Microwave PCB Structure Considerations: Microstrip vs. Grounded Coplanar Waveguide

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Microwave PCB Structure Considerations: Microstrip vs. Grounded Coplanar Waveguide

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GCPW also known as Conductor Backed Coplanar Waveguide (CBCPW)
The key to understanding differences of microstrip and GCPW is looking at the fields.

**Microstrip:**
- Most fields are between the signal plane and the ground plane.
- High field concentration at the signal conductor edges.

**GCPW:**
- Strong fields between the ground-signal-ground on the coplanar layer.
- Less fields between signal plane and bottom ground plane than microstrip.
- Tightly coupled GCPW:
  - Has more conductor loss but much reduced radiation loss.
  - Allows suppression of spurious modes.
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Normal fabrication influences such as copper plating thickness variation, impact on:

Microstrip has little difference on electrical performance

Thicker copper has a slight decrease for effective dielectric constant \((\text{eff}_{\varepsilon_r})\) and a very slight benefit to insertion loss

GCPW can have significant impact on electrical performance

Thicker copper increases fields between the ground-signal-ground, which has an affect on effective dielectric constant \((\text{eff}_{\varepsilon_r})\) and losses

Same design of tightly coupled GCPW circuits with two different copper plating thickness

Circuits are using 10mil thick RO4350B™ laminate

Thin copper plating  Thick copper plating
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- The tightly coupled circuits will have concentrated electric fields in air (air is lowest dielectric constant)
- Thicker copper will cause the conductor walls to be taller and more air is used
- The lowest $\text{Eff}_\varepsilon_r$ circuit has thick copper and is tightly coupled
- Reminder, this is using the same circuit material
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- Insertion loss comparisons of tightly / loosely coupled GCPW with thin / thick copper
  - Wider conductor has lower loss
  - Thick copper increases height of conductor sidewalls and more air is used (lower loss)

All circuits evaluated in this study used 10mil thick RO4350B™ laminate with standard 1/2 oz. ED copper
ENIG is a good finish but due to the nature of nickel being less conductive, ENIG will cause more conductor loss.

ENIG loss compared to copper is worse for GCPW than microstrip due to fields using 4 layers of ENIG for GCPW.
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- Tightly coupled GCPW will have increased electric field intensity between the ground-signal-ground coupled areas on the coplanar layer.

- Tightly coupled circuits will have more losses due to ENIG than loosely coupled GCPW.
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- Common tradeoffs between microstrip and GCPW
  - Microstrip is less affected by PCB fabrication than GCPW
  - Fields are more concentrated between the signal and ground plane for microstrip than GCPW, which makes microstrip performance more affected by copper surface roughness
  - When a plated finish causes more loss, microstrip has lower loss increase than GCPW
  - In general and at microwave frequencies:
    * microstrip has lower loss than GCPW
  - In general and at millimeter-wave frequencies:
    * microstrip has more radiation loss than GCPW
    * microstrip has more issues with mode suppression
    * microstrip is more dispersive and can limit bandwidth
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