Rosenberger

IEEE 802.3dm interim meeting
Return loss of automotive coaxial link segments

Thomas Müller (Rosenberger)

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Return loss of automotive coaxial link segments

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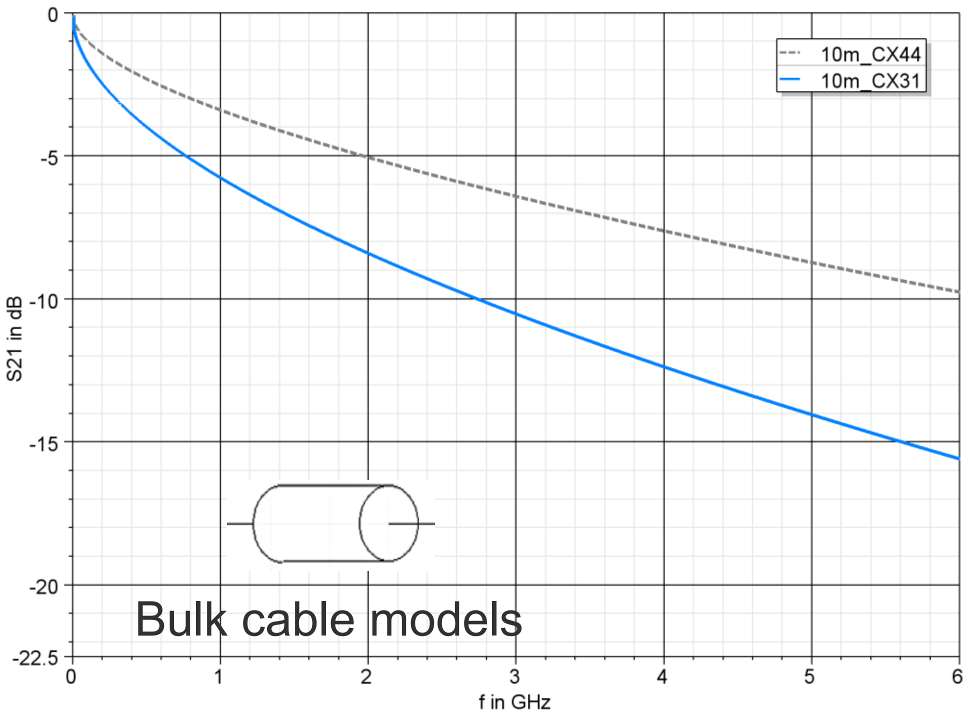
Scope and cable model

- Share simulation results on automotive coaxial link segment return loss (RL) to support defining appropriate RL requirements
- Physical model of automotive coaxial cable type RTK044 at -40°C including loss, propagation delay without micro-reflections (µR) and RTK031 at room temperature
- Nominal impedance 50±3 Ω (6%) with max./min. alteration between segments of 52.5 / 47 Ω, to consider comments from adhoc discussions about the impedance increase over length and micro-reflexions ripple within the cable impedance evaluation window in TDR measurements



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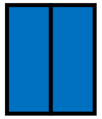
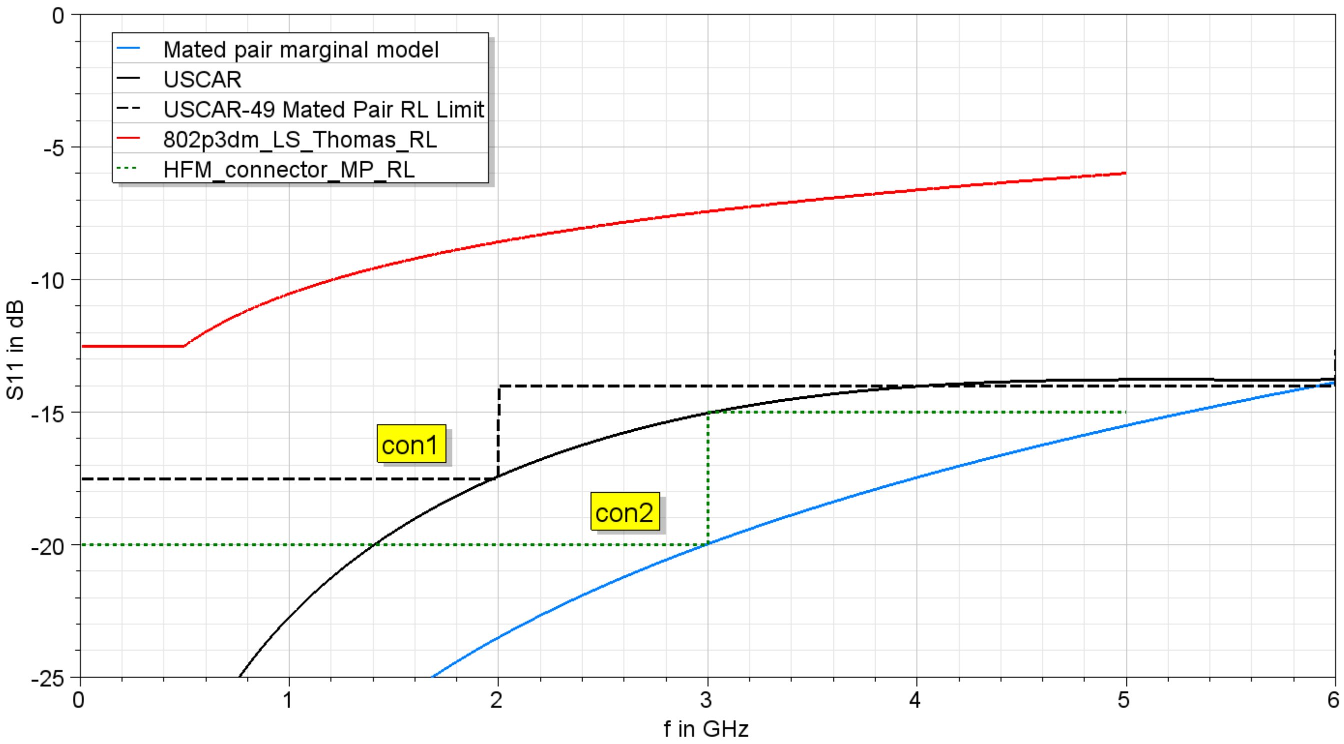
Connector models



Mated connector pair model

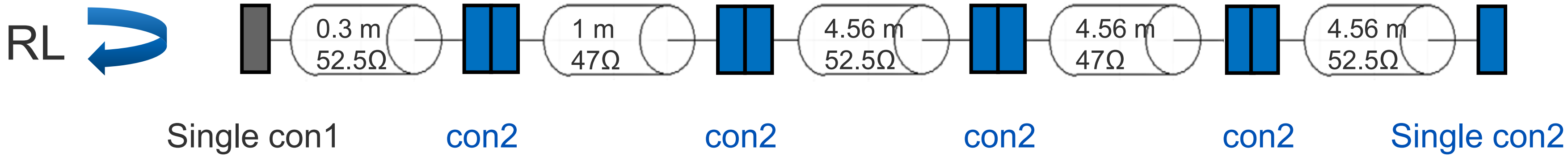
- Component models based on physical transmission line model valid for RL, IL and delay
- Two types of mated connector pairs with RL marginal to USCAR-49 mini coax requirements [2022-09] (connector con1) and tighter specified typical mini coax connector type as like HFM (con2)



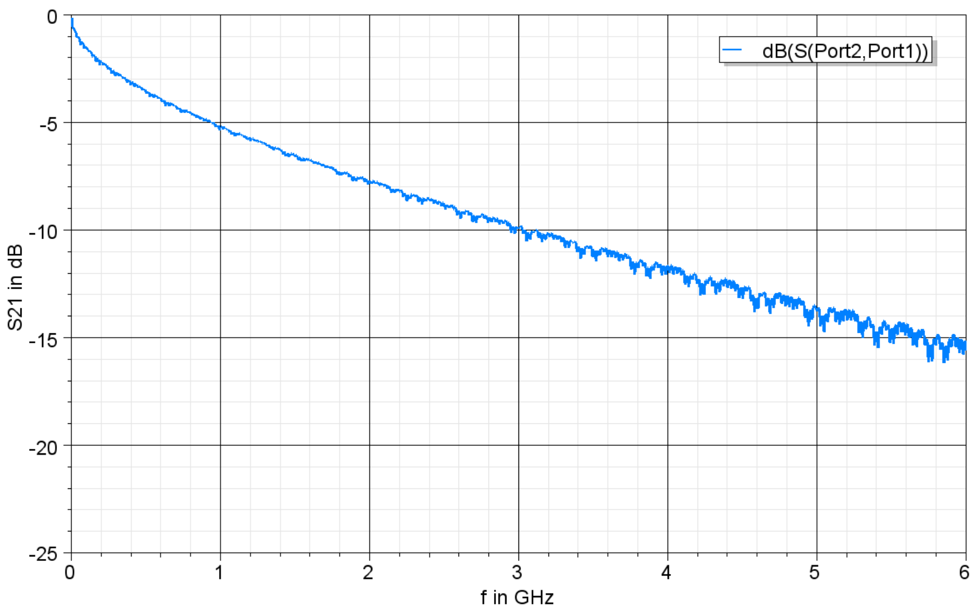
Return loss of automotive coaxial link segments

15 m with 4 inlines

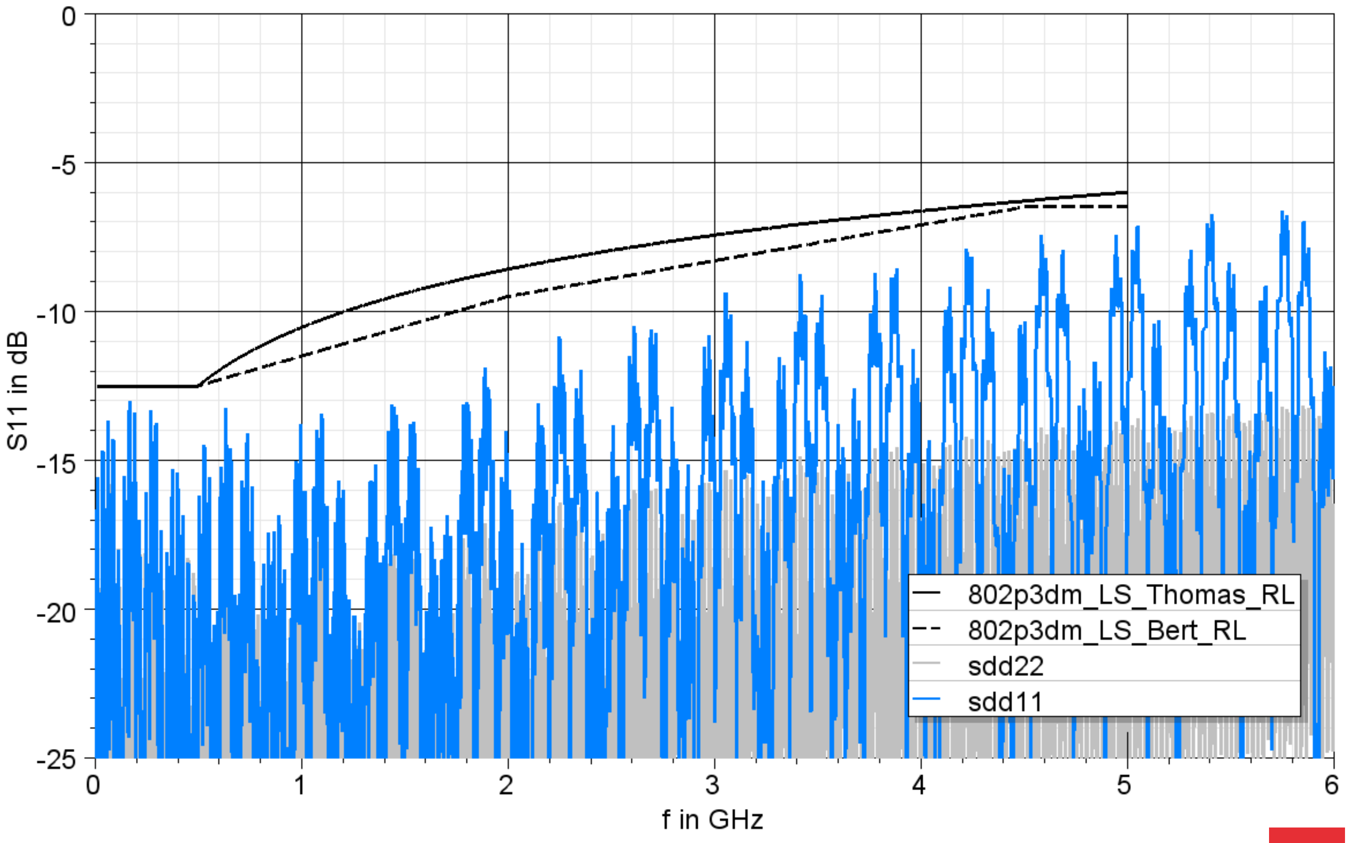
- Link segment RL with connector 1 at the sensor and connector 2 along the channel



Link segment Insertion Loss



Link segment Return Loss



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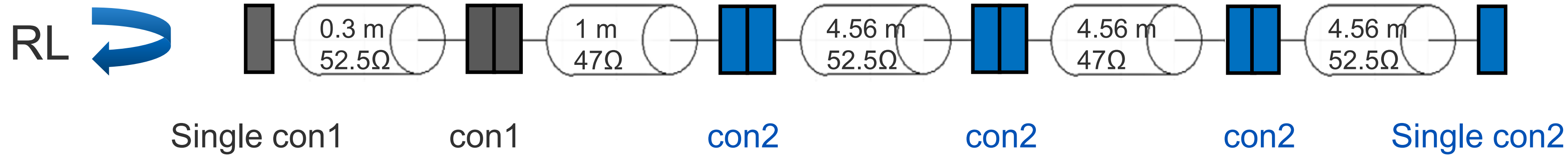
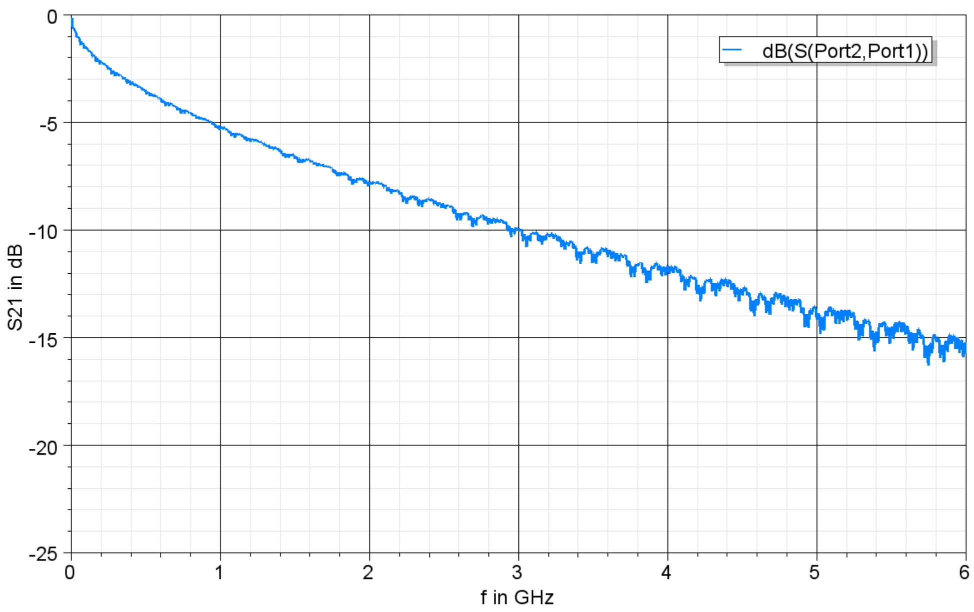
15 m with 4 inlines

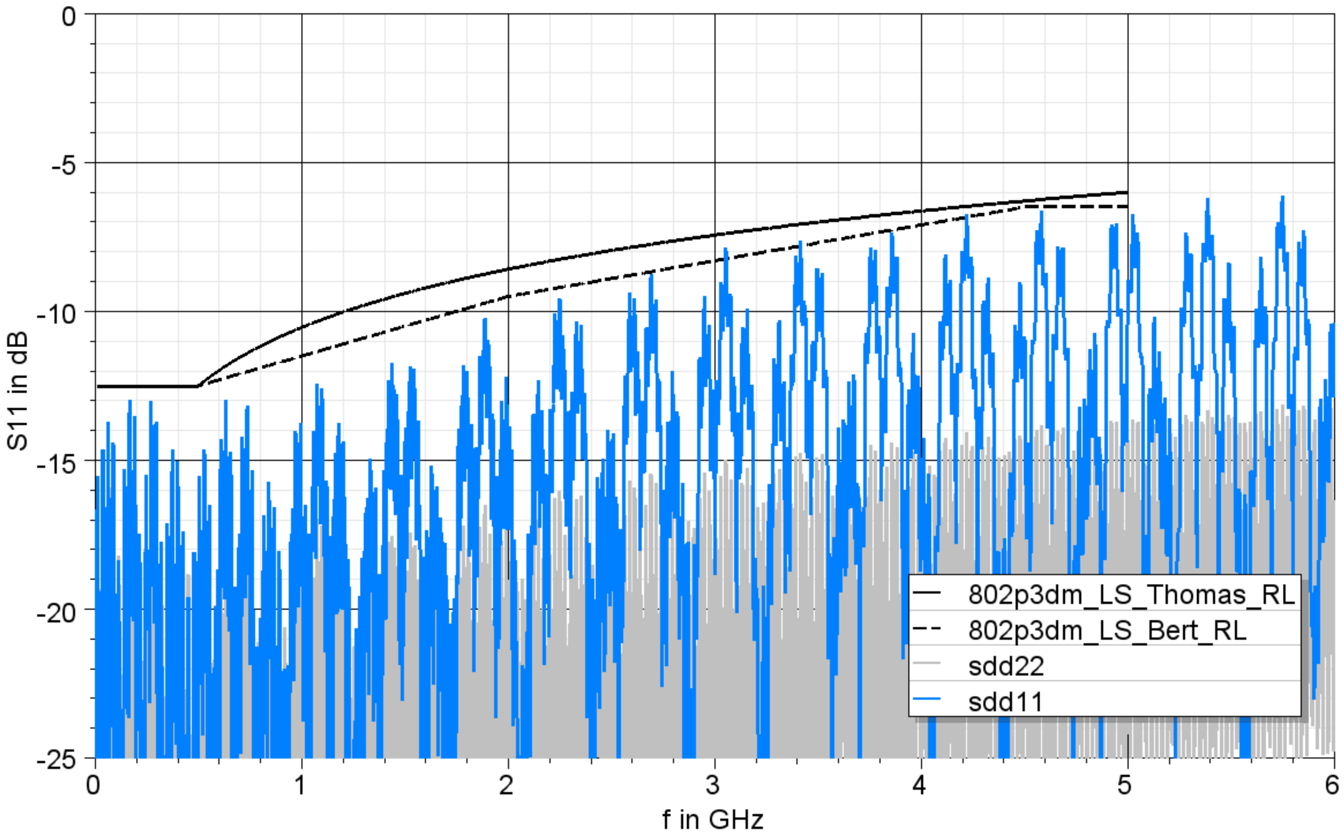
- Link segment RL with connector 1 at the sensor and first inline position and connector 2 along the channel



Link segment Insertion Loss



Link segment Return Loss



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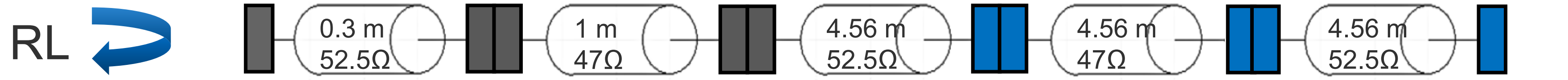
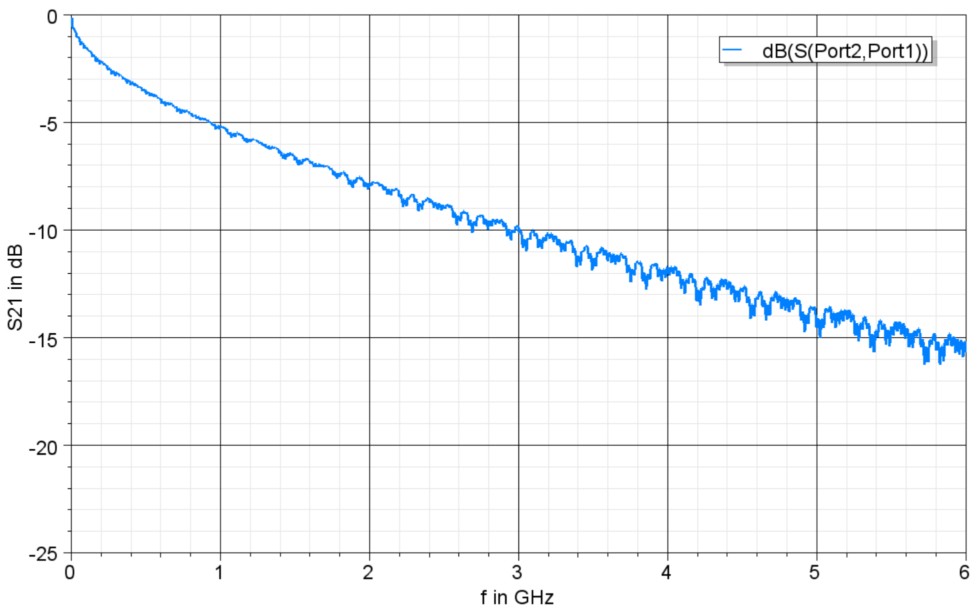
15 m with 4 inlines

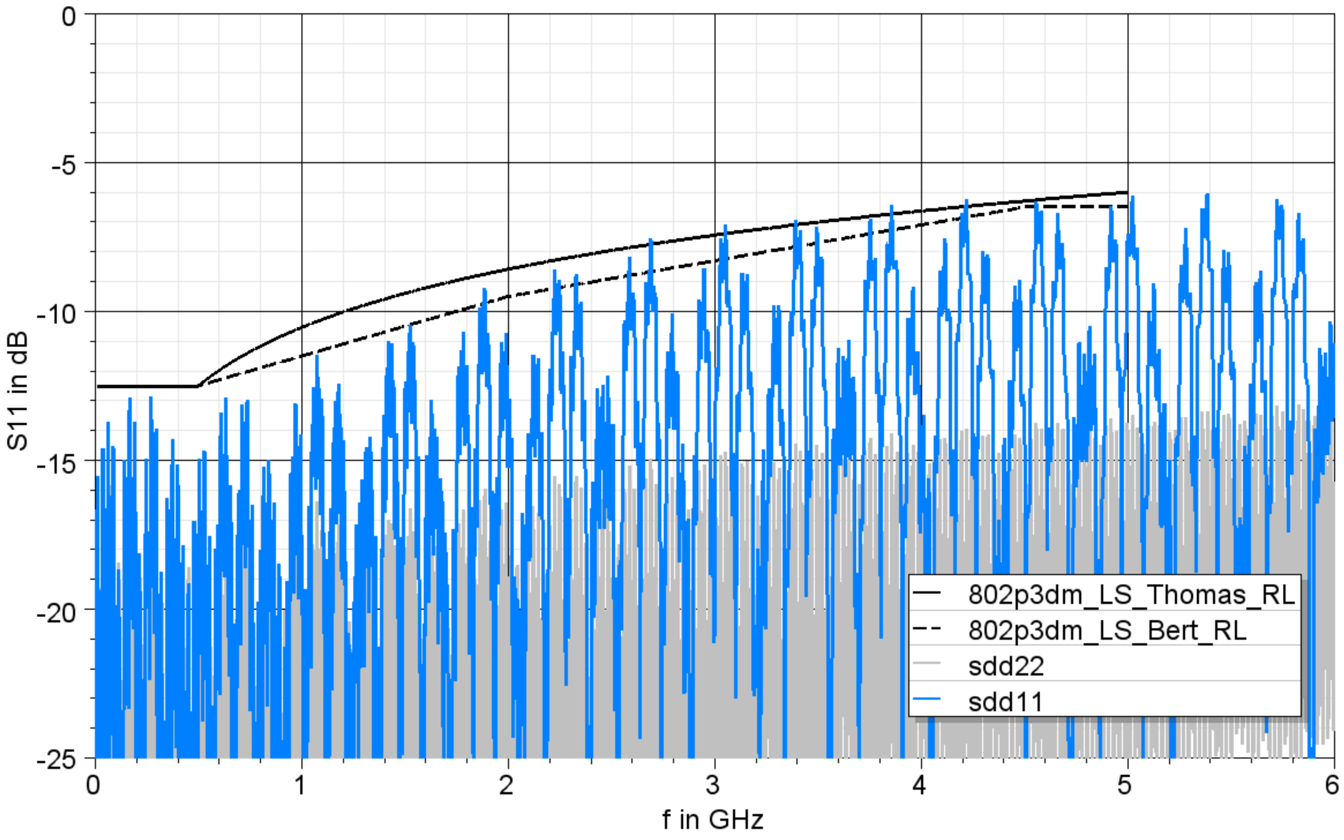
- Link segment RL with connector types as shown in the topology



Link segment Insertion Loss



Link segment Return Loss



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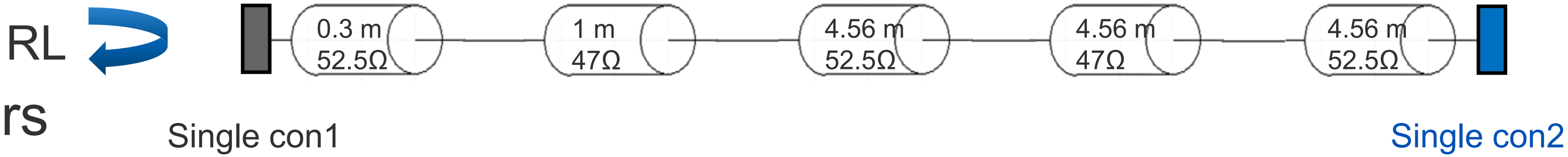
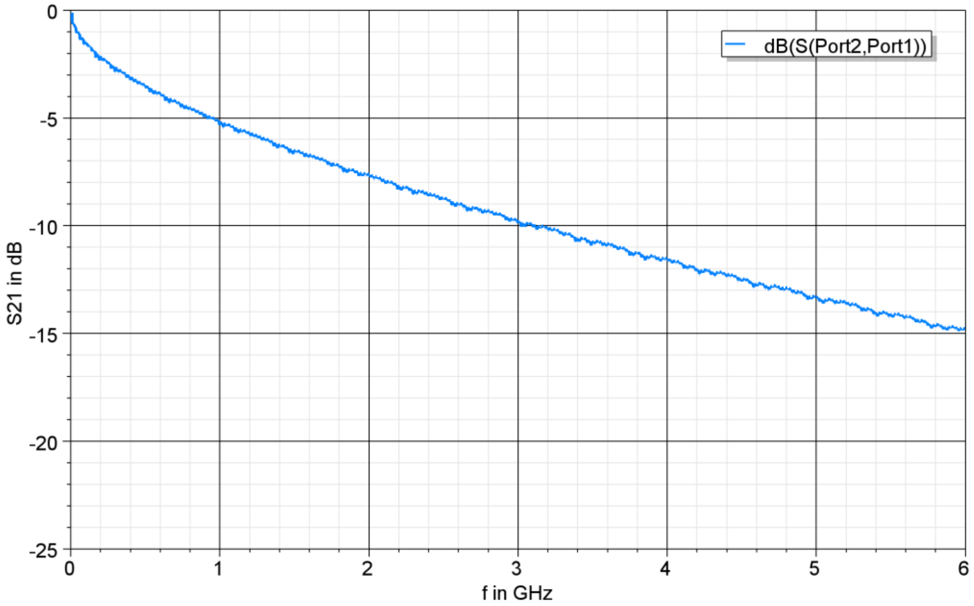
15 m with 4 inlines

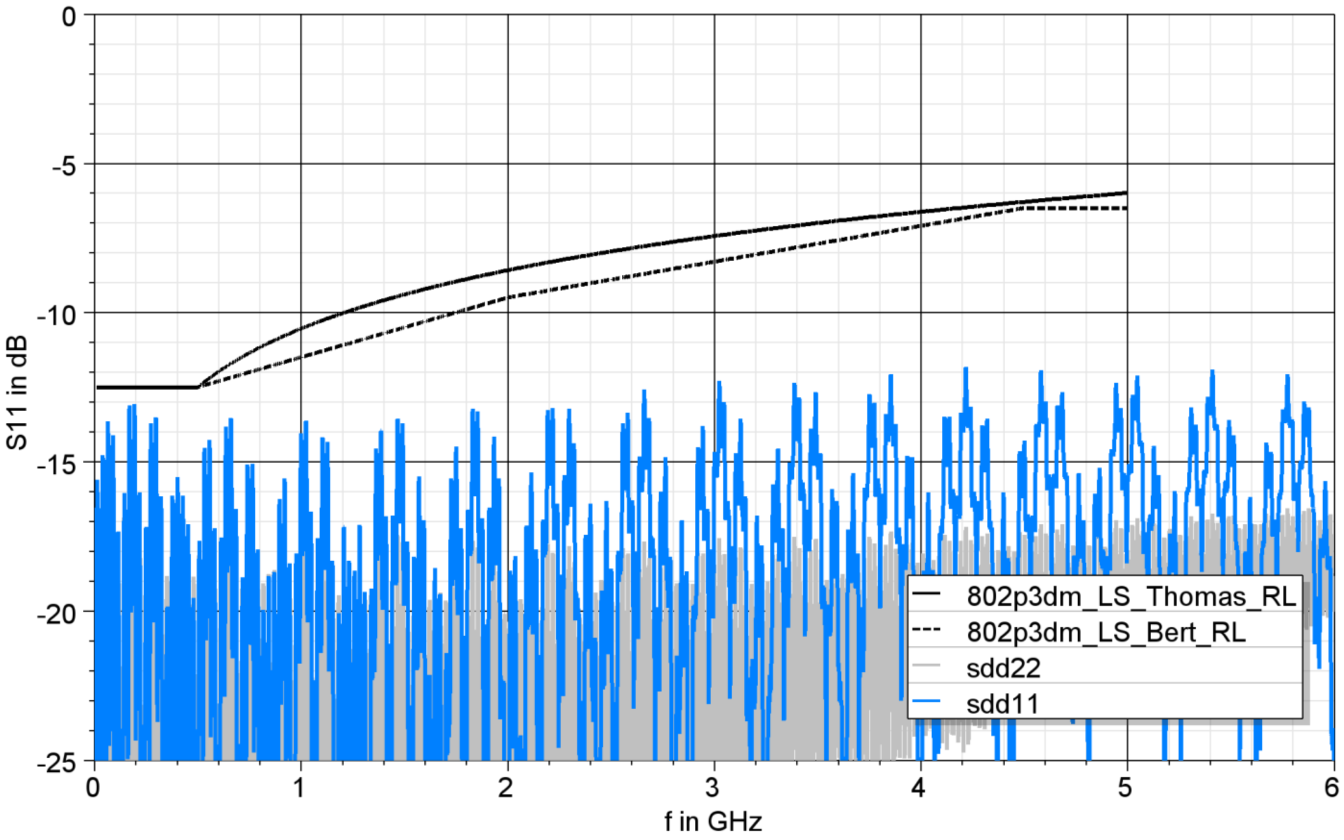
- Link segment RL without inline connectors (cable segments only, theoretical) as shown in the topology



Link segment Insertion Loss



Link segment Return Loss



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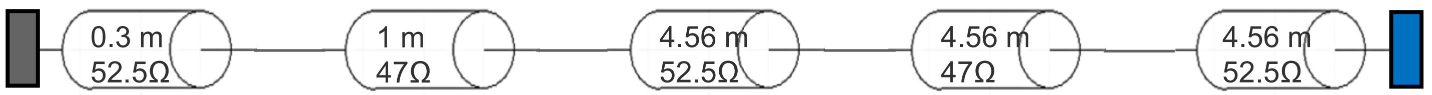
15 m with 4 inlines

- Link segment RL without inline connectors (cable segments only, theoretical) as shown in the topology

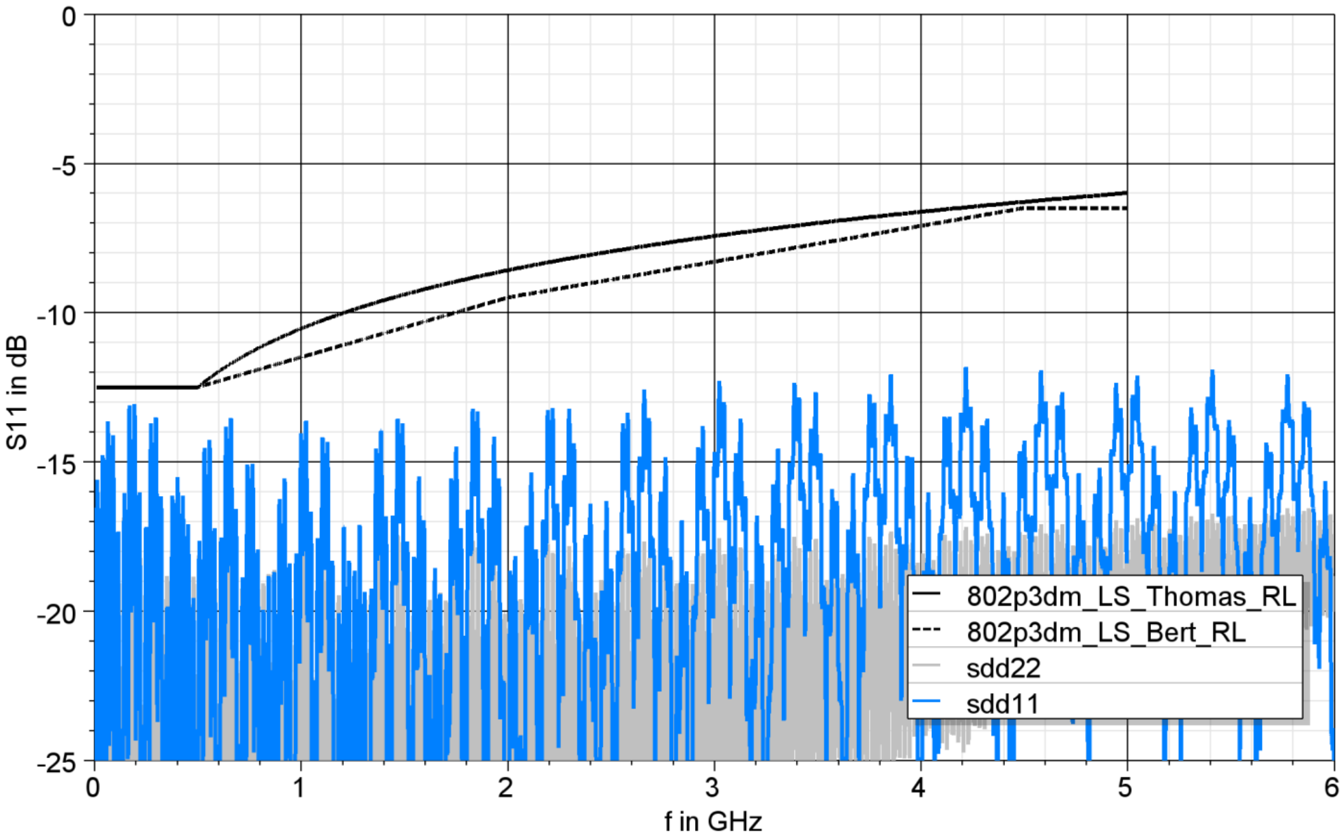
RL



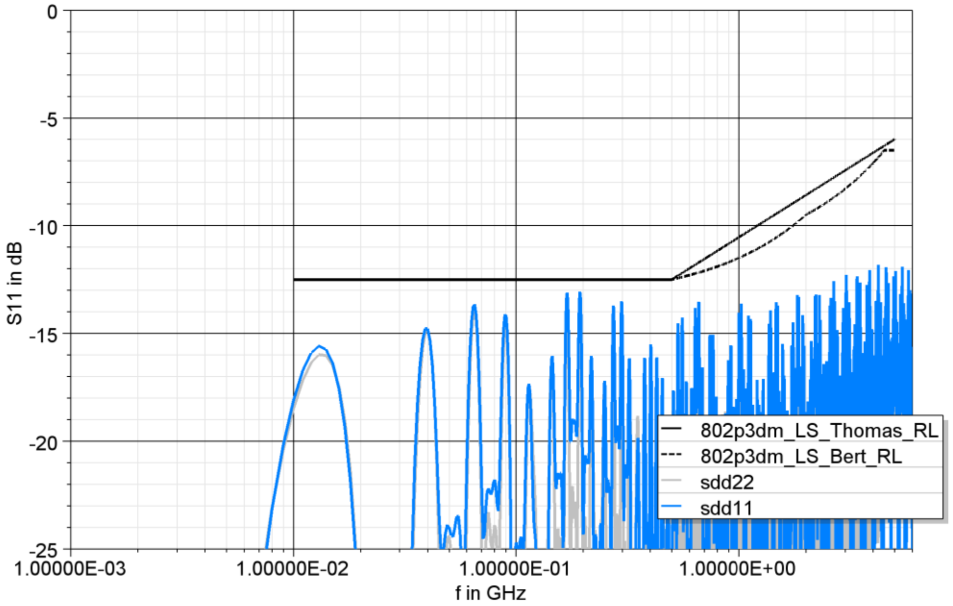
Single con1

Single con2

Link segment Return Loss



Link segment Return Loss low frequency (x-axis log)



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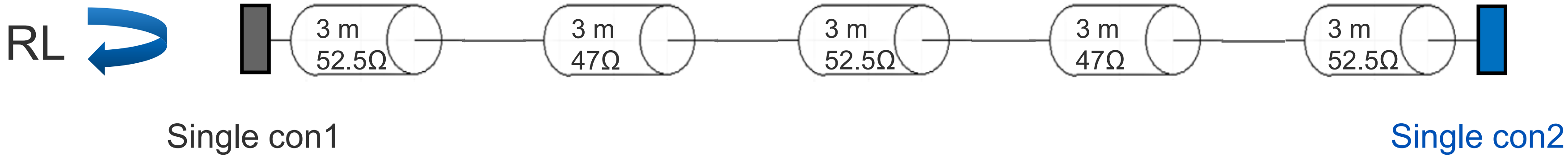
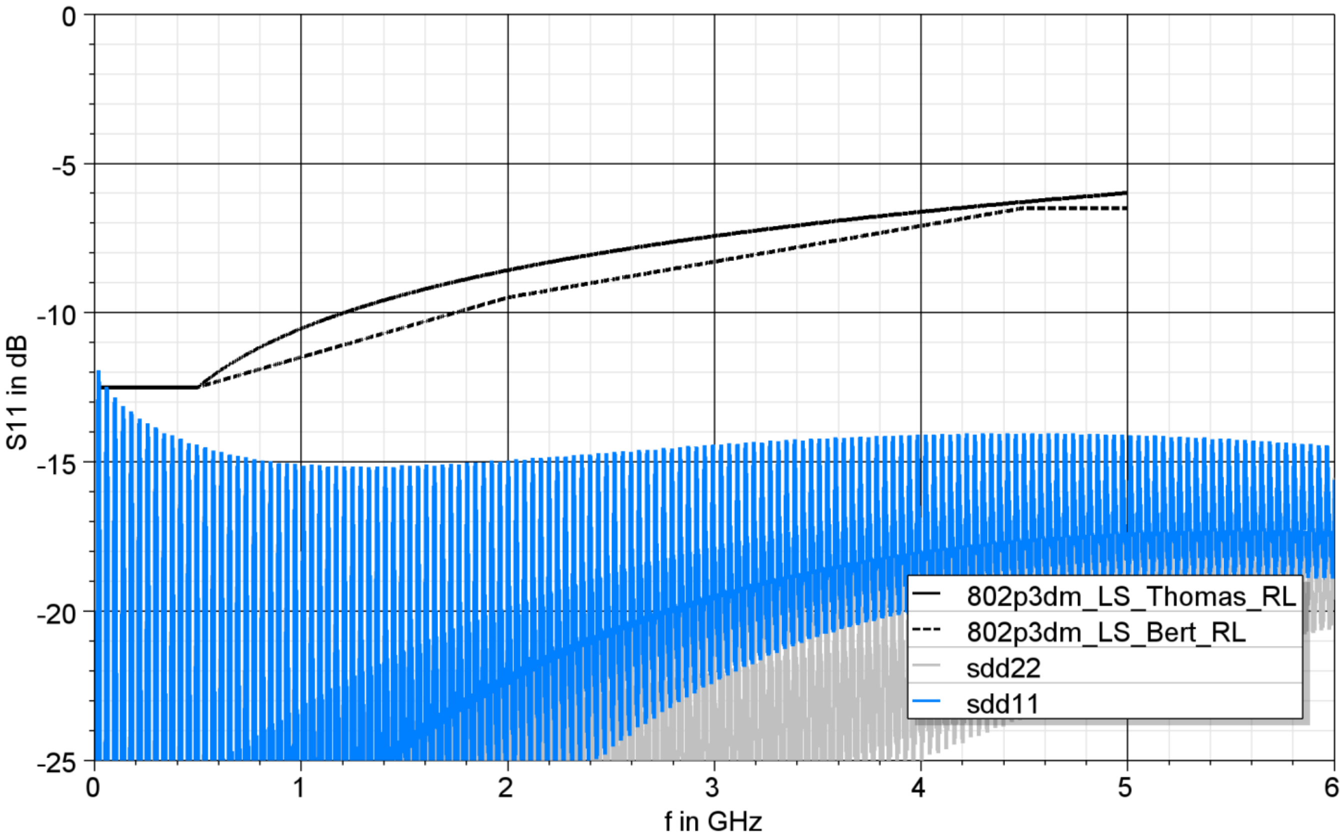
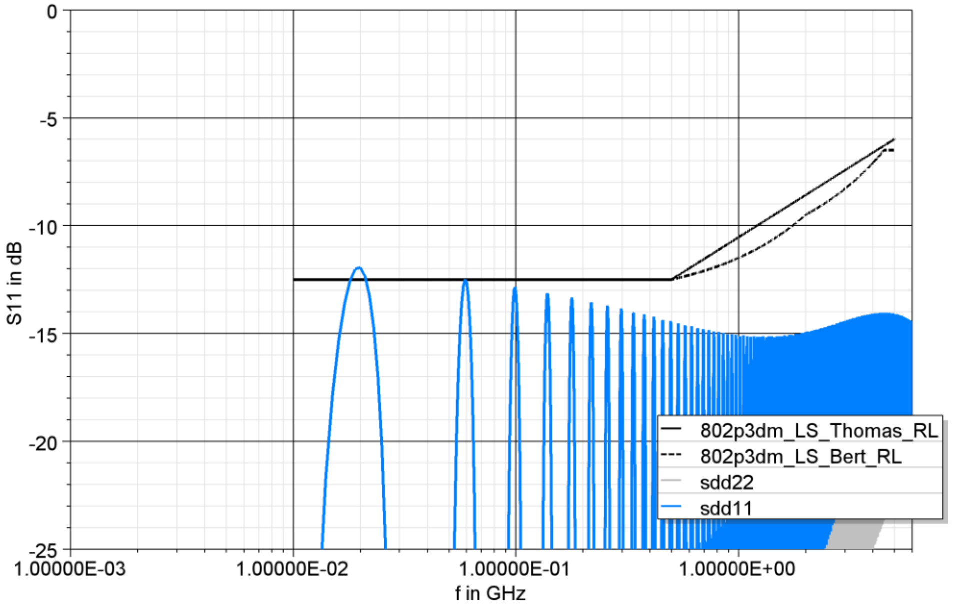
- Low frequency RL worst case if cable segment lengths are identical



Link segment Return Loss



Link segment Return Loss low frequency (x-axis log)



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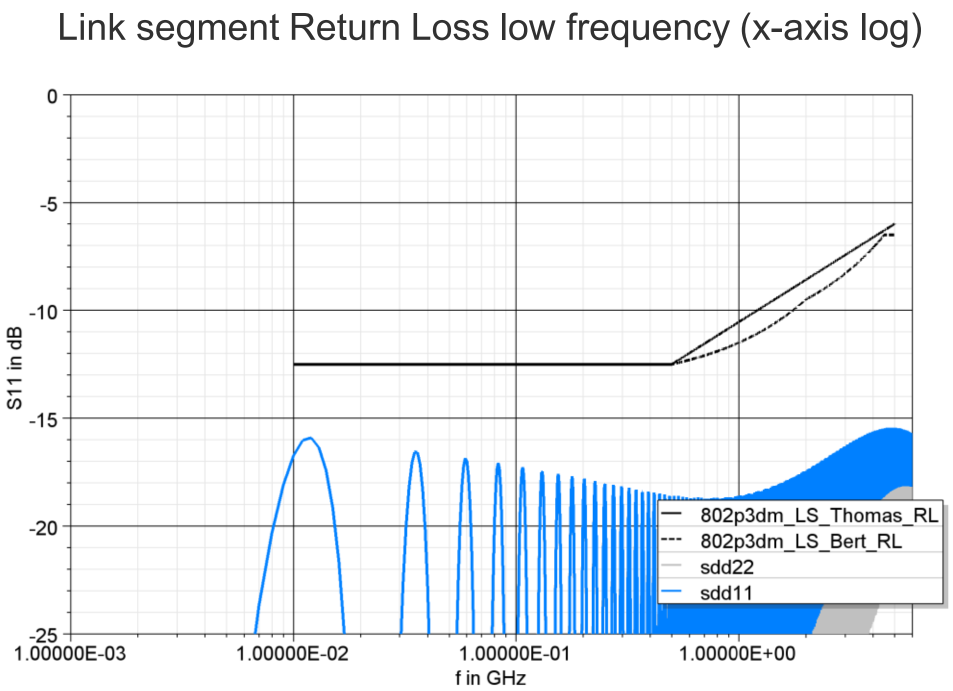
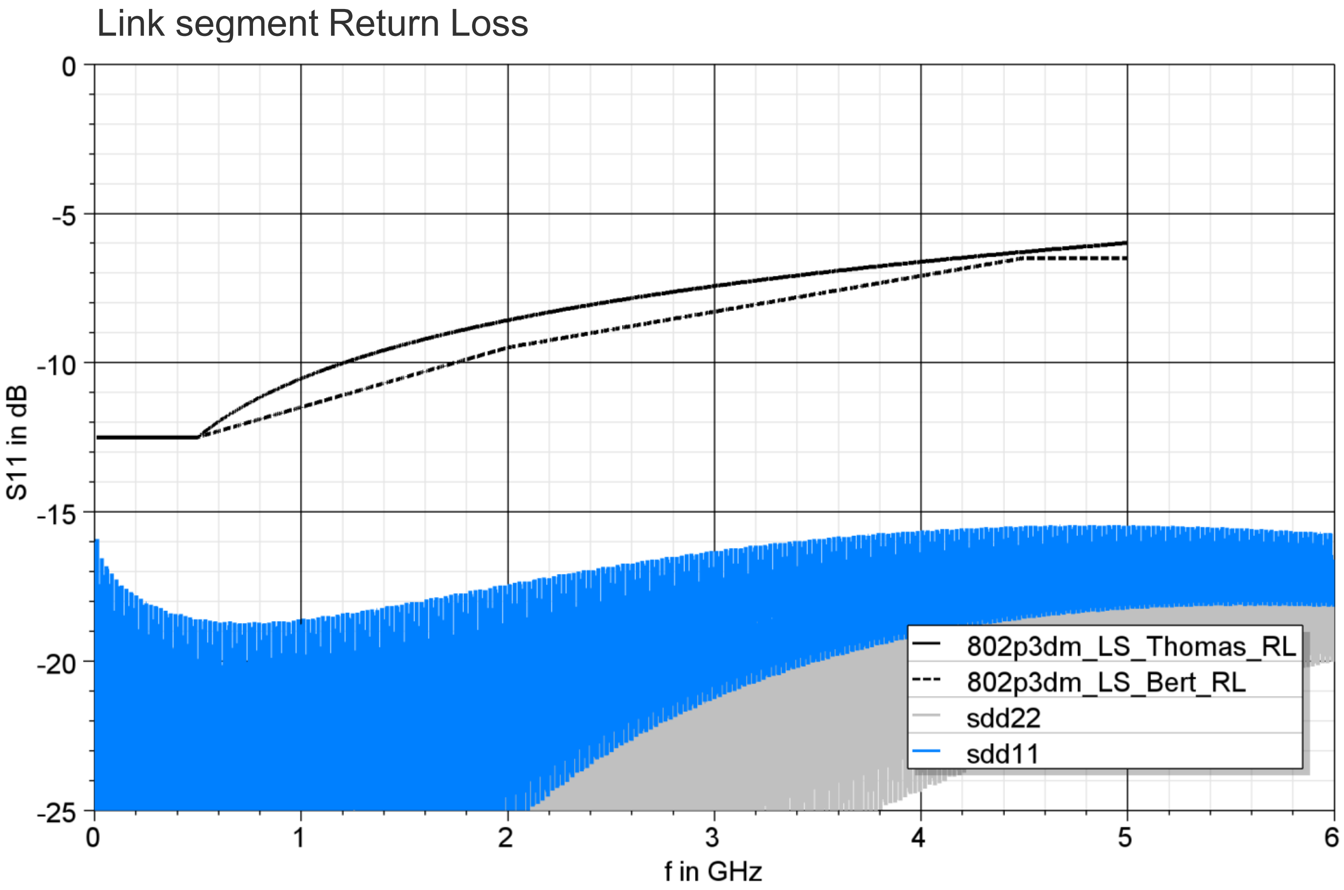
- Reducing number of cable segments improves RL





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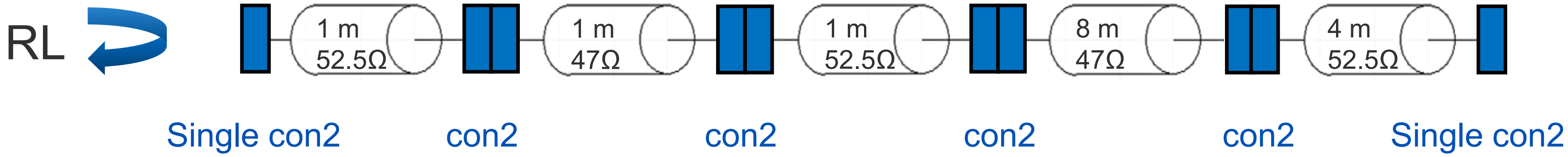
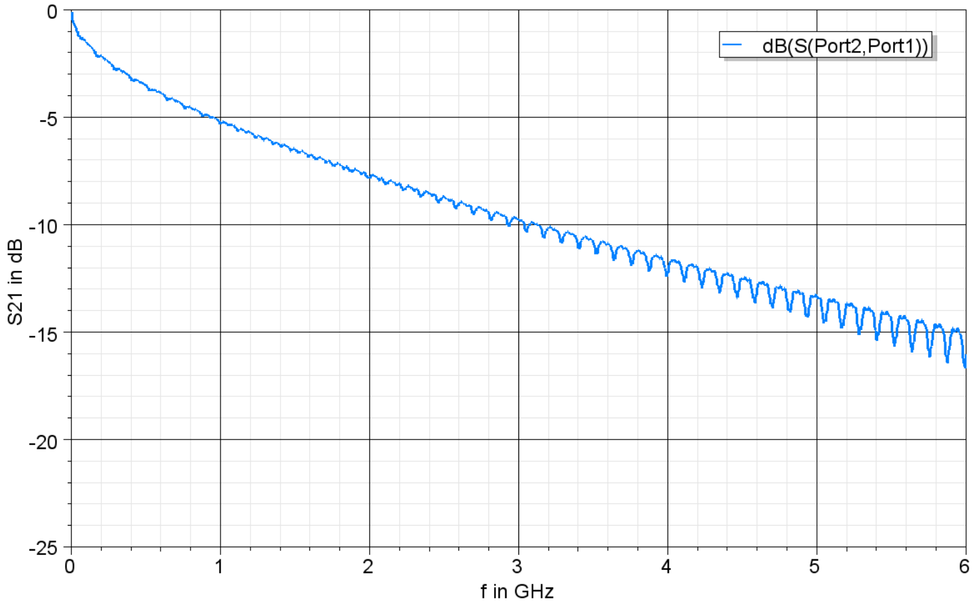
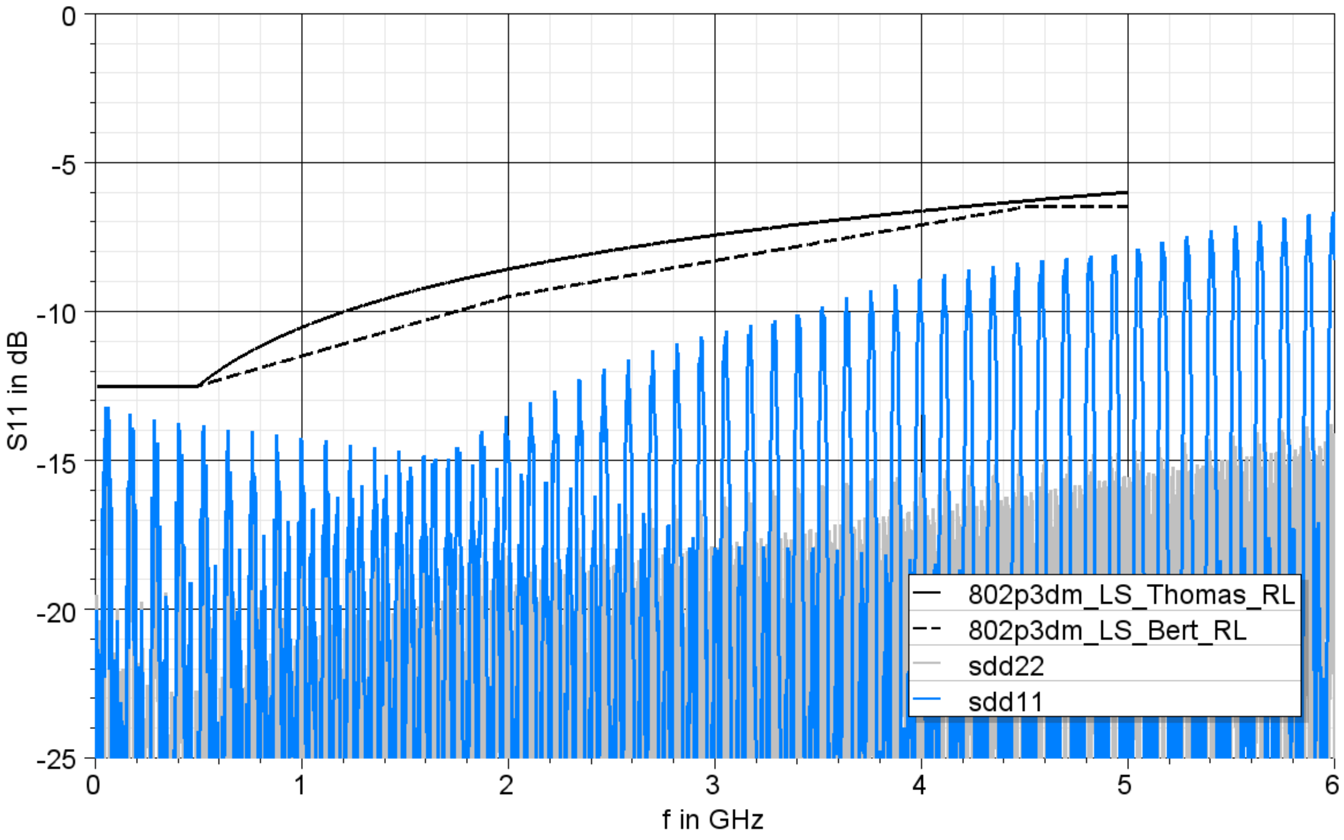
- Link segment RL with connector type 2 as shown in the topology with cable type **CX044**



Link segment Insertion Loss



Link segment Return Loss



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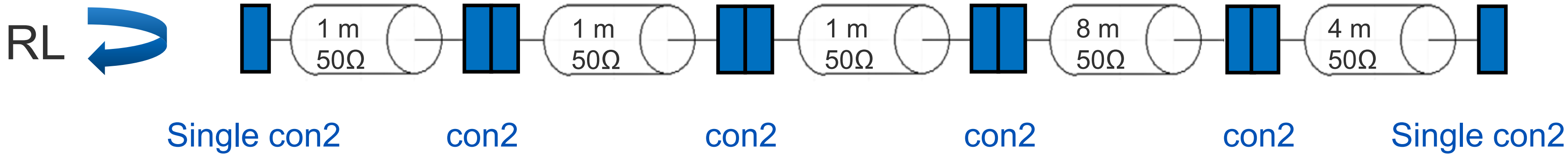
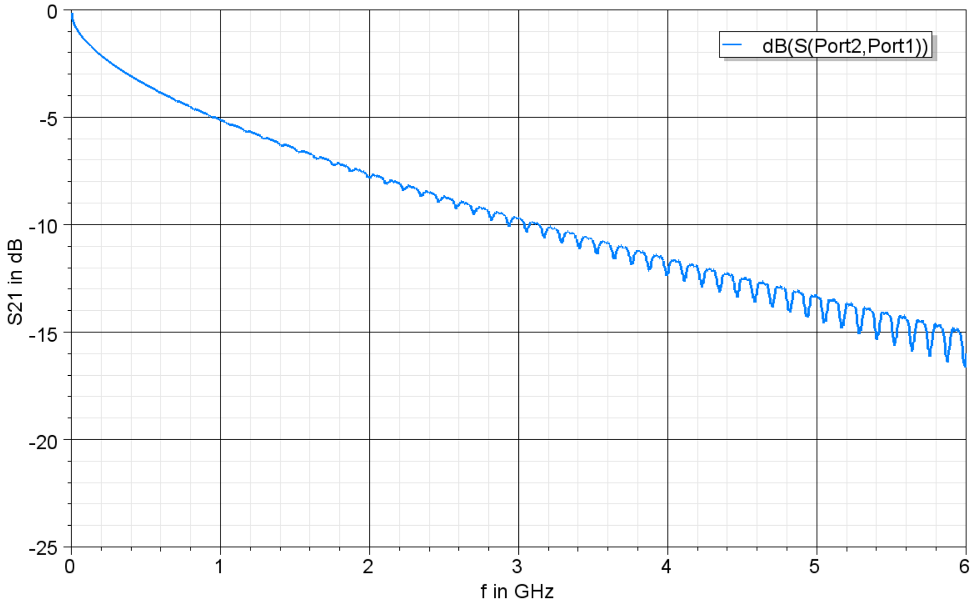
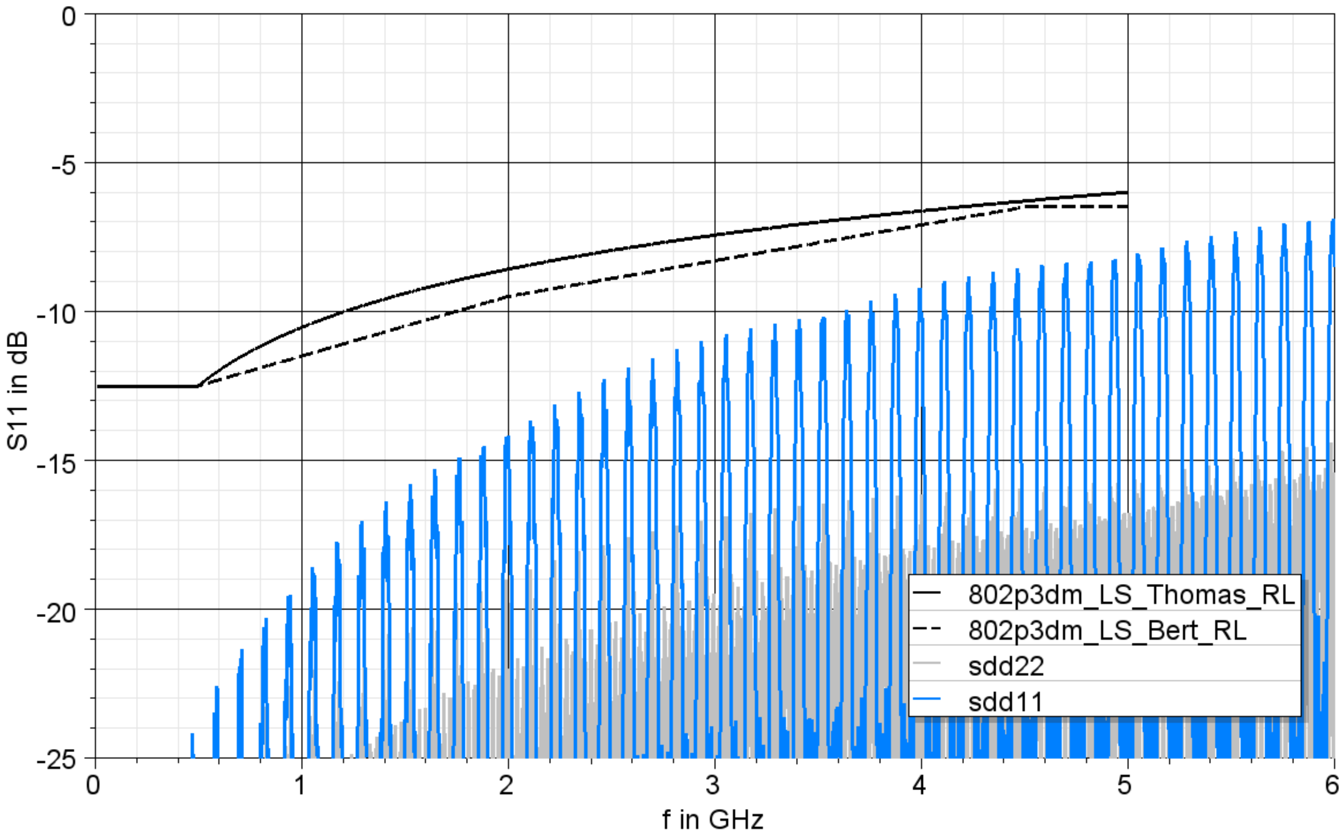
- Link segment RL with connector type 2 as shown in the topology with cable type **CX044** and ideal cable segment impedance



Link segment Insertion Loss



Link segment Return Loss



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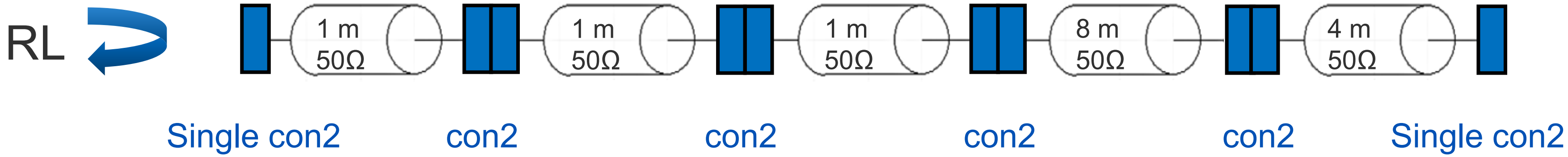
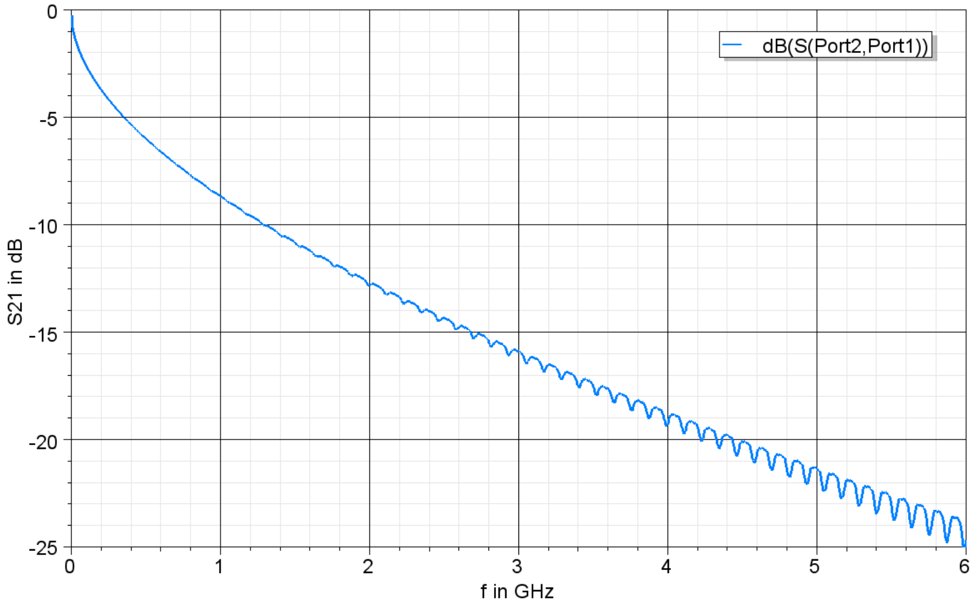
15 m with 4 inlines

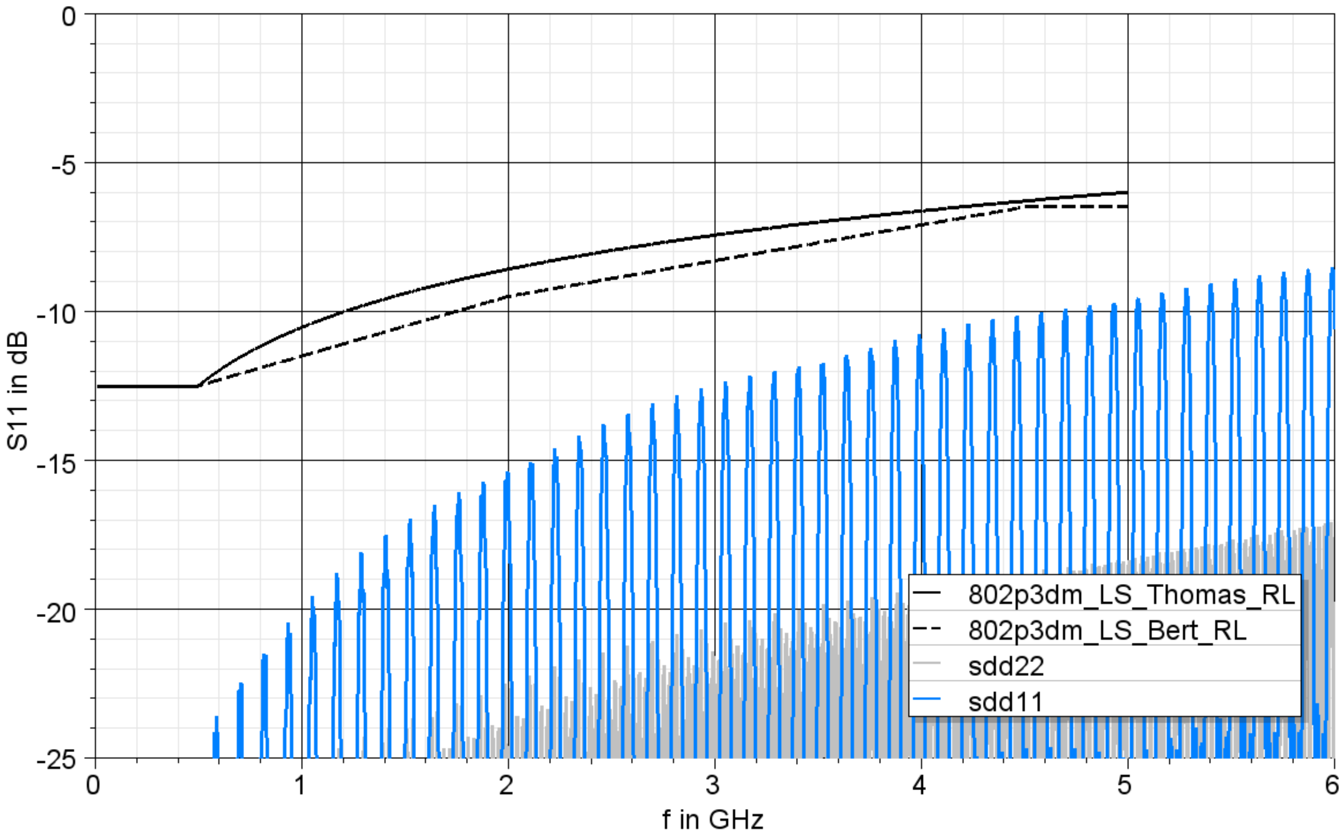
- Link segment RL with connector type 2 as shown in the topology with cable type **CX031** and ideal cable segment impedance



Link segment Insertion Loss



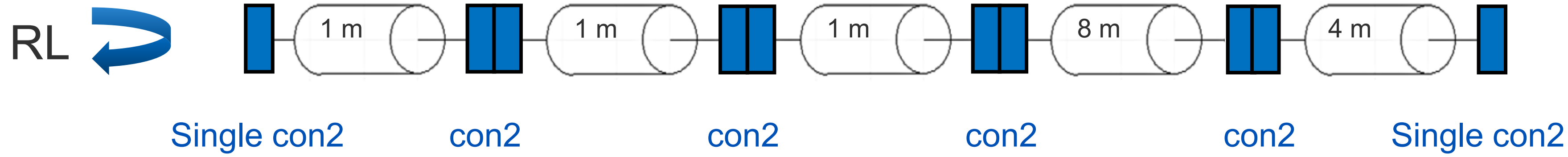
Link segment Return Loss



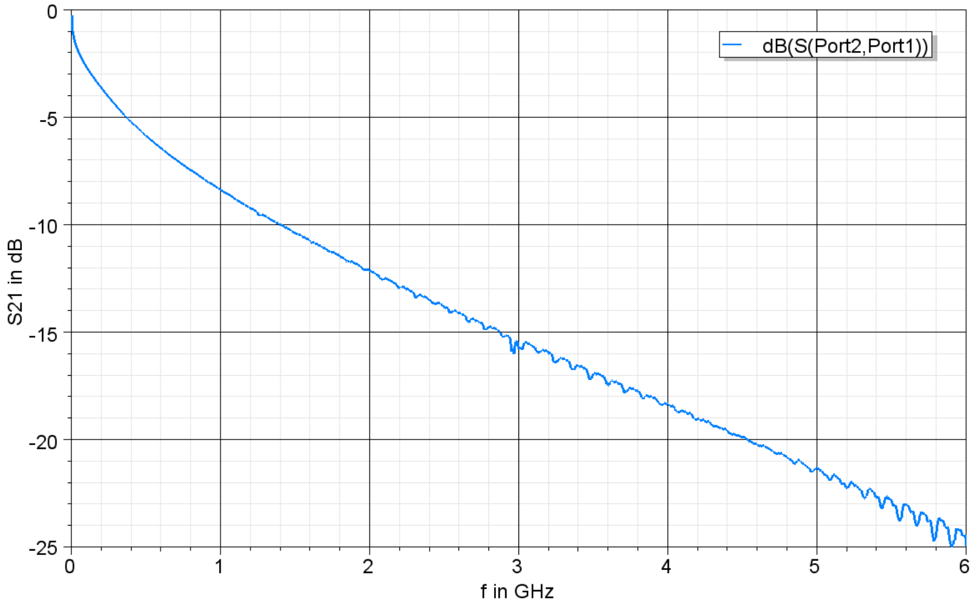
Return loss of automotive coaxial link segments

15 m with 4 inlines

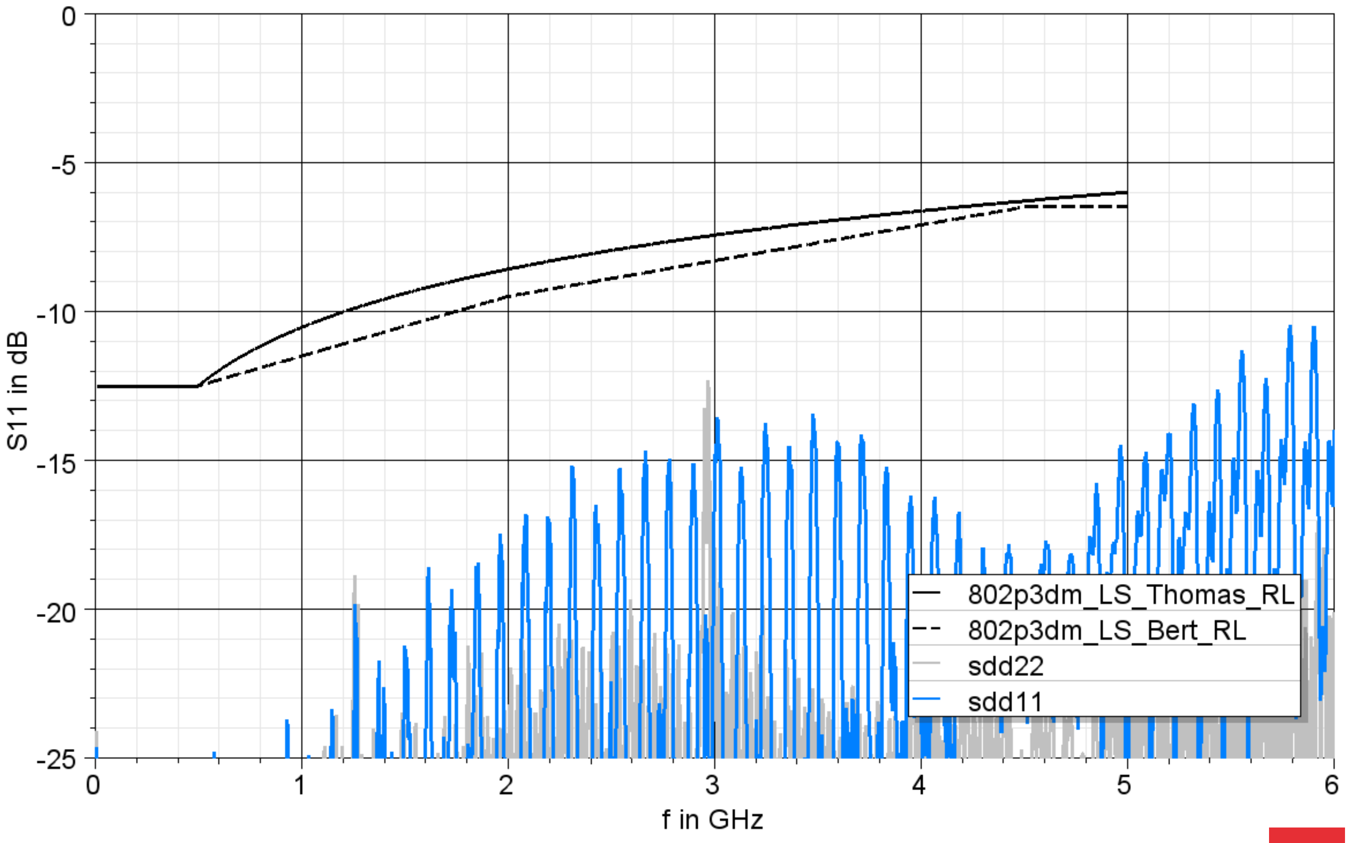
- **Measured**
  Link segment RL
  with connector type 2
  as shown in the topology
  with cable type **CX031**



Link segment Insertion Loss



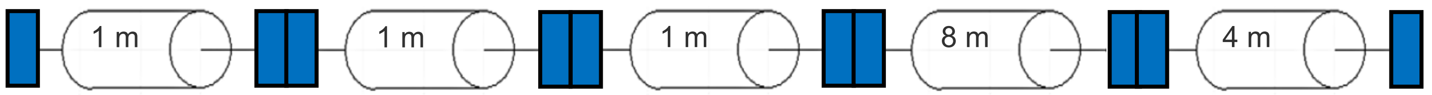
Link segment Return Loss



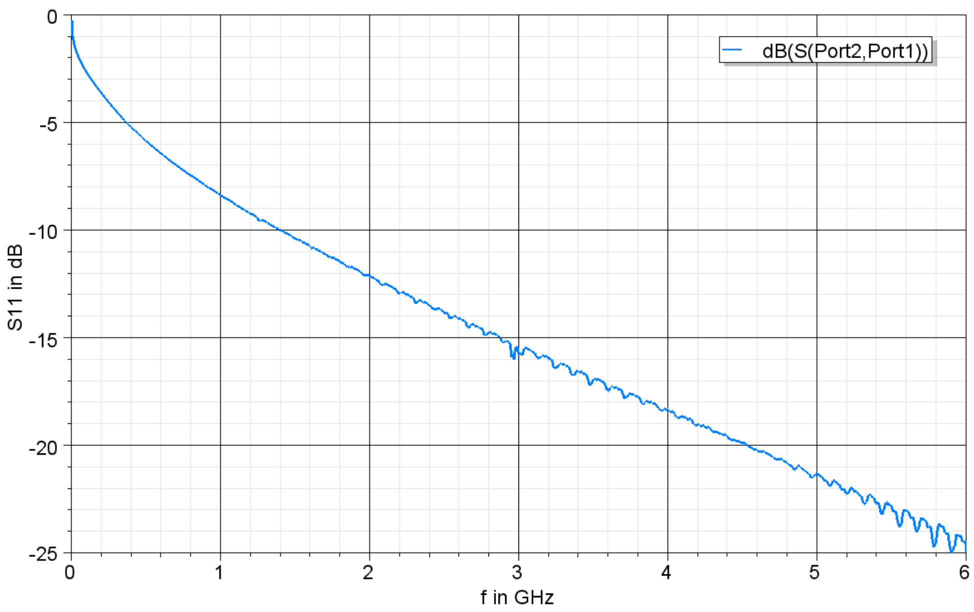
Return loss of automotive coaxial link segments

15 m with 4 inlines

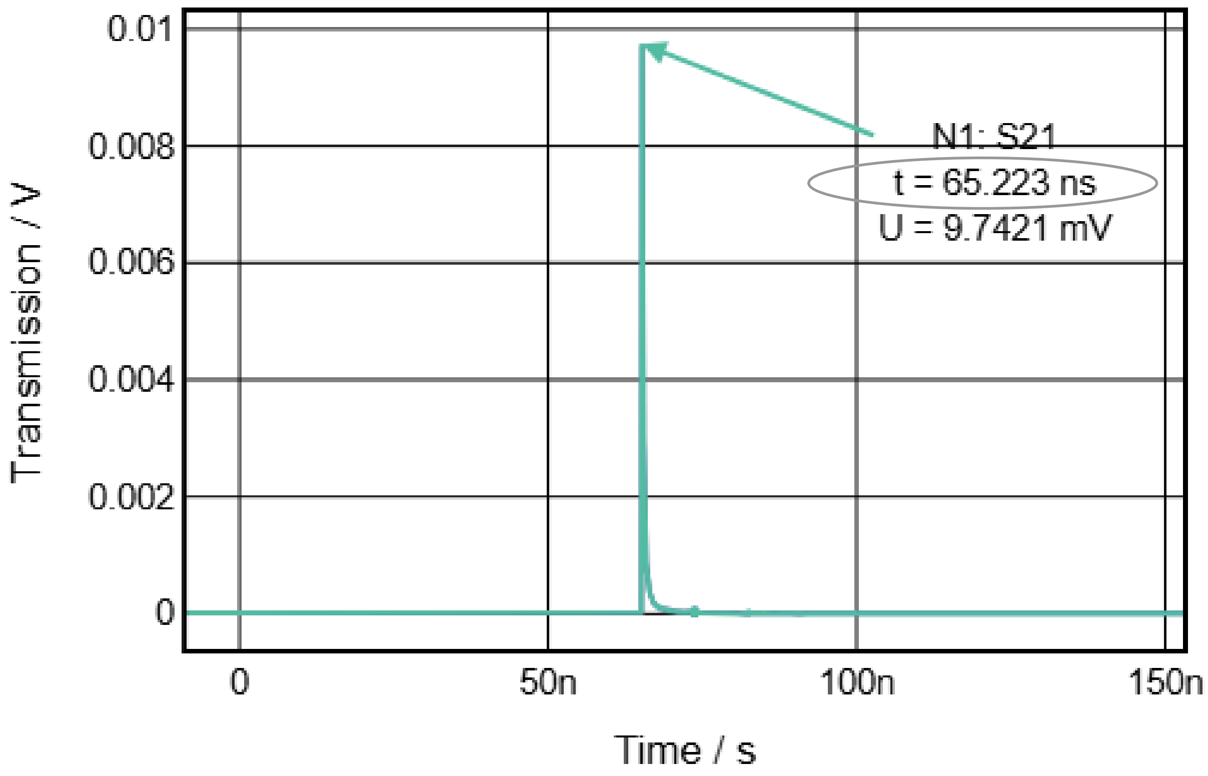
- **Measured**
  Link segment propagation delay with connector types as shown in the topology with cable type **CX031**



Link segment Insertion Loss



Link segment propagation delay



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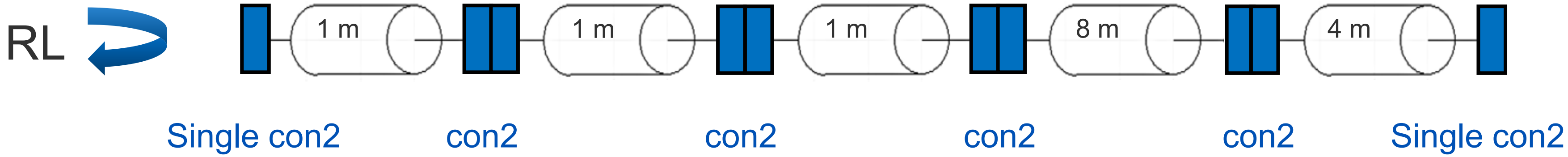
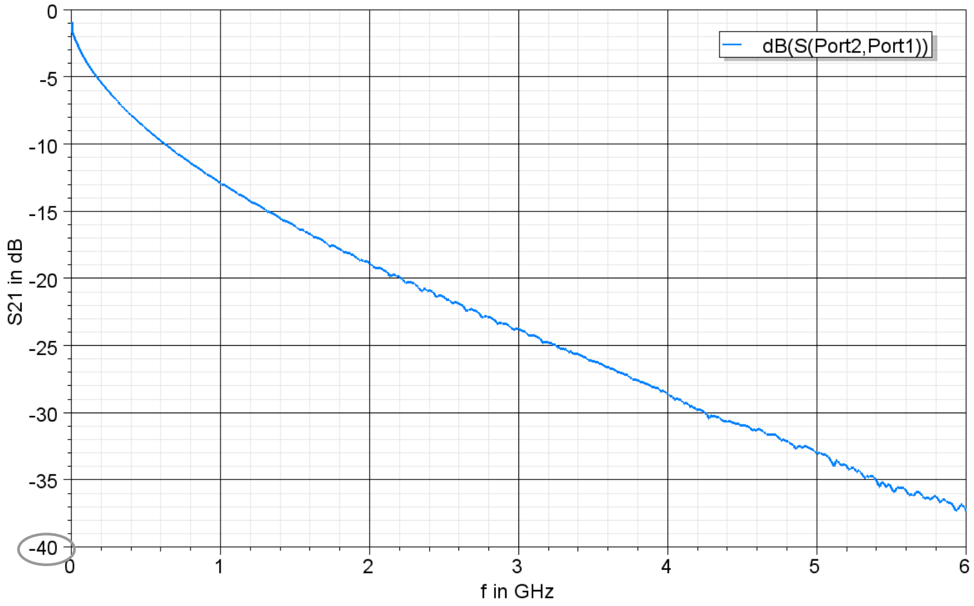
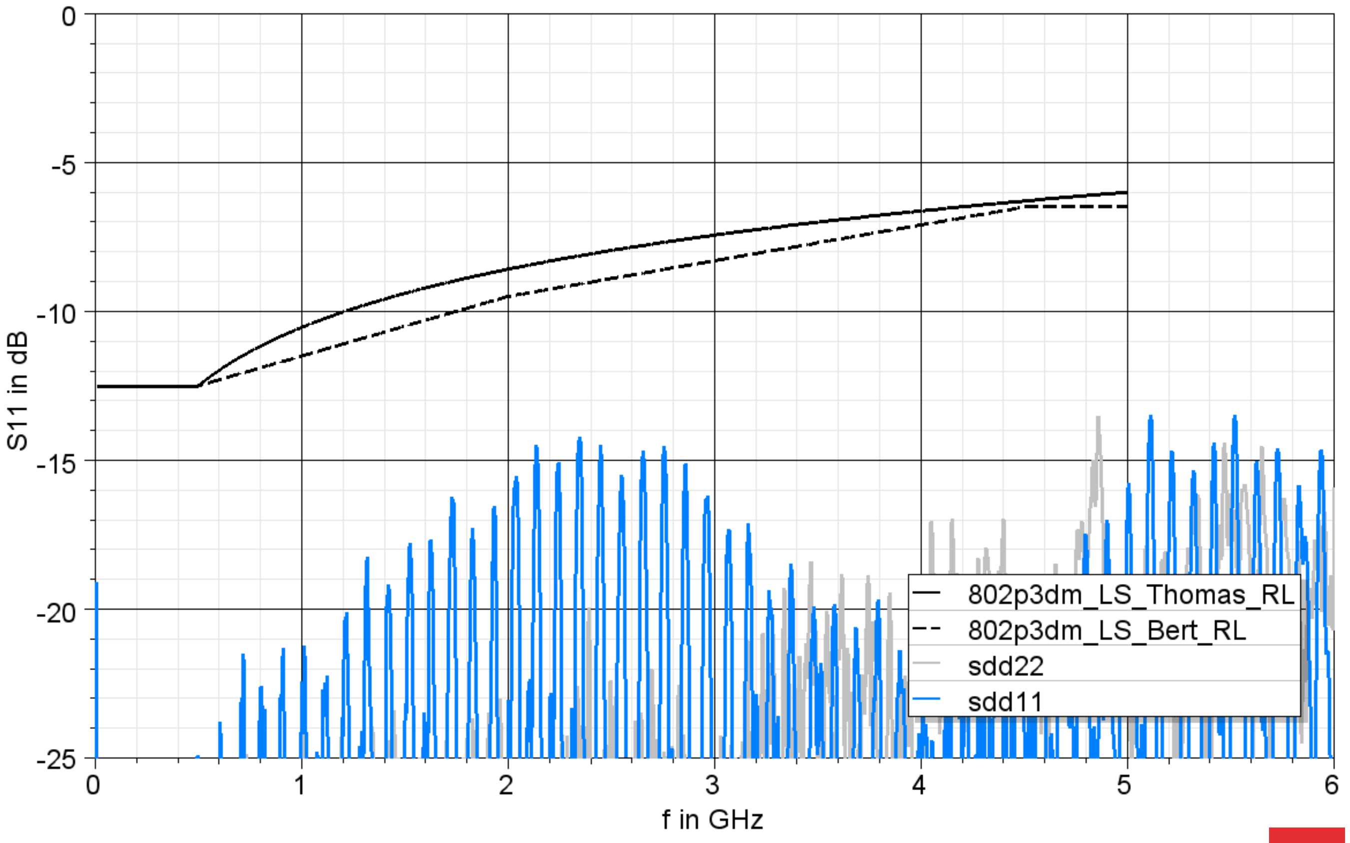
- **Measured**
  Link segment RL
  with connector types
  as shown in the topology
  with cable type **RG-174**



Link segment Insertion Loss



Link segment Return Loss



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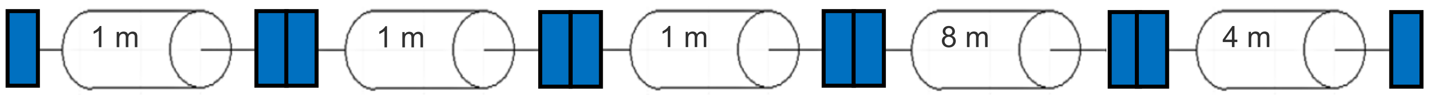
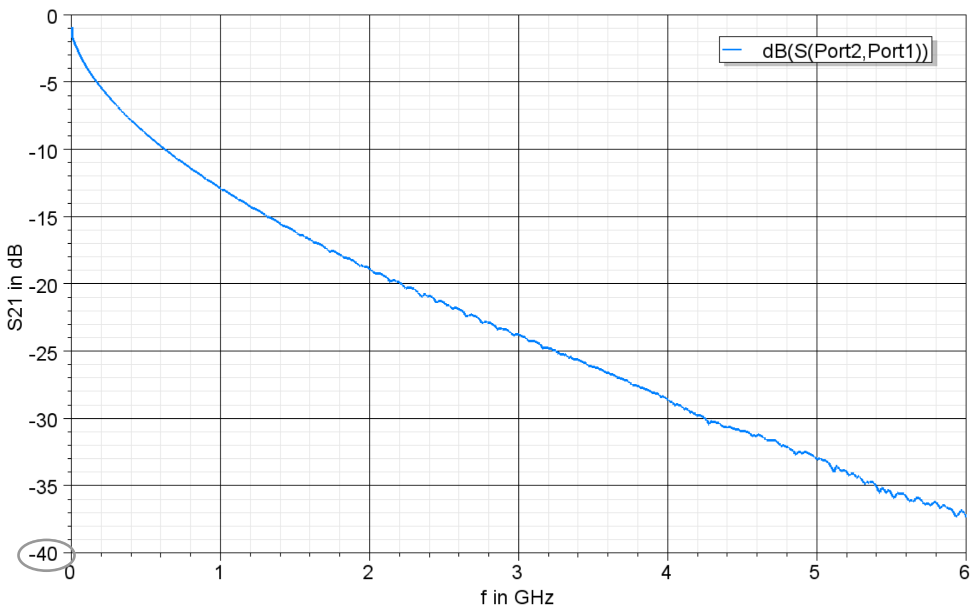
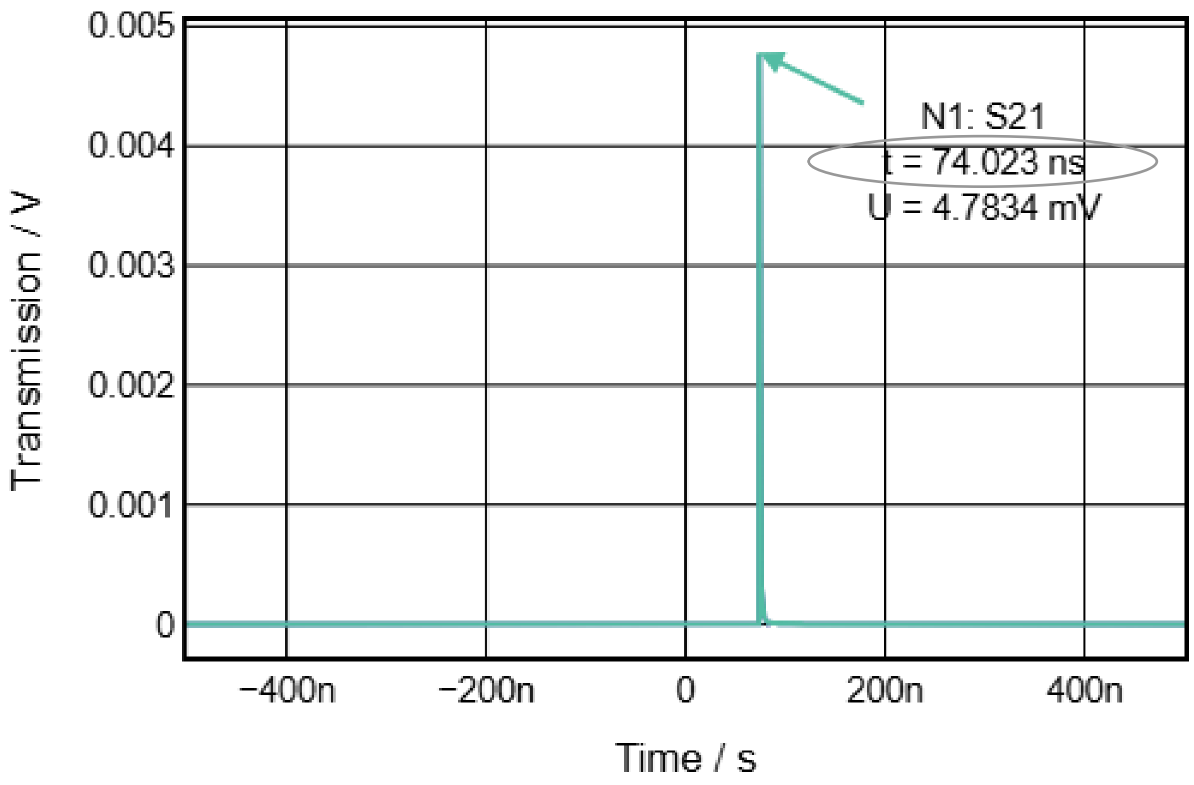


- **Measured**
  Link segment propagation delay with connector types as shown in the topology with cable type **RG-174**

Link segment Insertion Loss



Link segment propagation delay



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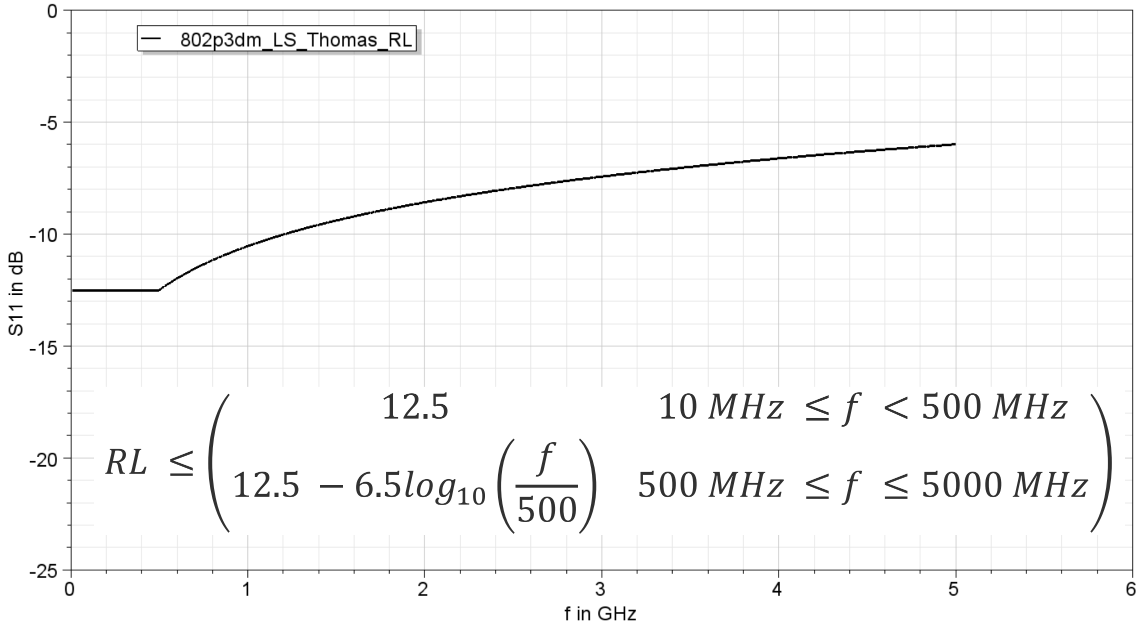
Summary

- Link segment RL results based on simulation and measurements for combinations of coaxial connectors marginal to USCAR-49 (mini coax) and a tighter specified connector based on Highspeed FAKRA Mini (HFM) with different cable types were presented.
- RL in the lower frequency range (≤ ~1.5 GHz) is determined mainly by cable segment properties including number of segments and impedance deviations.
- RL in the higher frequency range is determined by number and quality of connectors.
- Propose to consider the following link segment return loss as baseline for the coaxial case with upper frequency depending on speed rate
- Some small additional margin for cable micro reflexions caused impedance variations along the cable due to manufacturing processes (~2 dB) is considered in the proposal
- Propagation delay varies with the dielectric insulation material with the cable, which may reach up to er ≈ 2.2 for solid PP material



$$RL \le \begin{pmatrix} 12.5 & 10\,MHz \le f < 500\,MHz \\ 12.5 - 6.5 log_{10}\left(\frac{f}{500}\right) & 500\,MHz \le f \le 5000\,MHz \end{pmatrix}$$