emc STANDARDS

Another EMC resource
from EMC Standards

Good EMC Design Principles for Panel Builders - the RF Reference

Helping you solve your EMC problems

9 Bracken View, Brocton, Stafford ST17 0TF T:+44 (0) 1785 660247 E:info@emcstandards.co.uk

Good EMC Design Principles for Panel Builders – the RF Reference

Keith Armstrong explains how to create a radio-frequency (RF) reference, using unshielded metal chassis, frames and enclosures

EurIng Keith Armstrong C.Eng MIET

keith.armstrong@cherryclough.com

Originally published in PSB Magazine, July 2007, http://www.psbonthenet.net,
and reproduced here with their kind permission

The EMC of an item that contains two or more interconnected electronic units (e.g. a variable-speed drive and EMI filter; PLC and 24VDC power supply, etc.) will benefit from the use of a 'Radio-Frequency (RF) Reference', which can be created at low cost (perhaps no cost) using existing metalwork.

Even where electronic circuits do not emit RF noise (e.g. purely analogue thermocouple or strain-gauge amplifiers), all of their semiconductors can suffer interference from RF noises that get into their circuits, up to at least 1,000MHz, so they also benefit from an RF Reference.

This brief article introduces methods for creating RF References using unshielded metal chassis, frames and enclosures. For more information, and the use of shielded enclosures, read the REO (UK) guide: "*Good EMC Engineering Practices in the Design and Construction of Industrial Cabinets*", from www.reo.co.uk/guides after registration as a 'member'.

Similar techniques can be applied at system and installation level, and are described in "*EMC for Systems and Installations*" (Newnes, 2000, ISBN 0-7506-4167-3, www.bh.com/newnes, RS Components P/No. 377-6463).

An RF Reference is only effective when all cables and units containing electronics are closer than l/10th of a wavelength at the highest frequency (*f*) that it is desired to control, and when all the units that require an earth connection are 'RF-bonded' to the RF Reference. Wavelength in metres = 300/*f* when *f* is given in MHz, so for a typical walkie-talkie transmitting at 400MHz, the spacing should be less than 75mm. Even-closer spacing significantly improves EMC.

The fewer apertures, gaps and seams there are in an RF Reference – the better its EMC performance, with large areas or volumes of unbroken metal being the best. Some types of enclosures are seam-welded (e.g. for hygiene reasons) and also make excellent RF References.

However, most types of enclosures are metal frames to which a cladding is affixed. They may be fitted with shelves for mounting large items of equipment (for example the traditional 19-inch rack-mounting system); backplates for mounting DIN rails and 'chassis-mounted' units; or card cages for holding modules or printed-circuit cards. To make them function as a useful RF Reference, all of their metal parts (including hinged doors) should be RF-bonded together, as frequently as possible, to create a three-dimensional mesh.

At least the metal structures nearest to the cables and units containing electronics – such as walls, rear or front panels, top, bottom, doors, backplates, shelves, frames or card-cages – should be meshed to create an RF Reference. Extending the mesh to all metal structures associated with a chassis, frame or enclosure improves EMC. Smaller mesh size means better EMC.

RF-bonding

Single-point bonding (sometimes called 'star earthing') cannot control frequencies above a few hundred kHz, possibly as much as a few MHz, depending on the lengths of the bonding ('earthing') wires, straps or braids, and the size of the metal items being bonded.

RF-bonds require a very low *inductance* at the highest frequency to be controlled. Above a few MHz, direct metal-to-metal bonds between parts of an RF Reference, and between electronic units and their RF Reference, are <u>much</u> better for EMC than any wire or braid strap however short.

RF References create dozens, if not hundreds of what could be called 'ground loops' – but these are a <u>benefit</u> for electronic circuits that have been properly designed for EMC, and often improve their functional performance.

Highly-conductive metal surfaces preferred

Where painted, plastic-coated or anodised metalwork is used; great care is needed to achieve good 'RF-bonding', usually entailing local removal of paint, plastic or anodising to achieve direct metal-to-metal contact. This can require a lot of costly labour, and even so it is difficult to make the result look nice and prevent corrosion.

So for ease of construction it is best to use metalwork that has a highly conductive metal plating suitable for the anticipated physical/climatic environments and lifecycle. This is why zinc-plated steel or alochromed aluminium backplates are now standard for industrial control and instrumentation cabinets.

Sometimes thin metal plating is used with an overall polymer passivation (e.g. 'Zintec') – but the polymer film is insulating and can ruin RF-bonding. It is often claimed that fixing pressures readily puncture these films, but this might not be true where two smooth metal surfaces are being fixed together. And any conductive gaskets will generally not apply sufficient contact pressure to break through a polymer film.

It is generally much better to use metalwork that relies only upon good quality metal plating to prevent corrosion. Chromate passivation is acceptably conductive, but Chrome-6 is now (almost) banned by the RoHS Directive (2005/92/EEC) so metal finishers are tending to use polymer passivation instead. Instead, they should use the Chrome-3 alternatives that have been (or are being) developed – as long as they maintain a highly-conductive surface over the anticipated lifecycle.

For those who wish to investigate further, the Directives and Regulations, and their official guides, plus a great deal of useful and practical information, are available as described in the document: '*Some Useful References on EMI and EMC*' posted on this site.