# Picket Fences:
# A poor mans' faraday cage?

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## Abstract:

Faraday cage is an enclosure that shields electromagnetic fields from penetrating into or radiate out of the enclosure. Faraday cages have been around for a long time and are generally used to isolate test equipments or to measure radiated emissions and immunity from a DUT. The concept of Faraday cage works so well that engineers have been using it on PCB designs. But some engineers go to an extreme of using picket fences (ground vias on PCB edges) and believe that they act as a faraday cage while being cost effective. Can this be true? I set out to investigate.

## A Faraday Cage on PCBs:

The popular way of using faraday cage on PCBs is by constructing shields. When a particular area in the PCB needs to be shielded from incoming radiations or from outgoing radiations, shields are used. As miniaturization got popular, the number of shields used in a PCB has increased significantly. The shields on PCBs mimic faraday cages and are generally used to isolate electric fields and not magnetic fields – and they work quite well in containing the fields. But in projects where cost is involved, engineers recommend the usage of stitching ground vias around the corner of the PCB to help shield emissions.

Usage of shields is an accepted practice, but the usage of vias around the corner of the PCB to try and contain emissions from a PCB is very debatable. Even very experienced engineers have different thoughts on this practice. The usage of vias around the board edge however is not something that forms a faraday cage (unless there are supporting mechanics involved that have a conductive metal frame on top and are connected to the ground layer in the PCB or the whole system). Though some engineers completely dismiss this approach, there are a few who advocate this.

So, I wanted to try and build a simple PCB model in CST - a 3D EM Simulation tool and wanted to investigate the usage of picket fences (or placing vias at regular intervals around the PCB) and evaluate EMC performance from both near field and a far field point of view. I constructed a simple microstrip model with 50 ohm trace impedance. In one of the configurations, I added vias that stitch the top ground plane to the bottom ground plane and on the other I didn't have any.

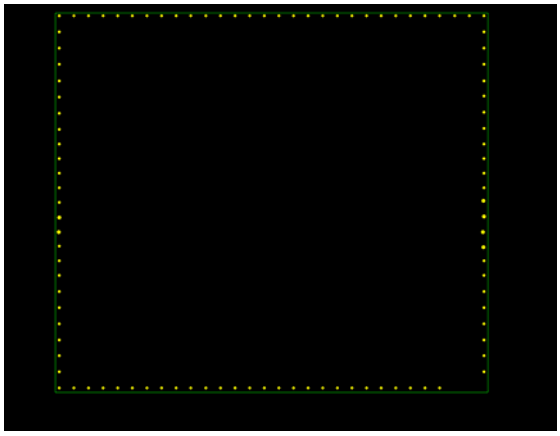

*Figure: Picket fences (Ground vias around the board edge)*

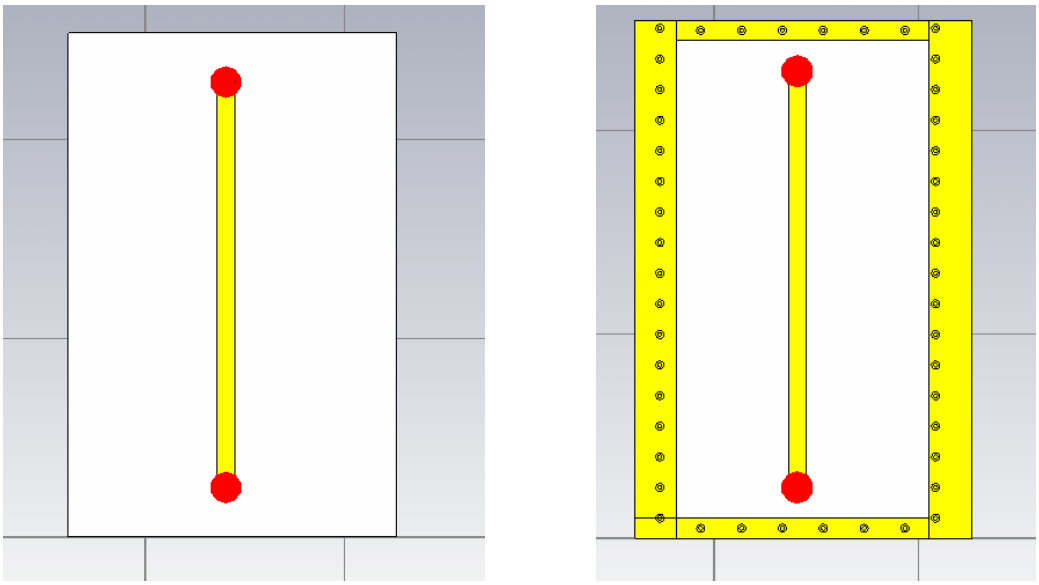

*Figure: Set-up without ground vias (Left) Set-up with ground vias (right)*

I then measured the 3-D fields around the PCB (and not the trace itself) to see if the picket fence plays any role in the reduction of emissions from the PCB.

The scales on the top right corner show that the field just outside the PCB is a bit higher when there is no faraday cage. The difference in values is very less and equates to around 0.5dB. A similar performance can be seen at 1GHz frequencies as well.

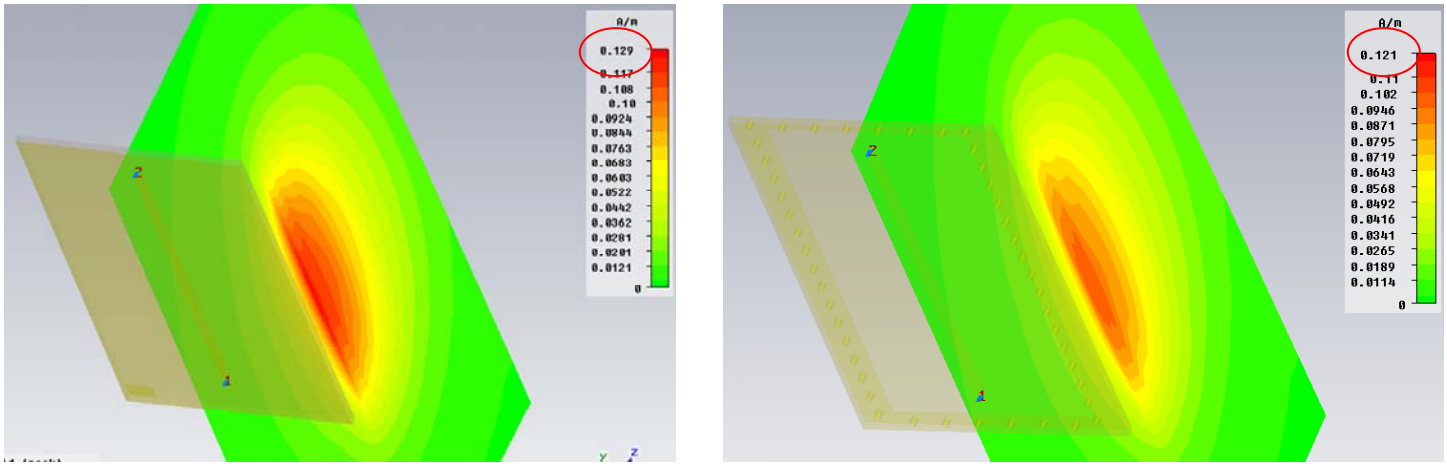


*Figure: Emissions at 200MHz without ground vias (Left) with ground vias (right)*

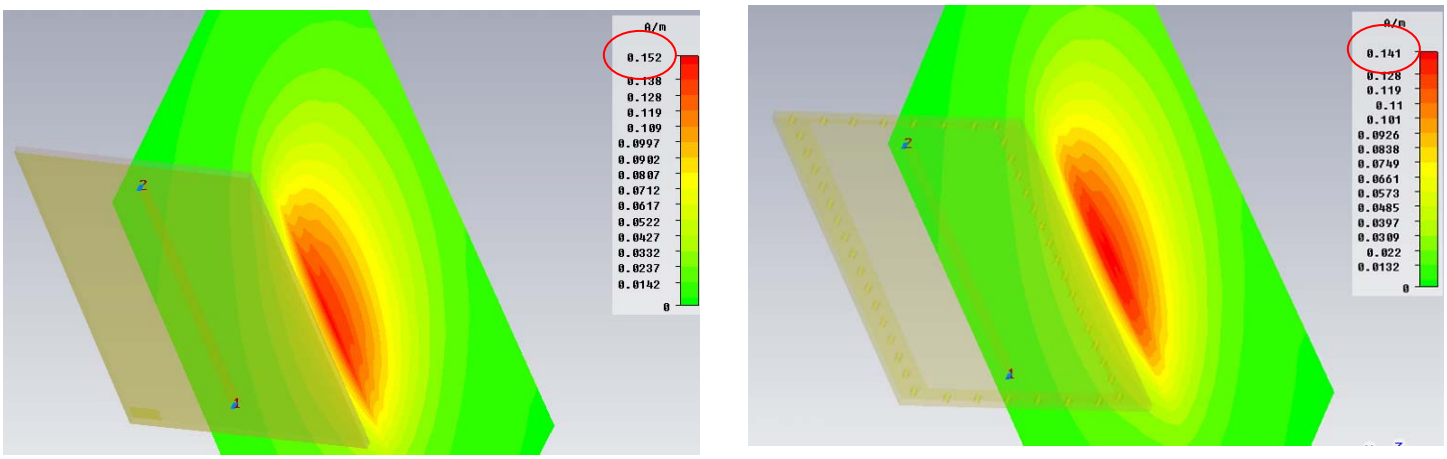


***Figure: Emissions at 1000MHz without ground vias (Left) with ground vias (right)***

## EMC Performance:

Now that we are clear that the field attenuated by using picket fences is around 0.5dB, I felt it is probably relevant to understand the emissions from the PCB at 10 metres (to mimic a standard EMC measurement from a PCB). The result of Emissions at 10 metres was very similar to each other.

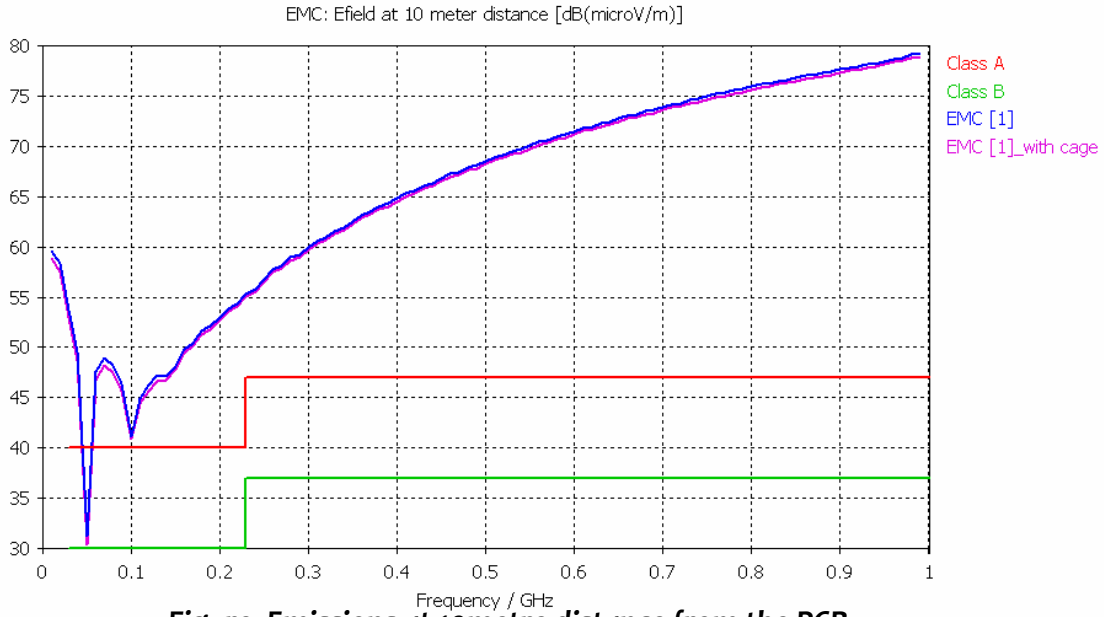


***Figure: Emissions at 10metre distance from the PCB***

## Conclusion:

It is very clear from the above results that picket fences do not help in reducing emissions in both near and far fields (the computed far field is an extrapolated value based on the near fields). Though it has some benefits (attenuation of around 0.5 dB), it does not justify the amount of board space and effort required. It is far better to concentrate on reducing emissions using other techniques than to try and shield them with picket fences.