

Variation of COM Parameters for Package Trace and Termination Resistance

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- Baseline COM Parameters specify
 - Two values (12mm and 30mm) for z_p (package trace length)
 - Lower value (90 Ω) than nominal for Z_c (package trace impedance)
 - Higher value (55 Ω) than nominal for R_d (termination resistance)

- There is a concern that the above combinations does not necessarily cover sufficient corner cases of variation of package trace and termination resistnace

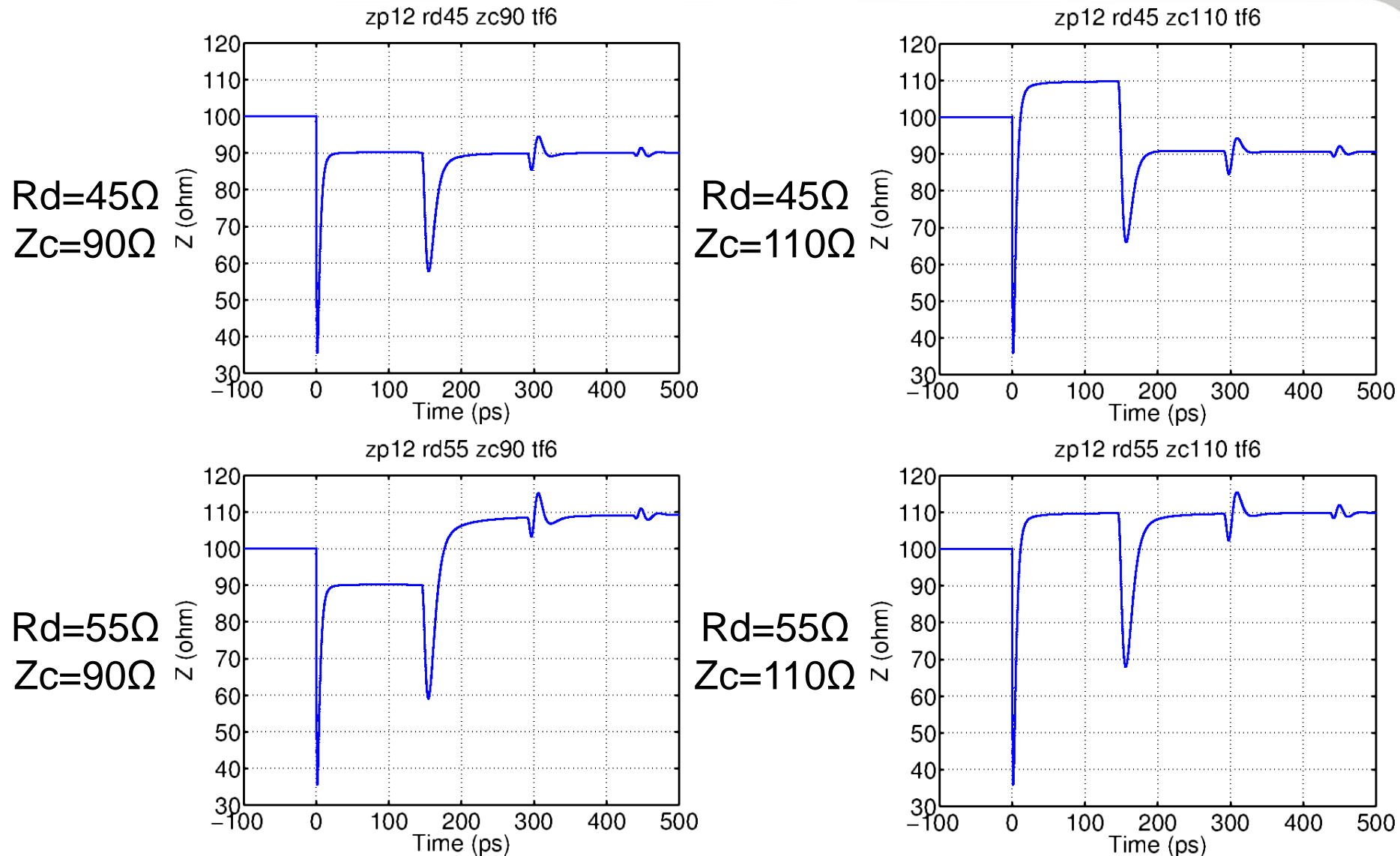
- Hence, I have studied various combinations of variation of the above COM parameters

- The following Eight combinations of values were studied

z_p Package trace length	R_d Termination resistance	Z_c Package trace impedance
12 mm	45 Ω	90 Ω
		110 Ω
	55 Ω	90 Ω
		110 Ω
30 mm	45 Ω	90 Ω
		110 Ω
	55 Ω	90 Ω
		110 Ω

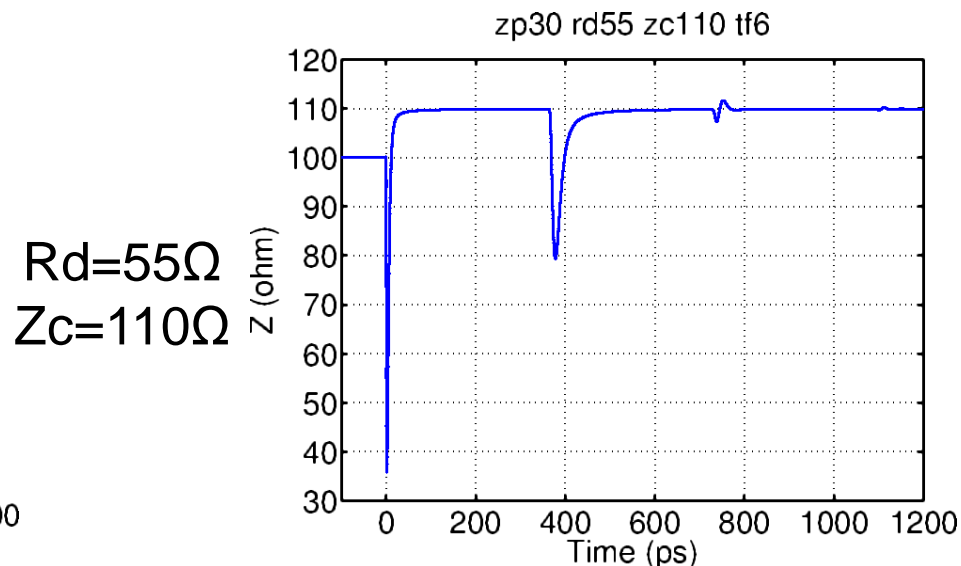
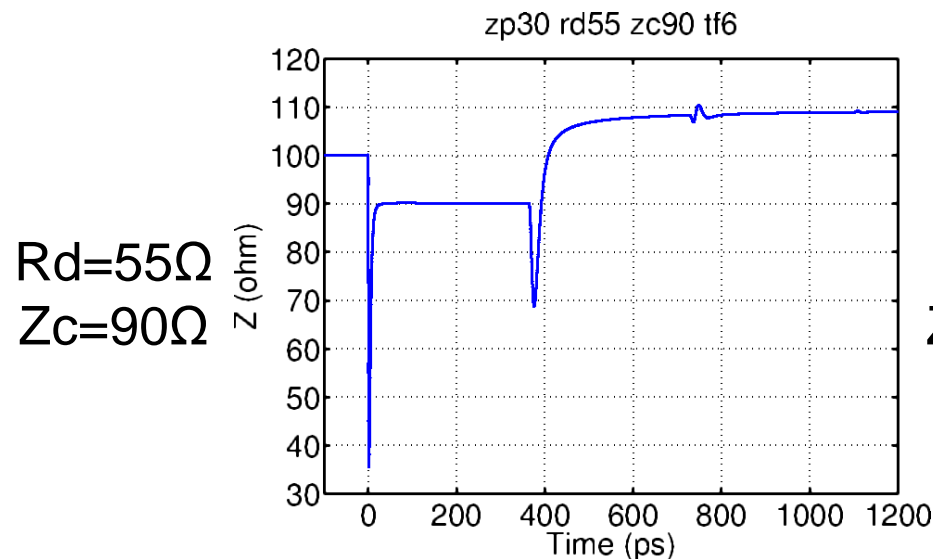
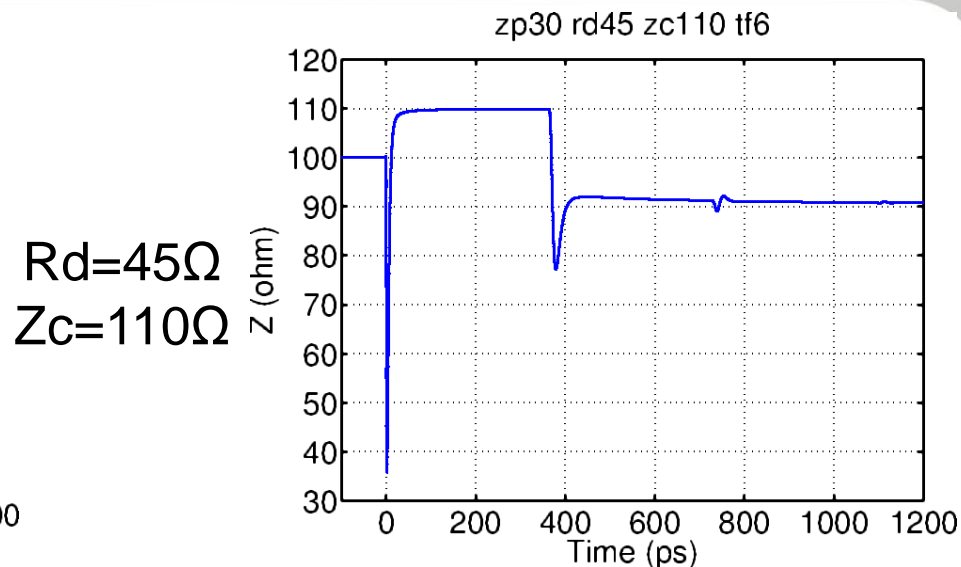
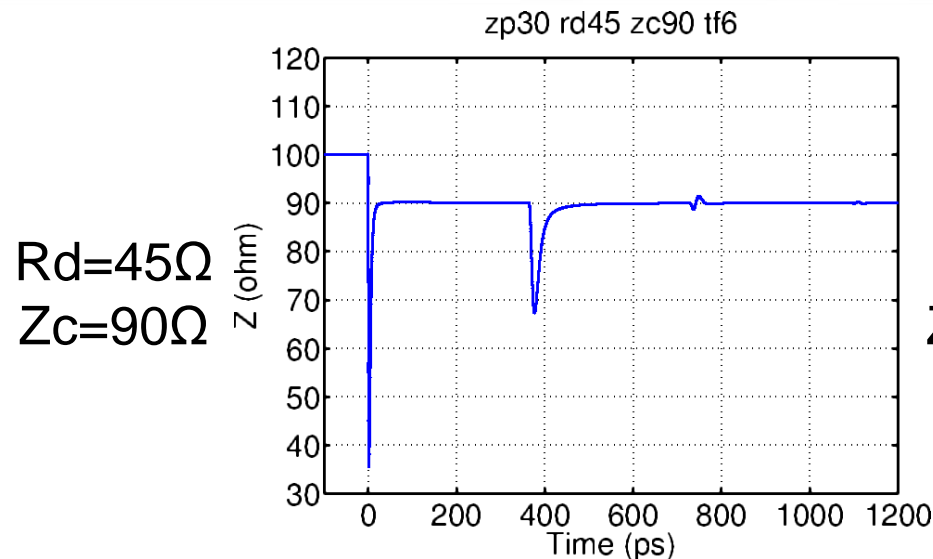
- The other COM Parameters are almost same as the baseline
 - Excepting that f_{p2} is 25GHz that differs from 26.5625GHz in the baseline
 - It was 25GHz in slide 8 of kareti_083116_3cd_adhoc-v2.
 - All the COM Parameters are shown in a backup slide.

Zdiff Profile of COM Package Model (zp=12mm)



- $C_p=110\text{fF}$, $C_d=180\text{fF}$.
- TDR step is ultra fast. Observed thru dummy trace that has 1.07dB loss @ 13.3GHz for round trip.

Zdiff Profile of COM Package Model (zp=30mm)



- $C_p=110\text{fF}$, $C_d=180\text{fF}$.
- TDR step is ultra fast. Observed thru dummy trace that has 1.07dB loss @ 13.3GHz for round trip.

■ 43 Channels were used

■ 10 Cisco Channels (CH1-10)

- 10 Different Insertion Losses (10~35dB)

■ 15 Intel 100Ω Channels (CH11-25)

- 5 Different Insertion Losses (10~30dB) x 3 Different Variations of Impedance

■ 15 Intel 85Ω Channels (CH26-40)

- 5 Different Insertion Losses (10~30dB) x 3 Different Variations of Impedance

■ 3 TE Channels (CH41-43)

- 3 Different Insertion Losses (10~32dB)

■ Channel Data Source

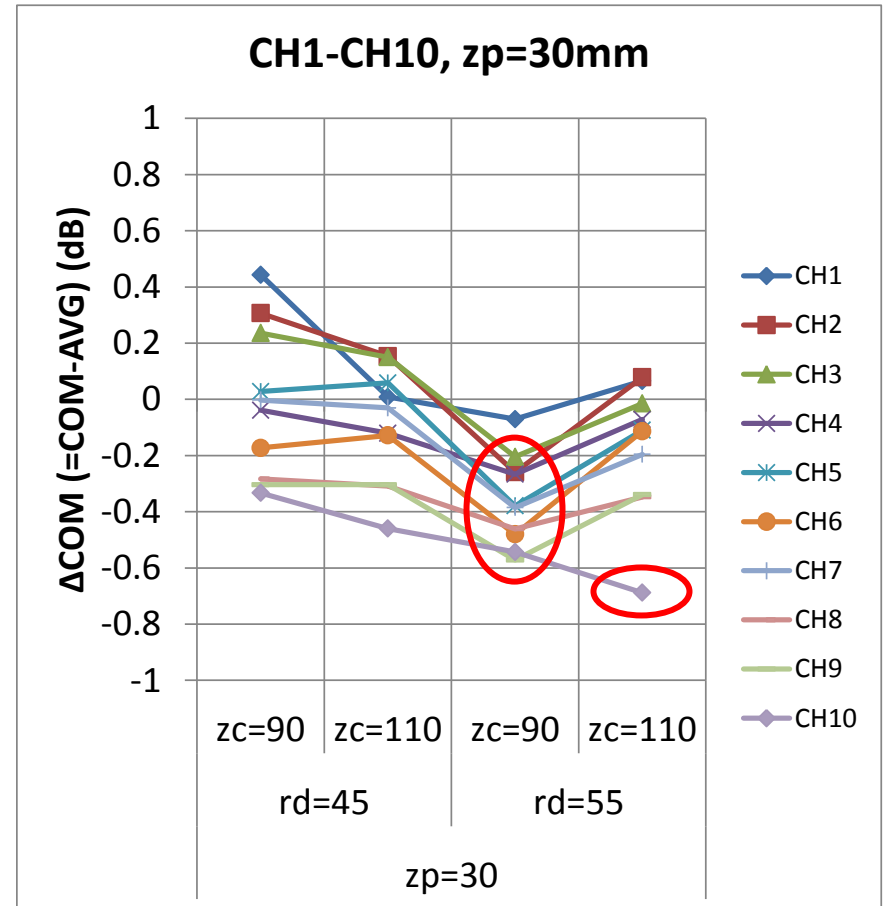
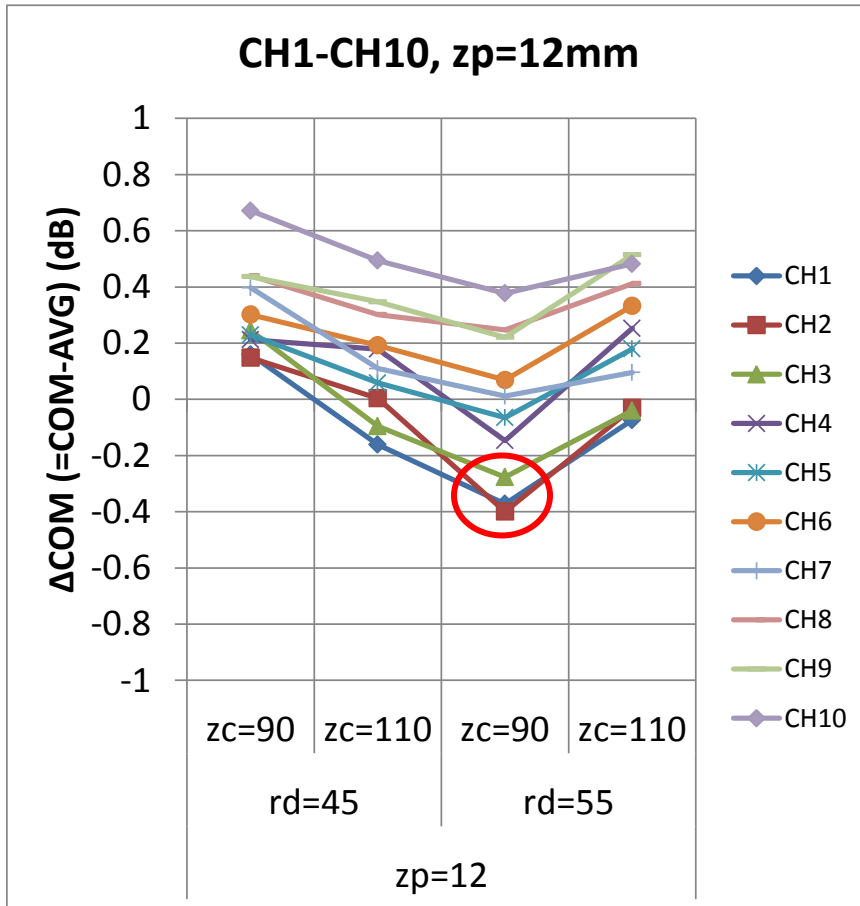
■ Cisco and TE Channels are from P802.3cd Task Force Channel Area

■ Intel Channels are from 50G&NGOATH Study Group Channel Area

■ See backup slides for the details

Cisco Channels (CH1-10): Δ COM Values

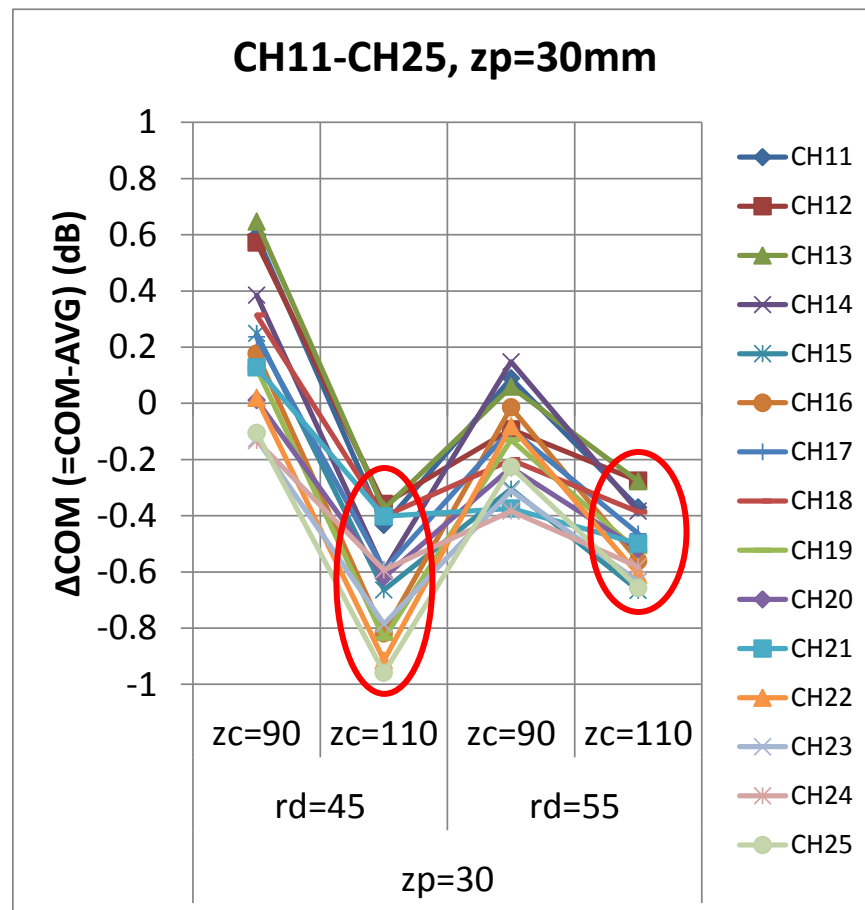
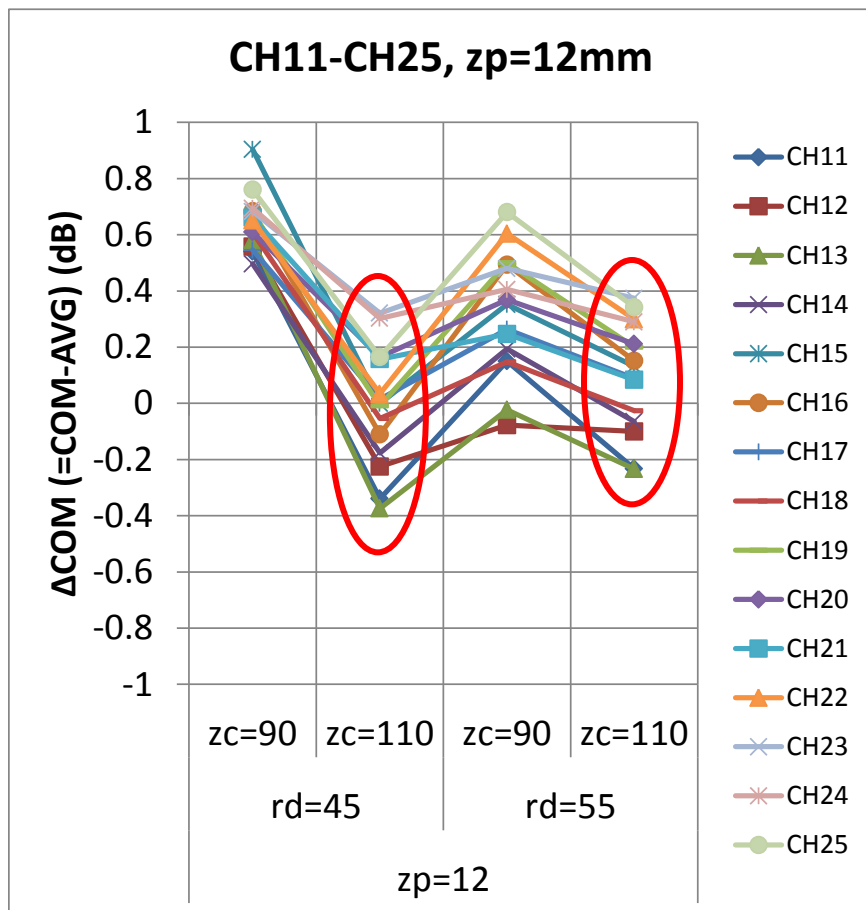
- The worst case is $Z_c=90\Omega$ & $R_d=55\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=110\Omega$ & $R_d=45\Omega$ is better than $Z_c=90\Omega$ & $R_d=55\Omega$
 - $z_p=30\text{mm}$ is worse than 12mm except CH1~3 where 12mm is worse



• Δ COM Value = COM Value minus the average for the 8 combinations of COM parameters.

Intel 100Ω Channels (CH11-25): Δ COM Values

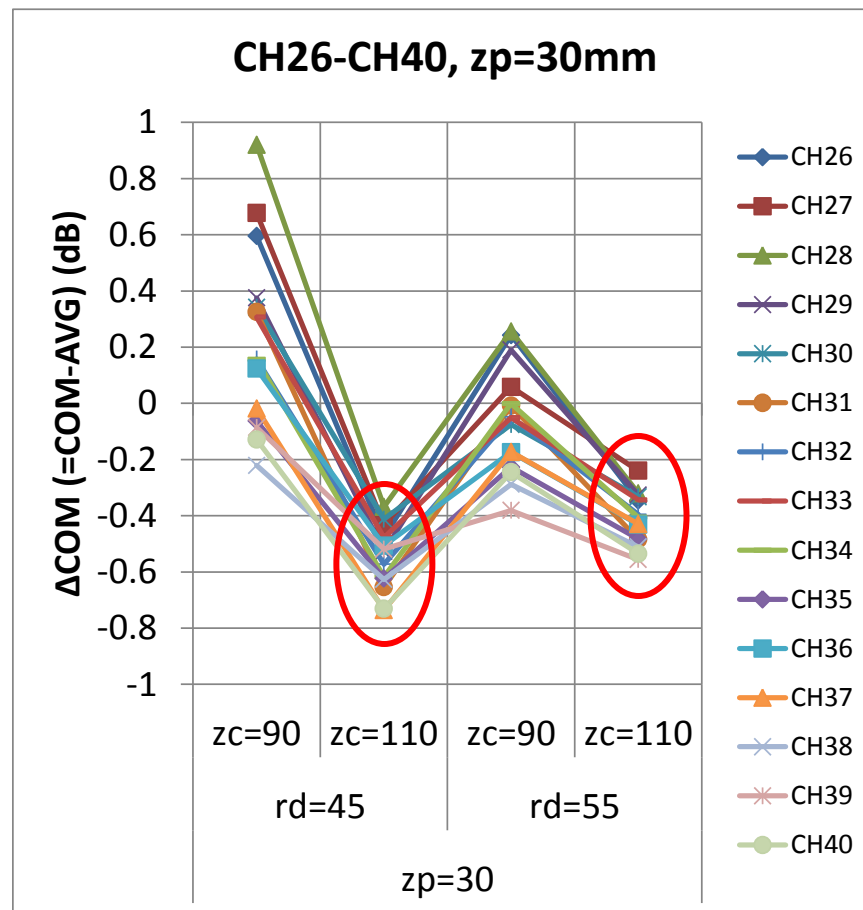
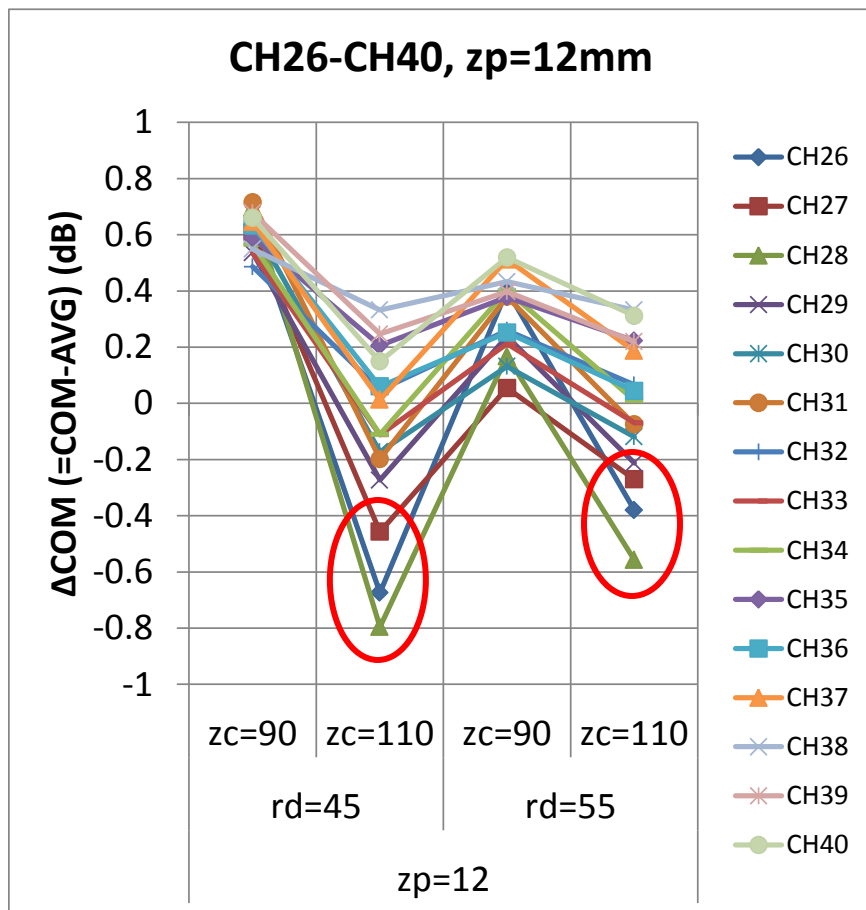
- The worst case is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=90\Omega$ & $R_d=55\Omega$ is better than $Z_c=110\Omega$ & $R_d=45\Omega$ or 55Ω
 - $z_p=30\text{mm}$ is worse than 12mm



• Δ COM Value = COM Value minus the average for the 8 combinations of COM parameters.

Intel 85Ω Channels (CH26-40): Δ COM Values

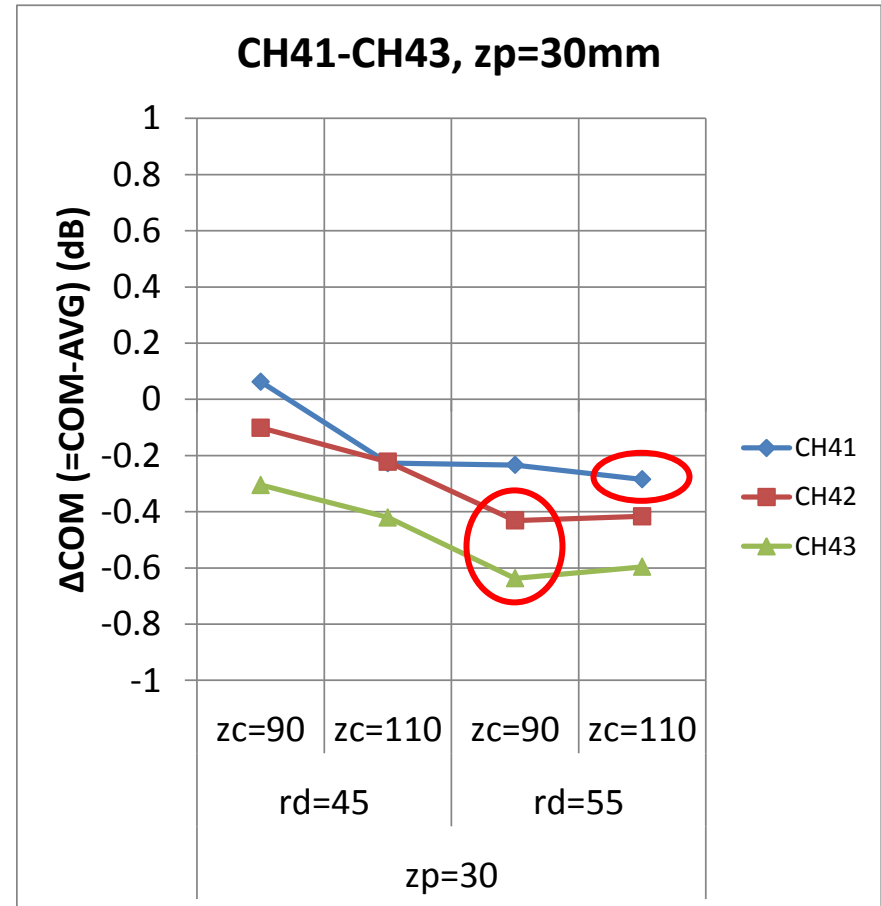
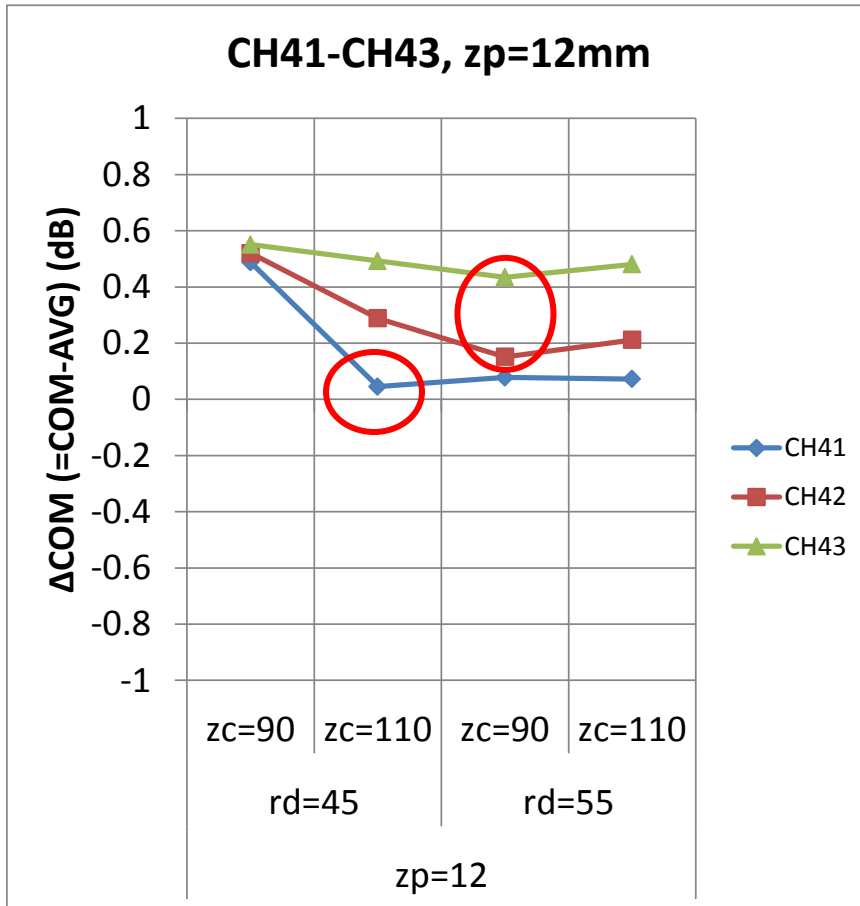
- The worst case is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=90\Omega$ & $R_d=55\Omega$ is better than $Z_c=110\Omega$ & $R_d=45\Omega$ or 55Ω
 - $z_p=30\text{mm}$ is worse than 12mm except CH26~28 where 12mm is worse



• Δ COM Value = COM Value minus the average for the 8 combinations of COM parameters.

TE Channels (CH41-43): Δ COM Values

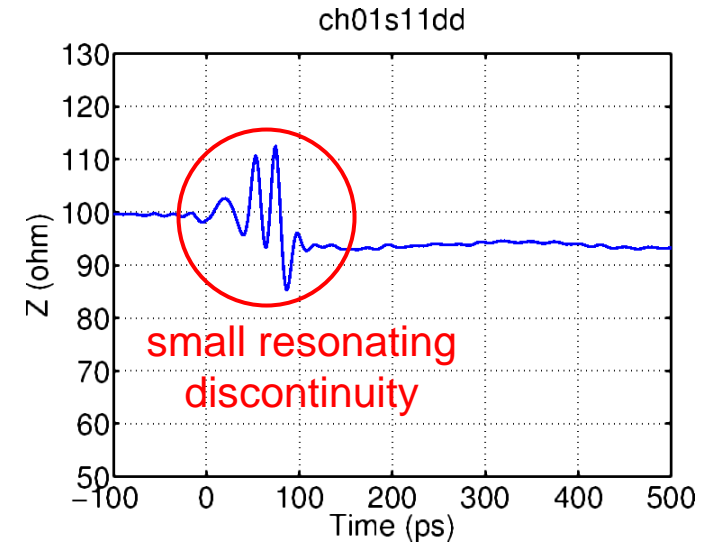
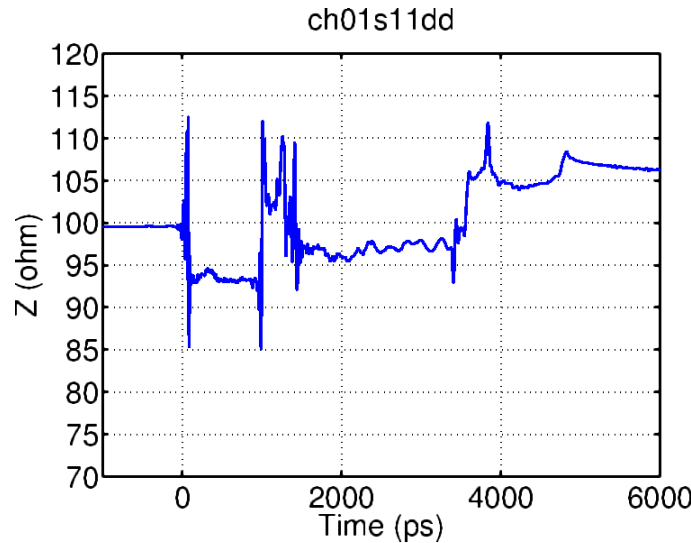
- The worst case is $Z_c=90\Omega$ & $R_d=55\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $z_p=30\text{mm}$ is worse than 12mm
 - For $z_p=12\text{mm}$, the worst is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=90\Omega$ & $R_d=55\Omega$



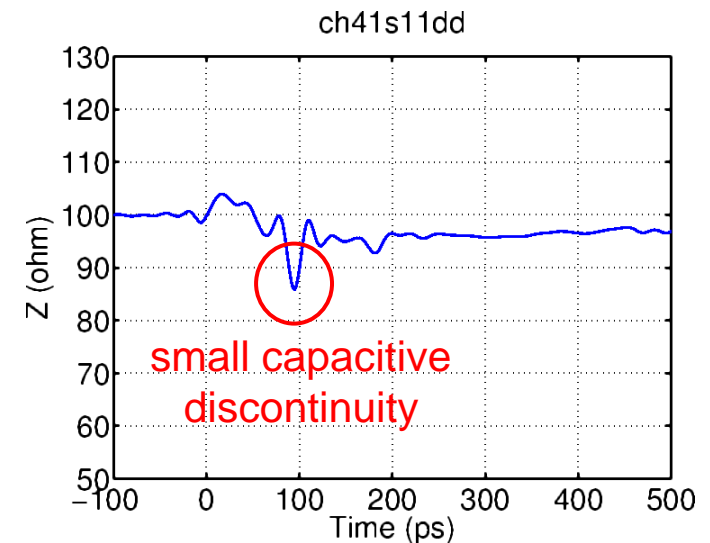
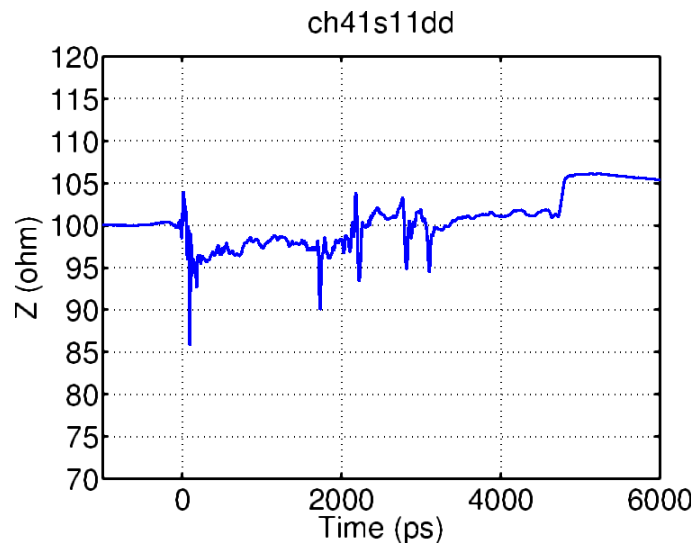
• Δ COM Value = COM Value minus the average for the 8 combinations of COM parameters.

■ Small resonating or capacitive discontinuities near port entry

Cisco 10dB
(CH1)
S11dd
Port 1



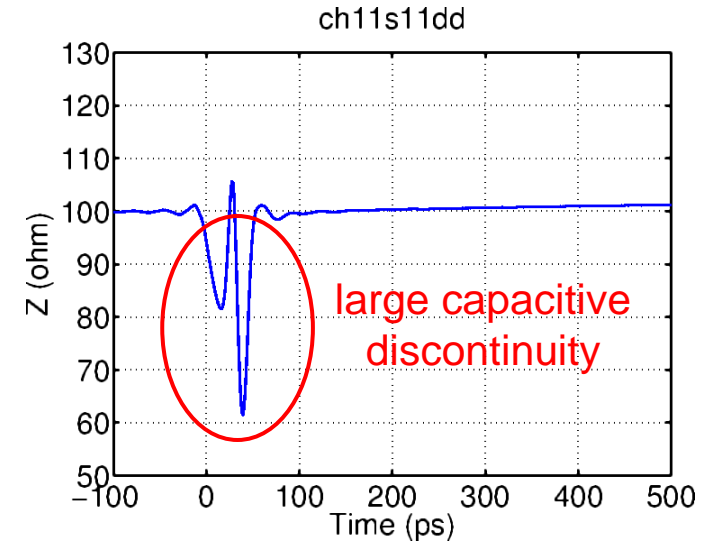
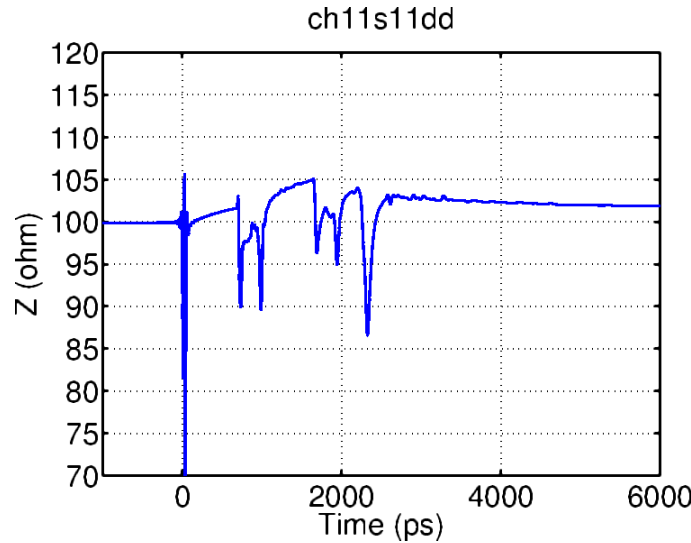
TE 11.75in
(CH41)
S11dd
Port 1



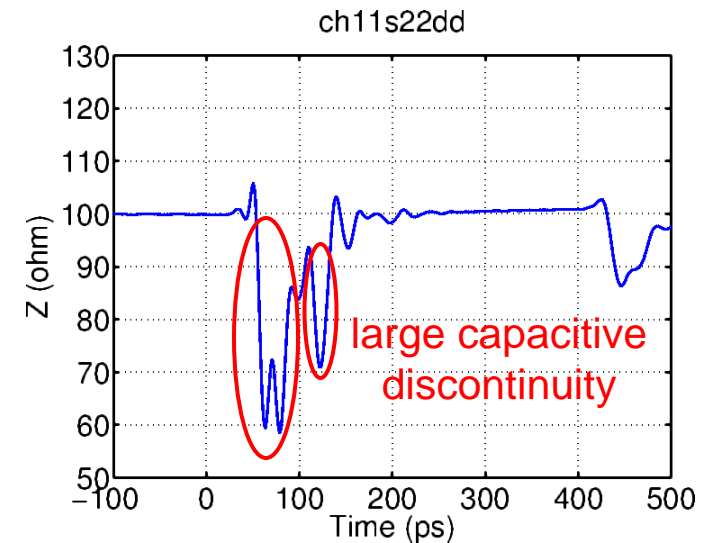
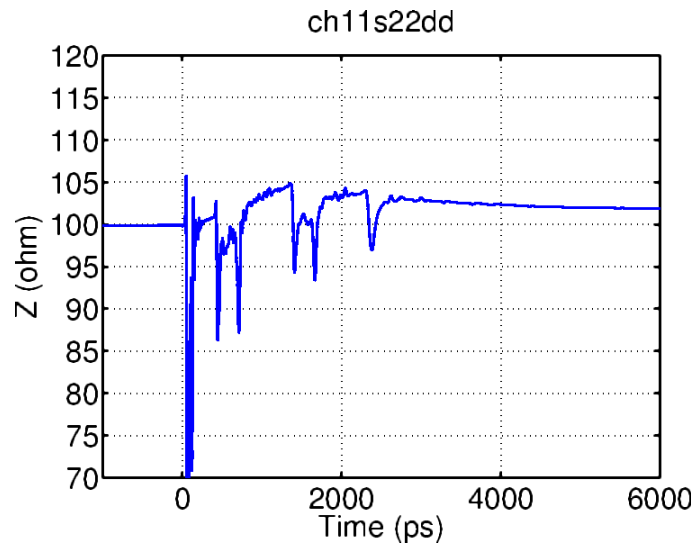
Representative Zdiff Profile of Intel Channels

- Large spike-like capacitive discontinuities near port entry

Intel 100Ω
10dB Nom
(CH11)
S11dd
Port 1



Intel 100Ω
10dB Nom
(CH11)
S22dd
Port 2



- High Rd (55Ω) & Low Zc (90Ω) is not always the worst case.
 - In particular, High Zc (110Ω) with Low Rd (45Ω) or High Rd (55Ω) is the worst case, when the channel has spike-like capacitive discontinuities.
- The following combinations of test cases cover all the worst cases in various channels tested in this study:

COM Parameter	Test Cases						Unit
	#1	#2	#3	#4	#5	#6	
zp (Package trace length)	12			30			mm
Rd (Termination resistance)	45	55		45	55		Ω
Zc (Package trace impedance)	110	90	110	110	90	110	Ω

- If this is too many, we may drop test cases for zp=12mm, because zp=12mm is worse than zp=30mm only for 10dB channels, where the absolute COM value is sufficiently high

■ Option A

COM Parameter	TC1	TC2	TC3	TC4	TC5	TC6	Unit
zp (Package trace length)	12			30			mm
Rd (Termination resistance)	45	55		45	55		Ω
Zc (Package trace impedance)	110	90	110	110	90	110	Ω

■ Option B

COM Parameter	TC1	TC2	TC3	Unit
zp (Package trace length)	30			mm
Rd (Termination resistance)	45	55		Ω
Zc (Package trace impedance)	110	90	110	Ω

■ Option C (No Change)

COM Parameter	TC1	TC2	Unit
zp (Package trace length)	12	30	mm
Rd (Termination resistance)	55		Ω
Zc (Package trace impedance)	90		Ω

Back up Slides

- COM Parameters in This Study
- Channel Data Source
- Channel Characteristics
- Absolute COM Values
- Select Channel Zdiff Profile

COM Parameters in This Study

- This table is same as slide 8 of kareti_083116_3cd_adhoc-v2.
 - f_p2 is 25GHz. It is 26.5625GHz in the baseline kareti_3cd_01a_0916.
 - Circled parameters were varied in this study.

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)	[0.0:0.025:0.1]		[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	25	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	logical	0, 1, 2
g_DC_HP	[-6:1:0]	dB	[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_CTLT	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

Cisco Channels (CH1-10)

■ Data source (in P802.3cd TF Channel Data Area)

- http://www.ieee802.org/3/cd/public/channel/Cisco_Backplane_channel_data.zip

■ Characteristics

- Insertion Loss @ Nyquist : 10.7876dB (CH1) ~ 34.9828dB (CH10)
- Crosstalk : 5 FEXT + 3 NEXT

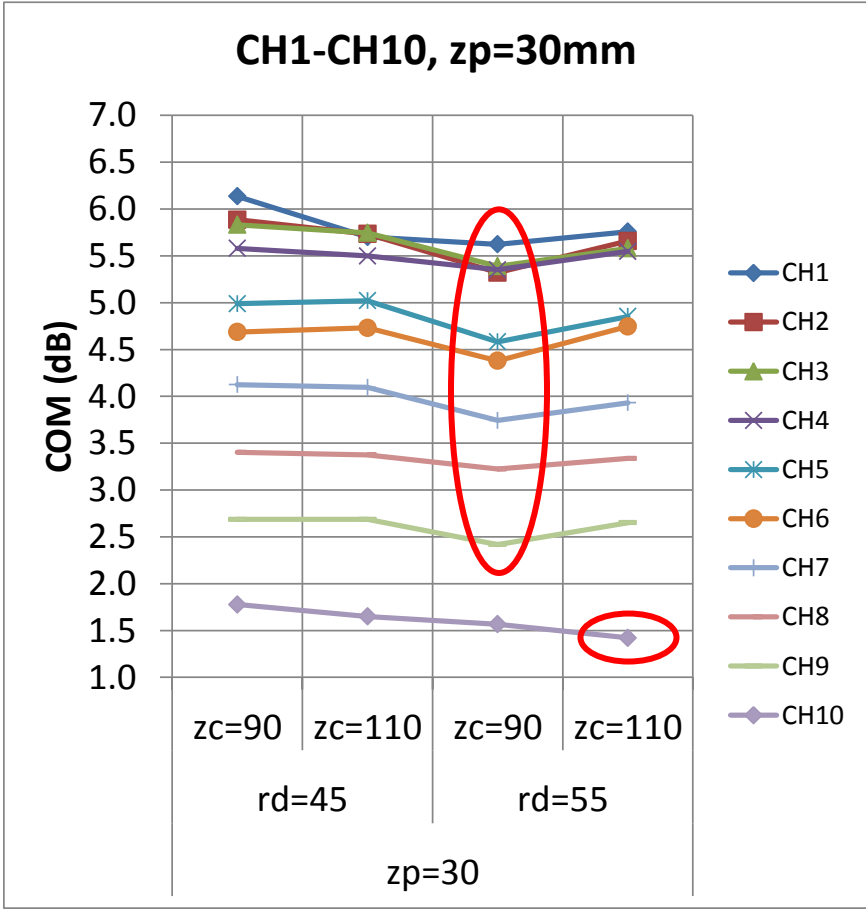
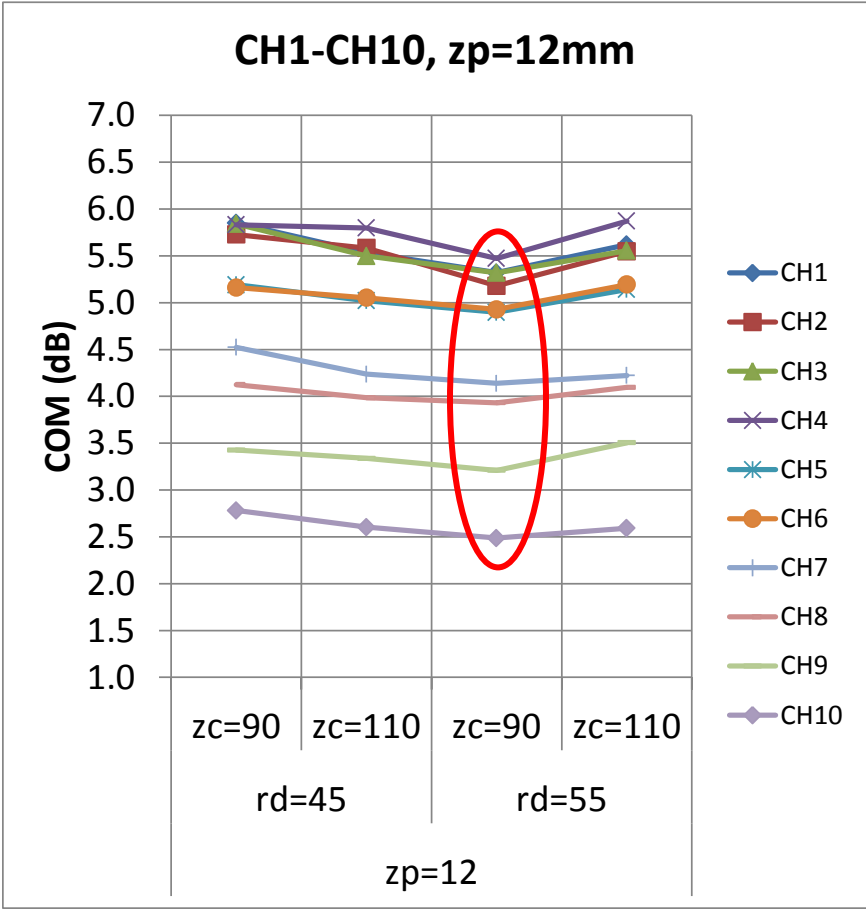
	IL (dB)	FOM_ILD	ICN (mV)
CH1	10.7876	0.31042	1.2534
CH2	12.4579	0.30047	1.1147
CH3	17.3145	0.28196	0.81725
CH4	20.874	0.31335	0.72664
CH5	22.3474	0.28224	0.69128

	IL (dB)	FOM_ILD	ICN (mV)
CH6	25.3573	0.3028	0.64907
CH7	27.6685	0.31005	0.60807
CH8	30.1441	0.30382	0.57276
CH9	32.859	0.31247	0.55667
CH10	34.9828	0.34579	0.54711

Cisco Channels (CH1-10): COM Values

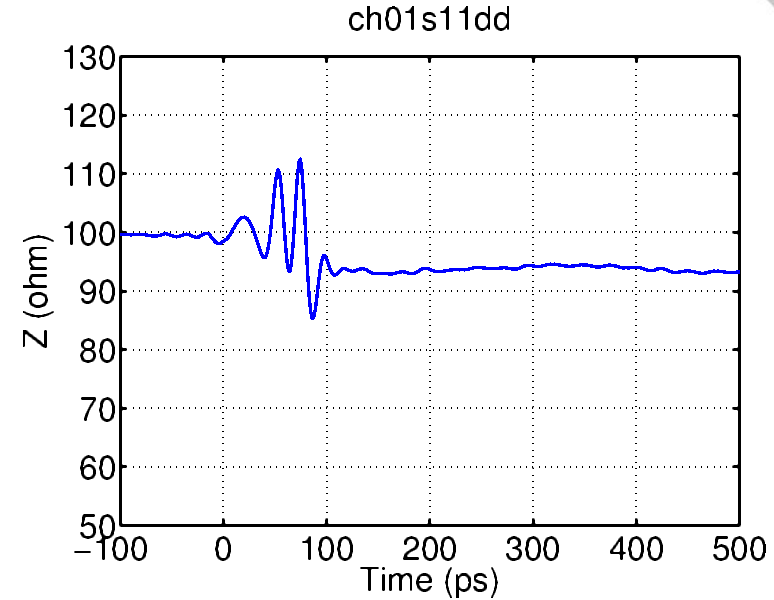
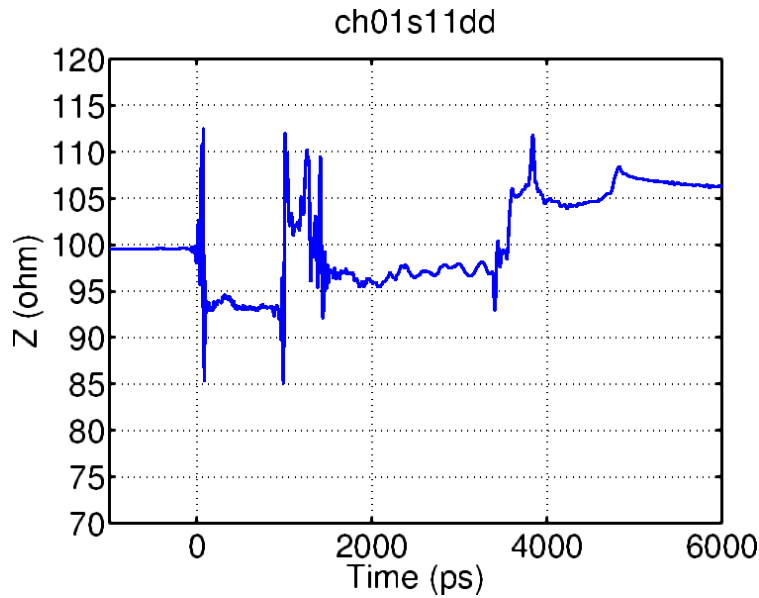


- The worst case is $Z_c=90\Omega$ & $R_d=55\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=110\Omega$ & $R_d=45\Omega$ is better than $Z_c=90\Omega$ & $R_d=55\Omega$
 - $z_p=30\text{mm}$ is worse than 12mm except CH1~3 where 12mm is worse

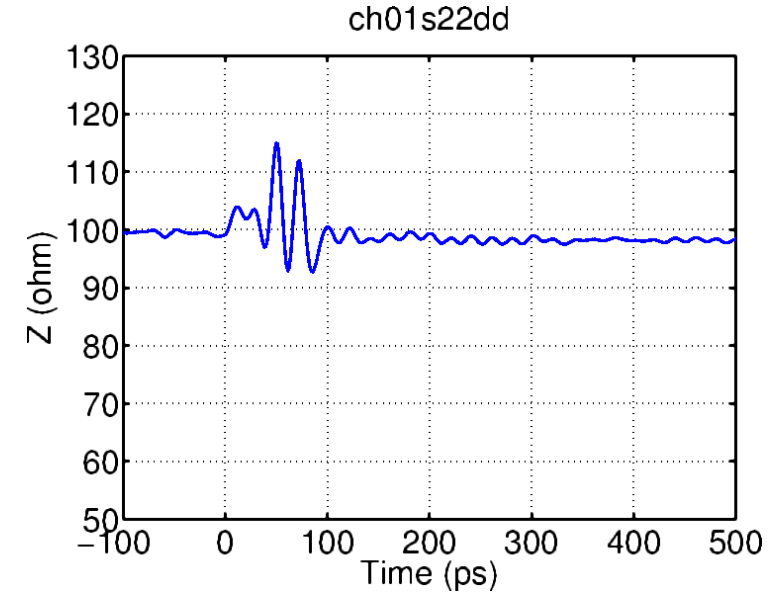
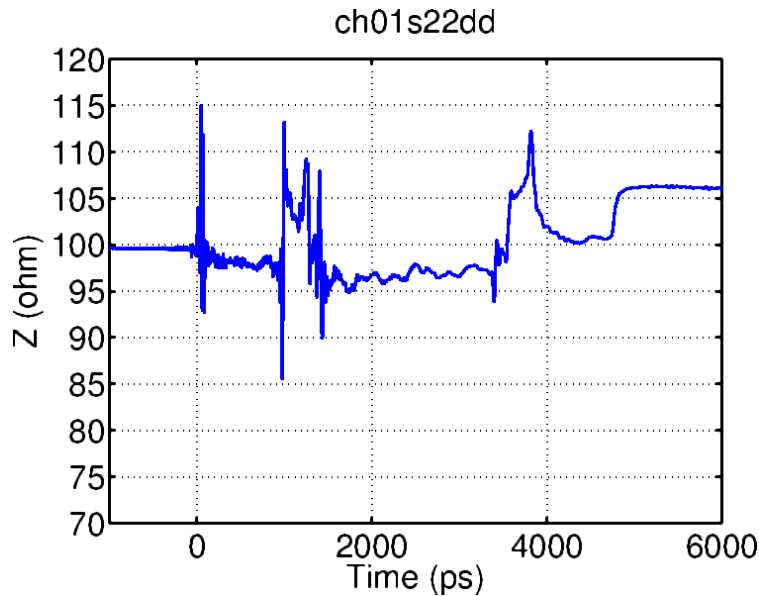


Cisco 10dB Channel (CH1): Zdiff Profile

S11dd

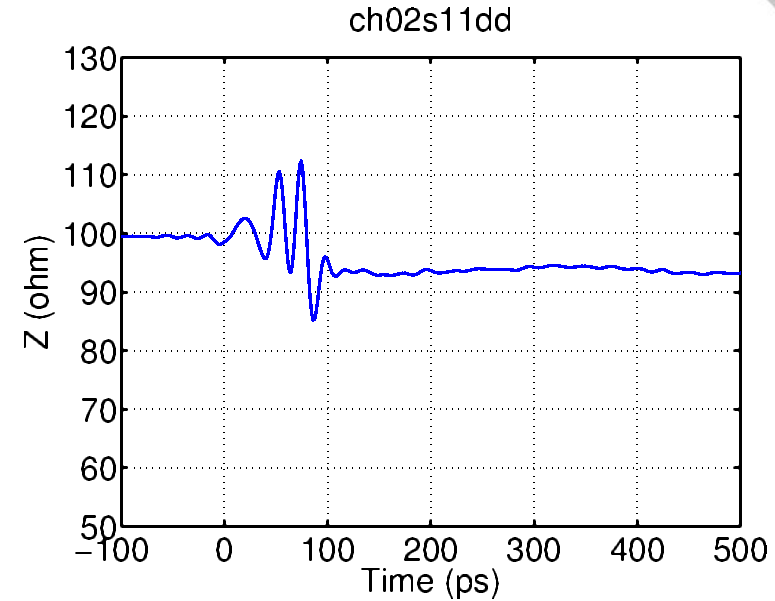
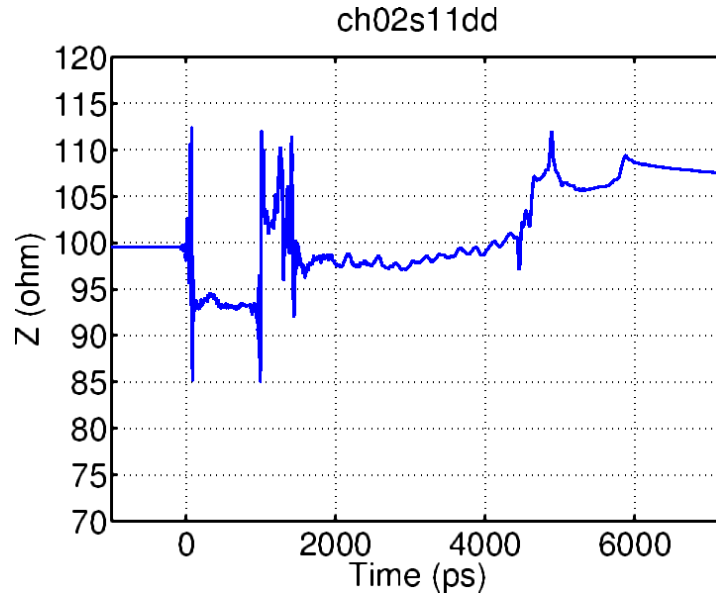


S22dd

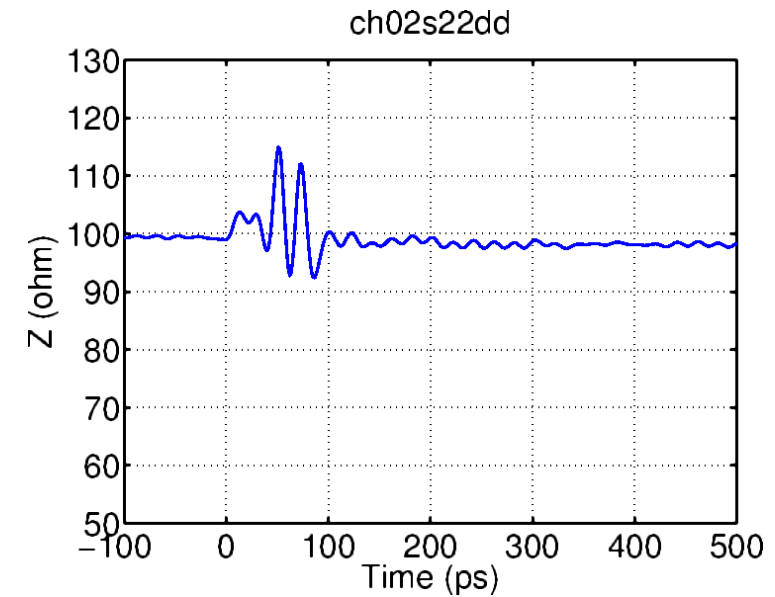
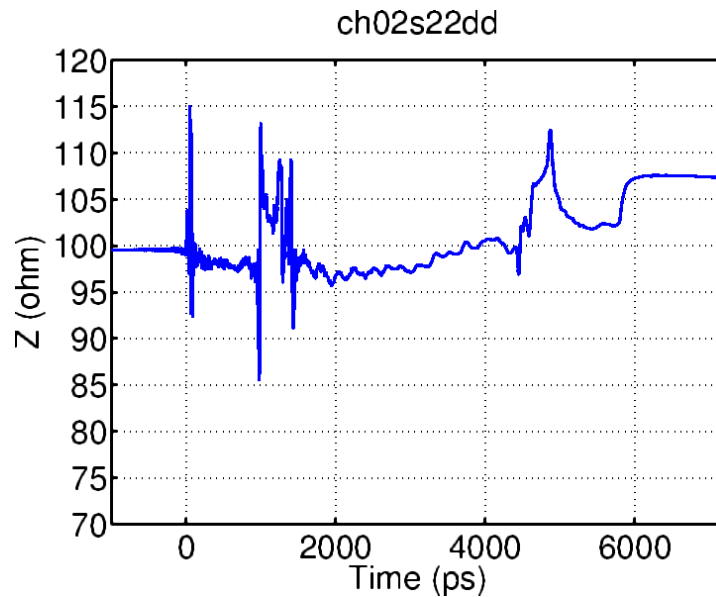


Cisco 12dB Channel (CH2): Zdiff Profile

S11dd

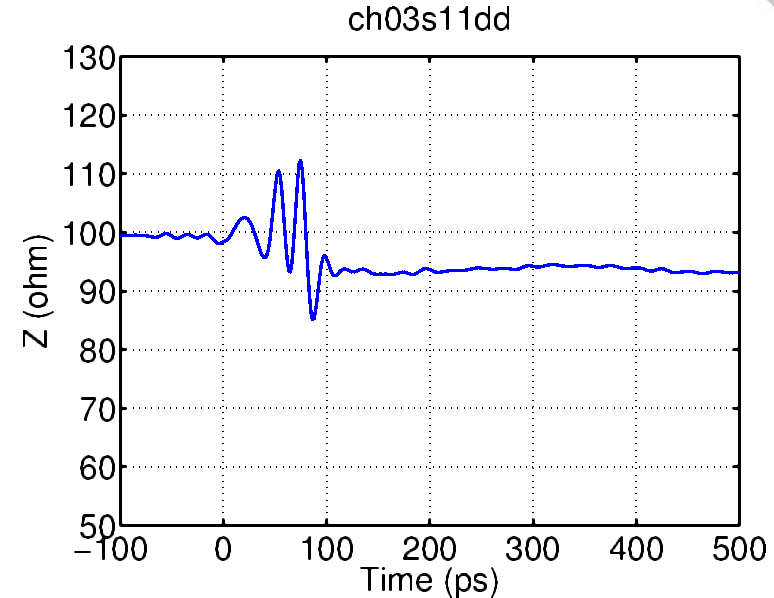
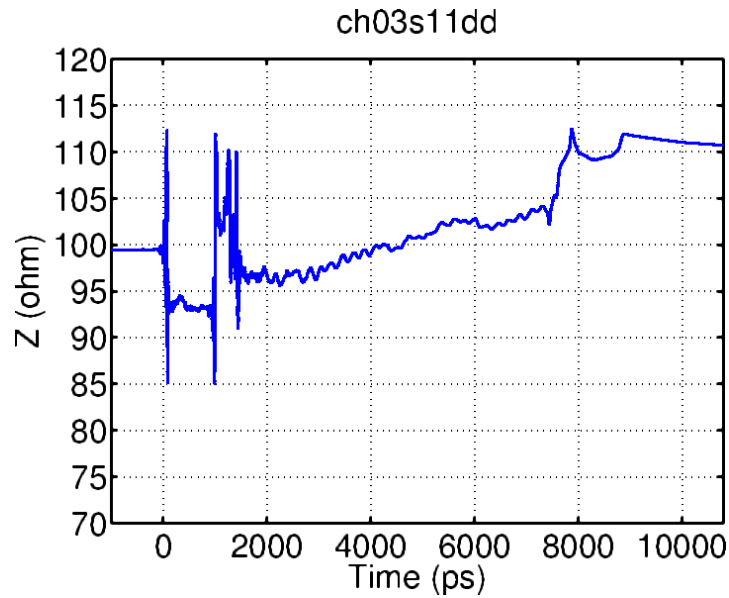


S22dd

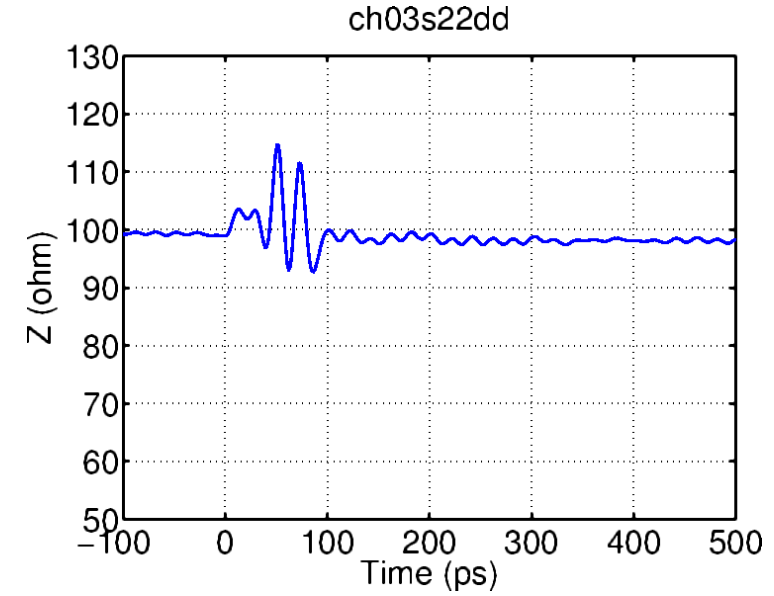
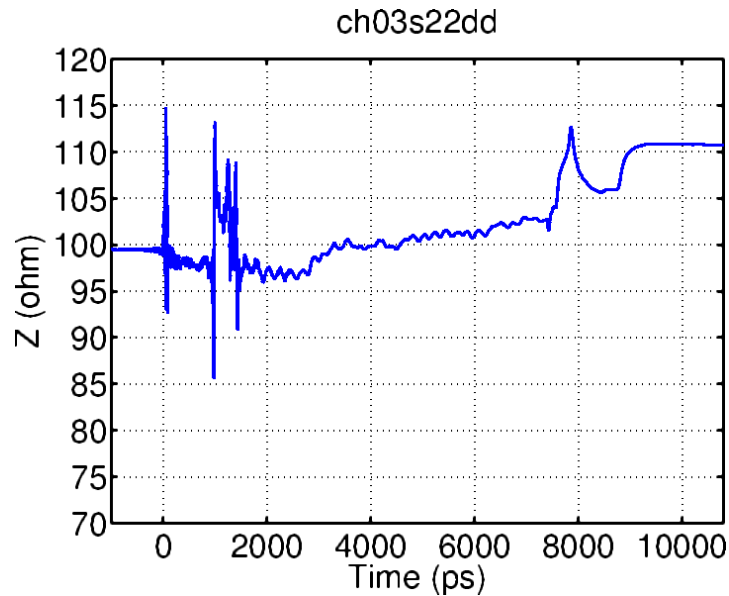


Cisco 17dB Channel (CH3): Zdiff Profile

S11dd



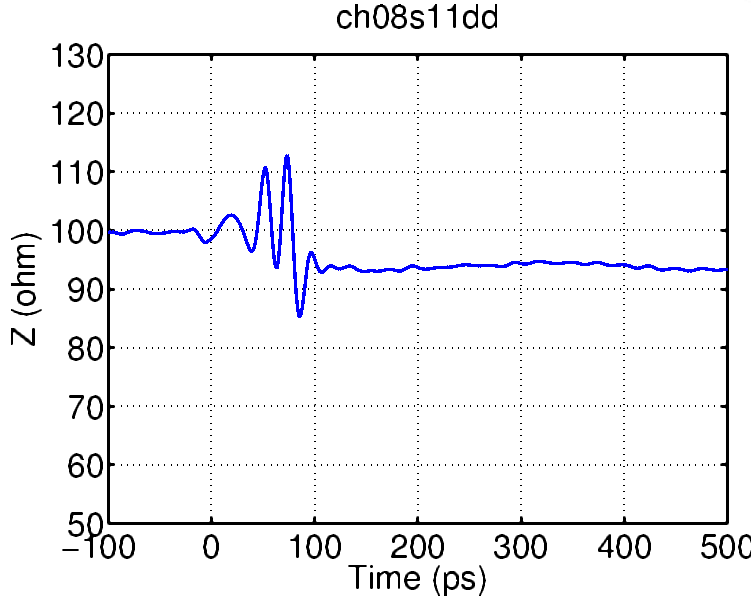
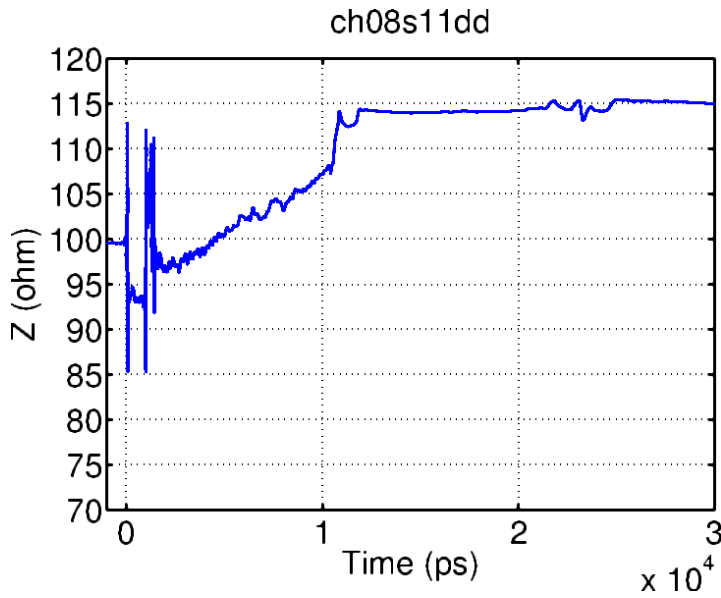
S22dd



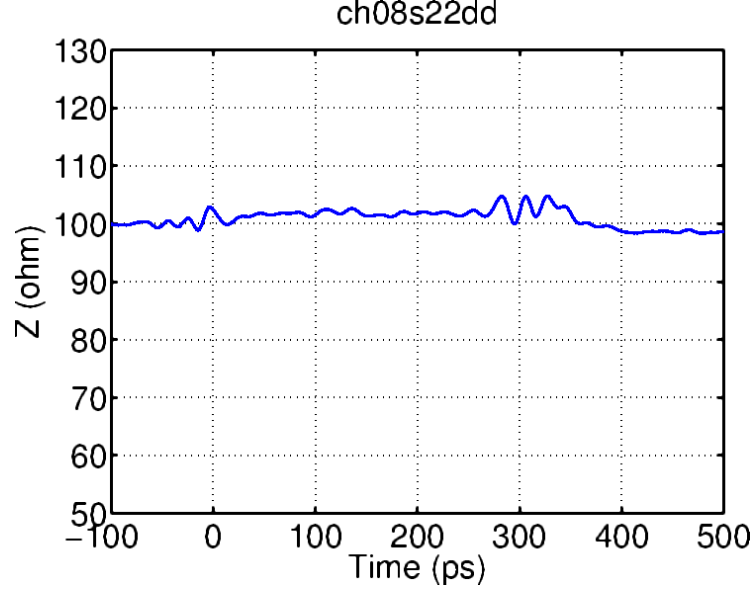
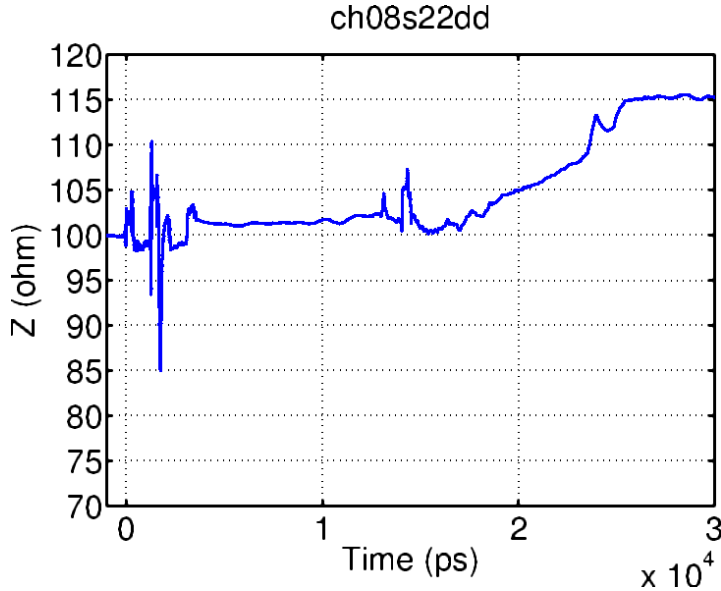
Cisco 30dB Channel (CH8): Zdiff Profile



S11dd



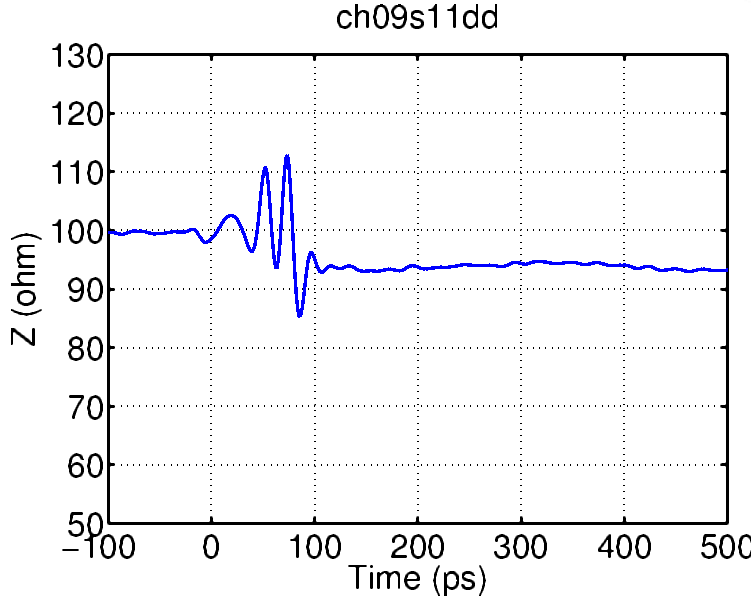
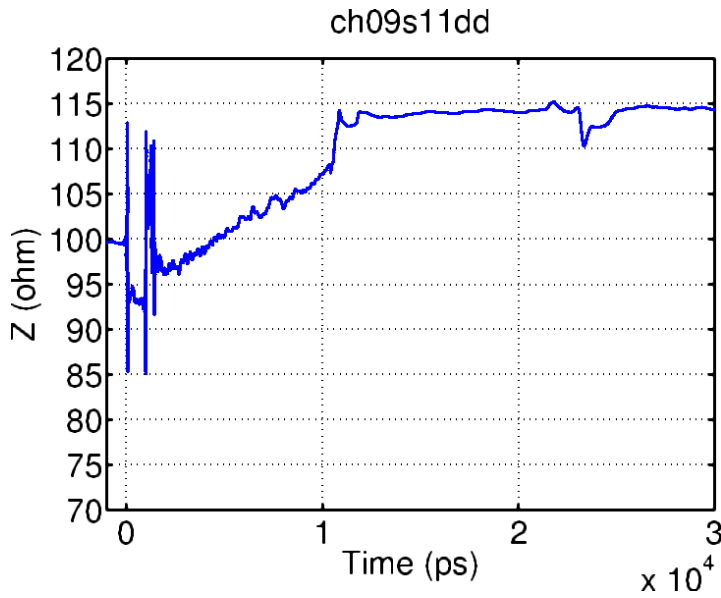
S22dd



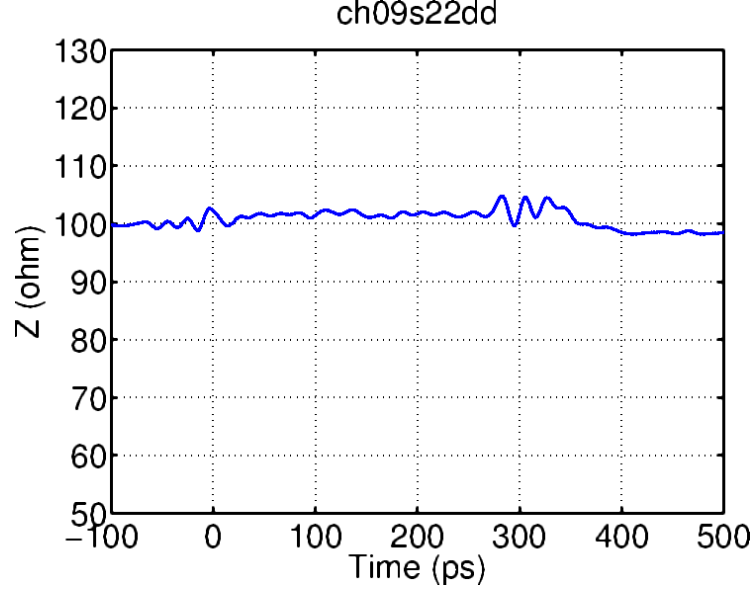
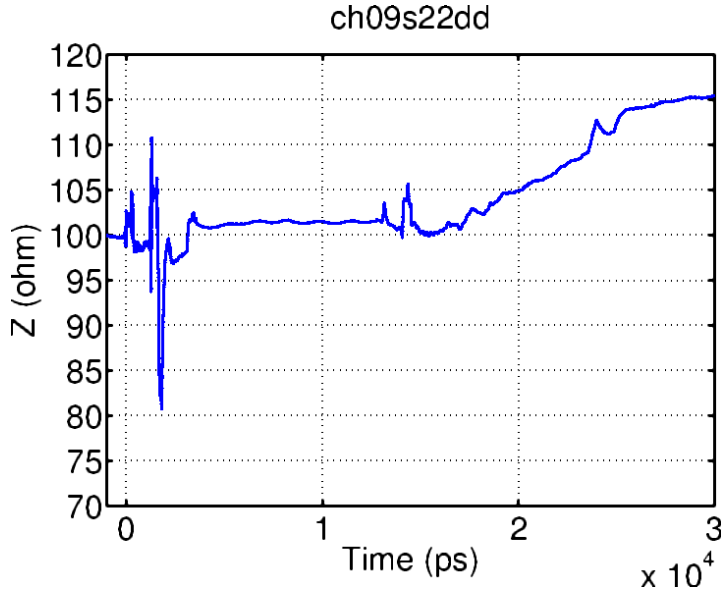
Cisco 33dB Channel (CH9): Zdiff Profile



S11dd

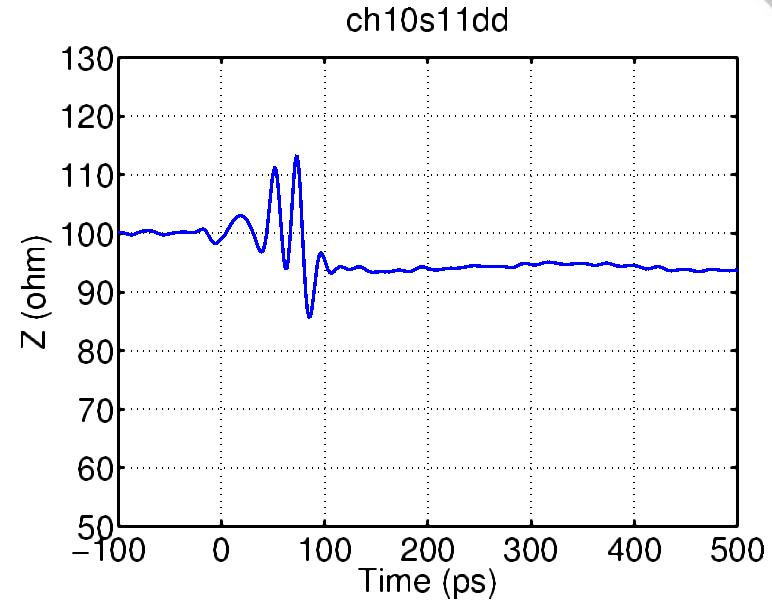
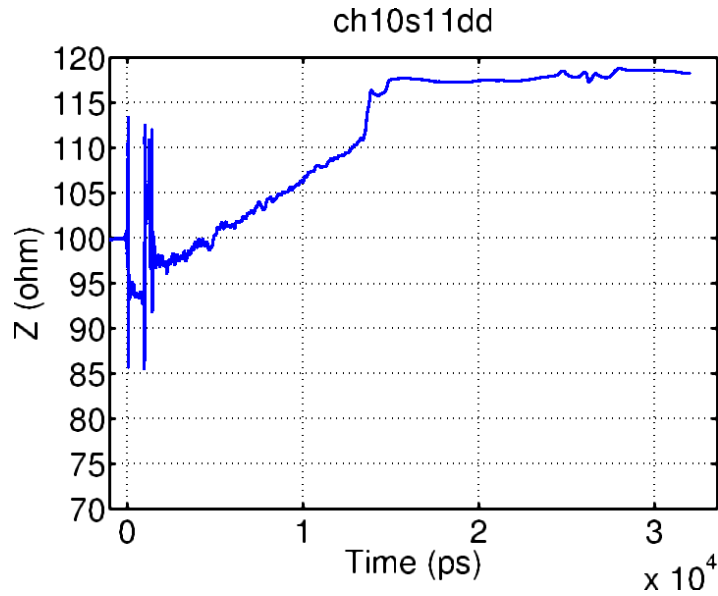


S22dd

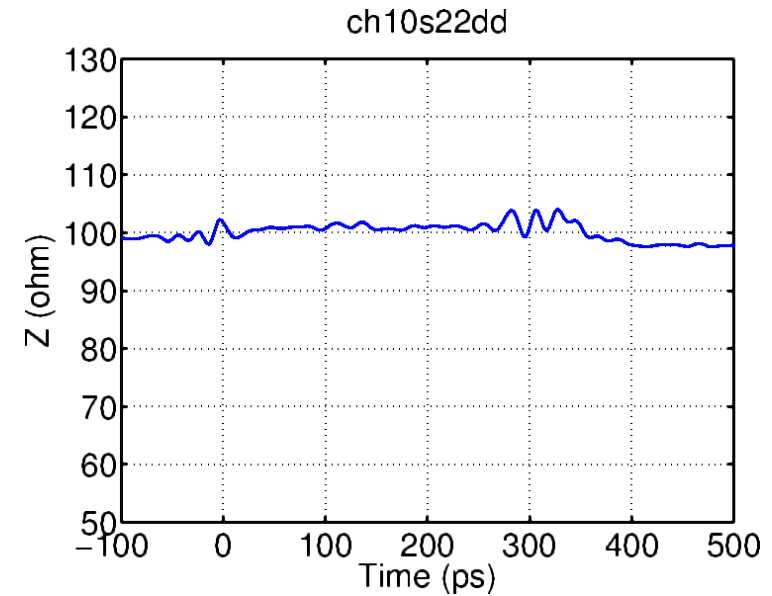
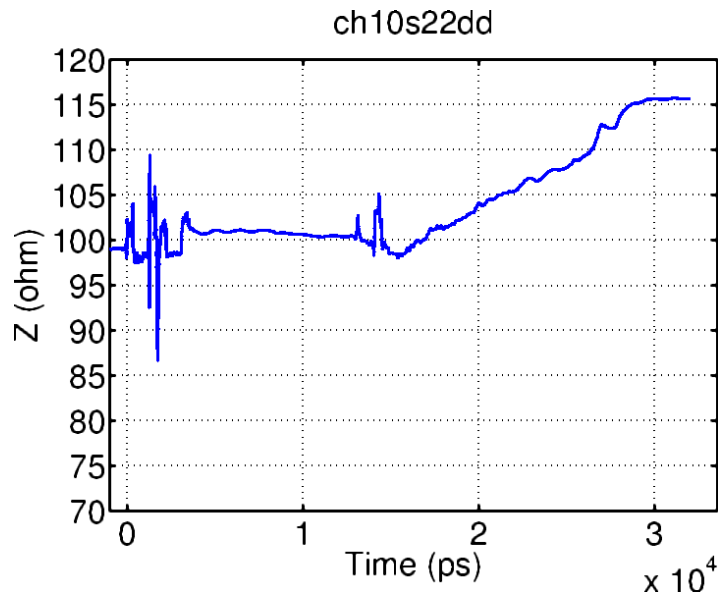


Cisco 35dB Channel (CH10): Zdiff Profile

S11dd



S22dd



Intel 100Ω Channels (CH11-25)

■ Data source (in 50G&NGOATH SG Channel Data Area)

- http://www.ieee802.org/3/50G/public/channel/mellitz_01_021716_??dB_6_channels.zip

■ Characteristics

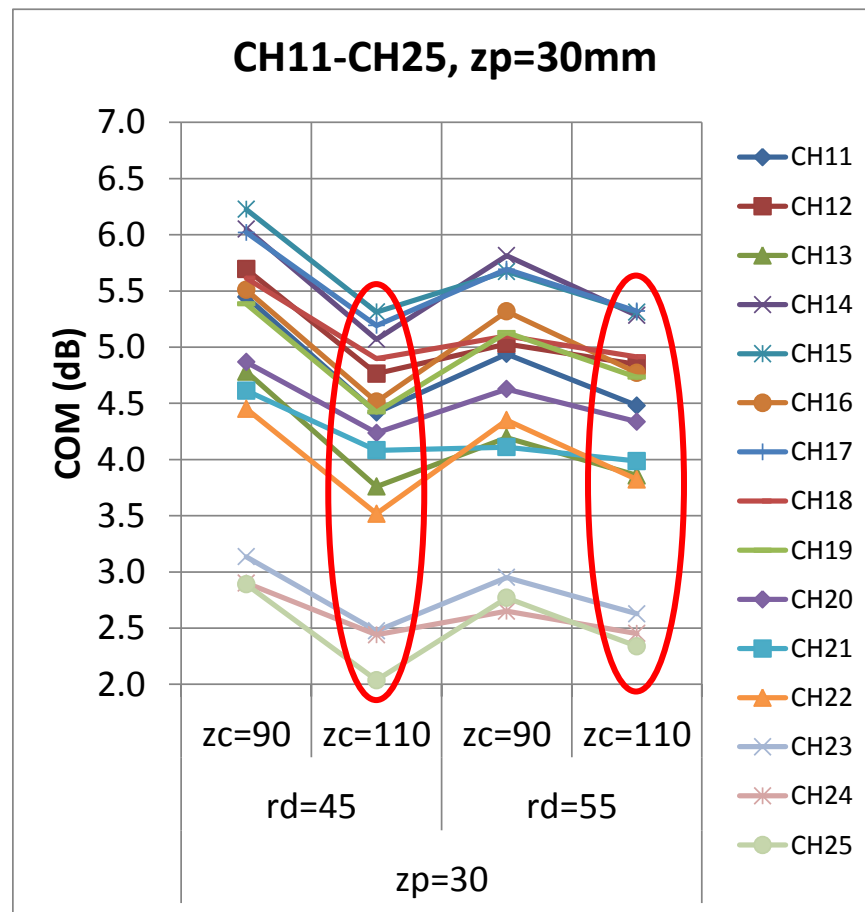
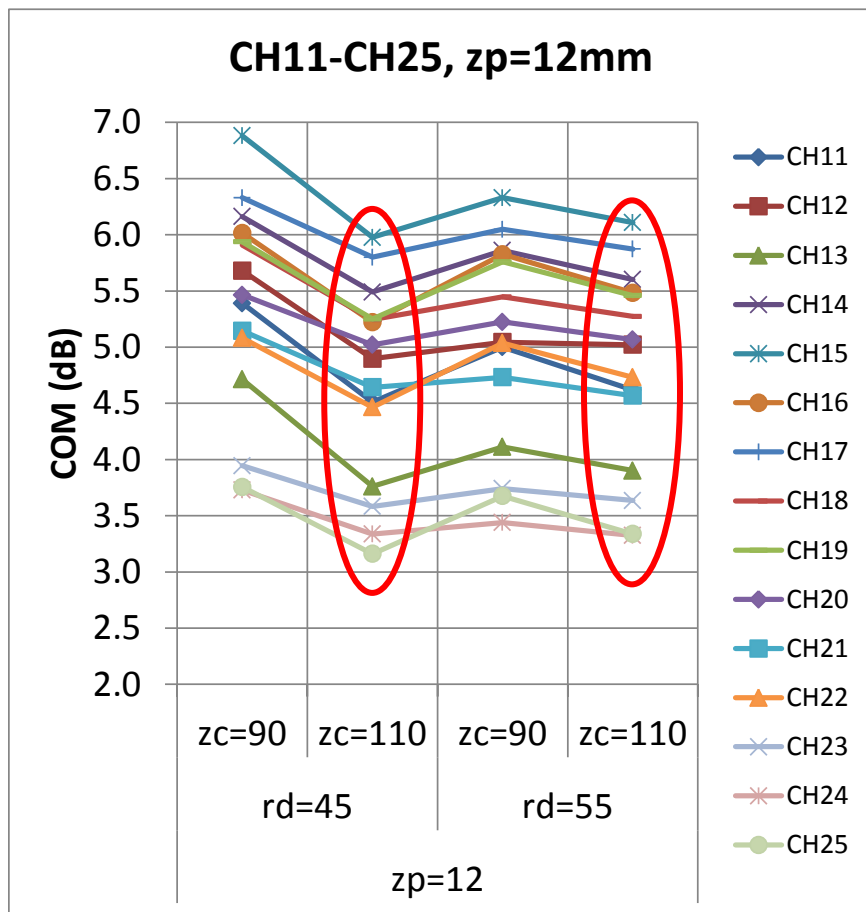
- http://www.ieee802.org/3/50G/public/adhoc/archive/mellitz_021716_50GE_NGOATH_adhoc.pdf
- Approximate IL @ Nyquist : 10dB (CH11/12/13) ~ 30dB (CH23/24/25)
- Crosstalk : 3 FEXT + 4 NEXT

	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH11	Nom	9.7636	0.35085	2.5159
CH12	HzLzHz	9.6743	0.30416	2.5299
CH13	LzHzLz	9.9267	0.33959	2.4796
CH14	Nom	14.8063	0.25593	1.6857
CH15	HzLzHz	15.1217	0.25119	1.6854
CH16	LzHzLz	15.0295	0.27047	1.7122
CH17	Nom	19.9038	0.23598	1.4094
CH18	HzLzHz	19.7834	0.23241	1.4131
CH19	LzHzLz	19.789	0.2501	1.3863

	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH20	Nom	24.9191	0.23847	1.2603
CH21	HzLzHz	24.8017	0.22766	1.2846
CH22	LzHzLz	24.8212	0.2604	1.2331
CH23	Nom	29.9563	0.24648	1.1876
CH24	HzLzHz	29.7874	0.22562	1.214
CH25	LzHzLz	29.8354	0.2849	1.1574

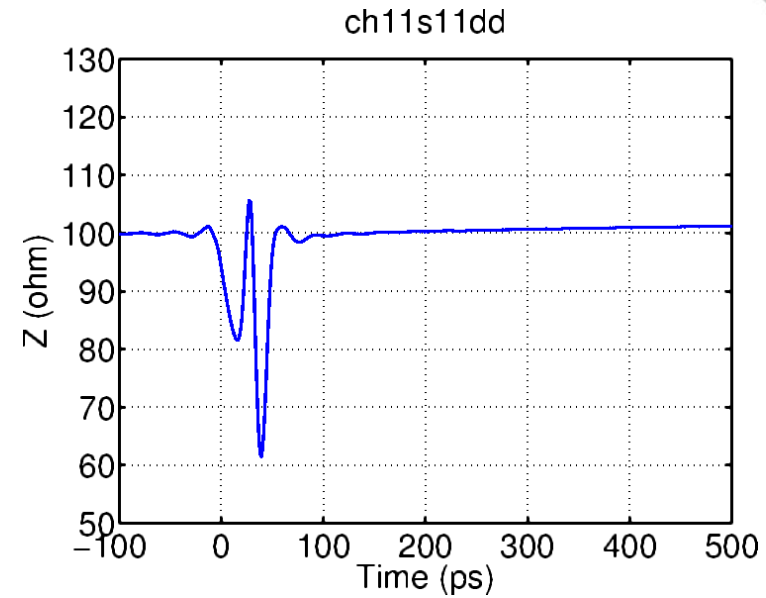
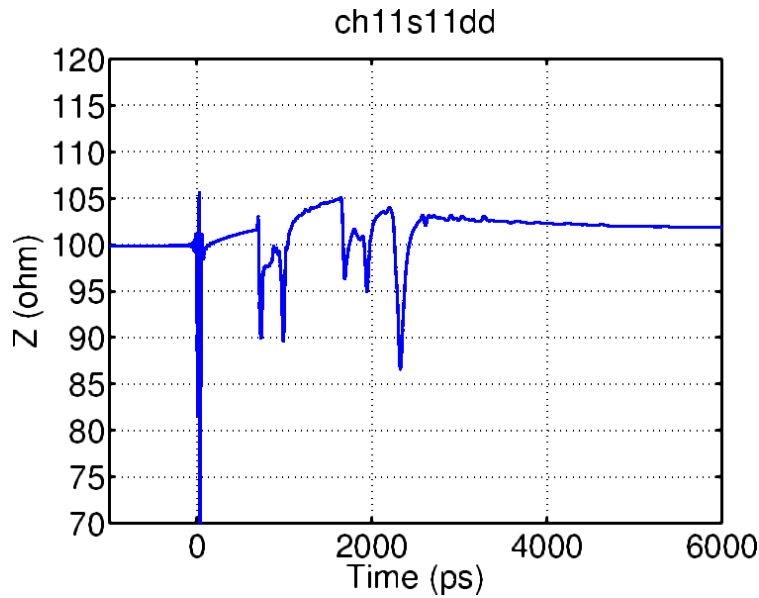
Intel 100Ω Channels (CH11-25): COM Values

- The worst case is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=90\Omega$ & $R_d=55\Omega$ is better than $Z_c=110\Omega$ & $R_d=45\Omega$ or 55Ω
 - $z_p=30\text{mm}$ is worse than 12mm

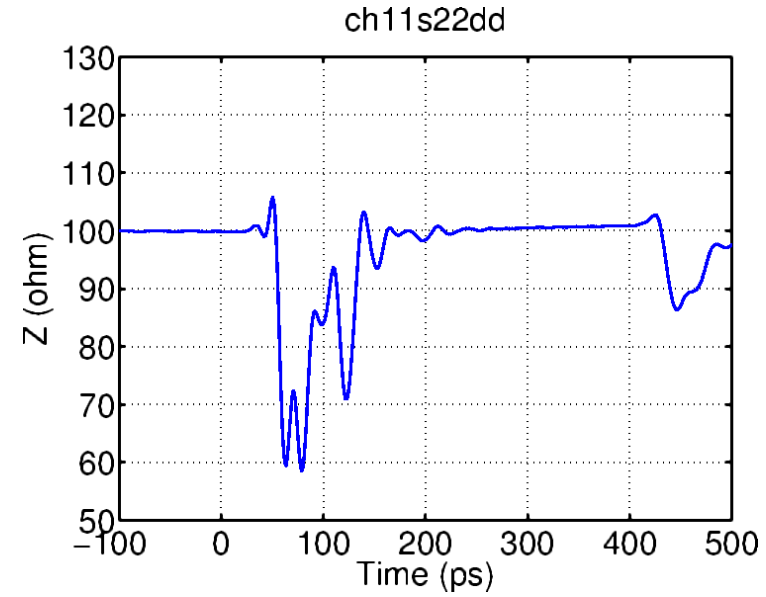
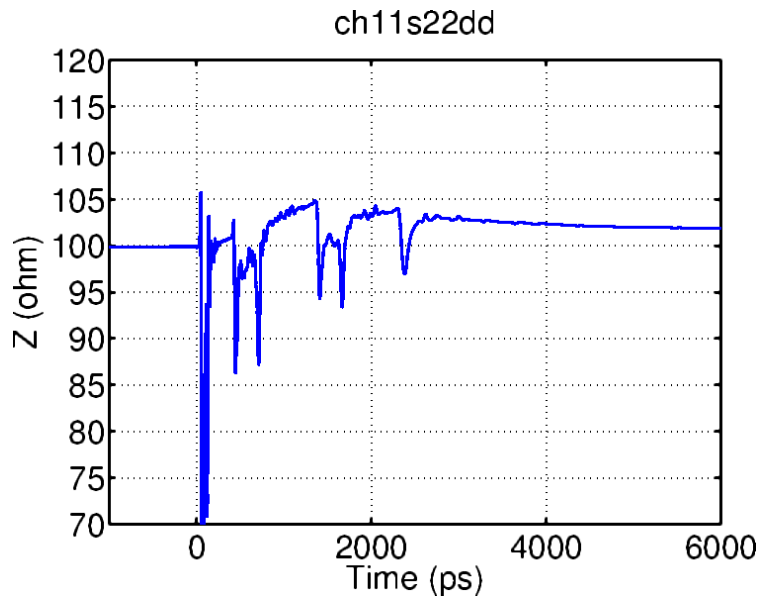


Intel 100Ω 10dB Nom (CH11): Zdiff Profile

S11dd

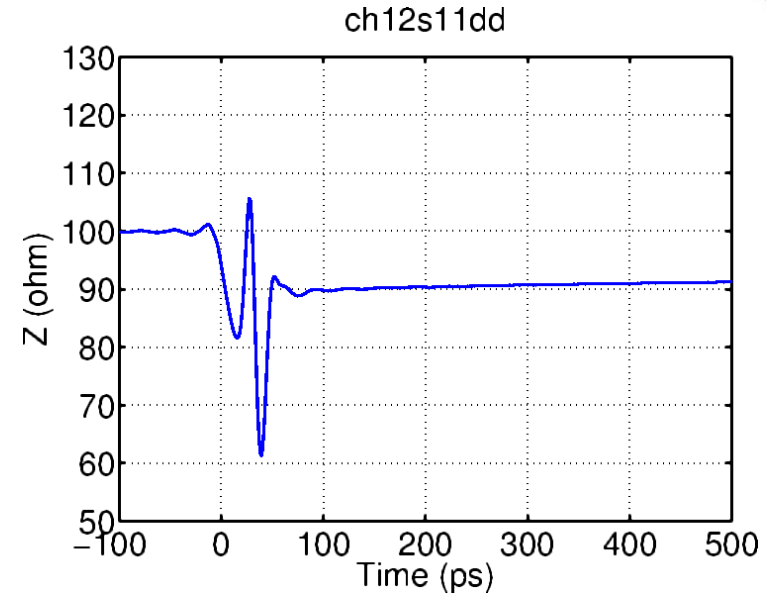
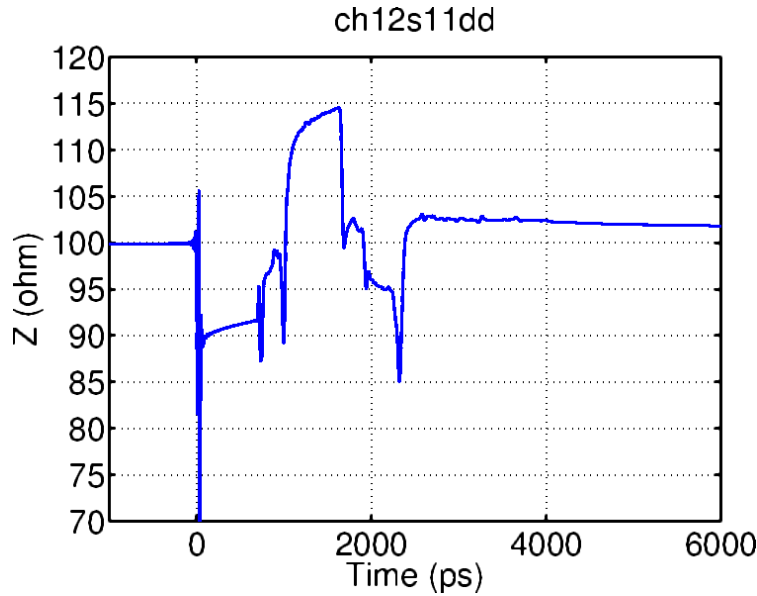


S22dd

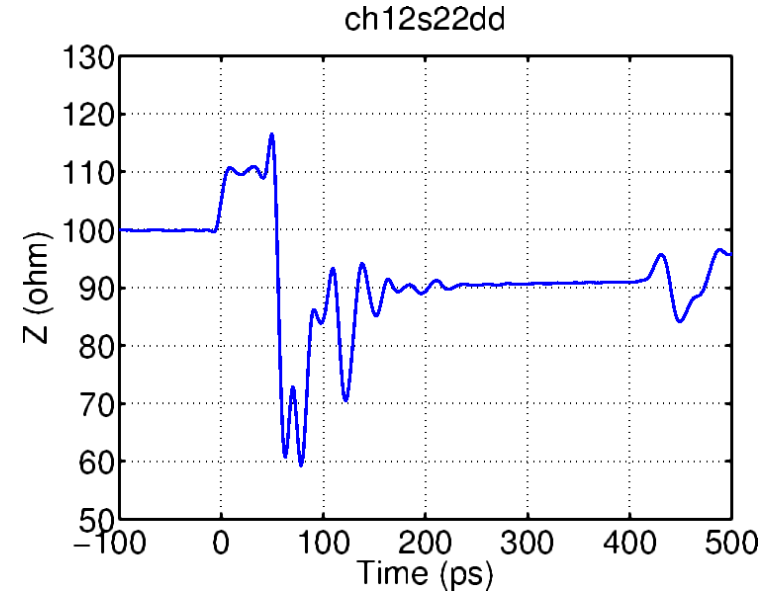
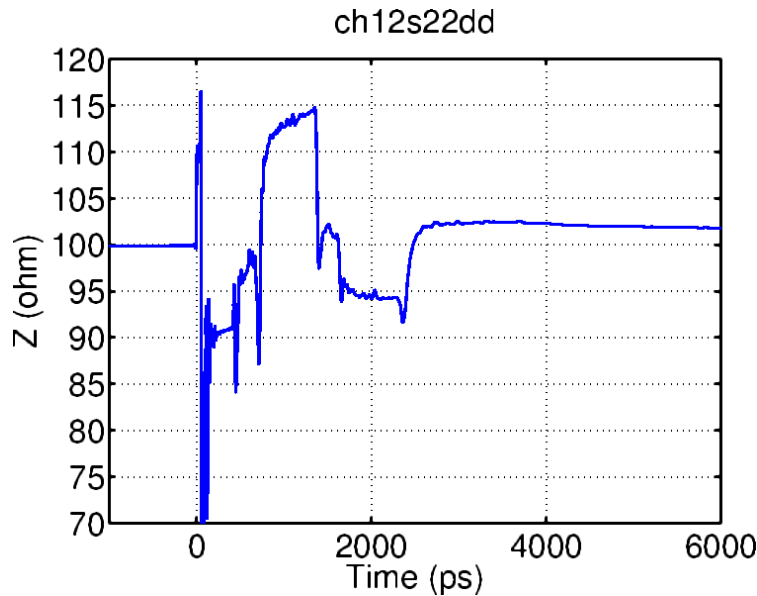


Intel 100Ω 10dB HzLzHz (CH12): Zdiff Profile

S11dd



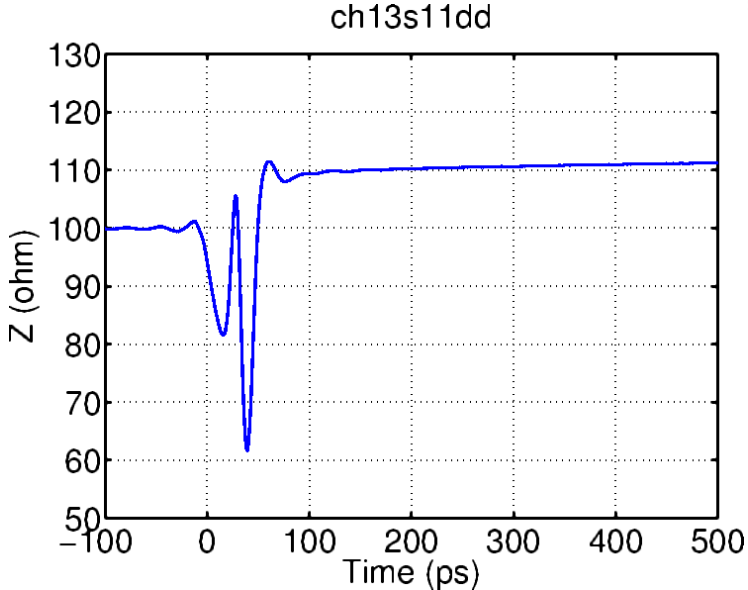
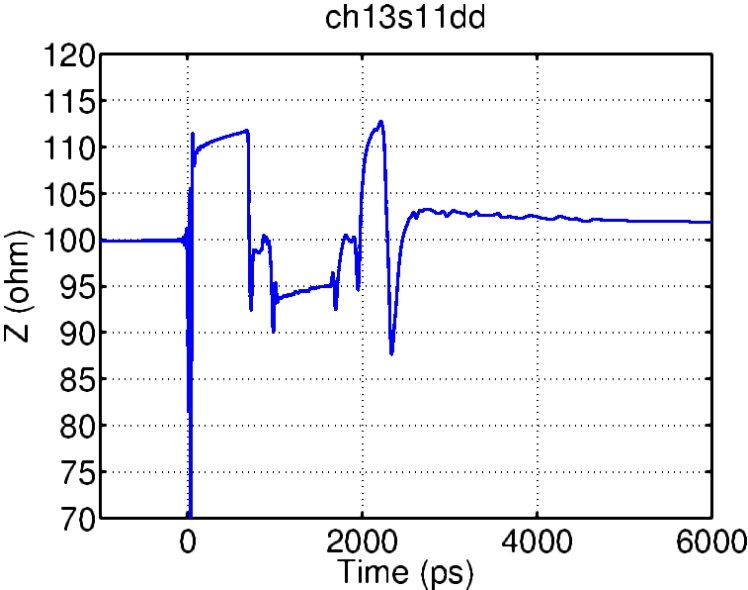
S22dd



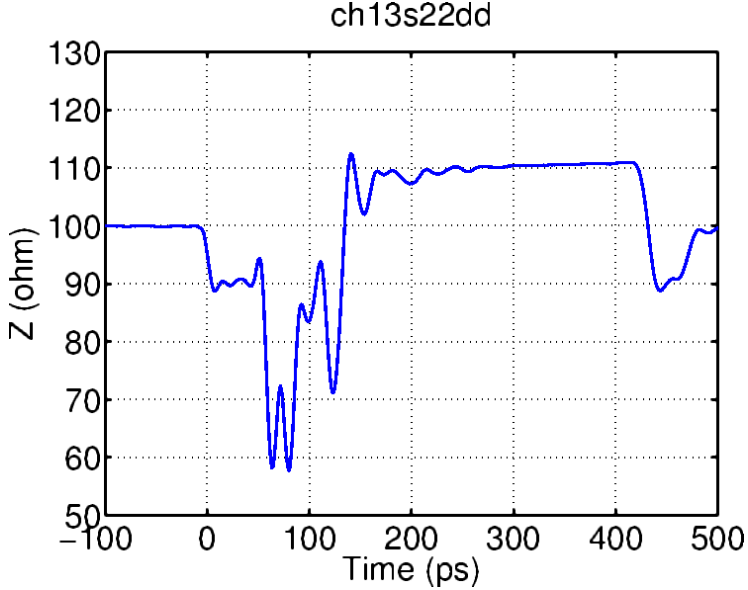
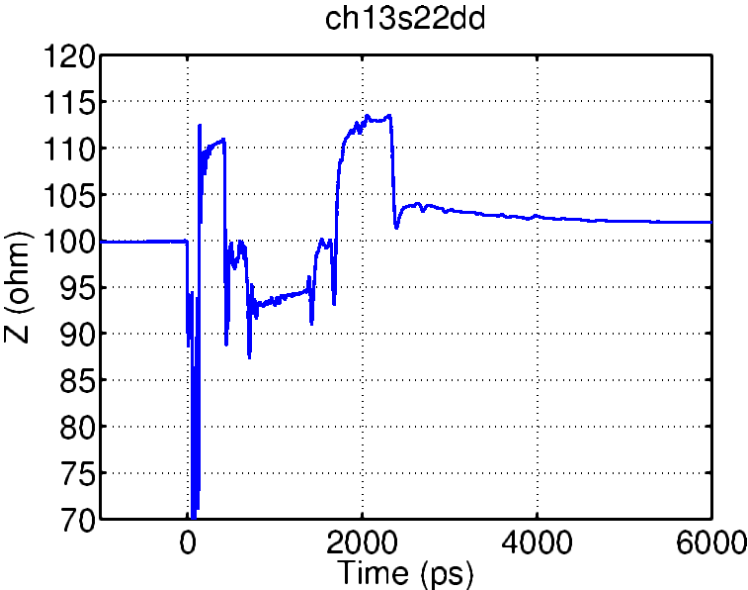
Intel 100Ω 10dB LzHzLz (CH13): Zdiff Profile



S11dd

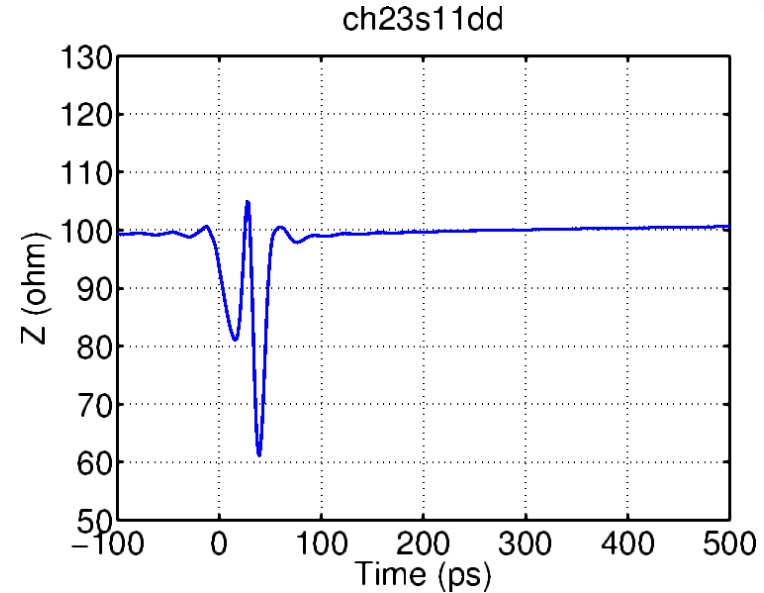
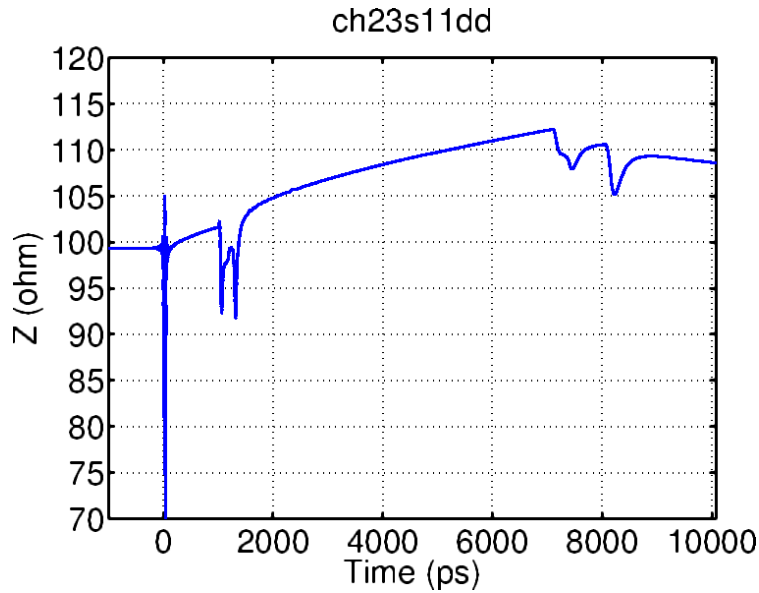


S22dd

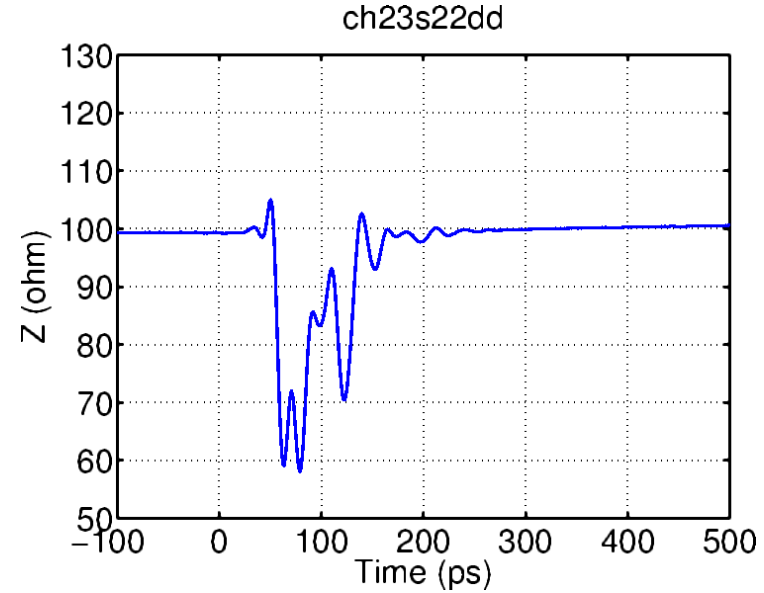
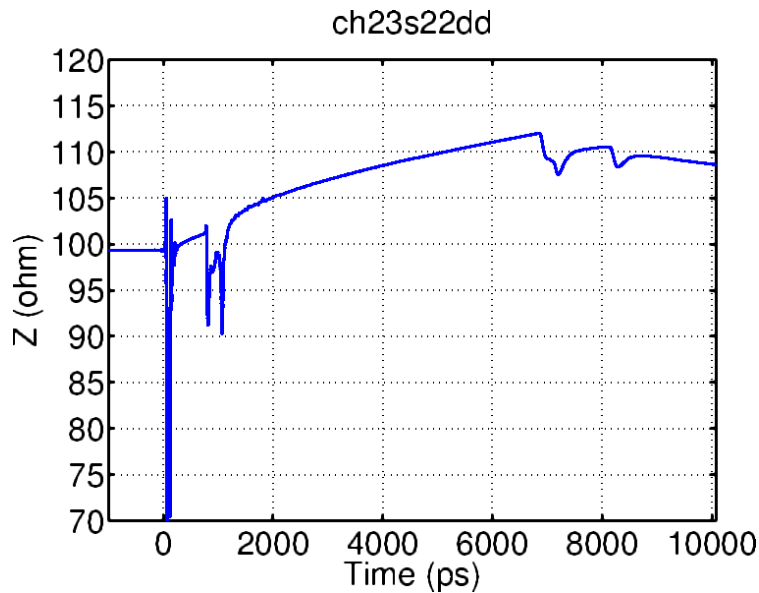


Intel 100Ω 30dB Nom (CH23): Zdiff Profile

S11dd

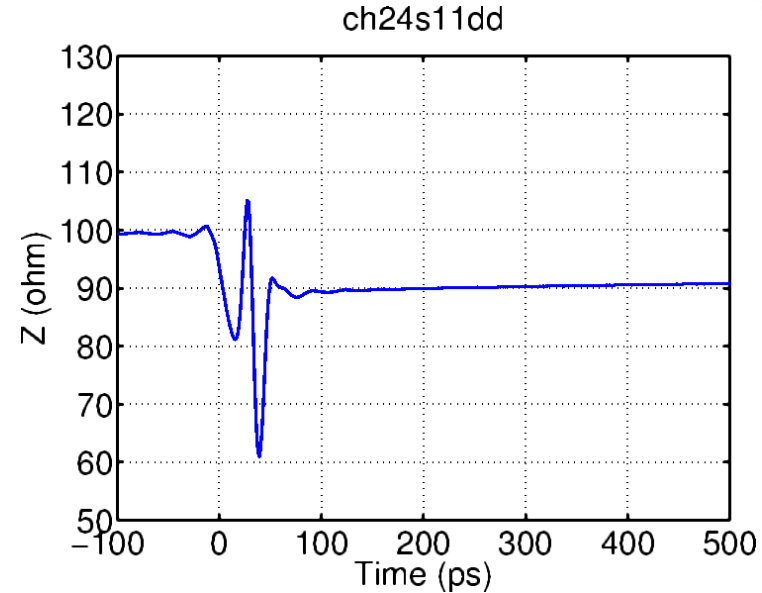
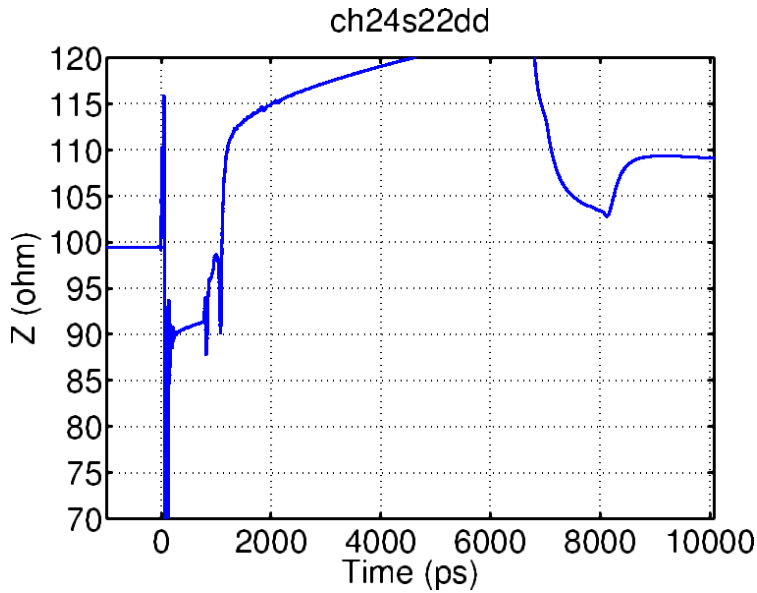


S22dd

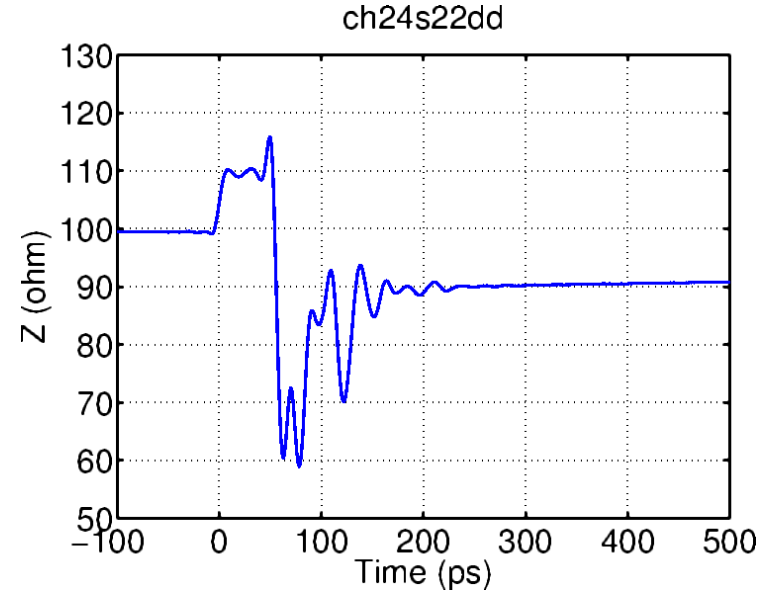
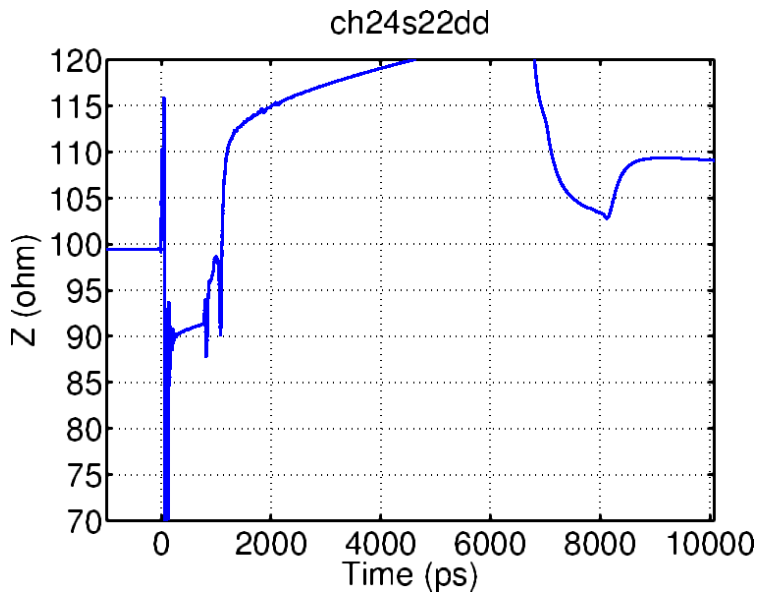


Intel 100Ω 30dB HzLzHz (CH24): Zdiff Profile

S11dd



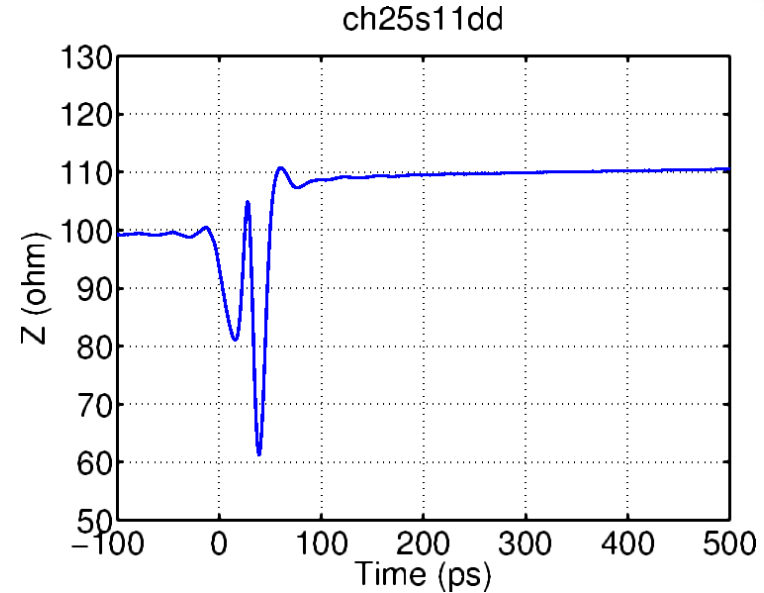
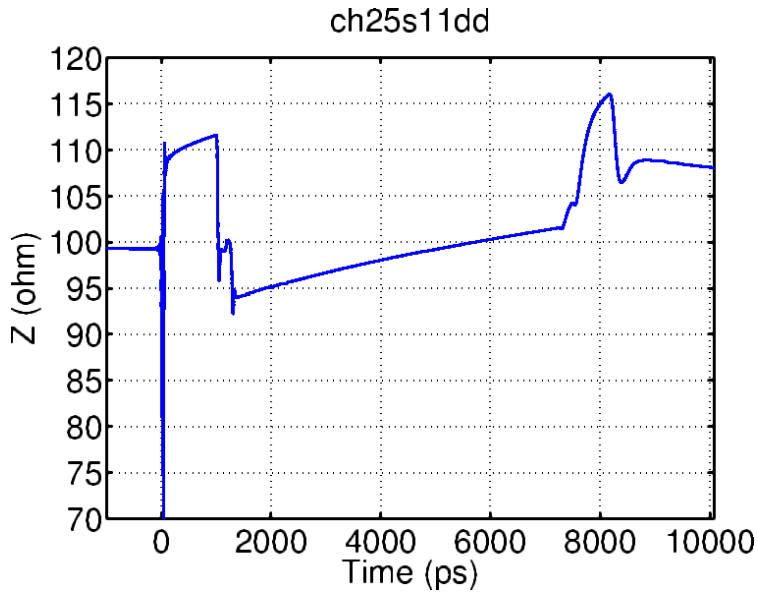
S22dd



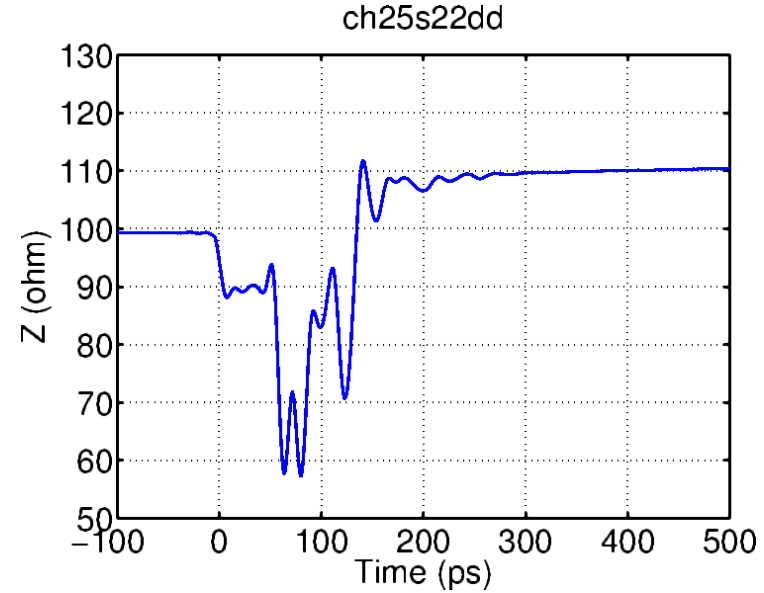
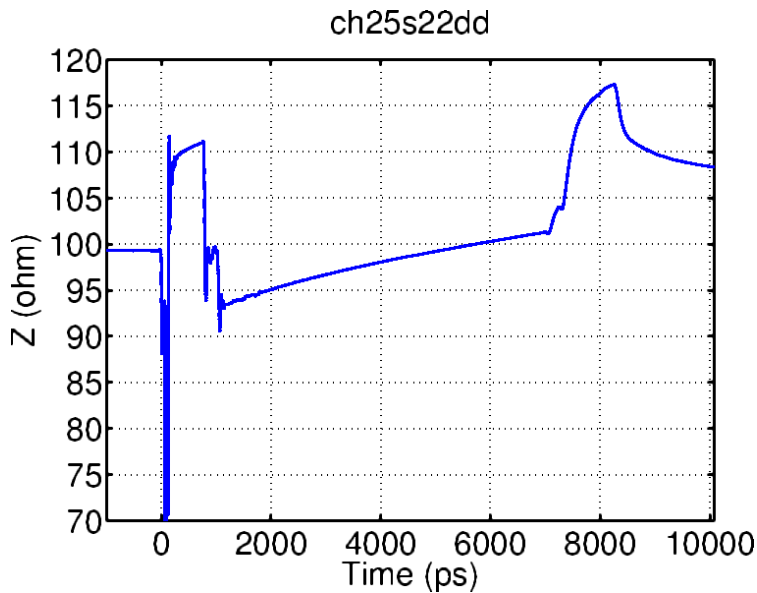
Intel 100Ω 30dB LzHzLz (CH25): Zdiff Profile



S11dd



S22dd



Intel 85Ω Channels (CH26-40)

■ Data source (in 50G&NGOATH SG Channel Data Area)

- http://www.ieee802.org/3/50G/public/channel/mellitz_01_021716_??dB_6_channels.zip

■ Characteristics

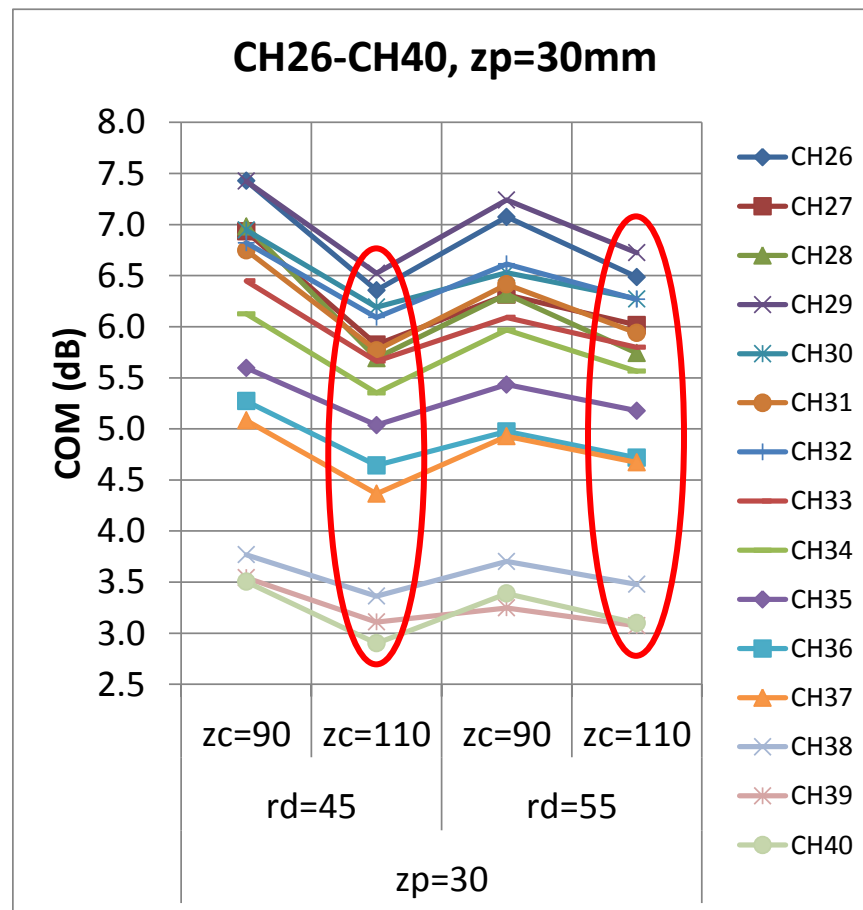
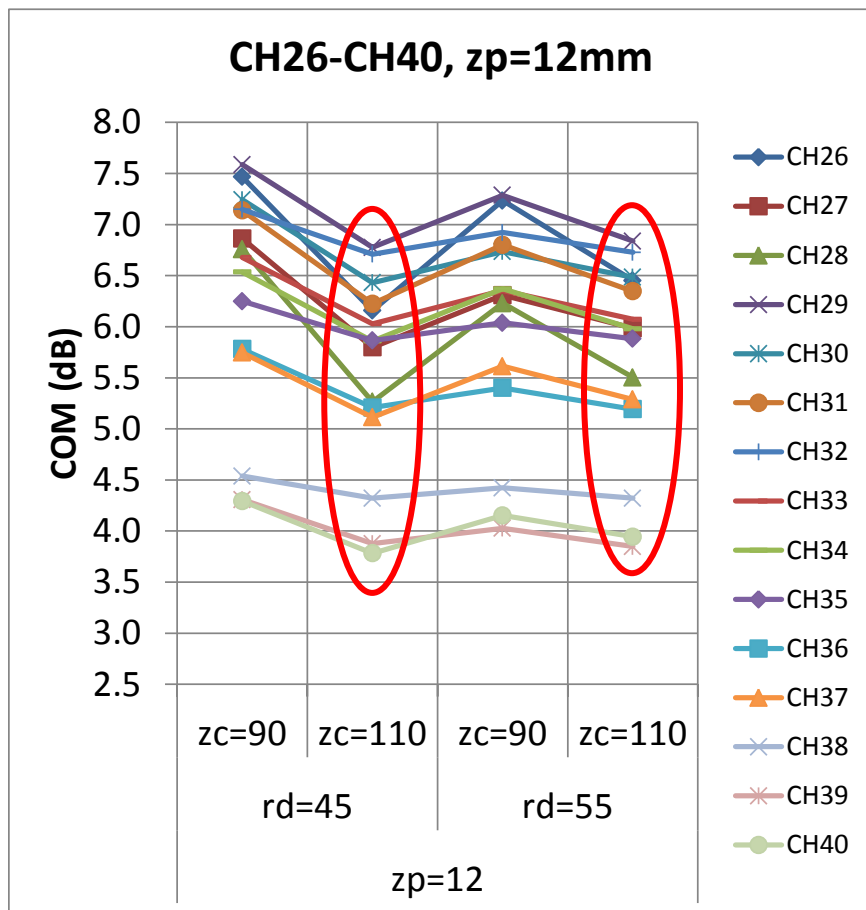
- http://www.ieee802.org/3/50G/public/adhoc/archive/mellitz_021716_50GE_NGOATH_adhoc.pdf
- Approximate IL @ Nyquist : 10dB (CH26/27/28) ~ 30dB (CH38/39/40)
- Crosstalk : 3 FEXT + 4 NEXT

	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH26	Nom	9.7602	0.21802	2.4937
CH27	HzLzHz	9.6093	0.22831	2.4977
CH28	LzHzLz	9.9398	0.23882	2.4522
CH29	Nom	14.6258	0.17817	1.6748
CH30	HzLzHz	15.1722	0.1794	1.6546
CH31	LzHzLz	14.8594	0.20324	1.6914
CH32	Nom	19.7787	0.16126	1.3745
CH33	HzLzHz	19.8607	0.16948	1.3622
CH34	LzHzLz	19.5802	0.1991	1.3502

	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH35	Nom	24.7794	0.16223	1.2236
CH36	HzLzHz	24.9387	0.16377	1.2332
CH37	LzHzLz	24.5843	0.21914	1.2003
CH38	Nom	29.8285	0.17168	1.1554
CH39	HzLzHz	29.9952	0.16709	1.1665
CH40	LzHzLz	29.568	0.27329	1.1305

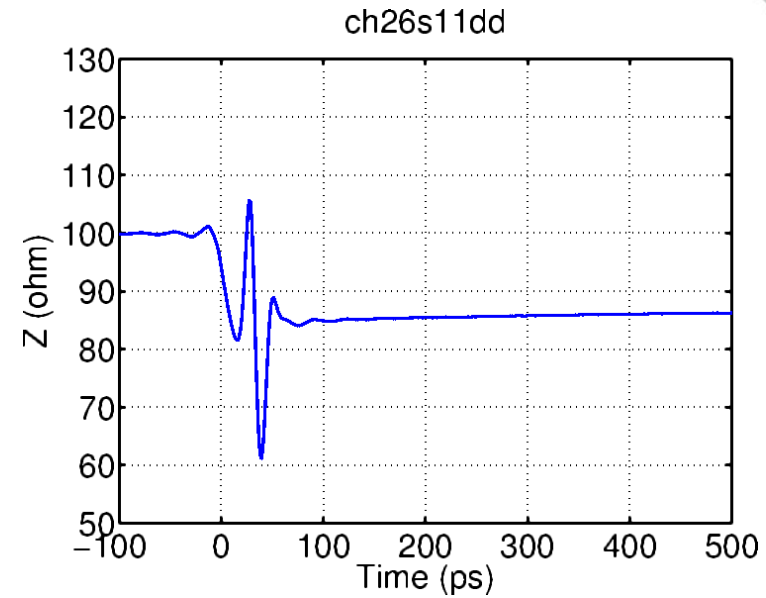
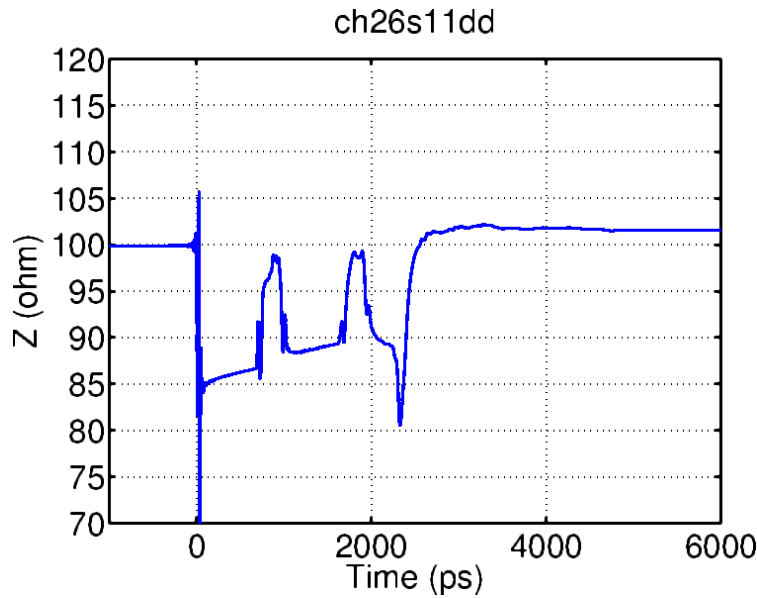
Intel 85Ω Channels (CH26-40): COM Values

- The worst case is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $Z_c=90\Omega$ & $R_d=55\Omega$ is better than $Z_c=110\Omega$ & $R_d=45\Omega$ or 55Ω
 - $z_p=30\text{mm}$ is worse than 12mm except CH26~28 where 12mm is worse

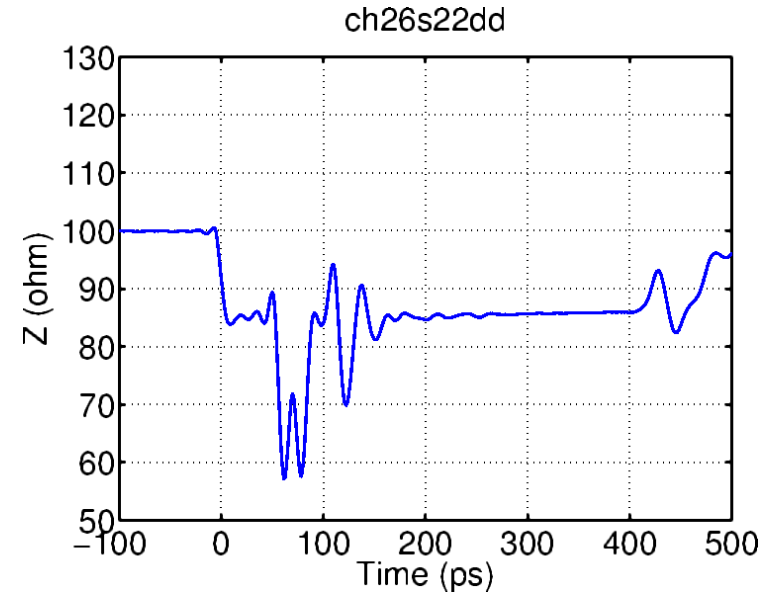
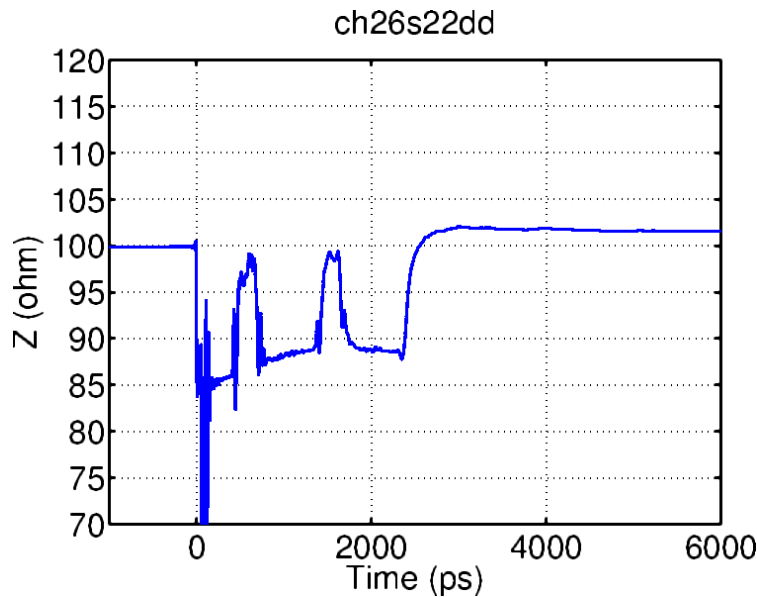


Intel 85Ω 10dB Nom (CH26): Zdiff Profile

S11dd



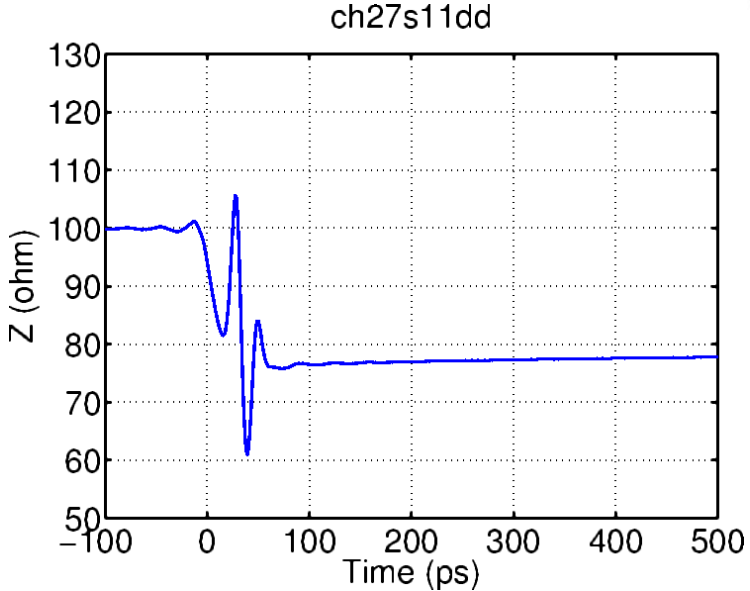
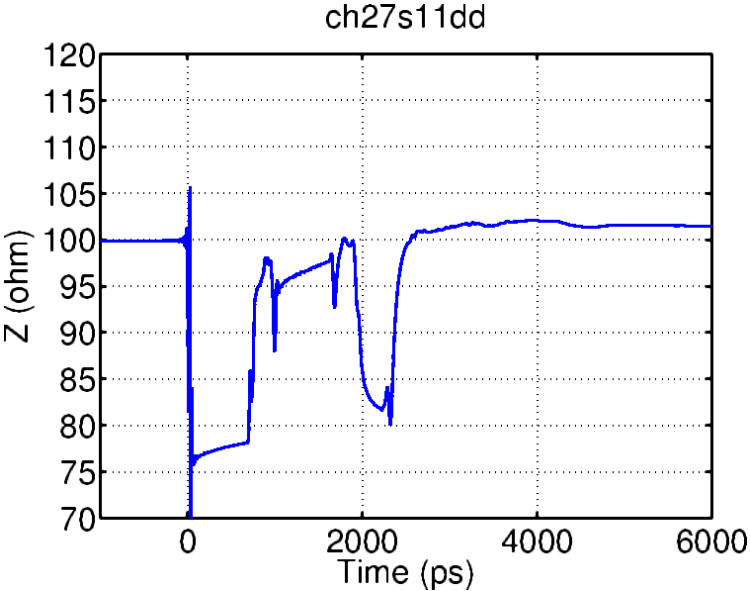
S22dd



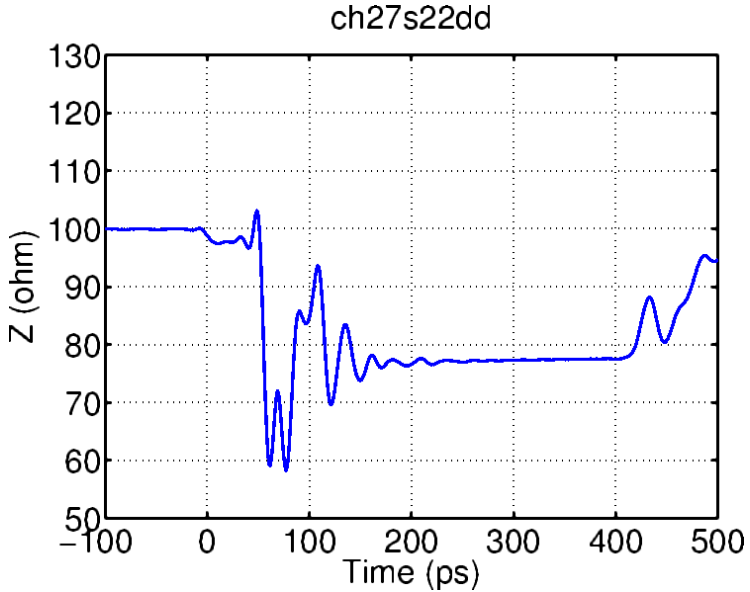
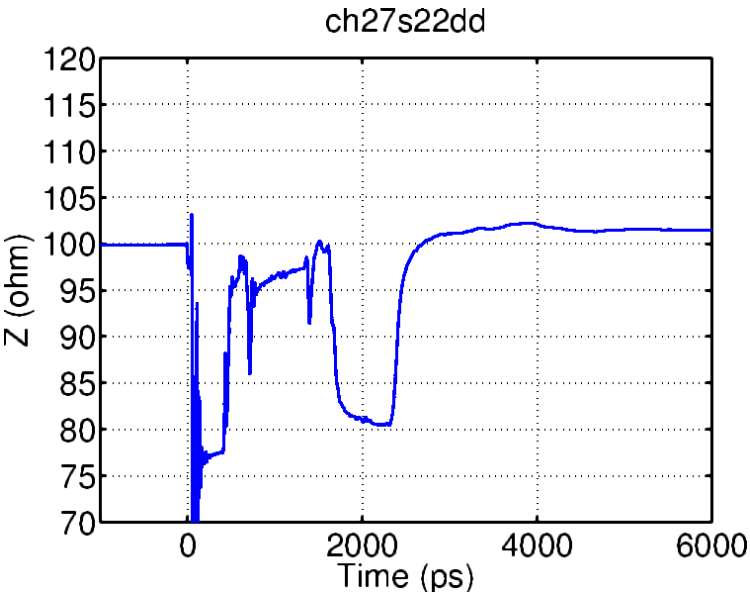
Intel 85Ω 10dB HzLzHz (CH27): Zdiff Profile



S11dd

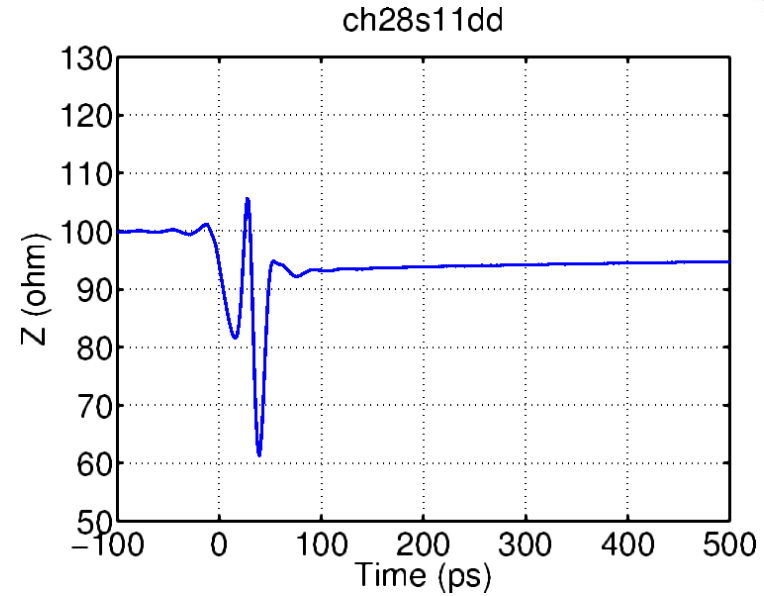
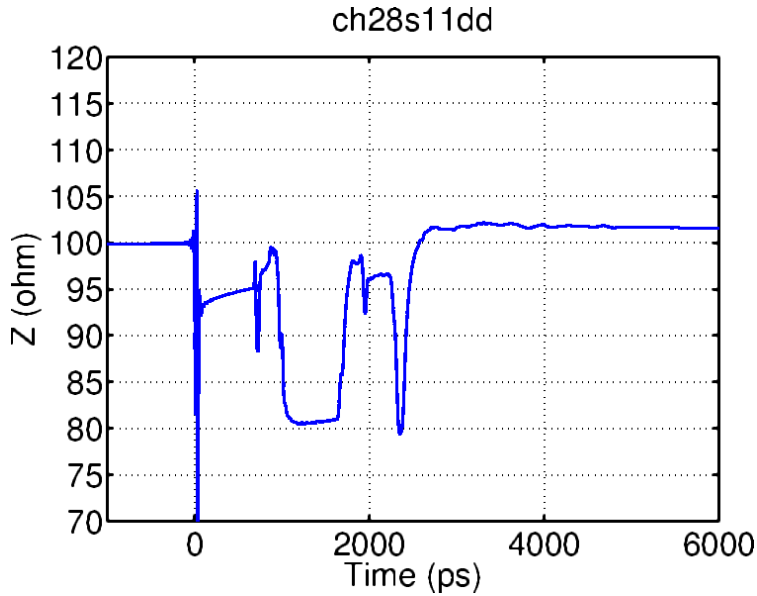


S22dd

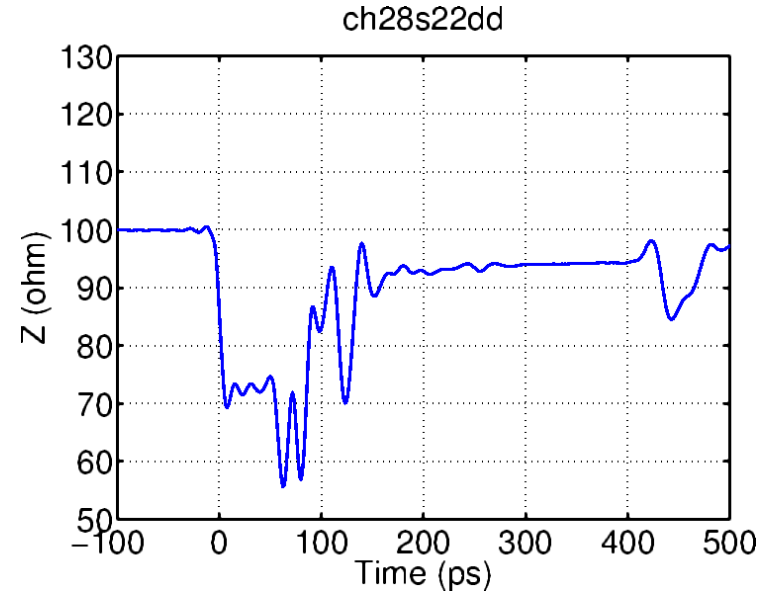
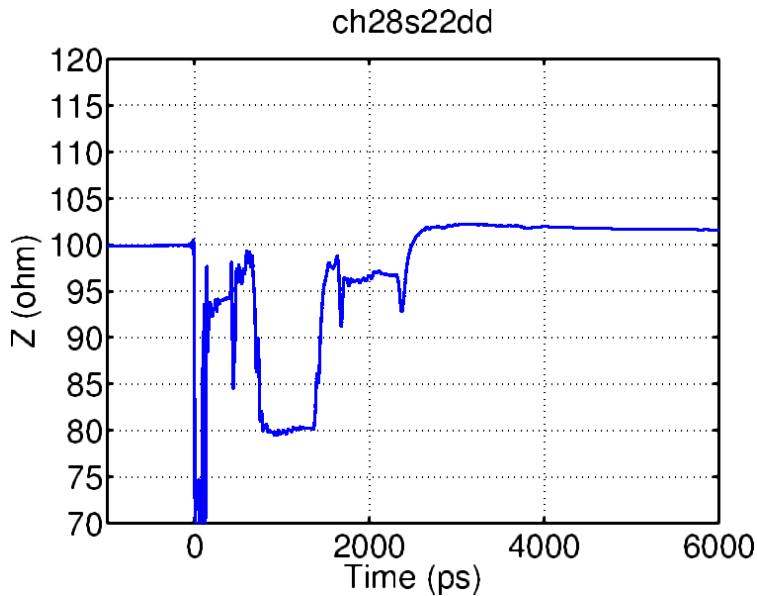


Intel 85Ω 10dB LzHzLz (CH28): Zdiff Profile

S11dd

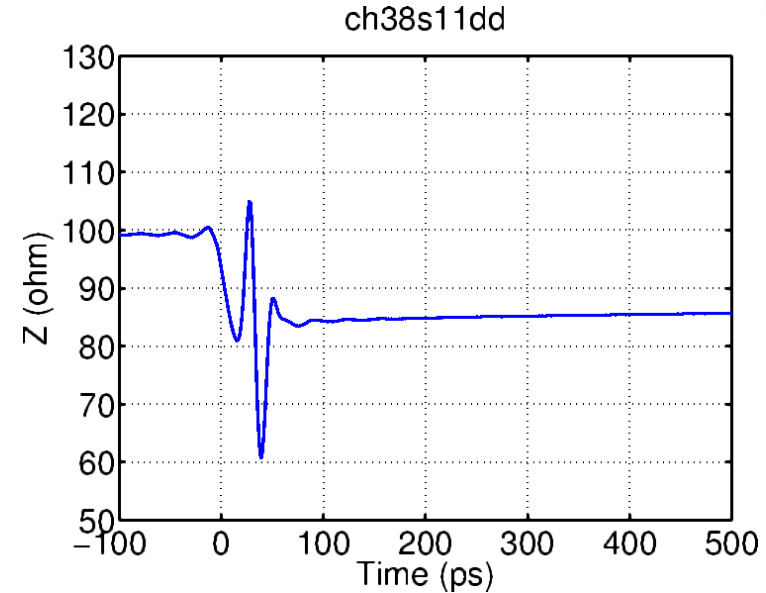
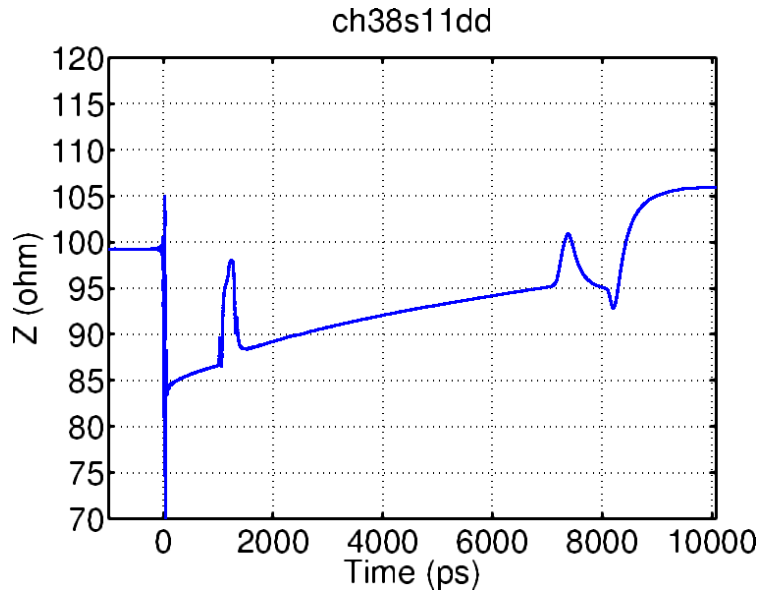


S22dd

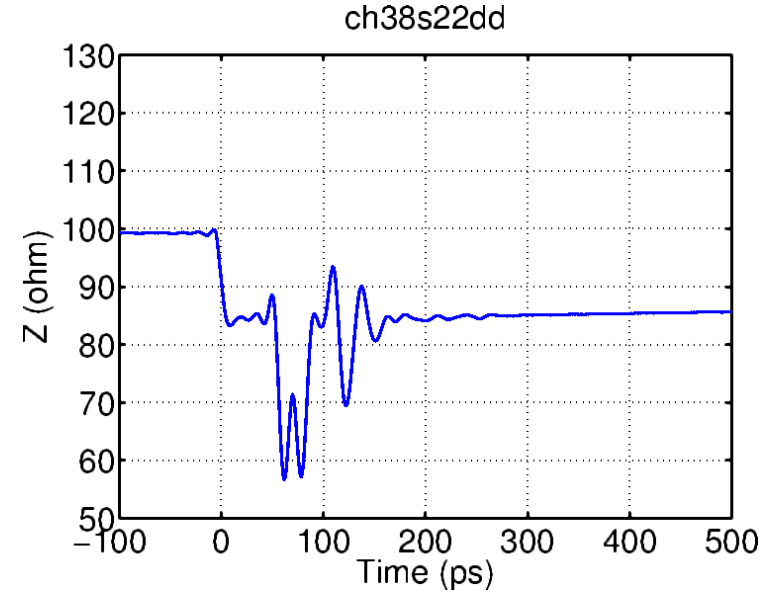
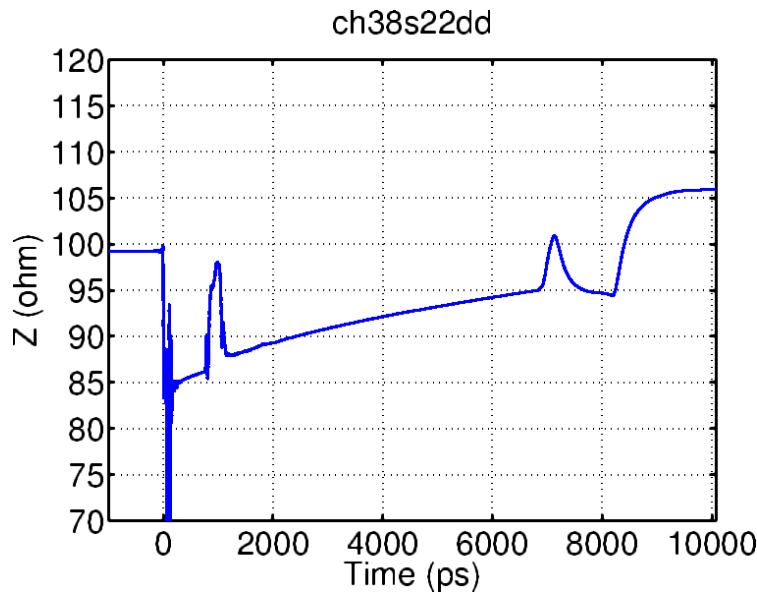


Intel 85Ω 30dB Nom (CH38): Zdiff Profile

S11dd

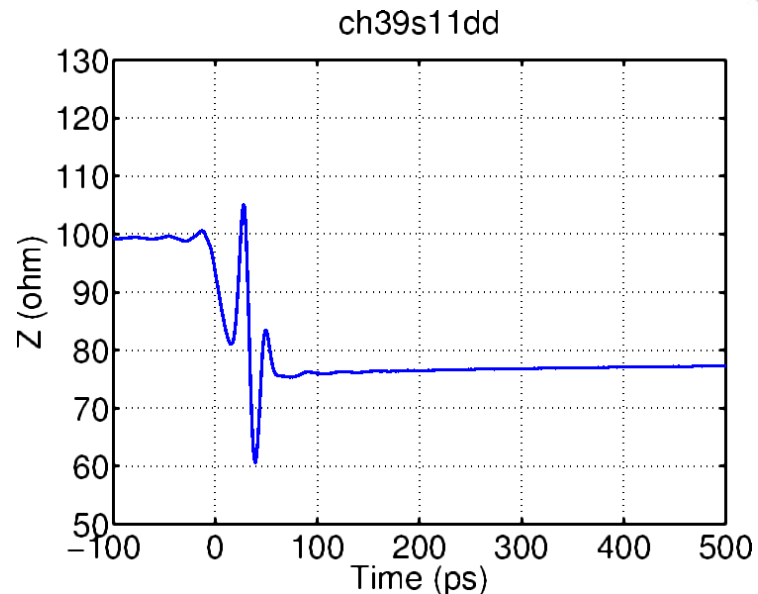
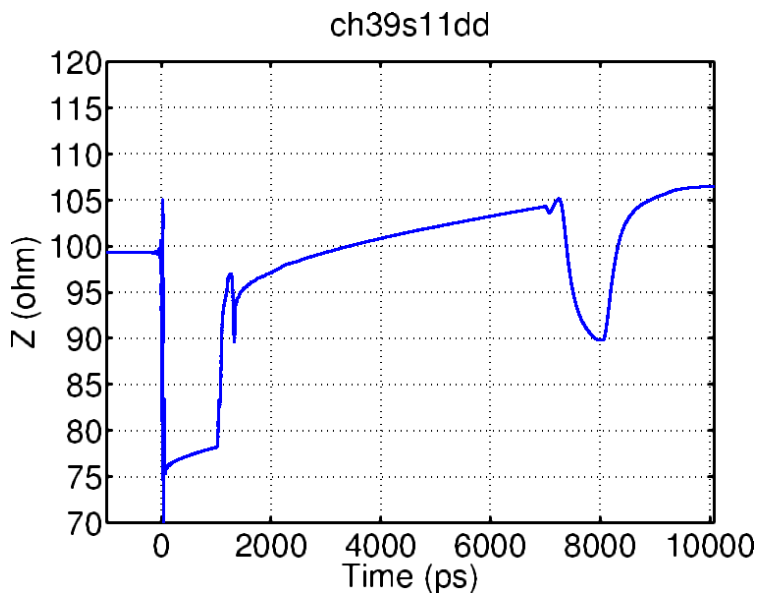


S22dd

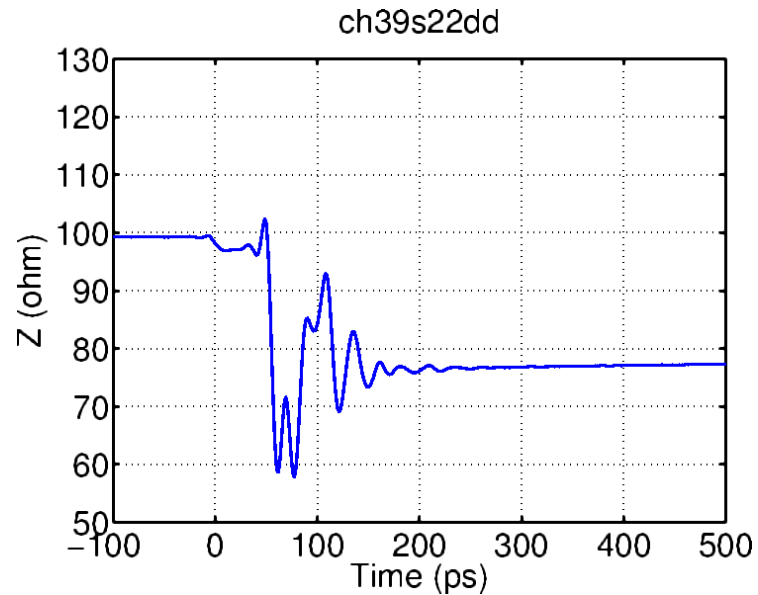
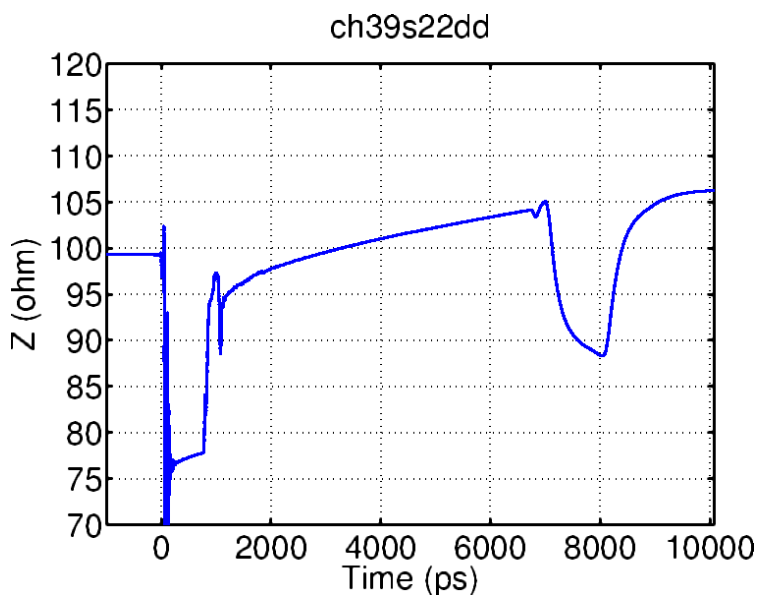


Intel 85Ω 30dB HzLzHz (CH39): Zdiff Profile

S11dd

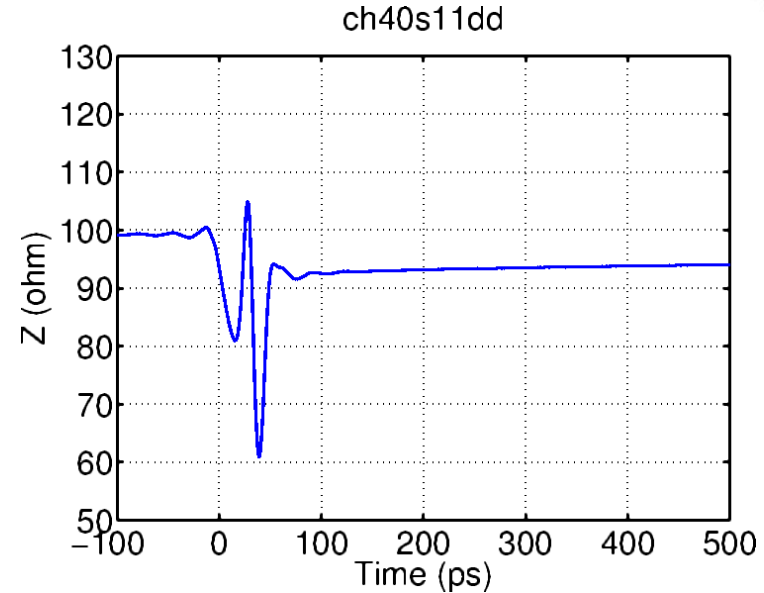
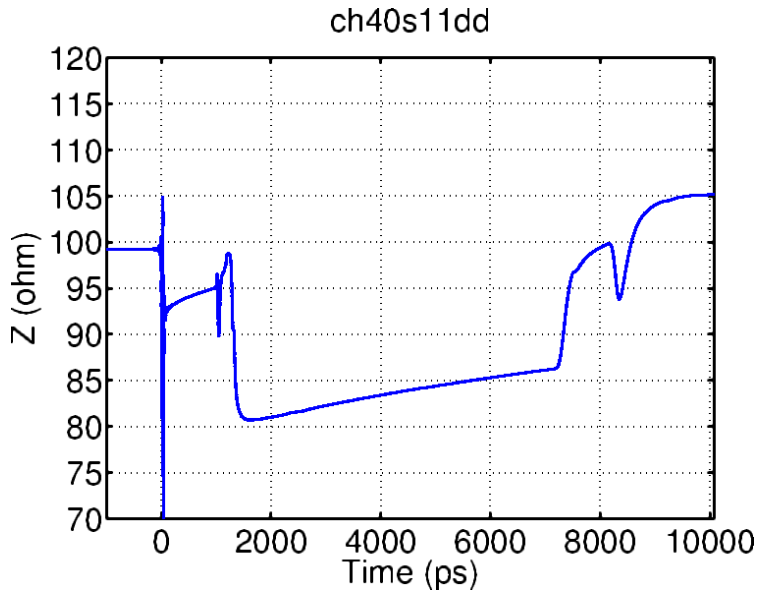


S22dd

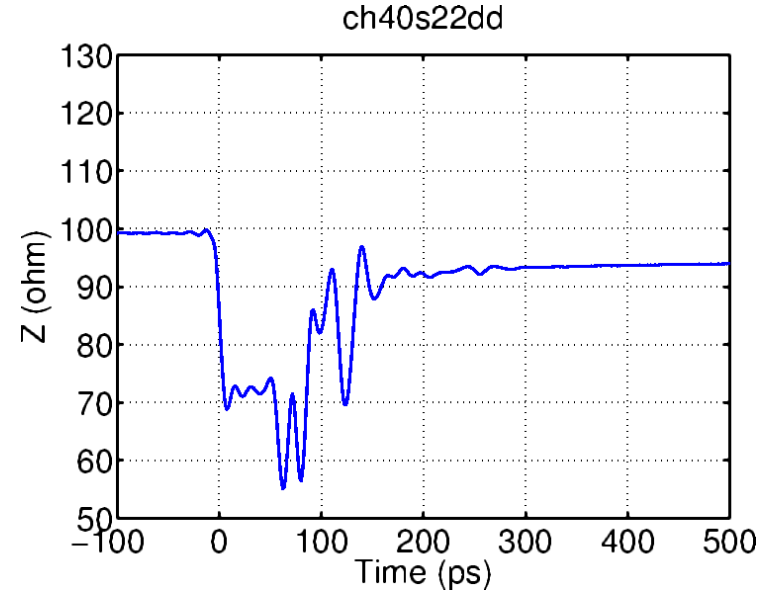
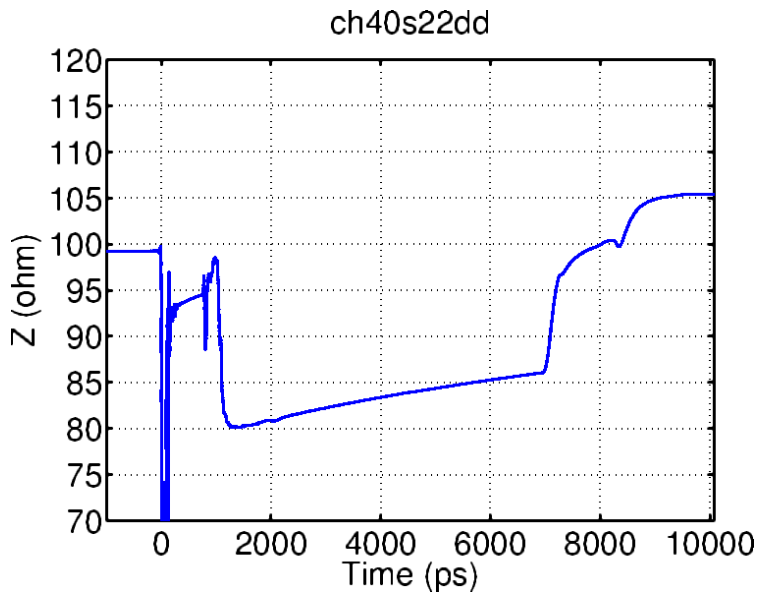


Intel 85Ω 30dB LzHzLz (CH40): Zdiff Profile

S11dd



S22dd



■ Data source (in P802.3cd TF Channel Data Area)

- http://www.ieee802.org/3/cd/public/channel/TEC_STRADAWhisper*.zip

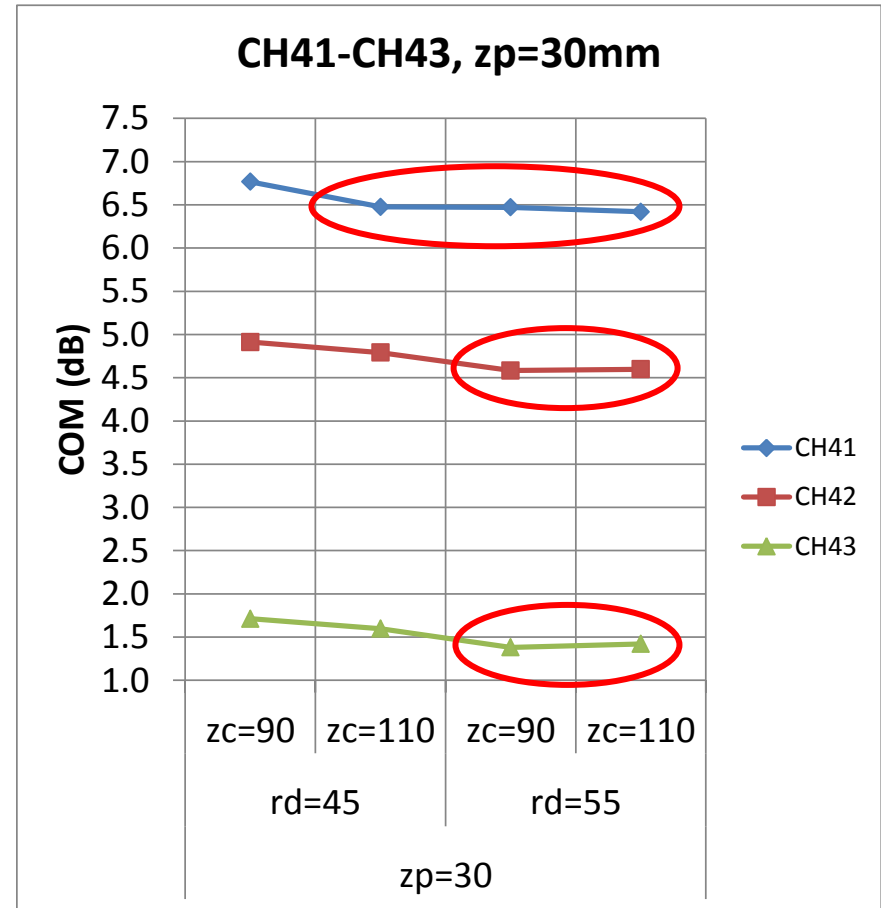
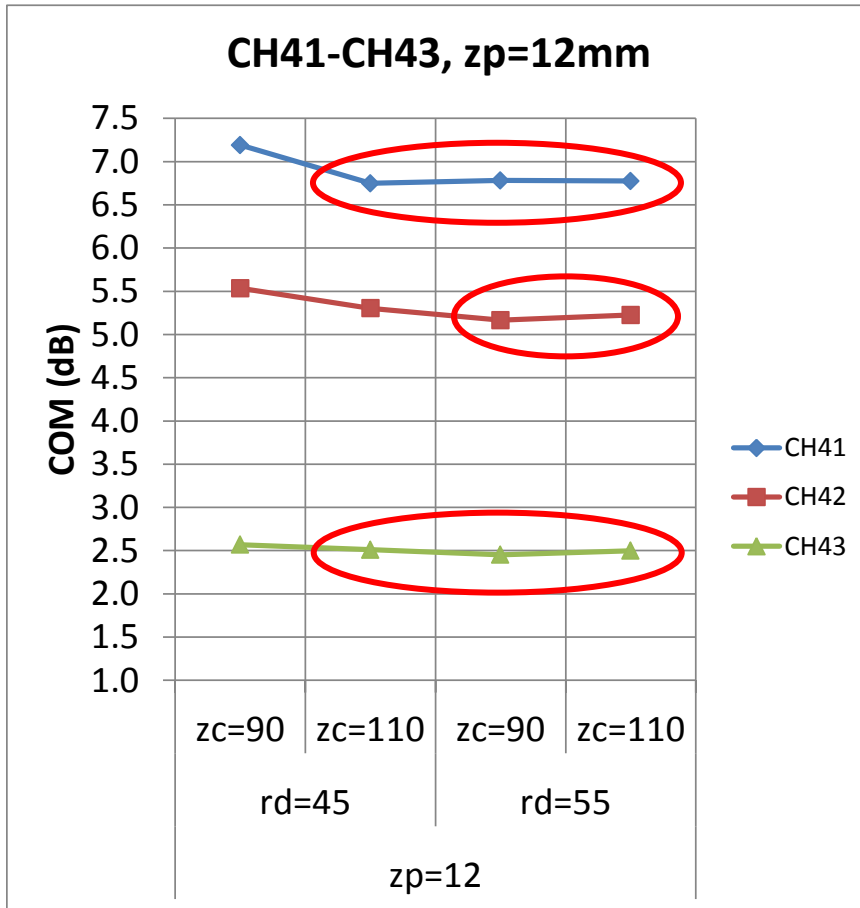
■ Characteristics

- http://.../Reference_document_for_TE_Connectivity_Backplane_S-Parameter_Channels_07_28_16.pdf
- Insertion Loss @ Nyquist : 10.4567dB (CH41) ~ 31.9644dB (CH43)
- Crosstalk : 4 FEXT + 4 NEXT
 - FEXT : F11F12, F17F18, H11H12, H17H18
 - NEXT : F14F15, G11G12, G17G18, H14H15

	Length	IL (dB)	FOM_ILD	ICN (mV)
CH41	11.75in	10.4567	0.1476	1.6848
CH42	27in	21.835	0.17028	1.1781
CH43	40in	31.9644	0.256	1.1277

TE Channels (CH41-43): COM Values

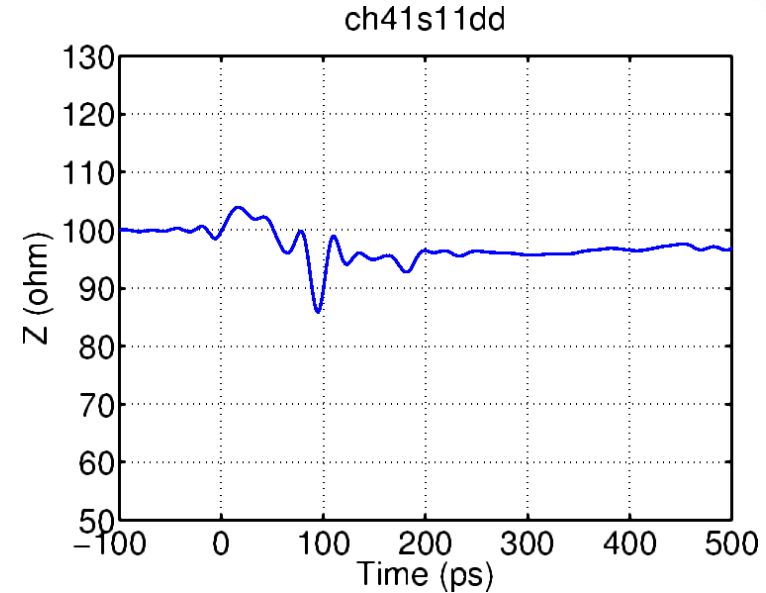
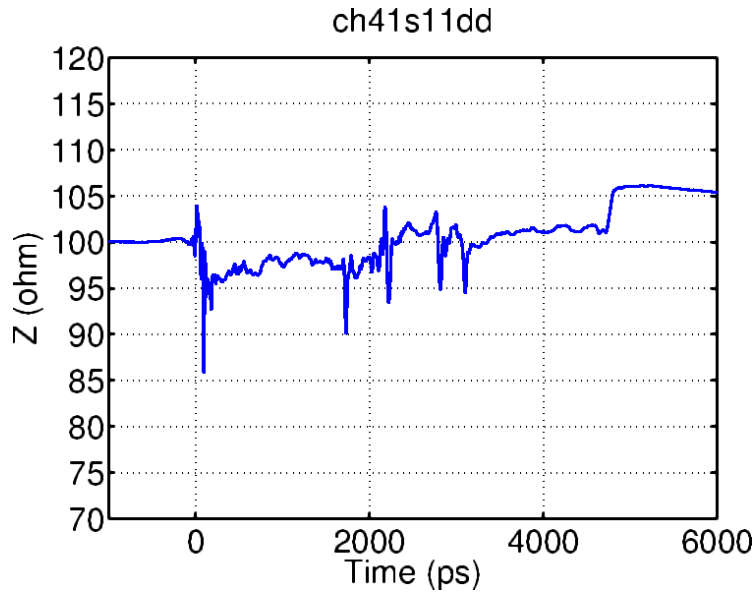
- The worst case is $Z_c=90\Omega$ & $R_d=55\Omega$ or $Z_c=110\Omega$ & $R_d=55\Omega$
 - $z_p=30\text{mm}$ is worse than 12mm
 - For $z_p=12\text{mm}$, the worst is $Z_c=110\Omega$ & $R_d=45\Omega$ or $Z_c=90\Omega$ & $R_d=55\Omega$



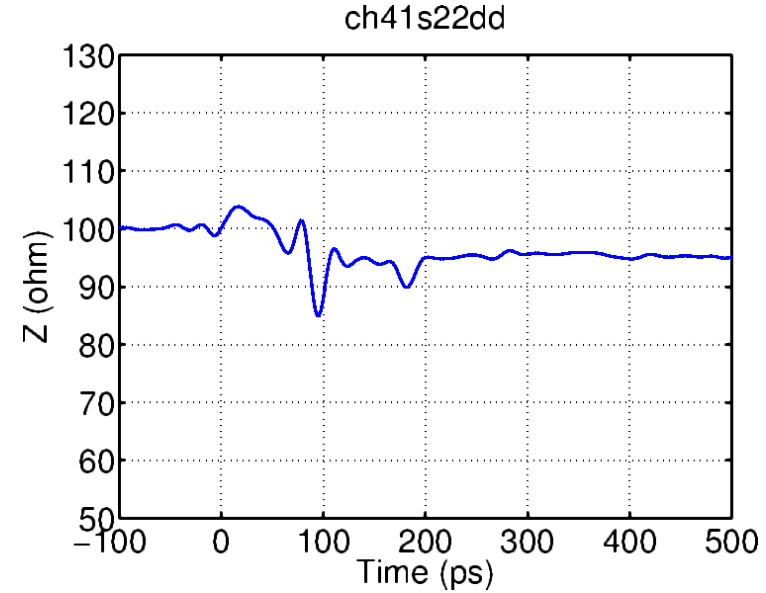
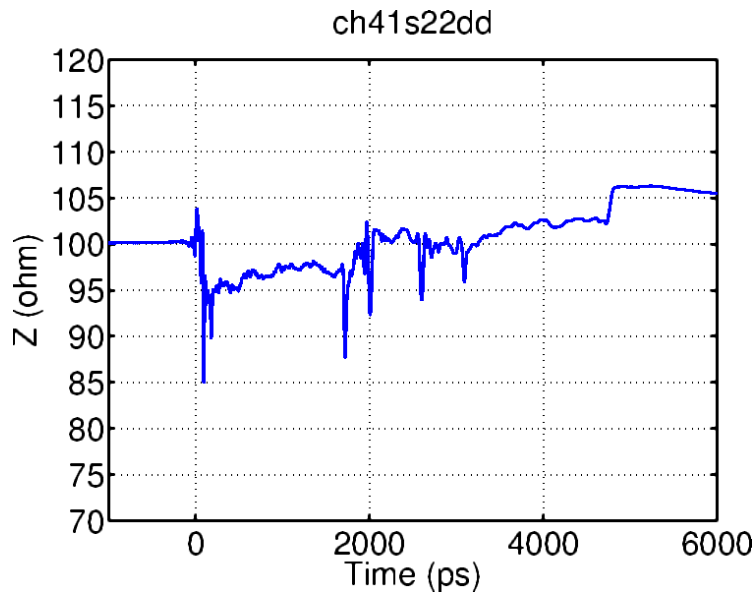
TE 10dB (11.75in) Channel (CH41): Zdiff Profile



S11dd

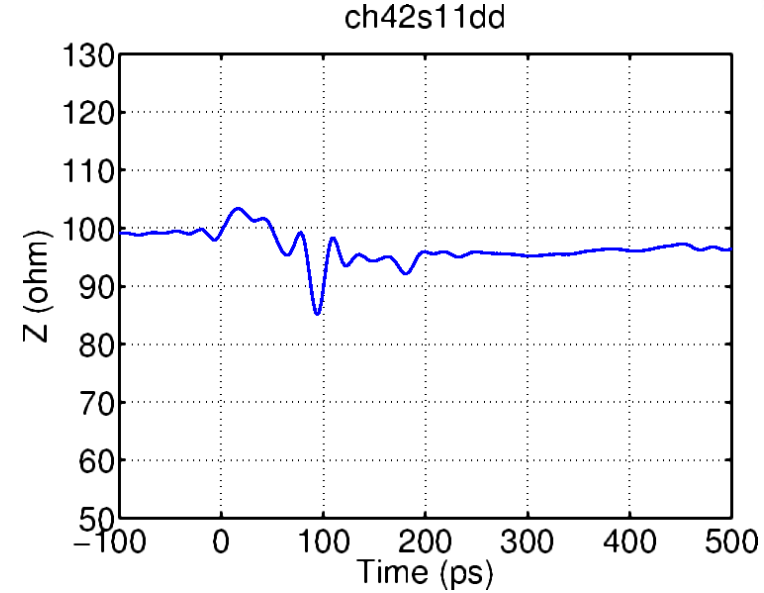
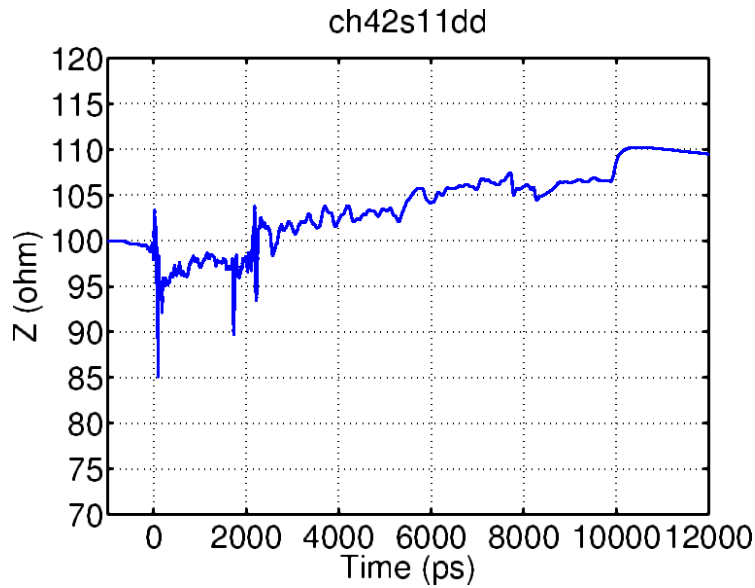


S22dd

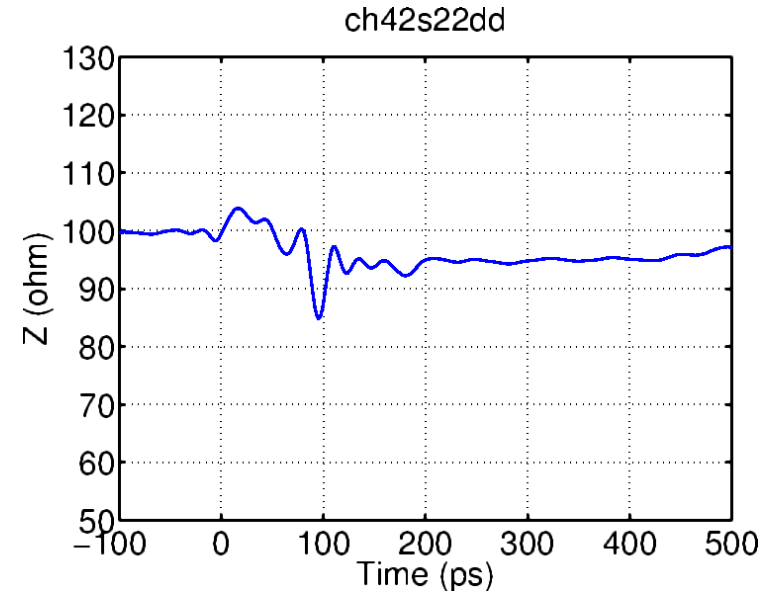
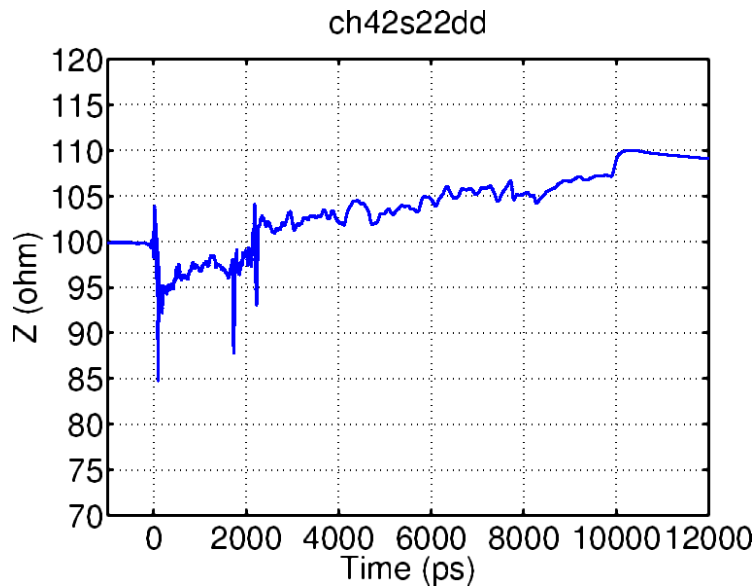


TE 22dB (27in) Channel (CH42): Zdiff Profile

S11dd

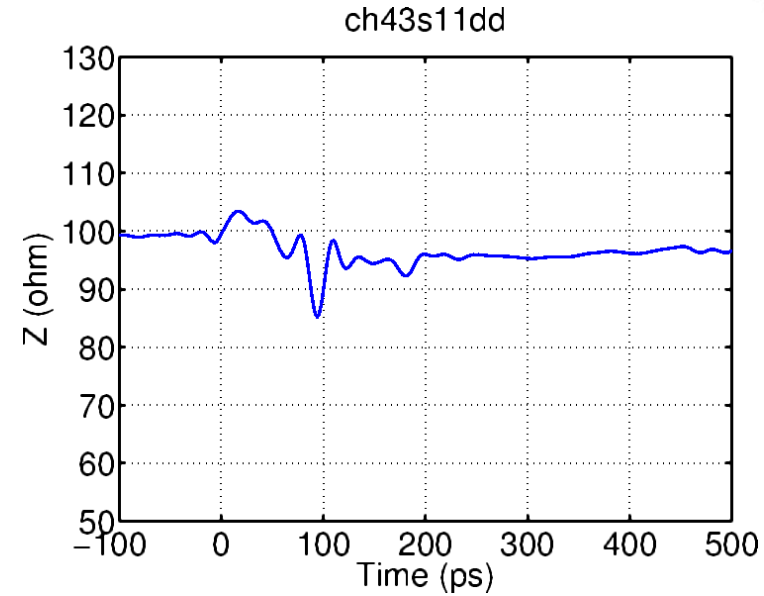
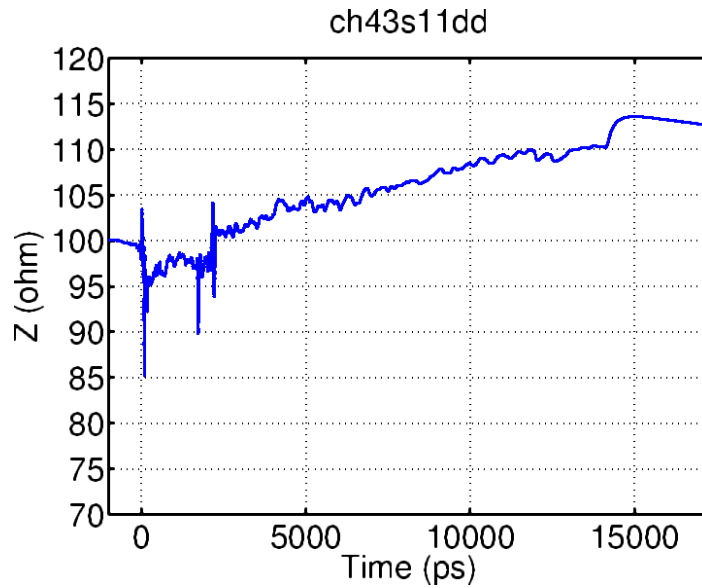


S22dd

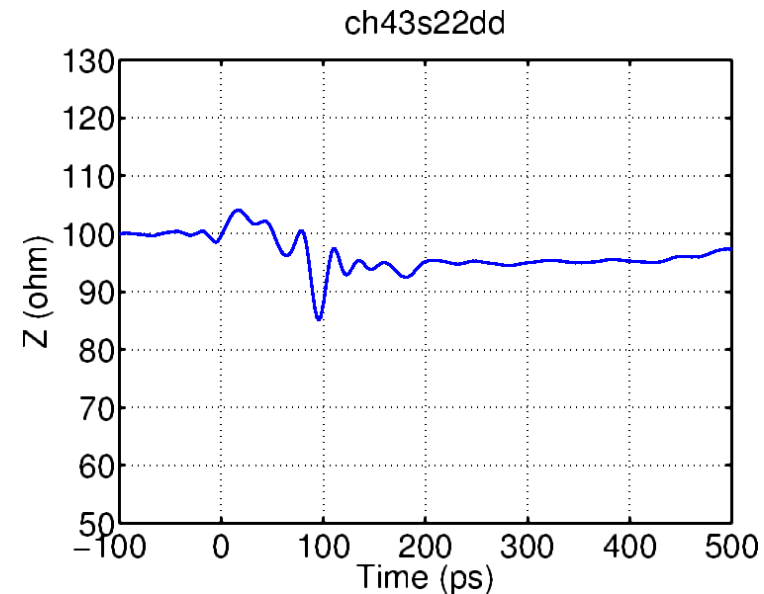
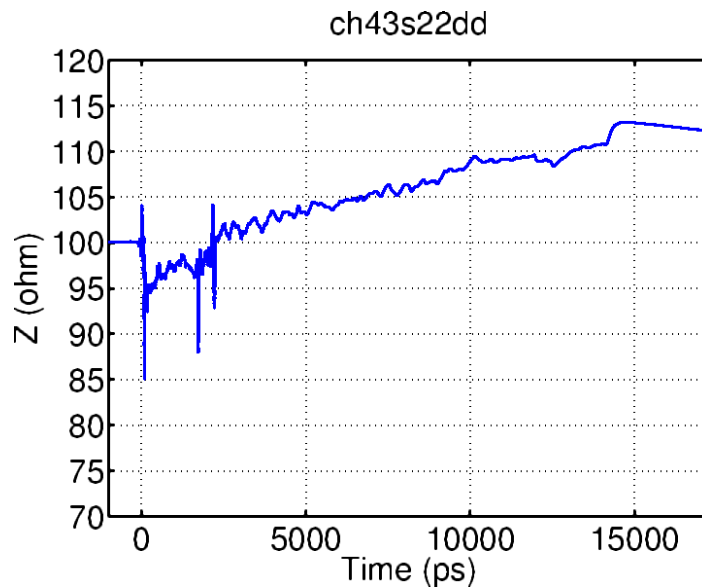


TE 32dB (40in) Channel (CH43): Zdiff Profile

S11dd



S22dd



Thank you