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Good EMC Design Techniques: EM Mitigation and Zoning (Part 3)

Helping you solve your EMC problems

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Good EMC Design Techniques: EM Mitigation and Zoning (Part 3)

Keith Armstrong offers more practical detail on segregation techniques, known as 'EM Zoning'

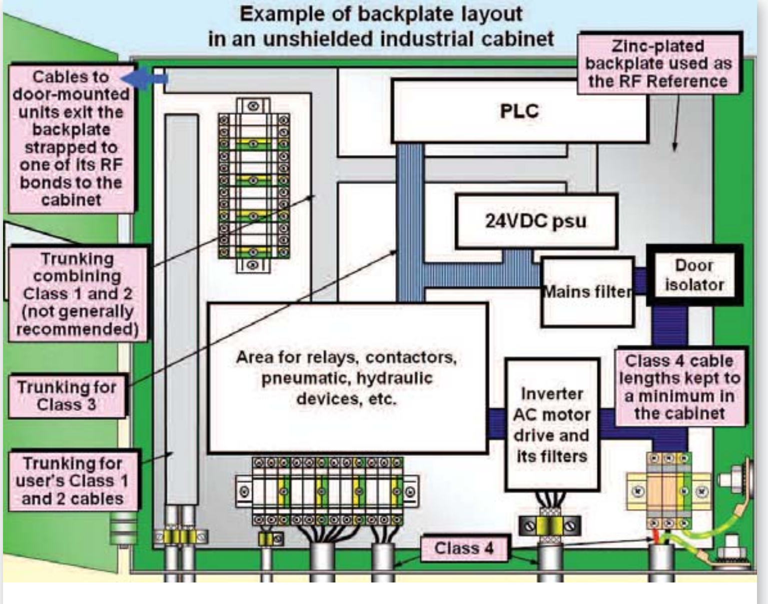

Figure 1: Example of segregation in a small industrial cabinet

In the last two editions 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.

Zoning is an effective EMC technique, and an important one, whether we are constructing a cabinet, a system, or an installation of any size (even up to a national network of some sort).

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.

In the last issue, I showed how 'nesting' low-cost shielding and filtering could achieve high overall specifications, with better confidence over the lifecycle that unexpected events or misuse will not degrade the overall EMC performance by too much, than would be achieved by relying on one very costly high-spec. overall enclosure.

Military equipment tends to rely on one costly overall enclosure, but that does not mean this is good EMC design practice. Apart from its excessive cost and vulnerability to unforeseen circumstances, the inside of the enclosure is not 'EM Zoned' and so the enclosed circuits can easily interfere with each other, what we might call "Internal EMC". In fact, most electronic designers and system integrators – not just military - prefer to focus on functionality, leaving internal system integration considerations until late in the project, at which point 'Internal EMC' problems generally mean they will have to throw huge amounts of resources at it just to make it work properly. Then when it is working to its functional specification they will generally have to throw even more resources at it to get it to even scrape through its EMC requirements.

[1] has more discussion on this issue, identifying it as a failure of project management that inevitably results in higher costs, greater delays, and greater financial/mission risk, than when using well-proven good EMC design techniques from the start of any project.

So let's start to look at how we should apply proven good EM Zoning design and construction techniques to a single metal box containing a number of electronic modules connected together by cables.

Although this discussions and its figures uses the example of an industrial-type control cabinet, this approach is appropriate for all metal boxes that contain two or more electronic and/or electro-mechanical/

hydraulic/pneumatic/optical modules connected together by wires, regardless of the application – from domestic HVAC controls, through industrial automation and robotics, vehicles of all types (road, rail, sea, subsea, air, space, etc., since in EMC terms any vehicle is just a metal box containing interconnected electronic and/or electro-mechanical/hydraulic/pneumatic/optical modules), professional audio, video and lighting control 'desks' or 'consoles', etc., whether civilian or military.

Figure 1 shows the example of a small seam-welded industrial cabinet, a little over one metre square, with various modules mounted on its zinc-plated backplate.

This example is taken from a real-life project, in which I was helping a manufacturer of custom-engineered control cabinets achieve low-cost compliance with the EMC Directive by using a 'Procedural TCF' approach [2] based on the use of good EMC business and engineering practices with a very little confirmatory EMC testing (maybe just one cabinet a year) rather than testing every single one in an EMC test lab.

(The financial argument was compelling – a complete set of EMC tests cost about £2,000 at that time, which was the typical selling price of their custom cabinets, of which they made about 50 'one-offs' a week! This approach also works just as well for declaring compliance with the new EMC Directive, 2004/108/EC, whichever conformity route is followed. Plus, of course, using good EMC engineering techniques from the first, as required by the Procedural TCF approach also reduces project/mission and financial risks [1].)

The cabinet sketched in Figure 1 was put through a full series of EMC tests for emissions and immunity, to prove the good engineering management, design and construction techniques that had been applied to it ensured a pass result.

Many of those techniques have been described in previous columns in this series [3], and now we are considering the EMC Zoning techniques that were used.

Referring to Figure 1, we can see that the cable classification and segregation scheme described in my March 2008 column has been applied. Because none of the field-wired inputs were very sensitive, no distinction was made between Class 1 and Class 2 cables.

In order to achieve the cable segregation and EM Zoning on the backplate, the various modules were arranged in a certain way. Modules that were very 'noisy' were placed towards the bottom of the backplate. This included the variable-speed AC motor drive, the electro-pneumatic 'valve islands' and all of the relays and contactors whose contacts were switching circuits connected to field wiring.

Modules that were very sensitive were located towards the top of the backplate. In this case these were all modules plugged into a single DIN-rail mounted PLC. Intermediate modules, like the 24V power supply, were located in an intermediate position.

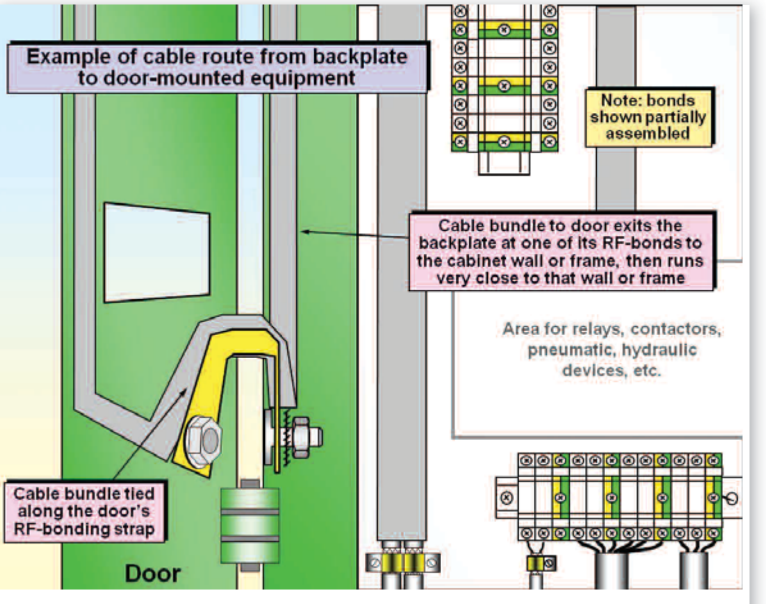

Figure 2: Showing the route taken by the cables to the door-mounted modules

Figure 2 shows how the cables to the door followed good EMC practice by having a common-mode current return path all along their route, from one module to another – the modules being 'RF-bonded' to the RF Reference created by their backplate and the structure of the welded cabinet. For detailed descriptions of the other EMC management, design and construction techniques employed, including more on EM-Zoning, see [4] and [5].

References:

[1] *"When the going gets tough - smarter design wins"*, Keith Armstrong, The EMC Journal, Issue 81, March 2009, pp 21-24, from the archives at www.theemcjournal.com

[2] *"Procedural TCFs"*, Keith Armstrong, The EMC Compliance Journal, February 1997, from the archives at www.theemcjournal.com

[3] Previous PSB columns in this series are archived at: www.psbonthenet.net/company.aspx?CompanyID=12242. Unfortunately these archives do not include the figures, often the most valuable parts of these columns. I hope PSB's archives will be updated to include all figures, to be a better resource for readers, and I also plan to post my complete set of columns (with figures) on my website www.cherryclough.com by the end of summer 2010.

[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