



A Look into channels for High connectivity and scalable systems *and initial considerations for COM*

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Overview



- Review some of the channels that are created for highly scalable systems with very high connectivity
- Run initial COM analysis and consider some of the requirements for Reference receiver to meet IEEE 802.3CK100 Gb/s per electrical lane Objectives

Measured Backplane Channels

Channel Overview

Channel Overview



- **Measured test boards**
 - Created for 100G generation
 - Represent balancing act of system design
 - Includes vias, Xtalk, connectors, etc.
- **Multiple channels representing range of implementation**
 - Not to discuss specifics of each channel
 - Providing wide set of channels

Test Board Choices

- **Multiple Architectures**

- Orthogonal
- Short traditional backplane
- Cabled backplane

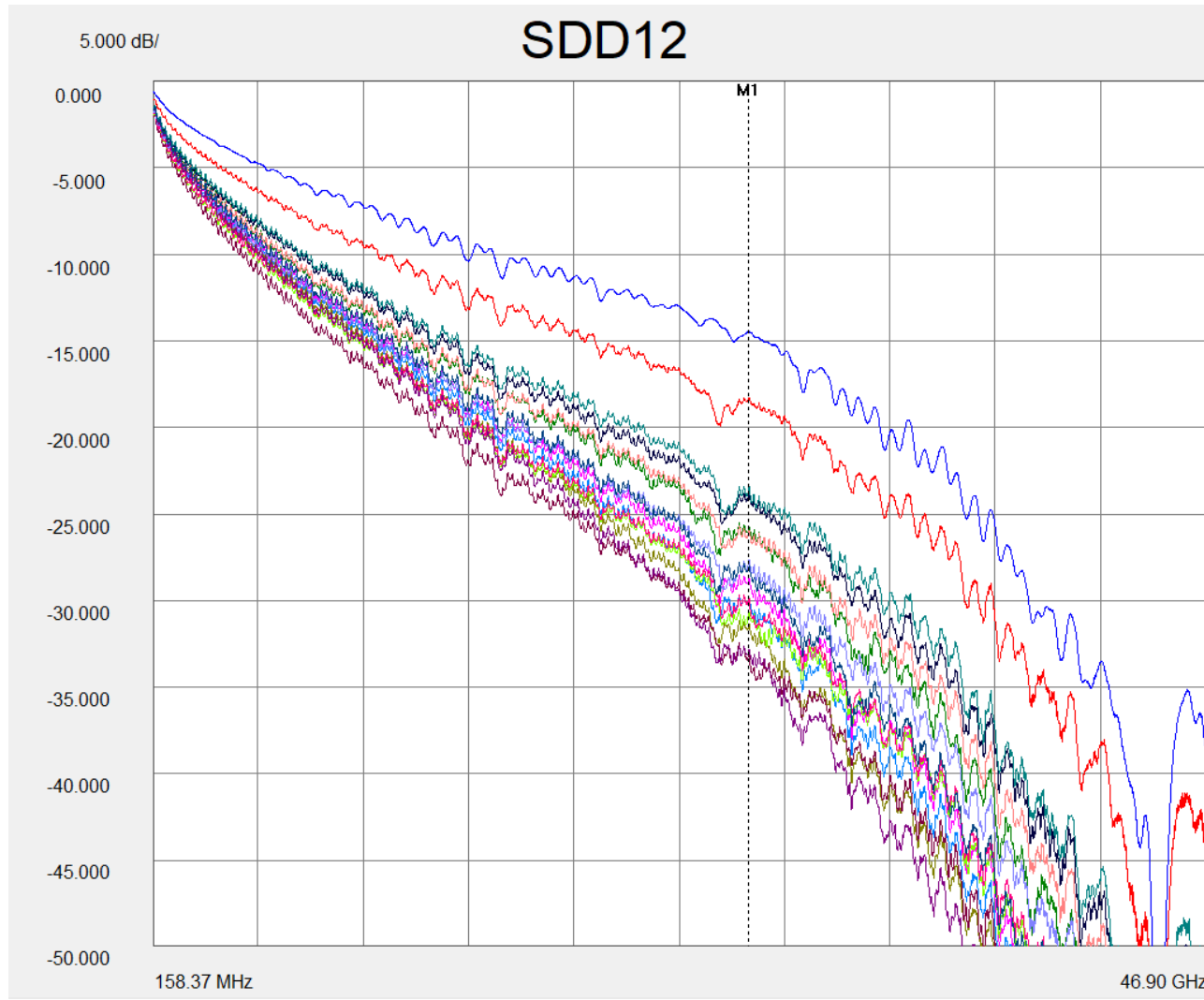
- **Moderate Technology Level**

- Represents *range* of System use cases
- Meg7 material with back-drilling
- More advanced PCB Technology exists
 - Trace Width
 - Via size
 - Board thickness
 - Surface Roughness
 - Back-drilling
 - Etc.

- **Manufacturing Tolerances**

- Physical test board → imperfections from Manufacturing
- Built in impedance changes → simulating larger manufacturing tolerances

Orthogonal Channels

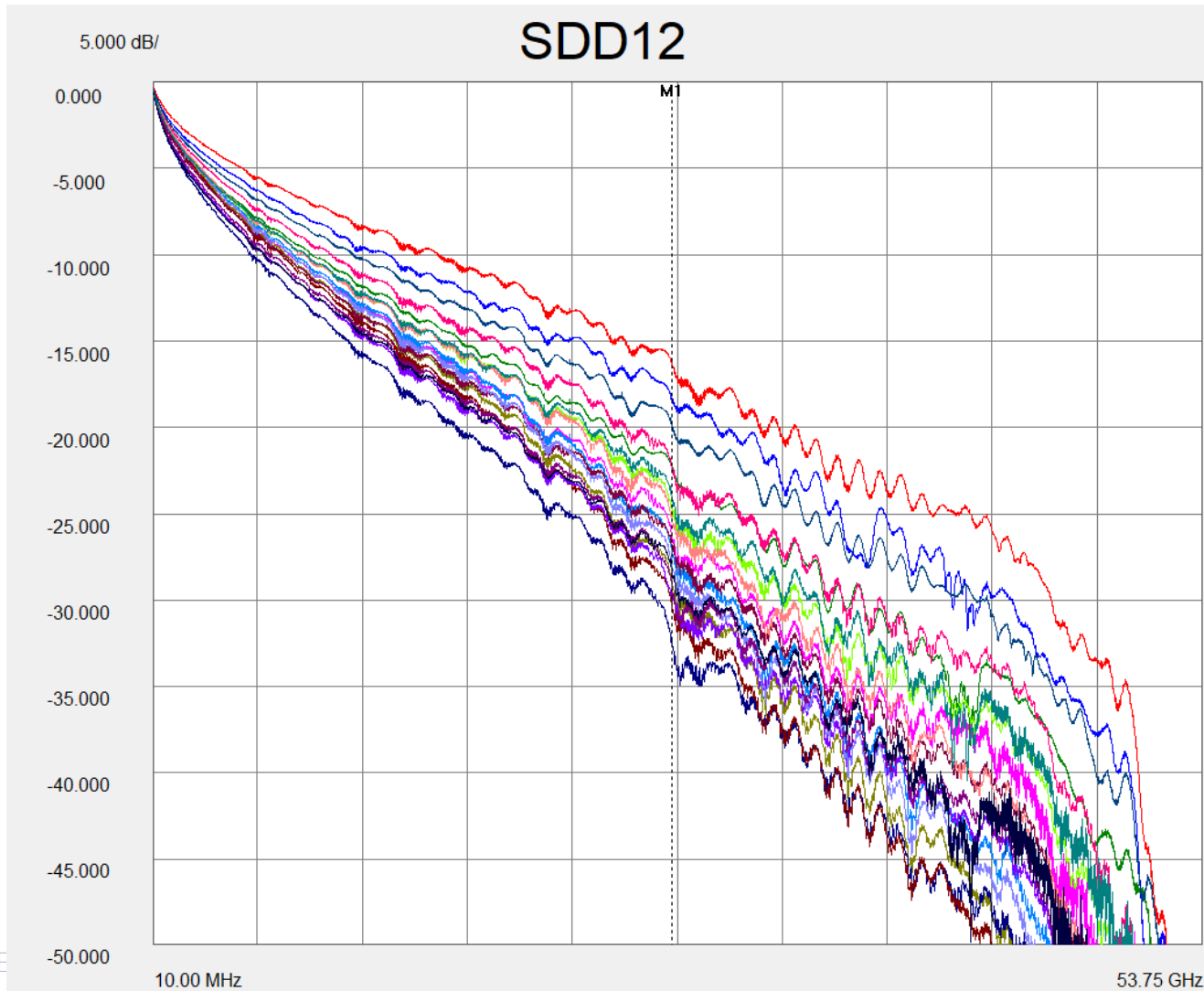


File Names	Insertion Loss @ Nyquist, dB	Fitted Insertion Loss@Nyquist, dB	FOM_ILD	ICN, mv
OAch1	23.489	24.3229	0.36023	1.1237
OAch2	23.8422	24.829	0.37517	1.1237
OAch3	26.0293	26.6045	0.35611	1.1237
OAch4	27.7158	28.6807	0.36272	0.69088
OAch5	29.8979	30.7353	0.35119	0.69088
OAch6	30.6565	31.329	0.33914	0.69088
OAch7	33.1323	33.6448	0.33466	0.69088
Och1	14.4974	14.8581	0.33668	1.1237
Och2	18.3011	19.053	0.35081	1.1237
Och3	25.897	26.6857	0.38112	1.1237
Och4	28.098	29.0613	0.36942	0.69088
Och5	28.8102	29.8155	0.35207	0.69088
Och6	29.9265	30.9476	0.35489	0.69088
Och7	31.4658	32.45	0.33526	0.69088
Och8	32.9464	33.7931	0.33132	0.69088

FOM_ILD is derived from IL fitting using piecewise fit
See backup Slide



Cable Backplane Channels

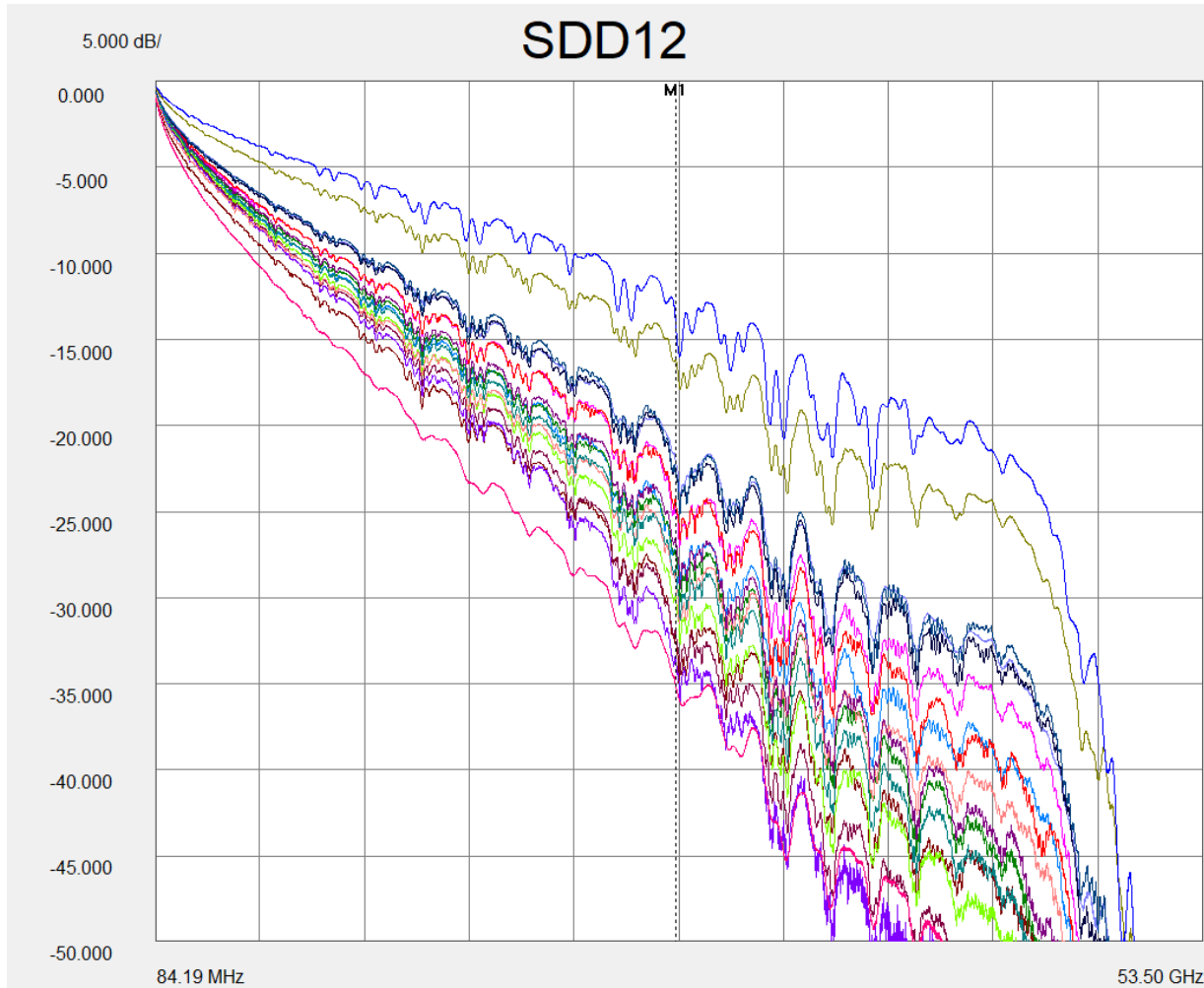


File Names	Insertion Loss @ Nyquist, dB	Fitted Insertion Loss@Nyquist, dB	FOM_ILD	ICN, mv
CAch1_b2	24.3196	24.0101	0.21586	0.50321
CAch1	18.3191	18.1924	0.19041	0.50321
CAch2_a0	25.2511	25.0934	0.21709	0.53049
CAch2_a10	30.2464	30.1895	0.20653	0.53049
CAch2_a2p5	27.0857	26.9785	0.2242	0.53049
CAch2_a5	27.8621	27.792	0.2225	0.53049
CAch2_a7p5	28.9234	28.8582	0.21664	0.53049
CAch2_b10	32.5842	31.8399	0.23279	0.53049
CAch2_b2p5	22.6305	22.7446	0.19217	0.53049
CAch2_b2	22.3403	22.3095	0.18889	0.53049
CAch2_b4	24.857	24.5718	0.19574	0.53049
CAch2_b6	26.8567	26.8507	0.17853	0.53049
CAch2_b7p5	29.356	28.7299	0.22777	0.53049
CAch2_b8	29.6861	29.3609	0.20319	0.53049
CAch2	16.3542	16.6371	0.1565	0.53049
CAch3_b2	28.4951	28.3263	0.21499	0.4691
CAch3	22.2867	22.6537	0.16935	0.4691
CAch4_b2	26.4827	25.9793	0.20419	0.46602
CAch4	19.9636	20.0157	0.15729	0.46602

FOM_ILD is derived from IL fitting using piecewise fit
See backup Slide



Traditional Backplane Channels



File Names	Insertion Loss @ Nyquist, dB	Fitted Insertion Loss@Nyquist, dB	FOM_ILD	ICN, mv
Bch1_3p5	13.9577	12.9618	0.40845	2.0228
Bch2_7	16.2112	15.6955	0.36421	1.7679
Bch2_a0_7	24.3522	23.6585	0.45582	1.7679
Bch2_a10_7	29.9398	29.3688	0.43349	1.7679
Bch2_a12p5_7	31.9169	31.1863	0.41584	1.7679
Bch2_a15_7	33.5487	32.6967	0.46055	1.7679
Bch2_a2p5_7	26.6063	25.9646	0.45786	1.7679
Bch2_a5_7	27.2465	26.6363	0.45685	1.7679
Bch2_a7p5_7	28.351	27.7659	0.45031	1.7679
Bch2_b10_7	32.6202	30.7395	0.45417	1.7679
Bch2_b15_7	37.8161	36.0909	0.45704	1.7679
Bch2_b2p5_7	22.7162	21.7172	0.43376	1.7679
Bch2_b2_7	22.7641	21.433	0.43567	1.7679
Bch2_b4_7	25.1108	23.6674	0.43805	1.7679
Bch2_b6_7	27.3091	26.1647	0.43418	1.7679
Bch2_b7p5_7	28.9215	27.5887	0.45026	1.7679
Bch2_b8_7	29.5622	28.2444	0.43923	1.7679
Bch3_14	22.0493	21.2992	0.35139	1.1085
Bch4_30	35.0513	34.1297	0.34902	0.84842

FOM_ILD is derived from IL fitting using piecewise fit
See backup Slide



COM Analysis

Considerations for Reference Receiver

COM parameters and Simulation Conditions

- **COM parameters**

- Default TX and Jitter parameters from KR configuration file used with COM 2.5.2
- Narrow to one Package trace length option that contributes 4 dB on each side of the channel

- **Simulation Conditions**

- Sim 1: DFE24
 - 24 Tap DFE
 - 1st tap constrained to 0.7 and rest of the tap are constrained to 0.2
- Sim 2: DFE24UC
 - The same as Sim1 with DFE tap constraints removed
- Sim 3: DFE24UC_6R100 (not a part of COM 2.5.2 distribution)
 - The same as Sim2 and
 - Added 6 floating taps with max range 100 UI from the main cursor
- Sim 4 : FFE24_3
 - Receiver FFE with 3 pre taps and 24 post taps
 - 1 tap DFE
- Sim 5 : FFE24_3_6R100 (not a part of COM 2.5.2 distribution)
 - The same as Sim4 and
 - Added 6 floating taps with max range 100 UI from the main cursor

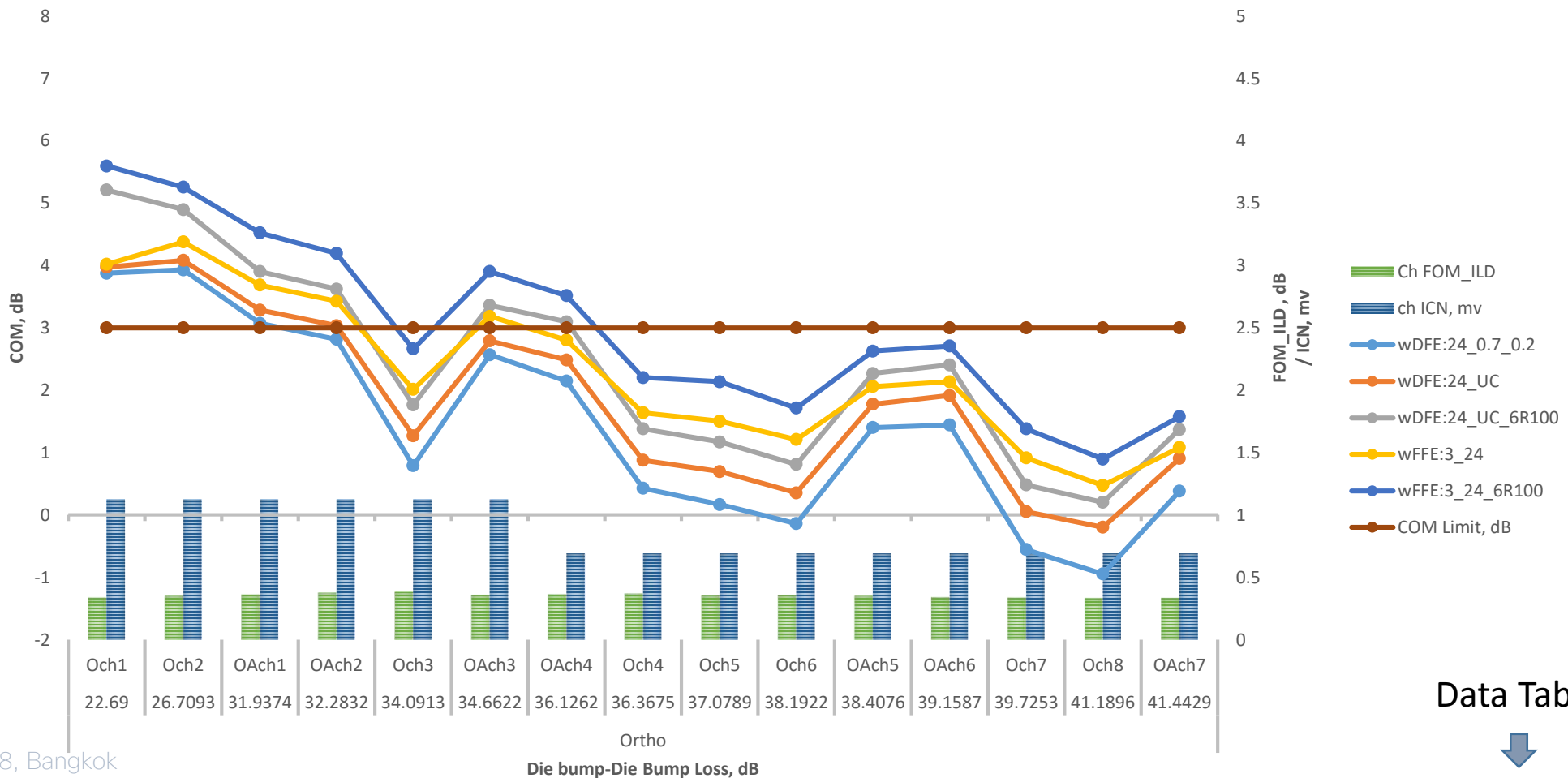
COM parameters and Simulation Conditions



- **Noise parameters**

- RX FFE noise amplification is included in COM2.5.2
- Quantization Noise from ADC,DFE ,FFE and Floating taps are not considered

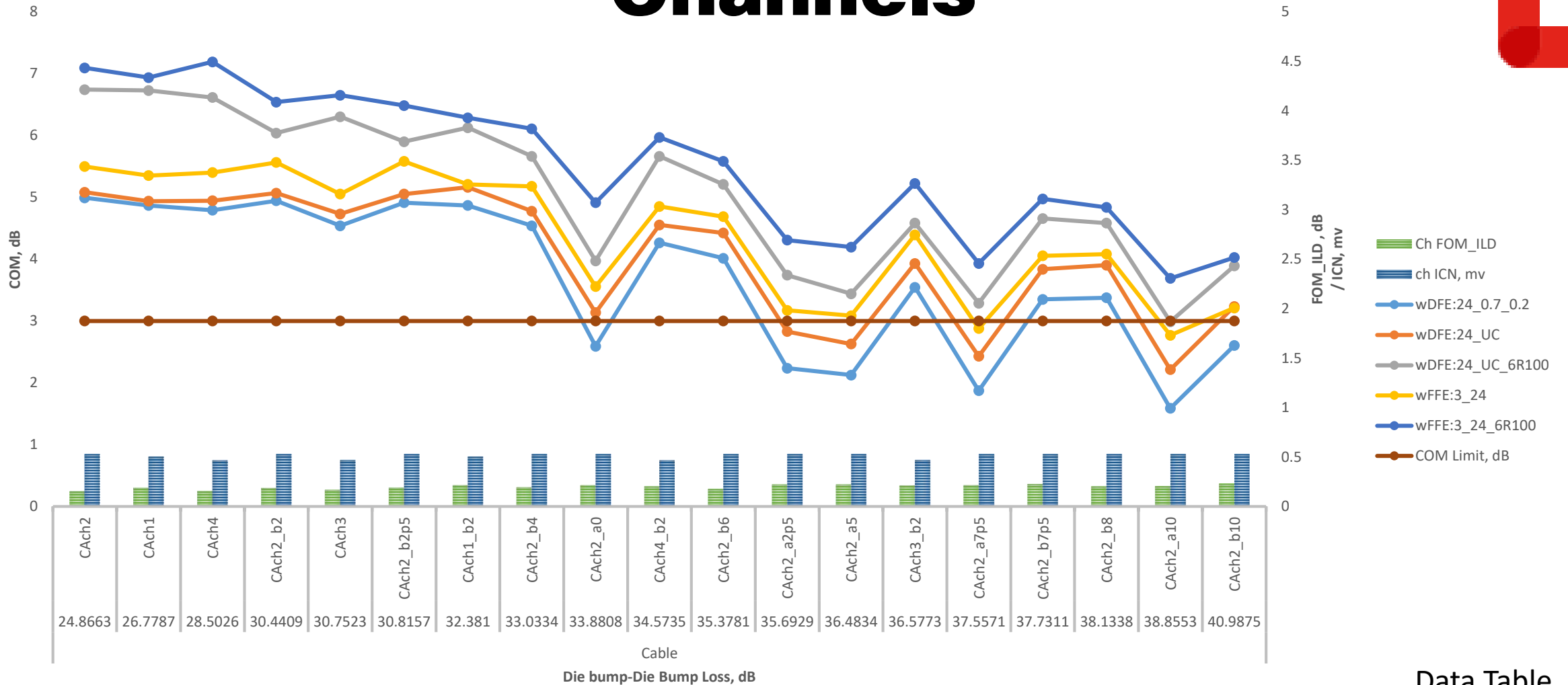
Simulation: Orthogonal Channels



Data Table



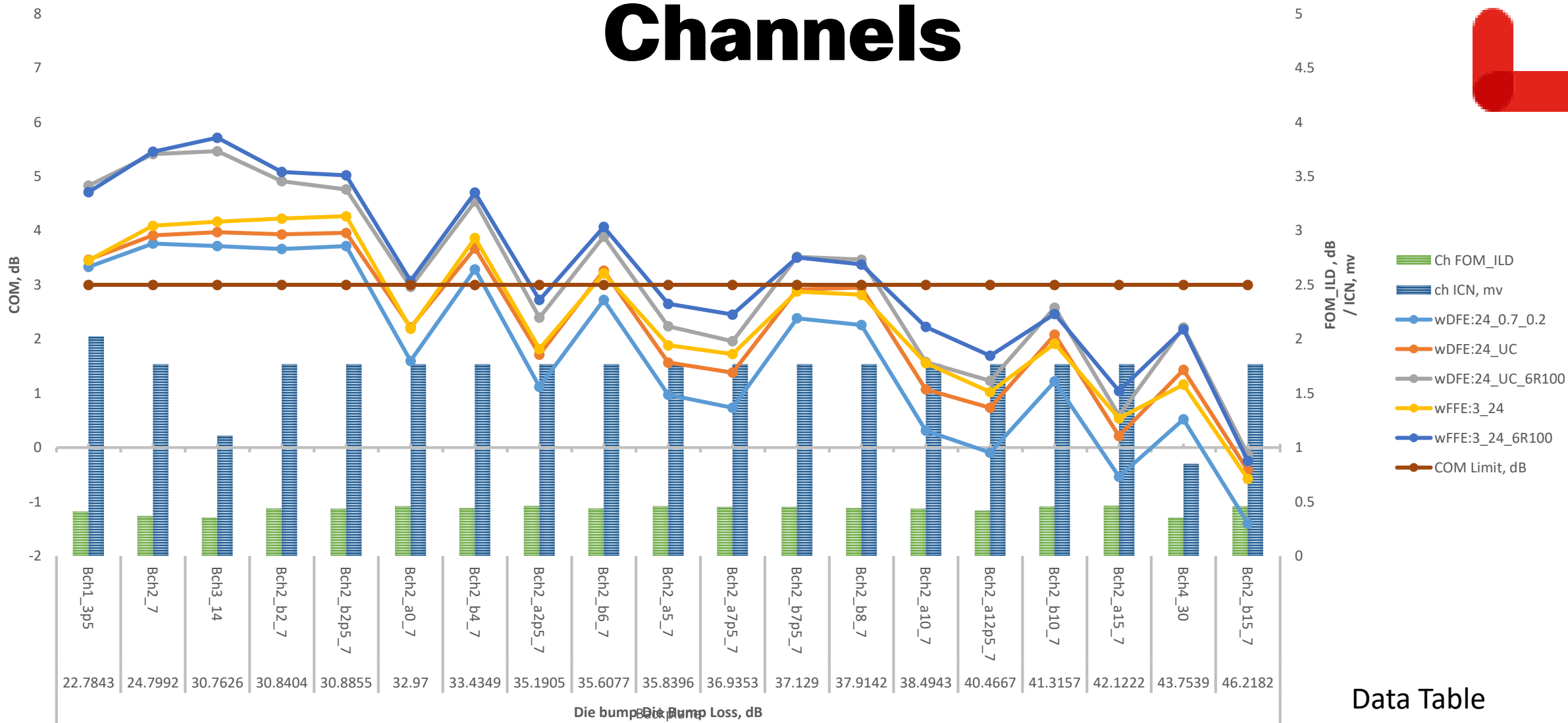
Simulation: Cable Backplane Channels



Data Table



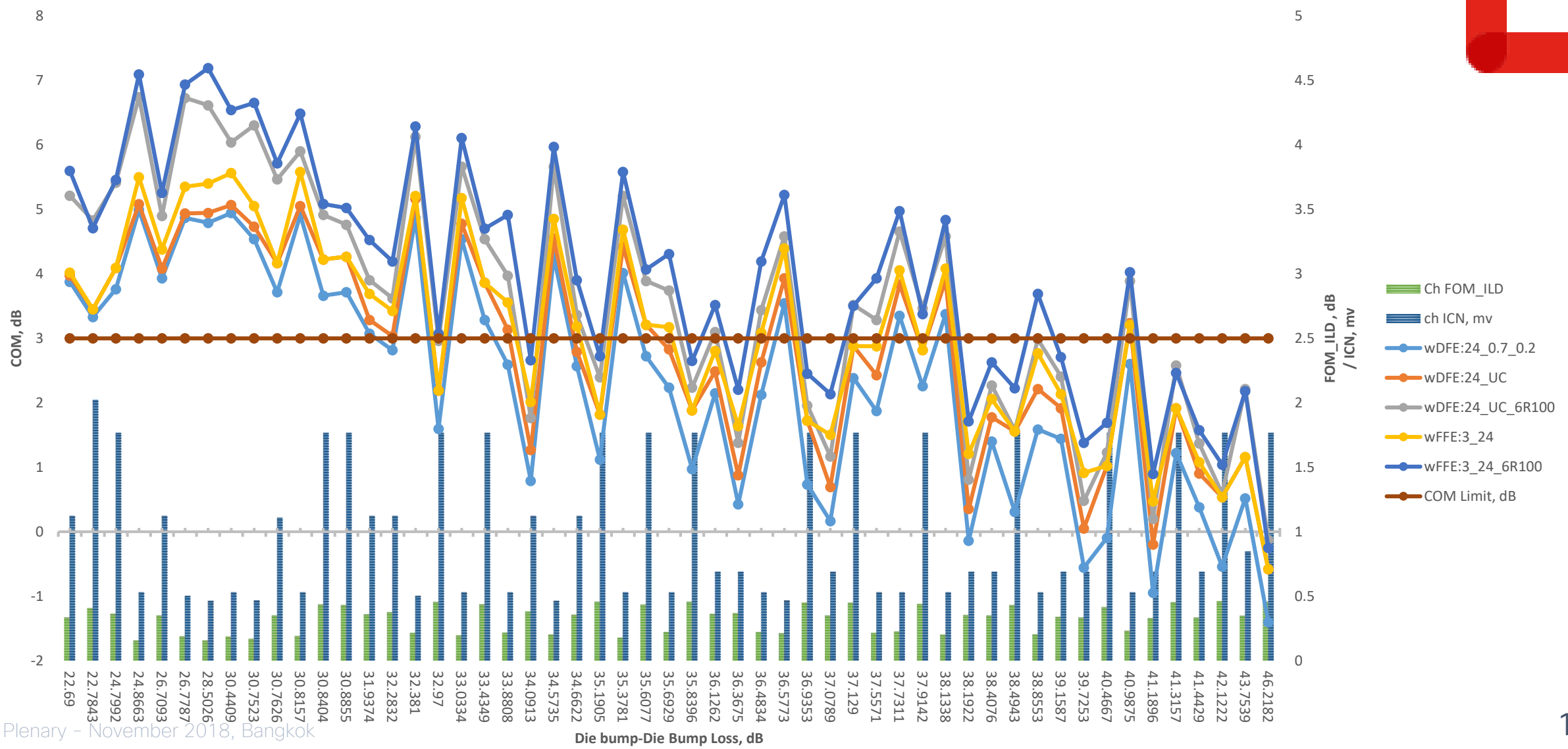
Simulation: Traditional Backplane Channels



Data Table



ALL Channels



Next steps ...

- **Deep look into the simulation data**
 - Study channels that under perform in simulation in spite of reasonable ILD and ICN
 - Explore far away cursors for low loss materials
- **Continue further Analysis to find more optimal package parameters and Reference receiver**

Silicon Validation

- **Testing channels with preliminary Silicon**
 - Some channels work with some silicon but not with others
 - Some Silicon are under revision for enhancements
- **Expect COM to mimic Silicon pass/fail, when stable Silicon tests are completed**



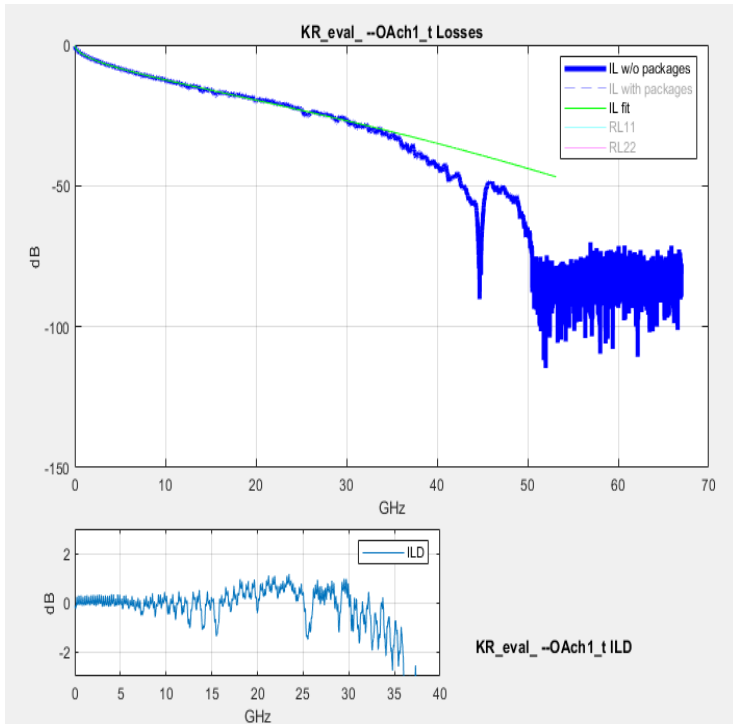
Questions?



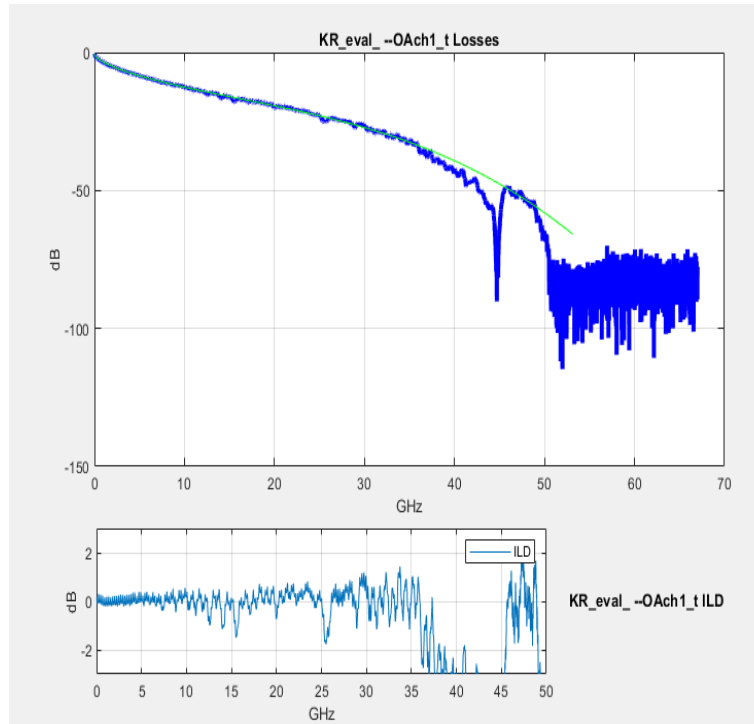
Back Up Slides

Supporting Data

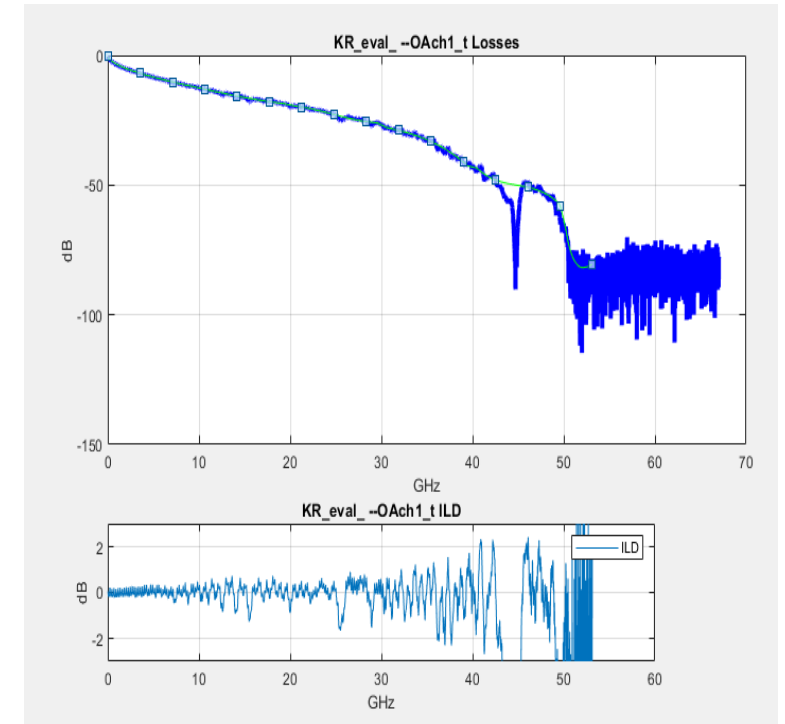
Insertion Loss fitting and ILD,FOM_ILD



Fit : present polynomial
 $c0 + c1.\sqrt{f} + c2.f + c3.f^2$
 FOM_ILD= 0.82846



Fit : Higher Order polynomial
 $c0 + c1.\sqrt{f} + c2.f + c3.f^2 + c4.f^3$
 FOM_ILD= 0.48421

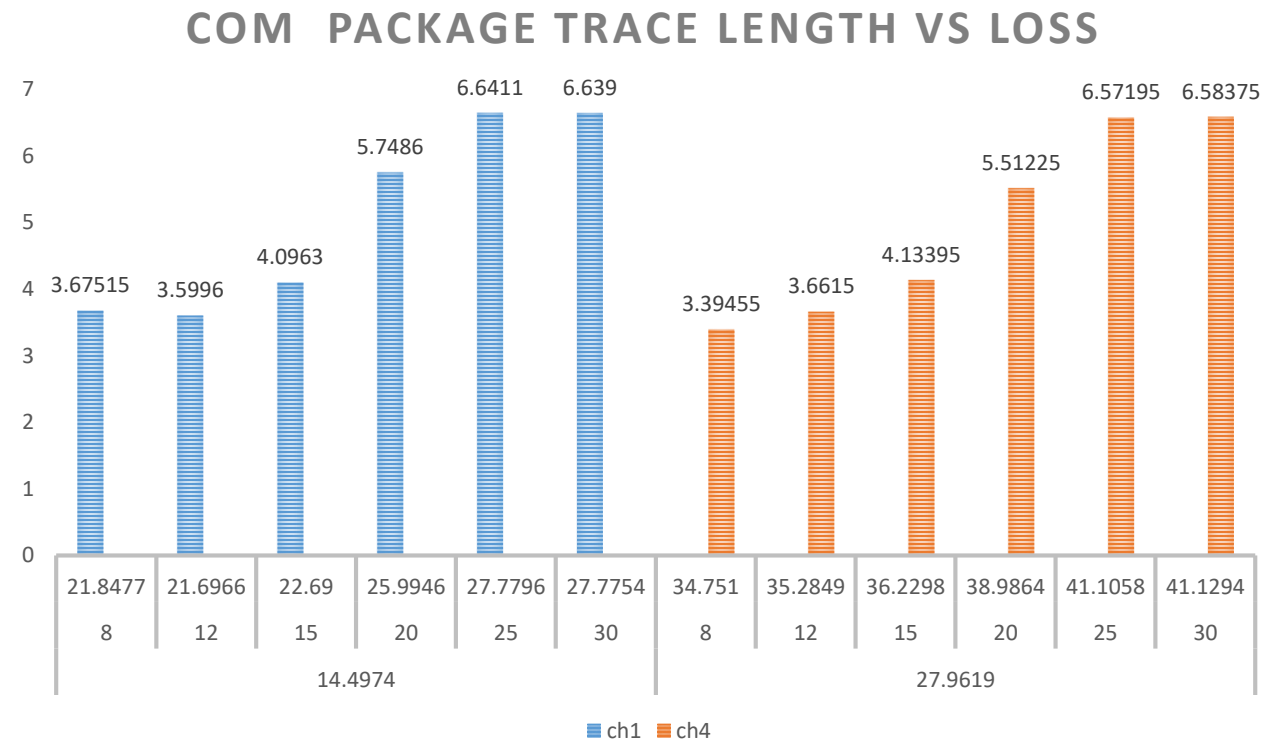


Fit : present polynomial but piecewise fit
 $c0 + c1.\sqrt{f} + c2.f + c3.f^2$
 FOM_ILD= 0.35343



COM Package choice

- Review different trace lengths in COM package and their contributions with channels
- Selected 15 mm Trace length Since that is contributing approx. 4 dB



COM Configuration Parameters

Table 93A-1 parameters			
Parameter	Setting	Units	Information
f_b	53.125	GBd	
f_min	0.05	GHz	
Delta_f	0.01	GHz	
C_d	[1.1e-4 1.1e-4]	nF	[TX RX]
z_p select	[1]		[test cases to run]
z_p (TX)	[15; 1.8; 0; 0]	mm	[test cases]
z_p (NEXT)	[15; 1.8; 0; 0]	mm	[test cases]
z_p (FEXT)	[15; 1.8; 0; 0]	mm	[test cases]
z_p (RX)	[15; 1.8; 0; 0]	mm	[test cases]
C_p	[0.8e-4 0.8e-4]	nF	[TX RX]
C_v	[0 0]	nF	[TX RX]
R_0	50	Ohm	
R_d	[50 50]	Ohm	[TX RX]
A_v	0.41	V	
A_fe	0.41	V	
A_ne	0.6	V	
L	4		
M	32		
filter and Eq			
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.3:0.025:0]		[min:step:max]
c(-2)	[0:.025:0.1]		[min:step:max]
c(-3)	[0]		[min:step:max]
c(-4)	[0]		[min:step:max]
c(1)	[-0.3:0.05:0]		[min:step:max]
N_b	1	UI	
b_max(1)	0.7		
b_max(2..N_b)	0.2		
g_DC	[-20:1:0]	dB	[min:step:max]
f_z	21.25	GHz	
f_p1	21.25	GHz	
f_p2	53.125	GHz	
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	
ffe_pre_tap_len	3	UI	
ffe_post_tap_len	24	UI	
Include PCB	0	logical	

Table 93A-3 parameters		
Parameter	Setting	Units
package_tl_gamma0_a1_a2	[0 0.0007901838 0.00050925]	
package_tl_tau	6.325E-03	ns/mm
package_Z_c	[87.5 87.5 ; 92.5 92.5; 100 100 ; 100 100]	Ohm (tdr sel)

Roaming Taps		
roam_taps	6	UI
roam_range_max	100	UI
roam_tap_step_size	0	

ffe_tap_step_size	0		
ffe_main_cursor_min	0.7		
ffe_pre_tap1_max	0.3		
ffe_post_tap1_max	0.3		
ffe_tapn_max	0.125		



Simulation: Orthogonal Channels



File name	Channel_type	Total Loss,dB	FOM_ILD	ICN, mv	DFE:24_0.7_0.2	DFE:24_UC	DFE:24_UC_6R100	FFE:3_24	FFE:3_24_6R100
Och1	Ortho	22.69	0.33668	1.1237	3.8767	3.9738	5.2116	4.0203	5.5968
Och2	Ortho	26.7093	0.35081	1.1237	3.9309	4.0824	4.8978	4.3793	5.2561
OAch1	Ortho	31.9374	0.36023	1.1237	3.0733	3.2862	3.9036	3.6884	4.5243
OAch2	Ortho	32.2832	0.37517	1.1237	2.8172	3.0362	3.6223	3.4268	4.1943
Och3	Ortho	34.0913	0.38112	1.1237	0.79058	1.2697	1.7662	2.0145	2.6624
OAch3	Ortho	34.6622	0.35611	1.1237	2.5685	2.7932	3.3626	3.1853	3.9036
OAch4	Ortho	36.1262	0.36272	0.69088	2.147	2.4872	3.098	2.8052	3.5175
Och4	Ortho	36.3675	0.36942	0.69088	0.42726	0.87663	1.381	1.6394	2.2028
Och5	Ortho	37.0789	0.35207	0.69088	0.16662	0.69597	1.1698	1.5041	2.1359
Och6	Ortho	38.1922	0.35489	0.69088	-0.13787	0.35458	0.80963	1.2096	1.7131
OAch5	Ortho	38.4076	0.35119	0.69088	1.4014	1.7768	2.2702	2.0585	2.6271
OAch6	Ortho	39.1587	0.33914	0.69088	1.4423	1.9165	2.4066	2.1359	2.7098
Och7	Ortho	39.7253	0.33526	0.69088	-0.55514	0.052272	0.48218	0.91515	1.381
Och8	Ortho	41.1896	0.33132	0.69088	-0.9455	-0.19751	0.20211	0.473	0.89587
OAch7	Ortho	41.4429	0.33466	0.69088	0.38176	0.9055	1.3708	1.0808	1.5767

Graph



Simulation: Cable Backplane Channels



File name	Channel_type	Total Loss,dB	FOM_ILD	ICN, mv	DFE:24_0.7_0.2	DFE:24_UC	DFE:24_UC_6R 100	FFE:3_24	FFE:3_24_6R 100
CAch2	Cable	24.8663	0.1565	0.53049	4.9913	5.0812	6.7409	5.4981	7.0916
CAch1	Cable	26.7787	0.19041	0.50321	4.8673	4.9371	6.7279	5.3521	6.9357
CAch4	Cable	28.5026	0.15729	0.46602	4.7916	4.9446	6.6137	5.4005	7.1904
CAch2_b2	Cable	30.4409	0.18889	0.53049	4.9437	5.0673	6.038	5.5638	6.5396
CAch3	Cable	30.7523	0.16935	0.4691	4.5389	4.7314	6.3031	5.0518	6.6509
CAch2_b2p5	Cable	30.8157	0.19217	0.53049	4.913	5.0518	5.8998	5.5803	6.4844
CAch1_b2	Cable	32.381	0.21586	0.50321	4.8673	5.1612	6.1255	5.2086	6.2852
CAch2_b4	Cable	33.0334	0.19574	0.53049	4.5389	4.7765	5.6632	5.177	6.1079
CAch2_a0	Cable	33.8808	0.21709	0.53049	2.5919	3.1353	3.9719	3.5566	4.913
CAch4_b2	Cable	34.5735	0.20419	0.46602	4.265	4.5536	5.6632	4.8521	5.9686
CAch2_b6	Cable	35.3781	0.17853	0.53049	4.0132	4.4225	5.2086	4.6866	5.5803
CAch2_a2p5	Cable	35.6929	0.2242	0.53049	2.2364	2.8293	3.7417	3.1728	4.3077
CAch2_a5	Cable	36.4834	0.2225	0.53049	2.1248	2.6271	3.4397	3.0856	4.1943
CAch3_b2	Cable	36.5773	0.21499	0.4691	3.5436	3.9309	4.583	4.3937	5.2244
CAch2_a7p5	Cable	37.5571	0.21664	0.53049	1.8733	2.4296	3.2862	2.8775	3.9309
CAch2_b7p5	Cable	37.7311	0.22777	0.53049	3.3498	3.8358	4.6569	4.0546	4.9744
CAch2_b8	Cable	38.1338	0.20319	0.53049	3.3754	3.9036	4.583	4.0824	4.8369
CAch2_a10	Cable	38.8553	0.20653	0.53049	1.5871	2.214	2.9871	2.7693	3.6884
CAch2_b10	Cable	40.9875	0.23279	0.53049	2.6036	3.2356	3.89	3.2104	4.027

Graph



Simulation: Traditional Backplane Channels

File name	Channel_type	Total Loss,dB	FOM_ILD	ICN, mv	DFE:24_0.7_0.2	DFE:24_UC	DFE:24_UC_6R100	FFE:3_24	FFE:3_24_6R100
Bch1_3p5	Backplane	22.7843	0.40845	2.0228	3.3314	3.4662	4.8312	3.451	4.7095
Bch2_7	Backplane	24.7992	0.36421	1.7679	3.7624	3.9125	5.4131	4.0907	5.456
Bch3_14	Backplane	30.7626	0.35139	1.1085	3.715	3.9719	5.4655	4.1662	5.7134
Bch2_b2_7	Backplane	30.8404	0.43567	1.7679	3.6619	3.9309	4.913	4.2225	5.0829
Bch2_b2p5_7	Backplane	30.8855	0.43376	1.7679	3.715	3.9582	4.7614	4.265	5.0207
Bch2_a0_7	Backplane	32.97	0.45582	1.7679	1.5975	2.214	2.9626	2.1916	3.0733
Bch2_b4_7	Backplane	33.4349	0.43805	1.7679	3.2862	3.6752	4.5389	3.8628	4.7015
Bch2_a2p5_7	Backplane	35.1905	0.45786	1.7679	1.1202	1.7131	2.3952	1.8196	2.7217
Bch2_b6_7	Backplane	35.6077	0.43418	1.7679	2.7217	3.2609	3.89	3.2104	4.0685
Bch2_a5_7	Backplane	35.8396	0.45685	1.7679	0.97325	1.5663	2.2364	1.8841	2.6507
Bch2_a7p5_7	Backplane	36.9353	0.45031	1.7679	0.73369	1.381	1.9599	1.7237	2.4526
Bch2_b7p5_7	Backplane	37.129	0.45026	1.7679	2.3837	2.9139	3.5175	2.8775	3.5045
Bch2_b8_7	Backplane	37.9142	0.43923	1.7679	2.2589	2.9504	3.4655	2.8172	3.3754
Bch2_a10_7	Backplane	38.4943	0.43349	1.7679	0.30945	1.071	1.5767	1.5559	2.2252
Bch2_a12p5_7	Backplane	40.4667	0.41584	1.7679	-0.09502	0.73369	1.2296	1.022	1.692
Bch2_b10_7	Backplane	41.3157	0.45417	1.7679	1.2196	2.0805	2.5802	1.9165	2.4641
Bch2_a15_7	Backplane	42.1222	0.46055	1.7679	-0.53883	0.211	0.59306	0.53744	1.0415
Bch4_30	Backplane	43.7539	0.34902	0.84842	0.51898	1.4321	2.214	1.1598	2.1804
Bch2_b15_7	Backplane	46.2182	0.45704	1.7679	-1.4008	-0.42379	-0.12932	-0.57955	-0.24831

