Component Issues for 100Base-LX10

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The Problem

- There is a general expectation that we will be able to use existing devices for this interface.
  - 100Base-TX/FX PHY chips
  - OC-3 Transceivers
- The current designs for these parts may produce problems in some combinations
  - At least two major vendors of PHY chips use single edge detection in their clock recovery
  - Optimizations made for SONET applications may not be appropriate for Ethernet applications where the unbalanced 4B/5B code is used rather than the scrambled code used for SONET

Single Edge Clock Recovery

- At least two major vendors of PHY chips use single edge detection in their clock recovery
  - The sampling with the recovered clock will track one edge of the signal. This renders them especially susceptible to the data dependant duty cycle distortion caused by base line wander
  - Any high (or low) duration less than 4ns (50%) will cause errors
  - The present eye mask was developed for dual edge clock recovery. It may be too narrow for single edge clock recovery.

Transmitter Overshoot

- SONET based transmitters are designed for a balanced pattern without baseline wander.
  - The response of the average power control is not critical.
  - Some transmitters have the average power control feedback loop under-damped.
- When subjected to base line wander the average power circuit may overshoot if it is under-damped.
- Overshoot on the optical signal envelope will cause aggravated jitter if it is faster than the receiver time constants.
- This may shrink the eye

DC Restore Circuits

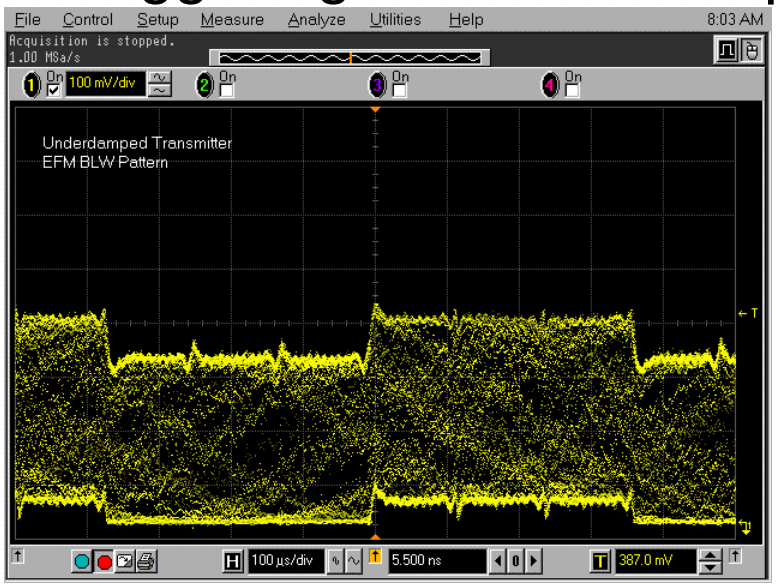
- Some receivers are designed with a DC restore circuit to automatically compensate for internal offsets and achieve the best sensitivity.
  - Feeds back a correction signal that expects a balanced data pattern
- When subjected to an unbalanced pattern the internal operating point is upset to attempt to achieve a balanced output.
  - Additional duty cycle distortion is introduced by the receiver

Effect of Transmitter Damping

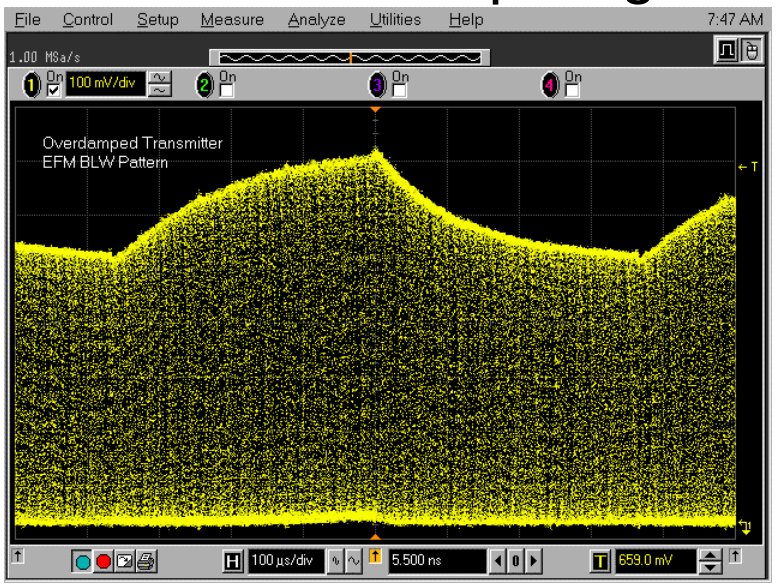
- In the following sequence of slides the output of a receiver is shown with inputs from two transmitters
- One transmitter has overshoot on the average power control circuit. The control loop is under-damped. This unit also has some additional noise.
- The other transmitter has an over-damped average power control loop and shows no overshoot.
- Both transmitters meet the present eye mask.
- The receiver used has DC restore.
- All optical waveforms were examined through a 4^{th} order B-T filter w/ 3dB at 177MHz (OC-3).
- Triggering was from the optical or electrical signal. No CDR unit was used.

Optical Envelope Using EFM BLW Test Pattern

- The under-damped transmitter shows a definite overshoot on the optical waveform.
- The over-damped unit is well controlled.
- Triggering was from the peak of the envelope signal



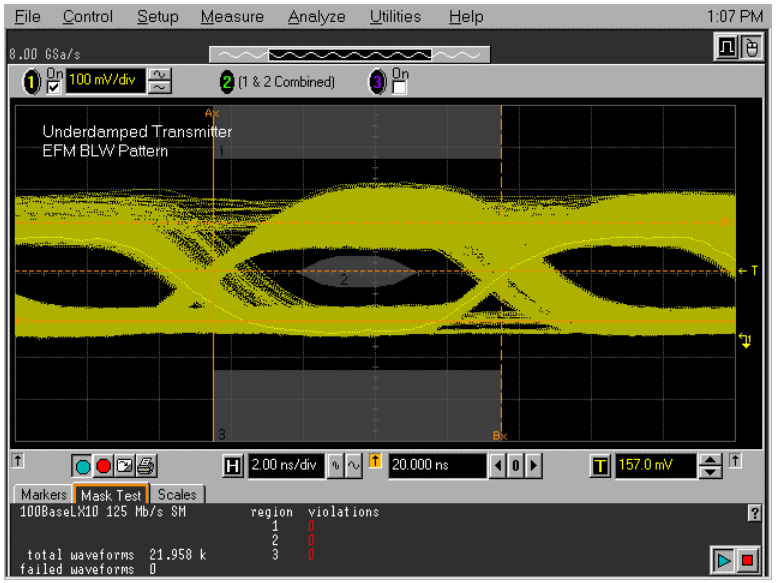
Under-damped Transmitter



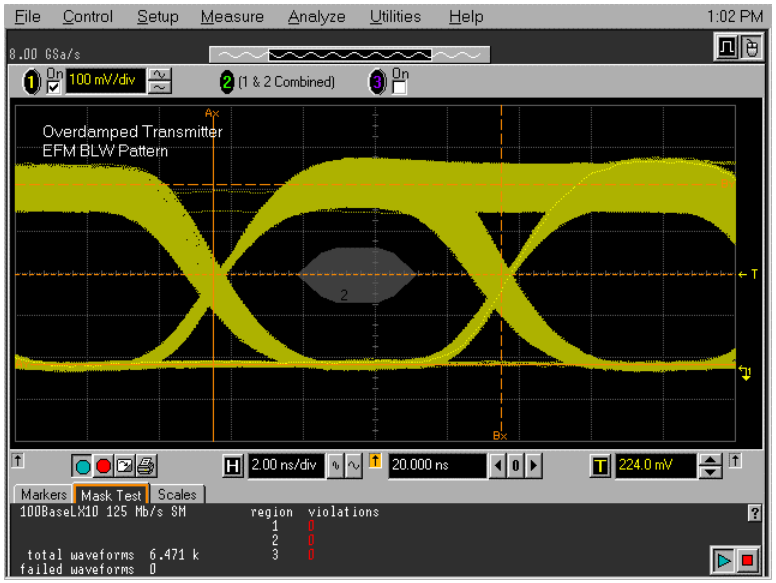
Over-damped Transmitter

Eye Pattern using EFM BLW Test Pattern

- Both units pass the mask
- Triggering from the rising waveform edge
- Examined through a 4th order B-T filter w/ 3dB at 177MHz (OC-3)



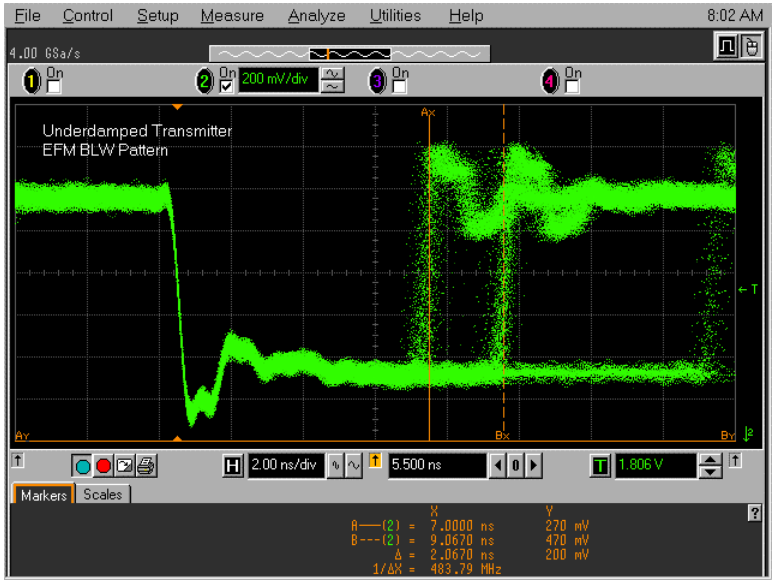
Under-damped transmitter

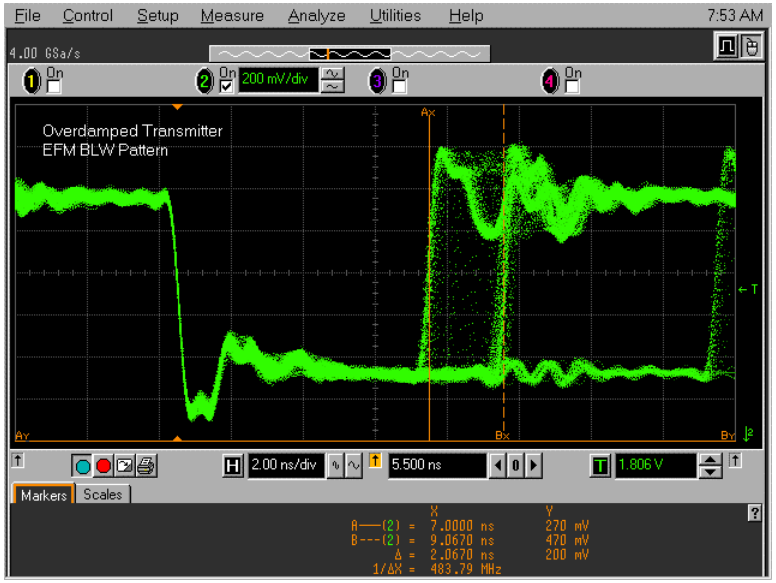


Over-damped Transmitter

Electrical Signal with EFM BLW Pattern

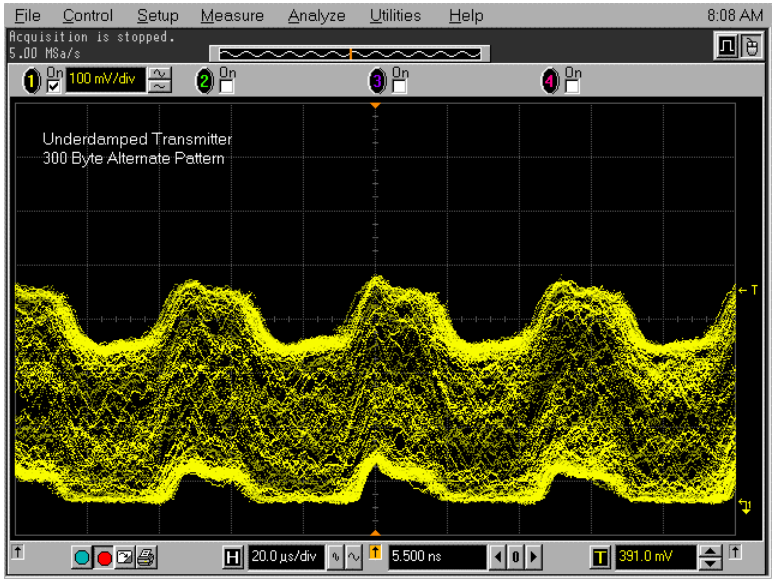
- Scope triggered on single edge to simulate single edge clock recovery
- The main jitter artifacts are nearly the same in spite of the differences in the optical waveforms.
- There is a wide, low density jitter on the under-damped unit that is difficult to see at this time scale.

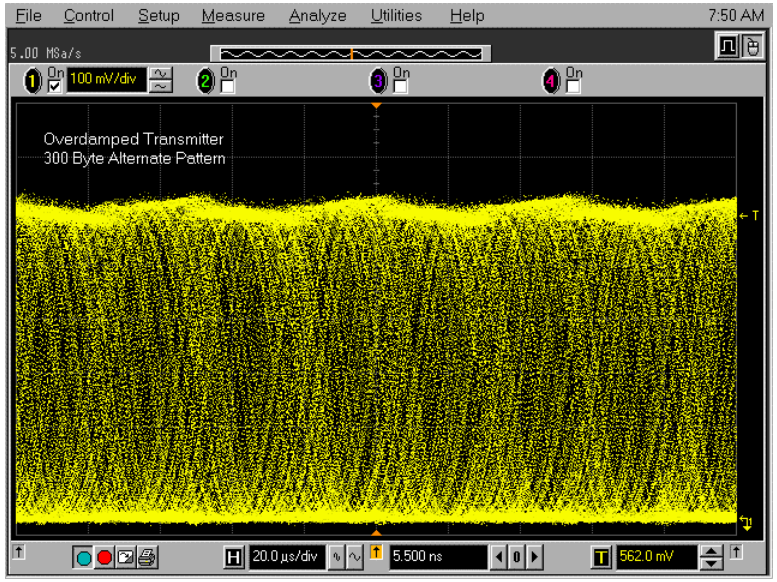




Optical Envelope with 300 Byte Alternate Pattern

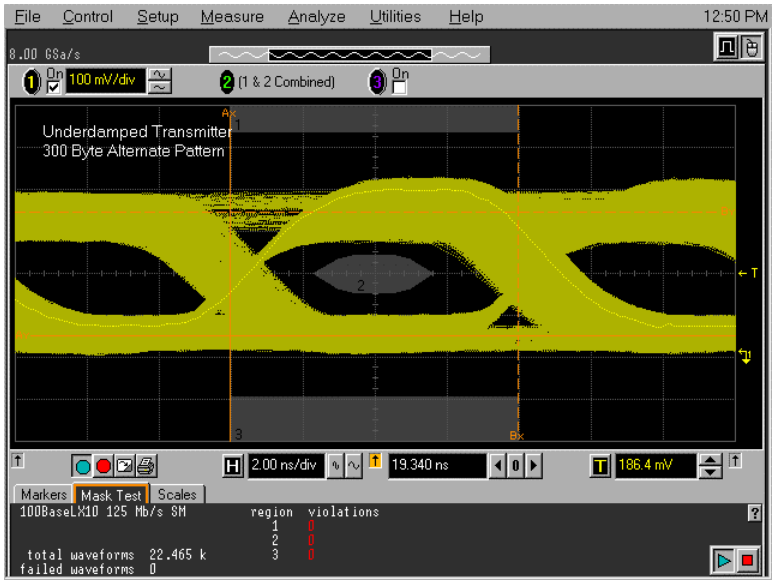
- The under-damped unit has a large envelope perturbation
- The over-damped unit is very little amplitude change with this high frequency pattern



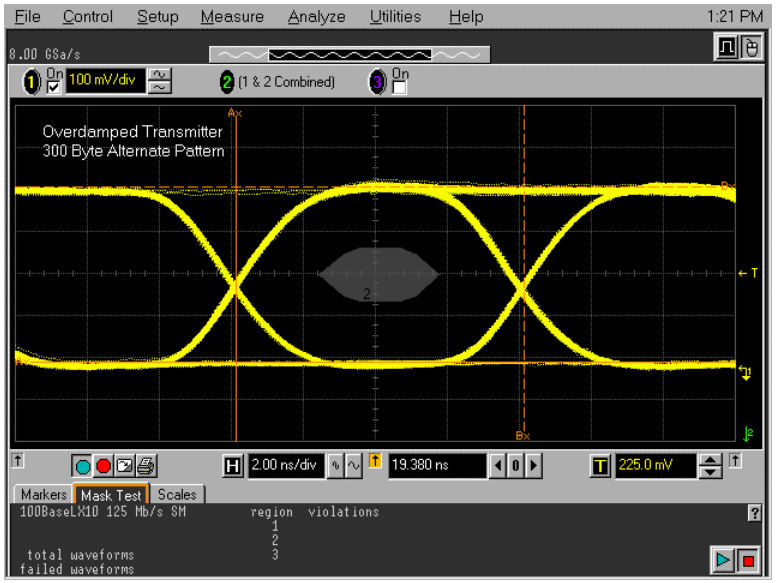


Eye Patterns with 300 Byte Alternate Pattern

- Note the importance of using the correct pattern



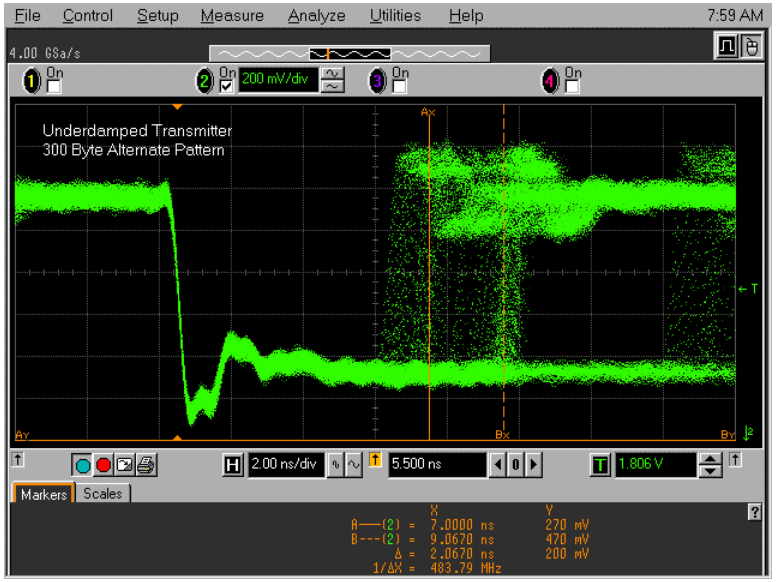
Under-damped transmitter

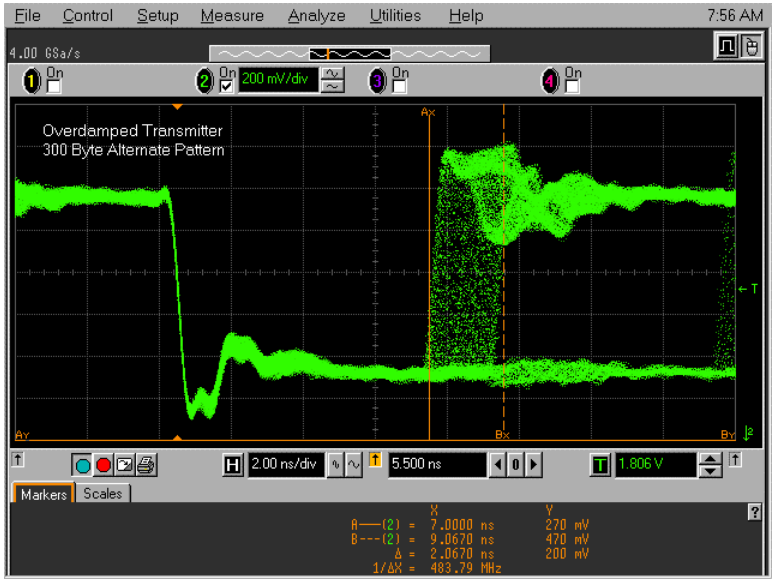


Over-damped Transmitter

Electrical Signal with 300 Byte Alternate Pattern

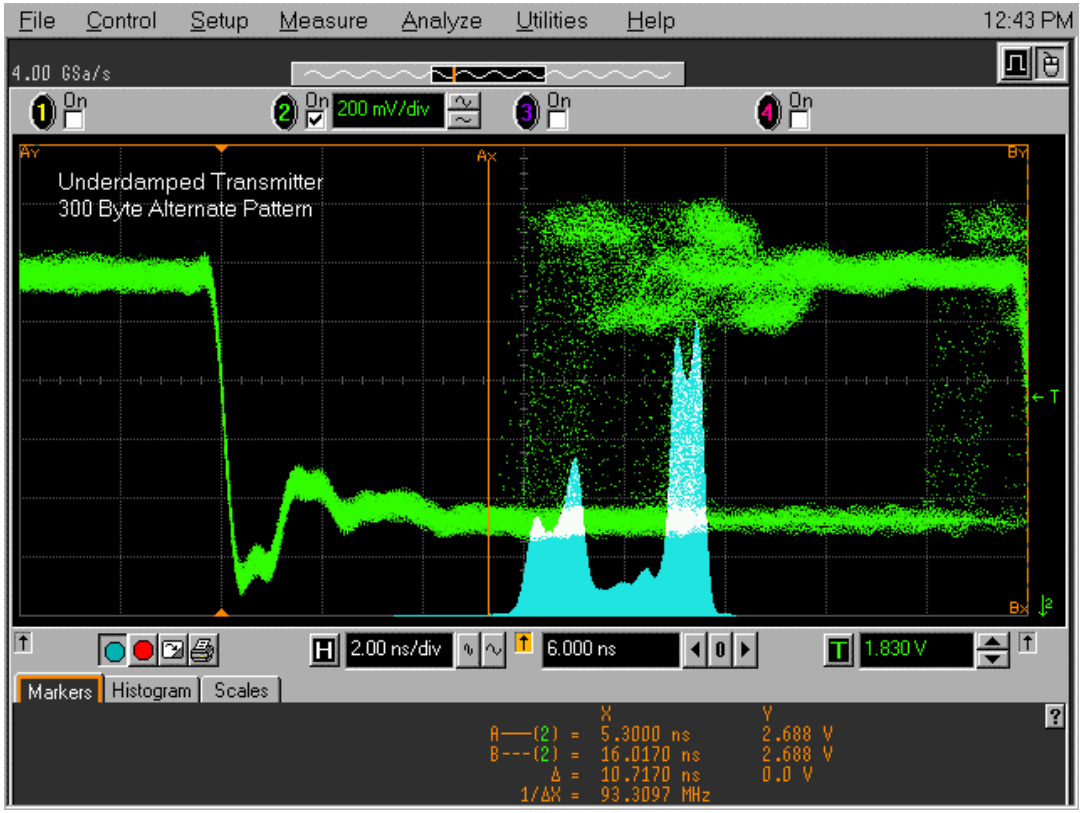
- The receiver is getting near it's bandwidth limit
- The under-damped transmitter produces low density noise due to the overshoot on the envelope



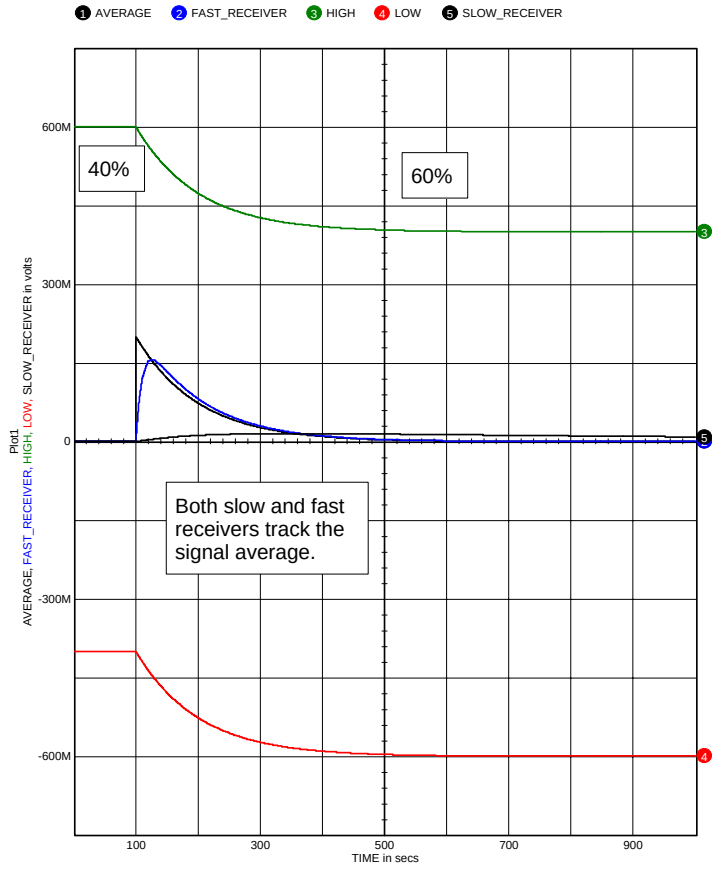


Histogram with 300 Byte Alternate Pattern

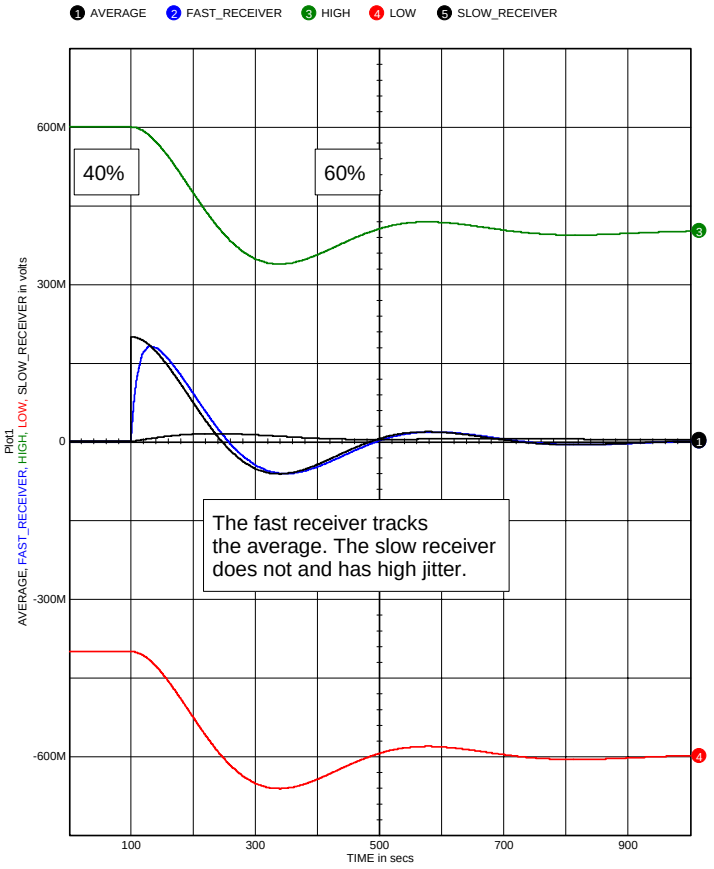
- The eye width to the tail of the distribution is 5.3ns from the falling edge



Simulation of Over and Under-damped Transmitters with Slow and Fast Receivers



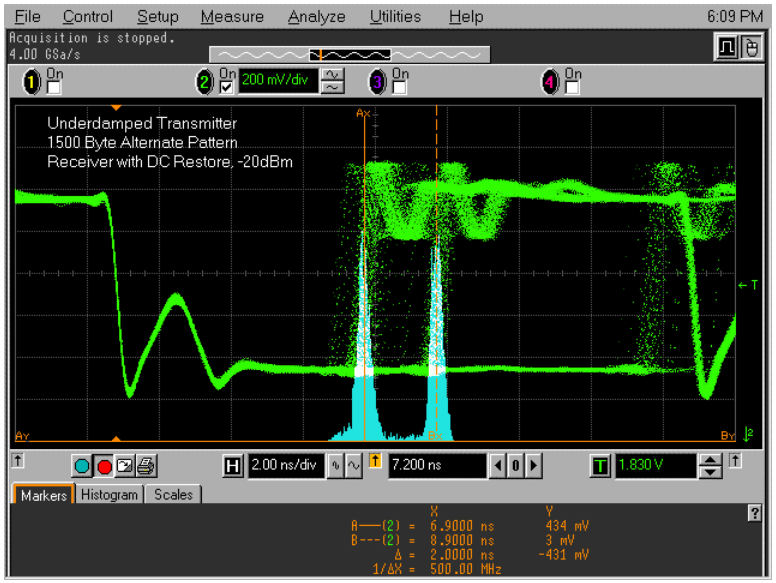
Over-damped Transmitter



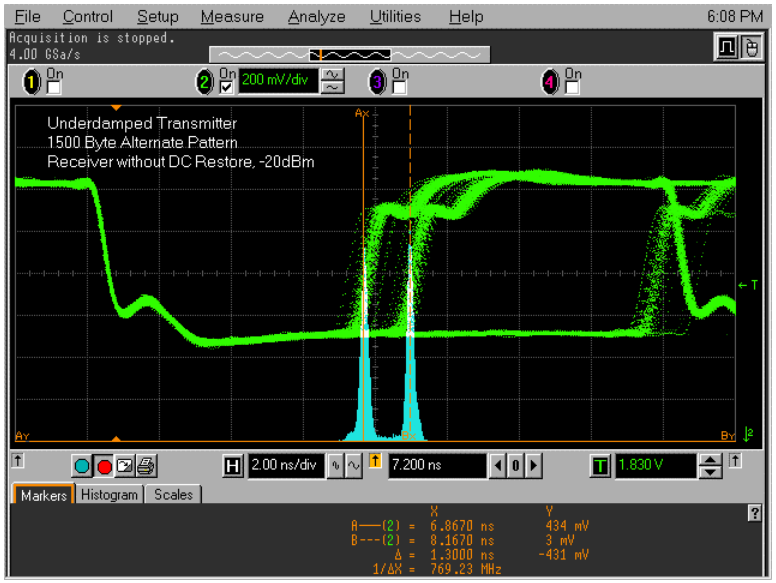
Under-damped Transmitter

DC Restore Impact

- The tests were run with 1500 Byte alternate pattern containing all zeros. The under-damped transmitter was used. Receive power level was –20dBm
- The receiver with DC restore has more jitter as a result of the feedback operation



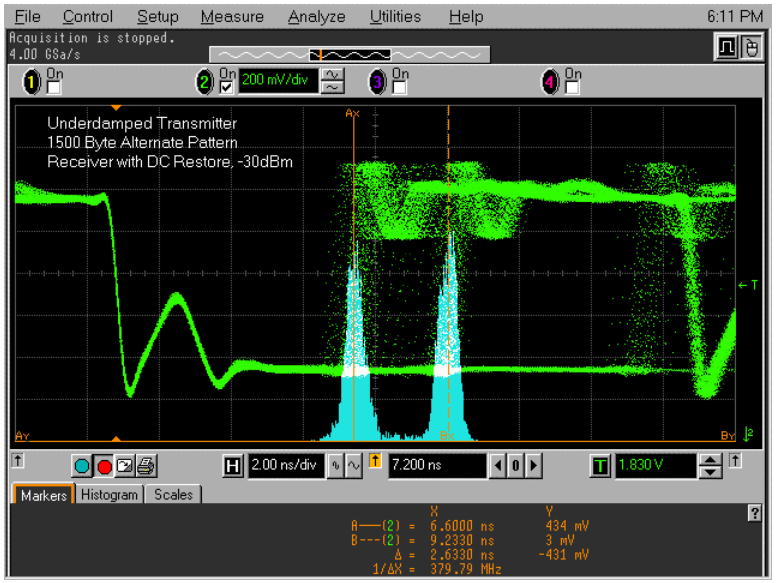
With DC Restore, 2ns jitter



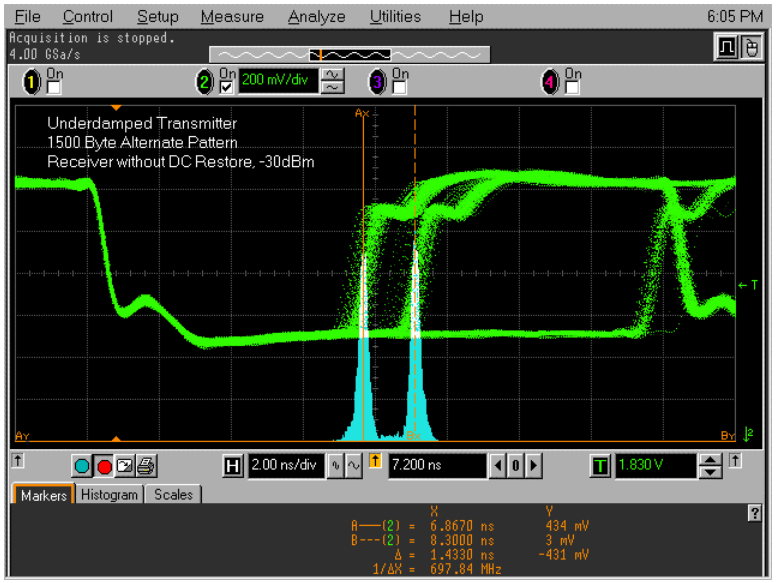
Without DC Restore, 1.3ns jitter

DC Restore Impact, Cont.

- Reducing the power to –30dBm increases the jitter in the DC restore case.
- In general, receivers with DC restore will have greater jitter than those without DC restore. These effects are power level and data dependent.



With DC Restore, 2.6ns jitter



Without DC Restore, 1.4ns jitter

Worst Case Combination

- The worst combination will be
  - Transmitter with
    - Under-damped APC
    - Duty cycle distortion (Table 60-8 limits DJ to 0.05UI)
  - Receiver containing DC restore
    - Worst case pattern is nibbles of 1, 2, 4 or 8.
  - Clock recovery with single edge clock detection
- We may have to prohibit some of these combinations

Recommendations

- We need more information on the prevalence of the factors that have the potential for causing problems
- Suppliers should be polled to determine the prevalence the design choices that could cause these problems.
- Once this information is gathered we may have to structure the standard to eliminate some of the aggravating circumstances.

Recommendations (Cont.)

- An editors note should be added to Clause 60.7.8 “Transmitter optical waveform (transmit eye)” noting the concern over the minimum eye width and stating that the eye mask is for further study. This is to prohibit editorial freezing the present mask.
- Table 60-8 (jitter budget) needs to have the TP-4 total jitter replaced by TBD. It is currently in excess of 50%
- The Clause 60 TDP measurements are all based on two edge clock recovery. They will have to be redone or eliminated.