

100GBASE-BR20 Baseline Proposal

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July 14, 2024

IEEE Plenary Meeting

Supporters

Overview

- Proposal for 100GBASE-BR20 baseline specifications
- Recall following motions:
 - Adopted 0 to 10 dB to be the BR20 insertion loss range (March, 2024, Motion #3)
 - Base the BR20 receiver parameters on an APD-based receiver (March 2024, Motion #4)
- Prior standards allow (encourage) interoperability between different reach PMDs
 - If we assume the BR20 Rx parameters are *exactly* the same as BR40, then there is no “operational overlap” between allowed insertion loss values

Table 999–14

Direction	Min loss	Max loss	Unit
100GBASE-BR20 transmitter to 100GBASE-BR40 receiver	2	10	dB
100GBASE-BR40 transmitter to 100GBASE-BR20 receiver	10	18	dB

- One sol’n is to make the BR20 Rx sensitivity higher (worse) than the BR40 and simultaneously increasing the Tx launch parameters so that the same BR20 optical power budget (with IL = 10dB) is accommodated.
 - However, the Rx overload/damage for the APD-based Rx must be increased--can APD Rx tolerate these higher power levels?
 - One option is to change the Min/Max IL from 0 to 10 dB to 2 to 10dB. This 8 dB range would be the same as the BR40 PMD. The min IL of 2dB would “protect” the Rx from overload/damage.

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Direction	Min loss	Max loss	Unit
100GBASE-BR20 transmitter to 100GBASE-BR40 receiver	2	10	dB
100GBASE-BR40 transmitter to 100GBASE-BR20 receiver	10	18	dB

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 - However, the Rx overload/damage for the APD-based Rx must be increased--can APD Rx tolerate these higher power levels?
 - One option is to change the Min/Max IL from 0 to 10 dB to 2 to 10dB. This 8 dB range would be the same as the BR40 PMD. The min IL of 2dB would “protect” the Rx from overload/damage.

And 1dB worse Rx sensitivity

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

Receive conditions	SIGNAL_DETECT value
Average optical power at TP3 \leq TBD dBm -20	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.

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	30	30	dB
Average launch power (max)	4.8	1.1	8.1	dBm
Average launch power ^a (min)	-1.9	-4.7	2.3	dBm
Outer Optical Modulation Amplitude (OMA _{outer}) (max)	5	1.3	8.3	dBm
Outer Optical Modulation Amplitude (min) ^b : for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB	1.1 -0.3 + TDECQ	-1.7 -3.1 + TDECQ	5.3 3.9 + TDECQ	dBm dBm
Transmitter and dispersion eye closure for PAM4 (TDECQ) (max)	3.4	3.9	3.9	dB
TECQ (max)	3.4	3.9	3.9	dB
TDECQ – TECQ (max)	2.5	2.5	2.7	dB
Transmitter over/under -shoot (max)	22	22	22	%
Transmitter power excursion (max)	2.8	-0.9	6.5	dBm
Average launch power of OFF transmitter (max)	-20 -20	-18	-15	dBm
Extinction ratio (min)	3.5	5.0	5.0	dB

Accommodate 3.4 & 3.9 values Use TDECQ (max)?

BR 20 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

Assumes ER=∞. {Suggestions this is unlikely in practice. Alternate value?}

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)	-1.7 -3.1 + max(TECQ, TDECQ)
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Same as P802.3cu, 100Gb/s per wavelength.

With 2dB min IL the Pavg (OFF) = -18dB gives -20dBm at TP3 (or lower)

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

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

BR20 Justification
Consistent with P802.3cu, 100Gb/s per wavelength.
Consistent with P802.3cu, 100Gb/s per wavelength.
P802.3cp, 50GBASE-BR20 uses 15 dB.
Consistent with P802.3cu, 100Gb/s per wavelength & P802.3cp, 50GBASE-BR40

^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_xOMA, “x” is the optical return loss tolerance (max) for the PHY under test.

^d Transmitter reflectance is defined looking into the transmitter.

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	5.8	0.1	-0.9	dBm
Average receive power (max)	4.8	-0.9	-1.9	dBm
Average receive power ^b (min)	-8.2	-14.7	-15.7	dBm
Receive power (OMA _{outer}) (max)	5	-3.3	-1.7	dBm
Receiver reflectance (max)	-26	-26	-26	dB
Receiver sensitivity (OMA _{outer}) ^c for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ 3.4 dB	-6.1 -7.5 + TECQ	-12.2 -13.6 + TECQ	-13.2 -14.6 + TECQ	dBm dBm
Stressed receiver sensitivity (OMA _{outer}) ^d (max)	-4.1	-9.7	-10.7	dBm
Conditions of stressed receiver sensitivity test: ^e				
Stressed eye closure for PAM4 (SECQ)	3.4	3.9	3.9	dB

Accommodate 3.4 & 3.9 values

BR20 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
	Avg Tx (max) plus 2 dB IL (min) => +1.1 dBm – 2 dB = -0.9 dBm
	Avg Tx (min) plus 10 dB IL (max) => -4.7 dBm – 10 dB = -14.7 dBm
	Tx OMA (max) plus 2 dB IL (min) => 1.3 dBm – 2 dB = -3.3 dBm
	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
	-13.6 dBm (intrinsic sensitivity) + TECQ (3.9) = -9.7 dBm
	SECQ = TECQ

^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.

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

Parameter	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit	BR20 Justification
Power budget (for maximum TDECQ)	10.6	14.4	22.4	dB	IL = 10dB, 3.9dB = TDECQ, 0.5dB => (MPI + DGD)
Operating distance	10	20	40	km	
Channel insertion loss	6.3 ^a	10 ^a	18 ^a	dB	
Maximum discrete reflectance	-35	-35	-35	dB	Same approach as the BR10 and BR40.
Allocation for penalties ^b (for maximum TDECQ)	4.3	4.4	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.

Add footnote to illustrative link power budgets Table

*** Table 139–14—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	-22 dB	-22 dB	-19 dB
2	-29 dB	-29 dB	-27 dB
4	-33 dB	-33 dB	-32 dB
6	-35 dB	-35 dB	-35 dB
8	-37 dB	-37 dB	-37 dB
10	-39 dB	-39 dB	-39 dB

^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 this table in the *.dk draft*

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	0.8 ps
100GBASE-BR20	$0.46 \times \lambda \times [1 - (1324 / \lambda)^4]$	$0.46 \times \lambda \times [1 - (1300 / \lambda)^4]$	Minimum	15 dB	0.8 ps
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

BR20 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)

^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.

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

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit	BR20 Justification
Operating distance (max)	10	20	40	km	
Channel insertion loss ^{a, b} (max)	6.3	10	18	dB	
Channel insertion loss (min)	0	2	10	dB	
Positive dispersion ^b (max)	TBD/3.3	TBD	37	ps/nm	Update per progress in P802.3dj (?)
Negative dispersion ^b (min)	TBD/-12.1	TBD	-77	ps/nm	Update per progress in P802.3dj (?)
DGD_max ^c	5	4.9	4.9	ps	Use the same as BR40. {Could recalculate if desired).
Optical return loss (min)	22	22	19	dB	Propose using the same methodology as other standards---assuming a table for discrete reflections is used. The first-row entry is for a <i>single connection</i> with the indicated RL => 22 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.

Add Table and update Section 999.10.1 Optical fiber cable

999.10.1 Optical fiber cable

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.

Are these references correct?



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.

Channel insertion loss req'ts for interoperation between 100GBASE-BR10/B20/BR40 *(page 6261)*

Table 999–14

Direction	Min loss	Max loss	Unit
100GBASE-BR20 transmitter to 100GBASE-BR40 receiver	3	11	dB
100GBASE-BR40 transmitter to 100GBASE-BR20 receiver	9	17	dB

NOTE: 2 dB overlap between BR20 & BR40 IL budgets.

Direction	Min loss	Max loss	Unit
100GBASE-BR10 transmitter to 100GBASE-BR20 receiver	6.7	12.4	dB
100GBASE-BR20 transmitter to 100GBASE-BR10 receiver	0	3.9	dB

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NOTE: No overlap between BR20 & BR10 IL budgets.

Thanks!