Mated Test Fixture Insertion Loss Comment #238

May 2026

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Contributors

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Objective

Provide supporting content for D3.0 comment #238 which addresses MTF insertion loss.

1. Show measured and fitted MTF IL and estimate the manufacturability impact of tightening the min/max MTF limits.
2. Address the proposal to provide “more details” on the de-embed/re-embed process.

Cl **179B** *SC* **179B.4.1** *P* **909** *L* **11** # 238

Heck, Howard — TE Connectivity

Comment Type **TR** *Comment Status* **D** *ILdd fit (E)*

Prior contributions (e.g. https://ieee802.org/3/dj/public/26_03/lusted_3dj_02a_2603.pdf) have proposed tightening the range of the min/max specs by using fitted insertion loss and accounting for differences between the fitted insertion loss of an actual test fixture and the reference insertion loss.

SuggestedRemedy

Change page 909, line 18 to
ILdd(f) is the fitted insertion loss in dB at frequency f

Change page 907, line 32 to
The effects of differences between the fitted insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements.

A supporting presentation is planned.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
The comment aligns with the direction of the straw poll following the discusstion at the March Plenary <https://www.ieee802.org/3/dj/public/26_03/motions_3dj_2603.pdf>. Further details may be needed to determine the consensus of the group to make a change to D3p0.

Pending review of the following related contribution:
https://www.ieee802.org/3/dj/public/26_05/heck_3dj_01_2605.pdf
For CRG discussion.

Resolve using the response to Comment #13.

Straw Poll #10

For the change to the Mated Test Fixture ILdd specification, I prefer the approach of:

A> no change needed

B> fitted ILdd mask

C> more details on de-embed/re-embed process included in the draft

D> B plus C

(choose one)

Results: A: 10 , B: 8 , C: 8 , D: 27

Slide 14 of https://ieee802.org/3/dj/public/26_03/motions_3dj_2603.pdf

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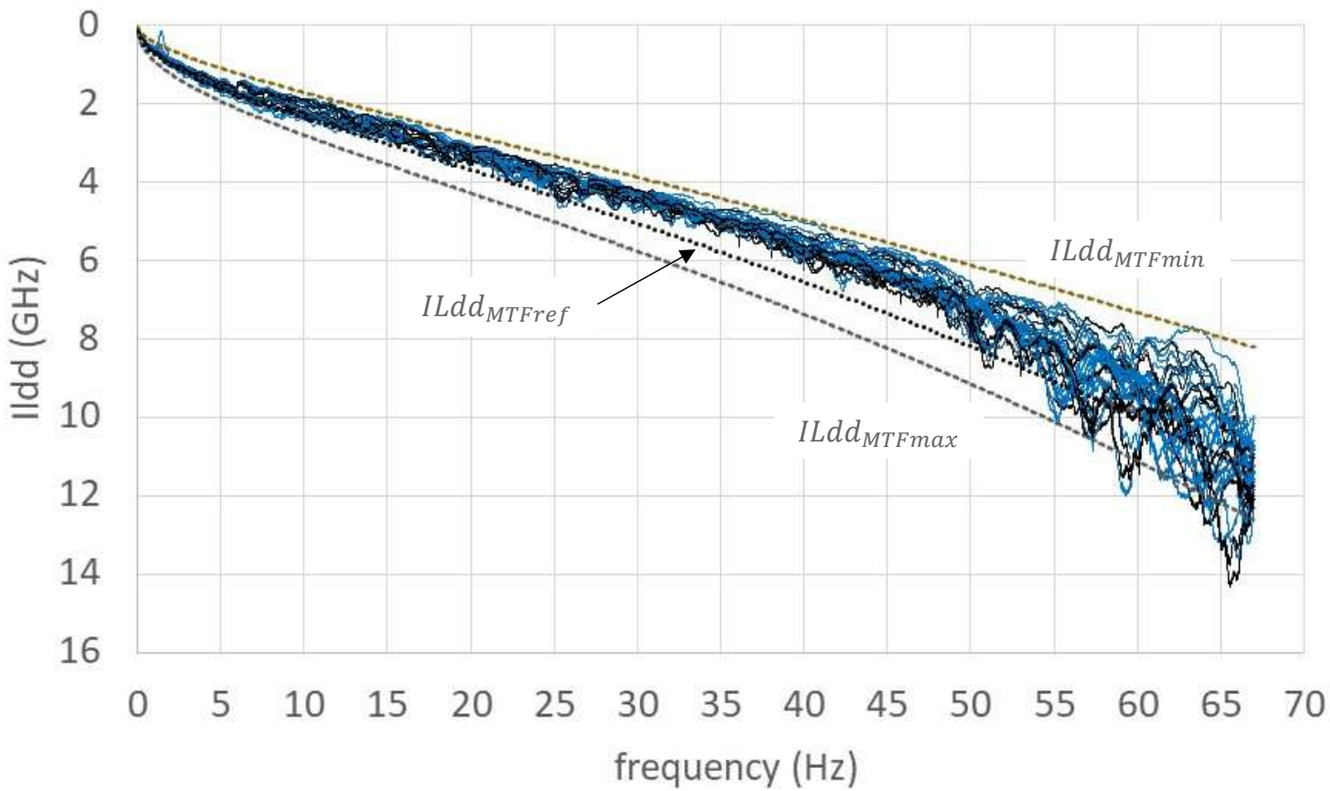
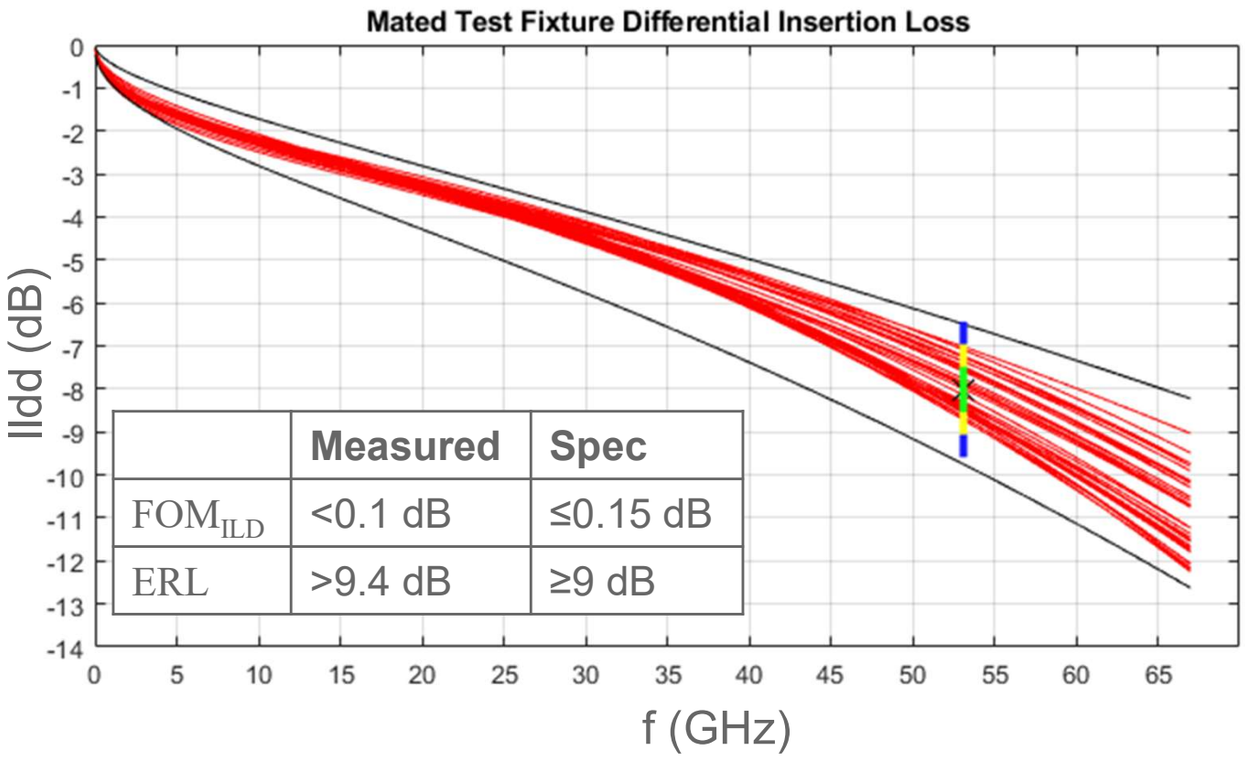
Differential Insertion Loss



- Data for mated test fixtures from two suppliers.
- Excursions exist beyond the insertion loss limits.

Fitted Insertion Loss



	Measured	Spec
FOM_{ILD}	<0.1 dB	≤0.15 dB
ERL	>9.4 dB	≥9 dB

Bar	#σ	Yield	
		per lane	per MTF
Green	±1	68.2%	<1%
Yellow	±2	95.4%	47.1%
Blue	±3	99.7%	95.5%

Calculations based on 16 diff pairs (lanes) per MTF

- Fitting IL shows ability to meet the min/max specs. Recommend basing specs on fitted IL.
- Reducing the min/max spec range by 1dB reduces from ±3σ to approximately ±2σ in terms lanes meeting spec. Impact: MTF yield reduced from 95% to 47%.
- Recommendation: Keep the limits where they are.

De-embedding/Re-embedding

- Goal: Provide guidance while keeping the magnitude of the draft change small.
- Approach:
  - De-embedding
    - Provide optional guidance by referencing the methodology defined in IEEE 370™-2020, IEEE Standard for Electrical Characterization of Printed Circuit Board and Related Interconnects at Frequencies up to 50 GHz, 2021. Given the frequency limit of that existing document, only the general methodology can be cited. Acknowledge and allow other known de-embedding methodologies as options.
  - Re-embedding
    - Generate S-parameters for the reference IL (179B.2.1 & 179B.3.1)
    - Re-embed by cascading the S-parameters for the reference IL by the de-embedded S-parameters.

Potential De-embed/Re-embed draft wording

- Applies to 179B.2.1 (p. 907, lines 5-7) and 179B.3.1 (p. 907, lines 32-34).
- Specific text to address (applies to both sub-clauses):

  The effects of differences between insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements.

- Draft wording

  The effects of differences between insertion loss of an actual test fixture and the reference insertion loss are accounted for in the measurements. The recommended method is to de-embed the fixture trace and re-embed the reference insertion loss.

  Multiple methods for de-embedding are available. One documented method is provided by IEEE Std 370™ using the impedance corrected 2x thru de-embedding method. It is acknowledged that other known de-embed methods exist and are allowed.

  Re-embedding of the reference insertion loss is accomplished by cascading the de-embedded S-parameters with the S-parameters for the reference insertion loss using equation (93A-6). The HCB and MCB trace reference insertion loss scattering parameters for the re-embedding are calculated using Equations (93A-9), (93A-10), (93A-11), (93A-12), and (93A-14) and the values contained in Table 179B-x/y.

- The method for determining the PCB trace reference insertion loss S-parameter model parameters is described on slide 9.

See next slide

Potential De-embed/Re-embed draft wording (cont.)

Insert the following tables:

Table 179B-x HCB Transmission Line Model Parameters

γ_0	0	1/mm
a_1	2.7×10^{-4}	$ns^{1/2}/mm$
a_2	4.54×10^{-5}	ns/mm
τ	5.79×10^{-3}	ns/mm
z_p	50	mm
Z_C	92.5	Ω
R_0	92.5	Ω

Table 179B-y MCB Transmission Line Model Parameters

γ_0	0	1/mm
a_1	2.7×10^{-4}	$ns^{1/2}/mm$
a_2	4.54×10^{-5}	ns/mm
τ	5.79×10^{-3}	ns/mm
z_p	35.5	mm
Z_C	92.5	Ω
R_0	92.5	Ω

Reference Insertion Loss S-Parameter Determination

This slide documents the method used to develop the potential transmission line parameters:

- Apply the transmission line S-parameter equations in 93A.
  - (93A-9) thru (93A-12) and (93A-14)
- HCB: Adjust a_1, a_2, z_p to match the reference curve in Figure 179B-1 & Equation (179B-1).
  - Match the $f^{1/2}$ shape at lower frequencies and match the insertion loss at 53.125 GHz.
- MCB: Adjust z_p to match the 2.7 dB MCB PCB insertion loss allocation (at 53.125 GHz).
  - D3.0 specifies 4.95 dB for trace + via + connector (Figure 179A-1). Allocated as 2.7 dB for trace and 2.25 dB for connector + via. (Refer to Figure 179A-1 in D1.4)
- Connector: We have no reference connector, therefore no reference S-parameters.
  - Without connector reference parameters, the benefit of this method doesn't justify implementation. We do not recommend adopting this approach.

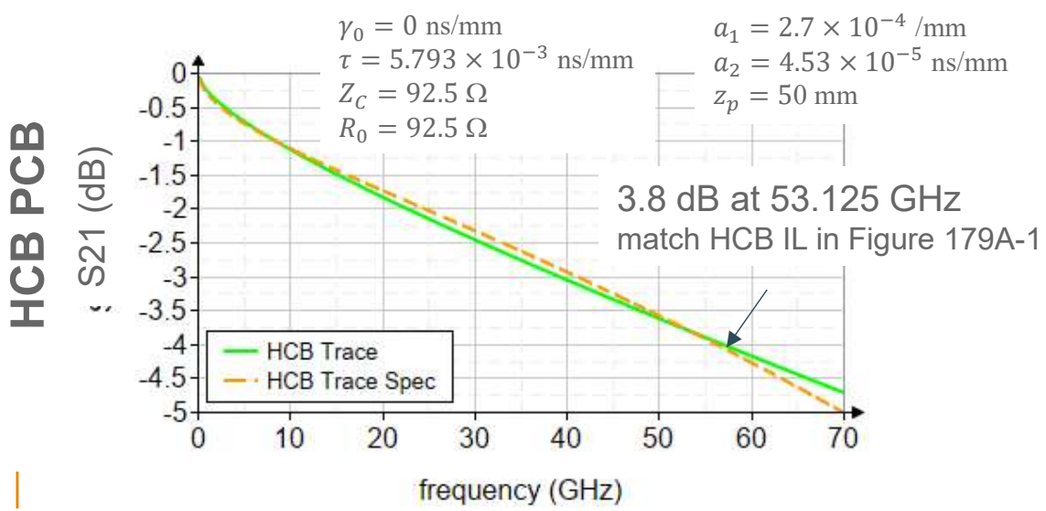
$$\gamma(f) = \begin{cases} \gamma_0 & f = 0 \\ \gamma_0 + \gamma_1\sqrt{f} + \gamma_2(f)f & f > 0 \end{cases} \quad \text{(93A–9)}$$

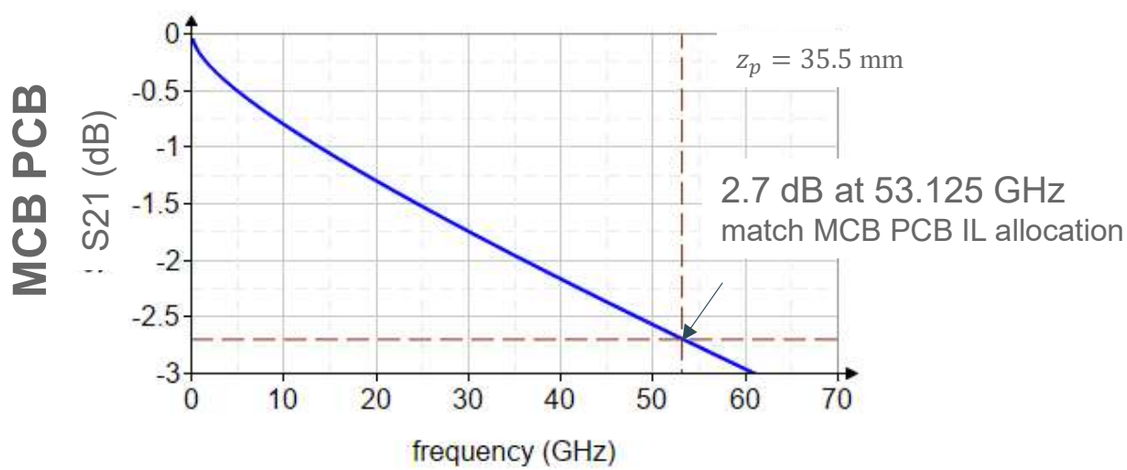
$$\gamma_1 = a_1(1+j) \quad \text{(93A–10)}$$

$$\gamma_2(f) = a_2(1 - j(2/\pi)\log_e(f/1\ \text{GHz})) + j2\pi\tau \quad \text{(93A–11)}$$

$$\rho = \frac{Z_c - 2R_0}{Z_c + 2R_0} \quad \text{(93A–12)}$$

$$s_{21}^{(l)}(f) = s_{12}^{(l)}(f) = \frac{(1-\rho^2)\exp(-\gamma(f)z_p)}{1-\rho^2\exp(-\gamma(f)2z_p)} \quad \text{(93A–14)}$$





Summary

Recommendations:

- Adopt MTF insertion loss specifications based on fitted data.
- Maintain current limit lines. Mature product testing shows insufficient margin to change them.
- Adopt the text proposed in the suggested remedy to address differences between measured and reference insertion loss.

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Thank You