10 Commandments of EMC Design

To make a system immune from degradation or causing degradation of adjacent devices by emitting electromagnetic energy, filtering, shielding/grounding, and system design techniques can be employed to achieve Electromagnetic Compatibility.

1. Know your EMI profile and specifications you need to meet

- Typical military governing specifications (MIL-STD-461, DO-160)
- FDA, FCC, automotive industries have governing specs also

2. Filter at immediate entry point to system

Power Filter Installation

- Figure A: incorrect
- Figure B: correct

Fig. A

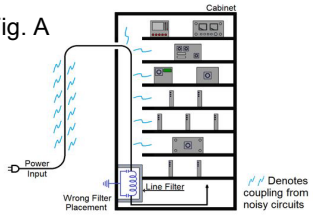
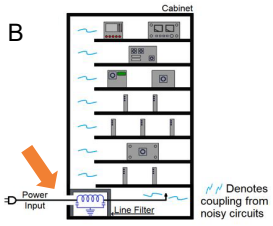
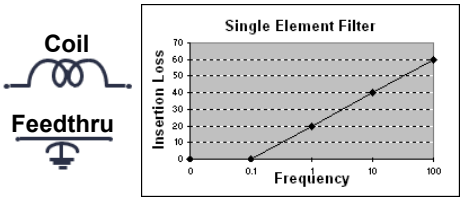


Fig. B

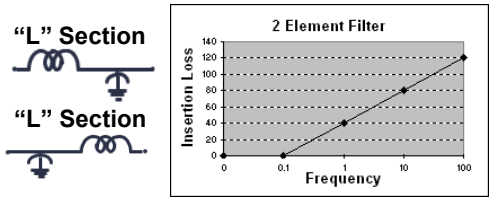


3. Design filter for I/O and signal lines with response tailored to the application

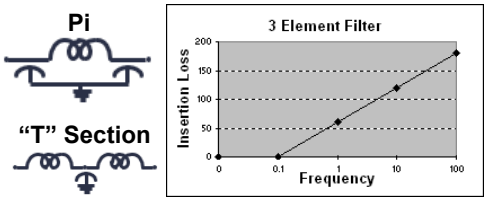
- Low pass filters are the most common filter type to solve EMC issues
- Depending on reject band insertion loss different filters provide necessary performance



20 dB per Decade



40 dB per Decade

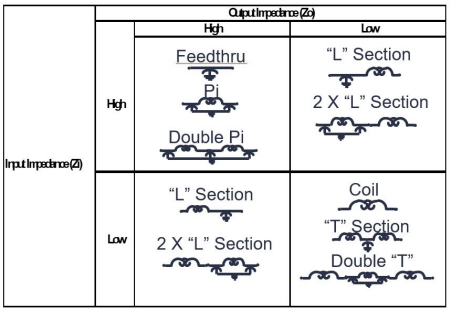


60 dB per Decade

4. Match and balance system impedances

Common Design Considerations

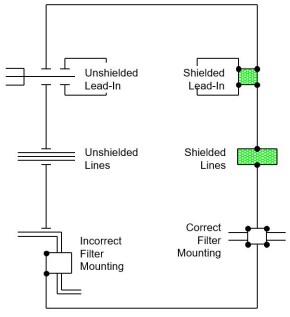
- Low impedance looking into high impedance
- High impedance looking into low impedance
- Impedance balancing on differential pairs
- Impedance of high-speed digital signals



5. Shielding: shield noise emitting or noise susceptible modules and devices, modules, circuit boards, interfaces (ground layer)

Common Mistakes

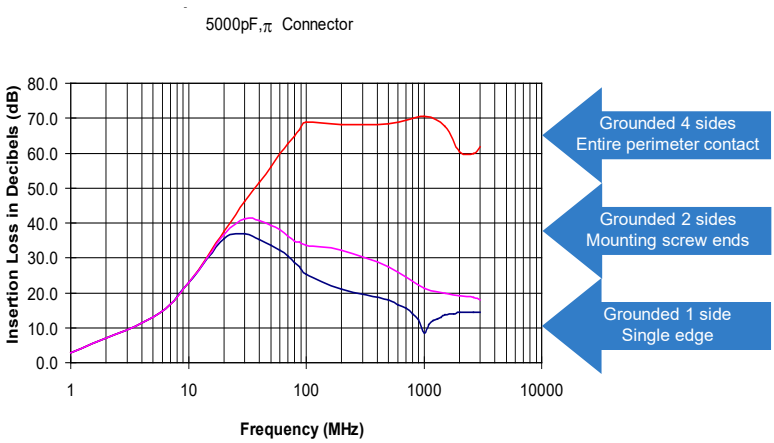
- Insulated wire passing ungrounded through chassis
- Shielded wire passing through chassis inadequately terminated
- Ground on outside of chassis then wire passing through chassis



SPECTRUM CONTROL

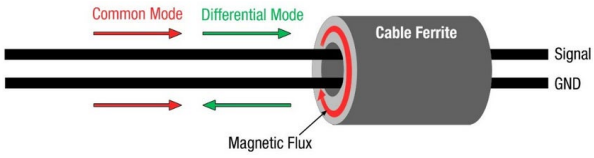
6. Grounding: provide adequate grounding to boards and modules including multilayer board ground planes to isolate power from signal circuits for EMI paths. Material surface finishes and plating's designed for low resistivity: 3milli-ohm / sq cm.

- Isolate signal and power grounds, also, add ground plane on multi-layer boards to separate
- Avoid long ground connections and traces to avoid ground loops
- Provide as many points of contact to substantial ground planes
- External power returns with dedicated wiring *[avoid power return through chassis]*
- Separate input and output (I/O) cables to avoid coupling *[bundling]* and use different connectors for power and signal
- As shown in figure, fully ground interface connectors



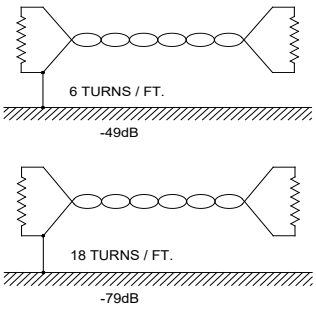
7. Ferrite cores for common mode emissions around input power, signal, coaxial lines, etc. for common mode emissions

- Apply ferrite beads/ sleeves in a common mode configuration
- Ferrite materials have a Real and Loss component (complex permeability u")
- Loss component is beneficial at frequencies above cross over in EMC applications



8. Twisted pairs at 18 turns / foot to minimize magnetic pick-up

- Field cancellation and cross talk reduction
- Differential voltage: same on both wires
- Dielectric constant: improves with tighter twist
- Better isolation from outside influences
- Makes wire equal distance from noise source



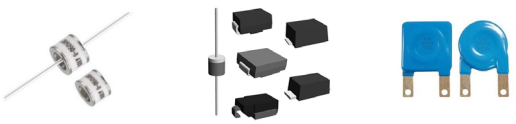
9. Keep all apertures to less that lambda/20

- Depending on frequency of operation, openings in chassis affect EMC compliance
- Simplified equation 591/f(MHz) = aperture max. inches

Frequency	Maximum gap	Frequency	Maximum gap
120MHz	4.92 inch	1.5GHz	0.394 inch
600MHz	0.98 inch	3GHz	0.197 inch

10. Use correct transient suppressors for transient speed, power, and parasitics

Common Types: ESD, lightning, EMP/HEMP



GDT TVS MOV

Style	Relative Energy Capability	Speed	Parasitic
Diode	Low	Fast	Med
Varistor	Med	Med	High
Gas Discharge Tube	High	Slow	Low