CX4 Electrical Spec Update

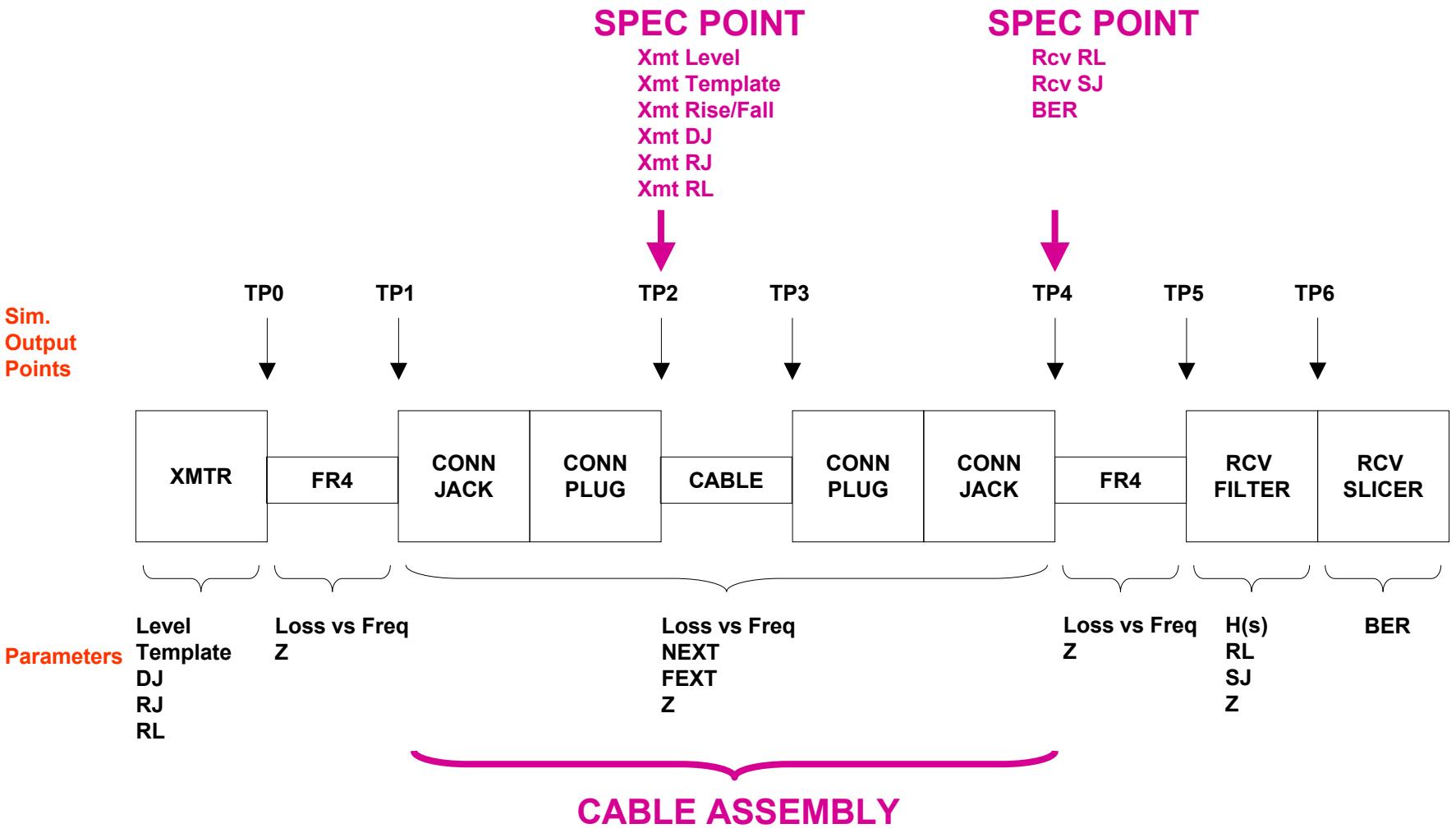
Presentors: Howard Baumer, Broadcom; Steve Dreyer, Intel; Ze'ev Roth, Mysticom

Contributors: Howard Baumer, Broadcom; Peter Bradshaw, Bitblitz; Kamal Dalmia, Marvell; John DeAndrea, Iterra; Dan Dove, HP; Adam Healey, Agere; Takeshi Horie, Fujitsu; Allan Liu, Agilent; Shawn Rogers, TI; Larry Rennie, National Semiconductor; Ze'ev Roth, Mysticom; John Stonick, Accelerant; Dimitry Taich, Mysticom;

Agenda

- Part 1: Loss Budget Team Report
- Part 2: Transmit Template Simulation Results
- Part 3: Proposed CX4 Electrical Specs

Channel Model for Simulation



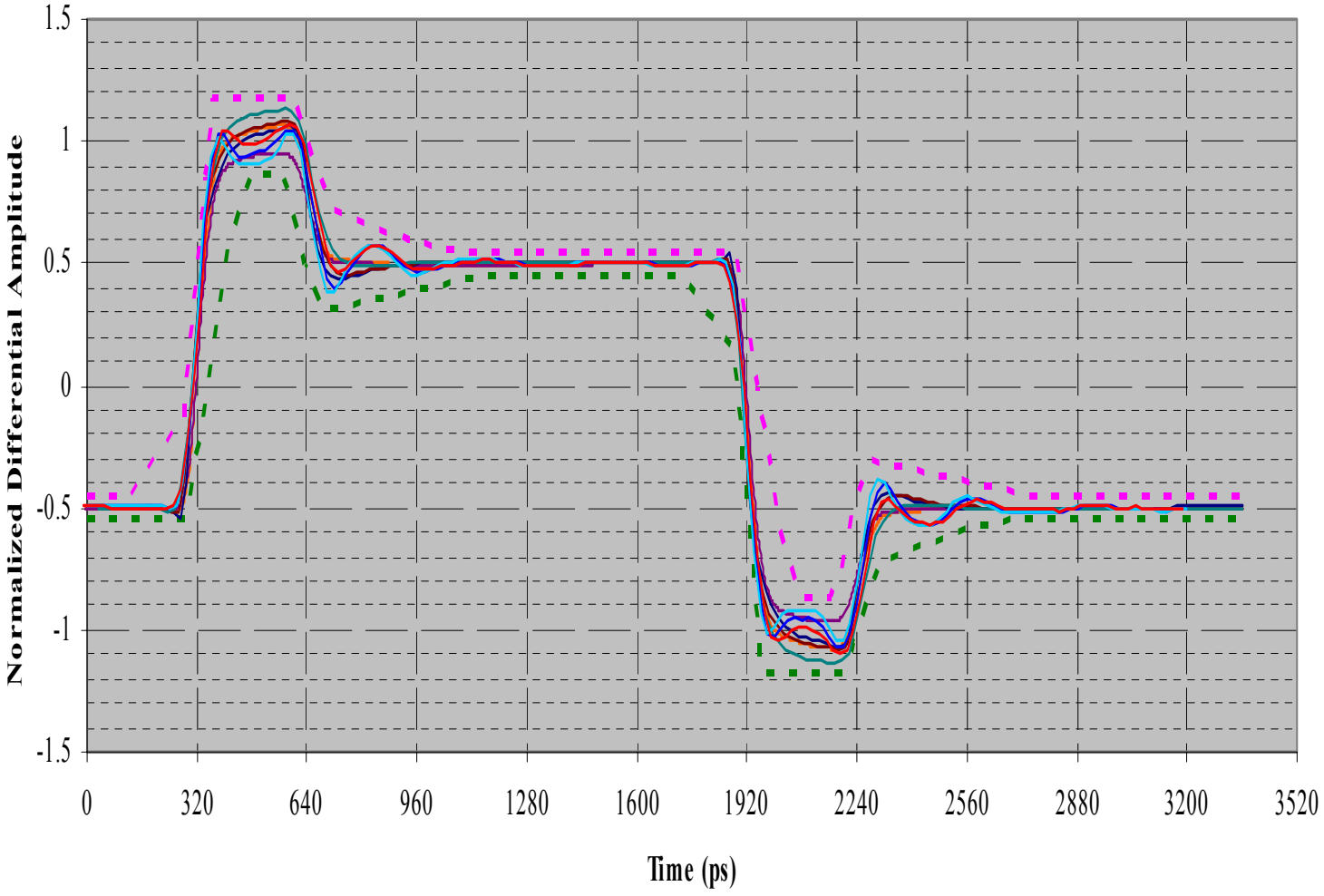
Parameters for Simulation

Block	Parameter	Worst Case	Comments
XMTR	Level	1V	This value is not worst case, it is a normalized value, wc value will be discussed after simulations done
	Template	See Page 6.	
	DJ	0.17 UI pp	From XAUI. This will be embedded in template
	RJ	0.18 UI pp	From XAUI
	RL	-10 db @ 312-625 MHz -10+10log(f/625) @ >625MHz	From XAUI
FR4	Loss vs. Freq	2" trace: $s_{21} = 20*\log_{10}(e)*[(a_1*\sqrt{f}+a_2*f+a_3*f^2)]*(1/10)$ a_1 = 6.5E-6 a_2 = 2.0E-10 a_3 = 3.3E-20 e=2.718…….	From XAUI. Decided 2" was worst case length, and then scaled XAUI linearly from 20" to 2".
	Z	45-55 ohm	From XAUI
Conn Mated Pair (Jack+Plug)	Loss	LOSS = $a*\sqrt{f}$ a = 1.266E-02 LOSS in dB, f in MHz	Preliminary model from Cable Assembly Team.

Parameters for Simulation (cont'd)

Block	Parameter	Worst Case	Comments
Cable Assbly	Loss vs Freq	LOSS = a*√f + b*f + c*(1/√f) + d a = 2.629E-01 b = 3.408E-03 c = 1.276E+01 d = 0.5 LOSS in dB, f in MHz	This is prelim model from Cable Assembly Team. Includes: plug+jack+cable+jack+plug.
	NEXT	-28 dB	From Sacro. Long term, this spec will be included in new cable assbly model.
	FEXT	-26 dB	From Sacro. Long term, this spec will be included in the new cable assbly model.
	Z	45-55 ohms	Cable vendor data indicates this paramter varies +/-10%.
Rcv Filter	H(s)	Up to Implementers	This won't be specified, is up to each person doing simulations.
	RL	-10 db @ 312-625 MHz -10+10log(f/625) @ >625MHz	From XAUI. This is actually XAUI Xmt RL spec, will use it for rcv for now.
	SJ	See IEEE Clause 47, Figure 47-5.	From XAUI
Rcv Slicer	BER	10E-12	From XAUI

Transmit Template @ TPO



Normilization Procedure	
1	Adjust the output waveform under test to fit as best as possible along the horizontal time axis.
2	Calculate the +1 low frequency level as Vlowp = average of any 2 continuous baud (640ps) between 800ps and 1760ps
3	Calculate the -1 low frequency level as Vlowm = average of any 2 continuous baud (640ps) between 2400ps and 3360ps
4	Calculate the verticle offset to be subtracted from the waveform as Voff = (Vlowp + Vlowm) / 2
5	Calculate the verticle normilization factor from the waveform as Vnorm = (Vlowp - Vlowm) / 2
6	Calculate the normalized waveform as NewWaveform = (OriginalWaveform - Voff) * ((1 - pre-emphasis) / Vnorm)
7	Adjust the normalized output waveform under test to fit as best as possible along the horizontal time axis.

Agenda

- Part 1: Loss Budget Team Report
- Part 2: Transmit Template Simulation Results
- Part 3: Proposed CX4 Electrical Specs

Overview

- Template Check
- Template at TP2
  - Propagate through 2inch FR4 + mated plug+ jack

PCB & Mated Connectors models

PCB_s21=log10(e)*[(a1*sqrt(f)+a2*f+a3*f.^2)]*(pcb_len)

- s21 equation is normalized to 20 inches
- pcb_len=2
- a1 = 6.5E-6; a2 = 2.0E-10; a3 = 3.3E-20; e=exp(1)

mated_connectors=b*sqrt(f/1e6)

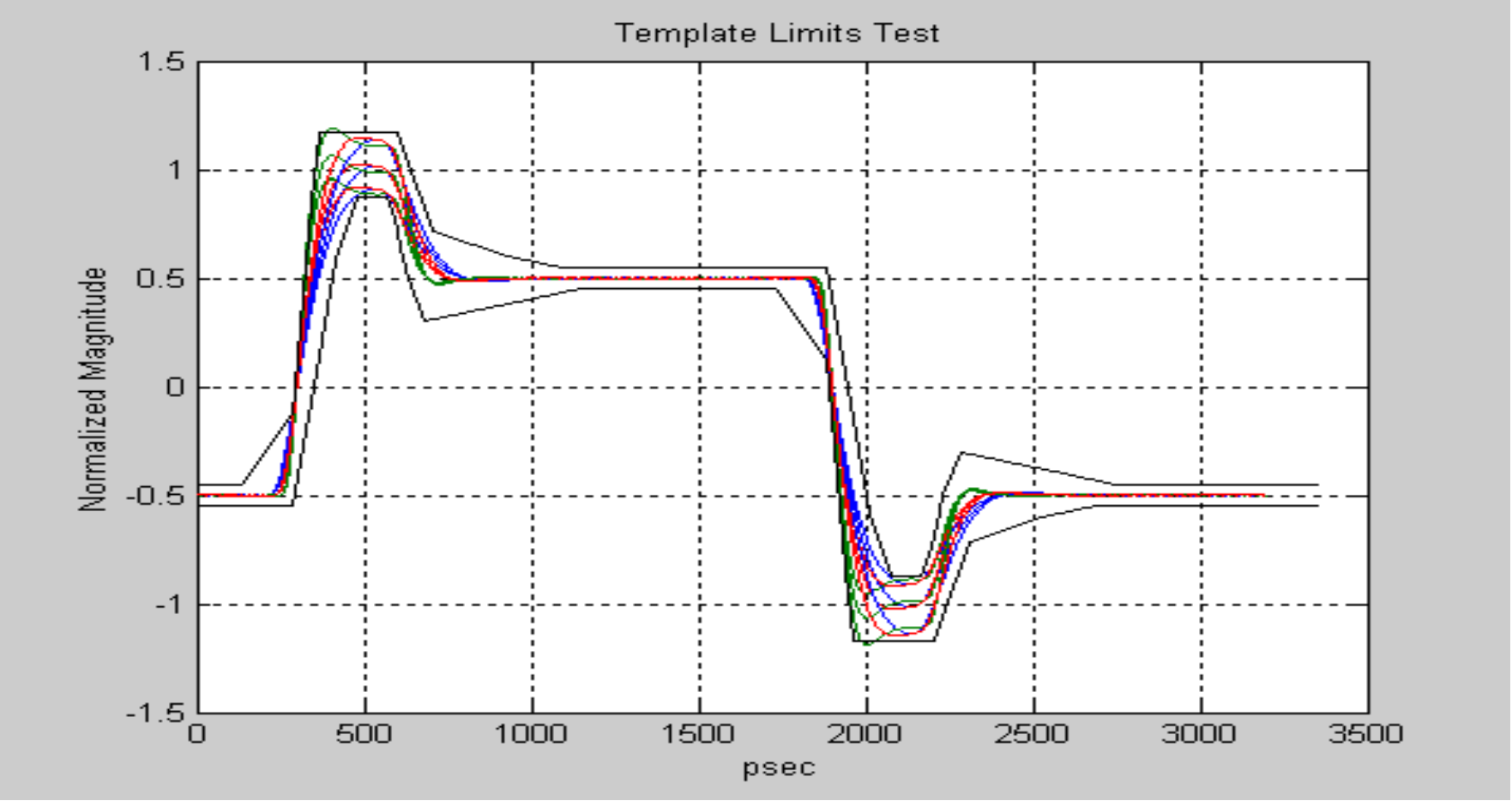
- b=0.0126592

- Note: f is in Hz

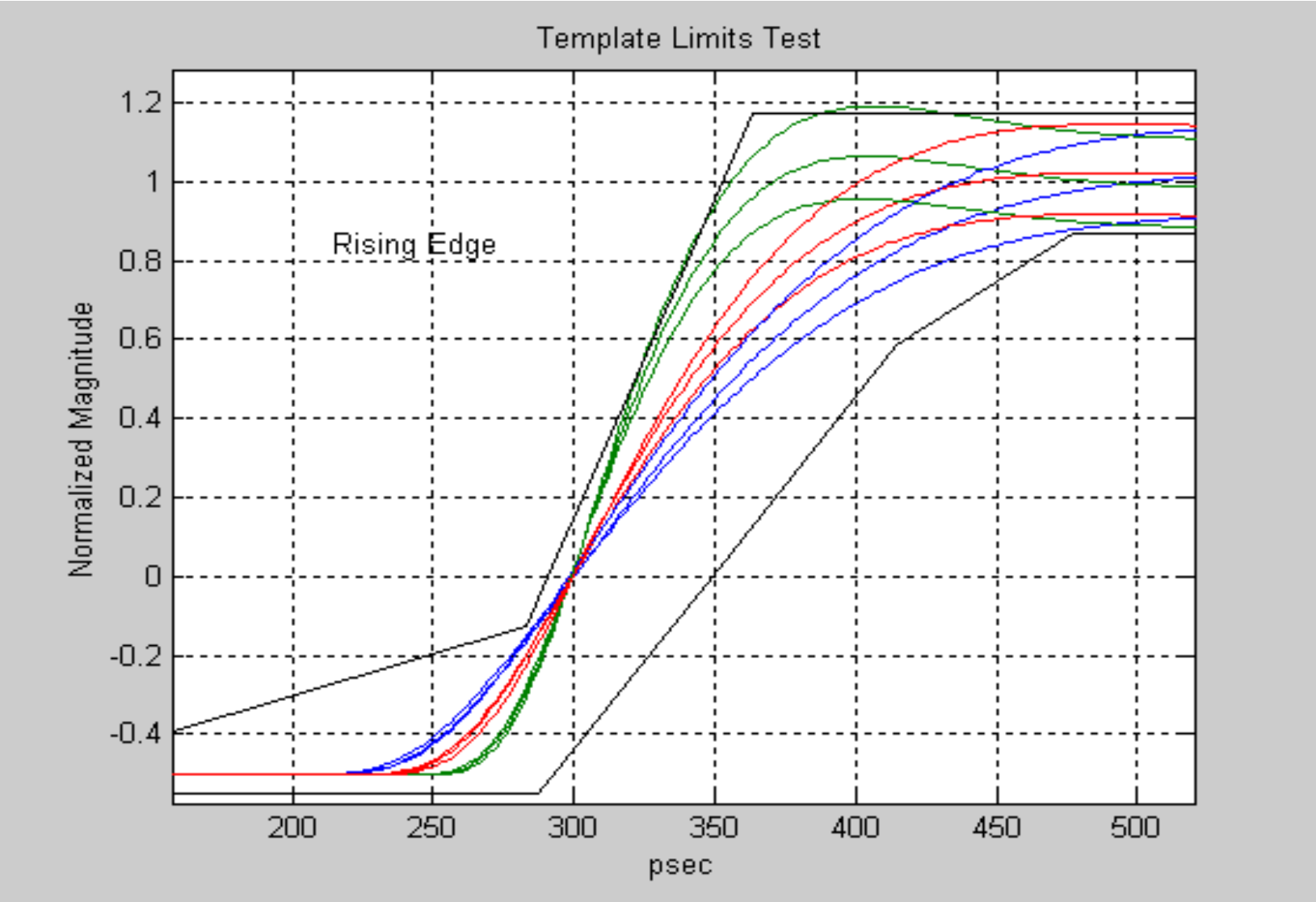
Template Check

- Method:Define set of conditions that “fill up” the template:
  - Pre-emphasis
    - 45% 50% 55%
  - Transmitter+Package filter
    - Fast Rise Time ~ 70ps
    - Medium Rise Time ~ 100ps
    - Slow Rise Time ~ 130ps
  - Altogether 9 combinations

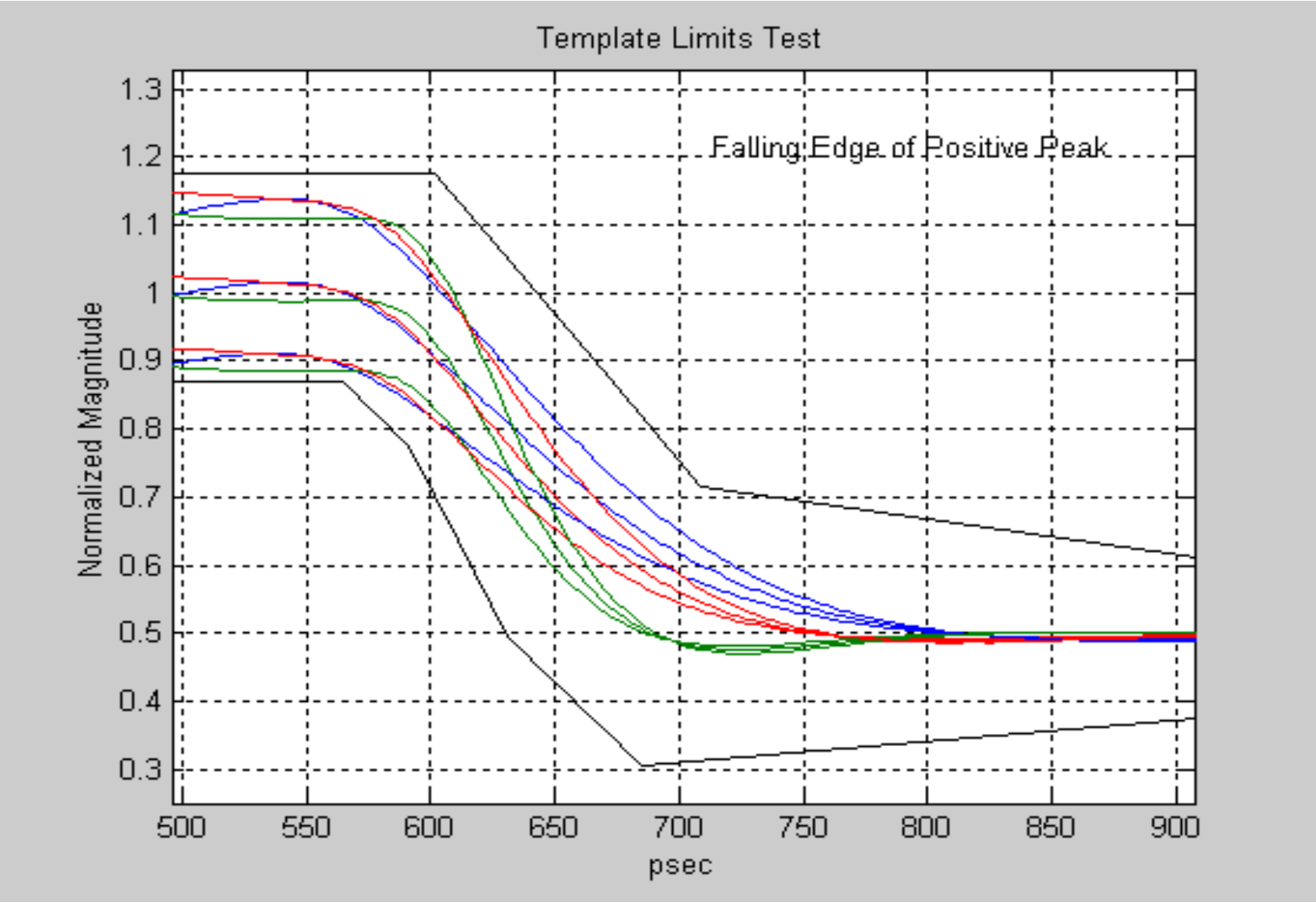
Template @TP0 – Over All



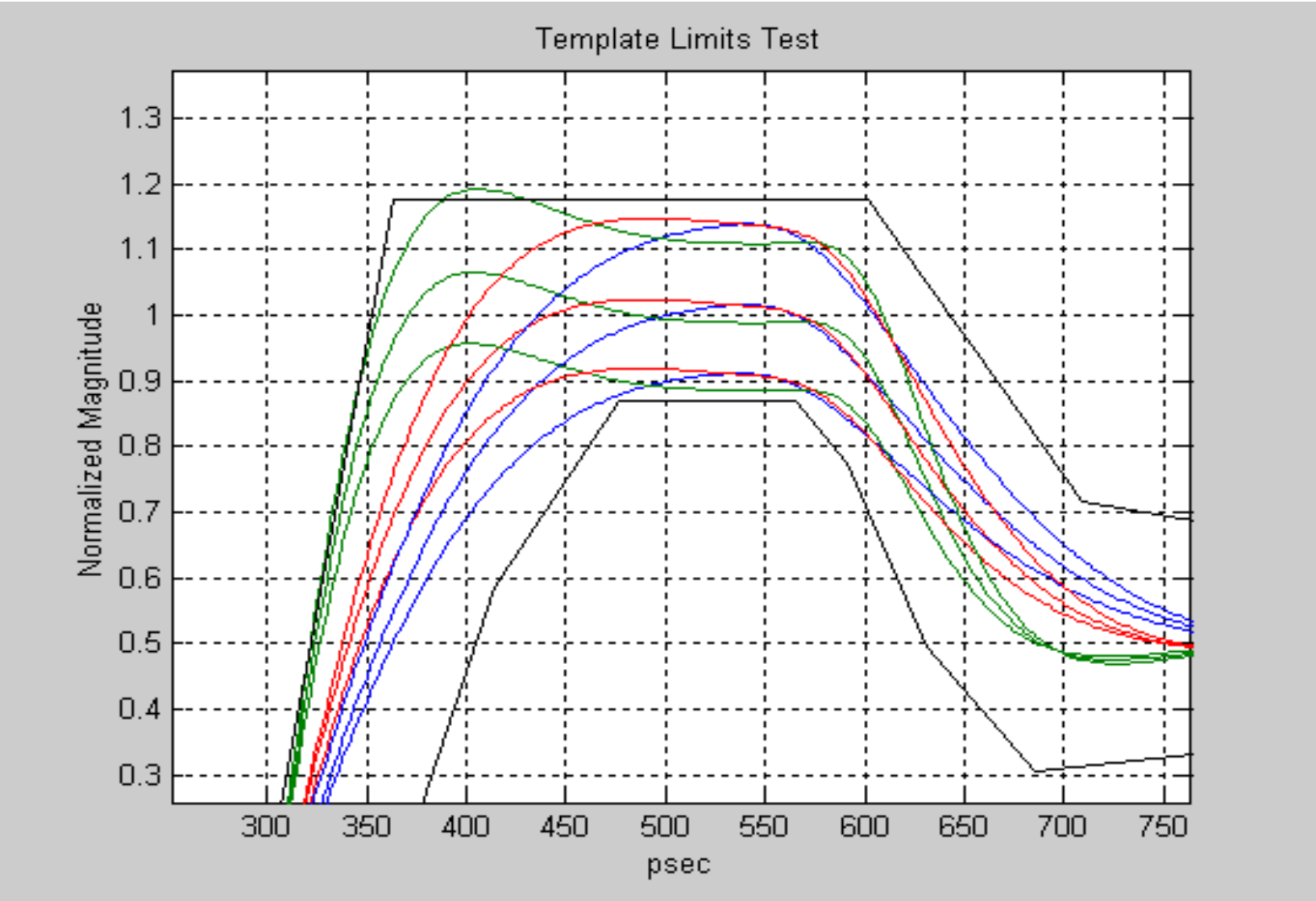
Template @TP0 Rising Edge



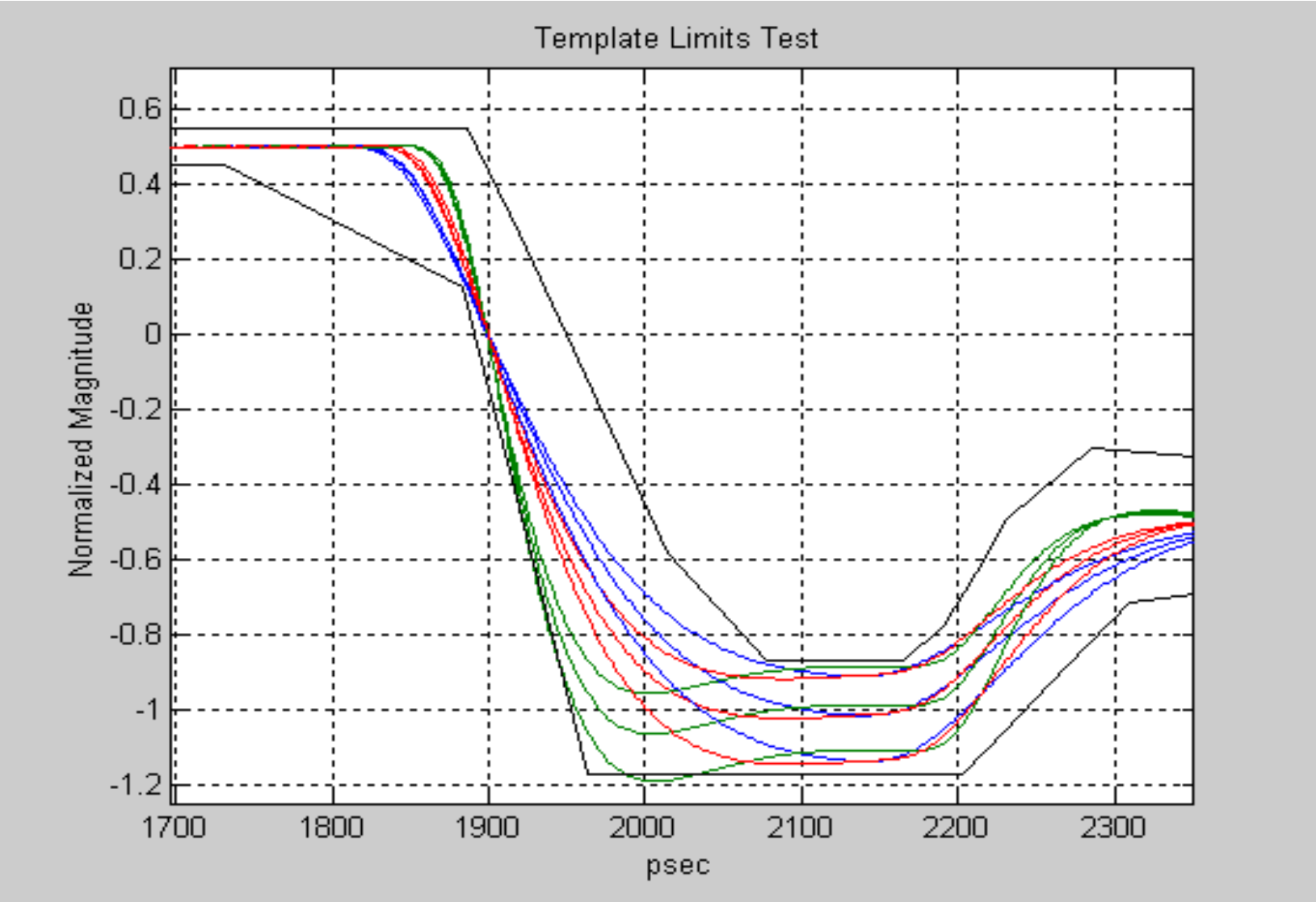
Template @TP0 Falling Edge



Template: Peak (Positive)



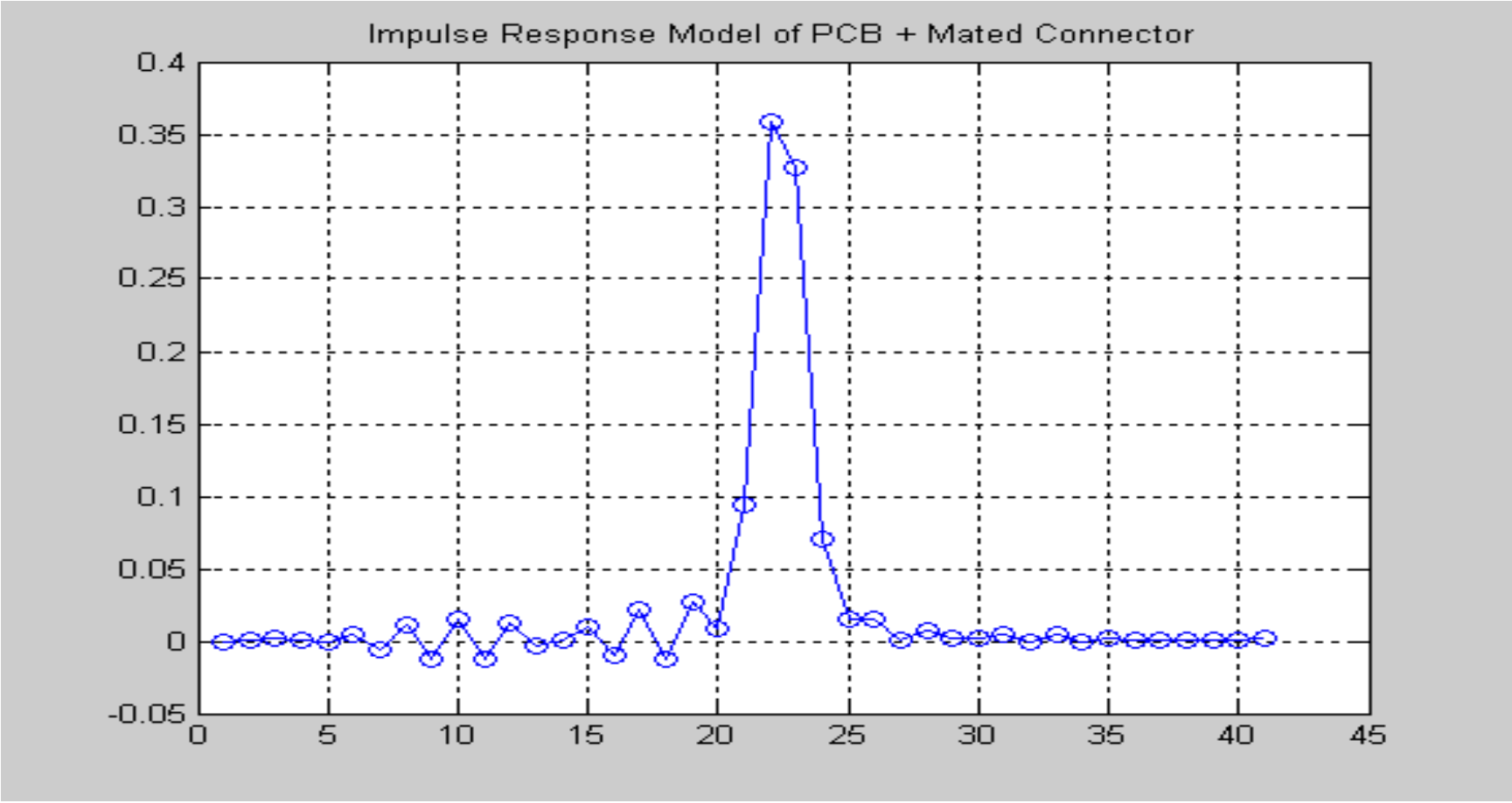
Template: Peak (Negative)



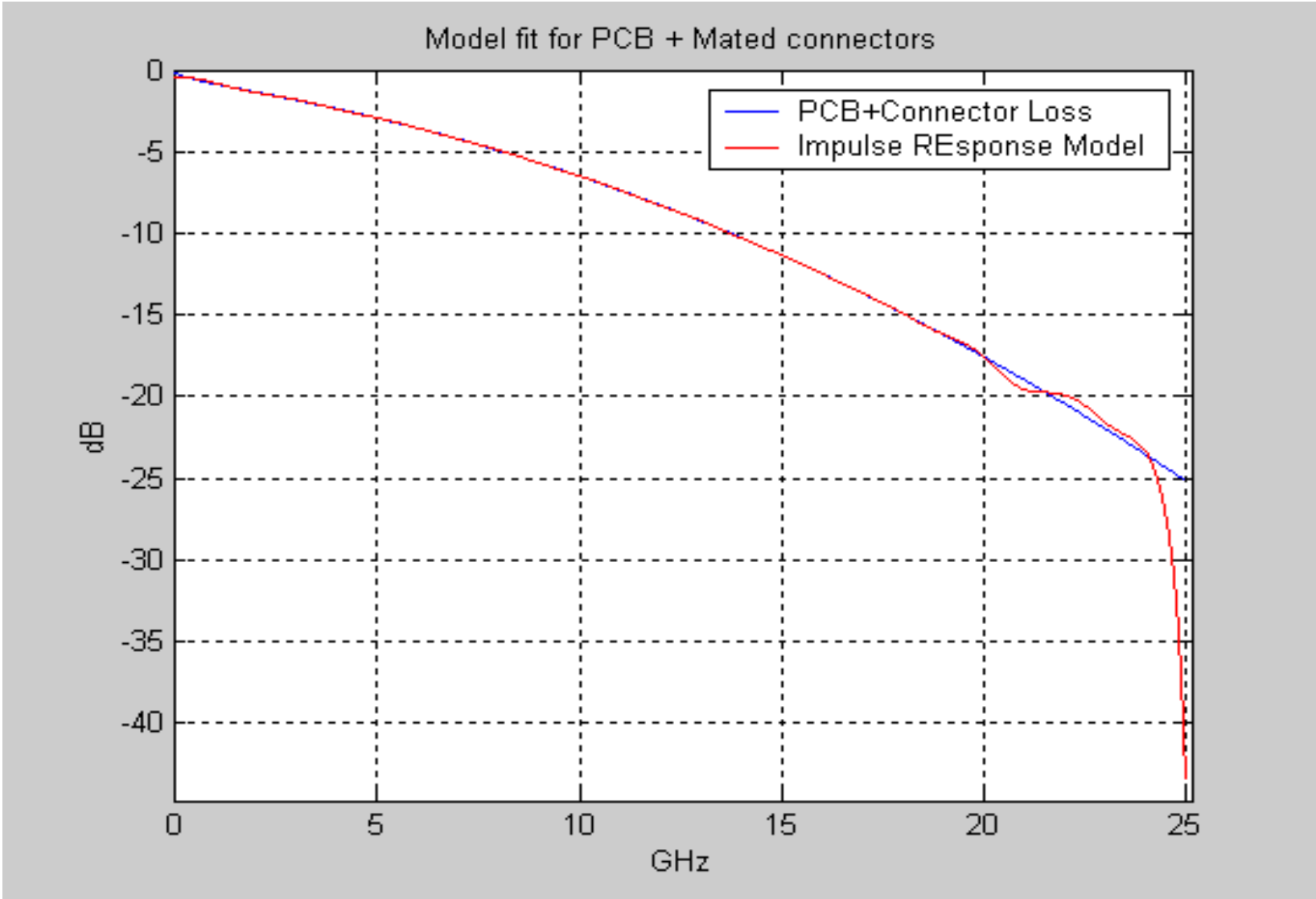
Template at TP2

- Method: Propagate defined signals through 2 inch FR4 + mated plug & jack

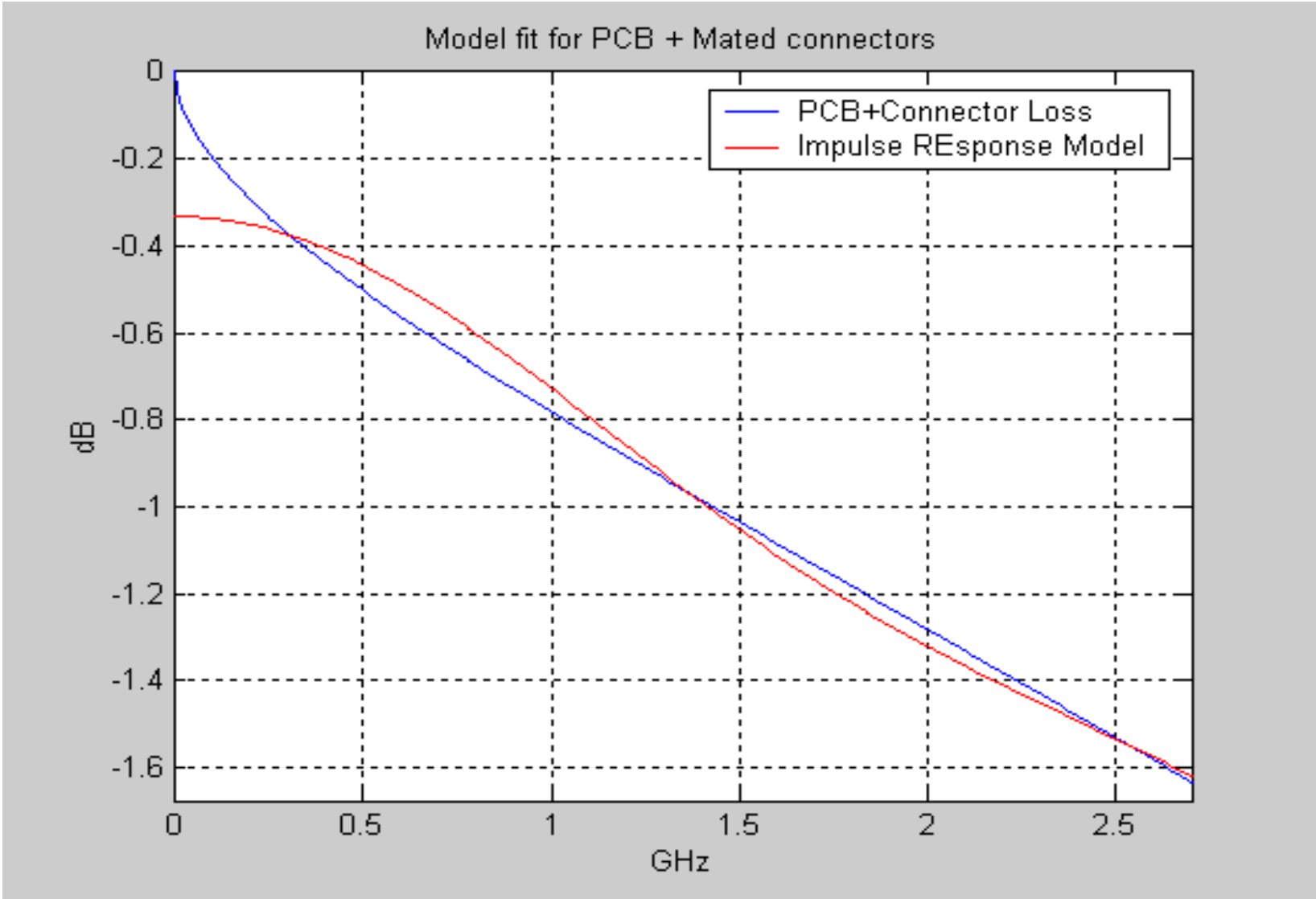
Impulse response model of 2’’ FR4+ Mated Connectors



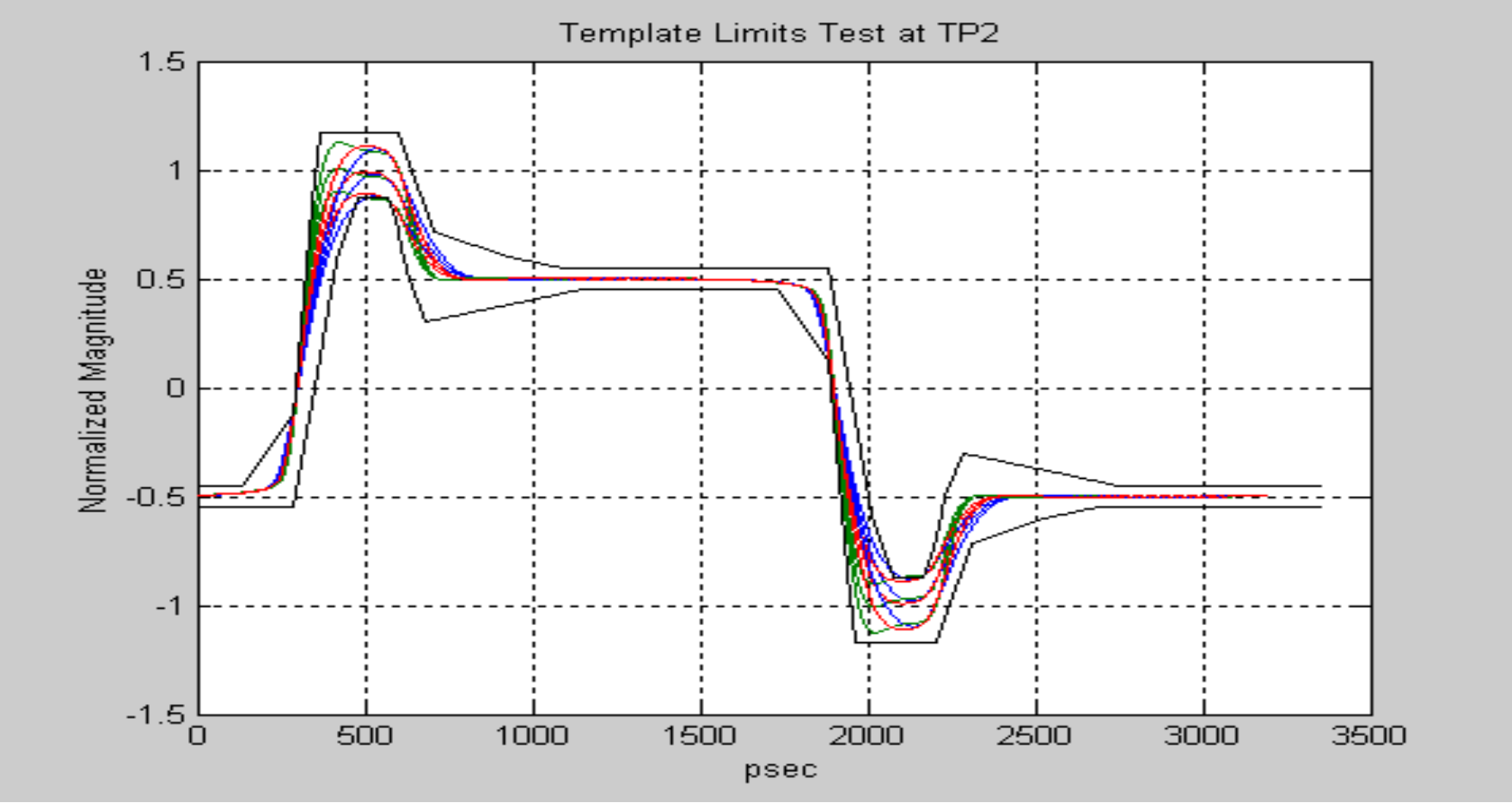
Model's frequency response for 2'' FR4+ Mated Connectors



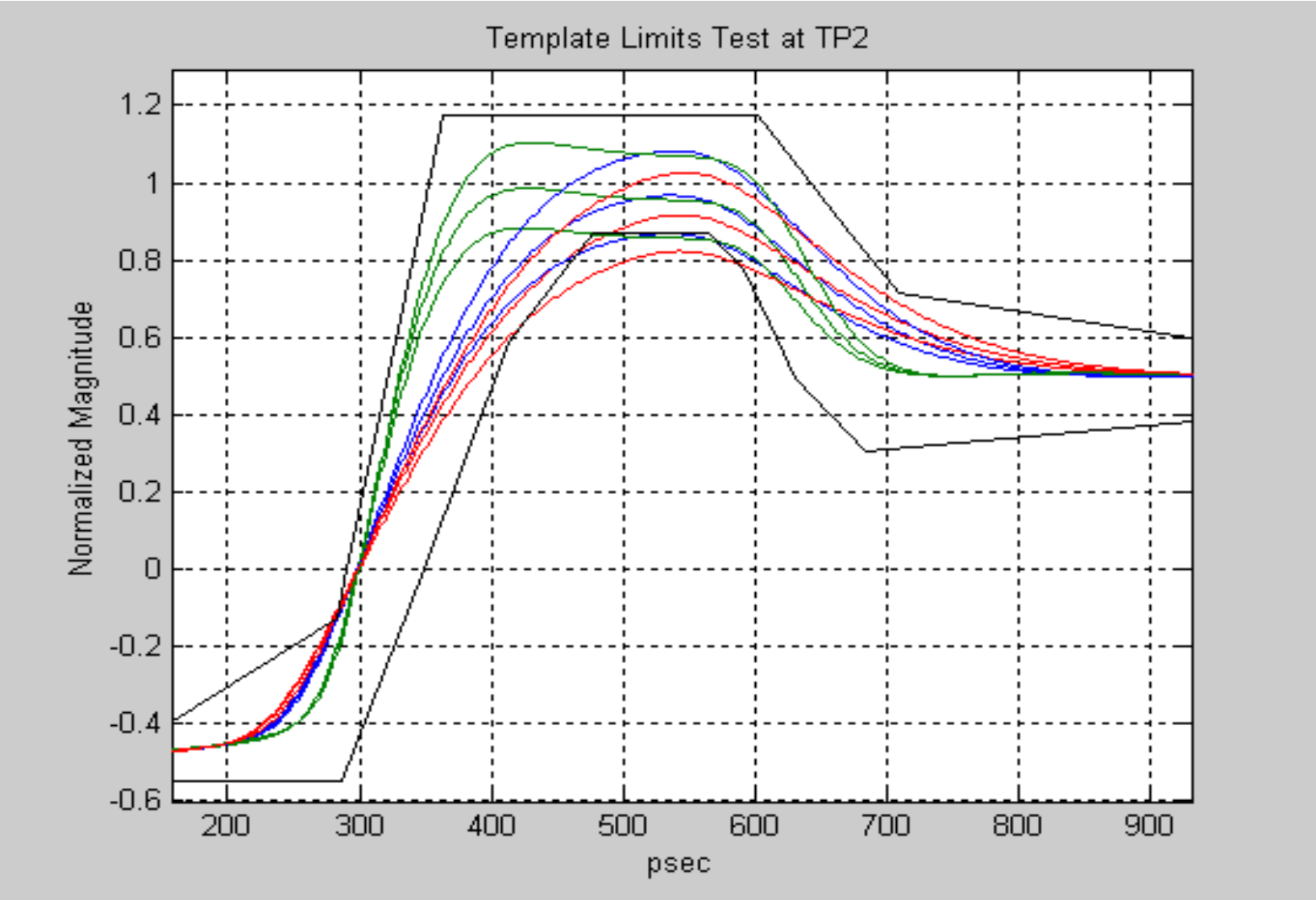
Zoom in on fit



Overall Template @TP2



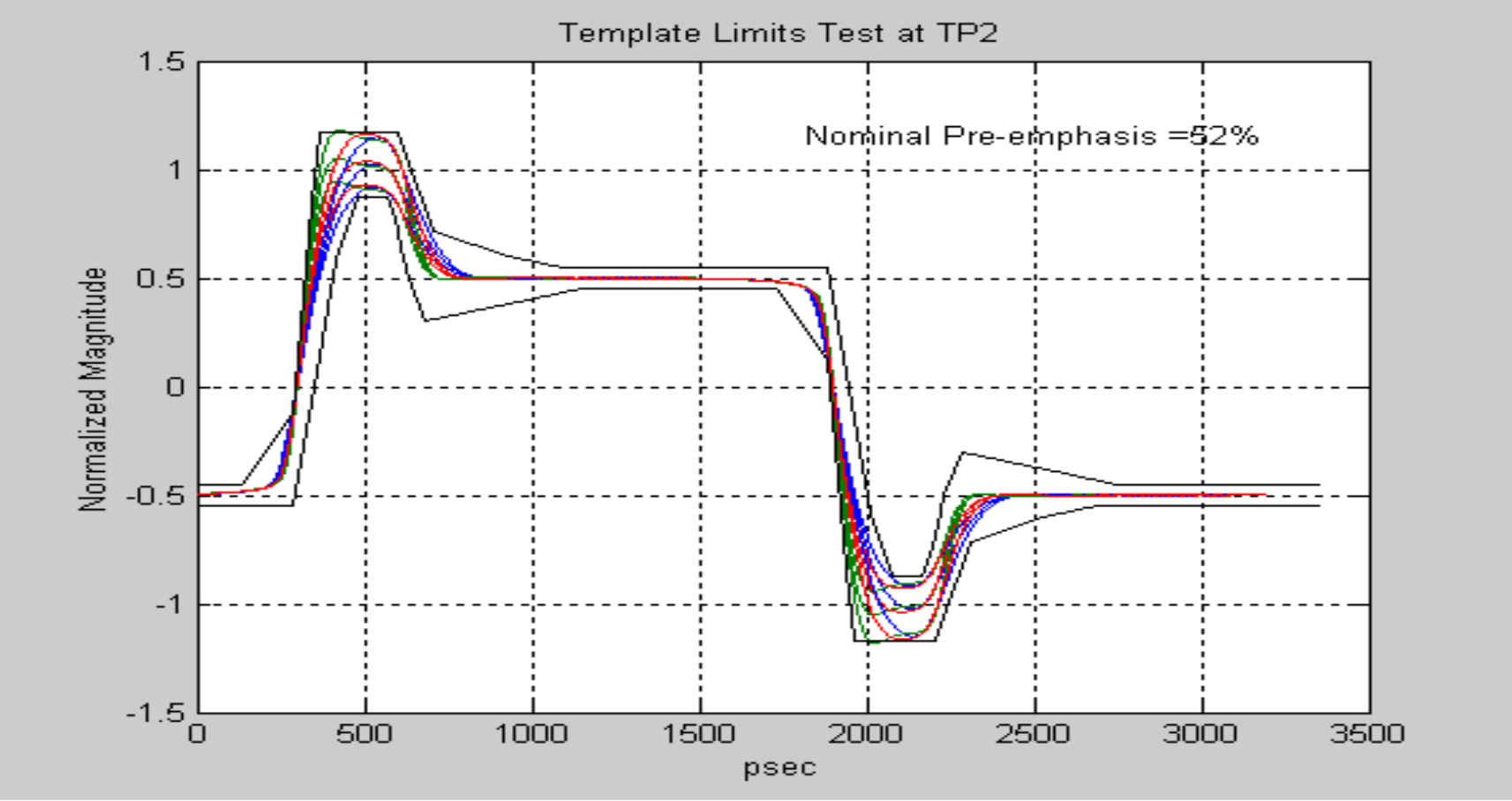
@TP2 Zoom in on Positive Peak



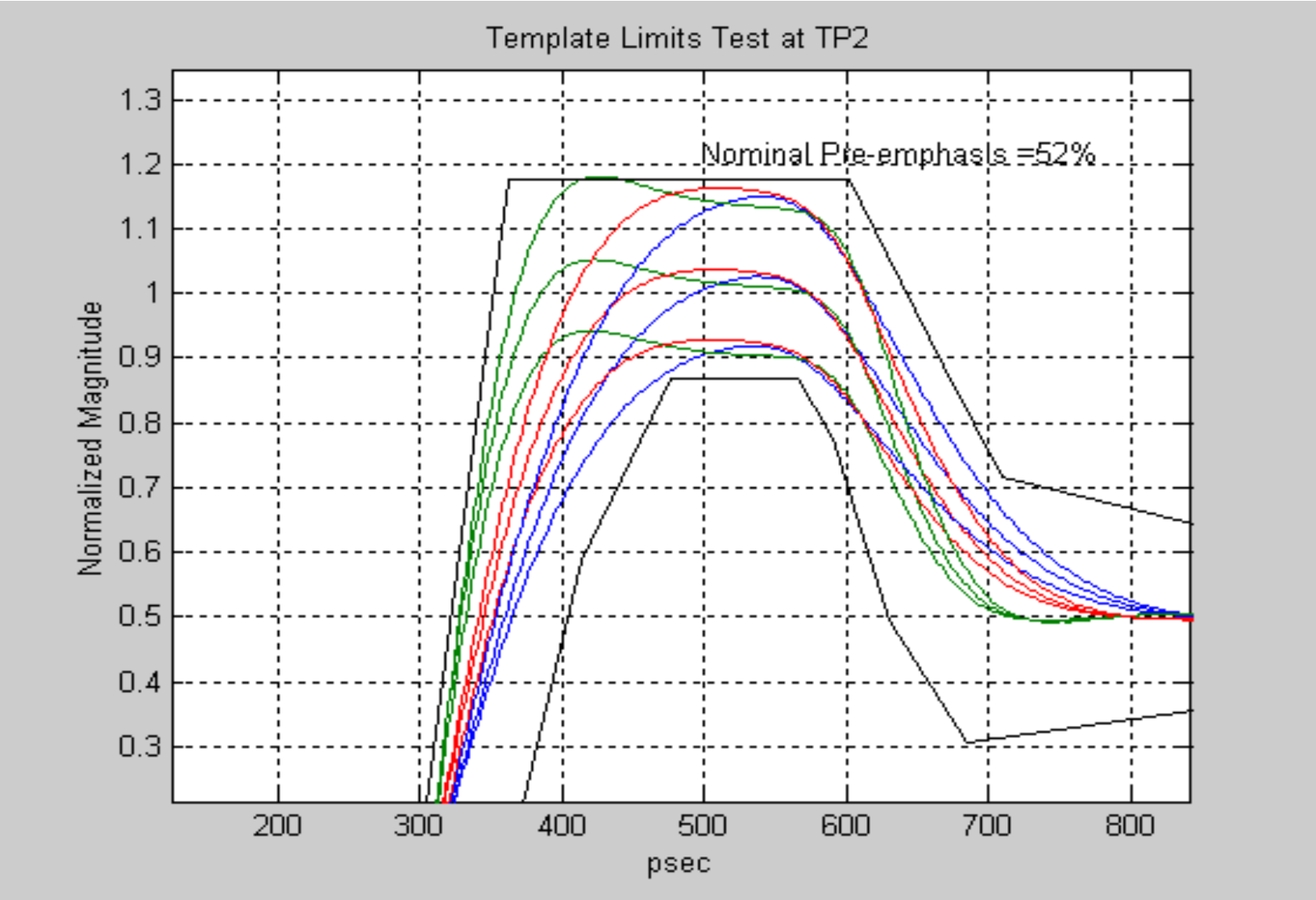
Problem

- Moving the template from TP0 to TP2 resulted in amplitude loss around the peak
- Solution: Raise the nominal pre-emphasis a bit:
  - 50% → 52%
- Following results at TP2 for 3 values of pre-emphasis:
  - 47%, 52%, 57%

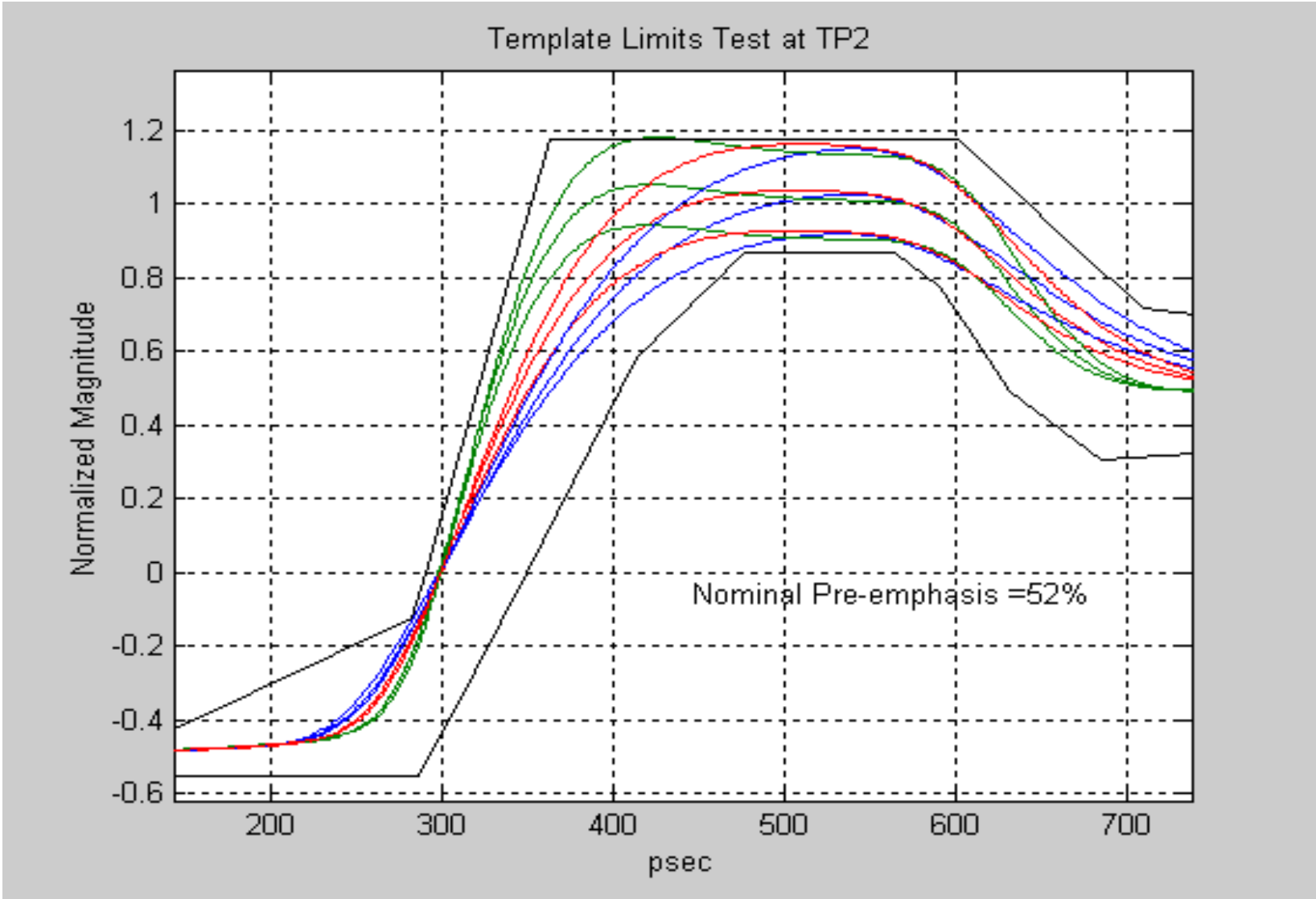
Overall Template @TP2 – modified preemphasis (52%)



@TP2 Zoom in on Positive Peak



@TP2 Zoom in on Positive Peak



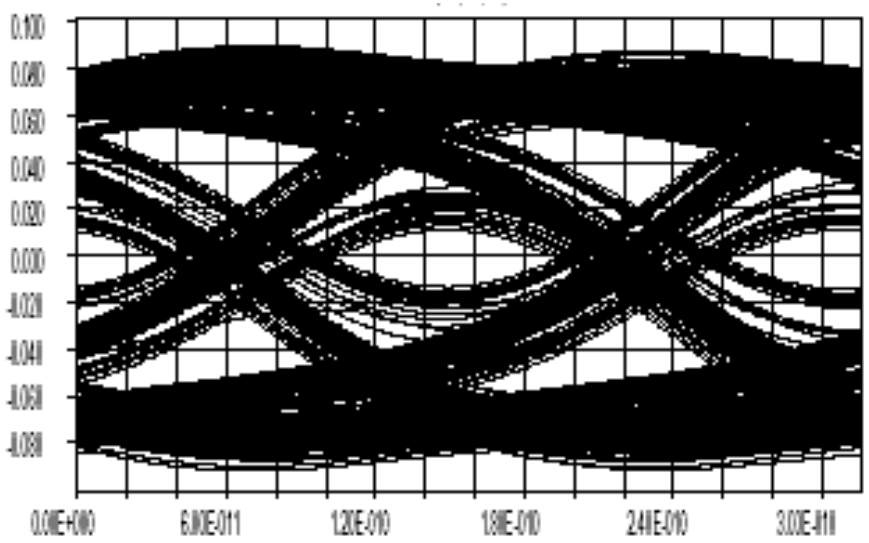
Summary & Next Steps

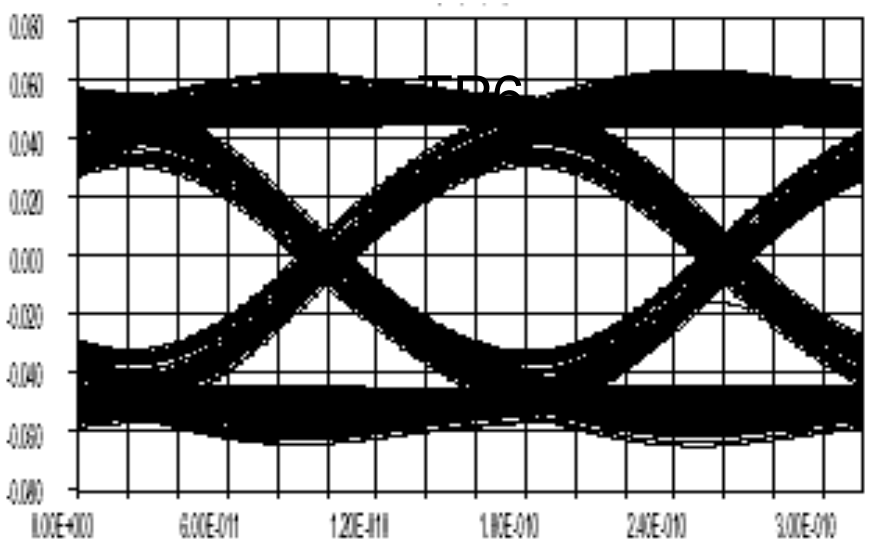
- Under the simulated conditions the template seems OK
  - Needed to slightly modify the nominal preemphasis value from 50% to 52%.
- Results here-in assumed:
  - Perfect impedance matching of chip, PCB, and connector
- Reflections were NOT accounted for
  - Expect widening of margins at the flat part
  - To this end need S parameters of PCB+connectors

Agenda

- Part 1: Loss Budget Team Report
- Part 2: Transmit Template Simulation Results
- Part 3: Proposed CX4 Electrical Specs

Worst Case Eye @ TP5, TP6



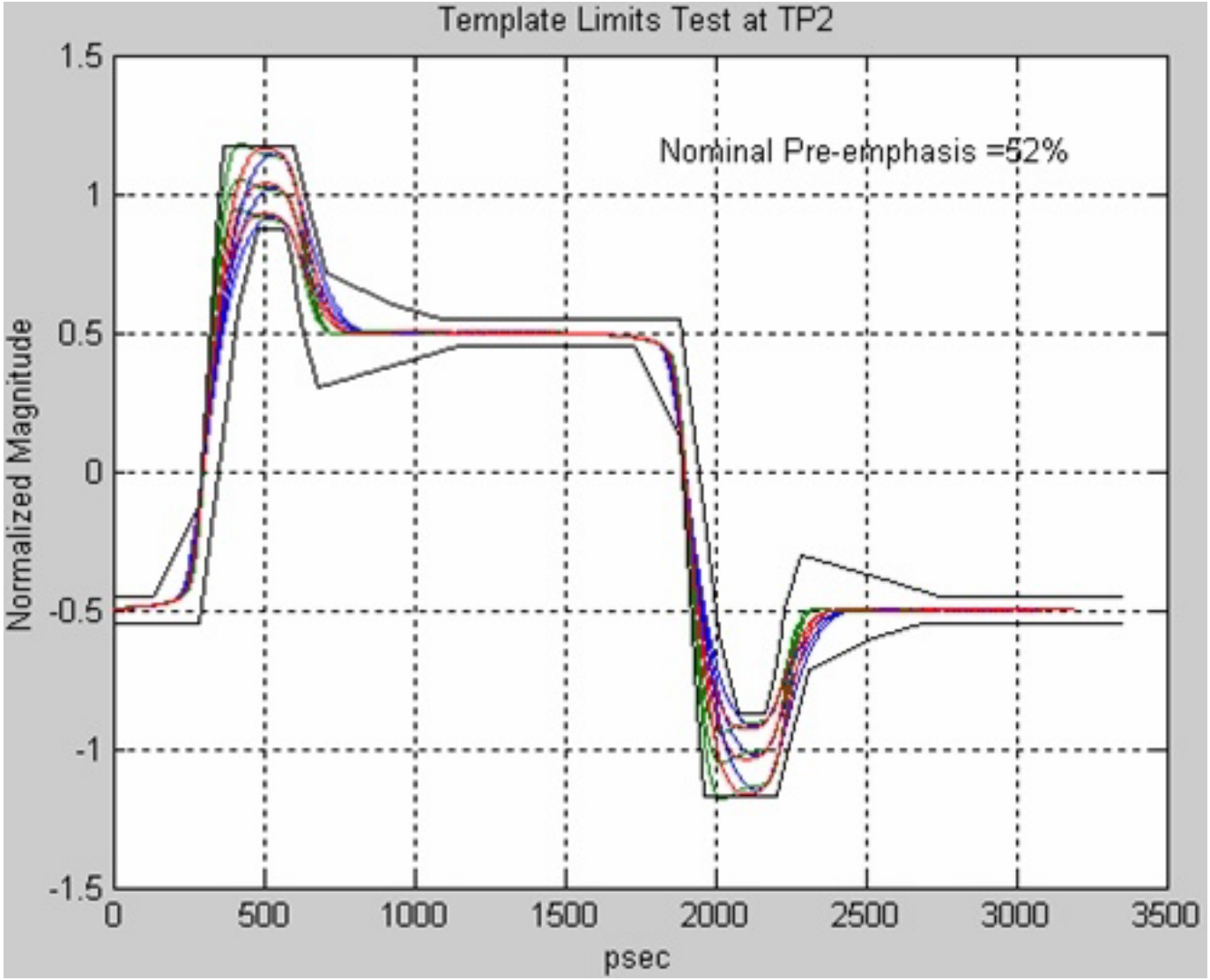


Conditions:
Xmt level = 750mV
Xmt tr,tf=130pS
WC preemphasis
Xmt Zout=40 ohms
WC FR4 model
WC Cable Assembly model
Rcv filter = s+z1/s+p1, z1=1.56G/2, p1=1.56G*(2/3)
All other Z +/-10%
Not in: DJ, RJ, NEXT, FEXT, phase

Proposed Specs @ TP2

Parameter	Value	Justification
Xmt Level	tbd	Proposals range from 750mV-1000mV pp dif. More sim results with all wc conditions needed.
Xmt Template	See next page	Template developed for TP0 based on XAUI & 2 chip vendor simulations & then derated for TP2
Xmt Rise and Fall	60-130pS	Same as XAUI
Xmt DJ	0.17 UI pp	Same as XAUI, embedded in template
Xmt RJ	0.18 UI pp	Same as XAUI
Xmt RL	-10 db @ 312-625 MHz -10+10log(f/625) @ >625MHz	Same as XAUI

Transmit Template @ TP2



Normilization Procedure	
1	Adjust the output waveform under test to fit as best as possible along the horizontal time axis.
2	Calculate the +1 low frequency level as Vlowp = average of any 2 continuous baud (640ps) between 800ps and 1760ps
3	Calculate the -1 low frequency level as Vlowm = average of any 2 continuous baud (640ps) between 2400ps and 3360ps
4	Calculate the verticle offset to be subtracted from the waveform as Voff = (Vlowp + Vlowm) / 2
5	Calculate the verticle normilization factor from the waveform as Vnorm = (Vlowp - Vlowm) / 2
6	Calculate the normalized waveform as NewWaveform = (OriginalWaveform - Voff) * ((1 - pre-emphasis) / Vnorm)
7	Adjust the normalized output waveform under test to fit as best as possible along the horizontal time axis.

Proposed Specs @ TP4

Parameter	Value	Justification
Rcv RL	-10 db	Same as XAUI
Rcv SJ	Same as IEEE Clause 47, Figure 47-5	Same as XAUI
BER	1E-12	Same as XAUI

Motion: Accept proposed receive specs from the Updated Electrical Specs Presentation with the change of TP4 to TP3 for insertion into the working paper.

Move: Peter B
Second: Steve D

Y:13 N: 0 A:1