Actual Cable Data

Insertion loss, return loss at different climatic and ageing conditions
Coupling attenuation in different ageing conditions

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Spokane, September 10, 2018

Motivation – Actual Cable Data

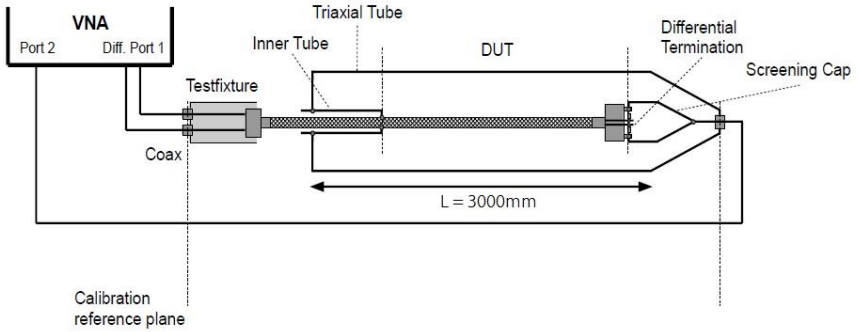
- Concerns about „suck out areas“ after ageing of cables
- Review of actual limit recommendation and new proposal to show a possibility to realize a data link with only one cable type (AWG26) for 11m and 15m link length

Test setup (IL, RL)

- A standard 4-port vector network analyzer from 1 MHz to 20 GHz was used
- The cable under test was connected to the VNA via LEONI fixture (no extra connector, inliner) with highly phase stable measurement cables .
- The tests were performed at room temperature (RT, 23°C) and at 105°C at climatic chamber before and after ageing (240h/130°C)
- Additional measurements were carried out at humidity heat 40°C/85% rel. Humidity (0h, 72h, 144h, 240h)
- The measured length of each cable is 10m and the results for IL were calculated for 11m and 15m respectively in the diagrams and compared to current limit TE proposed on 11th July plenary meeting
- The measured cables are bulk cable without any inliner or connector.

Test setup (Coupling attenuation)

- A standard 4-port vector network analyzer from 1 MHz to 8 GHz was used
- The cable under test was connected to the VNA via LEONI fixture (no extra connector, inliner) with highly phase stable measurement cables .
- The tests were performed at room temperature (RT, 23°C) before and after ageing (240h/130°C)
- The measured length of each cable is 3.5m
- The 3m Bedea measurement tube (triaxial method) was used

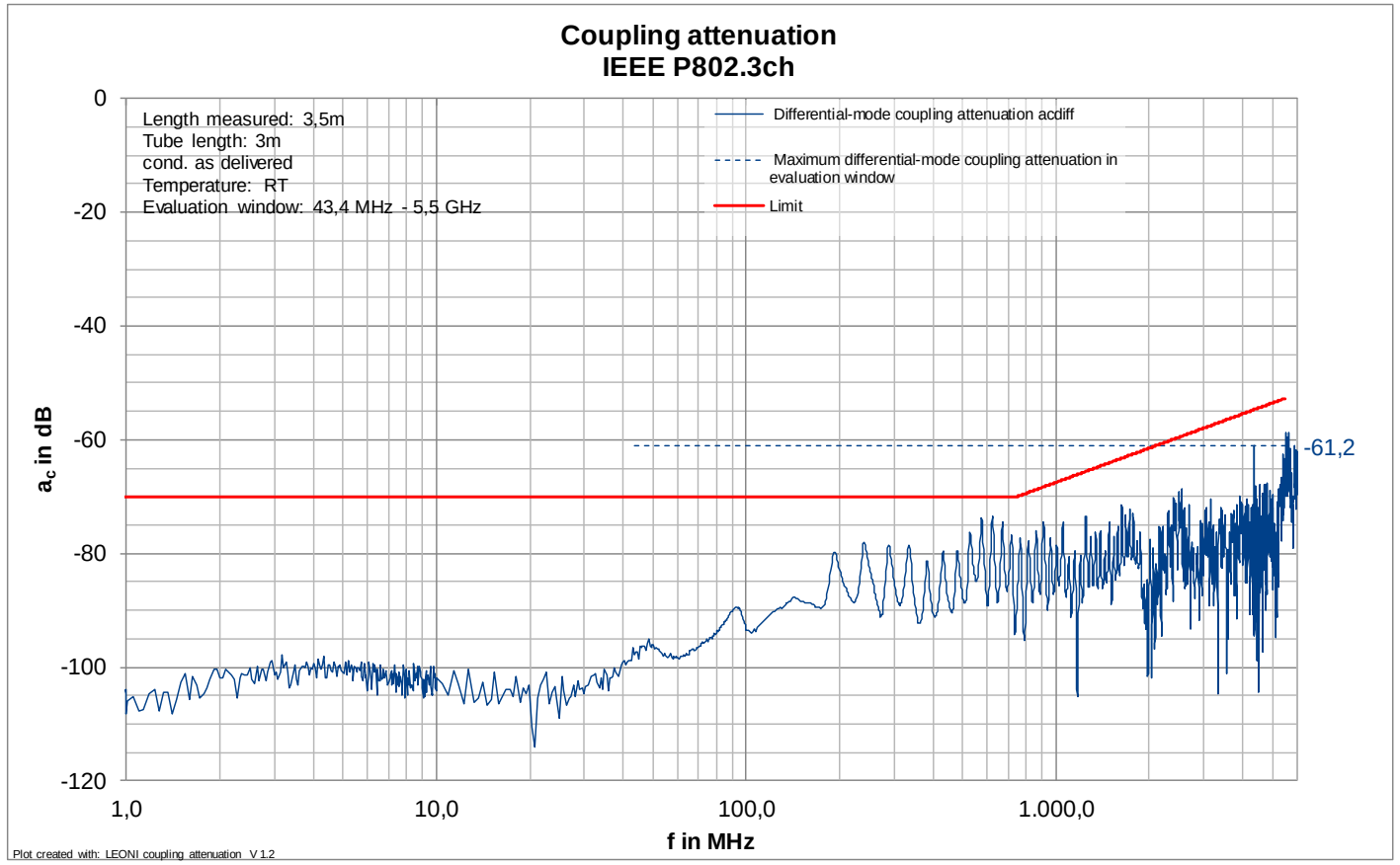


- The measured cables are bulk cable <u>without</u> any inliner or connector

Tested cables

- Shielded twisted pair (STP) 0.14mm² AWG 26 specified up 5.5 GHz to prevent suck out areas in used frequency range after ageing
- Cable length 10m
- Cables measured as a rolled up as a ring

Coupling attenuation data



Condition as delivered (new) at room temperature

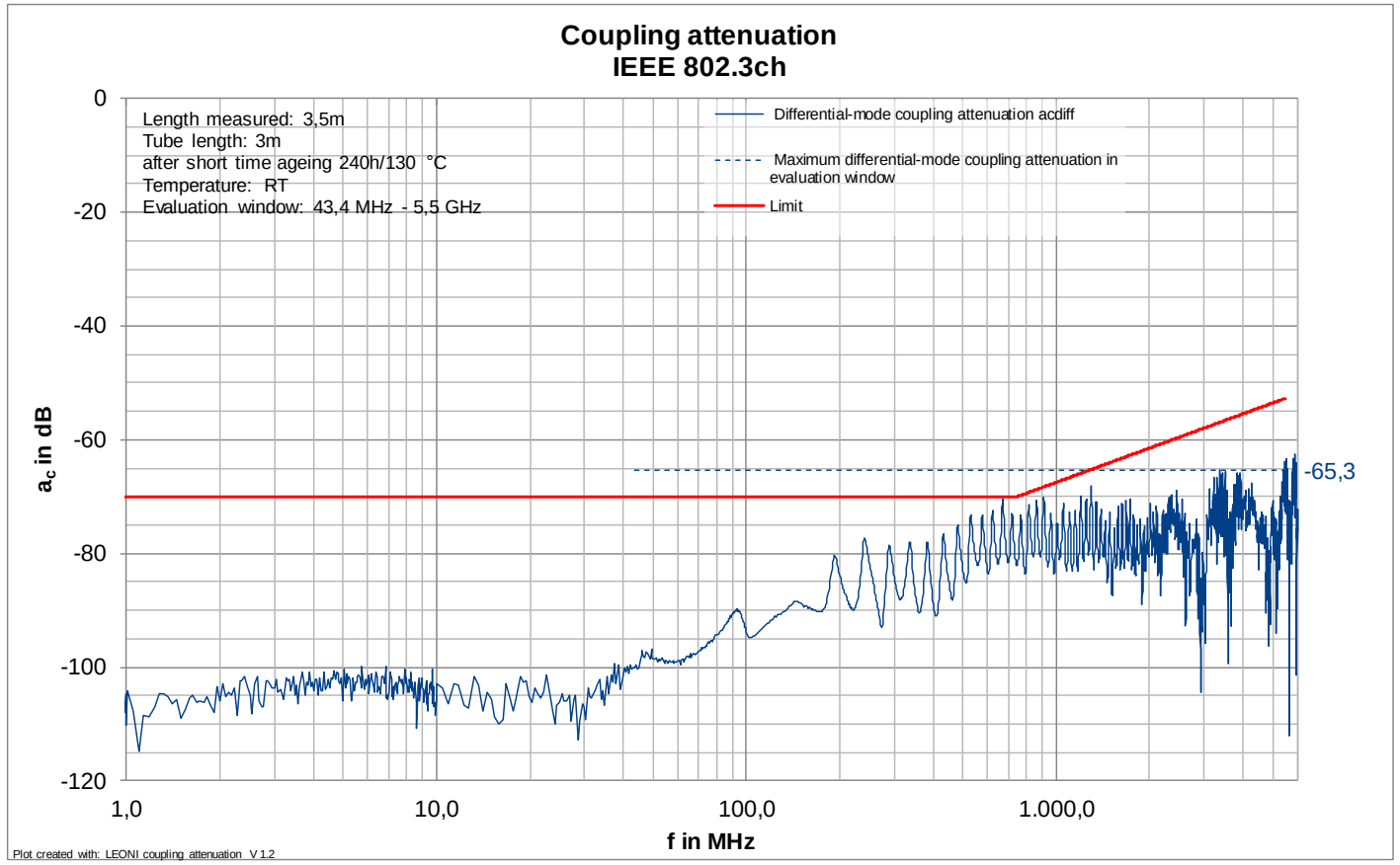
No limit violation

Limit: * mueller_3ch_02a_0518.pdf

$$\begin{pmatrix} 70 & 30 \le f < 750 \\ 50 - 20\log({}^{f}/_{7500}) & 750 \le f \le 5500 \end{pmatrix} dB$$

$30 \le f \le 5500$ frequency f in MHz

Coupling attenuation data



Condition: after short time ageing (240h/130°C) at room temperature

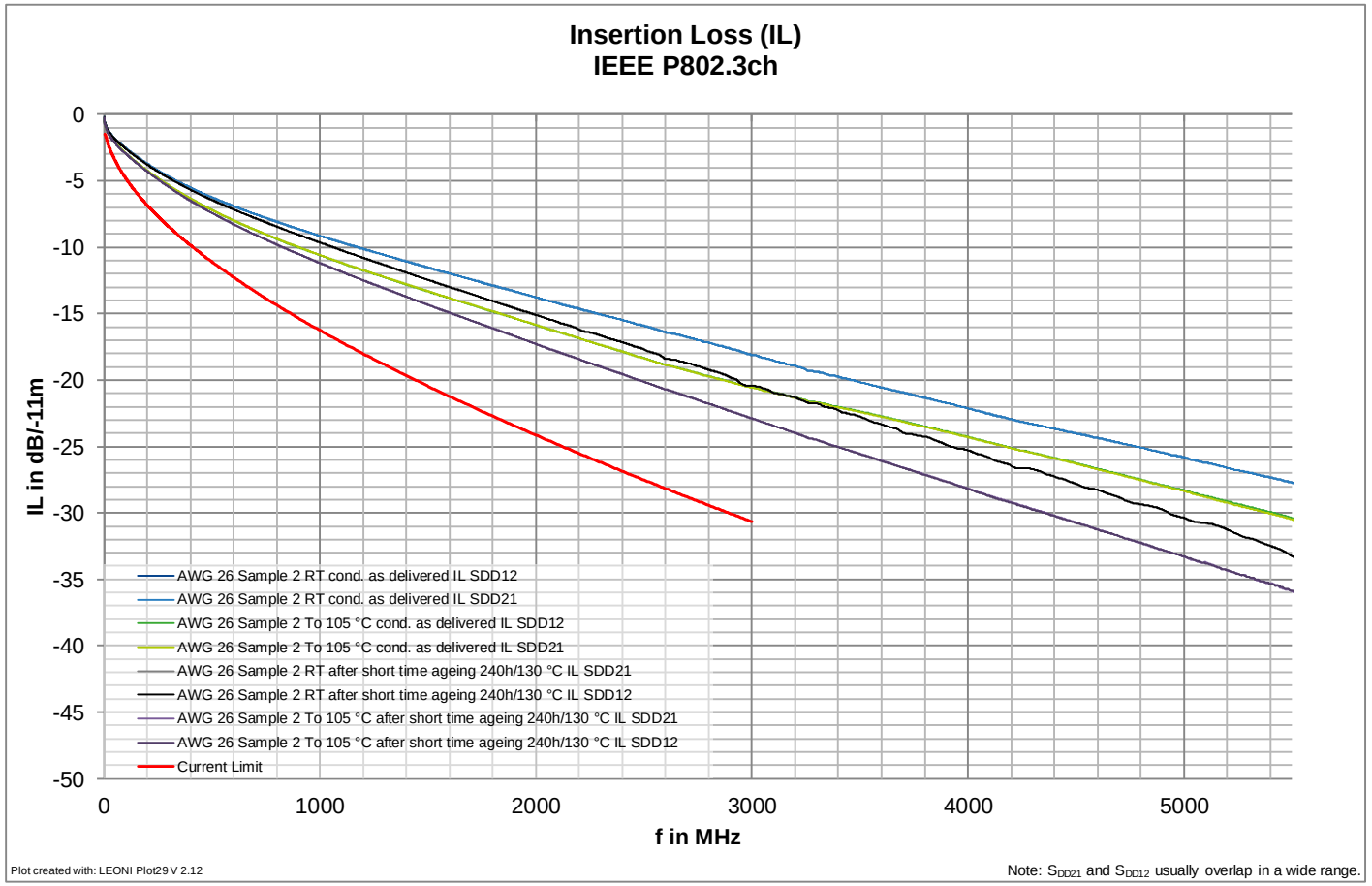
No limit violation

Limit: * mueller_3ch_02a_0518.pdf

$$\begin{pmatrix} 70 & 30 \le f < 750 \\ 50 - 20\log(f/7500) & 750 \le f \le 5500 \end{pmatrix} dB$$

$30 \le f \le 5500$ frequency f in MHz

Insertion loss data for 11m (short time ageing)



Calculated for 11m

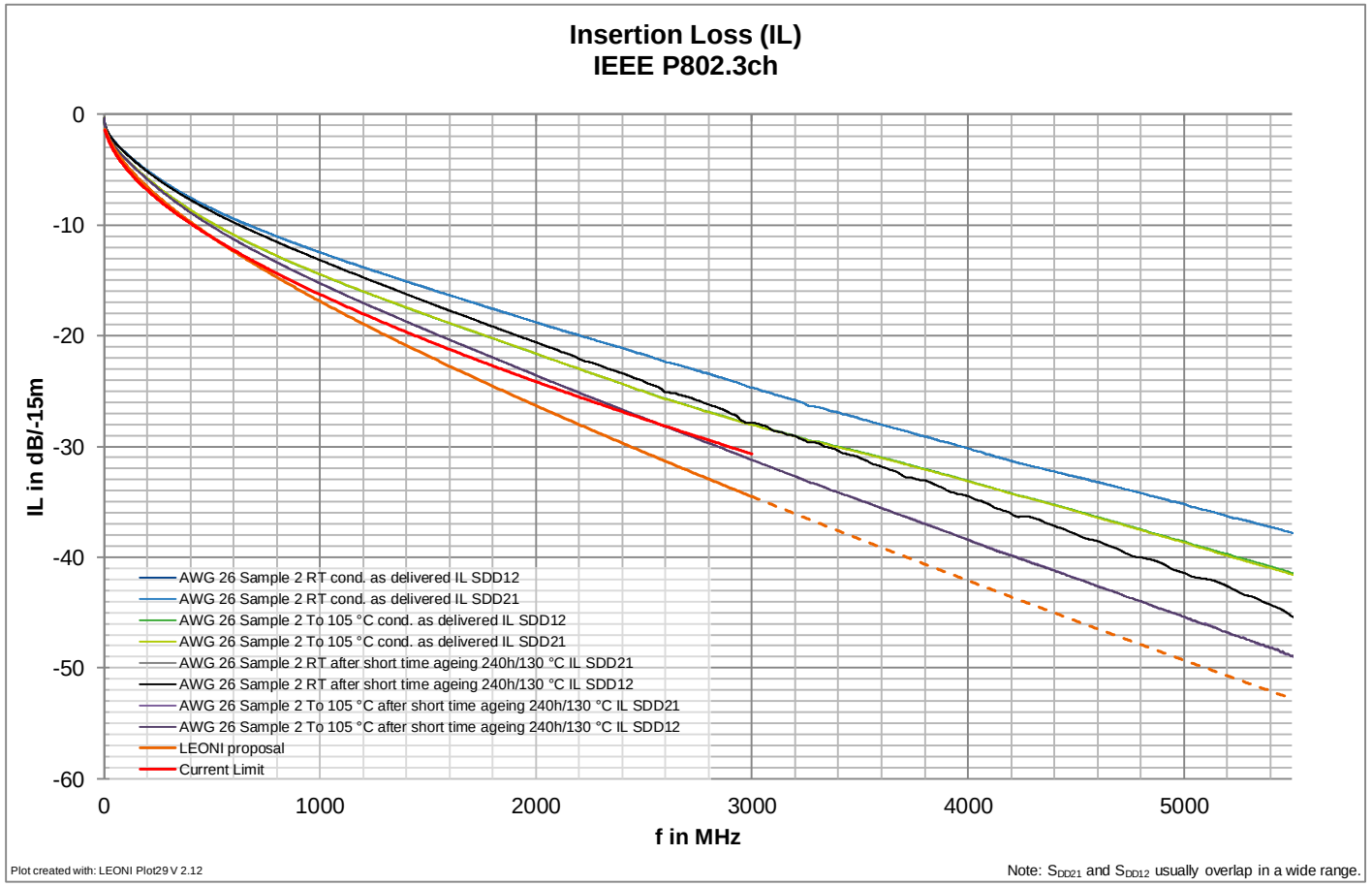
No limit violation of actual limit

This limit allows 8dB (@ 3 GHz) for connectors/inliner, measurement uncertainty and production variations for the worst case after ageing at 105°C.

Current Limit: *DiBiaso_3ch_01_0718.pdf

$ILdBf \leq 0.002*f+0.45*\sqrt{f}+1/\sqrt{f}$

Insertion loss data for 15m (short time ageing)



Current Limit: *DiBiaso_3ch_01_0718.pdf

$ILdBf \leq 0.002*f+0.45*\sqrt{f}+1/\sqrt{f}$

Calculated for 15m

Limit violation of actual limit after ageing

LEONI limit proposal:

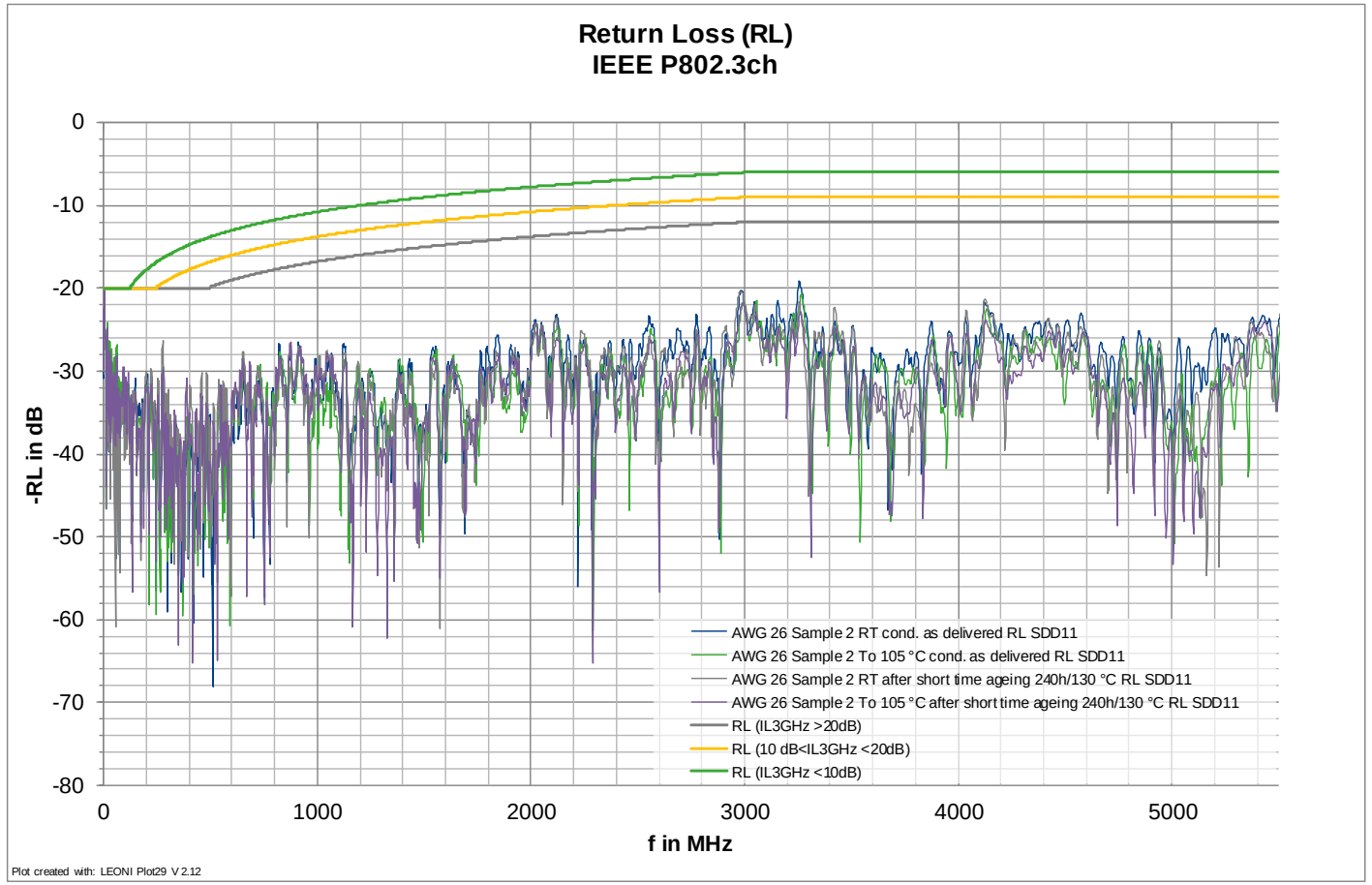
$$\boldsymbol{ILdBf \leq 0.0042*f+0.4*\sqrt{f}+1/\sqrt{f}}$$

f is the frequency in MHz: 5 ≤ 3000 (5500*)
Note*: cable specification

This limit allows 3dB (@ 3 GHz) for connectors/inliner, measurement uncertainty and production variations for the worst case after ageing at 105°C.

Limit allows the use of only one cable type for all link lengths.

Return loss data (short time ageing)



No limit violation

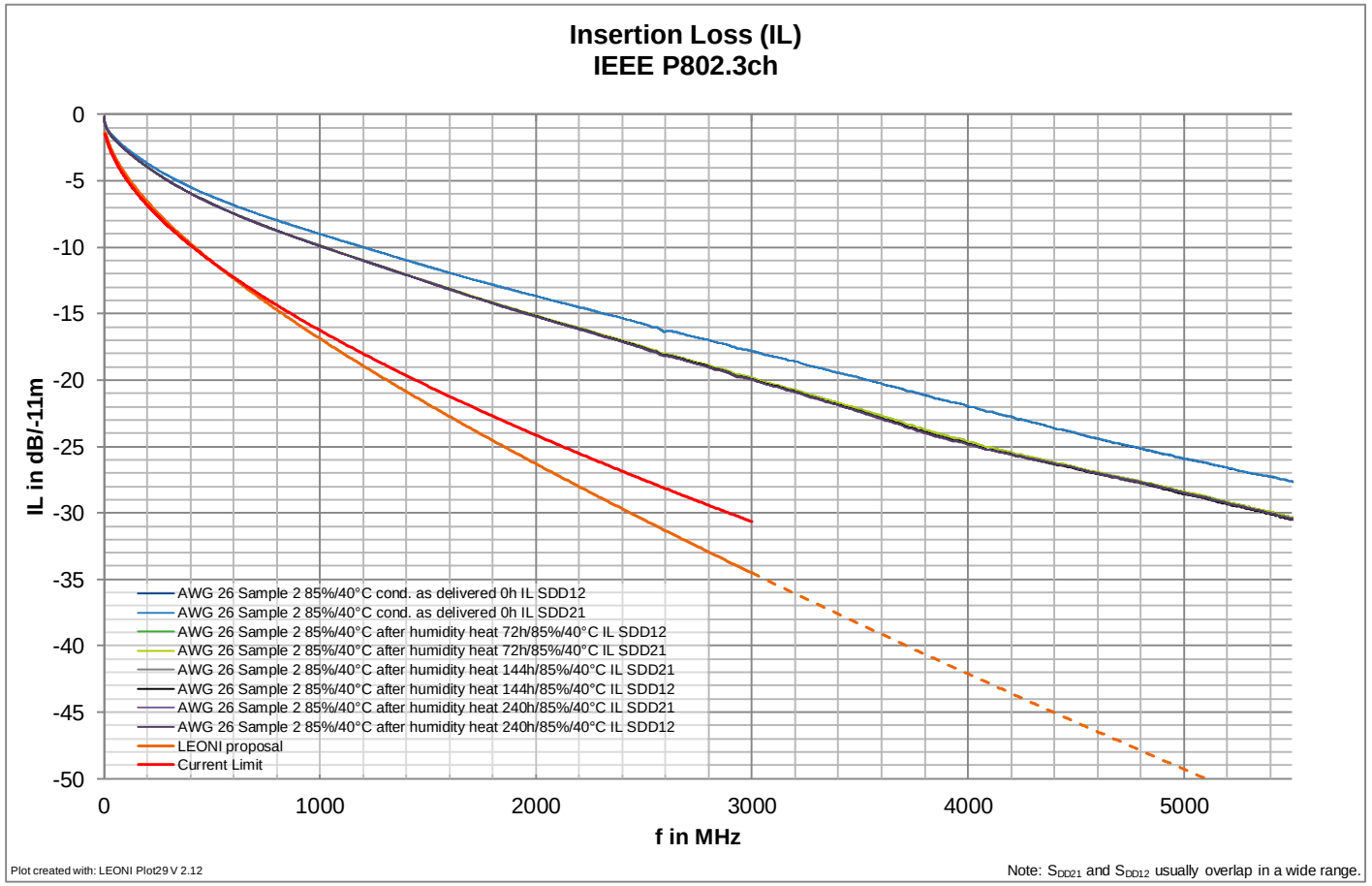
RL Limit: * Farjad_3ch_01b_0118.pdf

- IL_{3GHz} > 20dB → N=0
- 10dB< IL_{3GHz} < 20dB → N=1
- IL_{3GHz} < 10dB → N=2

$$\text{Return.Loss(dB)} \le \begin{cases} 20\text{dB} & 5 \le f < 500/2^N \\ 12\text{-}3N - 10\log(f/3000) & 500/2^N \le f < 3000 \\ 12\text{-}3N & 3000 \le f < 5500 \end{cases} \quad (f \text{ in MHz})$$

Contributions from :
Garret den Besten
Bert Bergner
James Withey
Masood Shariff

Insertion loss data for 11m (40°C, 85% rel. hum.)



Calculated for 11m

No limit violation at these climatic conditions. Other climatic conditions not investigated (higher temp. or humidity).

LEONI limit proposal:

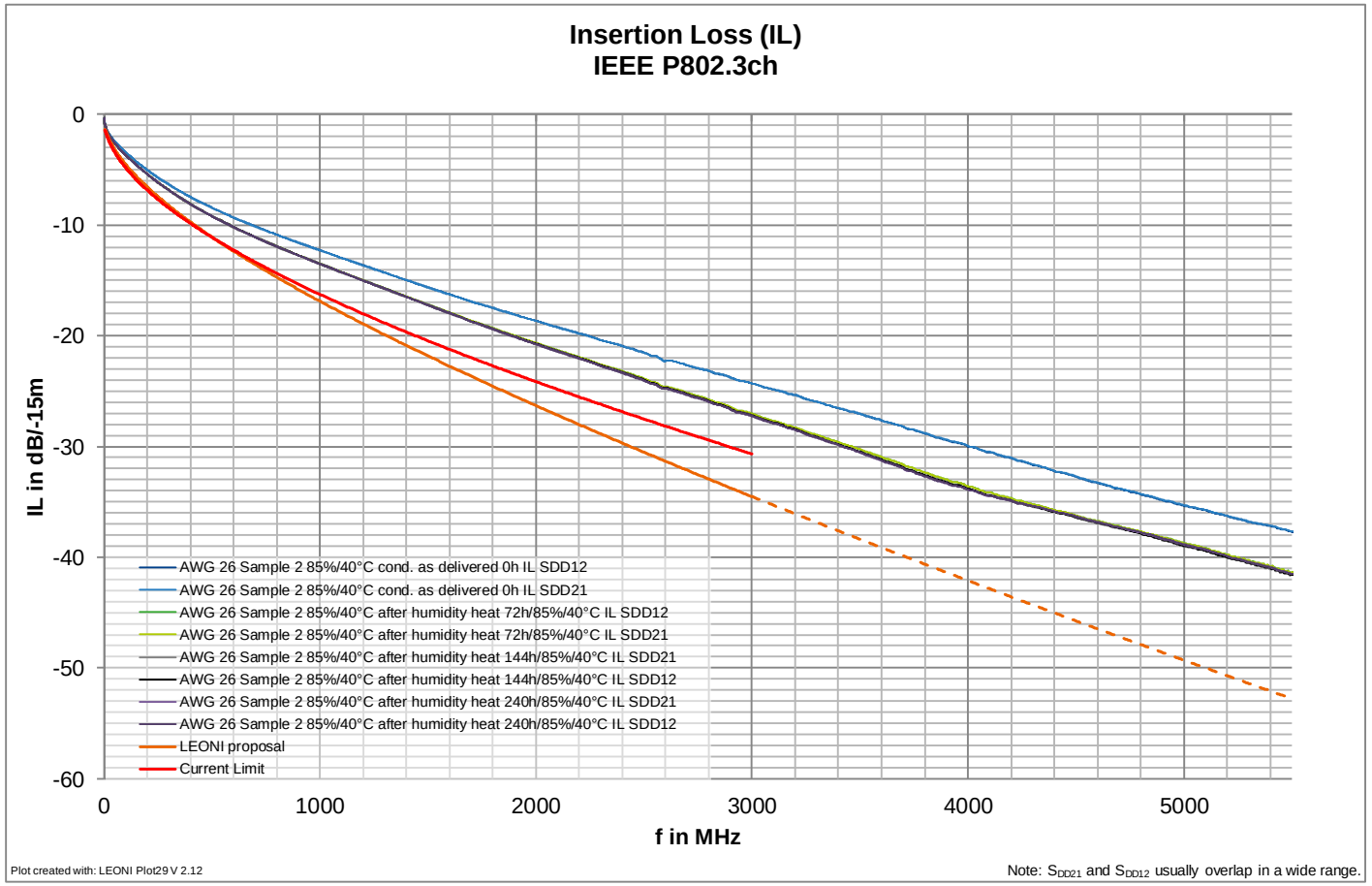
$$ILdBf \leq 0.0042*f+0.4*\sqrt{f}+1/\sqrt{f}$$

f is the frequency in MHz: 5 ≤ 3000 (5500*)
Note*: cable specification

Current Limit: *DiBiaso_3ch_01_0718.pdf

$$ILdBf \leq 0.002*f+0.45*\sqrt{f}+1/\sqrt{f}$$

Insertion loss data for 15m (40°C, 85% rel. hum.)



Calculated for 15m

No limit violation at these climatic conditions. Other climatic conditions not investigated (higher temp. or humidity).

LEONI limit proposal:

$$ILdBf \leq 0.0042*f+0.4*\sqrt{f}+1/\sqrt{f}$$

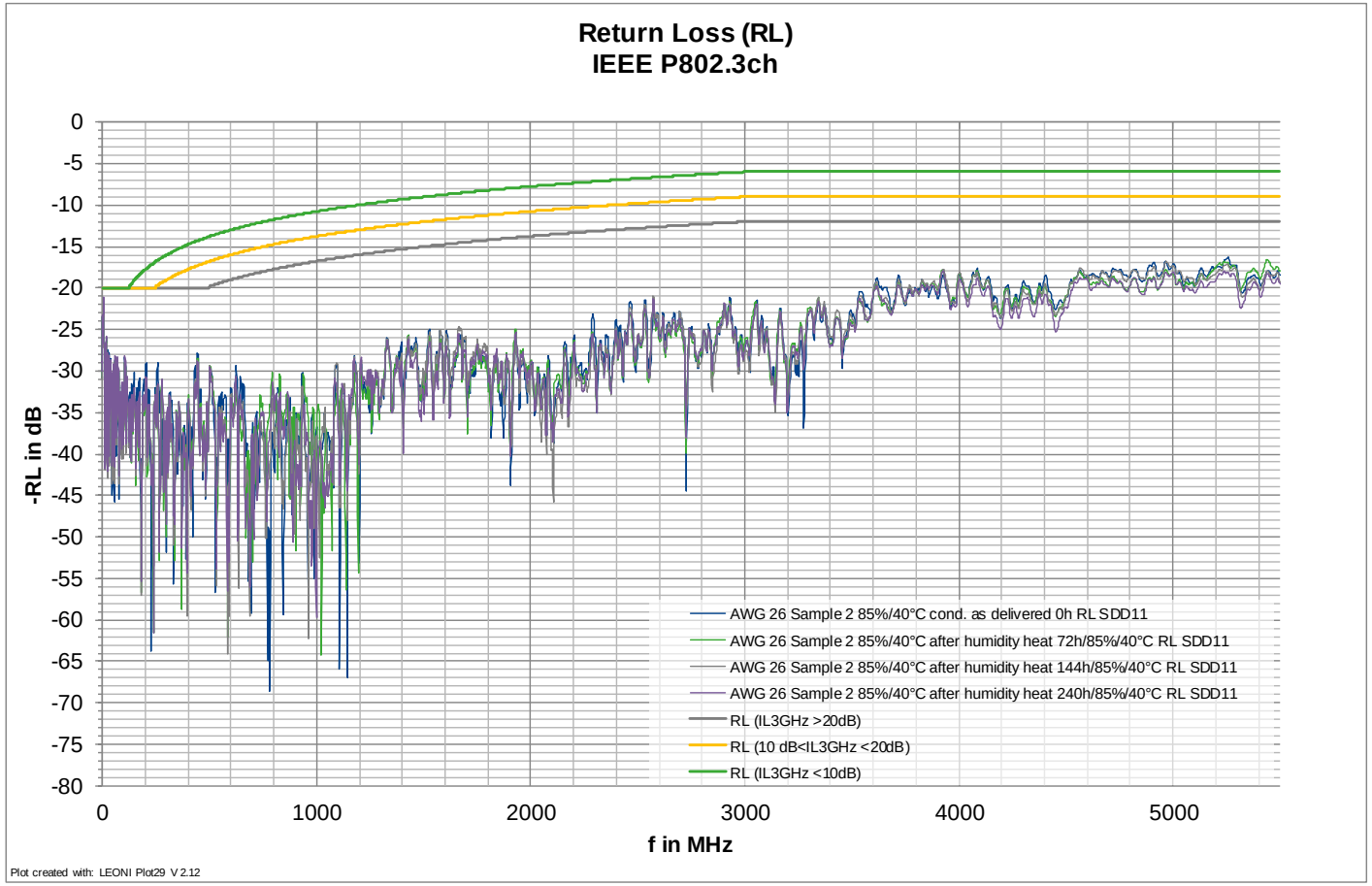
f is the frequency in MHz: 5 ≤ 3000 (5500*)
Note*: cable specification

Limit allows the use of only one cable type for all link lengths.

Current Limit: *DiBiaso_3ch_01_0718.pdf

$$ILdBf \leq 0.002*f+0.45*\sqrt{f}+1/\sqrt{f}$$

Return loss data (40°C, 85% rel. hum.)



No limit violation at these climatic conditions. Other climatic conditions not investigated (higher temp. or humidity).

RL Limit: * Farjad_3ch_01b_0118.pdf

- $IL_{3GHz} > 20dB$ → N=0
- $10dB < IL_{3GHz} < 20dB$ → N=1
- $IL_{3GHz} < 10dB$ → N=2

$$\text{Return.Loss(dB)} \le \begin{cases} 20\text{dB} & 5 \le f < 500/2^N \\ 12\text{-}3N - 10\log(f/3000) & 500/2^N \le f < 3000 \\ 12\text{-}3N & 3000 \le f < 5500 \end{cases}$$

(f in MHz)

Contributions from :
Garret den Besten
Bert Bergner
James Withey
Masood Shariff

Conclusions

- Rosenberger proposal for coupling attenuatian is acceptable from LEONIs point of view

- Humidity heat (40°C, 85% rel. Hum) doesn´t have much influence on the cable parameters and shall be no problem for this cable type.

- For 11m link length no limit violation for current limit.

Conclusions

- Insertion loss limit which was chosen during the San Diego meeting should be adjusted to cover also aged cables (ensures working link after ageing) and offers the use of only one cable type.

  LEONI proposal:

$$ILdBf \leq 0.0042*f+0.4*\sqrt{f}+1/\sqrt{f}$$

f is the frequency in MHz: 5 ≤ 3000 (5500*)

Note*: cable specification

Conclusions

Advantage of AWG26 (compared to AWG24): smaller (diameter), less weight and so on.

The construction of a AWG24 STP for the same frequency range (5.5 GHz) is physically not possible, because suck out areas will be present below 5 GHz, due to the construction, this is based on calculation and long experience in cable manufacturing.

We also expect an increase of return loss at the suck out area frequency range for AWG24 cable. Actually no measurement/simulation data is available for this type.

Measurement data will be available before next face to face meeting in November.

Motion

Move to adopt a new Insertion loss Limit given by the equation:

$$ILdBf \leq 0.0042*f+0.4*\sqrt{f}+1/\sqrt{f}$$

f is the frequency in MHz: 5 ≤ 3000

as shown on slide 9 of vernickel_3ch_01b_0918.pdf.

- M: Ricky Vernickel
- S:
- (Technical >=75%)
- Y: N: A:
- Motion Passes/Fails

Thank you !!!