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Shielding techniques for cabinets

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Good EMC Design

Keith Armstrong spells out good EMC design principles for panel and system builders with particular reference to shielding techniques for cabinets

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Shielding is often required against radio-frequency (RF) electromagnetic fields, either so that the electronic devices (modules, products, equipment, etc.) within a cabinet are made sufficiently immune to the electromagnetic threats that occur in real operation, or so that their RF emissions do not interfere with radiocommunications, telecommunications, or other equipment on the site.

Particular problems for immunity include the close proximity of cellphones, walkie-talkies, basestations, diathermic heaters, induction heaters, switch-mode power converters, etc., because such situations are not covered by the RF immunity tests listed under the EMC Directive (e.g. IEC 61000-4-6 and IEC 61000-4-3). Shielding with a metal cabinet can help make equipment reliable enough in real life operation.

Note that it is possible to comply with the conformity assessment requirements of CE marking, such as passing all relevant tests, whilst still failing to comply with the EMC Regulations by causing or suffering interference in real life. Of course, the test standards cannot cover all eventualities, but I don't understand why they don't at least cover immunity to cellphones and walkie-talkies, which are now almost ubiquitous.

On the emissions side, it is important to note that the limits are based on what is likely to interfere with radio and TV reception, so the same emissions limits apply to an individual variable-speed motor drive when it is CE marked by its manufacturer, as apply to a control panel that contains a number of the same drives.

Most manufacturers design their products to just 'sneak under' the emissions limit lines, so when you have three or more assembled on a backplate their combined emissions are almost certain to be over the limits. This is one of the reasons why the so-called 'CE + CE = CE' approach to compliance, discussed in this column in the special June Edition of PSB, cannot be considered to be 'due diligence'. Shielding with a metal cabinet is a good way of reducing emissions to prevent interference.

Because there is so little enforcement of the EMC Regulations in the UK, the real argument for doing good EMC engineering issue is the financial risks of projects that 'go bad' due to inadequate EMC, which are getting worse as electronic technologies advance, discussed in this column in the September 2007 Edition of PSB.

Ordinary low-cost industrial metal cabinets (enclosures) can provide some useful RF shielding, providing that certain design and assembly rules are followed. Where high performance shielding is required (say, more than 20dB of shielding effectiveness (SE), or any shielding at more than 100MHz) and special shielded cabinets are required, these six design and assembly rules are *mandatory* if the additional cost of the special cabinets is not to be wasted.

There are six basic design and assembly rules for cabinet shielding:

i) The cabinet must be made entirely of metal. (Glass-fibre or other non-conductive cabinets might be acceptable if they are entirely plated with metal on one surface, usually the inside).

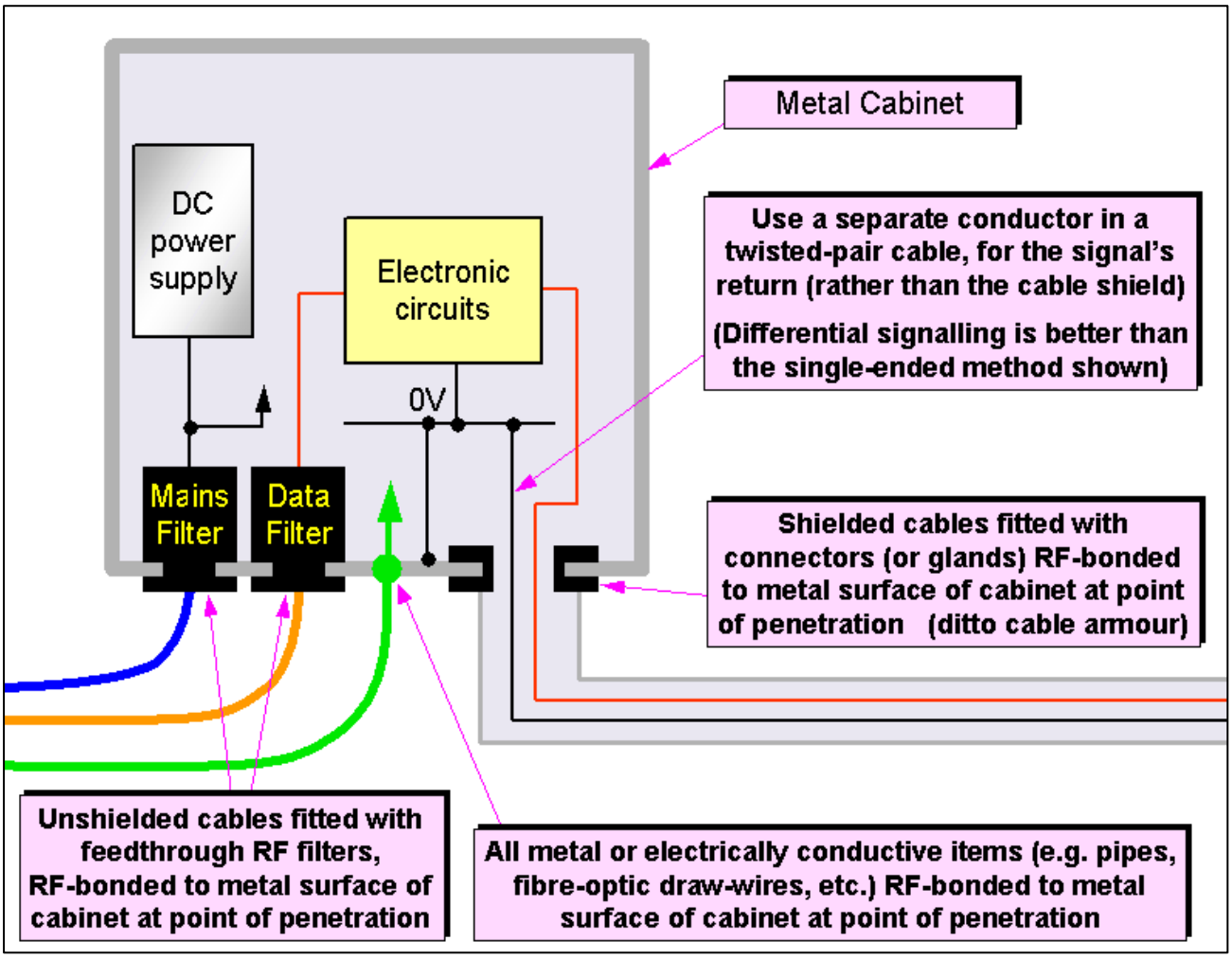
ii) All conductors and any metal items (e.g. pipes) that can be earthed should be RF-bonded directly to the metal surface at their point of penetrating the cabinet.

iii) All unshielded conductors that cannot be earthed should be fitted with RF filters that are RF-bonded to the metal surface at their point of penetrating the cabinet.

iv) All shielded cables entering/exiting the cabinet should have their shields RF-bonded to the metal surface at their point of penetrating the cabinet. Cable armour should be treated the same way.

v) The sizes of all apertures in the external metal surfaces of the cabinet (i.e. where there is not a seamless high-conductivity surface, for whatever reason) should be minimised, for example by replacing a large ventilation aperture with a metal mesh. This includes apertures associated with ventilation, seams and joints, displays, around doors and removable panels, etc.

vi) All cables, printed-circuit boards and electronic devices should be kept well away from any apertures in the metal cabinet.



RF-bonding techniques suitable for mains filters were covered briefly by this column in the November 2007 Edition, which also covered how to choose appropriate mains filters in the first place. Filters for signal, data and control cables should be RF-bonded similarly – but the method described for choosing mains filters does not apply because manufacturers only provide 50Ω data for signal/data filters.

The best and easiest assembly method for signal, control or data filters is to install 'through-bulkhead' filtered connectors in an external surface of the cabinet, each filter body being RF-bonded to the cabinet's metal surface all around the perimeter of their cutouts.

Shielded cables should use through-bulkhead glands or connectors that are RF-bonded all around the perimeter of their cutouts in the metal surface of the cabinet.

Future columns will discuss these techniques (e.g. RF-bonding) in more detail – but if you can't wait, download "*Good EMC Engineering Practices in the Design and Construction of Industrial Cabinets*" from http://www.reo.co.uk/knowledgebase. These techniques are described with more technical background in: "*EMC for Systems and Installations*" (Newnes, 2000, ISBN 0-7506-4167-3, www.bh.com/newnes, RS Components P/No. 377-6463).

The upcoming REO Guide "*Good EMC Engineering Practices in the Design and Construction of Fixed Installations*" will describe how to use RF shielding in systems and installations using (for example) existing metal structures, and will be available from http://www.reo.co.uk/knowledgebase soon.

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.