Balanced Cabling for 40 Gb/s over less than 100 m ISO/IEC PDTR 11801-99-1

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Information technology – Guidance for balanced cabling in support of at least 40 Gb/s data transmission

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Content

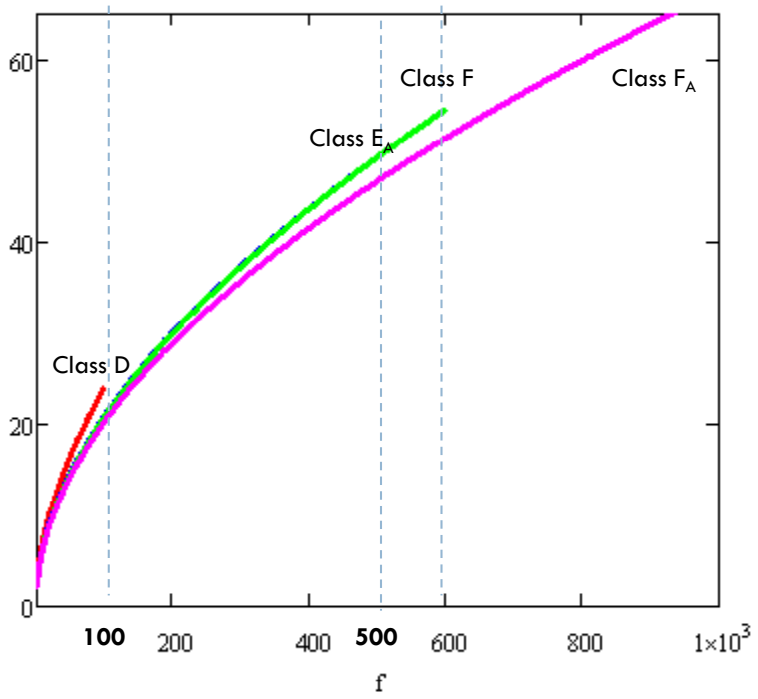
- 40G cabling & the existing generic cabling model
- 40G Cabling Measurements
- Assessment of cabling capacity for 40 Gb/s
  ISO/IEC PDTR 11801-99-1 Annex B

ISO/IEC Generic Cabling

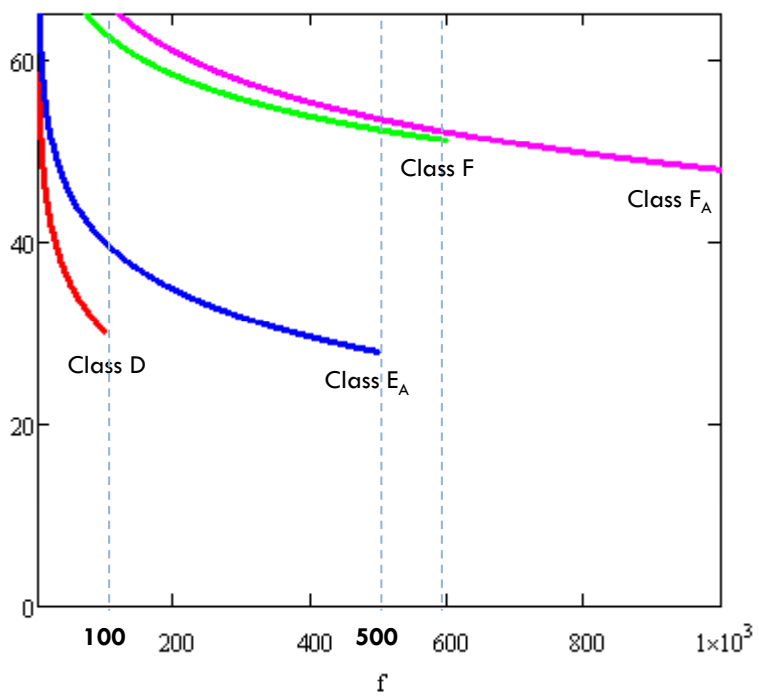
- In ISO/IEC 11801: 2010 cabling channels are specified as generic, 100 m with 4 connections.
  - Channel Approach
  - Reference implementation (Component Approach)
- If the installed length is less then 100 m with fewer than 4 connections, e.g. 40 m 2 connections, all 100 m channel limit values hold

ISO/IEC Generic Cabling

- Insertion Loss

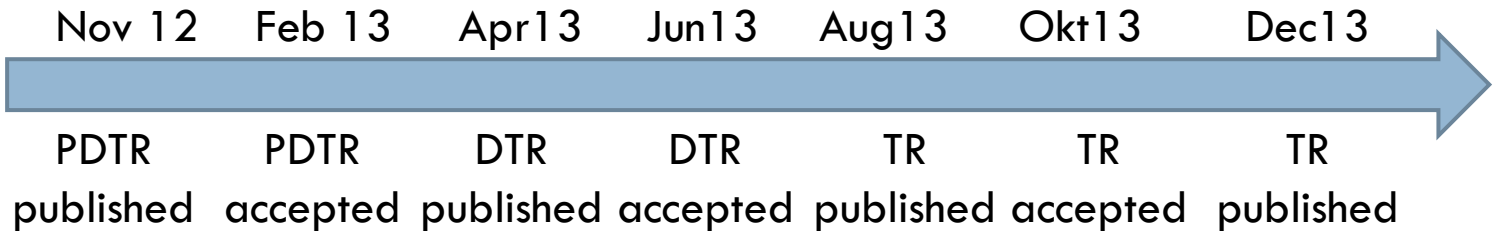


- NEXT



40G Balanced Cabling Support

- ISO/IEC Proposed Draft Technical Report 11801-99-1
  Information technology – Guidance for balanced cabling in support of at least 40 Gb/s data transmission



40G Balanced Cabling Support

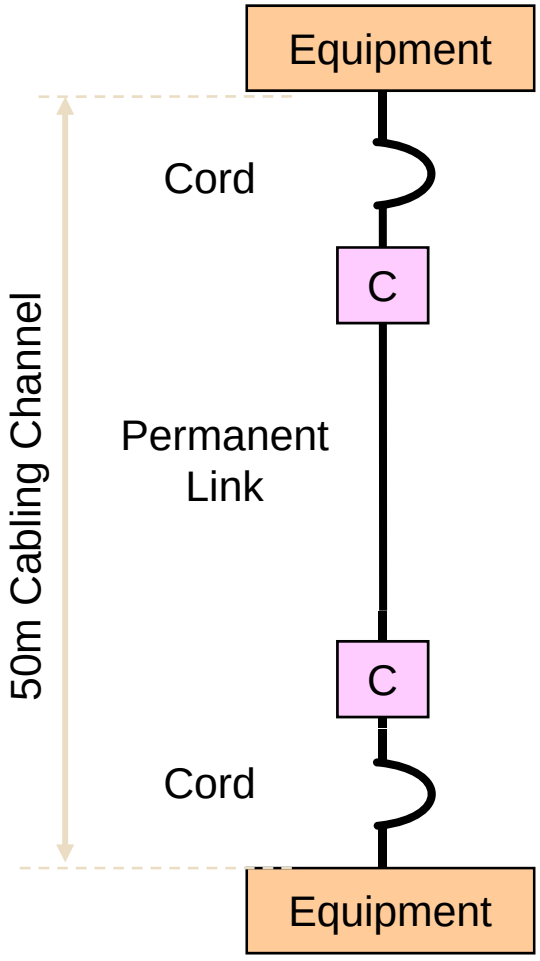
- ISO/IEC PDTR 11801-99-1 specifies shorter channels and less connectors (2 at each end with 2 m cords)
- Use existing specifications with extended frequencies
  - 25 m with Cat. 6_A (500 MHz)
  - 25 and 50 m with Cat. 7_A (1000 MHz)
  - 50m with improved components (1600 MHz)

    Class I with extended and improved **Cat. 6_A** components

    Class II with extended and improved **Cat. 7_A** components
  - Clause 6 explains qualification of existing channels

Note: Channel length is not fixed, PDTR is a Draft.
Formulas to calculate other length are found in Annex A of PDTR.

Comparison of ISO/IEC & TIA



- both use 50 m channel with 2 connectors
- Insertion loss is similar (connectors different)
- TIA Cat. 8 based on Cat. 6A components with some enhancements
- ISO/IEC Class I & II is based on fictitious components yet to be standardized.
- TIA upper frequency 2 GHz TBD
  ISO/IEC 1.6 GHz (values up to 2 GHz ffs)
- TIA-568-C.2.1 standard in development
- ISO/IEC 11801-99-1 TR expected in Q4-2013

Comparison of ISO/IEC & TIA

- Main differences of ISO/IEC Class I and II and TIA-568-C.2.1 at 1 GHz in dB

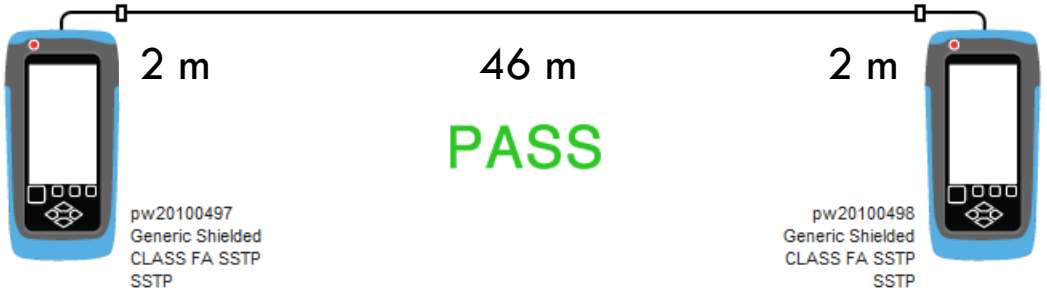
Parameter	Class I	Class II	Diff CI-II	TIA
Return Loss	6.0 ffs	8.0 ffs	2.0 ffs	6.0 TBD
Insertion Loss	33.5	31.5	2.0	35.3 TBD
NEXT	22.6	47.9	25.3	16.9 TBD
ACR-F	7.4	37.1	29.7	10.9 TBD

Result:

Less cancellation is needed for Class II

Measurements on prototype channels I and II

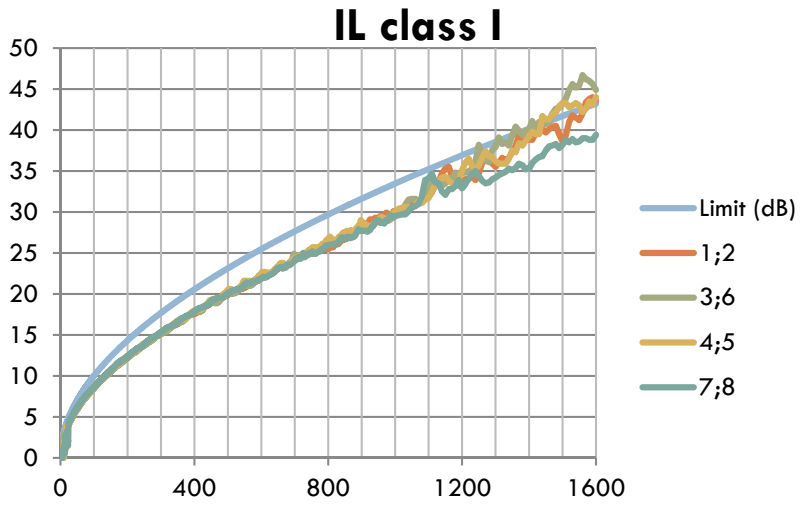
The measurements were performed with an PSIBER WIREXPERT up to 1600 MHz in the channel F_A setting

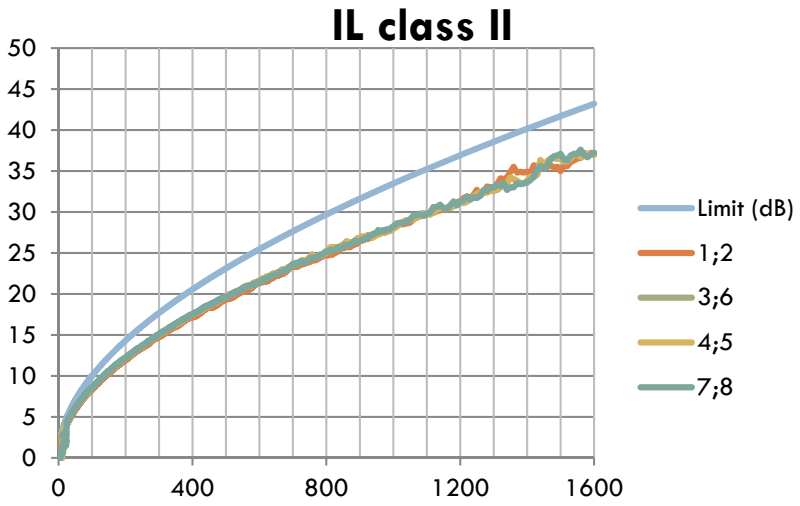


- 46 m horizontal cable S/FTP optimized for 1600 MHz, 8 mm diameter
- 2 m S/FTP patch cords cat6_A and Cat. 7_A non optimized, influence can be seen
- Class I connecting hardware selected Cat. 6_A
- Class II connecting hardware selected Cat. 7_A

Measurement results Class I and Class II

- Insertion Loss (non optimized patch cords)

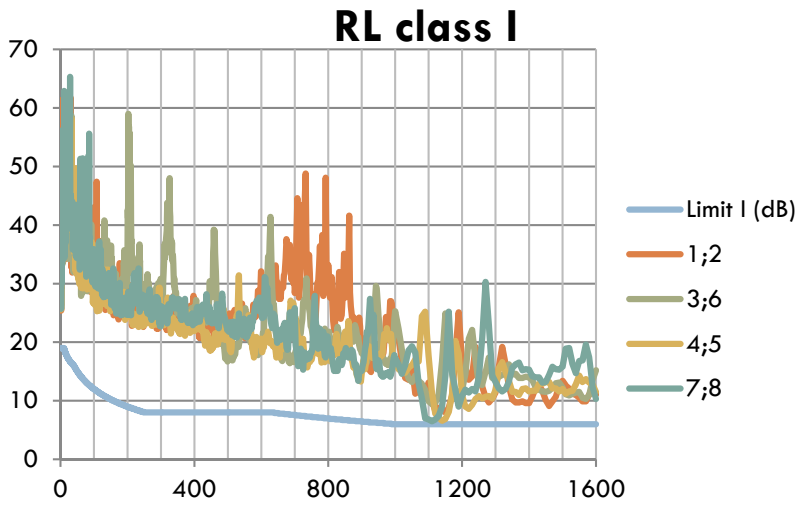


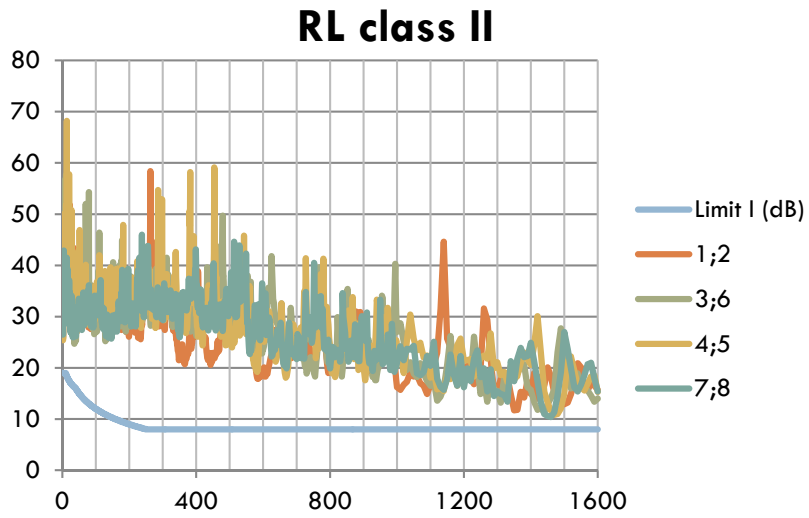


Limits met (influence of patch cords)

Measurement results Class I and Class II

- Return loss (limits ffs)

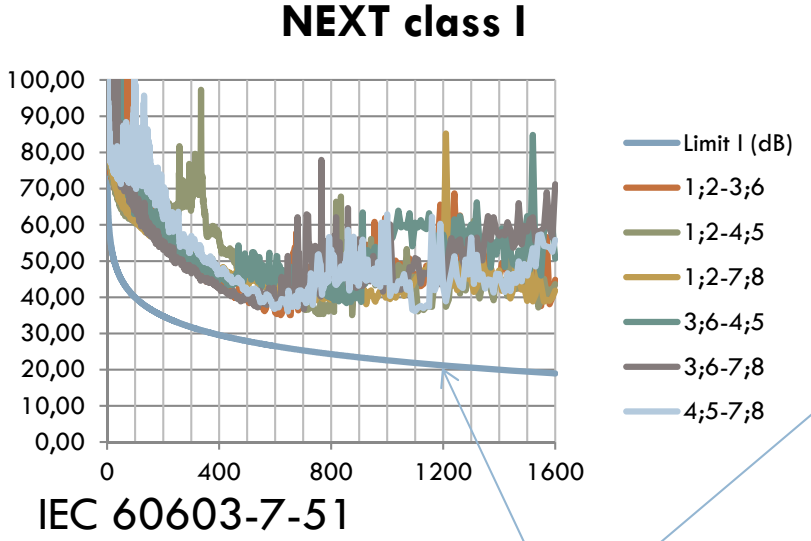




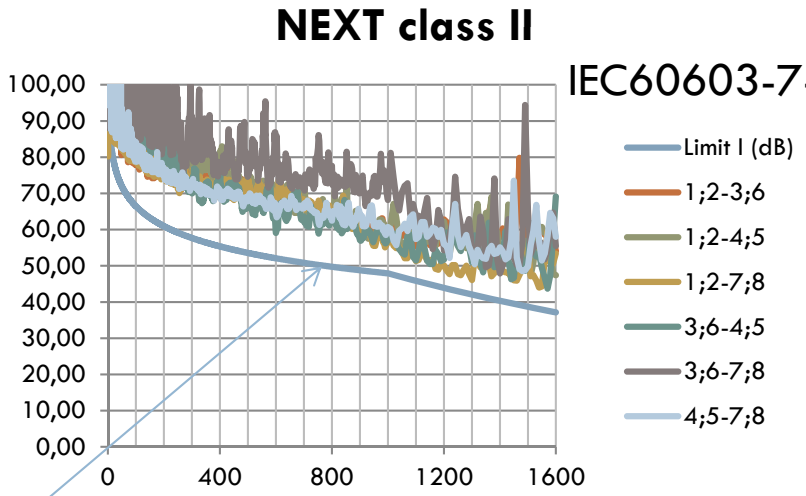
Limits met!

Measurement results Class I and Class II

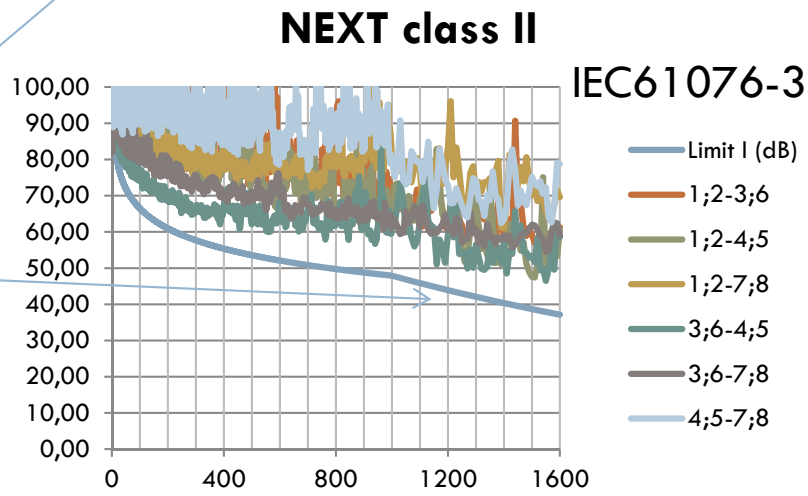
- Near end crosstalk



IEC 60603-7-51



IEC60603-7-71

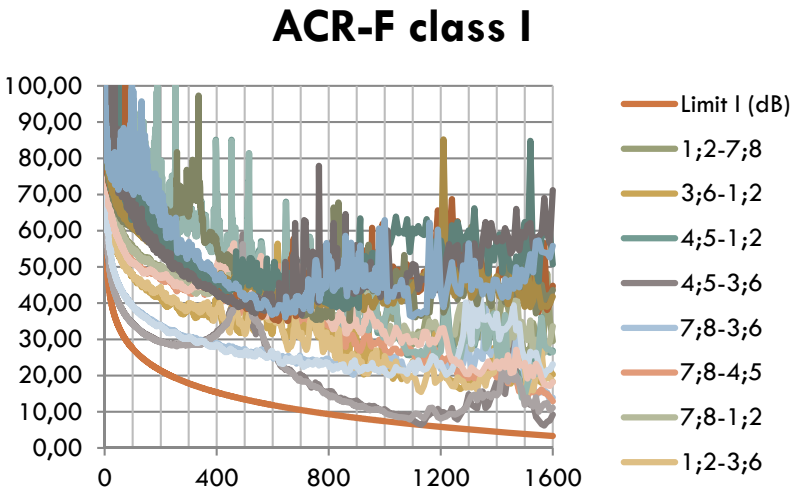


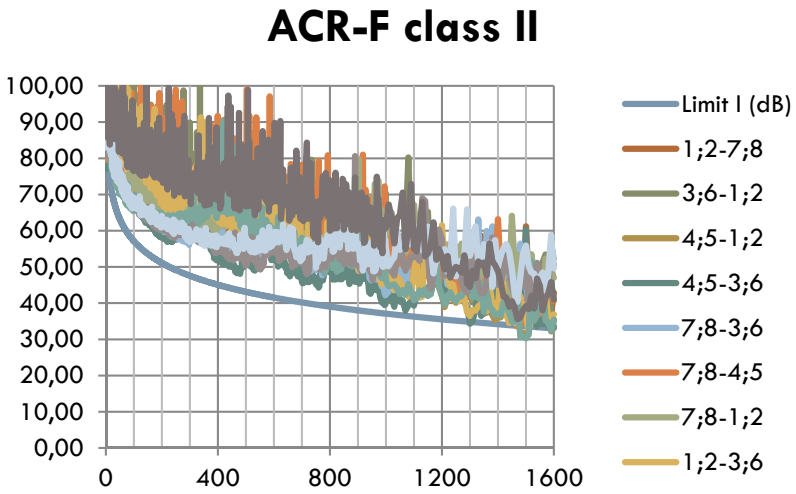
IEC61076-3-104

Limits met!

Measurement results Class I and Class II

- Attenuation to Crosstalk Far End





Limits met (effects of patch cords)

Annex B of ISO/IEC PDTR 11801-99-1

Assessment of cabling capacity for 40 Gb/s

- Assumptions
  - 155 dBm/Hz PHY background noise
    - As values up to 145 were discussed they will be presented but outside PDTR
  - Transmitter signal level 3 dBm
  - Cabling noise for the moment assumed to be neglected due to
    - Alien noise by shielding
    - NEXT, FEXT and RL by cancellation

Cancellation

Compensation of Cable Noise

To compensate the cabling noise below the background noise the following levels for the proposed classes need to be used. The 2 GHz values were calculated extrapolating the limits.
For other noise and transmit power values they translate linearly.

Table B1: compensation levels in dB at 50m channels for selected frequencies

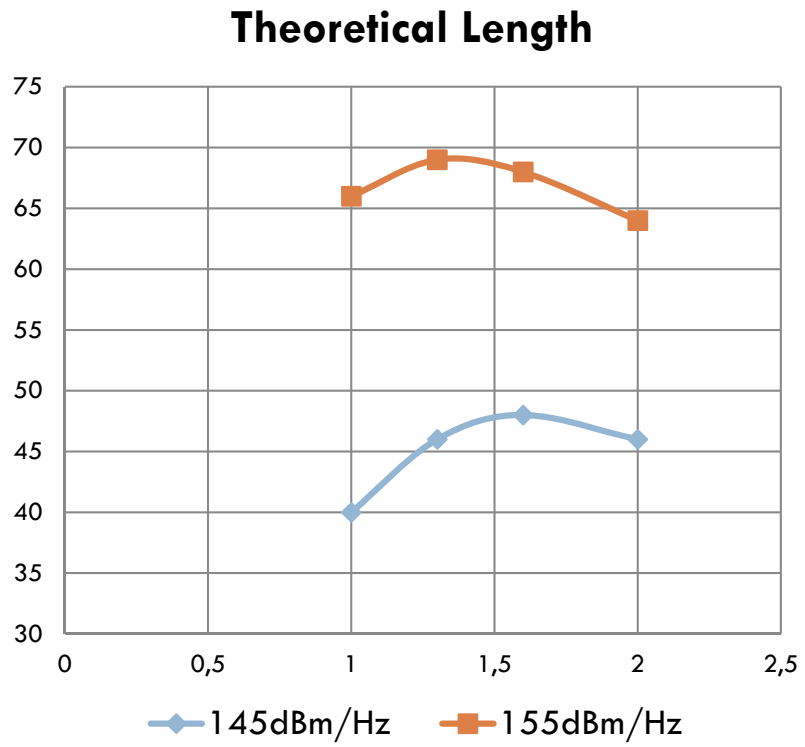
	Class I			Class II		
Max frequency GHz	1,2	1,6	2,0	1,2	1,6	2,0
Background noise level dB	67	66	65	67	66	65
CNEXT dB	50	50	52	25	30	35
CFEXT dB	40	37	36	7	5	5
CReturn loss dB	65	65	64	66	65	64

Channel Capacity

- Calculations of channel capacity were performed similar to the calculation presented by W. Bliss at the September 2012 meeting (bliss_01_0912.pdf)
- As margin is a preferred presentation this was added for 40 Gb/s to the Shannon capacity.
- The compensation was assumed flat over frequency up to the channel bandwidth.

Theoretical Length for 40 Gb/s

- Theoretical length as function of frequency under the assumption of 10 dB margin



Margin	1.0 GHz	1.3 GHz	1.6 GHz	2.0 GHz	
10dB	40 m	46 m	48 m	46 m	145dBm/Hz
10dB	66 m	69 m	68 m	64 m	155dBm/Hz

Conclusions

- Main purpose of the TR is to support the IEEE 40GBASE-T project with a range of possible solutions. Once the IEEE project has selected an appropriate channel, ISO/IEC will then consider the development of a formal standard for this.
- Publication of the Technical Report is expected in Q4-2013.
- 50 m channels are achievable under the PDTR assumptions.
- Class II channels require significantly less cancellation than Class I and EIA/TIA Cat. 8 channels.
- Existing ISO/IEC Cat. 7_A components specified to their existing upper frequency are sufficient
- Measurements to date suggest that proposed Class I & Class II channel limits are realistic.
- Bandwidth >1.3 GHz reduces the maximum length

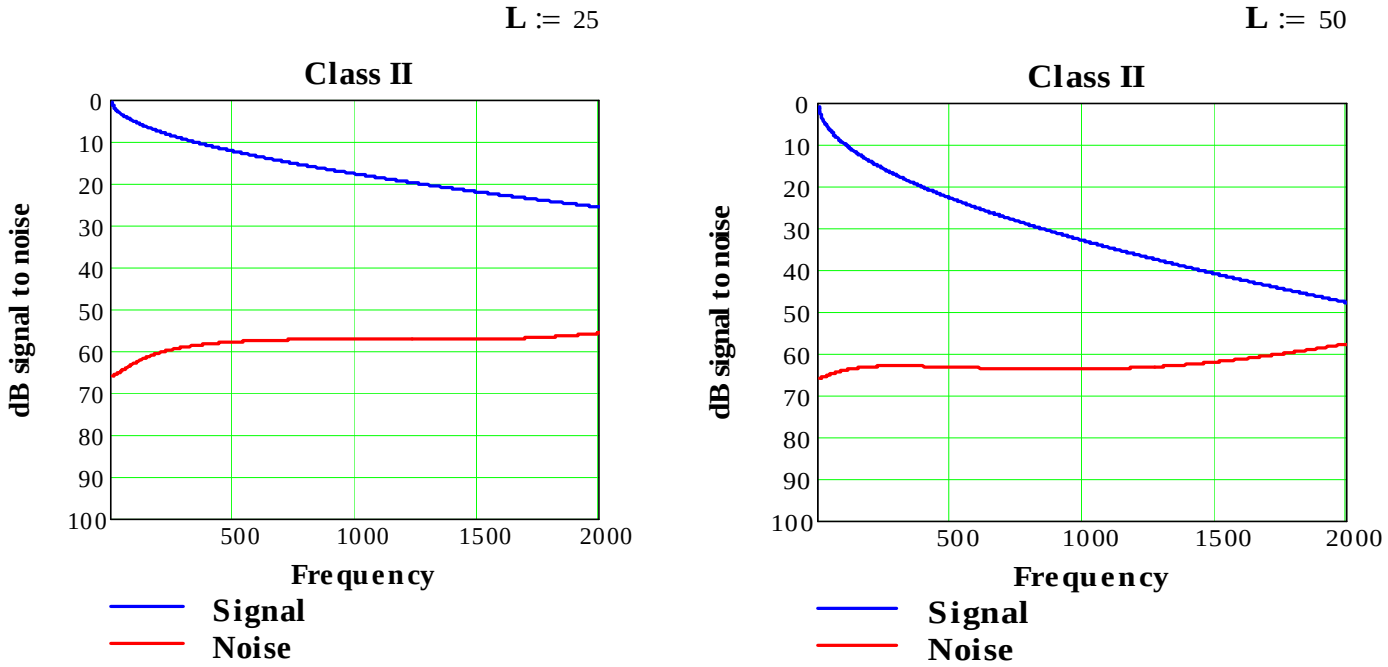
Thanks for your patients with me

Signal to Noise

2 theoretical channel length showing the signal and noise over frequency. As the noise was not completely compensated some influence can still be seen

At shorter length the theoretical increased FEXT is observed. Shielded pairs used normally in Class F_A and upwards behave differently . The expected influence is much less.

Channel I figures similar because of assumptions



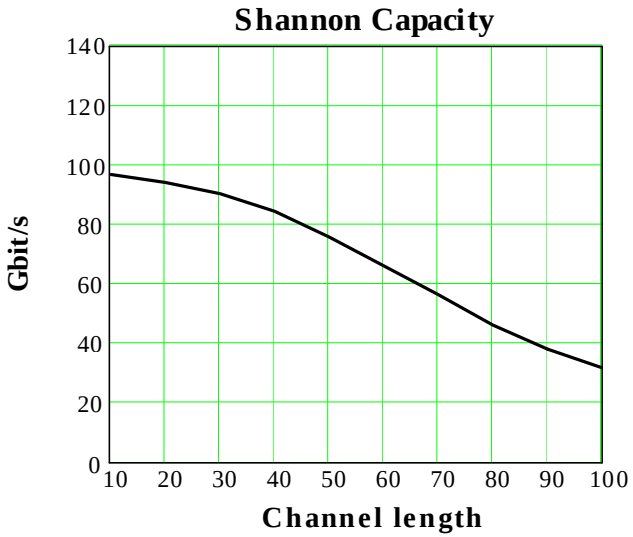
Shannon Capacity

The Shannon capacity and the corresponding margin for the case shown before

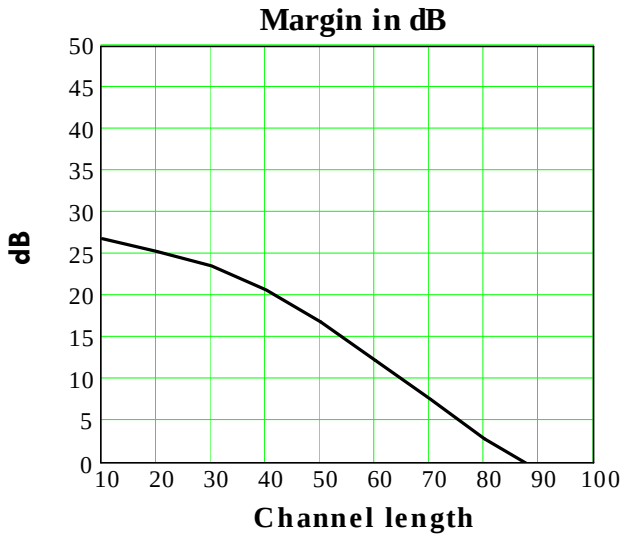
The deviation from a straight line

- below 40 m is because of the increasing FEXT (compensation was kept constant) and
- above 80 m because the S/N gets below 0 dB

Max Frequency 1600 MHz

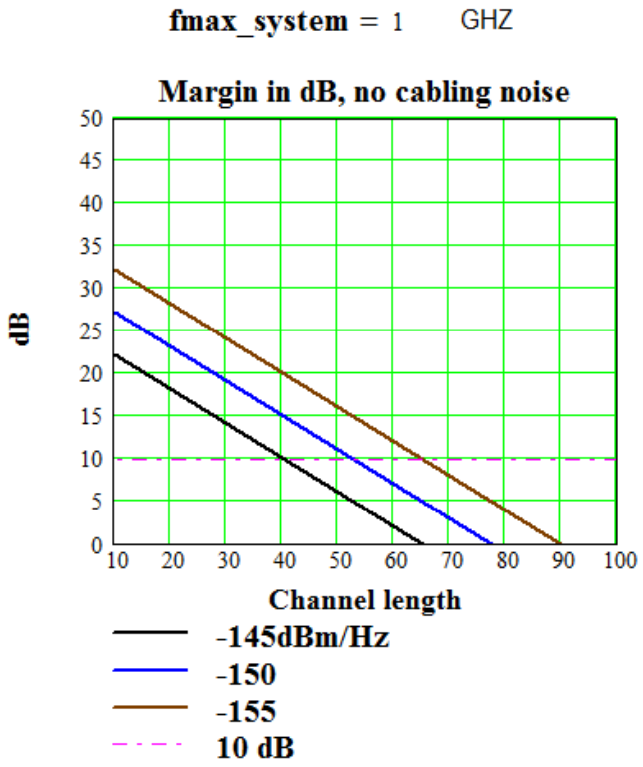


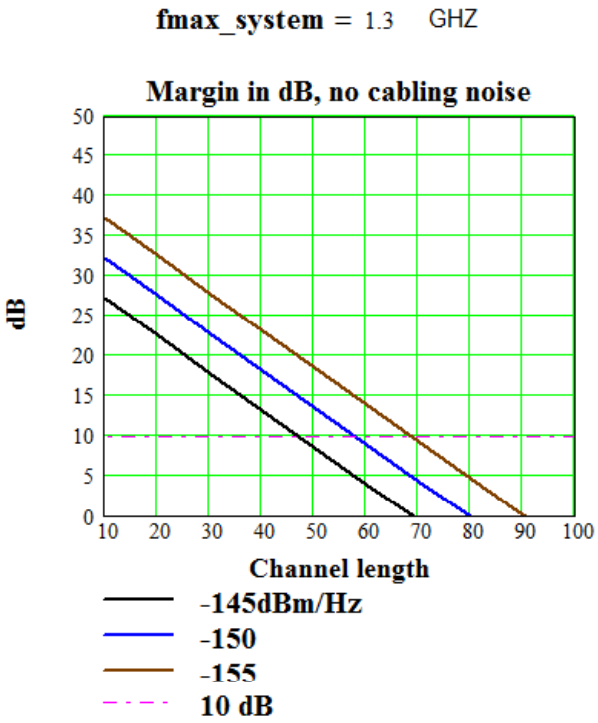
Margin at 40 Gb/s in dB



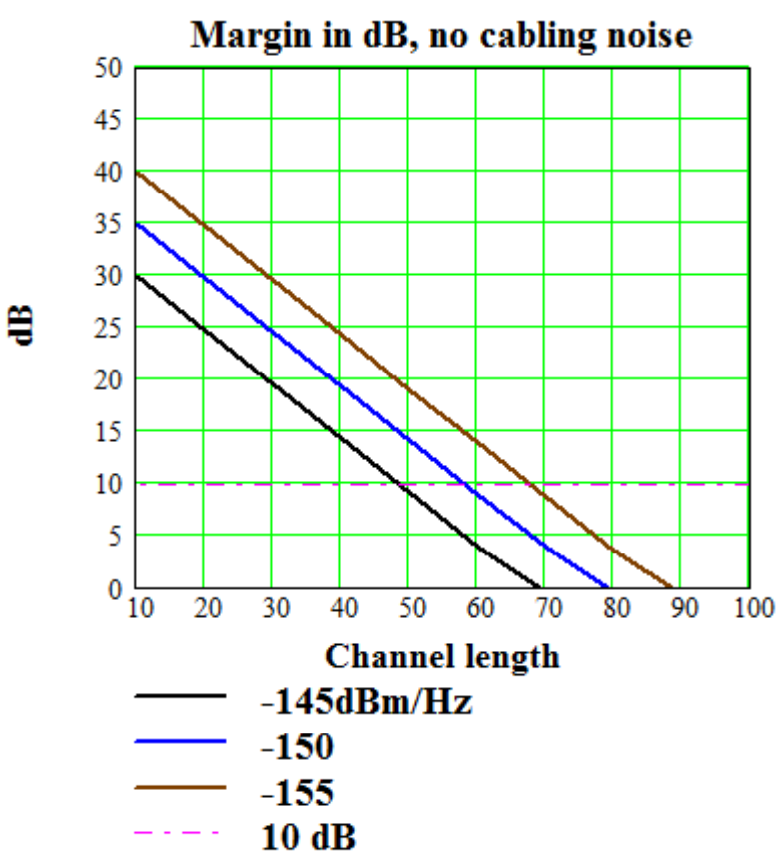
Additional Calculations

To see different possibilities new calculations were performed (not seen in PDTR) with different background noise levels. No cabling noise assumed. Therefore margin results for short length in a straight line.

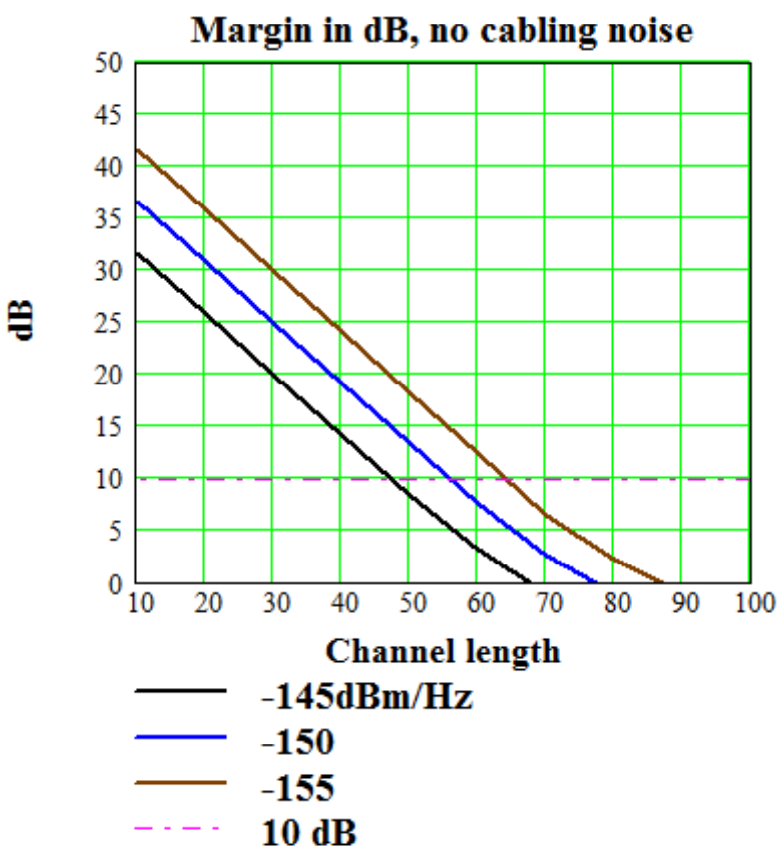


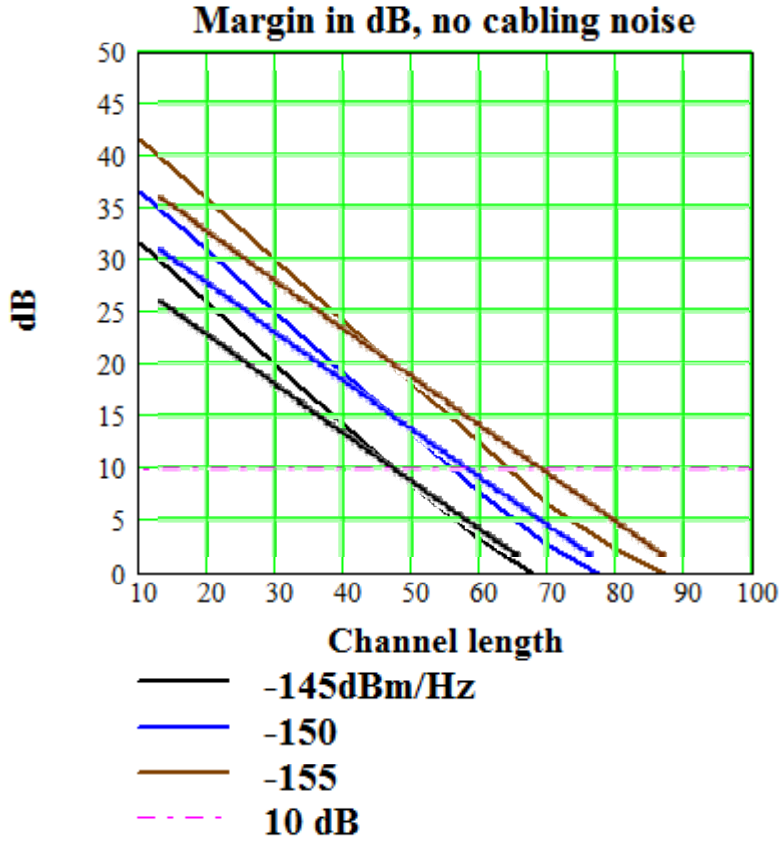


fmax_system = 1.6 GHZ



fmax_system = 2 GHZ





1,3 and 2 GHz figures overlaid
The short lines are for 1.3 GHz

It is therefore of no advantage to go to 2 GH for the assumptions chosen