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Good EMC Design Techniques - EM Mitigation and Zoning (Part 6)

Helping you solve your EMC problems

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Good EMC Design Techniques — EM Mitigation and Zoning (Part 6)

Keith Armstrong extends "EM Zoning" techniques into the installation.

In the last five editions [1] I have been briefly describing some issues associated with EM Zoning – an essential EMC engineering technique for a cabinet, a system, or an installation of any size for filtering, shielding (screening), galvanic isolation, surge and transient suppression to work as intended at frequencies above about 100kHz.

My last article in this series discussed using an electrical/electronic cabinet itself as an EMC Zone boundary. A shielded cabinet is best, but the techniques also help improve the EMC of ordinary metal cabinets.

Now its time to extend the Zoning technique into the installation. Many readers will be a familiar with IEC/EN 62305, the new lightning protection standard, and its Part 4 that deals with protecting electronics.

This also uses the concept of EM Zoning, although it calls them LPZs (for Lightning Protection Zones) instead. However, lightning protection is just one aspect of EMC, and so we can combine the lightning protection requirements with other EMC requirements, when we do EM Zoning.

The first requirement of zoning is to control the stray currents – the ones that cause the greatest problems for EMI and EMC (more properly called Common-Mode currents), and their associated voltages. Stray currents are always noise, and unwanted. Variable speed motor drives (VSDs) are a modern cause of large amounts of stray current, maybe 10s of Amps for large drives, and [3] describes how to deal with them. I'm working on a project at the moment in which the stray currents will exceed 10kA, but nevertheless the equipment must keep working without error or malfunction.

People often talk about "earthing" or "grounding" as an EMI or EMC measure, but they are wrong. Earthing and grounding only mean something for electrical safety. They are meaningless concepts for the operation of electrical or electronic circuits, and also for EMI and EMC, as explained in [2].

Because _all_ currents flow in closed loops (even stray currents), and because _everything_ (even a superconductor) has impedance, the idea of there being an infinite sink for noise or other unwanted currents, that we call "earth" or "ground" is just wrong. There can never be any such thing in our universe. And green/yellow striped wires and braid straps have no magical properties either.

So the first thing we must do for EMC, is to provide ourselves with a "common bonding network", or CBN – this is a conductive path that we create to control stray currents. To do this, it must provide a low impedance path (i.e. << 1 ohm) over the whole frequency range we want to control.

When using a cabinet as an EM Zone, as in the previous article in this series, we use the walls/floor/top or backplate as our CBN, also sometimes called a radio-frequency reference (or RF Reference). Some cabinet constructions (e.g. seam-welded) make very good CBNs to very high frequencies, whereas others (e.g. assembled from a kit of parts using insulating joints) are very poor indeed.

But what can we use for the CBN for our installation?

Figure 1 shows an old-fashioned building scheme based on the myth of the "earth" or "ground" as some kind of perfect sink for electricity. It is bad for EMC, and also bad for safety (during a thunderstorm, very dangerous voltages can build up between the "clean earth" and the "power earth", possibly even causing flashovers inside a building, and certainly deadly to all electronics).

Figure 2 shows a more recent scheme, using a combined set of earth electrodes and separate single-point earthing (sometimes called star grounding) for "clean" and "power" equipment earths. This is adequate for safety, most of the time (but vulnerable to single failures), but still terrible for EMC because the long lengths of earth wire simply have too much impedance. For example, for 1 ohm at 1 MHz (a problem frequency for many VSDs), a 6 mm diameter copper earth wire would have to be less than 250 mm long – and they are all going to be at least 10 times this length in any real installation. ***Single-point earthing is incapable of controlling the paths taken by high-frequency currents!***

Figure 3 shows how to create a CBN that has a low impedance up to whatever frequency we wish, simply by making the mesh size smaller until we end up with sheet metal (e.g. as used in some semiconductor manufacturing plant). This is called a MESH-CBN, and the good news is that – if we think about it sufficiently in advance – we can use the reinforcing rods in the concrete walls and floors as its basis, plus other “natural” metalwork, so that it hardly costs anything.

MESH-CBNs provide excellent EMC (depending on mesh size), and when connected to a suitable earth electrode system provide excellent safety too, even during a direct lightning strike. More on MESH-CBNs next time.

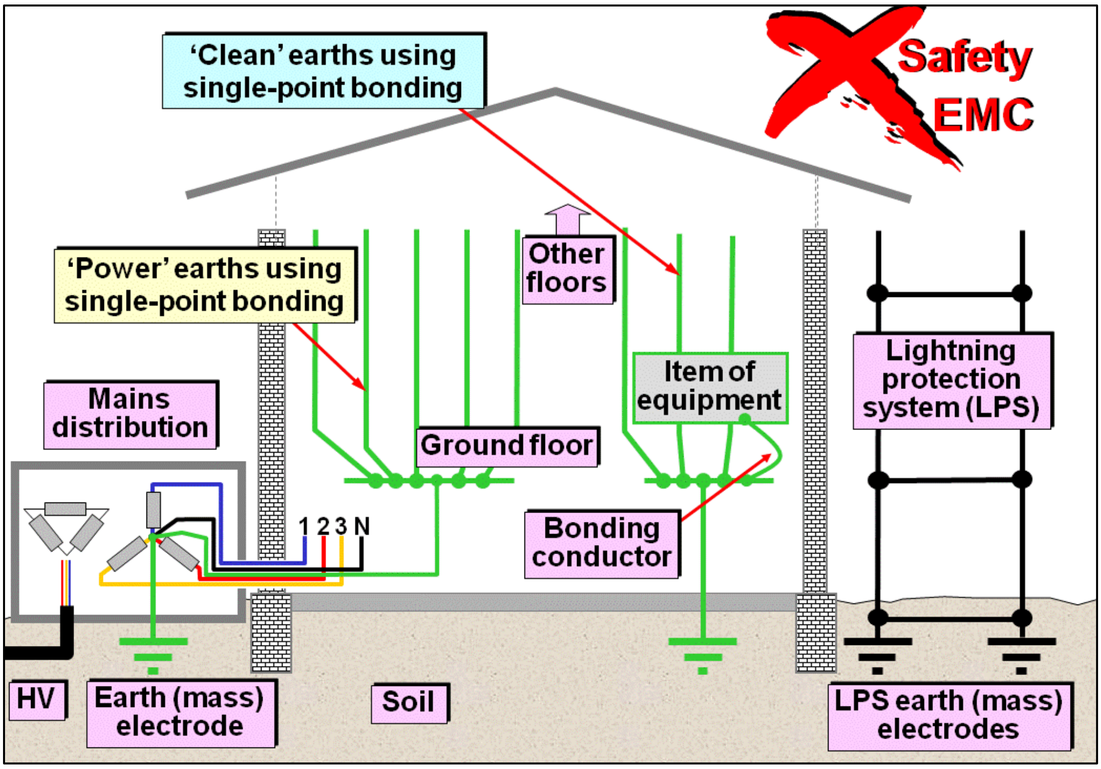

Figure 1 Independent earthing

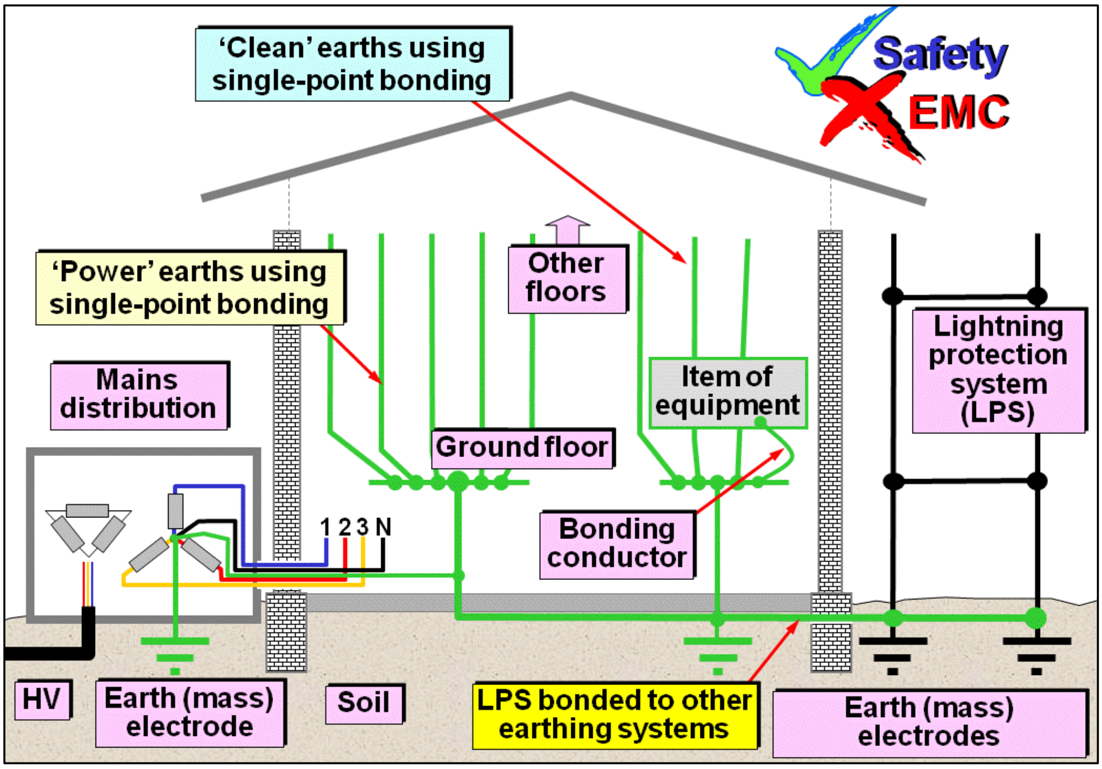

Figure 2 Single-point earthing

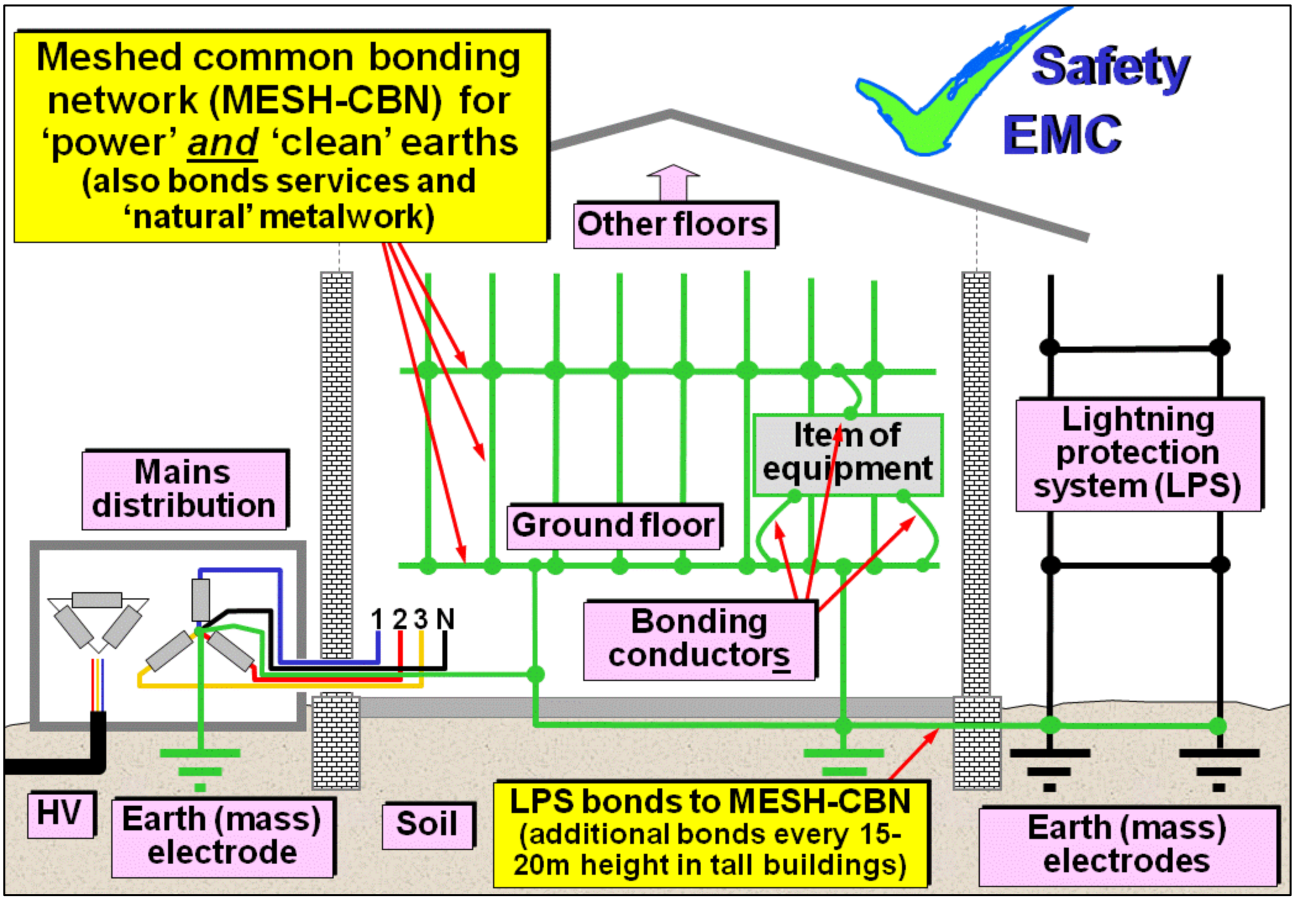

Figure 3 Mesh-bonding (plus earthing)

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, Nutwood/Armstrong October 2010, available from www.theemcacademy.org/books.asp

[3] "Complying with EN/IEC 61800-3, Good EMC Engineering Practices in the Installation of Power Drive Systems", Keith Armstrong, REO (UK) Ltd, August 2009, free download from www.reo.co.uk/knowledgebase