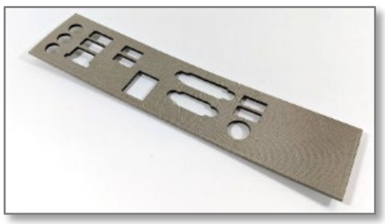
Additional Common Shielding Solutions

- Metalized Fabric
- Magnetic Shielding
- Microwave Absorbers
- Board Level Shields
- Wire Mesh
- Spring Contacts
- Vent Panels



EMI Absorber Solutions & Materials

EMI/RFI Absorption Materials rely on high conductivity, high permeability, and material thickness to reduce the amplitude of errant waves that could distort signals on electronic devices. Used primarily to eliminate emissions from cables and circuit traces, EMI/RFI Absorbers are ideal for higher frequencies, especially those used in communications. Absorbers are typically highly conformable, compressible, and cushion against vibration and shock. Incorporating EMI/RFI Absorbers can improve antenna performance, increase signal integrity and reduce emissions, crosstalk, and oscillations.



Many absorber solutions utilize Ferrite, a ceramic material that is electrically nonconductive and can be easily magnetized. Soft ferrites have low coercivity and make highly efficient magnetic cores for high-frequency components. Ferrite compounds are low cost, have excellent corrosive resistance, and are very stable.

EMI/RFI absorption materials can be customized to specific ranges, such as:

- General EMI noise absorption (1MHz – 10GHz, permeability from 20u' to 200u')
- RFID & WPC (1MHz – 3GHz, permeability from 20u' to 70u')
- Rigid NFC Ferrite (13.56MHz)
- WPC in a Rigid format (125KHz, permeability from 140 u' to 670 u')

POPULAR EMI ABSORPTION SOLUTIONS

<u>Magnetic Particle Filled Polymeric Sheets (Flexible Ferrite)</u>
These are one of the most common EMI Absorber Solutions. Flexible polymer sheets that are filled with specific magnetic flake particles, are nonconductive and can be directly applied to circuitry and noisy traces without fear of shorting out traces and IC pins.

These polymeric sheets are:

- High Permeability
- High Permittivity
- High Electrical Conductivity
- Flexible
- Ideal for High Frequencies
- Available with Adhesive Options
- Halogen Free Options
- RoHS Compliant
- UL 94 & NEMA Flame Retardant Rated Options

Conductive Foam

Conductive Foam

Conductive Foams for EMI absorption are open celled foams impregnated with carbon coating and are utilized where application requirements call for multi-functional solutions or typical EMI absorbers are not feasible.

These foams are:

- Lossy at Microwave Frequencies
- High Electrical Conductivity
- Flexible
- Compressible
- Available with Adhesive Options
- Halogen Free Options
- RoHS Compliant Options
- UL 94 & NEMA Flame Retardant Rated Options

Rigid Ferrite Cores

Solutions with rigid cores include sintered ferrite, typically Iron Oxide with Nickel Zinc (NiZn) or Manganese Zinc (MnZn). Installing ferrite cores over the affected cables increases impedance and reduces EMI noise.

Rigid cores are:

- High Volume Resistivity
- Moderate Temperature Stability
- Ideal for Low Power, High Inductance Resonant Circuits
- Available in Sheet, Bead, and More Complex Toroid or Snap-On Geometries
- UL 94 Rated Options

CHOOSING THE CORRECT PARTNER FOR YOUR EMI MATERIAL NEEDS

With growing EMI risks and an exponential rise in devices and EMI sources, it is imperative that you work with an engineered materials and converting partner that can provide a full range of services from design, prototyping, and testing to streamlined, scalable mass production.

For over 90 years, Boyd Corporation has specialized in material design, converting, and manufacturing, and has remained on the forefront of innovation for advanced, high performing materials. Boyd's decades of experience and expertise has expanded worldwide with global manufacturing across three continents with regionalized support and prototyping as well as in-house testing, design, and material expertise. This enables us to offer the widest range of innovative EMI/RFI solutions, chosen and designed to optimize your device, and solve the most challenging EMI issues.

Boyd also provides engineered material solutions spanning most major industry needs as well as thermal management solutions, systems and services to provide a strong and supportive supply chain for requirements beyond EMI/RFI. If you are unsure about your next steps in solving your current and future EMI challenges, consult with a Boyd engineer or Materials Expert at any time during the process.

To receive more information or schedule time with a Boyd Engineer regarding EMI & Engineered Materials, visit our website.