SAS-2 Application of StatEye v5

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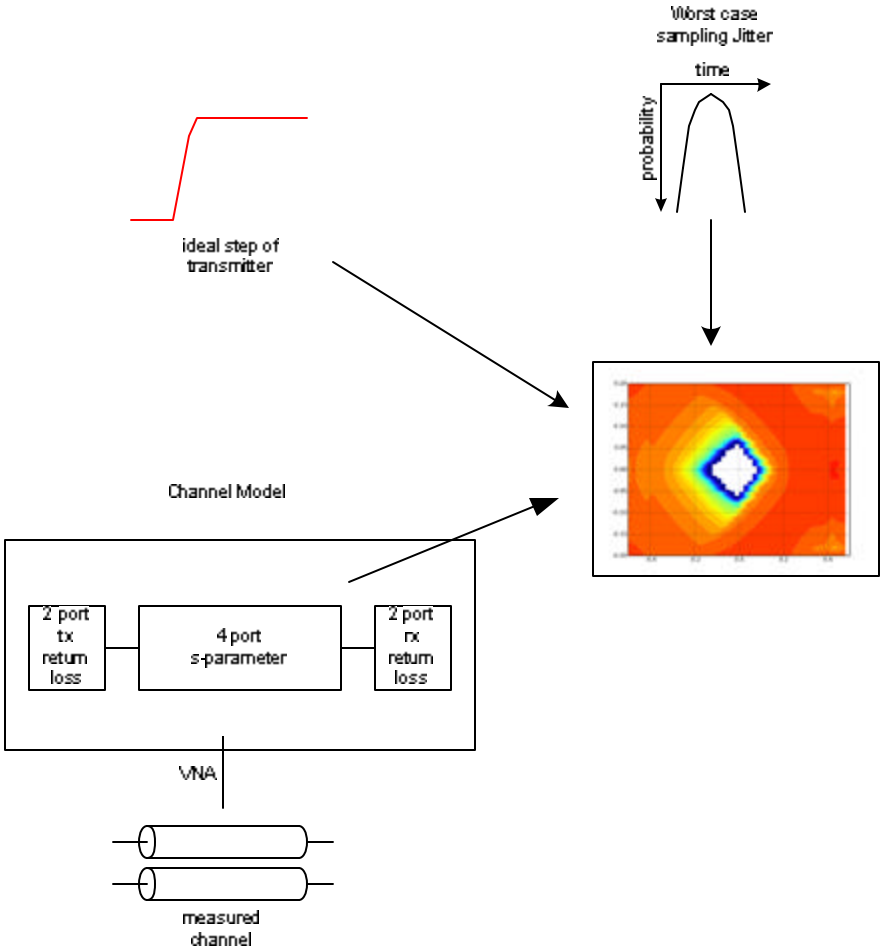
Harvey Newman
Monday, 05 Nov 07
T10/07-491r1

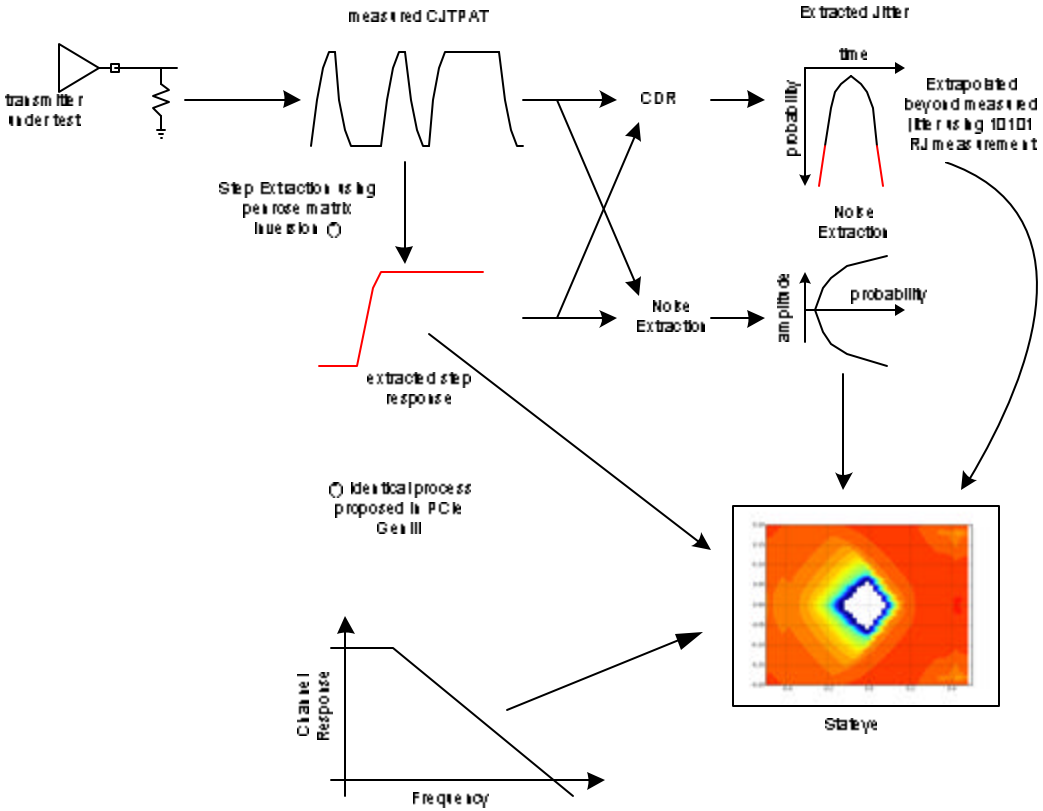
Never stop thinking

Channel Compliance



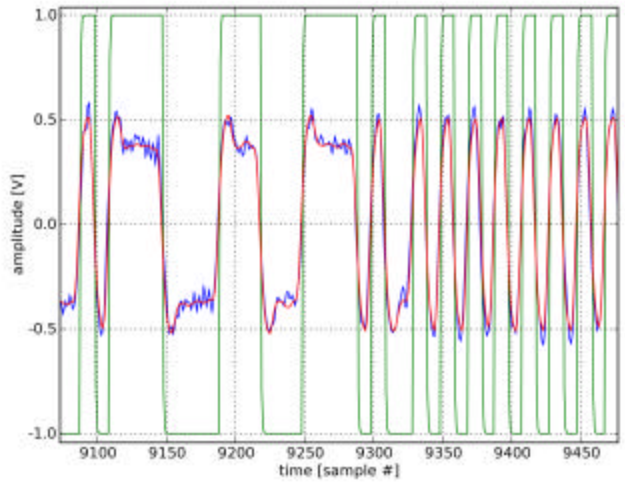
- Channel compliance is the classic usage model of stateye, with a measured channel being cascaded with reference return loss models of the transmitter and receiver
- In combination with a worst case transmit jitter and ideal step response, the channel capability with a given equalisation de-emphasis and DFE can be tested
- A GUI Wizard is currently in development

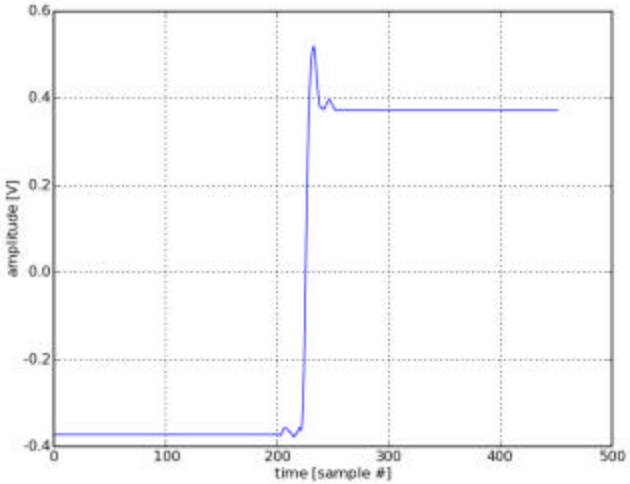
Transmitter Compliance



- Transmitter with CJTPAT is measured into a test load
- From signal the step response is extracted
- Using a CDR and Amplitude Noise Extraction function the timing jitter and amplitude noise is extracted
- These fundamental descriptions of the transmitter in combination with the test channel is then used to generate a Stateye which can be tested again the compliance requirements

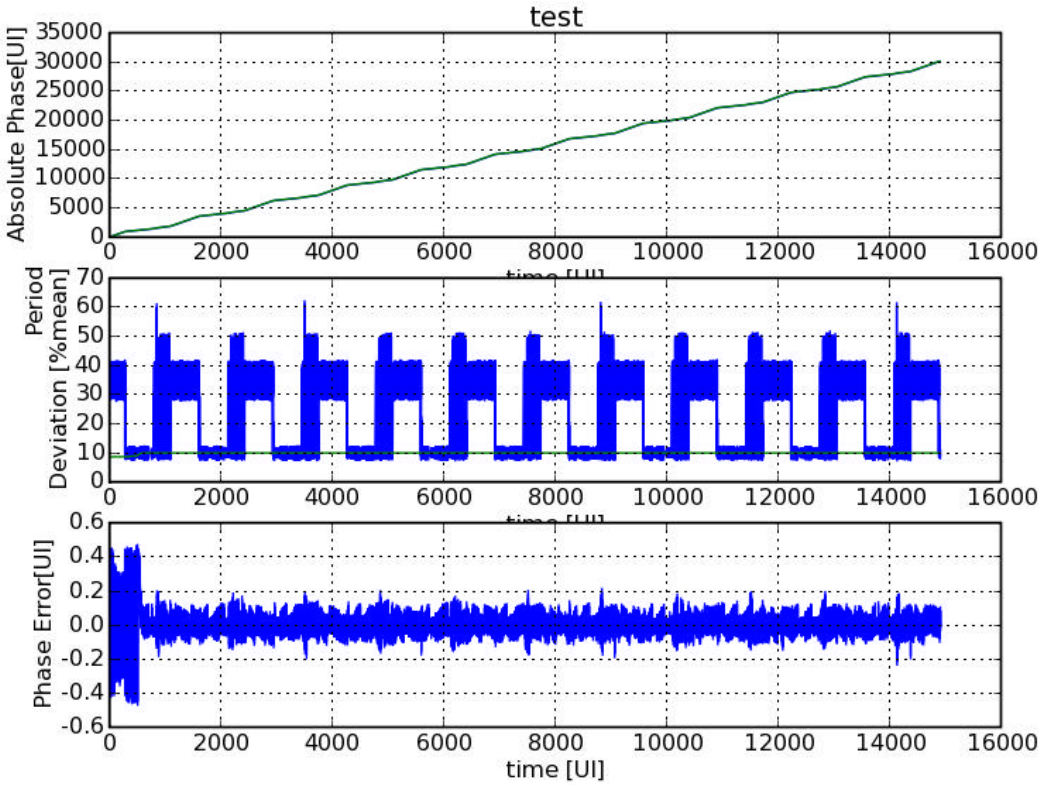
Silicon Correlation using real silicon Step Extraction





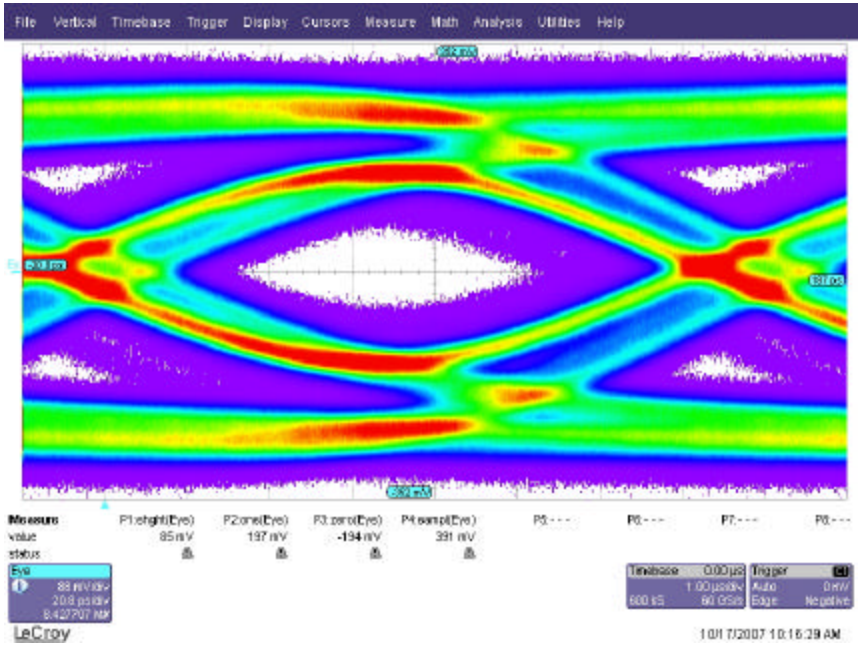
- From a measured CJTPAT signal (blue left) the equivalent step response (right) can be extracted by utilizing a penrose matrix inversion
- The accuracy of the step response is demonstrated by reconstructing the signal (red) using a fundamental transmit signal (green left).
- This fundamental transmit signal (green left) contains the true timing jitter of the transmitter and is then further used for the high frequency sampling jitter extraction
- This method is very similar to currently discussed transmitter compliance testing in PCIe Gen III

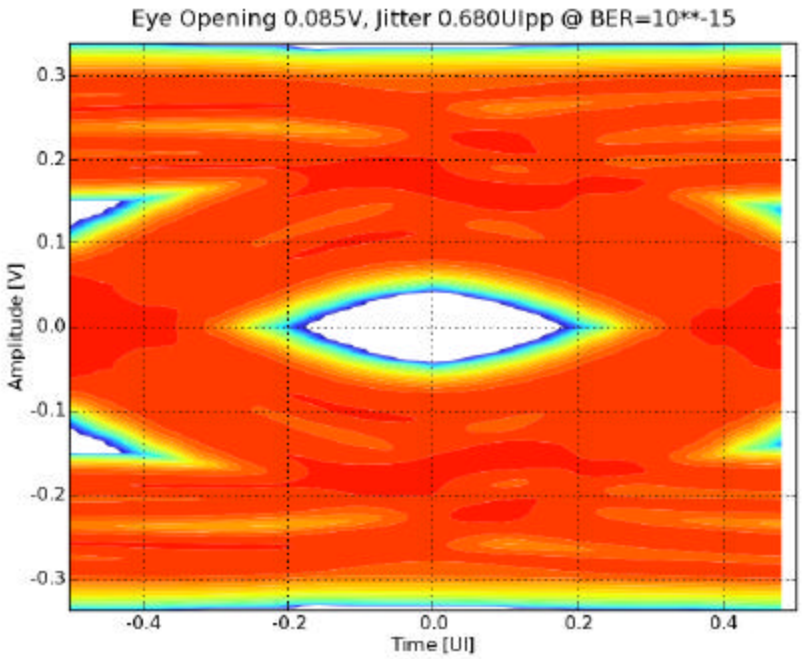
Silicon Correlation using real silicon CDR and Jitter Exactration



- The jitter on the fundamental transmit signal is passed through a compliance CDR transfer function, to extract the high frequency sampling jitter.
- This step is fundamentally important, as the measured signal cannot be used directly for compliance testing as the jitter and data are correlated and only represent a single possible case

Silicon Correlation using real silicon



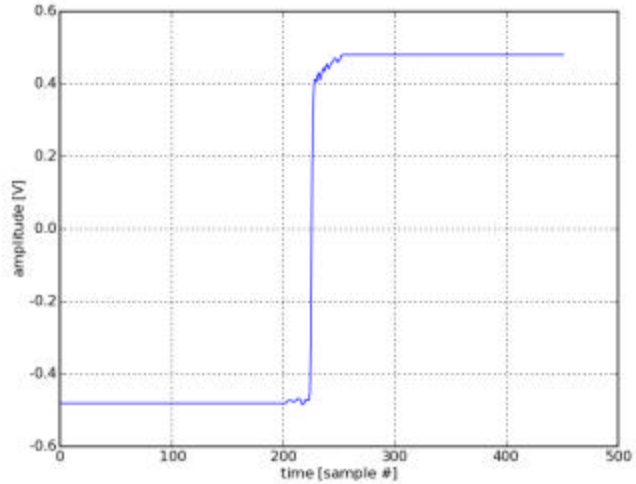


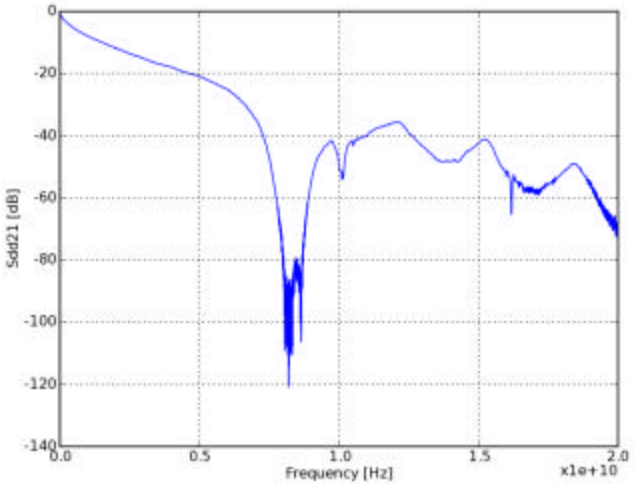
- Using measurements from LeCroy, Tek, and Agilent Real Time and Equivalent Time Scopes a stateye is generated for the output signal of a TCTF channel for no receiver equalization
- When comparing these eye to a measured eye with 0.62UI jitter and 85mV opening, good correction can be seen
- The larger jitter seen with Stateye is clearly a function of the lower sampling population of the RT scope, however, the amplitude shows good correction as the data pattern used has limited statistical content, i.e. 8b10b

Specification Proposal

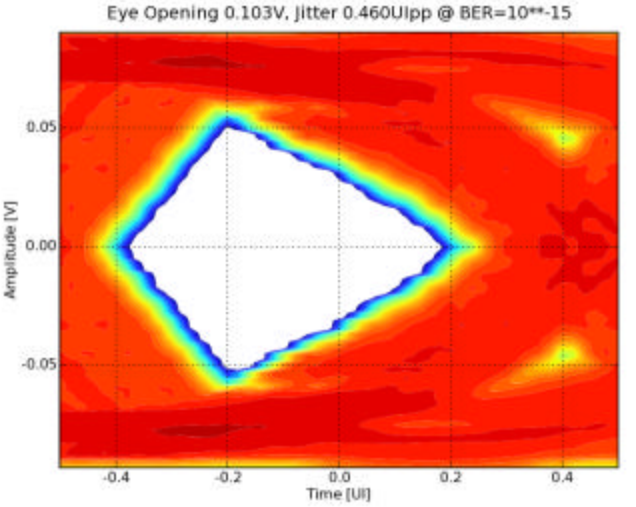
- Effective Transmit Jitter ; DJ=0.15UIpp, RJ=0.15UIpp@1e-12
  - measured with de-emphasis turned on, but measured at virtual test point in transmitter using penrose inversion
- Transmit amplitude ; 1Vppdiff max
- Transmit de-emphasis ; 2dB
- Channel ; Cascaded SAS10m and Transmit/Receiver Reference
- Receiver Equalization ; 3 tap DFE
- Receiver Sensitivity ; 100mVppdiff
- Receiver Jitter ; 0.55UIpp@1e-15

Proof of Specification Proposal
Measured BERT with maximum jitter

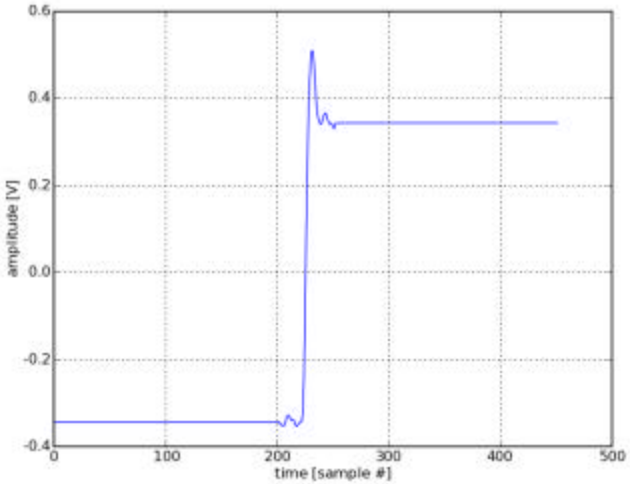


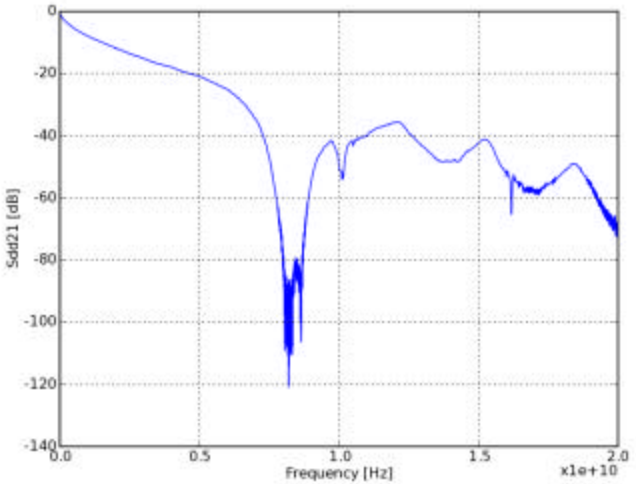


- RT Scope measurement of BERT output is used as basis for step response extraction
- De-emphasis is introduced using Stateye
- SAS 10m cable is used, cascaded with transmitter and receiver return loss model

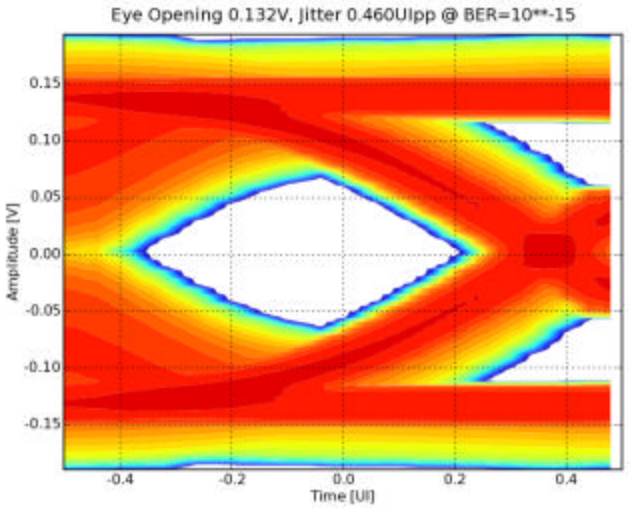


Proof of Specification Proposal
Measured Transmitter with measured jitter





- RT Scope measurement of PHY silicon with de-emphasis turned on is used for step response extraction and jitter extraction
- Good silicon correction was seen with this step response and the TCTF channel
- Resulting eye opening is within compliance requirement



Conclusion

- Stateye v5 has been seen to correlate against silicon measurement
- Stateye v5 has been shown to be able to compliance test a silicon transmitter based on generally available test equipment
- Propose Stateye v5 as
  - a means for transmitter compliance testing of SAS Gen III transmitters
  - a means for channel compliance testing of SAS Gen III cables
- Propose transmit jitter, transmit amplitude, transmit de-emphasis, reference receiver equalization, and post equalisation receiver tolerance specification as seen on pp.7
- Propose crosstalk is dealt with using a “real” channel, in a similar fashion to Stateye v4

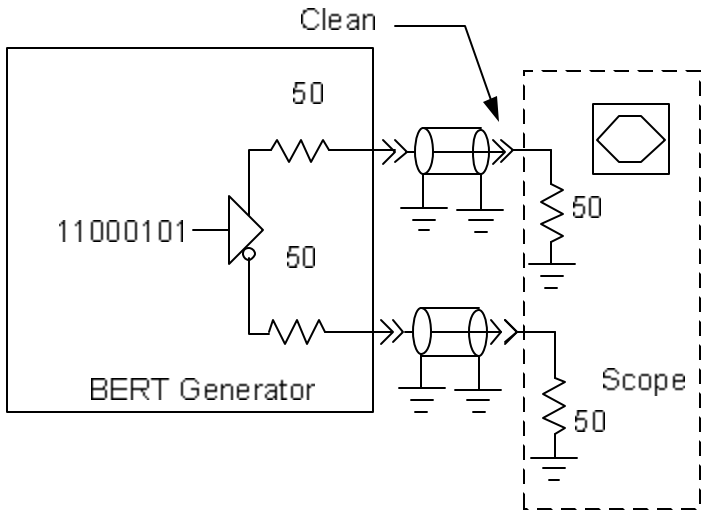
Timescale for final release

- GUI and Wizard for Channel Compliance
  - Edotronik is currently engaged in technical discussion for upgrading the GUI and XML parser to support v5
  - Currently targeting End of December for useable beta release
- Transmit compliance
  - Necessary API for measurement equipment tested for all major instrumentation companies
  - 1st integration of v5 into instrumentation to commence mid November
  - Release date being discussed with Instrumentation companies

Measurements

- Supplemental measurement section

Clean interface

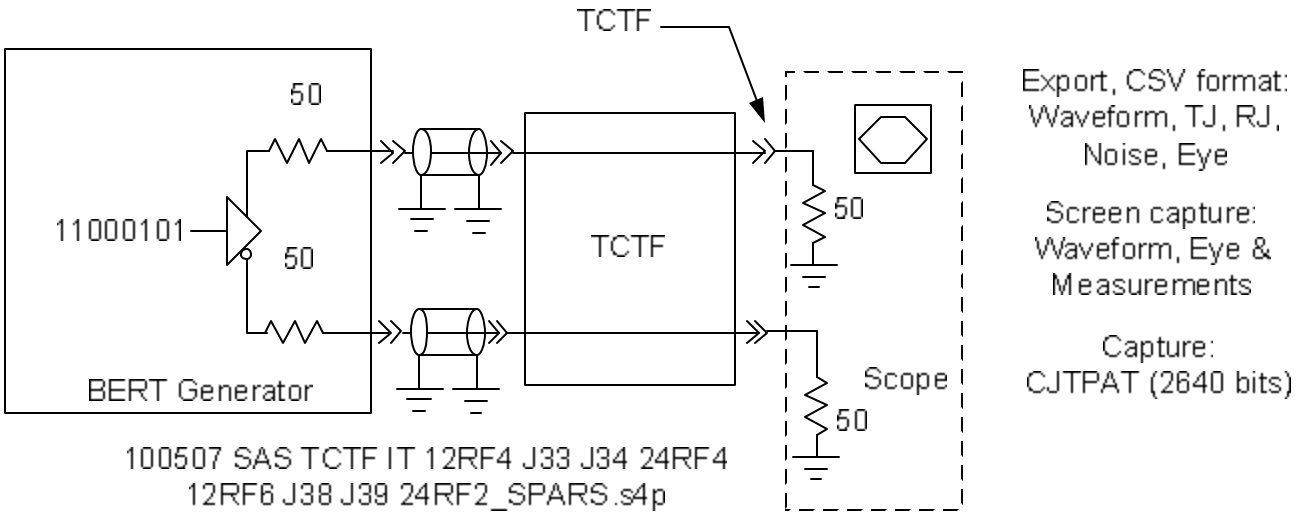


Export, CSV format:
Waveform, TJ, RJ,
Noise, Eye

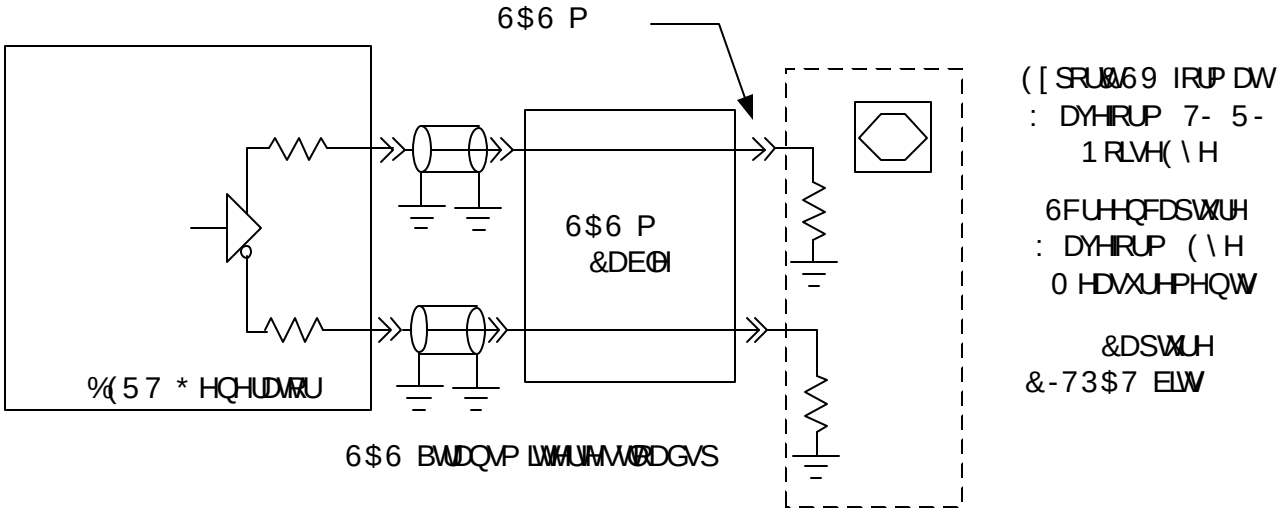
Screen capture:
Waveform, Eye &
Measurements

Capture:
CJTPAT (2640 bits)

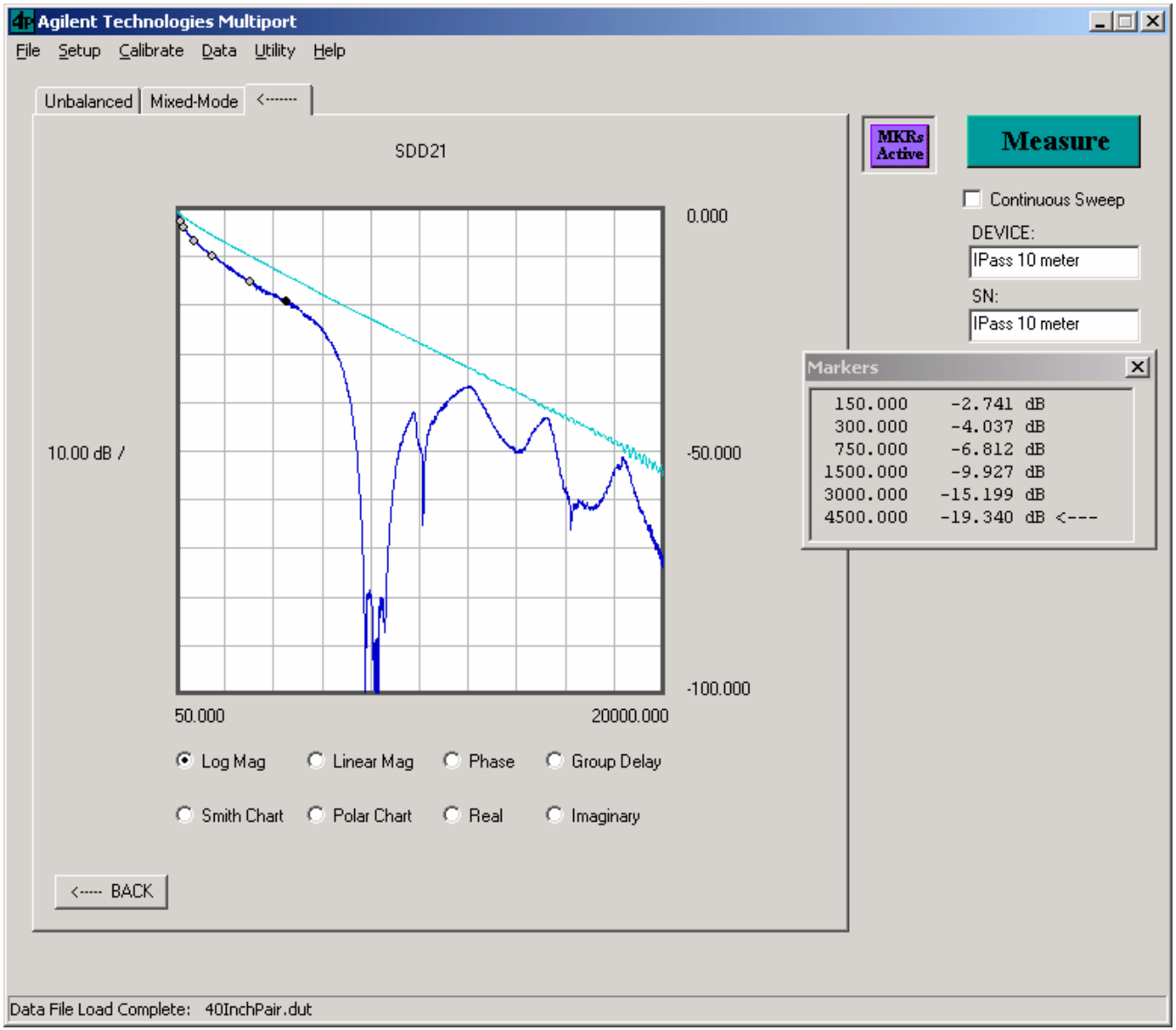
TCTF Measurement



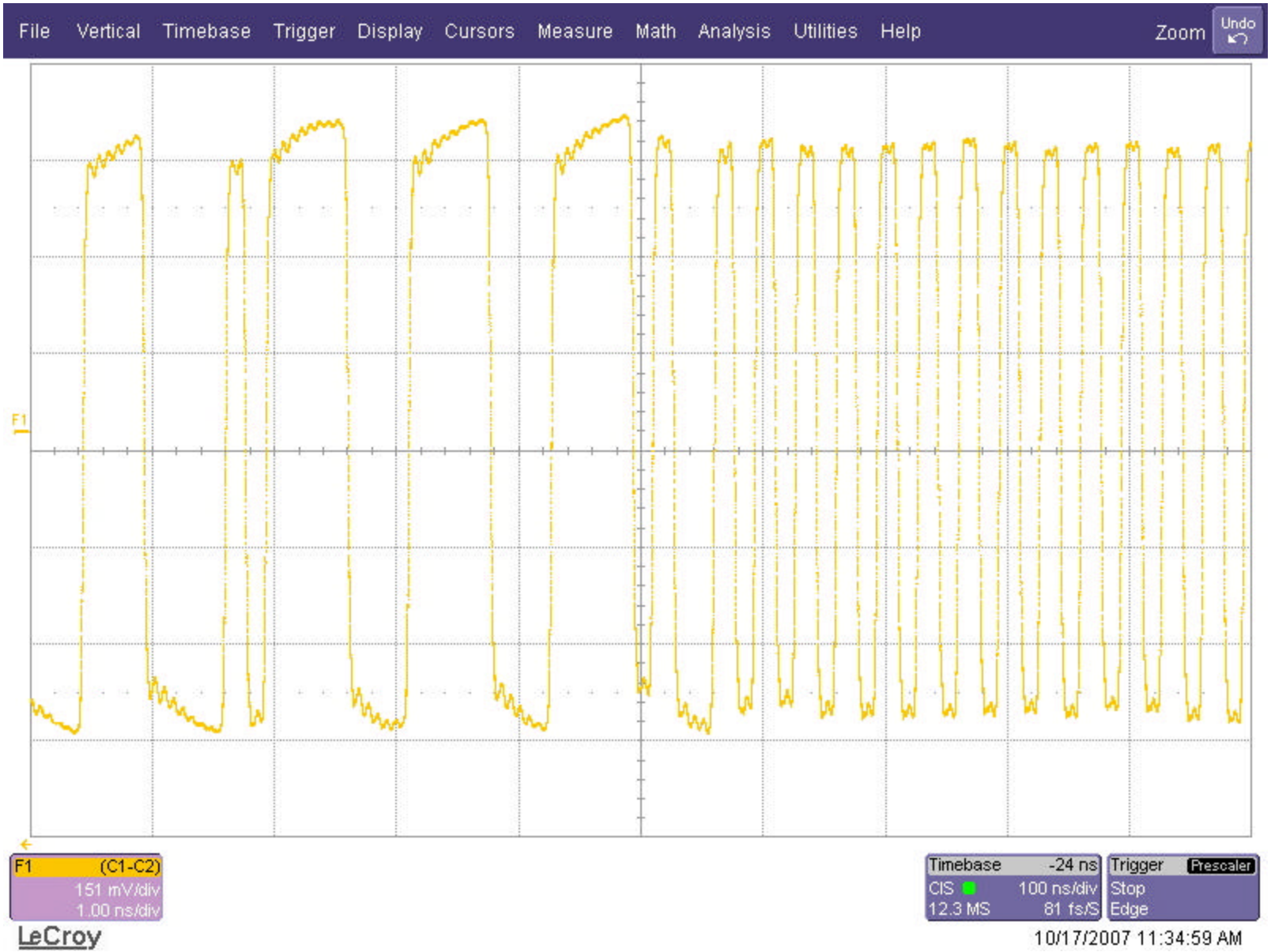
SAS 10 m Measurement



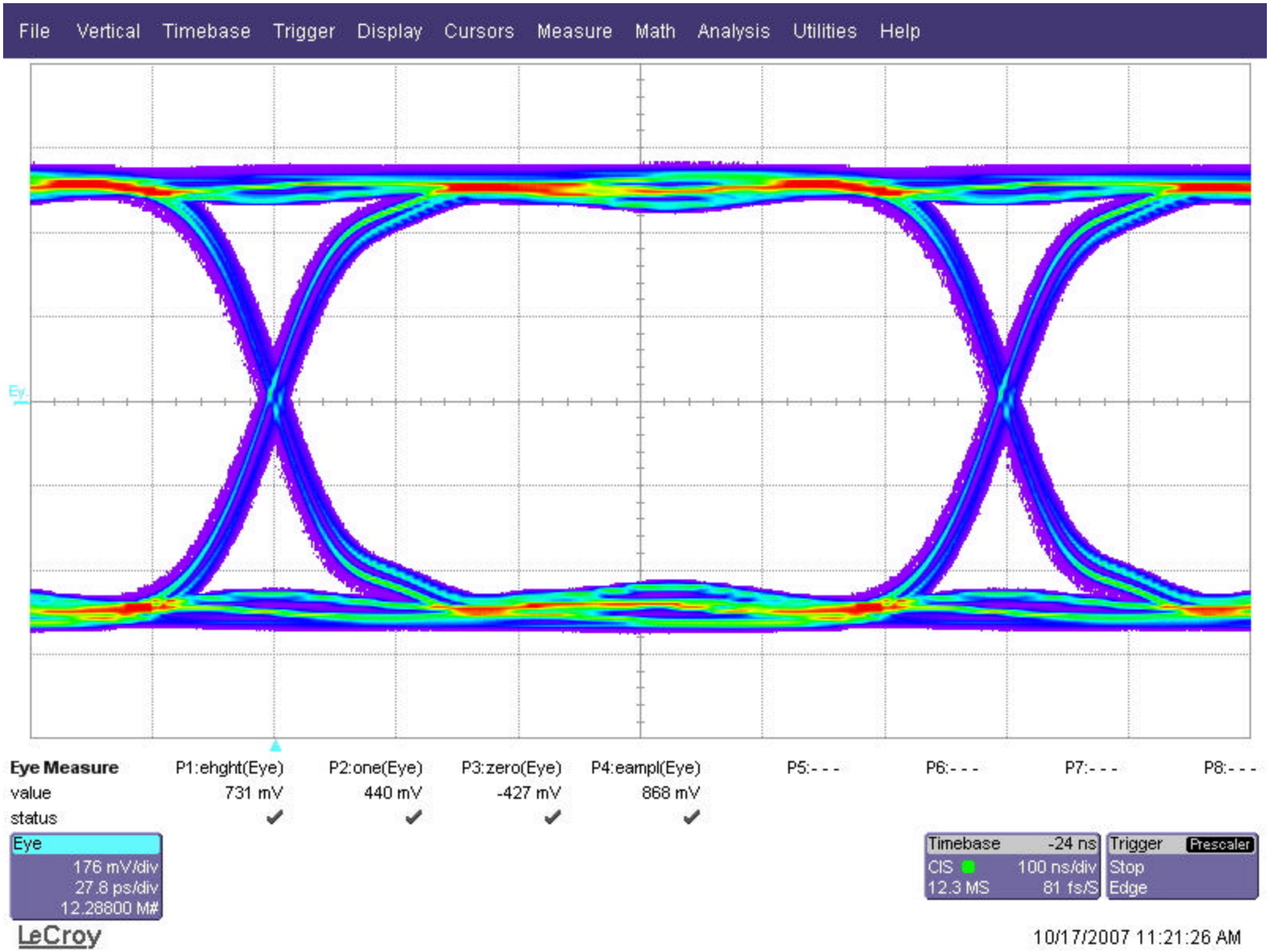
TCTF and SAS 10m



Equivalent Time bert_cjtpat_clean_wfm

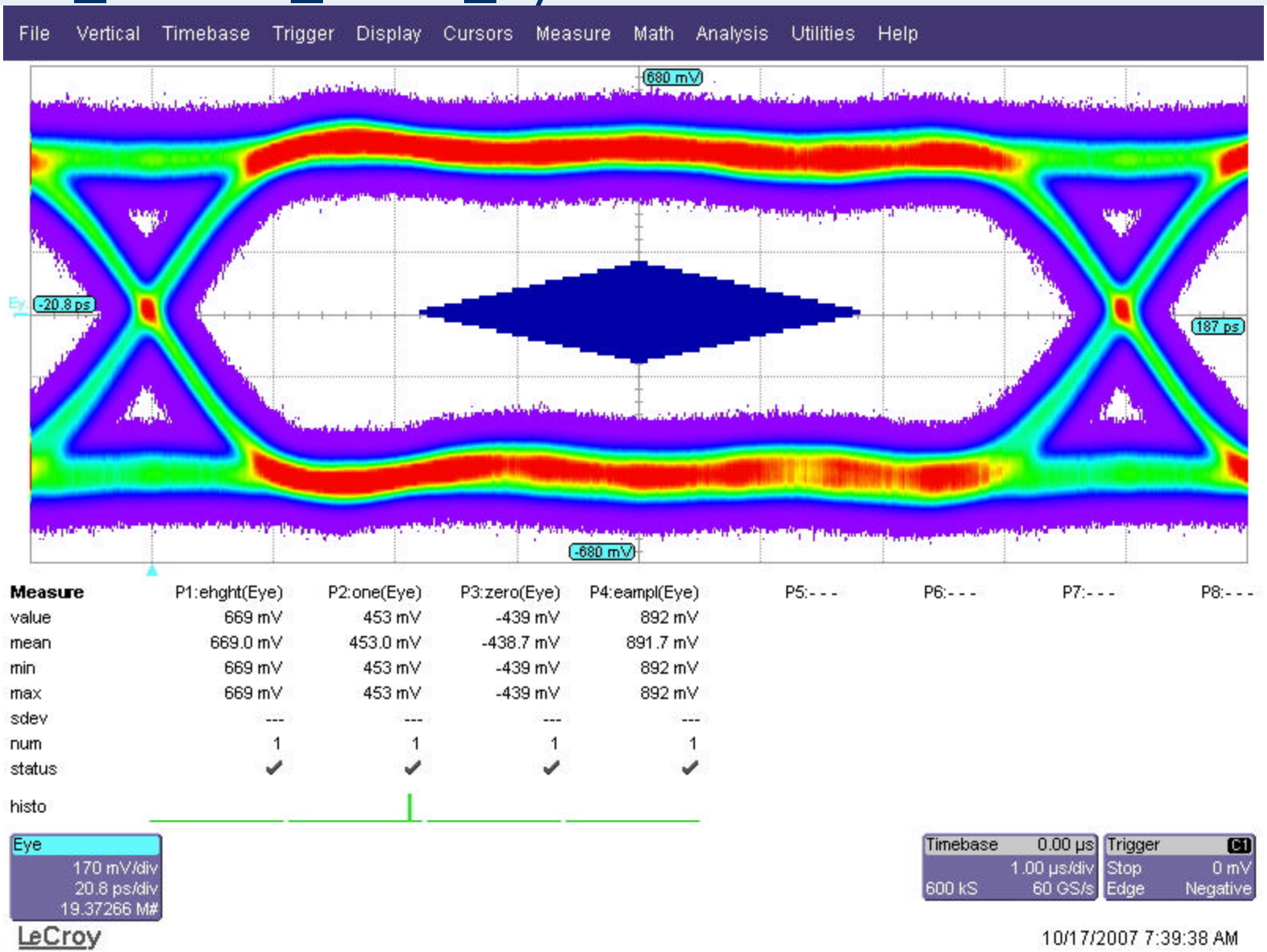


Equivalent Time bert_cjtpat_clean_eye

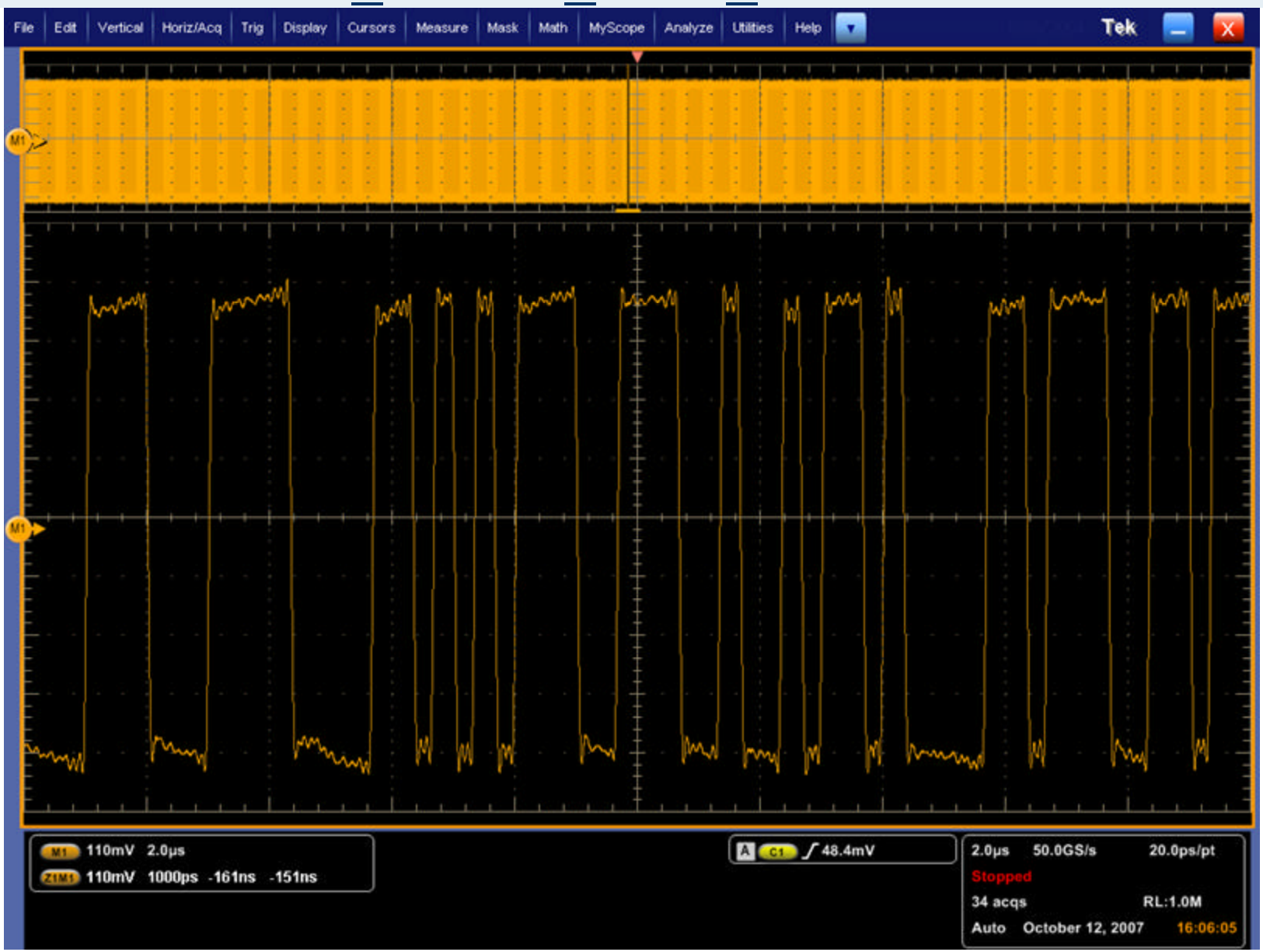


Real Time Bert_CJTPAT_Clean_wfm

Bert_CJTPAT_Clean_Eye



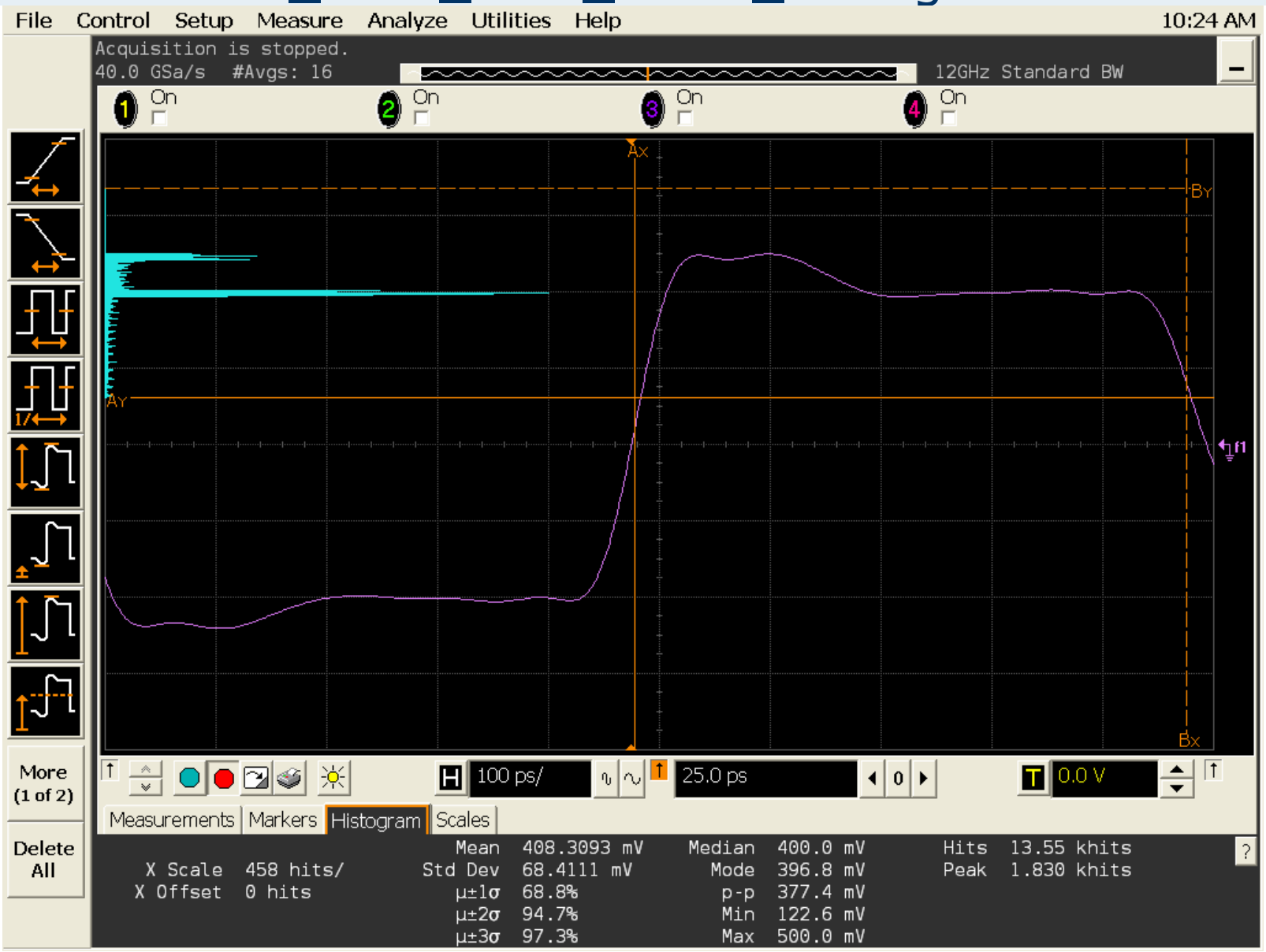
Real Time BERT_CJTPAT_clean_6G



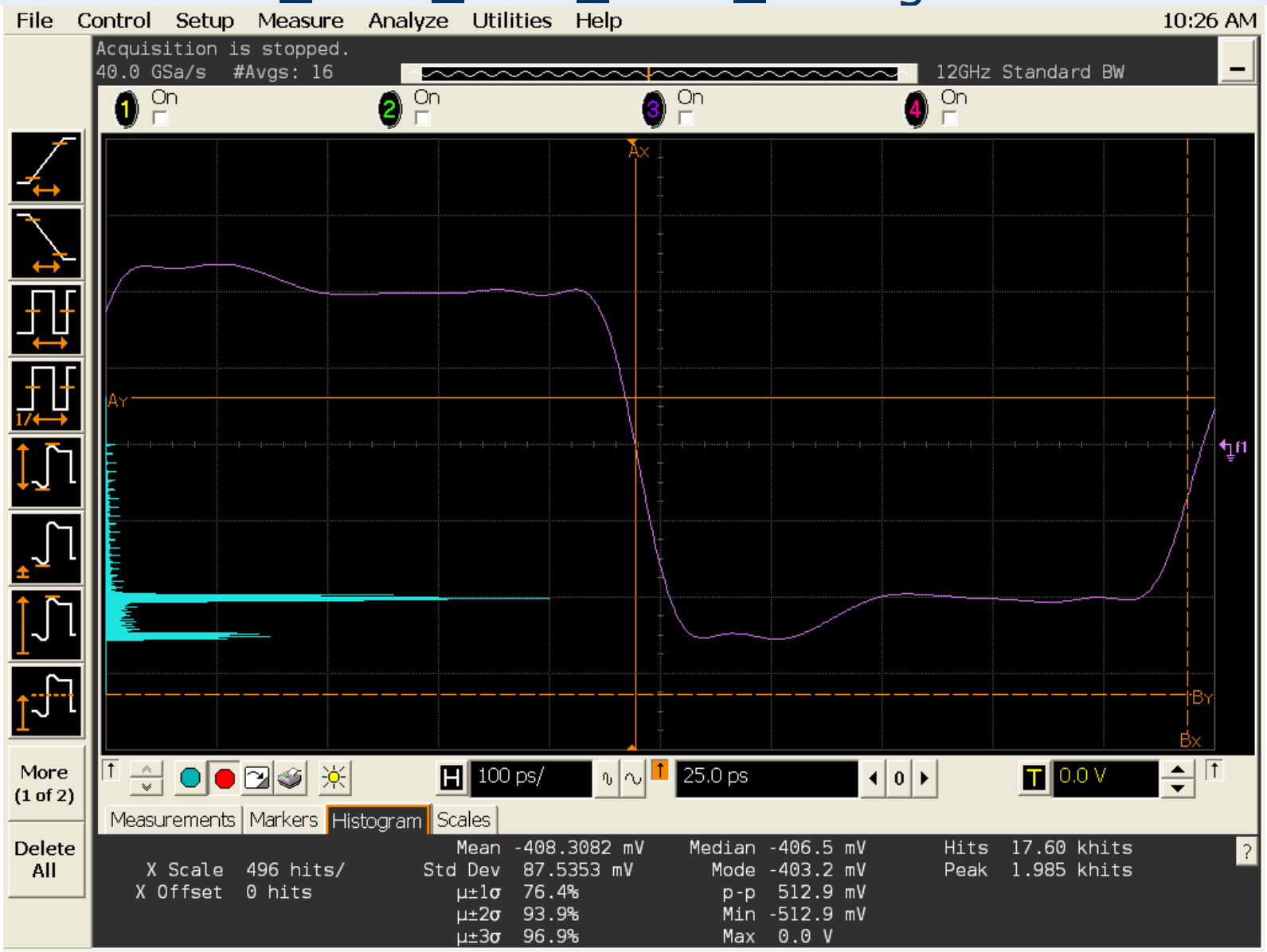
Agilent data used de-emphasis

- All Agilent data used a different signal source.
- Rise time filters were used to show rise times to SAS levels.
- De-emphasis module used to set 2dB.
- Peek to peek amplitude adjusted to 1000mVppd

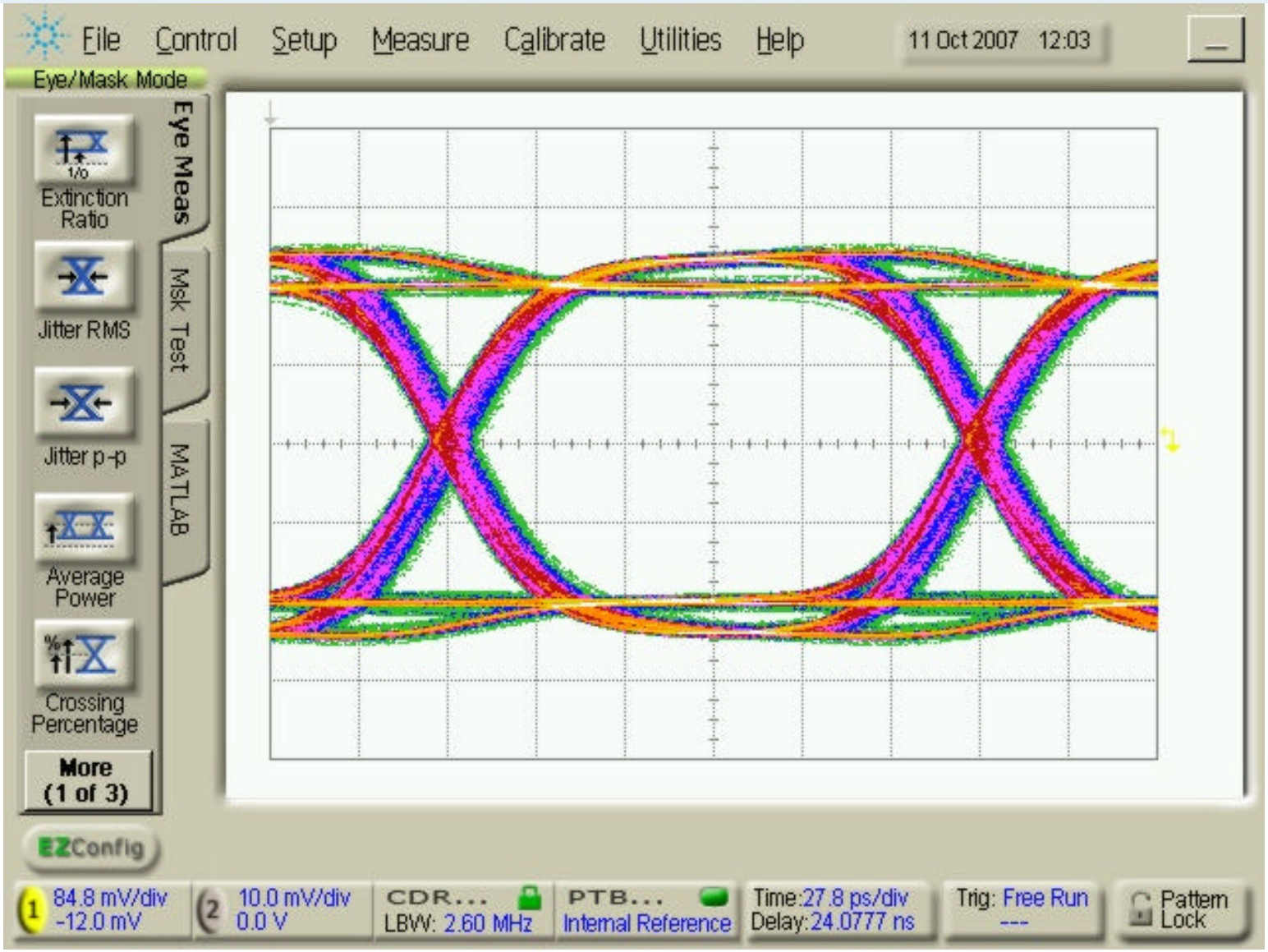
Real Time SAS_LFTP_VMA_VMax_Histogram



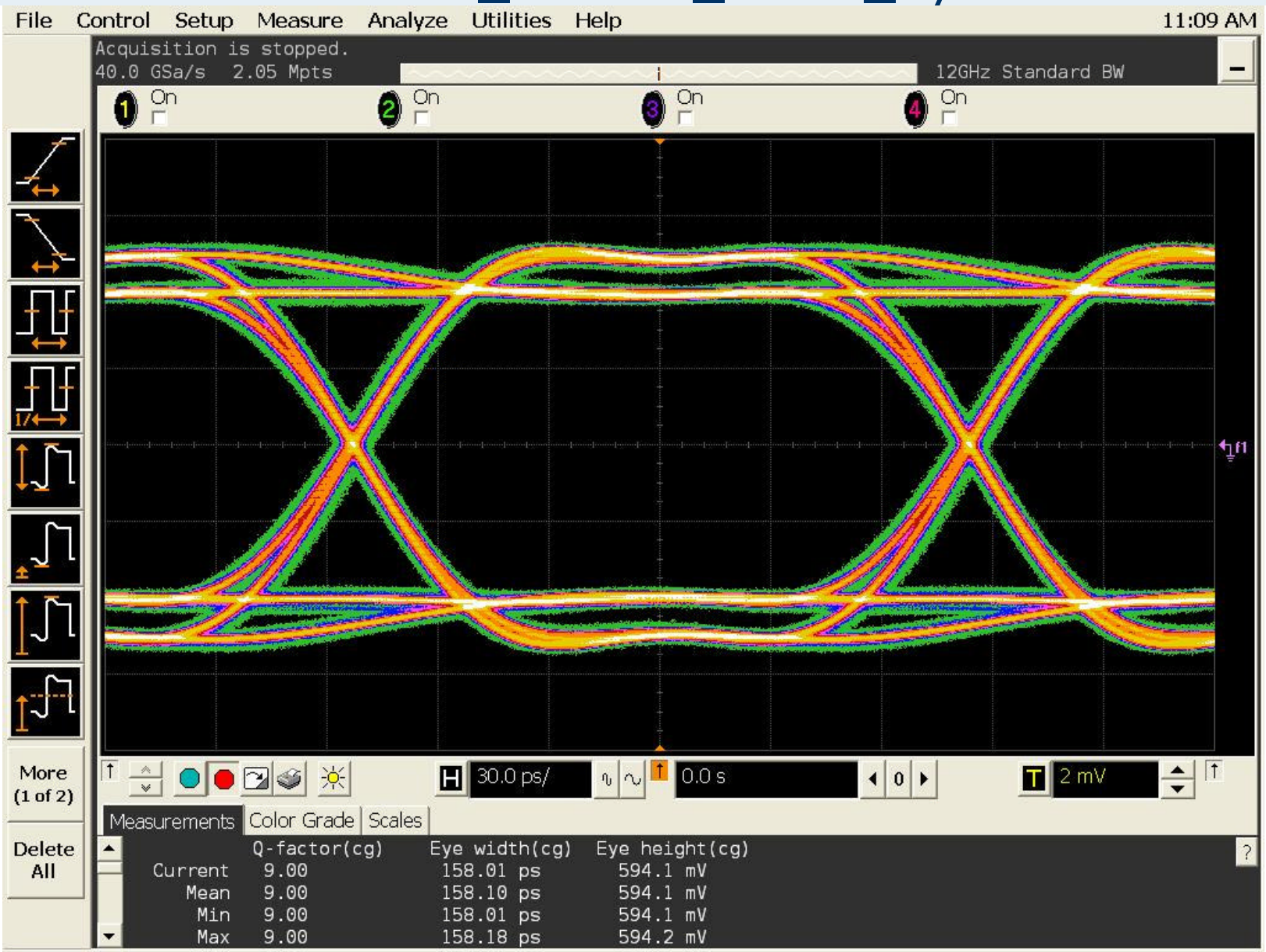
Real Time SAS_LFTP_VMA_VMin_Histogram



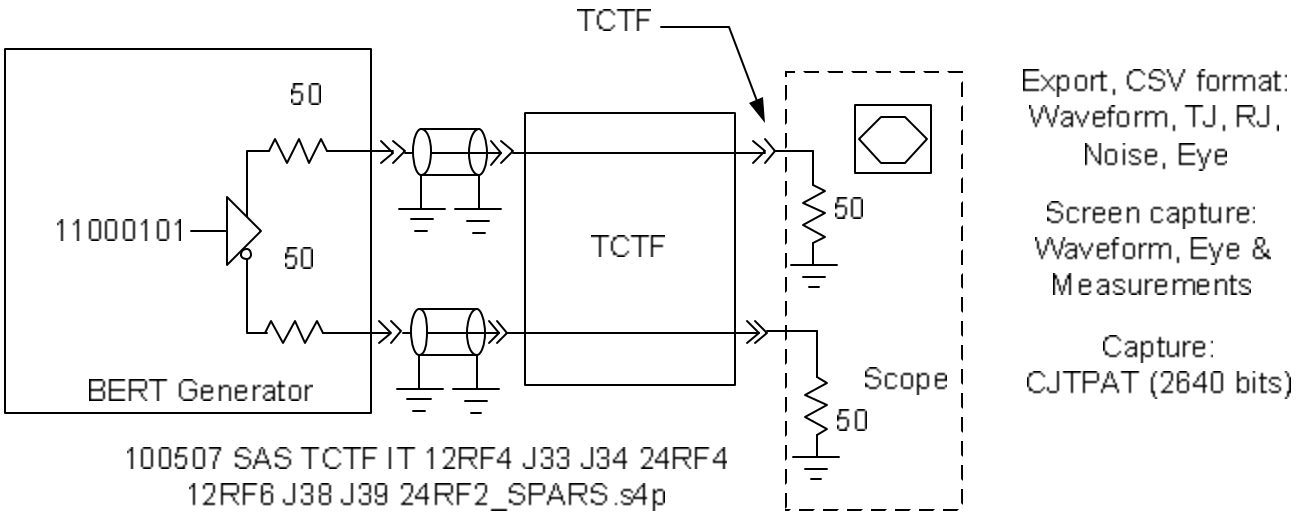
BERT CJTPAT Clean EYE



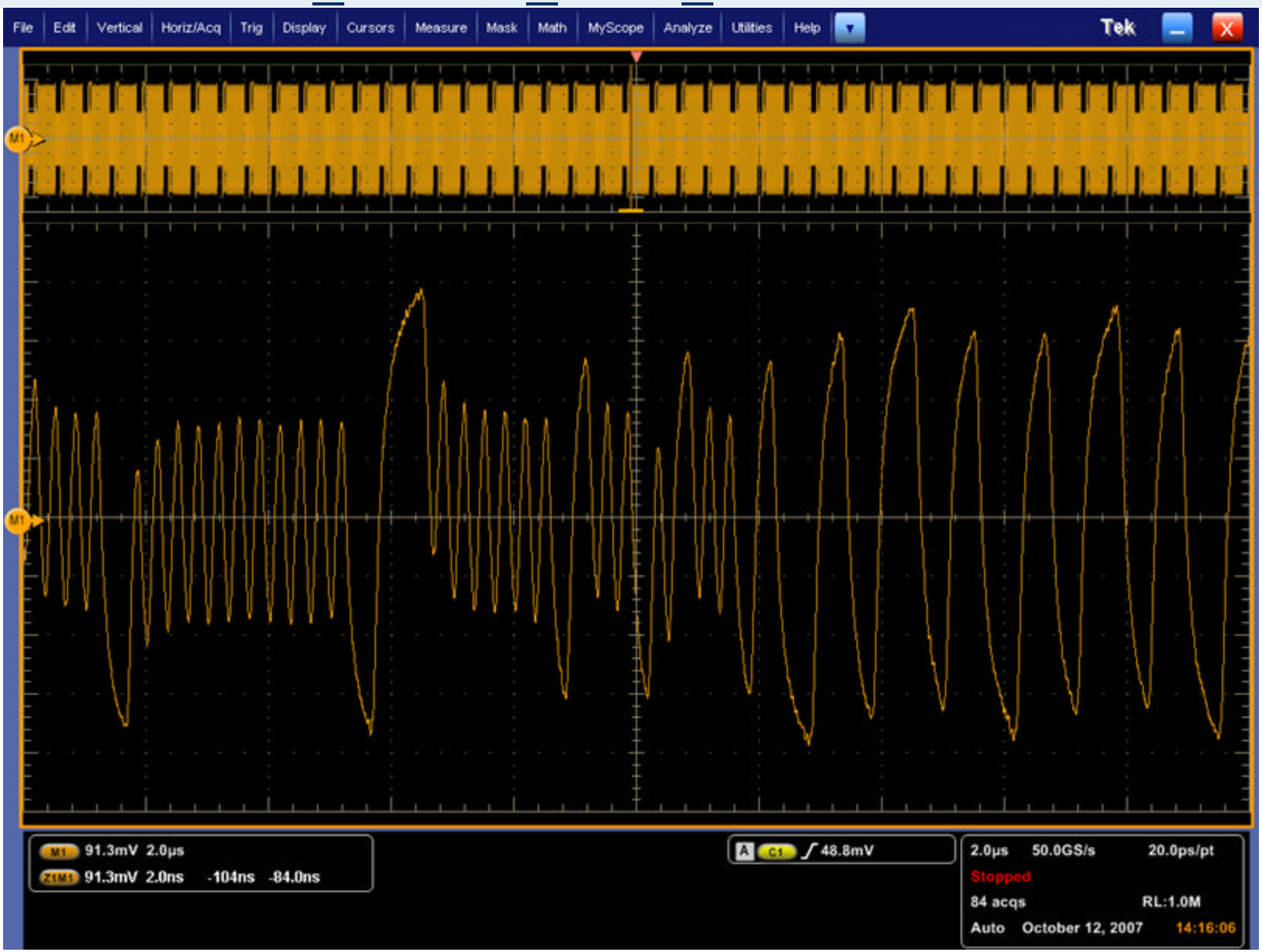
Agilent Real Time SAS_CJTPAT_Clean_Eye



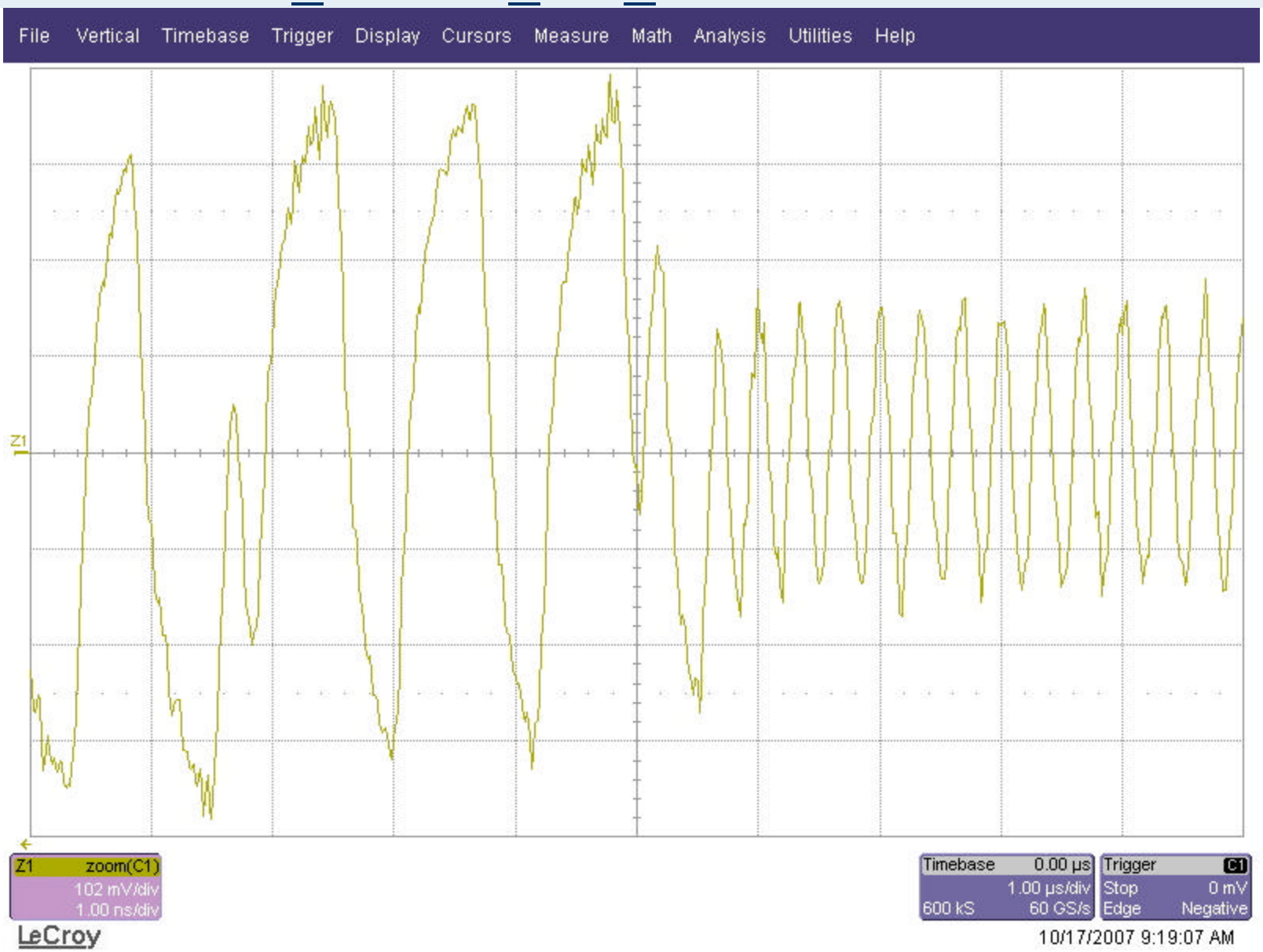
TCTF Measurement



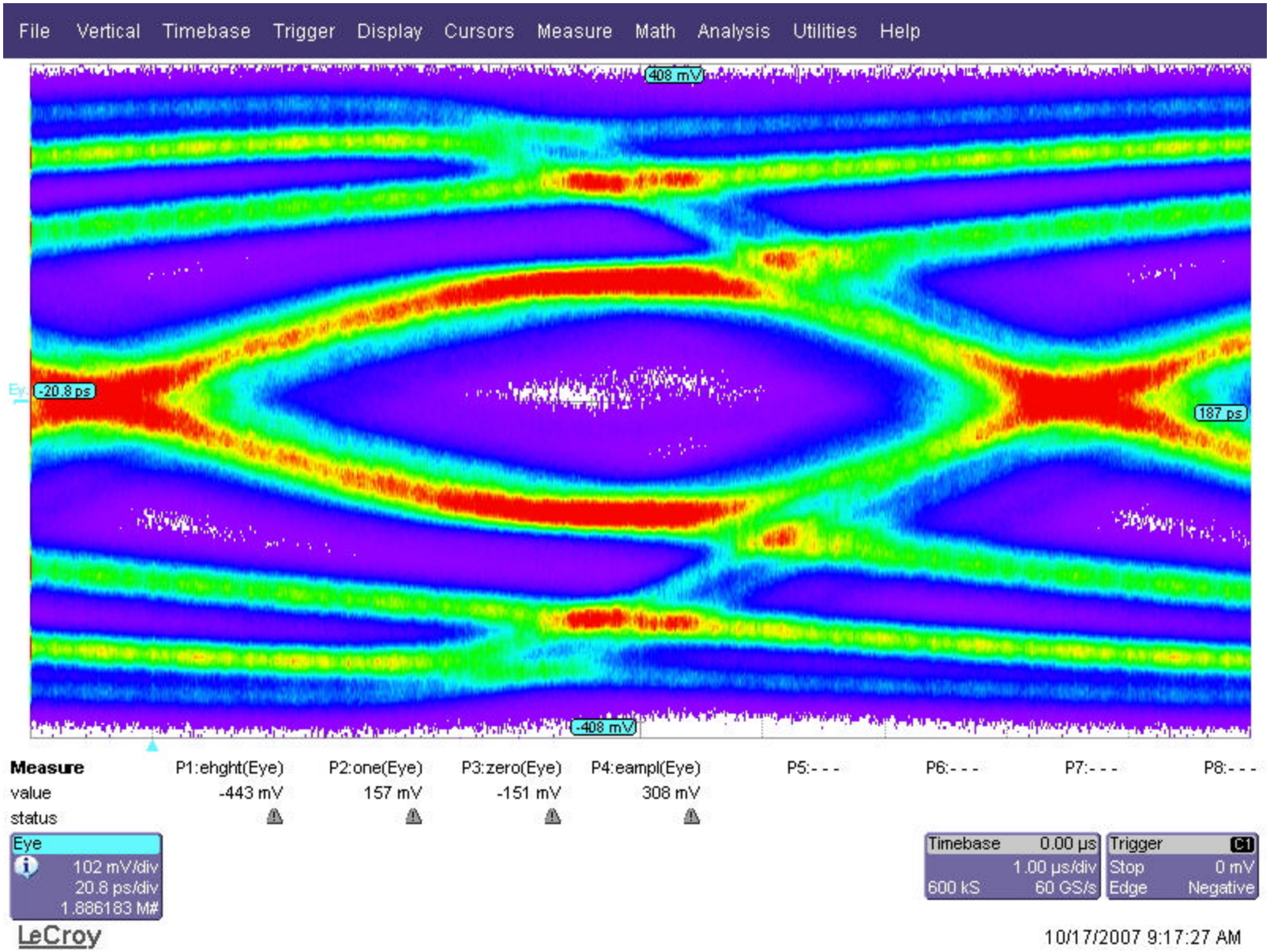
Real Time BERT_CJTPAT_TCTF_6G



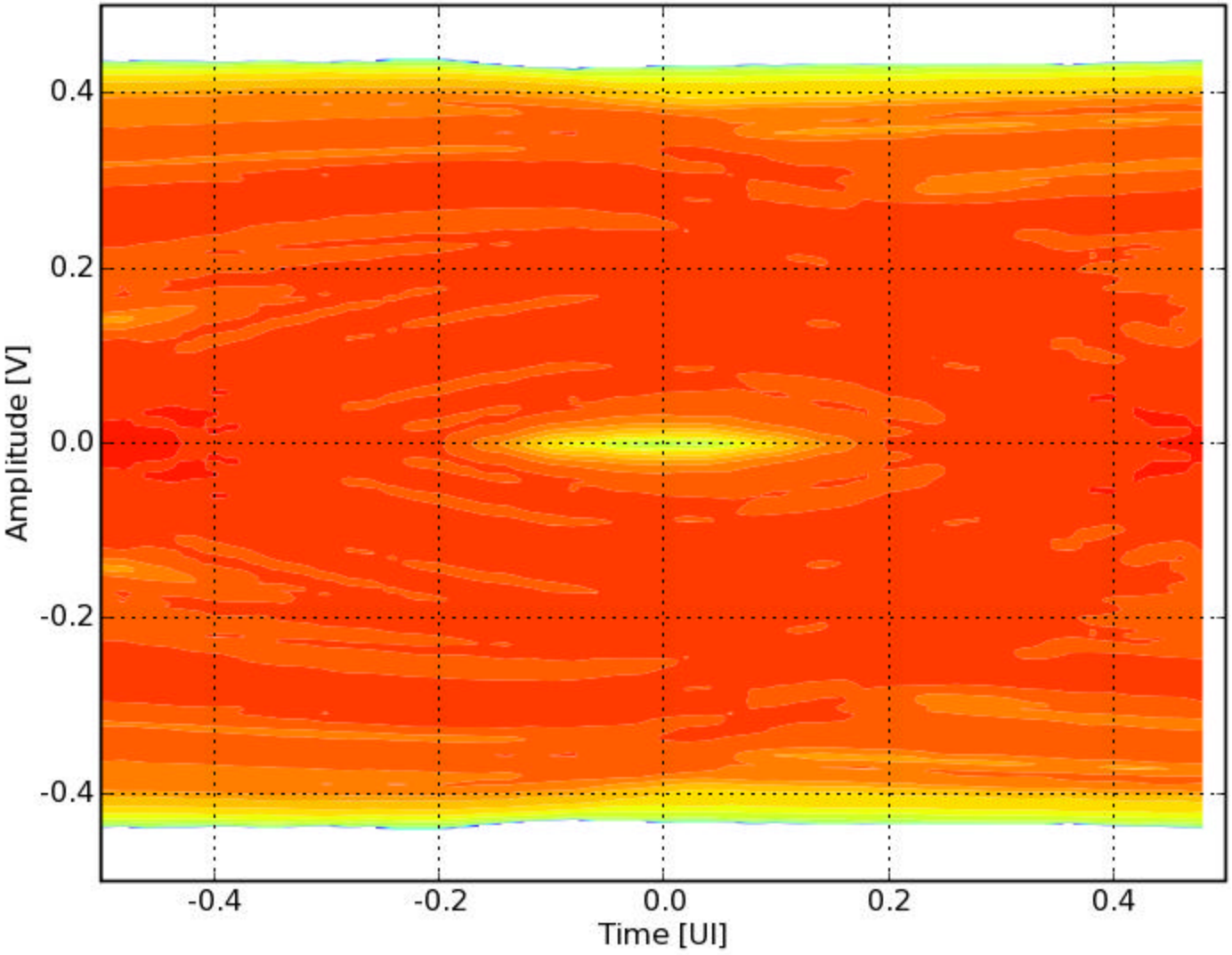
Real Time Bert_CJTPAT_tctf_wfm



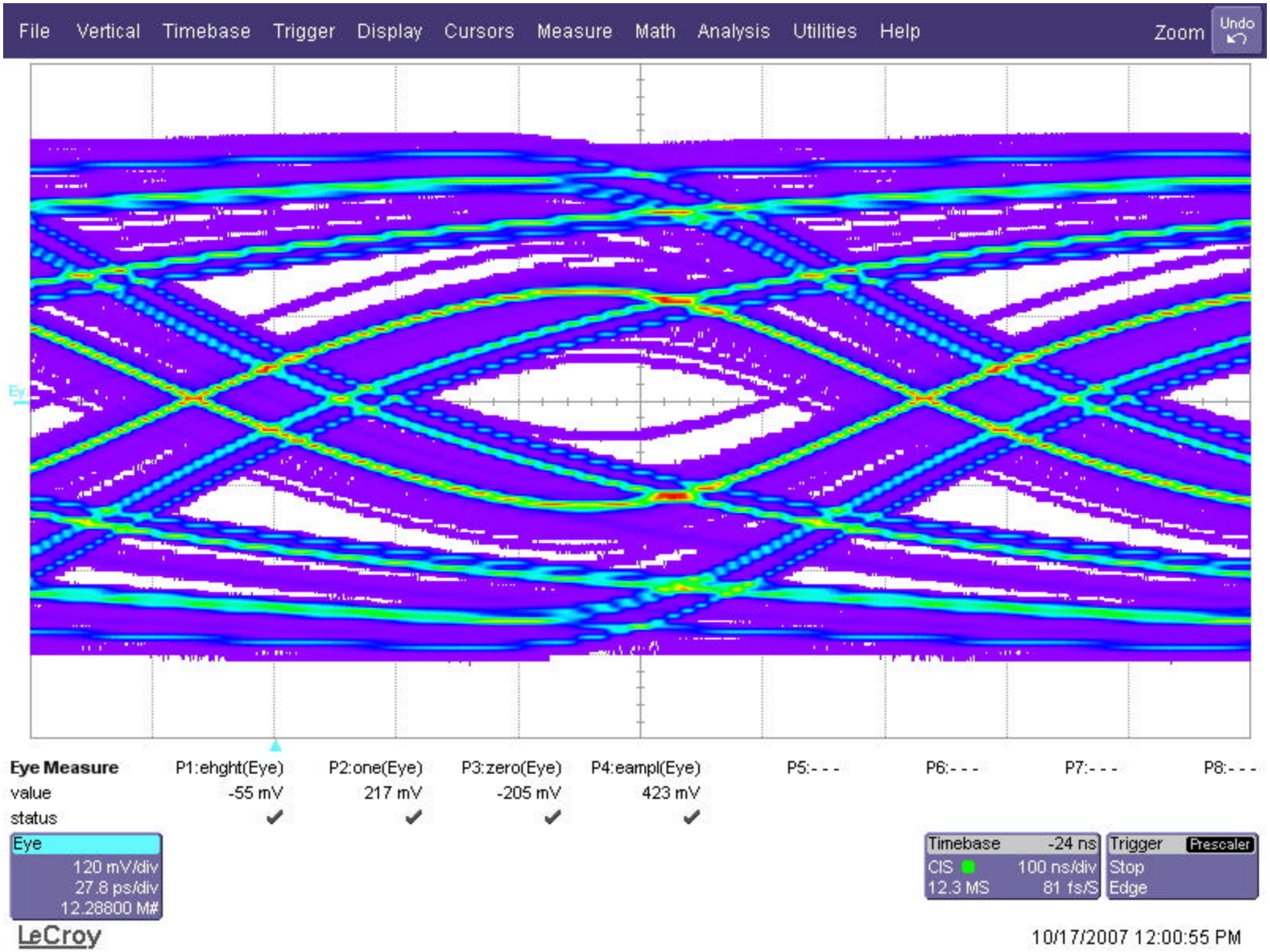
Real Time bert_cjtpat_tctf



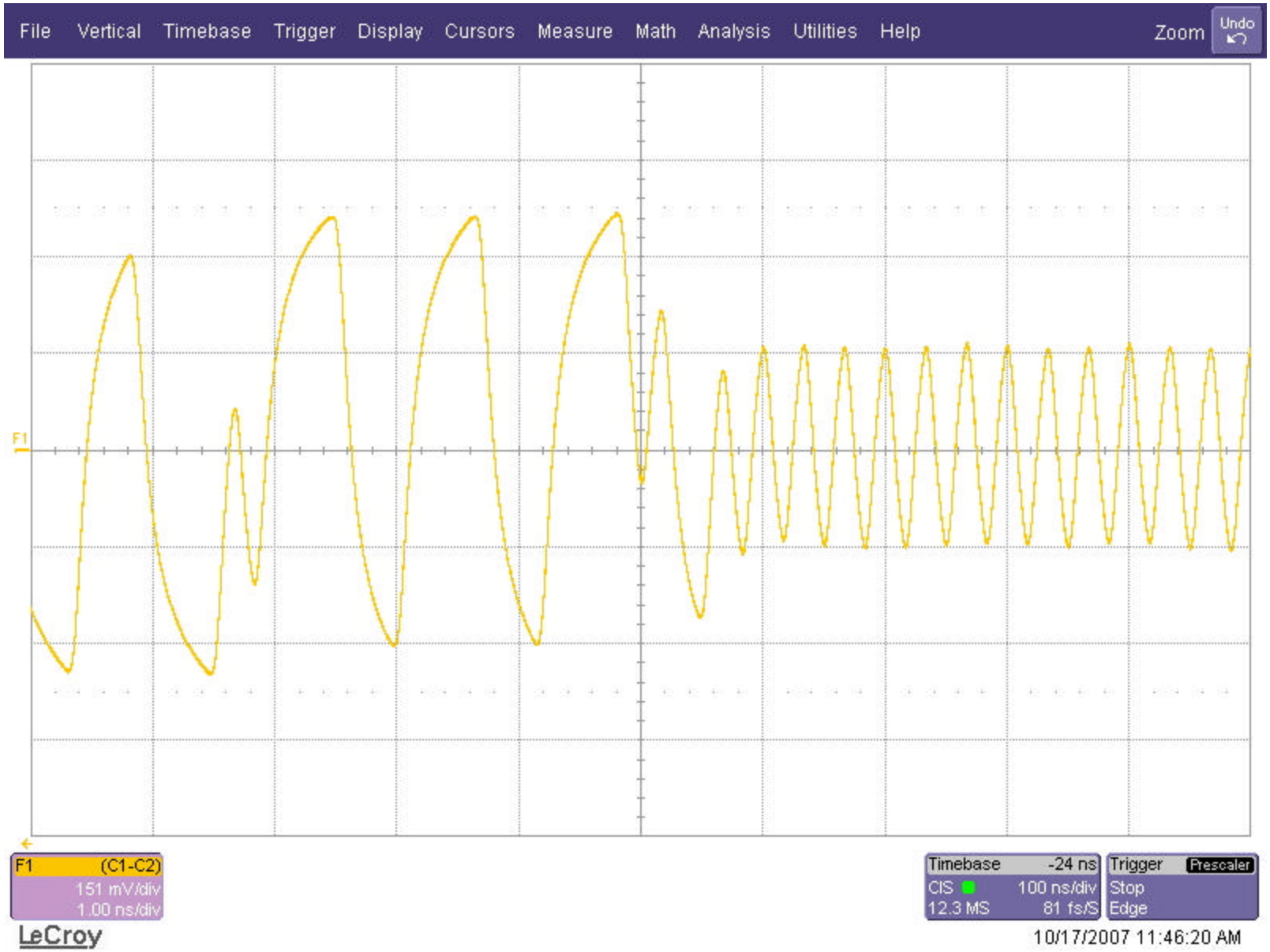
lecroy_BERT_TCTF_0tap



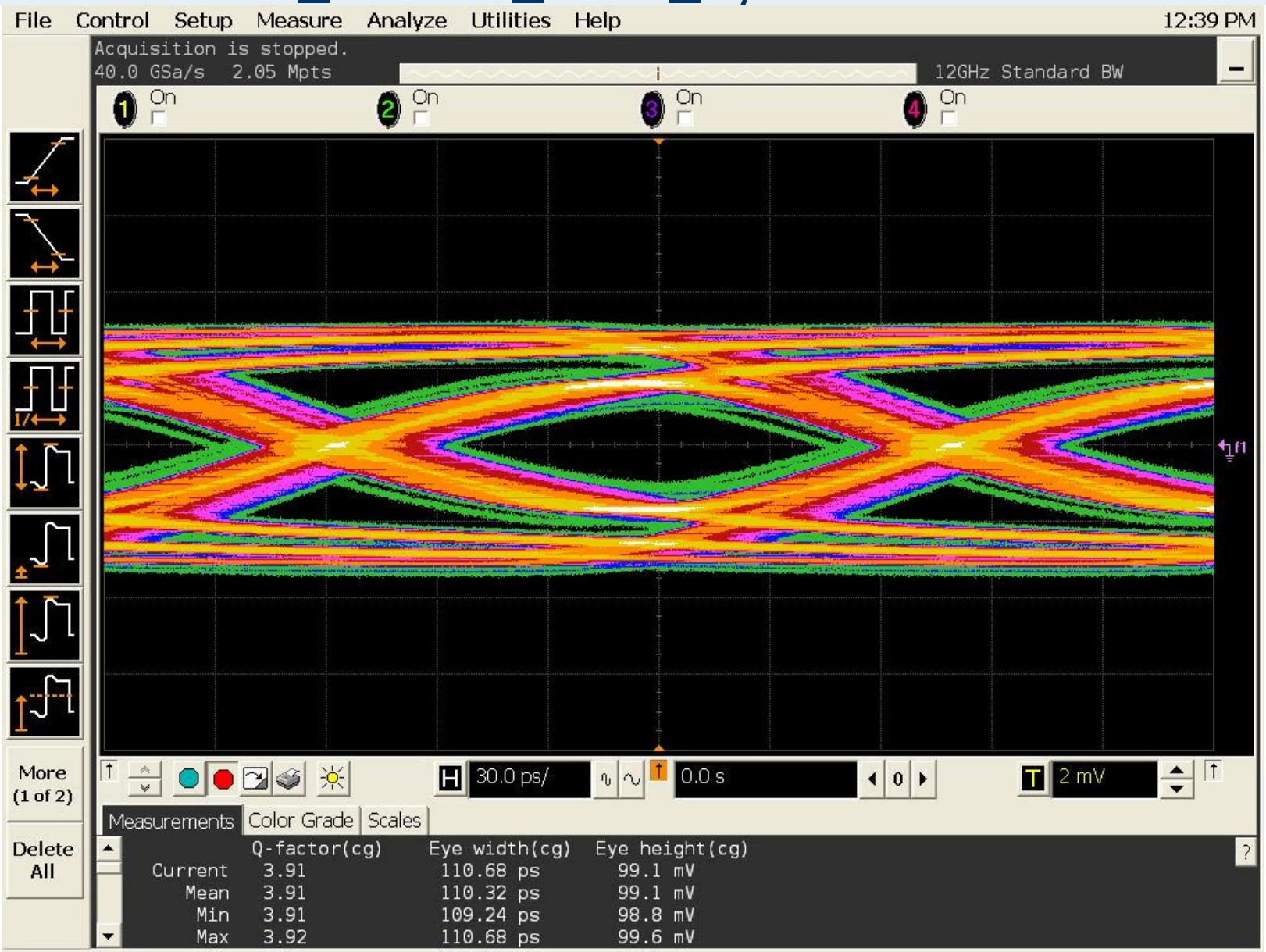
Equivalent Time bert_cjtpat_tctf_eye1



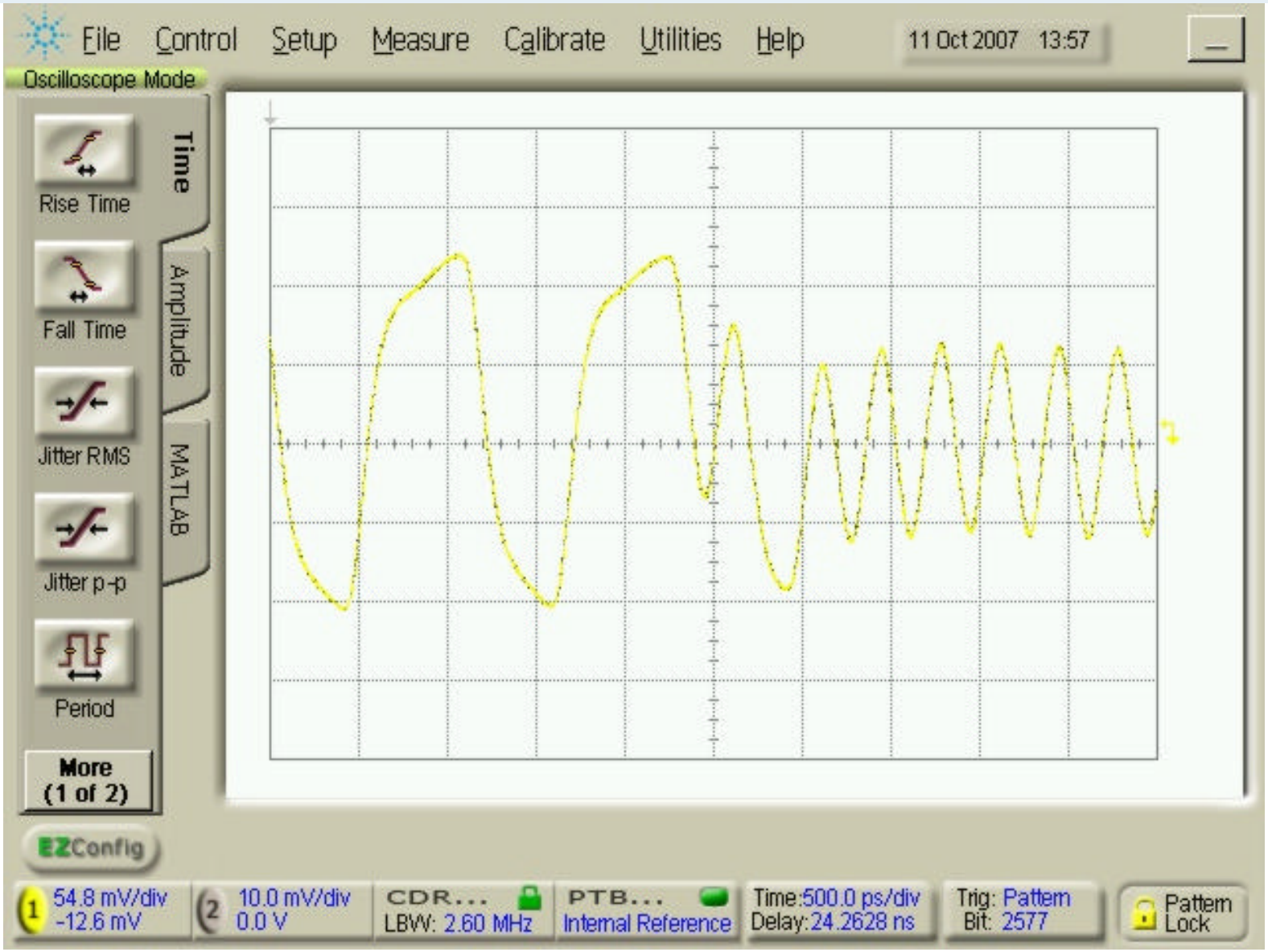
Equivalent Timebert_cjtpat_tctf_wfm1.jpg



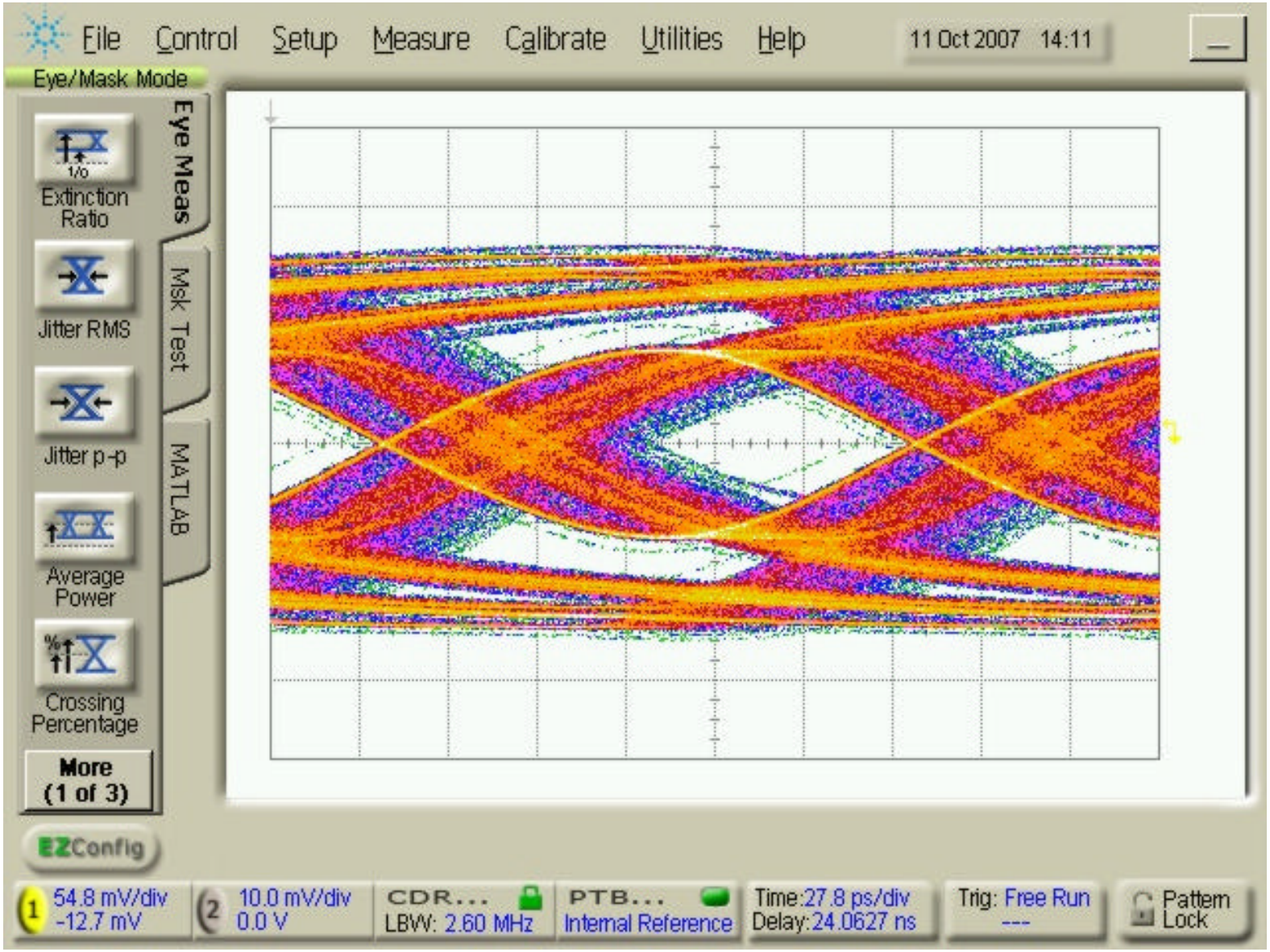
Real Time SAS_CJTPAT_TCTF_Eye



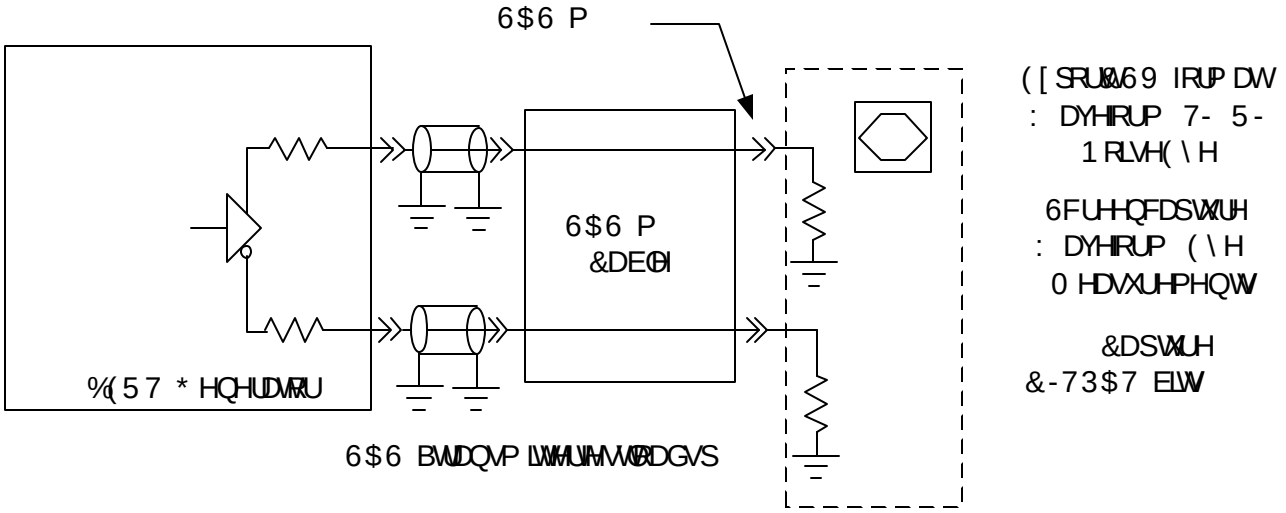
Equivalent Time BERT CJTPAT TCTF Waveform



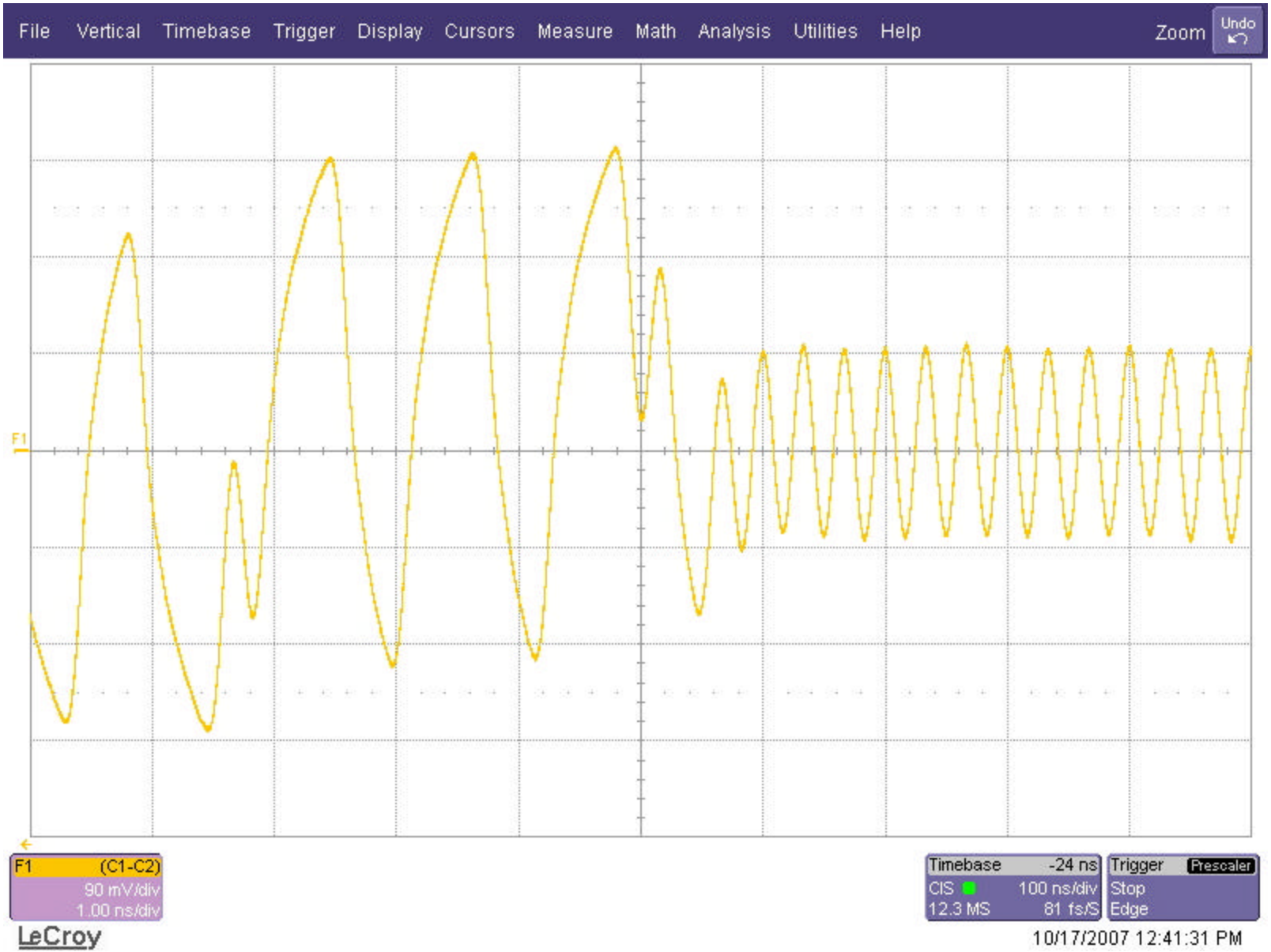
Equivalent Time BERT CJTPAT TCTF EYE_2



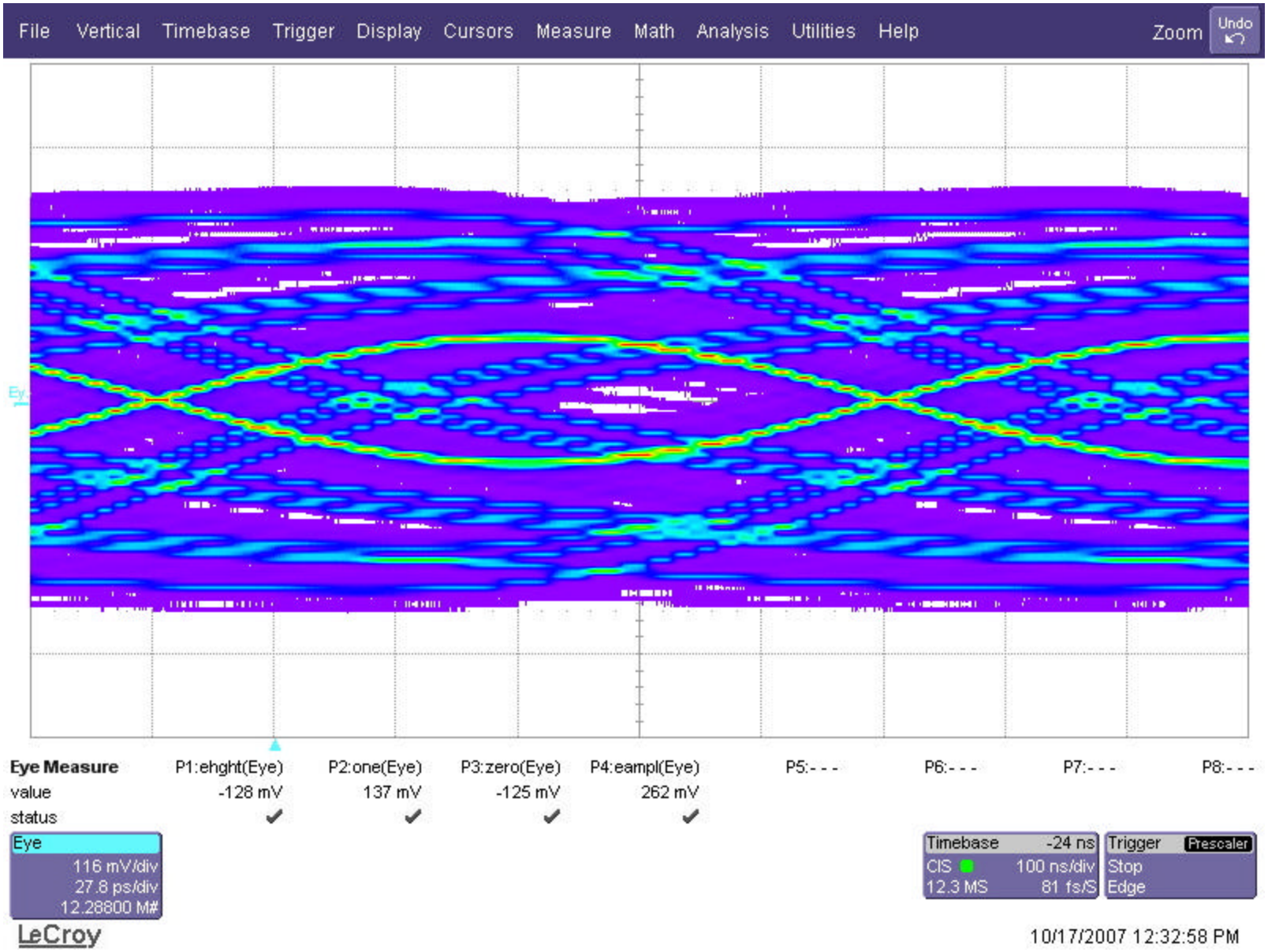
SAS 10 m Measurement



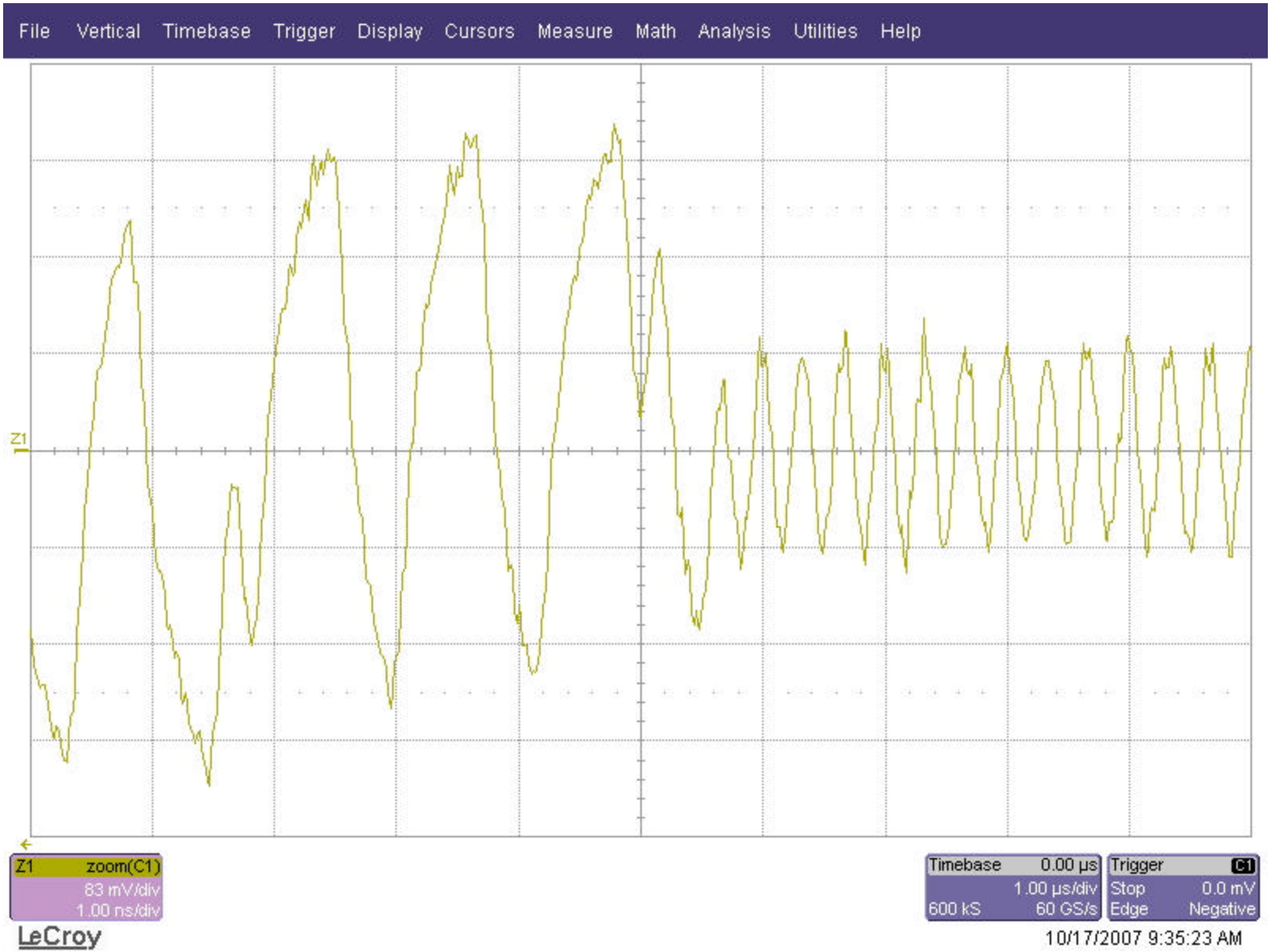
Equivalent Time bert_cjtpat_sas10m_wfm



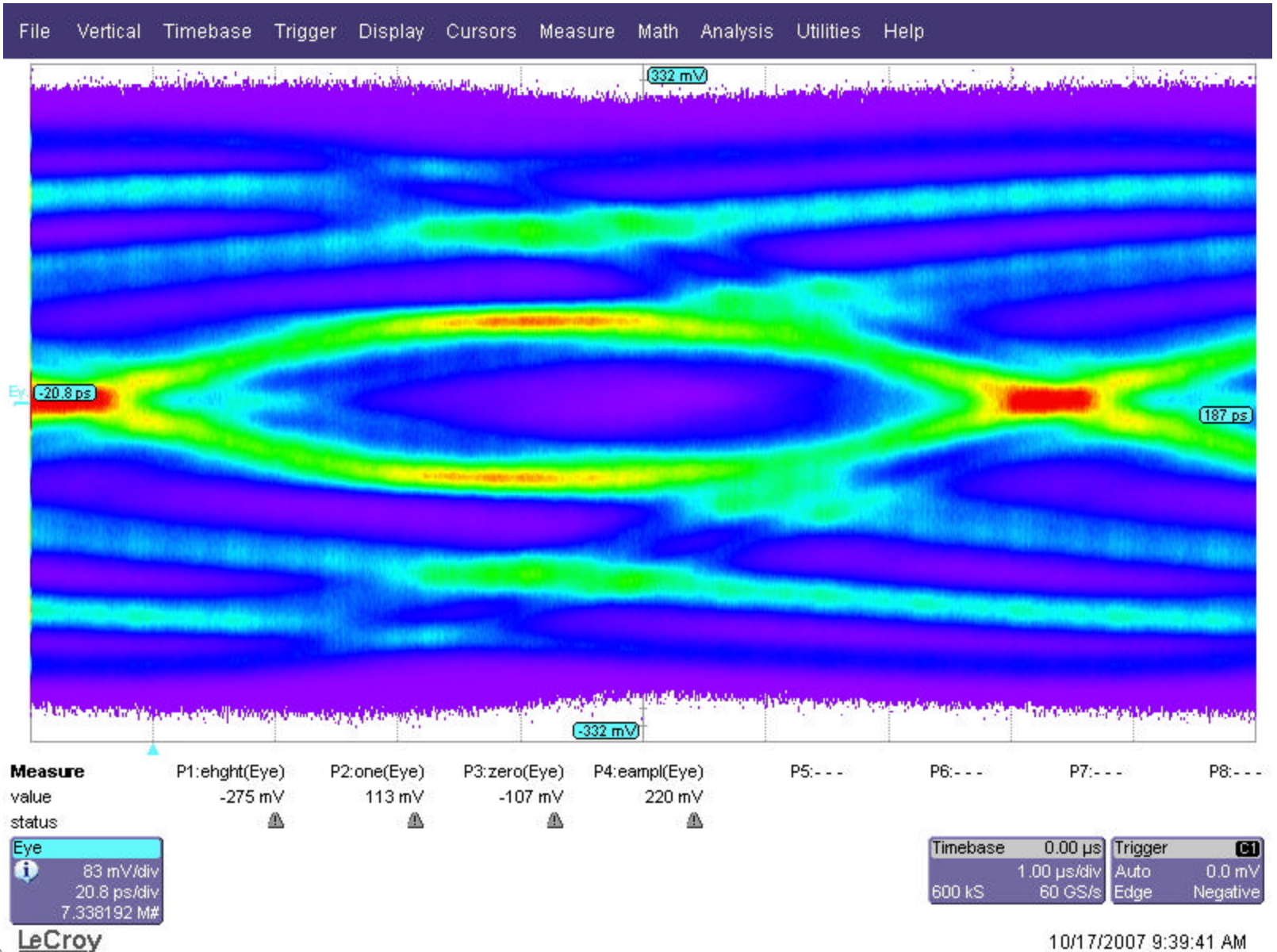
Equivalent Time bert_cjtpat_sas10m_eye



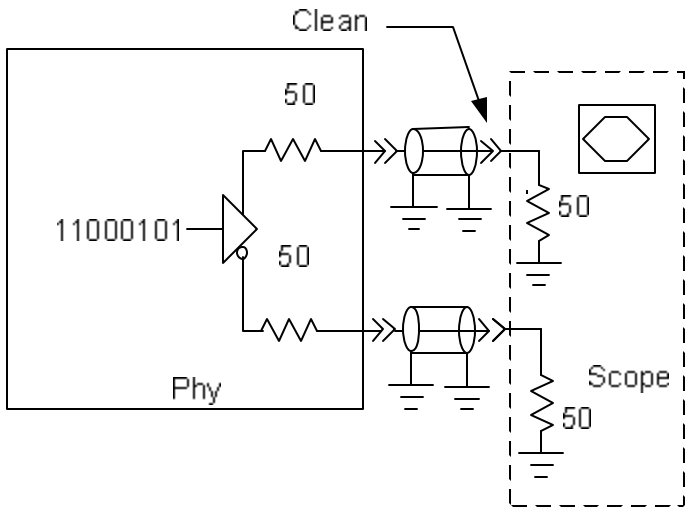
Real Time Bert_CJTPAT_sas10m_wfm



Real Time Bert_CJTPAT_sas10m_eye



Phy signal source clean



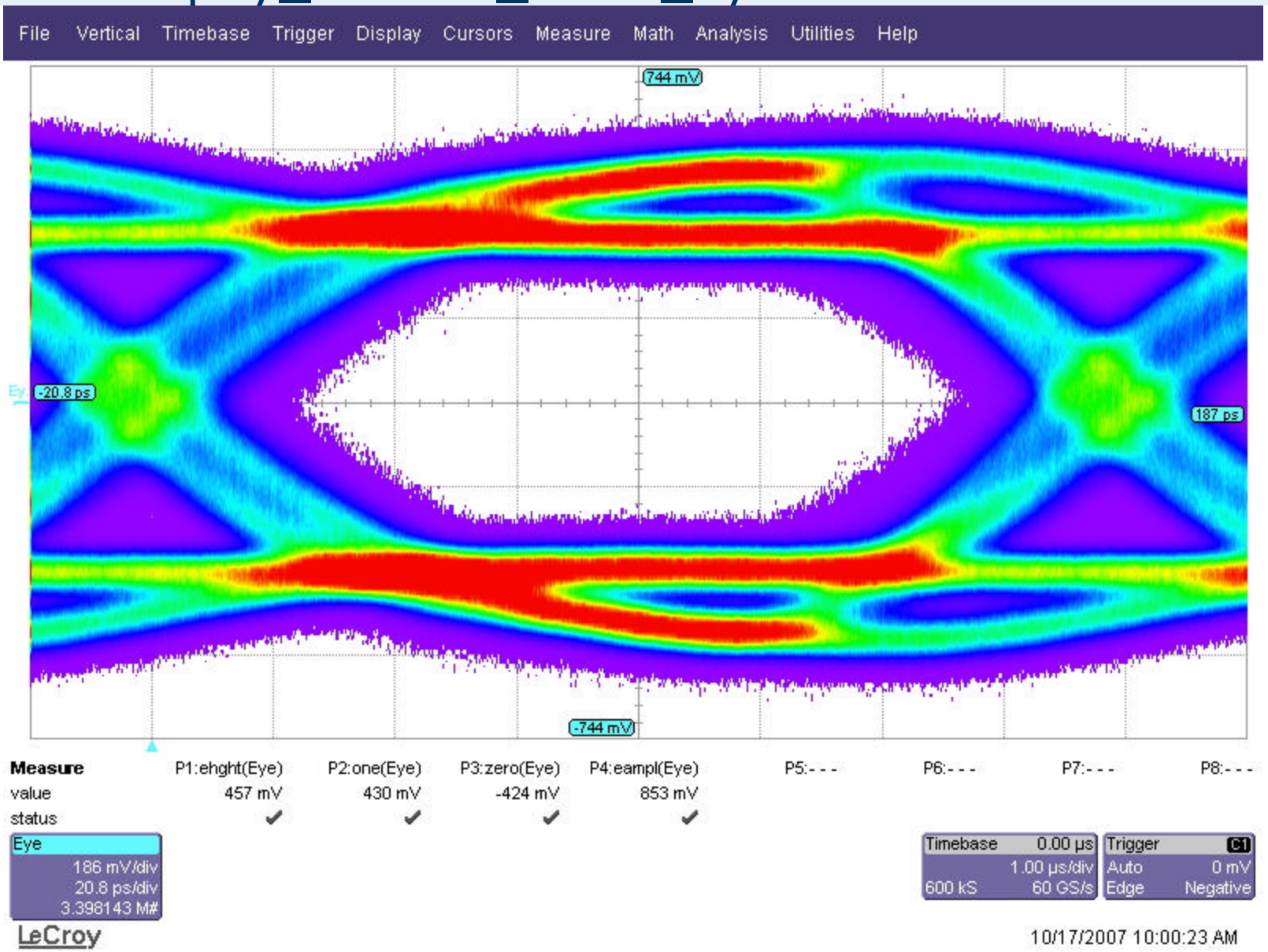
Export, CSV format:
Waveform, TJ, RJ,
Noise, Eye

Screen capture:
Waveform, Eye &
Measurements

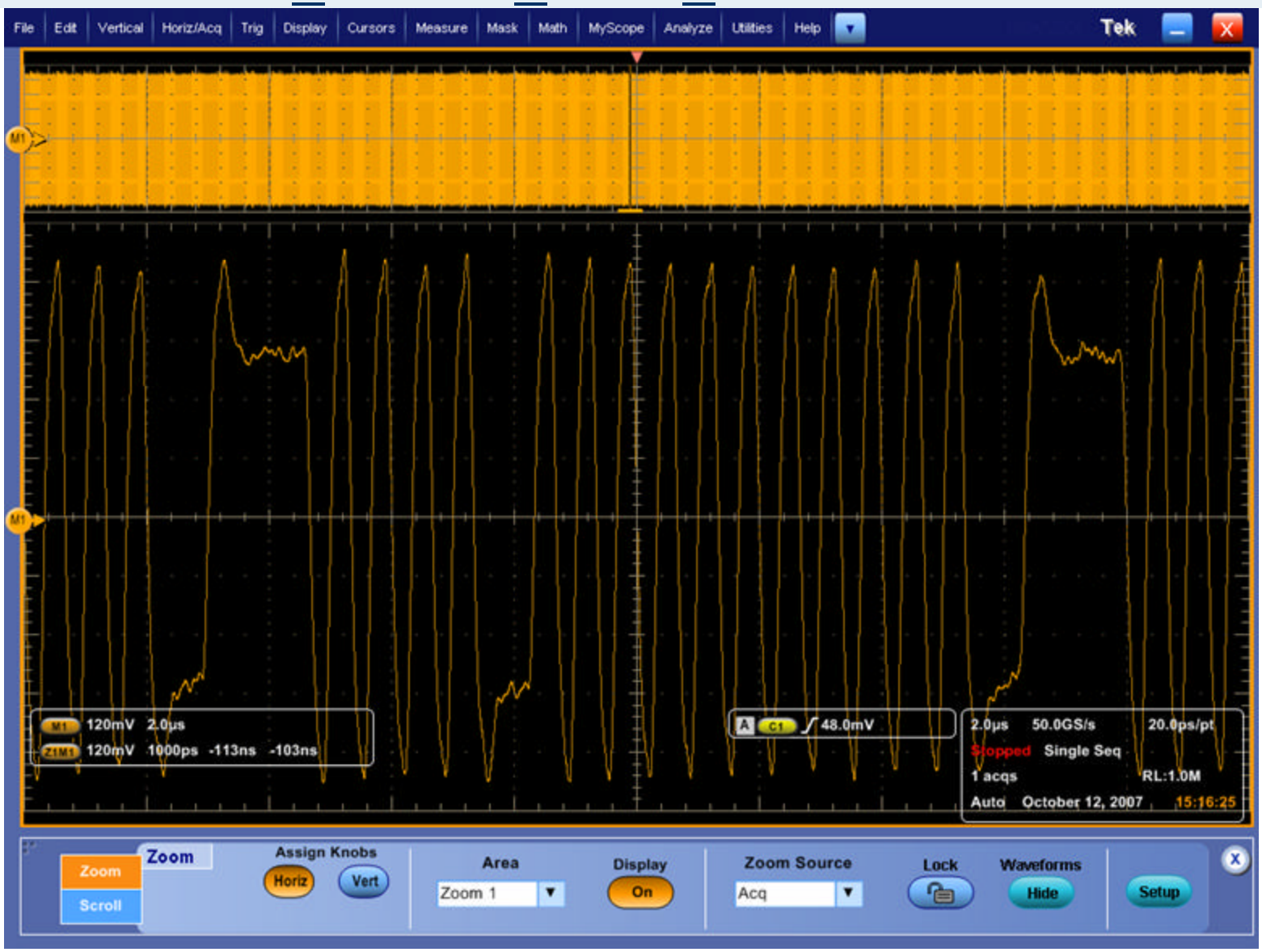
Capture:
CJTPAT (2640 bits)

Real Time phy_CJTPAT_clean_wfm

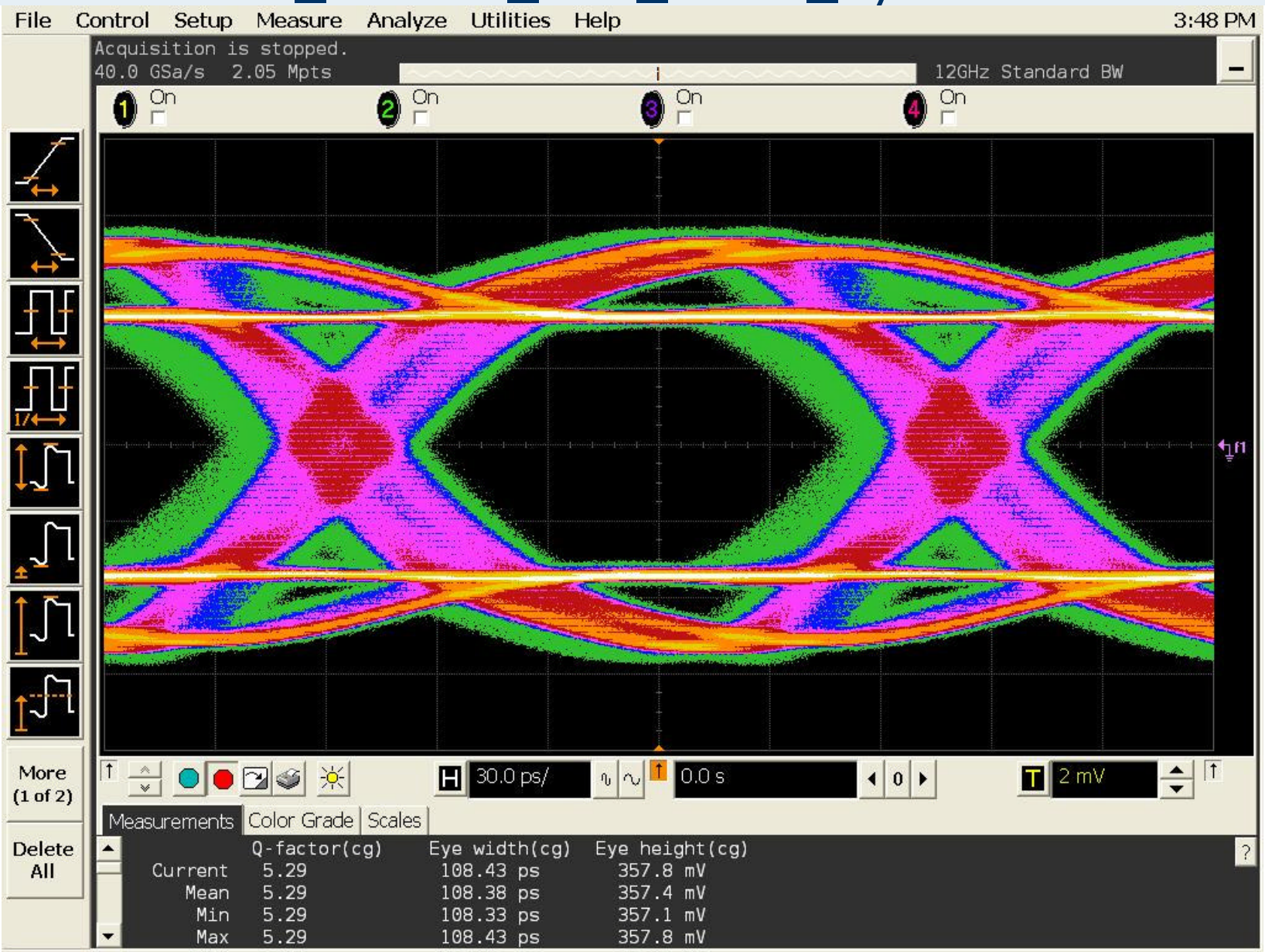
Real Time phy_CJTPAT_clean_eye



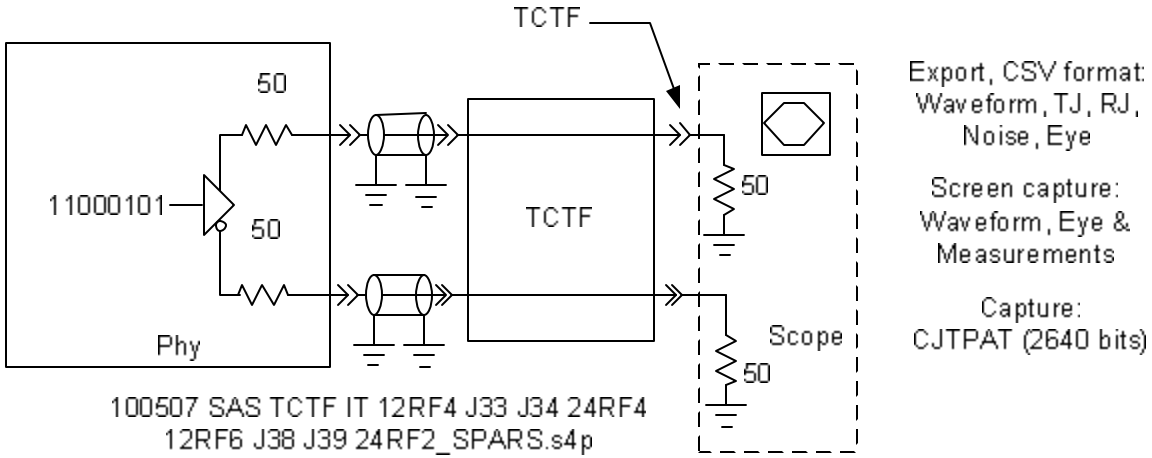
Real Time PHY_CJTPAT_clean_6G



Real Time SAS_CJTPAT_PHY_Clean_Eye



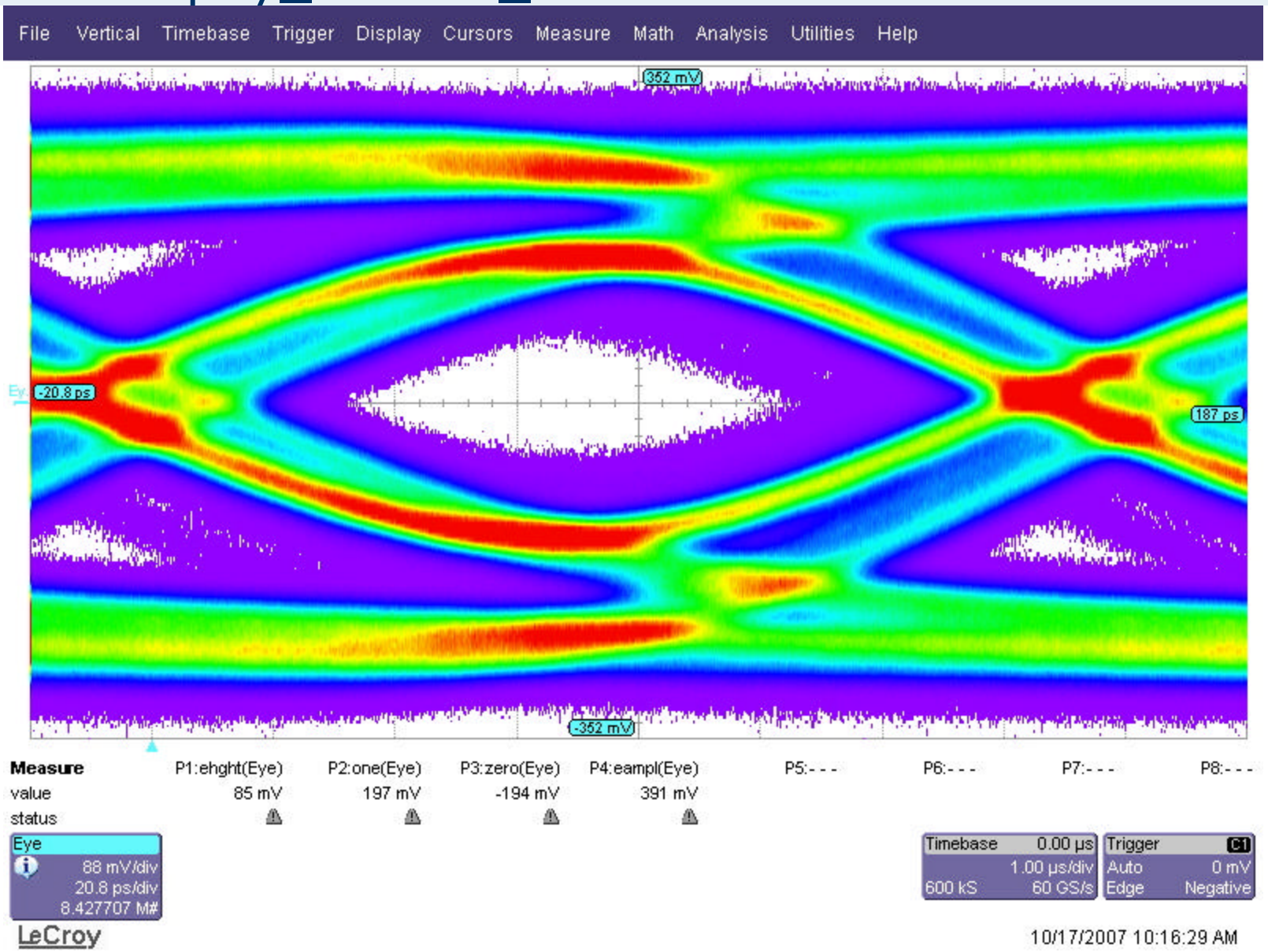
Phy signal source with TCTF



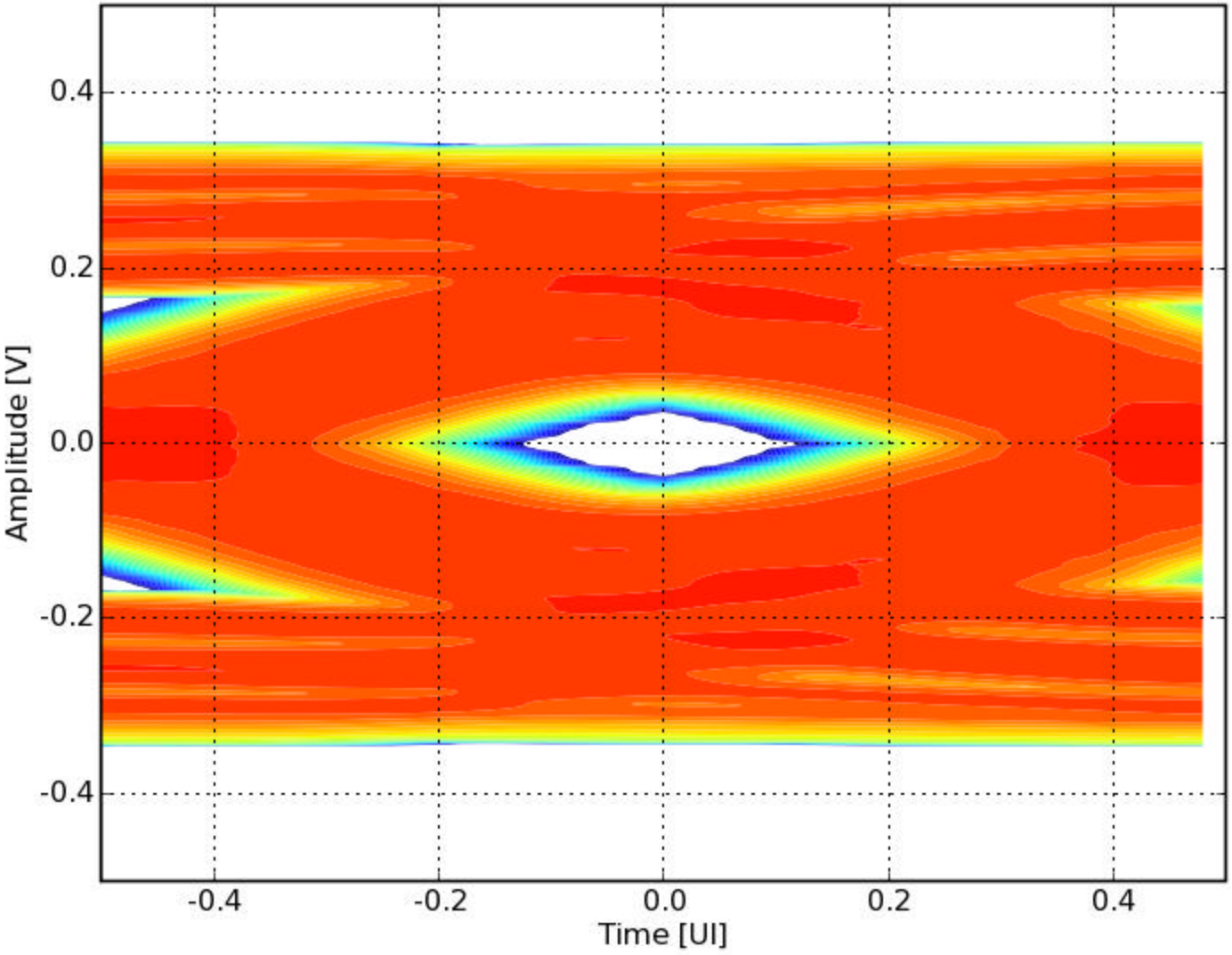
Real Time PHY_CJTPAT_TCTF_6G

Real Time SAS_CJTPAT_PHY_TCTF_Eye.jpg

Real Time phy_CJTPAT_tctf

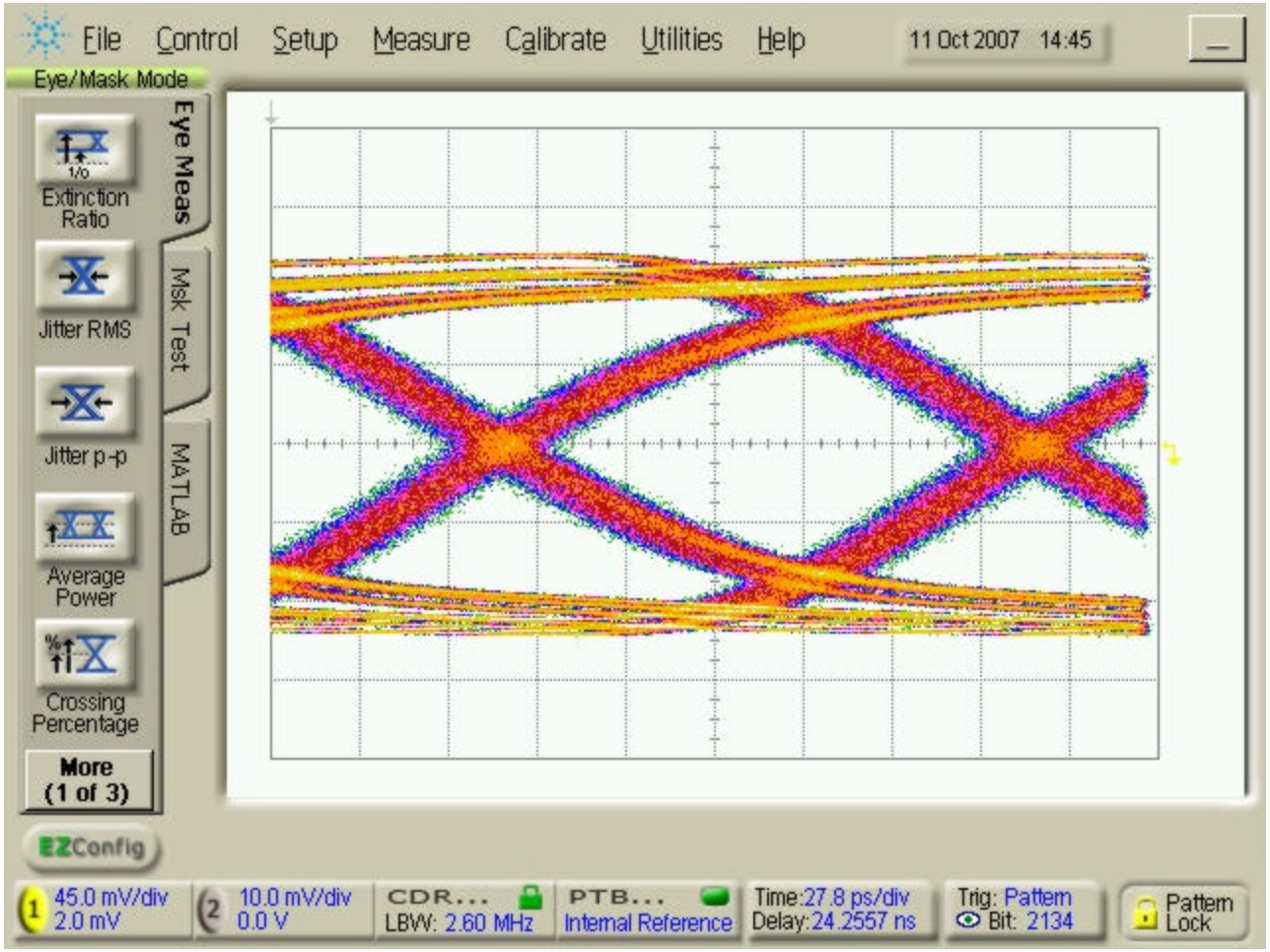


LeCroy_BERT_TCTF_0tap

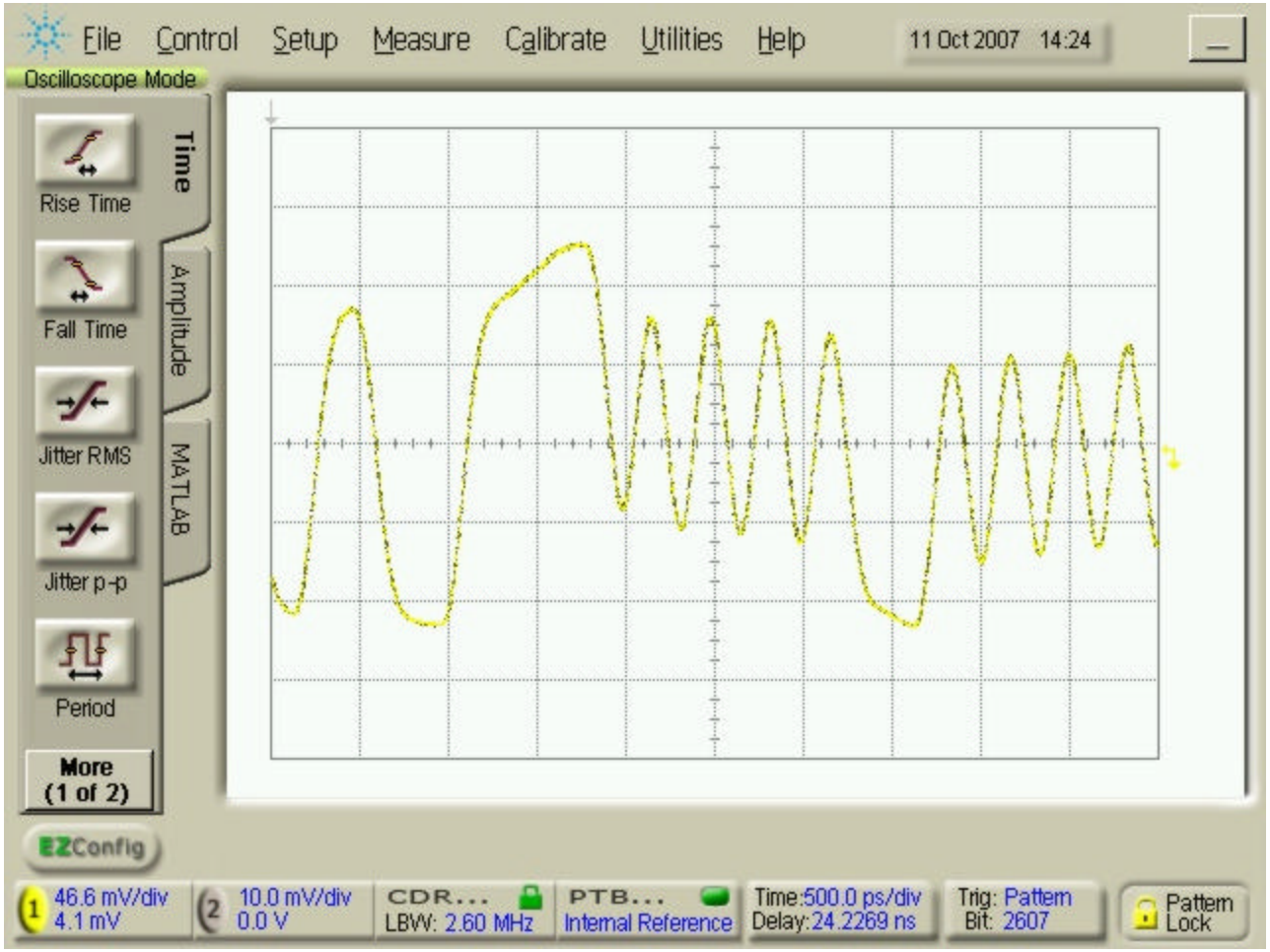


Real Time phy_CJTPAT_tctf_wfm

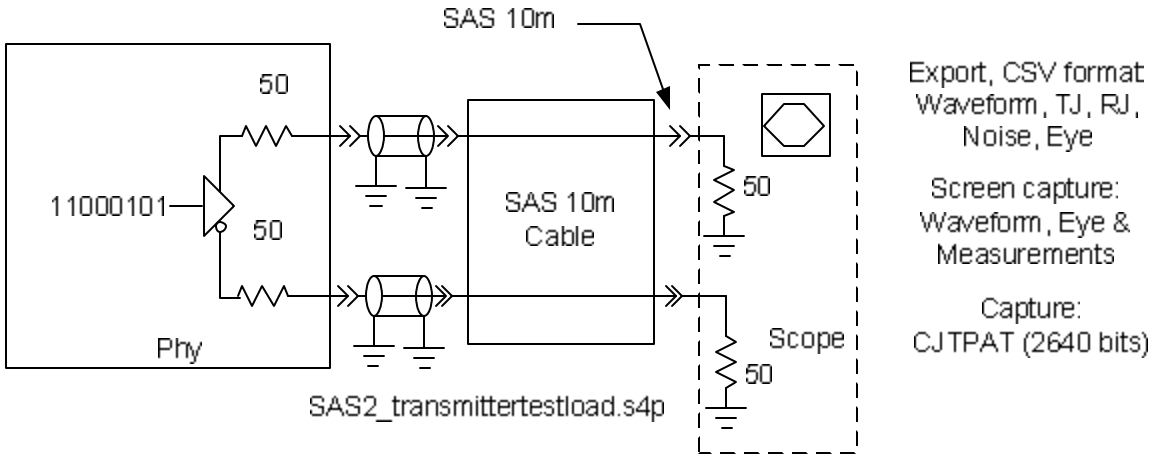
Equivalent Time PHY TCTF CJTPAT EYE



Equivalent Time PHY TCTF CJTPAT Waveform

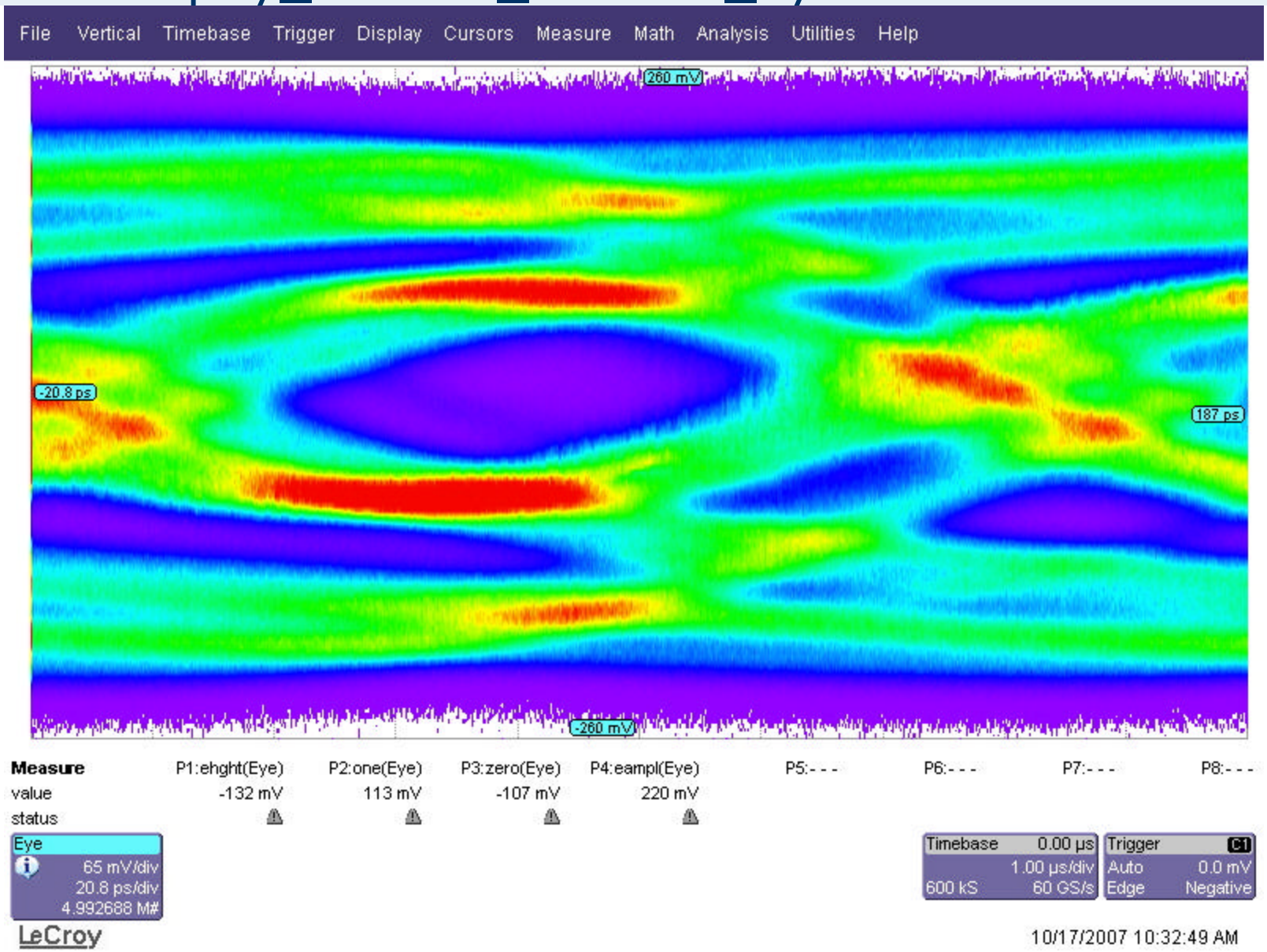


Phy signal source with SAS 10m

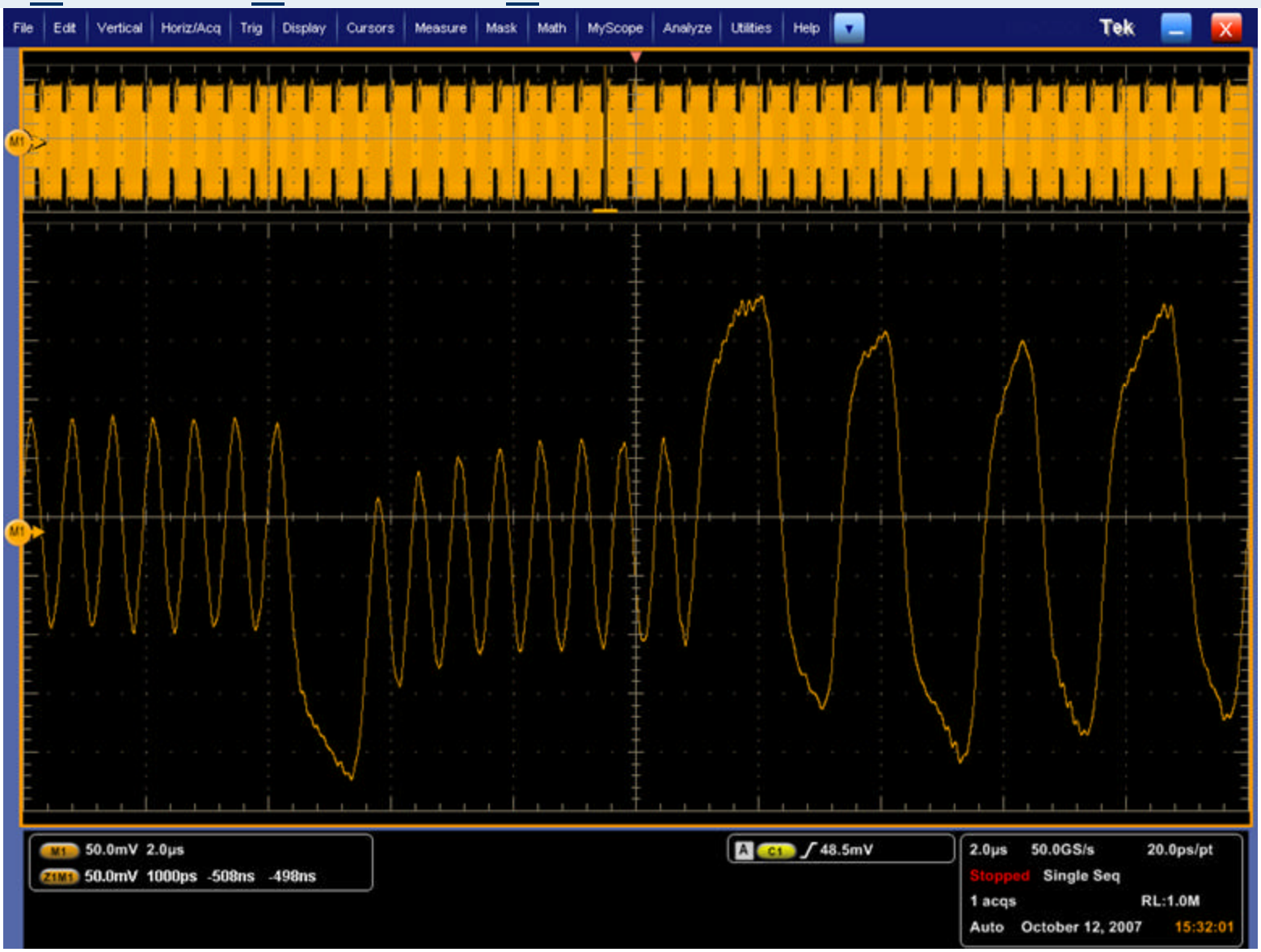


Real Time phy_CJTPAT_sas10m_wfm

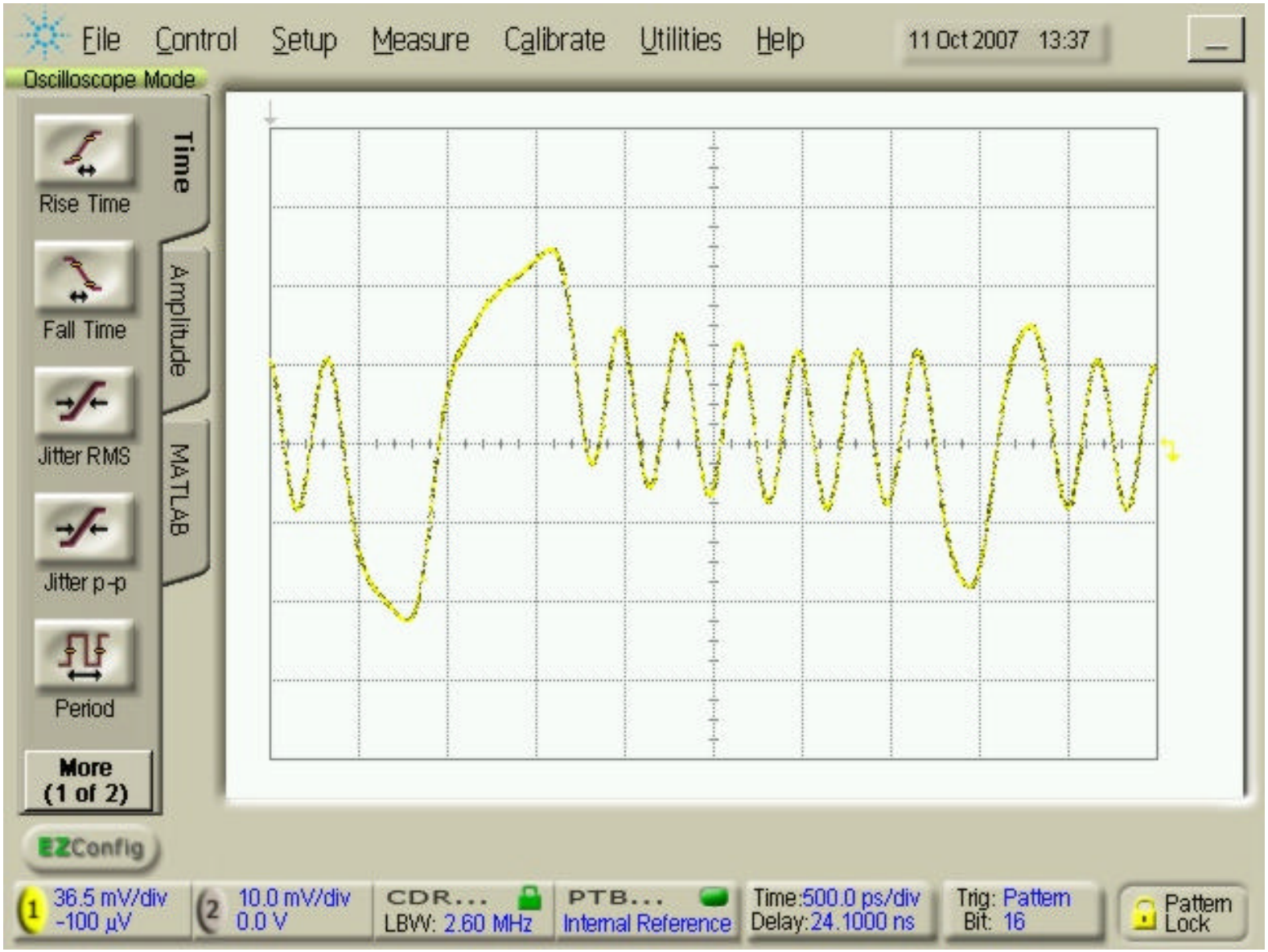
Real Time phy_CJTPAT_sas10m_eye



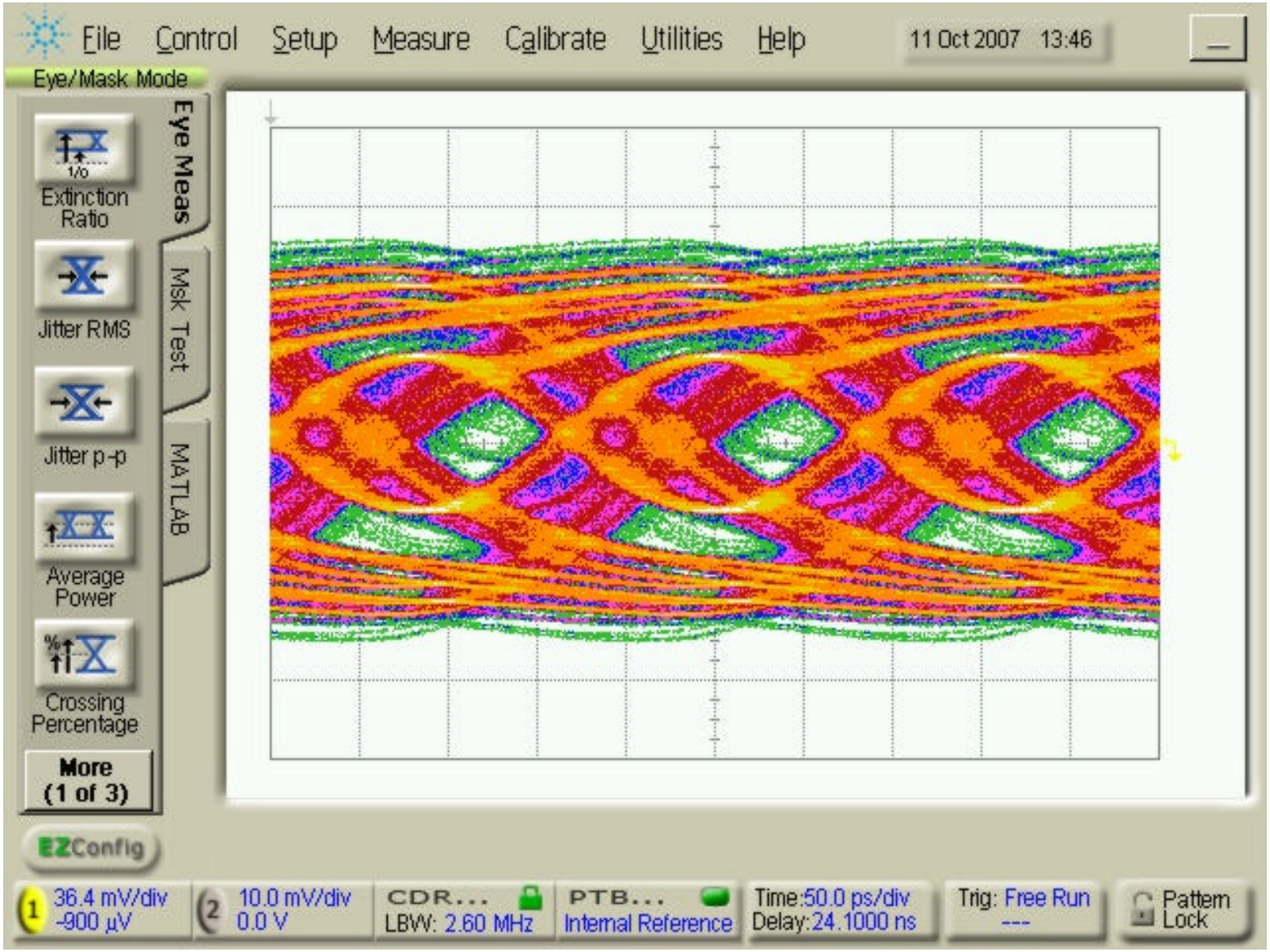
PHY_CJTPAT_SAS10m_6G



PHY CJTPAT SAS10m Waveform



PHY CJTPAT SAS10m EYE



Never stop thinking