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The Enclosure & Instrument Case Designer & Manufacturer

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Shielding at PCB Level

Shielding, perhaps the most common technique for controlling EMC - Electro-Magnetic Compatibility - is deceptively simple! Metal enclosures keep harmful interference out and also unwanted emissions in.

As with most simple concepts, practical EMC shielding requires considerable engineering skill to give good results. However, at product enclosure level, it can be complex and expensive, adding to both material and assembly costs. Added to that, effective enclosure shielding usually requires substantial filtering of all cables which pass out of the product, right at the point where they penetrate the enclosure shield.

Tackling an EMC solution cost effectively and conclusively, shielding at PCB level is simple and low-cost. Board level shielding solutions can be used to achieve an EMC performance that would be far more difficult and costly at product enclosure level.

At board level, small shielding cans can be applied selectively to the problem areas of a circuit, directly tackling components with emissions that are too high or are too sensitive.

In effect, PCB shielding cans are simple metal boxes that are easily soldered in place, much like any other board level component. Tackling EMC problems at this level, keeps component and assembly costs low and the appearance and ease of maintenance of the product are not compromised.

With circuit board tracking and wiring shielded inside a can solution, the contained tracks and wires are conse- quently very short and thus not very efficient as aerial radiating RFI or EMI. Furthermore, they may not need much, if any, filtering to reduce overall emissions to an acceptable level.

Where immunity is a pre-requisite and the problem to be resolved, board level shielding will require the same performance from cable filters as for enclosure-level shielding. However, as the filters can now be fitted to the PCB instead of an enclosure shield, component and assembly costs are minimised.

Although board level shielding using simple metal cans is much easier than shielding at enclosure level, there are still important design issues to be considered. These are discussed briefly as follows:

Ground Plane:

In operation, a PCB shielding can must be soldered to a good ground plane which lies underneath all the components that require shielding to create a complete six-sided metallic enclosure – a mini Faraday cage. The ground plane, as discussed later, must not have any significant apertures in it.

Can material:

Shields work by reflecting and absorbing electromagnetic fields. Good conductivity as exhibited for example by copper, is required for reflection and this is especially important above 100MHz. High permeability, as exhibited by steel and nickel, is required for absorption which is especially important below 100MHz where the interfering source is closer than $\frac{3x10^8}{2\pi F}$ metres. (F is the highest problem frequency.)

In general, tin plated steel is the best choice for shielding below 100MHz whilst tin plated copper is best above 200MHz. Tin plating makes for easy soldering. As aluminium is not easily soldered to a ground plane, it is not generally used.

Thicker materials give better shielding and 0.2mm steel is thick enough to give 40dB shielding effectiveness above 500kHz – assuming there are no significant apertures. (see below)

Apertures:

The real world performance of all shielding and ground planes is always compromised by apertures such as holes for adjustments, indicators, wires, construction seams and the gaps between a shielding can's ground plane connections. And it does not matter how narrow those apertures are! The effect of an aperture depends on the frequencies to be attenuated and the shielding performance required. As a rough guide, for a single aperture:

$$L = \frac{1.5x10^{11}}{FxSE}$$

Where: L = the longest dimension of the aperture (mm)
SE = the shielding effectiveness required (as a number, not dB)
F = the frequency at which the above SE is required

This formula indicates that for a shield with a single aperture to achieve a 40dB (100 fold) SE at 150MHz, the longest dimension of the aperture must be less than 10mm.

Normally, a safety factor of at least 6dB should be allowed when using this formula. Multiple apertures of the same size worsen SE by 3dB for every doubling in their number. In rare circumstances SE can be very much more than this equation suggests. So the best aperture is no aperture!

Making the best use of PCB Shielding Cans:

The lowest cost shielding cans are rectangular boxes, so it is prudent to arrange the components that need to be shielded inside a rectangular area on the PCB, providing sufficient clearance for the walls of the can.

Arranging the PCB to have a ground plane on the same side as the shielding can allows its edges to be soldered all around to eliminate any apertures in this area.

Realising all PCB tracks and wires in and out of a shielded area as correctly-terminated transmission lines is best practice but if this is not possible designs should allow for ferrite beads or more complex filters to be fitted where the tracks and wires cross the boundary of the shielding area.

So, if you want board level shielding solutions, call the best,
call Perancea now and see what we can do for you.

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