SAS-2 10-Meter Cable Specification Issues (06-499r1)

Barry Olawsky

Hewlett Packard

(SAS FTF - 1/16/2007)

Existing External Cable Specification (for 1.5 and 3Gbps)

Requirement [a, b]	Units	1,5 Gbps	3 Gbps
Bulk cable: [c, d]			
Differential impedance	ohm	100 ± 5	
Maximum differential impedance imbalance [e]	ohm	5	
Common-mode impedance	ohm	32,5 ± 7,5	
Mated connectors:			
Differential impedance [f, d]	ohm	100 ± 10	
Cable assembly: [g]			
Maximum insertion loss	See 5.3.3		
Maximum rise time [h, i]	ps	150	
Maximum ISI [j]	ps	60	
Maximum intra-pair skew [h, k]	ps	50	

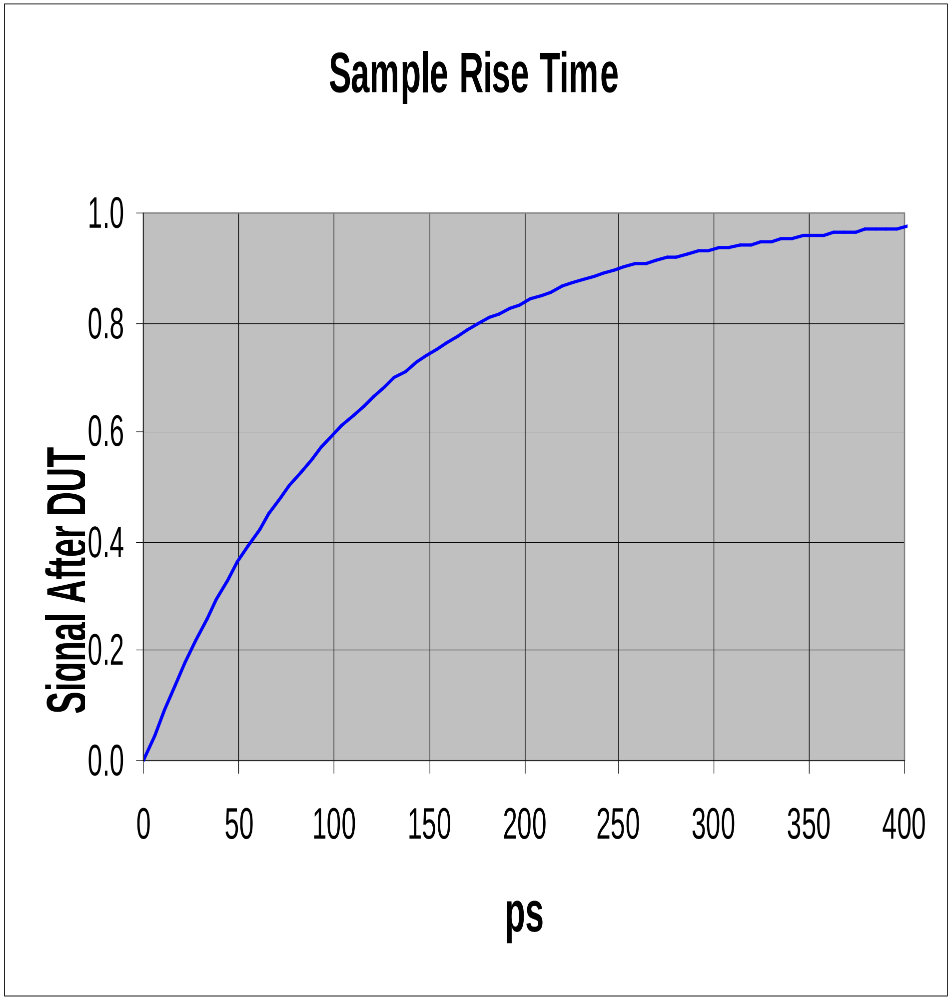
Note: 10m cable budgets were not defined for SAS1.1 (1.5 & 3Gbps)

Issues for Discussion

- The original intent of TCTF was a test load definition and not an insertion loss mask. Insertion loss mask specifications are problematic because they either disqualify designs with adequate margin or if specified too leniently, pass designs which are prone to interoperability issues due to insufficient margin.
- Intra-skew spec is difficult to meet on longer cables. The significance of intra-pair skew needs to be proven. Don’t expect a common mode conversion specification to be any easier to meet.

Issues for Discussion (continued)

- Applying the rise time test to long cables results in an output waveform that is very exponential. Precise measurements become very difficult.
- Furthermore, what significance does signal amplitude have a 2 or 3UI compared to 1UI?



Wrap-up

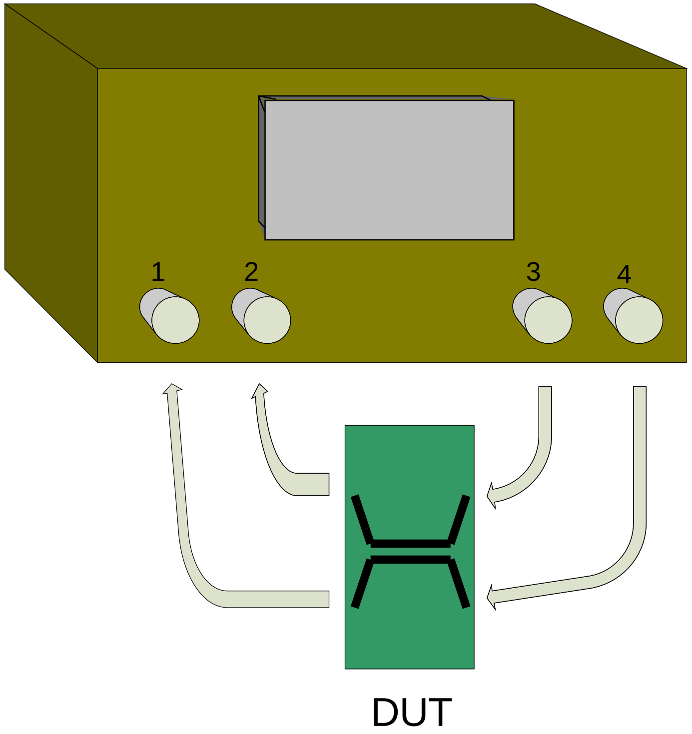
- Modeling and simulation may prove that we are focusing on parameters that are of minimal importance.
- Do we need to consider a channel based specification for cables too?

Revision 1 Updates

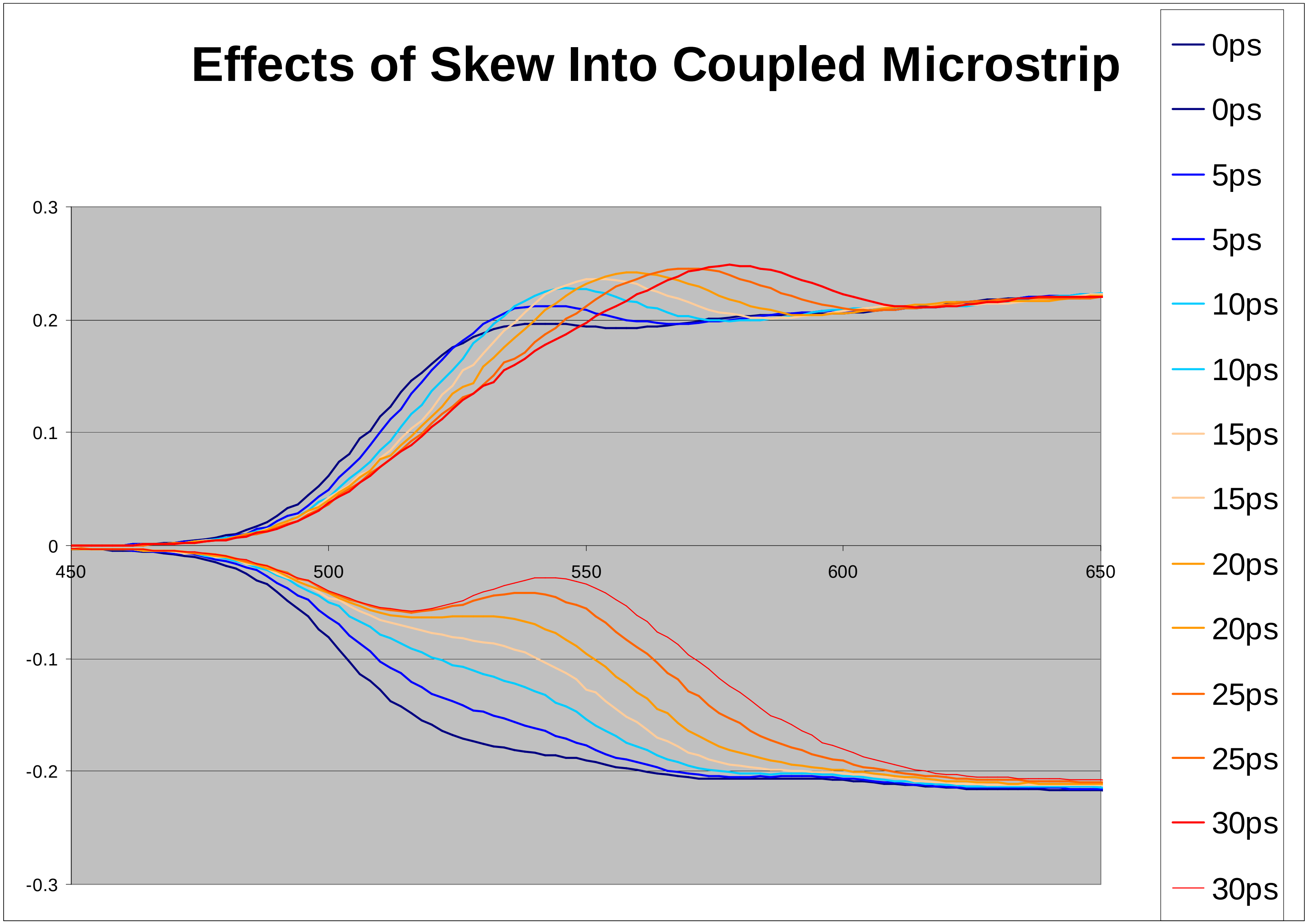
- The most contentious parameter in any of the cable specification is skew. The plan was to work with bulk cable suppliers to statistically characterize the differential to common mode conversion. This would then be an indicator of potential emissions.
- Further work on this topic was done in SFF8416, Annex C.
- I am now convinced my earlier goal is unattainable

Skew and Coupling

- Skew is to some degree self-limiting when applied to differentially coupled interconnect
- A sequence of small steps in skew demonstrate this effect
- The situation in bulk cable is not exactly the same. The coupling is tight and spans the sections where skew is generated



Skew and Coupling

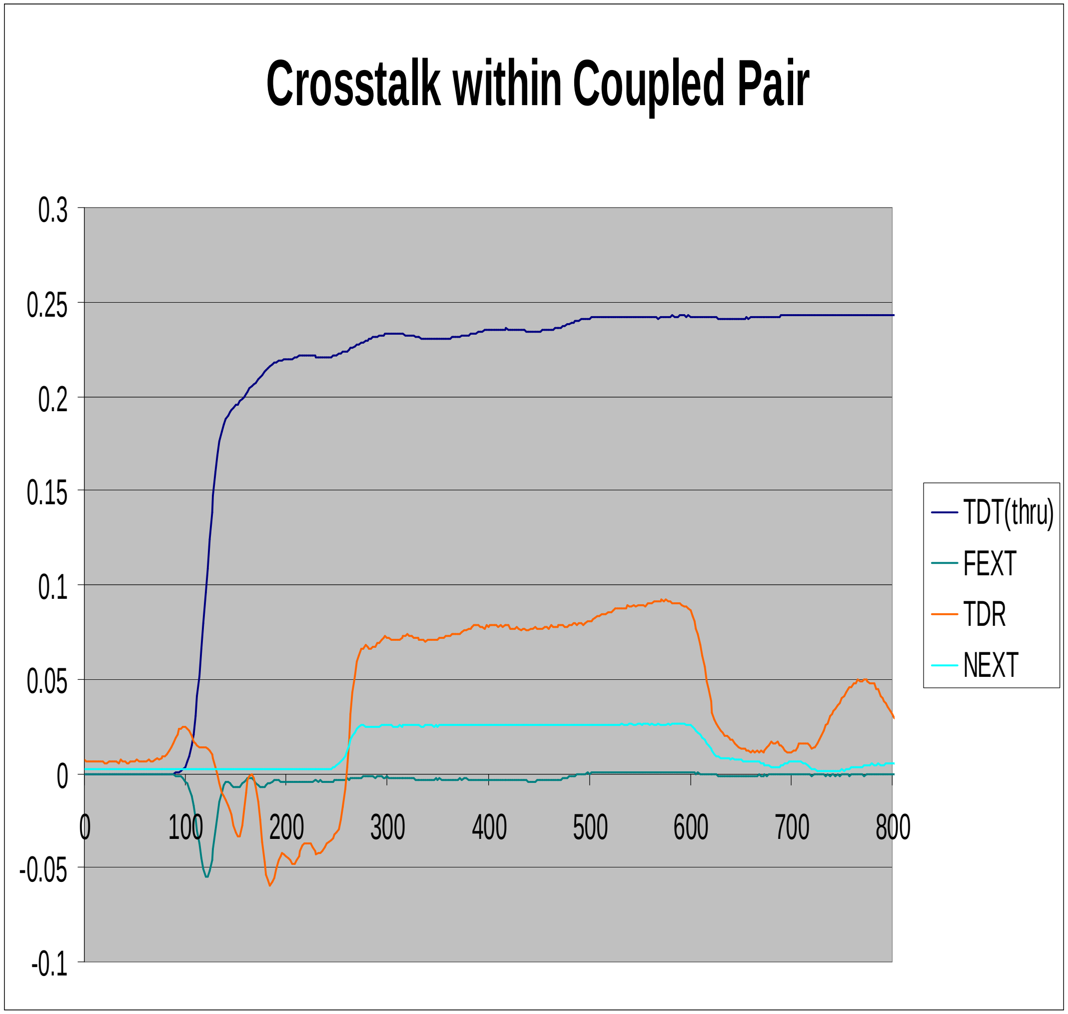


Observations

- The signals within a tightly coupled pair interact in an intentional way.
- As skew is increased, the lead leg experiences what appears to be an overshoot while the trailing leg is slowed
- To understand why this is we need to capture the FEXT of a tightly coupled pair

Observations

- The FEXT is inductive coupling which induces a spike in the victim with a polarity opposite of the aggressor. For differential signaling, the FEXT pulse would then be the same polarity as the victim edge – reinforcing the edge.



Observations

- For differential signaling, the FEXT pulse would then be the same polarity as the victim edge. With the result of reinforcing the edge.
- In the absence of signal on one leg, the trailing edge would start early and not reach full potential. The leading leg will get a spike after it's transition is complete.
- In conclusion, both waveforms are distorted. The "skew" parameter does not accurately describe this undesirable effect. Further work is required to understand how much differential to common mode conversion can be expected and tolerated.