HyperTransport™ CONSORTIUM

Validation and Compliance Testing Strategies for HyperTransport 3.0 Design

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HT3 Validation and Compliance Test Strategies

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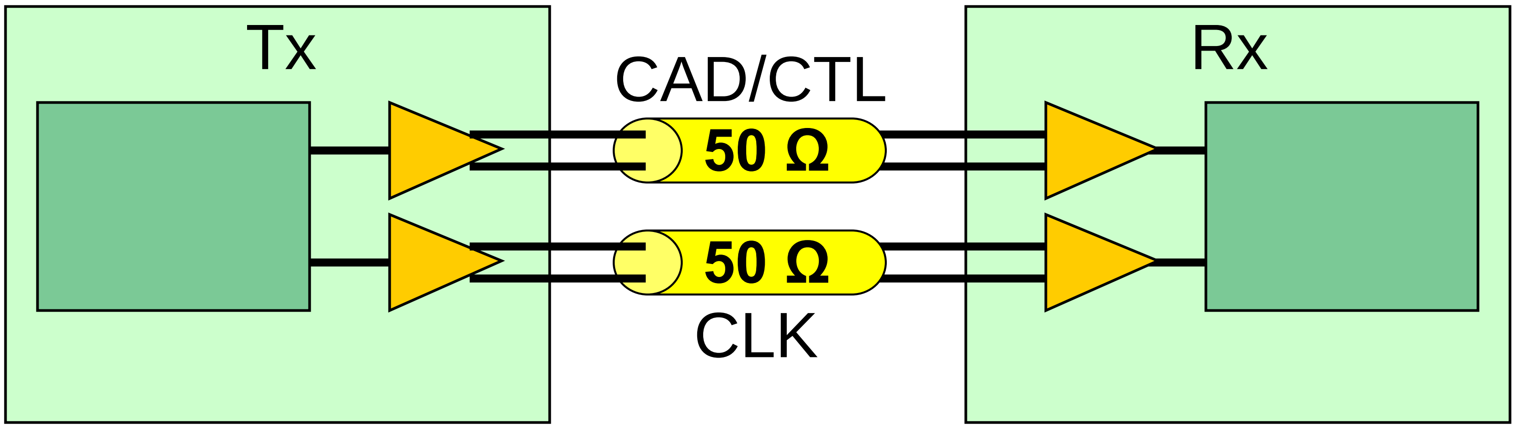
Outline

- Impact of HT3 on validation and compliance test
- Preparation for and execution of key HT3 test areas
  - Transmitter
  - Receiver
  - Channel
  - Protocol
- Summary and information pointers

HT3 Verification and Compliance Test Areas

- Transmitter
- Receiver
- HT3 Channel
- Functional and Protocol



“Conventional” Testing at Microwave Speeds

- Small variances in probe loading can produce significant changes in measured results
  - Even sub-pf loads are important at 7+Ghz HT3 harmonics
- Measurements become less accurate as distance from Tx/Rx increases.
  - Reflections due to Tx/Rx return loss and channel impedance variations sum in complex ways
  - Even the pad to package pin differences are significant
  - Existence of a standard connector interface cannot be assumed

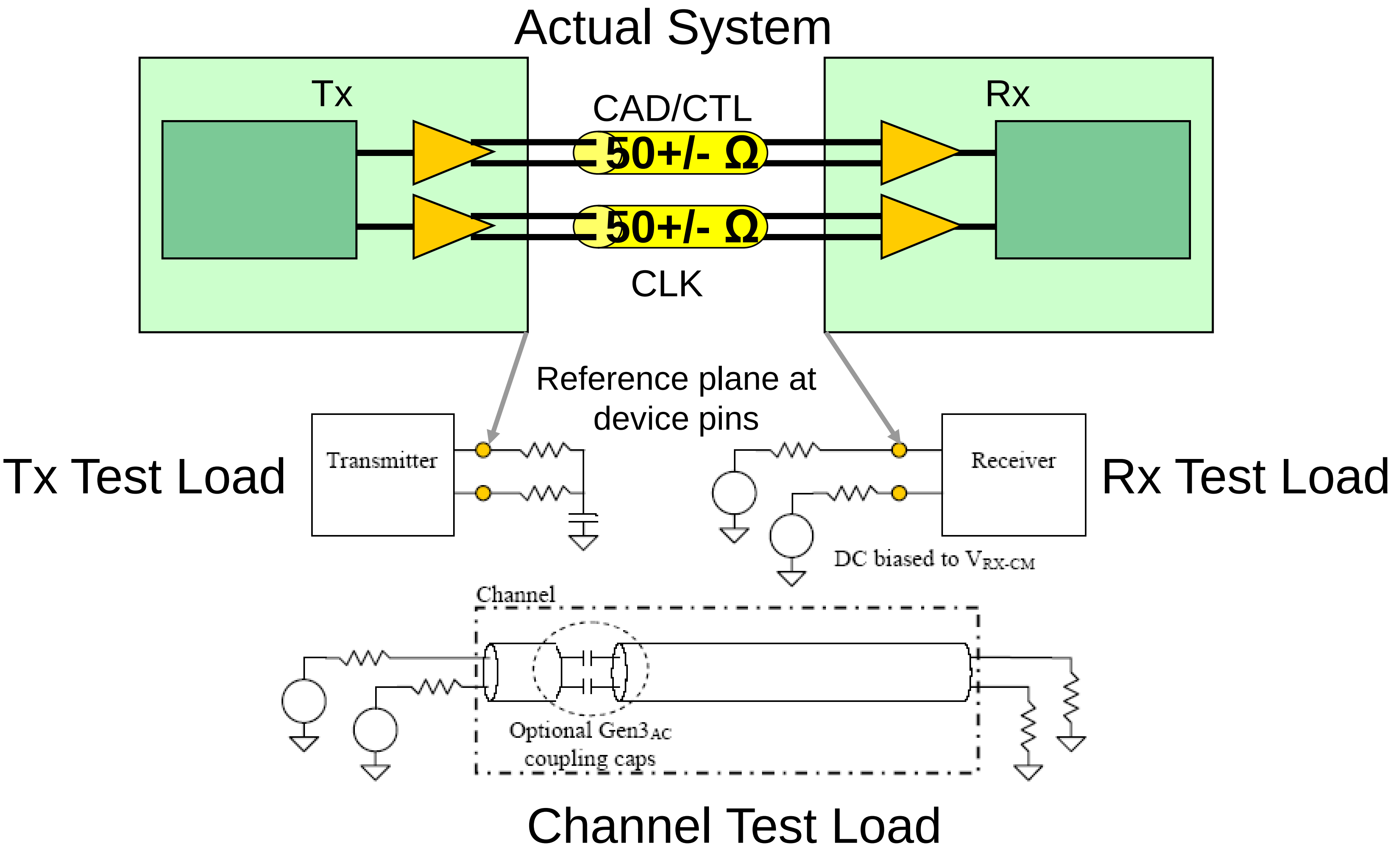
“Conventional” Testing at Microwave Speeds

- Compliant drivers and receivers are specified into 50 ohm load, so voltages measured in actual channels that deviate from 50 ohms cannot be used to verify compliance
- Traditional definition of channel in terms of loss and impedance rules out many valid channels and limits design options
- Result: Traditional direct measurements of Tx, Rx and channel characteristics in-system will not assure correct operation – a different strategy must be used.

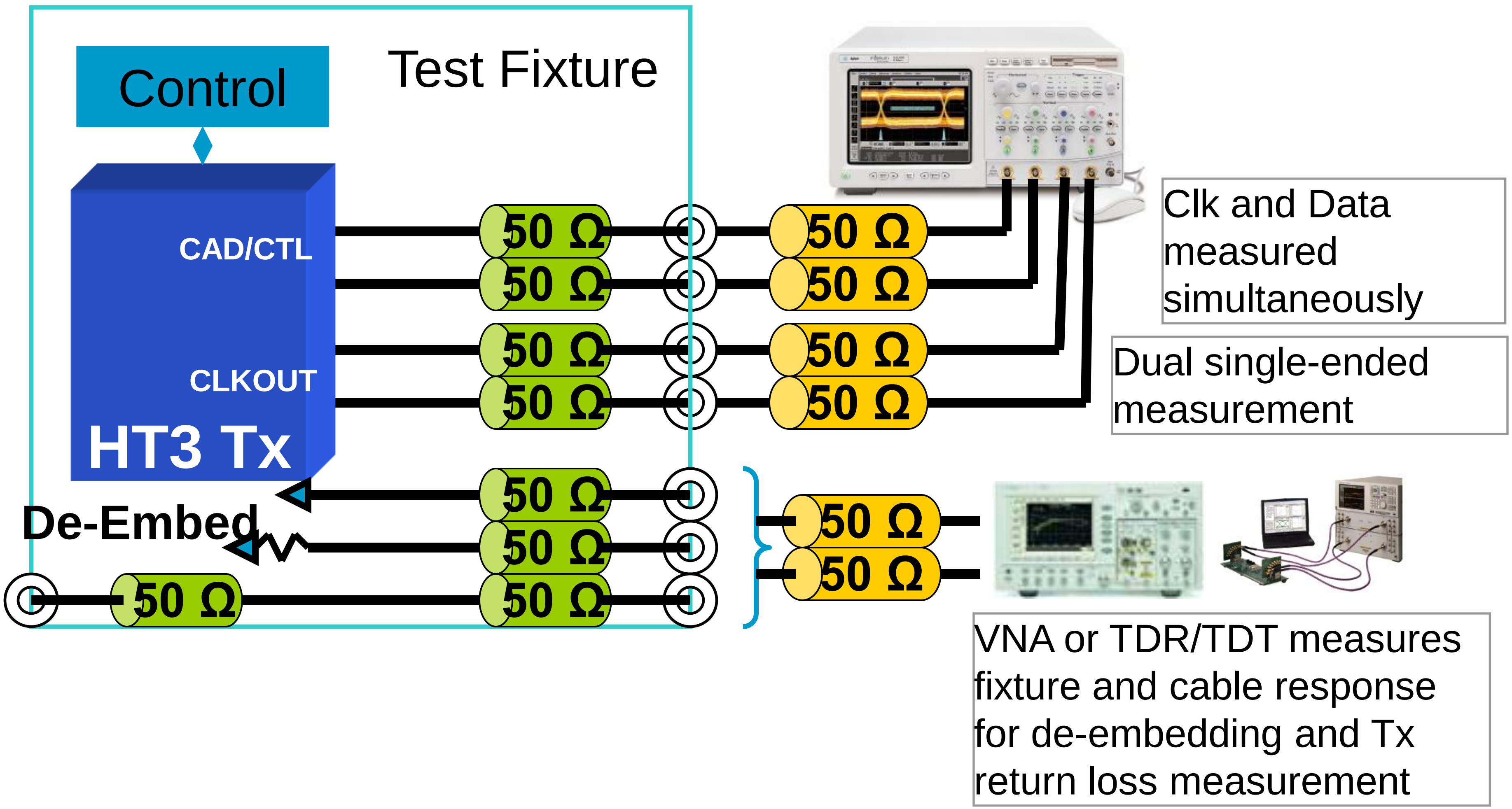
HT3 Compliance Test Philosophy

- Reference Plane methodology defines compliance test points
- Tx, Rx, and channel independently tested for compliance
- Microwave quality test fixtures customized for each Tx and Rx component are used for accuracy and repeatability
- "De-embedding" of probing and fixturing required
- Simulation of measured channel is used to assure worst case Tx signal generates acceptable Rx eye

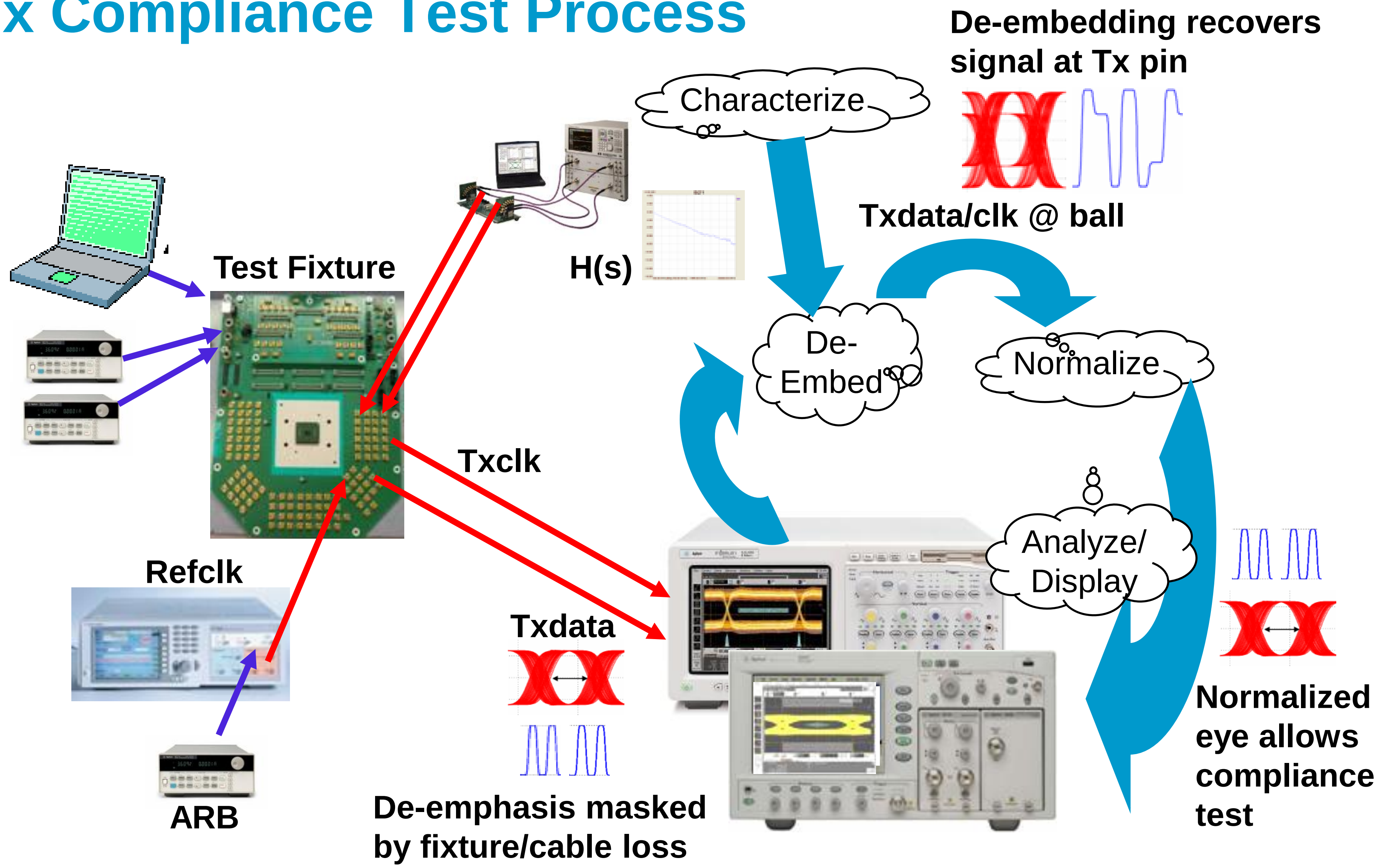
Tx / Rx/ Channel Compliance Measured Separately



Transmitter Test Preparation

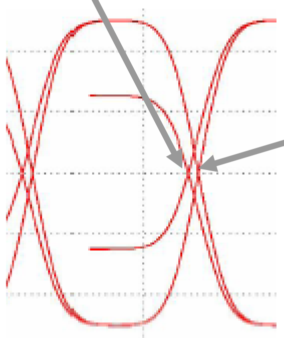


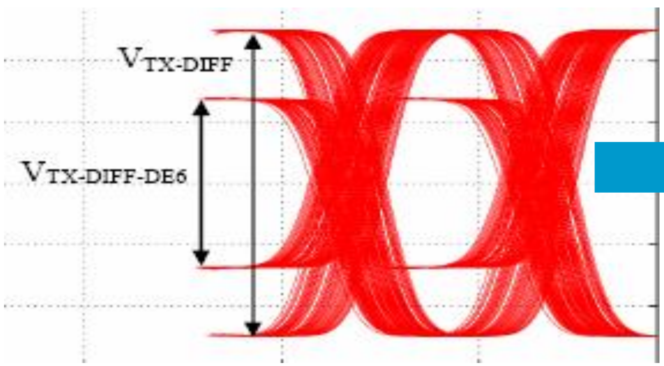
Tx Compliance Test Process



De-emphasis Induced Jitter

De-emphasized bit reaches threshold sooner than full swing bit





Tx eye as measured on low loss channel

IF fullswing :

$$scale = deemp; \quad offset = 0.0$$

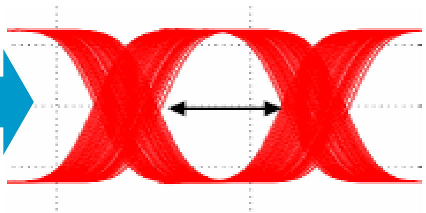
ELSEIF previousBit == 1 :

$$scale = \frac{2 \cdot deemp}{1 + deemp}; \quad offset = \frac{1 - scale}{4}$$

ELSE :

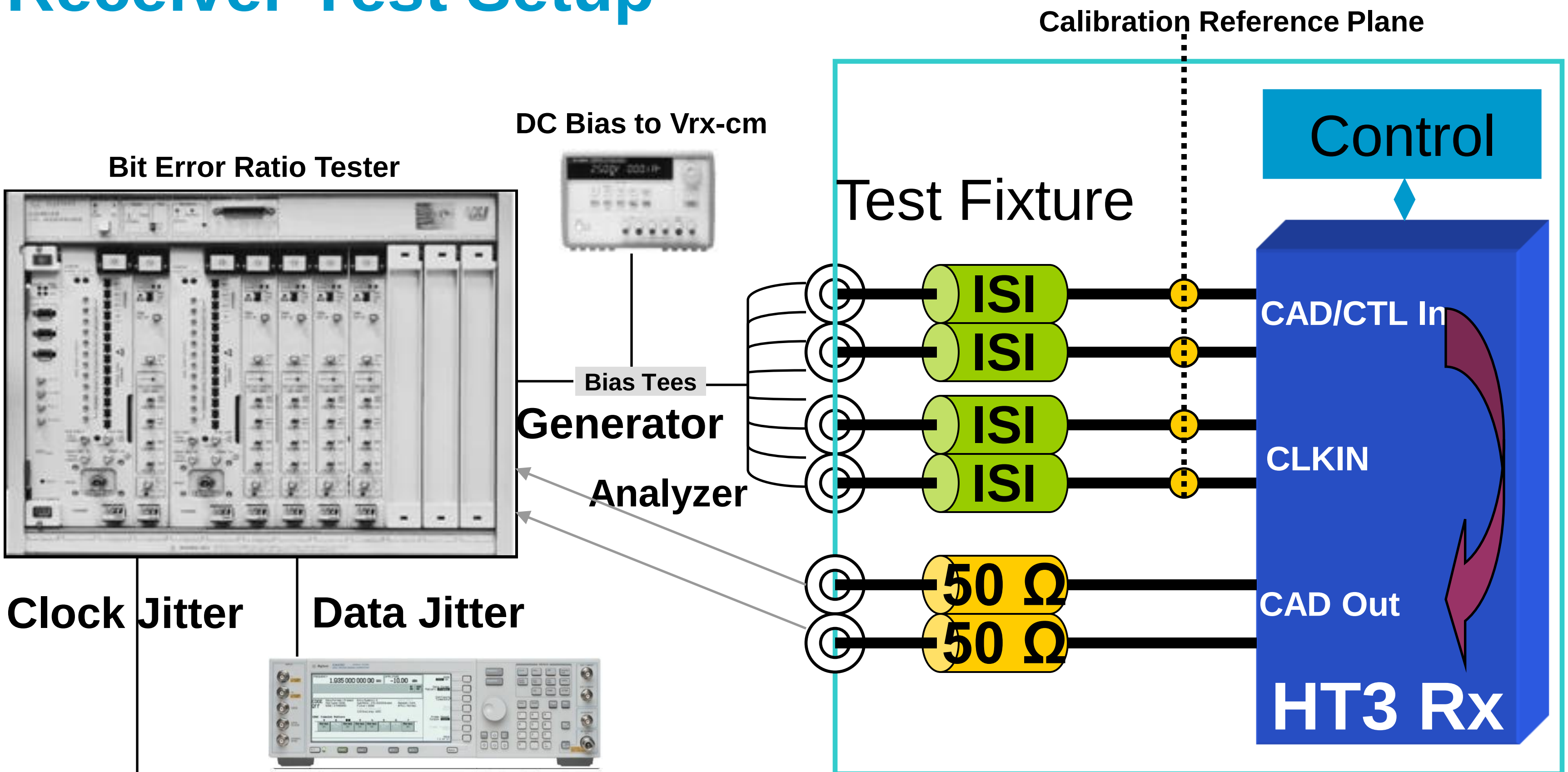
$$scale = \frac{2 \cdot deemp}{1 + deemp}; \quad offset = -\frac{1 - scale}{4}$$

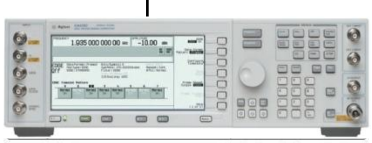
Each bit of waveform scaled based on de-emphasis level



De-emphasis precisely normalized to allow compliance measurement

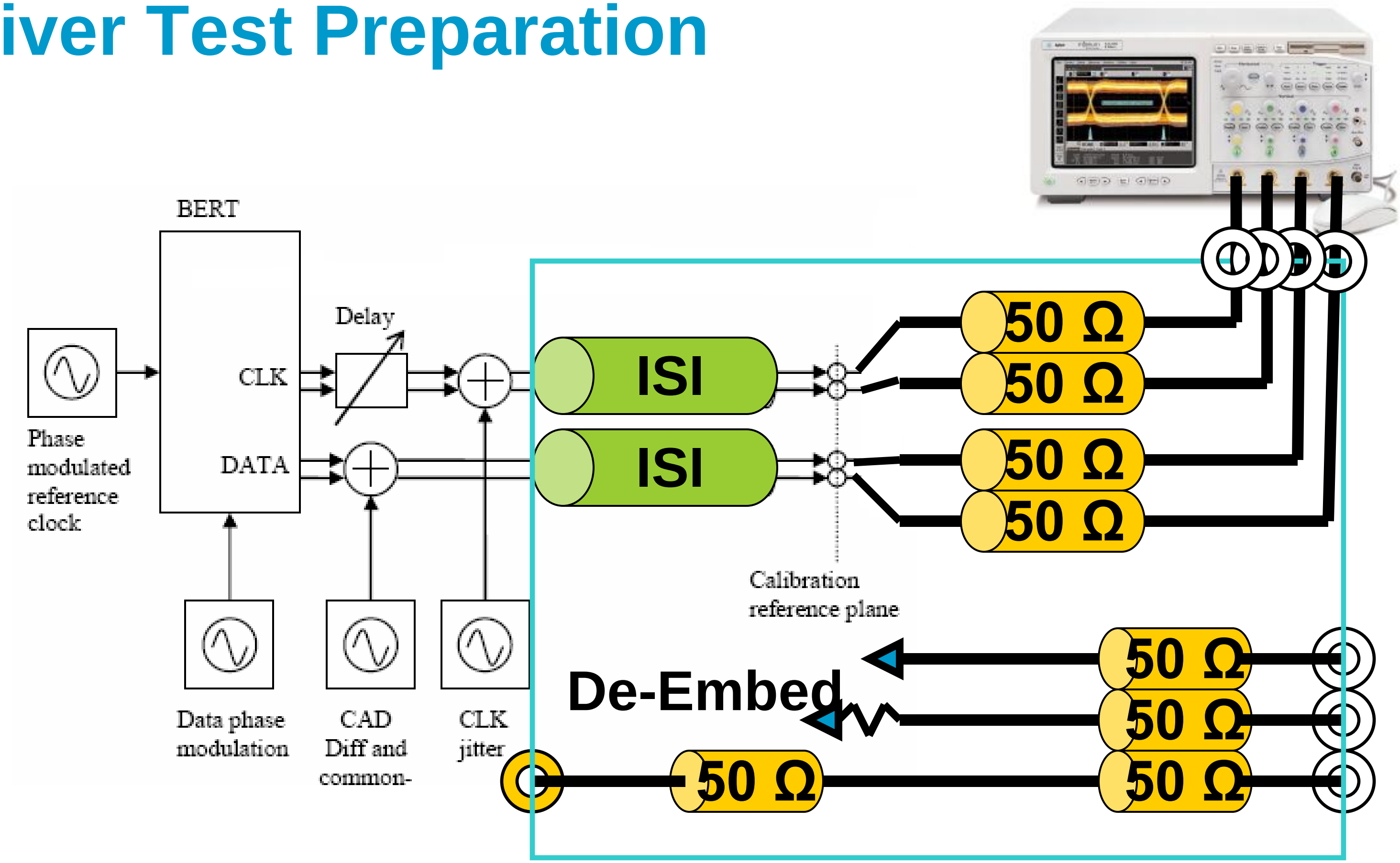
Receiver Test Setup





- BERT generates calibrated output at Rx reference plane (voltage and jitter)
- ISI Generator compensates for De-emphasis
- HT3 Receiver configured in loopback mode to allow BERT to detect Rx errors

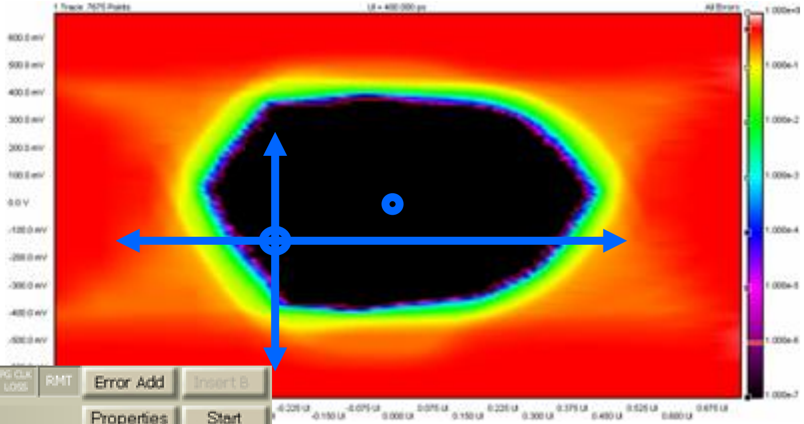
Receiver Test Preparation

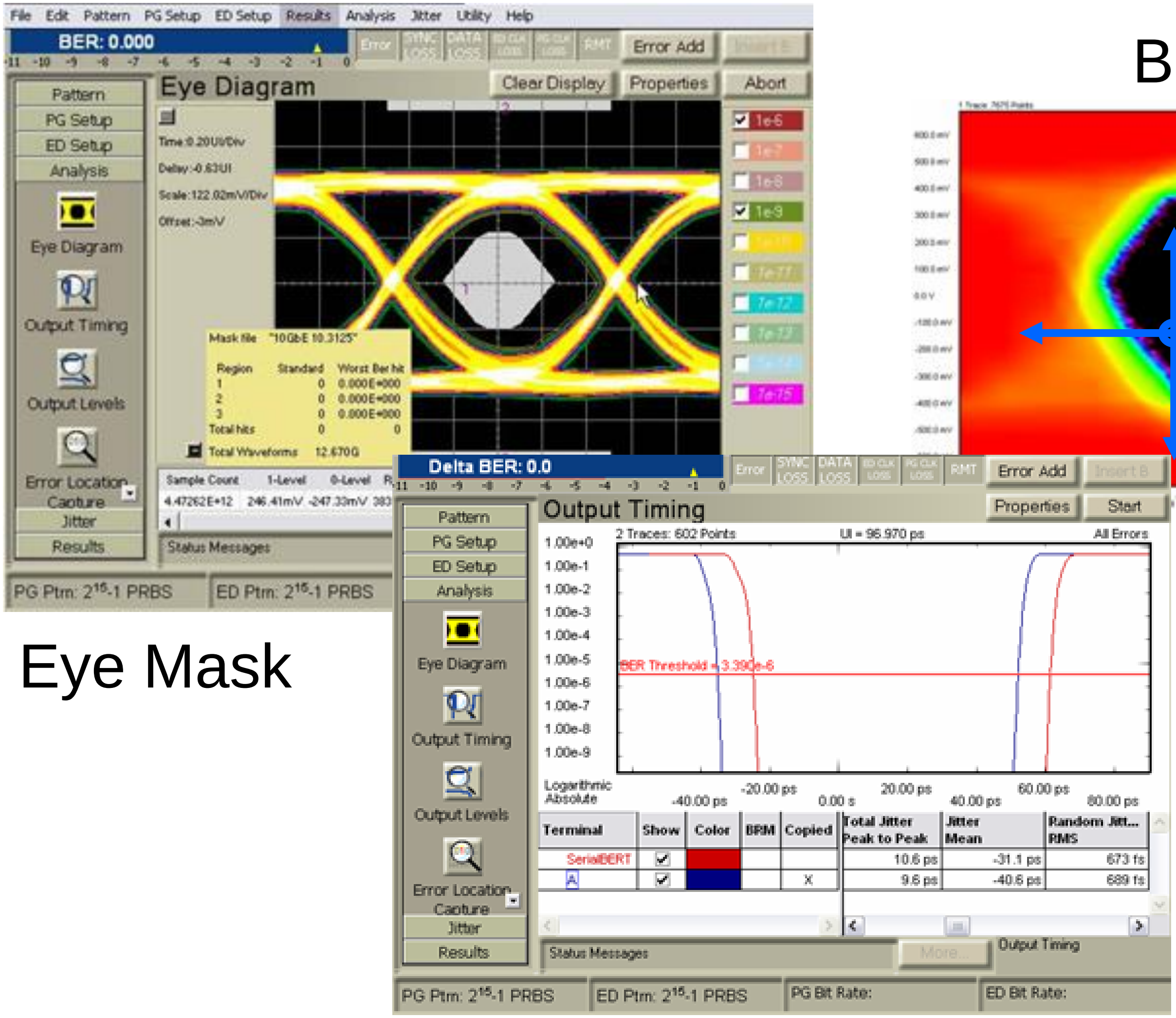


- BERT and jitter sources adjusted to produce compliance eye at reference plane
- ISI generator may be actual one driving HT3 Rx, or a calibrated copy
- Scope detects when compliance eye is created, based on de-embedding of scope probe connection to ISI generator

Receiver Eye Measurement

BER Contour



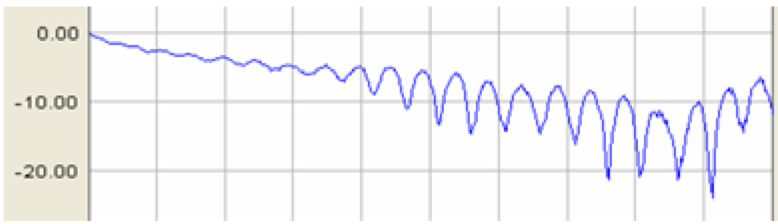


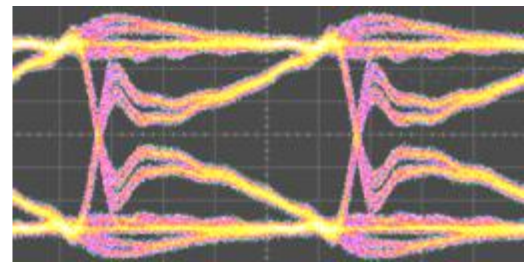
Eye Mask

Bathtub

Channel Compliance Methodology

- Direct specification of frequency or time domain characteristics of a microwave channel built from low cost materials (FR4) can be very complicated
  - What kind of mask could be used to tell if these channels are compliant?

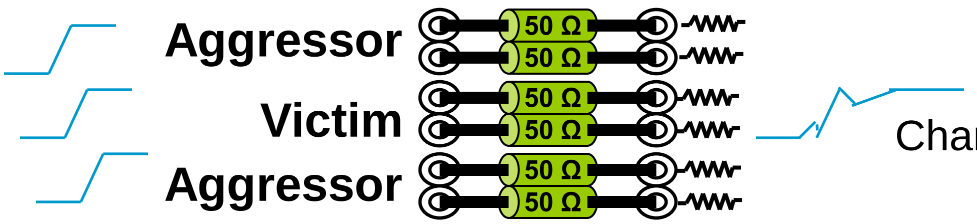




- What really counts is whether the transmitted eye, when traveling over a real channel, produces a signal the receiver can recognize
- HT3 takes a pragmatic approach that allows a channel to be physically measured and then tested in simulation for compliance

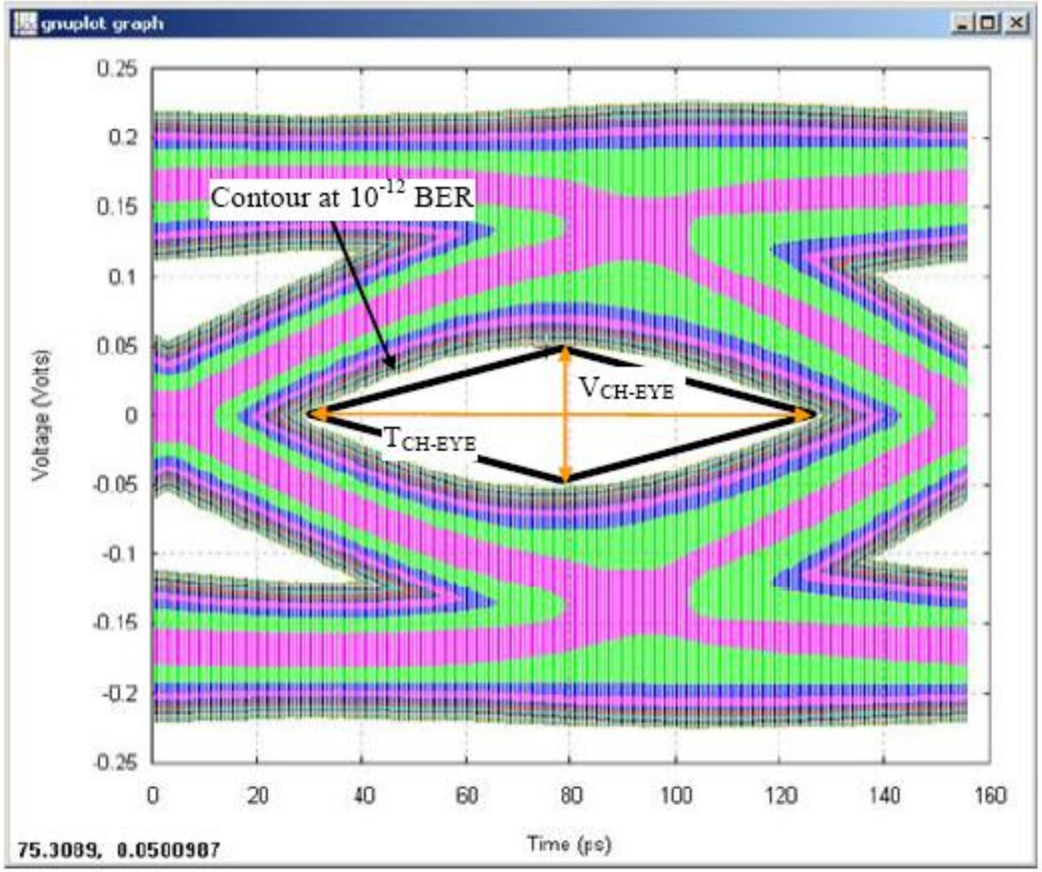
HT3 Channel Compliance

- Measure (or compute from 3D field solver) the channel step response. Include crosstalk effects:



  - This can be done with a 12 port VNA or TDR/TDT measurements
- Describe the statistical behavior of a worst case HT3 transmitter, including de-emphasis and pulse width jitter
- Simulate the channel's response to this stimulus using a statistical eye diagram simulation. Include clock crosstalk by modeling it as a data channel transmitting a 1010 pattern. (AMD's J-eye tool is described in the HT3 spec, although similar tools such as StatEye also exist.)
- Compare the statistical eye at 1E-12 BER to HT3 compliance mask

HT3 Statistical Eye Measurement



Functional Validation

- Validation of HT3 functionality and compliance utilizes standard protocol testing strategies
  - Software stress tests
  - System level white box and black box testing
  - HW protocol test state machines
  - Protocol analysis to allow visibility of stimulus and response
- Access to the HT3 channel for protocol analysis can help

Summary

- HyperTransport 3's microwave signaling speeds demand new approaches to design and test
  - High performance test fixtures
  - De-embedding of probing and fixture losses
  - Statistical approaches to channel validation and compliance
- Existing tools *can* be used to support design validation and implement compliance tests
- Completing your validation and compliance testing will be expedited significantly if the right preparation is done
- For more information:
  - www.hypertransport.org
  - Your local Agilent application and field engineer

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Questions and Answers

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