Addressing variability of test fixtures (comment #85)

Adee Ran, Cisco

Background and goal

- Test fixtures for hosts, cable assemblies, and modules are specified in Annex 179B
- The specification method is similar to what we had in several previous generations
- In 802.3dj the specification of insertion loss is somewhat loose
  - This led to concern that measurements can vary depending on the test fixture used
  - There is an unsatisfied comment that had support, but no clear remedy
- This presentation reviews the test fixture specification and suggests directions for possible improvements

The comments

Cl **179B** *SC* **179B.4.2** *P* **905** *L* **20** # 306

Noujeim, Leesa Google

Comment Type **TR** *Comment Status* **R** *test fixtures (E)*

Ildd_MTFmin is, at fNyquist, 4dB lower than Ildd_MTFmax. This large allowed variation in MTF IL introduces too much uncertainty as to whether a given DUT (host or cable assembly) passes or fails due to variation in the test fixture.

SuggestedRemedy

Decrease the spread between ILddMTFmin and ILddMTFmax to ~2dB, by adjusting equations 179B-3 and 179B-4.

Response *Response Status* **W**

REJECT.
The comment identifies an area for potential improvement in the current draft. However, the suggested remedy does not provide sufficient detail to implement.
A contribution with a detailed proposal would be helpful for the CRG to drive consensus on a specific change.

Comment #306 against D2.2 was rejected due to lack of a detailed proposal.

The response wording hints/suggests that the concern was recognized by the CRG.

Cl **179B** *SC* **179B.4.1** *P* **912** *L* **10** # 85

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Comment Type **T** *Comment Status* **X**

The difference between minimum and maximum ILdd for mated test fixtures is about 3 dB at the Nyquist frequency.
This difference allows significant variations in cable assembly test fixture (MCB), which can have a double effect (up to 6 dB) if used to measure a cable.

SuggestedRemedy

Reduce the allowed variablility of test fixtures, or its effect on measurements.
A detailed proposal is planned.

Follow up comment on the same topic.

Test fixture ILdd specifications

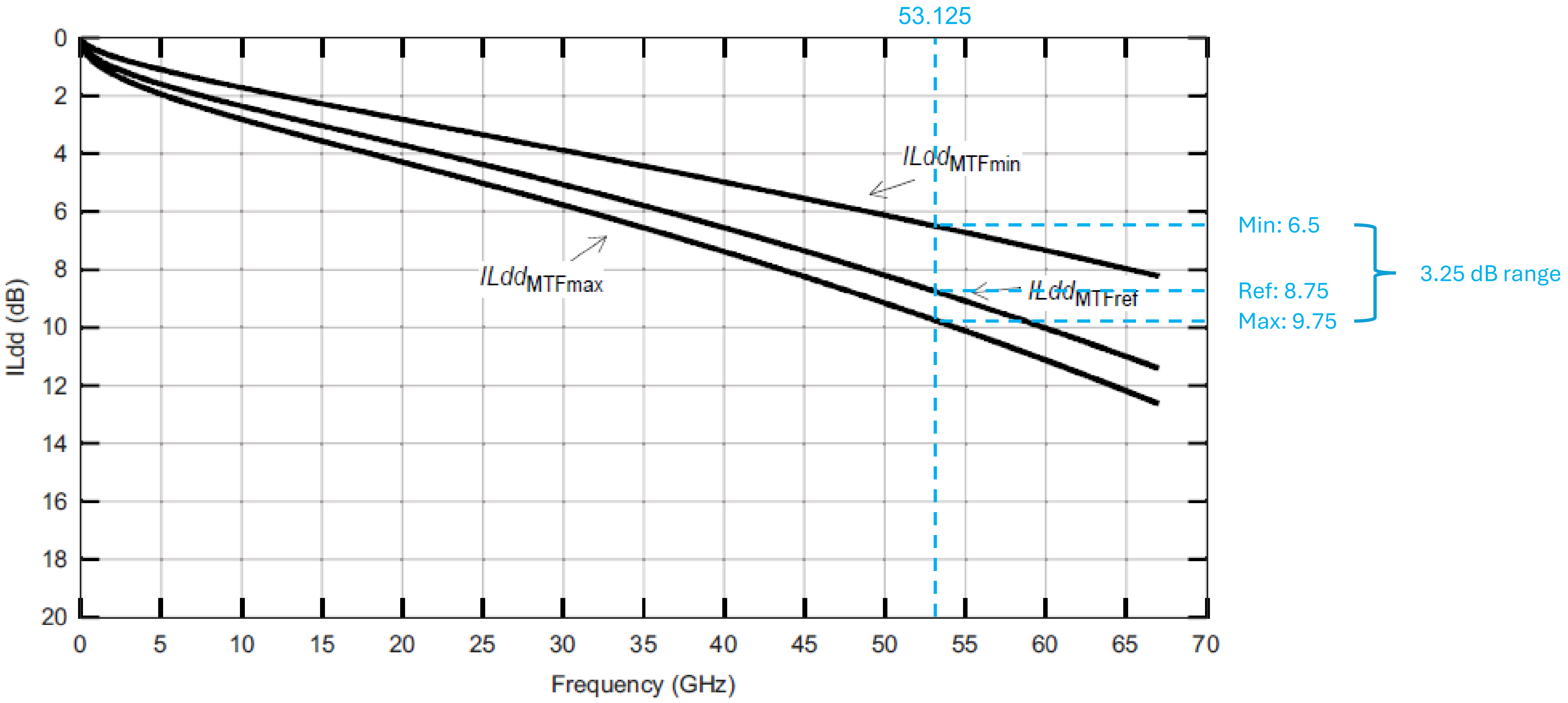
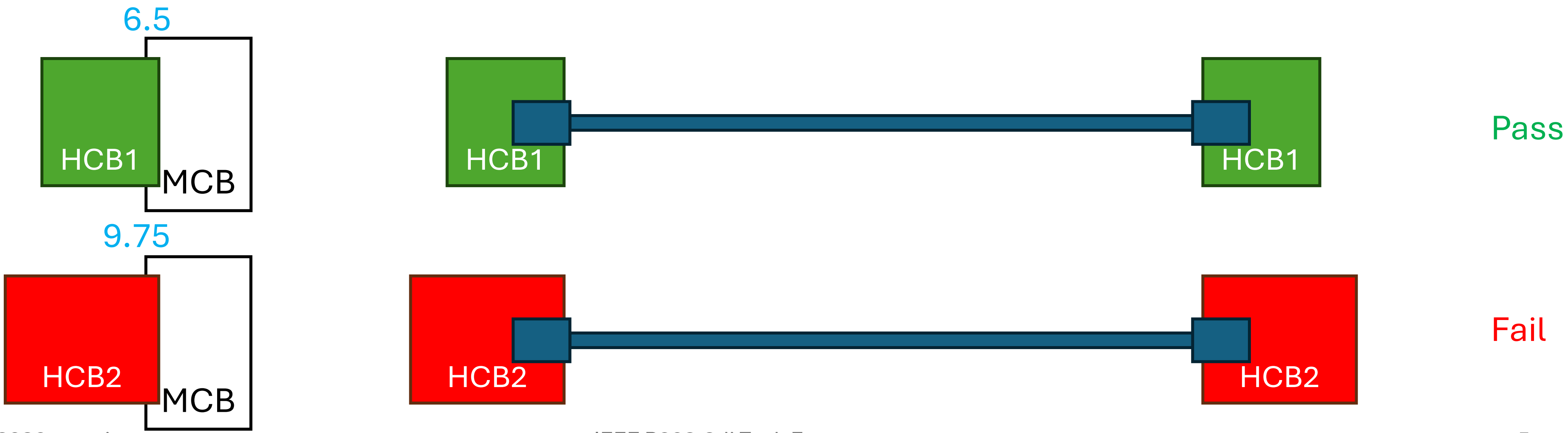


Figure 179B–2—Mated test fixtures insertion loss

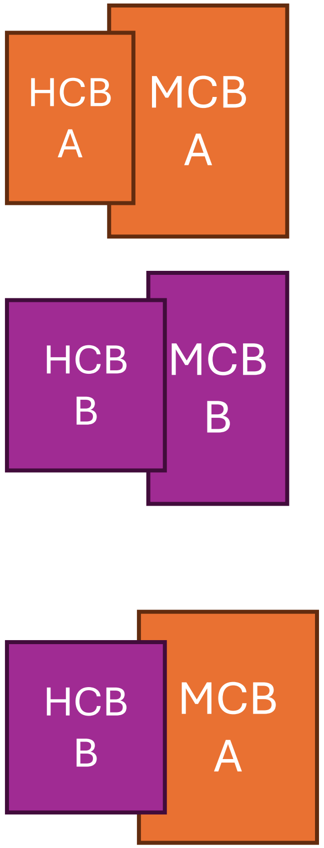
Why is that a problem

- Mated test fixtures (HCB and MCB) from different vendors can have 3.25 dB difference in Nyquist loss
- It is possible that the HCB is the same, and the difference is in the MCB
- Using different MCB designs at both ends of the cable assembly can result in 6.5 dB difference – about 1/3 of the maximum ILdd for CA-A
- The difference can affect all cable specs, not just ILdd



More potential problems

- A similar problem exists with HCBs
  - Host compliance may depend on HCB used in the measurement
- Specifications are only for mated test fixtures
  - Allowing variations in design of HCB and MCB
  - Possible inconsistency across combinations of fixtures
    - Mated HCB and MCB from vendor A are within the limits
    - Mated HCB and MCB from vendor B are within the limits
    - Mated HCB from vendor B and MCB from vendor A exceed the limits
    - Which HCB and MCB can one use for compliance testing?



More potential problems

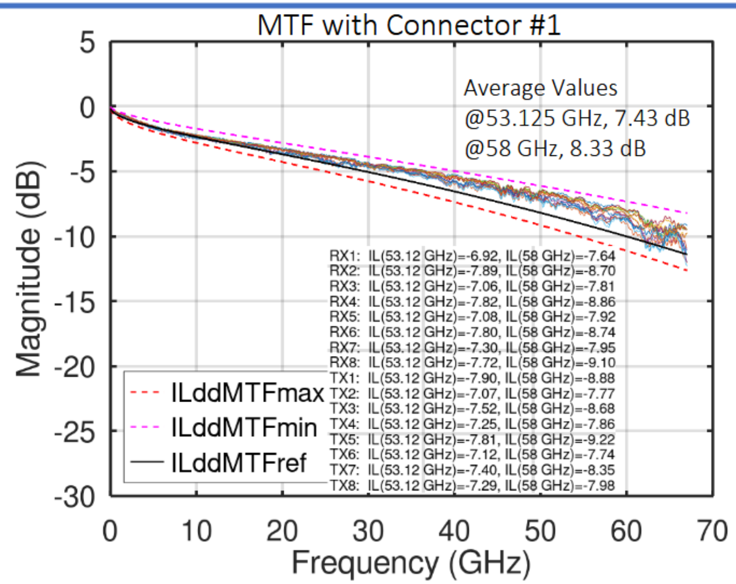
- The non-mated fixture specifications only have a reference insertion loss
- 179B.2.1 and 179B.3.1 state that "The effects of differences between the insertion loss of an actual test fixture and the reference insertion loss are to be accounted for in the measurements"
  - But it's unclear how that can be done
  - Especially if the "actual" data is not available

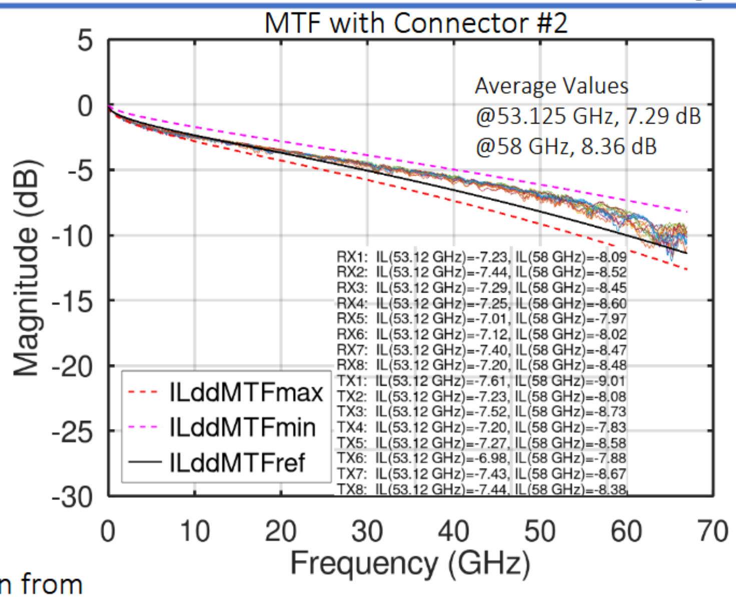
MTF measurement data

Mated Test Fixture (MTF) ILdd

110 GHz data is truncated for specification comparison and calculation. Full 110 GHz data available in data package.

Limits from IEEE P802.3dj™/D2.3





	Frequency (GHz)			
	8.69	26.51	57.92	67
Margin from Max	0.15	0.49	1.41	0.35
Margin from Min	0.49	0.43	0.56	0.93

Margin from limit lines at points along the bandwidth

	Frequency (GHz)			
	4.49	27.04	55.46	65.18
Margin from Max	-0.17	0.7	1.48	0.27
Margin from Min	0.66	0.62	0.7	1.27

IEEE P802.3dj 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force 6

Variation between lanes on the same MTF is significant – at 53.125 GHz, 0.98 dB for “connector #1”, 0.69 dB for “connector #2”. There is a larger variation above 53.125 GHz

The differences seem mainly in the ripple.

The range can be tightened somewhat by raising the “max” line (and the reference line)…
But this might coincide with manufacturing variations and yield

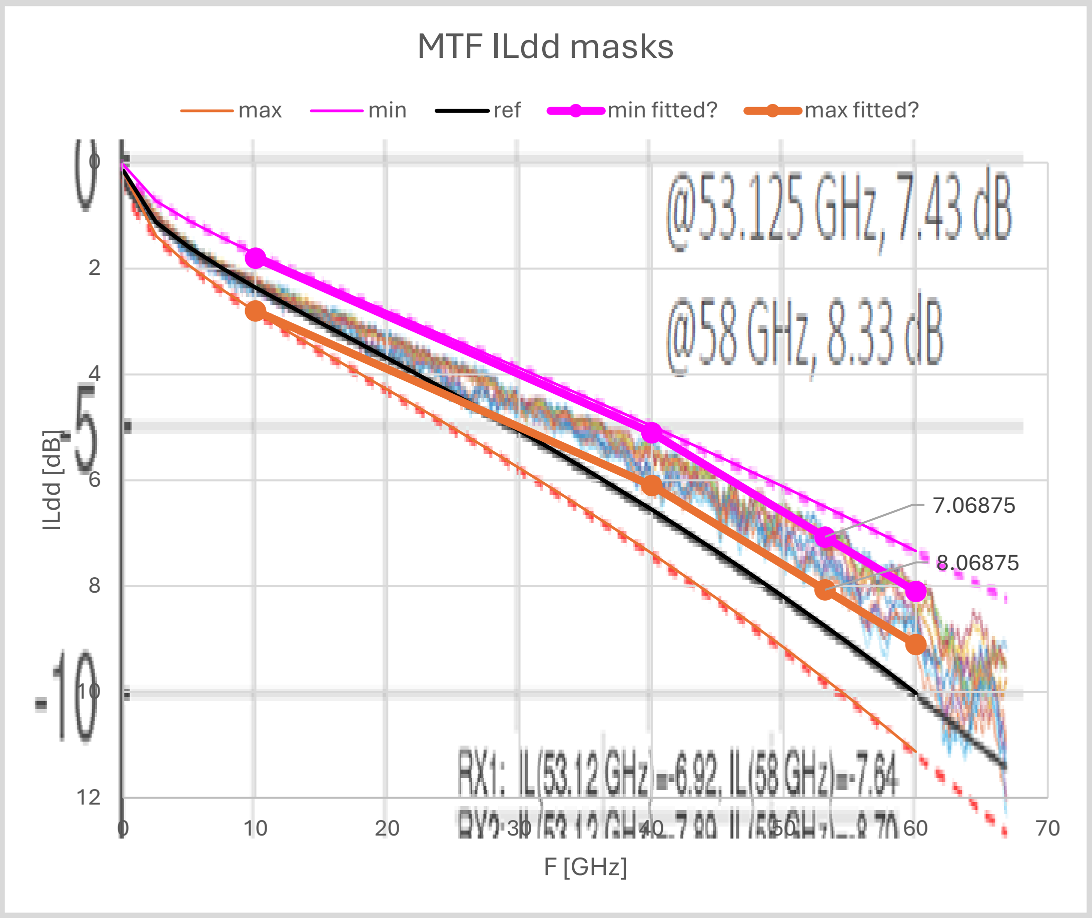
Source: mammenga_3dj_adhoc_01_251216, slide 6 (Kevin Mammenga, Wilder Technologies)

What can we do

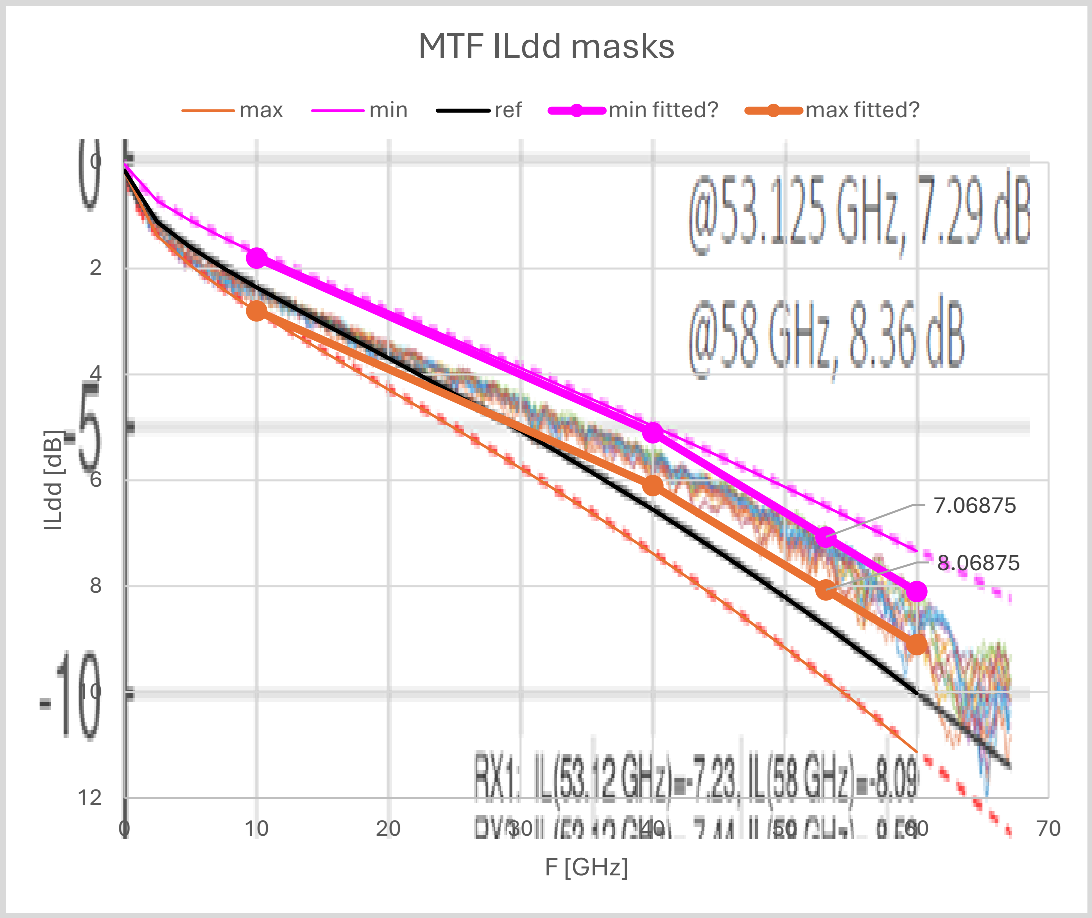
- One direction is to reduce variability, but without causing actual test fixtures to fail
- Since the ripple is limited by another specification (FOM_{ILD}) we can apply a tighter mask to the **fitted** ILdd (which should be less variable)
- The following piecewise-linear equations (with ±0.5 dB tolerance) create a possible mask based on the Mammenga dataset:
  - Min fitted ILdd: $\begin{cases} 1.8 + 0.11(f - 10) & 10 < f \leq 40 \\ 5.1 + 0.15(f - 40) & 40 < f \leq 60 \end{cases}$
  - Max fitted ILdd: $\begin{cases} 2.8 + 0.11(f - 10) & 10 < f \leq 40 \\ 6.1 + 0.15(f - 40) & 40 < f \leq 60 \end{cases}$
- Visualized on the next slide

Example fitted ILdd masks

Mask overlaid on “MTF with Connector #1” plots



Mask overlaid on “MTF with Connector #2” plots



Data from mammenga_3dj_adhoc_01_251216

Issues with fitted ILdd mask

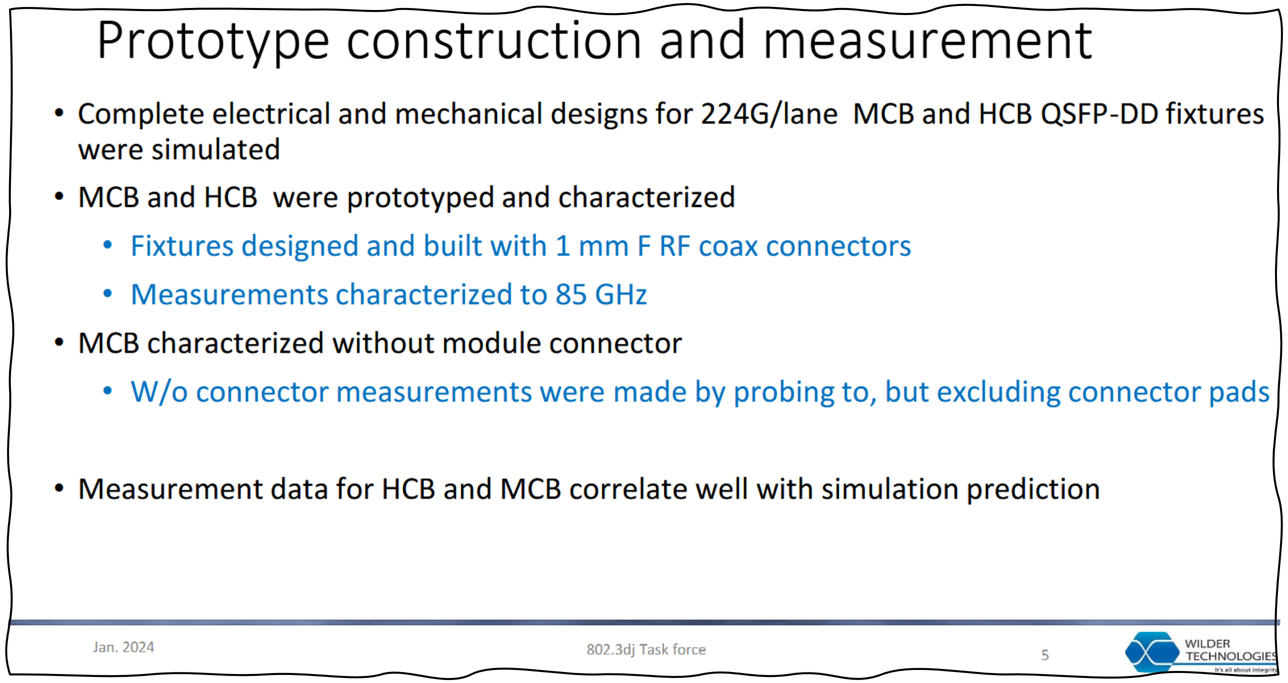
- This is an addition we can make quickly… but
  - It is tailored for this dataset – maybe not suitable for other designs
  - It does not solve the “combinations of fixtures” issue
  - It does not solve the “accounting for difference” issue
  - The reference ILdd is not within the mask…
- Not a complete solution
  - But mentioned here in case people want to check it

Alternative: use actual fixture data?

- We have reference ILdd equations for both HCB (equation 179B–1) and MCB (equation 179B–2)
- If the actual test fixture S-parameters are available, the difference from the reference can be “calibrated out”:
  - De-embed the actual S-parameters
  - Re-embed the reference S-parameters
- This would ideally remove fixture variability from the measurement…
  - … and possibly introduce inaccuracy of the de-embedded data, and some noise amplification
  - The net effect would likely be an improvement over what we have now
- We have not specified de-embedding in 802.3 but it is used in practice to calibrate test setups.

How to get fixture data?

- sekel_3dj_elec_01_240104 includes measured HCB SDD21 data
  - The presentation states that measurements correlates well with simulation
  - This suggests that HCB can be measured directly
- The measurement technique is not stated, but there seem to be known methods
  - Can we specify it in the standard?
  - Can we assume measurement by end-user?
  - Can we expect the vendor to provide HCB S-parameters?



- The MCB was measured without the receptacle
  - MCB S-parameters can perhaps be calculated instead by de-embedding the (measured/provided) HCB from a (measured) MTF
  - The result may be sufficiently good for the purpose of calibrating out the actual MCB

Summary

- There are issues with current test fixture specifications
  - Limits are too loose
  - Specification only in mated state
  - No clear way to account for difference from reference
  - All leading to measurement variability
- Ideas on how to mitigate these issues were presented
  - Tighten the ILdd specification by adding a **fitted ILdd mask**
  - Specify how to **calibrate out the difference** between the actual test fixture and its reference
- Further validation of theses ideas is encouraged

That’s all!

Questions?