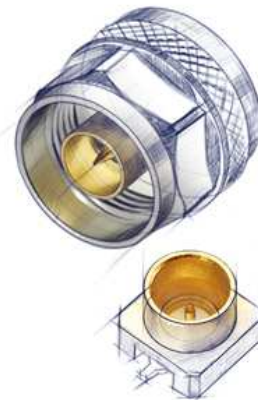

IEEE RTPGE

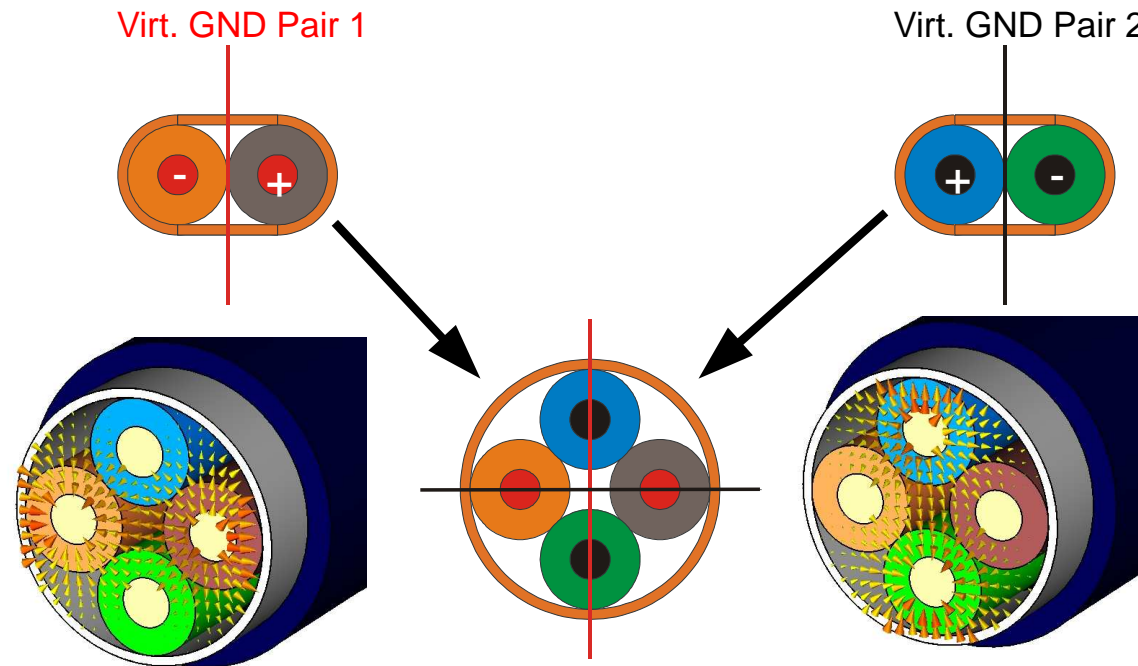
Automotive Datalinks over Twisted Quad Cabling

T. Müller

G. Armbrrecht, S. Kunz

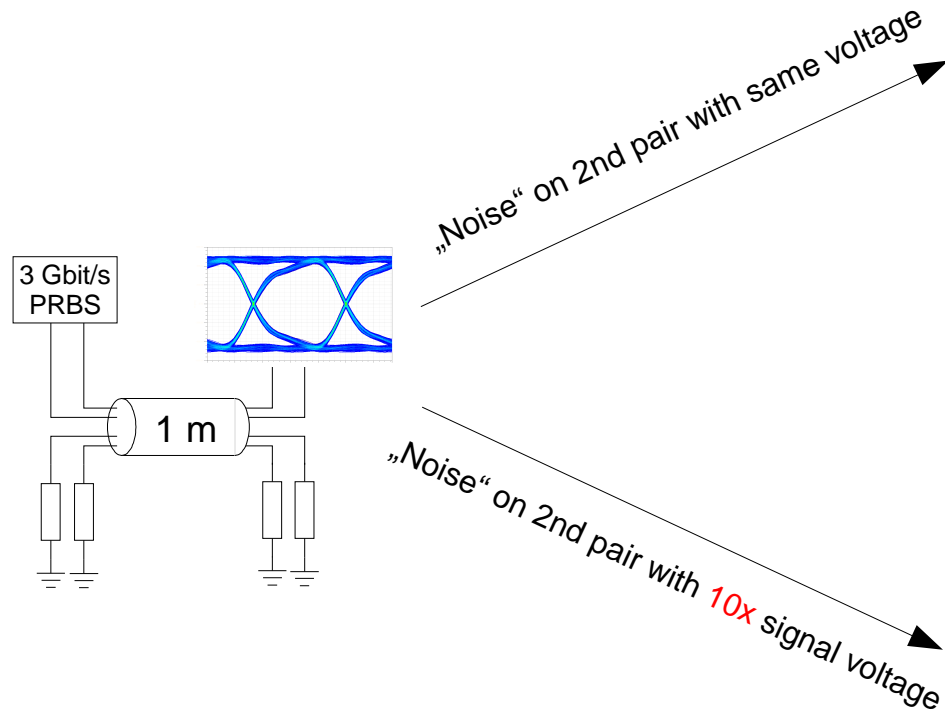


-
- Twisted Quad for High Speed Data Transmission (HSD)
 - Star quad fundamentals
 - HSD connector
 - System considerations (unshielded vs. shielded)
 - Investigations concerning Ethernet
 - Basic link tests
 - Qualification against CAT limits
 - Influence of inline-connections
 - Transmission lines in an automotive environment
“OPTIONAL, maybe to be discussed later or within the working groups”
 - Temperature
 - Humidity
 - Coupling to adjacent lines (alien crosstalk)
 - EMC
 - Summary

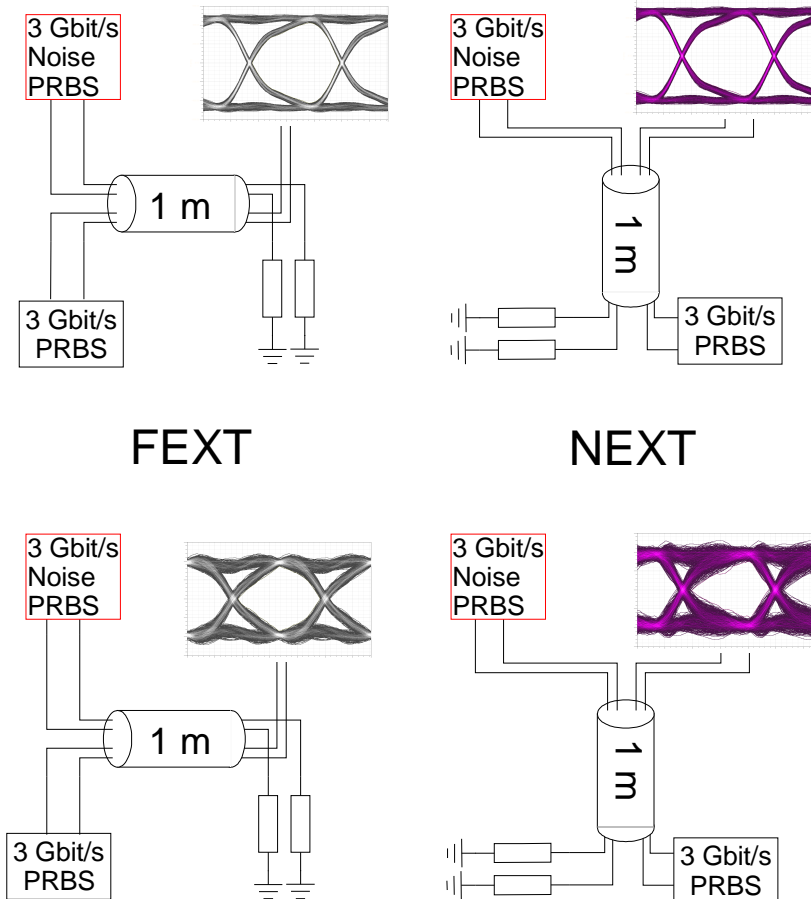


- Low crosstalk due to orthogonal position (fields cancel each other)
- Independent transmission of two data streams over one cable
- Compact size
- Round shape without fillers (mechanically stable)
- Second pair can also be used for remote powering devices or control channels (e.g. CAN)

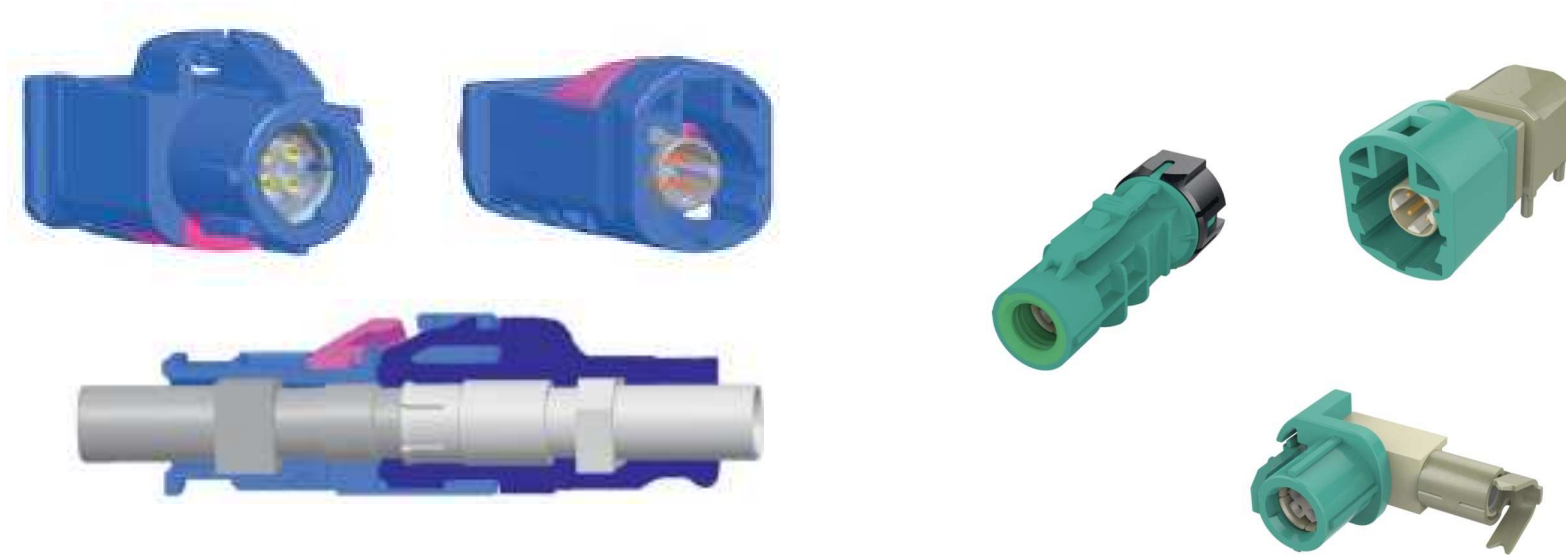
PRBS-datastream at a data rate of 3 Gbit/s.



Crosstalk to the adjacent pair

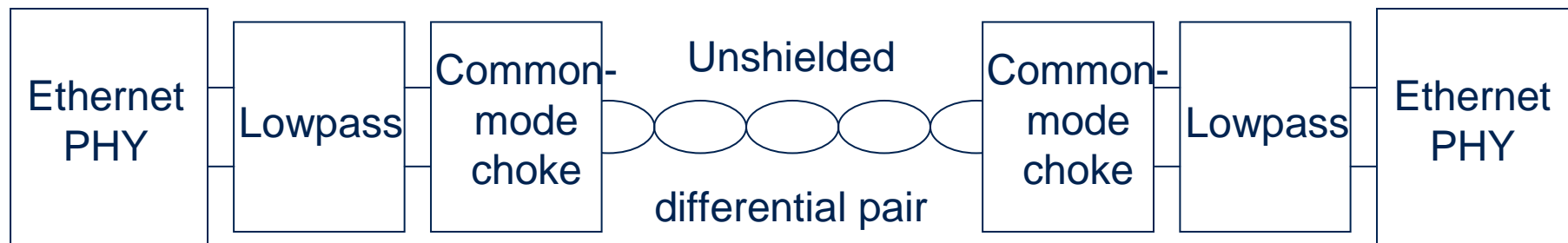


Crosstalk to the adjacent pair if the interferer's amplitude is increased tenfold



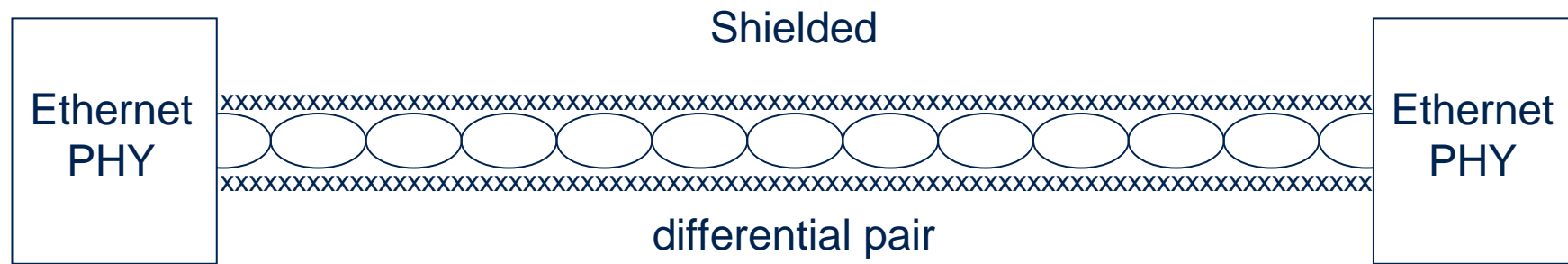
- HSD is an open interface (connectors are available from different vendors)
- Designed to meet automotive requirements (e.g. LV213, LV214, USCar)
- Mechanically robust (e.g. pull out forces)
- Waterproof versions
- Different codings and angles
- Fully automated cable assembly process
- Compatible with shielded, foil-shielded and unshielded Twisted Pair and Quad

- Unshielded solutions (UTP / UTQ)



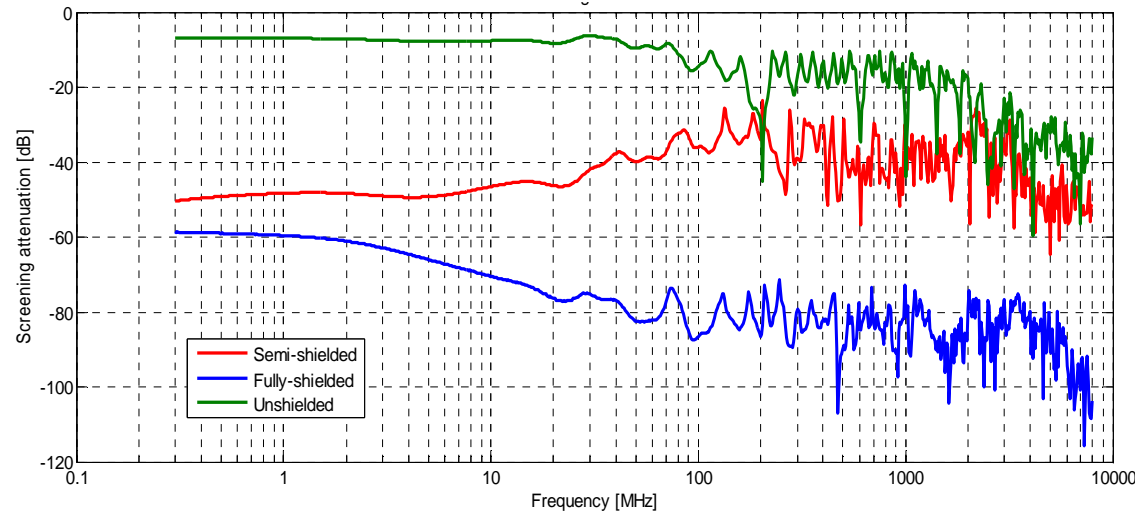
- Currently used for data rates up to 50 MBit / s (MOST 50)
- Lowpass-filters to limit the signal spectrum
- Common-mode chokes to limit the common-mode currents
- Accurate balance necessary to meet the EMC requirements
- Coupling attenuation is determined by mode conversion properties of the channel (cable / connector balance, termination, CMC...)

- Shielded solutions (STP / STQ)



- Currently used for data rates up to 3 GBit / s (LVDS, USB, Firewire)
- No extensive filtering and balance control needed
- Coupling attenuation is the sum of mode conversion properties and screening attenuation:
 - Balance is not affected by objects nearby
 - Alien crosstalk is reduced
 - EMC properties are improved

Screening attenuation

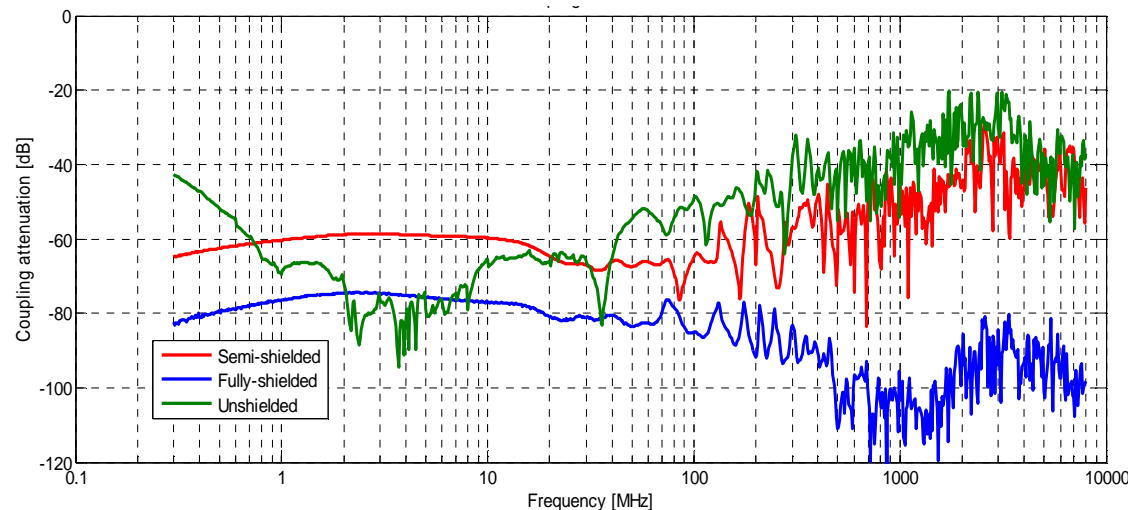


Defining a screening attenuation for unshielded cables makes no sense

The quality of a shield may be adjusted by construction.

Common mode signals are decoupled from the environment by measure of the screening attenuation.

Coupling attenuation



Unshielded differential pairs exhibit a high coupling attenuation at low frequencies.

Semi-shielded lines may show an attractive trade-off between cost and performance.

The highest coupling attenuation is obtained for fully shielded differential pairs.

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- **Investigations on Ethernet over Twisted Quad**
 - Basic link tests
 - Qualification against CAT limits
 - Influence on inline-connections
- Transmission lines in an automotive environment

“OPTIONAL, maybe to be discussed later or within the working groups”

 - Temperature
 - Humidity
 - Coupling to adjacent lines (alien crosstalk)

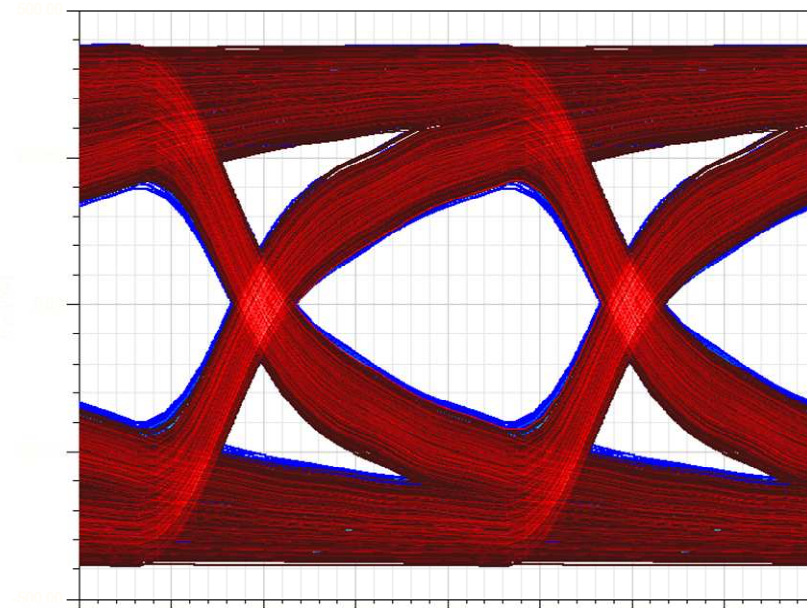
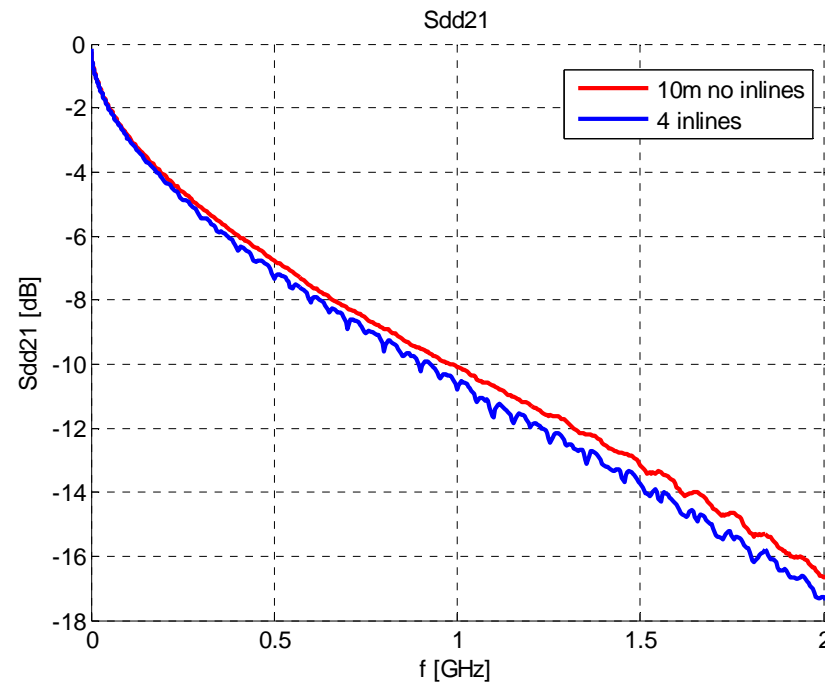
-
- 100 Base-TX
 - Bandwidth 33 MHz
 - Link length reached > 100 m

 - Two BroadR-Reach over one cable
 - Bandwidth 33 MHz
 - Link length reached > 100 m

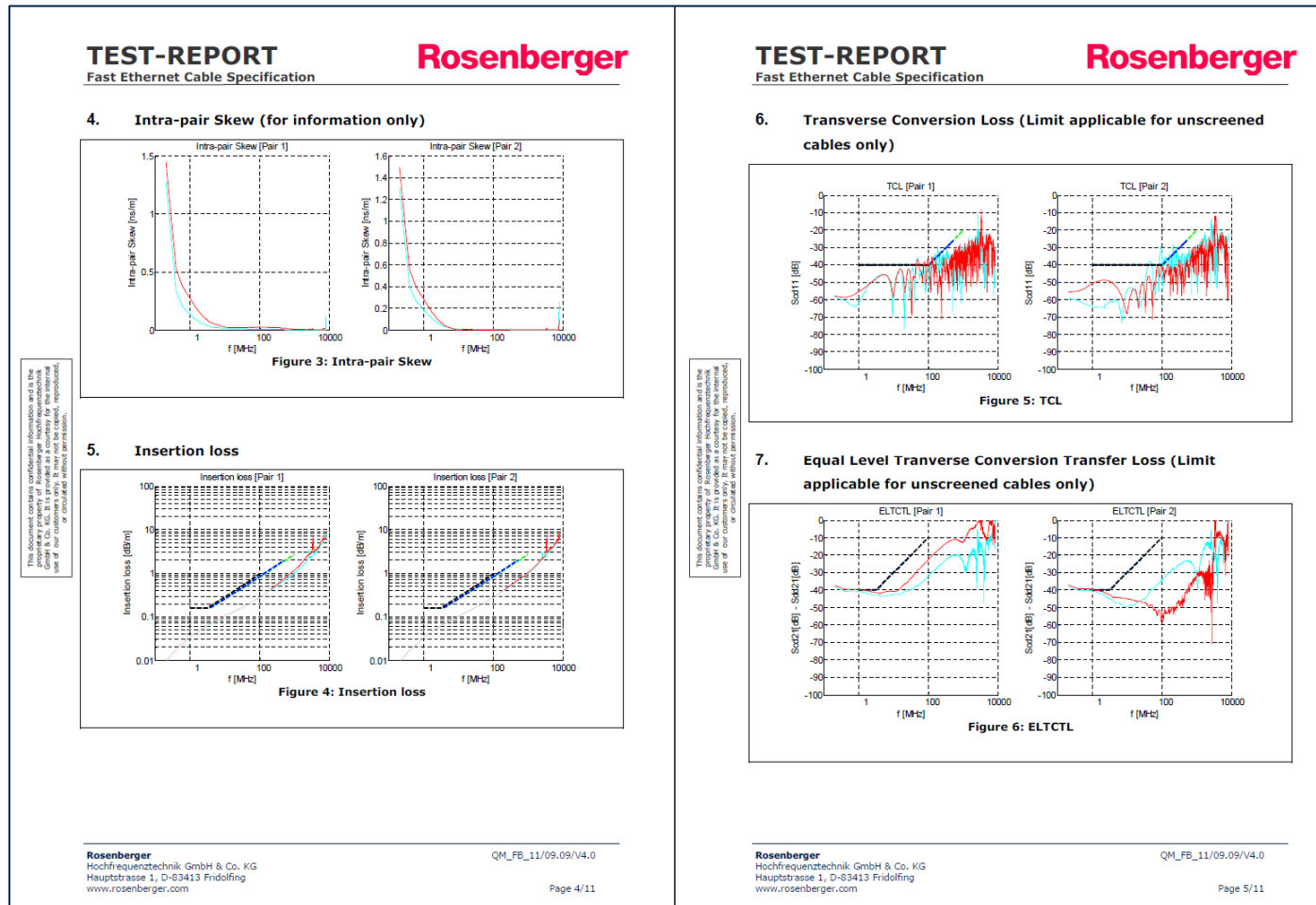
 - 1000 Base-CX
 - Bandwidth 625 MHz
 - Link length reached approx. 28 m

Details to be filled in....

- PRBS data-stream at 1 GBit / s
- 10 m cable with (blue) and without four in-lines (red)



- Low influence on system performance



- Meets up to CAT 6a requirements depending on cable type

- Twisted Quad cables are widely used for differential signal transmission within vehicles.
- In combination with the HSD interface the automotive requirements concerning mechanical and electrical properties are met.
- The grade of shielding may be adapted to bandwidth, topology and EMC-environment of the application to be implemented without the need to change the interface.