IEEE P802.3cg 10BASE-T1S Insertion Loss and Dielectric Properties

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Purpose

- The purpose of this presentation is to:
  - Describe implementation experience related to 10BASE-T1S mixing segment cables
    - Importance of considering the Dielectric Loss
  - Raise the concern for consideration within:
    - IEC TR 11801-9906 ED1
      - Annex E (Conductor size effects for reduced Insertion loss)

10BASE-T1S Assumption

- The IL for 10BASE-T1L is the same for:
  - Link segment @ 15 m
  - Mixing segment @ 25 m

- The assumption is that increased conductor AWG can be used to compensate for the increased reach
  - The PHY can have similar transmit levels and receive sensitivity

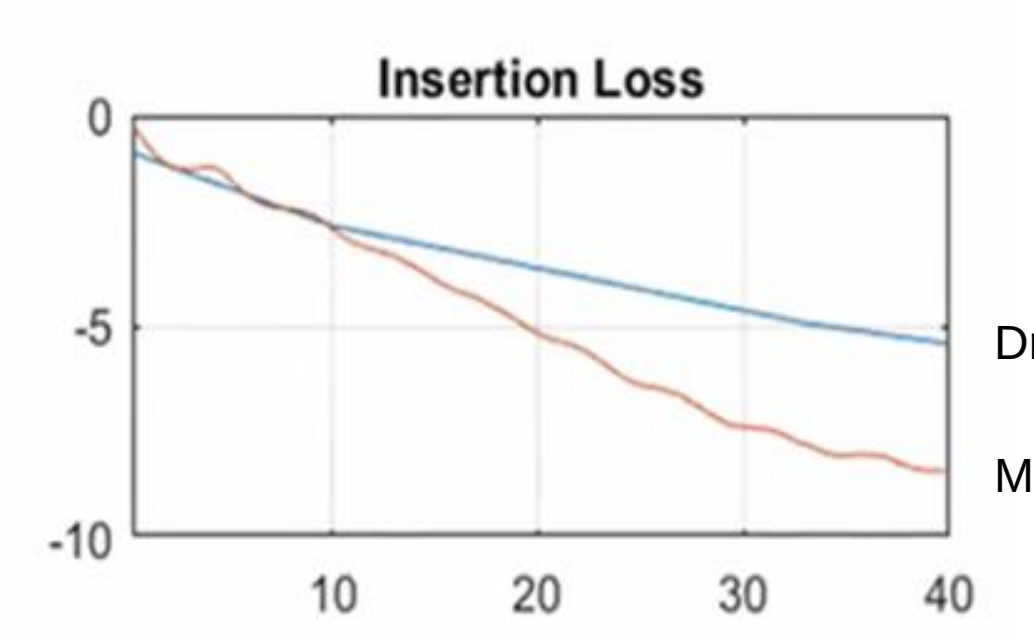
Rule-of-Thumb Validity

- The common wisdom is that the skin effect copper losses dominate and the dielectric losses can generally be ignored.
  - This assumption appears to be naïve with respect to IEEE P802.3cg.

- Excessive IL was found in sample cables.
- Simulations of PVC materials show that the Dissipation Factor of real materials can be the largest portion of the IL.

IL for a 10BASE-T1S Mixing Segment

20 AWG

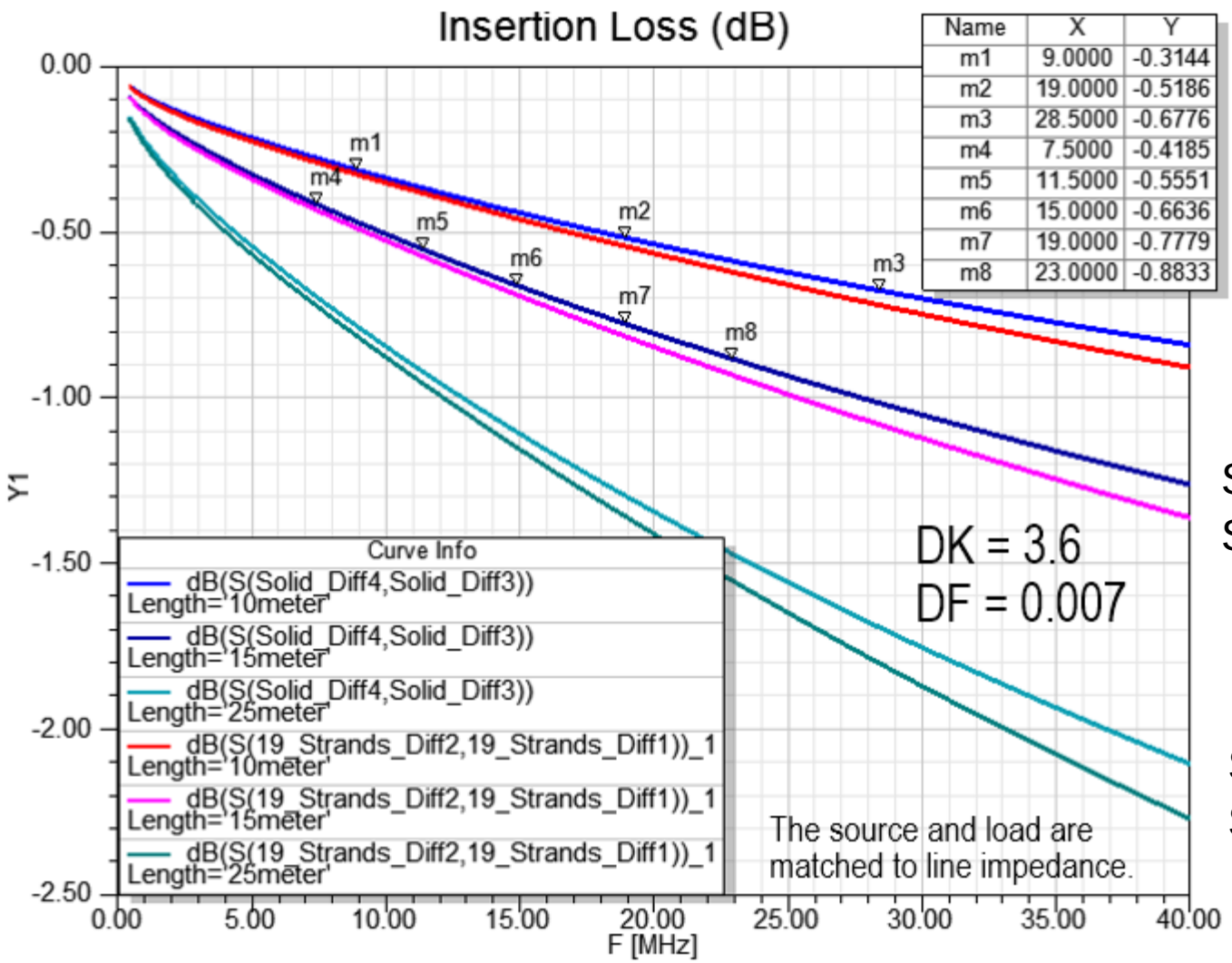


Draft limit

Measurement

- A number of cables were constructed and found to have more insertion loss than allowed, especially at high frequencies

Simulation for DF = 0.007

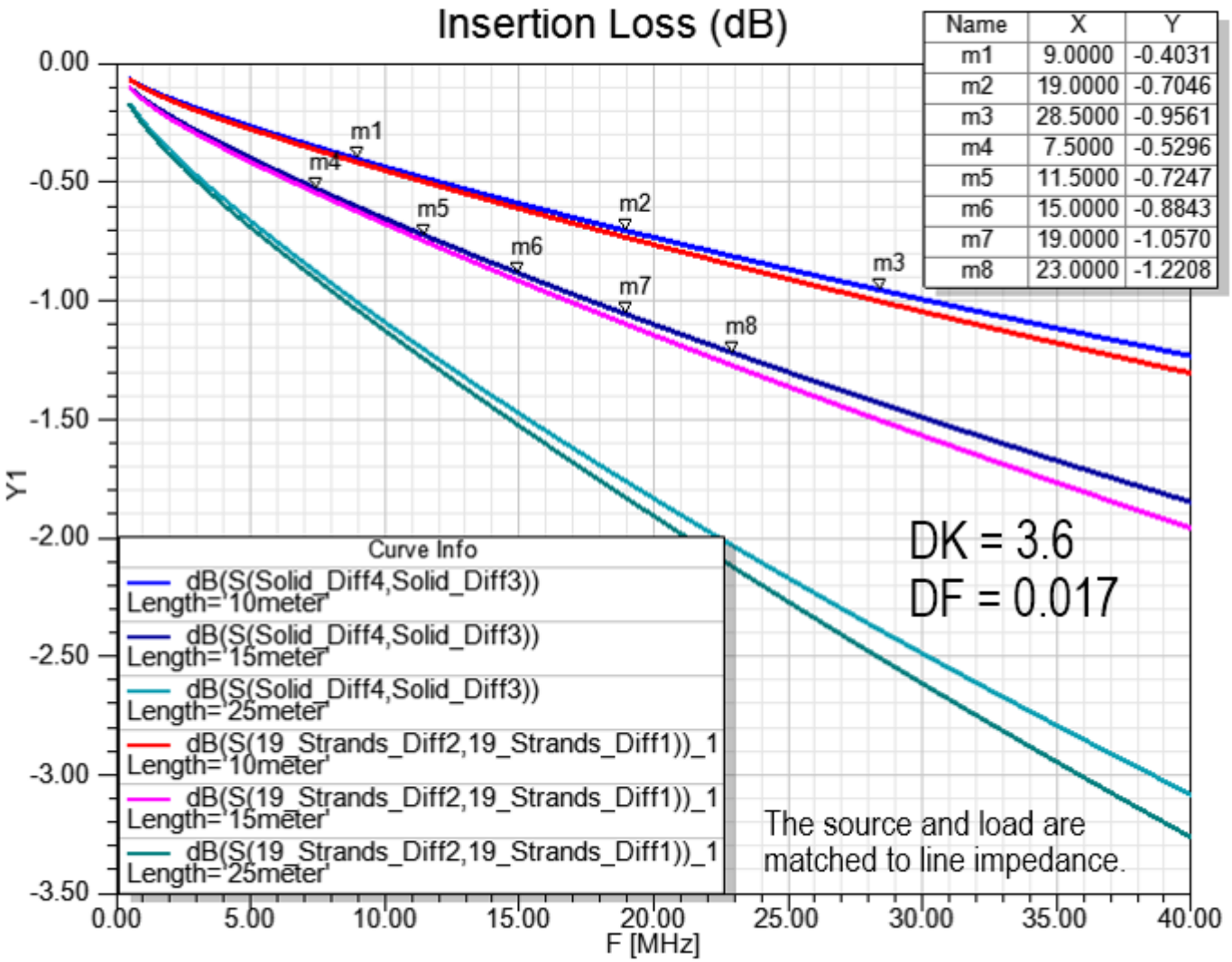


20 AWG

Solid
Stranded
} 15 m

Solid
Stranded
} 25 m

Simulation for DF = 0.017

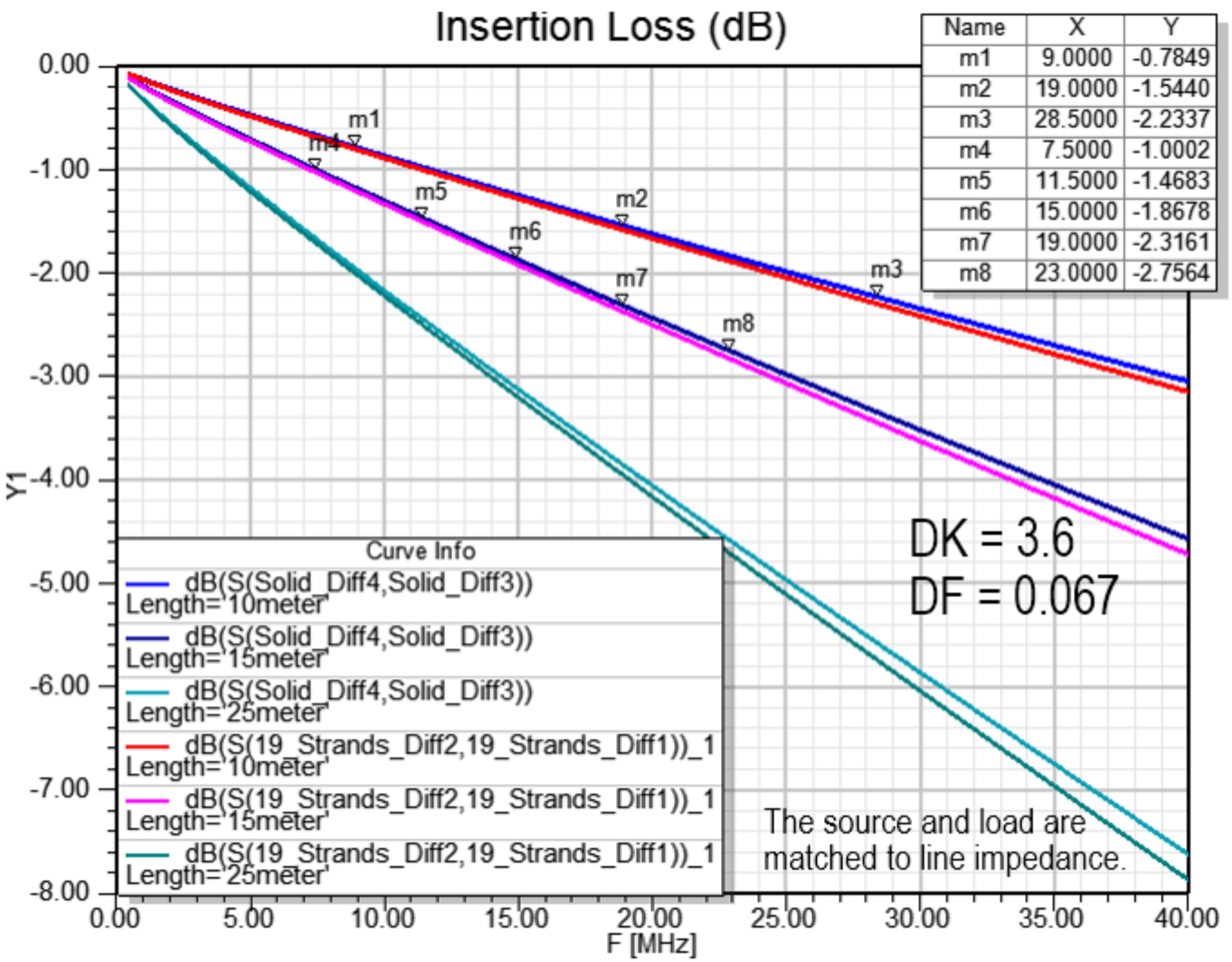


20 AWG

Solid
Stranded
} 15 m

Solid
Stranded
} 25 m

Simulation for DF = 0.067



20 AWG

Solid
Stranded
} 15 m

Solid
Stranded
} 25 m

Simulation Summary

PVC Material	Cable IL @25m @40MHz (stranded)
DK=3.6, DF=0.007	2.27
DK=3.6, DF=0.017	3.27
DK=3.6, DF=0.067	7.8

- At 12.5 MHz:
  - DK = 0.007
    - Copper + dielectric = 1 dB
  - DK = 0.067 (typical of PVC)
    - Copper + dielectric = 2.7 dB

- Even at this lower frequency, the dielectric can dominate over copper.

Materials

- Materials are often characterized with a single point, but DK and DF vary across frequency.
- Material properties can be measured from a sample, but cable vendors modify the base materials with plasticizers, colorants, fire retardants, irradiation to cross link polymers, etc., so it is inadequate to just take the characterization of the base material supplier.
- There are lower loss materials, but there are tradeoffs that require more thought: change in geometry that is incompatible with IDC minimal geometry, material too thin for regulatory without added jacket, inability to maintain the low DF due to additives, issues related to the hardness of these materials.

Conclusions

- Dielectric Loss can not be ignored for 10BASE-T1S cables
- Distance should not be scaled based on copper losses alone, while ignoring material properties and geometry