Link Segment Insertion Loss
IEEE 802.3 10 Mb/s Single
Twisted Pair Ethernet Study Group

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Purpose

- **Scope**
  - **Initiate discussion(s) on 10 Mb/s Single Twisted Pair Ethernet Link Segment Insertion Loss Specifications**
    - **Automotive**
    - **Industrial Automation**

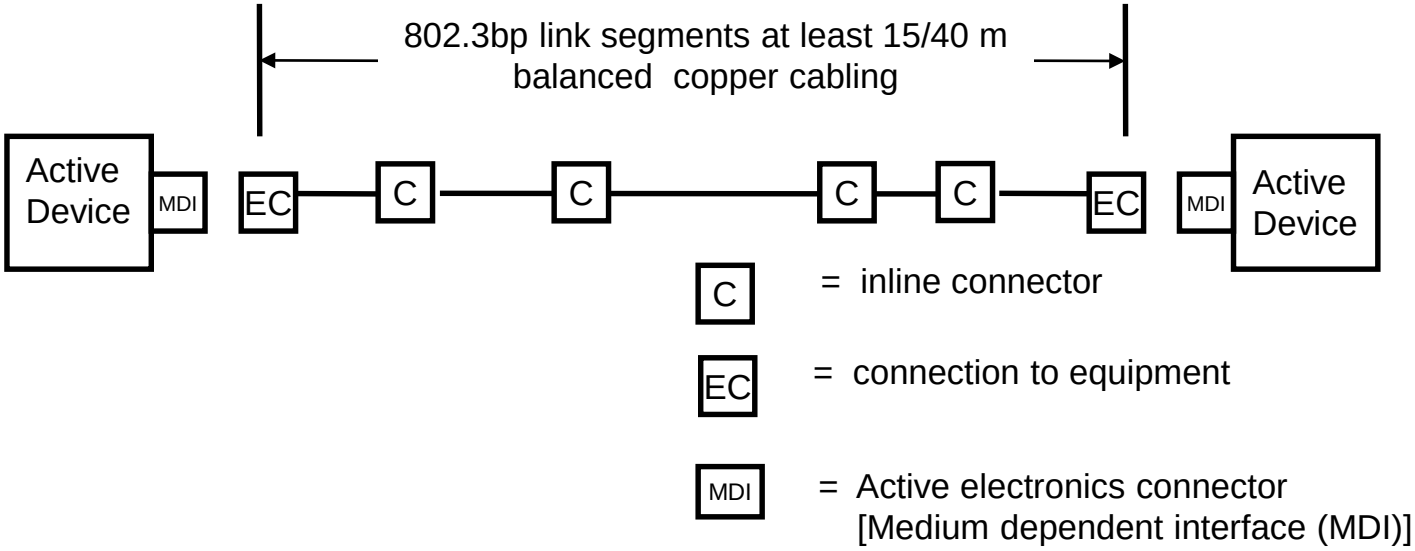
- **Rationale**
  - **Insertion loss length dependencies limit achievable link length distances (reach objectives)**
  - **Link segment characteristics enables considerations for PHY (e.g., signaling)**

- **Link Segment**
  - **To be developed in conjunction with the automotive/Industrial networking industries**

Link segment insertion loss

- Insertion loss derived from link segment components insertion losses and insertion loss deviation of link segment.
  - Cable IL
  - Connecting hardware IL
  - Link segment ILD

- Related characteristics to consider.
  - Gauge
  - Shield
  - Temperature dependencies



Cable insertion loss dB @ 100 Mhz/500 Mhz

- **Link Segment Insertion Loss Specifications**
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AWG	Diameter(in)	Diameter(mm)	dB/m at 100 MHz solid	dB/m at 500 MHz solid	dB/m at 100 MHz stranded	dB/m at 500 MHz stranded
22	0.025346	0.643795	0.170401	0.40	0.20	0.48
23	0.022571	0.573314	0.191350	0.45	0.23	0.54
24	0.020100	0.510549	0.214874	0.51	0.26	0.61
25	0.017900	0.454655	0.241290	0.57	0.29	0.68
26	0.015940	0.404881	0.270953	0.64	0.33	0.77
27	0.014195	0.360555	0.304263	0.72	0.37	0.86
28	0.012641	0.321083	0.341668	0.81	0.41	0.97
29	0.011257	0.285931	0.383671	0.91	0.46	1.09
30	0.010025	0.254628	0.430838	1.02	0.52	1.22
31	0.008927	0.226752	0.483804	1.14	0.58	1.37
32	0.007950	0.201928	0.543281	1.28	0.65	1.54

Usage of 26 and 27 stranded reported by 802.3bp survey respondents

*Reference IL =1.82*SQRT(f)+0.0091*f+0.25/SQRT(f)*

**commercially available specified to 500 MHz*
***~12% increase per gauge*
****20% increase for stranded*

Automotive operating environment

Lifetime Requirements and Testing of ECUs

Active Operation: Typical Temperature-Load Distribution (ambient)

$T_{i,ECU}$ = ECU inner air temperature	Typ. load (Passenger Car)	
	Vehicle body, bulkhead, extension close to the engine	
-40°C..10° C	6.0 %	480 h
10°C...45° C	20.0 %	1600 h
45°C...60° C	33.0 %	2640 h
60°C...70° C	18.0 %	1440 h
70°C...80° C	9.0 %	720 h
...85° C	3.0 %	240 h
...90° C	2.0 %	160 h
...95° C	1.7 %	136 h
...100° C	1.5 %	120 h
...105° C	1.4 %	112 h
...110° C	1.3 %	104 h
...115° C	1.2 %	96 h
...120° C	1.0 %	80 h
...125° C	0.9 %	72 h
Total	**100%**	**8000 h**

Automotive Electronics

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DGS-EC/EHM3-Mrt | 6/25/2012 |

BOSCH

http://grouper.ieee.org/groups/802/3/RTPGE/public/july12/hoganmuller_01a_0712.pdf

ANSI/TIA/EIA-568-C.2 – Annex G

- **Cable temperature correction**

G.2 Insertion loss

Equation (G-1) defines the insertion loss dependence on temperature:

$$IL_{20} = \frac{IL_T}{1+\delta_1(T-20)+\delta_2(T-40)}$$

where:

IL_T = Measured insertion loss at temperature T

IL_{20} = Insertion loss corrected to 20℃

T = Measured temperature in ℃

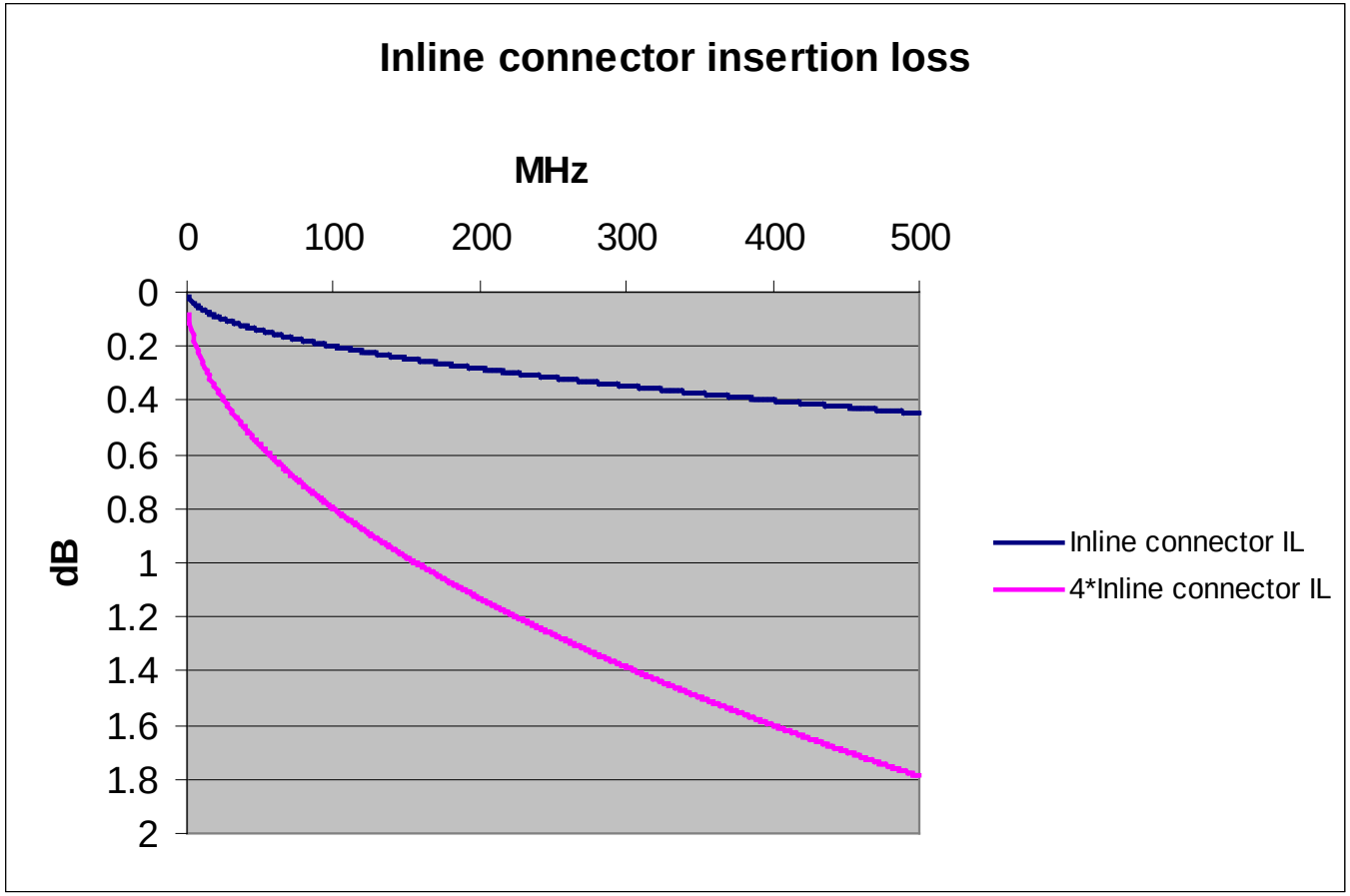
The correction factors, δ_1 and δ_2, are shown in table G.1.

Table G.1 – Maximum horizontal cable length de-rating factor for different temperatures

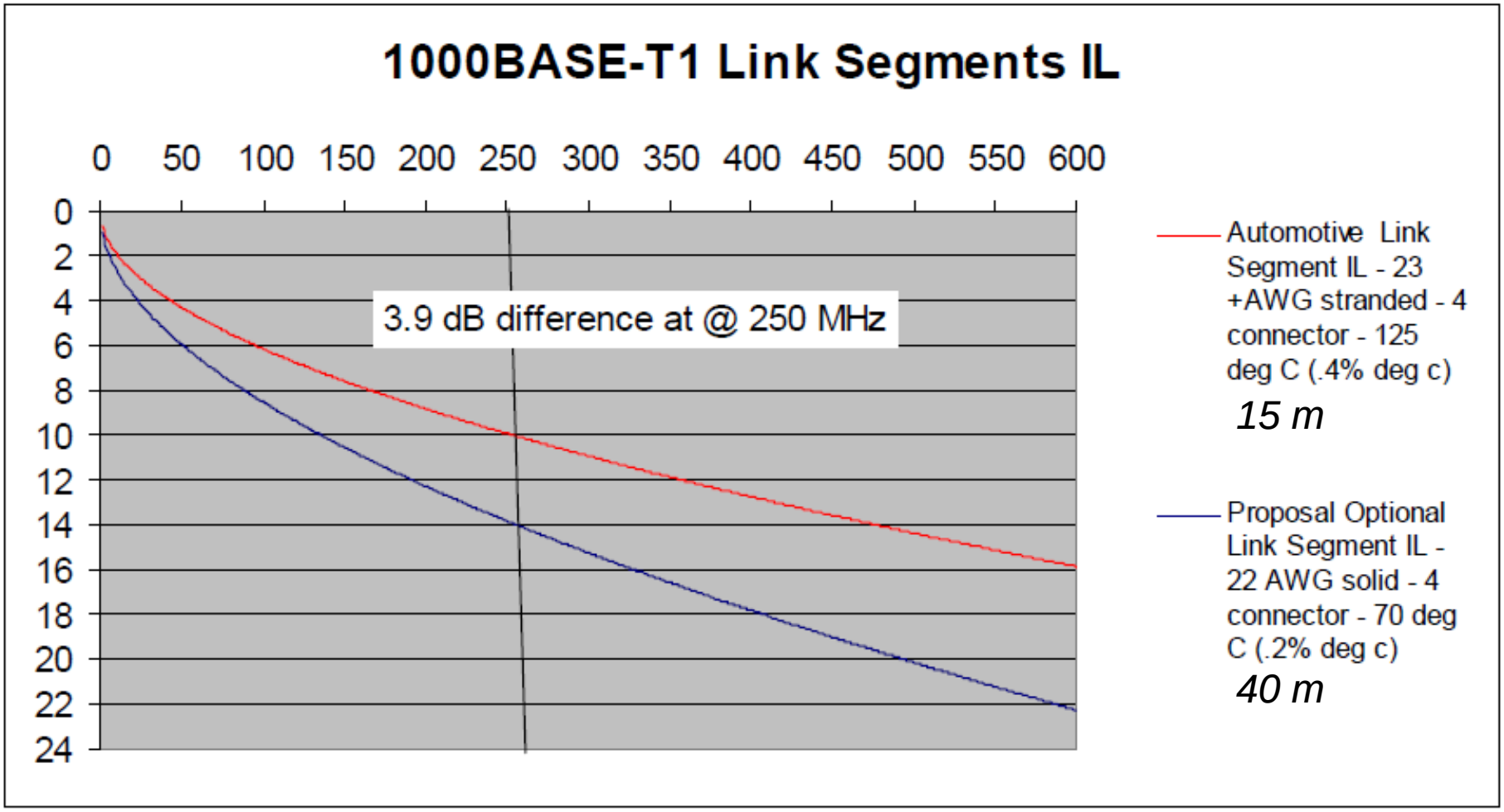
	Temperature (° C)	δ_1	δ_2
UTP	20 ≤ T ≤ 40	0.004	0
	40 < T ≤ 60	0.004	0.00248
F/UTP	20 ≤ T ≤ 60	0.002	0

Inline connector insertion loss assumed 802.3bp

- Inline connector IL(f) = x*sqrt(f)
- x=0.02*sqrt(f)



Link segment insertion loss comparison



Source: http://www.ieee802.org/3/bp/public/jul14/diminico_3bp_01b_0714.pdf

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