SAS-2 TCTF and Minimum Transmitter Amplitude

Barry Olawsky

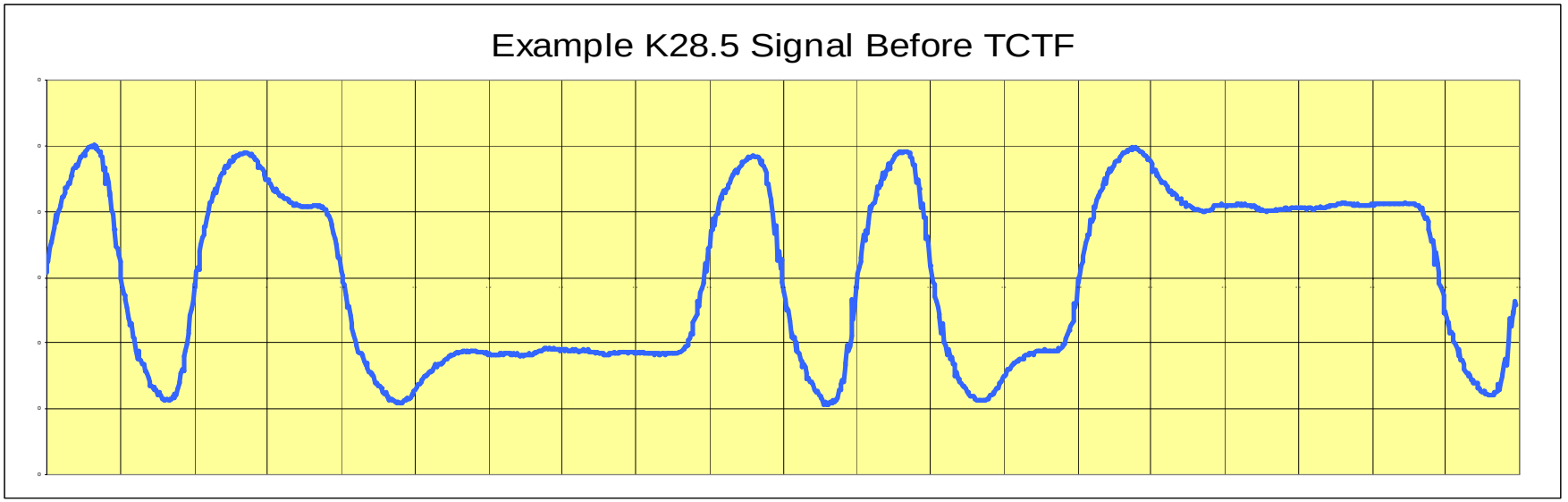
Hewlett Packard

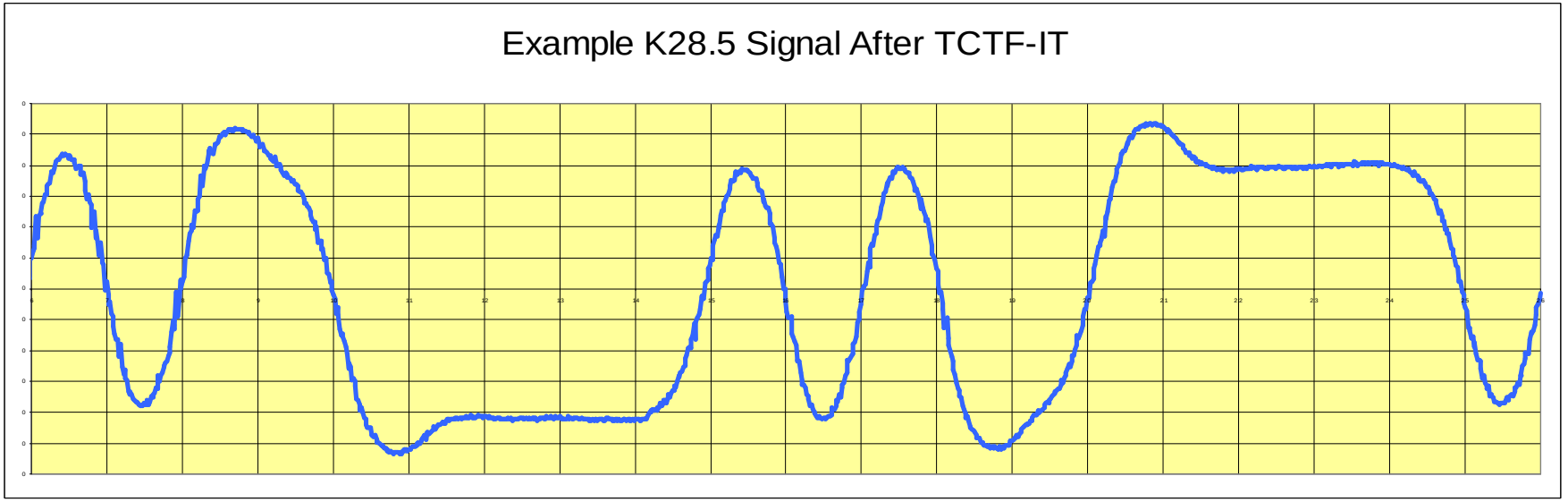
(SAS FTF - 4/9/2006)

Current Position on TCTF Test Load

- Assertion made that TCTF test load can simplify transmitter output compliance testing
- Some TX waveform characteristics have an insignificant effect on the waveform characteristics at the receiver. The TCTF test load is useful as a measurement tool to focus on characteristics that actually effect the receiver.

Example Waveforms



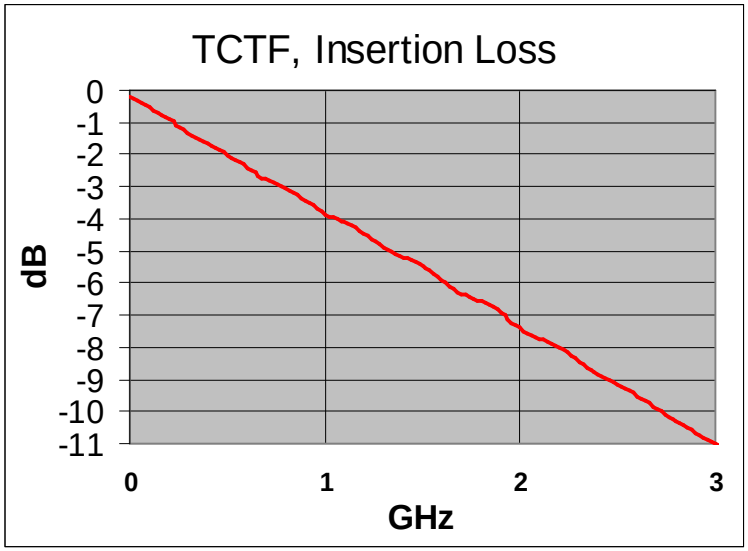


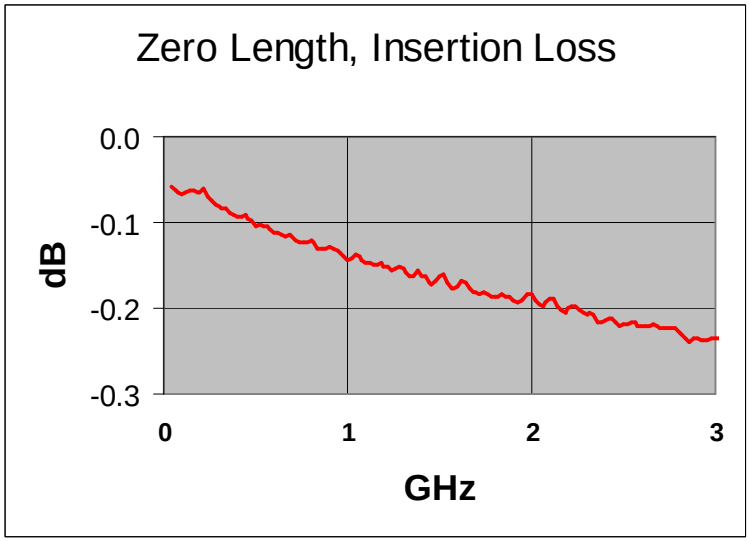
Value of TCTF Test Load

- Facilitates a much tighter specification of critical waveform characteristics than could be achievable by direct measurement at the transmitter output
- To maximize the benefit of this approach the test load characteristics should be matched to the transmitter settings (for example, pre-emphasis)

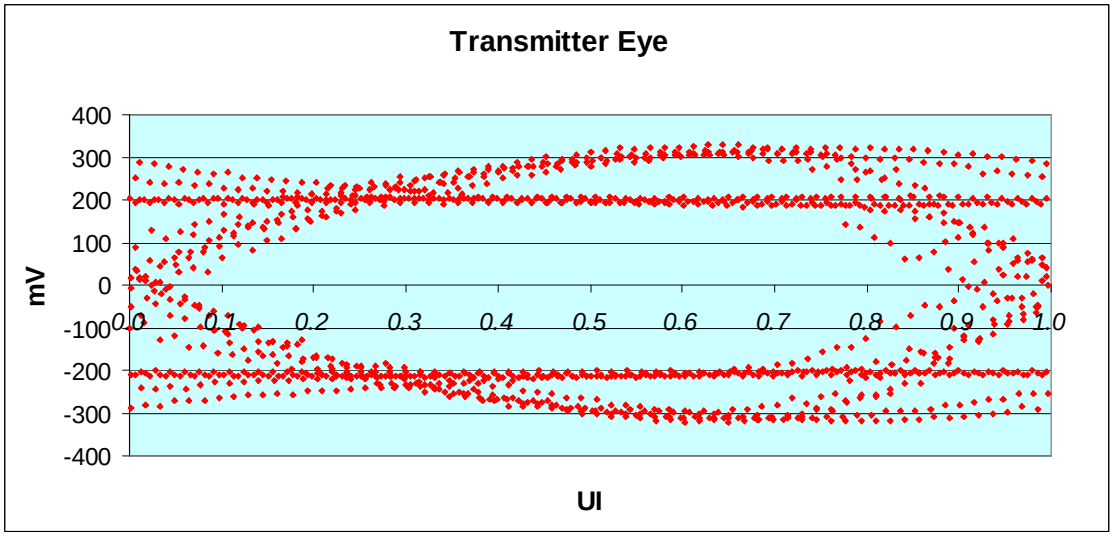
Side Effects of TCTF Approach

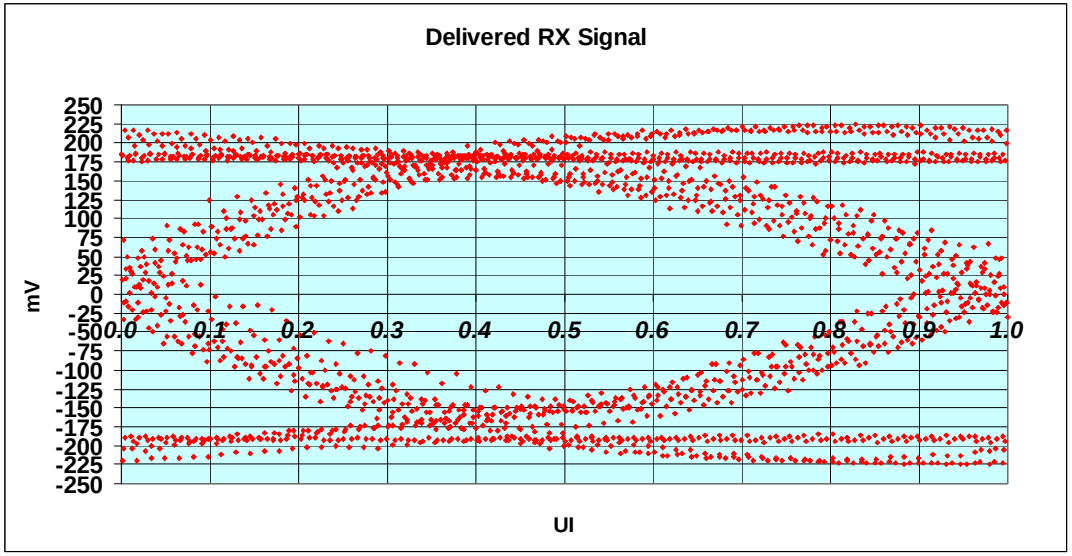
- Negative side effects can be demonstrated with a TCTF and zero-length physical implementations
- The TCTF-IT implementation to the right includes hardware used in the zero-length implementation





SAS Specification of TX Amplitude

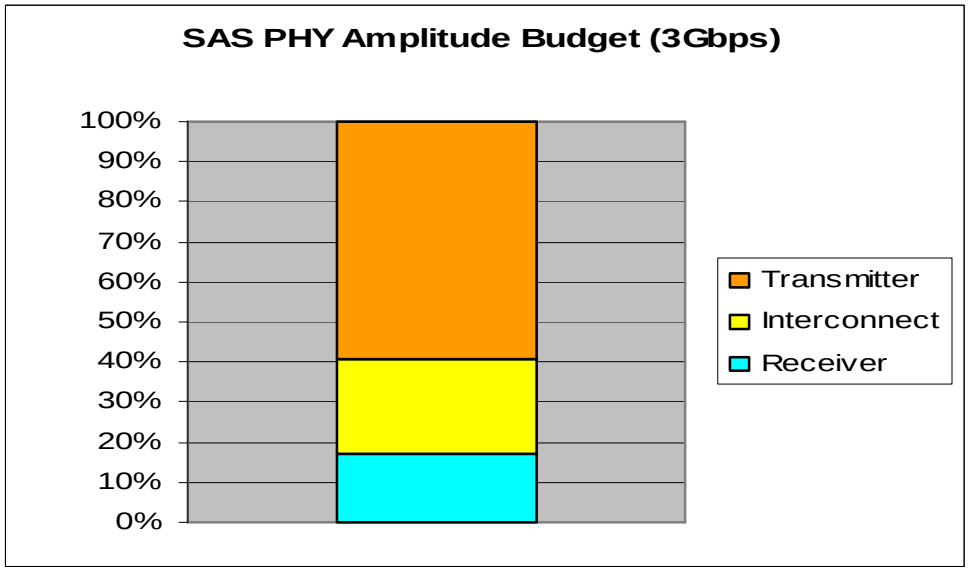


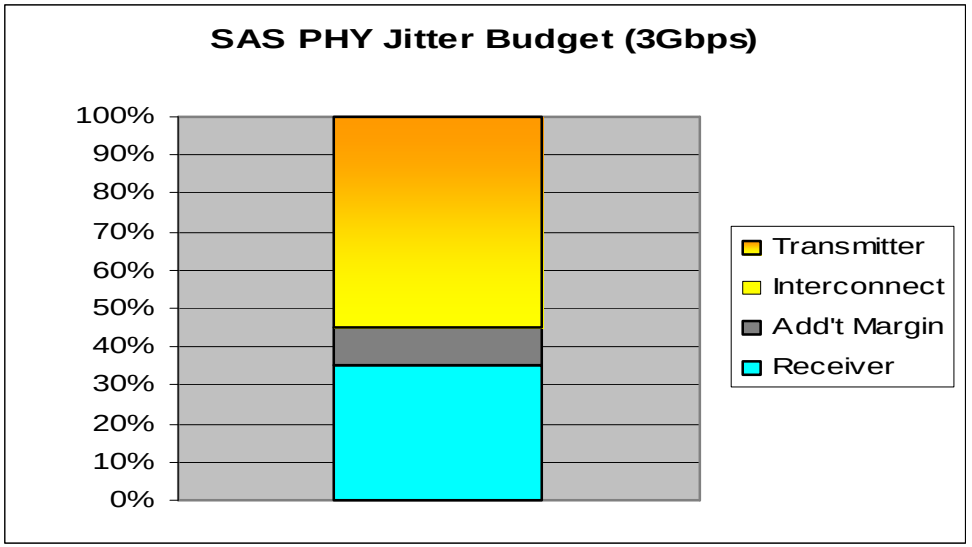


- SAS allows for a maximum transmitter amplitude of 1600mVpp
- Delivered amplitude and TCTF dictates minimum transmitter output
- Transmitter with ~650mVpp and a pre-emphasis ratio of 1/0.65 can deliver **zero-margin** signal to receiver under ideal conditions

SAS Margins

- Using this **zero-margin** TX amplitude output it is clear that the allocation of the SAS PHY jitter and amplitude budgets do not appear to correlate closely
- Nearly 60% of the amplitude budget is at the transmitter.
- Additionally, the receiver amplitude budget and overall system margin suffer



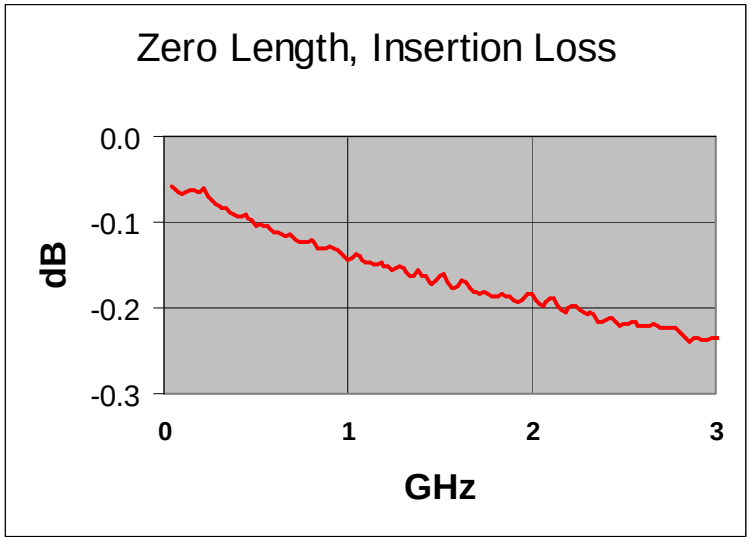


Complications

- Loosely specified transmitter output levels has resulted in confusion among suppliers and OEMs
- Wide range in TX output (1600mV … ~650mV) complicates system design
- Interoperability testing becomes a much larger task
- Many components have limited number of amplitude settings and a wide range has resulted in course controls to accommodate both SAS and SATA
- A tighter min/max ratio would address these issues

SAS-2 Considerations for TCTF and Zero-Length Test Loads

- Zero length test load is a fallacy. Measurement inconsistencies are inevitable at 6Gbps unless changes are made.
- If a well matched transmitter/test load is a goal then multiple TCTF loads are desirable
- TCTF may need to change as data rate changes



TCTF Going Forward

- TCTF should be used only as a test load and not an example of a realistic channel model
- Better specifications for both the zero-length and TCTF test loads would greatly benefit SAS-2. A tight ratio between maximum and minimum transmitter output levels should be a goal
- Use test loads for all measurements. Minimum TX should be based on nominal TX output and not an amplitude far lower. The characteristics of both the transmitter and test load should determine the exact values in the SAS-2 standard.
- Providing more guidance to PHY suppliers will reduce interoperability problems experienced with SAS-1

invent