100GBASE-SR4: TxVEC Update Comment i-35

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Presentation Summary

•At the May 2014 meeting there was a recommendation to explore inclusion of a bandwidth filter in the VEC measurement to emulate the bandwidth effects of the fiber. Attributes affected by such a filter, here 12.6 GHz when combined with the 19.3 GHz reference receiver bandwidth, include the TxVEC sampling point and max acceptable value. The max acceptable VEC measurement result is normalized with link margin to enable a trade-off with min OMA.

•After the May 2014 meeting the assumptions on which link model analyses were based were reviewed. One assumption, the sensitivity of the reference receiver (Ref Rx) based on the input noise of the expected 19.3 GHz optical plug-in, was found to be unrealistically optimistic. An RMS dark input noise of 4.5 μW was assumed; 17 μW is now expected for the 19.3 GHz plug-in and 9 μW is expected for the 12.6 GHz plug-in.

•Information regarding transmitter vertical eye closure sampling point and max acceptable value is presented.

•A normalized TxVEC attribute is developed with a max acceptable value of 5 dB where TxVEC margin has a one-to-one correlation with link model margin enabling a one-to-one tradeoff with min Tx OMA.

•An update to Comment i-35 follows.

Update to Comment i-35

- In Table 95-6, replace “Transmitter and dispersion penalty (TDP), each lane (max)” with “Transmitter vertical eye closure (TxVEC), each lane (max)” leaving the value entry unchanged at 5.
- In 95.8.5.2, change, “Four vertical histograms are measured through the eye diagram, centered at 0.4 UI and 0.6 UI” to “Four vertical histograms are measured through the eye diagram, centered at 0.38 UI and 0.62 UI”.
- In 95.8.5.2, change “TxVEC is defined as the largest of the four quantities” to “VEC(max) is defined as the largest of the four quantities”
- In 95.8.5.2, Eq 95-1, change TxVEC(A) to VEC(A), Eq 95-2, change TxVEC(B) to VEC(B), Eq 95-3, change TxVEC(C) to VEC(C) and Eq 95-4, change TxVEC(D) to VEC(D).
- In 95.8.5.2 insert the equation to normalize VEC(max) with link margin,

  TxVEC = 0.723 x (VEC(max) – 1.13 dB)

100G SR4 Example Link Model Attributes & Ref Rx BW

Parameter	Unit	Worst case	RefRx BW case
Signal rate	GBd	25.78125	
Q (BER)		3.8905 (5.0E-5)	
Center Wavelength	nm	840 (860)	
Spectral Width	nm	0.60 (0.05)	
OMA at max TxVEC	dBm	-3.0	
Extinction ratio	dB	3.0	
Tx output transition times, 20% -80%	ps	21	
TP3 DCD tolerance	UI	0.05	
$RIN_{12}OMA$	dB/Hz	-128	
RIN coefficient		0.7	
MPN coefficient		0.3	
Modal Noise Penalty	dB	0.129	
Reach, OM4	m	100	2
Fiber Attenuation	dB/km	3.5	
Dispersion min Uo	nm	1316	
Dispersion So	ps/nm^2km	0.10275	
Fiber modal bandwidth	MHz·km	4400	
Connector & splice loss allocation	dB	1.5	
Channel output transition times, 10% - 80%	ps	41.3 (37.8)	41.3 (37.8)
Ref Rx BW	GHz	19.336	12.551 (16.197)

•Attributes and values in the table are provided to document the determination of the reference receiver, RefRx, bandwidth where the effects of the fiber are included in the RefRx BW.
•Two columns of values are shown in the above table. Where the value is not changed the cells are merged.

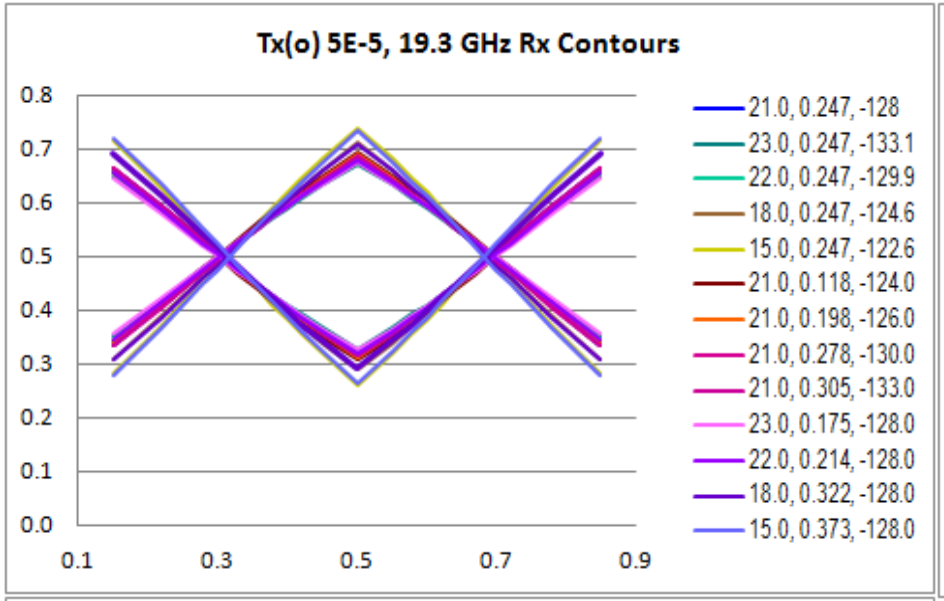
•The fiber reach was changed from 100 m to 2 m and the Ref Rx BW was then adjusted to yield the same channel output transition time as found for the 100 m case.
•Where the effects of chromatic dispersion and modal bandwidth are included the RefRx BW is reduced to 12.551 GHz.
•Where only the effects of modal bandwidth are considered RefRx BW is reduced to 16.197 GHz.

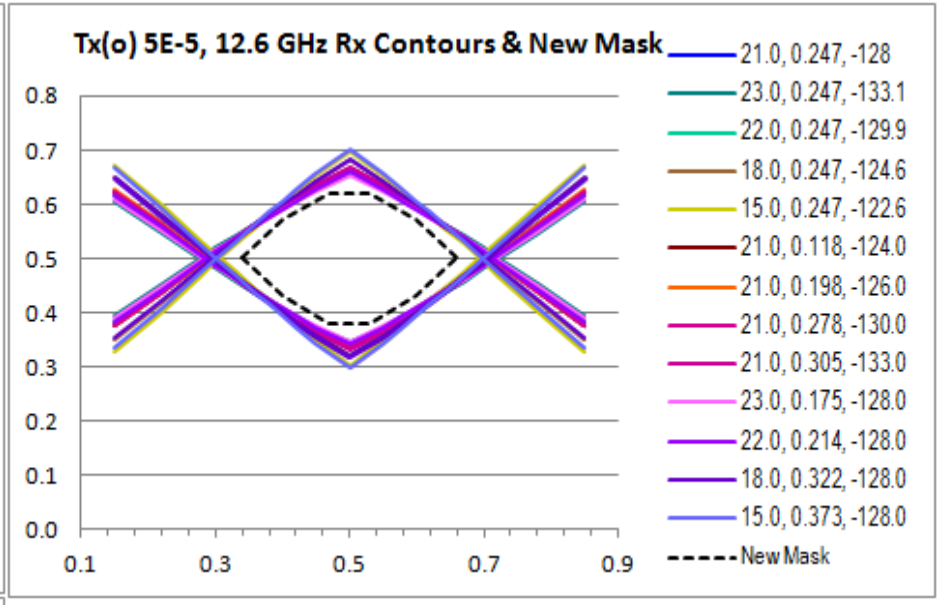
100G SR4 Example Link Model Attributes & Margin for Ideal Tx

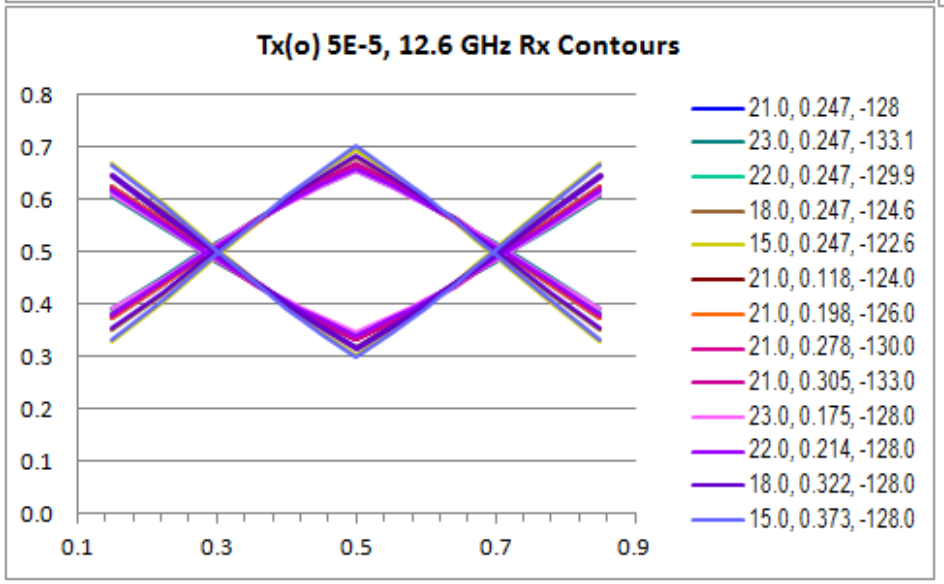
Parameter	Unit	Worst case	Ideal Tx case
Signal rate	GBd	25.78125	
Q (BER)		3.8905 (5.0E-5)	
Center Wavelength	nm	840	
Spectral Width	nm	0.60	
OMA at max TxVEC	dBm	-3.0	
Extinction ratio, min	dB	3.0	
Tx output transition times, 20% -80%	ps	21	1
TP1 RJrms	UI	0.0079	0.00
TP1 DJ	UI	0.11	0.00
TP3 DJ	UI	0.247	0.00
TP3 DCD tolerance	UI	0.05	0.00
RIN12OMA	dB/Hz	-128	
RIN coefficient		0.7	0.0
MPN coefficient		0.3	
Modal Noise Penalty	dB	0.129	
Reach	m	100	
Fiber Attenuation	dB/km	3.5	
Dispersion min Uo	nm	1316	
Dispersion So	ps/nm^{2}km	0.10275	
Fiber modal bandwidth	MHz·km	4400	
Connector & splice loss allocation	dB	1.5	
Link Margin with Worst Case Rx	dB	0.00	5.04

- Attributes and values in the above table are provided to document the range of link margin associated with attributes captured in a TxVEC test.for a worst case transmitter and an ideal transmitter.
- Two columns of values are shown in the above table. Where the value is not changed the cells are merged.

Observed Tx 5E-5 Contours: Ref Rx Sensitivity & BW

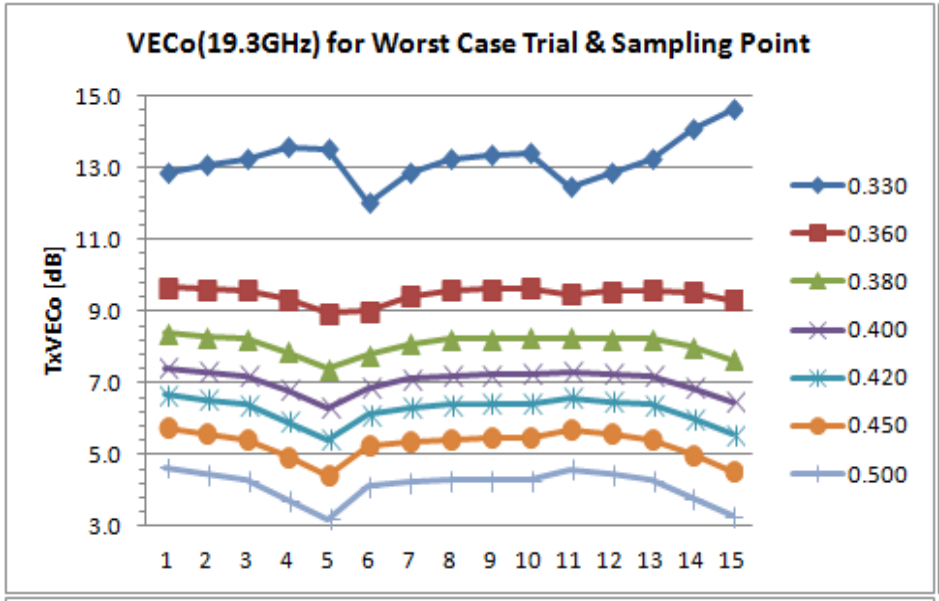


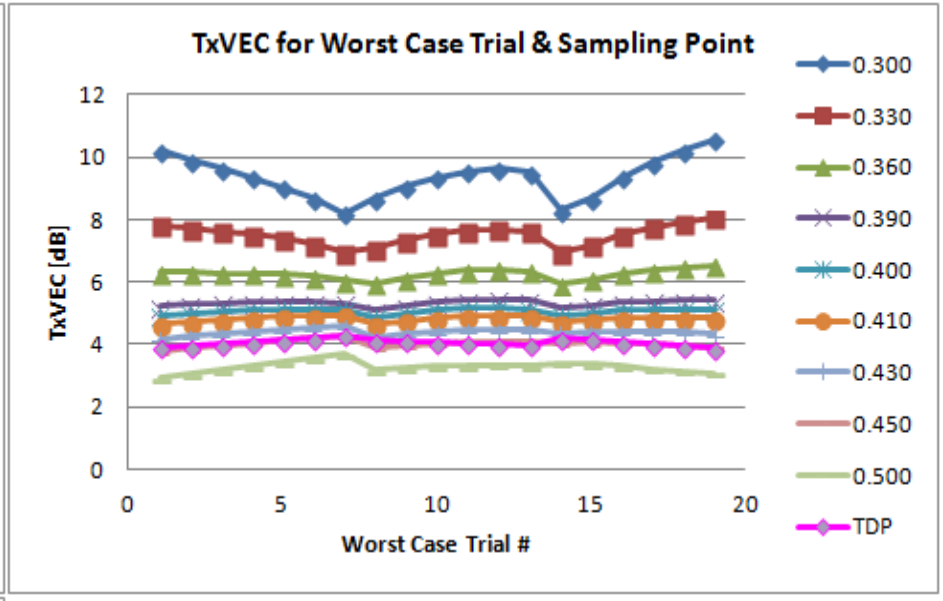


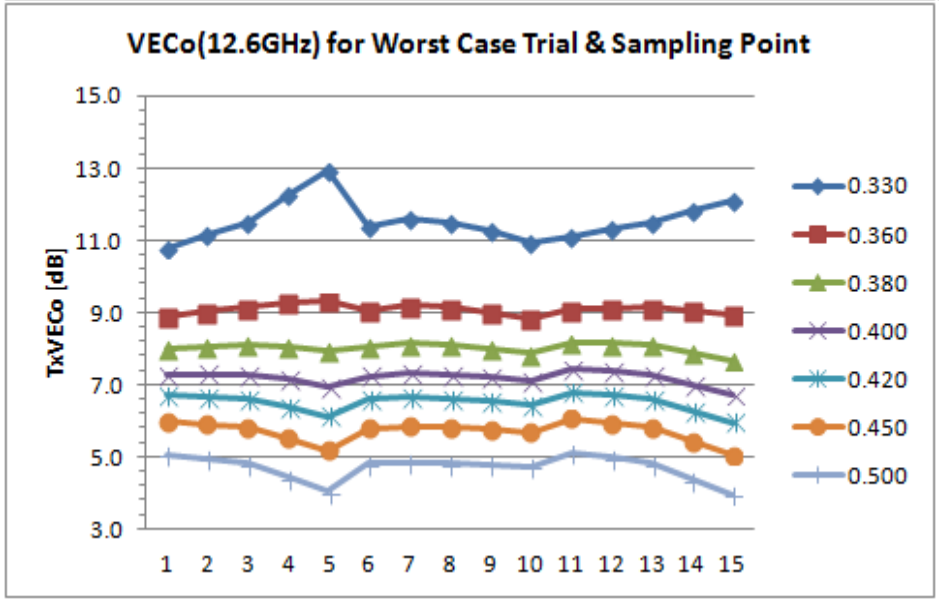


- The upper left chart shows expected observed Tx TP2 5E-5 contours for a set of worst case transmitters based on a scope with an expected dark RMS input noise of 17 uW for a 19.3 GHz optical plug-in.
- The lower left chart shows expected observed Tx TP2 5E-5 contours for the set of worst case transmitters based on a scope with an expected dark RMS input noise of 9 uW for a 12.6 GHz optical plug-in.
- The reduced input scope noise for the 12.6 GHz optical plug-in relative to that of the 19.3 GHz provides a reasonable eye opening for eye closure measurements even after the lower bandwidth receiver is used as shown in the upper right chart.

Observed VEC: Ref Rx Sensitivity & BW

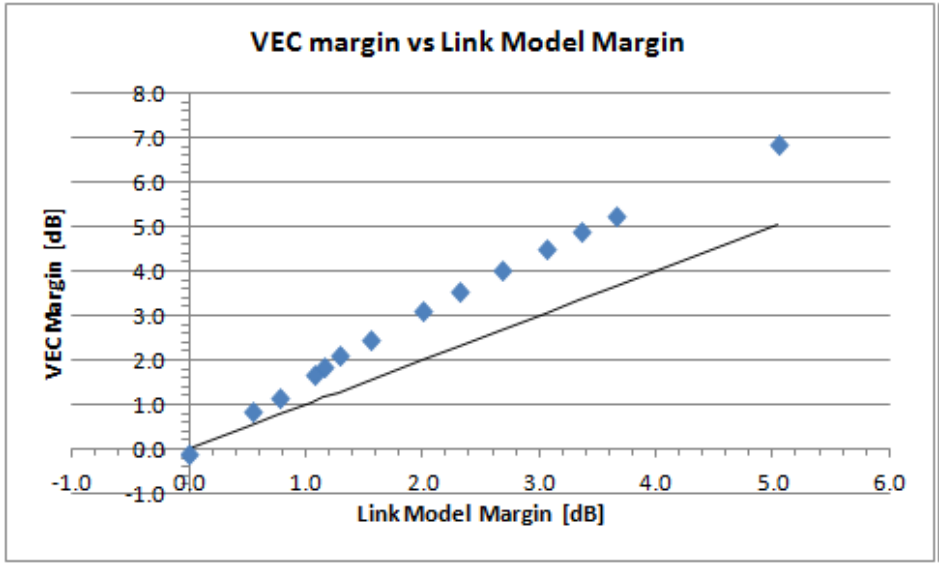


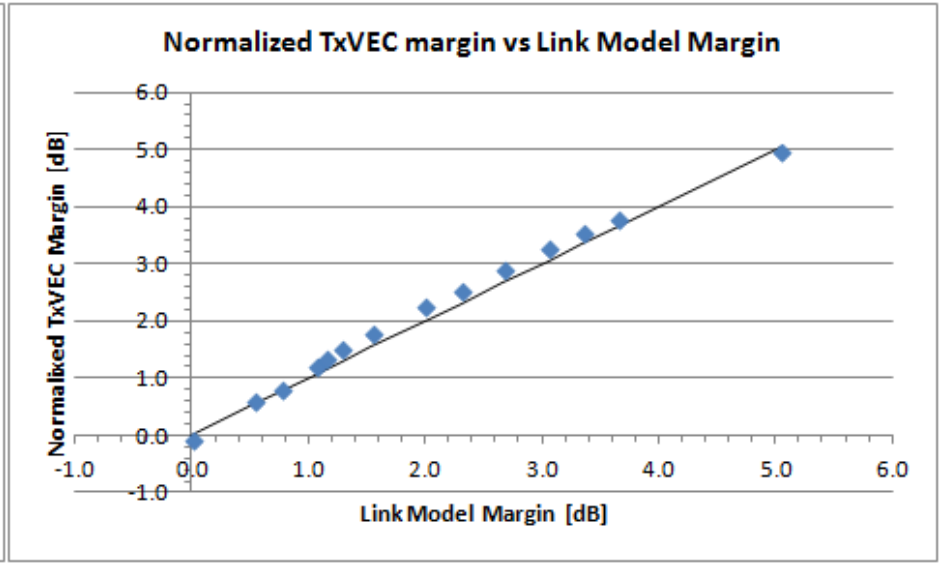




- The upper-left chart shows expected observed vertical eye closure, VECo, for various sampling points from a set of worst case transmitters based on a scope with an expected dark RMS input noise of 17 uW for a 19.3 GHz optical plug-in.
- The lower-left chart shows expected observed vertical eye closure, VECo, for various sampling points from a set of worst case transmitters based on a scope with an expected dark RMS input noise of 9 uW for a 12.6 GHz optical plug-in. Here the lowest variation is seen at the 0.38 UI sampling point. For this sampling point a max VECo(12.6GHz) of 8.0 dB appears appropriate.
- The upper-right chart shows for reference the expectations at the time of the March 2014 meeting

Normalized TxVEC & Margin Correlation





•The upper left chart shows expected VECo margin for a set of transmitters with positive model link margin ranging from worst case to ideal when observed with a 12.6 GHz Ref Rx. Here margin = VECo(12.6GHz)(max) – TxVEC(measurement) where VECo(12.6GHz) = 8.0 dB

•Link model margin for this set is found to vary from 0 dB to 5.04 dB corresponding to VECo results from 8.1 dB to 1.13 dB respectively and VECo margin from -0.1 dB to 6.87 dB.

•Normalized TxVEC margin is derived as follows:

Normalized TxVEC margin = (TxVEC margin) / (Tx VEC margin range / Link margin range)

= (TxVEC margin) / (8.1 – 1.13 / 5.04 – 0)

= 0.723 x (TxVEC margin)

TxVEC results can be normalized to link margin as follows:

Normalized TxVEC = 0.723 x (TxVEC result – 1.13 dB)

The normalized TxVEC results are shown in the upper right chart.