

EMI FILTERS 101: EVERYTHING YOU NEED TO KNOW



 **CAPTOR**
CORPORATION
THE MOST TRUSTED NAME IN EMI FILTERS



Motors, microprocessors, power supplies, and most other electronic devices create a certain level of high-frequency electromagnetic noise. While a common issue, electromagnetic noise can be a major problem. This is especially true in critical applications, where electromagnetic noise can degrade power transmissions and signal quality.

This problem can be remedied with electromagnetic interference (EMI) filters. EMI filters enhance overall system performance by redirecting or canceling out the noise. In this eBook, we'll discuss everything you need to know about EMI filters, including their importance, regulatory requirements, and different types.



What is EMI?

Electromagnetic interference (EMI) is electronic noise that results from electrical current switching. EMI disrupts electrical signals and compromises signal quality. All power lines and electronic devices are potential sources of EMI, but so are lightning strikes, solar flares, atmospheric noise, and other natural weather phenomena.

EMI features two main components: conducted EMI and radiated EMI. Conducted EMI is produced from power connections, ground connections, and parasitic impedances. Radiated EMI occurs via radio transmissions. In either case, unchecked EMI can lead to damaged electronics, equipment failures, connection disruptions, communication interference, and degraded power supplies.

What is an EMI Filter?

Also called an EMI suppression filter or radio frequency interference (RFI) filter, an EMI filter is a device that eliminates or reduces the electromagnetic interference from external sources and from within a given device. While they work differently across various applications, all EMI filters have the goal of minimizing damage from EMI.

EMI/RFI filters are typically an internal module or a separate device. They are common in power supplies and electronic devices. In electronics, EMI filters are usually embedded in circuit boards or are a separate component.



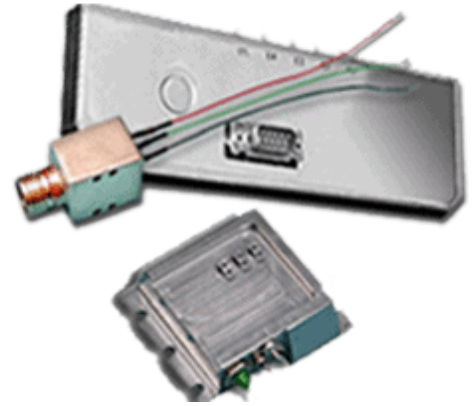
What Does an EMI Filter Do?

The EMI filter is a circuit typically made of capacitors, inductors, and resistors. The filter can identify and isolate a particular frequency or external frequency, which enables the filter to obtain a specific power signal frequency or eliminate the signal beyond an established frequency threshold. EMI filters are electrical devices or circuits that cut off the higher frequencies of electromagnetic noise found on power or signal lines.



How EMI Filters Reduce Dangerous EMI Levels

An EMI filter is made of three main components—an inductor, capacitor, and resistor—as well as relays, diodes, varistors, and chokes. The filter comprises a two-way passive network, where one end is the load and the other a power supply. When assembled, a complete LC circuit is formed.



The inductor (L) allows low-frequency and direct current (DC) power to flow without any restrictions. At the same time, the inductor blocks high-frequency currents responsible for electromagnetic interference. When blocked, the low impedance path created by the capacitor (C) directs the noise either to the grounded connection or back into the power supply.

On power lines, noise suppressed by the line filter can be divided into two separate modes: common-mode or differential mode. In common-mode circuits, the same noise generated from two or more power lines can be viewed as the noise of power lines to the ground. Differential mode circuits can be seen as noise between individual power lines.

Depending on whether it is common-mode or differential mode noise, EMI filters have different suppressing capabilities. These capabilities are generally detailed by the spectrum of the frequency in relation to the suppression in decibels.



The Importance of EMI Filters

Electromagnetic interference can degrade communication quality and even damage equipment. While these are the top reasons to use an EMI filter, there are several other compelling reasons:

Electromagnetic Compatibility

An EMI filter provides good electromagnetic compatibility within the system.

Equipment Protection

Signal interference can degrade the flow of electricity, making devices less efficient in their applications. EMI can also damage the affected equipment. Consumer devices such as microwaves, refrigerators, and televisions are particularly vulnerable to signal interference. Vital medical devices such as pacemakers, support sensors, and hearing aids also have unique vulnerabilities.

Maintain Transmission Quality

Signal interference poses a threat to the quality of communication transmissions. EMI can become powerful enough to disrupt local energy stations and power grids. In some cases, it can even cause the failure of independent power systems on military installations or remote power sites.

Data Loss Prevention

Should a computer or cloud-based interactions be disrupted even briefly, important data can be lost permanently.



Noise Regulation Compliance

Given the dangers posed by EMI, it's no surprise that strict industry and governmental regulations are in place. Electronics regulatory industries have provided rules that electronic devices must suppress noise to a reasonable level.

EMI Filter Guidelines and Standards

Filters are required to meet specific regulatory standards, which vary based on application, industry, positioning, geographic location, and other factors.

- **Application:** The EMI filter must meet the demands of its intended application. For example, in mains operations, inductor temperature rise and the minimum spacing between line, neutral, and ground must be closely monitored. These safety guidelines reduce the risk of electrical shock and fires. Capacitors are individually certified for safety, according to their position in the circuit.
- **National Standards:** In the United States, UL 1283 is the standard regulation for EMI filters. Specifically, "requirements cover electromagnetic interference (EMI) filters installed on, or connected to, 1000 V or lower potential circuits, 50 - 60 Hz, or up to 1500V DC, and installed in accordance with the National Electrical Code."
- **Industry Requirements:** The particular industry also determines what guidelines must be followed. U.S. military applications are governed by military standards (MIL-STD), while other North American sectors are regulated by the FCC and CSA/UL. Consider your industry's unique requirements before selecting an EMI filter for your application.



Types of EMI Filters

These are the main types of EMI filters we offer here at Captor Corporation:



Military EMI Filters

Military EMI filters can be custom-designed for airborne, ground, and sea vehicles. For navy applications they may require a maximum capacitance to ground limit for 50 Hz to 400 Hz per MIL-STD-461. Additionally, they must mitigate emissions between 10 kHz and 10 GHz.



DC EMI Filters

Since most power supplies utilize DC voltages, DC EMI filters enable DC and low-frequency currents to pass easily while blocking high-frequency currents. This allows for maximum functionality and the elimination of electrical noise.



Shielded-Facility EMI Filters

Shielded facility filters can protect rooms from external electromagnetic interference. Shielded rooms and secured areas regularly use designated EMI-shielded room filters.



Custom EMI Filters

We are capable of manufacturing custom EMI filters for your unique needs. Filters can be tailored to specific frequencies, voltages, applications, and sizes.

EMI Filter Guidelines and Standards

Captor Corporation is proud to be one of the most trusted providers of EMI filters. Our dedicated team can provide both custom solutions and stock EMI filters at competitive prices. Custom-designed EMI filters meet your exact specifications and are most cost-effective in the long term. Our engineers have completed over 10,000 unique designs, demonstrating our proven track record of delivering highly reliable EMI filters for signal and power lines in military, commercial, industrial, and aerospace applications.

Our standard filter solutions are rated 0-400 VDC, 0-480 VAC, 0-400 A, and DC-400 Hz. Higher currents, voltages, and frequencies are available upon request. If you have any questions about our capabilities, [contact us](#) today. If you already have a project in mind, please [request a quote](#).

Contact Us

Request a Quote

About Captor Corporation

At Captor Corporation, we specialize in creating standard and custom EMI filters for a range of electronic devices, including aerospace and military EMI filters. Each of our products is designed to keep critical systems performing in optimal and consistent condition. Browse our EMI filters portfolio page to learn more about our custom EMI filter experience.



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