The correlation between NEXT and PSANEXT of Cat6A U/UTP cable

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Abstract
The technology demands the higher speed and low latency network Datacom copper cables which requires compliance of the Alien cross talk. The Power Sum Alien Cross Talk has been introduced to international standards ISO/IEC 11801 Ed. 2.2, ANSI/TIA 568C.2 and it is mandatory parameter for Category 6A and above copper LAN Cables. Alien Crosstalk is the interference caused by a pair of insulated copper conductors in one cable inducing noise into other pairs of insulated conductors in adjacent cables. Power Sum Alien Cross Talk (PSANEXT) is an unwanted disturbing signal transferred from one balanced twisted pair of cable to twisted pair of another cable. The Alien Cross Talk measurement is time consuming and usually takes 4 hours to prepare testing set up and test. It was demand on us to reduce the time of the measurement and find a correlation between Near End Cross Talk and Alien Cross Talk. In our situation the same cable construction of Cat6a U/UTP was desired and our expectation was to reduce the time to 10 minutes. By reducing the time to 10 minutes we have saved significant amount of financial part for another development. The second factor behind carrying out this correlation study was to avoid the repeated Alien cross talk testing which is a destructive testing in nature. And without more destructive testing we needed to ensure the Alien cross talk compliance in all produced cables.

This study was carried out based on several production trials of cables and tested in 7 cables bunched together where one cable in middle of the bunch was disturbed cable and the remaining surrounding cables were disturbing cables. Detailed test results were recorded and summary of the results prepared. Recorded results were analysed with statistical method. And the co-relation found.

Our calculations are showing that we shall achieve Near Cross Talk worst case margins in the range of 2.6 dB to 8.9 dB or higher to get passing Alien Cross Talk (PSANEXT). It is showing us as the summary that in order to pass Alien Cross Talk we need to have minimum cross talk margin of 2.6 dB.

Keywords: LAN Cable; Alien Crosstalk; Data Copper Cable; Margin; Performance; Correlation; Cat6A; Near End Cross Talk; Power Sum Near End Cross Talk, Power Sum Allen Near End Cross Talk, Attenuation, Power Sum Attenuation to Alien Crosstalk Ratio – Far End.

1. Introduction
In this paper, we describe and provide The Power Sum Alien Cross Talk has been introduced to international standards ISO/IEC 11801 Ed. 2.2, ANSI/TIA 568C.2 and its mandatory for category 6A and above copper LAN Cables. Alien Crosstalk is the interference caused by a pair of insulated copper conductors in one cable inducing noise into other pairs of insulated conductors in adjacent cables as shown in Figure 1- Alien Cross Talk. Power Sum Alien Cross Talk (PSANEXT) is an unwanted disturbing signal transferred from one balanced twisted pair of cable to twisted pair of another cable. The Alien Cross Talk measurement is time consuming and usually takes about 4 hours to prepare testing set up and test one cable. It was demand on us to reduce the time of the measurement and find a correlation between Near End Cross Talk and Alien Cross Talk.

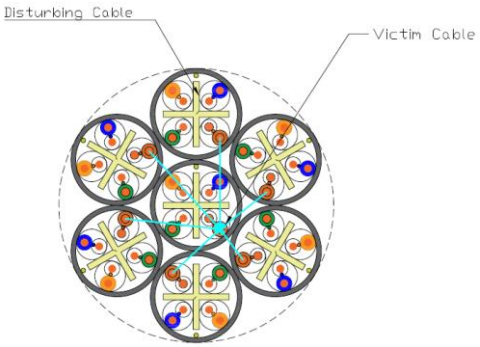

Figure 1 - Alien Cross Talk

2. Test Method of Measurement of Alien Cross Talk
2.1 Cable Preparation
In order to test Alien Cross Talk (ANEXT), we are preparing 7 samples of 100 meter Cat6A U/UTP Cable in reels. These cables are rolled out from the reel and passed through a special face plate to form a bunch of 7 cables such that the center cable will be surrounded by 6 cables. Velcro tape is tied up on this cable bunch at every 30 cm distance. The distance between each of the bunch in layers shall be maintained at 30 cm. The stranding lay length of all 7 cable shall be consistent. In our cable bunch lay length was 800 mm. This bunch is then laid on rods, a special arrangement for Alien - Cross talk testing as shown in Figure 2. Cable is connected to high frequency Network Analyzer at both ends to test the Alien Cross Talk. Results are recorded.

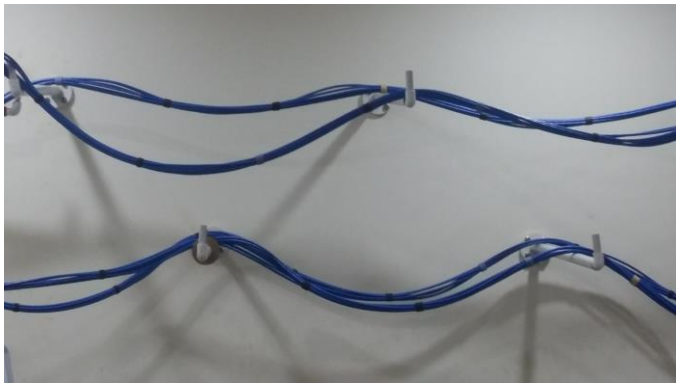

Figure 2 Arrangements for Alien Cross Talk

2.2 Time of Measurement of Alien Cross Talk

The method of Alien cross talk test takes minimum of 4 hours of time including the sample preparation and testing of one cable. As per standard we need to test all 7 cables for Alien Cross talk, making each cable as a Center victim cable, which takes almost 28 hours' time to complete one bunch of 7 cables. Alien Cross Talk is testing the suitable 7 cables out of the available samples. We have done a correlation study between cable's Near End Cross Talk results and Alien Cross Talk result. By this correlation study we can easily predict the test result for Alien Cross Talk test.

In Network Analyzer the measurement of Alien Cross Talk is calculated as Power Sum Alien Near End Cross Talk (PSANEXT). This loss takes into account the combined alien crosstalk (statistical) on a receiver pair from all external near-end disturbing pairs operating simultaneously. PSANEXT loss is calculated as a power sum on a selected pair k from all other pairs as shown in equation (1) for the

$$PSANEXT_k = -10\log\left(\sum_{j=1}^{N}\sum_{i=1}^{4} 10^{\frac{ANEXT_{k,i,j}}{10}}\right) dB \qquad (1)$$

Where:

N is the total number of disturbing devices under test (DUT).

k, i, j ANEXT , is the measured ANEXT loss, in dB, to pair k of the disturbed DUT from pair i in disturbing DUT j.

k is the number of the disturbed pair in a disturbed DUT.

i is the number of a disturbing pair in a disturbing DUT.

j is the number of a disturbing DUT.

ANEXT loss shall be measured for all DUT pair combinations and PSANEXT loss shall be calculated for all DUT pairs.

2.3 Near End Cross Talk (NEXT) Measurement

Near End Cross Talk (NEXT) of a cable is termed as when a current flow through an insulated conductor, an electromagnetic field is created which may interfere with signals passing through the adjacent insulated twisted pairs. As the frequency increases, NEXT increases significantly. Twisting of each pair opposes fields in the insulated conductor pair to cancel each other. The tighter the twist, the more effective is the cancellation and the higher the data rate supported by the cable. This is achieved by maintaining twist ratio of insulated conductor. If the all four different pairs are not twisted with different twist ratio then it results in higher NEXT.

Near End Cross Talk is measured by connecting both the ends of Cable connected to Network Analyzer as shown in Figure 3 – Measurement of Near End Cross Talk. This test takes about 10 minutes time.

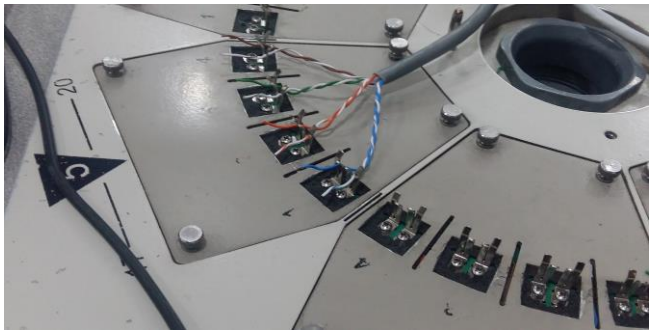

Figure 3 – Measurement of Near End Cross Talk

2.3.1 Correlation Between Near End Cross Talk & Alien Cross Talk

In order to reduce the total time of measurement of Alien Cross Talk and reduce the destructive testing frequency, we had to come up with the correlation between the Near End Cross Talk and Alien Cross Talk. We studied different sets of Cat6a U/UTP Cables from different trial lots and found the correlation of 2.6 to 8.9 dB.

This study was carried out keeping all other design and process parameter constant. Different results of Alien Cross Talk and Near End Cross Talk is referenced in Table 1 – Correlation data of Near End Cross Talk and Alien Cross Talk. Graphical representation of Near End Cross Talk Measurement is referenced in Figure – 4 Near End Cross Talk Test Results. And graphical representation of Alien Cross Talk in term of Power Sum Alien Cross Talk is reference in Figure 5 – Alien Cross Talk Test Results.

Lot No.	Spool No.	Max NEXT	Max PSANEXT
T32B	7	4.6	4
	9	4.9	2.2
	10	3.6	1.4
	12	5.5	0.6
	13	5	2.2
	15	4.9	0.9
	19	2.7	2.3
T32A	1	4.3	3.3
	4	7.4	4.2
	7	5.6	4
	13	2.8	4
T3R	7	8.3	0.7
	14	7.4	3.7
	15	8.8	2.2
	16	8.4	1.6
	18	6.8	1.3
	18	7.9	3.4
T3B	8	3.5	4.7
	10	5.1	4.7
	11	3.2	4.9
	19	4.3	5.7
	19	7.4	3.7
	21	7.8	4.1

Lot No.	Spool No.	Max NEXT	Max PSANEXT
T4B	3	7.4	3.3
	12	5.8	3.1
	7	6.6	3
	4	6.7	1.9
	1	6.5	3.2
	16	7.8	3
	7	6.6	2
T3	13	6.3	4.3
	19	3.4	5.5
	16	3	5.5
	14	3.7	4.2
	5	5.3	4.1
	12	8.7	2.8
	17	3.1	3.9
T33A	7	8.3	4.9
	5	8.2	3
	12	8.9	6
	21	6.9	3.5
	27	6.6	3.5
	28	6.7	3.3
	34	6	3
T33B	20	3.2	5.5
	1	2.7	4
	6	4.4	4.9
	12	5.7	3.6
	13	2.6	4
	19	3.3	4.1
	21	3.3	3.4

Table. No. 1: Statistical Method of calculation

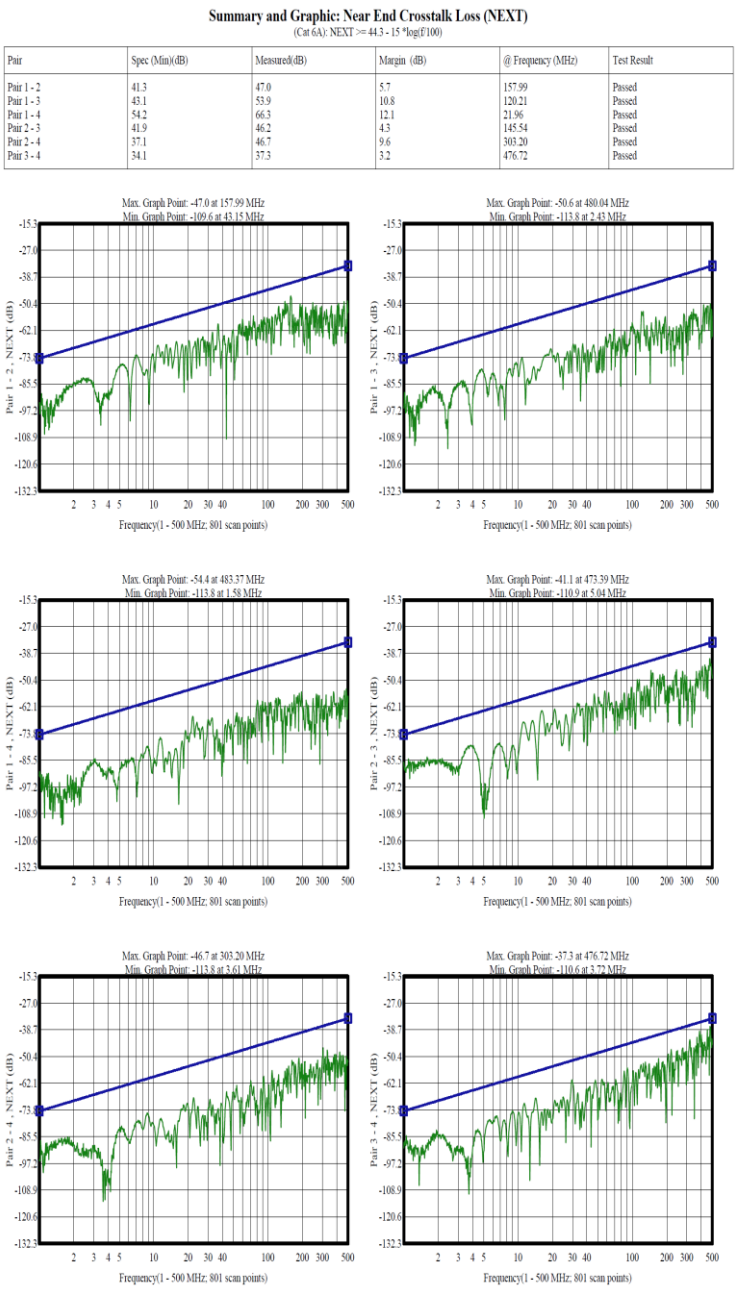

Figure – 4 Near End Cross Talk Test Results

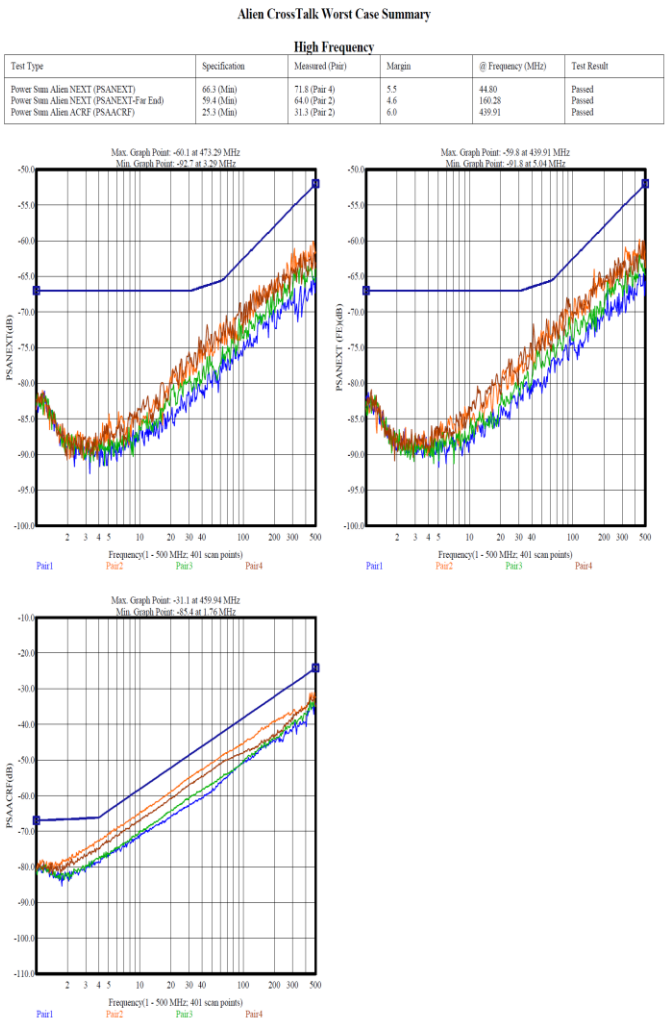

Figure – 5 Alien Cross Talk Test Results

2.3.2 Power Sum Attenuation to Far End Alien Cross Talk Test

AFEXT loss is the coupling of crosstalk at the far-end from external DUT pairs into a disturbed pair of the4-pair DUT under test. PSAACRF is the calculated power sum from all external pairs into the disturbed pair. PSAACRF for a DUT is determined using equation (2) for the case of a 4-pair DUT.

$$PSAACRF_k = PSAFEXT_k - IL_k \ dB \qquad (2)$$

Where k is the disturbed pair

We have studied this parameter for any correlation between the Near End Cross Talk and Power Sum Attenuation to Alien Far End Cross Talk but we have not found any correlation between them.

2.4 Title and Authors

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3. Conclusions

Our calculations are showing that we shall achieve Near Cross Talk worst case margins in the range of 2.6 dB to 8.9 dB or higher to get passing Alien Cross Talk (PSANEXT). It is showing us as the summary that in order to pass Alien Cross Talk we need to have minimum cross talk margin of 2.6 dB.

This correlation study makes the cable selection easy and saves time on Alien Cross Talk testing. In addition we are reducing the destructive testing and saving of the additional length of cable for customers. This co-relation study is carried out for one design type of the Cat6A U/UTP cable keeping other design and process parameters constant.

4. Acknowledgments

Special Thanks to Mr. Ankit Agrawal, Global Head Telecom Products & BH App Vertical, Sterlite Technologies Limited for the encouragement to write that paper.

5. References

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6. Pictures and Biography of Authors

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Andrew has over 24 years of experience in optical and copper network development, installation and management with international producers and exporters. Furthermore, he has reviewed network design, installation, innovations, technical back up and several patents. In his capacity as the manager, he has built direct relationships with customers, installers and has been consulted on a number of projects up to $2B. He has played a key role in the development and introduction of FTTx systems. He has developed a training structure for cabling, building automation and security, and assisted in putting safety data sheet and catalogues. He holds Master's and Bachelor's Degree in electronics.

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Darshana has over 12 years of experience in Design and Development of Power Cable, Jelly Filled Telecommunication cables, Structured Data Cables and Fiber Optic Cables. In her tenure as the manager, she has built direct relationships with customers, suppliers and has been consulted on a number of projects up to $100K. She has played a key role in the development and introduction of High end Data cables and FTTH Premise cables. She has developed a training structure for cabling design, testing and Management. She has participated in several patents and catalogues development. She holds Bachelor's Degree in Electrical.

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Noufal has over 7 years of experience in Design and Development of Structured Data Cables. In his tenure as the Engineer, he has built knowledge on different polymer materials, direct relationship with suppliers and customers directly. He has played a key role in the development and introduction of High end Data cables, Cable field testing. He holds Bachelor's Degree in Science.

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Abhishek has over 10 years of experience in Optical Fiber manufacturing ,Process, Structured Data Cables and Fiber Optic Cables. In his tenure as the Officer , He has built direct relationships with customers, suppliers and has been consulted on a number of projects like as Six sigma,5S, Lean ,Improvement of Head room ,Scrap Reduction, Quality tools, Testing methodology of Fiber as well as Data cable . He has played a key role in the development and introduction of High end Data cables and Optical Fiber . He has developed a training structure for testing and management. He has participated in several patents . He holds Master Degree in Chemical Science.