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Optimisation of physical layer components for RTPGE

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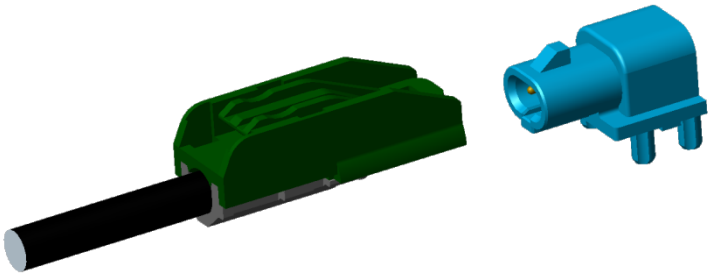
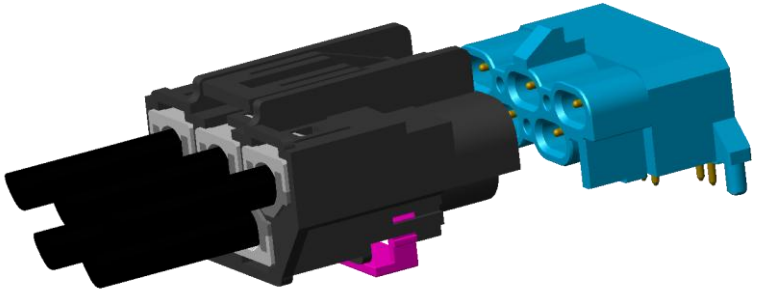
Outline

- 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

MDI connector performance
DUT description



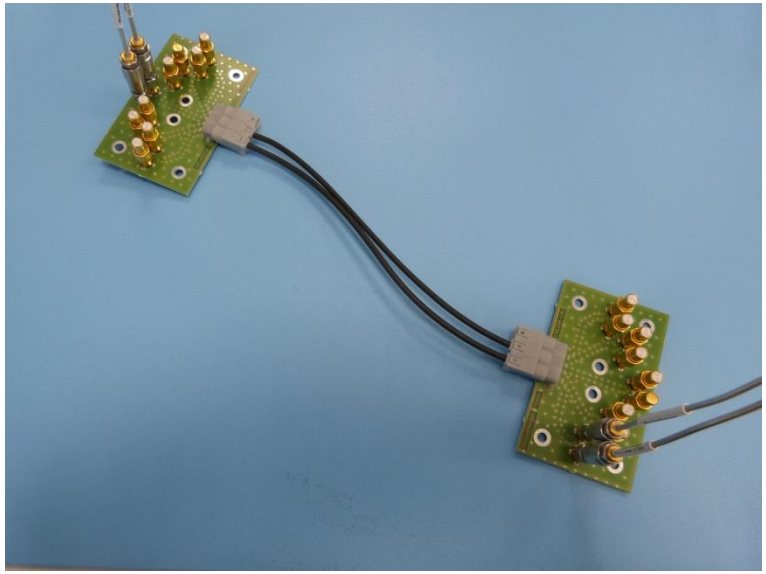


- Automotive twisted pair Ethernet connector
- Supports jacketed and unjacketed unshielded cables
- Electrically optimised for
  - Impedance matched to 100 Ohm
  - High balance
  - Low crosstalk
  - Minimum untwist area
- Open interface to the industry

MDI connector performance
VNA measurement setup

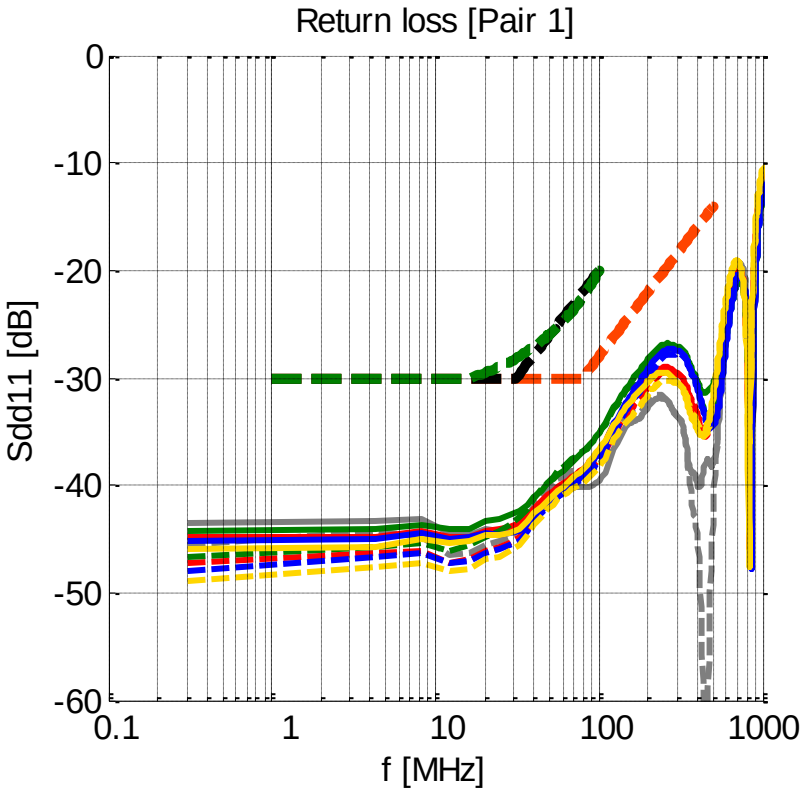
- Whole link consists of
  - 2x breakout boards
  - 2x MDI connectors
  - 200 mm jacketed cable

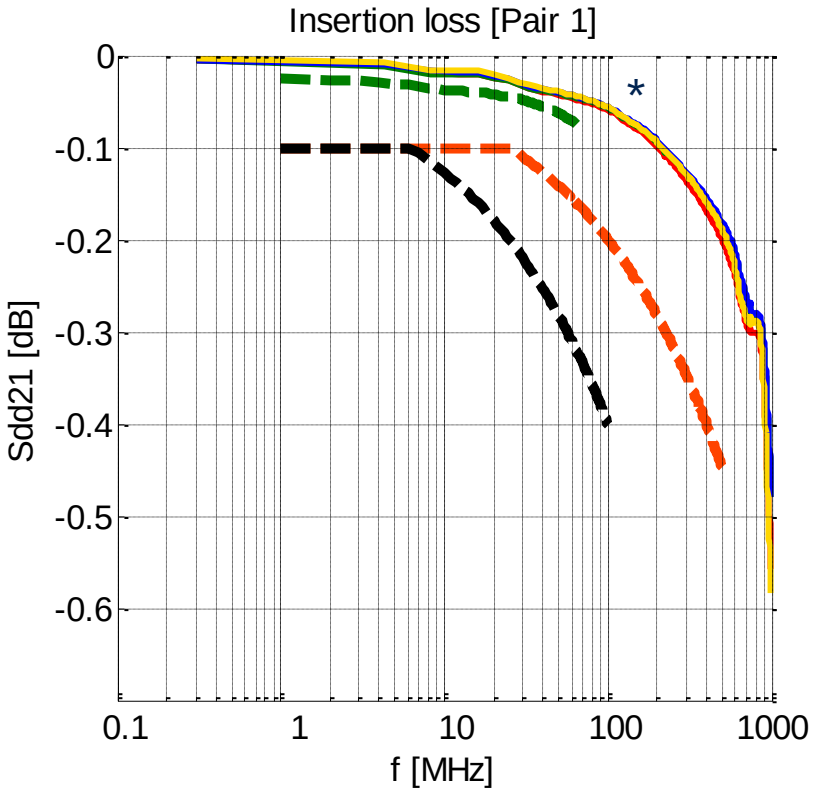
- Plot against the following limits for unshielded Ethernet connectors:
  - Cat 5 (IEC 60603-7-2)
  - Cat 6a (ISO/IEC 60603-7-41)
  - OPEN alliance spec draft v0.3



MDI connector performance

VNA measurements – Return- and insertion-loss

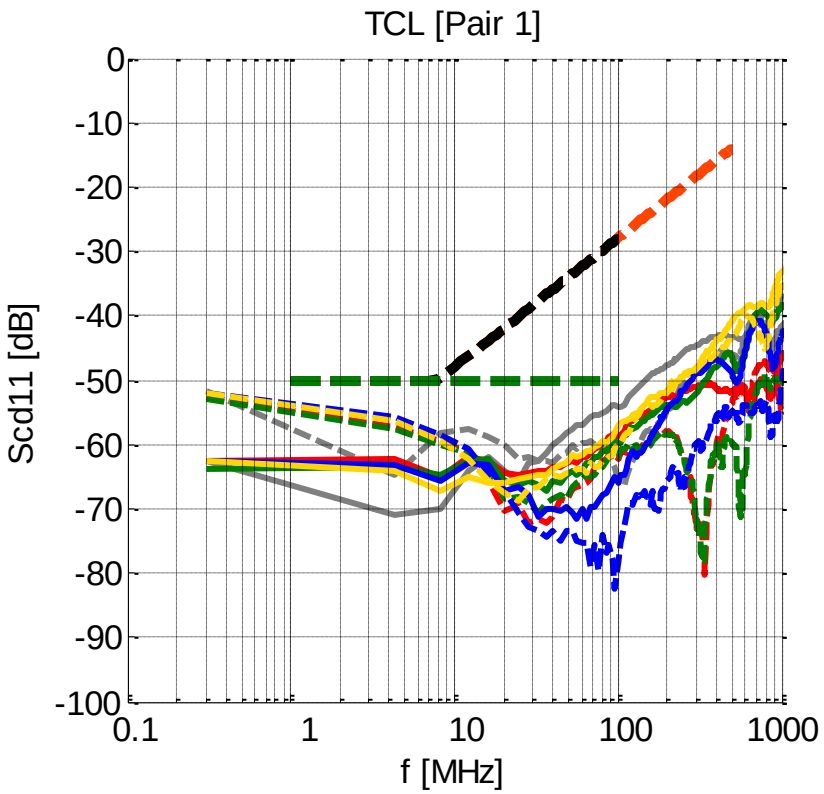


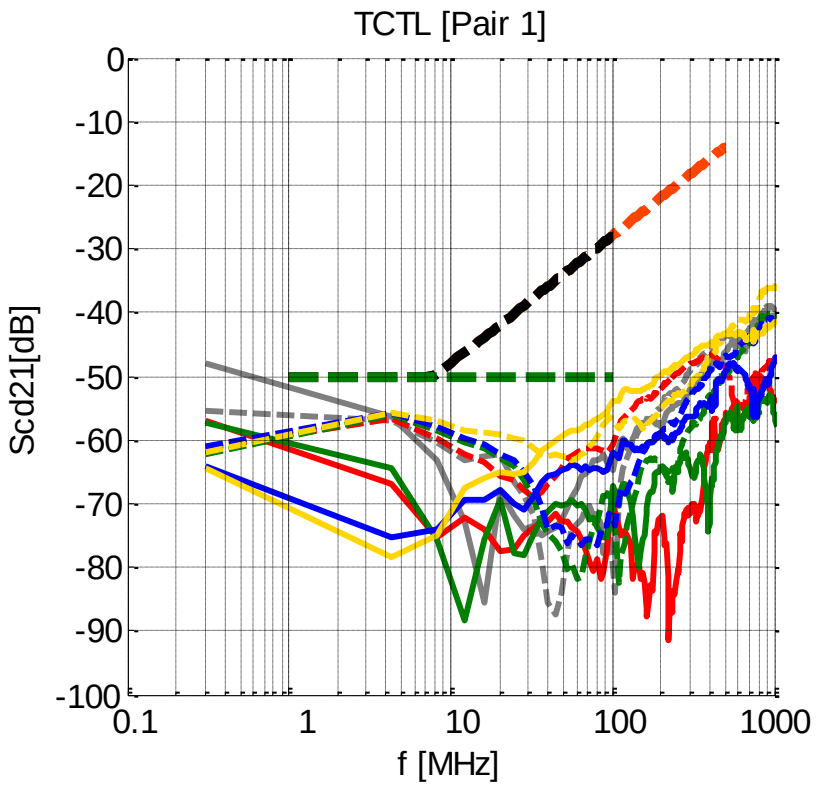


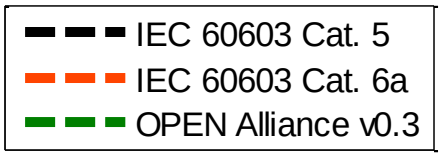
IEC 60603 Cat. 5
IEC 60603 Cat. 6a
OPEN Alliance v0.3

* Including breakout board

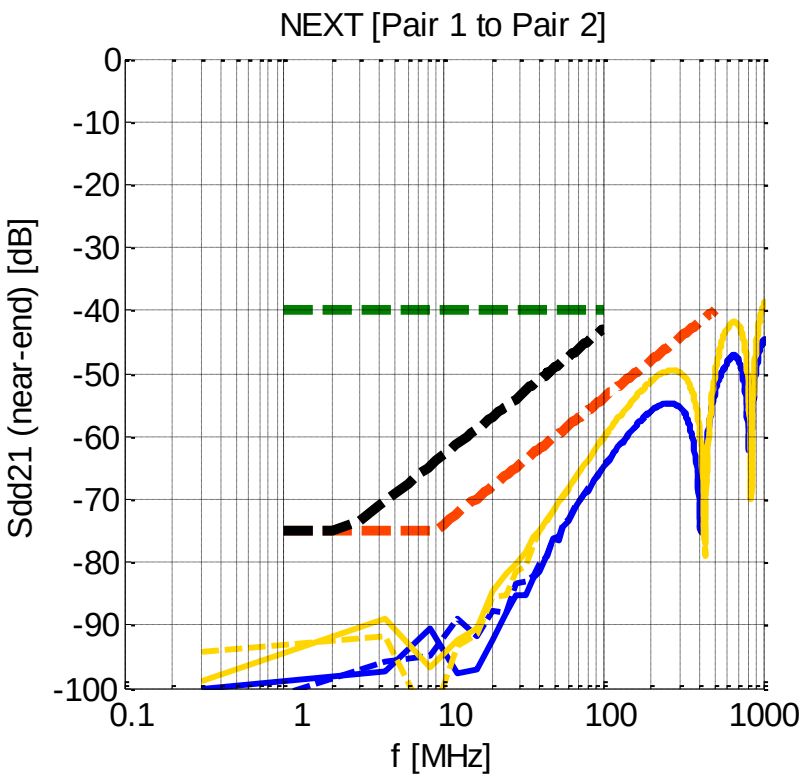
MDI connector performance
VNA measurements - Balance

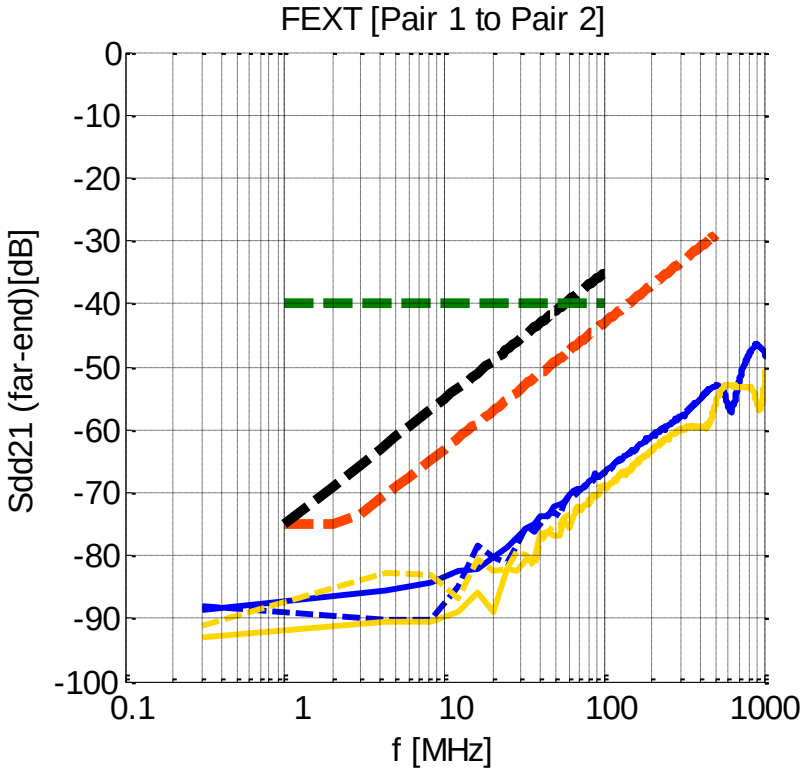


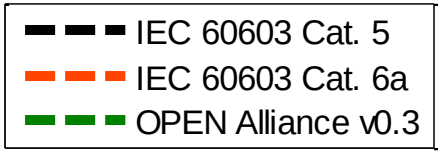




MDI connector performance
VNA measurements - Crosstalk







MDI connector performance
Differential impedance – Comparison to standard contact

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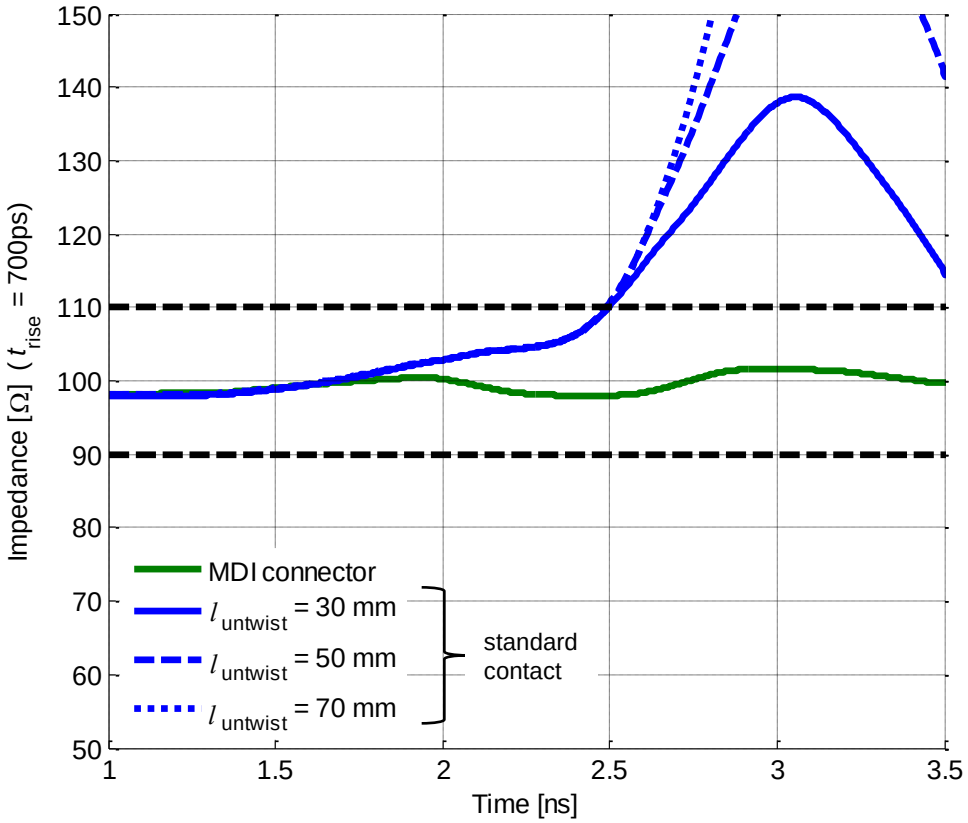
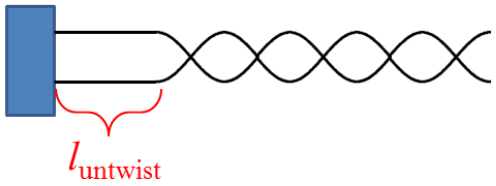
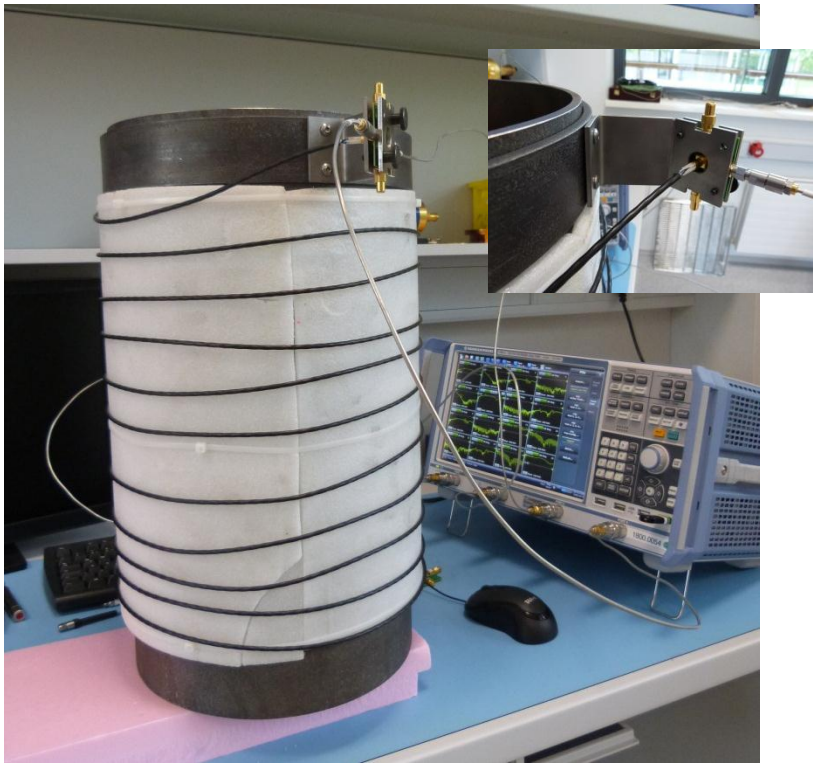




- 700 ps rise time 100 Ω ± 10 Ω (~ 500 MHz)
- Keeping the untwist length small is essential
- ➢ This is issue is not addressed by standard contacts (e.g. USCar).

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

Cable insertion loss over temperature

DUT overview

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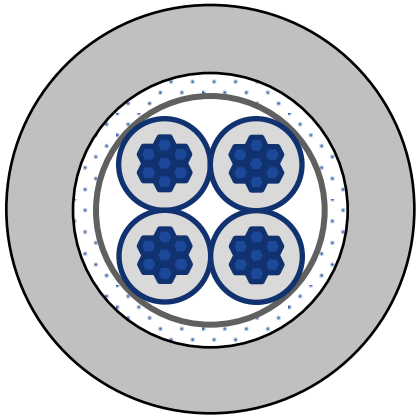
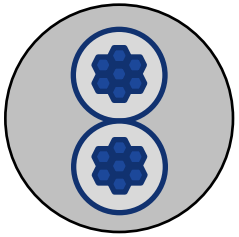
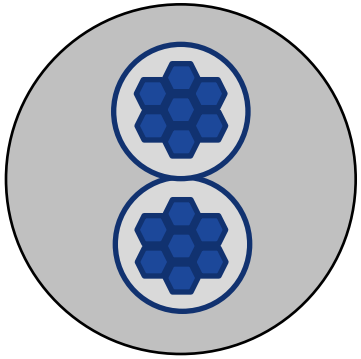


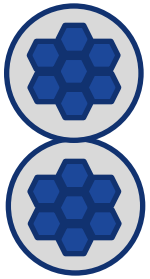
2 x 0.14 qmm
STQ



2 x 0.14 qmm
optimised jacket

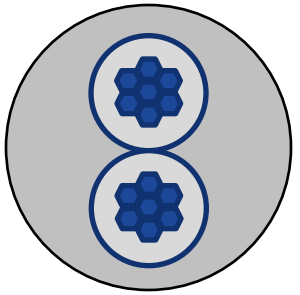


2 x 0.35 qmm
PVC jacket



2 x 0.35 qmm
unjacketed

note: every cable uses
PP conductor insulation



2 x 0.17 qmm
PVC jacket

Cable insertion loss over temperature

Results at room temperature

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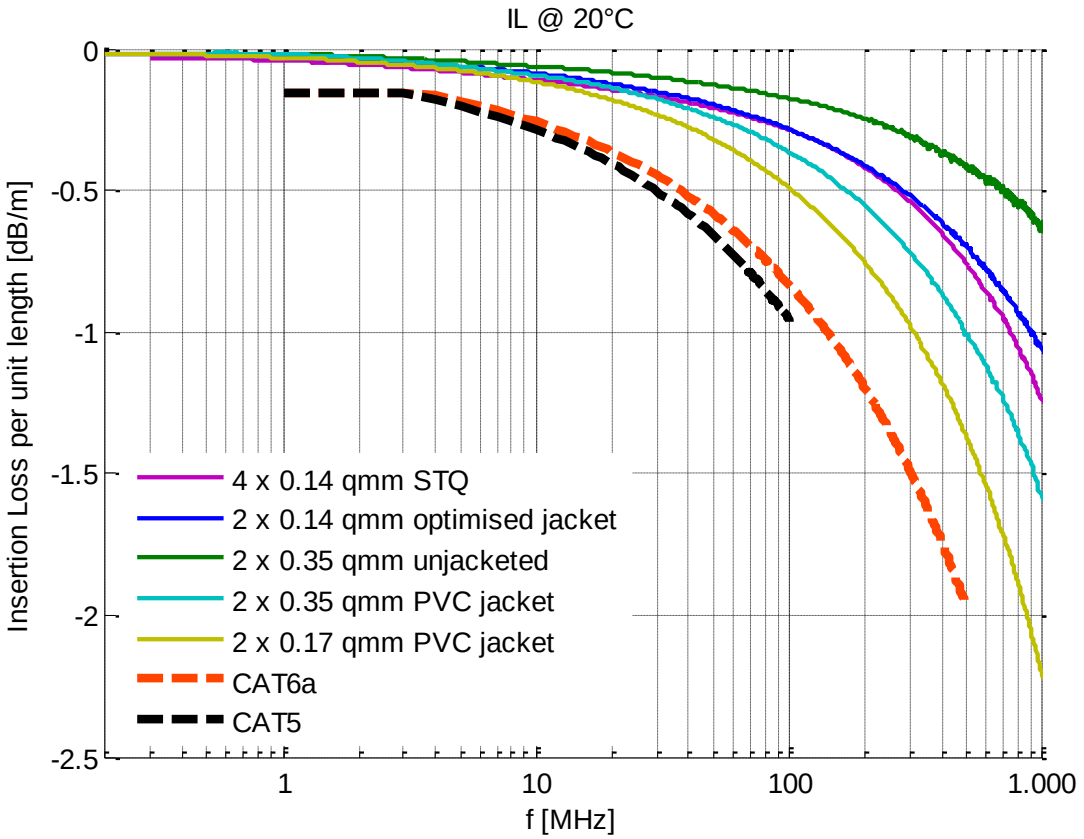

- Unjacketed cables can provide low insertion loss at the expense of unstable balance and environmental robustness
- 0.14 qmm cables provide low insertion loss if they are shielded or jacketed with proper material

Cable insertion loss over temperature
Results at 125°C

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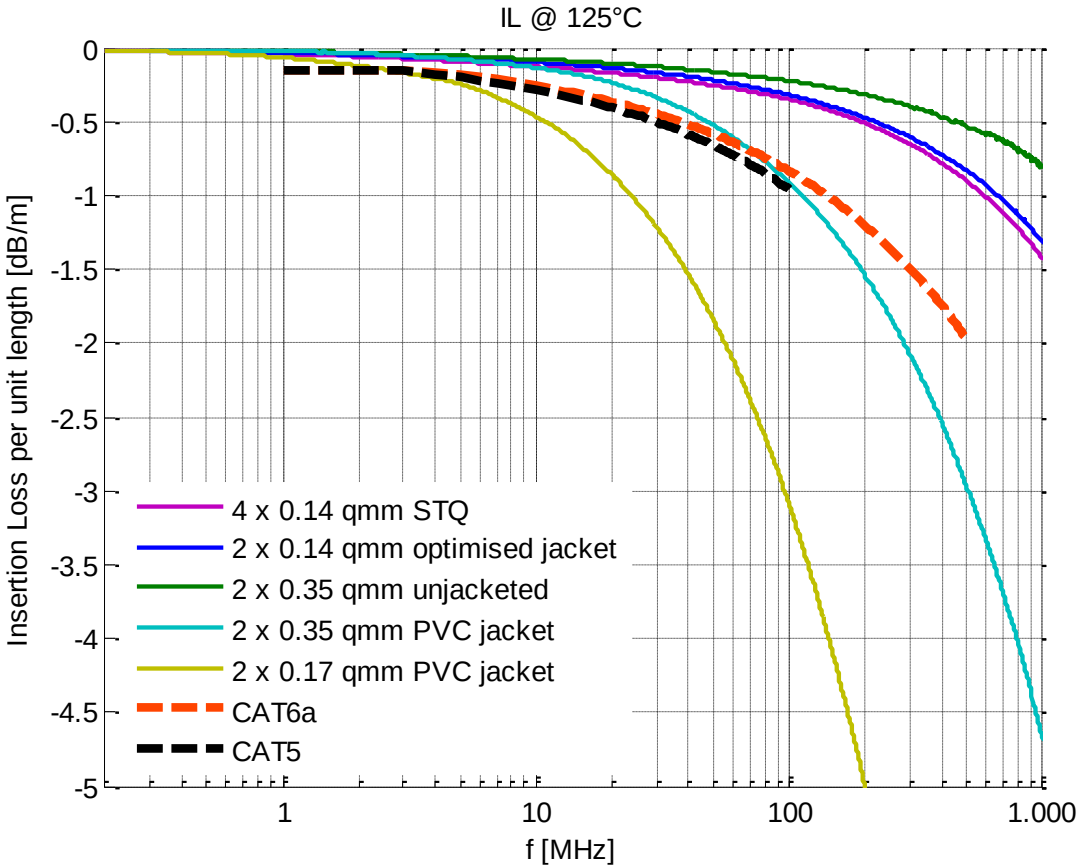

- PVC is not appropriate for high temperatures
- Cables with 0.14 qmm with optimised jacket material provide low insertion loss (~ 18% increase to room temperature) and high balance

EMC – Influence of inline connectors
Measurement setup

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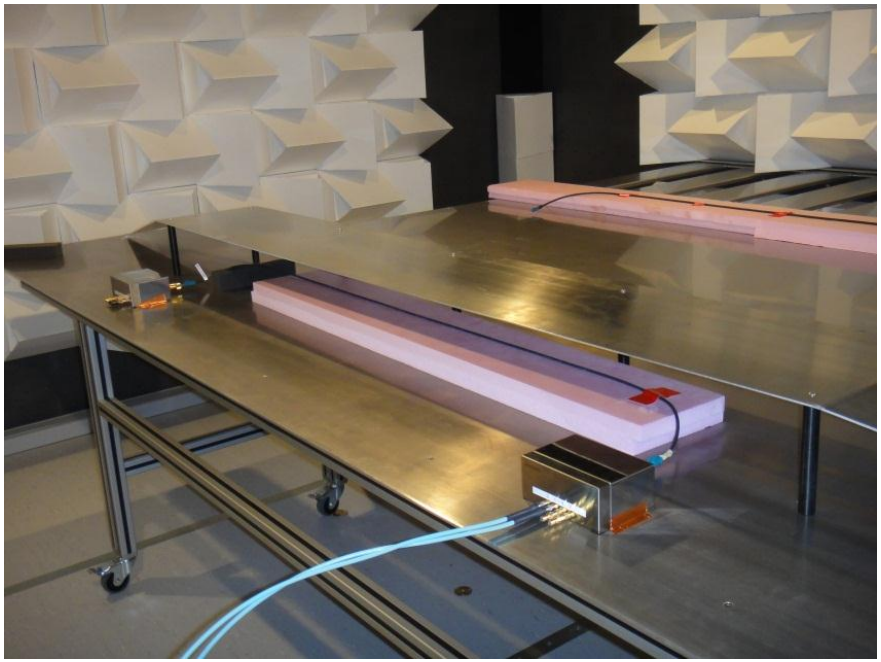

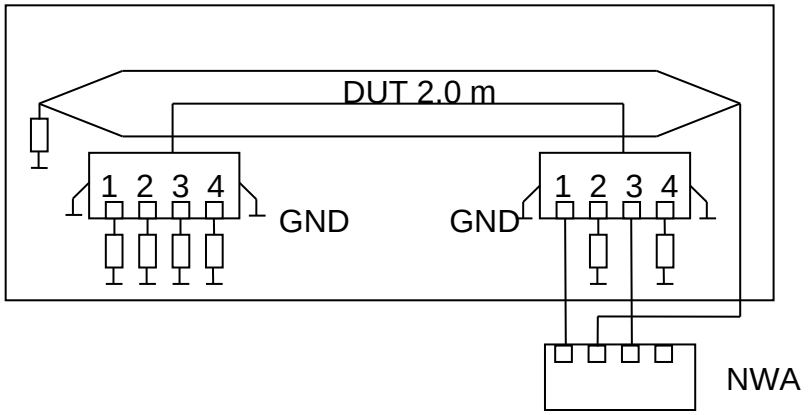

- Measure differential and common mode coupling to stripline in a three port NWA measurement
- DUT length 2.0 m
- Both ends connected to ground plane

EMC – Influence of inline connectors

Results for standard cable and contacts

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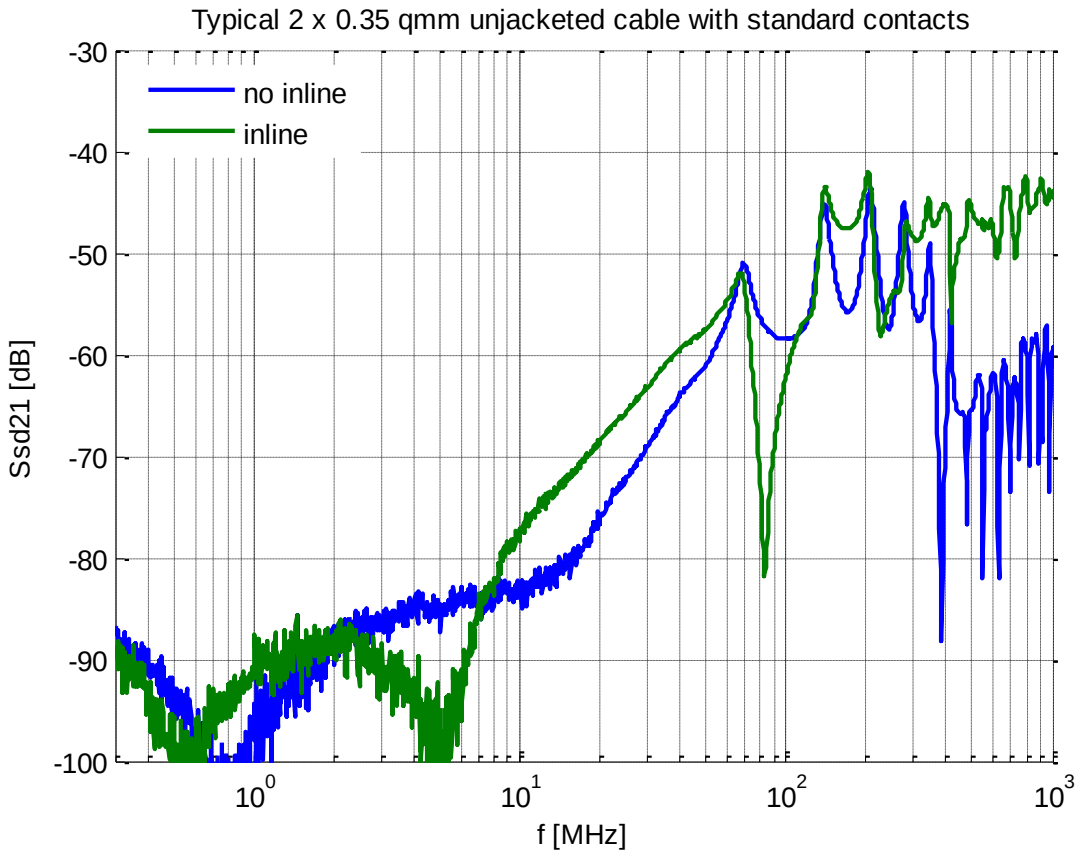

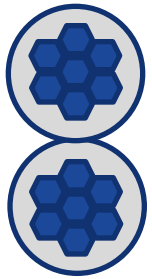

2 x 0.35 qmm unjacketed

- Typical unjacketed cable

EMC – Influence of inline connectors

Results for optimised cable and connector

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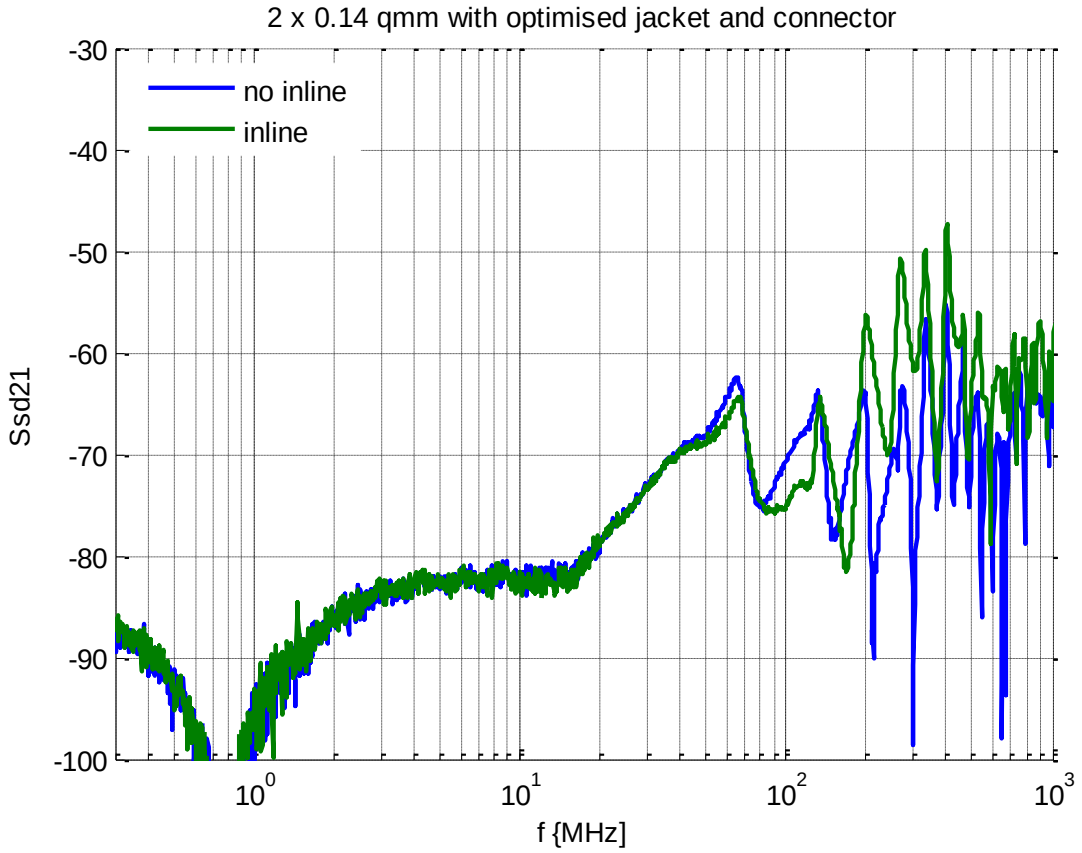

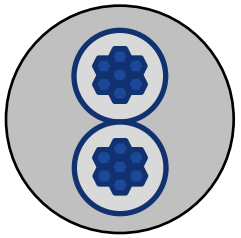

2 x 0.14 qmm
unjacketed

- Optimised jacketed cable

EMC – Influence of inline connectors

Results for shielded cables and connectors

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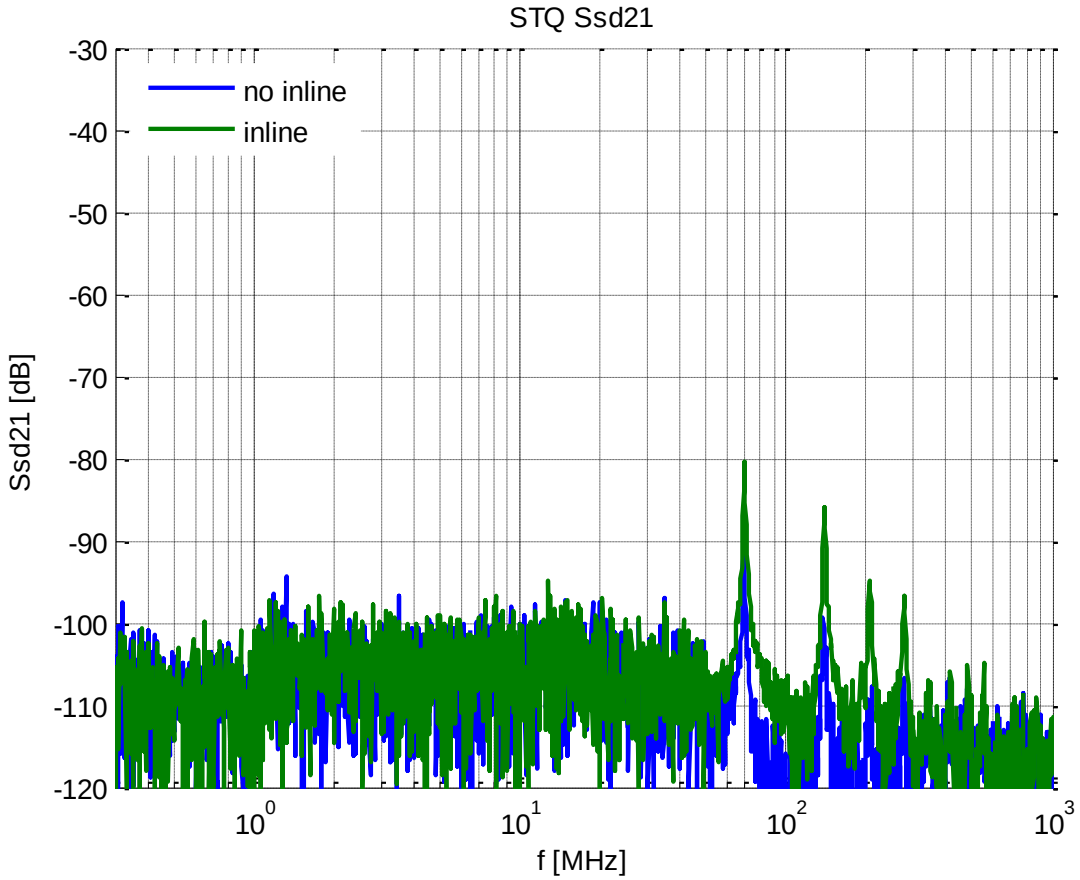
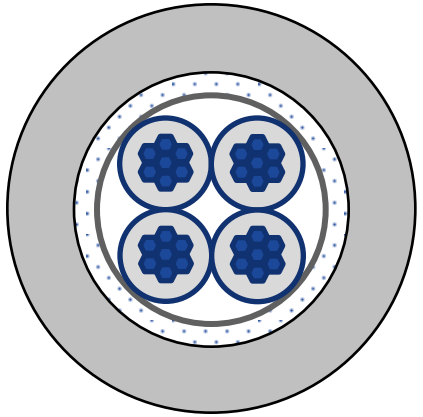
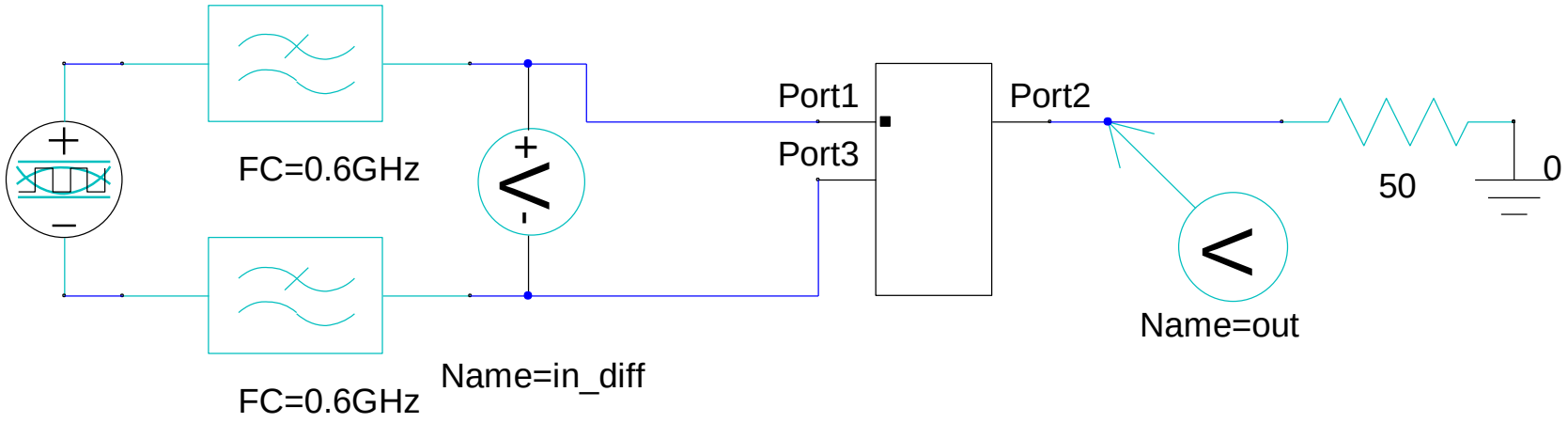


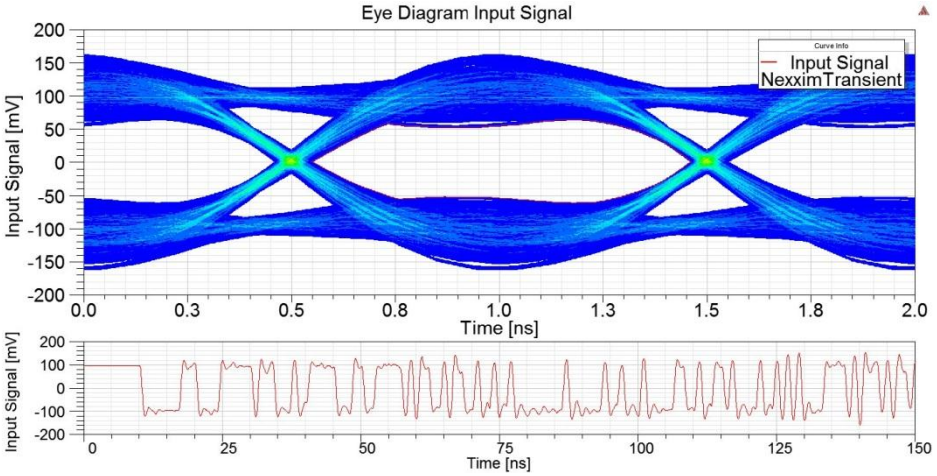


4 x 0.14 qmm
STQ

- 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
- 3rd order low pass (600 MHz)
- 3-port s-parameter file from stripline measurement
- Voltage probe at the stripline measurement output



EMC – System simulation
Outlook on stripline emission system simulation

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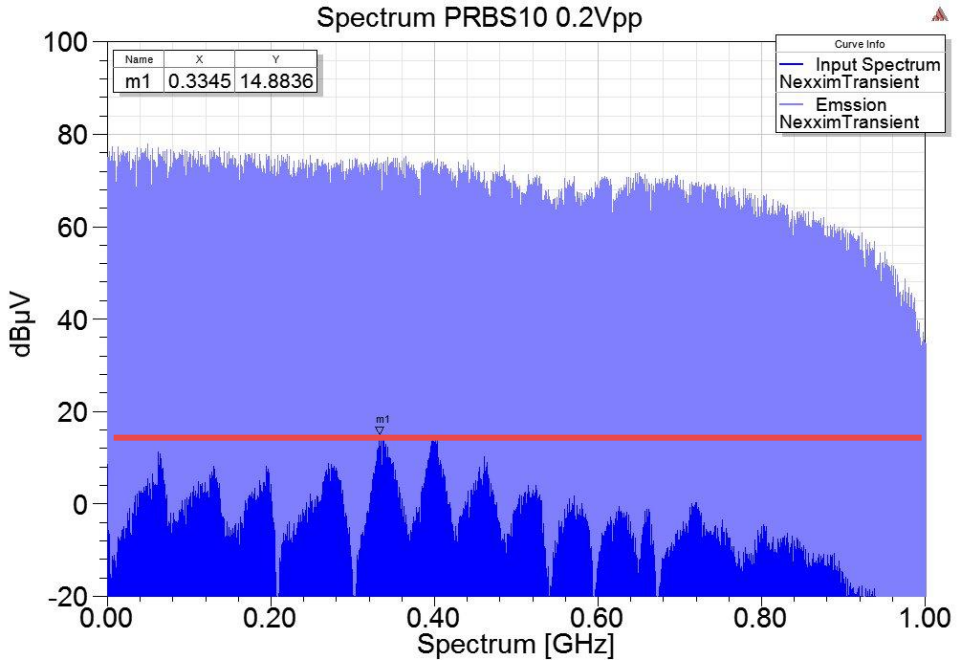
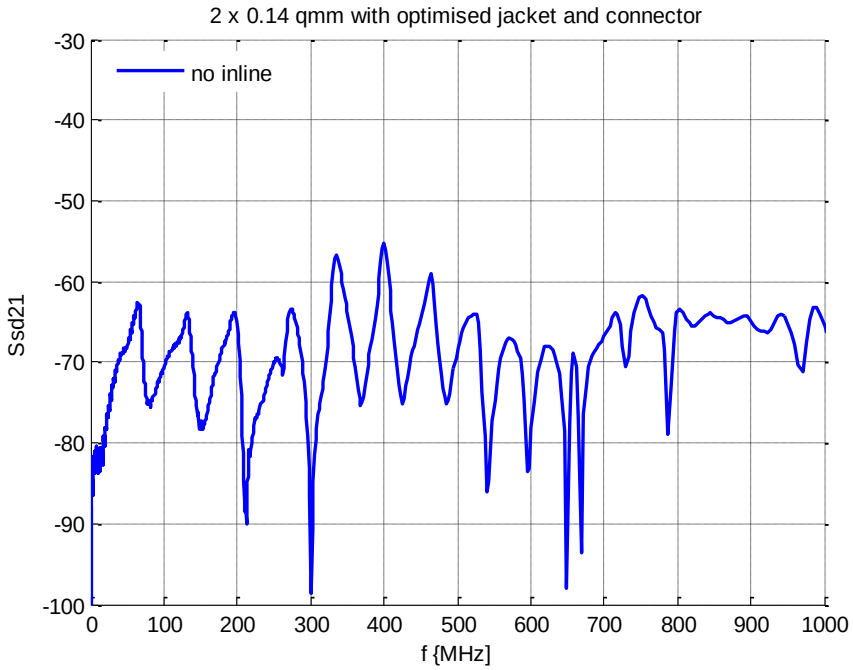
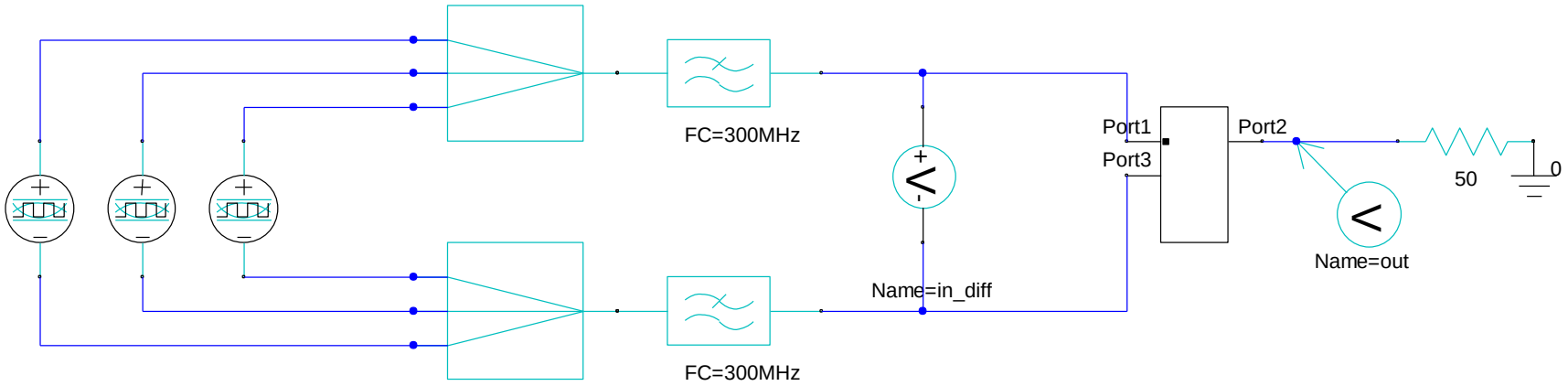
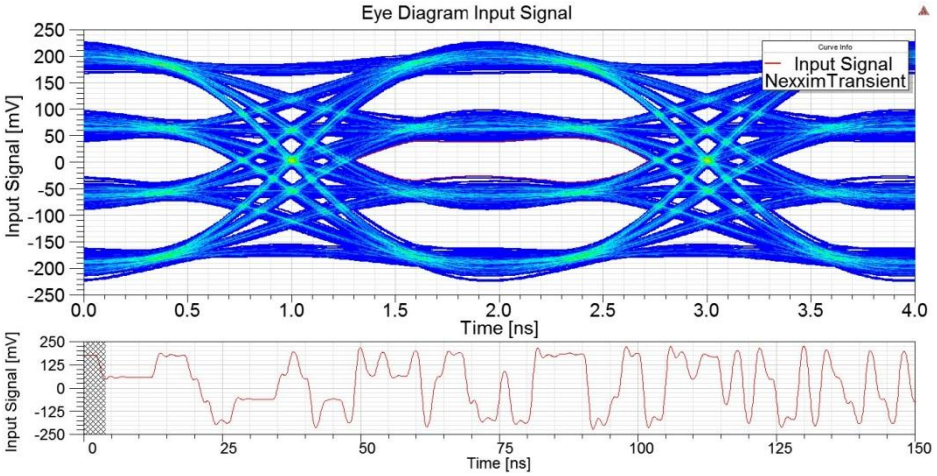




- If input spectrum and transfer function to stripline are known, the emitted spectrum can be predicted

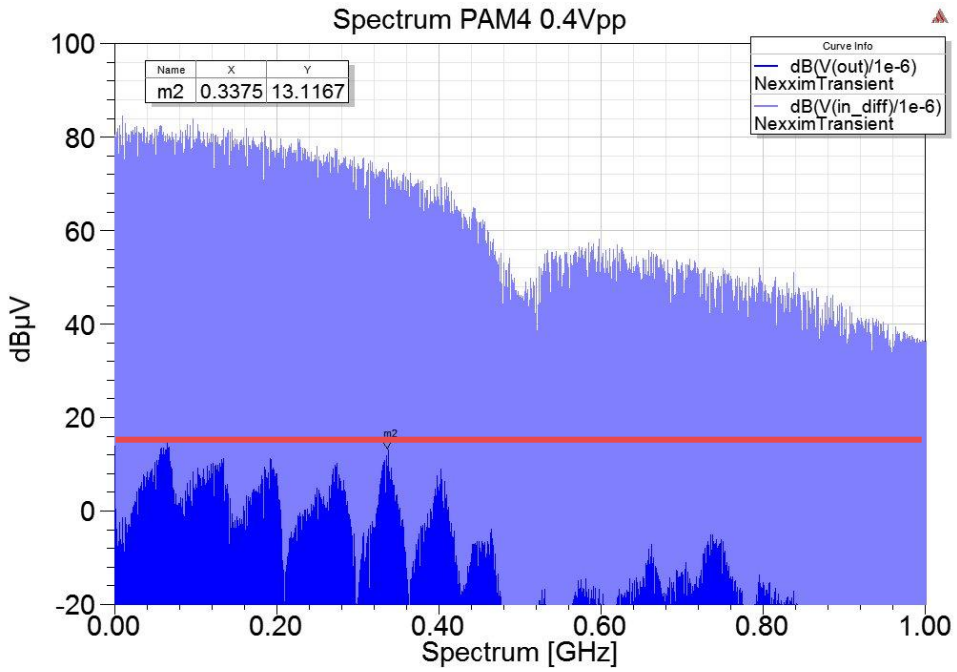


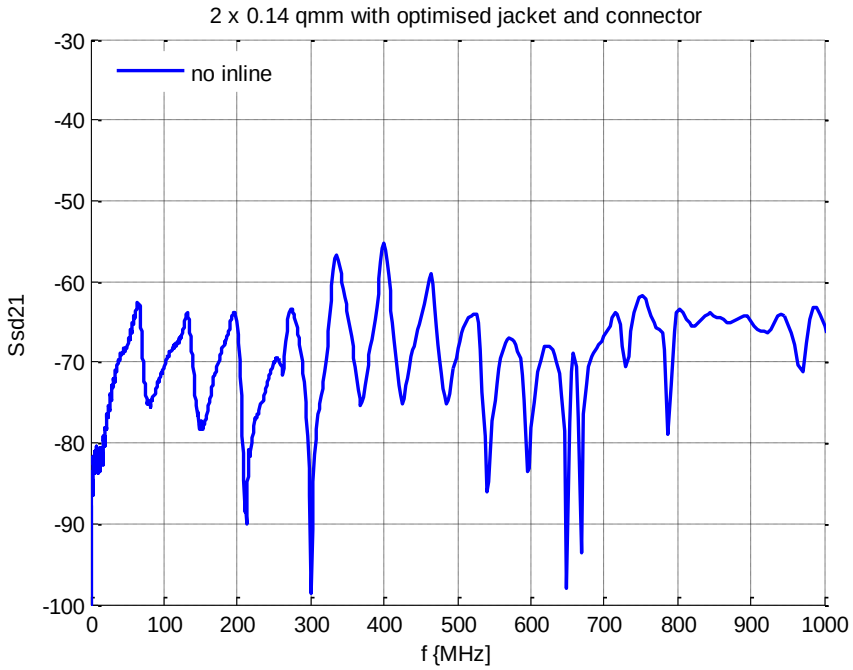
- Three bit sources combined
- 0.4 V peak to peak
- 250 ps rise time filter
- 3rd order low pass (300 MHz)
- 3-port s-parameter file from stripline measurement
- Voltage probe at the stripline measurement output



EMC – System simulation
Outlook on stripline emission system simulation

IEEE RTPGE





- With PAM4, the input voltage can be increased while maintaining the same emission peak level
- Points which need to be looked at
  - Detectors (e.g. peak, quasi-peak)
  - Measurement time and bandwidth
  - Quality and parameters of the source models