Assessment of Alien Crosstalk properties of a category 5e cabling system and attempts at mitigation

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1 Summary

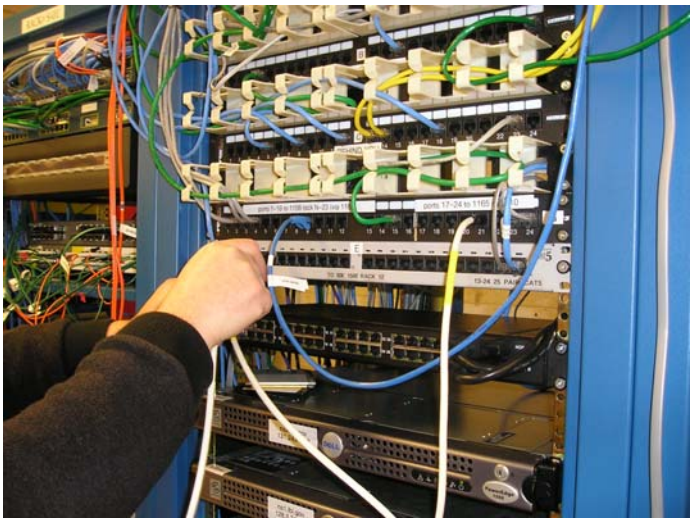
This document describes the results of assessing the alien crosstalk properties of an older category 5e rated cabling installation. The intent of this study was to determine whether category 5e rated installations might be able to carry 10GBASE-T transmissions. Furthermore, an attempt was made to mitigate unsatisfactory performance, by unbundling cable over a short distance. The results reflect only the properties of the installation tested. No general conclusions can be drawn on properties of other cat 5e installations.

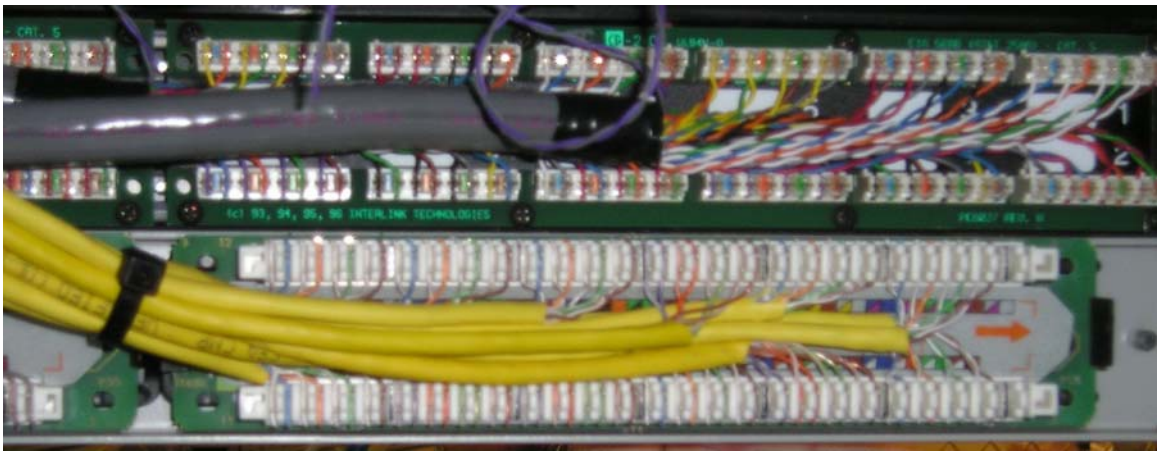
The measurement methodology was as described in "***Testing of Alien Crosstalk properties of an "as currently installed" category 6 cabling system***".

2 Description of test installation

A computer room category 5e rated cabling installation was measured. There were several different patch panels with different types of cabling connected to them. See Figure 1.


Rack view (front)


Rack view (front) close-up



Rack view (rear) Connections to cat 5e patch panels “D” (top) and “E” (bottom).

Rack view (rear) bundle before unbundling

Rack view (rear) bundle after unbundling

Figure 1: Pictures of cat 5e cabling tested for Alien Crosstalk.

The cables to patch panel “D” were 25 pair cat 5e types; the cables to patch panel “E” were individual cat 5e rated cables. A few measurements were made on outlets on panel “D”, which appeared to be rather poor”. Most of our measurements relate to patch panel “E”. The cable bundles were relatively small, and no attempt was made to measure alien crosstalk to different cable bundles. One of the channels terminating on patch panel “E” (position #1) was active and was not included in the measurements in order not to interrupt network operation.

The lay-out of patch panel “E” is shown in Table 1. Note that the connectors are organized in 4 unit blocks, which may help understand reasons for higher alien crosstalk between certain connectors. In this study, outlet # 6 was the victim channel. Channels 1 through 12 were connected into the same cable bundle. Channel 1 was active, but all other channels were included in the overall power sum alien crosstalk measurements.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1 block				1 block				1 block				1 block				1 block				1 block			

Table 1: Lay-out of 24 connector patch panel (labeled “E”).

3 PSANEXT measurements

3.1 Overall PSANEXT

The overall PSANEXT result for victim channel #6 to all available disturber channels in the same cable bundle is shown in Figure 2.

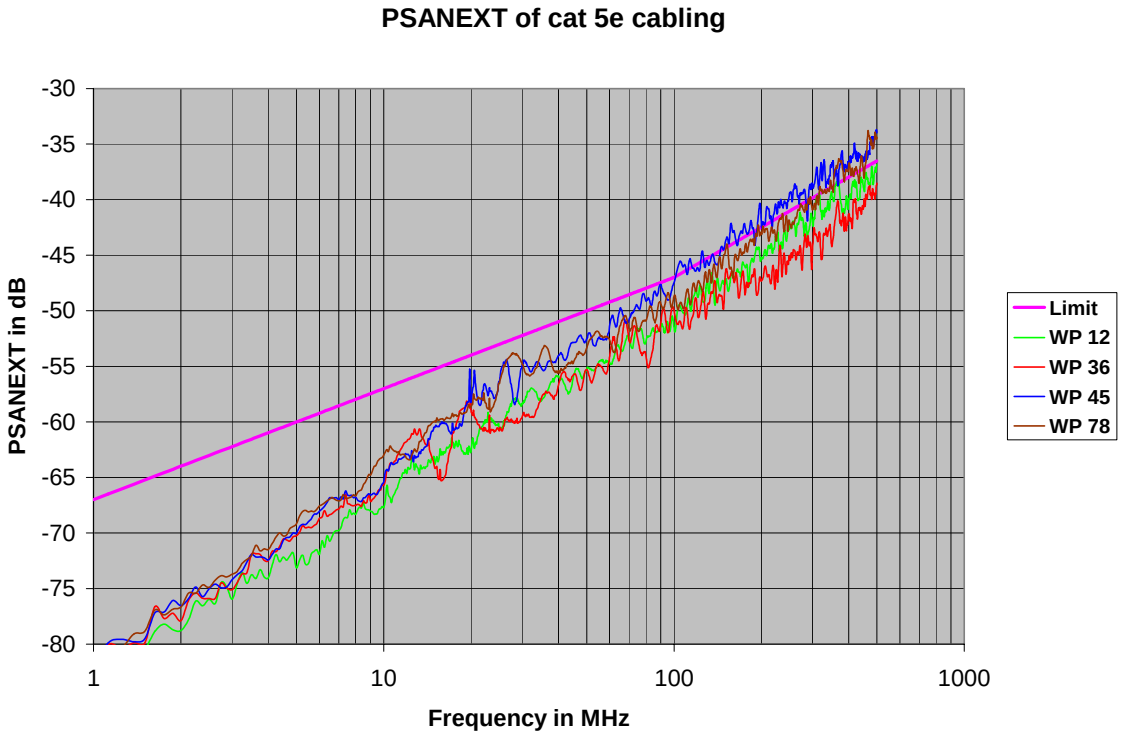


Figure 2: PSANEXT of victim channel 6 from disturber channels 2 through 5 and 7 through 12.

The PSANEXT limit is set to 47 dB @ 100 MHz. The alien crosstalk performance appears marginal relative to the 55 m PSANEXT requirements. However, since the channel is much shorter than 55 m (approx. 35 m), the channel appears to perform adequate for the proposed 10GBASE-T PSANEXT requirements since the insertion loss has considerable margin. The worst case PSANEXT margin relative to the limit was -3.2 dB.

3.2 Attempt to improve the PSANEXT result

The cable ties of the cable bundle that were in close proximity to the patch panel were cut, and the cables spread out and randomized relative to each other (see Figure 1). This was done over a relatively short distance (approx. 0.75 m). The worst case PSANEXT margin relative to the limit improved slightly to -2.7 dB. This could be explained based on two considerations:

- The distance over which the cable bundle was loosened up was only small: only the PSANEXT of that segment of cabling was reduced.
- The PSANEXT introduced by the patch panel was a substantial portion of the overall PSANEXT.

The more detailed results per victim/disturber channel are shown in Figure 3.

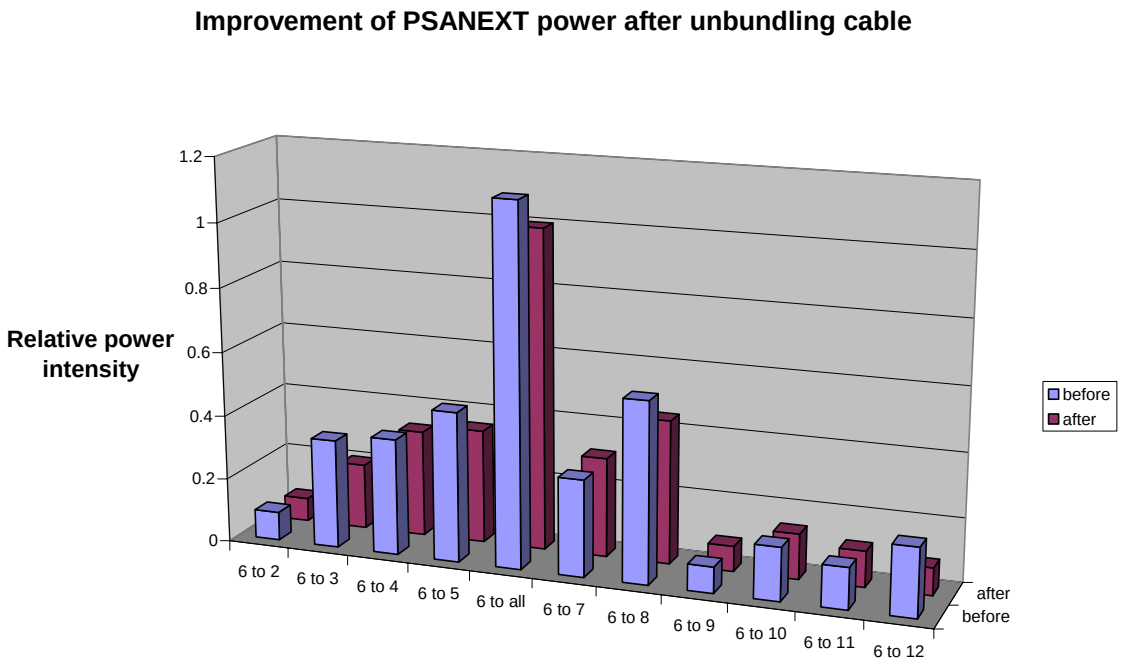


Figure 3: Improvement in PSANEXT between victim and disturber channels.

3.3 Measurement of PSANEXT of category 5e rated patch panel

It is not very attractive to disconnect all cabling to the terminations on the patch panel, and therefore the measured frequency responses were converted into the time domain using an FFT function, which is available in the field tester. All individual pair-to-pair FFT responses were analyzed at the location of the patch panel. The distance resolution was approx. 0.6 ns or 10 cm. As a reference, we assumed a "normal" PSANEXT between connectors on a patch panel would be 70 dB @ 100 MHz. This basically is to support the assumption that most of the PSANEXT in a channel originates from cable (as we will find out, this is not true in this case).

PSANEXT properties of patch panel based on FFT analysis in dB @ 100 MHz							
Wire Pair	**Channel 6 to 3**	**Channel 6 to 4**	**Channel 6 to 5**	**Channel 6 to 7**	**Channel 6 to 8**	**Channel 6 to 9**	**PSNEXT 6**
WP 12	75.3	69.6	62.0	73.9	70.0	85.4	60.4
WP 36	78.3	63.2	66.7	70.5	75.6	86.3	60.8
WP 45	71.5	67.4	57.8	56.0	53.3	83.4	50.4
WP 78	70.7	53.4	56.3	66.1	70.2	86.3	51.3

Table 2: PSANEXT properties of the patch panel.

When using the noise power caused by a 70 dB @ 100 MHz alien NEXT between connectors as a reference value, the power intensity of the victim channel to one of the disturbers PSANEXT and victim channel to all disturbers PSANEXT can be determined. The result is shown in Figure 4.

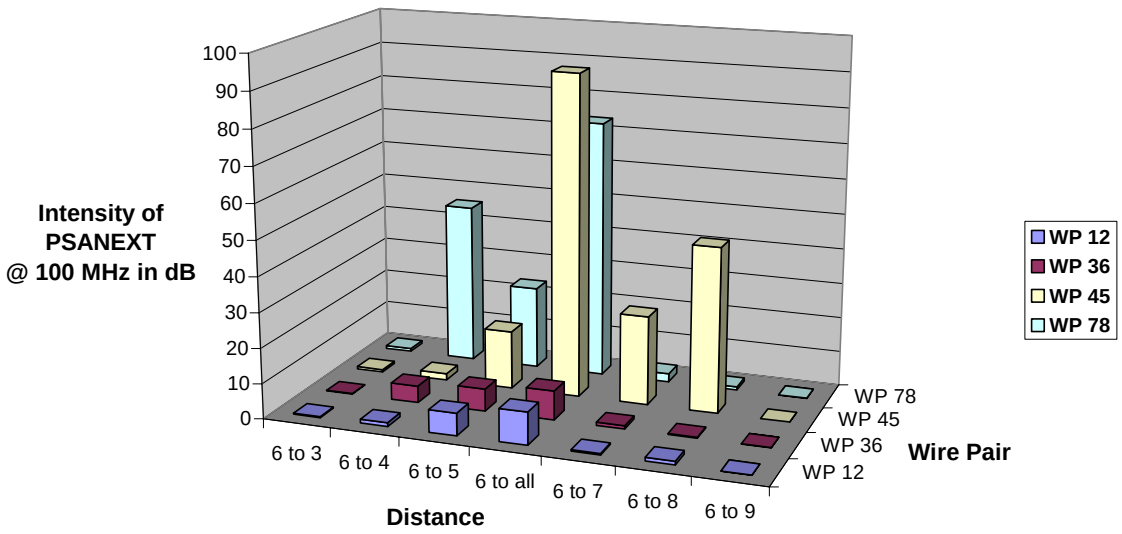


Figure 4: PSANEXT power of the patch panel connections relative to the noise power of a 70 dB @ 100 MHz PSANEXT between connectors.

Given that the PSANEXT test limit is 47 dB @ 100 MHz, it appears that the influence of the PSANEXT from the patch panel is relatively modest. To clarify this, the same figure was created relative to a 47 dB PSANEXT between connectors.

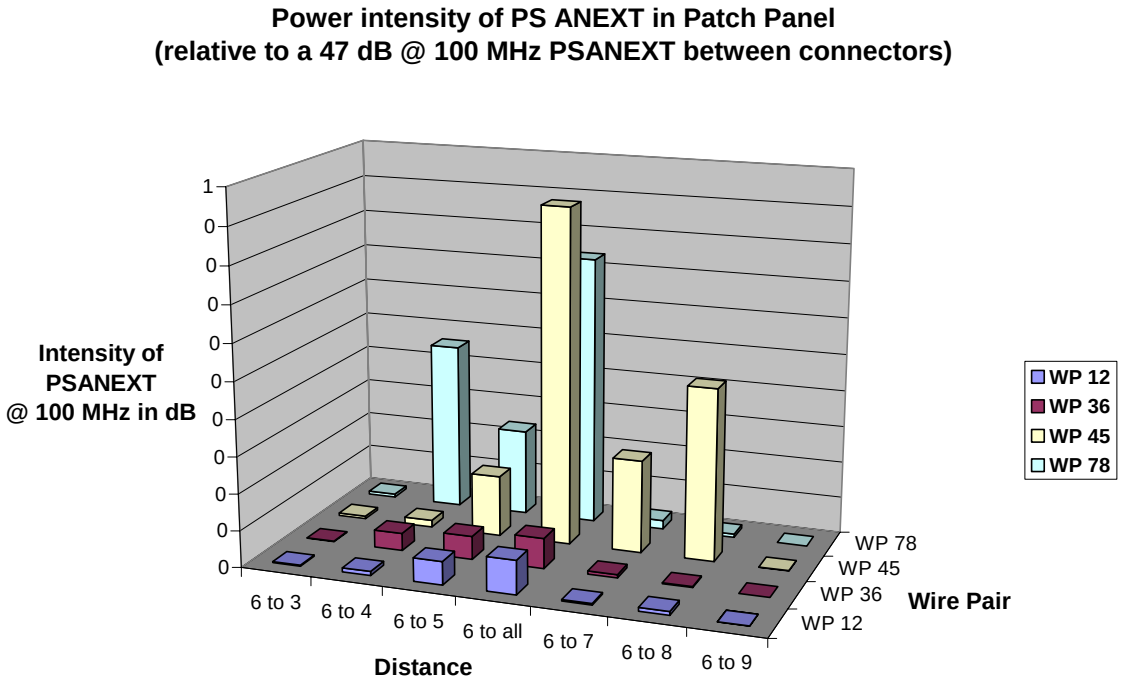


Figure 5: PSANEXT power of the patch panel connections relative to the noise power of a 47 dB @ 100 MHz PSANEXT between connectors.

From Figure 5 it appears that the PSANEXT power for the 45 wire pair is approx. 0.5 of the total budget. It appears therefore that in order to improve the overall PSANEXT properties, the patch panel should be replaced. However, if the channel is sufficiently small, the reduced insertion loss may be sufficient to overcome this deficiency.

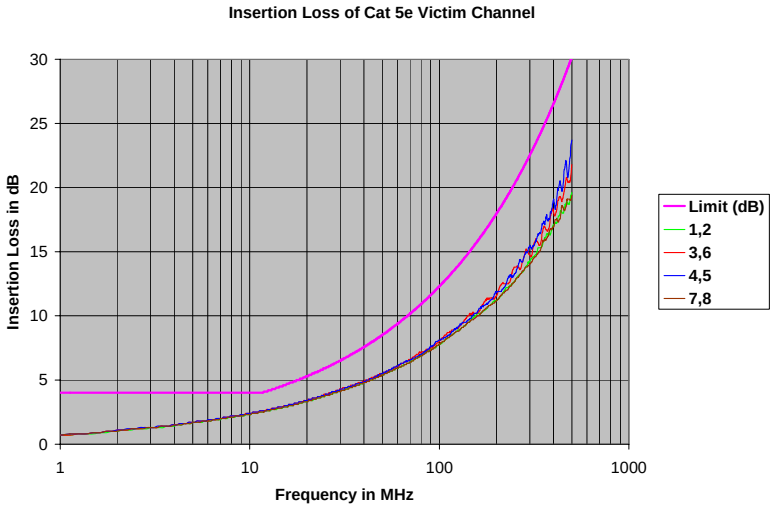


Figure 6: Insertion Loss of Category 5e victim channel.

4 PSAELFEXT measurements

We had substantial difficulty finding a signal return path with sufficient low alien crosstalk to make a reliable measurement. We found a return path with a substantial length, with the consequence that the total victim plus return path length was approximately 150 m. This obviously caused PSAFEXT signals to be well into the noise floor. However, up to approx. 100 MHz, the noise floor was not reached. Since PSAELFEXT has a distinct and well predictable 20 dB/decade slope in the frequency response, the measured results at lower frequencies can be reliably be extrapolated towards higher frequencies.

We only measured the PSAFEXT between the victim channel and one disturber channel. The result is shown Figure 7. The limit line assumes 33.6 dB @ 100 MHz. With a single disturber, the PSAELFEXT result is already at the limit. Since these are adjacent channels, we assumed that as a first approximation that the actual overall performance would be 6 dB worse.

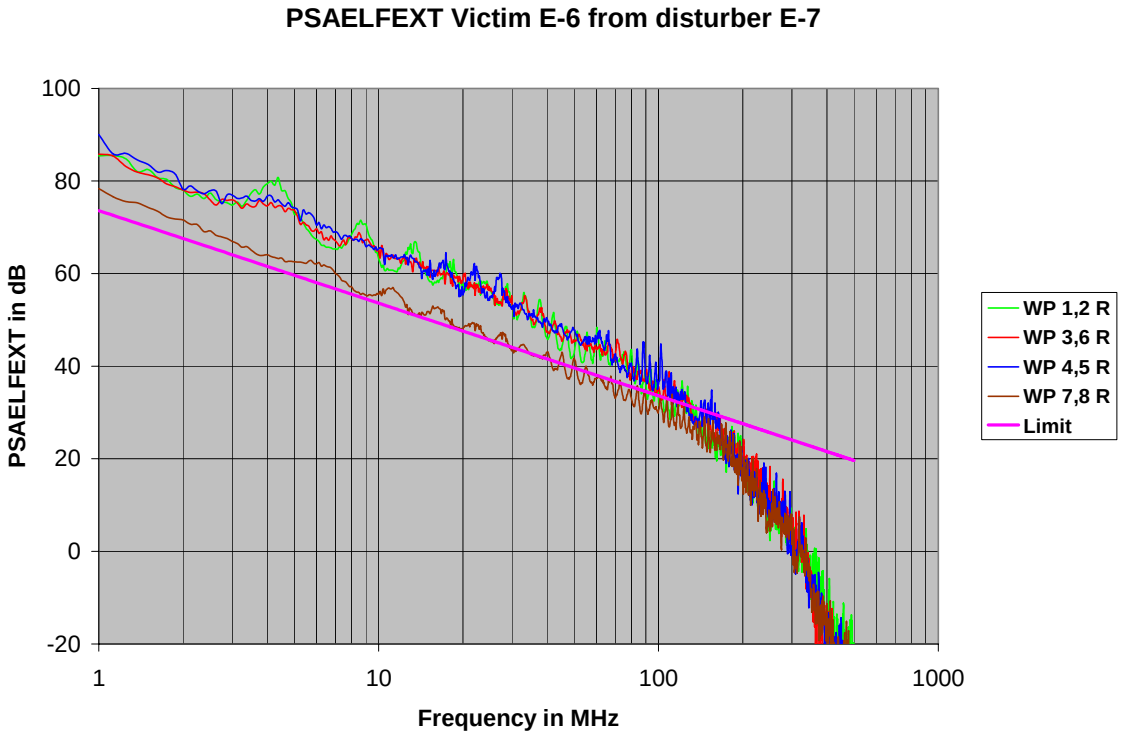


Figure 7: PSAELFEXT between victim channel 6 and disturber channel 7.

We acknowledge that we have not collected enough data to reach a properly based conclusion. We did not investigate, but given the construction of the patch panel (a PCB based connecting of clusters of 4 connectors), there is a real possibility that a lot of PSAFEXT originates from the patch panel. Again, substantially reduced channel insertion loss may overcome the shortcomings of PSAELFEXT requirements.

5 Conclusions

- It will be more challenging to find category 5e channels that will meet 10GBASE-T transmission requirements. In this case the alien crosstalk requirements were not met. However, since the insertion loss has a significant margin, channel lengths much less than 55 m may be able to handle 10GBASE-T signals.
- With assumptions for signal input power and environmental noise, regular field test results as well as alien crosstalk data could be processed to analyze the SNR for 10GBASE-T. The authors hope that a spreadsheet that computes the SNR can be developed and published.