

EMI, EMC, and UMF in DC Fans

Electromagnetic Interference (EMI)

Identifying the offending interference problem in a system can be difficult. To help in establishing a common language as a basis for understanding interference problems, a discussion of the effects of different types of interference and the possible methods of controlling them follows.

Electromagnetic Interference (EMI) sometimes seems to be the general catch-all term. In fact, it is a generic term for unwanted interference energies conducted as currents or radiated as electromagnetic fields. Radio frequency interference (RFI) is the older term used interchangeably in particular by the regulatory agencies.

The Federal Communications Commission (FCC) and other agencies, such as Germany's Verband Deutscher Elektrotechniker (VDE) have established rules governing EMI emissions.

The FCC Part 15 Subpart J (Docket 20780) deals with electronic data processing equipment, and applies to devices that generate pulse rates in excess of 10,000 pulses per second and use digital techniques. Equipment covered under Subpart J is broken down into two classes:

- Class A - Covers computing devices used in commercial and industrial and business applications.
- Class B - Applies to computing devices used in a residential environment.

Figure 1 demonstrates Class B limits are much more stringent, requiring additional design effort to assure compliance. Every component and subsystem must be carefully scrutinized ahead of time to assure that the goals will be met.

The main design goal is to meet and, if possible, reduce emissions well below Class B, provided costs are within tolerable limits. Frequently, careful design and layout will yield these results at no extra cost.

EMI currents in the fan power leads are referred to as conducted EMI and are usually more of a problem than radiated EMI. In fact, when dealing with brushless DC fans, conducted EMI is normally the only concern. Differential mode EMI is conducted on the power leads of the fan from the power switching transistors used for switching the motor windings.

Radiated EMI is generated by voltages and currents within the circuitry. If not properly suppressed or shielded, it may then be radiated by cables or structures which act as antennae.

The FCC has placed limits on conducted EMI on power lines from 0.45 MHz through 30 MHz.

Equipment to measure and establish compliance is expensive and verification of compliance is best accomplished by outside facilities specializing in EMI and EMC testing. The engineer can get a fairly good idea of how well the EMI is suppressed in the fan by analyzing the ripple across the power leads with an oscilloscope. See Figure 2.

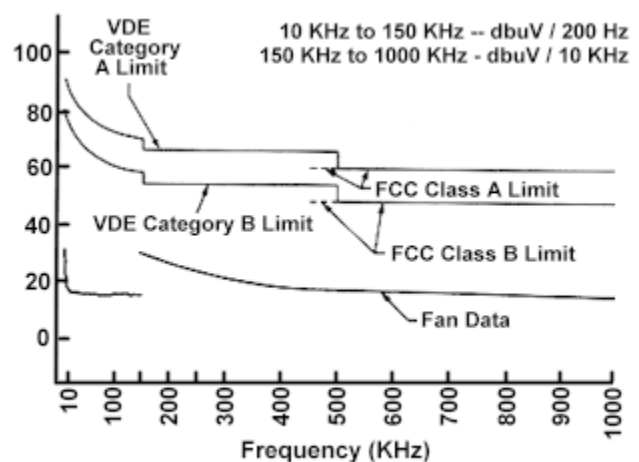


Figure 1: Conducted EMI Analysis of a Typical DC Fan

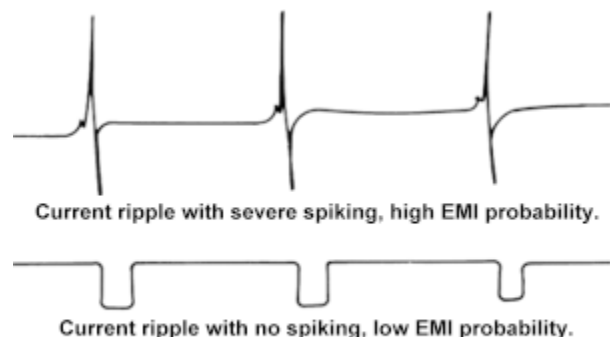


Figure 2: EMI Current Ripple Comparison

Electromagnetic Compatibility (EMC)

Electromagnetic compatibility (EMC) can best be described as the ability of equipment to operate without generating unwanted electromagnetic interference that can interfere with the operation of other products, and does not respond to unwanted interference generated elsewhere. If EMC is ignored during the design stages of product development, solutions to problems later become expensive and may yield limited results.

While the main desire is to reduce EMI generated by products, it is important to consider the susceptibility of products to EMI based on potential applications.

A good example is the use of a brushless DC fan for cooling a large switching power supply. Although the fan itself may generate EMI, sensitive control circuits, e.g. comparators, within the fan may be swamped by the EMI present in the power supply, resulting in faulty fan operation. For the power supply designer to resolve the problem would require additional filtering and grounding of the fan at additional cost. If resolved at the fan design level, a simple by-pass capacitor or ferrite bead might resolve the problem.

Uncontained Magnetic Fields (UMF)

Uncontained magnetic fields (UMF) refers to the magnetic field of the permanent magnet and stator windings which extends beyond the boundaries of the DC cooling fan. UMF exists in virtually all fans to some degree, but may appear most troublesome in one mounting plane, and non-existent in another.

To better understand the potential effects of a fan motor within a system, it is necessary to first evaluate the AC magnetic field levels present. In most brushless DC motor designs, the magnetic fields of the permanent magnet and the stator windings are shrouded within a steel housing which offers at least partial shielding (absorption) of the magnetic field, frequently in two of three possible mounting planes. Generally, mounting the fan with the open end of the motor (no steel) away from the sensitive electronic circuits and CRT's will offer the best protection from UMF.

The UMF can directly interface with the CRT presentation, creating distortion or ripple. If the magnetic levels are not strong enough to directly affect the CRT, magnetically induced voltage in sensitive circuitry, pre-amplifiers, and operational amplifiers, may generate interference or degradation of the presentation.

Controlling UMF starts with the fan manufacturer. The use of a drawn steel containment can go a long way toward reducing UMF to tolerable levels. Conservative motor designs will also help. From the user's standpoint, placement and location will be critical factors which will prevent costly problems later. In applications where certain confrontations cannot be avoided, the use of high permeability magnetic shielding material may be formed around critical locations to eliminate interference.