Summary of COM problems between Channel and Rx ITT (Interference Tolerance Test)

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Do we have enough margin for interoperability?

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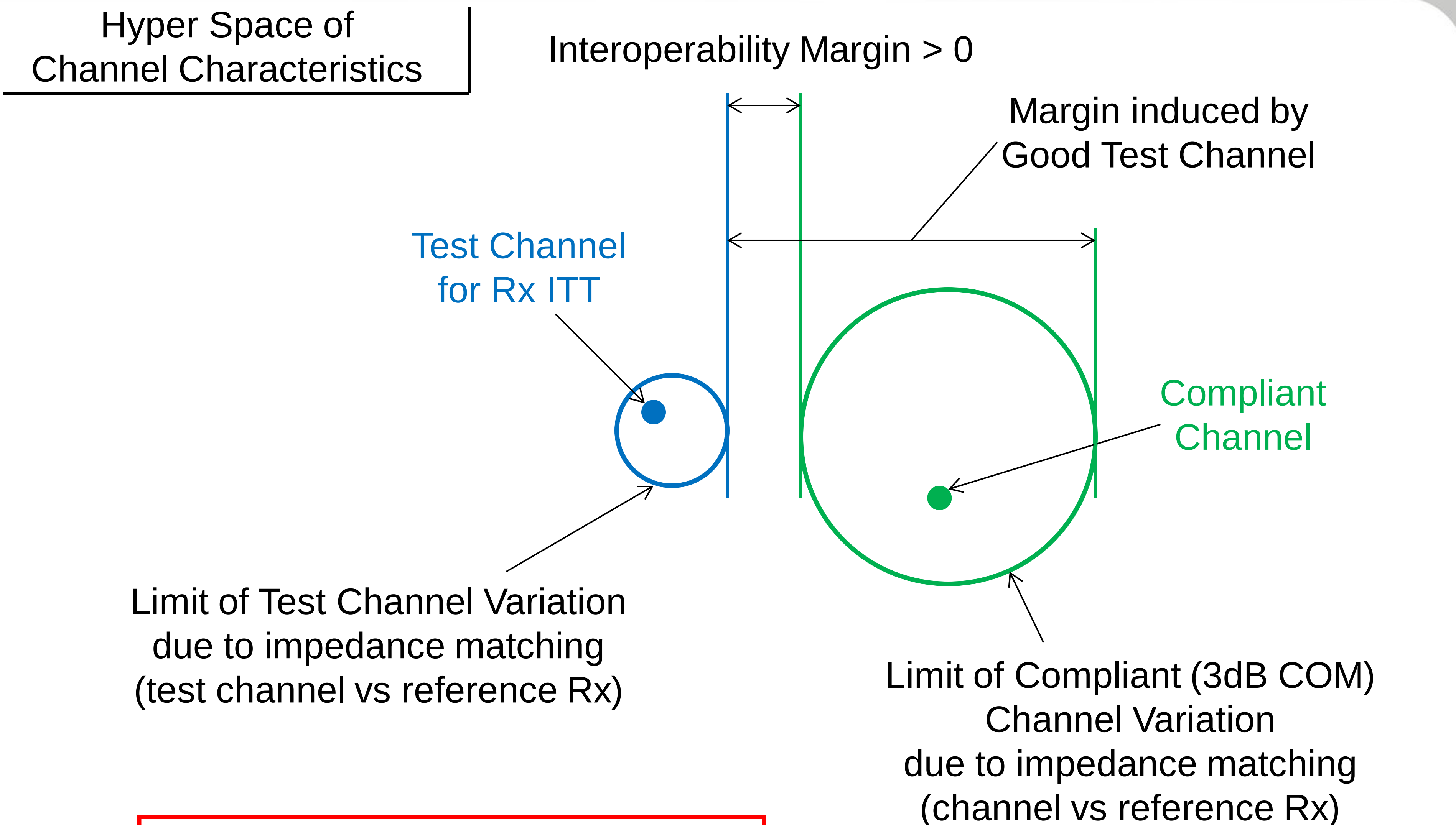
- May be, unless we push Rx ITT to the limit
  - i.e. May be, if the test channel of Rx ITT is very good
    - COM of the test channel before calibration is >> 3dB
    - Calibration injects a lot of broadband noise to limit COM ≤ 3dB
    - Broadband noise (unbounded Gaussian noise) may be more stressful than reflection and crosstalk noise (bounded uncorrelated noise) of real channels
    - Overstress of broadband noise will serve as the margin for interoperability with real channels

Do we have enough margin for interoperability?

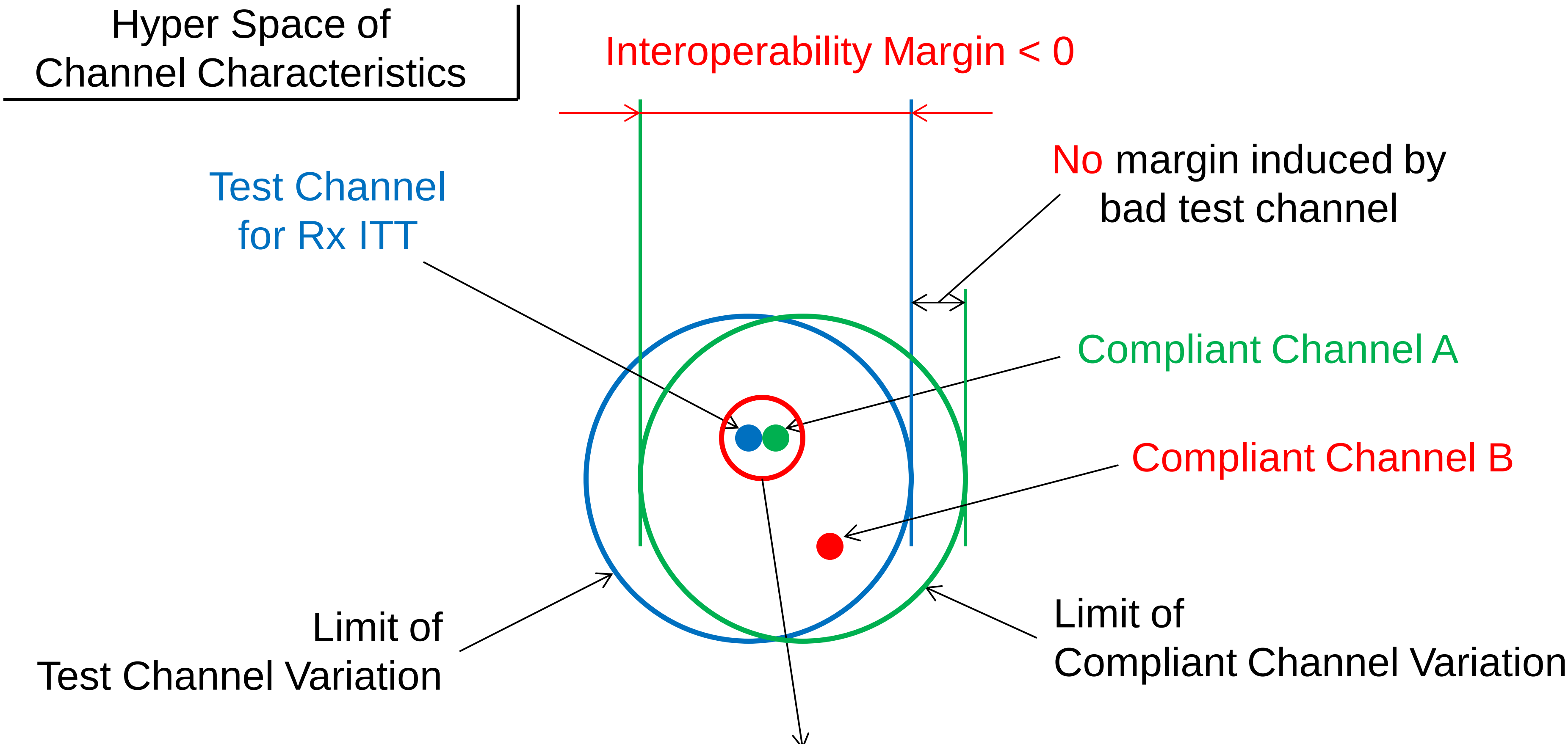
- May be not, if we push Rx ITT to the limit
  - i.e. May be not, if the test channel of Rx ITT is very bad
    - COM of the test channel before calibration may be already ≈ 3dB
    - Calibration injects no or little broadband noise to limit COM ≤ 3dB
    - Interoperability is not guaranteed due to interaction between channel and Rx as I have explained in hidaka_3cd_01a_0517.pdf, slide 4 and 5
      - Rx may be claimed to be tested in various corners of PVT variation for interoperability
      - However, if Rx barely passes Rx ITT in a particular worst PVT corner, interoperability is still not guaranteed in that particular worst PVT corner
      - Interoperability may be guaranteed only in other non-worst PVT corners

If the Test Channel of Rx ITT is Very Good …



We have interoperability margin > 0.

If the Test Channel of Rx ITT is Very Bad …



○ and ○ may actually completely overlap in the current spec

Rx *barely* passing Rx ITT (in the worst PVT corner) using Test Channel that has the same characteristics as Compliant Channel A may *not* work (in the worst PVT corner) with another Compliant Channel B.
It works only with such channels similar to Channel A.

A Solution: Restrict Test Channel Always Good

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- By specifying Worst Return Loss of Test Channel of Rx ITT
  - Interaction between Test Channel and Rx is reduced
  - Interaction between Test Channel and Reference Rx in COM is reduced
    - Reducing interaction will shrink the limit of Test Channel variation

- Broadband noise is always injected by the calibration of Rx ITT
  - It will guarantee the margin for interoperability (good)
  - However, it may be overstress for Rx more than required (bad)

- To avoid overstress for Rx, we may change broadband noise with bounded uncorrelated noise (e.g. sinusoidal noise)
  - This is an idea suggested by Rich Mellitz (Thanks)

- We may also revise Rx ITT COM value (it may go up or down)

- I think this looks a good direction to resolve the problem, but it takes time to develop a complete proposal and get consensus

A Quick Remedy: Use Nominal Rd and Zc

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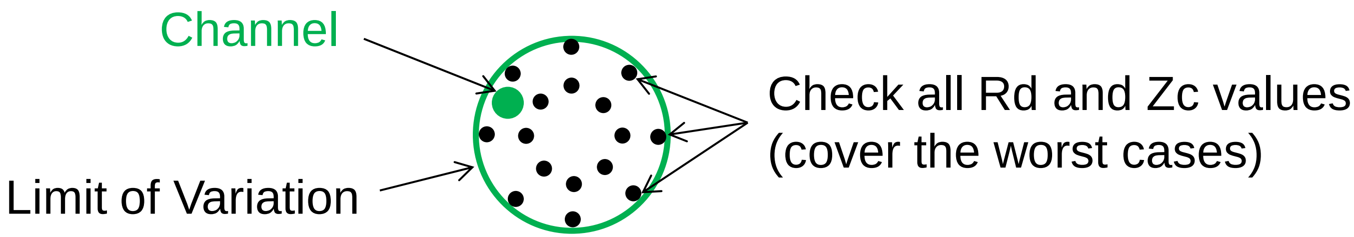
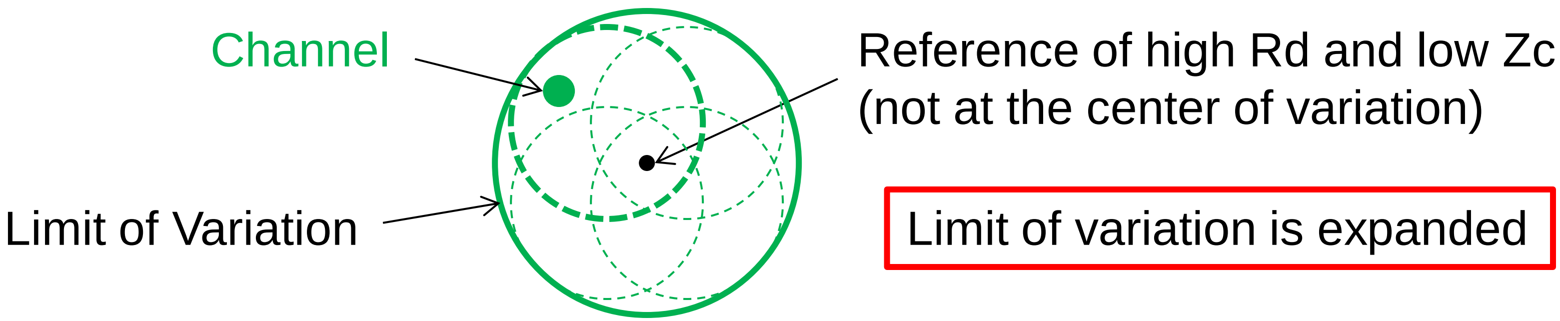
- Problems to use High Rd and Low Zc in Reference Rx
  - It is not the worst case at all
    - The worst case is usually High Rd and High Zc, or Low Rd and Low Zc
    - At DC and low frequency, the effect of High Rd and Low Zc is neutralized
    - At high frequency, the effect of High Rd and Low Zc may be good or bad, i.e. matched or mismatched, depending on the channel impedance close to port
  - Arbitrary matched or mismatched impedance at high frequency will enlarge the limit of variation of channel characteristics
  - It also gives misleading impression of tolerance for impedance variation
- Change Rd and Zc to nominal values
  - Interaction between Channel and Reference Rx in COM is reduced
    - Reducing interaction will shrink the limit of variation of channel characteristics
  - It will also raise a warning that the impedance tolerance is not specified

Nominal Rd and Zc reduce Channel Variation

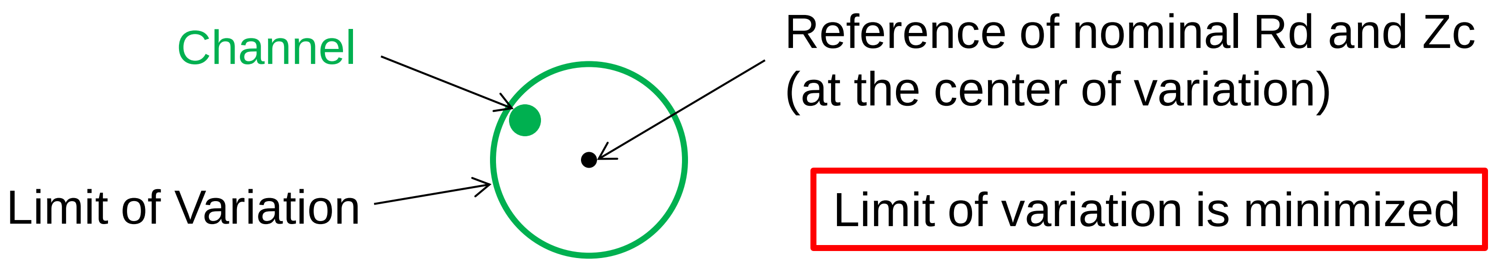
- If we check all possible combinations of Rd and Zc values



- If we check at a single reference of high Rd and low Zc values



- If we check at a single reference of nominal Rd and Zc values



If we use Nominal Rd and Zc Values

- We need to re-calibrate Av, Afe, and Ane of COM
  - To have the max/min amplitude at TP0a/TP2 as the Tx spec

- Do we need to revise Tx and Rx return loss?
  - No.
    - The nominal value is only for the reference package model in COM. Actual Tx and Rx still have impedance variation. Such variation should be acceptable.

- Do we need to revise Tx specifications?

  E.g. SNDR, SNR_{ISI}, linear fit pulse peak to vf ratio
  - No.
    - Actual Tx still has impedance variation. Such variation should be acceptable.

- Any other parameters to revise?
  - Maybe Channel COM value, not to change pass/fail. Anything else?

Tx Amplitude Calibration (Clause 120D)

Clause	120D					Note
Cd	180fF					
Cp	110fF					
tr	13ps					
Dp	2					
Np	200					
Nv	13					
Test Fixture	34mm COM Host PCB trace with Zdiff=100Ω (1.4058dB loss@12.89GHz)					From TP0 to TP0a
Scope Filter	4th-order Bessel-Thomson LPF with 33GHz 3dB Bandwidth					
Test Pattern	PRBS13Q					
Rd	55Ω	50Ω	50Ω	50Ω	50Ω	
Zc	90Ω	90Ω	93Ω	95Ω	100Ω	
Av, Afe 0.44V@D3.2	0.441V (0.441197V)	0.419V (0.419049V)	0.418V (0.418368V)	0.418V (0.417965V)	0.417V (0.417119V)	zp=30mm, vf=0.4V@TP0a
Ane 0.63V@D3.2	0.635V (0.634552V)	0.604V (0.604322V)	0.604V (0.604314V)	0.604V (0.604311V)	0.604V (0.604307V)	zp=12mm, Vdpp=1.2V@TP0a

Tx Amplitude Calibration (Clause 137)

Clause	137					Note
Cd	180fF					
Cp	110fF					
tr	12ps					
Dp	3					
Np	200					
Nv	13					
Test Fixture	34mm COM Host PCB trace with Zdiff=100Ω (1.4058dB loss@12.89GHz)					From TP0 to TP0a
Scope Filter	4th-order Bessel-Thomson LPF with 33GHz 3dB Bandwidth					
Test Pattern	PRBS13Q					
Rd	55Ω	50Ω	50Ω	50Ω	50Ω	
Zc	90Ω	90Ω	93Ω	95Ω	100Ω	
Av, Afe 0.45V@D2.0	0.438V (0.438474V)	0.416V (0.416285V)	0.415V (0.415269V)	0.415V (0.414718V)	0.414V (0.413736V)	zp=30mm, vf=0.4V@TP0a
Ane 0.63V@D2.0	0.634V (0.634552V)	0.604V (0.604321V)	0.604V (0.604314V)	0.604V (0.604310V)	0.604V (0.604306V)	zp=12mm, Vdpp=1.2V@TP0a

Tx Amplitude Calibration (Clause 136)

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Clause	136 (normative at TP2)					Note
Cd	180fF					
Cp	110fF					
tr	8ps					
Dp	3					
Np	200					
Nv	13					
Host PCB trace	COM Host PCB trace zp=151mm (6.4245dB loss@13.28GHz with Zc=109.8Ω) (for Av,Afe) or zp=72mm (for Ane)					From TP0 to TP1
Mated Test Fixture	Reference IL of Mated TF by EQ 136A-2 + minimum phase (3.6548dB loss@13.28GHz)					From TP1 to TP2
Scope Filter	4th-order Bessel-Thomson LPF with 33GHz 3dB Bandwidth					
Test Pattern	PRBS13Q					
Rd	55Ω	50Ω	50Ω	50Ω	50Ω	
PKG Zc	90Ω	90Ω	93Ω	95Ω	100Ω	
Host PCB Zc	109.8Ω	100Ω	100Ω	100Ω	100Ω	
Av, Afe 0.45V@D2.0	0.404V (0.403798V)	0.381V (0.381300V)	0.380V (0.380483V)	0.380V (0.380050V)	0.379V (0.379321V)	zp=30mm, host zp=151mm, vf=0.34V@TP2
Ane 0.63V@D2.0	0.644V (0.643901V)	0.613V (0.613240V)	0.613V (0.613228V)	0.613V (0.613224V)	0.613V (0.613220V)	zp=12mm, host zp=72mm, Vdpp=1.2V@TP2

Tx Amplitude Calibration (Clause 136A)

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Clause	136A (informative at TP0a)					Note
Cd	180fF					
Cp	110fF					
tr	8ps					
Dp	3					
Np	200					
Nv	13					
Test Fixture	34mm COM Host PCB trace with Zdiff=100Ω (1.4058dB loss@12.89GHz)					From TP0 to TP0a
Scope Filter	4th-order Bessel-Thomson LPF with 33GHz 3dB Bandwidth					
Test Pattern	PRBS13Q					
Rd	55Ω	50Ω	50Ω	50Ω	50Ω	
Zc	90Ω	90Ω	93Ω	95Ω	100Ω	
Av, Afe 0.45V@D2.0	0.438V (0.438328V)	0.416V (0.416144V)	0.415V (0.415114V)	0.415V (0.414554V)	0.414V (0.413556V)	zp=30mm, vf=0.4V@TP0a
Ane 0.63V@D2.0	0.634V (0.634551V)	0.604V (0.604321V)	0.604V (0.604313V)	0.604V (0.604309V)	0.604V (0.604306V)	zp=12mm, Vdpp=1.2V@TP0a

- Discrepancy with 136 is found, and either one should be fixed
  - Keep 136 (normative) ? 136A (informative but consistent with 137) ?

Summary

- Do we have enough margin for interoperability?
  - May be, if the test channel of Rx ITT is good
  - May be not, if the test channel of Rx ITT is bad
  - Currently, it depends on the quality of the test channel of Rx ITT

- My revised proposal (preliminary)
  1. Change Rd to 50Ω
  2. Change PKG Zc to one of 90Ω, 93Ω, 95Ω, or 100Ω as a nominal value
  3. Change Host PCB trace Zc to 100Ω (only Clause 136)
  4. Change Av/Afe/Ane in consistent with the change of Rd and Zc
     - Alternatively, we may re-calibrate Av/Afe/Ane to get typ Tx amplitude at TP0a/TP2
  5. (Option, simulation in progress) Change Channel COM value in the amount which will not largely affect pass/fail status of existing channels
  6. (Option, need more work, maybe .cd only) Specify the worst return loss of test channel of Rx ITT
     - Alternatively, specify test channel COM before calibration ≥ e.g. 4dB
  7. (Option, need more work, .cd only) Change broadband noise of Rx ITT to some sort of bounded uncorrelated noise
  8. (Option, need more work, .cd only) Change Rx ITT COM value to a relevant value to guarantee enough margin for interoperability

- Suggestions and contributions are welcome

Thank you