COM PARAMETERS FOR ADAPTING TO CHANNEL DRIVING POINT IMPEDANCE

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Comments

- Correction and comments in mellitz_3cd_01b_1216_elect_adhoc from Yasuo Hidaka

Background

- COM computation time has increased by 7 to 10 times
  - All ready 2 more loops were added to each computation for *c(-2)* and g_{DC2}
- hidaka_3cd_01_1116.pdf suggests a more COM computation required for package parameter combinations
  - Iterative COM combination could go to up at least 6 fold
  - Analysis only done on posted channels.
  - Is this enough to cover all possible line card impedance combination?
- mellitz_3cd_01_1116.pdf suggests a using the channel port impedance to set package parameters use in COM
  - Keeps the number of COM computations the same
  - Flexible enough to cover many more line cards
  - We will label this the adaptive package method.

Suggested Changes for Channel Configured Package COM Parameters

Draft 1.1

Table 137–5—COM parameter values *(continued)*

Parameter	Symbol	Value	Units
Device package model Single-ended device capacitance Transmission line length, Test 1 Transmission line length, Test 2 Single-ended package capacitance at package-to-board interface Package 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 Ω
Single-ended reference resistance	R_0	50	Ω
Single-ended termination resistance	R_d	55	Ω
Receiver 3 dB bandwidth	f_r	$0.75 \times f_b$	GHz
Transmitter equalizer, minimum cursor coefficient	$c(0)$	0.6	—
Transmitter equalizer, 1st pre-cursor coefficient Minimum value	$c(-1)$	 –0.25	
	f_{p2}	f_b	GHz
Transmitter differential peak output voltage Victim Far-end aggressor Near-end aggressor	 A_v A_{fe} A_{ne}	 0.45 0.45 0.63	 V V V
Number of signal levels	L	4	—

Suggestion

Table 137–5—COM parameter values *(continued)*

Parameter	Symbol	Value	Units
Device package model Single-ended device capacitance Transmission line length, Test 1 Transmission line length, Test 2 Single-ended package capacitance at package-to-board interface Package 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~~ 83.7, 102.3	 nF mm mm nF Ω
Single-ended reference resistance	R_0	50	Ω
Single-ended termination resistance	R_d	~~55~~ 45, 55	Ω
Receiver 3 dB bandwidth	f_r	$0.75 \times f_b$	GHz
Transmitter equalizer, minimum cursor coefficient	$c(0)$	0.6	—
Transmitter equalizer, 1st pre-cursor coefficient Minimum value	$c(-1)$	 –0.25	
	f_{p2}	f_b	GHz
Transmitter differential peak output voltage Victim Far-end aggressor Near-end aggressor	 A_v A_{fe} A_{ne}	 ~~0.45~~ 0.4 0.44 ~~0.45~~ 0.4 0.44 ~~0.63~~ 0.58 0.64	 V V V

Index package terms

Symbol	Value	Units
C_d	1.8×10^{-4}	nF
z_p	12	mm
z_p	30	mm
C_p	1.1×10^{-4}	nF
Z_c	~~90~~ 83.7, 102.3	Ω
R_0	50	Ω
R_d	~~55~~ 45, 55	Ω
A_v	~~0.45~~ 0.4 0.44	V
A_{fe}	~~0.45~~ 0.4 0.44	V
A_{ne}	~~0.63~~ 0.58 0.64	V

$Z_c(1)$ $Z_c(2)$

$R_d(1)$ $R_d(2)$

$A_v(1)$ $A_v(2)$

$A_{fe}(1)$ $A_{fe}(2)$

$A_{ne}(1)$ $A_{ne}(2)$

*Av(2) and Afe(2) of 0.43 were chosen for the COM computation runs.

* Correction from Yasuo Hidaka

Decision (after comments for Yasuo Hidaka)

1. Use 1.4 dB of loss for test fixture

or

2. Use 1.6 dB of loss for A_v and A_{fe} and 1.2 dB for A_{ne}

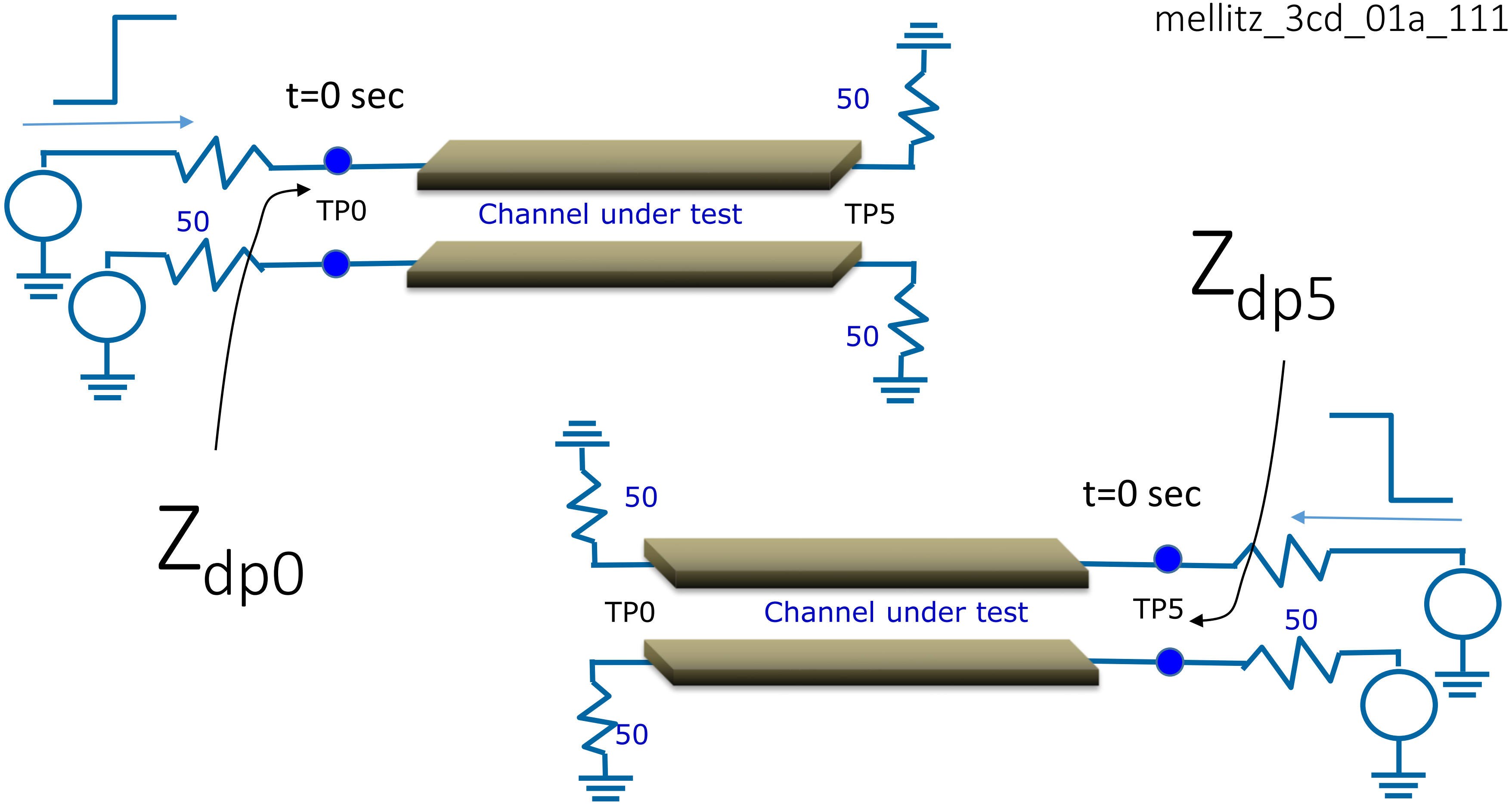
The COM tables in this presentation use “2” but impact of “1” and “2” on A_v, A_{fe}, and A_{ne} are illustrated at the end

Data to follow

From mellitz_3cd_01_1116
Define term Z_{dp0} and Z_{dp5}

Z_{dp0}=fit from zr11(t)
Z_{dp5}=fit from zr22(t)

From:
mellitz_3cd_01a_1116 slide 6



Consider Eq. 93A-12, 13, and 14 and 93A-23

$$\rho = \frac{Z_c - 2R_0}{Z_c + 2R_0} \quad \text{ρ(1) and ρ(2) are determined with drive point algorithm} \qquad (93A–12)$$

Algorithm on next slide

Table 93A–3—Transmission line model parameters and values

Parameter	Value	Units
γ_0		
a_1		
a_2		
τ		
Z_c	78.2	Ω

$$X(f) = A_t T_b \mathrm{sinc}(f T_b) \qquad (93A–23)$$

$X(f)$ is a function of A_t, which in turn is based on the path index k. If k=0, i.e., the victim path, then $A_t = A_v$. If k corresponds to a far-end crosstalk path, then $A_t = A_{fe}$. If k corresponds to a near-end crosstalk path, then $A_t = A_{ne}$.

he scattering parameters for a package transmission line of length z_p are defined by Equation (93A–13) and quation (93A–14). The units of z_p are mm.

$$s_{11}^{(l)}(f) = s_{22}^{(l)}(f) = \frac{\rho(1 - \exp(-\gamma(f)2z_p))}{1 - \rho^2 \exp(-\gamma(f)2z_p)} \qquad (93A–13)$$

ρ(1) or ρ(2) (for 11 or 22)

Determine $S_{11}^{(l)}$ and $S_{22}^{(l)}$ independantly

replace ρ^2 with ρ(1)∗ρ(2)

$$s_{21}^{(l)}(f) = s_{12}^{(l)}(f) = \frac{(1 - \rho^2)\exp(-\gamma(f)z_p)}{1 - \rho^2 \exp(-\gamma(f)2z_p)} \qquad (93A–14)$$

Algorithm (largest impedance difference determine A_v, A_{fe}, A_{ne}, Z_c, and Γ)

Transmitter End

$$if \left|Z_{dp0} - Z_c(1)\right| \geq \left|Z_{dp0} - Z_c(2)\right| \text{ then}$$

$$Z_c = Z_c(1)$$
$$A_V = A_v(1)$$
$$A_{fe} = A_V$$
$$\Gamma_1 = \frac{R_d(1) - R_0}{R_d(1) + R_0}$$

$$else$$

$$Z_c = Z_c(2)$$
$$A_V = A_v(2)$$
$$A_{fe} = A_V$$
$$\Gamma_1 = \frac{R_d(2) - R_0}{R_d(2) + R_0}$$

Receiver end

$$if \left|Z_{dp5} - Z_c(1)\right| \geq \left|Z_{dp5} - Z_c(2)\right| \text{ then}$$

$$Z_c = Z_c(1)$$
$$A_{ne} = A_{ne}(1)$$
$$\Gamma_2 = \frac{R_d(1) - R_0}{R_d(1) + R_0}$$

$$else$$

$$Z_c = Z_c(2)$$
$$A_{ne} = A_{ne}(2)$$
$$\Gamma_2 = \frac{R_d(2) - R_0}{R_d(2) + R_0}$$

COM Results for Adaptive Package vs D1.1 COM Table so far 1 Set of Cisco Channels

COM Parameters				
adaptive	orig	COM delta	file	pkg length
5.58	5.58	0.00	5F3N--Ch1_10_5F3N_t'	12 mm
5.96	5.96	0.00	5F3N--Ch1_10_5F3N_t'	30 mm
5.51	5.18	0.32	5F3N--Ch2_12_5F3N_t'	12 mm
5.69	5.43	0.26	5F3N--Ch2_12_5F3N_t'	30 mm
5.69	5.43	0.27	5F3N--Ch3_17_5F3N_t'	12 mm
5.71	5.57	0.14	5F3N--Ch3_17_5F3N_t'	30 mm
5.60	5.52	0.09	5F3N--Ch4_20_5F3N_t'	12 mm
5.47	5.47	0.00	5F3N--Ch4_20_5F3N_t'	30 mm
5.10	5.02	0.08	5F3N--Ch5_22_5F3N_t'	12 mm
4.79	4.75	0.05	5F3N--Ch5_22_5F3N_t'	30 mm
4.99	5.04	-0.05	5F3N--Ch6_25_5F3N_t'	12 mm
4.39	4.47	-0.07	5F3N--Ch6_25_5F3N_t'	30 mm
4.25	4.19	0.06	5F3N--Ch7_28_5F3N_t'	12 mm
3.74	3.81	-0.07	5F3N--Ch7_28_5F3N_t'	30 mm
3.74	3.94	-0.20	5F3N--Ch8_30_5F3N_t'	12 mm
2.89	3.14	-0.25	5F3N--Ch8_30_5F3N_t'	30 mm
2.89	3.11	-0.22	5F3N--Ch9_33_5F3N_t'	12 mm
2.00	2.30	-0.30	5F3N--Ch9_33_5F3N_t'	30 mm
2.15	2.34	-0.19	5F3N--Ch10_35_5F3N_t'	12 mm
1.14	1.47	-0.33	5F3N--Ch10_35_5F3N_t'	30 mm

Notes:

Av, Afe, Ane were not be recalibrated for lower Cd for original method. D2.1 COM data used as is.

The values of Av(2) and Af(2) used were 0.43 instead of 0.44

And Av(2) and Afe(2) were chosen for all cases.

COM Results for Adaptive Package vs D1.1 COM Table so far 1 Set of Intel Channels

COM Parameters				
adaptive	orig	COM delta	file	pkg length
6.42	6.45	-0.03	mellitz_01_021716_10dB_6_channels--PAM4_2conn_MP_v2_85ohm_10dB_HzLzHz_thru'	12mm
6.41	6.44	-0.03	mellitz_01_021716_10dB_6_channels--PAM4_2conn_MP_v2_85ohm_10dB_HzLzHz_thru'	30mm
6.06	6.31	-0.24	mellitz_01_021716_10dB_6_channels--PAM4_2conn_MP_v2_85ohm_10dB_LzHzLz_thru'	12mm
6.26	6.45	-0.19	mellitz_01_021716_10dB_6_channels--PAM4_2conn_MP_v2_85ohm_10dB_LzHzLz_thru'	30mm
6.84	6.88	-0.04	mellitz_01_021716_15dB_6_channels--PAM4_2conn_MP_v2_85ohm_15dB_HzLzHz_thru'	12mm
6.61	6.70	-0.09	mellitz_01_021716_15dB_6_channels--PAM4_2conn_MP_v2_85ohm_15dB_HzLzHz_thru'	30mm
6.75	6.98	-0.22	mellitz_01_021716_15dB_6_channels--PAM4_2conn_MP_v2_85ohm_15dB_LzHzLz_thru'	12mm
6.39	6.61	-0.22	mellitz_01_021716_15dB_6_channels--PAM4_2conn_MP_v2_85ohm_15dB_LzHzLz_thru'	30mm
6.31	6.48	-0.18	mellitz_01_021716_20dB_6_channels--PAM4_2conn_MP_v2_85ohm_20dB_HzLzHz_thru'	12mm
6.07	6.21	-0.14	mellitz_01_021716_20dB_6_channels--PAM4_2conn_MP_v2_85ohm_20dB_HzLzHz_thru'	30mm
6.26	6.54	-0.28	mellitz_01_021716_20dB_6_channels--PAM4_2conn_MP_v2_85ohm_20dB_LzHzLz_thru'	12mm
5.81	6.12	-0.31	mellitz_01_021716_20dB_6_channels--PAM4_2conn_MP_v2_85ohm_20dB_LzHzLz_thru'	30mm
5.34	5.53	-0.19	mellitz_01_021716_25dB_6_channels--PAM4_2conn_MP_v2_85ohm_25dB_HzLzHz_thru'	12mm
4.79	4.99	-0.20	mellitz_01_021716_25dB_6_channels--PAM4_2conn_MP_v2_85ohm_25dB_HzLzHz_thru'	30mm
5.48	5.75	-0.27	mellitz_01_021716_25dB_6_channels--PAM4_2conn_MP_v2_85ohm_25dB_LzHzLz_thru'	12mm
4.84	5.05	-0.21	mellitz_01_021716_25dB_6_channels--PAM4_2conn_MP_v2_85ohm_25dB_LzHzLz_thru'	30mm
3.82	4.07	-0.25	mellitz_01_021716_30dB_6_channels--PAM4_2conn_MP_v2_85ohm_30dB_HzLzHz_thru'	12mm
2.91	3.19	-0.27	mellitz_01_021716_30dB_6_channels--PAM4_2conn_MP_v2_85ohm_30dB_HzLzHz_thru'	30mm
3.88	4.24	-0.36	mellitz_01_021716_30dB_6_channels--PAM4_2conn_MP_v2_85ohm_30dB_LzHzLz_thru'	12mm
3.06	3.40	-0.34	mellitz_01_021716_30dB_6_channels--PAM4_2conn_MP_v2_85ohm_30dB_LzHzLz_thru'	30mm

Av(1) and Afe(1) were chosen for all cases.

Backup:

Data for re-adjusting package parameters to the transmitter specification

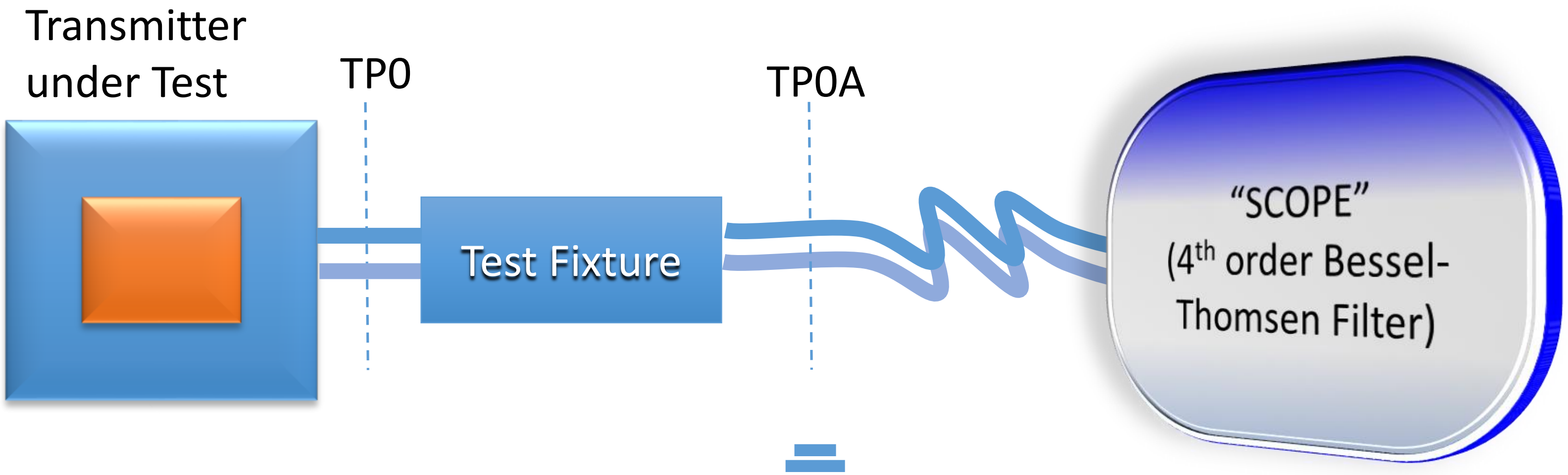
COM parameter voltage determination specified in 120D adjusted to requirements for peak

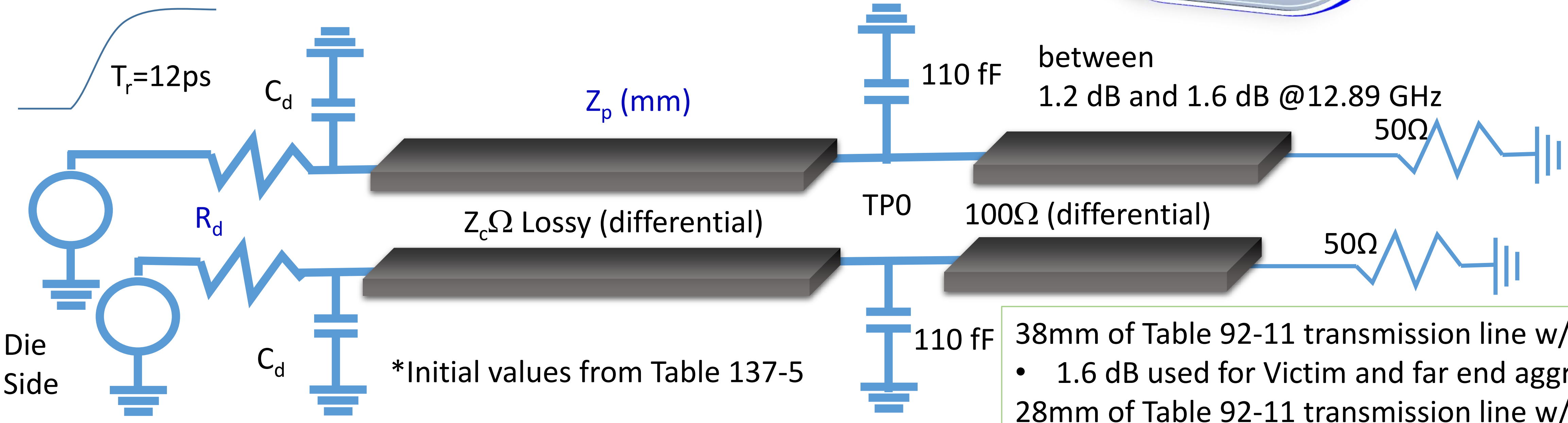
- ❑ Annex 120D COM parameter for number of DFE taps (Nb) is
  - N_v is $N_b + 1 + D_p$ → 10+1+2 = 13
- ❑ Clause 137 COM parameter specifies N_b=12
  - So N_v becomes 15 for clause 137

120D.3.1.4 Steady-state voltage and linear fit pulse peak

The linear fit pulse, *p(k)*, is determined according to the linear fit procedure in 120D.3.1.3. The steady-state voltage v_f is defined to be the sum of the linear fit pulse *p(1)* through $p(M\,N_v)$ divided by *M*, determined in step 3 of the linear fit procedure. Here, N_v represents the number of symbols to take into account for the steady-state voltage v_f and has a value of 13.

Transmitter Test Set-Up for COM Values Determination





38mm of Table 92-11 transmission line w/ Z_c=100Ω

- 1.6 dB used for Victim and far end aggressor

28mm of Table 92-11 transmission line w/ Z_c=100Ω

- 1.2 dB use for Near end aggressor

33 dB or 1.4 dB explored

Recommended/Decision COM Parameter for Adapting to Channel Driving Point Impedance

OPTION A
1.6/1.2 dB test fixture

R_d	[45 55]	Ohm	TDR selected
A_v	[0.4 0.44]	V	TDR selected
A_fe	[0.4 0.44]	V	TDR selected
A_ne	[.58 .64]	V	TDR selected
package_Z_c	[83.7 102.3]	ohms	TDR selected

OPTION B
1.4 dB test fixture

R_d	[45 55]	Ohm	TDR selected
A_v	[0.394 0.436]	V	TDR selected
A_fe	[0.394 0.436]	V	TDR selected
A_ne	[.581 .642]	V	TDR selected
package_Z_c	[83.7 102.3]	ohms	TDR selected

mellitz_3cd_01a_1116 slide 9

OPTION C

Just Keep table COM table as is in D1.1

Need to determine range for Z_c

- Zc min = 83.7 ohm and Zc max = 102.3 ohms is recommended in mellitz_3cd_01a_1116
- Data during P802.3bj from Liav Ben Artsi suggests that’s volume packages are not 100 ohms nominal. We settled on about 80 ohms.
- Many interconnect manufacturers are targeting 93 ohms target for interconnect.
- Perhaps need straw ballot to determine

Victim and Far End Simulation Data for COM reference package *Tr=12 ps, N_v=15 and 1.6 dB fixture (38 mm)*

A_v and A_{fe},volts	V_f ,volts	Peak/V_f	SNR_{ISI} (dB)	Z_c (package impedance, Ω)	R_d (die termination DC impedance, Ω)	Z_p (package length, mm)
.44	0.403	0.76	44.1	83.7	55	30
.44	0.404	0.76	45.3	102.3	55	30
0.4	0.407	0.77	45.1	83.7	45	30
0.4	0.406	0.76	45.6	102.3	45	30

Victim and Far End Simulation Data for COM reference package: **5 digits of voltage precision** *Tr=12 ps, N_v=15 and 1.4 dB fixture (33 mm)*

A_v and A_{fe},volts	V_f ,volts	Peak/V_f	SNR_{ISI} (dB)	Z_c (package impedance, Ω)	R_d (die termination DC impedance, Ω)	Z_p (package length, mm)
0.43582	0.40001	0.767	44.7	83.7	55	30
0.43458	0.40004	0.769	45.9	102.3	55	30
0.39357	0.40003	0.775	46.3	83.7	45	30
0.39319	0.40008	0.772	45.6	102.3	45	30

Near End Simulation Data for COM reference package *Tr=12 ps, N_v=15 and 1.2 dB fixture (29 mm) using Vf max (next work will use Vp-p for PRBS31)*

A_{ne} ,volts	V_f ,volts	Peak/V_f	SNR_{ISI} (dB)	Zc (package impedance, Ω)	Rd (die termination DC impedance, Ω)	Zp (package length, mm)
0.64	0.598	0.84	51.3	83.7/102.3	55	12
0.58	0.599	0.83	51.3	83.7/102.3	45	12

Near End Simulation Data for COM reference package: **5 digits of voltage precision**

Tr=12 ps, N_v=15 and 1.4 dB fixture (33 mm) using Vf max (next work will use Vp-p for PRBS31)

A_{ne} ,volts	V_f ,volts	Peak/V_f	SNR_{ISI} (dB)	Zc (package impedance, Ω)	Rd (die termination DC impedance, Ω)	Zp (package length, mm)
0.6419	0.60002	0.827	52.5	83.7/102.3	55	12
0.58063	0.60000	0.838	52.8	83.7/102.3	45	12

Tx voltage amplitude, package impedance, and die termination COM parameter recommendations

A_v and A_{fe} volts	A_{ne}, volts	Selected Zc (package impedance, Ω)	R_d (die termination DC impedance, Ω)
.44	-	83.7	55
.4	-	102.3	45
-	0.64	83.7	55
-	0.58	102.3	45