Modification to the calculation of COM for an MLSD reference receiver

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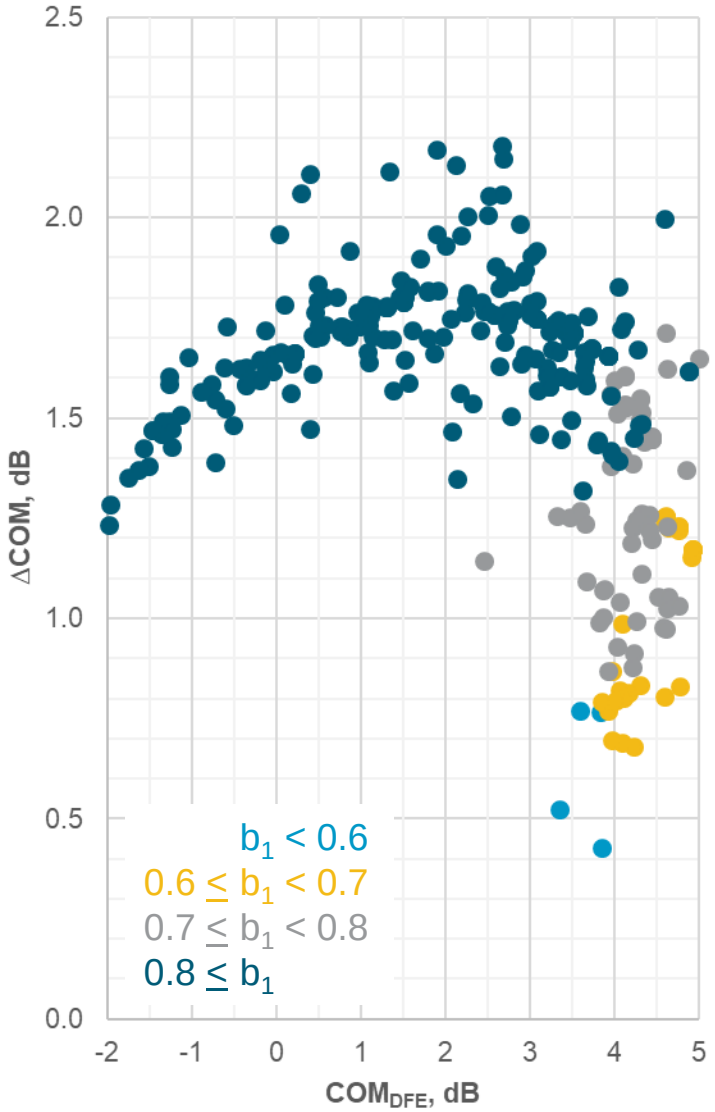
Problem statement

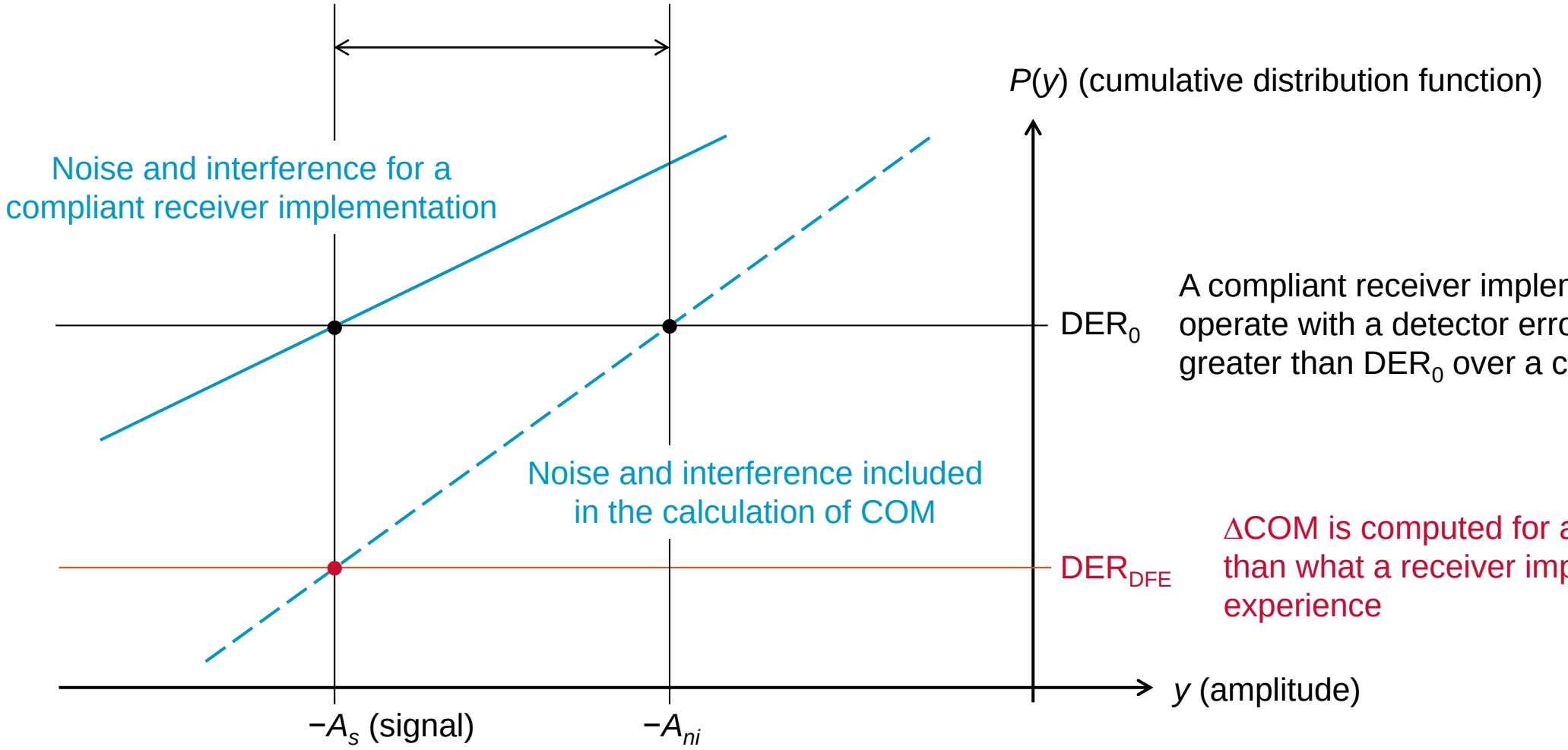


- Let COM_{DFE} be the channel operating margin for a reference receiver with decision feedback equalization (DFE)
- Let ΔCOM be the difference between COM for a reference receiver with maximum likelihood sequence detection (MLSD) and COM_{DFE}
- ΔCOM is related to COM_{DFE}
- However, the receiver impairment model used to compute COM_{DFE} is incomplete
- As a result, ΔCOM may be larger than what an actual implementation would experience

NOTE — The MLSD channel model is $1+b_1D$, where D is a 1 unit interval delay.

Relationship between channel and receiver requirements

A compliant channel must provide a minimum COM = 20 $\log_{10}(A_s / A_{ni}) \geq \text{COM}_{min}$ at DER_0



A compliant receiver implementation must operate with a detector error ratio (DER) no greater than DER_0 over a compliant channel

ΔCOM is computed for a lower DER value than what a receiver implementation might experience

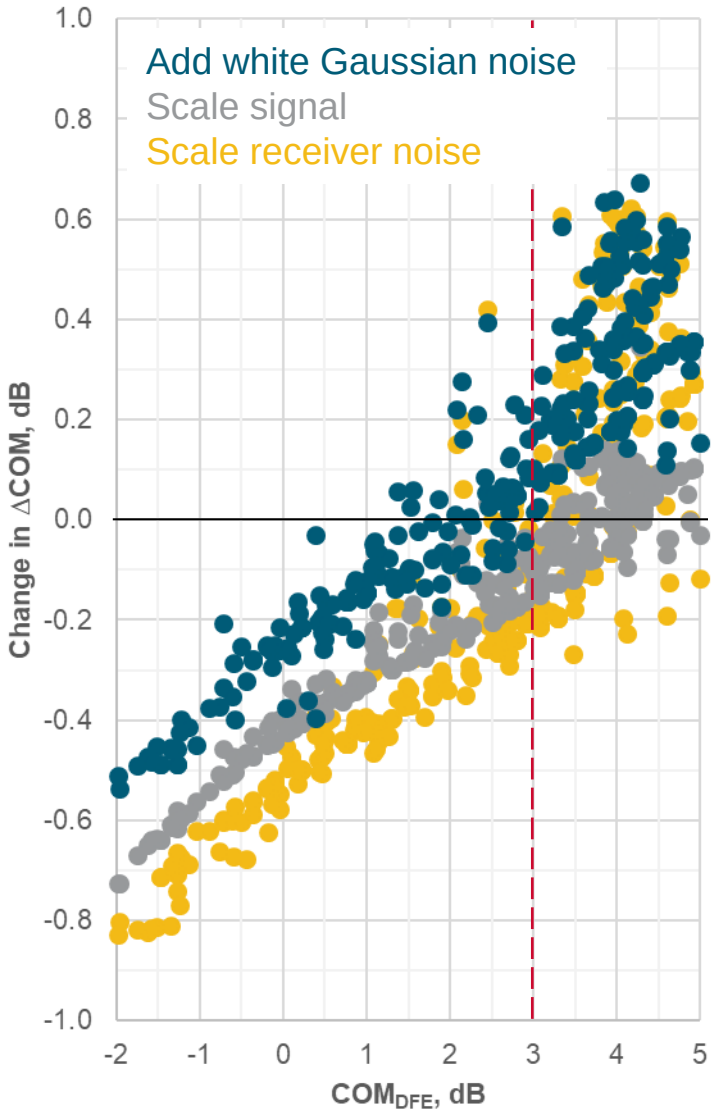
Some possible modifications to the ΔCOM calculation

- Different ways to approximate the impact of receiver impairments are considered

Label	Description
Add white Gaussian noise	• Add a constant to the receiver noise power spectral density $S_{rn}(\theta)$ • Increase the value of the constant until COM_{DFE} is reduced by COM_{min}
Scale signal	• Scale (reduce) A_s by the factor $10^{(-COM_{min}/20)}$ • No change to the noise and interference amplitude distribution or power spectral density
Scale receiver noise	• Scale (increase) $S_{rn}(\theta)$ by a constant factor • Increase the value of the constant until COM_{DFE} is reduced by COM_{min}

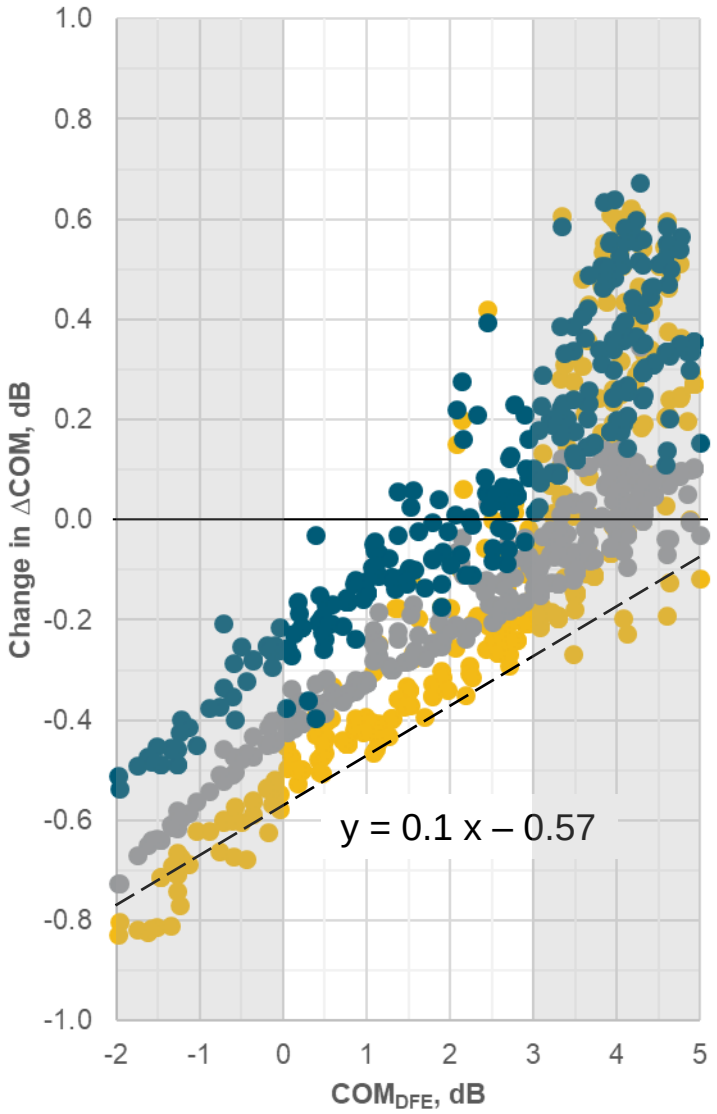
- Different approaches result in different distributions and coloring of the total noise and residual inter-symbol interference
- Changes are applied after optimization of variable parameters

Impact of the impairment allowance on ΔCOM



- COM_{min} = 3 dB
- For COM < COM_{min}, including the impairment allowance generally reduces ΔCOM
- Reduction in ΔCOM increases with decreasing COM_{DFE}
- The change in ΔCOM is also influenced by the distribution and coloring of the total noise and residual inter-symbol interference
- The “scale receiver noise” approach provides more conservative results

Another approach



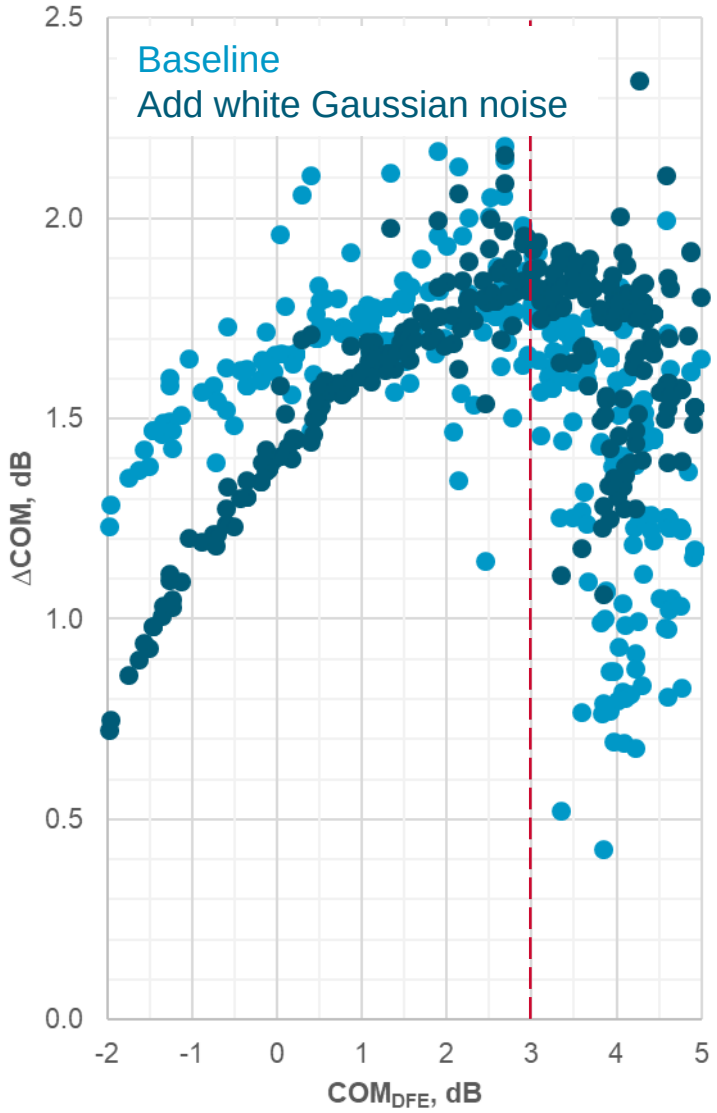
- The nature of the impairments that consume the allowance is implementation-specific and unspecified
- The amplitude distribution and power spectral density of these impairments are not known
- A simpler, conservative, bound could be used to abstract these implementation details
- The MLSD implementation allowance *Q* could be made a function of COM_{DFE}
- E.g., $Q(COM_{DFE}) = 0.57 - 0.1\,COM_{DFE}$

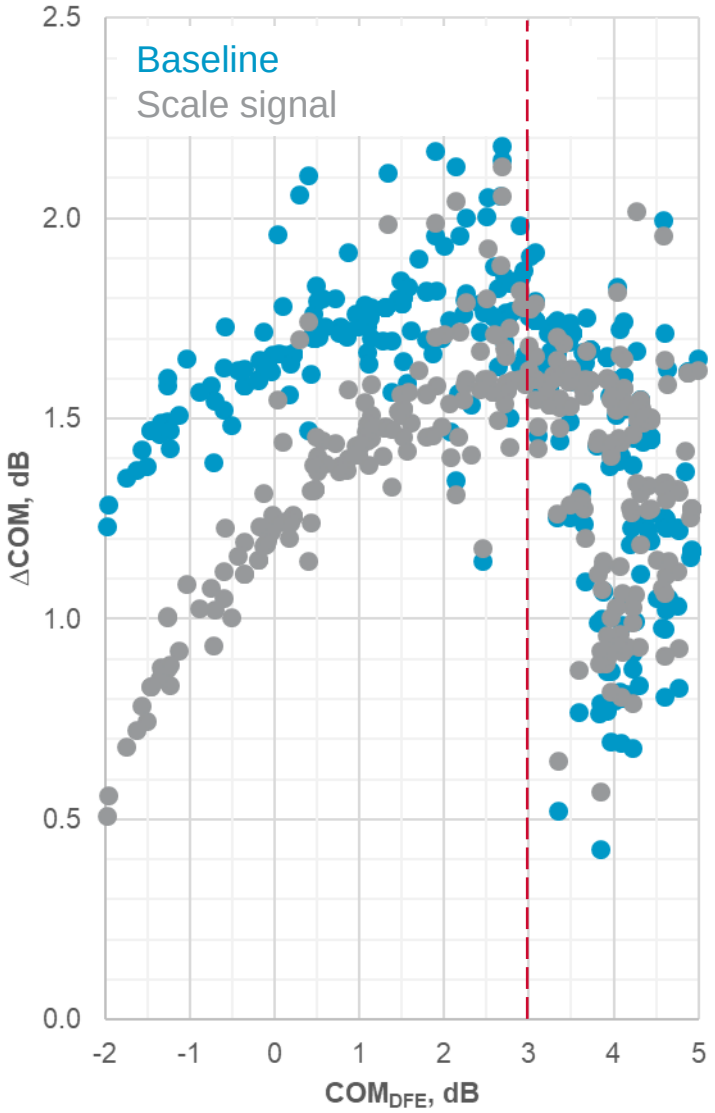
Summary and conclusions

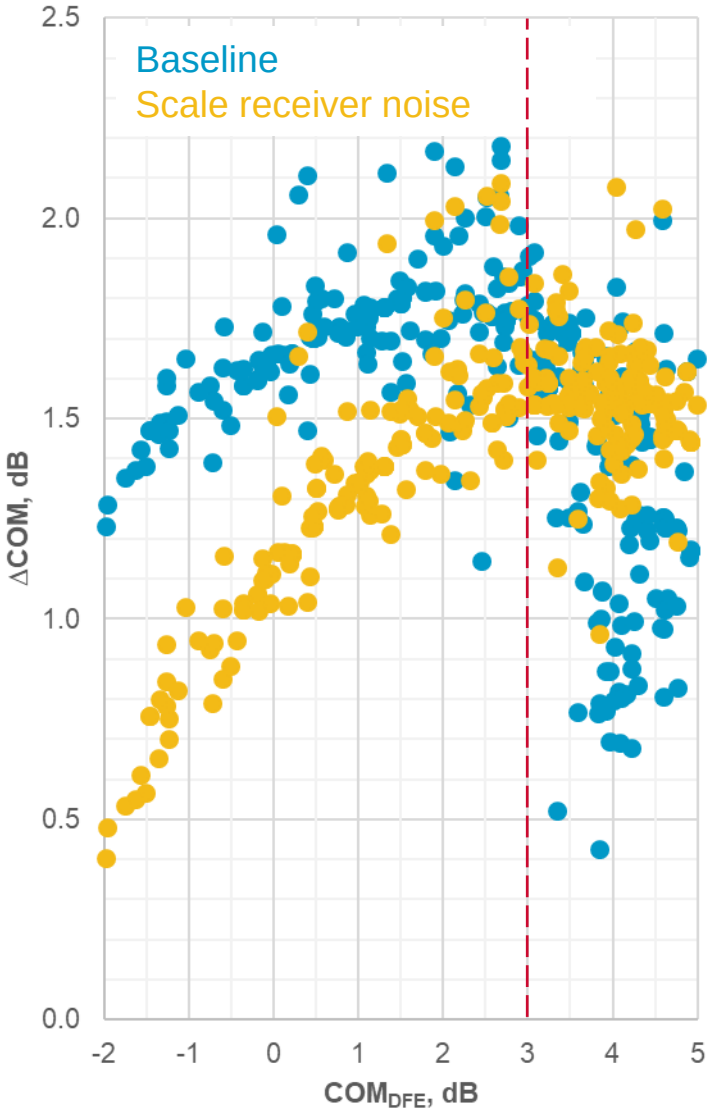
- Definition of ΔCOM for the MLSD reference receiver is optimistic relative to a receiver implementation
- This is because the calculation is based on a noise distribution and power spectral density that does not include all receiver impairments
- COM_{min} provides an allowance for these additional impairments
- Propose to include a proxy for the impairments allowed via COM_{min} in the calculation of ΔCOM
- Recommend that receiver noise be scaled (after variable parameters have been optimized) to represent the additional impairments or define a MLSD implementation allowance *Q* that is a function of COM_{DFE}
- If “pre-screening” is done (compute ΔCOM only for DER_{DFE} no greater than a given value), DER_{DFE} should include the additional impairment allowance

Back-up

ΔCOM for each of the different calculation methods







Test case definition (133 x 3 = 399 test cases)

KR channel source files	Number of cases
shanbhag_3dj_02_2305	4
weaver_3dj_02_2305	36
weaver_3dj_elec_01_230622	4
mellitz_3dj_02_elec_230504	27
mellitz_3dj_03_elec_230504	25
akinwale_3dj_01_2310	7
Total	103

CR channel source files	Number of cases
shanbhag_3dj_01_2305	6
kocsis_3dj_02_2305	5
lim_3dj_03_230629	1
lim_3dj_04_230629	1
lim_3dj_07_2309	1
akinwale_3dj_02_2311	4
weaver_3dj_02_2311	12
Total	30

Parameter	Model A1	Model A2	Model B	Units	Information
package_tl_gamma0_a1_a2	[5e−4, 8.9e−4, 2e−4]		[5e−4, 6.5e−4, 2.93e−4]	var.	
package_tl_tau	6.141e−3		6.141e−3	ns/mm	
package_Z_c	[87.5, 87.5; 92.5, 92.5]		[87.5, 87.5; 95, 95; 100, 100; 78, 78]	Ohm	[TX, RX]
z_p (TX)	[12; 1.8]	[33; 1.8]	[45; 2; 1.3; 1.5]	mm	
z_p (NEXT)	[12; 1.8]	[33; 1.8]	[45; 2; 1.3; 1.5]	mm	
z_p (FEXT)	[12; 1.8]	[33; 1.8]	[45; 2; 1.3; 1.5]	mm	
z_p (RX)	[12; 1.8]	[33; 1.8]	[44; 2; 1.3; 1.5]	mm	
C_p	[40e−6, 40e−6]			nF	[TX, RX]