IEEE 802.3dg Task Force

100BASE-T1L Coupling Attenuation

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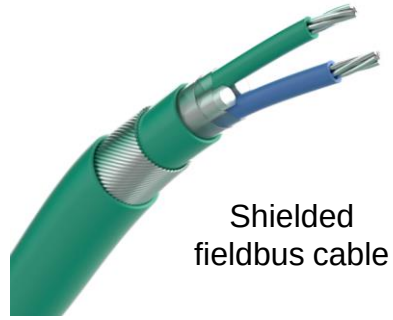
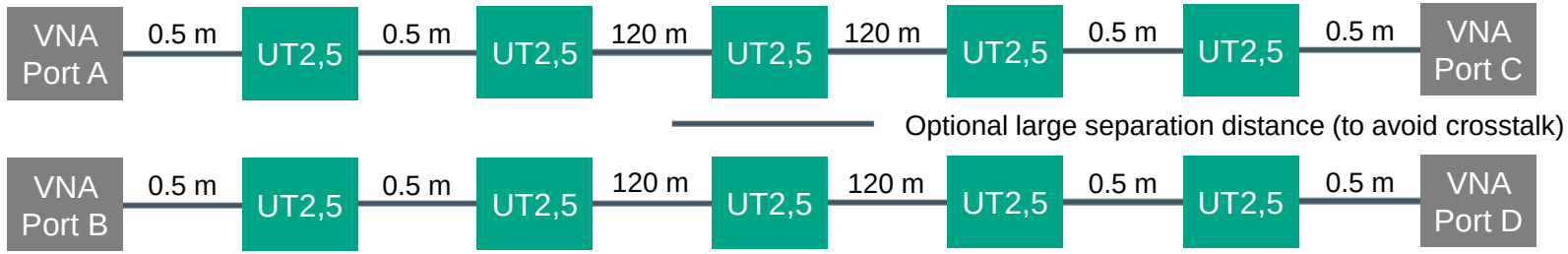
Link Segments

- Previously three different link segments, using shielded cables have been measured, see presentation https://www.ieee802.org/3/dg/public/May_2022/graber_3dg_01_03152023.pdf
- From the RAW data of these measurements the TCL (mode conversion) values have been calculated.
- Below the different link segments are shown again:

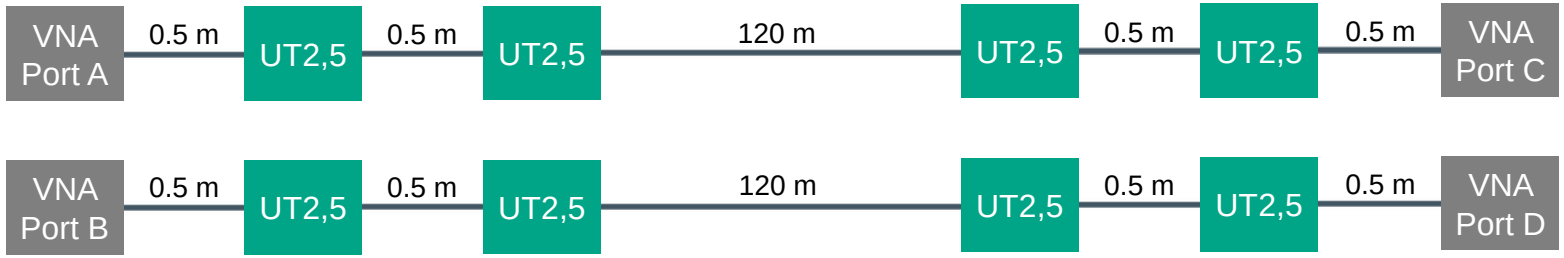


Shielded fieldbus cable

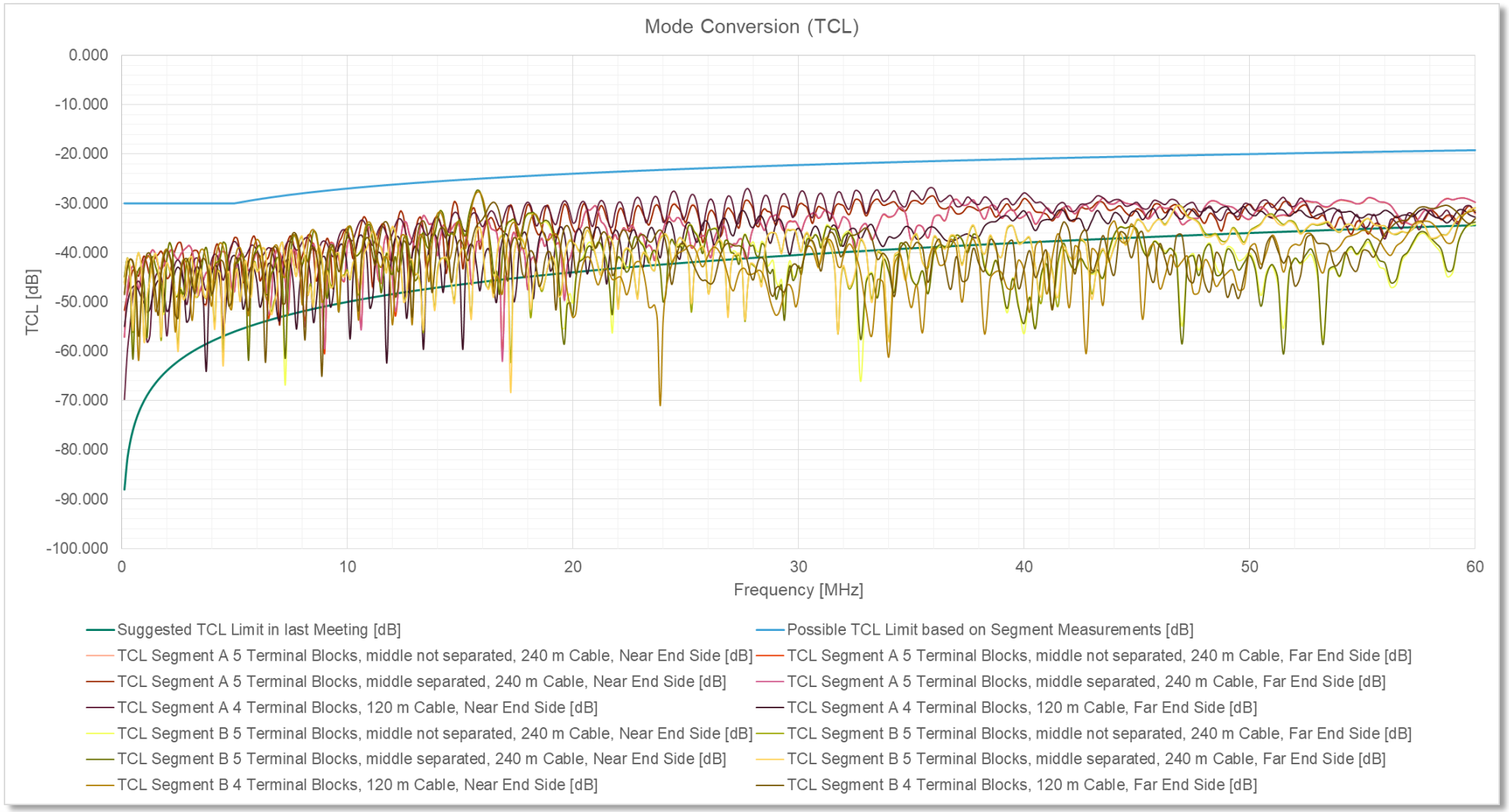
5 terminal blocks (240 m):



4 terminal blocks (120 m):

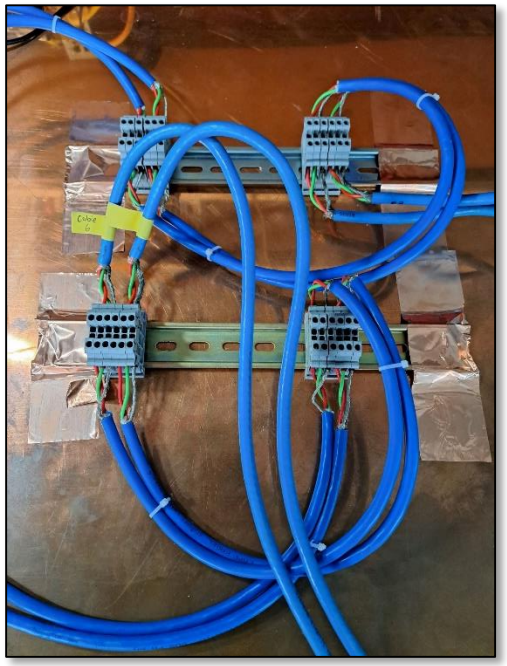


Measured Mode Conversion (TCL)



Measured Mode Conversion (TCL)

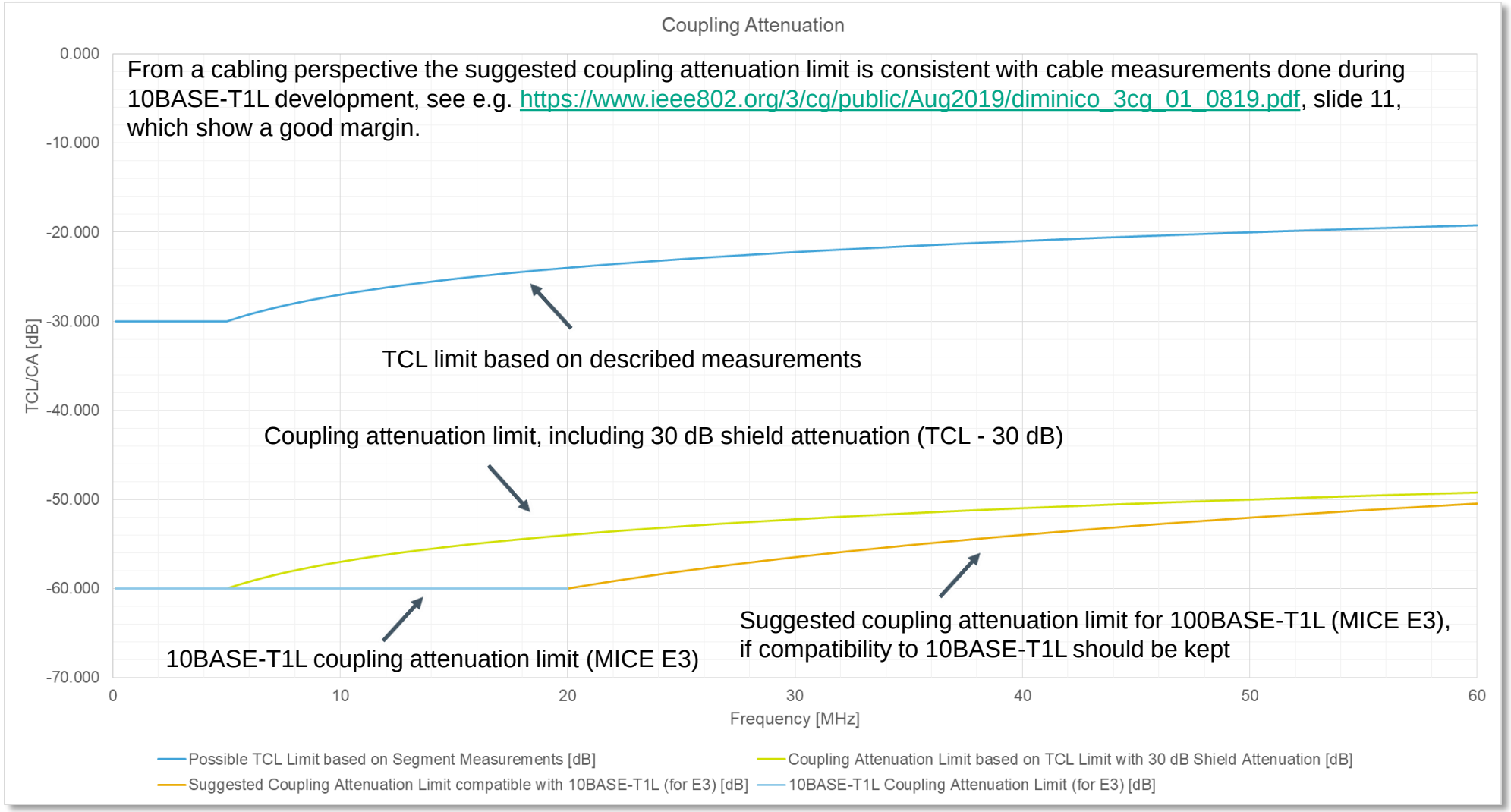
- The measurements show, that there is a difference between segment A (left segment, red colored curves) and segment B (right segment, yellow colored curves).
- This difference is related to the connector pinout (+, -, S), see picture.
- Segment A is having no neighbor segment left to it, providing a shield reference.
- Segment B is having segment A as neighbor on the left side and thus the data pair is seeing a shield reference on both sides (S, +, -, S), providing better TCL values.
- The TCL measurements show worse values, than what was suggested during the last meeting (green curve, TCL [dB] = 50 – 20 * log10(f / 10), with f in MHz from 0.1 to 60 MHz).
- Providing a fitting to the measurements with a little margin leads to:



$$TCL[dB] = \begin{cases} 30 & for\ 0.1\ MHz \leq f < 5\ MHz \\ 27 - 10 \times log\left(\frac{f}{10}\right) & for\ 5\ MHz \leq f \leq 60\ MHz \end{cases}$$

- For shielded link segments often instead of the mode conversion (TCL) the coupling attenuation (mode conversion + shield attenuation) is used.
- Assuming a shield attenuation of minimum 30 dB leads to the coupling attenuation limits shown on the next slide.
- Fieldbus Type A cables typically have a braided (tinned) copper shield with at least 90 % shield coverage, so it can be expected that they even provide a higher shield attenuation than 30 dB (30 dB is still assumed to be a “light” shielding).

Coupling Attenuation Limit



Summary

- If compatibility with 10BASE-T1L (which uses even more inline terminal blocks and the same cable) should be kept, this requires 60 dB coupling attenuation up to 20 MHz (for E3) and typically the coupling attenuation increases with 20 dB/decade.
- Therefore it is suggested to use the following limit for the coupling attenuation for MICE E3 environments:

$$Coupling\ Attenuation[dB] = \begin{cases} 60 & for\ 0.1\ MHz \leq f < 20\ MHz \\ 60 - 20\ \times\ log\left(\frac{f}{20}\right) & for\ 20\ MHz \leq f \leq 60\ MHz \end{cases}$$

- For a MICE E1/E2 environment it is suggested to reduce the coupling attenuation requirement by 10 dB compared to a MICE E3 environment (as for 10BASE-T1L):

$$Coupling\ Attenuation[dB] = \begin{cases} 50 & for\ 0.1\ MHz \leq f < 20\ MHz \\ 50 - 20\ \times\ log\left(\frac{f}{20}\right) & for\ 20\ MHz \leq f \leq 60\ MHz \end{cases}$$

- Do not additionally specify the mode conversion (TCL) for shielded link segments, as this is part of the coupling attenuation (mode conversion + shield attenuation) already.
- Currently for 10BASE-T1L (which we often take as reference) there are only very limited data from practical installations available (the tests have so far been done in demonstration/lab environments), as e.g. in the process automation world the deployment of field devices just starts.
- **Therefore it is important to get feedback as early as possible from upcoming real world installations.**

Thank you!