Electrical PMD measurements: What About Test Fixtures

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June 10, 2020, IEEE 802.3 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Task Force Ad Hoc

Focus Group Participants & Contributors

This presentation summarizes thoughts, feedback and recommendations of a group of contributors in multiple teleconference sessions:

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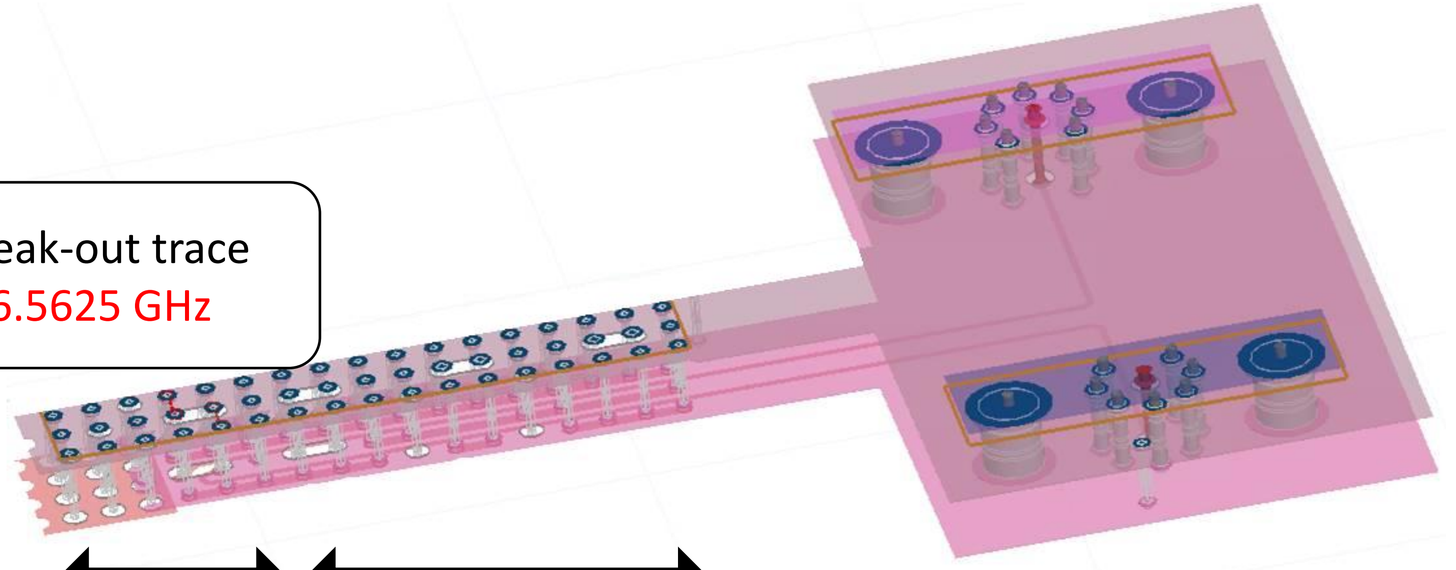
Problem statement

- As presented in mellitz_3ck_01a_0120

  ("Practical Device Test Fixtures for 100G KR ... or Not and the Impact on ERL and P max /V f")

  - Test fixtures introduce offset and variability
  - Accounting for practical test fixture variability test dwarfs the limit we would want set
  - Recommend: Specify transmitter at a TP0 and receiver at TP5

Why Throw Away the “Good-Old method” of specs at TP0a?



Even with high quality material, ~2.4mm via➔ break-out trace from an internal ball ➔ µvia to SMA ≥ 3dB @ 26.5625 GHz

Trace length differences | Routing angles | SMA vias | PCB material | Manufacturing tolerances

Multi-port devices | Test fixture variation

- These inaccuracies makes TP0-TP0a highly implementation and manufacturing dependent ➔ results will vary
- “Can’t you de-embed the fixture?!”
- Just thinking:

It is easier to *measure* a test fixture than to *de-embed* it!

The focus group dealt with the following

- ❑ Identify parameters which are “straightforward”, don’t require a sophisticated simulation/calculation
- ❑ How we have reached spec limits for measured parameters in previous projects
- ❑ How to define normative measurement at an implementation-dependent TP
- ❑ Need to specify limits of a test fixture
- ❑ Need for informative values at TP0 or TP0a

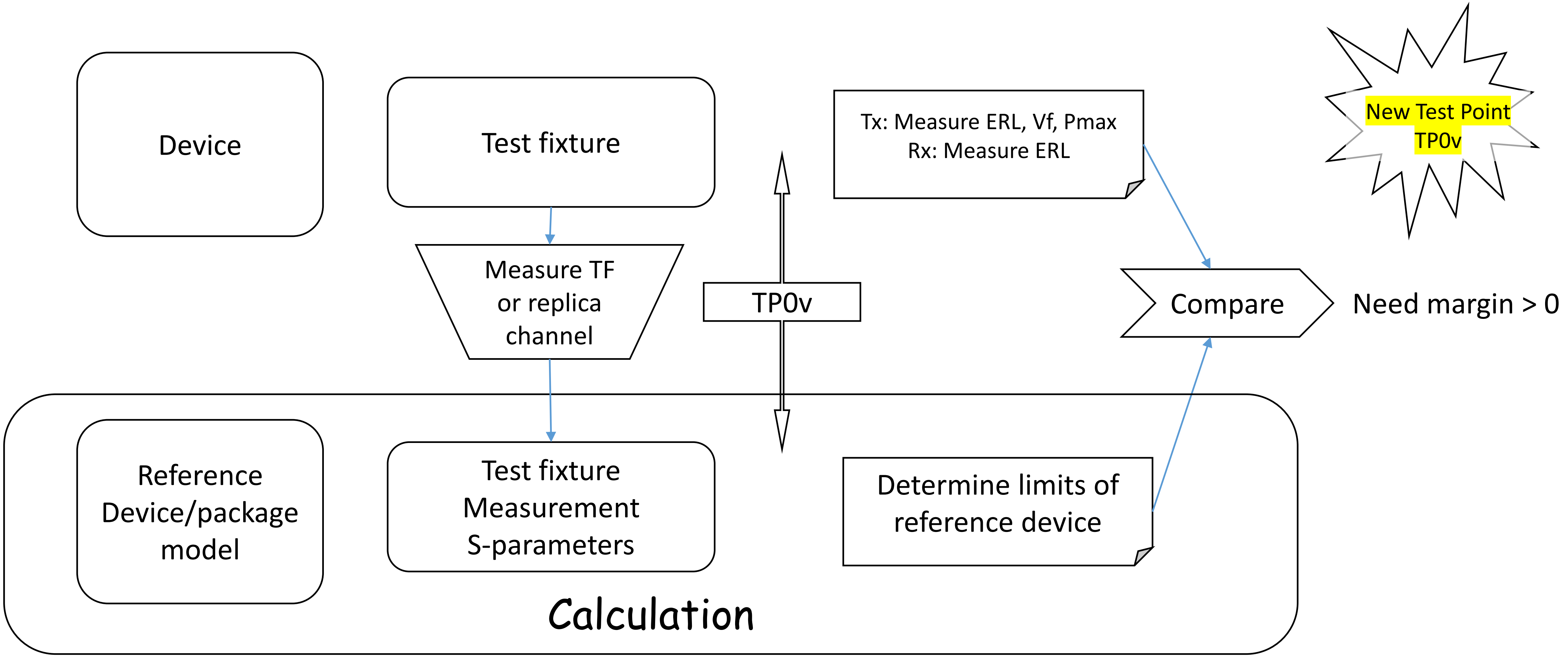
Measurements which do not vary with TP location
Thus, no need to change specs

- ❑ Signaling rate
- ❑ Differential pk-pk voltage (max) Tx disabled/enabled
- ❑ DC common mode voltage (max/min)
- ❑ AC common mode voltage RMS (fixture has low effect)
- ❑ Transmitter steady state voltage (max/min)
- ❑ Transmitter waveform
  - The method for finding Tx FFE taps is independent of TP0-TP0a; actually works even at TP2.
  - See: http://www.ieee802.org/3/cb/public/jan16/mellitz_cb_01a_0116.pdf slide 6-15
    C is vector if tap coefficients. P is fitted un-equalized pulse response. R is the fitted equalized pulse response. $C= (R^T*R)-1*R^T*P$.
  - Need to make sure scope CDR can lock ➔ suggested TP0-TP0v loss ≤ 5dB @ 26.5625GHz; ILD≤Loss/20 (2dB ≤Loss≤5dB ➔ 0.25dB for 5dB loss)
- ❑ SNDR – Tx parameters to be measured on an optimized test board, breakout section is part of the device budget; package/breakout Xtalk is included in measurement

Parameters that should be measured with adjustment to overcome test fixture loss

- Jitter
  - In D1.2: “jitter measurements are made with a single transmit equalizer setting selected to compensate for the loss of the transmitter package and TP0 to TP0a test fixture”
  - Need to be clarified to avoid ambiguity
  - Spec limit value can stay unchanged
- RLM
  - In Annex 120D it is under **Output waveform** for which “The state of the transmit equalizer is controlled by management interface “
  - Clarify that Tx equalization should be used to get clean level measurements
  - Spec limit value can stay unchanged

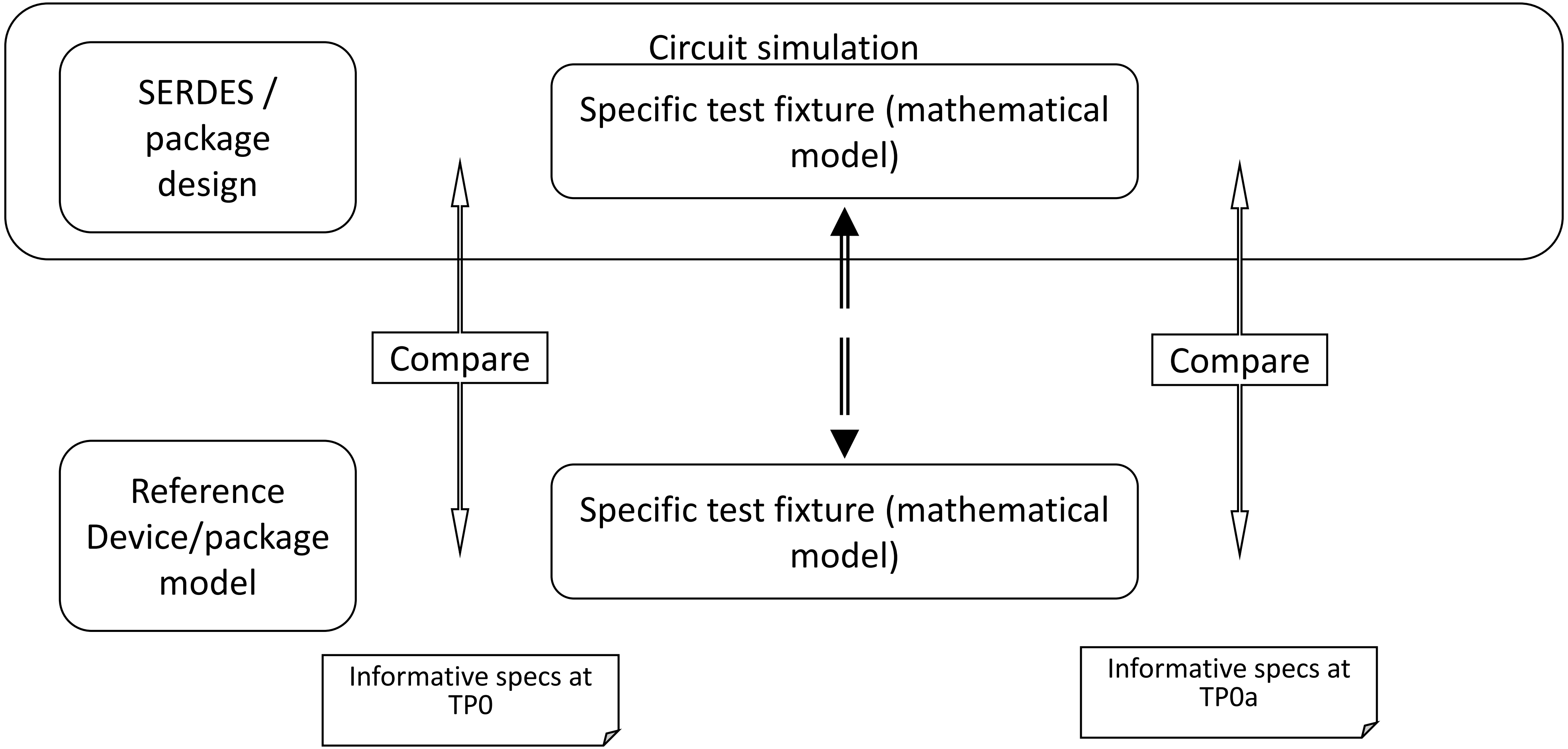
Enabling implementation-dependent test fixture



Proposed new Methodology

- ❑ Measure TP0-TP0v channel (or replica) for the device/lane under test
- ❑ Concatenate Tr filter, Tx reference device and package model, and B-T measurement filter (same equations used in COM)
- ❑ Using the concatenated channel, calculate an output pulse response (with minimum A_v) and TDR at TP0v, with ideal termination
- ❑ Calculate Vf, Vpeak/Vf, and ERL
  - The results are the expected parameters of the reference Tx at this TP0v
  - This is the bar that the DUT should be compared to!
- ❑ Now measure Vf, Vpeak, and ERL of the DUT at TP0v using existing method
- ❑ Margin from the calculated reference values → pass/fail

Informative specifications are useful to get things rolling prior to HW availability, or as a reference to validate calculation accuracy



Informative TP0/TP0a values

- ❑ Replace the reference insertion loss of the test fixture in Equation (163–1) with the following equations:

$$IL_{ref}(f) = s_{21}^{(l)}(f)$$
$$RL_{ref}(f) = s_{22}^{(l)}(f)$$

  - Where $s_{21}^{(l)}(f)$ and $s_{22}^{(l)}(f)$ are defined in Equation 93A–14 with parameters taken from Table 162–17, and $z_p = 76.5$, representing an insertion loss of 3 dB at 26.5625 GHz.

- ❑ Perform ERL; Linear fit pulse peak analysis to define informative values at reference points (TBD until calculated)
- ❑ Common mode return loss? May be TBD for now

Summary:

- Change 163.9.1.2 Transmitter normative test fixture requirements to:
  - TP0-TP0v loss ≤ 5dB @ 26.5625GHz
  - ILD magnitude ≤ Loss at 26.5625GHz / 20 (2dB≤ Loss at 26.5625GHz ≤5dB ➔ 0.1dB for 2dB loss ; 0.25dB for 5dB loss)
- Keep current values of parameters specified on slide #6
- Add subclauses with text based on the notes in slide #7 as clarification for jitter and RLM
- Add a subclause based on slide #9 explaining how to come up with required limits for test-fixture-dependent parameters
- Add a reference TP0-TP0a loss model and informative values as described on slide #11

THANK YOU