



# 100GBASE-BR40 Specification Proposal with Transceiver Module Test Data

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# Supporters



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- Fabio Bottoni, Cisco
- Jeffery Maki, Juniper Networks
- Carlo Mariotti, Cisco
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- Ray Nering, Cisco

# 100GBASE-BR40 Spec. Considerations

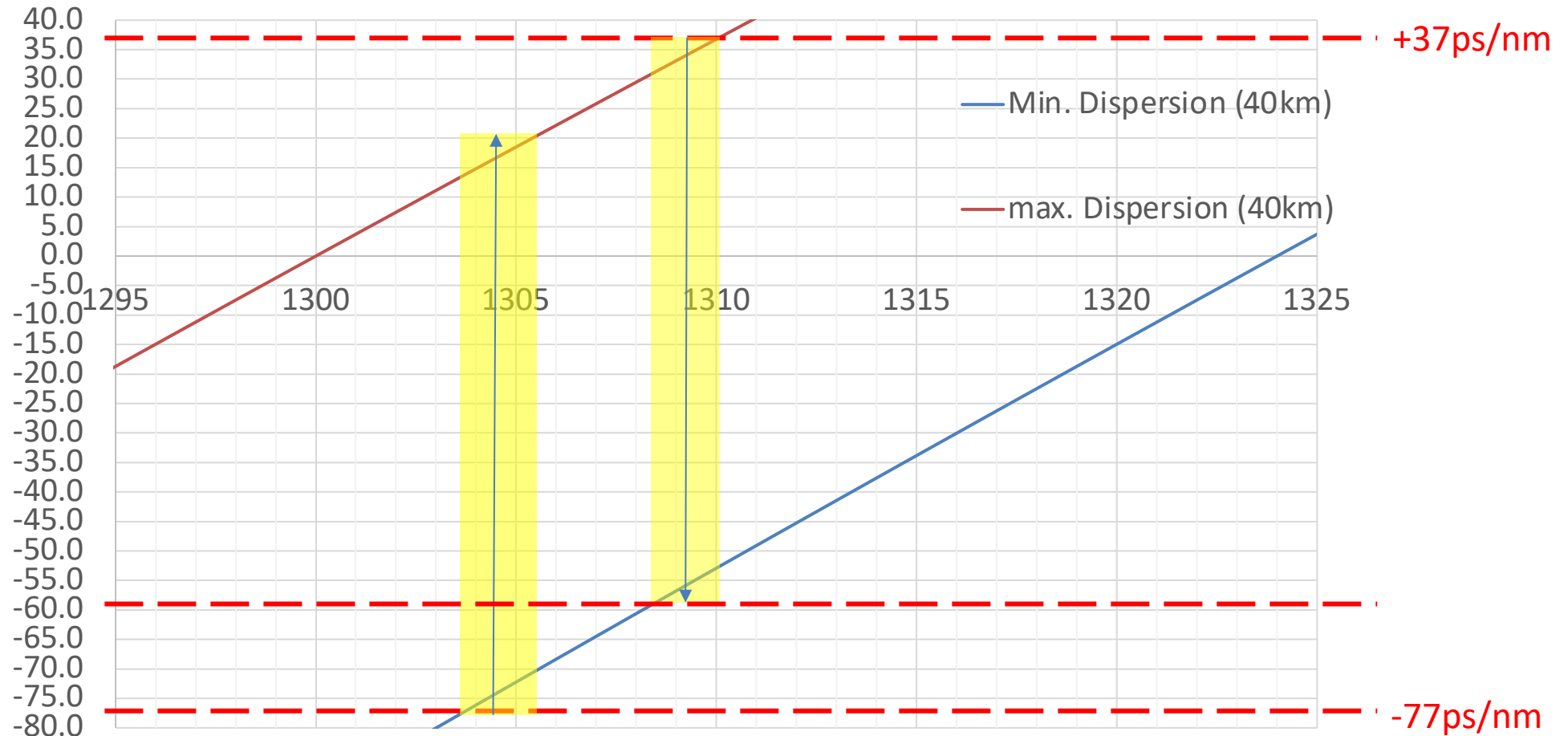


- Propose 100GBASE-BR40 spec. leveraging on 100G-ER1-40 by 100G Lambda MSA
  - 100G-ER1-40 supports 40km reach, with most up to date spec. released by 100G Lambda MSA in 2021 <https://100glambda.com/specifications/send/2-specifications/11-100g-lr1-20-er1-30-er1-40-technical-specs-rev-1p1>
  - 100G Lambda MSA supported by more than 45 industry leaders from key component suppliers, system OEMs, and operators.
  - Strong incentive to leverage on 100G-PAM4 eco system developed for high volume data center applications, especially PAM4 DSP technologies
  - 100G-ER1-40 products had been released by multiple suppliers and in deployment
- Questions need to be addressed:
  - Up/Down Wavelengths plan within dispersion tolerance range
  - Tx and Rx specification meeting link budget with additional BiDi WDM filter loss



# Proposed Up and Down Stream Wavelengths Plan

- 100G-ER1-40 wavelength set at 1309.1+/-1nm
- Propose 100G-BR40 re-use 1309.1+/-1nm as down stream, and adding 1304.6+/-1nm as up stream wavelength
  - Negative Dispersion limit updated to -77ps/nm from -59.6ps/nm



# Proposed Tx Spec



Description	100G-ER1-40 from 100G Lambda MSA	100GBASE-BR40-D	100GBASE-BR40-U	Unit
PAM4 Signaling rate (range)	53.125+/-100 ppm	53.125+/-100 ppm	53.125+/-100 ppm	Gbd
Wavelength range	1308.1-1310.1	1308.1-1310.1	1303.6-1305.6	nm
SMSR	30	30	30	dB
Average launch power (max)	7.1	7.1	7.1	dbm
Average launch power (max)	1.7	1.7	1.7	dbm
Outer OMA (max)	7.9	7.9	7.9	dbm
Outer OMA (min) for TDECQ < 1.4dB For 1.4dB<=TDECQ<= TECQ (max)	4.7 3.3+TDECQ	4.7 3.3+TDECQ	4.7 3.3+TDECQ	dbm dbm
TDECQ (max)	3.9	3.9	3.9	dB
TECQ (max)	3.9	3.9	3.9	dB
I TDECQ-TECQ I max	2.7	2.7	2.7	dB
Tx Overshoot/undershoot	22	22	22	%
Tx Power excursion (max)	5.4	5.4	5.4	dbm
ER (min)	5	5	5	dB
Tx Transient Time (max)	17	17	17	ps
Ave. Launch Power of off Tx (max)	-15	-15	-15	dbm
RIN, OMA (max)	-136	-136	-136	dB/Hz
Optical return loss tolerance	15	15	15	dB
Tx Reflectance (max)	-26	-26	-26	dB

<https://100glambda.com/specifications/send/2-specifications/11-100g-lr1-20-er1-30-er1-40-technical-specs-rev-1p1>

# Proposed Rx Spec



Description	100G-ER1-40 from 100G Lambda MSA	100GBASE-BR40-D	100GBASE-BR40-U	Unit
PAM4 Signaling rate (range)	53.125+/-100 ppm	53.125+/-100 ppm	53.125+/-100 ppm	Gbd
Wavelength range	1304.5-1317.5	1303.6-1305.6	1308.14-1310.14	nm
Damaging Threshold	-2.4	-2.4	-2.4	dbm
Average receive power (max)	-3.4	-3.4	-3.4	dbm
Average receive rpwoer (min)	-16	-16	-16	dbm
Receive Power (OMAouter) (max)	-2.6	-2.6	-2.6	dbm
Receiver reflectance (max)	-26	-26	-26	dB
Receiver sensitivity (OMAouter) (max) For TECQ < 1.4dB For 1.4<=TECQ<=3.9dB	13.8 -15.2+TECQ	-13.8 -15.2+TECQ	-13.8 -15.2+TECQ	dbm dbm
Stress ed receiver sensitivity (OMAouter)	-11.3	-11.3	-11.3	dbm
Conditions of stressed receiver sensitivity test				
Stressed eye closure for PAM4 (SECQ)	3.9	3.9	3.9	dB

<https://100glambda.com/specifications/send/2-specifications/11-100g-lr1-20-er1-30-er1-40-technical-specs-rev-1p1>

# Proposed Illustrative Power Budget



Description	50GBASE-BR40	100G-ER1-40 from 100G Lambda MSA	Proposed 100GBASE-BR40-D/U	Unit
Power Budget (for Max TDECQ)	21.7	22.4	22.4	dB
Operating Distance	40	40	40	km
Channel Insertion Loss	18	18	18	dB
Channel Insertion Loss (min)		10.5	10.5	dB
Maximum Discrete reflectance	-26	-35	-35	dB
Allocation for penalties (for max. TDECQ)	3.7	4.4	4.4	dB
Additional insertion loss allowed		0	0	dB

<https://100glambda.com/specifications/send/2-specifications/11-100g-lr1-20-er1-30-er1-40-technical-specs-rev-1p1>

# Transceiver Test Data To Support Proposed Spec.



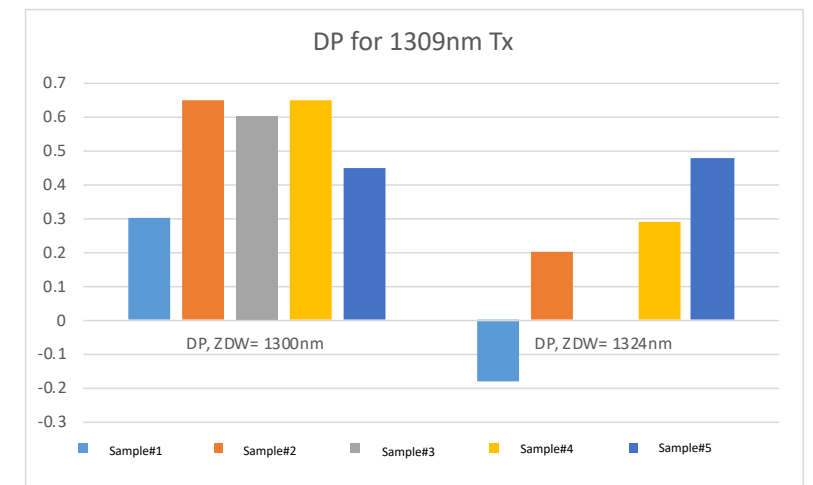
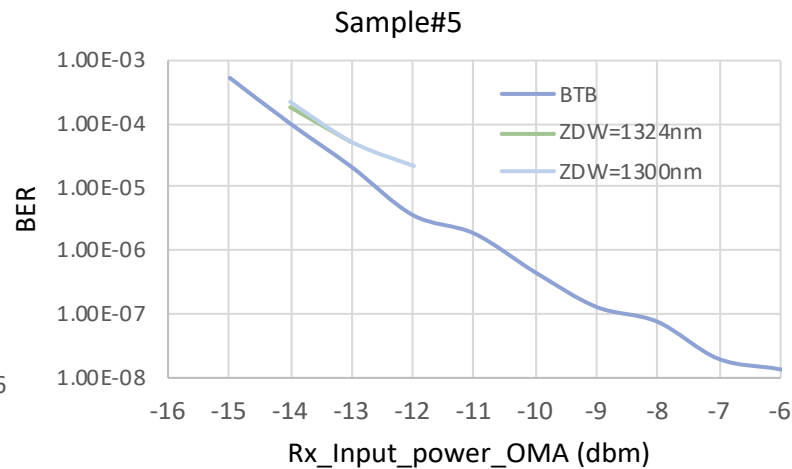
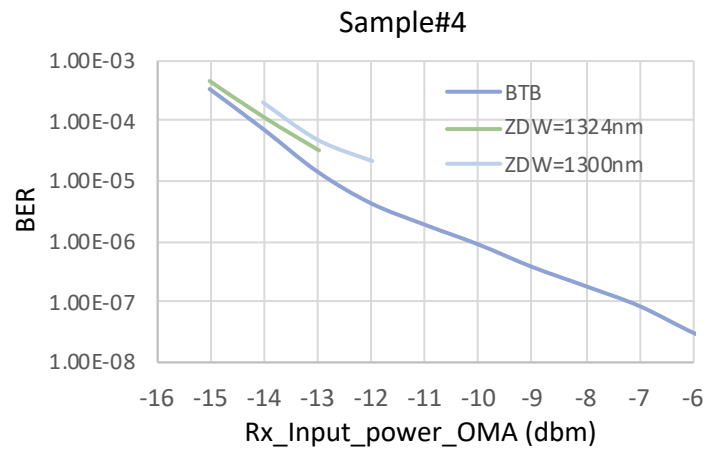
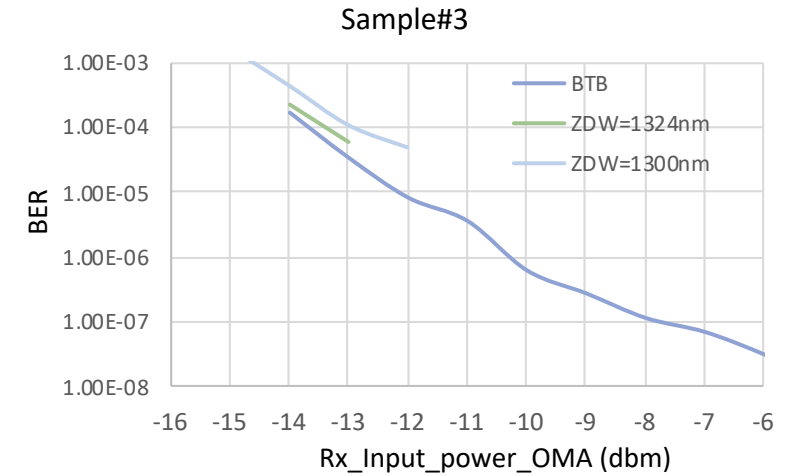
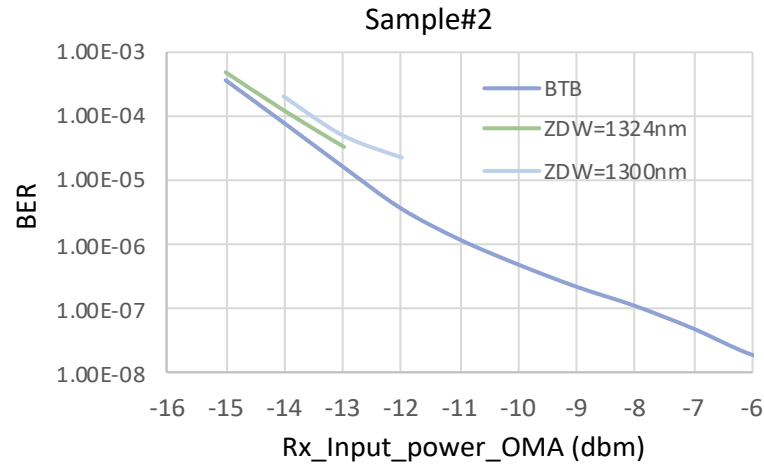
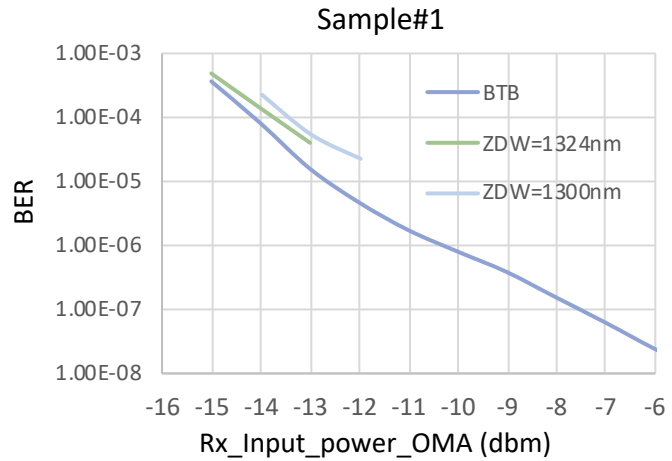
- Transceiver module samples are built with
  - Tx: EMLs with wavelengths at 1304 and 1309nm
  - Rx: Ge/Si APD receiver
  - DSP: commercial off the shelf PAM4 DSP
  - BiDi filters: thin-film filter technology
- Samples were tested over -40 to 85C



# Dispersion Tolerance Limit Test: 1309nm Tx



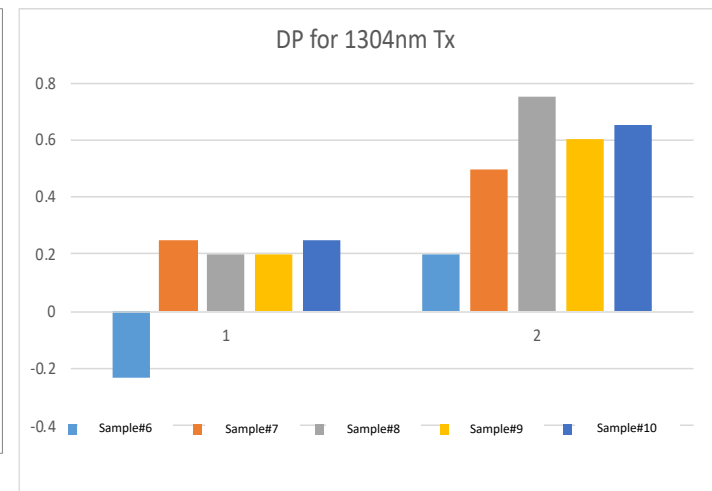
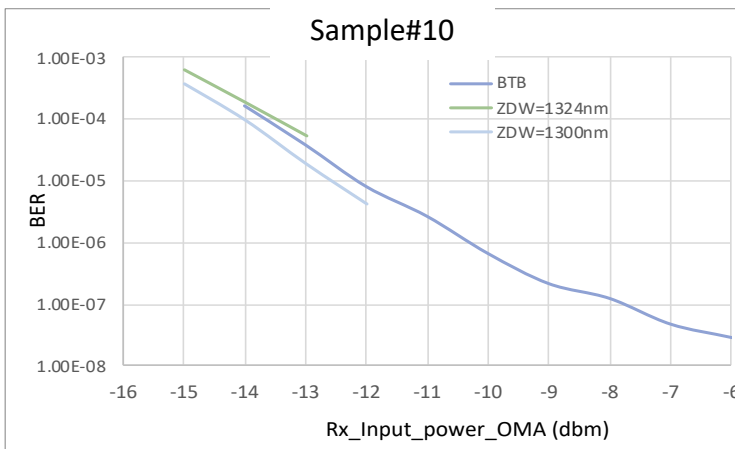
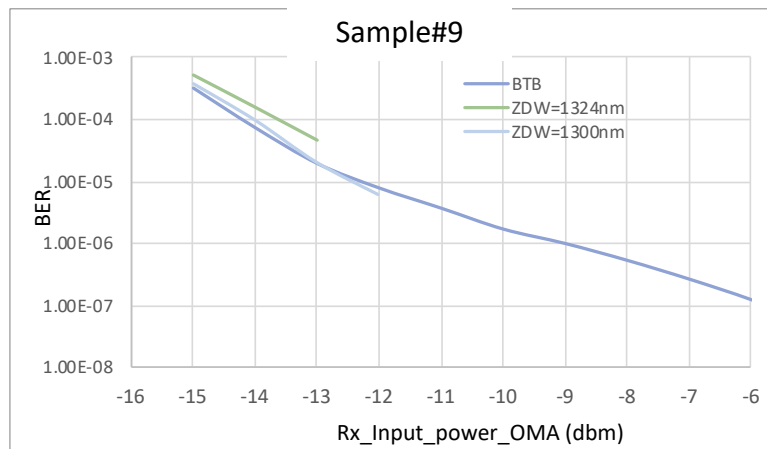
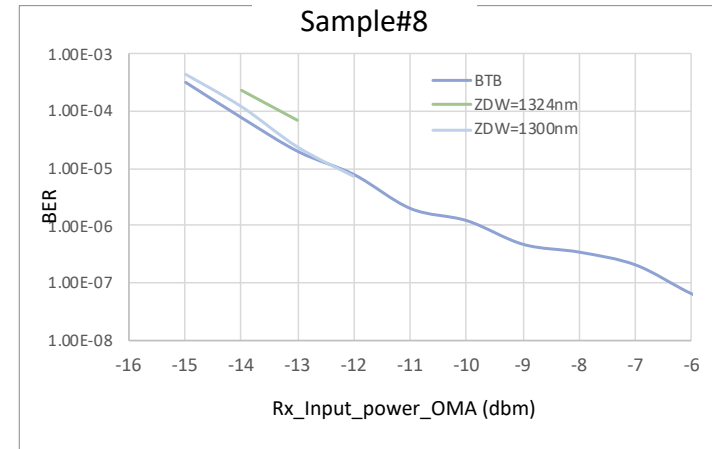
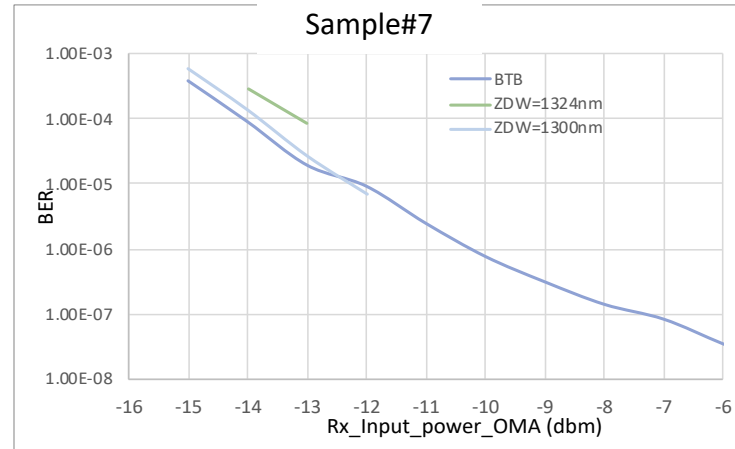
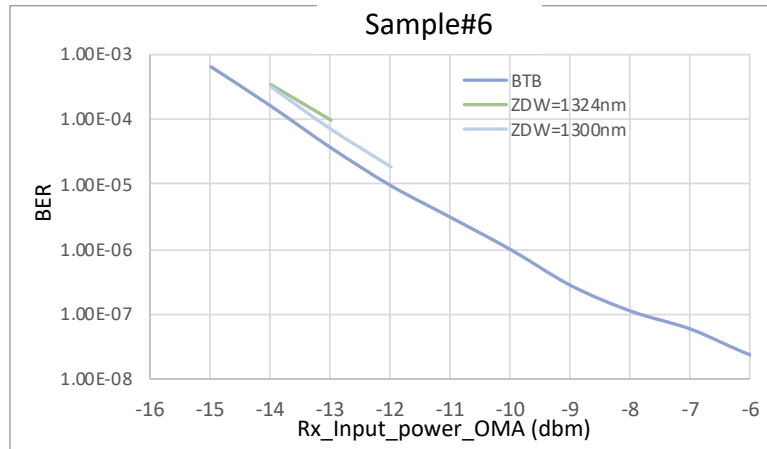
- 1309nm Transmitter, over 40km of ZDW=1324, and ZDW=1300nm SMF
- Higher dispersion penalty observed with ZDW=1300nm, up to < 0.7dB



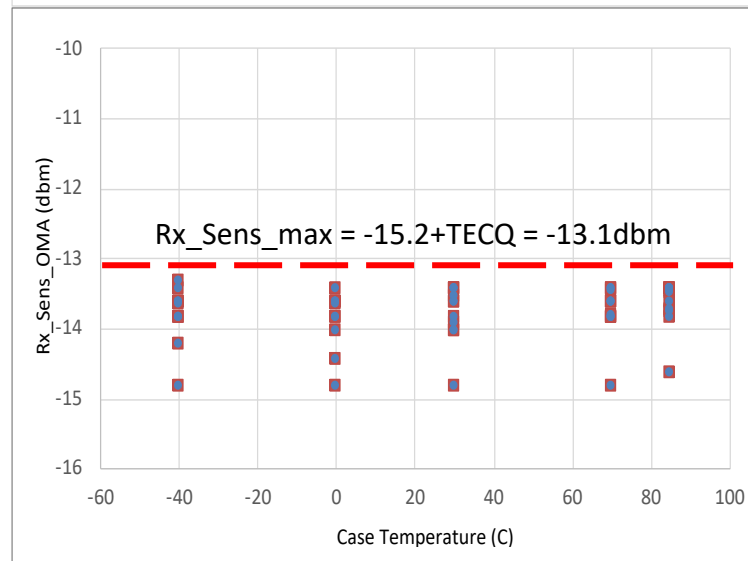
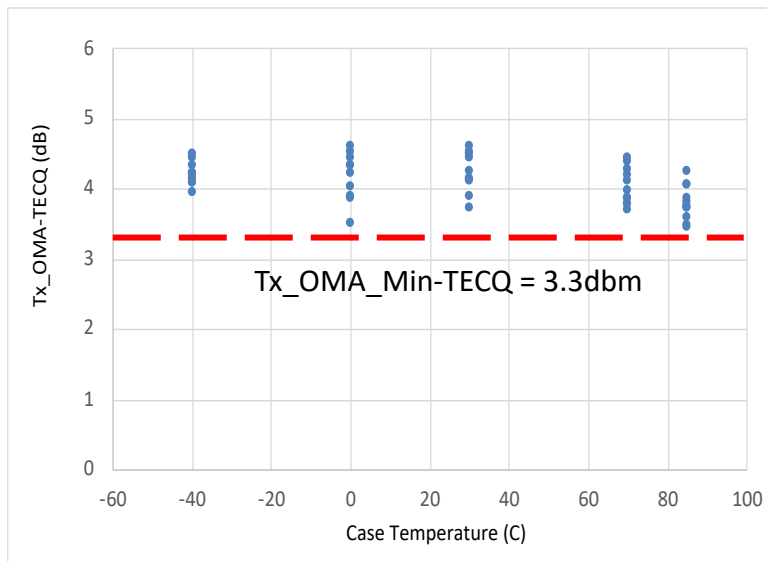
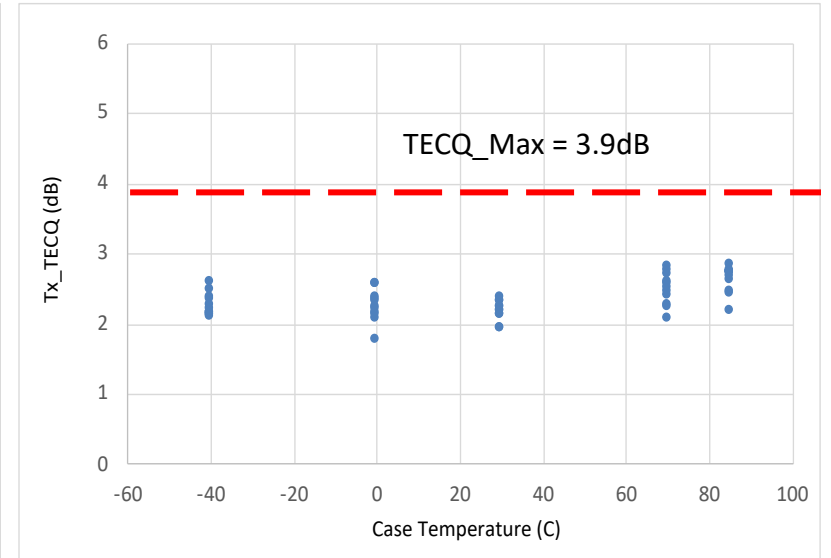
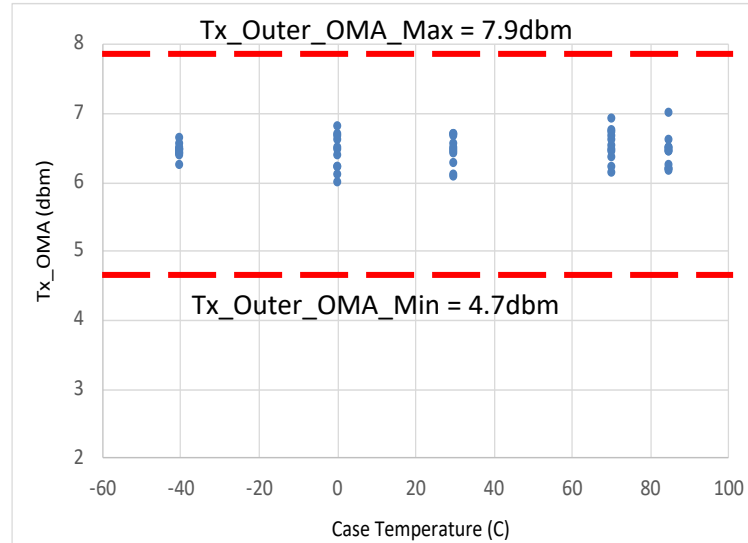
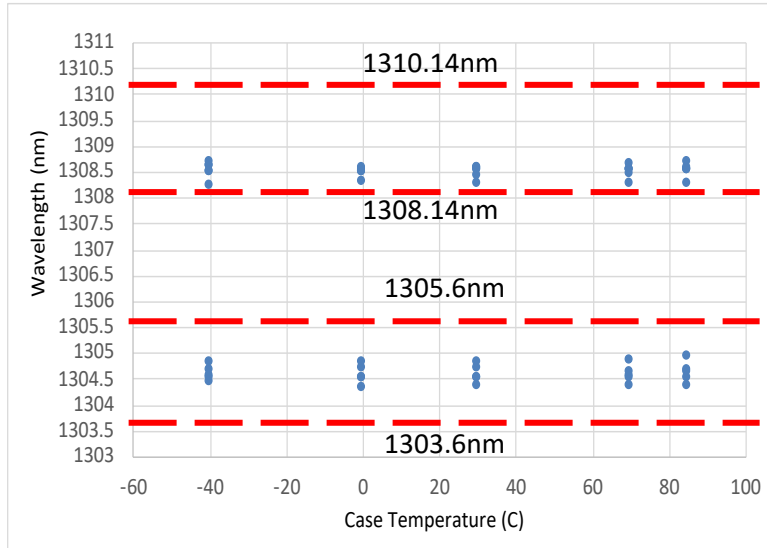


# Dispersion Tolerance Limit Test: 1304nm Tx

- 1304nm Transmitter, over 40km of ZDW=1324, and ZDW=1300nm SMF
- Higher dispersion penalty observed with ZDW=1324nm, up to < 0.8dB



# Transceiver Level Key Spec. Test Characterization





# Summary

- It is proposed for 100GBASE-BR40 spec. matching 100G lambda MSA 100G-ER1-40 specification
  - Wavelengths plan proposed
    - Up-stream 1304.6+/-1nm
    - Down-stream 1309.1+/-1nm
  - Tx\_OMA\_min:
    - 4.7 dbm with TDECQ<1.4dB;
    - 3.3+TDECQ dbm with TDECQ>=1.4dB
  - Rx\_Sens\_max:
    - -13.8 dbm with TECQ<1.4dB
    - -15.2+TECQ dbm with TECQ>=1.4dB
- Transceiver module samples test data presented supporting feasibility of proposed spec.



# Thank You!

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# Proposed Fiber Optic Cable (Channel) Characteristics



Description	100G-ER1-40 from 100G Lambda MSA	100GBASE-BR40-D	100GBASE-BR40-U	Unit
Operating Distance (max)	40	40	40	Km
Channel Insertion Loss (max)	18	18	18	dB
Channel Insertion Loss (min)	10.5	10.5	10.5	dB
Positive Dispersion (Max)	+37.1	+37.1	+20.5	ps/nm
Negative Dispersion (Min)	-59.6	-59.6	-77	ps/nm
DGD_max	4.9	4.9	4.9	ps
Optical return loss (min)	19	19	19	dB

<https://100glambda.com/specifications/send/2-specifications/11-100g-lr1-20-er1-30-er1-40-technical-specs-rev-1p1>

# Proposed Transmitter Compliance Channel



Type	Dispersion		Insertion Loss	Optical Return Loss	Max mean DGD
	Minimum	Maximum			
100GBase-BR40	$0.92 \cdot I \cdot [\lambda - (1324/\lambda)^4]$	$0.92 \cdot I \cdot [\lambda - (1324/\lambda)^4]$	Minimum	15dB	0.8ps