

COM 2.76 Update

Richard Mellitz, Samtec

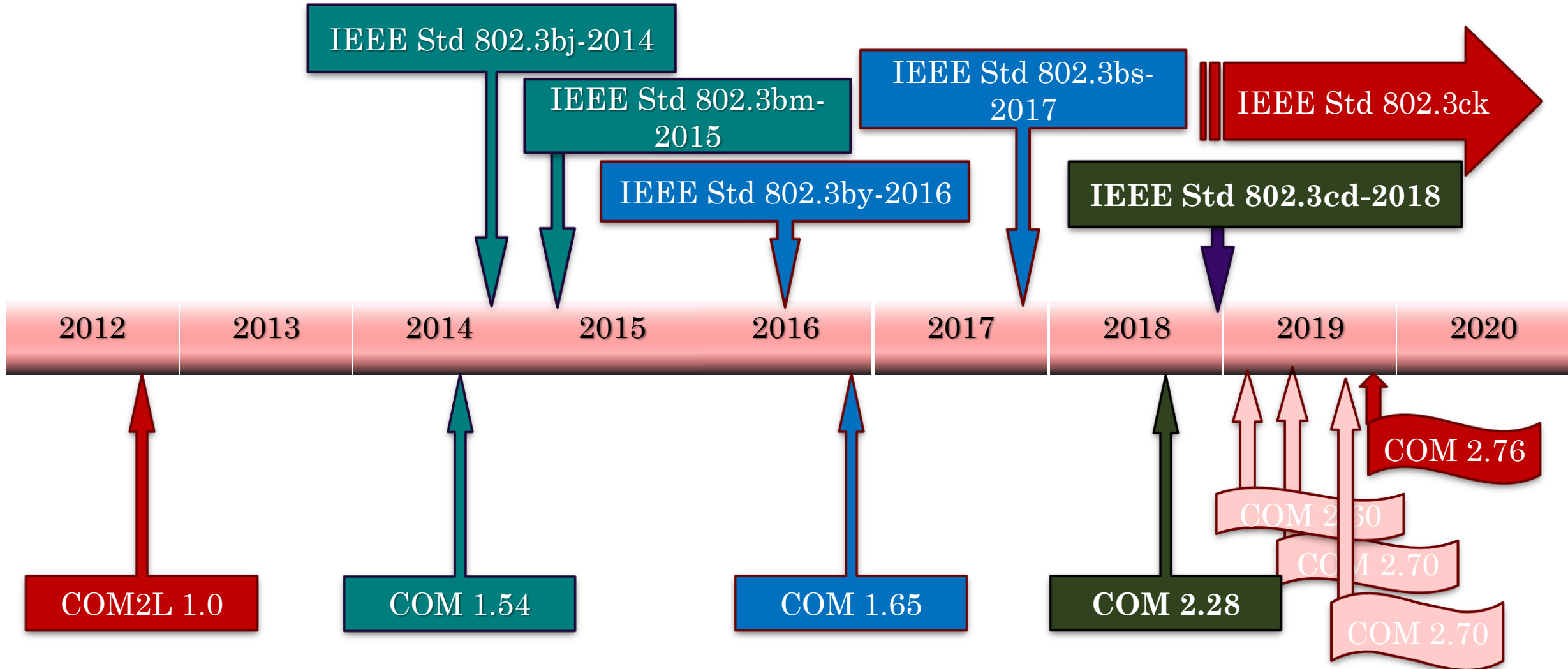
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IEEE 802.3 100 Gb/s, 200 Gb/s, and 400 Gb/s Electrical Interfaces Task Force Ad Hoc

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COM Timeline



Motivation

- ❑ Power limit (RSS) for tail DFE taps - kasapi_3ck_02_1119
- ❑ Motion accepted for baseline (minutes_3ck_1119_unconfirmed)

Power Limit (RSS) for Tail DFE Taps Added

- ❑ Syntax
- ❑ B_float_RSS_MAX
 - RSS tail tap limit
- ❑ N_tail_start
 - UI start for tail tap RSS limit

Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
B_float_RSS_MAX	0.03	RSS tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN parameters (v2.73)		
f_v	0.723	*Fb
f_f	0.723	*Fb
f_n	0.723	*Fb
f_2	39.844	GHz
A_ft	0.600	V
A_nt	0.600	V
heck_3ck_03b_0319	Adopted Mar 2019	kasapi_3ck_02_1119
walker_3ck_01d_0719	Adopted July 2019	Adopted Nov 2019
result of R_d=50		under consideration
benartsi_3ck_01a_0719	require COM 2.72 or later	
mellitz_3ck_03_0919	mellitz_3ck_03_1119	

Specification Related Fixes

- ❑ C_1 was instantiated as C_0 in r275. This was fixed

Non-specification Related and Reporting Fixes

- ❑ go back to reporting channel IL results
(`output_args.IL_dB_channel_only_at_Fnq`) with board added
`read_s4p_files` (as in r270)
- ❑ test for `output_args` for `isfield(chdata(1),'sdd22_raw')` so will work
with older spreadsheets
- ❑ Change divisor for ICN and FOM_ILD to `param.f2` from `param.fb`, may
raise ICN and ILD value reported in r275
- ❑ fixed rounding problem in reporting of loss at `f_nq`

KR Spreadsheet Suggestion

Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]
L_s	[0.12, 0.12]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.415	V	
A_fe	0.415	V	
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.12]		[min:step:max]
c(-3)	[-0.06:0.02: 0]		[min:step:max]
c(1)	[-0.2:0.05:0]		[min:step:max]
N_b	12	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.2		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
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
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_KR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	1.00E-04	
T_r	6.16E-03	ns
FORCE_TR	1	logical
TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	3000	
beta_x	2.3407E+09	
rho_x	0.19	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	12	UI
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	8.2E-09	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	

Table 93A-3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
benartsi_3ck_01_0119 & mellitz_3ck_01_0119		
Table 92-12 parameters		
Parameter	Setting	
board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	110.3	mm
z_bp (NEXT)	110.3	mm
z_bp (FEXT)	110.3	mm
z_bp (RX)	110.3	mm
C_0	[0.29e-4]	nF
C_1	[0.19e-4]	nF
Include PCB	0	logical
Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps
B_float_RSS_MAX	0.03	rss tail tap limit
N_tail_start	25	(UI) start of tail taps limit
ICN parameters		
f_v	0.723	*Fb
f_f	0.723	*Fb
f_n	0.723	*Fb
f_2	39.844	GHz
A_ft	0.600	V
A_nt	0.600	V
heck_3ck_03b_0319	Adopted Mar 2019	kasapi_3ck_02_1119
walker_3ck_01d_0719	Adopted July 2019	Adopted Nov 2019
result of R_d=50		under consideration
benartsi_3ck_01a_0719	no used for KR	
mellitz_3ck_03_0919		

CR Spreadsheet Suggestion

Table 93A-1 parameters				I/O control			Table 93A-3 parameters		
Parameter	Setting	Units	Information				Parameter	Setting	Units
f_b	53.125	GBd		DIAGNOSTICS	1	logical	package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
f_min	0.05	GHz		DISPLAY_WINDOW	1	logical	package_tl_tau	6.141E-03	ns/mm
Delta_f	0.01	GHz		CSV_REPORT	1	logical	package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]	RESULT_DIR	.\results\100GEL_CR_{date}\		benartsi_3ck_01_0119 & mellitz_3ck_01_0119		
L_s	[0.12, 0.12]	nH	[TX RX]	SAVE_FIGURES	0	logical	Table 92-12 parameters		
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]	Port Order	[1 3 2 4]		Parameter	Setting	
z_p select	[1 2]		[test cases to run]	RUNTAG	CR_eval_		board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	1 dB / in
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]	COM_CONTRIBUTION	0	logical	board_tl_tau	5.790E-03	ns/mm
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]	Operational			board_Z_c	100	Ohm
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]	COM Pass threshold	3	dB	z_bp (TX)	110.3	mm
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]	ERL Pass threshold	10	dB	z_bp (NEXT)	110.3	mm
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]	DER_0	1.00E-04		z_bp (FEXT)	110.3	mm
R_0	50	Ohm		T_r	6.16E-03	ns	z_bp (RX)	110.3	mm
R_d	[50 50]	Ohm	[TX RX]	FORCE_TR	1	logical	C_0	[0.29e-4]	nF
A_v	0.415	V	vp/vf=.694	TDR and ERL options			C_1	[0.19e-4]	nF
A_fe	0.415	V	vp/vf=.694	TDR	1	logical	Include PCB	1	logical
A_ne	0.608	V		ERL	1	logical	Floating Tap Control		
L	4			ERL_ONLY	0	logical	N_bg	3	0 1 2 or 3 groups
M	32			ERL_TDR	0.01	ns	N_bf	3	taps per group
filter and Eq				N	3000		N_f	40	UI span for floating taps
f_r	0.75	*fb		beta_x	2.3407E+09		bmaxg	0.2	max DFE value for floating taps
c(0)	0.54		min	rho_x	0.21		B_float_RSS_MAX	0.03	RSS tail tap limit
c(-1)	[-0.34:0.02:0]		[min:step:max]	fixture delay time	[0 0]	[port1 port2]	N_tail_start	25	(UI) start of tail taps limit
c(-2)	[0:0.02:0.12]		[min:step:max]	TDR_W_TXPKG	0		ICN parameters		
c(-3)	[-0.06:0.02: 0]		[min:step:max]	N_bx	12	UI	f_v	0.723	*Fb
c(1)	[-0.2:0.05:0]		[min:step:max]	Receiver testing			f_f	0.723	*Fb
N_b	12	UI		RX_CALIBRATION	0	logical	f_n	0.723	*Fb
b_max(1)	0.85			Sigma BBN step	5.00E-03	V	f_2	39.844	GHz
b_max(2..N_b)	0.2			Noise, jitter			A_ft	0.600	V
g_DC	[-20:1:0]	dB	[min:step:max]	sigma_RJ	0.01	UI	A_nt	0.600	V
f_z	21.25	GHz		A_DD	0.02	UI	heck_3ck_03b_0319	Adopted Mar 2019	kasapi_3ck_02_1119
f_p1	21.25	GHz		eta_0	9.00E-09	V^2/GHz	walker_3ck_01d_0719	Adopted July 2019	Adopted Nov 2019
f_p2	53.125	GHz		SNR_TX	32	dB	result of R_d=50		under consideration
g_DC_HP	[-6:1:0]		[min:step:max]	R_LM	0.95		benartsi_3ck_01a_0719	require COM 2.72 or later	
f_HP_PZ	0.6640625	GHz					mellitz_3ck_03_0919	mellitz_3ck_03_1119	

Thank You!

Reference data some older COM versions

COM 2.75 highlights

- ❑ For ERL computation:
 - Corrected delay TDR and ERL adjustment for Gaussian edge
 - No syntax change
 - May increase ERL by a few tens of dB
- ❑ For CR, added board added C_0 and C_1 syntax
 - http://www.ieee802.org/3/ck/public/19_09/benartsi_3ck_01a_0919.pdf
- ❑ Miscellaneous: These do not affect the COM computations
 - fixed version syntax problem
 - In output_args RL report
 - fixed eye width computation
 - problem: crosstalk for eye width was not included in previous versions
 - removed eye width report if doing a Rx calibration
 - Added syntax for ICN calculation
 - f_f, f_n, f_2, A_ft, A_nt
 - Use to use Av...etc. and other COM computation parameters
 - fixed PSXTK graph

In COM function get_TDR TDR, Transmitter edge delay is compensated. This which was introduced in the Gaussian edge filter

- ❑ For ERL computation: Transition time filter in COM added 3 times the Gaussian edge rate

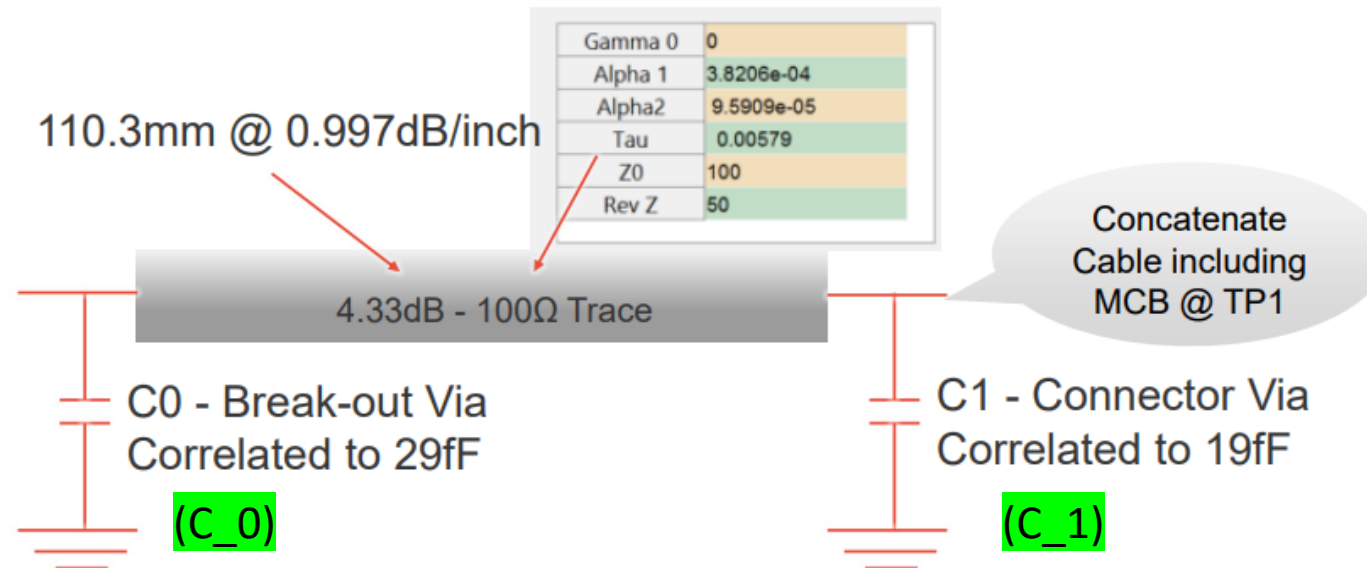
```
% add delay 500 ps for TDR and 3 times Gaussian transition time  
% (makes Gaussian edge somewhat causal)  
H_t = exp( -2*(pi*f9*(tr)/1.6832).^2 ) .* exp(-  
(1j)*2*pi*f9*TDR_results.delay/1e-9) .* exp(-1j*2*pi*f9*tr*3) ;
```

- ❑ Code introduced in V2.75 accommodates for this delay in gating functions G_{rr} and G_{loss} in ERL (eq 93A-61 and 93A-62)
 - Acknowledgement to Adam Healey

For CR, added board added C_0 and C_1 syntax

Model to be Inserted as “Include PCB” - Reminder

http://www.ieee802.org/3/ck/public/19_09/benartsi_3ck_01a_0919.pdf



Better ICN reporting control

COM keyword	ICN CL 83 parameter
f_f	f_{ft}
f_n	f_{nt}
f_2	Range f_n
A_ft	A_{ft}
A_nt	A_{nt}

85.10.7 Cable assembly integrated crosstalk noise (ICN)

In order to limit multiple disturber crosstalk noise at a receiver, the cable assembly integrated crosstalk noise (ICN) is specified in relationship to the measured insertion loss. ICN is calculated from the MDFEXT and MDNEXT. Given the multiple disturber near-end crosstalk loss $MDNEXT_{loss}(f)$ and multiple disturber far-end crosstalk loss $MDFEXT_{loss}(f)$ measured over N uniformly-spaced frequencies f_n spanning the frequency range 50 MHz to 10000 MHz with a maximum frequency spacing of 10 MHz, the RMS value of the integrated crosstalk noise shall be determined using Equation (85–28) through Equation (85–32). The RMS crosstalk noise is characterized at the output of a specified receive filter utilizing a specified transmitter waveform and the measured multiple disturber crosstalk transfer functions. The transmitter and receiver filters are defined in Equation (85–28) and Equation (85–29) as weighting functions to the multiple disturber crosstalk in Equation (85–30) and Equation (85–31). The sinc function is defined by $\text{sinc}(x) = \sin(\pi x)/(\pi x)$.

Define the weight at each frequency f_n using Equation (85–28) and Equation (85–29).

$$W_{nt}(f_n) = (A_{nt}^2/f_b) \text{sinc}(f_n/f_b)^2 \left[\frac{1}{1 + (f_n/f_{nt})^4} \right] \left[\frac{1}{1 + (f_n/f_r)^8} \right] \quad (85-28)$$

$$W_{ft}(f_n) = (A_{ft}^2/f_b) \text{sinc}(f_n/f_b)^2 \left[\frac{1}{1 + (f_n/f_{ft})^4} \right] \left[\frac{1}{1 + (f_n/f_r)^8} \right] \quad (85-29)$$

where the equation parameters are given in Table 85–11.

Note that the 3 dB transmit filter bandwidths f_{nt} and f_{ft} are inversely proportional to the 20% to 80% rise and fall times T_{nt} and T_{ft} respectively. The constant of proportionality is 0.2365 (e.g., $T_{nt}f_{nt} = 0.2365$; with f_{nt} in hertz and T_{nt} in seconds). In addition, f_r is the 3 dB reference receiver bandwidth, which is set to 7.5 GHz.

COM 2.70 highlights

❑ Floating DFE taps

- http://www.ieee802.org/3/ck/public/19_05/kareti_3ck_01b_0519.pdf
- http://www.ieee802.org/3/ck/public/19_05/heck_3ck_01_0519.pdf
- http://www.ieee802.org/3/ck/public/19_05/mellitz_3ck_01c_0519.pdf

❑ Coil Circuit Improving C_d Termination – Adam Healey

❑ Informative Eye Width Reported for C2M

KR Configuration Spreadsheet Instance So Far

Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]
L_s	[0.12, 0.12]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.415	V	
A_fe	0.415	V	
A_ne	0.608	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.54		min
c(-1)	[-0.34:0.02:0]		[min:step:max]
c(-2)	[0:0.02:0.12]		[min:step:max]
c(-3)	[-0.06:0.02: 0]		[min:step:max]
c(1)	[-0.2:0.05:0]		[min:step:max]
N_b	12	UI	
b_max(1)	0.85		
b_max(2..N_b)	0.2		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
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
CSV_REPORT	1	logical
RESULT_DIR	.\results\100GEL_KR_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	KR_eval_	
COM_CONTRIBUTION	0	logical
Operational		
COM Pass threshold	3	dB
ERL Pass threshold	10.5	dB
DER_0	1.00E-04	
T_r	6.16E-03	ns
FORCE_TR	1	logical

TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	3000	
beta_x	2.3407E+09	
rho_x	0.19	
fixture delay time	[0 0]	[port1 port2]
TDR_W_TXPKG	0	
N_bx	12	UI
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
Noise, jitter		
sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	8.2E-09	V^2/GHz
SNR_TX	33	dB
R_LM	0.95	

Table 93A-3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm

benartsi_3ck_01_0119 & mellitz_3ck_01_0119		
Table 92-12 parameters		
Parameter	Setting	
board_tl_gamma0_a1_a2	[0 3.8206e-04 9.5909e-05]	
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	110.3	mm
z_bp (NEXT)	110.3	mm
z_bp (FEXT)	110.3	mm
z_bp (RX)	110.3	mm
C_0	[0.29e-4]	nF
C_1	[0.19e-4]	nF
Include PCB	0	logical

Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	UI span for floating taps
bmaxg	0.2	max DFE value for floating taps

cable assemblies require this for each HCB

ICN parameters (v2.73)		
f_f	12.919	
f_n	12.919	
f_2	39.844	
A_ft	0.600	
A_nt	0.600	
heck_3ck_03b_0319	Adopted Mar 2019	
walker_3ck_01d_0719	Adopted July 2019	
result of R_d=50		
benartsi_3ck_01a_0719	no used for KR	
mellitz_3ck_03_0919		
under consideration		

Package Proposal with LC Termination Compensation (single sided model)

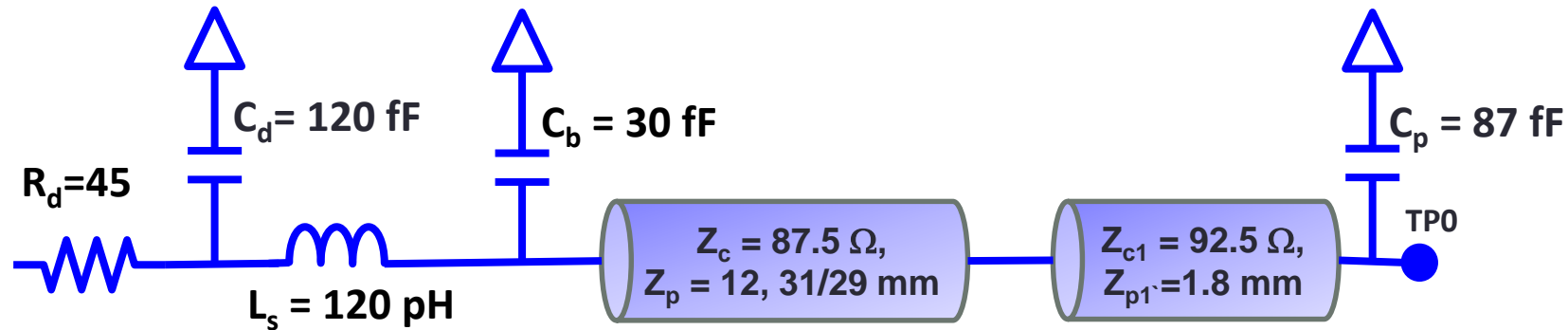


Table 93A-1 parameters

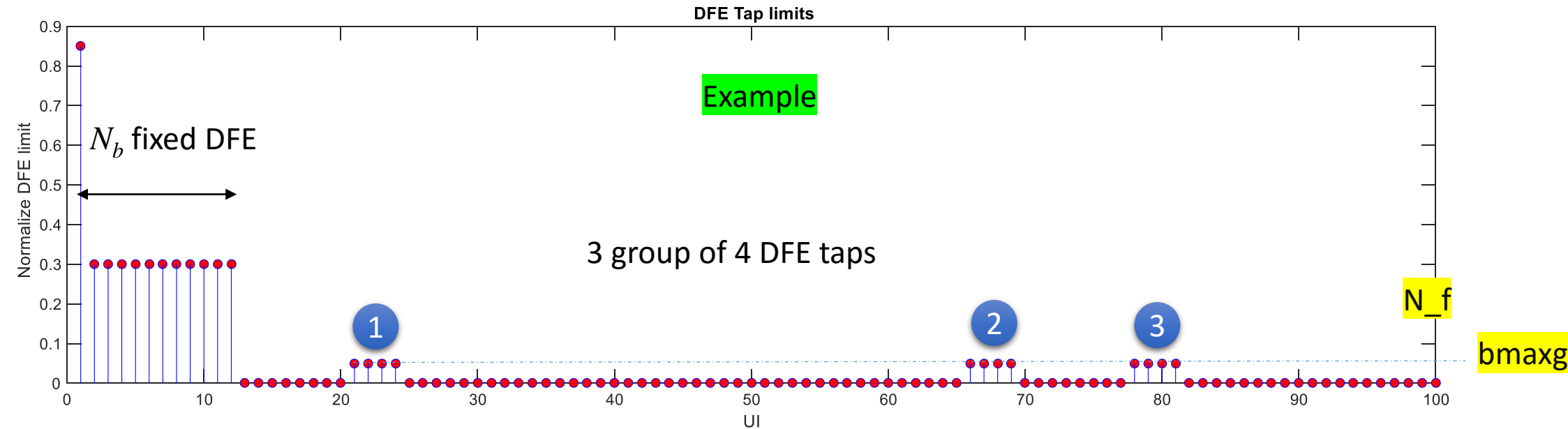
Parameter	Setting	Units	Information
C_d	[1.2e-4 1.2e-4]	nF	[TX RX]
L_s	[0.12, 0.12]	nH	[TX RX]
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]
z_p select	[1 2]		[test cases to run]
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]
z_p (RX)	[12 2990; 1.8 1.8]	mm	[test cases]
C_p	[0.87e-4 0.87e-4]	nF	[TX RX]
R_0	50	Ohm	
R_d	[45 45]	Ohm	[TX RX]
A_v	0.39	V	vp/vf=.694
A_fe	0.39	V	vp/vf=.694
A_ne	0.578	V	

Table 93A-3 parameters

Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 0.0009909 0.0002772]	
package_tl_tau	6.141E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm

Parameters for Floating DFE Taps and Example Values Maybe Further Refined

Floating Tap Control		
N_bg	3	0 1 2 or 3 groups
N_bf	4	taps per group
N_f	100	UI span for floating taps
bmaxg	0.1	max DFE value for floating taps



COM 2.60 and Earlier Highlights

- ❑ Include package in ERL computation for C2M COM
- ❑ Simplify 4 element to 2 element transmission line package model
- ❑ Max DER at COM limit now reported
- ❑ Computation speed up
- ❑ Rx FFE (vector forced) for C2M
 - http://www.ieee802.org/3/ck/public/18_07/mellitz_3ck_01_0718.pdf Slide 7
 - http://www.ieee802.org/3/ck/public/adhoc/oct03_18/mellitz_3ck_adhoc_01_100318.pdf Slide 10