SAS-2 Channel Stateye Analysis

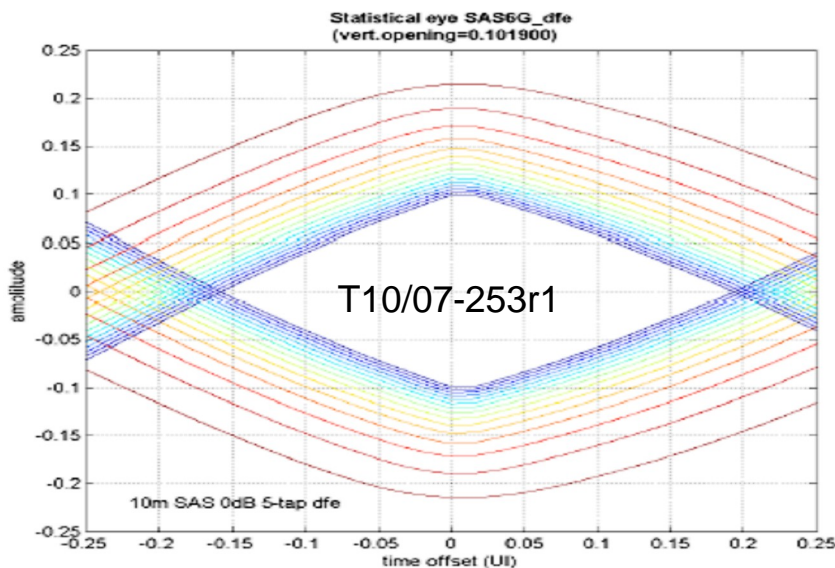*07-358r0*

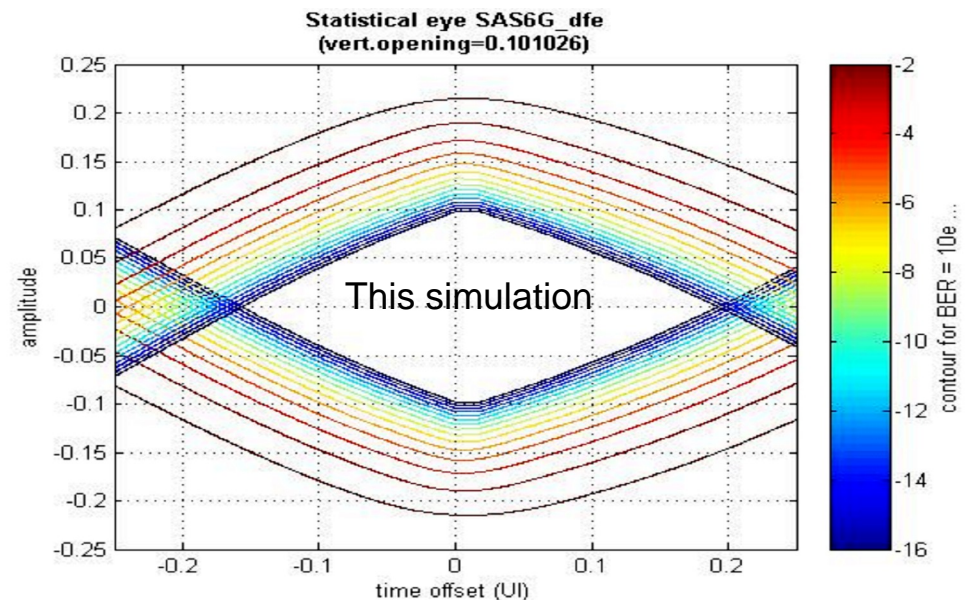*Yuming Tao & Rick Hernandez*

2007-07-26

Outlines

- Investigation of Factor of 2
  - 07-327r0: SAS2 compare measured data …
  - 07-227r0 & 07-253r1, SAS-2 10m Stateye results
- Stateye simulation results on SAS-2 10m Cable
  - Add scaling factor to set TX Vod=1000mVpp
- 8B/10B encoding stateye analysis using PMC SSA tool
- Appendix – Stateye analysis issues on 10m & 6m cable models

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SAS2 Channel Stateye Results Baseline

- TX/RX setup:
    - 6Gb/s; 0dB de-emphasis; 5-tap DFE
    - R/C filters for package Tx/Rx models (r=45ohm, c=800fF)
    - Jitter: Dj=0.18UI; RJ=.18/(2*7.94)UI
- Reference channel model: SAS2_transmittertestload.s4p
    - Need to rescale the frequency step-size from 1MHz to 10MHz to run stateye simulation on PC

Statistical eye SAS6G_dfe (vert.opening=0.101900)

T10/07-253r1

10m SAS 0dB 5-tap dfe

Statistical eye SAS6G_dfe (vert.opening=0.101026)

This simulation

contour for BER = 10e ...
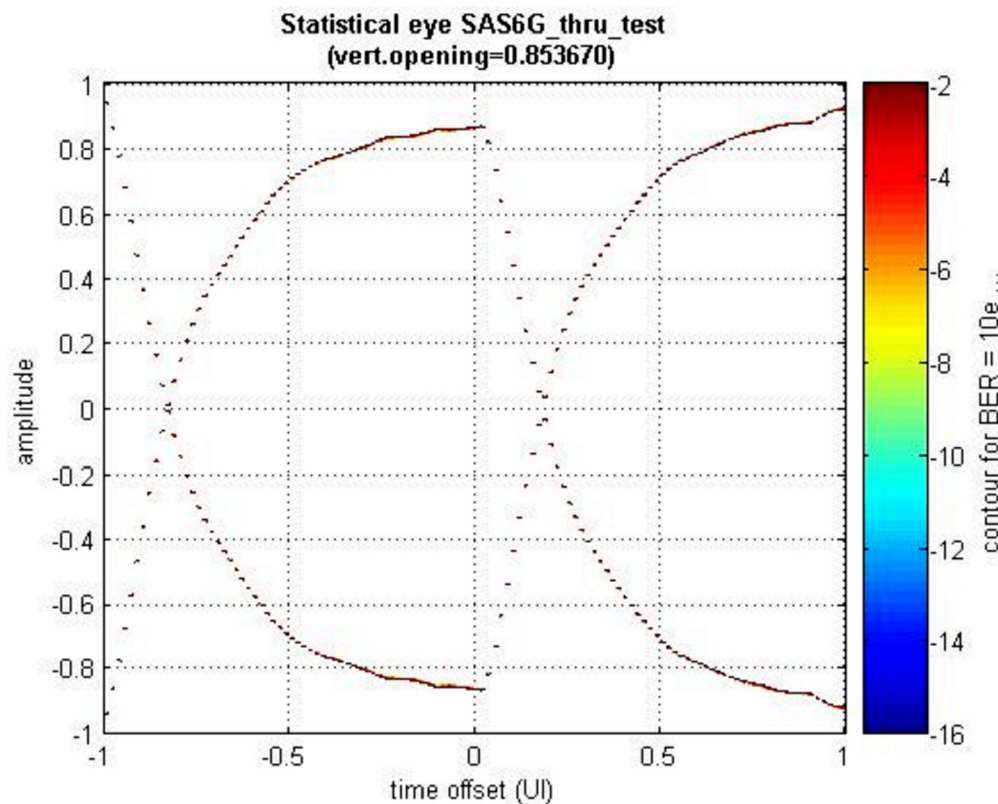
1MHz step-size S-parameter file

10MHz step-size S-parameter file

Factor of 2

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3

Factor of 2 Investigation (1)

- TX/RX setup:
  - 6Gb/s; 0dB de-emphasis; 0-tap DFE; DJ=0.01UI; RJ=.01/(2*7.94)UI
- Check the amplitude at the output of package model (TxRL)

Statistical eye SAS6G_thru_test
(vert.opening=0.853670)

Observation:

- Vod=2*0.8536=1.7072Vpp
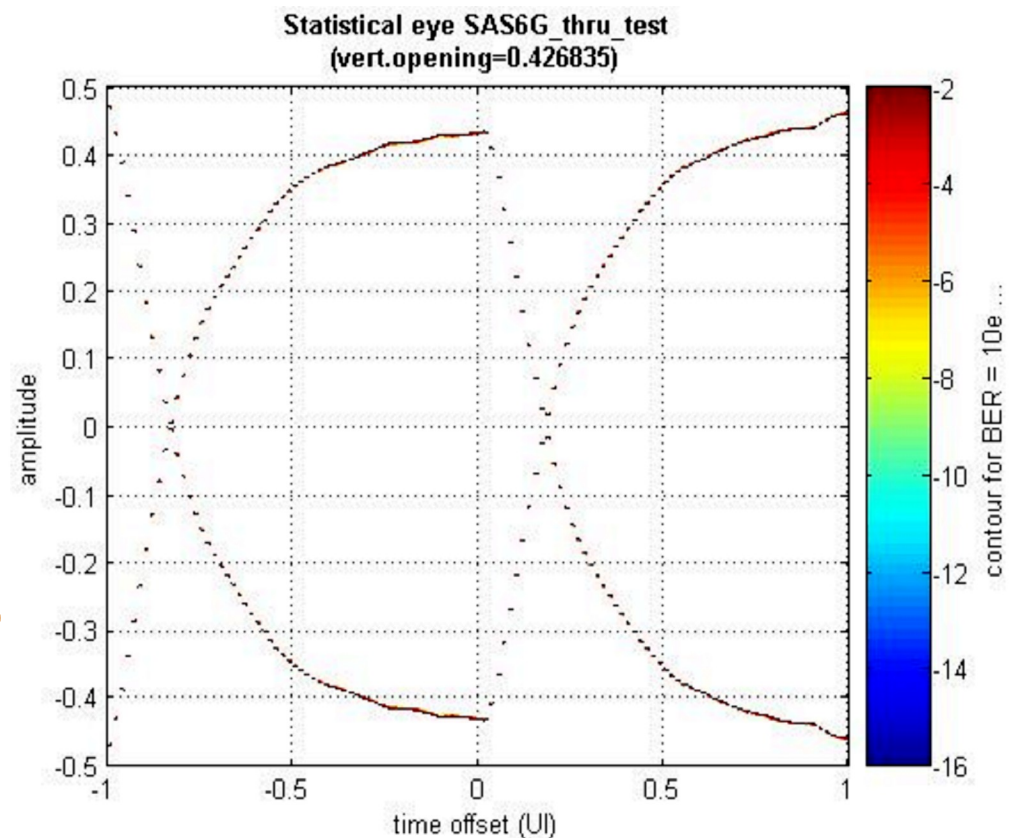- Vpk-to-pk= ~1.9Vpp

Conclusion:

- TX launch amplitude: 2.0Vpp

Factor of 2 Investigation (2)

- Add scaling factor (1/2) to change TX launch amplitude to 1.0Vpp differential
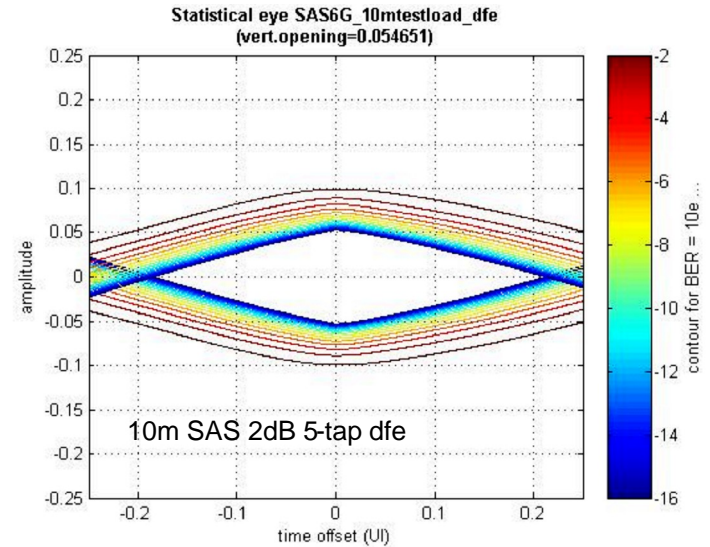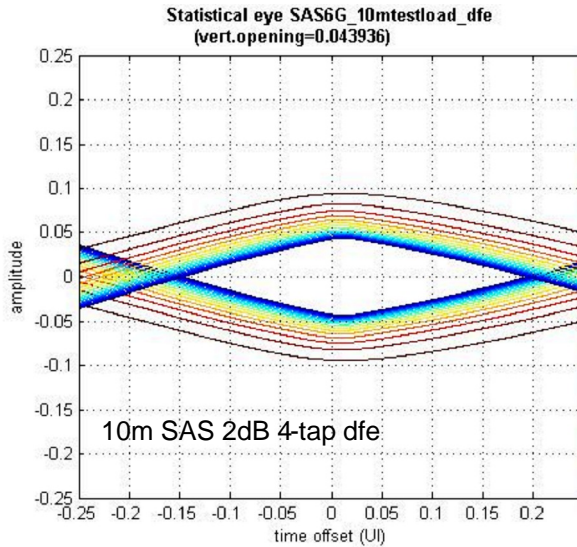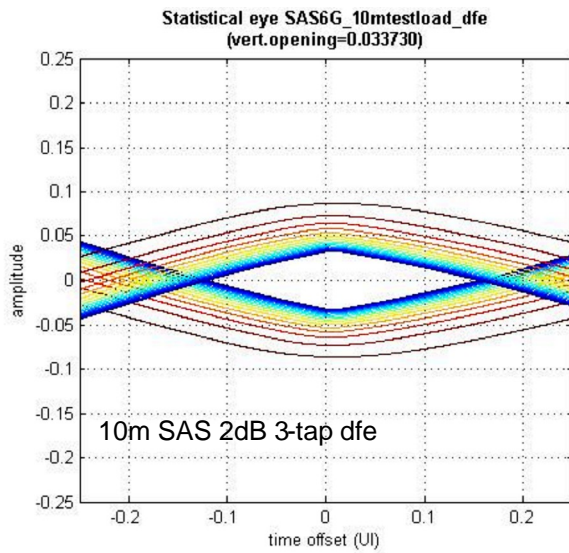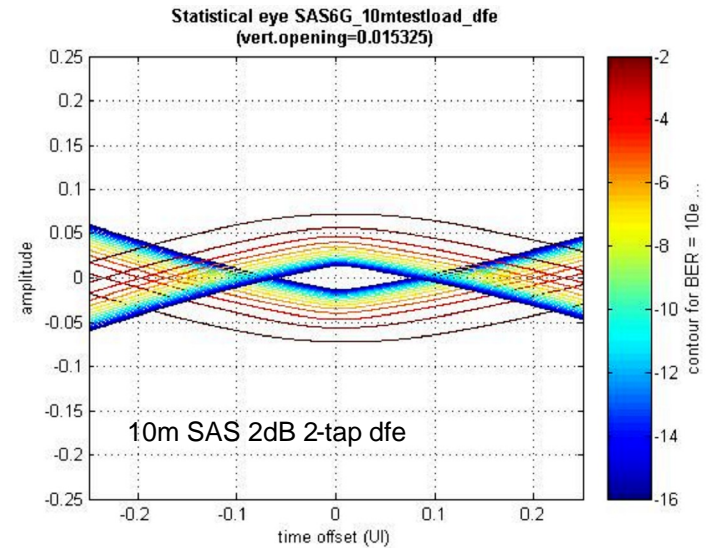- Ignore the warning messages at Stateye GUI

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10m MiniSAS Stateye Results (1)

- TX Vod=1000mVpp
- 2dB De-emphasis
  - Vvma=800mVpp
- DJ=0.18UI
- RJ=0.18/(2*7.94)UI
- 10MHz S-parameter file (under-sampled from the original data)

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=-0.012554)

10m SAS 2dB 1-tap dfe

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=0.015325)

10m SAS 2dB 2-tap dfe

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=0.033730)

10m SAS 2dB 3-tap dfe

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=0.043936)

10m SAS 2dB 4-tap dfe

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=0.054651)

10m SAS 2dB 5-tap dfe

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SAS-2 10m Cable Stateye Results (2)

Vod=1.0Vpp; 2dB de-emp / Eye-opening parameters	DFE				
	1-tap	**2-tap**	**3-tap**	**4-tap**	**5-tap**
Vertical opening (mVpp)	Closed eye	30.6	67.5	87.9	109.3
Horizontal opening (UI)	Closed eye	0.15	0.29	0.35	0.41

- **Target equalized eye**
  - 150mVpp (vertical) and 0.30UI (horizontal)

- **Observation**
  - It fails to meet the eye-opening height requirement of 150mVpp even with 5-tap DFE
  - It may meet horizontal spec (0.30UI) with 3-tap, 4-tap, 5-tap DFE

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8B/10B vs. PRBS Results Comparison (Using PMC SSA Tool)

Parameters / DFE	Vertical eye Opening (mVpp)		Horizontal eye Opening (UI)	
	PRBS	8B/10B	PRBS	8B/10B
1-tap	1	1	0.01	0.01
2-tap	22	25	0.15	0.19
3-tap	61	63	0.29	0.32
4-tap	84	86	0.37	0.41
5-tap	94	95	0.40	0.45

- Using PMC SSA tool to perform 8B/10B vs. PRBS statistic eye analysis on SAS-2 10m cable model
- Simulation condition: Vod=1000mVpp; 1.6dB de-emphasis; DJ=.18UI; RJ=.18/(2*7.94)
- Observations
  - The vertical eye-opening improvement is not significant with 8B/10B
 - 8B/10B encoding provides 10% more horizontal opening vs. PRBS pattern

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Summary

- A scaling factor of ½ is needed to justify Stateye TX launch amplitude to 1000mVpp differential

- For SAS-2 reference channel (10m cable), the reference TX (2dB de-emphasis) and RX with 3-tap (or 5-tap) DFE fails to meet the equalized eye opening limit

- 8B/10B encoding won't help vertical eye-opening but it does improve horizontal opening by 10% plus

Appendix

Stateye Analysis Issues on 10m & 6m Cable Models

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Molex iPass Mini SAS 10m Cable Models
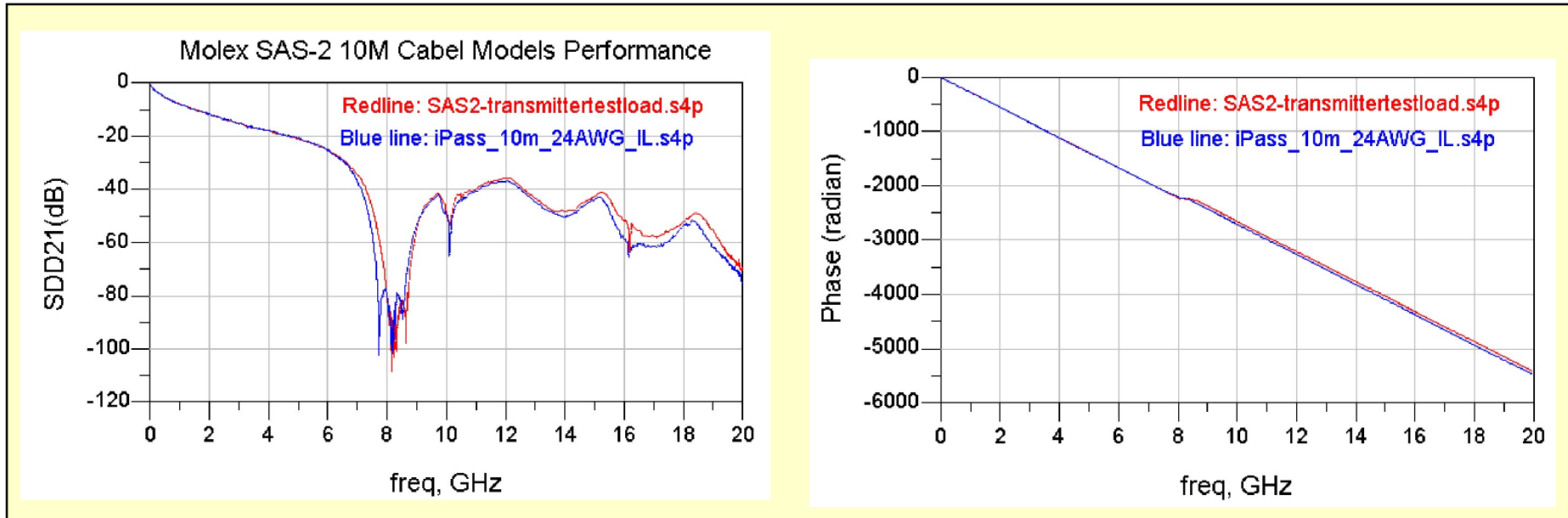
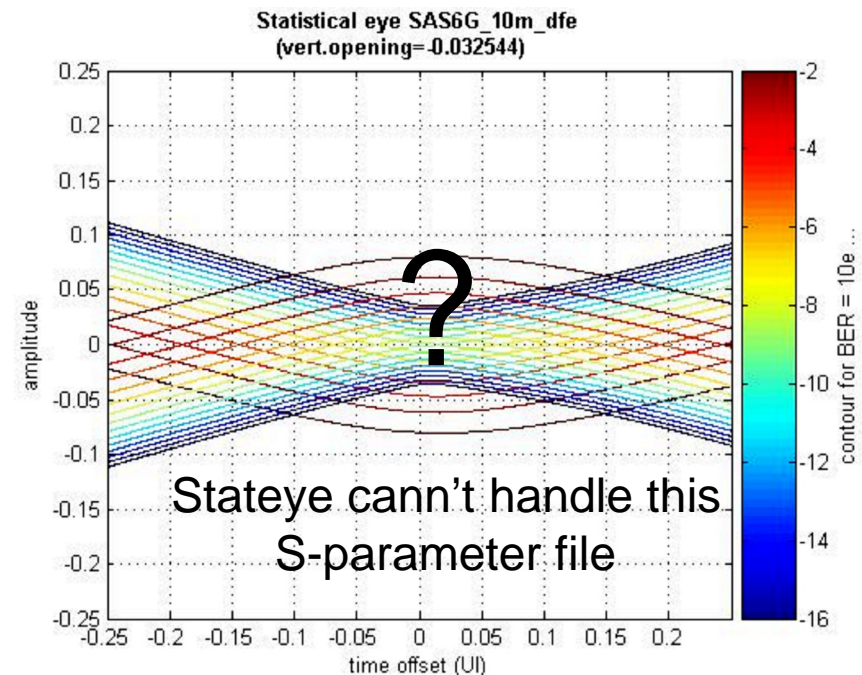| Number	Channel name	Channel Loss (dB)	
		50MHz	3GHz
T10/07-193r1	SAS2_transmittertestload.s4p (1MHz step)	1.673	15.12
T10/06-027r0	iPass_10m_24AWG_IL.s4p (10MHz step)	1.644	15.14

• This two channel models has almost identical performance from DC to 6GHz and differ each other over 7GHz

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Stateye Simulation on Two 10m Cable Models

SAS2_transmittertestload.s4p

iPass_10m_24AWG_IL.s4p

Statistical eye SAS6G_10mtestload_dfe
(vert.opening=0.054651)

Statistical eye SAS6G_10m_dfe
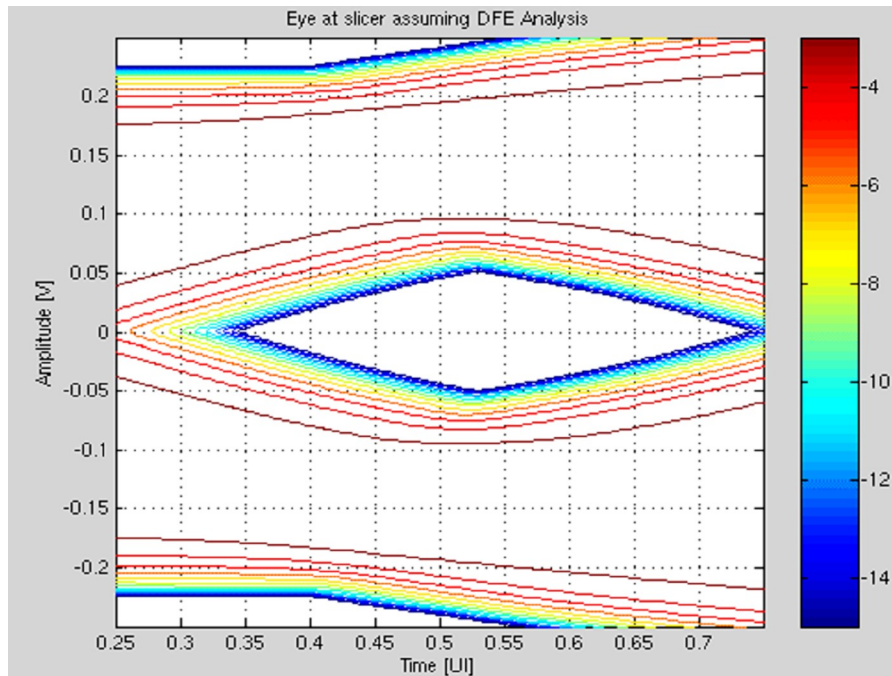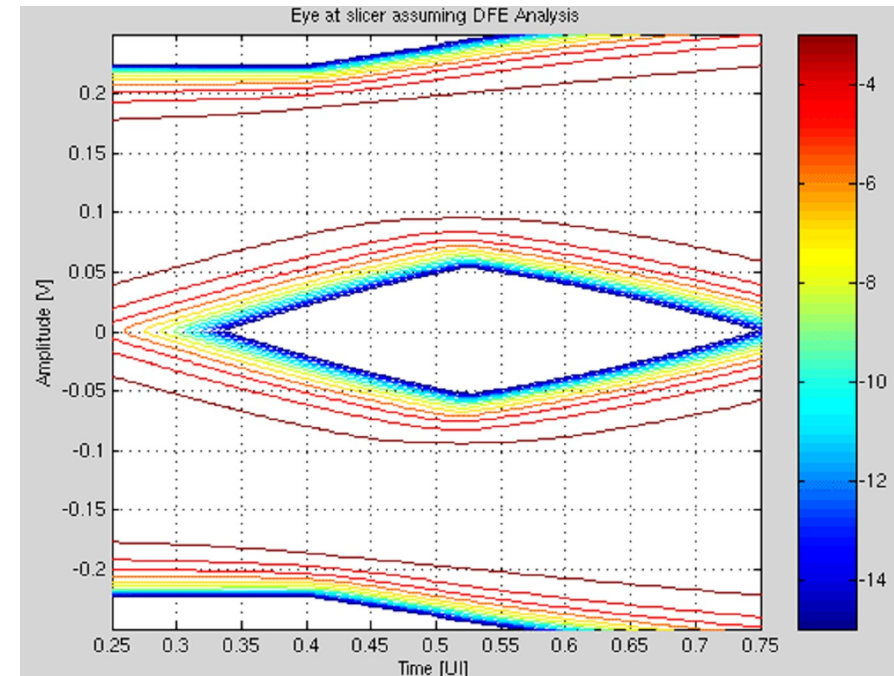(vert.opening=-0.032544)

?

Stateye cann't handle this
S-parameter file

- Vod=1000mVpp; 2dB de-emphasis; 5-tap DFE
- R/C filters for package Tx/Rx models (r=45ohm, c=800fF)
- Jitter: DJ=0.18UI; RJ=.18/(2*7.94)UI

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PMC SSA Simulation on Two 10m Cable Models
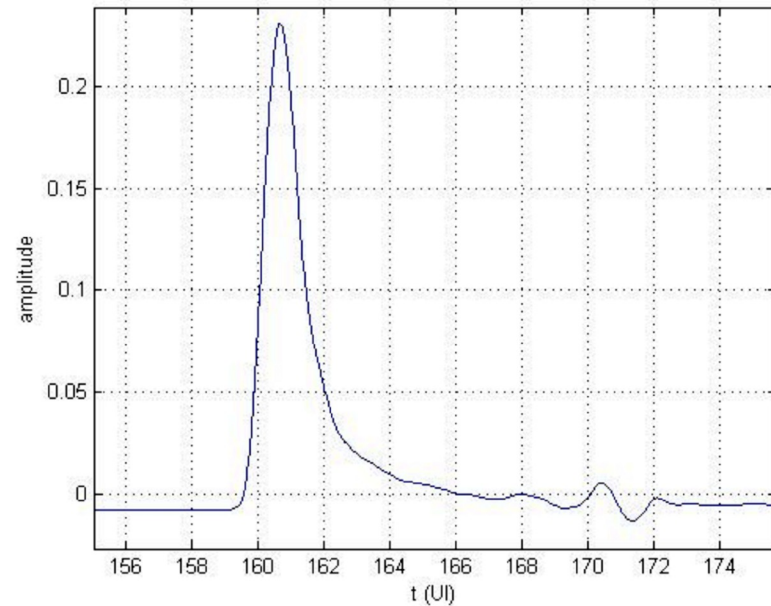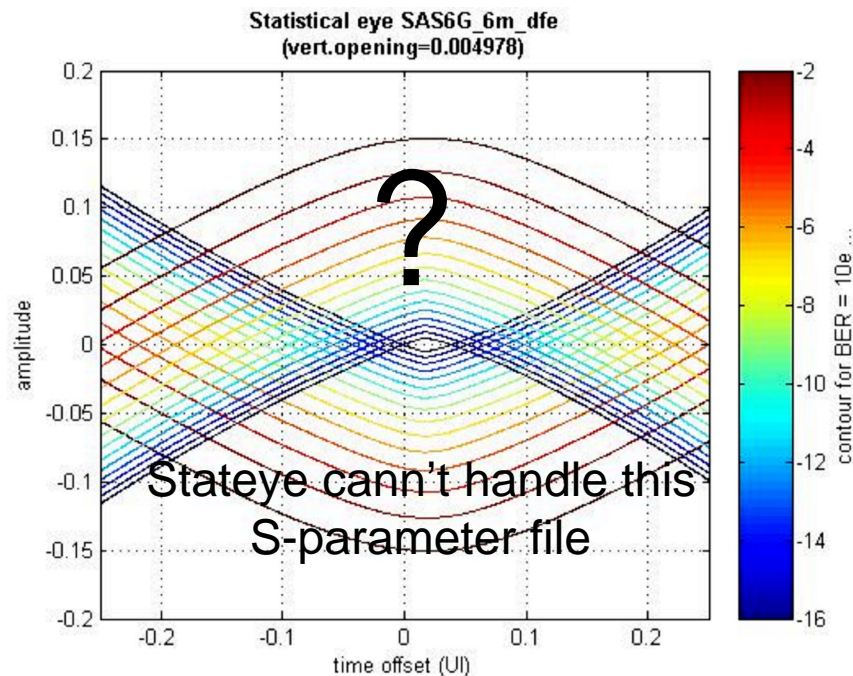
SAS2_transmittertestload.s4p

iPass_10m_24AWG_IL.s4p

- Vod=1000mVpp; 1.6dB de-emphasis; 5-tap DFE
- R/C filters for package Tx/Rx models (r=45ohm, c=800fF)
- Jitter: DJ=0.18UI; RJ=.18/(2*7.94)UI

Stateye Simulation on Molex 6m Cable model

6m_A5A6B5B6.s4p

Channel pulse response

Statistical eye SAS6G_6m_dfe
(vert.opening=0.004978)
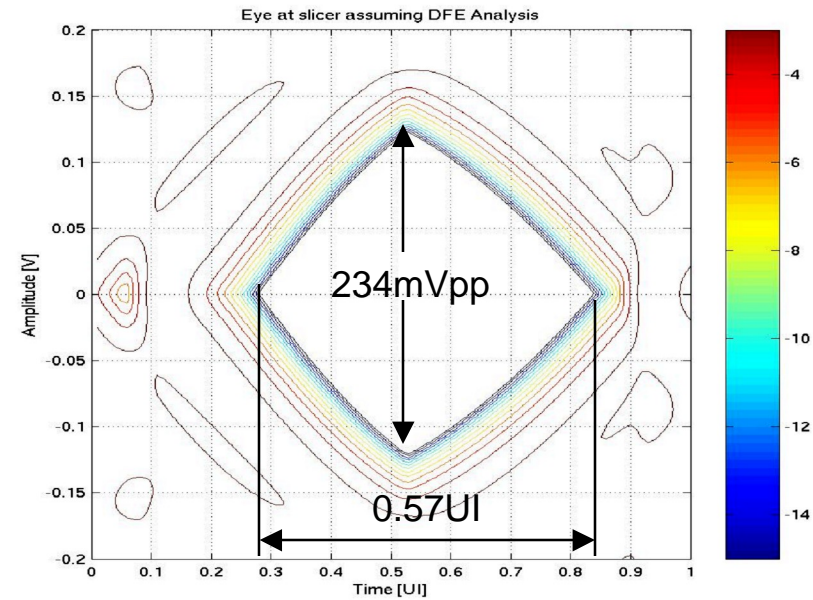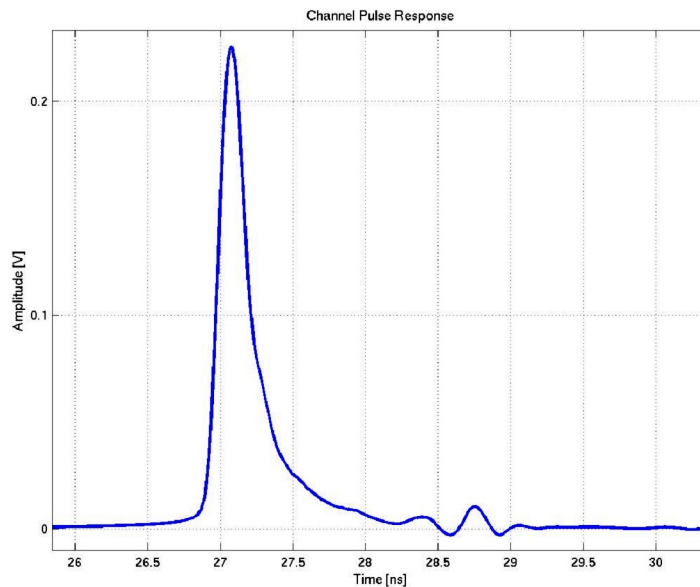
Stateye cann't handle this
S-parameter file

Also seen on doc T10/07-327r0

- Vod=1000mVpp; 0dB de-emphasis; 5-tap DFE
- R/C filters for package Tx/Rx models (r=45ohm, c=800fF)
- Jitter: DJ=0.18UI; RJ=.18/(2*7.94)UI

PMC SSA Simulation on Molex 6m Cable Model

6m_A5A6B5B6.s4p

- Vod=1000mVpp; 0dB de-emphasis; 5-tap DFE
- R/C filters for package Tx/Rx models (r=45ohm, c=800fF)
- Jitter: DJ=0.18UI; RJ=.18/(2*7.94)UI

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