100GBASE-BR20 Baseline Proposal

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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.

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)
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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.

And 1dB worse Rx sensitivity

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

Receive conditions	**SIGNAL_DETECT value**
Average optical power at TP3 ≤ 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	BR 20 Justification
Signaling rate (range)	53.125 ± 100 ppm			GBd	
Modulation format	PAM4			—	
100GBASE-BRx-D center wavelengths (range)	1308.1 to 1310.1			nm	Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (DS)—May 2023 Motion
100GBASE-BRx-U center wavelengths (range)	1303.6 to 1305.6			nm	Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (US)—May 2023 Motion
Side-mode suppression ratio (SMSR), (min)	30	30	30	dB	Consistent with other IEEE standards
Average launch power (max)	4.8	1.1	8.1	dBm	
Average launch power[a] (min)	–1.9	-4.7	2.3	dBm	Assumes ER=∞. *{Suggestions this is unlikely in practice. Alternate value?}*
Outer Optical Modulation Amplitude (OMA_{outer}) (max)	5	1.3	8.3	dBm	
Outer Optical Modulation Ampli[tude] (min)[b]: for TDECQ < 1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB *Accommodate 3.4 & 3.9 values Use TDECQ (max)?*	1.1 –0.3 + TDECQ	-1.7 -3.1+TDECQ	5.3 3.9+TDECQ	dBm dBm	Outer Optical Modulation Amplitude (OMA_{outer}), each lane (min) for max(TECQ, TDECQ) < 1.4dB: -1.7 for 1.4dB ≤ max(TECQ, TDECQ) ≤ TDECQ (max): -3.1 + max(TECQ, TDECQ)
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	%	Same as P802.3cu, 100Gb/s per wavelength.
Transmitter power excursion (max)	2.8	-0.9	6.5	dBm	
Average launch power of OFF transmitter (max)	~~–15~~ -20	-18	-15	dBm	With 2dB min IL the Pavg (OFF) = -18dB gives -20dBm at TP3 (or lower)
Extinction ratio (min)	3.5	5.0	5.0	dB	

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

Description	100GBASE-BR10	100GBASE-BR20	100GBASE-BR40	Unit	BR20 Justification
Transmitter transition time (max)	17	17	17	ps	Consistent with P802.3cu, 100Gb/s per wavelength.
RIN_xOMA (max)[c]	-136	-136	-136	dB/Hz	Consistent with P802.3cu, 100Gb/s per wavelength.
Optical return loss tolerance (max)	15.6	15	15	dB	P802.3cp, 50GBASE-BR20 uses 15 dB.
Transmitter reflectance[d] (max)	-26	-26	-26	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	BR20 Justification
Signaling rate (range)	53.125 ± 100 ppm			GBd	
Modulation format	PAM4			—	
100GBASE-BRx-D center wavelengths (range)	1303.6 to 1305.6			nm	Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (downstream)
100GBASE-BRx-U center wavelengths (range)	1308.1 to 1310.1			nm	Align with ITU-T G9608 Am 3, 100G BiDi wavelength plan (upstream)
Damage threshold[a]	5.8	0.1	-0.9	dBm	+1 dB higher than max average receive power, e.g. P802.3cu/cn/cp standards
Average receive power (max)	4.8	-0.9	-1.9	dBm	Avg Tx (max) plus 2 dB IL (min) => +1.1 dBm – 2 dB = **-0.9 dBm**
Average receive power[b] (min)	–8.2	-14.7	-15.7	dBm	Avg Tx (min) plus 10 dB IL (max) => -4.7 dBm – 10 dB = **-14.7 dBm**
Receive power (OMA_{outer}) (max)	5	-0.7	-1.7	dBm	Tx OMA (max) plus 2 dB IL (min) => 1.3 dBm – 2 dB = **-0.7 dBm**
Receiver reflectance (max)	-26	-26	-26	dB	Consistent with P802.3cu, 100Gb/s per wavelength & P802.3cp, 50GBASE-BR40
Receiver sensitivity (OMA_{outer})[c] for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ 3.4 dB *Accommodate 3.4 & 3.9 values*	 –6.1 –7.5 + TECQ	 -12.2 -13.6+TECQ	 -13.2 -14.6+TECQ	 dBm dBm	March 2024, Motion #5: Receiver sensitivity (OMA_{outer}), each lane (max) for TECQ < 1.4 dB for 1.4 dB ≤ TECQ ≤ SECQ
Stressed receiver sensitivity (OMA_{outer})[d] (max)	–4.1	-9.7	-10.7	dBm	-13.6 dBm (intrinsic sensitivity) + TECQ (3.9) = **-9.7 dBm**
Conditions of stressed receiver sensitivity test:[e]					
Stressed eye closure for PAM4 (SECQ)	3.4	3.9	3.9	dB	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 Footnote c Footnote d	–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

[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.

* **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

*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

[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.

BR20 Justification
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	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	
Negative dispersion[b] (min)	TBD/-12.1	TBD	-77	ps/nm	
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 *single connection* 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

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)	$1300 \le \lambda_0 \le 1324$	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

??

NOTE: No overlap between BR20 & BR10 IL budgets.

Thanks!