

TS2000 Series LAN Cable Certifier



TS2000 Series LAN Cable Tester

User's Guide

This document contains information proprietary to BLACK BOX[®] Corporation. The information in this document is not to be used or duplicated in any manner without prior written approval from BLACK BOX[®] Corporation.

BLACK BOX[®] and the BLACK BOX[®] logo are registered trademarks of BLACK BOX[®] Corporation.

All other product names mentioned in this book are trademarked or copyrighted by their respective manufacturers.

BLACK BOX[®] Corporation
1000 Park Drive
Lawrence, PA 15055-1018
Tech Support and Ordering: 724-746-5500
Fax: 724-746-0746

Manual Part No. TS2034 Rev B ENGLISH

© 2004, BLACK BOX[®] Corporation All Rights Reserved
Specifications subject to change without notice

Printed in USA 2004-09

BLACK BOX[®] Standard Warranty Policy

BLACK BOX[®] warrants that all Products manufactured or procured by **BLACK BOX[®]** conform to **BLACK BOX[®]**'s published specifications and are free from defects in materials and workmanship for a period of one (1) year from the date of delivery to the original Buyer, when used under normal operating conditions and within the service conditions for which they were designed. This warranty is not transferable and does not apply to used or demonstration products.

The obligation of **BLACK BOX[®]** arising from a Warranty claim shall be limited to repairing, or at its option, replacing without charge, any assembly or component (except batteries and cable adapters) which in **BLACK BOX[®]**'s sole opinion proves to be defective within the scope of the Warranty. In the event **BLACK BOX[®]** is not able to modify, repair or replace nonconforming defective parts or components to a condition as warranted within a reasonable time after receipt thereof, Buyers shall receive credit in the amount of the original invoiced price of the product.

BLACK BOX[®] must be notified in writing of the defect or nonconformity within the Warranty period and the affected Product returned to **BLACK BOX[®]**'s factory, designated Service Provider, or Authorized Service Center within thirty (30) days after discovery of such defect or nonconformity. Buyer shall prepay shipping charges and insurance for Products returned to **BLACK BOX[®]** or its designated Service Provider for warranty service. **BLACK BOX[®]** or its designated Service Provider shall pay costs for return of Products to Buyer.

BLACK BOX[®] shall have no responsibility for any defect or damage caused by improper storage, improper installation, unauthorized modification, misuse, neglect, inadequate maintenance, accident or for any Product which has been repaired or altered by anyone other than **BLACK BOX[®]** or its authorized representative or not in accordance with instructions furnished by **BLACK BOX[®]**.

The Warranty described above is Buyer's sole and exclusive remedy and no other warranty, whether written or oral, expressed or implied by statute or course of dealing shall apply. **BLACK BOX[®]** specifically disclaims the implied warranties of merchantability and fitness for a particular purpose. No statement, representation, agreement, or understanding, oral or written, made by an agent, distributor, or employee of **BLACK BOX[®]**, which is not contained in the foregoing Warranty will be binding upon **BLACK BOX[®]**, unless made in writing and executed by an authorized representative of **BLACK BOX[®]**. Under no circumstances shall **BLACK BOX[®]** be liable for any direct, indirect, special, incidental, or consequential damages, expenses, or losses, including loss of profits, based on contract, tort, or any other legal theory.

Index of Safety Precautions

BLACK BOX[®] recommends that the user review all of the information in Appendix A before using the TS2000 tester.

Important Notice

Charge Battery Packs Prior to Use

The battery packs in the Display and Remote Handsets are subject to discharge even when the units are turned off. With time on the shelf, the battery pack's charge levels may not support the instrument's operation. Refer to the User's Guide, *Chapter 4 Getting Started*, for charging instructions and observe all Safety Precautions in the front of the User's Guide.

Table of Contents

INDEX OF SAFETY PRECAUTIONS..... I

IMPORTANT NOTICE I

 CHARGE BATTERY PACKS PRIOR TO USE I

TABLE OF CONTENTS..... II

LIST OF FIGURES VIII

LIST OF TABLESIX

OPERATION NOTES, CAUTIONS, AND WARNINGS X

ABOUT THIS USER’S GUIDE.....XI

 CHAPTER 1 QUICK STARTXI

 CHAPTER 2 YOUR BLACK BOX® CABLE TESTERXI

 CHAPTER 3 SELF-TESTS, CALIBRATION, AND CONFIGURATIONXI

 CHAPTER 4 TS2000 CABLE TESTING FUNDAMENTALSXI

 CHAPTER 5 AUTOTESTING.....XI

 CHAPTER 6 ANALYZE TESTINGXII

 CHAPTER 7 USING BB RECORD MANAGER SOFTWARE.....XII

 APPENDIX A SAFETY PRECAUTIONS.....XII

 APPENDIX B CUSTOMER SUPPORTXII

 APPENDIX C SPECIFICATIONS.....XII

 APPENDIX D TIME DELAY REFLECTOMETRYXII

CHAPTER 1 QUICK START1-1

 CONTENTS 1-1

 WHAT’S IN THE BOX?..... 1-1

 TS2000 TESTER CHARACTERISTICS 1-2

 TS2000 TESTER OPTIONS AND ACCESSORIES 1-2

 QUICK START PROCEDURES 1-3

Power-up 1-3

Self-Test 1-3

Tester Calibration..... 1-3

Twisted Pair Cable Connections 1-4

Set Autotest Preferences 1-5

Perform Autotest on a Twisted Pair Cable..... 1-6

 NEXT STEPS 1-6

Chapter 2 Your BLACK BOX® Cable Tester..... 1-6

Chapter 3 Self-Tests, Calibration, and Configuration 1-7

<i>Chapter 4 TS2000 Cable Testing Fundamentals</i>	1-7
<i>Chapter 5 Autotesting</i>	1-7
<i>Chapter 6 Analyze Testing</i>	1-7
<i>Chapter 7 Using BB Record Manager Software</i>	1-7
CHAPTER 2 YOUR BLACK BOX® CABLE TESTER	2-1
CONTENTS	2-1
THE DISPLAY HANDSET.....	2-1
<i>The Display Handset</i>	2-1
<i>Ready Screen</i>	2-4
<i>Soft Keys</i>	2-6
<i>Display Handset Interface Ports</i>	2-8
<i>Connecting to a Printer</i>	2-9
THE REMOTE HANDSET	2-12
<i>Operational Sequence</i>	2-14
BATTERY AND POWER MANAGEMENT.....	2-14
<i>Operating the DH and RH from an AC Power Source</i>	2-15
<i>Battery Charging</i>	2-16
CHAPTER 3 SELF TESTS, CALIBRATION, AND CONFIGURATION	3-1
CONTENTS	3-1
SELF-TEST SCREEN.....	3-1
<i>Self Test Screens</i>	3-3
WARNING SCREENS	3-5
TESTER FIELD CALIBRATION	3-7
TESTER CONFIGURATION.....	3-10
<i>Entering User Information</i>	3-11
<i>Setting Autotest Preferences</i>	3-12
<i>Adjusting the Display Contrast</i>	3-13
<i>Setting Timeout Options</i>	3-14
<i>Setting Length Measurement Units</i>	3-15
<i>Configuring the PC or Printer Interface</i>	3-16
<i>Configuring the Talkset</i>	3-17
<i>Setting Date & Time</i>	3-18
<i>Selecting a Display Language</i>	3-19
<i>Restoring Factory Defaults</i>	3-20
<i>Clear Memory</i>	3-20
TONE GENERATOR.....	3-21
CABLE ID/AUTONAME OPTION.....	3-22
<i>Cable IDs and Test Numbering</i>	3-22
SELECTING A CABLE TYPE.....	3-28
CUSTOM CABLE SETTINGS.....	3-31
<i>Custom Cable Parameters</i>	3-35

CHAPTER 4 TS2000 CABLE TESTING FUNDAMENTALS	4-1
CONTENTS	4-1
INVASIVE LAN CABLE TESTING	4-1
TESTING TWISTED PAIR CABLES	4-2
<i>Shielded Twisted Pair (STP)</i>	4-3
<i>USOC Wiring</i>	4-4
<i>Permanent Link Test Setup</i>	4-5
<i>Channel Test Setup</i>	4-6
WIRE MAP TEST	4-7
<i>Wire Map Errors</i>	4-7
<i>Distance to Fault</i>	4-8
<i>Troubleshooting Wiremap Problems</i>	4-9
WIRE LENGTH TEST	4-10
<i>Wire Length Errors</i>	4-10
<i>Troubleshooting Wire Length Problems</i>	4-11
DC RESISTANCE TEST	4-11
<i>DC Resistance Errors</i>	4-11
<i>Troubleshooting DC Resistance Problems</i>	4-12
NEXT, ELFEXT, AND POWER SUM TESTS	4-13
<i>NEXT and ELFEXT Errors</i>	4-14
<i>Troubleshooting NEXT and ELFEXT Problems</i>	4-15
ATTENUATION TEST	4-16
<i>Attenuation Errors</i>	4-16
<i>Troubleshooting Attenuation Problems</i>	4-16
RETURN LOSS TEST	4-17
<i>Return Loss Errors</i>	4-17
<i>Troubleshooting Return Loss Problems</i>	4-17
AVERAGE IMPEDANCE TEST	4-18
<i>Impedance Errors</i>	4-18
<i>Troubleshooting Impedance Problems</i>	4-19
DELAY AND SKEW TEST	4-20
<i>Delay and Skew Errors</i>	4-20
<i>Troubleshooting Delay and Skew Problems</i>	4-20
CAPACITANCE TEST	4-21
<i>Capacitance Errors</i>	4-21
<i>Troubleshooting Capacitance Problems</i>	4-21
ACR TEST.....	4-22
<i>ACR and Power Sum ACR Errors</i>	4-22
<i>Troubleshooting ACR and Power Sum ACR Problems</i>	4-22
HEADROOM TEST	4-23
<i>Headroom Errors</i>	4-23
TESTING AND TROUBLESHOOTING 10BASE-T CABLING	4-24
TESTING AND TROUBLESHOOTING TOKEN RING CABLING	4-25
TESTING AND TROUBLESHOOTING WITH SPECIAL ADAPTERS.....	4-26
<i>Testing with 110 Connecting Block Adapters</i>	4-26

<i>Testing with Patch Cable Adapters</i>	4-26
<i>Testing with Custom Made Adapters</i>	4-27
<i>Patch Cable Testing</i>	4-28
CHAPTER 5 AUTOTESTING	5-1
CONTENTS	5-1
AUTOTEST OVERVIEW	5-1
<i>Test Suites</i>	5-1
<i>Test Setup</i>	5-4
<i>Test Sequence</i>	5-5
AUTOTEST PREFERENCES	5-6
<i>Setting your Autotest Preference Options</i>	5-6
RUNNING AUTOTEST	5-7
INTERPRETING AUTOTEST RESULTS	5-9
<i>Pass/Fail Reporting</i>	5-9
<i>Viewing Current Autotest Results</i>	5-11
<i>Understanding Test Failures</i>	5-12
<i>Using Jobs to Store Test Results</i>	5-13
<i>Saving Current Autotest Results</i>	5-15
<i>Printing Current Test Results</i>	5-17
<i>Viewing or Deleting Stored Autotest Results</i>	5-19
AUTOTEST GRAPHS	5-22
<i>Graphing Facts</i>	5-22
<i>Graph Formats, Layouts, and Controls</i>	5-25
CHAPTER 6 ANALYZE TESTING	6-1
CONTENTS	6-1
ANALYZE SINGLE TEST MODE OVERVIEW	6-1
<i>Analyze Test Descriptions and Availability</i>	6-2
<i>Test Setup</i>	6-2
<i>Test Sequence</i>	6-3
<i>Analyze Test Screens</i>	6-3
<i>Analyze Test Limitations</i>	6-3
RUNNING A SINGLE TEST.....	6-4
<i>Interpreting Analyze Test Results</i>	6-5
<i>Printing Analyze Test Results</i>	6-5
<i>Analyze Graphs</i>	6-6
CHAPTER 7 USING BB RECORD MANAGER SOFTWARE.....	7-1
CONTENTS	7-1
SYSTEM REQUIREMENTS.....	7-1
BB RECORD MANAGER INSTALLATION, STARTUP, AND NAVIGATION	7-2
<i>Installation Procedure</i>	7-2
<i>Starting the BB Record Manager Program</i>	7-2
TESTER TO PC CONNECTIVITY	7-3
<i>PC Cable</i>	7-3

<i>Establishing a Connection</i>	7-4
BB RECORD MANAGER USER INTERFACE	7-6
<i>The Menu Bar</i>	7-6
<i>The File menu</i>	7-7
<i>The Edit Menu</i>	7-9
<i>The View Menu</i>	7-11
<i>The Options Menu</i>	7-12
<i>The Help Menu</i>	7-12
<i>The Status Bar</i>	7-12
<i>The Toolbar</i>	7-13
<i>The Right Mouse Button</i>	7-14
BB RECORDS MANAGER HELP SYSTEM OVERVIEW	7-14
<i>Help Topic Menu Option</i>	7-14
<i>Help Topics Screen</i>	7-14
<i>Using Help Screen</i>	7-17
<i>About BBRM Screen</i>	7-18
PROGRAM CONFIGURATION	7-19
WORKING WITH DATABASES	7-20
<i>Creating a New Database</i>	7-20
<i>Opening an Existing Database</i>	7-21
WORKING AT THE JOB LEVEL	7-22
<i>Navigating the Job Tree</i>	7-22
<i>Adding a Job</i>	7-23
<i>Editing Job</i>	7-24
<i>Adding or Editing Customer Details</i>	7-25
<i>Adding or Changing the Test Set Operator Name</i>	7-26
<i>Finding a Job or Test</i>	7-27
WORKING AT THE TEST LEVEL	7-28
<i>Displaying the Test Grid</i>	7-28
<i>Viewing Test Details</i>	7-29
<i>Moving Tests Between Jobs</i>	7-30
<i>Adding and Editing Tests</i>	7-31
<i>Sorting the Tests</i>	7-32
<i>Finding Data</i>	7-33
BACKING UP AND RESTORING DATABASES	7-34
<i>Backing Up a Database</i>	7-34
<i>Restoring a Database</i>	7-34
<i>Uploading DH Tests to the PC</i>	7-35
PRODUCING AND PRINTING A REPORT	7-37
<i>Headers and Footers Command</i>	7-37
<i>Page Setup Command</i>	7-39
<i>Print Command</i>	7-40
<i>The Single Line Report Layout</i>	7-41
<i>The Brief Report Layout</i>	7-42
<i>The Detailed Layout</i>	7-44

APPENDIX A SAFETY PRECAUTIONS.....	A-1
CONTENTS	A-1
HANDLE BATTERY PACKS WITH CARE.....	A-1
STATEMENT OF LIABILITY	A-2
THANKS FOR HELPING TO PROTECT THE ENVIRONMENT.....	A-2
IMPORTANT USER INFORMATION.....	A-3
APPENDIX B CUSTOMER SUPPORT	B-1
CUSTOMER SERVICE.....	B-1
<i>Technical Assistance</i>	B-1
<i>Service in the USA</i>	B-1
<i>Service Outside the USA</i>	B-2
WORLD WIDE WEB	B-3
APPENDIX C SPECIFICATIONS.....	C-1
STANDARD AND OPTIONAL CABLES, ADAPTERS, AND ACCESSORIES.....	C-1
ENVIRONMENTAL AND PHYSICAL SPECIFICATIONS.....	C-2
<i>Temperature Range</i>	C-2
<i>Humidity</i>	C-2
<i>Shock/Bench Handling</i>	C-2
<i>Connector Stress</i>	C-2
<i>Dimensions and Weight</i>	C-3
<i>Battery and Power Management</i>	C-3
<i>Instrument Specifications</i>	C-4
APPENDIX D TIME DELAY REFLECTOMETRY	D-1
<i>How TDR Works</i>	D-1
TDR APPLICATIONS	D-1
HOW TO PERFORM TDR	D-4
<i>Test Setup</i>	D-4
<i>Running a TDR Analyze Function</i>	D-5
THE TDR PLOT	D-6
<i>TDR Plot Layout and Controls</i>	D-6
<i>Viewing TDR Results</i>	D-7
<i>Interpreting TDR Results</i>	D-9
<i>Storing, Retrieving, and Deleting TDR Results</i>	D-11

List of Figures

FIGURE 1-1: CONTENTS OF PACKAGE	1-1
FIGURE 2-1: DISPLAY HANDSET FRONT PANEL	2-2
FIGURE 2-2: READY SCREEN.....	2-4
FIGURE 2-3: DISPLAY HANDSET INTERFACE PORTS	2-8
FIGURE 2-4: REMOTE HANDSET.....	2-12
FIGURE 2-5: TESTER AC ADAPTER	2-15
FIGURE 3-1: TESTER FIELD CALIBRATION SETUP.....	3-7
FIGURE 3-2: TYPICAL TONE GENERATOR SETUP.....	3-21
FIGURE 3-3: CUSTOM CABLE PARAMETER SCREEN	3-35
FIGURE 4-1: TWISTED PAIR CABLES	4-2
FIGURE 4-2: SHIELD CONTINUITY TEST CONNECTIONS TWISTED PAIR	4-3
FIGURE 4-3: PERMANENT LINK TEST CONNECTIONS	4-5
FIGURE 4-4: CHANNEL TEST CONNECTIONS	4-6
FIGURE 4-5: 10BASE-T CONNECTOR.....	4-24
FIGURE 4-6: TOKEN RING TEST CONNECTIONS	4-25
FIGURE 4-7: CORD TEST OPTIONS.....	4-28
FIGURE 5-1: TABULAR DATA AND GRAPHICAL PLOT LAYOUT	5-26
FIGURE 7-1: PC UPLOADING CABLE PINOUT	7-3
FIGURE 7-2: PC/TESTER CONNECTION.....	7-4
FIGURE D-1: TDR GRAPHICAL PLOT.....	D-6
FIGURE D-2: GOOD TDR GRAPHICAL PLOT	D-9

List of Tables

TABLE 2-1: DISPLAY HANDSET (DH) FRONT PANEL	2-3
TABLE 2-2: READY SCREEN INDICATORS	2-5
TABLE 2-3: READY SCREEN FUNCTIONS	2-5
TABLE 2-3: READY SCREEN FUNCTIONS (CONTINUED)	2-6
TABLE 2-4: SOFT KEY DESCRIPTIONS	2-7
TABLE 2-5: DH CONNECTORS.....	2-9
TABLE 2-6: SERIAL PORT PIN ASSIGNMENTS	2-10
TABLE 2-7: REQUIRED PC SETTING FOR SERIAL PORT DATA STREAM	2-11
TABLE 2-8: RH BUTTONS, LED'S, AND CONNECTORS	2-13
TABLE 3-1: SELF TEST SCREENS	3-3
TABLE 3-1: SELF TEST SCREENS (CONTINUED).....	3-4
TABLE 3-2: WARNING SCREENS.....	3-5
TABLE 3-2: WARNING SCREENS (CONTINUED)	3-6
TABLE 3-3: UNSUCCESSFUL FIELD CALIBRATION CHECKLIST:	3-9
TABLE 3-4: AUTOTEST PREFERENCE OPTIONS	3-12
TABLE 3-5: DEFAULT TIMEOUT SETTINGS	3-14
TABLE 3-6: SINGLE ID COUNTING SAMPLES.....	3-24
TABLE 3-7: DOUBLE ID COUNTING SAMPLE.....	3-25
TABLE 3-8: CUSTOM CABLE PARAMETER OPTIONS	3-35
TABLE 3-8: CUSTOM CABLE PARAMETER OPTIONS (CONTINUED)	3-36
TABLE 4-1: TWISTED PAIR CABLE TYPES, ASSOCIATED NETWORKS, AND REQUIRED BLACK BOX® ADAPTERS:	4-3
TABLE 5-1: PRESET AUTOTEST SUITES AVAILABLE FOR SPECIFIC CABLE TYPES.....	5-2
TABLE 5-1: PRESET AUTOTEST SUITES AVAILABLE FOR SPECIFIC CABLE TYPES (CONTINUED)	5-3
TABLE 5-2: OVERALL TEST RESULT SYMBOLS	5-9
TABLE 5-3: INDIVIDUAL AUTOTEST REPORTS	5-9
TABLE 5-4: JOB OPTIONS	5-20
TABLE 5-5: TEST OPTIONS	5-21
TABLE 5-6: AUTOTEST GRAPH VIEW LAYOUT AND CONTROLS	5-27
TABLE 7-1: OPTIONS PULL-DOWN MENU	7-19
TABLE D-1: TDR GRAPHICAL PLOT LAYOUT AND CONTROLS	D-7

Operation Notes, Cautions, and Warnings

The following symbols are used in this manual to indicate that the user should take particular caution in order to prevent injury or damage to the tester or the system under test.



Exercise caution when you see this symbol. It indicates actions that could be harmful to the installer or to the equipment.



Exercise extreme caution when you see this symbol. It indicates potentially lethal voltages.

About This User's Guide

This document contains information and operational procedures that apply to the TS2000 tester.

Chapter 1 Quick Start

This chapter summarizes information and procedures for tester function, unpacking, setup, and operation.

Chapter 2 Your BLACK BOX[®] Cable Tester

This chapter describes the function of all controls and indicators. It also contains useful information regarding unit power management.

Chapter 3 Self-Tests, Calibration, and Configuration

This chapter describes the Startup screen, Tool icons, and Hard and Soft Key menus. It also explains how to run and interpret Self-Tests, respond to Warning screens, calibrate and configure the tester, and use the Tone Generator and Audio Talk Set.

Chapter 4 TS2000 Cable Testing Fundamentals

This chapter describes test setup, physical and electrical characteristics of cables, test descriptions, and test storage and data management procedures. This chapter also describes how to set up different cabling tests, what to do when tests fail, and typical causes of test failure.

Chapter 5 Autotesting

This chapter describes the Autotest function, and provides instructions for setting up test preferences. This chapter also describes individual tests that run during an Autotest, and provides instructions for viewing and interpreting Autotest results.

Chapter 6 Analyze Testing

This chapter describes the Analyze test function, and provides instructions for setting up test preferences and running an Analyze test. This chapter also describes each Analyze test, and provides instructions for viewing and interpreting test results.

Chapter 7 Using BB Record Manager Software

This chapter contains procedures for BB Record Manager software installation, configuration, operation, uploading test data into a PC database, and viewing and printing test reports.

Appendix A Safety Precautions

This appendix reviews safety information regarding setup and use of the tester.

Appendix B Customer Support

This appendix contains information regarding Customer Service and Tech Support.

Appendix C Specifications

This appendix contains information regarding standard and optional cables, adapters, accessories, and unit specifications.

Appendix D Time Delay Reflectometry

This appendix contains information regarding TDR applications and examination of results.

Contents

- Feature information for the experienced LAN cable tester
- Quick steps for tester calibration, setup, test modes, and operation

What's in the Box?

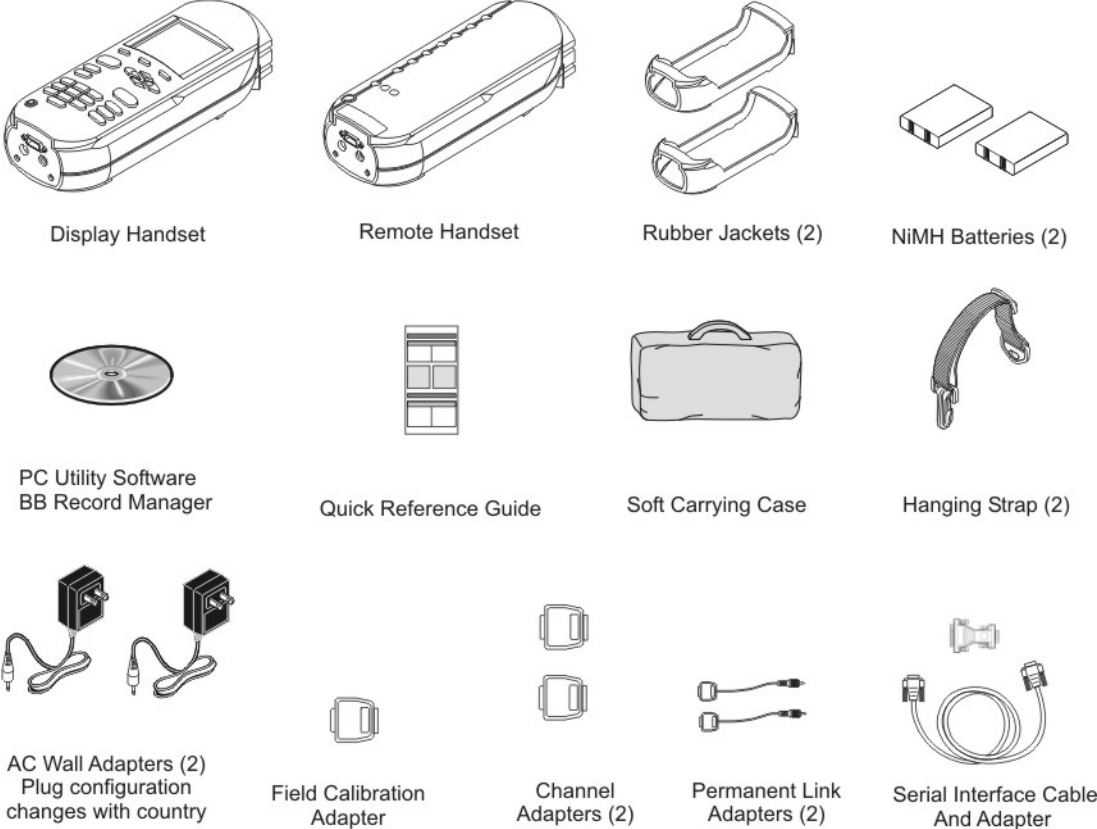


Figure 1-1: Contents of Package

TS2000 Tester Characteristics

Frequency Test Range	300 MHz
Highest Level of Standards Category Compliance	CAT 6,Class E with Headroom
Accuracy	Level III
Number of Test Records Stored	1500
Protective Rubber Boot on Both Handsets	Yes
Built-In Tone Generator	Yes
Talkset Capability	Yes
BB Record Manager Software Program Included	Yes
Use with Additional Remote Handset	Yes
Fiber Optic Cable Testing Capability	Yes
Deluxe Hard Shell Carrying Case Included	Yes
Basic/Permanent Link Adapter	Yes
Channel Link Adapter	Yes

TS2000 Tester Options and Accessories

110-Block Adapter Set	Yes
Token Ring Adapter Set	Yes
COAX Adapter Kit	Yes
Dual-Bay, Battery Quick Charger	Yes
Spare/Replacement Battery	Yes
Fiber Optic Cable Testing Capability	Yes

Quick Start Procedures

The objective of this section is to supply a *highly experienced cable installer* with enough information to perform an Autotest on a twisted pair cable.

Power-up

Power up the Display Handset by pressing the **On/Off** key.

Note: The Remote Handset will be powered up automatically by the Display Handset when the test begins.

Self-Test

When the TS2000 tester is turned on, it displays a *Self-Test In Progress* message and performs a quick self-test. An alert message is displayed if the self-test determines that calibration or repair is necessary.

Tester Calibration

A calibration screen will always appear 24 hours after the last field calibration. To recalibrate the tester perform the following steps:

1. Connect the DH and RH end-to-end using the Field Calibration Adapter.
2. From the DH **Ready** screen, select the **Field Calibration** icon.
3. Press the **Tone Key** on the RH. The unit turns on and indicates a test is running.
4. Select the **Run** option on the DH.

If the calibration was successful, remove the Field Calibration Adapter and proceed to the next section.

If the calibration was unsuccessful, proceed to *Chapter 3, Tester Field Calibration*. If you are unable to fix the problem, contact your local distributor or a BLACK BOX® Tech Support for assistance.

Twisted Pair Cable Connections

Most Autotests are performed with the DH and RH connected at opposite ends of the cable under test. The minimum level of connectivity required depends on the test and cable type selected.

- Some tests can be performed *without* the RH. Stored test results or test printouts will indicate the presence or absence of the RH during the test.
- If the test requires the RH, the DH will first attempt to communicate with the RH. If unable to communicate, the DH will display a message that it is looking for the RH.

Observe the following cautions while connecting the tester.

Shielded Cabling Systems



Do not create testing ground loops with shielded cable systems. Shielded cable systems (i.e., Token Ring, 4 pair STP, or Coaxial) present a unique testing problem due to the cable shield's ground connection. The TS2000 units can test these systems to specifications only if the handsets are operated on battery power and not connected to a PC or printer using a copper serial cable.

If connection to a printer or PC is essential to perform testing, BLACK BOX® recommends using battery operated devices and removing any wall power charging inputs. If this is not possible, an optically isolated serial cable should be used during testing to isolate the tester from all other ground connections.

TELCO Lines



Do not connect the tester to live/active TELCO lines. If you accidentally plug the unit into outlets with active TELCO present (indicated by a “Voltage Exceeds Limits” warning message) disconnect the tester immediately.

Permanent Link Test Setup

1. Attach the Permanent Link Adapters to both the Display and Remote Handsets.
2. On the horizontal network cable to be tested, disconnect the corresponding user patch cords from the network patch panel and the RJ-45 wall outlet.
3. Connect the DH Permanent Link Adapter to the network patch panel, and the RH Permanent Link Adapter to the wall outlet.

Note: Don't forget to change the Cable Type to Permanent Link.

Channel Test Setup

1. Attach the Channel Adapters to both the Display and Remote Handsets.
2. On the horizontal network cable to be tested, disconnect the corresponding user patch cords from the network equipment.
3. Connect the DH Channel Adapter to the network patch panel user patch cord, and the RH Channel Adapter to the wall outlet user patch cord.

Note: Don't forget to change the Cable Type to Channel.

Set Autotest Preferences

Autotest is the most frequently used test mode. A number of preferences can be selected for the Autotest function. The tester can be set to:

- Stop on a test failure

- Automatically save test results
- Automatically increment test names
- Display graphs of passed tests

To set Preferences:

1. Open the Autotest **Preferences** screen. Set preferences as required (refer to *Chapter 3, Set Autotest Preferences*).

Perform Autotest on a Twisted Pair Cable

The selection of cable type determines the default tests included in an Autotest suite.

1. Select the **Cable Type** (refer to *Chapter 3, Selecting Cable Type*).
2. Press the **Autotest** key to begin testing. The cable tester will perform a predefined test suite.
3. The test result is displayed below the Title Bar at the top right corner. A boxed checkmark indicates an overall pass.
4. To interpret, save, or print an Autotest result, refer to *Chapter 5, Autotesting*.

Next Steps

Refer to the following chapters for more information regarding the setup and operation of the TS2000 tester.

Chapter 2 Your BLACK BOX[®] Cable Tester

This chapter describes the TS2000 tester controls, indicators, and screens. It also contains information regarding tester power management.

Chapter 3 Self-Tests, Calibration, and Configuration

This chapter also explains how to run and interpret Self-Tests, respond to Warning screens, calibrate and configure the tester, and use the Tone Generator and Audio Talk Set.

Chapter 4 TS2000 Cable Testing Fundamentals

This chapter describes physical and electrical characteristics of cables, test descriptions, and test storage and data management procedures. This chapter also describes how to set up different cabling tests, what to do when tests fail, and typical causes of test failure.

Chapter 5 Autotesting

This chapter describes the Autotest function, and provides instructions for setting up test preferences. This chapter also describes individual tests that run during an Autotest, and provides instructions for viewing and interpreting Autotest results.

Chapter 6 Analyze Testing

This chapter describes the Analyze test function, and provides instructions for setting up test preferences and running an Analyze test. This chapter also provides instructions for viewing and interpreting test results.

Chapter 7 Using BB Record Manager Software

This chapter describes how to upload test data from the TS2000 tester to an IBM-compatible PC, and how to organize and print the test data.



Contents

- Tester controls and indicators
- Tester Ready screen
- Useful information about power management

The Display Handset

The TS2000 is a high-performance, portable LAN cable tester designed to test and measure twisted pair and coaxial cable used for high speed data communications networks.

The Display Handset

Figure 2-1 shows the controls and indicators of the Display Handset (DH). Table 2-1 provides a brief description of each DH feature.

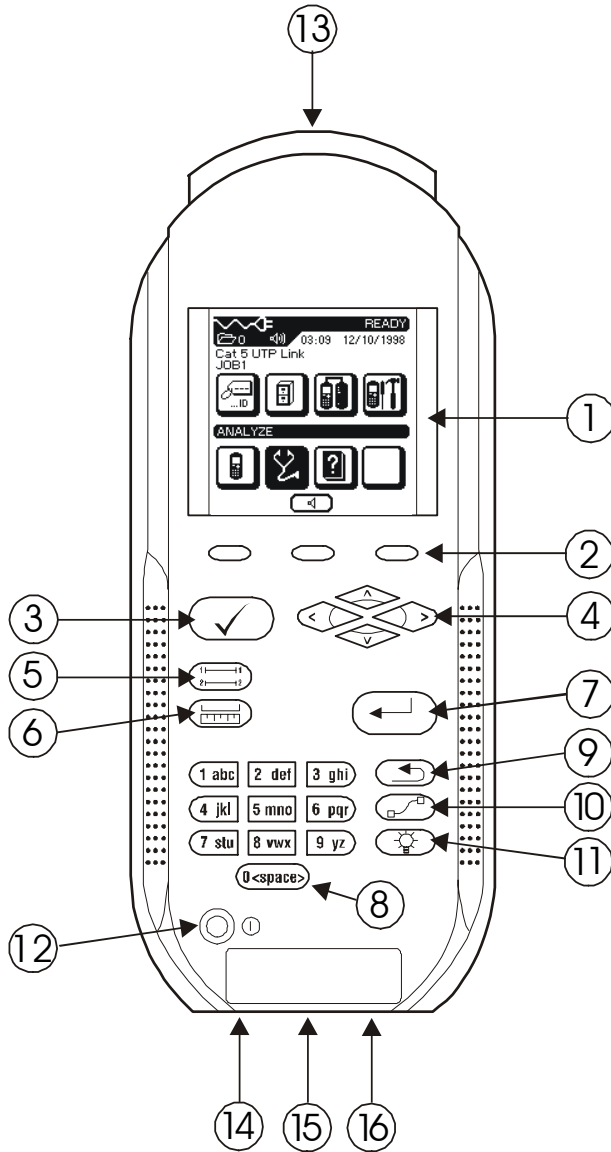


Figure 2-1: Display Handset Front Panel

Table 2-1: Display Handset (DH) Front Panel

Callout	DH Front Panel	Description
1	Graphical Display	Present menus, test results, graphs, action choices and option keys.
2	Option Keys	Select menu options displayed on screen.
3	Autotest Key	Perform a fast suite of tests. Test results are presented as pass/fail. Suites for established standards are preprogrammed in the tester.
4	Arrow Keys	Allow up, down, left, and right movement on the display.
5	Wiremap Key	Find shorts, opens and miswires such as split and reversed pairs.
6	Length Key	Initiate a Length test.
7	Enter Key	Select a highlighted option. Save changes.
8	Alphanumeric Keys	Enter numbers, letters or special characters. Select numbered menu options.
9	Escape Key	Abort and exit the current screen without making changes.
10	Cable Selection Key	Select a cable type.
11	Backlight Key	Toggle the screen backlight on/off.
12	On/Off Switch	Power the Display Handset on/off.
13	Low-Crosstalk Connector Port	Connect a test access cable.
14	Talkset Jack	Connect an Optional Talkset.
15	DB-9 Serial Port	Printer and PC upload port. Also used to load software upgrades.
16	DC Input Jack	Connect an external power supply.

Ready Screen

The Ready screen appears when the unit is powered up (if the unit has been calibrated within 24 hours) or after field calibration.

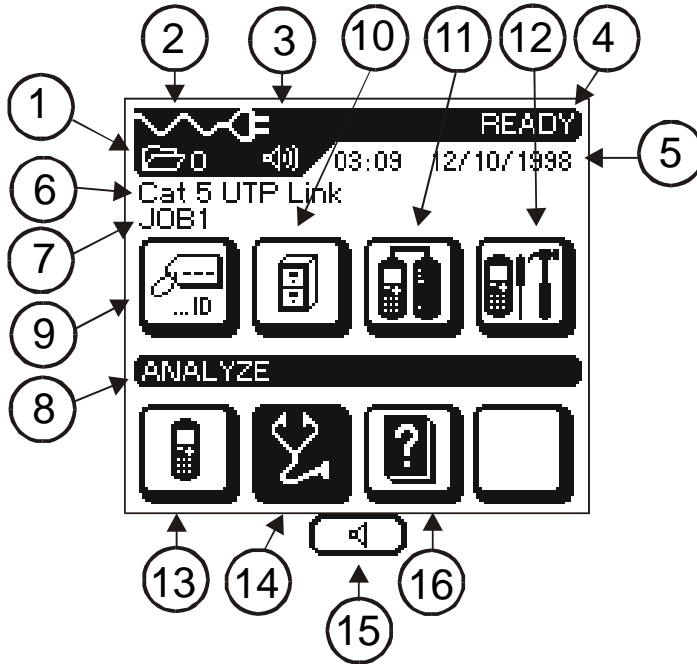


Figure 2-2: Ready Screen

Table 2-2: Ready Screen Indicators

Indicator	Function	Description
1	Memory Usage	Display the total number of records stored.
2	Battery Meter	Display remaining battery power level (from Empty to Full).
	AC Cable	Indicate when the unit is running off AC power.
3	Talk Set Indicator	Indicate when the Talk Set function is available.
4	Screen Title	Display the Screen Title.
5	Time and Date	Display time and date information.
6	Setting	Display the cable type selected for testing.
7	Label	Display the current job name.
8	Label	Display the screen title for the highlighted function.

Table 2-3: Ready Screen Functions

Icon	Function	Purpose
9	Cable ID	Select the cable naming function.
10	Test Record	Select the stored test file manager.
11	Field Calibration	Select the field calibration screens.
12	Preferences	Select the instrument preferences screen.



(Table Continues)

Table 2-3: Ready Screen Functions (Continued)

Icon	Function	Purpose
13	Instrument Information	Select the instrument information screen.
14	Analyze	Select option to perform individual cable tests (real time).
15	Talk Set Select	Activate/deactivate the Talk set function.
16	Help	Select the Information Screen.

Soft Keys

User options will often appear at the bottom of the tester display screen. These action items (soft keys) are positioned over the three function keys directly below the display screen. To select an action item, press its corresponding function key.

In the example below, you would press the **Function** keys directly below  or  to adjust the Timeout options.

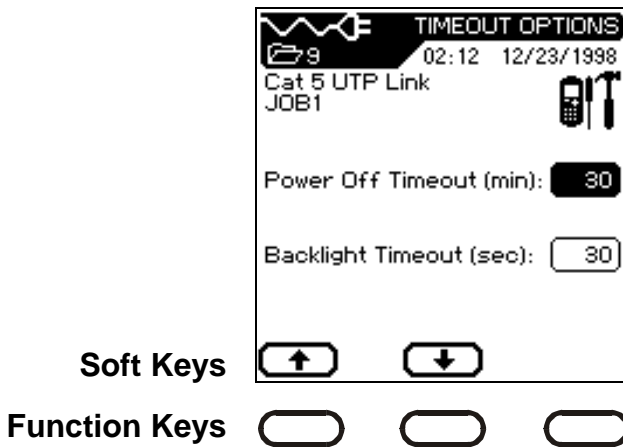














Table 2-4: Soft Key Descriptions

Soft Key	Description
	Okay or confirm an action.
	Stop or cancel an action.
	Print data.
	Save data using Auto Increment naming convention.
	Overwrite or rename data.
	Run the selected test in continuous mode (real time).
	Page-up for information.
	Page-down for information.
	<p>Select/Deselect an item in a list box.</p> <ul style="list-style-type: none"> • Check boxes are on-off switches. • If a check box is turned on, the box will contain a check mark.
	Select an action item.
	Activate/Deactivate the Talk Set option.
	Delete characters.

Display Handset Interface Ports

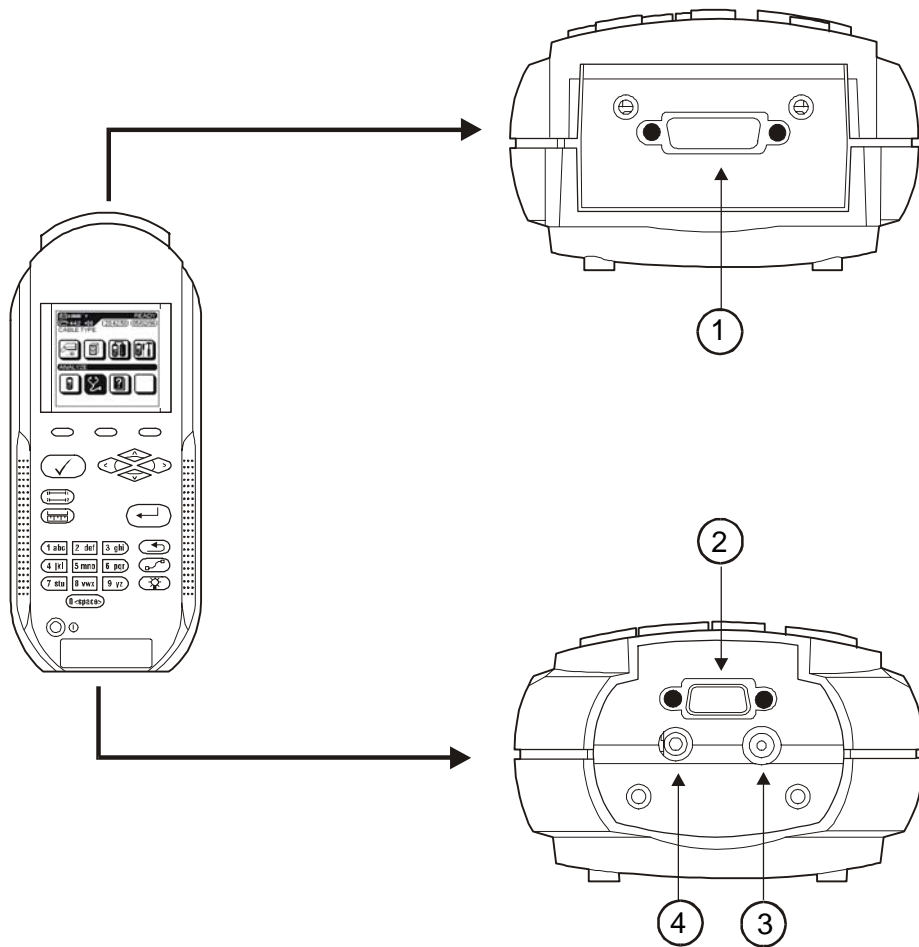


Figure 2-3: Display Handset Interface ports

Table 2-5: DH Connectors

Callout	Connector	Description
1	Low-Crosstalk Connector	Attach adapters for all types of cables.
2	DB-9 Serial Port	Supports the following functions: <ul style="list-style-type: none"> • Print test results on a serial printer. • Upload stored test results to a PC. • Load firmware upgrades.
3	DC Input Jack	Used to charge the battery in the handset.
4	Talkset Jack	Used to connect the optional Talkset to the tester.

Connecting to a Printer

Test results can be printed during Autotest, Fault Find or from memory using a serial printer. The testers are compatible with any serial printer that conforms to Epson or ASCII serial printer commands.

To connect a printer:

1. Connect the tester to the printer serial port.
2. Make sure the printer is powered up and on-line.
3. The tester is capable of supporting a baud rate of up to 115,000. Determine the printer baud rate, handshake (XON/XOFF is ON or OFF), and change the defaults using the Preferences screen. Refer to *Chapter 3, Self-Tests, Calibration, and Configuration* for setup information.

Table 2-6: Serial Port Pin Assignments

Pin	DTE Mode	DCE Mode
1	Data Carrier Detect	Data Carrier Detect
2	Transmit	Receive
3	Receive	Transmit
4	Data Terminal Ready	Data Terminal Ready
5	Ground	Ground
6	Data Set Ready	Data Set Ready
7	Ready To Send	Ready To Send
8	Clear To Send	Clear To Send
9	Not Connected	Not Connected
S	Shield	Shield

Note: DTE - DCE is selectable in the Setup menu, however DTE is the Default Mode.

Table 2-7: Required PC Setting for Serial Port Data Stream

Parameter	Setting
Data Length	8 bits, no parity
Start/Stop bit	1/1
Speed	1200 to 115,000 baud rate user selectable
Control	CTS

The Remote Handset

The RH (Remote Handset) works with the DH (Display Handset) to perform Autotest or individual real time Analyze tests. The RH terminates the cable link and communicates with the DH. The RH is automatically activated by the DH and does not have a separate power-on key. The RH does need to have power available when performing a field calibration, otherwise, the DH will not find it.

Figure 2.4 shows the controls and indicators of the Remote Handset (RH). Table 2-8 provides a brief description of each RH feature.

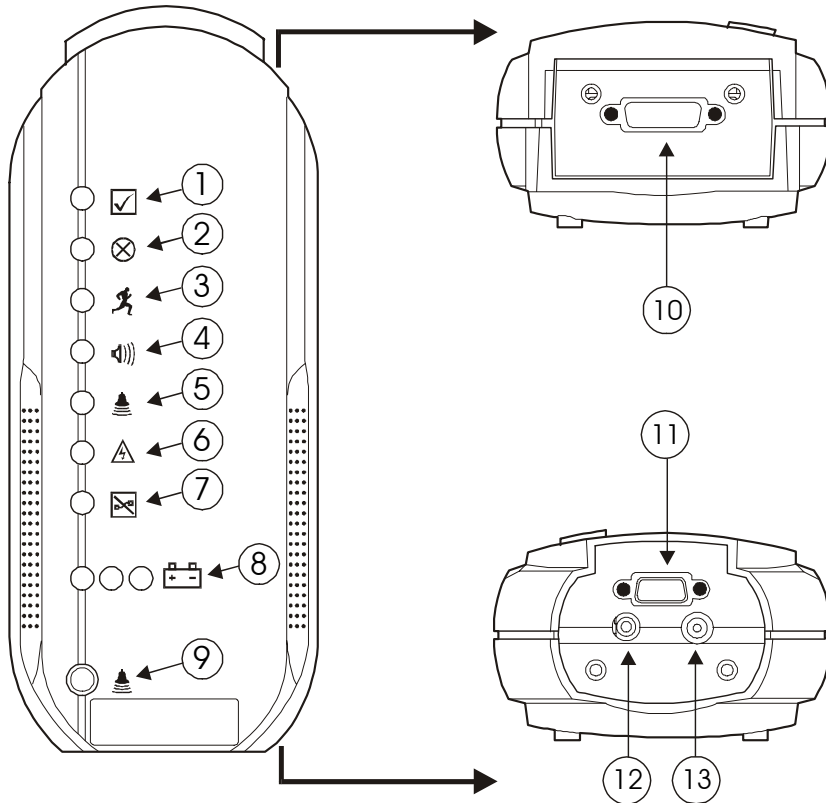


Figure 2-4: Remote Handset

Table 2-8: RH Buttons, LED's, and Connectors

Callout	RH Front Panel	Description
1	Pass LED	Successful test results
2	Fail LED	Unsuccessful test results
3	Testing LED	Test in progress
4	Talkset LED	Talkset is active
5	Tone LED	Toner is in operation
6	High Voltage LED	Excessive line voltage present (TELCO)
7	No Patch Cable LED	No patch cable connected
8	Battery Level LED's	Remaining battery life
9	Tone switch	Press to activate/deactivate Toner
10	Low-Crosstalk Connector Port	A test access cable connector
11	DB-9 Serial Port	Use to interface to a PC
12	Talkset Jack	Connect an Optional Talkset
13	DC Input Jack	Connect an external power supply

Operational Sequence

- The DH searches for the RH.
- During *testing*, if the two handsets are unable to communicate, the DH will display a message that it is searching for the RH and continue trying to establish communications until you manually cancel the operation or the RH is found. If the handsets are unable to establish communication, check the links to verify proper connection.
- During *field calibration*, if the two handsets are unable to communicate, the DH will display a message instructing you to connect the DH and RH together using the calibration adapter. If you attempt to run the test without the adapter, the DH will display a warning message.
- After a brief period of inactivity, the RH automatically powers down to save battery power.

Battery and Power Management

Both the Display and Remote Handsets use interchangeable, rechargeable NiMH (Nickel Metal-Hydride) battery packs.

- The DH (Display Handset) can be run on battery power for approximately eight hours. Actual battery power times will vary because of factors such as the tester model, operating time versus standby time, use of the display backlight, and temperature.
- When the battery is almost empty, the tester displays a warning message. The tester will automatically shut down before testing results are affected.
- The RH (Remote Handset) can be run on battery power for approximately ten hours.

Operating the DH and RH from an AC Power Source

The DH and RH handsets can be operated from an external DC source (Wall Cube).

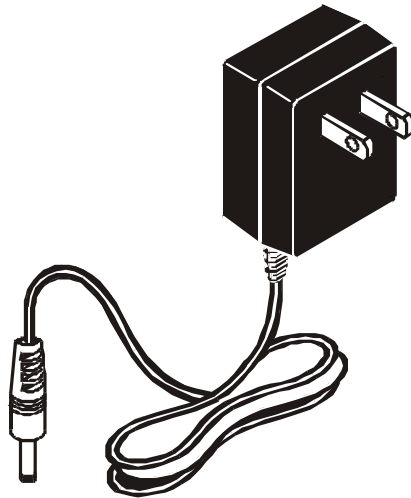


Figure 2-5: Tester AC Adapter

When the AC Wall Cube Adapter is used to power the handsets:

- Both handset batteries will receive a trickle charge.
- The DH handset will display the AC plug and cable indicator at the top left of the screen.
- All three RH battery power LEDs will illuminate when the unit is activated by the DH.



Only the Power Cube provided with the instrument should be used. Other types of Power Cubes may cause damage to the tester.

Battery Charging

The handset batteries are recharged using the AC Wall Cube. The DH uses battery powered flash ROM to store handset data and settings whenever the battery is removed from the tester. The internal flash ROM battery has a three year life expectancy.

Using the AC Wall Cube Adapters:

- The batteries can be recharged in the handsets (using the AC Wall Cube) in about 8 hours.

Chapter 3

Self Tests, Calibration, and Configuration

Contents



- Running and interpreting Self Tests
- Responding to Warning screens
- Calibrating and configuring the tester
- Using the Tone Generator and the Audio Talk Set
- Creating and using custom cable settings

Self-Test Screen

If you suspect a problem, self tests can be used to evaluate tester performance. The following self test options are available:

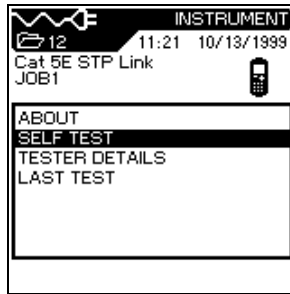
- Instrument
- Keyboard
- RS232 Interface

To run a self test:

1. In the **Ready** screen, select the Instrument  icon and press **Enter**  to open the Instrument screen.

The Instrument screen will list a set of user options that can be performed by the tester.

2. Use the **Arrow** keys to position the cursor bar on the **Self Test** option.



3. Press  to open the Self Test screen.

4. Use the **Arrow** keys to position the cursor bar on the desired **Self Test** option.



In this example, press the **Down Arrow** key once to select **Keyboard**.



5. Press **Enter**  to start the Keyboard Test.

The Keyboard Test screen displays.






6. While the Keyboard Test is running, press suspected bad key(s) and observe the display screen for a response.
7. When you are finished testing, press  to return to the Self Test screen.
8. For some tests, the **Stop/Cancel**  button will end the test in progress.

Self Test Screens


The Self Test screens allow you to monitor the progress and results of each test. Refer to the following table for a brief description of self test screens.

Table 3-1: Self Test Screens

Test	Screen	Description
Instrument	 <p>The screenshot shows the 'INSTRUMENT TEST' screen. At the top, it displays '01:30 12/21/1998' and 'Cat 5 UTP Link JOB1'. The main text reads 'Instrument Self Test Passed' with a checkmark icon below it.</p>	<p><input checked="" type="checkbox"/> The instrument self test was successful.</p> <p><input type="checkbox"/> The instrument self test has failed.</p> <p>Press the Run  key and proceed to the next error, if there has been more than one error.</p>
Keyboard	 <p>The screenshot shows the 'KEYBOARD TEST' screen. At the top, it displays '11:17 12/20/1998' and 'Cat 5 UTP Link JOB1'. The main text reads 'Keyboard Test Press Key' followed by 'Key:'.</p>	<p>The instrument is performing a keyboard self test.</p>

(Table Continues)



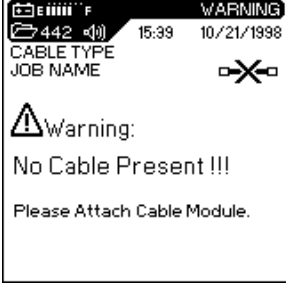
Table 3-1: Self Test Screens (Continued)

Test	Screen	Description
RS232 Serial Interface		The handset is transmitting a test message to the RS232 printer port.

Warning Screens

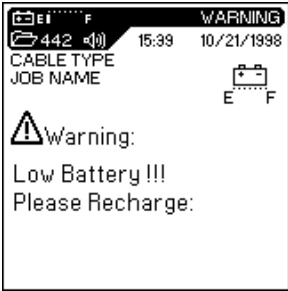
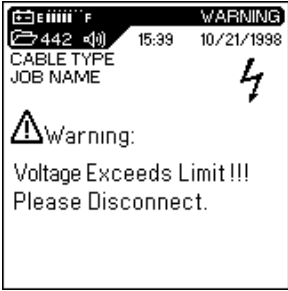
In response to a failure, harmful condition, or operational limitation, the tester will often display a warning screen.

Table 3-2: Warning Screens

Warning	Screen	Description
Memory Is Almost Full	 <p>The screen displays a warning icon, the text 'Warning: Memory Is Almost Full !!!', and 'You Should Upload Results Before Storing Any More.' The status bar shows '990' and '1200'.</p>	Tester memory is 80% full. You must upload or delete data to stop this message from appearing.
Memory Is Full	 <p>The screen displays a warning icon, the text 'Warning: Memory Is Full !!!', and 'You Must Upload Results Before Storing Any More.' The status bar shows '1000' and '1500'.</p>	A save operation has filled the tester's memory. You must upload or delete data to stop this message from appearing.
No Cable Present	 <p>The screen displays a warning icon, the text 'Warning: No Cable Present !!!', and 'Please Attach Cable Module.' The status bar shows '442' and a crossed-out cable icon.</p>	An operation requiring a cable type has been attempted without first connecting a patch cable to the unit.

(Table Continues)

Table 3-2: Warning Screens (Continued)

Warning	Screen	Description
Low Battery		<p>Handset battery voltage is low.</p> <p>This screen will continue to appear every time a Hard key is pressed or when you return to the Tools screen.</p> <p>Replace or recharge the battery to turn off this warning screen.</p>
Input Voltage Exceeds Limits		<p>High voltage has been detected on the connector pins.</p> <p>The warning message will stay on until the high voltage is removed.</p>

Tester Field Calibration

The TS2000 tester requires field calibration every 24 hours. A calibration reminder message will appear on the display handset screen when calibration is required.

Before performing field calibration, connect the Display and Remote Handsets together using the calibration connectors as shown below. Turn on the power to both the DH and RH before performing unit calibration.

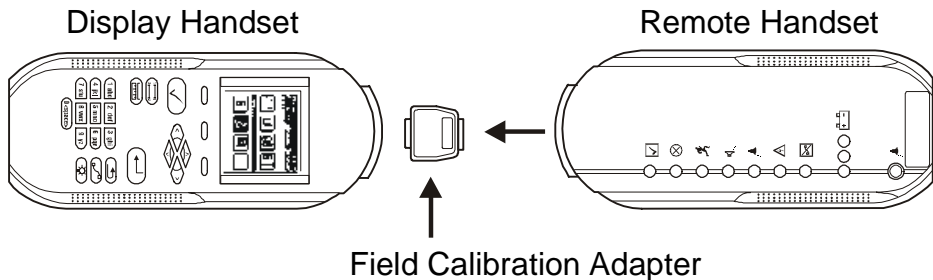




Figure 3-1: Tester Field Calibration Setup

To calibrate the tester:


1. From the **Ready** screen, select the **Field Calibration**  Icon. The Calibration screen appears.

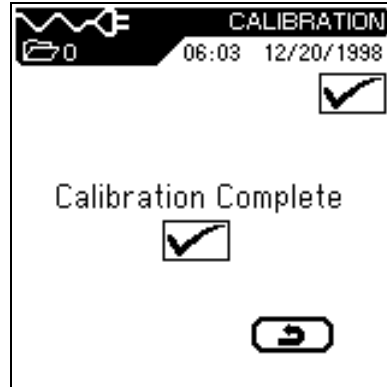
Activate the remote handset by pressing the **Tone Key**.



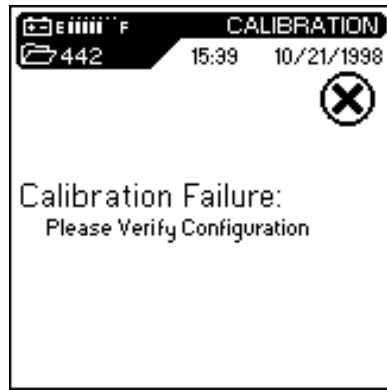
2. Press  to begin the calibration process. Calibration takes approximately one minute.

Chapter 3 Self Tests, Calibration, and Configuration

3. If calibration is successful, a **Calibration Complete**  symbol appears.
4. After a brief period, the tester returns to the **Ready** screen.



5. If calibration is unsuccessful, the tester will briefly display one of the following Error screens.



6. The tester display returns to the **Ready** screen upon exit from a calibration error screen.

Note: An Autotest failure will occur if the field calibration is out of date.

Table 3-3: Unsuccessful Field Calibration Checklist:


Action	Result
Check the battery power on both the Display and Remote Handsets.	Check the DH for a low battery message. If the Display Handset indicates a low battery, you must recharge the battery before the unit will pass calibration. The RH will not respond if its battery is low.
Check the calibration adapter.	Make sure the adapter is correctly seated and that there are no bent pins.

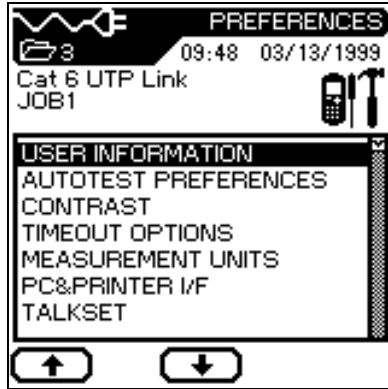
If you are unable to successfully calibrate the tester, contact your BLACK BOX[®] Tech Support for assistance.

Tester Configuration

Most tester configuration parameters are set from the Preferences screen.

To open the Preferences screen:

1. From the Ready screen, select the **Instrument**  Icon. The Preferences screen displays.




2. Use the **Arrow** keys to select one of the following options:
 - Enter User Information
 - Set Autotest Preferences
 - Adjust Display Contrast
 - Set Time-out Options
 - Set Measurement Units
 - Configure the PC & Printer I/F
 - Configure the Talkset Option
 - Set Date & Time
 - Select Display Language
 - Restore Factory Defaults
 - Clear Memory



Entering User Information

User information identifies the unit operator for test reports.

1. From the Preferences screen, select the **User Information** option. The User Information screen displays.



The screenshot shows a terminal-style interface titled "USER INFORMATION". At the top, it displays a folder icon with the number "3", the time "09:51", and the date "03/13/1999". Below this, it shows "Cat 6 UTP Link" and "JOB1" next to a small icon of a handheld device. The main section contains three input fields: "Name:" with "OPERATOR NAME", "Company:" with "COMPANY NAME", and "Contractor:" with "CONTRACTOR NAME". At the bottom, there is a button with a double arrow icon.

2. Use the **Alphanumeric** keys to enter your name.
3. Use the **Down Arrow** key to move to the company name or contractor name field.
4. Use the **Alphanumeric** keys to enter a name. Use the **Right Arrow** key to advance from one character to the next.
5. Press **Enter**  to save or **Escape**  to exit without saving changes.

Setting Autotest Preferences

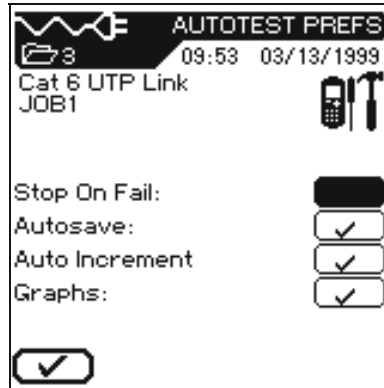
Autotest can be set to automatically stop on the first failed test, and to print, save, and name test results at the completion of each test series.


Table 3-4: Autotest Preference Options




Option	Action
Stop on Fail	Autotest aborts at the first failed test. Otherwise, Autotest continues until all tests are completed, regardless of results. <i>Note: If a wire map cannot be reliably completed due to gross miswiring, the Autotest may abort regardless of the setting of this preference.</i>
Auto Increment	Autotest automatically increments the Single and Double Cable ID test counters.
AutoSave	Autotest automatically names and saves any passed Autotest results. Failed tests are <i>not</i> automatically saved.
Graphs	Displaying graphs on the DH requires data to be transferred from the RH to the DH. To save time during testing, do not select this option.

1. From the Preferences screen, select the **Autotest Preferences** option. The Autotest Preference screen displays.

Use the **Arrow** keys to position the cursor next to the desired option.

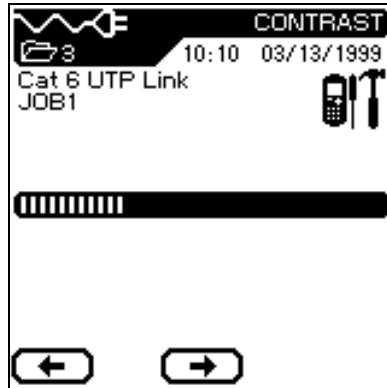






2. Press  to select or deselect an option.

3. Press **Enter**  to activate the selected Autotest Preferences.
4. Press **Enter**  to save or **Escape**  to exit without saving changes.

Adjusting the Display Contrast

1. From the Preferences screen, select the **Display Contrast** option. The Display Contrast screen displays.



2. Press the  or  key to adjust the screen contrast.
3. Press **Enter**  to save or **Escape**  to exit without saving changes.

Setting Timeout Options

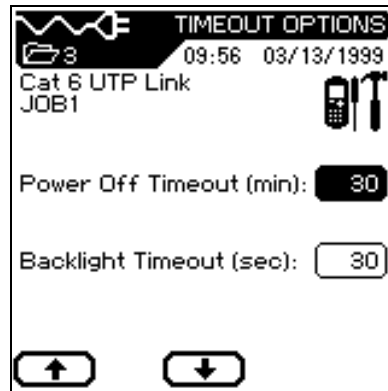
Use this option to set tester time-out options to help conserve battery power when the tester is not in use.







Table 3-5: Default Timeout Settings

Backlight	30 seconds
Power	30 minutes

1. From the Preferences screen, select **Timeout Options**. The Timeout Options screen displays with the cursor on the **Backlight Timeout** option.

Note: The timers begin counting from the last key press.

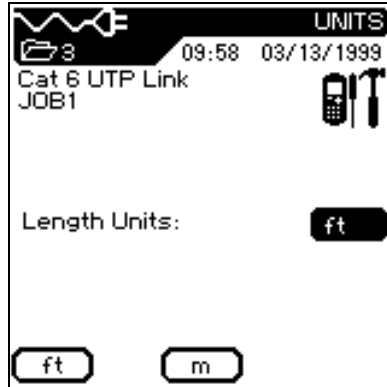




2. Press the  or  soft key to adjust the Backlight Timeout setting.
3. Press the **down cursor arrow** to select the Power Off Timeout option.
4. Press the  or  soft key to adjust the Power Off Timeout parameter.
5. Press **Enter**  to save or **Escape**  to exit without saving changes.

Setting Length Measurement Units

Use this option to set the unit of measurement parameter for length measurements. The unit default setting is “feet.”

1. From the Preferences screen, select the Measurement Units Option. The Measurement Units screen appears.



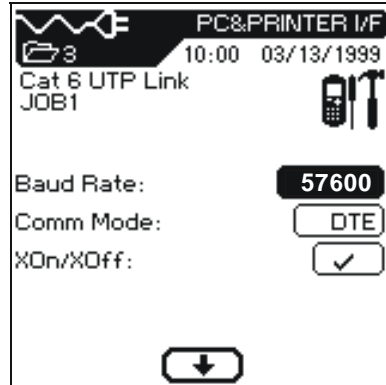
2. Select the **left or middle option** key to set the unit of measure parameter to feet or meters.
3. Press **Enter**  to save or **Escape**  to exit without saving changes.





Configuring the PC or Printer Interface

Use this option to configure the serial port and select the type of printer being used.

1. From the Preferences screen, select the **PC & Printer I/F** option. The PC & Printer I/F screen appears.

Note: DTE is selected for uploading to a PC. DCE is selected for direct printing to a printer using the serial port.



2. Press the **Arrow** keys to position the cursor next to the desired parameter.
3. Press the  or  key to select the desired setting.
4. Press **Enter**  to save or **Escape**  to exit without saving changes.

Configuring the Talkset



The TS2000 tester is “talkset ready.” Use this option to establish communications between the DH and the RH through an externally attached microphone/headset.

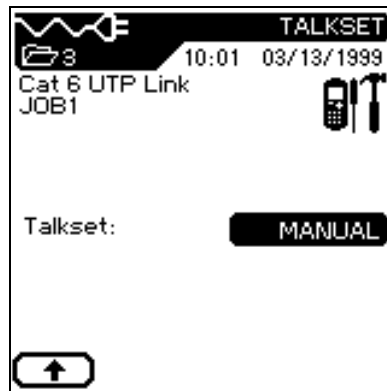
There are two modes of talkset operation: manual and auto.



- In manual mode, the talkset option is activated or deactivated using the soft keys at the bottom of the DH screen.
- Selecting Automatic in the Talkset Preference screen will enable the talksets after each Autotest.

During testing (Autotest or Analyze), the talksets are temporarily disabled until the test has completed. The talkset stays active until the cable under test connection is broken, the talkset cable is unplugged, or the option is deactivated by toggling the “speaker” soft key icon at the bottom of the Ready screen. The state of this selection is indicated by the “speaker” icon at the top of each screen and the “Talkset LED” on the RH.

1. From the Preferences screen, select the **Talkset** option. The Talkset screen displays.
2. Press the **Arrow** keys to position the cursor next to the desired parameter

The default setting for Talkset is “Manual”. Press the  or  key to select the desired setting.

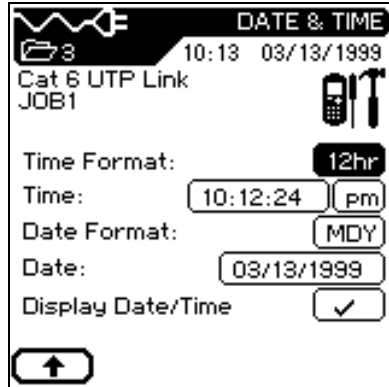






3. To talk with someone using the talkset both the Display Handset and the Remote Handset must be connected to a cable with the TS2000 adapters.
4. Adjust the audible volume in the earpiece by using the volume control wheel on the talkset's cord.
5. Press **Enter**  to save or **Escape**  to exit without saving changes.

Setting Date & Time

Accurate date and time settings are necessary to create reliable stored record and report information.

1. From the Preferences screen, select the **Date & Time** option. The Date & Time screen displays.



2. Use the **Arrow** keys to position the cursor next to the parameter to be changed.
3. Press the  or  keys, or **Alphanumeric** keys to enter the desired setting.
4. Repeat steps 2 and 3 until the desired parameters have been set.
5. Press **Enter**  to save or **Escape**  to exit without saving changes.





Selecting a Display Language

You can select one of six languages for the tester display screen:

- English (Default)
- Italian
- French
- Portuguese
- German
- Spanish


1. From the Preferences screen, select the **Language** option. The Language screen displays.

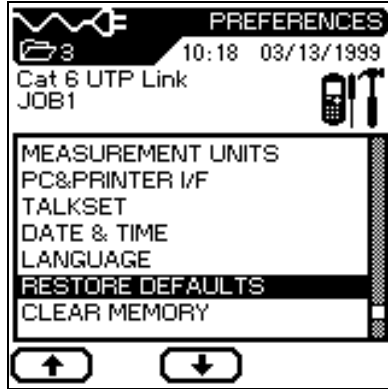


2. Press the  or  key to select the desired language.
3. Press **Enter**  to save or **Escape**  to exit without saving changes.

Restoring Factory Defaults


Use this option to reset all unit parameters to their factory default settings.

1. From the Preferences screen use the **Arrow** keys to position the cursor on the Restore Defaults option.
2. Press the **Enter**  key to set all unit parameters to their factory default settings.

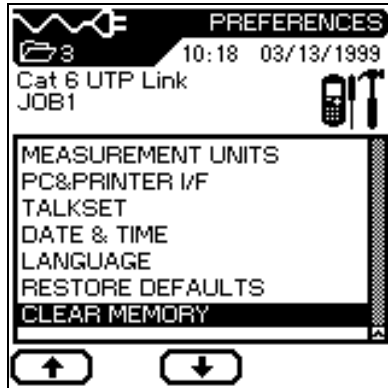


Clear Memory

Use this option to clear the tester memory.

1. From the Preferences screen use the **Arrow** key to position the cursor on the Clear Memory option.
2. Press the **Enter**  key to clear tester memory.

Note: There is no undelete option when clear memory is used. All stored tests will be permanently deleted.



Tone Generator

The RH can generate a “warble” tone (alternating 900 / 1100 Hz tone at 2 Hz rate) that is detectable by most standard inductive amplifiers.

To activate the Tone Generator:

1. Connect the RH to the cable under test.
2. Press the **Tone** key on the RH.
3. The Tone LED on the RH will illuminate when the Tone Generator is active.

To turn the Tone Generator off, perform one of the following actions:

1. Press the Tone button.
2. Connect the DH to the other end of the link under test.
3. Allow the tester to remain idle. After five minutes with no test activity the Tone Generator automatically turns off.

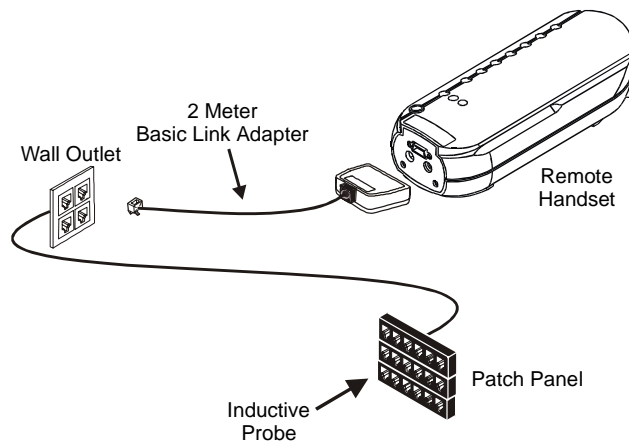


Figure 3-2: Typical Tone Generator Setup

Cable ID/AutoName Option

Cable IDs and Test Numbering

Single and Double Cable IDs

There are two levels of AutoName capability: Single and Double ID. The Double ID feature has many benefits:

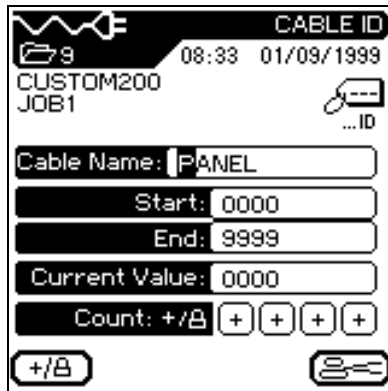
- Both ends of the cable under test are clearly identified.
- While reviewing saved test records, potential problems can be identified and quickly located.

If the *Autosave* Autotest preference is selected, names will automatically be assigned to completed tests.

- You can assign a maximum of two unique ten-character cable names for the cable under test (Double ID).
- The tester defaults to a single naming mode (Single ID). The following three screens are examples of unique Single and Double Cable IDs.

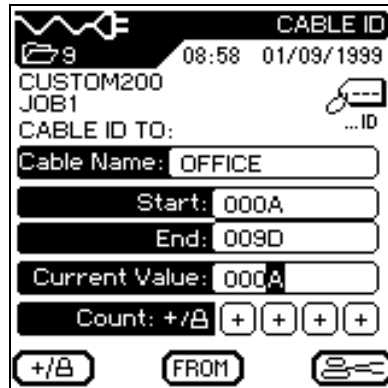
1. **Example:**
Single ID

A unique five-character name *PANEL*, followed by a four-character incrementing counter field. The counter is set by default or by the user to start at *0000* and ends at *9999*.



2. **Example:**
Double ID “Cable To”

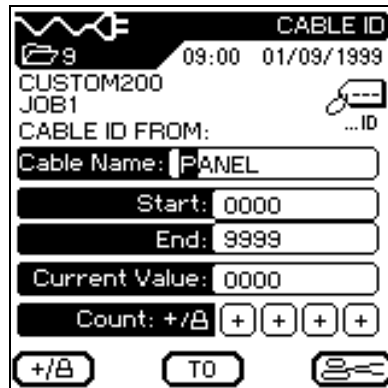
A unique six character name *OFFICE*, followed by a four character incrementing counter field. This example set by the user to start at *000A* and end at *009D*.



*Note: The **FROM** button is used to switch to the Cable From screen.*

3. **Example:**
Double ID “Cable From”

A unique five character name *PANEL*, followed by a four character incrementing counter field. This example set by the user to start at *0000* and end at *9999*.



*Note: The **TO** key is used to switch to the Cable To screen.*

Test Counter

In addition to the cable name, you can assign up to four incrementing characters to identify individual tests. A **⊖** symbol below a counter field signifies a non-incrementing field. A **⊕** symbol signifies an auto-incrementing field. Like the decimal numbering system, the counter always begins incrementing from the right most unlocked digit. The default numbering scheme is set to start counting from 0000, and end at 9999. Custom numbering schemes may be used. Refer to Table 5-1 and 5-2 for Single and Double ID counter numbering samples.

Table 3-6: Single ID Counting Samples

Default Example	Custom Examples	
Cable Name: TEST	Cable Name: PANEL	Cable Name: PANEL
Start: 0 0 0 0	Start: 0 0 0 0	Start: 0 0 0 A
End: 9 9 9 9	End: 0 0 2 2	End: 0 9 9 D
Locked: ⊕⊕⊕⊕	Locked: ⊖⊖⊕⊕	Locked: ⊖⊕⊕⊕
Current: 0 0 0 0	Current: 0 0 0 0	Current: 0 1 8 A
0 0 0 0	0 0 0 0	0 1 8 A
0 0 0 1	0 0 0 1	0 1 8 B
0 0 0 2	0 0 0 2	0 1 8 C
0 0 0 3	0 0 1 0	0 1 8 D
0 0 0 4	0 0 1 1	0 1 9 A
0 0 0 5	0 0 1 2	0 1 9 B
0 0 0 6	0 0 2 0	0 1 9 C
0 0 0 7	0 0 2 1	0 1 9 D
0 0 0 8	0 0 2 2	0 2 0 A
0 0 0 9	0 0 0 0	0 2 0 B
0 0 1 0	0 0 0 1	0 2 0 C
0 0 1 1	0 0 0 2	0 2 0 D
0 0 1 2	0 0 1 0	0 2 1 A

Table 3-7: Double ID Counting Sample

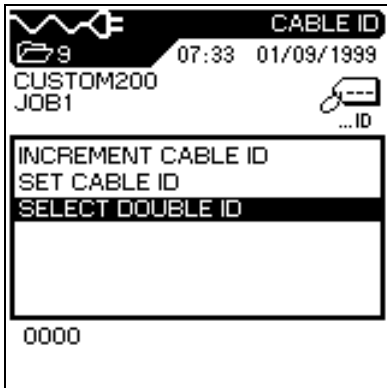
“Cable To”
Cable Name: OFFICE
Cable Counter
Start: 0 0 0 A
End: 0 0 9 D
Locked: ⊕⊕⊕⊕
Current: 0 0 0 A
0 0 0 A
0 0 0 B
0 0 0 C
0 0 0 D
0 0 1 A
0 0 1 B
0 0 1 C
0 0 1 D
0 0 2 A
0 0 2 B
0 0 2 C
0 0 2 D
0 0 3 A

“Cable From”
Cable Name: PANEL
Cable Counter
Start: 0 0 0 0
End: 9 9 9 9
Locked: ⊕⊕⊕⊕
Current: 0 0 0 0
0 0 0 0
0 0 0 1
0 0 0 2
0 0 0 3
0 0 0 4
0 0 0 5
0 0 0 6
0 0 0 7
0 0 0 8
0 0 0 9
0 0 1 0
0 0 1 1
0 0 1 2

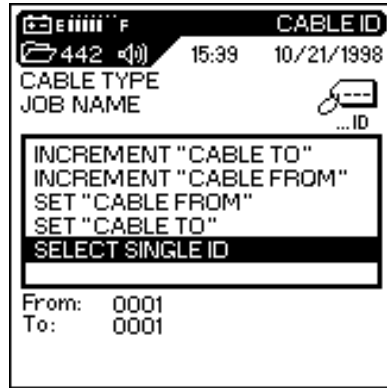
Opening the Single/Double Cable ID Screen:



1. Select the **Cable ID** icon to open the main Cable ID screen.
2. The screen that appears will reflect the *most recently assigned* Cable ID (either single or double). To toggle between Single and Double ID screens, position the cursor over the Select Single or select Double ID option.

Single ID Screen



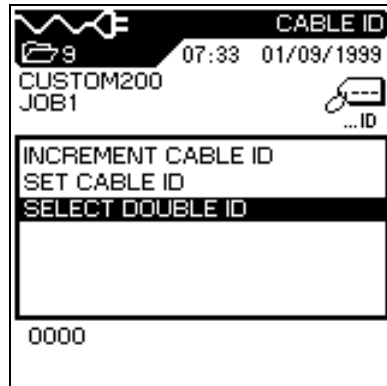
Double ID Screen



3. The following options may be executed from the main Cable ID screens:
 - Increment Cable ID (*Cable From* and *Cable To* in Double ID mode)
 - Set Cable ID (*Cable From* and *Cable To* in Double ID mode)
 - Select either Single or Double IDs for tests.
4. Press **Enter**  to save changes.
5. Press  to return to the previous screen after setting the printer communication settings.

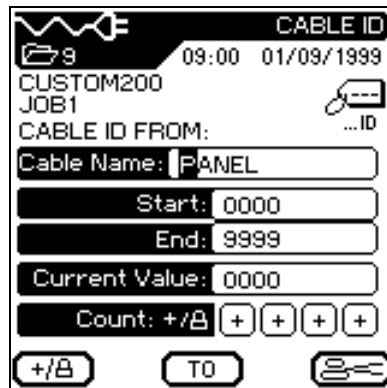
To set a Cable ID:

1. In the Cable ID screen, position the cursor over the **Set Cable ID** option.
2. Press **Enter** (↵) to open the Double ID screen.



Note: The screen that appears will reflect the most recently assigned Cable ID (either Single or Double). Double ID is used in this example.

3. Enter the following parameters as required:



- a. *Cable From* name, ten characters maximum.
 - b. Counter Start and End points, four characters each. Counter will reset at the end point.
 - c. Select the **Ⓛ** symbol to lock a character, or **⊕** to allow a character to auto-increment.
 - d. Use the **TO** key to go to the *Cable To* screen. Repeat steps a through c.
4. After entering the desired *Cable From* and *Cable To* names and parameters, press **Enter** (↵) to save and return to the Main Cable ID screen.

Selecting a Cable Type



The tester comes with several cable types stored in non-volatile memory. When a cable type is selected, the recommended limits for that cable are automatically programmed into the tester.

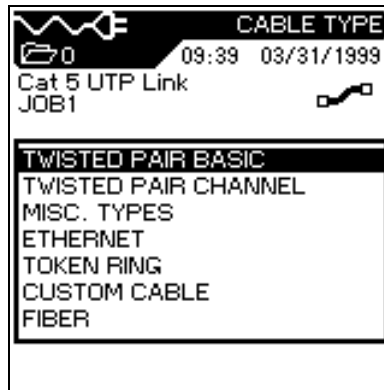
Cable choices are made by topology:

- Twisted Pair Basic
- Twisted Pair Channel
- Miscellaneous Types
- Ethernet
- Token Ring
- Custom Cable
- Fiber

Note: The TS2000 tester can also support custom cable types.


To select a cable type:

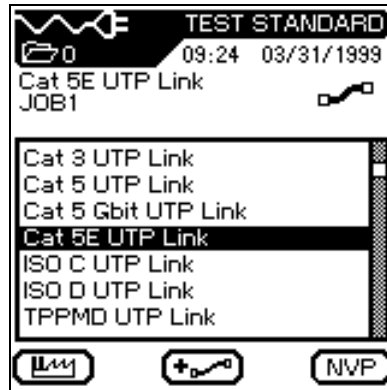
1. Press the **Cable Selection**  hard key. The Cable Types screen appears.
2. Press **Enter**  to select a cable type and its associated default NVP for testing.




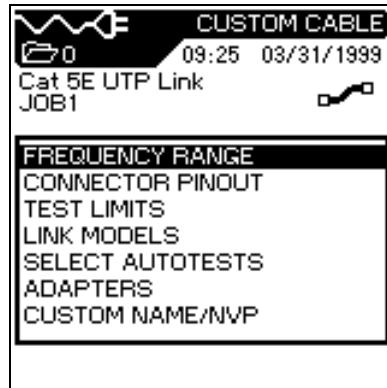
3. Position the cursor and press **Enter** (↵) to change to a new cable type and its associated default NVP for testing.

The Information screen appears briefly to confirm your cable selection.

Note: A number of unique cable manufacturer NVP values are stored in the tester memory. To access the list of manufacturer cables for the currently highlighted test standard, press the  soft key.

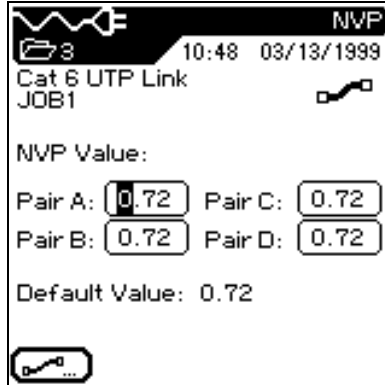


4. Press the  soft key if you want to use the selected cable as the basis for a Custom Cable. The tester will display the Custom Cable screen. You can then change default cable features and save the cable as a Custom Cable.



To change the default NVP value:

1. From the Test Standard screen, press the **NVP** key to select the Change NVP option. The NVP screen will display.



2. To manually enter a new NVP value, use the **Arrow** keys to position the highlighted cursor and enter new NVP values.
3. To automatically calculate a new NVP value, press **Measure NVP** to select the Measure NVP option. The Measure NVP screen appears.
4. Connect a test cable of known length.
5. Using the **Arrow** and **Number** keys, enter the known cable length.
6. Press the **Play** key to calculate a new NVP value. The display returns to the main NVP screen after the new NVP value has been calculated.

Note: For ISO Standards enter the known cable length plus 4 meters.



Custom Cable Settings

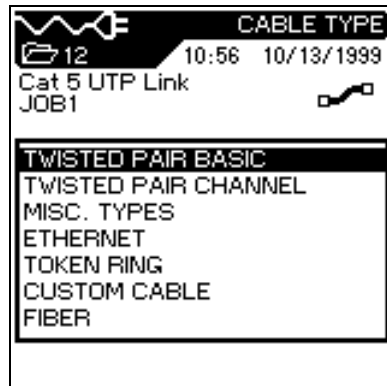
All of the cable types pre-programmed into the TS2000 tester are associated with a predefined test standard. You cannot change these pre-programmed parameters. If you want to run a different set of tests for a given cable you must create a Custom Cable.

For example, if you would like to run Return Loss in addition to the TIA 568A TSB-67 Category 5 tests (Return Loss is not a required TIA or TSB-67 test), you must create a Custom Cable and select the tests you want to include in the test suite for this cable.


A maximum of ten custom cable settings can be created, stored, removed and retrieved when needed.

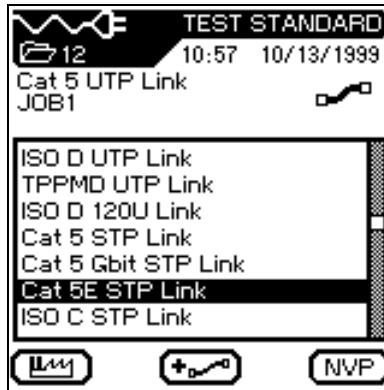
To create a new custom cable type:


1. Press the **Cable Selection**  hard key. The Cable Types screen displays.
2. Use the arrow keys to position the cursor over the desired cable topology cursor and press **Enter** . The Test Standard screen displays.

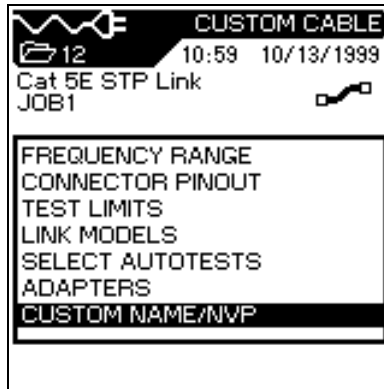



Chapter 3 Self Tests, Calibration, and Configuration

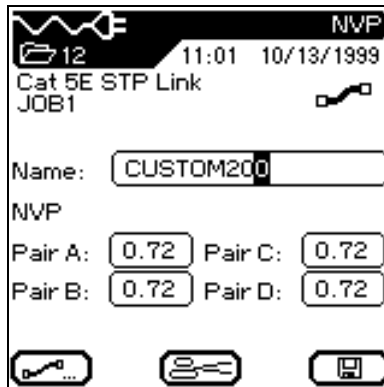
3. Position the cursor over the desired cable type and press the  key. The Custom Cable parameters screen displays.




4. Change the desired cable parameters, then proceed to the next step to name the cable.
5. Position the cursor over Custom Name/NVP and press **Enter** . The NVP Screen appears.

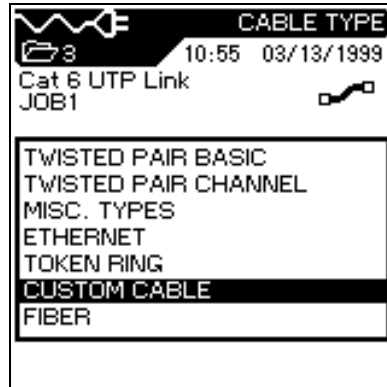



6. Change NVP parameters as required and then name your new custom cable.
7. Press the **Save** function key.
8. Press **Enter**  to return to the Custom Cable screen. The new custom cable is now selected as the cable under test.





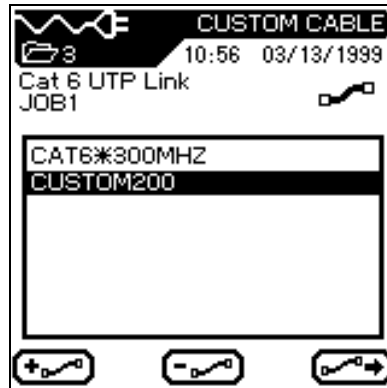
To select or delete a custom cable type:

1. Press the **Cable Selection**  hard key. The Cable Types screen appears.



2. Press the arrow keys to select **Custom Cable**.
3. Press **Enter**  to open the Custom Cable screen.

4. The tester displays any stored custom cable types.
5. Position the cursor over the desired custom cable type.
6. Press **Enter**  to make the custom cable you highlighted the new cable type, or press the  key to delete the selected custom cable type.

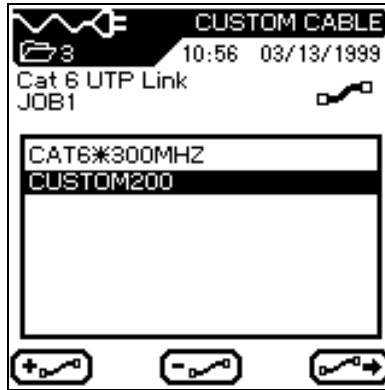



Note: Custom cables can not be deleted if there are stored tests associated with the cable.

To edit an existing custom cable type :


1. Press the **Cable Selection**  hard key. The Cable Types screen appears.

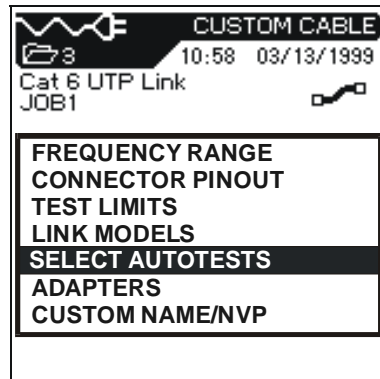
2. Open the Custom Cable screen and select the cable type to be customized.



3. Press the  soft key. The Custom Cable parameter screen displays.

Note: Custom cables can not be deleted if there are stored tests associated with the cable.

4. Position the cursor on the desired custom cable parameter and press the **Enter**  key to edit the settings.



5. After making the desired changes, select the Custom Name/NVP option. The NVP screen displays.

6. Save the cable under its current name or under a new name

Note: Refer to the next page for a description of custom cable parameter options.

Custom Cable Parameters

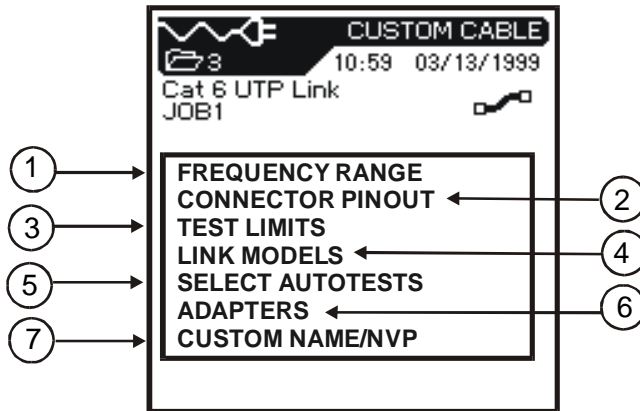


Figure 3-3: Custom Cable Parameter Screen

Table 3-8: Custom Cable Parameter Options

	Parameter Option	Description
1.	Frequency Range	Use this menu to set minimum and maximum certification and cable grade frequencies.
2.	Connector Pinout	This screen is used to define connector pinouts. <i>Note: If one wire pair is not selected, tests for NEXT, attenuation, capacitance, DC resistance, and impedance will not be performed on that pair.</i>
3.	Test Limits	This screen is used to customize Autotest pass/fail limits.

(Table Continues)

Table 3-8: Custom Cable Parameter Options (Continued)

	Parameter Option	Description
4.	Link Models	Custom NEXT and Attenuation limits are set by using a flat line limit or one of several different models. Frequency limits will vary from less than 1 MHz to 100 MHz based on the link type.
5.	Select Autotests	Not all cables will require the full suite of Autotests. Use this menu to select the Autotests to be run.
6.	Adapters	Use this menu to inform the tester which near-end and far-end cable adapter are currently being used.
7.	Custom Name/NVP	Use the alphanumeric keys to enter a custom name or change the NVP parameters. The TS2000 can store up to 10 custom cables.

Chapter 4

TS2000 Cable Testing Fundamentals

Contents

- Physical and electrical characteristics of cables
- Cable test descriptions
- How to set up different cabling tests
- What to do when tests fail

Invasive LAN Cable Testing

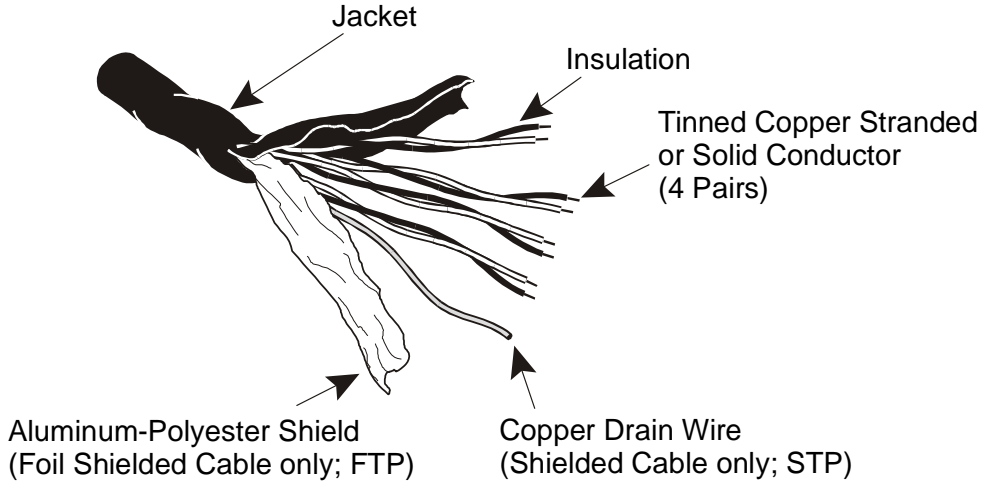
Whenever an electronic test instrument is connected to a circuit to obtain a reading, that unit and its connecting cables become part of the “circuit-under-test.” To some extent, the reading will always reflect the instrument’s participation in the measurement. BLACK BOX®’s goal has always been to reduce to an absolute minimum the effects the instrument has on the circuit.

A TS2000 tester uses special instrument connectors instead of RJ-45 (Modular 8) style jacks for the following reasons:

- RJ-45 connectors add significant crosstalk to higher frequency measurements.
- TIA/EIA’s proposed standards exclude the RJ-45 connection from the end of the model links used to define current LAN cable testing limits.
- RJ-45 connecting hardware is limited to 500-1000 mating cycles before requiring replacement.

Testing Twisted Pair Cables

Twisted pair wiring systems (Refer to Figure 4-1) typically employ four pairs of insulated conductors and connectors that allow you to operate different network types on the same cable (Refer to Table 4-1). Both unshielded (UTP) and foil shielded (STP, FTP) cables are available.



The following diagrams contain modular jack pin numbering and wiring patterns for T568A, T568B, 10 Base-T, TP-PMD, Token Ring and USOC cabling types.

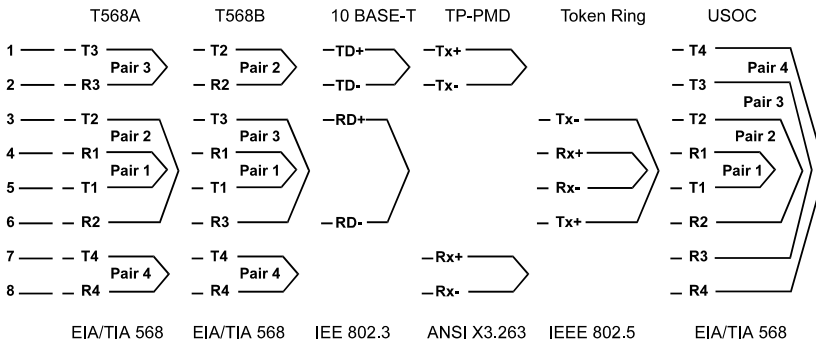


Figure 4-1: Twisted Pair Cables

Table 4-1: Twisted Pair Cable Types, Associated Networks, and Required BLACK BOX[®] Adapters:

Cable Type	Network Examples	Required Adapters
TIA Cat 3, 4, 5, 5 Gbit, 5E, and 6 UTP or STP	Ethernet, Fast Ethernet, ATM, and Gigabit Ethernet	Permanent Link or Channel
ISO Class C, D, and E UTP or STP	Ethernet, Fast Ethernet, ATM	
TP-PMD / TP-DDI	FDDI or ATM on Copper	
10Base-T	Ethernet	
Single Pair	Telephone, Apple Local Talk, ISDN	
Shielded Two-Pair (1,2,7,8)	ATM, Fiber Channel on Copper	

Shielded Twisted Pair (STP)

Testing the continuity of the shield is important and requires shielded test leads at both the Display Handset and Remote Handset. When testing STP, be sure to select Shielded Cable Type (STP) in the Cable Type menu.

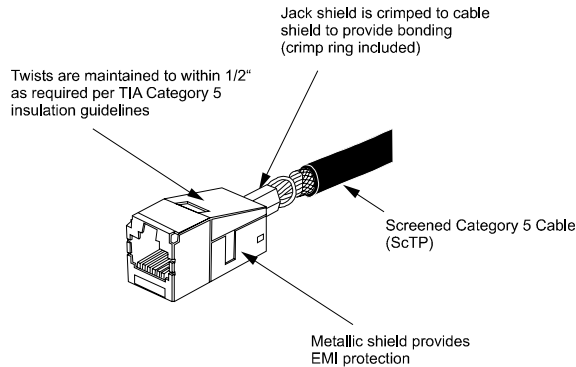


Figure 4-2: Shield Continuity Test Connections Twisted Pair

USOC Wiring

If a USOC (Universal Service Ordering Code) or other wiring scheme is used, a special adapter may be required for connection. Refer to *Appendix C, Model Accessories* for a full list of available cable adapters.

Note: If your testing requirements include connection to something other than an RJ-45 style jack, refer to Testing with Special Adapters later in this chapter.

Permanent Link Test Setup

ANSI, EIA, TIA, and ISO all provide two network communication circuit specifications: basic/permanent link and channel link. A permanent link consists of up to 90 meters of horizontal network cabling with permanent link test adapters at each end. The permanent link (shown below) is used to certify the horizontal network cable installation *before* network connection and user hookup. It excludes user patch cords and jumpers.

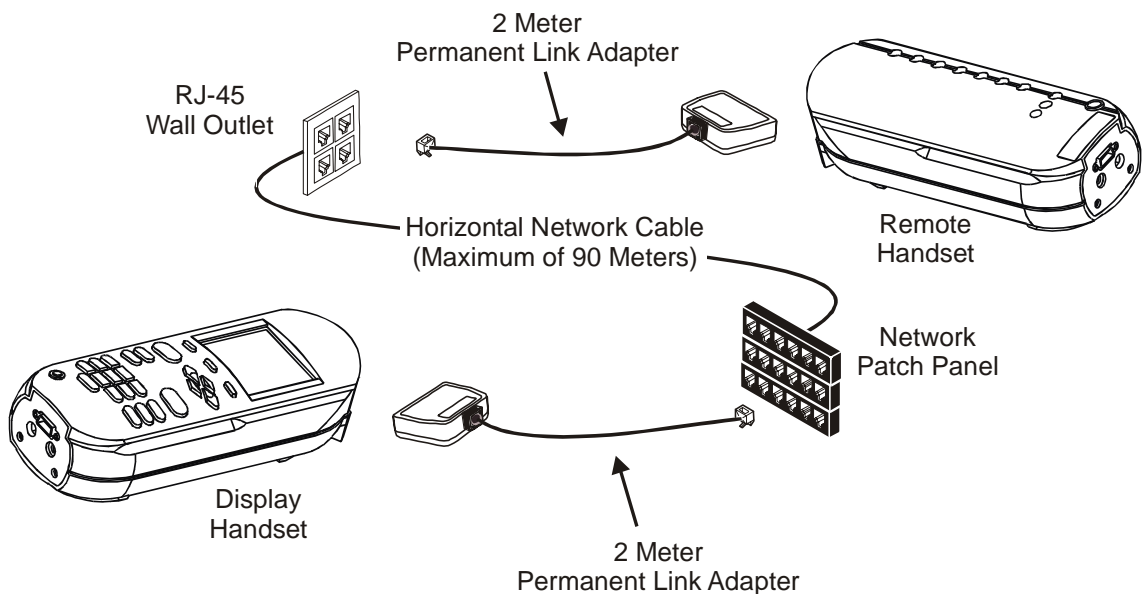


Figure 4-3: Permanent Link Test Connections

Connection	Cable Length Limits
Horizontal Network Cable	Maximum of 90 meters
Permanent Link Adapters	Combined Maximum length of 4 meters

Note: Don't forget to change the Cable Type to Twisted Pair Basic when working with permanent link adapters.

If you exceed the tester length test limits, the tester is required to fail the link.

Channel Test Setup

A channel test setup includes all aspects of the cabling system. It consists of up to 90 meters of horizontal network cabling, user patch cords, jumpers, and channel adapters at each end. The channel test setup (shown below) is used to certify the network installation *after* network connection and user hookup.

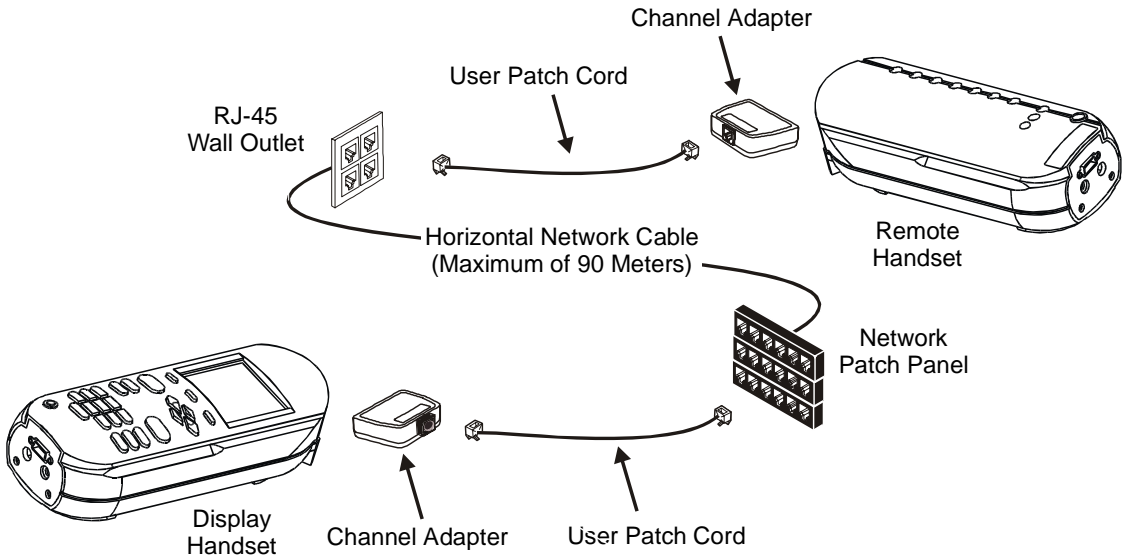


Figure 4-4: Channel Test Connections

Connection	Cable Length Limits
Horizontal Network Cable	Maximum of 90 meters
User Patch Cords	Combined Maximum length of 10 meters

Note: Don't forget to change the Cable Type to Twisted Pair Channel when working with channel adapters.

If you exceed the tester length test limits, the tester is required to fail the link.

Wire Map Test

Wire Map testing is used to locate shorts, opens and miswires. Test results are displayed graphically for easy visual indication of any problems.

Note: The RH is required to perform this test.

Wire Map Errors

A failure in a Wire Map should always be the first problem corrected, since it causes faults in other tests. One open pin can cause DC loop resistance and attenuation tests to fail. An open may also cause a zero capacitance reading, and will cause false readings in NEXT tests.

A wire map test will always look for and map all nine possible wires (four pairs + shield) but will only consider wires defined as present in the selected cable type (refer to *Chapter 3, Selecting a Cable Type, Page 3-22*) for pass/fail criteria. For example, a wire that is not specified in the cable type will show on the map but will not cause a test failure.

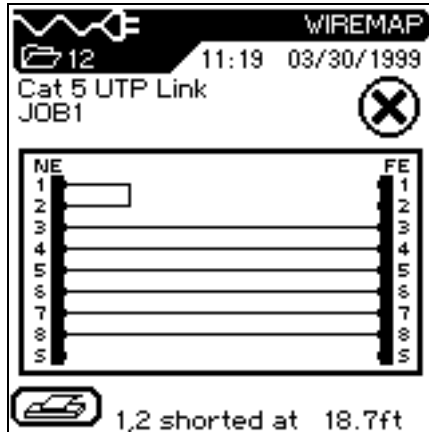
The Wire Map test guarantees the following minimum level of error detection (based upon four pairs of conductors, shield optional):

- Any wiring error or combination of wiring errors will indicate a wire map failure.
- Any combination of up to three opens, shorts or cross-connections will be correctly identified.
- Opens and shorts will provide an indication of the cable end that the error occurred on (provided by Length screen results in Autotest.).
- Split pairs will be identified based on specific patterns of inconsistent NEXT (Near-End Crosstalk).

Distance to Fault

The failed wire pair(s) and the calculated distance-to-fault data is displayed at the bottom of the wire map test result screen (refer to the example below). The distance to the fault is always calculated beginning from the DH unit.

Note: The LCD display is not scaled to represent the calculated distance.



Troubleshooting Wiremap Problems

Problem: One or more open pins

Probable Causes	Connector-to-wire punch down not mated Defective jack or plug. Broken wire(s).	
Other Tests Affected	<u>Test</u> DC Resistance: Attenuation: NEXT: Mutual Capacitance: Length:	<u>Possible Result</u> Fail. Fail. Some false measurements. 0 reading possible. May be low if the open is near the Display Handset.

Problem: Shorted pins

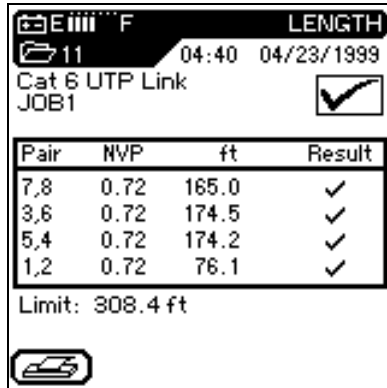
Probable Causes	Conductors making contact at a connector. Jack or plug has pin or circuit defect. Cable damaged.	
Other Tests Affected	<u>Test</u> DC Resistance: Attenuation: NEXT: Capacitance: Length:	<u>Possible Result</u> Low or zero. Fail. Some false measurements. Over limit. Reduced or shorted pairs.

Problem: Miswired pins

Probable Causes	Conductors reversed at a connector.	
Other Tests Affected	<u>Test</u> Usually none	<u>Possible Result</u> Infrequently, one or more tests may fail.

Wire Length Test

This test measures the length of each wire pair to make sure that the recommended limits for the particular cable type are not exceeded. Depending on the units selected in the Setup menu, length is reported in either feet or meters. See *Chapter 3, Setup information*.



Pair	NVP	ft	Result
7,8	0.72	165.0	✓
3,6	0.72	174.5	✓
5,4	0.72	174.2	✓
1,2	0.72	76.1	✓

Limit: 308.4 ft

Note: The RH is not required to perform this test.

Length and NVP

Measuring the length of the cable requires that you know the Nominal Velocity of Propagation (NVP) of the cable. Refer to the specification or the manufacturer of the cable you are testing for the cable NVP. If the wire specification is not available, use a known length of good cable (50 to 100 feet) and adjust the NVP until the tester displays the known cable length.

Wire Length Errors

Lengths may differ slightly between pairs in the same cable, due to minor NVP differences between the pairs and physical length differences due to twisting patterns. When electrically measured cable length varies too much from actual length, a problem exists.

Troubleshooting Wire Length Problems

Problem: Length between a pair of the same cables varies by more than 10%.

Probable Causes	Incorrect NVP. Excessive cable length Installed matched terminator not functioning correctly. Cable insulation damage to longer pairs. Break or short in a pair. Elevated capacitance on a pair.						
Other Tests Affected	<table style="width: 100%; border: none;"> <thead> <tr> <th style="text-align: left; border-bottom: 1px solid black;"><u>Test</u></th> <th style="text-align: left; border-bottom: 1px solid black;"><u>Possible Result</u></th> </tr> </thead> <tbody> <tr> <td>DC Loop Resistance:</td> <td>May be slightly high or fail.</td> </tr> <tr> <td>Attenuation:</td> <td>May be slightly high or fail.</td> </tr> </tbody> </table>	<u>Test</u>	<u>Possible Result</u>	DC Loop Resistance:	May be slightly high or fail.	Attenuation:	May be slightly high or fail.
<u>Test</u>	<u>Possible Result</u>						
DC Loop Resistance:	May be slightly high or fail.						
Attenuation:	May be slightly high or fail.						

DC Resistance Test

This test measures the loop resistance of each pair of wires. The instrument tests to make sure total loop resistance does not exceed recommended limits. Results are displayed with resistance in ohms for each pair, and comparison limit for the cable type.

Note: The RH is required to perform this test.

DC Resistance Errors

All four pairs of a network link should have about the same resistance. Pair resistance that exceeds the limit is indicated as a failure. The maximum limits in the default tables are based on the maximum length limit of the link or cable segment.

Troubleshooting DC Resistance Problems

Problem: Excessive Resistance

Probable Causes	Mismatched cable types. Poor punch block connection. Poor RJ-45 termination connections. Wire pair has a tap. Cable damage. Shorted cable.	
Other Tests Affected	<u>Test</u> Wire Map: Attenuation: NEXT: Capacitance:	<u>Possible Result</u> May fail. May fail. May have false readings. May fail.

Problem: One wire pair has a very high DC loop resistance, others are normal.

Probable Causes	Poor connection points. Cable damage. Connector blades not fully piercing wire insulation. Worn Connector.	
Other Tests Affected	<u>Test</u> Wire Map: Attenuation: NEXT: Capacitance:	<u>Possible Result</u> May fail. May fail. May have false readings. May fail.

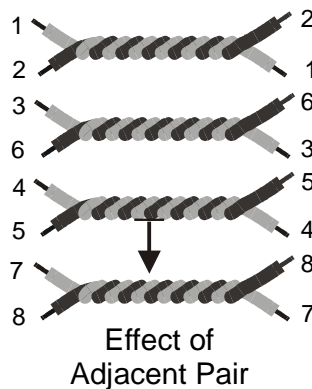
NEXT, ELFEXT, and Power Sum Tests

The NEXT (Near End Crosstalk) and ELFEXT (Equal Level Far-End Crosstalk) tests measure crosstalk at the near and far ends of the cable in one Autotest. High levels of crosstalk can cause excessive retransmissions, data corruption, and other problems that slow the network system.

Note: The RH is required to perform these tests.

NEXT and ELFEXT

The NEXT test measures cross-talk from a transmitting pair to an adjacent pair in the same cable sheath. NEXT is measured at the both the DH and the RH.

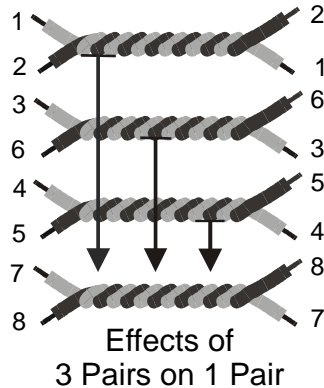


The ELFEXT test is similar to the NEXT test except that the traffic is generated at the RH and crosstalk is measured at the DH.

- NEXT measurements are made at *each end* of the cable for all pair combinations (pair 1-2 vs. 3-6, etc.), yielding a total of twelve measurements.
- ELFEXT measurements are made at the DH for all possible pair combinations (1-2 vs. 3-6, 3-6 vs. 1-2, 1-2 etc.) yielding a total of twelve measurements.

Power Sum NEXT and Power Sum ELFEXT

Power Sum tests measure the crosstalk effects of three transmitting pairs on the fourth pair in the same cable sheath.



- During the Power Sum NEXT test, six measurements are made at *each end* of the cable and combined (pairs 1-2 / 3-6 / and 4-5 vs. Pair 7-8, etc.) for a total of eight measurements.
- During the Power Sum ELFEXT test, twelve measurements are made at the DH side of the cable and combined (pairs 1-2 / 3-6 / 4-5 vs. Pair 7-8, etc.) for a total of four measurements.

Note: Power Sum NEXT measurements will generally read 2 - 3 dB lower in value (higher crosstalk) than conventional NEXT.

NEXT and ELFEXT Errors

Crosstalk is usually caused by poor connector termination on the ends of the cable. The smaller the number, the greater the crosstalk.

Troubleshooting NEXT and ELFEXT Problems

Problem: Low dB test readings

Probable Causes	<p>Installed cable or patch cable not correctly rated. Defective, poor quality cable or too many connectors. Poor quality installation at the connection points. Too much insulation has been stripped from the wires at termination. A pair of wires has been untwisted too much at termination. Split-pairs. Poor quality connectors or connectors not rated to desired category. Delay skew (ELFEXT).</p>						
Other Tests Affected	<table border="0" style="width: 100%;"> <tr> <td style="width: 50%;"><u>Test</u></td> <td style="width: 50%;"><u>Possible Result</u></td> </tr> <tr> <td>Return Loss:</td> <td>May be over limit.</td> </tr> <tr> <td>NEXT:</td> <td>May show same symptoms.</td> </tr> </table>	<u>Test</u>	<u>Possible Result</u>	Return Loss:	May be over limit.	NEXT:	May show same symptoms.
<u>Test</u>	<u>Possible Result</u>						
Return Loss:	May be over limit.						
NEXT:	May show same symptoms.						

Attenuation Test

This test measures the overall signal strength loss in the cable and verifies that it is within acceptable limits. Low attenuation is essential for error-free transmission. Attenuation is measured by injecting a signal of known amplitude at the Remote Handset and reading the amplitude at the Display Handset.

Note: The RH is required to perform this test.

Attenuation Errors

Attenuation causes a loss of signal strength over a cable. The loss increases with cable length, signal frequency, and temperature. Attenuation testing can be used to find problems in the cable, connectors or connecting hardware. The larger the number, the greater the attenuation.

Troubleshooting Attenuation Problems

Problem: High Attenuation Reading

Probable Causes	Poor connector termination points. Excessive cable length. Incorrect or poor quality adapter cable. Incorrect cable.	
Other Tests Affected	<u>Test</u> DC Loop Resistance: Capacitance: Length: NEXT: Average Impedance: Return Loss:	<u>Possible Result</u> May be high. May be high. May be over limit. May be low on pair combinations. May be low. May be over limit.

Return Loss Test

This test measures the ratio of reflected to transmitted signal strength. Good quality cable runs will have little reflected signal, indicating good impedance matches in the run's various components.

Note: The RH is required to perform this test.

Return Loss Errors

Like attenuation, excessive return loss reduces signal strength at the receive end. It also indicates a mismatched impedance at some point along the cable run. A value of 20 dB or greater indicates a good twisted pair cable. A value of 10 dB or less is very bad, and causes a large reflection of signal back to the source.

Troubleshooting Return Loss Problems

Problem: Excessive Return Loss (Value of 10 dB or less)

Probable Causes	Open, shorted, or damaged cable. Installed cable, cable segments, or patch cord have improper characteristics. Damaged or worn cable or connectors. Poor punch-down. Factory splice in cable.	
Other Tests Affected	<u>Test</u> Attenuation: Capacitance and Average Impedance: DC Loop Resistance:	<u>Possible Result</u> May be high. Could be affected if the impedance mismatch is caused by cable damage. May be high if due to a poor punch-down.

Average Impedance Test

Average impedance is derived from electrical delay and capacitance measurements. The results of this test are expressed in ohms. Average impedance testing can help identify physical damage to the cable, connector defects, or cable segments with incorrect characteristic impedance.

This test uses capacitive measurements; therefore, it is necessary to specify the correct cable type in order to accurately perform the test.

Note: If a CAT 3 cable is selected (specified as the cable type where PVC is used in the cable insulation) but a CAT 5 cable (where Teflon® is used as the cable insulation) is actually used, the average impedance will be calculated incorrectly. To avoid this problem, be sure to specify the correct cable type.

Note: The RH is not required to perform this test.

Impedance Errors

Impedance errors cause signal reflection and strength reduction. Average impedance of each pair should be equal to the LAN system impedance of 100, 120, or 150 Ω , plus or minus 15 Ω .

Troubleshooting Impedance Problems

Problem: High Impedance Readings

<p>Probable Causes</p>	<p>Compression, stretching, or excessive bending damage to the cable. Defective connectors. Insulation damage at a connector. Ground loops created between cable shielding (if used) and equipment grounding (via RS-232 cable to computer, or auxiliary power). Improperly chosen cables or patch cords. Moisture in the cable.</p>	
<p>Other Tests Affected</p>	<p><u>Test</u> Length: Average Impedance:</p>	<p><u>Possible Result</u> Affected pairs will appear longer. Change in average impedance is inversely proportional to change in capacitance.</p>

Delay and Skew Test

This test measures the period of time for a test signal applied to one end of a cable run to reach the other end. Skew indicates the difference between the measured time delay for that pair and the pair with the lowest value (displayed as 0.0 ns). Delay and Skew limits are set according to the currently selected cable type.

Note: The RH is not required to perform this test.

Delay and Skew Errors

Delay and skew measurements will usually differ slightly between pairs in the same cable. A substantial difference indicates a cable installation problem or a pair defect.

Troubleshooting Delay and Skew Problems

Problem: Excessive Differences Between Measurements

Probable Causes	Cables which use different materials for insulating the four pairs of wires. A break or short in the pair. Excessive cable length. Cable installation problems.
-----------------	--

Capacitance Test

This test measures the mutual capacitance between the two conductors of each wire pair to verify that installation has not affected the capacitance for the particular cable type. Bulk capacitance measurements are displayed in nanofarad (nF) in the Analyze Capacitance test. Autotest measures the bulk capacitance in picofarads (pF) per foot or meter.

Note: The RH is not required to perform this test.

Capacitance Errors

The larger the capacitance, the higher the error rate. Small changes in the capacitance measurements are normal due to the handling of the cable during shipping and installation. The addition of connectors and patch cables will also affect capacitance values.

Troubleshooting Capacitance Problems

Problem: Capacitance Exceeds the Maximum Limit

Probable Causes	Compression, stretching, or excessive bending damage to the cable. Defective connectors. Insulation damage at a connector. Ground loops created between cable shielding (if used) and equipment grounding (via RS-232 cable to computer, or auxiliary power). Improperly chosen cables or patch cords. Moisture in the cable. Poor connections at punch downs and wall plates.	
Other Tests Affected	<u>Test</u> Length: Average Impedance:	<u>Possible Result</u> Affected pairs will appear longer. Change in average impedance is inversely proportional to change in capacitance.

ACR Test

The ACR (Attenuation-to-Crosstalk Ratio) test performs a mathematical comparison (difference calculation) between the results of the Attenuation and NEXT tests. The difference reading between each pair gives an indication of how problem-free the cable pair will be for transmissions.

The ACR measurements are calculated pair-to-pair. The Power Sum ACR measurements are calculated by summing the NEXT between a selected pair and the other three pairs in the same cable sheath.

Note: The RH is required to perform these tests.

ACR and Power Sum ACR Errors

A large difference reading is desirable, since it indicates a strong signal and little noise interference.

Troubleshooting ACR and Power Sum ACR Problems

Refer to the NEXT (page 4-15) and Attenuation (4-16) troubleshooting suggestions in this chapter.

Headroom Test

The Headroom measurement is a mathematical analysis of the data already existing from previous tests. The calculated value is the sum of the Power Sum ACR test (Power Sum ACR of the worst pair after the attenuation for that pair has been normalized to 100 meters or 328 feet) and the additional margin between the worst case PS NEXT and the limit for PS NEXT.

Headroom provides a simplified means of reporting the margin available in a single cable run which will support an application with error-free performance. It also gives an indication of additional margin, which may be achieved through the utilization of “enhanced” cable and connectors and careful installation practices.

Note: The RH is required to perform this test.

Headroom Errors

The Headroom number, reported in dB, characterizes the worst-case margin found in a single cable run. A large number is desirable, since it indicates a strong signal and little noise interference. The pass/fail limit for Headroom is the same as Power Sum ACR.

Testing and Troubleshooting 10BASE-T Cabling

10BASE-T Ethernet systems use twisted pair cabling for transmission of network data frames. Both the cable and connecting hardware must meet minimum standards, as specified in the IEEE 802.3 standard. The default settings for 10BASE-T network links in the TS2000 tester reflects those standards.

10BASE-T systems use the 1 and 2 pins for transmit, and the 3 and 6 pins for receive, as shown in the following figure. The instrument passes or fails the Wire Map based on this pin configuration. If your system does not use the IEEE 802.3 wiring standard, a custom adapter is required to align nonstandard transmit and receive pairs.

8MP (RJ-45 Style) Connector

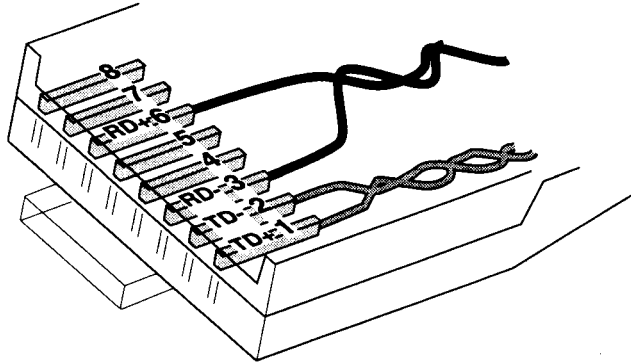


Figure 4-5: 10BASE-T Connector

Note: Other pairs may be wired but 10BASE-T uses only the pairs shown.

Testing and Troubleshooting Token Ring Cabling

Token Ring Cabling uses two-pair cable and connectors, shielded and unshielded, for network data transmission. The cable and connectors for Shielded Token Ring systems are very different from those used in 10BASE-T and Structured Wiring Systems. The default settings for each type of Token Ring network in the TS2000 tester is based on maximums for cable and connectors listed in the IEEE 802.5 standard.

The TS2000 tester requires the use of special adapters for connection to IBM Universal Data Connectors (UDC) or Enhanced Data Connector (EDC). The adapter test leads, (TS2032), are shown attached to the Display and Remote Handsets in the figure below.

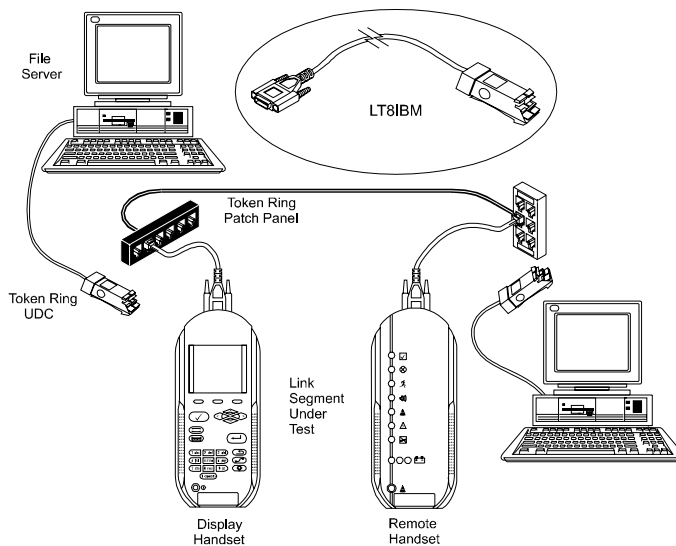


Figure 4-6: Token Ring Test Connections

When connected to a properly wired Token Ring network link, the adapters will return the proper Wire Map. The instrument uses the 3,6 and 4,5 pairs to map the two-pair system. When selecting Token Ring cable, be sure to select shielded or unshielded to ensure the parameters are correct. If a shielded system is being tested, Wire Map will also show the shield continuity.

Testing and Troubleshooting with Special Adapters

Testing with 110 Connecting Block Adapters

At times, it is necessary to test directly from a 110 connecting block to either a patch panel or office outlet. There are two types of 110 adapters that can be used with the TS2000 tester:

- The BLACK BOX[®] TS2028 adapter used in the 110 Blocks allows testing up to 155 MHz.
- A commercially available 8MJ (RJ-45 Style) to 110 block adapter can be used to support testing requirements up to 20 MHz (Category 4).

Use a T568A or T568B adapter test lead to replace one of the test leads supplied with the TS2000 tester. Usually this test lead is connected to the Display Handset. However if required, it can be connected to the Remote Handset. Connect the other handset using one of the test leads supplied with your tester.

Note: Observe the Wire Map results on the first test carefully. If the Wire Map fails, it may indicate a reversal between T568A and T568B wiring standards. Try replacing the adapter test lead with the opposite lead and the link should map correctly.

Testing with Patch Cable Adapters

The test leads supplied with the instrument are designed for the most common testing requirement, installed building cables.

- The BLACK BOX[®] Permanent Link test cord (Model TS2010) is designed to exceed TIA/EIA Category 5 ISO 11801 specifications, and is specifically designed with a Low-Crosstalk male connector for direct connection to the Display and Remote Handsets. The other end of the test cord has an 8MP (RJ-45 style) plug for connecting to network patch panels and wall outlets.
- The BLACK BOX[®] Channel Adapter (Model TS2025) is specifically designed with a Low-Crosstalk jack for direct connection to the network patch and equipment cords.

Testing with Custom Made Adapters

Occasionally, testing is required on cable systems that are wired differently than the popular pairing configurations standardized by TIA/EIA's T568A or T568B. Special adapters can be made if they are not commercially available.

All cables and components in a custom test adapter should equal or exceed the minimum standards for the link they test. If you attempt to test a Category 5 link with a custom adapter containing a Category 4 plug or cable, it will cause failures. Even if the link passes the Category 5 testing, the readings will not be representative of the actual link quality.

The TS2000 tests twisted pair cable in specific pairing. When using an adapter, be sure the alignment is correct. Compare the wiring schemes for T568A or B and USOC, as shown below:

T568A or B Pairs	USOC Pairs
1,2	1,8
3,6	3,6
4,5	4,5
7,8	2,7

Test results for the 3,6 and 4,5 pairs will be normal, but USOC's 1,8 and 2,7 will be out-of-limit since the pair alignment is incorrect. It should be noted that if only the 3,6 and 4,5 pairs are tested, and the connectors are 8MJ (RJ-45 style), no adapter is required. Use the test leads supplied with the instrument.

Please call BLACK BOX[®] Tech Support (*see Appendix B*) if you need help when fabricating custom adapters.

Patch Cable Testing

Patch cable connectors will wear out from over-insertions. RJ-45 connecting hardware is limited to 500-1000 mating cycles before requiring replacement.

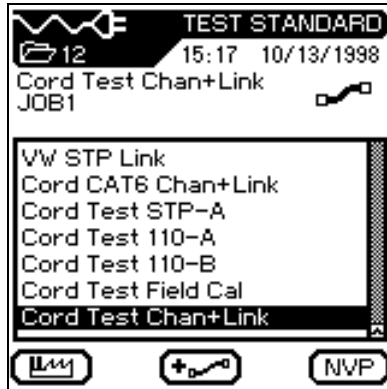






Figure 4-7: Cord Test Options

To perform a Cord Test on Channel and Permanent Link Adapters:

1. Connect the DH and RH together using a Permanent Link adapter connected to a Channel adapter.
2. Press the  soft key. The tester will display the Cable Type screen.
3. Position the cursor bar on **Misc. Types**, and press the  key to open the Test Standard screen.
4. Position the cursor bar on **Cord Test Chan+Link**, and press the  key to change the test standard.
5. Press the **Autotest**  key to perform the Cord Test.

Note: Perform the test on both sets of Channel and Permanent Link Adapters.

Contents

- Setting up Autotest preference
- How to run an Autotest function
- Viewing and interpreting Autotest results

Autotest Overview

Autotest is the easiest and quickest way to measure and verify your cable installation. When the Autotest key is pressed, the TS2000 tester automatically performs a series of pre-programmed tests. These test suites are pre-determined based on either adopted or proposed standards as well as specific parameters. After all tests have been completed, the tester displays a single overall pass/fail result and individual test pass/fail results.

Autotests are performed with the Display Handset (DH) and Remote Handset (RH) connected at opposite ends of the cable under test.

Test Suites

The tests run during an Autotest depend on the cable type selected (*refer to Chapter 3, Selecting a Cable Type*). Autotest can be preset to automatically save test results immediately following each suite of tests, or results can be saved and printed manually. To preset these functions, see *Autotest Preferences, page 5-6*, in this chapter. Individual sub-tests can be selected and viewed with more detailed data following completion of the Autotest using the Autotest Results screen.

Table 5-1: Preset Autotest Suites Available for Specific Cable Types

CABLE TYPES	Wire Map	Resistance	Length	Attenuation	NEXT	Capacitance	ELFEXT	Return Loss	Impedance	Delay & Skew	ACR	PS NEXT	PS ELFEXT	PS ACR	Headroom
TWISTED PAIR															
CAT 3, UTP (TIA/EIA568A & TSB67 - Channel)	•		•	•	•										
CAT 5, UTP/STP (TIA/EIA568A & TSB67 – Basic/Channel)	•		•	•	•										
CAT 5 Gbit, UTP/STP (TIA/EIA568A & TSB95 - Basic/Channel)	•		•	•	•		•	•		•					
CAT 5e, UTP/STP (TIA/EIA568A & TSB67 - Basic/Channel)	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
CAT 6, UTP/STP (Draft 5 Proposal) (TIA/EIA568A & TSB67, Basic/Channel)	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
ISO Class C, UTP/STP (ISO 11801 - Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
ISO Class D, UTP/STP (ISO 11801 - Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
ISO Class D 120, UTP/STP (ISO 11801 - Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
ISO Class D, UTP/STP (Proposal) (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
ISO Class D 120, UTP/STP (Proposal) (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
ISO Class E, UTP/STP (Basic/Channel)	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•
TP-DDI, STP (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
BOSS, STP (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
BOSS 120, STP (Basic/Channel)	•	•	•	•	•	•			•	•	•				
TPPMD, UTP (Channel)	•	•	•	•	•	•		•	•	•	•				
AS/NZS C, UTP/STP (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				
AS/NZS D, UTP/STP (Basic/Channel)	•	•	•	•	•	•		•	•	•	•				

(Table Continues)

Table 5-1: Preset Autotest Suites Available for Specific Cable Types (Continued)

CABLE TYPES	Wire Map	Resistance	Length	Attenuation	NEXT	Capacitance	ELFEXT	Return Loss	Impedance	Delay & Skew	ACR	PS NEXT	PS ELFEXT	PS ACR	Headroom
ETHERNET															
10BASET (IEEE 802.3)	•	•	•	•	•	•									
10BASE2 (IEEE 802.3)		•	•	•											
10BASE5 (IEEE 802.3)		•	•	•											
TOKEN RING															
4MB, UTP/STP (IEEE 802.5)	•	•	•	•	•	•									
16MB, UTP/STP (IEEE 802.5)	•	•	•	•	•	•									
Enhanced A, STP (IEEE 802.5)	•	•	•	•	•	•									
MISC. TYPES															
Local Talk	•	•	•	•		•									
ISDN	•	•	•	•	•	•						•			
DIN 44312-1	•	•	•	•	•	•		•	•	•	•	•			
Bavaria STP (Basic/Channel)	•	•	•	•	•	•		•	•	•	•	•			
AUTOMATCH	•	•	•	•	•	•			•	•	•	•			
ECOMATCH	•	•	•	•	•	•			•	•	•	•			
FOILTEK	•	•	•	•	•	•		•	•	•	•	•			
PAIRTEK	•	•	•	•	•	•		•	•	•	•	•			
Single Pair	•	•	•			•									
USOC	•	•	•	•	•	•					•				
IBM Coax		•	•	•											
Twinaxial		•	•	•											
Arcnet		•	•	•											
CATV		•	•	•											
FIBER	(Please refer to the TS2002 User Manual for more information)														

Note: For a detailed test description, refer to Chapter 4, TS2000 Cable Testing Fundamentals.

Test Setup

1. If the TS2000 tester has not been calibrated in the past 24 hours, perform a field calibration (*See Chapter 3, Calibrating the Tester*).
2. Configure the tester as required (*See Chapter 3, Configuring the Tester*):
 - Enter User Information
 - Set Autotest Preferences
 - Adjust Display Contrast
 - Set Time-out Options
 - Set Measurement Units
 - Configure the PC and Printer I/F
 - Configure the Talkset Option
 - Set Date & Time
 - Select Display Language
 - Restore Factory Defaults

Note: The tester retains the last configuration settings. You only need to set configuration options if one or more parameters have changed.


3. Select the Cable Type (*See Chapter 3, Selecting a Cable Type*).
4. Disconnect the cable to be tested from all network equipment.
5. Connect the Permanent Link or Channel Adapters to both handsets.
6. Connect the Display Handset test lead to one end of the link and the Remote Handset lead to the opposite end (*See Chapter 4, Permanent Link and Channel Test Setup*).

Note: TS2000 test leads come with a male connector on one end and an RJ-45-style, 110 block or other standard network connector on the opposite end. (For a complete list of standard and optional accessories, refer to Appendix C).

7. Power up the Display Handset by pressing the **On/Off** key.

Note: The Remote Handset will be powered up automatically by the Display Handset when the Autotest initiates.

Test Sequence

When the **Autotest** button  is pressed, the following actions occur:

1. The DH will first attempt to communicate with the RH (Remote Handset) using one correctly wired pair. If it is unable to establish communication, the DH will display a message that it is looking for the RH and continue trying until the Autotest is manually canceled or the RH is found.
2. Once communication with the RH is established, its serial number is checked to see if current field calibration data exists. If a field calibration has not been performed in the last 24 hours with this RH, the Autotest will be aborted and a Calibration Required message will display.
3. If the serial number is valid, the DH will proceed with the specified Autotest. The first test performed in most Autotests is the Wire Map for twisted pair cable types.
4. After running the Wire Map test, Autotest runs the remaining tests specified for the currently selected cable type. You have the option of specifying (in Autotest Preferences) that testing halt after any failed test or proceed through the entire Autotest regardless of test failures.

Note: All tests after Wire Map will only be performed on valid wire pairs.

5. Once an Autotest has been completed, all of the test data can be reviewed, saved, and printed.
 - The test results for the last Autotest are held in non-volatile memory and available for review or storage, even after power is cycled off and back on.
 - The last Autotest results remain in non-volatile memory until replaced by new test results or memory is cleared.

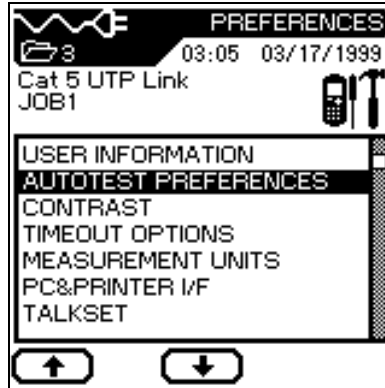
Autotest Preferences

Setting your Autotest Preference Options

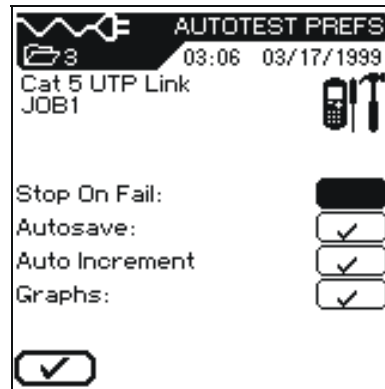
1. Select the **Preferences**







Icon. The Preferences screen appears



2. Select the **Autotest Preferences** option. The Autotest Preference screen appears.





3. Press the **Arrow** keys or use the **Page Up**  and **Page Down**  soft keys to position the cursor next to the desired option.
4. Press  to select or deselect an option.
5. Press **Enter**  to accept the selected Autotest Preferences.

Running Autotest


Autotest performs comprehensive tests to measure cabling using programmed testing limits. An overall pass or fail is displayed along with individual test results.



Before beginning Autotesting, connect the tester Display and Remote handsets to the cable or link to be tested.

1. Press the **Autotest** key .
2. If the RH unit is not found, a Searching for Remote Handset warning message is displayed on the DH.

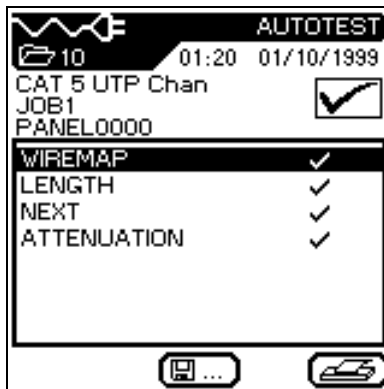
Press  to cancel the test and return to the Ready screen.




3. If the RH is found, Autotest compares the cable test readings to standards for the cable type selected and issues pass/fail statements for each test.
4. While Autotest is in progress, a circular timer displays test progress and indicates pass or fail for each completed test.

Note: Press and hold Stop/Cancel  prior to Autotest completion to stop Autotest after completion of the test in progress.

5. When the Autotest is completed, an overall result of pass  or fail  is displayed at the top right of the test information columns.

Results for individual tests are displayed opposite each test name.



- To begin the next Autotest, press **Autotest** .
- If results from the current test have not been printed, or you did not have AutoSave enabled in the Autotest Preference screen, you will be prompted to discard  or save  the current test results before the next Autotest will run.



Note: The tester also performs real time Analyze testing that enables the user to troubleshoot problem areas. If Autotest results indicate a failure, see Chapter 6, Analyze Testing.

Interpreting Autotest Results

Pass/Fail Reporting

The overall Autotest result is displayed below the Title Bar at the top right of the Autotest display screen. Individual Autotest results are displayed to the right of each test.

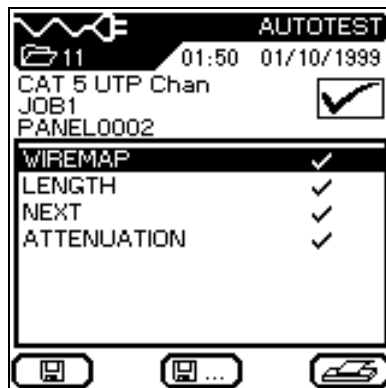


Table 5-2: Overall Test Result Symbols

Symbol	Overall Autotest Result
☑	Overall test result is a <i>pass</i> if each individual test is a <i>pass</i> or a <i>pass*</i> .
⊗	Overall test result is a <i>fail</i> if one or more individual test is either a <i>fail</i> or a <i>fail*</i> .

Table 5-3: Individual Autotest Reports

Symbol	Individual Autotest Result
✓	<i>Pass</i> All values pass with sufficient margin.
✓*	<i>Pass*</i> All values pass, but one or more test values passed by a margin smaller than the unit's specified accuracy for the measurement. The <i>pass*</i> result does not fail the cable. However, it is a warning that the cable is close to the limit on that parameter and should be inspected as soon as possible.

(Table Continues)

Table 5-3: Individual Autotest Reports (Continued)

Symbol	Individual Autotest Result
✘	<i>Fail</i> One or more values fail by a significant margin.
✘ ✱	<i>Fail*</i> One or more values fail, but the margin of failure is smaller than the unit's specified accuracy for the measurement. The <i>fail*</i> result fails the cable and must be cleared up, just like a standard fail. However, <i>fail*</i> means it has failed by a small margin and minor adjustments in the installation may correct the error.


The effect of the *pass*/fail** reporting of individual test results is to provide a built-in margin of safety above and below the advertised accuracy for a measurement. Measurements which fall outside this guard band are a clear *pass* or a clear *fail*, and the probability of the tester being in error is negligibly small.

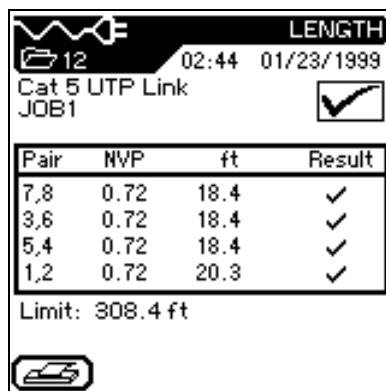
Viewing Current Autotest Results


Autotest results can be viewed at the completion of the test sequence or saved for later viewing.

1. Use the **Arrow** keys to position the cursor bar on the desired test.



2. Press **Enter**  to view test results.



3. When finished, press  to return to the Autotest screen.

Understanding Test Failures

A failure result for Autotest indicates that one or more tests did not meet minimum cable parameter levels for the cable type selected.

Note: Be sure that you have selected the correct cable type and are using appropriate connectors and links.

Identifying which tests failed and the characteristics of the failure will determine the type of fault. If the Autotest shows a failure on a particular sub-test, perform Analyze testing (Chapter 6) for the failing test in order to troubleshoot the cable.

When more than one test fails on Autotest, the test order used for troubleshooting is an important element in eliminating the source of the problem.

If any tests fail, Analyze tests should be run in the following order:

1. Wire Map
2. DC Resistance
3. Length
4. Delay and Skew
5. Impedance
6. Attenuation
7. NEXT
8. Dual Return loss



Refer to Chapter 6 to run these tests in Analyze mode.

Using Jobs to Store Test Results



The TS2000 tester gives you the ability to store cable test results under separate Job names. You can create Jobs, assign any name to them, and store test results on a Job by Job basis. By using Jobs, you can logically group and store test results in a descriptive manner.

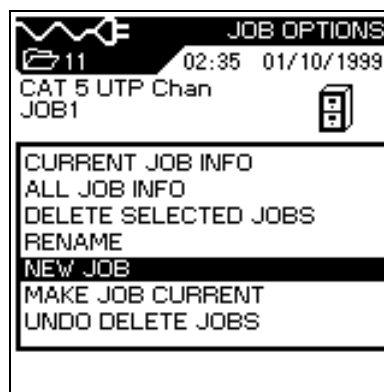
You can set up a separate Job for each floor in a building, each building on a campus, each customer, or for any other classification.

To create a New Job,

1. Select the **Stored Results**  icon and press **Enter** . At this point, you will see a list of all the jobs which are currently available. If you have never created a Job, the list will be empty.



2. To create a new Job press the options  button. The **Job Options** screen appears. Select **New Job** and press **Enter** .




3. Type a name into the text field on the **New Job** screen using the alphanumeric keyboard. You will need to press a key two or three times to get the second and third character on the key.

Press the right arrow hard key to advance to the next character position.



Note: Press  to delete a highlighted character.


4. When you have entered the name, press . You will return to the Job Options screen where you can Access Job information, Delete Jobs, Rename Jobs, make a Job the current Job, or create more Jobs.

Note: When you save test results, they will be stored in the last Job you made current.


Saving Current Autotest Results

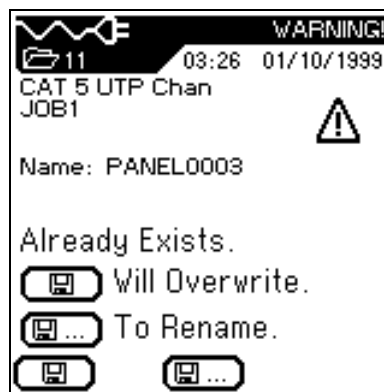
A maximum of 1,500 TIA Cat 5 individual Autotest results can be stored in the TS2000 tester memory and accessed later using the Test Results menu.



Autotest results can be saved immediately following the test.


- Only overall passed Autotests are automatically saved.
- The entire set of test results is saved as one file.
- Test results are automatically saved if the AutoSave preference is enabled. Refer to *Setting Autotest Preferences*, page 5-6.
- Test names are automatically assigned to completed tests. If a different name is desired, a test can be named manually using **Save As** . Refer to Step 4, below.

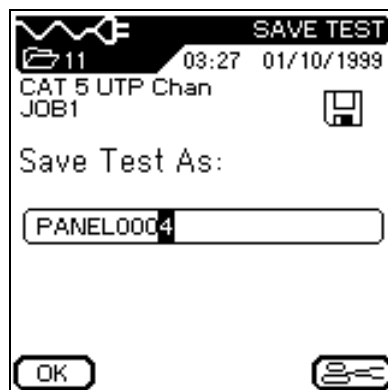
To save Autotest results (AutoSave Disabled):


1. To manually save an Autotest, press the  key.
2. The Test Saved screen will be displayed for a brief period, showing the name the test is saved under.
3. If the current name already exists, the following Warning screen appears.




4. Press  to Escape and return to the previous screen without performing a save operation, or Press  to Overwrite the existing file.


5. Press  to select the **Save As** option to rename the current test. The **Save Test** screen will display with a new name option.



Note: The default Save As name is derived from the cable name entered into the Cable ID screen  or from the previous saved name.


Printing Current Test Results

Printing can be done from a test results screen or from stored Autotest results. Once a serial printer is connected to the DH, test results are printed by pressing the Print  key. The tester does not perform batch printing.

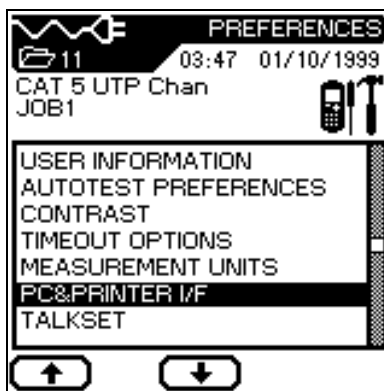
Note: The Print  key can also be used to upload the test data to a PC communication program (i.e. Hyper Terminal)

Connecting a Serial Printer

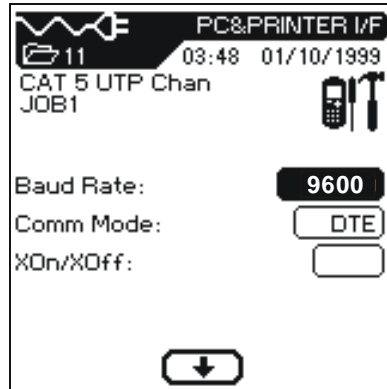
1. Connect a serial printer to the tester's DB-9 serial port (RS 232) and verify the following printer settings (parallel printers will not function with tester):
 - Baud Rate: 9600
 - Data Bits: 8
 - Stop Bit: 1
 - Parity: None
 - Flow Control: XON/XOFF

2. From the Ready screen, select the **Preferences**  icon to open the Preferences screen.

3. In the Preferences screen, use the **Arrow** keys to select the **PC & Printer I/F** option.



4. In the **PC & Printer I/F** screen, set the correct printer parameters.



5. Press **Enter** (↵) to save changes.
6. Press (⏪) to return to the previous screen after setting the printer communication settings.







If the printer does not respond, check the following:

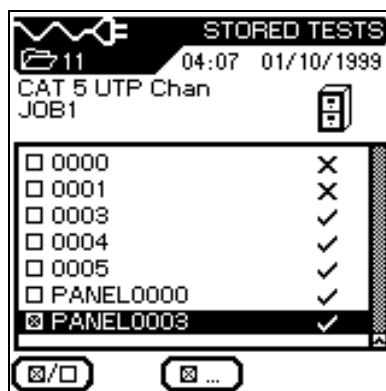
- Printer indicates “On-Line.”
- Printer parameters have been correctly set.
- Correct serial cable is securely fastened to the printer and the DH.

Viewing or Deleting Stored Autotest Results

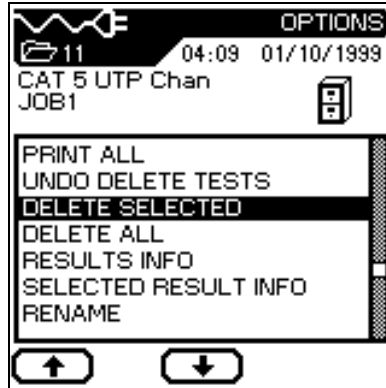
Test Results contain stored data from Autotest. On the TS2000 tester up to 1,500 Autotests can be stored in memory. Users can view, print, delete or rename these files.

When an Autotest or an individual test from Analyze is saved, the data is stored with a unique name. Test results can be viewed, printed, or deleted from the Stored Results screen.

1. Select the **Test Record**  icon to open the **Job List** screen.
2. Position the highlighted cursor over the desired Job.
 - Press  to select multiple items for processing.
3. Press **Enter**  or the **Check Box**  to select the job for viewing. The **Stored Results** screen opens.
 - Press  to select multiple items for processing.
4. Repeat step 3 as many times as necessary.
5. Press  to open the **Options** screen.



6. Position the highlighted cursor over the desired option. In this example, the marked job is to be deleted from memory.
7. Press **Enter** (↵) to perform the desired option.
8. Press **Escape** (⏪) at any time to return to the previous screen.



Job and Test Option Tables

Table 5-4: Job Options

Option	Description
Current Job Info	Total number of tests passed/failed, cable length, and headroom for <i>current</i> job.
All Job Info	Total number of tests passed/failed, cable length, and headroom for <i>all</i> jobs.
Delete Selected Jobs	Deletes selected jobs from memory.
Rename	Change name of currently selected job.
New Job	Add new job to job list.
Make Job Current	Activates highlighted job. Saved tests (Autotests/Analyze) will be stored in this test.
Undo Delete Jobs	Undo last delete action.

Table 5-5: Test Options

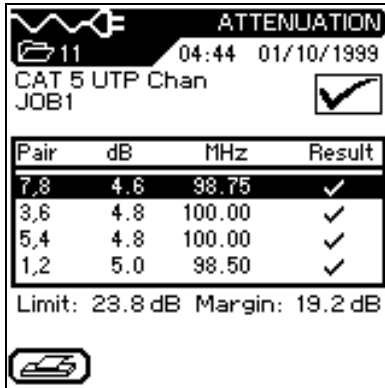
Note: The functions indicated below will only be performed on tests stored in memory.

Option	Description
Select All	Select all stored test results.
Select All Passed	Select only passed test for processing.
Select By Date	Select stored test results by date.
Select All Failed	Select only failed tests for processing.
De-select All	Unmark all stored test results.
Print Selected	Print selected test results.
Print All	Print a summary of stored test results.
Undo Deleted Tests	Undo the last delete action.
Delete Selected	Delete marked test results.
Delete All	Delete all stored test results.
Result Info	Displays test result information such as number of tests, number passed and failed, length tested, and headroom.
Selected Result Info	Display the results of selected tests.
Rename	Rename a selected test result.

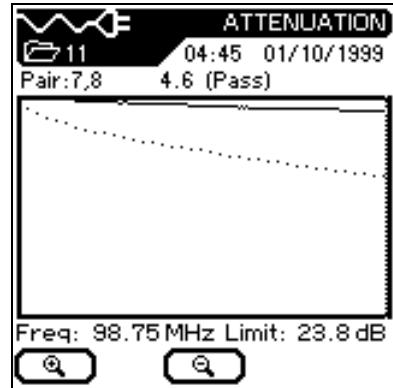
Autotest Graphs

Autotest results can be viewed at the completion of the test sequence in either a tabular or graphical format.

Tabular Format



Graphical Format




Graphing Facts

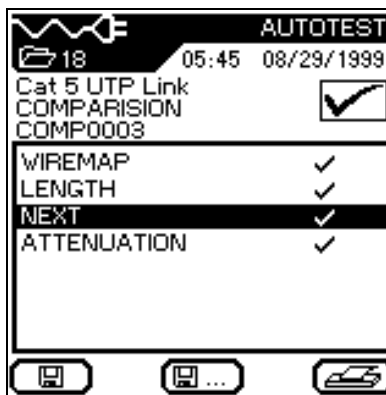
Graphs can be very useful for viewing test results. There are a few things you need to know before you start using them:

1. In order to view test graphs, graphs must be enabled from the Autotest preferences screen *before* running Autotest.
2. Graphs are *not stored* in flash ROM with the test results.
3. Once you save a test result or run another Autotest, the currently displayed graph is permanently erased from the graph memory buffer.
4. The Limit and worst case Margin parameters are always displayed at the bottom of the Tabular test screen.
5. When you go to graph view, the vertical cursor is always placed at the worst case Margin location.

To view an Autotest graph:

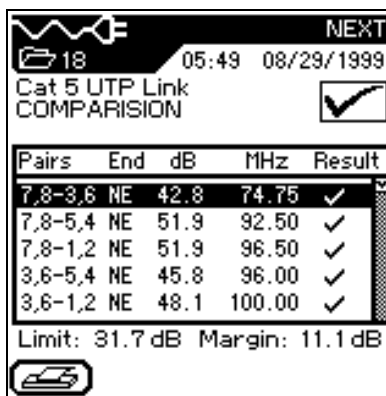
1. Configure the Autotest Preferences. Refer to this chapter, pages 5-6.
2. In Autotest Preferences, make sure the **Graphs** checkbox is selected.

3. Press the **Autotest**  button. Upon completion of the test suite for the cable type selected, the Overall Autotest results screen displays.



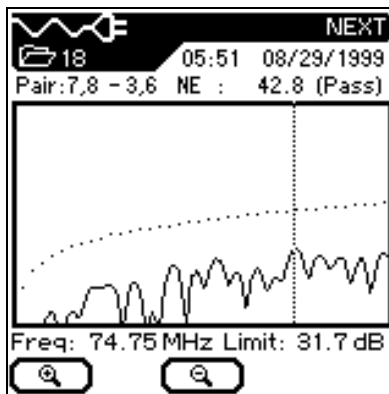
4. To display tabular data, position the cursor on the desired test result (the NEXT test) and press **Enter**.


5. To display a graph of the tabular data, position the cursor on the tabular data of interest (pairs 7,8 and 3,6) and press **Enter**.



- The graph will always open with the cursor positioned on the worst case margin. In this example, the cursor is positioned on the horizontal axis at 74.75 MHz.

Note: Graphs can only be displayed; they cannot be saved in memory.



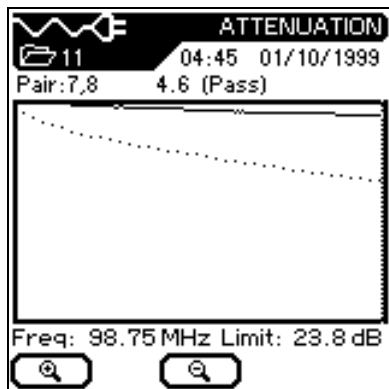
- Press  to return to the previous screen.

Graph Formats, Layouts, and Controls

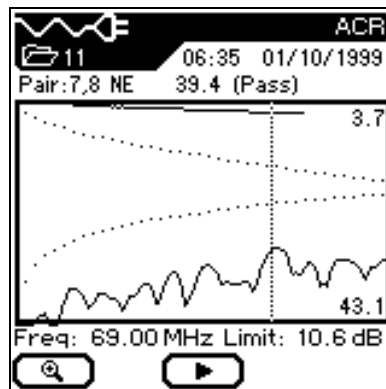
Formats

There are two different graph formats, single and dual plot. For an example of each format, refer to the following graphs.

Single Plot



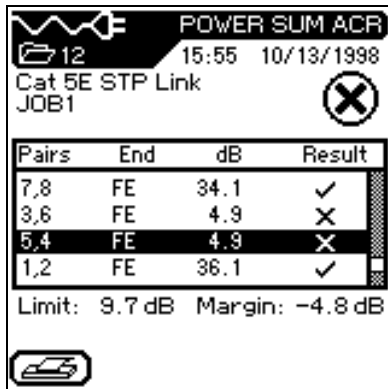
Dual Plot



Layout and Controls

Graphs are useful for observing the relationship between two network cable parameters, actual measured parameters and predefined worst case margins. The coordinate system of the graph is formed by horizontal and vertical axes. The horizontal axis represents frequency data and the vertical axis represents the measure values in dB, with limits indicated as a dotted trace.

Tabular View



Graphical View

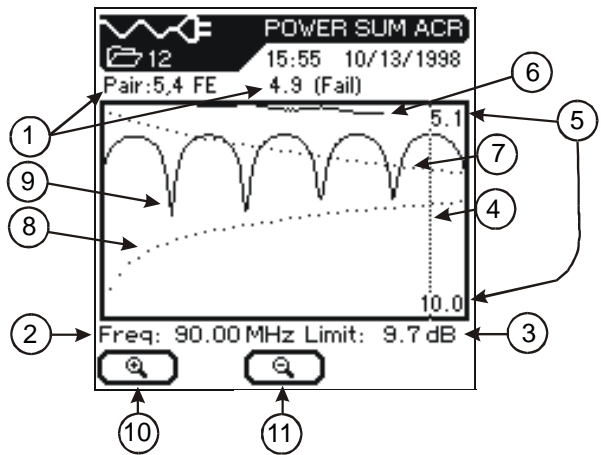


Figure 5-1: Tabular Data and Graphical Plot Layout

Note: The Margin data at the bottom right of the Tabular screen represents the worst case difference between the actual measured data and the predefined limit threshold as shown by the cursor position in the graph on the right.

Table 5-6: Autotest Graph View Layout and Controls

Point	Function
1	Wire Pair plotted from tabular data.
2	The horizontal axis represents frequency data.
3	The vertical axis is tracked by the cursor. The result represents measurements in dB.
4	When a wire pair graph is first displayed, the cursor is automatically positioned at the worst case limit and frequency point from the preceding tabular data.
5	Cursor values for each curve are displayed in the top right and bottom right corners of the graph. The values will change as the cursor is moved.
6	Actual data plot for a wire pair. Attenuation is plotted in this example.
7	Predefined worst case limit plot for attenuation.
8	Predefined worst case limit plot for NEXT.
9	Actual data plot for a wire pair. NEXT is plotted in this example.
10	Expands the horizontal axis of the graph about the cursor. Repeated operation of this key will repeatedly scale the graph. At full magnification, this key becomes inactive.
11	Compresses the horizontal axis of the graph about the cursor. Repeated operation of this key will repeatedly scale the graph. When the full graph is displayed, this key becomes inactive.
Left/Right Arrow Keys	Used to move the cursor horizontally. As the cursor moves, screen readouts will change to reflect cursor position.
Up/Down Arrows Keys	Used to scroll through the pair or pair combinations from the tabular test results screen and display plot data. Repeated up/down operations will cycle through the results list and cause a wraparound.



Contents

- How to run tests in the Analyze single test mode
- Setting up test preference
- Viewing and interpreting Analyze test results

Analyze Single Test Mode Overview

Analyze mode allows you to troubleshoot by running individual tests, making adjustments, and observing changed test results. For example, a failed capacitance measurement can indicate crimped or stretched cable. With Analyze testing, you can walk the cable and check for damage and stretching. Freeing the cable at suspected problem areas should improve the measured reading.

Depending on the cable type and defined test standard, any or all of the following individual tests are available:

- Wire Map
- Length
- NEXT
- Attenuation
- Power Sum NEXT
- DC Resistance
- Return Loss
- Delay and Skew
- Impedance
- Power Sum ACR
- Capacitance
- ACR
- Headroom
- ELFEXT
- Power Sum ELFEXT

Analyze Test Descriptions and Availability

For an overview of individual tests, refer to *Chapter 4, TS2000 Cable Testing Fundamentals*. The individual tests you can run depend upon the cable being tested. Test availability is pre-determined based on the adopted or proposed standards, refer to *Chapter 5, Test Suites, Table 5-1*.

Test Setup

1. If the TS2000 tester has not been calibrated in the past 24 hours, perform a field calibration (*See Chapter 3, Calibrating the Tester*).
2. Configure the tester as required (*See Chapter 3, Configuring the Tester*):

Note: The tester retains the last configuration settings. You only need to set configuration options if one or more parameters have changed.

3. Select the Cable Type (*See Chapter 3, Selecting a Cable Type*).
4. Disconnect the cable to be tested from all network equipment.
5. Connect the test leads to both the Display and Remote Handsets using the connectors.

Note: TS2000 test leads come with a male connector on one end and an RJ-45-style, 110 block or other standard network connector on the opposite end. (For a complete list of standard and optional accessories, refer to Appendix C).

6. Connect the Display Handset test lead to one end of the link and the Remote Handset lead to the opposite end.

Note: Refer to Chapter 4, Figures 4-3 and 4-4, for connections to complete Permanent Link and Channel testing.

7. Power up the Display Handset by pressing the **On/Off** key.



Note: The Remote Handset will be powered up automatically by the Display Handset when the Analyze testing initiates.

Test Sequence

When an individual test is run, the following actions occur:

1. If the test requires the RH (Remote Handset), the DH will first attempt to communicate with the RH. If it is unable to establish communication, the DH will display a message that it is looking for the RH and continue trying until the Analyze test is manually canceled or the RH is found.
2. Once communication with the RH is established, its serial number is checked to see if current field calibration data exists. If a field calibration has not been performed in the last 24 hours with this RH, the test will be aborted and an appropriate Calibration Required message will display.
3. If the serial number is valid, the DH will proceed with the specified individual test.
4. If the test does not require the RH, the DH will run the test and display test data.
5. Once a test is run, the test data can be reviewed or printed.

Analyze Test Screens

There are a total of 15 Analyze test screens. They are identical to the corresponding Autotest screens, with the addition of the **Run**  key to the soft key option row. When this key is pressed, the tester begins continuous execution of the selected test. The **Halt**  key is used to end the test in progress.


Analyze Test Limitations

Analyze and Autotest test limitations are identical.

Running a Single Test

Before beginning Analyze testing, connect the Model TS2000 Display and Remote Handsets to the cable or link to be tested.

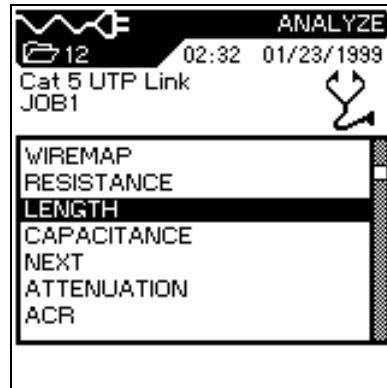
All Analyze tests are run using the following procedure:

1. In the **Ready** screen, select the **Analyze**  icon to open the Analyze screen.
The Analyze screen lists the tests that can be performed on the currently selected cable type (refer to *Chapter 3, Selecting a Cable Type*).



2. Use the **Arrow** keys to position the cursor bar on the desired test.

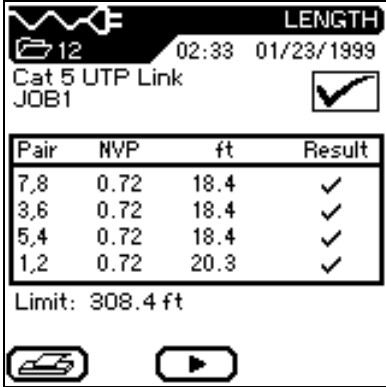
In this example, the **Length** test is selected.

3. Press  to start the test.



4. Upon test completion, the tabular results screen is displayed.

5. Press  to run the test in continuous mode. Press and hold  to end continuous mode testing.



The screenshot shows the LENGTH test results screen. At the top, it displays a signal strength indicator, a battery icon with '12', the time '02:33', and the date '01/23/1999'. Below this, it says 'Cat 5 UTP Link' and 'JOB1' with a checkmark icon. A table of results is shown:

Pair	MVP	ft	Result
7,8	0.72	18.4	✓
3,6	0.72	18.4	✓
5,4	0.72	18.4	✓
1,2	0.72	20.3	✓

Below the table, it says 'Limit: 308.4 ft'. At the bottom, there are two icons: a cable icon and a play button icon.

Interpreting Analyze Test Results

Pass/Fail Reporting

The overall Analyze test result is displayed below the Title Bar at the top right of the display screen. Individual wire pair test results are displayed to the right of each test.

Pair	NVP	ft	Result
7,8	0.72	18.4	✓
3,6	0.72	18.4	✓
5,4	0.72	18.4	✓
1,2	0.72	20.3	✓

Limit: 308.4 ft

In the example above, the Length test results screen is displayed.

- Individual wire pair test results are displayed in the last column on the right (Result column).
- An overall test result of pass or fail is displayed at the top right above the Result column.

Overall and Individual test result reporting is usually identical to Autotest mode. For a description of symbols and test results, refer to *Chapter 5, Pass/Fail Reporting*.

Printing Analyze Test Results

A Tabular test result screen can be sent directly to a serial printer. Before sending a result screen to the printer, the printer port needs to be configured. For detailed printer setup and screen printing instructions, refer to *Chapter 5, Printing Current Test Results*.

Analyze Graphs

Certain Analyze test results can be viewed at the completion of the test sequence in either a table or graphical format.

1. Run an Analyze test.
2. Position the highlighted cursor on the desired table data.
3. Press the **Enter** key to display the wire pair table data as a graph.

Analyze graphs are similar to Autotest graphs. For a description of these graphs, refer to *Chapter 5, Graph Formats, Layout, and Controls*.

Chapter 7

Using BB Record Manager Software

Contents

- BB Record Manager software installation, startup, and user interface
- BB Records Manager Help system overview
- Software configuration and options
- Importing Autotest data from the tester into a PC database
- Viewing and printing test reports

System Requirements

Your PC should have the following capability:

Minimum:	486DX-33, 8 MB RAM, 10 MB Free Disk Space, Windows 95.
Recommended:	Pentium 90 MHz, 16 MB RAM, 100 MB Free Disk Space, Windows 98 and 95, or Windows NT version 4.0 or greater.

BB Record Manager Installation, Startup, and Navigation

Installation Procedure

The BB Record Manager software is installed using the standard Windows 95 program installer.

1. Insert the BB Record Manager CD-ROM.
2. Click on the Start button, and then click Run.
3. Type, d:\ setup

Note: If your CD-ROM drive is not the “d” drive, replace “d” with the correct drive letter.

4. Follow the instructions on your screen.

*Note: Install BB Record Manager in the default directory, c:\bbrm.
An empty database will be created in c:\bbrm\db.*

Starting the BB Record Manager Program

Do one of the following:

- From the Windows desktop, click on the Start button. Next, click on Programs, BB Record Manager, BB Record Manager.
- From Windows Explorer, go to the bbrm folder and double-click on the BBRM application file.
- Click the Start button and then the Run command, type c:\bbrm\bbrm.

Tester to PC Connectivity

PC Cable

Use the cable supplied with your Tester (commonly referred to as a Null modem cable), to upload test results to a PC. If you supply your own cable, it must be wired to the following specifications.

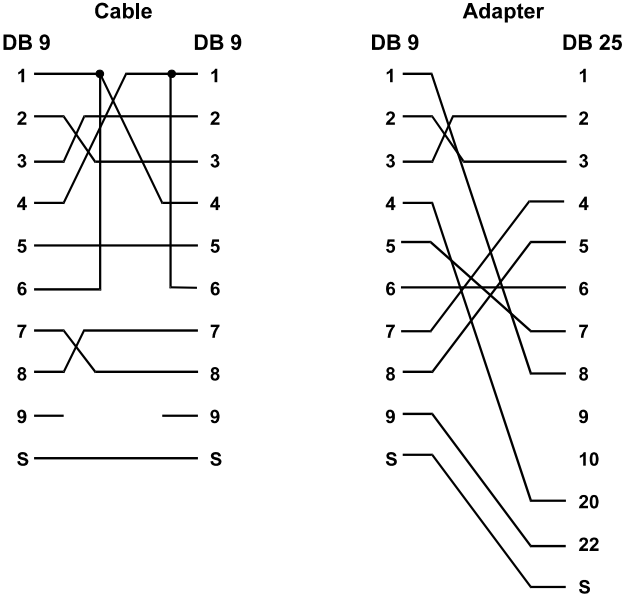


Figure 7-1: PC Uploading Cable Pinout

Establishing a Connection

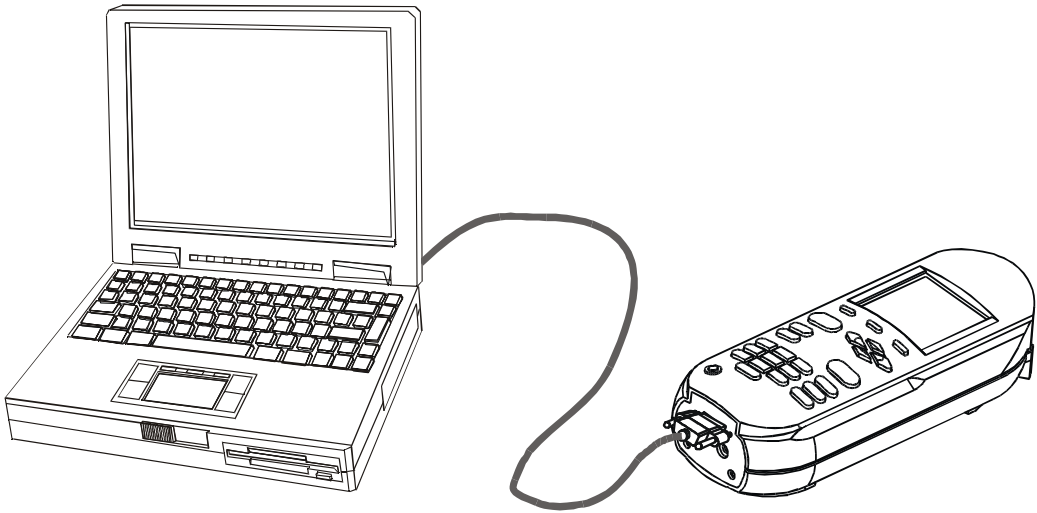
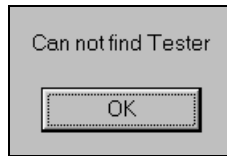


Figure 7-2: PC/Tester Connection

1. Attach the cable to the tester and an available serial port on the PC or Laptop.
2. Turn on the tester.
3. Start the BB Record Manager program on the PC or Laptop.
4. From the BB Record Manager **Options** menu, select the **Tester ID** command.

The program will automatically scan the available communications ports and baud rates to locate and identify an attached tester. If the tester is not identified, proceed to the next step.

5. Some PCs may have difficulties with this function and the following dialog box displays. Click on the **OK** button.

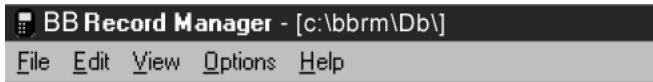


6. Click on the **Options** menu, select the **Serial Port** command. Select the correct **Port** and match the **Baud Rate** to that of your TS2000 tester.
7. After you have entered the values, click the **Test** button.
 - If the tester is identified, its serial and model numbers will be displayed.
 - If you have tried alternative baud rates and ports and BB Record Manager still cannot find the tester, call BLACK BOX[®] Tech Support.
7. Click on the **OK** button.

BB Record Manager User Interface

The Menu Bar

The menu bar is at the top of the screen, directly below the screen title bar. The bar displays the pull-down menu names.



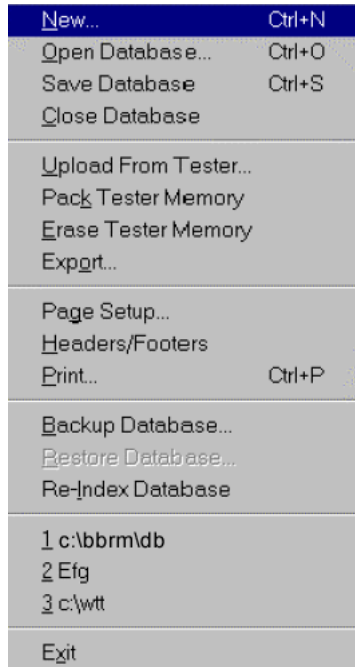
When you choose a menu, a list of commands drops down under the menu. You can choose only the commands that are solid black. Gray commands or options are disabled or may be context sensitive. For example, to use test commands such as **F**ind Test and **S**elect Test, the cursor must be in the test grid portion of the screen or the commands are not available.

To open a menu

1. Move the mouse so that the tip of the mouse pointer is on the desired menu.
2. Click the left mouse button, or press Alt and then the underlined letter in the menu name.

The File menu

Click on File to display the File pull-down menu. Many of the selections on this menu are standard Windows options.



Command	Description
New	Create a new database.
Open Database	Open an existing database. More than one database can be open at the same time.
Save Database	Save the currently open database
Close Database	Close the currently open database.
Upload From Tester	Pull result data from the TS2000 tester.
Pack Tester Memory	Erase all tests in the tester memory that are marked for deletion.

Chapter 7

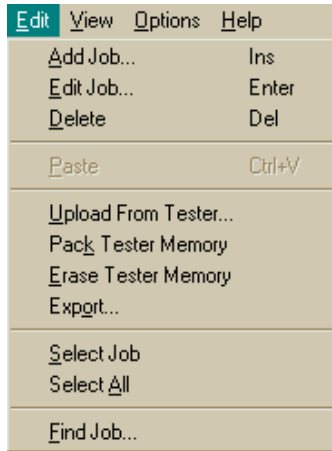
Using BB Record Manager Software

Command	Description
Erase Tester Memory	Erase all test in the tester memory.
Export	Export test results as Comma-Separated Values (CSV) or standard ASCII text files.
Page Setup	Modify the print settings.
Headers and Footers	Insert notes.
Print	Print a report.
Backup Database	Archive current data in the current folder.
Restore Database	Restore a closed database from a zipped archive file into the current folder.
Re-Index Database	Re-index the database.
Switch To	Switch to one of the last three most recently accessed databases.
Exit	Exit the application.

The Edit Menu

Click on Edit to display the Edit pull-down menus.

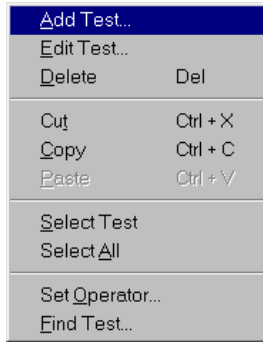
Job View



Command	Description
Add Job	Add a Job.
Edit Job	Modify a Job.
Delete	Delete a job from the database.
Paste	Copy the clipboard contents to the currently selected item.
Upload From Tester	Upload a job from the tester to the PC.
Pack Tester Memory	Erase all tests in the tester memory that are marked for deletion.
Erase Tester Memory	Erase all test in the tester memory.
Export	Export test results as Comma-Separated Values (CSV) or standard ASCII text files.
Select Job	Select an item in the database view in preparation for printing or reporting.

Command	Description
Select All	Select all entries in the database view.
Find Job...	Locate a database item.

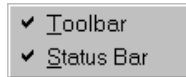
Database (Test) View



Command	Description
Add Test	Add a Test.
Edit Test	Modify a Test.
Delete	Delete a test from the database.
Cut	Cut the currently selected test(s).
Copy	Copy the currently selected tests to the clipboard.
Paste	Copy the clipboard contents to the currently selected item.
Select Test	Select a test in the database view for printing or reporting.
Select All	Select all tests in the job.
Set Operator	Provide details of the operator for the currently selected test.
Find Test	Locate a database test item.

The View Menu

The View pull-down menu allows you to hide or display the toolbar or status bar.



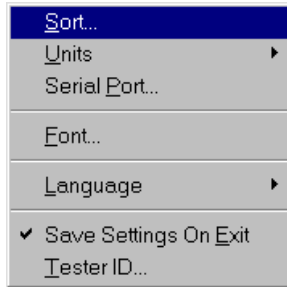
While in database (test) view, select a test and click on the Test Information option to open the Test Information window. A red dot on a test tab indicates one or more tests on the tab failed. A green dot indicates that all tests on the tab passed. Click on a test tab to display stored test results.

The screenshot shows a window titled 'Cable:TEST0000 (907)'. It contains a form with the following fields: Job Name: ADG, Date: 4/12/99, Operator: OPERATOR NAME, Customer: (empty), Test Instrument: TS2000 [0/0], Test Standard: Custom, Freq. Range: 1-300 MHz, and NVP: All 0.72. Below the form is a toolbar with buttons for Power Sum ACR, Power Sum ELFEXT, Power Sum NEXT, ELFEXT, Wiremap, Pair Data, Return Loss, NEXT, Attenuation, and ACR. The 'Return Loss' button is selected. The main area displays a table of test results for various pairs.

Pairs	IE/FE	Result	Worst	Limit	Margin
7,8	NE	Fail*	13.4 dB @ 147.50MHz	> 13.5 dB	-0.1 dB
3,6	NE	Fail	9.8 dB @ 140.00MHz	> 13.7 dB	-3.9 dB
5,4	NE	Fail*	11.0 dB @ 275.50MHz	> 11.5 dB	-0.5 dB
1,2	NE	Pass	18.5 dB @ 270.50MHz	> 11.6 dB	6.9 dB
7,8	NE	Fail*	12.5 dB @ 140.00MHz	> 13.7 dB	-1.2 dB
3,6	NE	Fail	7.8 dB @ 281.00MHz	> 11.5 dB	-3.7 dB
5,4	FE	Fail*	9.7 dB @ 285.50MHz	> 11.4 dB	-1.7 dB
1,2	FE	Pass	16.5 dB @ 271.00MHz	> 11.6 dB	4.9 dB

The Options Menu

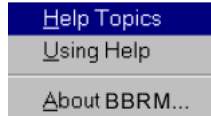
Click on Options to display the Options pull-down menu.



Refer to page 7-19 for a description of the Option menu.

The Help Menu

This menu provides the standard windows Help support, and displays the About dialog.



The Status Bar



















The Status Bar at the bottom of the screen lists the functions that are currently operating and indicates the number of tests residing in the currently highlighted job.



The Toolbar

The tools on the toolbar are shortcuts for commands you otherwise access with menu commands.

Tool Button Identification

	New		Upload
	Open		Get Tester ID
	Cut		Set Operator
	Copy		Backup
	Paste		Select All
	Delete Selected		Sort
	Export		Find
	Import		Help
	Print		About

The Right Mouse Button

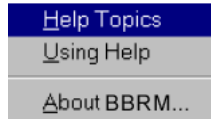
The right mouse button provides another shortcut to some of the more commonly used functions from the Edit menu. This feature is context sensitive; it supports different functions depending on where you utilize it.

BB Records Manager Help System Overview

You gain access to the BBRM Help system by using the Help menu command.

Help Topic Menu Option

The Help Topics menu option is the primary way to gain access to the BBRM Help system.



To open the Help System

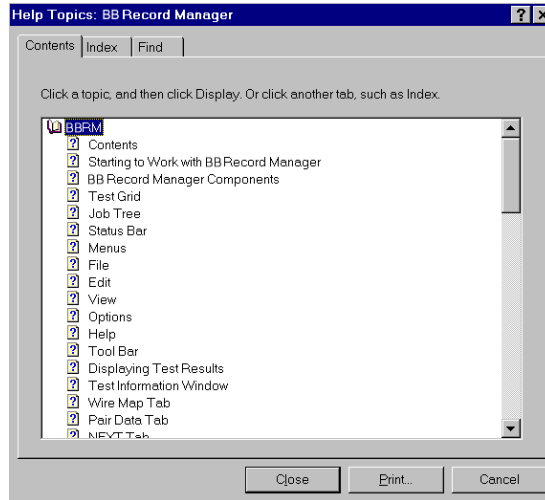
1. Pull down the **H**elp menu and click the **H**elp Topics command. The Help Topics screen displays.

Help Topics Screen

The BBRM **H**elp Topics screen contains three tabs and three buttons.

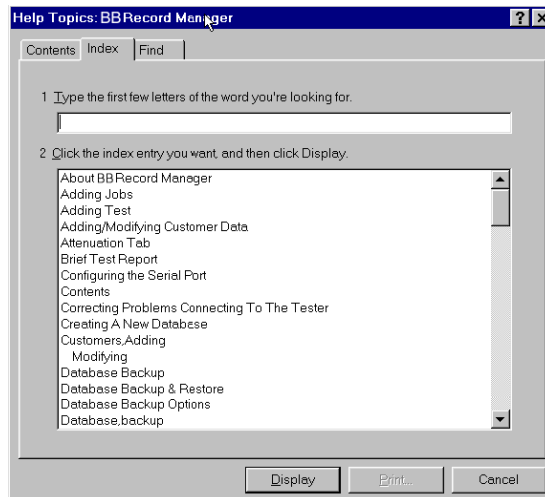
Content Tab

The **Content** tab displays a list of topics in the BBRM Help system; it is organized by category.



Index Tab

The **Index** tab is similar to a traditional book index, listing keywords and phrases alphabetically.



Find Tab

The **F**ind tab provides functionality for a full-text search for any word or phrase in the Help system.

Display Button

The **Display** button “opens” the selected BBRM Help item.

Print Button

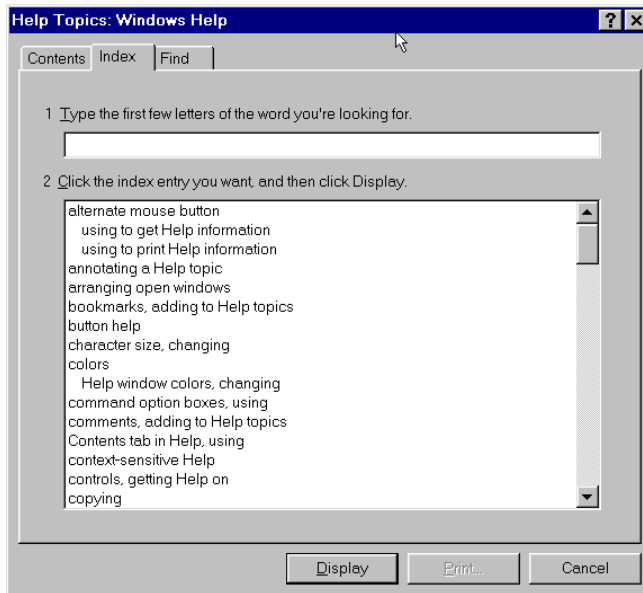
The **Print** button prints the selected item.

Cancel Button

The **Cancel** button closes the BBRM Help system.

Using Help Screen

The Using Help screen is arranged similar to the Help Topics screen. It also contains three tabs and 3 buttons. The screen contains instructions for using and customizing the BBRM Help system.



About BBRM Screen

The About BBRM screen displays the BBRM version number running on your computer.



Program Configuration

Use the Options pull-down menu to configure the BB Records Manager program to match your hardware and user preferences.



Table 7-1: Options Pull-Down Menu

Command	Description
<u>S</u> ort	Sort tests in the database view.
<u>U</u> nits	Choose feet or meters as the measurement units for both the screen display and printouts.
Serial <u>P</u> ort	Configure the serial port for your TS2000 tester.
<u>F</u> ont	Change the screen display font.
<u>L</u> anguage	Change the language for both the screen display and printouts.
Save Settings On <u>E</u> xit	Save and use the current hardware and user preferences the next time the program is started.
<u>T</u> ester ID	Locate and identify an attached tester.

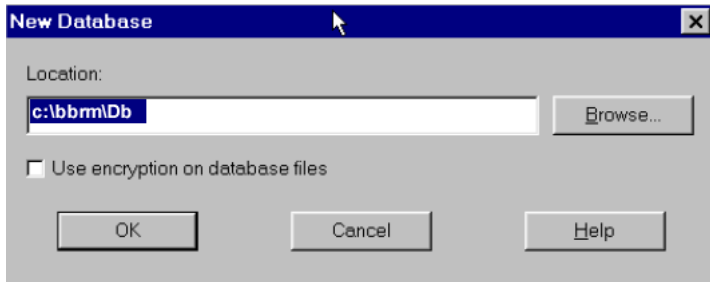
Working with Databases

On start-up, the database that was opened last will automatically reload.

Note: The first startup of BB Record Manager will load an 'empty' database (c:\bbrm\db) from the database directory.

Creating a New Database

1. Pull down the **File** menu and click the **N**ew command.



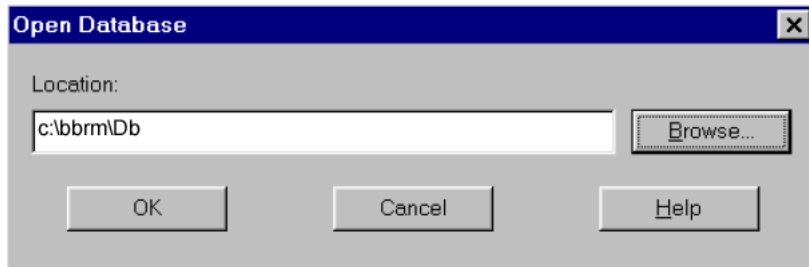
2. You can either type the new path and database name or choose **B**rowse and select an existing path and then type in the database name.

Note: The name of the new database displays only in the title bar of the main window.

3. Click the **OK** button when you are finished.

Opening an Existing Database

1. Pull down the **File** menu and select the **Open** command.



2. Type in a file path and name, or use the **B**rowse button to locate the desired database folder and file.
3. Click the **OK** button to open the database.

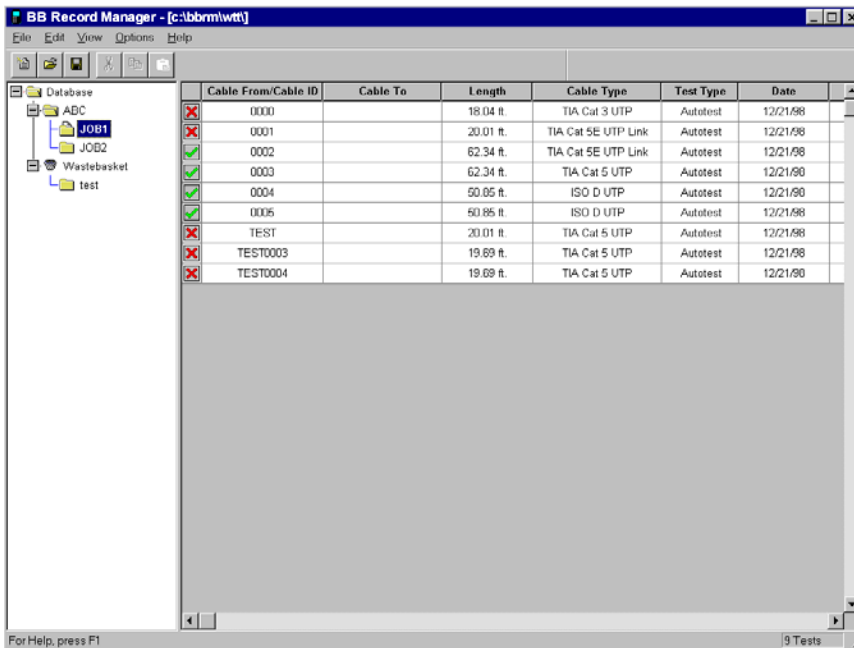
Note: The name of the open database displays in the title bar of the main window only.


Working at the Job Level

Navigating the Job Tree

Tests are stored in folders called Jobs. For example, each floor of a building can be listed as a separate Job. Another Job can represent the entire building or just those tests conducted by a particular technician.

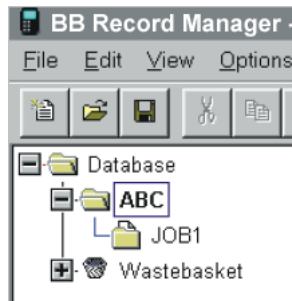
The left side of the Database View shows the hierarchy of Jobs. Clicking on a Job folder that is preceded by a plus (+) sign reveals the Jobs it contains. This hierarchy can be up to five levels deep.



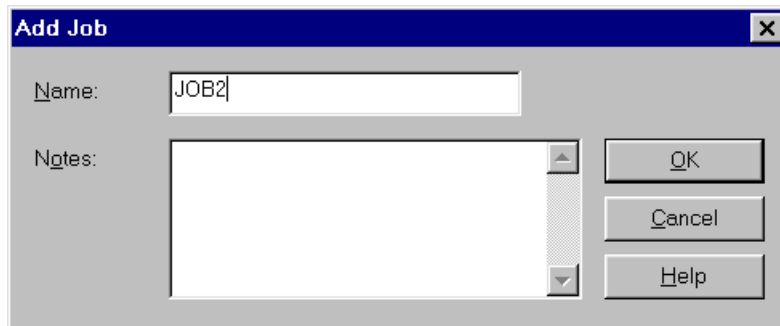
- Jobs that have attached test records are indicated by a  icon. When you click on this icon, the test records become visible.
- You may move Jobs by selecting and dragging them. Selection is indicated by a highlight bar.

Adding a Job

You must click on the left side of the main database view for the Add or Edit Job functions to be available. You can create a new collection of tests by adding a Job folder.



1. From the **E**dit menu, click **A**dd Job. The Add Job dialog box displays.

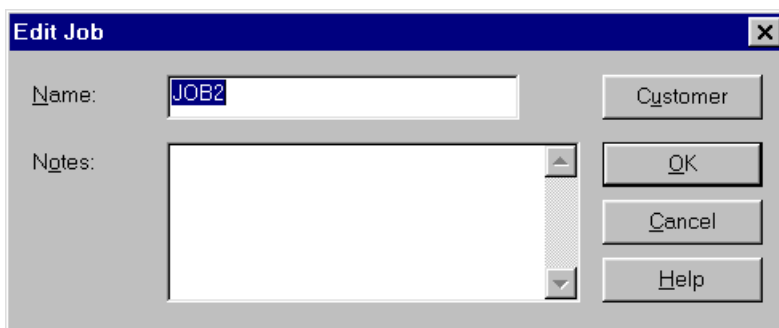


2. Type in a name for the Job folder and any notes you want to add.
3. Click **OK** to create the new job folder.

Editing Job

To change the name of a Job folder or attach some textual notes:

1. From the **E**dit menu, click **E**dit Job. The Edit job dialog box appears.

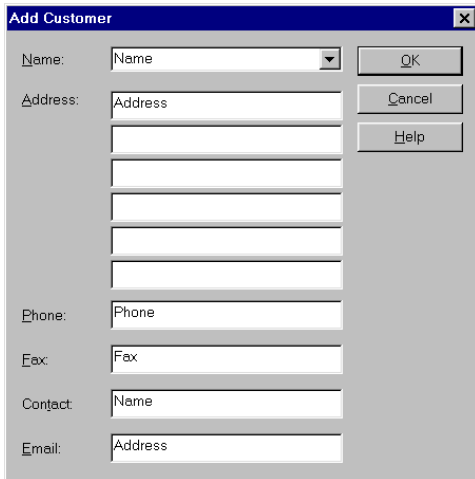


2. Click on the **N**ame or **N**ote text boxes to perform the desired edits.
3. Click **OK** when you are finished.

Adding or Editing Customer Details

You may also want to add or modify customer details on a specific Job entry.

1. From the **E**dit menu, select the **E**dit Job command.
2. Click on the **C**ustomer button. The Add Customer or Modify Customer dialog box displays.



Add Customer

Name: Name [v] [OK]

Address: Address [Cancel]

[] [Help]

[]

[]

[]

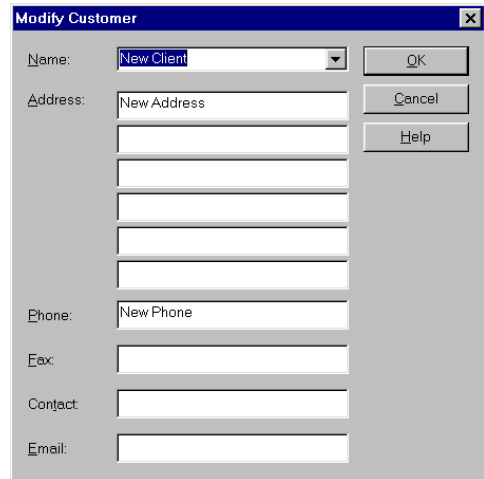
[]

Phone: Phone

Fax: Fax

Contact: Name

Email: Address



Modify Customer

Name: New Client [v] [OK]

Address: New Address [Cancel]

[] [Help]

[]

[]

[]

[]

Phone: New Phone

Fax: []

Contact: []

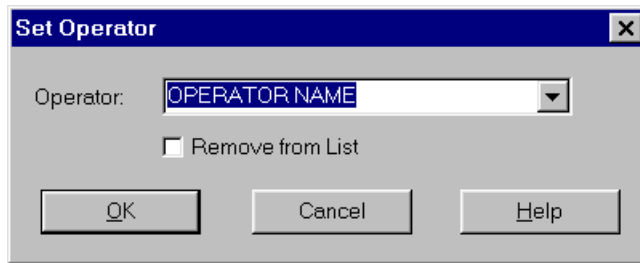
Email: []

3. Add new customer information or edit existing information. If a customer name is supplied it will appear at the beginning of a report.

Adding or Changing the Test Set Operator Name

You may add or change the operator name associated with a given test.

1. Open a job and position the cursor in the desired test field on the right side of the screen.
2. Select the **Edit** menu.
3. Click on the **Customer** button. The Set Operator dialog box displays.

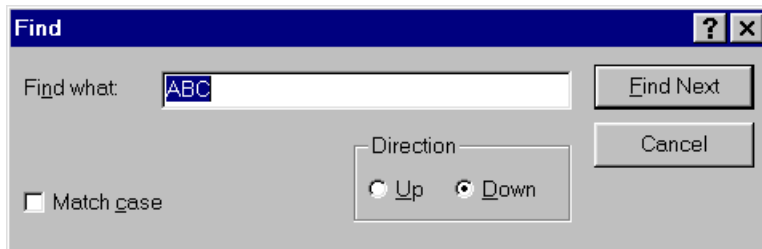


4. Click on the **Drop-down Arrow** for a list of all operators.
5. Select an operator from the drop-down list or enter a new operator name.
6. Click **OK** when you are finished.

Finding a Job or Test

The Find function searches for Job Names, Cable IDs and Tests. You can control both the type of match and the direction of the search.


1. Before opening the Find dialog box:
 - Click on a **folder** at the Job level at the left side of the main database screen to find a job.
 - Click on a **test** in the test grid on the left side of the main database screen to find a test.
2. Select the **Edit** menu.
3. Click on the **Find Job** or **Find Test** commands. The Find dialog box displays.











4. Enter the job name, then specify the find criteria using the **Match case** of text and **Direction** to search buttons.
5. Click on the **Find Next** button.
6. Click the **Cancel** button when you are done searching.


Working at the Test Level

Displaying the Test Grid

1. Click on a Job folder that contains tests, as indicated by a  icon.
2. A list of test records will appear in the right side of the Database View. This is referred to as the Test Grid.

	Cable From/Cable ID	Cable To	Length	Cable Type	Test Type	Date	Time	
	0000		18.04 ft.	TIA Cat 3 UTP	Autotest	12/21/98	18:58:24	
	0001		20.01 ft.	TIA Cat 5E UTP Link	Autotest	12/21/98	18:59:43	
	0002		62.34 ft.	TIA Cat 5E UTP Link	Autotest	12/21/98	19:01:12	
	0003		62.34 ft.	TIA Cat 5 UTP	Autotest	12/21/98	19:01:32	
	0004		50.85 ft.	ISO D UTP	Autotest	12/21/98	19:03:00	
	0005		50.85 ft.	ISO D UTP	Autotest	12/21/98	19:05:50	
	TEST		20.01 ft.	TIA Cat 5 UTP	Autotest	12/21/98	18:56:24	
	TEST0003		19.69 ft.	TIA Cat 5 UTP	Autotest	12/21/98	18:38:59	

Viewing Test Details

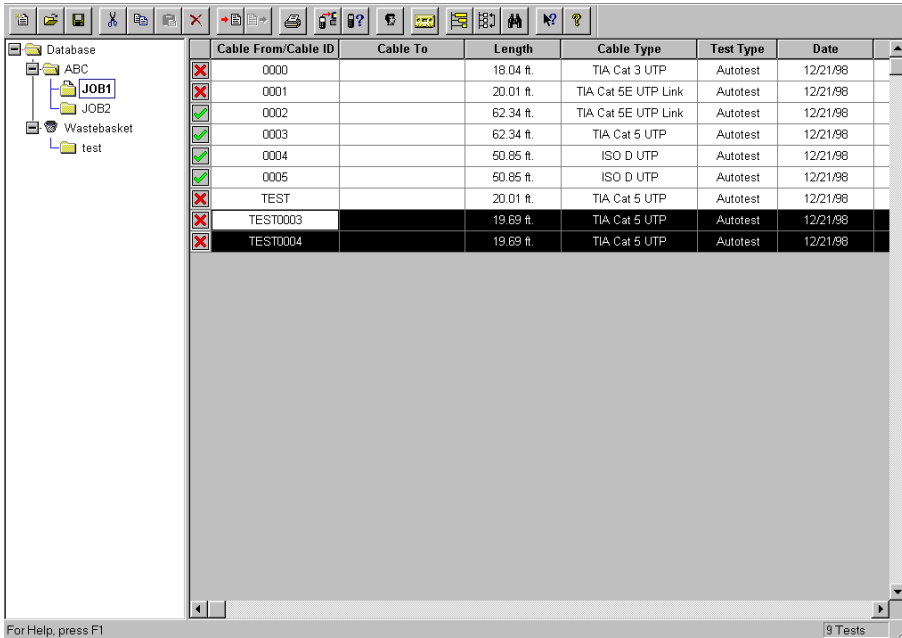
1. Click on a Job folder that contains tests, as indicated by a  icon.
2. Double-click on any test entry in the test grid (left side of the main database screen) or hold down the Ctrl key and type “V”. Depending on the type of cable, you will see individual tabs for each test.
3. Click on the Tab for the test results that you want to view.

Wiremap	Pair Data	NEXT	Attenuation		
Pairs	NE/FE	Result	Worst	Limit	Margin
7,8-3,8	NE	Pass	50.9 dB @ 16.00MHz	> 21.0 dB	29.9 dB
7,8-5,4	NE	Pass	59.5 dB @ 8.20MHz	> 25.8 dB	33.7 dB
7,8-1,2	NE	Pass	63.2 dB @ 15.70MHz	> 21.3 dB	41.9 dB
3,8-5,4	NE	Fail	16.1 dB @ 2.50MHz	> 35.5 dB	-19.4 dB
3,8-1,2	NE	Pass	50.9 dB @ 16.00MHz	> 21.0 dB	29.9 dB
5,4-1,2	NE	Pass	62.5 dB @ 6.25MHz	> 28.1 dB	34.4 dB
7,8-3,8	FE	Pass	51.9 dB @ 15.85MHz	> 21.2 dB	30.7 dB
7,8-5,4	FE	Pass	58.1 dB @ 6.70MHz	> 27.6 dB	30.5 dB
7,8-1,2	FE	Pass	64.2 dB @ 15.85MHz	> 21.2 dB	43.0 dB
3,8-5,4	FE	Fail	16.1 dB @ 2.50MHz	> 35.5 dB	-19.4 dB
3,8-1,2	FE	Pass	52.0 dB @ 16.00MHz	> 21.0 dB	31.0 dB
5,4-1,2	FE	Pass	62.8 dB @ 6.70MHz	> 27.6 dB	35.2 dB

Moving Tests Between Jobs

Tests may be selected and dragged into different Job folders.

1. Click on a test (or a range of tests) to select it.



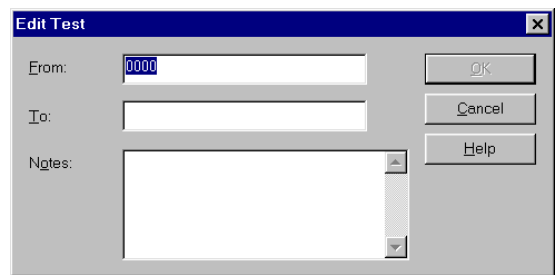
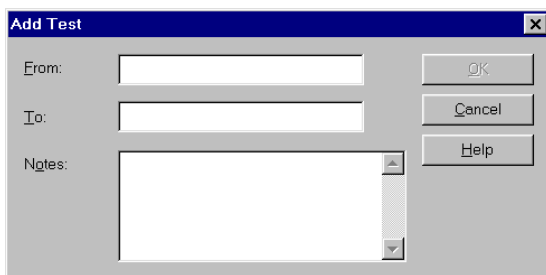
2. Move the cursor to the bottom of the highlighted area. The cursor will turn into a rectangle.
3. Click and hold the **left mouse** button while you drag the test into a new Job folder on the left side of the screen.
4. Release the mouse.

Adding and Editing Tests

These functions become available on the Edit menu when a test record is selected. They can also be accessed by using the right mouse button.

The Find function searches for Job Names, Cable IDs and Tests. You can control both the type of match and the direction of the search.

1. Before opening the Edit menu:
 - Click on a **folder** at the Job level at the left side of the main database screen to find a job.
 - Click on a **test** in the test grid on the left side of the main database screen to find a test.
2. Select the **E**dit menu.
3. Click on the **Add Test** or **Edit Test** command. The Add or Edit Test dialog box displays.
4. Enter the cable ID in the text box labeled “From”. Enter the destination of the cable in the text box labeled “To.”



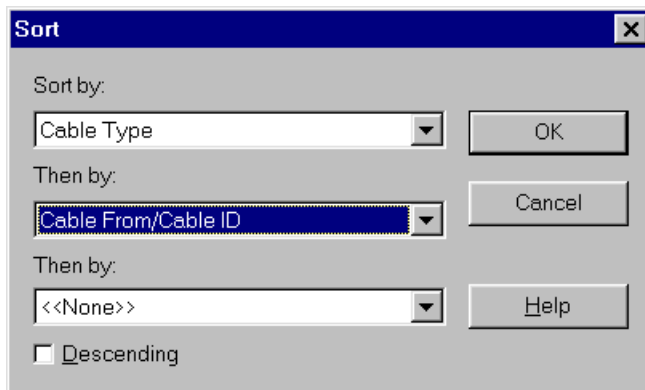
5. Enter data into the **F**rom, **T**o, and **N**otes text boxes.
6. Click on the **O**K button.

Sorting the Tests

The Sort function allows you to reorganize tests in the Database view. You may Sort by Result, Cable ID, Cable Origin, Cable Destination, Cable Type, Test Type, Date, and Time. The easiest way to sort is to click on a column title. You sort by ascending, descending or natural order. The Sort function can be found on the Options menu and is available when one or more tests are selected.

1. On the **Options** menu, click **Sort**.
2. Click the **down arrows** next to each field and choose from the sorting options that are displayed.
3. Click **OK** to begin the sort.

You can sort tests according to three different values, with highest sort criteria listed first, followed by the second, and then the least significant sort criteria.



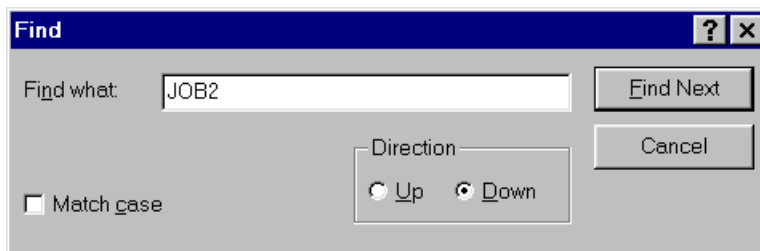
4. Sorting can also be accomplished by clicking on column headers.

Finding Data

The Find function searches for Job Names, Cable IDs and Tests. The Find function can be found on the Edit menu. It is context sensitive, and is available only when you have an item in the Test grid selected.

You can control both the type of match and the direction of the search. For example, if you are searching for a Test, you should have an item on the Test level of the hierarchy selected before bringing up the Find dialog box.

1. Before opening the Edit menu:
 - Click on a **folder** at the Job level at the left side of the main database screen to find a job.
 - Click on a **test** in the test grid on the left side of the main database screen to find a test.
2. Select the **Edit** menu.
3. Click on the **Find Test** command. The Find dialog box displays.



4. Enter the test name, then specify the find criteria using the **Match case** and **Direction** buttons.
5. Click on the **Find Next** button.

Backing Up and Restoring Databases

Regular data backups to a removable storage device are recommended. You may also restore databases to the PC from these archives.

Backing Up a Database

This function allows you to back up a database. Following a backup, the program will compact the database and remove any deleted records.

1. Click on the **File** menu, or click on the toolbar **Backup** button.
2. Select the **Backup** command. The backup will be placed in the current folder.

Restoring a Database

This function becomes available on the File menu only after all databases have been closed.

1. Click on the **File** menu.
2. If you have a database open, click on the **Close Database** option and proceed to step 3. If you don't have a database open, proceed to step 4.
3. Click on the **File** menu again.
4. Select the **Restore Database** command. The backup file will be restored to the current folder.

Uploading DH Tests to the PC

Introduction

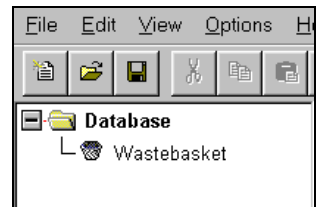
The TS2000 is capable of storing tests in individual job folders that can be uploaded. All tests are sequentially stored in base memory. To upload to a job folder on the PC, you must create a new job folder or use an existing job folder before uploading the tests.

To create a new database, refer to *Creating a New Database, page 9*. To create a new job name, refer to *Adding a Job, page 12*.

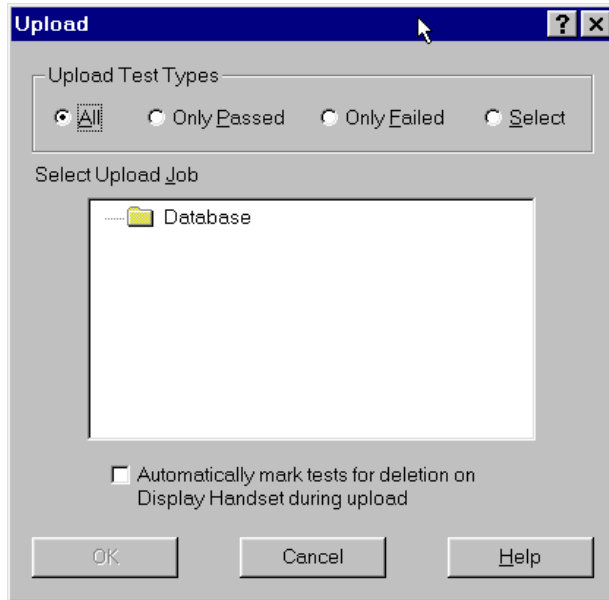
Upload procedure

1. Designate the upload location on the PC or Laptop.

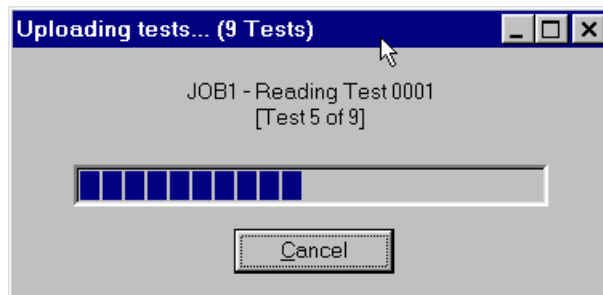
- Before uploading test data from the TS2000 DH, select a destination database in the Database View.



- From the **F**ile pull-down menu, Click on the **U**pload From Tester command. The Upload dialog box displays.



- Click on the desired **Upload Test Type** button.
- Select a job in the **Select Upload Job** text box.
- A status box will remain on screen during the uploading process and you will have the option to cancel at any time.

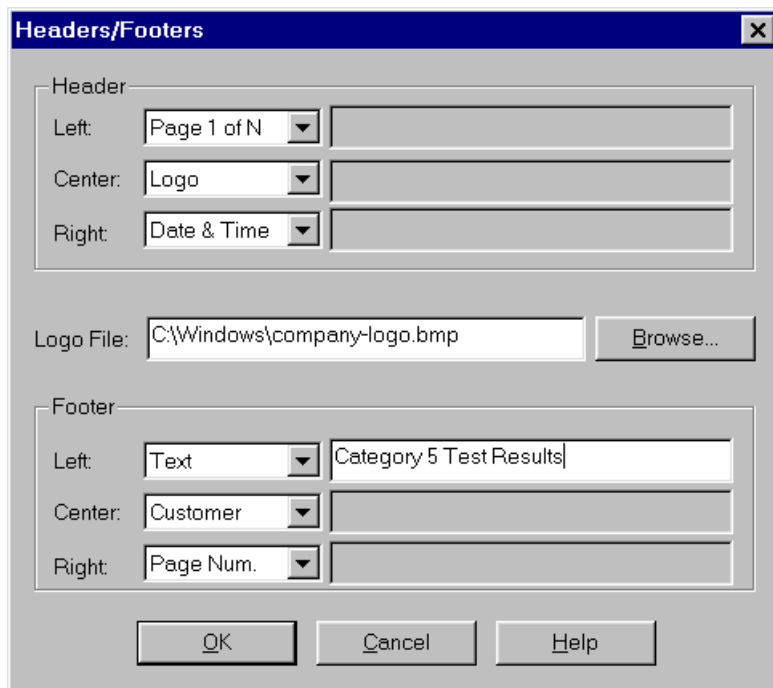


Producing and Printing a Report

Headers and Footers Command

Headers and footers can be added to your printed report. In a printed report, lines will separate the header and footer from the body of the report if the header or footer contain any information.

1. From the **F**ile menu, click on the **H**eaders/**F**ooters command. The Headers/Footers dialog box displays.



2. Decide on the position for your header or footer and click on the accompanying **D**own **A**rrow.

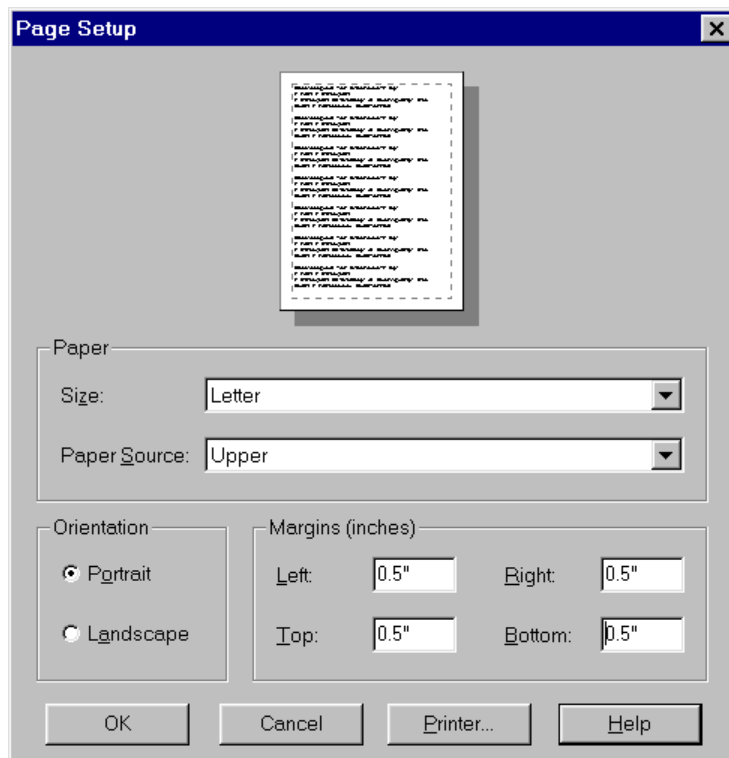
3. From the selected drop-down text box, select one of the displayed options.
 - If you select **Text**, the Text Box will open. Enter your information.
 - If you select **Logo**, you must supply the location of the Bitmap file (.bmp file) to be used as the logo. You can either type the name of the file directly into the box titled “Logo File:” or use the Browse function to locate the file.
 - **Customer** is a value that is set on the Edit Job function.
4. Click on **OK**.

Page Setup Command

Margins, paper instructions, and printer selection can be set in the Page Setup dialog box. Font style and size will be set by the program to maintain a single page per test.

1. From the **F**ile menu, Click on the **P**age **S**etup command. The Page Setup dialog box displays.
2. Set **P**aper **S**ize, **S**ource, **O**rientation, and **M**argins.
3. Click on **O**K.

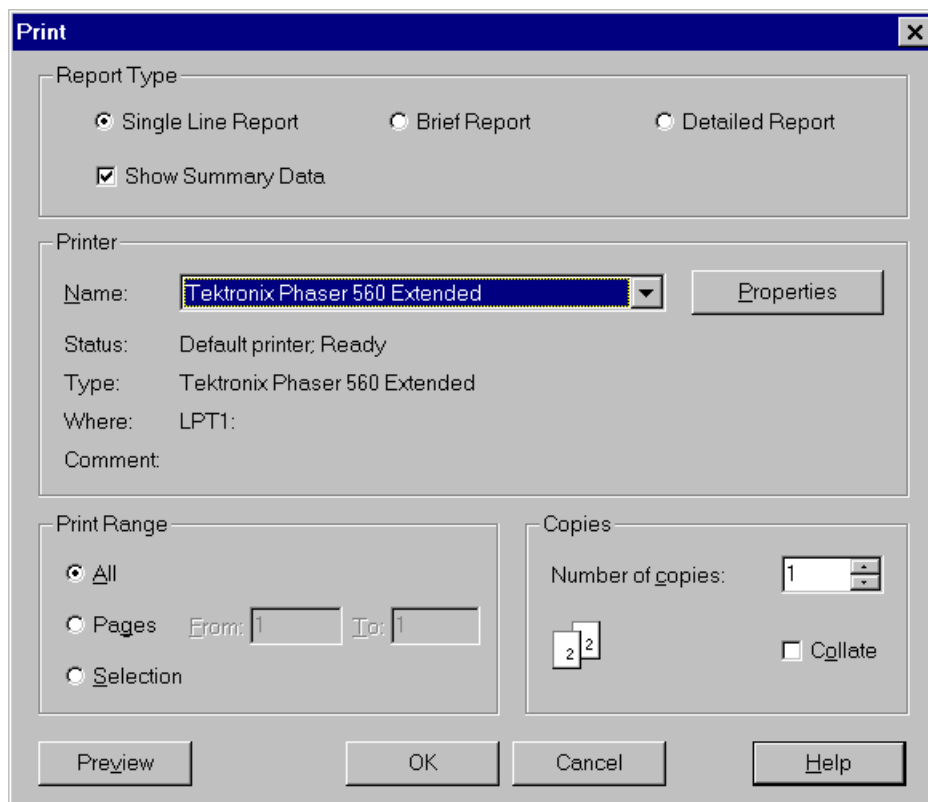
Note: You may also need to adjust the space you allocate to the header, footer, and margins in order to fit the report on one page.



Print Command

Printing involves two steps; selecting the printer, and specifying what you want to print.

1. From the **F**ile menu, click on the **P**rint command. The Print dialog box displays.
2. Select **Report Type**, **Printer**, **Print Range**, and number of **Copies**.
3. Click on the **P**review button to display your report as it will appear in print.
4. Click on **OK**.



The Single Line Report Layout

Report Type

Single Line Report
 Brief Report
 Detailed Report

Show Summary Data

Job Name: Headquarters Report Date: 5/15/03
 Customer: BLACK BOX Corp.
 Operator: User One
 Test Instrument: W TS2000 s/n: 1234567

Cable ID	Status	Test Date	Cable Type	Test Standard	Test Limit
Rack1001A	Pass	5/10/03	100 Ω UTP	TIA CAT 5 Basic	100 MHz
Rack1001B	Pass*	5/10/03	100 Ω STP	TIA CAT 5 Channel	100 MHz
Rack1002A	Fail	5/10/03	100 Ω UTP	ISO Class D Basic	100 MHz
Rack1002B	Fail*	5/10/03	100 Ω STP	ISO Class D Channel	100 MHz
Rack2010A	Pass	5/11/03	150 Ω STP	TIA CAT 3 Basic	16 MHz
Riser1A	Pass	5/11/03	MM Fiber	TIA 568-A	850 nm
Bldg1to2	Fail	5/11/03	SM Fiber	TIA 568-A	1310 nm
Panel001A	Pass	5/12/03	10BASE5	IEEE 802.3	10 MHz
Panel002A	Fail	5/12/03	TWINAX	IBM	10 MHz

Summary Data:

All Cables	Twisted Pair	Coax/Twinax	Fiber
Total Tests: 9	Total: 5	Total: 2	Total: 2
Pass: 5 (56%)	Pass: 4 (80%)	Pass: 1 (50%)	Pass: 1 (50%)
Fail: 4 (44%)	Fail: 1 (20%)	Fail: 1 (50%)	Fail: 1 (50%)
	Tot. Length: 1250 ft.	Tot. Length: 400 ft.	

The Brief Report Layout

A Brief Report only includes tests that contain data.

Report Type

Single Line Report
 Brief Report
 Detailed Report

Show Summary Data

PASS

Cable ID: Floor70Office1 Cable Type: 100 Ω UTP Test Standard: Custom
 Test Date: 5/15/03 NVP: 69.0 % Frequency Range: 1 - 100 MHz

	<u>Result</u>	<u>Worst</u>	<u>Pair</u>	<u>Limit</u>	<u>Margin</u>
Wire Map	PASS				
Attenuation	PASS	11.5 dB	4,5	<21.6 dB	10.1 dB
Length	PASS	276 ft.	1,2	328 ft.	52 ft.
NEXT	PASS	40.1 dB @ 56.1 MHz	3,6:4,5	>33.7 dB	6.4 dB

PASS

Cable ID: Floor70Office2 Cable Type: 100 Ω UTP Test Standard: Custom
 Test Date: 5/15/03 NVP: 69.0 % Frequency Range: 1 - 100 MHz

	<u>Result</u>	<u>Worst</u>	<u>Pair</u>	<u>Limit</u>	<u>Margin</u>
Wire Map	PASS				
Attenuation	PASS	11.5 dB	4,5	<21.6 dB	10.1 dB
Length	PASS	276 ft.	1,2	328 ft.	52 ft.
NEXT	NOT PASS	40.1 dB @ 56.1 MHz	3,6:4,5	>33.7 dB	6.4 dB
Resistance	PASS	5.5 Ω	7,8		
Impedance	PASS	103 Ω	1,2	80 - 120 Ω	
Return Loss	PASS	18.2 dB	3,6	10.0 dB	8.0 dB
Delay	PASS	800 ns	4,5	850 ns	50 ns
Delay Skew	PASS	25 ns	1,2:7,8	45 ns	20 ns
ACR	PASS	10.0 db	1,2:3,6	10.0 dB	0 dB

FAIL

Cable ID: Floor7Office3 Cable Type: 100 Ω UTP Test Standard: Custom
 Test Date: 5/15/03 NVP: 69.0 % Frequency Range: 1 - 100 MHz

	<u>Result</u>	<u>Worst</u>	<u>Pair</u>	<u>Limit</u>	<u>Margin</u>
Wire Map	→FAIL		1,2		
Attenuation	PASS	11.5 dB	4,5	<21.6 dB	10.1 dB
Length	PASS	276 ft.	1,2	328 ft.	52 ft.
NEXT	→FAIL	29.5 dB @ 99.8 MHz	1,2:4,5	>33.7 dB	-----
Resistance	PASS	5.5 Ω	7,8		
Impedance	PASS	105 Ω	1,2	80 - 120 Ω	
Return Loss	PASS	16.0 dB	3,6	10.0 dB	6.0 dB
Delay	PASS	812 ns	4,5	850 ns	38 ns
Delay Skew	PASS	27 ns	1,2:4,5	45 ns	18 ns
ACR	PASS	12.0 dB	3,6:7,8	10.0 dB	2.0 dB

PASS

Cable ID: Backbone2 Cable Type: 62.5 μ Multimode Fiber Wavelength: 850 nm
 Test Date: 5/15/03 NVP: 69.0 %
 Power Loss: 3.4 dB Loss Budget: 5.0 dB Reference (dBm): -20.35

The Detailed Layout

Report Type

Single Line Report
 Brief Report
 Detailed Report

Show Summary Data

PASS

Cable ID: Floor7Office1 Cable Type: 100 Ω UTP Test Standard: Custom
 Test Date: 5/15/03 NVP: 69.0 % Frequency Range: 1 - 100 MHz

Wire Map

```

1 2 3 4 5 6 7 8 S
| | | | | | | X
1 2 3 4 5 6 7 8
  
```

PASS or FAIL:
 Open/Short/Crossed Pair
 etc.

<u>Test</u>	<u>Pair:</u>	<u>3,6</u>	<u>4,5</u>	<u>7,8</u>	<u>Limit</u>	<u>Result</u>
	<u>1,2</u>					
Length	250 ft.	247 ft.	251 ft.	250 ft.	328 ft.	Pass
Attenuation	15.0 dB	15.5 dB	15.2 dB	15.1 dB	24.0 dB	Pass
Prop. Delay	200 ns	203 ns	204 ns	199 ns	800 ns	Pass
Delay Skew = 5 ns (Pairs 4,5 vs. 7,8)	45 ns					
Avg. Impedance	105 Ω	103 Ω	99 Ω	101 Ω	80-120Ω	Pass
Capacitance	5.5 pf	5.2 pf	5.9 pf	4.9 pf		

NEXT: PASS

<u>NE/FE</u>	<u>PAIRS</u>	<u>Result</u>	<u>Worst Case</u>	<u>Limit</u>	<u>Margin</u>
NE	1,2:3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	1,2:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	1,2:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	4,5:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	4,5:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB

ACR: 17.1 dB

Headroom: 7.1 dB

Return Loss: FAIL

<u>NE/FE</u>	<u>PAIRS</u>	<u>Result</u>	<u>Worst Case</u>	<u>Limit</u>	<u>Margin</u>
NE	1,2	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	4,5	Fail	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB

FAIL

Cable ID: Floor7Office2

Cable Type: 100 Ω UTP

Test Standard: Custom

Test Date: 5/15/03

NVP: 69.0 %

Frequency Range: 1 - 100 MHz

Wire Map

```

1 2 3 4 5 6 7 8 S
| | | | | X
1 2 3 4 5 6 7 8

```

PASS or FAIL:
Open/Short/Crossed Pair etc.

Chapter 7 Using BB Record Manager Software

<u>Test Pair:</u>	<u>1,2</u>	<u>3,6</u>	<u>4,5</u>	<u>7,8</u>	<u>Limit</u>	<u>Result</u>	
Length	250 ft.	247 ft.	251 ft.	250 ft.	328 ft.	Pass	
Attenuation	15.0 dB	25.3 dB	15.2 dB	15.1 dB	24.0 dB	Fail	
Delay	200 ns	203 ns	204 ns	199 ns	800 ns	Pass	
Delay Skew = 5 ns (Pairs 4,5 and 7,8)						45 ns	

NEXT:PASS

<u>NE/FE</u>	<u>PAIRS</u>	<u>Result</u>	<u>Worst Case</u>	<u>Limit</u>	<u>Margin</u>
NE	1,2:3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	1,2:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	1,2:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	4,5:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:3,6	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6:4,5	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	4,5:7,8	Pass	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB

ACR: 17.1 dB

Headroom: 7.1 dB

Power Sum NEXT

<u>NE/FE</u>	<u>PAIRS</u>	<u>Worst Case</u>	<u>Limit</u>	<u>Margin</u>
NE	1,2	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	3,6	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	4,5	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
NE	7,8	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	1,2	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	3,6	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	4,5	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB
FE	7,8	32.6 dB @ 100 MHz	>29.3 dB	3.3 dB

Power Sum ACR: 12.7 dB

Power Sum Headroom: 2.1 dB

Contents

- Read all precautions before handling battery packs

Handle Battery Packs With Care

CAUTION - All Nickel-Metal Hydride (NiMH) battery packs, regardless of their indicated charge state, are capable of producing electrical currents sufficient to cause personal injury and/or property damage.

BLACK BOX[®] has tried to provide the maximum protection possible by installing an automatic reset fuse in every battery pack to help stop high current discharges as quickly as possible. However, this fuse may not completely protect against a momentary arc, which can result if the battery pack's electrical contacts are shorted. The following are battery pack handling precautions that must be closely followed to avoid risk of injury.

DO NOT dispose of NiMH battery packs in a fire or with regular trash. NiMH batteries may explode if exposed to open flame, create hazardous waste and contaminate ground water sources if disposed of in land fills.

The following are battery pack handling precautions:

- When a battery pack is not installed in the handset or the charger, it should be kept in a clean dry non-conductive package.
- Keep conductive materials away from the battery contacts at all times.
- Keep the contact sides of the battery packs away from each other at all times.
- Batteries are normally charged while in the handsets or when using the optional Dual Bay Battery Charger. Charging with other chargers or in any other manner may cause the battery packs to explode.

Appendix A Safety Precautions

- Always install, remove, store and charge the battery packs in a non-explosive atmosphere.
- Use and store battery packs in locations that do not exceed 122 degrees Fahrenheit (50 degrees Celsius).
- Do not allow children or persons unfamiliar with the precautionary instructions in this manual to handle or recharge the battery packs.
- Leave the sealed battery pack case intact. There are no user-serviceable parts inside the case and the batteries in the case are not replaceable.

Statement of Liability

BLACK BOX[®] does NOT assume any liability for death, injury or damage to equipment or property resulting from the use of this charger in a manner inconsistent with the use for which it was intended. BLACK BOX[®] Corporation will not be liable for consequences that may result from tampering with the battery packs or charger or consequences resulting from their use thereafter.

Thanks For Helping To Protect The Environment

If you have any questions concerning these precautions, the operating instructions, or any other concerns about the safe operation of the TS2000 battery packs, please contact BLACK BOX[®] Tech Support (Appendix B).

Important User Information

Please read this information before proceeding with any cable testing/certification using the TS2000 tester.

All the cable parameter default settings preprogrammed in the TS2000 tester are based on generic standards, proposed industry recommendations for cables and network links, the latest technical information available from International LAN cabling standards committees, the LAN industry and BLACK BOX[®]'s own experience and testing. However, the default settings in the tester may not yield the desired certification / test results in every given instance because each network is a custom installation designed to suit the requirements of the users. It is therefore imperative that specific network parameter limits be obtained from the network designer(s) and employed during certification and testing.

Refer to *Chapter 3* for information and instructions on how to select the correct cable type, change testing methods, and customize the cable's parameters for certification and testing. *Chapter 5, Table 5-1* provides a complete list of cable topologies supported.



Customer Service

Technical Assistance

For technical assistance or service questions in the U.S.A. and Canada, call BLACK BOX[®] Corporation at 1-724-746-5500.

Service in the USA

Your TS2000 tester may require annual calibration to meet accuracy specifications. Before returning a unit for calibration or service, call BLACK BOX[®] Technical Support at 1-724-746-5500.

If cleaning is required, use a soft cloth and mild cleaner suitable for plastic. Do not immerse in water.

When returning a unit for service or calibration:

1. Customer name, company, address, telephone number, proof of purchase (for warranty repairs), and a description of the service is required. Use the guidelines below to repack the unit with commercially-available materials, if the original packing materials are not available.
2. Pack in soft carrying case, hard-sided carrying case or wrap the instrument in heavy paper or plastic.
3. Use a strong shipping container. A double-walled carton of 250-pound test material is recommended.

4. Use a layer of shock-absorbing material 70 to 100 mm (3 to 4 inches) thick around all sides of the instrument to provide firm cushioning and to prevent the unit from moving inside the container.
5. Seal the shipping container securely.
6. Ship prepaid to:

BLACK BOX[®] Corporation
1000 Park Drive
Lawrence, PA 15055-1018
Tech Support and Ordering: 724-746-5500
Fax: 724-746-0746

Return shipping to the customer within the domestic U.S.A. will be paid by BLACK BOX[®] Corporation.

Service Outside the USA

For technical assistance or service questions outside the U.S.A. and Canada, call your local distributor.

BLACK BOX[®] recommends annual calibration of the TS2000 tester to ensure that it continually meets its accuracy specifications. Before returning a unit for calibration or service outside the U.S.A., contact your local distributor or one of the BLACK BOX[®] offices listed on our website. If your local distributor does not have a service facility, they will provide assistance in returning the tester to an authorized BLACK BOX[®] service facility.

World Wide Web

Download the latest version upgrades, cable test application notes, Q&A forum, and product announcements.

BLACK BOX[®] provides a World Wide Web (WWW) site for LAN cable test products that allows you to use a PC and modem to obtain the latest information on cable test application notes or firmware version upgrades.

You can download the latest firmware upgrades for your TS2000 tester using a PC computer.

To download upgrade files:

Upgrade files are available on the World Wide Web at:

[http:// www.blackbox.com](http://www.blackbox.com)



Appendix C

Specifications

Standard and Optional Cables, Adapters, and Accessories

Model Number	Description
TS2024	Battery Pack Cartridge for Handsets; Extra/Spare/Replacement
TS2027	Headset, Set of 2; Includes earphone, microphone, vinyl case and user's guide
TS2028	110-Block Link Adapters (568A & 568B); Set of 2
TS2032	Token-Ring Link Adapters (Type 1,1A,2,6,6A IBM); Set of 2
TS2025	8-Pin Modular Jack Link Adapters; Set of 2
TS2030	Deluxe Hard-Shelled Carrying Case; holds tester set, rechargers, link adapters and accessories
TS2010	RJ-45 Link Adapters, Set of 2 (Replacements or spares)
TS2035	AC Power Line Adapter, 120V/60Hz w USA and Canada Style Wall Plug (Replacement)

Environmental and Physical Specifications

The following environmental specifications apply to the TS2000 Cable Tester.

Temperature Range

Operating Temperature Range:	0 to + 50 degrees C
Specified Operating Temperature:	Field cal ± 10 degrees C
Storage Temperature Range:	-20 to +70 degrees C

Humidity

5-90%, noncondensing

Shock/Bench Handling

The TS2000 tester is capable of surviving normal bench handling procedures such as found in maintenance and repair facilities.

Connector Stress

Strain

All connectors and adapters will withstand a strain of > 25 lb. in any direction or orientation when attached to a DH or RH.

Jerk

All connectors and adapters will withstand a jerk force of up to 1 lb. dropped from a 3 foot cord in any orientation when attached to a DH or RH.

Dimensions and Weight

Display Handset

Dimensions:	10"x4.25"x2.5"
Weight:	1.75 lb.

Remote Handset

Dimensions:	10"x4.25"x2.5"
Weight:	1.6 lb.

Battery and Power Management

Display Handset

Battery Pack	8.4 Vdc, 2.45 AH, NiMH
External Source	12 Vdc, 800mA continuous

Remote Handset

Battery Pack	8.4 Vdc, 2.45 AH, NiMH
External Source	12 Vdc, 800mA continuous

Test Connector Input Protection

Input Impedance	2 M Ω
Voltage Protection	20-200 VAC/DC

Instrument Specifications

Instrument specifications and ranges are described in the following table.

Parameter	Range/Limits
Length	
Range	0-1100 ft.
Resolution	0.0 ft (.3m)
Accuracy	3% + 3ft. (1m)
Propagation Rate (NVP)	0.5 - 0.99c
NEXT	
Frequency Range	1 - 300MHz
Dynamic Range	0 - NEXT Limit + 5dB
Freq. Step Size (kHz)	150, 250, 500
Resolution	0.1dB
Accuracy	Level IIE Level III
Attenuation	
Frequency Range	1 - 300MHz
Dynamic Range	0 - NEXT Limit + 5dB
Freq. Step Size (kHz)	150, 250, 500
Atten. Resolution	0.1dB
Atten. Accuracy	Level IIE Level III

Parameter	Range/Limits
FEXT Frequency Range Dynamic Range Freq. Step Size (kHz) Resolution Accuracy	1 - 300MHz 0 - NEXT Limit + 5dB 150, 250, 500 0.1dB Level IIE Level III
ELFEXT Frequency Range Dynamic Range Freq. Step Size (kHz) Resolution Accuracy	1 - 300MHz 0 - NEXT Limit + 5dB 150, 250, 500 0.1dB Level IIE Level III
DC Loop Resistance Range Resolution Accuracy	0 - 200 Ohms 0.1 Ohms +/- (1% + 2 Ω)

Appendix C

Model Features, Options, Accessories, and Specifications

Parameter	Range/Limits
Return Loss	
Frequency Range	1 - 300MHz
Measurement Range	0 - 30 dB
Freq. Step Size (kHz)	150, 250, 500
Resolution	0.1 dB
Accuracy	Level IIE Level III
Delay and Skew	
Range	0-8000ns
Resolution	1 nsec
Accuracy	±(3% + 1ns)
Impedance	
Range	35 – 180 Ω
Resolution	.1 Ω
Accuracy	+/- (3% + 1 Ω)
Capacitance (bulk)	
Range	0 – 100nf
Resolution	3 dig
Accuracy	+/- (2% + 20pF)
Capacitance (per ft.)	
Range	0 – 100nf
Resolution	0.1pF
Accuracy	+/- (2% + 1pF)

Appendix D

Time Delay Reflectometry

The TS2000 tester with Time Domain Reflectometry is one of the most powerful diagnostic tools available for metallic cable troubleshooting. Conventional test methods can detect if a cable is shorted or open, but they cannot locate the fault. TDR is used to reveal conditions about a cable that simple Pass/Fail reports and raw measurements may not show. The TS2000 tester uses TDR to scan the length of a cable for impedance problems, or to accurately verify the cable length. TDR is not limited to identifying just shorts or opens - it points out any disturbances in the cable.

TDR is not a test, and there are no TDR standards or pass/fail criteria. The TDR function simply provides a realtime graphical display of cable impedance (y-axis) versus length (x-axis). Impedance is the opposition to signal flow caused by a combination of resistance, capacitance, and inductance values of a cable.

How TDR Works

A time domain reflectometer works in a manner similar to radar. The TDR tester transmits energy into a cable pair and the returning reflections are monitored.

- The shape of reflection that returns identifies a cable deformity, open, short, or termination.
- The length of time it takes a transmitted pulse to return is used to calculate cable length.

TDR Applications

The following two scenarios show how the TDR function might be used for cable inspection and length verification.

Scenario - Cable Inspection

Step	Action
1. New Wiring Installation	The wiring contractor installs horizontal and backbone cables/wires in accordance with a Communication Cable Specification and supplied blueprints.
2. Cable Testing	All Autotests results are supplied in hard copy and on disk to the owner.
3. Final Inspection	Contractor and Owner conduct final inspection.
4. Final Acceptance	Owner accepts installation.
5. Office equipment is installed by the owner.	One of the telecommunications outlets appears to be faulty.
6. Owner calls the wiring contractor complaining of a bad cable.	The wiring contractor sends a technician out to investigate.
7. The technician runs Auto-test and TDR on the failed network drop.	A wire pair fails the Crosstalk test. TDR indicates an anomaly at 100 feet from the patch panel. The current TDR graph (with anomaly) is saved.
8. Contractor checks the cable at 100 feet out from the telecommunications closet.	The contractor finds a fire extinguisher mounting bracket on the cubicle wall. A bracket mounting screw has damaged the cable jacket.
9. Owner is informed that the problem is not related to a faulty cable or installation.	Repairs can be authorized by the owner. The contractor will invoice for time and materials.

Scenario - Cable Length Verification

Step	Action
1. Network owner requires the installation of an additional network drop.	A wiring contractor is called to install the new network drop.
2. The wiring contractor finds additional cable rolled and left in the wall.	The contractor needs to determine if there is enough cable left in the wall to install the additional network drop. The end of the cable is observed to be terminated without a connector.
3. The contractor needs to decide on the best method for determining cable length.	A Length Test would not work because it requires a Far End unit (FE) to perform the test. The contractor decides to run TDR to determine cable length because a Far End unit is not required.
4. Contractor determines cable length.	The TDR graph is inspected to determine remaining cable length.
5. Contractor recommends the most cost-effective installation approach.	The owner approves the installation of the new network drop.

How to Perform TDR

Before running the TDR function, connect the TS2000 Display Handset to the cable or link to be tested.

Test Setup

1. Select the Cable Type (See Chapter 3, *Selecting a Cable Type*)

Note: All TDR numerical information is derived from data in the cable database.

2. Calibrate and configure the tester as required (See Chapter 3, *Calibrating the Tester and Configuring the Tester*).

Note: The tester retains the last configuration settings. You only need to set configuration options if one or more parameters have changed.

The tester will automatically perform a TDR self-calibration if a field calibration has not been performed within the past 7 days.



3. Disconnect the cable to be tested from all network equipment.
4. Connect the required test lead to the Display Handsets and to one end of the link (TDR does not require a Remote Handset).

Note: TS2000 test leads come with a male connector on one end and an RJ-45-style, 110-block or other standard network connector on the opposite end. (For a complete list of standard and optional accessories, refer to Appendix C).


Refer to Chapter 4, Figures 4-3 and 4-4, for connections to complete [Permanent Link](#) and Channel testing.

5. Power up the Display Handset by pressing the **On/Off** key.



Running a TDR Analyze Function

1. In the **Ready** screen, select the **Analyze**  icon to open the Analyze screen.
The Analyze screen lists the options that can be performed on the currently selected cable type (refer to *Chapter 3, Selecting a Cable Type*).
2. Use the **Arrow** keys to position the cursor bar on the TDR function (if the TDR option is installed on the tester, TDR is the first option on the Analyze menu).
3. Press **Enter**  to start the TDR function. Once started, TDR automatically runs in the continuous mode.

Note: When TDR is running, relays will be heard clicking in the Display Handset.

4. Once the graph is displayed, note the wire pair being displayed. Use the **Up/Down Arrow** keys to change pairs as required.
5. Press **Stop**  to halt continuous mode TDR testing.

Note: The TDR function significantly reduces battery life.

6. Press **Save As**  to name and save the current TDR plot.
7. Press **Escape**  to exit the TDR screen and return to normal operation.

Note: The TDR function is not available through custom cable settings.

The TDR Plot

The TDR plot is a graphical picture of the structure of the cable under test along its entire length (2000 ft limit). This picture is valuable because cable anomalies will display features such as blips, peaks, or valleys on an otherwise flat line.

TDR Plot Layout and Controls

The coordinate system of the graph is formed by horizontal and vertical axes. The horizontal axis represents distance data and the vertical axis represents the percentage of reflection.

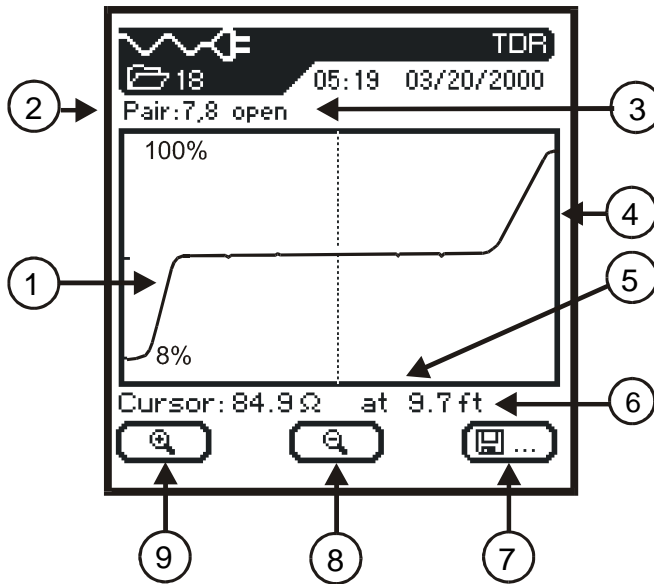


Figure D-1: TDR Graphical Plot

Note: There is no tabular view option for TDR graphs.

Table D-1: TDR Graphical Plot Layout and Controls

Point	Function
1	Actual TDR data plot for a wire pair. When a wire pair graph is first displayed, the cursor is automatically positioned at the midpoint of the data.
2	Wire Pair plotted from TDR data.
3	TDR diagnostic result. Identified as an open, short, or load.
4	The vertical axis is tracked by the cursor and represents percentage of reflection data.
5	The horizontal axis is tracked by the cursor and represents distance data.
6	Cursor values in ohms and distance (ft or m) at the current intersection of the cursor and the plot. The values will change as the cursor is moved.
7	Name and save a plot of the current screen to Display Handset memory. Up to 32 TDR results can be saved.
8	Zoom Out soft key. Expands the horizontal axis of the graph about the cursor.
9	Zoom In soft key. Compresses the horizontal axis of the graph about the cursor.



Viewing TDR Results

The following are tips to help you understand and view TDR plots.

- When the TDR diagnostic function is first started, the graphical plot is automatically scaled to the full length of the cable.
- A maximum of 2000 feet (609.6 meters) of cable results can be displayed on a TDR graph.
- When TDR is first activated, the left 10% of the graph displays prelaunch impedance signal rise distance data and the right 10% of the graph displays reflection data.

Appendix D

Time Delay Reflectometry

- No capability for printing of TDR results from the Display Handset or BBRM is provided. TDR data acquired via the BB Graphical Analyzer (BBGA) application can be saved and printed on a PC.
- Use the **Left/Right Arrow** keys to move the cursor horizontally. As the cursor moves, screen data displays will change to reflect cursor position.
- To view TDR results from a different wire pair, press the **Up/Down Arrow** keys. The TDR test runs one time and displays the results.
- Repeated operation of the Zoom In  key will repeatedly scale the graph. At full magnification, this key becomes inactive.
- Repeated operation of the Zoom Out  key will repeatedly reduce the graph magnification. When the full TDR plot is displayed, this key becomes inactive.
- When the graph is fully magnified, bumping the edge of the display with the cursor will cause the display to pan the plot (excluding a stored result).

Interpreting TDR Results

Always note the cable pair currently being displayed. The shape of the reflections plotted for the pair can be used to identify and locate problems. If the cable pair has no problems along the entire length of the pair:

- The graph has an upswing point on the left most 10% of the display (Start of Cable).
- The following 80% of the graph is relatively flat.
- The graph has an upswing or downswing point on the right most 10% of the graph (End of Cable).

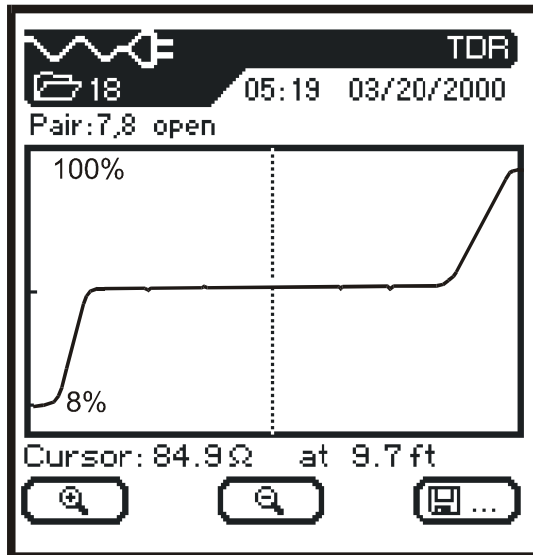


Figure D-2: Good TDR Graphical Plot

Evaluating a TDR Graph

When evaluating the TDR graph the first consideration should be the average impedance of the cable being tested. A graph with sharp dips or spikes can identify radical shorts or opens. For subtle problems, interpretations should be based on benchmark data obtained from the analysis of many cable segments. When anomalies are detected in the cable pair, the cursor is automatically placed on the first anomaly. Use the Arrow keys to position the cursor on the anomaly of interest. Impedance and distance values will be displayed on the screen.


The following troubleshooting tips identify typical cable conditions and their corresponding screen plots.

Condition	TDR Plot Indication
Open, Near End	Upswing develops early. In comparison to good cable pairs, this pair appears shorter in length.
Short, Near End	Downswing develops early. In comparison to good cable pairs, this pair appears shorter in length.
Open, Far End	Fully developed upswing at the Far End.
Short, Far End	Fully developed downswing at the Far End.
Split Pair	20 to 30% rise in relative impedance at the split with a corresponding drop in impedance where the pair is reconnected.
Cable segment with higher than nominal impedance	Peak in the level area of the plot.
Cable segment with lower than nominal impedance	Dip in the level area of the plot.
Level Plot, much higher than the known cable NVP	Wrong cable type selected, or wrong cable type installed.
No distinct upswing or downswing at the Far End	Matched terminator attached to the cable. The pair appears to have a very long length.


Storing, Retrieving, and Deleting TDR Results


Storing a Graph


The TDR results can be stored in the current Job. For detailed instructions regarding using jobs to store test results, refer to *Chapter 5, Using Jobs to Store Test Results*.

1. Using the **Up/Down Arrow** keys, select the desired cable pair graph.
2. Press the **Save As**  key. The Save Test screen is displayed.



3. The test name is automatically assigned. If a different name is desired, use the **Delete Character**  key to change the highlighted character.

Note: The default Save As name is derived from the cable name entered into the Cable ID screen , or from the previous saved name. Refer to *Chapter 3, Cable ID/Autname Option*.

4. When you have entered the name, press **OK** . You will return to the Ready screen.

Retrieving or Deleting a Graph

For detailed instructions regarding retrieving or deleting stored TDR results, refer to *Chapter 5, Viewing or Deleting Stored Autotest Results*.



I

10BASE-T Cabling	
testing and troubleshooting	4-24
110 Connecting block adapters	4-25

A

AC power source	2-15
Analyze test screens	6-3
Analyze tests	
applicable cable types	6-2
pass/fail reporting	6-5
results	6-5
setup	6-2
Analyze Tests	
running	6-4
Autotest	
graphs	5-22
results	5-9
running	5-7
Autotest data	
import	7-1
Autotest preferences	
selecting	5-6
Autotest results	
failures	5-12
printing current results	5-17
saving current results	5-15
stored	5-19
viewing current	5-11
Autotest Results	5-9
pass/fail reporting	5-9
symbols	5-9
Autotest setup	5-4
Autotest suites	5-2

B

Battery	2-14
Battery charging	2-16
Battery packs	
safety precautions	A-1
baud rates	7-4
BBRM	
connecting PC	7-3
Database	
backup and restore	7-34
customer details	7-25
file menu	7-20
opening	7-21
working with databases	7-20
edit menu	7-9
file menu	7-7
find	7-27
help menu	7-12
help system overview	7-14
installation	7-2
Job	
adding	7-23
editing	7-24
job tree	7-22
menu bar	7-6
options menu	7-12
preferences	7-19
starting program	7-2
status bar	7-12
Test	
adding and editing	7-31
display test grid	7-28
finding data	7-33
moving	7-30
sorting	7-32
uploading	7-35
view test details	7-29

toolbar.....	7-13
user interface	7-6
view menu	7-11
Brief Report.....	7-42
Bulletin board services	B-3

C

Cable ID	3-26
double	3-27
single	3-26
Cable Tester Power-up	1-3
Cable Type Selection	3-28
Cable types and applicable analyze tests.....	6-2
Custom Cable	
Parameter Options	3-35
Parameters	3-35
Custom Cable screen.....	3-33
Custom Cable Settings	3-31
custom cable type	
creating	3-31
Custom made adapters	4-26
Customer service	
in the USA	B-1
outside the USA.....	B-2

D

Database directory.....	7-20
DB-9 Serial Port.....	2-9
DC Input Jack.....	2-9
Deleting Tests.....	5-19
Detailed Report	7-44
Display Handset	1-1, 2-1
connecting to a printer	
serial port data stream information	2-11
serial port pin assignments.....	2-9
Ready screen.....	2-4, 2-5
Function keys.....	2-6
soft keys.....	2-6
Display Handset connectors.....	2-9
Display Handset front panel.....	2-2
Display Handset interface ports	2-8

E

Environmental specifications	C-2
------------------------------------	-----

F

Field calibration	
failure.....	3-9
Find	7-31, 7-33

H

Help menu	7-14
-----------------	------

I

Import Autotest data	7-1
Instrument Specifications	C-4
test parameters	C-4
ISO basic link test setup	4-5
ISO channel link test setup.....	4-6

J

Job folder.....	7-22
Jobs.....	5-13, 7-22
creating	5-13

L

Low-Crosstalk Connector.....	2-9
------------------------------	-----

M

Mutual capacitance.....	4-21
-------------------------	------

P

Patch cable adapters	4-25
Physical specifications.....	C-2
ports	7-4
Power management.....	2-14
Preferences screen	
setting tester configuration parameters ...	3-10

R

Remote Handset.....	2-12
Report	
footer.....	7-37
header.....	7-37
print command:.....	7-40
printing.....	7-37
setup:.....	7-39
Right mouse button.....	7-14

S

Saving Tests	5-13, 5-15
Self Test	
running.....	3-2
Self Test screen.....	3-1
Self Test screens	3-3
Set Operator.....	7-26
Shield continuity test	4-3
Shielded cabling systems.....	1-4
Single Line Report.....	7-41
Sort	7-32
Special Adapters	
testing and troubleshooting.....	4-25
Status Bar	7-12

T

Talkset Jack	2-9
Telco lines	1-5
Test	
ACR.....	4-22

Attenuation.....	4-16
Average Impedance	4-18
Capacitance.....	4-21
DC Resistance.....	4-11
Delay and Skew	4-20
Headroom.....	4-23
NEXT, ELFEXT and Power Sum.....	4-13
Patch Cable	4-27
Return Loss.....	4-17
Shield continuity	4-3
Wire Length.....	4-10
Wire Map	4-7
Test button	7-5
Test records.....	7-22
Tester calibration	3-7
Tester Characteristics.....	1-2
Tester configuration	
adjusting display contrast.....	3-13
clearing memory	3-20
configuring the PC or printer Interface ..	3-16
configuring the talkset	3-17
entering user information.....	3-11
restoring factory defaults	3-20
selecting a display language.....	3-19
setting.....	3-10
setting Autotest preferences.....	3-12
setting date and time	3-18
setting length measurement units	3-15
setting length measurement units	3-15
setting timeout options.....	3-14
Tester Field Calibration	3-7
Tester Field calibration setup.....	3-7
Tester Options and Accessories.....	1-2
Testing	
with 10BASE-T cabling.....	4-24
with 110 connecting block adapters.....	4-25
with custom made adapters.....	4-26
with patch cable adapters	4-25
with special adapters.....	4-25
with twisted pair cabling.....	4-4
Tests	
DH front panel	2-3
moving	7-30
RH front panel and connectors	2-1, 2-12

TIA and ISO channel link test setup	4-6
TIA basic link test setup.....	4-5
Tone generator	3-21
Tone generator setup	3-21
Twisted pair cable	4-2
Twisted pair cabling	
testing and troubleshooting.....	4-4

W

Warning screens	3-5
Web services	B-3



Black Box Corporation
1000 Park Drive
Lawrence, PA 15055-1078
(724) 746-5500
(724) 746-0746 fax
www.blackbox.com
techsupport@blackbox.com

Part Number TS2034 Rev. A

TS2000A / TS2000AE Operation Manual