FLUKE networks

Hope is Not a Warranty

A warranty serves several purposes. It reflects, on the one hand, the manufacturer's confidence in the quality of his product. On the other hand, it provides some protection to the buyer against defects in materials and workmanship and reduces the risk associated with the purchase. The use of the warranty program as a statement of the manufacturer's confidence made Lee Iaccoca, then chairman of Chrysler Corporation, famous. His expression of confidence, backed by the most aggressive warranty program, in that industry, at that time, communicated to potential car buyers the necessary reassurance to consider the new Chrysler products. It may be argued that this bold move saved the company.

A warranty is backed by facts and data

The market expects that the manufacturer who provides a better warranty program has implemented a higher degree of quality procedures in the design and manufacturing of its products. As consumers, we typically pay more attention to the details of a warranty program as the price of the item increases. The installation of a cabling system represents a significant investment for a commercial enterprise both in terms of the money spent and of the impact of this investment on the efficiency of the enterprise. Networks are an integral part of the Information Age. For many corporations, the network has become a mission-critical element of the information technology infrastructure. Downtime of this critical element can cause significant financial losses. The cabling system should be viewed as the foundation of this critical resource. If the foundation is flawed or unreliable, the network operation is flawed and unreliable. As such, corporate buyers should indeed insist on a warranty for this "product."

There are two parties involved establishing a cable infrastructure warranty: the manufacturers of the cable and the connecting hardware (patch panels, wall outlets and patch or equipment cords) and the contractor who installs these components. They must cooperate to assure the quality of the final product. A common plan or agreement between these parties should involve:

1. ***The component manufacturers' ability to deliver components that meet the performance and quality standards for the component involved***
2. ***The contractor/installer's responsibility for the quality and performance of a finished cabling installation. The contractor has the responsibility that technicians are knowledgeable and well-trained in the skills needed to implement a cabling installation. The contractor should also provide tangible proof that every installed link delivers the desired performance. Proper field test procedures will accomplish this requirement.***

Field-testing the performance of the links assures that all components meet the performance specifications and that the workmanship of the final installation did not detract in a significant way from the transmission quality that can be achieved with the installed components. This final test must be performed on-site after the last cable is terminated and the last wall outlet is buttoned-up. Premise wiring manufacturers who "underwrite" the warranty should carefully review the test results data of the completed installation. So should the representatives of the end-user customer or the consultant who represents the end-user.

DTX CableAnalyzer

Providing a warranty means using equipment that exceeds all relevant specifications, and provides documentation of all test results, such as Fluke Networks' DTX CableAnalyzer.

See the warranty you deserve with Fluke Networks

Field-testing is critical to the warranty process. No automobile manufacturer would warrant their product without following well-defined production and test procedures. The same paradigm holds true for cabling installations.

What defines the quality of the installed cabling?

The Telecommunications Industry Association (TIA) establishes and maintains standards for the premise wiring industry. The standards cover a variety of aspects relating to the design, planning and implementation of a generic – open architecture – cabling system. The TIA/EIA-568-B standard defines the field test procedures to ensure the installed links meet a specified level of performance. Testing against performance standards is often called ***certification testing*** and a

Bandwidth	TIA	ISO/MEC
16MHz	Category 3	Class C
100MHz Links	Category 5/5e	Class D
250MHz Links	Cateory 6	Class E
600MHz Links		Class F

Different categories and classes of cabling performance need to be tested over different bandwidths. "Categories" are commonly referred to in the U.S. "Class" designations are more common in Europe.

meaningful warranty statement should be based on the results of this type of testing.

Standards define different categories or levels of performance. Category 3 (Cat 3) is the lowest category suitable for lower-throughput data communication (up to 16 Mbps[1]). This category is also recommended for voice cabling. The next commonly used category is "Enhanced Category 5" or Cat 5e, and provides a 100 MHz communication channel. Cat 6 delivers a 250 MHz communication channel and represents the highest performance level defined at this time in the TIA standards. The TIA standards committees, in cooperation with the IEEE (Institute of Electrical and Electronics Engineers), are currently studying the transmission requirements for an Ethernet network implementation that delivers a 10 Gigabit per second transmission rate.

In addition, the International Standards Organization (ISO) refers to Class C, D, E and F for the installed link and uses the category designation for the component specifications. A twisted-pair cabling link constructed with Cat 3 components should meet the performance specification of a Class C link. Class D links require that all components meet the Cat 5e specification, and Class E corresponds to Cat 6 components. The international standards also define a Class F link (specified for a bandwidth of 600 MHz) when Cat 7 components are used.

Certification testing and compliance to industry standards

The ISO and TIA standards are closely harmonized and only subtle differences remain between them. The standards define two link models: the *channel* and the *permanent link*. The difference between the models is important. The channel model is the end-to-end cabling link from an active device – such as an Ethernet hub or switch – to the network interface of a personal computer, printer, fax machine, etc. The last segment of a channel link on either end is a patch cord. These patch cords may be changed relatively often over the life of a network, and are not considered part of the "permanent link" model. Therefore, the standards recommend that new installations are tested using the permanent link model. The certification test tool connects to the permanent link-under-test using high-performance *adapters* that exclude any effects of patch cords.

The performance test results describe the permanent link.

The channel test is available to troubleshoot an existing channel with the patch cords that are in use. Patch cords have a significant impact on the transmission characteristics of the channel. Therefore, the standards recommend to certify the performance of the permanent link and to assure that good patch cords are used to connect the active devices.

The standards also define the performance parameters to be tested, the frequency range over which these performance parameters are to be tested and the limits for the "Pass" or "Fail" performance at each frequency point.

This may sound very complicated, but the appropriate test equipment can offer an automated way to certify – with the press of a single button. A tool with "Autotest" lets the user select the cable type and test standard to apply, and then complete the test simply by pressing the test button. Newer testers such as the DTX-1800 or DTX-1200 from Fluke Networks perform an autotest for a Cat 6 link (1 though 250 MHz) in 12 seconds, three times faster than any other

Capturing test data is essential to providing a meaningful warranty. The best certification tools offer high-capacity storage and removable media.

certification tester on the market. The contractor can significantly reduce the total time to certify using one of these newer certification test tools.

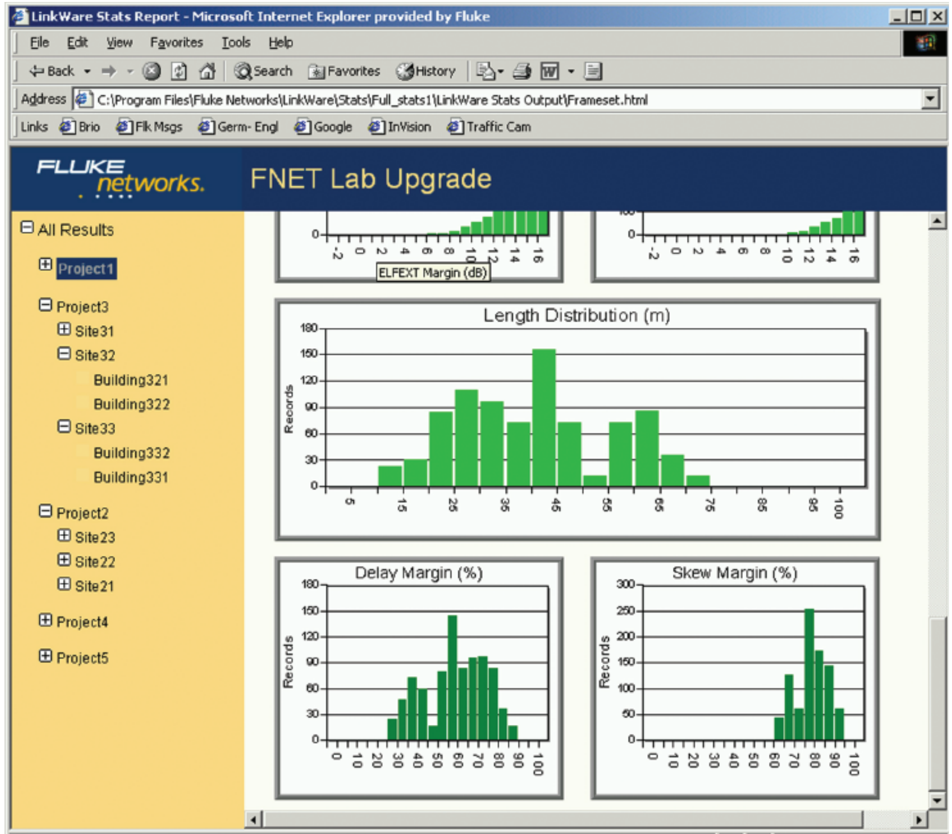
Certification documentation

Certification is incomplete – maybe even invalid – if properly executed test results are not documented. Documented test results provide legitimacy to the warranty program, and can be verified at any time. If documentation does not exist, the warranty may be almost useless.

The better certification testers provide several options to capture, store and upload these results. Data available in a protected database is much more useful than data that has been printed. Often the contractor delivers a huge three-ring binder in which each page contains the test results information of a tested link. Thumbing through those binders can be painstakingly time consuming. A test database program such as Fluke Networks' *LinkWare* allows the user to view the graphical test results of any parameter of any link in the database with a few mouse-clicks.

The same industry standards referenced above also prescribe the documentation requirements. They allow several options, from minimal documentation requirements to capturing and storing every measurement. A table of minimum reporting requirements is shown below. Everything in between these two extremes will be compliant with the standards. Saving every data point in the test results record for a link requires approximately 18,500 measurement values for a Cat 5e link and 30,000 for a single Cat 6 link. Many certification testers on the market offer a removable memory card to allow the user to store these large amounts of data.

If you are in a position to write the specifications for a cabling installation project,



Documentation of test results that is stored, sorted and retrieved electronically is far more useful than a notebook of raw data.

you should describe the test documentation you expect to receive. If you are a contractor and the statement of work for the job does not detail the test results requirements, you should request clarification before the testing phase commences or choose the maximum (store every measurement). The website **www.cabletesting.com** contains a reference to assist in writing the statement of work for the test and certification requirements of a cabling job [check under "Latest Topics"].

Conclusion

A cabling installation is an important investment. It forms the foundation of the network. Such an investment should not be made without requesting a solid warranty that the delivered product meets the specified requirements. Industry standards assist in formulating these requirements and offer a safe mechanism to future-proof the cabling infrastructure. Certification testing, as specified in these industry standards, provides the assurance that all the components meet the required specification and that the workmanship with which the installation was completed allows the components to perform as designed. Documentation is an integral and necessary part of the certification tests. A warranty that is not based on proper certification testing documented by electronically retrievable test results only provides hope, not a solid assurance.

Minimum reporting requirements

Test Parameter	Results Reporting (minimum requirements)
Wire Map	Verify continuity and pairing of the wiring in the link. Identify wiring errors such as shorts between any two or more conductors, an open circuit or break in the cable, reversed wire pairs, split pairs, and transposed pairs.
Propagation Delay	Identify the wire pair with the worst case propagation delay. The report shall include the propagation delay value measured, as well as the test limit value.
Delay Skew	Identify the wire pair with the worst case propagation delay (the longest propagation delay). The report shall include the delay skew value measured (longest minus shortest propagation delay), as well as the test limit value.
Length	The field tester shall be capable of measuring length of all pairs of a permanent link or channel based on the propagation delay measurement and the average value for NVP[2]. The physical length of the link shall be calculated using the pair with the shortest electrical delay. This length figure shall be reported and shall be used for making the Pass/Fail decision. The Pass/Fail criteria are based on the maximum length allowed for the permanent link configuration (90 meters – 295 ft) or the channel (100 meters – 328 ft) plus 10% allowing for the variation and uncertainty of NVP.
Insertion Loss (Attenuation)	Identify the worst wire pair (1 of 4 possible). The test results for the worst wire pair must show the highest attenuation value measured (worst case), the frequency at which this worst case value occurs, and the test limit value at this frequency.
Return Loss	Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for Return Loss. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs, as well as the test limit value at this frequency.
NEXT Loss (pair-to-pair)	Identify the wire pair combination that exhibits the worst case NEXT margin[3] ***and*** the wire pair combination that exhibits the worst value of NEXT (worst case). NEXT is to be measured from each end of the link-under-test. These wire pair combinations must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs, as well as the test limit value at this frequency.
Power Sum NEXT Loss	Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSNEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs, as well as the test limit value at this frequency.
ELFEXT (pair-to-pair)	Identify the wire pair combination that exhibits the worst case margin and the wire pair combination that exhibits the worst value for ELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs, as well as the test limit value at this frequency.
Power Sum ELFEXT	Identify the wire pair that exhibits the worst case margin and the wire pair that exhibits the worst value for PSELFEXT. These wire pairs must be identified for the tests performed from each end. Each reported case shall include the frequency at which it occurs, as well as the test limit value at this frequency.

About the author

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Draye manages product development and marketing of test equipment for structured cabling. Additionally, he has managed marketing projects related to the test and troubleshooting of enterprise networks. With more than 20 years of industry experience, Draye frequently lectures at industry seminars and conferences worldwide including NEPCON, GigNet, BiCSi and Cabling the Workplace and is regularly published in the trade press. Draye holds a degree in electrical engineering from the University of Louvain in Louvain, Belgium, and an MBA degree from Seattle University.

[1] Megabits per second. "Mega" indicates approximately one million or, more precisely, 1,048,576 bits. Mbps or Mb/s indicates a data rate of 1,048,576 bits of data per second.

[2] Nominal Velocity of Propagation (NVP) expresses the speed of the electrical signals along the cabling link in relation to the speed of light in vacuum ($3x10^8$ m/second). Insulation characteristics and twist rate of the wire pair influence NVP in minor ways. Typically, an "average" value for NVP is published for all four wire-pairs in a data cable.

[3] "Margin" designates the difference between the measured value and the corresponding test limit value. For passing links, "worst case margin" identifies the **smallest** margin over the entire frequency range, the point at which the measured performance is "closest" to the test limit.

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