Experiment on the relationship of measured Interference tolerance and Crosstalk.

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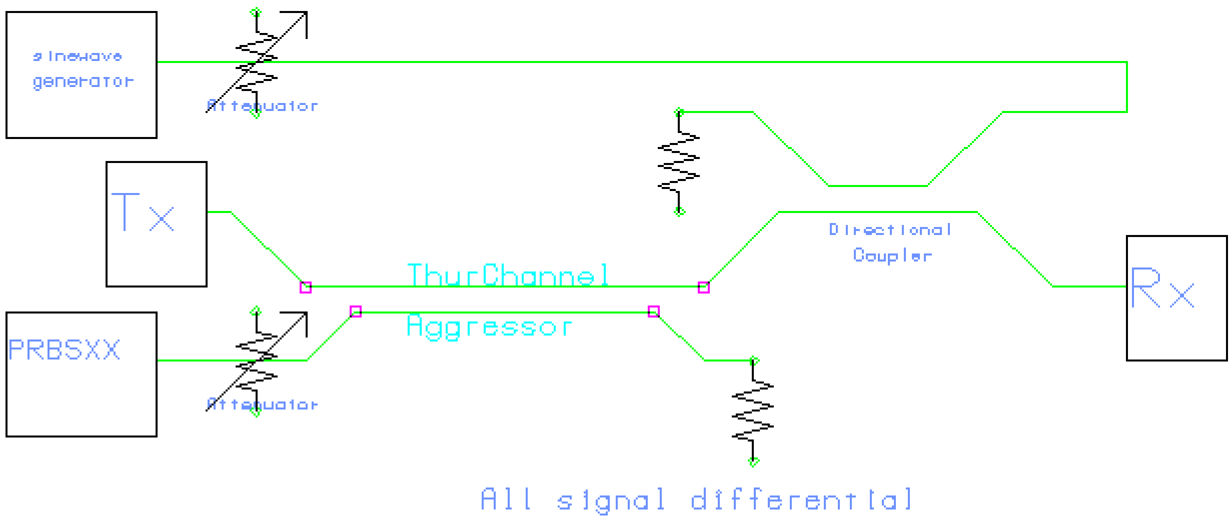
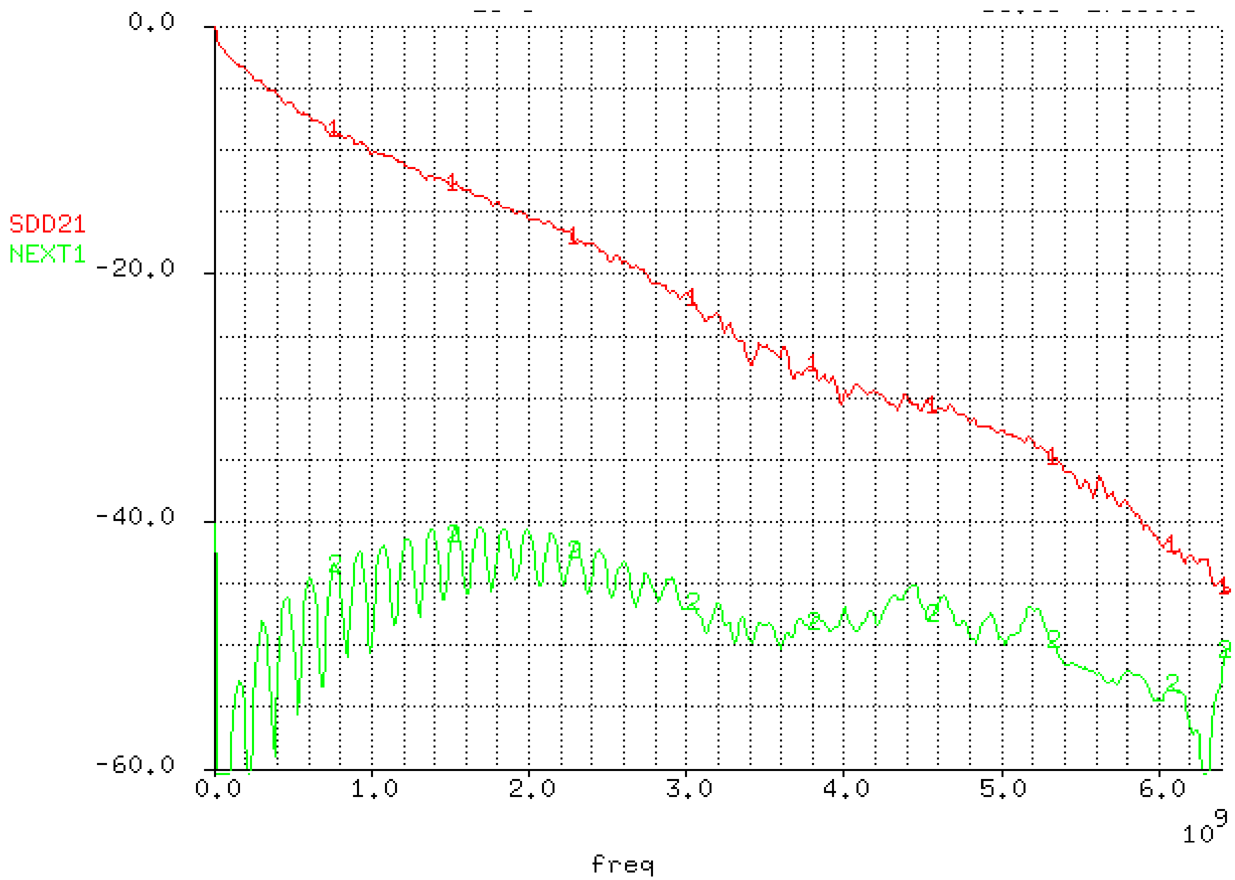
I want to determine the extent to which measured interference tolerance predicts ability to work in the presence of crosstalk Specifically I want to know quantitatively the relationship between measured interference tolerance and quantity of crosstalk which can be tolerated. To measure this I used this setup:

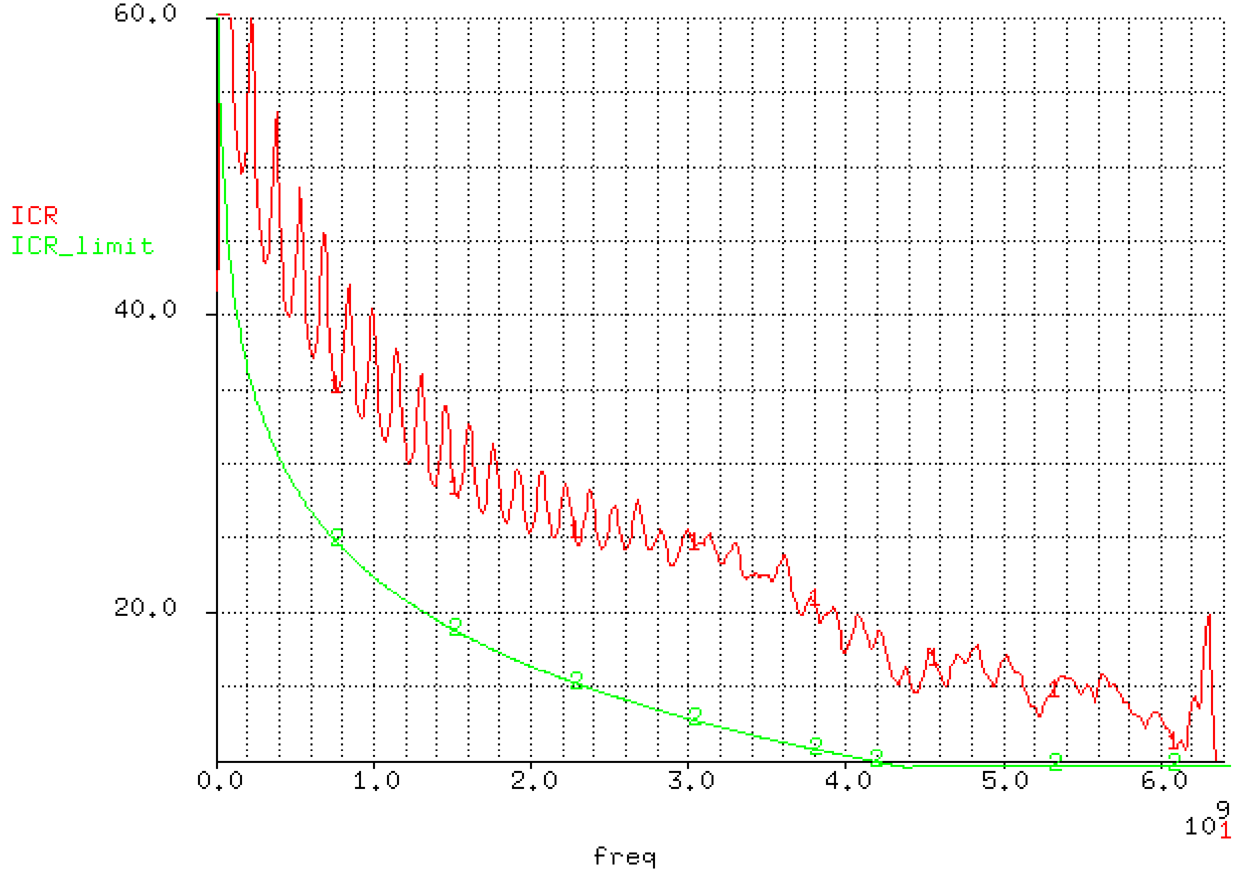


This setup allows me to adjust the amplitude of the aggressor signal there by simulating channels with different amounts of crosstalk.

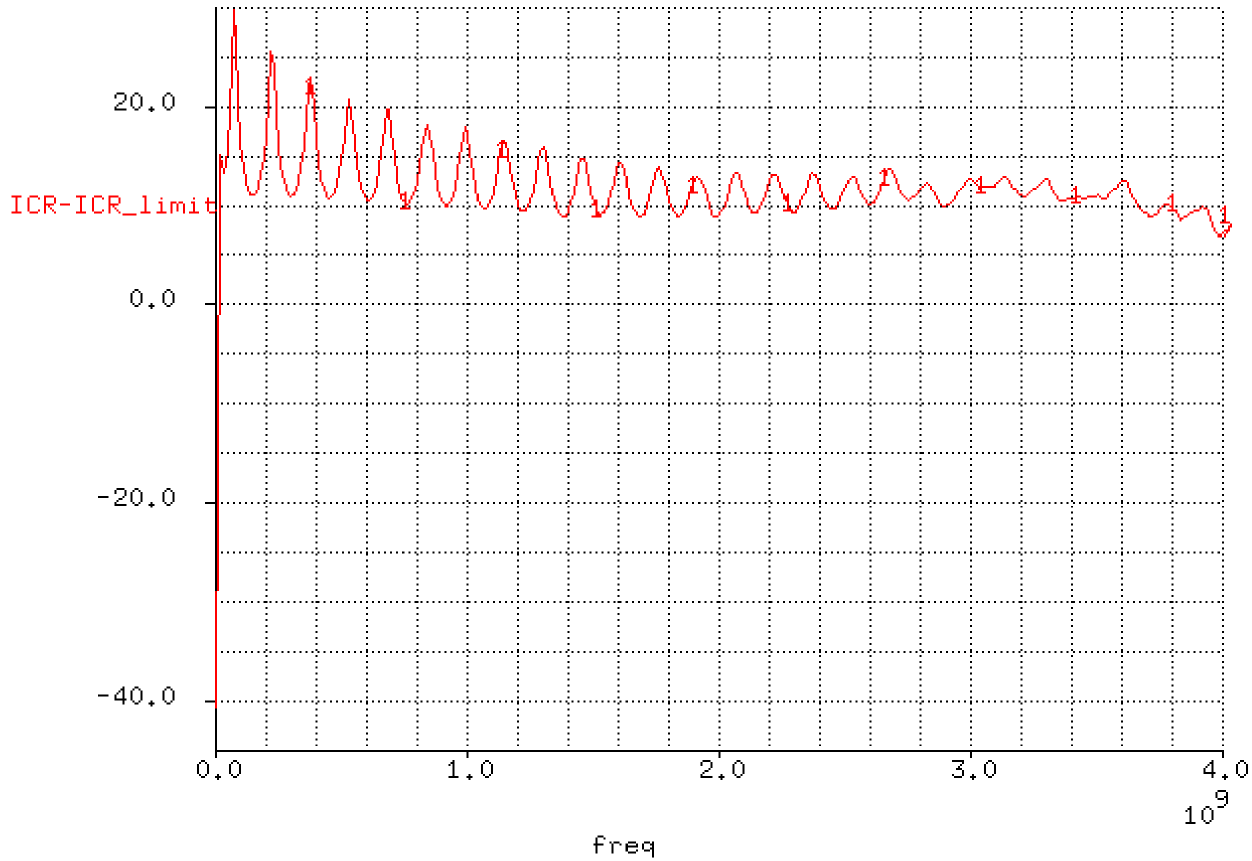
The transceiver is an Agilent part which works only to 6.25Gb/s and all tests shown art at that data rate. The Thru Channel and Aggressor are on an ATCA backplane generously provided by John D'Ambrosia of TYCO. They are the Case1 Thru and NEXT1:



SDD21 and NEXT for ATCA backplane and surrounding circuits

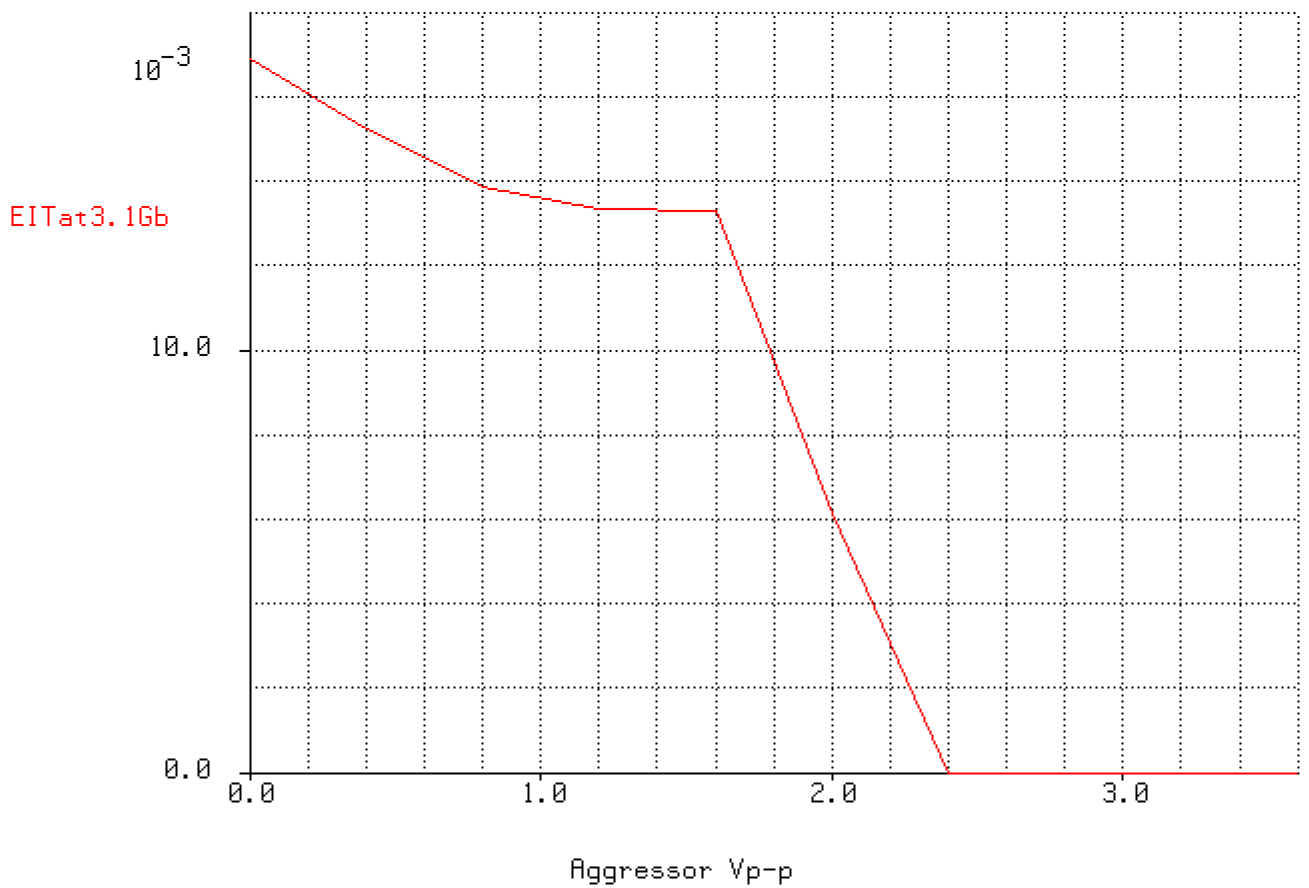


ICR and specified ICR limit, rescaled from 10.3125Gb to 6.25Gb



ICR relative to spec. I have not smoothed this but I estimate that it would be 11dB above 0 if smoothed.

The procedure I used was to measure interference tolerance as a function of the amplitude of the aggressor signal. Here is the measured EIT vs Aggressor amplitude. For this the Thru channel is driven by an 800mV p-p signal.



Interference tolerance, a measure of receiver margin, vs Aggressor amplitude in V p-p differential, a measure of the amount of crosstalk

Assuming:

1. ICR is 11dB better than spec
2. Normal transmitted level for the aggressor channel is 800mV p-p, that is, the same as the data channel.
3. The effective ICR can be adjusted by increasing aggressor amplitude.

A worst case channel would correspond to an aggressor amplitude 11dB greater than 800mV, 2.8V p-p. In this case a receiver which meets EIT spec fails (indicated by a 0 EIT) when the aggressor amplitude is only 2.4V p-p. It actually fails somewhere between 2.0V and 2.4V. This says that the system is failing by a margin of somewhere between 1.3 and 3dB, if the thru and aggressor signal are the same amplitude. It will fail by a greater margin if the aggressor is greater than the thru signal. To take into account the fact that aggressor may have a greater amplitude than victim, we need another 3.5dB of margin (1.2V/800mV).

Another way of looking at this that the Crosstalk RMS pulse gain:

$$CrosstalkRMSpulsegain = \sqrt{\int (\sin c(2 * f / fbaud)^2 * 10^{PSXT(f)/20} * df}$$

for this channel Crosstalk RMS pulse gain is $5.4*10^{-3}$. The RMS aggressor signal corresponding to 2.4V p-p is 1.2V so at the channel fails at a RMS crosstalk of 6.5mV. The Interference tolerance is 17mV p-p or 6mV RMS so the it appears that there is close to a 1:1 relationship between tolerance of sinusoidal interference and crosstalk if RMS measure is used.

Comments:

1. The channel shown is not actually quite as bad as a compliance channel for Interference Tolerance testing so EIT should be better than the 10GBASE_KR spec of 15mV. It is better by about 1dB but I think that it should be better by more like 3dB. This still leaves us 2.8-3.2dB of negative margin.
2. This is one measurement on one part of one design, scaled in frequency. It may not be representative of all or even most cases. Other cases may have a greater or lesser ratio of allowable crosstalk to measured interference tolerance. To have completely

valid spec, any receiver which meets spec (interference tolerance) should work in any channel which complies with informative ICR, attenuation, and attenuation ripple specs.

3. I recommend that we make one of the following changes:
    - Increase receiver interference tolerance spec by 3dB without changing any channel spec.
    - Increase ICR spec by 3dB, with no change to channel Thru spec or receiver spec.
    - Reduce worst case attenuation limit by 2dB, for both the channel and the interference compliance test channel, and increase receiver interference tolerance spec by 3dB.