The effect of Tfx on ERL using a measured test fixture

April 13th 2021
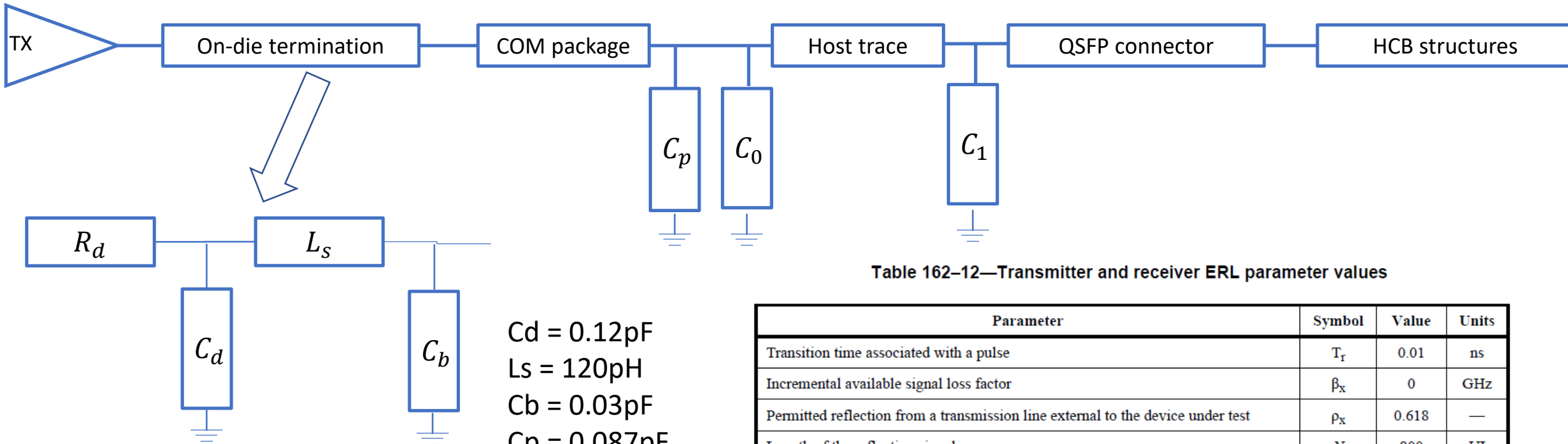Mike Dudek   Marvell
Tao Hu   Marvell

Introduction

- The purpose of having the Time-Gated propagation Delay (Tfx) in the ERL measurement is to remove the effect of the discontinuity caused by the RF connector of the test fixture.
- This presentation shows the results of simulations to determine the effect of Tfx value on the measurement of ERL.
- The simulations are of the CR, copper cable host but it is expected that the results will be applicable to all ERL measurements.
- Based on this work I intend to write a comment to change the value of Tfx for these measurements from 0.2ns to 0.3ns.

ERL simulation block diagram at TP2

TX ▷ — | On-die termination | — | COM package | — | Host trace | — | QSFP connector | — | HCB structures |

C_p C_0 (after COM package)

C_1 (after Host trace)

R_d — L_s

C_d C_b

Cd = 0.12pF
Ls = 120pH
Cb = 0.03pF
Cp = 0.087pF
C0 = 0.029pF
C1 = 0.019pF

Tfx: 0 to .5ns
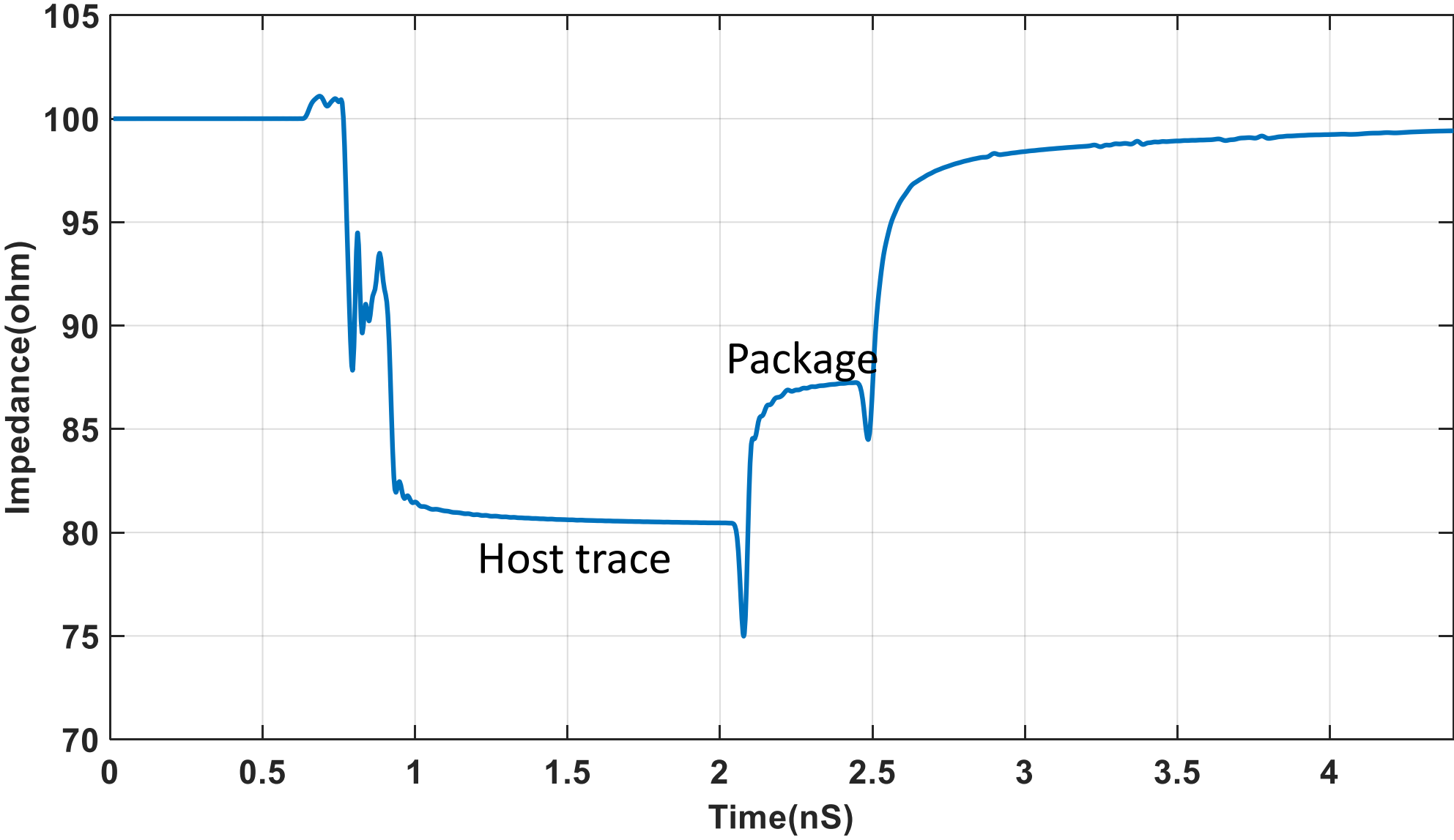Host trace length: 1mm to 400mm w/step 1mm
Host trace impedance: 100 OHM
Package length: 12mm

Table 162–12—Transmitter and receiver ERL parameter values

Parameter	Symbol	Value	Units
Transition time associated with a pulse	T_r	0.01	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	800	UI
Equalizer length associated with reflection signal	N_{bx}	0	UI
Time-gated propagation delay	T_{fx}	0.2	ns
Tukey window flag	tw	1	—

HCB as perfect 100OHM 2.5dB loss PCB

TDR of package, host trace, connector and perfect 100OHM PCB
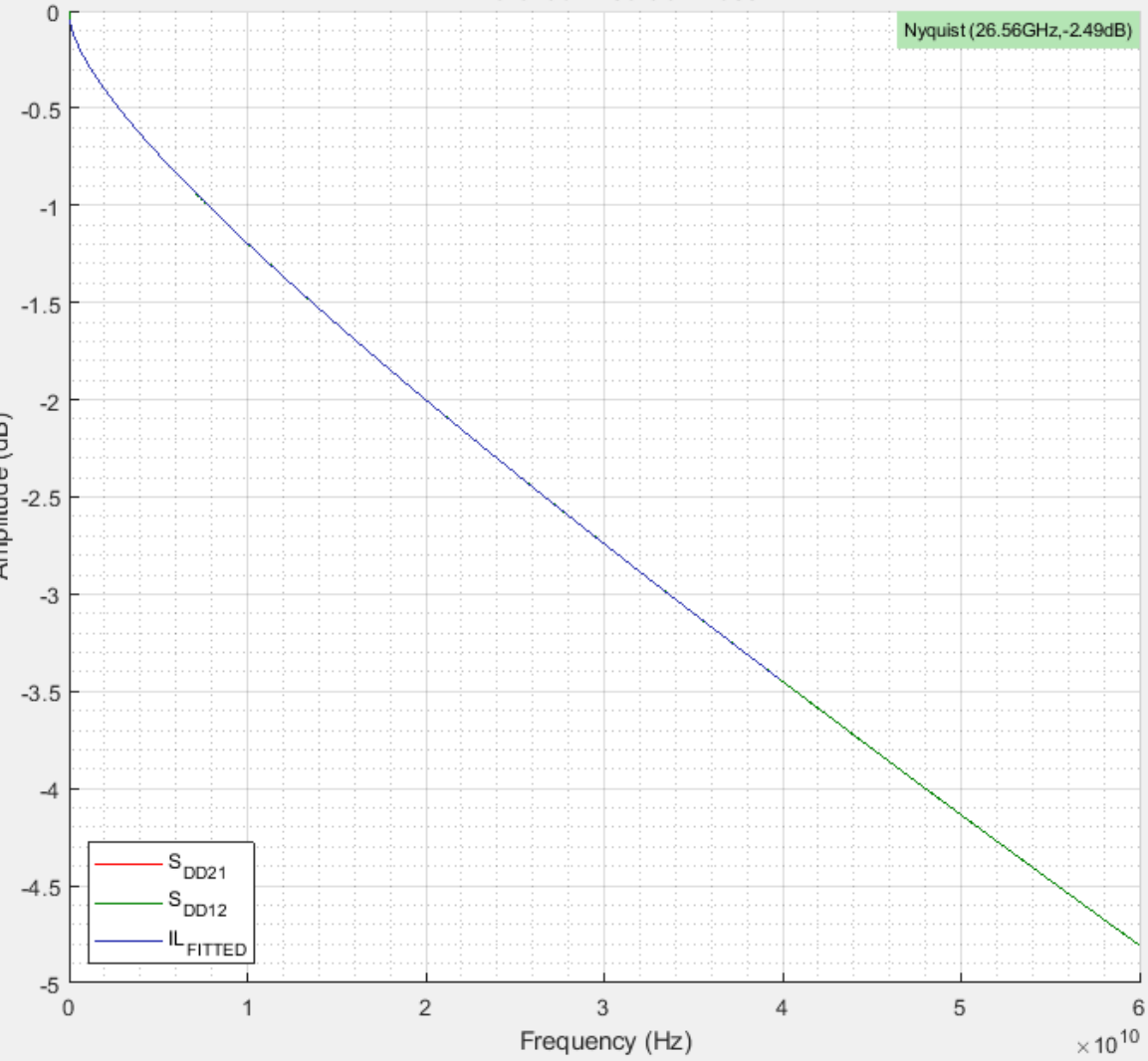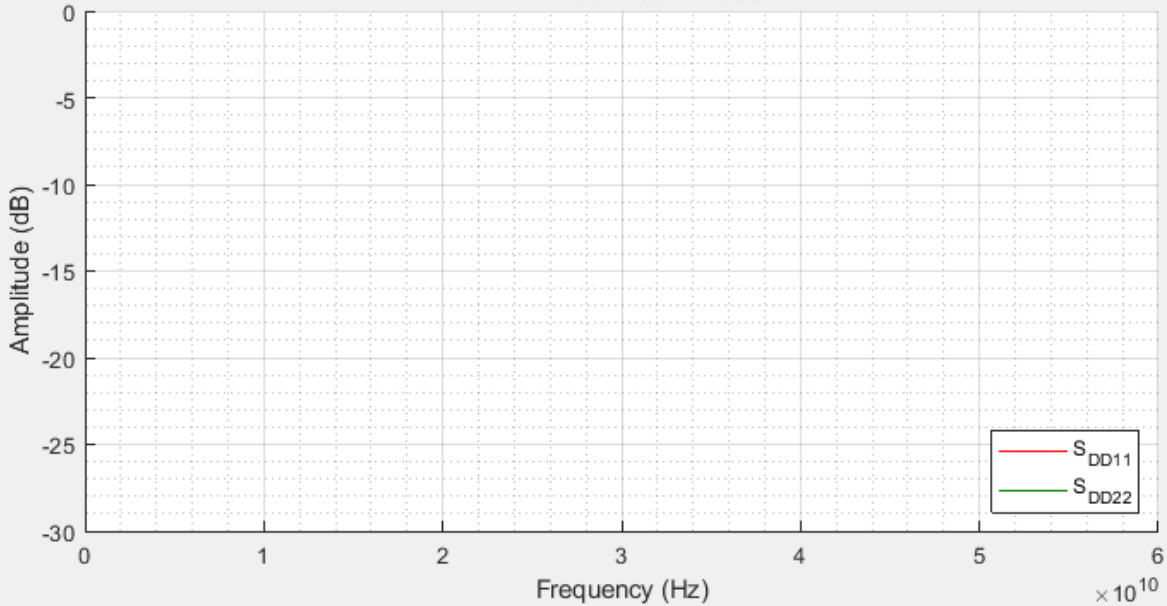
Perfect 100OHM PCB S parameter
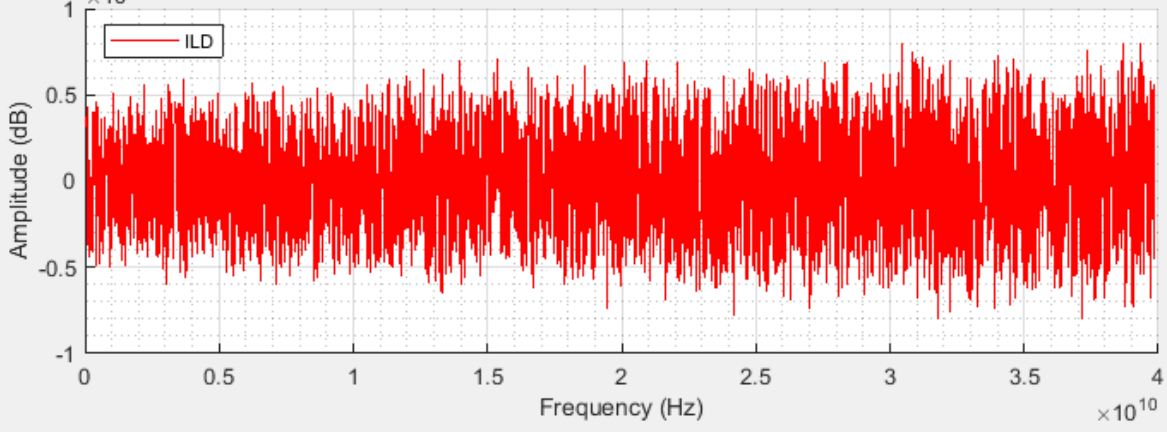
ERL with perfect 100 Ohm trace

ERL(dB) (y-axis)

Host trace length(mm) (x-axis)

Legend:
- Tfx=0ns Pkg=12mm Impedance=100ohm
- Tfx=0.1ns Pkg=12mm Impedance=100ohm
- Tfx=0.2ns Pkg=12mm Impedance=100ohm
- Tfx=0.25ns Pkg=12mm Impedance=100ohm
- Tfx=0.3ns Pkg=12mm Impedance=100ohm
- Tfx=0.4ns Pkg=12mm Impedance=100ohm
- Tfx=0.5ns Pkg=12mm Impedance=100ohm
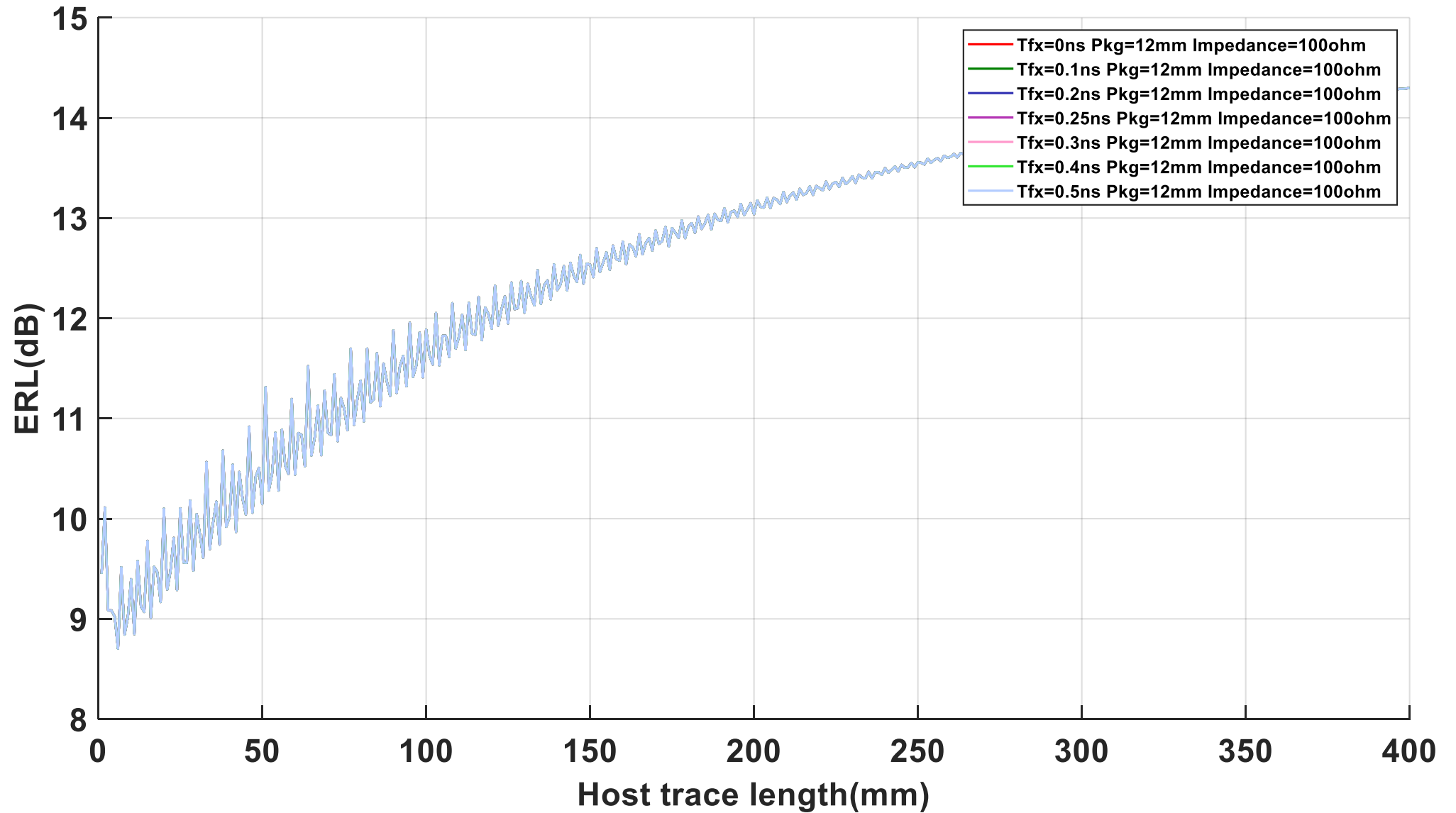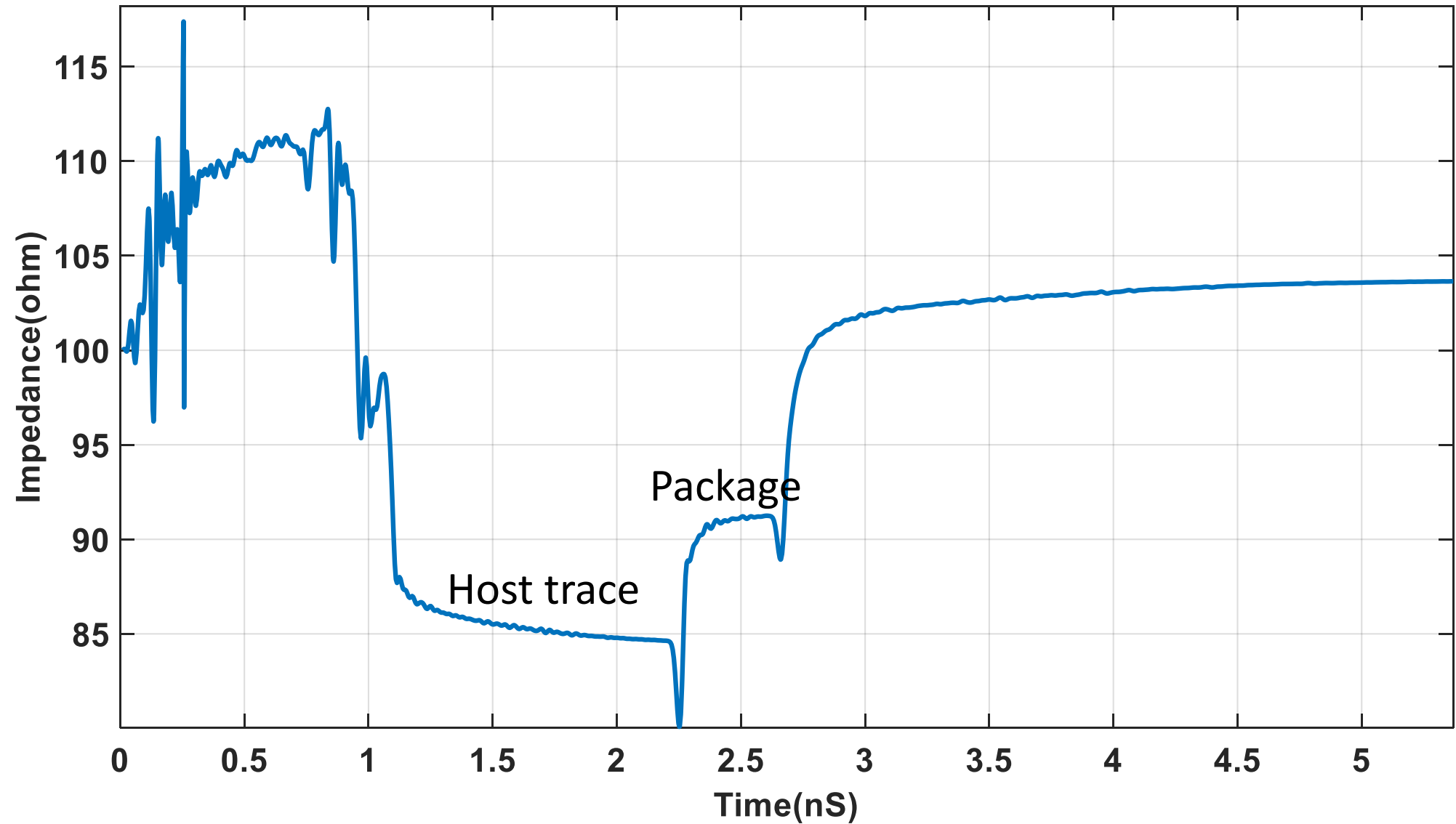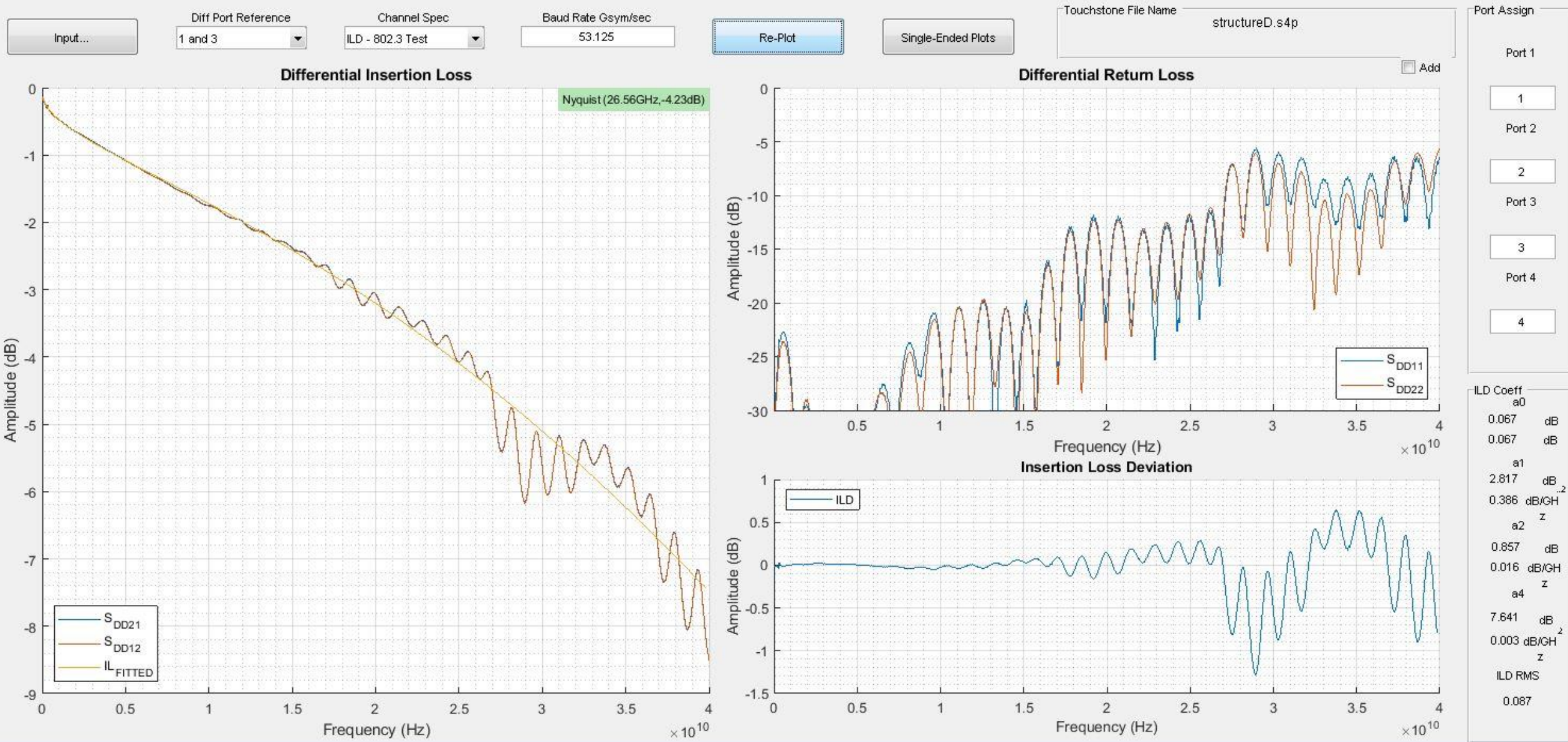
HCB as measured test trace Structure D

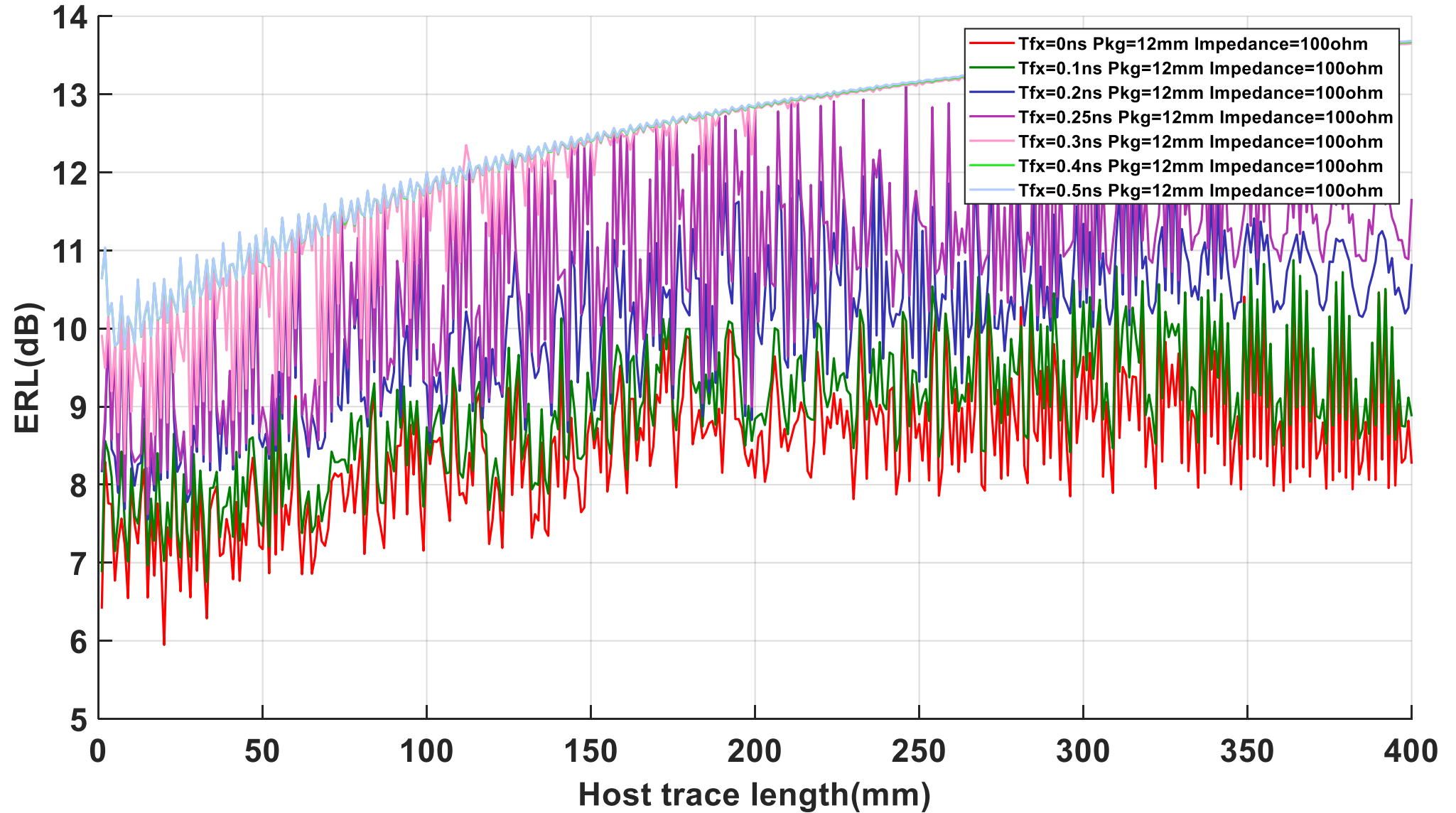**Molex SMA 2.92mm(73252-0090) + M6 100 Ohm 2.26 inch Stripline + Molex SMA 2.92mm(73252-0090)**

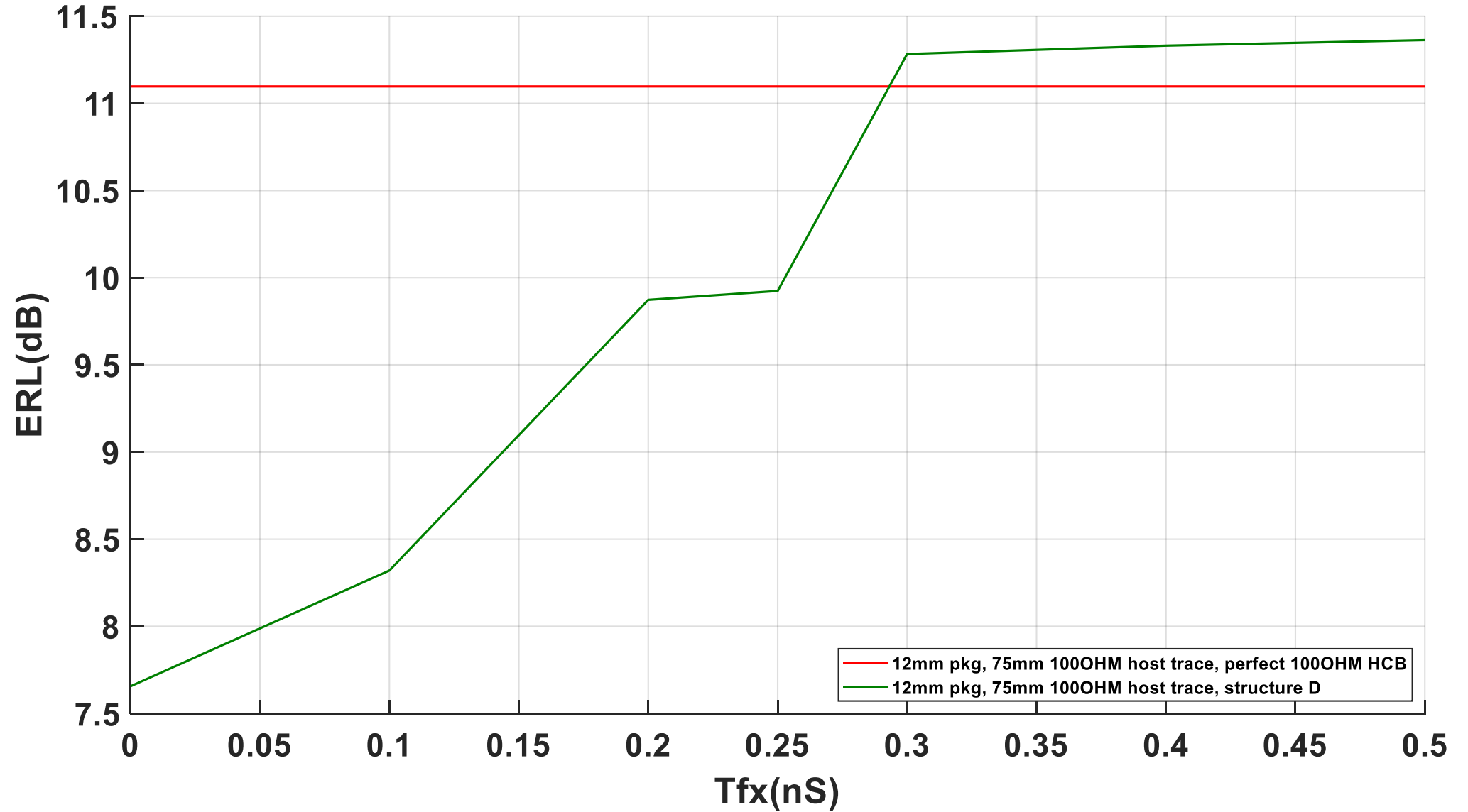# TDR of package, host trace, connector and structure D

Structure D S parameter

ERL with measured structure D

Legend:
- Tfx=0ns Pkg=12mm Impedance=100ohm
- Tfx=0.1ns Pkg=12mm Impedance=100ohm
- Tfx=0.2ns Pkg=12mm Impedance=100ohm
- Tfx=0.25ns Pkg=12mm Impedance=100ohm
- Tfx=0.3ns Pkg=12mm Impedance=100ohm
- Tfx=0.4ns Pkg=12mm Impedance=100ohm
- Tfx=0.5ns Pkg=12mm Impedance=100ohm

Y-axis: ERL(dB)
X-axis: Host trace length(mm)

ERL versus Tfx

Legend:
- 12mm pkg, 75mm 100OHM host trace, perfect 100OHM HCB (red)
- 12mm pkg, 75mm 100OHM host trace, structure D (green)

X-axis: Tfx(nS)
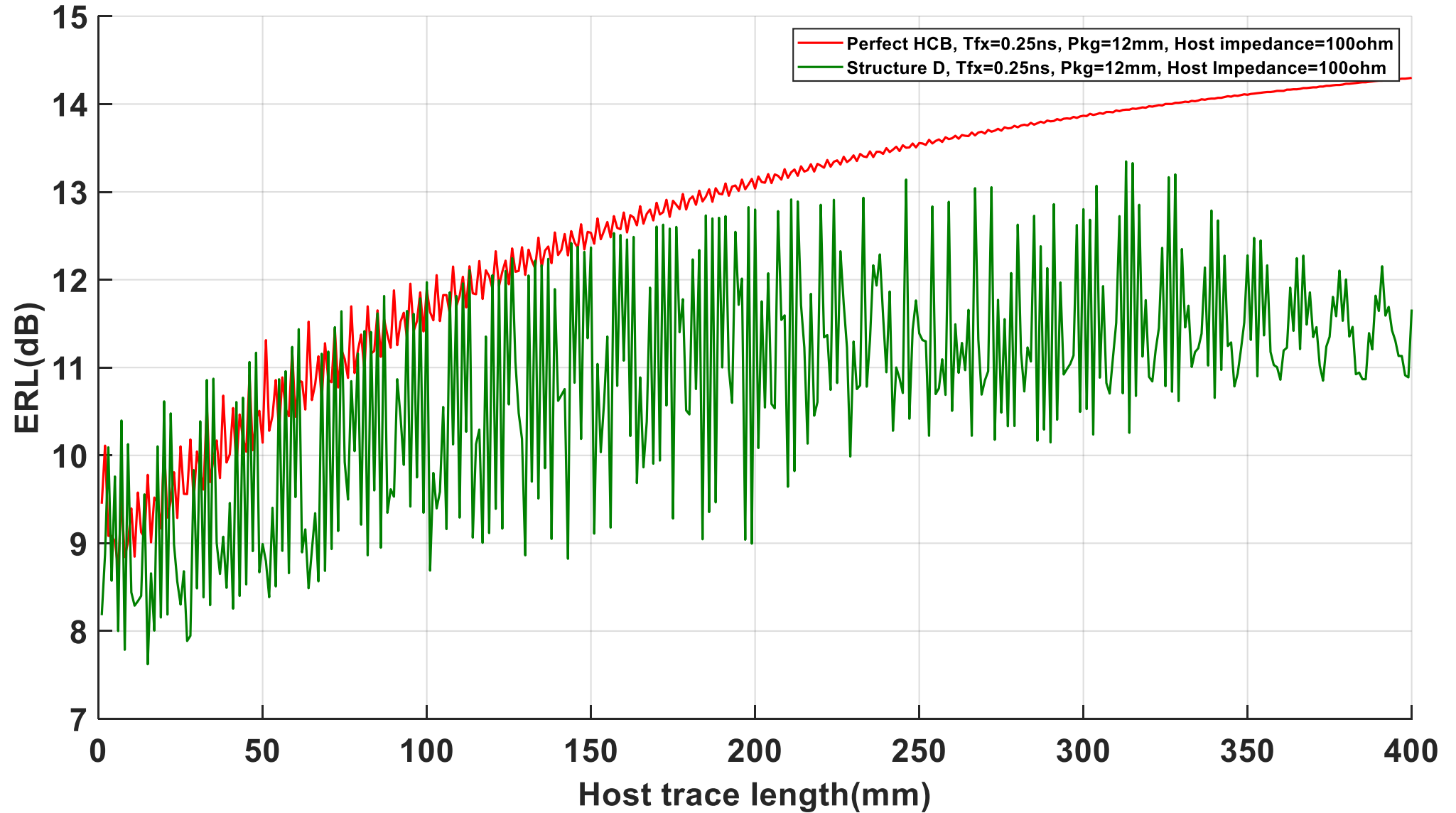Y-axis: ERL(dB)

ERL versus host trace length when Tfx=0.3ns
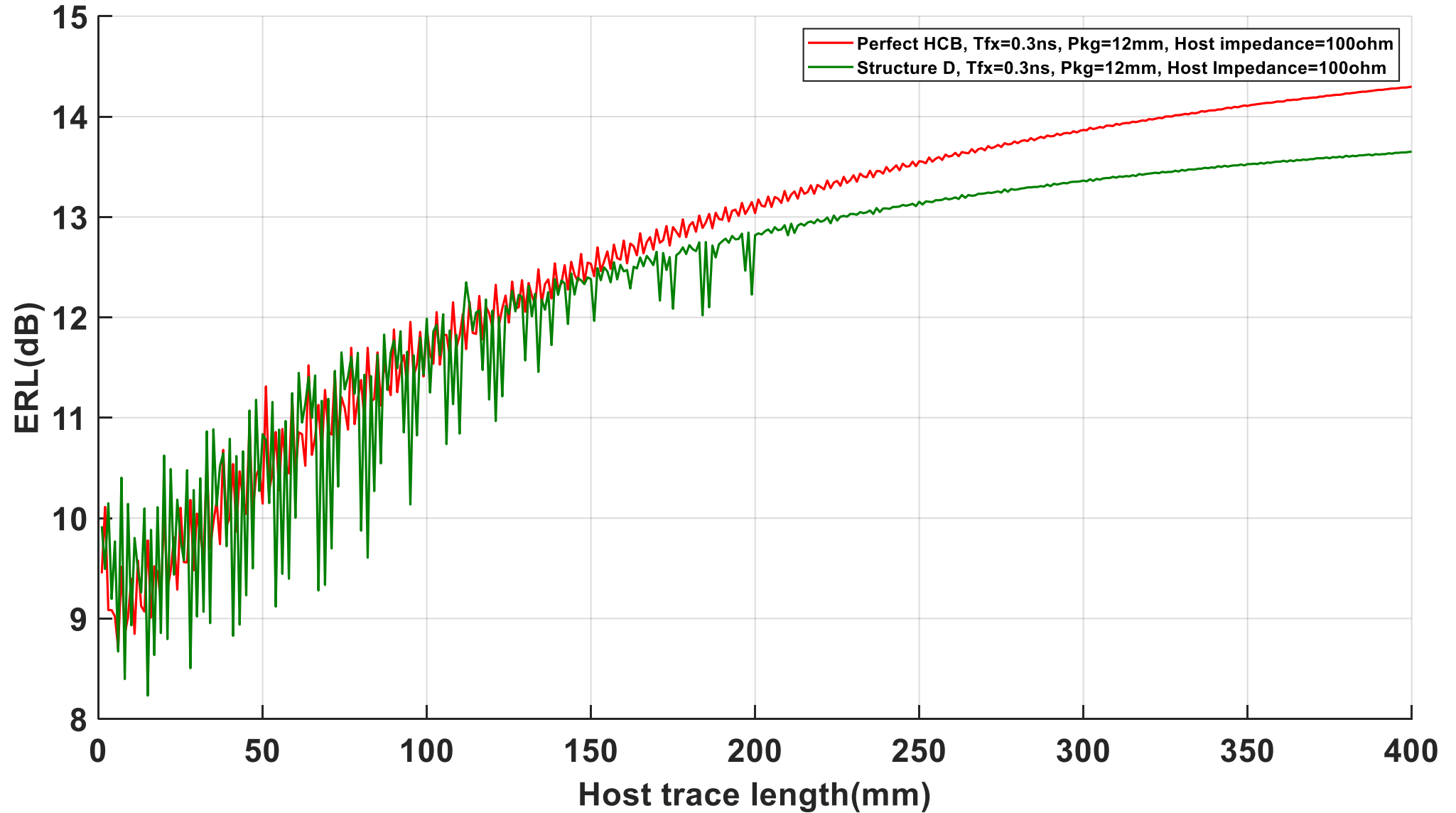
ERL versus host trace length when Tfx=0.25ns

Conclusions

- The present value of 0.2ns for Tfx is too short to remove the effect of the RF connector resulting in pessimistic (and variable) ERL measurements.
- Having too large a value of Tfx can result in optimistic results as it may remove the effect of discontinuities in the host itself.
- A value of 0.3ns is large enough to remove the RF connector effects without affecting the measurements of the host itself.
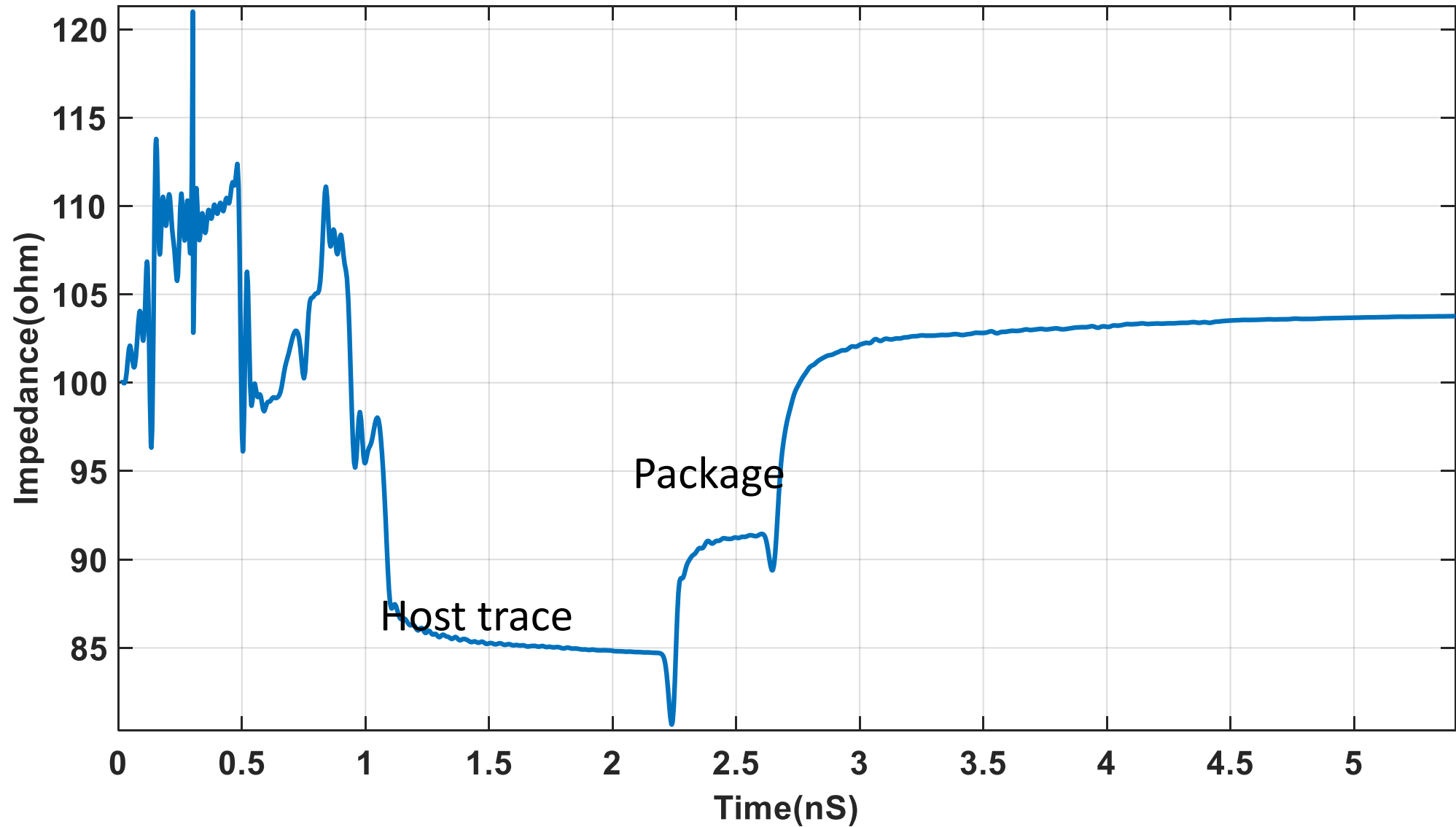
Backup

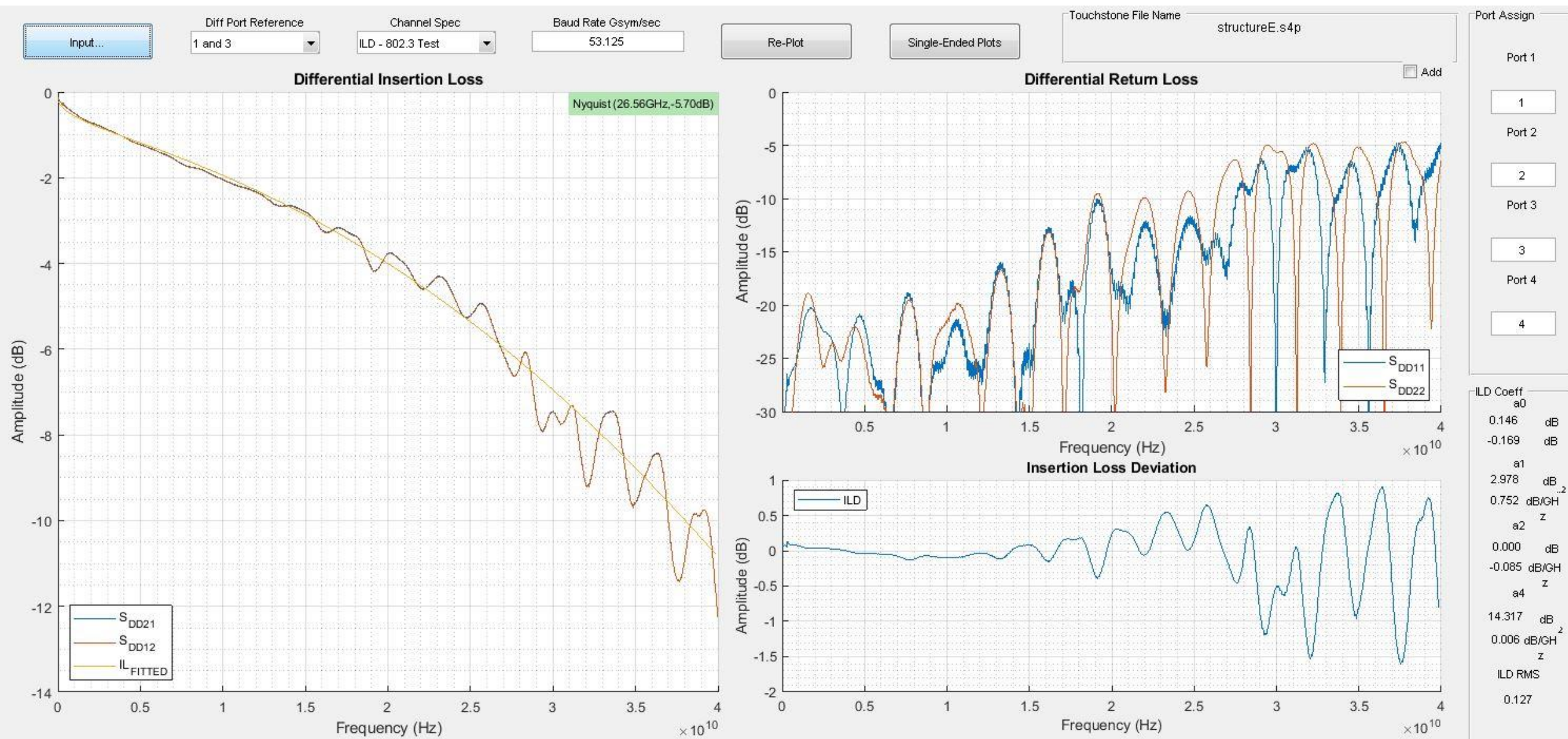**Effect of discontinuity in test trace.**

HCB as measured Structure E

Molex SMA 2.92mm(73252-0090) +
M6 100 Ohm 1.13 inch Microstrip + Via +
M6 100 Ohm 1.13 inch Stripline +
Molex SMA 2.92mm(73252-0090)

TDR of package, host trace, connector and structure E

Structure E S parameter

ERL with measured structure E
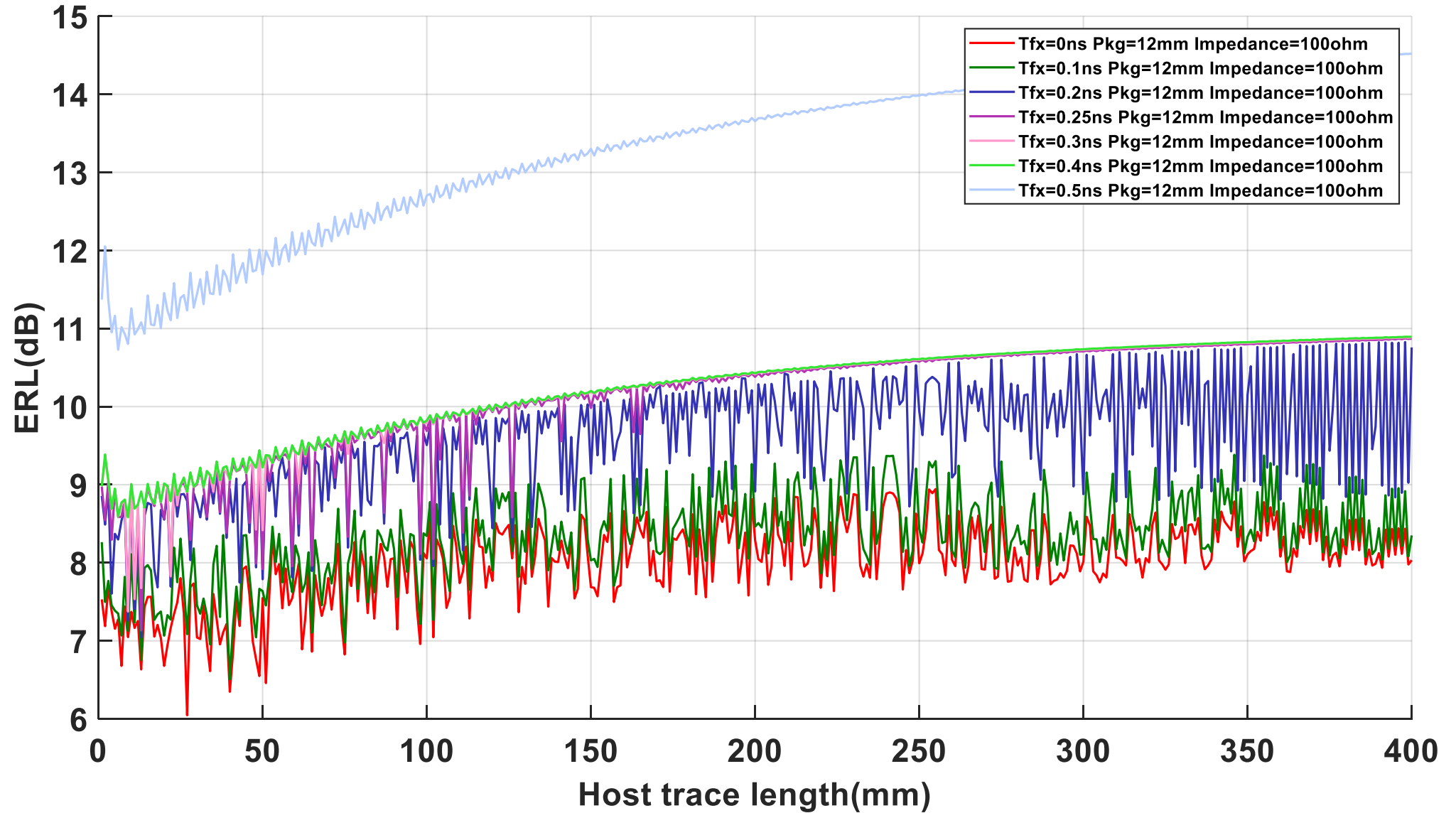

Legend:
- Tfx=0ns Pkg=12mm Impedance=100ohm
- Tfx=0.1ns Pkg=12mm Impedance=100ohm
- Tfx=0.2ns Pkg=12mm Impedance=100ohm
- Tfx=0.25ns Pkg=12mm Impedance=100ohm
- Tfx=0.3ns Pkg=12mm Impedance=100ohm
- Tfx=0.4ns Pkg=12mm Impedance=100ohm
- Tfx=0.5ns Pkg=12mm Impedance=100ohm

X-axis: Host trace length(mm)
Y-axis: ERL(dB)

ERL versus Tfx

Legend:
- 12mm pkg, 75mm 100OHM host trace, perfect 100OHM HCB (red)
- 12mm pkg, 75mm 100OHM host trace, structure D (green)
- 12mm pkg, 75mm 100OHM host trace, structure E (blue)

X-axis: Tfx(nS)
Y-axis: ERL(dB)
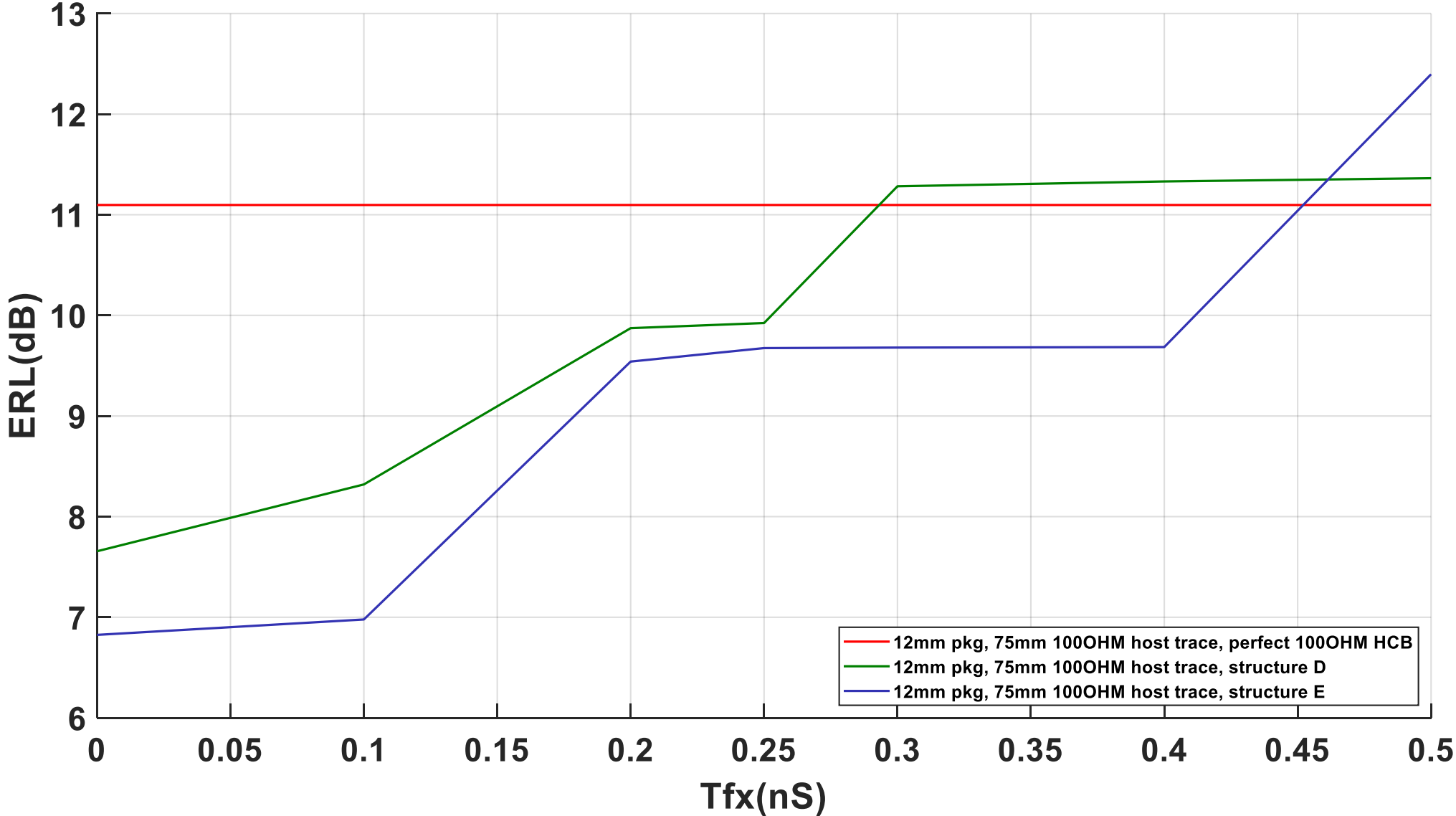
ERL with Tfx = 0.4ns

ERL versus host trace length when Tfx=0.4ns