802.3dj D3.0
Comment Resolution
Electrical Topics

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Introduction

- This slide package was assembled by the 802.3dj editorial team to provide background and detailed resolutions to aid in comment resolution.
- Specifically, these slides are for the various electrical-track comments.

Management variables

Comment #300

Management variables
Comment #300

Cl **178** *SC* **178.13** *P* **405** *L* **53** # 300

Dudek, Michael Marvell

Comment Type **T** *Comment Status* **D** *PMD variables (E)*

The notes to the tables 179-23 and 179-24 correctly apply to CR, but these tables are normatively referenced by clause 178 where these CR PMD references do not apply but should be replaced by other references.

SuggestedRemedy

In 178.13 Change ôThe PMD control and status variables are identical to those defined in 179.14.ô to ôThe PMD control and status variables are identical to those defined in 179.14, with the exception that references to CR PMDÆs are replaced by references to the equivalent KR PMDÆsô.

178.13 Management variables

The PMD control and status variables are identical to those defined in 179.14.

In 179.14, Table 179-23 and Table 179-22 have footnotes that are specific to CR

Table 179–23—PMD control variables and MDIO mapping

Control variable	Variable reference	MDIO register/bit number	MDIO register/bit reference
PMD_reset	179.8.10	1.0.15	45.2.1.1
Global_PMD_transmit_disable	179.8.6	1.9.0	45.2.1.8
PMD_transmit_disable_7, PMD_transmit_disable_6, PMD_transmit_disable_5, PMD_transmit_disable_4[a]	179.8.7	1.9.8:5	45.2.1.8
PMD_transmit_disable_3, PMD_transmit_disable_2[b]	179.8.7	1.9.4:3	45.2.1.8
PMD_transmit_disable_1[c]	179.8.7	1.9.2	45.2.1.8
PMD_transmit_disable_0	179.8.7	1.9.1	45.2.1.8

[a] Available only in 1.6TBASE-CR8.
[b] Available only in 800GBASE-CR4 and 1.6TBASE-CR8.
[c] Available only in 400GBASE-CR2, 800GBASE-CR4, and 1.6TBASE-CR8.

Suggested remedy is to insert “, with the exception that references to CR PMDs are replaced by references to the equivalent KR PMDs”.

C2M specs

Comments #174, 175, 12, 298, 245, 276, 277, 313

C2M specs related to module "device package model"
Comments #174, 175, 12, 298

Cl **176D** *SC* **176D.8.13.2** *P* **834** *L* **9** # **174**

Healey, Adam Broadcom Inc.

Comment Type **TR** *Comment Status* **D** *Test channel calibration (E)*

For the module receiver interference tolerance test, item b) states that "COM is calculated using the module device package and device termination models". However, the module test channel shown in Figure 176D-8b includes the host compliance board (HCB). The reference loss of the HCB equals the module loss allocation to TP1d illustrated in Figure 176D-6. Therefore, the addition of the module device package model results in the interference tolerance test being calibrated with approximately 2.1 dB more loss than a module has been allocated.

SuggestedRemedy

Replace 176D.8.13.2 item b) with the following. "For the module test, the test channel is measured between the Tx and Rx test references shown in Figure 176D-8b, and COM is calculated using device termination model in Table 176Dû6 for the receiver S-parameter model."

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
The suggested remedy removes the only mention of the module device package model in Annex 176D. As a result, the "Device package model, module" row in Table 176D–6 becomes irrelevant.

Implement the suggested remedy, and in addition, delete the "Device package model, module" row in Table 176D–6.
Implement with editorial license.

Cl **176D** *SC* **176D.6.5** *P* **824** *L* **25** # **175**

Healey, Adam Broadcom Inc.

Comment Type **TR** *Comment Status* **D** *C2M specs (E)*

Slide 7 of <https://www.ieee802.org/3/dj/public/25_11/healey_3dj_01a_2511.pdf> highlighted that there is some ambiguity in the loss that has been allocated to the module. The value computed on slide 12 for module output Rpeak was based on the more generous interpretation i.e., 5.9 dB from the TP4d to the mating point of the connector. If the loss from TP4d to the mating point of the connector is limited to 3.8 dB as shown in Figure 176D-6, then the Rpeak limit in Table 176D-3 needs to be adjusted.

SuggestedRemedy

If the module loss allocation is limited to 3.8 dB, then in Table 176D-3 change Rpeak (min) to 0.51 and change the lower value of the vf range to 0.392.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
In Table 176D-3, change Rpeak (min) to 0.51 and change the lower value of the vf range to 0.392.

Background for these comments is healey_3dj_01_2601.

Case		v_{max}, V	v_f, V	R_{peak}
	TP4d-to-TP4			
C2M module, D2.3	10.82	0.179	0.389	0.46
C2M module, proposed	8.75	0.2	0.392	0.51

Corrected specification limits

C2M specs related to module “device package model” Comments #174, 175, 12, 298

Cl **176D** *SC* **176D.6.5** *P* **821** *L* **22** # 298

Dudek, Michael Marvell

Comment Type **TR** *Comment Status* **D** *C2M specs (E)*

As discussed in healey_3dj_01_2601 the module loss allocated in the budget does not align with Rpeak and Vf specifications and the module input interference and jitter tolerance calibration

SuggestedRemedy

Implement the changes proposed in healey_3dj_01_2601

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
Resolve using the responses to comments #174 and #175.

Cl **176D** *SC* **176D.8.13.2** *P* **834** *L* **8** # 12

Lusted, Kent Synopsys, Inc.

Comment Type **TR** *Comment Status* **D** *C2M specs (E)*

Repeating comment #58 from D2.3: For the module receiver interference tolerance test, item b) states that "COM is calculated
using the module device package and device termination models". However, the module test channel shown in Figure 176D-8b includes the host compliance board (HCB). The reference loss of the HCB equals the module loss allocation to TP1d illustrated in Figure 176D-6. Therefore, the addition of the module device package model results in the interference tolerance test being calibrated with approximately 2.1 dB more loss than a module has been allocated.

SuggestedRemedy

Replace 176D.8.13.2 item b) with the following. "For the module test, the test channel is measured between the Tx and Rx test references shown in Figure 176D-8b, and COM is calculated using device termination model in Table 176Dû6 for the receiver S-parameter model."

Same as #174

implement the changes per
https://www.ieee802.org/3/dj/public/26_01/healey_3dj_01_2601.pdf

Slide #7 is the change suggested in #175

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
Resolve using the responses to comments #174 and #175.

Background for these comments is healey_3dj_01_2601.

C2M specs related to module "device package model" Comment #245

Cl **176D** *SC* **176D.7.2** *P* **825** *L* **49** # **245**

Ghiasi, Ali — Ghiasi Quantum LLC,Marvell Semiconductor, Inc.

Comment Type **TR** *Comment Status* **D** *C2M reference channel (E)*

Module packages if exist are core-less

SuggestedRemedy

In case of core-less package you just have stack via through the ABF layers, suggest replacing 1.8 mm with 0.25 mm.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
The proposed response to comment #174 removes the module's device package model altogether.
Resolve using the response to comment #174.

This whole row from Table 176D-6 should be deleted if the suggested remedy to #174 is accepted.

Device package model, module			
Transmission line parameter γ_0	γ_0	5×10^{-4}	1/mm
Transmission line parameter a_1	a_1	8.9×10^{-4}	$ns^{1/2}$/mm
Transmission line parameter a_2	a_2	2×10^{-4}	ns/mm
Transmission line parameter τ	τ	6.141×10^{-3}	ns/mm
Transmission line 1 length, case 1	$z_p^{(1)}$	4	mm
Transmission line 1 length, case 2	$z_p^{(1)}$	10	mm
Transmission line 1 characteristic impedance	$Z_c^{(1)}$	87.5	Ω
Transmission line 2 length	$z_p^{(2)}$	1.8	mm
Transmission line 2 characteristic impedance	$Z_c^{(2)}$	92.5	Ω
Single-ended package capacitance at package-to-board interface	C_p	40×10^{-6}	nF

Cl **176D** *SC* **176D.8.13.2** *P* **834** *L* **9** # **174**

Healey, Adam — Broadcom Inc.

Comment Type **TR** *Comment Status* **D** *Test channel calibration (E)*

For the module receiver interference tolerance test, item b) states that "COM is calculated using the module device package and device termination models". However, the module test channel shown in Figure 176D-8b includes the host compliance board (HCB). The reference loss of the HCB equals the module loss allocation to TP1d illustrated in Figure 176D-6. Therefore, the addition of the module device package model results in the interference tolerance test being calibrated with approximately 2.1 dB more loss than a module has been allocated.

SuggestedRemedy

Replace 176D.8.13.2 item b) with the following. "For the module test, the test channel is measured between the Tx and Rx test references shown in Figure 176D-8b, and COM is calculated using device termination model in Table 176Dû6 for the receiver S-parameter model."

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.

The suggested remedy removes the only mention of the module device package model in Annex 176D. As a result, the "Device package model, module" row in Table 176D–6 becomes irrelevant.

Implement the suggested remedy, and in addition, delete the "Device package model, module" row in Table 176D–6.
Implement with editorial license.

C2M specs related to module "device package model" Comments #276, 277

Cl **176D** *SC* **176D.6.4** *P* **821** *L* **22** # 276

Calvin, John Keysight Technologies

Comment Type **TR** *Comment Status* **D** *C2M specs (E)*

Vf minimum value of .372 still fails the majority of early designs.

Minimum v_f of host output

SuggestedRemedy

The interop report out:
https://www.ieee802.org/3/dj/public/26_01/calvin_3dj_01a_2601.pdf Page 23 shows 9 out of 12 modules failing Vf. We either need to review the measurement methodology in Vf (which is not new) or consider further reduction of the Vf values to 350mV.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The comment refers to host output v_f (based on the value 0.372) but the data in the presentation referred to in the suggested remedy is for module output (subject of comment #277).
The comment does not provide sufficient justification to support the suggested remedy.
[Editor's note: changed Clause/Subclause from 179D/179D.6.4 to 176D/176D.6.4]

Cl **176D** *SC* **176D.6.5** *P* **822** *L* **23** # 277

Calvin, John Keysight Technologies

Comment Type **TR** *Comment Status* **D** *C2M specs (E)*

Vf minimum value of .389V still fails the majority of early designs.

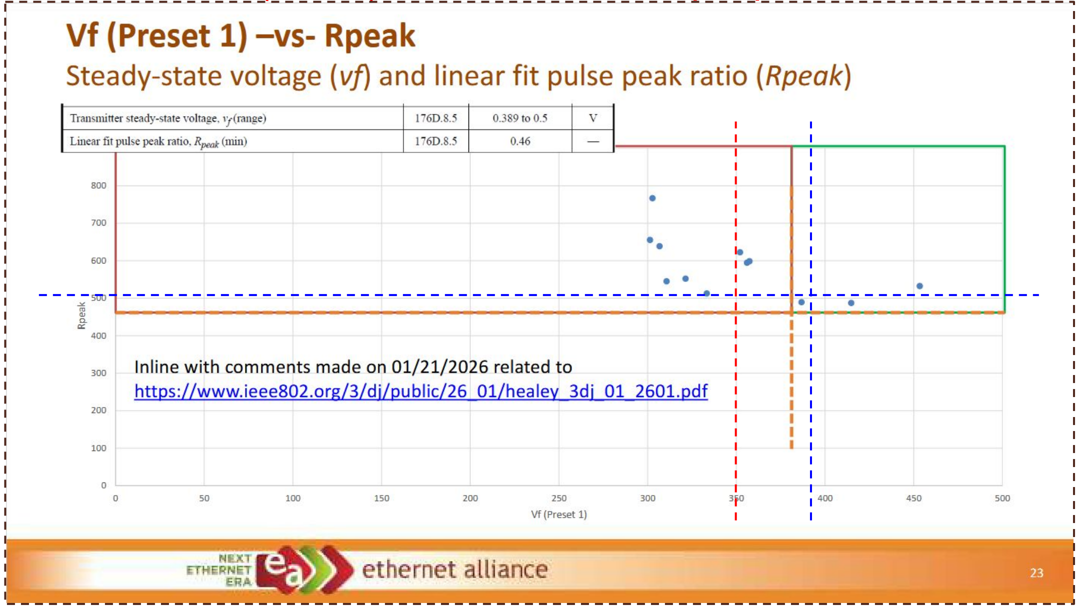
SuggestedRemedy

The interop report out:
https://www.ieee802.org/3/dj/public/26_01/calvin_3dj_01a_2601.pdf Page 23 shows 9 out of 12 modules failing Vf. We either need to review the measurement methodology in Vf (which is not new) or consider further reduction of the Vf values to 350mV.

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The v_f specification is an important component of the COM analysis that supports the loss budget of 32 dB for C2M applications. Reducing the minimum v_f would undermine this analysis and prevent interoperability with worst-case hosts.
The information in the referenced presentation does not justify reducing the v_f limits. It shows that some of the tested modules met the requirements. Devices that failed the requirements might have not been configured correctly or might be non-compliant.
[Editor's note: changed clause/subclause/page from 179D/179D.6.3/821 to 176D/176D.6.5/822]

Referenced presentation is calvin_3dj_01a_2601.
Slide 23 (below) shows *module* output parameters.



Blue overlay lines show (approximately) the new limit values proposed by comment #175.
Red overlay line shows the new limit value proposed by comment #277.

C2M specs related to module “device package model” Comments ##174, 175, 12, 298, 245, 276, 277

Editor’s recommendation:

- AIP #174 and #175 using the proposed responses, and AIP the related #12 and #298.
- AIP #245, since the text is being changed.
- Reject #276 due to lack of supporting data (host output).
- Reject #277 because:
    - The suggested changes invalidate all the COM analysis that led to the adopted C2M loss budget.
    - One result is well within the specification limits, showing feasibility.

C2M specs
Comment #313

Cl **176D** *SC* **176D.8.13.1** *P* **833** *L* **39** # 313

Dudek, Michael Marvell

Comment Type **TR** *Comment Status* **D** *Test channel calibration (E)*

The test channel for both Host test and Module itest L is just a mated test board. The loss value in Table 176D-11 is 9+/-2dB but the Mated test board loss given in 179B does not match this. (The value wasn't changed here when the MCB loss was changed).

SuggestedRemedy

Change "9+/-2" dB to "8+/-2" dB, or better delete the numbers and replace with "note a" rewording note a to "The test channel consists of mated MCB and HCB with no frequency-dependent attenuator."

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
Notes within tables are informative. Table footnotes are normative but need something to be attached to.
It is preferable to require that the actual pair of mated test fixtures used in the test is subject to some IL requirement.

Change "9+/-2" dB to "8+/-2" dB.

Table 176D–11—Interference tolerance test parameters

Parameter	Host test	Module test L (low loss)[a]	Module test H (high loss)	Units
Test channel insertion loss at 53.125 GHz	9 ± 2	9 ± 2	32 ± 0.5	dB
Host channel parameters	Table 176D–6	N/A	N/A	
Test pattern	PRBS31Q			
COM[b]	3			dB

[a] The low loss test channel consists of mated MCB and HCB with no frequency-dependent attenuator.
[b] COM is calculated as defined in 176D.8.13.2. Meeting the test requirements with a lower value of COM demonstrates margin to the specification but is not required for compliance.

The reference insertion loss of the mated test fixtures is determined using Equation (179B–5).

$$ILdd_{MTFref}(f) = 0.0912 + 0.6175\sqrt{f} + 0.0203f + 0.001091f^2 \qquad (179B–5)$$

This yields 8.75 dB at 53.125 GHz (matching Figure 179A-1, which is informative).
(Before D2.3 it was 9.75 dB)

Editor's recommendation: AIP, change both to 8.75±2.

SCMR_CH

Comments #171, 170

SCMR_CH Comment #171

Cl **178** *SC* **178.10** *P* **400** *L* **43** # 171

Mellitz, Richard Samtec, Inc.

Comment Type **TR** *Comment Status* **D** *SCMR_CH (E)*

Prior posted computations for SCMR_CH where computed using DER_0 for P_Peak. The current daft specifies P_peak as 1e-7. This reduces SCMR_CH by 3 dB.

SuggestedRemedy

Lower SCMR_CH (min) as follows:

178.10
Page 400
Line 43
Change
Minimum channel signal to common-mode ratio, SCMR_CH from 20 dB to 17 dB

179.11
Page 443
Line 21
Channel signal to common-mode ratio, SCMR_CH (min) from 12 dB to 9 dB

Page 807
Line 35
Change
Minimum channel signal to common-mode ratio, SCMR_CH from 20 dB to 17 dB

Proposed Response *Response Status* **W**

PROPOSED ACCEPT.

Table 178–13—Channel characteristics summary

Description	Reference	Value	Unit
Minimum COM	178.10.1	3	dB
Maximum insertion loss from TP0d to TP5d, *ILdd*, at 53.125 GHz (recommended)	178.10.2	40	dB
Minimum channel ERL	178.10.3	11	dB
Differential-mode to common-mode return loss, *RLcd*	178.10.4	Equation (178–6)	dB
Maximum AC-coupling 3 dB corner frequency	178.10.5	250	kHz
Minimum channel signal to common-mode ratio, $SCMR_{CH}$	178.10.6	20	dB

Table 179–16—Cable assembly characteristics summary

Description	Reference	Value	Unit
Insertion loss at 53.125 GHz, *ILdd* (max)	179.11.2		
CA-A		19	dB
CA-B		24	dB
CA-C		29	dB
CA-D		34	dB
Insertion loss at 53.125 GHz, *ILdd* (min)	179.11.2	16	dB
Minimum cable assembly ERL[a]	179.11.3	8.25	dB
Differential-mode to common-mode return loss, *RLcd*	179.11.4	Equation (179–23)	dB
Common-mode to common-mode return loss, *RLcc*	179.11.5	Equation (179–15)	dB
Minimum COM	179.11.6	3	dB
Channel signal to common-mode ratio, $SCMR_{CH}$ (min)	179.11.7	12	dB
NOTE—The expected cable assembly reach is 0.5 m for CA-A, 1 m for CA-B, 1.5 m for CA-C, and 2 m for CA-D. Compliant cable assemblies may be longer. The length of a cable assembly does not imply compliance to specifications.			

Table 176C–8—Channel characteristics summary

Description	Reference	Value	Unit
Minimum COM	176C.7.1	3	dB
Maximum insertion loss from TP0d to TP5d, *ILdd*, at 53.125 GHz (recommended)	176C.7.2	32	dB
Minimum ERL	176C.7.3	9.7	dB
Differential-mode to common-mode return loss, *RLcd*	178.10.4	Equation (178–6)	dB
Minimum channel signal to common-mode ratio, $SCMR_{CH}$	176C.7.4	20	dB
Maximum AC-coupling 3 dB corner frequency	178.10.5	250	kHz

SCMR_CH for MTF Comment #170

Cl **179B** *SC* **179B.4.3** *P* **912** *L* **5** # **170**

Mellitz, Richard Samtec, Inc.

Comment Type **TR** *Comment Status* **D** *MTF Requirements (E)*

Intrapair skew has not been directly considered for the MTF. Although intrapair skew is included in the computed differential modeûtoûdifferential mode insertion loss, the effect of skew has not been explicitly specified. Common modeûtoûdifferential mode insertion loss does contain elements of skew. An either or specification for SCMR_CH should be added to control MTF intrapair skew.

SuggestedRemedy

Replace line 3 with:
The common-mode to differential-mode insertion loss of the mated test fixtures measured in both directions shall meet Equation (179Bû6) as illustrated in Figure 179Bû3. or the channel signal to common-mode ratio (SCMR_CH) shall exceed 12 dB using the procedure described in 179.11.7.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
SCMR_CH is a specification of cable assemblies. The specifications of test fixtures cannot rely on the cable assemblies they are used to measure.
Note also that the mated test fixture includes an HCB which has no other specification of mismatch.
The text of the suggested remedy is unclear.
The minimum SCMR_CH specification of cable assemblies is 12 dB, and it seems that the mated test fixtures should be significantly better than that (cable assembly measurement includes two MCBs).

Replace line 3 with:
"The mated test fixture shall comply with at least one of the following conditions:
-- The common-mode to differential-mode insertion loss of the mated test fixtures measured in both directions meets Equation (179B–6) as illustrated in Figure 179B–3.
-- The channel signal to common-mode ratio (SCMR_CH) is greater than <x> dB using the procedure described in 179.11.7."

For CRG discussion, to determine if there is consensus to make a change to D3p0 and what value of <x> is acceptable.

179B.4.3 Mated test fixtures common-mode to differential-mode insertion loss

The common-mode to differential-mode insertion loss of the mated test fixtures measured in both directions shall meet Equation (179B–6) as illustrated in Figure 179B–3.

$$ILdc(f) \geq \begin{cases} 30 - 3\frac{f}{7} & 0.01 \leq f < 35 \\ 15 & 35 \leq f < 67 \end{cases} \qquad (179B–6)$$

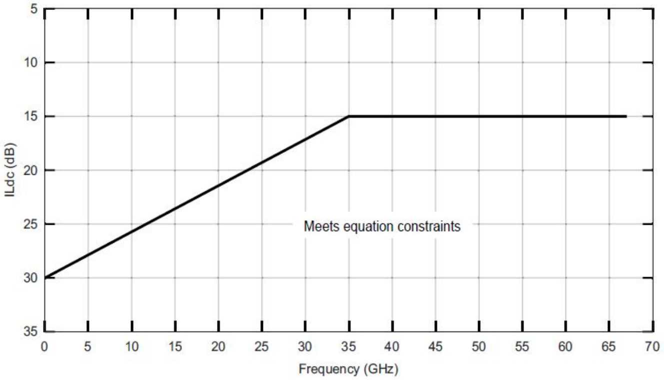


Figure 179B–3—Mated test fixtures common-mode to differential-mode insertion loss requirements

The comment suggests adding a minimum SCMR_CH of 12 dB as an alternative to the frequency mask of Equation 179B-6.

SCMR_CH for MTF
Comment #170

Table 179–16—Cable assembly characteristics summary

Description	Reference	Value	Unit
Insertion loss at 53.125 GHz, *ILdd* (max) CA-A CA-B CA-C CA-D	179.11.2	 19 24 29 34	 dB dB dB dB
Insertion loss at 53.125 GHz, *ILdd* (min)	179.11.2	16	dB
Minimum cable assembly ERL[a]	179.11.3	8.25	dB
Differential-mode to common-mode return loss, *RLcd*	179.11.4	Equation (179–23)	dB
Common-mode to common-mode return loss, *RLcc*	179.11.5	Equation (179–15)	dB
Minimum COM	179.11.6	3	dB
Channel signal to common-mode ratio, $SCMR_{CH}$ (min)	179.11.7	12	dB
NOTE—The expected cable assembly reach is 0.5 m for CA-A, 1 m for CA-B, 1.5 m for CA-C, and 2 m for CA-D. Compliant cable assemblies may be longer. The length of a cable assembly does not imply compliance to specifications.			

[a] Cable assemblies with a COM greater than 4 dB are not required to meet minimum ERL.

Note that the minimum SCMR_CH of a cable assembly is 12 dB. Comment #171 suggests changing this value to 9 dB.

Cable assemblies are measured with two MCBs, not MTF. It seems that the specifications for MTF should be tighter. Is 12 dB the right number?

Possible wording (if the CRG supports this direction)

The mated test fixture shall comply with at least one of the following conditions:

- The common-mode to differential-mode insertion loss of the mated test fixtures measured in both directions meets Equation (179B–6) as illustrated in Figure 179B–3.
- The channel signal to common-mode ratio ($SCMR_{CH}$) as defined in 179.11.7 is greater than <x> dB.

Jitter

Comments #309, 310,311, 297

Jitter
Comments #309, 310, 311

Cl **179** *SC* **179.9.4** *P* **424** *L* **24** # 309

Dudek, Michael Marvell

Comment Type **T** *Comment Status* **D** *Jitter (E)*

With the change from J4U to JH4u this jitter parameter is no longer expected to be dependent on channel loss and therefore there shouldn't be different values for different host classes and should match the value allocated to the die.

SuggestedRemedy

Remove the different host classes and have a single value of 0.118

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.
Note that 0.118 is the JH4u limit for module output in Table 176D–3 which assumes the lowest insertion loss to the measurement point (approx. 9 dB).
CR host channels assume (approx.) 12, 17, and 22 dB.
Comment #311 suggests applying the same limit for C2M host output, which assumes 32 dB loss before the measurement point.
Comment #310 suggests applying the same limit for C2C and KR transmitters, with a variable TP0v that can have a range from 3.4 to 8.5 dB (excluding the package).

For CRG discussion with comments #311 and #310.

Cl **178** *SC* **178.9.2** *P* **389** *L* **43** # 310

Dudek, Michael Marvell

Comment Type **T** *Comment Status* **D** *Jitter (E)*

With the change from J4U to JH4u this jitter parameter is no longer expected to be dependent on channel loss and therefore there shouldn't be different values for different package classes and should match the value allocated to the die

SuggestedRemedy

Remove the different package classes and have a single value of 0.118 Make the same change in 176C

Proposed Response *Response Status* **W**

PROPOSED ACCEPT.

[Editor's note: CC: 178, 176C]

Cl **176D** *SC* **176D.6.4** *P* **821** *L* **38** # 311

Dudek, Michael Marvell

Comment Type **T** *Comment Status* **D** *jitter (E)*

With the change from J4U to JH4u this jitter parameter is no longer expected to be dependent on channel loss and therefore there shouldn't be different values for the host and module and the value should match the value allocated to the die

SuggestedRemedy

In table 176D-2 change JH4U value to 0.118

Proposed Response *Response Status* **W**

PROPOSED REJECT.
The adopted JH4u measurement is intended to reduce the effect of channel loss on the measurement.
However, data provided with the JH4u proposal (see <https://www.ieee802.org/3/dj/public/25_11/calvin_3dj_01a_2511.pdf#page=8>) suggests that in some cases there is still a higher JH3u in measurements after 31 dB compared to the same transmitter after 12 dB.
Therefore, keeping a relaxed limit for host output JH4u after 32 dB, as in D3.0, may be justified.

Comment #297 is related and suggests that transmitters on other lanes should be active in JH4u measurement. JH4u is likely sensitive to additive noise too and results would likely degrade even if the phase jitter is the same. Data supporting the proposed change has not been provided.
For CRG discussion.

Jitter
Comment #297

Cl **179** *SC* **179.9.4.7** *P* **430** *L* **11** # 297

Dudek, Michael Marvell

Comment Type **TR** *Comment Status* **D** *Jitter (E)*

This comment is a re-submission of comment #105 on D2.3. With the change to using JH4u, amplitude noise is no longer creating jitter therefore disabling the other lanes should not be done as any true phase noise introduced by the other lanes should be included.

SuggestedRemedy

Delete "JH4u and"

Proposed Response *Response Status* **W**

PROPOSED REJECT.
Resolve using the response to comment #311.

Jitter
Comments #309, 310, 311, 297

Lab Instrument based test results

JH3U

- These results are for live data, PRBS9Q. JNU03 is included for comparison. With no channel, both JH3U and JNU03 are reasonably accurate. However, as the channel gets longer, JNU03 grows because it includes noise-to-jitter conversion, while JH3U does not (note that the last set of data has different impairments).
- The true values were estimated through modeling, by creating an ideal Gaussian histogram for RJ, an ideal histogram for PJ (sinusoidal jitter), convolving the two, and measuring J3U.

Latest JHNU results: 106.25 GBd, PRBS9Q, BERT

Channel	RJrms True	PJpp True	JH3U True	JH3U	JNU 03
0 dB	0	0	0	22	51
0 dB	30	0	198	192	188
0 dB	0	50	50	85	87
0 dB	30	50	223	218	219
12 dB	0	0	0	25	56
12 dB	30	0	197	193	202
12 dB	0	50	50	57	90
12 dB	30	50	222	219	232
31 dB	0	0	0	49	150
31 dB	30	0	198	190	241
31 dB	0	50	50	104	184
31 dB	30	50	223	230	368
31 dB	0	0	0	42	123
31 dB	50	0	330	317	331
31 dB	0	50	50	97	151
31 dB	50	50	347	333	394

KEYSIGHT   IEEE P8023dj: JH4u : J4u03 improvements for 212Gbps Nov 2025   8

Data provided with the JH4u proposal showed little increase after 12 dB but a large increase after 31 dB with SJ (and no RJ).

Crosstalk was not included.

Comments 309, 310, 311 suggest a changing the JH4U max to 0.118 UI for all interfaces.

Comment 297 suggests requiring other lanes to be active (adding NEXT).

Source: calvin_3dj_01a_2511

Package class

Comments #17

Package class Comment #17

Cl **178** *SC* **178.1** *P* **381** *L* **14** # 17

Brown, Matthew Qualcomm

Comment Type **TR** *Comment Status* **D** *Ref pkg (E)*

Relating to the following text: "The package is either class A or class B. PMD transmitters and PMD receivers conform to electrical specifications of either class A or class B."
It is not possible to determine if a package is of class A or class B. It is only possible to determine if a a device meets the class A or class B requirements. Also, these are not mutually exclusive; a device could possibly meet both the class A and class B requirements. Instead reword this to indicate that two classes, class A and class B, are defined for transmitters and receivers to allow for a range of package characteristics.

SuggestedRemedy

Change the paragraph to the following:
"This clause defines specifications for two classes of transmitters and two classes of receivers, class A and class B, to allow for a range of package characteristics. A transmitter or receiver is classified as class A or class B if it meets all the specifications for class A or class B, respectively. The required characteristics of the electrical interconnect between two PMDs depend on the intended transmitter class on one PMD and the receiver class on the other PMD."
Further changes elsewhere may be required to align with this restatement.

Proposed Response *Response Status* **W**

PROPOSED ACCEPT IN PRINCIPLE.

Implement the suggested remedy, and in addition, make the corresponding changes in 176C.1.
Implement with editorial license.
[CC 178, 176C]

Change in 178.1:

This clause defines specifications for two classes of transmitters and two classes of receivers, ~~identified by transmitter package class and receiver package class, respectively. The package is either~~ class A or class B, to allow for a range of package characteristics. A transmitter or receiver is classified as class A or class B if it meets all the specifications for class A or class B, respectively. ~~PMD transmitters and PMD receivers conform to electrical specifications of either class A or class B.~~ The required characteristics of the electrical interconnect between two PMDs depend on the transmitter ~~package~~ class on one PMD and the receiver ~~package~~ class on the other PMD.

Change in 176C.1:

This annex defines specifications for two classes of C2C transmitters and two classes of C2C receivers, ~~identified by transmitter package class and receiver package class, respectively. The package is either~~ class A or class B, to allow for a range of package characteristics. A transmitter or receiver is classified as class A or class B if it meets all the specifications for class A or class B, respectively. ~~Devices conform to electrical specifications of either class A or class B.~~ The required characteristics of the electrical interconnect between two devices depend on the transmitter ~~package~~ class on one device and the receiver ~~package~~ class on the other device.

Package class
Comment #17

178.9.2.3 Transmitter difference ERL

The difference ERL, *dERL*, of the transmitter at TP0v is computed using the procedure in 163A.3.2.2 with the values in Table 178–8 and Table 178–14, with differential reference impedance equal to 92.5 Ω, and with the value of T_{fx} equal to twice the delay from TP0 to TP0v. The reference value, $ERL^{(ref)}$, is calculated based on the transmitter package class to which the PMD adheres.

Change to "using the device package model of the transmitter class to which the PMD adheres".
Make corresponding changes in 178.9.2.5 (dvf/dRpeak), 178.9.3.7 (Rx dERL), 176C.6.3.7 (Tx dERL), 176C.6.4.2 (Rx dERL).

Table 179–20—Partial host channel model parameters per Host class

Parameter	Host class			Units
	HL	HN	HH	
Package class — Device package model class	A	B	B	—
Package transmission line 1 length, $z_p^{(1)}$	8	15	45	mm
Partial host PCB transmission line length, $z_p^{(h)}$	22	83	74	mm

In 178 and 176C, change all remaining instances of "package class" to "class".
(total 28 instances, all with "transmitter", "receiver", "Tx", or "Rx", except in Table 179-20 above)

Modal ERL

Comments #46, #153 to #165, and #239

Modal ERL definition
Comments #153 and #154

- Comment #154 proposes to define the modal ERL calculation in Annex 178A
- mellitz_3dj_02_2605 was provided as a sample implementation
- The proposed implementation is essentially a copy of 93A.5 with variable substitutions for the modal ERL variants
- To avoid unnecessary duplication of content, instead reference 93A.5 and state the required variable substitutions (we do this regularly)

- Comment #153 proposes to add a definition of modal S-parameters to Annex 178A to support modal ERL definitions
- This is also covered mellitz_3dj_02_2605, but the proposed definition seems incomplete and out of place
- Also, Annex 178A pertains to channels and modal ERL is also proposed for transmitters and receivers

- With regard to the definition of mixed-mode S-parameters, we usually try to avoid including extensive tutorial material in the standard
- However, it seem prudent to provide at least some rudimentary definition of the parameters subject to specification
- The text in the following slides is proposed to be used to address comments #153 and #154.

Annex 176D
Add modal ERL definition

Insert new subclause in Annex 176D to define host and module modal effective return loss.

176D.8.x Modal effective return loss

Modal effective return loss (ERL_{CC}, ERL_{CD}, or ERL_{DC}) is the effective return loss computed according to 93A.5 with the following exceptions.

— For host output ERL_{CC}, $s_{ii}(f)$ (see 93A.5.1) is replaced with the host output $s_{CC22}(f)$.
— For host output ERL_{DC}, $s_{ii}(f)$ is replaced with the host output $s_{DC22}(f)$.
— For host input ERL_{CD}, $s_{ii}(f)$ is replaced with the host input $s_{CD11}(f)$.
— For module output ERL_{CC}, $s_{ii}(f)$ is replaced with the module output $s_{CC22}(f)$.
— For module output ERL_{DC}, $s_{ii}(f)$ is replaced with the module output $s_{DC22}(f)$.
— For module input ERL_{CD}, $s_{ii}(f)$ is replaced with the module input $s_{CD11}(f)$.

The values of $s_{CC22}(f)$, $s_{DC22}(f)$, and $s_{CD11}(f)$ are defined in 176D.8.y. Modal effective return loss is computed using the values in Table 176D-7 and Table 176D-8. T_{fx} is defined in 176D.8.3.

Annex 176D
Define reflection coefficients for transmitters and receivers

Insert new subclause in Annex 176D to define mixed-mode reflection coefficients.

176D.8.y Mixed-mode reflection coefficients

Mixed-mode reflection coefficients can be computed from 2-port S-parameter measurements at transmitter outputs or receiver inputs. The transmitter output ports are labeled 3 and 4 and the receiver input ports are labeled 1 and 2.

The differential reference impedance is 92.5 Ω and the common-mode reference impedance is 23.125 Ω. This corresponds to a single-ended reference impedance of 46.25 Ω. The reference impedance for measured S-parameters may be transformed to the required reference impedance using the procedure defined in 178A.1.3.

The transmitter output common-mode to common-mode reflection coefficient is defined by Equation (176D-X).

$$s_{CC22}(f) = (s_{33} + s_{34} + s_{43} + s_{44}) / 2 \qquad \text{Equation (176D-X)}$$

The transmitter output common-mode to differential-mode reflection coefficient is defined by Equation (176D-Y).

$$s_{DC22}(f) = (s_{33} + s_{34} - s_{43} - s_{34}) / 2 \qquad \text{Equation (176D-Y)}$$

The receiver input differential-mode to common-mode reflection coefficient is defined by Equation (176D-Z).

$$s_{CD11}(f) = (s_{11} - s_{12} + s_{21} - s_{22}) / 2 \qquad \text{Equation (176D-Z)}$$

Clause 179
Transmitter and receiver modal ERL similar to Annex 176D

Insert new subclauses in Clause 179 to define transmitter and receiver modal effective return loss.

179.9.4.x Transmitter modal effective return loss

Transmitter modal effective return loss (ERL_{CC} or ERL_{DC}) is the effective return loss computed according to 93A.5 with the following exceptions.

— For transmitter ERL_{CC}, $s_{ii}(f)$ (see 93A.5.1) is replaced with the transmitter $s_{CC22}(f)$.

— For transmitter ERL_{DC}, $s_{ii}(f)$ is replaced with the transmitter $s_{DC22}(f)$.

The values of $s_{CC22}(f)$ and $s_{DC22}(f)$ are defined in 176D.8.y. Modal effective return loss is computed using the values in Table 179-10 and Table 179-21. Tfx is defined in 179.9.4.8.

179.9.5.x Receiver modal effective return loss

Receiver modal effective return loss (ERL_{CD}) is the effective return loss computed according to 93A.5 with the exceptions that sii(f) (see 93A.5.1) is replaced with the receiver $s_{CD11}(f)$. The value of $s_{CD11}(f)$ is defined in 176D.8.y. Modal effective return loss is computed using the values in Table 179-10 and Table 179-21. T_{fx} is defined in 179.9.4.8.

Clause 179
Cable assembly modal ERL

Insert new subclause in Clause 179 to define cable assembly modal effective return loss.

179.11.x Cable assembly modal effective return loss

Cable assembly modal effective return loss (ERL_{CC} and ERL_{CD}) is the effective return loss computed according to 93A.5 with the following exceptions.

— For cable assembly input ERL_{CC}, $s_{ii}(f)$ (see 93A.5.1) is replaced with the channel $s_{CC11}(f)$.

— For cable assembly input ERL_{CD}, $s_{ii}(f)$ is replaced with the channel $s_{CD11}(f)$.

— For cable assembly output ERL_{CC}, $s_{ii}(f)$ is replaced with the channel $s_{CC22}(f)$.

— For cable assembly output ERL_{CD}, $s_{ii}(f)$ is replaced with the channel $s_{CD22}(f)$.

The values of $s_{CC11}(f)$, $s_{CD11}(f)$, $s_{CC22}(f)$, and $s_{CD22}(f)$ are defined 178A.1.3. Modal effective return loss is computed using the values in Table 179-17 and Table 179-21. The differential reference impedance is 92.5 Ω and the common-mode reference impedance is 23.125 Ω. T_{fx} is defined in 179.9.4.8.

178A.1.3
Amend to add mixed-mode S-parameter definition

178A.1.3 Measurement of the channel under test

The S-parameters for each signal path are measured between the test points specified by the clause or annex that utilizes this calculation. It is recommended that the ~~scattering~~ S-parameters be measured with a uniform frequency step from a start frequency no greater than 10 MHz to a stop frequency of at least 67 GHz. The measurement frequency step corresponds to the time span of the pulse response derived from the S-parameters (see 178A.1.6). The frequency step should be chosen to be small enough so that all significant components of the pulse response are included.

Figure 178A–2 illustrates 4-port single-ended S-parameters $S^{(s)}$ and the corresponding mixed-mode S-parameters $S^{(m)}$ at any given frequency. COM is computed using the differential-mode S-parameters which are taken from the upper-left quadrant of mixed-mode S-parameter matrix. Other mixed mode S-parameters may be used as the basis for other specifications.

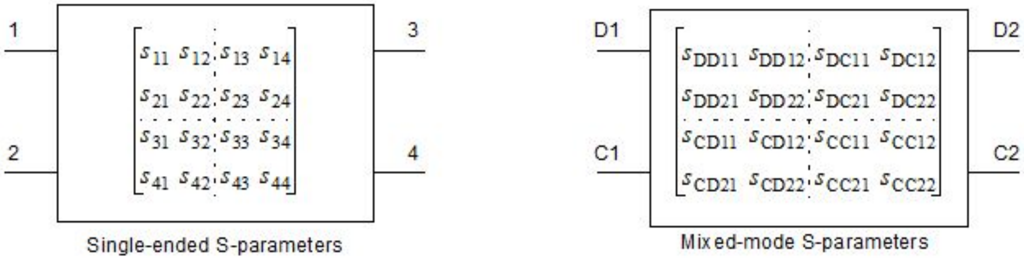


Figure 178A–2—Single-ended and mixed-mode S-parameters

178A.1.3
Amend to add mixed-mode S-parameter definition, continued

The reference impedance for the ~~differentialmode~~ single-ended S-parameters is required to be ~~twice~~ the single-ended reference resistance R_0 specified for the calculation of COM. Note that the differential reference impedance is $2R_0$ and the common-mode reference impedance is $R_0/2$. When the single-ended reference impedance for the measurement ~~R_m~~ R_x differs from R_0, the measured ~~differentialmode~~ single-ended S-parameters $S^{(mx)}$ are transformed using Equation (178A–4) where n is ~~2, Z_0 is $2R_0$, and Z_m is $2R_m$~~ the number of ports represented by $S^{(x)}$.

$$S^{(s)} = A^{-1}(S^{(x)} - \rho)(I - \rho S^{(x)})^{-1}A \qquad (178A–4)$$

where

A	is an $n \times n$ diagonal matrix with diagonal values $\sqrt{R_0/R_x}/(R_0 + R_x)$
I	is an $n \times n$ identity matrix
ρ	is an $n \times n$ diagonal matrix with diagonal values $(R_0 - R_x)/(R_0 + R_x)$

Single-ended S-parameters are then transformed to mixed-mode S-parameters using Equation (178A–5).

$$S^{(m)} = MS^{(s)}M^{-1} \qquad (178A–5)$$

where M is defined by Equation (178A–6).

$$M = \begin{bmatrix} 1 & 0 & -1 & 0 \\ 0 & 1 & 0 & -1 \\ 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 1 \end{bmatrix} \qquad (178A–6)$$

Clause 178 and Annex 176C
Channel modal ERL

Insert new subclause in Clause 178 to define channel modal effective return loss.

178.11.x Channel modal effective return loss

Channel modal effective return loss (ERL_{CD}) is the effective return loss computed according to 93A.5 with the following exceptions.

— For channel input ERL_{CD}, $s_{ii}(f)$ (see 93A.5.1) is replaced with the channel $s_{CD11}(f)$.

— For channel output ERL_{CD}, $s_{ii}(f)$ is replaced with the channel $s_{CD22}(f)$.

The values of $s_{CD11}(f)$ and $s_{CD22}(f)$ are defined 178A.1.3. Modal effective return loss is computed using the values in Table 178-15 and Table 178-16. The differential reference impedance is 92.5 Ω and the common-mode reference impedance is 23.125 Ω.

Annex 176C refers to Clause 178 for the existing differential-mode to common-mode return loss specifications. The same approach can be used for modal ERL specifications.

Annex 179B
Test fixture modal ERL

Insert new subclauses to define mated test fixtures modal effective return loss.

179B.4.x Mated test fixtures modal effective return loss

Mated test fixtures modal effective return loss (ERL_{CC}, ERL_{CD}) is the effective return loss computed according to 93A.5 with the following exceptions.

— For mated test fixtures input ERL_{CC}, $s_{ii}(f)$ (see 93A.5.1) is replaced with the mated test fixtures $s_{CC11}(f)$.

— For mated test fixtures input ERL_{DC}, $s_{ii}(f)$ is replaced with the mated test fixtures $s_{DC11}(f)$.

— For mated test fixtures output ERL_{CC}, $s_{ii}(f)$ is replaced with the mated test fixtures $s_{CC22}(f)$.

— For mated test fixtures output ERL_{DC}, $s_{ii}(f)$ is replaced with the mated test fixtures $s_{DC22}(f)$.

The values of $s_{CC11}(f)$, $s_{DC11}(f)$, $s_{CC22}(f)$, and $s_{DC22}(f)$ are defined 178A.1.3. Modal effective return loss is computed using the values in Table 179B-1 and Table 179-21. The differential reference impedance is 92.5 Ω and the common-mode reference impedance is 23.125 Ω. T_{fx} is defined in 179B.4.2.

Miscellanea

In Annex 176D, Clause 179, Annex 179B, and Clause 178, define *RLcc*, *RLdc*, and *RLcd* to be the negative of the values in dB of $s_{CC22}(f)$, $s_{DC22}(f)$, and $s_{CD11}(f)$ respectively

In Annex 178A.2, replace $H_{DD21}(f)$ and $H_{CD21}(f)$ with $s_{DD21}(f)$ and $s_{CD21}(f)$ respectively

These changes are expected to tie existing mixed-mode return loss and mode conversions specifications together with the new modal ERL requirements.

Modal ERL definitions
Comments #156, 46, 155, 157, 158, 239, 159, 160, 161, 162, 163, 164, 165]

- Comment #156 and related comments suggest adding modal ERL requirements in multiple places in the draft, based on the ad hoc contribution mellitz_3dj_adhoc_01a_260421.
- The contribution includes maximum values but does not specify all the parameters required for calculation of the modal ERL.
- The commenter indicated to the editors that the intent was to use **the same parameter values as in the existing ERL definition per case**, e.g., Table 179–10 (see below) for CR PMDs.
- We suggest adding the references to the appropriate tables in each modal ERL subclause, with editorial license.

Table 179–10—Transmitter and receiver ERL parameter values

Parameter	Symbol	Value	Units
Transition time associated with a pulse	T_r	0.005	ns
Incremental available signal loss factor	β_x	0	GHz
Permitted reflection from a transmission line external to the device under test	ρ_x	0.618	—
Length of the reflection signal	N	1600	UI
Equalizer length associated with reflection signal	N_{bx}	0	UI
Tukey window flag	tw	1	—
Number of samples per unit interval	M	32	—

Modal ERL
Comments #153 and #154

Editors' recommendation:
Resolve comments using slides 25 to 34 in this presentation with editorial license.