Is a Lumped Cd model accurate?

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What's the problem with a Lumped Cd

- As we approach high data rates, the interaction of the die model (usually a cap – Cd in com) with Package model is significant
  - Most packages are essentially a some trace followed by Pth
  - size of the trace and Pth depend on package size and application
  - The interaction can cause ripple in the frequency domain (ILD) or perturbance in the time domain pulse response

Sample package model

- **Inphi created a sample package model representing typical host packages**
  - A 30mm trace with a 1mm PTH (4.2dB loss at 26GHz)
  - A 10mm trace (1.5dB loss at 26GHz)
  - These routes were optimized for best insertion and return loss
- **We also consider typical traces from our module packages**
  - Routes are less than 5mm (4mm considered for study)
 - Pth is small (200u ~ 400u)
- **Serdes models**
  - Simple lumped models with $Cd=110fF$ and $Cd=130fF$ are baselines for comparison with t-coil based model

- A t-coil based model was built based on various implementations and publications

- Model includes key parasitic capacitances and routing resistances seen in typical implementations

- Implementations may choose to use asymmetric (esp. tx) or symmetric t-coils

Sample package Module Rx

RX Module - 4mm Pkg trace

Sdd21 [dB] vs Freq[Hz]

Legend:
- Sdd21 - PKG only
- Sdd21 Pkg + Cd=110fF
- Sdd21 Pkg + Cd=130fF
- Sdd21 Pkg + RxModel

RX Module - 4mm Pkg trace

Differential Return loss Sdd11 [dB] vs Freq[Hz]

Legend:
- Sdd11 PKG only
- Sdd11 Pkg + Cd=110fF
- Sdd11 Pkg + Cd=130fF
- Sdd11 Pkg + RxModel
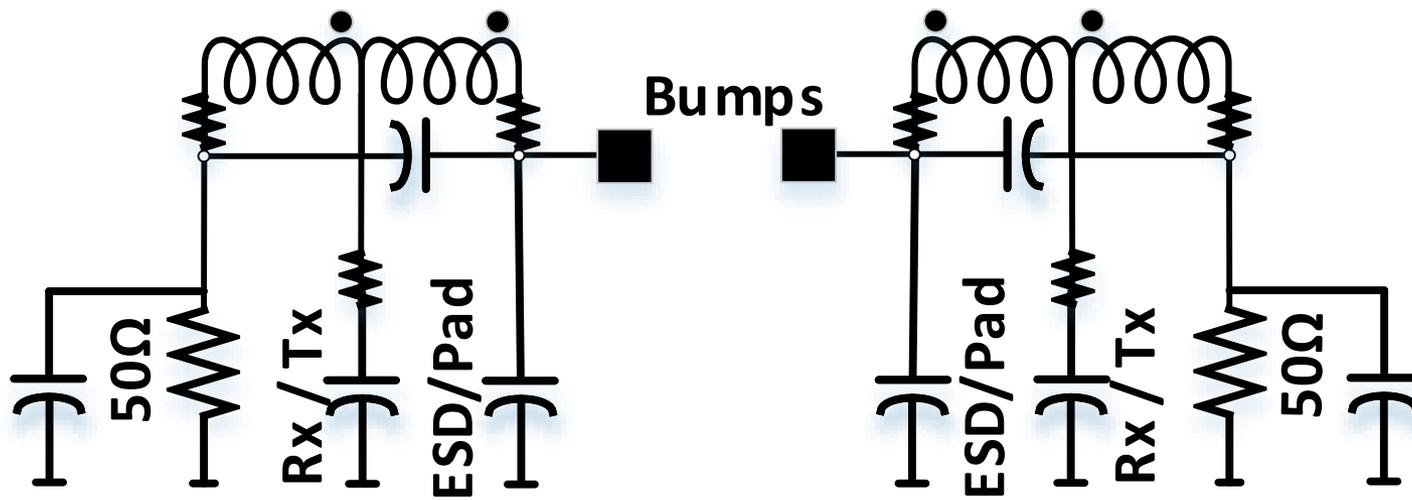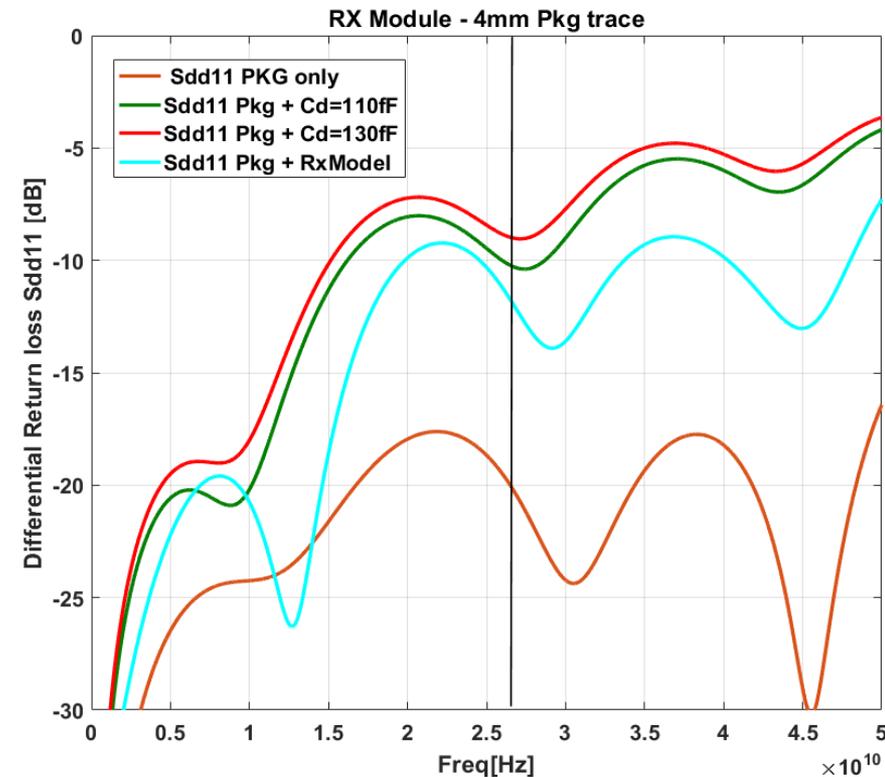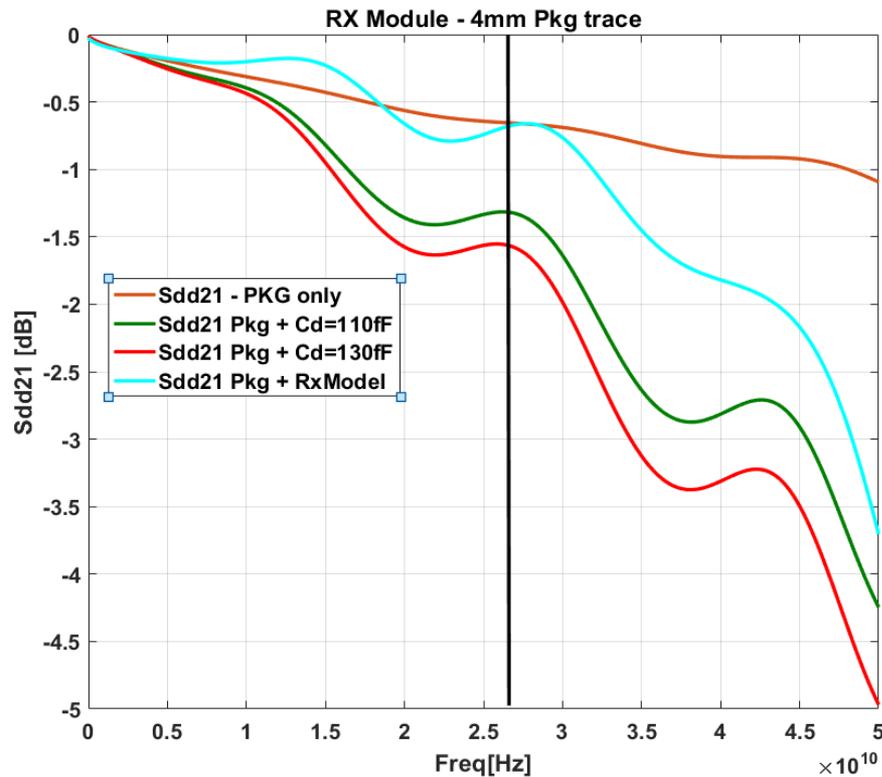
- A typical module package alone shows ~0.5dB loss
- Sdd21 is measured from ball to receiver inputs
- Sdd11 is return loss seen at device ball
- Cd impacts impact loss budget more than return loss in module Rx

Sample package Host Rx (10mm trace)
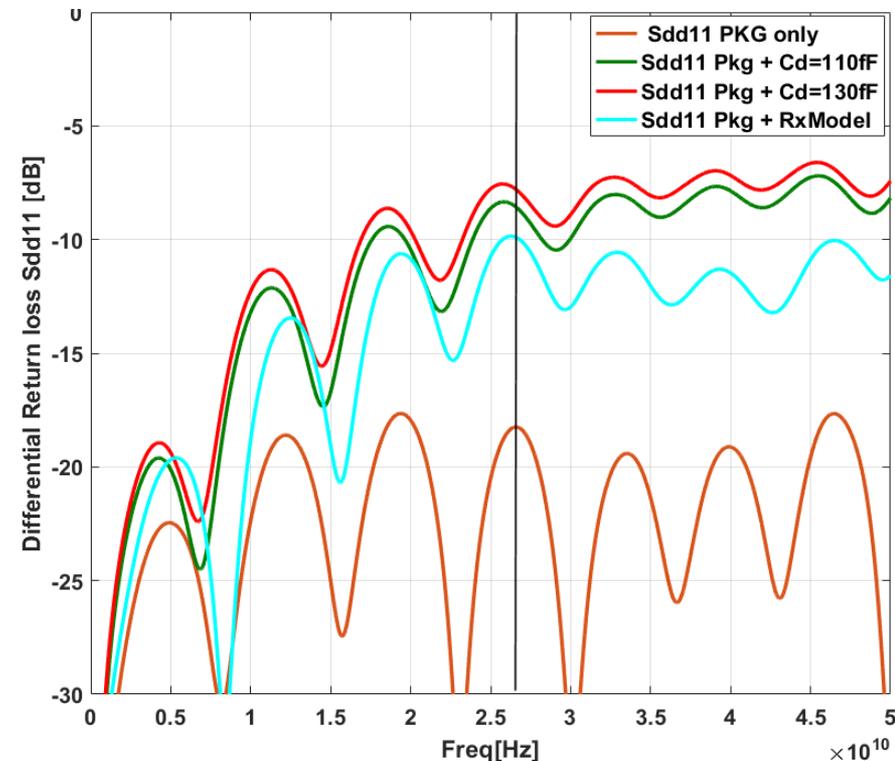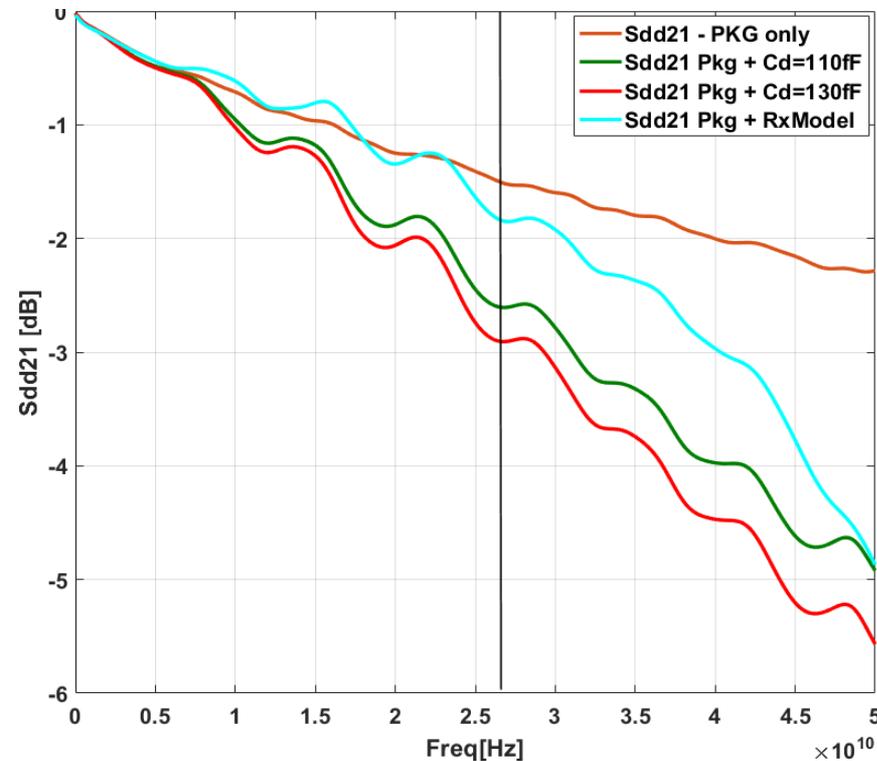
- Host ILD shows similar match with a lumped case
- Model is more critical for loss budget

# Sample package Host Rx (30mm trace)
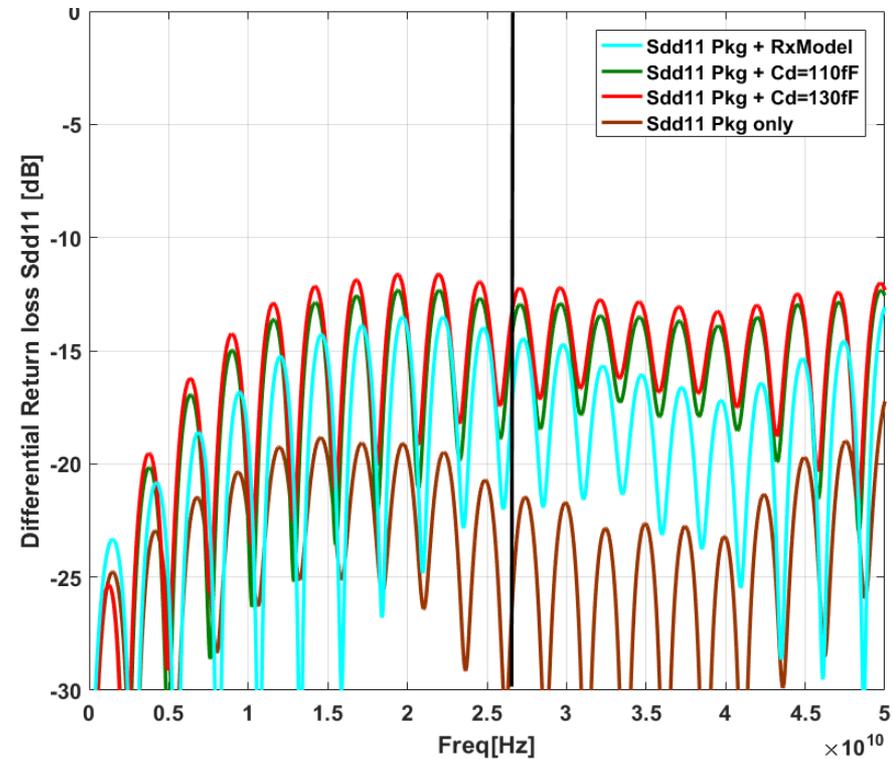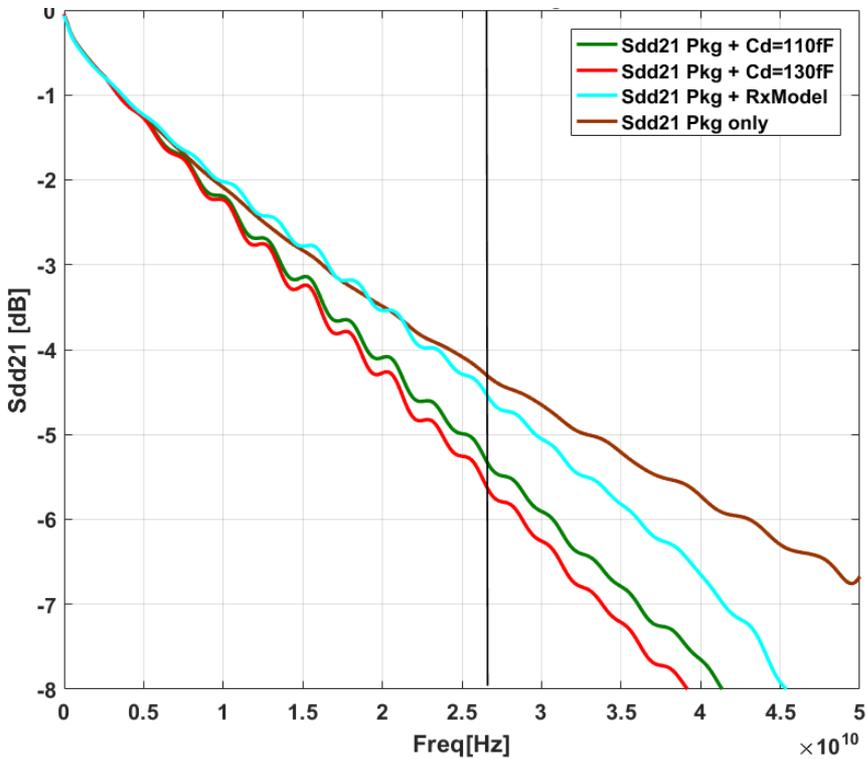
- ■ Similar trends to 10mm case

Sample package Module Tx

TX Module - 4mm Pkg trace
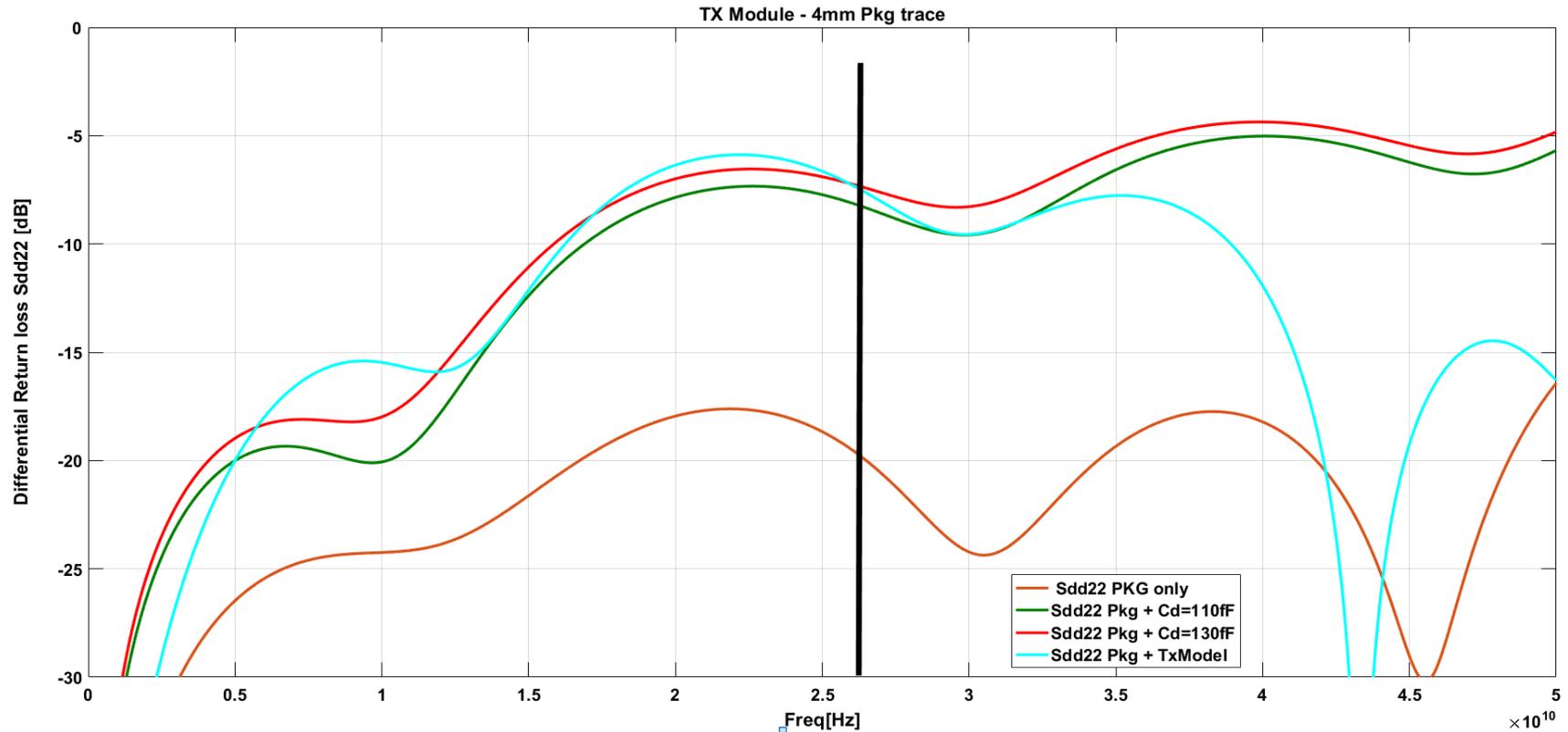
- **TX side return loss shows reasonable match with a lumped model**
  - This does not mean the parasitics inside are just 110 or 130. but seems reasonable to assume lumped equivalent

Sample package Host Traces Tx
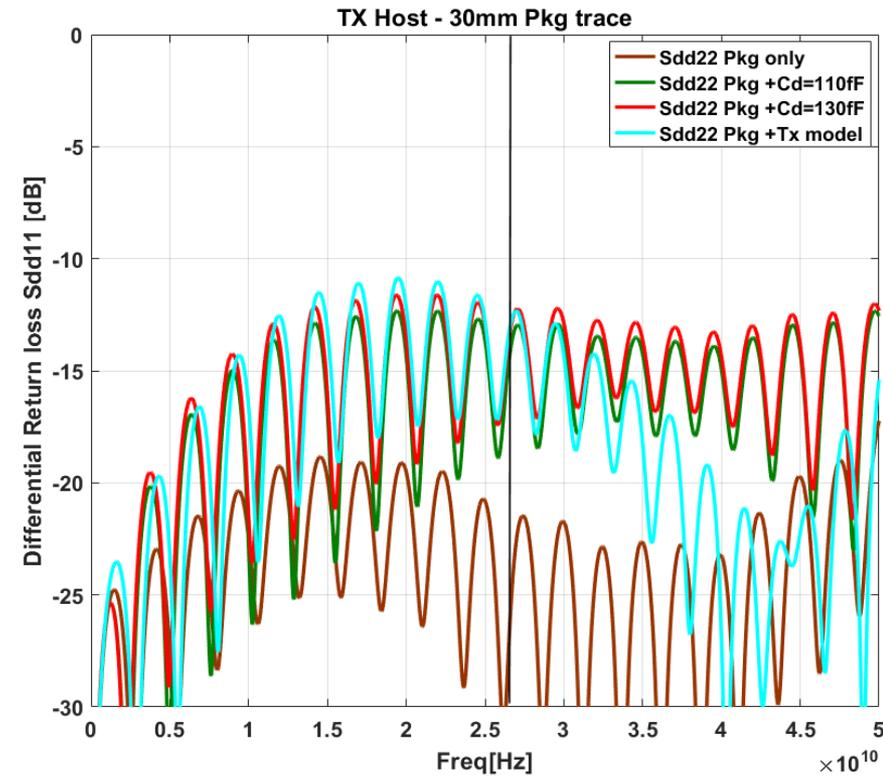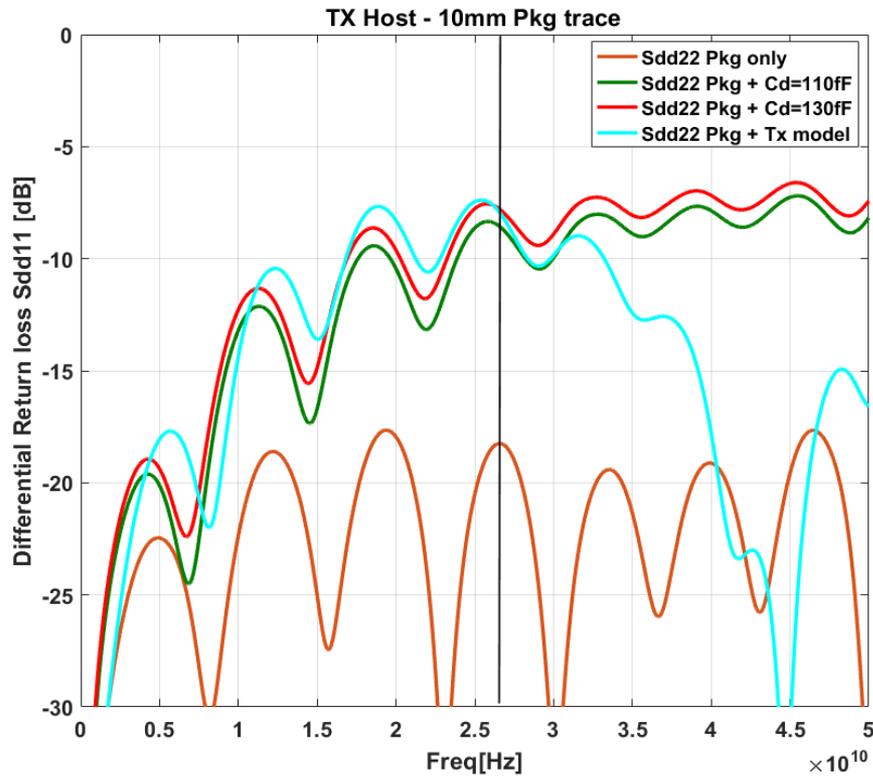
■ TX side return loss shows reasonable match with a lumped model as in the module case

Summary

- **Cd based model is sufficient on the transmit side**
  - A good estimate for a lumped model is $C_{dtx} \sim 130\text{fF}$

- **On the receive side, a broadband match could be useful**
  - The loss with a lumped model is pessimistic (~1.5dB per side)
  - A good estimate for a lumped model is $C_{drx} = 85\text{fF}$

- **If there is interest in using a broadband match similar to what was used, we could work towards building consensus for use in the COM tool**