White Paper:

What Component Compliance Means for CAT6A System Performance in Government Mission Critical Networks

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Introduction

When it comes to structured cabling performance in government systems, the objectives of a standard are both to ensure the performance of present, foreseen and perhaps unforeseen applications; and to allow interoperability of components from multiple manufacturers that make up a government structured cabling system. Ensuring the performance of applications has rarely been an issue, since the requirements defined in TIA 568B.2, and ISO 11801 are in excess of what typical applications such as Ethernet require, as developed in IEEE 802.3an. For example, the fact that some CAT6 cabling can work for 10GbE is due in part to the extra performance margin TIA built into the CAT6 standard. Nevertheless, when it comes to guaranteed performance and reliability, it takes a component compliant CAT6A System to meet the critical needs of a government or Department of Defense Network

Manufacturers often design their structured cabling solutions to have the best margins when their components are combined as a system in an installation. This approach takes advantage of tradeoffs that can be made when the performance envelope of each component is known. This envelope is typically narrower than what the standard requires for each component if the design is robust and manufacturing variables are well-controlled. Connectors can be designed to work best with a given cable and/or patch cord so as to optimize channel performance.

When a government structured cabling system has components from different manufacturers, the overall performance margin can drop, due to the need to work with connectivity that may be anywhere in the performance envelope defined by the standard for a channel or permanent link. To combat this, a competent manufacturer will design extra margin into a component-rated connector, patch cord, or cable. The result is excellent performance margin, both with a manufacturer’s own components and with a mix, if the end-user so chooses.

Does Component Compliance Guarantee Channel Performance?

With the advent of 10GbE, alien crosstalk (AXT) requirements are defined in TIA 568B.2-10, both at the channel, permanent link level, and the component level. In some instances, meeting component requirements for AXT for each part of the system — whether cable, connector, or cord — does not guarantee that the resulting channel or permanent link will meet AXT limits. The sum of the parts does not ensure the whole, as is normally true for internal parameters like NEXT and RL. The standard acknowledges this in Annex B, section B.1 and Annex C, section C.1, stating that in addition to component performance verification, cable and connectors should be verified for compliant channel AXT performance. This is because alien crosstalk can take many forms, not only differential to differential, but common mode to differential mode conversion. These different manifestations of AXT are affected by the balance of the component. The better the electrical balance of a cable, connector or cord, the better it is able to reject these common mode conversion forms of AXT, and the better AXT margin a channel has when made up of these components.

Leviton CAT6A component-rated connectivity is designed and tested to exceed the currently published AXT component requirements, so that not only will these components work well in a mixed channel, but maximum performance can be attained in a full Leviton government structured cabling system.

Worst-Case Alien Crosstalk testing at the Component Level

Component AXT testing for connecting hardware involves two setups: one for Alien Near End Crosstalk (ANEXT) and one for Alien Far End Crosstalk (AFEXT). For a given panel or wallplate, a victim port is selected, and the crosstalk from each disturbing port is measured. The results are summed to give a worst-case Power Sum Alien Near End Crosstalk (PSANEXT), or Power Sum Far End Alien Crosstalk (PSAFEXT).

The TIA standard defines limits for connecting hardware AXT, as well as a limit for how many disturbers must be included in the summing of crosstalk affecting the victim port. These “significant disturbers” are those ports that exceed the 90-20log(f/100) limit for AXT when measured from the victim port. In a typical installation, a significant disturbing link can be nearly any port in a panel, depending on how the cabling is bundled, whereas significant ports in a panel are generally located very near the victim port.

Figure 1 shows several panels arranged together with a victim port selected.

Disturbing the Peace – Identify the Significant Ports

In this example, we focus on measuring the AXT seen by the victim jack from neighboring ports (disturbers). This crosstalk can come from the connectors, the traces on the PWBs and the IDCs associated with each port. Figure 2 shows the results of measuring several ports surrounding the victim port for significant disturbers. Depending on the panel configuration, approximately 24-30 ports must be checked for significant ANEXT or AFEXT relative to a selected victim port. This process is time consuming, since ports are tested moving outward from the victim port in all directions until non-significant disturbers are found. One victim-disturber port combination is tested at a time, using a vector network analyzer to apply a signal to each disturber wire pair, listening for any coupling of that signal to any of the four victim port wire pairs.

Don’t be a Victim

Figure 3 shows a graph of the 16 pair-to-pair alien crosstalk measurements that were taken to determine the significance of just one port to the victim port.

This example shows the port to be significant, since the AXT measured exceeds the significance limit set by the TIA standard. As such, it will be included in the summing of all significant disturbers to the victim port. Only those pair combinations that exceed the significance limit will be selected for the calculation, and only at the frequencies they exceed it.

Notice that, for a disturber port located adjacent to the victim port, this disturber is remarkably quiet. Careful attention to port isolation at the connector, PWB and IDC level ensures this Leviton CAT6A patch panel will have margin to spare.

Once significant disturbers are known, one can calculate the AXT the victim port sees and compare this against the component requirements of the standard. In this test setup, only 6 disturbers were found to have significant ANEXT to include in the power sum calculation, though 24 ports were checked.

Put It All Together

Figure 4 shows the results for the Leviton CAT6A patch panel, recently verified by Intertek (ETL) to meet the component requirements of TIA 568B.2-10. Even when surrounded by several disturbing ports, the typical victim port in this patch panel has plenty of AXT margin relative to the standard.

This process is repeated for determining the amount of PSAFEXT seen by the victim port. Significant disturbers are located using AFEXT measurement techniques, and the results are power summed.

Connectors like these which exceed TIA requirements can be installed into CAT6A permanent links and channels and have exceptional results. When installed using Leviton cords and horizontal cable from Leviton partners, system alien crosstalk margin is maximized.

Show Me the Channel

What is the installed performance of a CAT6A government structured cabling system made up of component compliant jacks, panels, cords and cable? The new Leviton CAT6A component-rated patch panel tested for this paper was installed in the first two positions of a four connector 100M channel. The third connector was Leviton's component-rated CAT6A 110 block, and the fourth, Leviton's CAT6A component-rated connector. An approved CAT6A UTP horizontal cable was used. Rounding out the critical government system is Leviton's component compliant SlimLine patch cords. The 6 around 1 topology is shown in Figure 5:

Below is the channel PSANEXT performance of this topology, tested to TIA 568B.2-10 limits.

Figure 7 shows the PSAACR-F performance of the same topology. Careful test preparation using a calibrated instrument with a very quiet noise floor is needed to capture this parameter.

Maximum performance is available using Leviton components exclusively, with margin available if other cords or cables are used. These graphs show the excellent margins possible when components and cable are designed to work with each other.

Alien crosstalk is one of the more challenging parameters to mitigate, with several coupling modes to deal with. Minimizing both near and far end alien crosstalk in the channel involves addressing each of these modes of coupling in each component, as well as looking at how and where along the frequency of interest each component contributes to the measured channel performance.

Conclusion

When combining standard-compliant connecting hardware which meets CAT6A component specifications with compliant horizontal cable, the result should be an optimized system that is best suited for a government high end critical network. This critical government system will typically meet the channel and permanent link performance requirements. However, to assure the highest channel margin, both for internal parameters and the alien crosstalk parameters explored here, it is critical that the cable and connecting hardware be tuned together. Leviton components have been designed and verified with that in mind.

When putting together a government system of CAT6A connectivity and cable, ensure that applications such as 10GBase-T are supported well, with margin to spare. A component-rated panel, jack, cord or cable is only as good as the channel performance the combination is able to achieve. The technologies in a Leviton-based solution enable the highest performance available in the industry.

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