Greater than 10 Gb/s Automotive Ethernet Link Segment

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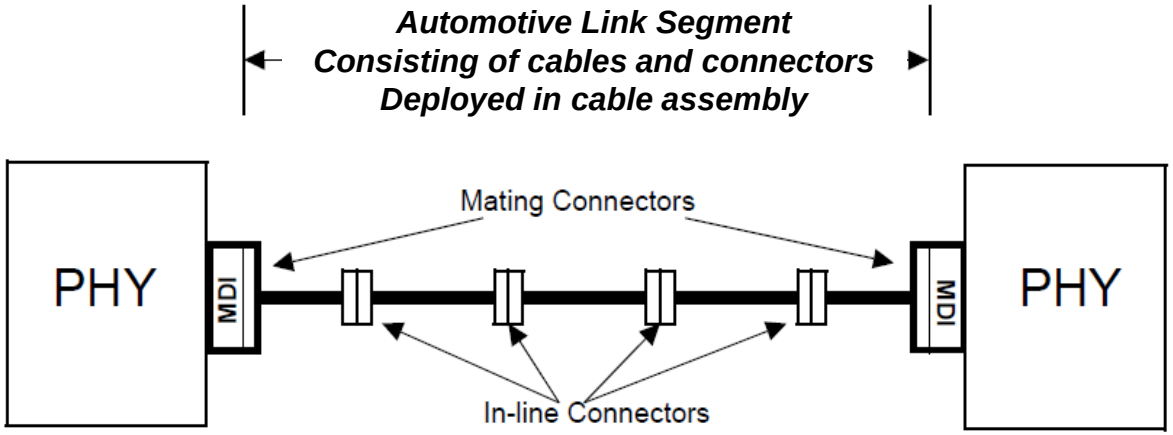
Purpose

- **Considerations for Greater than 10 Gb/s Automotive Ethernet Link Segment**
- **Considerations for technical feasibility**

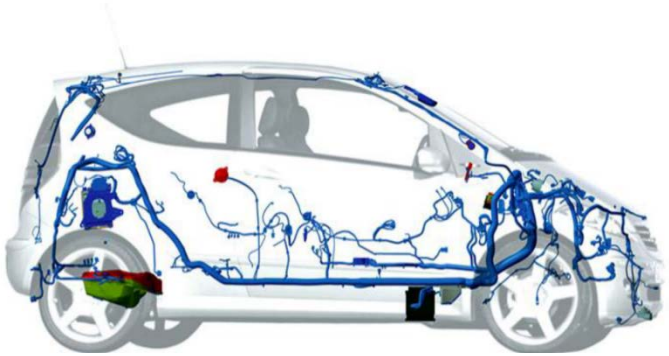
Automotive P-to-P Link Segment



Automotive Ethernet PHYs

- ***10M – 802.3cg***
- ***100M - 802.3cw***
- ***1G - 802.3bp***
- ***2.5G/5G/10G - 802.3ch***
- ***>10G – 802.3***

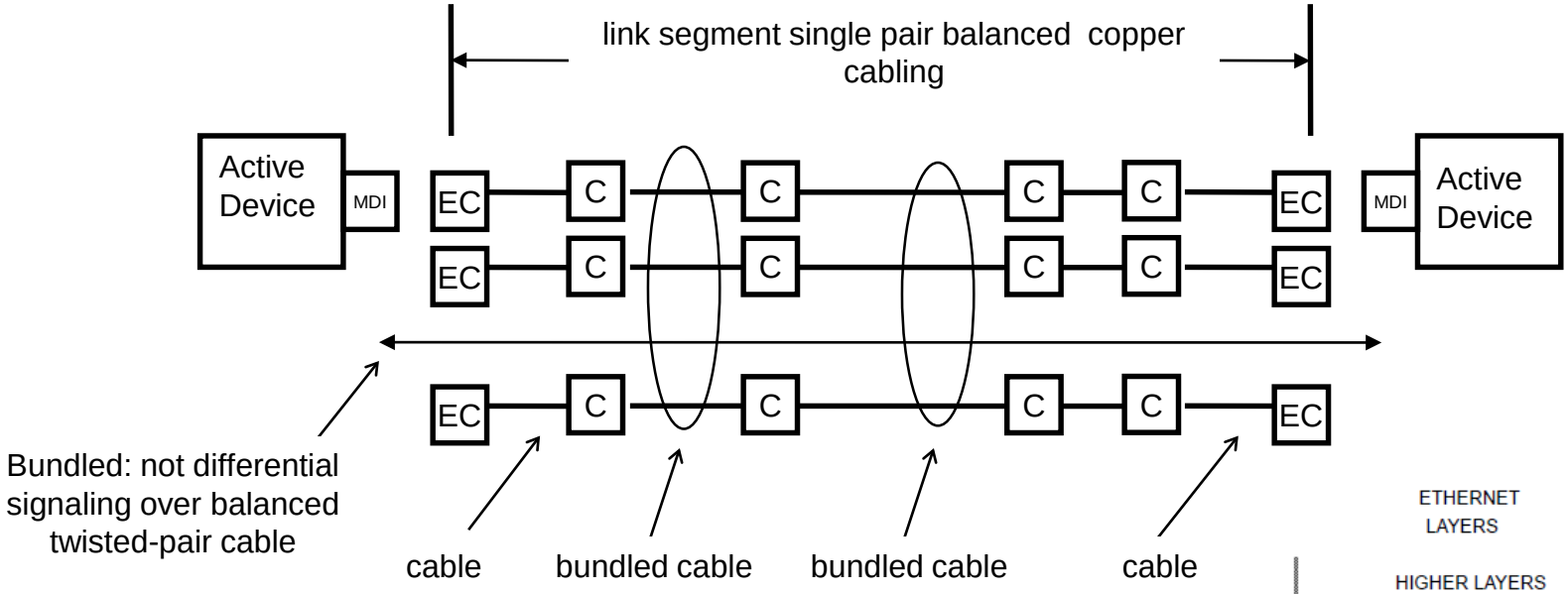
Point-to-Point



Length of automotive wiring system can exceed 3 km with up to 1,500 cables and up to 3,000 contacts.

Automotive cable harness -Link Segment

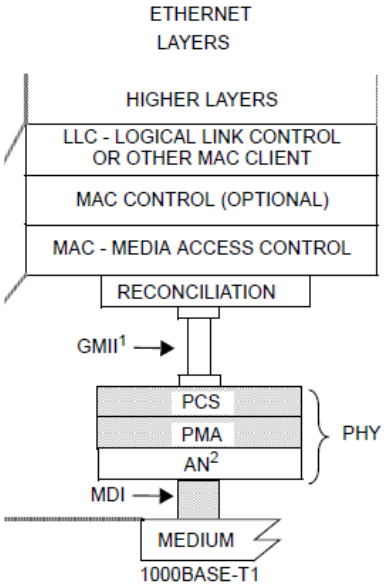
Automotive P-to-P Link Segment



C = inline connector

EC = connection to equipment

MDI = *PHY is coupled to the cabling at the MDI. MDI requirements: mechanical (to ensure complete compatibility) and electrical.*

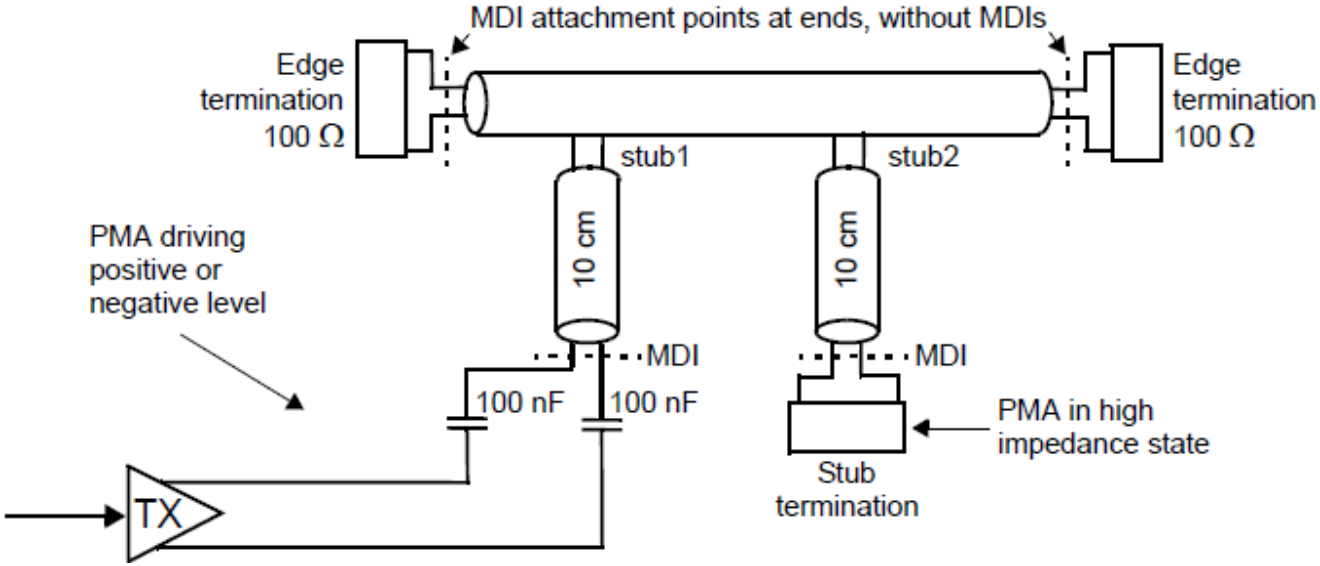


PCS = PHYSICAL CODING SUBLAYER
PMA = PHYSICAL MEDIUM ATTACHMENT
PHY = PHYSICAL LAYER DEVICE

Automotive Multidrop Topology

IEEE P802.3cg 10 Mb/s Single-Pair 10BASE-T1S

A mixing segment is specified based on cabling that supports up to at least 8 nodes and 25 m in reach.



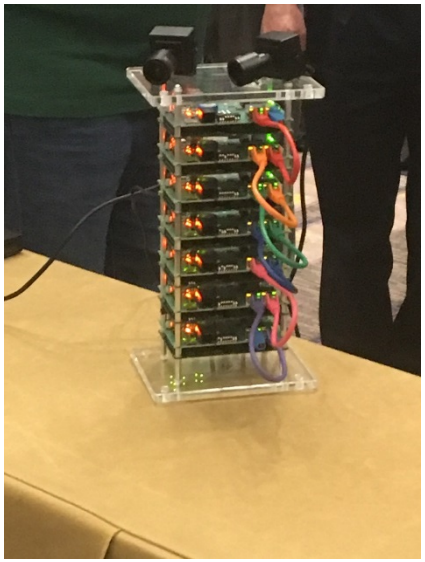
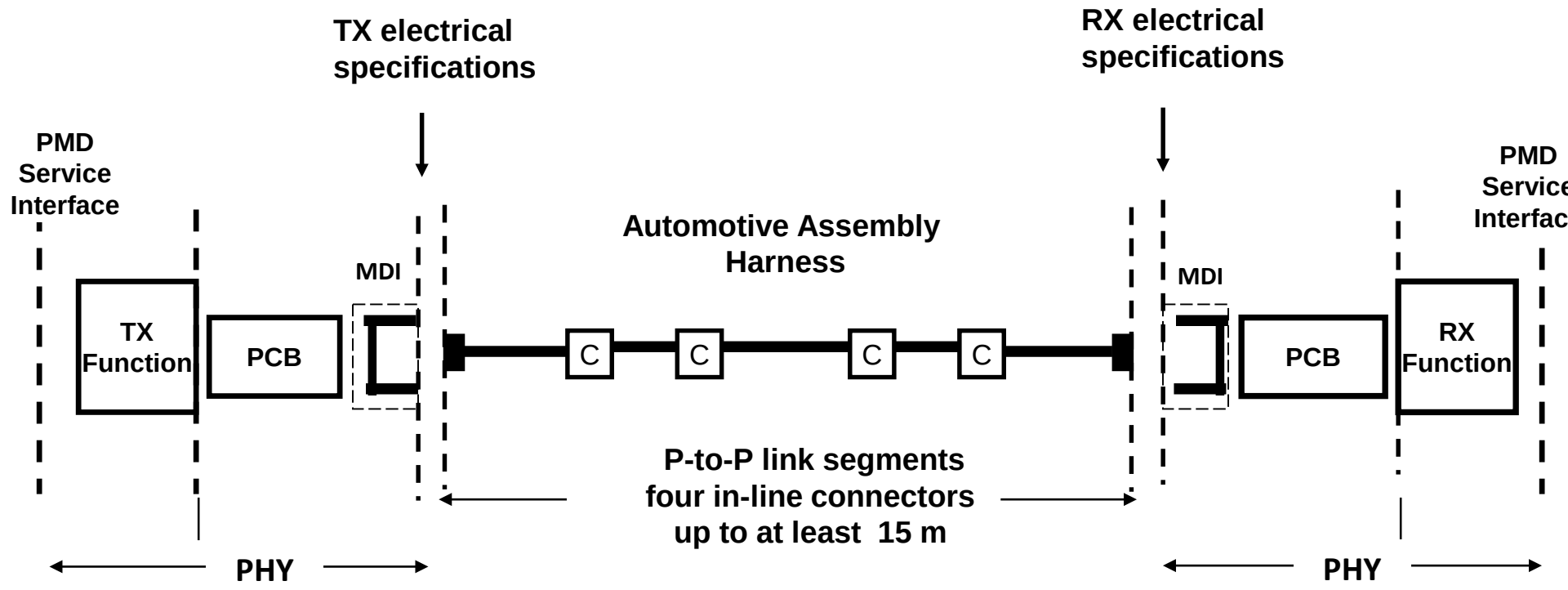


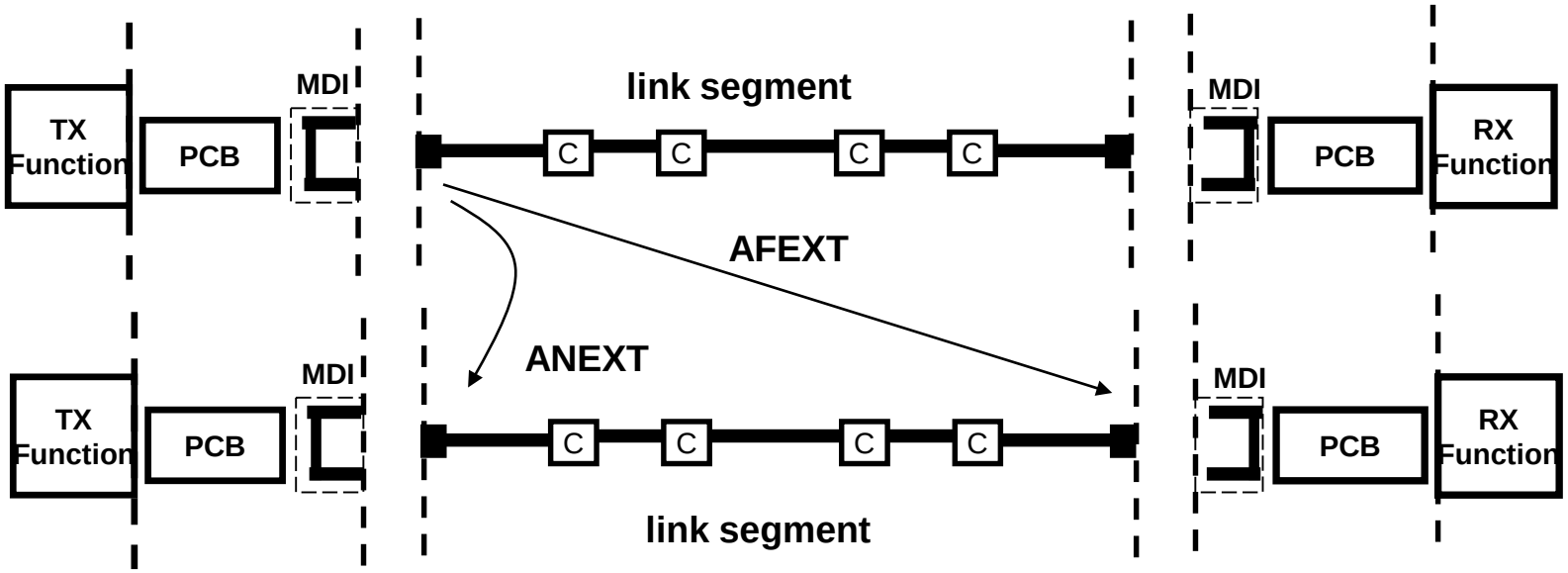
Figure 147–20—Multidrop line termination and PMA

Conformance



- Active equipment and link segment specified independently
- Compliant TX and RX interconnected with compliant link segment shall meet BER
- Supports interoperability of devices/automotive harnesses from different suppliers
- Testing methods/fixtures for Tx/Rx/MDI electricals not specified
- OPEN Alliance Channel and Components requirements for 1000BASE-T1 Link Segment Type A Version 2.0 specifies MDI Test head
- PICS Protocol implementation conformance statement (PICS) (requirements-shall meet)

Conformance



PSAACR-F - For multi-disturber AFEXT power summation of AFEXT relative to receive signal

PSANEXT - For multi-disturber ANEXT power summation of ANEXT

- ***Annex 97B (normative) Alien Crosstalk Test Procedure***

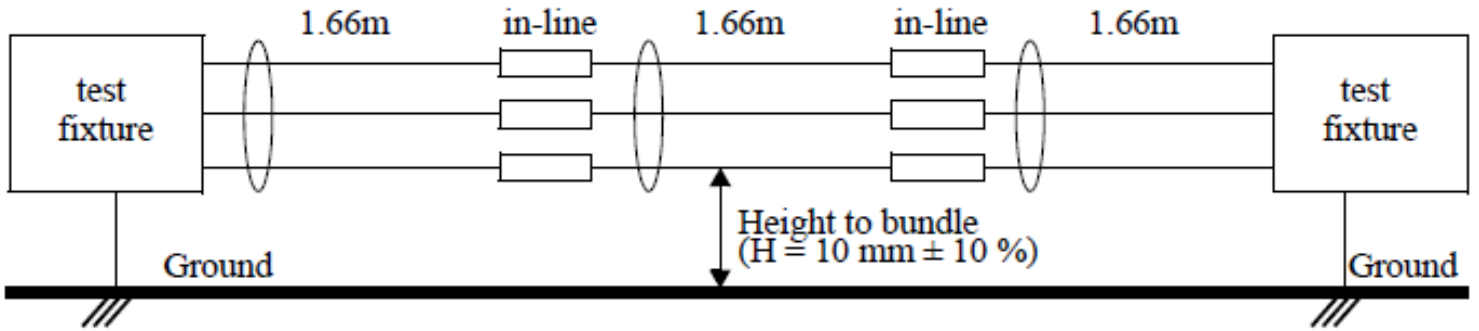


Figure 97B–2—Use Case 1 test configuration

Link Segment – 2.5/5/10GBASE-T1

- Link transmission parameters (up to at least 15 m)
  - Frequency range specified
    - Characteristic impedance
    - Insertion loss - 1 MHz ≤ f ≤ *fmax MHz
    - Return loss
      - 2.5GBASE-T1 - 1 MHz ≤ f ≤ 1000 MHz
      - 5GBASE-T1 - 1 MHz ≤ f ≤ 2000 MHz – RL mag limit is specified in relationship to IL@1.5 GHz
      - 10GBASE-T1 - 1 MHz ≤ f ≤ 4000 MHz – RL mag limit is specified in relationship to IL@3 GHz
    - Coupling Attenuation - 1 MHz ≤ f ≤ 5500 MHz
    - Shielding Effectiveness - 30 MHz ≤ f ≤ *fmax MHz
    - Maximum Link Delay - 2 MHz ≤ f ≤ *fmax MHz
      - Fmax = 4000*s. For 2.5GBASE-T1, S = 0.25; for 5GBASE-T1, S = 0.5; and for 10GBASE-T1, S = 1.

Link Segment – B10GAuto

- Link transmission parameters (up to at least TBD m)
  - Characteristic impedance (100 ohms)
  - Insertion loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
  - Return loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
  - Coupling Attenuation (TBD) - TBD MHz ≤ f ≤ TBD MHz
  - Shielding Effectiveness (TBD) - TBD MHz ≤ f ≤ TBD MHz
  - Maximum Link Delay (TBD) - TBD MHz ≤ f ≤ TBD MHz
- Coupling parameters between link segments
  - Power sum alien near-end crosstalk (PSANEXT) -(TBD) - TBD MHz ≤ f ≤ TBD MHz
  - Power sum alien attenuation to crosstalk ratio far-end (PSAACR-F) - (TBD) - TBD MHz ≤ f ≤ TBD MHz

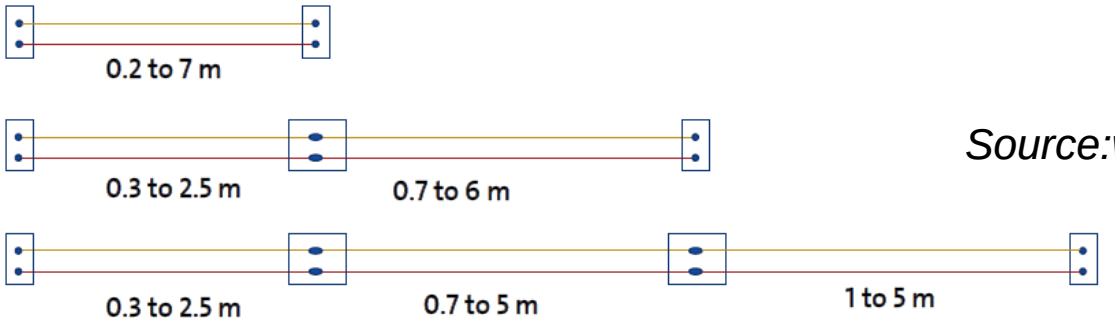
Link Segment – SNR

- Technical feasibility – SNR
  - Link transmission parameters (up to at least TBD m)
    - Insertion loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
      - Topology – length, number of inline connectors
      - Wire gauge
      - Operating temperature
  - Noise environment –
      - Electromagnetic environment (shielding considerations),
      - Alien crosstalk - Topologies

Main application spaces - Topologies

Backbone / Displays

- Contain 0, 1 or 2 in-line connections
- Are 0.2 m to 7.0 m in total length (not all combinations of the below lengths are possible)
  - Note: Segment lengths will vary by at least 10%

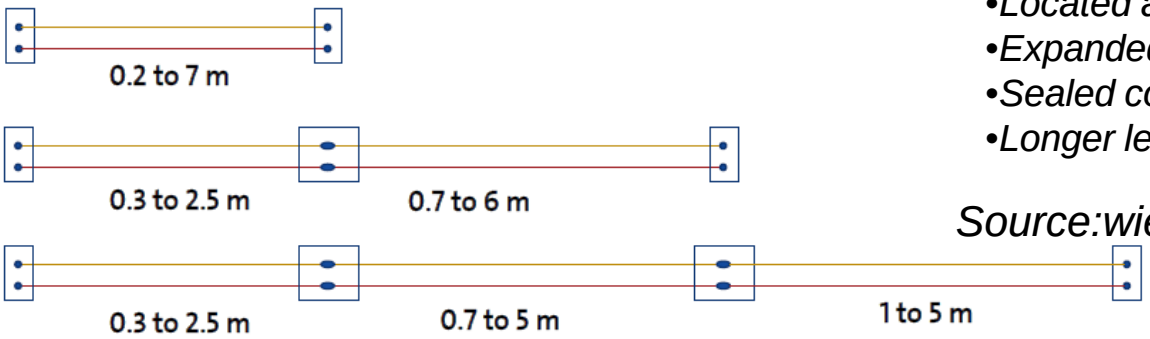


•Located in the passenger compartment
•Limited temperature range, -40C to 95C
•Unsealed connectors
•Shorter length

Source:wienckowski_3+10G_01a_0519.pdf

Cameras

- Contain 0, 1 or 2 in-line connections
- Are 0.2 m to 11.0 m in total length (not all combinations of the below lengths are possible)
  - Note: Segment lengths will vary by at least 10%



•Located at "edges" of vehicle
•Expanded temperature range, -40C to 105C
•Sealed connectors
•Longer length

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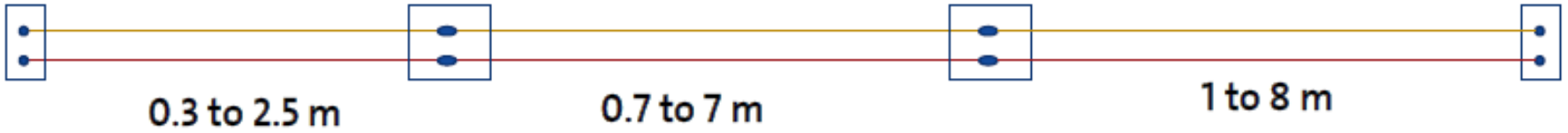
Application space - Topologies

POTENTIAL NETWORKS

- Small percentage of application or requested for future flexibility
- Contain 3 or 4 in-line connections
- Are 11 m to 15.0 m in total length (not all combinations of the below lengths are possible)
  - Note: Segment lengths will vary by at least 10%
- Requested by OEMS who haven't investigated use cases



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Application spaces – Topologies - SNR

- Backbone display
  - Link transmission parameters (up to at least 7 m)
    - Insertion loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
      - 2 inline connectors
      - Wire gauge (TBD)
      - Operating temperature -40C to 95C,
  - Coupling between link segments
    - Shielded cables
      - dB Isolation (>60 dB – TBD)
- Cameras
  - Link transmission parameters (up to at least 11 m)
    - Insertion loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
      - 2 inline connectors
      - Wire gauge (TBD)
      - Operating temperature -40C to 105C,
  - Coupling between link segments
    - Shielded cables
      - dB Isolation (>60 dB – TBD)

Application spaces – Topologies - SNR

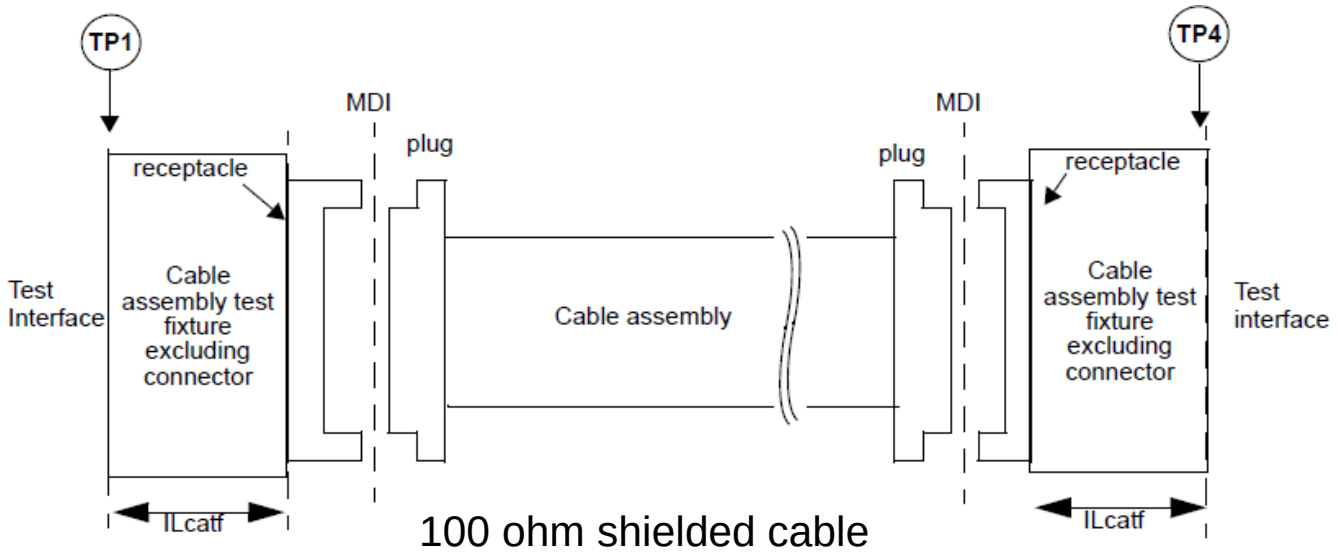
- Potential Networks
  - Link transmission parameters (up to at least 11-15 m)
    - Insertion loss (TBD) - TBD MHz ≤ f ≤ TBD MHz
      - 3 or 4 inline connectors
      - Wire gauge (TBD)
      - Operating temperature -40C to TBD C,
  - Coupling between link segments
      - Shielded cables
        - dB Isolation (>60 dB – TBD)

IEEE Standards - 25/50 Gb/s Operation – Shielded Cable

100GBASE-CR4 - 2-level PAM - 25.78125 GBd per lane – Channel loss budgets 12.8906 GHz, Link Segment 19 GHz. Up to at least 5 m

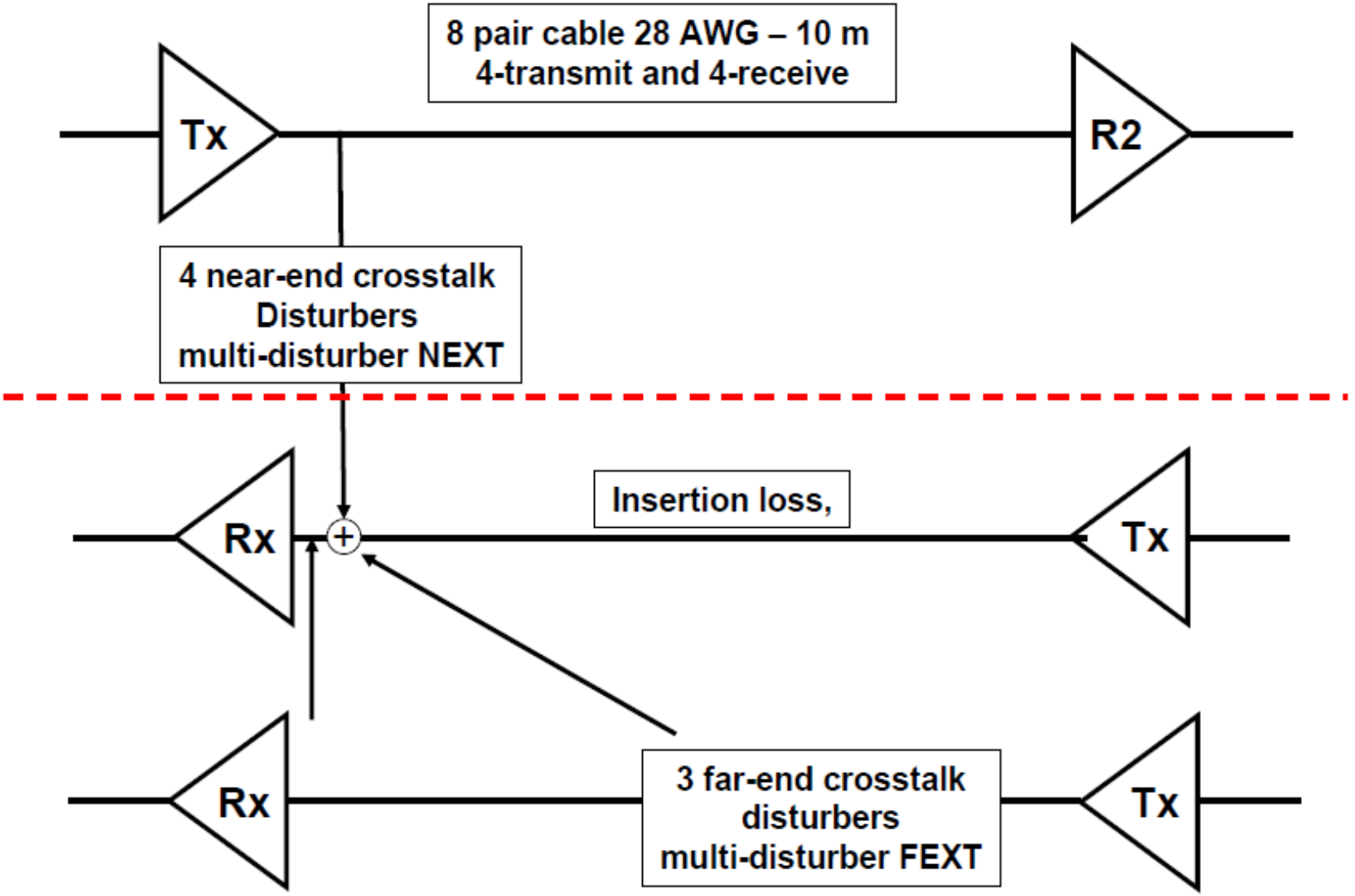
25GBASE-CR - 2-level PAM - 25.78125 GBd per lane – Channel loss budgets 12.8906 GHz, Link Segment 19 GHz. 3-5 m reach depending on FEC

50GBASE-CR – PAM4 - 26.5625 GBd per lane – Channel loss budgets 13.28 GHz, Link Segment 19 GHz. of at least 3 m reach



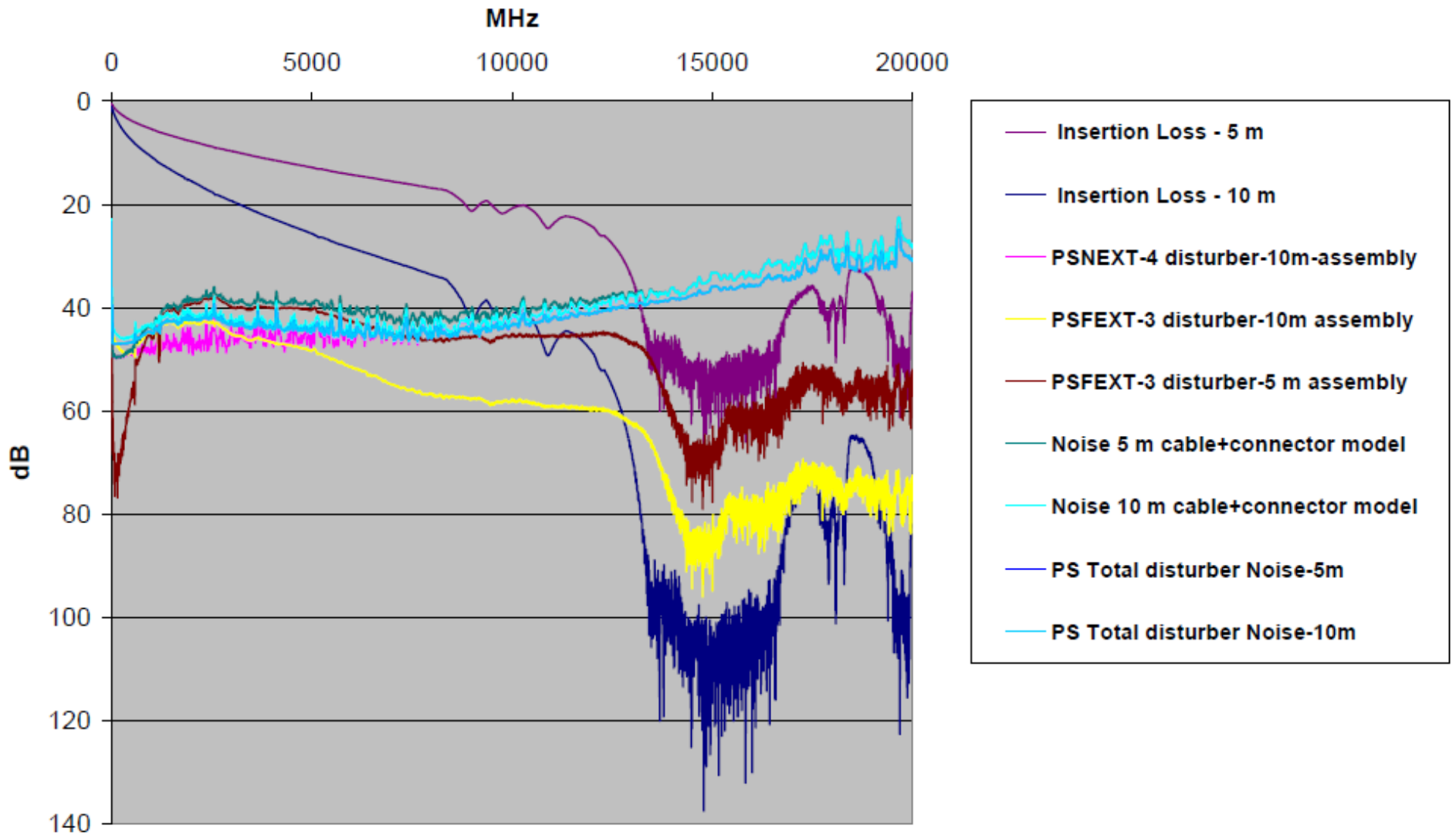
100 ohm shielded cable

Analysis: Copper Interconnect S-parameters



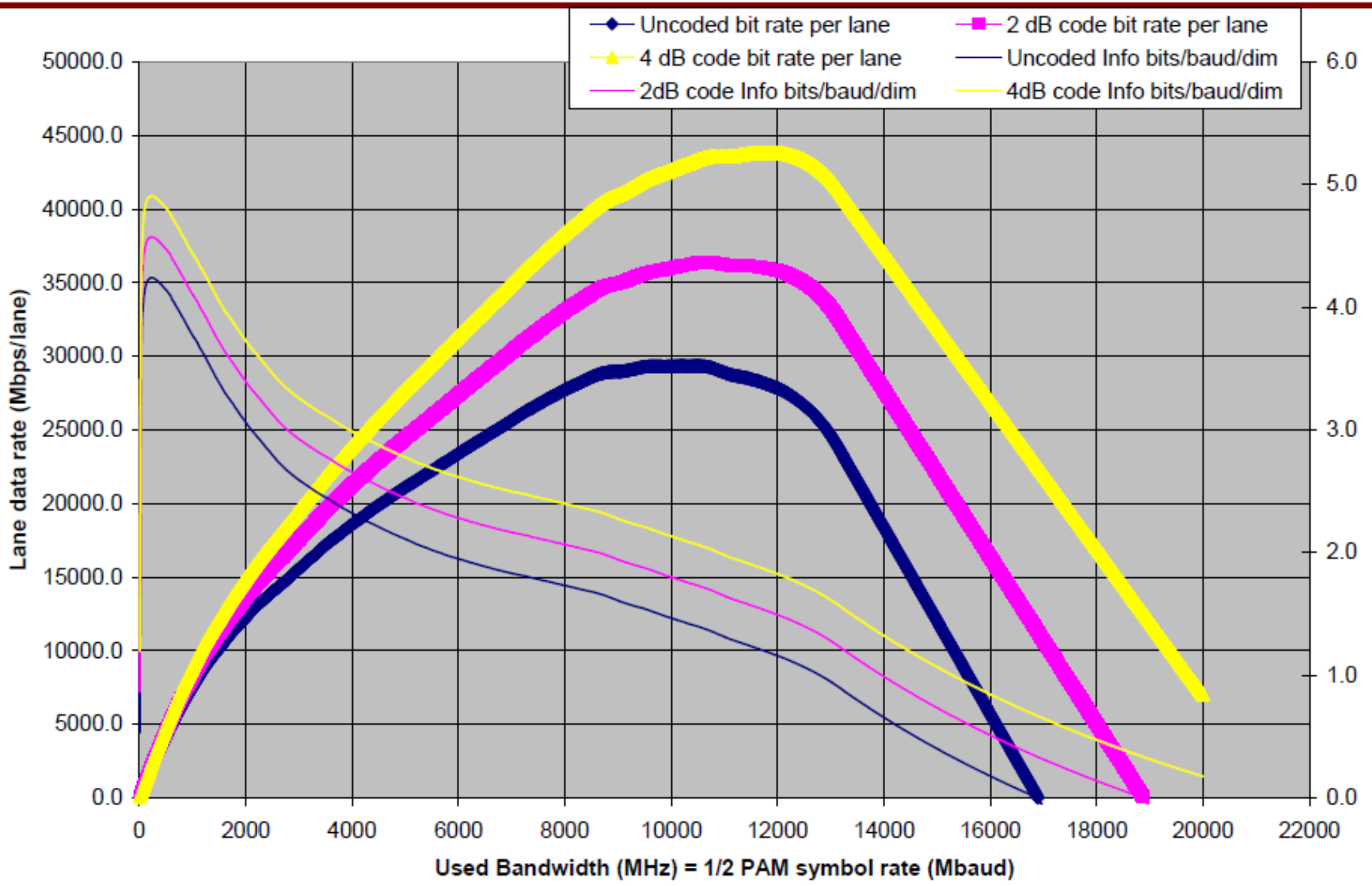
http://www.ieee802.org/3/hssg/public/nov06/diminico_02_1106.pdf

Interconnect Transmisson Characeristics



http://www.ieee802.org/3/hssg/public/nov06/diminico_02_1106.pdf

Lane Rate vs. 1/2 PAM symbol rate
6 dB Margin, 5m cable + connectors



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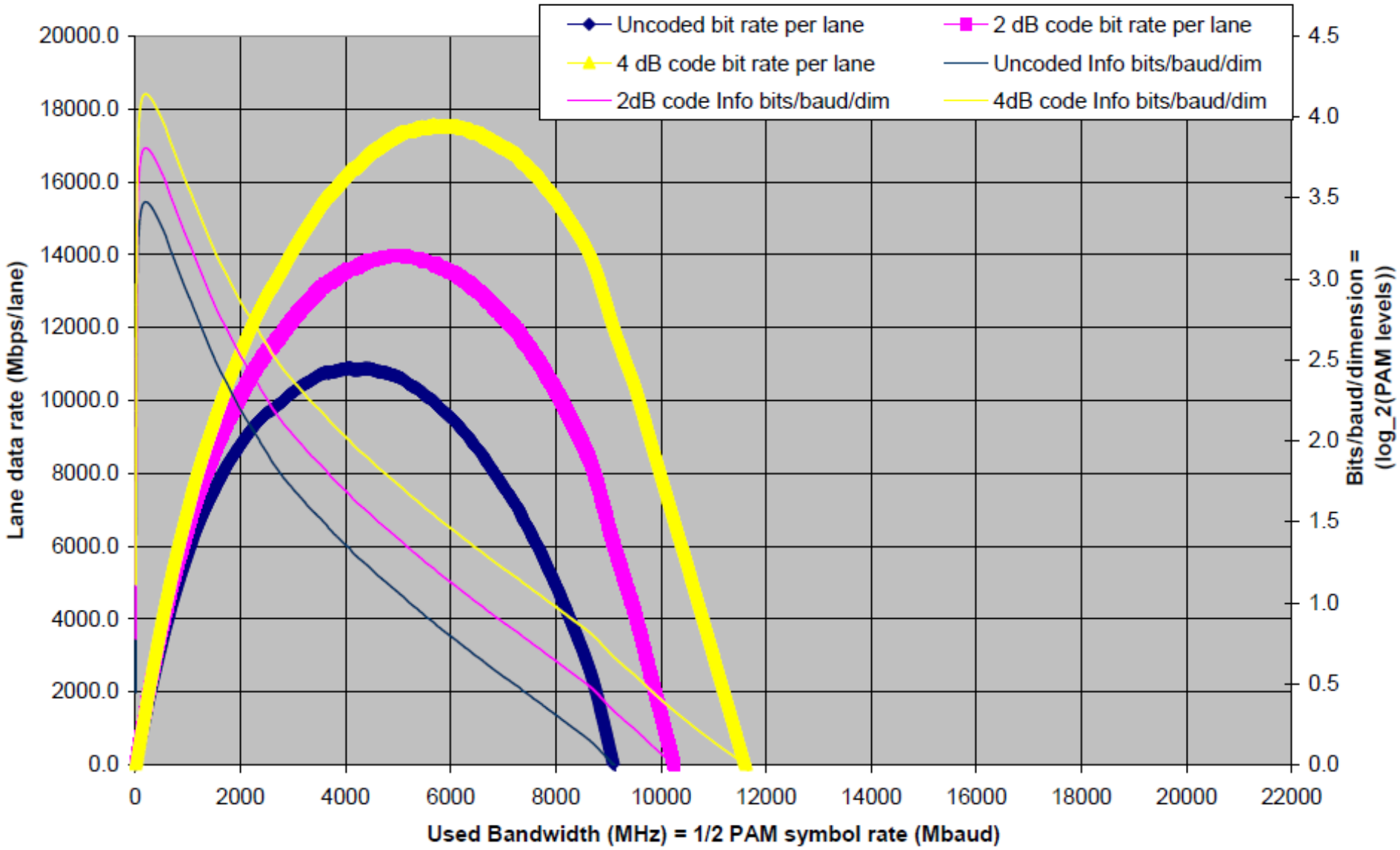
Lane Rate vs. 1/2 PAM symbol rate
6 dB Margin, 10m cable+connectors



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B10GAuto – (TBD) 25 Gb/s Operation

- (TBD) 25GBASE-T1 – PAM4 - 12.5 GBd per lane – Channel loss budgets 6.25 GHz, Link Segment .75*GBd (9.5 GHz) up to at least 7 m-11 m (11 m-15 m) reach

Summary

- **Considerations for Greater than 10 Gb/s Automotive Ethernet Link Segment**
- **Considerations for technical feasibility**