Alien Crosstalk Coupling Specifications

IEEE P802.3ch Multigig Automotive Ethernet PHY Task Force

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Overview

- Alien crosstalk specifications need to be filled in for technical completeness
- Good shielded cabling should have plenty of margin for alien crosstalk
  - Mueller_3ch_05_0319.pdf showed excellent measurements
  - Mueller_3ch_05_0319 suggested a limit with 30+ dB margin to cable measurements – worse than unshielded cabling.
  - Asked for feedback – what is adequate
- Issue: we will never get back noise allocated in the alien crosstalk specification
  - Allowing too high level of alien crosstalk will increase complexity of PHY and board solutions for the life of the standard

Alien Crosstalk Measurements from Mueller

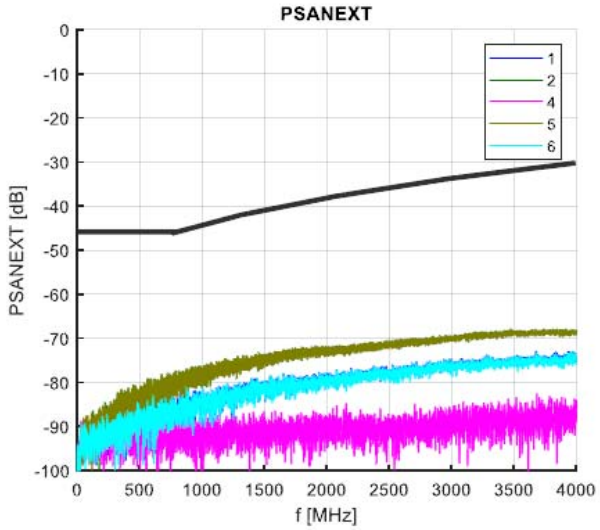
- Slide 7 from Mueller_3ch_05_0319.pdf

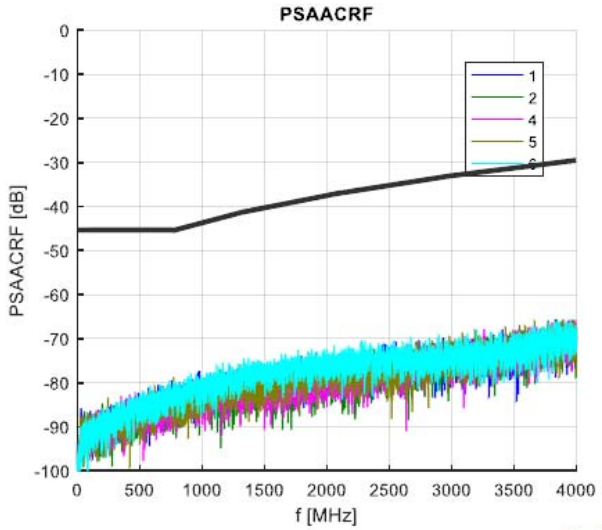
802.3ch link segment alien crosstalk and rejection test

Rosenberger

Comparison of measurement results against imaginary alien crosstalk limit

- Imaginary alien crosstalk limit provides margin against the actual measurement result





limit line manually added

Prior Alien Crosstalk Specs

- 802.3bq had similar issues
  - Alien crosstalk levels of shielded systems can be difficult to measure
  - Cap the maximum loss requirement at 75 dB
    - No more than 75 dB PSANEXT or PSAACR-F needs to be measured
    - Eliminates change of slope in the PSANEXT curve
- Model form:
  - PSANEXT loss ≤ $C_{AN} - 15\log_{10}(f/100)$ dB
  - PSAACR-F loss ≤ $C_{AF} - 20\log_{10}(f/100)$ dB

Getting to the Required Level

- Compute alien crosstalk noise contribution and allowable non-crosstalk noise at receiver input
  - 8 dB idealized ‘Salz’ margin (reserving FEC for other noise) -> Total input noise < -148 dBm/Hz, (sederat_3ch_01_0419)
  - Without basing on discrete time models, with jitter, ADC enob, short equalizers, fixed precoding, and measured board noise, this needs to be significantly higher than lower-speed BASE-T
  - Allocating margin for these effects drives power
- Sederat assumes -150 dBm/Hz board noise
  - < 0.4mVrms noise across 2.6 GHz bandwidth
- More margin would aid low-complexity ECUs and PHY power/complexity

Result, -150 dBm/Hz background

- No more than 13.9 dB margin relative to measurements can be allowed
- But what is reasonable?
  - This gives more margin to the cable than to the PHY and board

Margin proposed	13.899	dB					AWGN Background (dBm/Hz)			
Max loss proposed	75	dB								-150.00
	Measured (slide 7 mueller_3cg_05_0319.		0.25	Proposed		Max 10GBASE-T1 PSD	Proposed ANEXT noise level	Proposed PSAFEXT noise level	Proposed Combined Alien Noise	Proposed Alien + Background
Freq	PSANEXT	PSAACRF	IL (for fext	PSANEXT	PSAACRF					
0	-88	-85	0.00	-74.1013	-71.1013	-90.00	-164.10	-161.10	-159.34	-149.52
500	-80	-82	12.14	-66.1013	-68.1013	-90.00	-156.10	-170.25	-155.94	-149.01
1000	-76	-77	17.22	-62.1013	-63.1013	-90.67	-152.77	-170.99	-152.70	-148.13
1500	-73	-74	21.27	-59.1013	-60.1013	-91.50	-150.60	-172.87	-150.58	-147.27
2000	-72	-72	24.80	-58.1013	-58.1013	-92.33	-150.43	-175.23	-150.42	-147.19
2500	-70.5	-70	27.99	-56.6013	-56.1013	-93.17	-149.77	-177.26	-149.76	-146.87
3000	-69	-68	30.96	-55.1013	-54.1013	-94.00	-149.10	-179.06	-149.10	-146.51
3500	-67.5	-67	33.75	-53.6013	-53.1013	-96.00	-149.60	-182.85	-149.60	-146.78
4000	-67	-65	36.41	-53.1013	-51.1013	-98.00	-151.10	-185.51	-151.10	-147.50
(note - 1/4 IL is used for PSAFEXT to give a realistic worst case)						Geometric in band noise	-153.96	-171.28	-153.12	-148.00

Suggest 10 dB margin from Mueller

- Gives 1 dB extra PHY margin
- OR, allows 1.25 dB more board noise
- Splits the margin between PHY & cabling

Margin proposed	10.000	dB						AWGN Background (dBm/Hz)		
Max loss proposed	75	dB								-150.00
	Measured (slide 7 mueller_3cg_05_0319.		0.25	Proposed		Max 10GBASE-T1 PSD	Proposed ANEXT noise level	Proposed PSAFEXT noise level	Proposed Combined Alien Noise	Proposed Alien + Background
Freq	PSANEXT	PSAACRF	IL (for fext	PSANEXT	PSAACRF					
0	-88	-85	0.00	-75	-75	-90.00	-165.00	-165.00	-161.99	-149.73
500	-80	-82	12.14	-70	-72	-90.00	-160.00	-174.14	-159.84	-149.57
1000	-76	-77	17.22	-66	-67	-90.67	-156.67	-174.89	-156.60	-149.14
1500	-73	-74	21.27	-63	-64	-91.50	-154.50	-176.77	-154.47	-148.67
2000	-72	-72	24.80	-62	-62	-92.33	-154.33	-179.13	-154.32	-148.63
2500	-70.5	-70	27.99	-60.5	-60	-93.17	-153.67	-181.16	-153.66	-148.44
3000	-69	-68	30.96	-59	-58	-94.00	-153.00	-182.96	-153.00	-148.23
3500	-67.5	-67	33.75	-57.5	-57	-96.00	-153.50	-186.75	-153.50	-148.40
4000	-67	-65	36.41	-57	-55	-98.00	-155.00	-189.41	-155.00	-148.81
(note - 1/4 IL is used for PSAFEXT to give a realistic worst case)						Geometric in band noise	-157.36	-175.18	-156.81	-149.03

Proposed Alien Crosstalk Specification

- Allow 10 dB margin to measurements

  PSANEXT loss ≤

  $80–15\log_{10}(f/100)$ dB

  PSAACR-F loss ≤

  $86–20\log_{10}(f/100)$ dB

- Values greater than 75 dB revert to 75 dB

AN_C	80	AF_C	86		
	Requirement			Margin to measurements	
Freq	PSANEXT	PSAACRF		PSANEXT	PSAACRF
0	75.00	75.00		13.00	10.00
500	69.52	72.02		10.48	9.98
1000	65.00	66.00		11.00	11.00
1500	62.36	62.48		10.64	11.52
2000	60.48	59.98		11.52	12.02
2500	59.03	58.04		11.47	11.96
3000	57.84	56.46		11.16	11.54
3500	56.84	55.12		10.66	11.88
4000	55.97	53.96		11.03	11.04
		Worst inband margin		10.48	9.98
		Average inband margin		11.35	11.08
		Worst overall margin		10.48	9.98
		Average overall margin		11.22	11.22