SAS 1.1, TCTF ISI Specification Issue – Discussion and Proposal –

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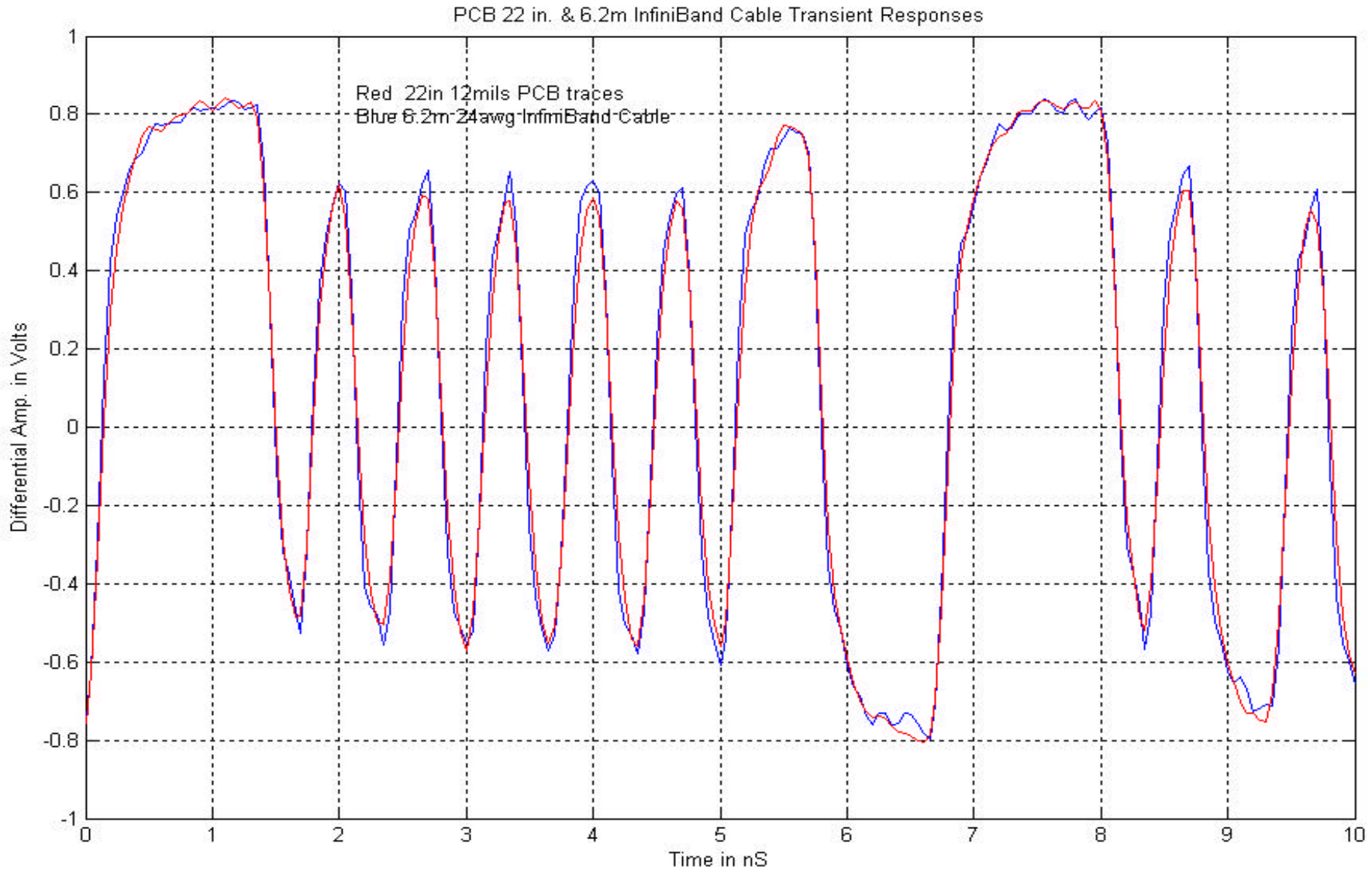
TCTF Specification Problem

- The TCTF is a test tool for transmitter signals, intended to introduce frequency response and ISI limitations representative of a worst-case, real interconnect
- It is possible to construct a TCTF function that meets the attenuation versus frequency characteristics but introduces very little ISI
- The present TCTF specification does not meet the intent

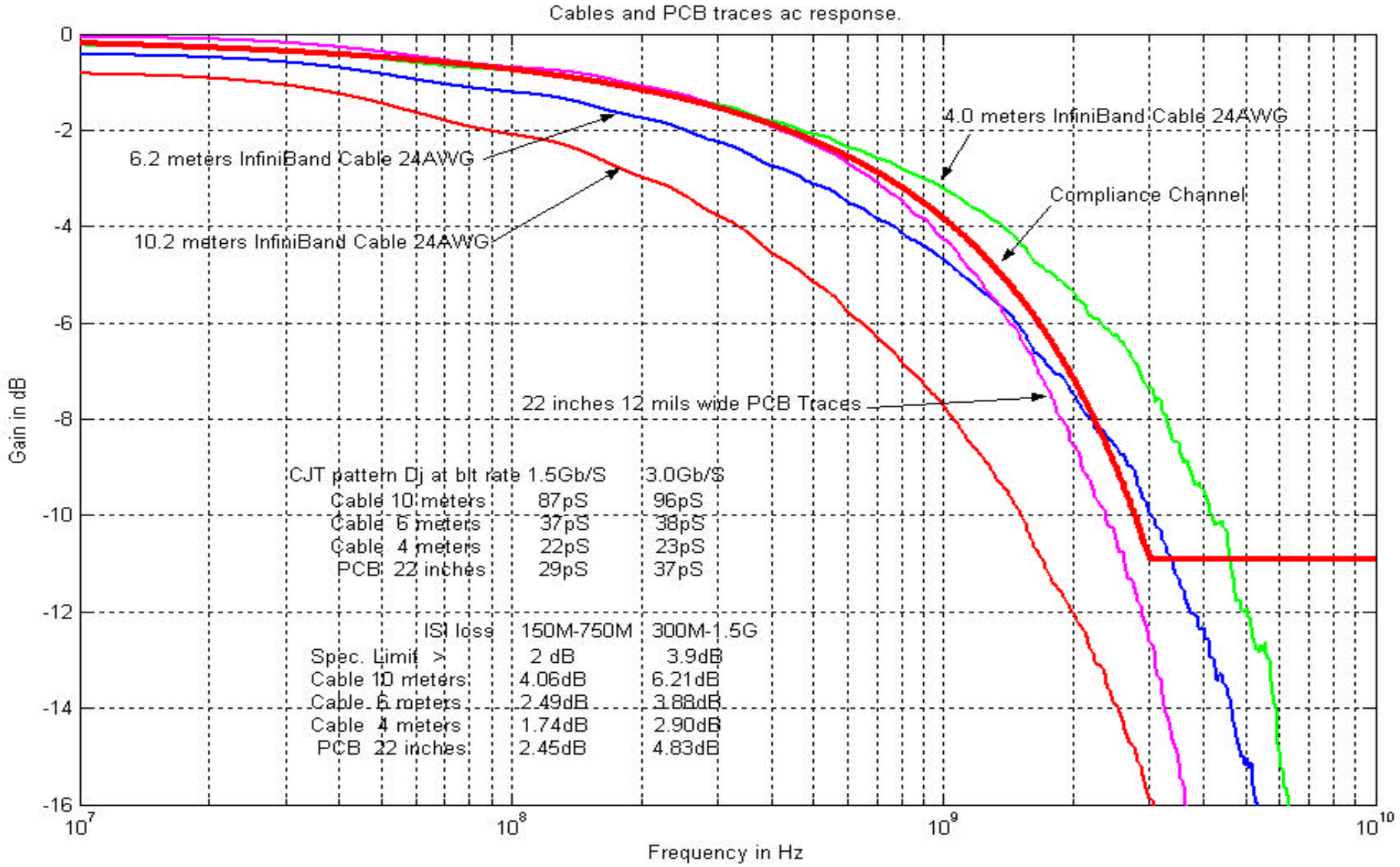
Sample Interconnects vs TCTF

- Data was taken for several transmission media
  - 24 AWG Infiniband cable of 4, 6.2 and 10.2 meter lengths
  - 22 inch long / 12 mil wide 100 Ω differential trace on FR4
- Test set-up:
  - CJTPAT was transmitted from a signal generator (Agilent 86130A) through each sample
  - Output captured on a LeCroy SDA6020
  - Frequency responses calculated from step response captured on an Agilent 86100A, jitter was calculated using Matlab
- Slide 4 shows the output waveforms for 6.2 m cable and FR4
- Slide 5 shows the frequency responses of the four interconnects with the SAS TCTF amplitude specification
- The data is summarized in the table on slide 6 including DJ contributions for each interconnect at 1.5 and 3 Gbps
- Slide 7 shows pre-TCTF vs SAS1r04 jitter specs for reference

Example Output Waveforms



Frequency Response Examples



Measured ISI Loss and DJ Data

	Added DJ with CJTPAT		ISI Loss	
	1.5 Gbps	3 Gbps	1.5 Gbps > 2 dB	3 Gbps >3.9 dB
10.2 m Cable	87 ps	96 ps	4.06 dB	6.21 dB
6.2 m Cable	37 ps	38 ps	2.49 dB	3.88 dB
4 m Cable	22 ps	23 ps	1.74 dB	2.9 dB
22 inch PCB	29 ps	37 ps	2.45 dB	4.83 dB

Pre-TCTF vs SAS1r04 Jitter Specs

	1.5 Gbps		3 Gbps	
	DJ	**TJ**	**DJ**	**TJ**
SAS-r01c Dt	0.15 UI 100 ps	0.25 UI 167 ps	0.2 UI 67 ps	0.35 UI 117 ps
SAS-r01c Dr	0.35 UI 233 ps	0.55 UI 367 ps	0.35 UI 117 ps	0.55 UI 183 ps
Delta J Dt $\Rightarrow$ Dr	133 ps	200 ps	50.3 ps	66 ps
SAS1r04 IR	0.35 UI 233 ps	0.55 UI 367 ps	0.35 UI 117 ps	0.55 UI 183 ps

Discussion and Proposal

- For the 22 inch PCB and 6.2 meter cable samples:
  - Both have frequency responses close to the TCTF attenuation curve
  - Added DJ is significant, but small compared to the pre-TCTF budget for the DJ difference between Dt and Dr compliance points
- Adding a phase or group delay requirement should fix the problem, but the limits would be difficult to establish
- Jitter is a major concern for SAS, and so a DJ specification for the TCTF would be a reasonable choice
- Maxtor proposes adding a minimum ISI requirement, e.g., the TCTF must introduce a minimum DJ (ISI) of x ps when transmitting CJTPAT
- More data and discussion are required to determine appropriate values for “x”