Accounting for deviation of a test fixture from the reference

(in support of comment #407)

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Problem statement

- The method of accounting for the difference between the reference and actual test fixture insertion loss is not specified.
- It was suggested to use the "de-embed and re-embed" method. This would effectively be a calibration procedure.
  - The process of de-embedding s-parameters is known in the industry, implemented in test equipment and used in many practical tests. It does not need a detailed specification.
  - The contribution heck_3dj_01_2607 includes suitable text for describing the procedure.
- The re-embedding part requires S-parameters for the reference HCB and MCB that match the magnitude of the insertion loss (existing equations 179B–1 and 179B–2).
  - It would be good to represent these S-parameters as a mathematical model using the methods of Annex 93A.

Outline of this presentation

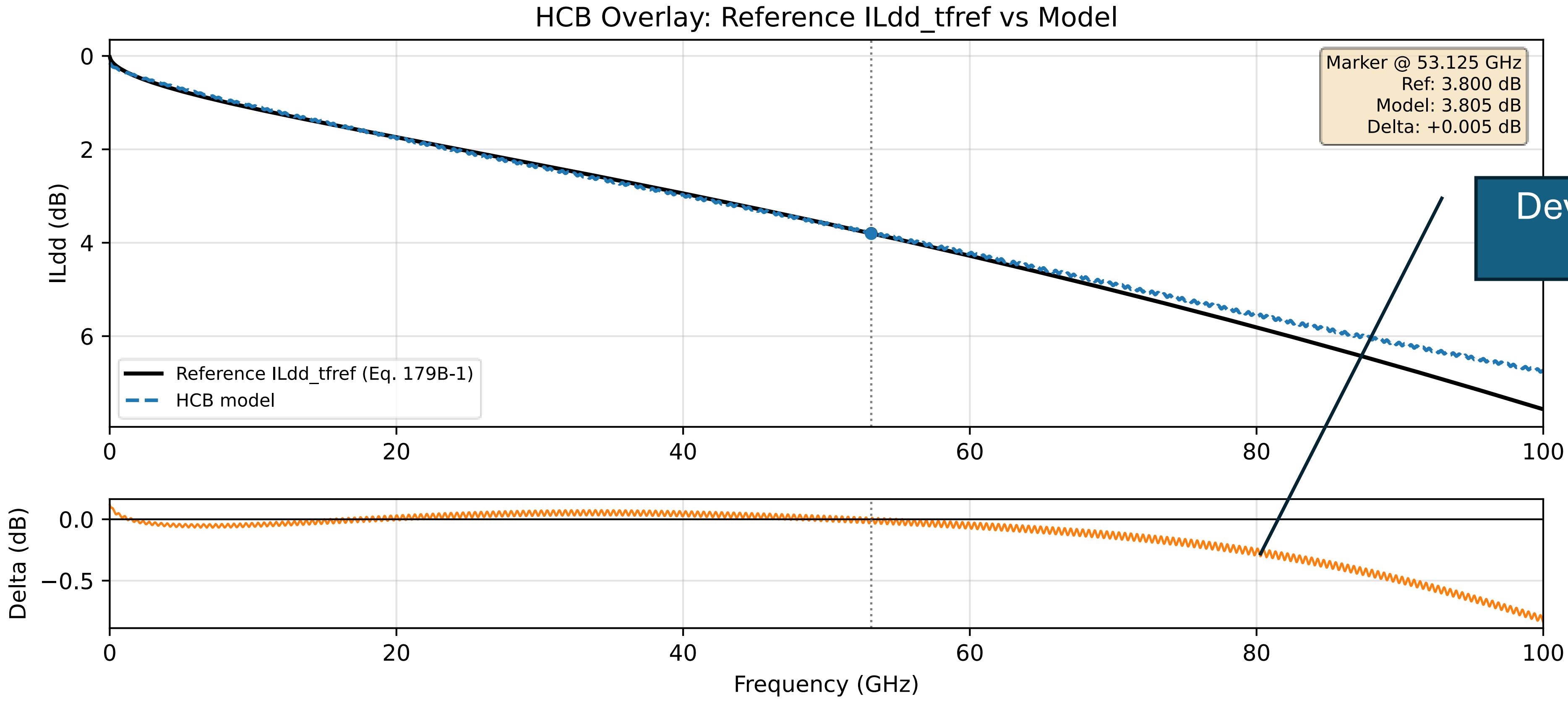
- Proposed models of the reference MCB and HCB; showing
  - The fit to the reference ILdd of each one, and the mated fixtures
  - Model structure and parameters
  - TDR of the MTF (concatenated models) from both sides
- Proposed text for Annex 179B

Rationale for models

- The model should match the ILdd equations and be representative of physical dimenstions of HCB and MCB.
- Physical dimentions were estimated from TDR calculation based on data from mammenga_3dj_02_2601 (contributed OSFP test fixture data).
- Goal was to fit the reference ILdd magnitude to a good degree, while forcing the lengths of the major elements to the estimated values.
- The same γ_0, a_1, a_2 (loss per mm) and τ were used for all segments of each model (HCB or MCB).
  - This may not match real design.
- Capacitor models were added to improve matching at high frequencies.
- The models are not intended to match recent designs – the intent is to match the reference equations!

HCB model fit results

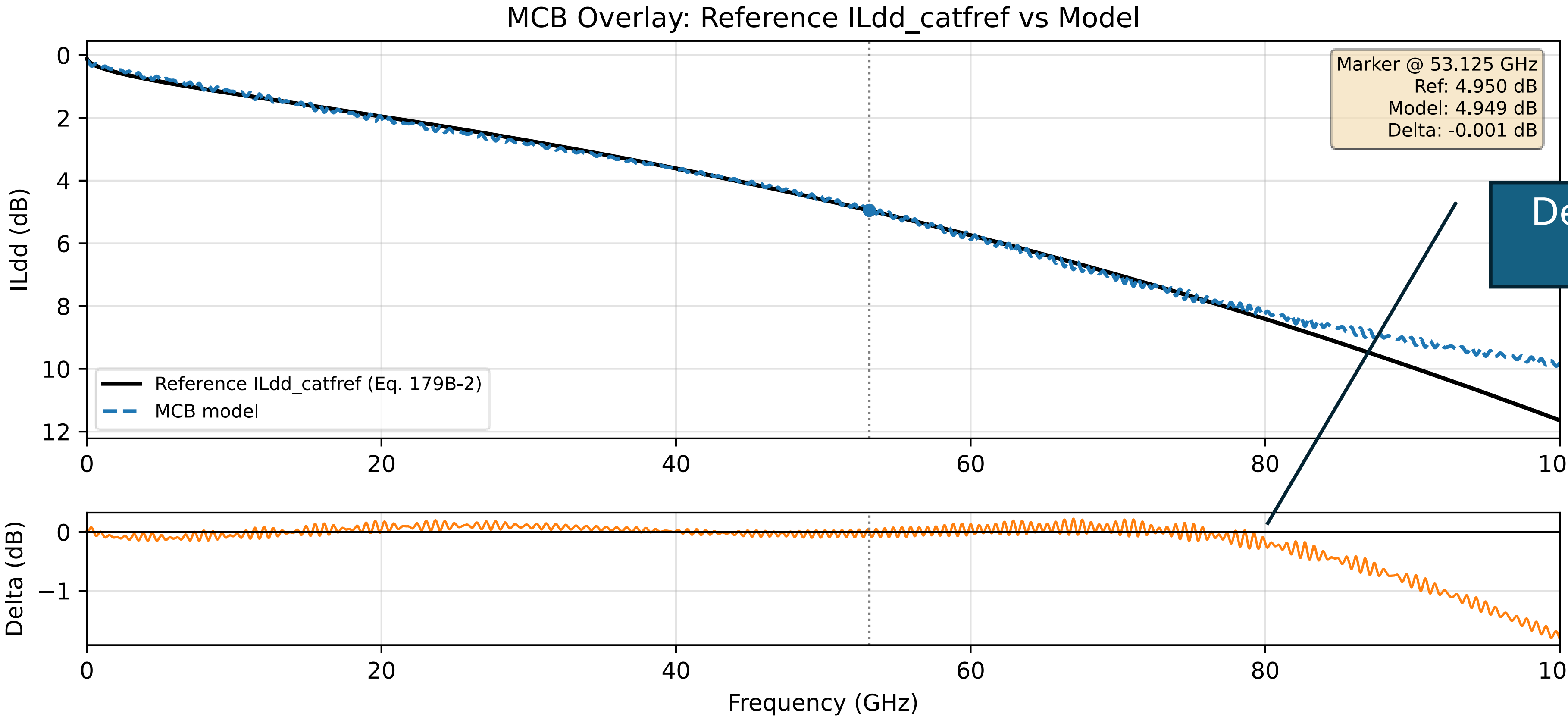
ILdd calculated with respect to single-ended impedance of 46.25 Ω



Deviation <0.25 dB up to 80 GHz

MCB model fit results

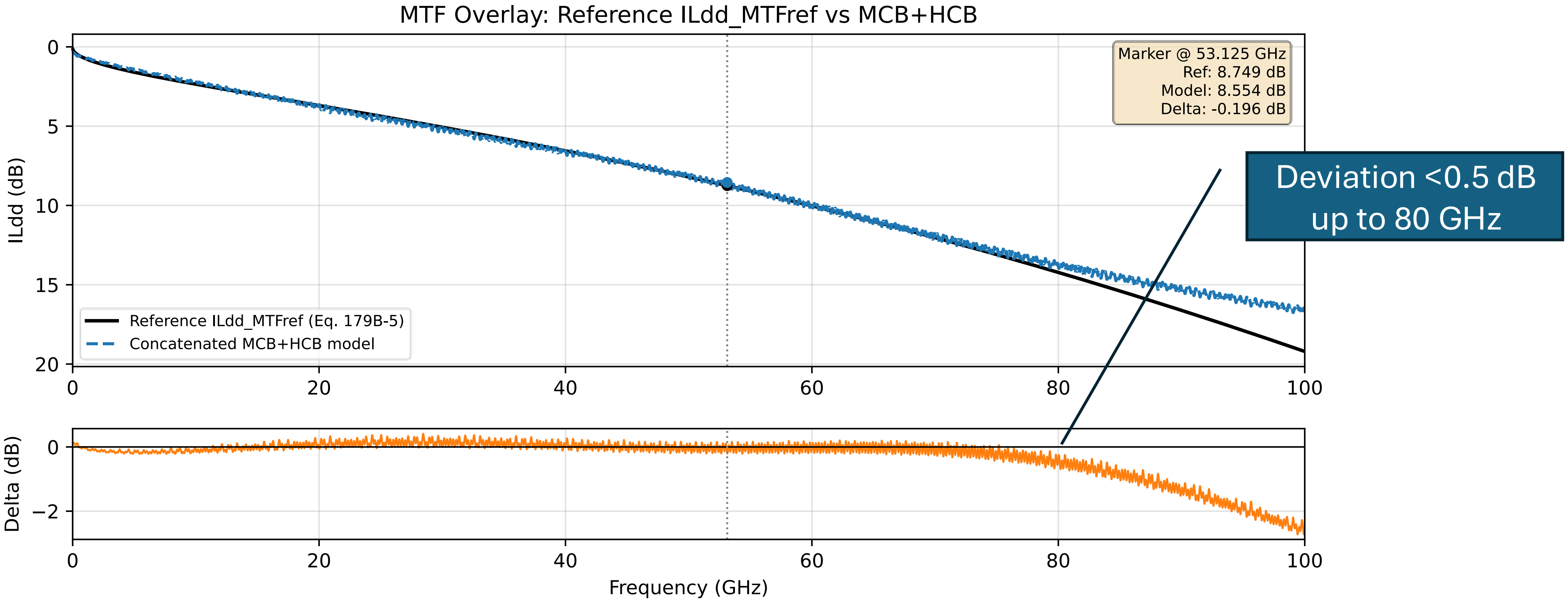
ILdd calculated with respect to single-ended impedance of 46.25 Ω



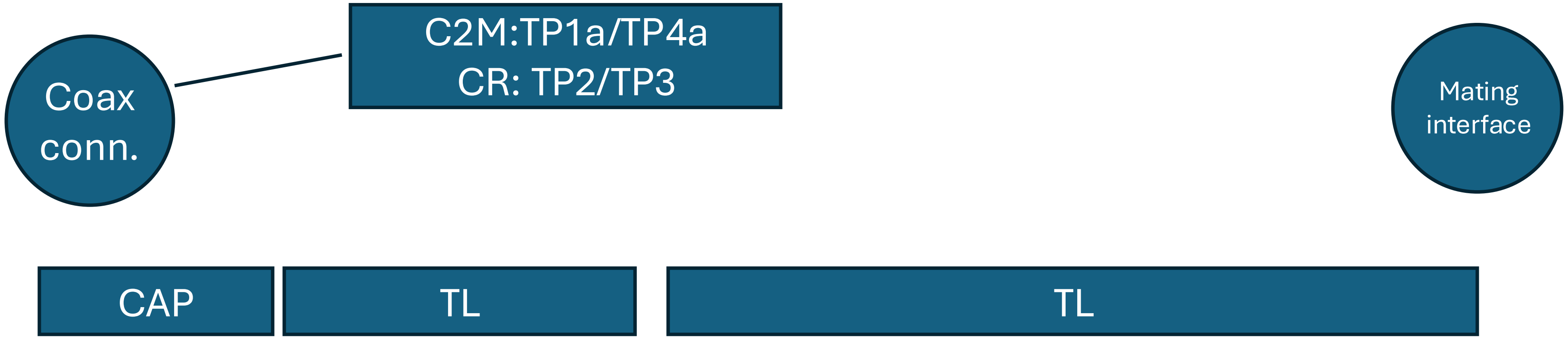
Deviation <0.25 dB up to 80 GHz

MTF model fit results

ILdd calculated with respect to single-ended impedance of 46.25 Ω



HCB model structure and parameters



C=2.34e-5 nF

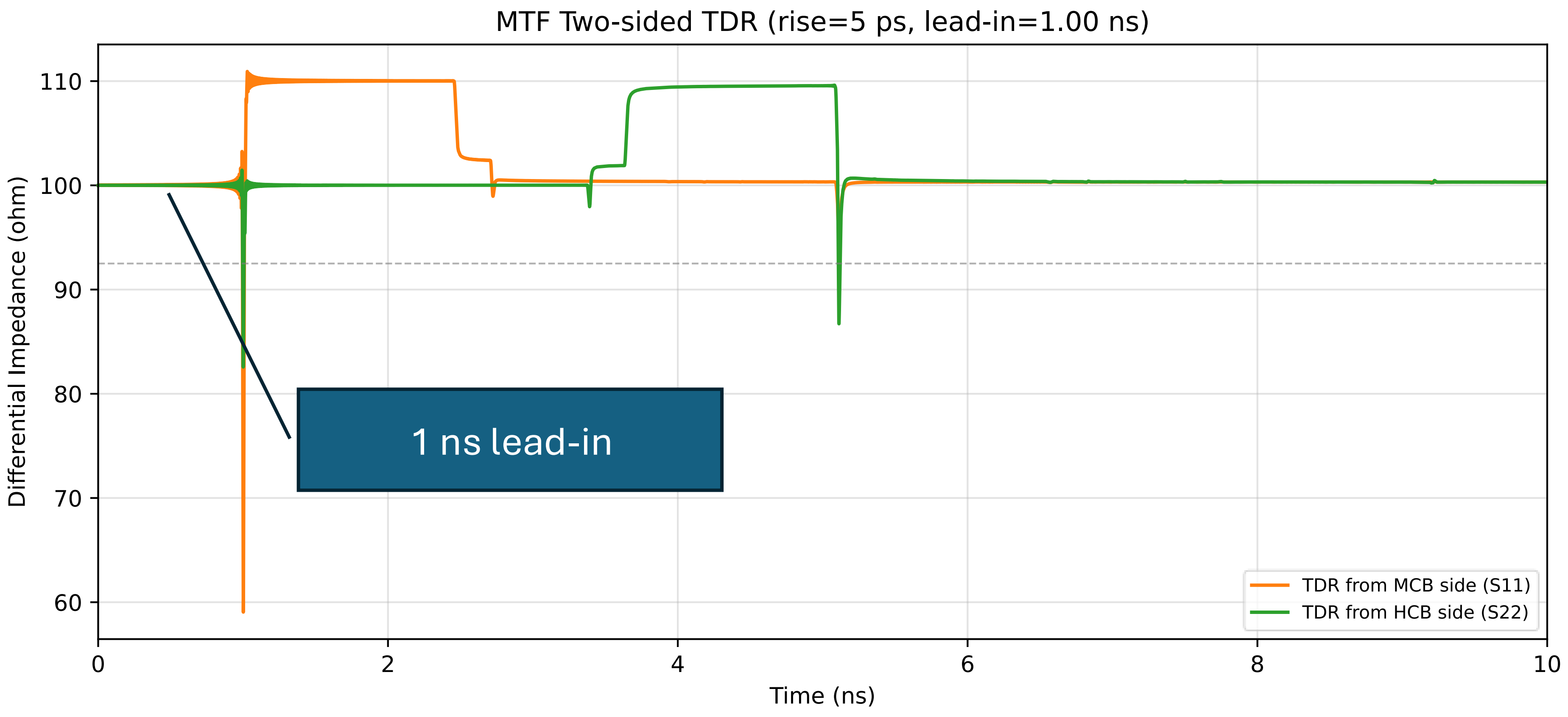
$\gamma_0^{(1)}$=6.16e-5 1/mm
$a_1^{(1)}$=6.68e-5 ns$^{1/2}$/mm
$a_2^{(1)}$=2.19e-5 ns/mm
$\tau^{(1)}$=4.83e-3 ns/mm
$Z_c^{(1)}$=95.6 Ω
$z_p^{(1)}$=1.5 mm

$\gamma_0^{(2)}$=6.16e-5 1/mm
$a_1^{(2)}$=6.68e-5 ns$^{1/2}$/mm
$a_2^{(2)}$=2.19e-5 ns/mm
$\tau^{(2)}$=4.83e-3 ns/mm
$Z_c^{(2)}$=100 Ω
$z_p^{(2)}$=246 mm

MCB model structure and parameters

C=7.93-5 nF	$\gamma_0^{(1)}$= 8.37e-5 1/mm $a_1^{(1)}$= 9.08e-5 ns$^{1/2}$/mm $a_2^{(1)}$= 2.97e-5 ns/mm $\tau^{(1)}$=4.83e-03 ns/mm $Z_c^{(1)}$=110 Ω $z_p^{(1)}$=150 mm	$\gamma_0^{(1)}$=8.37e-5 1/mm $a_1^{(1)}$= 9.08e-5 ns$^{1/2}$/mm $a_2^{(1)}$= 2.97e-5 ns/mm $\tau^{(1)}$=4.83e-03 ns/mm $Z_c^{(1)}$=99.4 Ω $z_p^{(1)}$=1.5 mm	$\gamma_0^{(1)}$= 8.37e-5 1/mm $a_1^{(1)}$= 9.08e-5 ns$^{1/2}$/mm $a_2^{(1)}$= 2.97e-5 ns/mm $\tau^{(1)}$=4.83e-03 ns/mm $Z_c^{(1)}$=106 Ω $z_p^{(1)}$=1 mm	$\gamma_0^{(1)}$= 8.37e-5 1/mm $a_1^{(1)}$= 9.08e-5 ns$^{1/2}$/mm $a_2^{(1)}$= 2.97e-5 ns/mm $\tau^{(1)}$=4.83e-03 ns/mm $Z_c^{(1)}$=102 Ω $z_p^{(1)}$=25.1 mm	$\gamma_0^{(1)}$= 8.37e-5 1/mm $a_1^{(1)}$= 9.08e-5 ns$^{1/2}$/mm $a_2^{(1)}$= 2.97e-5 ns/mm $\tau^{(1)}$=4.83e-03 ns/mm $Z_c^{(1)}$=97.1 Ω $z_p^{(1)}$=1.5 mm

TDR plots


MTF Two-sided TDR (rise=5 ps, lead-in=1.00 ns)
110
100
90
80
70
60
Differential Impedance (ohm)
0
2
4
6
8
10
Time (ns)
1 ns lead-in
TDR from MCB side (S11)
TDR from HCB side (S22)

Proposed text changes (HCB)

Implement with editorial license

- In 179B.2.1, add the following text and new equation at the end:

The reference insertion loss is approximately achieved by scattering parameters generated by equation (179B-X1) :

$$S = \mathrm{cascade}(S(C_1), S(TL_1), S(TL_2)) \qquad (179B\text{-}X1)$$

Where

$S(C_1)$ are the S-parameters for a shunt capacitor C_1 with value in Table 179B-X2, as defined in 93A.1.2.2

$S(TL_1)$ and $S(TL_2)$ are the S-parameters for transmission lines with parameters in Table 179B-X2, as defined in 93A.1.2.4

- Add new table 179B-X2 with C and TL parameters from slide 8.

Proposed text changes (MCB)

Implement with editorial license

- In 179B.3.1, add the following text and new equation at the end:

The reference insertion loss is approximately achieved by scattering parameters generated by Equation 179B-X3 :

$S = \text{cascade}(S(C_1), S(TL_1), S(TL_2), S(TL_3), S(TL_4), S(TL_5))$ (179B-X3)

Where

> $S(C_1)$ are the S-parameters for a shunt capacitor C_1 with value in Table 179B-X4, as defined in 93A.1.2.2
>
> $S(TL_1)$ through $S(TL_5)$ are the S-parameters for transmission lines with parameters in Table 179B-X4, as defined in 93A.1.2.4

- Add new table 179B-X4 with C and TL parameters from slide 9.