Cable Channel IL and RL limits

IEEE 802.3dm

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Motivation

- Clarify relation of liased ASA document(s) and proposed cable channel limits
- Show the scope of contributions and considerations, which are behind these limits

History and Relation of Activities

- Technical Committee A (and later B) have a similar role as an 802.3 task force
- ASA Transceiver Specification: version 1.01 was first document written (finished Dec 2020)

- Technical Committee D (and later E) have a similar role as Open Alliance TCs
- Test Specification for ASA devices, and cable/components
- Test specifications are written after the Transceiver Spec

- Partly overlapping, partly disjunct group of participants (ca. 30 – 35 companies for TCA/B, ca. 30 – 35 companies for TCD/E; larger number of individuals)
- Communicate work results among each through shared/cross-presentations

“Evolution” of cable harness Coax & STP IL limit

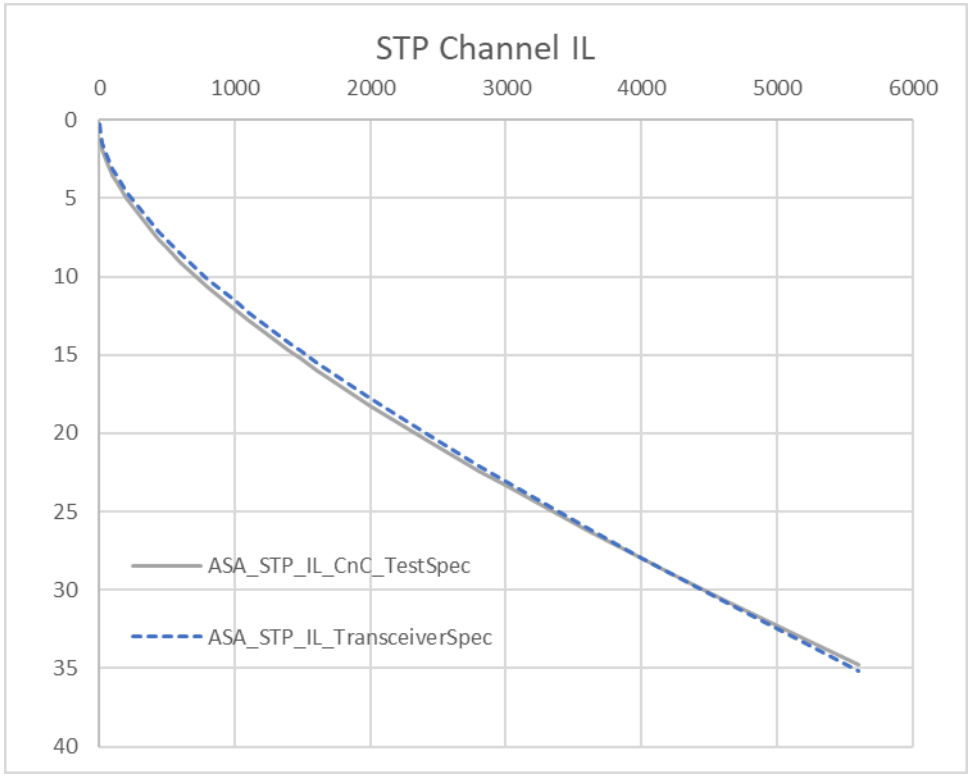
- TCA/B specified cable harness limits for a system definition in the Transceiver Specification
  - Based on measurements of several cable “products” for both Coax and STP respectively
  - Including aging investigation
  - Mostly driven by PHY vendors with support / cooperation of component maker / assembly maker

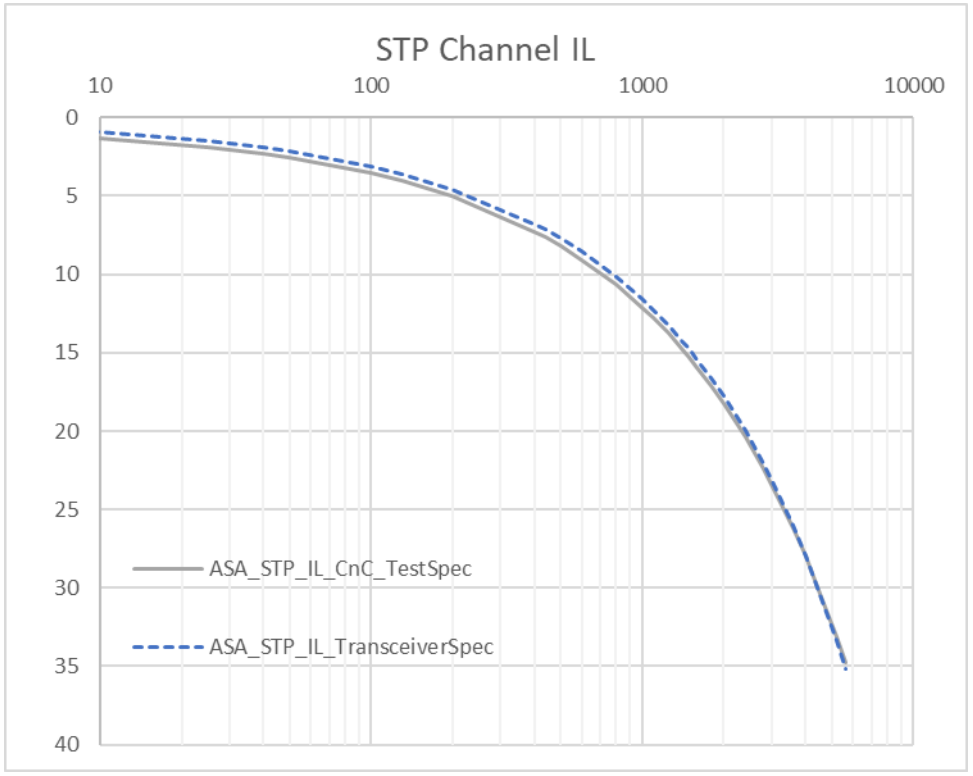
- TCD/E specifies testable limits for cable harness(es)
  - Two cable makers and one assembly maker measured different samples/batches of their products under different condition (factory fresh, aged/stressed) to validate the IL limits → **lots of measured data from independent sources** (if dm is interested in the data, could make a request under liaison)
  - Limits were generally matching with the measured data (allowing the measurements to pass), except for some miniscule violations in lower frequency range

  → TCE adjusted the limit line for the purpose of the test specification to allow sample variation to pass the spec

  → Change for the system definition (impact for the defined waveform) is very minor. Aligning the Transceiver Spec not considered a priority.

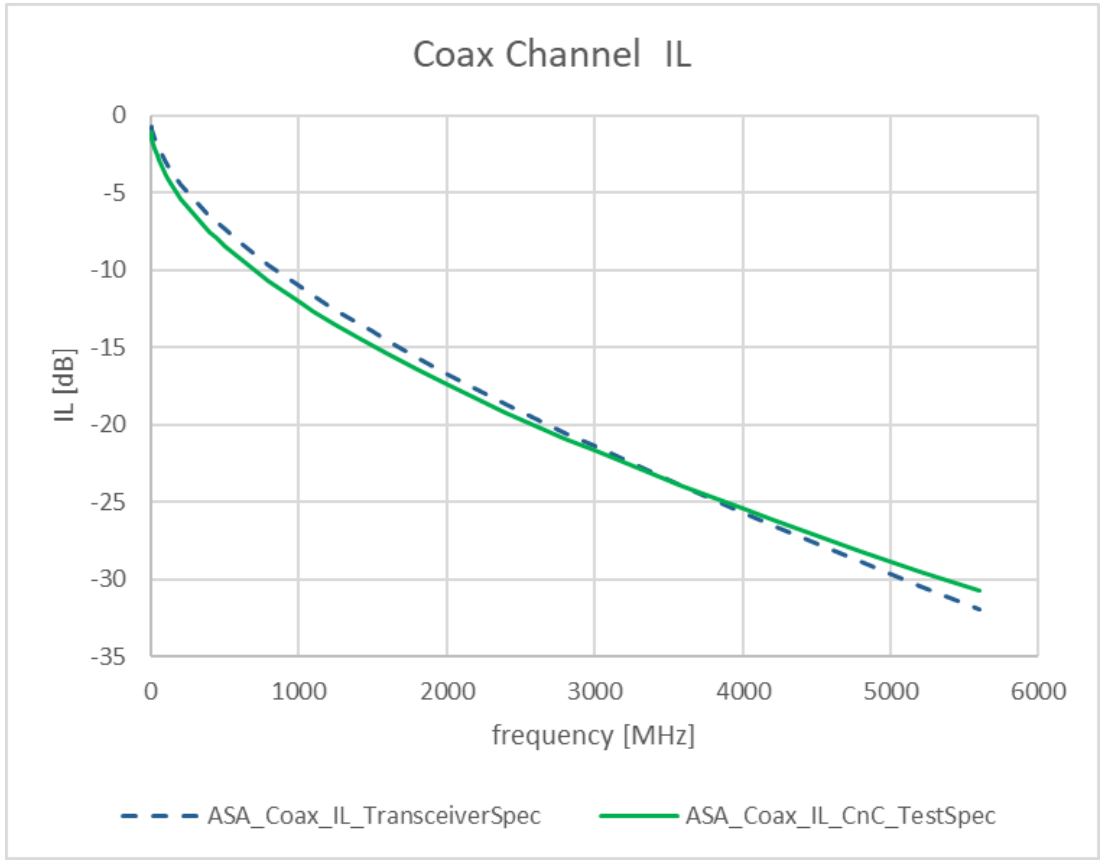
STP Cable Channel - Insertion Loss

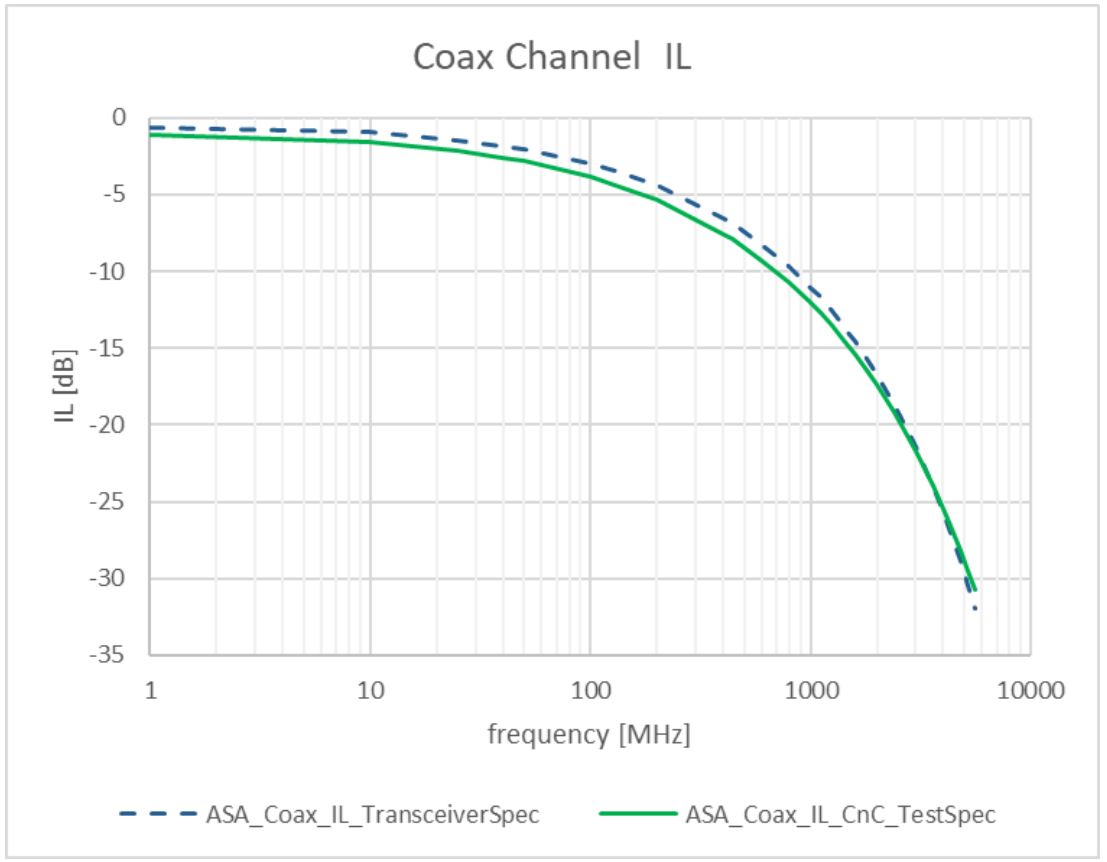




STP CnC IL Limit $IL = 0.322 \cdot \sqrt{f} + 0.0019 \cdot f + \frac{1}{\sqrt{f}}$

Coax Cable Channel - Insertion Loss





Coax CnC IL Limit $IL = 0.3 + 0.345 \cdot \sqrt{f} + 0.000825 \cdot f + \frac{0.48}{\sqrt{f}}$

https://ieee802.org/3/dm/public/0924/Zerna_802.3dm_01_240918_IL_Limit_Proposal.pdf

“Evolution” of cable harness RL limit

- TCA/B specified cable harness limits for a system definition in the Transceiver Specification
  - Mostly driven by PHY vendors with support / cooperation of component maker / assembly maker
  - Recombination of the limited number of cable samples (within limitations of connectors on assemblies) to evaluate RL and extrapolate a worst case
- TCD/E specifies testable limits for cable harness(es)
  - Cable characterization data from two cable makers
  - Monte-Carlo simulated evaluation by two component makers / assembly house
  - Harness definition as a mitigation measured (confirmed for feasibility / impact by OEM)
  - → Conclusion that ASA 1.01 Transceiver Specification limit is noticeably mismatching with real-world RL of (especially coax) cable harness

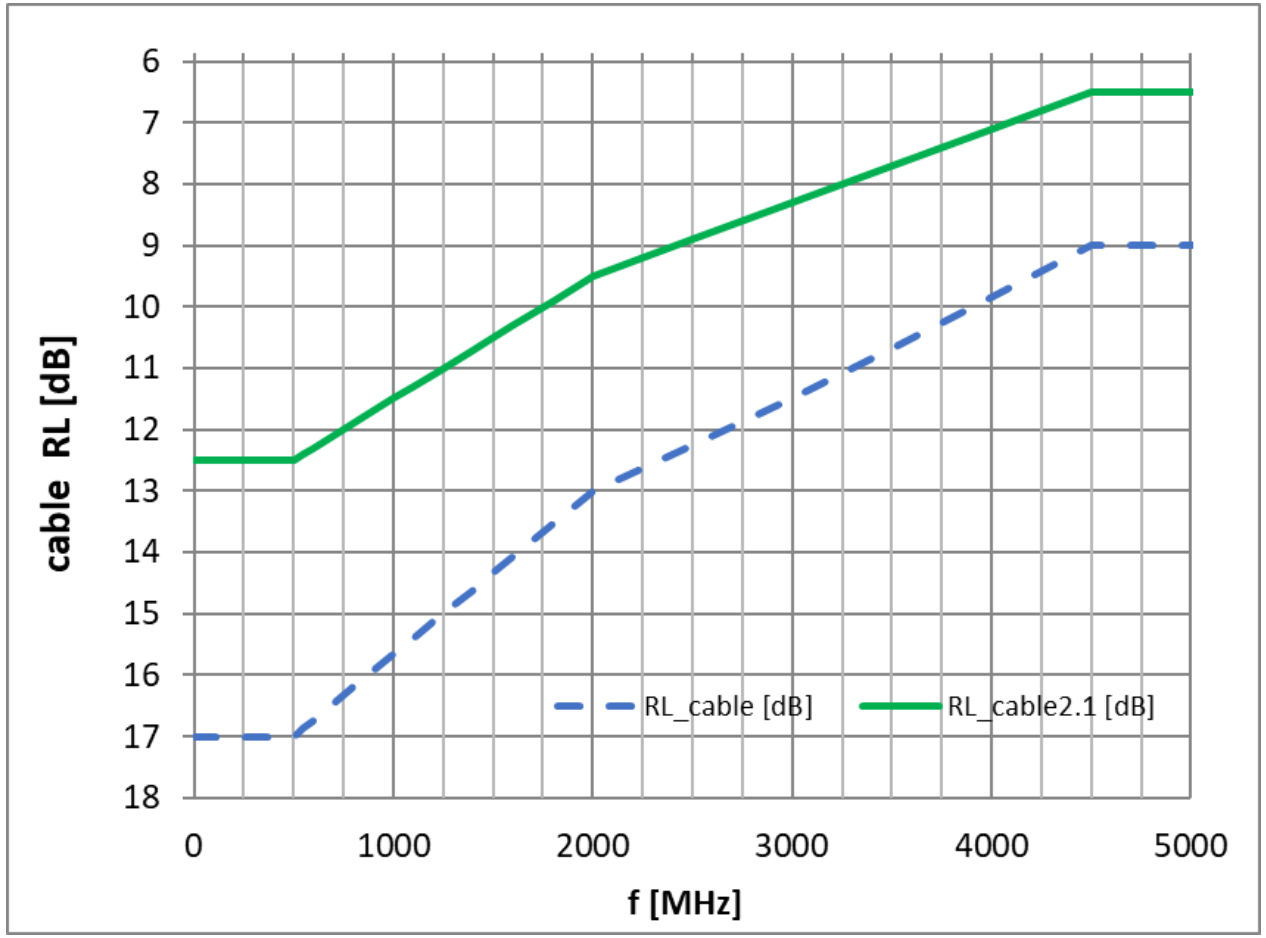
→ TCA/B

- → Formal request by TCE to TCA/B to change/relax RL limit.
- → Review period for PHY vendors to consider the change
- → Change accepted and implemented for ASA Transceiver Spec version 2.1 (same RL limit in Transceiver and Test Spec)

ASA 2.1 & TestSpec

- Notable change
- Long and deep discussion with many stakeholders
- Not changing the limit would require tightening cable spec to better than ±1.5Ω (2x tighter than ISO 19642-11 specification)
- Accepted by PHY vendors

$$RL \geq \begin{pmatrix} 12.5 & 10\ MHz \leq f < 500\ MHz \\ 12.5 - 3\frac{f-500}{1500} & 500\ MHz \leq f < 2000\ MHz \\ 9.5 - 3\frac{f-2000}{2500} & 2000\ MHz \leq f < 4500\ MHz \\ 6.5 & 4500\ MHz \leq f \leq 5000\ MHz \end{pmatrix} \text{dB}$$

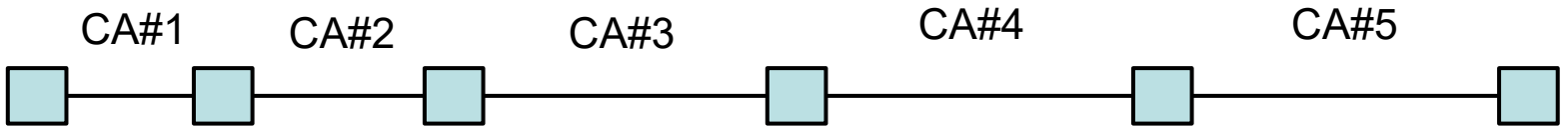


In-depth Presentations in 802.3dm

- Detailed analyses of Return Loss of cable harness
  - https://ieee802.org/3/dm/public/0924/bergner_3dm_01a_18_09_24.pdf
  - https://ieee802.org/3/dm/public/0724/Zerna_802.3dm_01b_240717_IL_RL_Limits.pdf
  - https://ieee802.org/3/dm/public/0724/mueller_3dm_01a_07_01_24.pdf
  - https://ieee802.org/3/dm/public/1124/Zerna_802.3dm_01a_241110_CableHarness.pdf

ASA 2.1 & TestSpec

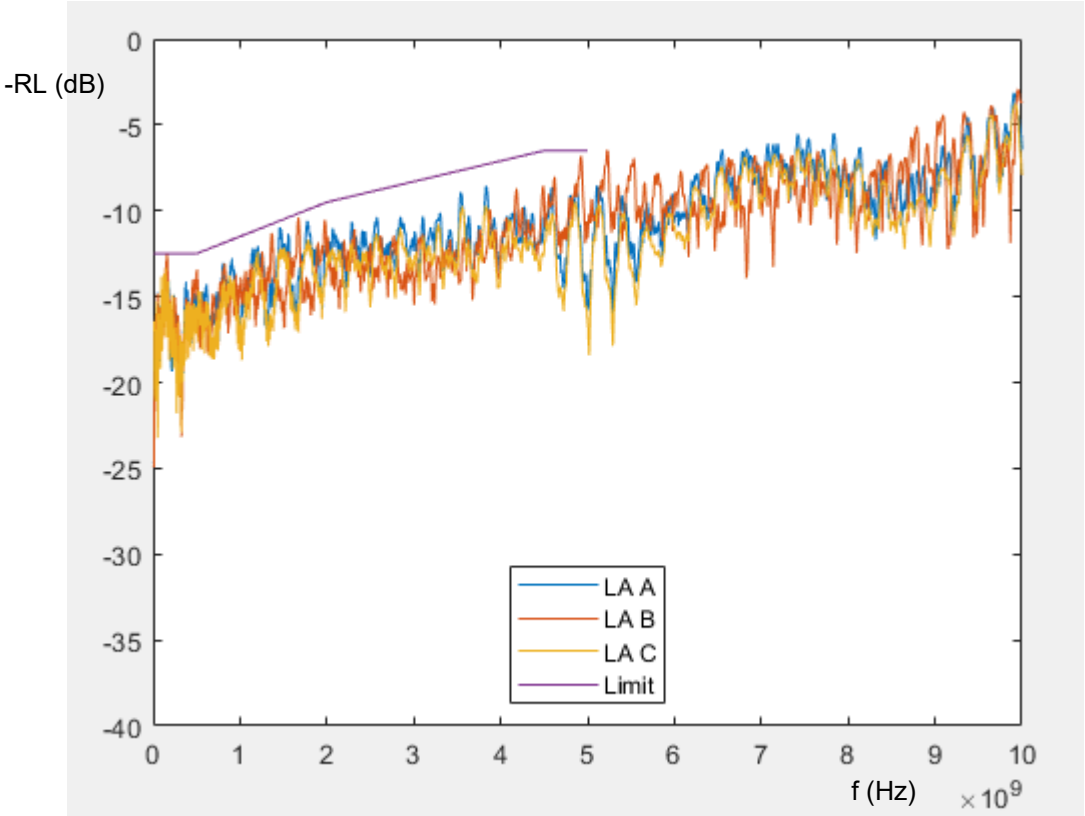
- Example for Coax – with connectors:



Topology variations, realistic connector model (no worst-case):

LA RL worst case (A)	CA#1	CA#2	CA#3	CA#4	CA#5
cable	CX174	CX174	CX31	CX31	CX31
length	0.3m	0.36m	1.0m	11.84m	1.5m
LA RL worst case (B)	CA#1	CA#2	CA#3	CA#4	CA#5
cable	CX31	CX31	CX31	CX31	CX174
length	0.3m	0.36m	1.0m	11.84m	1.5m
LA RL worst case (C)	CA#1	CA#2	CA#3	CA#4	CA#5
cable	CX174	CX174	CX31	CX31	CX31
length	0.3m	0.36m	6.34m	4m	4m

$$RL \geq \begin{pmatrix} 12.5 & 10\ MHz \leq f < 500\ MHz \\ 12.5 - 3\frac{f-500}{1500} & 500\ MHz \leq f < 2000\ MHz \\ 9.5 - 3\frac{f-2000}{2500} & 2000\ MHz \leq f < 4500\ MHz \\ 6.5 & 4500\ MHz \leq f \leq 5000\ MHz \end{pmatrix} \text{dB}$$



Summary

- This presentation clarified the liased and proposed data on cable harness insertion loss and return loss

- Showed the deep consideration from system perspective
- Hinted at amount of measured and simulated data behind these cable limits

- Propose to adopt cable IL limit of slide 5 and 6

- Propose to adopt the cable RL limit of slide 8

Thank You!