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How to design with EMI in mind

EMI doesn’t have to be a late-stage surprise. Here’s how Spectrum Control helps engineers cut through the noise.

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(Image: TTI Inc.)

High above contested airspace, a military aircraft locks onto its objective, preparing to engage. But then, systems flicker—navigation data skews, a communication signal drops out. The culprit is electromagnetic interference (EMI), disrupting key onboard functions at the worst possible time.

Electromagnetic compatibility (EMC) refers to a device’s capacity to operate as intended in the presence of external electromagnetic interference, while also avoiding emissions that interfere with nearby systems via conducted or radiated paths. When that balance is off, the result is non-EMC: systems that suffer malfunction, data corruption, or outright failure.

Managing EMI is becoming increasingly difficult as electronics grow more complex and densely integrated. Today’s systems rely heavily on high-speed processors, wireless technology, RF/microwave components, and compact power supplies—all of which are more sensitive to interference while simultaneously being more likely to generate it.

As the potential for EMI increases, it becomes all the more important for engineers to address it early in the design process.

How Spectrum Control Tackles EMI Challenges

Spectrum Control designs EMI solutions for a range of sectors, including military and aerospace, medical and measurement, and telecom, industrial and energy.

"It might be a control circuit for electronic warfare, or it might be an MRI machine—the problems end up being the same no matter what industry you're in," says Jeff Chereson, Director of Engineering at Spectrum Control.

The company produces a wide range of EMI mitigation components, including board-level filters, panel mount filters, filtered connectors, and chassis mount power line filters. "The focus is on putting our EMI solutions at the point of entry into the system, where you get maximum effectiveness," says Chereson.

While Spectrum Control offers off-the-shelf solutions, customization plays an equally important role in their business, if not a larger one.

"A lot of our custom work is derivative of our catalog offerings," says Matthew McAlevy, Engineering Manager at Spectrum Control. "For example, if you have a D-sub and want selective load filtering—where our catalog D-subs will have the same filter value on all lines, we can customize that and put different circuit values on individual lines. We can do mechanical customizations for different mounting configurations and higher-end sealing or ruggedization."

These tailored solutions are shaped not just by customers' preferences, but by their EMC requirements. "Depending on the industry, you'll get a whole plethora of specs you have to meet," says Chereson. "We try to get customers to meet their EMC requirements via a filter, but often there are also power, size, safety and ruggedization constraints to work within. Some of the time, we get the specification at the eleventh hour because people don't realize they have an EMC issue."

"Doing EMC at the tail end—now you're trying to shoehorn in a filter, and it's not costed in your budget," says McAlevy. "Like with most things in design, the earlier you do it, the better."

(Image: TTI Inc.)

How to Avoid Late-Stage EMI Issues

Spectrum Control recommends taking the following steps during the initial stages of development to avoid EMI headaches down the line:

1. **Know your EMI profile and specs:** Understand the standards you need to meet, whether it's MIL-STD-461 for defense, DO-160 for aerospace, FDA for medical devices, or FCC for telecom.
2. **Filter at the entry point:** Place filters where power or signals enter the system.
3. **Design application-specific signal line filters:** Tailor the filter response—i.e., the pass band and reject band.
4. **Match and balance impedances:** Prevent reflections and EMI by ensuring proper system impedances.
5. **Apply shielding where necessary:** Shield noisy or noise-sensitive modules and interfaces.
6. **Use proper grounding techniques:** Add low impedance ground planes—avoid large loops.
7. **Wrap cables with ferrites to suppress common mode currents:** Choose ferrite materials with high loss at EMI-relevant frequencies.
8. **Use twisted pair wiring:** Twisted pairs reduce magnetic pickup and crosstalk.
9. **Limit chassis openings:** Keep enclosure apertures small enough to block high-frequency emissions.
10. **Use appropriate transient suppressors:** Choose components based on energy level and response time: TVS diodes for fast, low-energy events; varistors for medium energy; gas discharge tubes for high-energy pulses like an Electro Magnetic Pulse (EMP).

Designing for Smaller, Faster Systems

As systems evolve, miniaturization is becoming an emerging trend. "When you go up in frequency, things naturally get smaller," says Chereson. "Because things are faster, they create more EMI, and there's a need for higher frequency filtering."

Spectrum Control is addressing these demands with two new standout products: the dual-line coaxial filter and the power circular connector. The dual-line coaxial filter combines the functionality of two single-line filters and a common mode choke within a compact, hermetically sealed panel-mount design, while the power circular connector incorporates a traditional power filter circuit into a form factor traditionally only used for control line filtering. Both products help customers meet SWaP-C goals by reducing size, weight and complexity.

To keep pace with changing systems, Spectrum Control continues to adapt its filtering solutions. "Every year, different platforms and configurations come out," says Chereson. "We do all kinds of unique shaped filter elements, capacitors, and inductors to fit into different connector sizes."

To learn more, visit Spectrum Control at TTI.com.