RF Multiple Cavity Structure of PCBs Using Coaxial Metal Walls

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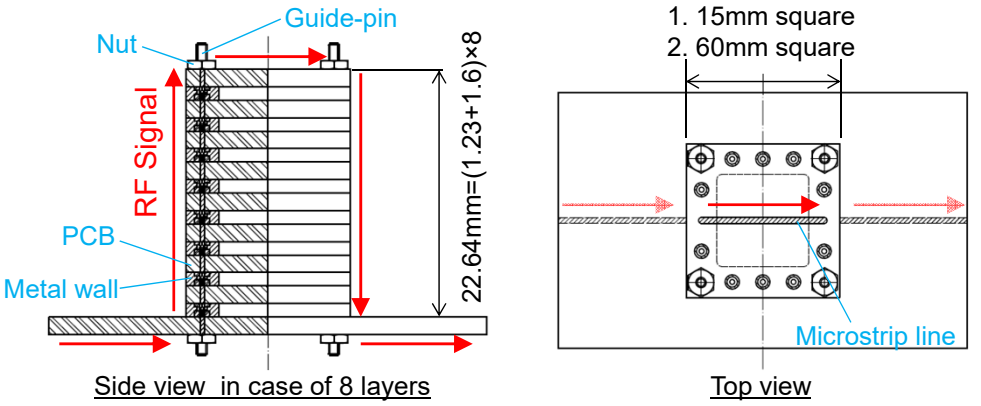
Introduction

Due to the demand of 5G, AI and IoT, it is necessary to increase the frequency range and density of the printed circuit board(PCB). To satisfy the requirements, RF multiple cavity structure of PCBs has been developed. It consisted of metal walls and PCBs which were alternately arranged in multiple stage up to 8 layers, and circuit components could be placed on the PCB within the cavity enclosed by the metal wall.

RF Multiple Cavity Structure

Two types were fabricated. One was layer size of 15mm square , and the other was layer size of 60mm square.



PCB : Material =MEGTORN6, Thickness=1.6mm
Metal wall : Material = Brass, Thickness=1.23mm

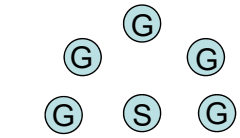
Considerations for RF vertical transmission

- Control of characteristic impedance of transmission lines.
- Reduction of ground resistance(Rg) .

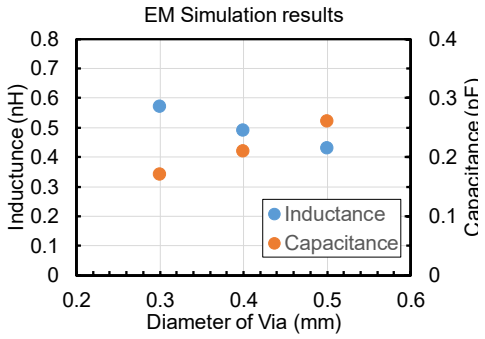
PCB structure : Via-in-pad designed G-S-G configuration

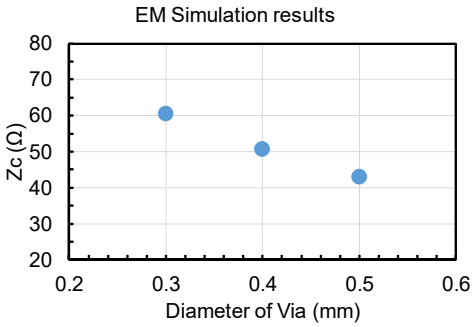
•The outer diameter of the via was optimized to control the characteristic impedance (Zc).

• Diameter of the via was 0.4mm (Via pitch=1.0mm) from the EM simulation results.

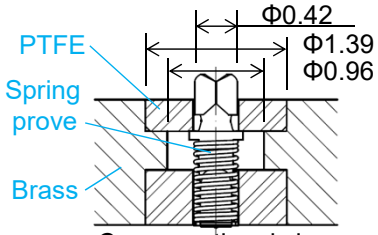


Top view of via configuration





Metal Wall : Co-axial structure using a spring probe



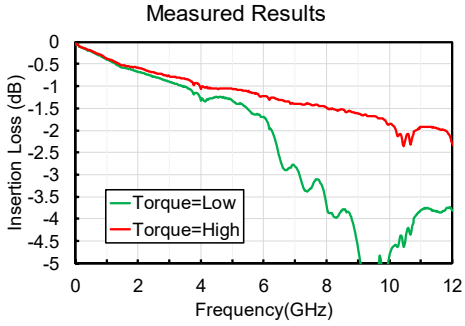
Cross sectional view

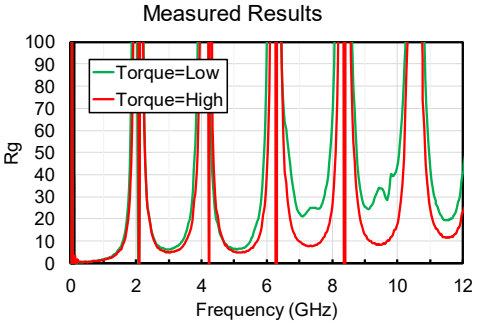
- Length of the spring prove = 1.51mm
- Diameter of the spring prove = φ0.42mm

- Calculation result of Zc
  Insulator=PTFE(φ1.39) → Zc=49.5Ω
  Insulator= AIR(φ0.96) → Zc=49.5Ω

Improvement of insertion loss by reducing Rg

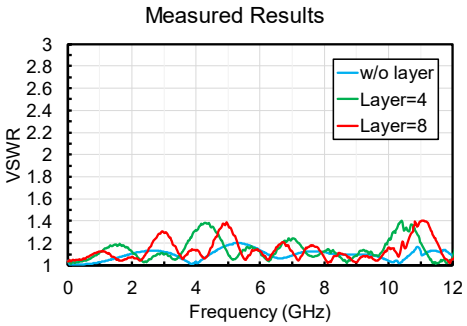
By tightening the nut of the guide-pin, the contact resistance between the metal wall and the PCB was reduced and Rg was reduced.

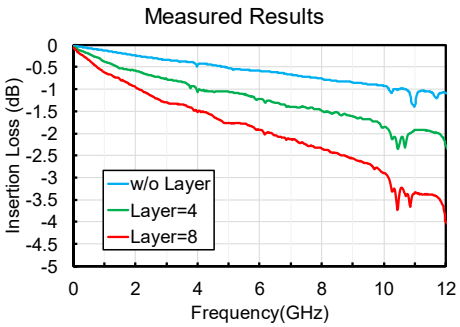




Rg=Rg1+Rg2
Rg1=real(1/(Y(1,1)+Y(1,2))
Rg2=real(1/(Y(2,2)+Y(2,1))

Results in the case of layer size = 15mm square



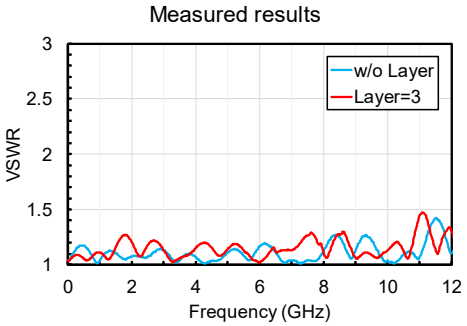


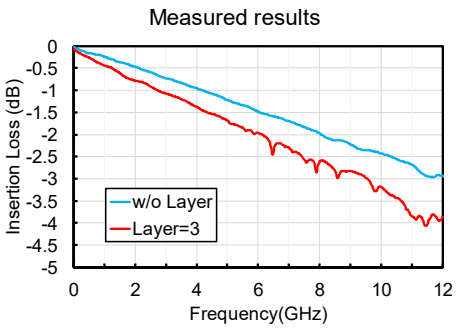

Layer=8

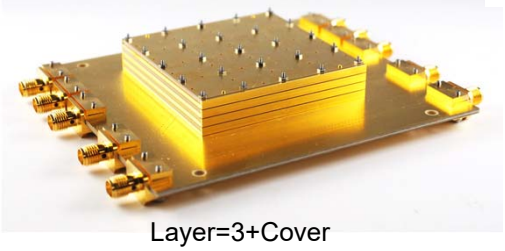

w/o Layer

Insertion Loss at 10GHz
w/o Layer = -0.92dB
Layer=4 = -1.85dB → -0.12dB/layer
Layer=8 = -2.89dB → -0.12dB/layer

Results in the case of layer size = 60mm Square






Layer=3+Cover

Insertion Loss at 10GHz
w/o Layer = -2.43dB
Layer=3 = -3.18B → -0.13dB/layer

Conclusion

- RF multiple cavity structure of PCBs has been developed.
- At 10GHz, VSWR≦1.3 and the insertion loss of 0.13dB per layer were obtained. In order to improve the insertion loss, not only the control of Zc but also the reduction of Rg was indispensable.

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