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Agilent Technologies N1627A
Service Advisor MTDR Test Module

User's Guide

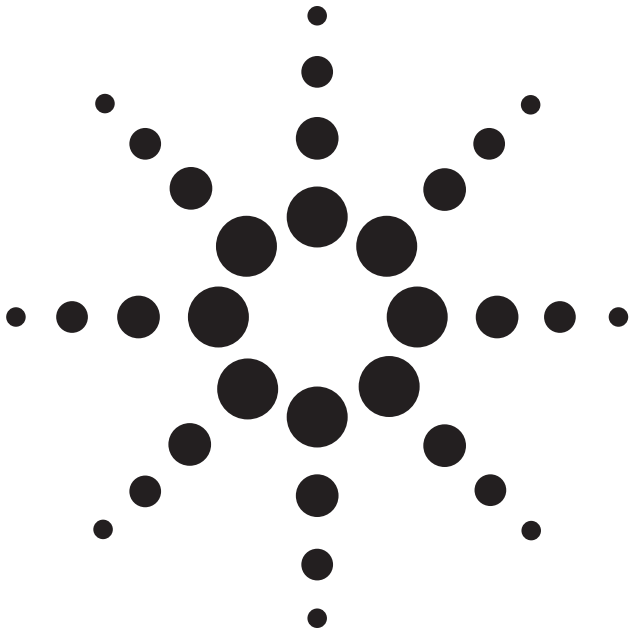


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Agilent Technologies N1627A
Service Advisor MTDR Test Module

User's Manual



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Agilent Technologies' Service Test Division (STD) is an International Standards Organization (ISO) 9001 registered company, recognizing that the quality system operated by STD meets the requirements established in accordance with ISO 9001. STD manufactures test equipment in strict compliance with this quality system.

STD received ISO 9001 certification (no. 6969) from National Quality Assurance (NQA) on August 30, 1995.



Certificate No. 6969

Agilent Technologies
Service Test Division
2 Robbins Road
Westford, Massachusetts 01886 USA

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Safety Notices

Observe the following safety precautions whenever you operate the MTDR Module. Failure to comply with these and other specific warnings and cautions in this manual is a violation of Agilent Technologies' safety standards of design, manufacturing, and intended use of the test module.

Agilent Technologies assumes no liability for the operator's failure to comply with these precautions.

Product Damage

Danger! Do not use this product if it shows visible damage, fails to perform, has been stored in unfavorable conditions, or has been subject to severe transportation stresses. Make the product inoperative and secure it against any unintended operation. Contact your Agilent Technologies representative for assistance.

Explosion Hazard

Danger! Do not operate the instrument in the presence of flammable gases or fumes.

Electric Shock Hazard

Danger! To avoid the possibility of severe injury or death, observe the following precautions when using the MTDR Module.

Do not remove the system covers, and do not perform electrical tests if there are signs of shipping damage to the outer enclosure.

When connecting test cables to a line, do not touch the cable's metal contact points, or allow the cable leads to touch each other.

Use only the supplied power cords and connect only to a properly grounded wall outlet. Do not use extension cords that do not have a protective ground conductor.

Symbols

The following are general definitions of safety symbols used on equipment and in manuals.

Dangerous voltage.



Protective ground.



Frame or chassis ground.



Alternating current.



Direct current.



Alternating or direct current.



Caution! Read the manual.



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Declaration of Conformity

according to ISO/IEC Guide 22 and EN 45014

Manufacturer's Name: Agilent Technologies Company

Manufacturer's Address: Service Test Division
2 Robbins Road
Westford, MA 01886-4113

Declares that the product

Product Name: Service Advisor MTDR Module

Model Numbers: N1627A

Product Options: This declaration covers all options of the above product.

Conforms to the following Product Specifications:

EMC: EN 55011:1991 / CISPR 11:1990 (Group 1, Class A)
EN 50082-1:1992
IEC 801-2:1984 8 kV AD
IEC 801-3:1984 3 V/m
IEC 801-4:1988 0.5 kV signal lines
1 kV AC power lines

Supplementary Information:

The product herewith complies with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC and carries the CE marking accordingly.

The product was tested in a full configuration.

Denis E. Viel
Quality Manager

September 14, 1999
Westford, MA, USA

European Contact: Your local Agilent Technologies Sales and Service Office or Agilent Technologies GmbH, Department ZQ/Standards Europe, Herrenberger Strass 130, D-71034 Boeblingen, Germany (FAX +49-7031-14-3143).

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About this Book

Getting Started

Chapter 1 *Getting Started* introduces the Metallic Time Domain Reflectometer (MTDR) Module, illustrating its connectors and controls. It also describes how to perform basic functions with the Service Advisor Tablet (*S.A. Tablet*), such as connecting power, and starting and stopping the user interface.

Testing

Chapter 2 *Testing Basics — Using the MTDR Module* provides step-by-step instructions for performing basic test routines with the MTDR Module.

Chapter 3 *Twisted-Pair Cable Measurements*, and Chapter 4 *Coaxial Cable Measurements*, describe how to perform specific tests with the MTDR Module.

Reference

Chapter 5 *File Management Options* describes how to use the MTDR Module's various file storage, retrieval, and printing capabilities.

Chapter 6 *MTDR Reference* contains reference information for the MTDR. This material describes the function of each of the controls and indicators in the MTDR display screens.

SCPI Reference

Chapter 7 *MTDR SCPI Commands* contains reference information for using SCPI commands to operate the MTDR Module remotely.

Specifications

Chapter 8 *MTDR Module Specifications* lists technical specifications of the MTDR Module, along with information about how to order accessories.

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About this Version

Applicability

This version of the *Agilent Technologies N1627A Service Advisor MTDR Test Module User's Manual* applies to the N1610A Service Advisor Tablet running operating system software version **1.40** and an MTDR Module running software version **1.20**.

Note that some systems running earlier software may not provide all of the features described in this manual; systems running later versions of software may operate differently than described in this manual. Be sure to refer to any user's manual supplements or release notes that came with the unit, or call 1-800-923-7522.

MTDR Test Module User's Manual printing history

Version	Release date	Notes
1.0	September, 2000	First release.

Check the Software Version

You can check the software version number by pressing the **Help** button on the tablet control screens, or by checking the **Tablet Control** tab of the Service Advisor Manager (see also the *Service Advisor Portable Test Tablet User's Manual*).

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Contents

Declaration of Conformity iv
About this Book v
About this Version vi

1 Getting Started 1-1

The Service Advisor Tablet at a Glance (N1610A) 1-2
The MTDR Module at a Glance (N1627A) 1-3
The MTDR Test Screen at a Glance 1-4
Using the Service Advisor Tablet 1-6

2 Testing Basics — Using the MTDR Module 2-1

Before You Begin 2-2
Power Turn-on and AutoStart 2-3
Making Connections 2-4
Test Mode Selection Controls 2-6
Test Setup Parameters 2-7
Waveform Cursors and Computations 2-9
Distance Measurements 2-10
Performance Parameters 2-11
Scaling the Waveform 2-12
Basic TDR Test Procedure 2-13
TDR Test Applications 2-16

3 Twisted-Pair Cable Measurements 3-1

Before You Begin 3-2
Reflection Characteristics 3-3
Measuring Cable Performance Parameters 3-4
Measuring Velocity of Propagation of Twisted-Pair Cable In an Uncontrolled Environment 3-6
Alternate VoP Adjustment Method 3-7
Locating an Open In a Twisted-Pair Line 3-8
Locating a Short In a Twisted-Pair Cable 3-9
Measuring the Distance To the First Bridged Tap 3-10
Measuring the Length of a Lateral Line 3-12

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Measuring the Distance Between Two Points in a Twisted-Pair Cable Run 3-14
Locating Load Coils 3-15
Locating Line Build-out (LBO) Capicators 3-17
Measuring the Distance To a Wire Splice In a Twisted-Pair Line 3-18
Locating a Wet Area 3-19
Locating Intermittent Problems In a Twisted-Pair Line 3-20
Locating a Crosstalk Point 3-21
Locating Splits and Resplits in a Twisted-Pair Line 3-22

4 Coaxial Cable Measurements 4-1

Before You Begin 4-2
Coaxial Cable Anomalies 4-3
Measuring the Velocity of Propagation of a Coaxial Cable In a Field Environment 4-5
Measuring the Length of Coaxial Cable Under Field Conditions 4-7
Measuring the Length of a Coaxial Cable Segment 4-8
Locating a Coaxial Cable Short 4-9
Locating a Cable Splice 4-10
Locating a Power Splitter or Directional Coupler 4-11
Locating Coaxial Cable Taps 4-11
Locating Intermittent Problems In a Coaxial Cable 4-12

5 File Management Options 5-1

Storing and Recalling Test Setup Parameters 5-2
Storing and Recalling Waveforms 5-5
Comparing Test Waveforms with Previously Stored Waveforms 5-7
Printing Test Results 5-9
Software Upgrades 5-9

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6 MTDR Reference 6-1

MTDR Module Indicators and Connectors 6-2
MTDR Screen Components 6-4
Test Mode Controls 6-6
Port Selection Options 6-7
Test Setup Controls 6-7
Velocity of Propagation 6-8
Pulse Width Settings 6-11
Rx Gain 6-14
Start Range / End Range (Measurement Start and End Points) 6-15
Test Time Setting 6-16
Rx Filter Selection 6-17
Viewing Results 6-18
Distance Display 6-19
TDR Waveform Display with Cursors 6-20
Test Result Parameter Display 6-21
Waveform Recall Area 6-23
File Management Options 6-24
Save Waveform As Display 6-25
Open a Stored Waveform Display 6-27
Delete a Saved Waveform Display 6-28
Test Start and Stop Buttons 6-28

7 MTDR SCPI Commands 7-1

SCPI Command Syntax 7-2
Connecting a S.A. Tablet to a PC 7-6
Programming a MTDR Test 7-7
Basic Test Commands 7-10
Common Commands 7-11
:ROUTe Commands 7-12
:SOURce Commands 7-13
:SENSe Commands 7-14
Other Commands 7-15
:FETCh Commands (retrieve results) 7-17

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8 **MTDR Module Specifications 8-1**

Physical Characteristics 8-2
Transmitter Characteristics 8-2
Receiver Characteristics 8-3
Connectors and Jacks 8-4
Ordering Information 8-5

Glossary

Warranty, Calibration, and Service

Index

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1

The Service Advisor Tablet at a Glance (N1610A) 1–2

The MTDR Module at a Glance (N1627A) 1–3

Front Panel Status Indicators 1–3

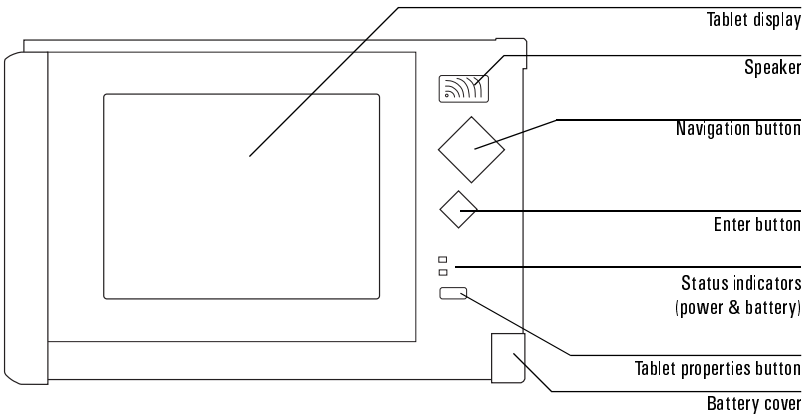
The MTDR Test Screen at a Glance 1–4

Using the Service Advisor Tablet 1–6

Getting Started

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The Service Advisor Tablet at a Glance (N1610A)



Front-Panel Buttons

Navigation button: Pressing a corner of this button moves the cursor in that direction (up, down, left, or right).

ENTER button: Pressing this button executes the selected function in the user interface.

Tablet properties button: Pressing this button displays a popup screen for setting properties, such as speaker volume and screen contrast. It also provides information about the battery charge, and has options for calibrating the touch screen.

Front-Panel Status Indicators

Power: This LED lights to show that the unit is switched ON and power is present.

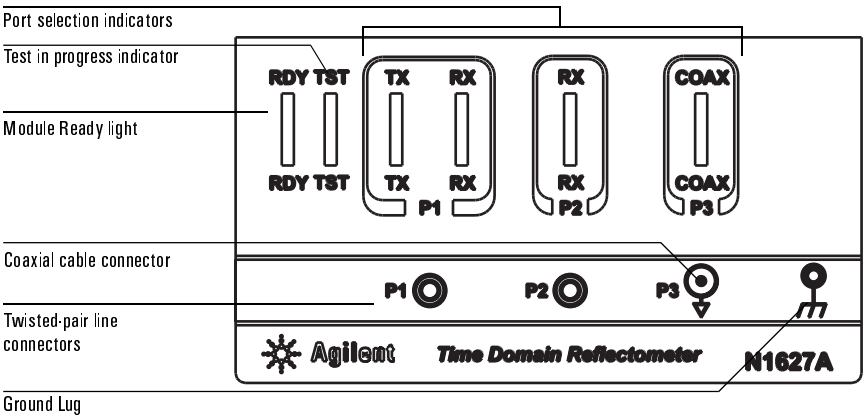
Battery: This LED lights to indicate the tablet is operating on battery, or that the battery is being recharged.

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The MTDR Module at a Glance (N1627A)

The Metallic Time Domain Reflectometer (MTDR) Module plugs into the Service Advisor Tablet to provide portable time domain reflectometer (TDR) testing capability. The MTDR Module also plugs into the N1700A Service Advisor undercradle to support operation with the Agilent J2300C Internet Advisor.

The following figure shows the connectors and indicators of the MTDR module:



Front Panel Status Indicators

RDY: Flashes green to indicate the module is performing its self diagnostic test. Stays lit to indicate the module is ready for use.

TST: Upon power turn on, this indicator flashes (green) while the module is performing its diagnostic tests. The indicator lights continuously while the MTDR is conducting a TDR test.

P1 TX and RX: The P1 TX indicator lights when the P1 port is used for transmit. The P1 RX indicator lights when the P1 port is used for receive. Both indicators are lit for standard (Std) mode tests.

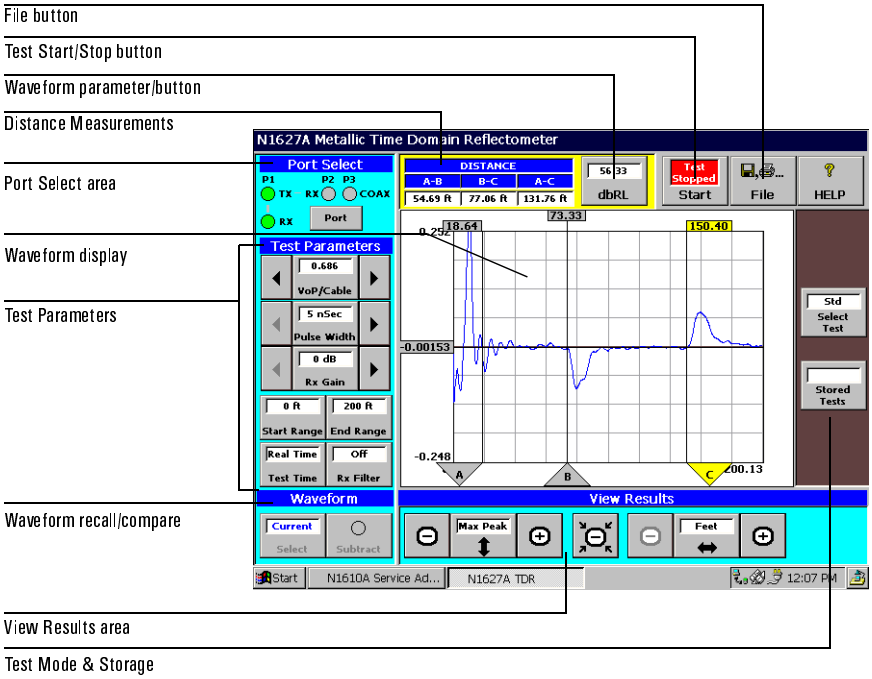
P2 RX: The P2 RX indicator lights when the P2 port is used for receive. The P2 port is used for receive in crosstalk (Xtalk) mode tests.

COAX: The P3 COAX indicator lights when the P3 port is selected. P3 is used for tests on coaxial cable.

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The MTDR Test Screen at a Glance

The following figure identifies the major components of the main MTDR test screen display.



Refer to the table on the following page for information on the various areas of the screen. See *MTDR Screen Components*, page 6–4 for fuller descriptions of the various components of the MTDR test screen.

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MTDR Screen Components

Screen Area	Description
File button	Calls a popup display offering six file management options.
Test Start/Stop button	Initiates and terminates the TDR tests.
Waveform parameter/button	Clicking this button cycles though three parameters measured at the selected point in the waveform.
Distance Measurement area	Displays the distance between the three cursors during a TDR test.
Port Select area	Controls the MTDR's input and output ports.
Waveform display area	Displays a graphical representation of the TDR signal return.
Test Parameters area	Configures the TDR test.
Waveform Recall/Compare area	Used to facilitate waveform comparisons during TDR tests.
View Results area	Scales the TDR waveform in the MTDR display.
Test Mode area	The Select Test button selects one of four basic test modes. The Stored Test button retrieves stored waveforms for comparison with the current waveform currently.

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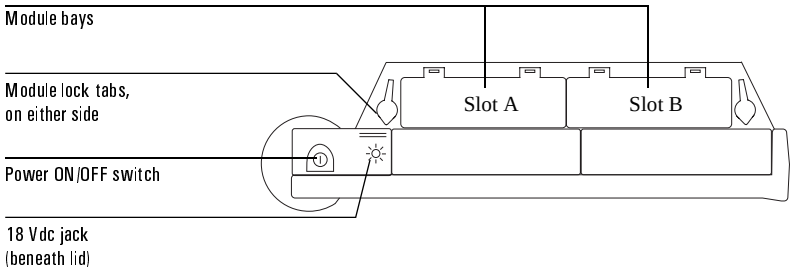
Using the Service Advisor Tablet

This section provides background information about using the Service Advisor Tablet (*S.A. Tablet*) with the MTDR Module.

Installing Module

Follow these steps to install the MTDR Module in the S.A. Tablet.

1. Lift the left module bay covers (on top of the S.A. Tablet) and align the MTDR Module with the bay.
2. Slide the module all the way into the bay until it seats firmly, and close the locking tab to lock the module in place.



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Switching ON the S.A. Tablet and User Interface

Follow these steps to turn on the S.A. Tablet and start the user interface.

1. If you plan to use external power, connect the S.A. Tablet's 18 Vdc jack to a powered ac adapter (N1612A) or 12 Vdc vehicle power adapter (N1614A). Otherwise, the tablet's battery will provide power.
2. Press ON the power switch on top of the S.A. Tablet. After a short delay, the front-panel power indicator should light up.
3. After a short startup routine, the S.A. Tablet invokes the Service Advisor Manager utility. When the AutoStart option is set, the software then launches the MTDR graphical user interface (GUI). See Chapter 2 for instructions on running MTDR tests.

Note: If you are using battery power and there isn't enough power to run the S.A. Tablet and MTDR module, a warning message is displayed.

Note: At the end of the tablet's initialization process the unit's software defaults to the MTDR screen display in STD Test mode. If you intend to perform another test, press the **Select Test** button to move to the test selection menu shown on *Test Mode Selection Controls*, page 2–6.

Note: For more detailed information on using the Service Advisor Tablet, refer to the Service Advisor Tablet User's Manual N1610-90000.

Navigating the User Interface

Following is a list of basic steps for navigating the S.A. Tablet GUI.

- Select options and buttons by touching the item on the screen. Use your finger or use the stylus that came with the S.A. Tablet. (The stylus is stored in the back of the module bay.)
- When you select a field button that requires a numeric value, the GUI displays a popup keypad containing touch selectable digits or a parameter options menu.

Select the appropriate button or buttons to specify a field value. Some popup displays include **OK**, **Clear**, and **Cancel** buttons. Select **OK** to write an entered value to a field (the popup display normally closes automatically). Use the **Clear** button to clear an entered value or, **Cancel** to close the display without making changes.

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Stopping MTDR Module Software

You can stop the MDTR module software and switch off the S.A. Tablet, as follows:

- Select the **Exit** option from the **File** toolbar button menu. This returns you to the S.A. Tablet's Service Advisor Manager. (You can also access the Manager by clicking its icon in the taskbar.)
- Select the **Shutdown** button in the Service Advisor Manager, and answer **yes** when prompted to shutdown.

The S.A. Tablet stops any active tests, closes the GUI, and then shuts down the Service Advisor Manager. By default, power is also switched off. To configure the Tablet to leave power ON when you shutdown, refer to the *Service Advisor Tablet User's Manual*.

Note: You can also shut down the GUI and Service Advisor Manager software by pressing the power switch off. However, Agilent recommends you use the shutdown option to avoid losing any unsaved test data.

See Chapter 2*Testing Basics — Using the MTDR Module*, for more information on using the MDTR GUI.

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2

Before You Begin 2–2

Power Turn-on and AutoStart 2–3

Test Mode Selection Controls 2–6

Test Setup Parameters 2–7

Waveform Cursors and Computations 2–9

Distance Measurements 2–10

Performance Parameters 2–11

Scaling the Waveform 2–12

Basic TDR Test Procedure 2–13

TDR Test Applications 2–16

Testing Basics — Using the MTDR Module

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Before You Begin

If you are not already familiar with the operation of the N1610A Service Advisor Tablet, please read the Service Advisor Portable Test Tablet User's Manual before beginning a TDR test. If you are not already familiar with the controls and indicators in the MTDR screen display, read Chapter 3 of this manual, to familiarize yourself with their functions.

Simulating Real World Faults in a Controlled Environment

Before attempting to perform TDR testing in the field, it may be useful to simulate some common faults in a laboratory environment and then test for them using the MTDR. This will allow you to familiarize yourself with the TDR waveform displays and the operation of the tester, before you have to use the tester in the field, under the pressure of a deadline.

Faults such as opens, high impedances areas, and shorts, are easy to simulate. Common network features such as splices, load coils, and bridged taps, are also easily simulated. The effects of moisture in a cable are, however, harder to duplicate.

Simple resistance checks can be used to measure line resistance. In general, an open-ended twisted-pair line with a resistance of 100 kOhms or less, is considered bad. However, the MTDR looks at total impedance, which includes: resistance, inductive, and capacitive effects; usually in an uncontrolled environment. These factors can be difficult to simulate. Impedance changes, such as those caused by moisture, can not generally be detected by an instrument measuring only resistance. Simulating an impedance fault with a simple resistor, does not accurately simulate the actual fault. When attempting to model a real world fault under laboratory conditions, attempt to simulate all of the factors contributing to the fault.

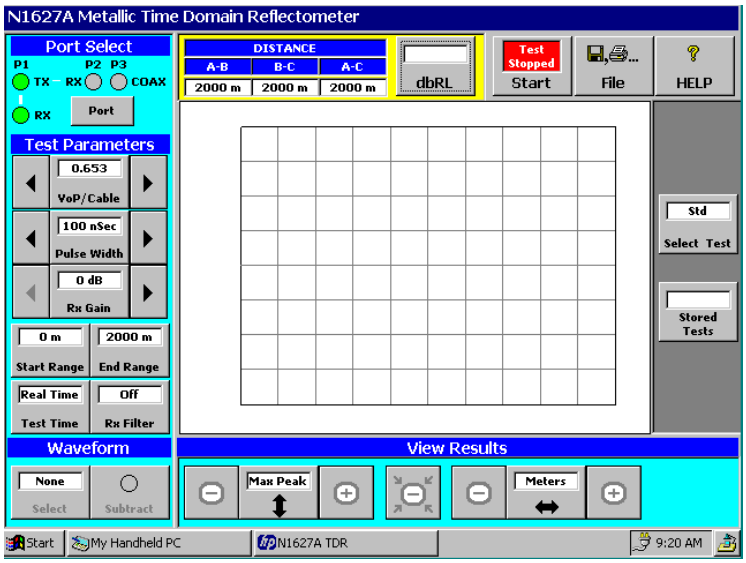
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Power Turn-on and AutoStart

To initiate TDR testing:

1. Set the S.A. Tablet's Power switch to **ON**.
2. If the MTDR Module's **Enable** button is not already enabled on the Service Advisor Manager's "Tablet Control" tab, set the **Enable** button. The icon's LED will light when the module is enabled.
3. If the **AutoStart** feature is not already enabled on the Service Advisor Manager's Setup tab, enable the feature. The **AutoStart** button's LED lights when the Autostart feature is enabled.

The table will display the MTDR test screen in Standard (Std) Test mode. The screen display should appear as shown.



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Making Connections

Warning! Before attempting a TDR test, disconnect any power source connected to the circuit. Potentially dangerous voltage may be present on the transmission line or coaxial cable. Use caution when disconnecting to the cable. See the section "Electric Shock Hazard" in the front of this manual.

Caution: When testing twisted-pairs, connect the ground lug on the MTDR Module to circuit ground.

TDR testing is normally conducted with an open circuit at the far end of the line or cable. In general, before beginning a TDR test, it is best to disconnect any equipment or terminating components at the far end of the cable. The terminating element of a properly terminated cable can absorb most or all of the TDR pulse, allowing little or no signal to reflect back to the MTDR for display.

To connect the MTDR Module to a line or cable under test, proceed as follows.

To perform a TDR test on a twisted-pair line:

1. Use Bantam plug test cables to connect the module to the twisted-pair subscriber line under test.
2. Install the test cable between the MTDR Module's **P1** connector and tip and ring leads of the twisted-pair line.
3. Use a jumper cable to connect the MTDR Module's ground lug to circuit ground.

For a crosstalk test on a twisted-pair line:

- Use Bantam plug test cables to make the connection.
- Install two test cables between the MTDR Module's **P1** and **P2** connectors and tip and ring leads of the two lines you plan to test. Use a jumper cable to connect the MTDR Module's ground lug to circuit ground.

Note: The reflected signal returning to the MTDR is generally very weak. Therefore, the quality of the connection between the MTDR Module and the twisted-pair cable under test is an important factor in TDR testing. When testing a twisted-pair line, make sure that the MTDR's alligator clips are securely connected to the twisted-pair.

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If you plan to perform a coaxial cable test:

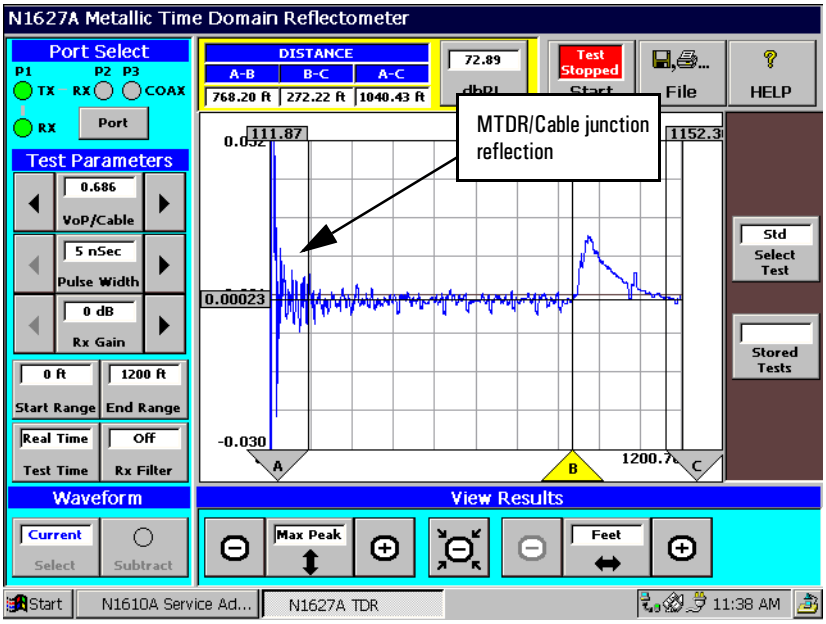
- Connect the coaxial cable directly to the MTDR Module's **P3 COAX** port.

Note: The signal reflected to the MTDR is generally weak, so the quality of the connection between the MTDR and the coax cable is an important factor in testing. Examine the connector for damage, rust, dirt, or loose fittings before connecting the cable to the module. Make sure the connector collar connecting the cable to the module, is snug.

Note: When attempting to locate a nearby fault, it may help to use a jumper cable to ensure that the area of interest is beyond the MTDR's blind spot. See *Blind Spots*, page 6–13. Remember the length of the jumper is included in the MTDR's distance measurements. If you are using a long jumper cable to connect to the MTDR, it is best (but not critical) to use a jumper cable with the same impedance and VoP as the cable under test.

TDR Output Connector Reflection

All waveforms displayed on the MTDR screen begin with a large positive spike. This is characteristic of all TDRs and represents the energy reflected by the junction of the TDR tester and the cable under test (see below). The width of this initial reflection varies in proportion to the selected pulse width and is not considered in the waveform analysis, unless a loose connection is indicated. In such a case the junction impedance would be abnormally high.



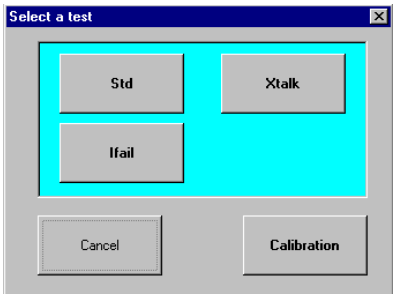
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Test Mode Selection Controls

You can use the **Select Test** button on the right side of the MTDR screen display, to bring up a test selection menu.



The menu offers four testing options, as shown below.



Std Test: In its standard (Std) test mode, the MTDR Module can perform a variety of TDR distance and length measurements using either the **P1** (twisted-pair) or **P3** (coaxial) connectors.

Xtalk Test : Sets up the MTDR Module to perform crosstalk (Xtalk) measurements using the module's **P1 and P2** signal ports (**P1** in transmit mode, and **P2** in receive mode).

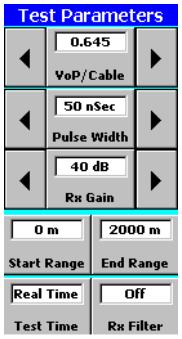
Ifail: This test option sets up the MTDR to perform a timed test, designed to detect intermittent problems in a line. In intermittent failure (Ifail) mode, any signal reflection (which may indicate a fault) occurring in the return signal, is detected and plotted on the MTDR's waveform display. The captured signal reflection persists in the waveform display for the remainder of the test (even after the fault disappears). Reflections that persist for the full duration of the test, appear as dark deviations in the TDR waveform. Intermittent, non-persisting, faults usually appear somewhat lighter in the TDR waveform.

An intermittent failure test can be performed using the module's **P1** port (in transmit/receive mode) to test a twisted-pair, **P1** and **P2** ports (with **P1** in transmit mode, and **P2** in receive mode) for a crosstalk test, or the **P3** port for a coaxial cable test.

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Test Setup Parameters

The Test Setup Parameters set up the MTDR testing parameters before a TDR test is started.



VoP/Cable: Using the correct **VoP** (velocity of propagation) value is of major importance in obtaining accurate measurements. The published VoP for the cable under test is often used as a starting point for TDR testing. However, the actual VoP of the cable may be different than the published VoP due to a combination of factors. These factors are discussed in detail on pages *Measuring Velocity of Propagation of Twisted-Pair Cable In an Uncontrolled Environment*, page 3–6 and *Measuring the Velocity of Propagation of a Coaxial Cable In a Field Environment*, page 4–5.

Note: Set the **Rx Gain**, **Pulse Width,** and **Rx Filter** values before the test, and then adjust them during the test to produce a TDR waveform with clearly discernible characteristics.

Pulse Width: This value sets the width of the outgoing TDR pulse. The pulse width is important to produce a signal return of sufficient magnitude for the MTDR to detect; the wider the pulse width, the greater the output signal energy. Because the MTDR generally transmits and receives TDR pulses through the same port (**P1** or **P3**), a "blind spot" is created ahead to the MTDR equal to the pulse width. This can make it difficult to locate a nearby fault or two faults that are close together. A fuller explanation of pulse width and the TDR blind spot is provided in *Pulse Width Settings*, page 6–11.

In general, use a narrow pulse width for locating nearby faults because the waveform resolution is better and the blind spot is shorter. However, sometimes a larger pulse width is helpful even when attempting to locate a nearby fault, when the fault is very small and the reflected signal very weak. Remember, when testing for a fault at a significant distance, the cable impedance (which attenuates the

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signal return), and the small signal reflection of a small or partial fault, can make the reflected signal difficult to detect. It is important to get as close as possible to such a fault, to diminish return signal attenuation.

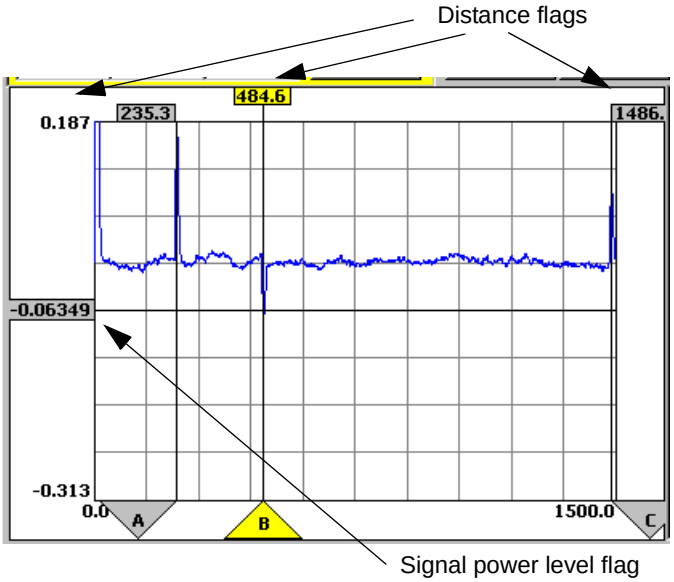
Start Range and End Range: These settings define an area of interest where testing will take place.The testing area is defined in distance or transit time from the MTDR. During tests, the MTDR takes between 2000 and 4000 test samples at equal intervals between the two points. A waveform graph comprising 400 of the samples. The **Test Time** control/indicator is used to specify the duration of the test.

The controls in the Test Setup Parameters area are described in detail in *Test Setup Controls*, page 6–7.

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Waveform Cursors and Computations

The MTDR software supports three cursors for each graphical waveform display, as shown below.



The near-end cursor (labeled **A**) defines the near-end measurement point. The flag at the top of the cursor displays the distance (when **feet** or **meters** is selected as the unit of measurement) or the transit time (when **µSec** is selected) form the MTDR Module to the **A** (near-end) cursor. The near-end cursor is used to set a starting point for measurements when a specific section of a line or cable is being measured. It can be moved back (in distance or transit time) to the point-of-interest cursor (labeled **B**) but can not be moved beyond it.

The far-end cursor (labeled **C**) defines the far-end measurement point. The flag at the top of the cursor displays the distance or transit time from the MTDR Module to the far-end cursor. The far-end cursor is used to set a far-end measurement point when a specific section of a line or cable is being measured. It can be moved forward (in distance or time) up to the point-of-interest cursor (labeled **B**) but can not be moved ahead of it.

The point-of-interest cursor (labeled **B**) can be moved to any point-of-interest in the TDR waveform between the near-end and far-end cursors. The point-of-interest cursor is used to provide an exact measurement of the distance or transit time

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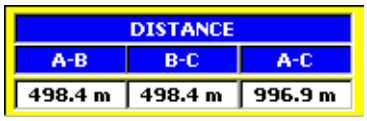
from the MTDR Module to a selected point. The distance flag at the top of the cursor indicates the exact distance or time delay from the MTDR Module to the point-of-interest cursor.

The three cursors can be placed on the waveform display by first selecting the icon for the desired cursor (either **A**, **B** or **C**) and by then clicking on the waveform or any point along the horizontal axis of the screen display where you want the cursor to appear. The selected cursor will move to the point in the screen where you click.

When you click on any of the three cursors and then a point in the TDR waveform, an amplitude cursor also moves vertically to that point and displays the amplitude of the TDR waveform at that point. The amplitude measurement appears in a flag at the end of the amplitude cursor, on the left side of the waveform display.

Distance Measurements

The three Distance measurements are automatic measurements of the distances or transit time between the three cursors, described above.



The Distance measurements indicate:

A-B: The distance or transit time from the near-end cursor (**A**) to the point-of-interest cursor (**B**)

B-C: The distance or transit time from the point-of-interest cursor (B) to the far-end cursor (C)

A-C: The distance or transit time from the near-end cursor (A) the to the far-end cursor (C)

Note: Notice that when the cursors are moved, the distance measurements change automatically.

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Performance Parameters

When a cursor is set at any point in the MTDR's waveform display, three waveform parameters are automatically calculated and one of the three parameters appears, immediately, in the TDR test result parameters control/indicator.

Tap the combination control/indicator to cycle through the three parameter measurements.



The there test parameters are:

- the return loss in decibels (**dBRL**) at the selected point
- the reflection coefficient (**rho**) at the selected point
- the effective impedance at the selected point, expressed in **Ohms**

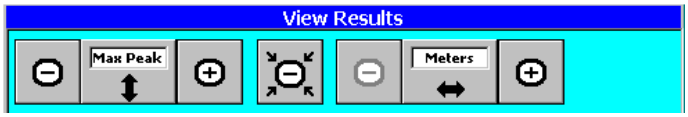
Note: The indicator displays parameters for the active cursor (Normally the cursor last selected, either **A**, **B**, or **C**). Notice the values change when the cursor is moved, or when another cursor is selected.

See *Test Result Parameter Display*, page 6–21 in Chapter 3 for a fuller explanation of these parameter measurements.

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Scaling the Waveform

To scale the TDR waveform, use the waveform scaling controls in the View Results area, at the bottom of the MTDR screen display.



The vertical arrow control offers a choice of waveform scaling functions: 1 dB (**DB1**), 2 dB (**DB2**), 3 dB (**DB3**), maximum peak (**Max Pk**), and maximum to maximum (**MIMAX**).

When pressed repeatedly, the horizontal arrow button steps through three distance measurement options: **Feet**, **Meters**, and **Sec**. The unit of measurement in the Start Range, End Range and Distance windows, and the waveform graph change as the unit of measurement option is changed.

The **+** and **-** buttons can be used to scale the TDR waveform. A more detailed description of these controls is provided in *TDR Waveform Display with Cursors*, page 6–20.

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Basic TDR Test Procedure

The follow procedure is a general setup procedure for performing a TDR test. See *TDR Test Applications*, page 2–16, for more information.

1. Connect the MTDR Module's ground lug to circuit ground.
2. To connect the MTDR Module to the line or cable, proceed as follows:
   - If testing a **single twisted-pair** line, use a test cable to connect the **P1** jack on the front of the MTDR Module to the twisted-pair.
   - If performing a **crosstalk test** on twisted-pair lines, use two test cables to connect the **P1** and **P2** jacks on the front of the MTDR Module to the two twisted-pairs under test.
   - If testing a **coaxial cable**, connect the cable directly to the **P3 COAX** connector on the front of the MTDR Module.

   See *Before You Begin*, page 2–2 for additional instructions and cautions.

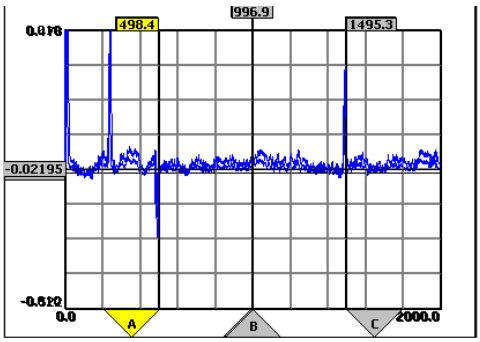
Note: If testing for a nearby fault you may want to use an additional jumper cable to move the fault beyond the tester's blind spot (a function of the tester's pulse width). See the information on Blind Spots on page 6–13.

3. Tap the **Port** selection button and:
   - select **P1** when testing a twisted-pair line
   - select **P1** and **P2** when performing a crosstalk test
   - select **COAX** when testing a coaxial cable
4. Use the **VoP / Cable** button or arrow controls to select the appropriate velocity of propagation (VoP) for the twisted-pair or coaxial cable being tested. To call up a list of VoP values for common cables use the **VoP** control and the Cable Database tab in the popup display. The table lists common cables from various manufacturers. If the cable in use is not listed in list of cables. You can find the cable's VoP in the data sheet supplied by the cable manufacturer. See *Velocity of Propagation*, page 6–8 for details on the VoP control.

Note: The actual VoP of a cable may vary significantly from the published VoP, due to cable aging, ambient temperature, and humidity. If testing a cable in an uncontrolled environment, follow the procedure on page 3–6 and page 4–5 to determine the actual VoP.

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5. Use the **Pulse Width** arrow controls to select an appropriate pulse width (from 5 ns to 5 µs). Begin with a narrow pulse width setting. See *Pulse Width Settings*, page 6–11 for specific factors in selecting a pulse width.
6. Set the receiver gain setting to a low gain setting. The reset default setting is 0.0 dB.
7. Use the horizontal arrow at the bottom of the screen, to choose the unit of measurement used in the test **(**either feet, meters, or µs).
8. Set the **Start Range (**defined as a distance in feet, meters, or µs) to a value expected to be less than the point of interest in the line or cable. If no estimate of the distance is possible, set the start range to 0.
9. Set the **End Range** (defined in feet, meters of µs) to a value expected to be greater than the point of interest in the line or cable. If no estimate of the distance is possible, set the end range to 2000 m, 6562 ft., or 10 µs.
10. Tap the **Test Time** button to select a test time. If no specific test time is desired, select **Continuous Real Time** from the popup display. The test duration will then be determined by the **Start** and **Stop** controls.
11. Tap the **Filter** button and select **0**, for no input filter.
12. Tap the vertical arrow at the bottom of the screen, to choose the type of measurement to be made: either 1 dB (**DB1**), 2 dB (**DB2**), 3 dB (**DB3**), maximum peak (**Max Pk**), or maximum to maximum (**MIMAX**).
13. Tap the **Start** button to initiate the test, and allow a few seconds for the TDR waveform to appear. The waveform display might appear as shown.



14. Tap the **Stop** button to terminate the test and freeze the test results.

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15. Use the – and + controls at the bottom of the MTDR screen display to scale the waveform and if needed increase the gain until a the reflected TDR waveform fills a substantial part of the MTDR's waveform display.
16. If the suspected fault does not appear in the waveform display, use the **Pulse Width** arrow control to increase the pulse width and retest the cable until the fault appears. See *Pulse Width Settings*, page 6–11.

Note: Remember, the waveform display resolution can be degraded as the pulse width is increased.

17. If the noise level observed in the TDR waveform is excessive, select filter 1 to insert a low-level noise input filter. Select filter 2 to insert a high-level noise input filter.
18. See the individual TDR test procedures listed on the next page for additional instructions.

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TDR Test Applications

Twisted Pair Cable Measurements

Measurement	Page
Checking Twisted-Pair Cable Terminations	3–2
Reflection Characteristics	3–3
Measuring Cable Performance Parameters	3–4
Measuring Velocity of Propagation of Twisted-Pair Cable In an Uncontrolled Environment	3–6
Alternate VoP Adjustment Method	3–7
Locating an Open In a Twisted-Pair Line	3–8
Locating a Short In a Twisted-Pair Cable	3–9
Measuring the Distance To the First Bridged Tap	3–10
Measuring the Length of a Lateral Line	3–12
Measuring the Distance Between Two Points in a Twisted-Pair Cable Run	3–14
Locating Load Coils	3–15
Locating Line Build-out (LBO) Capacitors	3–17
Measuring the Distance To a Wire Splice In a Twisted-Pair Line	3–18
Locating a Wet Area	3–19
Locating Intermittent Problems In a Twisted-Pair Line	3–20
Locating a Crosstalk Point	3–21
Locating Splits and Resplits in a Twisted-Pair Line	3–22

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Coaxial Cable Measurements

Measurement	Page
Coaxial Cable Anomalies	4–3
Measuring the Velocity of Propagation of a Coaxial Cable In a Field Environment	4–5
Measuring the Length of Coaxial Cable Under Field Conditions	4–7
Measuring the Length of a Coaxial Cable Segment	4–8
Locating a Coaxial Cable Short	4–9
Locating a Cable Splice	4–10
Locating a Power Splitter or Directional Coupler	4–11
Locating Coaxial Cable Taps	4–11
Locating Coaxial Cable Taps	4–11
Locating Intermittent Problems In a Coaxial Cable	4–12

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3

Before You Begin 3–2

Reflection Characteristics 3–3

Measuring Cable Performance Parameters 3–4

Measuring Velocity of Propagation of Twisted-Pair Cable In an Uncontrolled Environment 3–6

Alternate VoP Adjustment Method 3–7

Locating an Open In a Twisted-Pair Line 3–8

Locating a Short In a Twisted-Pair Cable 3–9

Measuring the Distance To the First Bridged Tap 3–10

Measuring the Length of a Lateral Line 3–12

Measuring the Distance Between Two Points in a Twisted-Pair Cable Run 3–14

Locating Load Coils 3–15

Locating Line Build-out (LBO) Capacitors 3–17

Measuring the Distance To a Wire Splice In a Twisted-Pair Line 3–18

Locating a Wet Area 3–19

Locating Intermittent Problems In a Twisted-Pair Line 3–20

Locating a Crosstalk Point 3–21

Locating Splits and Resplits in a Twisted-Pair Line 3–22

Twisted-Pair Cable Measurements

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Before You Begin

When testing twisted-pair cables, connect the twisted-pair under test to the **P1** port on the MTDR Module. Tap the **Port** selection button as needed to select the MTDR's **P1** port.

Checking Twisted-Pair Cable Terminations

When testing twisted-pair cables, it is best if the cable is not terminated. In order to produce a measurable signal reflection, the MTDR's output pulse must be reflected back from the fault or the far end of the cable, to the module's receiver. A cable termination can absorb the MTDR out pulses so that no signal is returned.

Common Twisted-Pair Ailments

Water is a common source of problems occurring in telephone terminal and junction boxes. Any moisture in a junction box will eventually corrode the wiring terminals and cable connections.

Water can reach into twisted-pair conductors through pin hole openings in the plastic insulation surrounding them. In a multi-pair, air-core cable, the low impedance area, caused by the excessive moisture, may be several feet wide. When testing such a cable for water problems, the distance measured to the fault may differ from pair to pair. This generally, indicates the water has penetrated through the wire insulation at different points. Excessive moisture in a cable typically shows up as a lowering of line impedance in the affected area.

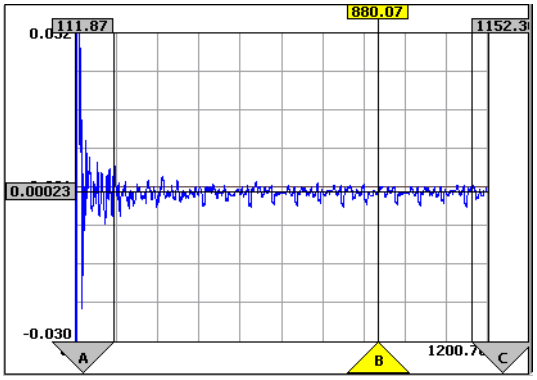
Wire breaks are caused by a variety of factors, including: falling limbs, excavation errors, lightning strikes, etc. and are not always apparent to the naked eye. Wire breaks can also occur during installation, if a wire is overstressed.

The constant flexing of the twisted-pairs cables in a harsh environment can sometimes break the cable's twisted-pairs. Modern cables are designed to withstand a great deal of punishment but not without limit.

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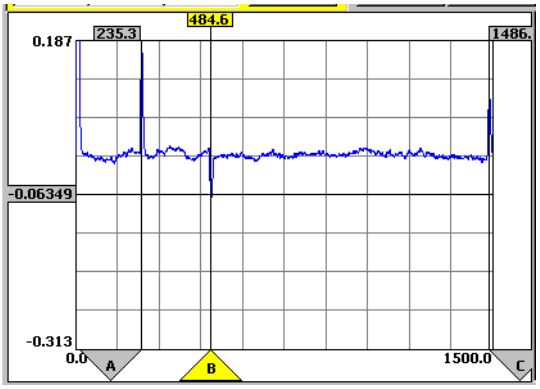
Reflection Characteristics

A properly terminated twisted-pair cable will absorb nearly all of the TDR pulse and so produces almost no reflection on the waveform display (as shown below).



If the cable under test is terminated and the TDR waveform appears like that shown above, the cable connections and terminations are OK. If, however, the cable termination causes a large reflection, either the line is poorly connected to the termination (causing a high impedance) or the termination itself is bad.

Line impedance variations cause signal reflections that appear as both positive- and negative-going reflections on the MTDR display, as shown below.



If the cable fault is a complete open or a dead short, the MTDR can only read up to that point. The TDR waveform will appear flat after the fault.

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Measuring Cable Performance Parameters

Three performance parameters can be checked at any of the 400 measurement points between the MTDR's measurement start and end points (Set by the **Start Range** and **End Range** buttons). Upon selecting a cursor and selecting a point in the TDR waveform, one of the three performance parameters is displayed on the performance parameter control/indicator (see *Performance Parameters*, page 2–11).

Measuring Return Loss

Each point in the TDR waveform represents a measurement of the reflected signal energy from a specific point in the line or cable under test. Because the power of the transmitted signal is always known, the MTDR can quickly calculate the single frequency return loss at any point in the waveform. (See *dBRL (return loss)*, page 6–21 for a fuller explanation.)

To determine the return loss at a specific point in the cable run:

1. Follow the test setup procedure described on page 2–13 to setup for the measurement.
2. To monitor the return loss at a specific point in a cable run, tap the performance parameters button until the **dBRL** indicator appears. (The parameters display cycles between **dBRL**, **rho**, and **Ohms** as the button is tapped.) See the return loss parameter is discuss on page 6–21 in chapter 3.
3. Set a cursor (usually the point-of-interest cursor) at the point in the TDR waveform you wish to monitor. The he return loss at that point will appear automatically in the **dBRL** window.

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Measuring rho

Reflection coefficient (or rho) is another measurement of impedance used in communications systems. (See *Reflection Coefficient (rho)*, page 6–22 for a fuller explanation.)

To determine the reflection coefficient at a specific point in the cable run:

Follow the test setup procedure described on page 2–13 to measure the at a specific point in the cable run. The rho parameter is discuss on page 6–21 in Chapter 6 *MTDR Reference*.

1. To monitor the effective impedance at a specific point in a cable run, tap the performance parameters button until the **rho** window appears.
2. Set a cursor (usually the point-of-interest cursor) at the point in the waveform you wish to monitor and the reflection coefficient value at that point, will appear automatically in the **rho** window.

Measuring Effective Impedance

1. Follow the test setup procedure described in *Basic TDR Test Procedure*, page 2–13, to setup for the effective impedance measurement. The effective impedance parameter is discussed in *Test Result Parameter Display*, page 6–21.
2. To monitor the effective impedance at a specific point in a cable run, tap the performance parameters button until the **Ohms** indicator appears.
3. Set a cursor (usually the point-of-interest cursor) at the point in the TDR waveform you wish to monitor. The effective impedance at that point will appear automatically in the **Ohms** window.

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Measuring Velocity of Propagation of Twisted-Pair Cable In an Uncontrolled Environment

Variations in the velocity of propagation (VoP) for a specific cable type are common. Factors such as environment, age, and manufacturer can affect a cable's VoP.

The difference between a cable's published VoP and the actual VoP in the field can cause inaccuracies in TDR distance measurements. Therefore, it may be necessary to determine a cable's actual VoP in the field environment when accurate distance measurements are needed.

To determine the actual VoP of a **cable of known length**:

1. Use the MTDR to perform a cable length measurement on the cable. Use the published VoP and a field environment. Note the cable's measured length.
2. Compare the cable's length measurement and the cable's known length. If the measured and actual length disagree, change the MTDR's VoP value and retest, repeatedly, changing the VoP value each time, until the cable's measured length and actual length agree.
3. Use the corrected VoP value when making TDR measurements on cables of the same type in the field environment (assuming the environmental conditions are the same).

To determine the actual VoP of a **cable of unknown length**:

1. Find a cable with a known length and of the same cable type as the cable to be tested. This cable will serve as a standard for adjusting VoP. Be sure to use a cable of at least 100 feet (33 meters) in length. Using a longer cable will improve measurement accuracy.
2. Initiate a TDR test to measure the length of the cable being used as a measurement standard. Use the published VoP, and the same ambient environment as will be experienced by the cable of unknown length, in the field. Note the cable's length measurement reading.
3. Compare the length measurement and the cable's known length. If the measured and actual length disagree, change the VoP value in the MTDR's screen display and repeat the test, until the length measurement and known (actual) lengths agree.
4. Initiate a TDR test on the cable of unknown length. Use the corrected VoP value obtained from the cable standard (described above) instead of the published VoP.

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Alternate VoP Adjustment Method

When trying to locate a fault in a cable of unknown length, a common method of reducing VoP error experimentally, involves testing the cable from both ends.

In this method:

1. First, determine the path of the cable under test and measure its length manually, using a measuring tape or measuring wheel.
2. On the MTDR screen display, set the **VoP/Cable** setting to the manufacturer's published VoP.
3. Test the cable from one end and record the distance to the fault.
4. Test the cable from the other end and record the distance to the fault.
5. Add the two distance measurements together, If the sum of the two distances (to the faults) is exactly equal to the cable's measured length, the distances to the fault are correct. However, if the sum of the measurement readings is more than the cable's measured length, the **VoP/Cable** setting is set to high and must be reduce. If the sum of the measurement readings is less than the cable's measured length, the **VoP/Cable** setting is to low and must be increased.

Note: You should also consider the possibility that there is more than one fault in the line.

- You can determine the correct VoP experimentally by adjusting the MTDR's **VoP/Cable** setting on the MTDR, and retesting (repeat steps 3 thru 5) until the sum of the two distances exactly equals the measured cable length.
- You can also determine the correct VoP mathematically, by dividing the cable's actual length by the sum of the two measurement readings. This calculation produces a correction factor. The VoP can then be adjusted by multiplying it by the correction factor to produce a corrected VoP. Each of the two distance readings (to the fault) and by the cable's total length reading (as appearing in the MTDR screen display) can also be multiplied by the correction factor to determine the actual distances.

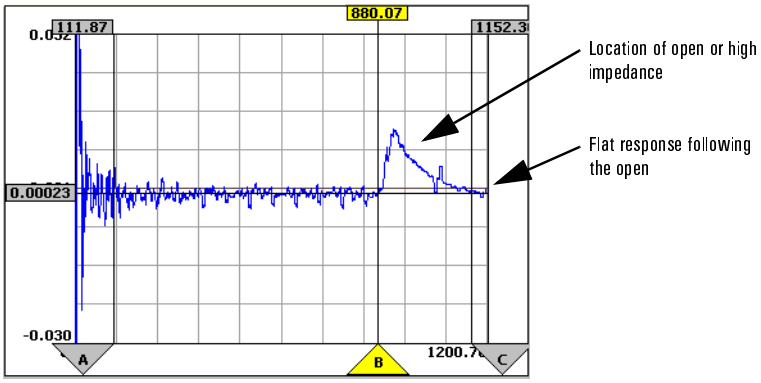
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Locating an Open In a Twisted-Pair Line

To locate an open in a twisted-pair line:

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the following:

   The TDR waveform might appear like that shown below.



   A reflection with a positive-going polarity can indicate: an open, a loose or corroded connection, a high impedance fault, or the unterminated end of the cable. The TDR waveform will appear flat after a complete open.

2. To measure the distance to the open, set the **B (**POI) cursor at the start of the positive-going discontinuity in the TDR waveform. The distance will appear in the distance flag at the top of the cursor.

   Partial opens produce relatively smaller positive-going discontinuities.

Note: When attempting to locate small faults such as partial opens, partial shorts, or wet splices, it is best to get as close as possible to the fault while keeping the pulse width (and therefore the tester's blind spot) in mind.

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Locating a Short In a Twisted-Pair Cable

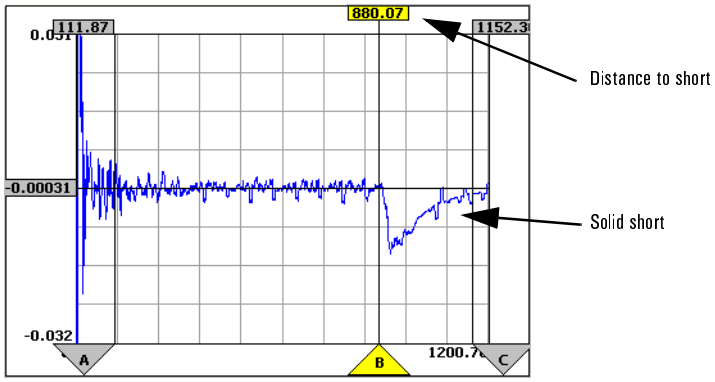
A short with little or no resistance is often referred to as a dead or solid short. Partial or low resistance shorts generally have a resistance of less than 1000 Ohms. The MTDR will work well in locating both types of shorts, provided there are no load coils between the tester and the short.

Both solid and partial shorts produce a downward deflection in the TDR waveform. The size of the deflection depends on the severity of the fault. The lower the resistance, the larger downward spike in the TDR waveform will appear. Partial shorts that approach 1000 Ohms are the most difficult to detect.

To locate a short in a twisted-pair cable:

1. Follow the test procedure described on page 2–13, and observe the following:

   The TDR waveform might appear like those shown below.



   A downward deflection in the TDR waveform can indicate a solid or partial short, or some other cause of low impedance.

2. Set the **B (**POI) cursor at the start of the negative going discontinuity in the TDR waveform to measure its distance. The distance will appear in the distance flag at the top of the cursor.

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Measuring the Distance To the First Bridged Tap

In residential and many commercial applications, bridged taps are a common way of supplying analog service form a single twisted-pair line to two or more telephones. However, bridged taps are fundamentally incompatible with digital service and are becoming an increasing problem as digital service gradually replaces analog service.

Some important facts about bridged taps worth noting are:

- A **bridged tap** is the point where a lateral connects to a twisted-pair line.
- A **lateral** is a twisted-pair line extending from a bridged tap on the main line (usually toward a subscriber). Lateral lines are frequently mistakenly referred to as bridged taps.

In analog service, a fault in a lateral extending from a main distribution cable can effect the quality of service in the trunk. When a twisted-pair line is being converted from analog to digital service, it is vital to first remove all bridged taps from the signal line. If this is not done, digital signals will travel down the unlocated lateral or laterals and reflect back into the data stream as signal noise. The resulting digital echoes can effectively render the data useless.

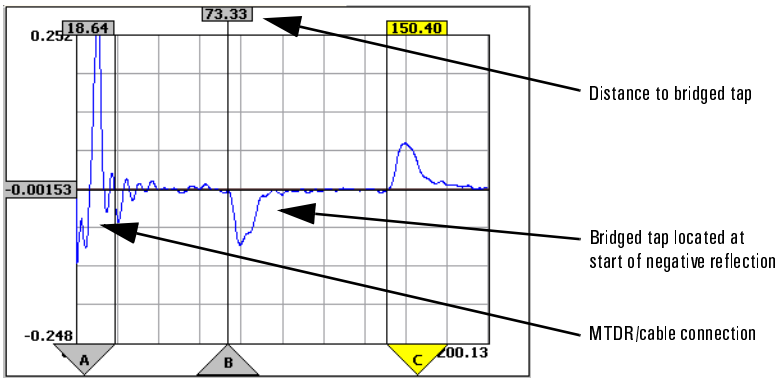
Locating bridged taps in a telephone system is one of the most common and sometimes difficult applications for an MTDR. In testing for bridged taps, it is important to remember that the MTDR will test through a bridged tap and display any discontinuities arising from sources on the far side of the bridged tap. These other sources can include other bridged taps and their associated laterals, shorts, opens, etc. When the relative length of the line and connected laterals is unknown, interpreting the TDR waveform display can be difficult. Wherever possible, consult local plant records to clarify the line layout, before attempting to interparty the TDR waveform display.

The impedance at the bridged tap drops to one half of the previous impedance, since two conductors carry the TDR signal after the bridged tap, rather than just one. This produces the negative going TDR reflection.

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1. To measure the distance from the MTDR Module to the first bridged tap follow the test procedure described on page 2–13, and observe the following:

   The TDR waveform might appear like that shown below.



   The impedance of the cable after the bridged tap is one-half that of the normal cable impedance. The bridged tap is, therefore, marked by a negative or downward reflection

   The TDR waveform anomaly associated with a bridged tap has three basic elements. The first is a dip in the TDR waveform where the bridged tap is located. After the dip, the response curve slants diagonally upward in a straight line. This is the lateral's reflection. The third element of the anomaly is a slight rise in the TDR waveform, marking the end of the lateral.

2. Set the **B (**POI) cursor at the start of the negative or downward dip (the start of the bridged tap) in the TDR waveform to measure the distance. The distance will appear in the distance flag at the top of the cursor.

The unfortunate problem with laterals is, where you find one, there are often more. The reflections from them ends of multiple laterals effects the TDR waveform and can make waveform interpretation very difficult beyond the bridge tap.

The more laterals there are, the harder it becomes to interpret the TDR waveform. Therefore, the easiest way to troubleshoot the problem is to locate the first bridge tap and remove its lateral line, Then reconnect the MTDR to the line continuation, locate the next bridge tap, and remove its lateral line. Repeat this procedure until all of the lateral lines have been removed.

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Measuring the Length of a Lateral Line

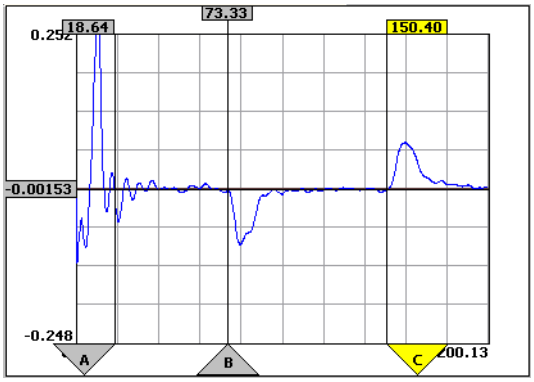
The end of a twisted-pair lateral is generally marked by a positive-going reflection after the bridged tap (which is marked by a negative-going reflection). However, remember that the MTDR will test through a bridged tap and display any discontinuities arising from sources on the far side of the bridged tap. These other sources can include other bridged taps and their associated laterals, shorts, opens, etc. When the relative length of the line and connected laterals is unknown, interpreting the TDR waveform display can be difficult. Wherever possible, consult local plant records to clarify the line layout, before attempting to interpret the TDR waveform display.

In a case where the length of the lateral is longer than the length of the line continuation, the reflection wave from the end of the line will appear before the reflection wave from the end of the lateral. In such a case, the second discontinuity after the bridged tap in might represent the end of the lateral.

This test displays both the distance to and the length of a lateral, extending from a twisted-pair line. The length of the lateral is the equal to the distance to a positive-going reflection following the bridged tap (marking the end of the lateral) minus the distance to the negative-going discontinuity (marking the bridged tap itself).

1. Follow the test procedure described on page 2–13, and observe the following:

   The TDR waveform might appear like that shown below.



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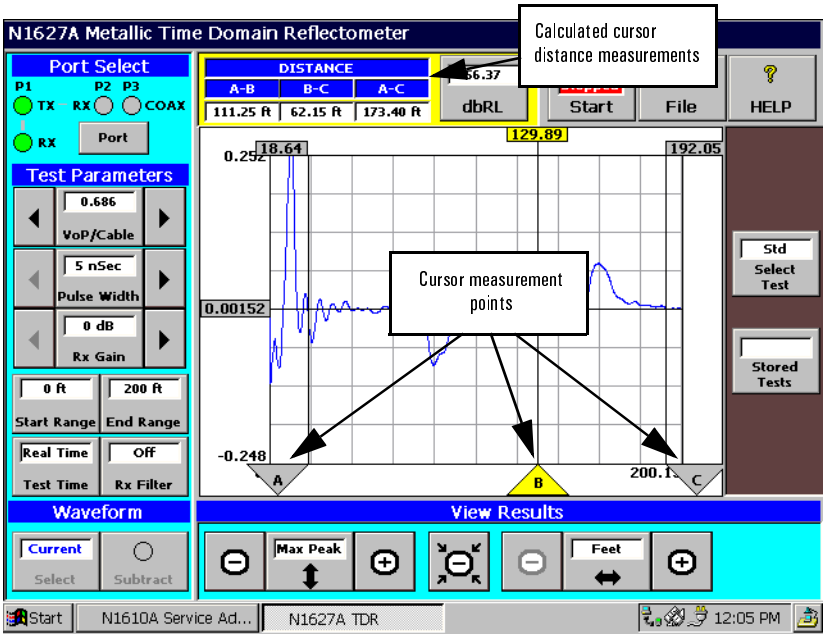
2. Set the **A** (NE) cursor at the beginning of the negative-going discontinuity marking the bridged tap and start of the lateral.
3. At the bridged tap, the response curve drops and then slants diagonally upward in a straight line. The lateral extends from the start of the drop in the curve to the end of the ascending straight line area, that immediately follows. Set the **B (**POI) cursor at the end of the ascending straight line area. This marks the end of the lateral.
4. The length of the lateral will appear as the **A-B** measurement in the Distance display.

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Measuring the Distance Between Two Points in a Twisted-Pair Cable Run

This test measures the distance between any two points (discontinuities) in a twisted-pair cable run. The distance measurements are generally made between discontinuities marking line fault conditions and cable ends.

1. Follow the test procedure described on page 2–13, and observe the display. The TDR waveform might appear like that shown below.



2. Set the **A** (near-end, or NE) cursor at the first point in the TDR waveform (the measurement start point).

3. Set the **C** (far-end, or FE) cursor at the second point (the measurement end point).

4. The distance between the two points will appear as the **A-C** measurement in the Distance display.

Note: The A and B or B and C cursors can also be used with the distance appearing as A-B or B-C measurement in Distance display.

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Locating Load Coils

Load coils are induction devices employed in local loops that exceed 18,000 ft, or 5,500 meters in length. These coils are typically either 66 mH or 88 mH inductors that compensate for signal loss caused by wire capacitance and boost signal frequencies in the voice frequency band (300 to 3000 Hz). In the USA, the first load coil is located about 3,000 ft (or 915 m) from the office. Other load coils spaced at 3,000 ft (915 m) or 6,000 ft (1830 m) intervals beyond the first. Sometimes the load coil is omitted in the final 10,000 feet to the subscriber. There is no international standard for load coil spacing and so the distances may vary in other systems.

In long subscriber loops carrying POTS service and equipped with load coils, missing load coils can cause complains of high-frequency voice attenuation or problems dialing with touch-tone phone.

Loaded analog systems must be upgraded to support a digit service such as ISDN, HDSL or ADSL. The upgrade process typically involves removing lateral lines, LBO capacitors, and load coils. To remove the load coils, you must first locate them using plant records and the procedure described below. A load coil can sometimes be hard to distinguish from an open at the far end of the line if you don't know what you are looking for. Remember that the first load coil about 3,000 ft (or 915 m) from the office and other load coils spaced at 3,000 ft (915 m) or 6,000 ft (1830 m) intervals beyond the first.

1. To locate the load coils, follow the test procedure described on page 2–13, and observe the waveform.

   A load coil causes a high impedance upward reflection, similar to a complete open. However, load coils generally produce a waveform deviation with a more rounded appearance than an open and the upward bump in the waveform is generally broader. The baseline after the bump angles upward slightly and runs below the level of the waveform baseline ahead of the coil. The MTDR can not test past a load coil, so the signal response after the load coil will appear relatively flat.

Note: Load coils will not always appear the same. This varies depending on how far you are from the coil. If you are close to a coil (less than 500 ft) and are using a medium pulse width, the load coil may appear as a complete open. At greater distances, a load coil's reflection will look like an open but with more rounded edges. Also, the baseline of the TDR waveform as it approaches a load coil is generally lower than the waveform baseline approaching an open.

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2. Set the **B (**POI) cursor at the beginning of the upward reflection in the TDR waveform and measure the distance form the MTDR Module to that point. The distance will appear in the distance flag at the top of the **B (**POI) cursor.
3. Once you have located the first load coil, remove it, and restart the test. The next load coil should be 3,000 ft (914 m) or 6,000 ft (1829 m) beyond the first.

Note: In general, the MTDR Module can not test past a load coil, so the TDR signal response after the load coil will appear flat. However, a special setup can be used to test past load coils and locate small problems in the line beyond coils. In this setup, the ends of the twisted wire pair under test are twisted together and are then connected to a one of the two MTDR test leads. A similarly loaded twisted-pair (usually from the same cable bundle) are then twisted together and connected to the other MTDR test lead. This setup nullifies any load coils in the line and allows the MTDR to see through the coils. This test configuration can be used locate small problems beyond one or more load coils in a line.

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Locating Line Build-out (LBO) Capacitors

As previously described, load coils are used in long twisted-pair cable runs carrying POTS service. They compensate for signal loss caused by wire capacitance and boost signal frequencies in the voice frequency band (300 to 3000 Hz). The load coils are spaced at equal distances (typically at 3,000 ft (915 m) or 6,000 ft (1830 m) intervals between the central office and a subscriber residence.

However, cable sections can not can not always be exactly 3,000 ft (915 m) or 6,000 ft (1830 m) long. This can lead to an imbalance between line capacitance and the inductance of the installed load coils.

Line build-out (LBO) capacitors can be installed at the end of short cable sections, when the distance between the installed load coils is less than the nominal 3,000 ft (915 m) or 6,000 ft (1830 m) line length. An LBO capacitor adds capacitance to the line and makes it appear electrically longer that it actually is. When added to the end of a short line section, the combined LBO capacitor and line section capacitance should balance out the inductance of the installed load coil.

1. To locate a line build-out coil, follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

   A line build capacitor causes a low impedance downward reflection, similar to a short, followed by a smaller positive reflection.

2. Set the **B (**POI) cursor at the beginning of the downward reflection in the TDR waveform and measure the distance to that point. The distance will appear in the distance flag at the top of the **B (**POI) cursor.

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Measuring the Distance To a Wire Splice In a Twisted-Pair Line

This test can be used to locate a degraded wire splice in a twisted-pair line. However, the reflection caused by a well made wire splice is extremely small and generally impossible to detect. The amount of signal reflection varies produced by a degraded wire splice varies with the junction impedance.

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, but set receiver gain (**Rx Gain**) to its highest setting, and observe the waveform.

   A reflection with a positive-going polarity can indicate an open, the unterminated end of the line, or a high impedance fault (typical of a degraded wire splice). The reflection caused by a wire splice is often smaller than the reflection from the unterminated end of the wire. The visibility of the splice will depend on the quality of the splice, the distance to the splice, the MTDR pulse width, receiver gain, and waveform scaling.

Note: If the splice is completely open, it may be mistaken for the far-end of the line. Knowing the total length of the line, can help to clarify such a the reading. You can also test the line from both ends.

2. Set the **B (**POI) cursor at the start of the waveform discontinuity caused by the degraded splice, and measure the distance. The distance will appear in the distance flag at the top of the cursor.

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Locating a Wet Area

Water can reach twisted-pair conductors through pinhole openings in the insulation around them. Many twisted-pair faults are caused by moisture. Intermittent noise problems are sometimes the first symptom of a water problem in the line. The noise is caused by a tiny current leak from tip (A) to ring (B). The problem may appear as a high resistance fault when checked with an ohmmeter. If the problem is allowed to persist, dial tone will eventually be lost.

Water problems often show up as a lowering of line impedance in the affected area. To detect such a fault with the MTDR get as close as possible to the fault. Note that distance measurements made through the water may be erroneous due to the change to the cable's VoP.

When water is present, it is not uncommon to find voltage on inactive twisted-pairs. The voltage generally comes from other active pairs in the cable. In a multi-pair, air-core cable, the low impedance area caused by the moisture, may be several feet wide. When testing such a cable for water problems, the distance readings may differ from pair to pair. This generally, indicates the water has penetrated through the wire insulation at different spots.

1. Follow the test procedure described on page 2–13, and observe the waveform.

   The TDR waveform anomaly associated with a wet area is very similar to that caused by a bridged tap. The waveform anomaly caused by a wet area also has three basic elements. The first is a dip in the TDR waveform where the water begins. After the dip, the response curve usually curves upward slightly in the wet area (a lateral produces a straight diagonal line). This area might also appear noisy for a wet area. What appears to be noise is actually impedance irregularities in the wet area. The third element of the anomaly is a slight rise in the TDR waveform at the end of the wet area.

2. Set the **B (**POI) cursor at the start of the dip marking the beginning of the wet area, and measure the distance. The distance will appear in the distance flag at the top of the cursor.

3. Test a sufficient number of wire pairs in the cable to be certain that you know the full extent of the problem.

Once the location and extent of the water problem is known, it is important to locate where the water actually entered the cable. The break in the cable sheath will not necessarily be within the low impedance area where the water is found. If the hole in the cable sheath is at a high point in the cable run, the water will usually migrate to a lower point. If the break in the cable's sheath is not repaired, the problem will most likely reoccur.

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Locating Intermittent Problems In a Twisted-Pair Line

Intermittent faults are typically caused by a high impedance series fault or an intermittent connection and are often reported as noisy sizzling static or a loss of dial tone. However, intermittent problems come and go with changes in the cable's ambient environment and can be difficult to locate.

Using the MTDR's intermittent failure (Ifail) mode, a line's TDR response can be monitored over an extended period of time. This allows the intermittent conditions to be captured and recorded on the MTDR's waveform display.

1. If attempting to find an intermittent fault in a single twisted-pair line, connect the twisted-pair under test to the **P1** port on the MTDR Module. Then, tap the **Port** selection button to select the **P1** port.
2. If attempting to find an intermittent crosstalk problem, connect the two twisted-pair in question to the **P1 and P2** ports on the MTDR Module. Tap the **Port** selection button to select the **P1** and **P2** ports.
3. Tap the **Select Test** button to call up the "Select a test" display and select the intermittent failure **(Ifail**) test mode.
4. Tap the **Test Time** button and choose a test duration. For locating intermittent faults, the **Continuous Real Time** option is usually selected.
5. Allow sufficient time for the intermittent fault to appear in the TDR waveform display.
6. Set the **B (**POI) cursor at the intermittent reflection in the TDR waveform display. An intermittent fault usually produces a light reflection in the TDR waveform. Use the distance flag at the top of the cursor to measure the distance.

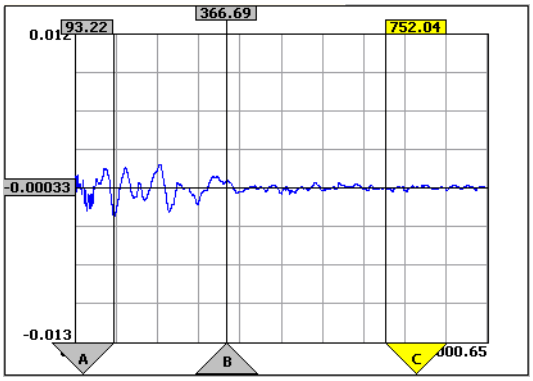
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Locating a Crosstalk Point

Crosstalk usually involves a signal leak from one twisted-pair to and another twisted-pair in the same binder group. In the crosstalk test, the MTDR sends a test signal down one of the two twisted-pair under test, via the **P1** port. It then monitors the signal returning from the second twisted-pair via the MTDR's **P2** port.

1. Use jumper cables to connect the two twisted-pairs under test to the **P1** and **P2** ports on the MTDR Module.
2. Tap the **Port** selection button to select the **P1 and P2** ports.
3. Follow the test procedure described on *Basic TDR Test Procedure*, page 2–13, and observe the following

   The TDR waveform might appear like that shown below.



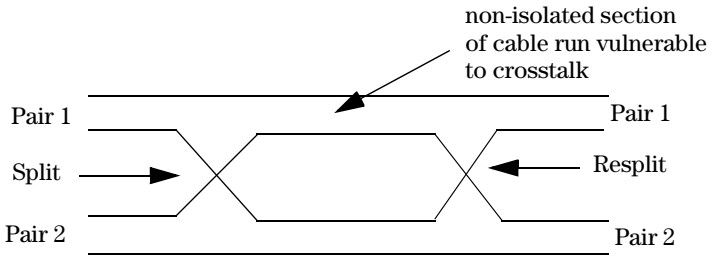
   Crosstalk appears as an upward reflection, similar to an open, but generally with a much lower amplitude than the transmitted signal.

4. Set the **B (**POI) cursor at the start of upward reflection in the TDR waveform and measure the distance form the MTDR Module to that point. The distance to the crosstalk point will appear in the distance flag at the top of the cursor.

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Locating Splits and Resplits in a Twisted-Pair Line

Twisted-pair wiring is designed to minimize the coupling of external signals into an unshielded line. In a multi-pair cable, twisted-pairs are twisted at different rates to cancel out signals leaking from other twisted-pairs, reducing crosstalk, and improving the signal isolation between pairs.



A *wiring split* exists when a wire in one twisted-pair is mistakenly spliced to a wire in a second twisted-pair. This usually causes an unacceptable amount of crosstalk on the line. A *resplit* (or corrected split) occurs when a split is only partially corrected by the rematching of the split twisted-pairs at a point further down the line. Such a correction usually lessens (but does not eliminate) the crosstalk problem. Most importantly, a resplit does not correct the actual problem (the split) and leaves a section of the twisted-pair line vulnerable to signal interference.

High-speed digital service is particularly sensitive to any form of noise on the line. So when a subscriber line is being upgraded for digital service, the presence of a split and resplit in the line, will likely cause transmission problems.

Locating Splits and Resplits In Standard Test Mode

Splits and resplits can be located in Standard (**Std**) test mode.

1. Select the Standard (**Std**) test mode and tap the **Port** selection button as needed to select the MTDR's **P1** port.
2. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

   In standard test mode (using port P1) a wire split appears as a small positive-going bump in the TDR waveform, since there is a slightly higher impedance. The waveform deflection caused by the resplit appears as a slight dip in the TDR waveform after the split (the bump). This is due to the lessened impedance of the rejoined twisted-pair.

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Locating Splits and Resplits In Crosstalk Mode

The MTDR is more effective in locating splits and resplits, when used in crosstalk (**Xtalk**) test mode. In this mode, the MTDR sends a test signal down one of the two twisted-pair under test, via the **P1** port. It then monitors the signal returning form the second twisted-pair via the MTDR's **P2** port. In this test, pairs of twisted-pair lines are tested for waveform deflections representing crosstalk and the twisted-pair split and resplit points.

1. Select the crosstalk (**Xtalk**) test mode and tap the **Port** selection button as needed to select the MTDR's **P1 and P2** ports.
2. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

   The TDR waveform will appear flat except at the points where the split and resplit occur. In this test, a split appears as a negative-going dip in the TDR waveform, indicating an area of lower impedance between the pairs. The waveform deflection caused by the resplit looks like a small bump in the TDR waveform after the dip. This represents the point where the two twisted-pairs are isolated once again.
3. Set a cursor at the start of the deflections in the TDR waveform and measure the distances form the MTDR Module to those points. The distances measurements appear in the distance flag at the top of the cursor.

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4

Before You Begin 4–2

Coaxial Cable Anomalies 4–3

Measuring the Velocity of Propagation of a Coaxial Cable In a Field Environment 4–5

Measuring the Length of Coaxial Cable Under Field Conditions 4–7

Measuring the Length of a Coaxial Cable Segment 4–8

Locating a Coaxial Cable Short 4–9

Locating a Cable Splice 4–10

Locating a Power Splitter or Directional Coupler 4–11

Locating Coaxial Cable Taps 4–11

Locating Intermittent Problems In a Coaxial Cable 4–12

Coaxial Cable Measurements

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Before You Begin

When testing a coaxial cable, connect the coaxial cable under test to the **P3** port on the MTDR Module. Tap the **Port** selection button to select the **P3** (coaxial) port.

When measurement accuracy is critical, perform one of the two VoP adjustment procedure on page 4–5, before attempting to measure the length of a cable and use the corrected VoP value for a more accurate measurement.

Common Coaxial Cable Ailments

Corrosion is a major problem in coaxial cable based networks. Corrosion problems most often occur at the cable connectors and at cable splices. Corrosion problems eventually lead to high impedance connections and often manifest as high levels of signal noise and snowy reception.

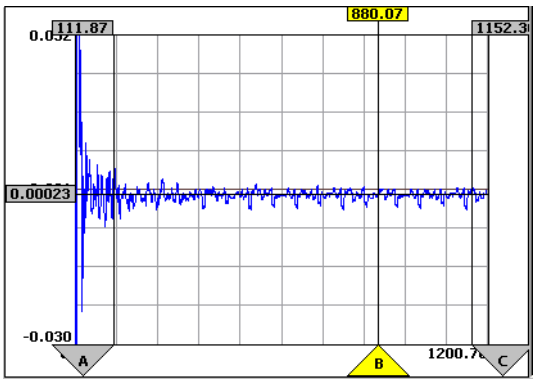
In a solid core coaxial cable, moisture cannot migrate inside the cable, so any moisture problem is limited to a single point (usually at a connector). In air core or pulp filled cables, moisture can migrate and become a problem.

Cable breaks are another source of signal disruption and can be quickly located using the MTDR. Unrecorded cable splices can complicate the fault location. In a case where the unrecorded splice is the source of the problem, a TDR is vital in quickly locating the splice with a minimum of service disruption.

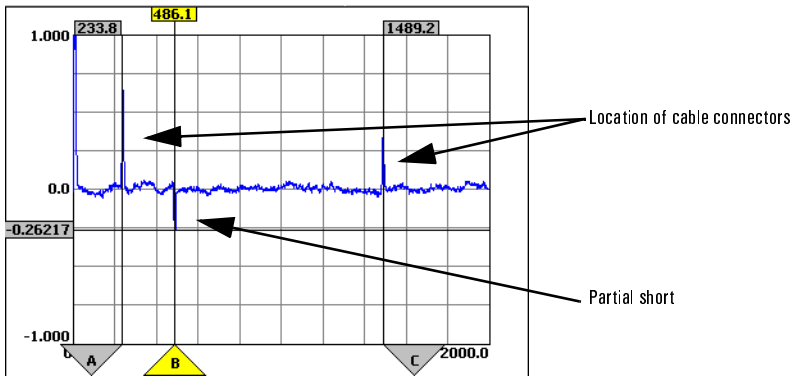
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Coaxial Cable Anomalies

A properly terminated cable will absorb all of the energy in the TDR pulse and will thus product almost no reflection on the MTDR's waveform display (as shown below).



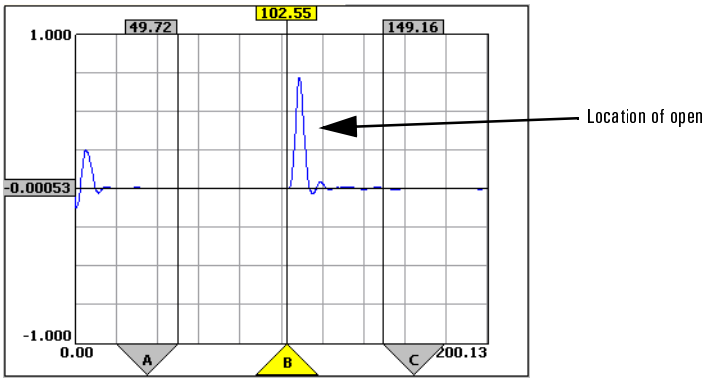
In a cable run comprising of several cable segments, a 1 dB insertion loss is typical for coaxial connectors and produces a reflection with a positive going reflection like those shown below.



Cable shorts appear as negative-going reflections of varying magnitude.

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A reflection with a positive-going polarity can indicate an open or high impedance fault. If the termination causes a substantial reflection at a connector location, either the cable connection is loose, corroded, or damaged, or the cable termination is bad. If the cable fault is a complete open, no additional reflections will be present in the TDR waveform after the open (the TDR waveform will be flat).



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Measuring the Velocity of Propagation of a Coaxial Cable In a Field Environment

Variations in the velocity of propagation (VoP) in any specific type of cable are not uncommon and can vary from one manufacturing run to another and from one manufacturer to another. In new cables, the VoP can vary by as much 3%. Short term changes to the VoP of a cable can be caused by changes in ambient temperature and humidity. The VoP of a cable can change with temperature by as much as 1% for every 10° C from room temperature. Cable aging can also cause long term changes to the VoP.

The resulting difference between the published VoP and the actual VoP (under field conditions) can result in a corresponding inaccuracy in the TDR distance measurements.

To ensure the accuracy of the cable length measurement, a cable of known length and of the same cable type as the cable being tested, can be used as a measurement standard. The standard cable must be tested under the same environmental conditions as experienced by those cables to be tested. When the standard cable is tested, its MTDR length measurement and its known length can then be compared. If the MTDR length measurement and the cable's actual length disagree, the MTDR's VoP value is changed, until the measured length and actual length agree. The corrected VoP value represents the corrections needed to adjust for environmental conditions and is used in measuring the length of the similar cables (of the same cable type) in the field.

When using a cable of known length as a measurement standard, be sure to use a cable of at least 100 feet (33 meters) in length. Using a longer cable will improve measurement accuracy.

To measure the VoP of a **cable of known length** under environmental conditions, follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the following:

- Measure the length of the cable, using the published VoP. Note the cable's length measurement on the MTDR's display.
- Compare the cable's length measurement and the cable's known length. If the measured and actual length disagree, change the VoP value in the MTDR's and retest, until the measured and actual lengths agree.
- Use the corrected VoP value when making TDR measurements in the field environment.

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To determine the VoP of a cable in a field environment using a **using a standard cable**, follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and do the following:

1. Use the MTDR to measure the length of the cable being used as a measurement standard. Use the published VoP and in the same field environment as the cables to be tested. Note the cable's length measurement on the MTDR's display.
2. Compare the cable's length measurement and the cable's known length. If the measured and actual length disagree, change the VoP value in the MTDR's screen display and retest, until the measured and actual lengths agree.

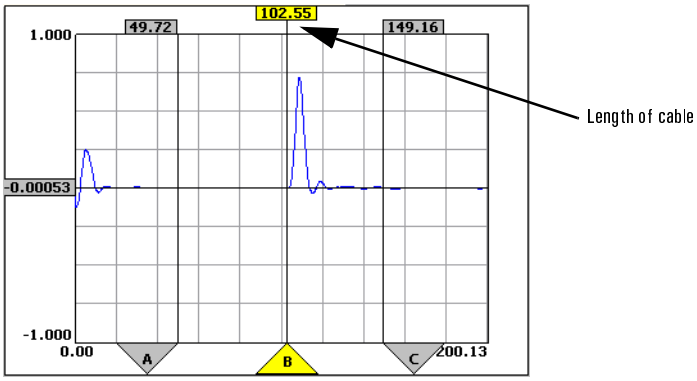
Use the corrected VoP value when making TDR measurements on cables of the same type in the same field environment.

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Measuring the Length of Coaxial Cable Under Field Conditions

The difference between the published VoP and the actual VoP in the field can cause inaccuracies in the TDR distance measurements. Follow the VoP adjustment procedure, previously described, before making the distance measurement and use the corrected VoP value to measure to more accurately measure the cable's length.

1. To measure the length of a cable in a field environment, follow the test procedure described on page 2–13, and observe the display. The waveform might appear like that shown below.



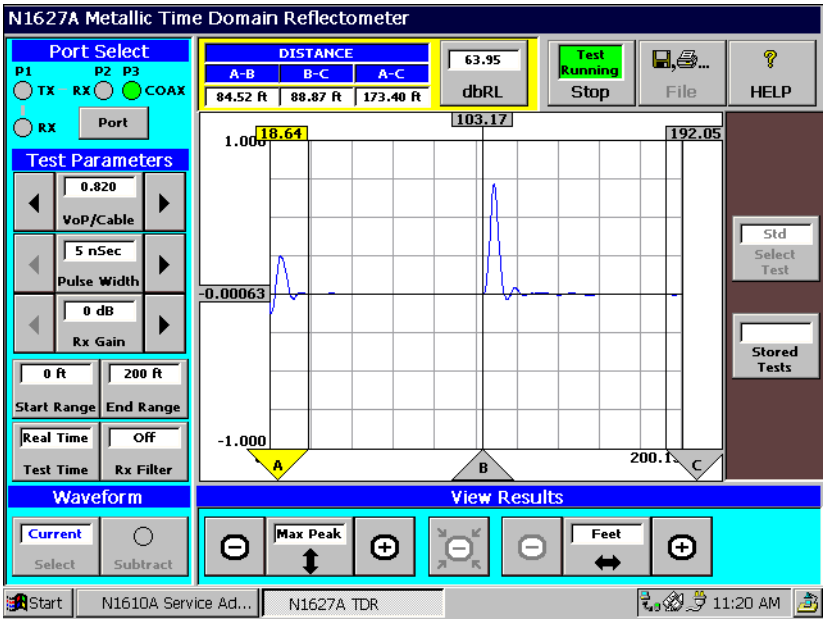
2. Set the **B (**POI) cursor at the second discontinuity in the TDR waveform and measure the distance between the MTDR Module and the discontinuity. The distance will appear in the distance flag at the top of the cursor.

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Measuring the Length of a Coaxial Cable Segment

Use this test to measure the length of a specific cable segment (or any two points) in a coaxial cable run.

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the display. The waveform might appear like that shown below.



   The ends of each length of coaxial cable are marked positive going reflections caused by the insertion loss of the cable connectors.

2. Set the **A** (near-end) cursor at the discontinuity marking the start of the cable segment of interest, and measure the distance between the distance form the MTDR Module to the segment. The distance will appear in the distance flag at the top of the cursor.

3. Set the **B** (POI) cursor at the discontinuity marking the end of the cable segment. The distance will appear in the distance flag at the top of the cursor.

4. The MTDR automatically calculates the distance between the two points and displays the distance in the **A-B** results field.

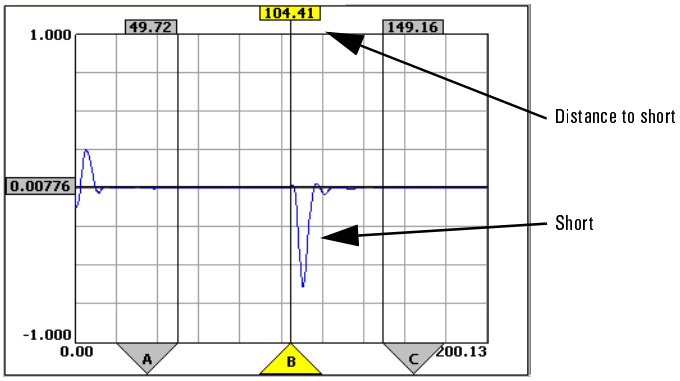
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Locating a Coaxial Cable Short

The following test procedures may be used to find the distance to a coaxial cable short. Follow the VoP adjustment procedure, previously described, before attempting to measure the distance to a short. Use the corrected VoP value for a more accurate distance measurement.

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the following:

   The TDR waveform might appear like that shown below.



   A reflection with a downward negative-going polarity can indicate an short, a partial short, or low impedance area.

2. Set the **B (**POI) cursor at the start of the negative-going reflection in the TDR waveform to measure the distance between the distance form the MTDR Module and the discontinuity. The distance will appear in the distance flag at the top of the cursor.

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Locating a Cable Splice

This test can be used to locate cable splices in a coaxial cable and determine their condition.

Note: The amount of signal reflection from a cable splice is inversely proportional to the quality of the splice. A well done splice with a signal loss of less than 1dB, can be very difficult to detect, especially from a significant distance. A degraded splice produces an increased reflection.

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

   A reflection with a positive-going polarity can indicate an open, a high impedance fault, the unterminated end of the line or, in this case, a cable splice. Remember, the reflection caused by a splice is often quite small, compared to the reflection from the unterminated end of the cable. The visibility of the splice in the TDR waveform will depend on the distance to the splice, the quality of the splice, the MTDR pulse width, receiver gain, and waveform scaling.

2. Set the **B (**POI) cursor at the start of the small positive-going reflection in the TDR waveform caused by the splice, and measure the distance. The distance will appear in the distance flag at the top of the cursor.

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Locating a Power Splitter or Directional Coupler

This test can be used to measure the distance to a power splitter or directional coupler at the far end of a coaxial cable.

The impedance at a power splitter or directional coupler drops due to the single input line and multiple output lines. The components insertion loss and negative-going reflection (caused by the reduced impedance) may combine to produce a small S-shaped reflection.

1. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

   In the above TDR waveform, the power splitter or directional coupler is located at the start of a small negative-going reflection in the TDR waveform. The two larger reflections following the splitter, are the ends of two cable segments extending form the splitter outputs.

2. Set the **B (**POI) cursor at the start of the TDR waveform discontinuity marking the location of the power splitter or directional coupler. Use the point-of-interest (**B**) cursor to measure the distance. The distance will appear in the distance flag at the top of the cursor.

Note: Distance measurements beyond the power splitter of directional coupler are usually inaccurate because of the multiple sources of signal reflection.

Locating Coaxial Cable Taps

This test can be used to measure the distance from the MTDR Module to signal taps along the coaxial cable. The impedance at the coaxial cable tap drops to one half of the previous impedance, because two conductors carry the TDR signal after the tap rather than just one. This produces the negative going TDR reflection.

- Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13, and observe the waveform.

  The reflection caused by the cable tap has a negative-going polarity and is followed by positive-going reflections marking the cable ends.

- Set the **B (**POI) cursor at the start of the negative-going reflection marking a cable tap and measure the distance to the tap. The distance will appear in the distance flag at the top of the cursor.

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Locating Intermittent Problems In a Coaxial Cable

One of the most difficult problems in cable troubleshooting is in locating an intermittent fault. These faults are typically caused by intermittent breaks or loose cable connections. Such problems often come and go with changes in the cable's ambient environment and can be very difficult to locate at a later date.

Using the MTDR's intermittent failure (Ifail) mode, a cable's TDR response can be monitored over and extended period of time. This allows the intermittent conditions to be captured and recorded on the MTDR's waveform display.

1. Tap the **Select Test** button to call up the "Select a test" display and select the intermittent failure **(Ifail**) test mode.
2. Tap the **Test Time** button and choose a test duration. When attempting to locate an intermittent fault, the **Continuous Real Time** option is usually selected.
3. Follow the test procedure described in *Basic TDR Test Procedure*, page 2–13 and allow sufficient time for the intermittent fault to appear in the TDR waveform display.
4. Set the **B (**POI) cursor at the intermittent reflection in the TDR waveform display. An intermittent fault usually produces a light reflection in the TDR waveform. Use the distance flag at the top of the cursor to measure the distance.

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5

Storing and Recalling Test Setup Parameters 5–2

Storing and Recalling Waveforms 5–5

Comparing Test Waveforms with Previously Stored Waveforms 5–7

Printing Test Results 5–9

Software Upgrades 5–9

File Management Options

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Storing and Recalling Test Setup Parameters

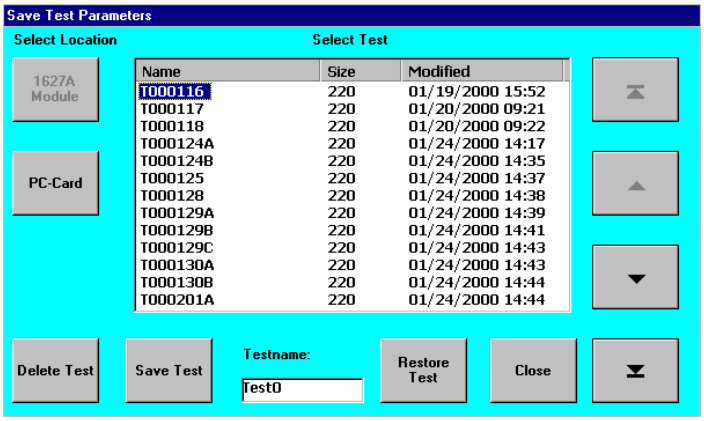
You can save test setup parameters for later use or retests. Stored test setup parameters are useful when testing for slow changes in transmission performance over time. To simplify the recording and recalling of test setup parameters the Service Advisor Tablet and MTDR Module include easy-to-use features for the storage and retrieval of test setup parameter data.

The MDTR module can internally store TDR test setup parameter files, for use in subsequent tests. TDR test setup parameters can also be directed to a 10 or 20 MB flash memory on a PCMIA card. The PCMIA card must be installed in the interface slot on the Service Advisor Tablet. See Chapter 2 of the S.A. Tablet User's Manual for details of PCMIA card installation.

Storing Test Setup Parameters

To save a set of TDR test setup parameters, for later recall:

1. Tap the **Stored Tests** button, on the right side of the main MTDR screen display, to call up the Saved Test Parameters display.



2. TDR test parameters may be directed to one of two memories: one located in the N1627A MTDR Module, and one located on the S.A. Tablet's PCMIA card. The memory currently selected is indicated by a grayed out memory selection button (either **1627A Module** or **PC Card**). The button for the non-selected memory is shown in black. If the currently enabled memory is not the one you desire, you can direct the parameters to the other memory by selecting its button. (The button will turn to gray when the memory is selected.)

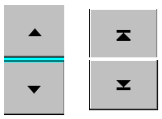
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3. A default parameter file name (Test0) appears in the Filename field. Enter a new file name in the field, to identify the test setup parameters being saved from the current test. Use the S.A. Tablet keyboard to make the test name entry. The keyboard icon should appear in the toolbar in the lower right-hand corner of the MTDR's screen display. The name of the test setup file can be any number of characters, however, the file name field has room for 19 characters. Entering additional characters will cause the entry to shift left and the first character will be shift off of the screen.

4. After the desired memory area is selected and the test parameters file is named, tap the **Save Test** button to save the parameters and return you to the main MTDR screen display.

File Management Options

The Save Test Parameters display includes two arrows buttons that allow you to scroll up and down through the list of parameter files and two jump buttons to allow you to jump to the ends of the list.



To delete a test setup parameter file, select the test you wish to delete from the list of parameter files and tap the **Delete Test** button. A popup conformation message appears prompting you to verify the intended deletion. Answer **yes** to delete the file from the list.

After your file management activities are complete, tap the **Close** button to close the "Save Test Parameters" display and return to the main MTDR screen display.

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Recalling Stored Test Setup Parameters

To recall stored test setup parameters from a previously conducted test:

1. Tap the **Stored Setups** button to call up the Saved Test Parameters display.
2. The desired test parameters may exist in one of two parameter memories: one located in the N1627A MTDR Module, and one located on the S.A. Tablet's PCMIA card. The memory currently selected is indicated by a grayed out memory selection button (either **1627A Module** or **PC Card**). The button for the non-selected memory is shown in black. If the currently enabled memory is not the memory containing the desired setup parameters, you can select the other memory by selecting its button. (The button will turn to gray when the memory is selected.)
3. Select the file name identifying the desired test parameters form the parameter files listed in the Select Test window.
4. After the desired parameter file is selected, tap the **Restore Test** button to initialize the TDR with the test setup parameters form the parameter file. You are returned, automatically, to the main MTDR screen display.

Note: If the current TDR test is stopped when a new setup is recalled, the **Start** button must be tapped to produce a TDR waveform that reflects the recalled test setup. If a TDR test is running when new setup parameters are recalled, the new parameters will usually produce an immediate change to the displayed TDR waveform.

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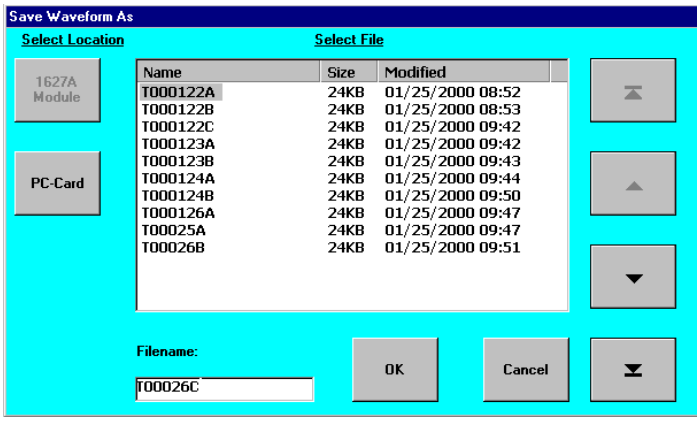
Storing and Recalling Waveforms

The MDTR Module can store up to 50 TDR waveforms for use in making waveform comparisons with the current test results. This can be helpful in monitoring the changes in transmission performance over time. TDR waveforms can also be saved on a 10 or 20 MB flash memory PCMCIA card.

Storing Waveforms

To save the TDR waveform currently on the MTDR display, for later recall:

1. Select the **Save As** button in the **File** menu. This calls the "Save Waveform As" display.



   This display is similar to the "Save Test Parameters" display (page 5–2) and its controls perform the same file management functions. A default waveform file name (WF0) appears in the Filename field.

2. TDR waveforms can be stored in either the N1627A MTDR Module, or in the S.A. Tablet's PCMCIA card. The currently selected memory button is grayed out. The button for the non-selected memory is shown in black. If the currently enabled memory is not the memory containing the desired TDR waveform, you can select the desired memory by selecting its button. The button will turn to gray when the memory is selected.

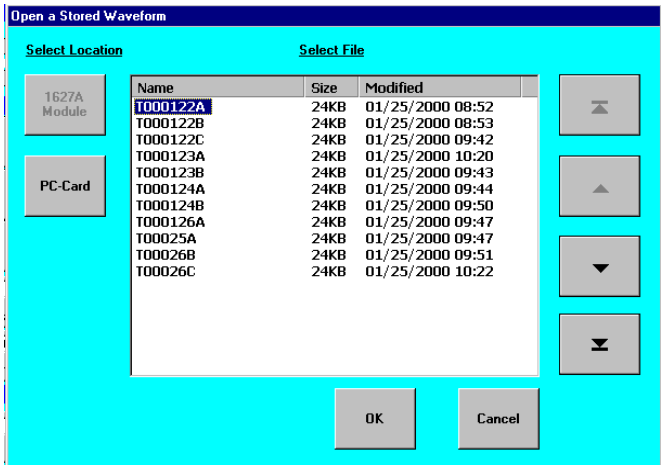
3. Enter a file name for the new waveform file into the Filename field, and tap the **OK** button to store the waveform. The test software automatically stores the waveform currently on the MTDR's screen display and returns you to the main MTDR screen display.

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Recalling Stored Waveforms

Stored waveforms may be recalled and displayed on the MTDR's waveform display. To recall a previously stored waveform:

1. Tap the **Open** option in the **File** menu. When this option is selected, the following display appears.



   The display is similar to the display used to save waveforms displays a list of the waveforms files previously stored.

2. The TDR waveform's memory location: either **1627A Module** or **PC Card**.
3. Select the waveform file you wish to display.
4. Tap the **OK** button to recall the waveform and return you to the main MTDR screen display.

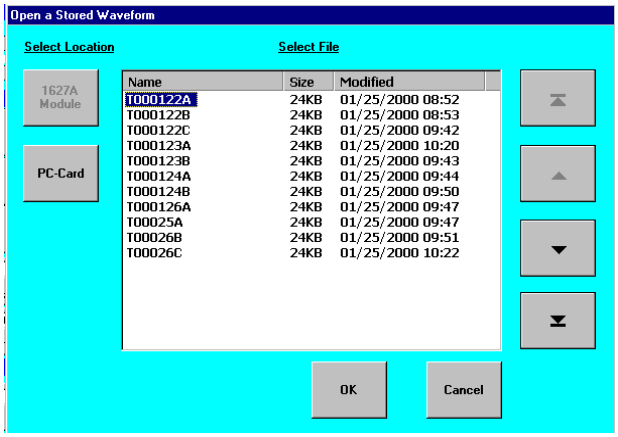
Note: Stored waveform are displayed in red when recalled from the waveform memories. The current waveform appears in blue.

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Comparing Test Waveforms with Previously Stored Waveforms

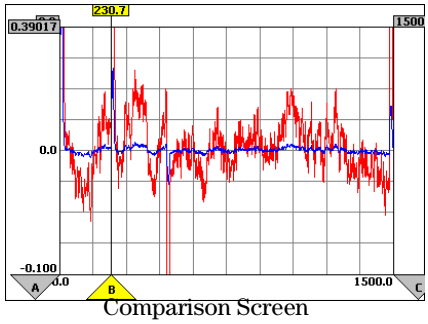
Stored waveforms can be recalled form a waveform memory and compared to a current waveform on the MTDR display screen. To accomplish this, the

1. Open the previously stored waveform file using the **Open** option in the **File** management menu.
2. Select the desired waveform file from the list of stored waveforms on the "Open a Stored Waveform" display.



3. Tap the **OK** button to open the selected waveform file. The test software returns automatically to the main MTDR screen display. The name of the selected waveform file should appear in the Waveform **Select** window in red and the actual stored waveform should appear in **red** on the MTDR waveform display (along with the waveform from the current test waveform shown in **blue**). A waveform comparison might appear like that shown on the following page.

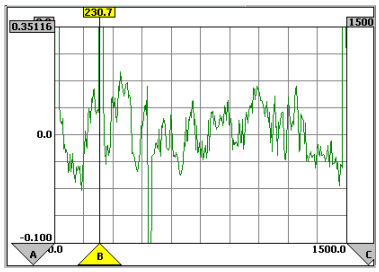
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Comparison Screen

4. Taping the **Select** button repeatedly, toggles the measurement cursors between the two waveforms. Notice that the cursor settings usually change as each waveform is displayed.

5. Tap the **Subtract** button to display the difference between the two waveforms. A difference waveform appears in **green** the MTDR waveform display, as shown below and replaces the two comparison waveforms.



Note: Tapping the Subtract button a second time will return you to Comparison display (showing both waveforms).

6. When finished with the comparison and difference displays, select the **Close** option under the **File** management menu to close the file containing the stored waveform. the Waveform (in read will then disappear from the waveform screen and the waveform **Select** field.

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Printing Test Results

The Print option allows you to output the waveform currently on the MTDR screen display, to a printer attached to the S.A. Tablet's printer port.

To print the waveform on the MTDR display:

1. Connect a DB-25 ribbon cable from the printer to the parallel printer port at the top of the S.A. Tablet (on the right side).
2. Tap the **File** button (at the top right-hand side of the TDR screen) and select the **Print** option.

Software Upgrades

Software upgrades are supported by the Service Advisor Manager. This feature can be accessed by selecting the **File** button and then the **Exit** option the **File** menu. Next select the **Upgrade** tab in the Service Advisor display and follow the software download procedure in the Service Advisor Portable Test Tablet User's Manual.

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6

MTDR Module Indicators and Connectors 6–2

MTDR Screen Components 6–4
- Test Mode Controls 6–6
- Port Selection Options 6–7

Test Setup Controls 6–7
- Velocity of Propagation 6–8
- Pulse Width Settings 6–11
- Rx Gain 6–14
- Start Range / End Range (Measurement Start and End Points) 6–15
- Test Time Setting 6–16
- Rx Filter Selection 6–17

Viewing Results 6–18
- Distance Display 6–19
- TDR Waveform Display with Cursors 6–20
- Test Result Parameter Display 6–21
- Waveform Recall Area 6–23

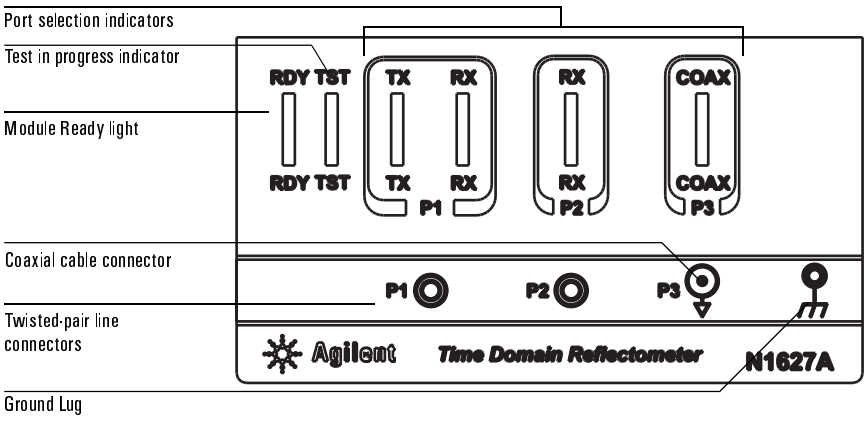
File Management Options 6–24
- Save Waveform As Display 6–25
- Open a Stored Waveform Display 6–27
- Delete a Saved Waveform Display 6–28

Test Start and Stop Buttons 6–28

MTDR Reference

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MTDR Module Indicators and Connectors



Module Indicators

The MTDR Module indicators display status and configuration information, as follows.

RDY: Flashes green to indicate the module is performing its self diagnostic test. Stays lit to indicate the module is ready for use.

TST: Upon power turn on, this indicator flashes (green) while the module is performing its diagnostic tests. The indicator lights continuously while the MTDR is conducting a TDR test.

P1 TX and RX: The P1 TX indicator lights when the P1 port is used for transmit. The P1 RX indicator lights when the P1 port is used for receive. Both indicators are lit for standard (Std) mode tests.

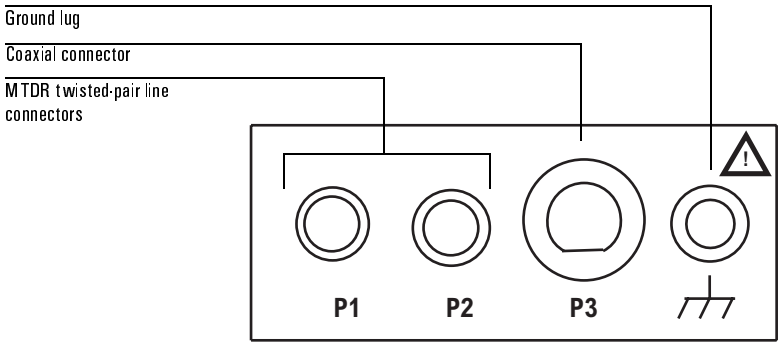
P2 RX: The P2 RX indicator lights when the P2 port is used for receive. The P2 port is used for receive in crosstalk (Xtalk) mode tests.

COAX: The P3 COAX indicator lights when the P3 port is selected. P3 is used for tests on coaxial cable.

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Module Connectors

The MTDR Module's faceplate has three connectors and a ground lug, as shown below.



Twisted-pair Line: The **P1** and **P2** are Bantam plug connectors. These connectors accept a test cable that is used to connect the MTDR Module to a twisted-pair line.

- When testing for faults in a twisted-pair line, use the **P1** connector and a test cable to connect the module to the twisted-pair line.
- When performing a crosstalk test, use the **P1 and P2** connectors and two test cables to connect the module to the two twisted-pair lines.

Coaxial Cable: The P3 connector is a BNC coaxial connector jack used for coaxial cable tests.

Note: Use two test cables equipped with Bantam plugs at one end and alligator clips an the other.

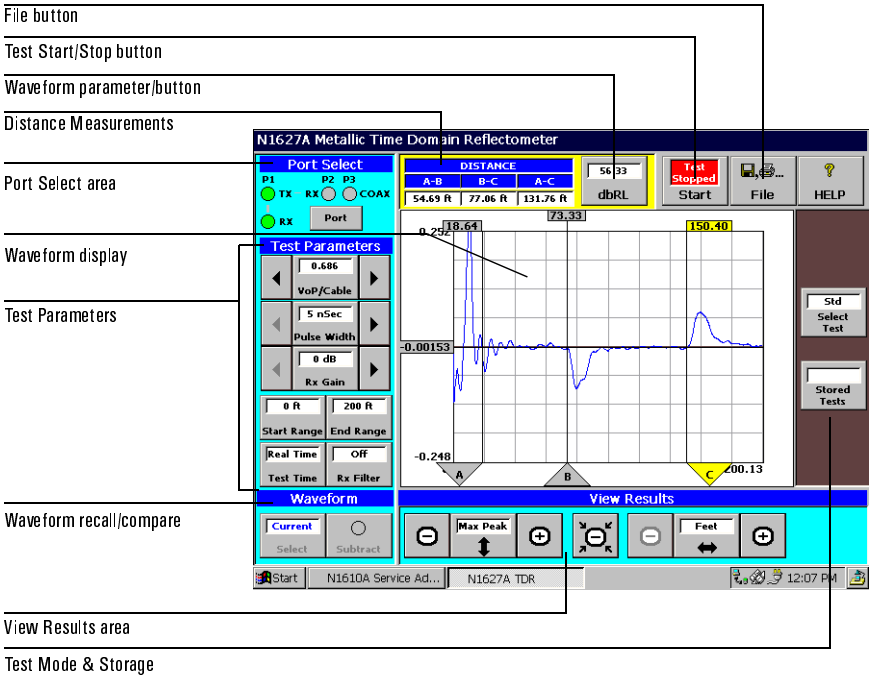
- When checking for faults in a coaxial cable, use the BNC connector **P3**.

Ground Lug: When testing twisted-pair lines, use the lug, and the a ground cable to connect the MTDR Module to circuit ground.

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MTDR Screen Components

The following figure identifies the major components of the main MTDR screen display.



Refer to the table on the following page for information on the various areas of the MTDR screen. More detailed descriptions of these components can be found in page 6–6 through page 6–28.

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MTDR Screen Components

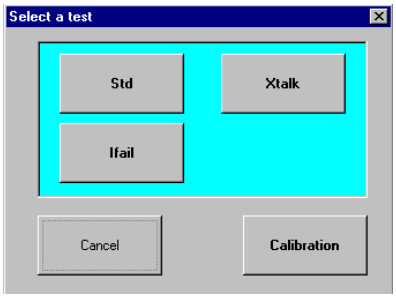
Screen Area	Description
File button	Calls a popup display offering six file management options (see page 6–24).
Test Start/Stop button	Initiates and terminates the TDR tests. The test results are frozen when a test is stopped (see page 6–28).
Waveform parameter/button	Displays one of three test parameters measured at a selected point in the TDR waveform. Clicking this button cycles through the parameters (see page 6–21).
Distance Measurement area	Displays the distance between the three cursors during a TDR test (see page 6–19).
Port Select area	Controls the MTDR's input and output ports (see page 6–7).
Waveform display area	Displays a graphical representation of the TDR signal return (see page 6–20).
Test Parameters area	Configures the TDR test (see page 6–7 through 6–17).
Waveform Recall/Compare area	Used to facilitate waveform comparisons during TDR tests (see page 6–23).
View Results area	Scales the TDR waveform in the MTDR display (see page 6–18).
Test Mode area	The **Select Test** button selects one of four basic test modes (see page 6–6). The **Stored Test** button retrieves stored waveforms for comparison with the current waveform currently (see page 6–23).

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Test Mode Controls

Use the **Select Test** button to call the Select a Test window. The window offers four testing options. When you tap **Std**, **Xtalk**, or **Ifail**, the window closes and you are returned to the main TDR screen in the selected test mode.





Std Test: In its standard (**Std**) test mode, the MTDR Module performs a variety of TDR distance and length measurements using the **P1** connector (twisted-pair), the **P1** and **P2** (twisted-pair, crosstalk) connectors, or the **P3** (coaxial cable) connector. See *Basic TDR Test Procedure*, page 2–13 for details on performing a TDR test.

Xtalk Test : Sets up the MTDR Module to perform crosstalk (XTLK) measurements using the module's **P1** and **P2** balanced cable ports. See *Locating a Crosstalk Point*, page 3–21, for details on performing a crosstalk test.

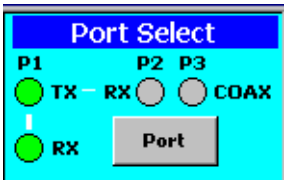
Ifail: This option sets up the MTDR to perform a timed test designed to detect intermittent problems in a line. In this mode, any signal reflections received are captured and displayed for the remainder of the test (even after the reflection goes away). Reflections that persist for the full duration of the test, appear as dark deviations in the TDR waveform. Intermittent, non-persisting, reflections appear as somewhat lighter deviations on the TDR waveform display. See *Locating Intermittent Problems In a Twisted-Pair Line*, page 3–20 for a fuller explanation of this type of test.

Calibration: This button is for factory testing purposes only.

Cancel: The cancel button returns you to the main test screen without changing to the current test mode.

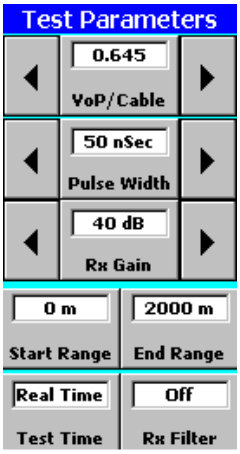
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Port Selection Options



Use the **Port Select** controls in the upper left-hand corner of the screen to select and enable an MTDR connector port (**P1**, **P1** and **P2**, or **P3**). A green indicator indicates an enabled port or ports. A gray indicator indicates that the port is disabled. The power on default setting for the port select function is P1. (See *Test Mode Selection Controls*, page 2–6.)

Test Setup Controls



The Test Parameters group contains controls for configuring the VoP, pulse width, receiver gain, start and end range, test time, and filters. These functions are described in the following sections (See page 6–8 through 6–17).

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Velocity of Propagation



Variables in the transmission characteristics of a line or cable under test, can cause inaccuracies in the TDR distance measurements. The velocity of propagation (VoP) of the cable under test is the most significant of these variables. The VoP is a specification of the speed at which a signal travels through a specific transmission media. Each type of cable has a unique VoP.

The speed of light in a vacuum is 186,400 miles per second and is represented by the number 1 (or 100%) in the VoP computation. Electrical signals travel more slowly in a twisted-pair or coaxial cable. For instance, in a coaxial cable with a VoP of 0. 89, the signal would travel at 89% of the speed of light. A twisted-pair cable will typically have a lower VoP (such as 0.66) depending on the cable's physical properties and number of wire twists per unit of measurement.

The velocity of propagation for the cable being tested must be entered into the VoP/Cable field. Pressing the **VoP/Cable** button to calls up a keypad for entering a VoP value. The popup display also offers a database listing commonly used cables and their published VoP ratings. If the cable you are testing is not listed in the cable database, the VoP can be obtained from the manufacturers data sheet.

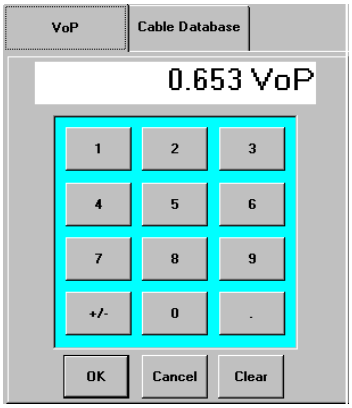
The actual VoP of a cable may vary significantly from the published VoP, due to cable aging, ambient temperature, and humidity. If you are testing a cable in an uncontrolled environment, and attempting to locate a fault from a significant distance, use the procedures on page 3–6 or page 4–5 to determine the cable's actual VoP. Entering the correct VoP for the cable under test is the most significant factor in ensuring the accuracy of the MTDR's distance measurements. The reset default value for the VoP parameter is 0.653.



The two arrow keys next to the **VoP/Cable** button can also be used to increment or decrement the least significant bit of the current VoP value.

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Pressing the **VoP/Cable** button calls the popup keypad, shown below.



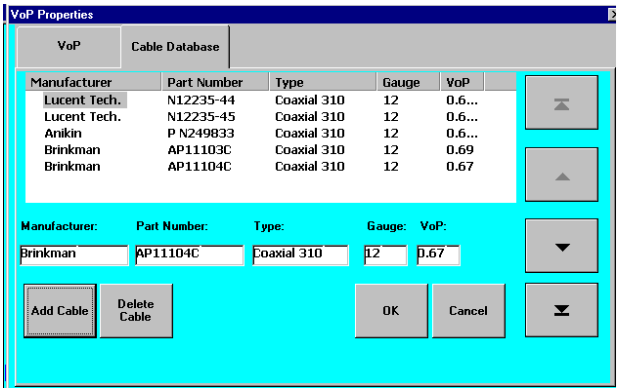
Keypad buttons (0–9): Use the keypad buttons to enter a 4-digit VoP value. The allowable range for the VoP values is from 0.100 to 0.999. When the keypad first appears, the VoP value currently in use appears in VoP entry field. Pressing the initial digit button (always 0) on the keypad clears the current VoP value and enters the digit in the VoP entry field. You can also press the **Clear** button to clear the current VoP value before entering a new value or to change an incorrect entry.

After you have entered the VoP value for the cable you plan to test, press the **OK** button to incorporate new value into the test setup parameters. The new will appear in the **VoP/Cable** window and will be used in making distance calculations during the next test. You can also press the **Cancel** button to close the "VoP Properties" display without making changes.

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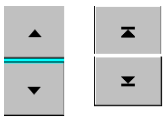
VoP Database

The VoP database provides an easy to use method of storing and retrieving cable VoP information. The database is accessed by selecting the Cable Database tab in the VoP Properties display.



The MTDR database is shipped with commonly used cables already listed. The cables in the database fields are listed in by manufacturer and then by cable part number. The cable type, wire gauge, and VoP value, are also listed for each cable.

The Cable Database display includes arrows keys that allow you to scroll up and down through the list of cables, and two jump keys that allow you to jump to the top and bottom of the list.



The Manufacturer, the cable Part Number, Type, Wire Gauge, and VoP entry fields are used with the S.A. Tablet keyboard to add a cable entry to the database. Pressing **Add Cable** enters the new cable entry into the database. The new cable listing appears in the database in order of the cable manufacturer and part number. **Delete Cable** is used to delete a selected cable from the cable database.

To use the VoP for one of the cables listed in the database, in the **VoP/Cable** field**,** the entry for the cable is first selected from the database and the **OK** button is pressed. The VoP value for the selected cable then appears in the **VoP/Cable** field and will be used in the next test. The **Cancel** button can be pressed to close the "VoP Properties" display, without changing the current VoP.

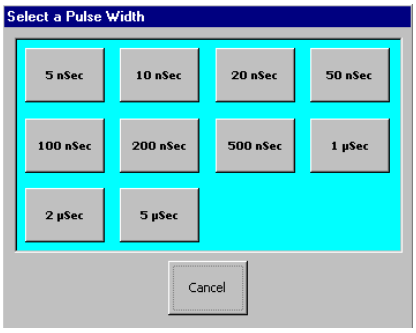
A cable's published VoP is useful for performing initial fault locations. However, where the distance between the MTDR and the fault is significant, and the cause of the problem is not apparent, it is often advisable to correct the VoP for the field environment before attempting a cable repair. See the VoP correction procedures on pages 3–6 and 4–5.

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Pulse Width Settings



The MTDR Module offers a choice of ten pre-programmed pulse width settings expressed in nano- and microseconds. Pressing the **Pulse Width** button calls a display offering the choice of width settings.



Note: Pulse width is limited to a maximum of 1000 ns when Port 3 (coaxial port) is used. When the 5 ns pulse width is selected, the 60 dB and 70 db gain settings cannot be used.

When a pulse width button is press, the Pulse Width display closes. The selected pulse width is shown in the **Pulse Width** field for use in the next test. Press **Cancel** on the Pulse Width display to close it without making any changes.

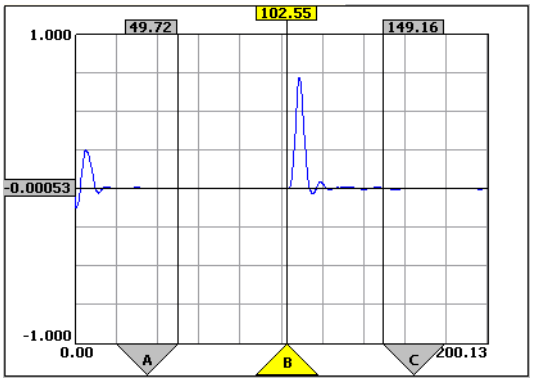
The arrow buttons next to **Pulse Width** can also be used to step through the ten pulse width selections. The reset default value for the pulse width setting is 100 ns.

By adjusting the pulse width, you set the amount of energy transmitted down the line. In general, increasing the pulse width increases the energy transmitted, and consequently the amount of energy reflected back to the MTDR. At longer distances this can be critical in producing a return signal of sufficient magnitude for the receiver to detect and display. However, measurement resolution decreases as the pulse width is increased. The loss of resolution can mask small details in the signal return and make it difficult to view faults that are close together.

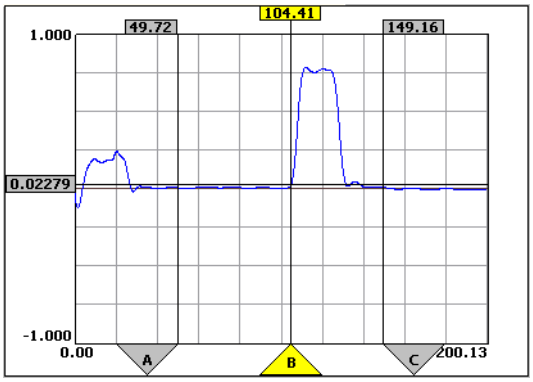
The waveforms on the next page show how changing pulse width can affect how the TDR signal return appears.

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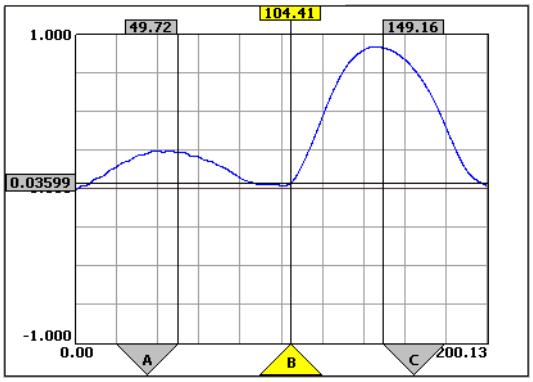
Waveform 5 ns Pulse Width



Waveform 50 ns Pulse Width



Waveform 200 ns Pulse Width



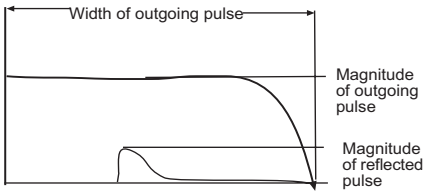
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In general, when first attempting to locate a fault, always begin with a short pulse width setting. Then use the MTDR's **Rx Gain** and waveform amplitude controls to scale the reflected signal and produce a meaningful waveform display. If the signal being reflect is insufficient to locate the fault, increase the pulse width, one setting at a time, to increase the test signal's energy, until the fault is located. However, remember that resolution decreases as the pulse width is increased. It is usually best to get as close as possible to the fault and use a narrowest useful pulse width.

When the cable under test is very long and the fault is a long distance from the measurement point, the pulse width of the MTDR signal may need to be increased to provide enough signal reflection to register on the MTDR waveform display. The reset default setting for the MTDR pulse width is 100 ns.

When the fault is very small, the signal reflection may be so weak that it is absorbed by the cable before it reaches the MTDR's Receiver.In such a case, it may be necessary to use a larger pulse width, even though the fault is nearby. Selecting a larger pulse width sends more energy down the cable and can make it easier to locate the fault.

Blind Spots

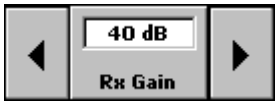


Most TDRs transmit and receive a test signal through the same signal port. However, since the reflected signal is always smaller in magnitude than the transmitted signal, this can make it impossible to locate a fault close to the tester (within a distance equivalent to the pulse width). The pulse of the test signal, in effect, creates a blind spot ahead of the tester's receiver that increases in size as the output pulse width is increased.

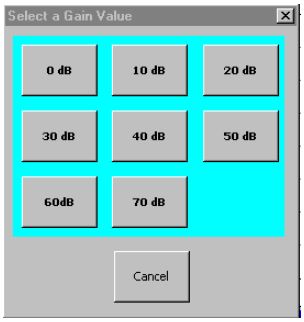
For many TDRs, the unit's blind spot is an important consideration when performing close-in TDR testing. Agilent's N1627A MTDR overcomes this problem with a unique transceiver design. The transceiver circuit includes a signal comparison circuit that passes only the difference between the MTDR's output and receiver input signal levels. The two signals in effect cancel each other out, leaving only the reflected test signal energy for display. This allows you to perform close-in testing without the difficulties associated with blind spot calculations.

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Rx Gain



The Rx Gain parameter can be set from 0 dB to 70 dB, in increments of 10 dB. Pressing the **RX Gain** button calls the a display offering eight receiver gain settings.



The arrow keys next to the **Rx Gain** button can be used to increase or decrease the receiver gain value in increments of 10 dB. A low gain setting (such as 0 dB) is generally used during an initial TDR test, and is then be increased until relevant discontinuities appear in the TDR waveform. The **60 dB** and **70 db** gain settings are not available when the **5ns** pulse width is used. The reset default setting for the gain control is **0 dB**.

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Start Range / End Range (Measurement Start and End Points)



Following waveform capture, the test set displays a graph comprising 400 pixels of measurement data measured at equal increments from a distance defined by the **Start Range** setting to a distance defined by the **End Range** setting. Each pixel represents a sample point in the TDR signal return. The unit of the measurement displayed can be specified in distance or transit time in: feet, meters, or nanoseconds. The unit of measurement is selected using the horizontal arrow control at the left side of the View Results area.

The tests measurement start and end points are independently selectable using the **Start Range** and **End Range** controls on the left side of the MTDR screen. Pressing either button calls a keypad for entering the range settings. This feature is useful in limiting the search range to a specific portion of a cable run.

The Start Range value can be set:

- from **0 m** to **19,970 m**, but must be at least 3 m less than the end range
- from **0 ft.** to **65,607 ft**, but must be at least 10 ft less than the end range, or
- from **0 µs** to **101 µs**, but must be at least 1 µs less than the end range,

depending on the unit of measurement selected (see *Viewing Results*, page 6–18). The reset default setting for Start Range is zero (**0**) meters.

The End Range value can be set:

- from **30 m** to **20,000 m**, but must be at least 3 m more than the start range
- from **10** ft. to **65,617 ft.**, or, but must be at least 10 ft more than the start range, or
- from **1** to **102 µs**, but must be at least 1 µs less than the end range.

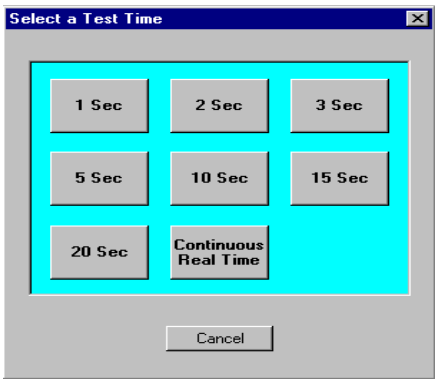
The unit for the range settings is dependant on the unit of measurement selected (see *Viewing Results*, page 6–18). The reset default setting for End Range is **2,000** meters.

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Test Time Setting



The **Test Time** button calls a popup display offering seven test run time options. These allow you to run a test for a predefined period of time (from **1 Sec** to **20 Sec**). There is also a **Continuous Real Time** option that allows you to manually control the test duration using the MTDR's **Start** and **Stop** buttons.



The reset default setting for the **Test Time** control is **Continuous Real Time**.

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Rx Filter Selection



The test signal reflected back to the MTDR is often very weak. For this reason, noise interference can make the waveform very noisy and difficult to interpret. To solve this problem, two input filters are available to filter out any signal noise.

The filter options include:

0: No filtering (off)

1: Level 1 low-level noise input filtering

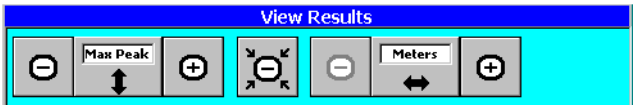
2: Level 2 high-level noise input filtering

The reset default filter selection is **0** (no filtering).

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Viewing Results

The controls in the View Results area are used to scale the waveform amplitude and the horizontal scaling (either distance or transit time) of the TDR waveform display.



Selecting a Unit of Distance or Transit Time Measurement

Before initiating a TDR test, the unit of measurement used in the test, must be selected. This is done using the horizontal arrow button located at the bottom of the MTDR screen at the right end to the View Results area. When pressed repeatedly, the arrow button steps through three distance measurement options: **Feet**, **Meters**, and **Sec**.

Note: Notice the unit of measurement in the Start Range, End Range and Distance windows, and the waveform graph change as the unit of measurement option is changed.

Note: Since the velocity of propagation through any transmission line is a constant, specifying a transit time, indirectly specifies a distance.

The reset default setting for the unit of measurement is in **meters**.

Selecting a Unit of TDR Power Measurements

Before initiating a TDR test, you should also select the type of signal power measurement desired in the test. This is done using the arrow button located at the bottom of the MTDR screen display at the left end to the View Results area. When pressed repeatedly, the arrow button steps through five amplitude measurement options: 1 dB (**DB1**), 2 dB (**DB2**), 3 dB (**DB3**), maximum peak (**Max Pk**), and maximum to maximum (**MIMAX**).

The reset default setting for the amplitude measurement is **Max Pk**.

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Zoom Feature

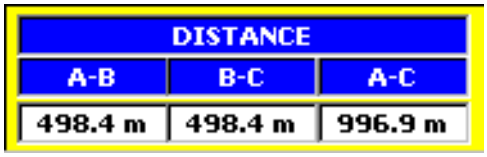
A screen display zoom feature is available using buttons located at the bottom of the MTDR screen (under the View Results caption). The minus (-) and plus (+) buttons at the left end to the View Results area, are used to expand or contract the horizontal scale of the waveform display after a waveform has been captured.

The minus (-) and plus (+) buttons at the right end to the View Results area, are used to expand or contract the vertical scale used in displaying the waveform magnitude (in dB) on the MTDR screen display.



A zoom back button is located between the unit of measurement and amplitude scaling controls. It allows you to return to the initial waveform scaling conditions (those before the minus (-) and plus (+) buttons were used) with the push of a single button.

Distance Display



The Distance display at the top of the MTDR screen, displays the distance or transit time between the three cursor locations, and indicate:

A-B: the distance or transit time from the point marked by the near-end (NE) cursor to the point marked by the point-of-interest (POI) cursor.

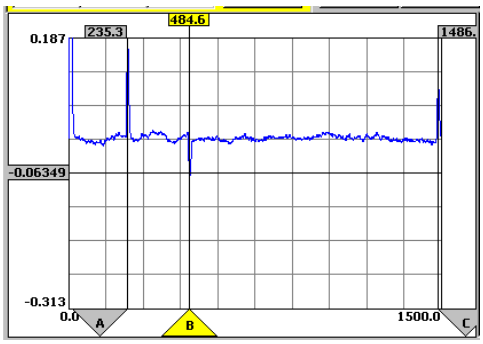
B-C: the distance or transit time from the point marked by the point-of-interest (POI) cursor to the point marked by the far-end (FE) cursor.

A-C: the distance or transit time from the point marked by the near-end (NE) cursor to the point marked by the far-end (FE) cursor.

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TDR Waveform Display with Cursors

The TDR waveform display depicts the time versus magnitude plot of the reflected signal coming back to the MTDR Module receiver.



A: The near-end cursor (labeled **A**) defines the near-end measurement point. The near-end cursor is generally used to set a starting point for making measurements. It can be moved back to the point-of-interest cursor (labeled **B**) but can not be moved beyond it. The distance flag at the top of the cursor indicates the distance or time from the MTDR Module to the near-end cursor.

B: The point-of-interest cursor (labeled **B**) can be moved to any point-of-interest in the TDR waveform between the near-end and far-end cursors. The distance flag at the top of the cursor indicates the distance or time from the MTDR Module to the point-of-interest cursor.

C: The far-end cursor (labeled **C**) can be set at a far-end measurement point. It can be moved up to the point-of-interest cursor (labeled **B**) but can not be moved ahead of it. The distance flag at the top of the cursor indicates the distance or time from the MTDR Module to the far-end cursor.

The three cursors can be placed on the display by selecting the cursor (**A**, **B** or **C**) and by then clicking on the waveform screen where you want the cursor to appear. The selected cursor will move to the point in the screen where you click.

When you click on any of the three cursors and then a point in the TDR waveform (or any point along the horizontal axis of the screen display) an amplitude cursor moves to that point and displays the magnitude of the TDR waveform (in dB) at that point. The measurement appears at the end of the amplitude cursor on the left side of the screen.

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Test Result Parameter Display

The waveform parameters control/indicator is located just right of the Distance area, at the top of the MTDR screen display. The button displays one of three waveform parameters measured at a point in the TDR waveform marked by the active (last selected) cursor.

Tap the button to cycle through the three results.



dBRL (return loss)

The dBRL result indicates the magnitude of the return loss in decibels (dB). Return loss is defined as the level of the reflected signal relative to the level of the transmitted signal. In two-wire circuits it is expressed as:

$$10 \log \frac{\text{Transmitted power}}{\text{Reflected power}}$$

or:

$$20 \log \frac{V_0 \text{ (output signal voltage)}}{V_R \text{ (reflected signal voltage)}}$$

Each of the 400 points in the TDR waveform represents a measurement of the reflected signal energy from a specific point in the line or cable under test. Because the power of the transmitted signal is always known, the MTDR can quickly calculate the single frequency return loss at any point in the waveform.

As transmitted signal energy travels down a cable, some of the energy is normally lost due to cable impedance. If the signal reaches an impedance discontinuity, some of its energy is reflected back up the cable as return loss. Return loss (sometimes called circuit loss) can be caused by a combination of impedance factors, including: capacitance, resistance, and induction.

In general, the larger the fault, the larger the reflected energy will be relative to the output signal, and the smaller the return loss ratio will be. A worst case fault such as a cable short or complete open will produce a dBRL reading of zero.

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In twisted-pair telephone lines loss is typically measured in dBm and is referenced to a standard 0 dBm milliwatt tone of 1004 Hz (or 1020 Hz). Since the reference level in a central office is 0 dB, any loss associated with a pair will have a negative value. Therefore, a twisted-pair with a return loss of -8 dBM would have more loss than another twisted-pair which had a return loss of -7 dBm. A return loss below -8dB at 1004 Hz (or 1020 Hz) is considered acceptable for most analog or voice services. If the loss exceeds -8 dBm, the subscriber will begin to experience dialing and volume problems.

An important factor in measuring return loss is the distance between the fault and the measuring device. The measured return loss includes the cable loss. Therefore, when you are very close to the fault the dBRL reading and the actual return loss will be the same. However, dBRL readings are often made at a considerable distance from the fault. At such a distance the return loss reading may be less than the actual fault because of attenuation of the reflected signal by the cable impedance.

Reflection Coefficient (rho)

Reflection coefficient (or rho) is a measurement of impedance used in communications systems. It is similar to return loss and is defined as follows:

$$\rho = \frac{Z_0 - Z_L}{Z_0 + Z_L}$$

Where ρ is the reflection coefficient and $\boldsymbol{Z_0}$ is the characteristic impedance of the transmission line, and $\boldsymbol{Z}_L$ is the load impedance.

Return loss and reflection coefficient are related by the formula:

$$returnloss = 20\log|\rho|$$

Ohms

The Ohms result displays the effective impedance at the selected point, expressed in Ohms.

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Waveform Recall Area

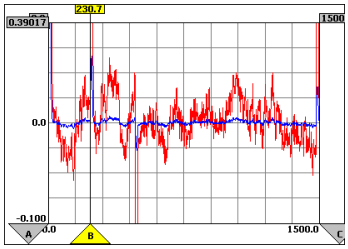
Waveform Selection

The **Select** button is used during waveform comparisons to select a waveform displayed on the MTDR waveform display.

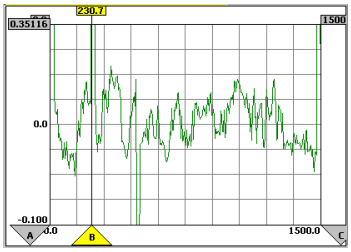
During testing, the Select window will normally read **Current**; indicating the waveform display is setup to display the results of the current TDR test. During a waveform comparison, a previously stored waveform file can be opened using the **Open** option in the **File** management menu. The desired waveform file is then selected from those listed on the “Open a Stored Waveform” display. The **OK** button is then pressed to open the selected file and you are returned to the main MTDR screen display. When this is done, the name of the selected waveform file appears in the Select window and the stored waveform appears on the main MTDR display along with the current waveform.

Waveform Comparison

Subtract: This button is used to initiate a waveform subtraction process which subtracts one waveform from the other. The difference waveform is displayed on the MTDR waveform display and is shown in green.



Comparison Screen



Difference Screen

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File Management Options

The **File** button is located in the top right corner of the MTDR screen. When pressed, this button displays a popup menu offering six file management options.



Open: Calls a file management screen for recalling stored waveforms. This button is grayed out when a recalled waveform is being displayed (see page 6–27 and See *Comparing Test Waveforms with Previously Stored Waveforms*, page 5–7.).

Close: Closes the open waveform file. This button is grayed out when no stored waveform file is open. When a recalled waveform file is closed, any current waveform remains on the MTDR screen.

Save As: Opens a screen to save the currently-displayed waveform in a waveform file. The file can be stored in either the MTDR Module's memory or in a memory card. (See page 6–25 and see *Storing and Recalling Waveforms*, page 5–5).

Print: prints the current screen to a printer connected to the Tablet's serial port.

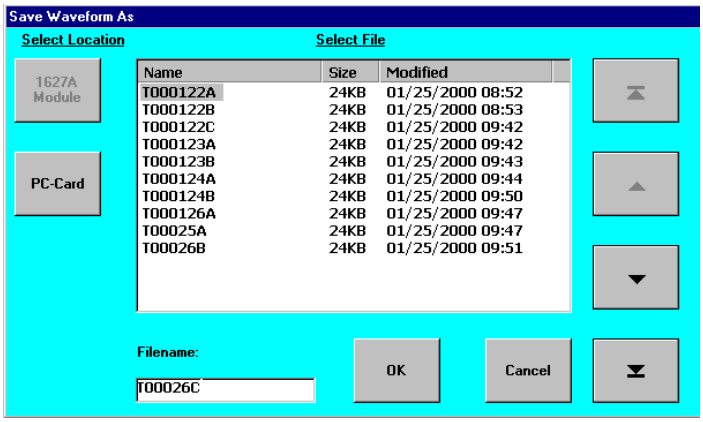
Delete: Opens a display that allows you to delete a waveform file in either the MTDR Module memory or in the waveform memory on a PCMIA card (see page 6–28).

Exit: Closes the MTDR program, and returns control to the Service Advisor Manager. (See the *Service Advisor Portable Test Tablet User's Manual* for information of the Service Advisor Manager).

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Save Waveform As Display

The “Save Waveform As” display is accessed using the **Save As** option in the **File** menu. It is used to save the waveform currently on the MTDR screen display in a waveform file.



The MDTR Module can internally store up to fifty TDR waveforms for use in comparisons with the current waveforms. This feature can be helpful in monitoring the changes in transmission performance over time. TDR waveforms can also be directed to a 10 or 20 MB flash memory on a PCMIA card.

Select Location Buttons: TDR test parameters may be directed to one of two memories: one located in the N1627A MTDR Module, and one located on the S.A. Tablet’s PCMIA card. The memory currently selected is indicated by a grayed out memory selection button (either **1627A Module** or **PC Card**). The button for the non-selected memory is shown in black. If the currently enabled memory is not the one desired, you can direct the parameters to the other memory by selecting its button. (The button will turn to gray when the memory is selected.)

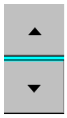
File Name: A default file name appears in the Filename field. You can use the default file name or enter a new file name in the field to identify the TDR waveform being saved. The waveform file name can be any number of characters long, however, the file name field has room for nineteen characters. Entering additional characters will cause the entry to shift left and the first character will shift of the screen.

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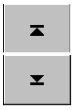
Use the S.A. Tablet keyboard to make the test name entry. The keyboard icon should appear in the toolbar in the lower right-hand corner of the MTDR's screen display.

File Selection Controls

Arrow buttons: The Save Test Parameters display includes two arrows buttons that allow you to scroll up and down through the list of waveform parameter files.



Jump buttons : The two jump buttons to allow you to jump to the ends of the list



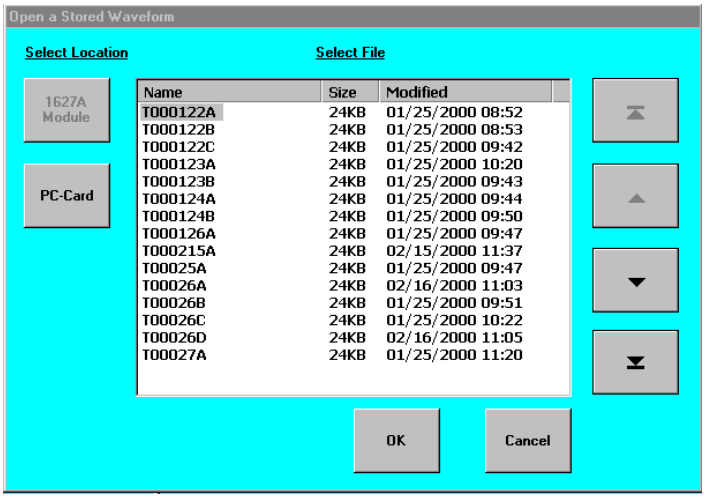
OK: After the desired memory area is selected and the new waveform file is named, Tap the **OK** button to save the waveform and return you to the main MTDR screen display.

Cancel: Used to return to the main MTDR screen display without storing the current waveform.

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Open a Stored Waveform Display

The “Open a Stored Waveform” display is accessed using the **Open** option in the **File** menu. It is used to select a stored waveform for display on the MTDR screen display. The waveform file can be retrieved from either the MTDR waveform memory or the memory of a PCMIA memory card.



The “Open a Stored Waveform” display is similar to the “Save Waveform As” screen display, previously described. To retrieve a waveform, a waveform memory, and then a stored waveform file are selected. The **OK** button is then pressed to recall the selected waveform for use in a waveform comparison.

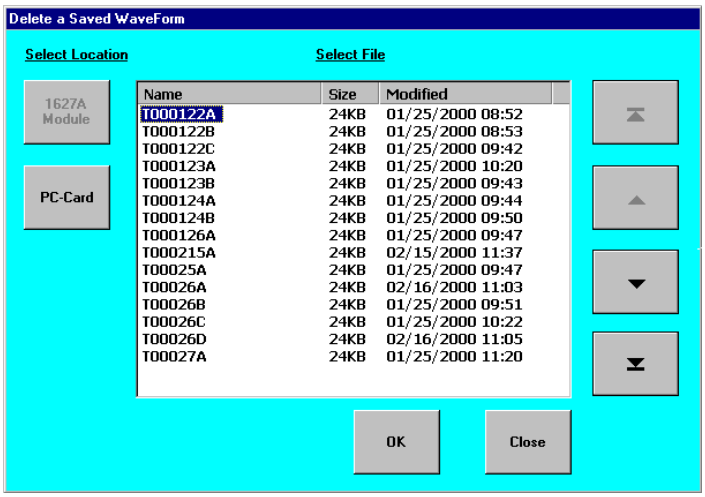
If the test setup parameters used to produce the stored waveform are the same as the current test setup parameters, you are returned to the MTDR’s main screen display and the name of the selected waveform file appears in the **Select** control/indicator. If the test setup parameters used to produce the stored waveform and those for the current test, are not the same, a popup display appears notifying you of the fact, and asking if you wish to continue. If you answer **no**, a second popup display appears indicating that the operation was canceled. Tap the **OK** button to return to the MTDR’s main screen display. If you answer **yes** to the first popup display, you are returned to the MTDR’s main screen display and the name of the reopened waveform file appears in the **Select** button.

For information on using the **Select** control/indicator button in waveform comparisons, see *Comparing Test Waveforms with Previously Stored Waveforms*, page 5–7.

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Delete a Saved Waveform Display

The Delete a Saved Waveform screen is similar to the Save Waveform As screen. However, the **OK** button is used to delete a selected file rather than save it.



OK: To delete a TDR waveform file, select the waveform from the list and tap **OK**. A popup conformation message appears prompting you to verify the intended deletion. Answer **yes** to delete the file from the list.

Close: Tap the **Close** button to close the Delete a Saved Waveform display.

Test Start and Stop Buttons

Start/Stop: Select the **Start** button to initiate a TDR test (the button turns into a **Stop** button). Press **Stop** to halt the test (the test is halted and button turns into a **Start** button).



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7

SCPI Command Syntax 7–2

Connecting a S.A. Tablet to a PC 7–6

Programming a MTDR Test 7–7

Basic Test Commands 7–10

Common Commands 7–11

:ROUTe Commands 7–12

:SOURce Commands 7–13

:SENSe Commands 7–14

Other Commands 7–15

:FETCh Commands (retrieve results) 7–17

MTDR SCPI Commands

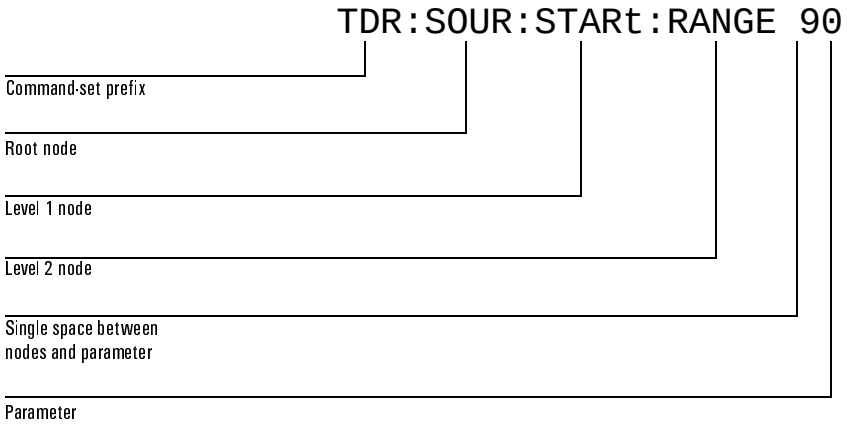
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SCPI Command Syntax

Standard Commands for Programmable Instruments (SCPI) is a command language used to control electronic test and measurement equipment. SCPI commands can be sent from a PC to a Service Advisor's test module to configure and perform tests, and gather data.

Note: SCPI is available only if you purchased N1610A Option 500.

Each SCPI command consists of a command-set prefix (such as TDR), a root node, one or more lower level nodes, followed by a parameter.



The test module uses this structure to interpret the SCPI command. Generally, each root and lower level node is preceded by a colon (:), but the command-set prefix is not. This helps the instrument correctly parse the command's component parts.

For example, you can enter the following command:

```
TDR:SENS:VSCale:DB1
```

This is an MTDR command, indicated by the TDR prefix. :SENSe is the root node, :VSC is the level 1 node, and DB1 is the parameter.

Command-Set Prefix

The S.A. Tablet uses the command-set prefix (TDR) to determine which plug-in module to access to initiate a SCPI command.

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Root Nodes

The following root nodes are supported by the MTDR test module.

:SELect: This group of commands lets you set up signal paths in the test module.

:ROUTe: This group of commands lets you select the primary port (P1 or P2) you are using on the MTDR test module.

:SOURce: This group of commands lets you set the transmitter functions for the test module.

:SENSe: This group of commands lets you configure the receiver functions of the test module.

:FETCh: This group of commands let you retrieve test results and configured settings from the MTDR module output queue.

:RST: This command resets the parameters in the MTDR module to their default settings.

:INITiate: This command starts a test running.

:ABORt: This command stops a test and freezes the test results.

:TIMed: This command sets the period of a timed test or a unique value for continuous real time operation.

:SELect: This command selects the MTDR's mode of operation.

:SAVe: This command saves the current results structure (a waveform) as a ASCII formatted file in the MTDR directory.

:SET: This command sets a test parameter within the MTDR module.

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Long Form and Short Form

SCPI commands have both a long and short version; for example :SOURCE and :SOUR. The S.A. Tablet responds to either version, but will not respond to variations of either version, such as :SOURC.

The SCPI interface does not differentiate between upper-case and lower-case letters, but only the long *or* short form of a command is valid. Notice the examples in the following table.

Correct Entry	Incorrect Entry
:SOURCE	:SOURC
:SourCe	:sou
:sour	:Sourc

Using Parameters

Parameters follow the nodes of commands and are specified throughout this reference in angle brackets (**< >**). If multiple parameters are available, they are shown separated by a vertical bar (|).

Various SCPI commands use the following types of parameters.

Types of Parameters	Description
Numeric	You can enter decimal numbers including optional signs, decimal points, and scientific notation.
Discrete	You can enter a keyword instead of a number. For example, INTernal and EXTernal.
Boolean	You can enter a single binary condition that is either true of false. For example, 1 and 0.

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Separating Commands and Parameters

The following table lists the different separators you can use between commands and parameter.

SCPI Command Separators

To Separate...	Use...	Example
A command-set prefix from a root node	Colon (:)	TDR:TERM P1
A root node from a lower level node	Colon (:)	TDR:SEL:TEST STD
Multiple commands entered in a command string	Semicolon (;)	TDR:SEL:TEST STD;TDR:ROUT:TERM P1
A parameter from a command	Space	TDR:SEL:TEST STD

Sending Multiple Commands in a Command String

You can send multiple SCPI commands in the same command string. The commands execute one at a time, in the order in which you have entered them. To separate the commands, use a semicolon (;).

Here's an example of a command string that contains more than one command:

```
TDR:SEL:TEST STD;TDR:ROUT:TERM P1;TDR:INIT;
TDR:FETC:LEDS ?;TDR:FETC:HWERR ?;TDR:ABORT
```

When the MTDR test module receives this command string, it executes the six commands separately. The module starts the standard (STD) test, and retrieves the status of the LEDs and any hardware error conditions. The number of commands you can enter in a single string is limited by the number of characters you can enter in the terminal-emulator's command line.

Note: You must always enter the TDR:*RST command by itself on a command-line.

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Connecting a S.A. Tablet to a PC

To use SCPI commands, you must connect the S.A. Tablet (with installed MTDR module) to a PC. Then, you use a terminal-emulation program to issue SCPI commands and view test results on your PC.

System Requirements

Connecting a S.A. Tablet to a PC requires the following:

- a desktop or laptop PC running Windows or MS-DOS operating system software
- a terminal-emulation package (such as HyperTerminal) on the PC
- an RS-232 null-modem cable (provided with N1617A)

Connection Procedure

Follow these steps to initiate a SCPI session:

1. Install an RS-232 null-modem cable between the Tablet's serial port and a PC comm port. Be sure both ports have the same communications settings.

   If you need to change the default comm settings (*115,200 baud, 8 data/1 stop bit, no parity*), use the **Serial Port** option under the Service Advisor Manager's Setup tab. (refer to the *Service Advisor Portable Test Tablet User's Manual* for information on changing Tablet settings. See the PC documentation for information on changing PC settings.)

2. Start the terminal-emulation program on the PC. This is where you will issue SCPI commands.

   - Press the "Enter" or "Return" key after entering each SCPI command or command string.

3. Issue the ***IDN ?** command to test the connection. If you receive identification information such as "N1610A Service Advisor Manager," you know the connection is valid.

4. Continue issuing SCPI commands at the command-line prompt. Command responses appear in the terminal-emulation window.

Note: While entering SCPI commands, you can also operate the S.A. Tablet by using the touch-screen display and GUI.

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Programming a MTDR Test

This section explains how to reset the S.A. Tablet before running a test, provides a guideline for entering commands in the proper sequence, and contains sample tests.

Resetting Your Test Set

Before you program a MTDR test, you should always enter the TDR:*RST command to reset the test module. When you issue this command, the MTDR module:

- sets all MTDR test results and configuration values to their default setting. Default settings are listed in the individual command descriptions.
- clears the SCPI control registers in the test module
- stops a MTDR test if one is currently running

When you become familiar with the SCPI default settings you will notice that, in many cases, you can enter just a few commands to run a test or make a measurement.

Note: If you enter *RST without specifying a command-set prefix, you get an error message.

Command Sequence

When programming a MTDR test with SCPI commands, you always:

- reset the tester to default settings
- select a test
- configure the transmitter and receiver functions
- initiate the test
- retrieve test results
- abort the test

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Sample Standard MTDR Test

The following table lists the basic commands needed to run a standard MTDR test in the order in which you should enter them.

SCPI Commands	Description
TDR:*RST	Resets the MTDR parameters in the TDR module to their default settings.
TDR:SEL:TEST STD	Selects the standard MTDR test to run.
TDR:ROUT:TERM Pn	Select the MTDR circuit connector port (P1 or P2) you are using.
TDR:SOUR:	Configure parameter settings for the MTDR transmitter.
TDR:SENS:	Configure parameter settings for the MTDR receiver.
TDR:INIT	Starts the test.
TDR:FETC:TEST:DRDY ?	Indicates (when you receive a return value of 1) the tester is in data-ready state and your test results will be valid.
TDR:FETC	Retrieve test results and configuration settings.
TDR:ABOR	Stops the test.

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Sample Intermittent Failure Test

This sample test shows the sequence of SCPI commands to enter if you want to perform an intermittent failure test.

SCPI Command	Description
TDR:*RST	Sets MTDR SCPI parameters to their default settings.
TDR:SEL:TEST IFAIL	Selects the Intermittent Failure Test.
TDR:SENS:GAIN G10	Sets the receiver gain setting to 10dB.
TDR:SENS:FILT 2	Selects the level 2 high filter.
TDR:SENS:VSC DB2	Sets the vertical scale to 2 dB.
TDR:SENS:HSC FEET	Sets the unit of scale for the horizontal measurement to feet.
TDR:INIT	Starts the Intermittent Failure Test.
TDR:FETC:DRDY ?	Queries the module to determine if the test data is ready.
TDR:FETC:RES?	Retrieves the test results.
TDR:ABOR	Stops the test.

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Basic Test Commands

This section describes the SCPI commands you use with most tests. See *Command Sequence*, page 7–7 for more information about the sequencing of the MTDR SCPI commands.

Basic MTDR Test Commands

Root	Level 1	Level 2
*RST		
ROUTe	TERMinal	
SOURce	VOP | PWIDth | STARt: | END	TIMe | RANGe
TDR:SELect	:TEST < STD test >	
TDR:TIMed	:TEST	:PERiod < test time >
TDR:INITiate		
TDR:ABORt		

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Common Commands

*RST

The system reset, this command resets the TDR subsystem, clearing SCPI control registers along with resetting TDR results and configuration values to default condition. Any current TDR test is stopped.

***RST Defaults:** Configurations set to defaults, Results zeroed.

INITiate

Starts the test operation, reset results to zero, and enable results processing.

***RST Defaults:** Test stopped.

ABORt

Stops the test operation and retains current processed results.

***RST Defaults:** Test stopped.

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:ROUTe Commands

ROUTe:TERMinal <P1 | P2 | P3>

Selects the primary port of operation based on test selected. The STD and CALTEST allows selection of P1 & P3, XTALK allows selection of P2 only, and the IFAIL allows selection of all ports P1, P2, or P3.

P1 = Port 1 Rx Port 1 Tx.

P2 = Port 2 Rx Port 1 Tx.

P3 = Coax port Rx & Tx. Restricts the pulse width to 1 µs or less, if greater then the pulse width is automatically set to 1 µs.

***RST Default:** P1.

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:SOURce Commands

SOURce:VOP:TIMe < double float value >

Sets the velocity of propagation for cable being tested.

Range: 0.100 to 0.999

***RST Defaults:** 0.653.

SOURce:PWIDth < int value >

Sets the Tx pulse width from 5 to 5000 ns, values between 1000 and 5000 ns are truncated to a resolution of 100 (i.e. 1523 ns truncated to 1500 ns and displayed as 1.5 µs). Pulse width is restricted to a maximum of 1000 ns when Port 3 (COAX) is selected.

Range: 5 to 5000 ns.

***RST Defaults:** Off.

SOURce:STARt:RANGe <long int value>

Sets a starting position on the cable from which test results are gathered. This position must be 3 meters (10 feet, or 1 us) less than the end position. This measurement is considered the minimum span.

Units: meters, feet, us, depends on the horizontal scale selection.

Range: 0 m to 199970 m, or 0 ft to 65607 ft, or 0 µs to 101 µs.

***RST Defaults:** 0 meters.

SOURce:END:RANGe <long int value>

Sets an end position on the cable from which test results are gathered. The end position must be at least 3 meters (10 feet, 1 µs) greater than the start position. This measurement is considered the minimum span.

Units: Meters, Feet, µsec, depends on the horizontal scale selection.

Range: 3 m to 20000m, or 10 ft to 65617 ft, or 1 µs to 102 µs.

***RST Defaults:** 2000 meter

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:SENSe Commands

SENSe:GAIN <G0 | G10 |....G70>

Sets Rx Gain to one of eight different settings. For Pulse Width of 5 ns the maximum gain is restricted to G50. G0 = 0 dB, G10 = 10 dB, G20 = 20 dB, G30 = 30 dB, G40 = 40 dB, G50 = 50 dB, G60 = 60 dB, G70 = 70 dB.

Units: dB (decibels).

***RST Defaults:** G0 (0 dB).

SENSe:FILTer <0 | 1 | 2>

Sets Rx filter to one of two levels of filter settings or off. 0 = off, 1 = level 1 low filtering, 2 = level 2 high filtering.

Range: 0 to 2.

***RST Defaults:** 0 (off).

SENSe:VSCale <MAXPK | MINMAX | DB1 | DB2 | DB5>

Sets the vertical scale to one of five settings.

MAXPK = ?, MINMAX = ?, DB1 = ?, DB2 = ?, DB5 = ?

***RST Defaults:** MAXPK

SENSe:HSCale <METER | FEET | SEC>

Sets the horizontal scale to one of three settings.

METER = meters, FEET = feet, SEC = µs.

***RST Defaults:** Meter

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Other Commands

TIMed:TEST:PERiod <short value>

Sets the timed test period value or “continuous real time” operation. When a time period from 1 to 20 seconds is set the test automatically stops when time expires. Results are averaged in every second. When a time period greater than 20 is set the module will run and update in a “real time continuous” mode with no averaging.

Units: seconds.

Range: 1 to 20 seconds, or >20 for “continuous real time” operation.

***RST Defaults:** continuous real time.

SELect:TEST: <STD | XTALK | IFAIL>

Selects one of three test modes.

- STD = the standard TDR test (if P2 active port is forced to P1)
- XTALK = the TDR crosstalk test. This test is conducted between port1 and 2 (If P2 is not active, port is forced to P2???).
- IFAIL = the intermittent failure test. This test performs a continuous test using a “peak hold” results mode of operation.

***RST Defaults:** STD.

SAVe:ASCII:FILE <file name>

Saves the current “results” structure (a waveform) in ASCII character formatted file in the data directory. The file name parameter is used to name the file and an extension of “.txt” is appended. The data format is the same as in the “FETCh:ASCII:RESults” command, but “CRLF” is inserted every 10 items for readability.

***RST Defaults:** N/A.

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SET:DISTance:MARK <long value>

Sets the distance mark from which “dBRL”, “rho”, and “ohms” is calculated. The units are based on the “SENSe:HSCale” setting and must be within the “SOURce:STARt:RANGe” and the “SOURce:END:RANGe” settings.

Units: meters, feet, microseconds.

Range: 0 to 20000 m, or 0 ft to 65617 ft, or 0 µs to 102 µs.

***RST Defaults:** distance mark = 0.

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:FETCh Commands (retrieve results)

FETCh:LEDS ?

Fetch TDR LED register (16 bits), 0 = LED off, 1 = LED on.

bit 0 = **Testing** LED.

bit 1 = **Ready** LED.

bit 2 = P2 **Rx** LED.

bit 3 = P3 **Coax** LED.

bit 4 = P1 **Rx** LED.

bit 5 = P1 **Tx** LED.

bit 6 to bit 15 = undefined.

***RST Defaults:** P1 **Tx** & **Rx**, **Ready** LEDs on.

FETCh:HWERRors ?

Retrieves the contents of the TDR HW error conditions register (16 bits), 0 = Error off, 1 = Error on. bIT 0 = WinCE virtual memory failure.

bit 1 = file system failure.

bit 2 to bit 15 = undefined.

Internal Param: unsigned short value.

SCPI_CMD_ERROR -- Command syntax error.

***RST Defaults:** N/A.

FETCh:TEST:STATe ?

Retrieves the test state, 0 = stopped, 1 = running.

***RST Defaults:** test stopped.

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FETCh:TEST:DRDY ?

Data ready state, 0 = results data invalid, 1 = results data valid. The data ready state should be monitored by the user at the start of every test to determine when the test results are valid. Due to the amount of data acquired during a test, intermediate results may change before all of the results are gathered. It is, therefore, recommended that the user "ABORT" (stop) the test before the results are gathered. Results are available after the first results are processed then updated for any subsequent processed results during a test, signified by Data Ready state = 1.

***RST Defaults:** Data Ready = 0.

FETCh:ASCII:RESults ?

Retrieves the current TDR results waveform structure as an ASCII string of data, each separated by a space character. These ASCII strings can be extremely large due to the amount of data samples and header information contained in each processed results. Up to 50 K of ASCII character data can be generated, allow an appropriate time for this transfer. The following is a break down of elements in the data stream. The elements are separated by a single space.

***RST Defaults:** Results structure is set to all zeros.

:FETCh:ASCII:RESults ? Command Data strings

Returned String	Description
Struct Size	The size of the binary structure in bytes before conversion to ASCII (i.e. 24760).
Struct Rev	The revision of the structure (i.e. 1).
Year	The year time stamp (i.e. 2000).
Month	The month time stamp (1 to 12).
Day of Week	The day of the week time stamp (1 to 7).
Day of Month	The day of month time stamp (1 to 31).
Hour	The hour Time stamp (1 to 23).
Minute	The minute time stamp (0 to 59).

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:FETCh:ASCII:RESults ? Command Data strings, continued

Returned String	Description
Second	The seconds time stamp (0 to 59).
Milli Second	The milliseconds time stamp (0 to 999).
Model	The model number (i.e. N1627A).
Sw Rev	The software revision number (i.e. 1.10).
Hw1 Rev	The hardware 1 revision number (i.e. 1.00).
Hw2 Rev	The hardware 2 revision number (i.e. 1.00).
Serial No	The module serial number (i.e. 4).
LEDs	The current state of Hw LEDs (0 to 63).
Drdy	The state of the data Ready indicator (0 or 1).
HwError	The hardware error bits (i.e. 3).
Config Change	Indicates if configuration parameters have changed since last results reading.
Port	The current port selection (1 to 3).
Vop	The velocity of propagation setting (i.e. 0.667).
Pulse Width	The pulse width setting in ns. (5 to 5000).
Rx Gain	Rx gain setting in dB (0 to 70).
Start Range	The start range in millimeters (0 to 19970000).
End Range	The end range in millimeters (30 to 20000000).
Test Time	The test time in seconds (1 to 20), or > 20 for “continuous real time” operation.
Rx Filter	The Rx filter setting (0 to 3).
VScale	The vertical scale setting (0 to 4).
HScale	The horizontal scale setting (0 to 2).
Threshold	The threshold setting (0.01 to 0.99).

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:FETCh:ASCII:RESults ? Command Data strings, continued

Returned String	Description
Test ID	The ID of current test (1 to 5).
Cycle Count	The number of test cycles completed.
Rho Factor 2	Used to scale the 32 bit integer to a real number from +1 to -1 (i.e. 0.34729).
Zero Point	The zero point index into data sample buffer (0 to 4096).
End Point	The end point index into the data sample buffer (0 to 4096).
Sample Distance	The distance between data samples in millimeters (i.e. 500.0).
dSpare1	A spare double floating point for future expansion (i.e. 0.).
dSpare2	A spare double floating point for future expansion (i.e. 0.).
ilSpare1	A spare long integer for future expansion (i.e. 0).
ilSpare2	A spare long integer for future expansion (i.e. 0).
iSpare1	A spare Int integer for future expansion (i.e. 0).
iSpare2	A spare Int integer for future expansion (i.e. 0).
sSpare1	A spare short integer for future expansion (i.e. 0).
sSpare2	A spare short integer for future expansion (i.e. 0).
1st Data Sample	The first data sample (0 to ± 2147483647).
2nd Data Sample	The second data sample (0 to ± 2147483647).
4096th Data Sample	The 4096th data sample (0 to ± 2147483647).

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FETCh:DBRL ?

Retrieves the “dbRL” value calculated at the distance mark set by the “SET:DISTance:MARK” command.

***RST Defaults:** Results are set to all zeros.

FETCh:RHO ?

Retrieves the “rho” value calculated at the distance mark set by the “SET:DISTance:MARK” command.

***RST Defaults:** Results are set to all zero’s.

FETCh:OHM ?

Retrieves the “Ohm” value calculated at the distance mark set by the “SET:DISTance:MARK” command.

***RST Defaults:** Results are set to all zero’s.

FETCh:SWRev ?

Retrieves the software revision number.

***RST Defaults:** Results are set to all zero’s.

FETCh:HW1Rev ?

Retrieves the first hardware revision number.

***RST Defaults:** Results set to all zero’s.

FETCh:HW2Rev ?

Retrieves the second hardware revision number.

***RST Defaults:** Results are set to all zeros.

FETCh:SNUMber ?

Retrieves the module serial number.

***RST Defaults:** Results are set to all zeros.

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8

Physical Characteristics 8–2

Transmitter Characteristics 8–2

Receiver Characteristics 8–3

Connectors and Jacks 8–4

Ordering Information 8–5

MTDR Module Specifications

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Physical Characteristics

Size (W×H×D): 7.8 × 9.0 × 2.6 inches (19.8 × 22.9 × 6.6 cm)

Temperature

Operating: 0 to +40 °C (+32 to 104 °F)

Storage: : –20 to +60 °C (–4 to 140 °F)

Power Characteristics

Power Consumption: 6 watts (provided by S.A. Tablet)

Transmitter Characteristics

Output impedance: Balanced: 100 Ohms; Unbalanced: 50 Ohms

Test signal output level: 3 to 25 Vpp

Pulse widths: 5, 10, 20, 50, 100, 200, 500, 1000, 2000, 5000 ns

Dynamic Range: >70 dB

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Receiver Characteristics

Input Protection: ±400 Vdc and ±400 Vac

Velocity of propagation: Range: 0.010 to 0.999; Resolution: 0.001

Maximum Range: 20,000 m at any VoP, depending on the cable type and condition

Distance Accuracy: 0.1% ±200 ps ±VoP uncertainty ±cursor resolution

Cursor Resolution: 0.28% of the selected range.

Displayed Resolution: Time/Distance display: 400 pixels;
Amplitude display: 250 pixels

Horizontal Resolution: 0.026 m at VoP 0.999; 0.039 m at VoP 0.660

Vertical Sensitivity: >65 dB

Vertical Resolution: Up to 16 effective bits depending on the test setup.
241 pixels (vertical) displayed.

Display (in Service Advisor Tablet): 640 x480 pixels color VGA LCD with touchscreen. Backlighting with contrast control.

Display Range: Start and stop range are independently selectable

Event Marking: Three cursors (A,B, and C)

Automatic return loss calculation: Two digit calculation at the cursor

Crosstalk calculation: Two digit calculation at the cursor set

Noise filters: Adaptive noise filtering based on test settings.

Waveform Storage: 50 waveforms

Test configuration database: Stores 50 test configurations, plus expansion via PCMCIA card. Can clone test configurations for service organization.

Standards Compliance : UL, ISO, CE

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Connectors and Jacks

P1 and P2: Balanced: dual Bantam connectors (standard configuration); Unbalanced: BNC

BNC jack: MTDR coaxial cable connector P3 (standard configuration)

BNC jack: Butt-set connection (& binding posts)

RS-232 connector: Remote connection & SCPI control

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Ordering Information

Contact your Agilent Technologies representative to purchase any of the following products or accessories.

N1627A MDTR Module Ordering Information

Part Number	Option	Description
N1610A	Service Advisor Portable Test Tablet, includes:	
		NiMH battery and internal battery charger, Service Advisor Companion software, Vac power adapter (N1612A), and DB-9 to DB-9 serial null-modem cable
	500	Remote Services (for S.A. Tablet and modules)
	910	Additional S.A. Tablet User's Manual
N1611A		Additional NiMH battery (for N1610A)
N1612A	Universal Vac power adapter and power cord (select one):	
	ABA	North America
	ABB	European HPSA
	ABG	Australia
	ABU	United Kingdom
	ACD	Switzerland
	ACF	Japan
	AKJ	Israel
	AKM	China
N1613A	External battery charger (for N1610A)	
N1614A	12 Vdc power adapter (for vehicle power source)	
N1615A	Softside carrying case (for N1610A and accessories)	
N1616A	Hard carrying case (for N1610A and accessories)	

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N1627A MDTR Module Ordering Information, continued

Part Number	Option	Description
N1617A	Service Advisor Connectivity kit, includes:	
		Service Advisor Companion software, DB-9 to DB-9 null-modem cable
N1618A	56 k/V.90 Modem PC card	
N1620A	10-BaseT Ethernet LAN PC card	
N1621A	10 Mb Compact Flash and PCMIA adapter	
N1623A	Grounded test cable equipped with two Bantam connectors and alligator ground clip.	
N1624A	Grounded test cable with two WECO 310 connectors and alligator ground clip.	
N1627A	Metallic Time Domain Reflectometer (MTDR) Module	
N1627A-910	Additional MTDR User's Manual	
8120-8845	DB-9 to DB-9 serial null-modem cable (standard with N1610A)	

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Glossary

ac: Alternating current.

ADSL: Asymmetric Digital Subscriber Line.

ANSI: American National Standards Institute.

attenuation: Signal loss.

bandwidth: A network's or channel's capacity to carry traffic.

Bridged tap: is the point where a lateral connects to a twisted-pair line; a common cause of problems when POTS lines are upgraded to digital service.

BW: See *bandwidth*.

cable fault: Any condition that makes a coaxial cable less efficient at delivering electrical energy. Poorly mated connectors, water leaks, and bad splices are typical cable faults.

CCITT. Consultative Committee on International Telegraph and Telephone, now the International Telecommunications Union (ITU). The standards produced by this organization are called ITU-T Recommendations.

CO. Central Office.

CPE. Customer premises equipment; the equipment located on the customer's side of the network interface box.

dB. Decibel. Standard unit for transmission loss, gain, and relative power ratios.

dBdsx. Decibels relative to the DSX level.

dBm: Decibels relative to one milliwatt.

dBRL: Decibels relative to reflected loss.

dBrnC: Decibels relative to reference noise with C-message weighting.

dc: Direct current.

DCE: Data circuit-terminating equipment. Equipment that provides the interface between a DTE device and a transmission circuit (for example, a modem).

DS1: Digital signal level 1; 1.544 Mbps.

DTE: Data terminal equipment. Equipment that converts user information into data signals for transmission (for example, a PC).

DTMF: Dual Tone MultiFrequency.

EDD: Envelope delay distortion.

envelope: A group of frequencies used to simulate a data signal.

EPD: Echo Path Delay.

EPL: Echo Path Loss.

ERL: Echo Return Loss.

ESD: Electrostatic discharge. The discharge of static electricity, which has the potential to damage electronic circuitry.

FEXT: Far-end cross talk.

FLA: Frequency, Level, and Attentuation.

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FTTH: Fiber to the home; a broadband deployment system that uses fiber optic cables to connect the central office/head end to local distribution nodes (in the subscriber area). Individual fiber optic cables are then used to connect subscribers to the local distribution node.

GUI: Graphical user interface.

HDSL: High-bit rate Digital Subscriber Line.

HFC: Hybrid Fiber/Coax; a broadband deployment system that uses a fiber optic cable to connect the central office/head end to a local distribution node (in the subscriber area). Coaxial cable is then used to connect the subscriber to the local distribution node.

Hz: Hertz. Measure of frequency, one cycle per second.

Incident Pulse: A transmitted pulse of electrical energy before it reaches and impedance barrier and is reflected back toward its source.

ISDN: Integrated Services Digital Network.

ISO: International Standards Organization.

ITU: International Telecommunications Union, formerly the Consultative Committee on International Telegraph and Telephone (CCITT). The standards produced by this organization are called ITU-T Recommendations.

jitter: Short-term variation in the phase of a digital signal (includes phase variation above 10 Hz).

Kb or Kbit: Kilobit. A thousand bits.

KB or Kbyte: Kilobyte. One thousand bytes.

Kbps: Kilobits per second.

kHz: Kilohertz. Measure of frequency, one thousand cycles per second.

LAN: Local area network.

lateral: a twisted-pair line extending from a bridged tap on the main line (usually toward a subscriber). Lateral lines are frequently mistakenly referred to as bridged taps

LBO capacitor: A capacitor used to match the capacitance of a short line segment to the inductance of an attached load coil.

Load Coil : an inductive device employed in local loops that exceed 18000 feet in length. Load coils compensate for wire capacitance and boost signals in the voice band (300 to 3,000 Hz).

LCD: Load Coil Detection.

LED: Light-emitting diode.

load coil: A device used to improve the quality of voice transmission, causes problems with digital services.

local loop: A pair of copper wires that connects a subscriber to the telephone company's central office.

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loopback: A state in which the transmit signal is reversed back as the receive signal, typically by a far-end network element.

mA: Milliampere. Measure of current, one thousandth of an ampere.

Mb or Mbit: Megabit. One million bits.

MB or Mbyte: Megabyte. One million bytes.

Mbps: Megabits per second.

MHz: Megahertz. Measure of frequency, one million cycles per second.

ms: Millisecond. One thousandth of a second.

MTDR: Metallic Time Domain Reflectometer.

NEXT: Near-end cross talk.

NHT: Noise with Holding Tone.

NIC: Network Interface Card. A type of PCMIA card.

NiMH: Nickel Metal Hydride. A type of battery.

noise: any unwanted electrical energy that interferes with communications.

NTG: Noise to Ground.

OC: Optical carrier.

octet: Eight bits. Typically refers to a group of bits that spans more that one byte.

PI: Power influence. A test used to measure the amount of noise on each wire in a twisted pair.

ppm: Parts per million.

POTS: Plain old telephone service.

PSD: Power Spectral Density.

QOS: Quality-Of-Service.

RAM: Random access memory.

rho: reflection coefficient.

RMS: Root mean square. A type of detector used for power measurements.

ROM: Read-only memory.

RX: (Receive) An input function.

SCPI: Standard Commands for Programmable Instruments.

SRL-lo: Singing Return Loss–low.

SRL-hi: Singing Return Loss–high.

S/TD: Signal-to-Noise and Total Distortion.

synchronous: Synchronized. Occurring at the same rate or period; sharing common timing with an outside timing source.

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T1: See *DS1*.

TDR: Time Domain Reflectometer.

TIMS: Transmission Impairment Measurement Set.

TLP: Transmission Level Point.

TX: (Transmit) An output signal or port.

V: Volt.

Vac: Volt, alternating current.

Vdc: Volt, direct current.

VF: Voice frequency.

VoP: Velocity of Propagation.

V pk: Volt peak.

V p-p: Volt, peak-to-peak.

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Warranty, Calibration, and Service

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Agilent Technologies Limited Warranty Statement

Agilent Product: N1627A Metallic Time Domain Reflectometer Module

Duration of Limited Warranty: Three years

1. Agilent warrants to you, the end-user customer, that Agilent hardware, accessories and supplies will be free from defects in materials and workmanship after the date of purchase, for the period specified above. If Agilent receives notice of such defects during the warranty period, Agilent will, at its option, either repair or replace products which prove to be defective. Replacement products may be either new or equivalent in performance to new.
2. Agilent warrants to you that Agilent software will not fail to execute its programming instructions after the date of purchase, for the period specified above, due to defects in material and workmanship when properly installed and used. If Agilent receives notice of such defects during the warranty period, Agilent will replace software which does not execute its programming instructions due to such defects.
3. Agilent does not warrant that the operation of Agilent products will be uninterrupted or error free. If Agilent is unable, within a reasonable time, to repair or replace any product to a condition as warranted, you will be entitled to a refund of the purchase price upon prompt return of the product.
4. Agilent products may contain remanufactured parts equivalent to new in performance or may have been subject to incidental use.
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Calibration

This instrument must be calibrated only by authorized Agilent Technologies personnel. Unauthorized service or calibration will void the warranty.

The Agilent Technologies N1627A MTDR Module requires calibration every three years. To arrange for calibration, please contact Technical Support at 1-800-923-7522 or 978-266-3300.

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Service

If your MTDR Module does not appear to be operating properly, carefully check all configuration parameters and connections. Improper selection of timing modes or drop channels, for example, can cause unexpected operation. Also check that the module is seated properly in the Service Advisor Tablet.

If you feel that your MTDR Module requires service, call Technical Support at 1-800-923-7522 or 978-266-3300. Trained personnel are available to help solve your problem or determine if the unit must be returned for repair.

Returning a Unit for Repair

If your MTDR Module must be returned, a Technical Support representative will assign a Return Material Authorization (RMA) number. No product will be accepted for service without an RMA number.

Ship the instrument to:

Repair Department
Agilent Technologies
Service Test Division
2 Robbins Road
Westford, MA 01886 USA

Be sure to mark the RMA number on the outside of the shipping container. In addition, be sure to include the following information:

- Model number (N1627A) and name (MTDR Module)
- Serial number
- Your name and phone number
- A written description of the problem
- Return “ship to” address
- Invoice address
- Payment information (if unit is out of warranty)

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Index

A

A-B/A-C distance 2-10, 6-19

abort (ABOR) command 7-11

“A” cursor 2-9, 6-20

Agilent limited warranty W-2

Autostart 2-3

B

basic test procedure 2-13

battery indicator 1-2

B-C distance 2-10, 6-19

“B” cursor 2-9, 6-20

before you begin testing 2-2

bridged tap 3-10

C

cable distance 3-14, 4-8

cable termination 3-2

calibration W-4

“C” cursor 2-9, 6-20

coaxial cable
- anomalies 4-3
- connecting 2-5
- length measurement 4-7
- problems 4-2
- segment measurement 4-8
- short location 4-9
- splice location 4-10

coils 3-15

command prefix 7-2

comparison 6-23

connecting lines 2-4

connection
- coaxial cable 2-5, 2-13
- crosstalk test 2-4
- twisted pair 2-4, 2-13

connector, output reflection 2-5

connectors 6-3

coupler 4-11

crosstalk mode 2-6

crosstalk point location 3-21, 3-22

cursors 2-9, 6-20

D

dBRL 2-11, 3-4, 6-21

declaration of conformity iv

deleting waveforms 6-28

directional coupler location 4-11

display 1-4

distance
- display 6-19
- flags 2-9
- measurements 2-10

E

effective impedance
- measurement 3-5, 6-22

end range 2-8, 2-14

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F

far-end cursor 6-20

fault simulation 2-2

fetch (FETC)
- ASCII results (RES)
  - command 7-18
- dBRL (DBRL) command 7-21
- effective impedance (OHM)
  - command 7-21
- errors (ERR) command 7-17
- hardware 1 revision (HW1R)
  - command 7-21
- LEDS command 7-17
- module serial number (SNUM)
  - command 7-21
- reflection coefficient (RHO)
  - command 7-21
- software revision (SWR)
  - command 7-21
- test (TEST) data ready (DRDY) state
  - command 7-18
- test (TEST) state (STAT)
  - command 7-17

file management options 5-1, 6-24

G

graphical user interface (GUI)
- starting 1-7

H

horizontal scaling 2-12

I

Ifail 2-6, 3-20, 6-6

impedance 3-5, 6-22

indicators 6-2
- S.A. Tablet 1-2

initialization, module 7-7

initiate (INIT) command 7-11

intermittent failure test mode 2-6

intermittent problems 3-20

issuing SCPI commands 7-6

J

jacks 6-3

L

lateral 3-10

lateral length measurement 3-12

LED indicators 1-2, 6-2

line build-out (LBO) capacitors 3-17

load coil location 3-15

long command form 7-4

M

main screen 1-4, 6-4

maximum peak 2-12

measurement
- viewing 6-18

measurements
- dBRL/rho/Ohms 2-11

measuring VoP 4-5

mode selection 2-6

module
- connection 2-4
- connectors 6-3
- indicators 6-2
- initialization 7-7
- installation 1-6

module indicators 6-2

moisture 3-19

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MTDR
connectors 1-3
front panel 1-3
indicators 1-3
main screen 1-4, 6-4

N

N1610A—*See* S.A. Tablet
N1627A—*See* MTDR Module
near-end cursor 6-20
noise filter selection 2-15

O

Ohms 2-11, 3-5, 6-21, 6-22
opens 3-8

P

parameter measurements 2-11
parameters, SCPI command 7-4
PC connections for SCPI 7-6
point-of-interest cursor 6-20
point-to-point measurement 3-14
power ON indicator 1-2
power splitter location 4-11
power turnon 1-7, 2-3
print 5-9, 6-24
pulse width setting 2-7, 2-14, 2-15

R

recall waveform 6-23
recall waveforms 6-27
reflection, output connector 2-5
reflection characteristics 3-3
reflection coefficient (rho) 3-5, 6-22
reset (RST) command 7-11
reset test set 7-7
resplit, twisted-pair 3-22
results viewing 6-18
return loss 3-4, 6-21
rho 2-11, 3-5, 6-21, 6-22
root nodes, SCPI command 7-3
route (ROUT) terminal (TERM) command 7-12
*RST command 7-7

S

S.A. Tablet 1-2, 1-6
save (SAV) ASCII file (FILE) command 7-15
save waveform 6-25
SCPI commands
abort (ABOR) command 7-11
command separators 7-5
command syntax 7-2, 7-5
fetch (FETC) commands 7-17 to 7-21
initiate (INIT) 7-11
issuing 7-6
parameters 7-4
reset (RST) command 7-11
root nodes 7-3
route (ROUT) command 7-12
*RST 7-7
save (SAV) ASCII file (FILE) command 7-15
select (SEL) test (TEST) command 7-15
sense (SENS) commands 7-14
set (SET) distance (DIST) marker (MARK) 7-16
source (SOUR) commands 7-13
timed test (TIM) test (TEST) period (PER) command 7-15
screen print 5-9
select (SEL) test (TEST) command 7-15

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select test 6-6

sense (SENS)
  gain (GAIN) command 7-14
  horizontal scale (HSC) command 7-14
  vertical scale (VSC) command 7-14

service or repair W-5

set (SET) distance (DIST) marker (MARK) 7-16

short 3-9, 4-9

short command form 7-4

shutdown button 1-8

software updates 5-9

software version vi

source (SOUR)
  end range (END RANG) command 7-13
  pulse width (PWID) command 7-13
  start range (STAR RANG) command 7-13

splice 3-18, 4-10

split, twisted-pair 3-22

splitter 4-11

standard test mode 2-6

Start/Stop 6-28

Start button 6-28

start range 2-8, 2-14

Std 2-6, 6-6

Stop button 6-28

subtract 6-23

syntax, SCPI command 7-2, 7-2 to 7-5

T

Tablet—*See* S.A. Tablet

tap, bridged 3-10

TDR test procedure, basic 2-13

test duration settings 2-14

testing, basic 2-13

testing considerations 2-2

test mode 2-6, 6-6

test parameters 2-7

test results 6-21

test setup 2-7

test start/stop 6-28

timed test (TIM) test (TEST) period (PER) command 7-15

TIMS module
  specifications 8-2 to 8-4

twisted pair
  bridged tap location 3-10
  connecting 2-4
  distance measurements 3-14
  intermittent problem location 3-20
  lateral length measurement 3-12
  open location 3-8
  short location 3-9
  VoP 3-6

twisted pair open location 3-8

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U

unit of measurement 2-12, 6-18
updating software 5-9

V

velocity of propagation (VoP) 3-6
vertical scaling 2-12
viewing results 2-12, 6-18
VoP 3-6
VoP/Cable 2-7, 3-7
VoP control 2-7
VoP correction 3-6, 3-7, 4-5

W

warranty W-2
water problems 3-19
waveform 6-23, 6-25
  comparison 6-23
  cursors 2-9
  deletion 6-28
  display 6-20
  recalling 6-27
  scaling 2-12
  scaling, horizontal 2-15
  scaling, vertical 2-14
wet area location 3-19
wire splice location 3-18

X

Xtalk 2-6, 3-21, 3-23, 6-6

Z

zoom 2-12, 6-18, 6-19

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