Quantum™

T10/00-147r1

Ultra320 SCSI vs Ultra160 SCSI Eye Diagram Data

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SCSI Physical Working Group Meeting

09 Feb 2000

Huntington Beach, CA

Objectives

- **Evaluate Ultra160 margins with the same techniques as used for our Ultra320 data**
  - **Ultra160 transmitter drive level used for evaluation was 400mV peak differential**
  - **Ultra320 data was taken from presentation (00-104r0)**
    - **400mV peak differential for No Comp and Rx Equalized**
    - **400mV / 720mV peak differential for Tx Precomp**
- **Measure the signal degradations to find eye opening with ISI, reflections and crosstalk for typical configurations, including:**
  - **Amplitude errors;**
  - **Timing shift errors;**
  - **Miscellaneous noise.**

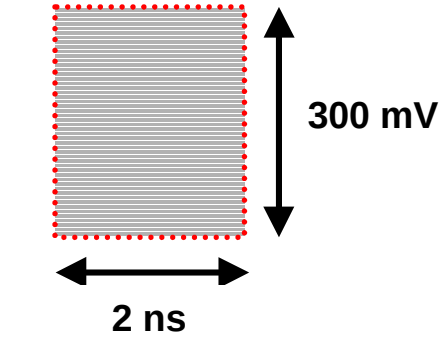
Quantum™ Estimated Ultra320/160 Error Sources

			U-320	U-160
Random amplitude (0-to-pk)	Terminator voltage mismatch	(SPI-3: Tab20)	13mV	13mV
	Terminator resistance mismatch	(SPI-3: Tab20)	5mV	5mV
	Driver error	(SPI-3: TabA2)	40mV	40mV
	Receiver comparator	(SPI-3: TabA5)	30mV	30mV
	Root sum squares of random amplitude		52mV	52mV
Deterministic Amplitude: (0-to-pk)	Cable + back-plane resistance	(cable spec + meas)	28mV	28mV
	Comparator overdrive requirement	(SPI-3: Fig48)	70mV	70mV
	Total amplitude 0-to-pk factors:		150mV	150mV
Timing factors (0-to-pk)	Low Vt vs substrate noise	(99-261r1)	100ps	50ps
	Receiver clock jitter	(99-261r1)	125ps	250ps
	Residual de-skew	(99-261r1)	125ps	3.3ns
	De-skew stability	(temperature)	100ps	N/A
	Input slew rate dependent skew	(99-261r1)	100ps	100ps
	Receiver amp dependent delay	(99-261r1*)	150ps	150ps
	Receiver FF rise/fall prop delay difference		300ps	300ps
	Total 0-to-pk timing factors:		1.0ns	4.15ns

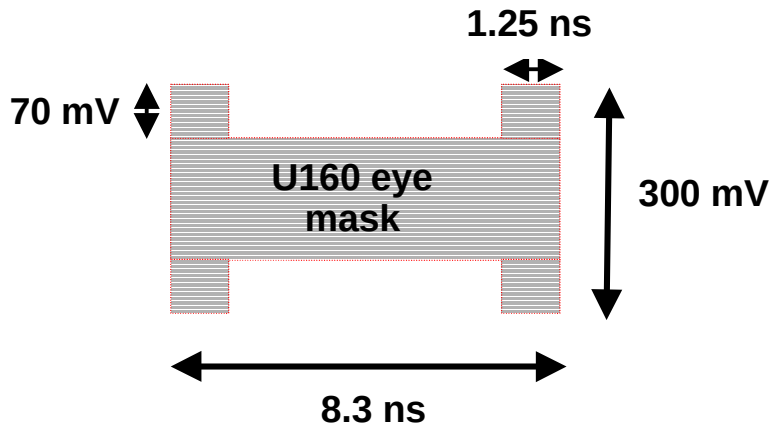
These are the error sources that are not accounted for by our test setup as well as those in the SPI-3 budget. 0-to-peak values converted from peak-to-peak numbers by a factor of 1/2.

Error Sources

- **Error sources are used to define the range over which a receiver characteristic may typically vary from the ideal sample point, i.e., the actual sample point may lie anywhere within a box defined by 2 times 0-to-peak height and 2 times 0-to-peak width of the errors.**



U320 Eye Mask

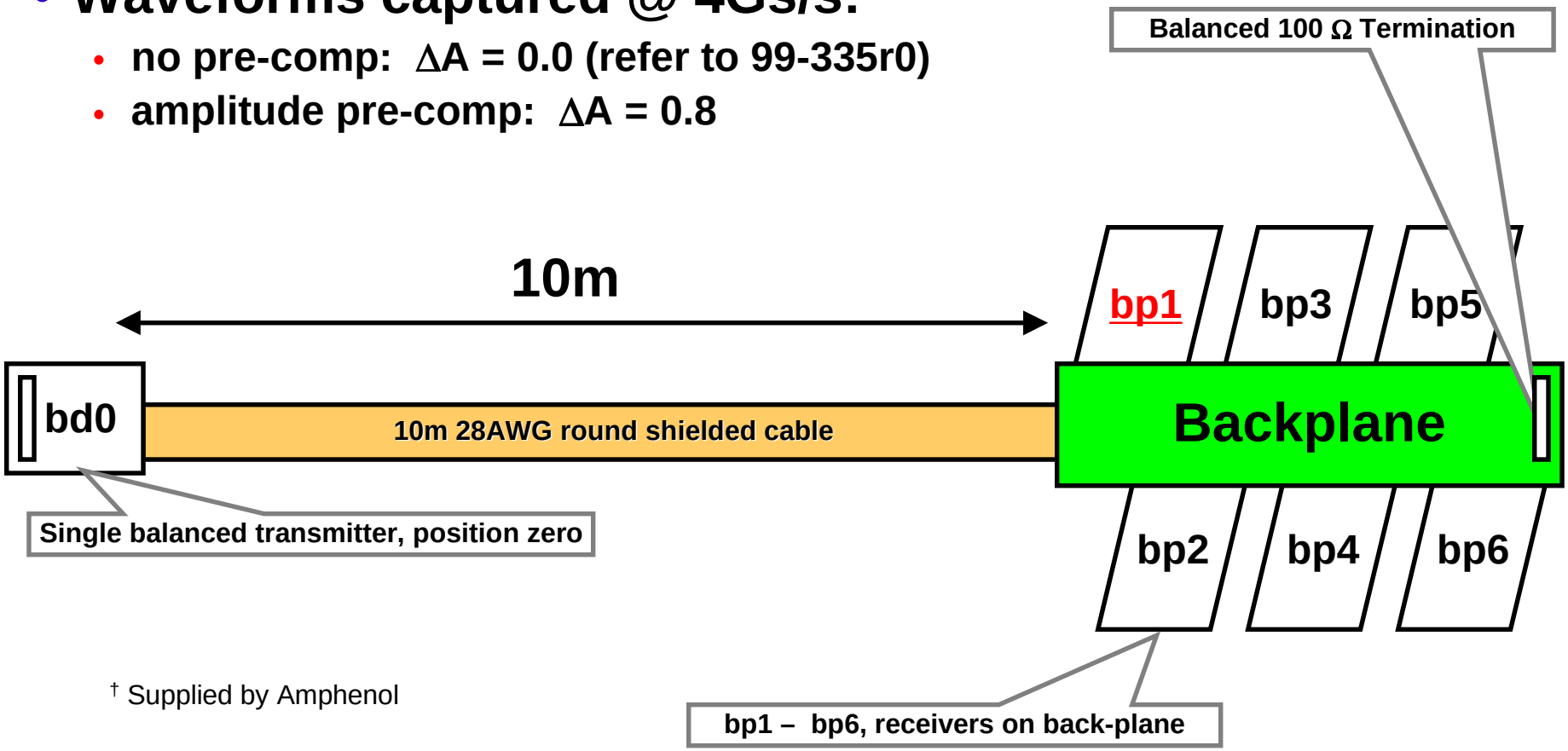


U160 Eye Mask
notched as in Fig 48, SPI-3

- **Amplitude error sources define height, and timing error sources define width, e.g., set-up time margin is measured as the distance from the eye diagram waveform to the box.**

Quantum™ Config 1: Long Cable + Backplane

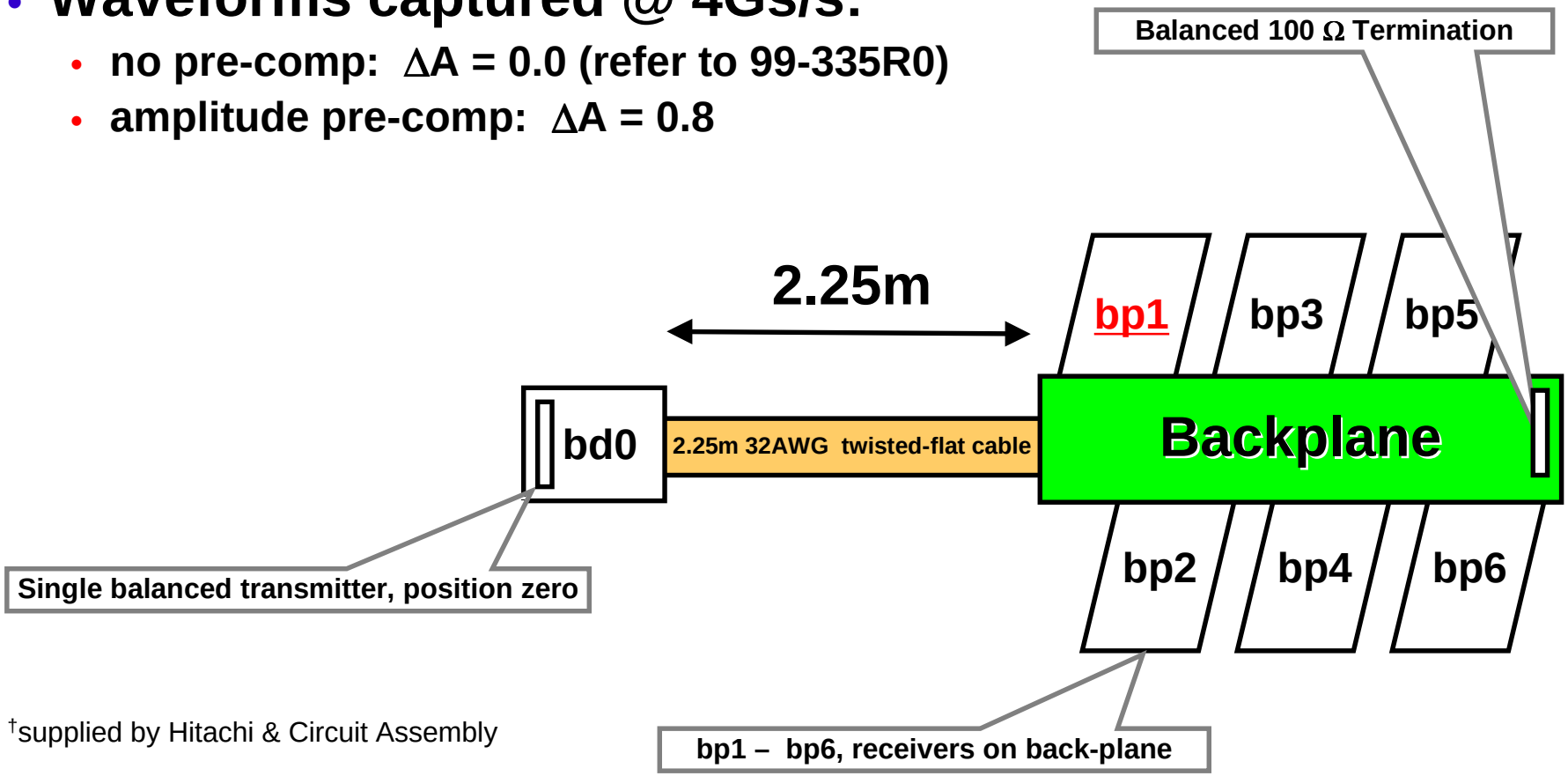
- **10 meter Madison 28AWG† round shielded cable plus 6-slot backplane.**
- **Waveforms captured @ 4Gs/s:**
  - **no pre-comp: ΔA = 0.0 (refer to 99-335r0)**
  - **amplitude pre-comp: ΔA = 0.8**



† Supplied by Amphenol

Quantum™ Config 2: Short Cable + Backplane

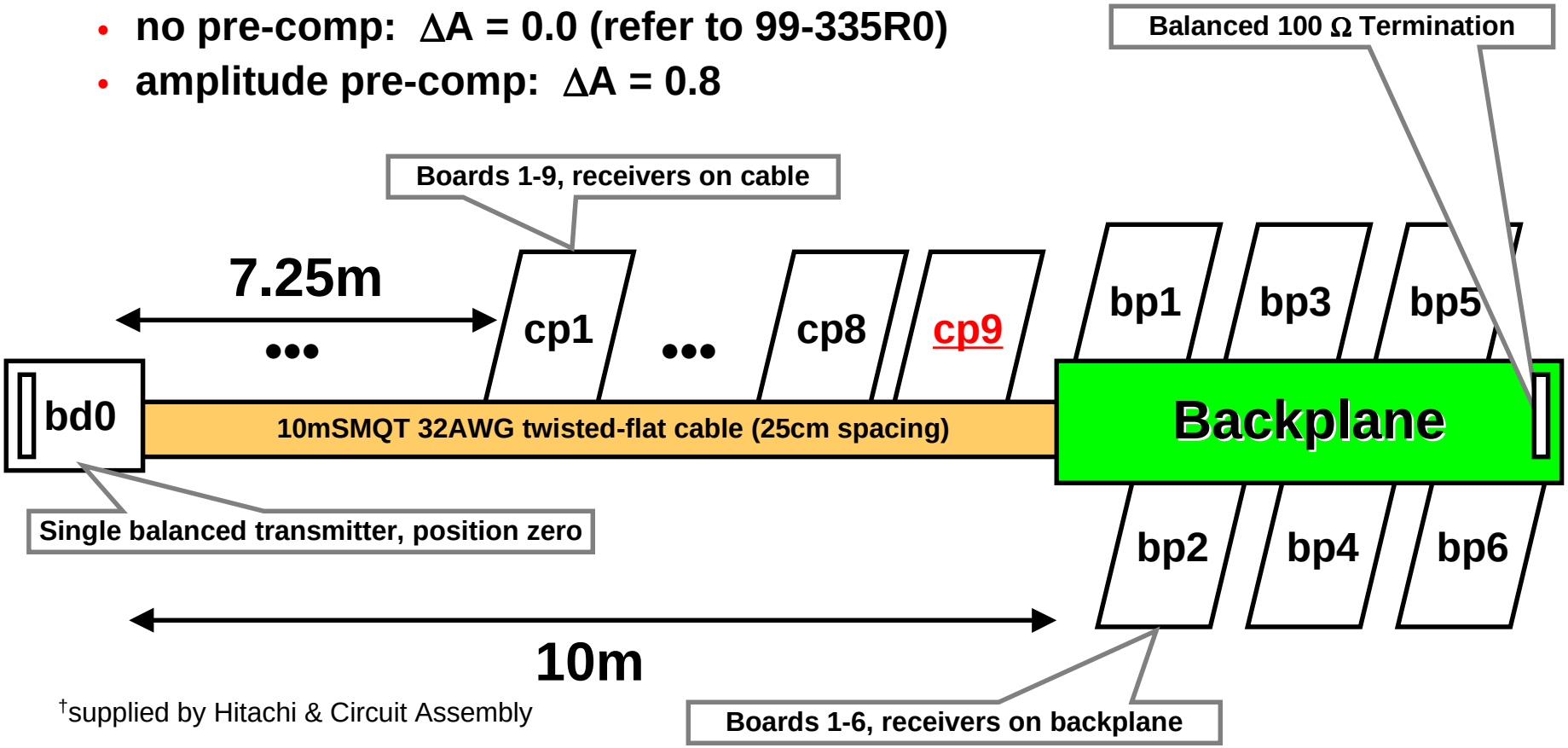
- **2.25 meter Hitachi 32AWG twisted-flat cable† plus 6-slot backplane.**
- **Waveforms captured @ 4Gs/s:**
  - **no pre-comp: ΔA = 0.0 (refer to 99-335R0)**
  - **amplitude pre-comp: ΔA = 0.8**



†supplied by Hitachi & Circuit Assembly

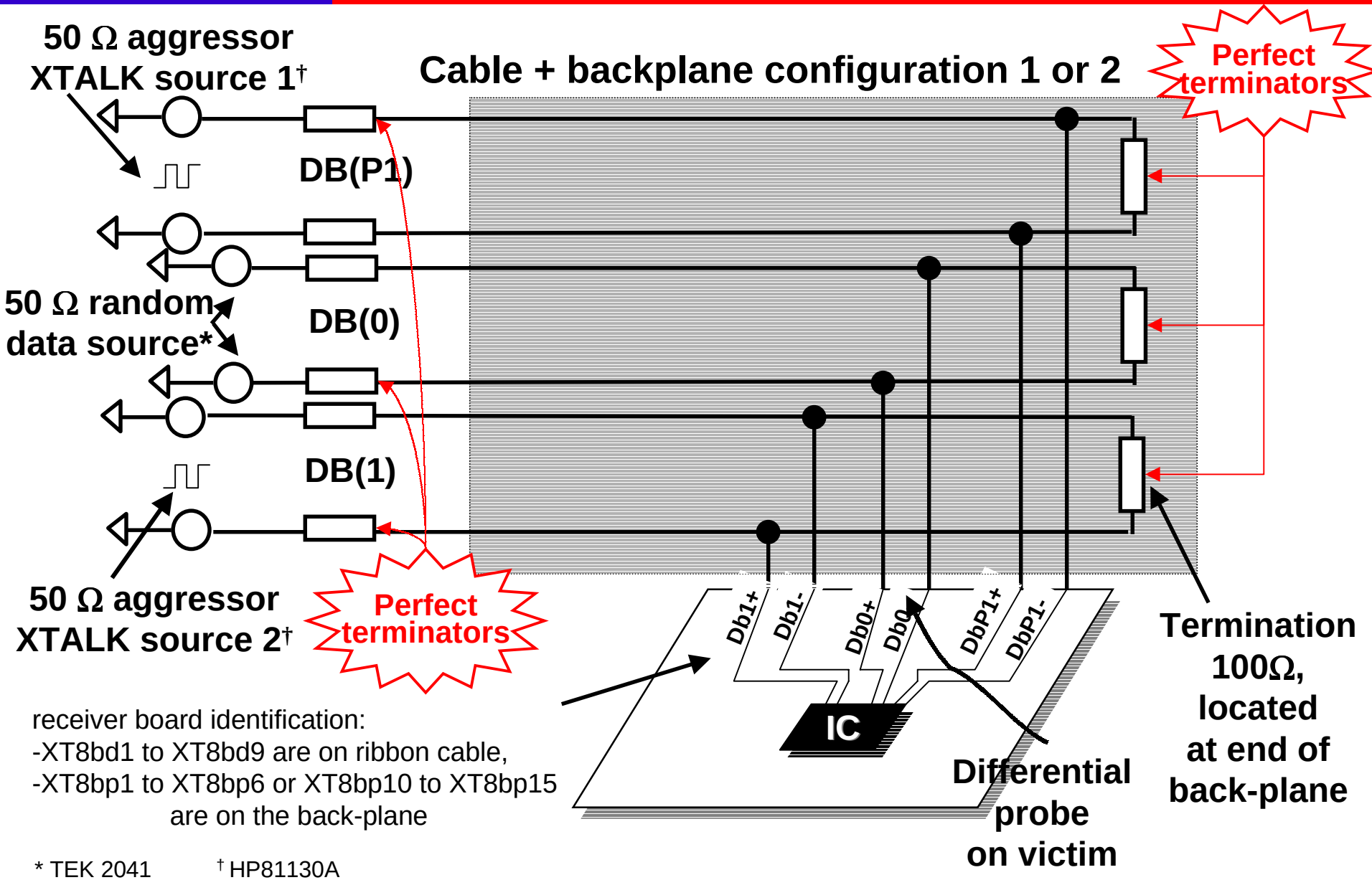
Quantum™ Config 3: Loaded Long Cable + BP

- **Hitachi 10 meter 32AWG twisted-flat ribbon cable† with 25cm load spacing plus 6-slot backplane.**
- **Waveforms captured @ 4Gs/s:**
  - **no pre-comp: ΔA = 0.0 (refer to 99-335R0)**
  - **amplitude pre-comp: ΔA = 0.8**



†supplied by Hitachi & Circuit Assembly

Test Schematic

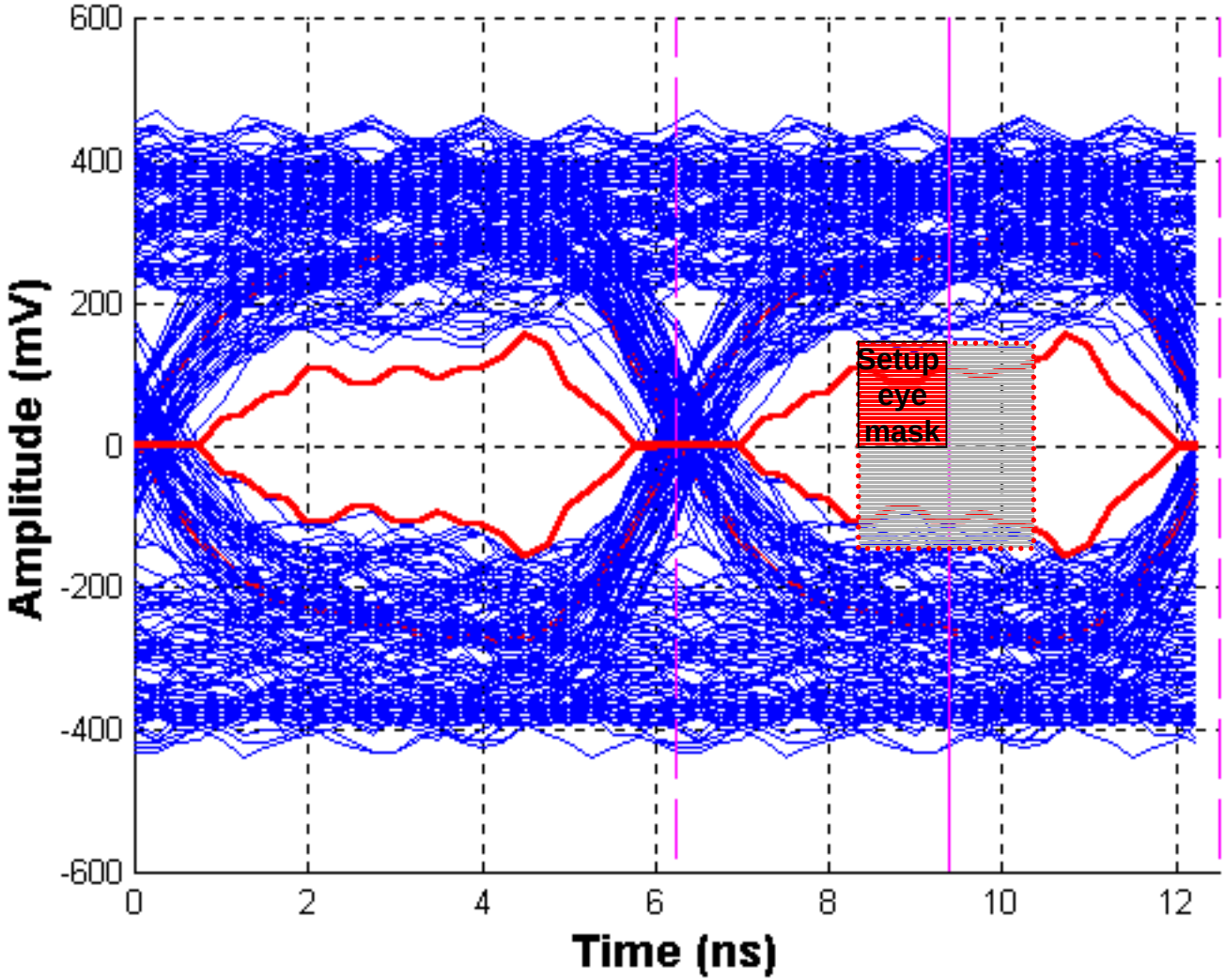


receiver board identification:
-XT8bd1 to XT8bd9 are on ribbon cable,
-XT8bp1 to XT8bp6 or XT8bp10 to XT8bp15 are on the back-plane

* TEK 2041 † HP81130A

Quantum™ Config 1*, Ultra320, No comp

*10m round cable + loaded 6-slot backplane @ bp1

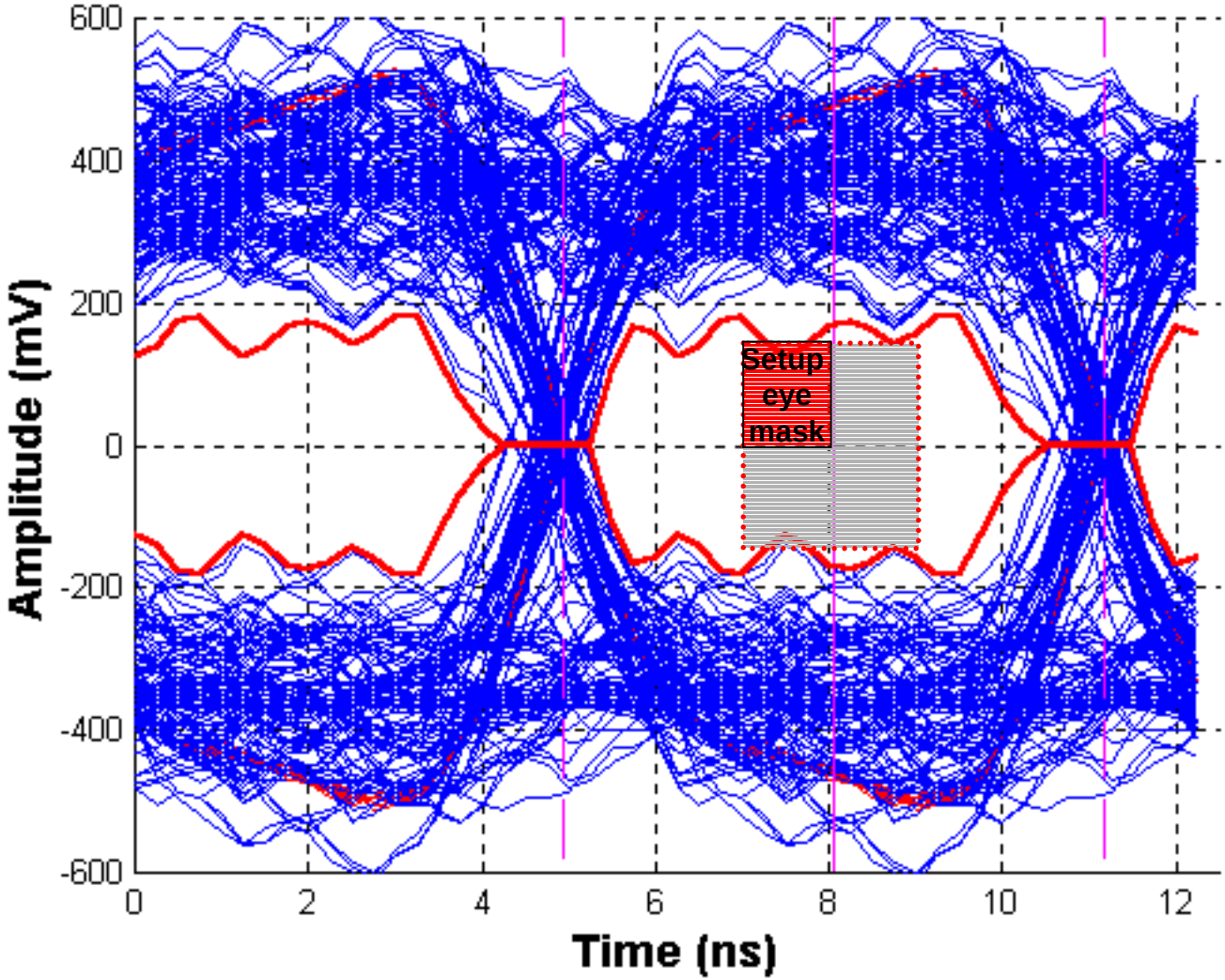


Conclusion: Failing Margin

(Increasing amplitude would still fail)

Quantum™ Config 1*, Ultra320, Tx Precomp

*10m round cable + loaded 6-slot backplane @ bp1



Conclusion: Failing Margin

(Can't increase amplitude to improve margin)

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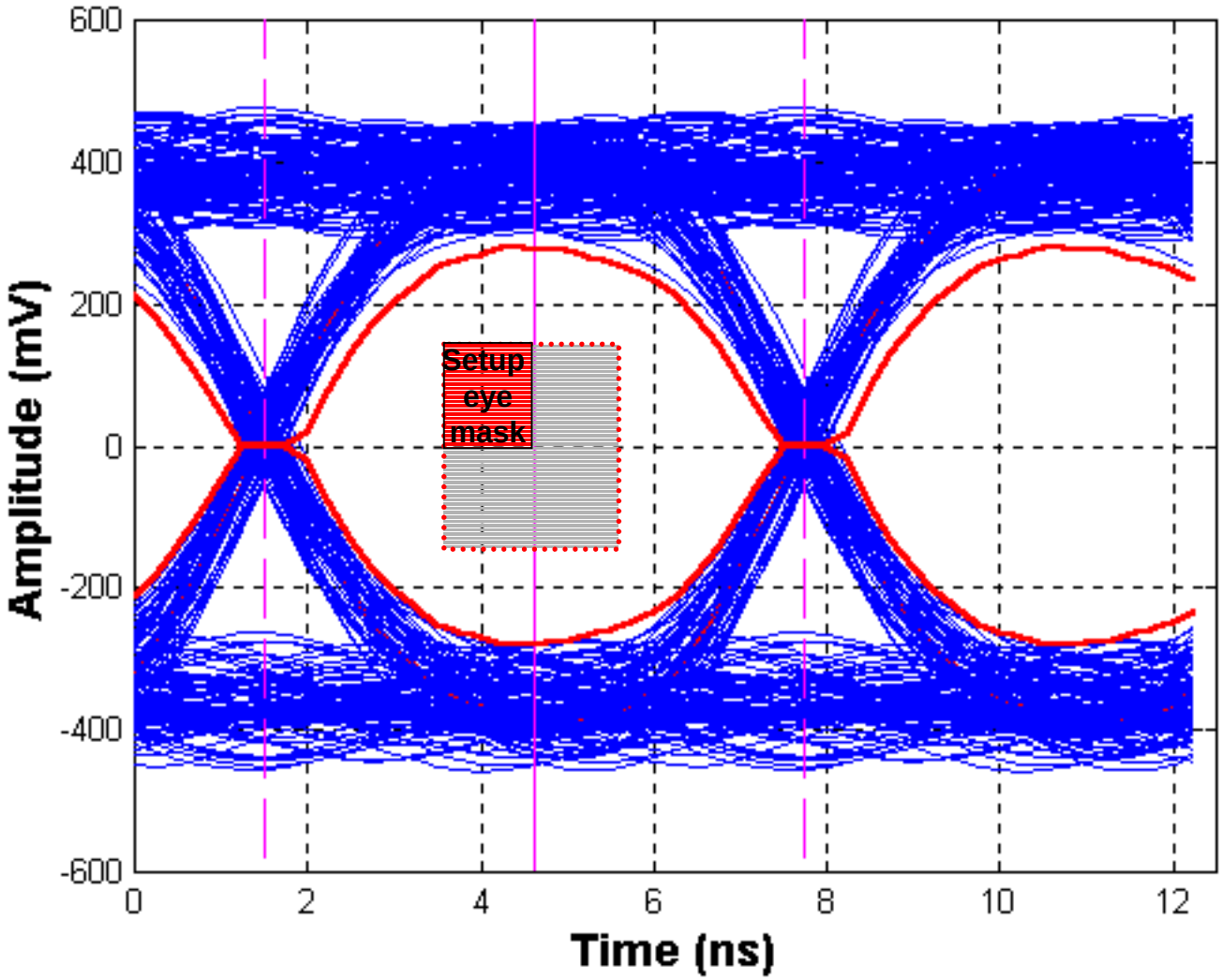
Config 1*, Ultra320, Rx Equalized

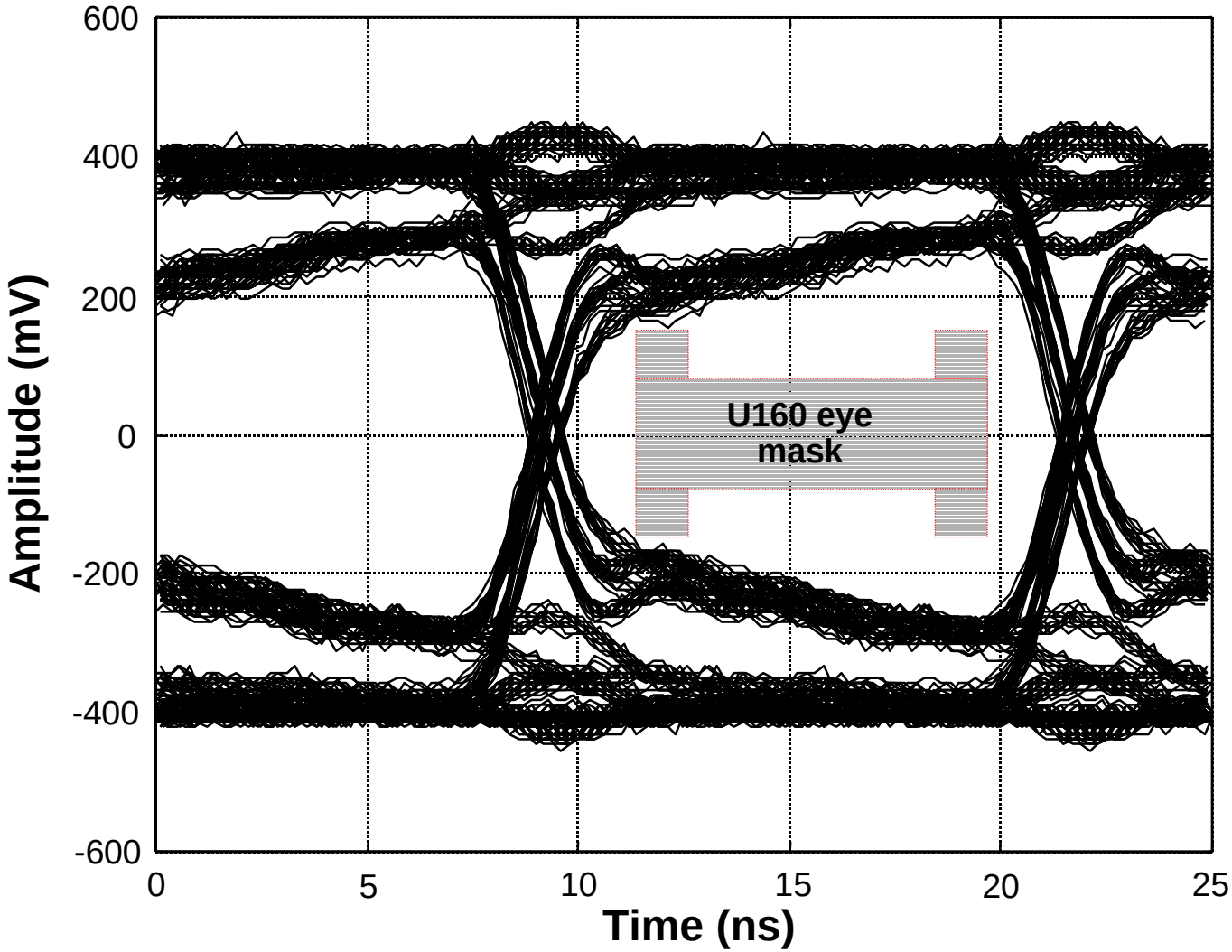
***10m round cable + loaded 6-slot backplane @ bp1**



Conclusion: <u>Excellent Margin</u>

Config 1*, Ultra160

*10m round cable + loaded 6-slot backplane @ bp1



Conclusion: Failing Margin*

(*Increasing amplitude would make margin adequate)

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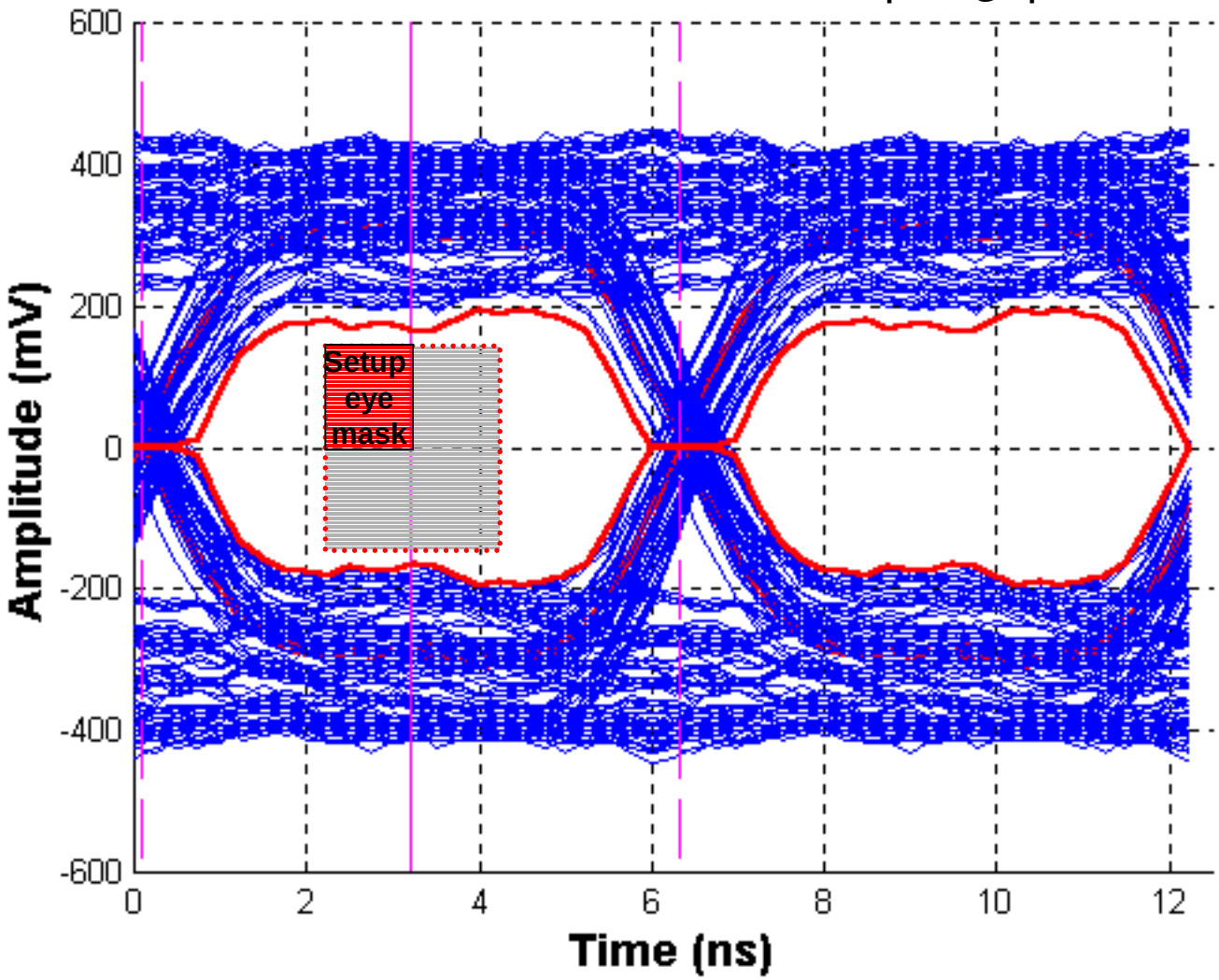
Config 2*, Ultra320, No comp

*2.25m twisted-flat cable + loaded 6-slot backplane @ bp1



Conclusion: <u>Adequate Margin</u>

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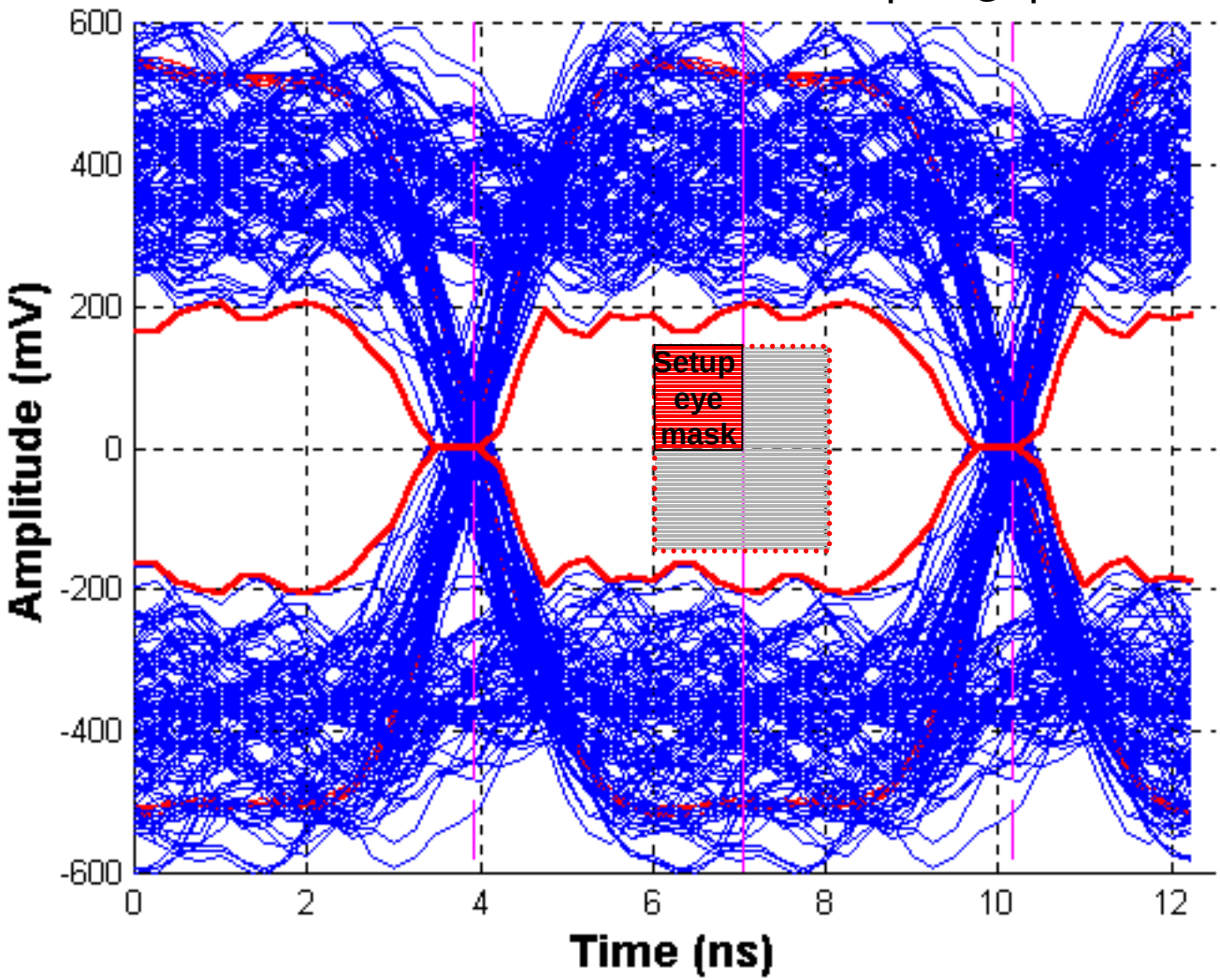
Config 2*, Ultra320, Tx Precomp

*2.25m twisted-flat cable + loaded 6-slot backplane @ bp1



Conclusion: Adequate Margin

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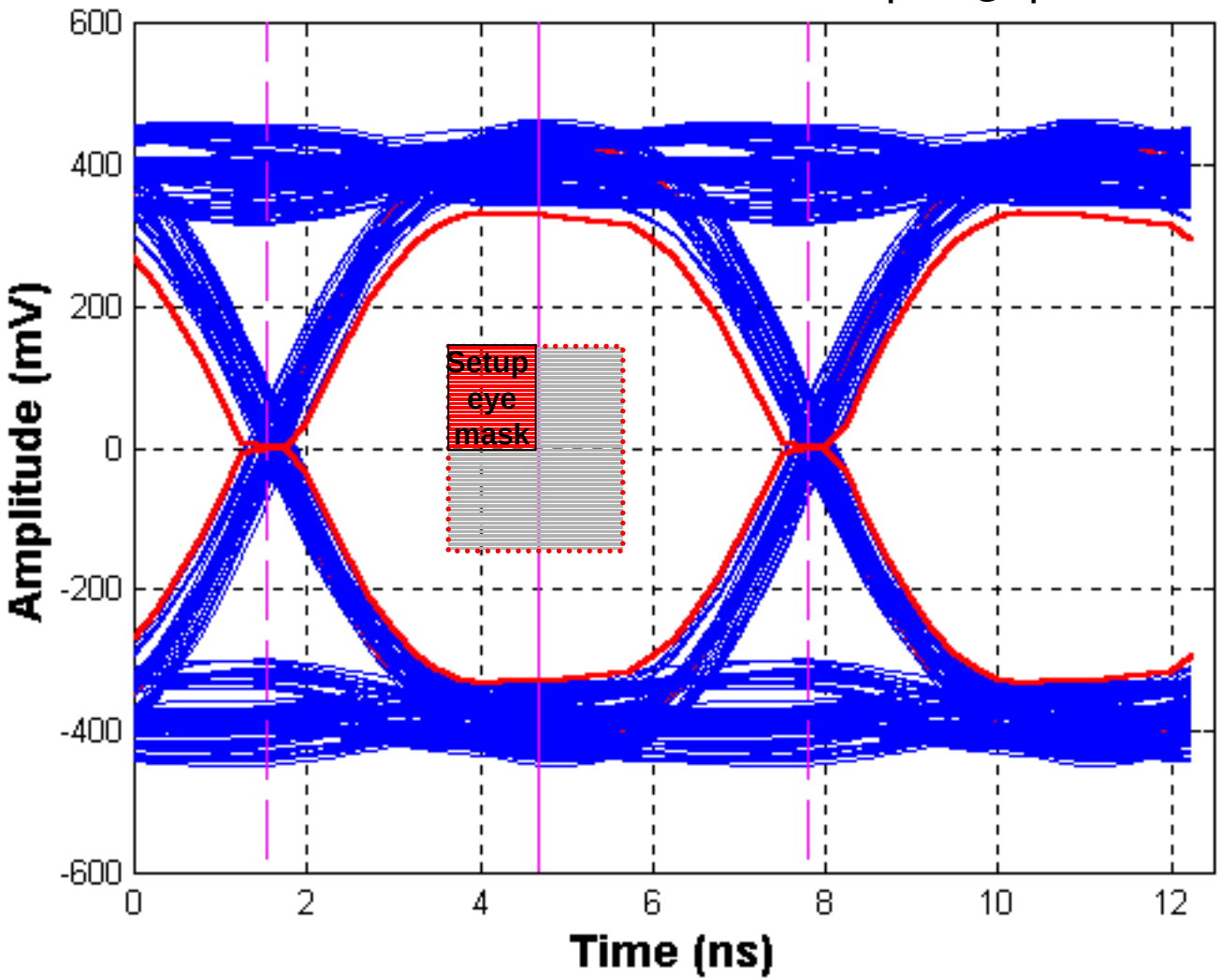
Config 2*, Ultra320, Rx Equalized

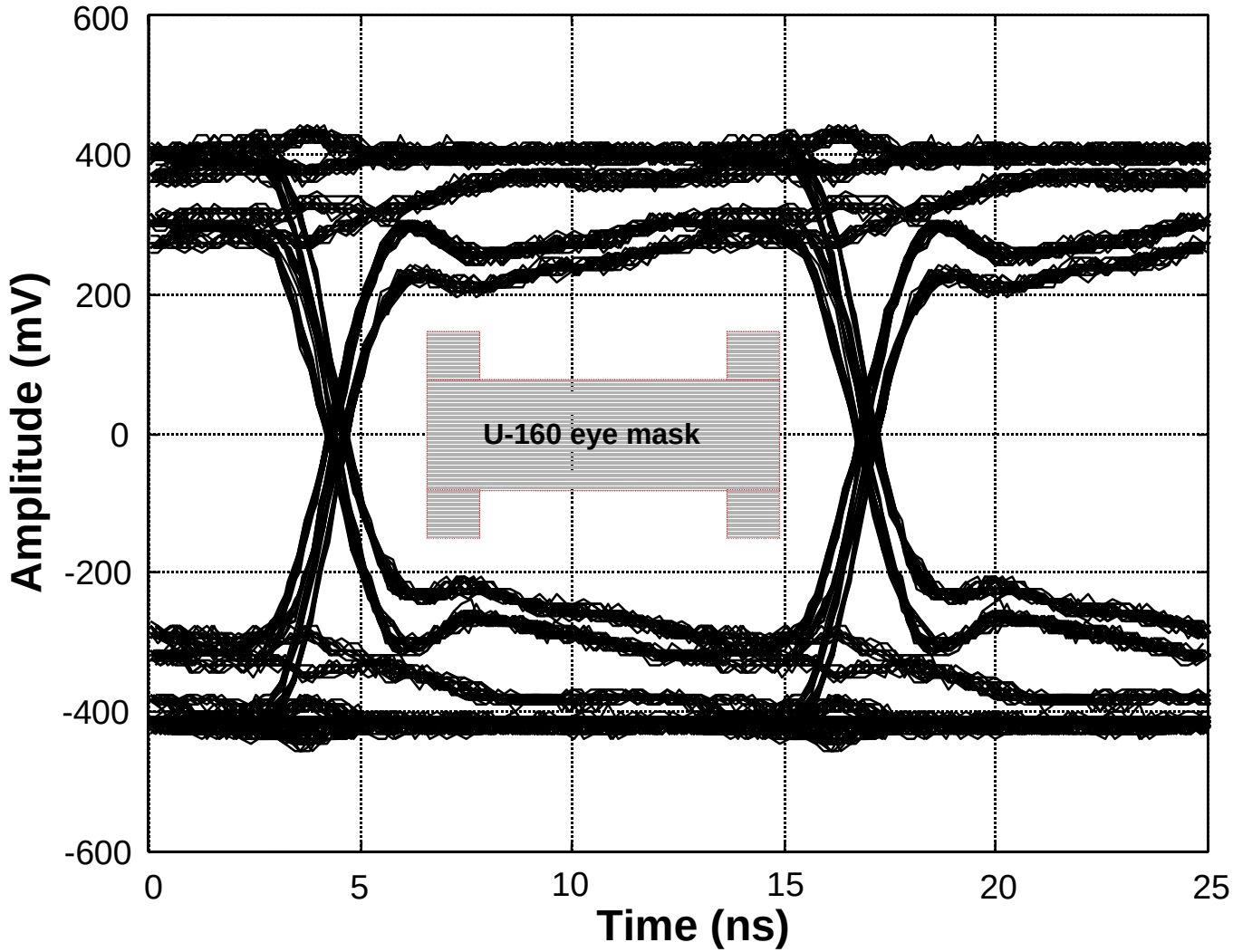
*2.25m twisted-flat cable + loaded 6-slot backplane @ bp1



Conclusion: Excellent Margin

Config 2*, Ultra160

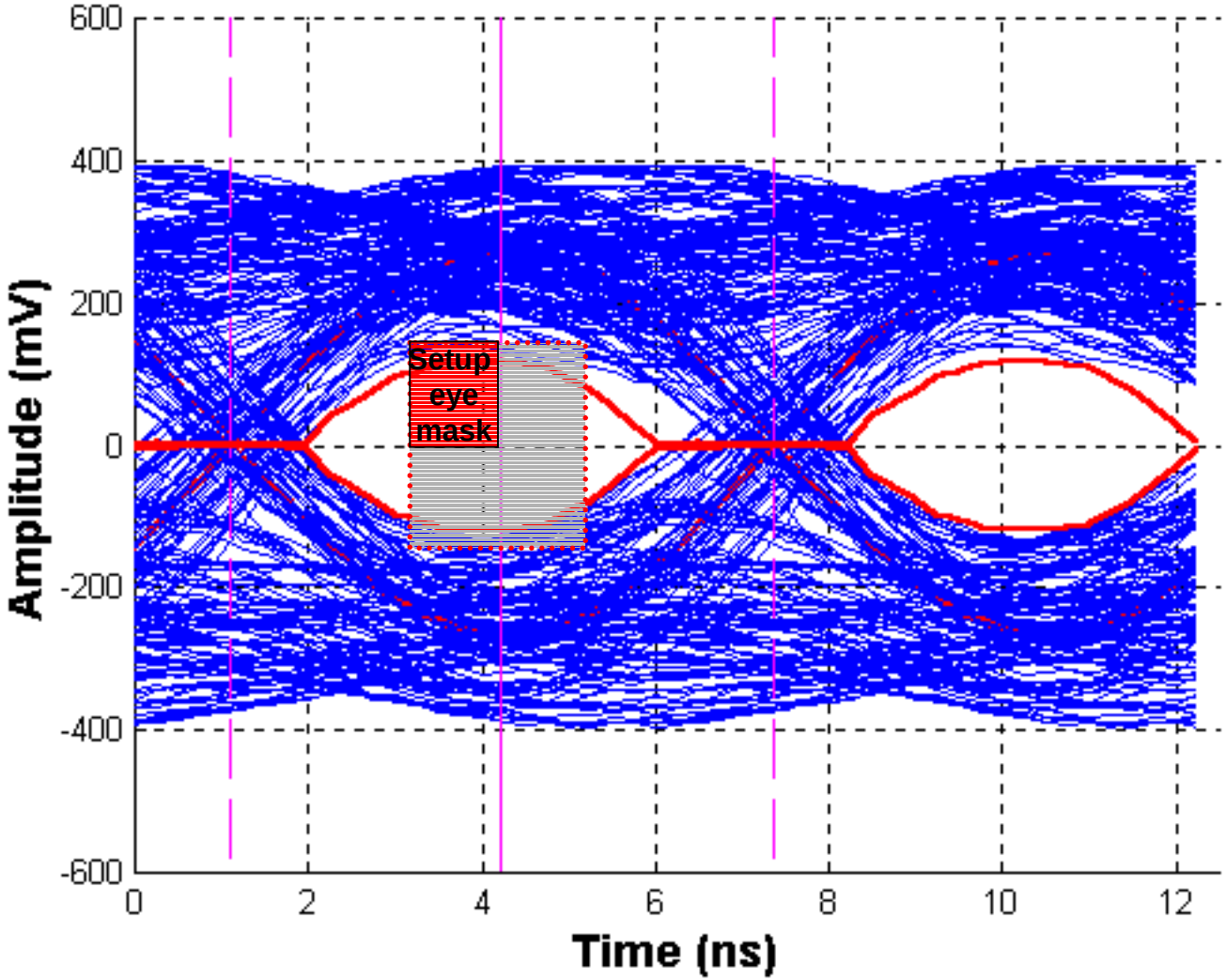
*2.25m twisted-flat cable + loaded 6-slot backplane @ bp1



Conclusion: Excellent Margin

Quantum™ Config 3*, Ultra320, No comp

*10m twisted-flat cable w/9 loads + loaded 6-slot backplane @ cp9



Conclusion: Failing Margin

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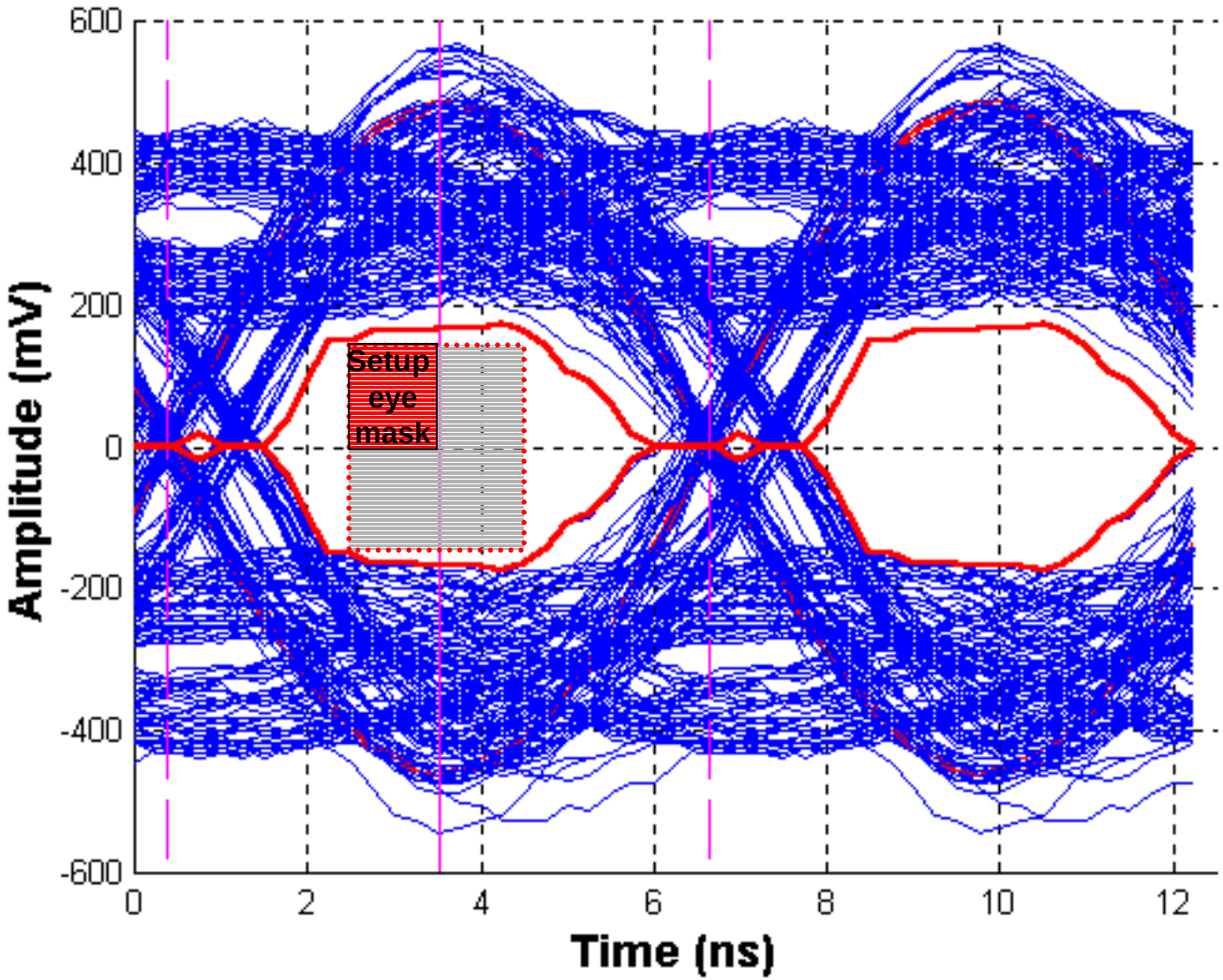
Config 3*, Ultra320, Tx Precomp

*10m twisted-flat cable w/9 loads + loaded 6-slot backplane @ cp9

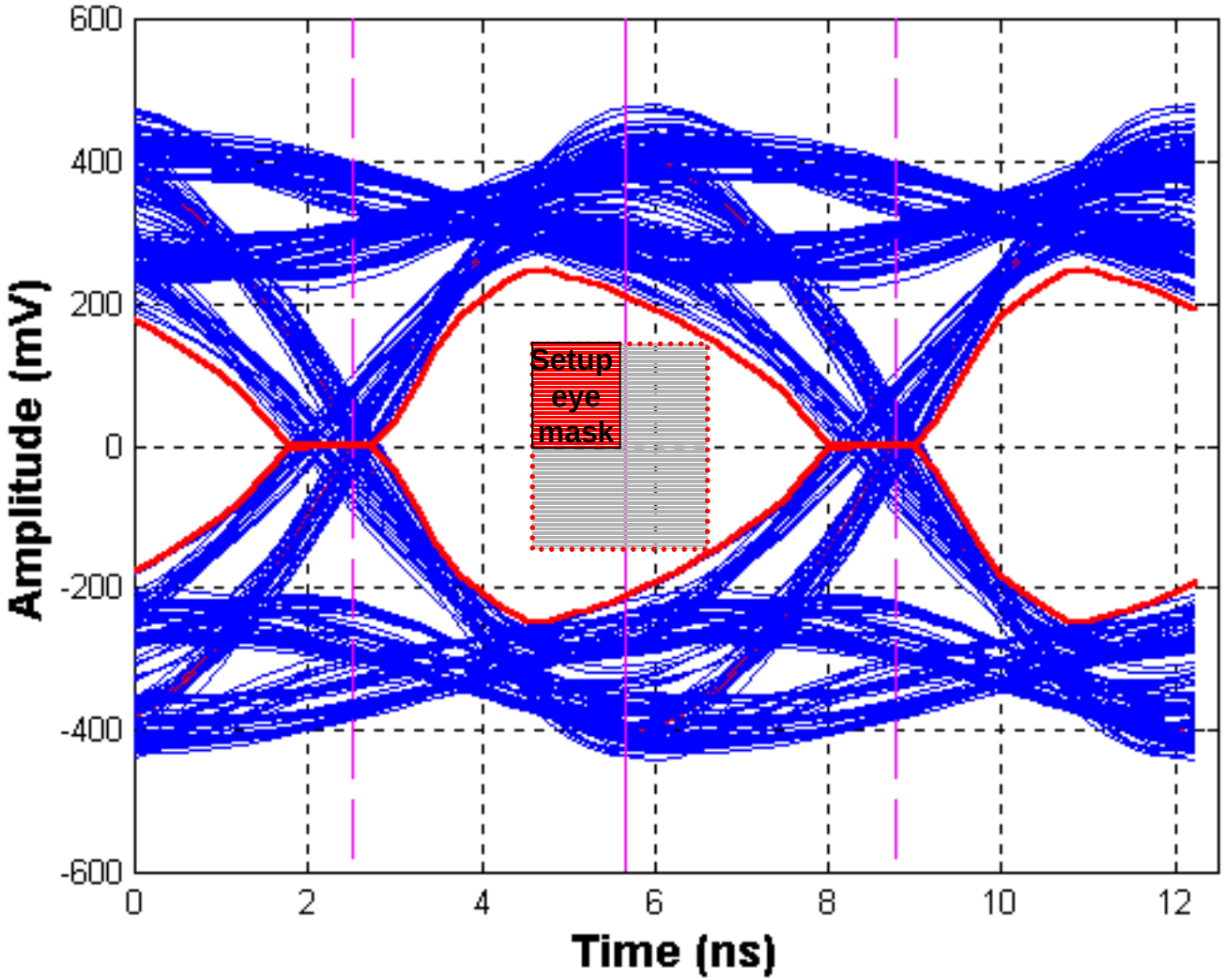


Conclusion: <u>Insufficient Margin</u>

(Can't increase amplitude to improve margin)

Quantum™ Config 3*, Ultra320, Rx Equalized

*10m twisted-flat cable w/9 loads + loaded 6-slot backplane @ cp9

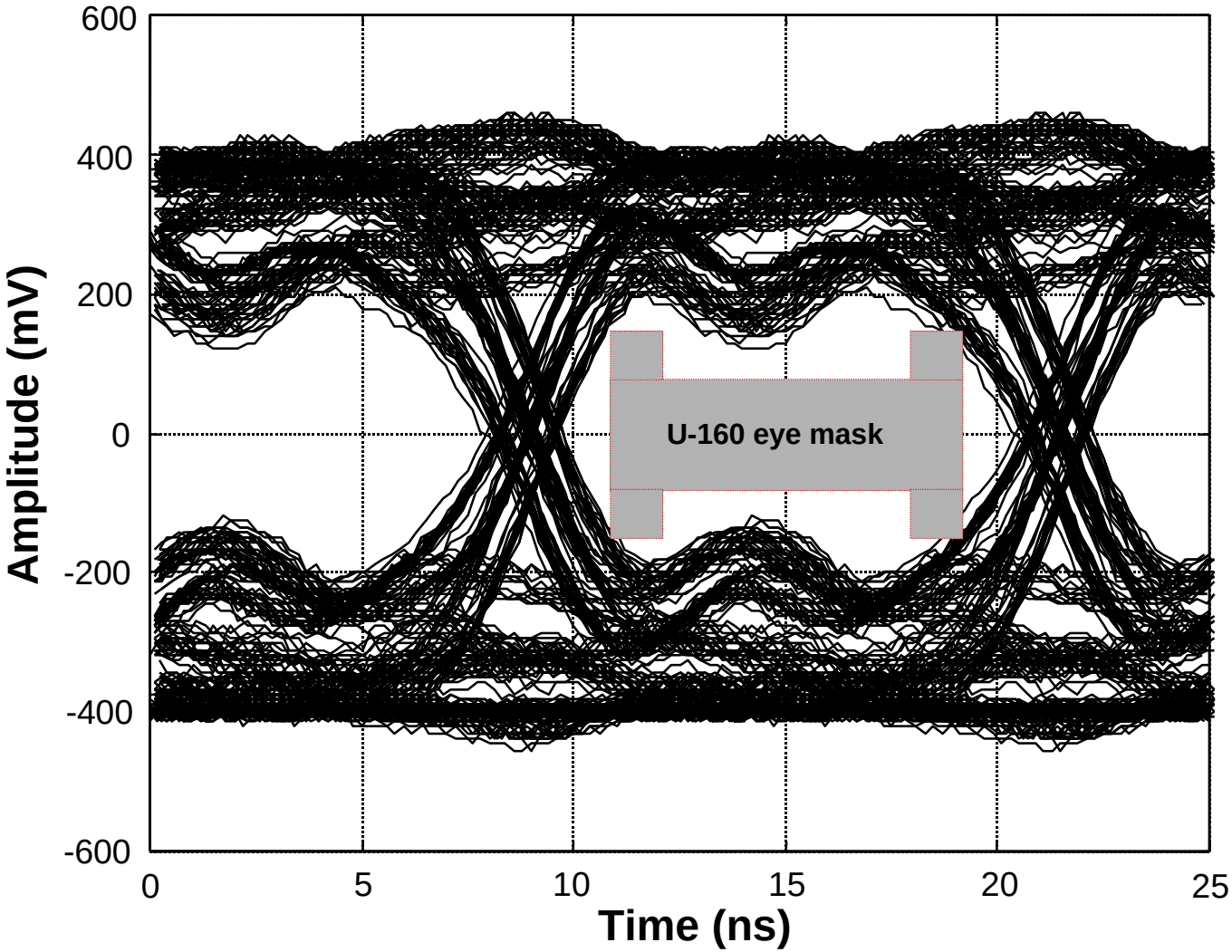


Conclusion: Excellent Set-up Margin*

(*Increased amplitude would make Hold margin adequate)

Config 3*, Ultra160

*10m twisted-flat cable w/9 loads + loaded 6-slot backplane @ cp9



Conclusion: Failing Margin*

(*Increasing amplitude would make margin adequate))

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Summary of Results

Configuration (description)		Ultra320			Ultra160
		No Comp	w/Tx Pre-comp	w/Rx Equalizer	
1	(10m round cable + loaded 6-slot backplane @ bp1)	Failing margin	Failing margin	Excellent margin	Failing margin *
2	(2.25m flat cable + loaded 6-slot backplane @ bp1)	Adequate margin	Adequate margin	Excellent margin	Excellent margin
3	(10m twisted-flat cable w/9 loads + loaded 6-slot backplane @ cp9)	Failing margin	Insufficient margin	Excellent Set-up margin	Failing margin *

* Increasing amplitude would make margin adequate.

Conclusions

1. U160 eye diagrams show adequate margin with all configurations (though getting close with 10m cable with 16 loads)
2. U320 provides adequate margin without precomp or equalization with a short cable (2.5m) configuration
3. U320 using transmitter precomp provides insufficient margin with typical configurations
4. U320 using receiver equalization provides excellent margins with all configurations