Service Manual

Tektronix

TX1 and TX3
True RMS Digital Multimeter

070-9893-01

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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Tektronix, Inc., P.O. Box 1000, Wilsonville, OR 97070–1000

WARRANTY

Tektronix warrants that the products that it manufactures and sells will be free from defects in materials and workmanship for a period of three (3) years from the date of shipment. If a product proves defective during this warranty period, Tektronix, at its option, either will repair the defective product without charge for parts and labor, or will provide a replacement in exchange for the defective product.

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, with shipping charges prepaid. 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.

This warranty shall not apply to any defect, failure or damage caused by improper use or improper or inadequate maintenance and care. Tektronix shall not be obligated to furnish service under this warranty a) to repair damage resulting from attempts by personnel other than Tektronix representatives to install, repair or service the product; b) to repair damage resulting from improper use or connection to incompatible equipment; c) to repair any damage or malfunction caused by the use of non-Tektronix supplies; or d) to service a product that has been modified or integrated with other products when the effect of such modification or integration increases the time or difficulty of servicing the product.

THIS WARRANTY IS GIVEN BY TEKTRONIX IN LIEU OF ANY OTHER WARRANTIES, EXPRESS OR IMPLIED. TEKTRONIX AND ITS VENDORS DISCLAIM ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. TEKTRONIX' RESPONSIBILITY TO REPAIR OR REPLACE DEFECTIVE PRODUCTS IS THE SOLE AND EXCLUSIVE REMEDY PROVIDED TO THE CUSTOMER FOR BREACH OF THIS WARRANTY. TEKTRONIX AND ITS VENDORS WILL NOT BE LIABLE FOR ANY INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES IRRESPECTIVE OF WHETHER TEKTRONIX OR THE VENDOR HAS ADVANCE NOTICE OF THE POSSIBILITY OF SUCH DAMAGES.

Service Assurance

If you have not already purchased Service Assurance for this product, you may do so at any time during the product's warranty period. Service Assurance provides Repair Protection and Calibration Services to meet your needs.

Repair Protection extends priority repair services beyond the product's warranty period; you may purchase up to three years of Repair Protection.

Calibration Services provide annual calibration of your product, standards compliance and required audit documentation, recall assurance, and reminder notification of scheduled calibration. Coverage begins upon registration; you may purchase up to five years of Calibration Services.

Service Assurance Advantages

- Priced well below the cost of a single repair or calibration
- Avoid delays for service by eliminating the need for separate purchase authorizations from your company
- Eliminates unexpected service expenses

For Information and Ordering

For more information or to order Service Assurance, contact your Tektronix representative and provide the information below. Service Assurance may not be available in locations outside the United States of America.

Name	VISA or Master Card number and expiration
Company	date or purchase order number
Address	Repair Protection (1,2, or 3 years)
City, State, Postal code	Calibration Services (1,2,3,4, or 5 years)
Country	Instrument model and serial number
Phone	Instrument purchase date

Table of Contents

Maintenance

Replaceable Parts

List of Figures

List of Tables

General Safety Summary

Review the following safety precautions to avoid injury and prevent damage to this product or any products connected to it. To avoid potential hazards, use this product only as specified.

Only qualified personnel should perform service procedures.

To Avoid Fire or Personal Injury

Connect and Disconnect Properly. Do not connect or disconnect probes or test leads while they are connected to a voltage source.

Observe All Terminal Ratings. To avoid fire or shock hazard, observe all ratings and markings on the product. Consult the product manual for further ratings information before making connections to the product.

Do not apply a potential to any terminal, including the common terminal, that exceeds the maximum rating of that terminal.

Replace Batteries Properly. Replace batteries only with the proper type and rating specified.

Do Not Operate Without Covers. Do not operate this product with covers or panels removed.

Use Proper Fuse. Use only the fuse type and rating specified for this product.

Avoid Exposed Circuitry. Do not touch exposed connections and components when power is present.

Do Not Operate With Suspected Failures. If you suspect there is damage to this product, have it inspected by qualified service personnel.

Do Not Operate in Wet/Damp Conditions.

Do Not Operate in an Explosive Atmosphere.

Keep Product Surfaces Clean and Dry.

Symbols and Terms

Terms in this Manual. These terms may appear 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. These terms may appear 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. The following symbols may appear on the product:


CAUTION
Refer to Manual


WARNING
High Voltage


Double
Insulated

Service Safety Summary

Only qualified personnel should perform service procedures. Read this *Service Safety Summary* and the *General Safety Summary* before performing any service procedures.

Do Not Service Alone. Do not perform internal service or adjustments of this product unless another person capable of rendering first aid and resuscitation is present.

Use Care When Servicing With Power On. Dangerous voltages or currents may exist in this product. Disconnect power, remove battery (if applicable), and disconnect test leads before removing protective panels, soldering, or replacing components.

To avoid electric shock, do not touch exposed connections.

Preface

This section contains information needed to properly use this manual to service the TX1 and TX3 True RMS Digital Multimeters as well as general information critical to safe and effective servicing of multimeters.

Manual Structure

This manual is divided into chapters, such as *Specifications* and *Theory of Operation*. Further, it is divided into subsections, such as *Product Description* and *Disassembly and Assembly Procedures*.

Sections containing procedures also contain introductions to those procedures. Be sure to read these introductions because they provide information needed to do the service correctly and efficiently. The following is a brief description of each manual chapter.

- *Specifications* contains a product description and tables of the characteristics and descriptions that apply to it.
- *Operating Information* includes general information and operating instructions at the level needed to safely service the multimeters. A statement of the service strategy is in this section.
- *Theory of Operation* contains circuit descriptions down to the module level.
- *Performance Verification* contains a collection of procedures for confirming that the multimeters function properly and meet warranted limits.
- *Adjustment Procedure* informs you how to obtain calibration services.
- *Options* lists the available options for the TX1 and TX3 meters.
- *Maintenance* contains information and procedures for doing preventive and corrective maintenance. This includes cleaning instructions and disassembly and assembly instructions.
- *Replaceable Parts* includes a table of all replaceable parts, their descriptions, and their Tektronix part numbers.

Manual Conventions

This manual uses certain conventions which you should become familiar with before doing service.

Safety Symbols and terms related to safety appear in the Safety Summary found at the beginning of this manual.

Symbols Refer to the Safety section in this manual to learn about the symbols used in this manual.

Related Manuals

The TX1 and TX3 digital multimeters are shipped with a user manual. Refer to the user manual for detailed operating instructions.

Contacting Tektronix

Product Support	For application-oriented questions about a Tektronix measurement product, call toll free in North America: 1-800-TEK-WIDE (1-800-835-9433 ext. 2400) 6:00 a.m. – 5:00 p.m. Pacific time Or, contact us by e-mail: tm_app_supp@tektronix.com For product support outside of North America, contact your local Tektronix distributor or sales office.
Service Support	Contact your local Tektronix distributor or sales office. Or, visit our web site for a listing of worldwide service locations. http://www.tektronix.com
For other information	In North America: 1-800-TEK-WIDE (1-800-835-9433) An operator will direct your call.
To write us	Tektronix, Inc. P.O. Box 1000 Wilsonville, OR 97070-1000

Introduction

Service Strategy

This manual contains all the information needed for periodic maintenance of the TX1 and TX3 True RMS Digital Multimeters.

All replaceable parts are listed in Table 8–3 Replaceable parts list. To remove and replace any parts, follow the instructions in *Dissasembly and Assembly Procedures* found in Chapter 7.

Service Offerings

Tektronix provides service to cover repair under warranty as well as other services that may provide a cost-effective answer to your service needs.

Whether providing warranty repair service or any of the other services listed below, Tektronix service technicians, trained on Tektronix products, are best equipped to service your TX1 and TX3 True RMS Digital Multimeters. Tektronix technicians are apprised of the latest information on improvements to the product as well as the latest options to the product.

Warranty Repair Service

Tektronix warrants this product for three years from date of purchase. (The warranty appears after the title page and copyright page in this manual.) Tektronix technicians provide warranty service at most Tektronix service locations worldwide. Your Tektronix product catalog lists all service locations worldwide.

Repair or Calibration Service

The following services may be purchased to tailor repair and/or calibration of your TX1 and TX3 True RMS Digital Multimeters to fit your requirements.

At-Depot Service. Tektronix offers several standard-priced adjustment (calibration) and repair services:

- A single repair and/or adjustment.
- Calibrations using equipment and procedures that meet the traceability standards specific to the local area.
- Annual maintenance agreements that provide for either calibration and repair or calibration only.

Of these services, the annual maintenance agreement offers a particularly cost-effective approach to service for many owners. Such agreements can be purchased to span several years.

Self Service

Tektronix supports self service repair by providing replaceable parts. See the *Replaceable Parts* chapter for a list of all replaceable parts.

Before You Begin

This manual is for servicing the TX1 and TX3 True RMS Digital Multimeters. To prevent injury to yourself or damage to the meter, do the following tasks before you attempt service:

- Read the Safety Summary found at the beginning of this manual.
- Read *Service Strategy* in this section.

When using this manual for servicing, be sure to read and follow all warnings, cautions, and notes.

Specifications

Specifications

All specifications are warranted, unless noted as typical, for the rated temperature range of 23° C ± 5° C at less than 80% relative humidity.

Table 1–1: General characteristics

Characteristics	Description
LCD display digits	3⅘ (default) or 4⅘
Display counts	5,000 (default) or 50,000
Bargraph	20 segment, updated 20 times per second
Memory locations	TX1: 10, TX3: 30
Out of range indicator	*OL*: overrange *Ur*: underrange
Low voltage indicator	Battery symbol shows on LCD at 2.0 V. Meter powers down at 1.5 V.
Battery life	100 hours continuous use with backlight off (typical)
Auto-off	Adjustable, 30 minute default
Power source	Two AA 1.5 V alkaline batteries (IEC LRG or ANSI/NEDA 15A)
Maximum input voltage between terminals and between terminals and earth	1000 V_{RMS} Installation Category III (CAT III) [1]
Maximum open circuit voltage when utilizing the A terminal	600 V_{RMS} CAT III
Overload protection, V terminal	1000 V_{RMS} (1500 V_{pk}) for all functions
F1 fuse protection	15 A (1000 V) fast
Backlight	Green LEDs

[1] **If meter is exposed to water, have it inspected by qualified service personnel.**

Table 1–2: DC voltage characteristics

Characteristic	Description
Settling time	3 readings (typical)
Reading rate	5,000 ct.: 4 readings per second 50,000 ct.: 1 reading per second
Rejection ratio	
Common mode	120 dB at DC or 50 Hz or 60 Hz
Normal mode	60 dB at 50 Hz or 60 Hz
Input impedance	10 MΩ (typical)

Table 1–3: DC voltage range, resolution, and accuracy

	Resolution		Accuracy [1]	
Range	5,000 counts	50,000 counts	TX1	TX3
0.5 V	100 µV	10 µV	± (0.07% + 1 count)	± (0.05% + 1 count)
5 V	1 mV	100 µV		
50 V	10 mV	1 mV		
500 V	100 mV	10 mV		
1000 V	1 V	100 mV		
Temperature coefficient			Add (0.005% + 0.1 ct.)/°C to accuracy beyond rated temperature range.	

1 **Accuracy in 50,000-count mode is % + 10 counts.**

Table 1–4: AC voltage characteristics

Characteristic	Description
Input impedance	10 MΩ in parallel with <100 pF (typical)
Settling time	4 readings (typical)
Reading rate	5,000 ct.: 4 readings per second 50,000 ct.: 1 reading per second
Common mode rejection ratio	60 dB at DC to 60 Hz
Crest factor, maximum	Full scale: 3 Half scale: 6
AC+DC [1] total RMS volts accuracy	AC (RMS) accuracy + 0.1% + 1 count

Table 1–4: AC voltage characteristics (cont.)

Characteristic	Description
AC DC [1] dual display accuracy	DC Accuracy + 0.05% + 1 count AC RMS Accuracy + 0.1% + 1 count
Upper display frequency (5,000 counts)	
Accuracy	±(0.002% + 1 count) for 20 Hz to 20 kHz
Sensitivity	10% of selected voltage range
dB reference [2]	1 V_{RMS} (adjustable)
dBm reference [2]	775 mV across 600 Ω (1 mW)

1 5,000-count mode only.

2 dB readout = 20 × log (main display readout/ref), where ref = 1 V is the default. dBm readout = 10 × log (main display readout^2/R), where R=600 Ω.

Table 1–5: AC voltage range, resolution, and accuracy

	Resolution		Accuracy [1]	
Range	5,000 counts	50,000 counts	TX1	TX3
0.5 V	100 µV	10 µV	40 Hz – 20 kHz: ± (0.6% + 2 counts)	40 Hz – 20 kHz: ± (0.4% + 2 counts)
5 V	1 mV	100 µV		
50 V	10 mV	1 mV		
500 V [2]	100 mV	10 mV		
1000 V [2]	1 V	100 mV	40 Hz – 10 kHz: ± (0.6% + 2 counts)	40 Hz – 10 kHz: ± (0.4% + 2 counts)
Temperature coefficient			AC: Add (0.03% + 0.1 ct.)/°C beyond rated temperature range. AC+DC: Add (0.06% + 0.1 ct.)/°C beyond rated temperature range.	

1 Accuracy in 50,000-count mode is % + 20 counts.

2 For voltages > 100 V, the maximum volts–Hz product is < 10 MVHz.

Table 1–6: DC current characteristics

Characteristics	Description
Burden voltage	5 mA to 5 A: 0.3 V max. 10 A: 0.5 V max.
Percent 4-20 mA (calculated in 50 mA range)	4 mA = 0% 20 mA = 100%
Settling time	4 readings (typical)
Reading rate	5,000 ct.: 4 readings per second 50,000 ct.: 1 reading per second

Table 1–7: DC current range, resolution, and accuracy

	Resolution		Accuracy	
Range	5,000 counts	50,000 counts	TX1	TX3
500 µA	100 nA	10 nA	± (0.2% + 4 counts) [1]	
5 mA	1 µA	100 nA	± (0.2% + 2 counts) [2]	
50 mA	10 µA	1 µA		
500 mA	100 µA	10 µA		
5 A	1 mA	100 µA	± (0.4% + 2 counts) [2]	
10 A (15 A for 3 minutes)	10 mA	1 mA	± (0.8% + 2 counts) [2]	
Temperature coefficient			Add (0.05% + 0.1 ct.)/°C beyond rated temperature range.	

[1] **Accuracy in 50,000-count mode is % + 40 counts.**

[2] **Accuracy in 50,000-count mode is % + 20 counts.**

Table 1–8: AC current characteristics

Characteristics	Description
Burden voltage	0.5 mA to 5 A: 0.9 V max. 10 A: 1.0 V max.
AC+DC [1] Accuracy	AC RMS amps accuracy + DC amps accuracy
Upper display frequency	
Accuracy	±(0.002% + 1 count) for 20 Hz to 5 kHz
Sensitivity	10% of range

Table 1–8: AC current characteristics (cont.)

Characteristics	Description
Settling time	4 readings (typical)
Reading rate	5,000 ct.: 4 readings per second 50,000 ct.: 1 reading per second

1 **5,000-count mode only.**

Table 1–9: AC current range, resolution, and accuracy

	Resolution		Accuracy [1,2]	
Range	5,000 counts	50,000 counts	TX1	TX3
0.5 mA	100 nA	10 nA	40 Hz – 1 kHz: ± (0.6% + 2 counts)	
5 mA	1 µA	100 nA	>1 kHz – 3 kHz: ± (1.0% + 2 counts)	
50 mA	10 µA	1 µA	>3 kHz – 5 kHz: ± (2.0% + 2 counts)	
500 mA	100 µA	10 µA		
5 A	1 mA	100 µA		
10 A (15 A for 3 minutes)	10 mA	1 mA		
Temperature coefficient			Add (0.05% + 0.1 ct.)/°C beyond rated temperature range.	

1 **Accuracy in 50,000-count mode is % + 20 counts.**

2 **> 5% of range.**

Table 1–10: Resistance (Ω) characteristics

Characteristics	Description
Update rate	5,000 ct.: 2 readings per second 50,000 ct.: 1 reading per second 50 MΩ: 1 reading per second
Settling time	50 Ω to 5 MΩ range: 3 readings (typical) 50 MΩ range: 4 readings (typical)
Compliance voltages (typical)	0.6 V (50 Ω and 500 Ω range is 1.3 V)
Common mode rejection ratio	60 dB at DC, 50 Hz, or 60 Hz
Normal mode rejection ratio	20 dB at ≥ 50 Hz

Table 1–11: Resistance range, resolution, and accuracy

Range	Resolution		Accuracy	
	5,000 counts	50,000 counts	TX1	TX3
50 Ω	0.01 Ω [1]	—	± (0.1% + 10 counts)	
500 Ω	0.1 Ω	0.01 Ω	± (0.1% + 4 counts) [2]	
5 kΩ	1 Ω	0.1 Ω	± (0.1% + 2 counts) [3]	
50 kΩ	10 Ω	1 Ω		
500 kΩ	100 Ω	10 Ω		
5 MΩ	1 kΩ	100 Ω	± (0.4% + 4 counts) [2]	
50 MΩ	10 kΩ [1]	—	± (1.0% + 4 counts) [2]	
Temperature coefficient			50 Ω to 500 kΩ: Add (0.03% + 0.1 ct.)/°C beyond rated temperature range. 5 MΩ to 50 MΩ: Add (0.2% + 0.1 ct.)/°C beyond rated temperature range.	

1 **5,000 count mode only.**

2 **Accuracy in 50,000-count mode is % + 40 counts.**

3 **Accuracy in 50,000-count mode is % + 20 counts.**

Table 1–12: Continuity characteristics

Characteristics	Description
Continuity threshold	Beeper sounds when resistance is 100 Ω or less (typical)
Response time	< 1 ms

Table 1–13: Diode test characteristics

Characteristics	Description
Test current (typical)	0.35 mA
Test voltage	2.8 V maximum, open circuit
Accuracy	± 1.0%

Table 1–14: Capacitance range, resolution, and accuracy (5,000 counts only)

Range	Resolution [1]	Accuracy [2]	
		TX1	TX3
5 nF	1 pF	± (1.0% + 5 counts) (using Δ mode)	
50 nF	10 pF	± (1.0% + 3 counts) (using Δ mode)	
500 nF	100 pF	± (1.0% + 3 counts)	
5 µF	1 nF		
50 µF	10 nF	± (3.0% + 3 counts)	
500 µF	100 nF		
5 mF	1 µF		
50 mF	10 µF		
Temperature coefficient		Add (0.05% + 0.1 ct.)/°C beyond rated temperature range.	

[1] **5,000 count mode only.**

[2] **> 1% of range.**

Table 1–15: Frequency characteristics, resolution, and accuracy

Characteristics	Description
Signal coupling	AC
Minimum frequency	0.5 Hz
Maximum frequency	1 MHz
Accuracy	±(0.002%) + 1 count
Best resolution	10,000 count: 0.01 Hz 100,000 count: 0.001 Hz
Temperature coefficient	Add 0.00004%/(°C)^2 beyond rated temperature range.

Table 1–16: Frequency voltage range

Range	Sensitivity, 10 Hz - 100 kHz	Sensitivity, 1 MHz [1]
500 mV	100 mV	—
5 V	500 mV	2 V
50 V	5 V	20 V

Table 1–16: Frequency voltage range (Cont.)

Range	Sensitivity, 10 Hz - 100 kHz	Sensitivity, 1 MHz [1]
500 V	50 V	—

[1] **For voltages > 100 V, the maximum volts–Hz product is < 10 MVHz.**

Table 1–17: Duty factor characteristics

Characteristics	Description
Range	1 Hz to 100 kHz
Accuracy	±(0.1% + 0.05% per kHz) for 5 V input (logic signals only)
Signal coupling	DC
Resolution	0.1%
Sensitivity	30% of range

Table 1–18: Temperature characteristics

Characteristics	Description
Main display	
Range	–50° C to +980° C
Accuracy	±3°C [1] (typical)
Thermocouple type	K
Upper display	
Accuracy	± 3°C of ambient temperature (typical)

[1] **Use the water and ice offset calibration method on page 2–9 for accuracy to ±1.0 °C.**

Table 1–19: 1ms peak hold characteristics

Characteristics	Description
Accuracy [1]	Specified voltage or current measurement ±30 counts of the peak value of a single 1ms pulse.

[1] **5,000-count mode only.**

Table 1–20: Physical characteristics

Characteristic	Description
Dimensions (H × W × D)	38 mm × 88 mm × 183 mm (without holster)
Weight (with batteries)	383 g (13.5 oz)
With holster	539 g (1 lb 3 oz)

Table 1–21: Environmental characteristics

Characteristic	Description
Temperature	
Operating	–10 to +50° C
Non-operating (storage)	–40 to +60° C
Humidity	–40 to +35° C: < 80% +35 to +40° C: < 70% +40 to +60° C: < 55%
Altitude	
Operating	2,000m (6,562 ft) For altitudes from 2,000 m up to 5,000 m (16,404 ft) derate voltage input to 600 VAC CAT III.
Non-operating (storage)	12,300 m (40,354 ft)
Vibration	
Operating	2.66 g_{RMS}, 5 to 500 Hz, 3 axes (10 minutes each)
Non-operating	3.48 g_{RMS}, 5 to 500 Hz, 3 axes (10 minutes each)

Table 1–22: Certifications and compliances

Category	Standards or description
EC Declaration of Conformity – EMC	Meets intent of Directive 89/336/EEC for Electromagnetic Compatibility. Compliance was demonstrated to the following specifications as listed in the Official Journal of the European Union: EN 55011 Class A Radiated Emissions EN 50082-1 Immunity: IEC 801-2 Electrostatic Discharge Immunity IEC 801-3 RF Electromagnetic Field Immunity [1,2] **1 Add 25 counts (250 counts in 50,000 count mode) to the accuracy specifications when in the presence of an RF field as defined in IEC801–3.** **2 Amps DC: Add 60 counts (600 counts in 50,000 count mode) to the amps accuracy specifications when in the presence of an RF field as defined in IEC801–3.**
Australia/New Zealand Declaration of Conformity – EMC	Complies with EMC provision of Radiocommunications Act per the following standard(s): AS/NZS 2064.1/2 Industrial, Scientific, and Medical Equipment: 1992
EC Declaration of Conformity – Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Union: Low Voltage Directive 73/23/EEC, amended by 93/69/EEC EN 61010-1/A2:1995 Safety requirements for electrical equipment for measuring control, and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	UL3111-1 – Standard for electrical measuring and test equipment.
Canadian Certification	CAN/CSA C22.2 No. 1010.1 Safety requirements for electrical equipment for measurement, control, and laboratory use.
Additional Compliance	IEC61010-1/A2:1995 Safety requirements for electrical equipment for measurement, control, and laboratory use.

Table 1–22: Certifications and compliances (cont.)

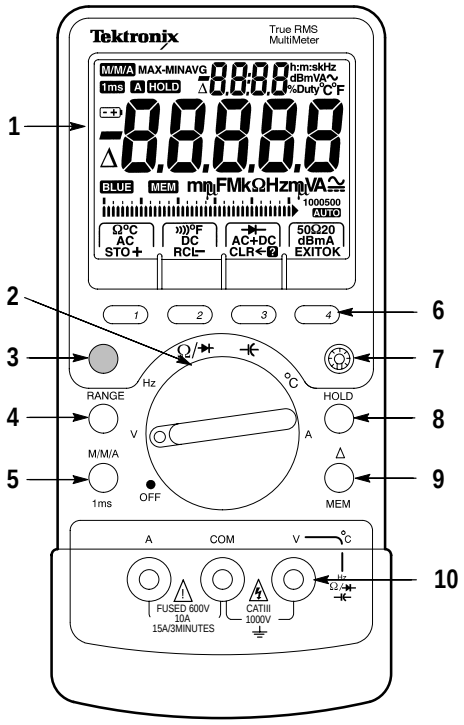
Category	Standards or description
Installation Category Descriptions	Terminals on this product may have different installation (overvoltage) category designations. The installation categories are: CAT III Distribution-level mains (usually permanently connected). Equipment at this level is typically in a fixed industrial location. CAT II Local-level mains (wall sockets). Equipment at this level includes appliances, portable tools, and similar products. Equipment is usually cord-connected. CAT I Secondary (signal level) or battery operated circuits of electronic equipment.
Pollution Degree	A measure of the contaminates that could occur in the environment around and within a product. Typically the internal environment inside a product is considered to be the same as the external. Products should be used only in the environment for which they are tested. Pollution Degree 2 Normally only dry, nonconductive pollution occurs. Occasionally a temporary conductivity that is caused by condensation must be expected. This location is a typical office/home environment. Temporary condensation occurs only when the product is out of service.

Operating Information

Operating Information

This chapter provides basic information about the controls and functions of the TX1 and TX3 meters. For more detailed operating information, refer to the User manual supplied with the meter.

Front and Rear Panel Overview



1 Extra large LCD display with dual numeric readout.

2 Measurement function knob – Use to select a measurement.

3 Blue Button – Use to access 1ms, MEM, and Setup menu.

4 RANGE Button – Use to set measurement range.

5 M/M/A Button – Use to set meter to MIN/MAX/AVG or 1ms modes.

6 Softkeys – Use with measurement function knob to select measurements.

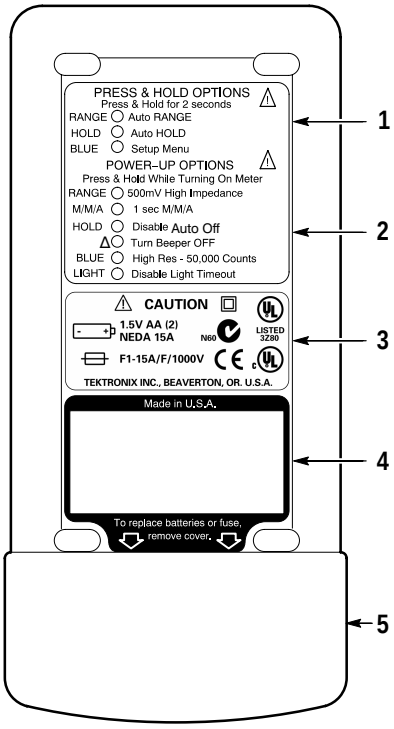
7 Backlight Button – Use to turn backlight on and off.

8 HOLD Button – Use to freeze display.

9 Δ Button – Use to make relative measurements and access the memory.

10 Input connectors.

Figure 2–1: Front panel overview



1 Press and hold options – Activate by holding down the specified button for two seconds while the meter is on.

2 Power-up options – Activate by holding down the specified button while turning on the meter.

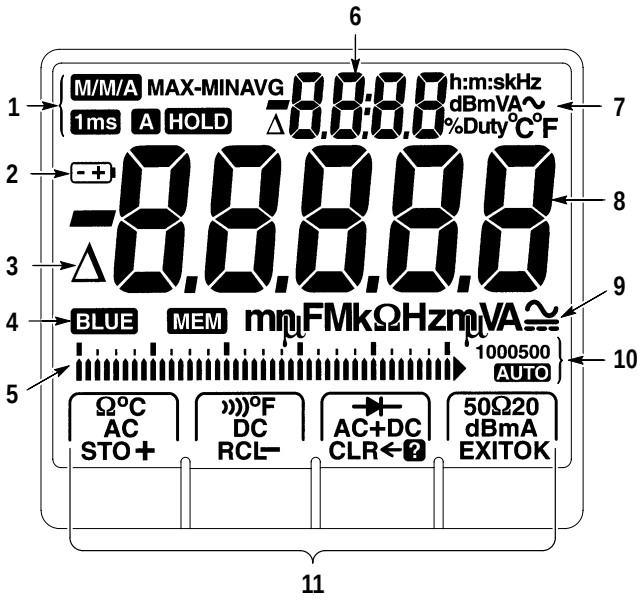
3 Compliance and battery and fuse replacement information.

4 Serial number and barcode tag.

5 Removable battery cover.

Figure 2–2: Rear panel overview

Display Indicators



1 Special feature indicators
2 Low battery indicator
3 Delta indicator
4 Blue button and memory mode indicators
5 Bargraph
6 Upper display
7 Upper display units
8 Main display
9 Main display units
10 Range indicators
11 Softkey menus

Figure 2–3: Display indicators

Measurement Function Knob

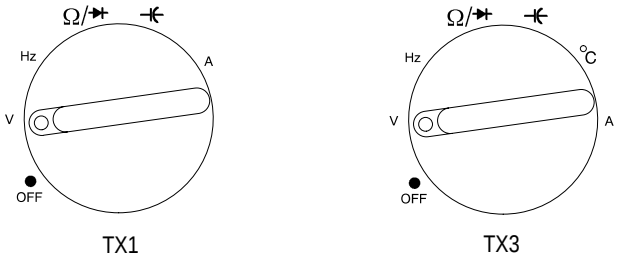


Figure 2–4: Measurement function knob

OFF Turns off the meter. Setup parameters and stored measurements are saved.

V. Volts AC RMS, Volts DC, Volts AC DC dual display, Volts AC+DC total RMS, dB, and dBm.

Hz. Frequency measurements. Duty factor also shows if it is turned on in the Setup menu.

Ω/⊳⊢. Access to resistance and continuity measurements and diode test.

⊣⊢. Capacitance measurements.

°C. Temperature measurements in degrees Celsius or Fahrenheit.

A. Amps AC RMS, Amps DC, Amps AC + DC total RMS, Amps AC DC dual display, and Amps DC 4-20 mA% (process control loop measurement).

Input Connectors

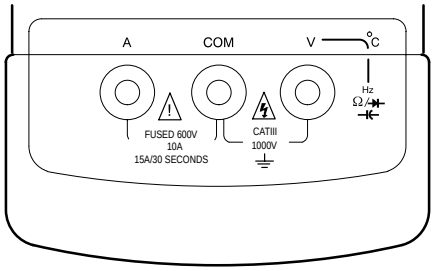


Figure 2–5: Input connectors

A. Input connector for current measurements up to 15 A (10 A continuous, or 15 A for 3 minutes on and 10 minutes off). Successive high current measurements (above 10 A) require a 10 minute cooling time between measurements. Rating is 600 V open circuit voltage.

COM. Common connector. All measurements are referenced to this connector.

V. Input connector for volts, frequency, ohms, continuity, diode, capacitance, and temperature measurements. Rating is 1000 V CAT III for all V input connector measurements.

WARNING. *To avoid personal injury, do not attach meter leads with the battery cover removed.*

CAUTION. *To avoid damaging the meter, do not attempt to measure current with the batteries removed.*

Button and Softkey Overview

Blue Button

To access functions in blue text, press the blue button and then press a function button while the BLUE indicator is on. The BLUE indicator shows on the display for five seconds.

Press and hold the blue button for two seconds to access the Setup menu. See page 2–8 for more information about the Setup menu.

RANGE Button

Use the RANGE button to manually select a range. Press and hold RANGE for two seconds to return the meter to auto range mode. The meter is in auto range mode when the AUTO indicator is on.

The range and units are displayed above the AUTO indicator, to the right of the bargraph.

M/M/A (Minimum, Maximum, and Average) Button

Press this button to scroll through the live**,** maximum, minimum, maximum–minimum, and average values. The elapsed time between the last recorded event and the start of the test shows in the upper display.

Press and hold the M/M/A button for two seconds to exit M/M/A mode.

1ms (1 ms Peak Hold)

1ms (1 ms Peak Hold)

To activate 1 ms peak hold, first press the blue button and then the M/M/A button while the BLUE indicator shows on the display. When in 1 ms mode, the LCD displays the 1ms and M/M/A indicators. Display resolution in 1ms peak hold is 5,000 counts. Live and average (AVG) readings are not available in 1ms peak hold mode.

You can use 1ms peak hold when you take AC or DC measurements. The meter only records events that have a pulse width that is greater than 1 ms.

Press the M/M/A button to view 1ms peak hold minimum and maximum values. The MAX value shown is the value of the positive peaks and the MIN value shown is the value of the negative peaks.

Press and hold the M/M/A button for two seconds to exit 1ms peak hold mode.

Backlight Button

Press the ⦾ button to turn the backlight on or off. Adjust the LOFF setting in the Setup menu to adjust the backlight timeout setting. Use the Setup menu information on page 2–8 to adjust the setting for the backlight.

HOLD Button

Press HOLD to turn hold mode on and off. When you activate the hold feature, the meter beeps, freezes the display, and displays the HOLD indicator. Hold mode freezes the display so you can remove the probes from the test points without losing the measurement reading.

Auto Hold

To activate auto hold, press down on the HOLD button until A HOLD appears on the display. Auto hold is not available for capacitance or AC DC measurements.

In auto hold mode the display automatically freezes and the meter beeps when the measurement reading stabilizes. The displayed value will be updated when the meter stabilizes on a new measurement value.

Auto hold is useful when it is not possible for you to press the HOLD button or see the meter display while probing and taking measurements.

Δ Button (Making Relative Measurements)

Use this button to set the meter to delta (Δ) mode and make relative measurements. The reference value for the Δ measurement can be a measured, a stored, or a programmed value.

Δ Relative to a Measured Value. When you take the measurement and the meter settles on the measurement value, press the Δ button.

For subsequent readouts, the measured reference value is subtracted from the actual measurement.

Δ Relative to a Saved Value. Use the measurement function knob and softkeys to set the meter to the measurement function you want. Use the memory information on page 2–8 to recall (RCL) a reference value from memory, then press the Δ button. To exit delta mode, press the Δ button.

For subsequent readouts, the recalled reference value is subtracted from the actual measurement.

Δ Relative to a Programmed Value. Use the measurement function knob and softkeys to set the meter to the measurement function and range you want and then press the Δ button. While the meter is in delta mode, press and hold the blue button until the Setup menu appears. Use the softkeys to edit ***rEF*** to the desired value and press softkey 4 for OK. To exit delta mode, press the Δ button.

For subsequent readouts the programmed reference value is subtracted from the actual measurement. The programmed reference value is lost when you turn off the meter.

You can also use the Δ button to make relative dB (ΔdB) measurements.

MEM (Memory)

Use the memory mode to store and recall measurement values. No data is lost during power cycles.

To activate the MEM (memory) mode, press the blue button and then the Δ button while BLUE shows on the LCD display. The display shows four softkey selections: STO, RCL, CLR, and EXIT.

STO. Select STO to store the held value in the next available memory location. The memory location number momentarily shows on the upper display. If no memory locations are available, FULL shows on the upper display for two seconds and nothing is stored.

To overwrite an existing memory value, recall the memory location using the RCL button, press CLR, then press STO to store the new value in this location.

RCL. Select RCL to scroll through the stored values in reverse order. The upper display momentarily shows the memory location while the main display shows the value stored in that location.

CLR. Select CLR to clear the currently selected memory location. The location is replaced with "-----".

To clear all memory locations, press and hold the CLR button for five seconds. A ▮ shows on the display next to the CLR enunciator. The word ***donE*** shows on the display indicating that all memory locations are clear and you can release the button. If you release the button before the word ***donE*** shows, no data is cleared from the memory.

EXIT. Select EXIT to exit memory mode. You can also exit memory mode by pressing any button.

Softkeys

Each setting on the measurement function knob may activate one or more softkey settings on the LCD. If there is more than one measurement for a function knob setting, a softkey menu appears on the display. Press the corresponding softkey to select the desired measurement.

Setup Menu

The Setup menu allows you to customize default settings. To activate the Setup menu, press and hold the blue button for two seconds.

Use the softkeys as shown in the following table to edit setup values. Setup menu values are saved when you turn off the meter, except for reference values.

Softkey	1 +	2 –	3 ←	4 OK
Function	Press to increase setting value.	Press to decrease setting value.	Press to step to next digit in setting value.	Press to save setting and move to next setup parameter.

The following table lists the setup menu prompts, the definition of parameters, and default values.

Table 2–1: Setup prompts, definitions, and default values

Upper display prompt	Definition of parameter (press OK to cycle through parameters)	Default value
POFF	Sets auto-off time (in minutes).	30 minutes
LOFF	Sets backlight auto-off time (in seconds).	60 seconds
bEEP	Toggles beeper on and off.	ON
HrES	Changes display to 50,000 counts.	OFF
POL (Duty)	Scrolls through OFF, POS (positive duty factor), and NEG (negative duty factor).	OFF
EdGE (Hz)	Toggles between POS (positive edge) and NEG (negative edge) triggering in Hz measurement.	Positive (rising)
rEF[1]	Changes the reference value for delta measurements.	Value before Δ button is pressed
(Δ)*rEF*(dB) [1]	Changes the reference value for dB measurements.	1 V

[1] **Meter must be in Δ or dB mode to access these setup parameters.**

Helpful Tip: Increased Temperature Accuracy

To achieve high accuracy temperature measurements to ±1.0 °C it is necessary to calibrate the meter to account for any thermocouple offset. Temperature accuracy without performing the following calibration is ±3 °C:

1. Turn on the meter in the environment you will make the measurements.
2. Fill a wide, shallow container with ice and water. Stir the ice and water mixture for two or three minutes to evenly distribute the temperature of the mixture. Place the container next to the meter and submerge the tip of the bead probe in the ice and water.
3. While in °C or °F mode, allow the temperature reading to stabilize on a value (this value should be very close to 0 °C for °C mode or 32.0 °F for °F mode). Any deviation from 0 °C or 32 °F represents the thermocouple's offset.
4. Once the reading stabilizes, press and hold softkey 1 for °C mode or softkey 2 for °F mode for five seconds until the display shows 0000 or 0032.

This calibrates the meter for the operating environment. Δ shows in the upper display. If you hear an error beep, the offset is greater than ±5 °C. You can repeat this calibration at any time. To undo this calibration, return the meter to factory settings by pressing both the blue button and M/M/A button while powering up the meter.

To insure accuracy of temperature measurements, you should follow this procedure when using other K-type thermocouple probes with the TX Series True RMS Digital Multimeters because accuracy specifications vary in different types of probes.

***NOTE**. Observe proper polarity on the probe adapter and do not calibrate the offset immediately following high amperage measurements.*

Battery Replacement

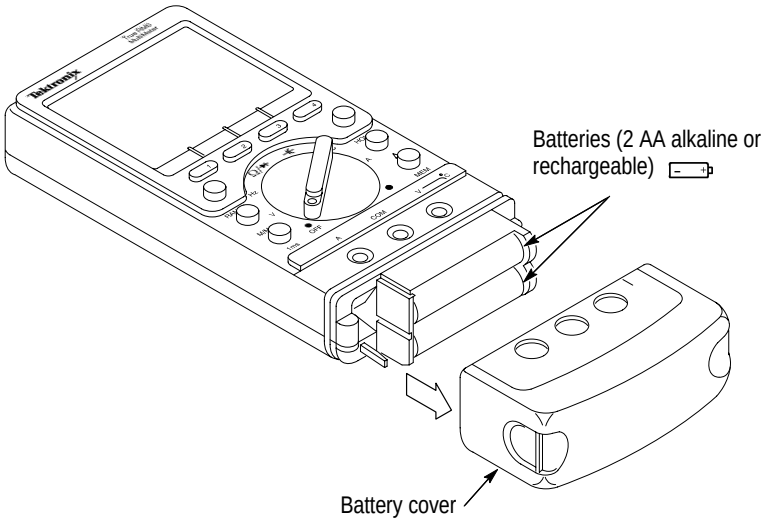


Figure 2–6: Battery replacement

When you replace a battery the meter calibration is not affected and the stored data is not lost.

Remove the battery cover only in a clean, dry environment.

See the *Specifications* chapter for the description and part numbers of the replaceable batteries.

Theory of Operation

Theory of Operation

This chapter provides a simple operating diagram of the TX1 and TX3 meters using the major circuit blocks.

General Description

As illustrated with the block diagram, the TX1 and TX3 meters have five main elements in the signal path.

- Signal conditioning
- A chip
- B chip
- Microprocessor
- Display

Signal Conditioning

The attenuators (compensated with parallel capacitors) condition (divide) the input signal to a level appropriate for the ICs. The conditioning includes transforming all inputs to voltage. The current shunts (selected by FET switches) provide the correct voltage drops. For ohms and capacitance, the inputs are configured as current sources and the voltage drop across the input impedance is measured.

A Chip

Chip A works with the attenuator and input conditioners to transform the signal to levels appropriate for chip B. Chip A has multiple inputs and three outputs. A ± 0.5 V analog signal is sent to chip B for analog-to-digital conversion.

B Chip

Chip B does the analog-to-digital conversion, provides all calculations, and sends the digital signals to the microprocessor.

Microprocessor

The microprocessor controls chips A and B and all relays upon receiving commands from the function switch and buttons (or the infrared PC interface port).

LCD

The liquid crystal display is a 160 segment, dual display capable of displaying 50,000 counts in the main display and 5,000 counts in the upper display. The backlight is provided by LEDs located on the circuit board.

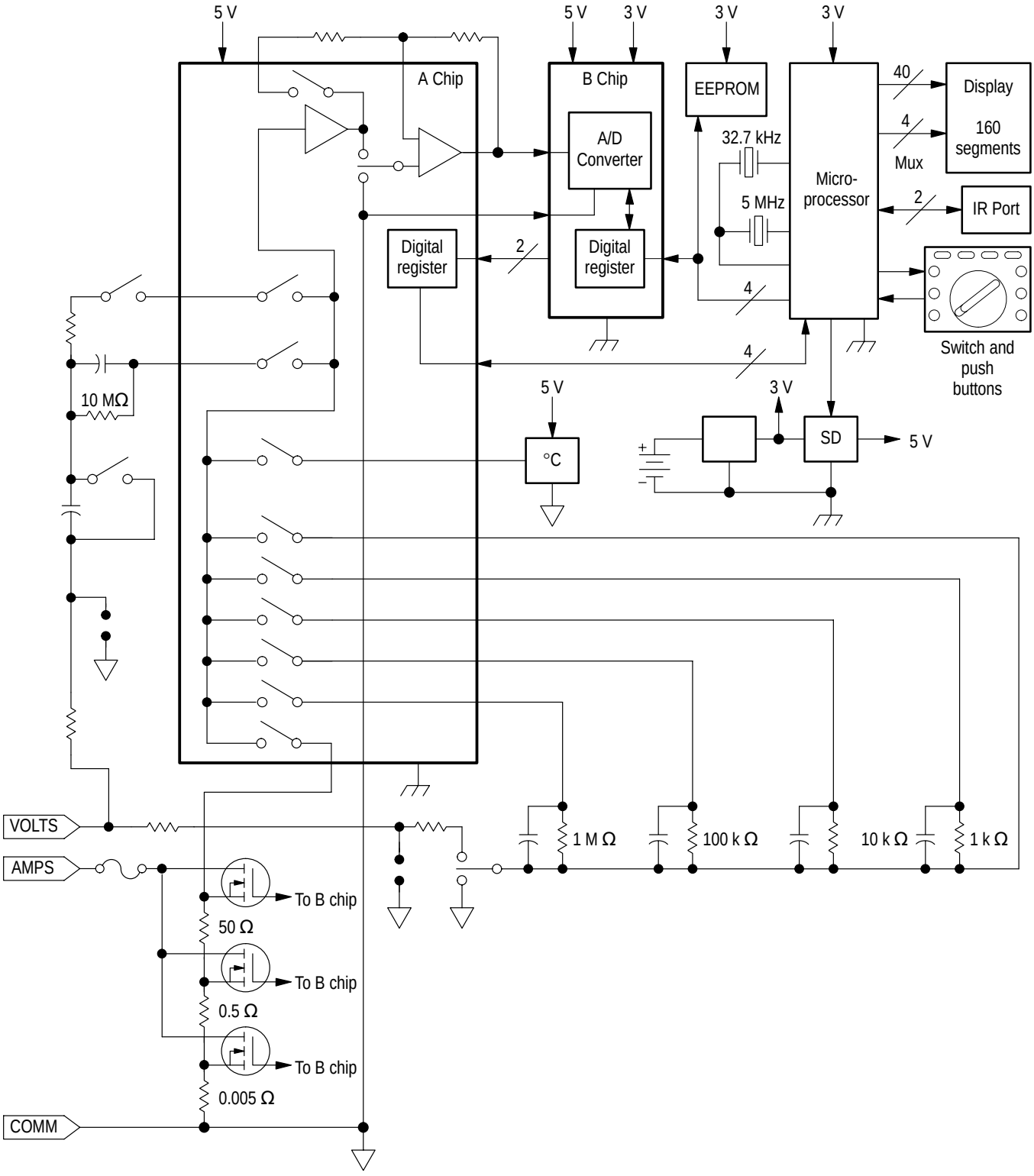


Figure 3–1: Simple block diagram

Performance Verification

Performance Verification

This section contains procedures to verify that the TX1 or TX3 True RMS Digital Multimeters perform as warranted. If a meter fails any of these tests, it needs calibrated and/or repaired.

The performance verification procedures confirm electrical characteristics under the following conditions:

- The meter operates in an 18° to 28° C (64° to 82° F) ambient environment with a relative humidity of less than 80%.
- The meter stabilizes in the stated ambient temperature for one hour.
- The meter warms up for 30 seconds.
- Allow the meter to settle to its final value before taking the measurement.
- The meter remains fully assembled and in the protective boot.

The performance verification consists of the tests listed in Table 4–1.

Table 4–1: Performance verification tests

AC Volts Test
AC Volts Frequency Test
DC Volts Test
Volts Peak Hold Test
AC DC Volts Test
AC+DC Volts and Frequency Test
Frequency Test
Duty Factor Test
Ω Test
Continuity Test
Diode Test
Capacitance Test
DC Current Test
AC Current Test

The performance verification procedure should be performed annually.

Test Equipment

The performance verification procedures use external traceable test equipment to test warranted characteristics.

Alternative test equipment must meet or exceed the intended minimum requirements listed in Table 4–2. If you substitute equipment, you may need to modify the procedures.

***NOTE**. Before beginning the performance verification procedures, warm up the test equipment according to the manufacturer's recommendations.*

Table 4–2: Test equipment

Description	Minimum requirements	Example product
Universal Calibration System	Resolution & accuracy 4 times greater than the meter display reading.	Wavetek 9100 with 9105 work mat/lead set. Fluke 5500A
	AC and DC volts measurement[1] AC and DC current measurement	
	Resistance measurement[1] Capacitance measurement	
	Sinewave generation Squarewave generation	
Capacitance Standard		Optional

1 **Choose 4-wire measurement setup if available.**

Set Up

Prepare the meter for the performance verification with the following steps.

1. Allow the meter to stabilize at the ambient temperature for one hour before testing.
2. Turn the meter on by rotating the function knob to any position other than OFF.
3. Warm up the meter for 30 seconds.

NOTE. *The auto power off time is adjustable using the setup menu. You can disable the auto power off by pushing the* HOLD *button when turning the function knob from the* OFF *position.*

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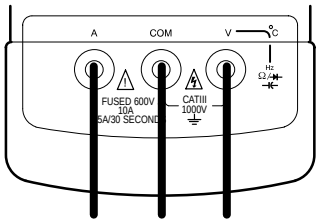
4. Connect the calibrator test leads to the meter inputs observing the color coded leads and inputs (for example: yellow to A, red to V, and black to COM).



Yellow Black Red

NOTE. Test lead colors from calibration equipment may vary

WARNING. *To avoid electric shock, avoid touching exposed connections.*

---

5. Keep the meter in the low resolution 5,000-count mode unless instructed otherwise.
6. Pages 4–11 through 4–21 contain test records for the TX1 and TX3 meters. Each model has its own test record. Photocopy the test record pages for your model to record your test results.

NOTE. *If stability of the display reading causes questionable accuracy of a test, set the meter to Average mode.*

Verification Procedure

Implement the following tests to verify the performance of your TX1 or TX3 meter. The procedures are written with the intent that all tests are made from beginning to end.

AC Volts Test

Perform the following steps to verify the AC voltage measurement accuracy.

1. Set the function knob to V.
2. Press softkey 1 to select AC (default setting).
3. Connect the calibrator outputs to the meter V and COM input connectors.
4. Set the calibrator to the first value in the AC volts test record.
5. Turn the calibrator output on.
6. Verify that the meter reads within the specified Display minimum and maximum limits for each of the values in the AC volts test record.
7. Turn the calibrator output off.

AC Volts Frequency Test

Perform the following steps to verify the AC voltage frequency measurement accuracy.

1. Set the function knob to V.
2. Press softkey 1 to select AC (default setting).
3. Connect the calibrator outputs to the meter V and COM input connectors.
4. Set the calibrator to the first value in the AC volts frequency test record.
5. Turn the calibrator output on.
6. Verify that the meter reads within the specified Display minimum and maximum limits for each of the values in the AC volts frequency test record.
7. Turn the calibrator output off.

DC Volts Test

Perform the following steps to verify the DC volts measurement accuracy.

1. Set the function knob to V in the high resolution 50,000-count mode (using the following sub-steps).
   a. Set the function knob to OFF.
   b. Press and hold the BLUE button while setting the function knob to V.
2. Press softkey 2 to select DC.

3. Set the calibrator to the first value in the DC volts test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each of the values in the DC volts test record.
6. Turn the calibrator output off.

Volts Peak Hold Test

Perform the following steps to verify the DC volts peak measurement accuracy.

1. Set the function knob to V.
2. Press softkey 2 to select DC.
3. Press the BLUE button and then the M/M/A button to select the 1 ms Peak Hold function.
4. Connect the yellow, red, and black calibrator outputs to the meter A, V, and COM input connectors.
5. Set the calibrator to the first value in the Volts peak hold test record.
6. Turn the calibrator output on.
7. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the Volts peak hold test record.
8. Turn the calibrator output off.

AC DC Volts Test

Perform the following steps to verify the AC DC voltage measurement accuracy.

1. Set the function knob to V.
2. Press softkey 3 repeatedly to select AC DC.
3. Set the calibrator to the first value in the AC DC volts test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each of the values in the AC DC volts test record.
6. Turn the calibrator output off.

AC+DC Volts and Frequency Test

Perform the following steps to verify the AC + DC voltage measurement accuracy.

1. Set the function knob to V.
2. Press softkey 3 repeatedly to select AC + DC.
3. Set the calibrator to the first value in the AC+DC volts and frequency test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each of the values in the AC+DC volts and frequency test record.
6. Turn the calibrator output off.

Frequency Test

Perform the following steps to verify the frequency measurement accuracy.

1. Set the function knob to Hz in the high resolution 50,000-count mode (using the following sub-steps).
   a. Set the function knob to OFF.
   b. Press and hold the BLUE button while setting the function knob to Hz.
2. Verify that duty factor mode is off (using the following sub-steps).
   a. If % DUTY is displayed in the upper display, press and hold the BLUE button for two seconds.
   b. Press softkey 4 until POL is displayed in the upper display.
   c. Press softkey 1 until OFF is displayed in the main display.
   d. Press the BLUE button to exit the setup mode.
3. Set the calibrator to the value in the Frequency test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits.
6. Turn the calibrator output off.

Duty Factor Test

Perform the following steps to verify the duty factor measurement accuracy.

1. Set the function knob to Hz.
2. Set the trigger edge polarity to positive (using the following sub-steps).
   a. Press and hold the BLUE button for two seconds.
   b. Press softkey 4 until POL is displayed in the upper display.
   c. Press softkey 1 until POS is displayed in the main display.
   d. Press the BLUE button to exit the setup mode.
3. Set the calibrator to the value in the Duty factor test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the Duty factor test record.
6. Turn the calibrator output off.
7. Restore default to frequency (using the following sub-steps).
   a. Press and hold the BLUE button for two seconds.
   b. Press softkey 4 until POL is displayed in the upper display.
   c. Press softkey 1 until OFF is displayed in the main display.
   d. Press the BLUE button to exit the setup mode.

Ω Test

Perform the following steps to verify the resistance measurement accuracy in Ω mode.

1. Set the function knob to Ω/⊣⊢.
2. Set the calibrator to the first value in the Ω test record.
3. Turn the calibrator output on.
4. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the Ω test record.
5. Turn the calibrator output off.
6. Set the function knob to OFF.

Continuity Test

Perform the following steps to verify continuity accuracy.

1. Set the function knob to Ω/⊣▶⊢.
2. Select))) with the softkeys.
3. Set the calibrator to the first value in the Continuity test record.
4. Turn the calibrator output on.
5. Verify proper operation for each value in the Continuity test record.
6. Turn the calibrator output off.
7. Disconnect the calibrator from the meter.
8. Insert the meter test leads into the V and COM input connectors of the meter.
9. Short the test leads together and check for proper operation.
10. Disconnect the meter test leads and reconnect the V and COM input connectors to the calibrator.

Diode Test

Perform the following steps to verify the diode test accuracy.

1. Set the function knob to Ω/⊣▶⊢.
2. Press softkey 3 to select the diode test mode.
3. Set the calibrator to the first value in the Diode test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the Diode test record.
6. Turn the calibrator output off.

Capacitance Test

Perform the following steps to verify the capacitance measurement accuracy.

1. Set the function knob to ⊣⊢.
2. Disconnect the test leads from the meter input connectors.
3. Record the reading in the Capacitance test record.

4. Null the residual DMM and lead capacitance offset as described here depending on the type of test equipment (using the following sub-steps).
   a. Using Wavetek 9100 with 9105 work mat and lead set:
      - Connect the black lead from the calibrator output to the meter COM input.
      - Press the meter Δ button.
      - Connect the red lead from the calibrator output to the meter V input.
   b. Using Fluke 5500A or Wavetek 9100 without the work mat and lead set:
      - Connect the black lead from the calibrator output to the meter COM input.
      - Connect the red lead to the meter V input. (Do not connect the red lead to the calibrator output yet.)
      - Press the meter Δ button.
      - Connect the red lead to the calibrator output.
5. Set the calibrator to the first value in the Capacitance test record.
6. Turn the calibrator output on.
7. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the Capacitance test record.
8. Turn the calibrator output off.

DC Current Test

Perform the following steps to verify the DC current measurement accuracy.

1. Set the function knob to A.
2. Set the calibrator to the first value in the DC current test record.
3. Turn the calibrator output on.
4. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the DC current test record.
5. Turn the calibrator output off.

AC Current Test

Perform the following steps to verify the AC current measurement accuracy.

1. Set the function knob to A.
2. Select AC with the softkeys.
3. Set the calibrator to the first value in the AC current test record.
4. Turn the calibrator output on.
5. Verify that the meter reads within the specified Display minimum and maximum limits for each value in the AC current test record.
6. Turn the calibrator output off.
7. Disconnect the calibrator from the meter.

TX1 Test Record

Serial number	Procedure performed by	Date

Table 4–3: TX1 test record results

Test input		Tolerance	Display minimum	Test result	Display maximum
AC volts test [1]					
0.0000 V	–	± 2 counts	0.0 mV		0.2 mV
50.00 mV	60 Hz	±(0.6% + 2 counts)	49.5 mV		50.5 mV
460.0 mV	60 Hz	±(0.6% + 2 counts)	457.0 mV		463.0 mV
	20 kHz	±(0.6% + 2 counts)	457.0 mV		463.0 mV
4.600 V	40 Hz	±(0.6% + 2 counts)	4.570 V		4.630 V
	1 kHz	±(0.6% + 2 counts)	4.570 V		4.630 V
	10 kHz	±(0.6% + 2 counts)	4.570 V		4.630 V
	20 kHz	±(0.6% + 2 counts)	4.570 V		4.630 V
46.00 V	60 Hz	±(0.6% + 2 counts)	45.70 V		46.30 V
	20 kHz	±(0.6% + 2 counts)	45.70 V		46.30 V
460.0 V	60 Hz	±(0.6% + 2 counts)	457.0 V		463.0 V
	20 kHz	±(0.6% + 2 counts)	457.0 V		463.0 V
1000 V	60 Hz	±(0.6% + 2 counts)	992 V		1008 V
	10 kHz	±(0.4% + 2 counts)	992 V		1008 V
AC volts frequency test (upper display readout)					
100.0 mV	40 Hz	± 1 count	39.99 Hz		40.01 Hz
	20 kHz	± 1 count	19.99 kHz		20.01 kHz
500.0 mV [2]	40 Hz	± 1 count	39.99 Hz		40.01 Hz
	20 kHz	± 1 count	19.99 kHz		20.01 kHz

1 The upper display readout is ±1 counts corresponding to the input frequency.

2 Manually select the 5 V range.

Table 4–3: TX1 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
DC volts test [3]					
0.0000 V		± 10 counts	–0.10 mV		0.10 mV
46.00 mV		±(0.07% + 10 counts)	45.87 mV		46.13 mV
460.0 mV		±(0.07% + 10 counts)	459.58 mV		460.42 mV
–460.0 mV		±(0.07% + 10 counts)	–460.42 mV		–459.58 mV
4.600 V		±(0.07% + 10 counts)	4.5958 V		4.6042 V
46.00 V		±(0.07% + 10 counts)	45.958 V		46.042 V
460.00 V		±(0.07% + 10 counts)	459.58 V		460.42 V
1000.0 V		±(0.07% + 10 counts)	998.3 V		1001.7 V
–1000.0 V		±(0.07% + 10 counts)	–1001.7 V		–998.3 V
Volts peak hold test					
3.2 V [4], 500 Hz square wave	MAX	± 30 counts	3.167 V		3.233 V
3.2 V [4], 500 Hz square wave	MIN	± 30 counts	–3.233 V		–3.167 V
AC DC volts test					
32 mV	DC	±(0.7% + 3 counts)	31.8 mV [5]		32.2 mV
460 mV	40 Hz	±(0.7% + 3 counts)	456.5 mV [5]		463.5 mV
AC+DC volts & frequency test					
–1.000 V	DC	±(0.7% + 3 counts)	0.990 V		1.010 V
1.000 V	DC	±(0.7% + 3 counts)	0.990 V		1.010 V
1.000 V	60 Hz	±(0.7% + 3 counts)	0.990 V		1.010 V
500.0 mV [6]	20 kHz	± 1 count	19.99 kHz [7]		20.01 kHz [7]

[3] Use the high resolution 50,000-count mode.

[4] Set input voltage to 6.4 V square wave if using a Fluke 5500A calibrator.

[5] The voltage is shown in the upper display readout.

[6] Manually select the 5 V range.

[7] The frequency is shown in the upper display readout.

Table 4–3: TX1 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
Frequency test [8,9]					
990.00 kHz	2.82 V_{p-p}	±(0.002% + 1 count)	989.97 kHz		990.03 kHz
Duty factor test [10]					
10.0%	5 V_{p-p}, 100 Hz, 10% DF pulse	±(0.1% + 0.05% per kHz + 1 count)	9.9 %		10.1 %
Ω test					
0.00 Ω [11]		± 4 counts	0.0 Ω		0.4 Ω
40.00 Ω [12]		±(0.1% + 10 counts)	39.86 Ω		40.14 Ω
400.0 Ω [11]		±(0.1% + 4 counts)	399.2 Ω		400.8 Ω
4.000 kΩ		±(0.1% + 2 counts)	3.994 kΩ		4.006 kΩ
40.00 kΩ		±(0.1% + 2 counts)	39.94 kΩ		40.06 kΩ
400.0 kΩ		±(0.1% + 2 counts)	399.4 kΩ		400.6 kΩ
4.000 MΩ		±(0.4% + 4 counts)	3.980 MΩ		4.020 MΩ
40.00 MΩ		±(1% + 4 counts)	39.56 MΩ		40.44 MΩ
Continuity test					
50 Ω		Beeper sounds	–		–
150 Ω		Beeper does not sound	–		–
Multimeter leads shorted		Beeper sounds	–		–
Diode test					
0.5 V		± 1%	0.495 V		0.505 V

8 **Use the high resolution 50,000-count mode.**

9 **The Wavetek 9100 (see Test Equipment table) is the recommended test equipment to accurately perform this test.**

10 **The duty factor is shown in the upper display readout.**

11 **Use Delta mode.**

12 **Select 50 ohm range using soft key 4 for this range only**

Table 4–3: TX1 test record results (cont.)

Test input	Tolerance	Display minimum	Test result	Display maximum
Capacitance test [13,14]				
4.000 nF	±(1% + 5 counts)	3.955 nF		4.045 nF
40.00 nF	±(1% + 3 counts)	39.57 nF		40.43 nF
400.0 nF	±(1% + 3 counts)	395.7 nF		404.3 nF
4.000 µF	±(1% + 3 counts)	3.957 µF		4.043 µF
40.00 µF	±(3% + 3 counts)	38.77 µF		41.23 µF
400.00 µF	±(3% + 3 counts)	387.7 µF		412.3 µF
4.000 mF [15]	±(3% + 3 counts)	3.877 mF		4.123 mF
40.00 mF [15]	±(3% + 3 counts)	38.77 mF		41.23 mF

13 **Variations in test equipment can cause erroneous readings. Use a fixed value capacitance standard if instability occurs.**

14 **Set the DMM to Delta mode. Delta mode removes stray capacitance for low capacitance measurements.**

15 **Wavetek 9100 only.**

DC current test				
0.0 µA	± 4 counts	–0.4 µA		0.4 µA
460.0 µA	±(0.2% + 4 counts)	458.7 µA		461.3 µA
–460.0 µA	±(0.2% + 4 counts)	–461.3 µA		–458.7 µA
4.600 mA	±(0.2% + 2 counts)	4.589 mA		4.611 mA
46.00 mA	±(0.2% + 2 counts)	45.89 mA		46.11 mA
0.4600 A	±(0.2% + 2 counts)	458.9 mA		461.1 mA
4.600 A	±(0.4% + 2 counts)	4.580 A		4.620 A
10.00 A	±(0.8% + 2 counts)	9.90 A		10.10 A

Table 4–3: TX1 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
AC current test [16]					
0.0 µA		±2 counts	0.0 µA		0.2 µA
460.0 µA	60 Hz	±(0.6% + 2 counts)	457.0 µA		463.0 µA
	5 kHz	±(2% + 2 counts)	450.6 µA		469.4 µA
4.600 mA	60 Hz	±(0.6% + 2 counts)	4.570 mA		4.630 mA
	5 kHz	±(2% + 2 counts)	4.506 mA		4.694 mA
46.00 mA	60 Hz	±(0.6% + 2 counts)	45.70 mA		46.30 mA
	3 kHz	±(1.0% + 2 counts)	45.52 mA		46.48 mA
	5 kHz	±(2% + 2 counts)	45.06 mA		46.94 mA
460.00 mA	60 Hz	±(0.6% + 2 counts)	457.0 mA		463.0 mA
	3 kHz	±(1.0% + 2 counts)	455.2 mA		464.8 mA
	5 kHz	±(2% + 2 counts)	450.6 mA		469.4 mA
4.600 A	60 Hz	±(0.6% + 2 counts)	4.570 A		4.630 A
	5 kHz	±(2% + 2 counts)	4.506 A		4.694 A
10.00 A	60 Hz	±(0.6% + 2 counts)	9.92 A		10.08 A
	5 kHz	±(2% + 2 counts)	9.78 A		10.22 A

[16] The upper display readout is ±1 count corresponding to the input frequency.

TX3 Test Record

Serial number	Procedure performed by	Date

Table 4–4: TX3 test record results

Test input		Tolerance	Display minimum	Test result	Display maximum
AC volts test [1]					
0.0000 V	–	± 2 counts	0.0 mV		0.2 mV
50.00 mV	60 Hz	±(0.4% + 2 counts)	49.6 mV		50.4 mV
460.0 mV	60 Hz	±(0.4% + 2 counts)	458.0 mV		462.0 mV
	20 kHz	±(0.4% + 2 counts)	458.0 mV		462.0 mV
4.600 V	40 Hz	±(0.4% + 2 counts)	4.580 V		4.620 V
	1 kHz	±(0.4% + 2 counts)	4.580 V		4.620 V
	10 kHz	±(0.4% + 2 counts)	4.580 V		4.620 V
	20 kHz	±(0.4% + 2 counts)	4.580 V		4.620 V
46.000 V	60 Hz	±(0.4% + 2 counts)	45.80 V		46.20 V
	20 kHz	±(0.4% + 2 counts)	45.80 V		46.20 V
460.00 V	60 Hz	±(0.4% + 2 counts)	458.0 V		462.0 V
	20 kHz	±(0.4% + 2 counts)	458.0 V		462.0 V
1000.0 V	60 Hz	±(0.4% + 2 counts)	994 V		1006 V
	10 kHz	±(0.4% + 2 counts)	994 V		1006 V

1 The upper display readout is ±1 count corresponding to the input frequency.

AC volts frequency test (upper display readout)					
100.0 mV	40 Hz	± 1 count	39.99 Hz		40.01 Hz
	20 kHz	± 1 count	19.99 kHz		20.01 kHz
500.0 mV [2]	40 Hz	± 1 count	39.99 Hz		40.01 Hz
	20 kHz	± 1 count	19.99 kHz		20.01 kHz

2 Manually select the 5 V range.

Table 4–4: TX3 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
DC volts test [3]					
0.0000 V		± 10 counts	–0.10 mV		0.10 mV
46.00 mV		±(0.05% + 10 counts)	45.88 mV		46.12 mV
460.00 mV		±(0.05% + 10 counts)	459.67 mV		460.33 mV
–460.00 mV		±(0.05% + 10 counts)	–460.33 mV		–459.67 mV
4.6000 V		±(0.05% + 10 counts)	4.5967 V		4.6033 V
46.000 V		±(0.05% + 10 counts)	45.967 V		46.033 V
460.00 V		±(0.05% + 10 counts)	459.67 V		460.33 V
1000.0 V		±(0.05% + 10 counts)	0998.5 V		1001.5 V
–1000.0 V		±(0.05% + 10 counts)	–1001.5 V		–0998.5 V
Volts peak hold test					
3.2 V [4], 500 Hz square wave	MAX	± 30 counts	3.167 V		3.233 V
3.2 V [4], 500 Hz square wave	MIN	± 30 counts	–3.233 V		–3.167 V
AC DC volts test					
32 mV	DC	±(0.5% + 3 counts)	31.8 mV [5]		32.2 mV
460 mV	40 Hz	±(0.5% + 3 counts)	457.4 mV [5]		462.6 mV
AC+DC volts and frequency test					
–1.000 V	DC	±(0.7% + 3 counts)	0.990 V		1.010 V
1.000 V	DC	±(0.7% + 3 counts)	0.990 V		1.010 V
1.000 V	60 Hz	±(0.7% + 3 counts)	0.990 V		1.010 V
500.0 mV [6]	20 kHz	± 1 count	19.99 kHz [7]		20.01 kHz [7]

[3] Use the high resolution 50,000-count mode.

[4] Set input voltage to 6.4 V square wave if using a Fluke 5500A calibrator.

[5] The voltage is shown in the upper display readout.

[6] Manually select the 5 V range.

[7] The frequency is shown in the upper display readout.

Table 4–4: TX3 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
Frequency test [8,9]					
990.00 kHz	2.82 V_{p-p}	±(0.002% + 1 count)	989.97 kHz		990.03 kHz
Duty factor test [10]					
10.0%	5 V_{p-p}, 100 Hz, 10% DF pulse	±(0.1% + 0.05% per kHz + 1 count)	9.9 %		10.1 %
Ω test					
0.00 Ω [11]		± 4 counts	0.0 Ω		0.4 Ω
40.00 Ω [12]		±(0.1% + 10 counts)	39.86 Ω		40.14 Ω
400.0 Ω [11]		±(0.1% + 4 counts)	399.2 Ω		400.8 Ω
4.000 kΩ		±(0.1% + 2 counts)	3.994 kΩ		4.006 kΩ
40.00 kΩ		±(0.1% + 2 counts)	39.94 kΩ		40.06 kΩ
400.0 kΩ		±(0.1% + 2 counts)	399.4 kΩ		400.6 kΩ
4.000 MΩ		±(0.4% + 4 counts)	3.980 MΩ		4.020 MΩ
40.00 MΩ		±(1% + 4 counts)	39.56 MΩ		40.44 MΩ
Continuity test					
50 Ω		Beeper sounds	–		–
150 Ω		Beeper does not sound	–		–
Multimeter leads shorted		Beeper sounds	–		–
Diode test					
0.5 V		± 1%	0.495 V		0.505 V

8 **Use the high resolution 50,000-count mode.**

9 **The Wavetek 9100 (see Test Equipment table) is the recommended test equipment to accurately perform this test.**

10 **The duty factor is shown in the upper display readout.**

11 **Use Delta mode.**

12 **Select 50 ohm range using soft key 4 for this range only**

Table 4–4: TX3 test record results (cont.)

Test input	Tolerance	Display minimum	Test result	Display maximum
Capacitance test [13,14]				
4.000 nF	±(1% + 5 counts)	3.955 nF		4.045 nF
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400.0 nF	±(1% + 3 counts)	395.7 nF		404.3 nF
4.000 µF	±(1% + 3 counts)	3.957 µF		4.043 µF
40.00 µF	±(3% + 3 counts)	38.77 µF		41.23 µF
400.00 µF	±(3% + 3 counts)	387.7 µF		412.3 µF
4.000 mF [15]	±(3% + 3 counts)	3.877 mF		4.123 mF
40.00 mF [15]	±(3% + 3 counts)	38.77 mF		41.23 mF

13 **Variations in test equipment can cause erroneous readings. Use a fixed value capacitance standard if instability occurs.**

14 **Set the DMM to Delta mode. Delta mode removes stray capacitance for low capacitance measurements.**

15 **Wavetek 9100 only.**

DC current test				
0.0 µA	± 4 counts	–0.4 µA		0.4 µA
460.0 µA	±(0.2% + 4 counts)	458.7 µA		461.3 µA
–460.0 µA	±(0.2% + 4 counts)	–461.3 µA		–458.7 µA
4.600 mA	±(0.2% + 2 counts)	4.589 mA		4.611 mA
46.00 mA	±(0.2% + 2 counts)	45.89 mA		46.11 mA
460.00 mA	±(0.2% + 2 counts)	458.9 mA		461.1 mA
4.600 A	±(0.4% + 2 counts)	4.580 A		4.620 A
10.00 A	±(0.8% + 2 counts)	9.90 A		10.10 A

Table 4–4: TX3 test record results (cont.)

Test input		Tolerance	Display minimum	Test result	Display maximum
AC current test [16]					
0.0 µA		± 2 counts	0.0 µA		0.2 µA
460.0 µA	60 Hz	±(0.6% + 2 counts)	457.0 µA		463.0 µA
	5 kHz	±(2% + 2 counts)	450.6 µA		469.4 µA
4.600 mA	60 Hz	±(0.6% + 2 counts)	4.570 mA		4.630 mA
	5 kHz	±(2% + 2 counts)	4.506 mA		4.694 mA
46.00 mA	60 Hz	±(0.6% + 2 counts)	45.70 mA		46.30 mA
	3 kHz	±(1.0% + 2 counts)	45.52 mA		46.48 mA
	5 kHz	±(2.0% + 2 counts)	45.06 mA		46.94 mA
460.0 mA	60 Hz	±(0.6% + 2 counts)	457.0 mA		463.0 mA
	3 kHz	±(1.0% + 2 counts)	455.2 mA		464.8 mA
	5 kHz	±(2% + 2 counts)	450.6 mA		469.4 mA
4.600 A	60 Hz	±(0.6% + 2 counts)	4.570 A		4.630 A
	5 kHz	±(2% + 2 counts)	4.506 A		4.694 A
10.00 A	60 Hz	±(0.6% + 2 counts)	9.92 A		10.08 A
	5 kHz	±(2% + 2 counts)	9.78 A		10.22 A

[16] The upper display readout is ±1 count corresponding to the input frequency.

Adjustment Procedure

Adjustment Procedure

Adjustment of the TX1 and TX3 meters should only be performed if the Performance Verification procedure indicates that adjustment is necessary.

There are no internal adjustments. Contact Tektronix for adjustment information. See page x for methods for contacting Tektronix.

Options

Options

There are no options available for the TX1 and TX3 meters. For a list of available accessories, refer to the *Replaceable Parts* chapter.

Maintenance

Maintenance

This chapter contains the information needed to do periodic and corrective maintenance on the TX Series True RMS Digital Multimeters. The following sections are included:

- *Preparation* refers you to important information contained elsewhere in this manual.
- *Preventing ESD* provides general information on preventing damage to internal modules when doing maintenance.
- *Cleaning* provides procedures for cleaning the exterior of the meter.
- *Drying Procedure* provides instructions to dry the meter should it be exposed to water.
- *Disassembly/Assembly Procedures* provide procedures for the disassembly and reassembly of the meter.
- *Troubleshooting* provides information to help isolate failed modules.
- *Repackaging Instructions* provides packaging information for shipment or storage.

Related Maintenance Procedures

The following sections contain information and procedures related to maintenance.

- Chapter 2, *Operating Information*, covers instructions useful when operating the meter in order to troubleshoot it.
- Chapter 3, *Theory of Operation*, contains a circuit description at the block level.
- Chapter 4, *Performance Verification*, contains procedures that may be useful in isolating problems by testing performance.
- Chapter 5, *Adjustment Procedure*, addresses after repair adjustment and the interval between periodic adjustments.
- Chapter 8, *Parts List*, lists all replaceable parts with part numbers.

Preparation

Only qualified service personnel should perform service procedures. Read the *Service Safety Summary*, the *General Safety Summary*, and the ESD information below before performing any service procedures.

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

Preventing ESD

When performing any service which requires internal access to the meter, adhere to the following precautions to avoid damaging internal components due to electrostatic discharge (ESD).

1. Minimize handling of static-sensitive modules.
2. Transport and store static-sensitive modules in their static protected containers or on a metal rail. Label any package that contains static-sensitive modules.
3. Discharge the static voltage from your body by wearing a grounded antistatic wrist strap while handling these modules. Service static-sensitive devices only at a static-free work station.
4. Nothing capable of generating or holding a static charge should be allowed on the work station surface.
5. Handle circuit boards by the edges when possible.
6. Do not slide boards or components over any surface.
7. Avoid handling in areas that have a floor or work-surface covering capable of generating a static charge.

Susceptibility to ESD. Table 7–1 lists the relative susceptibility of various classes of semiconductors. Static voltages of 1 kV to 30 kV are common in unprotected environments.

Table 7–1: Relative susceptibility to static-discharge damage

Semiconductor classes	Relative susceptibility levels[1]
MOS or CMOS microcircuits or discrete circuits, or linear microcircuits with MOS inputs (most sensitive)	1
ECL	2
Schottky signal diodes	3
Schottky TTL	4
High-frequency bipolar transistors	5
JFET	6
Linear microcircuits	7
Low-power Schottky TTL	8
TTL (least sensitive)	9

1 **Voltage equivalent for levels (voltage discharged from a 100 pF capacitor through resistance of 100 ohms**):

1 = 100 to 500 V
2 = 200 to 500 V
3 = 250 V
4 = 500 V
5 = 400 to 600 V
6 = 600 to 800 V
7 = 400 to 1000 V (est.)
8 = 900 V
9 = 1200 V

Inspection and Cleaning

This section describes how to inspect for dirt and damage and how to clean the exterior. Inspection and cleaning are done as preventive maintenance. Preventive maintenance, when done regularly, may prevent malfunction and enhance its reliability.

Preventive maintenance consists of periodic inspection and cleaning and using general care when operating.

How often to do maintenance depends on the severity of the environment in which the meter is used. A proper time to perform preventive maintenance is just before adjustment.

General Care

The boot helps protect the meter from damage due to bumps and drops. It's recommended to leave the boot on during normal use of the meter. The case keeps out dust and moisture and should be in place when ever operating the meter.

Protect the meter from adverse weather conditions.

Do not expose the LCD display to direct sunlight for long periods of time.

Inspection and Cleaning Procedures

Inspect and clean the meter as often as operating conditions require.

Clean the exterior of the meter by removing dust with a lint-free cloth. Use care to avoid scratching the clear plastic display filter.

For further cleaning, use a soft cloth or paper towel dampened with water. You can use an alcohol-free glass cleaner for more efficient cleaning.

CAUTION. *To avoid damage to the surface of the meter, do not use abrasive or chemical cleaning agents.*

WARNING. *The meter is not protected from exposure to water. Exposing the meter to water can create a shock hazard.*

Internal Cleaning Procedures

In rare cases, the interior of the meter may require cleaning.

Clean the interior by using the disassembly procedures in this chapter. Use a soft lint-free cloth dampened with water. If more efficient cleaning of the LCD contacts and function knob contacts on the circuit board is required, a 75% isopropyl alcohol solution can be used.

Drying Procedure

If the meter is exposed to water, open the case and allow the meter to fully dry. To open the meter, use the procedure in the *Disassembly/Assembly Procedures* section. Before reassembling the meter, check that all seams, battery compartment, and input connectors are dry.

Lubrication

There is no periodic lubrication required.

Disassembly and Assembly Procedures

The following procedures are ordered in the logical sequence of disassembly. You will usually need to start from the beginning and continue until you reach the objective. Reassemble the meter by following the procedures in the reverse order. Use the exploded view of the meter on page 8–5 as an overall guide in both the disassembly and assembly of the meter.

Table 7–2: List of tools

Flat blade screwdriver
#10 Torx tip screwdriver

CAUTION. *The internal components and contacts are adversely affected by skin oil. Take precautions to avoid direct skin contact when performing these procedures. Refer to* Internal Cleaning Procedures *on page 7–4 if you need to clean components before reassembling the meter.*

Meter Case

Use the following procedure to gain access to the service replaceable fuse and all replaceable modules. You must first remove the protective boot to open the meter case. You will need a small flat blade screwdriver and a #10 torx tip screwdriver.

Opening.

1. Remove the battery cover. Remove the batteries and the two screws (one on each side of the batteries).
2. Carefully insert a screw driver between the gasket and meter case and gently lift and remove the gasket.

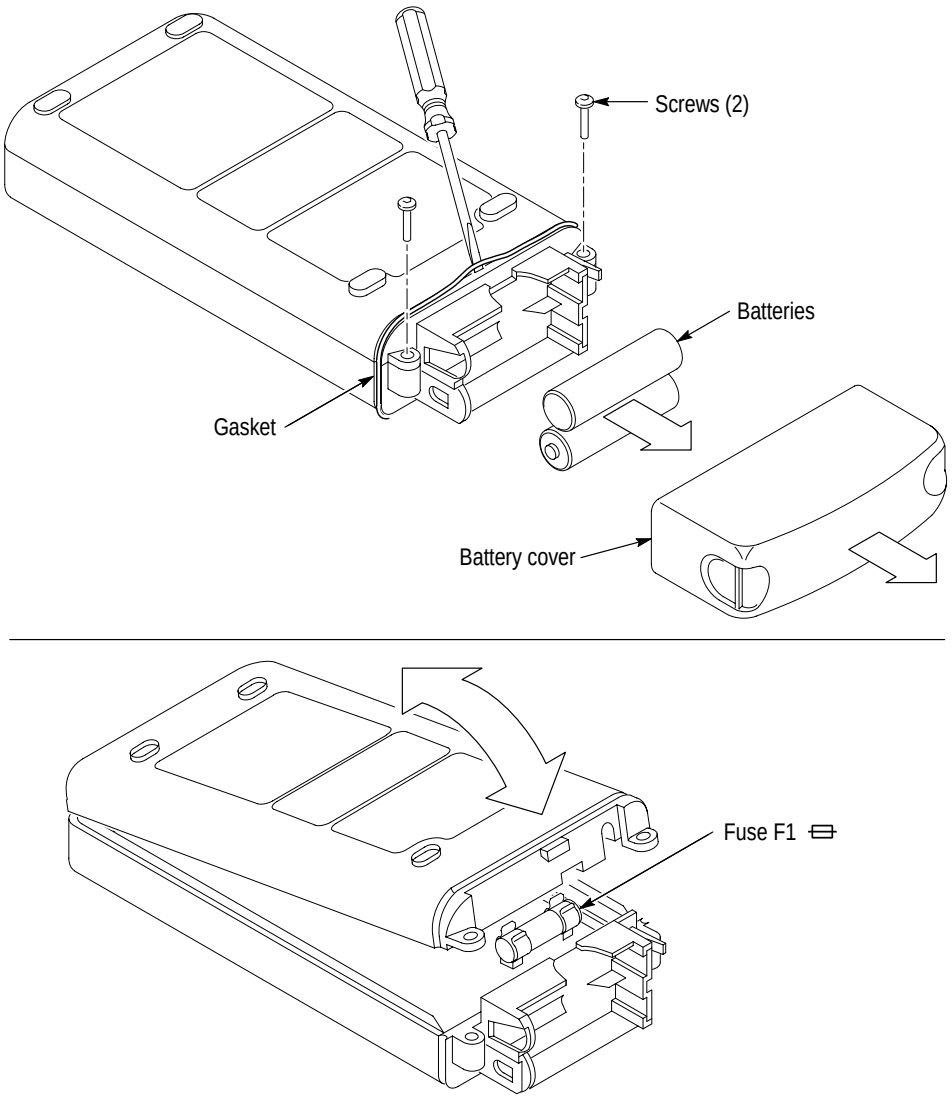

Figure 7–1: Opening and closing the case

CAUTION. *Opening the case allows a "pogo stick" type electrical contact pin to fall out of its holder. Use care not to lose the contact or allow it to remain loose in the instrument when reinstalling the bottom case half. See Figure 7–2 for the location of this pin.*

3. From the end near the batteries, carefully lift the case half up until the opposite end snaps loose.

WARNING. *Installing improper fuses can cause injury and product damage.*

The internal fuse (F1) is accessible at this time. If replacing the fuse, see the *Replaceable Parts* chapter for the proper replacement fuse.

Closing.

1. Check that all seals and contacts are in place.
2. Slip the end of the bottom case half (opposite end from the batteries) into the top case half.
3. Pivot the bottom case half down and press firmly together.
4. Secure the case halves together with the two screws.
5. Install the battery cover gasket. Install the gasket so that its shape matches the shape of the meter case and the bumps on the gasket point towards the batteries.

NOTE*. It's important to install the battery cover gasket correctly to retain the stated environmental characteristics.*

6. Insert batteries and slide the battery cover on.

Internal Assembly

The internal assembly is comprised of the circuit board and display assembly. The internal assembly must be removed from the case half as a unit.

Removal.

1. Disconnect the battery cable from the circuit board. Do not pull on the wires.
2. Remove the two screws securing the internal assembly to the top case.
3. From the front of the top case half, push in on the input connectors to loosen the assembly from the case half.

4. Lift the entire assembly straight up out of the case half.

***NOTE**. The easiest method to lift the assembly out is to grasp the large component on the circuit board and lift straight up.*

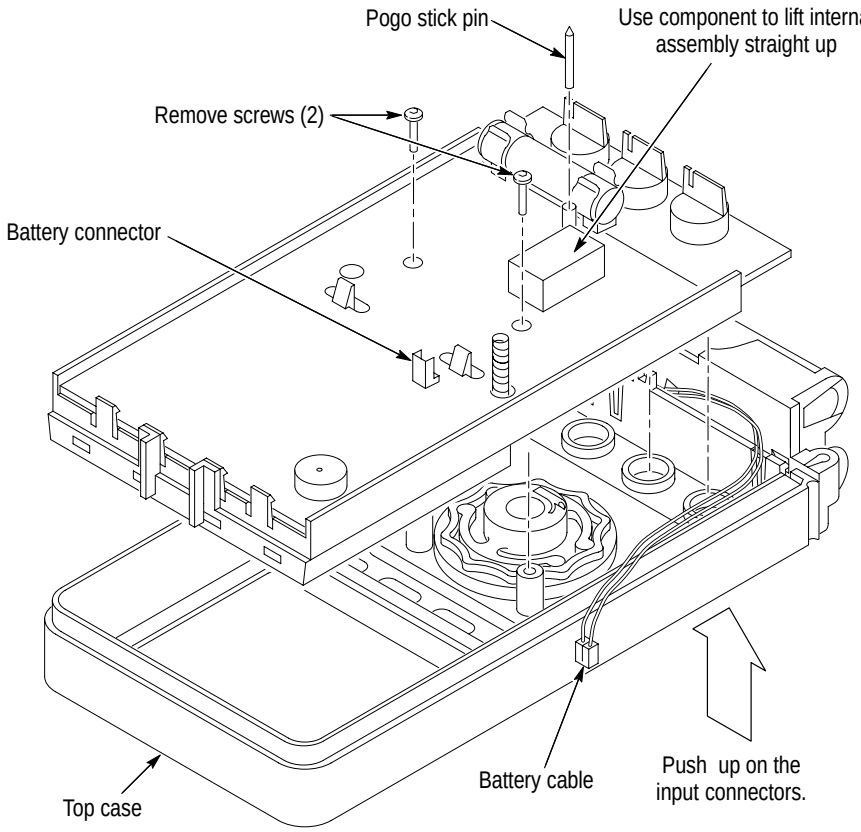

Figure 7–2: Internal assembly removal and installation

Installation.

1. Hold the entire assembly directly above the top case half.
2. Lower the assembly down into the case half and seat the assembly firmly into the case half.
3. Reinstall the two screws to secure the internal assembly to the top case half.
4. Connect the battery cable to the circuit board.

Battery Holder

The battery holder slides off the top case half after disengaging the two securing tabs. The internal assembly must be removed first to allow room for the securing tabs to disengage. Refer to Figure 7–3.

Removal.

1. Remove the internal assembly (see page 7–7).
2. Disconnect the battery cable from the circuit board.
3. Locate the two tabs securing the battery holder to the top case half.

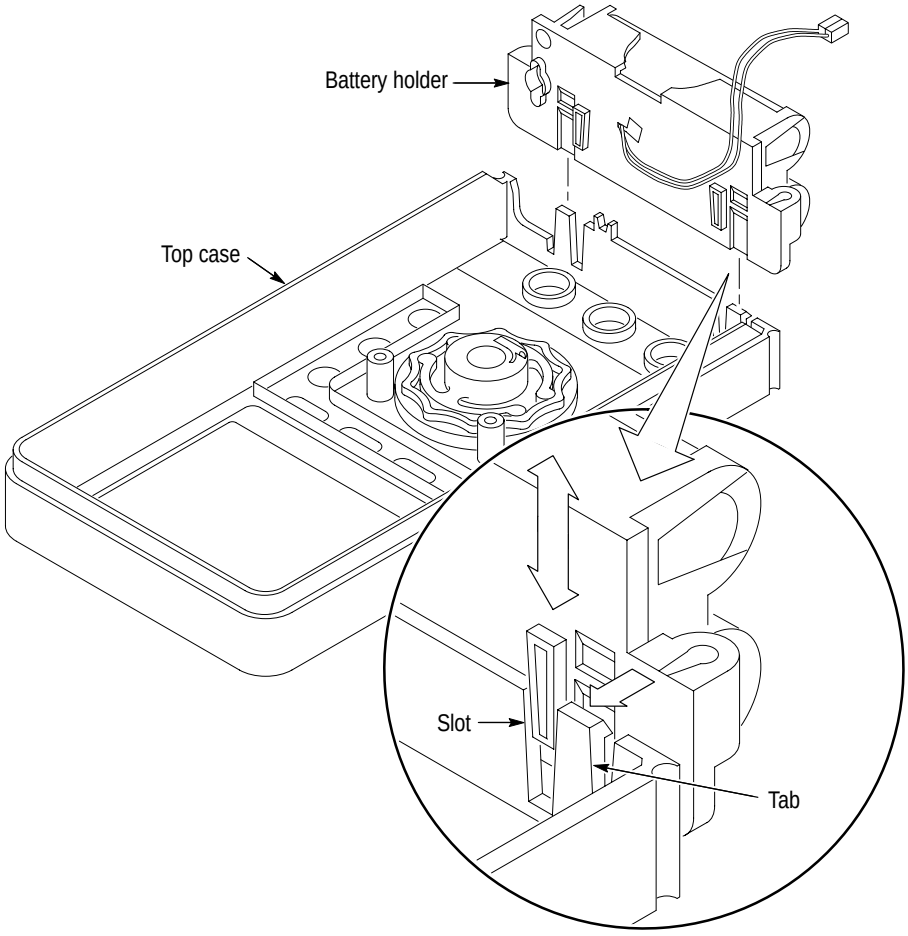

Figure 7–3: Battery holder removal and installation

4. Disengage the tabs and slide the battery holder off the top case half.

Installation.

1. Slide the battery holder down onto the top case half ensuring the two slides on the battery holder engage the matching slots in the top case half.
2. Slide the holder down until the two securing tabs lock into place.

LCD Assembly

The LCD assembly can be accessed after the internal assembly is removed from the top case half.

NOTE. *It is not necessary to remove the circuit board to remove the LCD assembly.*

Removal.

1. Remove the internal assembly (see page 7–7).
2. Using a small flat blade screwdriver, disengage the four tabs (at the top end of the assembly) securing the display bezel.

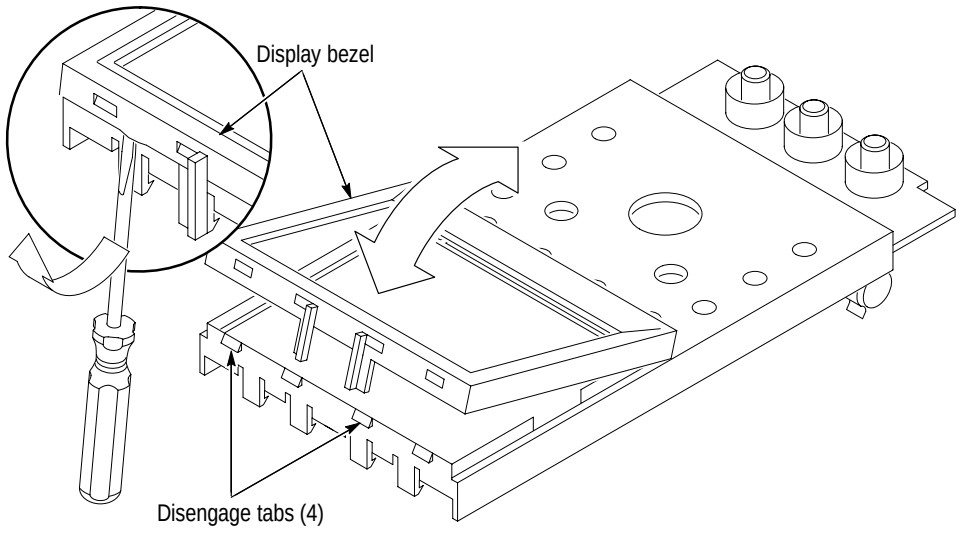

Figure 7–4: LCD bezel removal and installation

3. Lift the top end of the display bezel up until the four tabs (at the bottom end of the display assembly) disengage.
4. The LCD display and contacts can be lifted out of the display housing.

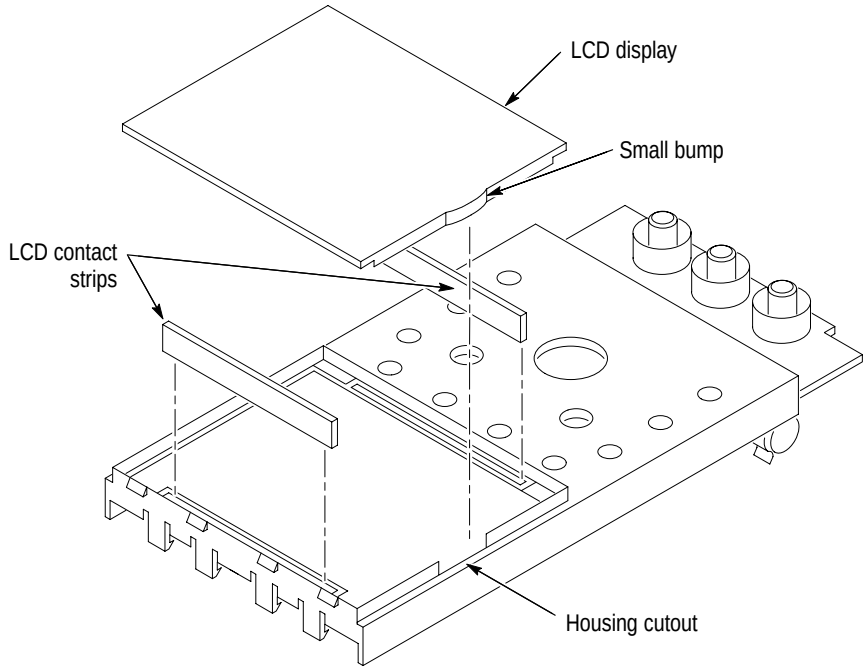

Figure 7–5: LCD removal and installation

Installation.

1. Install the two LCD contact strips into the display housing.
2. Place the LCD into the display housing.

NOTE*. Place the LCD into the assembly so that the side with the small bump is aligned with the cutout in the housing and the contacts are facing the contact strips.*

3. Press the bottom of the LCD bezel down until the bottom four tabs snap into place.
4. Place the top of the LCD bezel over the display and push down to snap the top four tabs into place.

NOTE*. Before proceeding, check to make sure all eight tabs securing the LCD bezel are seated properly. The display may have moved if all the tabs do not engage. Remove the bezel, check that the display is seated properly and try again.*

Circuit Board

The circuit board can be removed from the internal assembly after the internal assembly is removed from the top case half.

***NOTE**. It is not necessary to remove the circuit board to remove the LCD assembly.*

Removal.

1. Remove the internal assembly (see page 7–7) and LCD assembly (see page 7–10).
2. Disengage the two tabs protruding through the middle of the circuit board.
3. Disengage the four tabs at the top end of the circuit board (the end without the input connectors).

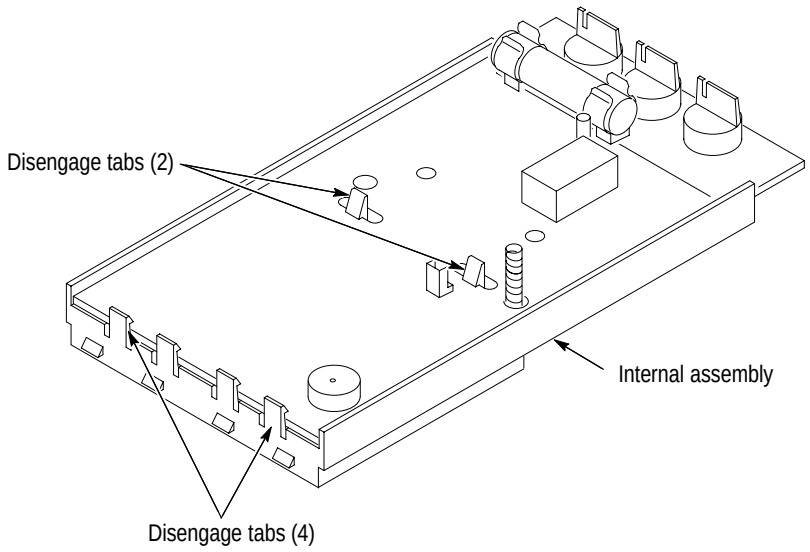

Figure 7–6: Circuit board tabs

4. Lift the circuit board off of the assembly

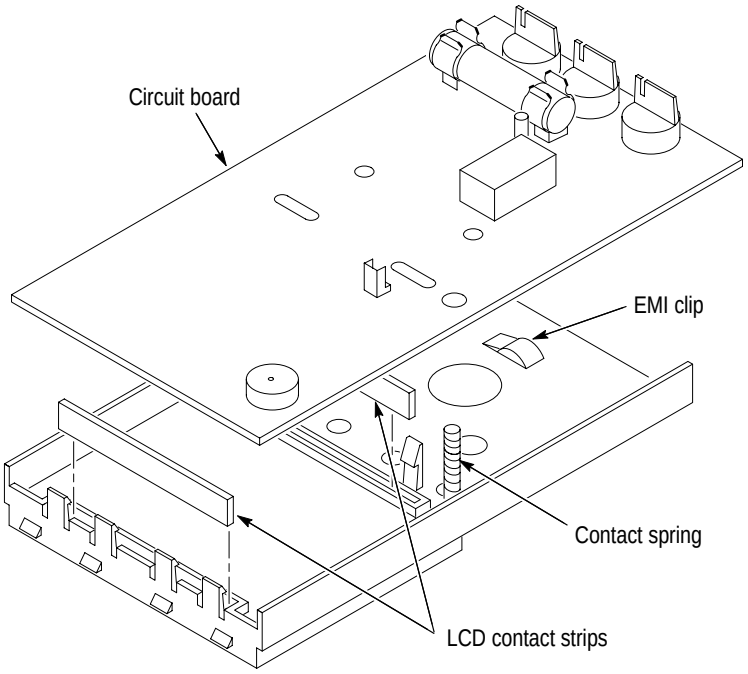

Figure 7–7: Circuit board removal and installation

Installation.

1. Ensure that the contacts listed are in place before installing the circuit board.
   - Contact spring
   - LCD contact strips (two)
   - EMI clip
2. Lower the circuit board straight down onto the assembly ensuring that all six securing tabs lock into place.

NOTE*. Installing a new circuit board requires that the meter be re-calibrated. Refer to the* Adjustment *chapter for calibration.*

Light Diffuser

The light diffuser can only be removed after removing the circuit board and LCD assembly. Refer to Figure 7–8.

Removal.

1. Remove the internal assembly (see page 7–7), LCD assembly (see page 7–10), and circuit board (see page 7–12).

1. Grasp the housing and flex the corner, causing the light diffuser corner to pop up.

2. Flip the diffuser up and slide it out through the slot in the housing.

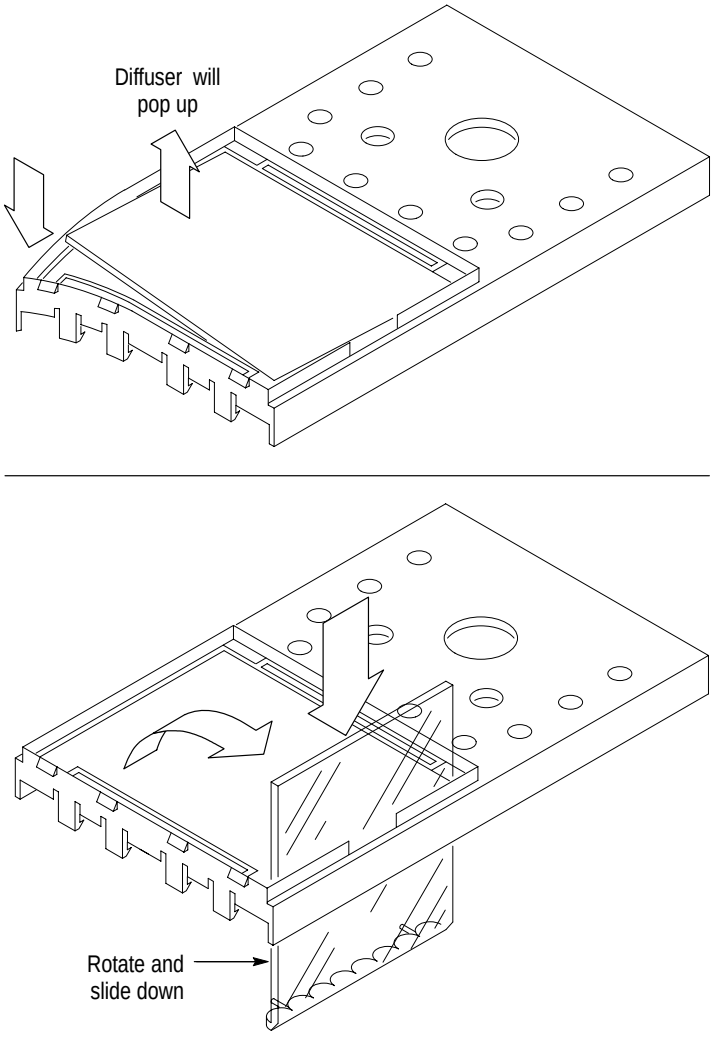

Figure 7–8: Light diffuser removal and installation

Installation.

1. From the back of the housing, slide the light diffuser up through the slot and flip it down into the LCD compartment.
2. Press the diffuser down to ensure it is seated into the LCD compartment.

Switch Keypad

The internal assembly must be removed to gain access to the switch keypad. The keypad is easily lifted out or placed in the top case half. Refer to Figure 7–10.

NOTE. *Avoid touching the keypad contacts on either the keypad or the circuit board.*

Function Knob

The internal assembly must be removed to gain access to the function knob assembly. Refer to Figures 7–9 and 7–10.

Removal.

1. Hold the top case half in the palm of your hand (or support both ends of the top case half, allowing the function knob room to be removed).
2. Insert a narrow object (such as a small screwdriver) into the hole in the back side of the function knob and press down until the knob assembly snaps apart.

CAUTION. *Take extreme care not to damage the contacts on the clicker. This will need to be replaced if the contacts are bent.*

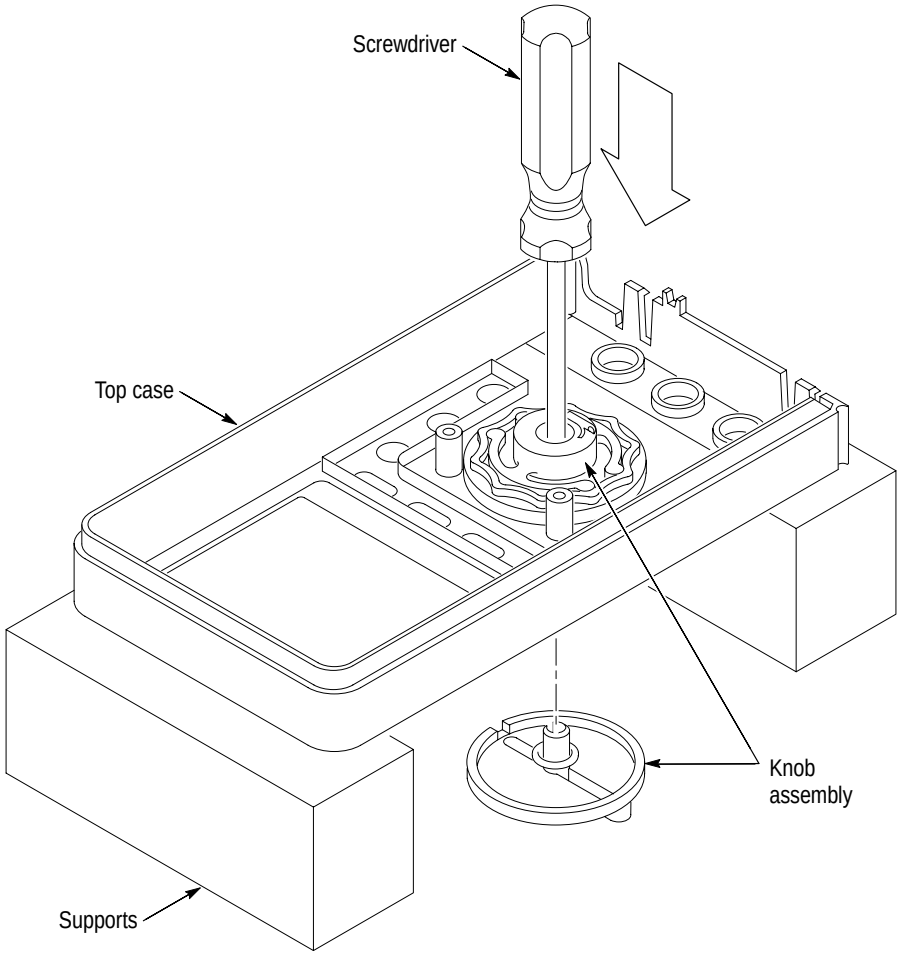

Figure 7–9: Function knob removal

Installation.

1. Place the function knob into the top case half. Place the knob so that it is able to rotate to all functions. Ensure that the o-ring is in place on the function knob.
2. From inside the case half, place the clicker onto the function knob (use the key for alignment) and press down until it snaps into place.

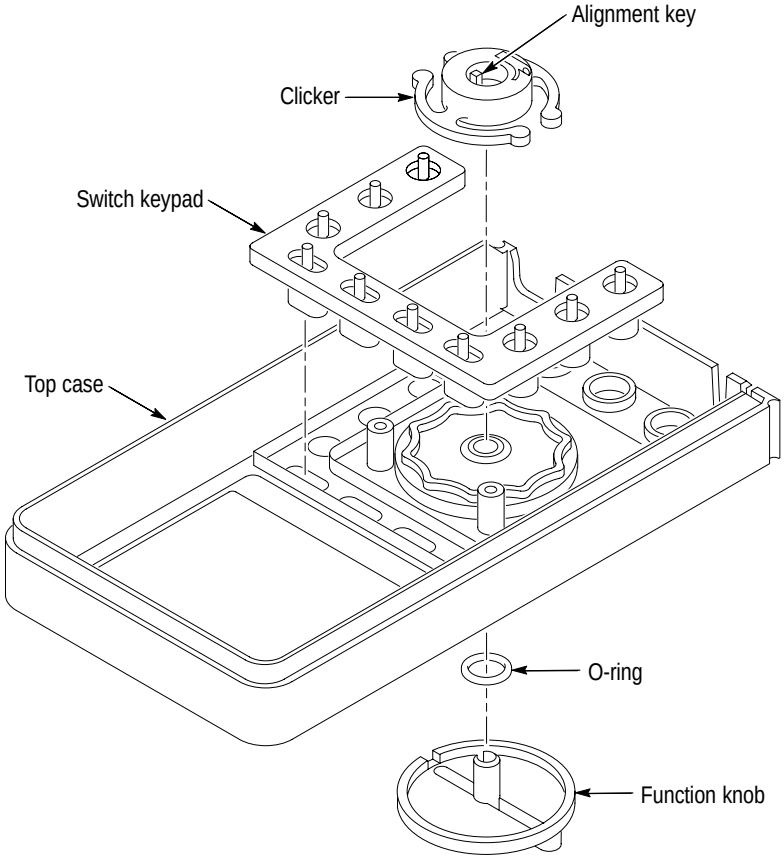

Figure 7–10: Function knob and switch keypad installation

Troubleshooting

This section contains a troubleshooting tree divided into three sections to help isolate problems to the most probable cause.

In most cases the easiest method to use the trees is to begin with the first tree at "Start Here."

WARNING. *Before doing this or any other procedure in this manual, read the* General Safety Summary *and* Service Safety Summary *found at the beginning of this manual. Also, to prevent possible injury to service personnel or damage to electrical components, read* Preventing ESD *and* Inspection and Cleaning *in this chapter.*

Some checks require partial disassembly of the meter. Read the Safety Summaries at the beginning of this manual and then see the section *Disassembly and Assembly Procedures* in this chapter for instructions.

NOTE*. The battery cover must be in place for the meter to operate.*

Adjustment After Repair

Refer to the chapter *Adjustment Procedure* if you replace the circuit board.

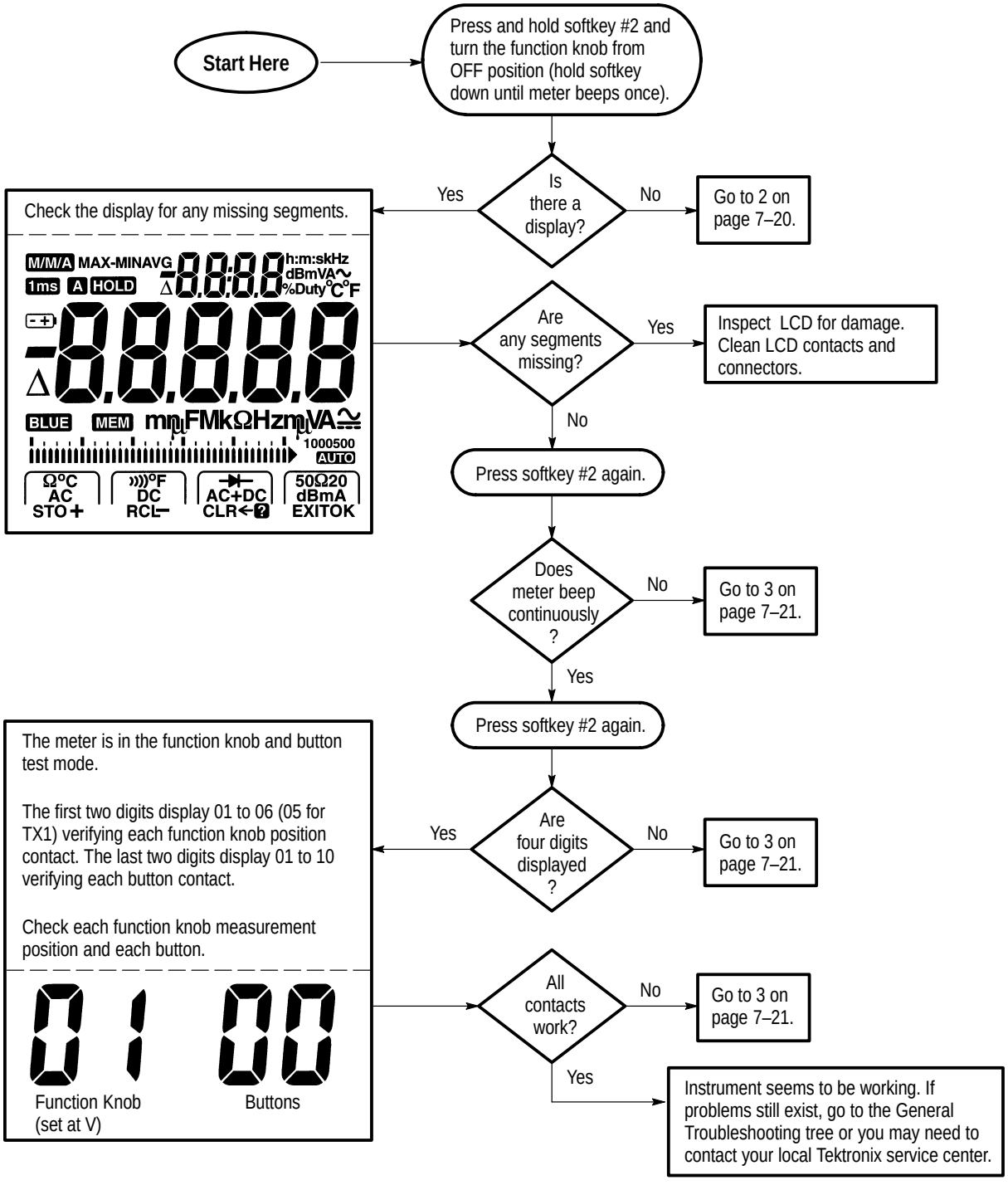

Figure 7–11: Troubleshooting start

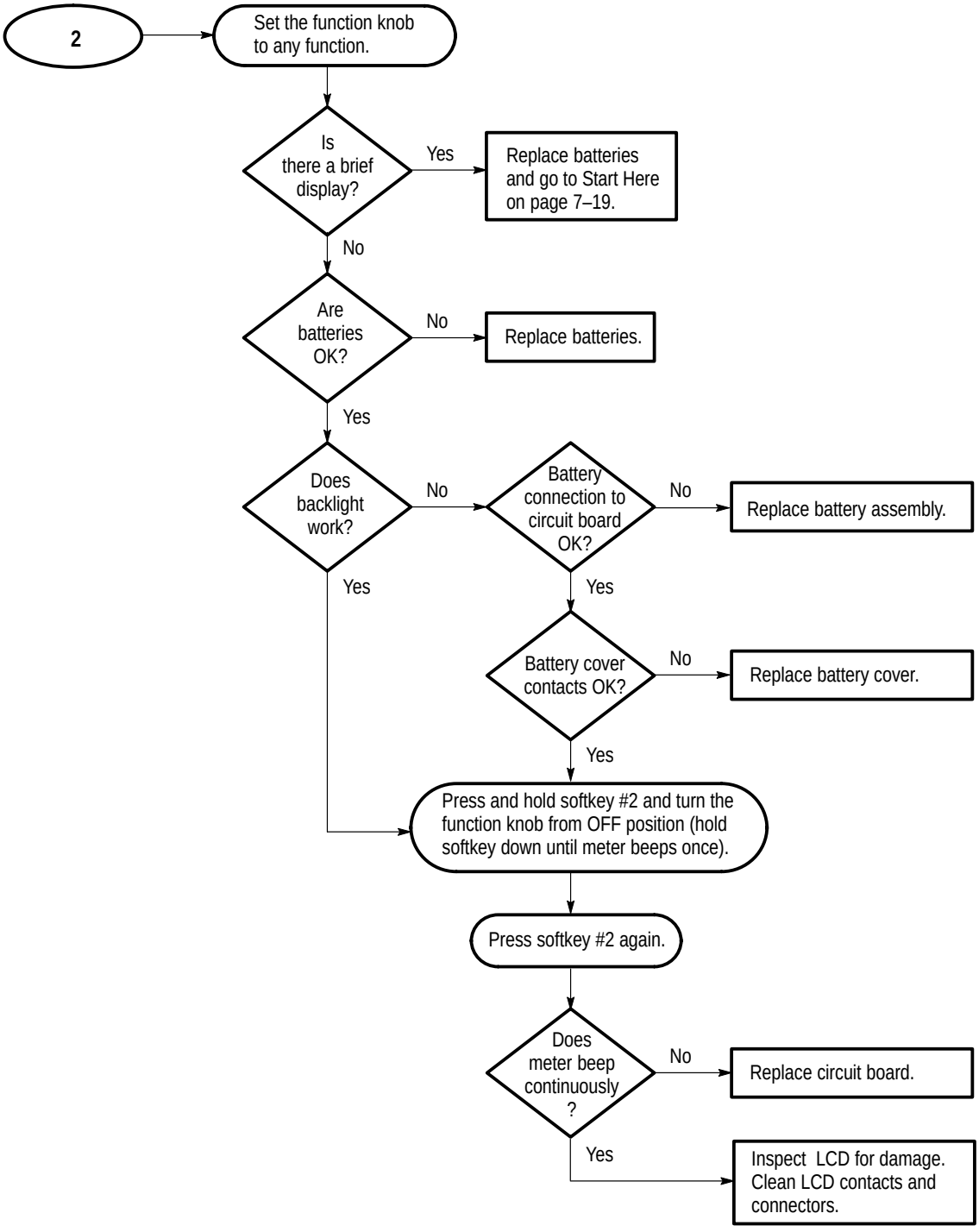

Figure 7–12: Troubleshooting two

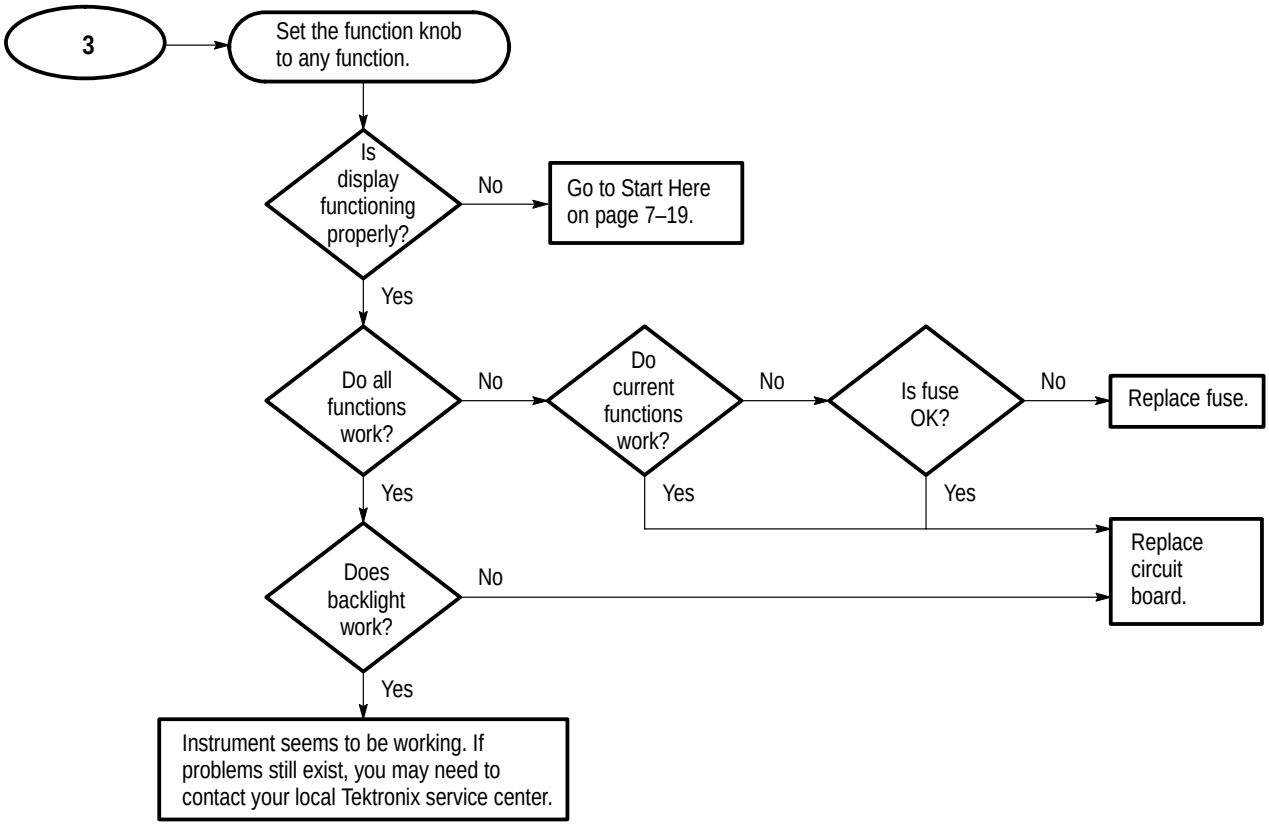

Figure 7–13: Troubleshooting three

Repackaging Instructions

This section contains information needed to repackage the meter for shipment or storage.

Packaging

Use a corrugated cardboard shipping carton having a test strength of at least 275 pounds (125 kg) and with an inside dimension at least six inches (15.25 cm) greater than the meter dimensions.

If the meter is being shipped to a Tektronix Service Center, enclose the following information:

- The owner's address
- Name and phone number of a contact person
- Type and serial number of the instrument
- Reason for returning
- A complete description of the service required

Seal the shipping carton with an industrial stapler or strapping tape.

Mark the address of the Tektronix Service Center and also your own return address on the shipping carton in two prominent locations.

Storage

The meter should be stored in a clean, dry environment. The following environmental characteristics apply for both shipping and storage (meter not operating):

- Temperature range: –40 to +60° C
- Altitude: 12,300 m (40,354 ft)

See the chapter *Specifications* for a complete listing of the environmental characteristics.

Replaceable Parts

Replaceable Parts

This section contains a list of the replaceable parts for the TX1 and TX3 True RMS Digital Multimeters. 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 products are sometimes made to accommodate improved components as they become available and to give you the benefit of the latest 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.

Servicing

The TX1 and TX3 True RMS Digital Multimeter can be serviced by contacting your local Tektronix service center or representative for repair assistance.

Using the Replaceable Parts List

This section contains a list of the mechanical and/or electrical components that are replaceable for the TX1 and TX3 meters. Use this list to identify and order replacement parts. The following table describes each column in the parts list.

Table 8–1: 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 entry indicates 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.

Table 8–2: Manufacturers cross index

Mfr. code	Manufacturer	Address	City, state, zip code
0A828	IDI (INTERCONNET DEVICES)	TEST COMPONENTS DIVISION 5101 RICHLAND AVENUE	KANSAS CITY, KS 66106
0KB01	STAUFFER SUPPLY CO	810 SE SHERMAN	PORTLAND, OR 97214–4657
0KB05	NORTH STAR NAMEPLATE INC	5750 NE MOORE COURT	HILLSBORO, OR 97124–6474
56329	LAUREN MANUFACTURING COMPANY	2228 REISER AVE SE	NEW PHILADELPHIA, OH 44663
62351	APPLE RUBBER PRODUCTS INC.	310 ERIE STREET	LANCASTER, NY 14086
75915	LITTELFUSE INC	800 E NORTHWEST HWY	DES PLAINES, IL 60016–3049
80009	TEKTRONIX INC	14150 SW KARL BRAUN DR PO BOX 500	BEAVERTON, OR 97077–0001
8X345	NORTHWEST SPRING MFG CO	5858 WILLOW LANE	LAKE OSWEGO, OR 97035
TK1163	POLYCAST INC	9898 SW TIGARD ST	TIGARD, OR 97223
TK2376	CONDUCTIVE RUBBER TECH	22125 17TH AVE SE, SUITE 117	BOTHELL, WA 98021
TK2383	PANASONIC INDUSTRIAL CO	1600 MCCANDLESS DR	MILPITAS, CA 95035
TK2548	XEROX CORPORATION	14181 SW MILLIKAN WAY	BEAVERTON, OR 97005
TK2647	INSTRUMENT SPECIALTIES CO INC.	C/O TEMCO NW 1336 SE 51ST STREET	HILLSBORO, OR 97123
TK6126	VL ELECTRONICS	3250 WILSHIRE BLVD, SUITE 1901	LOS ANGELES, CA 90010–1502

Table 8–3: Replaceable parts list

Fig. & index number	Tektronix part number	Serial no. effective	Serial no. discont'd	Qty	Name & description	Mfr. code	Mfr. part number
1–1	437–0474–00			1	CASE,TOP:3.2 X 6.1 X 0.860,PLASTIC,TX1	TK1163	437–0474–00
	437–0475–00			1	CASE,TOP:3.20 X 6.10 X 0.860,PLASTIC,TX3	TK1163	437–0475–00
1–2	354–0749–00			1	O–RING:O–RING KNOB,0.239 X 0.064,SILICONE 50SL,COMPATIBLE W/ABS PLASTIC	62351	AS568A–902
1–3	650–3683–00			1	KNOB ASSY:TX1/TX3	TK1163	650–3683–00
1–4	260–2688–00			1	SWITCH,KEYPAD:ELASTOMERIC,2.790 X 2.150 X .200,RUBBER,TX1/TX3	TK2376	260–2688–00
1–5	426–2562–00			1	BEZEL:2.685 X 2.85 X 0.217,MACROBLEND PLASTIC,TX1/TX3	TK1163	426–2562–00
1–6	342–1028–00			1	DIFFUSER,LIGHT:BACKLIGHT,2.0450 X 2.680,PLASTIC,TX1/TX3	TK1163	342–1028–00
1–7	119–5661–00			1	DISPLAY MODULE:LCD,CUSTOM,DMM,SEGMENTED TN,3.0 VOLT,1/4 DUTY,VL2572V01	TK6126	VL–2572
1–8	131–6346–00			2	CONN,ELASTOMER:COMPRESSION,STR,280 POS,0.008 CTR,0.285H X 2.05L X 0.080W,LG180 RUBBER	TK2376	100680
1–9	650–3684–00			1	CHASSIS ASSY:LCD,TX1/TX3	TK1163	650–3684–00
1–10	679–4091–00			1	CKT BD SUBASSY:TRUE,671–4091–00 UNTESTED,389–2390–00 WIRED,TX1/TX3	80009	679–4091–00
1–11	131–6560–00			1	SPRING,CONTACT:POGO PIN,0.345 H,7 OZ FORCE,ST STEEL,GOLD PLATING	0A828	SS–11–7–G
1–12	214–4778–00			1	SPRING:EMI,0.015 MUSIC WIRE,0.0003 BRIGHT NICKLE,TX1/TX3	8X345	214–4778–00
1–13	211–0927–00			4	SCREW,PT:K35–1.57 X 10.0MM,T10,STL,BLACK PHOSPHATE	0KB01	K35–1.57 X 10 PN PT STL/BLK
1–14	650–3682–00			1	CASE ASSY:BOTTOM,TX1/TX3	TK1163	650–3682–00
1–15	334–9525–00			1	MARKER,IDENT:BACK LABEL,SERIAL NUMBER,0.002 GLOSS WHITE POLYESTER,TX1/TX3	0KB05	334–9525–00
1–16	159–0409–00			1	FUSE,CARTRIDGE:13/32 X 1 1/2,15A,1000 VAC/VDC,585 015	75915	585 015
1–17	348–1616–00			1	SHLD GSKT,ELEC:FOLD OVER,ADHESIVE,0.25L X 0.51W,BECU BRIGHT NI PLT,TX1/TX3	TK2647	0097–0521–19
1–18	650–3679–00			1	CARRIER ASSY:BATTERY ,TX1/TX3	TK1163	119–5668–00
1–19	146–0121–00			2	BATTERY,DRY:1.5V,ALKALINE,AA,AM–3	TK2383	AM–3
1–20	650–3680–00			1	COVER ASSY:BATTERY,TX1/TX3	TK1163	650–3680–00
1–21	354–0748–00			1	O–RING:WATER SEAL,3.24 X 1.75,TX1/TX3	56329	354–0748–00
1–22	650–3685–00			1	CLICKER ASSY:TX1/TX3	TK1163	650–3685–00

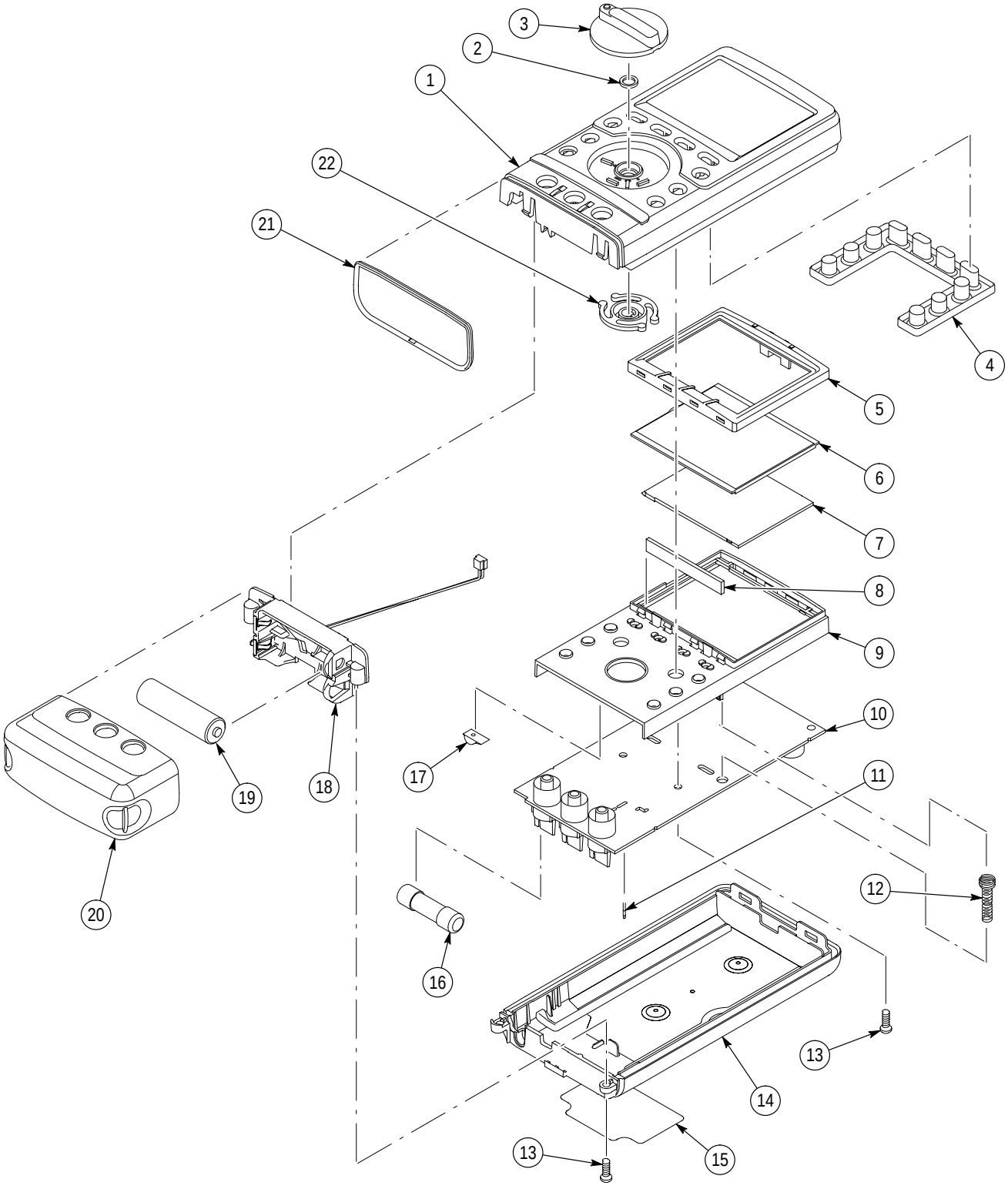

Figure 8–1: Exploded view

Tables 8–4 and 8–5 list the standard and optional accessories provided for the TX1 and TX3 True RMS Digital Multimeters.

Table 8–4: Standard accessories

Standard accessory	Product or part number		
Test lead set	ATL01, or equivalent		
Test leads (1 red, 1 black)	Certified to 1000 V CAT III		
Alligator clips (1 red, 1 black)	Certified to 1000 V CAT III		
Protective boot	650-3681-XX, or equivalent		
User Manual			
Language	Part Number	Language	Part Number
English	070-9880-XX	Portuguese	070-9885-XX
French	070-9881-XX	Korean	070-9886-XX
German	070-9882-XX	Simplified Chinese	070-9887-XX
Italian	070-9883-XX	Traditional Chinese	070-9888-XX
Spanish	070-9884-XX	Japanese	070-9889-XX
Installed dry cell batteries	Two AA 1.5 V alkaline batteries (IEC LRG or ANSI/NEDA 15A)		
Fuse (installed)			
15 A, 1000 V_{RMS} fast	159-0409-00 (Littelfuse® 585 015), or 11 A, 1000 V (Buss® DMM–B–11)		
Temperature probes (TX3 only)	ATK01, or equivalent, K-type thermocouple adapter and ATP01, or equivalent, bead probe.		

Table 8–5: Optional accessories

Optional accessory	Product or part number
Probing solutions	ATL21, ATL22, ATL23, ACL21, ACL22, ACL23, ACL24
Nylon softcases	AC12, AC13
Clamp-on current probes	A605, A621, A622
Cables and software	WSTRM
TX1 and TX3 Service Manual	070-9893-XX