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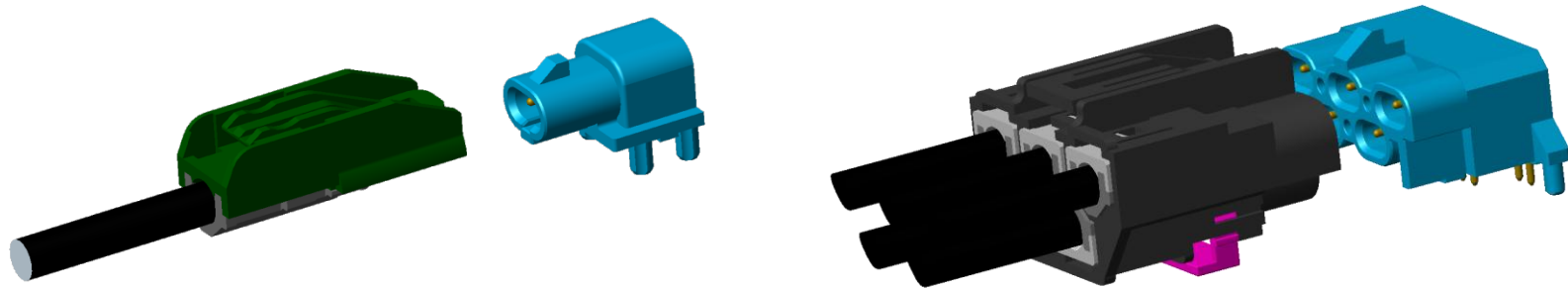
# IEEE RTPGE

## Optimisation of physical layer components for RTPGE

Thomas Müller, Gunnar Ambrecht, Stephan Kunz (Rosenberger)

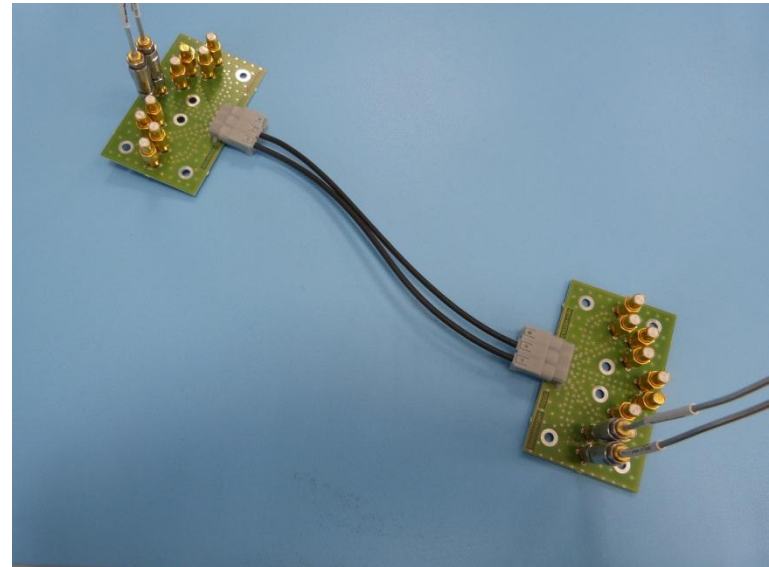
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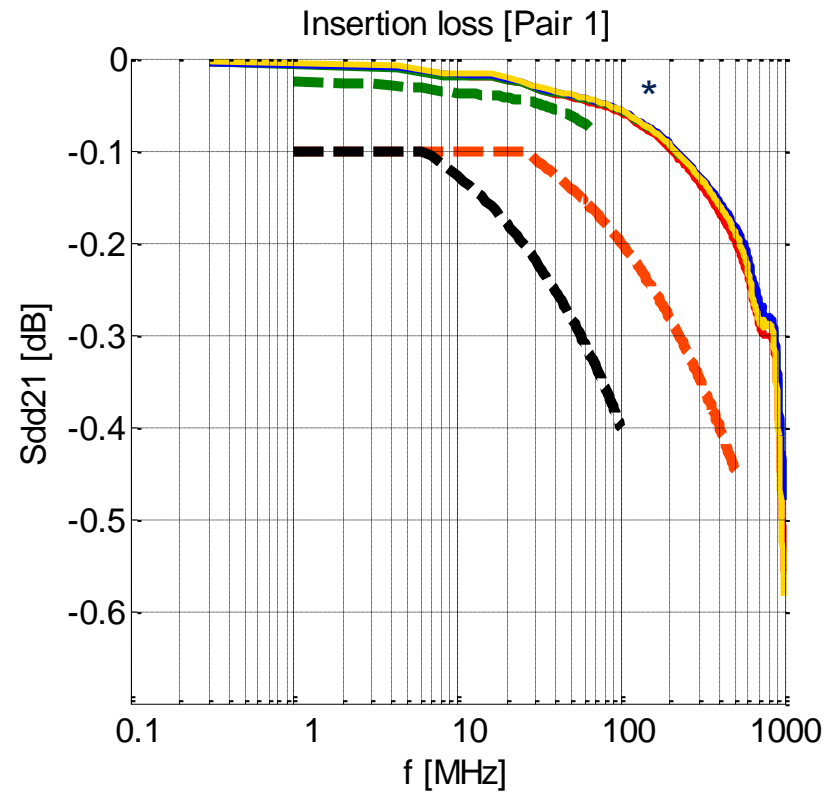
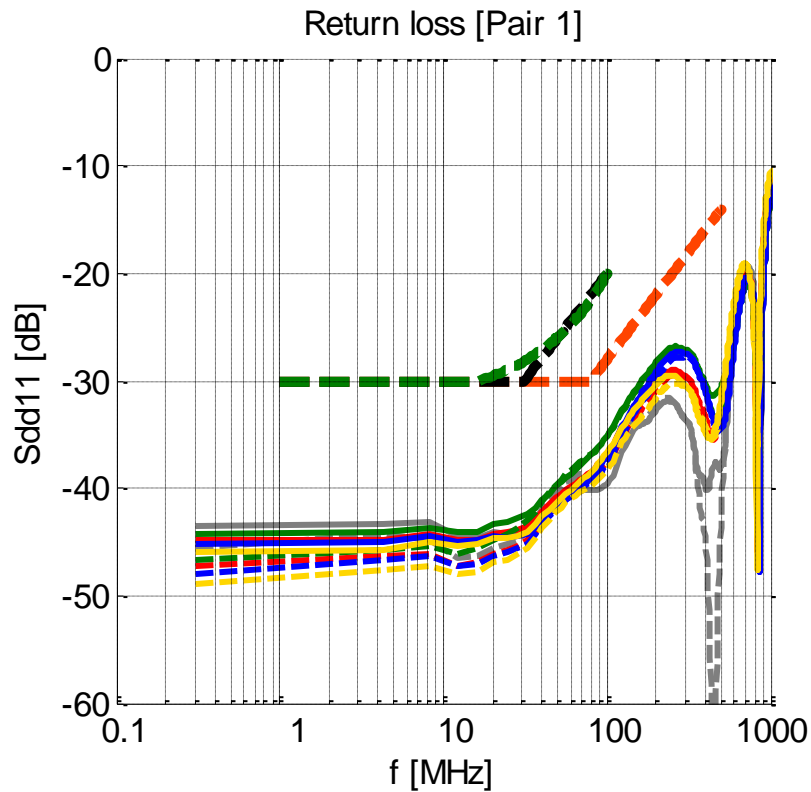
- Channel definition
  - MDI connector performance measurements
  - Cable insertion loss over temperature
  
- EMC
  - Evaluation of the influence of inline connectors on EMC by means of stripline VNA measurements
  - Outlook on using system simulation for predicating stripline test results



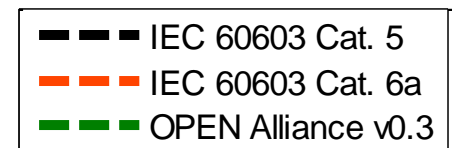
- Automotive twisted pair Ethernet connector
- Supports jacketed and unjacketed unshielded cables
- Electrically optimised for
  - Impedance matched to 100 Ohm
  - High balance
  - Low crosstalk
  - Minimum untwist area
- Open interface to the industry

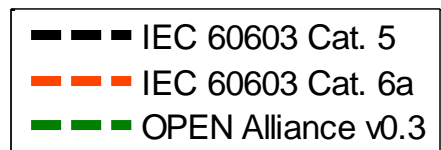
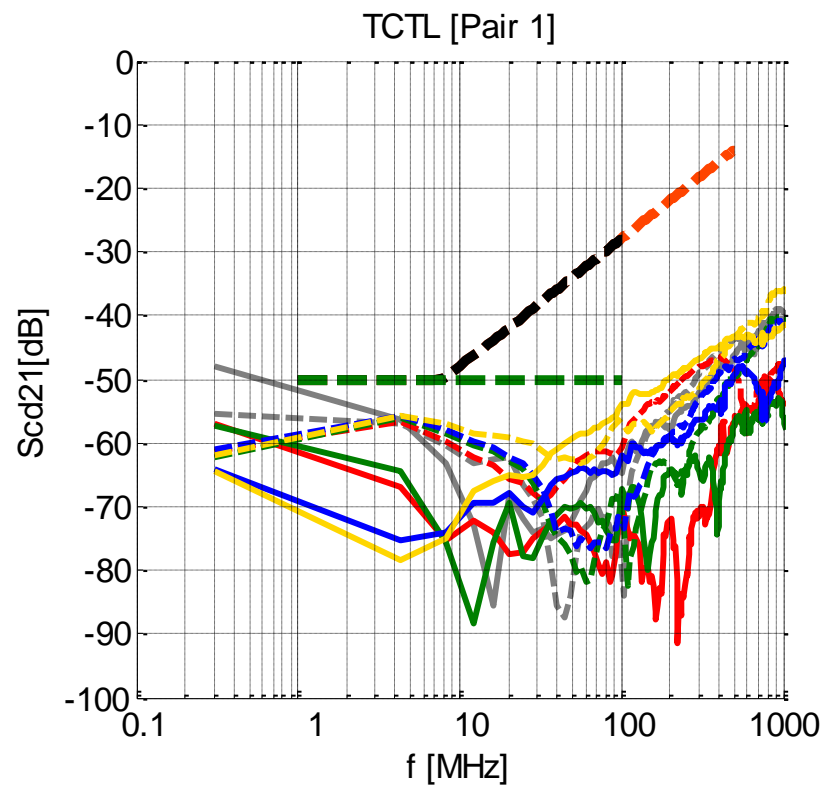
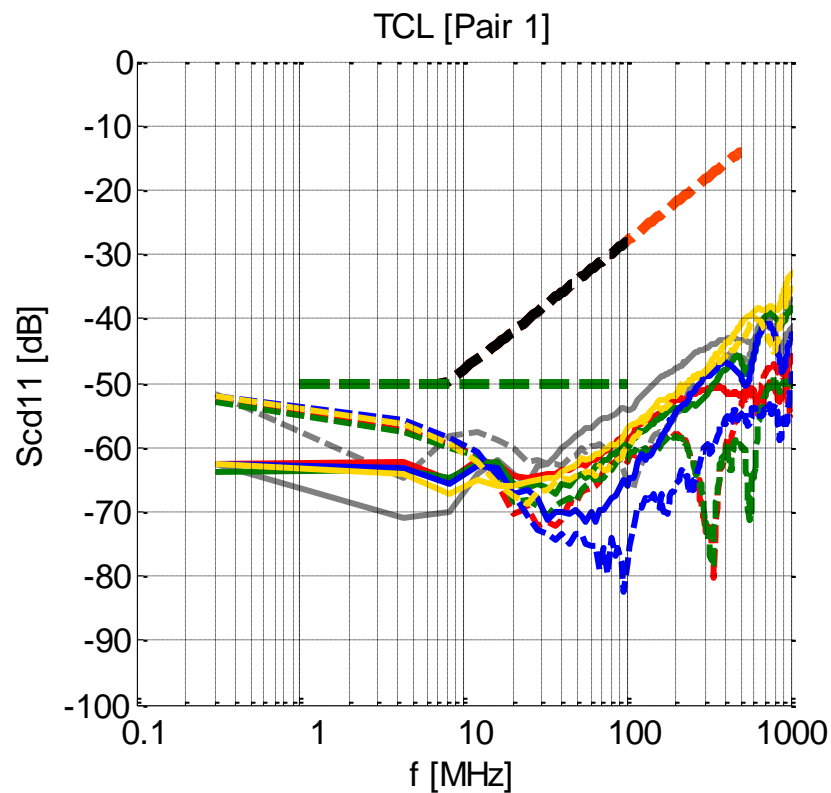
- Whole link consists of
  - 2x breakout boards
  - 2x MDI connectors
  - 200 mm jacketed cable
- Plot against the following limits for unshielded Ethernet connectors:
  - Cat 5 (IEC 60603-7-2)
  - Cat 6a (ISO/IEC 60603-7-41)
  - OPEN alliance spec draft v0.3

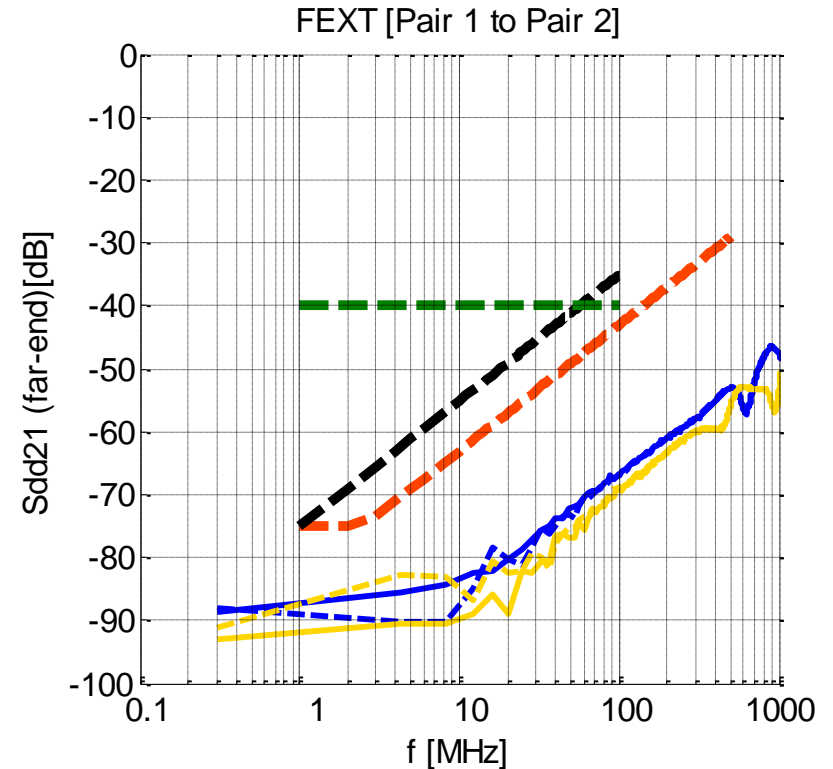
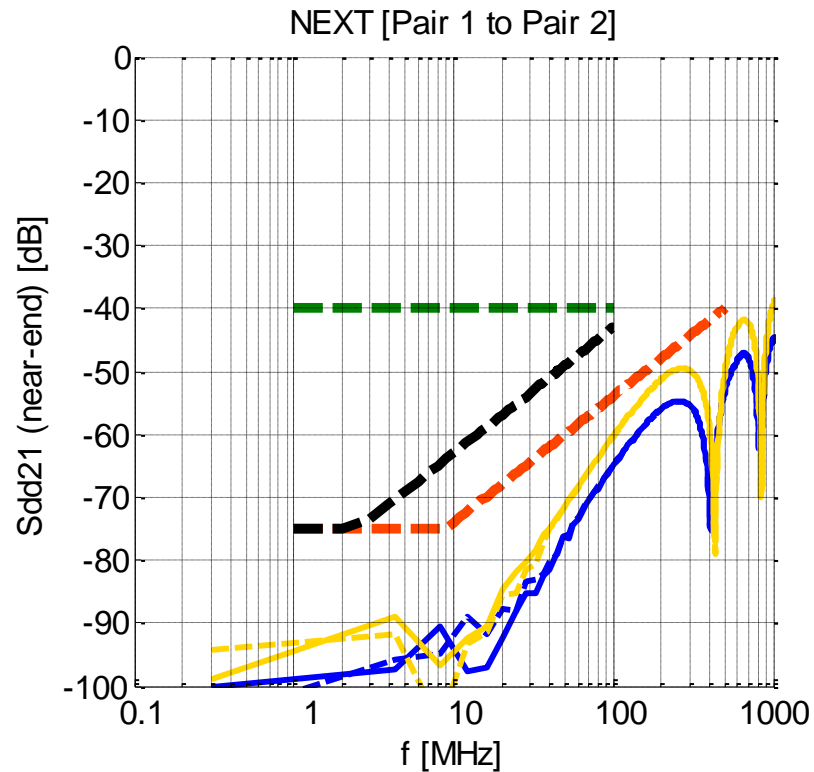




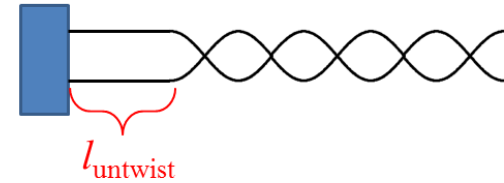
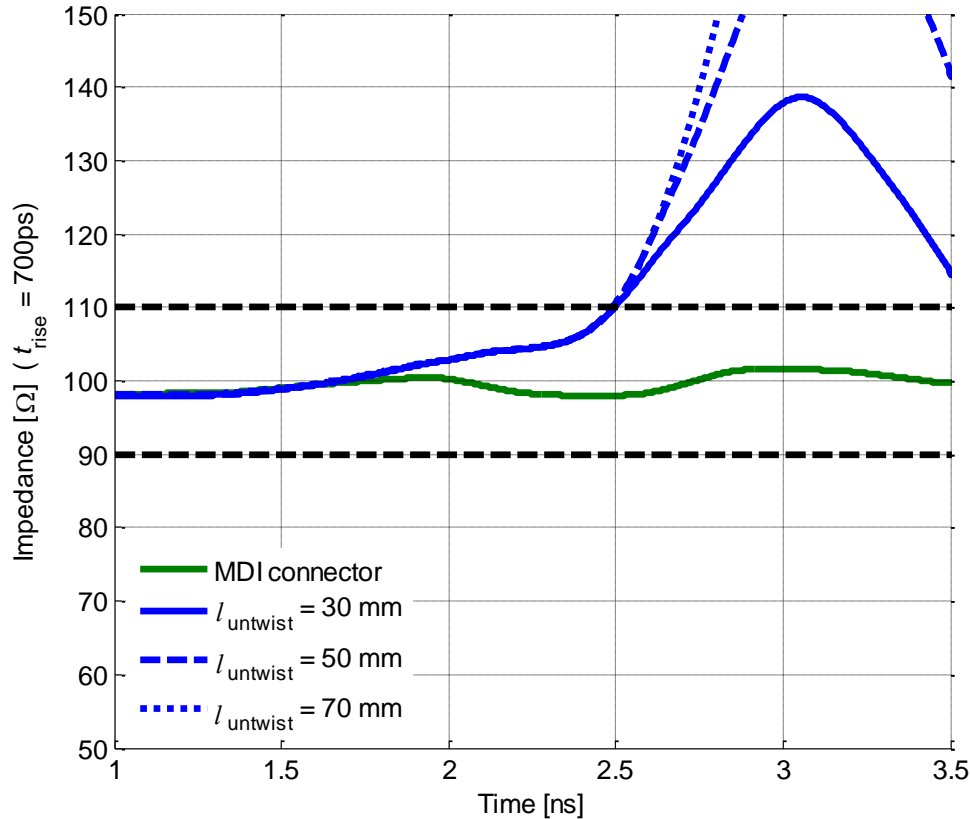
\* Including breakout board







- IEC 60603 Cat. 5
- IEC 60603 Cat. 6a
- OPEN Alliance v0.3

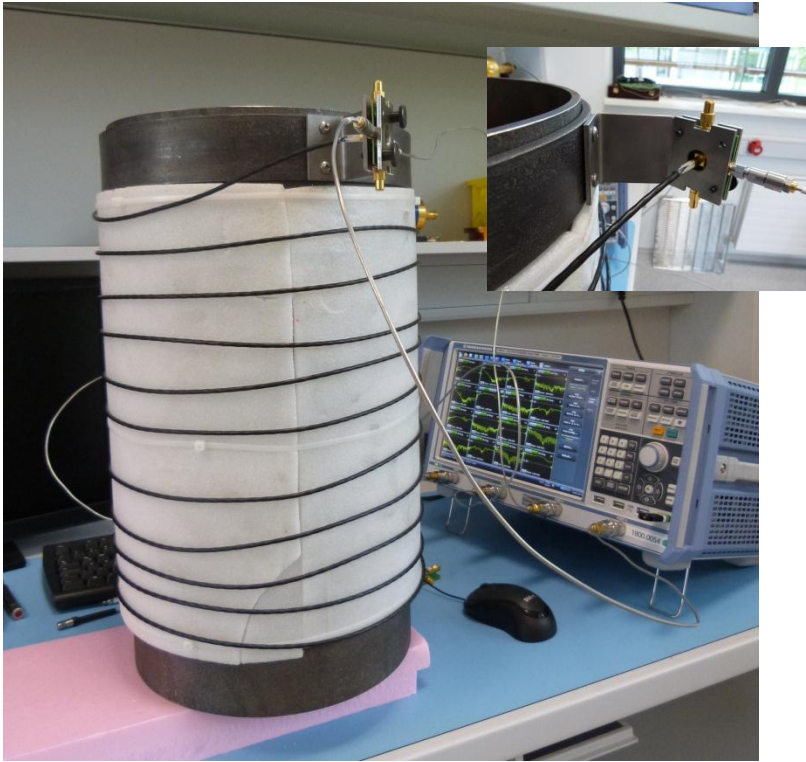


- 700 ps rise time  $100\ \Omega \pm 10\ \Omega$  ( $\sim 500\text{ MHz}$ )
- Keeping the untwist length small is essential
- This issue is not addressed by standard contacts (e.g. USCar).

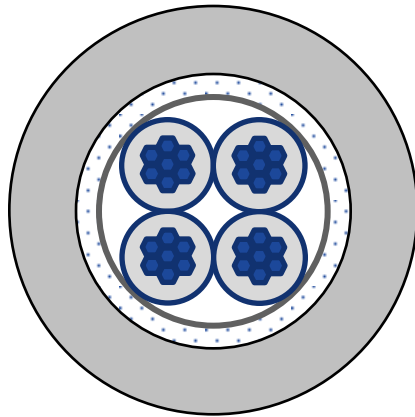


# Cable insertion loss over temperature

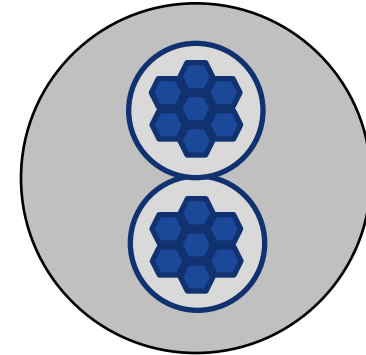
## Measurement setup



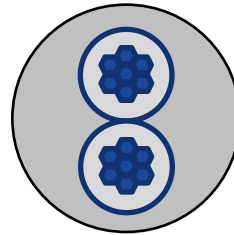
- Cable of length 10 m is coiled on a conductive drum with 10 mm of Rohacell® as insulation material
- Breakout-board ground is connected to conducting drum to close the common mode loop



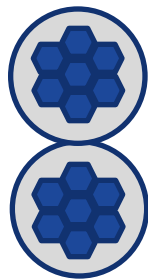
2 x 0.14 qmm  
STQ



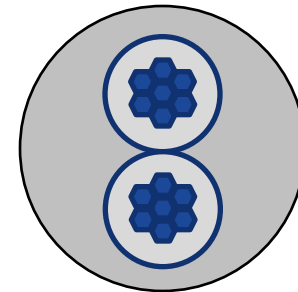
2 x 0.35 qmm  
PVC jacket



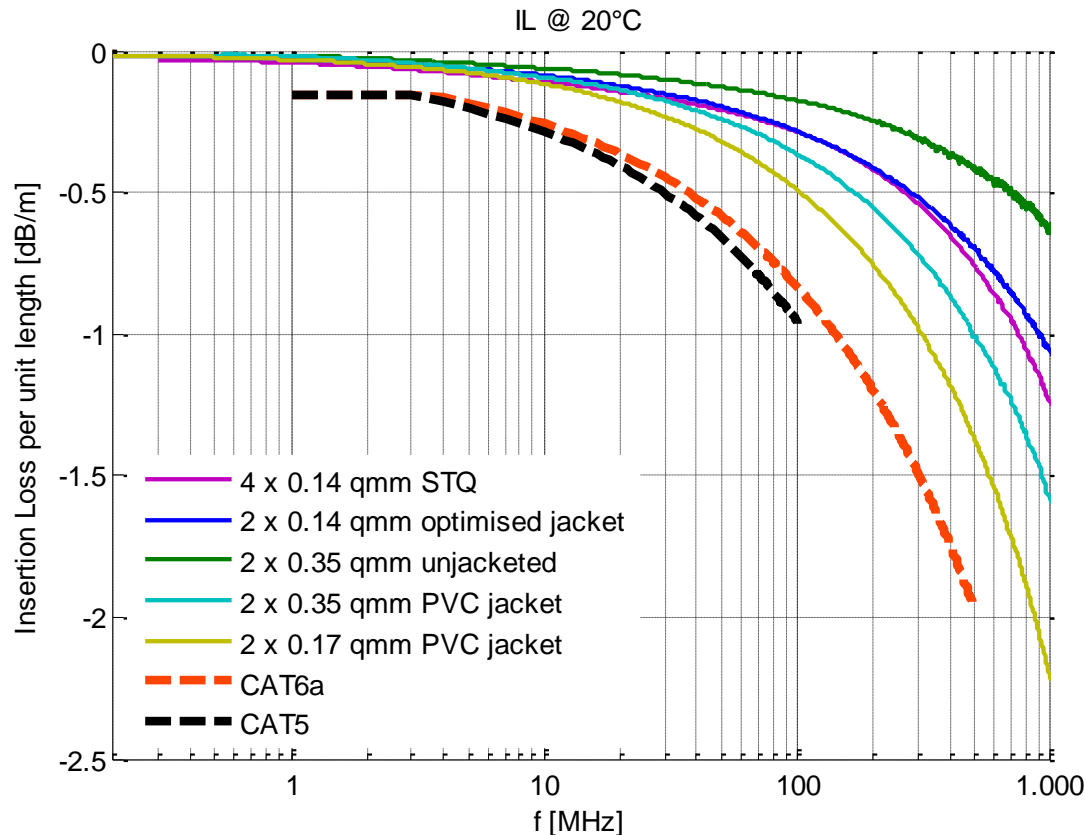
2 x 0.14 qmm  
optimised jacket



2 x 0.35 qmm  
unjacketed



2 x 0.17 qmm  
PVC jacket

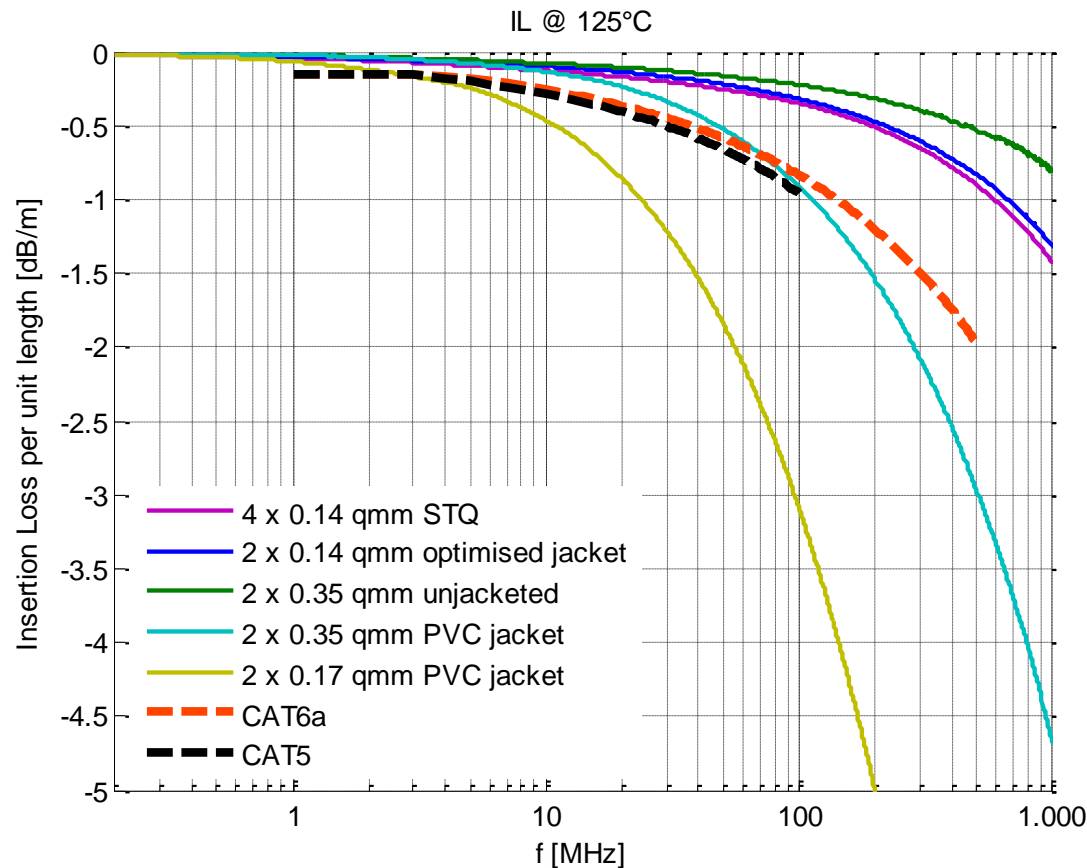


- Unjacketed cables can provide low insertion loss at the expense of unstable balance and environmental robustness
- 0.14 qmm cables provide low insertion loss if they are shielded or jacketed with proper material

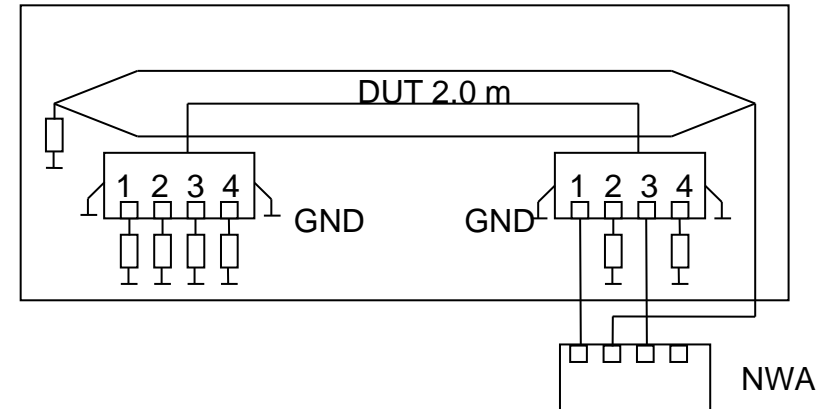
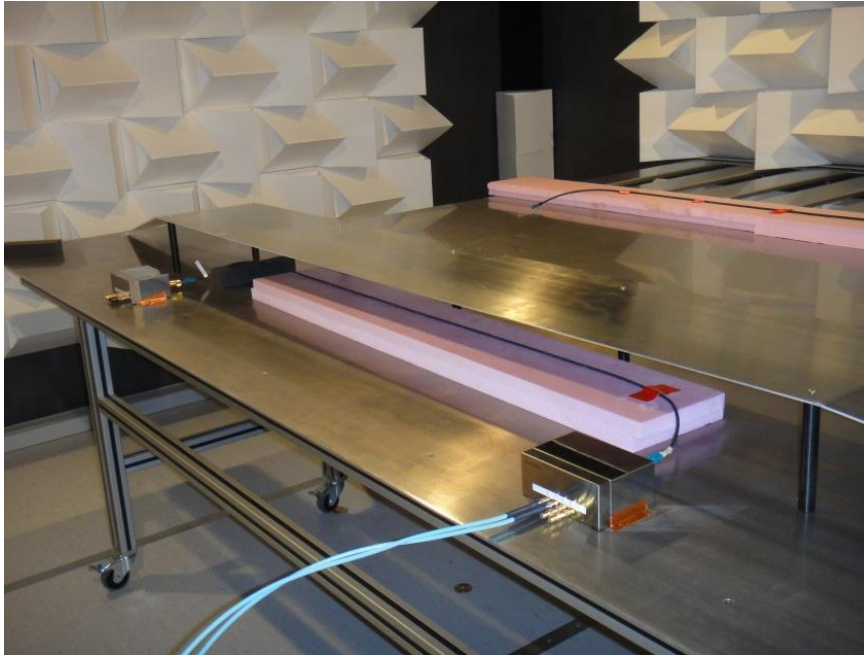
# Cable insertion loss over temperature

Results at 125°

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- PVC is not appropriate for high temperatures
- Cables with 0.14 qmm with optimised jacket material provide low insertion loss (~ 18% increase to room temperature) and high balance

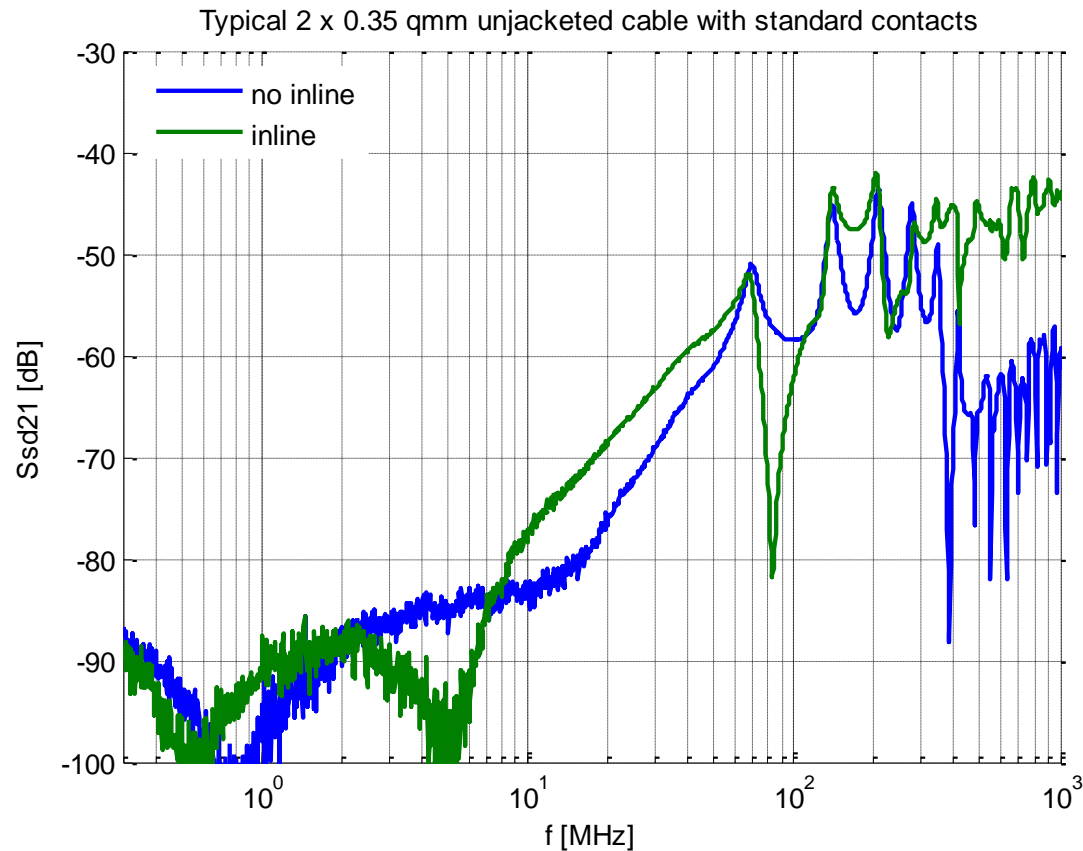


- Measure differential and common mode coupling to stripline in a three port NWA measurement
- DUT length 2.0 m
- Both ends connected to ground plane

# EMC – Influence of inline connectors

## Results for standard cable and contacts

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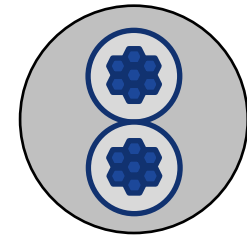
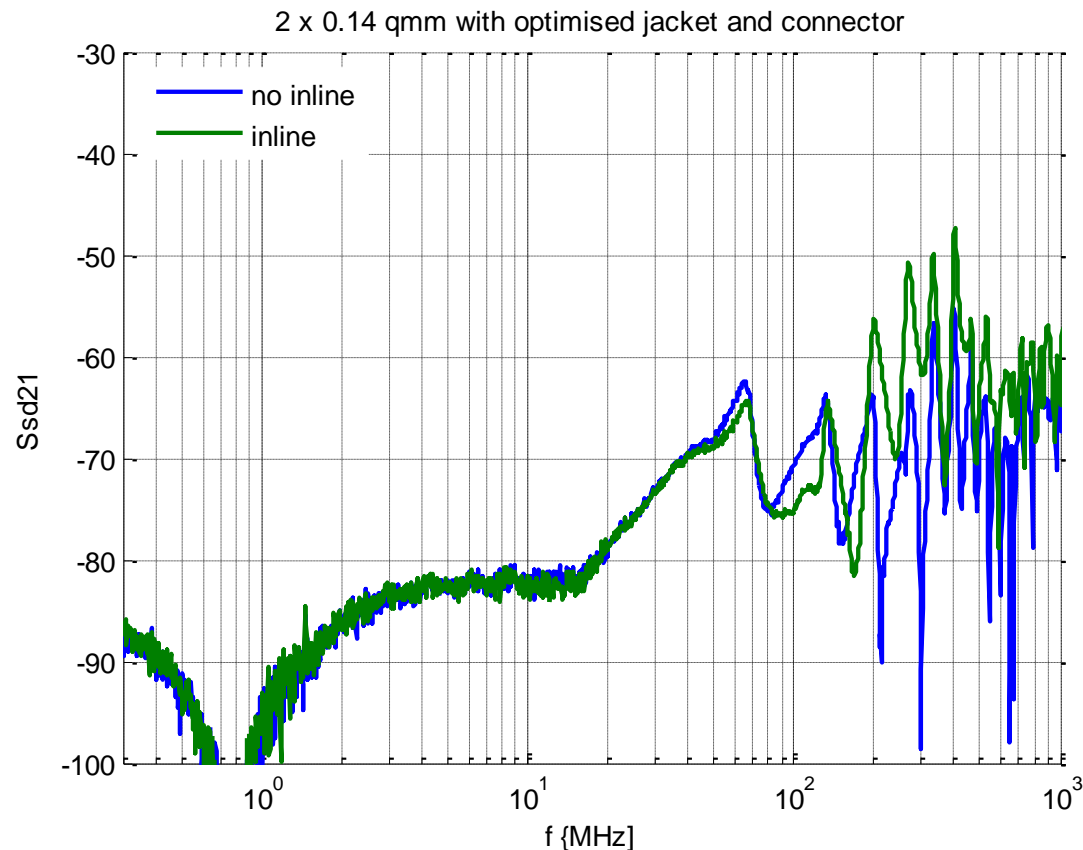
2 x 0.35 qmm  
unjacketed

- Typical unjacketed cable

# EMC – Influence of inline connectors

## Results for optimised cable and connector

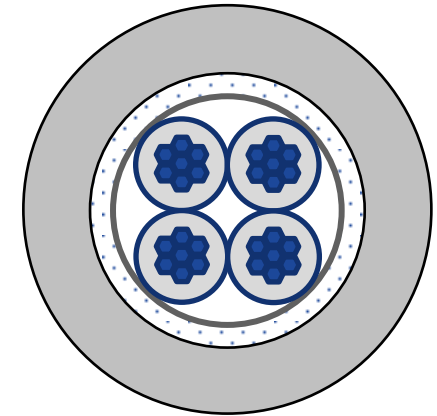
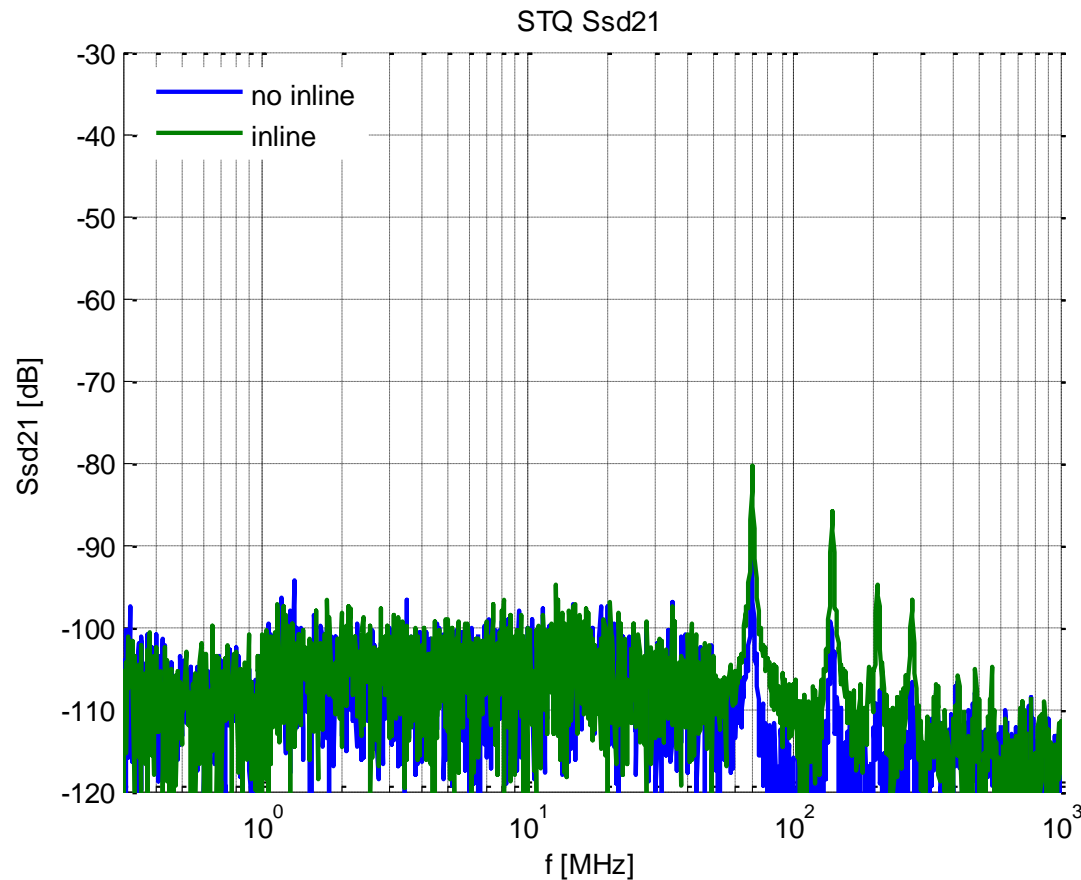
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2 x 0.14 qmm  
unjacketed

- Optimised jacketed cable

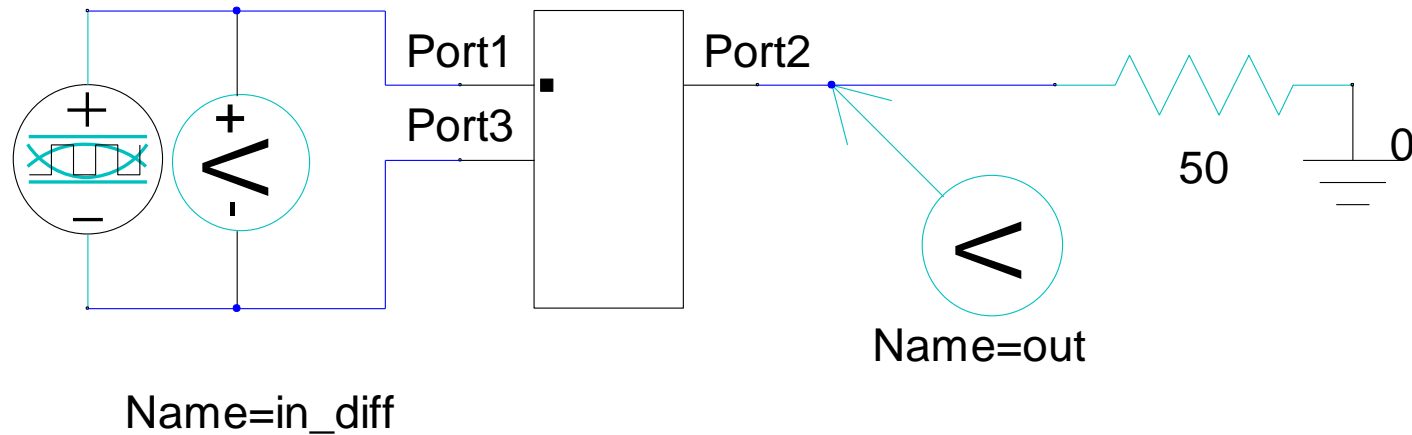




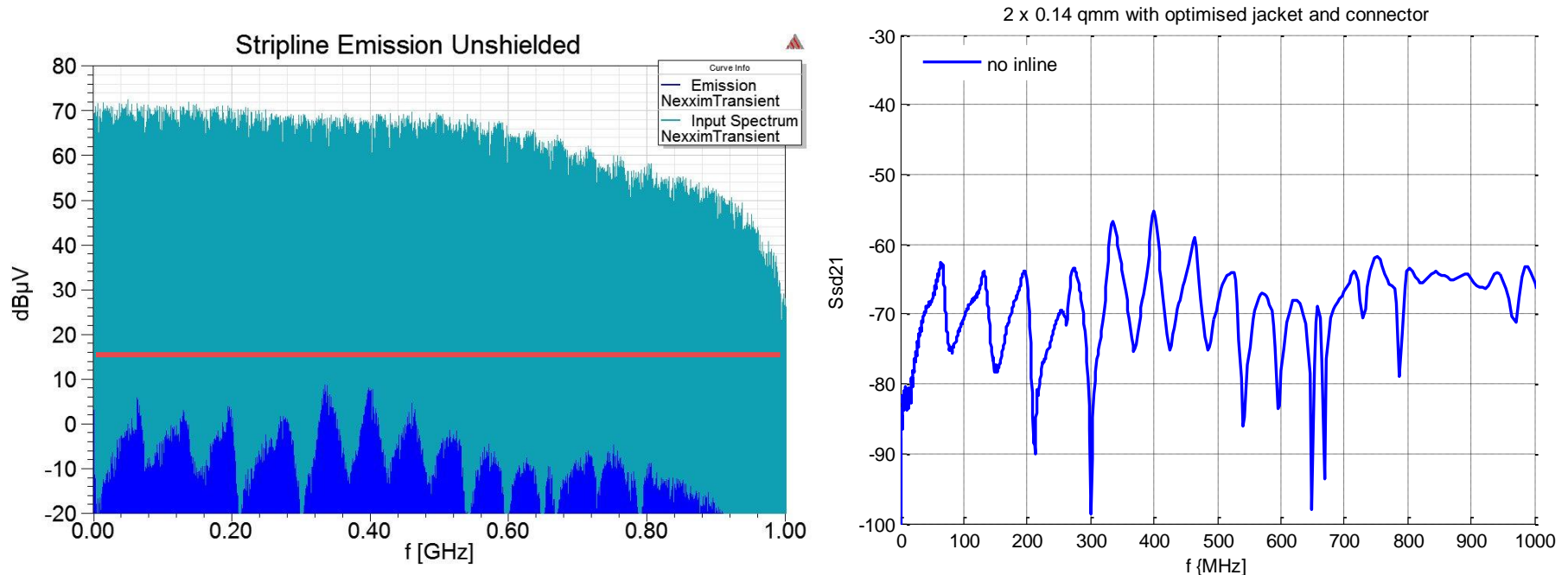
4 x 0.14 qmm  
STQ

- Shielded cables and connectors provide best EMC performance





- 1 Gbit/s PRBS10 signal source
- 0.2 V peak to peak
- 250 ps rise time filter
- 3-port s-parameter file from stripline measurement
- Voltage probe at the stripline measurement output



- If input spectrum and transfer function to stripline are known, the emitted spectrum can be predicted
- Points which need to be looked at
  - Detectors (e.g. peak, quasi-peak)
  - Measurement time and bandwidth
  - Other sources have to be modelled (e.g. PAM)