STRUCTURED CABLING VERIFICATION TO VENDOR SPECIFICATIONS: MARKETING HYPE OR BETTER FOR YOUR NETWORK?
Summary

Many structured cabling vendors submit their products to third-party verification programs that perform testing to TIA-568. Some go a step further and have independent verification to their own specifications that are commonly better than the minimum requirements from TIA. This paper will explain why this is important and how this will affect your network. The difference between channel and component testing and why you need both will also be discussed.

Introduction

Structured cabling suppliers have, for many years, relied on agencies like Intertek (ETL) and Underwriter’s Laboratory (UL) to independently verify that their products meet TIA standards. To be clear, standards are minimum criteria to which companies must design in order to interoperate with other parts of a cabling system. Many providers of communications cable, such as Berk-Tek, a Nexans Company and CommScope/Systimax, have chosen to develop products that perform “above the standards.” While this seems to be adding value to networking cable, there are some intricacies that buyers of such products should heed. With this perceived added performance also comes a higher price tag. So how does one know if the purchased cable actually meets the “better than the standard” specification? How can you know that you are getting more for your money? Unfortunately in most instances, short of acquiring specialized test equipment (network analyzer) and hiring an engineer that knows how to use it, you can’t.

This paper will discuss two main ideas about structured cabling verification:

1) Independent verification to cabling vendor’s specifications is paramount to maintaining a reliable local area network.

2) Component certification will assure proper end-to-end operation as well as allow flexibility in cabling systems, supporting the use of any cable with any connector.

Using cable that is verified to the TIA standard assures minimum compliance and will allow you to connect your current version of networking equipment, but utilizing cable with headroom results in a more reliable connection with more immunity to disturbances that could cause errors.

The cable discussed in this article will be copper Category cable. Fiber-optic cable will not be covered.

What is structured cabling?

According to Wikipedia, structured cabling is “building or campus telecommunications cabling infrastructure that consists of a number of standardized smaller elements (hence structured) called subsystems.” These subsystems are defined in the TIA standards and consist of the following: entrance facilities, equipment rooms, telecommunications rooms, backbone cabling, horizontal cabling and work area components. Copper structured cabling, because it has distance limitations of 100 meters, is typically used for horizontal and work area parts of the network as well as within equipment rooms (including data centers) and entrance facilities. While it can be used for backbone cabling if the distance is less than 100 meters, it rarely is any more.
There are two main specifications used to design and install structured cabling – TIA-568 and ISO 11801. The TIA standards typically rule in North America, while the ISO standard is used throughout the world. There are slight differences between the two series of standards, but most manufacturers make their cables so they meet both. However, TIA does not cover Class F (Category 7) cable as of yet. This is only defined in the ISO standard.

The following table summarizes the different cables, their bandwidths and their application data rates. While these cables are touted as “application non-specific” products, the reality is that most times they are used for Ethernet local area networking.

<table>
<thead>
<tr>
<th>Category</th>
<th>Bandwidth (MHz)</th>
<th>Data Rate (Mbps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>16</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>100</td>
<td>100</td>
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<tr>
<td>5e</td>
<td>100</td>
<td>1000</td>
</tr>
<tr>
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<td>1000</td>
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<tr>
<td>6A</td>
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</tr>
<tr>
<td>7</td>
<td>600</td>
<td>10,000</td>
</tr>
<tr>
<td>7A</td>
<td>1000</td>
<td>10,000</td>
</tr>
</tbody>
</table>

The most commonly used LAN cables today are Category 5e, Category 6, Category 6A and Category 7. Together, Category 5e and Category 6 make up the bulk of the market. Category 6A was specifically designed to address alien crosstalk (crosstalk from one cable to the next), which is a concern for 10G networks. It is being used mainly in data centers that are planning on implementing 10G systems. Category 7 is almost exclusively used in Europe, but is starting to make some inroads in North America as an option for 10G and beyond. Category 6A, which amounts to about five percent of the North American market is much more common than Category 7, which is less than one percent.

Third-Party Testing

Third-party testing has been used in the communications industry from the time of its inception. There has always been a need for independent testing of complicated infrastructure components. The most well-known companies providing these services are Intertek (ETL) and UL. Both of these agencies provide fire safety and performance testing, however, UL has developed its reputation focusing on fire testing, while ETL is well known for both. For the purposes of this article, we will focus on electrical performance testing and not fire and safety testing.

Listed versus Verified

While this paper is focused on performance testing, it is instrumental to explain the differences between third-party listing and verification programs because there seems to be much confusion in the industry as to what each of them entails.
According to Intertek, “A product bearing the ETL Listed Mark is determined to have met the minimum requirements of prescribed product safety standards. Moreover, the mark indicates that the manufacturer’s production site conforms to a range of compliance measures and is subject to periodic follow-up inspections to verify continued conformance.”

Verification is more of a product differentiation tool where manufacturers voluntarily participate in ongoing testing programs. Again, according to Intertek – “A wide range of industries, companies, associations, and manufacturers have found performance and benchmark testing – and the ETL Verified Mark – to be an effective way to differentiate their products and brands in competitive markets. Whether it's verified bandwidth of cabling products, verified cleaning ability of a dishwasher, or verified fire resistance of safes, the ETL Verified Mark is a symbol of performance integrity of the products that bear the mark.” In structured cabling, manufacturers almost always verify their products to the TIA standard. This is customary practice even for manufacturers who claim that their products operate at levels above the standard.

So exactly what does this mean? Being “Listed” is required for manufacturers to show their products and factories are safe and comply with codes and standards. Verification is entirely voluntary, and shows that a particular product or family of products meets TIA or vendor-specific performance criteria. A prime example of verification is the ETL Verified Program discussed above. To bear the ETL Verified Mark, manufacturers agree to have Intertek choose samples from manufacturers’ stock to prevent the practice of “cherry picking,” wherein a manufacturer can select a test sample from a particularly high-performing product run and then treat it as a typical example of product performance.

Additionally, manufacturers that are part of this program agree to have Intertek repeat this random testing quarterly. If the testing process does not involve having Intertek select the sample on a continuing basis, the product or system cannot bear the ETL Verified Mark.

Manufacturers can at any time have products third-party tested. If the products that are submitted are shown to meet the performance standards (either TIA or vendor-specific) against which they were tested, the cable supplier can then say that the products have been “independently third-party tested” to a particular standard, or that they have “third-party performance certification.” Neither of these statements is untrue. But, neither of these statements means that the company has ongoing independent testing as part of regular business process. These products would not be eligible for the ETL Verified Mark.

Why should this matter to you? The fact that a manufacturer has made and sent a single product at a single point in time that passes the minimum performance specification of the standard does not guarantee that they are able to achieve these performance levels on an ongoing basis, or that the product that you purchase has a high likelihood of performing at these levels.

Cable manufacturers all have warranty programs as well, but these are not related to third-party testing or verification programs. Product warranties are based on specific installations and are granted upon proof of proper installation, which is provided by using field testers. These “certificates of conformance” show that a particular permanent link or channel complies with the TIA specification. They say nothing about whether each component of that link or channel (cable, connectors, consolidation point, etc.) actually complies with its own component specification.
Electrical Performance Criteria and Verification

Structured cabling verification comes in several different forms:

1) Component verification – verify the separate cable and connectors meet their respective specifications
2) Link verification – a link, as defined in TIA-568, is a transmission path between two points which includes two jacks and the cable in between them, but excludes patch cords and network equipment. This is shown in Figure 1 below.
3) Channel verification – a channel, as defined in TIA-568, is an end-to-end transmission path where the network equipment would be connected. This would include the link as well as patch cords, but not the networking equipment.

If you have proof from the manufacturer that the channel is TIA-568 complaint, why would you need anything else?

Well, as one cable manufacturer representative that was interviewed for this report said, “a chain is only as strong as its weakest link.” Channel testing is required, but is not sufficient. Your channel may be compliant even with a component that is not – especially if one component is compensating for or has more margin than another. For instance, if your connectors have a lot of margin to the specification, you could use a cable that is borderline failing and still pass the channel requirements. The same would be true if you had marginal connectivity and a cable with excess margin. This has been seen time and time again in laboratories, but is largely unknown to end users because they cannot perform the actual component tests themselves without a network analyzer and the expertise to use it. This situation can actually be predicted as well, just by looking at the TIA specifications. For example, take the near-end crosstalk (NEXT) parameter of a Category 6 cable; the channel requirement at 100MHz is 39.9dB. The connector specification is 54dB, the horizontal cable is 44.3dB and the patch cable is 46.4dB. One of these components could be out-of-spec while the others meet or exceed the spec, but together they would still meet the channel requirement.

Antoine Pelletier, Intertek Datacom Engineer, agrees, “One component should never rely on another component to achieve channel compliance. What happens if the ‘compensating’ component gets replaced? For instance, if a connector gets damaged and is replaced by a connector which doesn’t have those ‘compensating’ capabilities, then the channel performance may no longer be met. Therefore, the only way to guarantee end-to-end channel compliance is to opt for Verified components.”

Figure 1: Representation of a Link
Figures 2 and 3 below show a perfect example of a passing link and a failing component used in that link. Due to cost and complexity, a minimal amount of alien crosstalk testing is conducted in the field. However, lab tests by manufacturers are commonplace, and this example shows an Augmented Category 6 alien crosstalk test. The cable fails Power Sum Alien Near-End Crosstalk (PSANEXT) while the link it is installed in passes.

In the case of Augmented Category 6, this situation could be catastrophic. Alien crosstalk is the single most important parameter when it comes to 10-Gigabit systems, which is the application for Augmented Category 6. No matter how “borderline” the failure, it is an indication that the cable will not withstand noise from a similar cable, which will in turn cause bit errors in the system.
At an absolute minimum, end users should always make sure their vendors show ongoing third-party verification that their products are component compliant to the TIA specification and better yet, to their own “above the standards” component specifications. This is one way that an end user can “verify” that they are getting what they paid for. Do not rely solely on the manufacturer for this data, as it is trying to market its products in the best possible light.

Intertek’s Pelletier also says that “the best way to ensure full interoperability is to choose components that have been independently Verified. Interoperability is the foundation of industry standards. At Intertek’s laboratory, we have seen several instances where usage of non-compliant components may either result in a compliant channel or in a non-compliant channel. The channel performance always depends on several factors, but one thing that is for sure, such gambling [with component compliance] is not an appropriate solution.”

Typically, a new installation is done during the building-construction phase and all that is available at the time of testing is the link. The equipment and patch cords are added much later. Therefore, link and field testing specifications were developed. However, these still have the same issue as channel verification does – a weak cable can be compensated for by a connector with more margin and vice-versa.

According to Intertek’s Pelletier, “usage of verified patch cords is also very important because the 54dB at 100MHz connector limit is representative of the mated connection (connector + plug) response. So, usage of a lower-grade patch cord will have several bad impacts on the cabling-system performance. First, it can convert a compliant connector into a non-compliant connection point. Then, it annihilates all ‘compensating’ capabilities of the connector and may amplify other problems rather than hiding them and it can ultimately lead [to] very bad end-to-end channel non-compliances. This is something that is impossible to capture during the permanent link testing that is regularly performed on installed links.”

Vendor-specific verification has become a rising trend over the last few years because so many of the cable suppliers tout “above the standards” performance.
Vendor-Specific Verification

As stated earlier, it is the norm in the structured cabling industry to demonstrate component performance compliance through verification programs that test to the standard. However, Intertek has created some specialized verification and testing programs for various companies. Below are listed the cable manufacturers that maintain vendor-specific verification programs with Intertek.

### Vendor-Specific Verification Programs

<table>
<thead>
<tr>
<th>Vendor</th>
<th>Products</th>
<th>Verification Program</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cable</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Berk-Tek®, a Nexans Company</td>
<td>LANmark-350®, CAT 5e UTP, CMP, CMR, 100m</td>
<td>LANmark Specification</td>
</tr>
<tr>
<td></td>
<td>LANmark®-1000, CAT 6 UTP, CMP, CMR, 100m</td>
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</tr>
<tr>
<td></td>
<td>LANmark-2000, CAT 6 UTP, CMP, CMR, 100m</td>
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<tr>
<td></td>
<td>LANmark-10G2, CAT 6A UTP, CMP, CMR, 100m</td>
<td></td>
</tr>
<tr>
<td><strong>Channel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CommScope®</td>
<td>Uniprise® 30m and 100m 3, 4 and 6-connector channel Category 5e, 6</td>
<td>Uniprise Specification</td>
</tr>
<tr>
<td>Leviton®/Superior Essex®</td>
<td>NextLAN®4-connector channel Category 5e, 6</td>
<td>NextLAN Specification</td>
</tr>
</tbody>
</table>

In reviewing these programs, there are two observations that can be made:

1. There is only one cable supplier that maintains third-party vendor-specific component verification for its cable. So even though all of the other top cable suppliers show margin above the standards on their data sheets, Berk-Tek is the only company to date with this differentiation.

2. There are only two channel verification programs, even though there are many advertised claims of above the standards performance by many top manufacturers including Belden, Berk-Tek/Legrand Ortronics, CommScope/Systimax, Panduit/General Cable, The Siemon Company and Tyco Electronics among others. It is possible that so few channel verification programs exist because channel specifications are able to be verified in the field, so this may account for the scarcity of such programs.

Some representative verification data can be found on both Berk-Tek’s and the NextLAN (Leviton/Superior Essex) Web sites.

In analyzing a couple of these reports, the Berk-Tek LANmark-2000 NEXT data (test report number 3081381CRT-032d; dated 4/24/2009) shows that indeed Berk-Tek meets its claim that its LANmark-2000 cable has 10dB less NEXT than the industry standard requires. To read the graph, one must remember that it is shown inverted and thus the higher the number, the better the NEXT performance. Also what is interesting about the data presented in this graph is that the results show the “worst case on the worst pair” as well as the average pair’s performance. The average pair is all that many cable manufacturers show and can be significantly better (in this case as much as 8dB) than the worst case pair.
From the NextLAN data (test report number 3124129CRT-023c; dated 12/18/2009), it can be seen that this channel solution meets the claims that all of the electrical parameters exceed the TIA standard and by several dB. Again, like the Berk-Tek testing, this data is presented with both worst case and average.

We have established why it is important to have component verification, but why is it important to have vendor-specific verification? How else would you know whether you are receiving product that actually meets the “above the standard” claims as advertised? The cost of premium performance is higher than the cost for a minimally-compliant product so determining whether the product meets its advertised parameters tells you if this was money well spent.

Why are you paying for the extra headroom? Better crosstalk and return loss performance have both been shown to be directly related to a more reliable network by reducing bit errors. Many structured cabling suppliers as well as Intertek and UL have shown this. Figure 4 is a diagram of just the crosstalk parameters. It can be seen that if the crosstalk gets to be too much, it will overpower the signal and the signal will be lost.

![Diagram of crosstalk parameters](image)

*Figure 4: Demonstration of Near-End Crosstalk and Far-End Crosstalk*

Bit errors are caused when the signal is so weak compared to the noise at the receiver that it cannot discern what the bit actually is. NEXT, FEXT, RL and IL all contribute to the noise so if they are better, they will contribute less. Having components that exceed the standard will ensure that you have a more reliable network.
Conclusions

Component compliance to the TIA standard is a minimum requirement, but end users cannot verify this so they need to make sure that their suppliers do. Simply testing channel performance at the time of installation does not guarantee component compliance and may not be sufficient to ensure the most error-free network possible. Independent verification to component vendor’s specifications is paramount to maintaining a more reliable local area network. Specifying a cabling system from a vendor that provides this can help to ensure that you get the most from your network.
List of References


