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# IEEE 802.3dm adhoc meeting
# Return loss of automotive coaxial link segments

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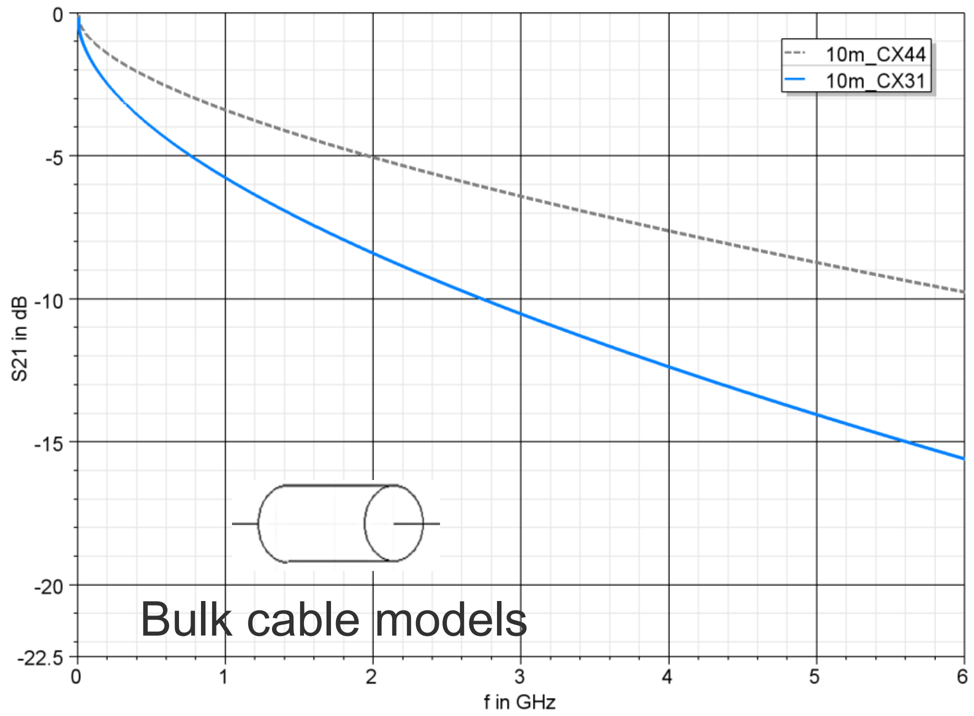
# Return loss of automotive coaxial link segments



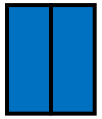
## Scope and cable model

- 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



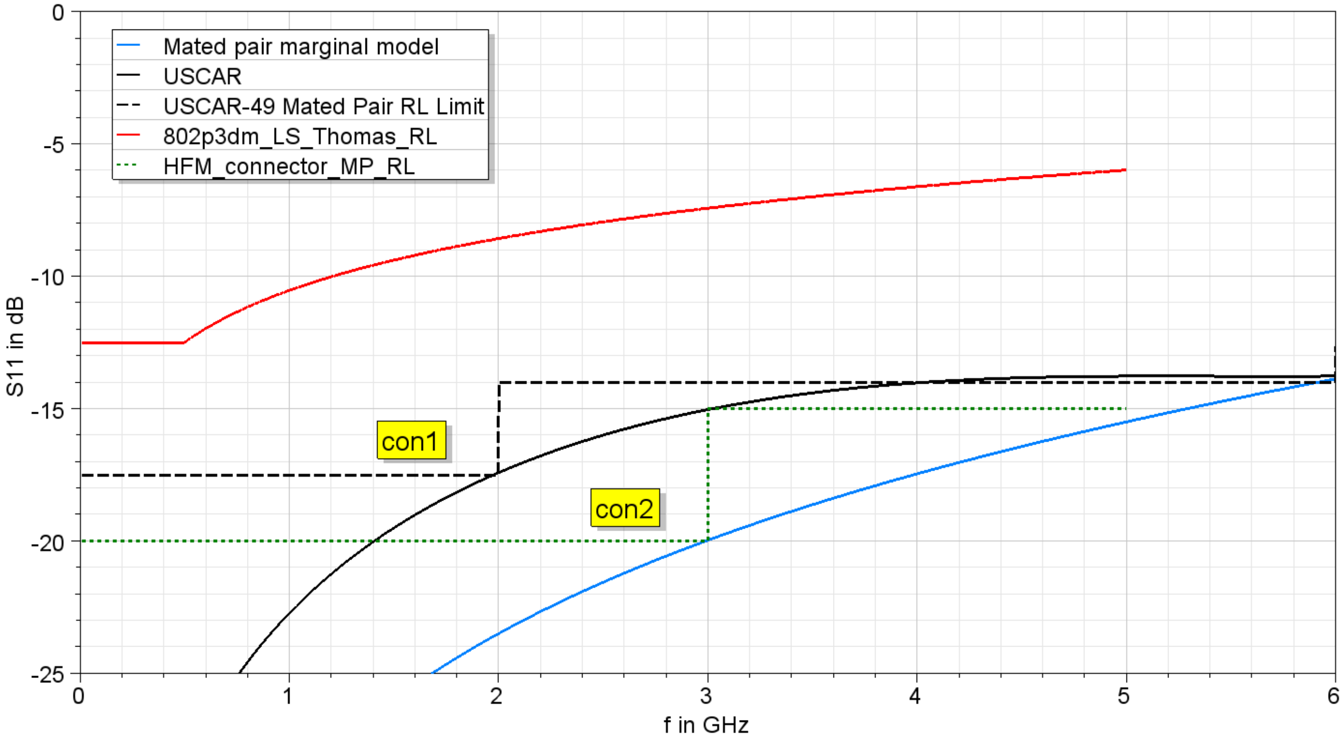
# Return loss of automotive coaxial link segments

## 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)

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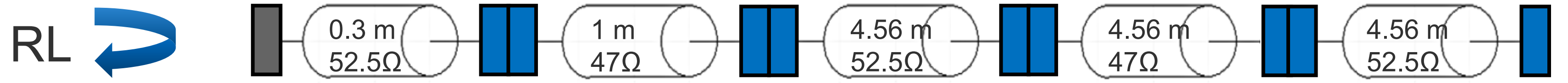
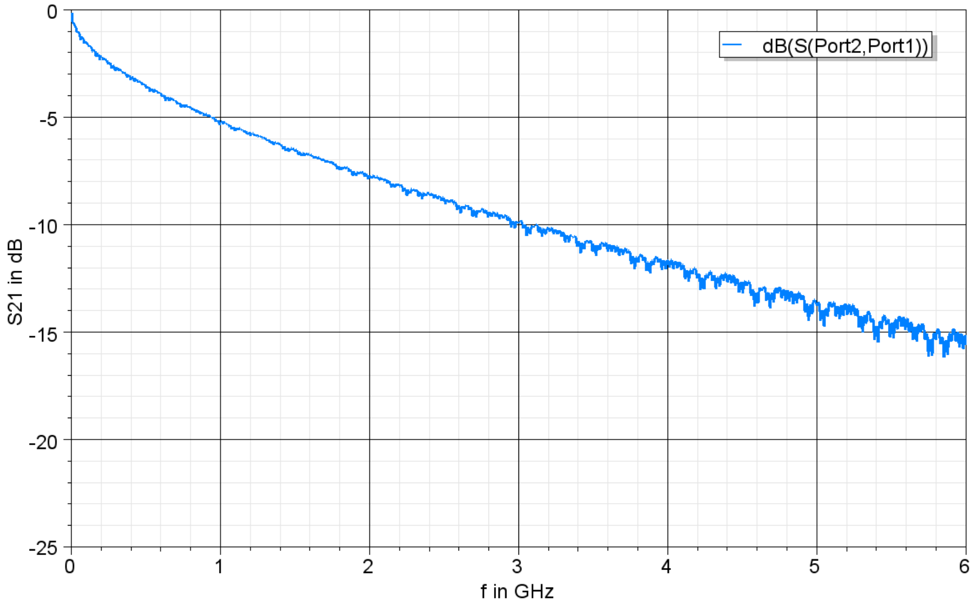
## 15 m with 4 inlines

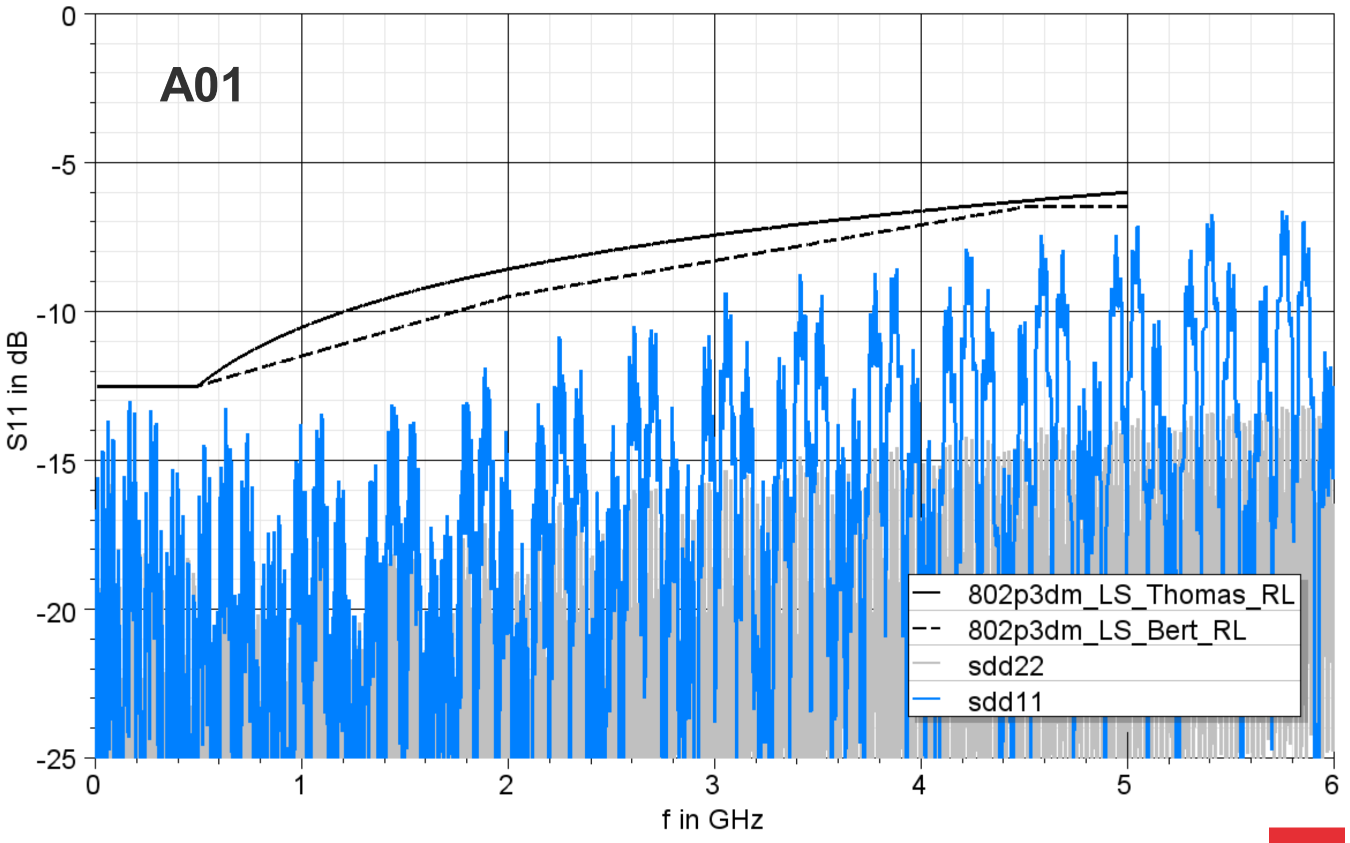
- Link segment RL with connector 1 at the sensor and connector 2 along the channel




Link segment Insertion Loss




Link segment Return Loss



# Return loss of automotive coaxial link segments

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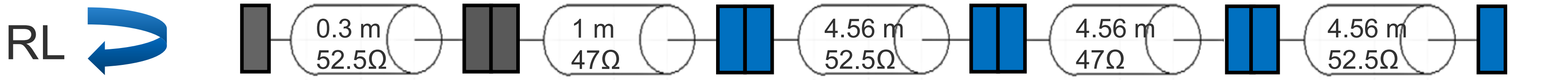
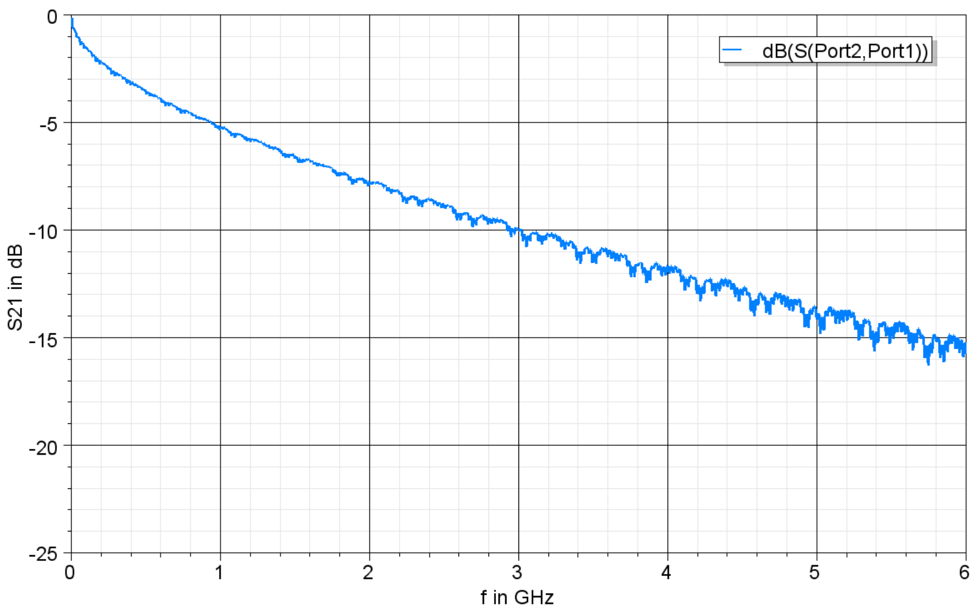
## 15 m with 4 inlines

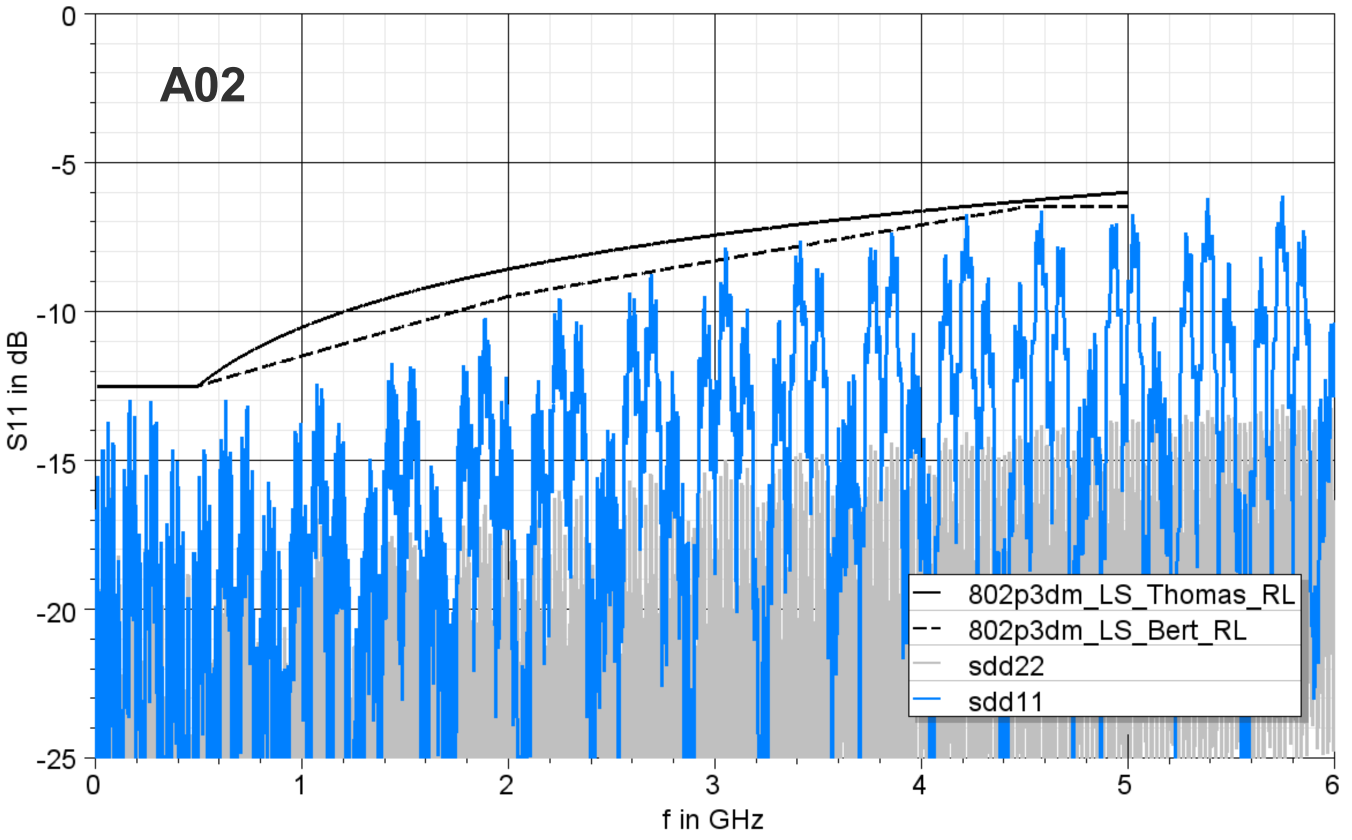
- Link segment RL with connector 1 at the sensor and first inline position and connector 2 along the channel




Link segment Insertion Loss




Link segment Return Loss



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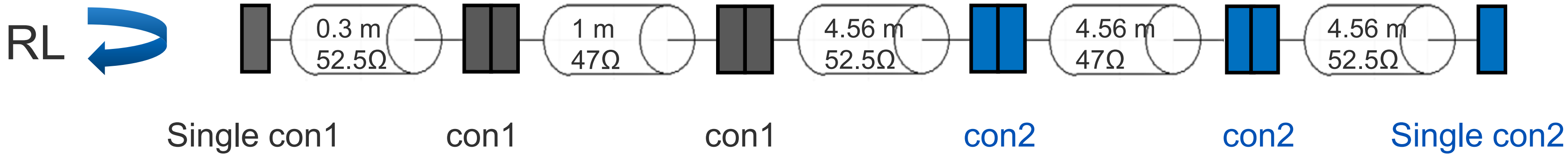
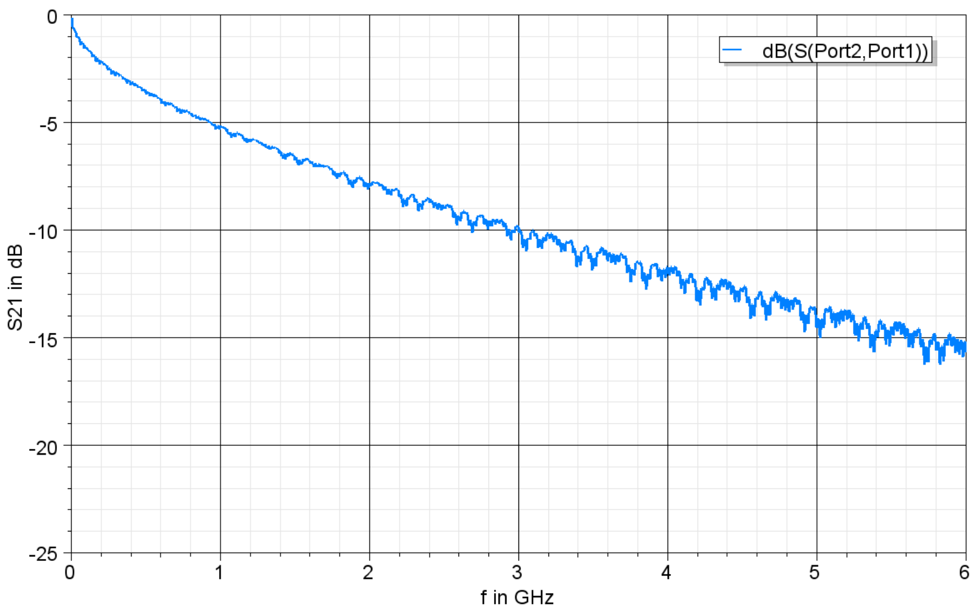
## 15 m with 4 inlines

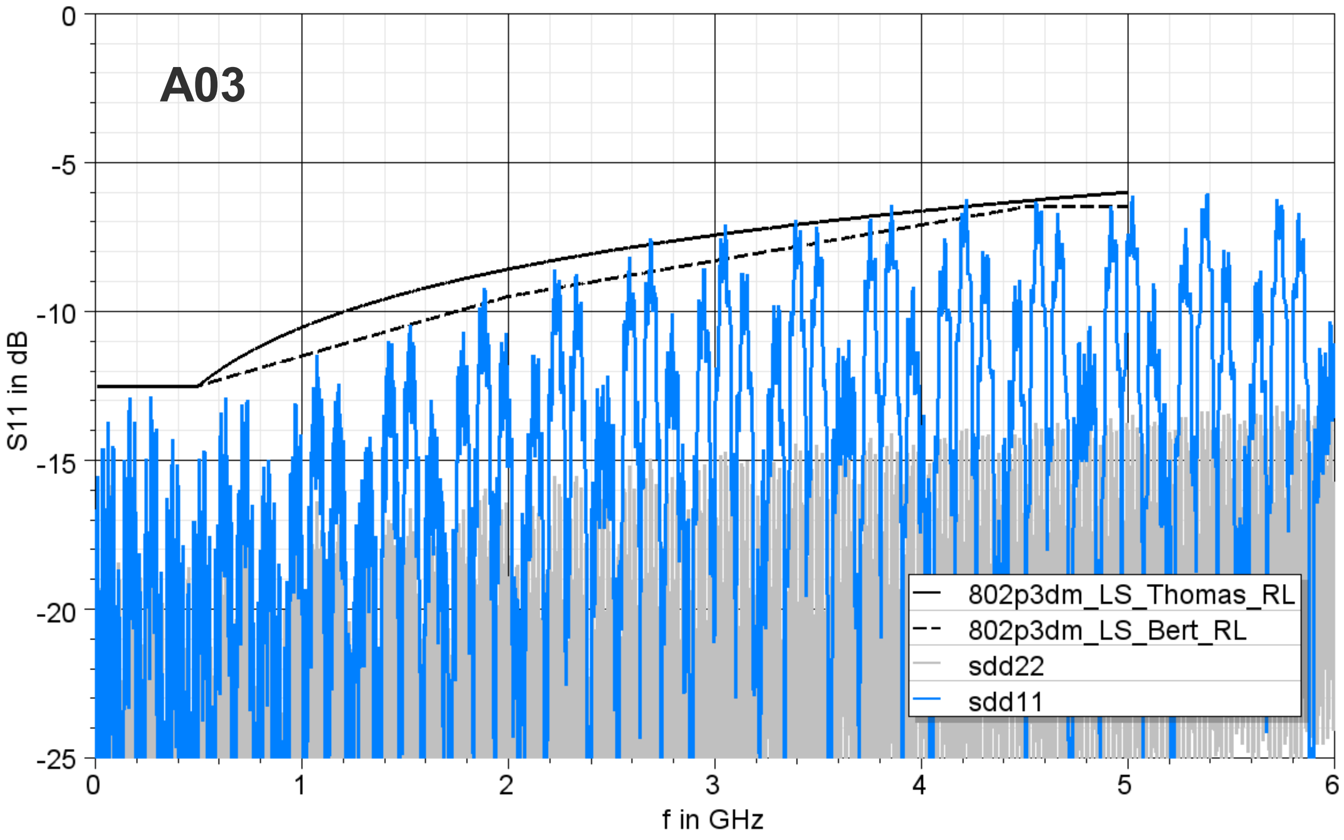
- Link segment RL with connector types as shown in the topology




Link segment Insertion Loss




Link segment Return Loss



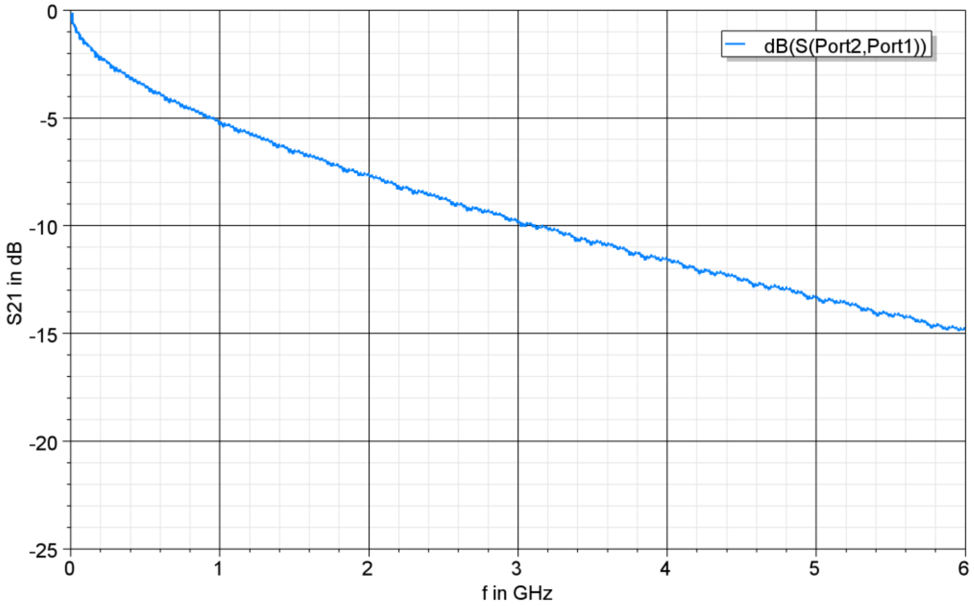
# Return loss of automotive coaxial link segments



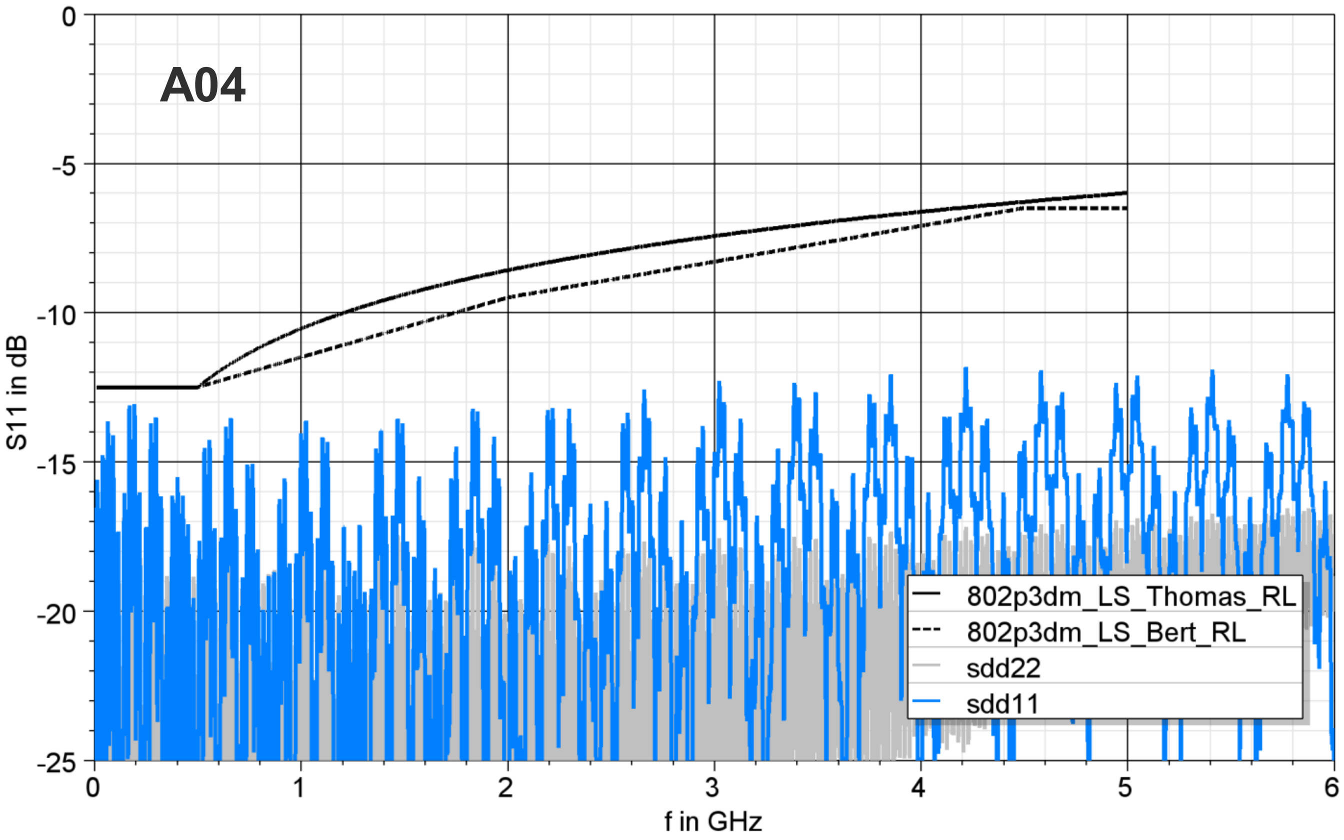
## 15 m with 4 inlines

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


Link segment Insertion Loss




Link segment Return Loss

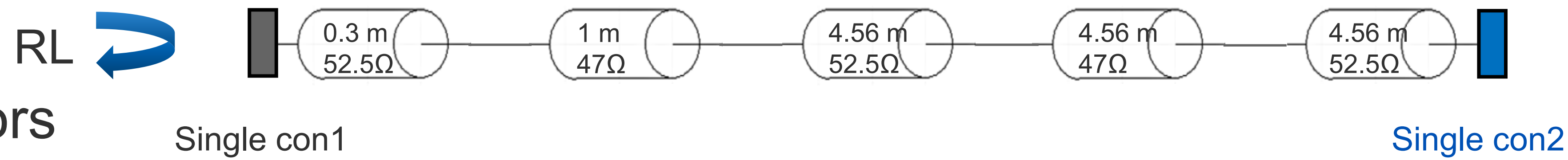


# Return loss of automotive coaxial link segments

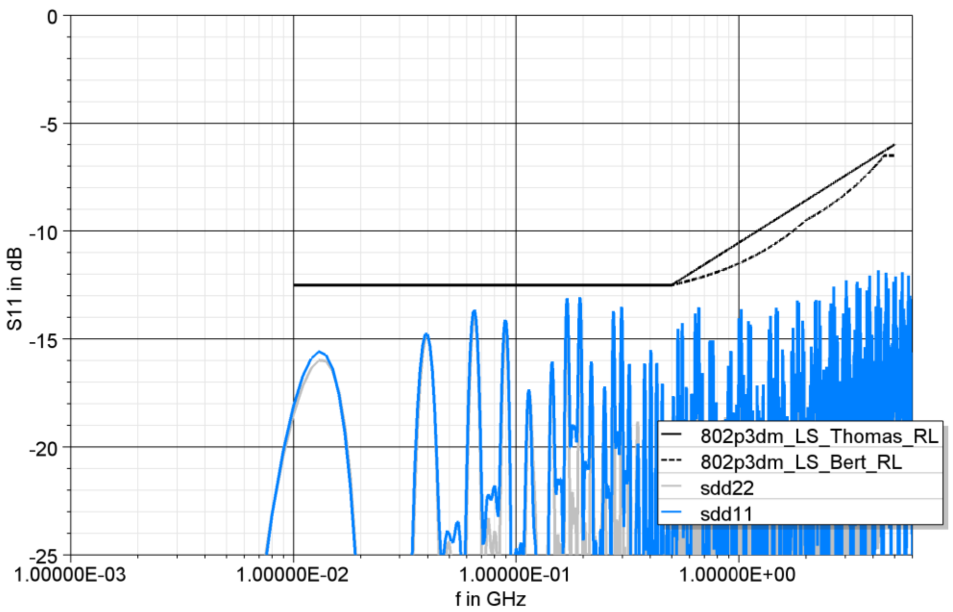


## 15 m with 4 inlines

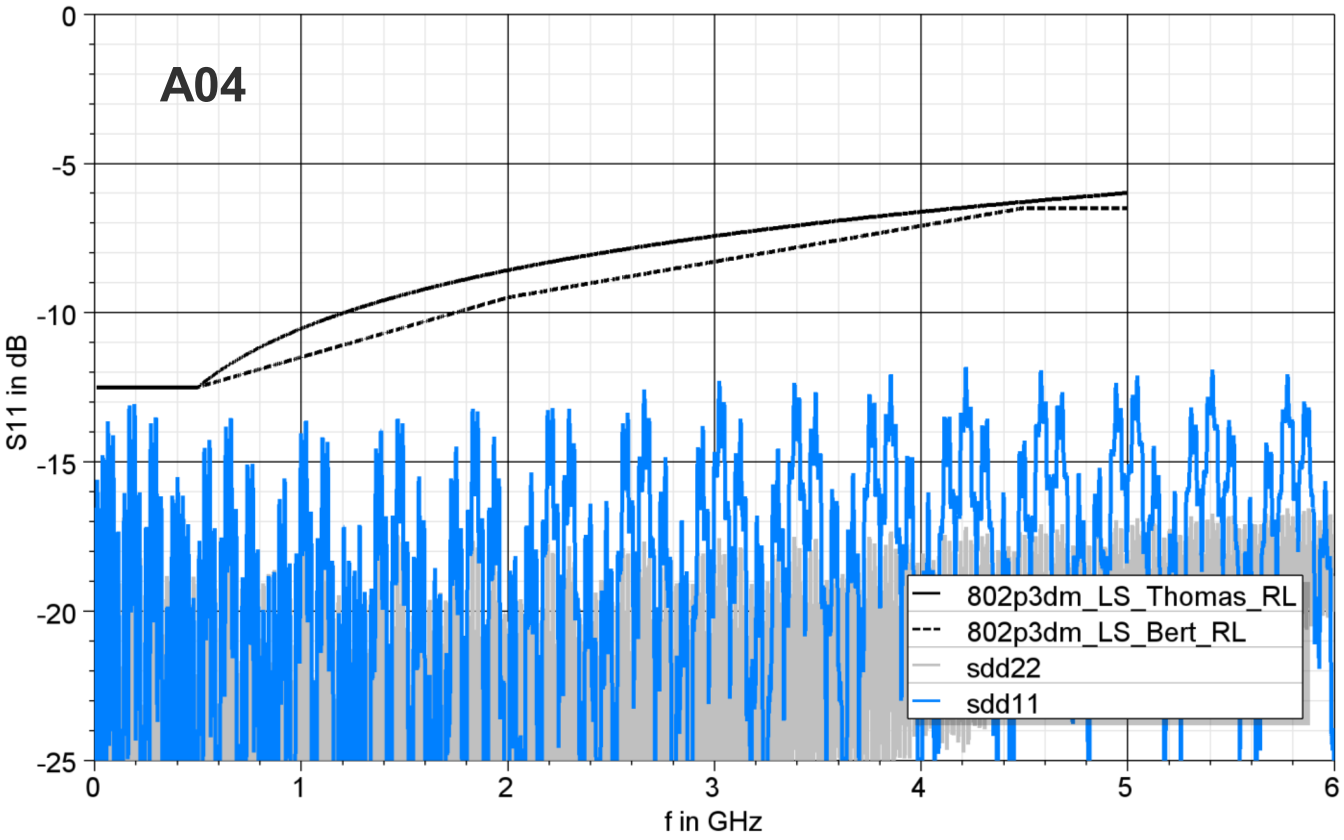
- Link segment RL without inline connectors (cable segments only, theoretical) as shown in the topology




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




Link segment Return Loss



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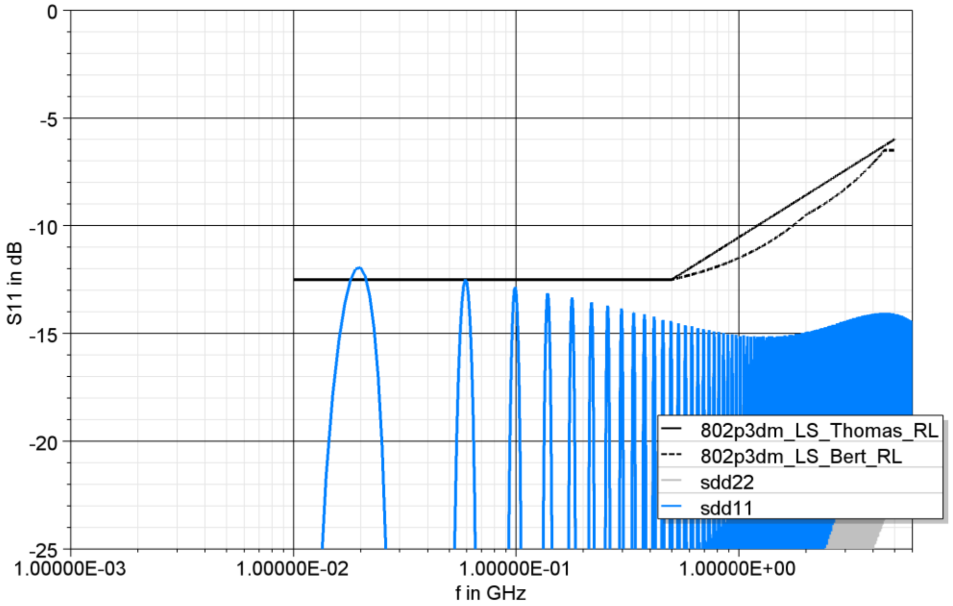
## 15 m with 4 inlines

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

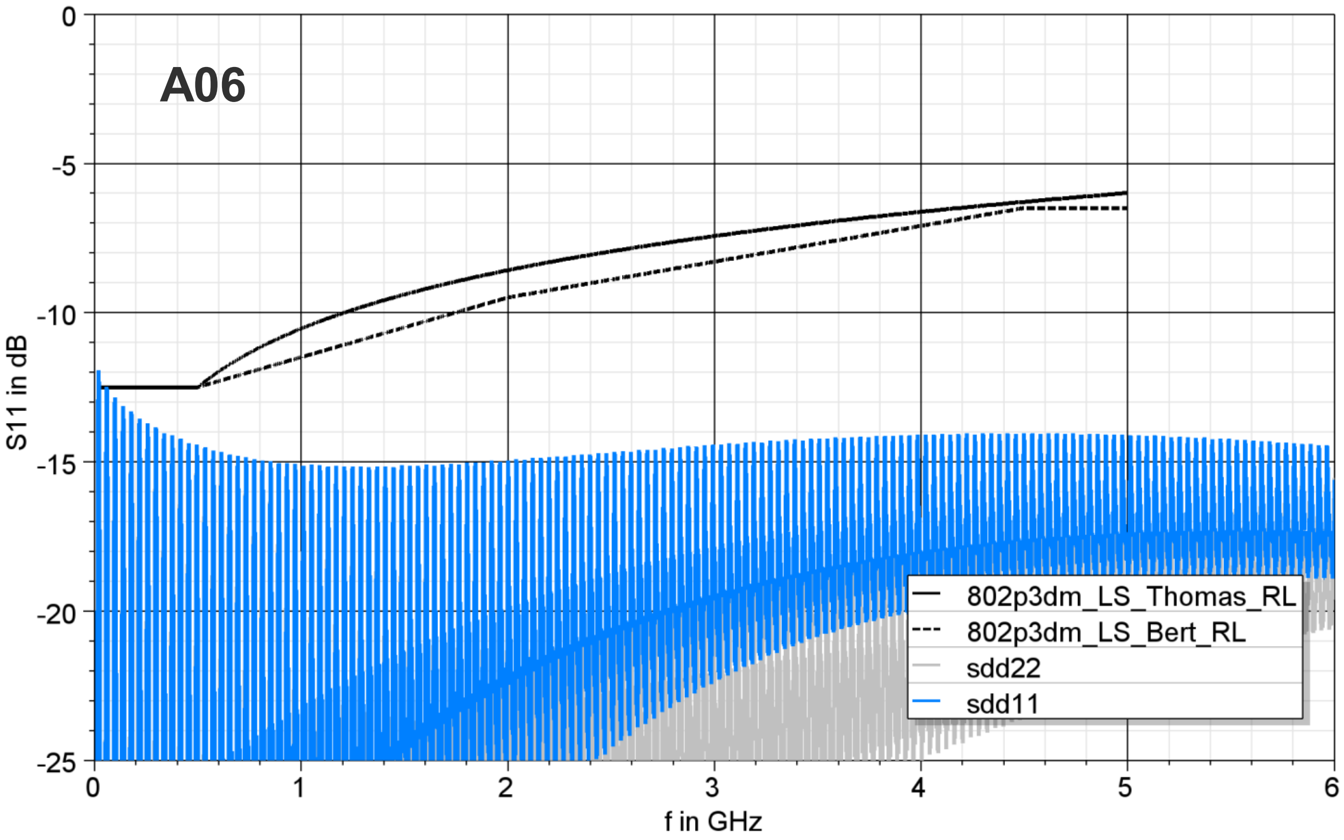

Single con1

Single con2

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




Link segment Return Loss



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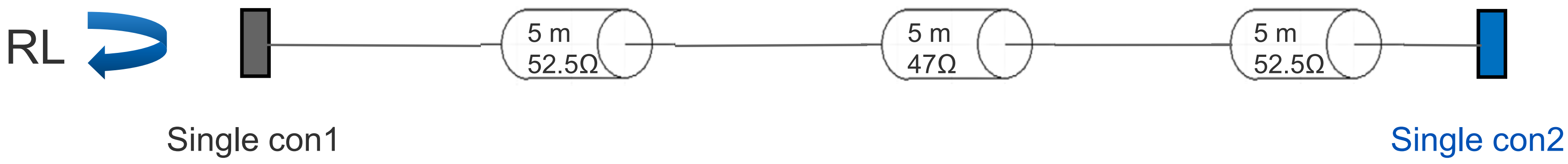
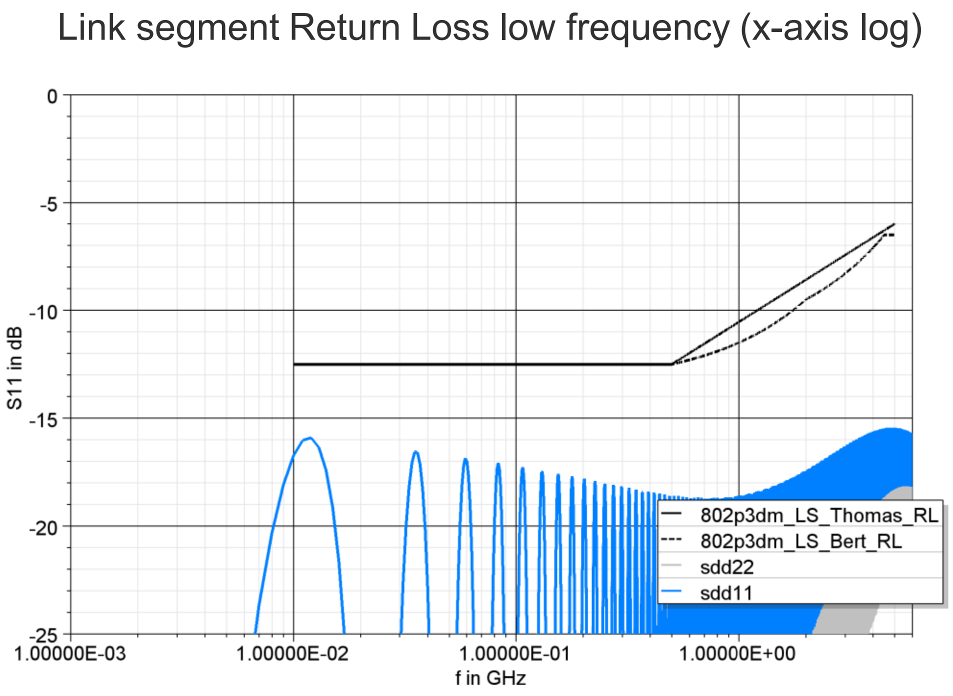
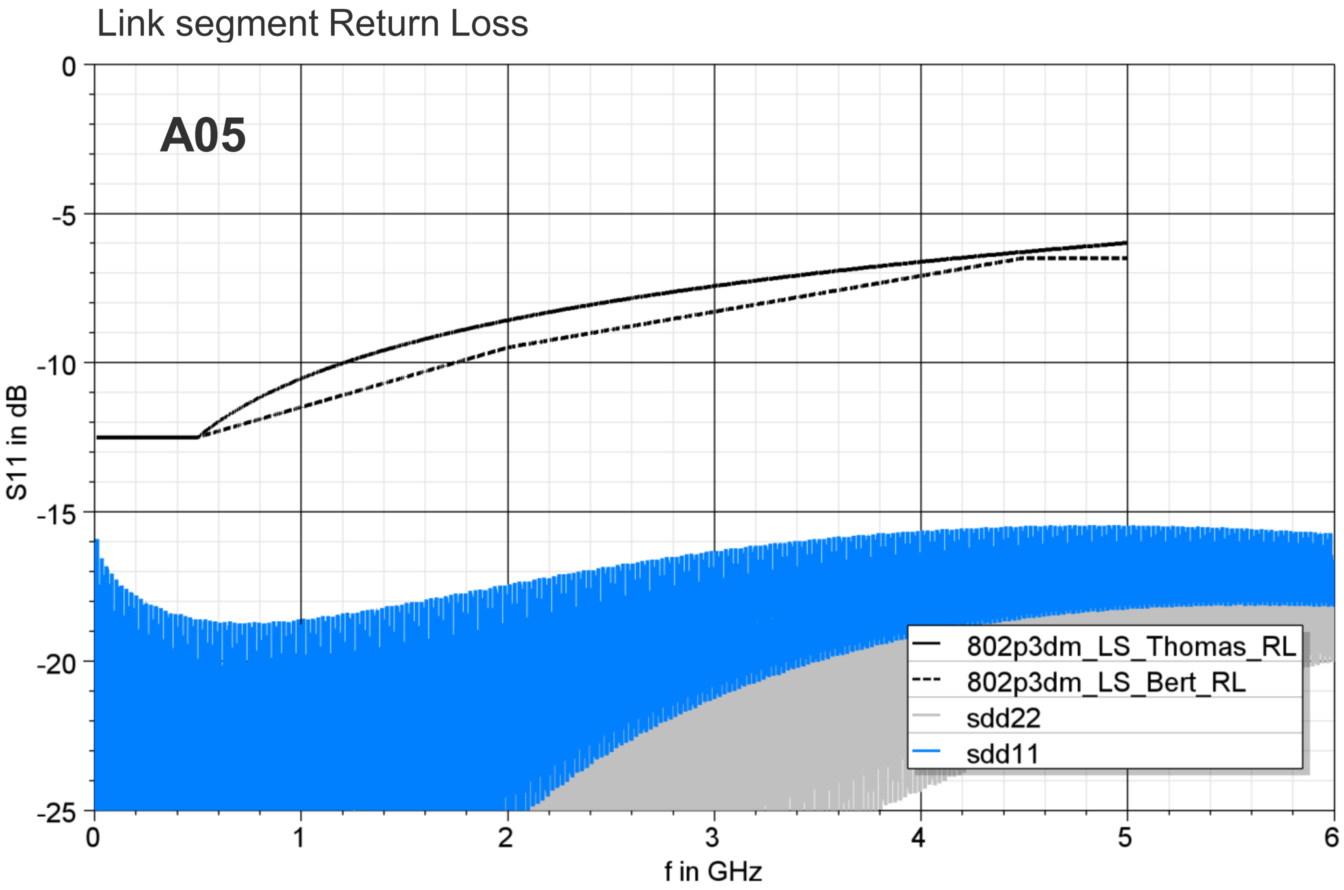
## 15 m with 4 inlines

- Reducing number of cable segments improves RL



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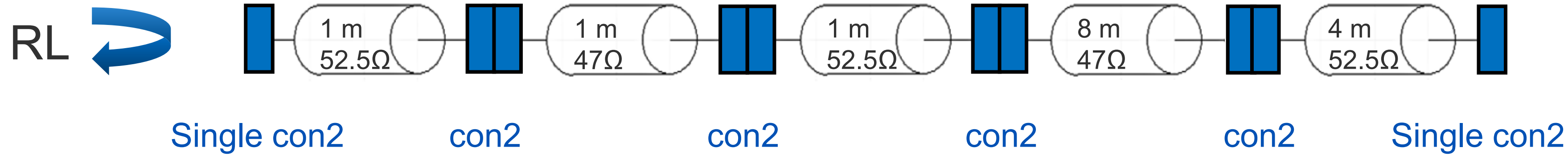
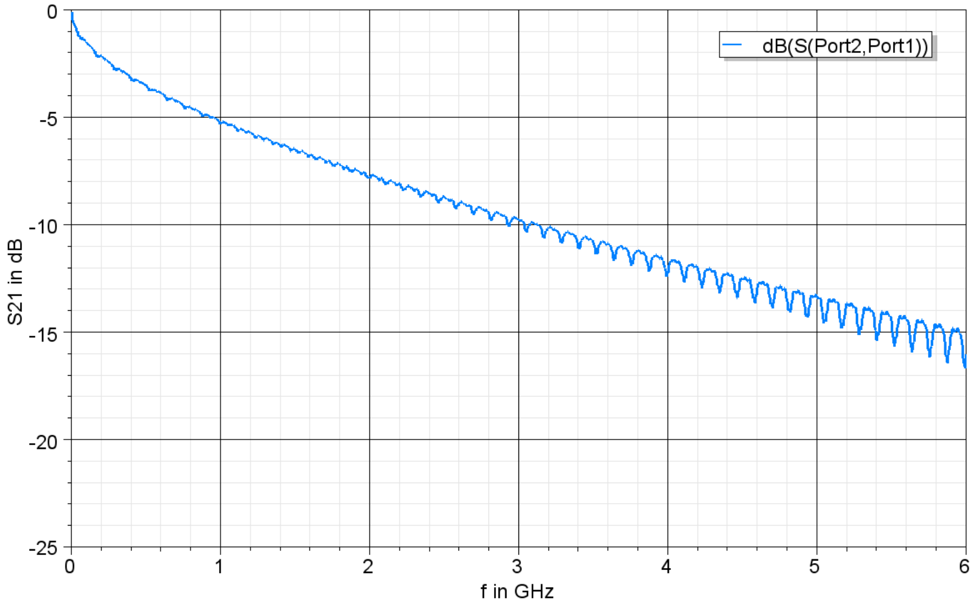
## 15 m with 4 inlines

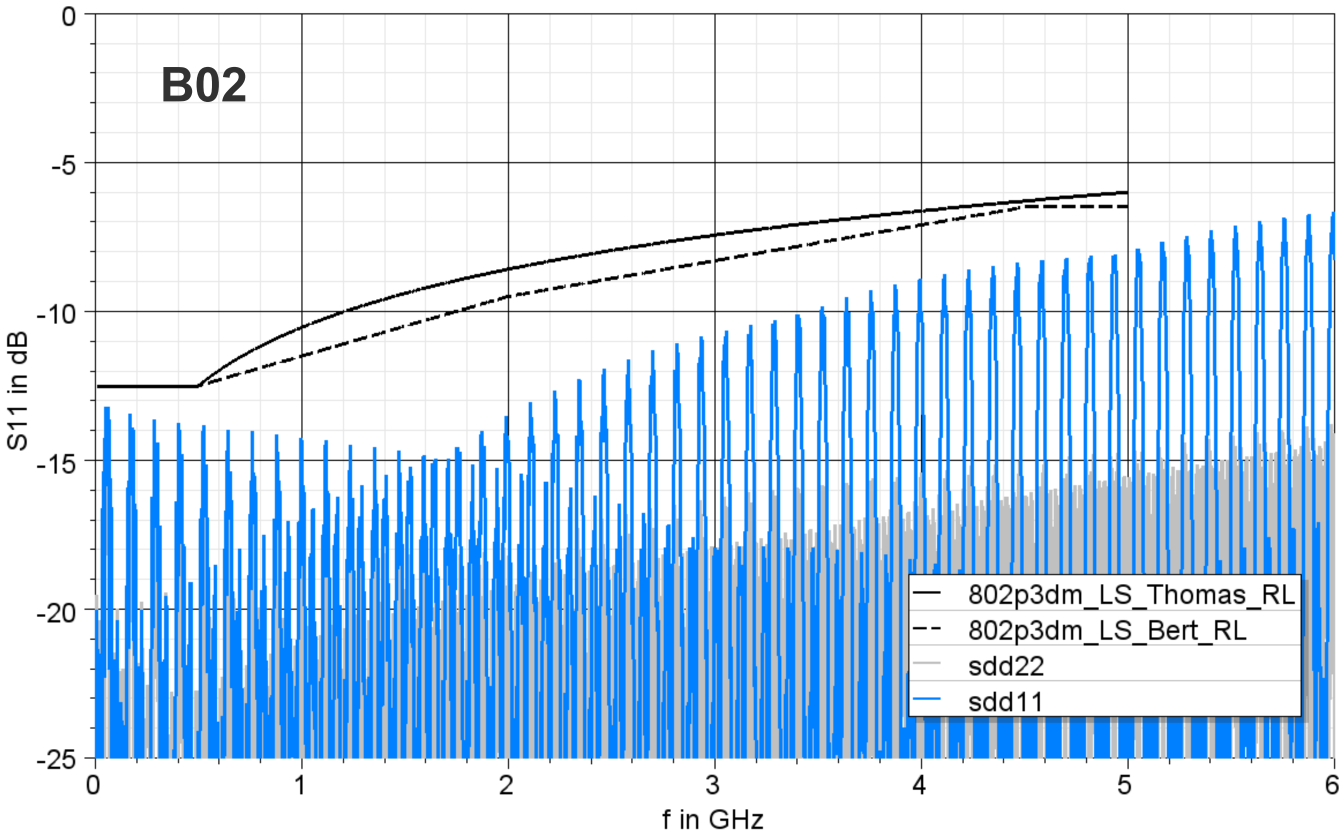
- Link segment RL
  with connector type 2
  as shown in the topology
  with cable type **CX044**




Link segment Insertion Loss




Link segment Return Loss



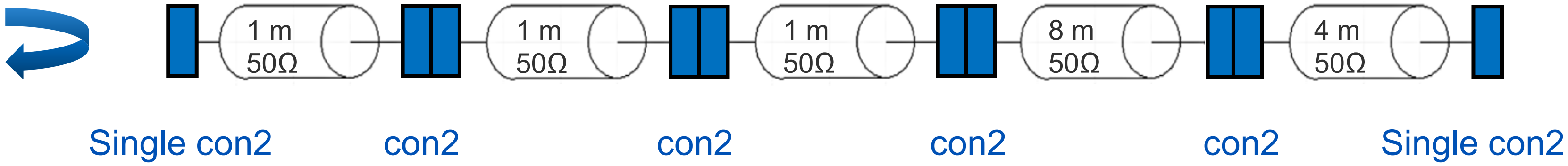
# Return loss of automotive coaxial link segments



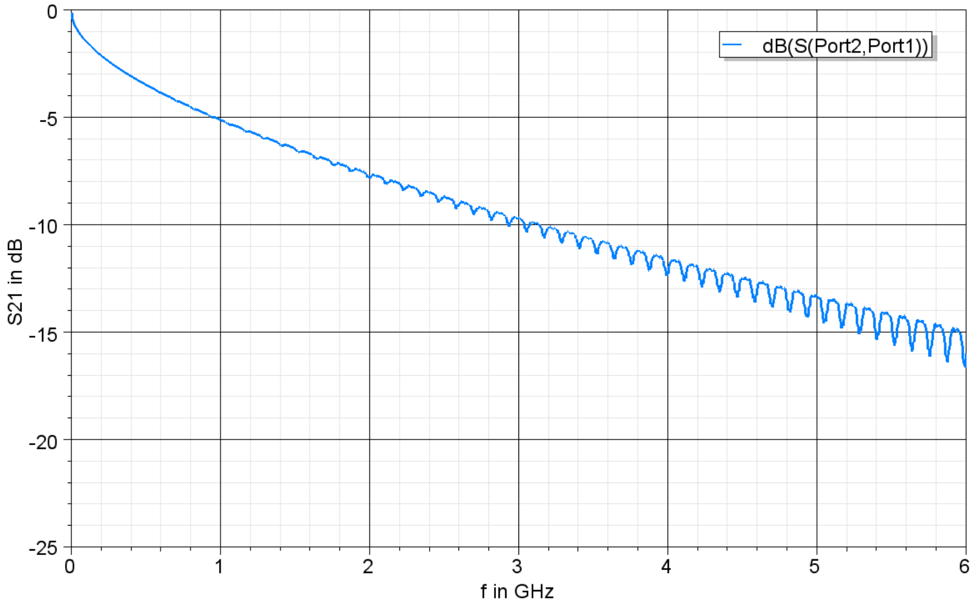
## 15 m with 4 inlines

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

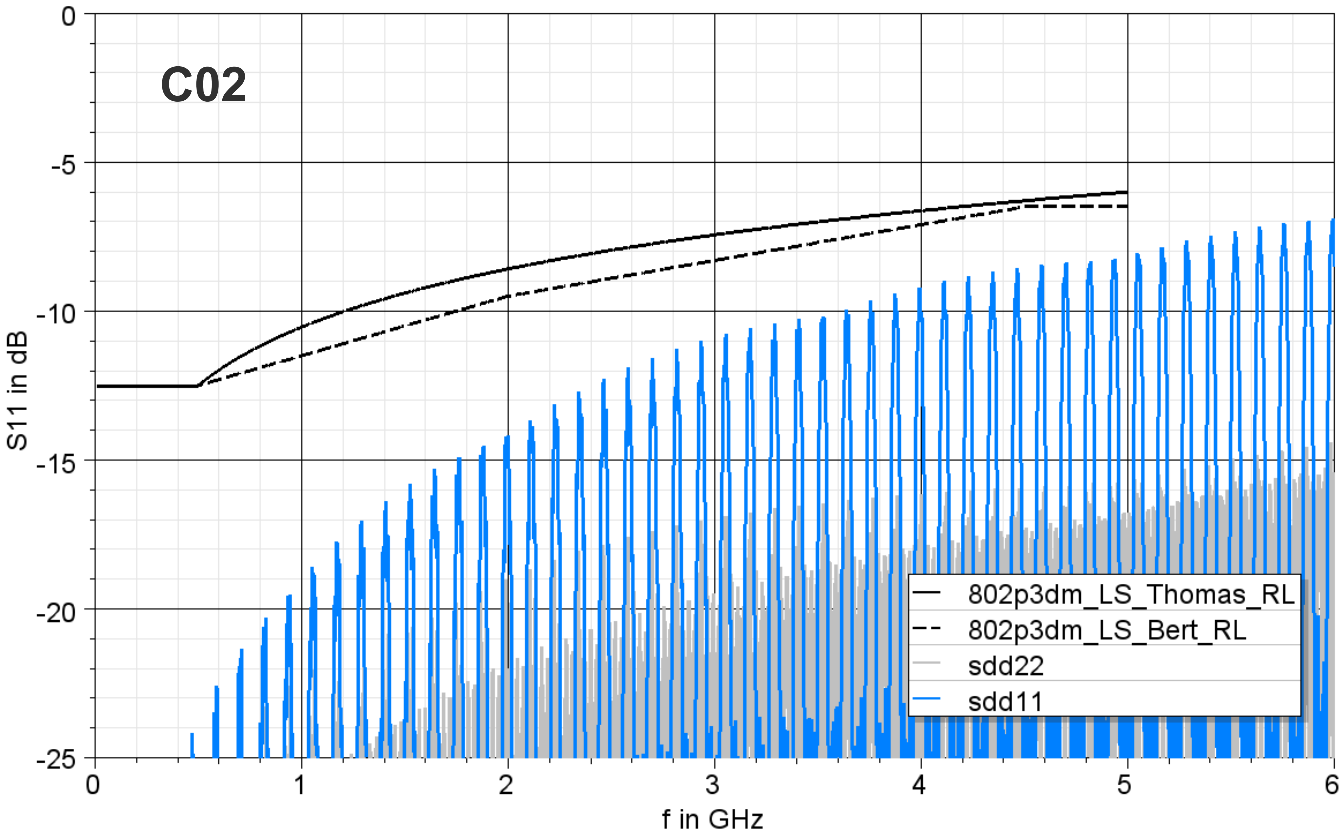
RL




Link segment Insertion Loss




Link segment Return Loss



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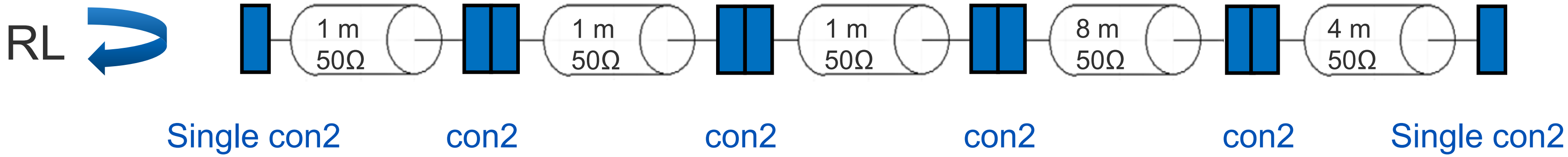
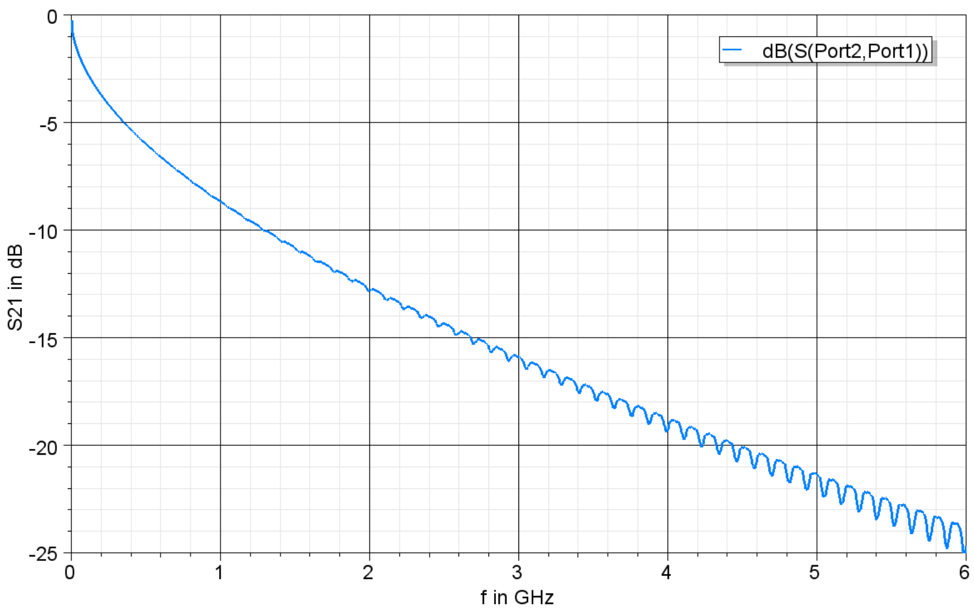
15 m with 4 inlines

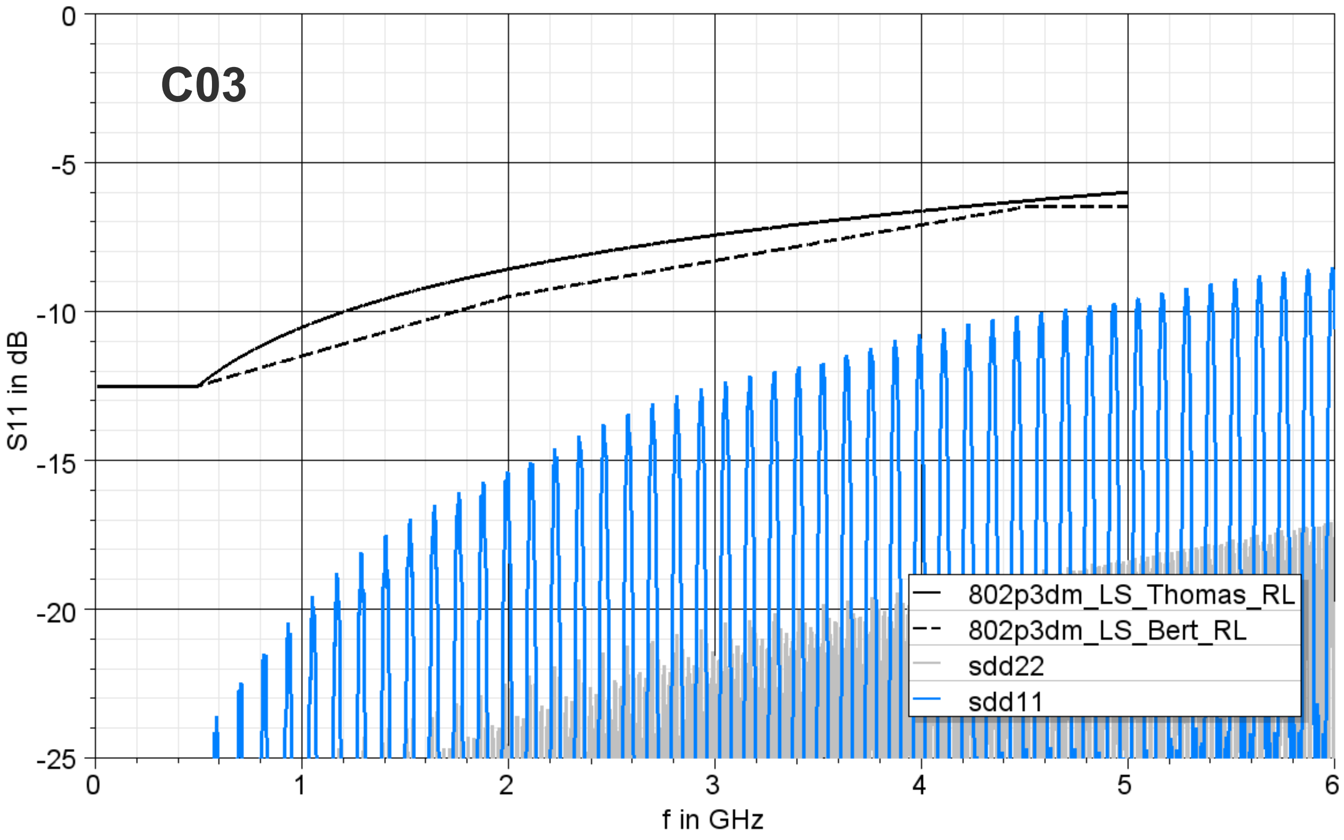
- Link segment RL with connector type 2 as shown in the topology with cable type **CX031** and ideal cable segment impedance




Link segment Insertion Loss




Link segment Return Loss



# Return loss of automotive coaxial link segments

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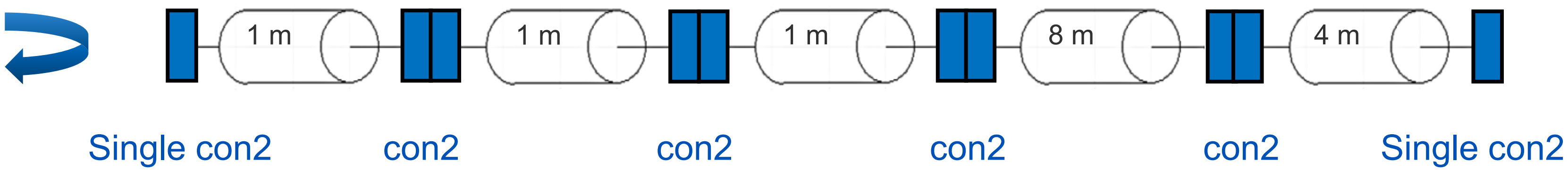
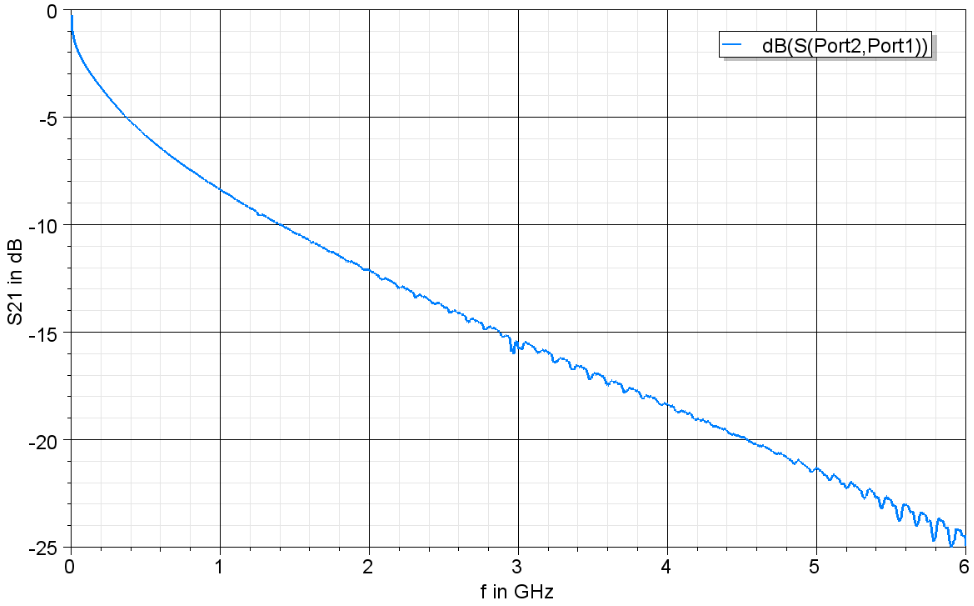
## 15 m with 4 inlines

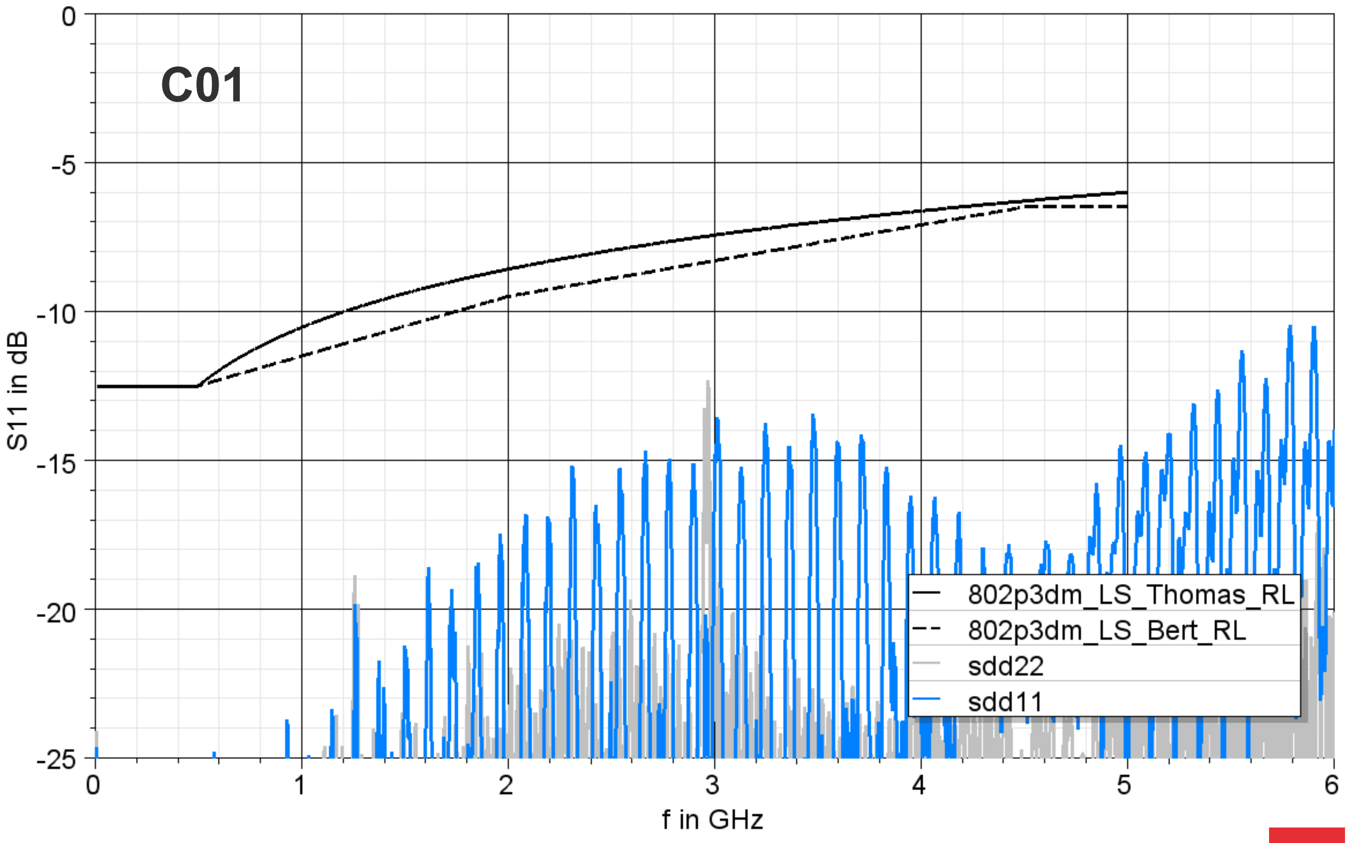
- **Measured**
  Link segment RL
  with connector type 2
  as shown in the topology
  with cable type **CX031**




Link segment Insertion Loss



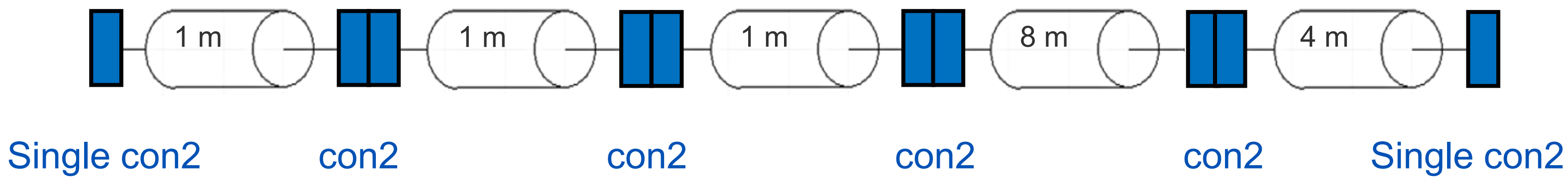

Link segment Return Loss



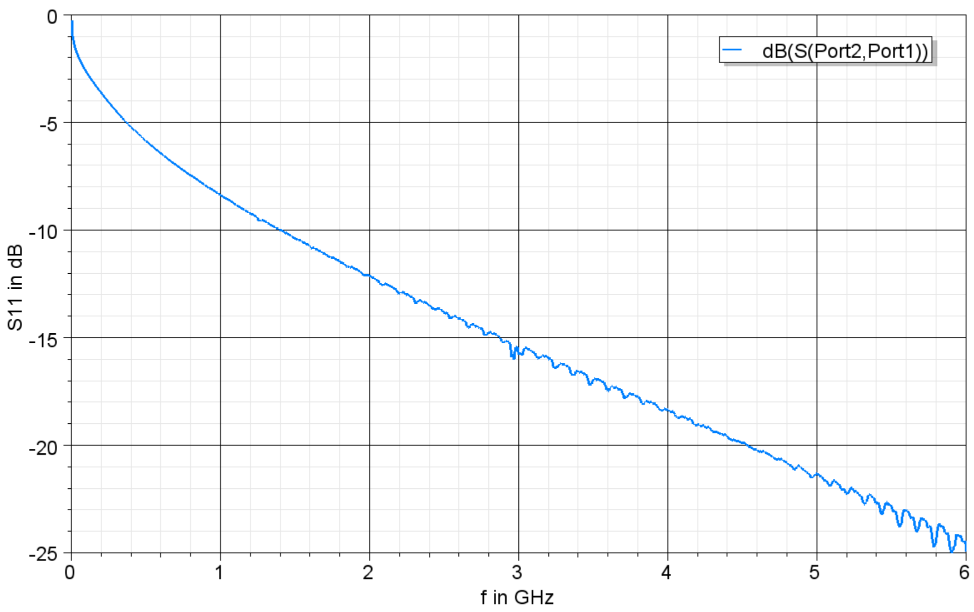
# Return loss of automotive coaxial link segments

## 15 m with 4 inlines

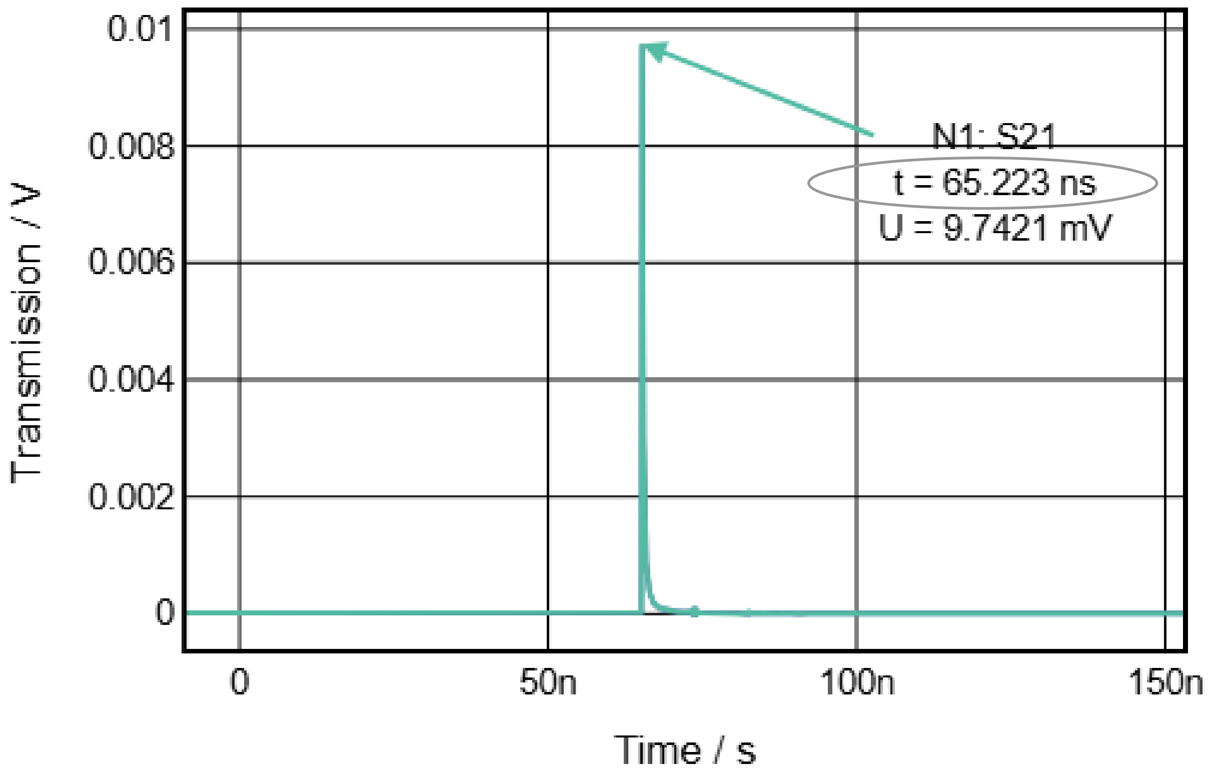
- **Measured**
  Link segment propagation delay with connector types as shown in the topology with cable type **CX031**




Link segment Insertion Loss




Link segment propagation delay



# Return loss of automotive coaxial link segments

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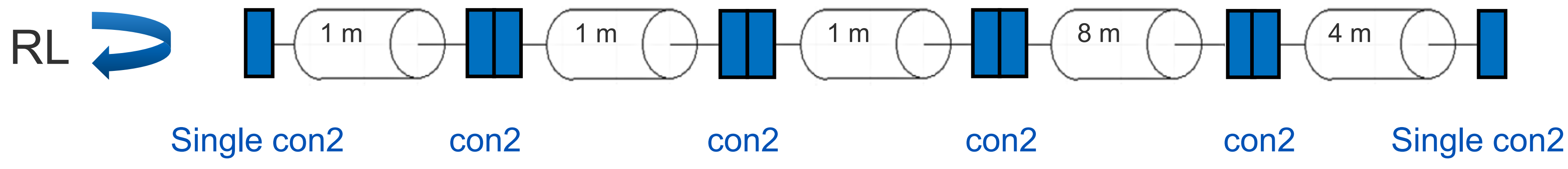
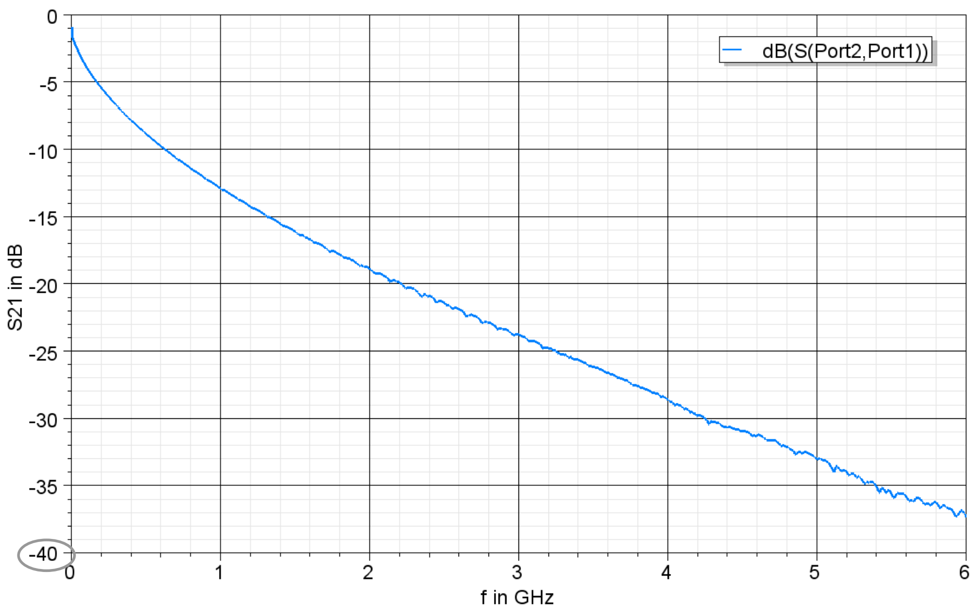
## 15 m with 4 inlines

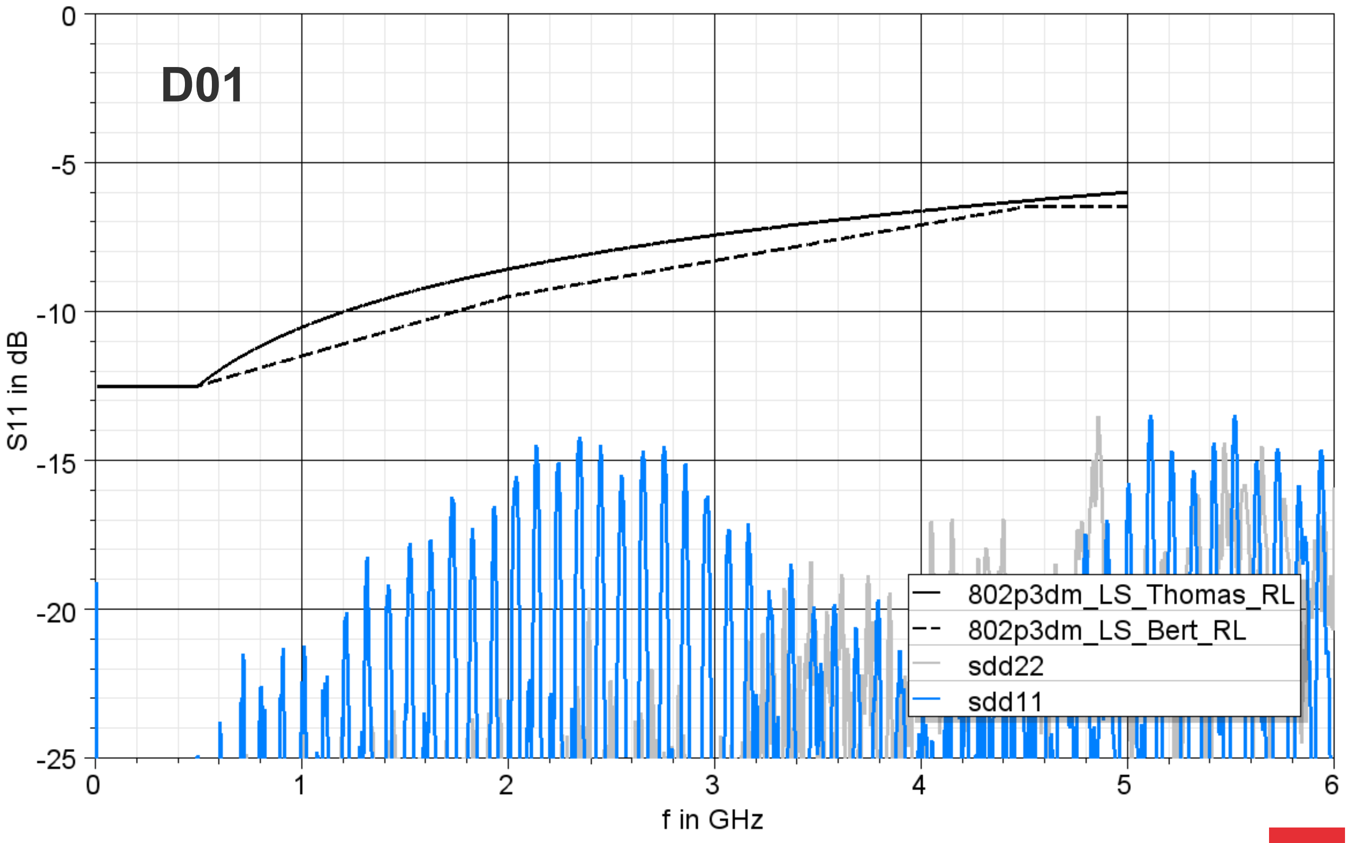
- **Measured**
  Link segment RL
  with connector types
  as shown in the topology
  with cable type **RG-174**




Link segment Insertion Loss




Link segment Return Loss

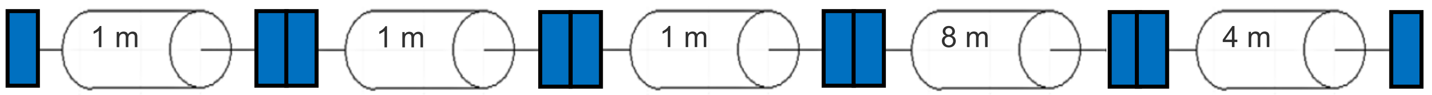


# Return loss of automotive coaxial link segments

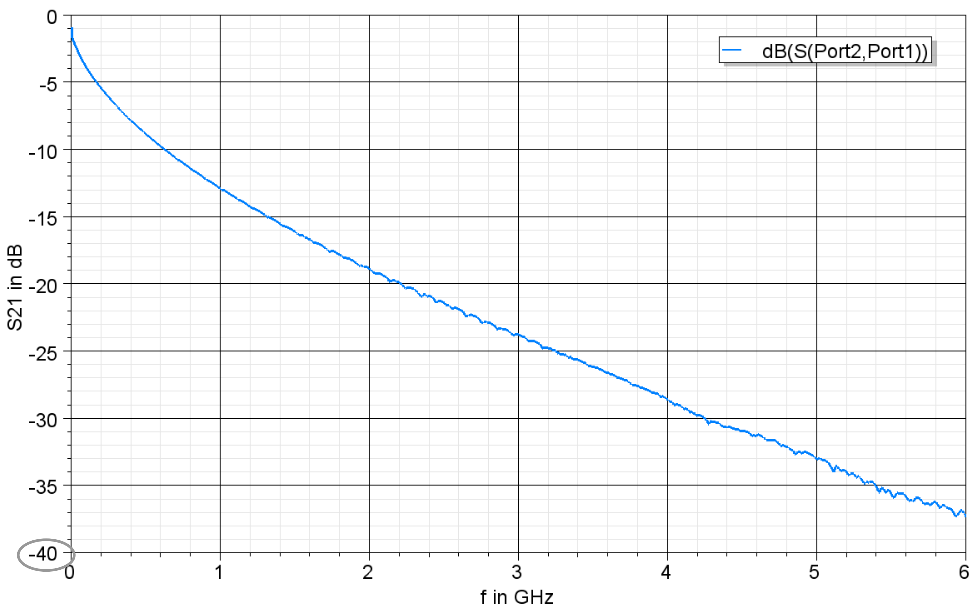


15 m with 4 inlines

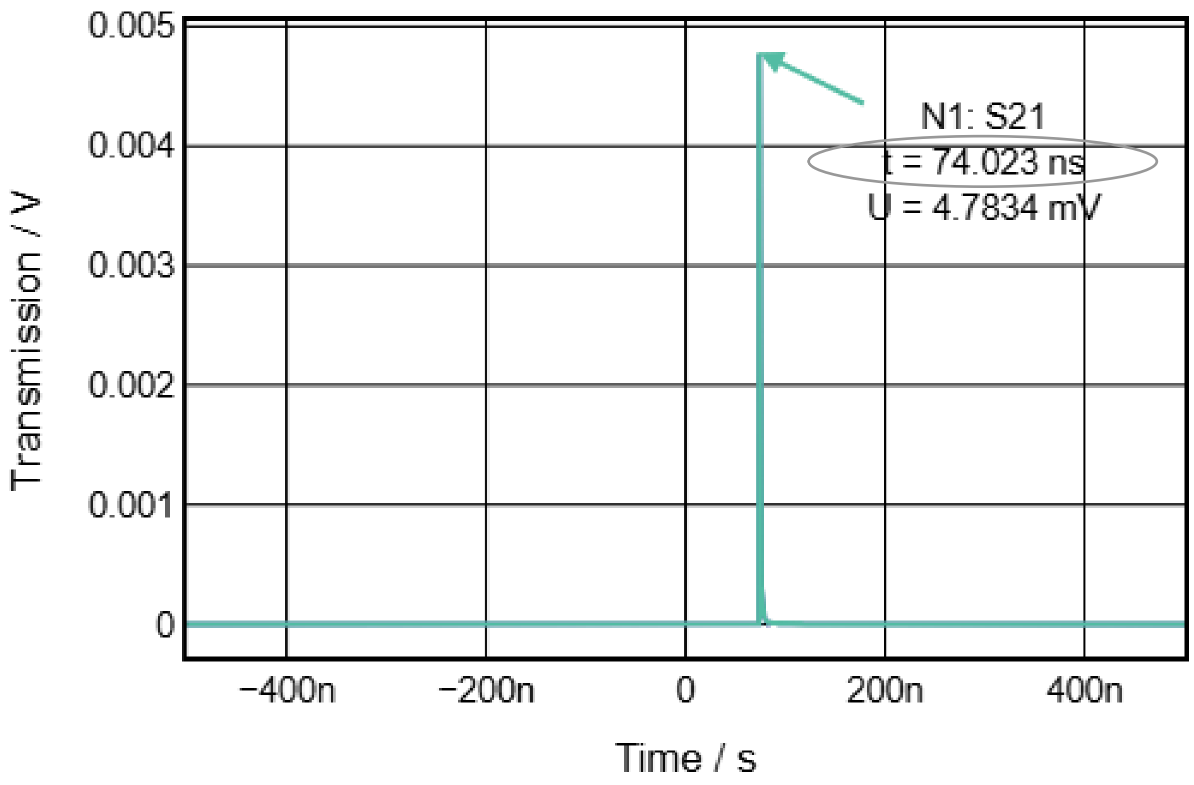
- **Measured**
  Link segment propagation delay with connector types as shown in the topology with cable type **RG-174**




Link segment Insertion Loss




Link segment propagation delay



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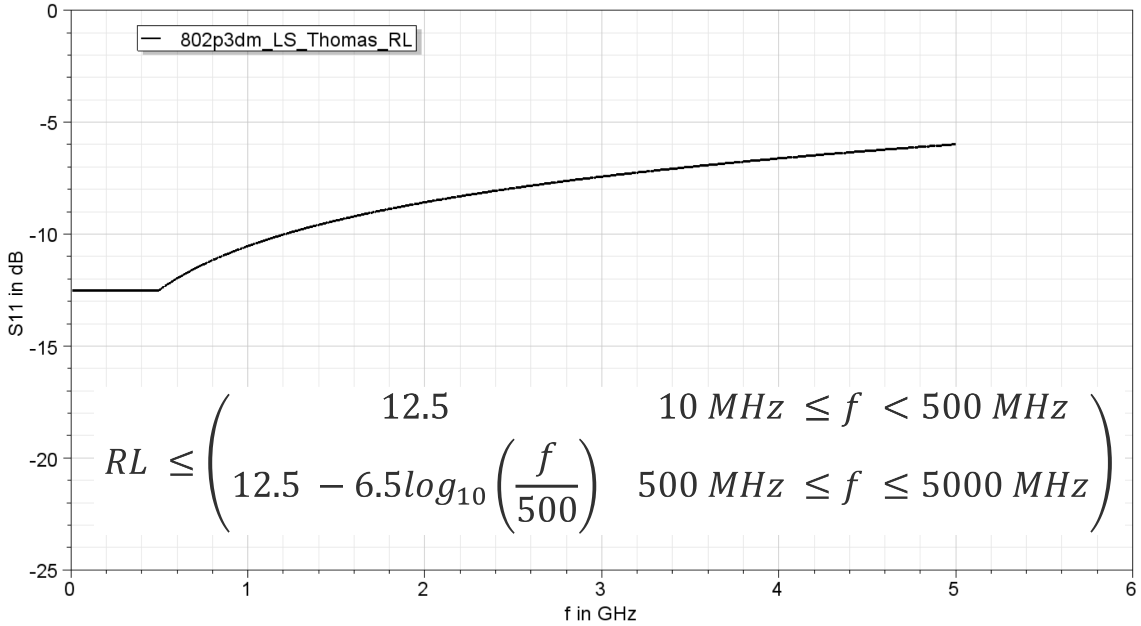
## Summary

- 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




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