To Shield or Not to Shield - Part 2

The Importance of Shielding in Electronics

As emphasized in Part 1 (refer to link on p.3), stray electric and magnetic fields can cause numerous problems during the operation of electronic circuitry. Some of them include: degradation of SNR and adjacent channel interference in analog and RF circuits, increase in BER in digital systems, and failure to meet power supply EMC standards. Thus, it is important to seriously consider electric and magnetic field shielding early in the design process.

Electric shielding usually entails relatively thin conductive metal alloys (brass, aluminum, etc.) where geometry of the shield can be critical for high shielding effectiveness at high operating frequencies. Magnetic shielding involves thicker soft magnetic materials whose permeabilities are greater than unity. They divert the stray low frequency magnetic fields by inducing them via flux lines within the materials themselves. The magnetic energy converts to heat or ohmic losses, which is commonly referred to as absorption loss. This loss is directly proportional to permeability, thickness and conductivity.

The materials to choose from appear to be quite vast and have more properties to become familiar with versus their electric counterparts, due to their nonlinear and hysteretic nature. Ferrites, powdered irons, mumetal, etc. all have varying performance in relation to frequency, saturation and temperature, where Perm rolloff at higher frequencies, strong magnetic strength and/or extreme temperatures is possible, depending on the material chosen. Even high perm ferrites will lose shielding effectiveness, if encapsulated or physically stressed improperly due to the magnetostriction phenomenon.

Alternative Methods to Shielding: Avoid Overkill

It is important to note that shielding can add cost, size and weight needlessly in some applications, where shielding is not critical. Assess the circuit design for limited grounding points and loops, circuit loops acting as magnetic dipole antennas, the number and power levels of all magnetic components, clock oscillators, switching transistors, wireless RF or microwave paths, and coexisting Signal & Power PCB traces and cabling.

Clever positioning of an unshielded inductor may be all that is needed. Magnetic field strength and coupling decreases considerably by maximizing the gaps between inductors and transformers. The mutual inductance is inversely proportional to the square of the gap between them. It also helps to orient them 90 degrees from each other (orthogonal positioning) to minimize the coaxial components of the flux lines coupling with each other. Even a “cross” pattern directly in line between a pair of inductors on the top and bottom side of a PCB assembly can also aid in preventing EMI issues. Keep in mind that closed magnetic core constructions (toroids, EE, pot cores, as some examples) and distributed and multiple discrete air gaps aid in magnetic shielding in and of themselves, by concentrating more of the magnetic flux generated within their magnetic paths, as opposed to the surrounding space.

Another EMI prevention design tip is to connect the start lead of an inductor to high dV/dt switching nodes in the circuit, as that varying AC flux can be shielded by outer windings, as opposed to connecting the opposite end where radiative emissions and susceptibility increase on the outer windings. Gowanda Components Group (GCG) can identify the start wire, per your requirements.

Testing of Shielding Effectiveness can be Achieved from Component to Circuit to System Level

There exist many standards and testing methods to assess how well shielding has been implemented in a design. This enables, at times, to add shielding at all stages of product development from the conceptual all the way to production. Shielding levels can be tested by GCG or in the field, for example, by the popularly implemented Percent Coupling method, specified in MIL-PRF-83446D. Typically, the pair of inductors under test are configured in the series aiding or series bucking scenarios. A maximum value of 3% of magnetic shielding is found to be very good for a magnetically shielded part. Typically, some electric field shielding occurs, also, due to the addition of conductive metallic materials.

GCG Ready to Support your Application with a Myraid of Standard & Custom Devices

There are many standard shielded design options available from GCG, in which self-shielding, closed magnetic loop, sleeved, “canned” and/or magnetically loaded compounds are integral to superior design, quality and reliability. Customization of inductors, transformers, EMI suppressors, solenoids, antennas, and proximity switches from our Engineering Team in form, fit and/or function are achieved on a daily basis, based on your requirements and preferences. Validation of your specifications, electrical, thermal, mechanical and chemical, are routine for GCG’s advanced Space-level Test Lab. GCG’s ruggedized axial-leaded ER17S inductor series, with one of the highest reliability ratings in the global magnetics industry, Level R Qualified under MIL-PRF-39010, exhibit excellent inductance, quality factor (Q), and magnetic shielding, with performance exceeding 100 MHz for many signal and RF circuit applications. Its molded encapsulation and thick leads are virtually impervious to damage in extreme temperature and mechanical vibration environments. One of the compact SMT counterparts is the iron-shielded SMRF3013S series, where GCG proprietary design and automation processes provide a precisely reliable shielded, wound and internally soldered magnetic solution. The ferrite-shielded SMRF1512S series is extremely efficient with Q’s exceeding 100, operating frequencies reaching into the VHF and UHF wireless bands, all built on a tiny alumina substrate, where gold-plated terminations, temperature stability and high-mechanical strength are key.

ER17S

SMRF1512S

SMRF3013S

Gowanda's expansive selection of Power Toroidal constructions are good self-shielding options. For example, the 050KMVSM high-performance Kool Mu powdered iron cores feature an SMT thermoset mount designed and molded by GCG's own Tech Center. Self-shielding and potted Common mode chokes, such as the CMF61SM series, are excellent for Power EMI filters for containment of radiative EMI, but also for minimizing Common mode and differential mode conducted EMI noise due its inherent cancellation of opposing flux lines.

050KMVSM

CMF61SM

IN CONCLUSION

Shielding is a common and effective method to solve radiative EMI issues with inductors. Shielding can be accomplished by utilizing physical barriers made of specific metal or magnetic materials. Alternative methods to shielding can be considered. As with all electronic components, cost/performance tradeoffs should be evaluated when deciding to shield or not to shield.

LINK

To Shield or Not to Shield - Part 1

If you have any questions about this Technical Tip, suggestions for future Technical Tips, or need assistance with our standard or custom products, please contact us.

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