FUJITSU
shaping tomorrow with you

Comment #74: Variation of COM Parameters for Package Trace and Termination Resistance

Yasuo Hidaka
Fujitsu Laboratories of America, Inc.

IEEE P802.3cd 50GbE/100GbE/200GbE Task Force
San Antonio, November 9-11, 2016

Supporters

- Ali Ghiasi (Ghiasi Quantum)
- Phil Sun† (Credo)
- Geoff Zhang (Xilinx)
- Ken Ly (Cisco)
- Toshiaki Sakai (Socionext)

†: Supported the old revision of this presentation hidaka_3cd_01_1116.pdf, but has not reviewed this revised presentation hidaka_3cd_01a_1116.pdf, yet.

Background

FUJITSU

- Baseline COM Parameters specify
  - Two values (12mm and 30mm) for zp (package trace length)
  - Lower value (90Ω) than nominal for Zc (package trace impedance)
  - Higher value (55Ω) than nominal for Rd (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

This presentation is an updated version of hidaka_100516_3cd_adhoc.pdf and hidaka_102616_3cd_adhoc.pdf which were presented at P802.3cd ad hoc call on October 5, 2016 and October 26, 2016

Varied COM Parameters

FUJITSU

- The following Eight combinations of values were studied

zp Package trace length	Rd Termination resistance	Zc 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 basline
  - Excepting that fp2 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.

Channels

- 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)

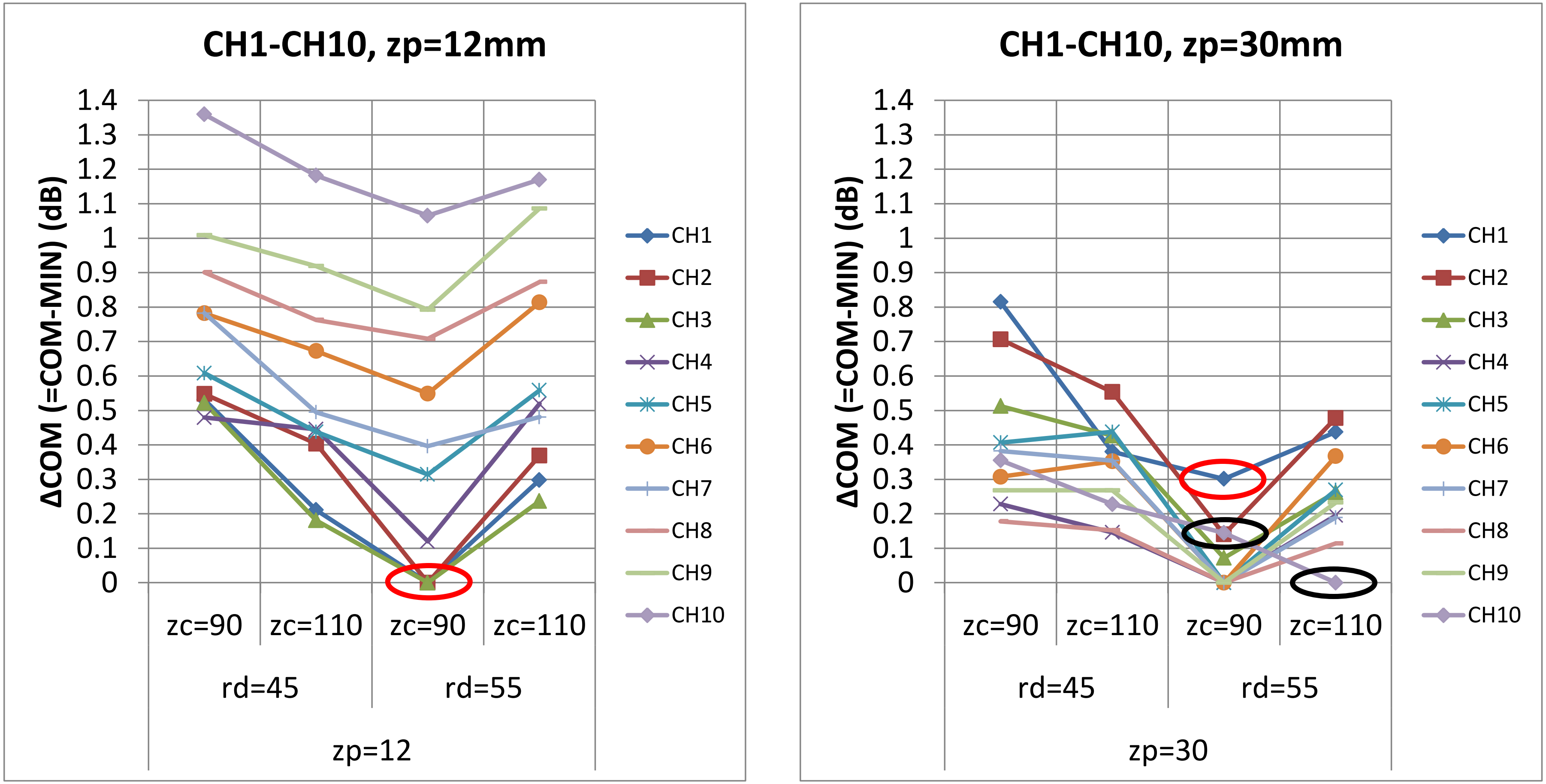
- Channel Data Source
  - Cisco and TE Channels are from P802.3cd Task Force Channel Area
  - Intel Channels are from 50G&NGOATH Stody Group Channel Area

- See backup slides for the details

Cisco Channels (CH1-10): ΔCOM Values

FUJITSU

- The worst case is Zc=90Ω & Rd=55Ω or Zc=110Ω & Rd=55Ω
  - If we test only for zp=30mm, we miss 0.3dB for CH1
  - If we test only for Zc=90Ω & Rd=55Ω, we miss 0.15dB for CH10

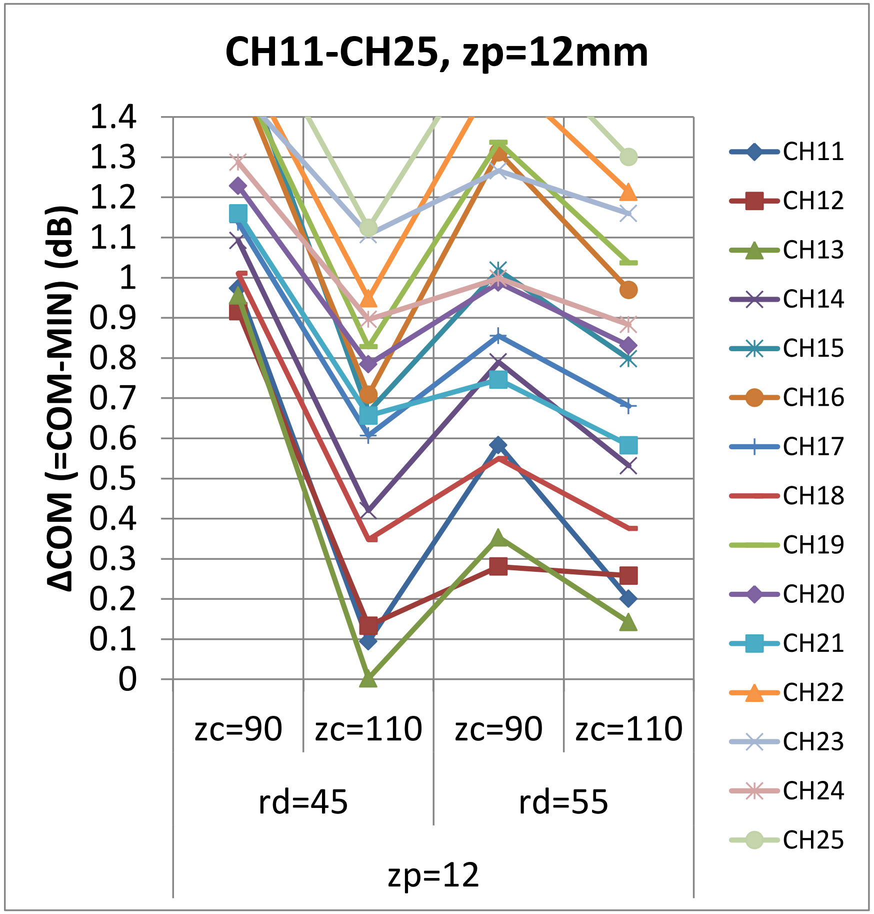


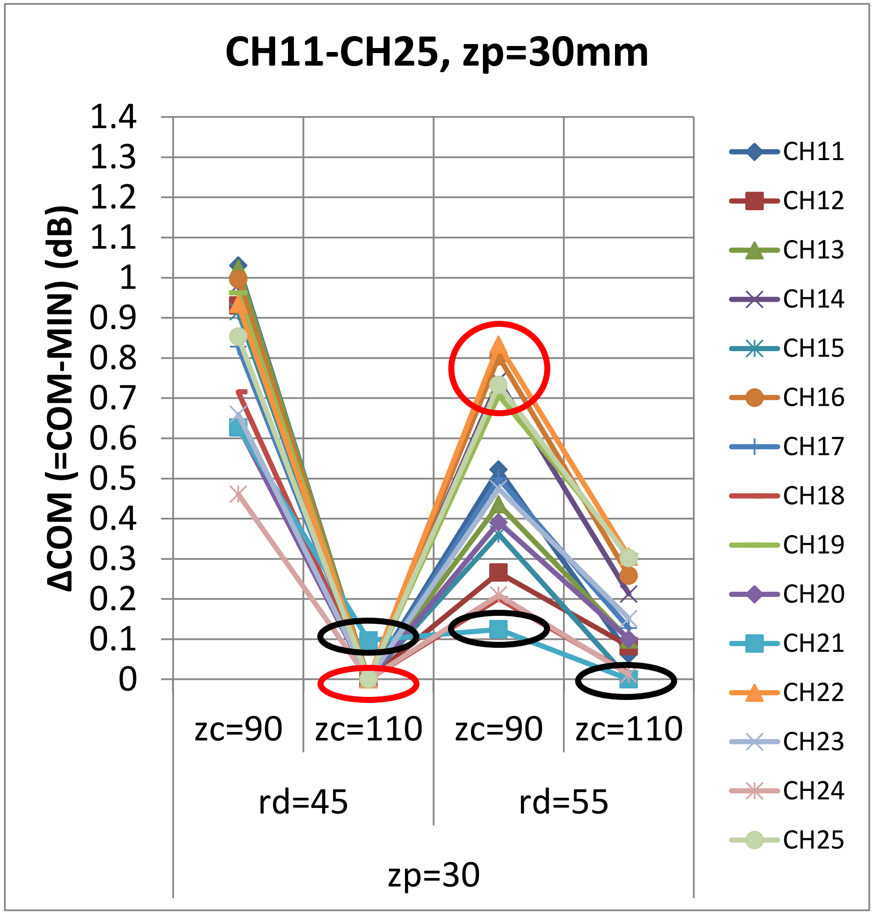
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

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

FUJITSU

- The worst case is Zc=110Ω & Rd=45Ω or Zc=110Ω & Rd=55Ω
  - If we test only for Zc=90Ω & Rd=55Ω, we miss up to 0.8dB for CH16&22
  - If we do not test for Zc=110Ω & Rd=55Ω, we miss 0.1dB for CH21



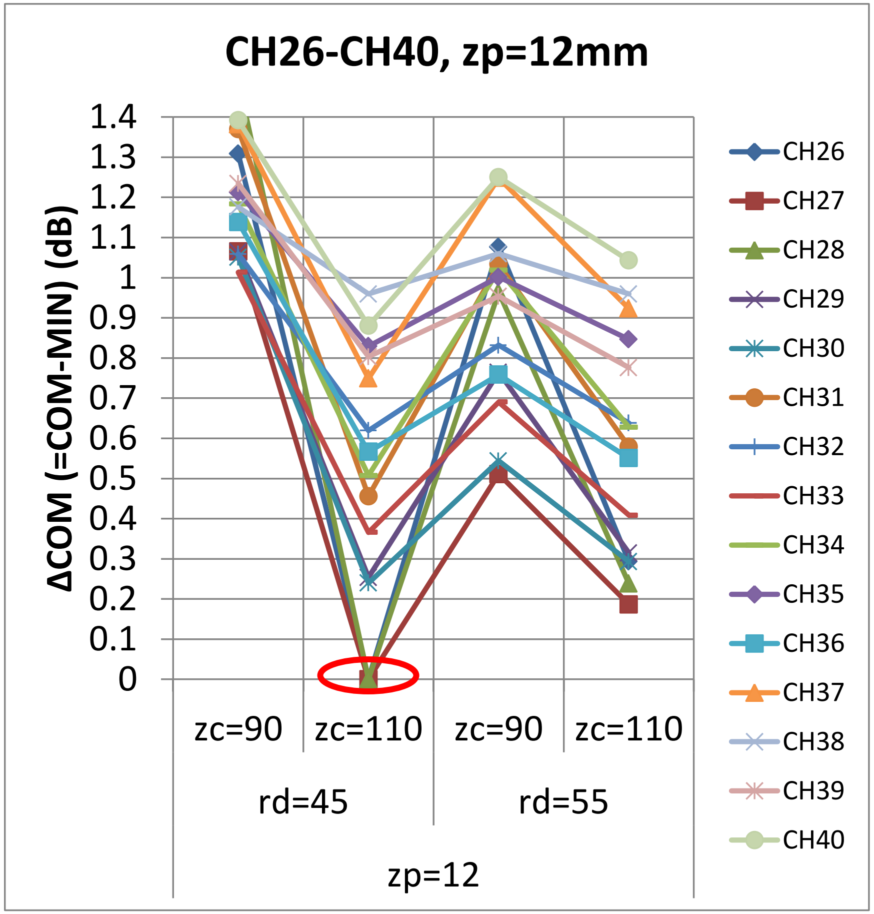


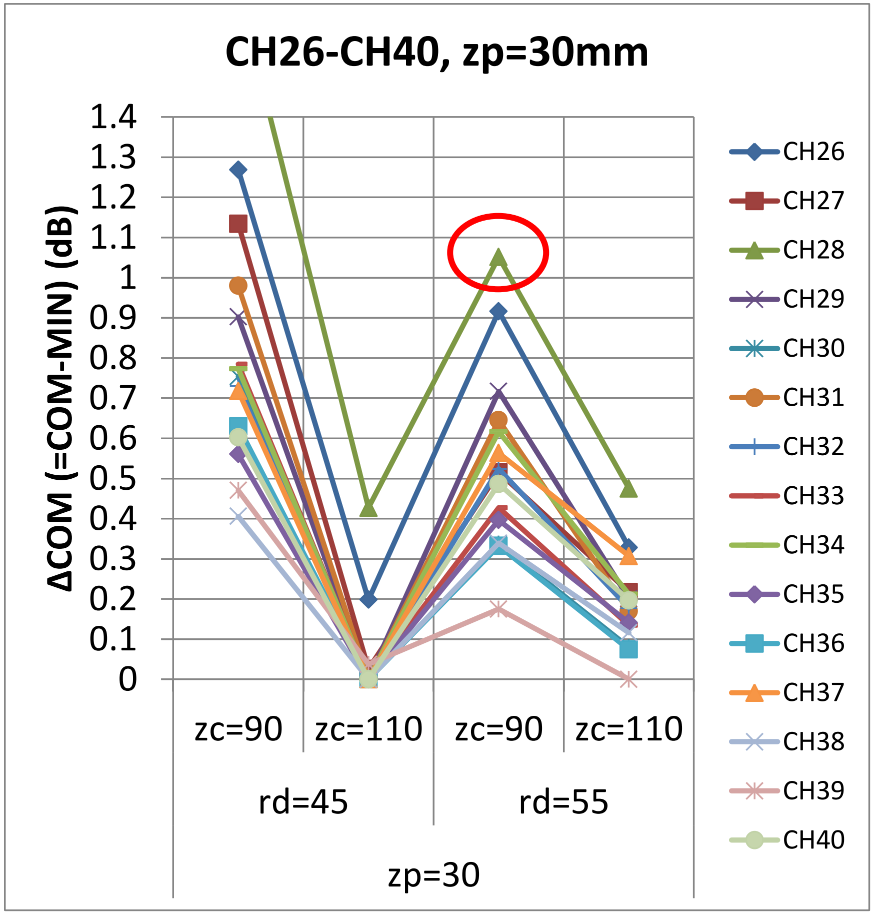
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

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

FUJITSU

- The worst case is Zc=110Ω & Rd=45Ω or Zc=110Ω & Rd=55Ω
  - If we test only for Zc=90Ω & Rd=55Ω, we miss up to 1.05dB for CH28



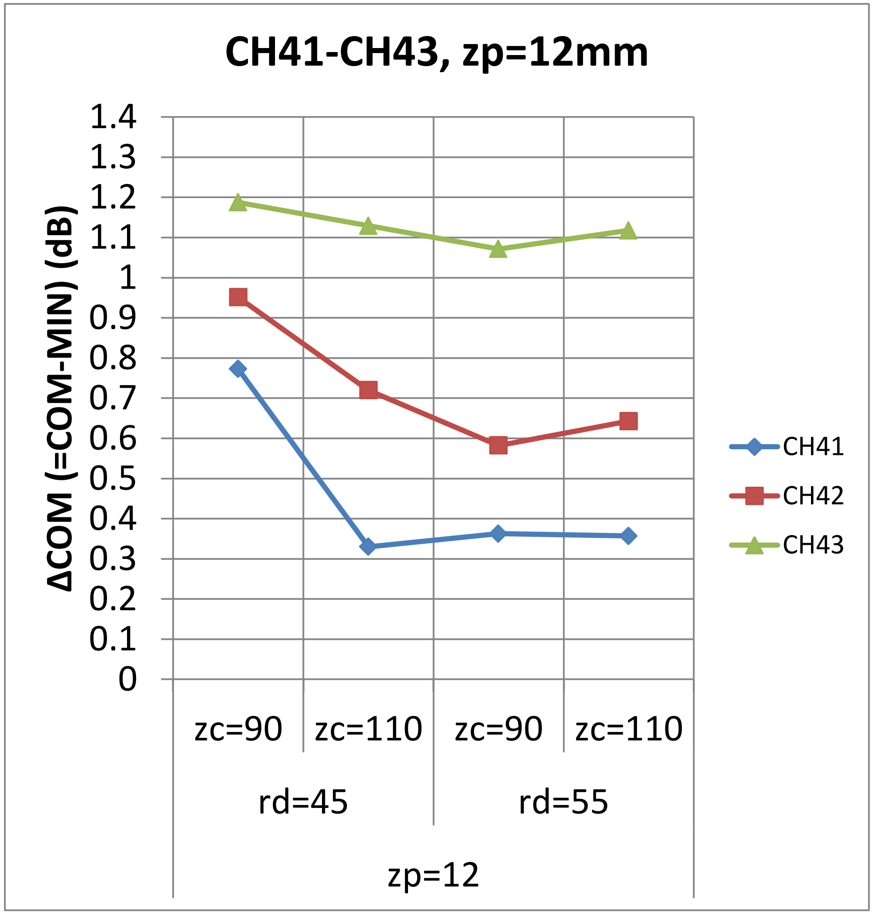


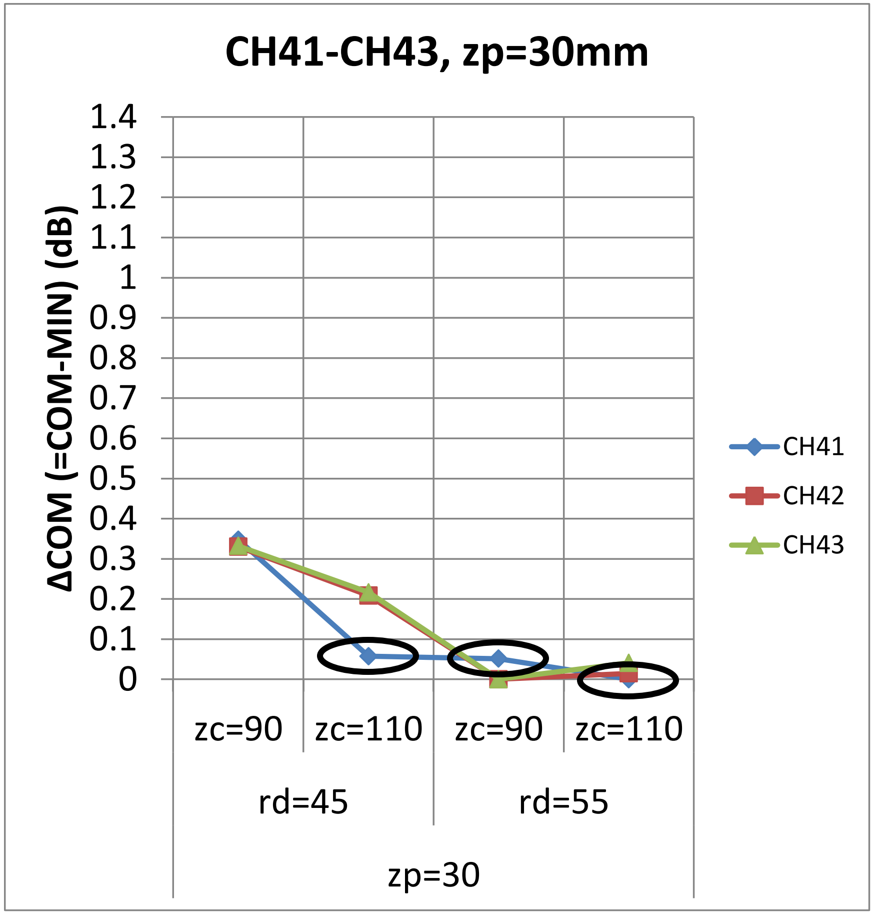
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

TE Channels (CH41-43): ΔCOM Values

FUJITSU

- The worst case is Zc=90Ω & Rd=55Ω or Zc=110Ω & Rd=55Ω
  - If we do not test for Zc=110Ω & Rd=55Ω, we miss 0.05dB for CH41
  - zp=30mm is always worse than 12mm





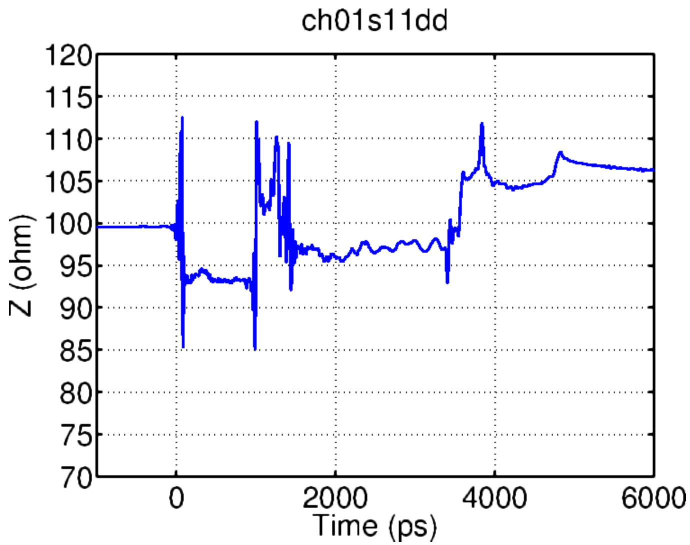
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

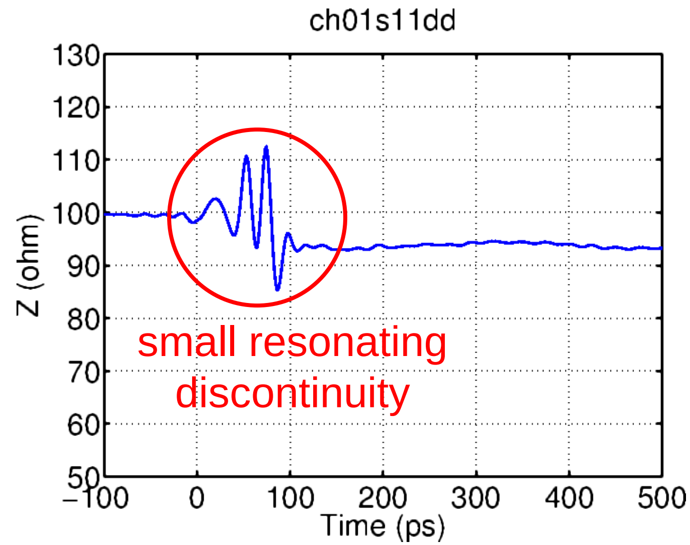
Representative Zdiff Profile of Cisco and TE Channels

FUJITSU

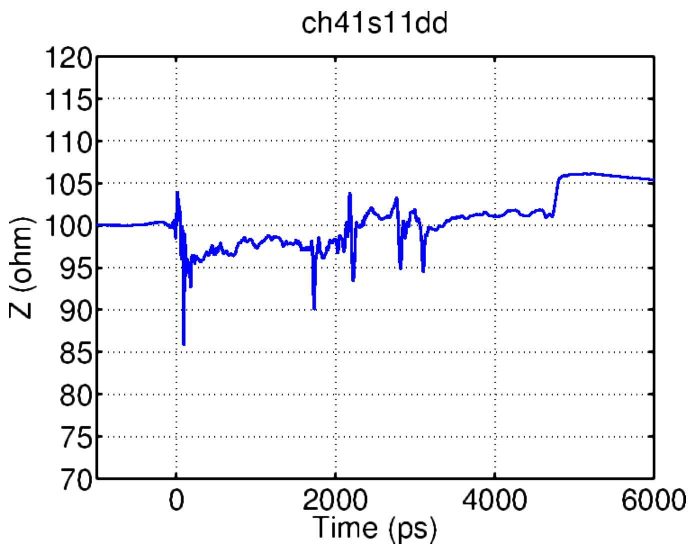
- Small resonating or capacitive discontinuities near port entry

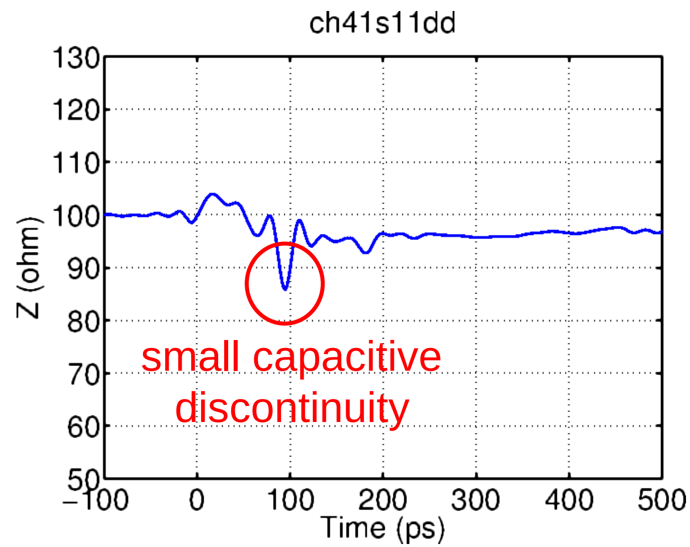
Cisco 10dB
(CH1)
S11dd
Port 1





TE 11.75in
(CH41)
S11dd
Port 1



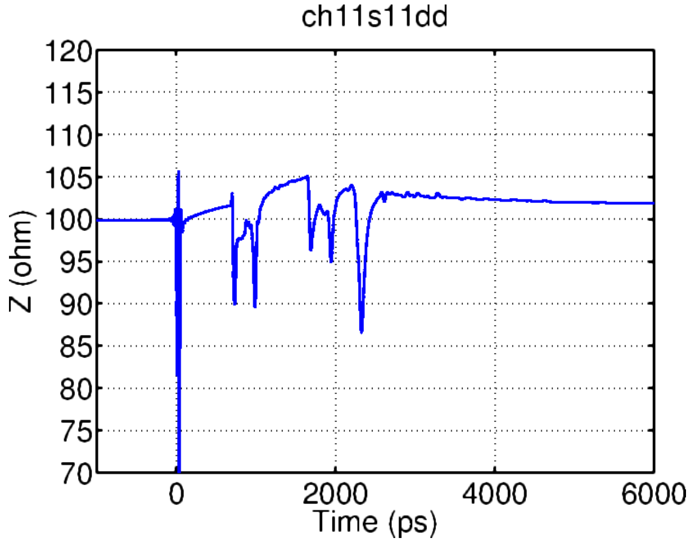


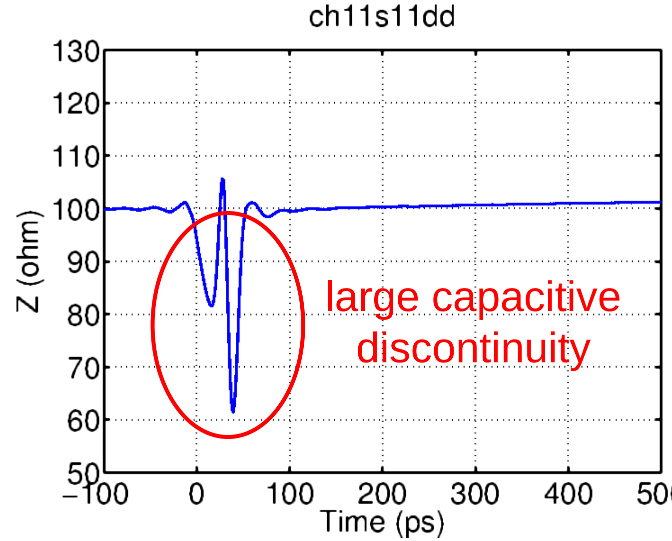
Representative Zdiff Profile of Intel Channels

FUJITSU

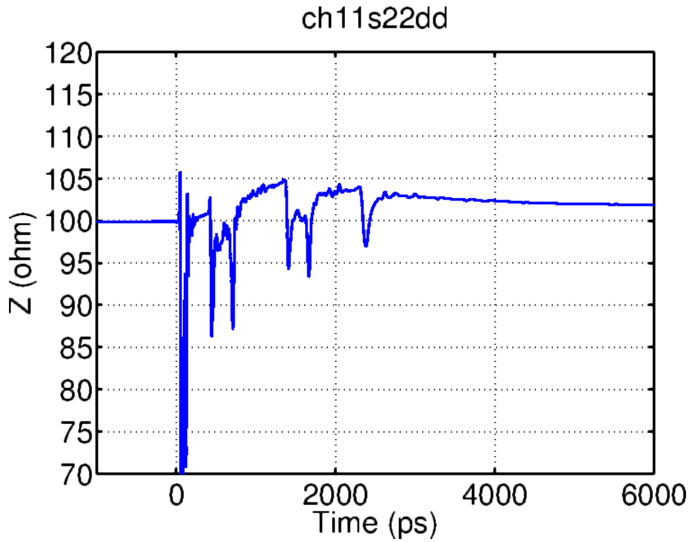
- Large spike-like capacitive discontinuities near port entry

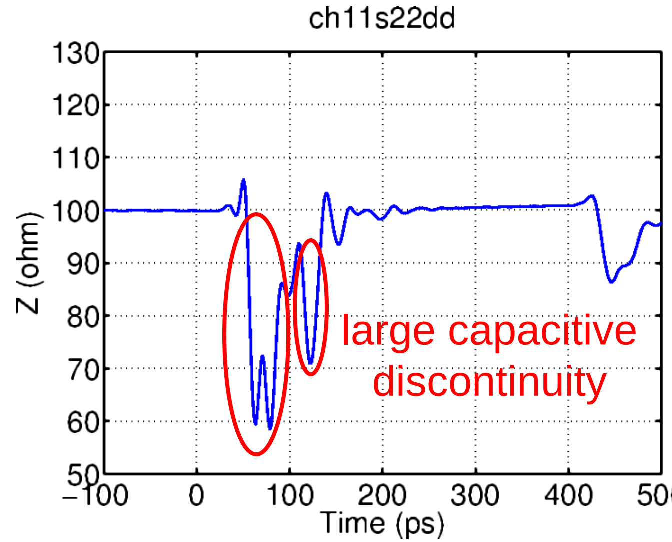
Intel 100Ω
10dB Nom
(CH11)
S11dd
Port 1





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





Effect on Tx amplitude and Tx SNDR

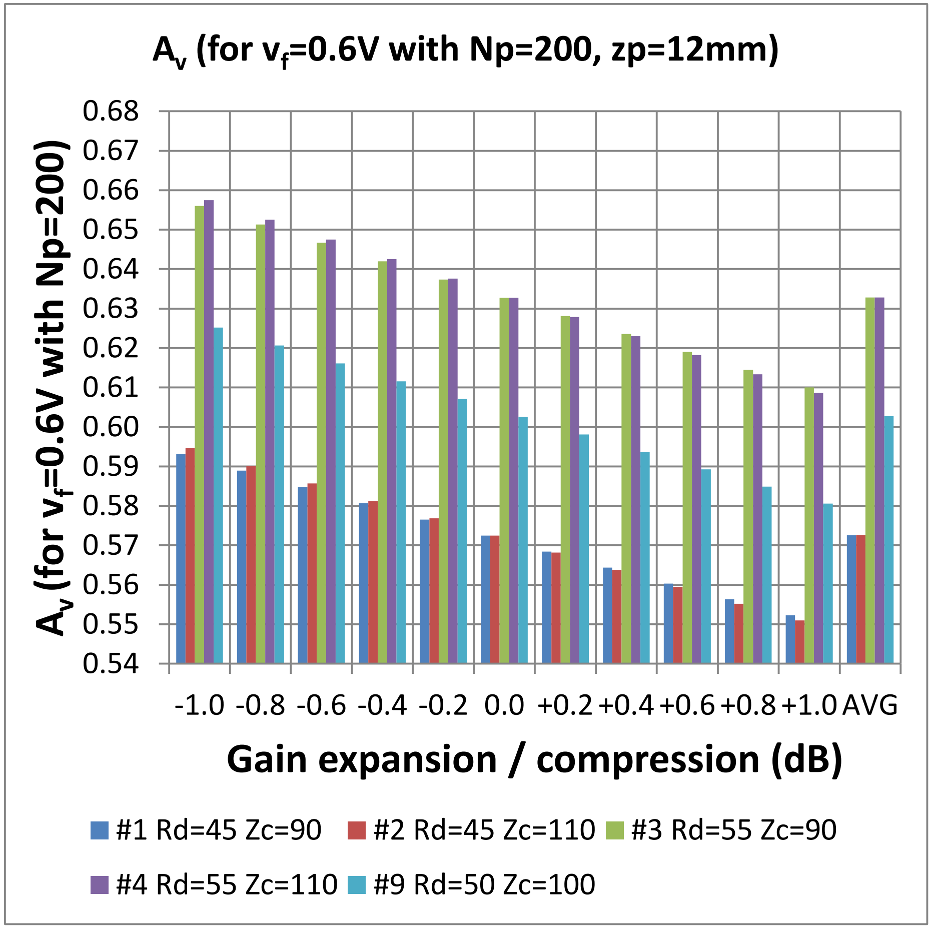
FUJITSU

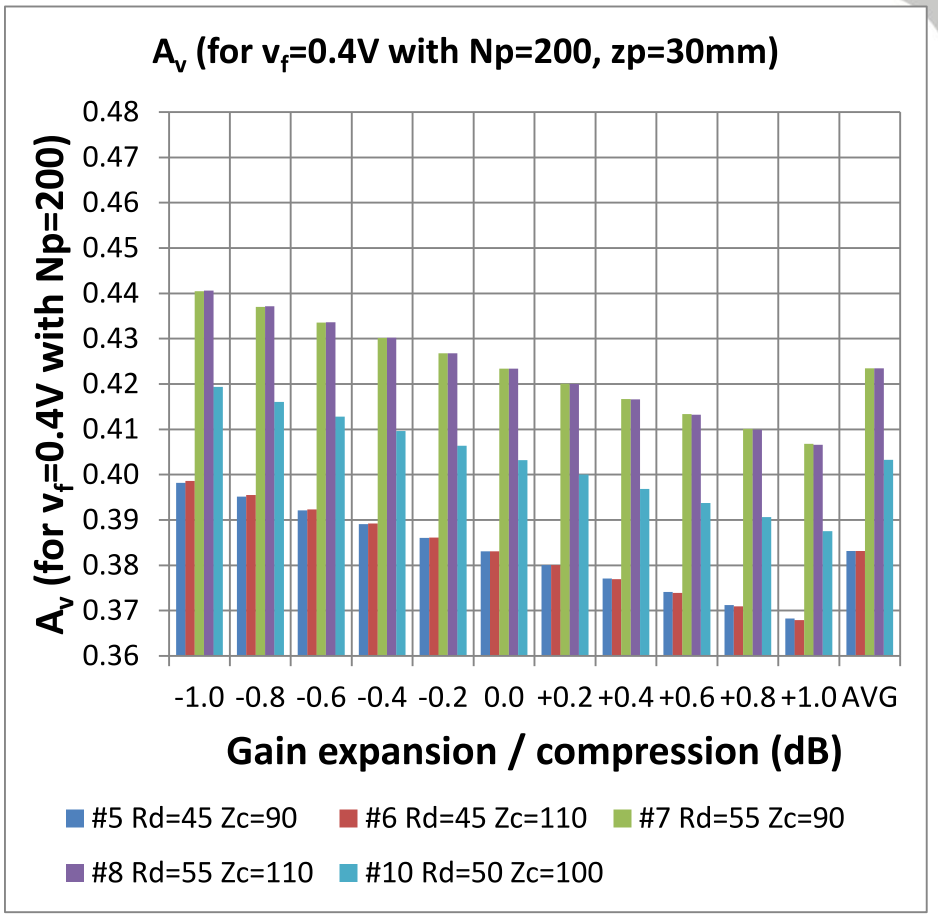
- There was a concern that Tx-related COM parameters such as Av, Afe, Ane and SNR_{TX} may have to be changed consistently with Rd and Zc, because Tx output amplitude and Tx SNDR may be also affected by Rd and Zc

- The results presented at P802.3cd ad hoc call on October 26 were not correct
  - Tx model in COM was not correct
  - Rd has significant effect on Av, Afe, and Ane

- So, I have re-run simulation with revised COM parameters for select channels (with ~10/20/30dB loss)

A_v for v_f=0.6V or 0.4V with Np=200





Condition	#1	#2	#3	#4	#9
Av	0.5725	0.5725	0.6327	0.6327	0.6026
Rd	45	45	55	55	50
Zc	90	110	90	110	100
vf (Np=200)			0.6		

Condition	#5	#6	#7	#8	#10
Av	0.3830	0.3831	0.4234	0.4234	0.4032
Rd	45	45	55	55	50
Zc	90	110	90	110	100
vf (Np=200)			0.4		

Varied COM Parameters including Av

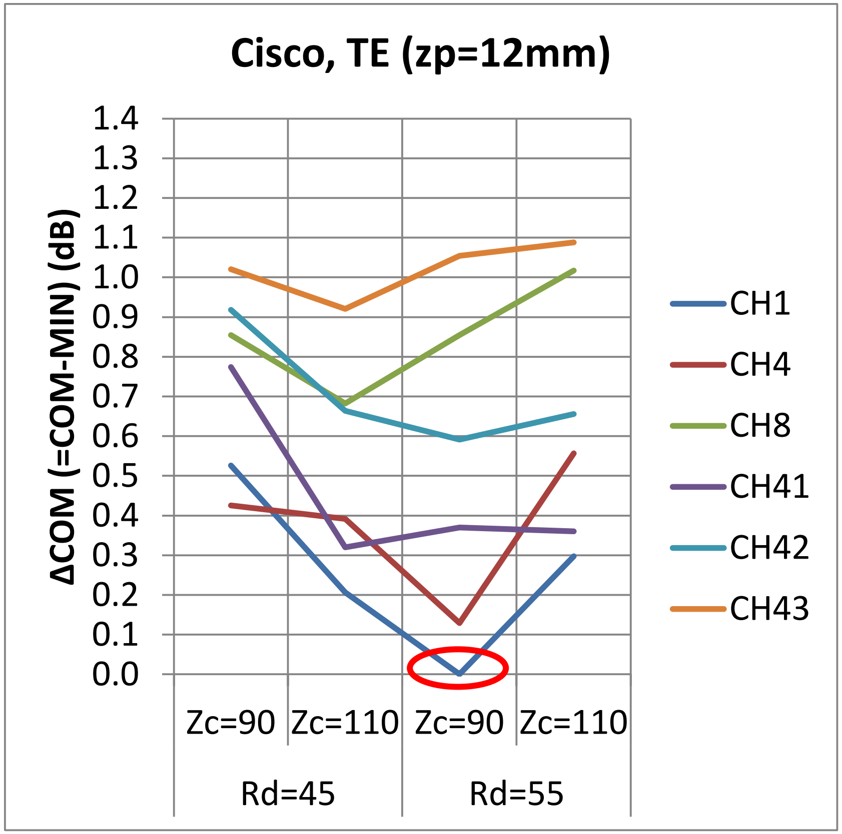
- The following Eight combinations of values were studied

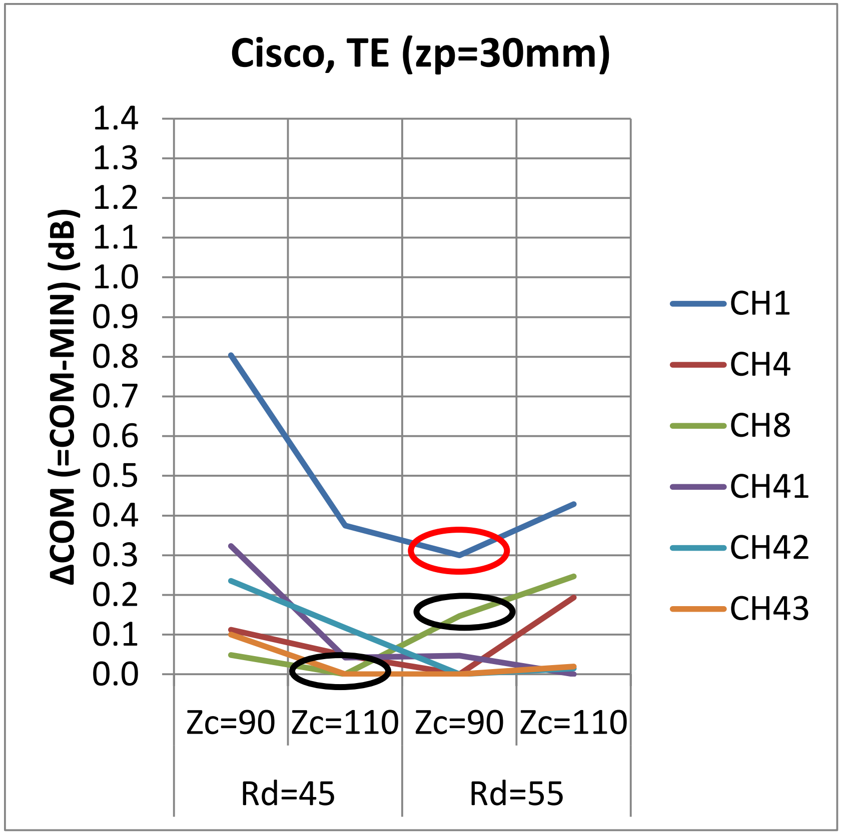
zp	Rd	Zc	Av	Afe	Ane
12 mm	45 Ω	90 Ω	0.383 V	0.383 V	0.573 V
		110 Ω			
	55 Ω	90 Ω	0.424 V	0.424 V	0.633 V
		110 Ω			
30 mm	45 Ω	90 Ω	0.383 V	0.383 V	0.573 V
		110 Ω			
	55 Ω	90 Ω	0.424 V	0.424 V	0.633 V
		110 Ω			

Results with Varied Av: Cisco & TE Channels

FUJITSU

- The results with Rd=45Ω were degraded due to low amplitude
  - If we test only for zp=30mm, we miss 0.3dB for CH1
  - If we test only for Zc=90Ω & Rd=55Ω, we miss 0.15dB for CH8



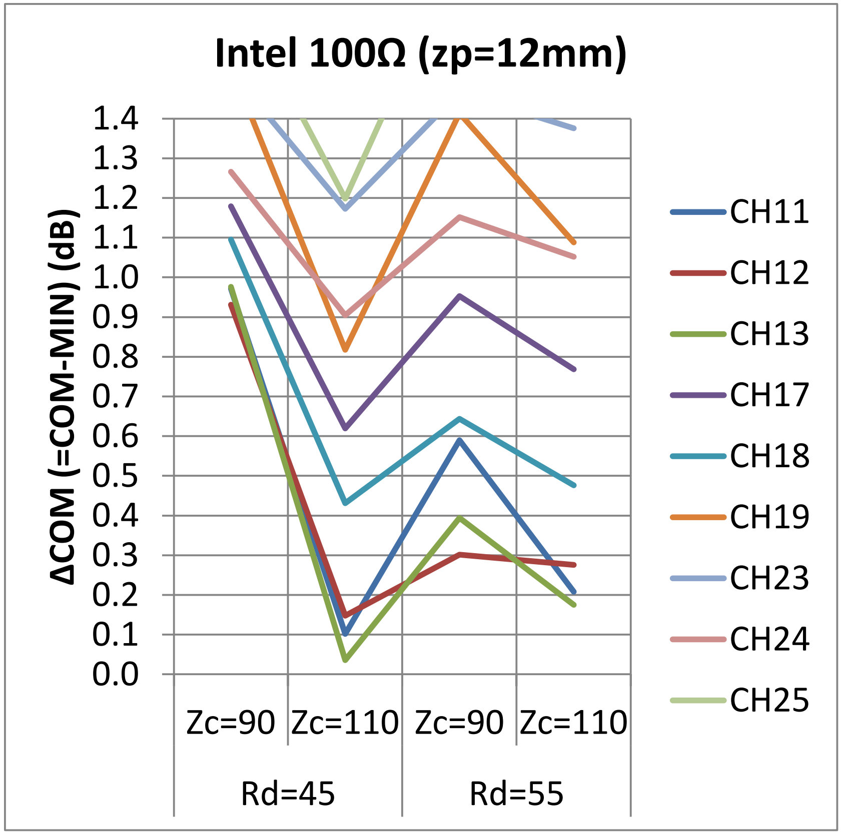


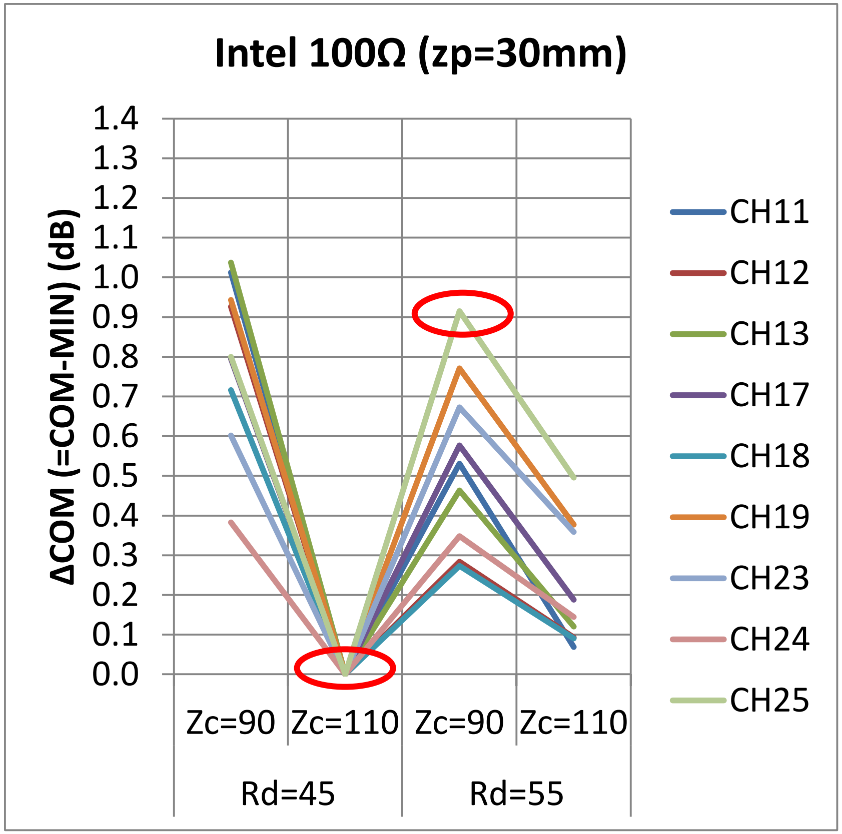
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

Results with Varied Av: Intel 100Ω Channels

FUJITSU

- The worst results always with zp=30mm, Rd=45Ω & Zc=110Ω
  - If we test only for Zc=90Ω & Rd=55Ω, we miss up to 0.9dB for CH25



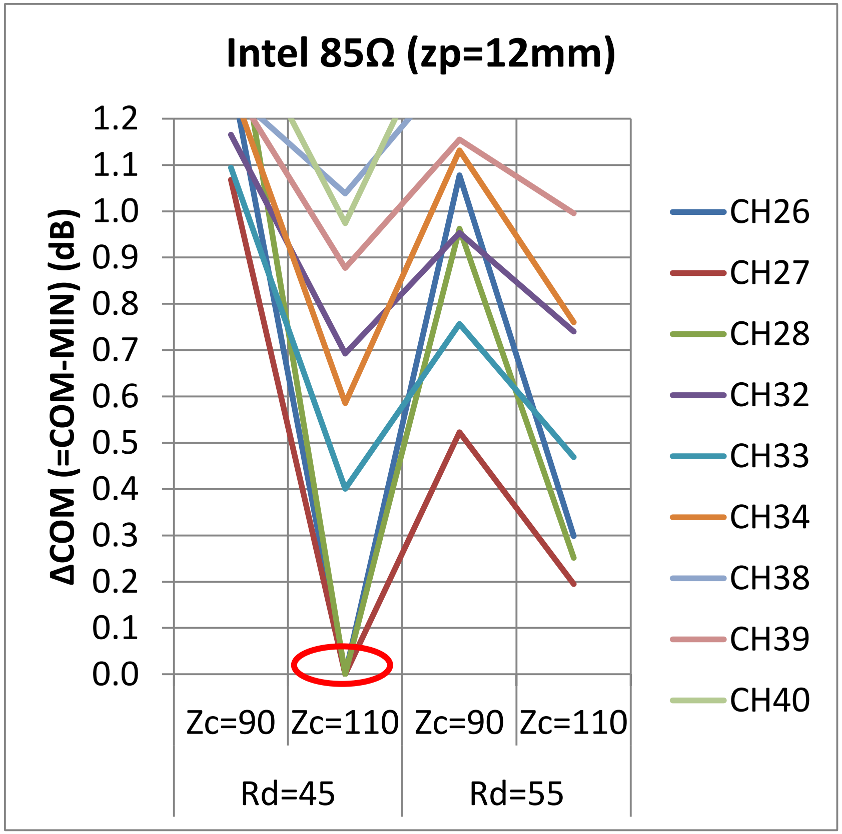


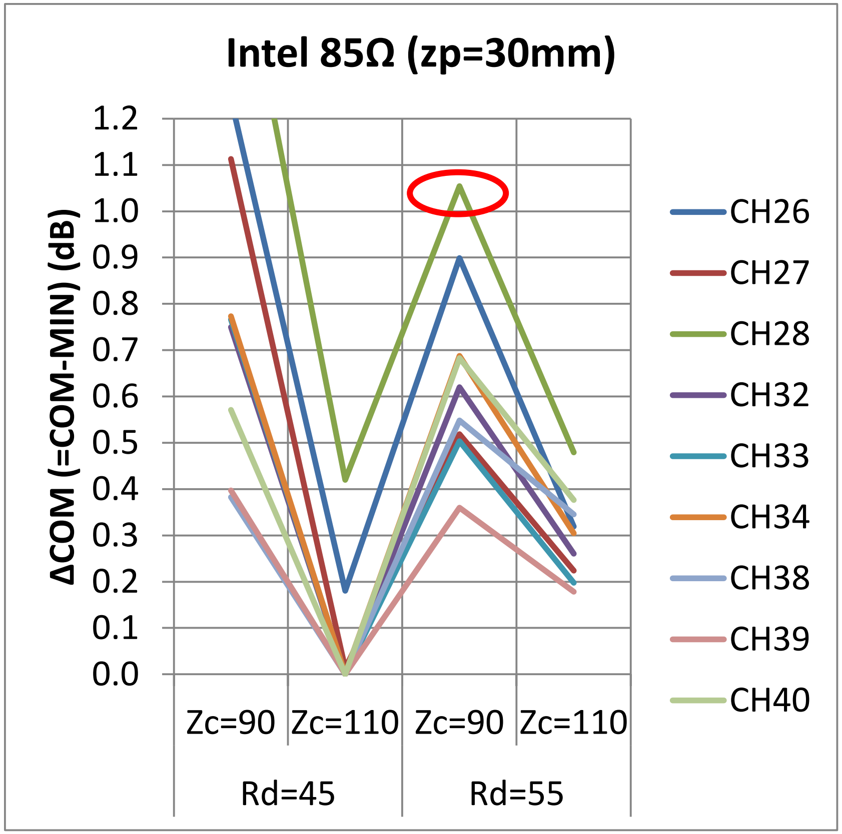
- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

Results with Varied Av: Intel 85Ω Channels

FUJITSU

- The worst results always with Rd=45Ω and Zc=110Ω
  - If we test only for Zc=90Ω & Rd=55Ω, we miss 1.05dB for CH28





- ΔCOM Value = COM Value minus the minimum for the 8 combinations of COM parameters.

Conclusion

- It is very clear that the current values of Rd (55Ω) & Zc (90Ω) do not cover the worst case.
  - The worst COM value may be overlooked by up to ~1dB.

- The following test cases are recommended to cover the worst case:

COM Parameter	Test Cases				Unit
	#1	#2	#3	#4	
zp (Package trace length)	12		30		mm
Rd (Termination resistance)	45	55	45	55	Ω
Zc (Package trace impedance)	110	90	110	90	Ω
Av (Tx output voltage, victim)	0.383	0.424	0.383	0.424	V
Afe (Tx output voltage, far-end XT)	0.383	0.424	0.383	0.424	V
Ane (Tx output voltage, near-end XT)	0.573	0.633	0.573	0.633	V

  - We may drop test cases of zp=12mm, because zp=12mm is the worst only for 10dB channels, where COM is high enough.

Options

FUJITSU

Option A

Parameter	TC1	TC2	TC3	TC4	Unit
zp	12		30		mm
Rd	45	55	45	55	Ω
Zc	110	90	110	90	Ω
Av	0.383	0.424	0.383	0.424	V
Afe	0.383	0.424	0.383	0.424	V
Ane	0.573	0.633	0.573	0.633	V

Option B

Parameter	TC1	TC2	Unit
zp	30		mm
Rd	45	55	Ω
Zc	110	90	Ω
Av	0.383	0.424	V
Afe	0.383	0.424	V
Ane	0.573	0.633	V

Option C (No Change)

Parameter	TC1	TC2	Unit
zp	12	30	mm
Rd	55		Ω
Zc	90		Ω

Back up Slides

- COM Parameters in this study
- Simulation for Effect on Tx amplitude and SNDR
- 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_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

Sim Parameters for Tx amplitude and SNDR

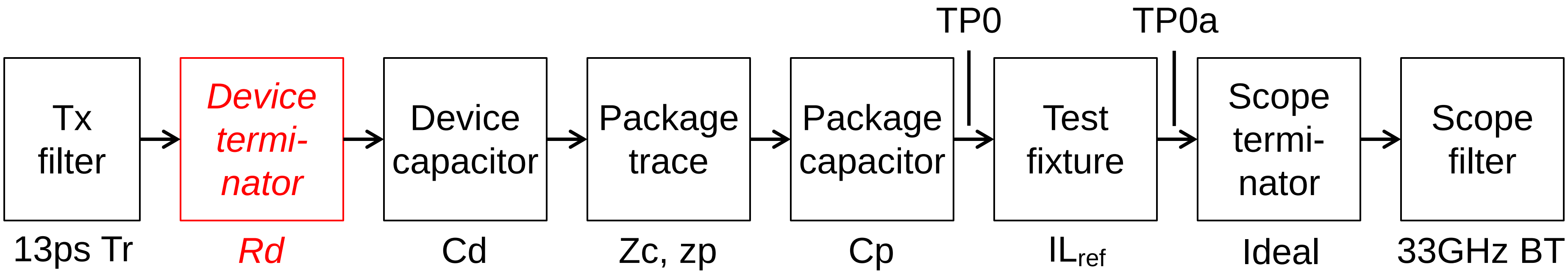
- The following 10 combinations of parameters were simulated

Case	zp Package trace length	Rd Termination resistance	Zc Package trace impedance
#1	12 mm	45 Ω	90 Ω
#2			110 Ω
#3		55 Ω	90 Ω
#4			110 Ω
#5	30 mm	45 Ω	90 Ω
#6			110 Ω
#7		55 Ω	90 Ω
#8			110 Ω
#9	12 mm	50 Ω	100 Ω
#10	30 mm		

- The original conditions were #3 and #7
- The proposed conditions were #2/#3 and #6/#7

Sim Model for Tx amplitude and SNDR

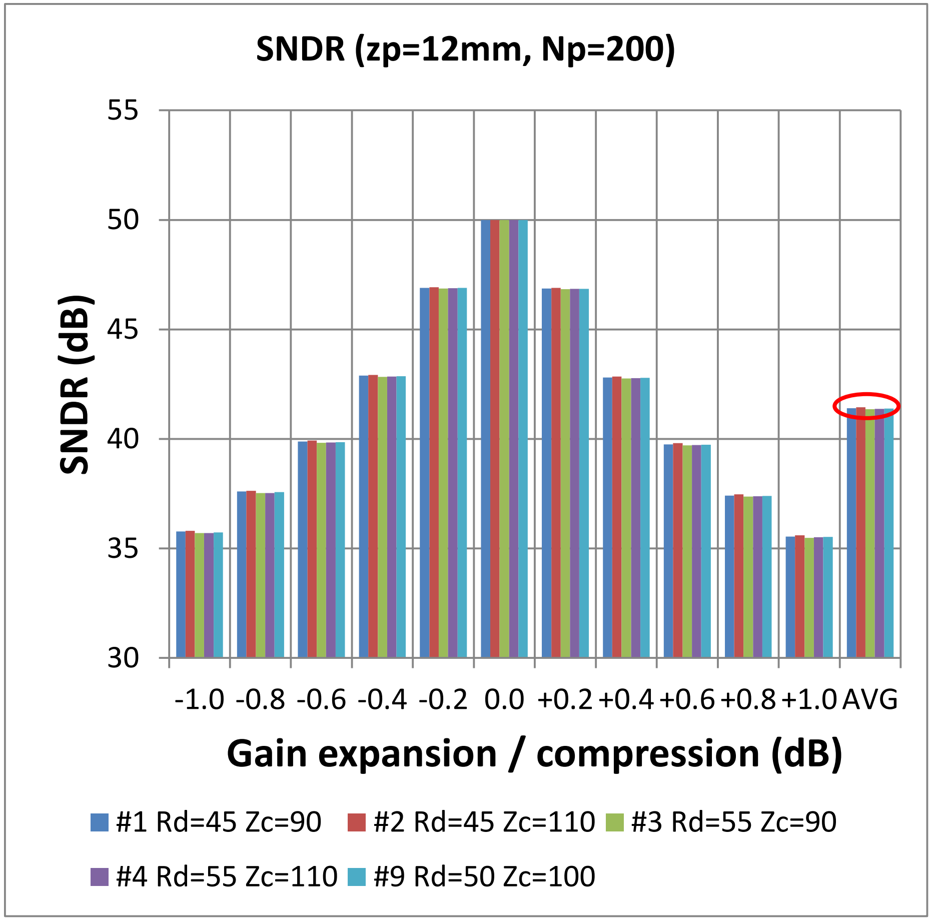
FUJITSU

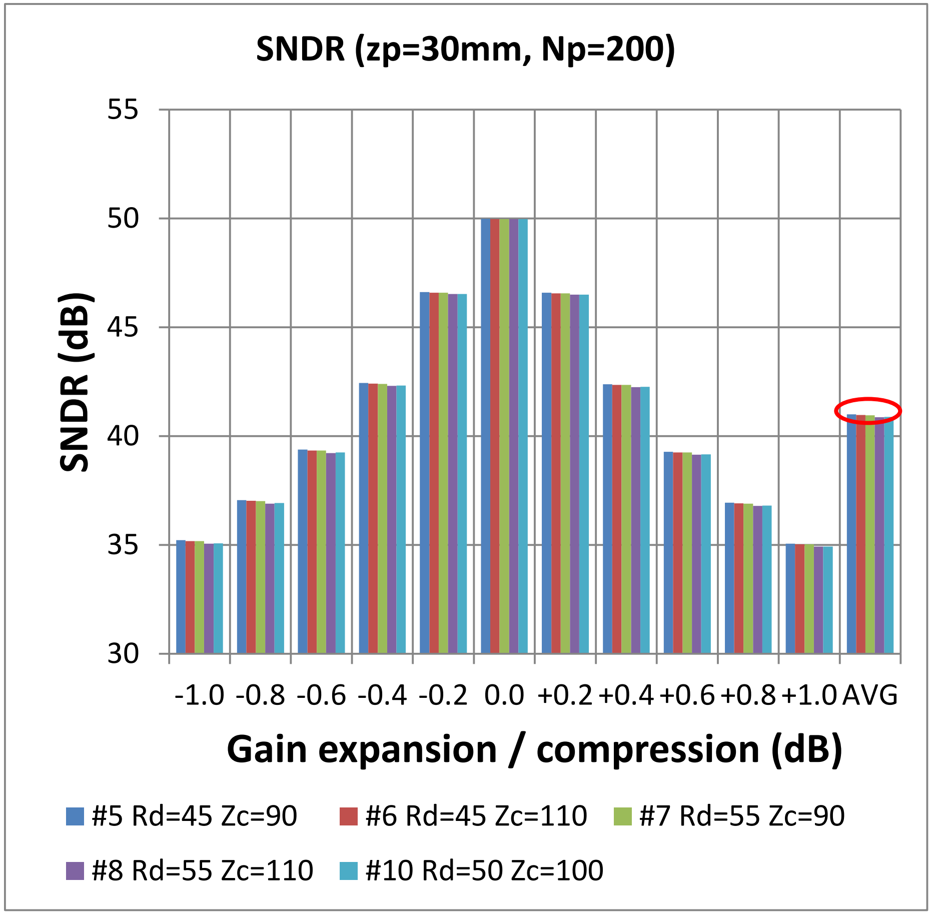


- Tx filter: $S_{21} = (\mathrm{EQ93A{-}46} | T_r = 13\mathrm{ps}, \beta = 2)$ (i.e. 13ps 20-80% Tr)
- Device terminator: $S_{21} = \frac{100\Omega}{Rd+50\Omega}, S_{22} = \frac{Rd-50\Omega}{Rd+50\Omega}$
  - S_{21} was updated from 1 that was used for hidaka_102616_3cd_adhoc.pdf
- Device capacitor: $S = (\mathrm{EQ93A{-}8} | C = C_d)$
- Package trace: $S = \left(\mathrm{EQ93A{-}13{,}14} \middle| \mathrm{Table93A{-}3\ except}\ Z_c, z_p\right)$
- Package capacitor: $S = \left(\mathrm{EQ93A{-}8} \middle| C = C_p\right)$
- Test fixture:
  - A: $|S_{21}| = 10^{-(\mathrm{EQ93-1})/20}, \angle S_{21} = \text{minimum phase}(|S_{21}|)$
  - B: 38mm Host PCB trace using EQ93A-13,14 with Table 92-12
- Scope terminator: $S_{21} = 1, S_{11} = 0$ (i.e. ideal)
- Scope filter: 4-th order Bessel-Thomson LPF with 33GHz 3dB BW
  - $\omega_0 = 98.28967142447435\ \mathrm{G\,rad/s}$

Effects on SNDR (Np=200)

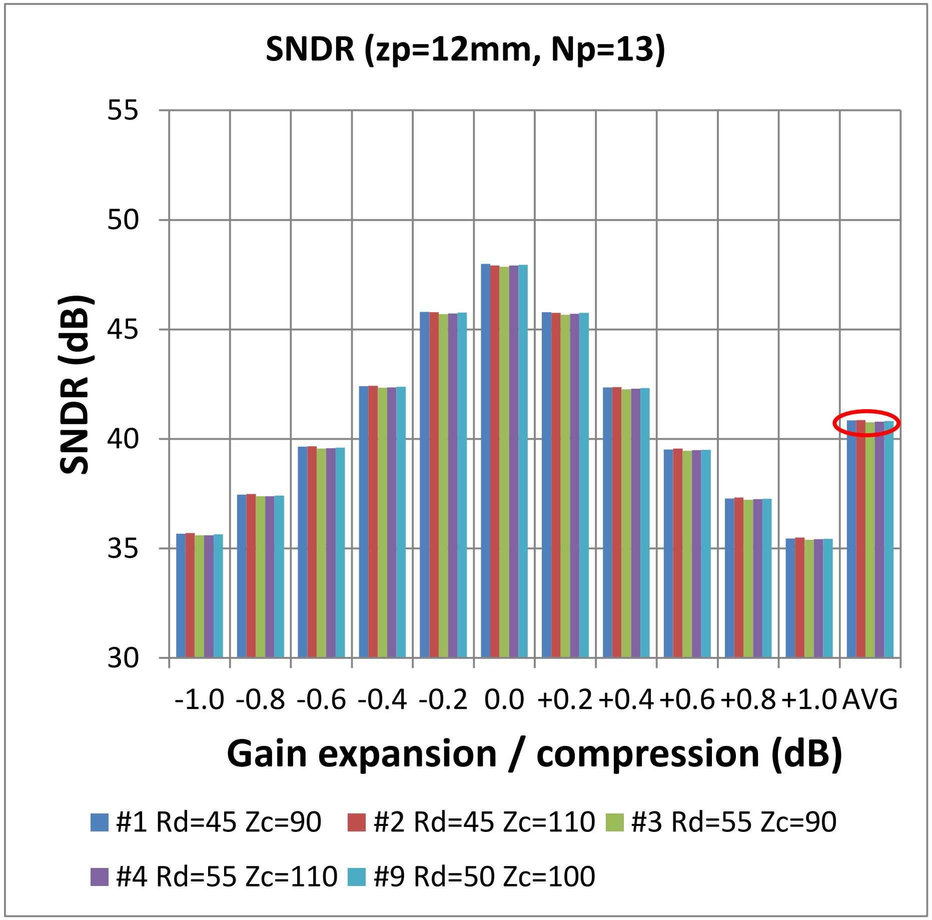
- The effect of Rd and Zc on SNDR is very small

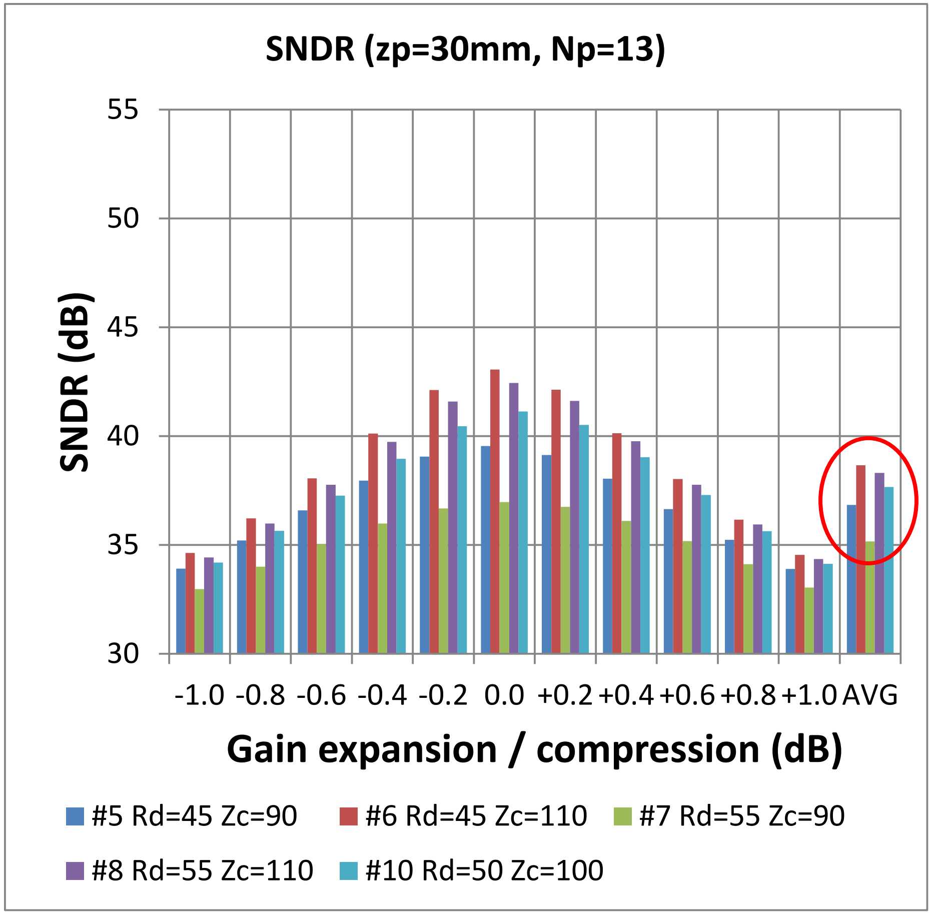




Effects on SNDR (Np=13)

- There are some effects of Rd and Zc on SNDR with zp=30mm when Np=13
  - However, it is difficult to take account of these effects in the COM model





Effects on Tx Amplitude

FUJITSU

#	Description	TF	TF IL @ 12.89GHz	Np	vf	pmax (min)	Av, Afe, Ane	zp	Cd	Zc
1	Old spec (min)		1.2~1.6dB	13	0.4V (min)	0.736 * vf	0.45V	30mm		
2	Old spec (max)		1.2~1.6dB	13	0.6V (max)		0.63V	12mm		
3	Check old spec	B	1.5770dB	13	0.4V (min)	0.738102 * vf	0.44914V	30mm	280fF	85Ω
4			1.5770dB	13	0.6V (max)		0.64446V	12mm	280fF	85Ω
5	Check old spec	A	1.4049dB	13	0.4V (min)	0.762583 * vf	0.44172V	30mm	180fF	90Ω
6			1.4049dB	13	0.6V (max)		0.64394V	12mm	180fF	90Ω
7	Revised spec with anchored Av	A	1.4049dB	200	0.4173V (min)	0.730950 * vf	0.44172V	30mm	180fF	90Ω
8			1.4049dB	200	0.6106V (max)		0.64394V	12mm	180fF	90Ω
9	Revised spec with anchored vf	A	1.4049dB	200	0.4V (min)	0.730950 * vf	0.42339V	30mm	180fF	90Ω
10			1.4049dB	200	0.6V (max)		0.63273V	12mm	180fF	90Ω

- Test Fixture
  - A: Reference Insertion Loss EQ93-1 with minimum phase and Zdiff=100Ω
  - B: 38mm Host PCB trace (Zdiff=109.8Ω) using EQ93A-13,14 with Table 92-12
- #3~#10 are simulated with Rd=55Ω, Cp=110fF, Gaussian Filter (Tr=13ps) and 4-th order Bessel-Thomson LPF with 33GHz 3dB bandwidth

Cisco Channels (CH1-10)

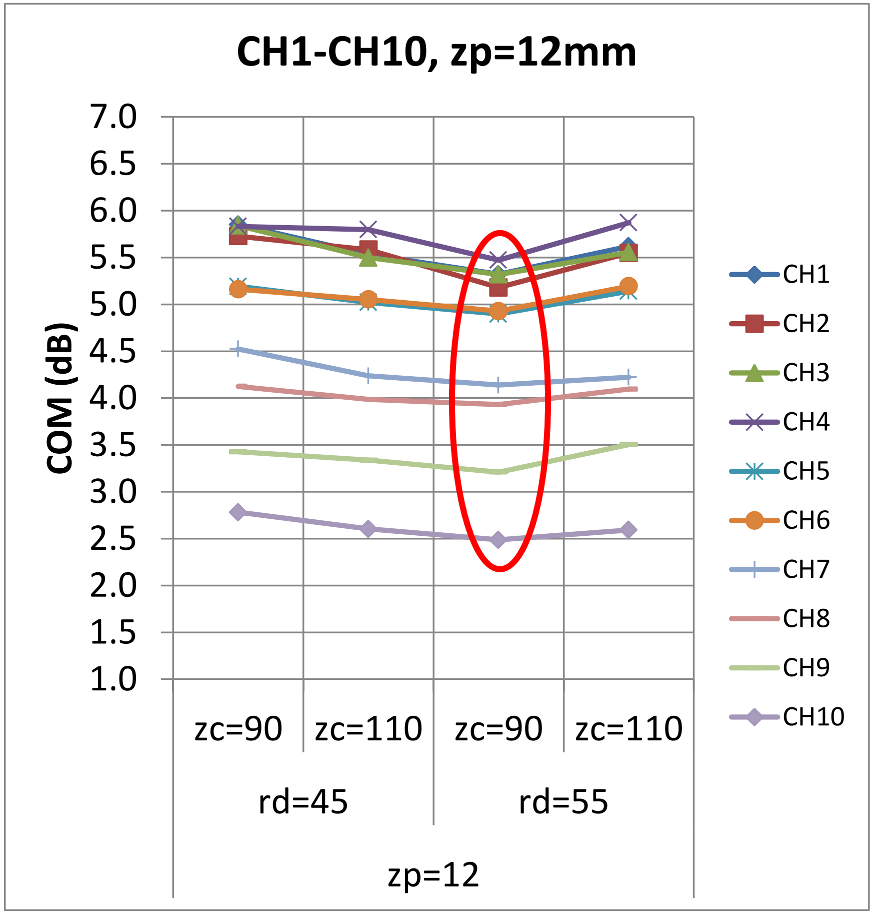
- Data source (in P802.3cd TF Channel Data Area)
  - http://www.ieee802.org/3/cd/public/channel/Cisco_Backplane_channel_data.zip
- Characteristics
  - Insertion Loss @ Nyquist : 10.7876dB (CH1) ~ 34.9828dB (CH10)
  - Crosstalk : 5 FEXT + 3 NEXT

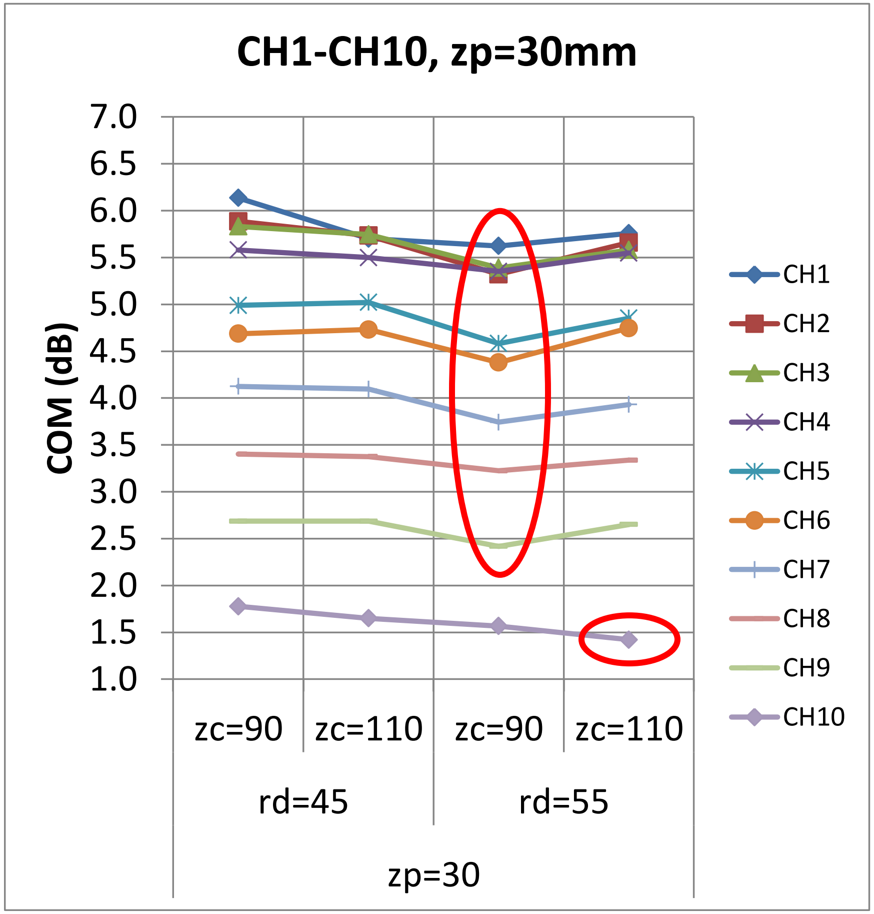
	IL (dB)	FOM_ILD	ICN (mV)
CH1	10.7876	0.31042	1.2534
CH2	12.4579	0.30047	1.1147
CH3	17.3145	0.28196	0.81725
CH4	20.874	0.31335	0.72664
CH5	22.3474	0.28224	0.69128

	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 Zc=90Ω & Rd=55Ω or Zc=110Ω & Rd=55Ω
  - Zc=110Ω & Rd=45Ω is better than Zc=90Ω & Rd=55Ω
  - zp=30mm is worse than 12mm except CH1~3 where 12mm is worse

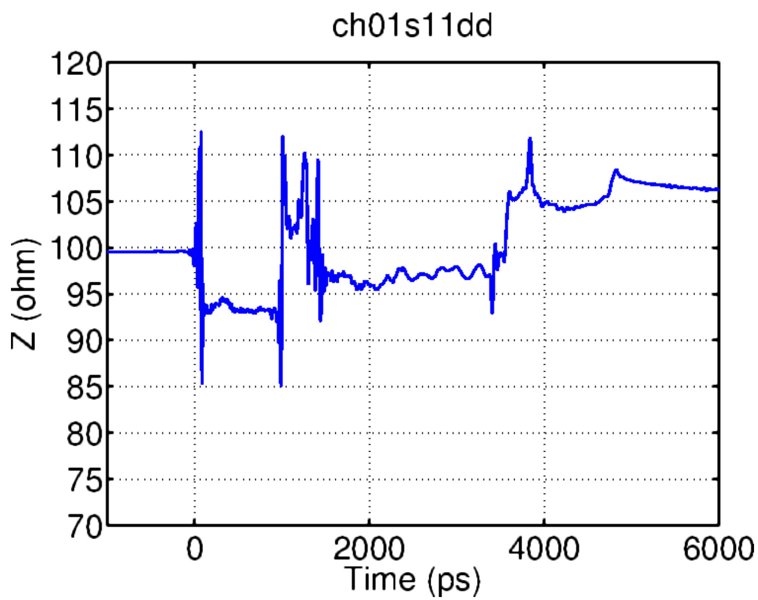


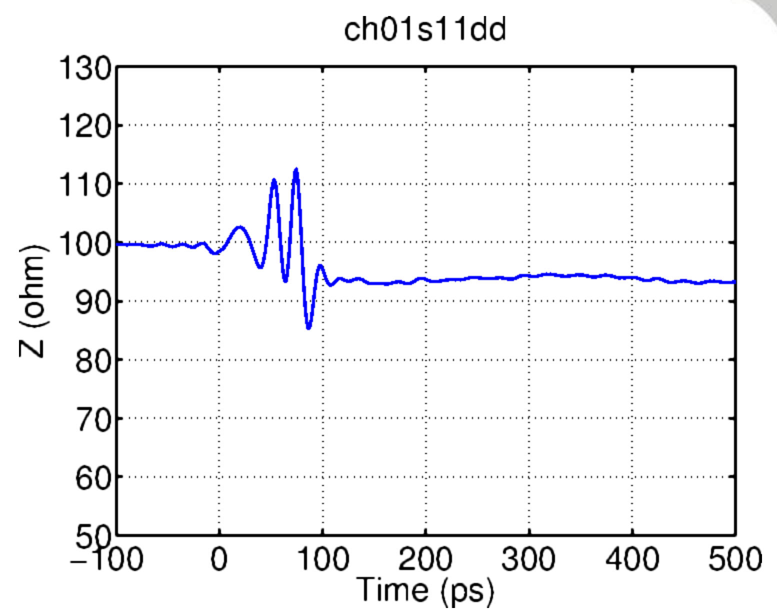


Cisco 10dB Channel (CH1): Zdiff Profile

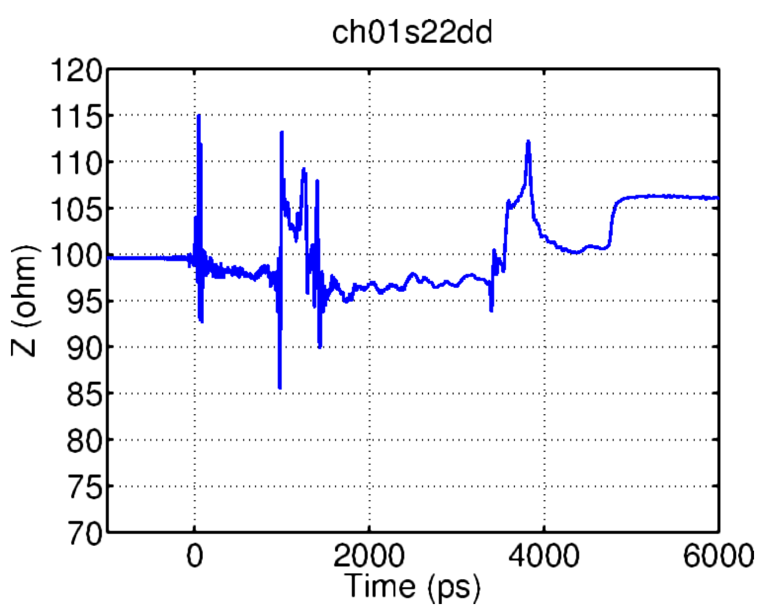
FUJITSU

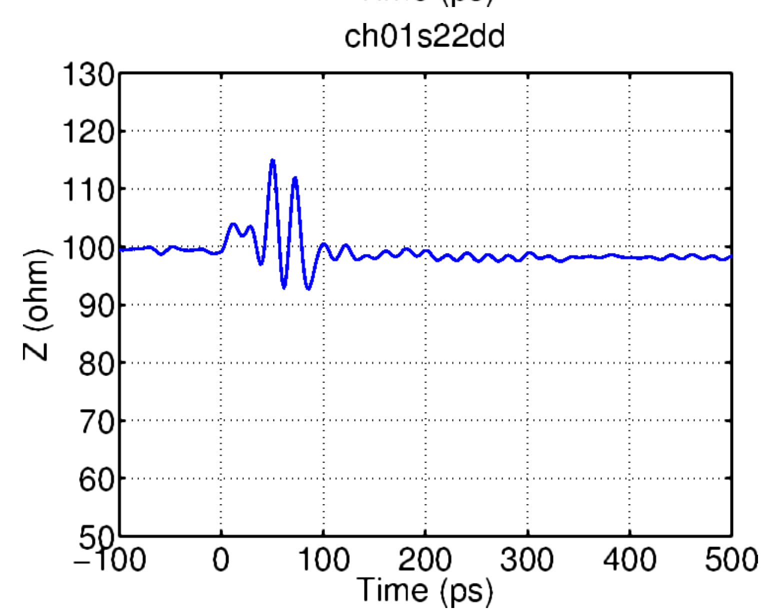
S11dd





S22dd

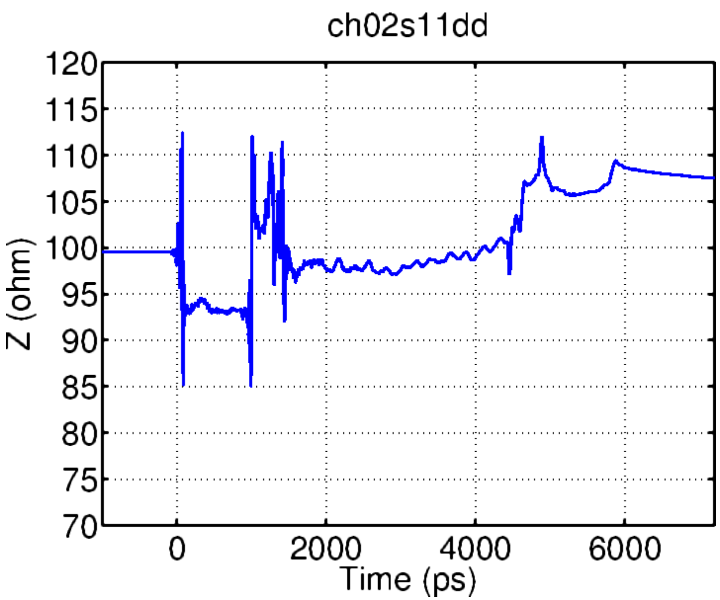


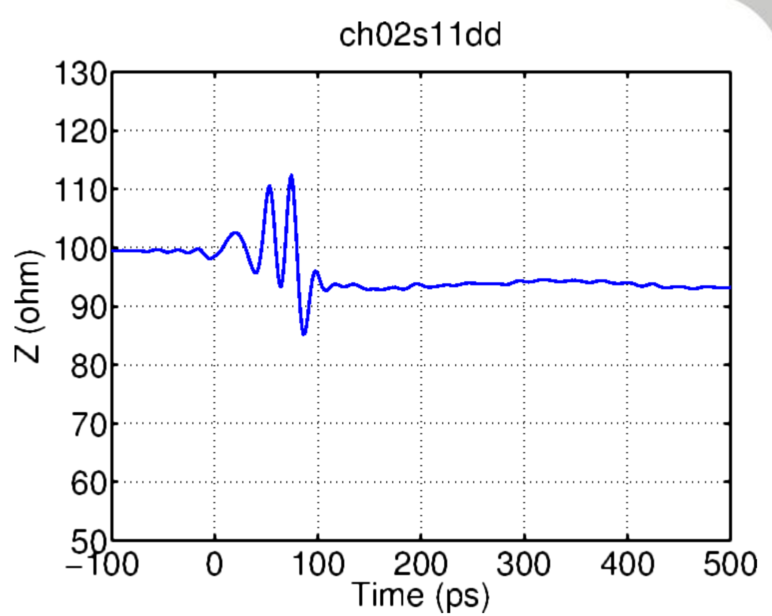


Cisco 12dB Channel (CH2): Zdiff Profile

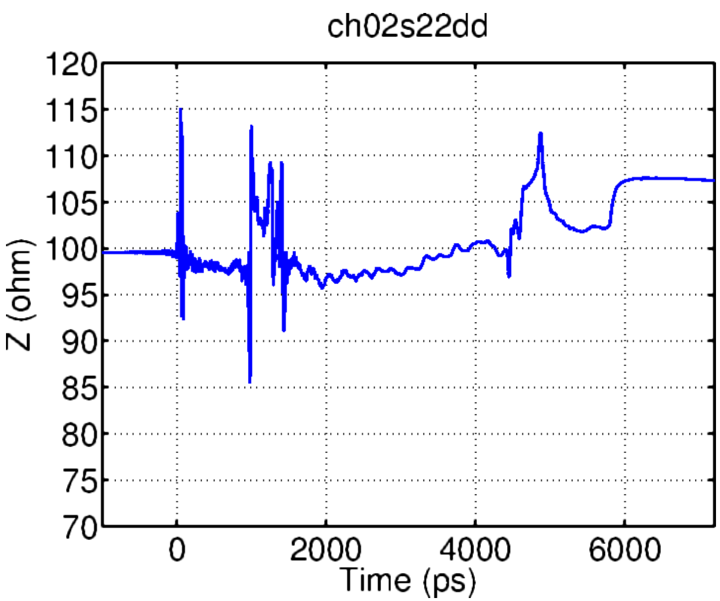
FUJITSU

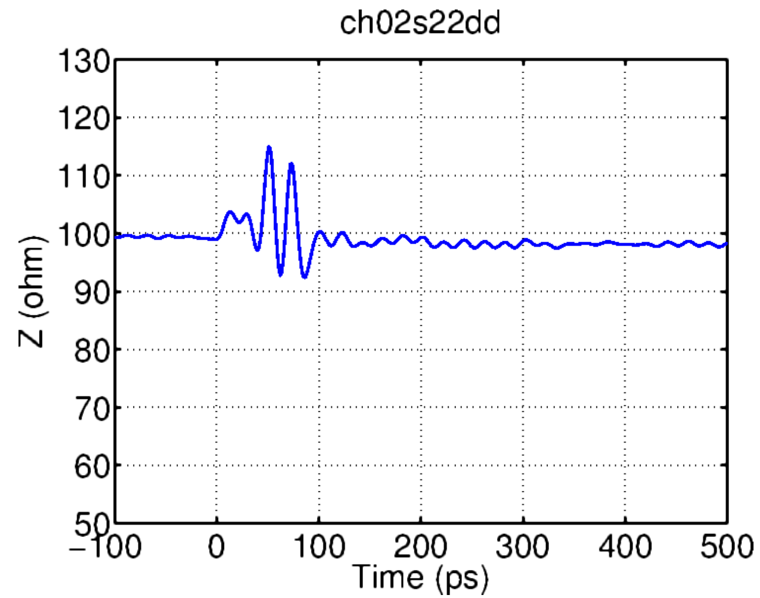
S11dd





S22dd

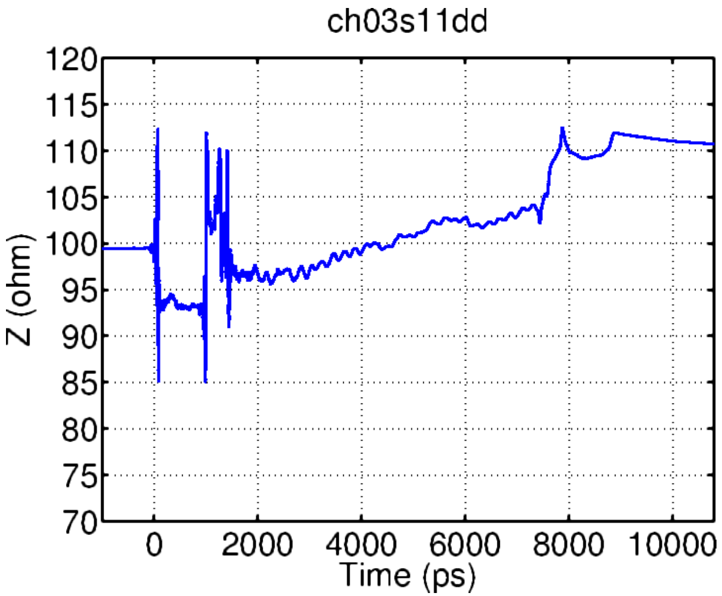


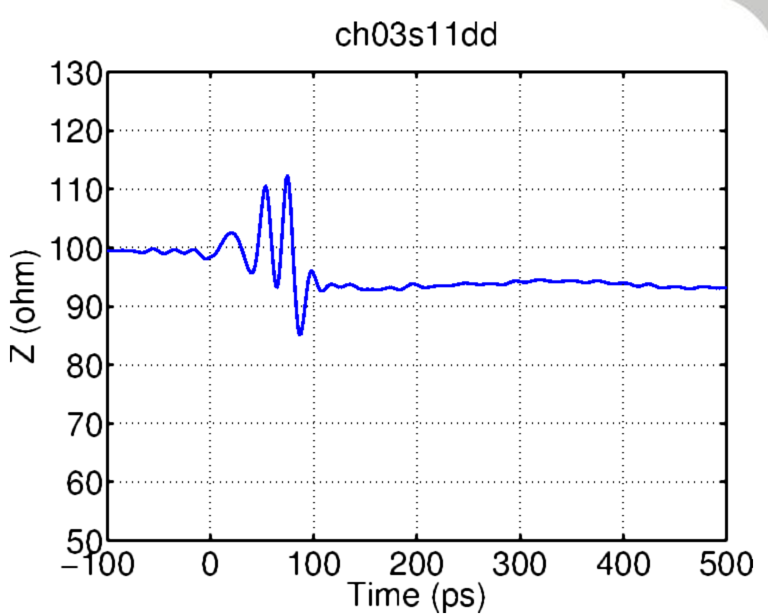


Cisco 17dB Channel (CH3): Zdiff Profile

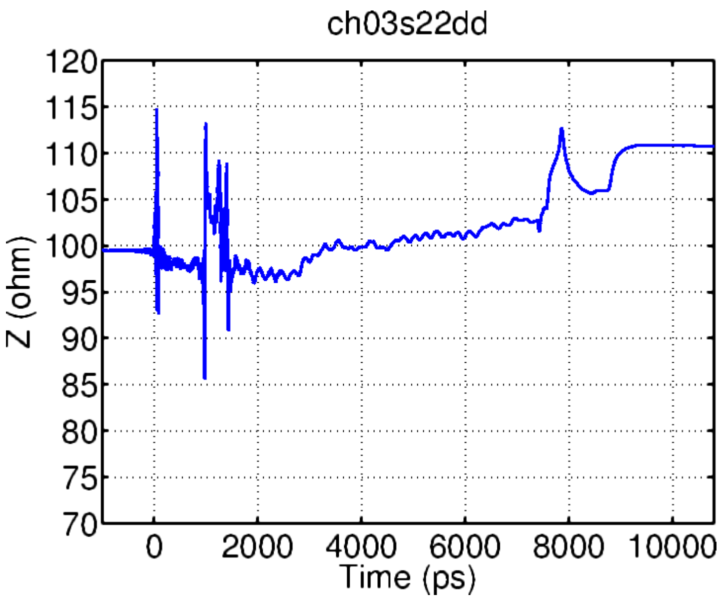
FUJITSU

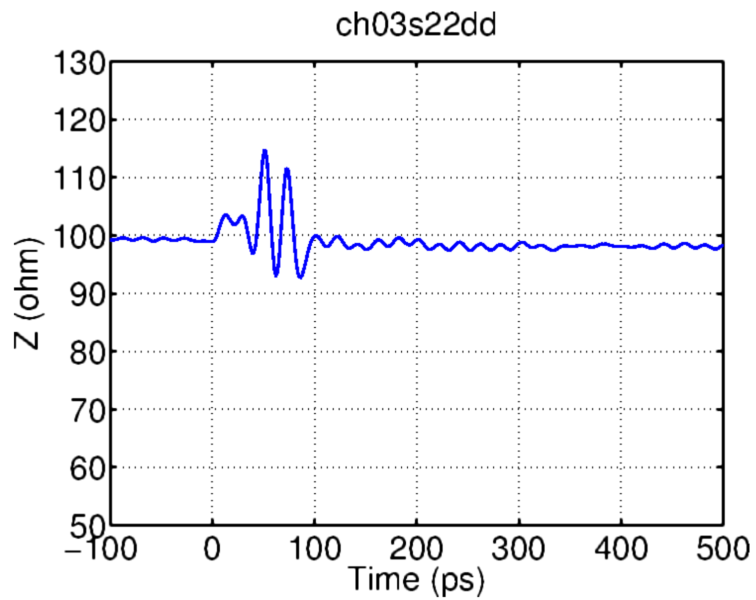
S11dd





S22dd

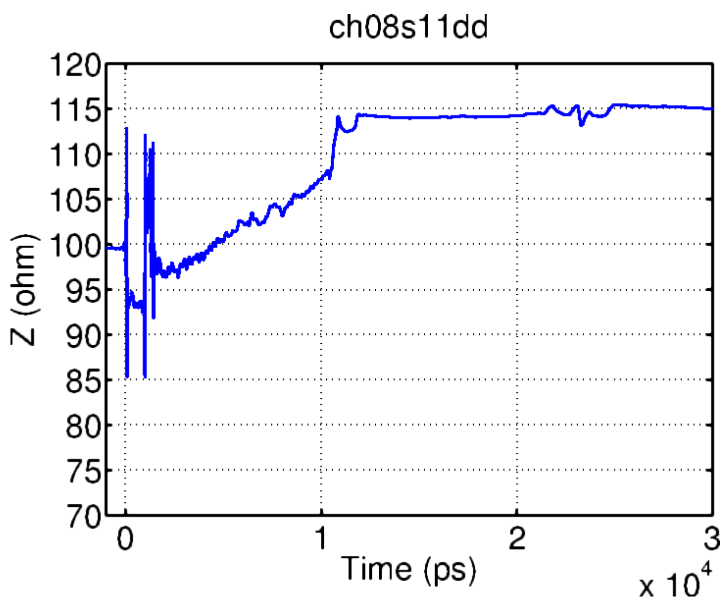


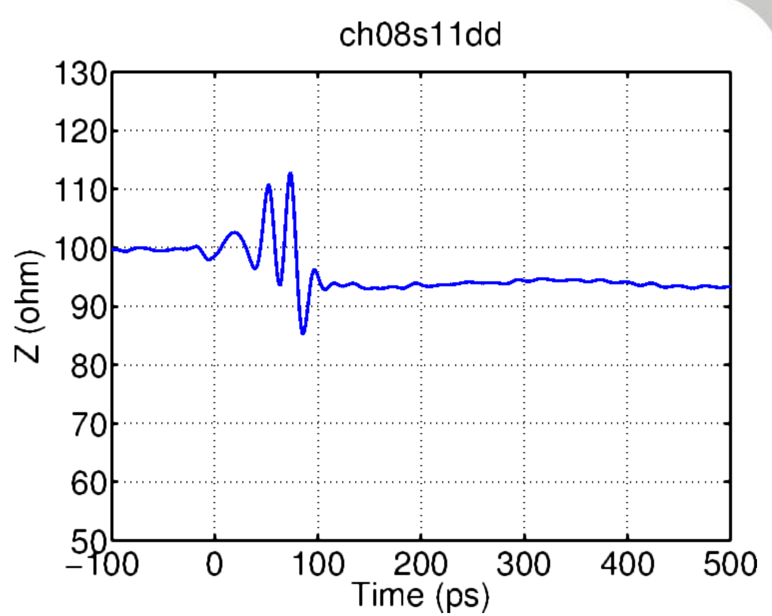


Cisco 30dB Channel (CH8): Zdiff Profile

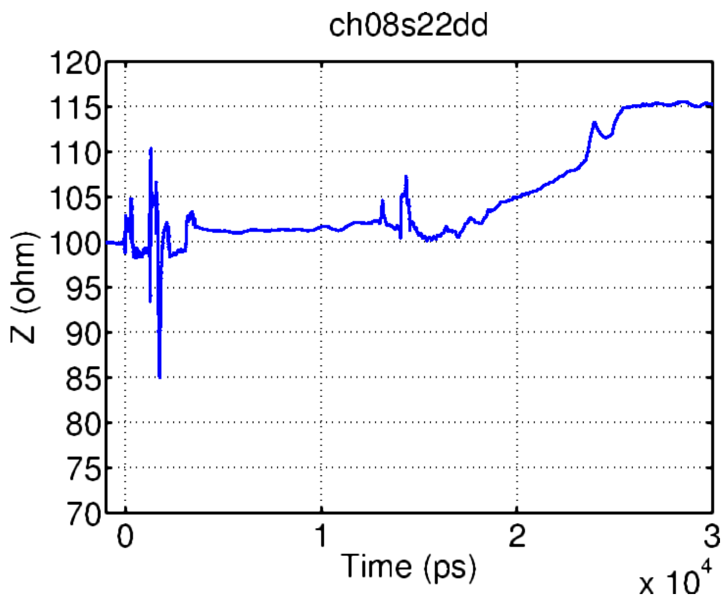
FUJITSU

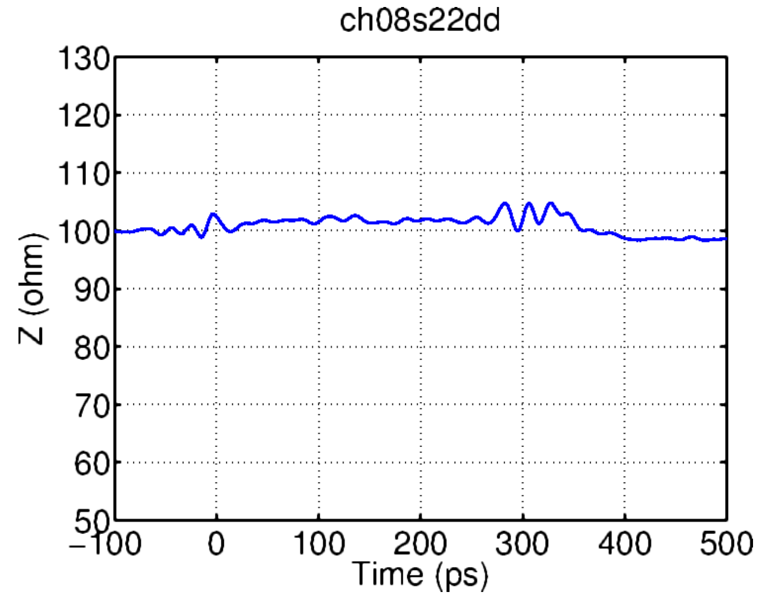
S11dd





S22dd

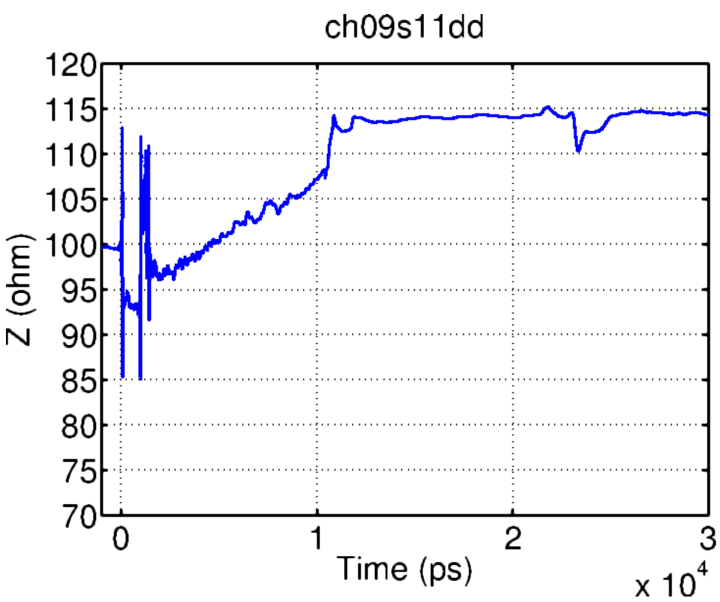


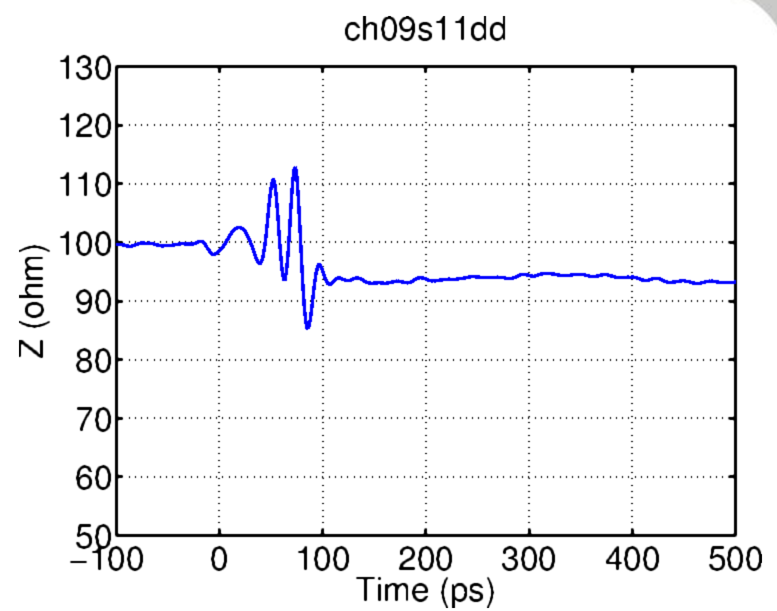


Cisco 33dB Channel (CH9): Zdiff Profile

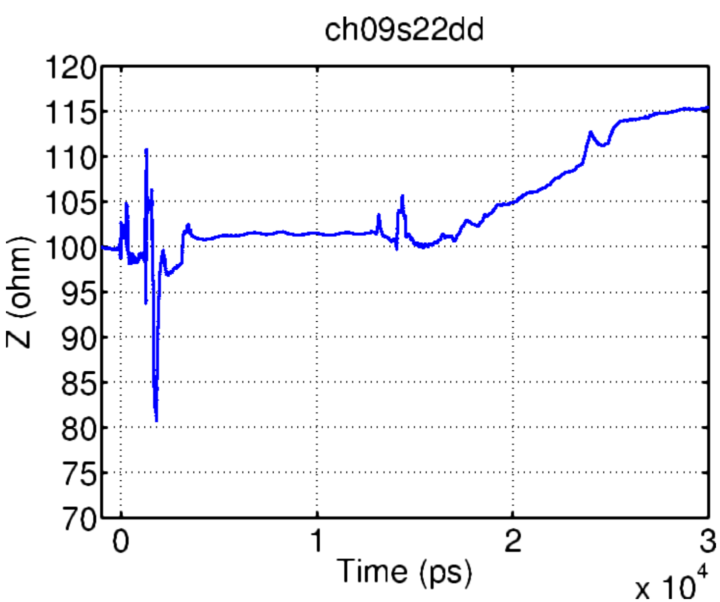
FUJITSU

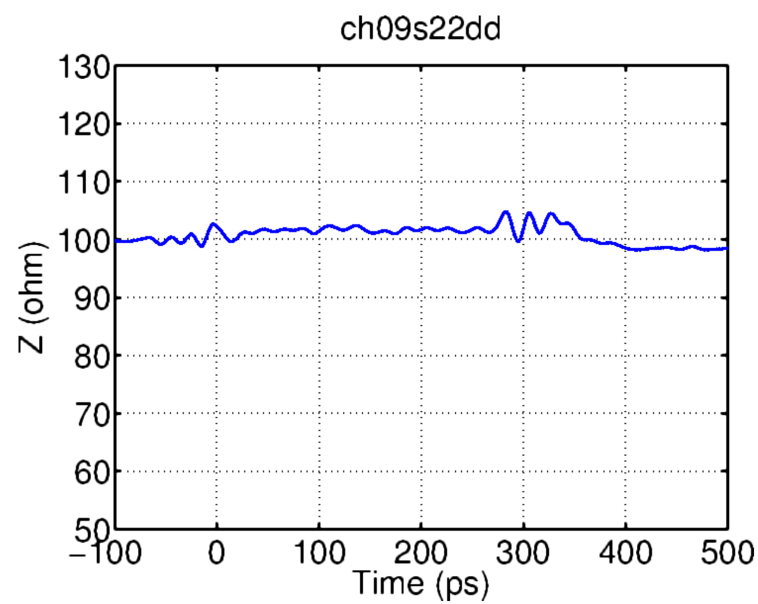
S11dd





S22dd

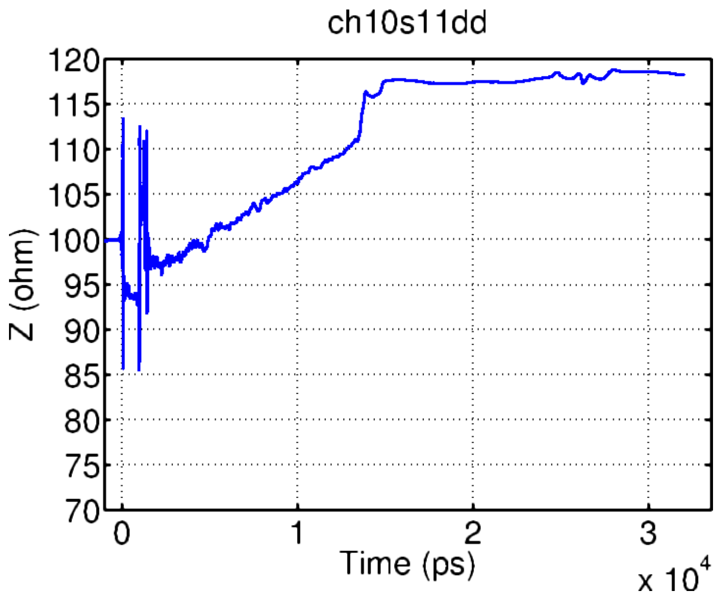


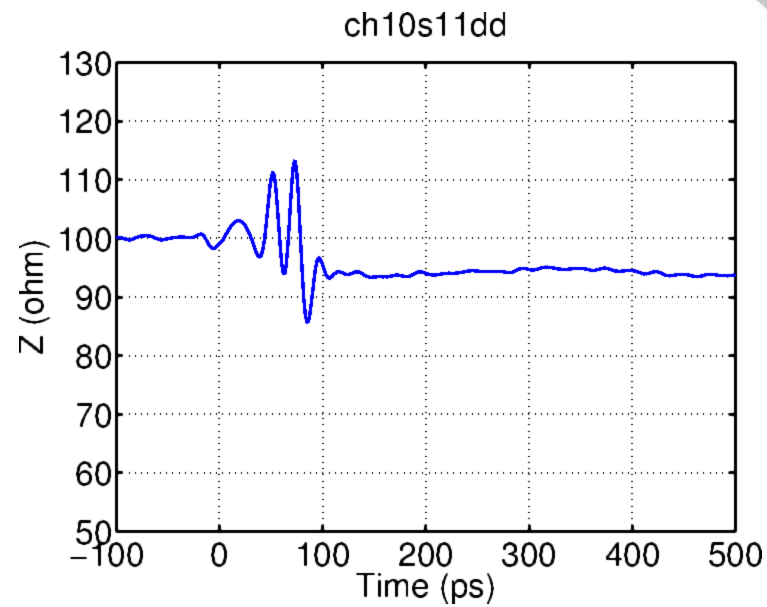


Cisco 35dB Channel (CH10): Zdiff Profile

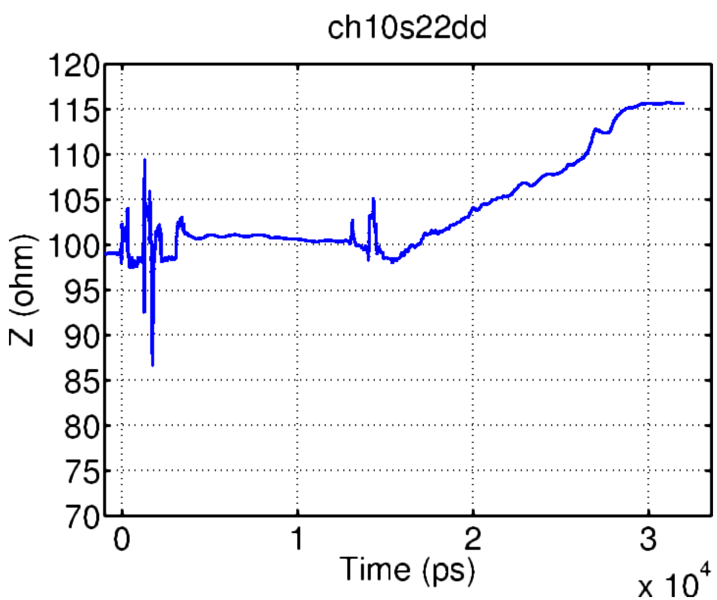
FUJITSU

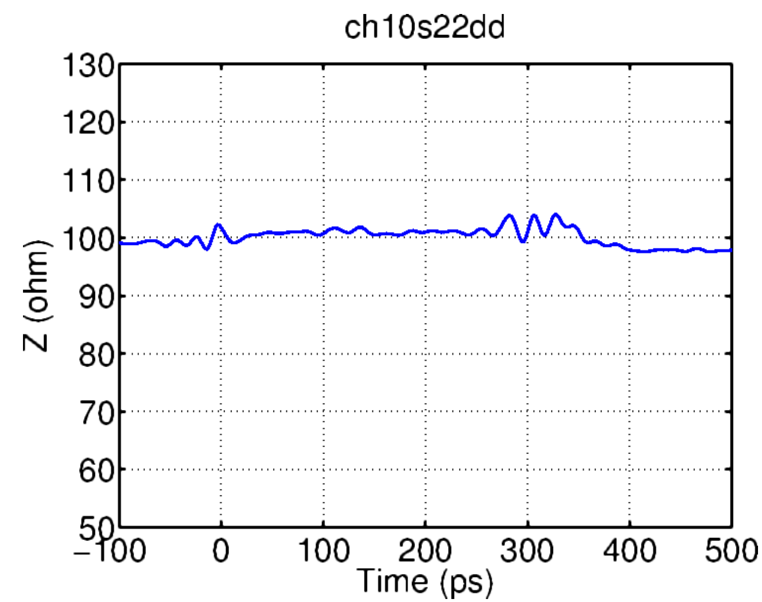
S11dd





S22dd





Intel 100Ω Channels (CH11-25)

FUJITSU

- 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

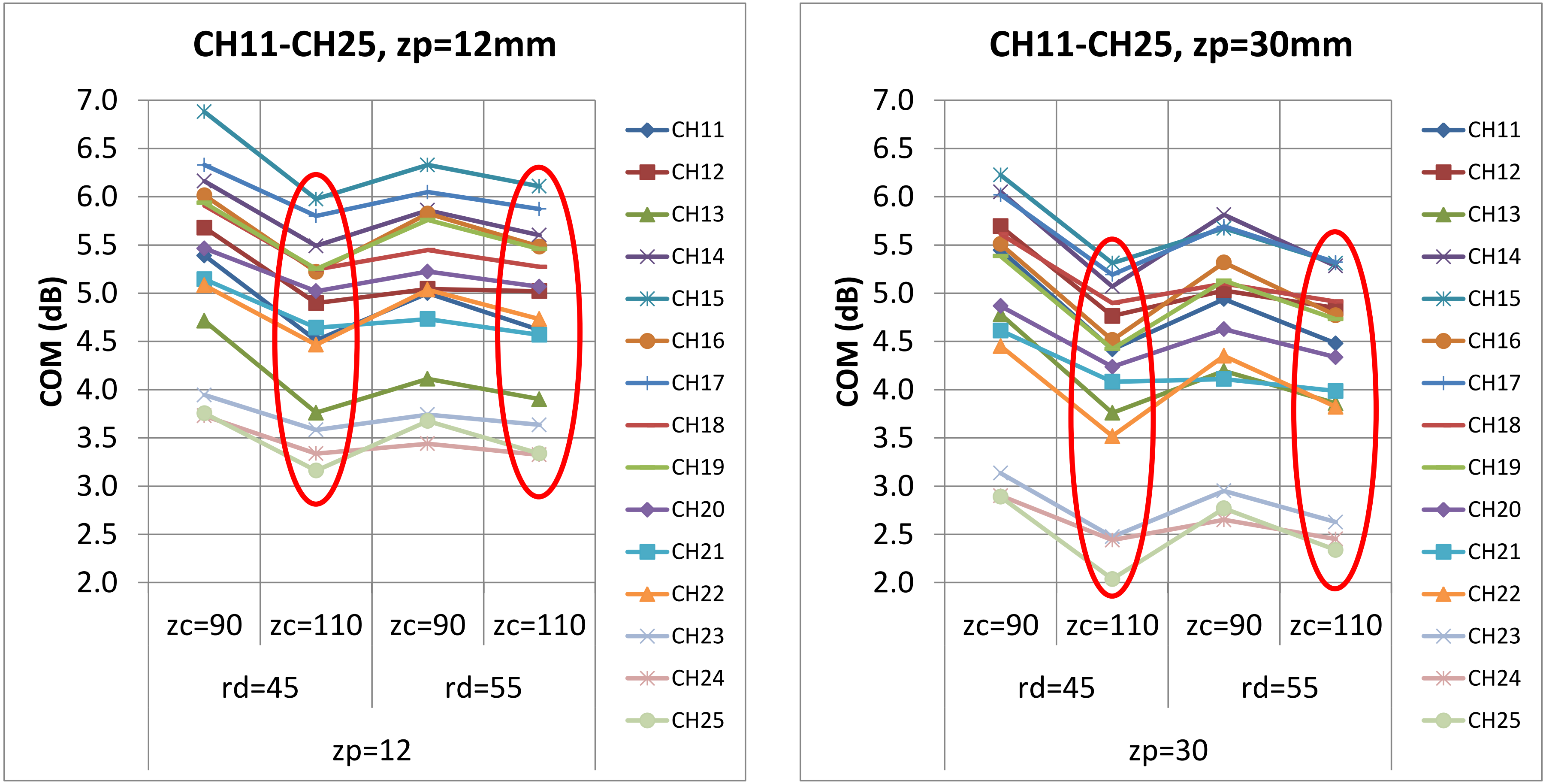
	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH11	Nom	9.7636	0.35085	2.5159
CH12	HzLzHz	9.6743	0.30416	2.5299
CH13	LzHzLz	9.9267	0.33959	2.4796
CH14	Nom	14.8063	0.25593	1.6857
CH15	HzLzHz	15.1217	0.25119	1.6854
CH16	LzHzLz	15.0295	0.27047	1.7122
CH17	Nom	19.9038	0.23598	1.4094
CH18	HzLzHz	19.7834	0.23241	1.4131
CH19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

FUJITSU

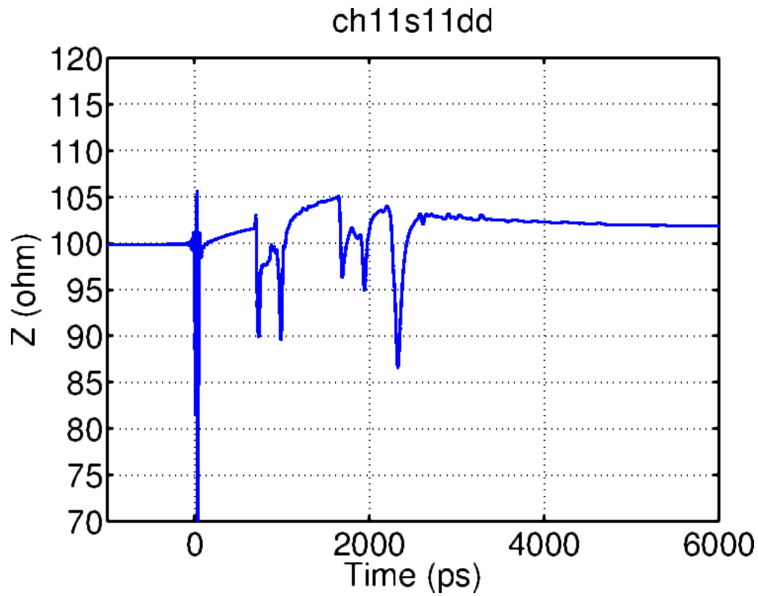
- The worst case is Zc=110Ω & Rd=45Ω or Zc=110Ω & Rd=55Ω
  - Zc=90Ω & Rd=55Ω is better than Zc=110Ω & Rd=45Ω or 55Ω
  - zp=30mm is worse than 12mm

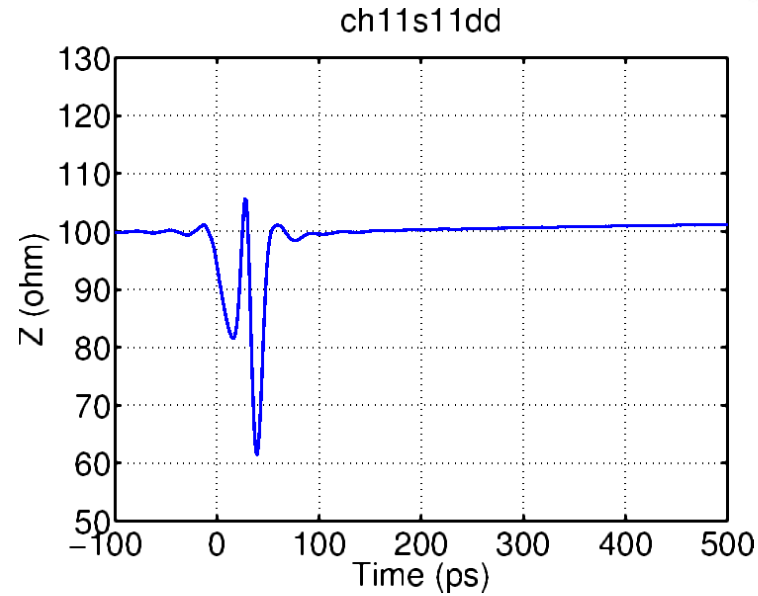


Intel 100Ω 10dB Nom (CH11): Zdiff Profile

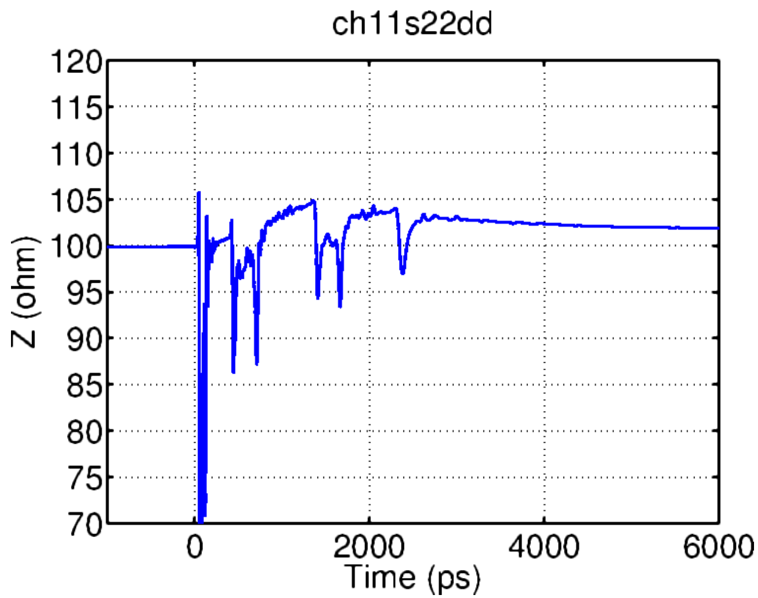
FUJITSU

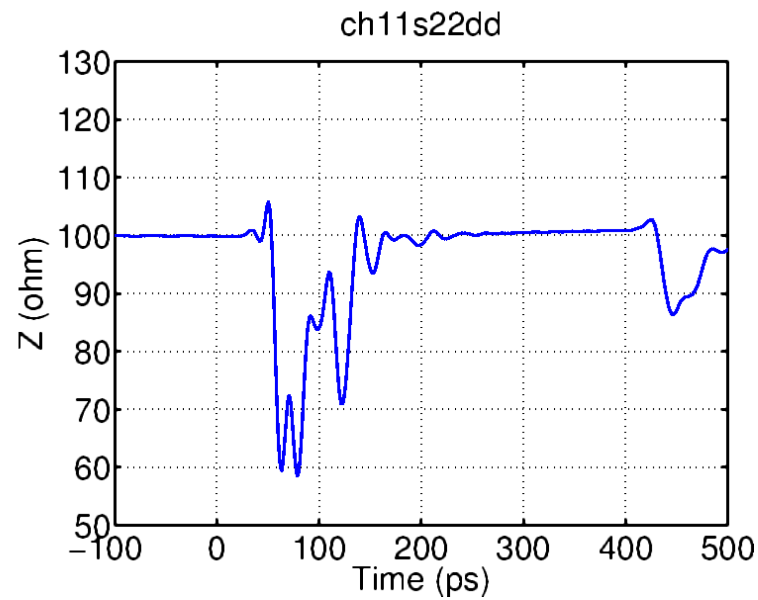
S11dd





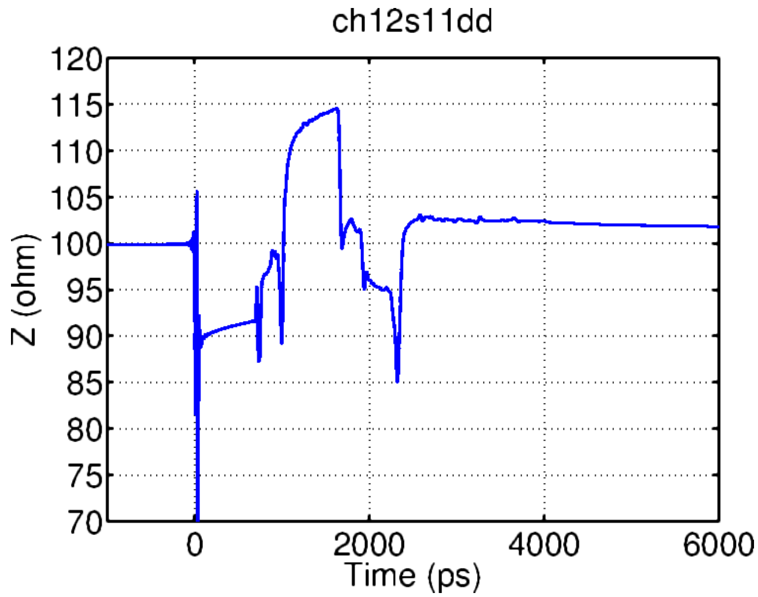
S22dd

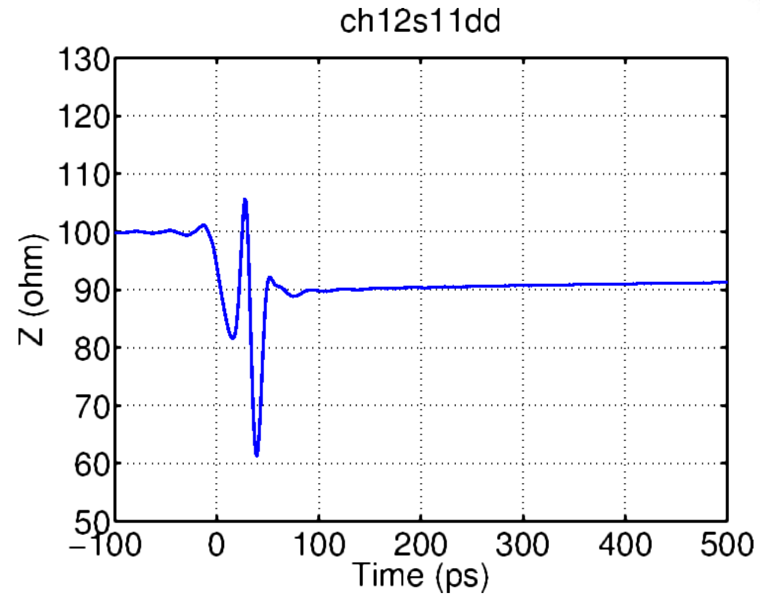




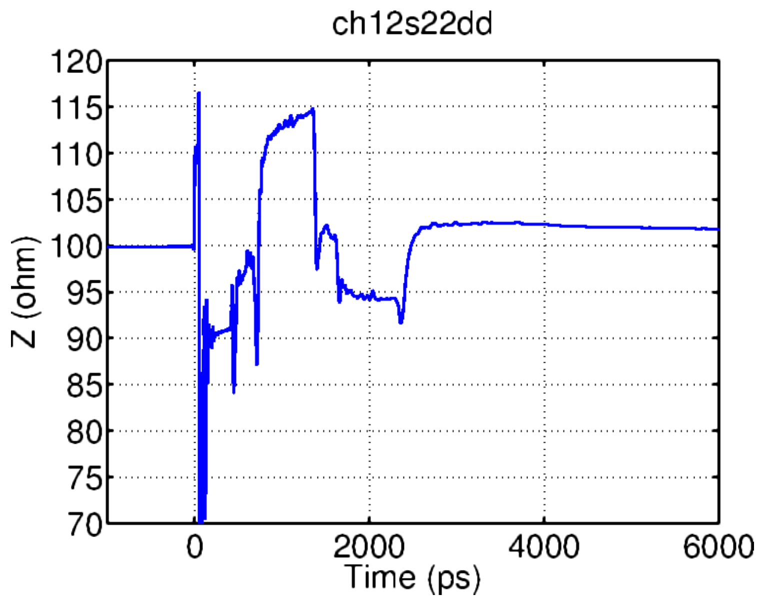
Intel 100Ω 10dB HzLzHz (CH12): Zdiff Profile

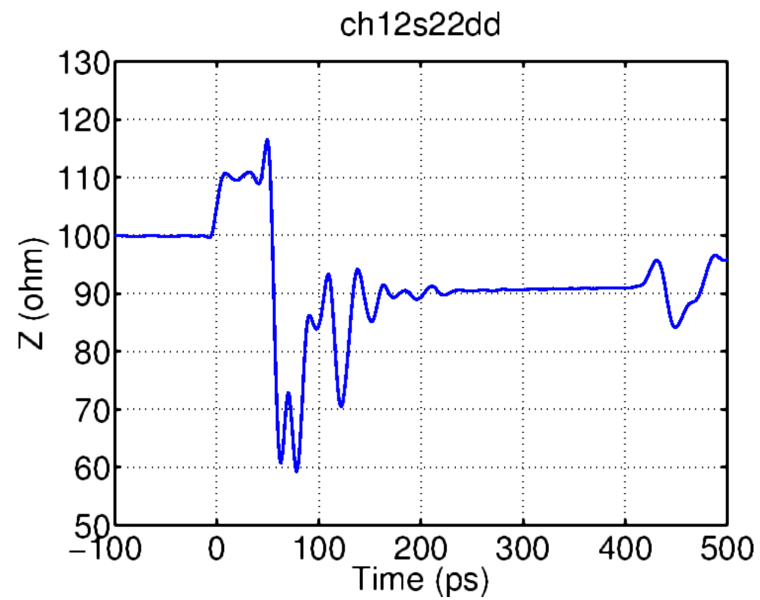
S11dd





S22dd

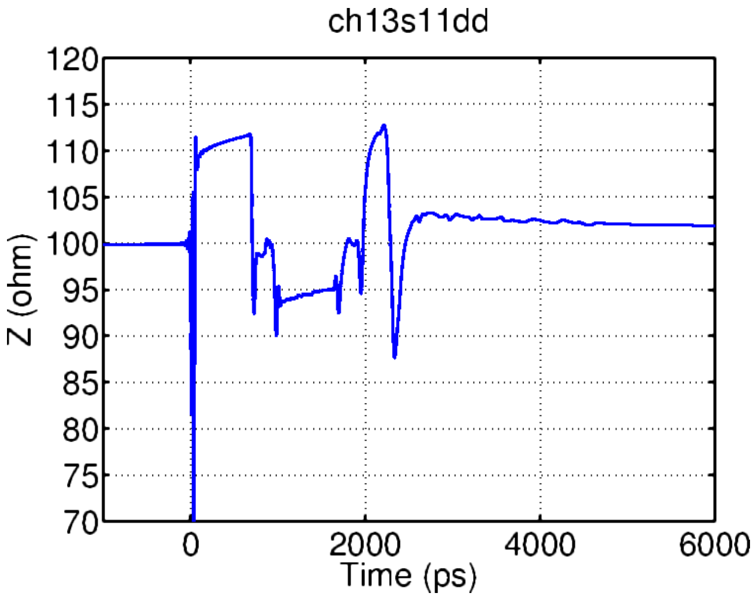


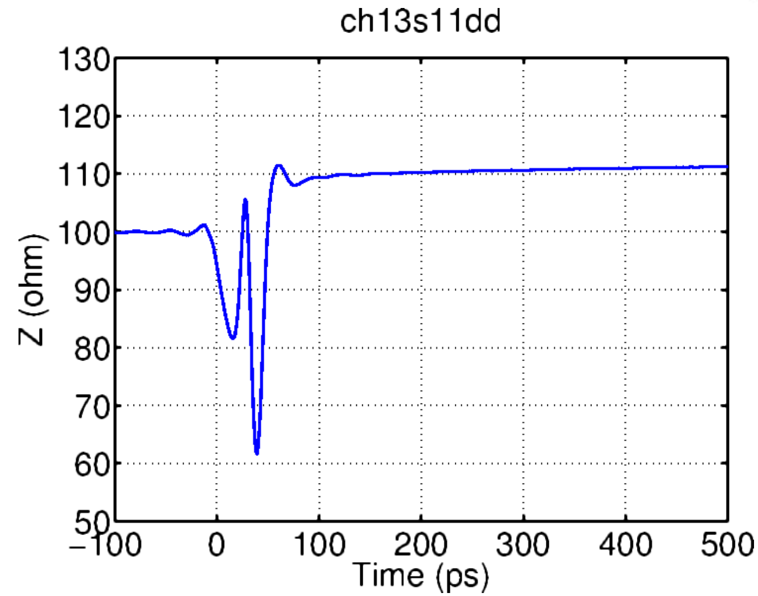


Intel 100Ω 10dB LzHzLz (CH13): Zdiff Profile

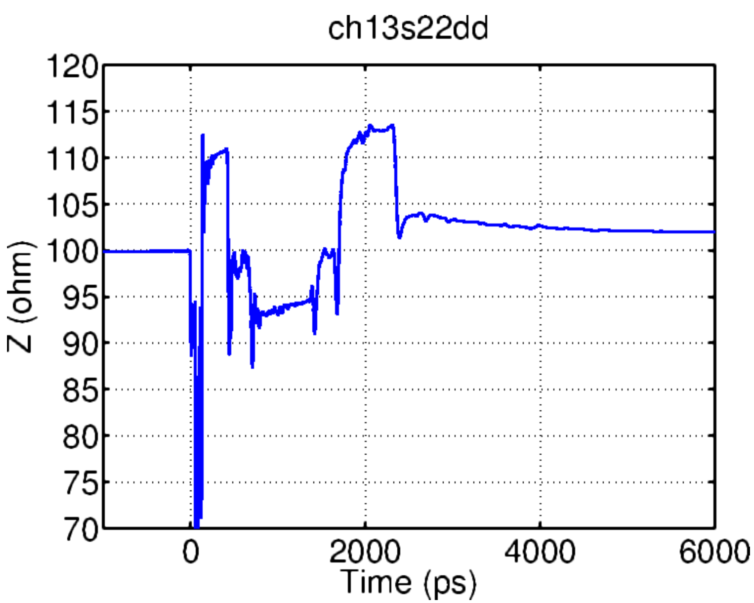
FUJITSU

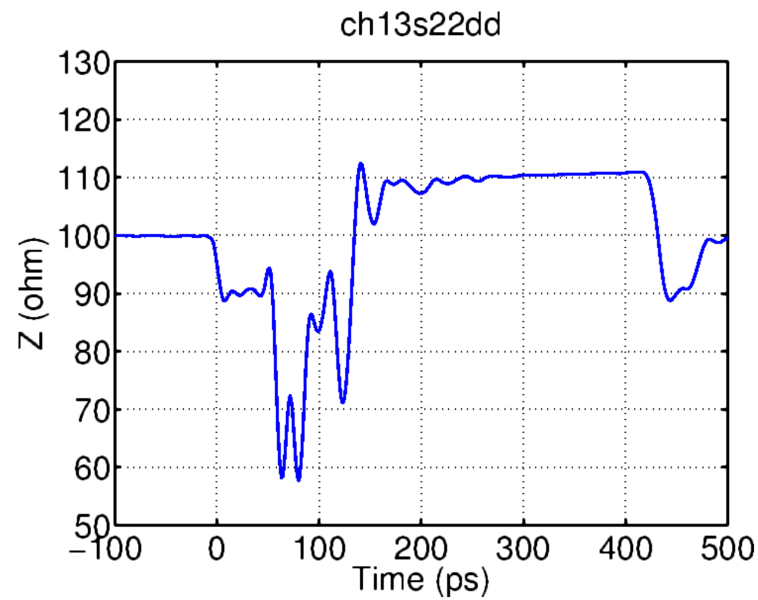
S11dd





S22dd

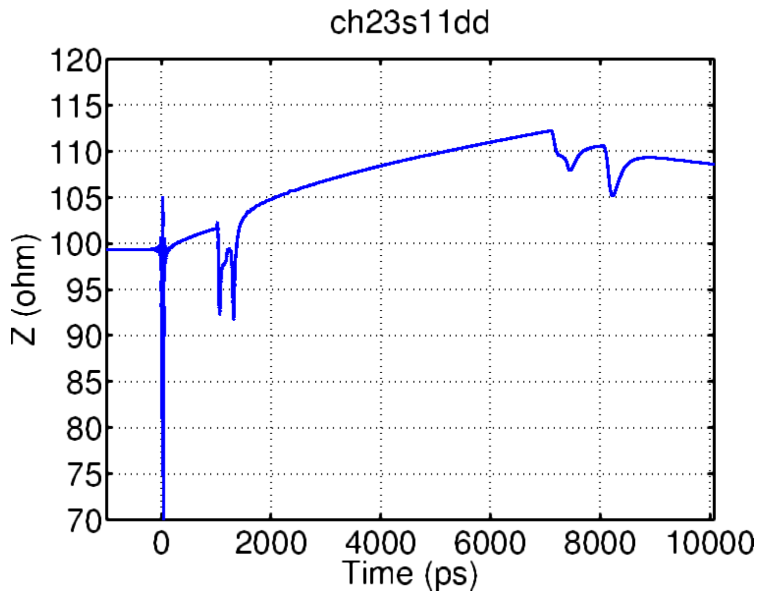


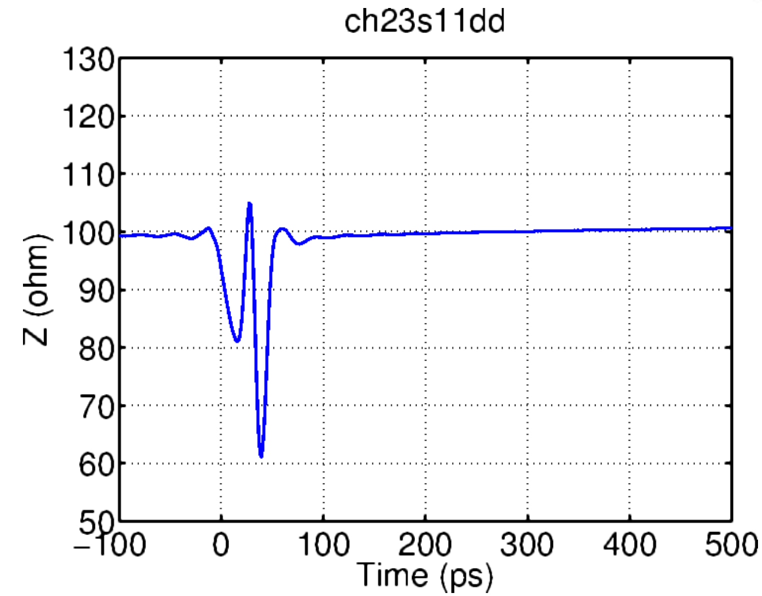


Intel 100Ω 30dB Nom (CH23): Zdiff Profile

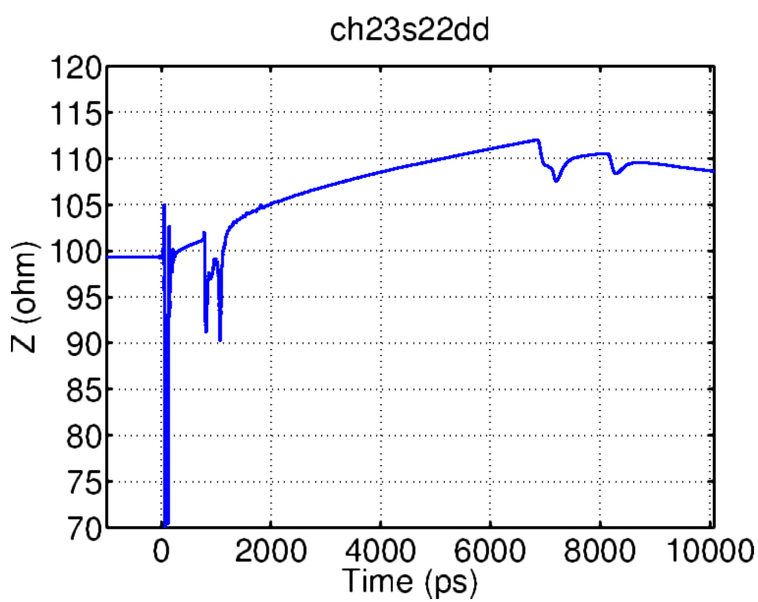
FUJITSU

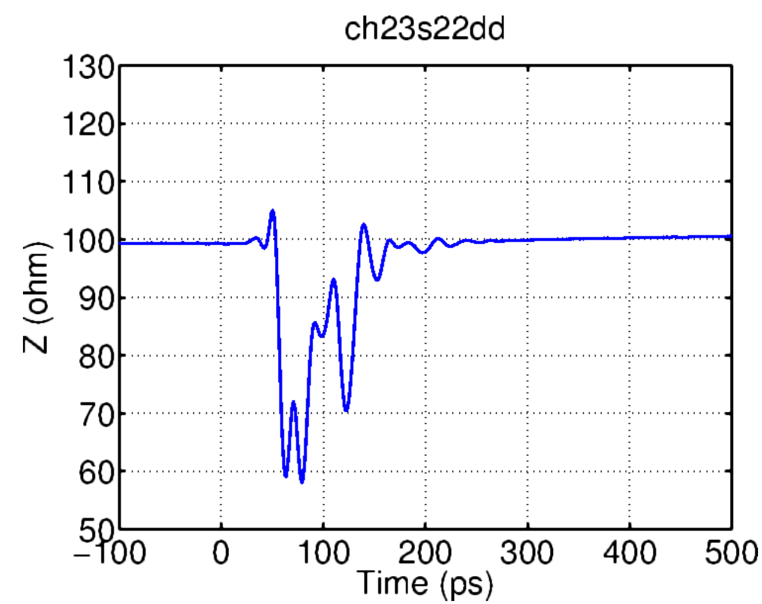
S11dd





S22dd

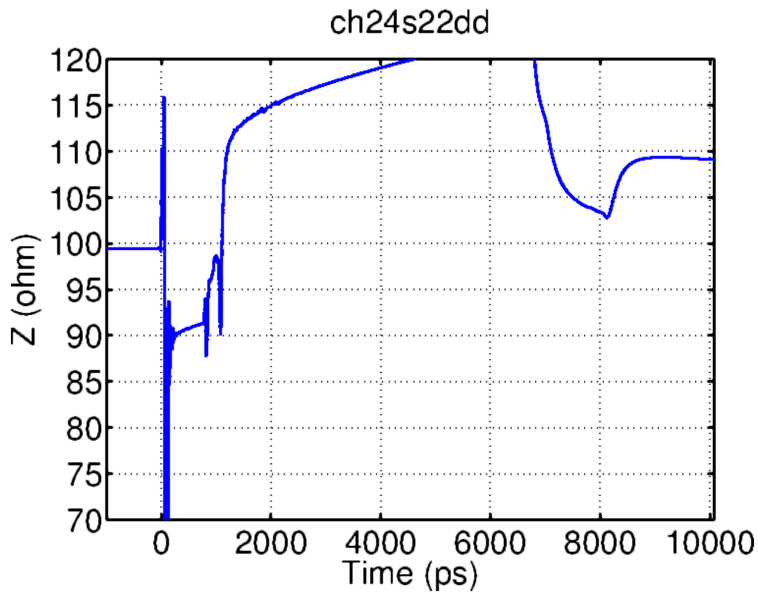


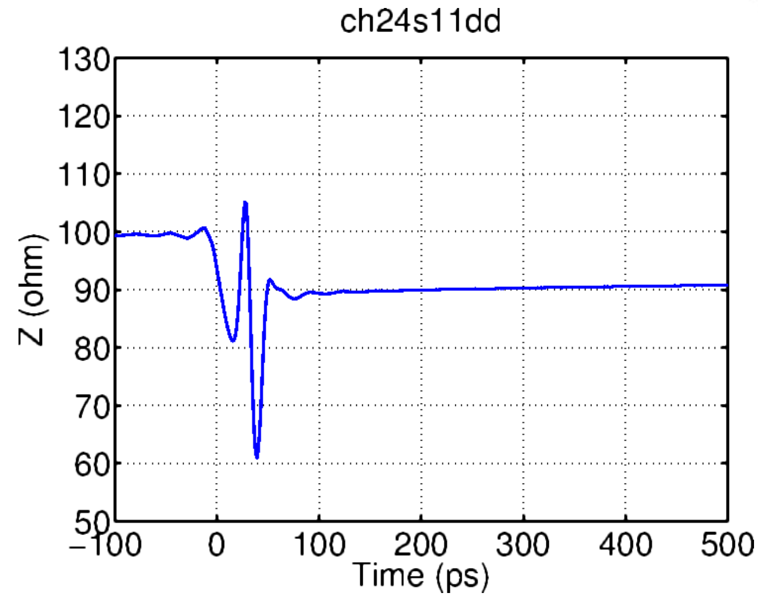


Intel 100Ω 30dB HzLzHz (CH24): Zdiff Profile

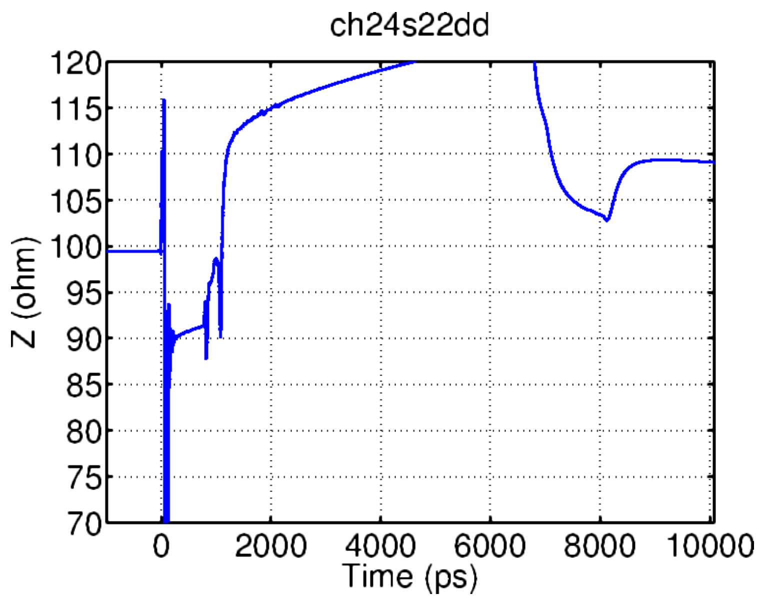
FUJITSU

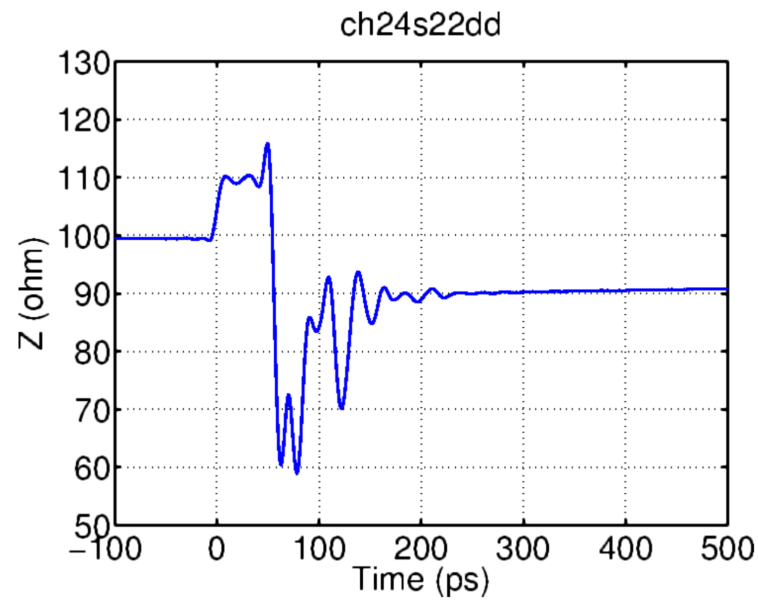
S11dd





S22dd

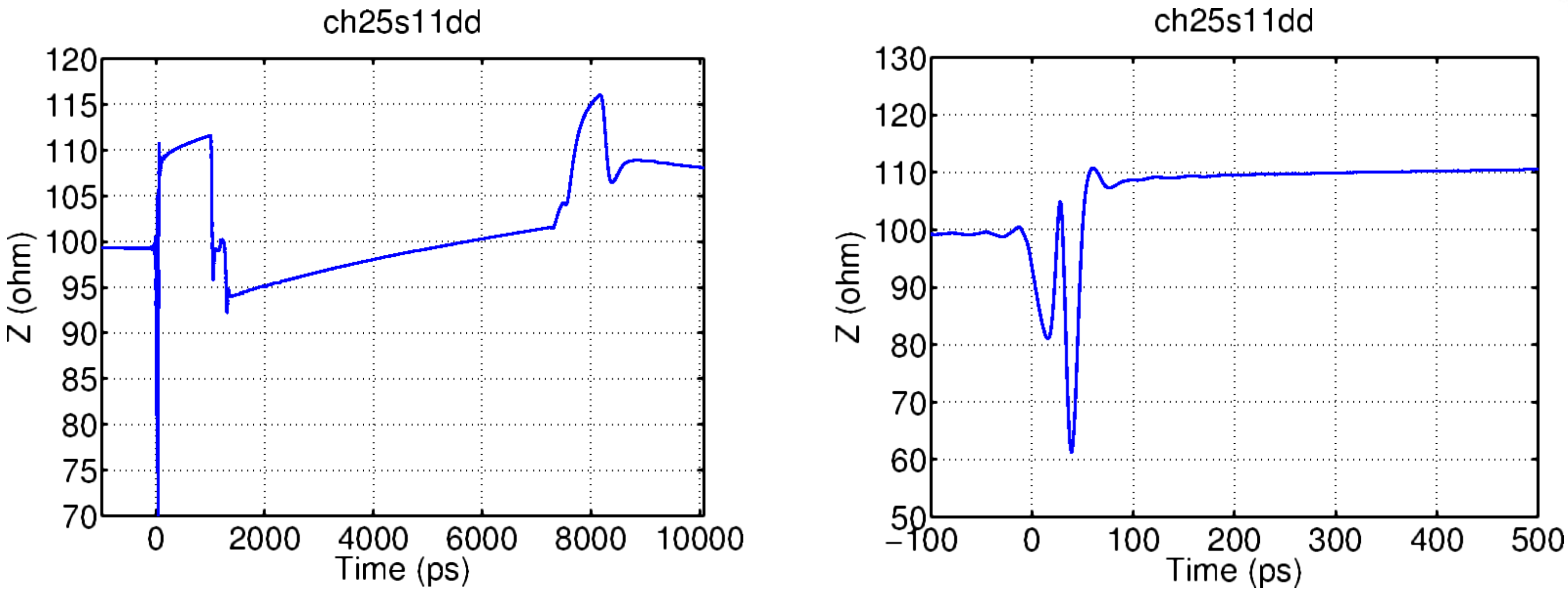




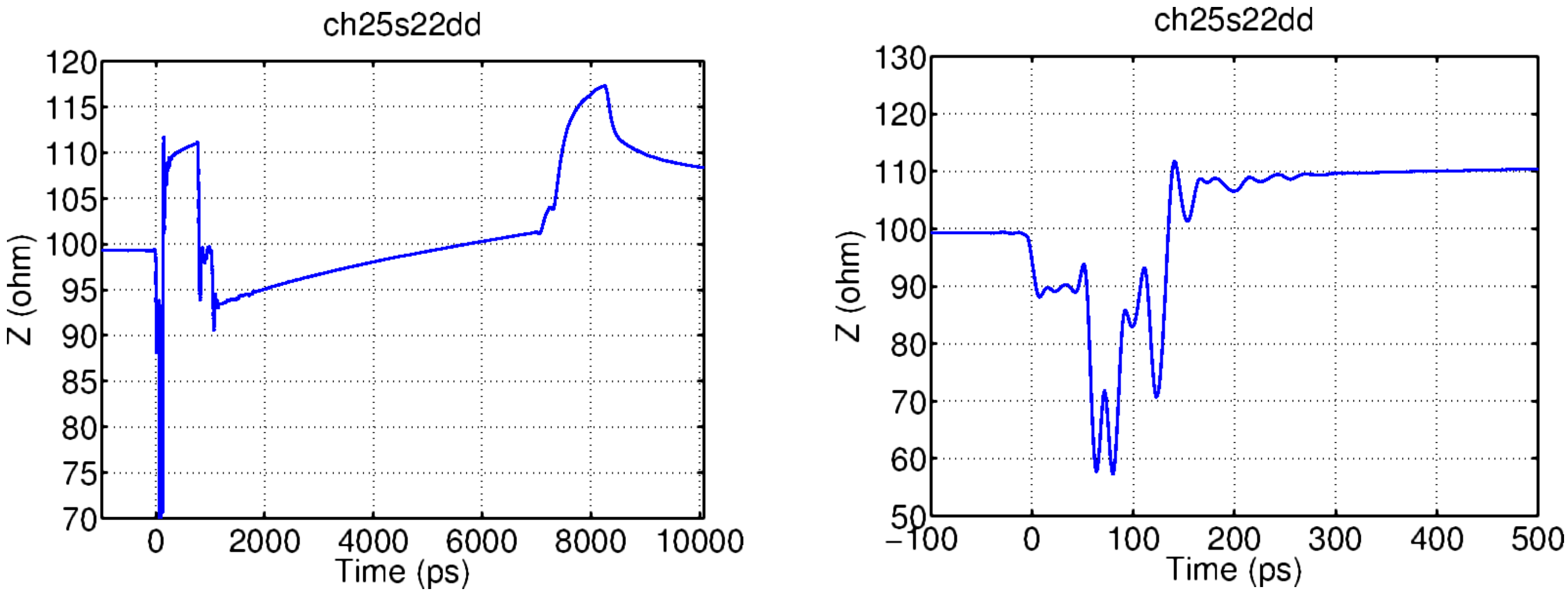
Intel 100Ω 30dB LzHzLz (CH25): Zdiff Profile

FUJITSU

S11dd



S22dd



Intel 85Ω Channels (CH26-40)

FUJITSU

- 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

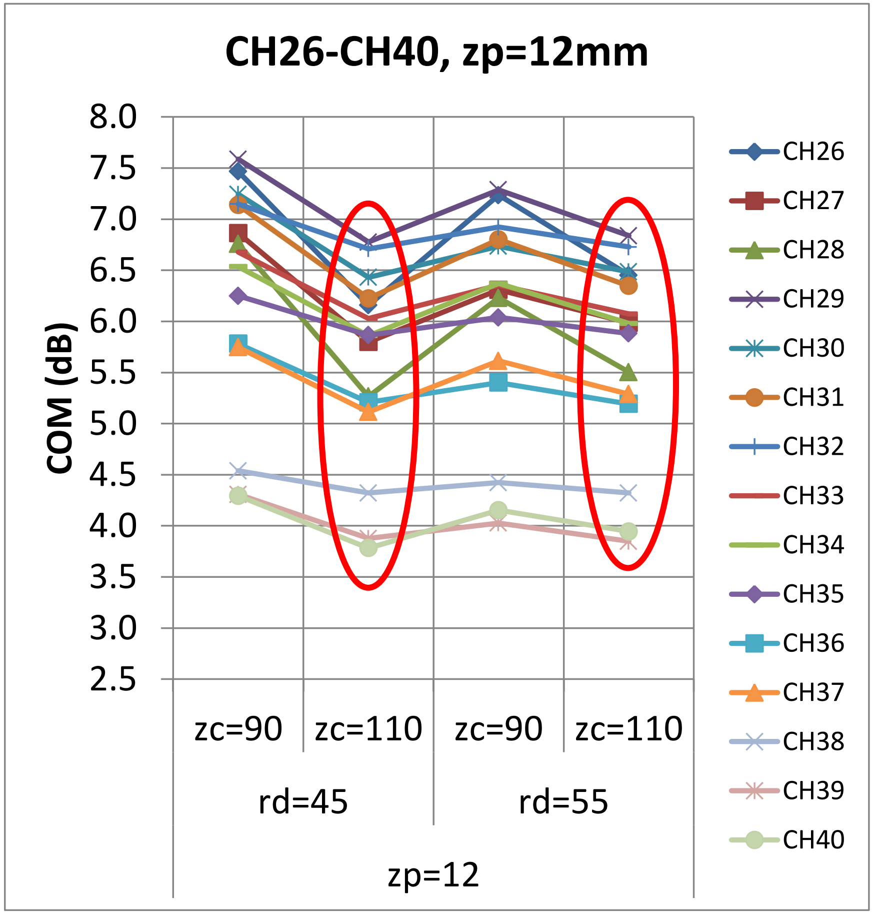
	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH26	Nom	9.7602	0.21802	2.4937
CH27	HzLzHz	9.6093	0.22831	2.4977
CH28	LzHzLz	9.9398	0.23882	2.4522
CH29	Nom	14.6258	0.17817	1.6748
CH30	HzLzHz	15.1722	0.1794	1.6546
CH31	LzHzLz	14.8594	0.20324	1.6914
CH32	Nom	19.7787	0.16126	1.3745
CH33	HzLzHz	19.8607	0.16948	1.3622
CH34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

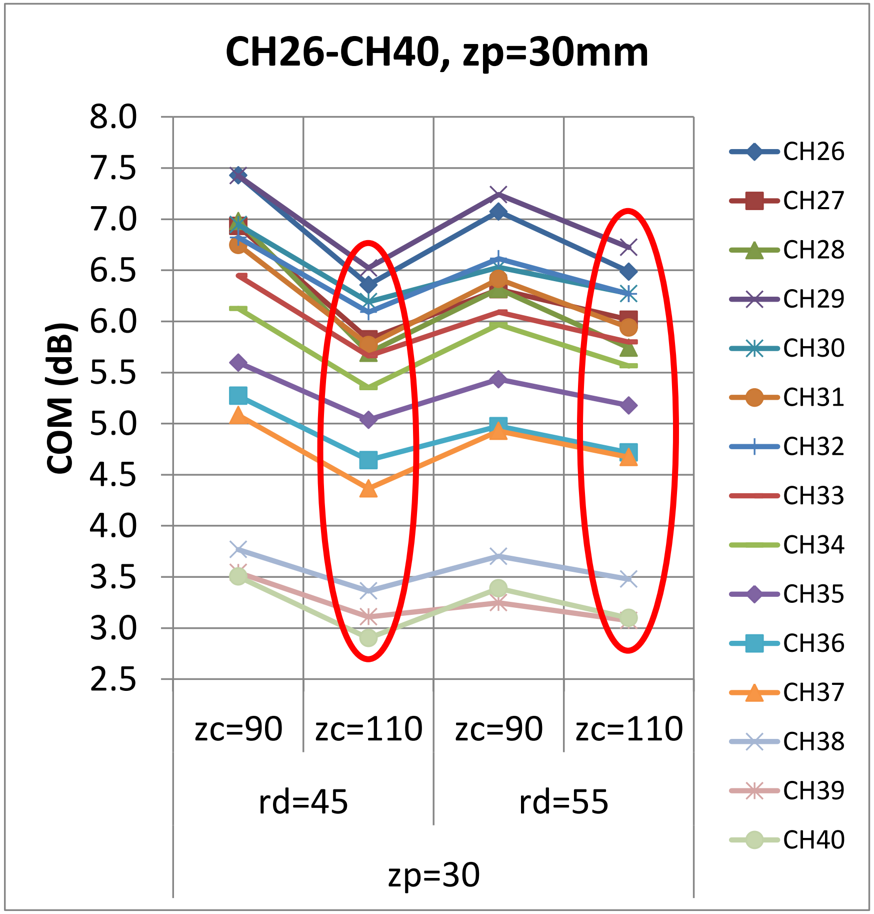
	Corner	IL (dB)	FOM_ILD	ICN(mV)
CH35	Nom	24.7794	0.16223	1.2236
CH36	HzLzHz	24.9387	0.16377	1.2332
CH37	LzHzLz	24.5843	0.21914	1.2003
CH38	Nom	29.8285	0.17168	1.1554
CH39	HzLzHz	29.9952	0.16709	1.1665
CH40	LzHzLz	29.568	0.27329	1.1305

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

FUJITSU

- The worst case is Zc=110Ω & Rd=45Ω or Zc=110Ω & Rd=55Ω
  - Zc=90Ω & Rd=55Ω is better than Zc=110Ω & Rd=45Ω or 55Ω
  - zp=30mm is worse than 12mm except CH26~28 where 12mm is worse

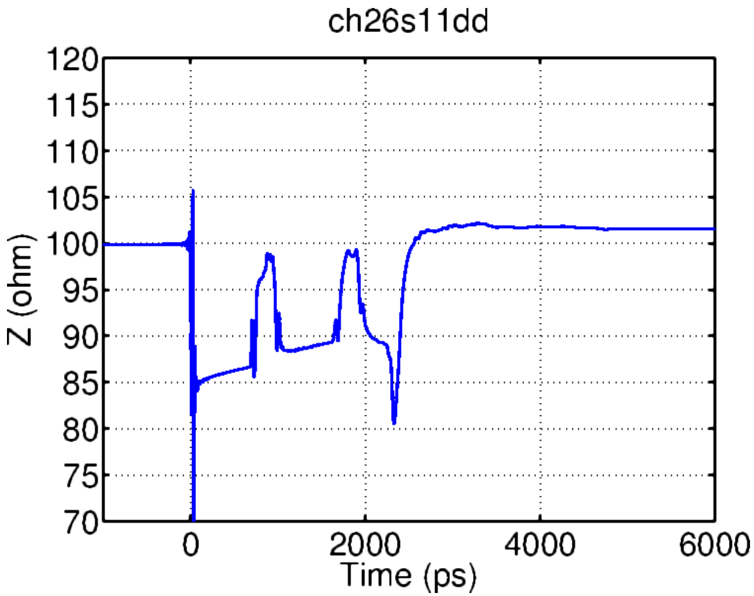


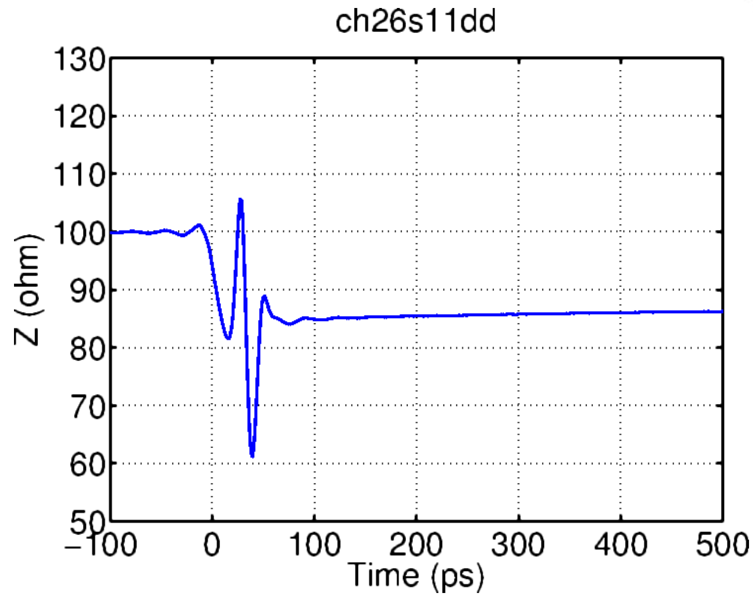


Intel 85Ω 10dB Nom (CH26): Zdiff Profile

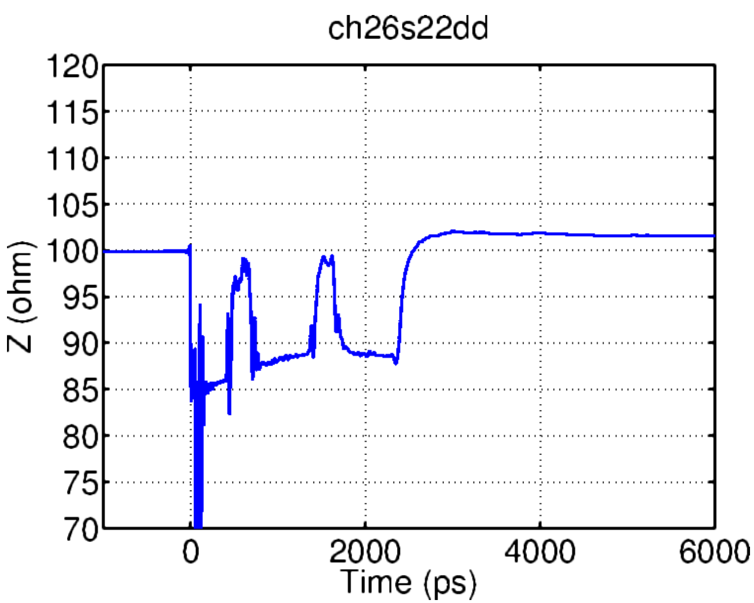
FUJITSU

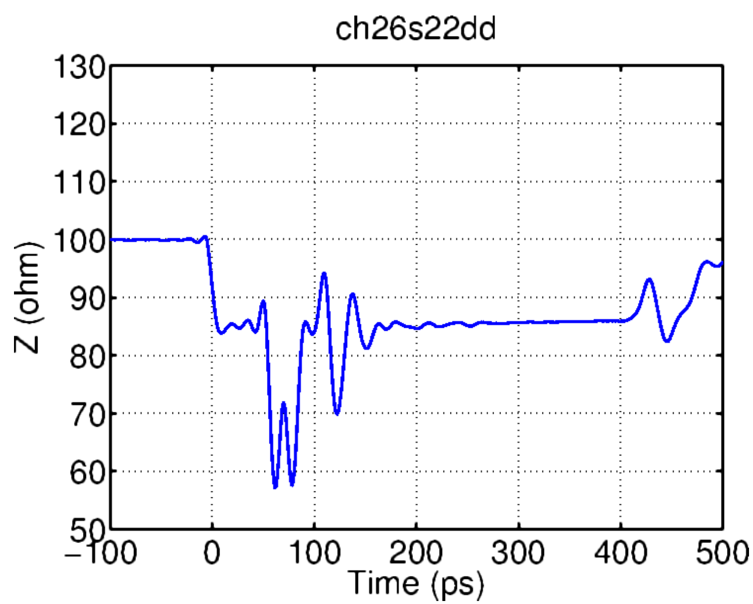
S11dd





S22dd

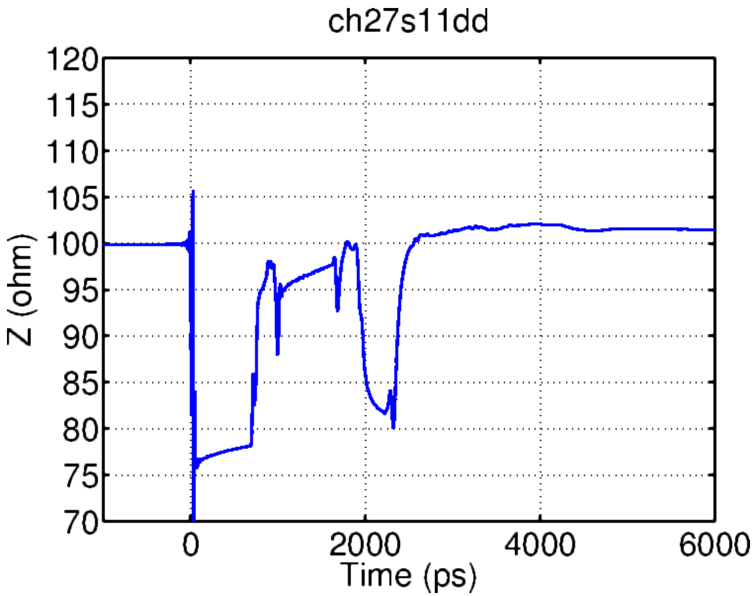


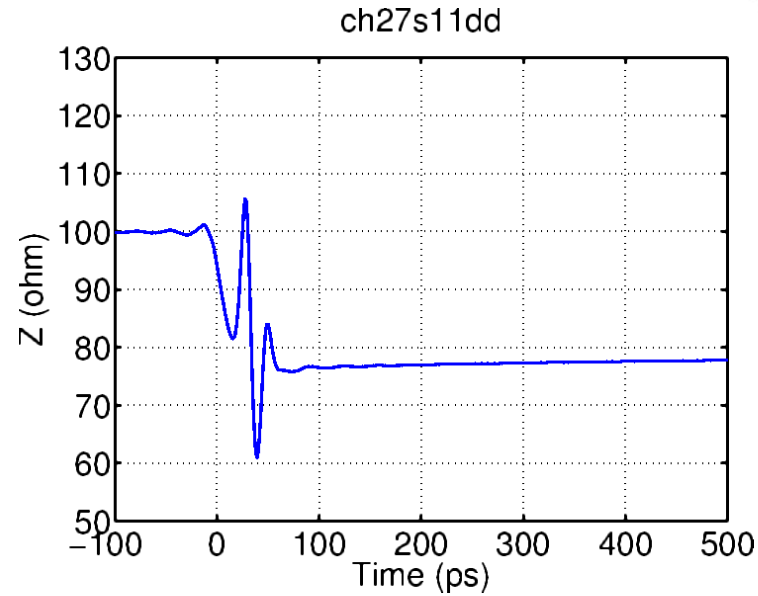


Intel 85Ω 10dB HzLzHz (CH27): Zdiff Profile

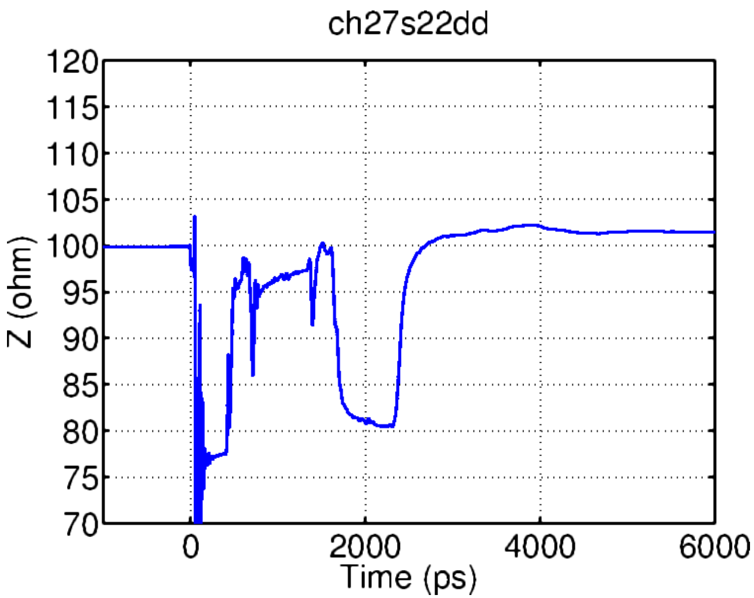
FUJITSU

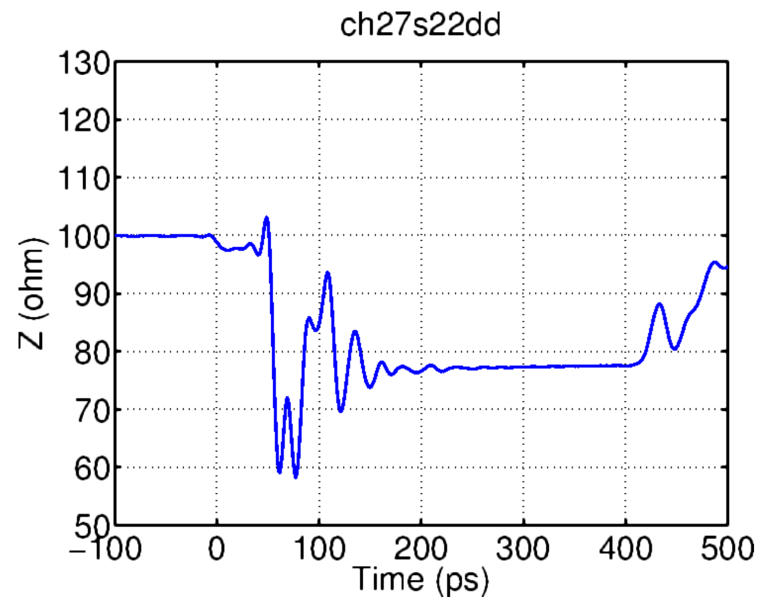
S11dd





S22dd

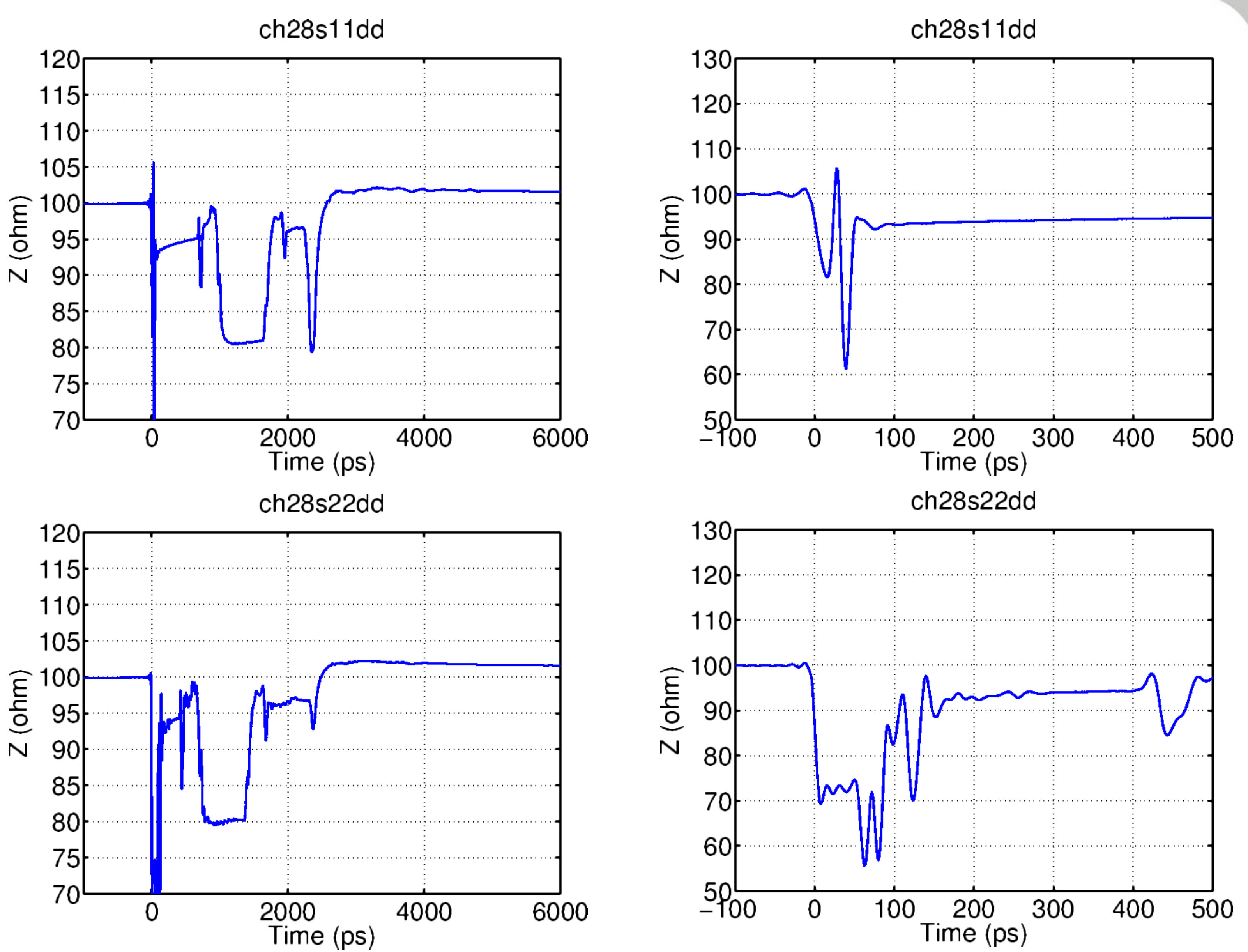




Intel 85Ω 10dB LzHzLz (CH28): Zdiff Profile

S11dd

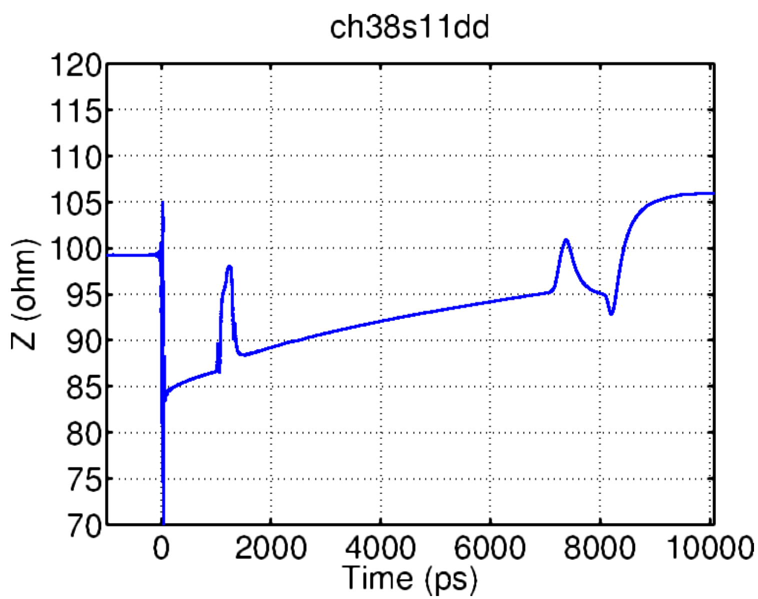
S22dd

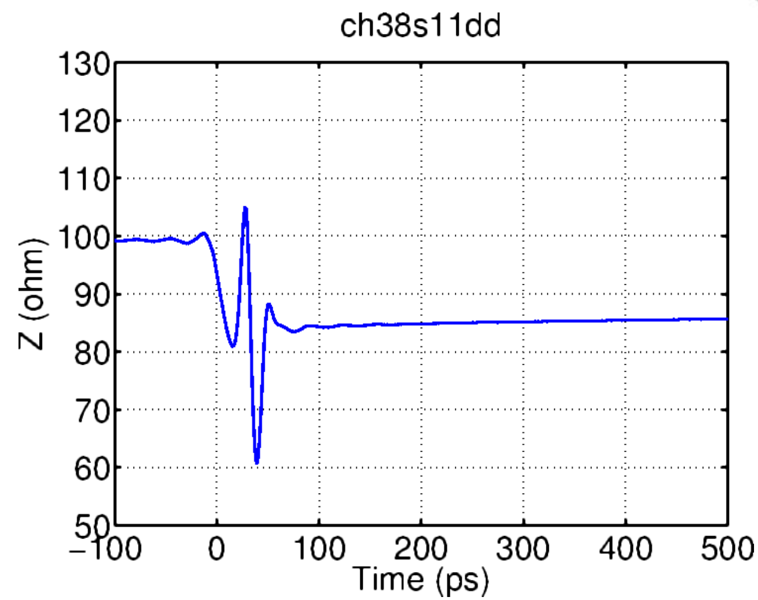


Intel 85Ω 30dB Nom (CH38): Zdiff Profile

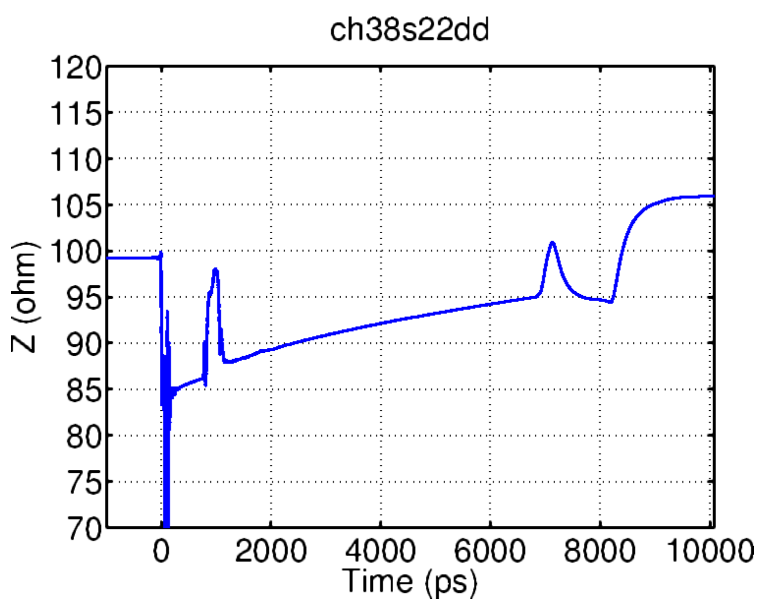
FUJITSU

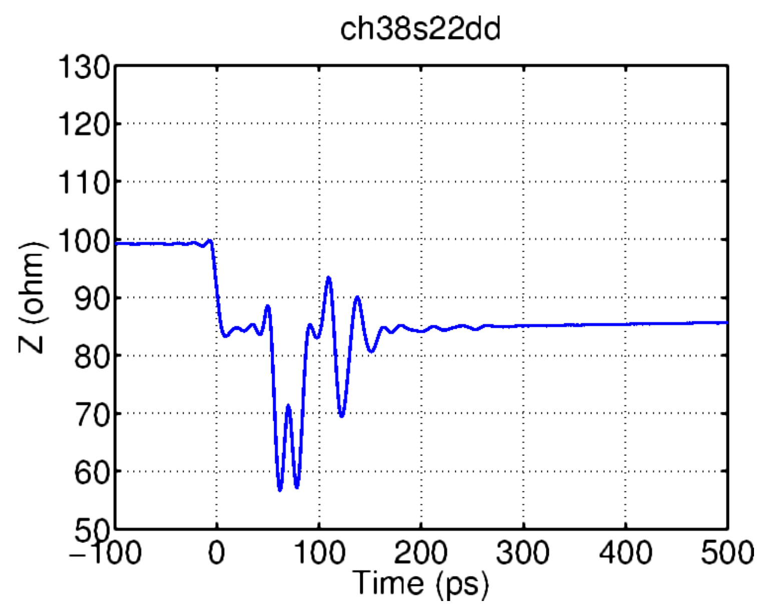
S11dd





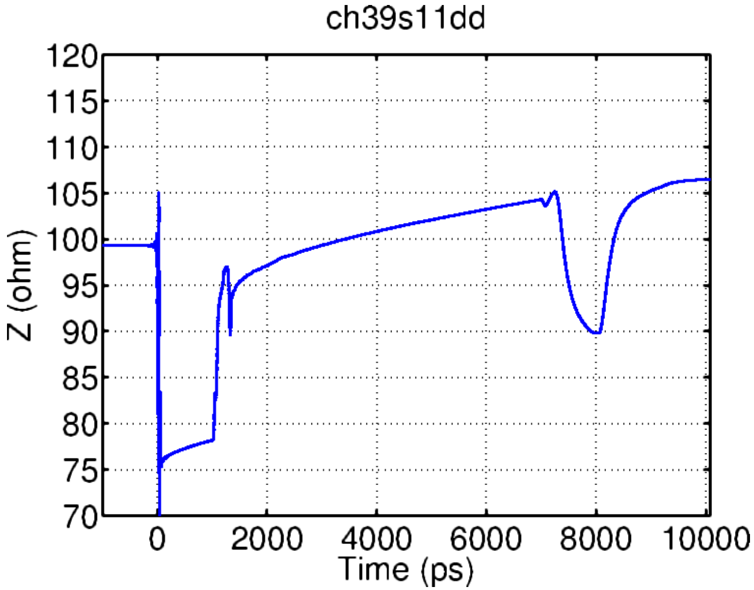
S22dd

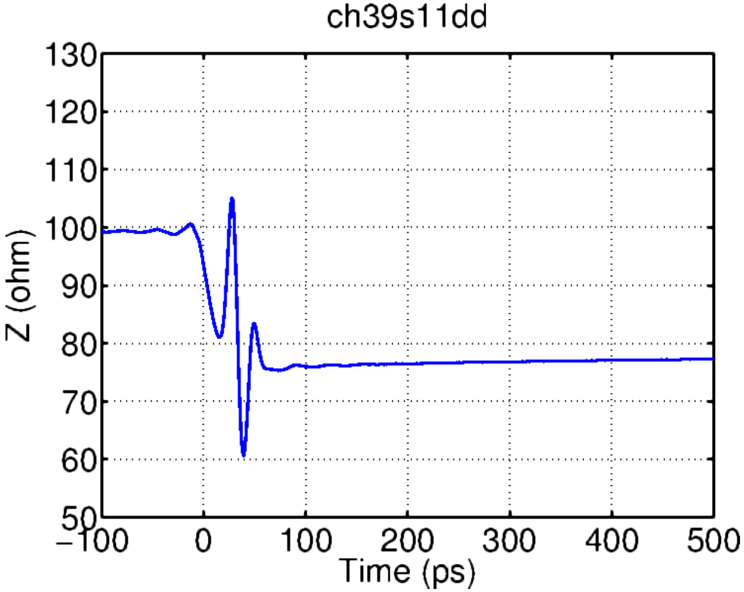




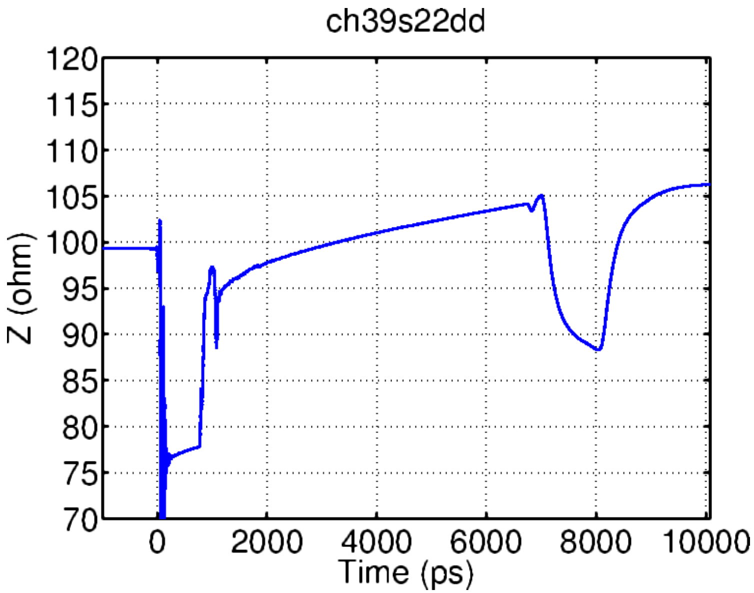
Intel 85Ω 30dB HzLzHz (CH39): Zdiff Profile

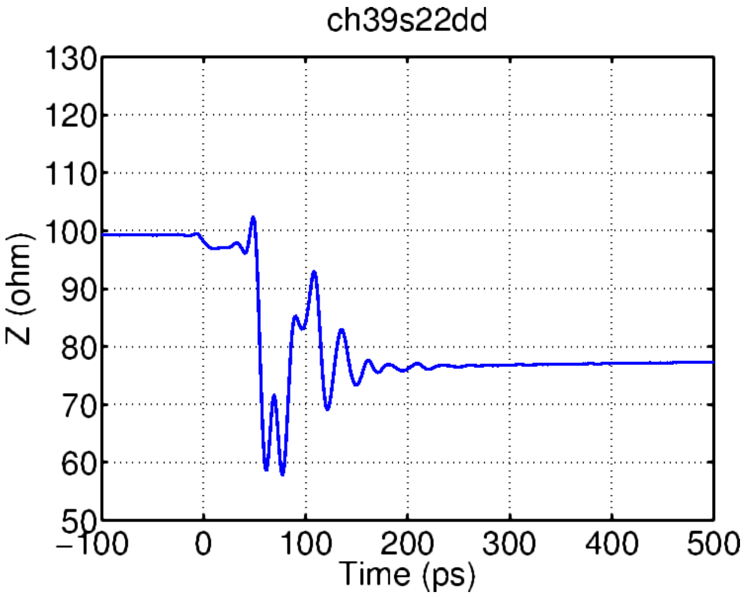
S11dd





S22dd



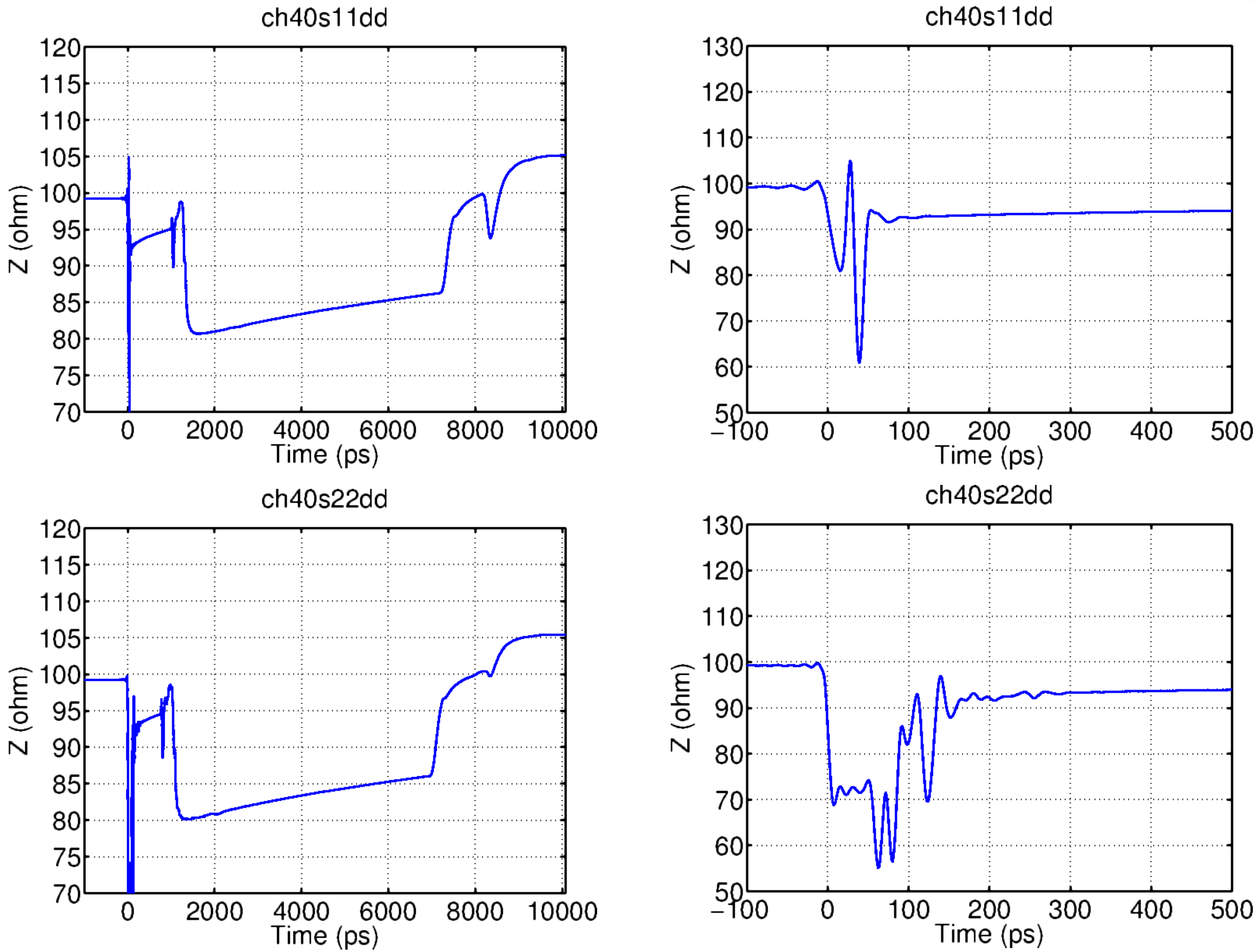


Intel 85Ω 30dB LzHzLz (CH40): Zdiff Profile

FUJITSU

S11dd

S22dd



TE Measured Backplane Channels (CH41-43)

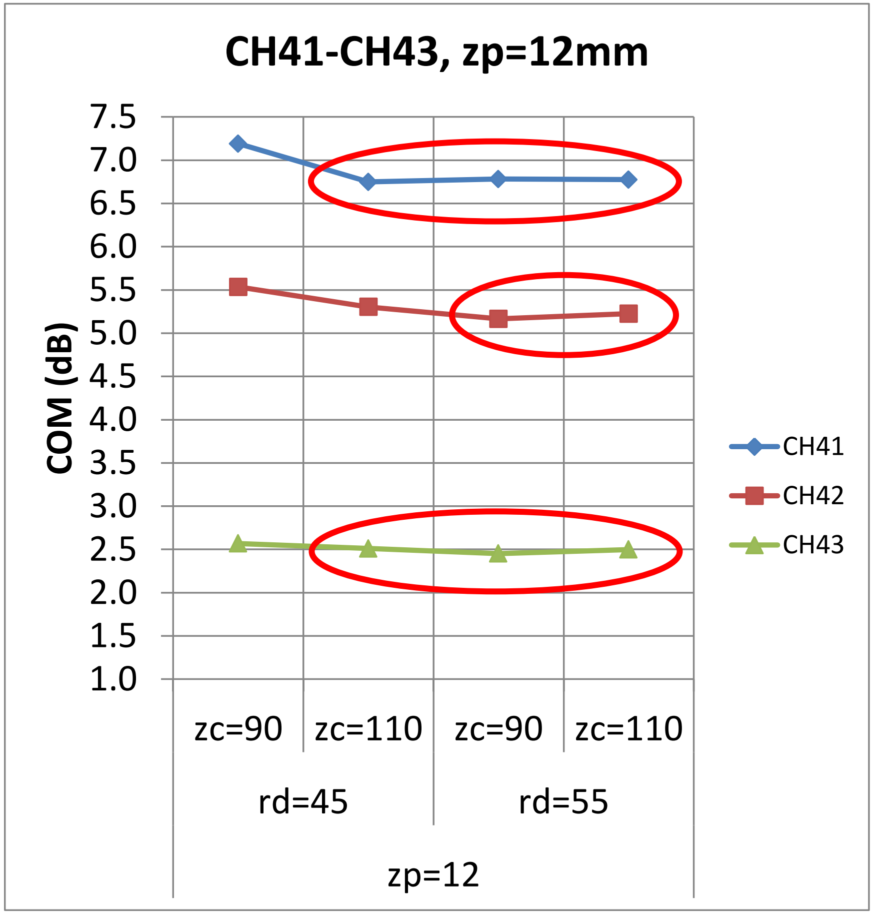
FUJITSU

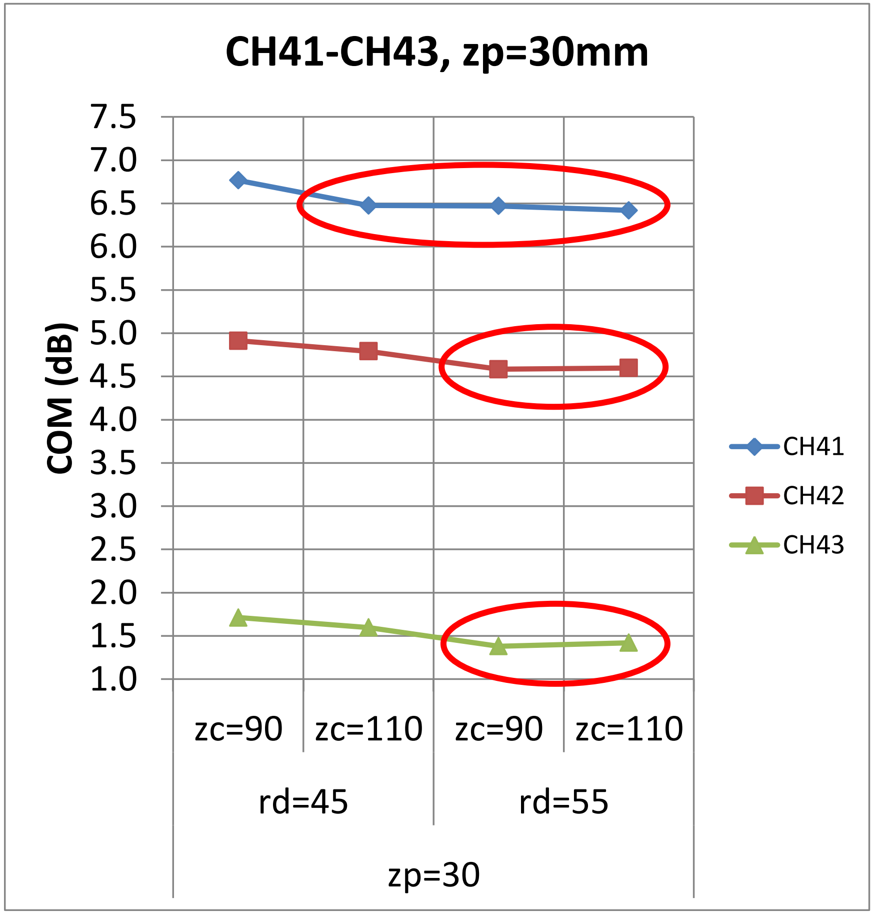
- Data source (in P802.3cd TF Channel Data Area)
  - http://www.ieee802.org/3/cd/public/channel/TEC_STRADAWhisper*.zip
- Characteristics
  - http://…/Reference_document_for_TE_Connectivity_Backplane_S-Parameter_Channels_07_28_16.pdf
  - Insertion Loss @ Nyquist : 10.4567dB (CH41) ~ 31.9644dB (CH43)
  - 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

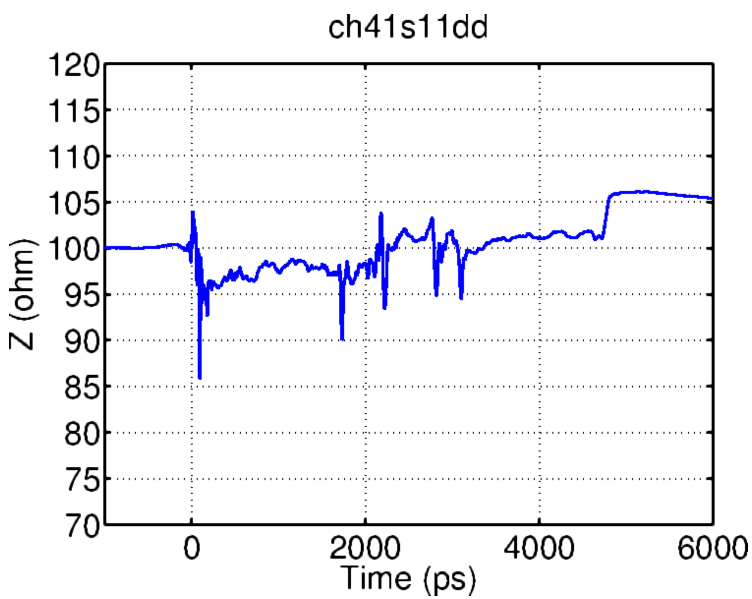
- The worst case is Zc=90Ω & Rd=55Ω or Zc=110Ω & Rd=55Ω
  - zp=30mm is worse than 12mm
  - For zp=12mm, the worst is Zc=110Ω & Rd=45Ω or Zc=90Ω & Rd=55Ω

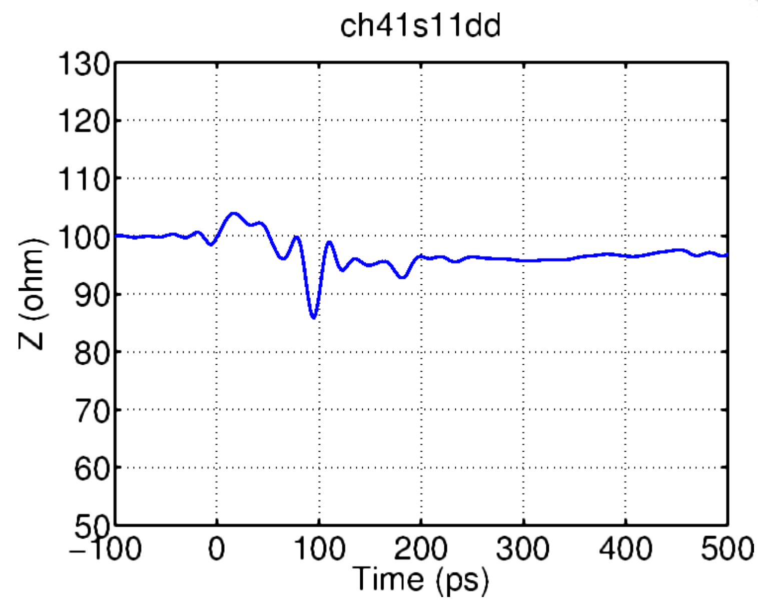




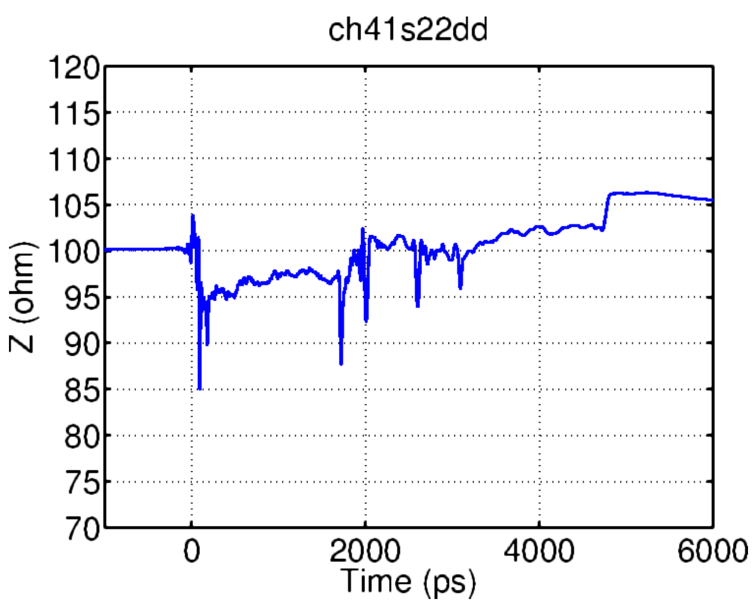
TE 10dB (11.75in) Channel (CH41): Zdiff Profile

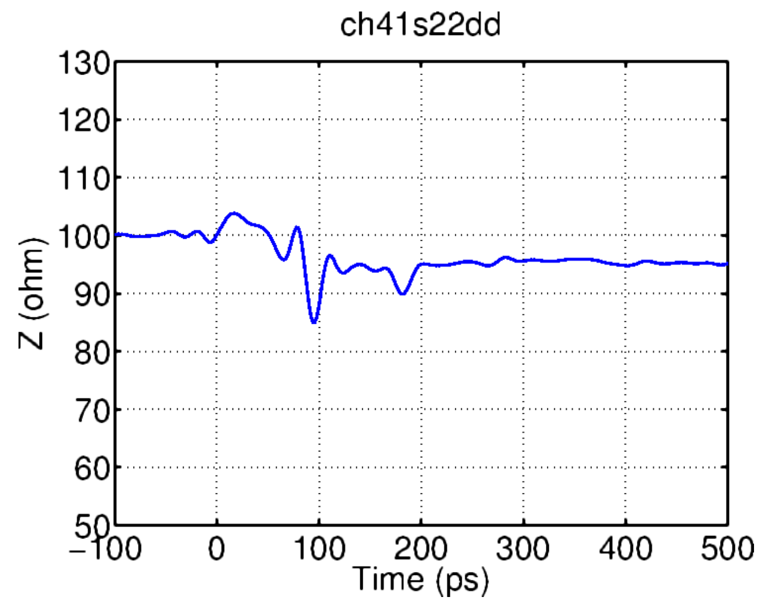
S11dd





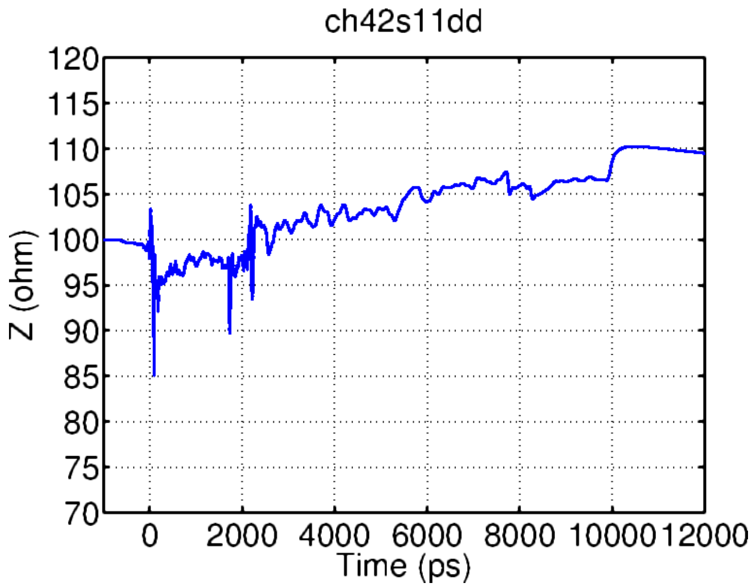
S22dd

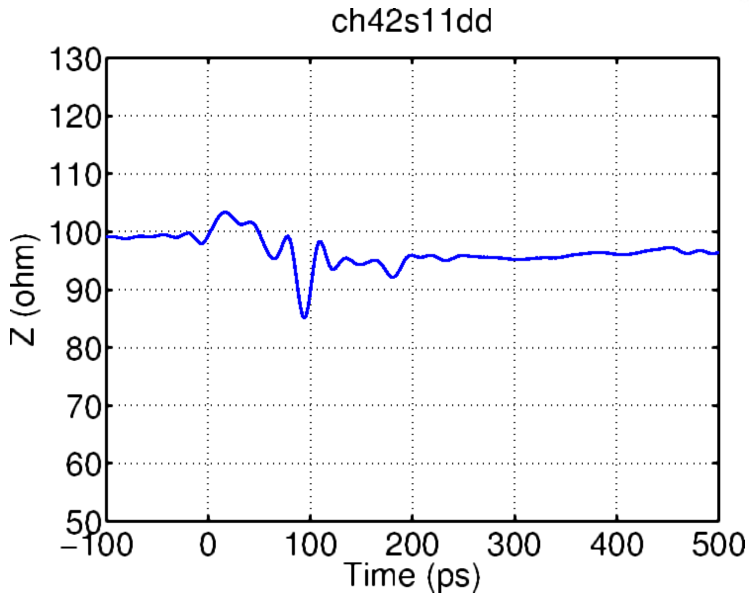




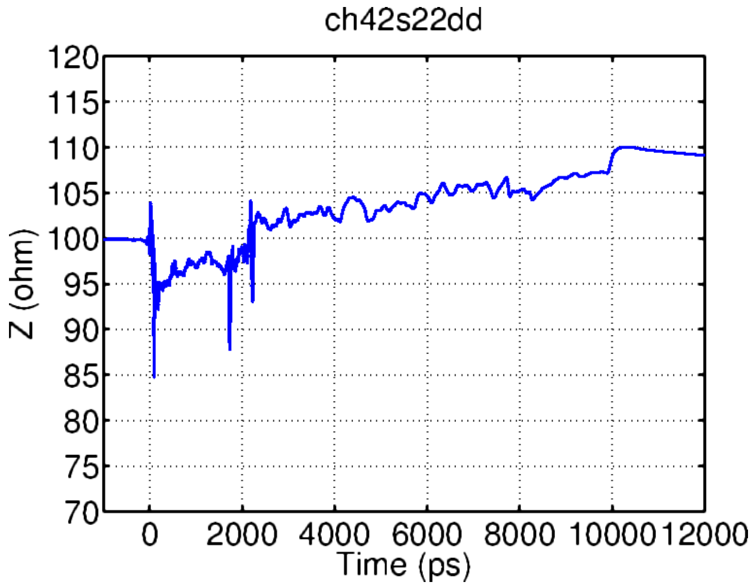
TE 22dB (27in) Channel (CH42): Zdiff Profile

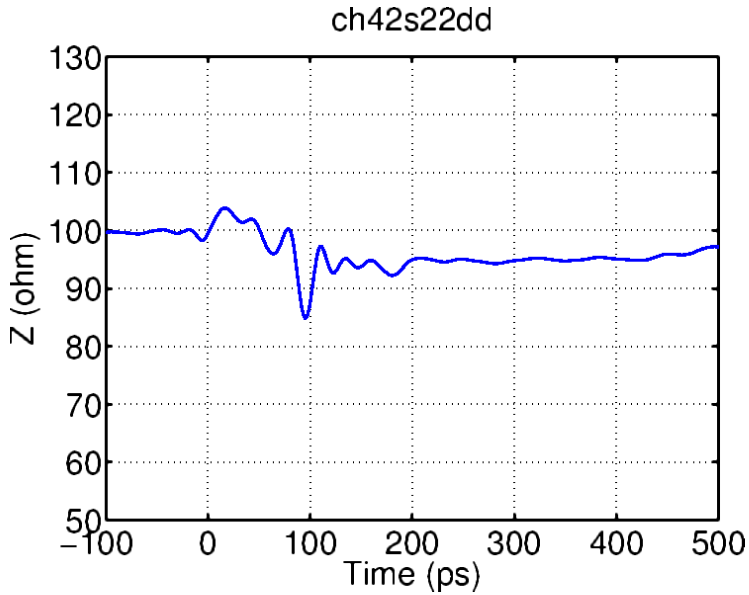
S11dd





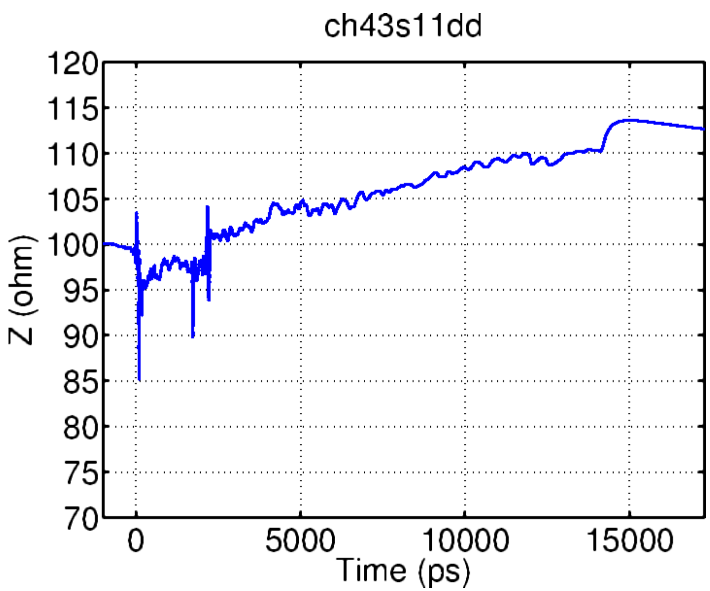
S22dd

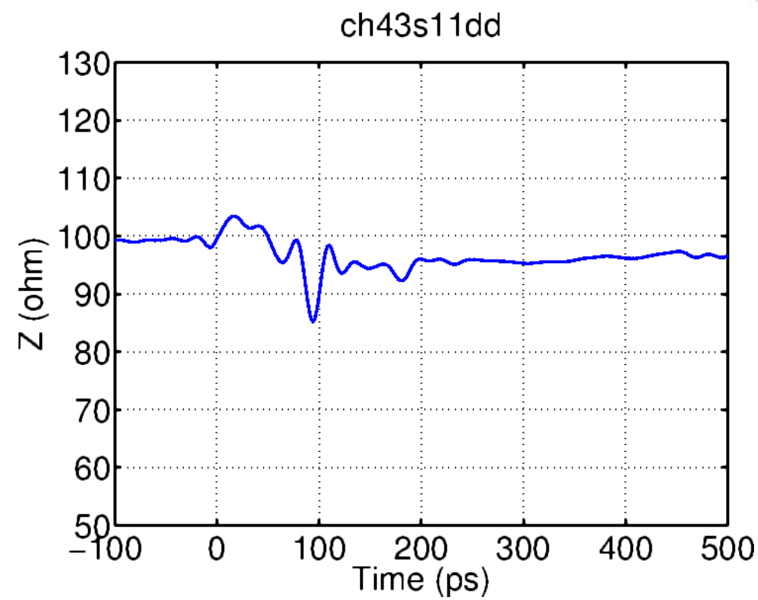




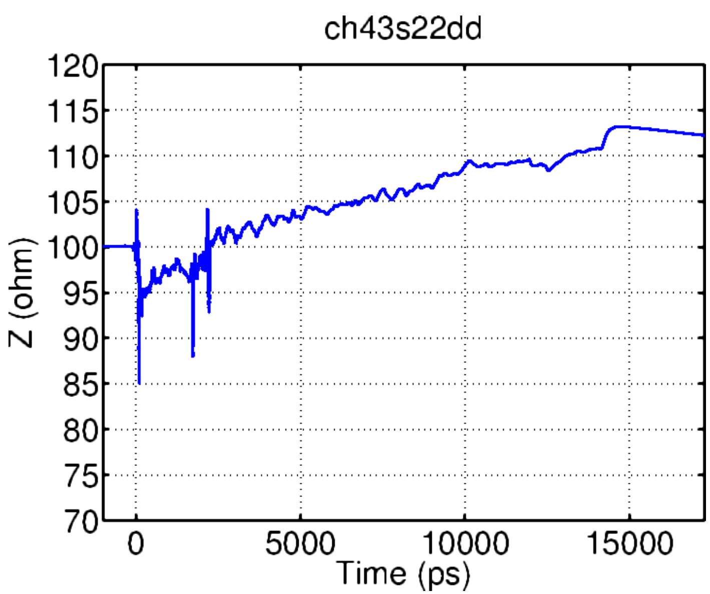
TE 32dB (40in) Channel (CH43): Zdiff Profile

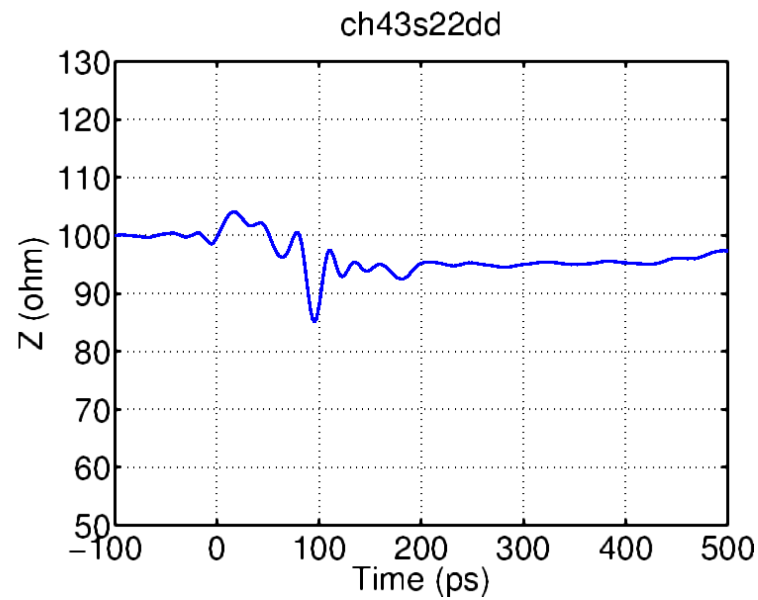
S11dd





S22dd





Thank you