Considerations for MTF Specification Comments against D2P0

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Joint Ad-hoc 250605

Supporters

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ERL Computation Modifications (to COM v4.9)

COM v4.9*

Call **get_TDR()**

Step 1. **Renormalized** Return Loss= RL_Z(f)

Step 2. **Filtered** Renormalized Return Loss= RL_Z_f(f)

-Apply low-pass Butterworth and Bessel Thompson filer.

Step 3. Call **s21_to_impulse_DC()**

A. **Interpolate and Extrapolate** the
Filtered Renormalized Return Loss=RL_Z_f_intp_extr(f)

B. **IFFT: f-domain to t-domain**= RL_Z_f_intp_extr(t)

***Tested with COM v4.8**

kocsis_01b_2505

Call **get_TDR()**

Step 1. **Renormalized** Return Loss= RL_Z(f)

Step 2. Call **s21_to_impulse_DC()**

A. **Interpolate and Extrapolate** the
Filtered Renormalized Return Loss= RL_Z_intp_extr(f)

B. **Filtered** Renormalized Interpolated & Extrapolated
Return Loss= RL_Z_intp_extr_f(f)
- Apply low-pass Butterworth and Bessel Thompson filter.

C. **IFFT: f-domain to t-domain**= RL_Z_intp_extr_f(t)

***Tested with COM v4.8**

Proposal

Call **get_TDR()**

Step 1. **Renormalized** Return Loss= RL_Z(f)

Step 2. **Filtered** Renormalized Return Loss= RL_Z_f(f)

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…

For high-frequency Extrapolation,

eps(0): Smallest positive number representable in double precision.

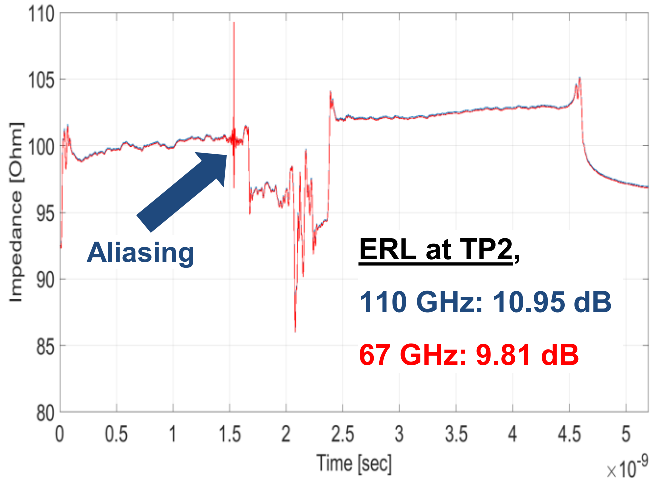
eps(0)= 2^-1024
= 4.9407e-324
= -6.4661e+03 dB

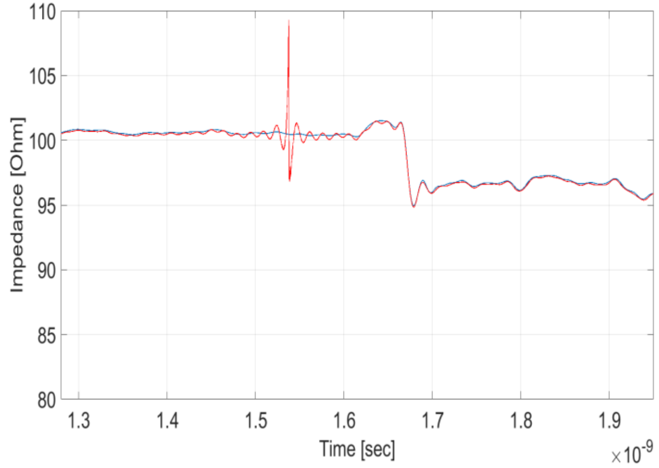
In working COM repository HERE

- Zero-padding based Extrapolation
  - Pros:
    - Reducing aliasing for channels with practical sampling rates for lab measurements
    - No new information added to signal
  - Cons:
    - Increased computation time – observed as insignificant from trials with 3dj posted MTF data
    - Does not actually provide more frequency resolution

Comparison of Methods

COM v4.9*





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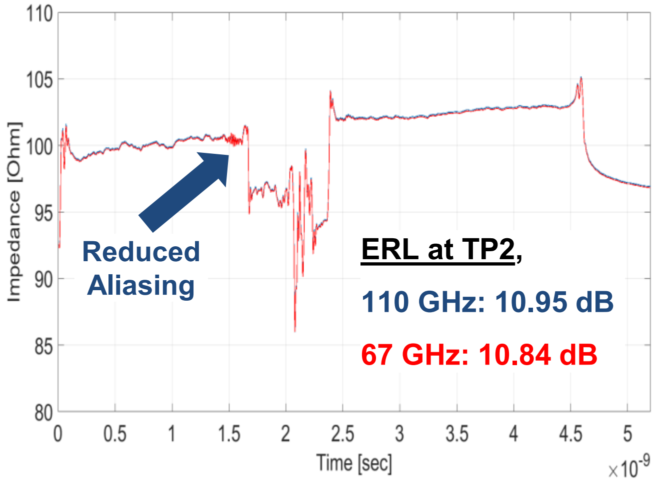
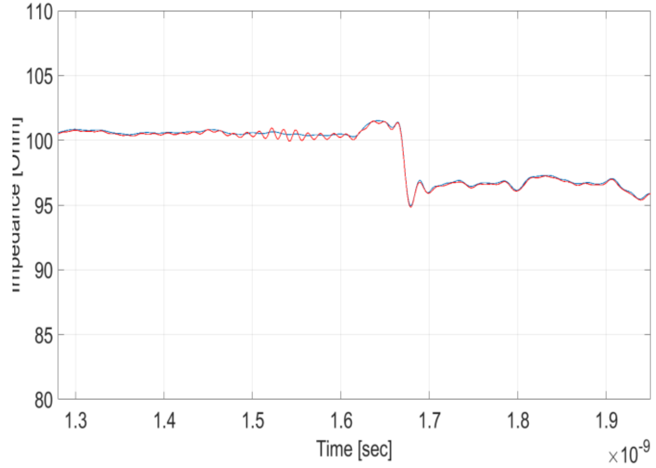
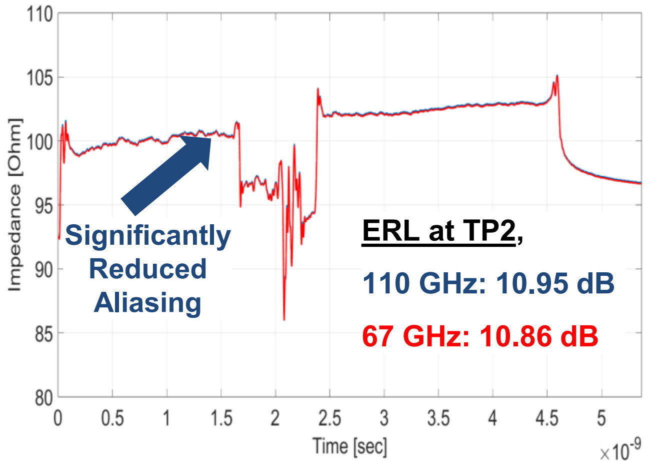
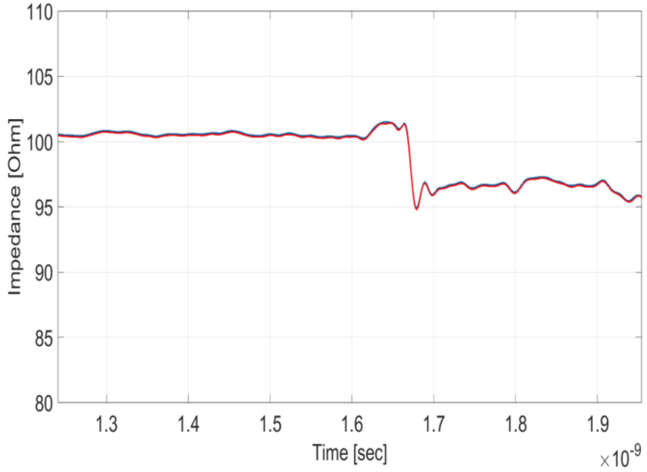




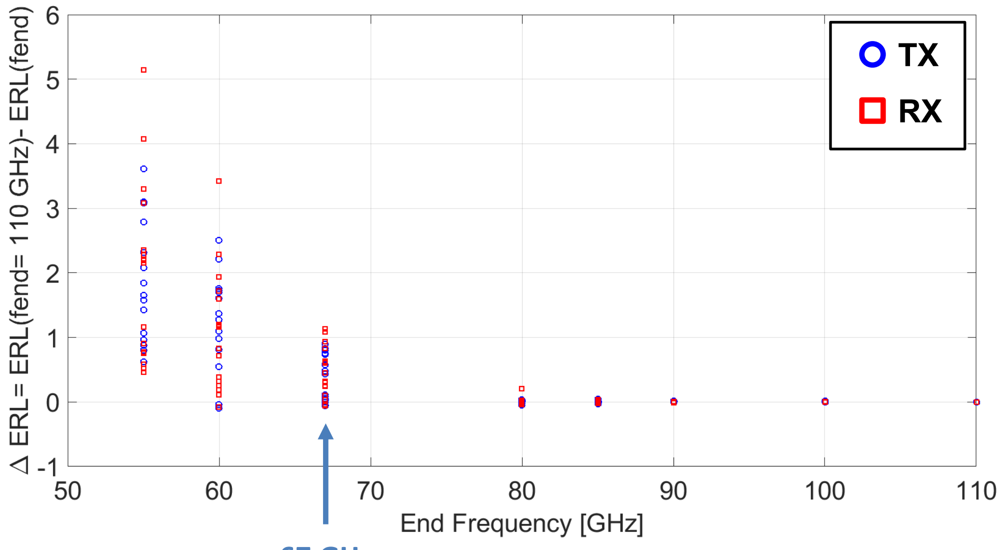
Proposal





Comparison of Measurement Bandwidth

COM v4.9*

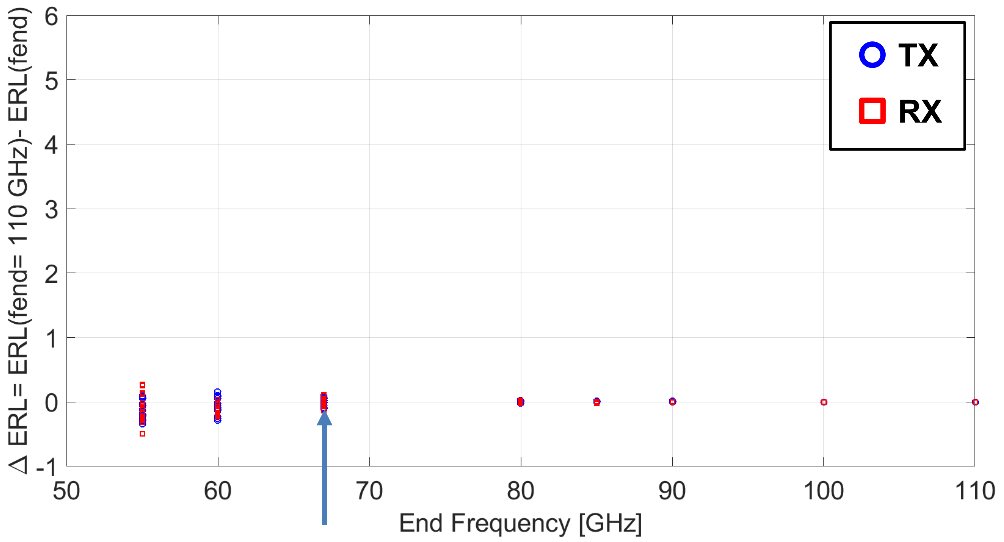


67 GHz

Min: -0.0633

Max: +1.1299

kocsis_01b_2505



67 GHz

Min: -0.1364

Max: +0.1068

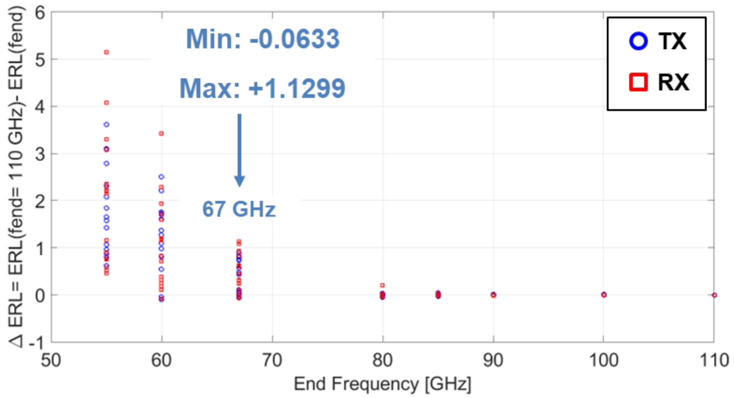
Files used (Total= 32),

1. **OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29449_TX1 to TX8.**
2. **OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29449_RX1 to RX8.**
3. **OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29796_TX1 to TX8.**
4. **OSFP1p6T_Mated_File_HCB-WT29563_MCB-WT29796_RX1 to RX8.**

- Target goal is a small ΔERL (±0.1 dB) between 67 GHz and 110 GHz measurements

Comparison of Measurement Bandwidth

COM v4.9*



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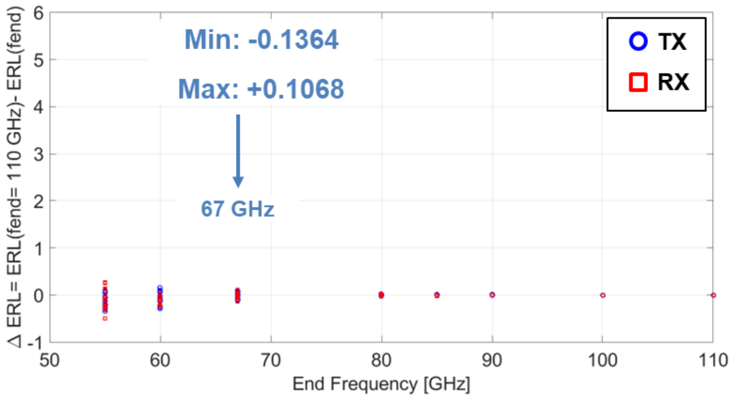
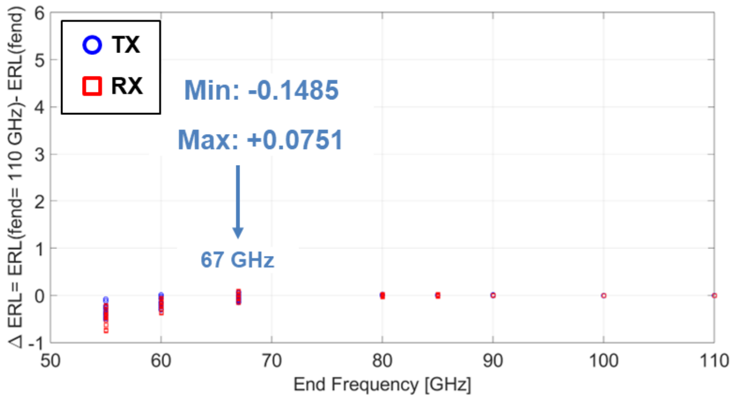


Proposal



- Recommended is the zero-padding based extrapolation for the high frequency
- The change in the COM tool will need to be done in considering both COM and ERL

ERL Reference Impedance

179B.4.2 Mated test fixtures effective return loss (ERL)

The values of the mated test fixtures ERL are computed using the procedure in 93A.5 with the parameter values in Table 179B–1. Parameters that do not appear in Table 179B–1 take values from Table 179–18.

The reference differential impedance for the mated test fixtures ERL computation shall be 92.5 Ω. The mated test fixtures ERL shall be greater than or equal to 10.3 dB.

Table 179B–1—Mated test fixtures ERL parameter values

Parameter	Symbol	Value	Units
Transition time associated with a pulse	T_r	0.005	ns
Incremental available signal loss factor	β_x	0	GHz
Permitted reflection from a transmission line external to the device under test	ρ_x	0.618	—
Length of the reflection signal	N	1600	UI
Equalizer length associated with reflection signal	N_{bx}	0	UI
Time-gated propagation delay	T_{fx}	0	ns
Tukey window flag	tw	1	—
Target detector error ratio	DER_0	2×10^{-5}	—
NOTE—The mated test fixtures test connector and transmission line are not time-gated (by setting T_{fx} to 0) in order to include the entire test fixture.			

From 93A.5

The filtered return loss, $H_{ii}(f)$, is defined by Equation (93A–58).

$$H_{ii}(f) = H_t(f) s_{ii}(f) H_r(f) \qquad (93A–58)$$

where
- f is the frequency in GHz
- $H_r(f)$ is defined by Equation (93A–20)
- $H_t(f)$ is defined by Equation (93A–46)
- i is the port index of the scattering parameters, 1 or 2

The pulse TDR signal, PTDR(t), is defined by Equation (93A–59).

$$PTDR(t) = \int_{-\infty}^{\infty} X(f) H_{ii}(f) \exp(j2\pi f t) df \qquad (93A–59)$$

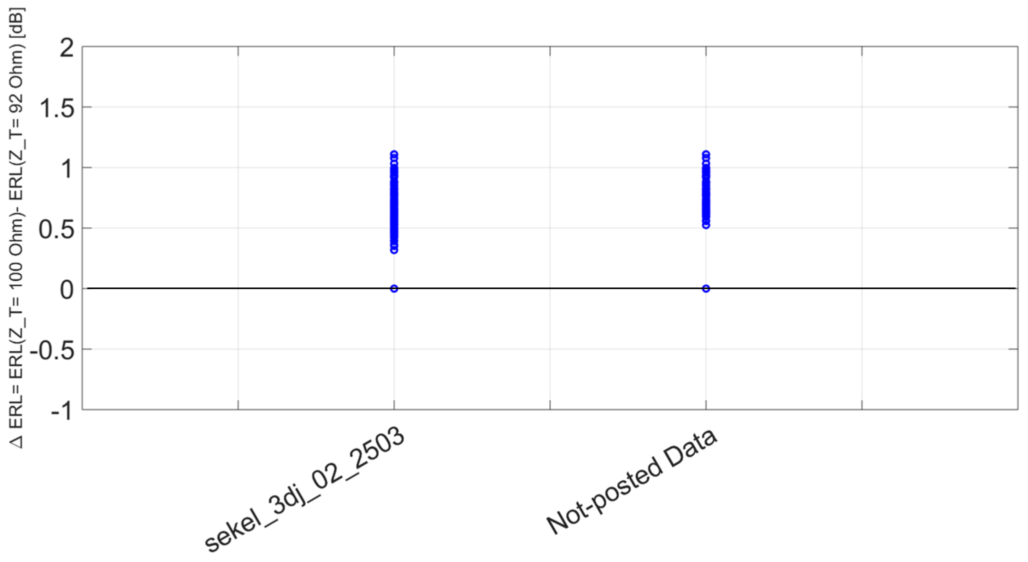
where
- t is the time in ns starting from the peak of the injected pulse
- $X(f)$ is defined by Equation (93A–23) with A_t set to 1

- The reference impedance of the computation will impact the return loss result
  - No explicit history in IEEE specs to define multiple reference impedances
  - COM v4.9 has an embedded parameter “Z_t” that acts as a definition of the reference impedance (50-Ω)

Impact of Reference Impedance on ERL

TDR and ERL options		
TDR	1	logical
ERL	1	logical
ERL_ONLY	1	logical
TR_TDR	0.005	ns
N	1600	logical
TDR_Butterworth	1	
beta_x	0	
rho_x	0.618	
TDR_W_TXPKG	0	UI
N_bx	0	
fixture delay time	[0 0]	
Tukey_Window	1	
Z_t	46.25	Ohm

Delta-ERL with 100-Ω reference compared to 92.5-Ω reference



- “Not-posted Data” includes a collection of different, but similar MTF data
  - Takeaway point: The observed impact is not expected to be unique to the posted 3dj MTF measurement data
- ERL computations with a reference impedance of 92.5-Ω have an observable penalty of ~1dB

Summary and Proposal

- Propose implementing zero-padding based high-frequency extrapolation
  - Promote the method as default setting in future COM release
  - Promote changes with commit request to COM ad-hoc
- Only Annex179B requires an ERL computation of 92.5-Ω
  - Posted data suggests test fixtures will be designed with a bias towards test and measurement equipment and results will be calibrated with a 100-Ω reference
  - Align computation method in Annex179B with all other Clauses in 802.3dj