Alien Crosstalk at the MDI

IEEE P802.3ch Multigig Automotive Ethernet PHY Task Force

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Overview

- Alien crosstalk specifications for the link segment need to be independent of the MDI
- Draft 2.2 allocates noise for the link segment
- The specification does not specify noise coupled between adjacent MDIs
- The informative annex for board considerations creates an opportunity to provide guidance for alien crosstalk coupling at the MDI

How we got to the Required Levels (April 2019)

- 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

Link segment Alien Crosstalk Specification

PSANEXT loss ≤ $80–15\log_{10}(f/100)$ dB

PSAACR-F loss ≤ $86–20\log_{10}(f/100)$ dB

- Loss 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

What about the MDI?

- Generally, the MDI is in the implementation loss budget, which currently has 8 dB against uncoded transmission
  - Note this budget is composed of all sources, and additive components such as crosstalk will mask each other, and not simply add in dB
  - (see http://www.ieee802.org/3/ch/public/apr19/zimmerman_3ch_02c_0419.pdf and http://www.ieee802.org/3/ch/public/apr19/sedarat_3ch_01a_0419.pdf)
- The dominant source of alien crosstalk in the link segment coupling is the connectors
  - The MDI connectors are similar
  - Crosstalk level is unlikely to be substantially below the link segment alien crosstalk coupling
- Suggest MDI connector PSAXT loss ≤ 80 – 15log10(f/100) dB

Results

- Using the suggested PSAXT specification results in worst-case 2.1 dB Salz SNR loss when background noise is at full -150 dBm/Hz and alien disturbers fully fill TX PSD mask (overly pessimistic assumption)
  - Note that if PHY margin is reduced due to additive sources (residual echo, ISI, or receiver noise, the reduction in SNR due to MDI alien noise will be less)

Max loss	75 dB					AWGN Background (dBm/Hz)	-150.00 dBm/Hz								
PSANEXT Loss Req form <= MAX (75, AN_C - 15*log10(f_MHz/100)) dB															
Link Seg Requirement: PSAACRF Loss requirement form <= MAX (75, AF_C - 20log10(f_MHz/100)) dB (note PSAFEXT loss <= IL + PSAACRF)															
AN_C	80	AF_C	86	Fraction of max IL	**1.00**					MDI AN_C	80				
	Link seg coupling (dB)				**Max 10GBASE-T1 PSD**	**Max Noise based on Cabling Requirement (dBm/Hz)**				**MDI Interface**	**TOTAL ALIEN Noise (dBm/Hz)**		**TOTAL W/BKGND (dBm/Hz)**		
Freq	**PSANEXT**	**PSAACRF**	**IL (used in calcs)**	**PSAFEXT**	**(dBm/Hz)**	**PSANEXT**	**PSAFEXT**	**Total Cable Alien**	**Total Cable Alien + Bkgnd**	**Coupling (dB) (FEXT/NEXT)**	**No remote MDI coupling**	**Remote MDI coupling**	**No remote MDI coupling**	**Remote MDI coupling**	
0	75.00	75.00	0.00	75.00	-90.00	-165.00	-165.00	-161.99	-149.73	75.00	-158.98	-158.01	-149.48	-149.36	
500	69.52	72.02	12.14	84.16	-90.00	-159.52	-174.16	-159.37	-149.52	69.52	-156.30	-156.18	-149.09	-149.06	
1000	65.00	66.00	17.22	83.22	-90.67	-155.67	-173.89	-155.60	-148.94	65.00	-152.58	-152.54	-148.09	-148.08	
1500	62.36	62.48	21.27	83.75	-91.50	-153.86	-175.25	-153.83	-148.49	62.36	-150.82	-150.80	-147.38	-147.37	
2000	60.48	59.98	24.80	84.78	-92.33	-152.82	-177.11	-152.80	-148.17	60.48	-149.79	-149.79	-146.88	-146.88	
2500	59.03	58.04	27.99	86.03	-93.17	-152.20	-179.20	-152.19	-147.95	59.03	-149.18	-149.18	-146.56	-146.56	
3000	57.84	56.46	30.96	87.42	-94.00	-151.84	-181.42	-151.84	-147.81	57.84	-148.83	-148.83	-146.36	-146.36	
3500	56.84	55.12	33.75	88.87	-96.00	-152.84	-184.87	-152.84	-148.18	56.84	-149.83	-149.83	-146.90	-146.90	
4000	55.97	53.96	36.41	90.37	-98.00	-153.97	-188.37	-153.97	-148.54	55.97	-150.96	-150.96	-147.44	-147.44	
				In-band Geometric mean		-156.51	-174.10	-155.96	-148.80		-152.94	-152.75	-147.91	-147.89	
				SNR Noise budget loss					1.20				2.09	2.11	

Recommendation

- Consider ballot comment on d3.0 to include recommendation in informative annex 149C
- 149.C.5 MDI PSAXT Coupling:
  - PSAXT coupling of MDI should be less than or equal to Equation (149-25).

$$\text{PSANEXTloss}(f) \geq \min\left(75,\ 80-15\log_{10}\frac{f}{100}\right)\text{dB} \qquad (149\text{–}25)$$

where

f is the frequency in MHz; $1 \leq f \leq 4000$

PSANEXT is illustrated in Figure 149–46.

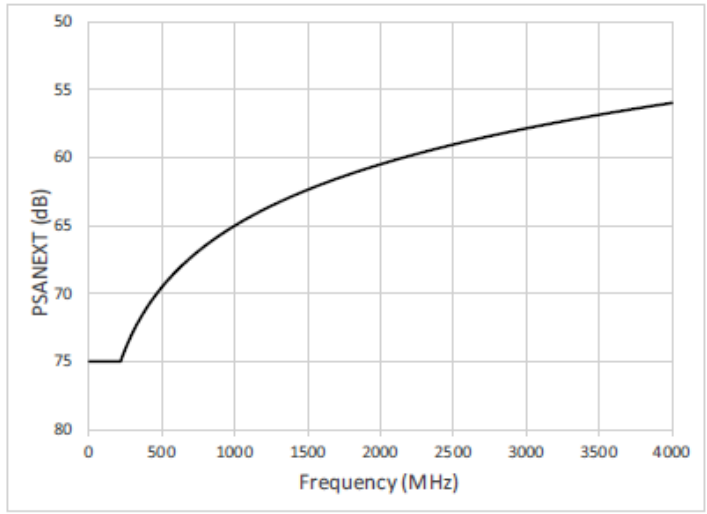

Figure 149–46—PSANEXT calculated using Equation (149–25)