802.3 Multidrop Mixing Segment Specifications

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Purpose

- Review mixing segment specifications in 147.8 with MDI attachments.
- Considerations for insertion loss and mode conversion specification references.
- Considerations for cable sectioning.
- SPE Multidrop Mixing Segment Considerations for TIA/ISO specifications.
- TDR specifications
- Not addressed: implications of tuning inductors

802.3cg Mixing Segment Specification

- Link and Mixing Segment Characteristics are the same with exception of RL reference impedance.
- Specifications referenced between any two MDI attachment points; other MDI attachments not specified.

Multidrop Mixing Segment

147.8.1 Insertion loss

The mixing segment shall meet the insertion loss characteristics specified for link segments in 147.7.1 between any two MDI attachment points.

(100 Ω Reference)

147.8.2 Return loss

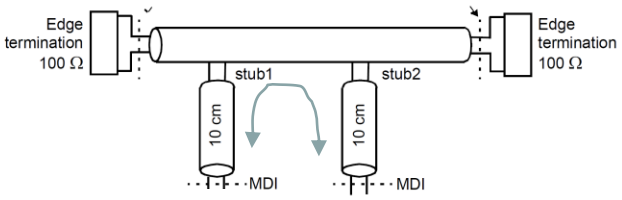
The mixing segment shall meet the return loss characteristics specified for link segments in 147.7.2 at any MDI attachment point. The reference impedance for the return loss specification is 50 Ω.

(50 Ω Reference)

147.8.3 Mode conversion loss

The mixing segment shall meet the mode conversion loss characteristics specified for link segments in 147.7.3 between any two MDI attachment points.

(100 Ω Reference)



Given the specification for either P-to-P or MD:
-IL and MC loss is measured between any two MDIs referenced to 100 Ω
-For P-to-P RL is measured referenced to 100 Ω
-For MD RL is measured referenced to 50 Ω

Link Segment (100 Ω Reference)

147.7.1 Insertion loss

The insertion loss of each 10BASE-T1S point-to-point link segment shall meet the values determined using Equation (147–3).

$$\text{Insertion loss}(f) < \begin{cases} 1.0 + \frac{1.6(f-1)}{9} & 0.3 \le f < 10 \\ 2.6 + \frac{2.3(f-10)}{23} & 10 \le f < 33 \\ 4.9 + \frac{2.3(f-33)}{33} & 33 \le f \le 40 \end{cases} \text{ dB} \qquad (147\text{–}3)$$

where

f is the frequency in MHz; $0.3 \le f \le 40$

147.7.2 Return loss

In order to limit the noise at the receiver due to impedance mismatches, each 10BASE-T1S point-to-point link segment shall meet the values determined using Equation (147–4) at all frequencies from 0.3 MHz to 40 MHz. The reference impedance for the return loss specification is 100 Ω.

$$\text{Return loss}(f) > \begin{cases} 14 & 0.3 \le f < 10 \\ 14 - 10\log_{10}\left(\frac{f}{10}\right) & 10 \le f \le 40 \end{cases} \text{ dB} \qquad (147\text{–}4)$$

where

f is the frequency in MHz; $0.3 \le f \le 40$

147.7.3 Mode conversion loss

The mode conversion loss of each 10BASE-T1S point-to-point link segment shall meet the values determined using Equation (147–5).

$$\text{Mode conversion loss}(f) > \begin{cases} 43 & 0.3 \le f < 20 \\ 43 - 20\log_{10}\left(\frac{f}{20}\right) & 20 \le f \le 200 \end{cases} \text{ dB} \qquad (147\text{–}5)$$

where

f is the frequency in MHz; $0.3 \le f \le 200$

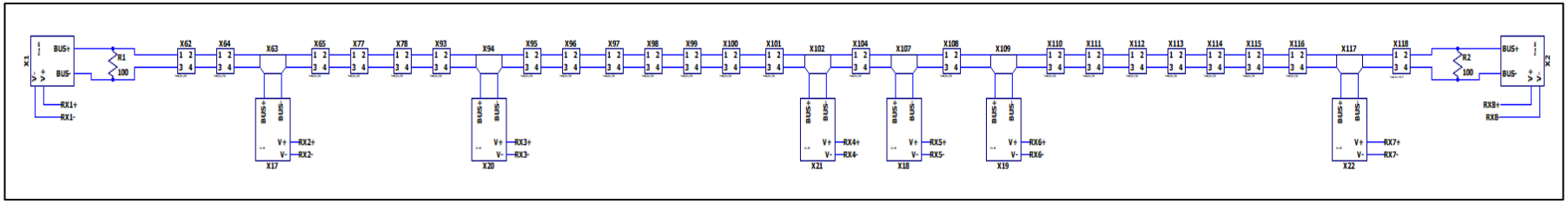
802.3cg Mixing Segment Specification and Validation

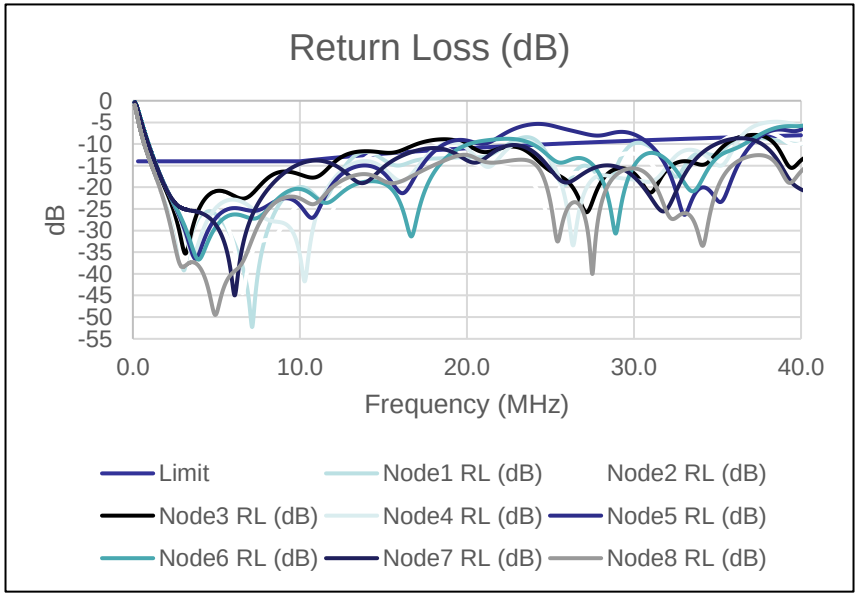
147.8.2 Return loss

The mixing segment at any MDI attachment point shall meet the return losss characteristics specified for link segments in 147.7.2. The reference impedance for the return loss specification is 50 Ω .

RL with MDI's attached

1 m 2 m 3.5 m 0.5 m 0.5 m 3.5 m 14 m



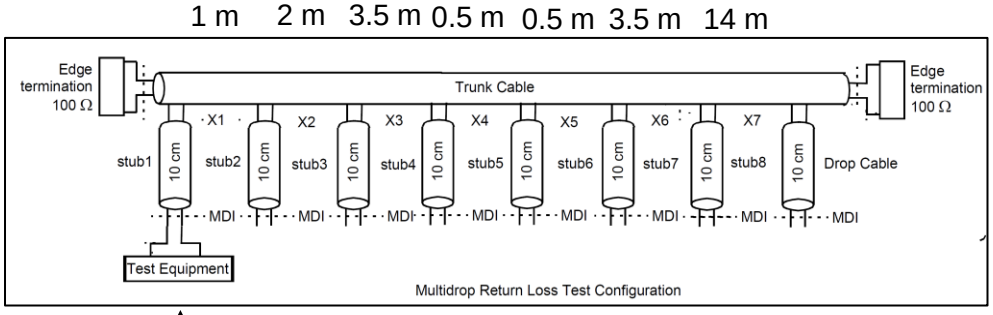


802.3cg Mixing Segment Specification and Validation

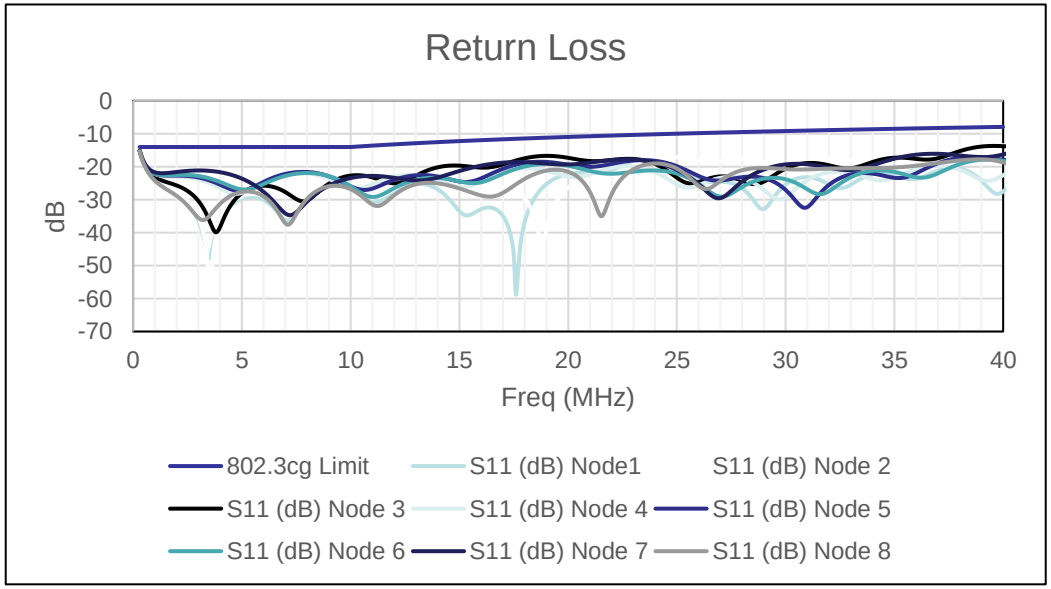
147.8.2 Return loss

The mixing segment at any MDI attachment point shall meet the return loss characteristics specified for link segments in 147.7.2. The reference impedance for the return loss specification is 50 Ω .

RL without MDI's or tuning inductors attached



RL

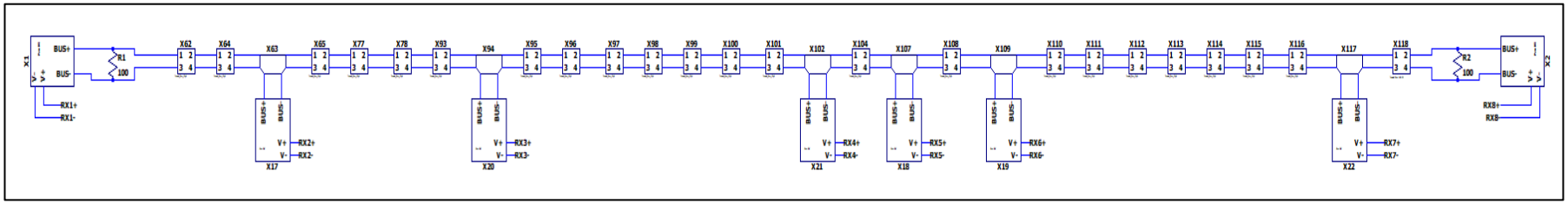


802.3cg Mixing Segment Specification and Validation

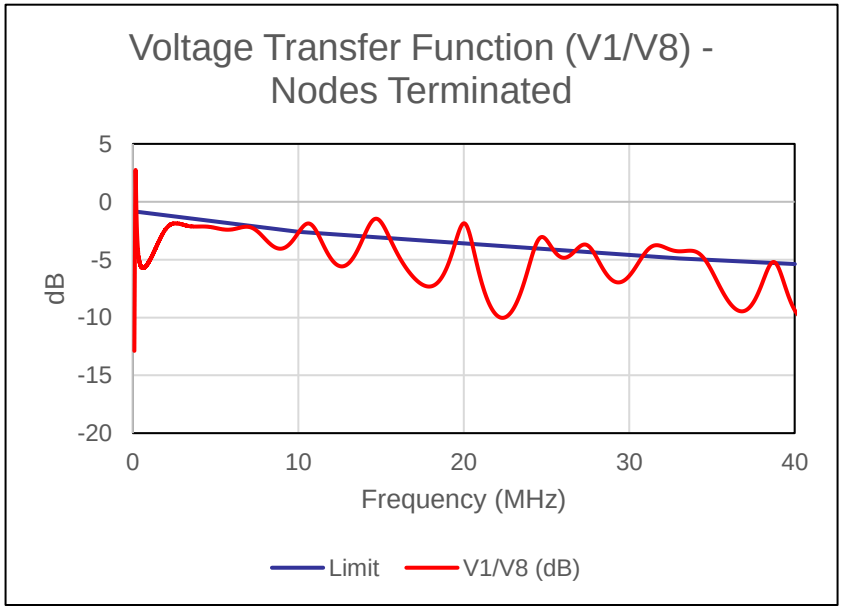
147.8.1 Insertion loss

The mixing segment shall meet the insertion loss characteristics specified for link segments in 147.7.1 between any two MDI attachment points.

1 m 2 m 3.5 m 0.5 m 0.5 m 3.5 m 14 m



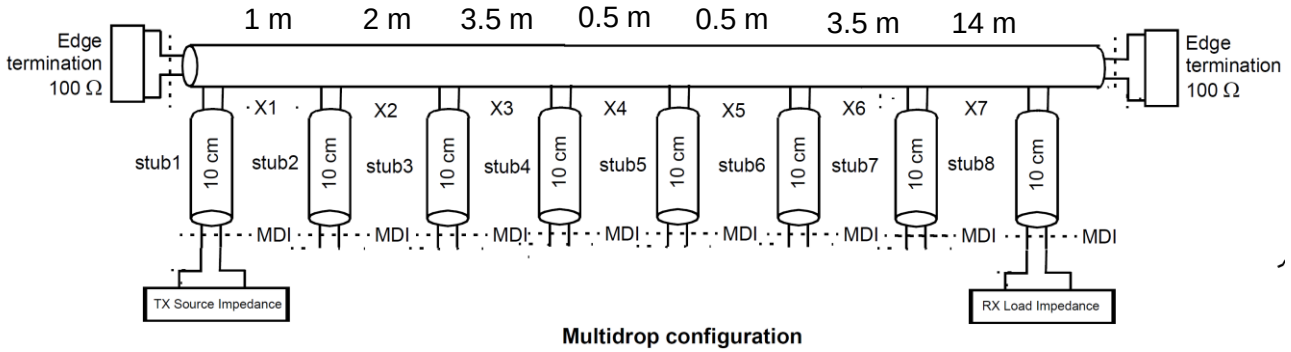
VTF with MDI's attached



802.3cg Mixing Segment Specification and Validation

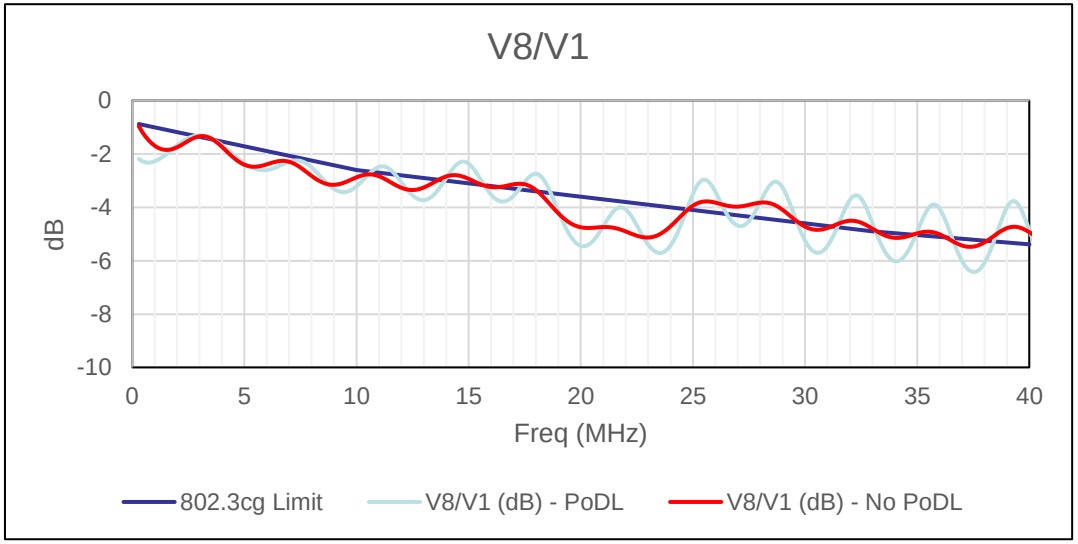
147.8.1 Insertion loss

The mixing segment shall meet the insertion loss characteristics specified for link segments in 147.7.1 between any two MDI attachment points.



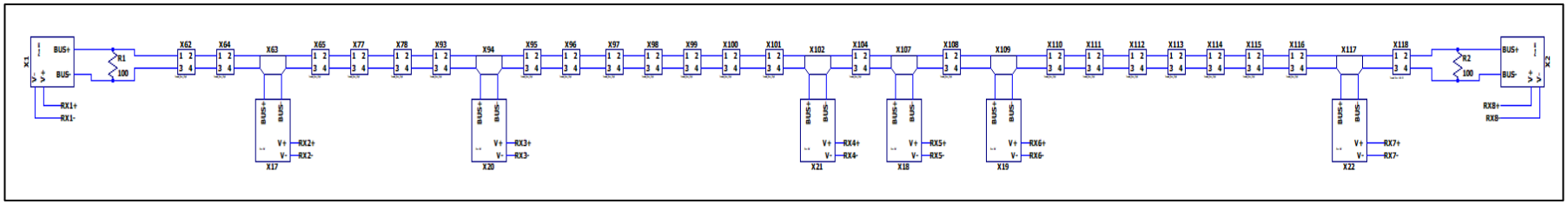
Multidrop configuration

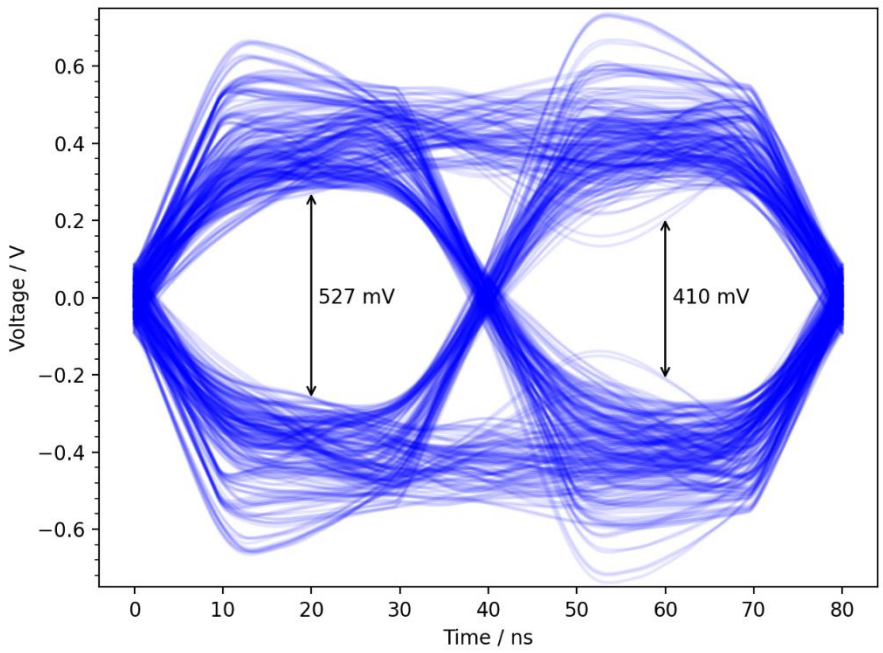
VTF without MDI's or tuning indutors attached



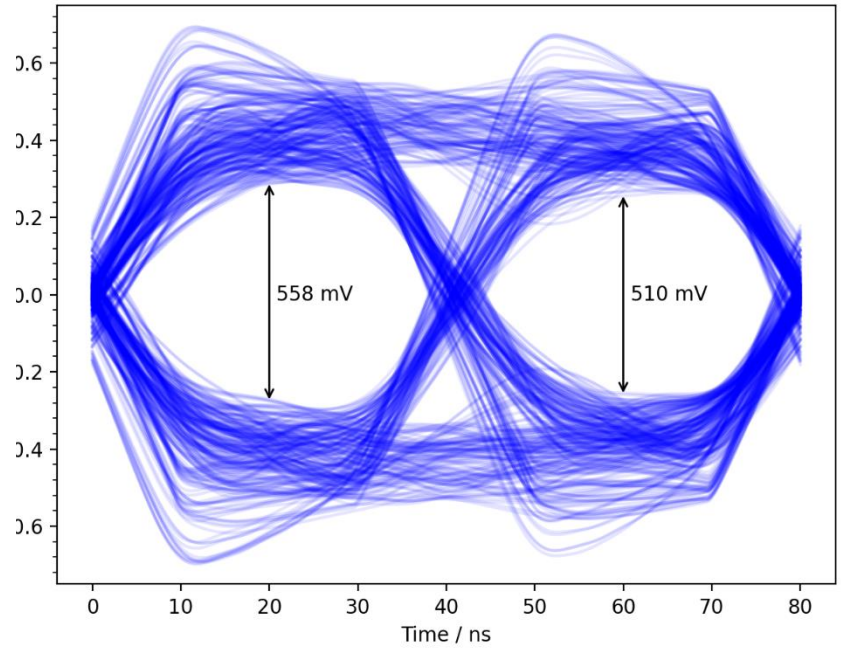
802.3cg Mixing Segment Specification and Validation

1 m 2 m 3.5 m 0.5 m 0.5 m 3.5 m 14 m



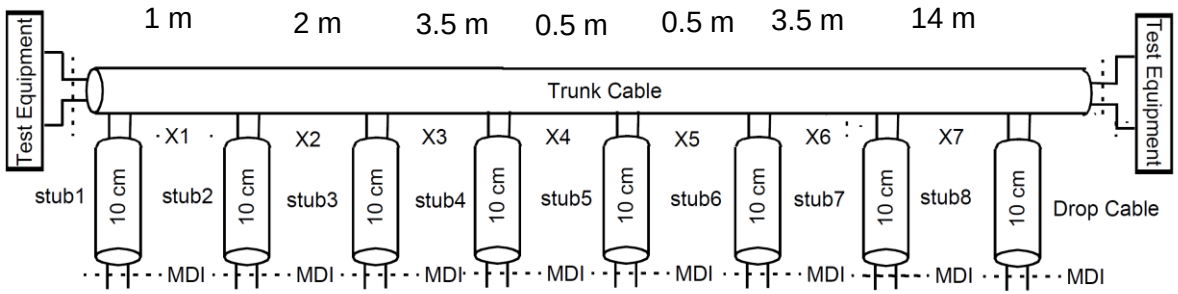


Node 8 without PoDL



Node 8 with PoDL

802.3cg Mixing Segment Specification and Validation



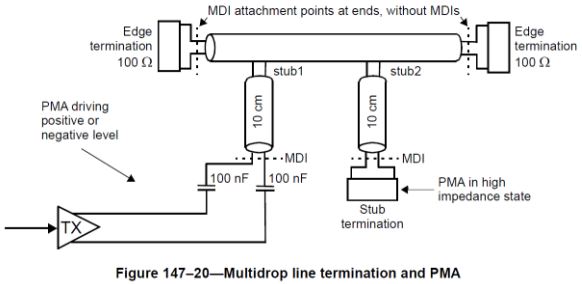


Figure 147–20—Multidrop line termination and PMA

Multidrop Configuration

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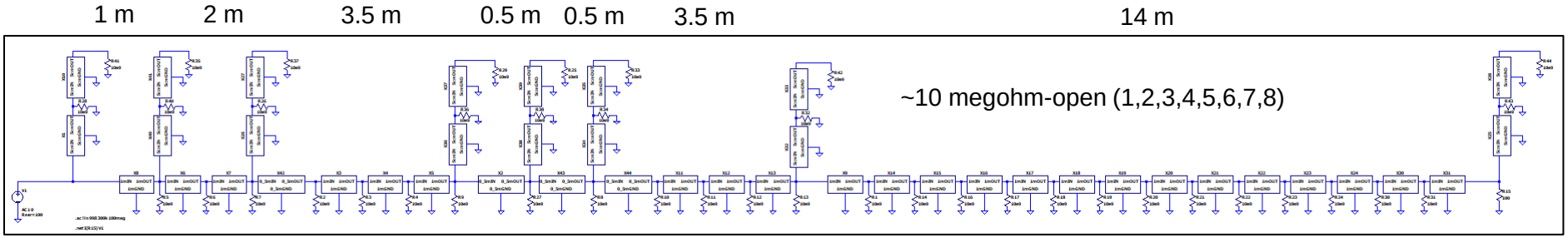


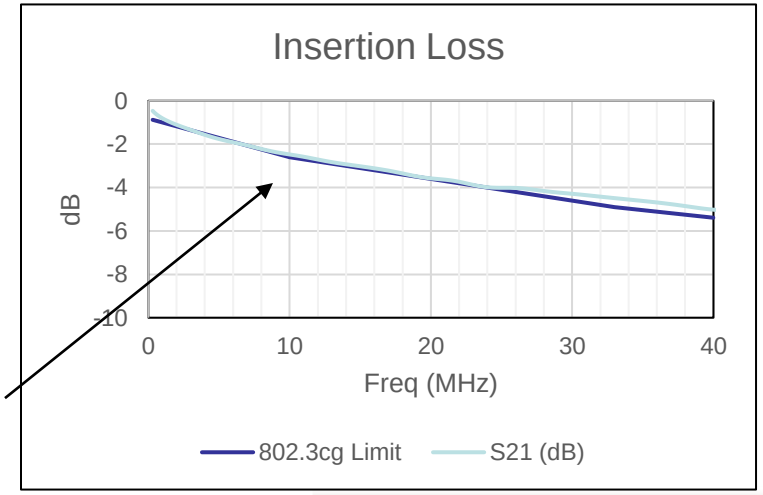
147.8.1 Insertion loss

The mixing segment shall meet the insertion loss characteristics specified for link segments in 147.7.1 between edge termination attachment points.

147.8.3 Mode conversion loss

The mixing segment shall meet the mode conversion loss characteristics specified for link segments in 147.7.3 between edge termination attachment points.

Insertion loss between edge termination attachment points all nodes open.



Cable Sectioning

- A mixing segment is a medium that may be connected to more than two Medium Dependent Interfaces (MDIs).

- 10BASE2 and 10BASE5 allow for the coaxial cable segment to be made from a number of cable sections with variation on impedance.

10BASE2- 10.7.2 Transmission system requirements

10.7.2.1 Cable sectioning

The 185 m maximum length coaxial cable segment will be made from a number of cable sections. As the variation on cable characteristic impedance is ±2 Ω on 50 Ω, a possible worst-case reflection of 4% may result from the mismatch between two adjacent cable sections.

10BASE5- 8.6.2 Transmission system requirements

8.6.2.1 Cable sectioning

The 500 m maximum length coaxial cable segment need not be made from a single, homogeneous length of cable. The boundary between two cable sections (joined by coaxial connectors: two male plugs and a barrel) represents a signal reflection point due to the impedance discontinuity caused by the batch-to-batch impedance tolerance of the cable. Since the worst-case variation from 50 Ω is 2 Ω, a possible worst-case reflection of 4% may result from the joining of two cable sections. The configuration of long cable segments (up to 500 m) from smaller sections has to be made with care.

Time Domain Reflectometry

10BASE2- 10.4 MAU–medium electrical characteristics
10.4.1 MAU-to-coaxial cable interface
10.4.1.1 Input impedance
The magnitude of the reflection from a MAU plus the cable connection specified in 10.6.3 shall not be more than that produced by an 8 pF capacitance when measured by both a 25 ns rise time and 25 ns fall time waveform. The resistance presented to the coaxial cable shall be greater than 100 kΩ.

8.3 MAU–medium electrical characteristics
8.3.1 MAU-to-coaxial cable interface
8.3.1.1 Input impedance
The magnitude of the reflection from a MAU shall not be more than that produced by a 4 pF capacitance when measured by both a 25 ns rise time and 25 ns fall time waveform. This shall be met in both the power on and power off, not transmitting states.

Source IEEE Draft P802.3/D3.2
SECTION ONE 15th March 2022

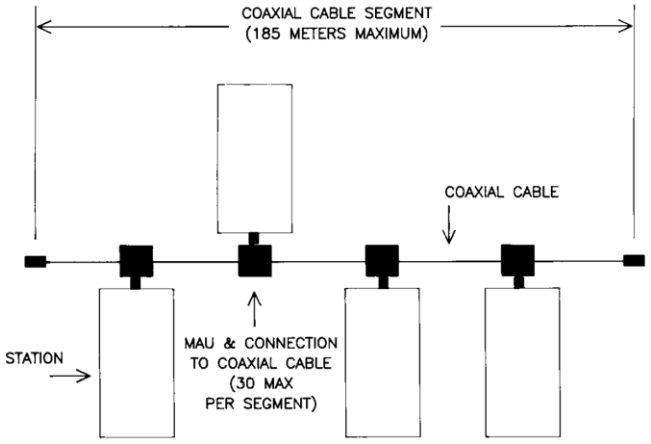
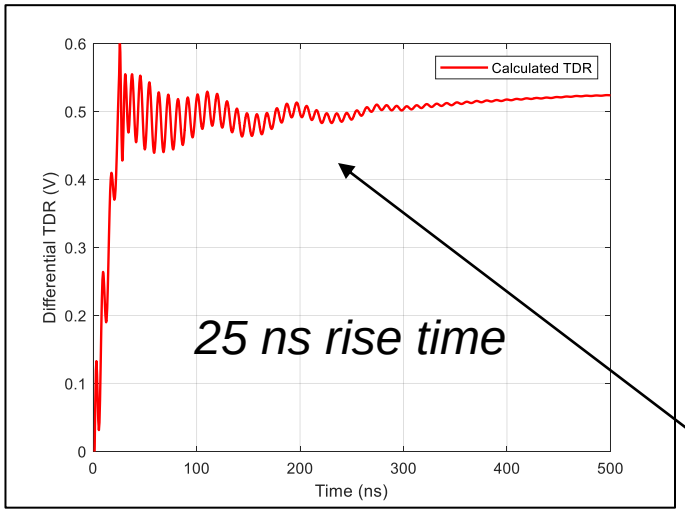


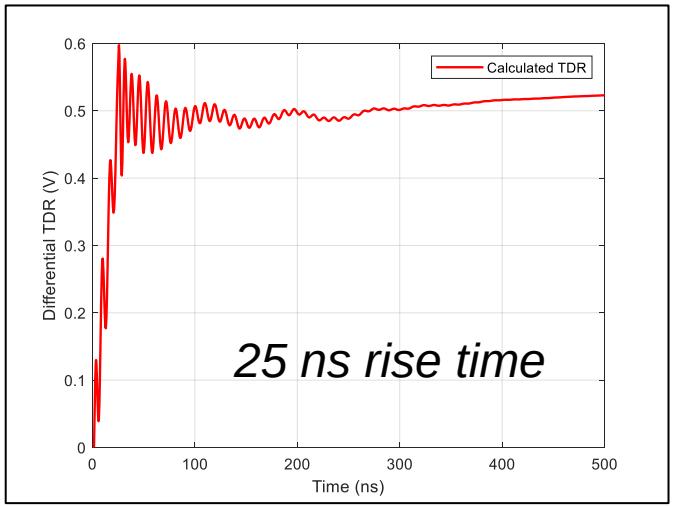
Figure 10–8—The minimum system configuration

TDR derived from RL (S-parameters)

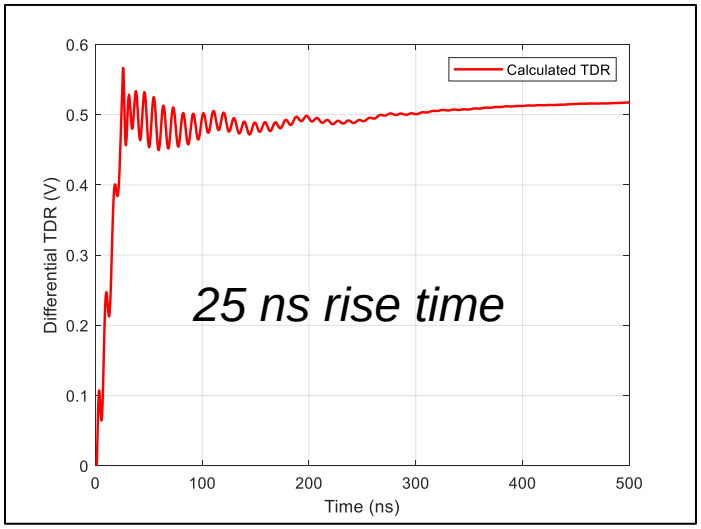
Node 7

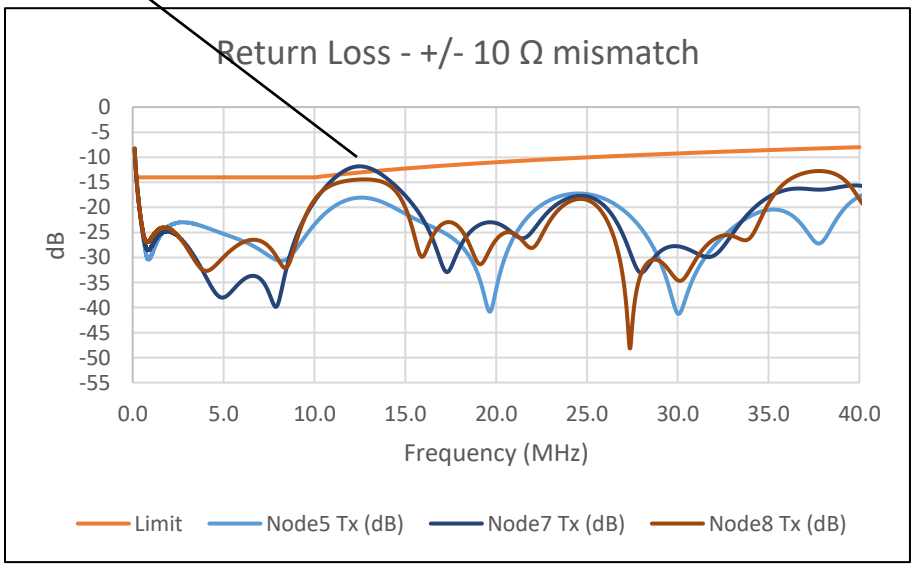


Node 8



Node 5



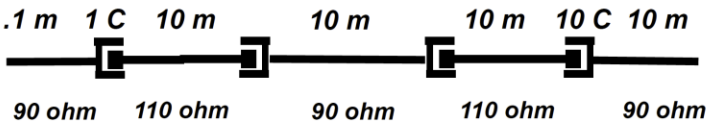


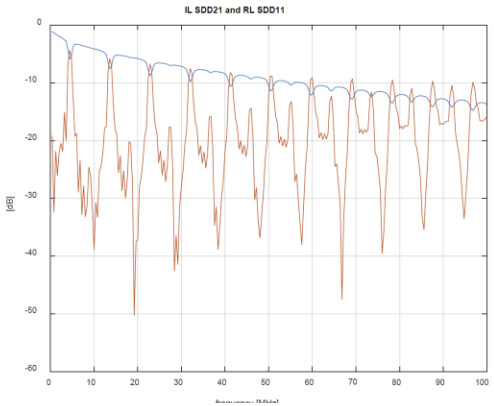
Point-to-point topologies

- Point-to-point link segments may consist of cable sections with different impedances between inline connectors as considered in developing 10BASE-T1L return loss specifications.
- Link Segment Baseline Proposal Industrial Applications IEEE 802.3 10 Mb/s SingleTwisted Pair Ethernet Task Force
  https://www.ieee802.org/3/cg/public/Mar2017/diminico_01_0317.pdf

Link Segment RL Model

- 10 connectors separated by 10 meters
- Cables +/- 10%

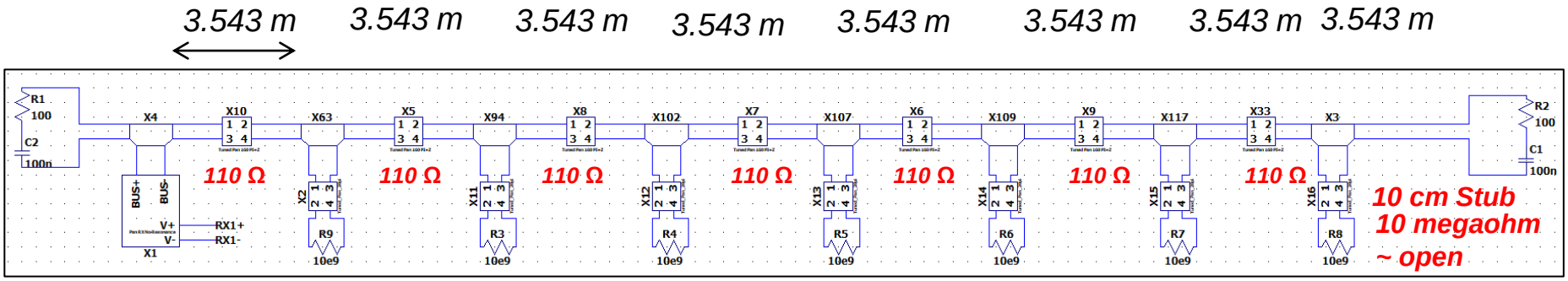




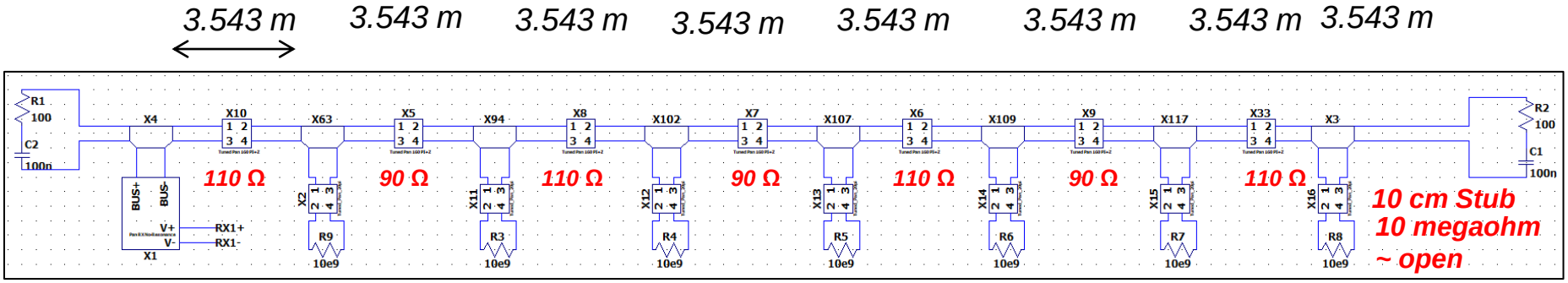
Slide 21

Mixing segment topologies - LT-spice model

- Reference 110 ohm mixing segment; 8 nodes equally spaced 3.543 m; open circuit (without MDI attached).

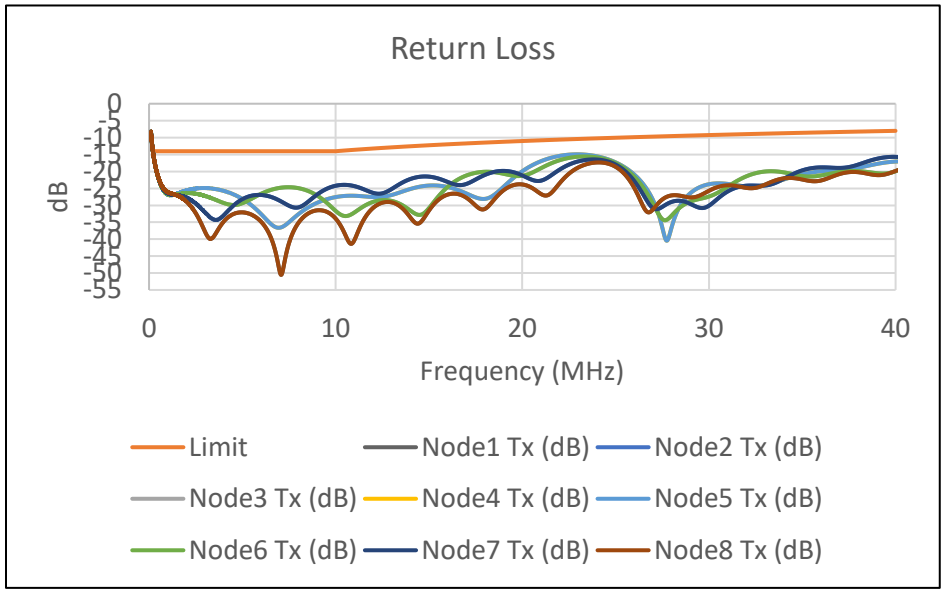


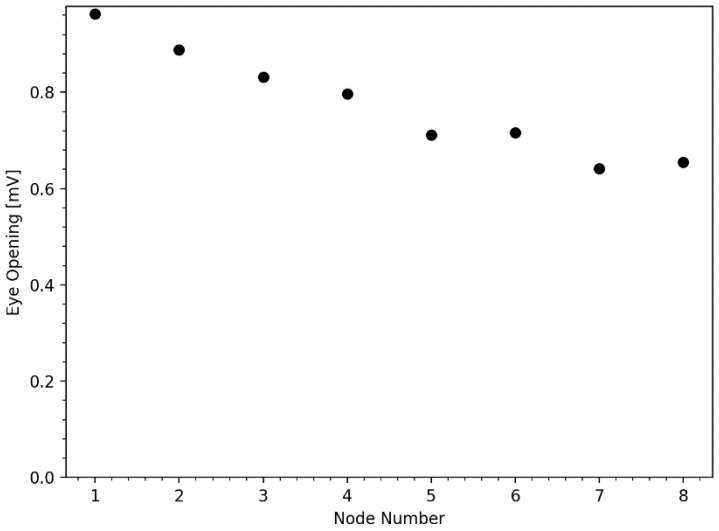
- Mixing segment considered consisting of cable sections between MDIs with variation on cable impedances of 10 Ω; 8 nodes equally spaced 3.543 m.

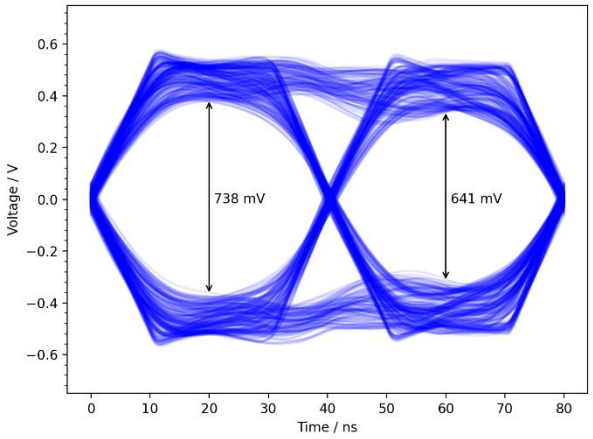


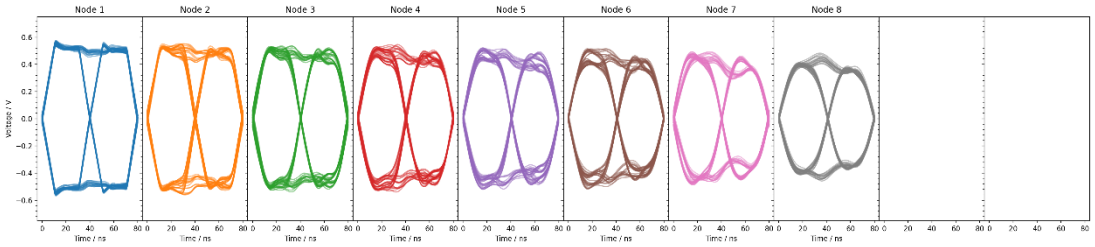
Mixing segment topologies - LT-spice model

- Reference 110 ohm mixing segment; 8 nodes equally spaced 3.543 m; open circuit 10 cm stub (without MDI attached).



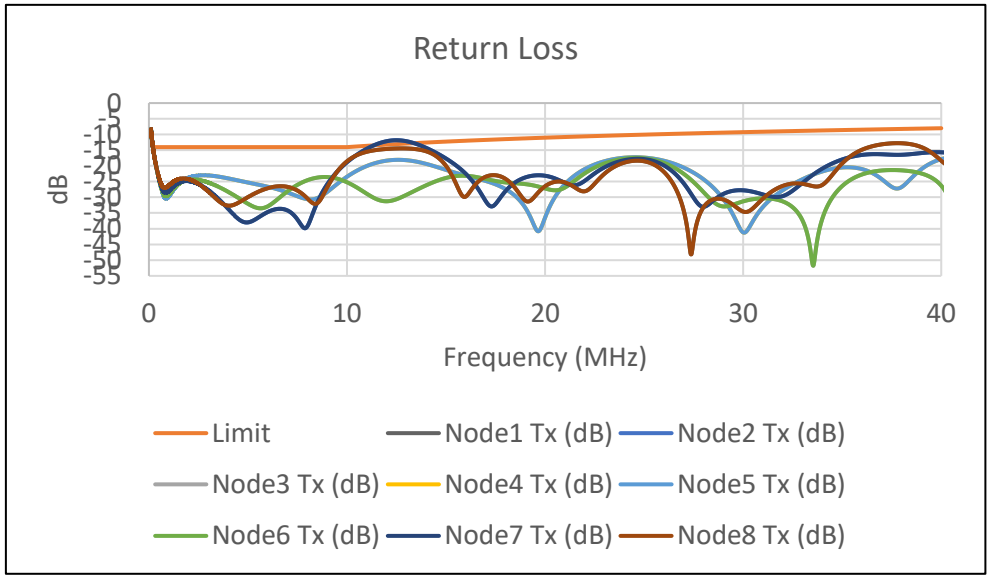


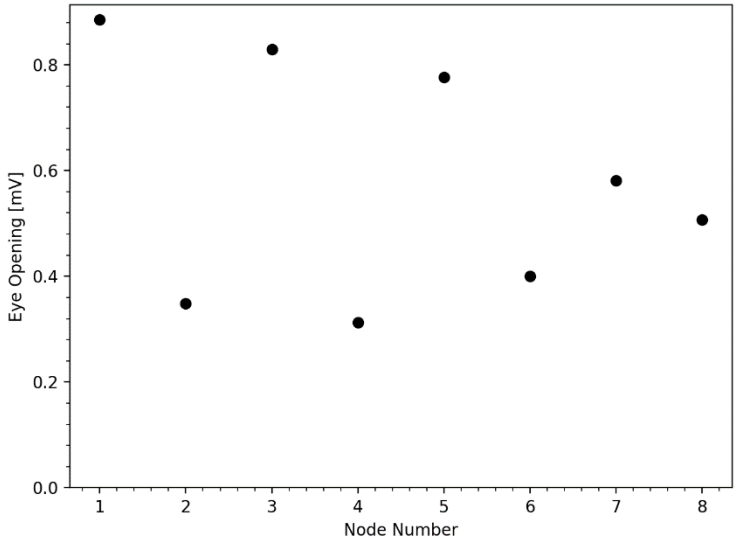


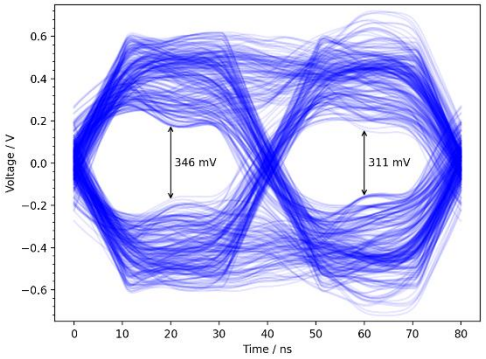


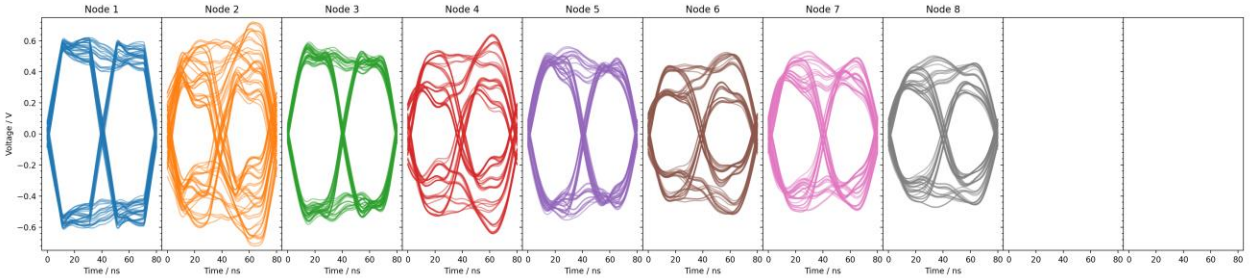
Mixing segment topologies - LT-spice model

- Mixing segment considered consisting of cable sections variation on cable impedances of 100 +/- 10 Ω; 8 nodes equally spaced 3.543 m open circuit 10 cm stub (without MDI's or tuning inductors attached).



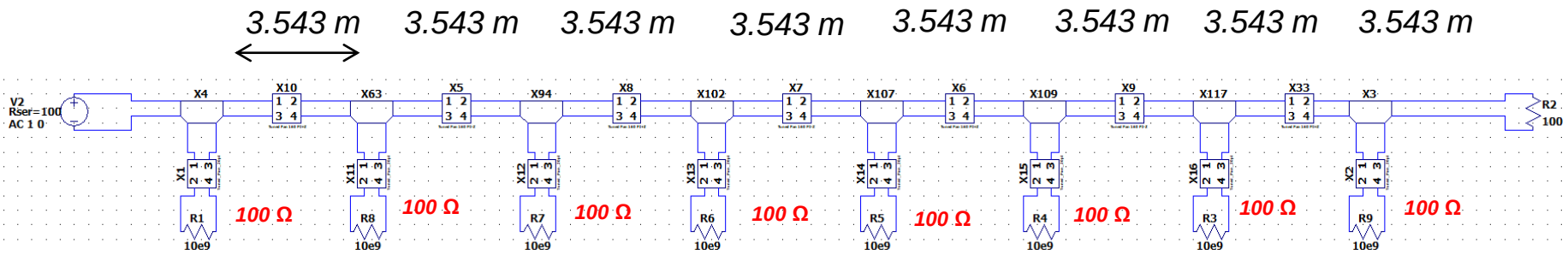






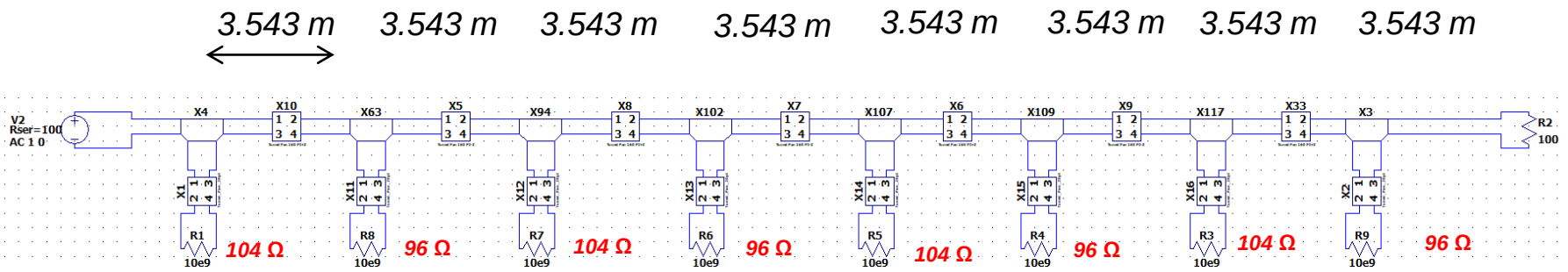
Mixing segment topologies - LT-spice model

- Reference 100 ohm mixing segment; 8 nodes equally spaced 3.543 m; open circuit (without MDI's or tuning inductors attached).



10 cm stub
10 megaohm ~ open

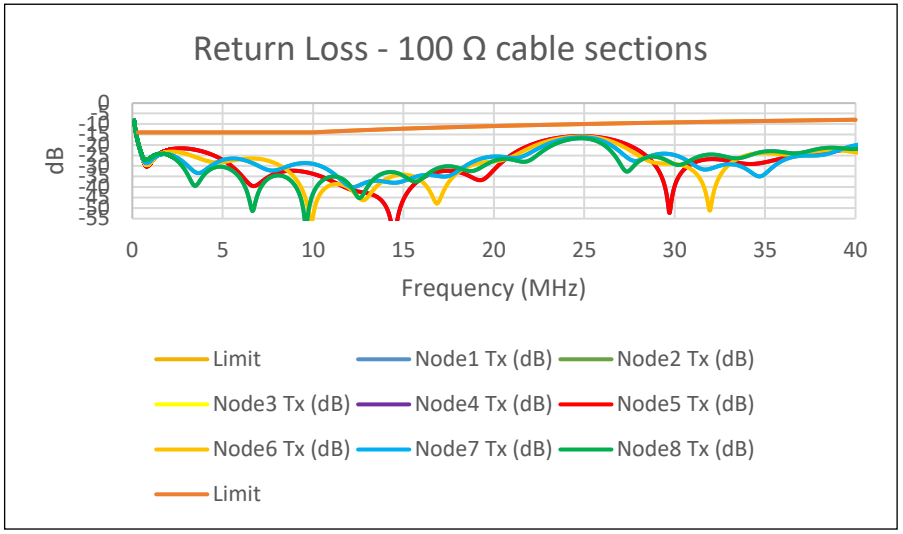
- Mixing segment considered consisting of cable sections between MDIs with variation on cable impedances of 100 +/-4 Ω; 8 nodes equally spaced 3.543 m; open circuit (without MDI or tuning inductors attached).

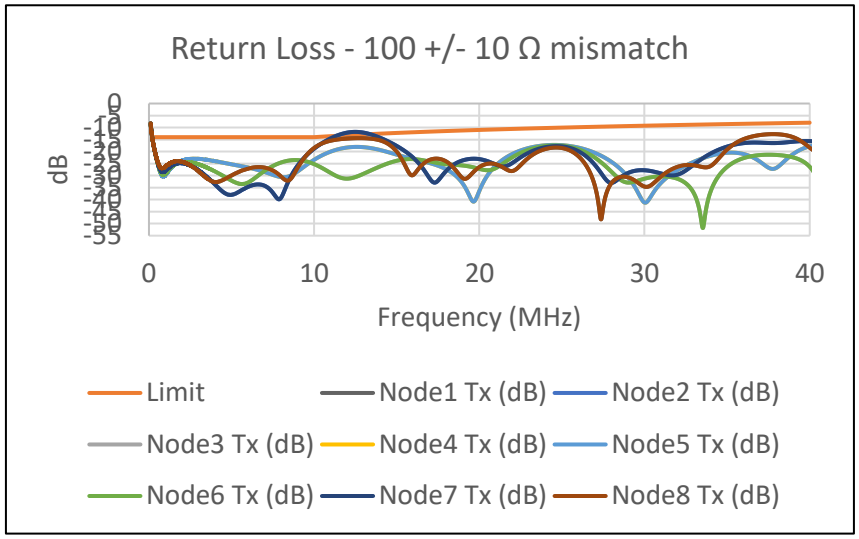


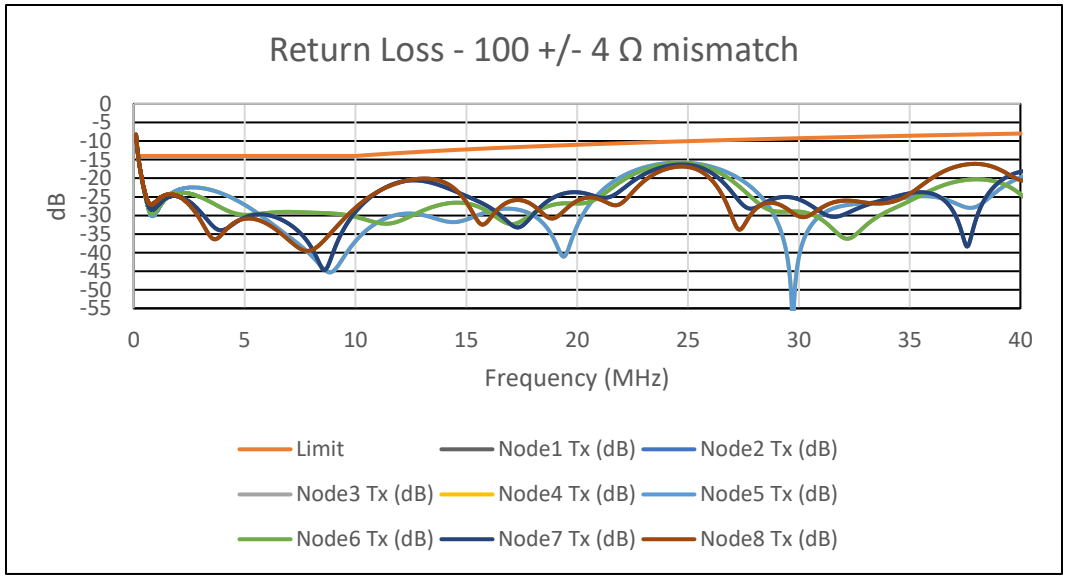
10 cm stub
10 megaohm ~ open

Mixing segment topologies - LT-spice model

Mixing segment; 8 nodes equally spaced 3.543 m; open circuit (without MDI's or tuning inductors attached).

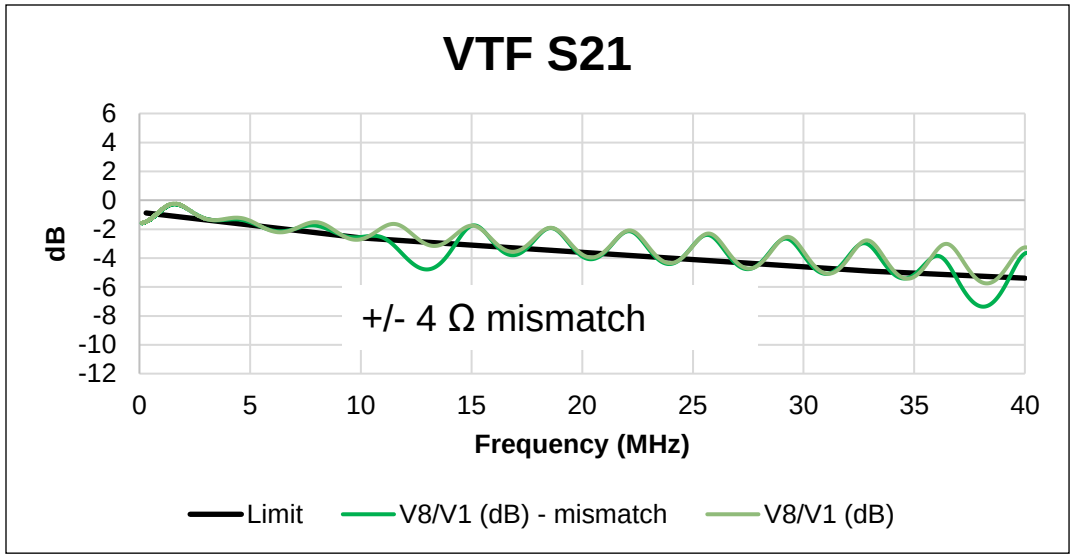


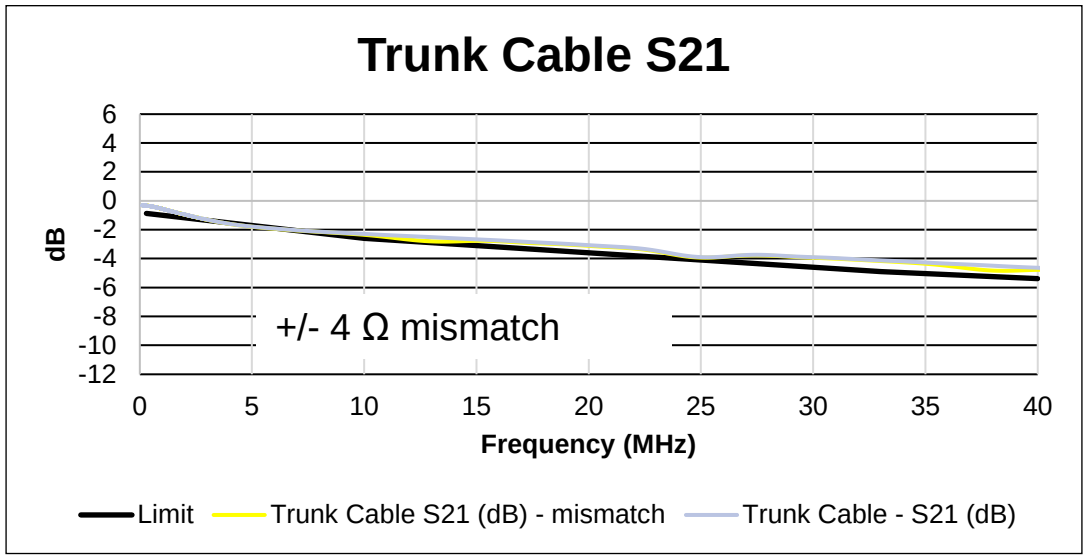




Mixing segment topologies - LT-spice model

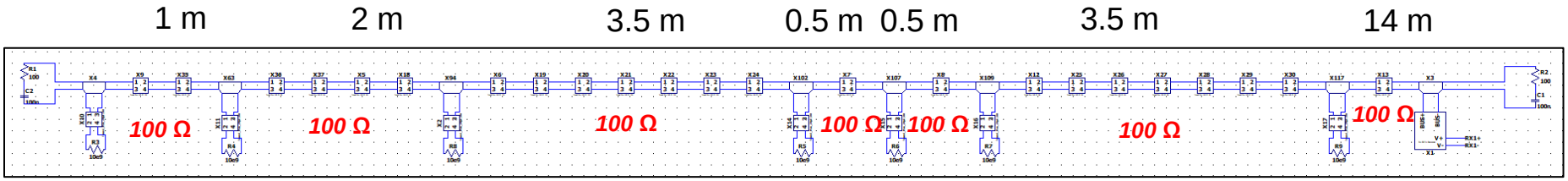
Mixing segment; 8 nodes equally spaced 3.543 m; open circuit (without MDI's or tuning inductors attached).





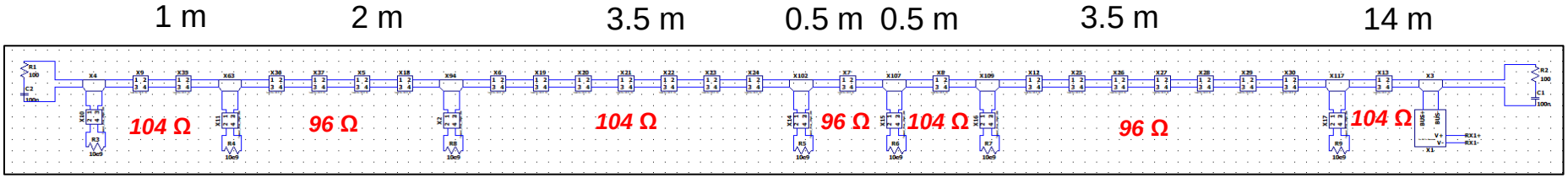
Mixing segment topologies - LT-spice model

- Reference 100 Ω mixing segment open circuit (without MDI attached).



10 cm Stub
10 megaohm
~ open

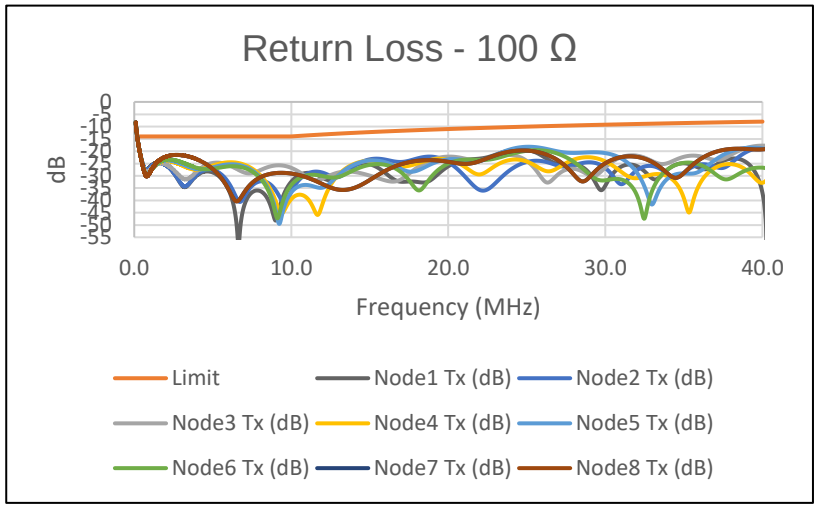
- Mixing segment considered consisting of cable sections between MDIs with variation on cable impedances of 100 +/-4 Ω.



10 cm Stub
10 megaohm
~ open

Mixing segment topologies - LT-spice model

- Reference 100 Ω mixing segment open circuit (without MDI attached).



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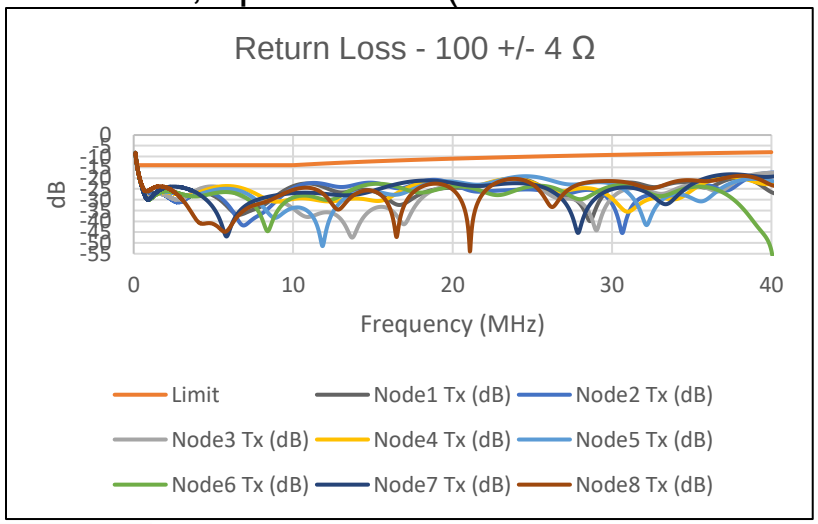
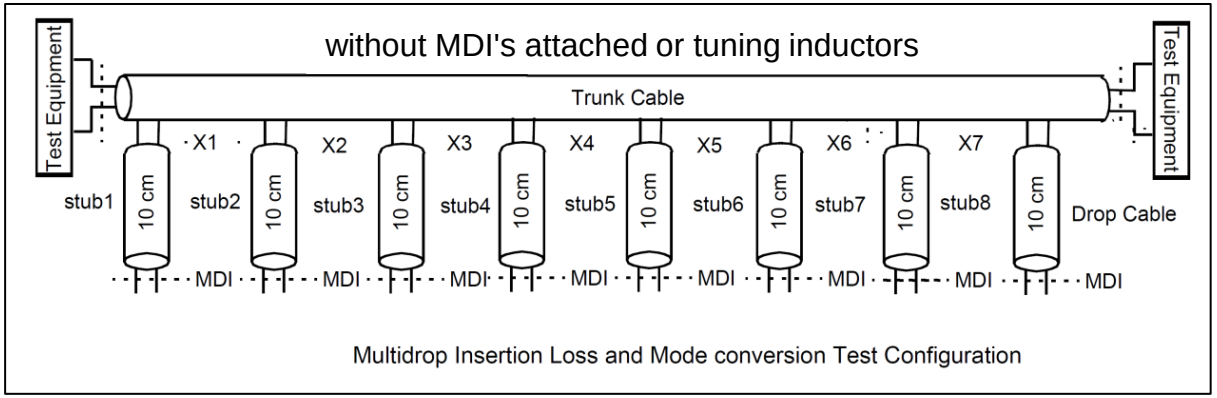


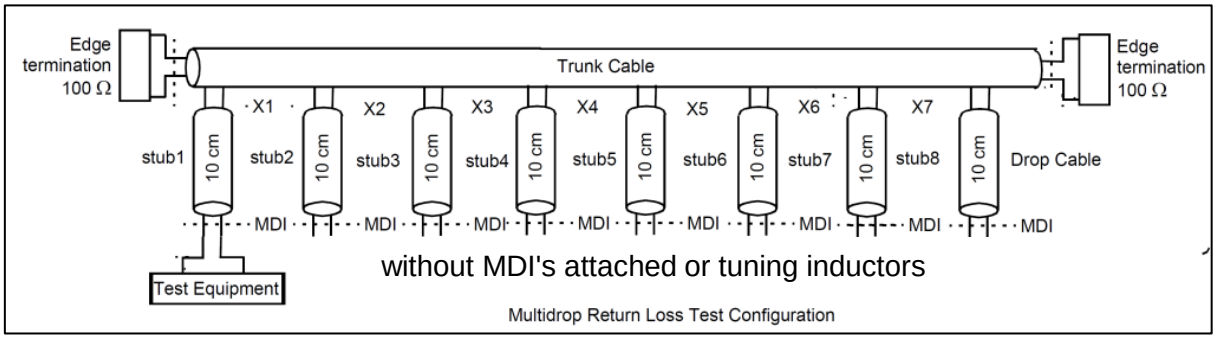
Multidrop: Mixing segment cabling

Trunk, attachment point, and trunk/drop cable can be specified independent of mixing segment enabling independent s-parameter measurements of mixing segment components.

- Cables -
  - Trunk cables (100 Ω) and cable sectioning, drop cables
  - Measurement procedures
- Connecting hardware
  - Trunk connections, plug attachments
  - Measurement procedures
- Transmission parameters
  - between (e.g., IL/CL) and into (e.g., RL) attachment points
  - measurement procedures,
  - test instruments.



Multidrop Insertion Loss and Mode conversion Test Configuration



Multidrop Return Loss Test Configuration

Summary

- Review mixing segment specifications in 147.8 related to MDI attachments.
  - Recommend mixing segment specifications are to be met without MDI attachments or stub terminations.

- Considerations for insertion loss and mode conversion specification references.
  - Recommend specifications be met between edge termination attachment points.

- Considerations for cable sectioning -
  - Trunk cable can consist of cable sections 100 Ω ±4 Ω.

- SPE Multidrop Mixing Segment Considerations for TIA/ISO specifications.

- Future work: implication of tuning inductors