Multi-Line De-Embedding Technique for Millimeter-Wave Circuit Design

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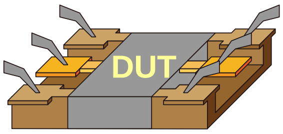
1 Background

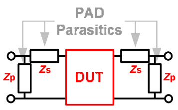
- **On-wafer measurement needs contact pads**
  - Measurement data includes the device under test (DUT) and the pad parasitic components.
  - At millimeter wave (MMW), parasitic components are not negligible.

Device Measurement

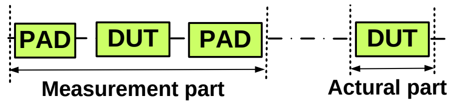


Contact Pads

- **De-Embedding**
  - Remove parasitic components from measurement data



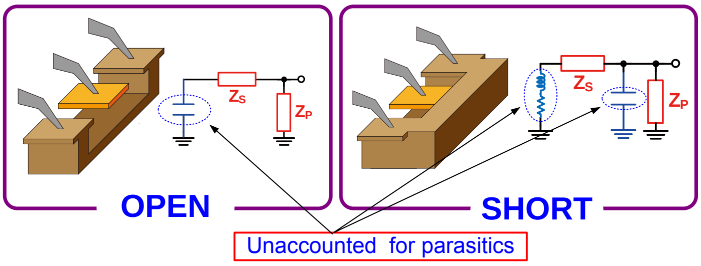
Parasitics of pad



De-embedding process

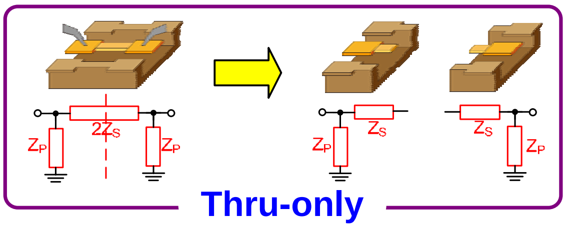
2 Conventional de-embedding method

- **Open-short de-embedding method**



☹ ▪Difficult to get the ideal patterns at high frequency (MMW)

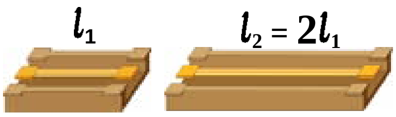
- **Thru-only de-embedding method**



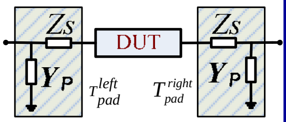
☹ ▪The through-line is required to be very short

☹ ▪Probe coupling

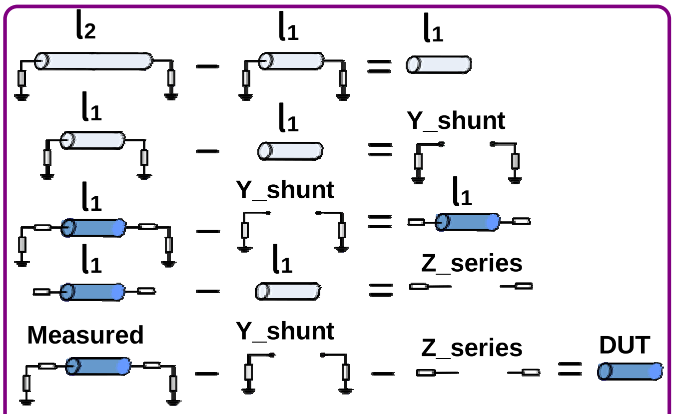
3 Proposed de-embedding method



Two transmission lines



Pad model



De-embedding process

- Based on distributed-constant approach
- Doesn`t need “Short” or “Short-Line”

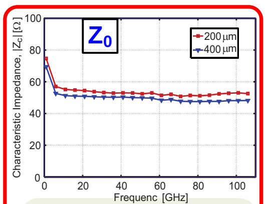
$$Y_{shunt} = \frac{Y_{pad}(1,1) + Y_{pad}(2,1) + Y_{pad}(1,2) + Y_{pad}(2,2)}{2}$$

Shunt Impedance

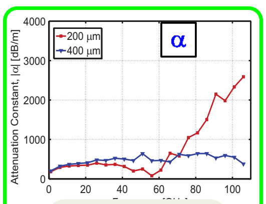
4 Results and Conclusion

- De-embedding of different-length TLs (200µm and 400µm)
- Compare Z_0, α, β

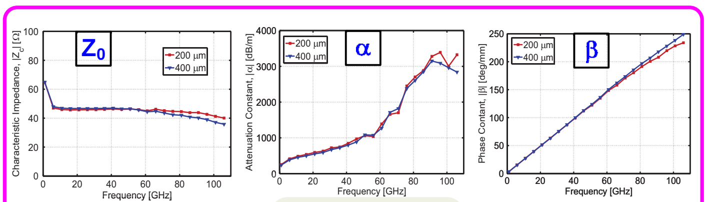
Chip photo



OPEN-SHORT



Thru-only



Proposed

☹ **▪Mismatched in Z_0 when using open-short**

☹ **▪Thru-only gives a large difference in α**

☺ **▪Up to 80GHz, the error in Z_0, α, β is less than 5.5%, 2% and 3% respectively by using the proposed method.**