

Thoughts about long reach cabling

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Purpose

- The purpose of this presentation is to:
 - Follow-up on:
 - brandt_cg_02c_0717.pdf (presented in Berlin)
 - Consider re-use of installed IEC 61158-2 type A Fieldbus cables

Background

- Belden 3076F
 - Rated as IEC 61158-2 type A Fieldbus cable
 - Dual use
 - A Fieldbus Foundation Registered Product
 - Marked and usable as a Profibus PA cable
- Characterization indicated worse performance than our existing link segment model
 - Increased IL, reduced RL, low impedance

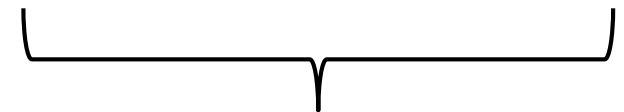
Background

- Primary cause of poor performance is the use of a solid polyolefin (non-foamed) insulation with $V_p = 66\%$
 - Foundation Fieldbus specified 90°C in FF-844 as an additional requirement above IEC 61158-2
 - Dual use cable is likely to be similar

Problem is recognized

- http://www.fieldbus.org/images/stories/international/asiapacific/India/presentations/13-2009-ffieuc-leoni-alexander_weiss.pdf

Property	Foamed PE	Solid PE	XPE	FEP	PFA
Vp (% c)	77	66	66	69	71
Max. temp.	70°C	70°C	90°C	200°C	260°C



Solid Teflon materials

- Conclusion is that 90°C excludes the best Vp materials

Implications

- New installations
 - It has been shown that 1000 m link segment is achievable with the currently proposed level of PHY complexity
- Retrofit installations
 - There is an expectation that installed cables of “adequate construction” can be re-used
 - The PHY reach may be compromised by the most common materials

Example Cables

Vendor	Usage	Description	AWG	Dielectric	Temp
Belden	FF, Profi PA		18	PO	90°C
ABB	Profi PA	Standard	18	Foamed PE	75°C
ABB	Profi PA	Long Distance	16, 14	PE	75°C
Belcom	Profi PA	EasyStrip, EMC	18	Foamed PE	80°C
Belcom	Profi PA	Long Distance	16, 14	PE	80°C
HELUKABEL	Profi PA	Long Distance	16	Foamed PE	70°C
LAPP	Profi PA		18	Foamed PE	60°C
Southwire	Instrumentation	Class 1 Div. 2	18, 16	PVC, nylon	90°C
Galco	BACNet		22	PVC	75°C

https://library.e.abb.com/public/da54d5edee606e3ac1257aa0002f3dc9/10_63_647_EN_D.1.pdf

<https://www.belcom.co.uk/cable-range/fieldbus-cables/profibus/profibus-pa/>

http://www.helukabel.com/en/products/helukabel-reg-profibus-cable-l2-bus-1x2x1.0-pa-blue-armoured-opc-DNT_802180.html

<https://procentec.com/media/1287/standard-profibus-pa-cable-fc-uv-blue.pdf>

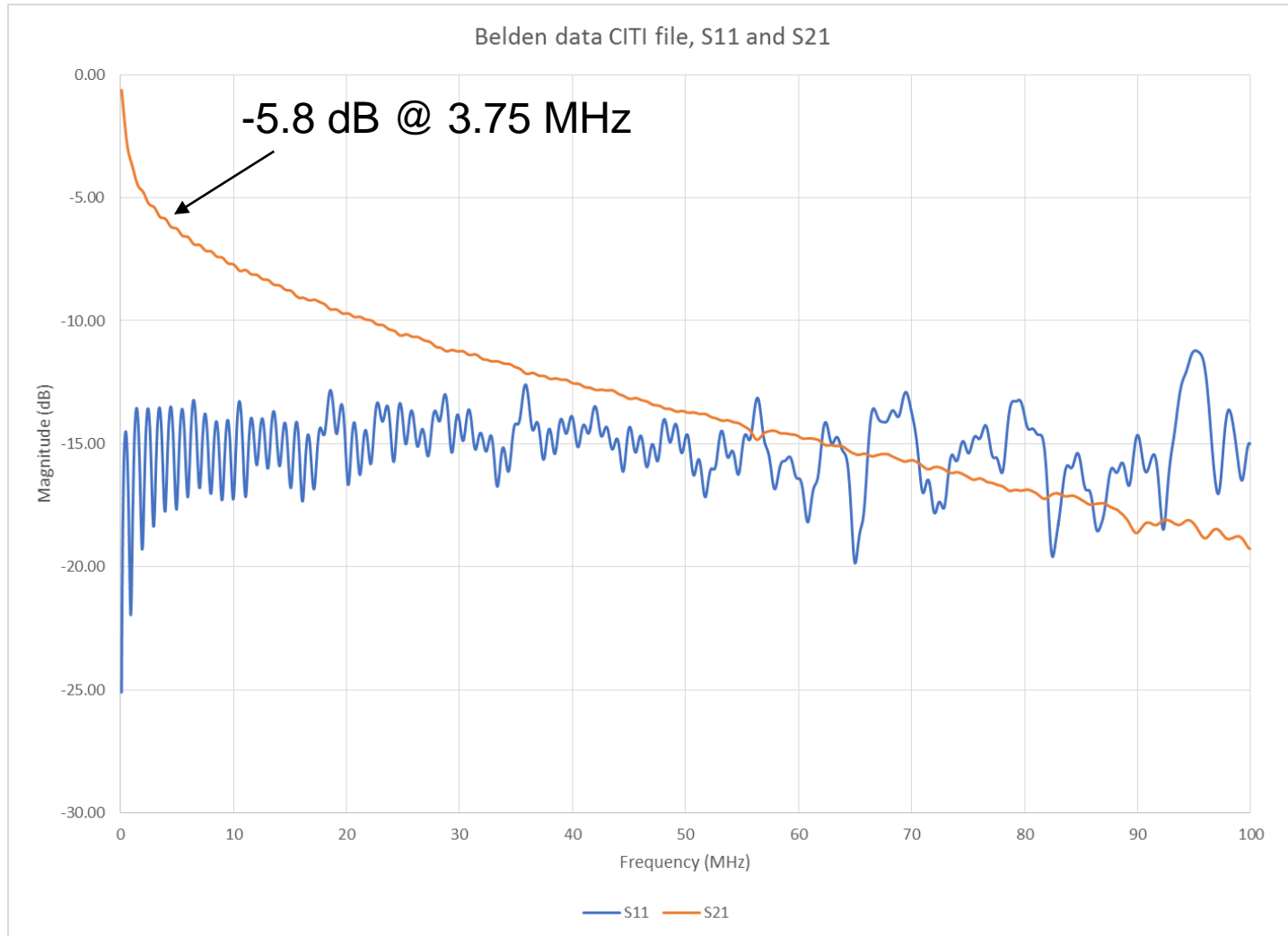
<http://www.southwire.com/products/subst-instrumentation-cable.htm>

https://www.galco.com/techdoc/jhsn/cbl-22_3-fc-pln_cp.pdf

Additional Belden 3076F characterization

- Thanks to Markus Wucher (Endress + Hauser) provided additional characterization via a local university
 - Includes longer distances, 100 m and 150 m
- Thanks to George Zimmerman for helping to get the database files plotted

Belden 3076F, 100 m



Belden 3076F reach estimate

- Cable IL (1000 m) = $10 \cdot (1.23 \cdot \text{SQRT}(f) + 0.01 \cdot f + 0.2 / \text{SQRT}(f))$
- Cable IL (1000 m, 3.75 MHz)
= $10 \cdot (1.23 \cdot \text{SQRT}(3.75) + 0.01 \cdot 3.75 + 0.2 / \text{SQRT}(3.75))$
- Cable IL (1000 m, 3.75 MHz) = $10 \cdot (2.38 + 0.04 + 0.10) = 25.2 \text{ dB}$
- $1000 \text{ m} \cdot 25.2 / 58 = 434 \text{ m}$
- This is a 33 dB gap
 - It seems unreasonable to increase PHY complexity to achieve an additional 33 dB of margin

Decreased rate?

For Belden Cable:

- 5 Mb/s, 1.875 MHz -> IL = 47 dB @ 1000 m
- 2 Mb/s, 750 kHz -> IL = 32 dB @ 1000 m
- 1 Mb/s, 375 kHz -> IL = 19 dB @ 1000 m

- Low enough rate encroaches on power
- Longest reach may be for a trunk between a application master and multiple slaves

Conclusions

- Reach of 1000 m is reasonable for new installations
- A portion (possibly a substantial portion) of the installed cable base will not achieve a reach of 1000 m in a retrofit situation
- Increasing PHY complexity or reducing data rate are not attractive options

Final thoughts

- We are aware of the issue
- Field measurement could identify the issue
- If long link segments are broken into sections, interposing field switches could be applied
- We lack knowledge of the distribution of lengths in the field
 - 400 m is still substantial
- New cable can be pulled selectively
- New installations do not have the issues, so it will disappear over time