Baseline COM parameters for 50G Backplane and Copper Cable specifications

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- Studies in kareti_3cd_01a_0716 illustrate solution space for ~30dB Backplane and Copper cable channels
  - Improve package and device termination
  - Optimize equalization
  - Reduce Gaussian noise contributors
  - COM is more sensitive to the following parameters
    - SNR_TX
    - eta_0
    - T_r
- These parameters directly impact transmitter and receiver (interference tolerance) requirements
- Encouraged broader participation to build consensus on baseline values
  - Teleconference meetings held 26th August and 2nd September, 2016

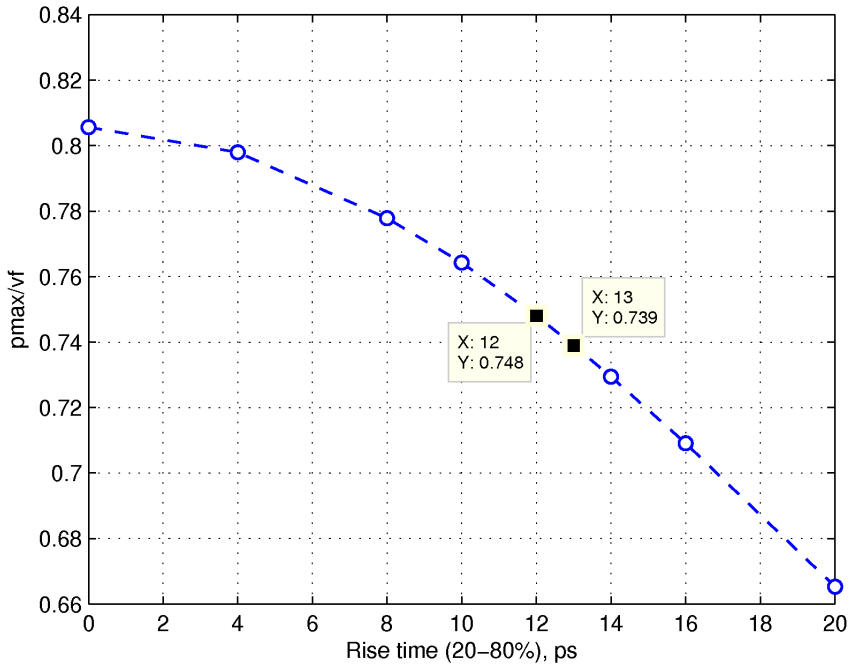
- Initial proposed Options for Baseline
  - Reduce COM limit to 2.2 dB
  - Or choose one of the possible combination of SNR_TX and eta_0 from the solution space in the study with T_r as 13 ps (preferred)

SNR_TX	eta_0	COM
dB	x 1e-08 V^2/GHz	dB
31.1	1.3	3.1105
32.5	1.64	3.1229
33.4	1.84	3.1105

  - Or Leave SNR_TX and eta_0 as TBD for baseline

- Conclusion from the discussion was to follow P802.3bs approach and identify with magenta font those areas of the baseline where further consideration and/or confirmation is required
  - Magenta Items and their discussion points
    - C_d (160 fF, 180 fF) - C2M type of conditions
    - C_p (110 fF) - overall package reflections
    - C(0),C(-1),C(-2),C(1) - range and resolution
    - F_P2 (26.5625 GHz) - CTLE POLE2 location
    - A_v, A_fe, A_ne - Vf value with T_r filter
    - N_b, bmax(1), bmax(2 ..N_b) - number of taps and tap values; cumulative tap effects
    - Sigma_RJ; A_DD - revisit basis for these numbers.
    - SNR_TX; eta_0 - impact of other parameter changes
    - COM - impact of other parameter changes
    - T_r - pmax/Vf ratio
    - Package_Z_c – Overall package reflections

- The relationship between the T_r filter and the p_max/v_f ratio, with the updated package model

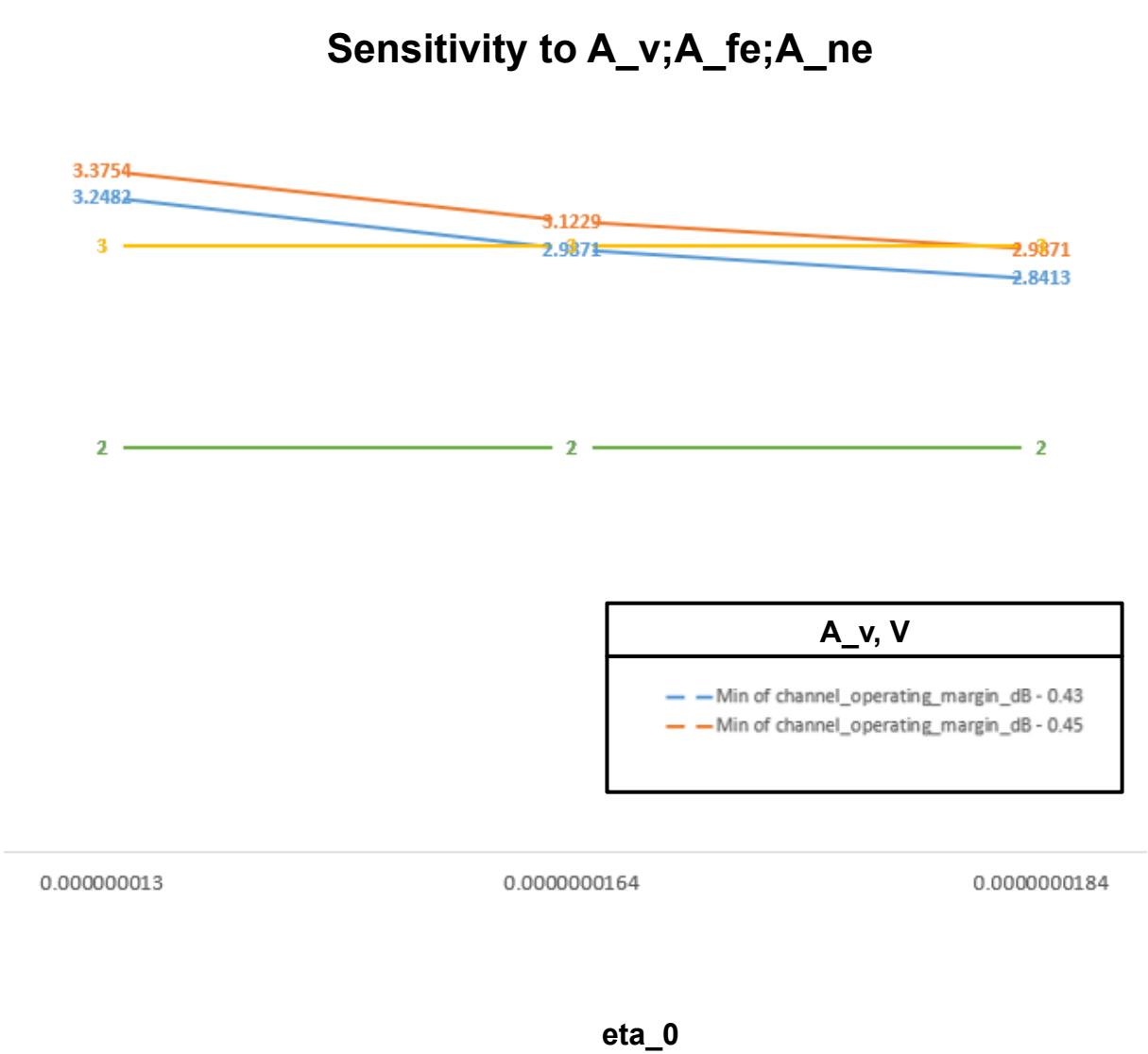


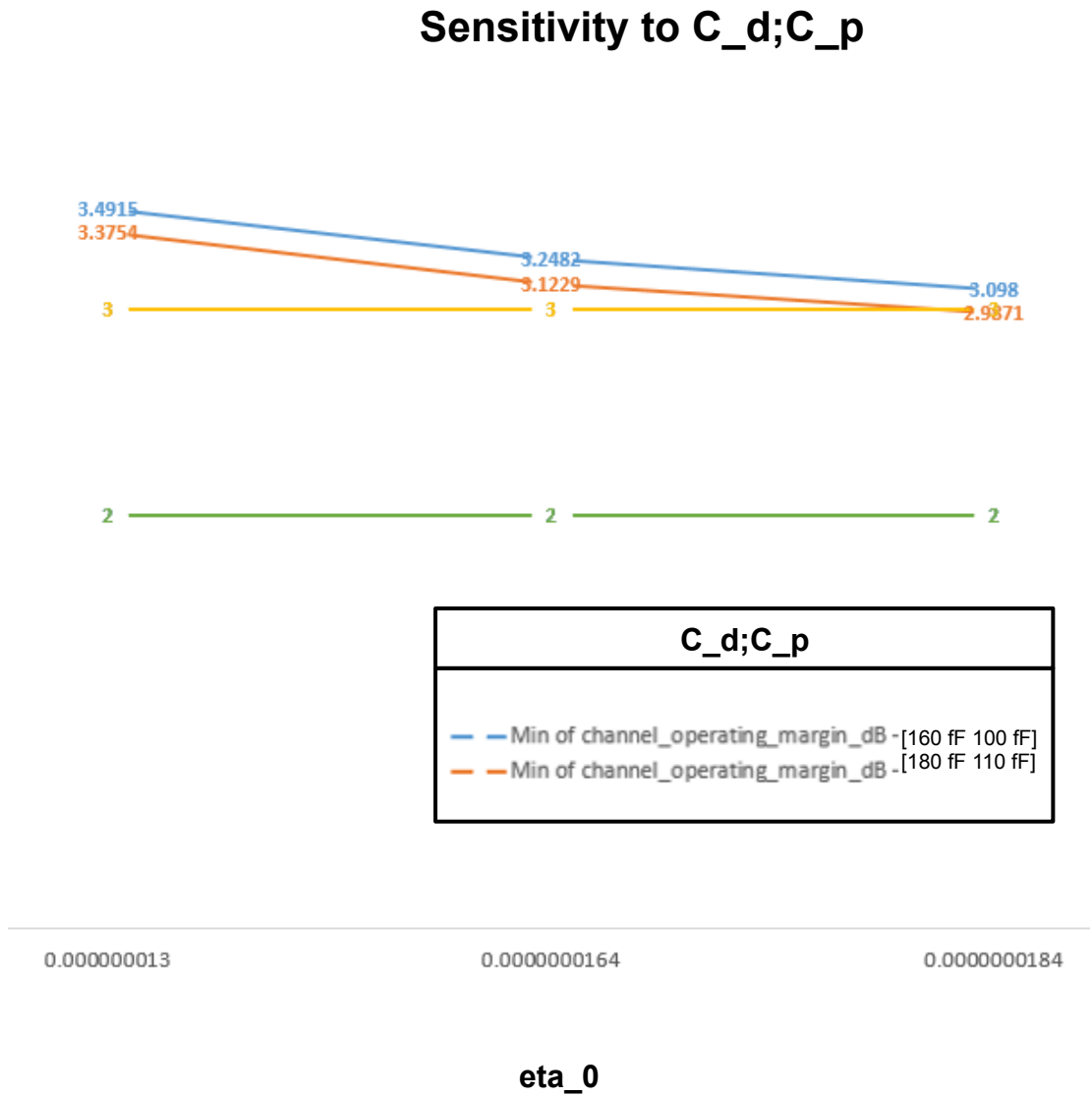
- Not much different than what is presented in [healey_3bs_01_0516](#) slide 3

Influence of Range and resolution of TX FIR taps

		CISCO Channels										
		Ch1	Ch2	Ch3	Ch4	Ch5	Ch6	Ch7	Ch8	Ch9	Ch10	
	Insertion Loss @ NQ, dB	10.7876	12.4579	17.3145	20.874	22.3474	25.3573	27.6685	30.1441	32.859	34.9828	
	FOM_ILD	0.31042	0.30047	0.28196	0.31335	0.28224	0.3028	0.31005	0.30382	0.31247	0.34579	
	ICN,mv	1.2534	1.1147	0.81725	0.72664	0.69128	0.64907	0.60807	0.57276	0.55667	0.54711	
	Change Log	COM @ DER_0 = 1e-4										Comments
1	Initial COM Parameter	5.619	5.3514	5.4172	5.3521	4.5683	4.3649	3.7417	3.1728	2.4181	1.608	
2	1 + Modify F_P2 = 1e99	5.701	5.4024	5.519	5.5167	4.6717	4.4081	3.6884	3.0856	2.2364	1.4116	Worsens for High loss channels
3	1 + modify No c(1)	5.619	5.3514	5.3953	5.3521	4.5243	4.3649	3.7417	3.1728	2.4181	1.608	Virtually No impact
4	1 + Modify resolutions c(-1,-2,1) = 0.025	5.619	5.3514	5.4172	5.3682	4.583	4.4805	3.7953	3.3626	2.4988	1.692	Better for High Loss channels
5	1 + Modify resolutions c(-1,-2) = 0.02; No c(1)	5.5786	5.2929	5.3601	5.5145	4.6272	4.5977	3.8493	3.4139	2.6271	1.7237	Better for High Loss channels
6	1 + Modify resolutions c(-1,-2) = 0.02; range of c(-2)	5.5786	5.2929	5.3601	5.5145	4.6272	4.5977	3.8493	3.4139	2.6271	1.7237	No difference from (5)

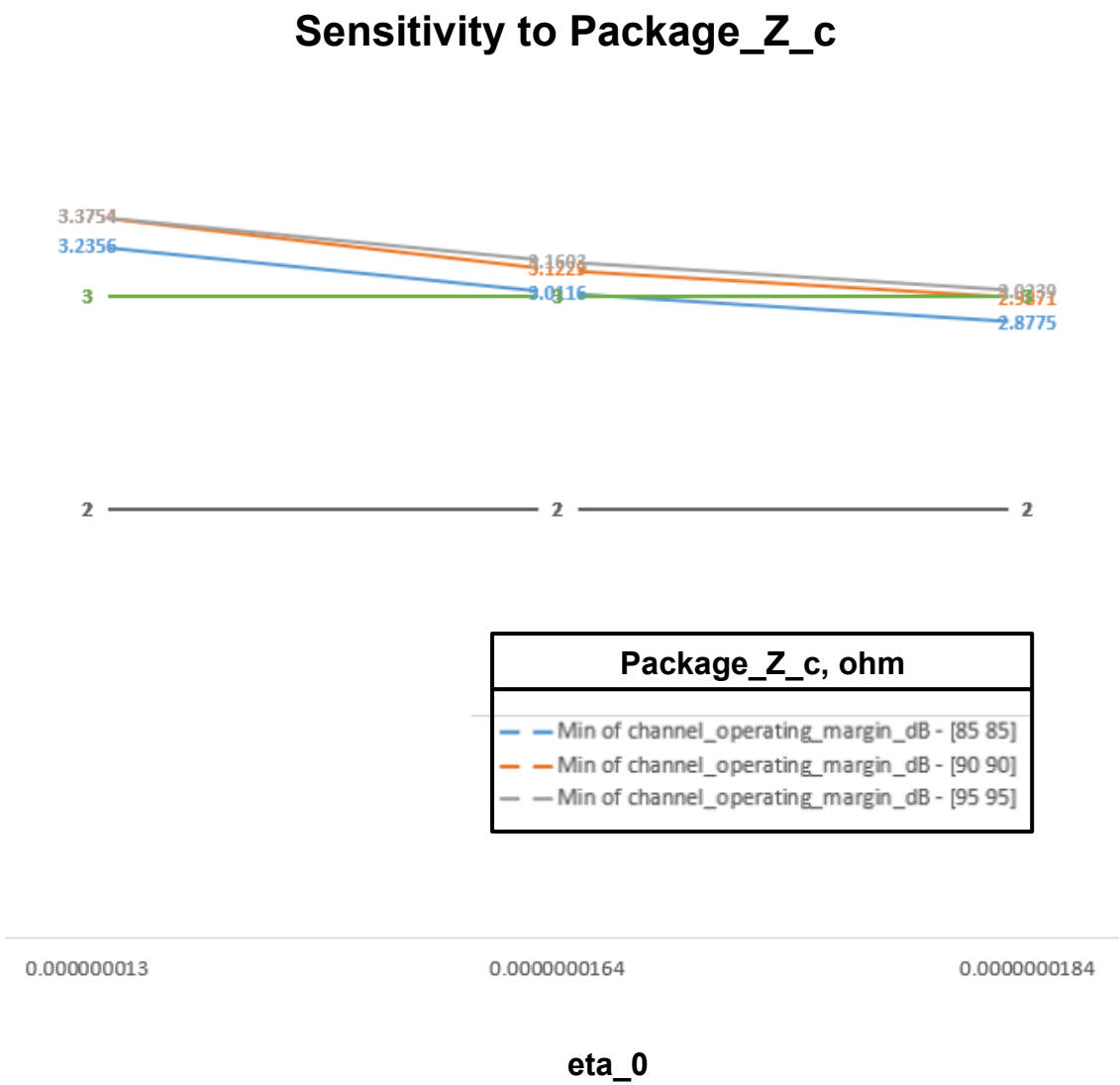
Sensitivity analysis for Ch8 (~30 dB)

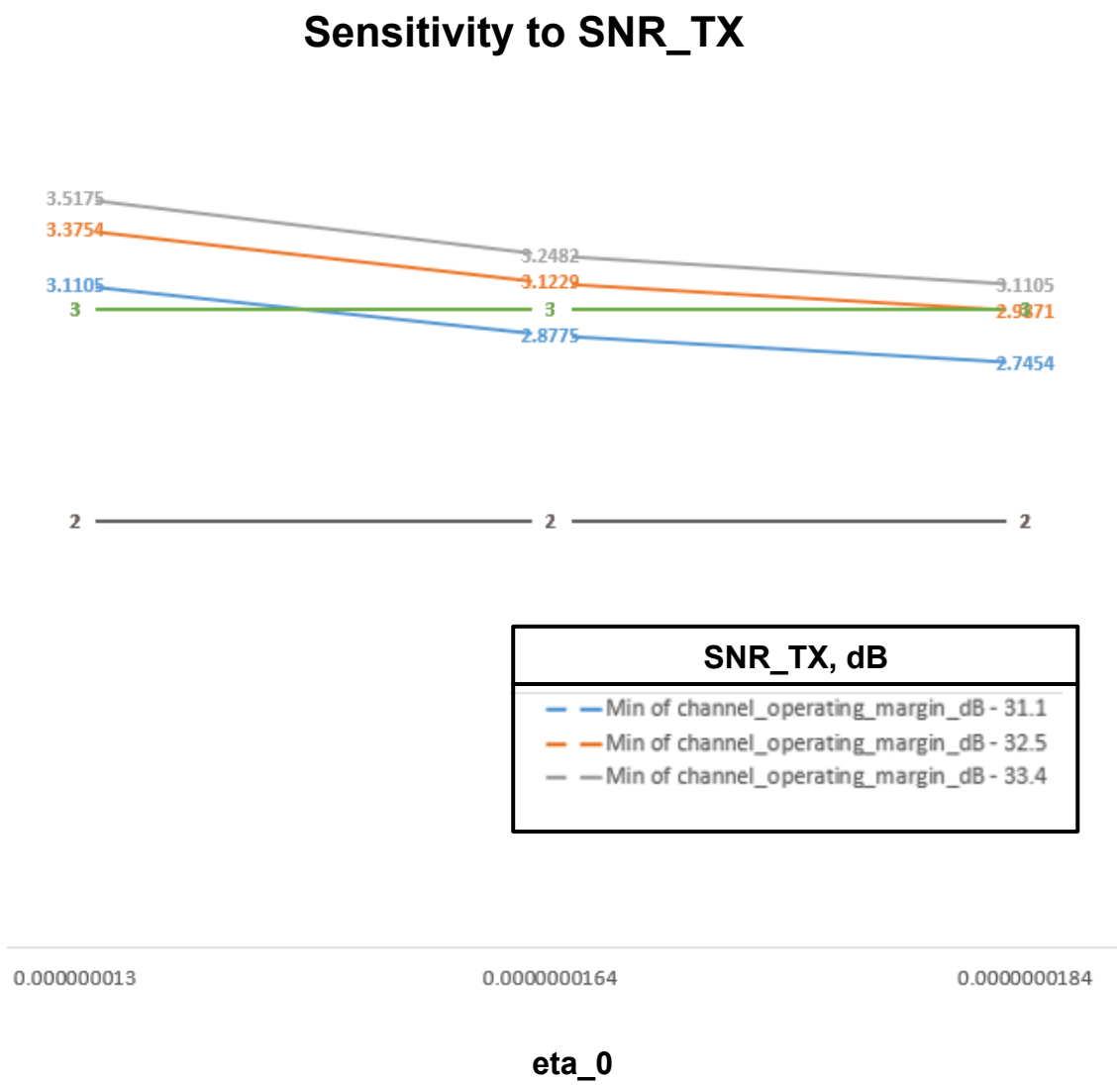




Note: deviation from base parameters - used 0.5 dB CTLE and LFEQ steps and F_p2 = 1e+99

Sensitivity analysis for Ch8 (~30 dB)





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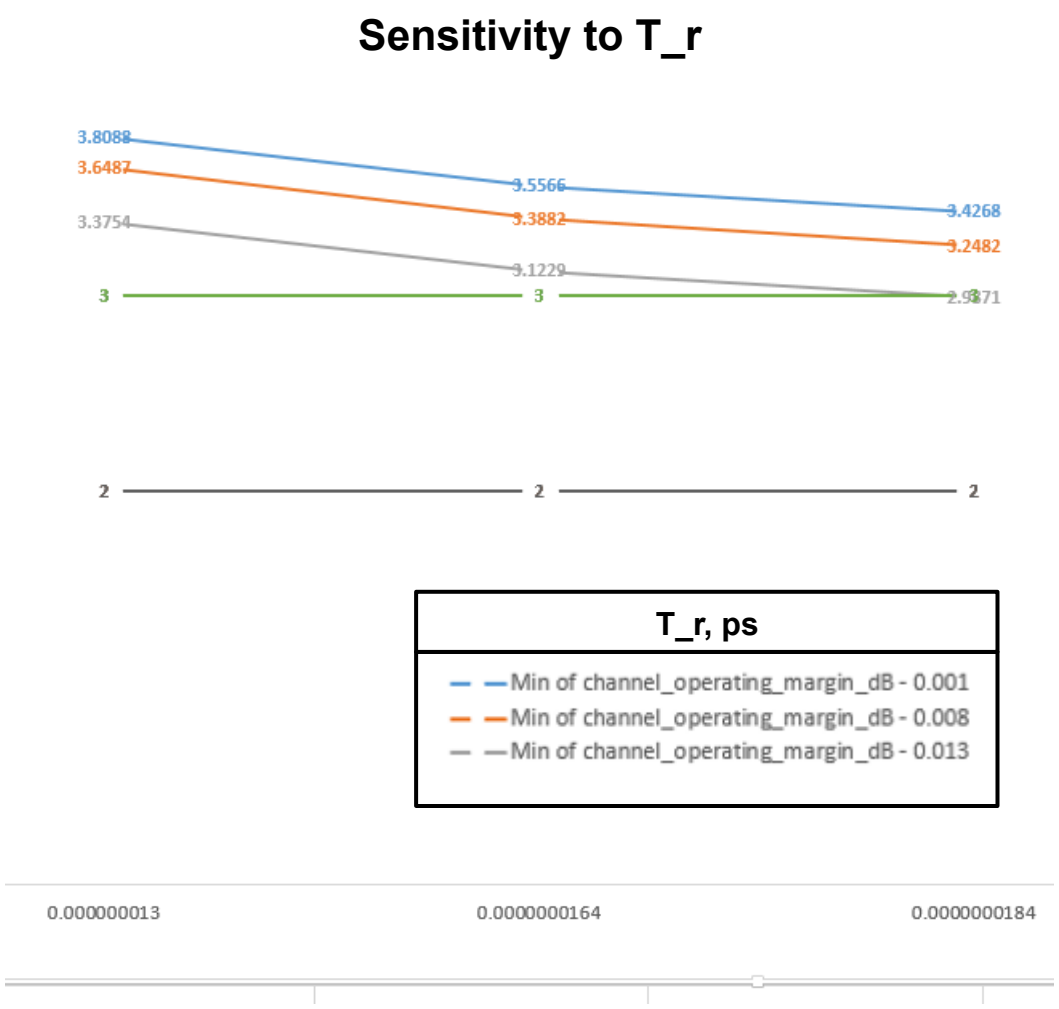

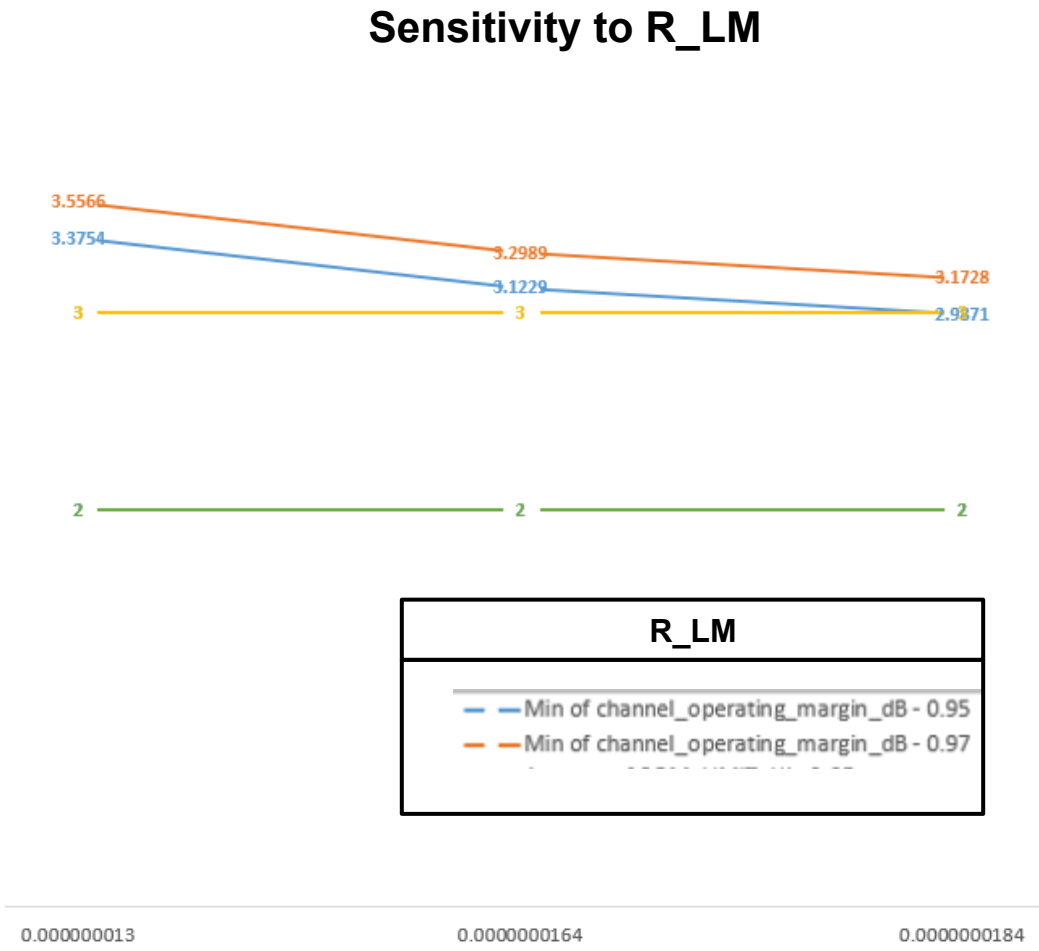

Note: deviation from base parameters - used 0.5 dB CTLE and LFEQ steps and F_p2 = 1e+99

Table XXX -X - Channel operating margin parameters

Parameter	Symbol	Value	Units
Signaling rate	f_b	26.5625	GBd
Maximum start Frequency	f_{min}	0.05	GHz
Maximum frequency step	Δf	0.01	GHz
Device package model Single-ended device capacitance Transmission line length, Test 1 Transmission line length, Test 2 Single-ended board capacitance Transmission line Characteristic Impedance	 C_d z_p z_p C_p Z_c	 1.8×10^{-4} 12 30 1.1×10^{-4} 90	 nF mm mm nF ohms
Singel-ended reference resistance	*Ro*	50	ohms
Singel-ended termination resistance	*Rd*	55	ohms
Receiver 3dB bandwidth	f_r	0.75 x f_b	GHz
Transmitter equalizer, minimum cursor coefficient	*c(0)*	0.6	-
Transmitter equalizer, 1st pre-cursor coefficient Minimum value Maximum value Step size	*c(-1)*	 -0.25 0 0.05	-
Transmitter equalizer, 2nd pre-cursor coefficient Minimum value Maximum value Step size	*c(-2)*	 0 0.1 0.025	-
Transmitter equalizer, post-cursor coefficient Minimum value Maximum value Step size	*c(1)*	 -0.25 0 0.05	-
Continuous time filter, DC gain Minimum value Maximum value Step size	g_{DC}	 -20 0 1	dB
Continuous time filter, DC gain 2 Minimum value Maximum value Step size	g_{DC2}	 -6 0 1	dB

Table XXX -X - Channel operating margin parameters (continued)

Parameter	Symbol	Value	Units
Continuous time filter, zero frequencies	f_z f_{zHP}	f_b/2.5 f_b/40	GHz
Continuous time filter, pole frequencies	f_{p1} f_{p2} f_{pHP}	f_b/2.5 f_b f_b/40	GHz
Transitter differential peak voltage Victim For-end aggressor Near-end agrressor	A_v A_{fe} A_{ne}	 0.45 0.45 0.63	 V V V
Number of signal levels	L	4	-
Level separation mismatch ratio	R_{LM}	0.95	-
Transmitter signal-to-noise ratio	SNR_{TX}	32.5	dB
Number of samples per unit interval	M	32	-
Decision feedback equivalizer (DFE) length	N_b	12	UI
Normalized DFE coefficient magnitude limit, for n = 1 for n = 2 to N_b	$b_{max}(n)$	 0.7 0.2	-
Random jitter, RMS	σ_{RJ}	0.01	UI
Dual-Dirac jitter, peak	A_{DD}	0.02	UI
One-sided noise spectral density	η_0	1.64×10^{-8}	V^2/GHz
Target Detection error ratio	DER_0	10^{-4}	-

Summary and further work

- Summary
  - Increasing Transmit equalizer coefficient resolution had minimal effect on the COM result.
  - Sensitivity analysis provides possible paths to additional enhancements.
  - Worked out baseline COM parameters through wide participation.
  - This proposal include table of COM parameters for Backplane and Copper cable
  - This COM parameter table complements the following baseline proposals
    - Baseline proposals for copper twin axial cable specifications adopted by taskforce during San Diego Jul 2016 plenary meeting
    - Baseline Proposal for 50, 100, and 200 Gb/s Backplane and Copper Cable being proposed now during Fort Worth Sep 2016 Interim meeting.

- Future Work
  - Explore improved modeling and/or constraining other parameters to gain more margin in order to Refine SNR_TX and eta_0
  - Explore suitability to existing 25G NRZ channels and also to channels with additional BGA via and fan-out Xtalk

Thanks !!

COM tool configuration spreadsheet

Table 93A-1 parameters			
Parameter	**Setting**	**Units**	**Information**
f_b	26.5625	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.8e-4 1.8e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[30]	mm	[test cases]
z_p (NEXT)	[12]	mm	[test cases]
z_p (FEXT)	[30]	mm	[test cases]
z_p (RX)	[30]	mm	[test cases]
C_p	[1.1e-4 1.1e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[55 55]	Ohm	[TX RX]
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.25:0.05:0]		[min:step:max]
c(-2)	[0:0.025:0.1]		[min:step:max]
c(1)	[-0.25:0.05:0]		[min:step:max]
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	10.625	GHz	
f_p1	10.625	GHz	
f_p2	26.5625	GHz	
A_v	0.45	V	
A_fe	0.45	V	
A_ne	0.63	V	
L	4		
M	32		
N_b	12	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
sigma_RJ	0.01	UI	
A_DD	0.02	UI	
eta_0	1.64E-08	V^2/GHz	
SNR_TX	32.5	dB	
R_LM	0.95		
DER_0	1.00E-04		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2

g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\COM50_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 2 3 4]	
RUNTAG	_CDAUI-8	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.30E-02	ns
T_r_filter_type	1	logical
T_r_meas_point	0	logical

Non standard control options		
INC_PACKAGE	1	logical
IDEAL_RX_TERM	0	logical
INCLUDE_CTLE	1	logical
INCLUDE_TX_RX_FILTER	1	logical
COM_CONTRIBUTION	0	logical
CDR_OVERSAMPLED	0	logical

Table 93A–3 parameters		
Parameter	**Setting**	**Units**
package_tl_gamma0_a1_a2	[0 1.734e-3 1.455e-4]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	90	Ohm

Table 92–12 parameters		
Parameter	**Setting**	
board_tl_gamma0_a1_a2	[0 4.114e-4 2.547e-4]	
board_tl_tau	6.191E-03	ns/mm
board_Z_c	110	Ohm
z_bp (TX)	151	mm
z_bp (NEXT)	72	mm
z_bp (FEXT)	72	mm
z_bp (RX)	151	mm