RTPGE Channel definitions ad hoc insertion loss and return loss consensus

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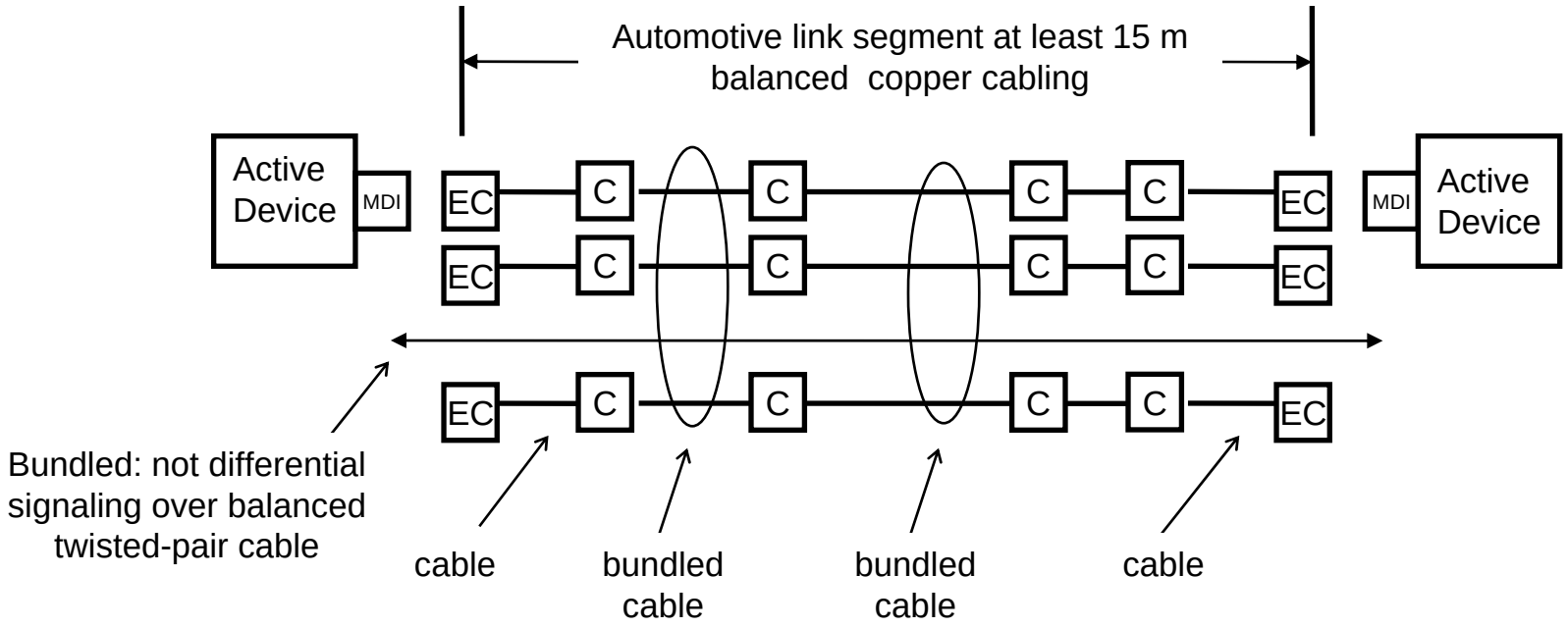
Summary

- **Insertion loss and return loss proposal developed from**
  - **–diminico_02_0313_rtpge.pdf**
  - **–Channel performance ad hoc contribution from - Todd Herman CommScope**

Automotive link segment



The IEEE 802.3 nomenclature is bracketed to identify relationship to the IEEE 802.3 definitions.

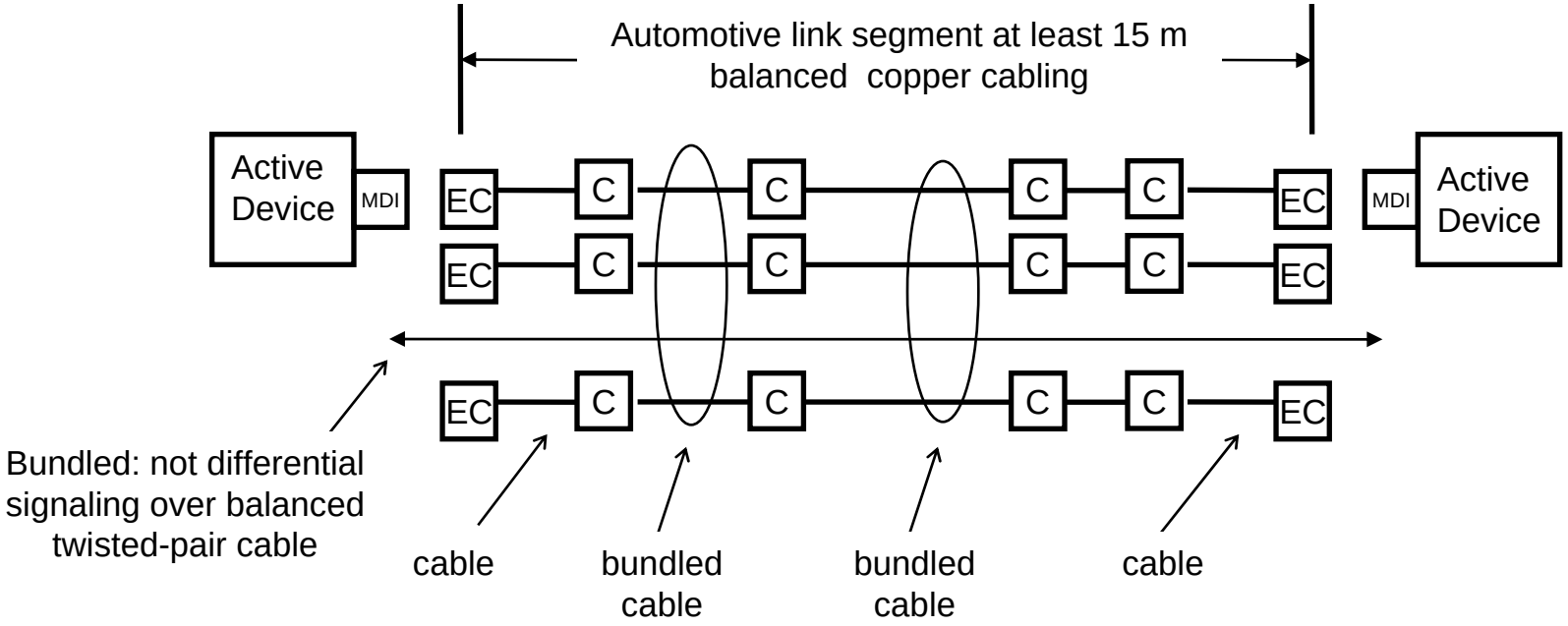
Length objective [EC] to [EC] at least15 m
Number of inline connectors [C] = 4

C = inline connector

EC = connection to equipment

MDI = Active electronics connector [Medium dependent interface (MDI)]

Link segment transmission parameters



Link segment transmission and coupling parameters

- *Insertion loss*, return loss
- NEXT, FEXT, multiple disturber crosstalk
- Alien Crosstalk
- Balance

Cable insertion loss dB @ 500 MHz

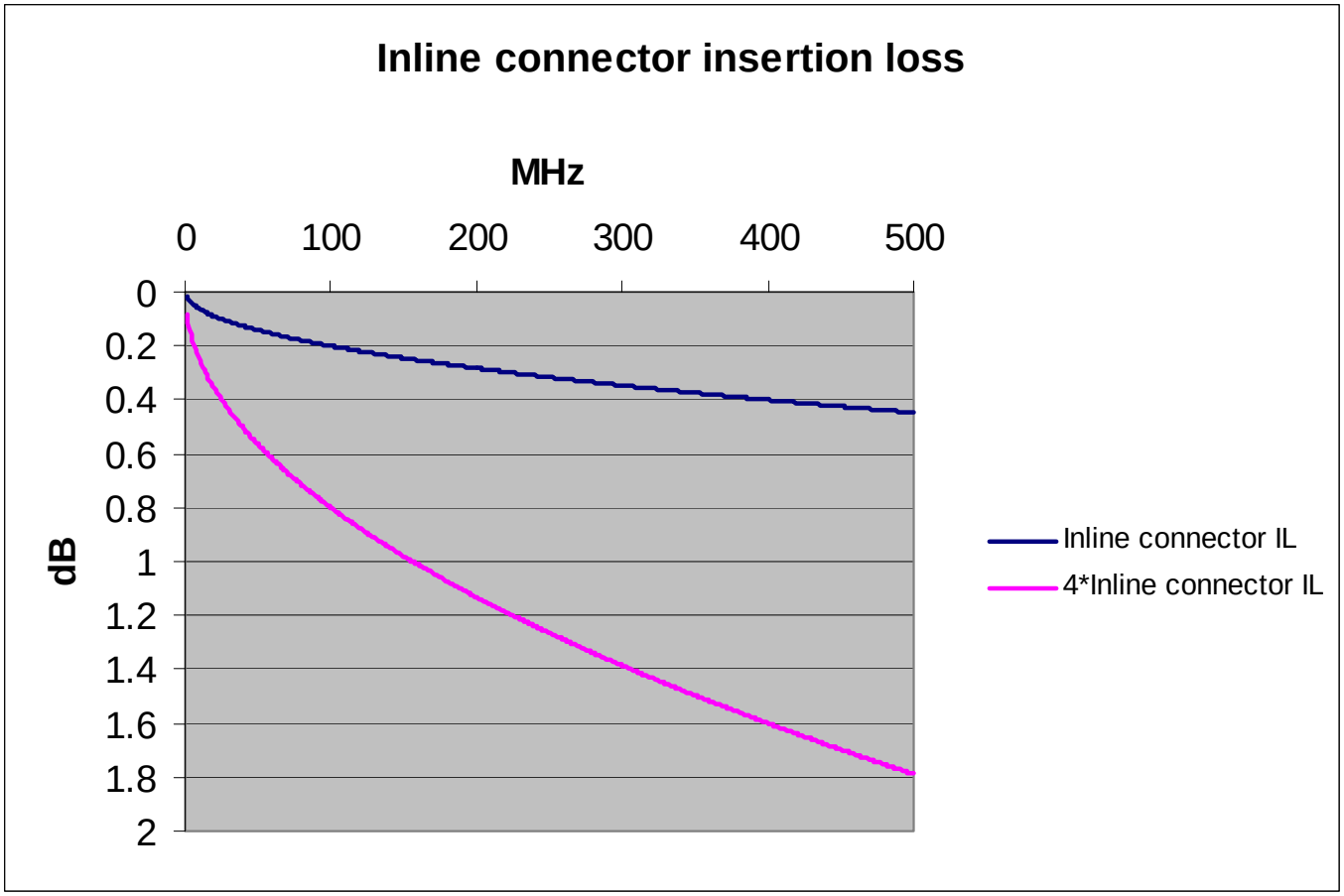
AWG	Diameter (in)	Diameter (mm)	dB/m at 500 MHz solid	dB/m at 500 MHz stranded	dB/15m stranded	dB/40m stranded
22	0.025346	0.643795	0.40	0.48	7.25	19.35
23	0.022571	0.573314	0.45	0.54	8.15	21.72
24	0.020100	0.510549	0.51	0.61	9.15	24.39
25	0.017900	0.454655	0.57	0.68	10.27	27.39
26	0.015940	0.404881	0.64	0.77	11.54	30.76
27	0.014195	0.360555	0.72	0.86	12.95	34.54
28	0.012641	0.321083	0.81	0.97	14.55	38.79
29	0.011257	0.285931	0.91	1.09	16.33	43.56
30	0.010025	0.254628	1.02	1.22	18.34	48.91
31	0.008927	0.226752	1.14	1.37	20.60	54.93
32	0.007950	0.201928	1.28	1.54	23.13	61.68

- IL(f)
- Reference IL (dB/100m) =1.82*SQRT(f)+0.0091*f+0.25/SQRT(f)
- Reference IL (dB/m) = 0.01*(1.82*SQRT(f)+0.0091*f+0.25/SQRT(f))
- 20% increase for stranded (dB/m) = 1.2*(0.01*(1.82*SQRT(f)+0.0091*f+0.25/SQRT(f)))
- 12% increase per gauge (dB/m) = 1.12*(0.01*(1.82*SQRT(f)+0.0091*f+0.25/SQRT(f)))

Source: diminico_02_0313_rtpge.pdf

Inline connector insertion loss

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



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ANSI/TIA/EIA-568-C.2 – Cable insertion Loss

Temperature correction

•The maximum insertion loss for UTP horizontal cables shall be adjusted at elevated temperatures using a factor of 0.4 % increase per °C from 20 °C to 40 °C and 0.6% increase per °C for temperatures from 40 °C to 60 °C.

•The maximum insertion loss for ScTP horizontal cables shall be adjusted at elevated temperatures using a factor of 0.2% increase per °C from 20 °C to 60 °C.

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Channel Performance Formulation Proposal -Todd Herman CommScope

equations for insertion loss of 1-pair ethernet channel

For 20 degrees C and AWG 23

$$IL := \left(1.2 \cdot \frac{L}{100}\right) \cdot \left(1.82 \cdot \sqrt{f} + .0091 \cdot f + \frac{.25}{\sqrt{f}}\right) + B \cdot .02 \cdot \sqrt{f}$$

Inline connector IL

where

B := number of connectors

f := frequency_MHz

L.. length_m

20% increase for stranded

Category 6A reference (23 AWG)

For any temperature above 20 degrees C and for any conductor size

$$IL := [1 + .004 \cdot (T - 20)] \cdot \left(1.2 \cdot \frac{L}{100}\right) \cdot \left[\frac{1.82}{92^{\frac{(23-n)}{39}}} \cdot \sqrt{f} + .0091 \cdot f + \frac{.25}{\sqrt{f}}\right] + B \cdot .02 \cdot \sqrt{f}$$

~12% increase for each gauge reduction

where

T := Temperature in degrees_C

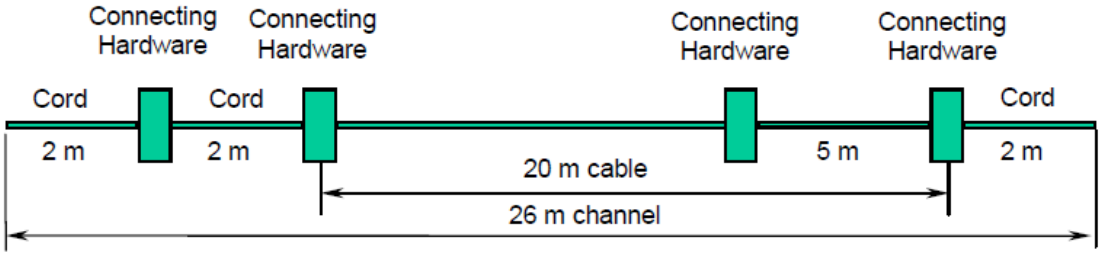
n := conductor_size_in_AWG

insertion loss adjusted using a factor of 0.4 % increase per °C from 20 °C to 125 °C

Link segment return loss

- **Use ANSI/TIA-568-C.2 Annex I (informative) - Development of channel and component return loss limits as basis for RTPGE link segment RL limits.**
- **Use Category 6A cable and connector return losses as basis for return loss limit modeling of automotive link segment…example below…**

Modeling configuration example



Category 6A Channel Return Loss

Category 6A	$1 \le f < 10$ $10 \le f < 40$ $40 \le f < 398.1$ $398.1 \le f \le 500$	19 $24-5\log(f)$ $32-10\log(f)$ 6

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**

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

Summary

- **Use insertion loss closed form equations slide 8 for link segment insertion losses**
- **Use ANSI/TIA-568-C.2 Annex I (informative) - Development of channel and component return loss limits as basis for RTPGE link segment RL limits.**
- **Use Category 6A cable and connector return losses as basis for return loss limit modeling for automotive link segment**