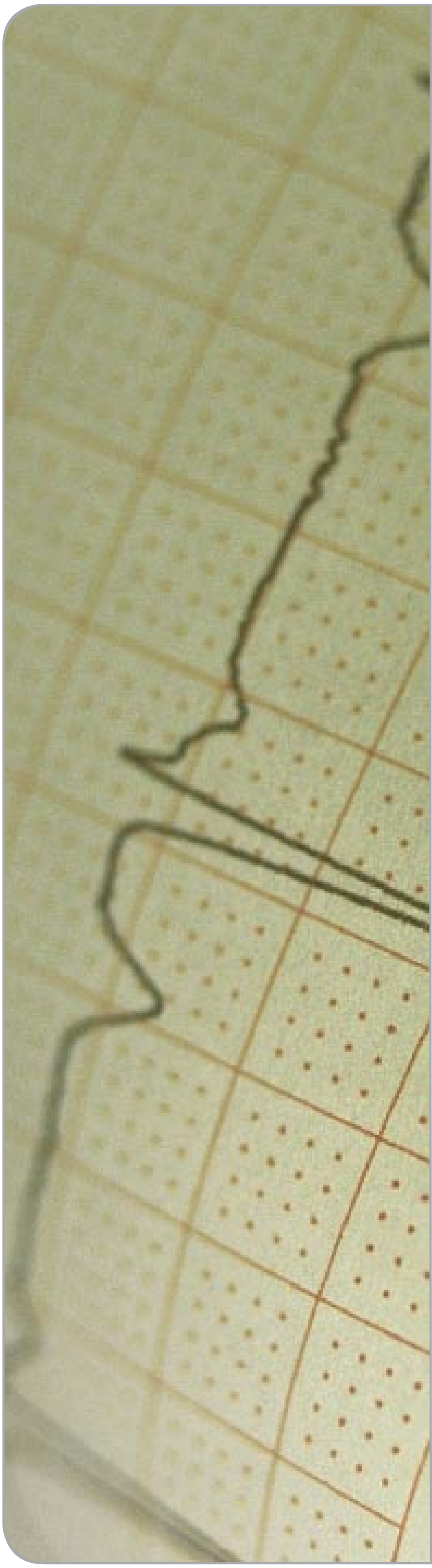


WHITE PAPER

10Gig Field Testing Comes of Age

ADC KRONE

10Gig Field Testing Comes of Age

It doesn't seem all that long ago that 10 Gigabit Ethernet over copper infrastructure was nothing more than a pipe dream. Consultants and End Users alike were focused on designing structured cabling solutions that could support a migration from 100BaseTX to 1000BaseT (Gigabit Ethernet). The thought of increasing speeds another tenfold in the horizontal was far reaching to say the least.

At the same time industry experts from both Active and Passive disciplines were investigating the technology to see if it was even theoretically possible.

We take a step back to mid 2003. The IEEE 802.3an working group are struggling to find the correct answers to problems that must be solved if UTP copper cables are to migrate to the next level in technology…10Gig. Closer to home, the ADC KRONE team are working hard to find those answers before the November meeting of the working group. Seen as a make or break milestone in the development of the standard, we realise that proving the concept would initiate the next wave in not only structured cabling, but in economical copper based active hardware e.g. NIC's and Switch Blades.

History will show that ADC KRONE not only opened the gates in proof of concept, but took many more steps behind the scenes in the development of laboratory test methodology and more recently by cooperating with Field Test Manufacturers in the development of fast and accurate test methodologies to qualify installations.

The IEEE 802.3an working group was then transforming into a Task Force (tasked with building the standard). This meant it was no longer a question of if, but when the standard would be released.

As a direct result of our proof of concept stage, we went straight to work on three areas. First, we needed an end-to-end solution that we knew would support 10Gig up to 100m. Second, we needed to convince customers that it would work. Third, we needed a way to qualify the installations once installed.

In January of 2004, while the IEEE was transforming into a Task Force, we paid a visit to Fluke Networks (FNET). Cable samples in hand we first had to convince FNET that there would be a need to test 10Gigabit copper infrastructure post installation. Engineering teams from both ADC KRONE and FNET brainstormed together trying to understand challenges with equipment and methodologies.

Fortunately FNET were close to releasing their market leading DTX-1800 Field Tester. The DTX platform expedited the process in having full equipment capability, with only the need for adaptive methodology. We had a plan!

Concurrent to meeting with FNET, ADC KRONE engineering was deep in the development of the connectivity to compliment our new "wonder" cable and mounting systems to support the full end to end solution requirements. Now we needed a customer.

February 2004, mission control, we have lift off! Our first customer was identified. One month later both FNET and ADC KRONE were onsite to field test the world's first 10Gigabit installation. The process was crude to say the least, but at the same time highly accurate! The data captured that day gave both of our companies the confidence that the cabling systems to support 10Gig were possible and they could be audited.

April 2004, ADC KRONE officially launches CopperTen™ in support of the IEEE 802.3an proposed standard for 10Gig transmission to 100m. Customers from all vertical markets, including Finance, Education, Government, Healthcare and the Tech Sector start installing CopperTen to get ready for the next wave in transport speed. With the promise that our products would run 10Gigabit Ethernet to the standard, once ratified. That's a pretty bold statement, but we know we had something very special.

Four distinctly different types of networks were chosen to initiate our audit of existing installations.

In developing CopperTen™ very early on in the race to 10Gig infrastructure, ADC KRONE were also given the ability to further develop the technology and performance levels to what they are today. A cross-section of Version 1 (early product) installations, as well Version 2 (current products) were chosen.

Figure 1. Diagram Displaying Types of Installations

Step forward more than two years. June of 2006, the IEEE ratifies the 802.3an standard. Electrical requirements to run the protocol are set and specified. It's now time to put our money where our mouths are.

Fortunately the release of FNET's DTX AXTalk Analyzer was only months behind the ratified standard. All concepts are now reality and electrical auditing for full compliance is now possible.

On the road again, we set out to prove to our loyal, trusting customers that they had made the correct decision in trusting ADC KRONE engineering pre-standard. Our task was to test a diverse cross-section of installation types. Several different types of installation practices, lengths, products and applications of products were selected, that would prove once and for all that CopperTen could support 100m transport of 10Gig, under any standard industry practice installation methodology. Or to simplify matters, "The Long and Short of it"!

After the installer has completed a 100% check of the Links/Channels to compliance for internal electrical performance, further testing can then be conducted on the effects of Alien Crosstalk between cables.

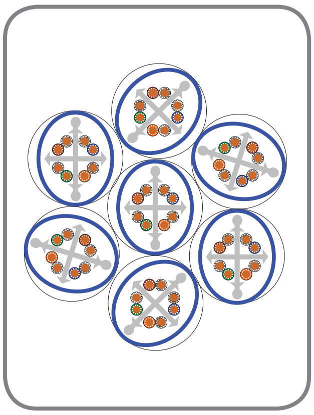


Figure 2. CopperTen Cross Section

Alien Crosstalk, as most people in the industry are aware, is the effect of noise generated between adjacent cables that couples from one cable to another. This is most often depicted as a 6 around 1 configuration. Where the centre (disturbed) cable is effected by all 6 of the (disturber) cables surrounding it in a cable bundle.

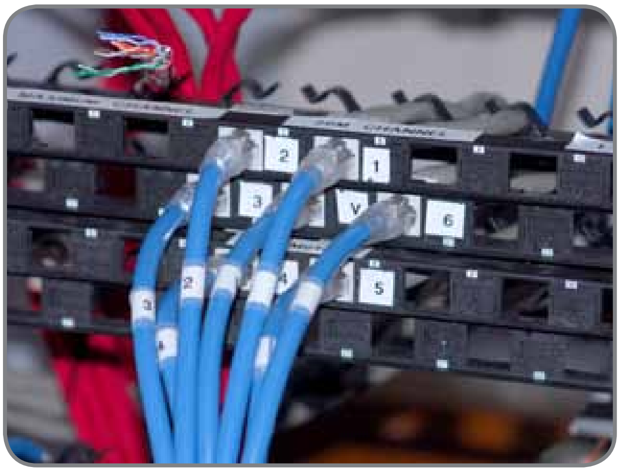


Figure 3. Testing Alien Crosstalk between cables

How We Test In The Field

The testing on all sites was conducted using FNET's DTX-1800 main and remote units with the AxTalk Analyzer.

Both PSANEXT (**P**ower**s**um **A**lien **N**ear **E**nd **Cross** **T**alk) and PSAACR-F (**P**ower**s**um **A**lien **A**ttenuation to **C**rosstalk **R**atio - **F**ar end) were tested on all scenarios.

PSANEXT tests the amount of coupled signal found on the disturbed cable at the signal launch point. The main unit monitors the amount of coupled noise on each cable pair from the disturber cable, which has noise induced from the remote unit. Both the main and remote units are then linked together for synchronisation purposes.

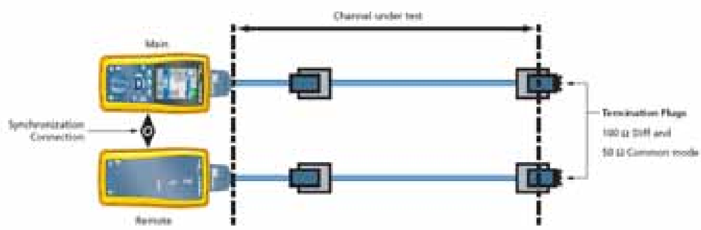


Figure 4. Testing Alien Crosstalk between cables

PSAACR-F tests the amount of noise found at the far end of the circuit, taking into account the attenuated signal strength due to cable length. Again, both units are connected together for synchronisation purposes and the measurement is taken in both directions.

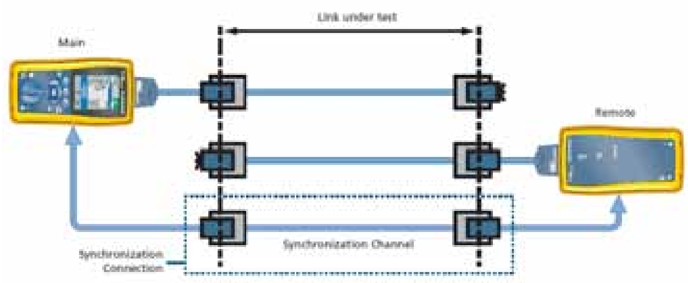


Figure 5. Testing Alien Crosstalk between cables

Version 1 vs. Version 2
Metal vs. Polymer Patch Panels

Both version 1 and 2 installations were chosen for auditing to ensure the level of warranty given was in full compliance on all installed solutions throughout the 3 years ADC KRONE has offered CopperTen™.

Early in the development phase of 10Gigabit UTP copper solutions we discovered an industry wide problem with regards to the types of mounting systems that were being used.

Version 1
Metal Patch Panels

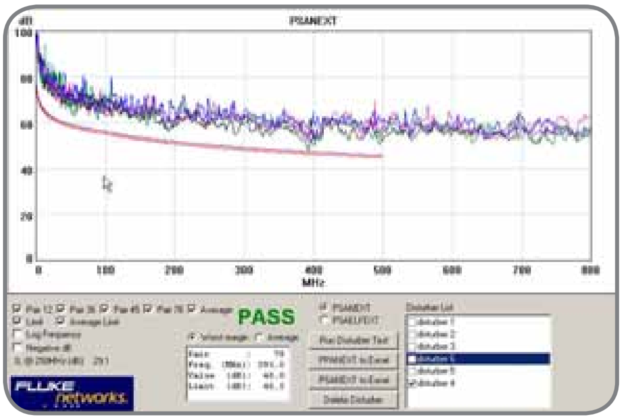


Figure 6a. Version 1. Metal Test

Traditionally, metal is used in the production of Patch Panels. Metal works well as an economical, strong, well-finished patch panel mounting material for both Cat 5e and Cat 6. Version 1 patch panels (2004-2005) for Cat 6A also used metal as the primary material.

Through vast amounts of transmission testing during development activities, a phenomenon was discovered that lowered the Alien Crosstalk performance of the system. This degradation didn't occur at all frequencies, but rather at unpredictable spot frequencies. These anomalies were painstakingly investigated and found to occur not only at unpredictable frequencies, but also vary depending on jack position, patch panel rack placement, type of rack and number of panels and complimentary active and passive equipment mounted in the rack. We had a high frequency waveguide issue!

Clearly we were chasing multiple variables and fixing the problem would not be easy. Grounding and shield of jacks in the mounting system gave limited improvement. We had to get to the root cause of the problem, the metal had to go!

Version 2
Polymer Patch Panels

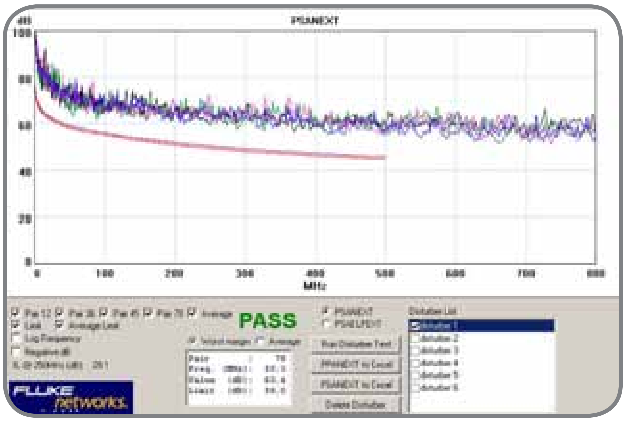


Figure 6b. Version 2. Polymer Test

Once we eliminated the metal and tested using polymer mounting systems the problem went away. We no longer saw any degradation in performance levels due to mounting system.

Sites Tested

After 3 years of installing CopperTen and through the ability to finally be able to audit the facilities for Alien Crosstalk compliance we selected a range of installations that included both Version 1 product and Version 2. Different configurations, lengths and vertical markets were also purposely selected.

Scenario 1 – An Engineering Firm

Figure 7 IEEE 802.3an Requirements met. Version 2. Polymer Test

- Version 1 – Metal Patch Panel to plastic face plate
- Date of Install – June 2004
- Warranty – IEEE802.3an
- Design Engineering Firm in the USA
- Low Density
- Short to Medium Runs - 65' to 107' channels tested
- Good spacing

Full 6 around 1 testing was conducted. Spacing between patch panels at a 1:1 ratio to horizontal cable management meant that Alien Crosstalk would be minimised in the mounting system.

Compliance to IEEE802.3an requirements, as warranteed, have been achieved. Margin from the limits needed to run 10Gigabit Ethernet were 17dB great than required on the worst pair combination.

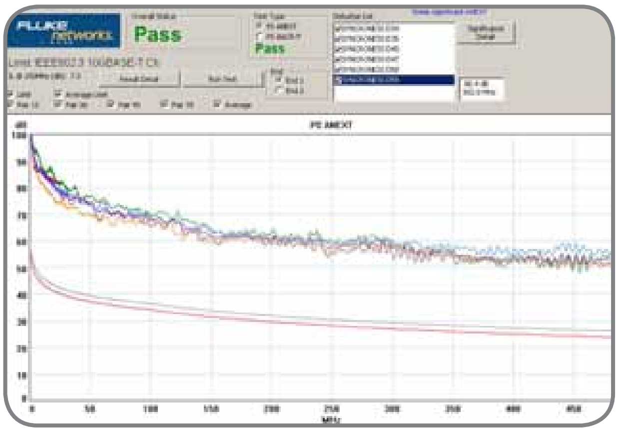


Figure 8a. Short floor run passing well to IEEE

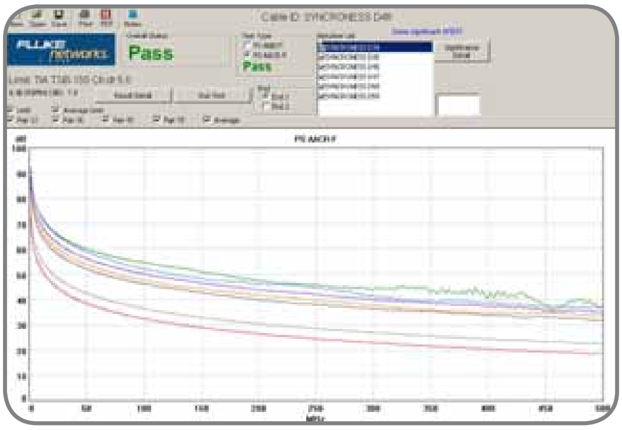


Figure 8b. Far End Floor run passing well to IEEE

Scenario 2 – A University Weather Sciences Building

In this scenario the density was maximised. Cable Management was filled to capacity. "Speed Pull" bundles of 4 cables were pulled in from the face plates back to the Floor Distributors (FD's). This was deemed the worst possible contributor of all the sites we tested. Cables in the bundle are side by side for the entire length of the run and contribute the most Alien Crosstalk as a result. It's also the best way to test the ability of the solution.

Figure 9. Pushing the limits by Maximising the Density

Version 1 – Metal Panel to plastic face plate

- Date of Install – February 2005
- Warranty – IEEE802.3an
- University in the USA
- High Density
- Long Runs – 215' to 265' channels tested
- Poor Spacing
- Speed pull – 4 in a bundle

Full 6 around 1 testing was conducted. All ports tested were found to be compliant with IEEE802.3an requirements as warranted.

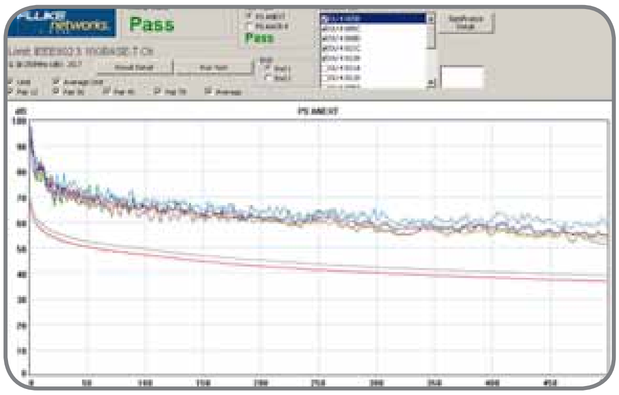


Figure 9a. 6 around One only

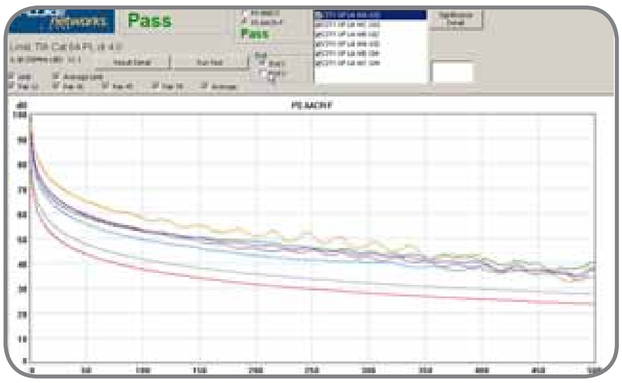


Figure 9b. Short floor run passing well to IEEE

Additionally, further positions were tested in an effort to understand the effects of positions outside the directly related 6 around 1. The increased disturber number was brought to 14 around 1. Significant data was found in the outer positions that contributed to the overall noise on the disturbed cable, but still was not enough to be of concern.

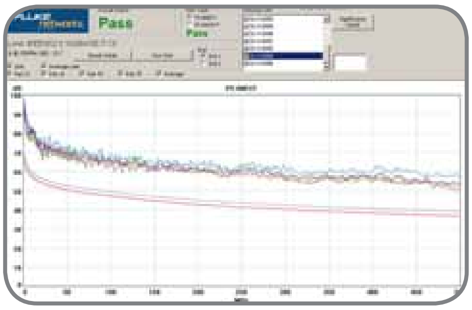


Figure 10a. 14 Around One

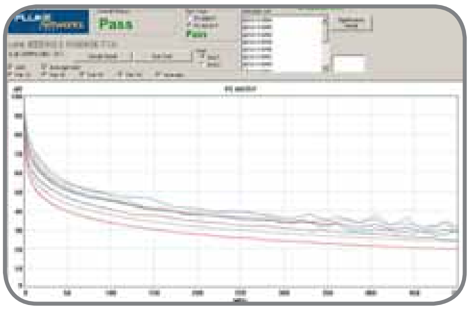


Figure 10b. 14 Around One

Scenario 3 – A University Data Centre

The next scenario was selected for its short run lengths and the configuration of Patch Panel to Patch Panel in Data Centre racks. Where Scenario 2 was a good example of "worst case" cable contribution from "speed pull", Scenario 3 was deemed the worst case for Metal Panel high frequency waveguide issues.

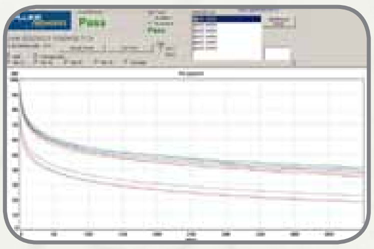
- Version 1 – Metal Panel to Metal Panel
- Date of Install – February 2005
- Warranty – IEEE802.3an
- University in the USA
- High Density
- Short Runs – 110' to 112' channels tested
- Good Spacing and Management
- 24 ports to 24 ports, all cables bundled together

IEEE 802.3an Limit

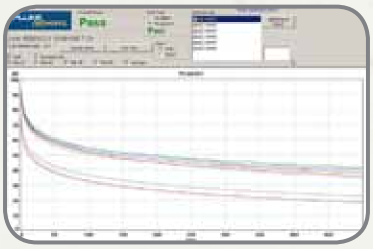
6 Around 1: Tests all passed

Several 6 around 1 tests were conducted with all passing the requirements of the IEEE802.3an standard. ADC KRONE CopperTen™ metal panels were fully compliant with all warranty statements made pre-standards.

6 around 1

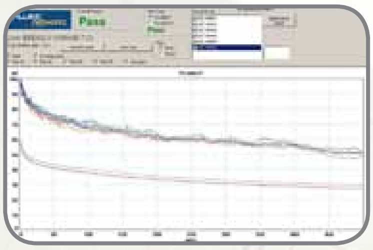


PSANEXT

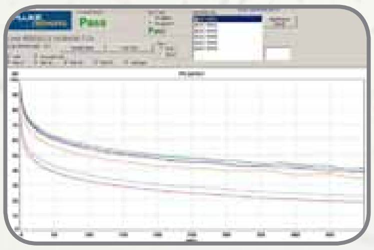


PSAACR-F

6 around 1

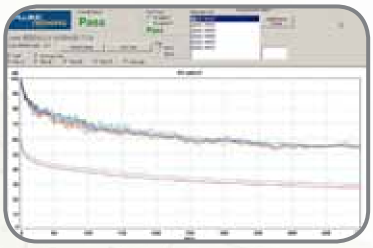


PSANEXT

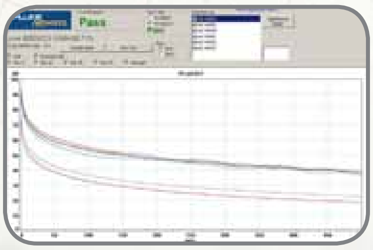


PSAACR-F

6 around 1



PSANEXT



PSAACR-F

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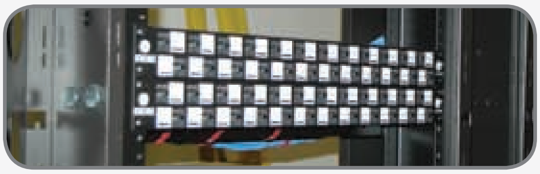
Scenario 4 – Local Government Offices

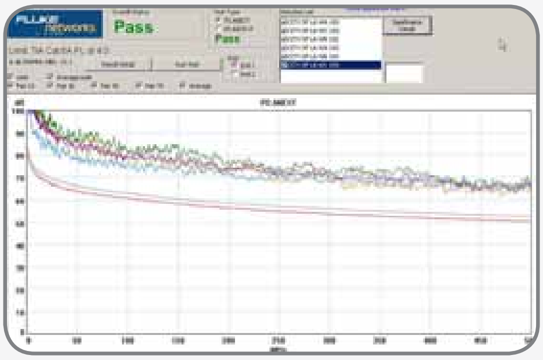
In this scenario we find the longest runs tested. The floor plan was large office space going back to the FD at high density. Version 2 Polymer Patch Panels were used. This allowed for higher overall performance and for a more stringent test criteria in the TIA-568-B.2-10 Draft.

- Version 2 – Polymer Patch Panel
- Date of Install – November 2006
- Warranty – TIA Link
- Local Government in the USA
- High Density
- Medium to Long Runs – 186’ to 239’ links tested
- Tight Spacing and no horizontal management
- 24 ports polymer Panel to 3 port face plates

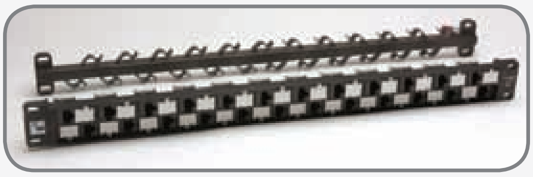
The difference in performance between Versions 1 and 2 can be entirely attributed to the elimination of metal in the mounting system. Although Version 1 Systems are fully compliant to run 10Gigabit Ethernet, as per IEEE802.3an, additional performance was needed to be fully compliant to TIA and ISO specifications as they became available. With the introduction of the Polymer mounting system we were also able to create great jack separation through not only staggering the jacks in the X and Y axis, but also in the Z axis, where the lower 12 jacks are back from the upper 12 jacks. This ensured that jack to jack crosstalk was eliminated entirely as a contribution to Alien Crosstalk.

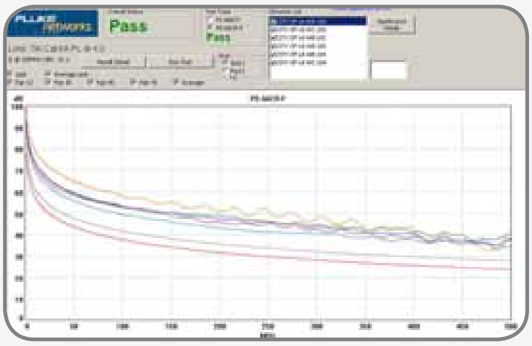
Metal Version1 Panel





Polymer Version 2 Panel





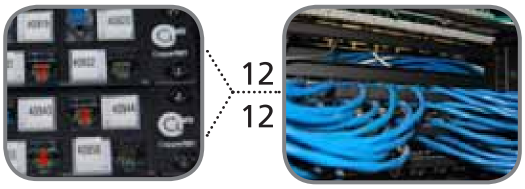
Fully Field Compliant to more Strict TIA/ISO Draft requirements!

Four Sites, Four Different Ways to Manage Cables

There are differences in techniques with just about all installations. Installer preference, types of pathways available, space considerations and network design all dictate how cables will be managed. While conducting the audit of CopperTen™ facilities we were surprised at how vastly different the cables were being managed at the back of the patch panels.

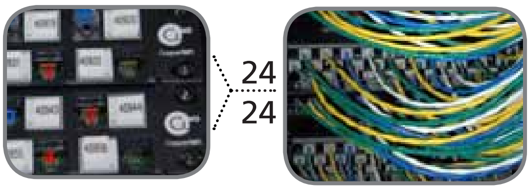
Scenario 1

- In Scenario 1 the panels were split into bundles of 12 going in either direction
- Bundles of 12 from panels on top of one another were then joined together to create a bundle of 24
- This technique creates the worst possible scenario for AxTalk connector and cable combination by having maximum contribution



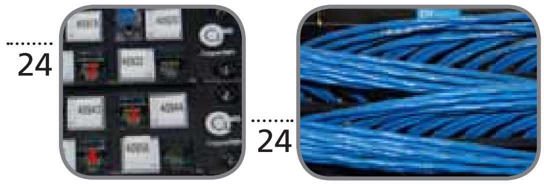
Scenario 2

- The cables at the back of the patch panels were brought out in groups of 48
- Same 4 port face plate bundles were kept close all the way back to the patch panels
- This allows for maximum AxTalk impact. All 6 around 1 cables are together



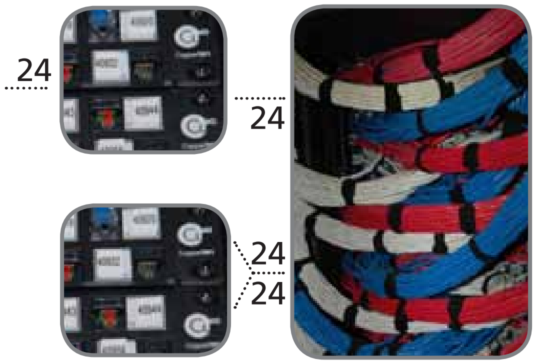
Scenario 3

- Scenario 3 works best by changing the direction of the cables from the back of panel 6 around 1
- This is only a recommendation and not a requirement
- All techniques passed the level of warranty required



Scenario 4

- In Scenario 4 each patch panel was bundled together in a group of 24
- The bundles didn't alternate in both directions 1 for 1, but were more random
- This meant two panels on top of one other could have their bundles managed in the same direction
- Not the best practice, but not the worst



Conclusion

All scenarios tested were 100% compliant with the stated level of warranty. Despite different cable management techniques, little impact to overall transmission is evident. Cable techniques can, however, improve the overall alien crosstalk margin.

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www.adckrone.com/in

Corporate Office and Factory: P.B. No. 5812. 10C II Phase, Peenya, Bangalore – 560058 INDIA
Tel: +91 80 28396101 Fax: +91 80 28396104
TOLLFREE: 1800 425 8232
OFFICE LOCATIONS: BANGALORE, NEW DELHI, MUMBAI, PUNE, CHENNAI, HYDERABAD

ADC Telecommunications, Inc., P.O. Box 1101, Minneapolis, Minnesota USA 55440-1101