100GBASE-BR40:
Updates to Tables*

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Supporters

Overview

- This presentation includes updates to table entries from the following:
  - 3dk_jackson_2406_1.pdf
  - 3dk_takahara_2406_1.pdf *{Takahara's slide 6 => 0.4dB improved Rx sensitivity value proposed}*
- Update also includes additions from off-line comments received to reflect recent editorial notes adopted in *.dj project to enhance readability. *{Some accepted comments during P802.3dj "comment resolution" will be incorporated after editors have completed their wording.}*

Note: *This presentation is covering 100GBASE-BR40. 100GBASE-BR10/BR20 specification values are addressed in separate presentations.*

Table 999-4 Signal Detect value definition *(page 6244)*

Receive conditions	SIGNAL_DETECT value
Average optical power at TP3 ≤ TBD dBm -20 (Note)	FAIL
[(Optical power at TP3 average receive power (min) Table 999–7) AND (compliant 100GBASE-BRx signal input)]	OK
All other conditions	Unspecified

Justification
Value must be lower than Rx avg power at TP3. Some projects used -15 dBm, which are for shorter reaches (higher Rx power) & the desire to include SiPh technology where the squelch was initiated by an MZM modulator.

*Note: 3dk_takahara_2404_1a.pdf proposed **-15 dBm**.*

Table 999–6—100GBASE-BRx transmit characteristics *(Page 6246)*

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit
Signaling rate (range)	53.125 ± 100 ppm			GBd
Modulation format	PAM4			—
100GBASE-BRx-D center wavelengths (range)	1308.1 to 1310.1			nm
100GBASE-BRx-U center wavelengths (range)	1303.6 to 1305.6			nm
Side-mode suppression ratio (SMSR), (min)			30	dB
Average launch power (max)			8.1 ~~8.5~~	dBm
Average launch power[a] (min)			2.3 ~~2.7~~	dBm
Outer Optical Modulation Amplitude (OMA_{outer}) (max)			8.3 ~~8.7~~	dBm
Outer Optical Modulation Amplitude (OMA_{outer}) (min)[b]: for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB		3.9+TDECQ	5.3 ~~5.7~~ ~~4.3 + TDECQ~~	dBm dBm
Transmitter and dispersion eye closure for PAM4 (TDECQ) (max)			3.9	dB
TECQ (max)			3.9	dB
| TDECQ – TECQ | (max)			2.7	dB
Transmitter over/under -shoot (max)			22	%
Transmitter power excursion (max)		6.1	TBD ~~6.5~~	dBm
Average launch power of OFF transmitter (max)			-15	dBm
Extinction ratio (min)			5.0	dB

Recommend format shown at right (highlighted yellow)

BR 40 Justification
Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (DS)—May 2023 Motion
Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (US)—May 2023 Motion
Consistent with other IEEE standards
March 2024, Motion #5.
Assumes ER=∞. *{Suggestions this is unlikely in practice. Alternate value?}*
March 2024, Motion #5. 8.7 gives 0.5dB of margin relative to 4.3+TDECQ=+8.2dBm
Outer Optical Modulation Amplitude (OMA_{outer}), each lane (min) for max(TECQ, TDECQ) < 1.4 dB for 1.4 dB ≤ max(TECQ, TDECQ) ≤ TDECQ (max) — 5.3 3.9 + max(TECQ, TDECQ)
March 2024, Motion #5
March 2024, Motion #5
March 2024, Motion #5
Same as P802.3cu, 100Gb/s per wavelength.
April presentation (3dk_takahara_2404_1a.pdf). (2.2 dB less than OMA_max value)
Same as P802.3cu, 100Gb/s per wavelength & P802.3cp, 50Gb/s BiDi.
March 2024, Motion #5

Table 999–6—100GBASE-BRx transmit characteristics *(continued)*

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit
Transmitter transition time (max)			17	ps
$RIN_x OMA$ (max)[c]			-136	dB/Hz
Optical return loss tolerance (max)			15.6 15	dB
Transmitter reflectance[d] (max)			-26	dB

[a] Average launch power (min) is not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
[b] The OMA_{outer} (min) requirement holds even if the TDECQ < 1.4 dB. Even though the representation of the OMA_{outer} requirement is different from that in Clause 139, they are consistent.
[c] In $RIN_x OMA$, "*x*" is the optical return loss tolerance (max) for the PHY under test.
[d] Transmitter reflectance is defined looking into the transmitter.

BR40 Justification
Consistent with P802.3cu, 100Gb/s per wavelength.
Consistent with P802.3cu, 100Gb/s per wavelength.
15.6 adopted in March Motion #5. Should it be **15**? Consistent with 50GBASE-ER/BR40?
Consistent with P802.3cu, 100Gb/s per wavelength & P802.3cp, 50GBASE-BR40

Table 999–7—100GBASE-BRx receive characteristics *(page 6248)*

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit
Signaling rate (range)	53.125 ± 100 ppm			GBd
Modulation format	PAM4			—
100GBASE-BRx-D center wavelengths (range)	1303.6 to 1305.6			nm
100GBASE-BRx-U center wavelengths (range)	1308.1 to 1310.1			nm
Damage threshold[a]		-0.9	TBD ~~-0.5~~	dBm
Average receive power (max)		-1.9	TBD ~~-1.5~~	dBm
Average receive power[b] (min)		-15.7	~~-15.3~~	dBm
Receive power (OMA_{outer}) (max)		-1.7	TBD ~~-1.3~~	dBm
Receiver reflectance (max)			-26	dB
Receiver sensitivity (OMA_{outer})[c] for TECQ < 1.4 dB		-13.2	~~-12.8~~	dBm
for 1.4 dB ≤ TECQ ≤ 3.4 dB		-14.6+TECQ	~~-14.2 + TECQ~~	dBm
Stressed receiver sensitivity (OMA_{outer})[d] (max)		-10.7	TBD ~~-10.3~~	dBm
Conditions of stressed receiver sensitivity test:[e]				
Stressed eye closure for PAM4 (SECQ)			3.9	dB

*Accommodate 3.4 & 3.9 values Use **SECQ***

[a] The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.
[b] Average receive power (min) is not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
[c] Receiver sensitivity (OMA_{outer}) (max) is optional and is defined for a transmitter with a value of SECQ up to 3 dB for 100GBASE-BR10 and 3.2 dB for 100GBASE-BR20, and 100GBASE-BR40.
[d] Measured with conformance test signal at TP3 (see 999.7) for the BER specified in 999.1.1.
[e] These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

BR40 Justification	
Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (downstream)	
Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (upstream)	
+1 dB higher than max average receive power, e.g. P802.3cu/cn/cp standards (1)	
Avg Tx (max) plus 10 dB IL (min) => +8.1 dBm – 10 dB = **-1.9 dBm**	
Avg Tx (min) plus 18 dB IL (max) => 2.3 dBm – 18 dB = **-15.7dBm**	
Tx OMA (max) plus 10 dB IL (min) => 8.3 dBm – 10 dB = **-1.7dBm**	
Consistent with P802.3cu, 100Gb/s per wavelength & P802.3cp, 50GBASE-BR40	
March 2024, Motion #5	Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ SECQ
-14.2 dBm (intrinsic sensitivity) + TECQ (3.9) = **-10.7 dBm**	
SECQ = TECQ	

Table 999–8—100GBASE-BRx illustrative link power budgets
(page 6249)

Parameter	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit
Power budget (for maximum TDECQ)			22.4	dB
Operating distance		20	40	km
Channel insertion loss		10[a]	18[a]	dB
Maximum discrete reflectance *Footnote c* *Footnote d*			-35	dB
Allocation for penalties[b] (for maximum TDECQ)			4.4	dB

[a] The channel insertion loss is calculated using the maximum distance specified in Table 999–5 for 100GBASE-BR10, 100GBASE-BR20 and 100GBASE-BR40 and fiber attenuation of 0.4 dB/km plus an allocation for connection and splice loss given in 999.10.2.1.

[b] Link penalties are used for link budget calculations. They are not requirements and are not meant to be tested.

BR40 Justification
IL = 18dB, 3.9dB = TDECQ, 0.5dB => (MPI + DGD)
~~P802.3cp has -26dB (?) whereas P802.3cn cites table.* Propose P802.3cn approach.~~ Propose P802.3cu and *.dj approach => -35dB with footnote c citing the Table below and footnote d stating the row with 6 reflectances above -55dB.

Table 999-xx -Maximum value of each discrete reflectance

Number of discrete reflectances above –55 dB	Maximum value for each discrete reflectance		
	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40
1			–19 dB
2			–27 dB
4			–32 dB
6			–35 dB
8			–37 dB
10			–39 dB

(see other presentations)

Add footnote to illustrative link power budgets Table

[c] See 999.10.2.2 for details and specifications as a function of the number of discrete reflectances within the channel.
[d] Maximum value for each discrete reflectance with 6 discrete reflectances above –55 dB within the channel.

Recommend using Table 160-13 from P802.3cp and 50GBASE-ER (P802.3cn)

Table 999-11—Transmitter compliance channel specifications *(page 6252)*

PMD type	Dispersion[a] (ps/nm)		Insertion loss[b]	Optical return loss[c]	Max mean DGD
	Minimum	Maximum			
100GBASE-BR10	$0.23 \times \lambda \times [1 - (1324 / \lambda)^4]$	$0.23 \times \lambda \times [1 - (1300 / \lambda)^4]$	Minimum	15.6	5
100GBASE-BR20	$0.46 \times \lambda \times [1 - (1324 / \lambda)^4]$	$0.46 \times \lambda \times [1 - (1300 / \lambda)^4]$	Minimum	TBD	TBD
100GBASE-BR40	~~$0.92 \times \lambda \times [1 - (1324 / \lambda)^4]$~~	~~$0.92 \times \lambda \times [1 - (1300 / \lambda)^4]$~~	Minimum	15 dB	0.8 ps

[a] The dispersion is measured for the wavelength of the device under test (λ in nm). The coefficient assumes 10 km for 100GBASE-BR10, 20 km for 100GBASE-BR20, and 40 km for 100GBASE-BR40. The link may be as short as 2 m, and the minimum or maximum dispersion may be 0.

[b] There is no intent to stress the sensitivity of the O/E converter associated with the oscilloscope.

[c] The optical return loss is applied at TP2.

BR40 Justification
~~Update with latest from Statistical Dispersion in P802.3dj.~~ Optical Return Loss = Tx spec table. Max mean DGD = same as other specifications (this is Tx compliance spec, not fiber cable plant spec)

Table 999-12—Fiber optic cabling (channel) characteristics *(page 6259)*

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit
Operating distance (max)	10	20	40	km
Channel insertion loss[a, b] (max)	6.3	10	18	dB
Channel insertion loss (min)	0	0	10	dB
Positive dispersion[b] (max)	9.3		37	ps/nm
Negative dispersion[b] (min)	-19.4		-77	ps/nm
DGD_max[c]	5		TBD 4.9	ps
Optical return loss (min)	22		~~22~~ 19	dB

[a] These channel insertion loss values include cable, connectors, and splices.
[b] Over the wavelength range ~~1260 nm to 1340 nm for 100GBASE-BR10 and 1281 nm to 1322 nm for 100GBASE-BR20 and 100GBASE-BR40~~ 1303.6 nm to 1310.1 nm.
[c] Differential Group Delay (DGD) is the time difference at reception between the fractions of a pulse that were transmitted in the two principal states of polarization of an optical signal. DGD_max is the maximum differential group delay that the system is required to tolerate.

BR40 Justification
~~Update per progress in P802.3dj (?)~~
~~Update per progress in P802.3dj (?)~~
P802.3cp, BR40 has 10.3 psec. Leads to high penalty. Too conservative?
P802.3cn, 50GBASE-ER has 19 dB. P802.3cp, 50G BiDi has 21 dB. Propose using the same methodology as other standards---assuming a table for discrete reflections is used. The first-row entry is for a *single connection* with the indicated RL => **19 dB** (see slide 8 of this presentation)

Add Table and update Section 999.10.1 Optical fiber cable

999.10.1 Optical fiber cable

Are these references correct?

The optical fiber cable requirements are satisfied by cables containing ITU-T ~~G.652.B (dispersion unshifted), type~~ G.652.D (low water peak, dispersion unshifted), or type G.657.A1, or type G.657.A2 (bend insensitive) fibers, or the requirements in Table 182–11 where they differ.

Table 139–13—Optical fiber and cable characteristics

{from P802.3cn, 50GBASE-ER}

Description	Value	Unit
Nominal fiber specification wavelength	1310	nm
Cabled optical fiber attenuation (max)	0.43[a] or 0.5[b]	dB/km
Zero dispersion wavelength (λ_0)	$1300 \leq \lambda_0 \leq 1324$	nm
Dispersion slope (max) (S_0)	0.093	ps/nm^2 km

[a] The 0.43 dB/km at 1304.5 nm attenuation for optical fiber cables is derived from Appendix I of ITU-T G.695.

[b] The 0.5 dB/km attenuation is provided for Outside Plant cable as defined in ANSI/TIA 568-C.3. Using 0.5 dB/km may not support operation 10 km for 100GBASE-BR10, 20km for 100GBASE-BR20 or 40km for 100GBASE-BR40.

Thanks!