

Service Manual



TS200 TelScout Access Network Analyzer

071-0070-02

This document applies to firmware version 2.00 and above.

Warning

The servicing instructions are for use by qualified personnel only. To avoid personal injury, do not perform any servicing unless you are qualified to do so. Refer to all safety summaries prior to performing service.

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In order to obtain service under this warranty, Customer must notify Tektronix of the defect before the expiration of the warranty period and make suitable arrangements for the performance of service. Customer shall be responsible for packaging and shipping the defective product to the service center designated by Tektronix, shipping charges prepaid, and with a copy of customer proof of purchase. Tektronix shall pay for the return of the product to Customer if the shipment is to a location within the country in which the Tektronix service center is located. Customer shall be responsible for paying all shipping charges, duties, taxes, and any other charges for products returned to any other locations.

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General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it.



CAUTION. Refer all repair problems to qualified service personnel. See the Preface chapter for a list of phone numbers to call for service information.

Injury Precautions

Power Source

The TS200 analyzer is designed to operate from an internal rechargeable battery pack or an external battery charger/adaptor. The internal power is provided by a 9-cell, 3.5 Ah NiMH battery pack with an integral fuel gage circuit. The external power source supplies 24 DC volts at 1.5 A to the instrument.

Battery Pack

Do not expose the battery pack to fire or intense heat. Do not open or mutilate the battery pack. Avoid contact with released electrolyte which is corrosive and may damage eyes, skin, and clothing. Check with local codes for special disposal instructions. Only the entire battery is replaceable. Individual cells are not replaceable.

Always disconnect the test leads and turn off the instrument before disconnecting the battery pack.

To reduce environmental pollution, the battery must be recycled.

Disconnect battery when stored for long periods of time.



CAUTION. Do not charge the battery in a gas-tight container.
Do not short the battery terminals.
Do not incinerate the battery.
Flush with water at once if contact is made with electrolyte.

External Power

Use only the power charger/adaptor that is specified for the TS200.



CAUTION. *The power charger/adaptor is not designed for outdoor use. Use in an indoor environment only.*

Grounding the Instrument

It is not necessary to ground the instrument during normal use. Cases are non-conductive and internal voltages are not accessible to the operator.

Fuse

The TS200 contains a 1.5-amp, 30-volt, surface mounted self resetting fuse on the TDR board. The fuse is not user replaceable.

Do Not Operate in Explosive Atmosphere

Do not operate the instrument in an explosive atmosphere unless it has been specifically certified for such operation.

Do Not Remove Covers or Panels

To avoid personal injury, do not remove the instrument covers or panels, nor operate the instrument without covers and panels in place. Refer service to qualified service personnel.

Electromagnetic Emissions

The TS200 has been verified for compliance to FCC Class A and European Union EMC.

Disposal of Batteries

This instrument contains a NiMH battery pack. Some states and/or local jurisdictions might require special disposition/recycling of this type of material in accordance with Hazardous Waste guidelines. Check your local and state regulations prior to disposing of an old battery.

For the location of a local battery recycler in the U.S. or Canada, please contact:

RBRC
Rechargeable Battery Recycling Corp.
P.O. Box 141870
Gainesville, Florida 32614

(800) BATTERY
(800) 227-7379
www.rbrc.com

Safety Terms and Symbols

Terms in this Manual



WARNING. Warning statements identify conditions or practices that could result in injury or loss of life.



CAUTION. Caution statements identify conditions or practices that could result in damage to this product or other property.

Terms on the Product

DANGER indicates an injury hazard immediately accessible as you read the marking.

WARNING indicates an injury hazard not immediately accessible as you read the marking.

CAUTION indicates a hazard to property including the product.

Symbols on the Product



DANGER
High Voltage



Protective Ground
(Earth) Terminal



ATTENTION
Refer to
Manual

Preface

This manual provides module level servicing information for the TelScout TS200 Access Network Analyzer. It does not contain component-level service information. However, the *Supplemental Information* chapter does contain component-level schematics of the multi-test fixture which is required for performance verification testing.

Contacting Tektronix

| | |
|--------------------------|---|
| Phone | 1-800-833-9200* |
| Address | Tektronix, Inc. Department or name (if known) 14200 SW Karl Braun Drive P.O. Box 500 Beaverton, OR 97077 USA |
| Web site | www.tektronix.com |
| Sales support | 1-800-833-9200, select option 1* |
| Service support | 1-800-833-9200, select option 2* |
| Technical support | Email: support@tektronix.com 1-800-833-9200, select option 3* 1-503-627-2400 6:00 a.m. – 5:00 p.m. Pacific time |

* This phone number is toll free in North America. After office hours, please leave a voice mail message. Outside North America, contact a Tektronix sales office or distributor; see the Tektronix web site for a list of offices.

Assumptions

The procedures in this manual assume that you are a qualified electronics technician and have a working knowledge of servicing procedures for metallic time-domain reflectometry test equipment and POTS test equipment.

The procedures also assume you are familiar with and practice clean, static control measures.

Before Servicing

To prevent injury to yourself or damage to equipment:

- You must be a qualified service person.
- Read the *General Safety Summary* at the beginning of this manual.
- Heed all warnings, cautions, and notes in this manual.

What You Will Find in this Manual

Section 1. Introduction. Contains product information, user information, battery recharging and replacement information, instrument specifications, characteristic tables, accessories, and options.

Section 2. Theory of Operations. Shows the functional relationship of the modules.

Section 3. Performance Verification. Checks TS200 performance to verify correct operation after repairs and adjustments have been made.

Section 4. Maintenance. Includes:

- Inspection and cleaning of exterior, connectors, and test cables.
- Disassembly procedure to module level.
- Troubleshooting problems to module level.
- Resolving error messages displayed on the screen.

Section 5. Replaceable Parts. Lists and describes replaceable electrical and mechanical parts.

Section 6: Supplemental Information. Multi-Test Fixture reference panel and schematics. This fixture is for calibration and performance testing on the TS200.

Related Documents

The *TelScout TS200 Series Access Network Analyzer User Manual* explains how to use the TS200 analyzer to test telephone cables. The user manual is translated into ten languages. See *Accessories*.

Tektronix Service

Tektronix provides service to cover repair under warranty and post-warranty problems.

The TS200 Access Network Analyzer is warranted for one year. The warranty appears at the beginning of this manual.

Introduction

Overview

This manual is used for servicing the TS200 to *module level only*. A module is defined as a complete circuit board assembly or other *electrical* part that performs a specific function.

When a problem is traced to a module, the usual corrective procedure is to replace the module.

This manual *does not* contain:

- Component-level troubleshooting or calibration information.
- Information pertaining to component replacement or module repair.
- Circuit board schematics.
- Component-level electrical parts lists or information.

The Functional Modules

There are four functional modules in the TS200.

Table 1-1: TS200 Functional Modules

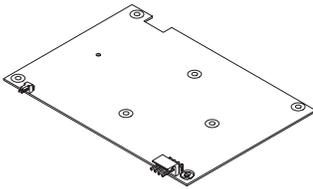
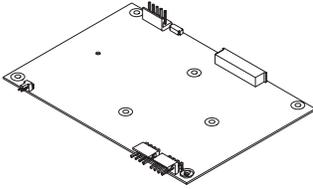
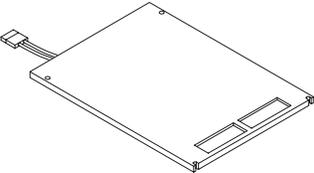
| Module | Module Name | Function | Assembly Number |
|---|-------------|---|-----------------|
|  | POTS board | Telephone service measurements | A1 |
|  | TDR board | Option 01 Assembly MTDR, power, control, external access | A2 |

Table 1-1: TS200 Functional Modules (Cont.)

| Module | Module Name | Function | Assembly Number |
|---|--------------------|---------------------------------------|-----------------|
|  | Power supply board | DC-AC converter for backlight | A3 |
|  | Display module | Display (LCD) assembly with backlight | A4 |

Static-Sensitive Components



CAUTION. All modules in the TS200 contain components that are sensitive to electrostatic discharge (ESD).

When servicing the TS200, work only at a static-free work station, and practice standard anti-static handling procedures.

Operation

The following information describes the product and the operating features of the product.

The Tektronix TS200 TelScout Access Network Analyzer consists of three separate but related product configurations. The loop-test configurations include a TDR unit, a POTS only unit, and a combined TDR and POTS unit. The TS200 allows customers to analyze and troubleshoot the access network for analog or digital services. It is designed specifically for telephone access network applications, including xDSL, ISDN, and POTS.

Controls, Indicators, and Connectors

The TS200 controls are described briefly in this chapter.

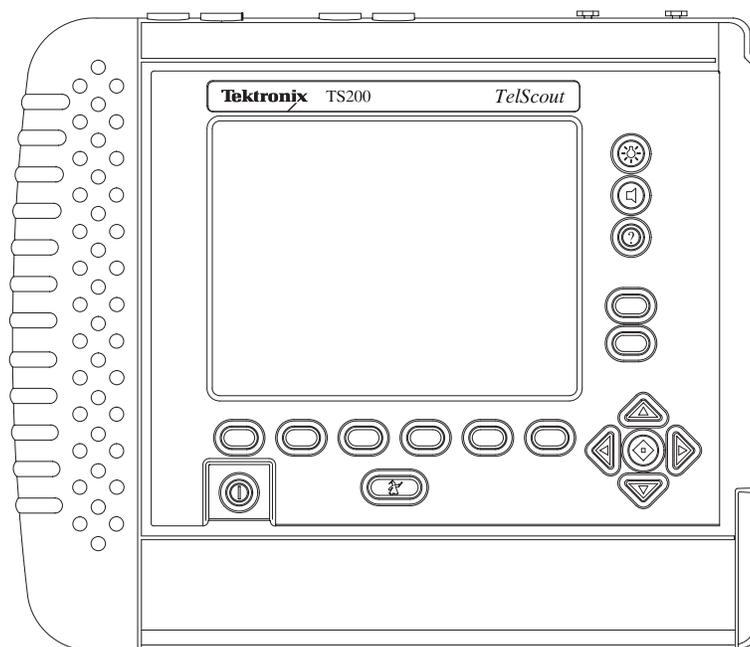


Figure 1-1: Front-Panel Controls, Indicators, and Connectors

Display/Indicators

LCD Display

The display will convey three distinct kinds of information to the operator at all times: operating mode (current status), softkey labels, and the data operating

information. The measurement display shows numerical data in a readout bar at the bottom of the data/information window.

Display Organization: TDR

The current operating mode of the instrument is displayed on the top status line of the display, above the framed data window, which is above the bottom seven lines reserved for softkey labels and dialog. When the instrument needs to display additional information in a message to the operator, it will appear in the dialog test box.

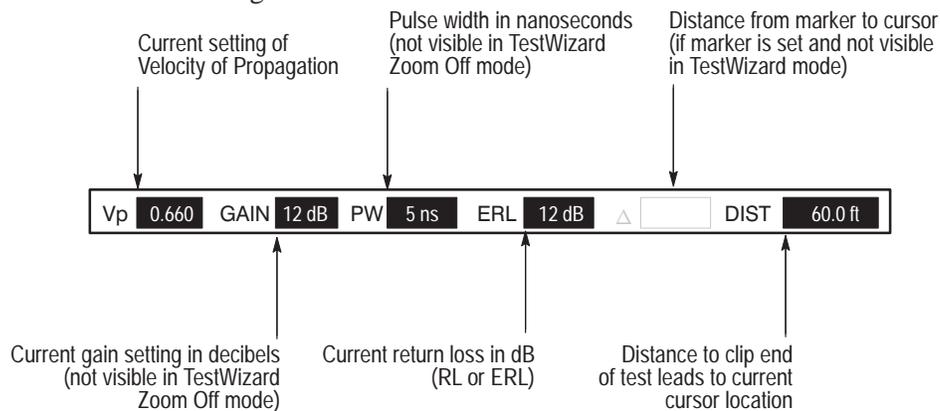


Figure 1–2: Arrangement of the Readout Bar in TDR Mode

Vp: Velocity of Propagation. In Auto TDR and TestWizard, this is set in the selection of the cable type being used. In Manual TDR, this can be changed from the measurement display.

GAIN: This is set with (▲ ▼) while no softkey is active. The visual result of increasing the gain is to increase the height of the displayed waveform. It might also bring out an event that is barely noticeable.

PW: Pulse width is shown in the Readout Bar when the measurement display is in Auto or Manual TDR mode. PW is selectable in Manual TDR through the Pulse softkey. In the Auto TDR or TestWizard modes, the pulse width selection is automatically made by the instrument and is dependent on the distance from the instrument, cable dielectric, etc.

RL or ERL: RL is the Return Loss and ERL is the Event Loss. This box can be turned off from the More Setups menu.

Δ: The delta symbol indicates a difference-distance. When a marker (◆) is placed on the waveform display, the instrument calculates the distance from the marker to the current cursor location and displays the number in this box. If no marker is placed, this box is not shown.

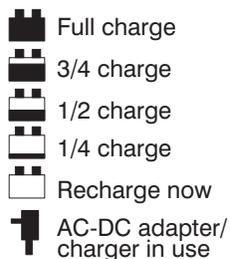
DIST: This is always the distance from the clip end of the test leads to the current cursor location. Distance to the cursor can be shown in feet, meters, or nanoseconds.

Display Organization: POTS

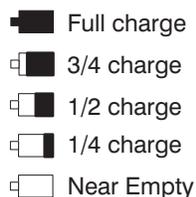
Display organizations vary for POTS measurements. The current operating mode of the instrument is displayed on the top status line of the display, above the framed data window, which is above the bottom seven lines reserved for softkey labels and dialog. When the instrument needs to display additional information in a message to the operator, it will appear in the dialog test box.

Indicators

NiMH Battery icons



Alkaline Battery icons



AC-DC adapter/charger icon



Power On / Off Indicator: A five-level battery-status indicator, located in the upper right corner of all displays, shows the battery-charge level. A low-battery/power-off message is displayed when the battery level is too low for safe operation (the dialog box will indicate *low batt* and the audible warning beeps when the low battery message is first displayed). When this happens, connect the charger/adaptor to the instrument. If alkaline batteries are being used, replace all ten cells at the same time. If you are using a NiMH battery pack, you can continue using the TS200 on AC power while the battery is recharging. The NiMH battery should be fully discharged and then fully recharged periodically.

Speaker On / Off Indicator: An icon is located on the display just to the left of the power indicator. It will show that the speaker is currently either on or off.

Controls

All operator controls are elastomeric-technology push buttons.

Hard Buttons



POWER: This button turns the TS200 on and off.

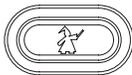


HELP: Pressing **HELP** displays detailed information about the current operation being performed by the TS200. The **HELP** function provides information on the operation of each of the instrument controls.

The help displays are context-sensitive pop-up windows that overlay the current display when you press the **HELP** button. In each of the measurement modes, the help display describes the current mode and provides access to additional help on how to use the front-panel controls.

Press **HELP** a second time to remove the help display.

In selected menus, Lesson softkeys are available, which provide tutorial information about using the TS200, Auto TDR, Manual TDR, cable selection, printing, and transferring data.



TestWizard: Pressing the **TestWizard** button initiates a simplified measurement mode for TDR, POTS, xDSL, or Load Coil.

TestWizard TDR measurement mode prompts the user for any required information. It requires minimal decisions on the user's part and displays a mosaic waveform with all significant events (at or above the predefined threshold) marked and numbered.

TestWizard POTS measurement mode has five sequential displays, with the option of continuing from one display to the next or going back to the previous test. The xDSL TestWizard measurement mode has a single display with the most common tests used for xDSL line qualifications. The Load Coil TestWizard detects and locates up to two missing load coils on a properly spaced line.



BACKLIGHT: Press this button to switch the display backlight on and off. The default at power-up is with the backlight off. Press the backlight button to turn on the backlight. The backlight stays on as long as the user continues to press buttons or softkeys.

The backlight automatically turns off, using the specified default time from the **More Setups** menu, after the user stops pressing any buttons (one minute is the TS200 default, but it is user adjustable).

The user can turn the backlight on again by pressing the Backlight button.



SPEAKER: Press this button to turn on/off the speaker. You can perform operations eliminating unwanted sounds and alerts.

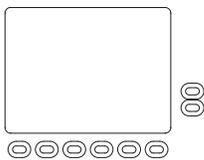
Scroll Controls



In the lower right area of the front panel is a five-button group (up-down-left-right-center). The arrow buttons serve the functions of moving the cursor left and right across the displayed waveform or changing values (◀▶), scrolling through a menu or changing values (▲▼), and scrolling pages (◆ + ▲▼).

These buttons have an accelerated repeating function when operated with continued pressure.

Softkeys



There are six softkeys across the bottom of the LCD and two at the right side. These are called softkeys because their labels are displayed on the LCD. Their functions vary according to the instrument function.

The softkeys are used in three different ways: function change, item selection, and item toggle.

In the function change use, the softkey is briefly displayed in reverse video (black box around white letters) until the function or mode change is complete. After the function or mode change, the softkey label returns to normal, possibly with a different label. An example of this type of operation is: changing from measurement mode to setup mode.

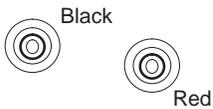
In item selection, the softkey label is displayed in reverse video when the key is pressed and remains in that state until pressed again or a different softkey is pressed. Usually, pressing an item-selection softkey enables the up and down arrow keys to change the value of the selected item. Examples of item selections are: span, pulse, vertical position, and Vp in the manual measurement mode; baud rate in the printer setup mode. Value changes might also be displayed in another manner, such as the distance scale change when **More Cable** or **Less Cable** is pressed in Auto TDR mode.

In item toggle, the softkey label toggles from an on to off to on form. Whichever is active at the moment will be shown in reverse video. An example of this is: Zoom On / Zoom Off.

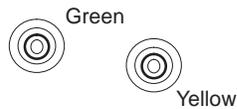
Connectors



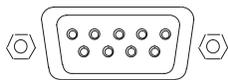
AC–DC Adapter/Charger: This connector provides a jack for connecting to the battery charger/adapter.



TEST: This connector consists of two standard-size banana jacks (one red, one black) for connecting to the test pair of the cable under test.



REFERENCE: This connector consists of two standard-size banana jacks (one yellow, one green) for connecting to the reference pair of the cable under test.



Serial Port: This connector provides a subminiature DB-9 IBM PC-AT-compatible serial port. Use this connector to connect a printer, and to transfer data between the TS200 and an IBM PC (or compatible).

Instrument Settings

When you power on the instrument, the TS200 shows a display indicating that the initialization sequence is in progress. The instrument returns to the same settings in place when the power was last turned off, except for the following setups: Power-on Test Type, Auto Event Locator Threshold, and Smoothing.

Specification Tables

Table 1–2: Environmental Performance Conditions

| REQUIREMENT | SPECIFICATION |
|--------------------------------|---|
| Temperature | Operating: –15° C to +60° C Non-operating: –30° C to +65° C |
| Operational Specs, Guaranteed | 0° C to +45° C |
| Humidity | Operating: 10 to 95% RH, non-condensing Non-operating: 10 to 95% RH, non-condensing |
| Altitude | Operating: 10,000 ft (4.6 km) Non-operating: 50,000 ft (15.2 km) |
| Shock | Operating: 50 g. Survives impact shock of 6.5 feet (2 m) to concrete in standard soft case. |
| Drop, free fall, non-operating | Surface to concrete, 12 drops @ 2 m |
| EMC | Complies with national standards |
| Water / Rain | Drip Proof |

Table 1–3: Certifications and Compliances

| REQUIREMENT | SPECIFICATION |
|------------------------------|---|
| EC Declaration of Conformity | <p>Meets intent of Directive 89/366/EEC for Electromagnetic Compatibility and Low Voltage Directive 73/23/EEC for Product Safety. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Union:</p> <p>EMC Directive 89/336/EEC: EN 55011 Class A Radiated & Conducted Emissions IEC 1000-3-2 Powerline Harmonic Emission IEC 1000-4-2 Electrostatic Discharge Immunity IEC 1000-4-3 RF Radiated Immunity IEC 1000-4-4 Electrical Fast Transit Immunity IEC 1000-4-6 RF Conducted Immunity IEC 1000-4-11 Powerline Interruptions</p> <p>Low Voltage Directive 73/23/EEC, amended by 93/69/EEC: EN 61010-1:1993 Safety requirements for electrical equipment for measurement control and laboratory use EN 61010-2-031:1994 Particular requirements for hand-held probe assemblies for electrical measurement and test equipment</p> |
| FCC Compliance | Emissions comply with FCC Code of Federal Regulations 47, Part 15, Subpart B, Class A Limits |

Table 1–3: Certifications and Compliances (Cont.)

| REQUIREMENT | SPECIFICATION |
|-------------------------------------|---|
| Certifications | EMC (Australia/New Zealand): Complies with EMC provision of Radio Communications Act per the following standard(s): AN/NZS 2064.1/2 Industrial, Scientific, and Medical Equipment: 1992 UL 3111-1 Standard for Electrical Measuring and Test Equipment |
| Installation (overvoltage) category | CAT II Local level, appliances, and portable equipment |

Table 1–4: Safety Requirements

| REQUIREMENT | SPECIFICATION |
|-------------|-------------------------------------|
| CSA | CAN/CSA-C22.2 No. 1010.1 EN 61010-1 |
| UL | UL 3111-1 |

Table 1–5: Reliability

| REQUIREMENT | SPECIFICATION |
|-------------|--|
| MTBF | >40 khours (TDR only) >24 khours (POTS & TDR) |
| MTTR | <0.5 hours to module level |

Table 1–6: Physical Characteristics

| REQUIREMENT | SPECIFICATION |
|-------------------|---|
| Size (max) | 10 inches (254 mm) wide 8.5 inches (216 mm) high 2.75 inches (70 mm) deep |
| Weight (max) | 5.4 lbs. (2.4 kg) fully configured |
| Waveform Capacity | Minimum of 20 waveforms |

Table 1-7: Base Product Characteristics

| REQUIREMENT | SPECIFICATION |
|---------------------|---|
| Power Source: | |
| Internal Batt | 4 hours continued operation (with backlight off), 8 hours at 50% duty cycle, meets UL safety requirements |
| Charger Circuits | Charge time: 4 hours at 25° C/77° F (full discharge to 90% capacity) |
| PS Input/Output | External input, charger jack, current input limit: 1.5 A, 18 to 25 VDC |
| AC adapter/charger | Output: 5.5 mm OD, 2.1 mm ID plug, center +, sleeve – Input: 90-255 VAC, 47-63 Hz |
| System Load: | |
| Base product only | 24 V IN, 360 mA |
| Base product + POTS | 24 V IN, 400 mA |
| POTS only | 24 V IN, 400 mA |

TS200 Characteristic Tables

| Table 1–8: TDR Characteristics | | |
|--|---|---|
| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
| Pulse Width 2 ns: 75 ns: 10 ns: 340 ns: 3400 ns: | typical typical 12 ns \pm 20% +30%, –15% +15%, –25% | Measured at the end of test leads with 105 Ω \pm 2 Ω termination. Measured differentially with oscilloscope |
| Pulse Height 2 ns 10 ns: 75 ns: 340 ns: 3400 ns: | 1.55 V typical 4.44 V typical 8 V typical 18 V Pk-Pk typical 28 V Pk-Pk typical | Measured at the end of test leads with 105 Ω \pm 2 Ω termination. Measured differentially with oscilloscope |
| Pulse Shape short range long range | | 2 ns, 10 ns, 75 ns: 1/2 sine 340 ns, 3400 ns: 1/2 sine with line charge compensation |
| Distance Accuracy | 0.1% \pm 300 ps \pm Vp uncertainty \pm cursor resolution | Verified with digital delay generator. Range: 5 ft to >50 kft Resolution: 0.5 ft @ Vp 1.0 Cursor resolution: 0.33% of selected range |
| Test Interface Port Parameters Impedance Port Over-voltage Protection Two Pairs | 105 Ω typical | Designed to work on standard telephone twisted pair wire, copper, or aluminum 400 VDC + AC peak at power line frequency; no damage with application up to 30 seconds duration Tests for crosstalk; compares two pairs |
| TestWizard Event Marking Wire Diameter Range Accuracy | 22 AWG 0 – 8,000 ft @ 1000 kft \pm 100 ft typical | Marks multiple events. Accuracy is defined as marking a 0 dB known event while marking no non-cable-structure events. |

| Table 1-8: TDR Characteristics (Cont.) | | |
|--|---|--------------------------|
| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
| Wire Diameter Range Accuracy | 22 AWG @ 8,001 – 18,000 ft @ 8,500 ft \pm 850 ft typical @19,500 ft \pm 1,950 ft typical | |

| | | |
|---------------------|--|------------------|
| Receiver: Bandwidth | | 10 kHz – 200 MHz |
|---------------------|--|------------------|

| | | |
|-----------------------------|------------------------------|--|
| Gain | | |
| Range System Noise Floor | 0 dB to 72 dB <1 cm noise | Steps of 6 dB, 6 dB, 8 dB 52 dB gain, 10 ns pulse, span >4000 ft, no connections on test port, filter OFF |

| Table 1-9: POTS Characteristics | | |
|---|---|--|
| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
| VOM DC Volts | | The DCV function is designed to work on standard telephone twisted pair wire. Voltage above 150 V is not considered normal conditions. |
| Range Resolution Accuracy Impedance Overload Protection | 0 V to \pm 400 V 0.1 V \pm (1% + 0.5 V) >10 M Ω 400 V peak | |

| | | |
|---------------------------------|--|--|
| VOM Ohms (loop/insulation) | | |
| Test Voltage Test Current | <130 VDC open circuit <1 mA short circuit | |
| Range Resolution Accuracy | 0 to 1 k Ω 0.1 Ω \pm (0.9% + 1 Ω + 1 count) | |
| Range Resolution Accuracy | 1 k to 100 k Ω 10 Ω \pm (0.9% + 1 count) | |
| Range Resolution Accuracy | 100 k to 1 M Ω 100 Ω \pm (1% + 1 count) | |
| Range Resolution Accuracy | 1 M to 100 M Ω 100 k Ω \pm (6% + 1 count) | |

Table 1-9: POTS Characteristics (Cont.)

| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
|---|---|--|
| Resistance Fault Locator | | Designed to work on standard telephone twisted pair wire, copper, or aluminum. Fault resistance <100 k Ω for specified accuracy. Accuracy specs only for fault resistance values <100 k Ω |
| Distance Range | 0 to 60 km (200 k ft) | |
| Resistance to Fault Range Resolution Accuracy | 0.00 to 400 Ω 0.01 Ω \pm (0.9% + 1 Ω +1 count) | |
| Range Resolution Accuracy | 400 to 4 k Ω 0.1 Ω \pm (0.9% +1 count) | |
| Range Resolution Accuracy | 4 k to 40 k Ω 1 Ω \pm (0.9% +1 count) | |
| Open Meter (measure fault dist to open) | | Calculations assume no bridge taps or laterals. Accuracy at 10 kft = \pm 1% \pm uncertainty of capacitance per unit length. Accuracy verified by capacitance meter verification. |
| Accuracy Distance Calculation Range Resolution | \pm 1% @ 10 kft 0 to 1 kft 1 ft | |
| Range Resolution | 1001 ft to 200 kft 10 ft | |
| Open Meter Capacitance Measurement | Range: 10 pF to 10 μ F | |
| Accuracy Range Resolution | \pm (1% + 50 pF + 1 count) up to 3.5 μ F 10 pF to 10 nF 10 pF | |
| Range Resolution Input Protection | 10 nF to 10 μ F 10 nF 400 Vp | |
| VOM Loop Current Measurement | | Up to 120 mA continuous measurement. Above 120 mA, measurements are one-shot $Z_{IN} = 430 \Omega$ |
| Range Resolution Accuracy | 0 to 300 mA 0.1 mA \pm 1% at 60 mA | |

| Table 1-9: POTS Characteristics (Cont.) | | |
|---|--|--|
| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
| VOM Ohms-to-Distance Calculator | | Calculated distance resolution is 0.01 ft on all ranges |
| Range Resolution | 0 to 99.99 Ω 0.01 Ω | |
| Range Resolution | 100 to 999.9 Ω 0.1 Ω | |
| Range Resolution | 1000 to 9999 Ω 1.0 Ω | |
| VOM Distance-to-Ohms Calculator | | Calculated ohms resolution is 0.01 ohms on all ranges |
| Range Resolution | 0 to 200 kft 1 ft | |
| Longitudinal Balance | | Measure common mode impedance difference between conductors |
| Range Resolution Accuracy | 40 to 62 dB 0.1 dB ± 2 dB | |
| | | |
| VOM Count Load Coils | Counts up to 7 load coils on properly loaded line using D66; counts up to 6 load coils on properly loaded line using H88 | |
| VOM AC Volts | | Identify hazardous voltage on line 50–60 Hz sinusoidal The ACV function is designed to work on standard telephone twisted pair. Voltage above 60 V is not considered normal conditions. |
| Range Resolution Accuracy | 0 to 300 VAC 0.1 V $\pm (1\% + 0.5 V)$ | |
| | | |
| Transmission Tests Power Influence Meter (PI) | | Unfiltered PI measurements are converted to dBmC using NM measurements or default conversion factor. $Z_{IN} = 10 M\Omega$ C message filter, 60 Hz PI filter Psophometric filter, 50 Hz PI filter |
| Range Resolution Accuracy | 40 to 100 dBmC 0.1 dB ± 2.0 dB + filter accuracy | |
| | | |

Table 1-9: POTS Characteristics (Cont.)

| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
|---|---|---|
| Transmission Test Metallic Noise Measurement (NM) | | No filter used when PI exceeds 4.5 V _{rm} |
| Range | 10 to 50 dBmC | |
| Resolution | 0.1 dB | |
| Accuracy | ± 2.0 dB + filter accuracy | Z _{IN} = 600 Ω |
| Transmission Tests Loss | | Tone receiver |
| Frequency | | |
| Range | 20 Hz to 200 kHz | |
| Resolution | 1 Hz | |
| Accuracy | ± 2 Hz at 0 dBm | |
| Level | | |
| Range | -40 dBm to + 10 dBm | 20 Hz to 20 kHz: dBm referenced to 600 Ω |
| Resolution | 0.1 dB | >20 kHz: dBm referenced to 135 Ω |
| Accuracy | | |
| 300 Hz – 4.5 kHz | ± 0.5 dB | POTS |
| 40 kHz | ± 2.0 dB | ISDN |
| 196 kHz | ± 4.0 dB | ADSL |
| Transmission Tests Dial Phone Number | | |
| DTMF | | Meets TR-TSY - 000450 |
| Pulse | | 10 pps, make/break ratio 39/61 and 33/67 supported |
| Store # | | 25 numbers, up to 12 digits each |
| Transmission Tests Generate Tone | Up to 5 user-programmed frequencies | |
| Frequency | | |
| Range | 20 Hz to 64 kHz; 40 kHz (ISDN) | 20 Hz to 20 kHz: Z _{out} = 600 Ω except 135 Ω for 577.5 Hz ID tone |
| Resolution | 1 Hz | 20 Hz to 65 kHz: Z _{out} = 135 Ω |
| Accuracy | ± 2 Hz | |
| Level | | |
| Range | -40 dBm to + 10 dBm | Z _{out} = 600 Ω |
| Resolution | 1 dB | |
| Accuracy | ± 0.5 dB above -25 dBm | |
| ID Tone (Trace Tone) | | |
| Level | -40 dBm to +10 dBm | Z _{out} = 135 Ω |
| Accuracy | 577.5 Hz ± 1 Hz; Continuous/Intermittent | |

Table 1-9: POTS Characteristics (Cont.)

| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
|--|--|--|
| Transmission Tests Slope Frequency Range Resolution Accuracy (300 Hz – 4.5 kHz) Level Range Resolution Accuracy 300 Hz – 4.5 kHz 40 kHz 196 kHz | 20 Hz – 200 kHz and 40 kHz (ISDN) and 196 kHz (DSL) 1 Hz ± 2 Hz @ 0 dBm –40 dBm to + 10 dBm 0.1 dBm ± 0.5 dB ± 2.0 dB ± 4.0 dB | Displayed ranges are: 0 to 5 kHz 0 to 100 kHz 0 to 200 kHz |
| VOM Ringers Range Resolution Accuracy | Counts number of C4 ringer equivalents 0 to 5 0.1 ± 0.5 | Ringer equivalence programmable from 0.2 μ F to 2 μ F per ringer. Accuracy verified by capacitance meter. |

Table 1–10: Load Coil TestWizard Characteristics

| REQUIREMENT | SPECIFICATION | SUPPLEMENTAL INFORMATION |
|---|--|--|
| Load Coil Test Wizard | | Software version 2.0 and above. |
| Number of load coils | Maximum: 12 ¹ Minimum: 0 | H88 load coils, properly spaced. Specification assured by software and performance verification of tone generator and tone receiver. |
| Number of missing load coils | 0, 1 or 2 | Specification assured by software. |
| Loop span – single wire diameter, resistance design rules | 19 AWG: 0 to 70 kft 22 AWG: 0 to 37 kft 24 AWG: 0 to 25 kft 26 AWG: 0 to 15 kft | Resistance design rule summary: <ul style="list-style-type: none"> ● Loop resistance below 1300 Ω ● 3 kft between CO and first load coil ● 6 kft between load coils ● end section between 3 kft and 15 kft, including bridge tap ● no bridge taps between load coils ● no loaded bridge taps |
| Load span – single wire diameter, unigauge design rules | 26 AWG: 0 to 30 kft | Unigauge design rule summary: <ul style="list-style-type: none"> ● 26 gauge wire ● no gauge changes ● 15 kft between CO and first load coil ● 6 kft between load coils ● end section between 3 kft and 15 kft |
| Loop span – mixed wire diameter | 0 to 1500 Ω loop resistance | |
| Wire types supported | 19 AWG (0.91 mm) copper 22 AWG (0.65 mm) copper 24 AWG (0.51 mm) copper 26 AWG (0.40 mm) copper | Aluminum wire will perform similar to its copper equivalent based on resistance. 17 AWG Al \approx 19 AWG Cu 20 AWG Al \approx 22 AWG Cu 22 AWG Al \approx 24 AWG Cu For other wire diameters not listed here, the TS200 will look for the closest match assuming the listed diameters. |
| Cable capacitance | | |
| LA Option | 13.7nF/kft (0.072 μ F/mi, 45 nF/km) | |
| All Options except LA | 15.7 nF/kft (0.083 μ F/mi, 51.6 nF/km) | |

¹Considerations:

- H88 load coils, properly spaced (spacing tolerance: \pm 120 ft typical, \pm 500 ft maximum).
- Build-out network should be used when cable sections are shorter than design rules.
- Line meets either resistance design rules or unigauge design rules.
- Line passes all other fault tests.
- Termination is either an open circuit or an on-hook telephone.
- CO battery should be disconnected.
- For midspan tests, line should be opened at test point (test in one direction at a time).

Accessories and Options

Standard Accessories

| ACCESSORY | TEKTRONIX PART NO. |
|--|--------------------|
| Test lead set (red/black and green/yellow) | 012-1552-xx |
| RFL strap (Options 02, 03) | 346-0292-xx |
| Power Supply (36W, 100-250VAC, 47-63 Hz in; 24VDC, 1.5A out) | 119-6031-xx |
| Standard cord = N. American power cord, OR | 161-0228-xx |
| Option 1C European power cord | 161-0066-09 |
| Option 2C United Kingdom power cord | 161-0066-10 |
| Option 3C Australian power cord | 161-0066-11 |
| Option 6C Japanese power cord | 161-0288-xx |
| Auto adapter, cigarette lighter | 012-1553-xx |
| Accessory pouch, soft | 016-1690-xx |
| TS200 user manual (includes all international language options) | 071-0069-xx |
| Custom rechargeable battery pack (9 cell) | 146-0126-xx |
| Alkaline battery holder | 352-1071-xx |

Optional Accessories

| ACCESSORY | TEKTRONIX PART NO. |
|--|--------------------|
| TS200 service manual | 071-0070-xx |
| Custom rechargeable battery pack (9 cell) | 146-0126-xx |
| Serial PC Cable (DB9 to DB9) | 012-1379-xx |
| Cable, printer, RS232, DB9 female to DB25 male | 012-1313-xx |
| MCTAP (PC software for TDR) | MCTAP |
| Custom test lead set (Australian) | 012-1558-xx |
| Hard Travel Case, black | 016-1210-xx |
| D-Ring Hook | 354-0745-xx |
| RFL strap | 346-0292-xx |
| Waist strap | 346-0202-xx |
| Coaxial Cable Adapter (75 Ω Banana to F type) | 174-3525-xx |

Optional Operating System Software

| SOFTWARE | TEKTRONIX PART NUMBER |
|------------|-----------------------|
| English | 063-3306-xx |
| French | 063-3307-xx |
| German | 063-3308-xx |
| Spanish | 063-3309-xx |
| Portuguese | 063-3311-xx |
| Australian | 063-3313-xx |
| Dutch | 063-3315-xx |

Instrument Configuration Options

| OPTION NUMBER | INSTRUMENT INCLUDES: |
|----------------------------|---|
| 01 | TDR only |
| 02 | xDSL, ISDN, POTS |
| 03 | TDR, xDSL, ISDN, POTS (Option 01 + 02) |
| 04 (Version 2.0 and above) | LOAD COIL TESTWIZARD (only with Option 02 or Option 03) |

TS200 Options

| OPTION NUMBER | INSTRUMENT INCLUDES: |
|---------------|---|
| L0 | English language option |
| L1 | French language option |
| L3 | German language option |
| L4 | Spanish language option |
| L6 | Portuguese language option |
| LA | Australian language option |
| LD | Dutch language option |
| R3 | Extended warranty option (3 years) |
| AU | Custom Test Lead Set (Australian) |
| C3 | Three year calibration services |
| D1 | Calibration data report |
| D3 | Three year calibration data reports (requires C3) |

Theory of Operation

Block Diagram

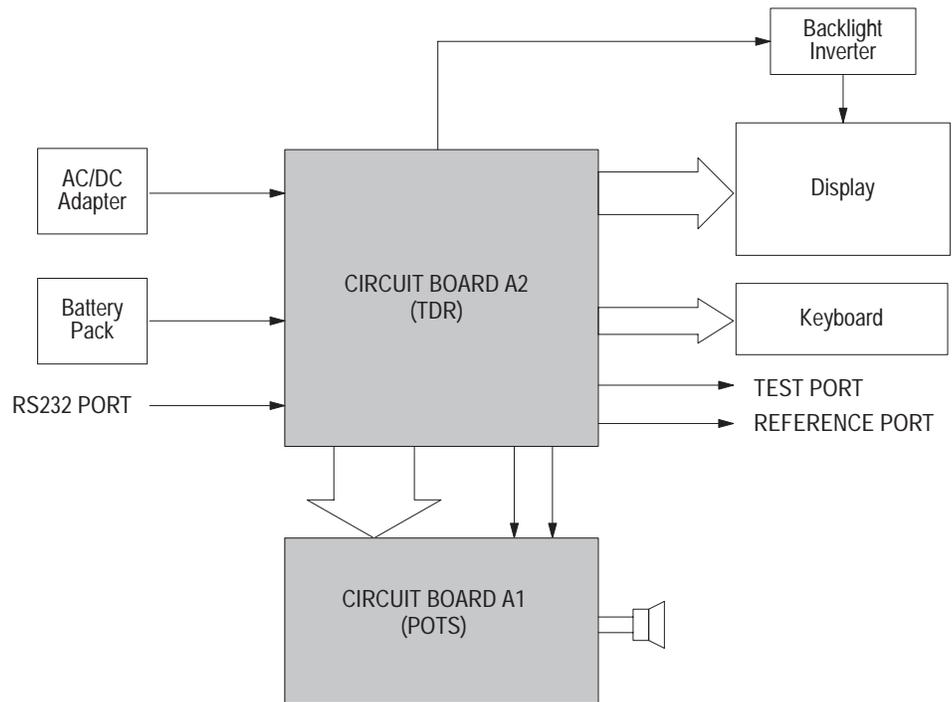


Figure 2-1: TS200 Block Diagram

The TS200 consists of two circuit boards, noted as CIRCUIT BOARD A1 (TDR) and CIRCUIT BOARD A2 (POTS), in the block diagram above.

Functional Descriptions

- Circuit Board A1** The A1 circuit board does all the POTS (Plain Old Telephone Service) measurements. This board relies on the A2 TDR board for power, control, and access to the external test leads and is mounted to A2 board using stand-off posts. Board A1 contains an analog-to-digital converter along with circuits to measure voltage, current, resistance, capacitance, frequency, tone amplitude, noise, number of load coils, and longitudinal balance. The A1 POTS board contains the pulse and DTMF dialing circuit, tone, generator, and a foreign voltage detection circuit. The A1 circuit board also directs signals to the speaker.
- Circuit Board A2** The A2 circuit board contains the Microprocessor, TDR circuits, display controller, keyboard interface, power supply, and battery charging circuits. The board connects to the display, backlight inverter, keyboard, printer port, beeper, and to the A1 POTS board.

The A2 board routes signals on the test leads either to the TDR circuits on the A2 board or to the A1 POTS board, depending on the measurement function selected. The microprocessor adjusts the power supply voltage going to the display to control the display contrast. The A2 board is mounted to the aluminum LCD stiffener plate assembly.

Display Assembly

The LCD is a VGA (640 X 480 pixel) display with a cold-cathode backlight supported by a foam gasket and a rigid aluminum stiffener plate. The backlight inverter attaches to the aluminum plate. Power for the display and backlight inverter as well as LCD row and column data come from the A2 TDR board.

Keyboard

The keyboard assembly contains an elastomeric keypad, a polyester flex circuit, and an aluminum support plate. The flex circuit connects to the A2 TDR board.

Battery

The standard battery is a 9-cell, 10.8 volt NiMH battery pack with built-in fuel gauge, temperature sensor, and self-resetting fuse. The fuel gauge monitors charge going into and out of the battery pack. The microprocessor on the A2 TDR board reads the data from the fuel gauge using a one-wire bi-directional digital interface that is wired to the battery connector. The battery must go through a complete charge/discharge/charge sequence periodically to recalibrate the fuel gauge. Circuitry on the A2 TDR board controls battery charging. The charging circuit monitors the temperature sensor inside the battery pack and the voltage across the battery to determine when the battery is fully charged. The start of a charge cycle is postponed if the battery temperature is above about 40° C. The A2 TDR board has a hardware shut-down circuit to prevent battery cell reversal at 8 V.

Optional Battery

A 10-cell, 15 volt AA battery holder can be used in place of the standard battery. Standard AA-size alkaline cells are used in the optional battery holder. The battery holder is designed for disposable batteries and does not connect to the NiMH charging circuit. This prevents accidental charging of non-rechargeable batteries. Optional battery life is short, so this pack should be used for emergencies only.

AC-to-DC External Adapter

The AC-to-DC external power adapter accepts a wide range of input voltages and frequencies. It outputs 24 Volts at up to 1.5 Amp. Different power cords are available to allow the adapter to connect to various power line outlets. The cable from the adapter to the instrument has a 5.5 mm OD, 2.1 mm ID center positive socket.

Backlight Inverter

The backlight inverter receives 12 Volts from A1 TDR board and provides 1000 VAC to power the cold-cathode lamp LCD backlight. An insulating cover prevents accidental contact with high voltage by service personnel. The TDR board also provides digital signals to turn the backlight power on/off and adjust the bright/dim setting.

Performance Verification

Performance verification verifies the operation of the TS200 analyzer to make sure that it is operating properly and conforms to instrument specifications as listed under *Specifications* in Section 1.

Performance verification should be done after an instrument has been serviced and at 12-month intervals.

If you are unfamiliar with how the TS200 analyzer works, it may help to review the *TelScout TS200 Access Network Analyzer User Manual* or *on-line help* before doing the performance verifications.

NOTE. Throughout the PV typical equipment set-ups, test lead connections will be represented by the letter *T* for tip (black), *R* for ring (red), and *G* for ground (green).

Required Equipment

The following is required to verify that the TS200 is operating correctly. Some of the equipment is Tektronix part numbered and can be ordered as an optional accessory.

NOTE. The multi-test fixture is not available outside Tektronix Factory Service. All procedures requiring the multi-test fixture must be performed at a Tektronix service depot.

- AC adapter/charger
- One set of standard accessory test leads
- Tektronix 784C Oscilloscope or equivalent
- Two P6139A, 10:1 probes
- One P6245 FET probe
- TS200 multi-test fixture (with banana plugs and cable) (See Section 6)
- DMM frequency counter (using Keithley Instruments 2000 multimeter)
- DTMF ASCII Converter (using Black Box Corporation)
- 9100 Wavetek calibrator with Options 100, 600, & S251 or equivalent
- 50 Ω Coax test cable (10 feet or less)

- BNC female to alligator clip adapter
- Telephone cable (4 to 5 feet)
- 105 Ω carbon composition resistor
- Amp meter
- BNC female to banana plugs adapter
- Power Supply capable of minimum output of -52.1 V @ 500 mA

Check Port Configurations

1. Press the **POWER** button to turn on the TS200.
2. On the power-up display, there is a symbol indicating whether the TS200 is on AC or DC power. A battery icon is used for DC and an AC-adaptor icon is used for AC.
 - Verify that the correct icon appears when the AC adapter is plugged into the unit and removed.

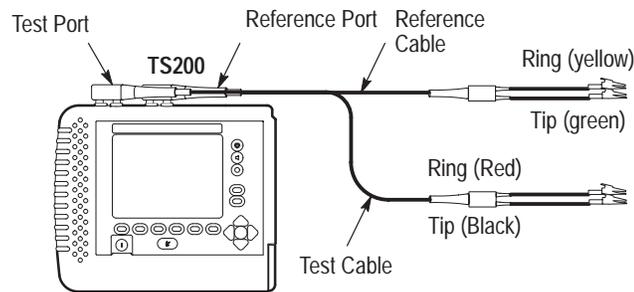


Figure 3-1: TS200 with Standard Test Leads Attached

3. Plug the standard accessory port cables into the ports labelled TEST and REFERENCE (red to red, black to black, yellow to yellow, and green to green).
4. Press the **Reset to Defaults** softkey.

Note: Each time the Reset to Defaults softkey is pressed, you will be prompted by a screen display to verify your request to Reset to Defaults.

5. Press the **TDR** softkey to view a waveform with test leads attached.
6. Press the **Setup** softkey.

7. Use the **up and down arrow** buttons to highlight your test cable type. Also select the appropriate cable diameter and Vp before proceeding.
8. Press the **More Setups** softkey.
9. Use the **arrow** buttons to highlight TDR Distance Units and change to FEET.
10. Press the **Previous Menu** softkey.
11. Press the **Test Type** softkey and highlight Auto TDR.
12. Press the **Return to Test** softkey.

TDR

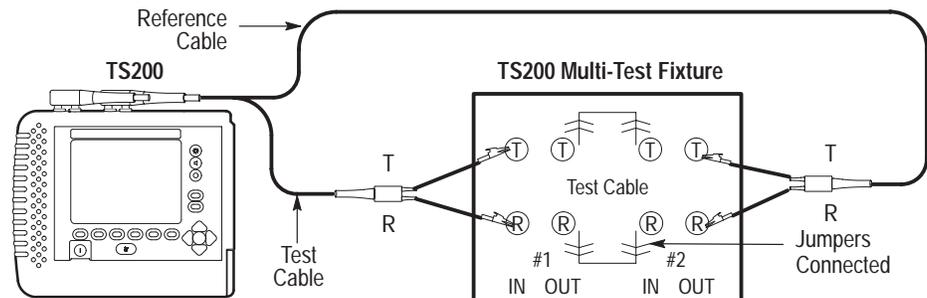


Figure 3-2: TDR Performance Checks

13. Verify the **Zoom Off** softkey is highlighted.
14. Connect all test leads to the test cable portion of the multi-test fixture (tip to tip and ring to ring).
15. Connect jump wires as illustrated in Figure 3-2.
16. Press the **More Cable** softkey until the end-of-cable reflection appears on the display.
17. Press the **Setup** softkey.
18. Press the **Test Type** softkey.
19. Use the **up and down arrow** buttons to highlight REFERENCE PAIR.
20. Press the **Return to Test** softkey.
 - Verify this waveform looks the same as the previous waveform.

Check Distance Readouts

21. Using the **left and right arrow** buttons, move the cursor to the beginning of the rising edge of the reflection.
 - Verify distance readout (DIST) matches the cable length $\pm 10\%$.

***NOTE.** The setup consists of two 10-foot test cables plus the 1000-foot cable. The instrument is set to zero distance at the end of the test leads, which negates the leads on the selected port. However, the instrument is not using the test leads on the other port for this particular test, so it will see the total cable length as 1010 feet. If your test cable is a different length, add the cable length plus 10 foot test lead.*

Check Crosstalk

22. Press the **Setup** softkey.
23. Press the **Test Type** softkey.
24. Use the **up and down arrow** buttons to highlight SPLIT AND CROSS-TALK [TEST PAIR TO REFERENCE PAIR].
25. Press the **Return to Test** softkey.
26. Position the cursor near the leading edge of the pulse.
27. Press the **Zoom On** softkey.
28. Reposition the cursor at the leading edge of the pulse.
29. Press the **Zoom Off** softkey.
 - Verify the DIST readout is approximately 505 feet.

***NOTE.** Because this test uses the same cable, testing from either end, and both ports are alternately sending pulses into this cable, each port does not see the end reflection of its own pulse but receives the pulse from the other port. This fools it into seeing a crosstalk reflection halfway down the cable. Therefore, the reflection will occur at one-half the length of the total cable, ± 2 feet. In this example, $1010/2 = 505$, ± 2 feet is 503 to 507 feet. If your test cable is a different length, your display and result will be different.*

Check Dual Displays

30. Press the **Setup** softkey.
31. Press the **Test Type** softkey.

32. Press the **down arrow** button to highlight TEST PAIR/REFERENCE PAIR.
33. Press the **Return to Test** softkey.
 - Verify there are two identical waveforms displayed on screen.
34. Press the **Setup** softkey.
35. Press the **Test Type** softkey.
36. Press the **down arrow** button to highlight TEST PAIR/DIFFERENCE/REFERENCE PAIR.
37. Press the **Return to Test** softkey.
 - Verify the software has performed a difference calculation; view a third waveform on screen.
38. Disconnect the test leads from the multi-test fixture.
39. Power off the TS200.

Verify Pulse Widths and Heights

NOTE. Outgoing pulses will not be visible on the TS200 display. They can be viewed on the oscilloscope display only.

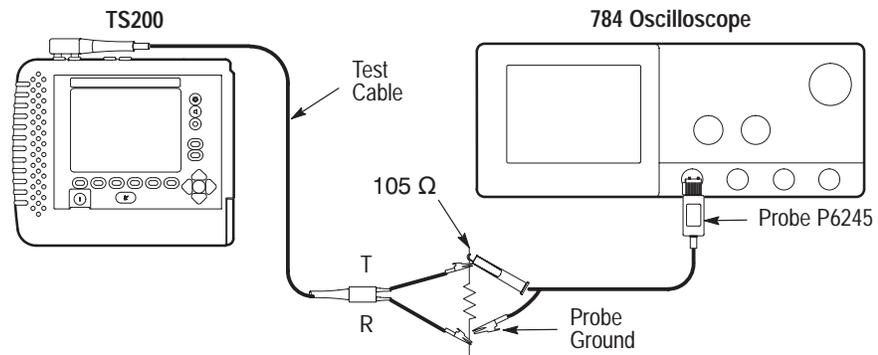


Figure 3–3: Verify 2 ns and 10 ns Pulse Widths and Heights

Measure 2 ns and 10 ns Pulses

1. Power on the TS200 and the oscilloscope.
2. Connect a 105 Ω carbon composite resistor across the tip and ring of the test cable.

3. Connect the P6245 probe to Channel 1 of the oscilloscope.
4. Connect the probe tip to the test cable tip.
5. Connect the probe ground to the test cable ring.
6. Oscilloscope control settings:
 - Set the vertical scale on Channel 1 to 1V/Div
 - Set the horizontal scale on Channel 1 to 1 ns/Div
 - Press the Shift button
 - Press the Acquire Menu button
 - Press the Repetitive Signal Off button
 - Select Off (Real Time Only)
 - Press the Trigger Menu button
 - Set Trigger Source to Channel 1
 - Set the Trigger Slope to positive
 - Adjust trigger level for approximately 1 volt
 - Adjust horizontal scale to display the initial portion of the pulse ONLY
 - Press the Average button and set at 15
 - Press the Measure button
 - Select Positive width for measurement one
 - Select Max Positive for measurement two

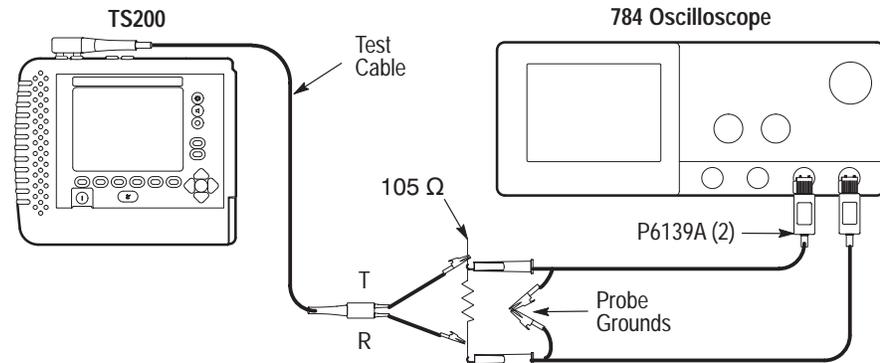


Figure 3-4: Example of Initial Pulse

7. Press **TDR**.
8. Press **Setup**.
9. Press **Test Type**.
10. Highlight Manual TDR.
11. Press **Return to Test**.
12. Press **Pulse**.
13. Use the **up and down arrow** buttons to select 2 ns.
 - Verify the 2 ns pulse readings are within specifications.
14. Use the **up and down arrow** buttons to select 10 ns.
15. Measure the 10 ns pulse. Adjust the vertical and horizontal scales as needed.
 - Verify the 10 ns pulse readings are within specifications.
16. Disconnect the cables and remove the P6245 probe.

Table 3-1: 2 ns and 10 ns Pulse Specifications

| MEASUREMENT | PULSE WIDTH | PULSE HEIGHT |
|-------------|------------------|----------------|
| 2 ns | 2 ns typical | 1.55 V typical |
| 10 ns | 12 ns $\pm 20\%$ | 4.44 V typical |

**Figure 3-5: Verify Pulse Widths / Heights (75 ns 340 ns and 3400 ns)****Measure the 75, 340 & 3400 ns Pulse**

17. Connect a P6139A probe to oscilloscope Channels 3 and 4.
18. Connect the Channel 3 probe tip to the test cable tip.
19. Connect the Channel 4 probe tip to the test cable ring.
20. Connect both probe ground leads together.
21. Connect the probe ground leads to the outer sleeve of the AC adapter.
22. Connect a 105 Ω resistor as shown in the typical set-up illustration.
23. Oscilloscope control settings:
 - Turn on Channels 3 and 4 only
 - Set the vertical scale on Channels 3 and 4 to 2V/Div
 - Set the horizontal scale on Channels 3 and 4 to 25 ns/Div
 - Press the Shift button
 - Press the Acquire Menu button
 - Press the Repetitive Signal Off button
 - Select Off (Real Time Only)
 - Press the Vertical Menu button
 - Set Channel 3 and 4 input impedance to 1 M Ω
 - Press the Trigger Menu button
 - Set Trigger Source to Channel 3
 - Press the Math Ref button

- Select Change Math W/F Definition
- Press the Dual Wfm Math button
- Set 1st Source to Channel 3
- Set 2nd Source to Channel 4
- Set Operator to minus (-)
- Select OK to Create Math Wfm
- Turn off Channels 3 and 4
- Press the Math Ref button
- Press the Average button and set at 15
- Increase the vertical scale of the math waveform to 2.5 V/Div

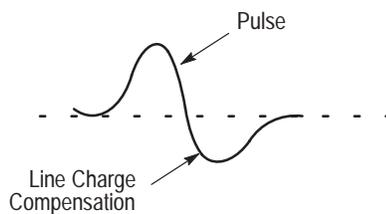


Figure 3-6: Example of Peak to Peak Pulse

24. Measure the pulse width at 50% amplitude.
25. Use the **up and down arrow** buttons to select the 75 ns pulse.
 - Verify the 75 ns pulse readings are within specifications.
26. Use the **up and down arrow** button to select and then measure the 340 and 3400 ns pulses.
27. Adjust the vertical scale, horizontal scale, and trigger as required.
 - Verify all pulse readings are within specifications.

Table 3-2: 75 ns, 340 ns, 3400 ns Pulse Specifications

| PULSE | PULSE WIDTH | PULSE HEIGHT |
|---------|------------------------------|--------------------|
| 75 ns | 75 ns typical | 8 V typical |
| 340 ns | 340 ns (284 ns to 442 ns) | 18 V Pk-Pk typical |
| 3400 ns | 3400 ns (2550 ns to 3910 ns) | 28 V Pk-Pk typical |

28. Power off the TS200.

Check Smoothing

1. Disconnect all attachments from both test cables.

2. Power on the TS200.
3. Press the **Reset to Defaults** softkey.
4. Press the **TDR** softkey.
5. Press the **Setup** softkey.
6. Press the **Test Type** softkey.
7. Select Manual TDR and verify TEST PAIR is highlighted.
8. Press the **Previous Menu** softkey.
9. Press the **More Setups** softkey.
10. Verify TDR Distance Units is in FEET.
11. Use the **up and down arrow** buttons to highlight Smoothing.
12. Use the **left and right arrow** buttons to select the OFF setting.
13. Press the **Return to Test** softkey.
14. Press the **Pulse** softkey.
15. Use the **up and down arrow** buttons to set the pulse width to 10 ns.
16. Press the **Span** softkey.
17. Press the **up arrow** until approximately 2000 feet is visible on screen.
18. Position the cursor at approximately 2000 feet.
19. Use the **up and down arrow** keys to adjust the GAIN to 52 dB.
 - Verify height of the noise is well within the display window.
20. Press the **Setup** softkey.
21. Press the **More Setups** softkey.
22. Use the **up and down arrow** buttons to highlight Smoothing.
23. Use the **left and right arrow** buttons to select the 7 setting.
24. Press the **Return to Test** softkey.
 - Verify a significant reduction in noise level.
25. Power off the TS200.

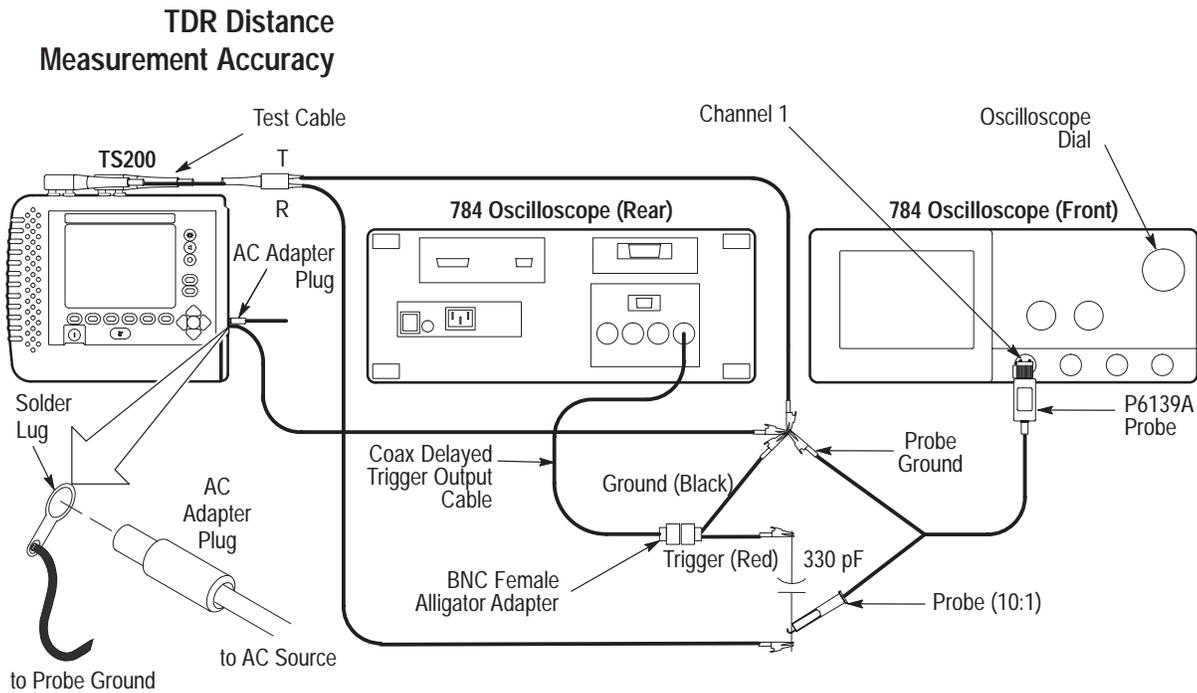


Figure 3-7: Check TDR Distance Accuracy

1. Power on the TS200.
2. Connect the BNC female adapter to the coax cable.
3. Connect a P6139A probe to Channel 1.
4. Probe, test cable, and coax cable connections:

| | |
|-----------------------|--|
| P6139A probe | 330 pf capacitor |
| TS200 test cable ring | 330 pf capacitor |
| P6139A ground | TS200 test cable tip (Probe ground) |
| Coax cable (red) | 330 pf capacitor (opposite end) |
| Coax cable (black) | P6139A ground and TS200 test cable tip (Probe ground) |
| AC adapter ground | TS200 test cable tip (Probe ground) to obtain stable pulse on screen |
5. Oscilloscope control settings:

| | |
|--|------------|
| Vertical Scale | 2 V/div |
| Horizontal Scale | 500 ns/div |
| Press Trigger Menu button | |
| Press Source button (screen bottom) | |
| Press CH1 button (screen right) | |
| Press Type button until Edge is selected | |
| Press Coupling button (screen bottom) | |
| Press AC button (screen right) | |

Press Slope button (screen bottom)
Press positive going transition (screen right, top button)
Press Level button
Dial knob to set trigger level to approximately $-1V$
Press Horizontal Menu button
Press Time Base button (screen bottom)
Press Delayed Only button (screen right)
Use the Horizontal Scale knob to set the Delayed Runs After at 500 ns
Dial knob to set Delay Time at 600 ns
Press Shift
Press Acquire Menu
At screen bottom, press Repetitive Signal *Off*
Press Off (Real Time Only)

6. Press the **Reset to Defaults** softkey.
7. Press the **TDR** softkey.
8. Press the **Setup** softkey.
9. Press the **More Setups** softkey.
10. Use the **up and down arrow** buttons to highlight TDR Distance Units.
11. Use the **left and right arrow** buttons to change the setting to NANOSECS.
12. Press the **Previous Menu** softkey.
13. Press the **Test Type** softkey.
14. Select Manual TDR.
15. Press the **Return to Test** softkey.
 - Verify the oscilloscope displays both an incident pulse and a negative-going delayed pulse.
16. Press the **Span** softkey.
17. Use the **up and down arrow** buttons to span to 600 ns.
 - Verify a positive-going delayed pulse at approximately 300 ns.
18. Place the cursor at the leading edge of the 300 ns pulse.
19. With the **Span** softkey still highlighted, press the **down arrow** button until there is an approximately 80-ns spread across the screen top.
20. Move the cursor to the half-way point on the rising edge of the reflection.
21. Press the **Marker** softkey.
22. Use the oscilloscope dial to set the DELAY TIME to 2.600 μ s.

23. Verify **Span** is highlighted.
24. Press the **up arrow** button to increase the span to approximately 1.3 μ s.
25. Use the **left and right arrow** buttons to place the cursor on the rising edge of the reflection.
26. Press the **down arrow** button until there is an approximately 80-ns spread across the screen top.
27. Move the cursor to the half-way point on the rising edge of the pulse.
 - Verify the Δ distance is 1 μ s \pm 0.0013 μ s (0.9987 to 1.0013).
28. Set the oscilloscope DELAY TIME to 36.600 μ s.
29. Verify that the **Span** softkey is highlighted.
30. Press the **up arrow** button until there is an approximately 18 μ s on screen.
31. Use the **left and right arrow** buttons to place the cursor on the rising edge of the reflection.
32. Press the **down arrow** button until there is an approximately 80-ns spread across the screen top.
33. Move the cursor to the half-way point on the rising edge of the pulse.
 - Verify the Δ distance is 18 μ s \pm 0.0183 μ s (17.9817 to 18.0183).
34. Power off the TS200.

POTS

NOTE. Before performing POTS performance verification testing, disconnect the AC power source. These tests are to be conducted using TS200 battery power with the backlight off to minimize interference. POTS testing involves sensitive measurements; you may want to run the Self Calibration Test frequently.

1. Power on the TS200.
2. Press the **Self Calibration** softkey.
3. Follow the on-screen instructions.
 - Verify the final screen response reads “Self Calibration Complete.”
4. Press the **Done** softkey.

DC Volts

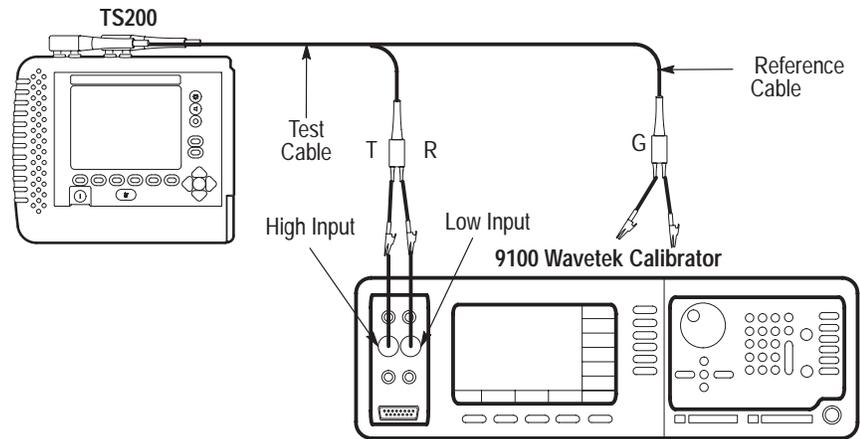


Figure 3–8: Measure DC Volts

5. Connect the test cable tip and ring to the DC voltage terminals on the calibrator (tip to high, ring to low).
6. Press the **VOM** softkey.
7. Select **DC Volts**.
8. Set the calibrator at 5 VDC.
 - Verify the TS200 T–R reading is within tolerance.
9. Connect the reference ground to the low input DC Voltage terminal.
10. Connect the test cable tip to the high input terminal of the calibrator.
 - Verify the TS200 T–G reading is within tolerance.
11. Connect the test cable ring and reference cable ground to the DC Voltage terminals (ring to high, ground to low).
 - Verify the TS200 R–G reading is within tolerance.
12. Set the calibrator to provide 30 VDC.
 - Verify the TS200 R–G reading is within tolerance.
13. Repeat the steps for calibrator settings of 50 VDC and 280 VDC.
 - Verify the readings are within tolerance.

AC Volts

14. Connect the TS200 test cable tip and ring leads to the AC voltage terminals on the calibrator.

15. Press the **Main Display** softkey.
16. Press the **VOM** softkey.
17. Select **AC Volts**.
18. Set the calibrator to provide 5 VAC @ 60 Hz.
 - Verify the TS200 T–R reading is within tolerance.
19. Now connect the reference cable ground to the low input voltage terminal.
20. Connect the test cable tip to the high input terminal.
 - Verify the TS200 T–G reading is within tolerance.
21. Connect the test cable ring and the reference cable ground to the AC voltage terminals (ring to high, ground to low).
 - Verify the TS200 R–G reading is within tolerance.
22. Set the calibrator to provide 30 VAC.
 - Verify the TS200 R–G reading is within tolerance.
23. Repeat the steps for calibrator settings of 50 VAC and 280 VAC.
 - Verify the readings are within tolerance.
24. Power off the TS200.

Loss and Slope

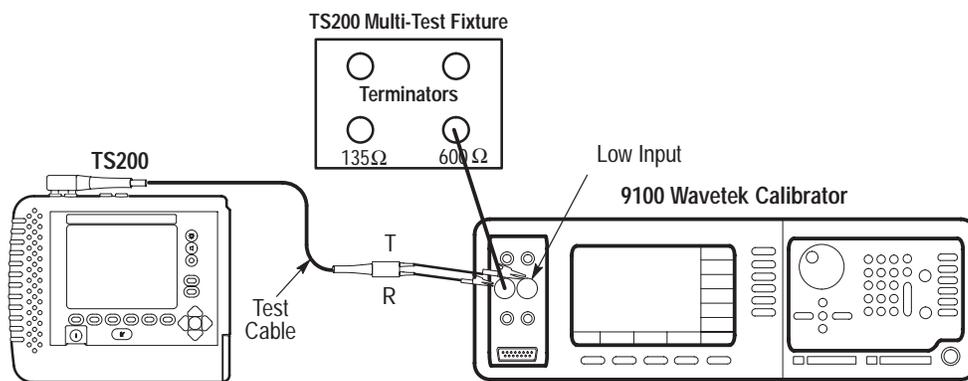


Figure 3–9: Loss Slope (Tone Receiver) Performance Check

1. Power on the TS200, the multi-test fixture, and the calibrator.

2. Connect the test cable tip to calibrator low and the ring to the calibrator high output.
3. Set the calibrator output level to 0.7746 Vrms @ 1004 Hz.

NOTE. $0.7746 \text{ Vrms} = 0 \text{ dBm at } 600 \Omega$
 $\text{dBm at } 600 \Omega = 10 * \log \left(\frac{\text{Vrms}^2}{600} \right) + 30$

$$\text{Vrms} = \sqrt{600 \times 10^{\left(\frac{\text{dBm}-30}{10}\right)}} \text{ at } 600 \Omega$$

-
4. Press the **Trans. Tests** softkey.
 5. Press the **Loss** softkey.
 - Verify the LOSS LEVEL and FREQUENCY are within specification.
 6. Set the calibrator output to 77.46 mVrms.
 - Verify the LOSS LEVEL is within specification.
 7. Set the calibrator output to 13.775 mVrms.
 - Verify the LOSS LEVEL is within specification.
 8. Set the calibrator output level to 0.7746 Vrms @ 20 Hz.
 - Verify the LOSS LEVEL is -3 dB typical.
 9. Reset the calibrator output level to 0.5998 Vrms @ 40 kHz.

NOTE. *The TS200 uses a 600 Ω input impedance for all loss and slope measurements. The TS200 assumes the calibrator output impedance is 600 Ω for frequencies below 20 kHz and 135 Ω for frequencies above 20 kHz. To correct for the loading error above 20 kHz, the actual voltage at the TS200 terminals should be 1.6327 times the voltage calculated for a 135 Ω load.*

- Verify LOSS LEVEL is within specification.
10. Set the calibrator output to 59.99 mVrms.
 - Verify LOSS LEVEL is within specification.
 11. Set the calibrator output to 10.67 mVrms.
 - Verify the LOSS LEVEL is within specification.

12. Connect a BNC to banana adapter to the SIG OUT terminal on the back panel of the calibrator. Install 54.5 Ω resistor across SIG OUT terminals on rear of calibrator using a BNC to banana plug.

NOTE. The 54.5 Ω resistor, in parallel with the TS200's 600 Ω impedance, provides a 50 Ω load to the calibrator.

13. Connect the test cable tip and ring to the banana plugs on the BNC adapter.
14. Set up the Wavetek calibrator:
 - Press the AUX button
 - Press the Sine Wave button
 - Highlight DIRECT
15. Set the output volts to 1.6967 V Pk-Pk @ 196 kHz.

NOTE. $V_{pk-pk} = 2 * \sqrt{2} * V_{rms}$

- Verify the LOSS LEVEL and FREQUENCY readings are within specification.
16. Set the calibrator output volts to 0.16967 V Pk-Pk.
 - Verify the LOSS LEVEL reading is within specification.
 17. Set the calibrator output volts to .05365 V Pk-Pk.
 - Verify the LOSS LEVEL reading is within specification.
 18. Disconnect the test cable tip and ring from the calibrator SIG OUT connector.
 19. Connect the TS200 test cable tip to the red 600 Ω terminator of the test fixture.
 20. Connect the TS200 test cable ring to the calibrator high output.
 21. Connect the calibrator low output to the black 600 Ω terminator.
 22. Return the calibrator setting to AC Volts.
 23. Set the calibrator output volts to 0.7746 Vrms @ 1004 Hz.
 - Verify the LOSS LEVEL is -6 dBm \pm 0.5.
 24. Power off the TS200.

Metallic Noise / Power Influence

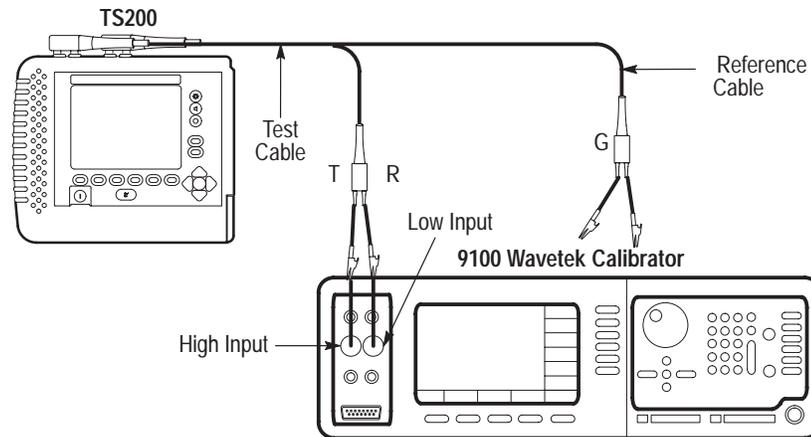


Figure 3-10: Psophometric / C-Message Filter Frequency

NOTE. In this section, noise is measured in dBrn which is power referenced to $1 \text{ pw} = 10^{-12}$ Watts.

$$\text{dBrn} = \text{dBm} + 90.$$

dBrnC is measured with a C-message filter.

dBrnP is measured with a Psophometric filter.

1. Power on the TS200 and the calibrator.
2. Connect the test cable tip and ring to the calibrator high and low input terminals.
3. Press the **Setup** softkey.
4. Press the **More Setups** softkey.
5. Use the **up and down arrow** buttons to highlight Noise Filter.
6. Use the **left and right arrow** buttons to select the Psophometric setting.

Testing Psophometric Filter

7. Press the **Main Display** softkey.
8. Press the **Trans. Test** softkey.
9. Press the **Noise** softkey.
10. Set the calibrator to 7.746 mV @ 800 Hz.
 - Verify the NOISE display reads within specification.

- To establish a reference point for psophometric frequency responses, adjust the calibrator output until the TS200 displays the exact reading of 50 dBrnP.
- 11. Use the table below and continue to adjust the calibrator for each setting listed under the Calibrator output setting column.
 - Verify the NOISE level readings for each setting are within tolerance.

Table 3-3: Psophometric and C-Message Filter Frequency Responses

| Calibrator output setting | Psophometric filter setting | C-Message filter setting |
|---------------------------|-----------------------------|--------------------------|
| FREQUENCY | NOISE – dBrnP | NOISE – dBrnC |
| 100 Hz | 9.0 ± 4.0 | 7.5 ± 4.0 |
| 200 Hz | 29.0 ± 4.0 | 24.9 ± 4.0 |
| 500 Hz | 46.4 ± 3.0 | 42.3 ± 3.0 |
| 800 Hz | 50.0 (reference point) | 48.7 ± 3.0 |
| 1 kHz | 51.0 ± 3.0 | 50.0 (reference point) |
| 2 kHz | 47.0 ± 3.0 | 48.9 ± 3.0 |
| 3 kHz | 44.4 ± 3.0 | 47.0 ± 3.0 |
| 4 kHz | 35.0 ± 5.0 | 35.4 ± 5.0 |
| 5 kHz | 14.0 ± 5.0 | 21.3 ± 5.0 |

Testing C-Message Filter

12. Press the **Setup** softkey.
13. Press the **More Setups** softkey.
14. Change the Noise Filter setting to the C-Message setting.
15. Press the **Return to Test** softkey.
16. Set the calibrator to 7.746 mV @ 1000 Hz.
 - Verify the NOISE display reads within the tolerance.
 - To establish a reference point for C-Message frequency responses, adjust the calibrator output until the TS200 displays the exact reading of 50 dBrnC.
17. Measure the frequency responses for the C-Message filter. Adjust the calibrator for each setting listed under the Calibrator output setting column.
 - Verify the NOISE level readings for each C-Message filter setting are within the tolerance.

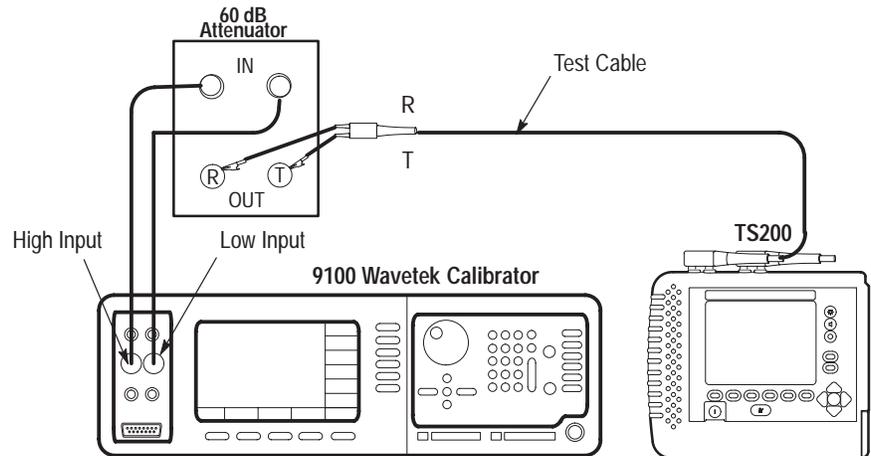


Figure 3–11: Measure Metallic Noise / Power Influence

Measuring Noise and Power Influence

18. Confirm the Noise Filter setting is in C-Message.
19. Connect the test port tip and ring to the test fixture 60 dB Attenuator output.
20. Connect the calibrator high and low output to the 60 dB input.

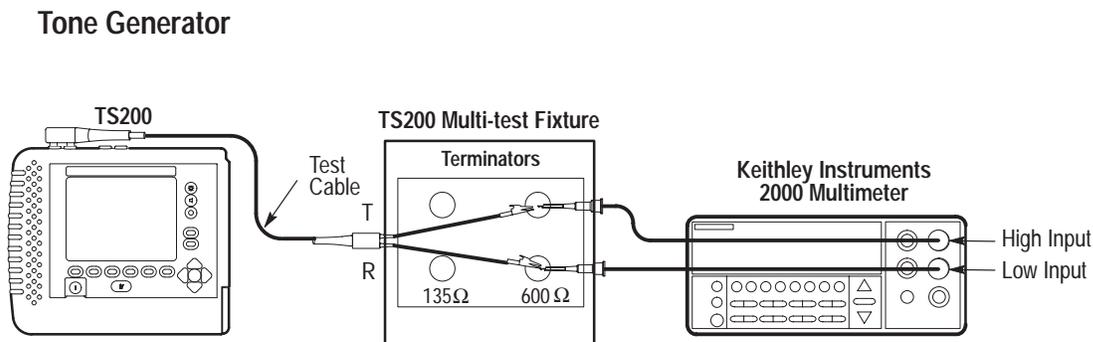
NOTE. Do not apply more than 35 Vrms while performing this test.

21. Set the calibrator to 1 kHz.
22. Use the table below. Adjust the calibrator for each setting listed.
 - Verify the NOISE level readings for each setting are within tolerance.
23. Disconnect all connectors from the 60 dB Attenuator.
24. Connect the reference cable ground to the calibrator low output terminal.
25. Connect the test cable tip and ring to the calibrator high output terminal.
26. Set the calibrator for 0.1946 Vrms @ 600 Hz.
 - Verify the POWER INFLUENCE reading is 36 dBmC typically.
27. Reset the calibrator to 60 Hz.
28. Adjust the calibrator for each setting listed in the table below.
 - Verify the POWER INFLUENCE readings are within tolerance.

Table 3-4: C-Message Noise and Power Influence Values

| Calibrator output volts (rms) | NOISE – dBrnC | POWER INFLUENCE – dBrnC |
|-------------------------------|---------------|-------------------------|
| 7.746 V | 50 ± 2.0 | |
| 2.449 V | 40 ± 2.0 | |
| .7746 V | 30 ± 2.0 | |
| .2449 V | 20 ± 2.0 | |
| .07746 V | 10 ± 2.0 | |
| 194.6 V | ----- | 100 ± 2.0 |
| 19.46 V | ----- | 80 ± 2.0 |
| 1.946 V | ----- | 60 ± 2.0 |
| .1946 V | ----- | 40 ± 2.0 |

29. Power off the TS200.

**Figure 3-12: Tone Generator Performance Check**

1. Power on the TS200, the multi-test fixture, and the digital multimeter.
2. Set the multimeter impedance at 600 Ω.
3. Connect the test cable tip and ring to the test fixture 600 Ω terminators.
4. Connect the multimeter high and low probes to the 600 Ω terminator.
5. Press the **Trans. Tests** softkey.
6. Press the **Tone** softkey.
7. Using the **up and down arrow** buttons, highlight 1004 Hz TONE.
8. Using the **left and right arrow** buttons, set the LEVEL to 0 dBm.
 - Verify the frequency and signal levels are within tolerance.

9. At the TS200 TONE display, use the **arrow** buttons to set the dB levels at -40 , -30 , -20 , -10 , and $+10$ dBm. (Accuracy is specified for levels > -25 dBm only.)
 - At each level, verify the multimeter signal level readings are within tolerance.
10. At the TS200 TONE display, use the **arrow** buttons and select the following: 20 Hz and 20,000 Hz at 0 dBm.
 - Verify the multimeter frequency is within tolerance.
 - Verify the multimeter level is $0 \text{ dBm} \pm 4 \text{ dB}$.
11. Connect the TS200 and the multimeter leads to the 135Ω terminals.
12. Set the multimeter impedance at 135Ω .
13. Use the **up and down arrow** buttons to select the 40 kHz TONE at 0 dBm.
 - Verify the frequency and signal levels are within tolerance.
14. Power off the TS200.

VOM Ohms

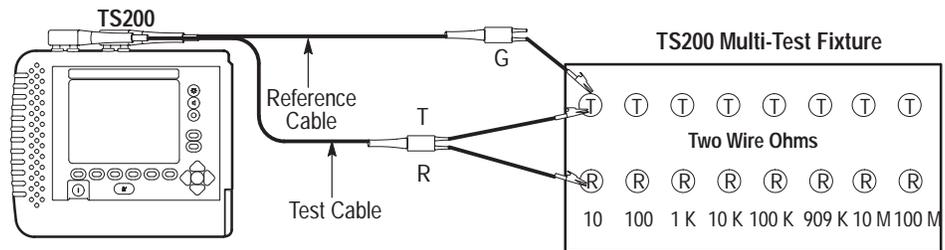


Figure 3–13: VOM Ohm Performance Check

1. Power on the TS200 and the multi-test fixture.
2. Connect the test cable tip and ring to the 10Ω terminals on the Two Wire Ohm portion of the multi-test fixture.
3. Press the **VOM** softkey.
4. Press the **Ohms** softkey.
 - Verify the TS200 T–R reading is within tolerance.
5. Connect the test cable tip and the reference cable ground to the 10Ω terminals.

- Verify the TS200 T–G reading is within tolerance.
- 6. Connect the test cable ring and reference cable ground to the 10 Ω terminals.
- Verify the TS200 R–G reading is within tolerance.
- 7. Test all resistor terminal sets of the Two Wire Ohm test fixture (100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 909 kΩ, 10 mΩ and 100 mΩ).
 - Verify the tolerance of the R–G readings for each terminal hook-up.
- 8. Power off the TS200.

Resistance Fault Locator

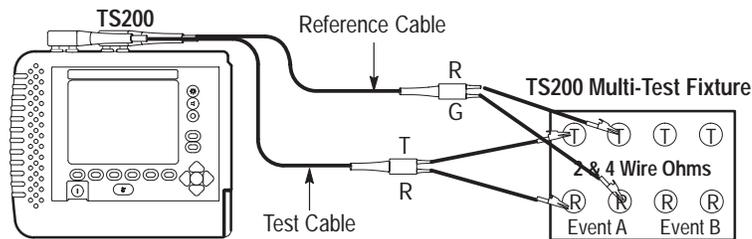


Figure 3–14: Resistance Fault Locator Performance Check

1. Power on the TS200 and the multi-test fixture.
2. Perform an instrument self-calibration test to correct for lead resistance. It is important that the leads make good mechanical contact during the “short leads together” part of the test.

NOTE. Avoid moving the test leads or disturbing the connections while self-calibration testing is in process.

3. Connect all TS200 test cable leads to the Event A terminals of the 2 & 4 Wire Ohm section of the multi-test fixture (red to red, black to black, green to green, and yellow to yellow).
4. Press the **Resistance Fault Loc.** softkey.
5. Verify **Short Two Pair** is highlighted.
6. Verify **Ohms** is highlighted.

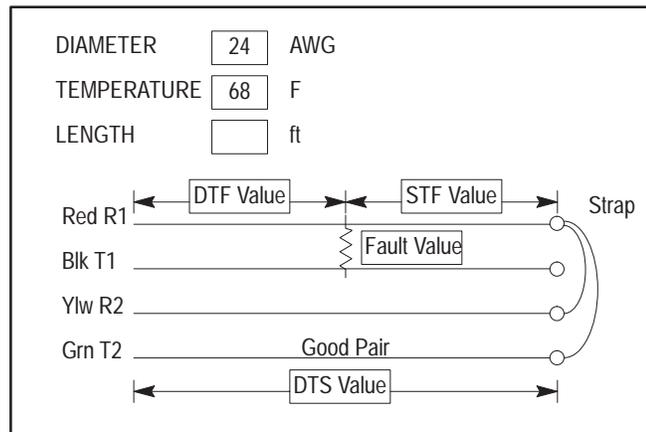


Figure 3-15: Sample Display to Verify Readouts

- Verify the display readouts are all within tolerance.
 - DTS equals the measured value of R3 + R4 ($\pm 0.9\%$ typical).
 - DTF equals the measured value of R3 ($\pm 0.9\% + 1$ count).
 - STF equals the measured value of R4 ($\pm 0.9\%$ typical).
 - FAULT equals the measured value of R5 ($\pm 0.9\%$ typical).

NOTE. Refer to test fixture calibration data for actual values of R3 through R5.

7. Power off the TS200.

Loop Current

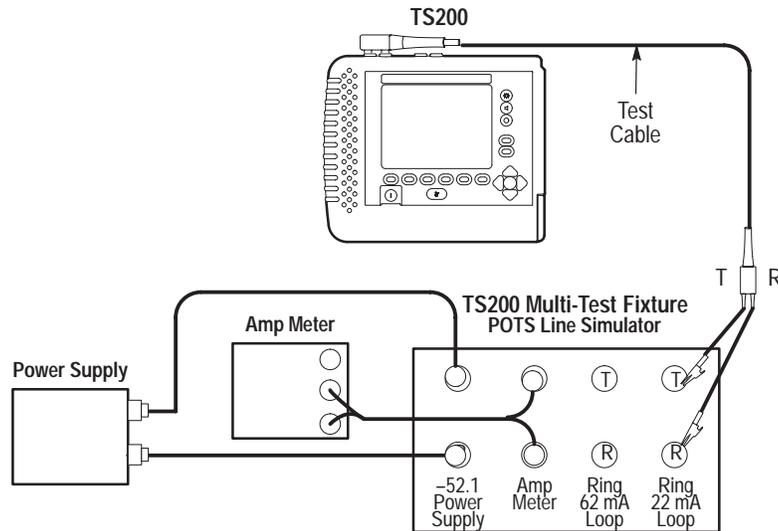


Figure 3-16: Loop Current Performance Check

1. Power on the TS200, the multi-test fixture, amp meter, and power supply.
2. Connect the test cable tip and ring to the 22 mA Current Loop terminals in the POTS Line Simulator section of the multi-test fixture (red to red, black to black).
3. Connect an amp meter to the multi-test fixture Amp Meter terminals.
4. Set the power supply unit to -52.1 volts. Connect the power supply terminals to the multi-test fixture (red to red, black to black).
5. Press the **VOM** softkey.
6. Press the **Loop Current** softkey.
 - Verify the LOOP CURRENT and amp meter readings are equal $\pm 1\%$.
7. Connect the test cable tip and ring to the fixtures 62 mA Current Loop terminals.
 - Verify the LOOP CURRENT and amp meter readings are equal $\pm 1\%$.
8. Power off the TS200.

Longitudinal Balance

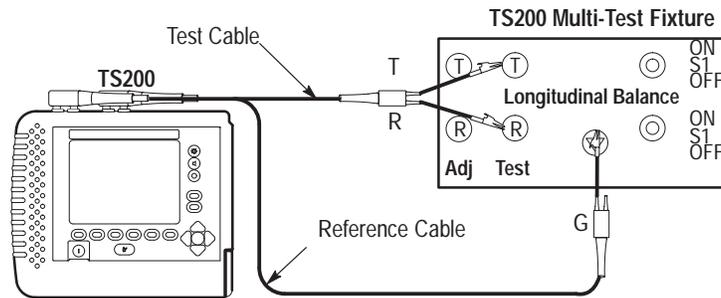


Figure 3–17: Longitudinal Balance Performance Check

1. Power on the TS200 and the multi-test fixture.
2. Connect the test cable tip and ring to the multi-test fixture Longitudinal Balance Test terminals (red to red, black to black).
3. Connect the reference cable ground to the test fixture (green to green).
4. Press the **Trans. Test** softkey.
5. Press the **Long. Balance** softkey.

NOTE. Refer to test fixture calibration data for actual values.

- Verify the LONGITUDINAL BALANCE reading is within tolerance
6. Reverse the connections (red to black and black to red).
 - Verify the LONGITUDINAL BALANCE reading is within tolerance.
 7. Power off the TS200.

Capacitance (Open) Meter

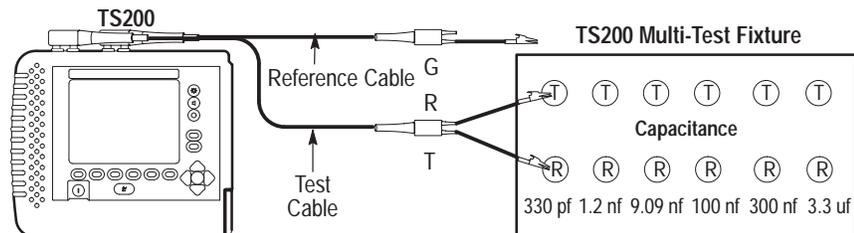


Figure 3–18: Open Capacitance Meter Performance Check

1. Power on the TS200 and the multi-test fixture.
2. Perform an instrument self-calibration test to correct for lead capacitance. It is important that the leads make good mechanical contact during this test. For best results, lay the test leads on a non-conductive surface.

NOTE. *Avoid moving the test leads or disturbing the connections while self-calibration testing is in process.*

3. Connect the test cable tip and ring to the Capacitance section 330 pF terminals of the multi-test fixture.
4. Press the **Open Meter** softkey.
 - Verify the T–R capacitance is within tolerance.
5. Connect the test cable tip and the reference cable ground to the 330 pF terminals.
 - Verify the T–G capacitance is within tolerance.
6. Connect the test cable ring and the reference cable ground to the 330 pF terminals.
 - Verify the R–G capacitance is within tolerance.

NOTE. *If the instrument fails steps 3, 4, or 5, verify that the self-calibration testing was performed properly.*

7. Test the tip and ring tolerances at the 1.2 nF, 9.09 nF, 100 nF, and 3.3uF terminals.
 - Verify the T–R capacitance is within tolerance.
8. Power off the TS200.

Pulse Dialer

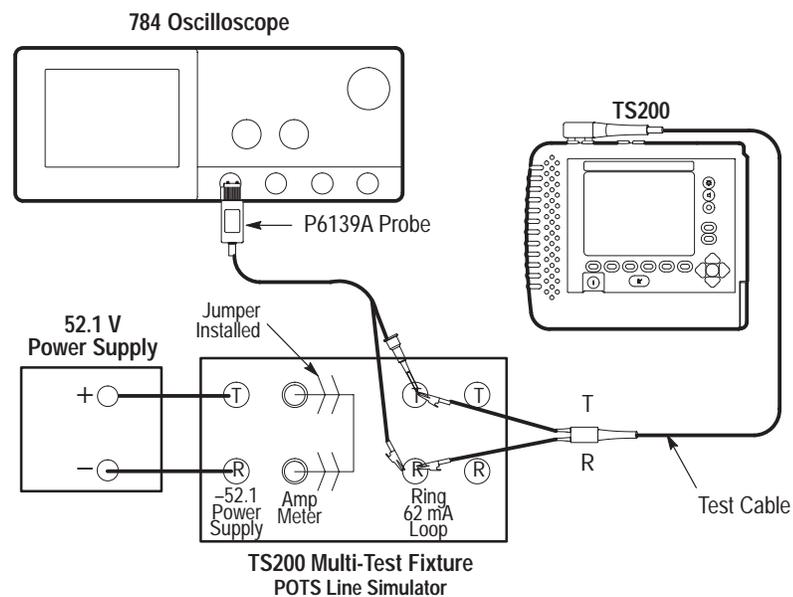


Figure 3–19: Pulse Dialer Performance Check

1. Power on the TS200, oscilloscope, multi-test fixture, and the power supply.
2. Make the cable connections as illustrated in the equipment setup.
3. Oscilloscope set-up:
 - Press the Horizontal menu button
 - Press the Record Length button
 - Press the More button
 - Highlight the *5000 Points* block
 - Press the Time Base button
 - Select Main
 - Press the Horizontal Scale button
 - Use the Horizontal Scale dial to set at 200 ms
 - Use the Vertical Scale dial to set at 20 V/div
 - Press the Trigger Menu Button,
 - Set Trigger Level on screen to 33-35 V
4. Press the **Trans. Test** softkey.
5. Press the **Select Phone #** softkey.
6. Press the **Enter Phone #** softkey.
7. Enter a phone number.
8. Press the **Dial Type** softkey.

9. Use the **left and right arrow** buttons to highlight Pulse on-screen.
10. Return to the oscilloscope for further setups.
 Press the Shift button
 Press the Single Trig button
11. Observe the Trigger position reading. There will be a momentary flash of PrTrig. After the flash when TRIG appears, press the **Send** softkey.
12. Press the oscilloscope ZOOM button.
13. Adjust the Horizontal Position and Horizontal Scale controls as needed.
14. Measure the time between dialing frequency.
 - Verify the reading is between 100 ms and 125 ms.
15. Measure the Break Time.
 - Verify the North American reading is 53 ms to 80 ms (UK, 60 – 70 ms).
16. Measure the Inter-digit Pause.
 - Verify the reading is 680 ms to 2 seconds (North American and the UK).

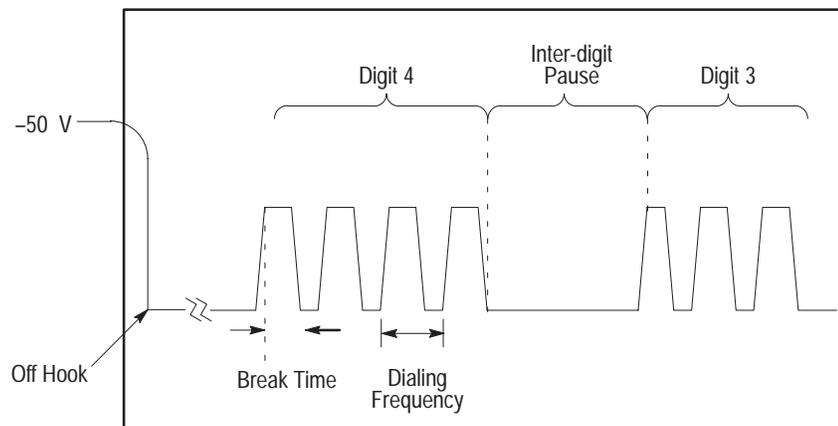


Figure 3-20: Typical Waveform for Dialer Performance Check

17. Power off the TS200.

DTMF Dialer

1. Refer to the DTMF typical setup and connect test equipment.
2. Power on the TS200, computer, DTMF converter, and the multi-test fixture.

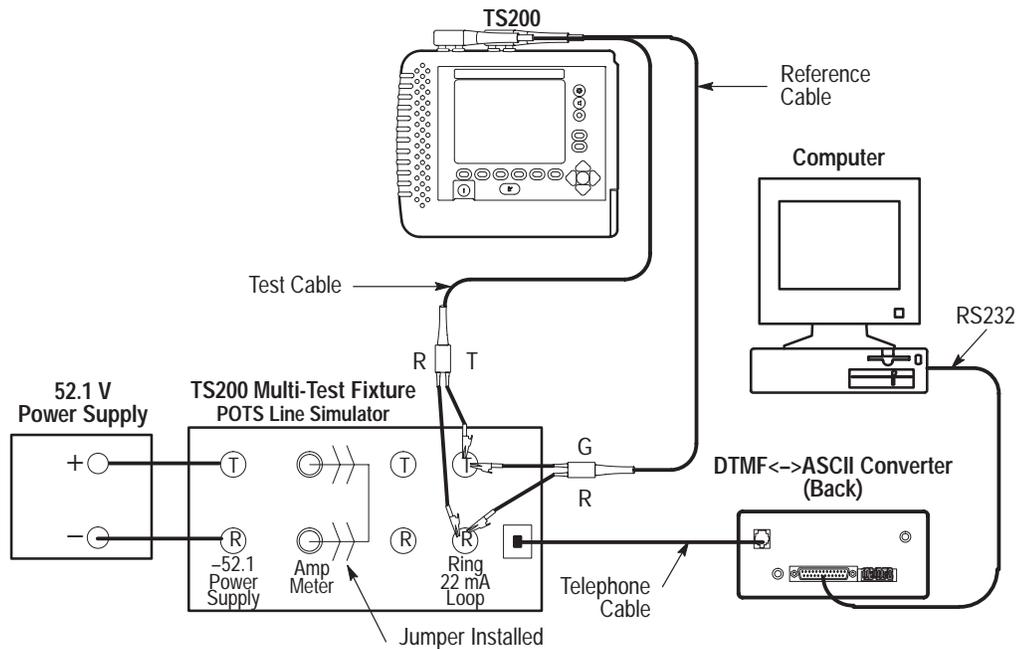


Figure 3-21: DTMF Dialer Performance Check

NOTE. The DTMF and computer communications set-ups: Baud rate = 19200, Data bits = 7, Stop bits = 2, Parity = None, Flow control = Xon/Xoff.

3. Press the **Trans. Tests** softkey.
4. Press the **Select Phone #** softkey.
5. If no phone number is displayed, press the **Enter Name** softkey.
 - Use the **DIAMOND** button or the **Insert Char** softkey to enter the name.
 - Press the **Done** softkey.
 - Press the **Enter Phone #** softkey.
 - Use the **arrow** buttons and front-panel softkeys to select numbers.
6. Press the **DIAMOND** button to return to the Select Phone# display.
7. Press the **Dial Type** softkey.
8. Use the **left and right arrow** buttons to select DTMF.

NOTE. Before starting a terminal session on the computer, be sure the terminal settings match the DTMF box settings.

9. At the computer keyboard, press the Ctrl-A key.
10. Press the **Send** softkey and verify the computer displays the correct phone number.
11. Power off the TS200.

Load Coils, 66 mH / 88 mH

1. Power on the TS200 and the multi-test fixture.
2. Connect the test port tip to the black 66 mH Load Coils terminal of the multi-test fixture.

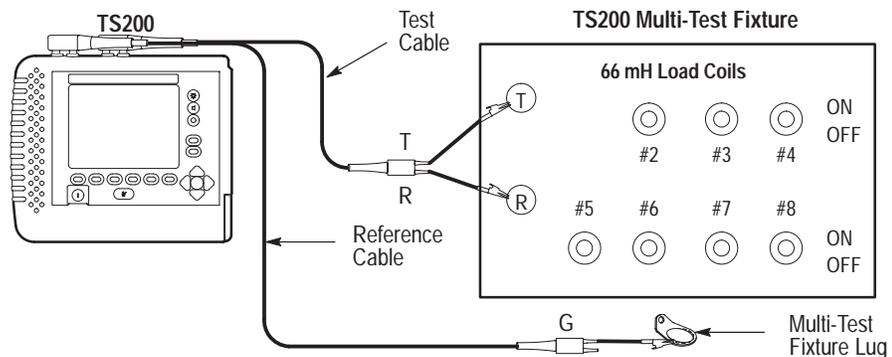


Figure 3-22: Load Coil Performance Checks

3. Connect the test port ring to the red terminal.
4. Connect the reference port ground to the lug at the bottom of the fixture.
5. Flip all test fixture toggle switches to the OFF position.
6. Press the **VOM** softkey.
7. Press the **Counts Load** softkey and verify there are at least 7 LOAD COILS FOUND.
8. Connect the test port tip and ring to the 88 mH Load Coil terminals.
9. Press the **Counts Load** softkey and verify there are at least 6 LOAD COILS FOUND.

NOTE. Successful completion of this test with the 88 mH fixture, along with the Loss and Slope test and Tone Generator test, is sufficient for verifying correct operation of the Load Coil TestWizard function.

TS200 Test Record

| | |
|----------------------|---------------------|
| TS200 Serial Number: | Certificate Number: |
| Date of Calibration: | Technician: |

* Minimum and maximum values are nominal values. Adjust to correspond with the TS200 multi-test fixture calibration values (CV).

Table 3-5: TelScout TS200 Test Record

| TS200 Performance Parameter | | Minimum | Incoming | Outgoing | Maximum |
|------------------------------|-------------|-----------------|----------|----------|-----------------|
| TDR Pulse Width | | | | | |
| 10 ns | Width | 9.6 ns | | | 14.4 ns |
| 340 ns | Width | 289 ns | | | 442 ns |
| 3400 ns | Width | 2550 ns | | | 3910 ns |
| TDR Distance Accuracy | | | | | |
| 1 μ s | | 0.9987 μ s | | | 1.0013 μ s |
| 18 μ s | | 17.9817 μ s | | | 18.0183 μ s |
| POTS DC Volts | | | | | |
| 5 VDC | Ring to Gnd | 4.45 V | | | 5.55 V |
| 30 VDC | Ring to Gnd | 29.2 V | | | 30.8 V |
| 50 VDC | Ring to Gnd | 49.0 V | | | 51.0 V |
| 280 VDC | Ring to Gnd | 276.7 V | | | 283.3 V |
| POTS AC Volts | | | | | |
| 5 VAC | Ring to Gnd | 4.45 V | | | 5.55 V |
| 30 VAC | Ring to Gnd | 29.2 V | | | 30.8 V |
| 50 VAC | Ring to Gnd | 49.0 V | | | 51.0 V |
| 280 VAC | Ring to Gnd | 276.7 V | | | 283.3 V |

Table 3–5: TelScout TS200 Test Record (cont.)

| TS200 Performance Parameter | Minimum | Incoming | Outgoing | Maximum |
|--|-------------|----------|----------|-------------|
| Loss and Slope | | | | |
| Calibrator @ 0.0 dBm (0.7746 Vrms) @ 1004 Hz | | | | |
| Loss | -0.5 dBm | | | 0.5 dBm |
| Frequency | 1002 Hz | | | 1006 Hz |
| Calibrator @ -20 dBm (77.46 mVrms) @ 1004 Hz | | | | |
| Loss | -20.5 dBm | | | -19.5 dBm |
| Calibrator @ -35 dBm (13.775 mVrms) @ 1004 Hz | | | | |
| Loss | -35.5 dBm | | | -34.5 dBm |
| Calibrator @ 0.0 dBm (0.5998 Vrms) @ 40 kHz | | | | |
| Loss | -2.0 dBm | | | 2.0 dBm |
| Frequency | 39998 Hz | | | 40002 Hz |
| Calibrator @ -20 dBm (59.99 mVrms) @ 40 kHz | | | | |
| Loss | -22.0 dBm | | | -18.0 dBm |
| Calibrator @ -35 dBm (10.67 mVrms) @ 40 kHz | | | | |
| Loss | -37.0 dBm | | | -33.0 dBm |
| Calibrator @ 0.0 dBm (1.6967 V Pk-Pk) @ 196 kHz | | | | |
| Loss | -4.0 dBm | | | 4.0 dBm |
| Frequency | 195.998 kHz | | | 196.002 kHz |
| Calibrator @ -20 dBm (0.16967 V Pk-Pk) @ 196 kHz | | | | |
| Loss | -24.0 dBm | | | -16.0 dBm |
| Calibrator @ -30 dBm (0.05365 V Pk-Pk) @ 196 kHz | | | | |
| Loss | -34.0 dBm | | | -26.0 dBm |
| Calibrator @ 0.0 dBm (0.7746 Vrms) @ 1004 Hz | | | | |
| Loss (600 Ω in series) | -6.5 dBm | | | -5.5 dBm |
| POTS Metallic Noise/Power Influence – Psophometric filter | | | | |
| Calibrator set to 7.746 mVAC | | | | |
| @ 800 Hz | 48.0 dBrnP | | | 52.0 dBrnP |
| Reset Calibrator reading to 50.0 dBrnP | | | | |
| @ 100 Hz | 5.0 dBrnP | | | 13.0 dBrnP |
| @ 200 Hz | 25.0 dBrnP | | | 33.0 dBrnP |
| @ 500 Hz | 43.4 dBrnP | | | 49.4 dBrnP |
| @ 1 kHz | 48.0 dBrnP | | | 54.0 dBrnP |
| @ 2 kHz | 44.0 dBrnP | | | 50.0 dBrnP |

Table 3-5: TelScout TS200 Test Record (cont.)

| TS200 Performance Parameter | Minimum | Incoming | Outgoing | Maximum |
|-----------------------------|------------|----------|----------|------------|
| @ 3 kHz | 41.4 dBrnP | | | 47.4 dBrnP |
| @ 4 kHz | 30.0 dBrnP | | | 40.0 dBrnP |
| @ 5 kHz | 9.0 dBrnP | | | 19.0 dBrnP |

POTS Metallic Noise/Power Influence – C-Message filter

Calibrator set to 7.746 mVAC

| | | | | |
|-----------|----------|--|--|----------|
| @ 1000 Hz | 48 dBrnC | | | 52 dBrnC |
|-----------|----------|--|--|----------|

Reset Calibrator reading to 50.0 dBrnC

| | | | | |
|----------|------------|--|--|------------|
| @ 100 Hz | 3.5 dBrnC | | | 11.5 dBrnC |
| @ 200 Hz | 20.9 dBrnC | | | 28.9 dBrnC |
| @ 500 Hz | 39.3 dBrnC | | | 45.3 dBrnC |
| @ 800 Hz | 45.7 dBrnC | | | 51.7 dBrnC |
| @ 2 kHz | 45.9 dBrnC | | | 51.9 dBrnC |
| @ 3 kHz | 44.0 dBrnC | | | 50.0 dBrnC |
| @ 4 kHz | 30.4 dBrnC | | | 40.4 dBrnC |
| @ 5 kHz | 16.3 dBrnC | | | 26.3 dBrnC |

NOISE (with 60 dB attenuator @ 1000 Hz)

| | | | | |
|--------------|------------|--|--|------------|
| 7.746 Vrms | 48.0 dBrnC | | | 52.0 dBrnC |
| 2.449 Vrms | 38.0 dBrnC | | | 42.0 dBrnC |
| 0.7746 Vrms | 28.0 dBrnC | | | 32.0 dBrnC |
| 0.2449 Vrms | 18.0 dBrnC | | | 22.0 dBrnC |
| 0.07746 Vrms | 8.0 dBrnC | | | 12.0 dBrnC |

Power Influence

| | | | | |
|---------------------|------------|--|--|-------------|
| 194.6 Vrms @ 60 Hz | 98.0 dBrnC | | | 102.0 dBrnC |
| 19.46 Vrms @ 60 Hz | 78.0 dBrnC | | | 82.0 dBrnC |
| 1.946 Vrms @ 60 Hz | 58.0 dBrnC | | | 62.0 dBrnC |
| 0.1946 Vrms @ 60 Hz | 38.0 dBrnC | | | 42.0 dBrnC |

POTS Tone Generator @ 600 Ω

| | | | | |
|---------------------|-----------|-----------|--|-----------|
| 1004 Hz @ 0.0 dBm | Level | -0.5 dBm | | 0.5 dBm |
| | Frequency | 1002 Hz | | 1006 Hz |
| 1004 Hz @ -20.0 dBm | Level | -20.5 dBm | | -19.5 dBm |

Table 3-5: TelScout TS200 Test Record (cont.)

| TS200 Performance Parameter | Minimum | Incoming | Outgoing | Maximum |
|-----------------------------|------------|----------|----------|------------|
| 1004 Hz @ -10.0 dBm Level | -10.5 dBm | | | -9.5 dBm |
| 1004 Hz @ +10.0 dBm Level | 9.5 dBm | | | 10.5 dBm |
| 20 kHz @ 0.0 dBm Frequency | 19.998 kHz | | | 20.002 kHz |

POTS VOM Ω *

| | | | | | |
|----------------|-------------|---------------------|--|--|---------------------|
| 10 Ω | Tip to Ring | CV-1.2 Ω | | | CV+1.2 Ω |
| | Tip to Gnd | CV-1.2 Ω | | | CV+1.2 Ω |
| | Ring to Gnd | CV-1.2 Ω | | | CV+1.2 Ω |
| 100 Ω | Ring to Gnd | CV-2.0 Ω | | | CV+2.0 Ω |
| 1 k Ω | Ring to Gnd | CV-0.011 k Ω | | | CV+0.016 k Ω |
| 10 k Ω | Ring to Gnd | CV-0.1 k Ω | | | CV+0.1 k Ω |
| 100 k Ω | Ring to Gnd | CV-0.91 k Ω | | | CV+1.1 k Ω |
| 909 k Ω | Ring to Gnd | CV-9.2 k Ω | | | CV+9.2 k Ω |
| 10 M Ω | Ring to Gnd | CV-0.7 M Ω | | | CV+0.7 M Ω |
| 100 M Ω | Ring to Gnd | CV-6.1 M Ω | | | CV+6.1 M Ω |

POTS Resistance Fault Locator *

| | | | | | |
|-----|--|-----------------|--|--|-----------------|
| DTF | | CV-9.1 Ω | | | CV+9.1 Ω |
|-----|--|-----------------|--|--|-----------------|

POTS Loop Current

| | | | | | |
|-------|--|----------|--|--|----------|
| 22 mA | | 21.78 mA | | | 22.22 mA |
| 62 mA | | 61.38 mA | | | 62.62 mA |

POTS Longitudinal Balance *

| | | | | | |
|-----------------------|--|-----------|--|--|-----------|
| Reading #1 | | CV-2.0 dB | | | CV+2.0 dB |
| Reading #2 (reversed) | | CV-2.0 dB | | | CV+2.0 dB |

Capacitance *

| | | | | | |
|---------|-------------|------------|--|--|------------|
| 0.33 nF | Tip to Ring | CV-0.06 nF | | | CV+0.06 nF |
| | Tip to Gnd | CV-0.06 nF | | | CV+0.06 nF |
| | Ring to Gnd | CV-0.06 nF | | | CV+0.06 nF |
| 1.2 nF | Tip to Ring | CV-0.07 nF | | | CV+0.07 nF |
| 9.09 nF | Tip to Ring | CV-0.15 nF | | | CV+0.15 nF |

Table 3–5: TelScout TS200 Test Record (cont.)

| TS200 Performance Parameter | Minimum | Incoming | Outgoing | Maximum |
|------------------------------|-----------------|----------|----------|-----------------|
| 0.1 μ F Tip to Ring | CV–0.01 μ F | | | CV+0.01 μ F |
| 3.3 μ F Tip to Ring | CV–0.04 μ F | | | CV+0.04 μ F |

POTS Pulse Dialer

| | | | | |
|---------------------|--------|--|--|--------|
| Time between pulses | 100 ms | | | 125 ms |
| Break time | 53 ms | | | 80 ms |
| European settings | 60 ms | | | 70 ms |
| Inter-digit pause | 680 ms | | | 2 sec |

POTS Load Coil Counter

| | | | | |
|-------|---------|--|--|--|
| 66 mH | 7 loads | | | |
| 88 mH | 6 loads | | | |

Maintenance

This chapter contains information you need to do periodic and corrective maintenance on the TelScout TS200. These maintenance instructions are for qualified service personnel only. Prior to performing any maintenance on this instrument, read the *General Safety Summary* and the *Preface* at the beginning of this manual. If you have not used the TS200 before, refer to the *TelScout TS200 User Manual*.



CAUTION. *These servicing instructions are for use by qualified personnel only. To avoid electric shock, do not perform any servicing other than that contained in this manual unless you are qualified to do so.*



CAUTION. *Static discharge can damage any semiconductor component in this instrument.*

When performing any service that requires internal access to the instrument, take the following precautions to avoid damaging internal modules and their components with electrostatic discharge (ESD):

- Minimize handling of static-sensitive modules.
- Transport and store static-sensitive modules in static-protected containers. Label any package that contains static-sensitive modules.
- Discharge the static voltage from your body by wearing a grounded wrist strap while handling these modules. Service the modules only at a static-free workstation.
- Do not allow anything capable of generating or holding a static charge on the workstation surface.
- Handle the circuit board by the edges whenever possible. Avoid touching the board surface and components to prevent contamination.
- Do not slide the modules over any surface.
- Avoid handling the modules in areas that have carpeted floors or work surfaces capable of generating static charges.

Inspection and Cleaning

The TelScout TS200's enclosure minimizes dust accumulation inside the instrument. Never operate the MTDR without the covers properly installed. When storing or transporting the instrument, it is a good idea to keep it in the soft carry case to protect it from dust and accidental damage.

Inspect and clean your TelScout TS200 as often as operating conditions require. If used indoors, this might be once every 1000 hours of use. If used outdoors, this might be after each use, depending on field conditions, but the instrument should be inspected and cleaned after no more than 500 hours of use. Dirt acts as a thermal insulator, which could cause overheating and component breakdown. It also provides an electrical conduction path that could cause instrument failure, especially under high-humidity conditions.

Exterior Inspection

- Inspect the exterior of the TS200 for wear, missing parts, or cracks in the enclosure. Replace any defective parts.
- Inspect all connectors for cracked insulation, broken shells, deformed contacts, or dirt in the connectors. Clean or replace as necessary.
- Inspect test cables for bent or broken plugs/clips or frayed/cut insulation. Replace as necessary.

Exterior Cleaning



CAUTION. To avoid the possibility of getting water in the instrument, use only enough liquid to dampen the cloth. Do not use abrasive cleaners or harsh chemicals (e.g., alcohol, acetone) as damage to the enclosure might result.

- Remove dust from the outside of the instrument by wiping with a lint-free cloth or small brush. Use the brush to remove dust from the connectors.
- Clean the remaining dirt with a lint-free cloth, dampened in a general-purpose mild-detergent-and-water solution.

Interior Inspection

To gain access to the inside of the TS200 for inspection and cleaning, refer to the *Removal and Reinstallation Procedures* given later in this chapter.

- Inspect the circuit board for loose, broken, or corroded solder connections and burned, broken, or cracked circuit plating. Replace the circuit board if these conditions exist.

- Inspect resistors for burns, cracks, blisters, or breaks. Replace the circuit board if these conditions exist.
- Inspect capacitors for damaged or leaking cases, or corroded solder on leads. Replace the circuit board if these conditions exist.
- Inspect all solder joints for cold or rosin joints. Replace the circuit board if these conditions exist.
- Inspect all semiconductor devices for loose socket connections or bent/damaged leads. If the device is socketed, attempt to reseat the device properly. If device is soldered on the board, replace the circuit board.
- Inspect wiring and cables for loose plugs or connectors and burned, broken, or frayed wiring. Reseat connector or replace wiring as necessary.
- Inspect interior of enclosure for deformation, cracking, or damaged hardware. Replace as necessary.

Interior Cleaning

- Blow any dust found in the interior of the instrument out using dry, low pressure (approximately x. 9psi), de-ionized air.
- Remove any remaining dust using a lint-free cloth dampened in de-ionized water. Lint-free swabs are useful for cleaning narrow spaces and on the circuit board.

Software Downloading

To download software to the TS200, an IBM compatible computer running Windows 95 or Windows 98 needs to be used. The process takes approximately 20 minutes. In the event of a failure that cannot be resolved, call 1-800-833-9200 for assistance.

The TS200 must be connected to a PC using a PC/AT serial (Com1) port with Tektronix part numbered optional accessory (9-pin D-connector) (Tektronix part number 012-1380-00) or equivalent serial null-modem cable conforming to the following pinout chart:

Table 4-1: Serial Cable Pinout Chart

| Female 9-PIN | Female 9-PIN |
|--------------|--------------|
| 2 | 3 |
| 3 | 2 |
| 4 | 6 |
| 5 | 5 |

Table 4–1: Serial Cable Pinout Chart (cont.)

| Female 9-PIN | Female 9-PIN |
|--------------|--------------|
| 6 | 4 |
| 7 | 1, 8 |
| 8 | 7 |
| 9 | --- |

After connecting the TS200 to your PC, follow the steps described below:

1. While pressing the (◆) button, press the power button to power on the instrument.
2. Insert the release disk into the PC's floppy disk drive.
3. Open a DOS window and from the DOS prompt type "A:INSTALL."
4. After the installation is complete, enter LDTS200 TS101L?.SYS, where "?" refers to the language option.

The LDTS200 program uses COM1 by default. If the TS200 is attached to a port other than COM1, type "LDTS200" and press enter. The program will prompt you for the COM port and the filename.

Functional Testing

Follow the *Performance Verification* in Chapter 3 to test the TS200 for functionality. If the TS200 does not meet all performance specifications, it must be returned to Tektronix for repair and/or calibration.

Removal / Installation Procedures

The TDR circuit board memory contains all calibration constants and instrument configuration information. If either circuit board is replaced, a complete calibration must be performed. Additionally, if the TDR board is replaced, the instrument configuration must be reset.

External software is required for both calibration and configuration. The TS200 must be returned to your Tektronix Service Center for both calibration and configuration.

Required Equipment

- Static-free workstation
- Small pair of sidecuts (dikes)
- Phillips screwdriver, medium point or Pozidrive screwdriver, PZI
- Torx T10 screwdriver
- Torx T15 screwdriver
- Nut drivers, 1/4 inch and 3/16 inch
- Needle-nose plier
- End wrench, 5/16



CAUTION. To prevent possible damage to the front panel or display, be sure the work surface is clear of debris (e.g., screws, wire clippings, etc.) prior to laying the top case-half face down. One way to do this would be to place a clean soft cloth on the flat work surface.

NOTE. Maintenance illustrations demonstrating cable attachment/placements are often represented by simple line drawings shaded in gray. Refer to the cable section of the replaceable parts chapter for a full description and technical drawing of each cable.

Disassembly Procedures

1. Place the TS200 on a static-free work station. To remove the battery pack, use a flat screwdriver to back out four 6–32 x 0.50 captive screws. Disconnect the battery connector from the DC power jack cable. Slide the battery pack out. The Tektronix product label for the TS200 may be removed by lifting from any corner and peeling back carefully.

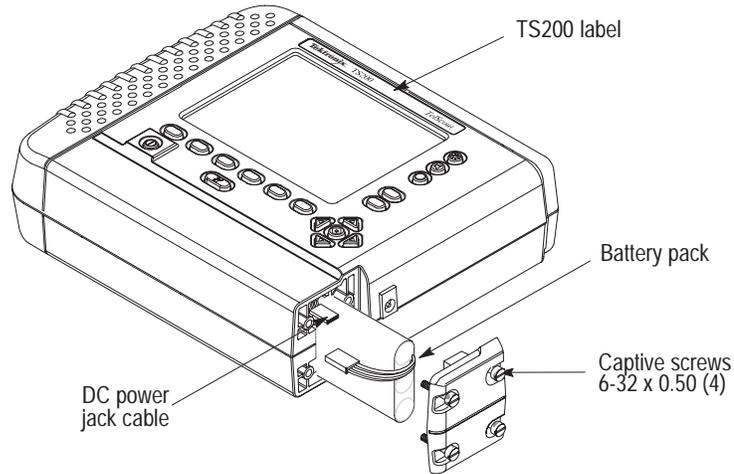


Figure 4-1: Battery Removal

2. Turn the TS200 display-side down. Use a Pozidrive screwdriver to remove eight 6-32 x 1.75 screws attaching the case halves. Set the bottom case-half aside. Gently lift the eight inch long o-ring gasket from the edge of the top case-half.

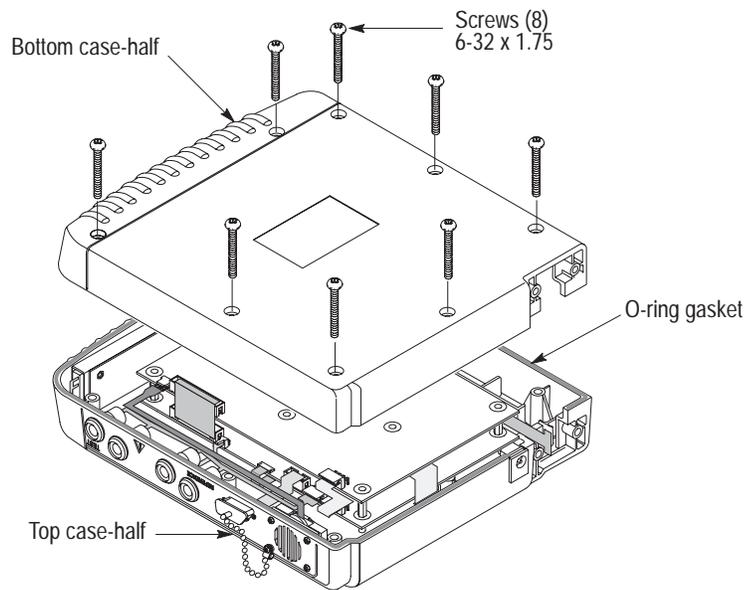


Figure 4-2: Opening the TS200 Instrument

3. Disconnect the speaker cable assembly, ribbon data cable, and tip and ring cable assemblies attached to circuit board A1.

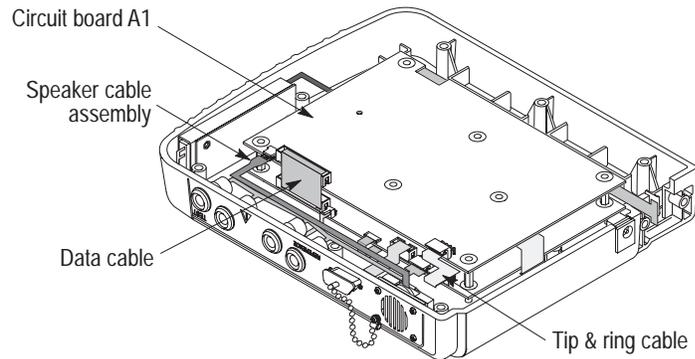


Figure 4-3: Disconnecting Circuit Board Assembly A1 Cable Attachments

4. Use a Pozidrive screwdriver to remove six 4-40 x 0.312 screw assemblies from the hex spacer posts between circuit boards A1 and A2. Lift circuit board A1 and place on a static-free mat.

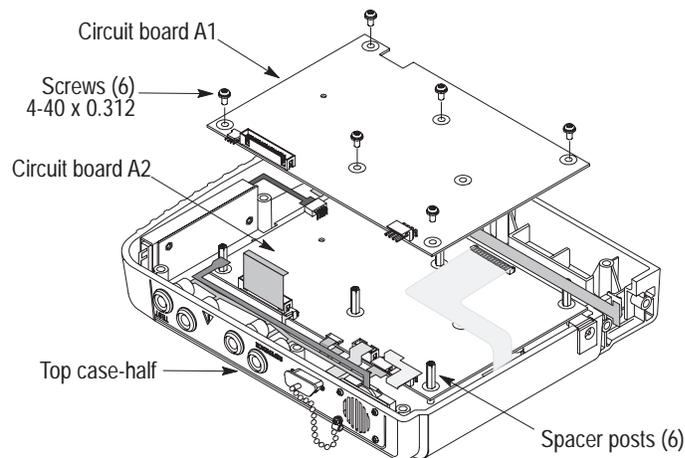


Figure 4-4: Removing Circuit Board Assembly A1

5. Disconnect the LCD inverter cable, the DC power/battery cable assembly, and the flex circuit cable from circuit board A2. Position the unconnected ends of all cables clear of the A2 board. Disconnect and remove the data cable and the tip & ring cable.

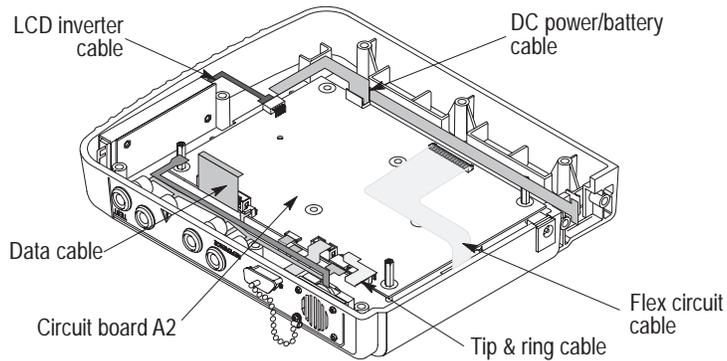


Figure 4-5: Disconnecting Circuit Board Assembly A2 Cables

6. Before removing circuit board A2, disconnect the remaining four cables including the serial interface ribbon cable, the LCD temperature sensor cable, the FPC cable, and the twisted pair cable.

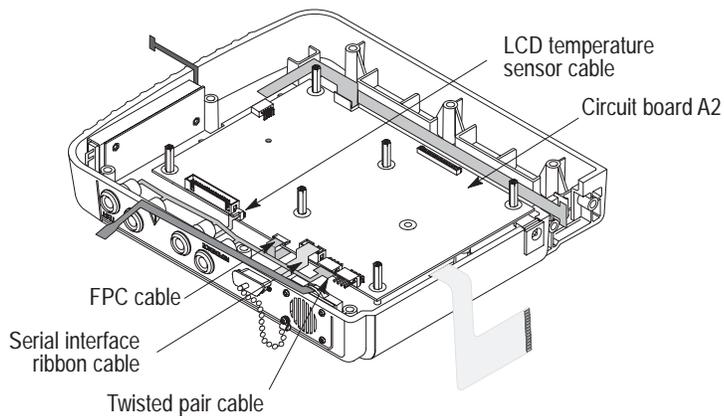


Figure 4-6: Preparing to Remove Circuit Board Assembly A2

7. Use a 1/4 inch hex socket driver to remove five 4-40 x 0.751 hex spacer posts. Use a 3/16 hex socket driver to remove one smaller hex spacer post. Lift circuit board A2 and place on a static-free work station.

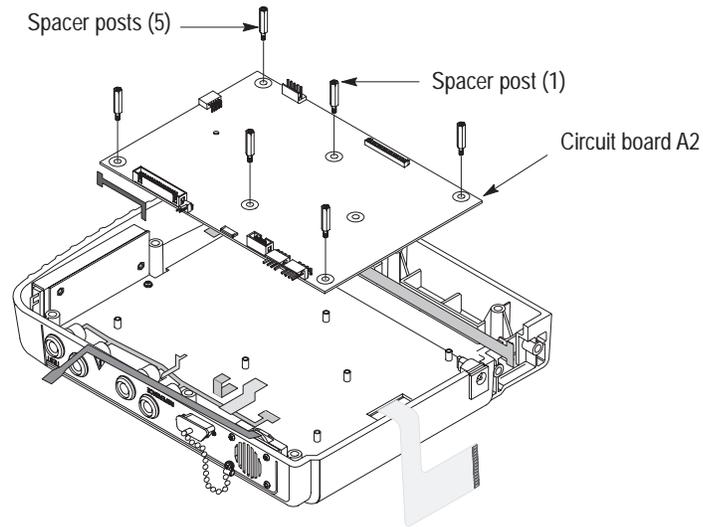


Figure 4-7: Removing Circuit Board Assembly A2

8. Remove the DC power jack cable assembly. Carefully slide the external power input connector up and out of the top case-half. Next, release the DC power jack cable from three nylon cable clamps. Use a Pozidrive screwdriver to remove three 4-40 x 0.312 screws which secure the clamps to the support plate.

NOTE. The DC power jack cable assembly includes an o-ring on the connector. Be careful and not misplace during disassembly.

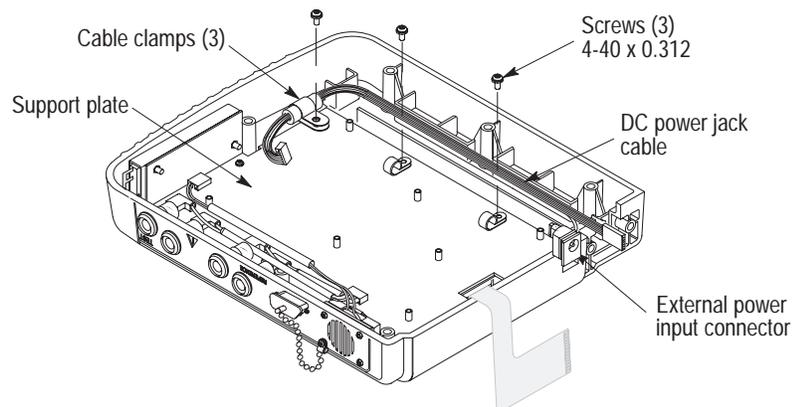


Figure 4-8: Removing More Cable Assemblies

9. The speaker cable assembly is attached to the top case-half by four 6–32 screws and four 6–32 x 0.312 nut assemblies. One of the 6–32 screws attaches the dust cap assembly. Use a 5/16 end wrench and a Torx T15 screwdriver to remove this hardware. The speaker, grill gaskets, and the dust cap are now free. The speaker portion with the cable assembly is ready for removal.

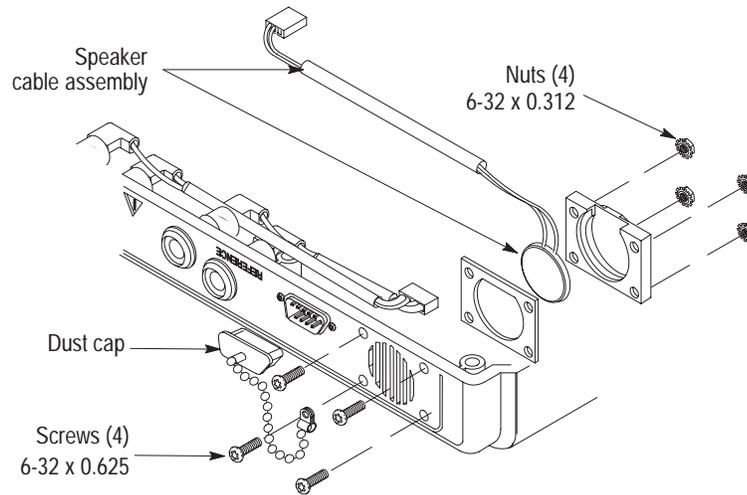


Figure 4-9: Removing the Speaker Cable Assembly

10. Use a needle-nose plier to grasp each quick disconnect terminal on the twisted pair cable assembly and remove from the four safety jack lugs. Remove the twisted pair cable assembly.
11. Use a Pozidrive screwdriver to remove one 4–40 x 0.312 screw assembly.
12. The inverter board jumper cable is attached to the LCD display assembly under the support plate. Disconnect this cable. The FPC cable is secured to the support plate with adhesive tape. Gently lift from support plate and slip out through the ferrite bead which is secured to the support plate.

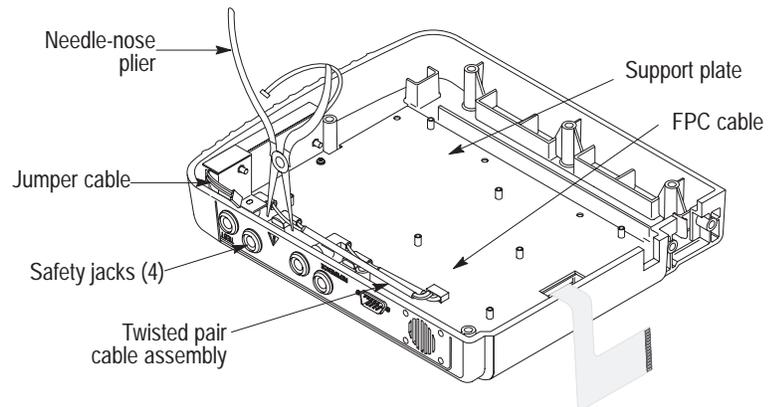


Figure 4-10: Preparing to Remove the Support Plate Assembly

- 13.** Use a Pozidrive screwdriver to remove the remaining four 4-40 x 0.312 screw assemblies which attach the support plate to the top case-half. Lift the support plate and set on a static-free mat. The inverter circuit board A4 is part of this assembly.

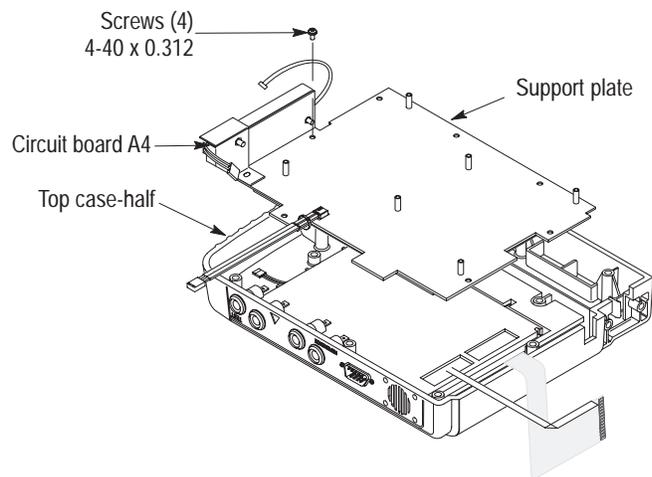


Figure 4-11: Removing the Support Plate Assembly

- 14.** The support plate with the DC-AC converter board A3 is ready for disassembly. Remove the LCD temperature sensor cable from the support plate by clipping the zip tie with a small pair of sidecuts.
- 15.** Use a Pozidrive screwdriver to remove the two 4-40 x 0.312 screw assemblies which attach the circuit board A3 and insulate to the support plate. Remove two 4-40 nut assemblies to free the brass inverter shield attached to the support plate.

16. Disconnect both the LCD cable and the jumper cable from the inverter board.

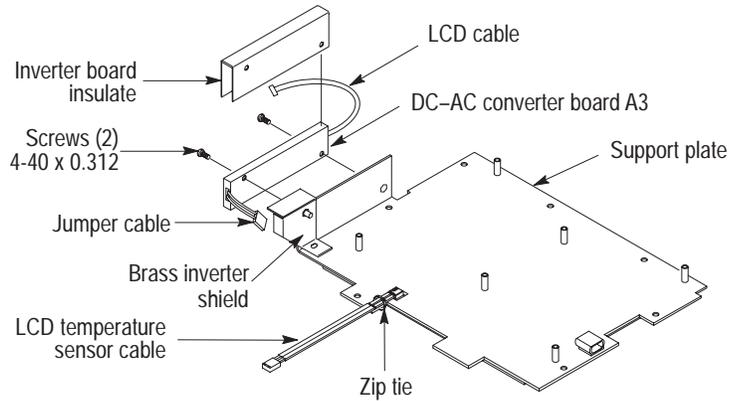


Figure 4-12: Disassemble the Support Plate; Remove DC-AC Converter Board A3

17. Removing the LCD display module is simple; it has no attaching hardware. It is indexed by the LCD plate below and the support plate on top. Be careful to lift around the safety jack terminals. Disconnect the FPC cable from the LCD display module A4 assembly.

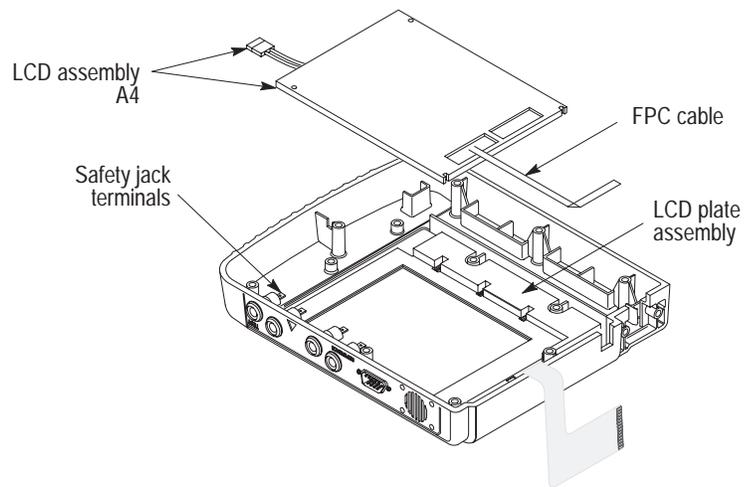


Figure 4-13: Removing the LCD Display Module A4 Assembly

18. Lift the LCD plate assembly off the top case-half index tabs. Gently lift the flex circuit off the same index tabs.

NOTE. Be careful to avoid contact with exposed traces on the bottom side of the flex circuit.

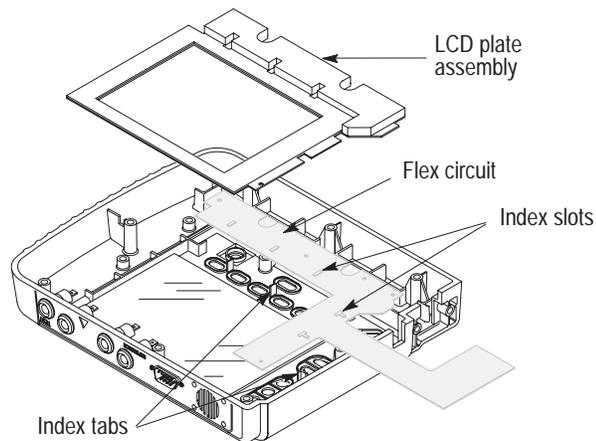


Figure 4–14: Removing the LCD Plate Assembly and Flex Circuit

19. Remove the elastomeric keypad by simply lifting it off the top case-half index tabs.

NOTE. Avoid contact with the conductive pads on the elastomeric keypad.

20. Remove the serial interface ribbon cable assembly from the top case-half. Use a Torx T10 screwdriver to remove two 4–40 x 0.375 screws.

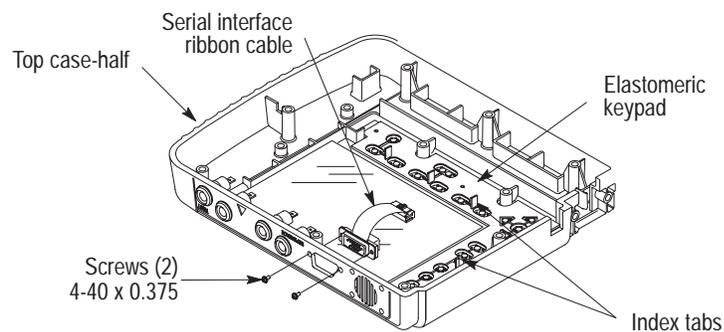


Figure 4–15: Disassembling the Top Case-half

21. If it becomes necessary to replace the TS200 top case-half, the display window must be replaced also. Install by simply removing the adhesive covering from the display window and gently pressing down into the top case-half. Snug the window into the corner indicated below.

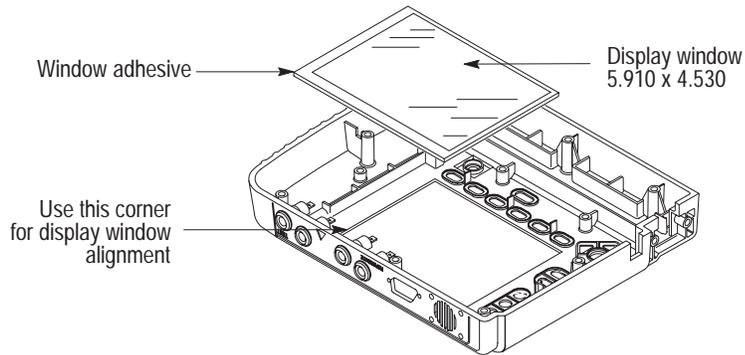


Figure 4-16: Installing the Display Window

22. Disassembly of the TS200 is now complete.

Reassembly To reassemble the TS200, reverse the disassembly procedures.

Longitudinal Balance Adjustment

1. Press the TS200 **Long. Balance** softkey.
2. Connect the test port tip and ring to the longitudinal balance “Adjustment” terminals on the Longitudinal Balance section of the TS200 Multi-Test Fixture.
3. Set the longitudinal balance switches on the multi-test fixture to the OFF position.
4. Access the POTS board through the shield access hole. Adjust R1066 for maximum reading. The reading should be 80 dB or greater (see Figure 4-17).

NOTE. By reversing the tip and ring connectors, you can verify that the TS200 is not being miscalculated and there is not an unbalance in the test fixture.

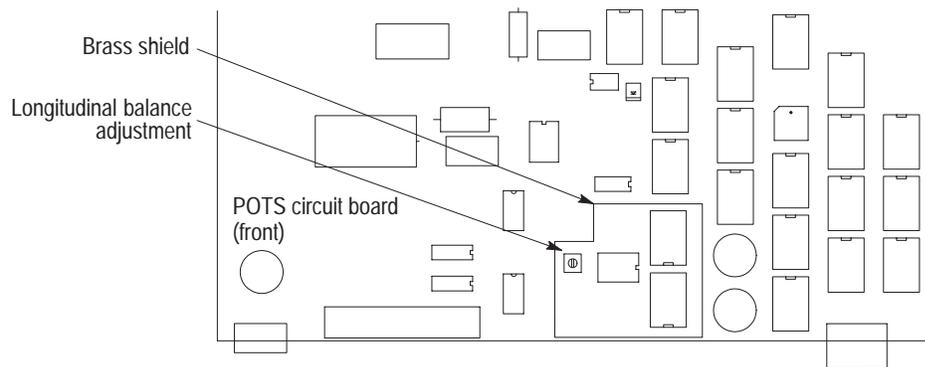


Figure 4-17: POTS Longitudinal Balance Adjustment

5. Connect the test port tip and ring to the longitudinal balance “Test” terminals on the Longitudinal Balance section of the multi-test fixture.
 - Verify the reading is approximately 62 dB.
6. Reverse the tip and ring connections at the multi-test fixture.
 - Verify the reading is approximately 62 dB.

Troubleshooting

Required Equipment

- Static-free workstation
- Digital multimeter

Setup for Troubleshooting

- Perform preliminary disassembly.
- Leave all electrical connections intact.
- Connect AC adapter/charger and plug into known good AC source.

Troubleshooting

1. **TS200 WILL NOT POWER ON, or WILL NOT STAY POWERED ON, or BATTERY LIFE IS TOO SHORT, or BATTERY WILL NOT CHARGE.**

- Step 1. Measure the voltage at the External DC adapter connection. The voltage should be 18 to 25 VDC under all normal charging or operating conditions.
- ◆ If the External DC adapter voltage is above 25 V, replace the external adapter.

- ◆ If the External DC adapter voltage is below 18 V, check for excess current consumption by the TS200.
- ◆ If current consumption is not excessive, replace the external adapter.
- a) Verify the TS200 does not require excessive current. Connect the External DC power adapter and disconnect the battery. Typical current requirements with 24 V power from the external adapter are:

| | |
|---|--------|
| Instrument off, battery disconnected | 10 mA |
| Instrument off, battery charging | 600 mA |
| TDR only, main screen, backlight off | 250 mA |
| TDR only, main screen, backlight normal | 300 mA |
| TDR only, main screen, bright backlight | 360 mA |
| Combo unit, main screen, backlight normal | 350 mA |
| Combo unit, DCV screen, backlight normal | 430 mA |

- ◆ If the current requirement is excessive on a combo unit, unplug POTS connector J1001 to see if the POTS board is causing the excessive current consumption.

NOTE. *The battery will not charge or will stop charging if the battery voltage is too high (above approximately 16.2V) or too low (below approximately 9 V).*

If the battery temperature is too high, the charging circuit will hold off charging until the battery temperature drops below approximately 40° C. Charging will terminate if the battery temperature rises above approximately 50° C, if the battery temperature increases rapidly, or if the battery voltage decreases.

The fully discharged battery will take approximately four hours to charge. A battery is considered discharged if the TS200 shuts off automatically due to low battery voltage.

Charging systems for NiMH batteries are more complex than for lead acid or NiCad batteries. If a spare battery and spare external adapter are available, it is useful to verify the problems below with the substitute parts.

Battery capacity drops as ambient temperature increases or decreases from room temperature. This is a normal battery characteristic for both charging and discharging. As an example, if the battery is charged at 40° C, it could have 25% lower charge capacity. For best results, charge the battery at room temperature with the instrument power off.

Battery self-discharge is assumed to be about 2% per day. It may be higher immediately following a charge.

- b) When the instrument is off, current from the external adapter should be approximately 600 mA when the battery voltage is approximately 12 V. The current will be lower when battery voltage is low and higher when battery voltage is high. Charging should start within five seconds after an external adapter is connected to the TS200 if voltages and temperatures are correct.
 - ◆ If the charge current is too high, replace the TDR board.
- c) When the charge current is too low, check the battery voltage while charging (pins 1 and 6 of the 6-pin battery connector).
 - ◆ If the battery voltage is below 9.1 V for more than a few minutes while charging, replace the battery.
 - ◆ If the battery voltage is between 9.1 V and 15 V and charge current is low, replace the TDR board.
 - ◆ If battery voltage is above 15 V at room temperature, the battery may have a full charge, or it may be defective.
 - ◆ If the voltages and currents are normal, but the battery life is short, the battery should be replaced.

2. BATTERY CAPACITY GAUGE IS INACCURATE.

NOTE. *The battery capacity gauge automatically recalibrates when the battery goes through a complete charge/discharge/charge cycle. With normal operation, the battery is often charged without having a full discharge. Over time, the battery capacity gauge will become less accurate until another complete charge/discharge/charge cycle occurs.*

The fuel gauge for the battery is mounted inside the battery pack. The fuel gauge is designed to work correctly when the battery is removed and reinstalled. The current sense for charge and discharge is mounted in the TS200. Best fuel-gauge accuracy is obtained if the battery is both charged and used in the same instrument.

- Step 1. Recalibrate the battery fuel gauge using the following steps.
- a) Allow the battery to charge with the instrument off for at least four hours.
 - b) Disconnect the charger and turn the instrument power on.
 - c) Set the auto shut-off time (in the setup menu) of the instrument to off.
 - d) Operate the instrument until it automatically shuts off; the battery is properly discharged. This may take four or more hours.
 - e) Reconnect the charger and allow the battery to charge with the instrument off for at least four hours.
 - f) Verify the fuel gauge in the upper right corner of the display shows a full battery.

- ◆ If the fuel gauge display does not show a full battery, repeat steps d through f.
- ◆ If the fuel gauge does not work properly, replace the battery.

3. DISPLAY – NO DISPLAY or ROWS OF DOTS ARE MISSING.

- Step 1. Turn the instrument power on and listen for normal power-on tones (short beep, relays click, then two beeps).

NOTE. *The display cable connector is a locking connector; unlock the connector before removing the cable. Be careful to keep proper alignment of the cable while inserting the cable and locking the connector. Do not allow fingerprints on the contact area of the cable.*

- ◆ If normal beeps are heard but the display is blank or missing rows of dots, continue with this step; otherwise, go to the section which describes power-on tones.
- ◆ If the display is blank, check for normal voltage on pin 7 of J1006. This voltage is typically 20 V at room temperature but may be between 15 V (lowest contrast setting) to 25 V (highest contrast setting).
- ◆ If this voltage is low after powering on the instrument and hearing the power-on beeps, press and hold the front-panel up arrow.
- ◆ If the voltage does not increase to 20 V, unplug the display cable and try again.
- ◆ If the voltage is normal without the display connected but too low with the display connected, replace the display.
- ◆ If the voltage is too low or too high with the display disconnected, replace the TDR board.
- ◆ If the display has rows of dots missing, this may be an indication of a bad connection between the display cable and the TDR board. Inspect the connector for signs of damage. Check to see if the display cable enters the connector at right angles.
- ◆ If this does not correct the problem, perform a continuity check on the connection at each end of the cable. If the voltages and continuity are correct, replace the display.

4. DISPLAYED TDR WAVEFORM IS INCORRECT or FLAT.

- Step 1. Check test lead connections for continuity. These should read less than 1 Ω per lead.
- ◆ If test lead is not acceptable, replace the test lead.
- Step 2. Check wire connections from the TDR board to the test lead connectors. These should read less than 0.1 Ω per lead.
- ◆ If wire/cable is not acceptable, replace the wire/cable.
 - ◆ If wire/cable is acceptable, replace the TDR board.

5. TDR TEST IS GOOD ON ONE PORT, BUT NOT ON THE OTHER.

- Step 1. Check connections on the test leads for continuity. These should read less than 1 Ω per lead.
- ◆ If the test lead is not acceptable, replace the test lead.
 - ◆ If the test lead is acceptable, replace the TDR board.

6. SERIAL PRINTER PORT IS NOT WORKING (all other functions are fine).

- Step 1. Check the cable connections from the TDR board connector to the serial port connector. These should read less than 0.2 Ω per lead.
- ◆ If the wire/cable is not acceptable, replace the wire/cable.
 - ◆ If the wire/cable is acceptable, replace the TDR board.

7. SPECIFIC KEYS DO NOT WORK or WORK ONLY INTERMITTENTLY.

- Step 1. Disconnect the keyboard cable from the circuit board and test the keyboard-switch continuity at the cable end. Verify that the offending switch contact resistance is greater than 500 k Ω when not pressed and less than 1500 Ω when pressed.
- ◆ If the switch resistance is not acceptable, replace the front-panel keyboard assembly.
 - ◆ If the switch resistance is acceptable, replace the TDR board.
 - ◆ Check button to pin numbers:

| | |
|--------------------------------------|--------|
| Backlight | 12, 13 |
| Speaker | 12, 11 |
| Help | 10, 11 |
| TestWizard | 2, 3 |
| Up arrow | 4, 5 |
| Right arrow | 3, 4 |
| Diamond button | 5, 6 |
| Down arrow | 3, 5 |
| Left arrow | 5, 7 |
| Power on/off | 1, 14 |
| Bottom row soft keys (left to right) | |
| F1 | 2, 13 |
| F2 | 2, 11 |
| F3 | 2, 10 |
| F4 | 2, 8 |
| F5 | 3, 7 |
| F6 | 7, 8 |
| Right side soft keys (bottom to top) | |
| F7 | 6, 7 |
| F8 | 9, 10 |

8. TS200 HAS LOCKED UP AND WILL NOT RESPOND TO ANY KEY PRESSES.

- Step 1. Remove the external power and disconnect the battery. Reconnect the battery to see if the instrument recovers. Check the external power adapter and battery voltages, the display (see Section 3), and the keyboard (check on/off button).
- Step 2. Check the external power adapter, battery voltages, display, and keyboard.
- ◆ If these checks do not uncover the problem, replace the TDR board.

9. BEEPER DOES NOT WORK or BEEPER ON ALL THE TIME (all other functions are fine).

- Step 1. Check the power supply.
- ◆ If the external power adapter is good, replace the TDR board.

10. TDR DISTANCE READINGS ARE NOT ACCURATE.

- Step 1. Verify distance accuracy using a standard 100-foot cable with a known V_p , or compare readings to a known good TS100 or Tektronix 1503B/C MTDR.
- ◆ If measurement agrees within the $\pm 1\%$, the TS200 is good.
 - ◆ If measurement error appears $>1\%$, replace the TDR board.

11. PHONE LINE STOPS WORKING WHEN THE TDR BOARD IS CONNECTED TO AN ACTIVE TELEPHONE LINE.

- Step 1. Check TS200 TEST and REFERENCE ports for capacitive open between red and black (tip and ring) leads (there should be $>10\text{ M}\Omega$ DC, and you should see capacitive charging effect using DMM). Be sure the TS200 is set for testing on each port on which you are checking continuity.
- ◆ If TEST and REFERENCE port continuity is not acceptable, replace the TDR board.

12. SELF CALIBRATION FAILS.

NOTE. Verify that self calibration is done with the backlight off, using battery power. Nothing should be connected to the serial port. The test leads must have good mechanical contact when clipped together. Disconnected leads should be placed on a non-conductive surface and not be in contact with each other.

- Step 1. Check the resistance of each test lead. These should read less than $0.5\ \Omega$ per lead.
- ◆ If test lead is not acceptable, replace the test lead.
- Step 2. Check the wire connections from TDR board J1008 to the test lead connectors. These should read less than $0.1\ \Omega$ per lead.
- ◆ If wire/cable is not acceptable, replace the wire/cable.

- Step 3. Check signal routing through the TDR board to the POTS board.
- Disconnect signal cable from POTS board J1002.
 - Turn on the instrument and select VOM–DCV.
 - Measure the resistance from each test clip to the matching conductor on the cable end which plugs into J1002. The total resistance should be less than 1.5 Ω per lead from test lead clip to the cable end which plugs into J1002.
 - ◆ If the total resistance is not acceptable, replace J1002 connector.
 - ◆ If total resistance is not acceptable, replace the TDR board.
- Step 4. Check leakage on signal lines leading to the POTS board.
- Turn on instrument and select VOM–Ohms.
 - Measure the leakage resistance between each pair of test leads (red to black, red to green, black to green). All three readings should display $>200 \text{ M}\Omega$.
 - ◆ If any reading is less than 200 $\text{M}\Omega$, isolate the problem by first disconnecting the test leads, then the connection to TDR J1008, and then the connection to POTS J1002.
 - ◆ If total resistance is not acceptable, replace the offending lead, cable, or circuit board.

13. POTS FUNCTION FAILURE.



CAUTION. *There is a –130 VDC supply near J1001. Probe the voltages below with caution! Avoid selecting Ohms or RFL when the circuit boards are exposed because a current limited version of the –130 V supply is routed to the test leads during Ohms and RFL measurements.*

NOTE. *The power supplies for the POTS and TDR functions are on the TDR board. A switch is used to route the input leads to either board from J1009. Most of the POTS board power supplies are switched off unless a POTS function is selected.*

- Step 1. Test lead resistance.
- Step 2. Test lead leakage resistance.
- Step 3. Check signal routing from test leads through the TDR board to the POTS board.

Step 4. Select VOM–DCV and check the power supply voltages on POTS board above J1001 including:

- + 5 V (25 mA typical causes 10 mV drop across supply inductor)
- 5 V (20 mA typical causes 80 mV drop across supply inductor)
- + 10 V (6 mA typical causes 24 mV drop across supply inductor)
- + 15 V (80 mA typical causes 320 mV drop across supply inductor)
- 15 V (70 mA typical causes 280 mV drop across supply inductor)

- ◆ If supply voltages are not acceptable but current requirements are, replace the TDR board.
- ◆ If current requirements are unacceptable, replace the POTS board.

Replaceable Parts

This section contains a list of the replaceable modules for the TS200. Use this list to identify and order replacement parts.

Parts Ordering Information

Replacement parts are available through your local Tektronix field office or representative.

Changes to Tektronix instruments are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest circuit improvements. Therefore, when ordering parts, it is important to include the following information in your order.

- Part number
- Instrument type or model number
- Instrument serial number
- Instrument modification number, if applicable

If you order a part that has been replaced with a different or improved part, your local Tektronix field office or representative will contact you concerning any change in part number.

Change information, if any, is located at the rear of this manual.

Module Servicing

Modules can be serviced by selecting one of the following three options. Contact your local Tektronix service center or representative for repair assistance.

Module Exchange

In some cases, you may exchange your module for a re-manufactured module. These modules cost significantly less than new modules and meet the same factory specifications. For more information about the module exchange program, call 1-800-TEK-WIDE, extension 6630.

Module Repair and Return

You may ship your module to us for repair; after which, we will return it to you.

New Modules

You may purchase replacement modules in the same way as other replacement parts.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the TS200. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Parts List Column Descriptions

| Column | Column Name | Description |
|---------|-----------------------|--|
| 1 | Figure & Index Number | Items in this section are referenced by figure and index numbers to the exploded view illustrations that follow. |
| 2 | Tektronix Part Number | Use this part number when ordering replacement parts from Tektronix. |
| 3 and 4 | Serial Number | Column three indicates the serial number at which the part was first effective. Column four indicates the serial number at which the part was discontinued. No entries indicate the part is good for all serial numbers. |
| 5 | Qty | This indicates the quantity of parts used. |
| 6 | Name & Description | An item name is separated from the description by a colon (:). Because of space limitations, an item name may sometimes appear as incomplete. Use the U.S. Federal Catalog handbook H6-1 for further item name identification. |
| 7 | Mfr. Code | This indicates the code of the actual manufacturer of the part. |
| 8 | Mfr. Part Number | This indicates the actual manufacturer's or vendor's part number. |

Abbreviations

Abbreviations conform to American National Standard ANSI Y1.1–1972.

Mfr. Code to Manufacturer Cross Index

The table titled Manufacturers Cross Index shows codes, names, and addresses of manufacturers or vendors of components listed in the parts list.

CROSS INDEX – MFR. CODE NUMBER TO MANUFACTURER

| Mfr. Code | Manufacturer | Address | City, State, Zip Code |
|--------------|---|-------------------------------|---------------------------|
| TK1947 | NORTHWEST ETCH TECHNOLOGY | 2601 S HOOD ST, PO BOX 110610 | TACOMA WA 98411-0610 |
| TK2174 | TETON MACHINE CO | 1600 VALLEY RD | PAYETTE ID 83661 |
| TK2376 | CONDUCTIVE RUBBER TECH | 22125 17TH AVE SE SUITE 117 | BOTHELL WA 98021 |
| TK2569 | SHARP CORPORATION C/O TJBO LIAISON | M/S 78-201 | BEAVERTON OR 97077 |
| TK2545 | ORNELAS ENTERPRISES INC | 7275 NW EVERGREEN PKWY #100 | HILLSBORO OR 97124 |
| 0J7N9 | MCX INC | 30608 SAN ANTONIO ST | HAYWARD CA 94544 |
| 0J9P4 | DELTA ENGINEERING | 19500 SW TETON | TUALATIN OR 97062 |
| 0KB01 | STAUFFER SUPPLY | 810 SE SHERMAN | PORTLAND OR 97214 |
| 0KB05 | NORTH STAR NAMEPLATE | 5750 NE MOORE COURT | HILLSBORO OR 97124-6474 |
| 06383 | PANDUITT CORP | 17301 RIDGELAND | TINLEY PARK IL 60477-3048 |
| 07416 | NELSON NAME PLATE CO | 3191 CASITAS | LOS ANGELES CA 90039-2410 |
| 2K262 | BOYD CORP | 6136 NE 87TH AVE PO BOX 20038 | PORTLAND OR 97220 |
| 5H194 | AIR-OIL PRODUCTS CORP (DIST) | 2400 E BURNSIDE | PORTLAND OR 97214-1752 |
| 55335 | JKL COMPONENTS CORP | 13343 PAXTON STREET | PACOIMA CA 91331 |
| 7X318 | KASO PLASTICS INC | 11015 A NE 39TH | VANCOUVER WA 98662 |
| 74594 | COMPONENT RESOURCES INC (DIST) DIV OF CPI INTERNATIONAL CORP | 14525 SW WALKER ROAD | BEAVERTON OR 97006 |
| 80009 | TEKTRONIX INC | PO BOX 500 | BEAVERTON OR 97077-0001 |
| 85471 | BOYD CORP | 13885 RAMOMA AVE | CHINO CA 91710 |

Replaceable Electrical Modules

Replaceable Parts List

| Assy Number | Tektronix Part Number | Serial No. Effective | Serial No. Discont'd | Qty | Name & Description | Mfr. Code | Mfr. Part Number |
|------------------------------------|-----------------------|----------------------|----------------------|-----|--|-----------|------------------|
| TS200 ELECTRICAL ASSEMBLIES | | | | | | | |
| A1 | 671-4646-01 | | | | CIRCUIT BD ASSY: POTS | 80009 | 671-4646-01 |
| A2 | 671-4643-01 | | | | CIRCUIT BD ASSY: TDR MAIN | 80009 | 671-4643-01 |
| A3 | 119-5411-00 | | | | CIRCUIT BD ASSY: POWER SUPPLY, DC-AC CONVERTER | 55335 | BXA-12563 |
| A4 | 119-5913-00 | | | | DISPLAY MODULE: LCD | TK2569 | LM64K111 |

Replaceable Mechanical Parts

Replaceable Parts List

| Assy Number | TektronixPart Number | Serial No. Effective | Serial No. Discont'd | Qty | Name & Description | Mfr. Code | Mfr. Part Number |
|---|----------------------|----------------------|----------------------|-----|--|-----------|------------------|
| TS200 MECHANICAL REPLACEABLE PARTS | | | | | | | |
| 9-1 | 390-1190-00 | | | 1 | CABINET ASSY: BOTTOM | 7X318 | 390-1190-00 |
| 9-2 | 334-9713-00 | | | 1 | MARKER,IDENT: MARKED CD/UL CERTIFIED | 0KB05 | 334-9713-00 |
| 9-3 | 351-1066-00 | | | 2 | GUIDE, BATTERY:POLYCARBONATE 0.031 THK,BLK,7.125 L | 2K262 | 351-1066-00 |
| 9-4 | ----- | | | | SEE A1 ELECTRICAL ASSEMBLIES | | |
| 9-5 | 129-1509-00 | | | 1 | SPACER,POST:0.750 L,4-40,BRASS,HEX | 0KB01 | 129-1509-00 |
| 9-6 | 129-1501-00 | | | 5 | SPACER POST: 4-40 X 0.25 X 0.75L,M/F | 0KB01 | 129-1501-00 |
| 9-7 | ----- | | | | SEE A2 ELECTRICAL ASSEMBLIES | | |
| 9-8 | 343-1633-00 | | | 1 | CLAMP, CABLE: SCREW MNT, NYLON, 0.56 X 0.5W | 74594 | 22CC50C0562 |
| 9-9 | 337-4183-00 | | | 1 | SHIELD,ELEC:INVERTER,0.016 THK BRASS | TK1947 | 337-4183-00 |
| 9-10 | 343-1634-00 | | | 2 | CLAMP,CABLE:0.25 X 0.375,SCREW MNT,NYLON | 74594 | 222CC37B0250 |
| 9-11 | ----- | | | | SEE A4 ELECTRICAL ASSEMBLIES | | |
| 9-12 | 386-7051-00 | | | 1 | STIFFENER PLATE: WITH DISPLAY FOAM | 0J9P4 | 386-7072-01 |
| 9-13 | 259-0151-00 | | | 1 | FLEX CIRCUIT: POLYESTER FILM, 0.005 THK | 07416 | 259-0151-00 |
| 9-14 | 260-2705-00 | | | 1 | KEYPAD: ELASTOMERIC, BLACK | TK2376 | 260-2705-00 |
| 9-15 | 354-0728-00 | | | 1 | GASKET, O-RING: 0.062 +/-0.005 D,BLACK | 0JRZ5 | 354-0728-00 |
| 9-16 | ----- | | | 1 | BATTERY PACK: SEE STANDARD ACCESS | | |
| 9-17 | 200-4448-00 | | | 1 | DOOR, BATTERY: BL, W/ CAPTIVE HRDW, 6-32 x 0.5 INCH | 7X318 | 200-4448-00 |
| 9-18 | 348-1348-00 | | | 1 | GROMMET:12MM ID X 1MM,NITRILE O-RING NOTE: ORDER WITH DC POWER JACK CABLE | 5H194 | 348-1348-00 |
| | 650-3953-00 | | | | TOP CASE ASSEMBLY | 7X318 | 650-3953-00 |
| 9-19 | 334-9706-00 | | | 1 | MARKER, IDENT: FRONT PANEL, MKD TEKTRONIX TS200 | 0KB05 | 334-9706-00 |
| 9-20 | 390-1189-00 | | | 1 | . CABINET ASSY: TOP CASE, BLACK | 7X318 | 390-1189-00 |
| 9-21 | 348-1601-00 | | | 1 | . GASKET: SPEAKER, 1.15 X 1.5 X .062, ALL UNITS | 2K262 | 348-1601-00 |
| 9-22 | 407-4594-00 | | | 1 | . BRACKET: SPEAKER, ABS, 1.5 X 1.095 X 0.25 | TK2174 | 407-4594-00 |
| 9-23 | 200-4125-00 | | | 1 | . CAP, DUST: PLASTIC ASSY | TK2545 | 200-4125-00 |
| 9-24 | ----- | | | 1 | . WINDOW, DISPLAY: 5.910 X 4.530 X 0.080, CLEAN W/ADHE | 85471 | 337-4167-00 |
| | 650-3952-01 | | | | PLATE ASSEMBLY | 0J7N9 | 650-3952-01 |
| 9-25 | 386-7072-01 | | | 1 | . SUPPORT PLATE: 0.031 THK, AL | 0J9P4 | 386-7051-00 |
| 9-26 | 343-0549-00 | | | 1 | . STRAP,TIEDOWN: 0.098 W X 4.0 L,ZYTEL | 06383 | PLT1M |
| 9-27 | ----- | | | | . SEE A3 ELECTRICAL ASSEMBLIES | | |
| 9-28 | 342-1043-00 | | | 1 | . INSULATOR, COVER: INVERTER BOARD | 2K262 | 342-1043-00 |

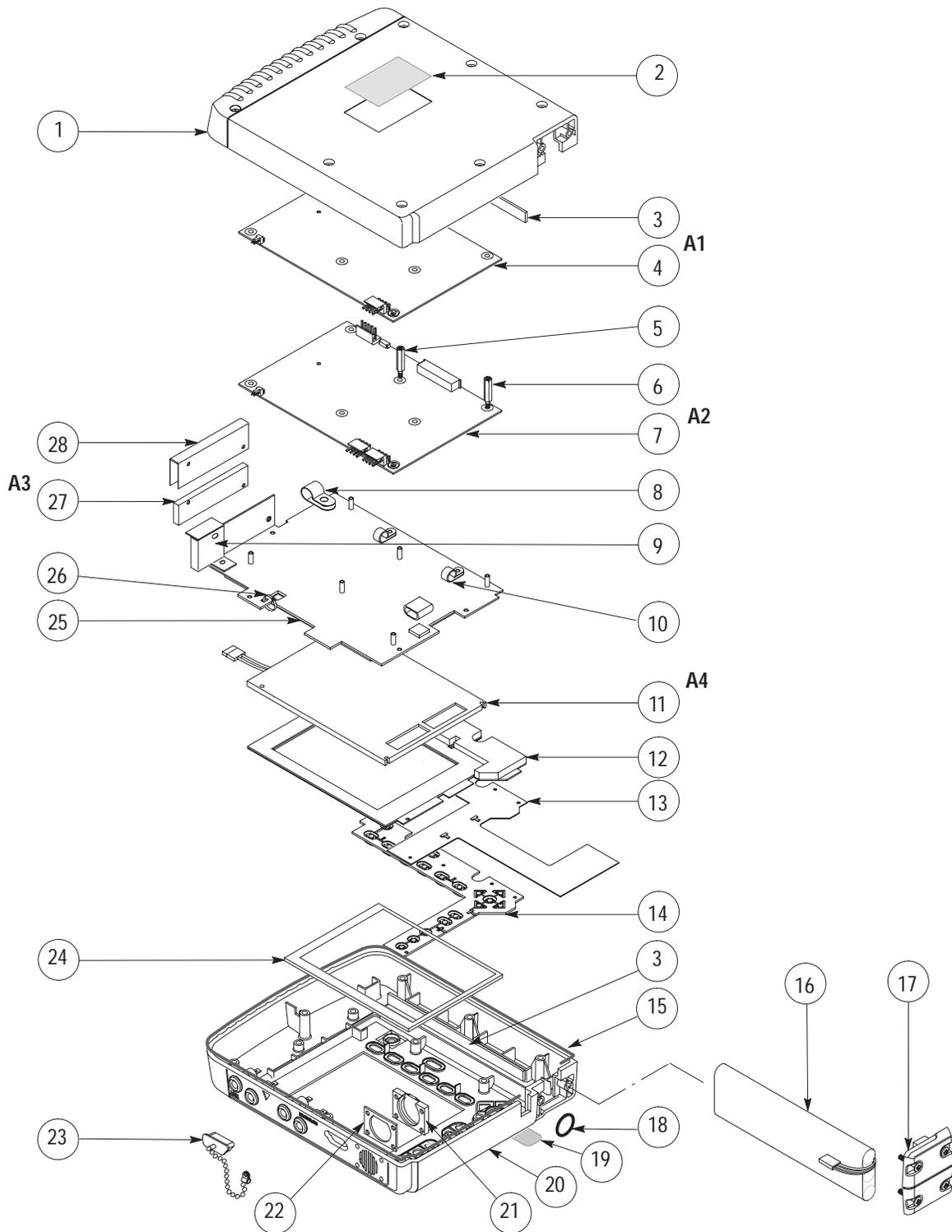
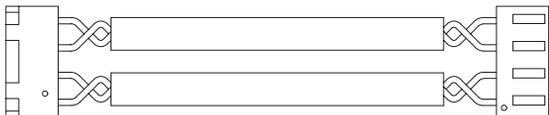
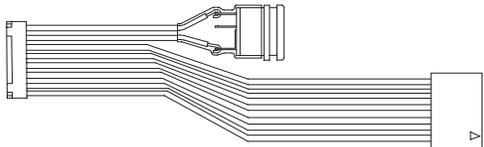
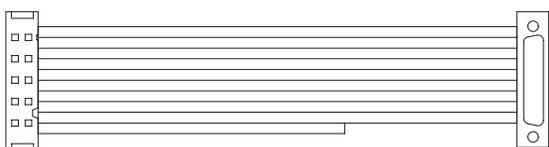
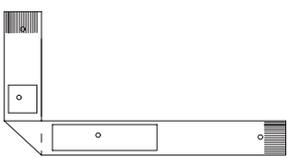
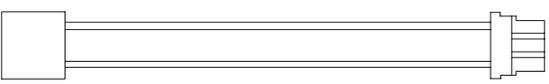


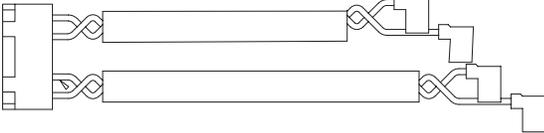
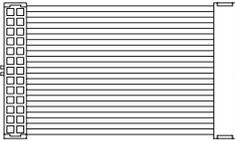
Figure 5-1: Exploded View, Replaceable Mechanical Parts

Wire and Cable Assemblies

NOTE. Cable replacement vendor number is 0J7N9 on all cables except the FPC cable. Order by part number.

| Illustration | Part Number | Location |
|---|-------------|--|
|  | 174-3960-00 | LCD TEMPERATURE SENSOR CABLE TO A2 TDR BOARD SUBPART OF STIFFENER PLATE ASSY |
|  | 174-3954-00 | TIP & RING CABLE FROM A2 TDR BOARD TO A1 POTS BOARD (OPTION 01 ONLY) |
|  | 174-3959-00 | DC POWER JACK & BATTERY TO A2 TDR BOARD |
|  | 174-3961-00 | SERIAL INTERFACE CONDUCTOR RIBBON CABLE SUBPART OF TOP CASE ASSY |
|  | 174-3962-00 | FPC CABLE FROM DISPLAY TO A2 TDR BOARD (Vendor 1DM20) |
|  | 174-3958-00 | INVERTER BOARD JUMPER CABLE SUBPART OF STIFFENER PLATE ASSY |
|  | 174-3963-00 | SPEAKER CABLE ASSY TO A1 POTS BD SUBPART OF TOP CASE ASSY |

Wire and Cable Assemblies, con't

| Illustration | Part Number | Location |
|---|-------------|---|
|  | 174-3955-00 | TWISTED PAIR CABLE ASSEMBLY FROM A2 TDR BOARD TO EXTERNAL ACCESS |
|  | 174-3973-00 | DATA CABLE A2 TDR BOARD TO A1 POTS BOARD (OPTION 01 ONLY) |
|  | 174-4073-00 | LCD INVERTER CABLE FROM A3 INVERTER BOARD TO A2 TDR BOARD SUBPART OF STIFFENER PLATE ASSY |

Supplemental Information

Multi-Test Fixture

The equipment required to perform the POTS performance verification testing includes a TS200 multi-test fixture. The multi-test fixture is not available outside Tektronix Factory Service. All procedures requiring the multi-test fixture must be performed at one of the Tektronix service centers. Figure 6–1 represents the front panel of the multi-test fixture. Test lead connections will be represented by the letter T for tip, R for ring, and G for ground.

The schematics used in the design of this test fixture are illustrated in Figure 6–2.

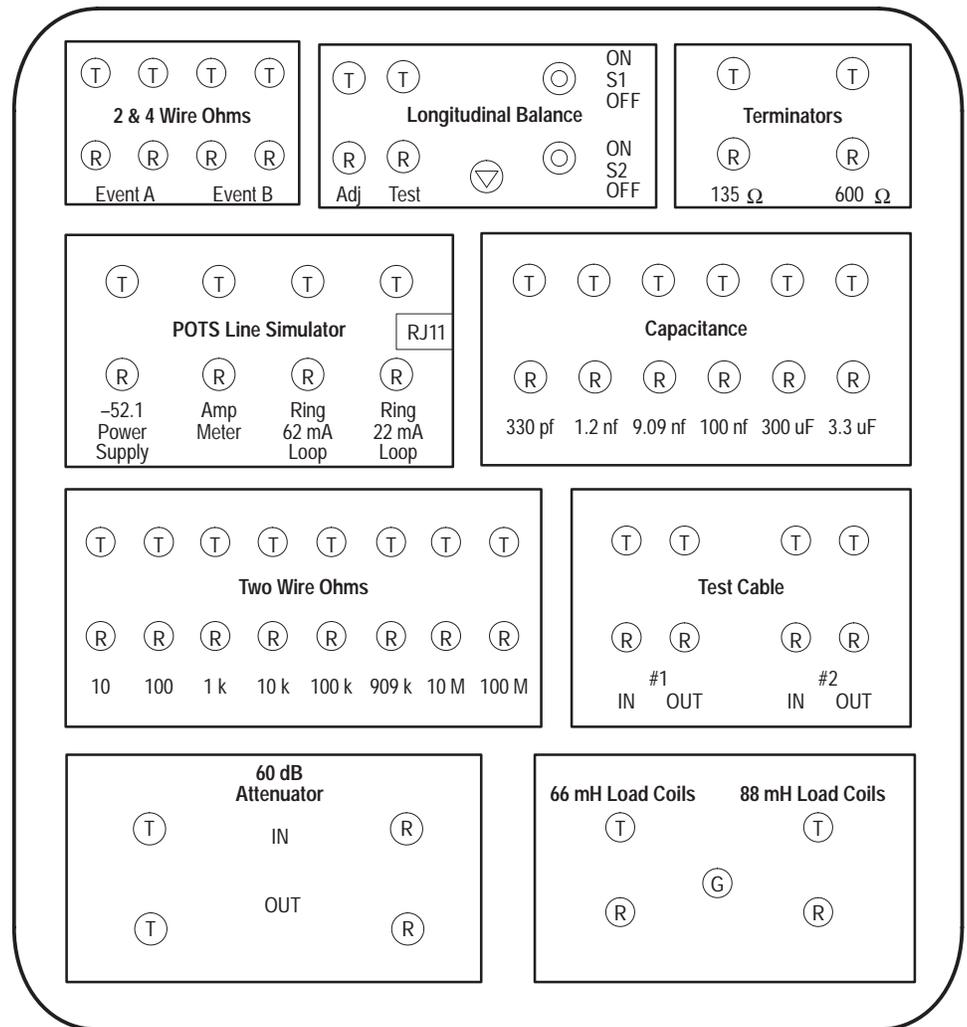


Figure 6–1: Multi-Test Fixture Front Panel

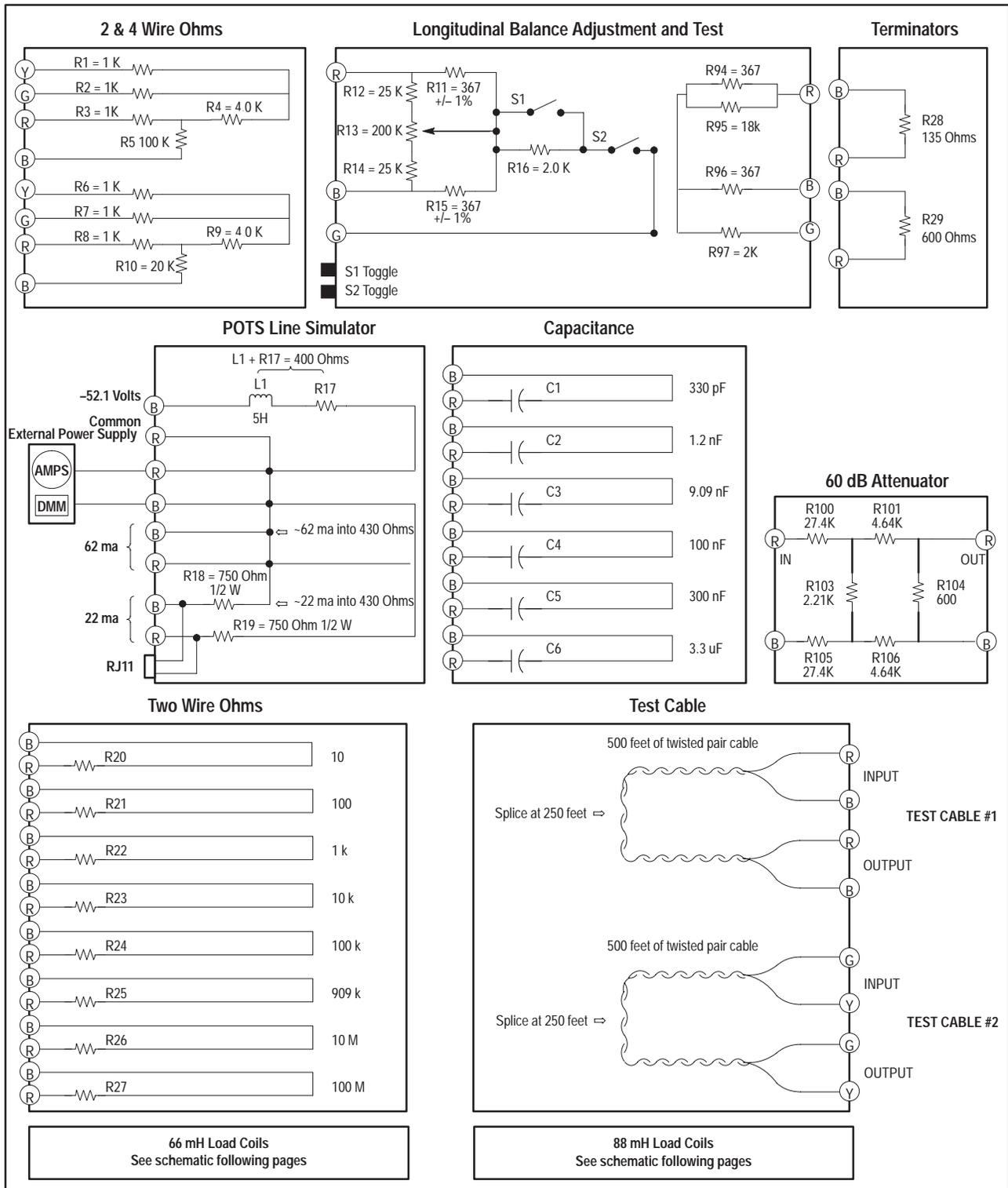
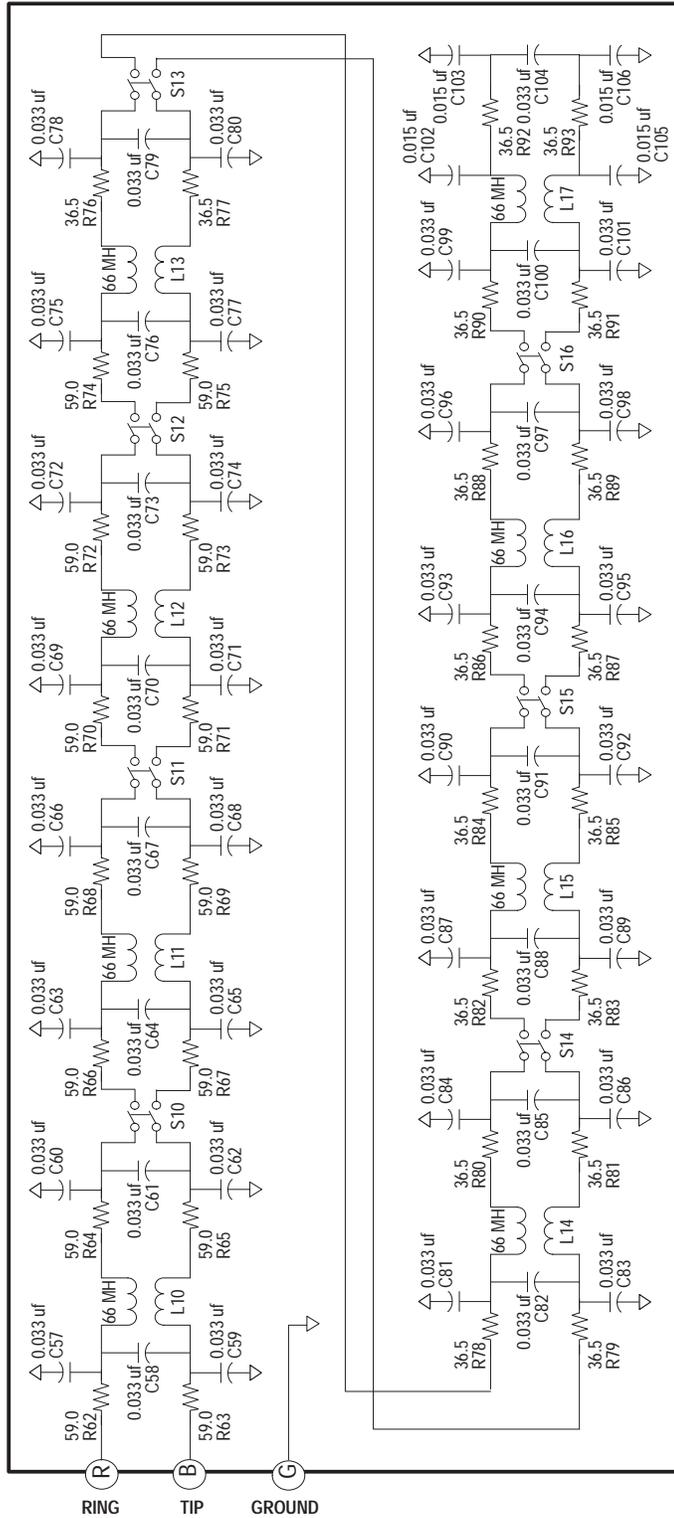


Figure 6-2: Multi-Test Fixture Schematics

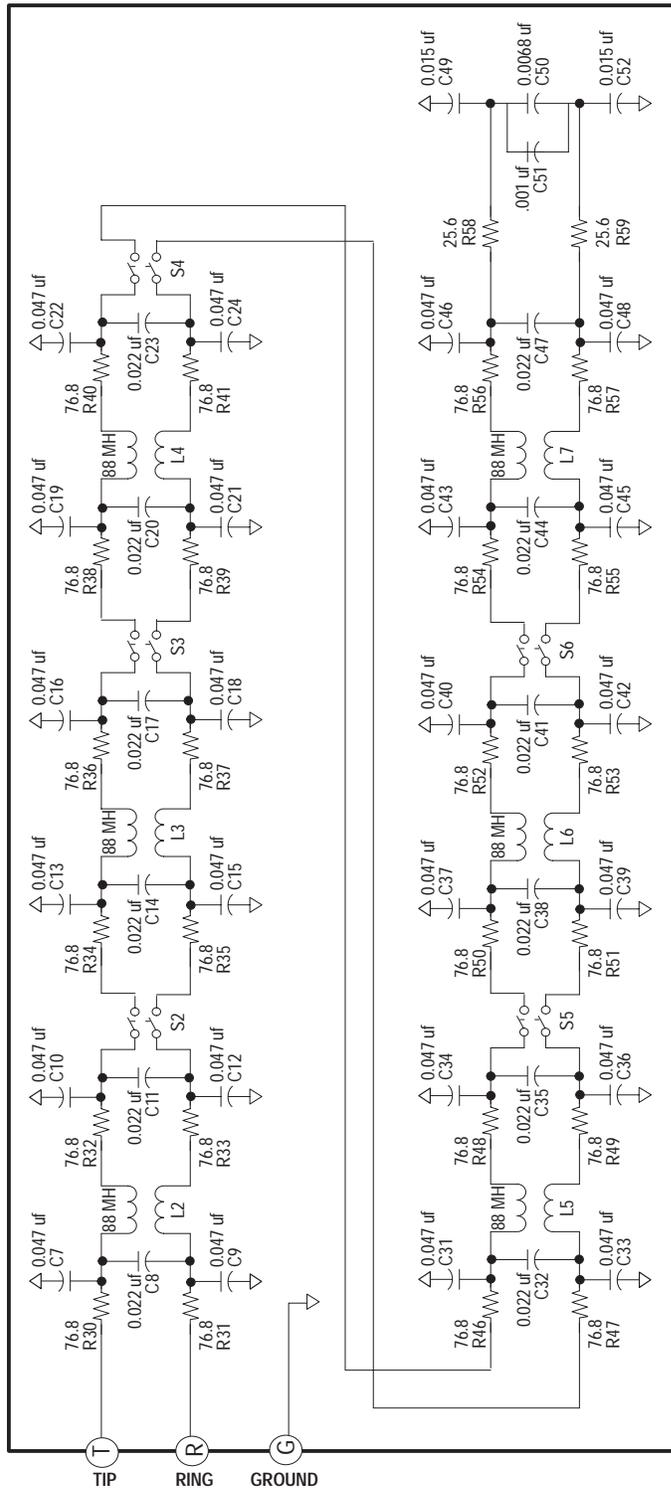
Count Load Coils
66 MH



Note: Switches Optional

Count Load Coils

88 MH



Note: Switches Optional

Multi-Test Fixture Calibration and Performance Verification

See Table 6-1 for the list of equipment required to perform calibration testing.

Table 6-1: Required Equipment for Calibration / Performance Verification

| Description | Key Specifications | Example |
|-------------------|--|---|
| Capacitance Meter | 0.11% accuracy @ 100 pF 0.06% accuracy @ 1 nF 0.05% accuracy > 10 nF | Stanford Research SR720 RLC Meter |
| Ohm Meter | 0.015% accuracy 10 Ω to 1 M Ω 0.1% accuracy 10 M Ω to 100 M Ω | Keithley Instruments 2000 Multimeter |
| AC Voltmeter | 0.1% accuracy @ 1 kHz | Keithley Instruments 2000 Multimeter |
| Signal Generator | 1 kHz @ +40 dBm | Wavetek 9100 |

Before you begin to follow the testing procedure, remove the cover from the multi-test fixture to allow access to the internal components.

1. Measure and record the value of the resistors on the Two and Four Wire Ohm section of the multi-test fixture.
 - a. R3 (distance to fault – DTF value event #A)
 - b. R4 (strap to fault – STF value event #A)
 - c. R3 and R4 (distance to strap – DTS value event #A)
 - d. R5 (fault value event #A)
 - e. R8 (distance to fault – DTF value event #B)
 - f. R9 (strap to fault – STF value event #B)
 - g. R8 and R9 (distance to strap – DTS value event #B)
 - h. R10 (fault value event #B)

2. Measure and record the value of resistors R94 through R97 on the Longitudinal Balance section of the multi-test fixture. Calculate their longitudinal balance by using this formula:

$$1) \quad \begin{aligned} R_A &= 369.1 \, \Omega + R1 \\ R_B &= 369.1 \, \Omega + R2 \end{aligned}$$

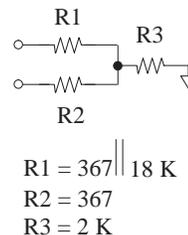
$$2) \quad \text{Calculate } X = \left(1 - \left[\frac{1}{1 + \left(\frac{R_A * R_B}{(R_A + R_B) * R3} \right)} \right] \right)$$

$$3) \quad Y = (X) * (369.1) * \left| \frac{1}{R_A} - \frac{1}{R_B} \right|$$

$$4) \quad \text{Calculate } dB = 20 * \log | Y |$$

EXAMPLE

- 1) $R1 = 367 \parallel 18 \text{ K} = 359.666$; $R2 = 367$; $R3 = 2 \text{ K}$
 $R_A = 728.767 \, \Omega$; $R_B = 736.100$
- 2) $X = 0.154766$
- 3) $Y = 780.863E -6$
- 4) $dB = 20 \log | Y | = -62.1485 \text{ dB}$



3. Measure and record the value of capacitors C3 through C6 on the Capacitance section of the multi-test fixture.
4. Measure and record the value of resistors R21 through R27 on the Two Wire Ohm section of the multi-test fixture.
5. Follow these steps to prove the attenuation of the 60 dB Attenuator section of the multi-test fixture:
 - a. Set the calibrator to AC volts mode.
 - b. Select a 1000 Hz tone.
 - c. Set the level to +40 dBm (77.46 Vrms).
 - d. Connect the calibrator output to the AC voltmeter input.
 - e. Set the AC voltmeter to read dBm at an impedance of 600 Ω
 - Record the value displayed on the AC voltmeter.
 - f. Remove the calibrator leads from the AC voltmeter.
 - g. Connect the calibrator leads to the 60 dB Attenuator input.
 - h. Connect the 600 Ω terminator to the 60 dB Attenuator output.
 - i. Connect the AC voltmeter input to the 60 dB Attenuator output.
 - Record the value displayed on the AC voltmeter.
 - j. Subtract the first recorded value (AC voltmeter) from the last recorded value to obtain the attenuation of the 60 dB Attenuator.

6. Measure and record values for terminators. Verify they measure within specified tolerance.
 - 135 Ω terminator (R28) 132.3 Ω to 137.7 Ω
 - 600 Ω terminator (R29) 588 to 612 Ω

Table 6–2: Multi-Test Fixture Calibration and Performance Test Record

| Parameter | TS200 Name | Units | Target Value | Calibration Value (CV) |
|---------------------------------|------------|---------|--------------|------------------------|
| Two & Four Wire Ohms | | | | |
| Event A R3 | DTF | Ohms | 1000 | |
| Event A R4 | STF | Ohms | 4000 | |
| Event A R3 and R4 | DTS | Ohms | 5000 | |
| Event A R5 | FAULT | Ohms | 100,000 | |
| Event B R8 | DTF | Ohms | 1000 | |
| Event B R9 | STF | Ohms | 4000 | |
| Event B R8 and R9 | DTS | Ohms | 5000 | |
| Event B R10 | FAULT | Ohms | 20,000 | |
| Longitudinal Balance | | | | |
| R94 and R95 | | Ohms | 358 | |
| R96 | | Ohms | 367 | |
| R97 | | Ohms | 2000 | |
| Calculated LB | | dB | 62 | |
| Capacitance | | | | |
| C1 | | pF | 330 | |
| C2 | | nF | 1.2 | |
| C3 | | nF | 9.09 | |
| C4 | | nF | 100 | |
| C5 | | nF | 300 | |
| C6 | | μ F | 3.3 | |

Table 6–2: Multi-Test Fixture Calibration and Performance Test Record (Cont.)

| Parameter | TS200 Name | Units | Target Value | Calibration Value (CV) |
|-----------------------------|------------|--------|----------------|------------------------|
| Two Wire Ohm | | | | |
| R20 | | Ohms | 10 | |
| R21 | | Ohms | 100 | |
| R22 | | K Ohms | 1 | |
| R23 | | K Ohms | 10 | |
| R24 | | K Ohms | 100 | |
| R25 | | K Ohms | 909 | |
| R26 | | M Ohms | 10 | |
| R27 | | M Ohms | 100 | |
| 60 dB Attenuator | | | | |
| Calibrator output @ 1000 Hz | | dBm | +40 | |
| Output of 60 dB Attenuator | | dBm | -20 | |
| Total attenuation | | dB | 60 | |
| Terminators | | | | |
| R28 | | Ohms | 132.3 to 137.7 | |
| R29 | | Ohms | 588 to 612 | |

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