White Paper

To Screen or not to Screen? – A subject re-visited.

excel without compromise.

Should Class E_A /Category 6_A cabling installations be Screened?

Overview

The debate rages on in many sectors of the market concerning whether ISO/IEC 11801 Class E_A, or Category 6_A should or in fact NEED to be Screened to effectively support 10Gig Ethernet transmission.

Each method has its pros and cons; there is a misguided belief that unscreened is cheaper and easier to install and terminate and that screened has its own issues in relation to grounding and bonding.

In this white paper we try to balance a number of these choices and dispel some of the myths and try to give the reader a balanced view on what is the best route to follow. In the last few years there have been a number of studies carried out by manufacturers in their own right and independent studies that have been part or wholly funded by manufacturers, we will look at some of those findings.

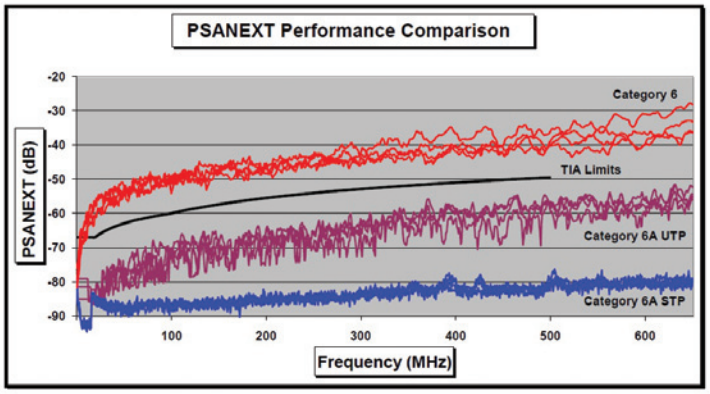
The IEEE 802.3an-2006 standard for 10GBASE-T operation was ratified in June 2006. It defined an application standard for 10 Gb/s data transmission over copper twisted pair cabling of up to 100 metres, it includes the use of both unscreened twisted pair (UTP) and screened twisted pair (STP) copper cabling systems.

Detail

In 10GBASE-T applications, the noise source that most limits the ability to transmit 10Gb Ethernet over copper cabling is alien crosstalk. Because the 10GBASE-T receiver cannot compensate for the noise from adjacent channels, this effect must be cancelled out wherever possible by the cabling system to ensure reliable data transmission. This noise is measured as Power Sum Alien Near-End Crosstalk (PSANEXT) and as Power Sum Alien Attenuation to Crosstalk Ratio at the Far-End (PSAACRF). Both ISO/IEC 11801 Ed 2.2 Class E_A and TIA-EIA-568-C.2 Category 6_A require that crosstalk be measured in a 6-around-1 cabling configuration that takes into account the worst-case effect on a centre cable with six cables tightly bundled around it.

A Category 6 U/UTP system will not meet the alien crosstalk limits required for 100 metres of 10GBASE-T transmission (see Figure 1).

Figure 1. 100-Metre Channel PSANEXT Performance Characteristics



The above shows the TIA limits, it must be noted that ISO/IEC limits are somewhat tighter, meaning the Category 6 and is even further from success and whilst Category 6_A U/UTP still passes it is a lot closer to the limits than a screened system.

Coming back to the question of whether to screen are not there are some basic considerations to weigh up when making the choice. Some of the benefits for a screened solution are clear from the above chart, however there are a number of screening types available, each has a different level of effectiveness and we will look at that in more detail later however the basics remain the same.

In properly installed and bonded screened cabling, the foil screen within the cable prevents signals from coupling which reduces alien crosstalk well below the required limits. All the tests we mentioned in the opening of this paper indicate that screened cabling systems provide significant margin over the IEEE 802.3an-2006 specification for 10GBase-T PSANEXT and PSACCRF, thereby removing the need for time-consuming and complicated field-testing of alien crosstalk completely. Therefore ISO 11801 clearly states that Alien Crosstalk testing is NOT required for screened systems.

The standards also state that an unscreened solution may be 'compliant by design' this may be the products or the design

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of the installation or in fact a combination of both, however it is clear that much more care must be taken when considering an unscreened solution. This includes both selection of the product, through to the design of the installation itself, taking into account specific routes the cables take and proximity to potential sources of external noise.

The client or their representative is fully within their rights to request proof that the unscreened system complies either by way of independent certification or if that is not available, by carrying out testing of the actual installation itself.

Independent Testing

In a recent independent test a leading testing establishment selected 5, Class E_A Cabling Systems from five different market-leading suppliers they included 2 x U/UTP systems 1 x F/UTP solution and 2 x S/FTP systems. The test set up involved the use of real 10GBase-T equipment and live 10Gb/s traffic.

Initial Findings

The first and most important fact was the basic Class E_A performance in all cases the screened solutions provided greater headroom than the unscreened systems

The second factor was the U/UTP systems tested demonstrated significantly weaker ANEXT performance and coupling attenuation in comparison to the screened systems.

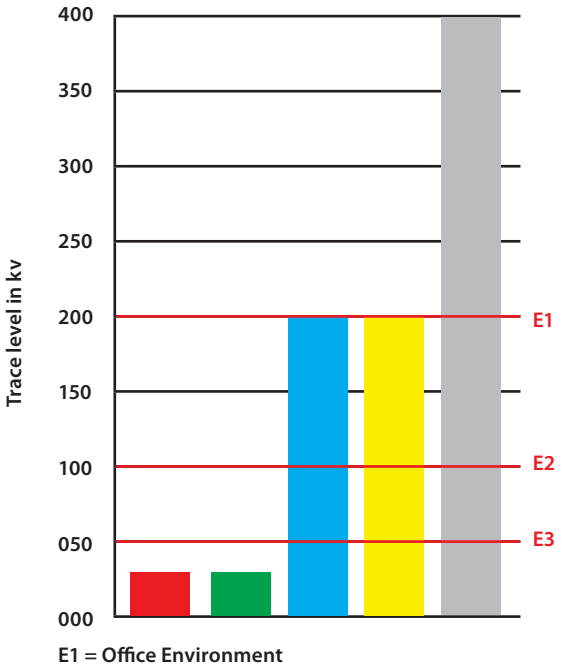
	System 01	System 02	System 03	System 04	System 05
Channel type	**U/UTP**	**U/UTP**	**F/UTP**	**S/FTP**	**S/FTP**
Insertion loss (margin) [db]	8.8	8.6	8.6	10.5	15.5
PS NEXT (margin) [db]	5.5	8.2	7.8	5.8	6.2
TCL (margin) [db]	9.2	8.9	9.6	5.45	10.4
RL (margin) [db]	8.8	9.5	3.4	6.9	8.2
PS ANEXT (margin) [db]	**-7.6**	**0.93**	**27.44**	**31.37**	**37.92**
Coupling Attenuation [db]	**45.0**	**47.5**	**78.0**	**76.0**	**79.0**

Other tests included immunity against fast transient electrical disturbances, such as Powering of Fluorescent Lamps and immunity against radiated electromagnetic fields, such as those produced by GSM based mobile phones. Once again the U/UTP systems performed badly in comparison to the Screened Systems.

Figure 3 – Practical Radiated HF

Test (3m distance)	System 01	System 02	System 03	System 04	System 05
Walkie-talkies	✗	✗	✓	✓	✓
Mobile communication devices (mobile phone, GSM card)	✗	✗	✓	✓	✓

Figure 4 – Fast Transients



Without knowing the full details of the systems selected and cable constructions used, it would be wrong to jump to the conclusion that all U/UTP systems will fail to meet the performance requirements, so we should look to consider some of the other factors that are being discussed.

Field Testing

The reason why Alien Crosstalk testing be should avoided wherever possible is very simple, it comes down to time and money.

Performing a 100% alien crosstalk test in a cabling plant is impractical and virtually impossible in large cabling plants. Using the specified 6-around-1 method, the formula to determine the number of tests that would need to be run for 100% coverage is (n2+n)/2 where n is the number of links in the installation. For example, in an installation with 100 links, a total of 5,050 tests would need to be run to test every possible combination. In a 500-link installation the total number of tests climbs to 125,250 tests when testing every possible combination. Therefore the ISO/IEC 61935-1 standard provides guidelines for sample testing.

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ISO/IEC 61935-1 states sample testing should be conducted based upon evaluating links that meet all of the following conditions:

- Links with the Highest Insertion Loss
- Links with the Lowest Insertion Loss
- Links with the Median Insertion Loss
- Longest installed lengths
- Cables within the same bundle
- Adjacent ports in the patch panel

The key weakness of a U/UTP system comes about when you have a large quantity of adjacent ports loaded into patch panels, a fact that is highlighted within the measurement of ANEXT within ISO/IEC 11801 ed2.2 as by definition it does not meet the criteria of the infrastructure design element.

"Worst case conditions occur where ANEXT coupling occurs over the full length of disturbing and disturbed cabling and where all connections within each link are co-located".

"Simple models assume equal lengths of disturbed and disturbing links and co-location of connecting hardware (patch panels)".

Power over Ethernet

Whilst not in the original scope of this White Paper (the full details are discussed in our 'Demystifying PoE' white paper) this technology has more of an impact on this matter than a lot of people realise.

It is widely accepted that the use of remote powering or PoE has the side effect of heating up bundles of cables. As the demand for higher levels of power increases the level of heating is also following on.

What some have forgotten is an increase in Temperature is one of the major contributors for the increase in Attenuation, what a lot don't realise is the extent of this and the fact that it differs for Unscreened and Screened.

All the performance criteria for the 100m Channel as outlined in EN 50173-2 is based upon it operating at an ambient temperature of 20˚C and for every degree over this level this distance should be reduced. The following formula provided in the above standard gives the rate of reduction for unscreened cables. In short for temperature increases up to 20˚C above the ambient the Channel should be reduced by 4% and for temperatures over 20˚C above the ambient, there is an additional 6% that has to be added.

Unscreened
$L_{t>20^{\circ}C}=L/(1 + (T-20) \times 0{,}004)$
$L_{t>40^{\circ}C}=L/(1 + (T-20) \times 0{,}004 + (T-40) \times 0.006)$

This could potentially have a dramatic effect to the performance of installed cabling as recent research shows that the level of heating can be significant in some cases 30-40˚C above the ambient.

Again Screened Cabling performs much better, firstly research has proved it does not heat up as much as an unscreened cable and when it does the de-rating formula is much simpler as it is based upon 2%.

Screened
$L_{t>20^{\circ}C}=L/(1 + (T-20) *0{,}002)$

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On this basis what are the real differences and myths.

Unscreened	Screened
No Screen, Simpler and quicker to terminate. Yes and No; more care is needed in the preparation to ensure twist ratios are maintained etc. Most U/UTP solutions are very tightly twisted pairs and a large plastic separator.	Most manufacturers offer either a termination aid or have toolless products which lead to the overall time taken being quicker than U/UTP. Certainly the cable pulling time will not change
Cable pulling time for an unscreened solution can vary from slightly to a lot worse depending on the actual construction of the cable	Most screened cables have a relaxed twist on each of the pairs meaning that the cable itself is much less stiff and easier to handle and install
Does not require Bonding – This is a Myth, all metal panels within a cabinet whether Screened or Unscreened need to be bonded within the cabinet in accordance with BS/EN50310	A small amount of additional time is required to ensure all the outlets within each panel have a clean contact with the frame.
UTP cables are smaller – Again a myth, some U/UTP cable have an elliptical design and overall OD which is on average anywhere between 7.3 - 9.3mm, depending upon the manufacturer , however they are all bigger requiring more containment, larger bends and larger back boxes.	Average size of an Excel F/FTP solution is 6.9mm U/FTP is 6.7mm. The U/FTP cable is also available in a 305m box, thereby reducing set up time for cable pulling by as much as 75%. For the same physical space, it is possible to get as many as 15% more cables in the same space based upon the smallest U/UTP available from a leading manufacturer.
Field Testing although not common Alien Cross Talk testing can be requested requiring a 6 around 1 test method. A number of field testers make assumptions for this and rely on the manufacturer to back them up. If the full 6 around 1 test is called for the additional time for testing is a minimum 10-15mins per link. This is separate and on top of the Permanent Link Testing	Field Testing – ANEXT testing is not required, typical test time for a permanent link is approx 14-22 seconds, although there are next generation testers on the market that can test a Permanent Link less than 10 seconds.
Separation distances between Power and data are greatly increased with an unscreened cable e.g. for 10 circuits of 20A there has to be a physical separation between the Power and the Data cables of 80mm	The separation distances between the same number of power circuits is at least halved with foil screening requiring a distance of only 40mm and a S/FTP construction requiring even less.
Increased attenuation caused by temperature. Unscreened cable has a higher and more complex de-rating factor	Increased attenuation caused by temperature. Screened cable has a lower and simpler de-rating factor

Conclusions

It is clear that all the evidence shows that Screened is best, while Unscreened can be a viable option for those who choose to take that route, when they understand the implications highlighted in this paper.

One thing that is becoming clear is the number of companies choosing a screened solution is dramatically increasing across the globe, even in markets that have been firmly unscreened historically, as they start to understand the benefits while at the same time the myths of screening have been dispelled by better education.

This Technical Note has been produced by Paul Cave, Technical Manager, on behalf of Excel.

European Headquarters
Excel House
Junction Six Industrial Park
Electric Avenue
Birmingham B6 7JJ
England

T: +44 (0) 121 326 7557
E: sales@excel-networking.com

Middle East & Africa Headquarters
Office 11A
Gold Tower
Jumeirah Lake Towers
Dubai
United Arab Emirates

T: +971 4 421 4352
E: salesme@excel-networking.com

www.excel-networking.com

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