802.3da Mixing Segment Model Correlation

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Chris DiMinico
PHY-SI LLC/ MC Communications/SenTekse
cdiminico@ieee.org

Contributors

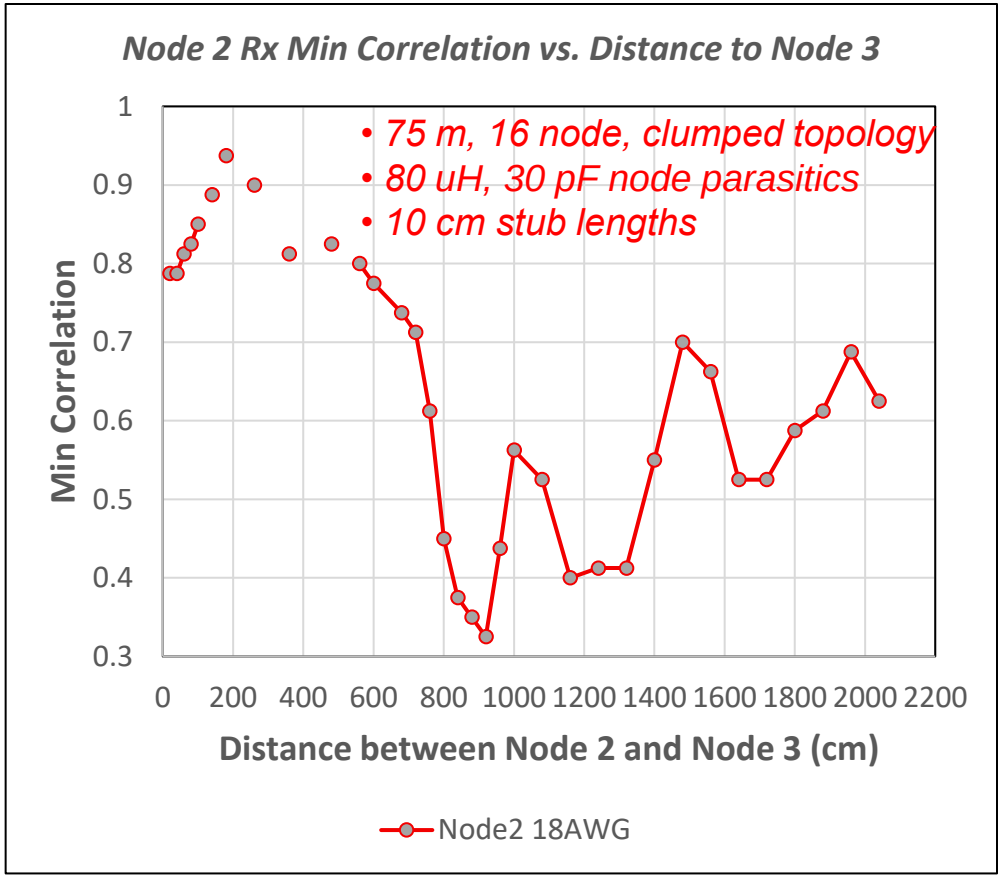
- Bob Voss/Paul Wachtel - Panduit

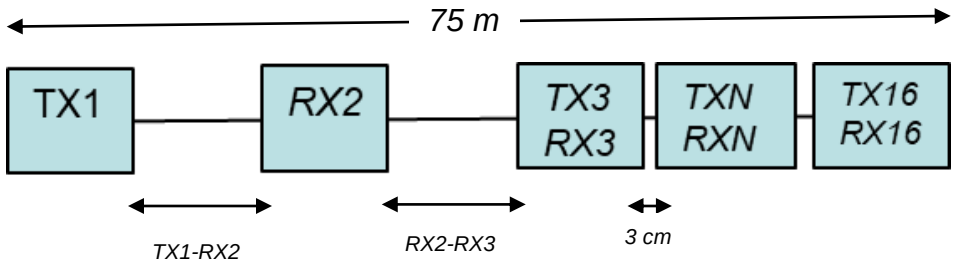
Purpose

- Resolve differences to reference simulation in:
  - https://www.ieee802.org/3/da/public/050323/schreiner_3da_May_23.pdf
- Method
  - For model correlation use parameter's and topology slide 4: https://www.ieee802.org/3/da/public/0323/diminico_SPMD_01b_0323.pdf
  - With typical TX slide 4 >>https://www.ieee802.org/3/da/public/011723/diminico_SPMD_01_0123.pdf
- Background
  - LT-spice models
    + Cable model
    + TX model
    + TX/RX parasitics
  - Simulation environment
    - Python script
    - RX correlation output

Mixing Segment Correlation Topology

Tx1 to Rx2 (m)	Rx2 to Rx3 (cm)	Total Length (m)	Node 2 RX Min Correlation
72	20	75	0.7875
71.8	40	75	0.7875
71.6	60	75	0.8125
71.4	80	75	0.825
71.2	100	75	0.85
71	120	75	
70.8	140	75	0.8875
70.6	160	75	
70.4	180	75	0.9375
70.2	200	75	
69.6	260	75	0.9
69	320	75	
68.6	360	75	0.8125
68.2	400	75	
67.8	440	75	
67.4	480	75	0.825
67	520	75	
66.6	560	75	0.8
66.2	600	75	0.775
65.4	680	75	0.7375
65	720	75	0.7125
64.6	760	75	0.6125
64.2	800	75	0.45
63.8	840	75	0.375
63.4	880	75	0.35
63	920	75	0.325
62.6	960	75	0.4375
62.2	1000	75	0.5625
61.4	1080	75	0.525
60.6	1160	75	0.4
59.8	1240	75	0.4125
59	1320	75	0.4125
58.2	1400	75	0.55
57.4	1480	75	0.7
56.6	1560	75	0.6625
55.8	1640	75	0.525
55	1720	75	0.525
54.2	1800	75	0.5875
53.4	1880	75	0.6125
52.6	1960	75	0.6875
51.8	2040	75	0.625





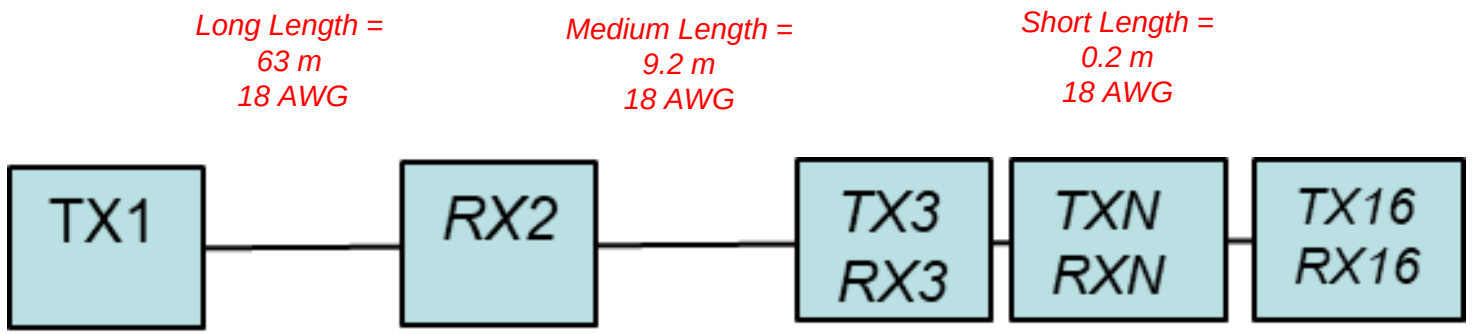
Stephan Schreiner Rosenberger Github Results

- Stephan: Simulation results of topology below - github, 4 permutations:

TX Filter	Correlation/Eye Measurement Point	MinCorr
20 MHz	MDI	0.556
200 MHz	MDI	0.630
20 MHz	RX Filter Output	0.308
200 MHz	RX Filter Output	0.333

- All permutations used the AWG18 cable model from Panduit.

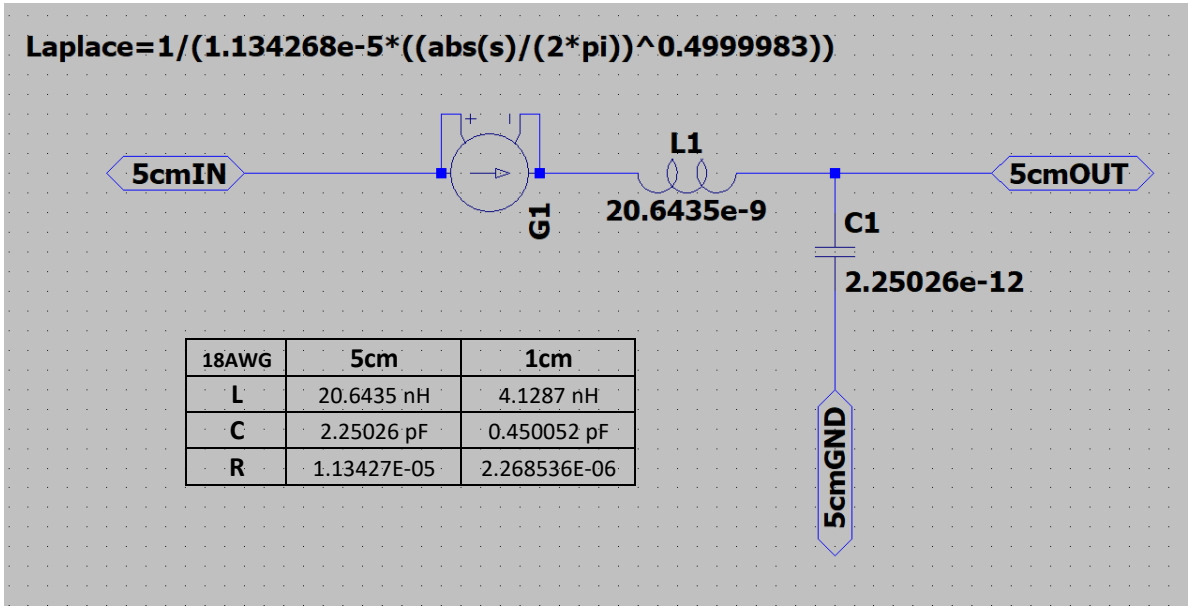
- Simulation results pervious slide - MinCorr - 0.325



- *75 m, 16 node, clumped topology*
- *80 uH, 30 pF node parasitics*
- *10 cm stub lengths*

Supplemental

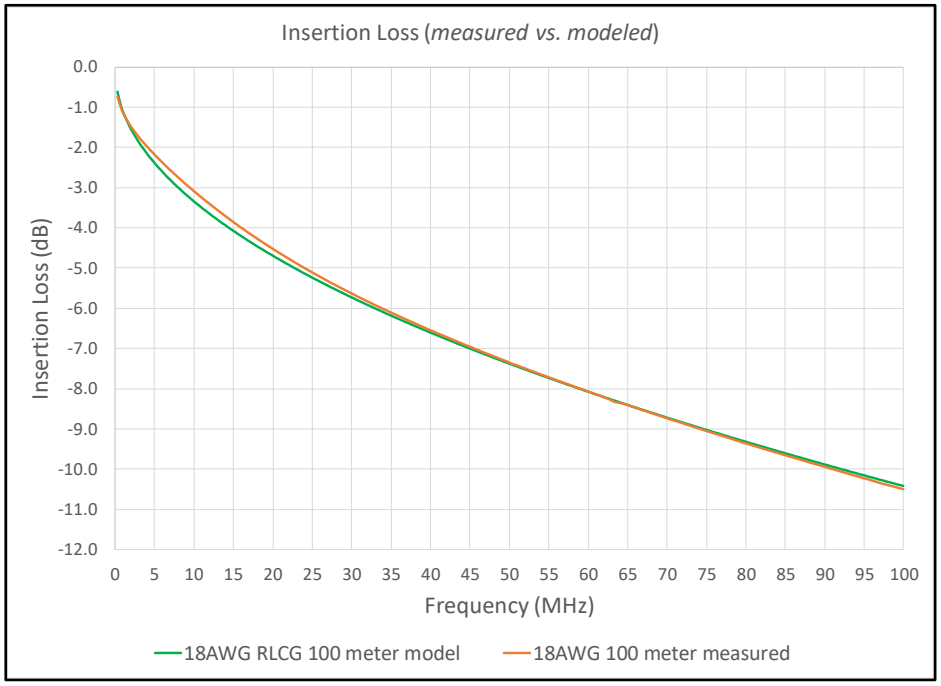
18 AWG - RLCG Model

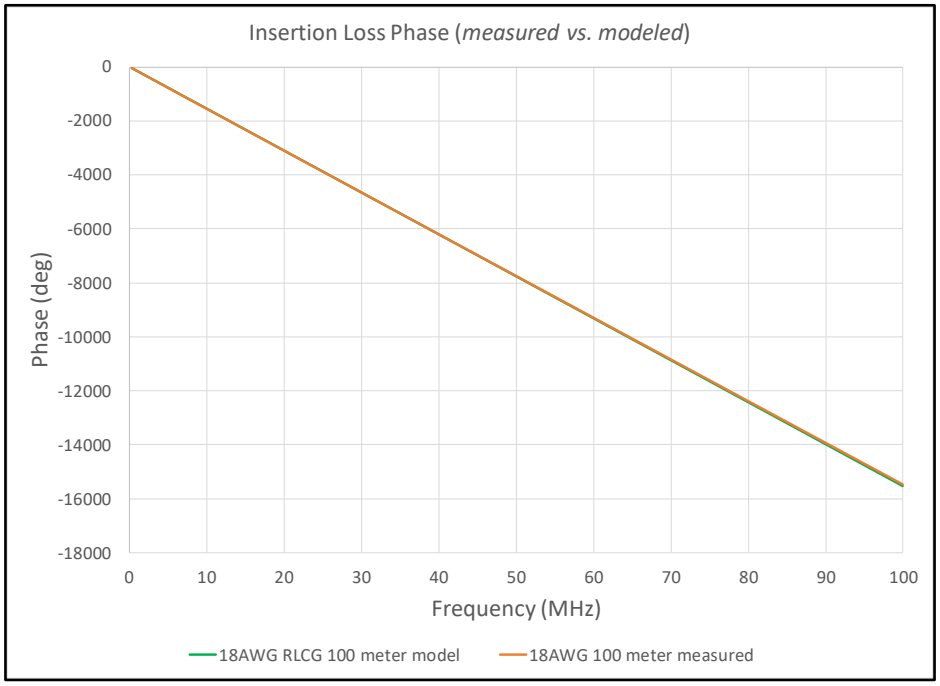


18AWG	5cm	1cm
L	20.6435 nH	4.1287 nH
C	2.25026 pF	0.450052 pF
R	1.13427E-05	2.268536E-06

- *RLGC parameters (R,L,G,C,R_s,G_d) extracted from S-Parameters*
  - *Extracted RLGC matrices include frequency dependent skin effect (R_s) and dielectric losses (G_d)*
    - *Dielectric losses not significant at these frequencies so not included in model*
    - $R(f) \approx R + (Rs \times \sqrt{f})$
    - *Frequency dependent resistance modeled as voltage controlled current source.*
      - *Laplace function defines frequency dependent relationship between I, V*
  - *All RLGC parameters scaled for 5cm segment to construct longer length transmission lines.*

18 AWG RLCG Model vs. Measured



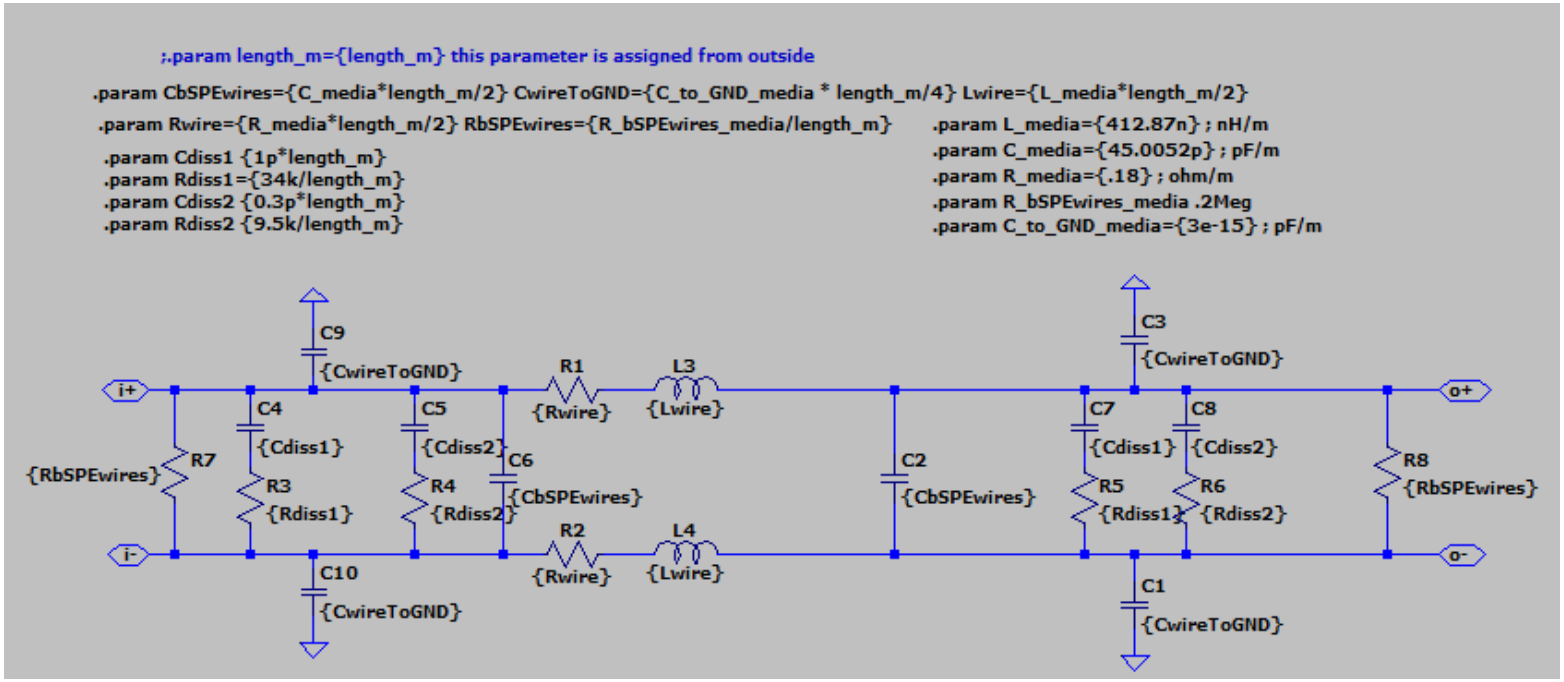


Alternate 18 AWG RLCG Model

- The Laplace function defining the frequency dependent resistance characteristic is not suitable for transient simulations in LT-Spice.

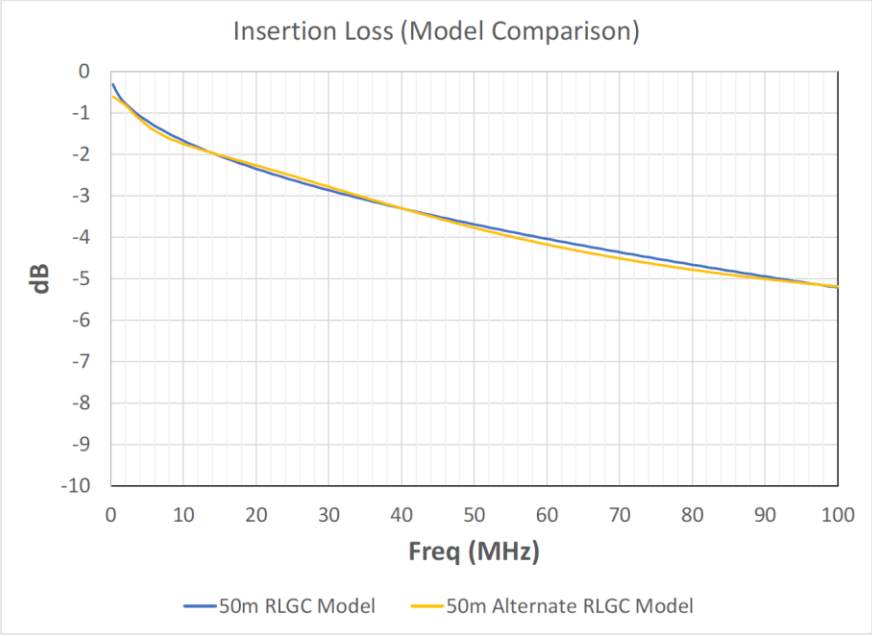
- Alternate model is implemented with a different approach to modeling the frequency dependent nature of the resistive losses of the cable. In the alternate model, low pass RC filtering is incorporated into the R, L, G, C building block element. The RC filtering values are tuned to produce the appropriate frequency response to match the characteristics of the measured cable.

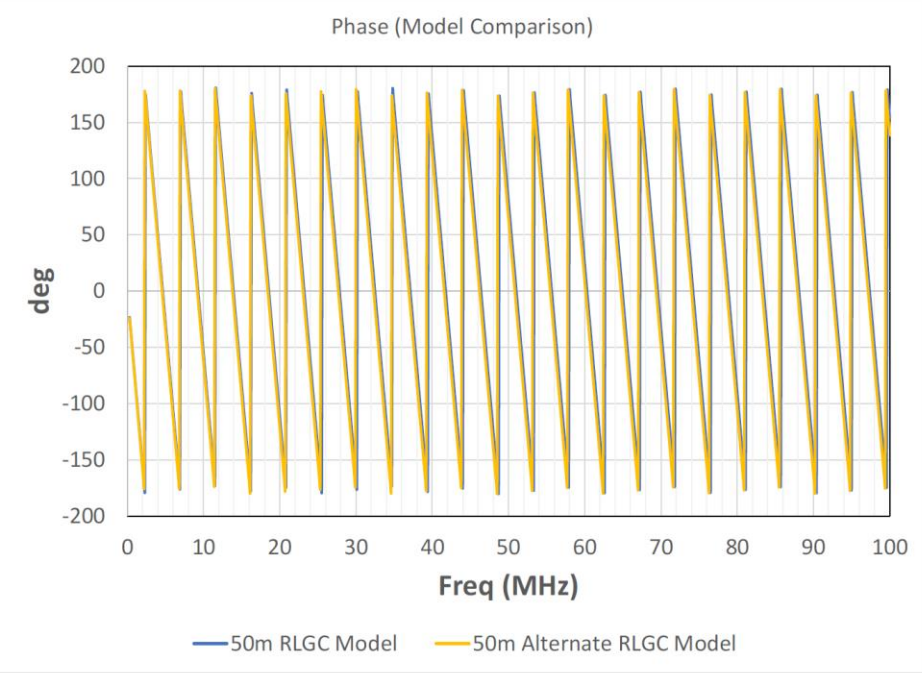
- Both models produce results that closely match the magnitude and phase characteristics of the 18 AWG SPE cable over the frequency band of interest.



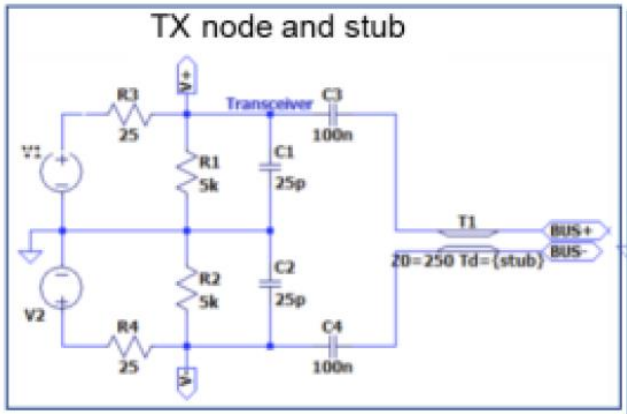
18 AWG RLCG Model Comparisons

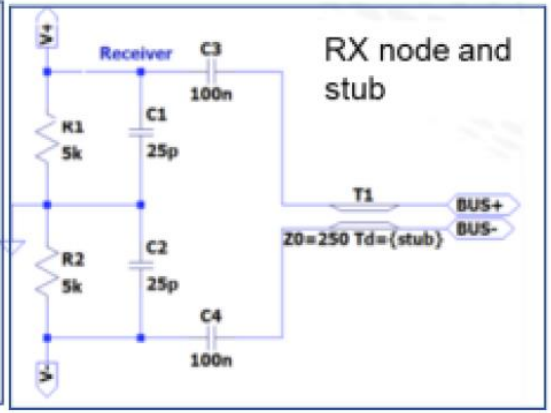
- **Alternate 18 AWG RLCG Model used in LT-spice for RX correlation**

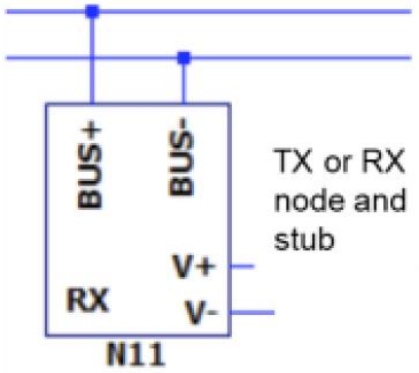




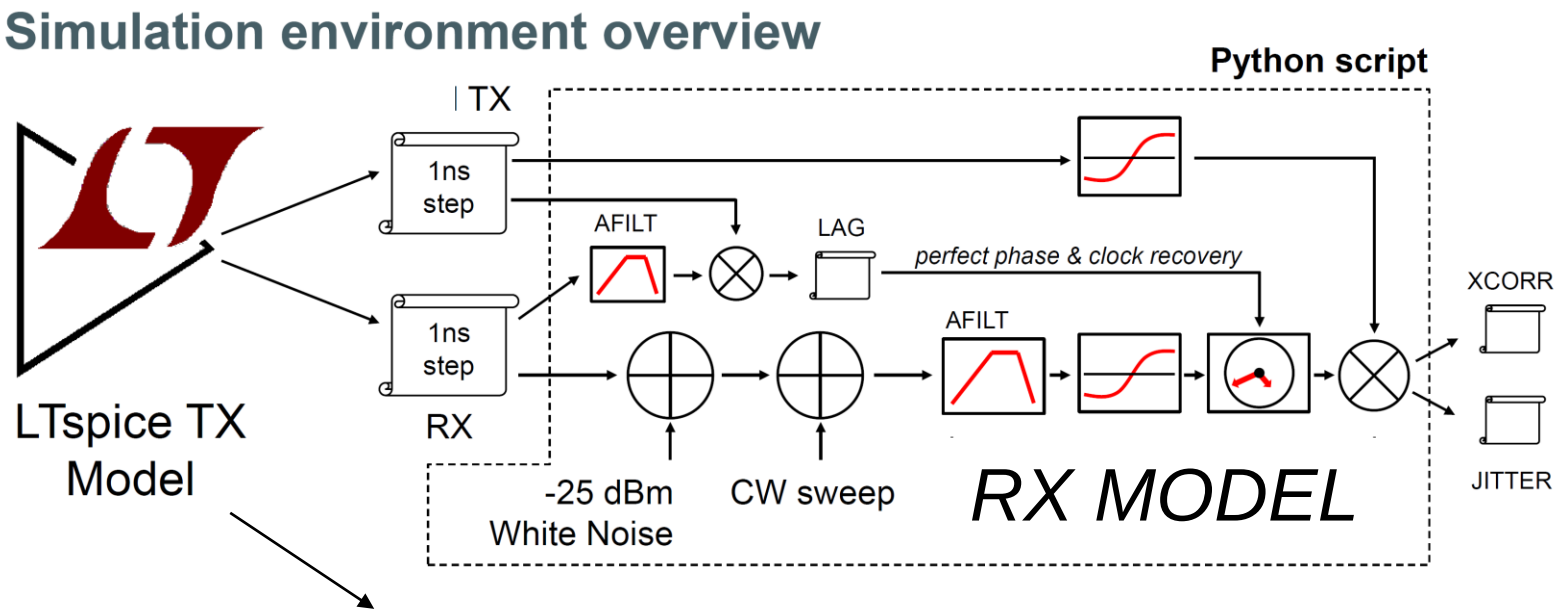
LT-spice TX/RX and stub parasitics

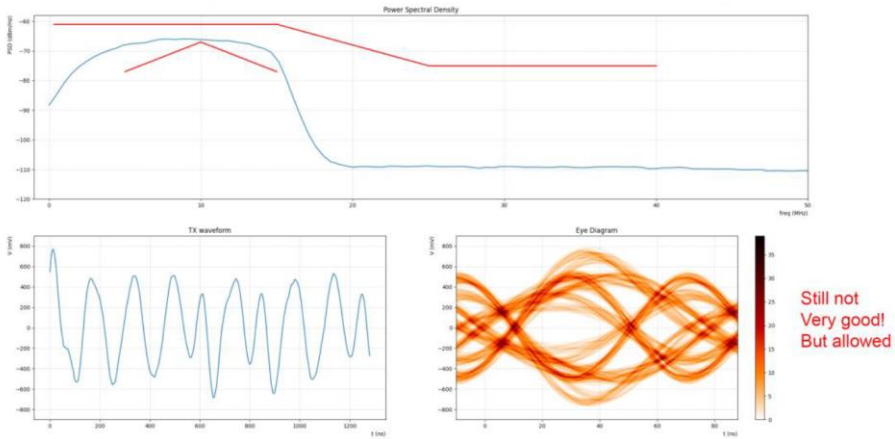




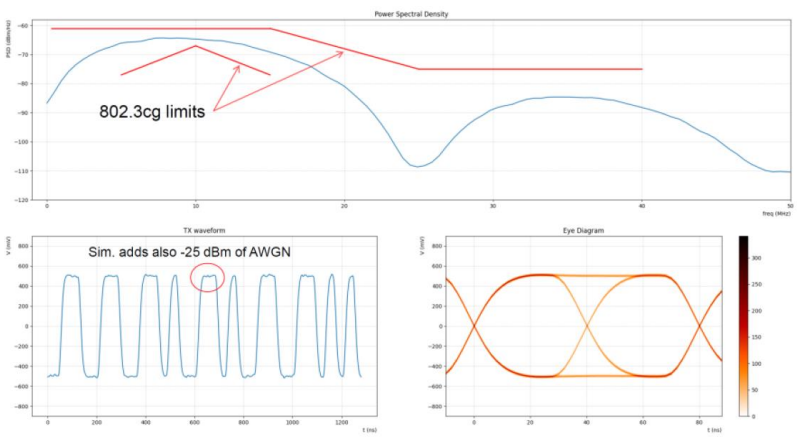


Multidrop Topology - TX/RX models





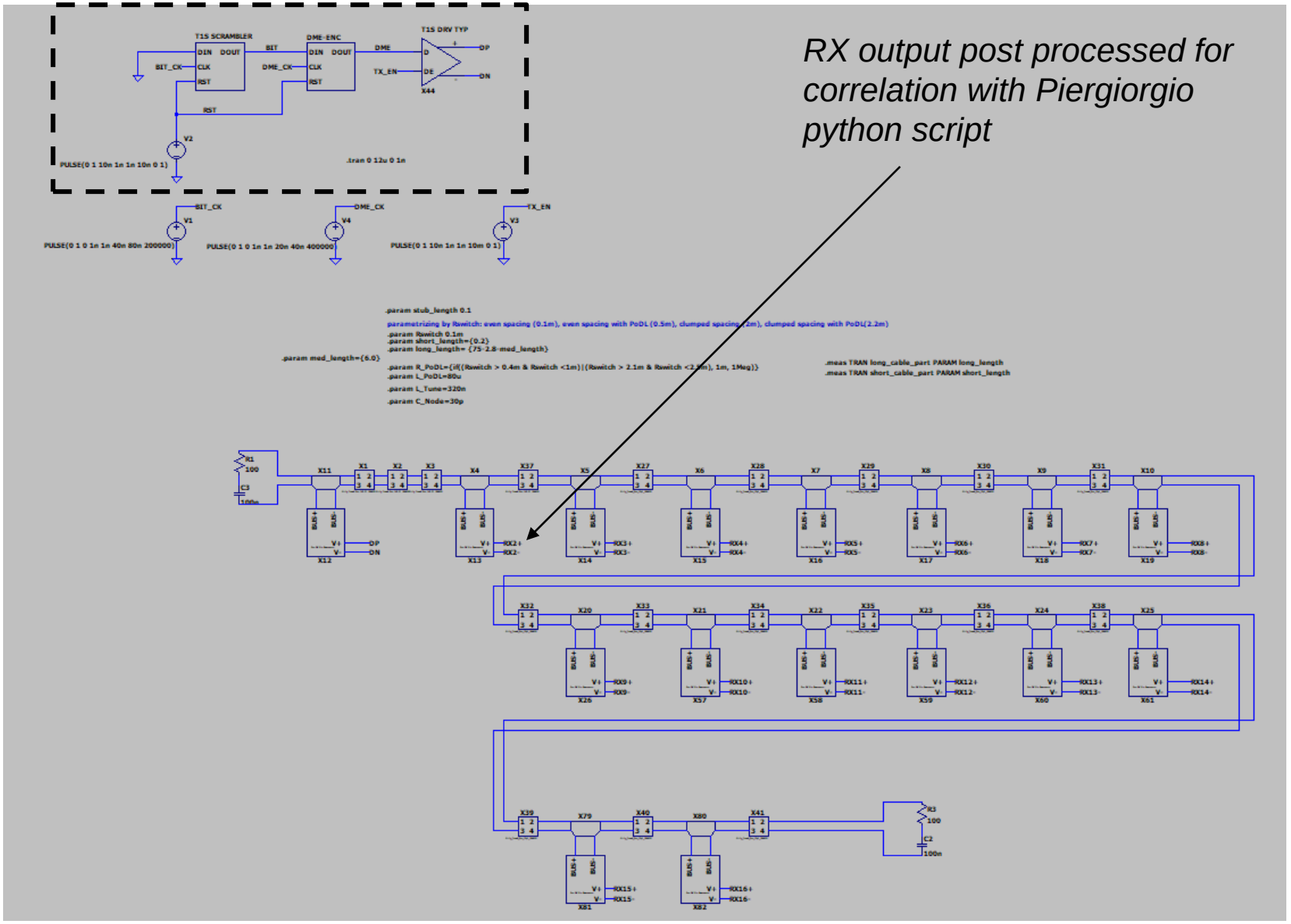
minimally compliant TX



Typical TX

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

The LT-spice with Piergiorgio TX



RX output post processed for correlation with Piergiorgio python script

Mixing Segment Insertion Loss vs AWG

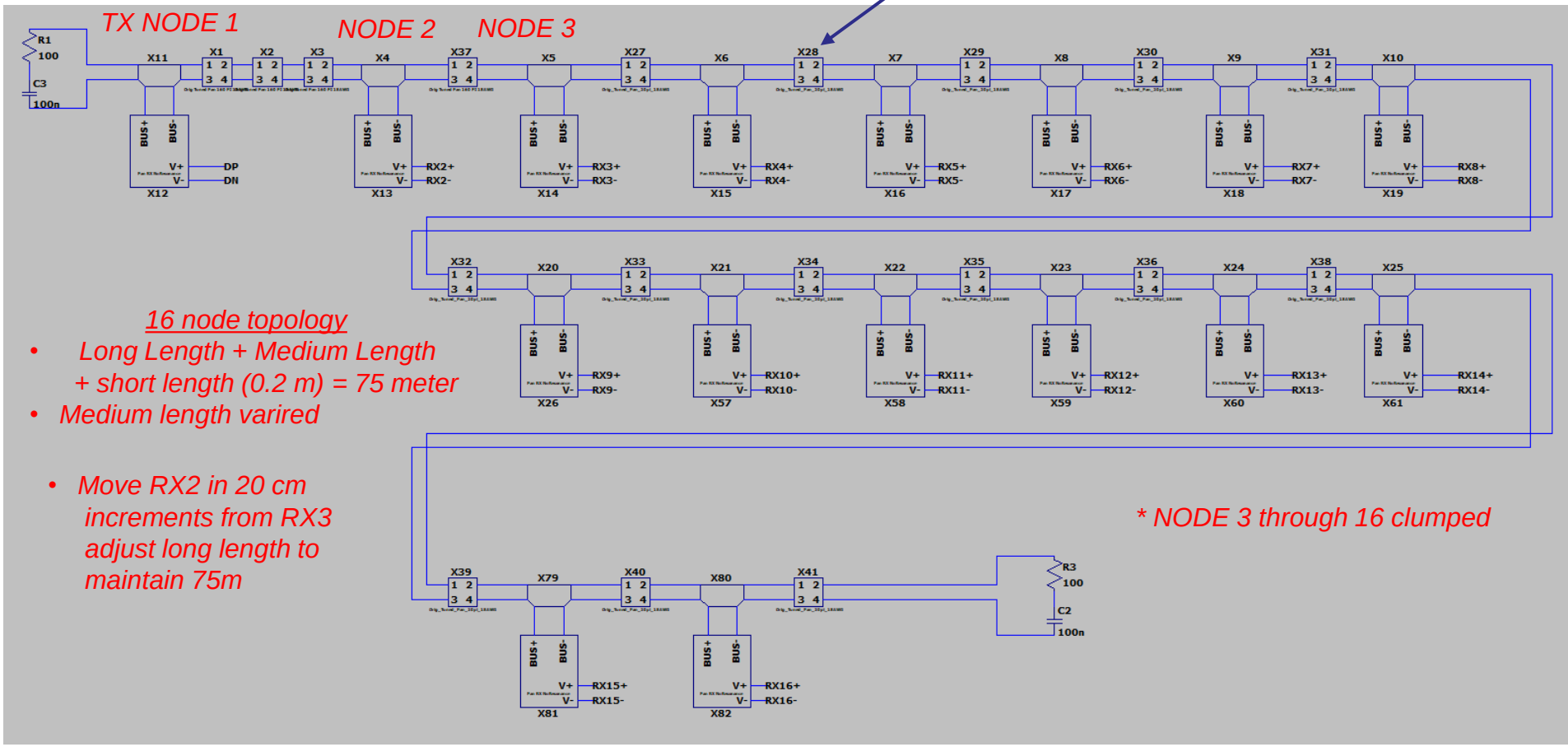
https://www.ieee802.org/3/da/public/0323/diminico_SPMD_01b_0323.pdf

Long Length
18 AWG or 23 AWG

Medium Length
18 AWG or 23 AWG

Short Length
18 AWG or 23 AWG

- *75 m, 16 node, clumped topology*
- *80 uH, 30 pF node parasitics*
- *10 cm stub lengths*



16 node topology

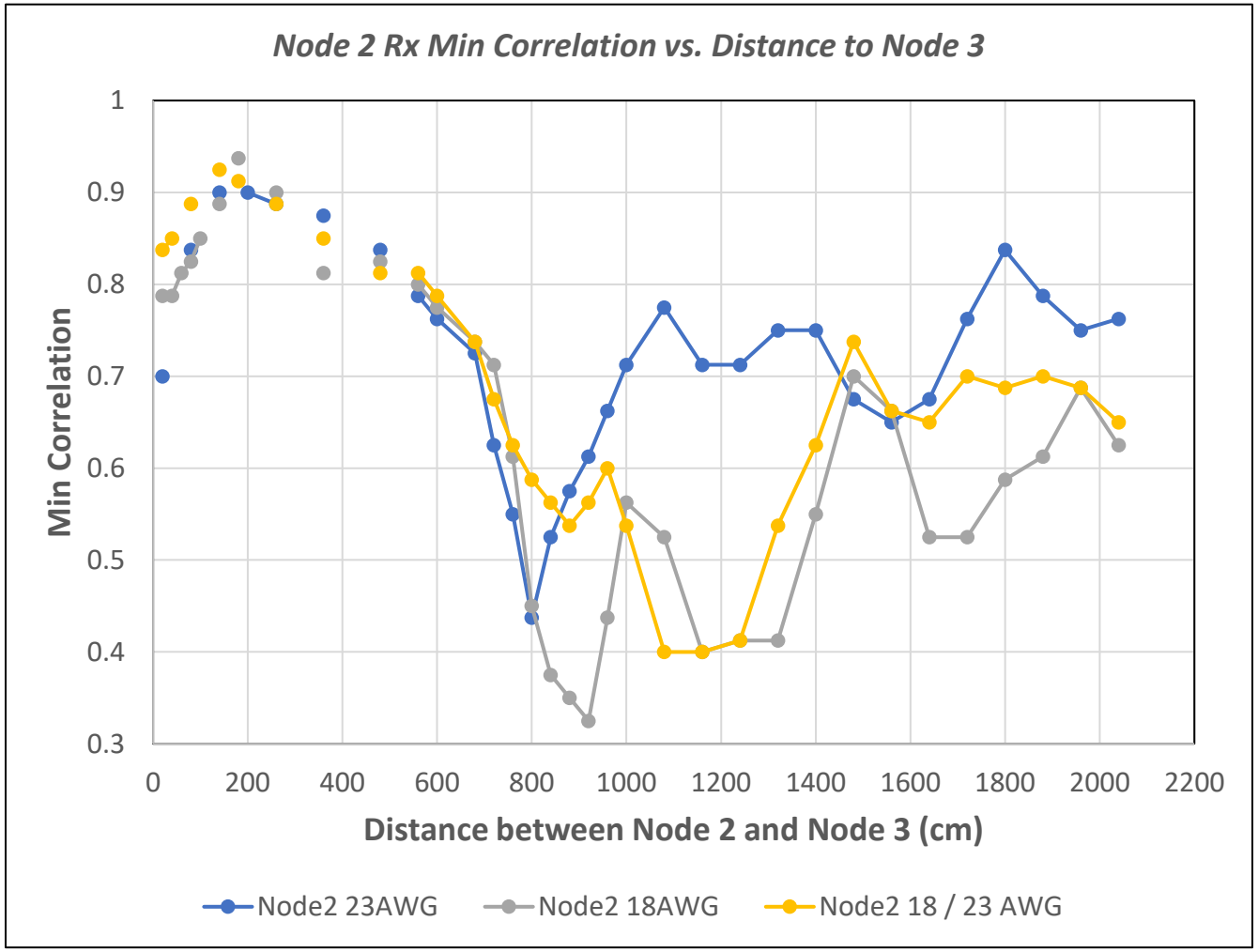
- *Long Length + Medium Length + short length (0.2 m) = 75 meter*
- *Medium length varied*

- *Move RX2 in 20 cm increments from RX3 adjust long length to maintain 75m*

** NODE 3 through 16 clumped*

Mixing Segment Insertion Loss vs AWG

https://www.ieee802.org/3/da/public/0323/diminico_SPMD_01b_0323.pdf



- **Mixing Segment Insertion Loss vs AWG topology slide 4**

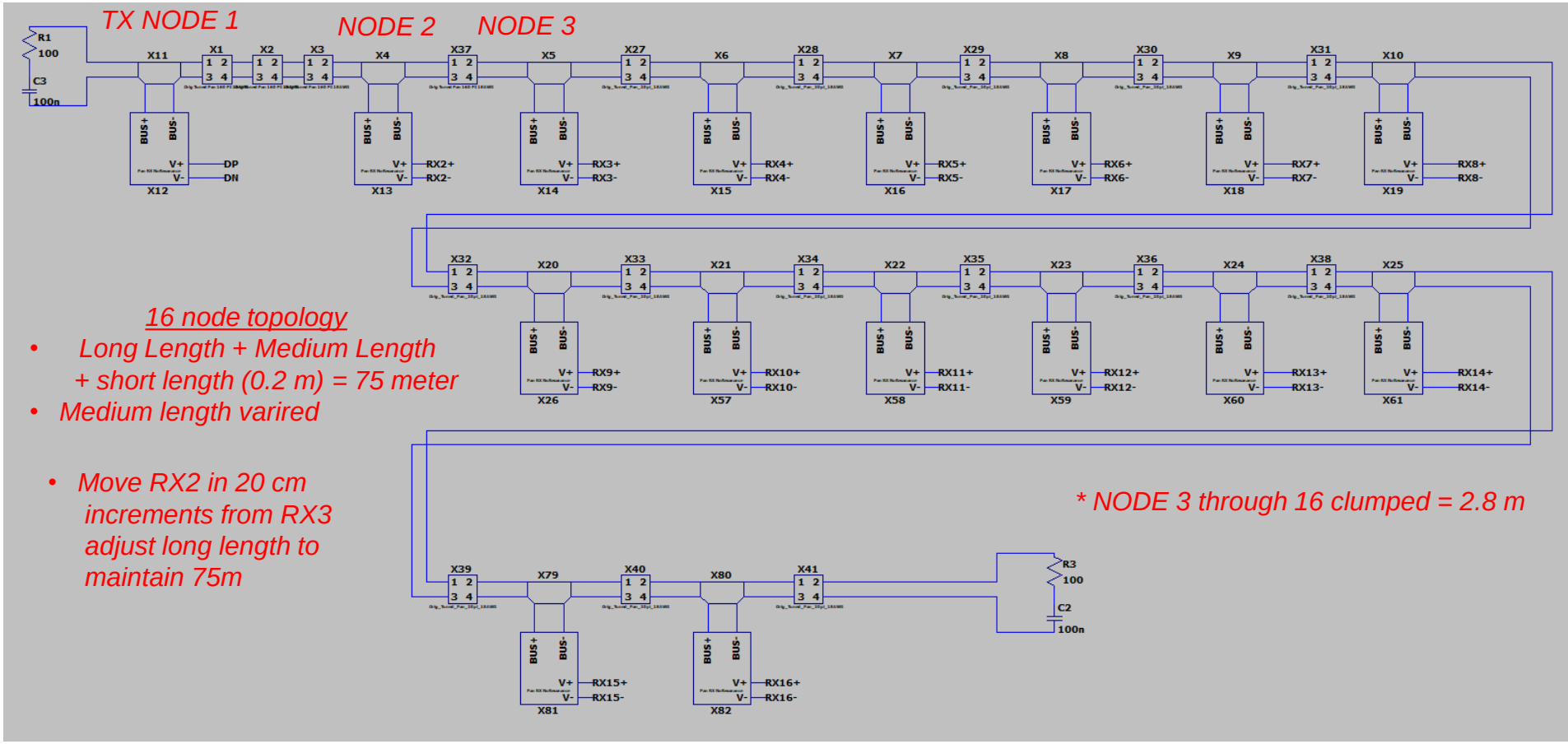
Mixing Segment Correlation Topology

Long Length = 63 m 18 AWG

Medium Length = 9.2 m 18 AWG

Short Length = 0.2 m 18 AWG

- *75 m, 16 node, clumped topology*
- *80 uH, 30 pF node parasitics*
- *10 cm stub lengths*



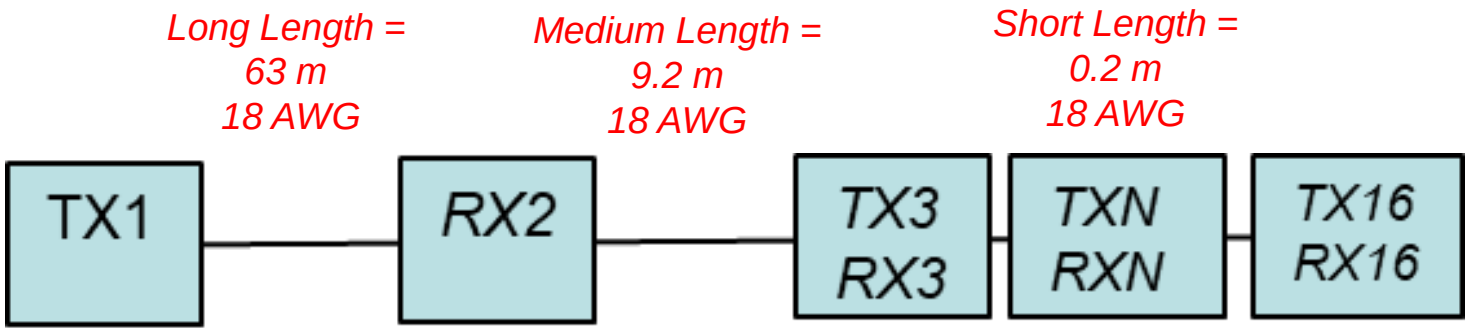
16 node topology

- *Long Length + Medium Length + short length (0.2 m) = 75 meter*
- *Medium length varied*

- *Move RX2 in 20 cm increments from RX3 adjust long length to maintain 75m*

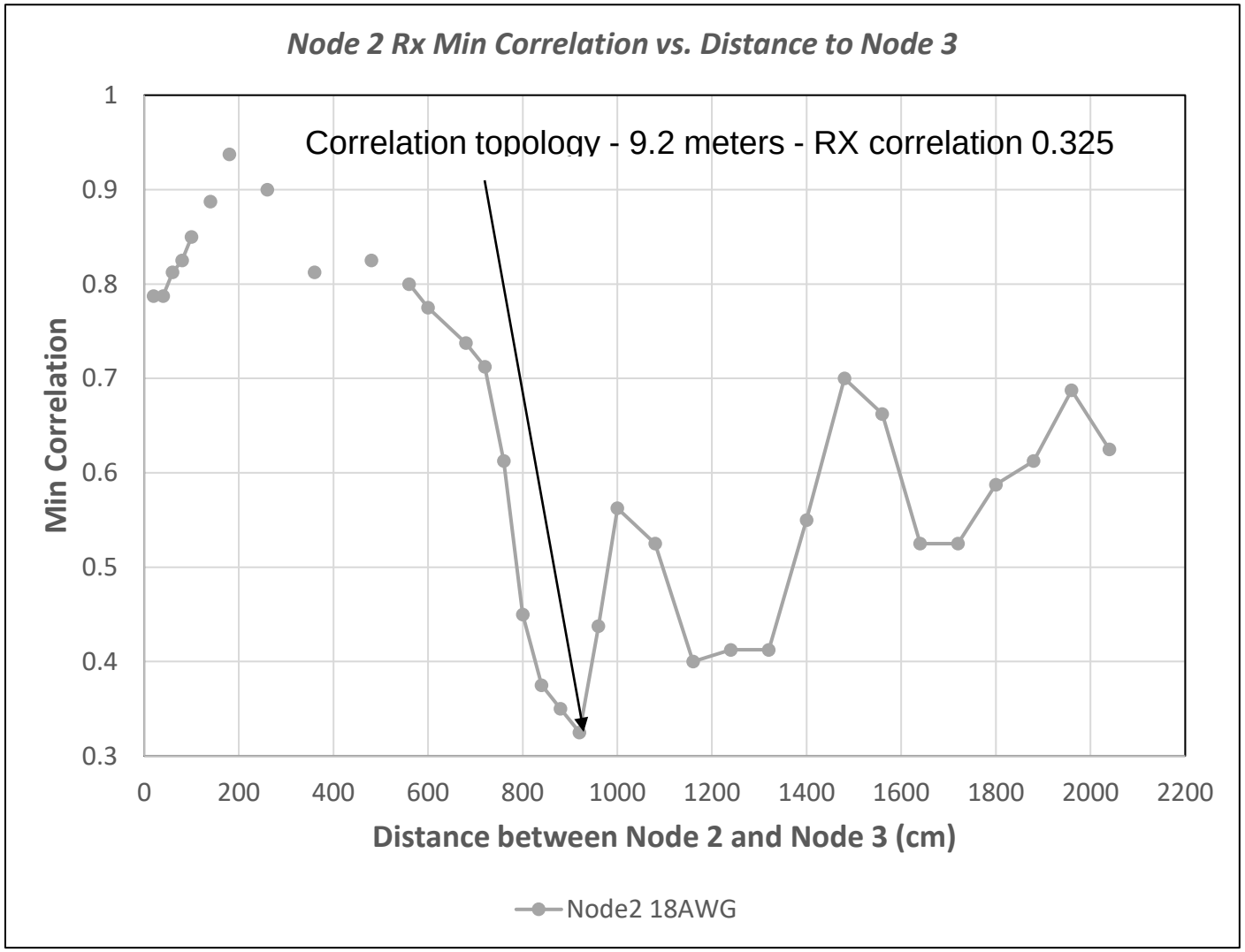
** NODE 3 through 16 clumped = 2.8 m*

Mixing Segment Correlation Topology



- *75 m, 16 node, clumped topology*
- *80 uH, 30 pF node parasitics*
- *10 cm stub lengths*

Mixing Segment Insertion Loss vs AWG



- **Mixing Segment Insertion Loss vs AWG topology slide 8**