

To: T10 Technical Committee
From: Barry Olawsky, HP (barry.olawsky@hp.com)
Date: 13 January 2005
Subject: T10/05-025r1 SFF8470 Crosstalk Study

Revision History

Revision 0 (5 January 2005) First revision

Revision 1 (13 January 2005) Second revision – Further clarify the problem and solution.

Related Documents

sas1r07 - Serial Attached SCSI 1.1 revision 7

T10/05-007r0 - SAS-1.1 External Cable Electrical Specification

Overview

Provide technical data (electrical) to evaluate the feasibility of proposal 05-007r0. Specifically, demonstrate crosstalk summation and provide analysis to support necessary changes.

Reference Information

Included below

SFF8470 Crosstalk Study

Prepared by Barry Olawsky
Hewlett Packard
January, 2005

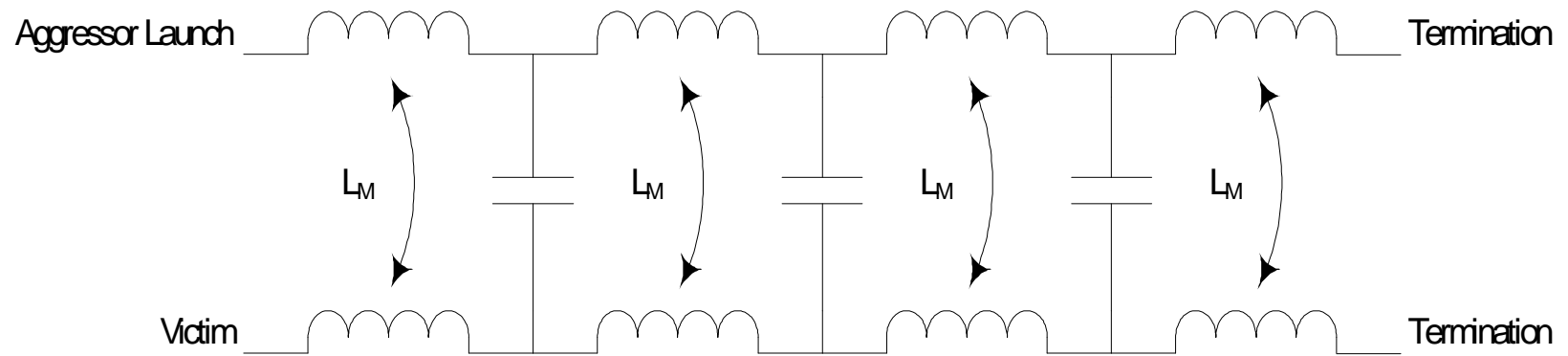
Topics

- Demonstrate multi-lane SFF8470 near-end crosstalk is additive
- Review crosstalk spec in proposal 05-007r0
- Effects of crosstalk with spectral content above fundamental
- Proposed levels

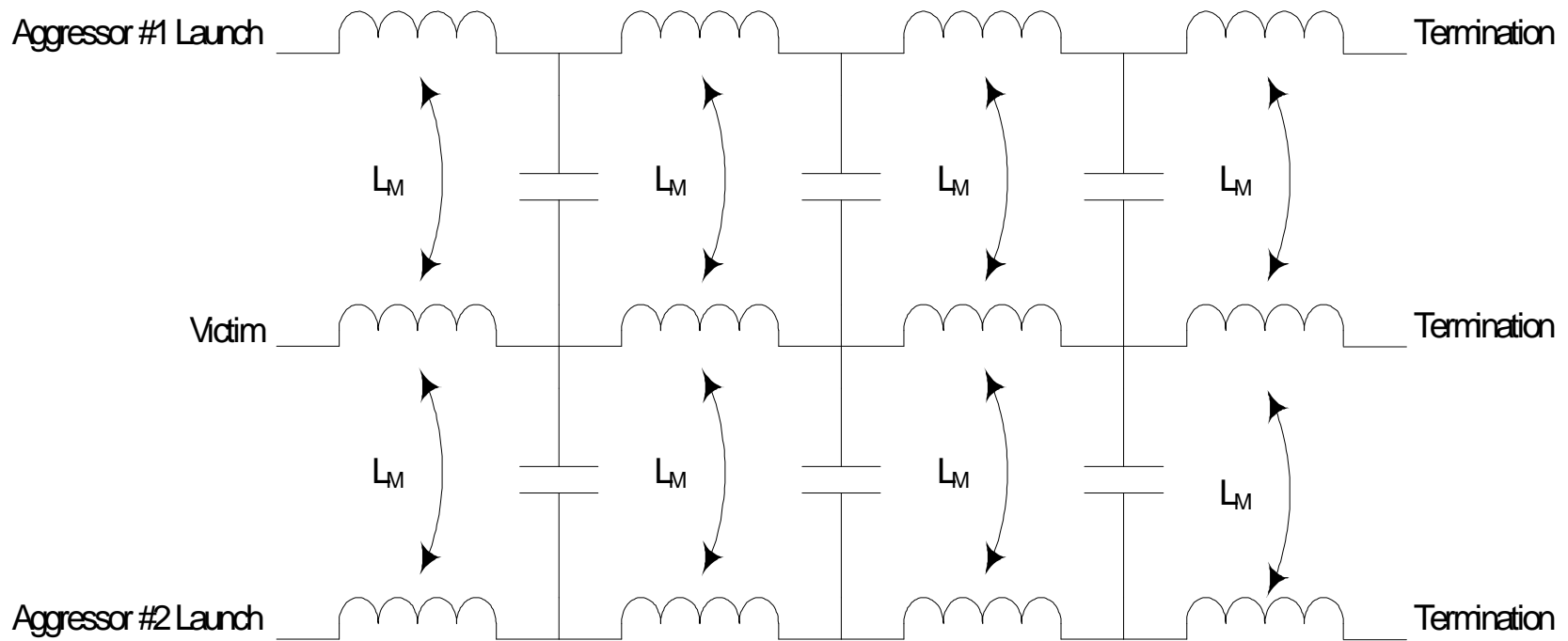
Multi-Aggressor Crosstalk Assertion

- Near-end inductively coupled crosstalk is additive. At a frequency of interest, crosstalk magnitude at the victim is a summation of the amplitude due to each aggressor. The phase offset of the two aggressors, observed at the victim, is a parameter in the summation.

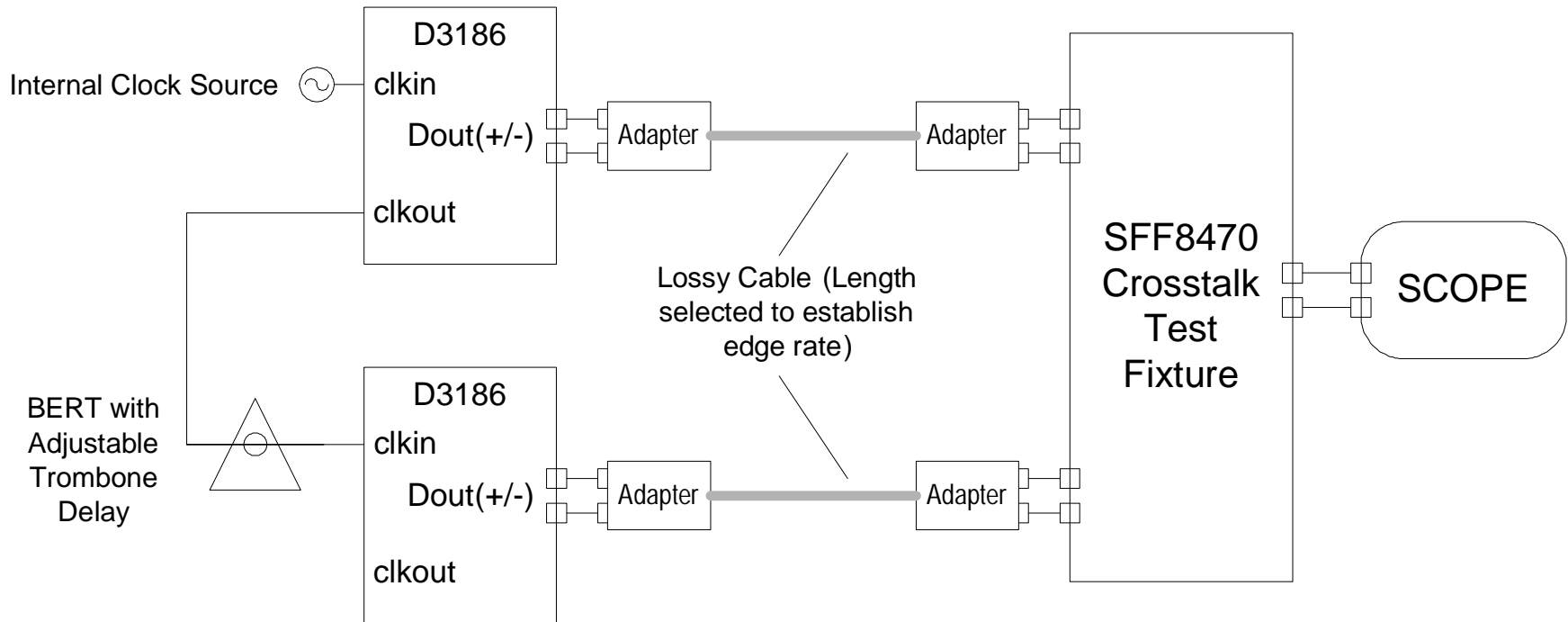
Near-End Crosstalk Model



Multi-Aggressor Near-End Crosstalk Model



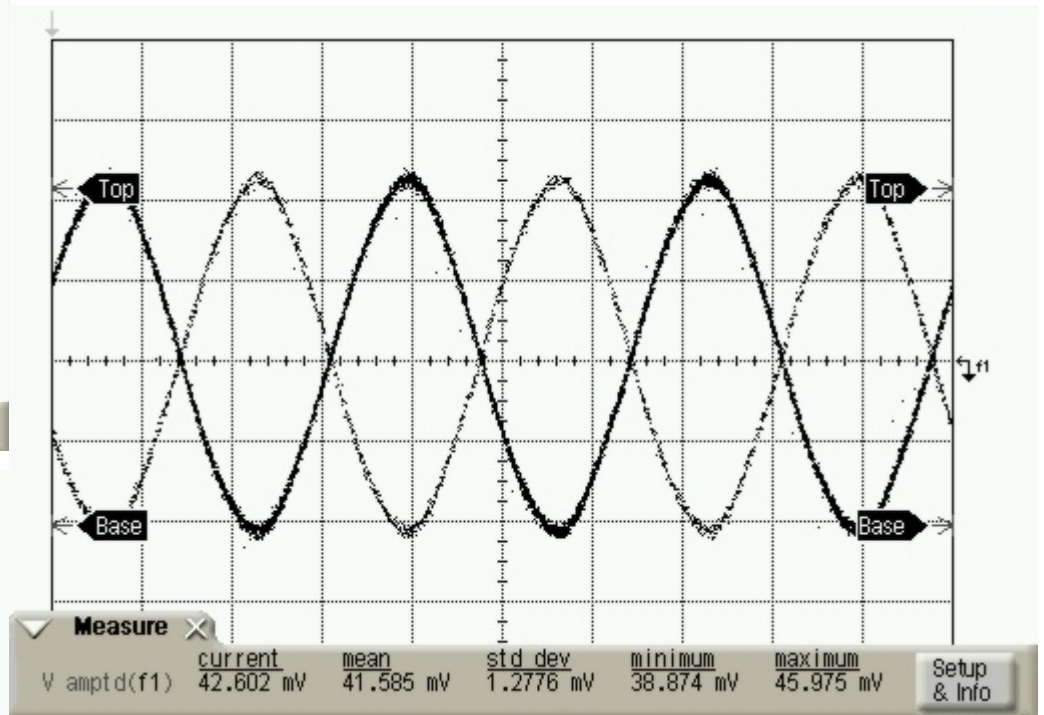
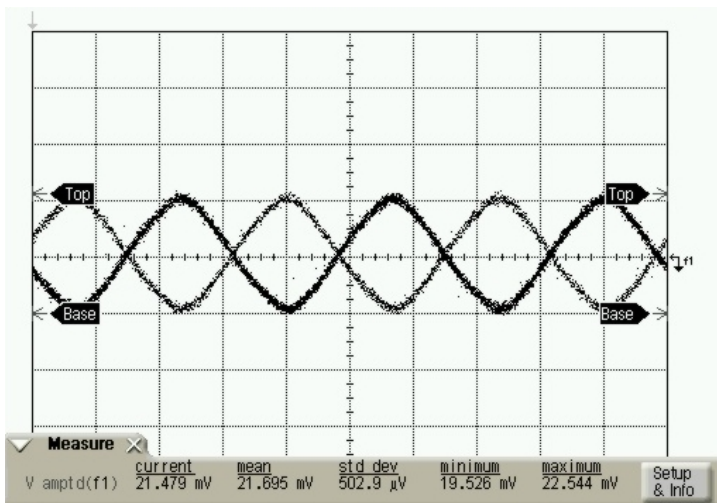
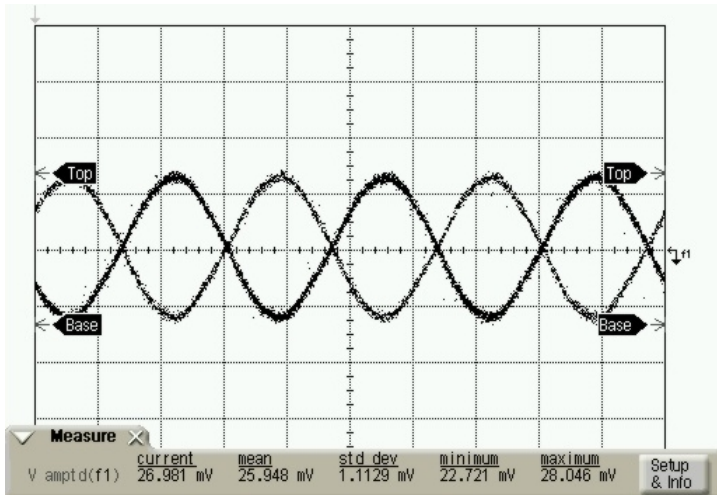
Differential NEXT Test Fixture Setup



D10.2 used. BERT varies phase offset between aggressors.

NEXT at Victim

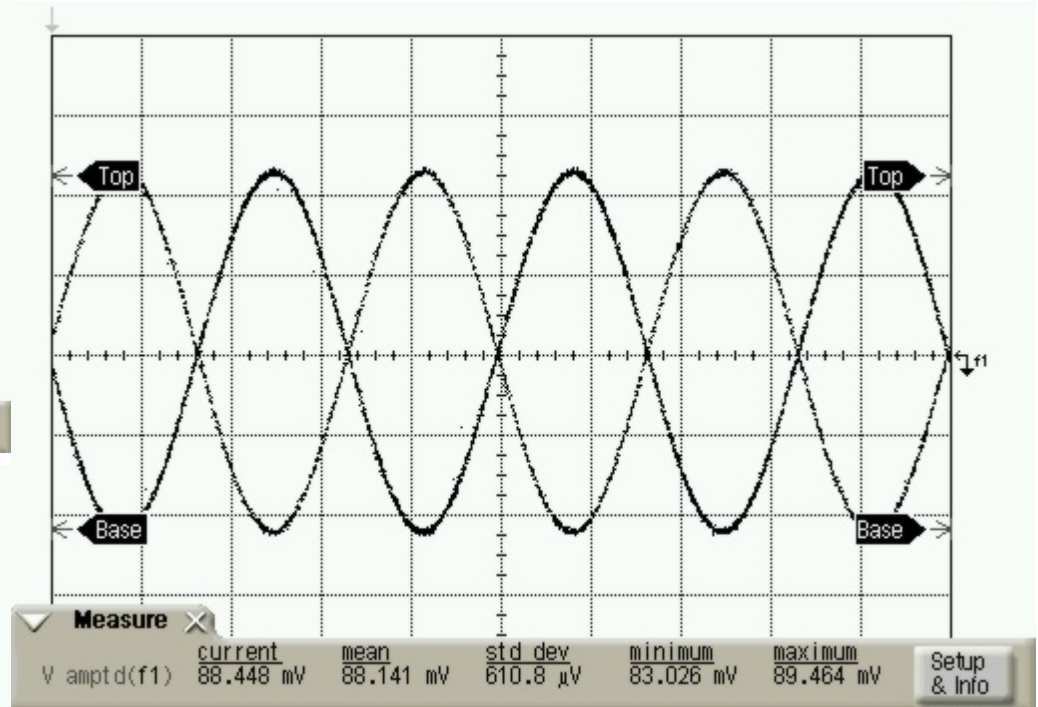
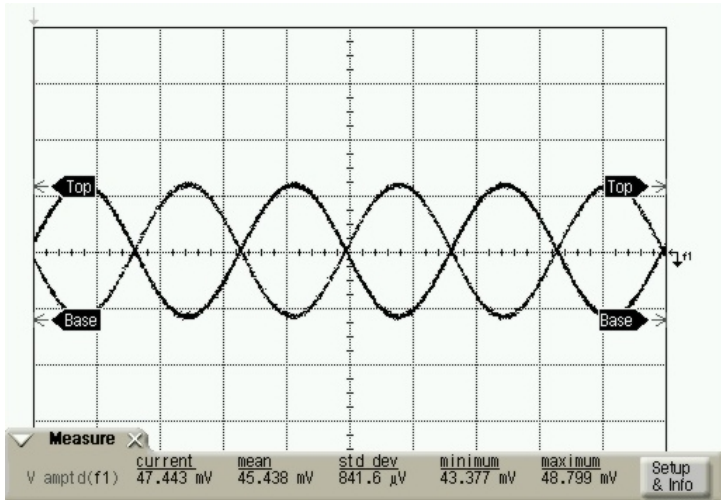
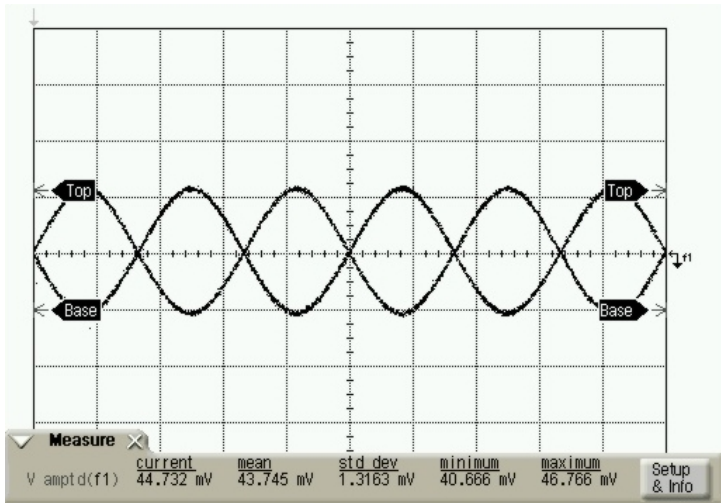
(Aggressor edge rare of 120ps), UI: 333ps



Aggressor 1: 26mV
 Aggressor 2: 22mV
 In-phase Summation: 42mV

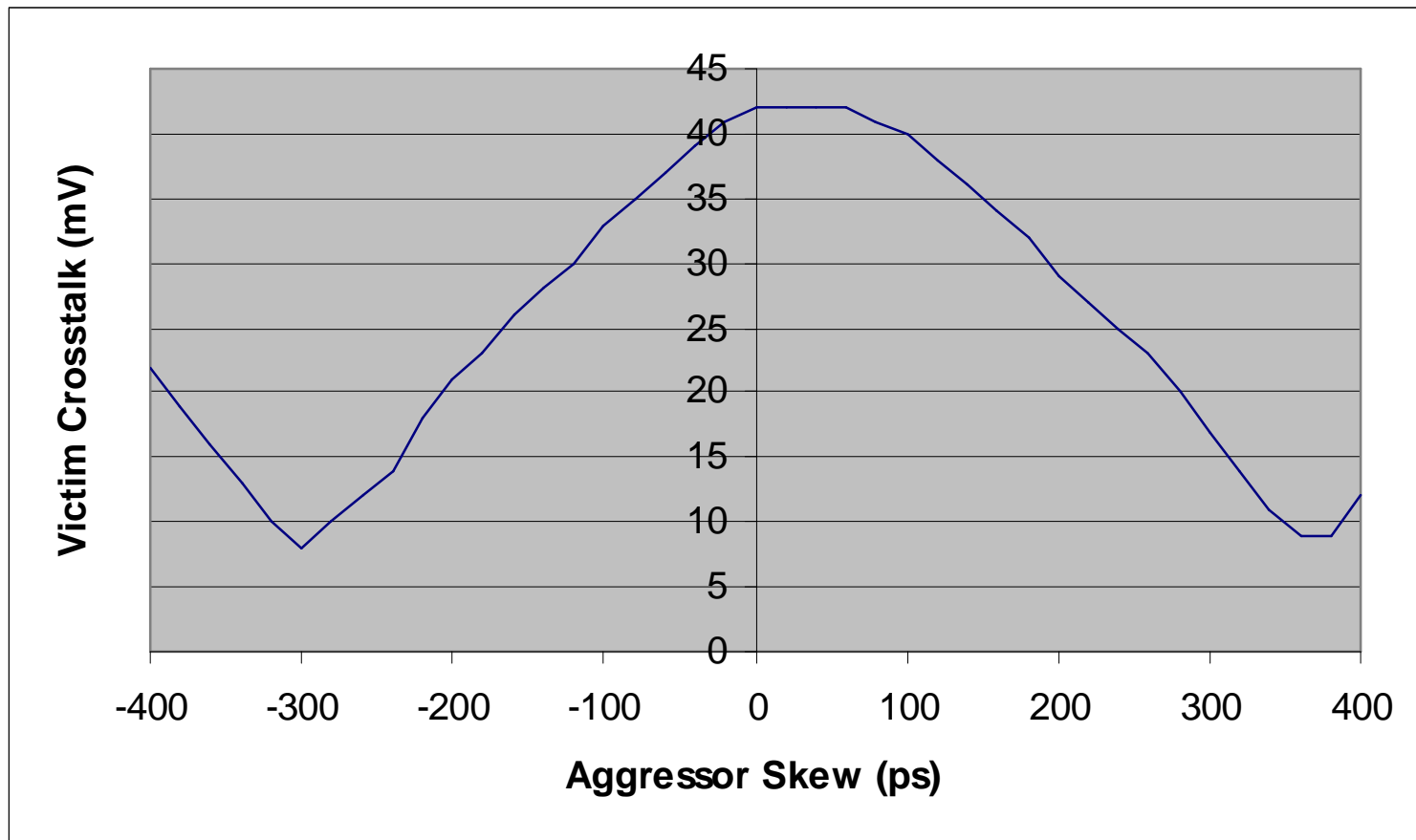
NEXT at Victim

(Aggressor edge rare of 60ps), UI: 167ps

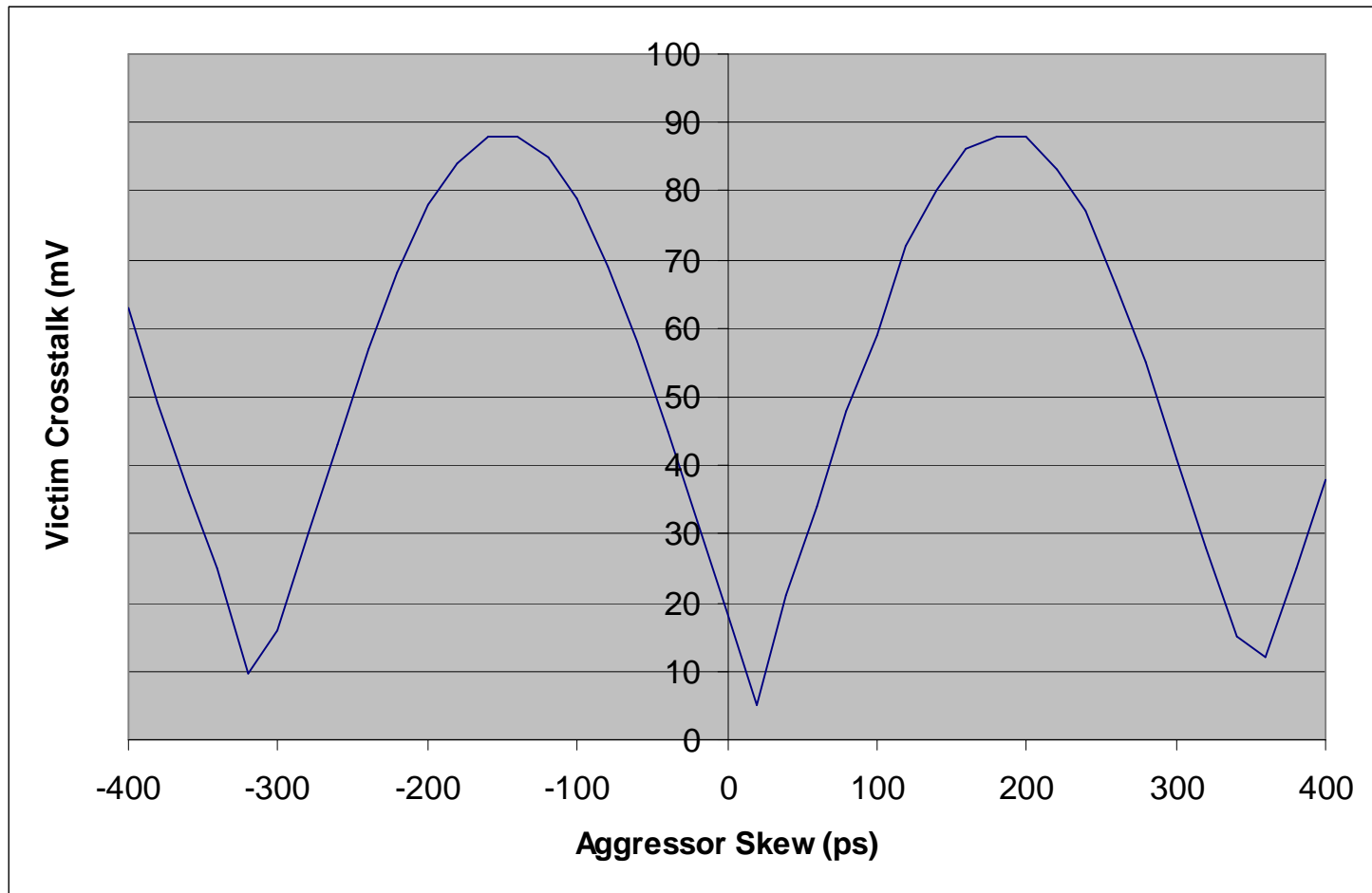


Aggressor 1: 44mV
 Aggressor 2: 45mV
 In-phase Summation: 88mV

Multi-Aggressor Crosstalk Amplitude vs. Aggressor Pair Skew, UI: 333ps, ER: 120ps



Multi-Aggressor Crosstalk Amplitude vs. Aggressor Pair Skew, UI: 167ps, ER: 60ps



Summary of Test Results

- Screen captures show additive property of multi-aggressor NEXT using D10.2 pattern at the above documented edge and data rates
- Amplitude variation with respect to aggressor skew is further evidence of additive property

Review of 05-007r0

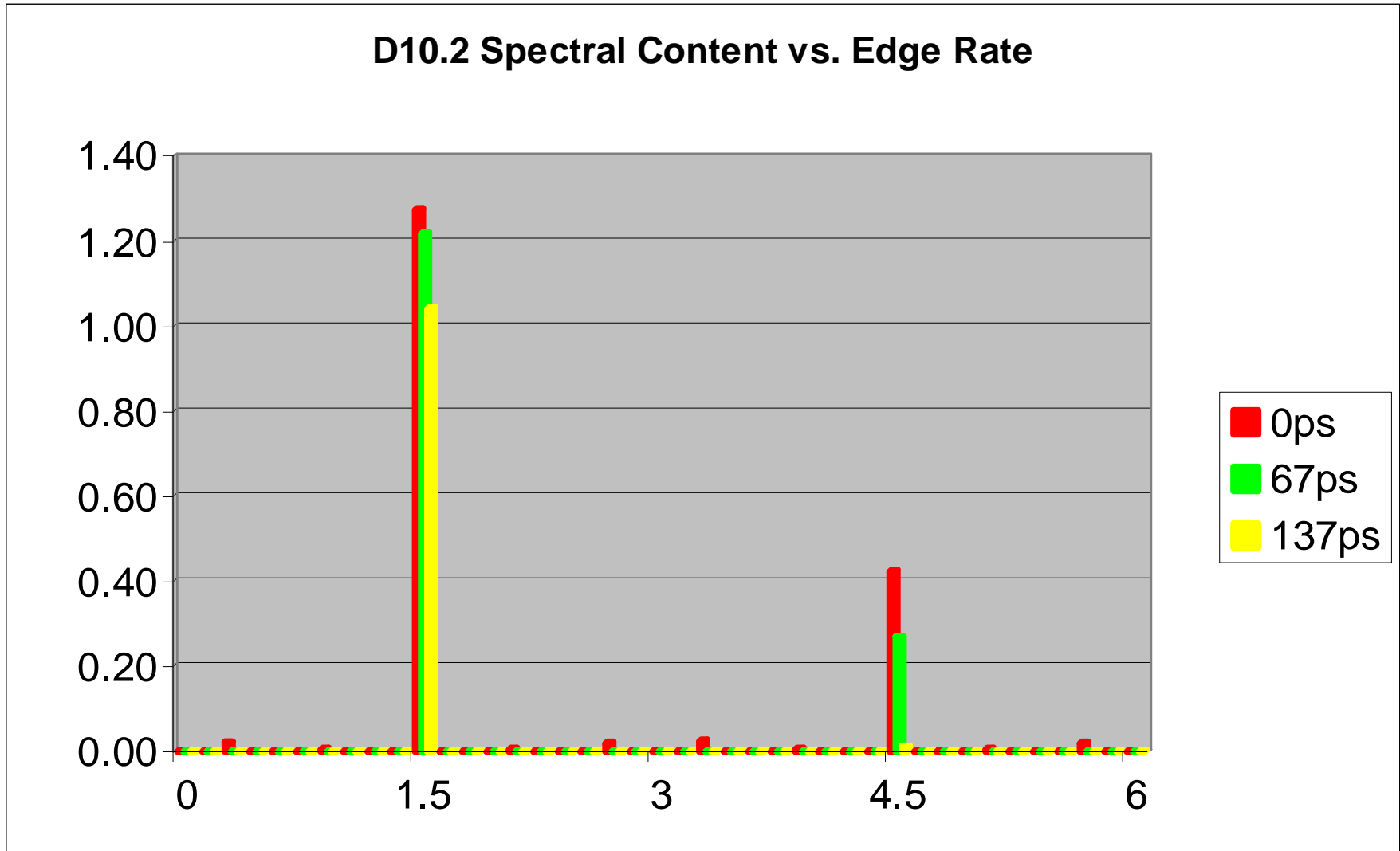
- Proposal specifies NEXT of -30dB (3.2%) for single pair from 10 to 4500MHz.
- Combining crosstalk from different pairs could yield value that is much larger than 5%.
- Previous sample measurements have demonstrated NEXT amplitudes in excess of 3.2% above 2GHz for most samples tested.

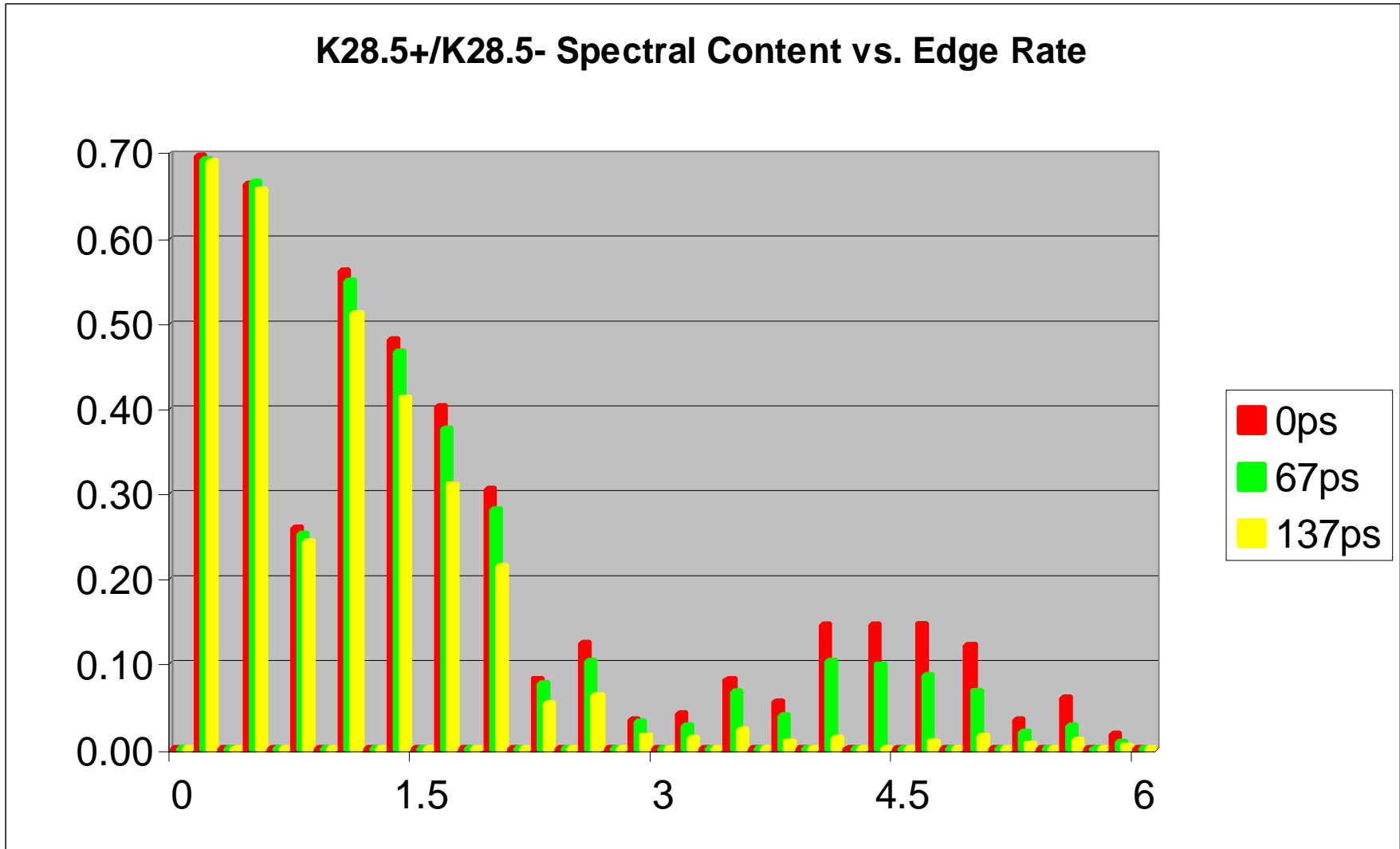
Proposed Changes to 05-007r0

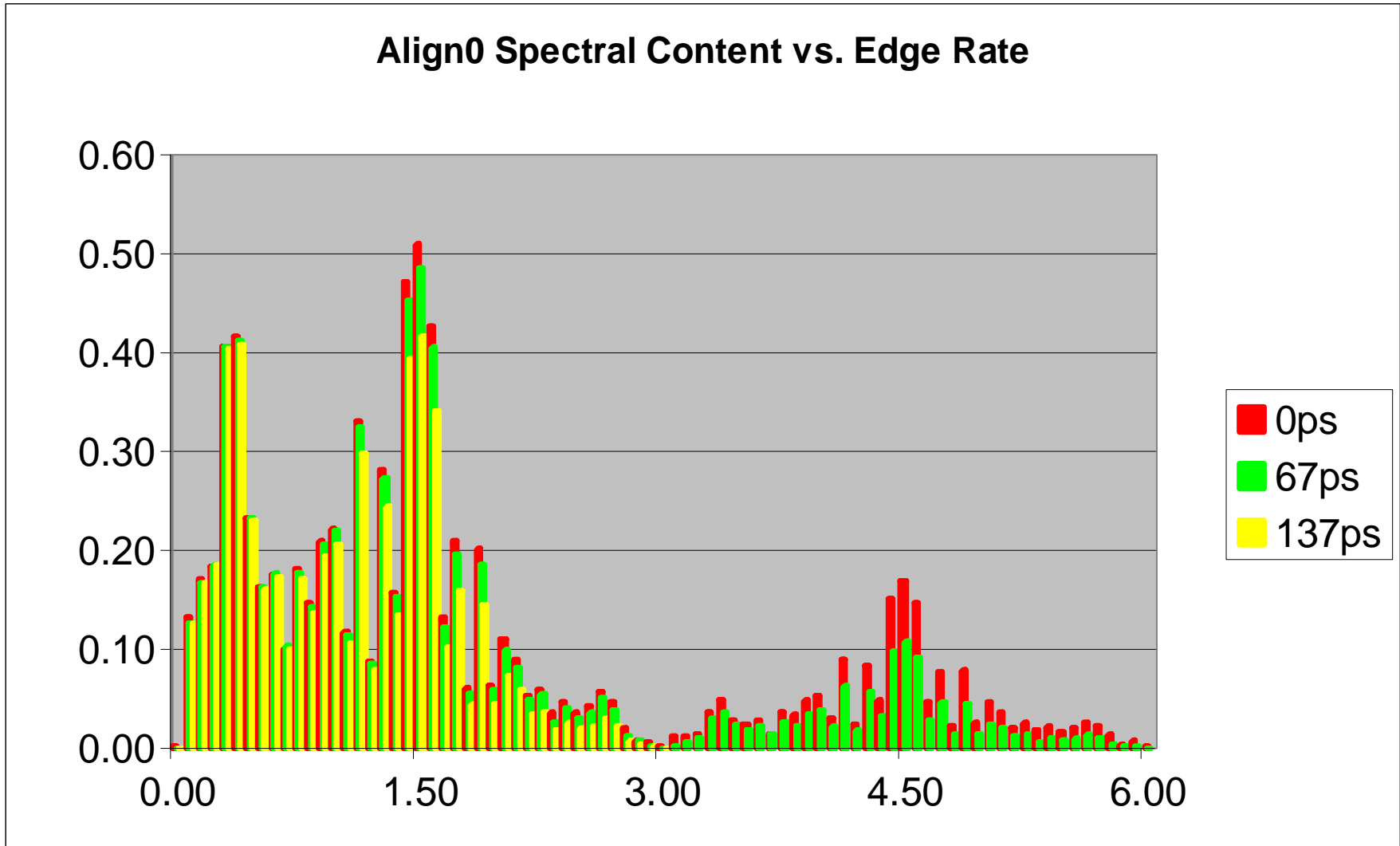
- Consider reducing allowable crosstalk at fundamental such that multi-aggressor sum is less than or near 5%
- Crosstalk isolation required above the fundamental may possibly be reduced. Crosstalk of energy at harmonics must be appropriately accounted for in crosstalk budgeting.

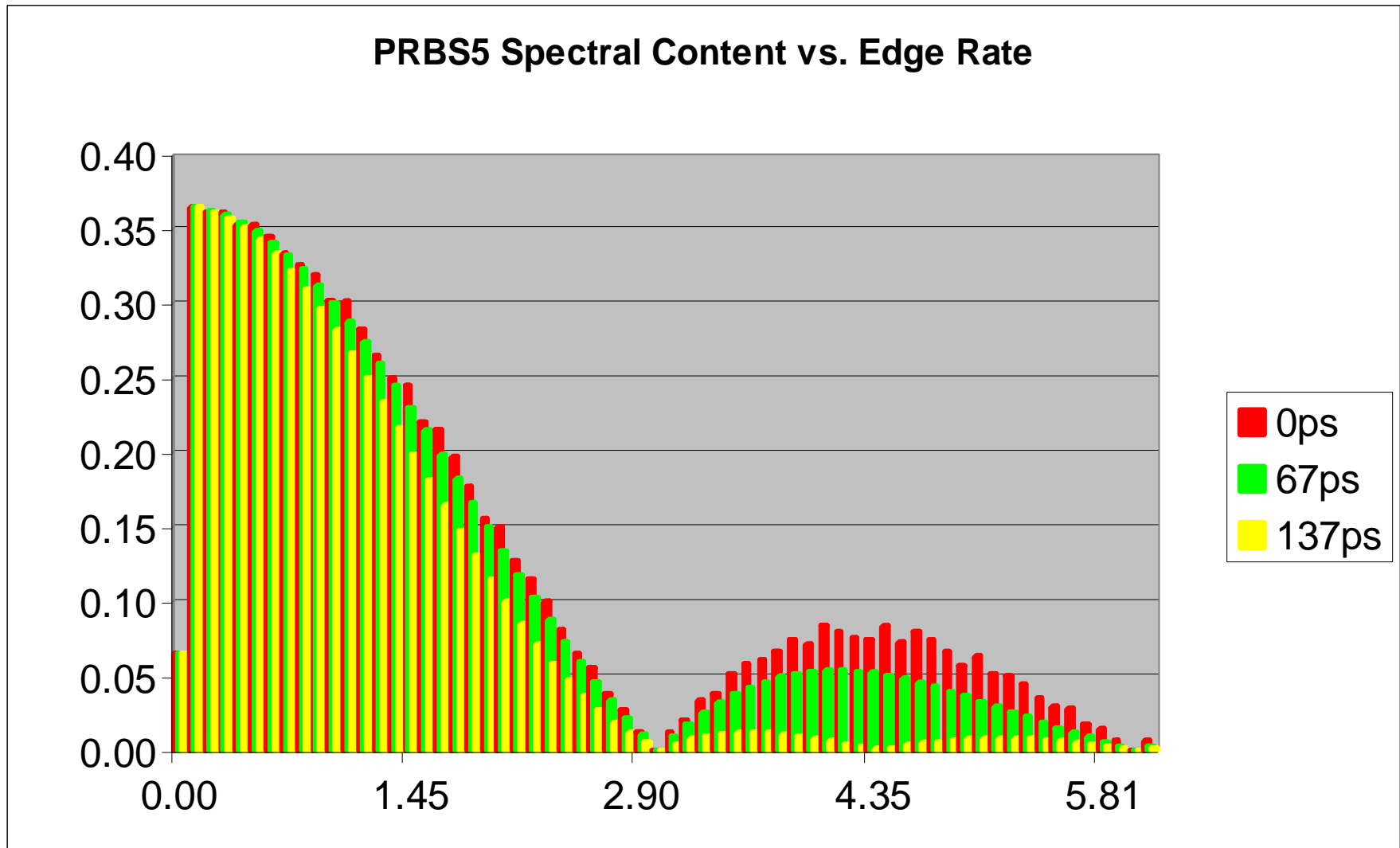
Spectral Content and Edge Rate

- For 3Gbit signaling, all spectral components above 1.5GHz are harmonics
- Both pattern type and edge rate effect the spectral content
- Can crosstalk isolation be reduced at some point above 1.5GHz? Consider 2.25GHz.





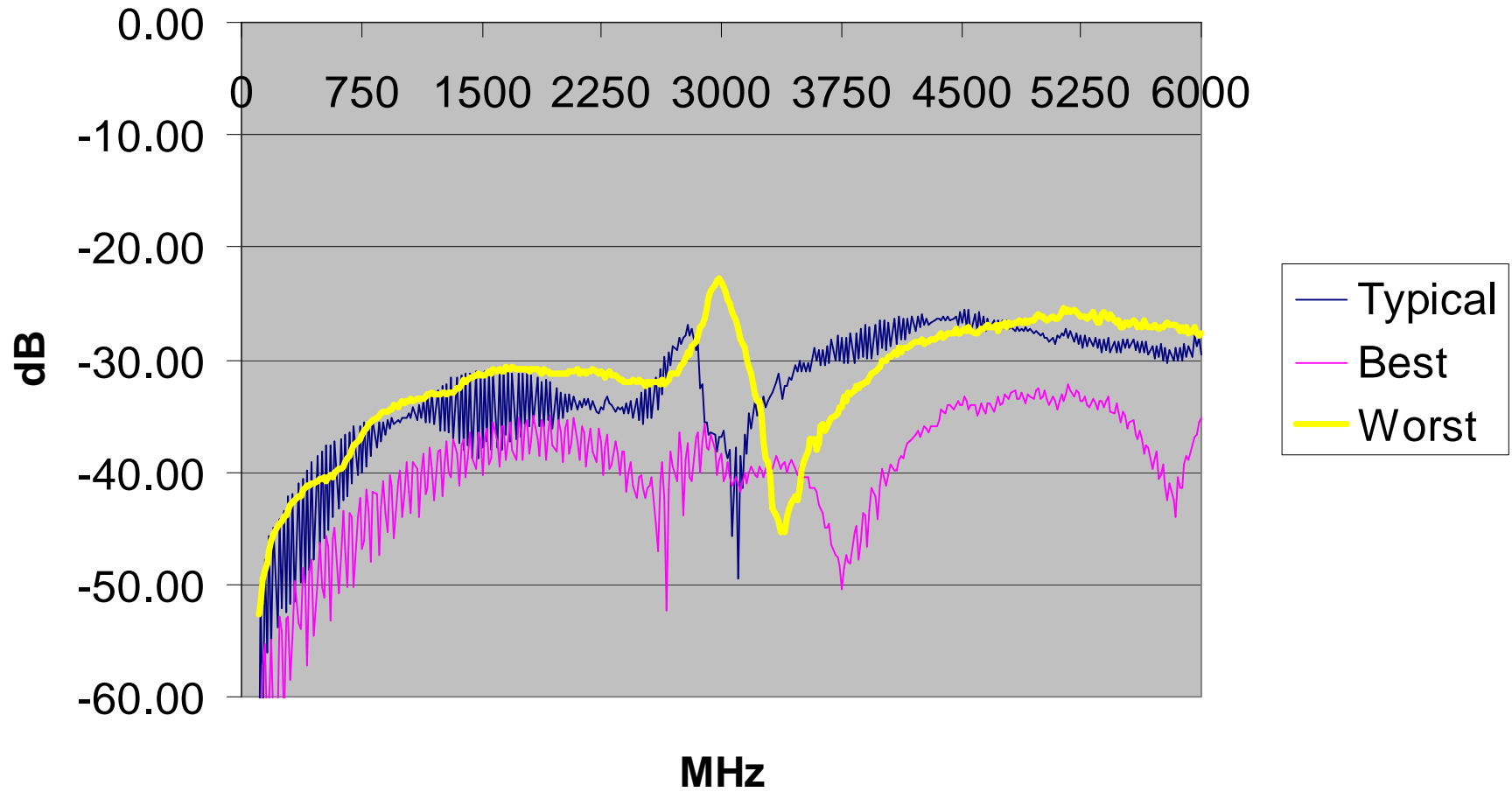




Spectral Content Summary

- Reduction in harmonic amplitude at 4.5GHz less than 6dB. However, reduction at slowest edge rate is dramatic!
- Variation in reduction based on pattern type
- 2.25GHz appears to be feasible point for shift in crosstalk isolation spec

Sample Adjacent Pair Crosstalk Plots



Proposed Changes Below 2.25GHz

- Proposal based on samples from several industry suppliers
- 30dB isolation for pairs offset by 1 position (adjacent)
- 36dB isolation for pairs offset by 2 positions
- 40dB isolation for all other pairs

Proposed Changes From 2.25 to 4.5GHz

- Shift spec by 6dB for offsets of 1 and 2
- 24dB isolation for pairs offset by 1 position (adjacent)
- 30dB isolation for pairs offset by 2 positions
- 40dB isolation for all other pairs

Summary

- Industry suppliers have difficulty meeting 30dB (10 .. 4500MHz) isolation spec
- At fundamental, 30dB isolation is insufficient
- Proposal attempts to offer a compromise of those two conflicting objectives