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802.3cy Ingress Noise Measurement Results

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Scope

- Ingress noise, coupling from external sources into the channel is one of the primary factors on SNR
- This presentation shows the ingress noise into an automotive STP link segment up to 3 GHz by means of antenna measurement (ALSE method) according to ISO 11452-2 (previous results in farjarad_3ch_01b_0918.pdf and mueller_3ch_03_0518.pdf)
- Primary intent is to present data for differential and common mode ingress noise voltage at the MDI connector, for a normalized electrical field strength at different MDI connector shield termination implementations (typical cases of shield termination)
- Secondary aim is to provide a link between the adopted coupling- and screening attenuation baseline proposals and ingress noise (mueller_3cy_01_08_03_21.pdf)

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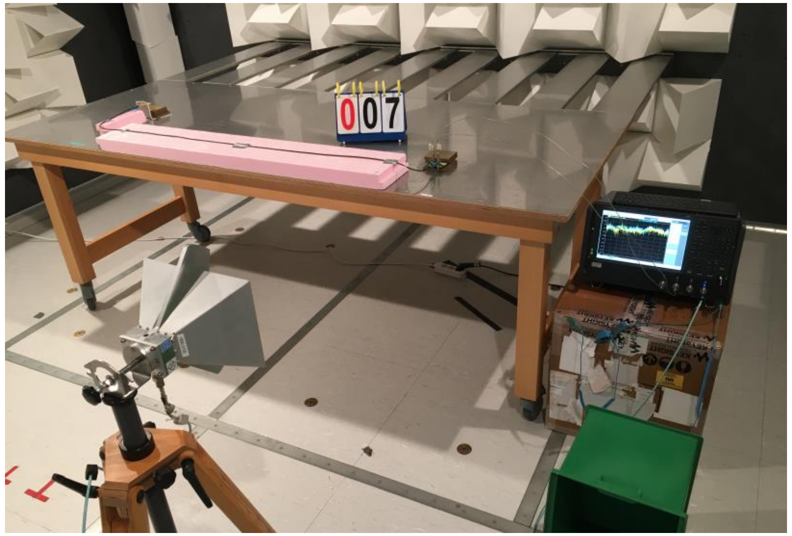
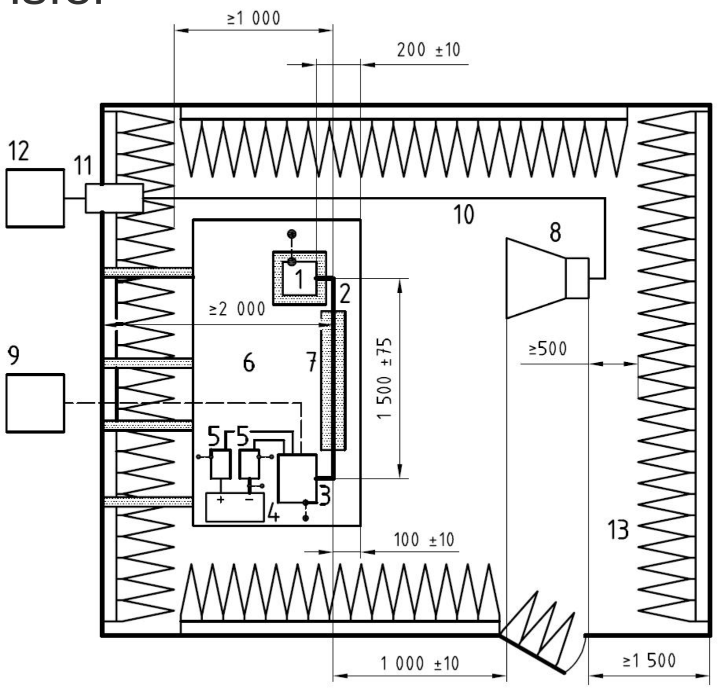
Measurement Setup

- Modified measurement setup based on ISO 11452-2 ALSE method
- Double ridge horn antennas directly pointing at the DUT
- Polarizations horizontal and vertical.
- Instead of measuring with full high field strength, VNA was used to derive full s-parameter with transfer functions in differential- and common mode





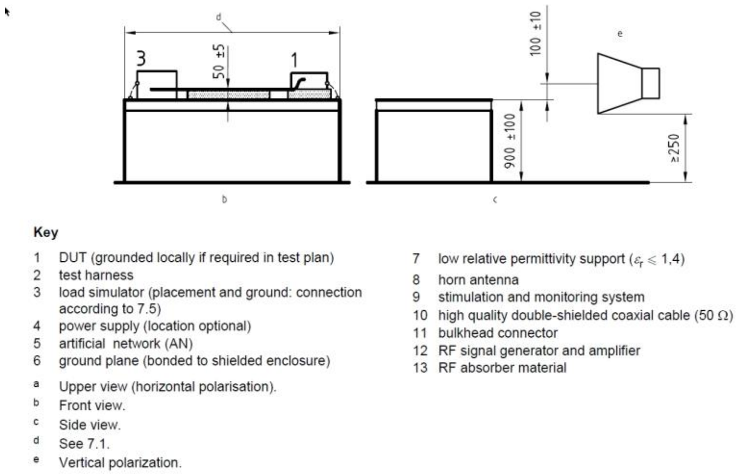


Figure 3 — Example test set-up for frequencies above 1 GHz — Horn antenna

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Measurement Setup

- Modified measurement setup based on ISO 11452-2 ALSE method
- Double ridge horn antennas directly pointing at the DUT with polarizations horizontal and vertical.
- Instead of measuring with full high field strength, VNA was used to derive full s-parameter with transfer functions in differential- and common mode
- Electrical field strength of 1 V/m between 1 GHz and 9 GHz, calibrated with generator and field probe and scaled to 100 V/m

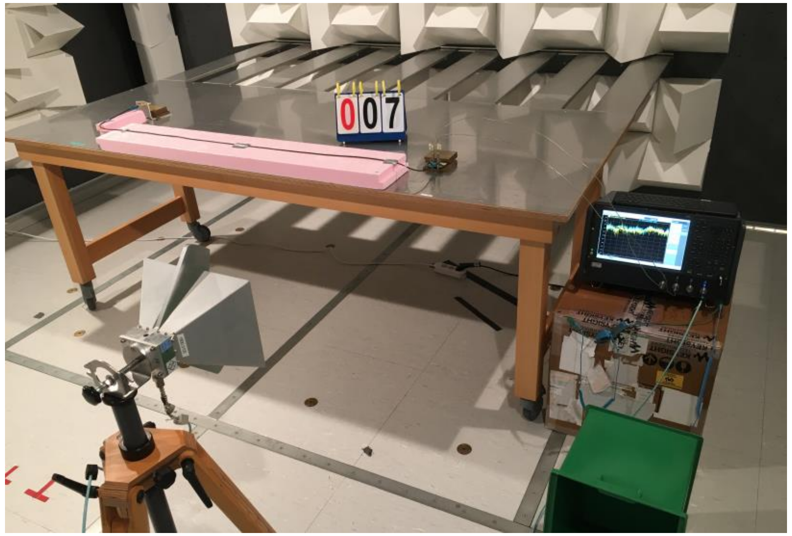
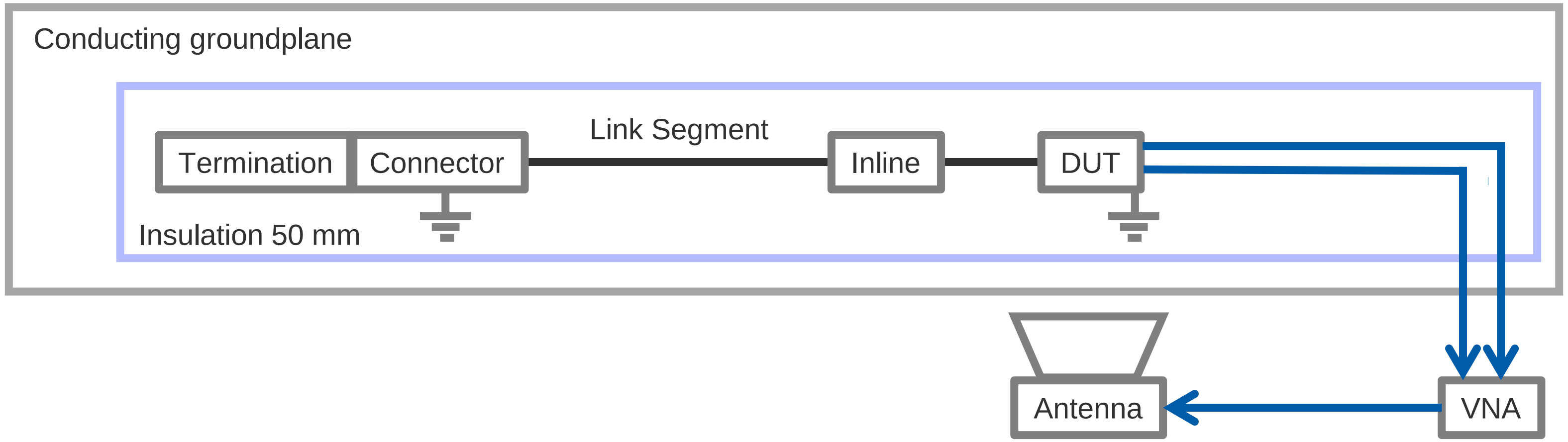


Table C.1 — Suggested test severity levels

Test severity level	Value V/m
I	25
II	50
III	75
IV	100
V	Specific value agreed between the users of this part of ISO 11452, if necessary



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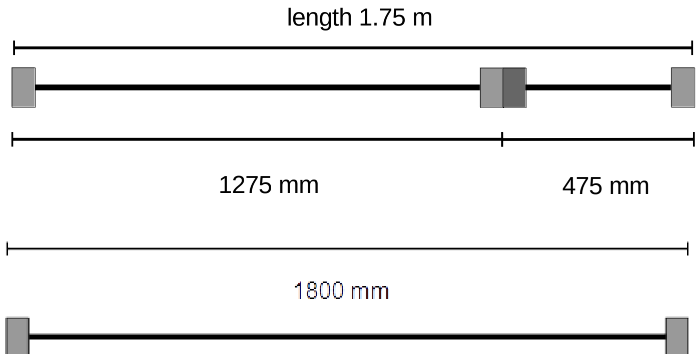
Measurement setup

Link segments under test:

- DUT 1 0.475 m + 1.275 m STP link segment, inline located at DUT side
- DUT 10 1.8 m STP cable assembly without inlines



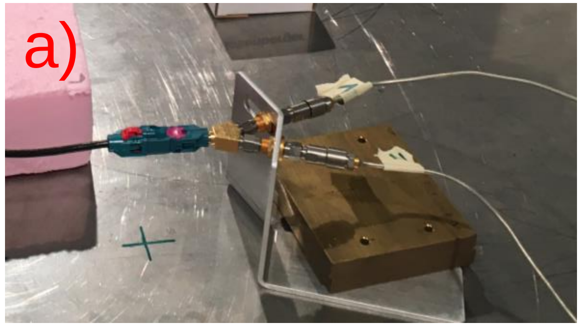
Shield termination scenarios:

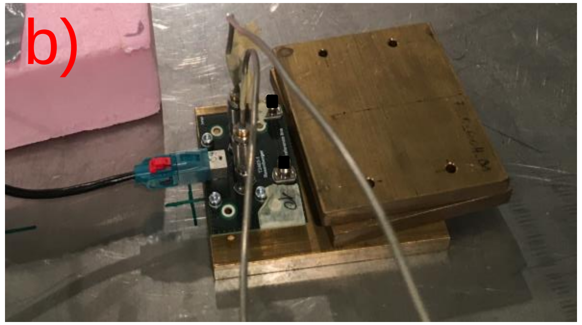
a) Ideally shielded test fixtures to reproduce perfect shield termination at the MDI with direct contact to shielded enclose.

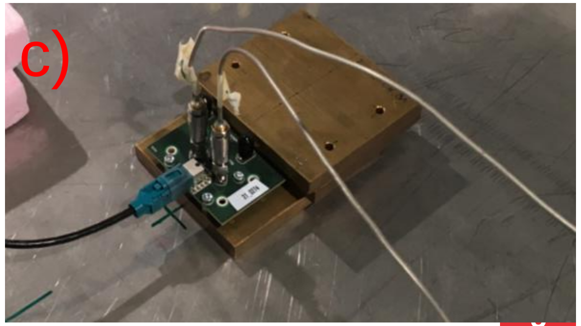
b) PCB test fixture with DC shield termination without shielded enclosure.

c) PCB test fixture with AC shield termination with high number of capacitors. Lower number of capacitors reduces complexity but also shield termination quality.

- Far end always ideally terminated like a)







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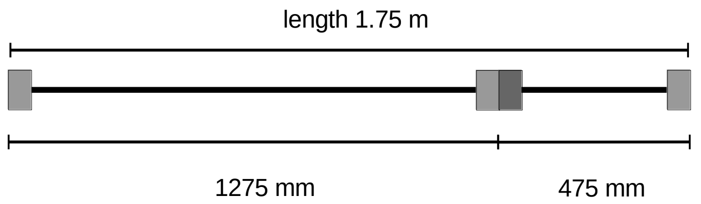
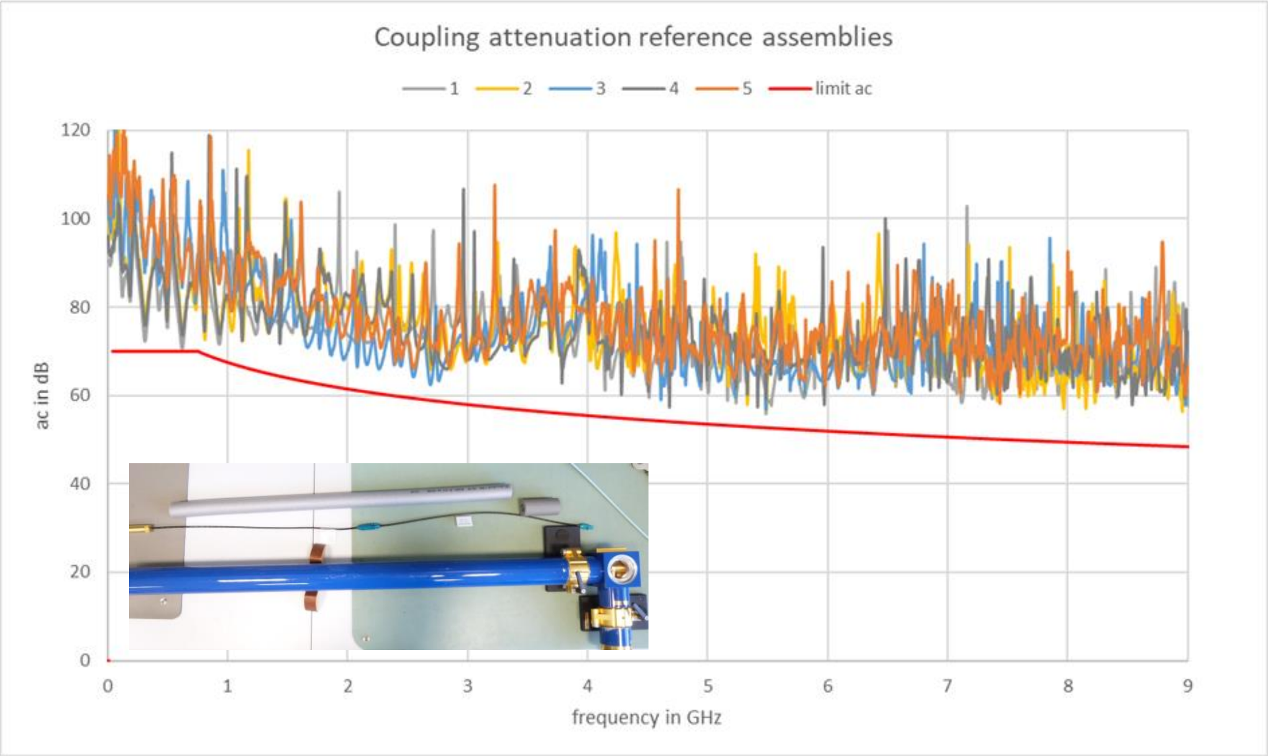
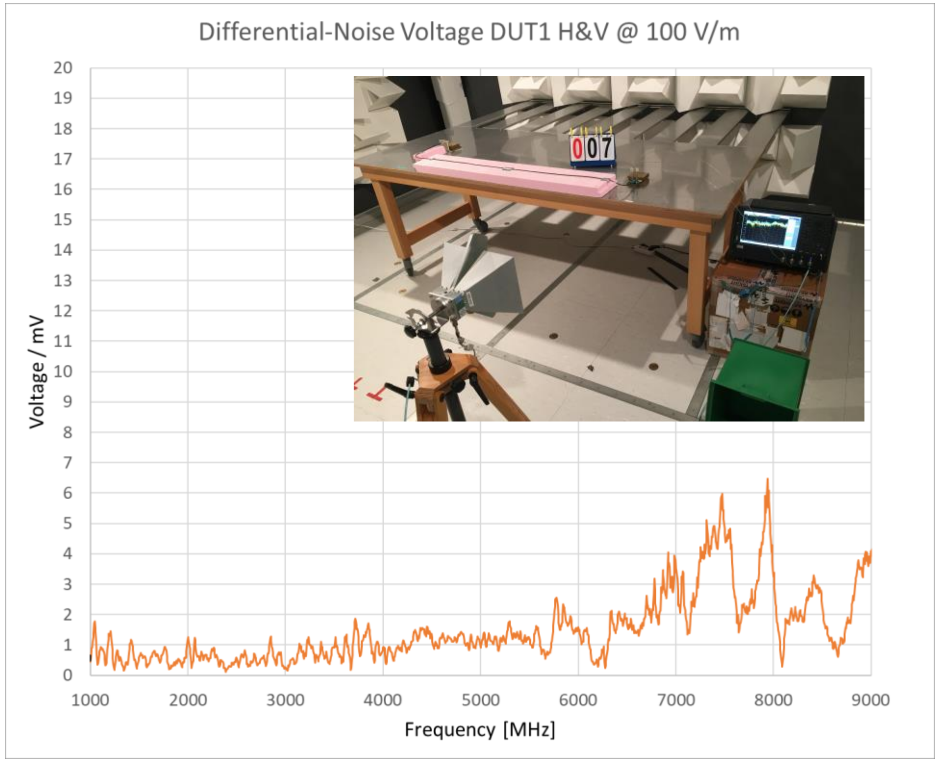
Measurement results

- Comparison of coupling attenuation vs. differential noise at 100 V/m
- Identical link segment DUT tested in the triaxial setup before (5 samples) with ingress noise at ideal shield termination a) (DUT1)
- Maximum rms ingress voltage with vertical and horizontal antenna polarization combined







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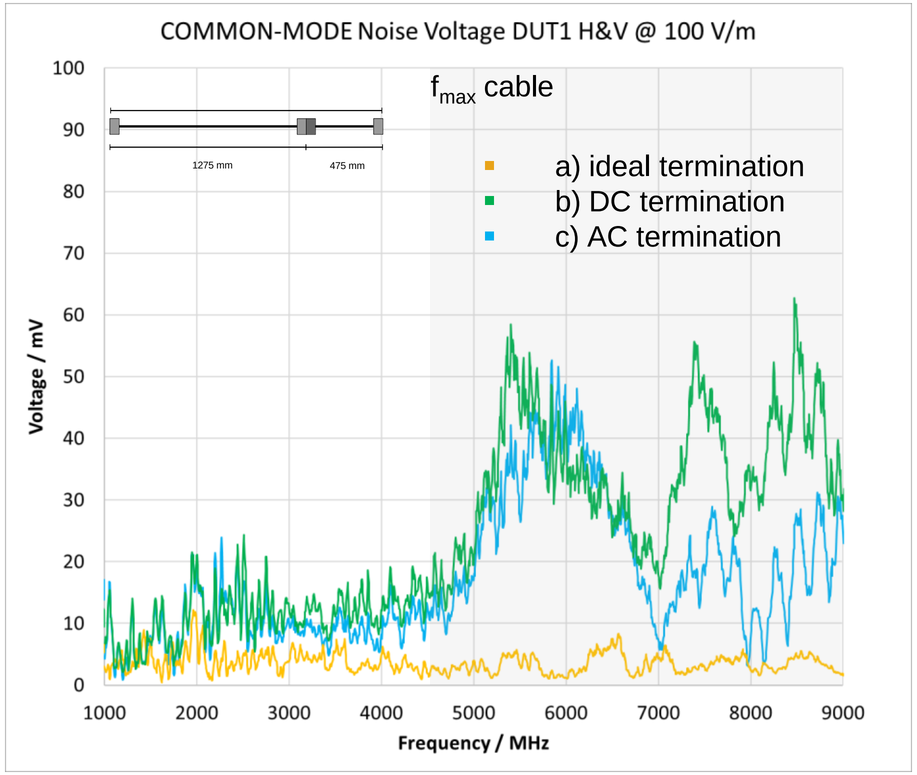
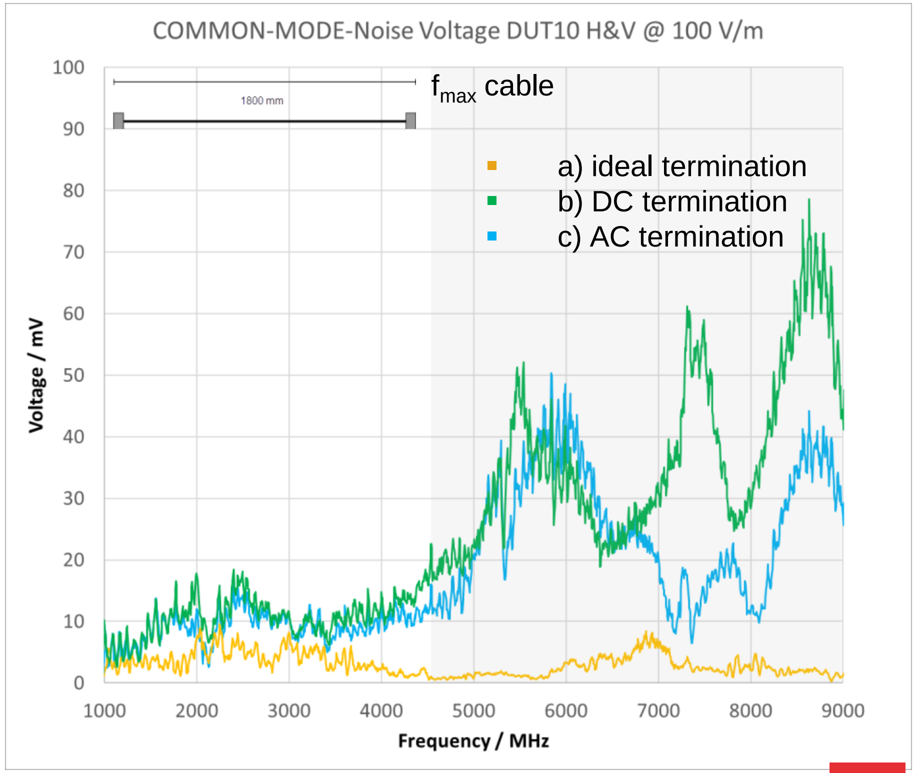
Measurement results

- Common mode ingress noise at 100 V/m below 80 mV_{rms} between 1 GHz and 9 GHz
- Increase above 5 GHz due to finite screening of the PCB, potential influence of f_{max} of the cable due to increased mode conversion.
- Ideal termination much better than PCB due to contiguous shielding along the whole link (better screening beyond the connector interface on the device).
- Ideal termination represents best configuration achievable with the specific cable and connector type under test, using shielded enclosure and EMC sealed connector in practical application





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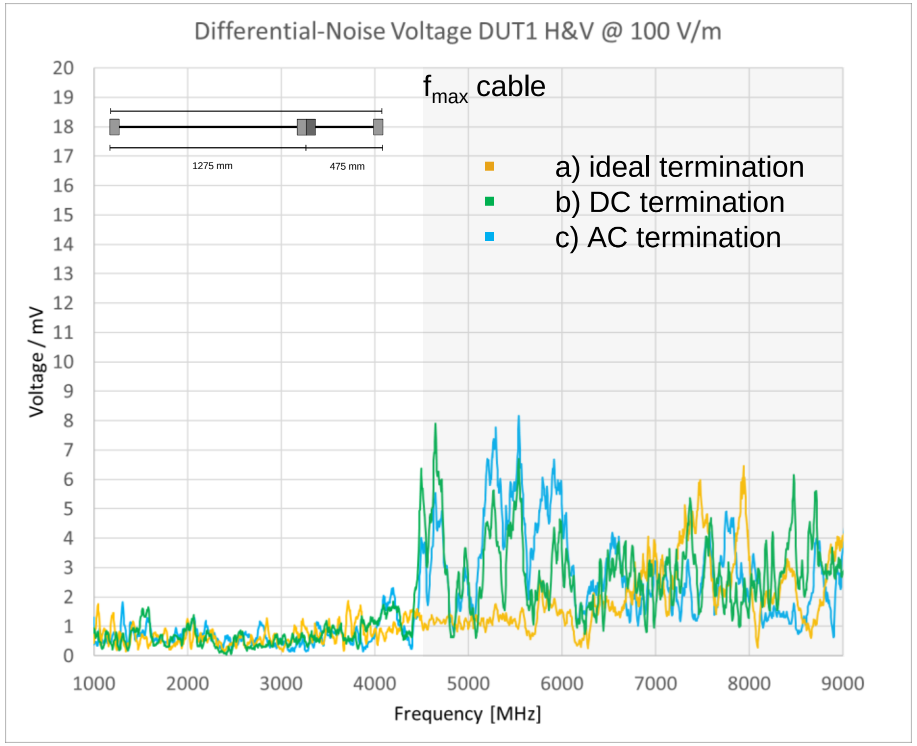
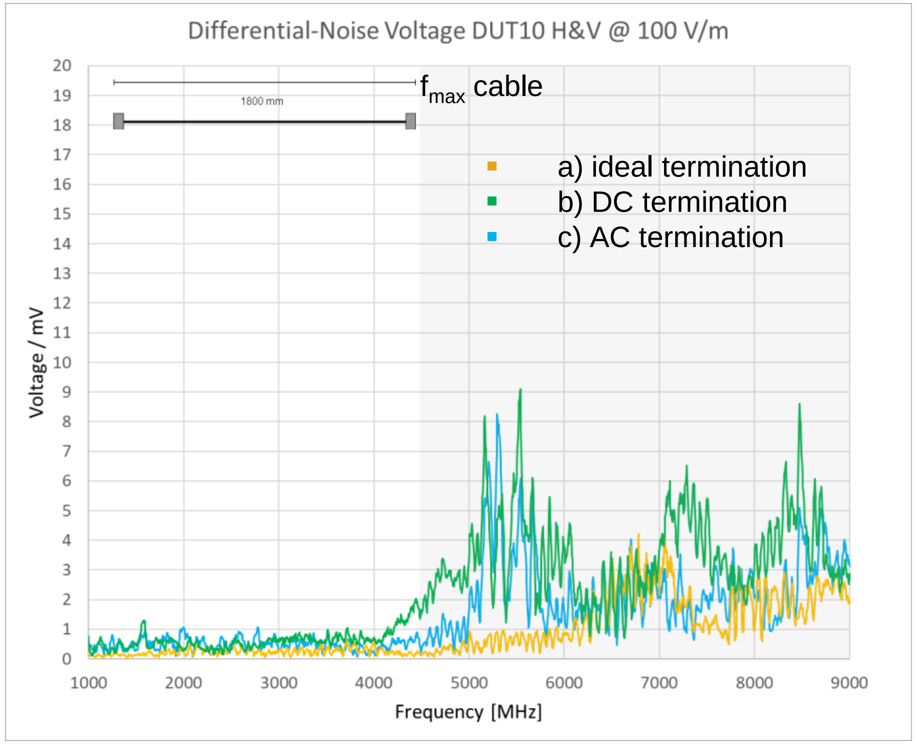
Measurement results

- Differential ingress noise at 100 V/m below 10 mV_{rms} between 1 GHz and 9 GHz
- Ideal termination in overall better, but both PCB based terminations hold up quite well
- Comparable results for DC and AC terminations





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Summary

- The link segment under test that passes the adopted coupling attenuation baseline proposal showed a differential noise of <10 mV_{rms} and common mode noise of <80 mV_{rms} at 100 V/m between 1 GHz and 9 GHz in the presented measurement setup.
- The ideally shielded case represents a best case shield termination implementation with shielded enclosure and EMC sealed connector, which may serve as reference as reference. Feedback whether the levels of ingress noise are acceptable is welcome.
- Higher noise levels may occur at frequencies <1 GHz, when the cable assembly is in resonance at e.g. ½ the wavelength (not part of this presentation, see previous presentations from 802.3ch).
- The defined coupling attenuation baselines cover the link segment including the PCB header itself and its transition to the PCB. The quality of the shield termination implementation on the device affects the overall EMC performance of the subsystem. Factors include e.g. layout and routing of traces on the PCB, quality of AC shield termination, contact points to a shielded enclosure and external grounding of the ECU. These effects are considered as implementation and the designer of a device should consider them for EMC robust design.