Aligning Reference Impedances in P802.3dj
D2.0 Comments: 62, 63, 64, 65, 66, 235, 236, 237, 238, 239

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Abstract

- Proposal:
  - Align reference impedances in P802.3dj to reflect actual interconnect environments.
- Motivation:
  - Real systems often deviate from 100 Ω differential impedance.
  - Aligning with 92.5 Ω supports more realistic evaluation and improves coherence with ERL and COM modeling.

Synopsis of Comments Scope

Includes but not limited to:

- ❑ ERL test fixture (e.g., 178.9.2.1.2, 179.9.4.7)
- ❑ Cable assembly ERL
- ❑ Reference impedance sections across 178/179/176C
- ❑ COM calibration updates to match new impedance baseline

Define Conversion* From Original S-parameters (Z_0) To New S-parameters (Z_1)

To transform an S-parameter matrix from reference Z_0 to Z_1 use

$$\boldsymbol{S' = A^{-1}(I - S\rho)^{-1}(S - \rho)A}$$

where:

- $\rho = \frac{Z_1 - Z_0}{Z_1 + Z_0}$
- $A = \frac{Z_1 + Z_0}{\sqrt{Z_1 Z_0}}$
- I is the identity matrix
- Z_0 is the original diagonal impedance matrix where each diagonal entry is the impedance of that port
- Z_1 is the new diagonal impedance matrix where each diagonal entry is the impedance of that port

* T. Reveyrand, "Multiport conversions between S, Z, Y, h, ABCD and T parameters," AWR Corporation Application Note, 2011.

COM and ERL

S-parameter files with reference impedance ≠ 50 Ω do not affect COM's internal computation.

- In COM, Rd (die load resistance) is the effective reference, not Z0.

Av, Af, and An may need to change to reflect the Tx test environment.

ERL uses $\boldsymbol{S' = A^{-1}(I - S\rho)^{-1}(S - \rho)A}$

- This is already in the COM example code
- The Z_t parameter in the COM code is the reference for ERL

Recommend: Include generalized renormalization method directly in COM and ERL specifications

Options 1, 2, 3

1. Change all ERL impedance references to 46.25 ohms SE
   - Pro: Matches typical interconnect impedance
   - Con: May complicate other TD specs if not applied uniformly.
2. Change test fixture back to 50 ohms SE
   - Pro: Compatible with standard test instruments
   - Con: May misrepresent performance in mission-like systems.
3. Renormalize all graphs and test fixture speciation to 92.5 for differential and 23.125 ohms for common mode
   - Graphs are a cosmetic alignment with real-world differential systems
   - Pro: More mission centric representation
   - Con: Work needs to done to get new graphs and fixture specification. Requires fixture spec update and possible redesign.

Options 4 & 5

4. Change time domain impedance reference to 46.25 ohms SE (92.5 ohms diff)
   - Change Av, Af, An in COM tables aligning to test equipment redefined impedance
   - Pro: More accurate alignment if combined with other changes
   - Con: Limited by current instrument impedance matching capabilities.
   - Question: Could the impedance change be bifurcated between pattern generator and scope?
5. No change to the impedance references in the document
   - Pro: Lowest disruption
   - Con: Leaves inconsistency between fixture design and measurement assumptions

Summary and Recommendation

Option	Description	Pros	Cons
1	Change ERL to 46.25 Ω SE (92.5 Ω diff)	Matches actual interconnect tech	Risk of TD spec difficulty
2	Revert fixture to 50 Ω SE	Matches lab equipment	Less representative of mission
3	Renormalize graphs/specs to 92.5 Ω diff	Visual/analytical coherence	Requires redesign effort
4	Change TD reference to 46.25 Ω SE	Best real-world match	May exceed tool capabilities
5	Do nothing	Least disruption	Breaks consistency across specs

- Recommend: Option 1 as the most pragmatic path.
  - It balances alignment with real-world interconnects and manageable implementation effort.
- Recommend:
  - Adopt generalized impedance transformation into Annex 178A
  - Add parameter Z_t to ERL references

Thank You!

Additional Associated Information

Changes in D2.0

P 363 line 45
178.9.2.1.2 Test fixture effective return loss (ERL)
ERL impedance should be aligned to Rd and 179B.
Suggested Remedy
Add line:
The reference differential impedance for the test fixture ERL computation shall be 92.5 Ω.

P 403 line 23
179.9.4.7 Transmitter effective return loss (ERL)
ERL impedance should be aligned to Rd and 179B.
Suggested Remedy
Add line:
The reference differential impedance for ERL computation shall be 92.5 Ω.

P 413 line 11
179.11.3 Cable assembly ERL
ERL impedance should be aligned to Rd and 179B.
Suggested Remedy
Add line:
The reference differential impedance for ERL computation shall be 92.5 Ω.

P 726 line 38
176C.6.3.5 Transmitter difference effective return loss (ERL)
ERL impedance should be aligned to Rd and 179B.
Suggested Remedy
Add line:
The reference differential impedance for the test fixture ERL computation shall be 92.5 Ω.

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P 361 line 43
178.9.1 Reference impedance
The reference impedance for measurement should align with the test fixture reference.
Suggested Remedy
Change line to:
The reference impedance for differential specifications is 92.5 ohms . The reference impedance for common-mode specifications is 23.125 ohms .

P 393 line 40
179.9.3 Reference impedance
Change line to:
The reference impedance for differential specifications is 92.5 ohms . The reference impedance for common-mode specifications is 23.125 ohms .

P 412 line 47
179.11.1 Reference impedance
Change line to:
The reference impedance for differential specifications is 92.5 ohms . The reference impedance for common-mode specifications is 23.125 ohms .

P 723 line 18
176C.6.2 Reference impedance
Change line to:
The reference impedance for differential specifications is 92.5 ohms . The reference impedance for common-mode specifications is 23.125 ohms.

Changes in D2.0 (new section) and Av changes

P785 line 19
Annex 178A (normative) Specification methods for 200 Gb/s per lane electrical channel

Re-normalization of s-parameter is not defined in the document.

Reference impedance
Add new section 178A.2

The conversion of S s-parameter with reference Z_0 to S' s-parameter with reference Z_1 is computed as follows:

S'= A^(−1) *(I−S*rho)^(−1)* (S−rho)*A
where:
rho= $(Z\_1-Z\_0)/(Z\_1+Z\_0)$
A= (Z_1+Z_0)/sqrt(Z_1*Z_0)
S is the original s-parameter matrix with Z_0 as the original diagonal impedance matrix where each diagonal entry is the impedance of that port.
S' is the new s-parameter matrix with Z_1 as the new diagonal impedance matrix where each diagonal entry is the impedance of that port

- P 372 line 7
  178.10 Channel characteristics
  P 416 line 27
  179.11.7.1 COM parameters
  P 733 line 10
  176C.7.1 Channel Operating Margin
  P 750 line 23
  176D.7.2 COM reference model

  Adjust COM voltage to 46.25 ohms measurement reference.
  Change

A_v	to 0.415
A_fe	to 0.415
A_ne	to 0.608