Current COM spec is broken between channel and Rx (comment #32)

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Supporters

- Geoff Zhang (Xilinx)
- Phil Sun (Credo)
- Toshiaki Sakai (Socionext)
- Mike Dudek (Cavium)

Background

- Current COM spec is broken between Channel and Rx
  - Interoperability is not guaranteed between compliant channel and Rx due to variation of package impedance (Zc) and device termination (Rd)
- The problem was explained in March (hidaka_3cd_01a_0317)
  - Comment #145 on D1.2
  - With proposal for ±10% impedance variation
- The proposal in March was not well accepted, probably because
  - Low-yield concern > low-interoperability concern
  - Low-interoperability concern may not be accepted as a serious issue
    - Or, it may not be well understood
      - However, it is a real serious issue

Updates to CEI-56G-MR/LR-PAM4 in OIF

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- Recent updates to CEI-56G-MR-PAM4 & CEI-56G-LR-PAM4
  - Change Rd to 50Ω
  - Change Package Zc to 95Ω (as the nominal value)
  - Change COM for Channel spec to 3.5dB
  - Leave COM for Rx ITT spec at 3.0dB
- COM value is expected to increase by about 0.5dB, because
  - Rd is relaxed
  - Package Zc is relaxed
  - For CEI-56G-MR-PAM4, SNR_{TX} is also relaxed
- This is a variant of option 2 in hidaka_3cd_01a_0317

A Bad Scenario: Mismatched Test Channel

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- Suppose Rx A barely passes Rx ITT w/ Mismatched Test Channel B

Mismatched Test Channel B, Z = 110Ω calibrated to 3dB COM (less BB noise) ⟷ Mismatched ⟷ Reference Rx, Zc = 90Ω

Mismatched Test Channel B, Z = 110Ω calibrated to 3dB COM (less BB noise) ⟷ Fairly matched ⟷ Rx A, Zc = 100Ω barely passes Rx ITT

- If Best matched Test Channel C was used, more broadband noise would be injected by calibration, and Rx A would have failed Rx ITT

Best-matched Test Channel C, Z = 90Ω calibrated to 3dB COM (more BB noise) ⟷ Best matched ⟷ Reference Rx, Zc = 90Ω

Best-matched Test Channel C, Z = 90Ω calibrated to 3dB COM (more BB noise) ⟷ Fairly matched ⟷ Rx A, Zc = 100Ω would have failed Rx ITT

- Suppose Customer Channel D has best-matched impedance, but barely meets 3dB COM due to a lot of noise such as crosstalk

Best-matched Customer Channel D, Z = 90Ω barely meets 3dB COM (a lot of noise) ⟷ Best matched ⟷ Reference Rx, Zc = 90Ω

- *Compliant* Rx A and *compliant* Channel D will fail to work together

Customer Channel D, Z = 90Ω will not work with Rx A ⟷ Fairly matched ⟷ Rx A, Zc = 100Ω will not work with channel D

Rx ITT using a Mismatched Test Channel

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- Yield of Rx ITT can be improved, by selecting test channel as mismatched with Reference Rx as possible, because less broadband noise is injected
  - However, we should not do this, because it will damage interoperability
    - Rx barely passing this Rx ITT will not work with barely-compliant best-matched real channels
  - It is a kind of cheating Rx ITT at the expense of degraded interoperability

- How to make Rx ITT fair and stressful enough
  - Option 1: Use Reference Rx always best-matched for the test channel
    - Have to search for the best-matched reference Rx
  - Option 2: Use the nominal impedance for reference Rx
    - If the test channel is mismatched, Rx ITT is still easier than real channels
    - To fill the gap, have an offset of COM specs between channel and Rx ITT
  - These are similar to option 1 and 2 in my previous proposal

Recap Option 1 in hidaka_3cd_01a_0317

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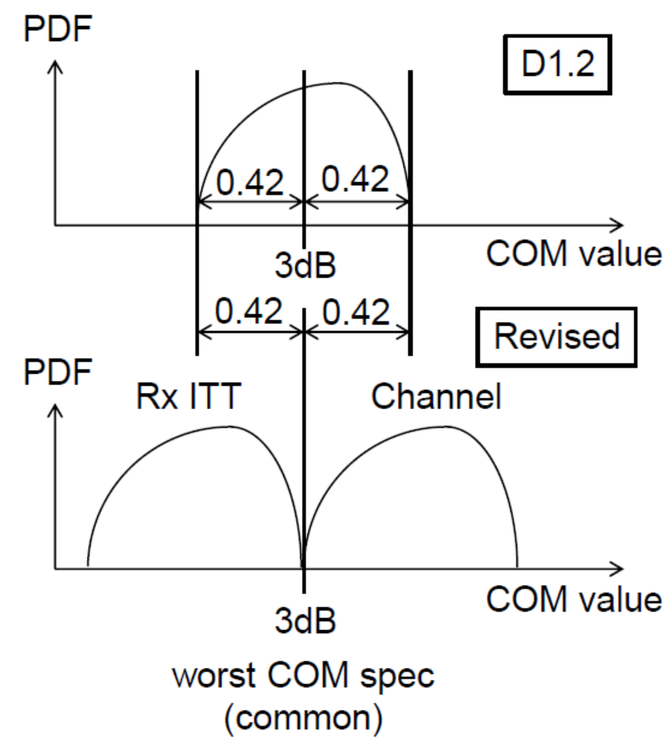
- Check COM for all max/min combinations of Rd and Zc in Tx and Rx (i.e. search for the worst COM value)
  - Brute-force search can be accelerated by two-phase optimization of LE
  - Major change of COM tool is required

- Define the worst COM value as follows:
  - *Min* COM value for Channel Test
  - *Max* COM value for Rx ITT

hidaka_3cd_01a_0317, slide 12, right half

- For Zc (nominal) = 93Ω
  - Worst common = 3.0dB



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Recap Option 2 in hidaka_3cd_01a_0317

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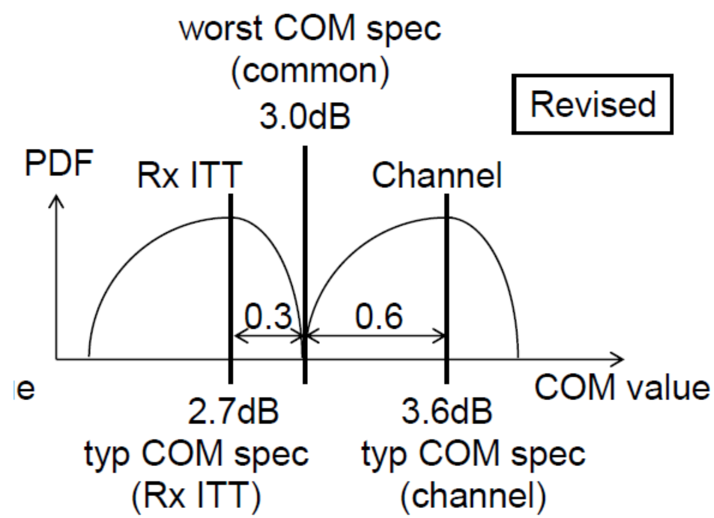
- Check the typical COM value for nominal values of Rd and Zc
  - No COM tool change is required
- Offset COM spec value as follows:
  - For Channel Test, X dB higher than the worst COM spec (option 1)
  - For Rx ITT, Y dB lower than the worst COM spec (option 1)
  - X and Y are chosen base on the amount of variation

hidaka_3cd_01a_0317, slide 13, right half

- For Zc (nominal) = 93Ω
  - Typ Channel = 3.6dB
  - Typ Rx ITT = 2.7dB



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Straw Poll Results for Comment #145 on D1.2

- Straw Poll #1
  - To resolve this comment I support:

    (pick one)

    A: option 1 proposed in hidaka_3cd_01a_0317

    B: option 2 proposed in hidaka_3cd_01a_0317

    C: do nothing at this time (e.g., need more information)

    A: 9, B: 1, C: 35

- Straw Poll #2
  - To proceed I support:

    (pick one)

    A: continue in direction of option 1 in hidaka_3cd_01a_0317

    B: continue in direction of option 2 in hidaka_3cd_01a_0317

    C: do not continue with either option 1 or option 2

    A: 11, B: 1, C: 15

Interpretation of Straw Poll Results

- Low-yield concern is higher than low-interoperability concern
  - Impedance variation of ±10% (~0.9dB COM) may be too much
- Low-interoperability concern is not negligible small
- Compromise between yield and interoperability is important
- Option 1 is much preferable to Option 2

Compromise between yield and interoperability

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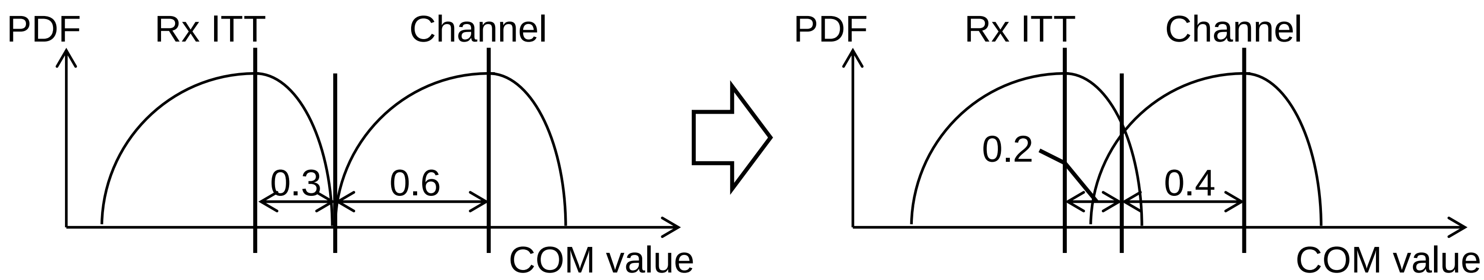
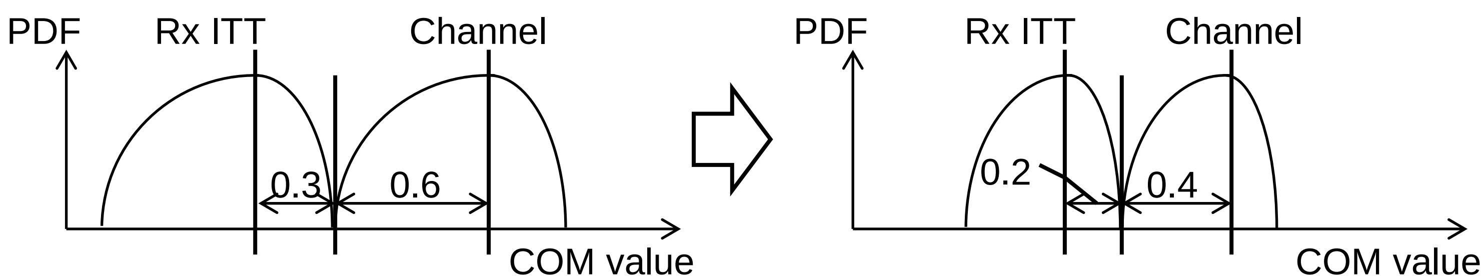
- The old scheme in hidaka_3cd_01a_0317, slide 23-24
  - Overlap distribution

The worst case (±10%) Compromise (e.g. ±7%)

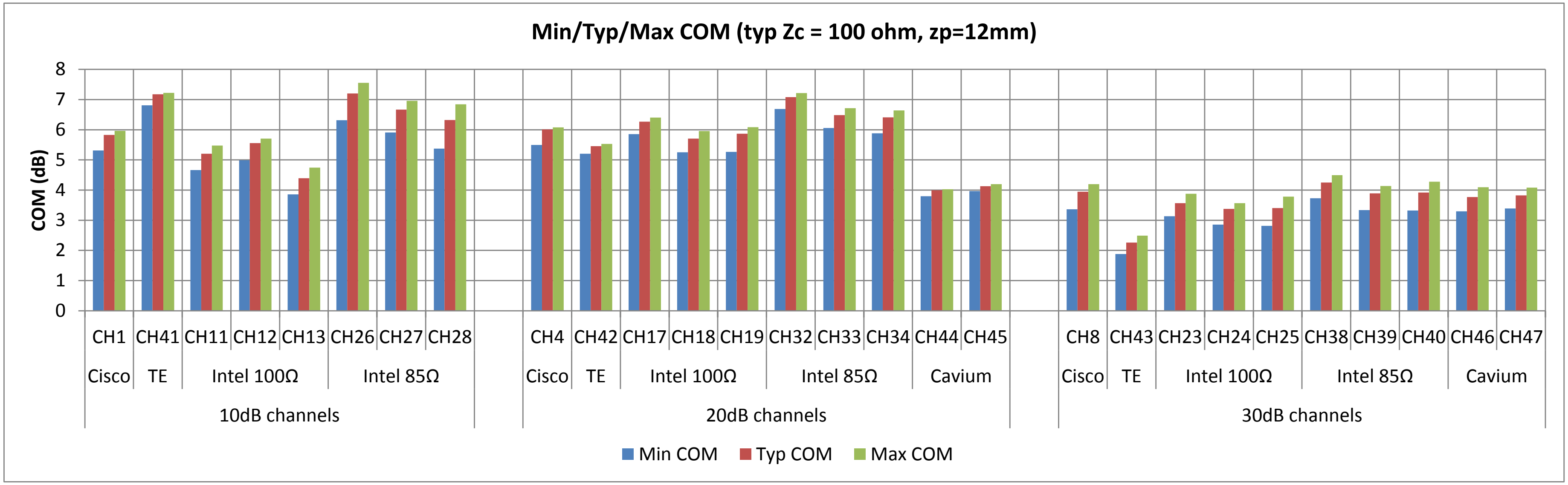


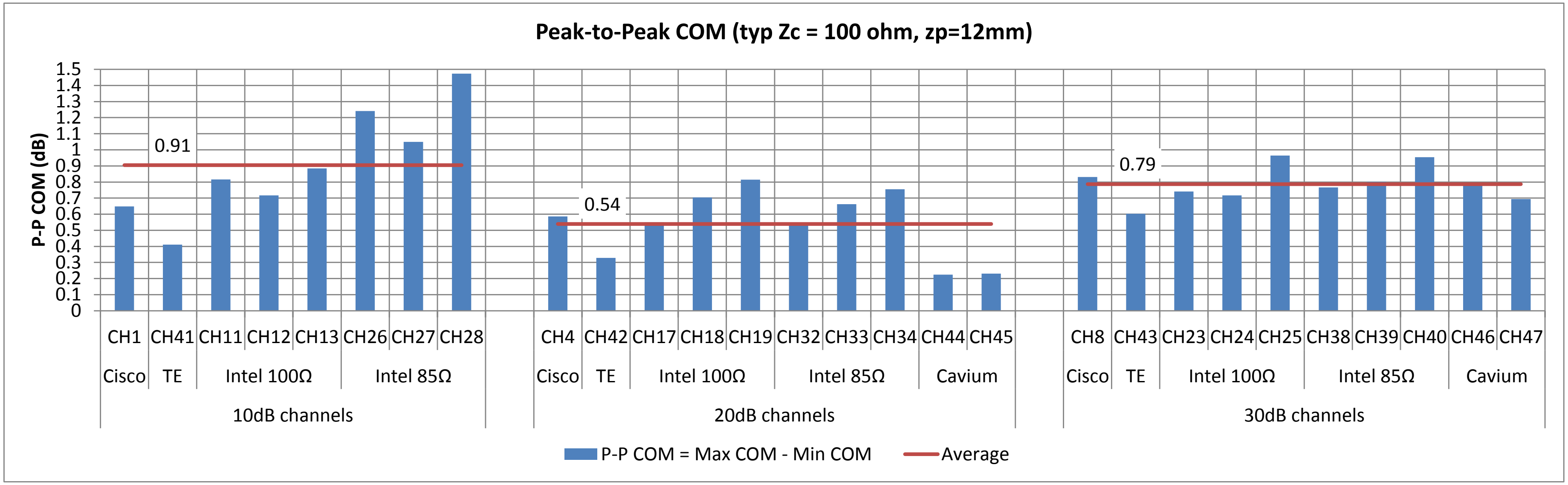
- A revised scheme (new)
  - Just reduce amount of variation

The worst case (±10%) Compromise (e.g. ±7%)



P-P COM for ±10% Variation (typ Zc=100Ω, zp=12mm)





P-P COM for ±10% Variation (typ Zc=100Ω, zp=30mm)

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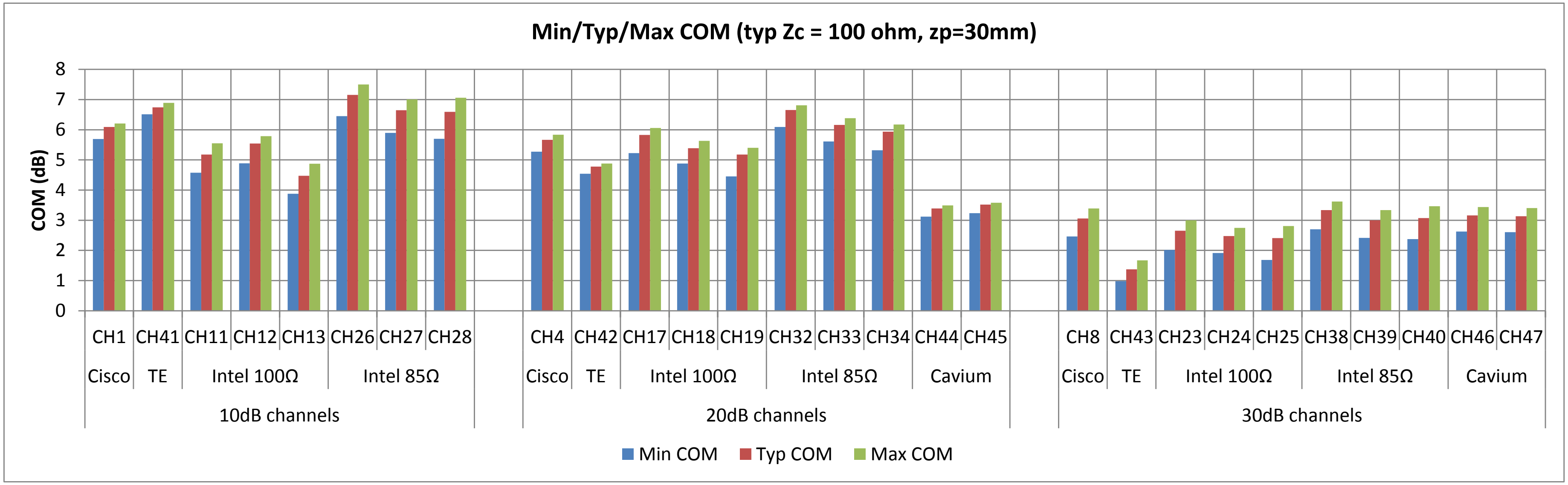

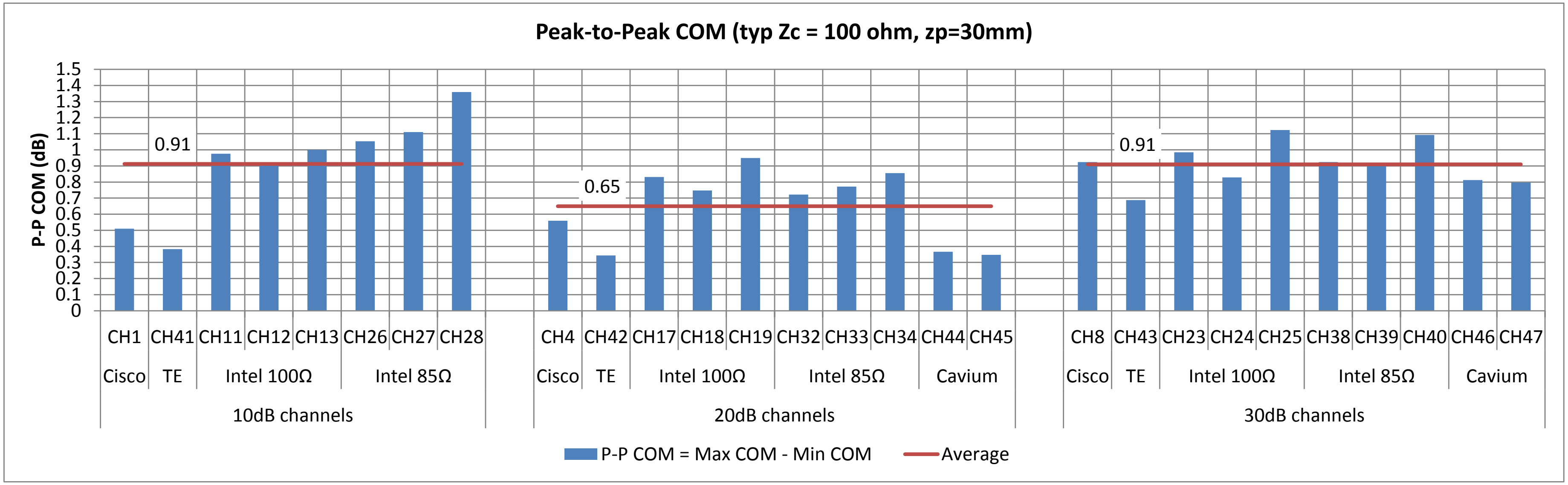

P-P COM for ±10% Variation (typ Zc=93Ω, zp=12mm)

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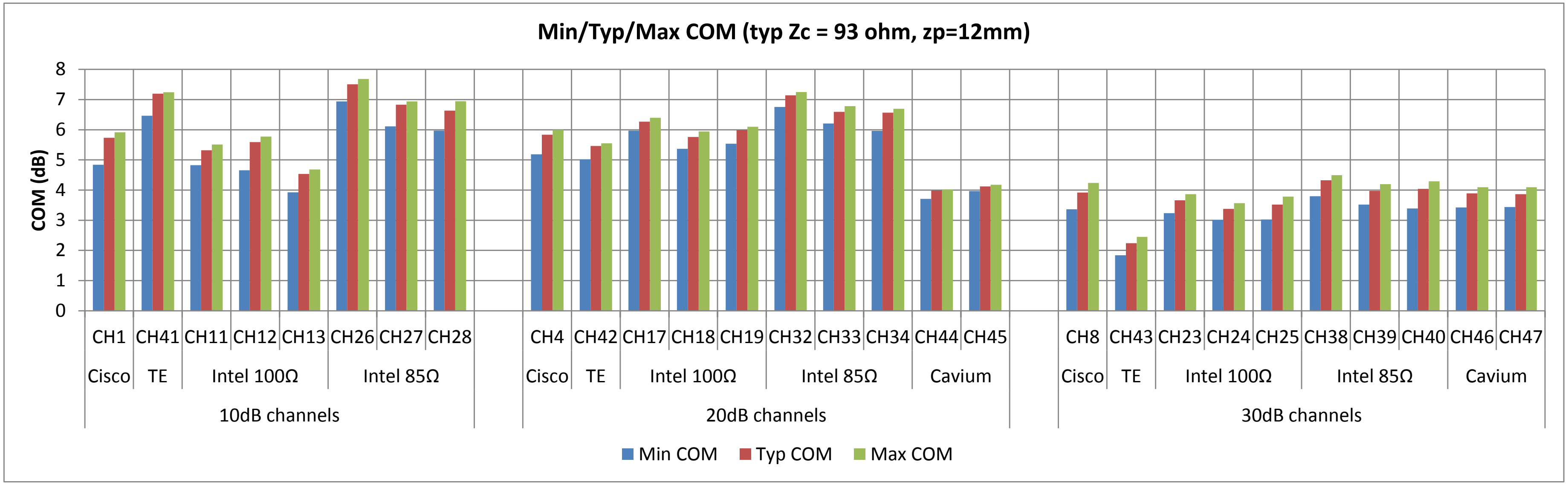

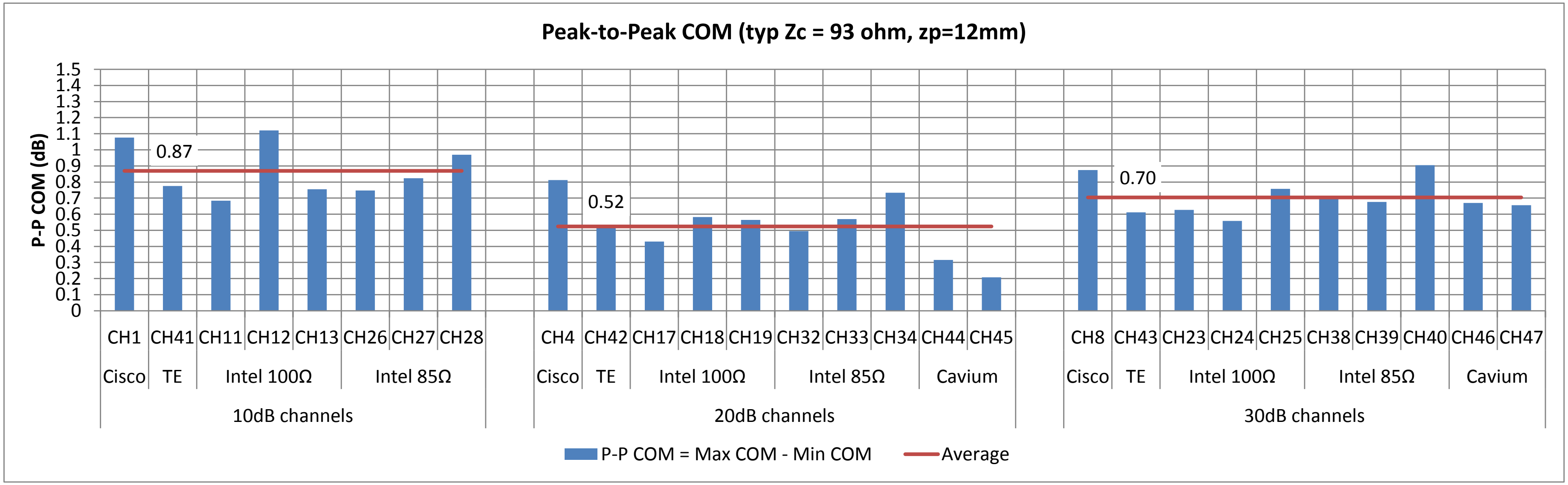

P-P COM for ±10% Variation (typ Zc=93Ω, zp=30mm)

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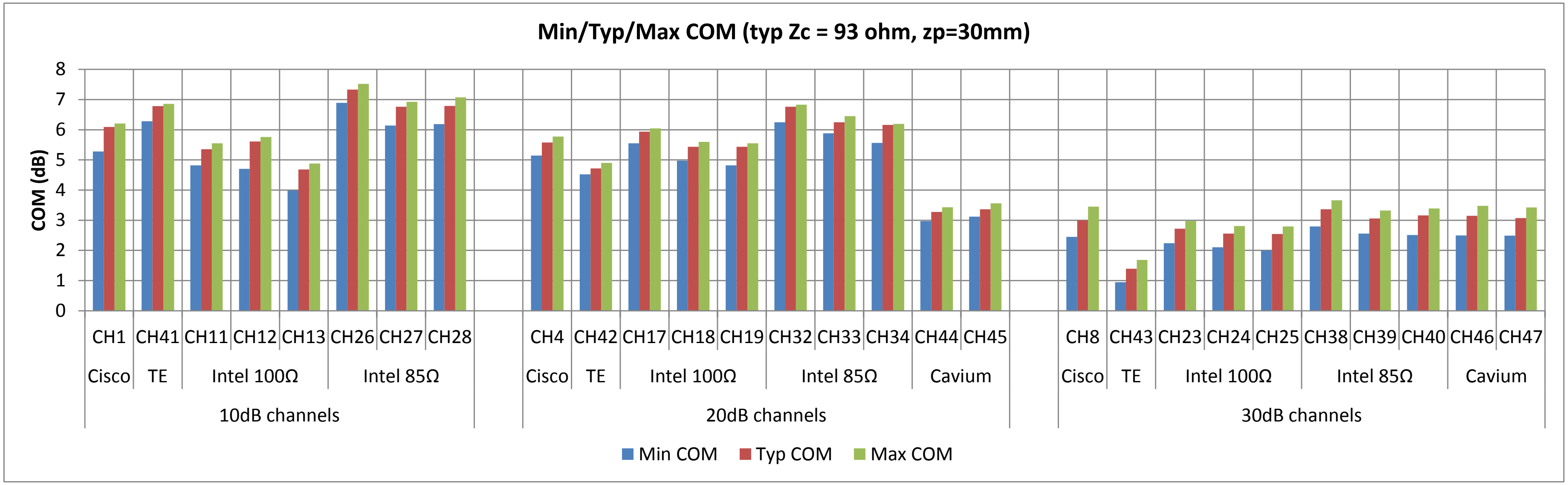

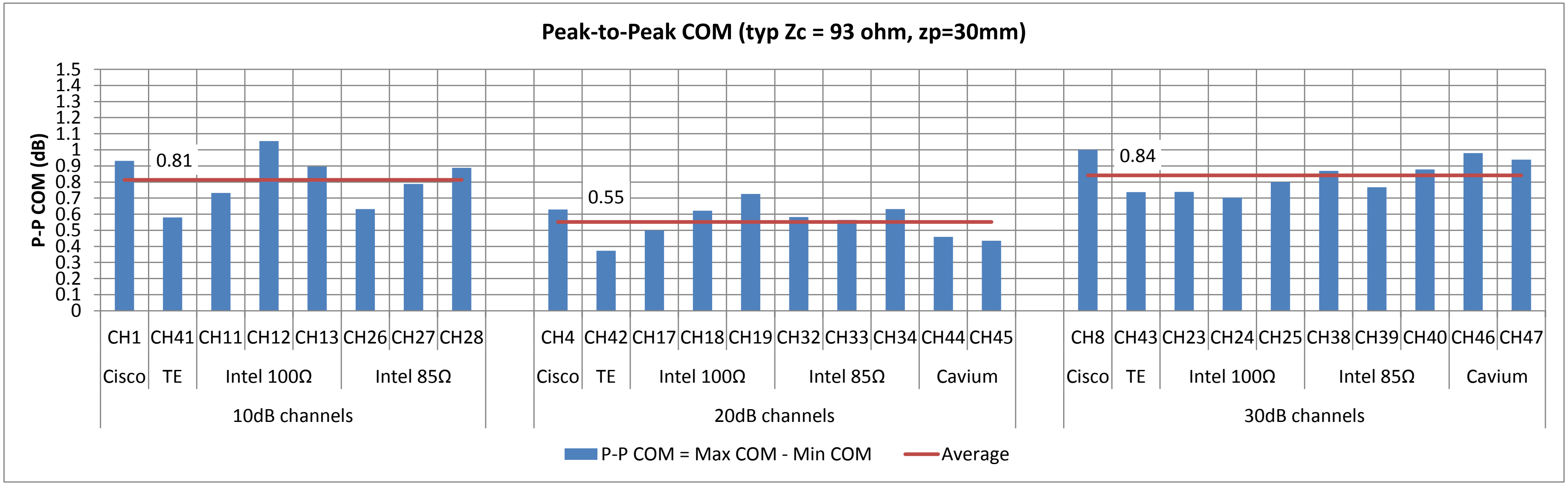

P-P COM for Reduced Variation

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Simulation Method

1. Check COM for all combinations of ±10% for Rd and Zc in Tx and Rx
   - Av, Afe, Ane are deviated by the same amount of Tx Rd
2. Rd and Zc combination of min COM is -10% deviation of parameter
3. Rd and Zc combination of max COM is +10% deviation of parameter
4. Rd and Zc combination of all typ values is 0% deviation of parameter
5. Sweep deviation from -10% to +10% in 1% step

Conditions

- Channels
  - Cisco 30dB Channel (CH8)
  - Cavium 30dB Hi-Z Channel (CH46)
- Typ Zc = 100Ω or 93Ω
- zp = 30mm

Reduced Variation (Cisco 30dB, typ Zc=100Ω)

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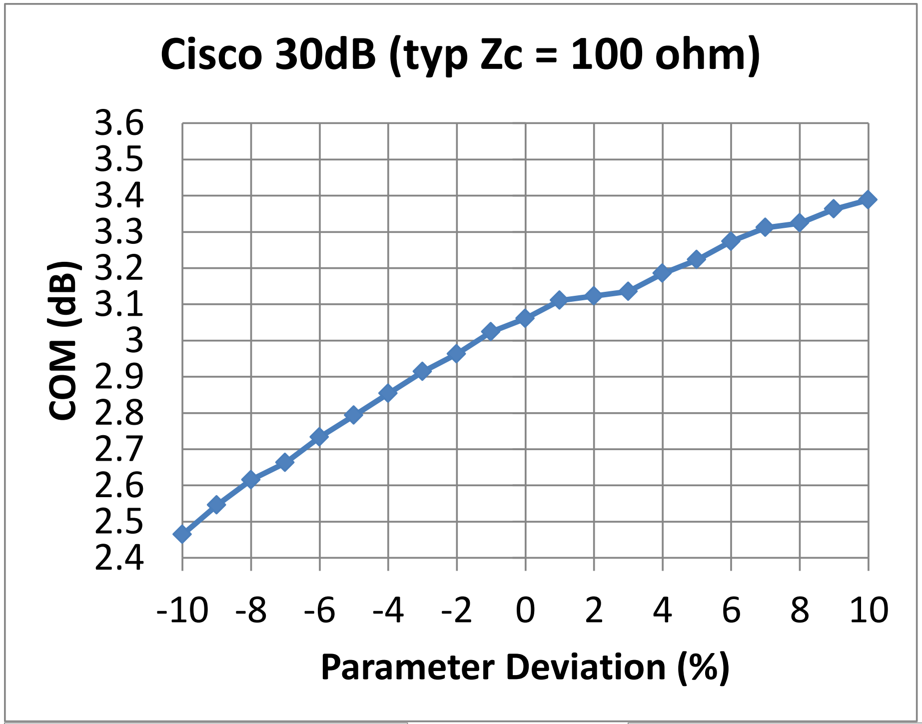

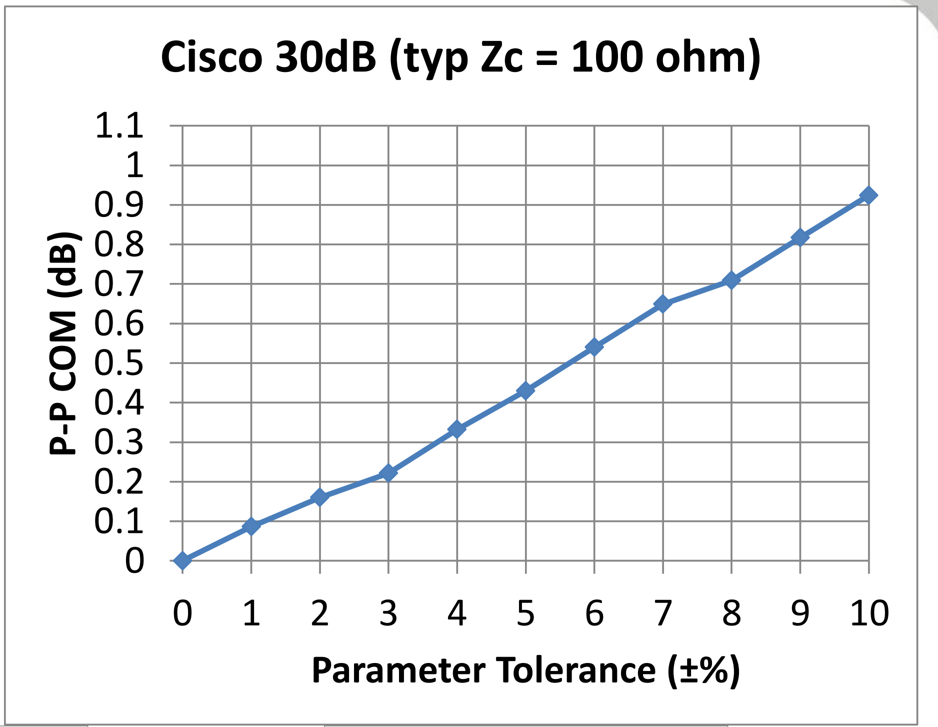

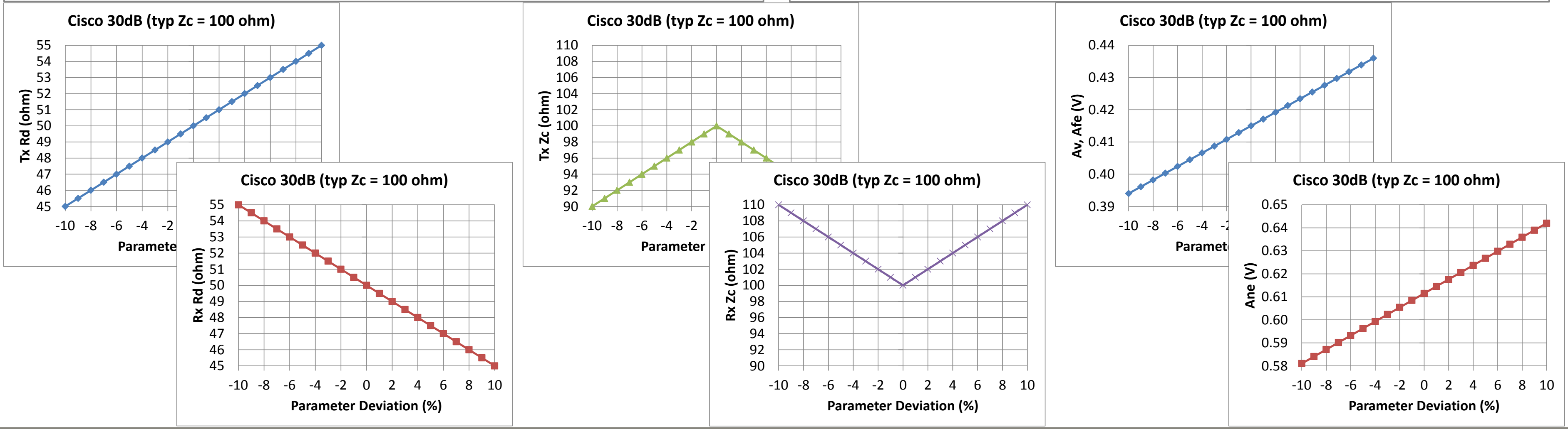

Reduced Variation (Cisco 30dB, typ Zc=93Ω)

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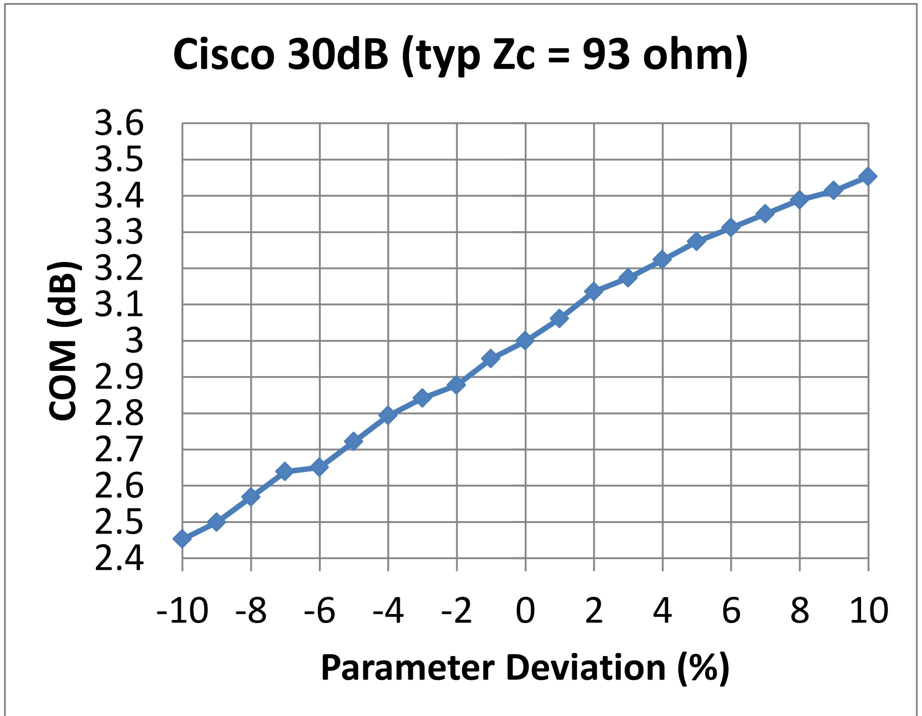

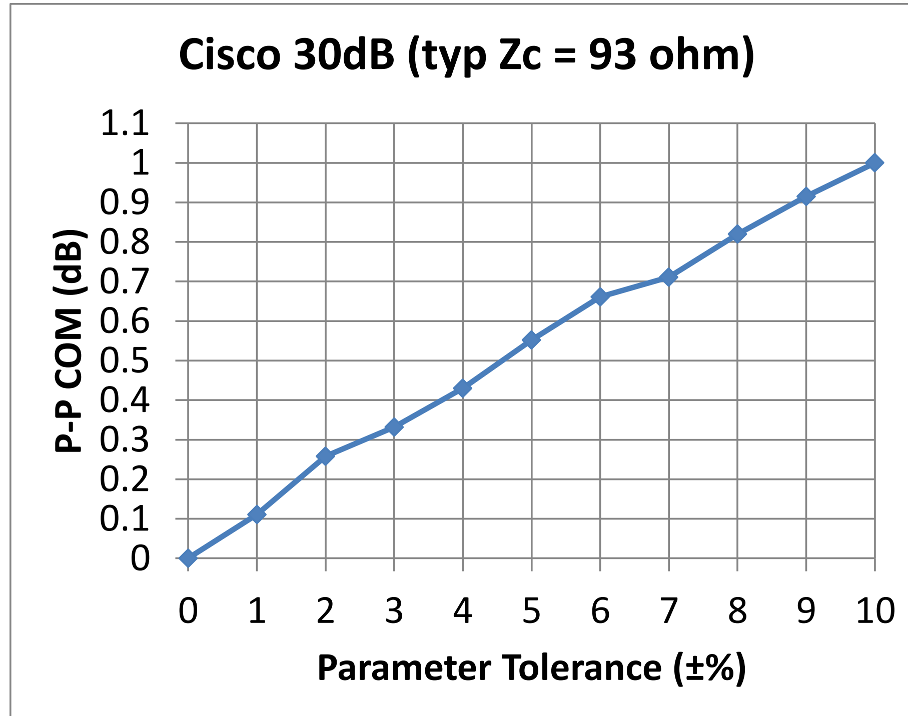

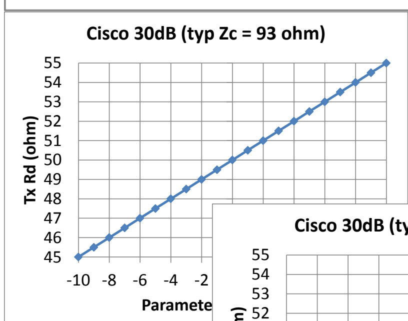

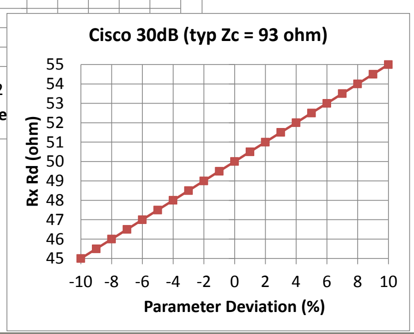

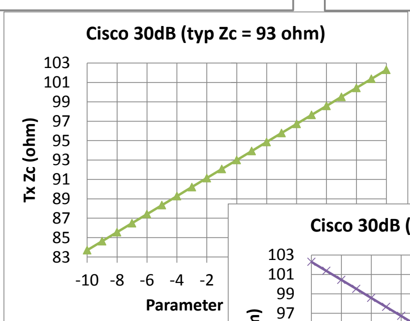

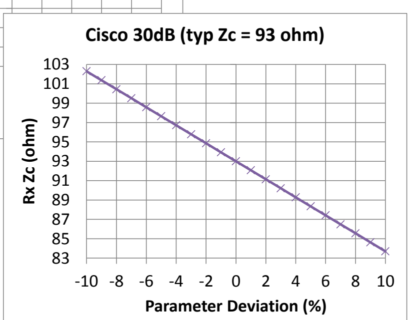

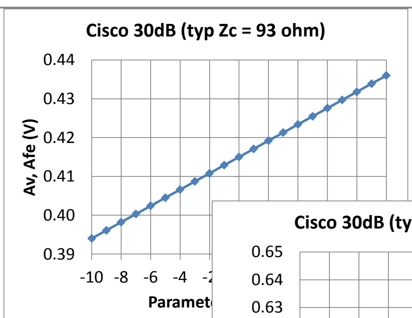

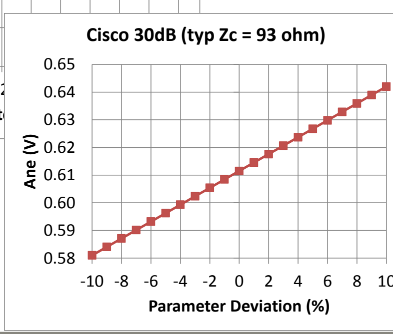

Reduced Variation (Cavium 30dB HiZ, typ Zc=100Ω)

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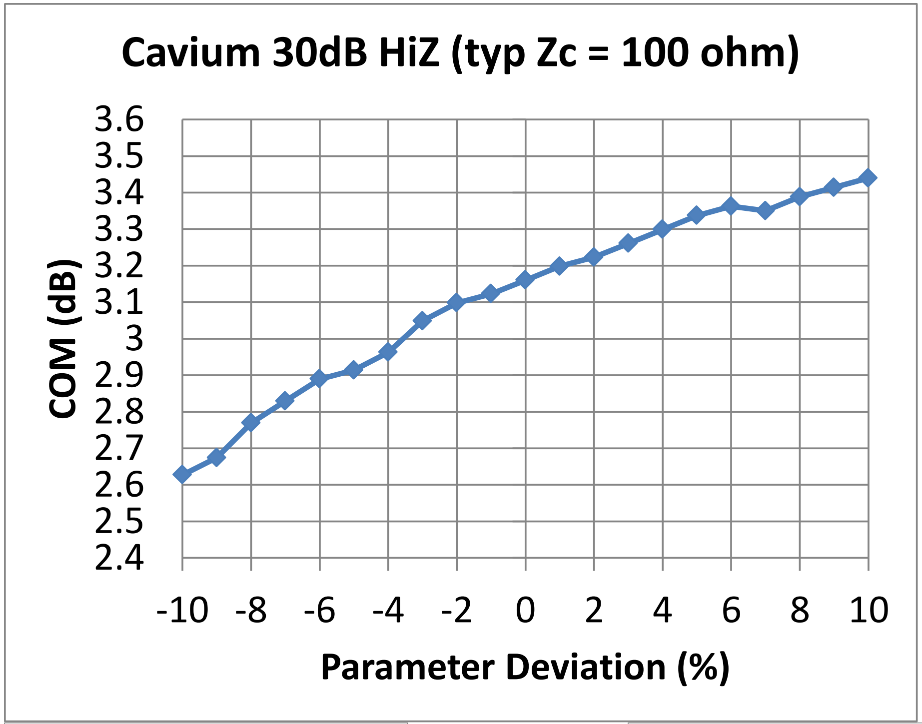

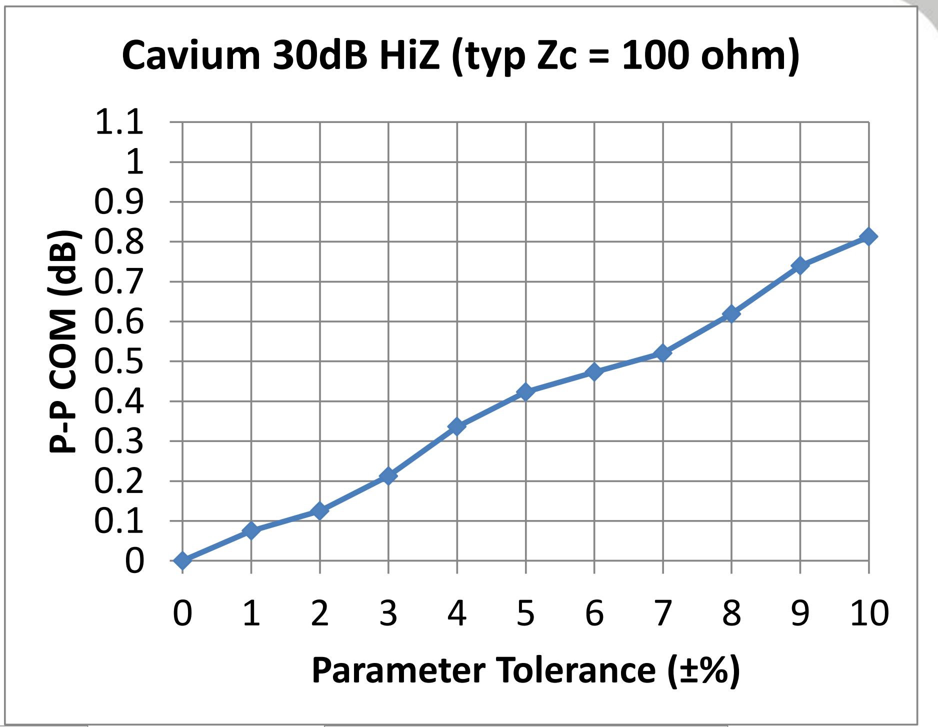

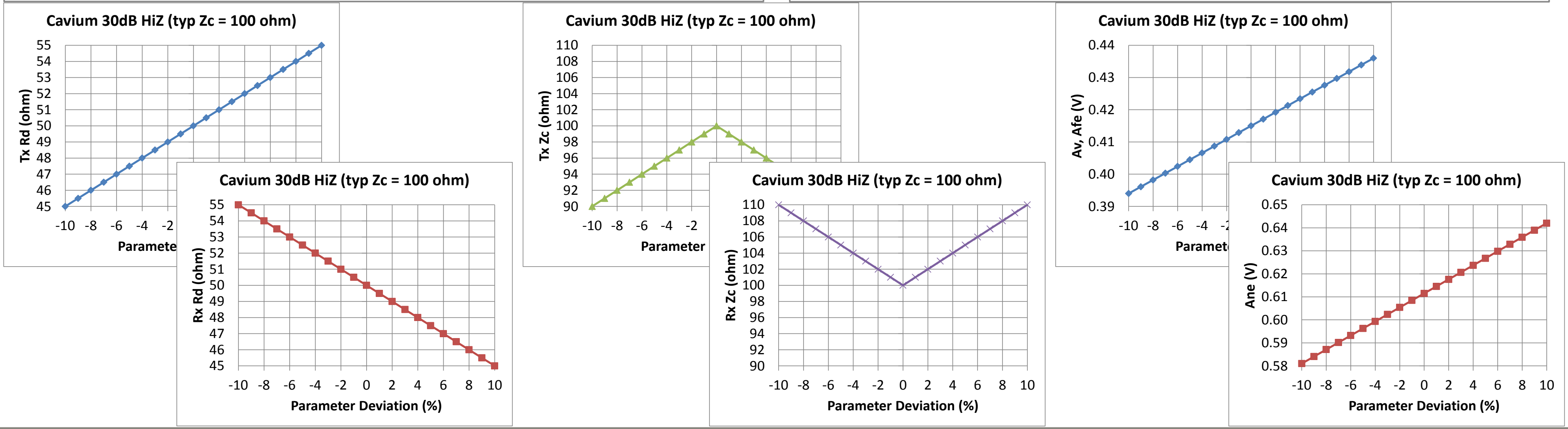

Reduced Variation (Cavium 30dB HiZ, typ Zc=93Ω)

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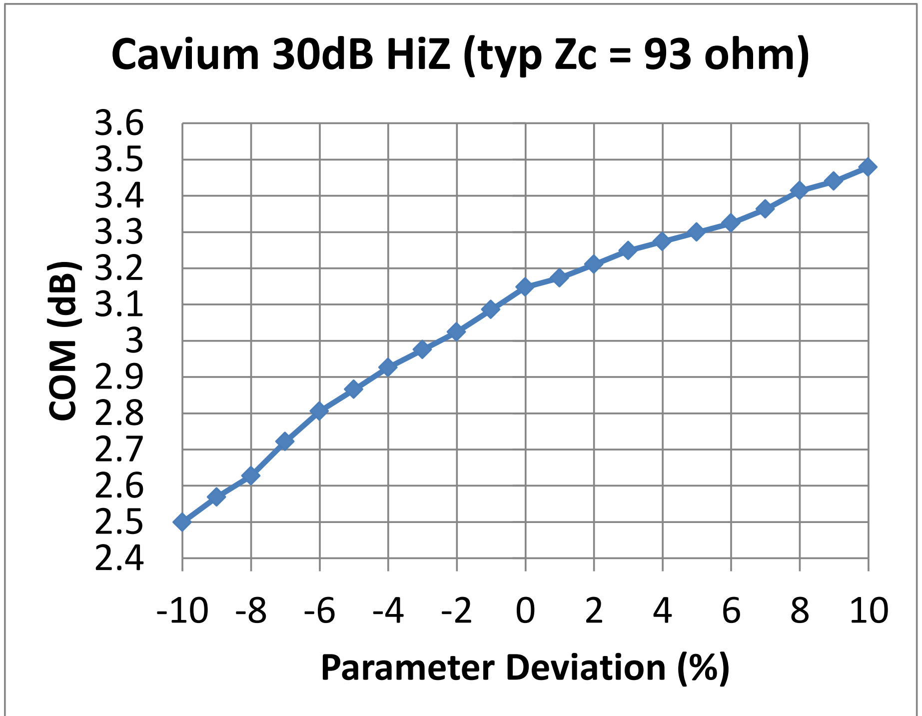

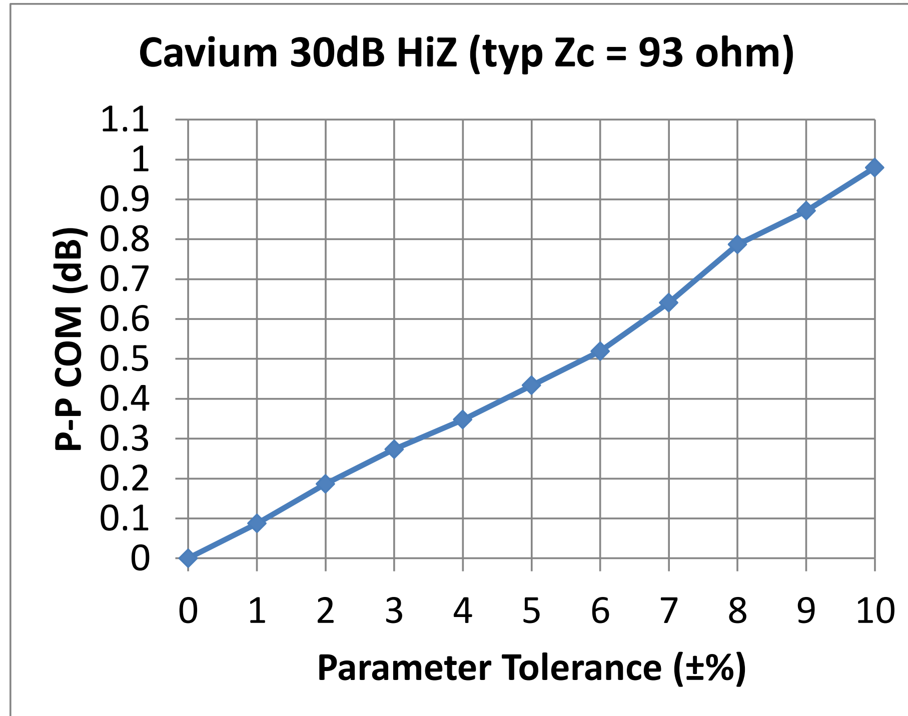

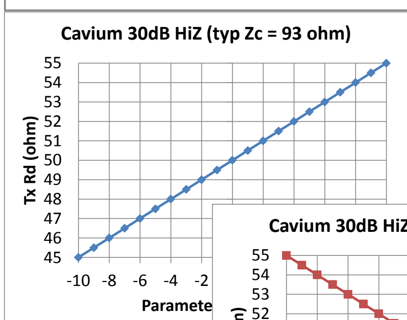

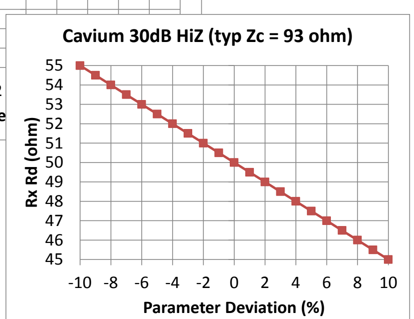

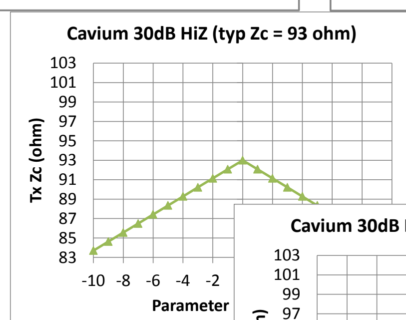

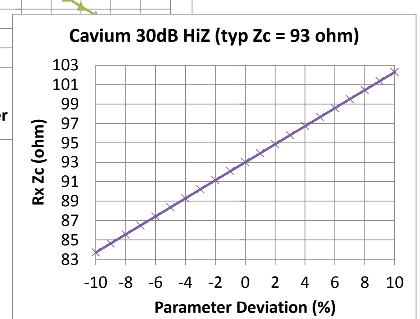

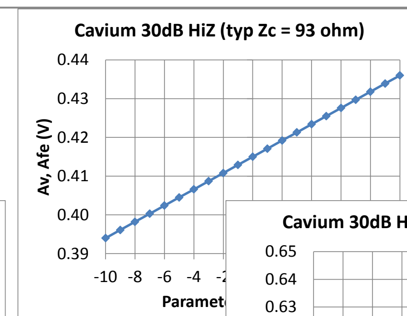

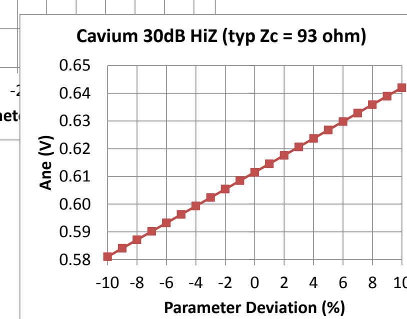

Summary

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- If test channel for Rx ITT is *mismatched* with Reference Rx
  - This Rx ITT may be less stressful than best-matched real channels
  - Rx barely passing this Rx ITT will not work with barely-compliant best-matched real channels
- Current spec has *zero margin* for impedance variation
- Hence, we need extra margin somewhere for interoperability
  - Add whole extra margin to 802.3cd spec?
  - Or, manage whole extra margin by double standard in each vendor?
  - Or, add partially to 802.3cd spec and manage the rest by each vendor?

Options for impedance variation

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- Option A
  - Implement option 1 with ±10% variation
- Option B
  - Implement option 1 with ±7% variation
- Option C
  - Implement option 1 with ±5% variation
- Option D
  - Implement option 1 with ±3% variation
- Option E
  - No change to P802.3cd standard spec
    - Each vendor defines their own double standard to guarantee interoperability.

Z Variation	Extra P-P COM
±10%	0.8~1.0dB
±7%	0.5~0.7dB
±5%	0.4~0.6dB
±3%	0.2~0.4dB
±1%	~0.1dB
±0%	0.0dB

Options for the nominal value of Package Zc

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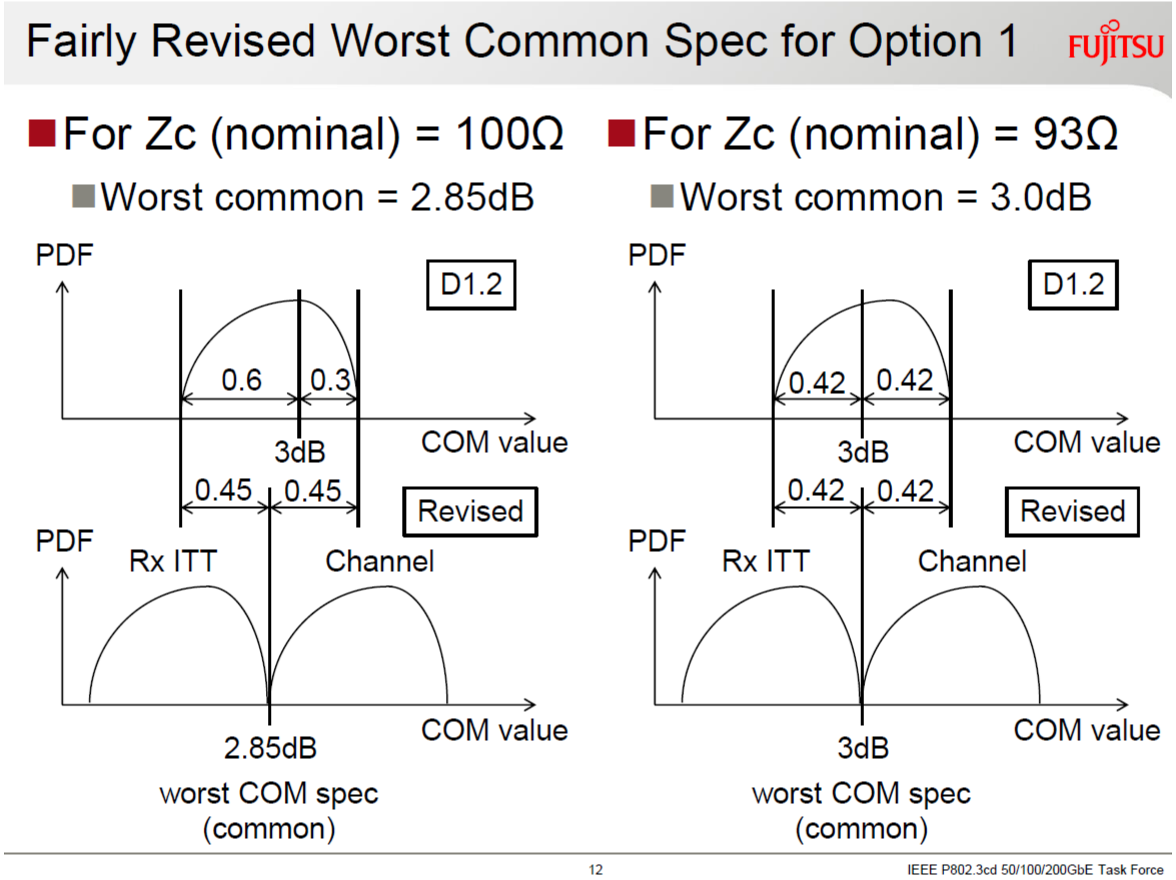
- 100Ω
- 95Ω
- 93Ω
- 90Ω



- For 93Ω, recommend to keep COM spec value of 3dB
- For 100Ω, recommend to change COM spec value to 2.85dB
- For 95Ω or 90Ω, no data at this moment

Proposal of Core Text

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93A.1 Channel Operating Margin

Figure 93A–1 illustrates the reference model that is the basis for the calculation for COM. The parameters used to calculate COM are listed in Table 93A–1. The values assigned to these parameters are defined by the Physical Layer specification that invokes the method (see Table 93A–2).

When max and min values are specified for R_d, Z_c, A_v, A_{fe}, and A_{ne}, COM is calculated for all combinations of max and min values of R_d for calculation of Γ_1 by Equation (93A-17), R_d for calculation of Γ_2 by Equation (93A-17), Z_c for calculation of the transmitter device package model $S^{(tp)}$ by Equation (93A-15), and Z_c for calculation of the receiver device package model $S^{(rp)}$ by Equation (93A-16). When the max value of R_d is used for calculation of Γ_1, the max value of A_v, A_{fe}, and A_{ne} is used. When the min value of R_d is used for calculation of Γ_1, the min value of A_v, A_{fe}, and A_{ne} is used. For channel test using COM, the minimum of resulting COM values is used. For test channel calibration using COM in 93A.2 for receiver interference tolerance test, the maximum of resulting COM values is used. Determination of variable equalizer parameters in 93A.1.6 may be precisely done for each combination of R_d, Z_c, A_v, A_{fe}, and A_{ne}, or done for two times – first approximately done using the mean value of max and min for R_d, Z_c, A_v, A_{fe}, and A_{ne}, before finding the combination of their values that maximizes or minimizes COM value, and second precisely done using the chosen combination of R_d, Z_c, A_v, A_{fe}, and A_{ne}, to re-calculate the final COM value.

Back up Slides

- Baseline/Min/Max/Typ COM Results (updated)
- COM Parameters
- Channel Data Source

BL/Min/Max/Typ COM for zp=12mm, Zc=100Ω

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Loss	Channel Type	CH #	Baseline COM (zp=12)				Min COM (zp=12)						Max COM (zp=12)						Typ COM (zp=12)						Difference		
			TC #	Tx Rx Rd	Tx Rx Zc	COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Min COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Max COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Typ COM	Typ COM - Min COM	Max COM - Typ COM	Max COM - Min COM
10dB	Cisco	CH1	TC11	55	90	5.31	TC11	55	90	55	90	5.31	TC13	55	110	45	90	5.96	OC1	50	100	50	100	5.82	0.51	0.14	0.65
	TE	CH41	TC11	55	90	6.87	TC8	45	110	55	110	6.81	TC1	45	90	45	90	7.22	OC1	50	100	50	100	7.18	0.36	0.05	0.41
	Intel 100Ω	CH11	TC11	55	90	5.07	TC6	45	110	45	110	4.66	TC1	45	90	45	90	5.48	OC1	50	100	50	100	5.21	0.54	0.27	0.82
		CH12	TC11	55	90	5.12	TC13	55	110	45	90	4.99	TC1	45	90	45	90	5.70	OC1	50	100	50	100	5.55	0.57	0.15	0.72
		CH13	TC11	55	90	4.17	TC6	45	110	45	110	3.86	TC1	45	90	45	90	4.74	OC1	50	100	50	100	4.39	0.53	0.35	0.89
	Intel 85Ω	CH26	TC11	55	90	7.36	TC6	45	110	45	110	6.32	TC1	45	90	45	90	7.56	OC1	50	100	50	100	7.20	0.89	0.35	1.24
		CH27	TC11	55	90	6.42	TC6	45	110	45	110	5.91	TC1	45	90	45	90	6.96	OC1	50	100	50	100	6.67	0.76	0.29	1.05
		CH28	TC11	55	90	6.28	TC14	55	110	45	110	5.37	TC1	45	90	45	90	6.84	OC1	50	100	50	100	6.32	0.95	0.52	1.47
	Average																								0.64	0.27	0.91
20dB	Cisco	CH4	TC11	55	90	5.49	TC11	55	90	55	90	5.49	TC10	55	90	45	110	6.08	OC1	50	100	50	100	6.01	0.52	0.07	0.59
	TE	CH42	TC11	55	90	5.20	TC11	55	90	55	90	5.20	TC10	55	90	45	110	5.53	OC1	50	100	50	100	5.45	0.25	0.08	0.33
	Intel 100Ω	CH17	TC11	55	90	6.17	TC8	45	110	55	110	5.85	TC1	45	90	45	90	6.40	OC1	50	100	50	100	6.27	0.41	0.14	0.55
		CH18	TC11	55	90	5.52	TC8	45	110	55	110	5.25	TC1	45	90	45	90	5.96	OC1	50	100	50	100	5.70	0.45	0.26	0.70
		CH19	TC11	55	90	5.85	TC6	45	110	45	110	5.27	TC9	55	90	45	90	6.08	OC1	50	100	50	100	5.87	0.60	0.21	0.81
	Intel 85Ω	CH32	TC11	55	90	7.02	TC4	45	90	55	110	6.69	TC1	45	90	45	90	7.22	OC1	50	100	50	100	7.08	0.39	0.14	0.53
		CH33	TC11	55	90	6.42	TC8	45	110	55	110	6.06	TC1	45	90	45	90	6.72	OC1	50	100	50	100	6.48	0.43	0.23	0.66
		CH34	TC11	55	90	6.47	TC4	45	90	55	110	5.88	TC9	55	90	45	90	6.64	OC1	50	100	50	100	6.41	0.53	0.23	0.75
	Cavium	CH44	TC11	55	90	3.90	TC6	45	110	45	110	3.80	TC10	55	90	45	110	4.02	OC1	50	100	50	100	3.99	0.19	0.03	0.22
		CH45	TC11	55	90	4.20	TC6	45	110	45	110	3.97	TC11	55	90	55	90	4.20	OC1	50	100	50	100	4.13	0.16	0.07	0.23
	Average																								0.39	0.15	0.54
30dB	Cisco	CH8	TC11	55	90	3.84	TC4	45	90	55	110	3.36	TC10	55	90	45	110	4.19	OC1	50	100	50	100	3.94	0.58	0.25	0.83
	TE	CH43	TC11	55	90	2.21	TC8	45	110	55	110	1.88	TC10	55	90	45	110	2.49	OC1	50	100	50	100	2.26	0.37	0.23	0.60
	Intel 100Ω	CH23	TC11	55	90	3.60	TC8	45	110	55	110	3.14	TC9	55	90	45	90	3.88	OC1	50	100	50	100	3.57	0.43	0.31	0.74
		CH24	TC11	55	90	3.30	TC8	45	110	55	110	2.85	TC10	55	90	45	110	3.57	OC1	50	100	50	100	3.38	0.52	0.19	0.72
		CH25	TC11	55	90	3.54	TC8	45	110	55	110	2.82	TC9	55	90	45	90	3.78	OC1	50	100	50	100	3.40	0.58	0.38	0.96
	Intel 85Ω	CH38	TC11	55	90	4.31	TC4	45	90	55	110	3.73	TC9	55	90	45	90	4.50	OC1	50	100	50	100	4.25	0.52	0.24	0.77
		CH39	TC11	55	90	3.89	TC8	45	110	55	110	3.34	TC9	55	90	45	90	4.14	OC1	50	100	50	100	3.89	0.55	0.25	0.80
		CH40	TC11	55	90	4.08	TC4	45	90	55	110	3.32	TC9	55	90	45	90	4.28	OC1	50	100	50	100	3.92	0.59	0.36	0.95
	Cavium	CH46	TC11	55	90	3.90	TC8	45	110	55	110	3.30	TC9	55	90	45	90	4.10	OC1	50	100	50	100	3.77	0.47	0.33	0.80
		CH47	TC11	55	90	3.97	TC8	45	110	55	110	3.39	TC9	55	90	45	90	4.08	OC1	50	100	50	100	3.82	0.43	0.26	0.69
	Average																								0.51	0.28	0.79

Values in red were incorrect in hidaka_3cd_01a_0317 and updated with correct values.

BL/Min/Max/Typ COM for zp=30mm, Zc=100Ω

FUJITSU

Loss	Channel Type	CH #	Baseline COM (zp=30)				Min COM (zp=30)						Max COM (zp=30)						Typ COM (zp=30)						Difference		
			TC #	Tx Rx Rd	Tx Rx Zc	COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Min COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Max COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Typ COM	Typ COM - Min COM	Max COM - Typ COM	Max COM - Min COM
10dB	Cisco	CH1	TC27	55	90	5.71	TC24	45	110	55	110	5.69	TC26	55	90	45	110	6.20	OC2	50	100	50	100	6.09	0.40	0.11	0.51
	TE	CH41	TC27	55	90	6.58	TC32	55	110	55	110	6.51	TC17	45	90	45	90	6.89	OC2	50	100	50	100	6.74	0.23	0.15	0.38
	Intel 100Ω	CH11	TC27	55	90	5.08	TC22	45	110	45	110	4.58	TC17	45	90	45	90	5.55	OC2	50	100	50	100	5.17	0.60	0.38	0.98
		CH12	TC27	55	90	5.13	TC22	45	110	45	110	4.88	TC17	45	90	45	90	5.79	OC2	50	100	50	100	5.55	0.66	0.24	0.90
		CH13	TC27	55	90	4.28	TC22	45	110	45	110	3.88	TC17	45	90	45	90	4.88	OC2	50	100	50	100	4.47	0.60	0.40	1.00
	Intel 85Ω	CH26	TC27	55	90	7.14	TC22	45	110	45	110	6.45	TC17	45	90	45	90	7.50	OC2	50	100	50	100	7.15	0.70	0.35	1.05
		CH27	TC27	55	90	6.41	TC22	45	110	45	110	5.89	TC17	45	90	45	90	7.01	OC2	50	100	50	100	6.65	0.75	0.36	1.11
		CH28	TC27	55	90	6.41	TC30	55	110	45	110	5.70	TC17	45	90	45	90	7.06	OC2	50	100	50	100	6.59	0.89	0.47	1.36
	Average																								0.60	0.31	0.91
20dB	Cisco	CH4	TC27	55	90	5.43	TC24	45	110	55	110	5.27	TC26	55	90	45	110	5.83	OC2	50	100	50	100	5.66	0.39	0.17	0.56
	TE	CH42	TC27	55	90	4.60	TC24	45	110	55	110	4.54	TC25	55	90	45	90	4.88	OC2	50	100	50	100	4.78	0.24	0.11	0.34
	Intel 100Ω	CH17	TC27	55	90	5.78	TC22	45	110	45	110	5.22	TC17	45	90	45	90	6.06	OC2	50	100	50	100	5.82	0.60	0.23	0.83
		CH18	TC27	55	90	5.18	TC24	45	110	55	110	4.88	TC17	45	90	45	90	5.63	OC2	50	100	50	100	5.39	0.51	0.24	0.75
		CH19	TC27	55	90	5.24	TC22	45	110	45	110	4.45	TC17	45	90	45	90	5.40	OC2	50	100	50	100	5.18	0.73	0.22	0.95
	Intel 85Ω	CH32	TC27	55	90	6.68	TC24	45	110	55	110	6.09	TC25	55	90	45	90	6.81	OC2	50	100	50	100	6.65	0.56	0.16	0.72
		CH33	TC27	55	90	6.14	TC24	45	110	55	110	5.61	TC17	45	90	45	90	6.39	OC2	50	100	50	100	6.16	0.55	0.22	0.77
		CH34	TC27	55	90	6.04	TC22	45	110	45	110	5.32	TC25	55	90	45	90	6.18	OC2	50	100	50	100	5.93	0.61	0.24	0.86
	Cavium	CH44	TC27	55	90	3.13	TC19	45	90	55	90	3.12	TC30	55	110	45	110	3.49	OC2	50	100	50	100	3.39	0.27	0.10	0.37
		CH45	TC27	55	90	3.32	TC19	45	90	55	90	3.24	TC30	55	110	45	110	3.58	OC2	50	100	50	100	3.52	0.28	0.07	0.35
	Average																								0.47	0.18	0.65
30dB	Cisco	CH8	TC27	55	90	3.01	TC20	45	90	55	110	2.46	TC26	55	90	45	110	3.39	OC2	50	100	50	100	3.06	0.60	0.33	0.92
	TE	CH43	TC27	55	90	1.33	TC19	45	90	55	90	0.98	TC26	55	90	45	110	1.67	OC2	50	100	50	100	1.37	0.39	0.30	0.69
	Intel 100Ω	CH23	TC27	55	90	2.73	TC24	45	110	55	110	2.01	TC25	55	90	45	90	3.00	OC2	50	100	50	100	2.65	0.64	0.35	0.98
		CH24	TC27	55	90	2.45	TC24	45	110	55	110	1.92	TC25	55	90	45	90	2.75	OC2	50	100	50	100	2.48	0.56	0.27	0.83
		CH25	TC27	55	90	2.59	TC24	45	110	55	110	1.68	TC25	55	90	45	90	2.81	OC2	50	100	50	100	2.41	0.73	0.40	1.12
	Intel 85Ω	CH38	TC27	55	90	3.41	TC24	45	110	55	110	2.70	TC25	55	90	45	90	3.62	OC2	50	100	50	100	3.34	0.64	0.29	0.92
		CH39	TC27	55	90	3.00	TC24	45	110	55	110	2.42	TC25	55	90	45	90	3.34	OC2	50	100	50	100	3.00	0.58	0.34	0.92
		CH40	TC27	55	90	3.22	TC24	45	110	55	110	2.37	TC25	55	90	45	90	3.47	OC2	50	100	50	100	3.07	0.70	0.39	1.09
	Cavium	CH46	TC27	55	90	3.02	TC20	45	90	55	110	2.63	TC26	55	90	45	110	3.44	OC2	50	100	50	100	3.16	0.53	0.28	0.81
		CH47	TC27	55	90	3.01	TC20	45	90	55	110	2.60	TC26	55	90	45	110	3.40	OC2	50	100	50	100	3.14	0.53	0.27	0.80
	Average																								0.59	0.32	0.91

Values in red were incorrect in hidaka_3cd_01a_0317 and updated with correct values.

BL/Min/Max/Typ COM for zp=12mm, Zc=93Ω

FUJITSU

Loss	Channel Type	CH #	Baseline COM (zp=12)				Min COM (zp=12)						Max COM (zp=12)						Typ COM (zp=12)						Difference		
			TC #	Tx Rx Rd	Tx Rx Zc	COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Min COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Max COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Typ COM	Typ COM - Min COM	Max COM - Typ COM	Max COM - Min COM
10dB	Cisco	CH1	TC11	55	83.7	4.84	TC11	55	83.7	55	83.7	4.84	TC14	55	102.3	45	102.3	5.92	OC1	50	93	50	93	5.73	0.89	0.18	1.08
	TE	CH41	TC11	55	83.7	6.46	TC11	55	83.7	55	83.7	6.46	TC2	45	83.7	45	102.3	7.24	OC1	50	93	50	93	7.19	0.73	0.05	0.78
	Intel 100Ω	CH11	TC11	55	83.7	4.83	TC11	55	83.7	55	83.7	4.83	TC1	45	83.7	45	83.7	5.51	OC1	50	93	50	93	5.32	0.49	0.19	0.68
		CH12	TC11	55	83.7	4.65	TC11	55	83.7	55	83.7	4.65	TC2	45	83.7	45	102.3	5.78	OC1	50	93	50	93	5.59	0.94	0.19	1.12
		CH13	TC11	55	83.7	3.93	TC11	55	83.7	55	83.7	3.93	TC1	45	83.7	45	83.7	4.68	OC1	50	93	50	93	4.53	0.61	0.15	0.75
	Intel 85Ω	CH26	TC11	55	83.7	7.23	TC6	45	102.3	45	102.3	6.94	TC1	45	83.7	45	83.7	7.68	OC1	50	93	50	93	7.51	0.57	0.18	0.75
		CH27	TC11	55	83.7	6.11	TC11	55	83.7	55	83.7	6.11	TC1	45	83.7	45	83.7	6.94	OC1	50	93	50	93	6.83	0.72	0.11	0.82
		CH28	TC11	55	83.7	6.14	TC14	55	102.3	45	102.3	5.97	TC1	45	83.7	45	83.7	6.94	OC1	50	93	50	93	6.64	0.66	0.31	0.97
	Average																								0.70	0.17	0.87
20dB	Cisco	CH4	TC11	55	83.7	5.19	TC11	55	83.7	55	83.7	5.19	TC14	55	102.3	45	102.3	6.00	OC1	50	93	50	93	5.83	0.65	0.16	0.81
	TE	CH42	TC11	55	83.7	5.02	TC11	55	83.7	55	83.7	5.02	TC2	45	83.7	45	102.3	5.55	OC1	50	93	50	93	5.46	0.44	0.09	0.53
	Intel 100Ω	CH17	TC11	55	83.7	5.97	TC11	55	83.7	55	83.7	5.97	TC1	45	83.7	45	83.7	6.40	OC1	50	93	50	93	6.27	0.30	0.13	0.43
		CH18	TC11	55	83.7	5.36	TC11	55	83.7	55	83.7	5.36	TC1	45	83.7	45	83.7	5.95	OC1	50	93	50	93	5.76	0.39	0.19	0.58
		CH19	TC11	55	83.7	5.67	TC4	45	83.7	55	102.3	5.53	TC13	55	102.3	45	83.7	6.10	OC1	50	93	50	93	5.99	0.46	0.11	0.56
	Intel 85Ω	CH32	TC11	55	83.7	6.94	TC4	45	83.7	55	102.3	6.76	TC1	45	83.7	45	83.7	7.25	OC1	50	93	50	93	7.14	0.38	0.11	0.49
		CH33	TC11	55	83.7	6.33	TC15	55	102.3	55	83.7	6.21	TC1	45	83.7	45	83.7	6.78	OC1	50	93	50	93	6.59	0.38	0.19	0.57
		CH34	TC11	55	83.7	6.32	TC4	45	83.7	55	102.3	5.96	TC1	45	83.7	45	83.7	6.69	OC1	50	93	50	93	6.57	0.61	0.13	0.73
	Cavium	CH44	TC11	55	83.7	3.71	TC11	55	83.7	55	83.7	3.71	TC14	55	102.3	45	102.3	4.02	OC1	50	93	50	93	3.99	0.28	0.03	0.32
		CH45	TC11	55	83.7	4.05	TC4	45	83.7	55	102.3	3.97	TC15	55	102.3	55	83.7	4.17	OC1	50	93	50	93	4.12	0.16	0.05	0.21
	Average																								0.41	0.12	0.52
30dB	Cisco	CH8	TC11	55	83.7	3.58	TC3	45	83.7	55	83.7	3.36	TC14	55	102.3	45	102.3	4.24	OC1	50	93	50	93	3.92	0.55	0.32	0.87
	TE	CH43	TC11	55	83.7	2.08	TC3	45	83.7	55	83.7	1.84	TC10	55	83.7	45	102.3	2.45	OC1	50	93	50	93	2.24	0.40	0.22	0.61
	Intel 100Ω	CH23	TC11	55	83.7	3.50	TC8	45	102.3	55	102.3	3.24	TC10	55	83.7	45	102.3	3.86	OC1	50	93	50	93	3.66	0.43	0.20	0.63
		CH24	TC11	55	83.7	3.14	TC8	45	102.3	55	102.3	3.01	TC10	55	83.7	45	102.3	3.57	OC1	50	93	50	93	3.38	0.36	0.19	0.56
		CH25	TC11	55	83.7	3.50	TC4	45	83.7	55	102.3	3.02	TC9	55	83.7	45	83.7	3.78	OC1	50	93	50	93	3.52	0.49	0.26	0.76
	Intel 85Ω	CH38	TC11	55	83.7	4.24	TC4	45	83.7	55	102.3	3.80	TC9	55	83.7	45	83.7	4.50	OC1	50	93	50	93	4.32	0.53	0.17	0.70
		CH39	TC11	55	83.7	3.84	TC4	45	83.7	55	102.3	3.52	TC10	55	83.7	45	102.3	4.19	OC1	50	93	50	93	3.97	0.45	0.22	0.68
		CH40	TC11	55	83.7	4.03	TC4	45	83.7	55	102.3	3.39	TC9	55	83.7	45	83.7	4.29	OC1	50	93	50	93	4.04	0.65	0.25	0.91
	Cavium	CH46	TC11	55	83.7	3.77	TC8	45	102.3	55	102.3	3.43	TC10	55	83.7	45	102.3	4.10	OC1	50	93	50	93	3.89	0.46	0.21	0.67
		CH47	TC11	55	83.7	3.96	TC8	45	102.3	55	102.3	3.44	TC9	55	83.7	45	83.7	4.10	OC1	50	93	50	93	3.86	0.42	0.23	0.66
	Average																								0.48	0.23	0.70

BL/Min/Max/Typ COM for zp=30mm, Zc=93Ω

FUJITSU

Loss	Channel Type	CH #	Baseline COM (zp=30)				Min COM (zp=30)						Max COM (zp=30)						Typ COM (zp=30)						Difference		
			TC #	Tx Rx Rd	Tx Rx Zc	COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Min COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Max COM	TC #	Tx Rd	Tx Zc	Rx Rd	Rx Zc	Typ COM	Typ COM - Min COM	Max COM - Typ COM	Max COM - Min COM
10dB	Cisco	CH1	TC27	55	83.7	5.28	TC27	55	83.7	55	83.7	5.28	TC29	55	102.3	45	83.7	6.21	OC2	50	93	50	93	6.09	0.82	0.12	0.93
	TE	CH41	TC27	55	83.7	6.28	TC27	55	83.7	55	83.7	6.28	TC18	45	83.7	45	102.3	6.86	OC2	50	93	50	93	6.79	0.51	0.07	0.58
	Intel 100Ω	CH11	TC27	55	83.7	4.82	TC27	55	83.7	55	83.7	4.82	TC17	45	83.7	45	83.7	5.55	OC2	50	93	50	93	5.35	0.53	0.20	0.73
		CH12	TC27	55	83.7	4.70	TC27	55	83.7	55	83.7	4.70	TC18	45	83.7	45	102.3	5.76	OC2	50	93	50	93	5.61	0.91	0.15	1.06
		CH13	TC27	55	83.7	3.98	TC27	55	83.7	55	83.7	3.98	TC17	45	83.7	45	83.7	4.88	OC2	50	93	50	93	4.68	0.70	0.20	0.90
	Intel 85Ω	CH26	TC27	55	83.7	7.02	TC29	55	102.3	45	83.7	6.89	TC17	45	83.7	45	83.7	7.52	OC2	50	93	50	93	7.33	0.44	0.19	0.63
		CH27	TC27	55	83.7	6.14	TC27	55	83.7	55	83.7	6.14	TC17	45	83.7	45	83.7	6.93	OC2	50	93	50	93	6.76	0.63	0.16	0.79
		CH28	TC27	55	83.7	6.19	TC31	55	102.3	55	83.7	6.18	TC17	45	83.7	45	83.7	7.07	OC2	50	93	50	93	6.79	0.60	0.29	0.89
	Average																								0.64	0.17	0.81
20dB	Cisco	CH4	TC27	55	83.7	5.15	TC27	55	83.7	55	83.7	5.15	TC30	55	102.3	45	102.3	5.78	OC2	50	93	50	93	5.58	0.43	0.20	0.63
	TE	CH42	TC27	55	83.7	4.52	TC27	55	83.7	55	83.7	4.52	TC18	45	83.7	45	102.3	4.90	OC2	50	93	50	93	4.72	0.19	0.18	0.37
	Intel 100Ω	CH17	TC27	55	83.7	5.62	TC22	45	102.3	45	102.3	5.55	TC17	45	83.7	45	83.7	6.05	OC2	50	93	50	93	5.93	0.39	0.11	0.50
		CH18	TC27	55	83.7	4.97	TC27	55	83.7	55	83.7	4.97	TC17	45	83.7	45	83.7	5.60	OC2	50	93	50	93	5.43	0.46	0.16	0.62
		CH19	TC27	55	83.7	5.05	TC22	45	102.3	45	102.3	4.82	TC17	45	83.7	45	83.7	5.55	OC2	50	93	50	93	5.43	0.61	0.11	0.73
	Intel 85Ω	CH32	TC27	55	83.7	6.61	TC20	45	83.7	55	102.3	6.25	TC17	45	83.7	45	83.7	6.83	OC2	50	93	50	93	6.76	0.51	0.07	0.58
		CH33	TC27	55	83.7	6.06	TC20	45	83.7	55	102.3	5.88	TC17	45	83.7	45	83.7	6.45	OC2	50	93	50	93	6.25	0.37	0.20	0.57
		CH34	TC27	55	83.7	5.78	TC20	45	83.7	55	102.3	5.56	TC17	45	83.7	45	83.7	6.20	OC2	50	93	50	93	6.16	0.60	0.04	0.63
	Cavium	CH44	TC27	55	83.7	2.97	TC27	55	83.7	55	83.7	2.97	TC30	55	102.3	45	102.3	3.43	OC2	50	93	50	93	3.28	0.30	0.15	0.46
		CH45	TC27	55	83.7	3.23	TC19	45	83.7	55	83.7	3.12	TC30	55	102.3	45	102.3	3.56	OC2	50	93	50	93	3.36	0.24	0.20	0.43
	Average																								0.41	0.14	0.55
30dB	Cisco	CH8	TC27	55	83.7	2.84	TC19	45	83.7	55	83.7	2.45	TC30	55	102.3	45	102.3	3.45	OC2	50	93	50	93	3.00	0.55	0.45	1.00
	TE	CH43	TC27	55	83.7	1.26	TC19	45	83.7	55	83.7	0.94	TC26	55	83.7	45	102.3	1.68	OC2	50	93	50	93	1.39	0.45	0.29	0.74
	Intel 100Ω	CH23	TC27	55	83.7	2.70	TC24	45	102.3	55	102.3	2.24	TC26	55	83.7	45	102.3	2.97	OC2	50	93	50	93	2.72	0.49	0.25	0.74
		CH24	TC27	55	83.7	2.32	TC19	45	83.7	55	83.7	2.10	TC26	55	83.7	45	102.3	2.81	OC2	50	93	50	93	2.56	0.45	0.25	0.70
		CH25	TC27	55	83.7	2.51	TC24	45	102.3	55	102.3	1.99	TC25	55	83.7	45	83.7	2.79	OC2	50	93	50	93	2.55	0.55	0.25	0.80
	Intel 85Ω	CH38	TC27	55	83.7	3.39	TC20	45	83.7	55	102.3	2.79	TC25	55	83.7	45	83.7	3.66	OC2	50	93	50	93	3.36	0.57	0.30	0.87
		CH39	TC27	55	83.7	2.94	TC20	45	83.7	55	102.3	2.56	TC26	55	83.7	45	102.3	3.32	OC2	50	93	50	93	3.06	0.50	0.26	0.77
		CH40	TC27	55	83.7	3.09	TC20	45	83.7	55	102.3	2.51	TC25	55	83.7	45	83.7	3.39	OC2	50	93	50	93	3.16	0.65	0.23	0.88
	Cavium	CH46	TC27	55	83.7	2.83	TC19	45	83.7	55	83.7	2.50	TC26	55	83.7	45	102.3	3.48	OC2	50	93	50	93	3.15	0.65	0.33	0.98
		CH47	TC27	55	83.7	2.91	TC19	45	83.7	55	83.7	2.49	TC30	55	102.3	45	102.3	3.43	OC2	50	93	50	93	3.07	0.59	0.35	0.94
	Average																								0.54	0.30	0.84

Values in red were incorrect in hidaka_3cd_01a_0317 and updated with correct values.

COM Parameters for typ Zc = 100Ω

FUJITSU

Condition #			TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10	TC11	TC12	TC13	TC14	TC15	TC16	OC1
zp	Tx	Victim	12																
		FEXT	12																
		NEXT	12																
	Rx		12																
Rd	Tx (Victim, XT)		45								55								50
	Rx		45		55		45		55		45		55		45		55		50
Zc	Tx (Victim, XT)		90				110				90				110				100
	Rx		90	110	90	110	90	110	90	110	90	110	90	110	90	110	90	110	100
Av			0.394								0.436								0.415
Afe			0.394								0.436								0.415
Ane			0.581								0.642								0.611

TC#			TC17	TC18	TC19	TC20	TC21	TC22	TC23	TC24	TC25	TC26	TC27	TC28	TC29	TC30	TC31	TC32	OC2
zp	Tx	Victim	30																
		FEXT	30																
		NEXT	12																
	Rx		30																
Rd	Tx (Victim, XT)		45								55								50
	Rx		45		55		45		55		45		55		45		55		50
Zc	Tx (Victim, XT)		90				110				90				110				93
	Rx		90	110	90	110	90	110	90	110	90	110	90	110	90	110	90	110	93
Av			0.394								0.436								0.415
Afe			0.394								0.436								0.415
Ane			0.581								0.642								0.611

COM Parameters for typ Zc = 93Ω

Condition #			TC1	TC2	TC3	TC4	TC5	TC6	TC7	TC8	TC9	TC10	TC11	TC12	TC13	TC14	TC15	TC16	OC1
zp	Tx	Victim	12																
		FEXT	12																
		NEXT	12																
	Rx		12																
Rd	Tx (Victim, XT)		45								55								50
	Rx		45		55		45		55		45		55		45		55		50
Zc	Tx (Victim, XT)		83.7				102.3				83.7				102.3				93
	Rx		83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	93
Av			0.394								0.436								0.415
Afe			0.394								0.436								0.415
Ane			0.581								0.642								0.611

TC#			TC17	TC18	TC19	TC20	TC21	TC22	TC23	TC24	TC25	TC26	TC27	TC28	TC29	TC30	TC31	TC32	OC2
zp	Tx	Victim	30																
		FEXT	30																
		NEXT	12																
	Rx		30																
Rd	Tx (Victim, XT)		45								55								50
	Rx		45		55		45		55		45		55		45		55		50
Zc	Tx (Victim, XT)		83.7				102.3				83.7				102.3				93
	Rx		83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	83.7	102.3	93
Av			0.394								0.436								0.415
Afe			0.394								0.436								0.415
Ane			0.581								0.642								0.611

The Other COM Parameters

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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 45]	Ohm	tdr selected
f_r	0.75	*fb	
c(0)	0.6		min
c(-1)	[-0.25:0.05:0]		[min:step:max]
c(-2)	[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	1.00E+99	GHz	
A_v	[0.39357 0.436]	V	tdr selected
A_fe	[0.39357 0.436]	V	tdr selected
A_ne	[0.5754 0.636]	V	tdr selected
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	tdr selected
R_LM	0.95		
DER_0	1.00E-04		
Operational control			
COM Pass threshold	3	dB	
Include PCB	0	Value	0, 1, 2
g_DC_HP	[-6:1:0]		[min:step:max]
f_HP_PZ	0.6640625	GHz	

I/O control		
DIAGNOSTICS	0	logical
DISPLAY_WINDOW	0	logical
Display frequency domain	1	logical
CSV_REPORT	1	logical
RESULT_DIR	.\results\V165_{date}\	
SAVE_FIGURES	0	logical
Port Order	[1 3 2 4]	
RUNTAG	v165_d1p0a	
Receiver testing		
RX_CALIBRATION	0	logical
Sigma BBN step	5.00E-03	V
IDEAL_TX_TERM	0	logical
T_r	1.20E-02	ns
FORCE_TR	1	logical
Non standard control options		
COM_CONTRIBUTION	0	logical
New 'cd exploratory		
TDR	1	logical
WC_PORTZ	0	logical
T_k	0.6	ns

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	[83.7 102.3]	Ohm (tdr sel)
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

Channel Data Source

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- Cisco Channels (CH1, CH4, CH8)
  - http://www.ieee802.org/3/cd/public/channel/Cisco_Backplane_channel_data.zip
  - CH1 (10.8dB), CH4 (20.9dB), CH8 (30.1dB)
  - 5 FEXT + 3 NEXT
- TE Channels (CH41, CH42, CH43)
  - http://www.ieee802.org/3/cd/public/channel/TEC_STRADAWhisper*.zip
  - CH41 (10.5dB), CH42 (21.8dB), CH43 (32.0dB)
  - 4 FEXT (F11F12,F17F18,H11H12,H17H18)
  - 4 NEXT (F14F15,G11G12,G17G18,H14H15)
- Intel 100Ω Channels (CH11-13, CH17-19, CH23-25)
  Intel 85Ω Channels (CH26-28, CH32-34, CH38-40)
  - http://www.ieee802.org/3/50G/public/channel/mellitz_01_021716_??dB_6_channels.zip
  - CH11-13/26-28(10dB), CH17-19/32-34(20dB), CH23-25/38-40(30dB)
  - CH11/17/23/26/32/38 (Nom), CH12/18/24/27/33/39 (HzLzHz), CH13/19/25/28/34/40 (LzHzLz)
  - 3 FEXT + 4 NEXT
- Cavium Channels (CH44-47)
  - http://www.ieee802.org/3/cd/public/channel/Cavium_??dB_H*.zip
  - CH44-45 (20dB), CH46-47 (30dB)
  - CH44/46 (HighZ), CH45/47 (HighZ_Nom_HighZ)
  - 3 FEX + 4 NEXT

Thank you