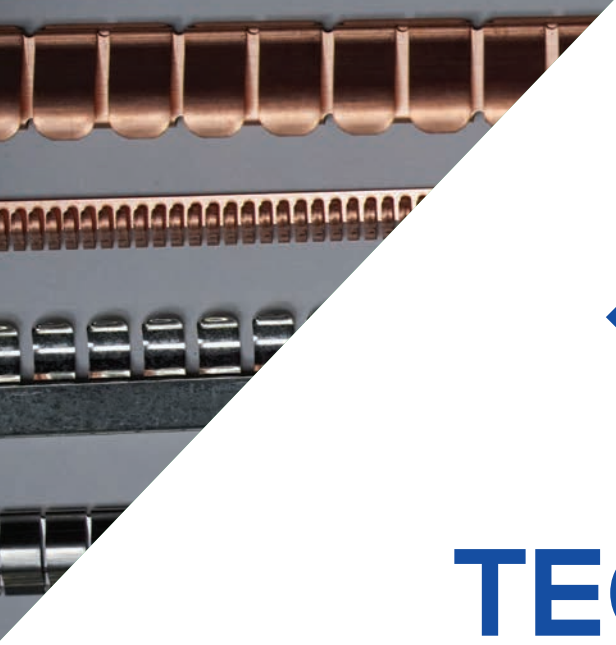


TECH|ETCH

EMI/RFI SHIELDING WHITEPAPER

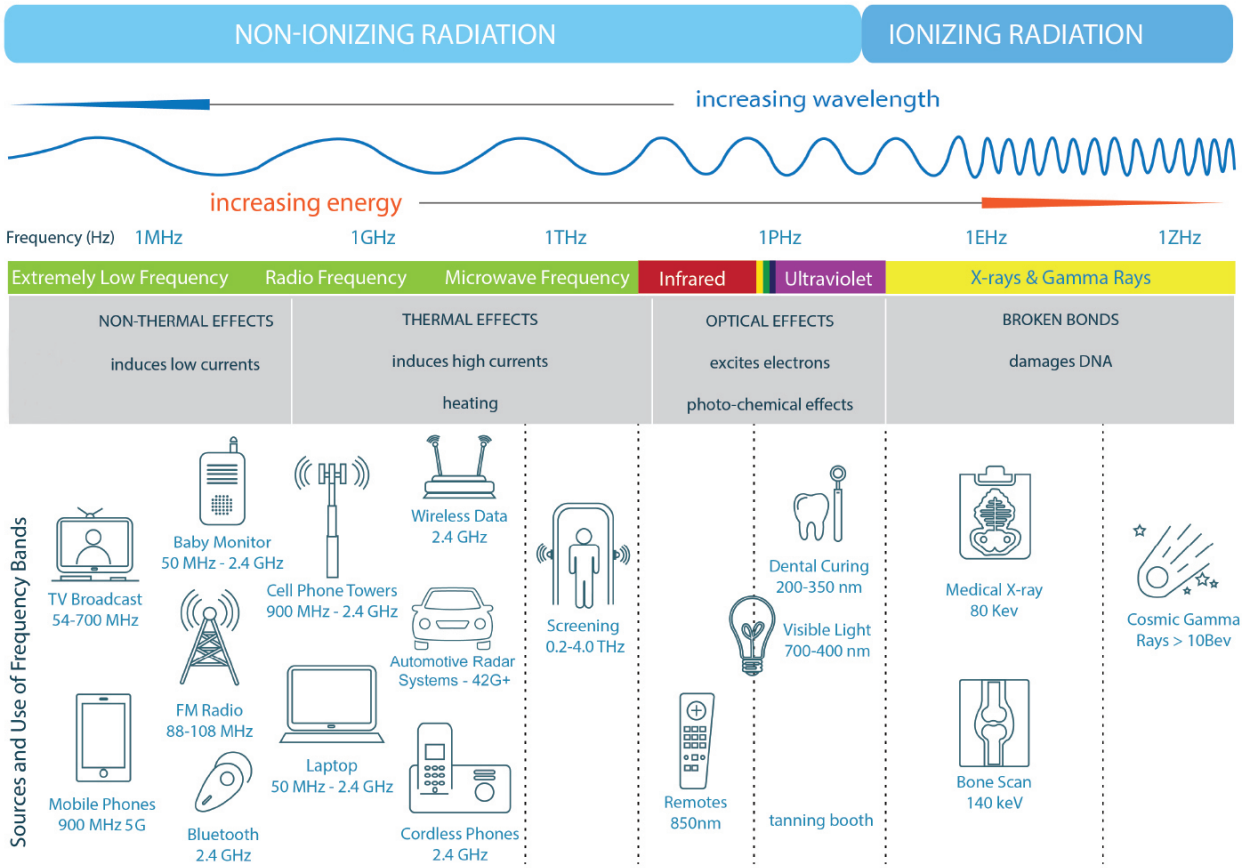
1

INTRODUCTION

Electromagnetic Interference (EMI) and Radio Frequency Interference (RFI) reduce signal integrity and quality of communications devices and systems. Signal disturbances can come from external sources like radios and cell towers, as well as internal sources within the device, such as microprocessors. By blocking external electromagnetic waves and preventing internal sources from interfering with the device, EMI/RFI shielding reduces signal disturbances and device malfunctions. As the use of electronic devices continues to grow through every major industry, so does the market for EMI shielding.

WHAT CAUSES EMI/RFI?

Communication devices emit electromagnetic radiation (EMR) in the form of waves; the most common examples include radio waves, microwaves, infrared light, ultraviolet, X-rays, and gamma rays. Here's a visible representation of where each falls on the electromagnetic spectrum:



Note that the frequency of a wave is inversely proportional to its size; the lower the frequency, the greater the wavelength, and vice versa. When in use, all electronic devices will produce radiation that falls somewhere on this spectrum. These radioactive waves disturb the signals going to and from other devices as they travel, at times resulting in unsent or corrupted data. As communication devices continue to trend faster and smaller, EMR frequency goes up and wavelength size shrinks. Smaller wavelengths are more difficult to contain or prevent, causing more external interference issues as well as problems within larger devices and systems. Internal radiation can also travel along wires and circuit boards, causing additional interference throughout the device.

Another issue that affects the quality of EMI shielding is cavity resonance. Cavity resonance occurs when an electromagnetic frequency's wavelength is similar to that of a circuit or shield, causing a resonance that disturbs the signal.

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HOW DOES IT AFFECT MY DEVICES?

The general trend in technology is to make a product that is faster, more convenient, and all-in-one. Automobiles, aviation equipment, and medical/military devices continue to be equipped with new high-speed electronics, all of which emit EMR and can be affected by it as well. Cell phones, computers, GPS, WiFi hotspots, and radios can all cause interference. While radio static or a bad cell signal present little more than an inconvenience, there is far less margin for error when it comes to automobiles or medical devices.

Another issue to consider is that engineers often develop technology for multiple uses. While it might not seem necessary to incorporate EMI shielding for a feature that will be installed in a television, that same technology might eventually be used in a commercial automobile's infotainment system.

Excessive radiation may interfere with the vehicle's other features and displays.

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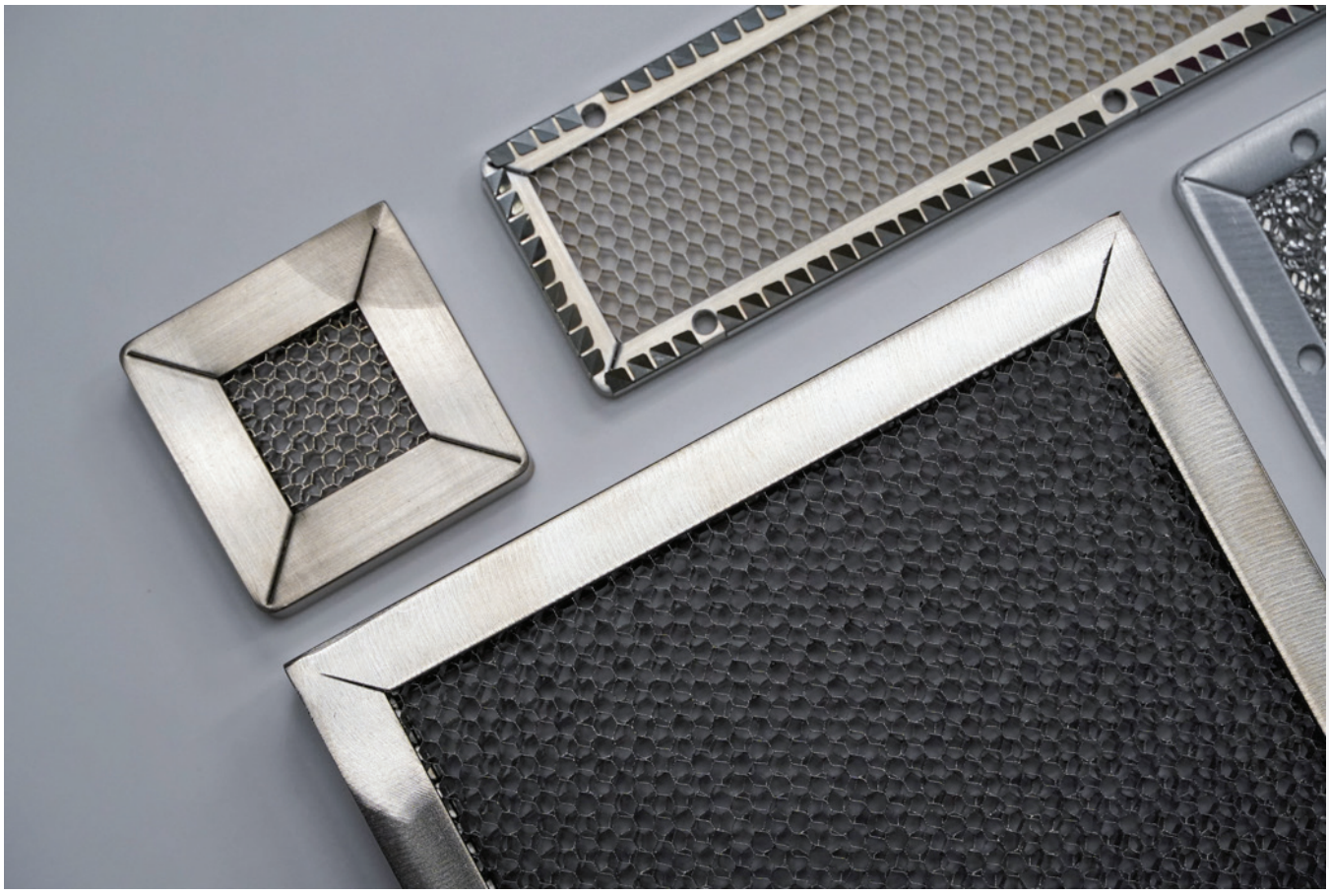
A GROWING MARKET

With the growing use of communication devices and increasing prevalence of built-in features, secure EMI shielding has become a necessity. 5G networks, which produce tremendous amounts of EMR, will only continue to expand with time. The recent push in the automotive industry to use nonmetallic components, though better for the environment and the consumer, has also made commercial automobiles more susceptible to interference from external sources. Autonomous transport and self-driving cars depend greatly on electronic sensors, cameras, and GPS devices to assure passengers a safe trip and protect them in the event of an accident. The latest cars and trucks can carry over 100 networked microprocessors running upwards of 150 million lines of code. Some of these devices are purely for convenience and others are for safety – but functioning communication across the network is necessary to operate the vehicle safely and comfortably. All of these items emit EMR, and all can be protected with EMI shields.



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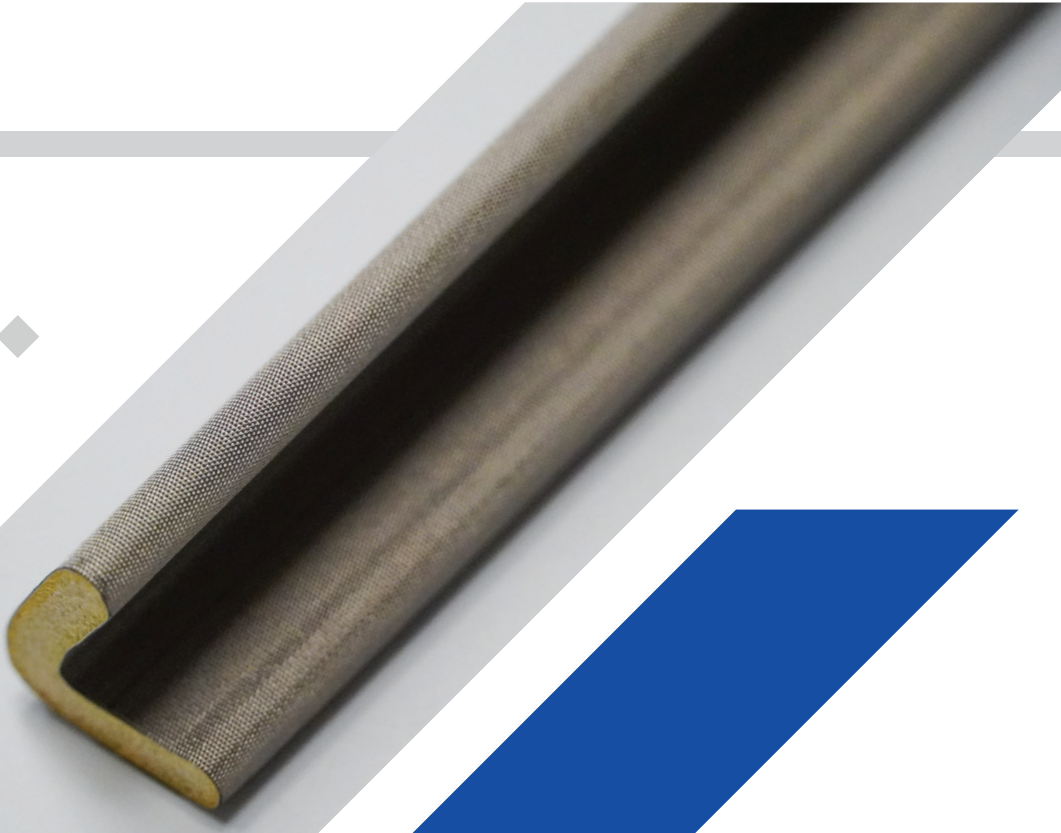
ELECTROMAGNETIC COMPATIBILITY STANDARDS AND TESTING

New devices must pass Electromagnetic Compatibility (EMC) compliance testing before the first production run. EMC standards and tests are designed to ensure that new devices a) do not emit a level of radiation that could result in emissions and susceptibility issues.

While EMC tests can only be conducted at a certified testing facility, manufacturers and suppliers are strongly encouraged to run pre-compliance tests beforehand. An EMC compliance test failure can be extremely costly and time-consuming, especially if a device or component needs to be redesigned. It is far easier and more cost-effective to run precompliance tests.



HOW IT WORKS

Engineers and designers employ a number of techniques to prevent signal interference from EMR, such as circuit grounding or using separate wire conduits. While useful, advancements in communication technology present an ongoing challenge for developers to create effective and affordable shields for various devices and components. Among the most common materials for metal shields are copper, pre-tin plated steel, and aluminum.

A shield's ability to absorb and reflect electromagnetic waves to reduce interference is known as shielding effectiveness, or SE. Effectiveness is determined by two measurements - the level of external and internal EMR reflected away from the circuit, and the level of radiation absorbed by the shield. SE is measured in in terms of radiation loss, with loss referring to the amount of radiation under control. The greater the loss, the more effective the shield.

Because shields act as a physical barrier between circuits, most are mounted directly to the printable circuit board, or PCB. As a developer, it is important to plan for shielding as early on in the design process as possible to avoid last-minute changes and additions to the PCB after the design is finalized. An experienced designer knows what types of circuits emit the highest levels of radiation and which are most susceptible to outside noise. Early planning and preliminary EMC testing provide developers significant savings in both time and money.

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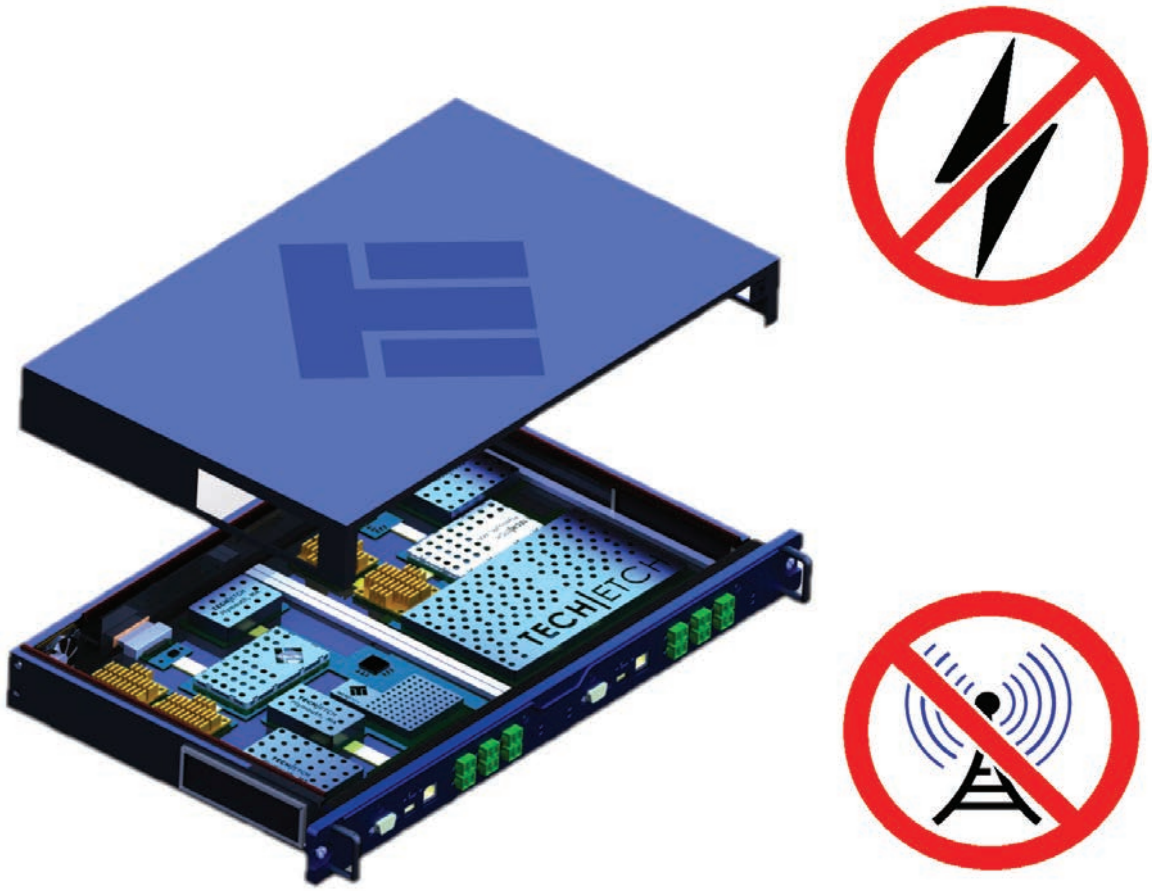
EMI SHIELD DESIGN AND FEATURES

A standard EMI shield is a small metal box covering a specific component or section of a PCB. Boxes are typically closed metal, metal with apertures or small holes, or metal mesh, depending on the frequencies being emitted and blocked. Higher frequencies result in smaller waves, in which case a closed metal box would be best. A lower frequency means larger waves that can be blocked by mesh or metal with holes.



The size, shape, material, and point of attachment must be considered for maximum effectiveness of a metal shield. A weak solder or clip can cause the shield to come loose or detach, and some metals are too heavy or light for their function. In addition to the device and its components, cavity resonance can also affect the shield itself. If the space inside the shield resonates at certain frequencies, EMR leaks and interference can occur – especially if the box has apertures or mesh. Using only solid boxes isn't always an option either, as they tend to restrict air flow and cause thermal buildup – another reason why it is imperative to incorporate a plan for EMI shielding as early in the design process as possible.

CHOOSING THE RIGHT MATERIAL

The Electrical / Mehcanical Engineer considers a number of factors to create the most effective EMI shield for a project:

- frequency and SE per EMC compliance standards
- allowable footprint area
- surface resistance of shielding material
- environmental sealing considerations
- cost impact to product
- availability of prototype samples
- material data and global material compliance
- ability for customer to assemble

Some metals are better at reflecting radiation and others are better at absorbing it. Generally speaking, electrically dominant incident waves reflect more strongly and are best shielded by reflection with a highly conductive metal such as brass, copper, or silver. Magnetically dominant incident waves are best countered by absorption, making a highly permeable metal like steel a better choice.

CLEANLINESS AND PACKAGING

Once an EMI shield has been developed for a specific use, the developer must take care to ensure the box is in the best possible condition prior to assembly. Finished parts should be clean, free of defects, and carefully packaged when they reach the stamper. This is measured according to technical cleanliness, which refers to the number and type of various particles (metal fragments, dust, etc.) or oils on a given part that can adversely affect its performance. Effective design, clean cuts and shaping, and regular maintenance of tools are all needed to create the most effective EMI shield for the job.