Annex 93A Package/Die Load Proposal and COM 3.70 with Exploratory Features including Package/Die Load Ladder

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Reference Nomenclature

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force
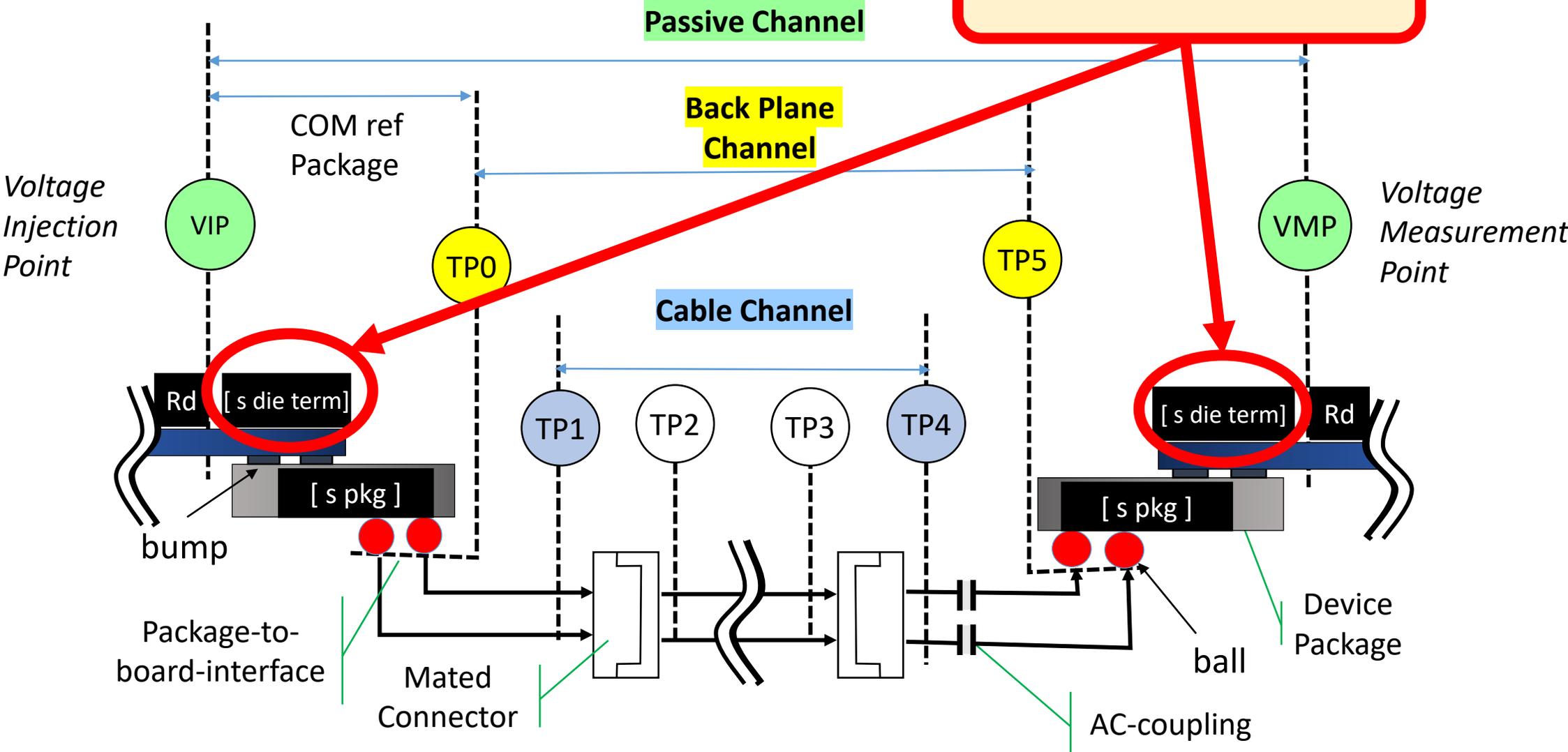
IEEE802.3 ck Package Model (COM 3.4) (single sided representation)
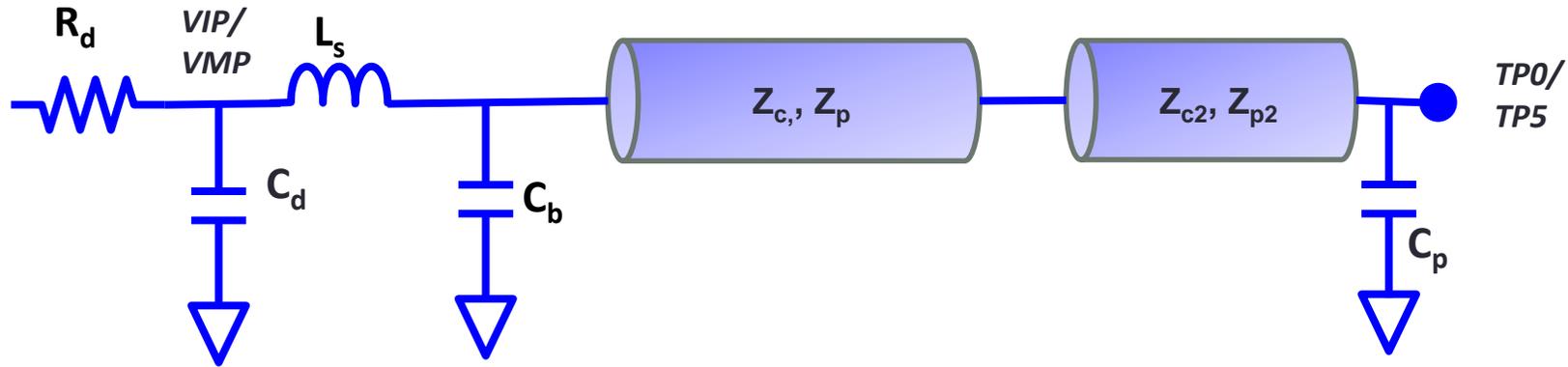
Table 93A-1 parameters

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]		[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	[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

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force

Replace Cd and Ls with a Ladder
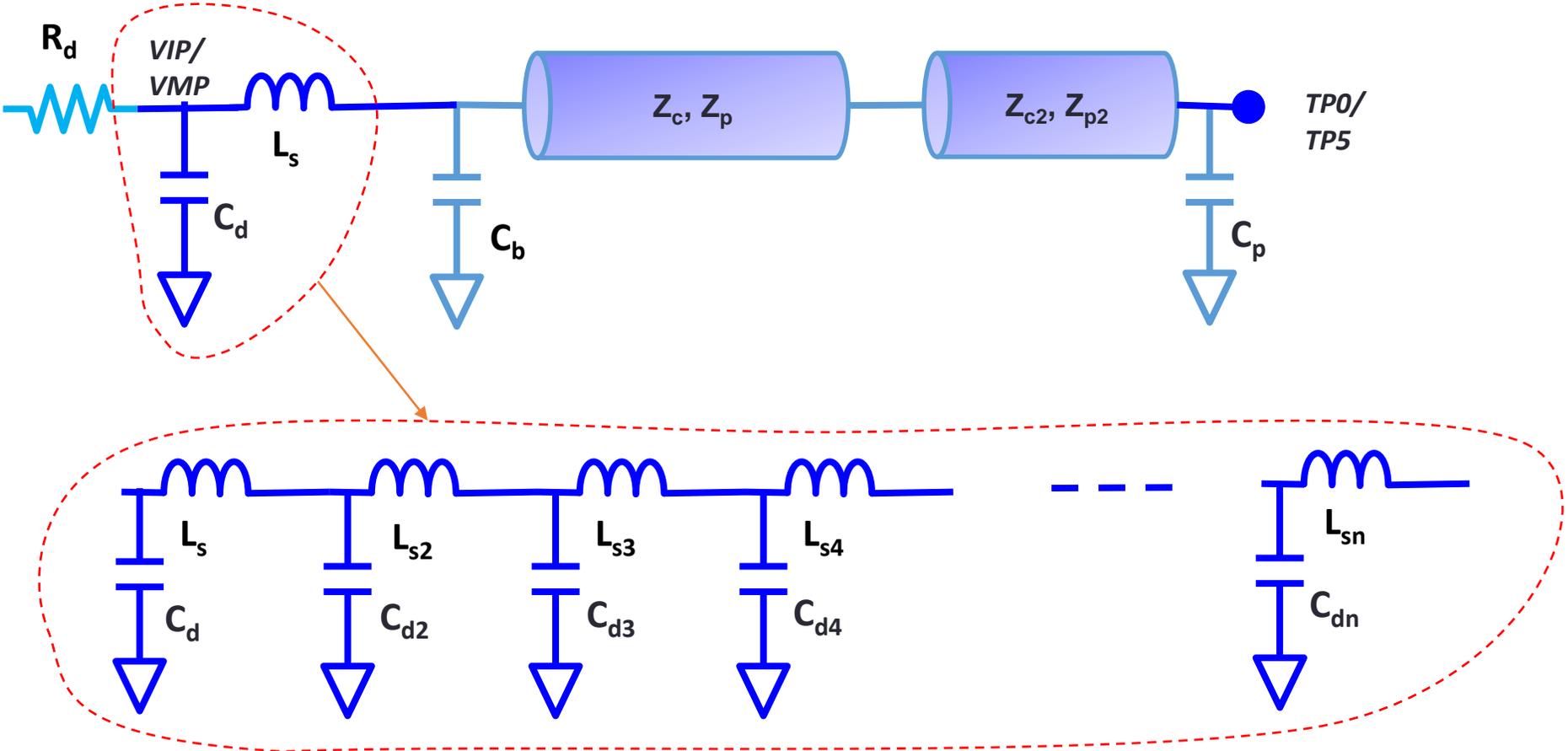
C_d	[Cd Cd2 Cd3 Cd4 ... Cdn ; Cd Cd2 Cd3 Cd4 ... Cdn]	nF	[TX ; RX]
L_s	[Ls Ls2 Ls3 Ls4 ... Lsn; Ls Ls2 Ls3 Ls4 ... Lsn]	nH	[TX ; RX]

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force

Figure 93A–2—Reference package model
Proposal

Transmitter reference package

$S^{(d)} \rightarrow S^{(s)} \rightarrow S^{(d2)} \rightarrow S^{(s2)} \rightarrow \cdots \rightarrow S^{(dn)} \rightarrow S^{(sn)} \rightarrow S^{(b)} \rightarrow S^{(l)} \rightarrow S^{(l2)} \rightarrow S^{(p)}$

Device termination

Receiver reference package

$S^{(p)} \rightarrow S^{(l2)} \rightarrow S^{(l)} \rightarrow S^{(b)} \rightarrow S^{(sn)} \rightarrow S^{(dn)} \rightarrow \cdots \rightarrow S^{(s2)} \rightarrow S^{(d2)} \rightarrow S^{(s)} \rightarrow S^{(d)}$

Device termination
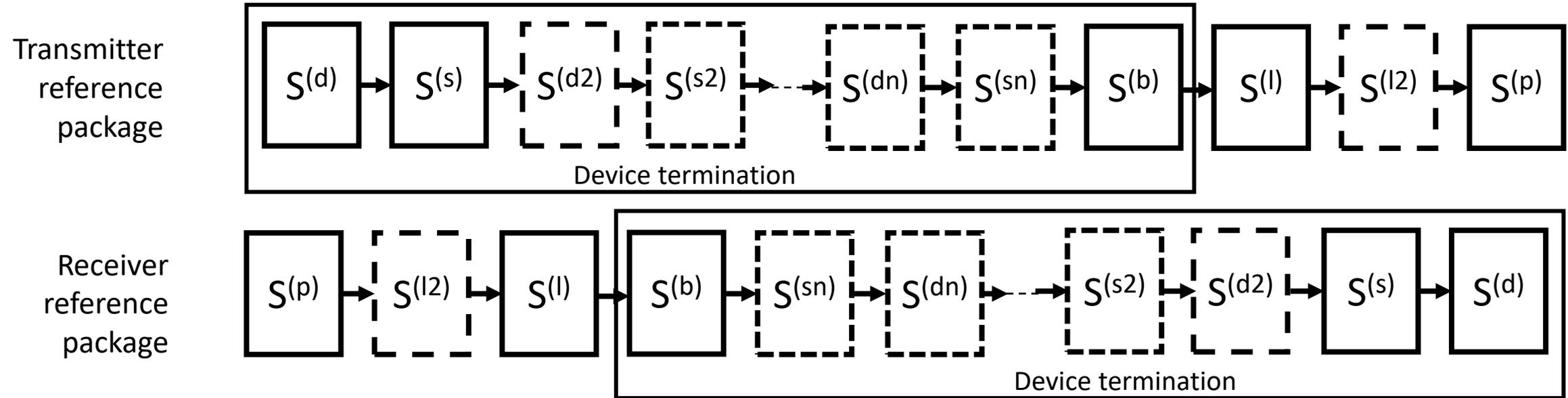
$S^{(d)}$ = device capacitance S-parameter

$S^{(s)}$ = device series inductance S-parameter

$S^{(d2)}$ = device capacitance 2 S-parameter

$S^{(s2)}$ = device series inductance 2 S-parameter

$S^{(dn)}$ = n^{th} device capacitance S-parameter

$S^{(sn)}$ = n^{th} device series inductance S-parameter

$S^{(b)}$ = bump capacitance S-parameter

$S^{(l)}$ = package transmission line S-parameter

$S^{(l2)}$ = package transmission line 2 S-parameter

$S^{(p)}$ = package capacitance S-parameter

Note: PMD calls out which blocks are included in the package model

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force

Example: T-coil ladder data in li_3df_02_220316

50 Ω   VIP/ VMP   130 pH   150 pH   140 pH

Z_c=87.5 Ω, Z_p= 12 mm 30 mm

Z_{c1}=82.5 Ω, Z_{p1}=1.8 mm

TP0/ TP5

40 fF   90 fF   110fF   30 fF   40 fF
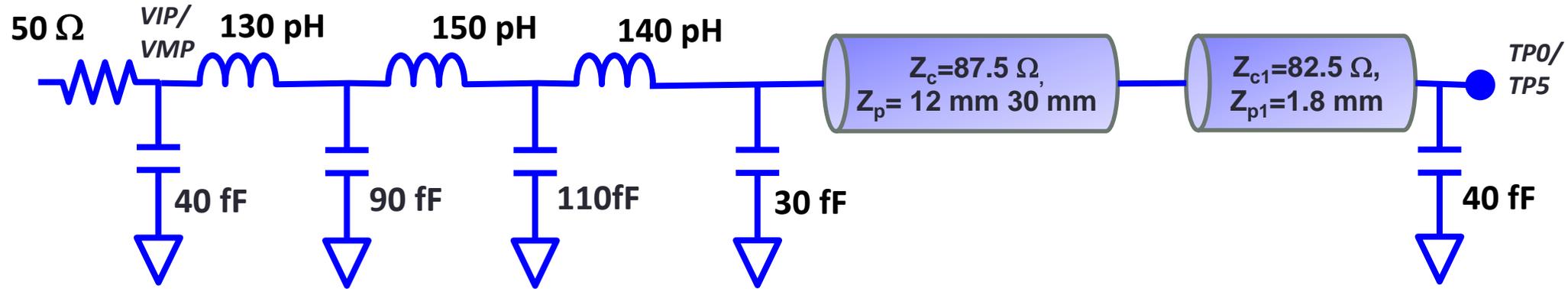
C_d	[0.4e-4 0.9e-4 1.1e-4 ; 0.4e-4 0.9e-4 1.1e-4]	nF	[TX RX]	
L_s	[0.13 0.15 0.14; 0.13 .15 0.14]	nH	[TX RX]	
C_b	[0.3e-4 0.3e-4]	nF	[TX RX]	
z_p select	[1 2 3 4]		[test cases to run]	
z_p (TX)	[12 31; 1.8 1.8]	mm	[test cases]	
z_p (NEXT)	[12 29; 1.8 1.8]	mm	[test cases]	
z_p (FEXT)	[12 31; 1.8 1.8]	mm	[test cases]	
z_p (RX)	[12 29; 1.8 1.8]	mm	[test cases]	
C_p	[0.4e-4 0.4e-4]	nF	[TX RX]	
R_0	50	Ohm		

Parameter	Setting
package_tl_gamma0_a1_a2	[0 8.9e-4 1.55e-4]
package_tl_tau	6.14E-03
package_Z_c	[87.5 87.5 ; 92.5 92.5]

Initially parameters and number of element should be TBD for the baseline

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force

Additional Exploratory COM Capability: Expanded Tx FFE taps and minor improvements

❑ Changed output
- total_IL_wpkgs_dB_at_Fnq   to   VIP_to_VIM_IL_dB_at_Fnq

❑ Fix .3bj backward compatibility issue.
- No change to prior configuration spreadsheets.
  - i.e., backward compatible

❑ Expands syntax for Tx FFE to any number of taps
- Syntax c(n) where n is an a positive or negative non-zero integer.
- Rules: all tap ranges up to n must be specified. Set c(n) to zero if tap is not used.
- Example
  - C(-4) = [0.1 ; 0.05 ; 0]
  - C(-3)=0
  - C(-2)=[0.1 ; 0.05 ; 0]
  - C(-1)=0

❑ Exploratory implementation of ran_3ck_03_0122 for SNR_Tx
- By setting keyword, SNR_TXwC0, to 1 (default is 0 if not specified)

C2M like COM Comparison for 14 dB (@ 53.25 GHz) Channel

C2M WITH T-COIL LADDER EXAMPLE MODEL
C2M WITH .3CK PACKAGE MODEL

		.3ck die termination	ladder termination	delta
pkg 1 12 mm	VEC (dB)	41.2	10.8	-30.3
	EH (mV)	0.4	15.9	15.5
	COM (dB)	0.1	2.95	2.9
pkg 2 30 mm	VEC (dB)	18.2	10.1	-8.1
	EH (mV)	4.1	11.7	7.6
	COM (dB)	1.1	3.3	2.1

A .3ck model with cd=70 fF, Ls=100 pH, and Cb=23 fF has about the same VEC, EH, and COM for the ladder model above.
A 70 fF die load seems quite small.
More work need here.

PCB A Conn. M+F PCB B

IEEE P802.3df 200 Gb/s, 400 Gb/s, 800 Gb/s, and 1.6 Tb/s Ethernet Task Force

COM tables follow

9
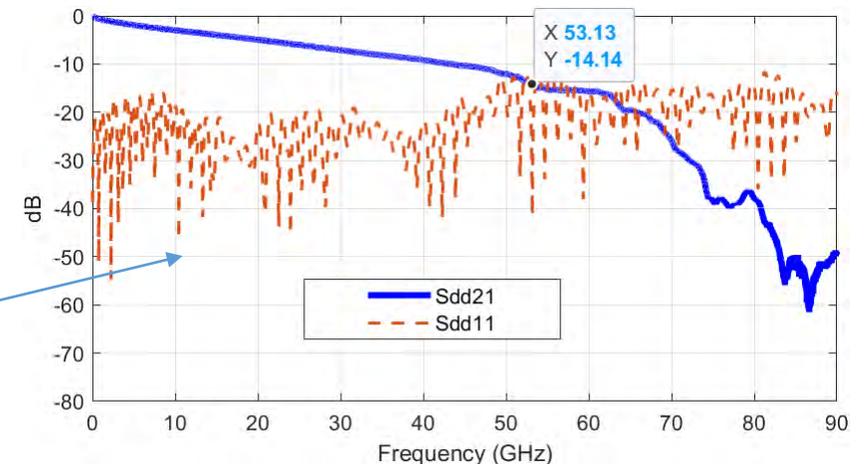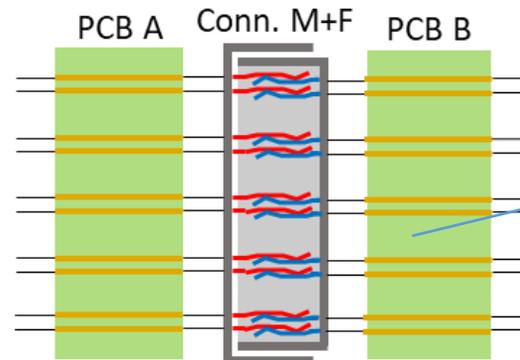
COM for C2M with T-Coil ladder example model

Table 93A-1 parameters

Parameter	Setting	Units	Information
f_b	106.25	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[0.4e-4 0.9e-4 1.1e-4 ; 0 0 0]	nF	[TX RX]
L_s	[.12 .15 .14; 0 0 0]	nH	[TX RX]
C_b	[.3e-4 0]	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	[0.5e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.413	V	vp/vf=
A_fe	0.413	V	vp/vf=
A_ne	0.608	V	
L	4		
M	32		

filter and Eq

Parameter	Setting	Units	Information
f_r	0.75	*fb	
c(0)	0.65		min
c(-1)	[-0.2:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.1:.02:0]		[min:step:max]
c(1)	[-0.2:0.02:0]		[min:step:max]
N_b	9	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	0.15		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	-0.15		As/dfe2..N_b
g_DC	[-13:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	

Receiver testing

Parameter	Setting	Units	
RX_CALIBRATION	0	logical	
Sigma BBN step	5.00E-03	V	

I/O control

DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\c2m106_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M TP1a	
COM_CONTRIBUTION	0	logical

Operational

ERL Pass threshold	10	dB
VEC Pass threshold	12.5	db
DER_0	1.00E-05	
T_r	2.35E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	1	mV
PHY_type	C2M	
EH_min	10	Value
EH_max	1000	Value
T_O	50	mUI
samples_for_C2M	100	samples/UI
Dynamic TXFFE	1	
FloatingDFE_Development	1	
EW	1	

TDR and ERL options

TDR	1	logical
ERL	1	logical
ERL_ONLY	0	logical
TR_TDR	0.01	ns
N	6000	
TDR_Butterworth	1	logical
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	
N_bx	8	UI
fixture delay time	[0 0.2e-9]	
Tukey_Window	1	

Noise, jitter

sigma_RJ	0.01	UI
A_DD	0.02	UI
eta_0	2.05E-08	V^2/GHz
SNR_TX	32.5	dB
R_LM	0.95	

Table 93A–3 parameters

Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 8.4e-4 1.1e-4]	2.75 dB /in at 56
package_tl_tau	6.14E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm

Parameter	Setting	
board_tl_gamma0_a1_a2	[0 6.44084e-4 3.6036e-05]	1.5 db/in @ 56(
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	50	mm
z_bp (NEXT)	0	mm
z_bp (FEXT)	50	mm
z_bp (RX)	0	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	**0**	**logical**

Seletions (rectangle, gaussian,dual_rayleigh,triangle

Histogram_Window_Weight	gaussian	
QL	2.5	

ICN parameters

f_v	0.278	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V

Floating Tap Control

N_bg	0	0 1 2 or 3 group
N_bf	3	taps per group
N_f	40	span for floating
bmaxg	0.05	DFE value for float
B_float_RSS_MAX	0.02	rss tail tap limit
N_tail_start	9	l) start of tail taps

COM for C2M with .3ck package model

Table 93A-1 parameters

Parameter	Setting	Units	Information
f_b	106.25	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]
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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	[0.5e-4 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.408	V	vp/vf=
A_fe	0.408	V	vp/vf=
A_ne	0.608	V	
L	4		
M	32		

filter and Eq

Parameter	Setting	Units	Information
f_r	0.75	*fb	
c(0)	0.65		min
c(-1)	[-0.2:0.02:0]		[min:step:max]
c(-2)	[0:.02:0.1]		[min:step:max]
c(-3)	[-0.1:.02:0]		[min:step:max]
c(1)	[-0.2:0.02:0]		[min:step:max]
N_b	9	UI	
b_max(1)	0.85		As/dffe1
b_max(2..N_b)	0.15		As/dfe2..N_b
b_min(1)	0		As/dffe1
b_min(2..N_b)	-0.15		As/dfe2..N_b
g_DC	[-13:1:0]	dB	[min:step:max]
f_z	42.5	GHz	
f_p1	42.5	GHz	
f_p2	106.25	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	1.0625	GHz	

Receiver testing

Parameter	Setting	Units	
RX_CALIBRATION	0	logical	
Sigma BBN step	5.00E-03	V	

I/O control

DIAGNOSTICS	1	logical
DISPLAY_WINDOW	1	logical
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SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	C2M TP1a	
COM_CONTRIBUTION	0	logical

Operational

ERL Pass threshold	10	dB
VEC Pass threshold	12.5	db
DER_0	1.00E-05	
T_r	2.35E-03	ns
FORCE_TR	1	logical
Min_VEO_Test	1	mV
PHY_type	C2M	
EH_min	10	Value
EH_max	1000	Value
T_O	50	mUI
samples_for_C2M	100	samples/UI
Dynamic TXFFE	1	
FloatingDFE_Development	1	
EW	1	

TDR and ERL options

TDR	1	logical
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TDR_W_TXPKG	0	
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fixture delay time	[0 0.2e-9]	
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package_tl_tau	6.14E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5]	Ohm

Parameter	Setting	
board_tl_gamma0_a1_a2	[0 6.44084e-4 3.6036e-05]	1.5 db/in @ 56G
board_tl_tau	5.790E-03	ns/mm
board_Z_c	100	Ohm
z_bp (TX)	50	mm
z_bp (NEXT)	0	mm
z_bp (FEXT)	50	mm
z_bp (RX)	0	mm
C_0	[0.2e-4 0]	nF
C_1	[0.2e-4 0]	nF
Include PCB	0	logical

Seletions (rectangle, gaussian,dual_rayleigh,triangle

Histogram_Window_Weight	gaussian	
QL	2.5	

ICN parameters

f_v	0.278	Fb
f_f	0.278	Fb
f_n	0.278	Fb
f_2	79.688	GHz
A_ft	0.450	V
A_nt	0.450	V

Floating Tap Control

N_bg	0	0 1 2 or 3 groups
N_bf	3	taps per group
N_f	40	span for floating tap
bmaxg	0.05	DFE value for floating
B_float_RSS_MAX	0.02	rss tail tap limit
N_tail_start	9	l) start of tail taps lin

Thank You!