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Good RF bonding techniques for cabinets

Helping you solve your EMC problems

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Good RF bonding techniques for cabinets

Previous editions of this column introduced the six basic good EMC engineering practices for shielded cabinets. Keith Armstrong continues with some more practical details on how to 'RF-bond' filters and cable shields. Lack of attention to these issues has ruined the EMC performance of many a costly shielded enclosure!

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These practices are recommended even when using ordinary metal cabinets, because they help make equipment more reliable as regards interference, reducing the number of call-outs under warranty.

'RF-bonding' means achieving a low-impedance electrical connection at the highest frequency that must be controlled. For compliance with normal commercial/industrial EMC standards this is 1GHz, likely to become 2.7GHz or more in the near future.

Most of the electronic units used in commercial/industrial control panels and systems do not (yet) suffer from significant EMC problems at such high frequencies. Variable-speed motor drives and other switch-mode power convertors (e.g. inverters, UPSs, AC-DC and DC-DC converters, etc.) tend to have problems up to about 2,000 times their switching rate, so for example a 100kW motor drive switching at 10kHz would most likely have 'a highest frequency to be controlled' of about 20MHz.

But note that where a cabinet contains powerful computers or other digital processing, problems can exist up to the highest frequencies in the test standards, and beyond.

By a 'low impedance electrical bond' we mean *much* less than 0.1 ohm, ideally less than 10 milliohms. When we consider that 30mm of a wire with cross-sectional area 4 sq.mm has an inductance of about 20 nanoHenries, giving it an impedance of about 2.5 ohms at 20MHz, and 125 ohms at 1GHz, it shows us that we can't use wires for these bonds.

The 'skin effect' makes all RF currents travel on the surfaces of conductors and metalwork, rather than through its bulk metal thickness. To get good EMC performance from any metal cabinet we use this effect to encourage the noise currents created by the equipment *inside* our cabinet to stay *inside*, to reduce its RF emissions. And we can use it to encourage the noise currents flowing in the environment *outside* of our cabinet, to remain on its *outside*, to improve RF immunity.

These two key issues – the need for low impedance bonding up to the highest frequency to be controlled, plus using skin effect to keep internal noises inside, and external noises outside, show us how to bond filters and cable shields to our cabinets:

a) Direct metal-to-metal electrical bonds between the filters or cable shields and the cabinet's metal structure. Rather than a single point of contact, we need complete circumferential (360°), or at least multi-point bonding.

b) These electrical bonds must be at the points where the cables enter/exit a cabinet surface. These should be in an RF-bonded part of the cabinet's structure. For a small cabinet made from folded steel, this would simply be one of its walls. But for a larger cabinet consisting of a frame with cladding panels, it should be a metal connector panel that is RF-bonded (with spot welds or screw fixings) at multiple points around its perimeter, to the cabinet's frame.

Figure 1 shows the basic details of how to RF-bond filters to a cabinet surface, and Figures 2 to 5 show some details for RF-bonding cable shields.

Future columns will discuss more such details, but if you can't wait, or would like more details, download the free REO Guide: "*Good EMC Engineering Practices in the Design and Construction of Industrial Cabinets*" from http://www.reo.co.uk/knowledgebase. If you want more technical background to these methods, or details of good EMC practices for systems and/or installations, read: "*EMC for Systems and Installations*" (Newnes, 2000, ISBN 0-7506-4167-3, www.bh.com/newnes, RS Components P/No. 377-6463).

The REO Guide "*Good EMC Engineering Practices in the Design and Construction of Fixed Installations*" describes proven good EMC engineering practices for systems and installations, and will be available from http://www.reo.co.uk/knowledgebase soon.

If errors or malfunctions in the electronics or software of your project could increase safety risks, complying with the EMC Directive will not be enough to show 'due diligence' in ensuring tolerable safety risks despite the possibilities for electromagnetic interference. For a suitable EMC methodology, download the IET's new free guide on "*EMC for Functional Safety*" from www.theiet.org/factfiles/emc/index.cfm, or buy it as a reasonably-priced (£27) colour-printed-book from www.emcacademy.org/books.asp.

Figure 1 Examples of mounting filters in cabinet walls

These examples are power filters, signal filters are usually combined with their connectors

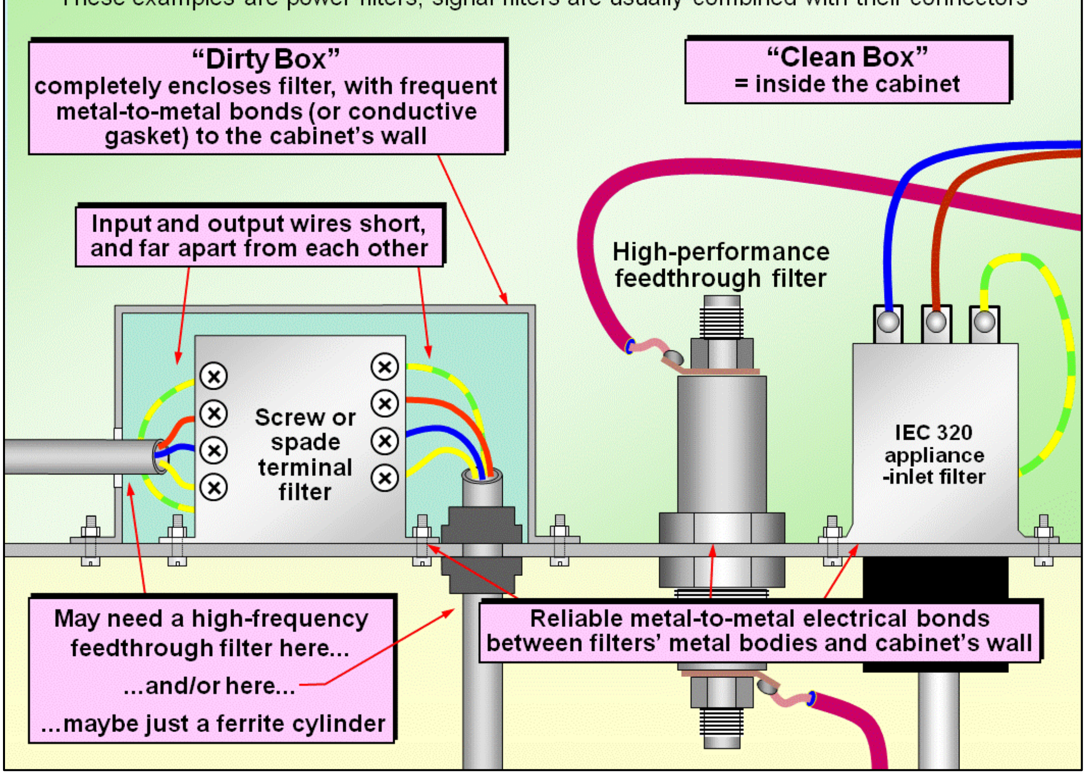
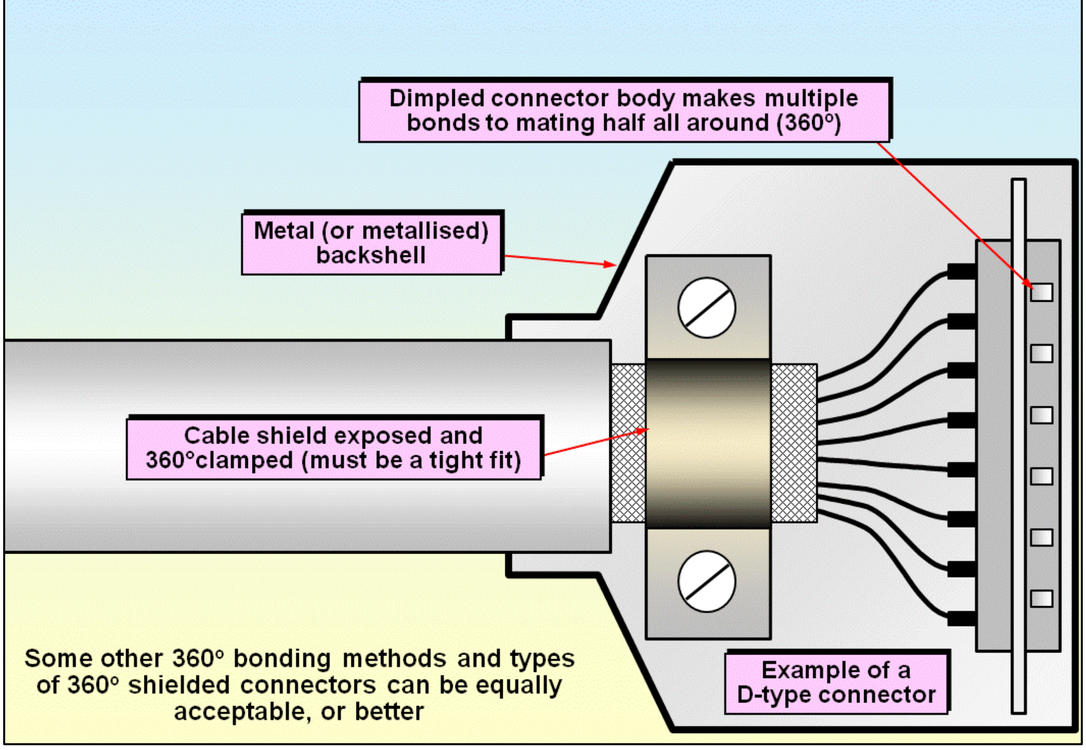


Figure 2
Example of 360° cable shield bonding in a D-Type connector



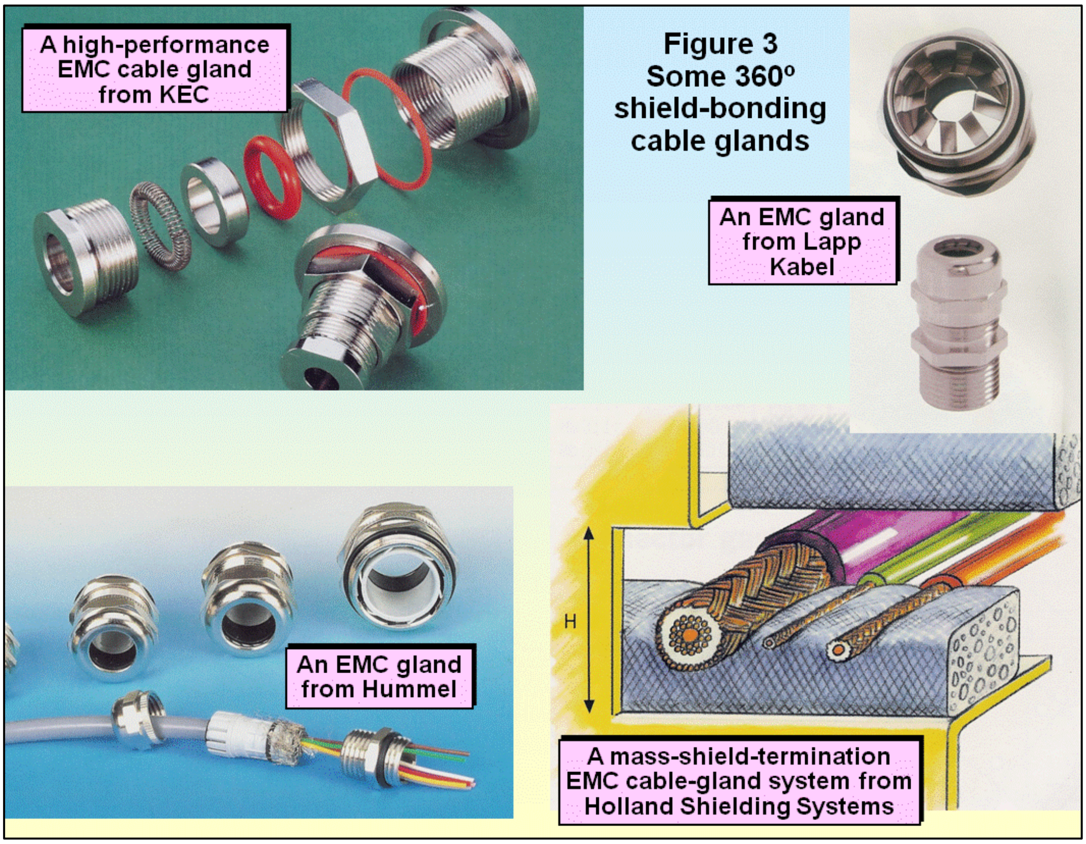


Figure 3
Some 360º shield-bonding cable glands
A high-performance EMC cable gland from KEC
An EMC gland from Lapp Kabel
An EMC gland from Hummel
H
A mass-shield-termination EMC cable-gland system from Holland Shielding Systems

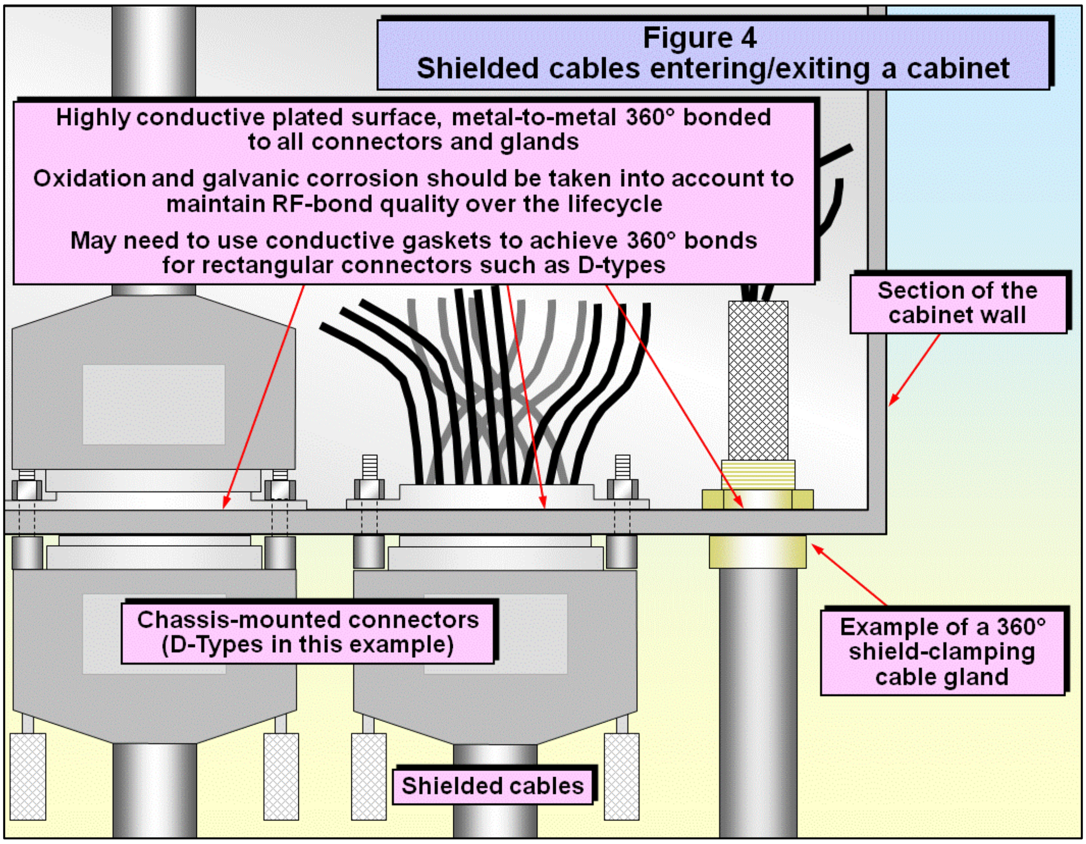


Figure 4
Shielded cables entering/exiting a cabinet
Highly conductive plated surface, metal-to-metal 360° bonded to all connectors and glands
Oxidation and galvanic corrosion should be taken into account to maintain RF-bond quality over the lifecycle
May need to use conductive gaskets to achieve 360° bonds for rectangular connectors such as D-types
Section of the cabinet wall
Chassis-mounted connectors (D-Types in this example)
Example of a 360° shield-clamping cable gland
Shielded cables

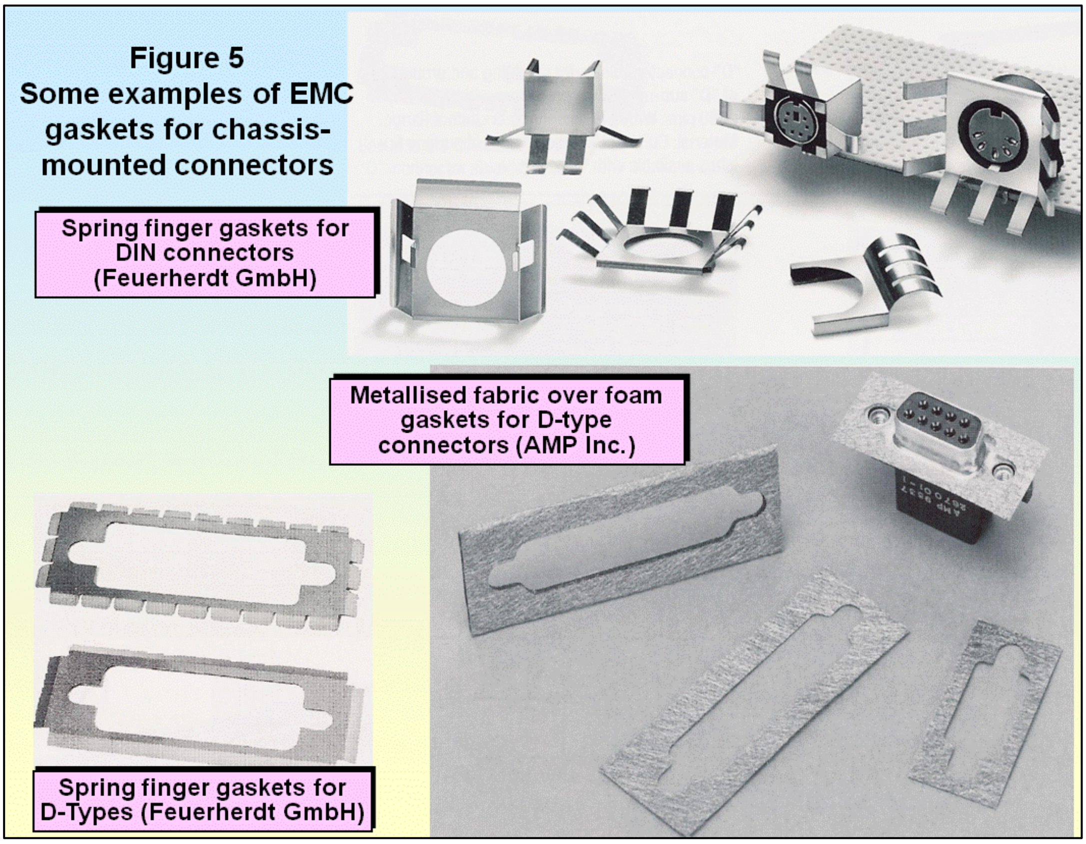


Figure 5
Some examples of EMC gaskets for chassis-mounted connectors

For those who wish to investigate further, the EMC 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.