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Introduction

“Certification” is the process of comparing the transmission performance of an installed cabling system to a standard, using a standard defined method of measuring the performance. Certification of the cabling system demonstrates component quality and installation workmanship. It is typically a requirement to obtain the cabling manufacturer’s warranty. Certification demands that the cabling links yield a “passing” result. Technicians must diagnose the failing links and after a corrective action has been implemented they must retest to ensure the link meets the required transmission performance. The total time to certify an installation does not only include making the certification measurements but also documentation and troubleshooting.

Why the need for advanced diagnostics?

Today’s cabling installation professionals must therefore know how to troubleshoot and diagnose high-performance cabling systems.

As newer high-performance cabling systems have been developed and deployed, every aspect of the installation demands a higher level of skill and more attention to detail. New test parameters have been added. The links must be tested using one of two link models – the Permanent Link or the Channel – and the links are tested and evaluated over a greater frequency range and with more data points. The components with which these links are constructed need to deliver better performance and the quality of the workmanship during installation must rise accordingly.

Due to the increased complexity of these cabling systems, determining the cause of failure and quickly restoring suitable performance has become a challenging task. This handbook guides you through the troubleshooting of advanced structured cabling systems using the Fluke Networks DTX Series CableAnalyzer™ so you can increase your productivity and deliver better value to your organization.



Troubleshooting Basics

Most common causes of failures in twisted pair cabling:

1. Installation errors – Proper connections while maintaining the wire pairs and the twist rate in each pair; always keep the “original twist” in each wire pair as much as practical
2. Connectors that do not meet the required transmission quality
3. Incorrect tester set up
4. Defects or damage in the installed cable
5. Bad patch cords*

**Patch cords rate high on the list in operating networks. Certification is often executed using the Permanent Link Model before the patch cords used by the operating network are installed.*

Before you begin testing, you should verify the basics:

- Has the correct test standard been selected? – The certification test is executed as an automated test or an “autotest”. The test standard you select for an autotest determines the link model (Permanent Link or Channel), the test parameters to be measured, the frequency range over which the tests are executed and the Pass/Fail criteria for each test.
- Has the correct link model been selected?
- Are you using the appropriate test adapter with a plug that matches the jack in the Telecommunication Outlet (TO) or the patchpanel?
- Has the test reference been set in the last 30 days? – It is recommended to set the reference on a regular basis at a time that is easy to remember (such as every Monday morning).
- Are you using the most current version of the tester software?
- Is the Normal Velocity of Propagation (NVP) set correctly for the cable under test? – NVP plays a role when the tester reports length or distance to a defect.
- Is the tester within its operating temperature range and in calibration? – Remember that your Fluke Networks CableAnalyzer is a very accurate instrument that measures small noise disturbances in cables. These instruments are calibrated in the factory before shipping and this calibration should be verified every 12 months in an authorized service center. If the tester has been stored in a colder or warmer place than the one in which you are working (overnight in a vehicle), allow the unit to warm up to its steady-state operating temperature before setting a reference or executing any measurements. This may take 10 to 15 minutes or more depending on the temperature differential.

Link Models

To obtain meaningful results, it is essential to select the appropriate autotest and link model. The Permanent Link performance is defined in such a way that after adding good patch cords to a passing link, the channel performance is automatically met. By “good” patch cords, we mean patch cords that pass the same class or category rating as the link.

For this reason, it is recommended that new cabling installations are certified using the Permanent Link model and test standard. Patch cords and equipment cords may be changed many times during the life of the Permanent Link.

The Permanent Link test model requires that the test-interface cables connecting the test tool to the link-under-test are totally transparent to the measurements. In a practical sense, this means that certification test tools must be much more sophisticated to subtract the test cord effects/contributions for each test parameter measurement.

However, the Permanent Link model includes the performance of the end connections – the mated connection of the 8-pin modular plugs (RJ45) at the end of the test adapters and the jacks (sockets) of the link. Plug-jack combinations can deliver varying test results for critical parameters like Near-End Crosstalk (NEXT) and Return Loss. To properly assess the performance of the end jacks of the link (in the TO and the patch panel) and the wire pair terminations in those jacks, the plug at the end of the Permanent Link test adapter shall be a test-reference plug. A test-reference plug delivers, for all frequency-sensitive test parameters, performance in the center of the component specifications within a narrow band of tolerance. These plugs do not vary much one from the other and deliver repeatable test results.

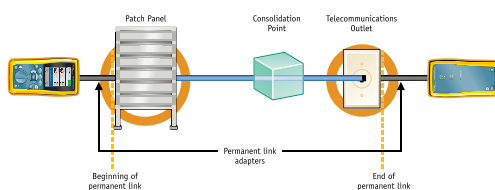


Figure 1: Permanent Link Model

Channel measurements are typically performed when restoring service, or verifying cabling for application support. It is uncommon to perform Channel tests at the conclusion of a new installation, since the patch cords that belong to each link are rarely available at that time. Correct Channel measurements must cancel the effects of the mated connection in the tester's Channel adapters.

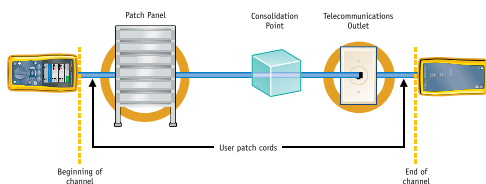


Figure 2: Channel Model

The Automated DTX Series Diagnostics

When an autotest fails or delivers a “marginal” pass result, the DTX Series testers automatically process data to produce diagnostic information for the cabling link. After the diagnostic process has been completed, the user can press the “FAULT INFO” key to see the results of the diagnostic data processing of the test results.

First, let us review what a “marginal” test is. The margin of a test is the difference between the measured value and the applicable Pass/Fail limit value. The margin is positive when the test passes, negative when the measurement fails and zero when the measured value is equal to the limit value. A greater margin indicates that the result is further away from the limit. A larger positive margin therefore indicates a very good test result. A very small margin means that the test result is close to the limit value. A test result is called marginal when its margin is smaller than the accuracy specification for the test parameter. For example, the accuracy of the Near End Crosstalk (NEXT) measurements is 1 dB at 250 MHz and the worst case margin of a link at 250 MHz is 0.4 dB. That NEXT test results at 250 MHz is considered very close to the limit and is called a marginal test result. In this case, the tester automatically generates diagnostics information to point out what may have caused this marginal result. This information provides the opportunity to locate the problem, correct it and deliver a link with good performance.

If the cabling link fails to pass the wire map test – the test that verifies that all 8 wires connect the right pins at either end of the cable – the tester halts the test and displays the results. Figure 3 shows such a wire map failure. The wire in pair 1 that connects pin 4 is open at 48 m from the Main units and at 17 m from the Smart Remote unit. The DTX Main unit is represented as the left-hand side of these screens. The software halts and asks the operator whether or not to continue the test. It often makes more sense to tackle the wire map error before continuing the test. The open wire causes the results for some test parameters to be undefined. For example, the insertion loss of the wire pair that is open is infinite. Any parameter based on a calculation with the insertion loss value is therefore invalid or undefined.

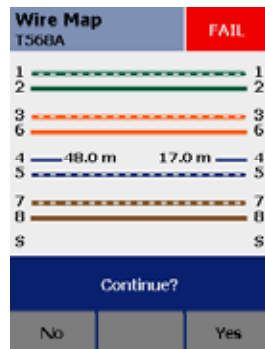


Figure 3: The wire connecting pin 4 is open at 48 m from the main unit and at 17 m of the Smart Remote unit.



Figure 4: Upon completion of an Autotest, the tester’s screen shows the list of test parameters executed for the selected test standard. Test parameters marked with the red X fail. The tester also displays the worst-case margin for each parameter in parentheses at the right edge of the screen.

The unique value of the DTX Series diagnostics come to the forefront in the testers' ability to locate performance problems such as return loss or NEXT.

Figure 4 shows the test result screen of a failing Class E link. Return Loss shows a marginal failure whereas Near End Crosstalk (NEXT), Power Sum NEXT (PSNEXT), Attenuation-to-Crosstalk Ratio (ACR) and Power Sum ACR (PSACR) show outright failures. The numbers in parentheses on the right hand side of the screen show the worst-case margin for the corresponding test parameter.

By pressing the FAULT INFO key the tester offers four diagnostic possibilities. Figures 5a through 5d show these different possible scenarios for the failure. The user should evaluate all of these possibilities, inspect the cable for what is described and when a problem is confirmed, perform the corrective action.

In figure 5a, the tester entertains that the link may have more than four connectors. A first possibility for the failures after analyzing the test results data. The link in question contains four connectors as the tester screen shows. So this diagnostic does not apply.

In figure 5b, the diagnostics show that a shorter cable segment at 18 m from the remote unit contains a Return Loss defect that causes the marginal result for wire pair 4,5. The tester prints the recommended inspection: "Verify wire twist is maintained at the jack and verify that the jack is the correct category rating." In other words, either the wire termination at the jack or the jack itself is the source of the marginal test result for RL on pair 4,5.

Figure 5c shows the next possible fault location identified by the tester diagnostics. At approximately 17 m from the remote tester unit, excessive crosstalk occurs between two wire pair combinations.

A last possibility is shown in the screen of figure 5d. The tester locates a connector at 9 m from the tester remote unit and an 8 m cord to the next connector in the link and suspects the cable in the segment between these connectors. The message "Verify the cable is the correct type. Cable appears to be category 5." warns that the source of the failure could be that the 8-meter cord is a Cat 5 cable in a link in which all component should rate as Cat 6 in order to obtain Class E performance. Note that this screen tells us that the second connector at the end of the patch cord is 17 m removed from the tester remote unit. So, which one of these automatically generated diagnostics is correct?

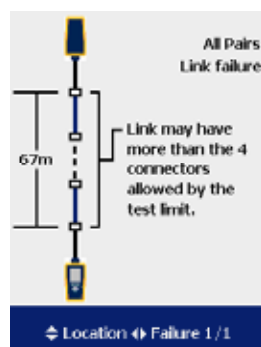


Figure 5a: All of the automatically generated diagnostics graphically show the link with the main unit at the bottom of the picture and the Smart Remote on top. The diagnostics show a link of 67 m with four connections and some uncertainty in the center (dashed line). The diagnostics suspects that the permanent link may have too many connections.

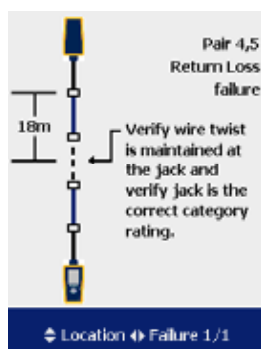


Figure 5b: Press the up or down arrows to move from one suspect location in the link to the next. Move the right/left arrow keys to read multiple diagnostics at a location. This location at 18 m from the Smart remote only shows one defect that is expected to be the cause of the marginal return loss results for wire pair 4,5. The tester also posts the recommended inspections and corrections.

Figure 6 shows the configuration of the link we constructed for this test.

Figure 7 shows a picture of the actual defect. The wire pairs at the end of the 2 m patch cord are untwisted in an excessive manner and caused the NEXT failures at that connection as well as the marginal return loss problem for pair 4,5 at that same location. The diagnostics described above locate the defects at 18 m from the Smart remote unit for return loss and at 17 m for NEXT. This is indeed an accurate diagnostic. When the test technician locates this point along the physical link, the defect indeed stands out. The most expedient and typically best remedy for a failing patch cord is to obtain and install a good Cat 6 replacement cord. At that time, you should retest the link to ensure that all defects have been corrected and that the link passes. The actual time to execute this repair should not exceed a few minutes.

Note that the configuration of this test link is unusual. The recommended Permanent Link configuration ends in a patch panel on one end and the TO at the other end with optionally a consolidation point (CP) (connection) no less than 15 m from either end, as depicted in figure 1. In this regard, the diagnostic depicted in figure 5a is also correct. This Permanent Link contains one more connection than usual or than recommended. We know, however, that after replacing the defective patch cord with a good one, this link, including the connector, normally meets the Class E permanent link test.

If the defect in this link had been at the consolidation point, the technician would have to re-terminate that connection after verifying that the connectors themselves are specified as Cat 6 compliant components.

The automated link diagnostics save time over trial-and-error techniques that usually include re-terminating the wiring and/or replacing the connecting hardware in several locations in order to get a failing link to pass. The section on advanced troubleshooting techniques will show you how you can obtain and interpret the underlying diagnostic information generated by the tester's analysis algorithms.

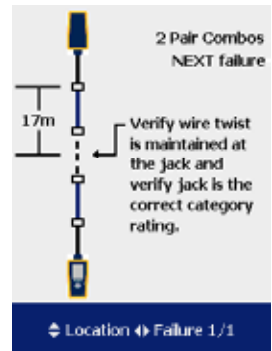


Figure 5c: This screen places the source of the NEXT failures in two of the wire pair combinations at 17 m from the Smart Remote unit. The text in the screen provides the suggested inspections and corrective actions.

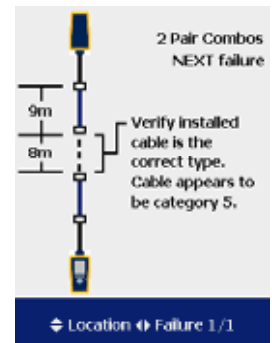


Figure 5d: The last diagnostic suspects the cable between the two middle connections. You learn in this text that the real cause of the link failures is the untwist of the wires at the end of the patch cord.

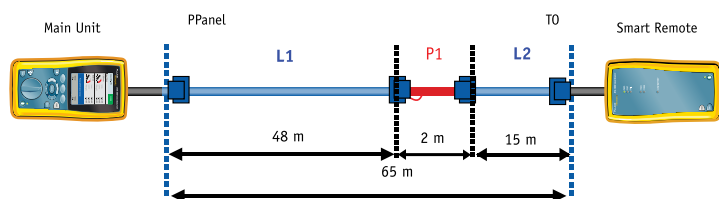


Figure 6: The map of the permanent link under test. The wire pairs of patch cord 1 are untwisted at the left termination as indicated in the schematic diagram.

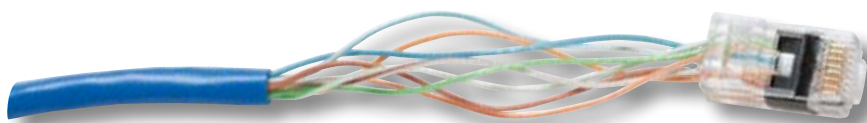


Figure 7: This photo shows a close up of the wire pair termination at one end of the 2-meter patch cord. This is the defect in the tested link.

Causes of Cabling Faults

For each of the required TIA and ISO structured cabling measurements, you will find troubleshooting tips to help quickly pinpoint the cause of failures when they occur. In some instances, you will find suggested reasons why the measurement does not fail in cases you would expect to see a failure.

Wiremap

Test Result	Possible Cause of Result
Open	<ul style="list-style-type: none"> • Wires broken by stress at connections • Cables routed to wrong connection • Wire is not punched down properly and does not make contact in the IDC • Damaged connector • Cuts or breaks in cable • Wires connected to wrong pins at connector or punch block • Application-specific cable (e.g. Ethernet using 12/36 only)
Short	<ul style="list-style-type: none"> • Improper connector termination • Damaged Connector • Conductive material stuck between pins at a connection • Damage to cable • Application – <i>specific cable (e.g. factory automation)</i>
Align reversed pair	<ul style="list-style-type: none"> • Wires connected to wrong pins at connector or punch block
Crossed pair	<ul style="list-style-type: none"> • Wires connected to wrong pins at connector or punch block • Mix of 568A and 568B wiring standards (12 and 36 crossed) • Crossover cables used (12 and 36 crossed)
Split pair	<ul style="list-style-type: none"> • Wires connected to wrong pins at connector or punch block

Length

Test Result	Possible Cause of Result
Length exceeds limits	<ul style="list-style-type: none"> • Cable is too long – <i>check for coiled service loops and remove in this case</i> • NVP is set incorrectly
Length reported is shorter than known length	<ul style="list-style-type: none"> • Intermediate break in the cable
One or more pairs significantly shorter	<ul style="list-style-type: none"> • Damage to cable • Bad connection

Note: Standard practices dictate that the cabling length be defined by the length of the shortest pair. NVP varies per pair, meaning each pair could be reported with a different length. These two conditions can result in a cable with three of four pairs over the length limit, yet the link result is a Pass (e.g. a channel with 101, 99, 103, 102 meters for the four pairs). A Pass in this case is the correct interpretation.

Delay/Skew

Test Result	Possible Cause of Result
Exceeds limits	<ul style="list-style-type: none"> • Cable is too long – <i>Propagation delay</i> • Cable uses different insulation materials on different pairs – <i>Delay skew</i>

Insertion Loss (Attenuation)

Test Result	Possible Cause of Result
Exceeds limits	<ul style="list-style-type: none"> • Excessive length • Non-twisted or poor quality patch cables • High impedance connections – <i>Use time domain techniques to troubleshoot</i> • Inappropriate cable category – e.g. <i>Cat 3 in a Cat 5e application</i> • Incorrect autotest selected for cabling under test

NEXT and PSNEXT

Test Result	Possible Cause of Result
Fail, *fail, or *pass	<ul style="list-style-type: none"> • Poor twisting at connection points • Poorly matched plug and jack (Category 6/Class E applications) • Incorrect link adapter (Cat 5 adapter for Cat 6 links) • Poor quality patch cords • Bad connectors • Bad cable • Split pairs • Inappropriate use of couplers • Excessive compression caused by plastic cable ties • Excessive noise source adjacent to measurement
Unexpected pass	<ul style="list-style-type: none"> • Knots or kinks do not always cause NEXT failures, especially on good cable and far removed from the ends of the link • Incorrect autotest selected (e.g. “Bad” Cat 6 link tested to Cat 5 limits) • “Fails” at low frequency on NEXT graph but passes overall. When using the ISO/IEC standards, the so-called 4dB rule states all NEXT results measured while insertion loss <4dB cannot fail

Return Loss

Test Result	Possible Cause of Result
Fail, *fail, or *pass	<ul style="list-style-type: none"> • Patch cord impedance not 100 ohms • Patch cord mishandling causes changes in impedance • Installation practices (untwists or kinks of cable – <i>the original twists should be maintained as much as possible for each wire pair</i>) • Excessive amount of cable jammed into the Telecom Outlet box • Bad connector • Cable impedance not uniform • Cable not 100 ohm • Impedance mismatch at junction between patch cable and horizontal cable • Poorly matched plug and jack • Use of 120 ohm cable • Service loops in telecommunications closet • Inappropriate autotest selected • Defective link adapter
Unexpected pass	<ul style="list-style-type: none"> • Knots or kinks do not always cause return loss failures, especially on good cable and far removed from the ends of the link • Incorrect autotest selected (easier to pass RL limits) • “Fails” at low frequency on RL graph but passes overall <p>Due to the 3 dB rule, whereby all RL results measured while insertion loss <3 dB cannot fail</p>

ACR-F and PS ACR-F (older names: ELFEXT and PSELFEXT)

Test Result	Likely Cause of Result
Fail, *fail, or *pass	<ul style="list-style-type: none"> • General rule: troubleshoot NEXT problems first. This normally corrects any ACR-F (ELFEXT) problems • Service loops with many tightly coiled windings

Resistance

Test Result	Likely Cause of Result
Fail, *fail, or *pass	<ul style="list-style-type: none"> • Excessive cable length • Poor connection due to oxidized contacts • Poor connection due to marginally attached conductors • Thinner gauge cable • Incorrect patch cord type

Advanced Troubleshooting Diagnostics

The DTX Series diagnostics discussed above represent a distillation of a more complex analysis of test results. In this section, we discuss the lower level, more detailed diagnostics information that the DTX Series testers generate. This section is provided to enhance the understanding of the diagnostic analysis of link failures. In many cases, the automated diagnostics provide a clear description of the locations of defects or poor cable termination. Knowledge of advanced diagnostics may be able to distinguish cases in which automated diagnostics fall short.

The basis of the tester's ability to report the distance to a location on the link-under-test where crosstalk is excessive or where Return Loss is excessive, is the conversion of the test results collected in the frequency domain to the time domain. The DTX Series testers execute this conversion using unique and patented digital signal processing techniques. The data in the time domain is in turn converted to a profile of the measured disturbance along the length of the link¹.

The two parameters that provide the time domain information are HDTDX (High Definition Time Domain Crosstalk) and HDTDR (High Definition Time Domain Reflectometry). As the name indicates, the HDTDX parameter shows the profile of crosstalk happening along the link-under-test while HDTDR shows signal reflections along the link. Impedance changes cause signal reflections that contribute to the measured return loss value. If these reflections become too big and the total amount of energy reflected exceeds the maximum amount allowed, the return loss test fails.

Investigate HDTDX

When an Autotest yields a Fail result and the diagnostics in the tester generate the time domain data, the detailed diagnostic information is captured in the HDTDX and HDTDR test parameters. The tester software further analyzes this time domain information to generate the graphical results with recommendations for the corrective action as we discussed earlier. The user can view the HDTDR and HDTDX information. Figure 8 shows the two diagnostic parameters on the tester's screen. Highlight HDTDX and press ENTER to see the screen depicted in Figure 9. This figure shows the magnitude of the NEXT coupling along the link for all six



Figure 8: Access HDTDX and HDTDR data by selecting the parameters. They are shown at the end of the list of test parameters. They are not test parameters as defined by the standards. The 'i' symbol before their names indicates "for information only."

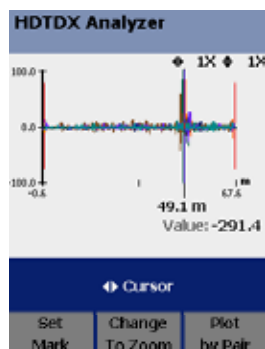


Figure 9: The HDTDX trace depicts the amount of crosstalk that is generated at each location along the link. The horizontal axis is labeled in meters or feet (not MHz!). The Main unit is always located at the left of the screen and the distances are measured from the Main unit. The spike at 49.1 meters from the Main unit shows the location with an exceptionally high amount of crosstalk.

¹ The conversion from time to distance relies on the knowledge of the speed with which the electrical signals travel over the twisted pair copper cabling. The cabling characteristic called NVP (Nominal Velocity of Propagation) expresses this speed with reference to a constant, which is the speed of light in vacuum. It is desirable that the tester knows the correct value of NVP for each cable type. Working with the correct value of NVP allows the tester to report the distance to a cabling defect more precisely

wire-pair combinations. First, note that the horizontal axis runs from 0.6 m to 67.6 m or shows the length of the cabling link-under-test. The link starts at 0 m and runs through 67 m. The very ends (0.6 m) of the trace show the permanent link adapters, which do not belong to the tested permanent link. This is the same link we discussed earlier and that is depicted in figure 6.

The curves show the magnitude of the NEXT coupling at each point along the link. When you inspect the curves from left to right, it is immediately clear that the NEXT coupling is relatively low until we arrive at 49.1 m. A huge spike in the NEXT curves indicates that the coupling at this point is excessive and the probable cause of the link NEXT test failure. The cursor is automatically positioned at this spike and the tester reports the distance at which the cursor is located. The tester's screen also displays the magnitude of the NEXT coupling measured at the point where the cursor is placed. The value is -291.4 and is "off the chart" indicating that a huge amount of crosstalk takes place at this location.

Use the "Zoom controls" to analyze the details

The tester initially displays the full length of the link with the vertical scale showing the reflection magnitude from +100% to -100%. The operator can adjust the scales of both axes to "zoom in" on a problem area. Press the soft key F2, labeled "Change to Zoom", to control the zoom features. Figure 10 shows the same data as Figure 9 but with a zoom or magnification of the vertical scale of a factor 2. Now the vertical scale runs from +50 % to -50 %. And as figure 10 demonstrates, in this view the NEXT profile curve is magnified by a factor of 2. It facilitates a more detailed inspection of the NEXT profile. The symbol cursor or zoom appears in the blue band below the display, above the soft key labels, to indicate the mode of operation of the cursor keys. They either increase the zoom along the vertical or horizontal scales or allow you to move the cursor position left or right along the link.

The screen in figure 10 remains very busy because it shows the NEXT profile for all wire pair combinations. For further analysis, you may elect to show the data for each pair combination; press F3, labeled 'Plot by Pair' to view each pair combination. Figure 11 shows the NEXT profile for the 1,2 – 4,5 pair combination while at the same time we have zoomed in on the horizontal axis around the main reflection located at 48.7 m. Note that this location is physically the same one as shown in figures 9 and 10 at 49.1 m. The conversion from time to distance varies a little from pair-to-pair, because the

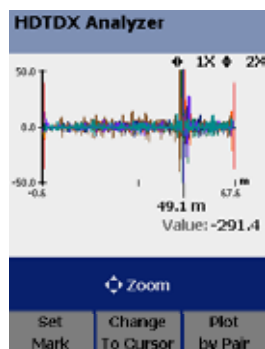


Figure 10: In order to get a better assessment of the profile of crosstalk, we have selected to zoom in on the vertical axis with a factor of two. The scale now runs from +50 to -50.

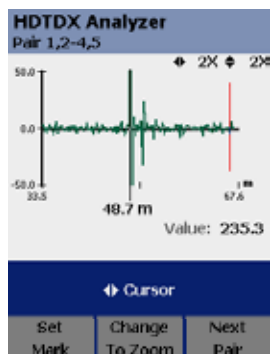


Figure 11: To further examine the HDTDX trace and determine what is happening between different wire pairs, we view the traces by wire pair combination. This screen shows the crosstalk along the link for the combination of the 1,2 and 4,5 wire pairs. Two spikes are clearly visible, the biggest one at 48.7 m. The screen also shows the value of the reflection from this location as 253.3 – a value that is clearly off the charts.

electrical signals travel at a slightly different speed on each wire pair. Each wire pair in the cable is twisted at a different twist rate to improve the NEXT performance of the cable. However, this difference in twist rate changes both the length of the copper conductor as well as the speed of the signal. The tester reports what is called the electrical length or distance which deviates somewhat from the physical length you would obtain with a tape measure along the link.

We can further analyze what is happening along the cable at the first huge NEXT spike at 48.7 m. In the cursor mode of operation, press the 'Set Mark' key (F1) with the cursor in position at 48.7 m and move the cursor to the right and align it with the second big spike. The result shown in figure 12 tells us that this second spike is located at 50.8 m and that the distance between the marker and cursor is 2.1 m.

The two bigger spikes we have identified here show the location of the connectors at either end of the 2-meter patch cord in the link (see figure 6). No other significant spikes are shown in the graph of figure 11. Thereby we can conclude that the 2m patch cord is the source of the problem. This conclusion, of course, coincides with the conclusion we had reached using the automatic diagnostics generated by the tester. In some case, this more detailed HDTDx analysis can greatly assist in a determination between a faulty cable versus faulty connections or poor wire termination. If significant levels of NEXT are shown in a portion of the cable, removed from any connections, defects are disclosed in the cable and the remedy may be much more complicated since the cable itself may have to be replaced.

Investigate HDTDR

If the link fails return loss, the HDTDR parameter provides the detailed profile of signal reflections along the length of the link. At each location along the link, the HDTDR graph shows the magnitude of reflections. The total energy of reflections results in the Return Loss measurement.

Figure 13 shows the full-scale HDTDR plot for the channel we have been analyzing in this booklet. Without zooming in, the HDTDR trace shows few reflections except at the initial location of the cursor at 47.7 m where the measured reflection is -17.3%. The values for HDTDR will generally be smaller but the link test results are much more sensitive to small reflection values. To show a more detailed analysis, we

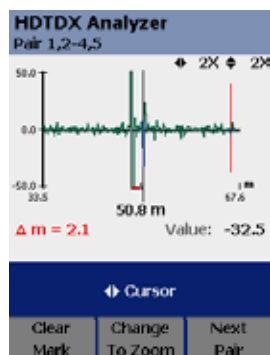


Figure 12: The traces can also be examined around peaks of interest. This screen shows that we can set the marker at the location identified in figure 11 and then move the cursor to the right. It places the second peak at 50.8 m. By comparing this information to the link map shown in figure 6, you can see that the HDTDx trace identified the two connectors of the patch cord and the one with the untwisted wire pairs causes a huge amount of crosstalk.

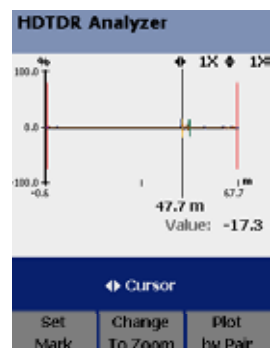


Figure 13: The HDTDR trace shows the signal reflection on each wire pair. Locations showing an excessive amount of reflected energy are the cause of return loss failures. The HDTDR traces typically show fewer and smaller reflections than the HDTDx traces.

have increased the zoom for the vertical axis of the same trace to 8X in figure 14. Figure 15 shows the HDTDR trace for wire pair 4,5. We have moved the cursor to the left to show the sharp peak more clearly in the trace at the location of the untwisted wire pairs. This picture clearly shows how the HDTDR trace allows us to identify a location with a significant return loss problem.

Upon closer inspection of figure 14 we can also determine that the shorter 15 m link segment (L2 in figure 6) to the right of the defective patch cord shows significantly more return loss for several wire pairs than the higher quality cabling segment to the left (L1).

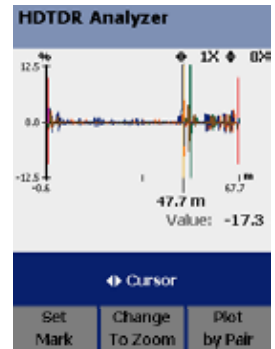


Figure 14: This figure shows the exact same data as in figure 13 but we have increased the sensitivity of the vertical scale by enlarging the vertical axis with a factor of 8. More reflections are now visible but the major one remains at the distance of 47.7 m.

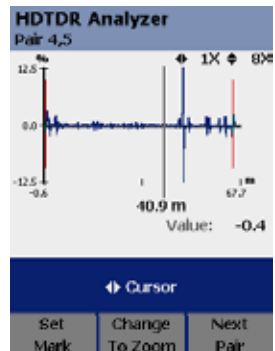


Figure 15: This figure shows the reflection for pair 4,5 only. To show the spike in the reflections more clearly, we moved the cursor a bit to the left. The more significant points of reflection toward the ends show the location of the connectors. The cable segment L2 on the right shows significant reflections in the cable itself.

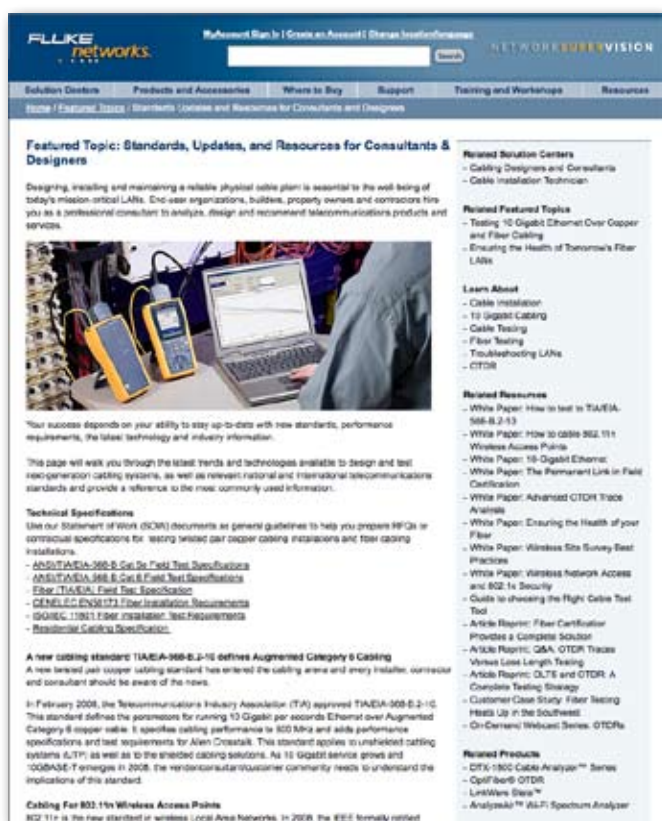


Figure 16: Consult the Fluke Networks web page for product information as well as updates in standards or white papers on best practices. Go to www.flukenetworks.com/design

Conclusion

Cabling installation is a multi-step process. It is a prudent practice to certify the cabling system after installation to ensure that all installed links meet their expected level of performance. Certification will likely identify some failing or marginally passing results. In order to deliver a high quality cabling system, the defects that cause the failures and marginal passes must be uncovered and corrected.

The Fluke Networks certification tools have always provided unique and powerful diagnostics assistance to installation technicians. By knowing the nature of typical faults, and how the tester's diagnostics report them, you can significantly reduce the time to correct an anomaly, an installation error or a defective component. Personnel responsible for the networks operation can also benefit from the diagnostic capabilities of a certification test tool; with the tester's assistance they can limit the duration of network downtime and restore service quickly.

Familiarize yourself with the capabilities of your test tool. A modest investment that pays for itself many times over. For the latest information on cable testing standards, news, and issues, visit the Fluke Networks web site.

Partner with Fluke Networks

Fluke Networks provides the most comprehensive line of premises network test solutions for the inspection, verification, certification and documentation of high-speed copper and fiber cabling systems.

Advanced certification for premium network testing

DTX Series CableAnalyzer™ has been the preferred tester by cable installers and network owners worldwide. They deliver laboratory accuracy and productivity.

The DTX-1200 and DTX-1800 are the first “platform” cable test tools that combine in one unit: twisted pair cabling certification, coaxial cable testing, fiber loss/length testing (OLTS), and Fiber Extended (OTDR) certification. Cabling certification includes documentation and the LinkWare cable test management software is widely recognized. LinkWare supports a number of Fluke Networks test tools including older generations of test tools.

Fluke Networks plays a leading role and regularly contributes original research in the development of cabling standards in TIA and ISO/IEC committees. All major manufacturers of cable and connecting hardware endorse the Fluke Networks DTX Series CableAnalyzer testers and the LinkWare documentation.

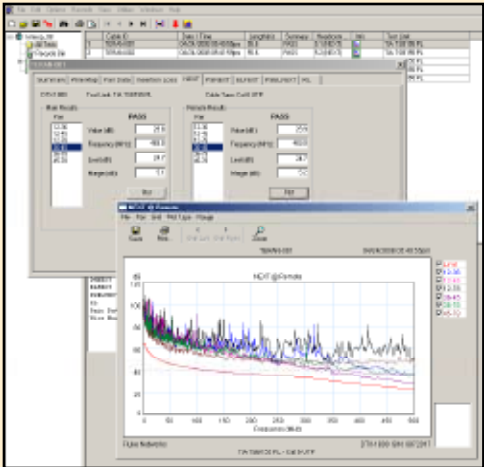


Figure 17: LinkWare allows you to manage the test results data. If you store the graphical data in the tester, you can upload this data into LinkWare. This allows the user to access the information with a few mouse clicks any time in the future. HDTDX and HDTDR data are part of the data stored in LinkWare if they have been generated as a result of the link failing. This information can be useful if the technicians in the field need assistance with the analysis of the cabling defects.

NETWORK **SUPERVISION**

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Printed in U.S.A. 11/2008 3403692 BR-ENG-N Rev A