Alternative Proposal For TP2 Testing

IEEE 802.3aq Interim Meeting

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Talk Layout

- Motivation for alternative test method
- Overview of the two proposed methods
- Experimental results: laser with lower frequency distortion, scope effects vs. BER effects
- Analysis: why does this cause a scope based test to give false passes?
- Low cost alternative that measures the low probability distortions (think TDP from –LR)
- Conclusion

Motivation: Need a low cost test to ensure TP2 compliance

- Need to come up with a metric that will separate the good Tx from the bad Tx.
- The goals of the test should be:
  1. Reliable: Accurately separates good from bad
  2. Fast: Test cycle time impacts product cost
  3. Low cost: Can we leverage test equipment and methodology from the LR spec?

Two Competing Proposals

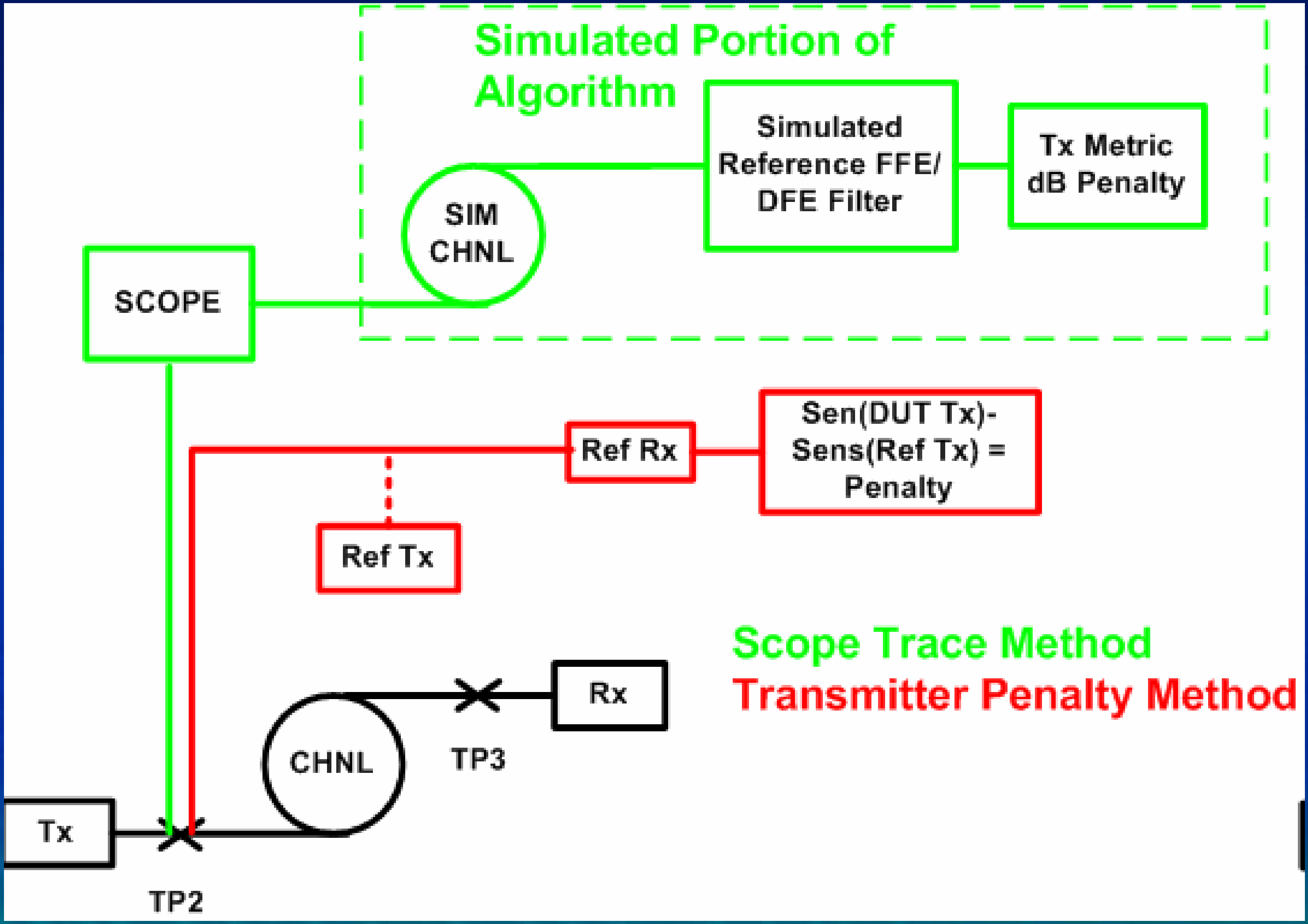
Scope Scan Proposal

- Capture a trace of the wave form for a short pattern (PRBS7) to characterize the eye.
- Use a 1010 pattern to measure noise and jitter.
- From this data it is able to find the correctable and uncorrectable penalties.
- Uses these penalties qualify/disqualify the transmitter.
- Requires new/different scope than that used for LR. [$$]

Transmitter Penalty Proposal

- Similar to the LR test, uses a reference receiver to measure the penalty of a transmitter for long data rates and low probabilities.
- Is not able to differentiate between correctable and uncorrectable penalties.
- Accurately measures low-probability features of the eye and accounts for them in the link budget.

Diagram of the Two Methods

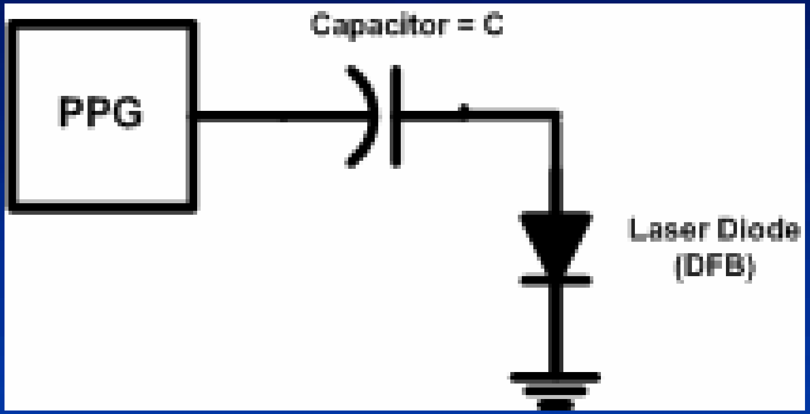


Testing the Effects of Low Probability Events

- Our idea is that low-probability events do matter, and that they need to be accounted for in a transmitter test.
- We built a laser that passes all tests when made with the Scope Trace method, yet fails when tested in a link.
- The distortion made to the laser is a realistic impairment (not a canonical example)

Test Setup

- **DFB laser in a butterfly package.**
- **Two different capacitors were used for the DC block.**
  - **0.22uF cap for standard non-distorted TX.**
  - **1nF cap to create a transmitter with low frequency distortion.**

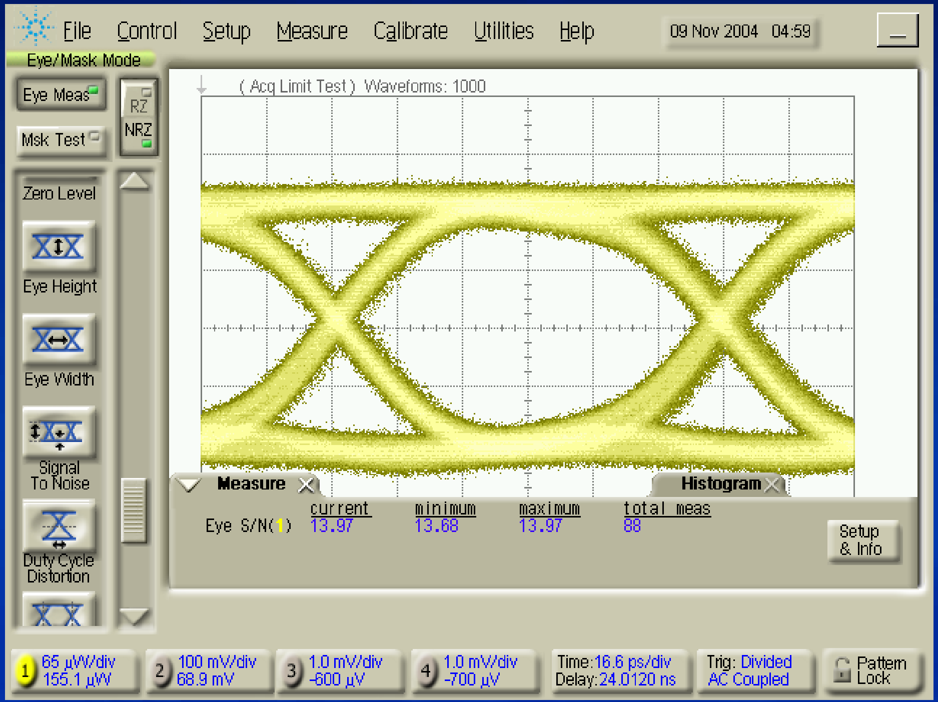


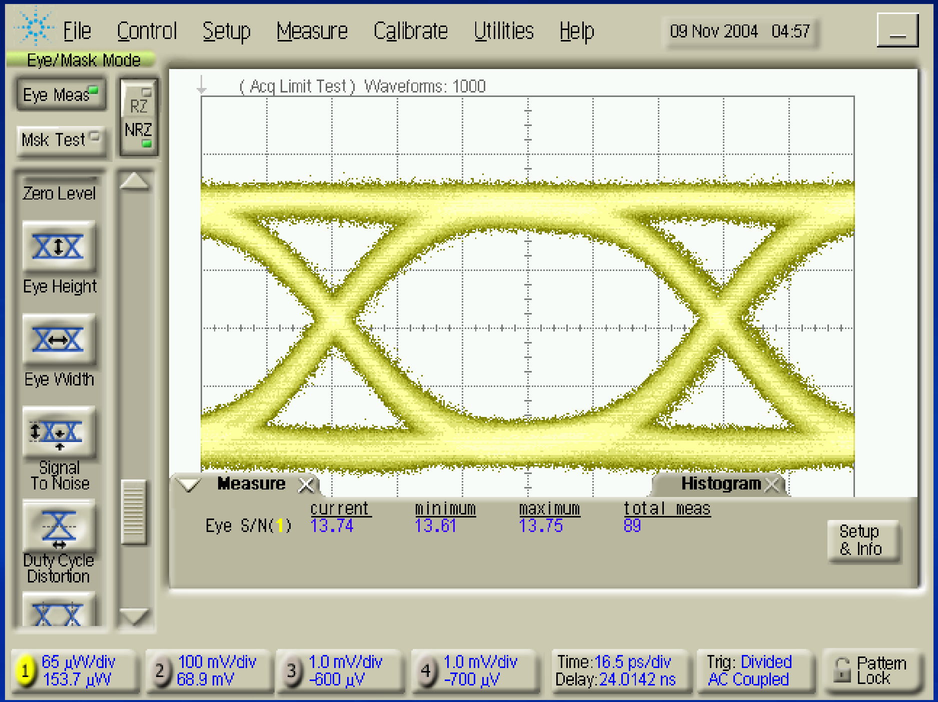
Analysis done –

Eye diagram, Trace of Signal, BER curves and SNR were made using both capacitors values and for various PRBS pattern lengths.

Receiver and Optical Path were kept constant.

Side by Side Comparison at PRBS7





0.22uF Capacitor Tx **1nF Capacitor Tx**

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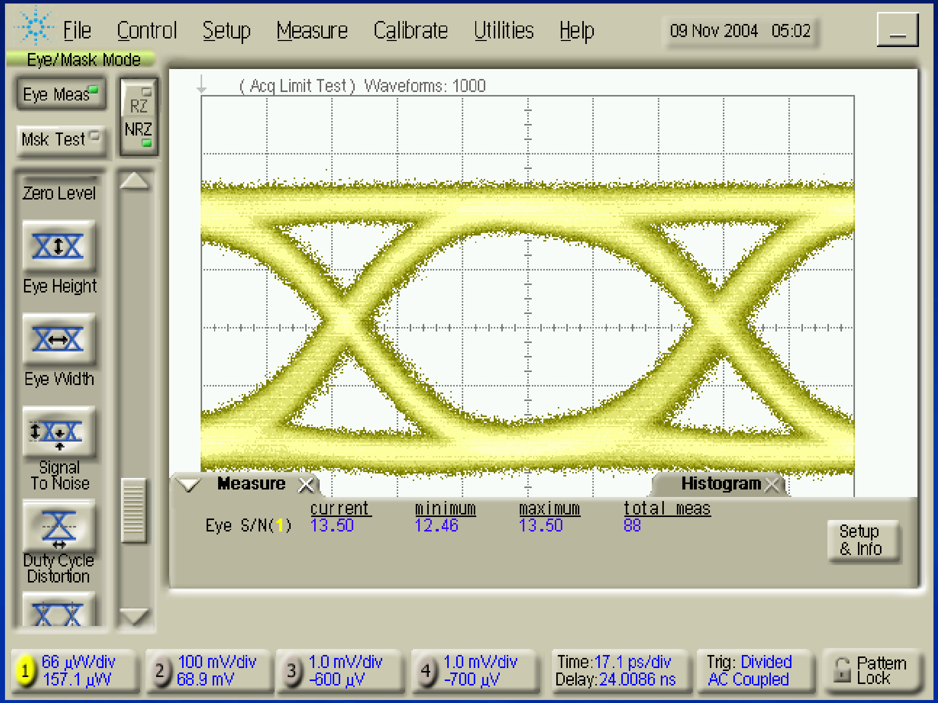
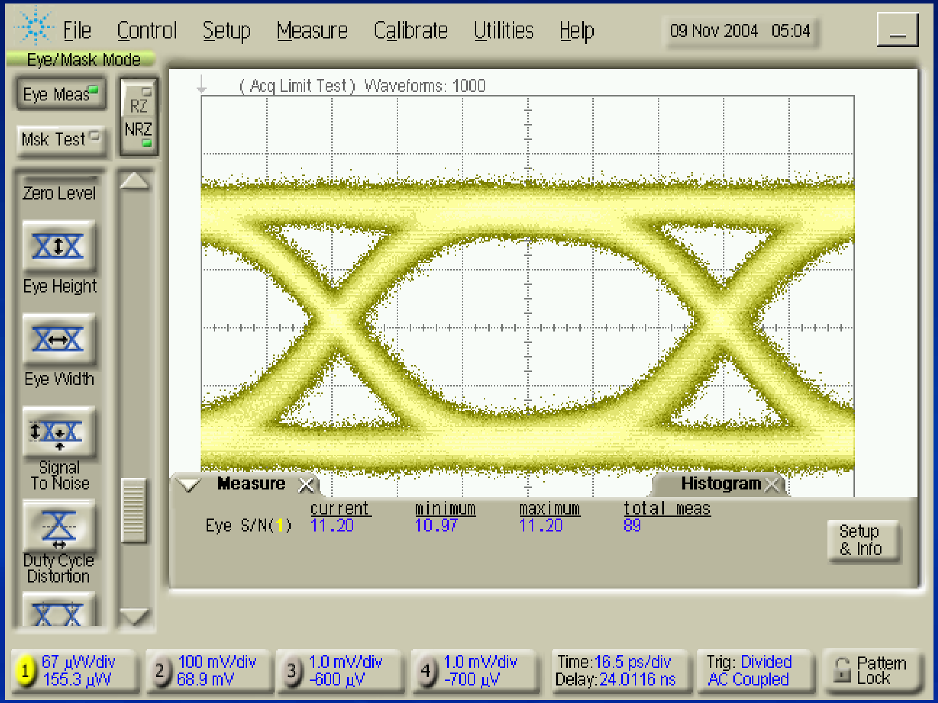
Side by Side Comparison at PRBS31





0.22uF Capacitor Tx

1nF Capacitor Tx

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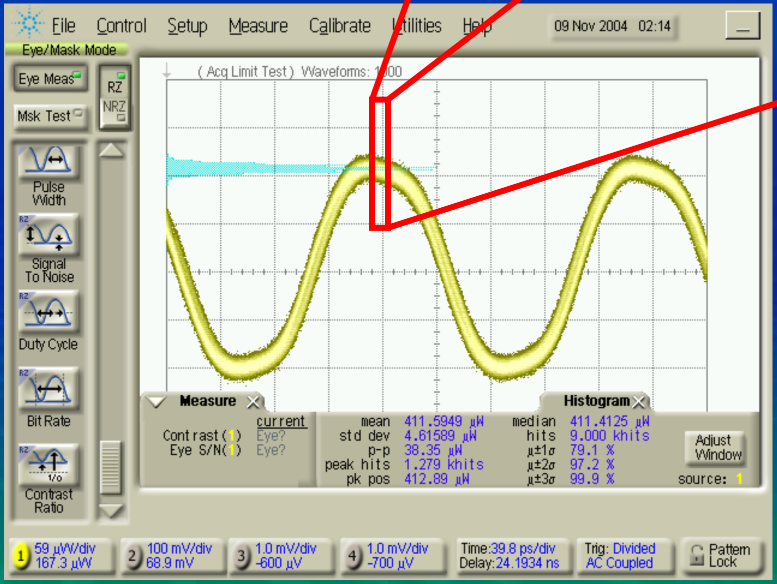
Comparison of 10101 patterns

- The Scope Trace method would use the noise from a known pattern to calculate Noise Penalties.
- There is a small difference in the noise characteristics of the two different Waveforms

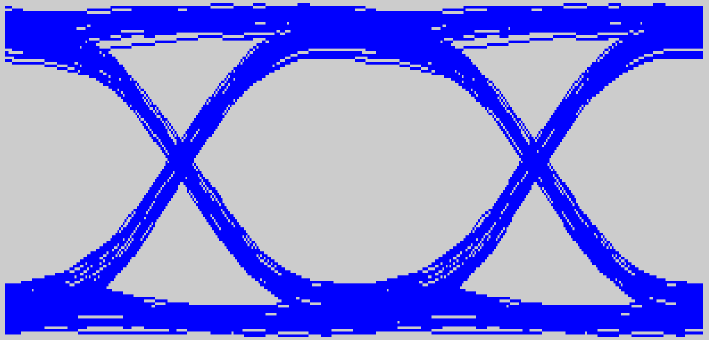
	.22uF	1nF
STD uW	4.5	4.6
P2P uW	38.4	38.4
1-sigma	73.3	79.1
2-sigma	96.5	97.2
3-sigma	99.8	99.9



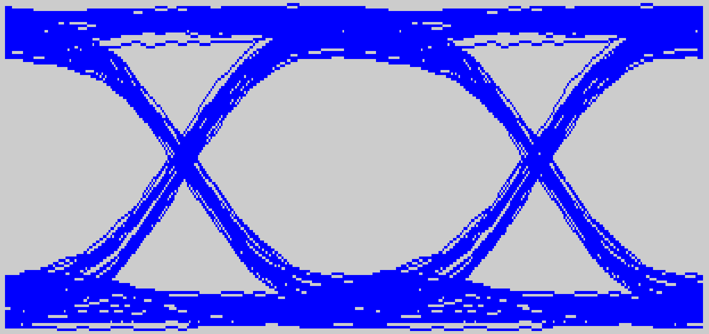
Noise calculated using histogram of 1010 pattern.

Trace Eye Diagrams of Both TXs

- Trace Eye Diagrams of 0.22uF and 1nF capacitor tests with PRBS7
- Eye closure of both values is the same.
- Some double trace starting to form for on the rising edge of the low capacitance eye.



0.22uF Eye [From Trace Scan]



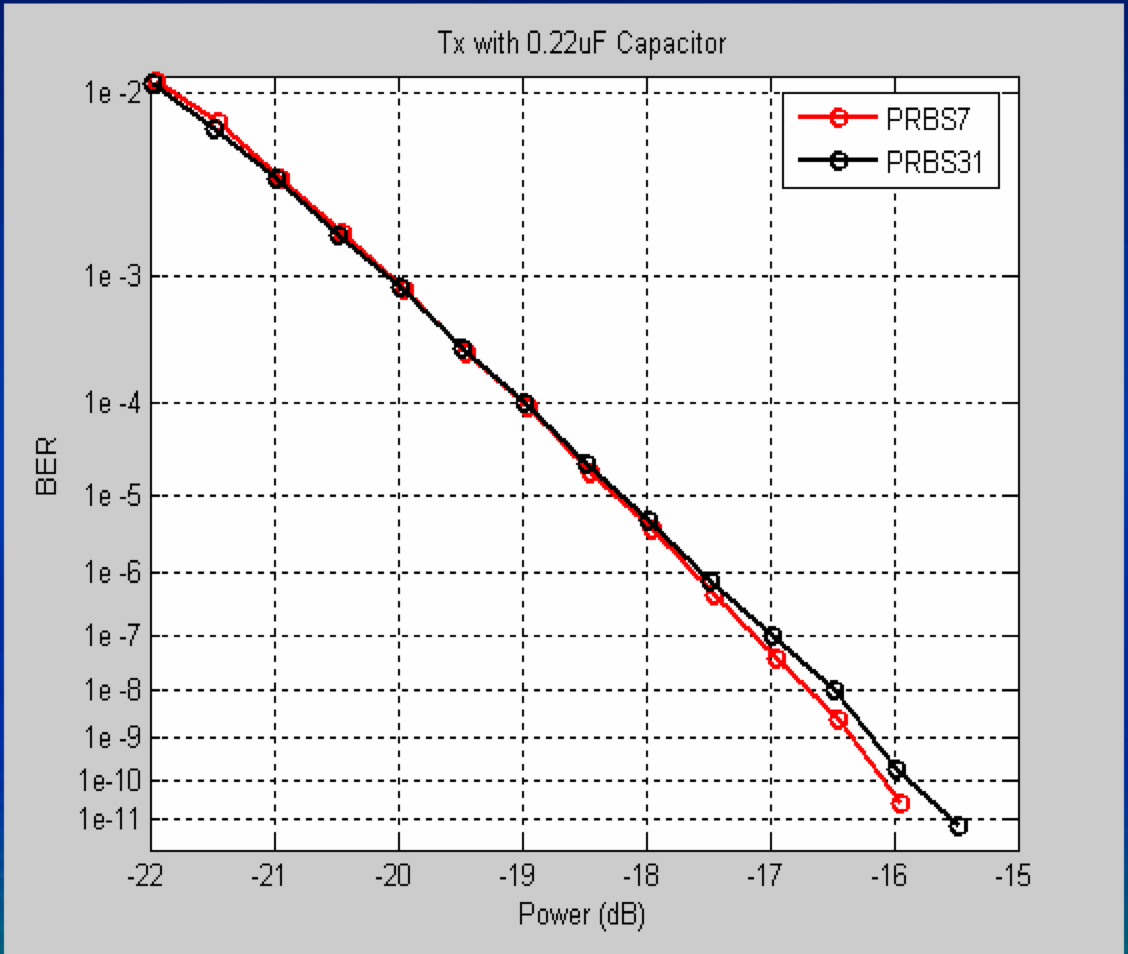
1nF Eye [From Trace Scan]

BER Results: 0.22uF Tx

0.22uF TX shows little difference between PRBS7 and PRBS31

PRBS7 -15.8dBm

PRBS31 -15.5dBm



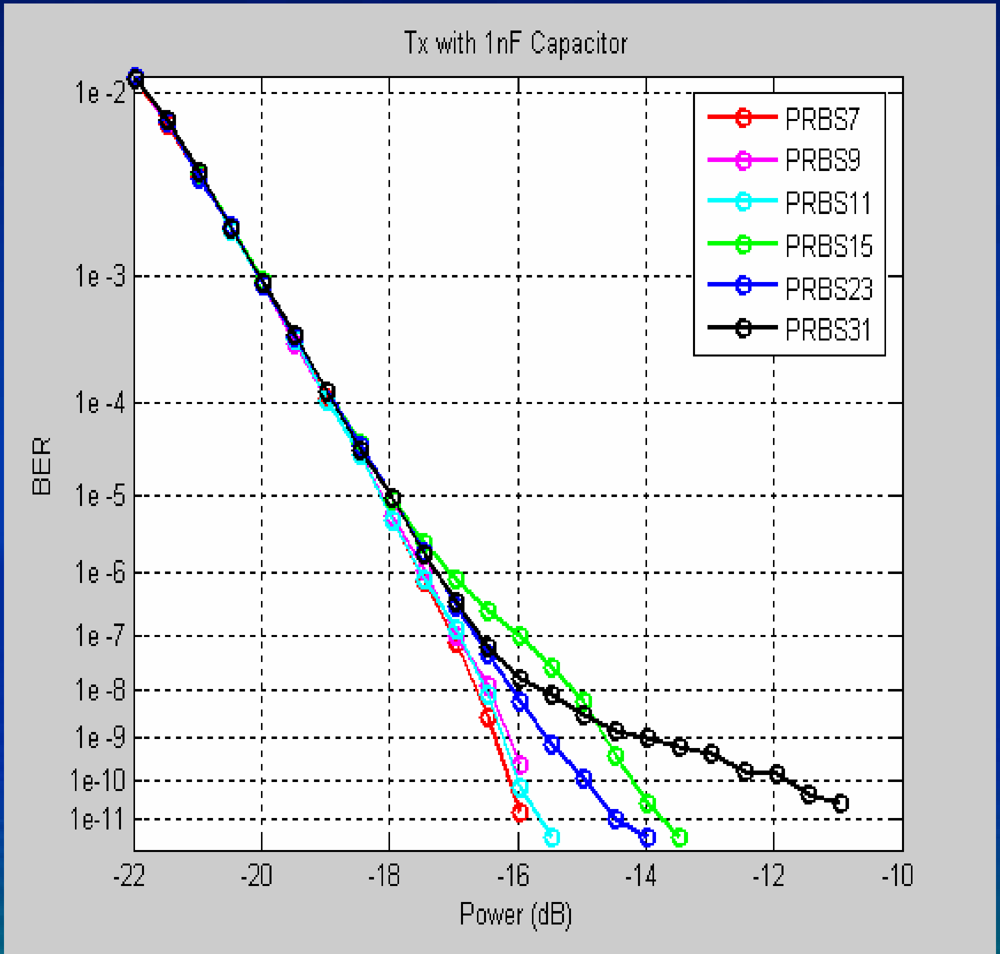
BER Results: 1.0nF Tx

Sensitivity is a function of Pattern Length

PRBS7 -15.9dBm (no change)

PRBS31 -10.5 (5dB Penalty)

Degradation doesn't show up until 1e-6, would be difficult to see this type of closure on a sampling scope.



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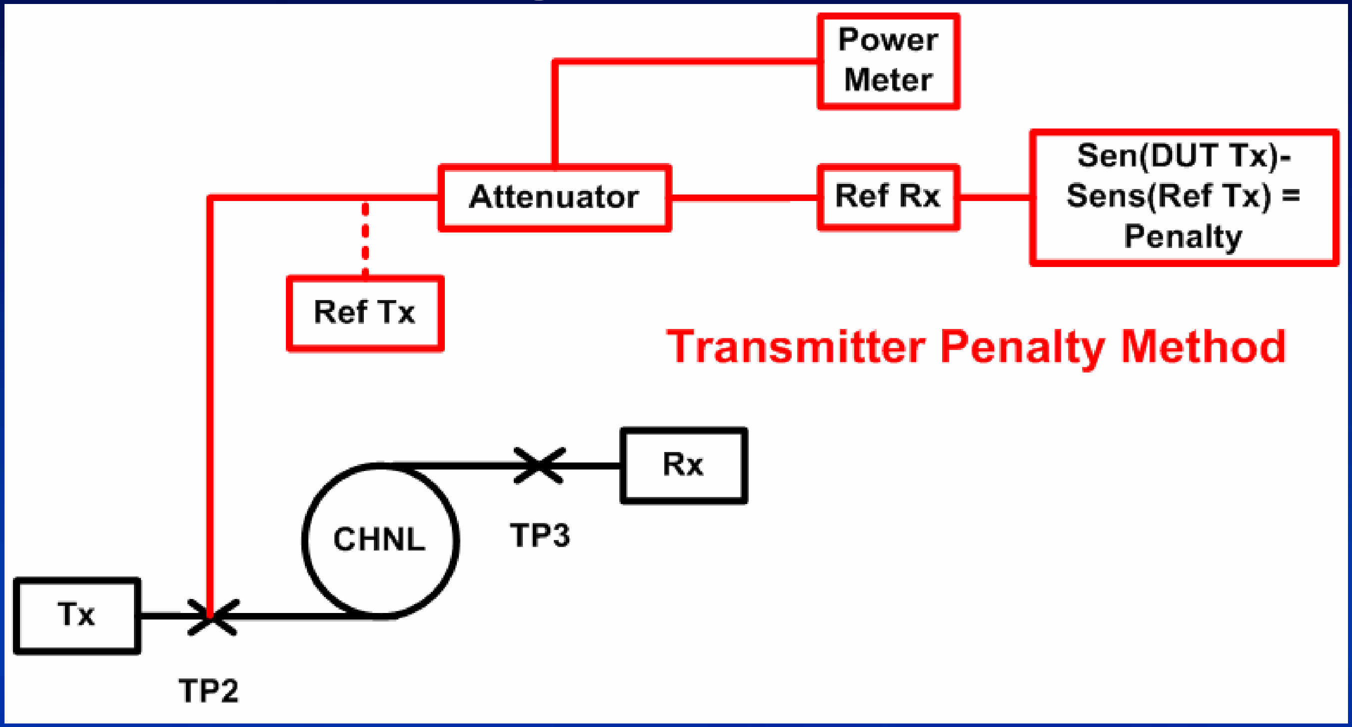
Experimental Recap

- Two lasers with roughly the same eye diagram and identical traces (for short patterns) have drastically different BER performance when tested with PRBS31 vs. PRBS7 patterns.
- Current proposed methodology addresses only the high probability and high frequency degradations of an eye, not the low frequency and low probability distortions.

Proposal: New TDP test

- Propose that we eliminate the dispersion part of the TDP test and test only through a patch cord of (at most) several meters.
- Dispersion penalty would accounted for by the channel metrics [one of - PIE-D, PIE-L, etc.]
- Eliminate the +/- 5ps offset in the TDP test. [It is doubtful that this effectively screens for jitter, and it tended to be difficult to implement without a BERT (couldn't use an internal error-detector because of the offset).
- The TP number can then be used in link budget (not the eye mask limit), it can also be used to lower the transmit power, again similar to the existing LR, SR, and ER specs.

Diagram of New Test



Test Procedure:

1. Measure sensitivity of Ref Tx in OMA = Sref
2. Measure sensitivity of DUT Tx in OMA = Sdut
3. Transmitter Penalty TP = min (Sdut - Sref, Zero)
4. Correct for closure of the reference:

   TP = min (Sdut - (Sr – VECP) , Zero)

Eye Mask

- We propose to keep an eye mask test, could be relaxed from LR mask
- Eye mask is a quick and known method for measuring eye quality, including jitter
- Customers like it and it will most likely be done anyway as part of a manufacturing screening setup.

Conclusion

- Propose that we add a TP test to the transmitter specification in place of the scope trace method.
- This new TP test would accurately account for the low probability events that are overlooked by the Scope Trace methods.
- The TP test would not account for correctable vs. non-correctable distortion, but would give a stronger guarantee of interoperability.
- TP test would allow us to leverage already existing test equipment, leading to lower overall test costs.