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Good EMC design techniques: EM mitigation and zoning (Part 2)

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Good EMC design techniques: EM mitigation and zoning (Part 2)

Keith Armstrong continues his current series on segregation techniques to suppress or mitigate EM phenomena, otherwise known as 'EM Zoning'

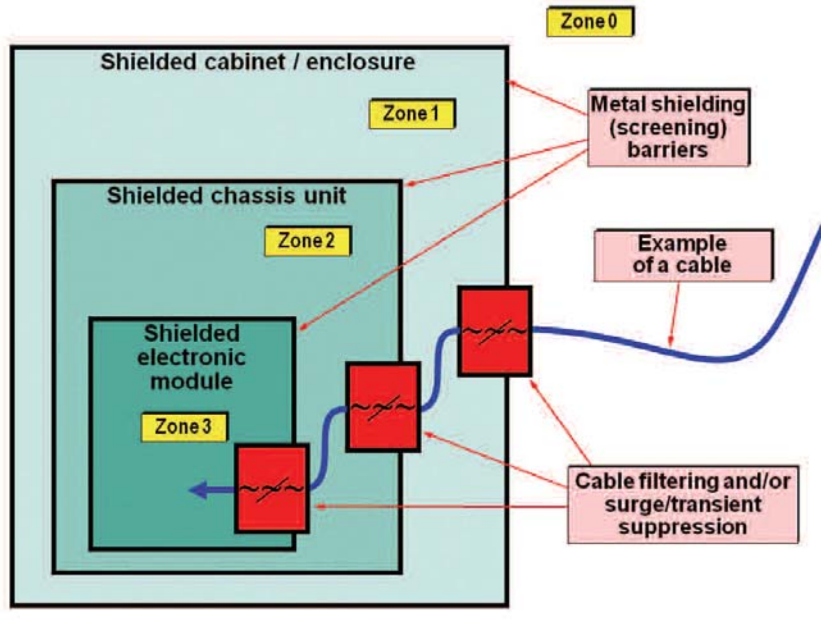

Figure 1: an example of Zoning for a single item of electronic equipment

In the last edition I introduced the concept of EM zoning - an essential EMC engineering technique if filtering, shielding (screening), surge and transient suppression are to work as intended.

Cherry Clough Consultants was started by Keith Armstrong in 1990 to help manufacturers reduce costs, time-scales and warranty costs whilst complying with the EMC Directive and other regulations.

Keith has a great deal of experience with the EMC of control panels, systems and installations, of all types and sizes, and with Tim Williams, wrote the only textbook on the subject: "EMC for Systems and Installations" (Newnes, 2000, ISBN 0-7506-4167-3, www.bh.com/newnes, RS Components P/No. 377-6463).

The 'Publications & Downloads' pages at www.cherryclough.com contain a great deal of helpful and practical information on EMC.

The need for zoning arises because electricity does not remain inside wires and cables; it is associated with electric and magnetic fields that surround conductors and which can easily couple some of their energy into other conductors. In fact, all conductors behave as 'accidental antennas' for the electrical power and electronic signals they carry. After all, an intentional radio antenna, like the telescopic rod on your portable FM radio, is simply a conductor. To learn more about this, read [1].

Because electrical power and electronic signals can 'leak' from one conductor to another (the conductors acting as accidental transmitting and receiving antennas), we need to keep all the conductors that we don't want to interfere with each other, segregated in some way from each other. A gap of several metres will often do the trick, but a seamless sheet metal barrier (called a shield or screen) can be better and saves space.

The remaining problem is with the conductors that have to pass from one zone to another. Where these are not shielded types, we rely on galvanic isolation and/or filtering instead, and we may also need to apply surge/transient suppression.

The article in the previous edition showed a general scheme for EM-zoning an area of a site. A general scheme for employing EM Zoning to a single electronic control cabinet is illustrated in Figure 1. This shows three ‘nested’ shielding barriers, with a single conductor or cable passing from the outside world (Zone 0) through each shield in turn (Zones 1 and 2) and eventually into the electronic circuits in the module (Zone 3).

At each of the three points where the cable passes through a shield barrier, it is filtered and/or surge/transient suppressed. Previous articles in this series have described in some detail how the filters or suppressers must be RF-bonded to a shield wall, in order not to compromise its shielding effectiveness, but [2] will prove a more useful source of free design/assembly guidance on this and other EMC techniques for cabinets, as it collects all of them in one place.

There are several advantages to the zoning technique shown in Figure 1. For example, it allows there to be noisy equipment such as high-power electrical contactors or variable-speed motor drives in Zone 1, with the shielded/filtered/suppressed barriers on either side protecting both Zone 0 and Zones 2 and 3 from their high levels of interference.

Another advantage is that if a very high degree of RF protection is required for the electronic module in Zone 3, the shielded/filtered/suppressed barriers between that Zone and Zones 2, 1 and 0 need not be very costly or high performance. For example, if 60dB of shielding is required at, say, 100MHz, then relying totally on achieving this with the outer cabinet wall is a risky business. Sure, it is easy to purchase cabinets with such a shielding specification - then easy to ruin it all with even just one cable that is badly installed or uses inadequate filtering as it passes through the cabinet wall.

But if each of the metal barriers in Figure 1 achieved just 30dB of shielding, then even if one of them was totally ruined by accident or poor design the electronics in the module would still have the 60dB of shielding it needed.

Shielding always degrades anyway, with time, due to oxidation and other types of corrosion increasing the resistance between its RF-bonding points, or across its conductive gaskets. So starting off with 3 times 30dB provides some hope that the module’s circuits might still be adequately protected by at least 60dB after a few years of use.

Because dBs are a logarithmic scale, 60dB is actually about 33 times harder to achieve than 30dB. For ‘harder’, read ‘more costly’, so it could easily happen that three sets of 30dB shields could cost less than one 60dB shield.

References:

[1] “The Physical Basis of EMC”, Keith Armstrong, The EMC Journal, Part 1 Issue 85, Nov 2009, pages 23 - 34, “Part 2” Issue 86, January 2009, from the archives at www.theemcjournal.com

[2] “Good EMC Practices in the Design and Construction of Electrical Cabinets”, 2007, www.reo.co.uk/knowledgebase