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Good EMC design techniques: EM mitigation and zoning (Part 1)

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Good EMC design techniques: EM mitigation and zoning

Segregation is a vital technique when controlling (suppressing, mitigating) EM phenomena, and is an aspect of the more general technique usually called 'EM Zoning'. Keith Armstrong explains

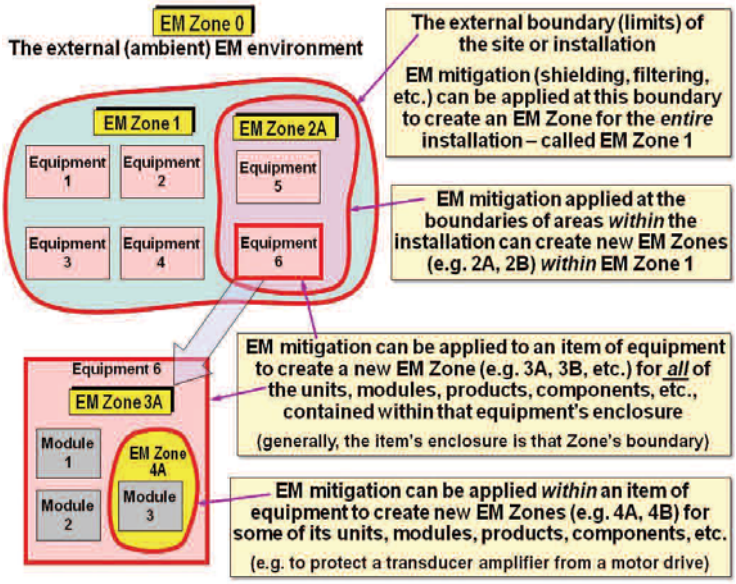

Figure 1: an example of Zoning for a site that contains six items of electrical/ electronic equipment

Several electromagnetic (EM) mitigation techniques have been discussed in previous columns, including, for example: Grounding (Creating an RF Reference, July 2007 and October 2009), Filtering (November 2007), Cable Routing (March 2008) and Shielding (July 2008, January and September 2009). All these (and more) are available from [1].

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.

Reading these columns, it should have been obvious that successful mitigation depended upon the use of "segregation" techniques. If it was not that obvious I apologise wholeheartedly - hopefully this column will make up for my previous lack of clarity.

Segregation is necessary so that the EM mitigation techniques used actually protect one area or volume from another. For example, shielding and filtering techniques are used at the surface of a cabinet (walls, floor, top, front, rear) to protect the electronics inside the cabinet from the nasty EM environment outside the cabinet. And also to protect the world outside the cabinet from the nasty EM emissions from the electronics inside the cabinet.

If we don't comprehensively segregate the electronics and its cables that are inside of the cabinet, from whatever is outside it, our shielding and filtering won't work very well, and may even be completely useless – just a waste of time and money.

In my daily work, I often see examples of EM mitigation, such as grounding, filtering and shielding, designed/assembled/installed in a way that ignores segregation, making them ineffective, sometimes even worsening the problem they were supposed to fix!

EM mitigation uses components like metal grids, metal plates, filters, surge suppressors, etc., but it is not enough simply to have the components - they must also be used in a certain way if they are to be at all effective. They must be used in a way that achieves good segregation, for example between the inside of a cabinet and its outside.

If you were to re-read my previous columns, you will see that this design/assembly/ installation approach - segregation - is always present, even if not explicitly discussed. Remember that EM phenomena can pass into or out of (i.e. 'couple') our cabinet via several routes: by conduction, and by induction and radiation (both through the air), so our

segregation methods must take all of these into account. For a more detailed discussion of EM coupling, see [2].

EM segregation techniques are part of a larger topic in EMC Engineering that is often called “EM Zoning”. EM mitigation measures are applied at the boundary of each EM Zone, to control the EM disturbances that could enter or exit the zone. The boundary of an EM Zone can be thought of as a layer of protection, that:

- Protects equipment within the zone from EM disturbances originating outside the zone, and/or
- Protects equipment outside the zone from EM disturbances originating inside the zone

Although we generally draw EM Zones as areas on a plan (like Figure 1) and their boundaries as lines, we must not forget that the boundary lines are really the entire surface of a three-dimensional volume, and any/all EM phenomena disturbances that could penetrate that 3-D surface by conduction, induction or radiation may need to be controlled, to prevent electromagnetic interference (EMI).

The EM mitigation measures that can be applied at the boundary of an EM Zone to provide its layer of protection, include...

- Leaving lots of empty space [4] [5] [6]
- Improving Power Quality [3]
- Galvanic Isolation, e.g. isolating transformers, fibre-optics, etc. [5]
- Grounding (earthing) by creating an RF Reference that has a low-enough impedance at the frequencies to be controlled [1] [4] [5] [6]
- RF-bonding at joints, seams, and electrical bonds [1] [4] [5] [6]
- Cable Routing techniques [1] [4] [5] [6]
- Filtering of conductors [1] [4] [5] [6]
- Shielding (cabinet shielding is covered by [1] [4] and [5], rooms and installations by [6])
- Surge protection of conductors [4] [5]

(Note that the word ‘conductor’ in the above list includes everything that could conduct but cannot be RF-Bonded to the RF Reference - not just wires and cables.)

Figure 1 shows the general scheme of how EM Zoning is employed, from a complete installation or site, down to the inside of a cabinet that is part of the installation. I shan't write more about it here, because Fig. 1 is supposed to be self-explanatory.

In the next column in this series I plan to provide more detail on EM Zoning.

References:
[1] Previous PSB columns in this series are archived at: www.psbonthenet.net/company.aspx?CompanyID=12242.
[2] “The Physical Basis of EMC”, Keith Armstrong, The EMC Journal, “Part 1” Issue 85, November 2009, pages 23 - 34, “Part 2” Issue 86, January 2009, www.theemcjournal.com
[3] REO EMC Guide on “Mains Power Quality”, Keith Armstrong, 2007, www.reo.co.uk/knowledgebase
[4] “EMC for Systems and Installations”, Tim Williams and Keith Armstrong, Newnes, 2000, ISBN: 0-7506-4167-3, www.bh.com/newnes, RS Components Part No. 377-6463
[5] “Good EMC Practices in the Design and Construction of Electrical Cabinets”, 2007, www.reo.co.uk/knowledgebase
[6] “Good EMC Engineering Practices in the Design and Construction of Fixed Installation”, 2009, www.reo.co.uk/knowledgebase