

100G SR4 TxVEC Review

Comment r01-43

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Presentation Summary

Link model analysis results from various combinations of worst and best case Tx attributes are shown to provide background for determination of the max TxVEC limit.

Simulations results show that while instrumentation noise can affect the observed eye, TxVEC results appear unaffected.

A variety of Tx eyes (as observed after a 12.6 GHz LPF with 9 uW additive noise) and associated TxVEC results are shown.

BER plots are shown for a TxVEC = 4.56 dB Tx and a TxVEC = 5.30 dB Tx, a 110 m, 5023 MHzkm EBW OM4 fiber and several receivers.

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The value, 5, entered for max TxVEC may not be correct for the method defined 95.8.5 and its subclauses and should be verified. One check was to use a link model and replace the worst case Rx with an Ref Rx with the same sensitivity and then replace the worst case Tx with an idealized Tx. The difference in link penalties and margin varies from 4.9 dB to 5.0 depending on inclusion/deletion of Pmn.

Suggested Remedy

Review the value entered in Table 95-6 for max TxVEC and the factors 0.0257 and 0.01 in the equation for M and adjust as appropriate. For details see petrilla_01_0914_optx

Consideration of Max and Min TxVEC Results

	WC	B Rx	B Tx F	BC	Max 1 TxVEC	Min TxVEC	Max 2 TxVEC
Reach	100	100	2	2	2	2	2
Uc	840	840	860	860	840	840	840
Uw	0.60	0.60	0.05	0.05	0.60	0.60	0.60
tt	21	21	1	1	21	1	21
kRIN	0.70	0.70	0	0	0.70	0	0.70
kMPN	0.30	0.30	0	0	0	0	0
Pmn	0.129	0.129	0	0	0	0	0.129
TP1 RJ (BER)	0.053	0.053	0	0	0.053	0	0.053
TP1 DJ	0.110	0.110	0	0	0.110	0	0.110
DCD	0.05	0.05	0	0	0.05	0	0.05
TP3 DJ	0.247	0.247	0	0	0.247	0	0.247
Rx DJ	0.05	0	0.05	0	0	0	0
TP4 TJ	0.780	0.780	0.780	0.780	0.780	0.780	0.780
BLW	0.025	0	0.025	0	0	0	0
RxBW	18.05	19.34	18.05	19.34	12.60	12.60	12.60
Signal Budget	8.20	8.20	8.20	8.20	8.20	8.20	8.20
IL	1.86	1.86	1.51	1.51	1.51	1.51	1.51
LP Pen	6.34	5.34	0.21	0.10	4.86	0.75	5.17
Margin	0.00	1.00	6.48	6.59	1.83	5.94	1.52

- The table shows link penalty, LP Pen, and link margin, Margin, for combinations of attributes relevant in the determination of the max acceptable TxVEC value.

- A worst case, WC, is shown as a base line.

- A best case, B Rx, shows the approximate Rx penalties (1.00 dB).

- A best case, B Tx F, shows the approximate Tx and fiber penalties and insertion loss (6.48 dB).

- The combined best cases, BC, shows that penalties and insertion losses can be reduced by 6.59 dB. Note the combined penalty reduction is less than the sum of the individual cases.

- Penalties included in the max TxVEC cases can amount to 4.86 dB to 5.17 dB depending on the inclusion of Pmn in the TxVEC calculation. Inclusion to Pmpn (not shown) can add another 0.1 dB to 0.2 dB to the Tx VEC calculation. **The max value for TxVEC should be 4.9 dB to 5.3 dB depending on the inclusion of Pmn & Pmpn.**

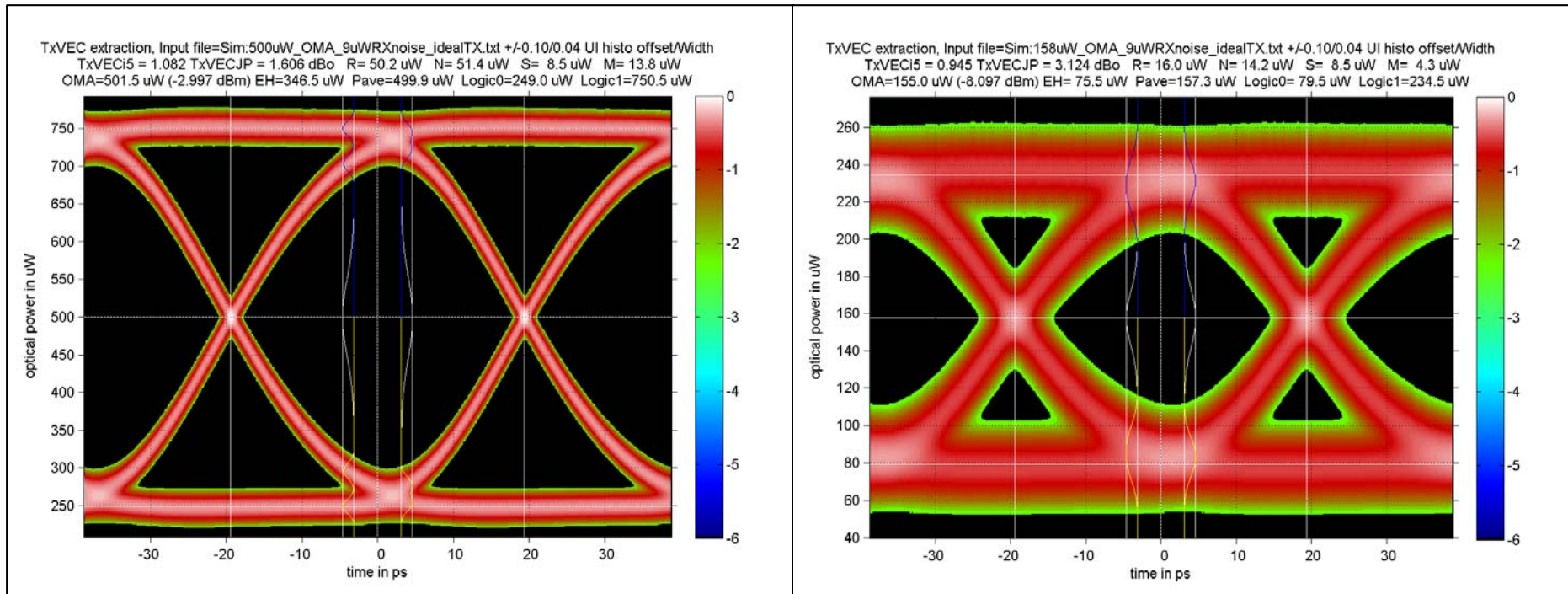
- The min expected value for TxVEC is expected to be 0.8 to 1.1 dB depending on the inclusion of Pmn and Pmpn.

Comparison of Fiber & Filter in TxVEC results

	WC										
Reach	100	100	2	100	2	100	2	100	2	100	2
Uc	840	840	840	840	840	840	840	840	840	840	840
Uw	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60	0.60
tt	21	21	21	1	1	21	21	21	21	1	1
kRIN	0.70	0.70	0.70	0.70	0.70	0	0	0.70	0.70	0	0
kMPN	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Pmn	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129	0.129
TP1 RJ (BER)	0.053	0.053	0.053	0.053	0.053	0.053	0.053	0	0	0	0
TP1 DJ	0.110	0.110	0.110	0.110	0.110	0.110	0.110	0	0	0	0
DCD	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0	0	0	0
TP3 DJ	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0	0	0	0
Rx DJ	0.05	0	0	0	0	0	0	0	0	0	0
TP4 TJ	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780	0.780
BLW	0.025	0	0	0	0	0	0	0	0	0	0
RxBW	18.05	19.34	12.6	19.34	12.6	19.34	12.6	19.34	12.6	19.34	12.6
Signal Budget	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20	8.20
IL	1.86	1.86	151	1.86	151	1.86	151	1.86	151	1.86	151
LP Pen	6.34	5.34	5.17	2.32	2.18	4.68	4.55	3.54	3.42	0.98	0.88
Margin	0.00	1.00	1.52	4.02	4.51	1.66	2.14	2.8	3.27	5.35	5.81

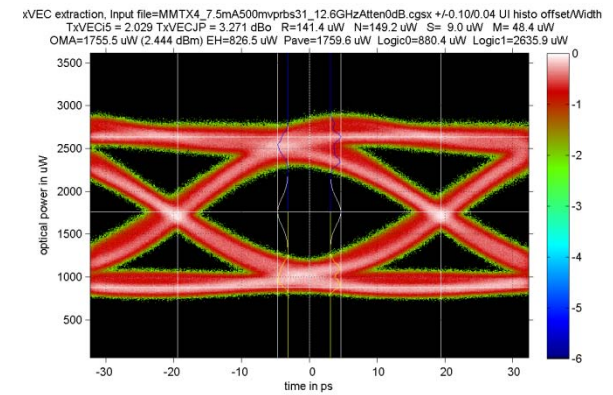
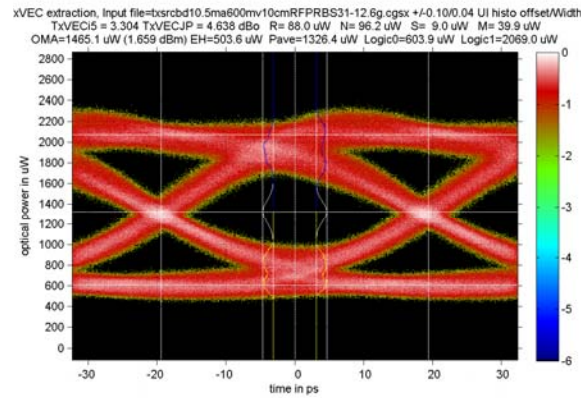
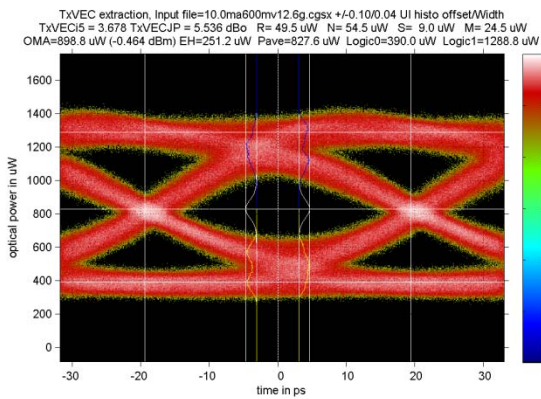
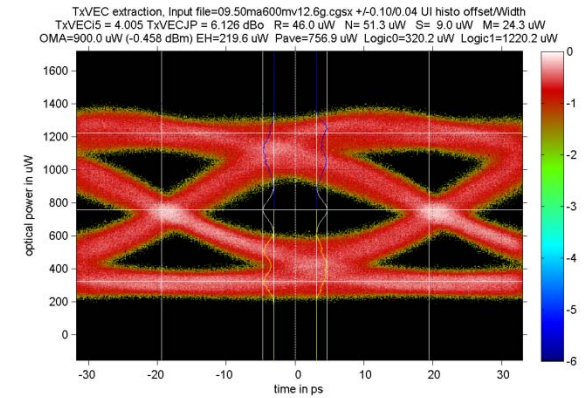
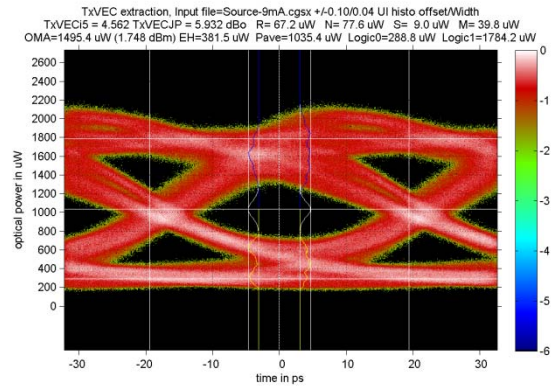
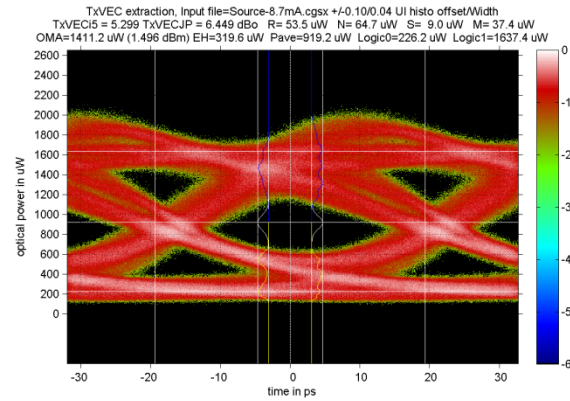
- The table show comparisons of penalties between a worst case fiber and the 12.6 GHz filter used for TxVEC tests. A reference Rx replaces the worst case Rx.
- Depending on the case, the results based on the 12.6 GHz filter appear to slightly understate the penalties based on a worst case fiber.
- Consequently, the credit for a better than worst case Tx is understated.

TxVEC Simulations



- Simulation results are shown above for two different Tx output signal levels, -3.0 dBm and -8.1 dBm, as observed after a 12.6 GHz LPF with 8.5 uW additive noise.
- Note the TxVEC result for this ideal Tx is relatively unaffected by the scope noise. This is a significant benefit of the TxVEC method.
- Also note that the TxVEC result for this ideal Tx is ~ 1.0 dB.

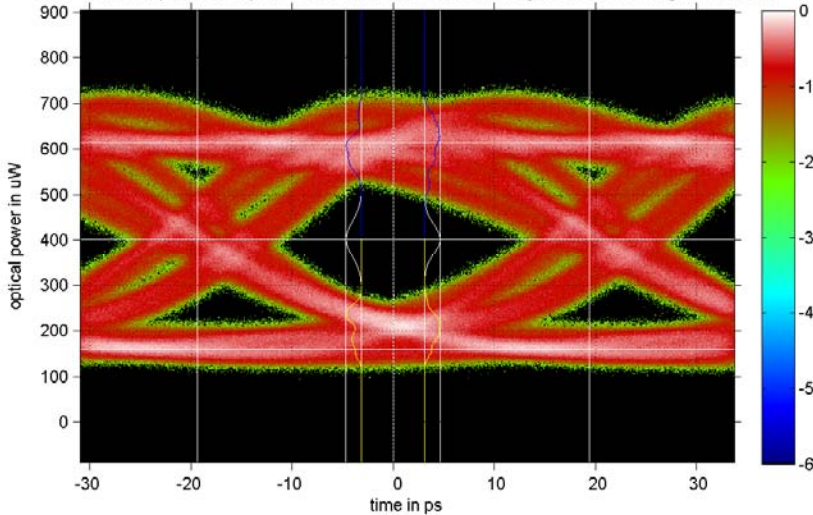
Tx Eyes and TxVEC Results with 12.6 GHz, 9uW Plug-in (1)



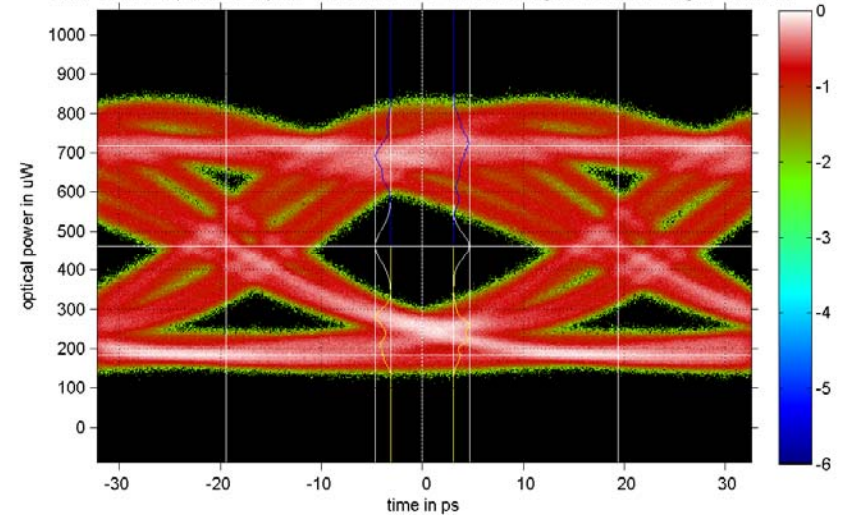
- The above charts show eyes and TxVEC results for cases ranging from a TxVEC = 5.3 dB to a TxVEC = 2.0 dB.
- These transmitters included little to no equalization.

Tx Eyes and TxVEC Results with 12.6 GHz, 9uW Plug-in (2)

TxVEC extraction, Input file=sna0002-txopt-12p6ghz-tx1_70c_3p3v_jitter.cgsx +/-0.10/0.04 UI histo offset/Width
TxVECi5 = 2.783 TxVECJP = 4.735 dBo R= 30.7 uW N= 31.9 uW S= 9.0 uW M= 12.3 uW
OMA=454.0 uW (-3.429 dBm) EH=152.6 uW Pave=403.0 uW Logic0=160.5 uW Logic1=614.5 uW

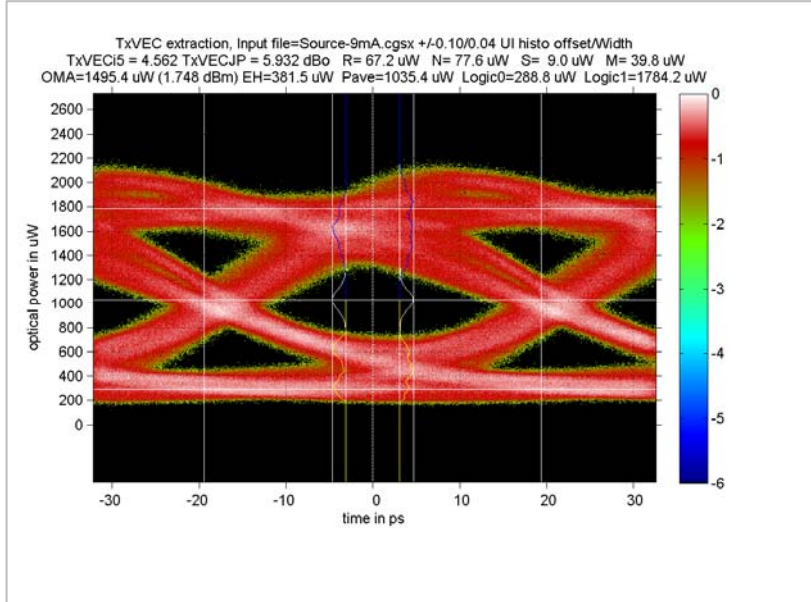
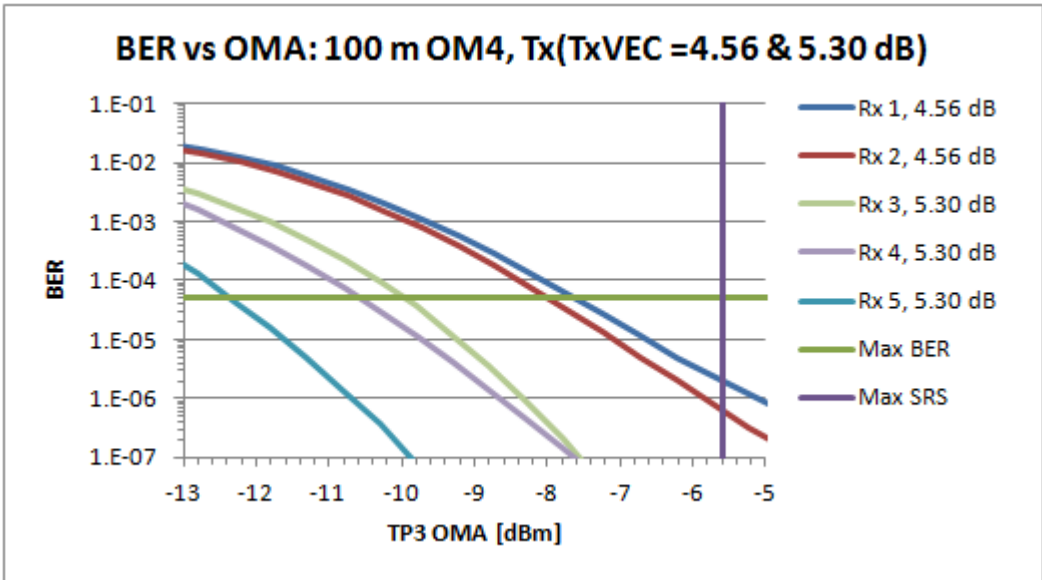


TxVEC extraction, Input file=sna0003-txopt-12p6ghz-tx3_70c_3p3v_jitter.cgsx +/-0.10/0.04 UI histo offset/Width
TxVECi5 = 3.768 TxVECJP = 4.955 dBo R= 28.8 uW N= 31.0 uW S= 9.0 uW M= 14.5 uW
OMA=533.9 uW (-2.725 dBm) EH=170.6 uW Pave=462.3 uW Logic0=183.3 uW Logic1=717.2 uW

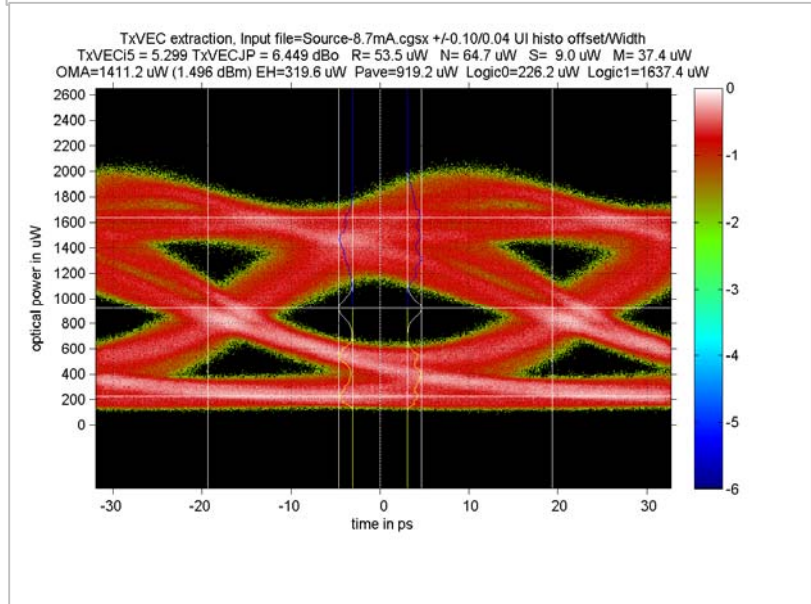


- These charts show eyes and TxVEC results for a TxVEC = 2.78 dB Tx and a TxVEC = 3.77 dB Tx.
- Here modest amounts of equalization were used to yield better eye openings.

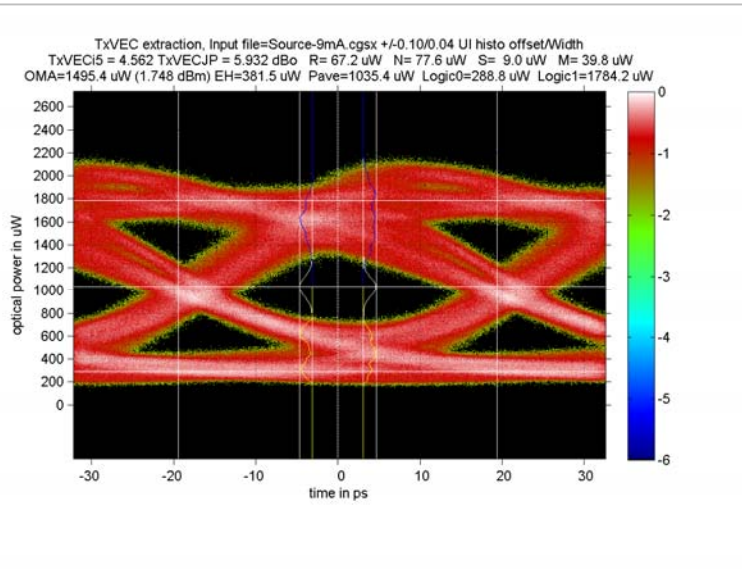
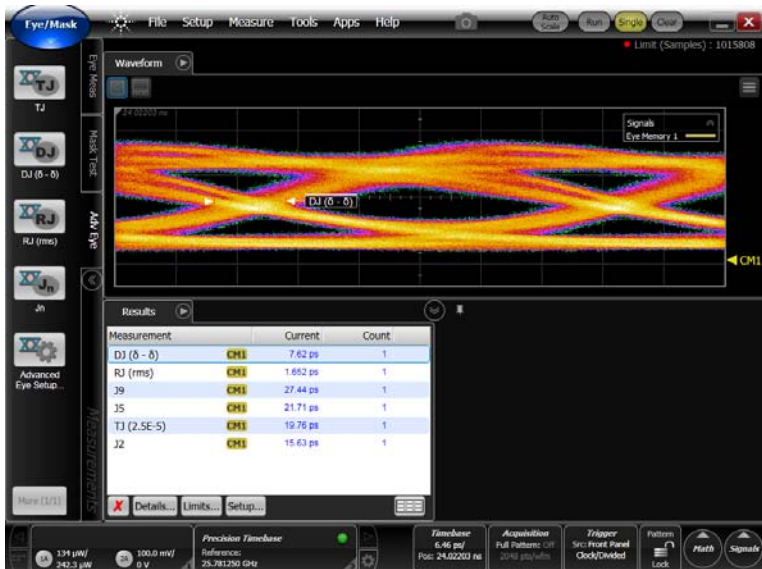
BER with a TxVEC=4.56/5.30 dB Tx & 100 m of OM4



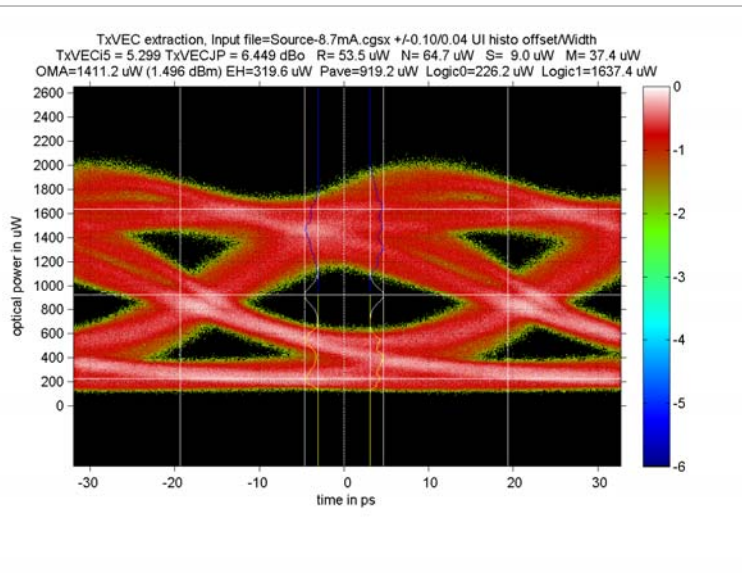
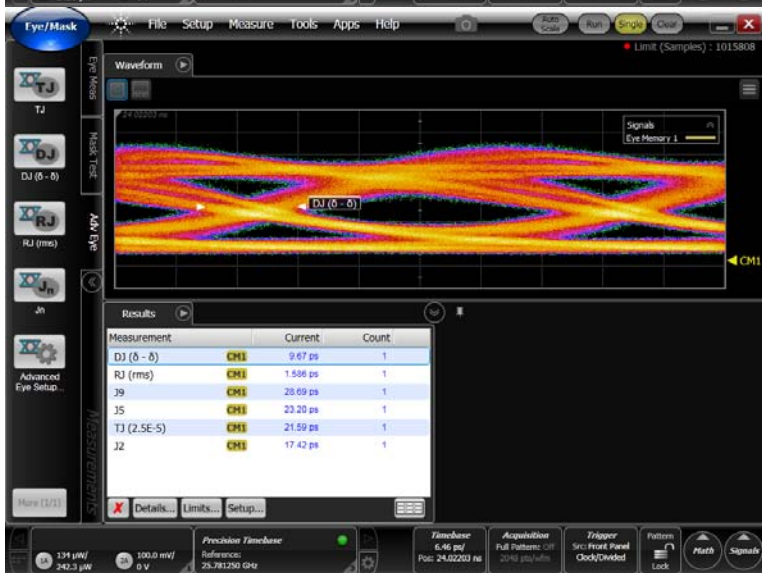
•The charts show a BER plot and the eyes and TxVEC characteristics for the transmitters used for the BER plot. Here TxVEC= 4.56 dB for one and 5.30 dB for the other. A worst case 100 m OM4 fiber (actually 110 m of 5023 MHzkm EBW OM4) was used to connect the Tx and Rx along with breakout jumpers and VOA. **These results indicate that a 100 m OM4 link can operate using a Tx with a TxVEC = 5 dB.**



BER with a TxVEC=4.56/5.30 dB Tx & 100 m of OM4



Top charts
 TDEC = 4.56 dB
 J2 = 0.40 UI
 J4 = 0.51 UI
 J5 = 0.56 UI



Bottom charts
 TDEC = 5.30 dB
 J2 = 0.45 UI
 J4 = 0.56 UI
 J5 = 0.60 UI