Noise Immunity Performance Analysis of Screened Cabling Systems

Comparison of various cables & channels

Martin Rossbach, Nexans Cabling Solutions

IEEE P802.3bq 40GBASE-T Task Force
Victoria, BC, Canada
May 16, 2013

Overview

- Definition
- Current Specifications in ISO/IEC and TIA
- Test Data Cables
- Test Data Channels
- Conclusions and Recommendations

Definition of Coupling attenuation

- **What is Coupling Attenuation?**

  Coupling Attenuation is a measure of both emission and immunity of twisted pair cabling. It is defined as the ratio of the power transmitted into the pair to the power coupled into its environment.

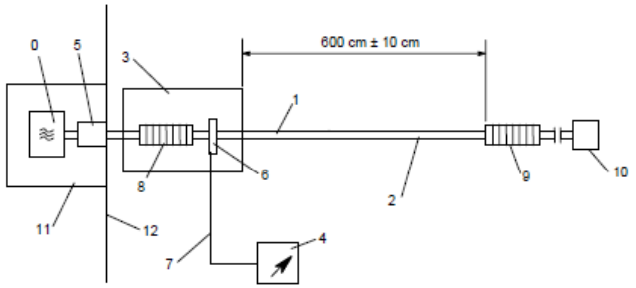
- For balanced cables it combines **unbalance attenuation (a_u)** and **screening attenuation (a_s)**

$$a_c = a_u + a_s$$

IEC Standards for Coupling Attenuation

- Full Set of Test Standards is developed
- 2 Methods comparable results (~3 dB deviation[1])
  - Absorbing Clamp
  - Triaxial
- Frequency Range covered : 1 – 1GHz

IEC 62153-4-5: Metallic communication cable test methods – Part 4-5: Electromagnetic Compatibility (EMC) – Coupling or screening attenuation – Absorbing clamp method

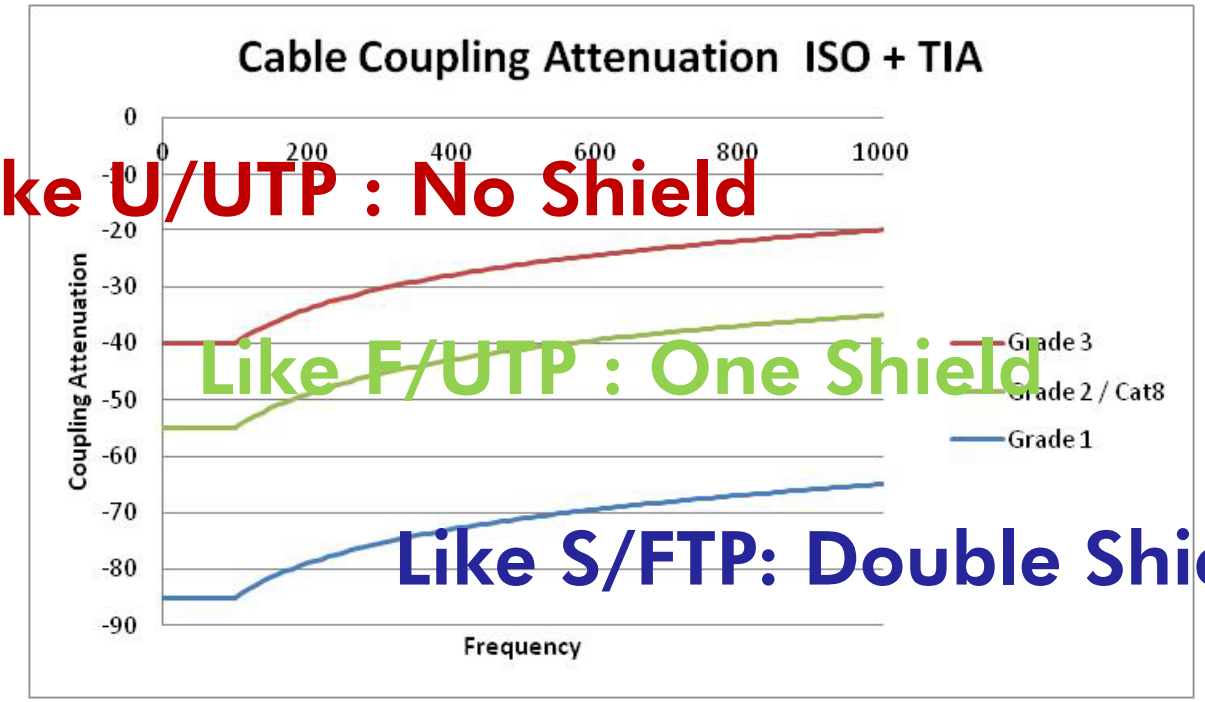


IEC 62153-4-9 / Ed.1.0	Metallic communication cable test methods —Part 4 - 9: Electro Magnetic Compatibility (EMC) — Coupling attenuation of screened balanced cables, triaxial method	published
IEC 62153-4-10 / Ed.1.0	Metallic communication cable test methods - Part 4-10: Electromagnetic Compatibility (EMC) - Shielded screening attenuation test method for measuring the screening effectiveness of feed-throughs and electromagnetic gaskets - Double coaxial method	published
IEC 62153-4-11 / Ed.1.0	Metallic communication cable test methods - Part 4-11: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of patch cords, coaxial cable assemblies, pre-connectorized cables - Absorbing clamp method	published
IEC 62153-4-12 / Ed.1.0	Metallic communication cable test methods - Part 4-12: Electromagnetic compatibility (EMC) - Coupling attenuation or screening attenuation of connecting hardware - Absorbing clamp method	published
IEC 62153-4-13 / Ed.1.0	Metallic communication cable test methods - Part 4-13: Electromagnetic compatibility (EMC) - Coupling attenuation of links and channels (laboratory conditions) - Absorbing clamp method	published
IEC 62153-4-14 / Ed.1.0	Metallic communication cable test methods — Part 4 - 14: Electro Magnetic Compatibility (EMC) — Coupling attenuation of cable assemblies (field conditions) absorbing clamp method	published

Note 1: O. Breitenbach, T. Hähner, B. Mund, "Screening of cables in the MHz to GHz frequency range extended application of a simple measuring method", Colloquium on screening effectiveness measurements, Savoy Place London, 6 May 1998, Reference No:1998/452; T. Hähner, B. Mund, Background, content and future of the EMC measurement standard prEN 50289-1-6, T. Hähner, B. Mund, EMC Symposium Wroclow 2000, TEST METHODS FOR SCREENING AND BALANCE OF COMMUNICATION CABLES, EMC Symposium Zürich, 1999

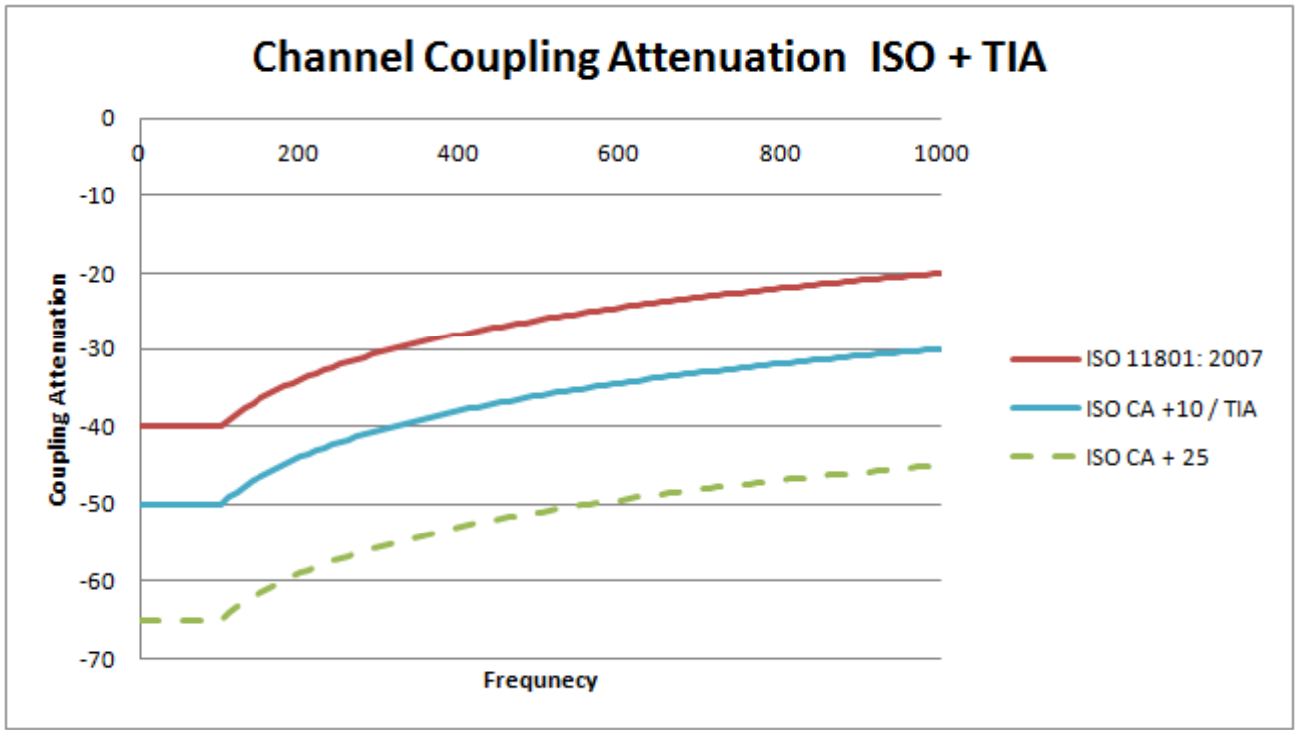
Current Specifications: Cable

- ISO/IEC Cable standard (IEC61156-5) know 3 different cable grades in terms of Noise Immunity



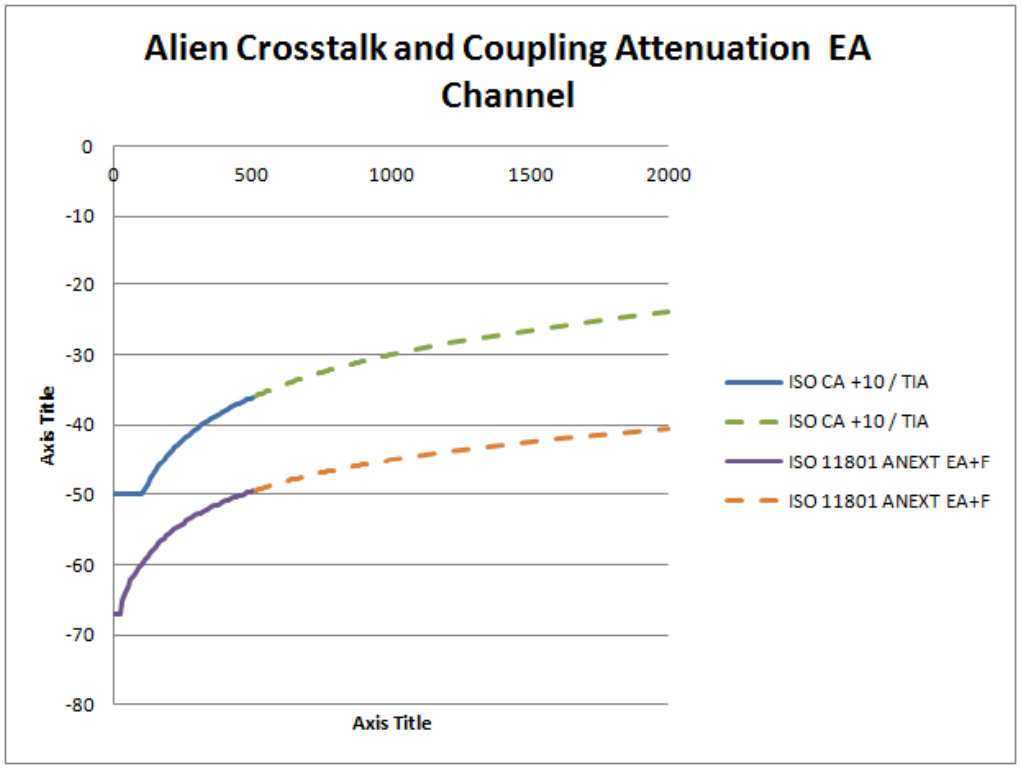
Current Specifications: Channel

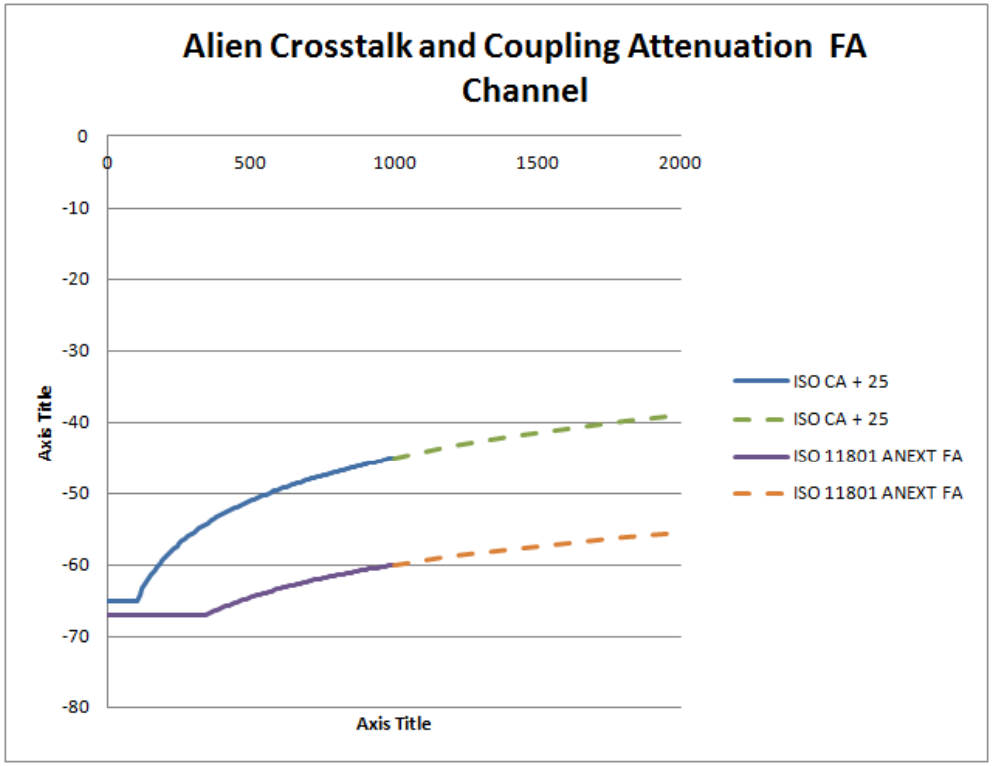
- ISO/IEC 11801 has one requirement for all cabling channels and does not make a difference between various cabling types
- Some difference in Noise immunity is recognised in combination with Alien Crosstalk testing : +10dB an + 25 dB leads to „Met by design“ rule
- TIA recently added Coupling attenuation and now defines a requirement for Cat. 8
- ISO 40GReport uses also +10dB line



CA and PSANEXT

- ‚Met by Design' Rules of ISO11801 imply that Alien Crosstalk assumed to be at least 15dB better then Coupling attenuation





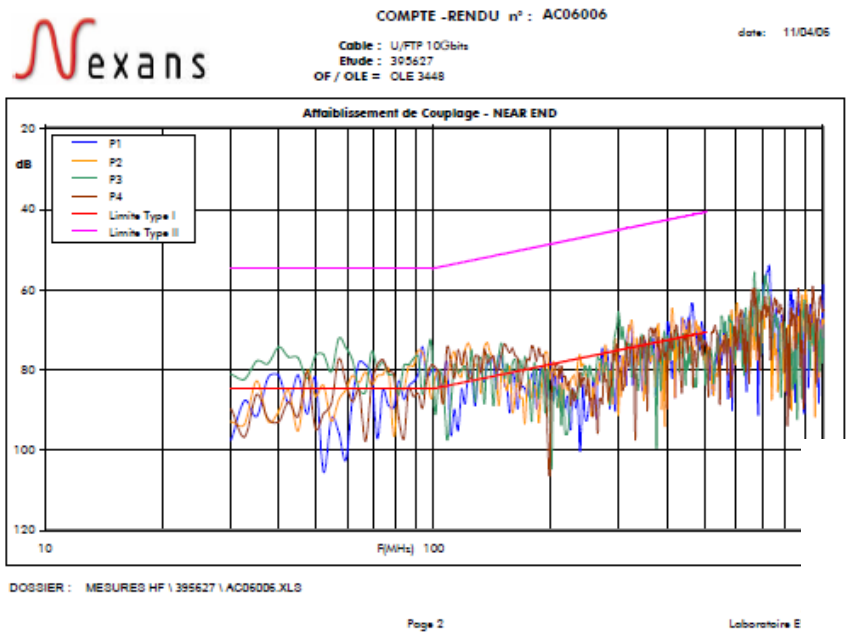
TEST DATA CABLE

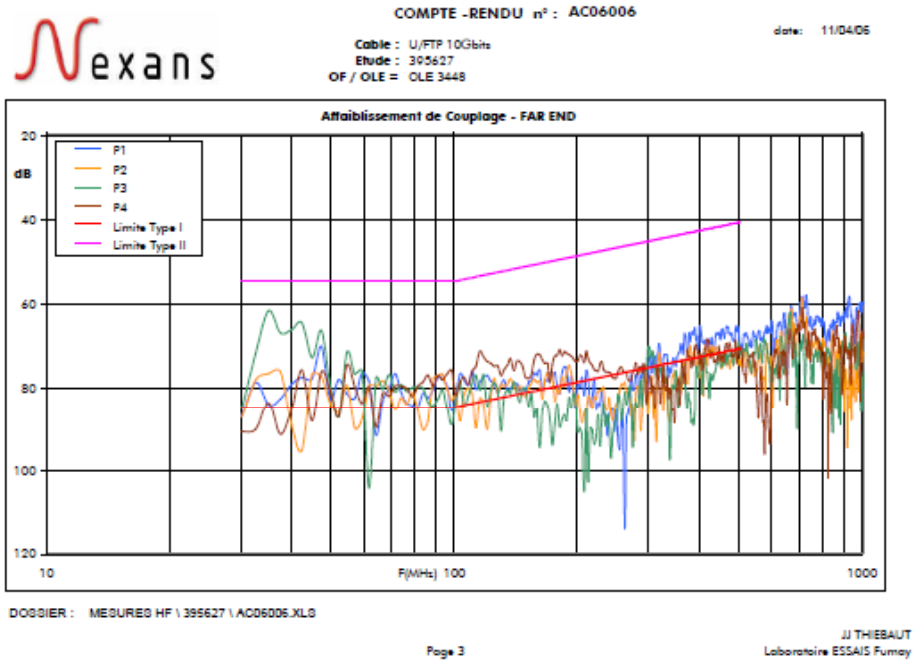
Test Description

- All measurements done during 2009 and 2010
- Testmethod: EN50289-1-6
- Frequency Range : 30-1000MHz
- 7 cable types tested

Name	Outer Shield	Pair Shield
CAT6 F/UTP	Foil	No
Cat6A F/UTP	Foil	No
Cat6A U/FTP	No	Foil
Cat6A F/XTP	Foil	Half Alu Cross
Cat6A F/FTP	Foil	Foil
Cat7A S/FTP low	Loose Braid	Foil
Cat7A S/FTP High	Tight Braid	Foil

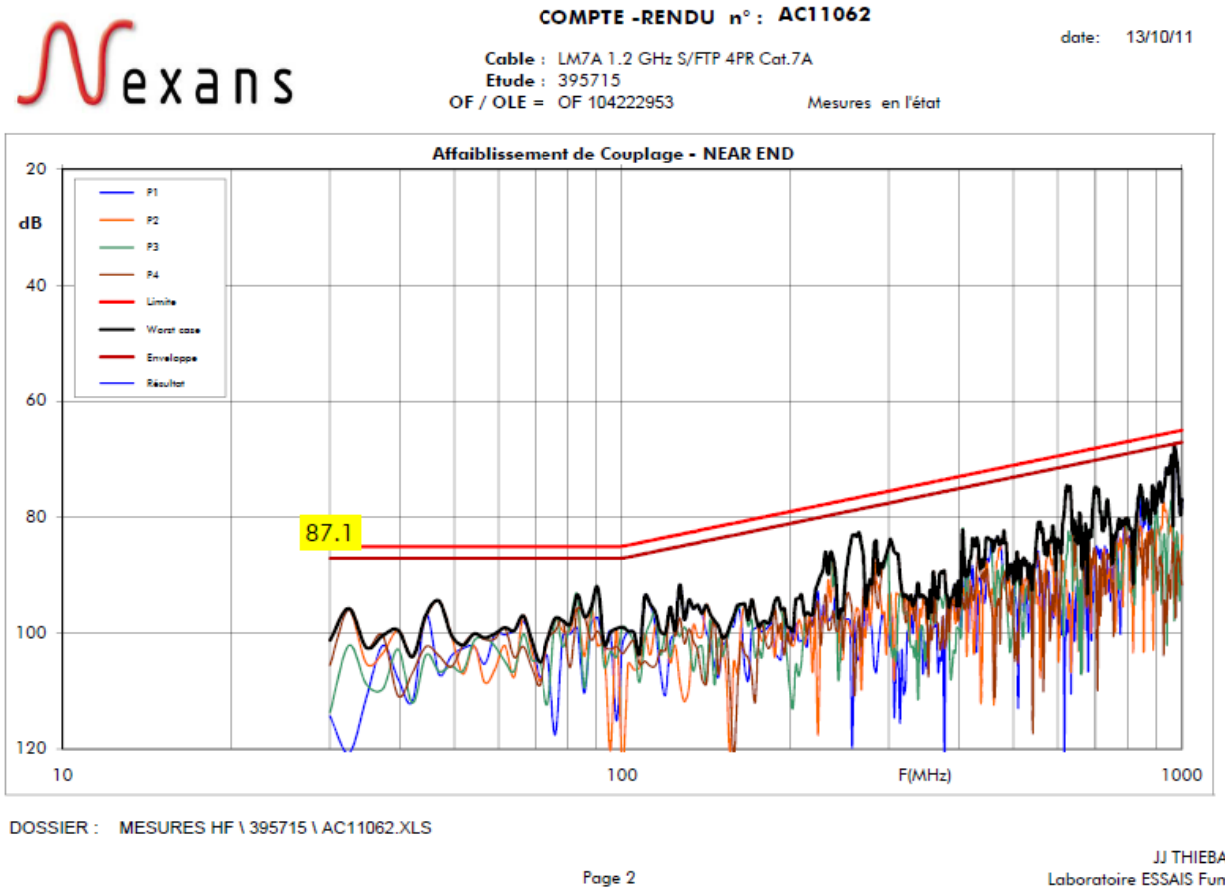
Worst Case: Cat6A UFTP Cable





Best Case: Cat7A Cable 1200MHz

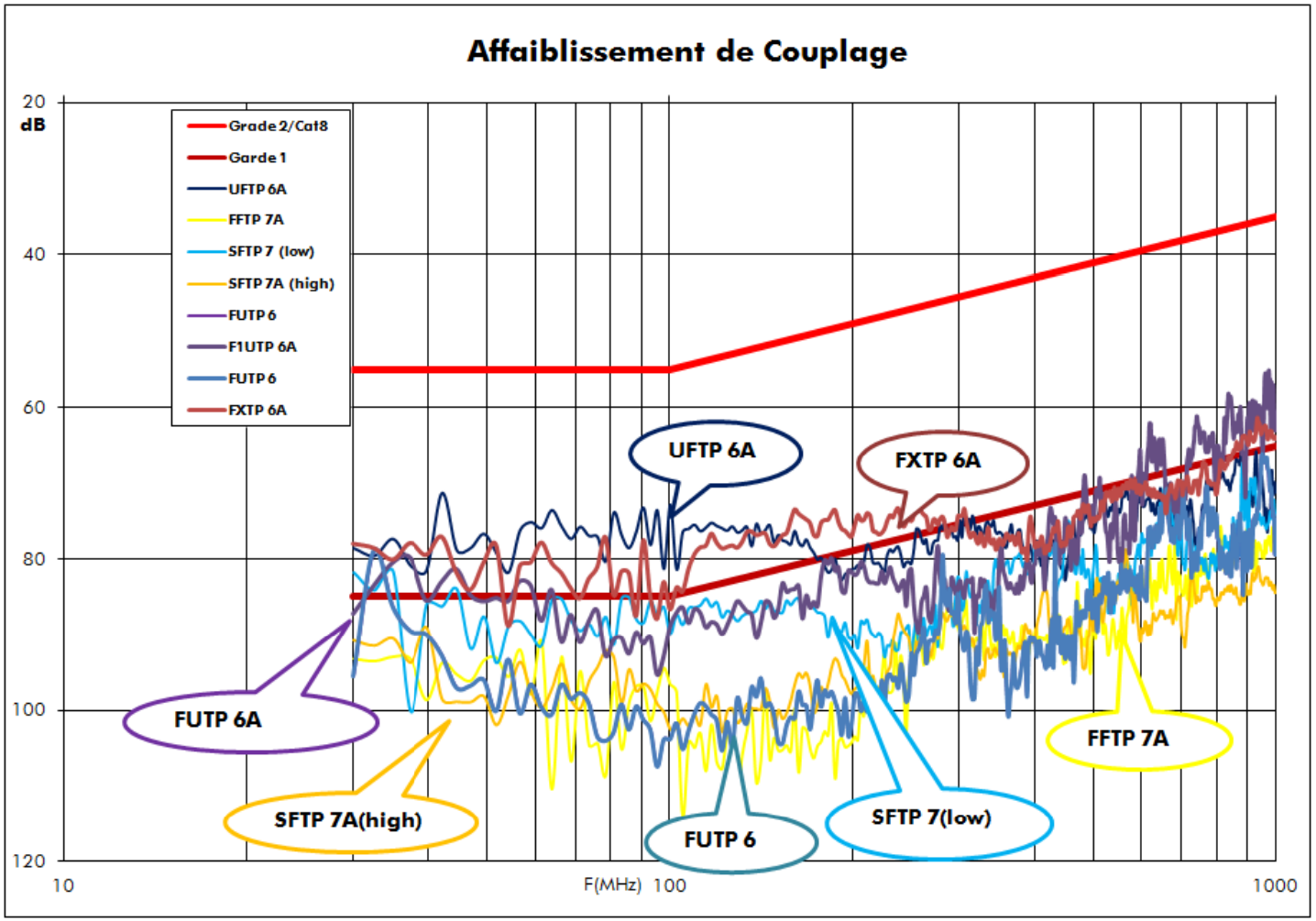
- SFTP Cat7A 1200MHz



Comparison of Cabling Types

Observations

- 1 Shield = Enables Grade 2
- 1 Shield and Good Balance enables almost Grade 1 (not at extremes of freq range)
- 2 „Good“ Shields = Enable Grade 1
- Current Spec of ISO/TIA not very ambitious

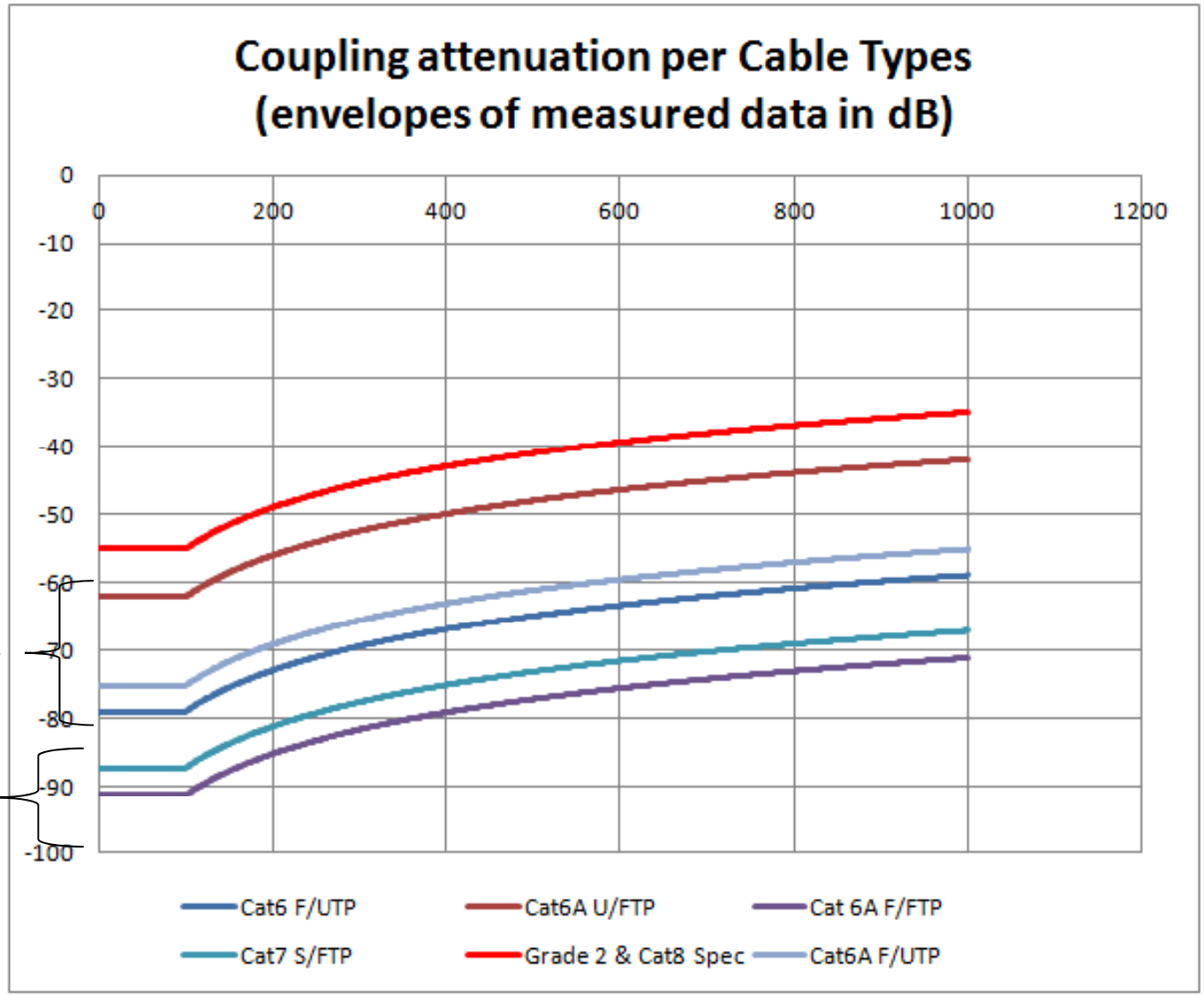


Comparison of Screened Cable Types

- Same test results but presented in form of limit lines / envelopes
- Significant Improvement compared to Grade 2 / Cat.8 spec is possible

Single Shield ←

Double Shield ←

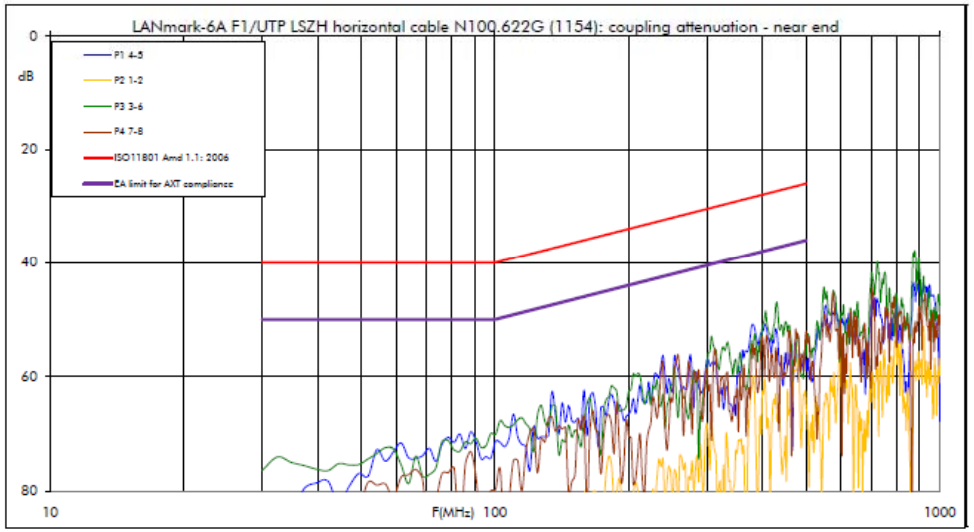


TEST DATA CHANNEL

- Historic Data made in 2009
- Frequency Range 30-1000 MHz
- 3Types of Cables : F/UTP; F/FTP; S/FTP
- 2 Types of Connectors IEC60603-7-51 (RJ45);
  IEC60603-7-71 (GG45)

Coupling Attenuation

- Cat6A Connectivity with F/UTP Cable



Pass margins

ISO11801 Amd 1.1: 2006 Table 22

	P1 4-5	P2 1-2	P3 3-6	P4 7-8	
	22.4	14.8	19.6	24.4	dB
at	379.2	478.6	430.1	258.0	MHz

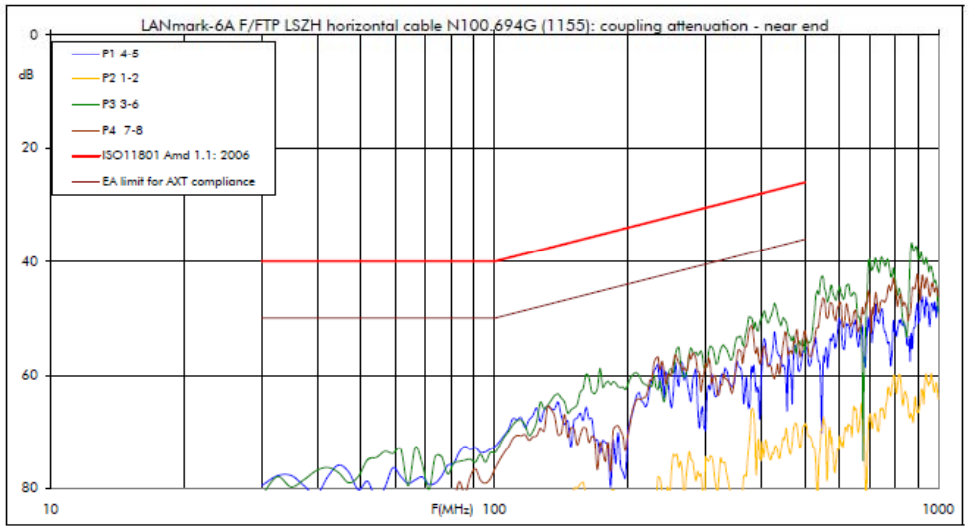
ISO11801 Amd 1.1: 2006 Clause 6.4.15.1
Coupling attenuation limit for Class EA
PS ANEXT and PS AACR-F compliance by design

	P1 4-5	P2 1-2	P3 3-6	P4 7-8	
	12.4	4.8	9.6	14.4	dB
	379.2	478.6	430.1	258.0	MHz

Nexans Cabling Solutions

19/11/2009 15:01

Cat6A Connectivity with F/FTP Cable



Pass margins

ISO11801 Amd 1.1: 2006 Table 22

	P1 4-5	P2 1-2	P3 3-6	P4 7-8	
	25.1	22.3	20.0	22.8	dB
at	427.7	381.6	427.7	379.2	MHz

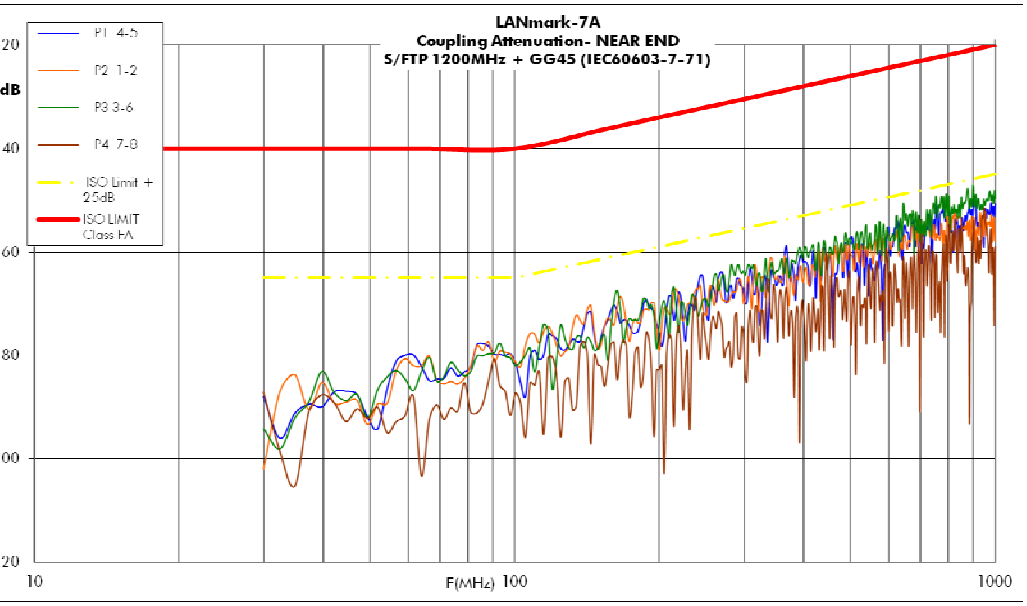
ISO11801 Amd 1.1: 2006 Clause 6.4.15.1
Coupling attenuation limit for Class EA
PS ANEXT and PS AACR-F compliance by design

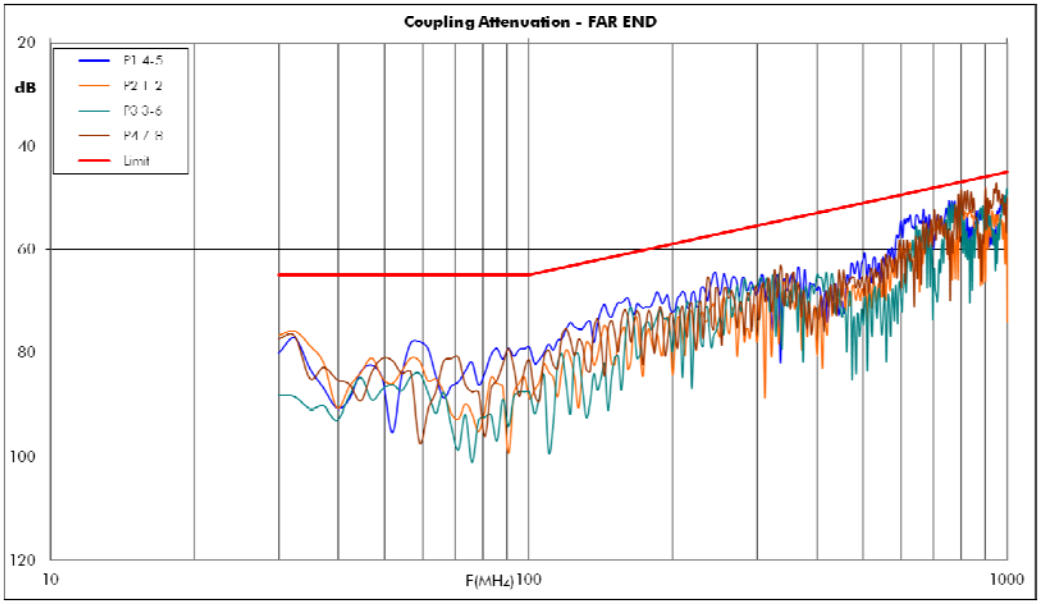
	P1 4-5	P2 1-2	P3 3-6	P4 7-8	
	15.1	12.3	10.0	12.8	dB
	427.7	381.6	427.7	379.2	MHz

Nexans Cabling Solutions

19/11/2009 15:02

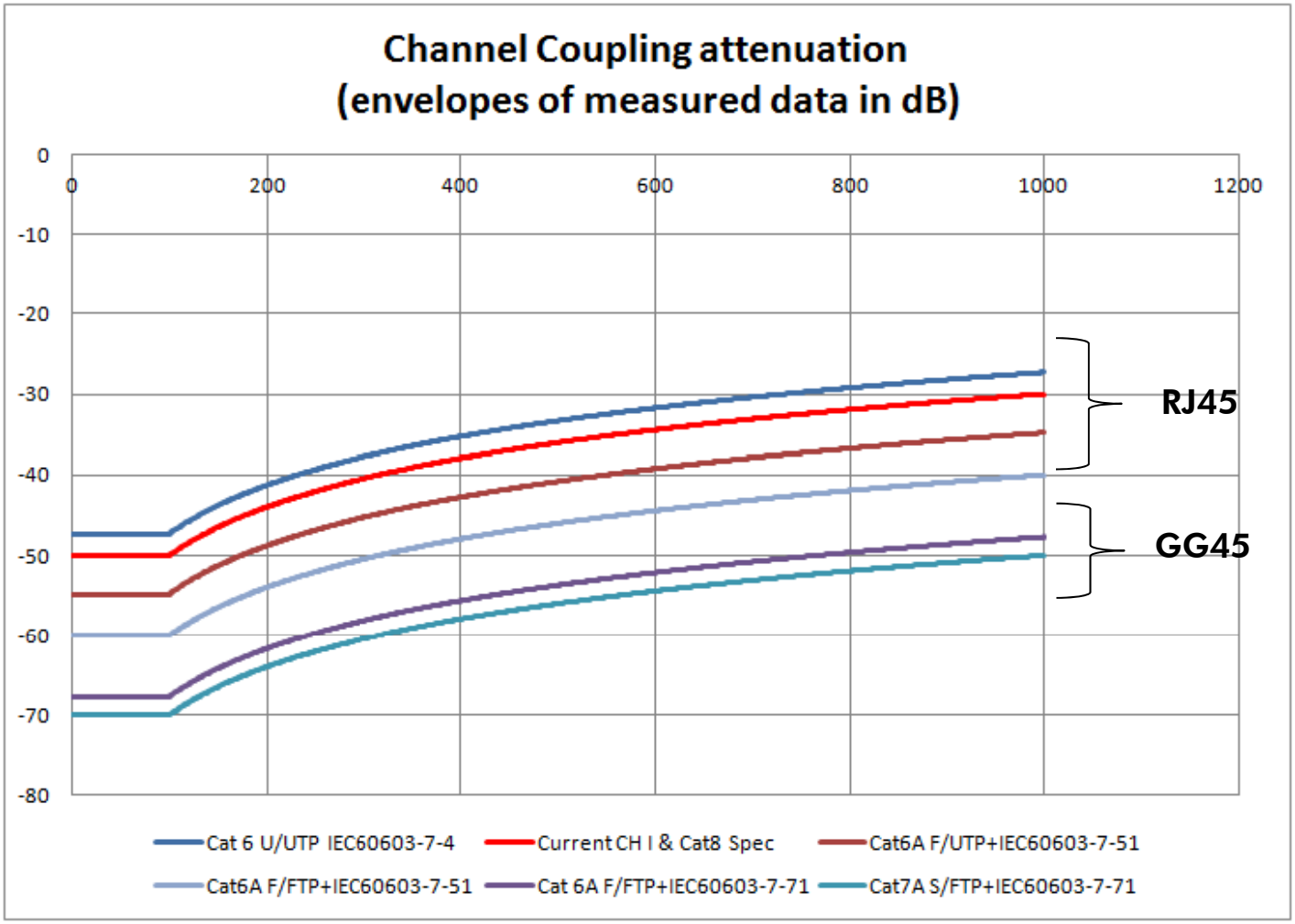
Coupling Attenuation of Cat7A Channel





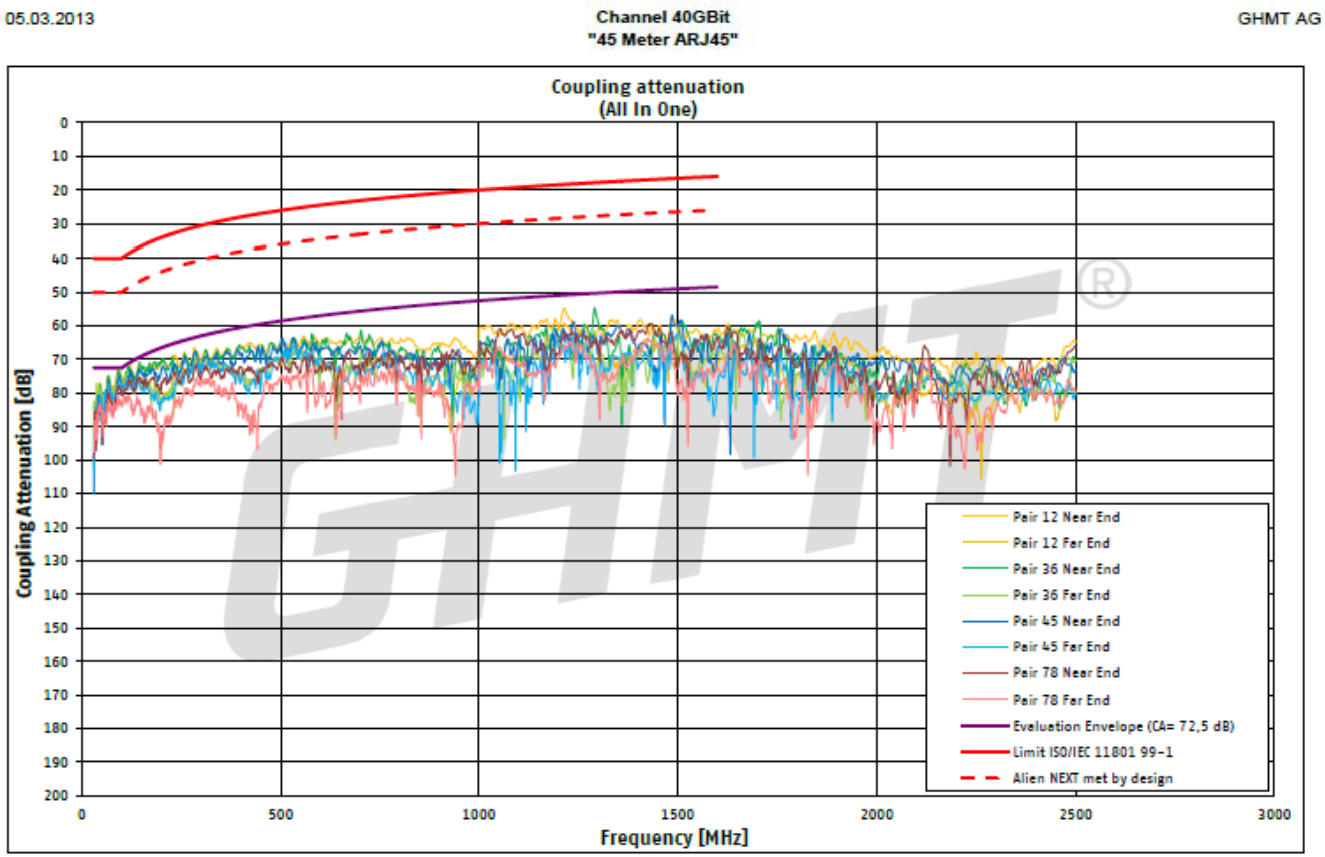
Comparison of Channel Types

- New limits challenging for U/UTP
- Influence of Connectors clearly visible
- Channels ~ 15-20dB below cable
- IEC60603-7-71 Connector shows room for tighter specification



Data from March 2013 up to 2GHz

- Measurement data provided by indepen-dant testlab GMHT using S/FTP cable
- 2 Connector Channel 45M

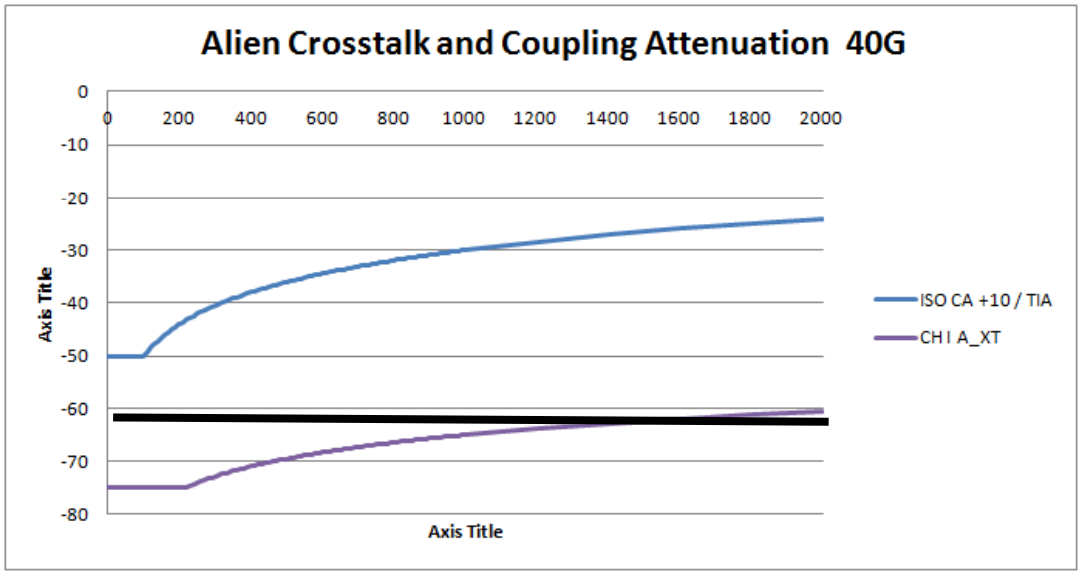


Current Specifications re-visited

- Alien Crosstalk Spec was increased in TIA Draft Cat.8 and ISO Channel I and II to match background noise
- Coupling attenuation has been increased, but not yet to this extent

- „Met by Design“ Rule of ~ 15dB indicates another 10dB increase could be needed

- But any increase should follow not considerations for ‚Field testing of cabling systems‘ but the demand of the application



Conclusion

- Second Shield seems to be more effective than Balance for Noise Immunity
- First test indicates that frequency extension for Double Foil products is possible
- Historic Data for Coupling attenuation of screened cables and channels indicate that current CA specfications can be tightened, if needed for 40GBase-T

- Next Steps:
  - Task Group shall give guidance to cabling commitees which level of Coupling attenuation is appropiate for 40GBase-T (how much increase ?)
  - Measure „Single Shielded“ cable and channels above 1 GHz
  - Explore Ways to improve CA of Connectors/Assemblies