SPE Multidrop Enhancements
Mixing Segment Considerations
Minimum Insertion Loss, Return Loss

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Purpose

- Mixing segment modeling updated to further investigate multidrop clumped topology node spacing versus RX correlation metric.
- Return Loss specification review - Test Points

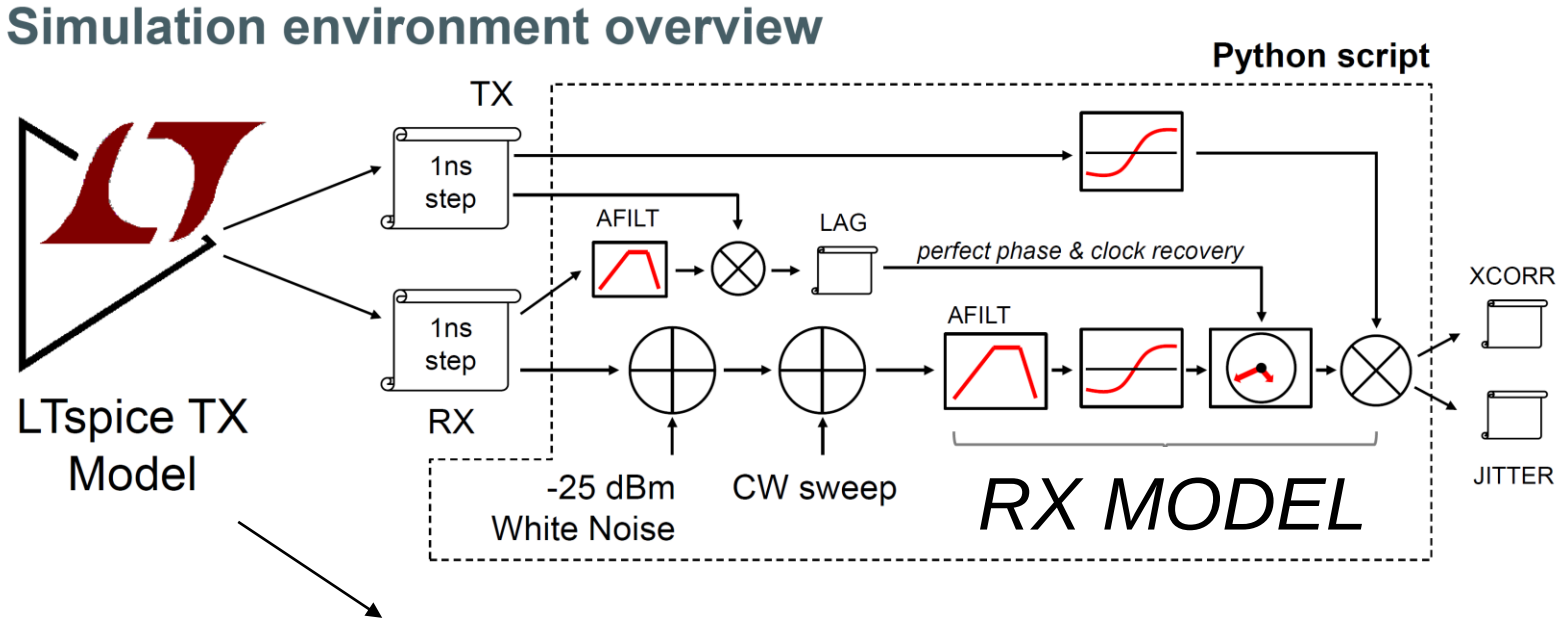
  - Source integration of TX and RX model: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf

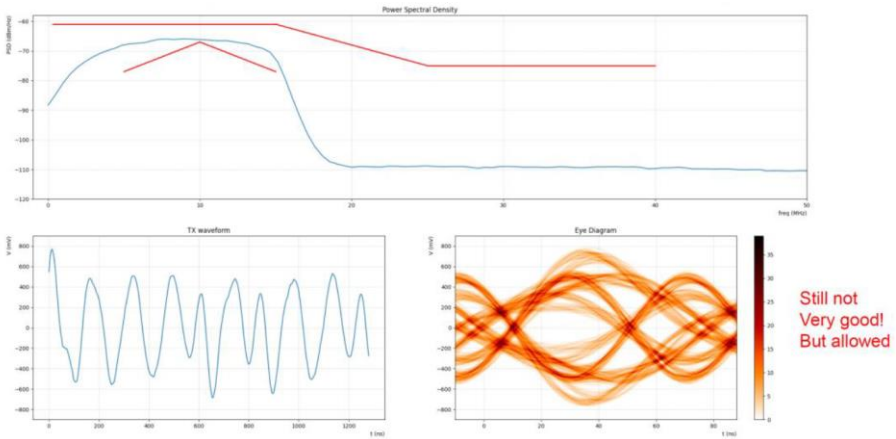
  - Source Mixing Segment Model: https://www.ieee802.org/3/da/public/0122/diminico_SPMD_01_012.pdf

  - Source TX Model: https://www.ieee802.org/3/da/public/050422/beruto_3da_20220502_tx_model.pdf

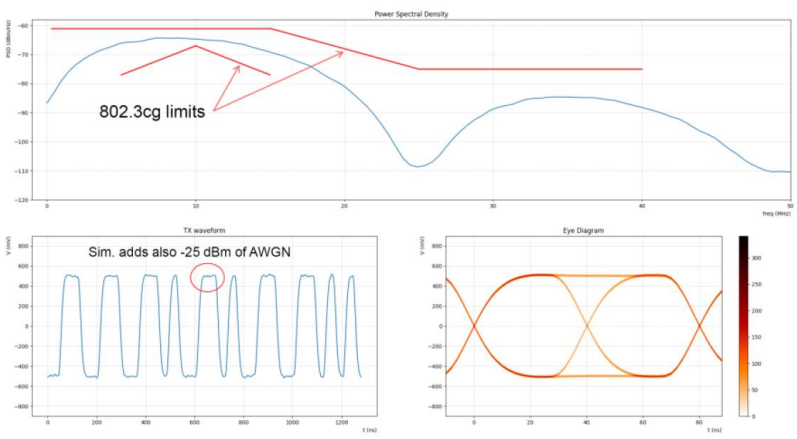
  - Source RX Model: https://www.ieee802.org/3/da/public/0722/beruto_3da_20220711_rx_model.pdf

Multidrop Topology - TX/RX models





minimally compliant TX

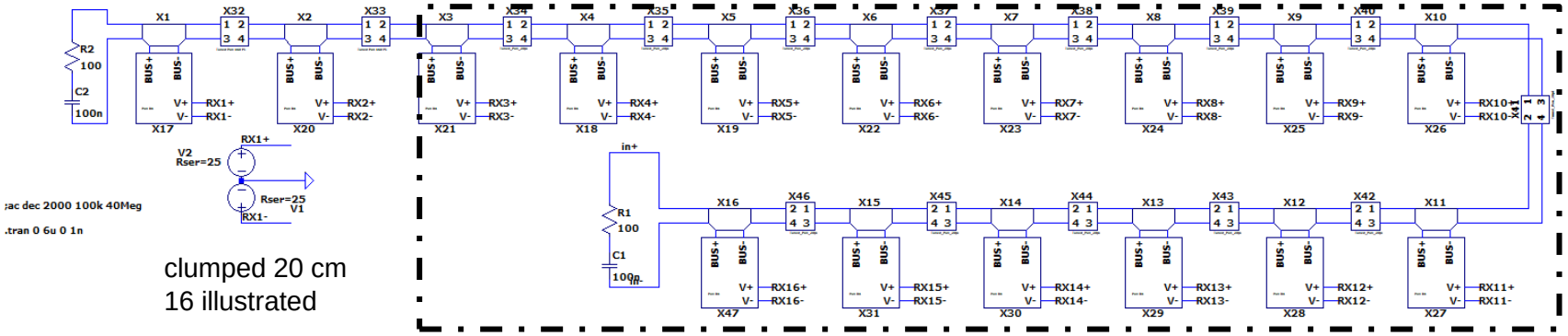


Typical TX

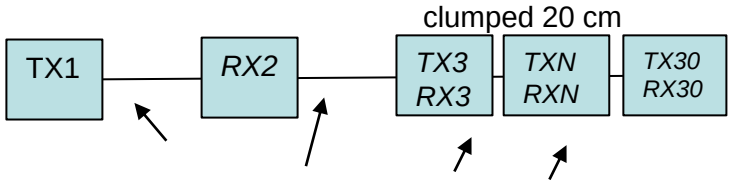
Source: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf

Multidrop Topology -75 m, 30 node, clumped

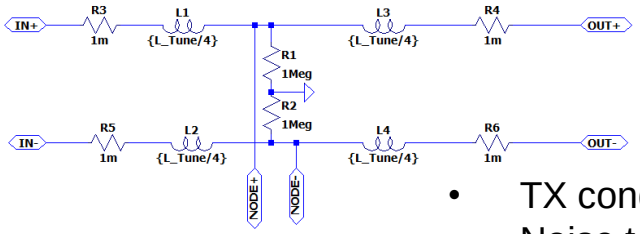
For compensated topology inductances incorporated in stub connectors



- 75 m, 30 node, clumped topology
- 80 uH, 30 pF node parasitics
- 10 cm stub lengths



4X80 nH inductances



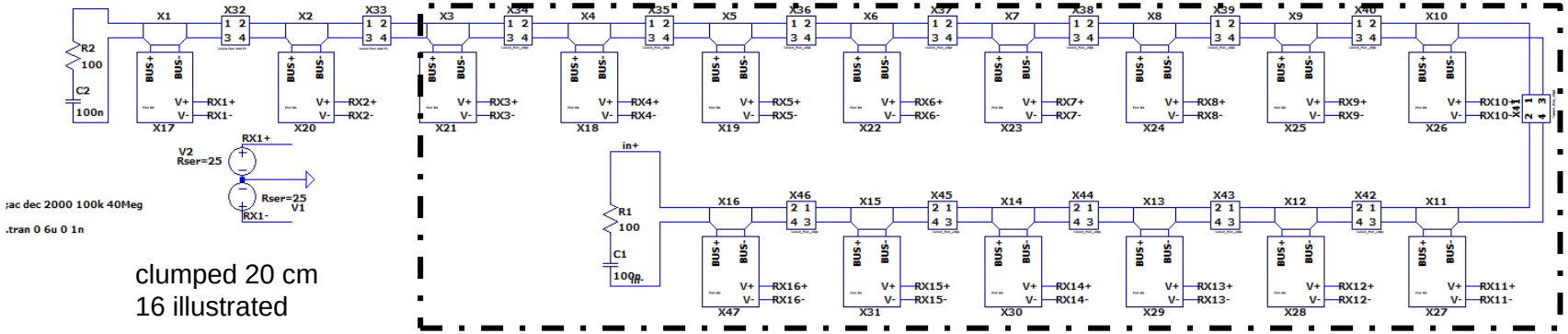
- TX condition/Compensation - CORR_MIN >0.6
- Noise tolerance with and without compensation

TX/Compensation	CWA (V)	CORR_AVG	CORR_MAX	CORR_MIN >0.65	JITTER (ns)	JITTER_MAX (ns)
MIN TX UNCOMPANSATED	0.1	0.906522	1	0.6875	5.577323	21
TYP TX UNCOMPANSATED	0.15	0.952067	1	0.65	2.654554	11
MIN TX COMPANSATED	0.15	0.909936	1	0.675	5.615945	19
TYP TX COMPANSATED	0.3	0.941119	1	0.65	3.902001	19

Source: https://www.ieee802.org/3/da/public/1122/diminico_SPMD_01_1122.pdf

Multidrop Topology -75 m, 30 node, clumped

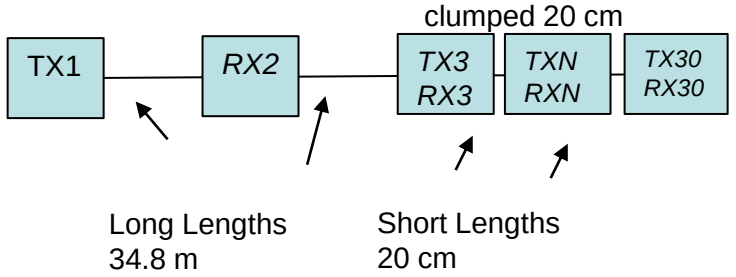
Uncompensated

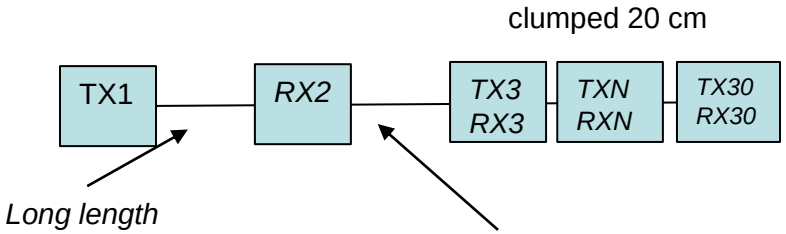


clumped 20 cm
16 illustrated

Total Length 75 m

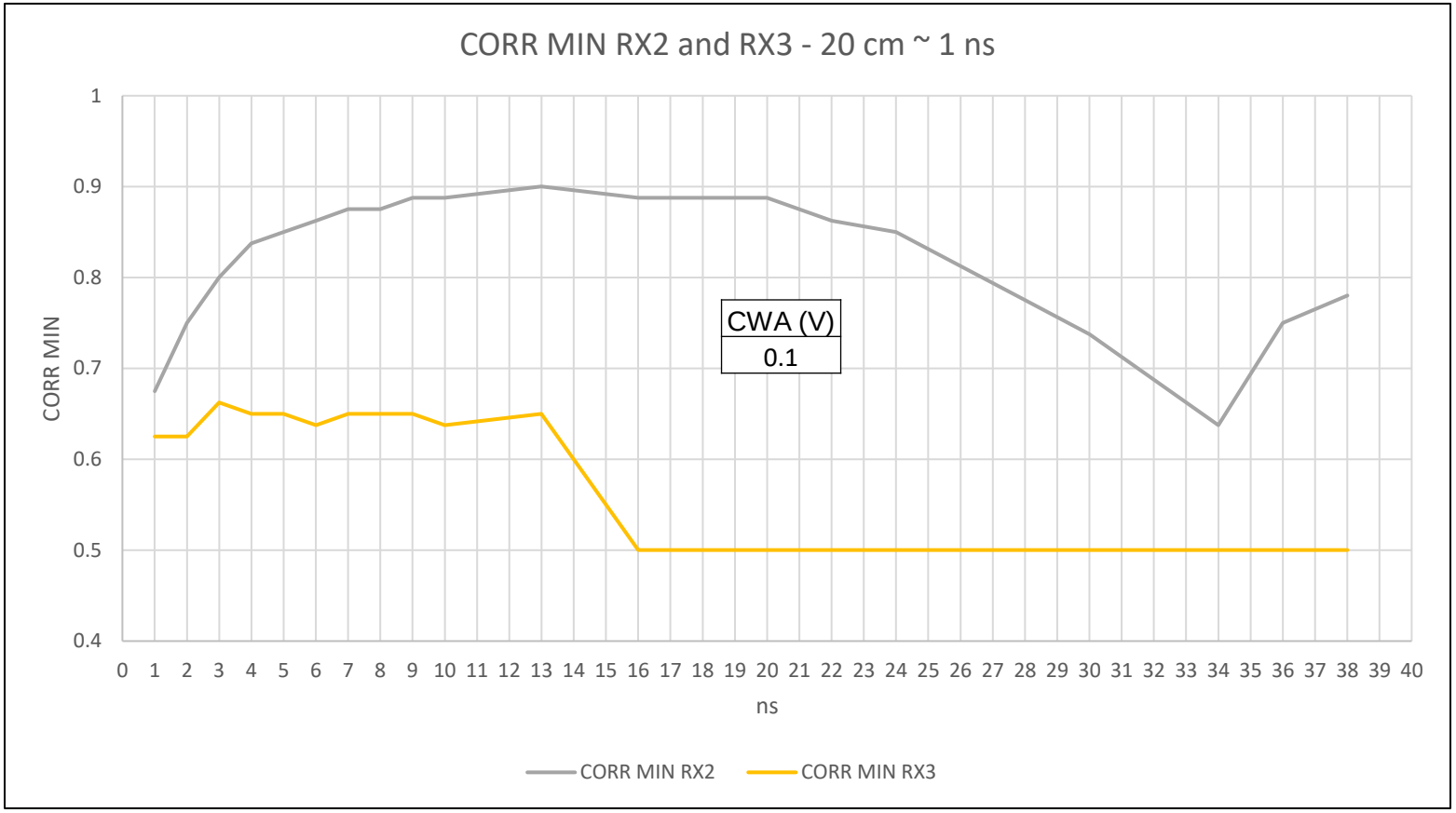
- 75 m, 30 node, clumped topology
- 80 uH, 30 pF node parasitics
- 10 cm stub lengths



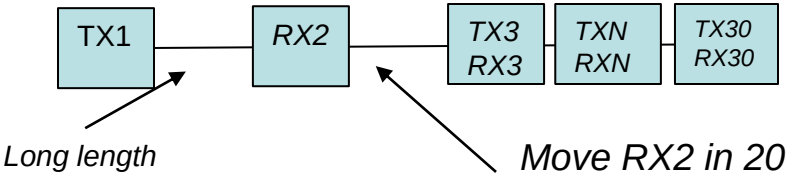


Move RX2 in 20 cm increments from RX3 adjust long length to maintain 75m
20 cm, 40 cm, 60 cm…..

Multidrop Topology -75 m, 30 node, clumped

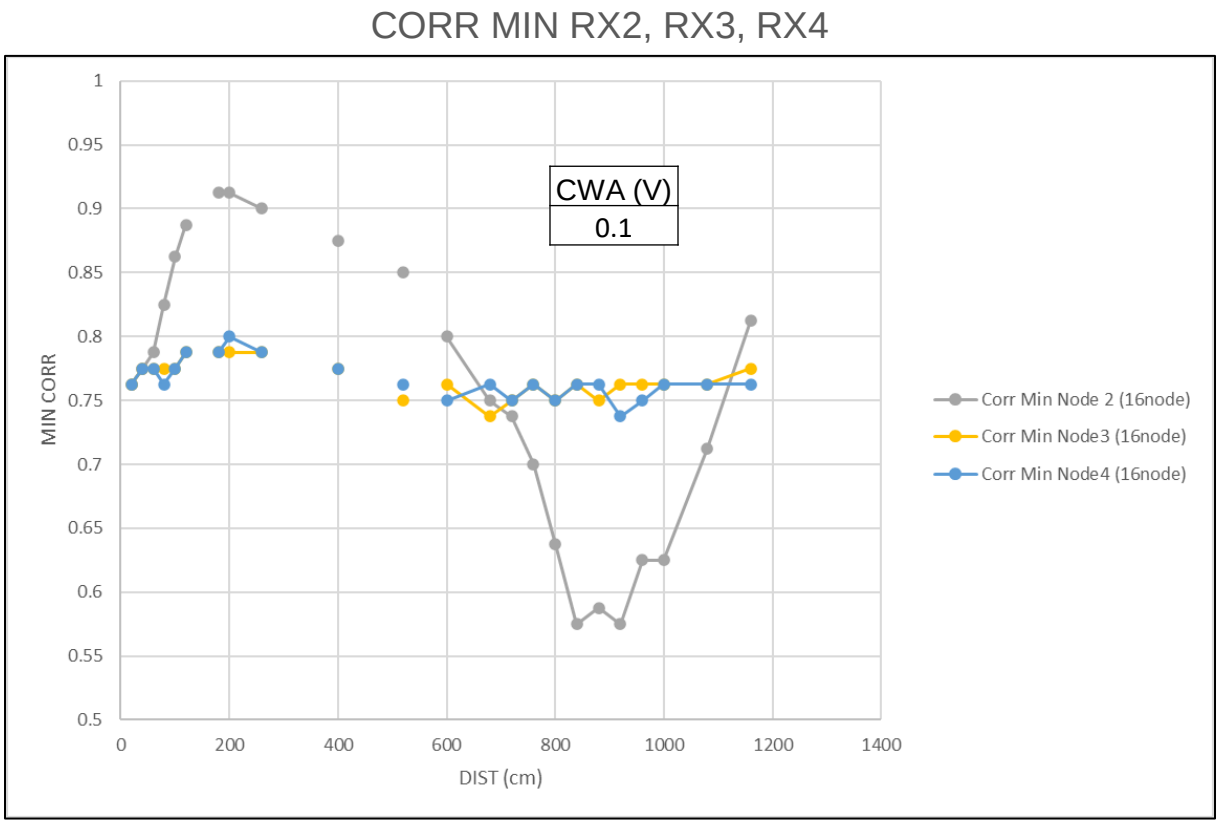


clumped uncompensated 20 cm

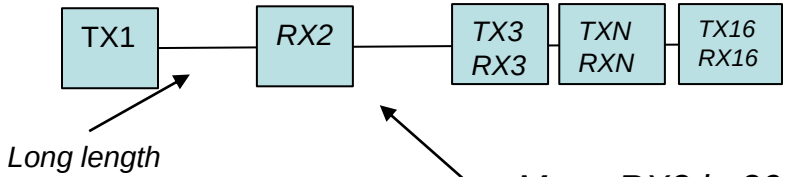


Move RX2 in 20 cm increments from RX3 adjust long length to maintain 75 m
20 cm, 40 cm, 60 cm…..

Multidrop Topology -75 m, 16 node, clumped



clumped uncompensated 20 cm



https://www.ieee802.org/3/da/802d3da_objectives.pdf
(1) Define performance characteristics of a mixing segment for 10Mb/s multidrop single balanced pair networks supporting up to at least 16 nodes, for up to at least 50m reach.

Move RX2 in 20 cm increments from RX3 adjust long length to maintain 75 m …20 cm, 40 cm, 60 cm……

Next steps(s) modeling

- Source of reflections impedance mismatch(s)
  - Node impedance(s)
  - Cable impedance(s)
- Magnitude
  - Phase of node reflections - node separation
  - Insertion loss between reflections

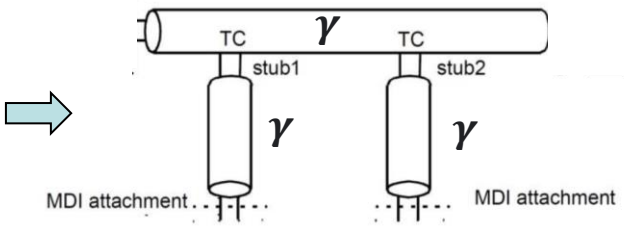
Source: TR42-7-2014-Category 8 channel length scaling.pdf (2014)

$$RLcnx_k := -20 \cdot \log\left[\left|\exp\left(-2 \cdot \gamma_k \cdot x_1\right) \cdot 10^{-\left(\frac{RLconn_k}{20}\right)} + \exp\left(-2 \cdot \gamma_k \cdot x_3\right) \cdot 10^{-\frac{RLconn_k}{20}}\right|\right]$$

k= f(Mhz)
γ= propagation constant of cable
X=cable length

$$RLch_k := -10 \cdot \log\left[10^{-\left(\frac{RLcbl_k}{10}\right)} + 10^{-\left(\frac{RLcnx_k}{10}\right)}\right]$$

- Modeling to evaluate minimum insertion loss -
  - between nodes
  - stub



Mixing Segment Review - Return Loss

168.6 Mixing segment characteristics

10BASE-T1M PHYs are designed to operate over media that meet the requirements specified in this subclause. The 10BASE-T1M mixing segment (1.4.331) is a single balanced pair of conductors that may have more than two MDIs attached.

Figure 168–x shows an example mixing segment with reference points. The mixing segment specifications in 168.6 are referenced to these designated points and are to be met without the MDI or other loads attached. The mixing segment specifications are based on a trunk-stub configuration. Other configurations may be possible, provided they meet the electrical parameters in this 168.6. The example configuration assumes that the trunk comprises TBD m of 1.02mm (18 AWG) 100 Ω cabling and the stubs are 100 Ω balanced pairs of conductors up to 30 cm long. The trunk is terminated at each end into 100 Ω, at a point designated the 'edge termination'. One end of the stub is designated the trunk connection (TC) and the other designated the 'MDI attachment point'.

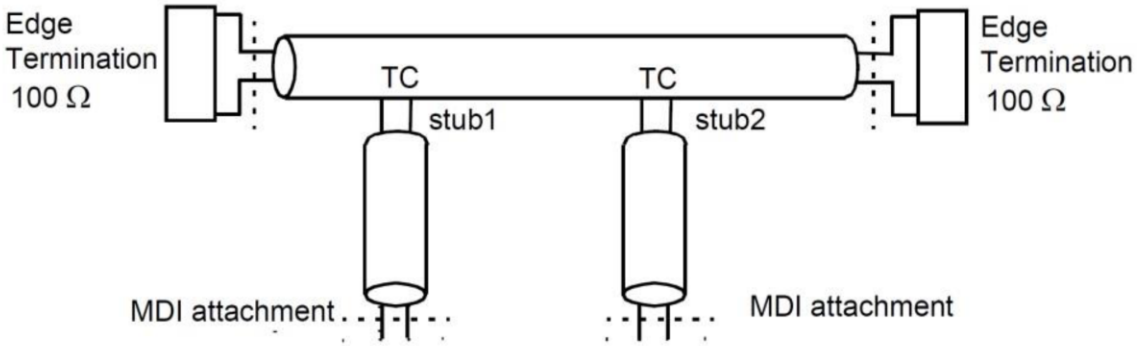


Figure 168–x Mixing segment and reference points

https://www.ieee802.org/3/da/public/062922/diminico_SPMD_02_06292022.pdf

168.6 Mixing segment characteristics

168.6.1 Insertion loss and delay

The mixing segment insertion loss is specified by independently meeting the requirements specified in this section for trunks and stubs. The stub time delay is specified to limit reflective resonances.

The mixing segment insertion loss, without the MDI or other loads attached, shall meet the values determined using Equation (168–xxa) between edge termination attachment points. The reference impedance is 100 Ω.

$$IL \geq TBD \qquad \text{Equation (168–xxa)}$$

$$0.3 \leq f(MHz) \leq 40$$

Editor's Note (to be removed prior to Working Group ballot):
The need for additional specifications to be considered to assess MDI attachments with compensation are needed; see.
https://www.ieee802.org/3/da/public/102021/Koczwara_3da_01_102021.pdf
The need for additional specifications to be considered to assess the IL and Mode Conversion of the trunk/stub connection point with and without the inductive compensation to be considered; see.https://www.ieee802.org/3/da/public/0522/Koczwara_3da_01_20220523.pdf -(option 3 and

https://www.ieee802.org/3/da/public/062922/diminico_SPMD_02_06292022.pdf

168.6 Mixing segment characteristics

The insertion loss of each stub, between MDI attachment point and trunk connection point (TC), shall meet the values determined using Equation (168–xxb). The reference impedance is 100 Ω.

$$IL \leq 0.15 \text{ dB} \qquad \text{Equation (168–xxb)}$$

$$0.3 \leq f(\text{MHz}) \leq 40$$

The time delay of each stub, between MDI attachment point and trunk connection point (TC), shall meet the values determined using Equation (168–xxc) at a frequency of 10 MHz. The reference impedance is 100 Ω.

$$\text{time delay} \leq 1.6 \text{ ns} \qquad \text{Equation (168–xxc)}$$

168.6.2 Return loss

The mixing segment at any MDI attachment point, without the MDI or other loads attached, shall meet the return loss values determined using Equation (168–xxd). The reference impedance is 50 Ω.

$$RL \geq \text{TBD} \qquad \text{Equation (168–xxd)}$$

$$0.3 \leq f(\text{MHz}) \leq 40$$

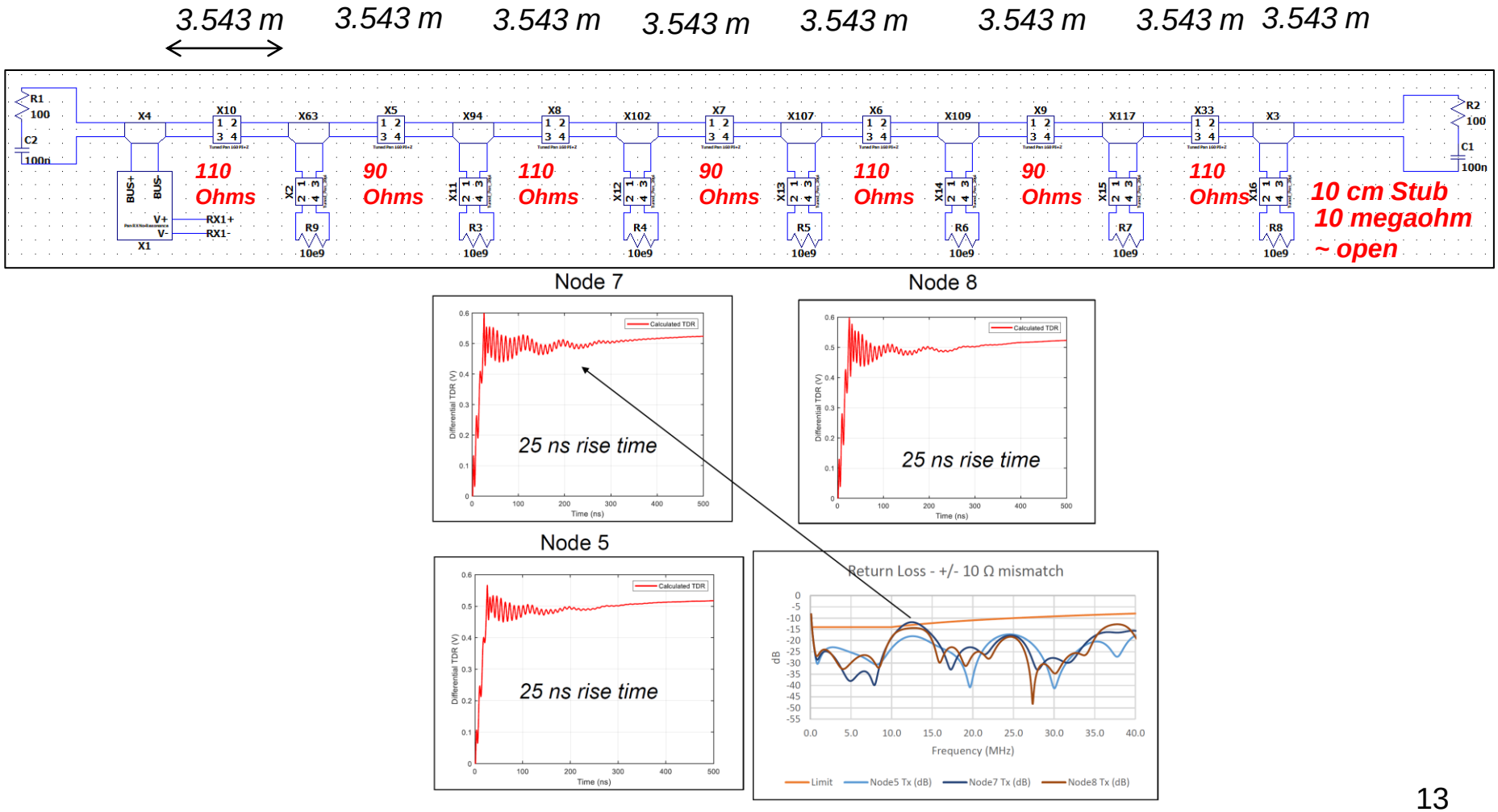
The mixing segment at edge terminations, without the MDI or other loads attached, shall meet the return loss values determined using Equation (168–xxe). The reference impedance is 100 Ω.

$$RL \geq \text{TBD} \qquad \text{Equation (168–xxe)}$$

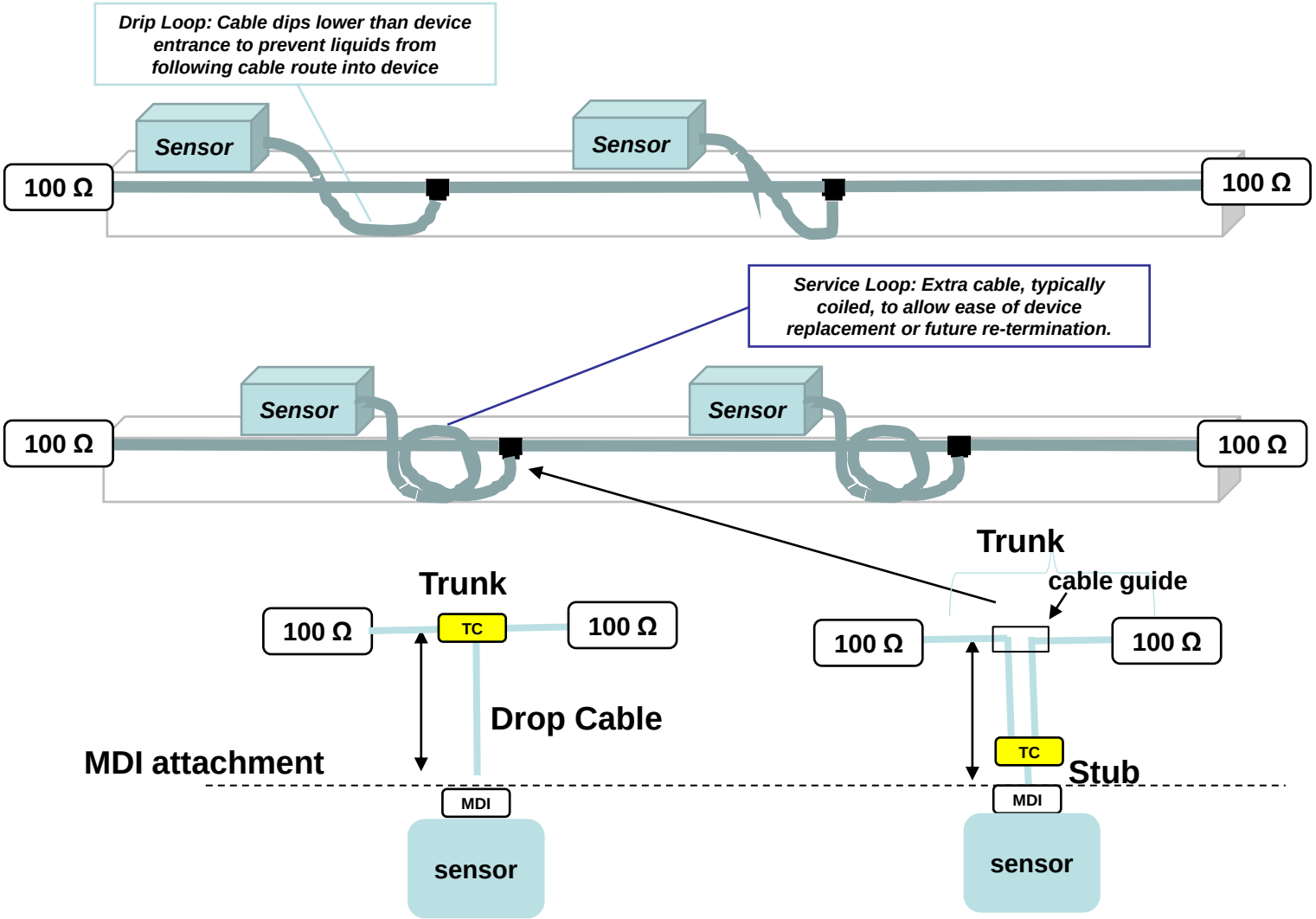
$$0.3 \leq f(\text{MHz}) \leq 40$$

Return Loss - TDR

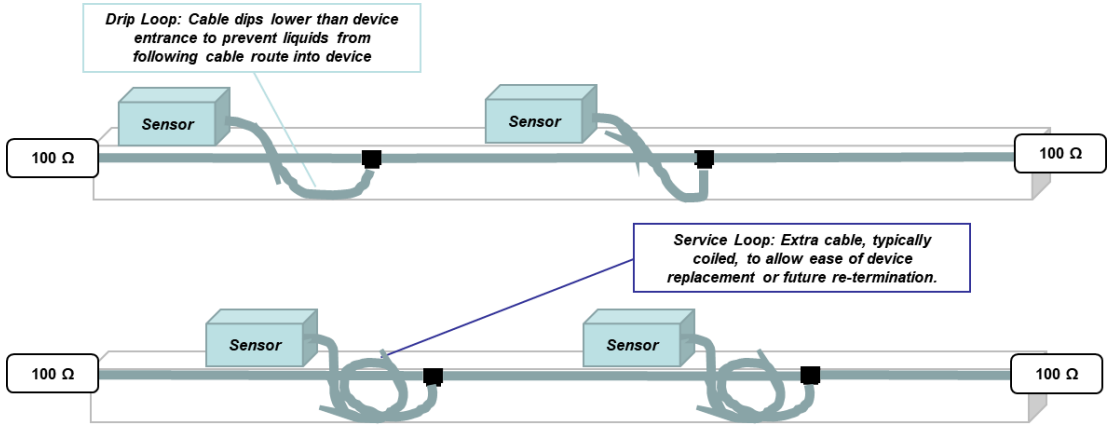
- Mixing segment considered consisting of cable sections between MDIs with variation on cable impedances of 10 ohms; 8 nodes equally spaced 3.543 m.

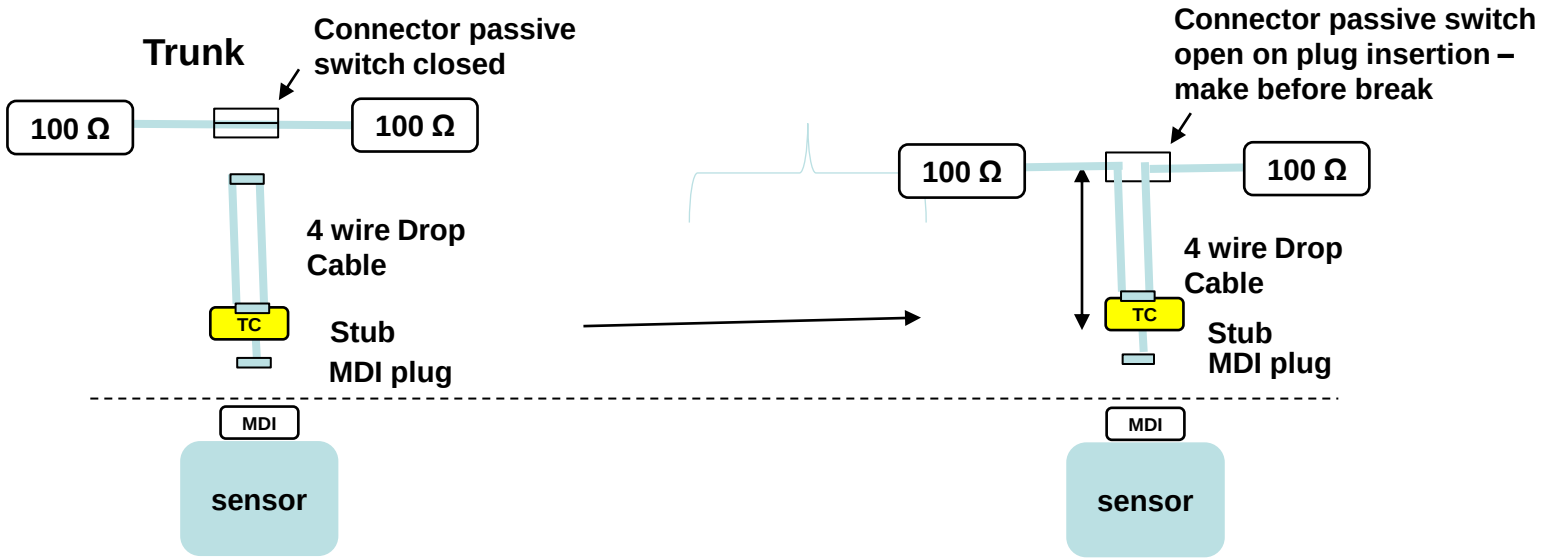


Reference Test Points



Reference Test Points

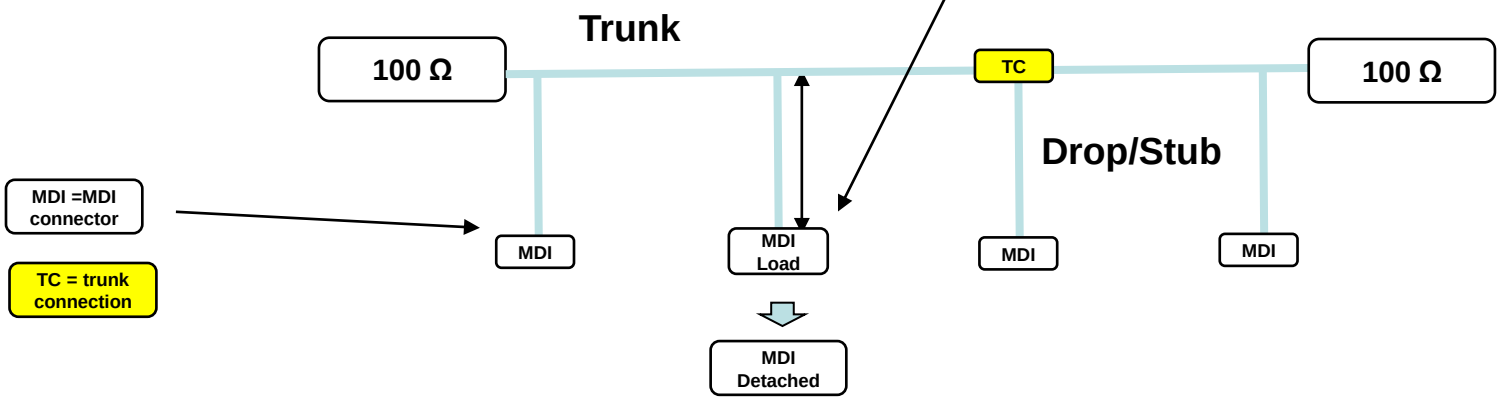




Inductive Compensation

- Mixing segment RL specifications; MDI attachments/tuning inductors.

Inductors	MDI Attachment	RL
Y	Y	spec supported
N	N	spec supported
Y	N	spec can be supported with an implementation that enables first two conditions
N	Y	NA



165.5.2 Test Points

Source: IEEE P802.3cy™/D2.0, July 1, 2022

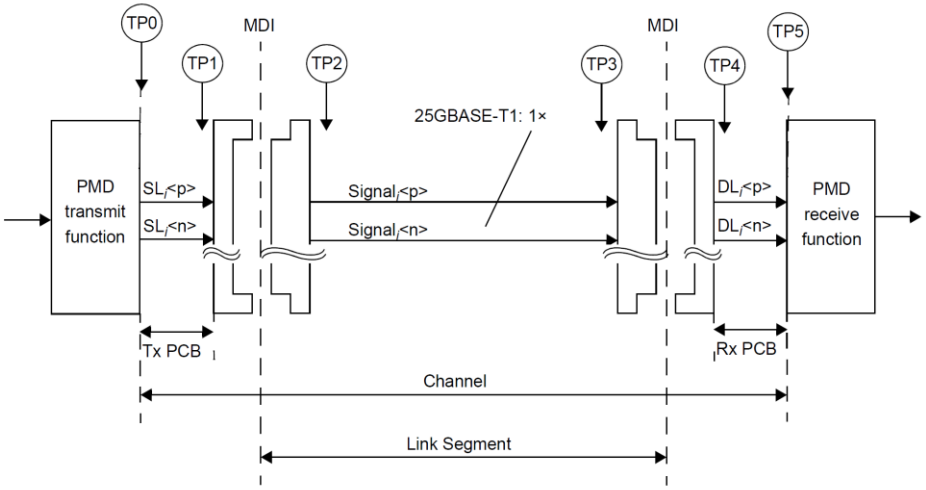


Figure 165–34—25GBASE-T1 link

Test Points	Description
TP0 to TP5	The channel including the transmitter and receiver differential controlled impedance PCB insertion loss and the link segment insertion loss.
TP1 to TP4	All link segment measurements are made between TP1 and TP4 as illustrated in Figure 165–34.
TP0 to TP2 TP3 to TP5	A mated connector pair has been included in both the transmitter and receiver specifications defined in 165.5.3 and 165.5.4. The recommended maximum insertion loss from TP2 to TP0 or from TP3 to TP5 including the test fixture is provided in 165A.2.1.
TP2	Unless specified otherwise, all transmitter measurements defined in 165.5.3 are made at TP2.
TP3	TP3 represents the link partner's TP2 test point.

Summary

- Mixing segment modeling updated to further investigate multidrop clumped topology node spacing versus RX correlation metric.
    - Minimum loss
        + Between nodes
        + Stub

- Return Loss specification review.
    - Test point definitions
    - Compensation