802.3da Multidrop Mixing Segment Specifications

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Purpose

- Consideration for stub characterization/specification and trunk connections.
  - Stub specifications
  - Trunk connection specification
  - Measurement considerations
- Trunk cable
  - Return Loss
  - Mode Conversion
  - Coupling attenuation

Stub Characterization

Details

- Measurements can be made with a VNA
  - Note – these would require new, partitioned specs
  - Trunk IL – without MDI loading
    - Separates mixing segment from MDI measurements
  - Stub RL – (can be done in-situ)
  - Trunk delay
  - Stub delay, Stub IL
    - Probably not measurable in-situ, but specify for new builds/components
    - Constrain them to be small to maximize trunk length
- Do we constrain stub positioning (inter-stub delay?)
  - Probably would need a TDR measurement in our spec

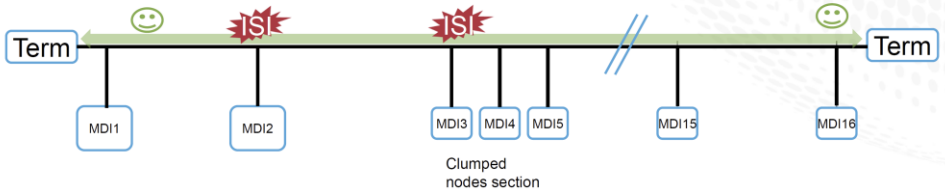
https://www.ieee802.org/3/da/public/0522/zimmerman_3da_01_05232022.pdf

Option 1: End-to-End trunk measurement (MDIs attached)

Green line shows the 4-port VNA connection at termination points

+ Mixed mode trunk parameters (IL, RL, MC) directly measurable with 4-port VNA (connecting in place of terminators)

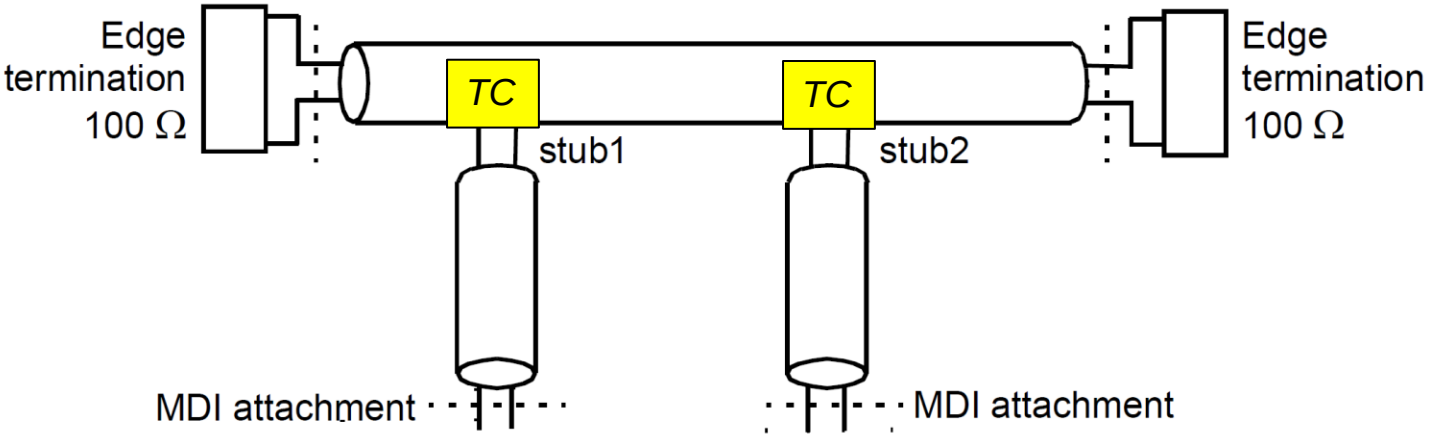
- **May not be enough to catch an impairment in the middle of link**
- **Stub losses may be missed**
- **Long distance between terminators**



https://www.ieee802.org/3/da/public/0522/Koczwara_3da_01_20220523.pdf

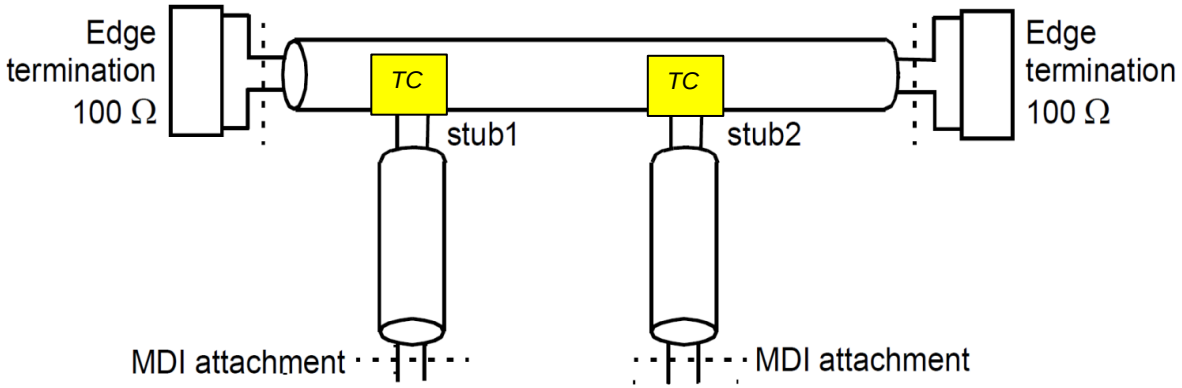
Stub Characterization

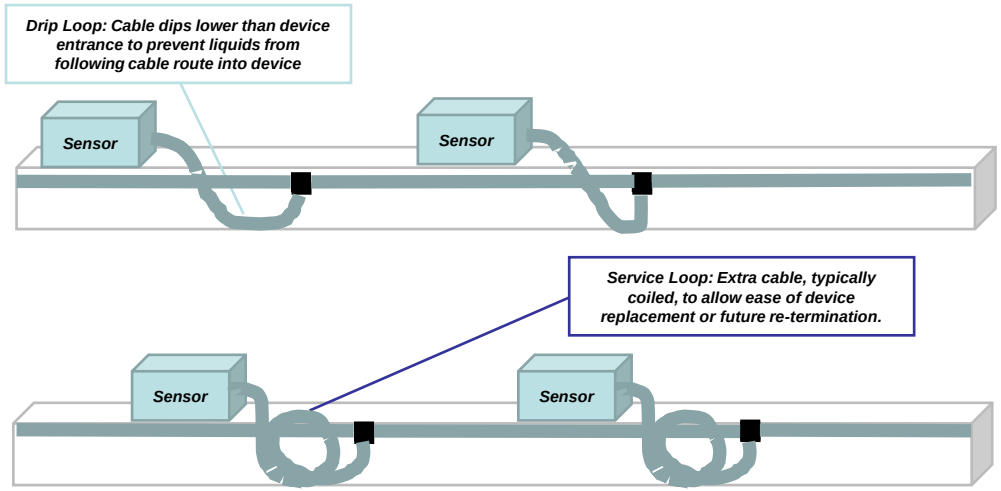
- Stub connected to trunk otherwise not specified
- Trunk connection not specified



Stub Characterization

- Recommend specifying stub delay and IL to limit stub length of up to 30 cm, minimize insertion loss, reduces delay related resonances, and supports use cases.

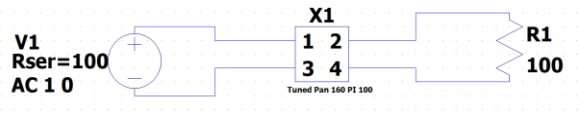




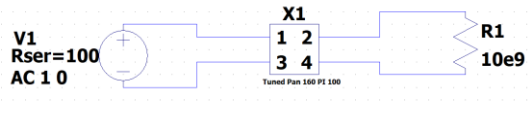
Spur Length (mm)	Application	Comments
100mm	Per 802.3cg	Very short for machine building practices
300mm (~12”)	Fairly typical length for drip loop installations	Fairly commonplace in sensor applications
500mm (~20”)	Service Loop applications	

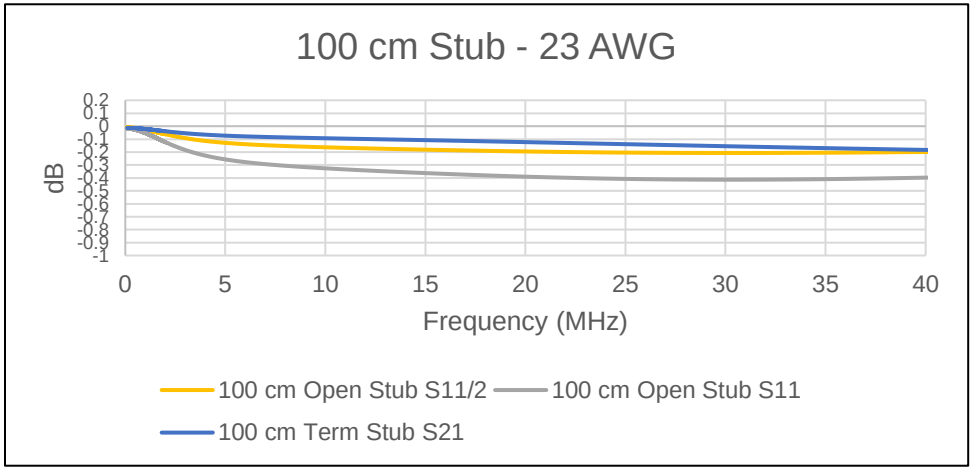
Stub Characterization - insertion loss

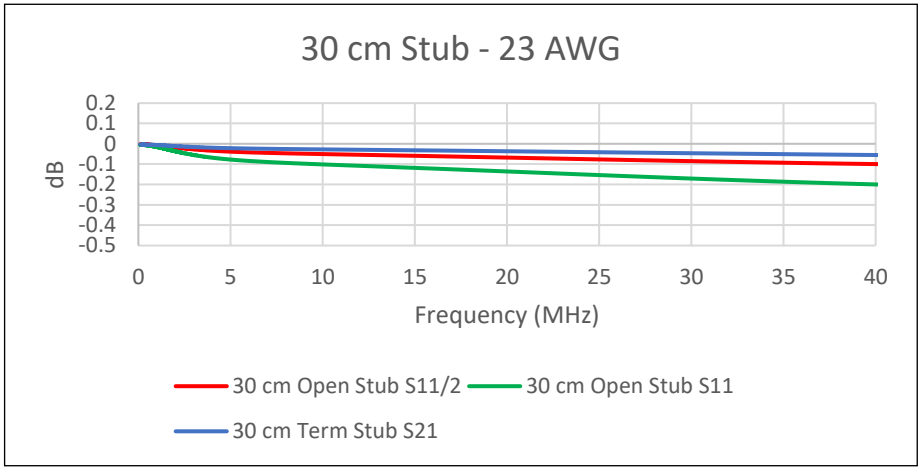
Stub insertion loss

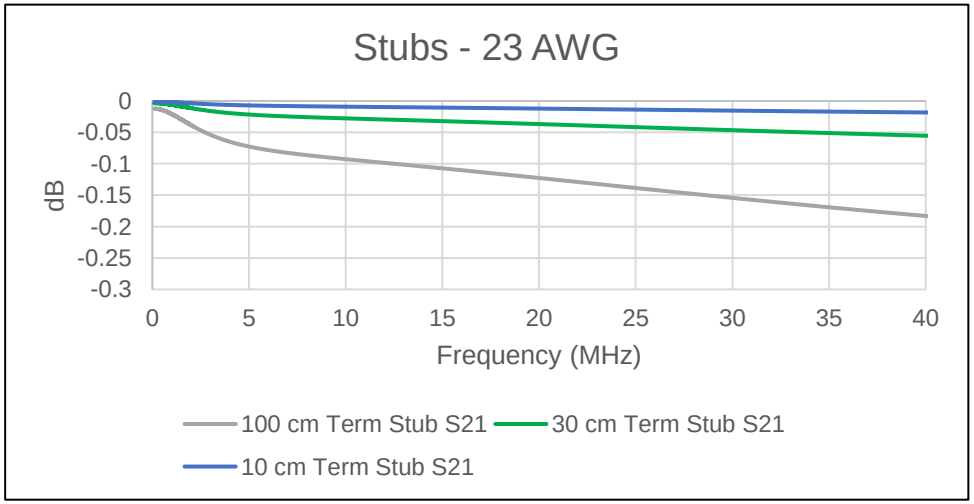


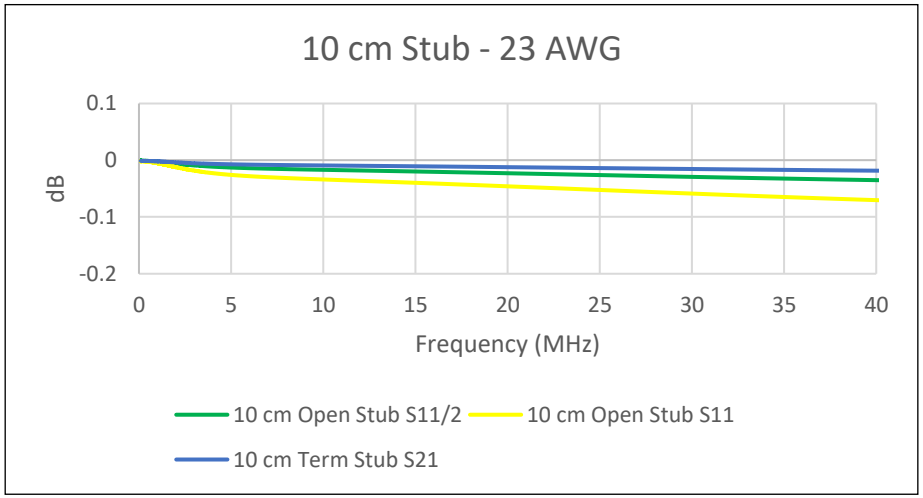
Open circuit return loss



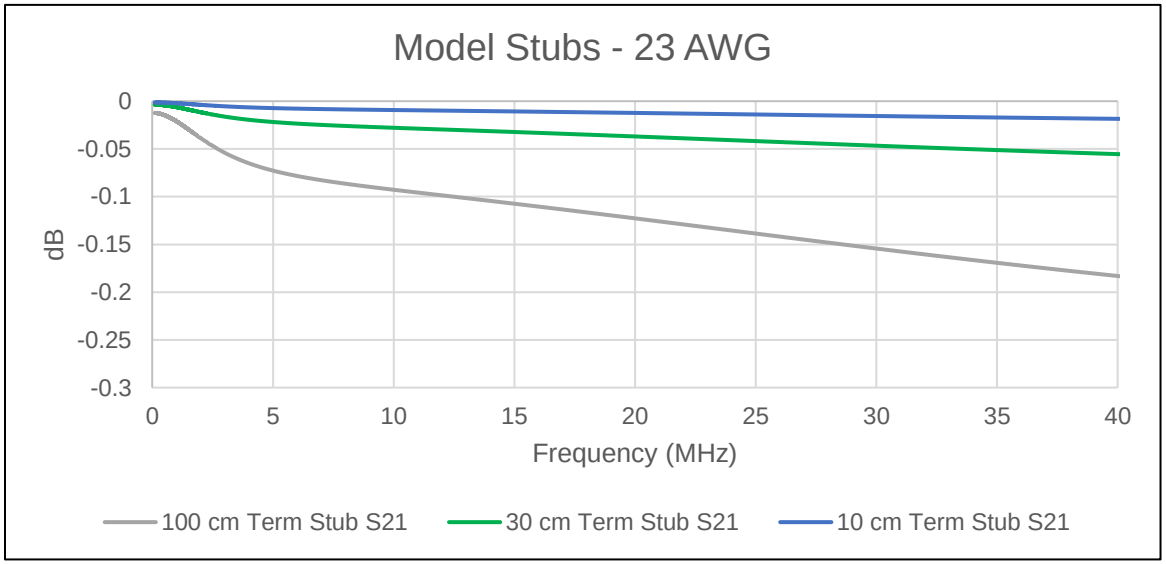








Stub Characterization - insertion loss

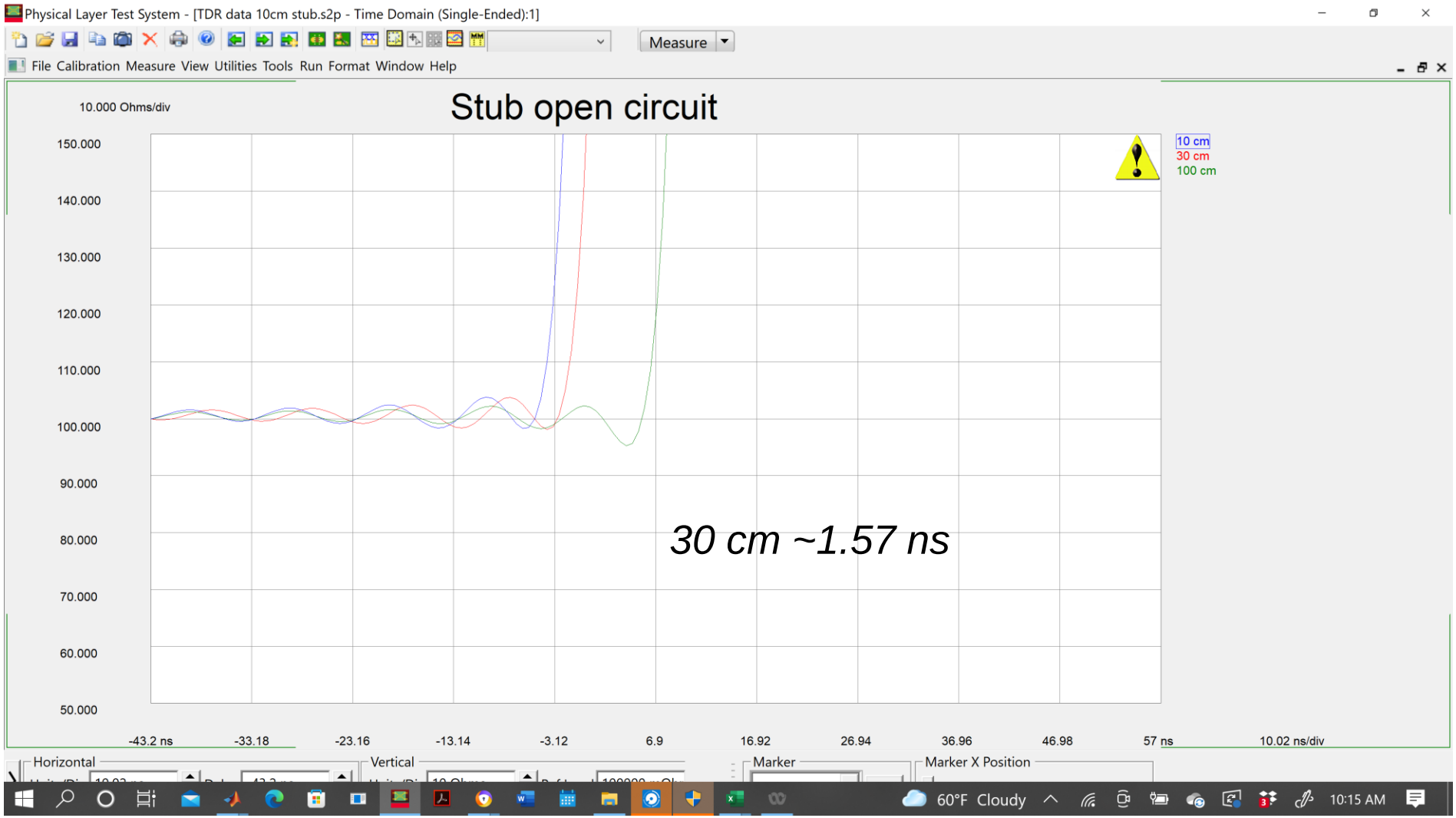


Stub_IL ≤ 0.15 dB
0.3 ≤ f(MHz) ≤ 40

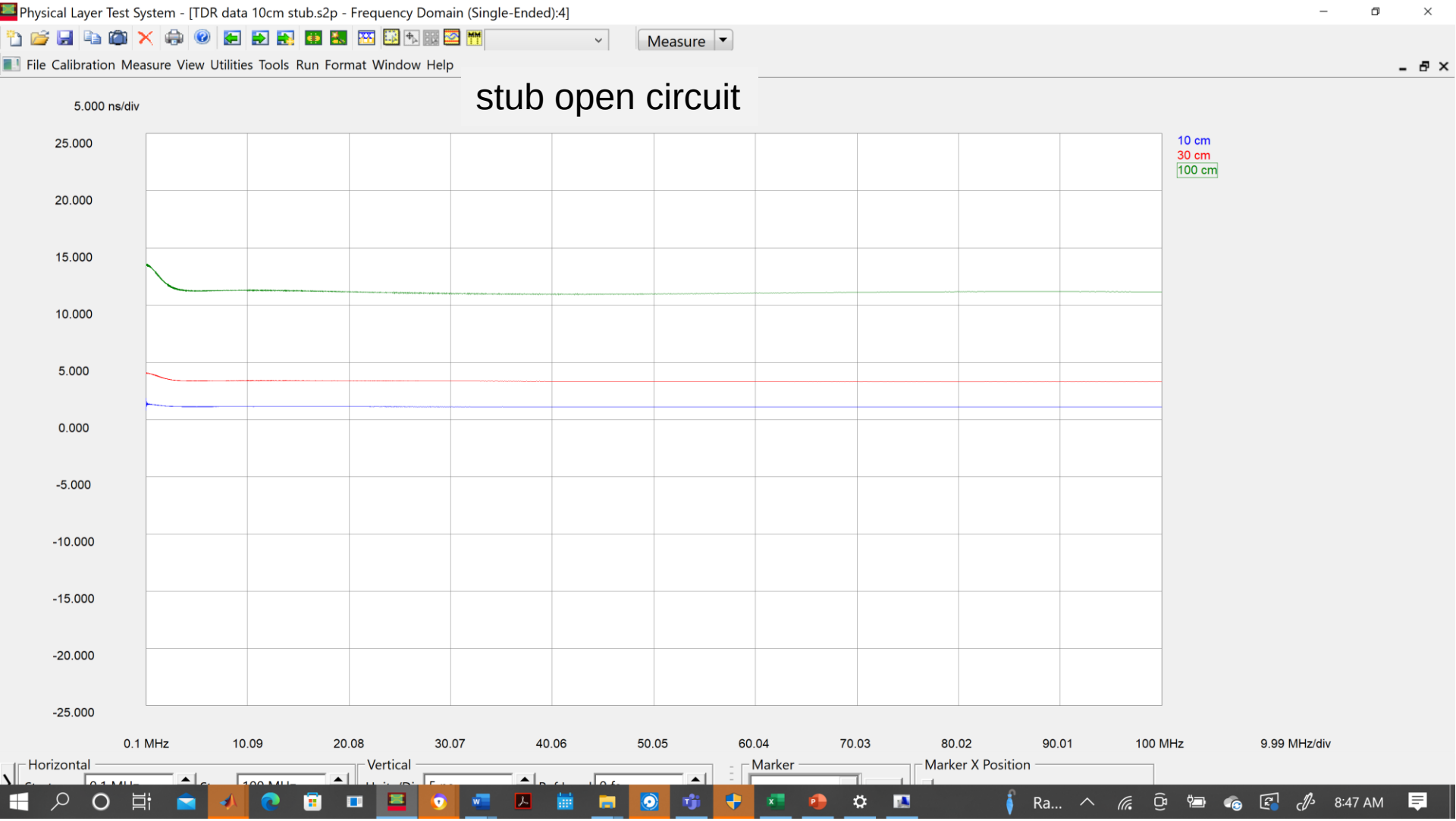
Derived from copper losses

AWG	dB/100 cm @ 40 MHz solid	dB/100 cm @ 40 MHz stranded	dB/30 cm at 40 MHz solid	dB/30cm at 40 MHz stranded
18	0.067	0.080	0.020	0.024
19	0.075	0.090	0.022	0.027
20	0.084	0.101	0.025	0.030
21	0.094	0.113	0.028	0.034
22	0.106	0.127	0.032	0.038
23	0.119	0.143	0.036	0.043
24	0.134	0.161	0.040	0.048
25	0.150	0.180	0.045	0.054
26	0.169	0.202	0.051	0.061
27	0.189	0.227	0.057	0.068
28	0.213	0.255	0.064	0.077
29	0.239	0.287	0.072	0.086
30	0.268	0.322	0.080	0.097
31	0.301	0.361	0.090	0.108
32	0.338	0.406	0.101	0.122

Stub Characterization - delay



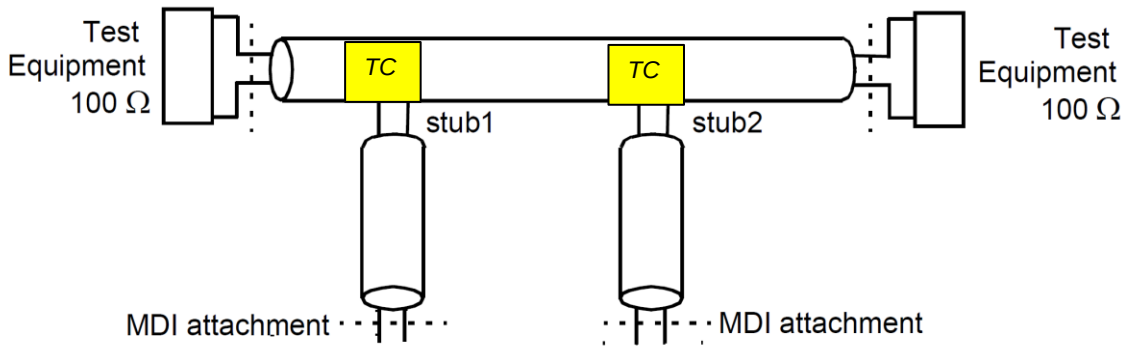
Stub Characterization - group delay



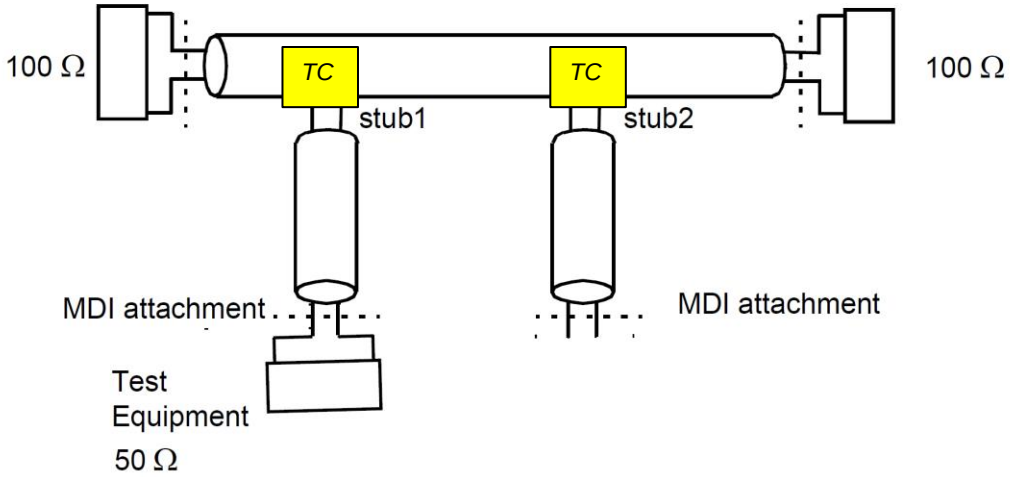
Multidrop qualification

- Given stub specifications of IL and delay, are these measurements/specifications sufficient to characterize trunk connection impact(s) to qualify link?
- Do we need trunk connection specifications?

Measurements: Insertion loss, mode conversion, return loss

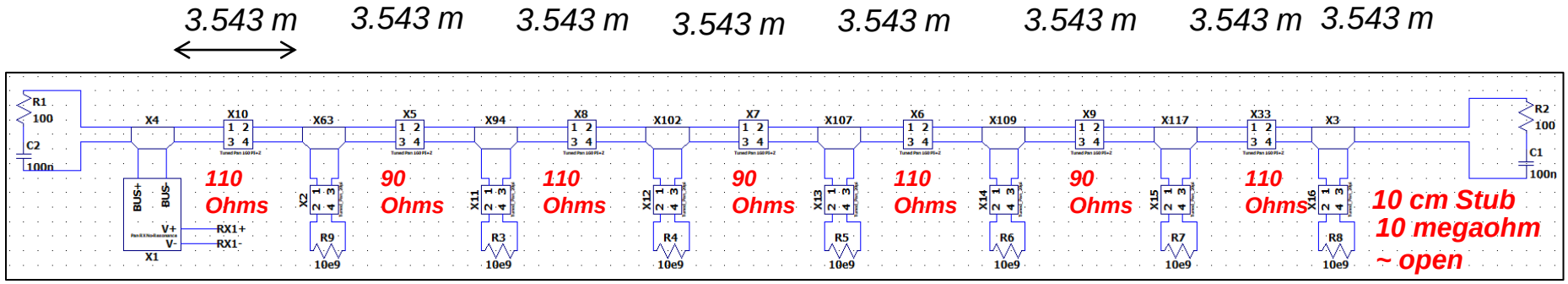


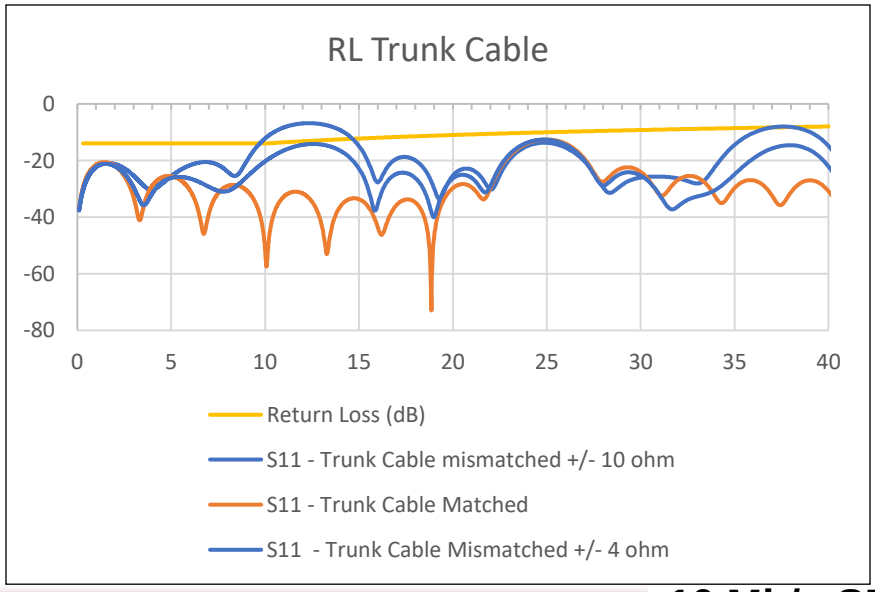
Measurements: Mode conversion, return loss

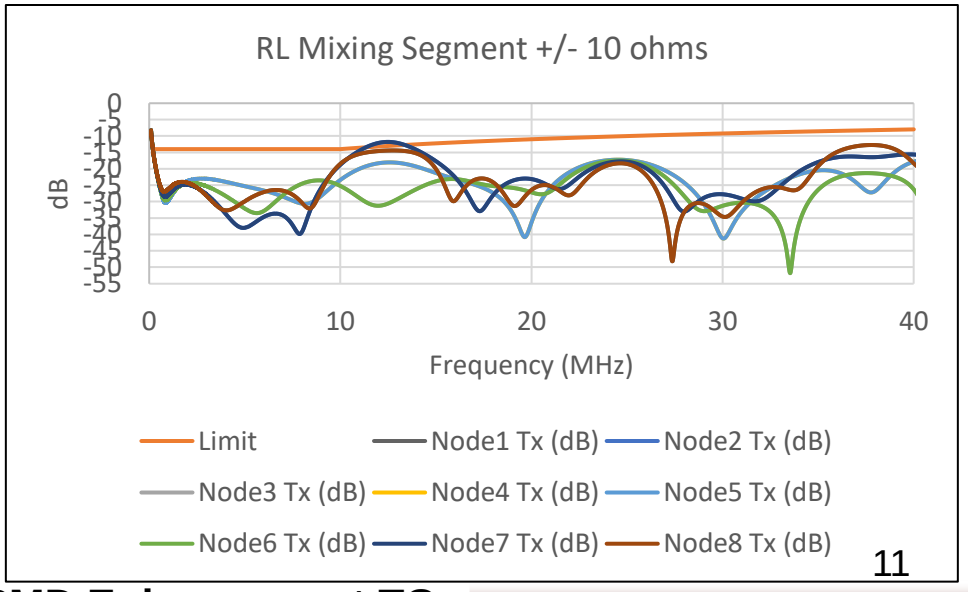


Trunk cable return loss

- Trunk cable considered consisting of cable sections variation on cable impedances of 10 ohms; 8 nodes equally spaced 3.543 m open circuit 10 cm stub (without MDI's or tuning inductors attached).







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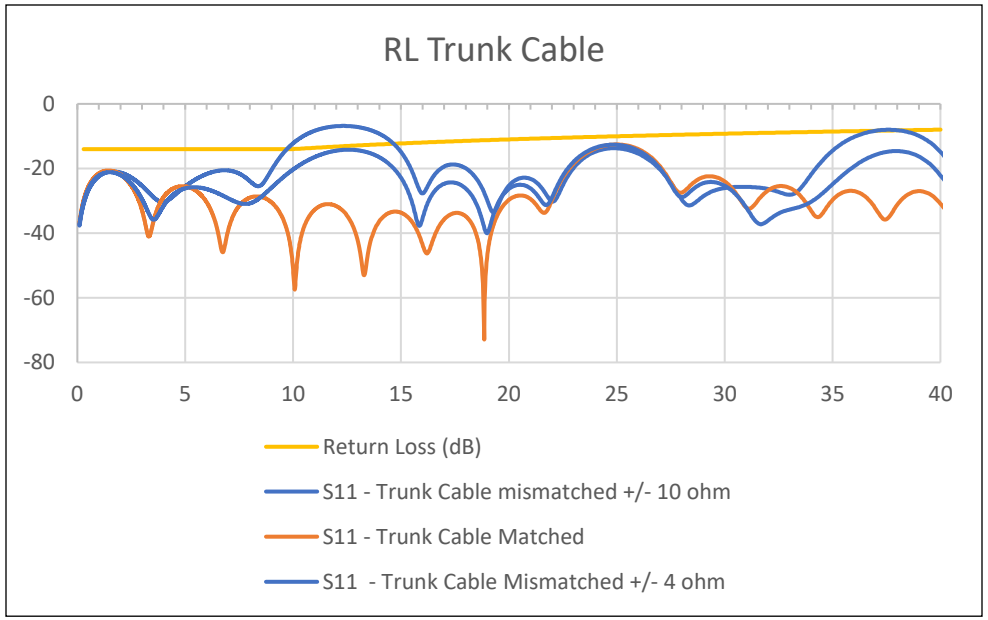


Trunkcable_RL ≥ TBD
To be based on cable section variations and OC stubs

Trunk cable mode conversion - 802.3bp

Link segment type A - 97.6.1.4 Differential to common mode conversion

The mode conversion specification applies to:
— Longitudinal conversion loss (LCL) with s-parameter SDC11/SDC22 and description common mode to differential mode return loss
— Transverse conversion loss (TCL) with s-parameter SCD11/SCD22 and description differential mode to common mode return loss
— Longitudinal conversion transmission loss (LCTL) with s-parameter SDC12/SDC21 and description common mode to differential mode insertion loss
— Transverse conversion transmission loss (TCTL) with s-parameter SCD12/SCD21 and description differential mode to common mode insertion loss

Trunk cable mode conversion

802.3da Mixing segment starting point - Trunk cable mode conversion loss - per electromagnetic classifications (ISO/IEC 11801-1)

- Mode conversion requirements to be met at any MDI attachment. The reference impedance is 50 Ω.
- Mode conversion requirements to be met between or at edge termination attachment points. The reference impedance is 100 Ω.

802.3cg Table 146–7—Link segment electromagnetic classifications (ISO/IEC 11801-1)

Electromagnetic	E1	E2	E3
Conducted RF	3 V at 150 kHz to 80 MHz	3 V at 150 kHz to 80 MHz	10 V at 150 kHz to 80 MHz

Differential to common mode conversion

	Frequency (MHz)	E1	E2
Mode Conversion	TBD $\leq f \leq$ TBD	≥ TBD	≥ TBD

Trunk cable coupling attenuation

802.3da Mixing segment starting point- Trunk cable mode conversion loss -per electromagnetic classifications (ISO/IEC 11801-1)

802.3cg Table 146–7—Link segment electromagnetic classifications (ISO/IEC 11801-1)

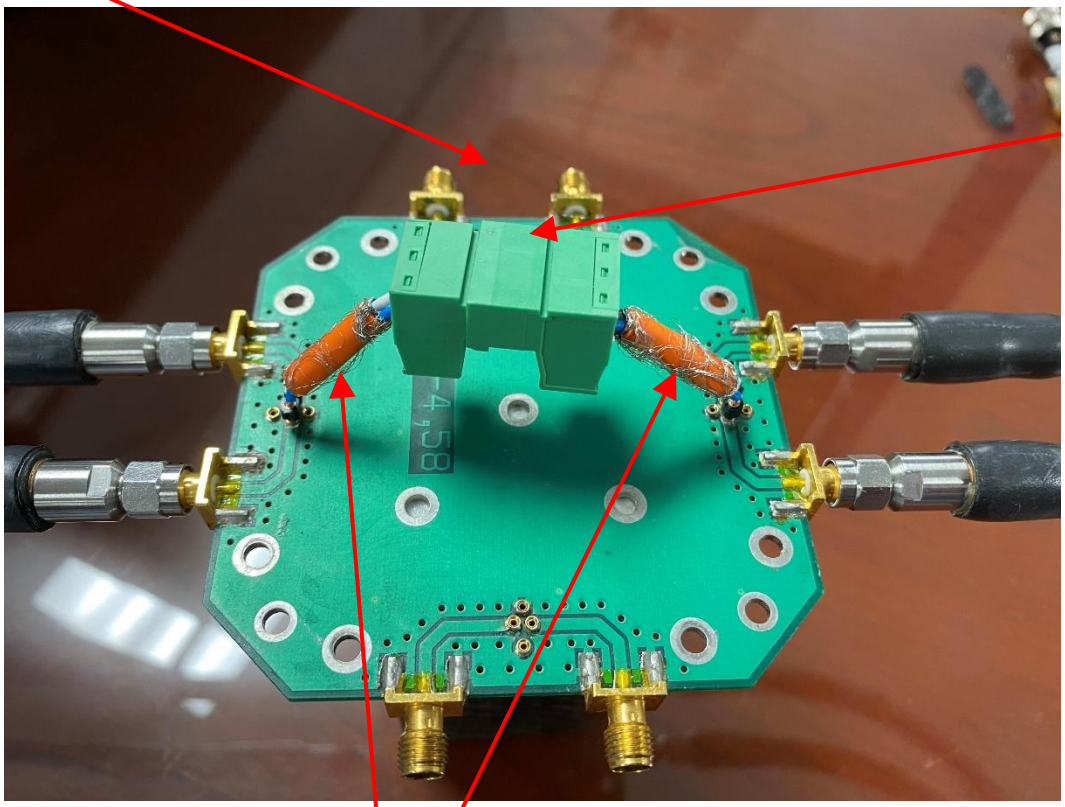
Electromagnetic	E1	E2	E3
Conducted RF	3 V at 150 kHz to 80 MHz	3 V at 150 kHz to 80 MHz	10 V at 150 kHz to 80 MHz

Coupling attenuation

Frequency (MHz)	(dB)		
	E_1	E_2	E_3
TBD to TBD	≥TBD	≥TBD	≥TBD

Trunk Connection - 2 wire terminal

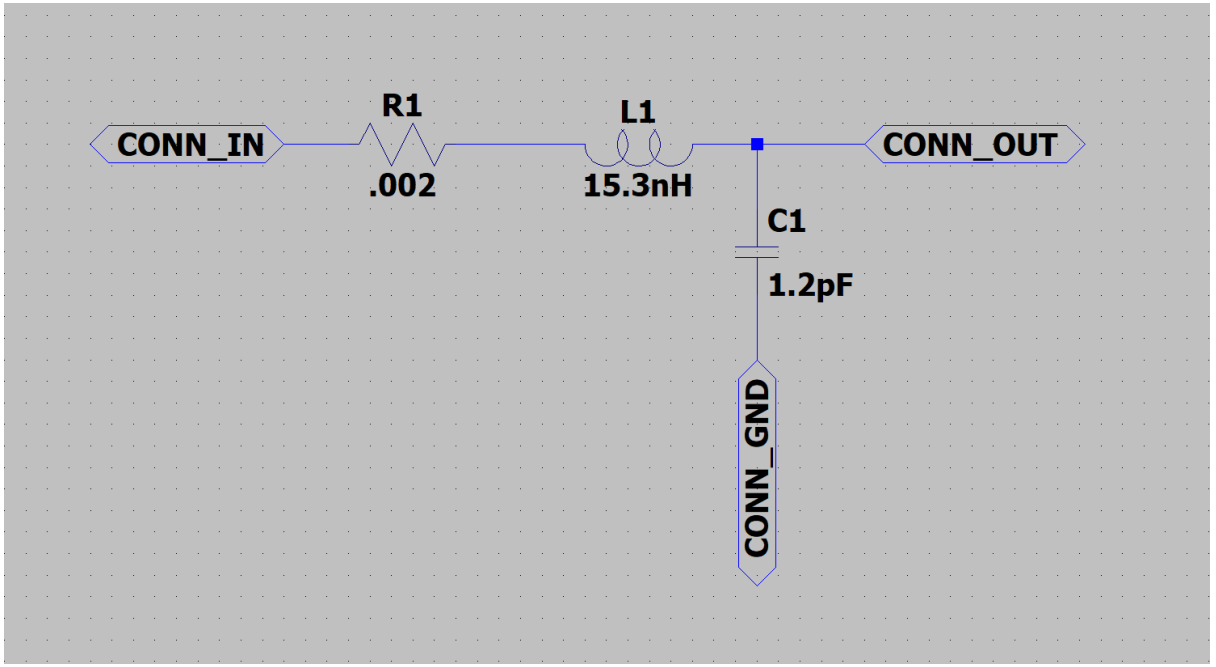
Trunk Connection Stub/Drop Cable



2 wire terminal

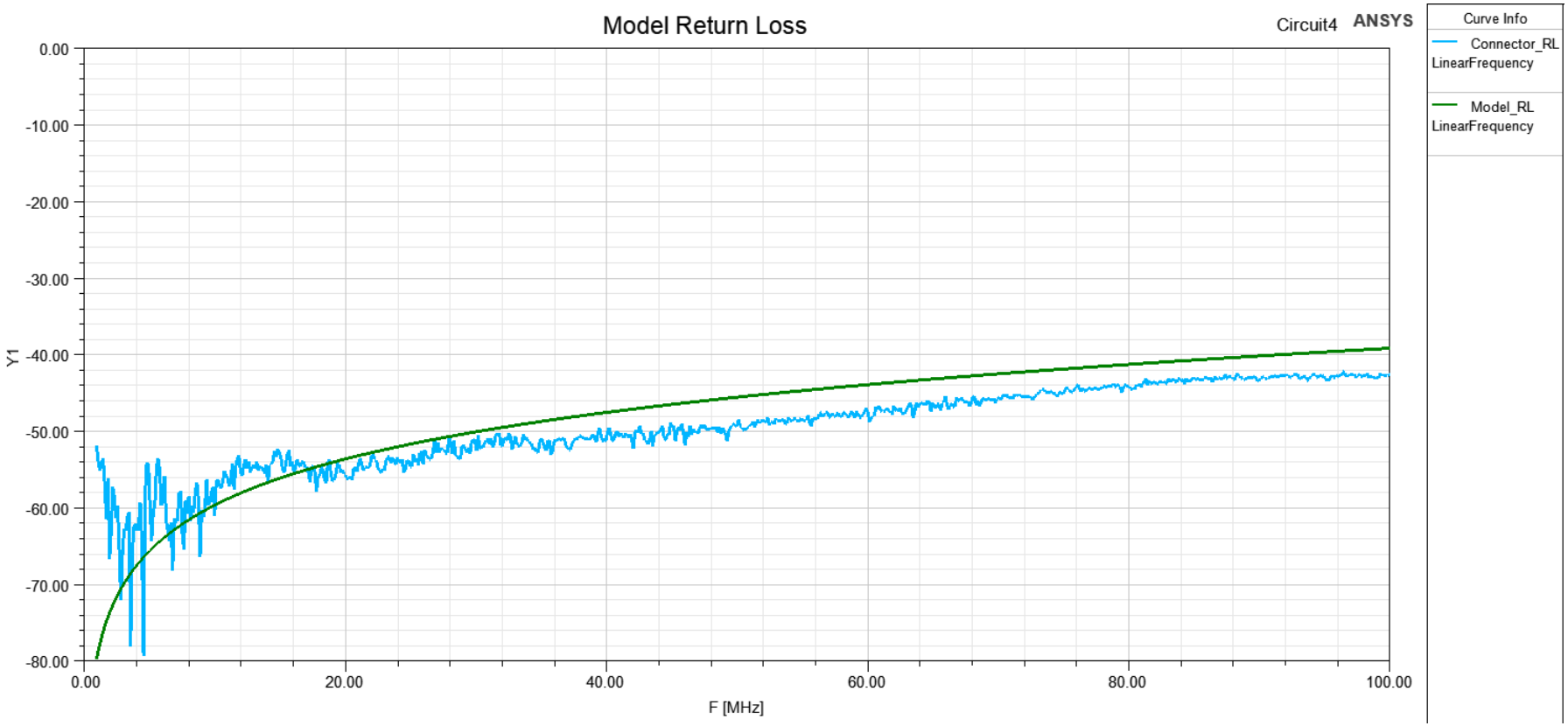
Trunk Cable

Trunk Connection - 2 wire terminal – Model



- ***Very short T-Line with Z ~ 113 Ohms***
- ***Approximately 1 inch @ Vp ~ 67%***

Trunk Connection - 2 wire terminal - RL

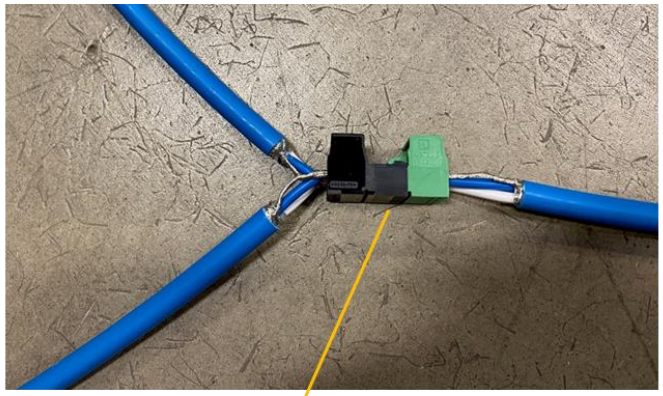


NOTE: *Comparing IL magnitude measurements between 1) and 2) was not useful due to the very low loss of the Connector. Connector IL is on the same order as the accuracy of measurement setup and calibration*

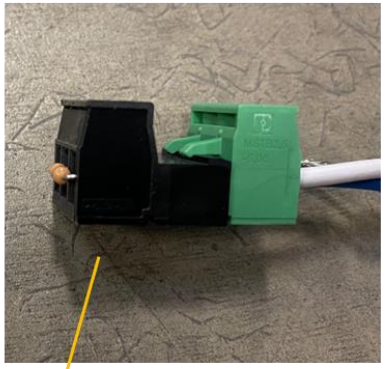
Trunk connection

Four 30 cm stubs, 60 cm separation

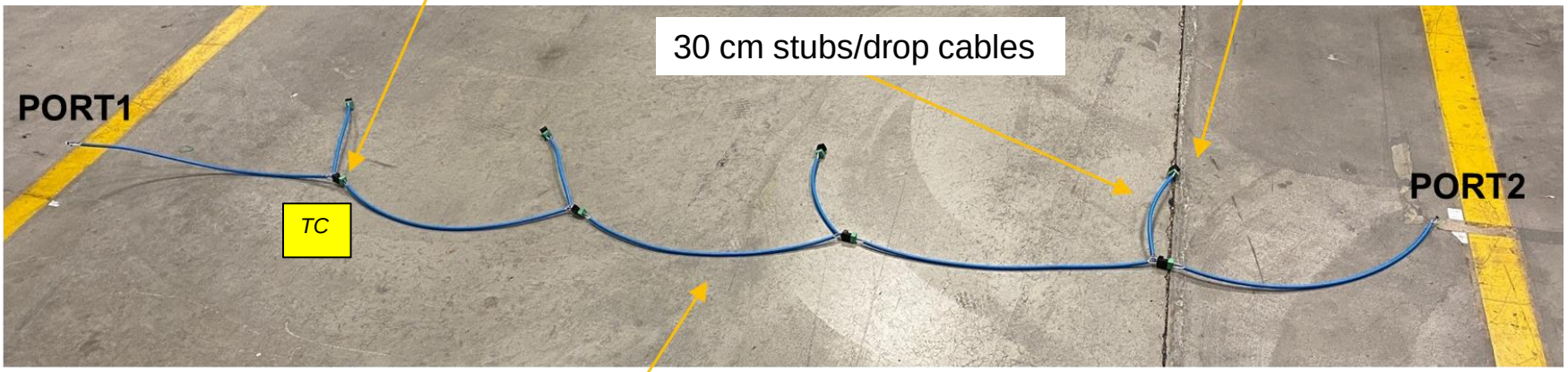
Trunk connection



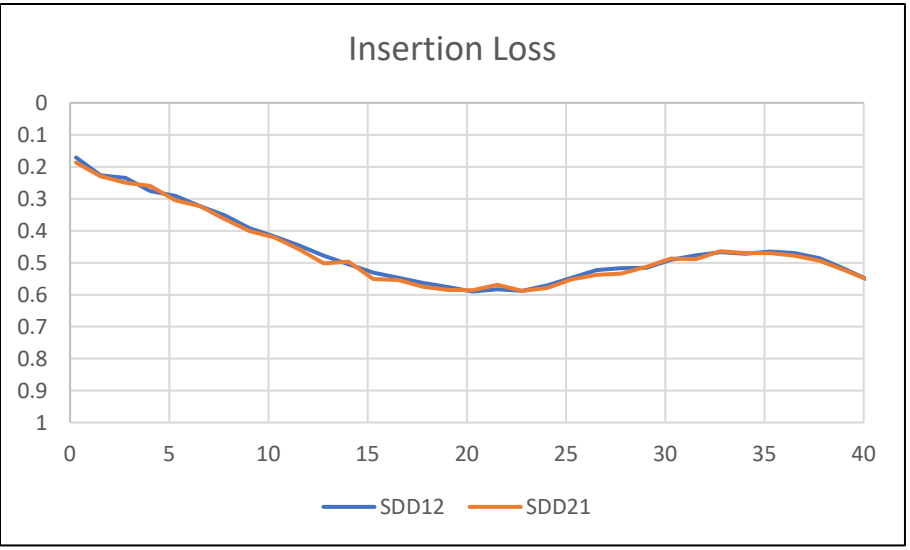
10K Load

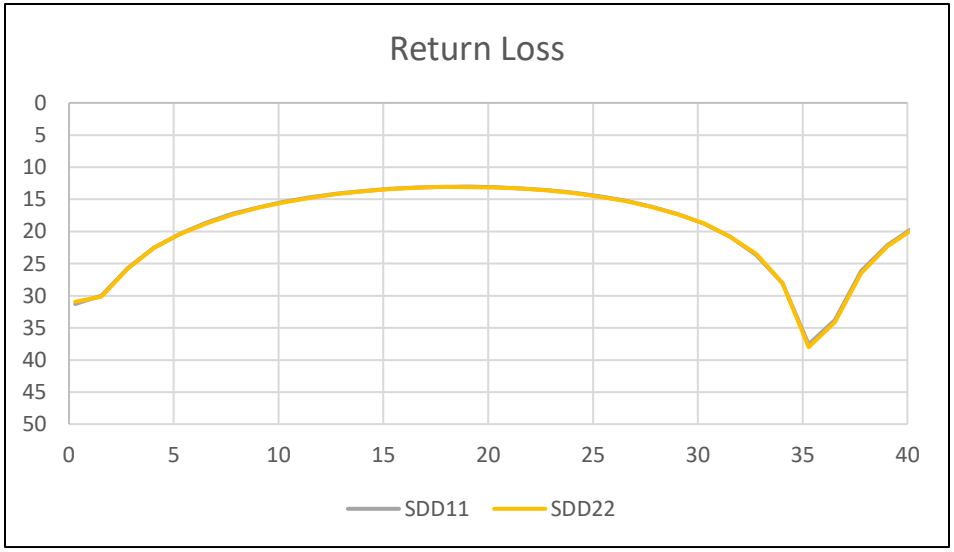


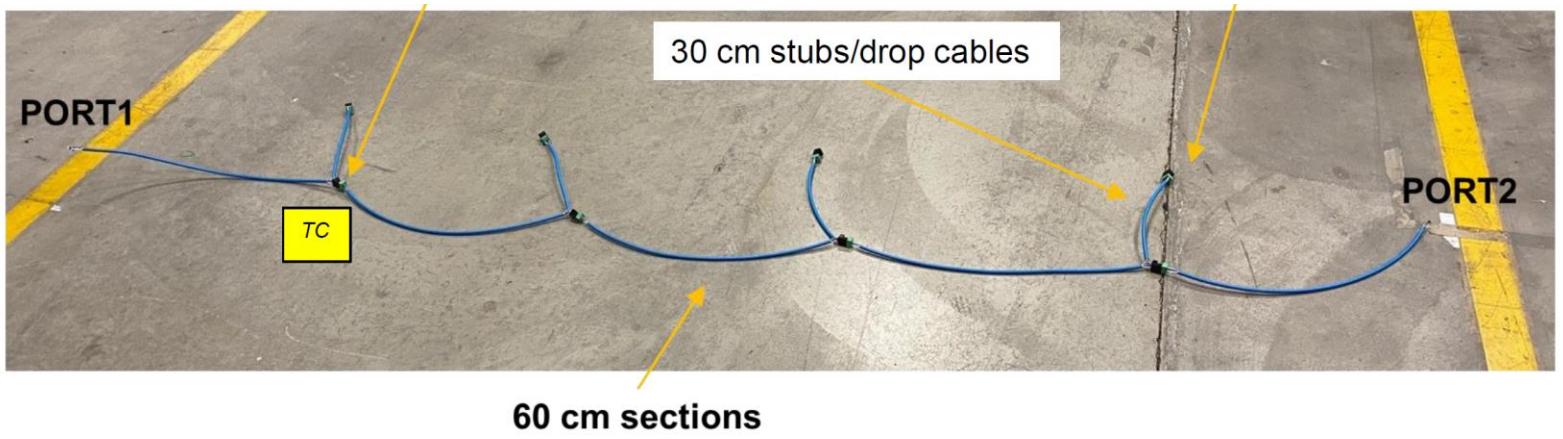
2 wire terminal connection



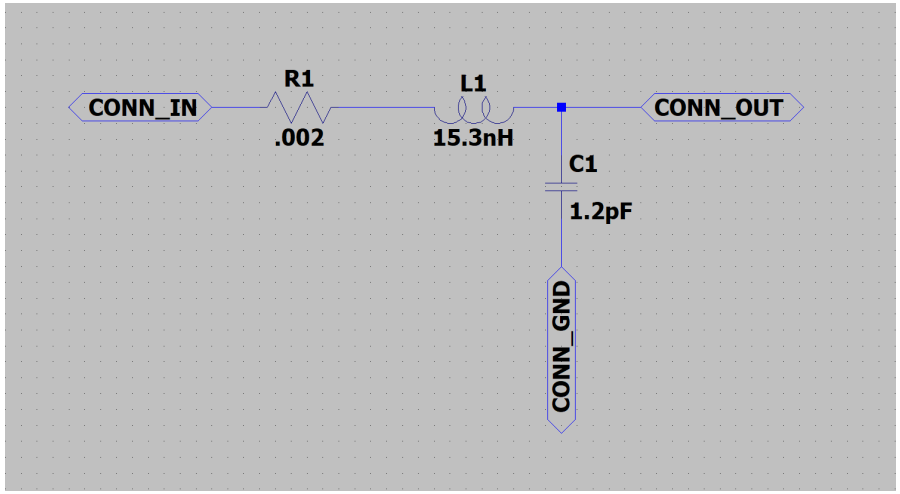
Trunk cable - trunk connection/drop cable







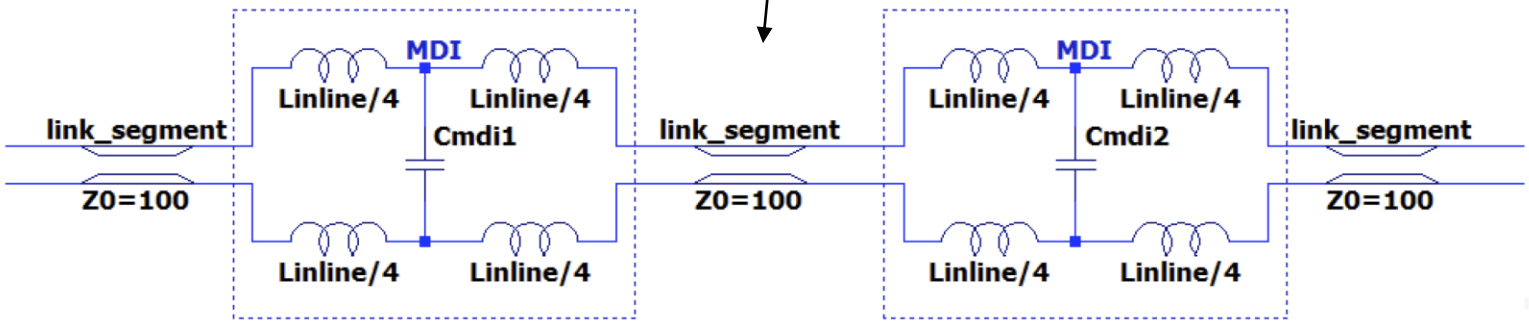
Trunk Connection - 2 wire terminal



Very short T-Line with Z ~ 113 Ohms
Approximately 1 inch @ Vp ~ 67%

Model to be updated with inline inductors

Connector with inline inductors



Source:
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Summary

- Recommendations for stub characterization/specification and measurements
- Trunk cable
  - Return Loss
  - Mode Conversion
- Trunk connection specifications TBD