

TEK INTER-OFFICE COMMUNICATION

TO John Martin 94-540 DATE June 25, 1991
FROM Frank Gray, 50-PAT
SUBJECT GIDEP permit request

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Francis I. Gray
Group Patent Counsel

imp



Measurement



TEKTRONIX TX1, TX3

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True RMS Digital Multimeters

TX3 * TX1 (with Optional WSTRM PC Interface Package)



Features

- Extra-Large, Dual Numeric Display with Backlight
- 1000V CAT III (IEC 61010 Compliant) Input Voltage Safety Rating
- Built-in K-Type Digital Thermometer (TX3 only)
- Diode Check and Continuity Beeper
- Setup Menu for Custom User Defaults
- Auto and Manual Hold and Ranging
- MIN/MAX/AVG/MAX-MIN Recording with Time Stamp
- Relative (Delta) Measurements
- dBm and dB (TX3 only)
- 4-20 mA Process Loop Measurement with % Readout (TX3 only)
- Rugged Boot w/ Versa-Stand™
- Tracable Calibration Certificate Included
- Easy Battery Access without Breaking Calibration Seal
- AC + DC Total RMS and Hz Dual Readout

- CE (EEC) and UL (USA and Canada) Safety Certifications
- Made in USA

You don't need to sacrifice ruggedness, safety, and quality to enjoy the accuracy and features needed in today's changing maintenance environment. The Tektronix TX-DMM™ True RMS digital multimeters feature an extra large, dual numeric display that provides more information in fewer steps and can be viewed from across the room.

The simple user interface eliminates guesswork and allows you to view AC and DC values without changing meter function, saving troubleshooting time.

The data storage capability allows measurements to be saved into memory and later recalled or downloaded to a PC using the optional WSTRM PC interface package.

WSTRM consists of WaveStar™ for Meters software and a PC interface cable. WSTRM provides virtual digital multimeter capability, real-time data logging, and easy documentation on a Windows®95/NT platform. Error-free data recording is a necessity for successful preventive maintenance programs.

TX-VMM digital RMS technology provides high accuracy, 50,000 count resolution, and fast AC settling time

WSTRM OPTIONAL PC INTERFACE PACKAGE

WSTRM is the complete solution for data transfer and analysis from the TX-DMM multimeters to a PC. The WSTRM features WaveStar for Meters software and includes an interface cable.

WaveStar for Meters software allows users to easily capture, analyze, and record TX-DMM data, as well as professionally create, save, and print documents. Through its unique virtual instrument interface, WaveStar software enables remote access and control of the TX-DMM from a PC, without the need for programming. WaveStar software's familiar Windows®95/NT features, such as drag-and-drop, provide users a quick and simple means for inserting important DMM information into other Windows applications.

The included cable provides an interface between the TX-DMM IR port and the PC's K-232 port.

TX3 * TX1 (with Optional WSTRM PC Interface Package)

Characteristics Ordering Information



Tektronix Measurement products are manufactured in ISO registered facilities.  (TX3 TX1 only)

49A-10733-2p461
06/1998, 08/26/1998

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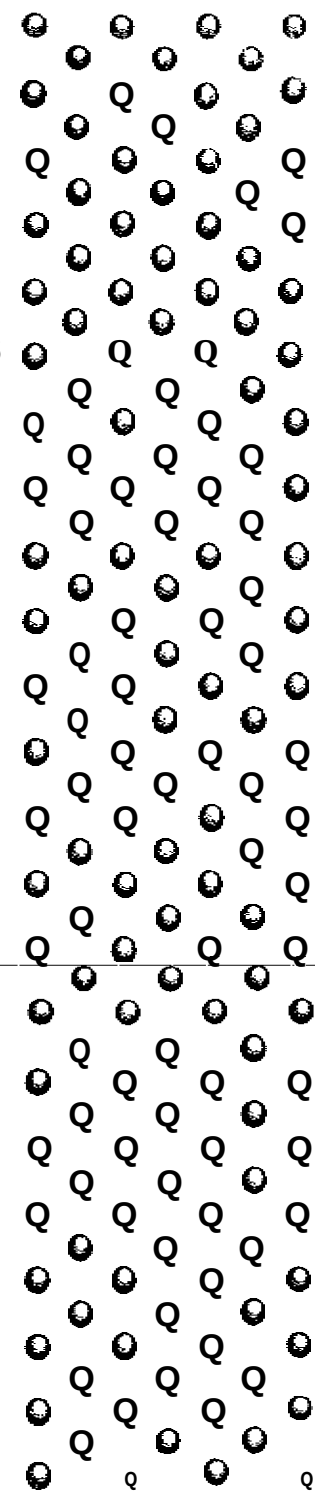


Tektronix

**TX-DMM™ TX1 and TX3
True RMS Digital Multimeters
Reference**

070-9880-00

CC



Quick Reference Guide to Measurements

To measure:	Set knob to:	Press:	See page:
AC Volts with frequency	V		8
DC Volts			
AC DC dual display		Press to toggle between AC DC and AC+DC	
AC+DC total RMS volts			
AC Volts and dB or dBm			10
dBm with 600 Ω reference		Press to toggle between dB and dBm.	
dB with 1.000 V reference		adjust rEF in Setup menu $\rightarrow$	
dB with adjusted reference		$\rightarrow$ Measure reference volts $\rightarrow$ Δ	
dB with measured reference			
Frequency (Use Setup menu to turn on Duty Factor and select polarity)	Hz	—	12
Ohms	$\Omega/\leftrightarrow$		14
Continuity			
Diode Check			
50 Ω		$\rightarrow$ short test leads	
Capacitance	μF	—	15
Temperature, Celsius	$^{\circ}\text{C}$		16
Temperature, Fahrenheit			
AC Amps with Frequency	A		18
DC Amps			
AC DC dual display		Press to toggle between AC DC and AC+DC	
AC+DC Total RMS			
4–20 mA Current loop measurement with % readout			

Quick Reference Guide to Functions

To:	Press:	Display shows:	See page:
Change default settings (access Setup menu)	Blue button for two seconds	First setup parameter (POFF)	23
Exit setup menu	Any button	Meter returns to normal operation	
Turn backlight on or off		Backlight LEDs light up	20
Change range of meter	RANGE button	The range shows to the right of the bargraph below the main display	19
Set meter to autoranging mode	RANGE button for two seconds	AUTO	
Manually freeze display	HOLD button	HOLD	21
Automatically freeze display when signal changes (Auto Hold)	HOLD button for two seconds	A HOLD	
Record min, max, avg values with timestamp	M/M/A button	WA. MAX, MIN, MAX-MIN, or AVG	28
1 ms peak hold min and max with timestamps	blue button $\rightarrow$ M/M/A button	M/M/A and 1ms	20
Exit MAX/MIN/AVG mode	M/M/A button for two seconds	Meter returns to normal operation	28
Store a measurement	Blue button $\rightarrow$ A button $\rightarrow$	Memory location and measurement	22
Recall a measurement	Blue button $\rightarrow$ A button $\rightarrow$	Memory location and measurement	
Clear recalled memory location	Blue button $\rightarrow$ Δ button $\rightarrow$	Upper display: shows memory location Main display: —	
Clear all memory locations	Blue button $\rightarrow$ A button $\rightarrow$ for five seconds	dOnE	

Tektronix, Inc.
P.O. Box 500
Beaverton, Oregon 97077-0001
503 627 7111

Tektronix

CERTIFICATE OF TRACEABLE CALIBRATION

certificate : MFG1797CHC5
Mfg/Model : Tektronix TX3
Description : Handheld DMM
Serial Num. : BN001748

Cal Date: 14-MAY-1998 Temperature : 22 C Cal Interval: 365 Days
Rue Date: 14-MAY-1999 R. Humidity : 30 %

Tektronix certifies the above instrument meets or exceeds published measurement specifications (unless otherwise noted) and has been calibrated using standards traceable to the National Institute of Standards and Technology. The policies and procedures at this facility comply with ANSI/NCCL Z540-1-1994 (ISO Guide 25). This certificate shall not be reproduced, except in full, without the written approval of the calibration facility.

CALIBRATION PROCEDURE - .

Factory Automated Test Ver. EXP V 2, Control Ver. 1.105

CALIBRATION EQUIPMENT USED:

Mfg/Model Type	ID #	C 1 Date	Rue Date
=====	=====	==4=====	=====
WaveTek 9100	34073	07-APR-1998	07-APR-1999
Omega DP86	E122118	22-APR-1998	22-APR-1999

Issued By: *Lyal Purinton*
Manager : Lyal Purinton

Certified By: TOM MAHAR
Date Printed: 14-MAY-1998

Tektronix

**TX-DMM™ TX1 and TX3
True RMS Digital Multimeters
User Manual**

070-9880-00


070988000

CE

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@tek.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.tek.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

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General Safety Summary

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

Safety Terms and Symbols

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:

CAUTION indicates a hazard to property including the product.

Symbols on the Product. These symbols may appear on the product:



WARNING
Risk of
Electric Shock

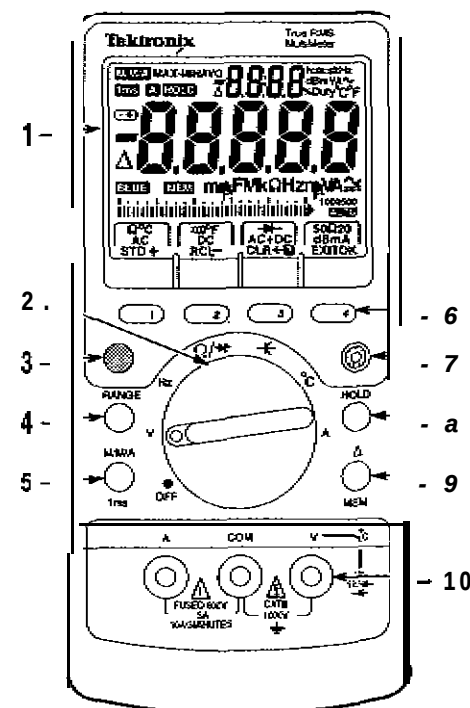


CAUTION
Refer to Manual

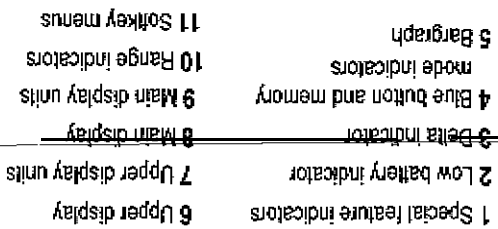


Double
Insulated

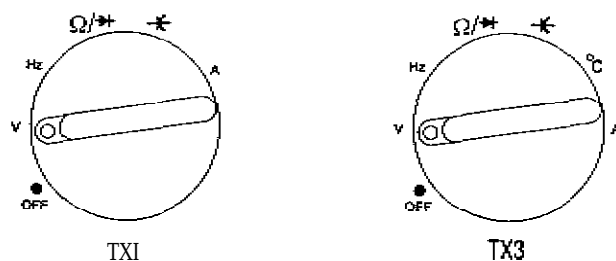
Front and Rear Panel Overview



- 1 Extra large LCD display with dual numerical readout.
- 2 Measurement function knob-Use to select a measurement.
- 3 Blue Button - Use to access lms, 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 lms 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 A Button - Use to make relative measurements and access the memory
- 10 Input connectors.



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.

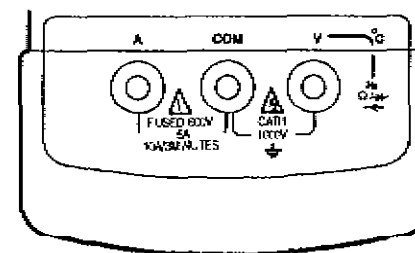
Ω/∗. Access to resistance and continuity measurements and diode test.

∗. 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



A. Input connector for current measurements up to 5 A (10 A for three minutes or 15 A for 30 seconds). 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 1000V 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.

Operating Basics

Before you take any of the measurements described in this section, follow these steps:

- For specified accuracy, allow the meter to stabilize for 30 seconds after you turn on the meter.
- Observe the safe test lead connections below when you remove the test leads from the meter.
- Always disconnect power to the circuit when you measure resistors, capacitors, diodes, or continuity within the circuit.
- Discharge capacitors before taking capacitance measurements.

Safe Test Lead Connections

To safely disconnect the test leads from the meter, first disconnect all test leads from the circuit being tested, then disconnect the leads from the input connectors.



WARNING. To prevent electrical shock, do not insert unnecessary test leads or metal pins into the A (amps) connector. Voltages applied to any connector may be present at all other input connectors. Only use the test leads supplied or recommended (or their equivalent) with the meter. Refer to Accessories on page 43.

Using Procedures in this Section

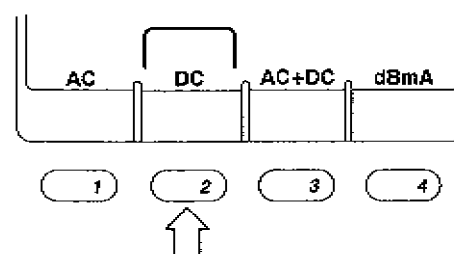
All measurements are made by first setting the measurement function knob to a function setting and then selecting a measurement from the softkeys. Note that not all knob settings have corresponding softkey settings.

For example, the steps below show how to make a DC voltage measurement:

1. Set the measurement function knob to V for a voltage measurement.

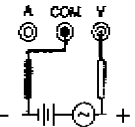
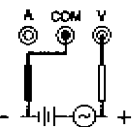


2. Select softkey 2 for DC voltage



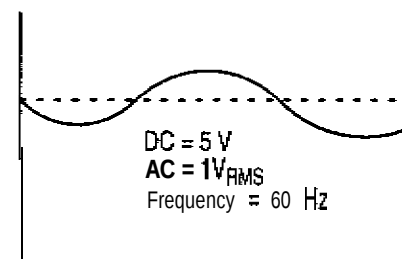
3. Connect the leads to the measurement points.

Voltage Measurements

Measurement	Softkey	Connect leads	Main display	Upper display
True RMS AC voltage (default)	1 AC		AC	Hz
DC voltage	2 DC		DC	—
AC DC dual display	3 AC DC or AC+DC (press to toggle)		DC	AC
AC+DC total RMS ¹			AC+DC Hz	

$$1 \quad V_{RMS} = \sqrt{V_{AC}^2 + V_{DC}^2}$$

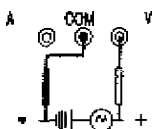
Application: Using AC DC and AC+DC in Volts Mode



AC voltages riding on power supplies can cause problems with electronic circuits. If you set the meter to DC Volts mode, the display shows the DC component of 5.000 V. However, the AC component may be missed. It is recommended that you set the meter to AC DC dual display mode. The main display shows the 5.000 V DC voltage and the upper display shows the 1.000 V AC voltage. AC DC mode also allows you to simultaneously make AC and DC measurements without changing the meter settings.

Another useful measurement is AC+DC total RMS. To take this measurement, press softkey 3 to toggle to AC+DC. In the above example, the total RMS of 5.099 V shows on the main display and the frequency of 60.00 Hz shows on the upper display. When calculating the power dissipated in a circuit component, it is critical that the DC value is factored into the equation $V_{RMS} \times I_{RMS}$, where V_{RMS} is AC+DC total RMS.

dB and dBm Voltage Measurements

Measurement	Softkey	Connect leads	Main display	Upper display
dB (TX3 only) ¹	 dB or dBm (press to toggle)		AC	dB
dBm (TX3 only) ²			AC	dBm

¹ **dB readout** = $20 \times \log (\text{main display readout}/\text{ref})$, where **ref** = 1 V is the default.

² **dBm readout** = $10 \times \log (\text{main display readout}^2/R)$, where **R**=600 Ω .

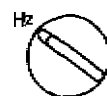
Application: Using a Reference Value Other than Default 1.000 V_{RMS} in dB Mode

To manually change the reference voltage in dB mode, press and hold the blue button to display the Setup menu. Adjust the **REF (dB)** value to the value you want and press **softkey 4** for OK. Subsequent dB measurements will use this stored value as the reference voltage until you turn off the meter.

Application: Using Voltage in a Circuit as the Reference Value in dB Mode

An example of using a voltage in a circuit as the reference value is measuring the AC voltage gain of an amplifier. Set the meter to dB mode and measure the voltage that you want to use for the reference (the input of the amplifier). Press the A button to save the measured value as the reference value. Next, measure the output of the amplifier. The voltage gain of the amplifier (in dB) shows in the upper display.

In both of these applications, the Δ indicator shows in the upper display to indicate the reference is a voltage other than the default value of 1.000 V_{RMS}. The reference value returns to 1.000 V when you exit dB mode.



Frequency Measurements

Measurement	Softkey	Connect leads	Main display	Upper display
Frequency	(no selection)		Hz	- EdGE ¹
Frequency and duty factor dual display			Hz	% Duty ²

¹ Displayed when you set negative edge triggering in the Setup menu. -EdGE is active but not displayed when % duty is on.

² You must turn on positive or negative duty in Setup menu

Negative Edge Triggering

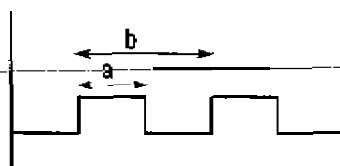
To trigger on the negative edge of the waveform, set **EdGE** to **nEG** in the Setup menu. The word **-EdGE** shows in the upper display when you exit the Setup menu.

Positive and Negative Duty Factor

To measure duty factor, set duty (**POL** in the Setup menu) to either **POS** or **nEG**. When you measure negative duty factor, a "-" symbol shows in the upper display.

Positive duty factor:
 $\% \text{ duty} = (a/b) \times 100$

Negative duty factor:
 $\% \text{ duty} = (1-a/b) \times 100$



AC vs. DC Coupled Frequency Measurements

When the duty factor measurement mode is off, the frequency measurement is AC coupled; otherwise, it is DC coupled.

Changing Voltage Range in Frequency Mode

To change voltage range, press the **RANGE** button. The voltage range shows momentarily in the upper display. Continue pressing the **RANGE** button to cycle through the available voltage ranges until the range you want shows. The default voltage range is 5 V.



Resistance Measurements (Ohms, Continuity, Diode, and 50 Ω Range)

Measurement	Softkey	Connect leads	Main display	Upper display
Resistance (default)	1 Ω		Ω	—
Continuity	2		Ω	OPEN or Shrt (beeps on short)
Diode	3	 Forward bias Reverse bias	V	—
50 Ω ¹	4 50 Ω		Ω	—

¹ See application below.

Application: Measuring Low Resistance Values

To measure low resistance values to 0.01 Ω resolution, set the meter to 50 Ω mode and short the leads together to subtract the lead resistance from low-resistance measurements. If you do not short the leads together, the meter will not enter 50 Ω mode. The lead resistance must be less than 5 Ω . The measured resistance shows on the main display.



CAUTION. To avoid damaging the meter, remove all power from the circuit before connecting the test leads.



Capacitance Measurement

Measurement	Softkey	Connect leads	Main display	Upper display
Capacitance	(no selection)		F	—



CAUTION. To avoid damaging the meter, remove all power from the circuit before connecting the test leads.

Measuring large-value capacitors may take several seconds.

Follow the procedures below when making capacitance measurements:

- Remove capacitors from circuitry.
- Discharge capacitors before measuring them
- Connect **polarized caps** as shown above.
- To measure **small values** of capacitance accurately, press the button when the leads are open.



Temperature Measurements (TX3 only)

Measurement	Softkey	Connect leads	Main display	Upper display
Celsius temperature (default)	°C		°C	Ambient temp. °C
Fahrenheit temperature	°F		°F	Ambient temp. °F

Before you take a temperature measurement, momentarily change the temperature of the thermocouple to verify a shorted or open thermocouple is not incorrectly displaying the ambient temperature.

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. A 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 (see Table 2 on page 27).

To insure accuracy of temperature measurements, you should follow this procedure when using other K-type thermocouple probes with the TX Series DMMs 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.



A Current Measurements

Measurement	Softkey	Connect leads	Main display	Upper display
True RMS AC Amps	1 AC		C	Hz
DC Amp? (default)	2 DC		DC	
Amps AC DC dual display	3 AC DC or		DC	AC
Amps AC+DC total RMS ¹	AC+DC {press to toggle}		AC+DC	Hz
4-20 mA current % ² (TX3 only)	4 20 mA		DC	%

$$1 \quad I_{RMS} = \sqrt{I_{AC}^2 + I_{DC}^2}$$

- 2 4-20 mA measurement is used in process loop calibration.
% = (measured current - 4 mA)/16 mA

When overrange occurs in manual range, the meter will uprange in order to protect the internal circuitry.



CAUTION. To avoid damaging the meter, limit large current measurements to 10 A for three minutes or 15 A for 30 seconds and allow ten minutes of cooling between measurements. Do not connect to circuits with > 600 V.

Do not attempt to measure current with batteries removed.

When you exit current measurement mode, the words **CHEC Probe** show on the display reminding you to remove your test lead from the A (amps) input connector.

When you make high current measurements, > 15 A, use a current clamp probe (optional accessory) connected to the volts input connector.

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 23 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 multimeter 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 value. 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.

See MAX/MIN/AVG Operation on page 28 for more information.

1ms (1 ms Peak Hold)

To activate 1ms peak hold, first press the blue button and then the M/M/A button while the BLUE indicator shows on the display. When in 1ms 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 23 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 instrument 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 instrument 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.

A Button (Making Relative (A DELTA) Measurements)

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

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

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

A 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 22 to recall (RCL) a reference value from memory, then press the A button. To exit delta mode, press the A 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 A 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 A 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 A button to make relative dB (ΔdB) measurements. See page 10 for more information.

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 A 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 2 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 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 A or dB mode to access these setup parameters.

Special Features

High Resolution (HrES) 50,000-Count Mode

By default, the meter is set to 5,000-count mode. For 50,000-count mode, press the blue button when you turn on the meter. To change the default resolution to 50,000-count mode, use the Setup menu information on page 23.

The following measurements are limited to 5,000-count mode: 50 Ω , 50 M Ω , 1 ms peak hold, AC + DC amps, AC DC amps, AC + DC volts, AC DC volts, capacitance, and Hertz dual display mode.

Beeper

A single beep indicates correct operation. You can turn the single-beep feature off in the Setup menu. A double beep indicates a warning or error condition. A triple beep indicates the meter will auto-off in one minute. Continuous beeping indicates there is circuit continuity while in continuity mode. You can not disable double, triple, or continuous beeps.

Auto-Off

The auto-off feature automatically turns off the meter if no controls or settings are changed within a set amount of time. To turn on the meter after auto-off, press any button. The meter will return to the state it was in before auto-off occurred, but held values are lost.

Use the Setup menu to adjust the auto-off delay. The default auto-off time is thirty minutes. You can disable auto-off by pressing the **HOLD** button when you turn on the meter or by using the Setup menu.

Auto-off is disabled during M/M/A mode.

Power-Up Options

To activate power-up functions, press and hold a button or softkey when you turn on the meter. Hold the button or softkey until you hear a single beep and see a text acknowledgment on the display (see Table 2 below). The following table lists all power-up options. Most of the power-up option descriptions also appear on the rear panel.

When you turn off the meter, the power-up options are not saved. Use the Setup menu to change default settings.

Table 2: Power-up options

Button	Power-up function	Explanation
RANGE (<i>HIO mV</i>) ¹	Sets meter to 500 mV high impedance mode	Enables high impedance (> 10 MΩ) across the input jacks in the 500 mV DC range so that the device under test is not loaded when you measure small voltages.
M/M/A (<i>1 SEC</i>) ¹	Sets meter to 1 second M/M/A mode	See <i>MAX/MIN/AVG Operation</i> on page 28 for more information.
Δ (<i>BECP</i>) ¹	Turns off beeper	Double, triple, and continuity beeps are not affected.
BLUE (<i>HRES</i>) ¹	Sets meter to high resolution (50,000 count) mode	See <i>High Resolution (HRES) 50,000-Count Mode</i> on page 25 for further information.
LIGHT (<i>LOFF</i>) ¹	Disables light timeout	—
Softkey 1	Displays software version and calibration date	Displays the software version (M.mm, where M is the major revision and mm is the minor revision). Press softkey 1 again to display the date the meter was last calibrated (upper display shows month and main display shows year).

Table 2: Power-up options (Cont.)

Button	Power-up function	Explanation
Softkey 2	Overall Diagnostics	Displays all LCD segments. Press softkey 2 again to hear the beeper. Press softkey 2 again to perform button and knob diagnostics. The display shows two two-digit numbers. The numbers on the left confirm the knob location and the numbers on the right confirm the button operation. To exit diagnostics, turn off meter.
Softkey 3	LCD test	Displays all LCD segments so you can verify correct LCD operation and display. Compare this to the LCD figure on page 3.
Softkey 4	Battery test	Displays the voltage across the battery terminals. The meter will shut off at 1.5 V.
HOLD (<i>POFF</i>) ¹	Disables auto-off	—
BLUE and M/M/A (<i>RESET</i>)	Resets meter to factory default settings	You must press both buttons at the same time while powering on the meter.

¹ The bold ed text in parentheses in the Button column shows when the meter registers the power-up setting. Do not release the button until you either hear a single beep or see the text.

MAX/MIN/AVG Operation

Press the **M/M/A** button to start recording **M/M/A** values. In 5,000 count mode the **M/M/A** default recording rate is 4 measurements per second. Press and hold the **M/M/A** button when turning on the meter to apply averaging, which reduces the recording rate to 1 measurement per second (1 sec **M/M/A**).

The **M/M/A** button cycles through the operations listed in the following table.

Table 3: MIN/MAX/AVG operations

Display indicator	Description
M/M/A	The live signal value is shown. The upper display shows the elapsed time since the recording began.
MAX	The MAX indicator and maximum value are shown. The upper display shows the timestamp at which the maximum value occurred, relative to the start of the test.
MIN	The MIN indicator and minimum value are shown. The upper display shows the timestamp at which the minimum value occurred, relative to the start of the test.
MAX-MIN	The MAX-MIN indicator and maximum value minus minimum value are shown. The upper display shows the time difference between the MAX and MIN events.
AVG	The AVG indicator is shown and the value shown is the average value of all meter readings. The upper display shows the elapsed time since recording began.

Once you set the meter to **M/M/A** mode, the meter will uprange, or automatically increase range setting, but will not downrange. You must exit **M/M/A** mode to restore downranging abilities to the meter.

While in **M/M/A** mode, press the **HOLD** button to stop the recording and freeze the most recent **M/M/A** values. Press the **M/M/A** button to cycle through the held values. Press the **HOLD** button a second time to reset and restart the **M/M/A** recording.

While in **M/M/A** mode, activate memory mode to hold the displayed **M/M/A** value for storage into memory without stopping or resetting the **M/M/A** recording.

To exit **M/M/A** mode and clear stored values, press and hold the **M/M/A** button for two seconds.

Auto Fuse Detection

The meter automatically verifies the integrity of the internal fuse when you set the measurement function knob to **A**. If an open fuse is detected, the word **FUSE** shows on the main display.

See page 48 for instructions on how to replace fuse **F1**.

Specifications

All specifications are warranted, unless noted as typical, for the rated temperature range of $23^{\circ}\text{C} \pm 5^{\circ}\text{C}$ at less than 80% relative humidity.

Characteristics	Description
LCD display digits	$3\frac{4}{5}$ (default) or $4\frac{4}{5}$
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	minute default
Power source	Two AA alkaline batteries (NEDA 15A)
Maximum input voltage between terminals and between terminals and earth	1000 V _{RMS} Installation Category III (CAT III) [†]
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) service-replaceable
Backlight	Green LEDs

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

Specifications

Table 4: 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 M Ω (typical)

Table 5: DC voltage range, resolution, and accuracy

Range	Resolution		Accuracy [†]	
	5,000 counts	50,000 counts	TX1	TX3
0.5 V	100 μV	10 μV	$\pm (0.07\% + 1 \text{ count})$	$\pm (0.05\% + 1 \text{ count})$
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 $(0.005\% + 0.1 \text{ ct.})/^{\circ}\text{C}$ to accuracy beyond rated temperature range		

[†] Accuracy in 50,000-count mode is % + 10 counts.

Specifications

Table 6: AC voltage characteristics

Characteristic	Description
Input impedance	10 M Ω 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 
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	$\pm(0.002\% + 1 \text{ count})$ 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 See page 10 for dB and dBm calculations.

Specifications

Table 7: 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 i	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.

Specifications

Table 8: 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 9: DC current range, resolution, and accuracy

Range	Resolution		Accuracy	
	5,000 counts	50,000 counts	TX1	TX3
500 μ A	100 nA	10 nA	$\pm (0.2\% + 4 \text{ counts})^1$	
5 mA	1 μ A	100 nA	$\pm (0.2\% + 2 \text{ counts})^2$	
50 mA	10 μ A	1 μ A		
500 mA	100 μ A	10 μ A		
5 A	1 mA	100 μ A	$\pm (0.4\% + 2 \text{ counts})^2$	
10 A for 3 minutes (15 A for 30 sec.)	10 mA	1 mA	$\pm (0.8\% + 2 \text{ counts})^2$	
Temperature coefficient		Add $(0.05\% + 0.1 \text{ ct.})/^{\circ}\text{C}$ beyond rated temperature range.		

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

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

Specifications

Table 10: 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	$\pm (0.002\% + 1 \text{ count})$ for 20 Hz to 5 kHz
Sensitivity	10% of range
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 11: 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 for 3 minutes (15 A for 30 sec.)	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.

Specifications

Table 12: Resistance (Ω) characteristics

Characteristics	Description
Update rate	5,000 ct.: 2 readings per second 50,000 ct.: 1 reading per second 50 M Ω : 1 reading per second
Settling time	50 Ω to 5 M Ω range: 3 readings (typical) 50 M Ω 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 $\geq$ 50 Hz

Table 13: Resistance range, resolution, and accuracy

	Resolution		Accuracy	
Range	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 ← ERROR	
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. ← ERROR

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

Specifications

Table 14: Continuity characteristics

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

Table 15: Diode test characteristics

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

Table 16: 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 A mode)	
50 nF	10 pF	± (1.0% + 3 counts) (using A 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.

Specifications

00N LIEBBERG 100Hz
-5958 1MHz @ .0000

Table 17: Frequency characteristics, resolution, and accuracy

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

Table 18: Frequency voltage range

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

[†] For voltages > 100 V, the maximum volts-Hz product is < 10 MVHz.

Specifications

Table 19: Duty factor characteristics

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

Table 20: Temperature characteristics

Characteristics	Description
Main display	
Range	-50 $^{\circ}\text{C}$ to +99.9 $^{\circ}\text{C}$
Accuracy	$\pm 3^{\circ}\text{C}^{\dagger}$ (typical)
Thermocouple type	K
Upper display	
Accuracy	$\pm 3^{\circ}\text{C}$ of ambient temperature (typical)

[†] Use the water and ice offset calibration method on page 16 for accuracy to $\pm 1.0^{\circ}\text{C}$.

Table 21: 1ms peak hold characteristics

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

[†] 5,000-count mode only.

Specifications

Table 22: Physical characteristics

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

Table 23: 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)

Specifications

Table 24: 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 Communities: 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}
Australia/New Zealand Declaration of Conformity - EMC	Complies with EMC provision of Radiocommunications Act per the following standard(s): AS/NZS 2064.1/2 Class A Radiated Emissions
EC Declaration of Conformity - Low Voltage	Compliance was demonstrated to the following specification as listed in the Official Journal of the European Communities: Low Voltage Directive 73/23/EEC as amended by 93/68/EEC. EN 61010-1/A2:1995 Safety requirements for electrical equipment for measuring control, and laboratory use.
U.S. Nationally Recognized Testing Laboratory Listing	JL3111-1 - 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	EC61010-1/A2:1995 Safety requirements for electrical equipment for measurement, control, and laboratory use.

Specifications

Table 24: Certifications and compliances (cont.)

category	Standards or description
Installation Category Descriptions	Terminals on this product may have different installation 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
Pollution Degree	A measure of the contaminants 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
	Pollution Degree 3 Conductive pollution or dry, nonconductive pollution that becomes conductive due to condensation. These are sheltered locations where neither temperature nor humidity is controlled. The area is protected from direct sunshine, rain, or direct wind.

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.

Accessories

This section lists all standard and optional accessories for the TX1 and TX3 true RMS digital multimeters.

Table 25: 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	0704681 -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 A.A. 1.5 V alkaline batteries (IEC LRG or ANSI/NEDA 15A)		
Fuse (installed)			
15 A, 1000 V _{RMS}	159-0409-XX (Littelfuse®), or 11 A, 1000 V (Buss® DMM-B-11) (service-replaceable)		
Temperature probes (TX3 only)	ATK01, or equivalent. K-type thermocouple adapter and ATP01, or equivalent, bead probe.		

Accessories

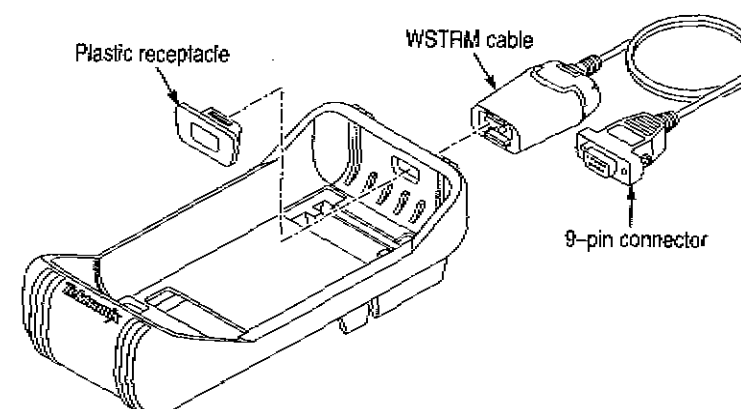
Table 26: Optional accessories

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

Setup for Optional Computer Interface Accessory (WSTRM)

Follow the steps below to set up the computer interface accessory:

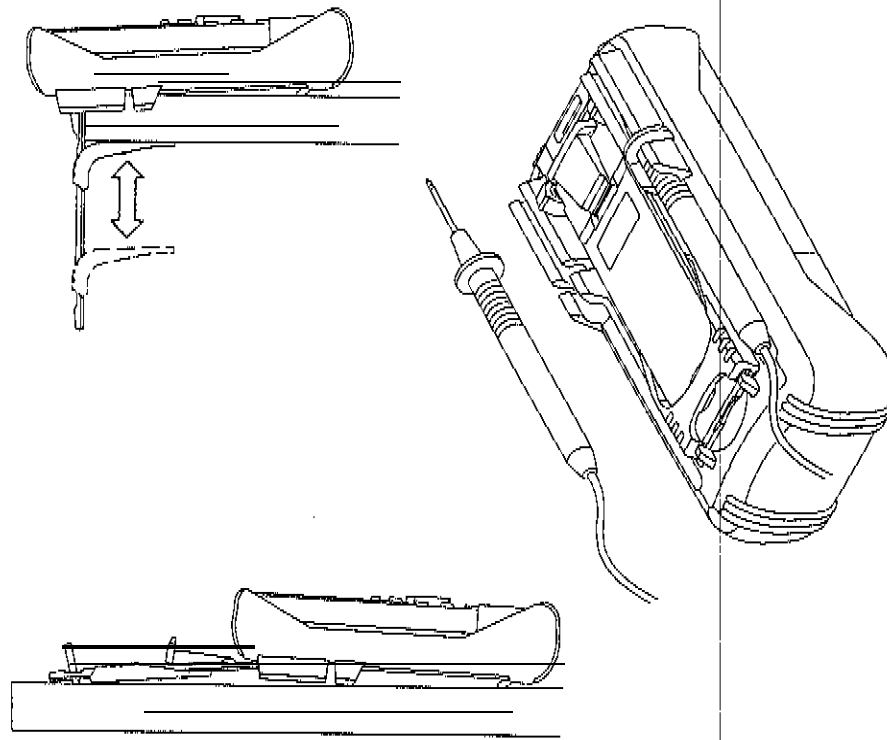
1. Press the plastic receptacle into place in the top of the DMM protective boot. Connect the WSTRM cable to the plastic receptacle.



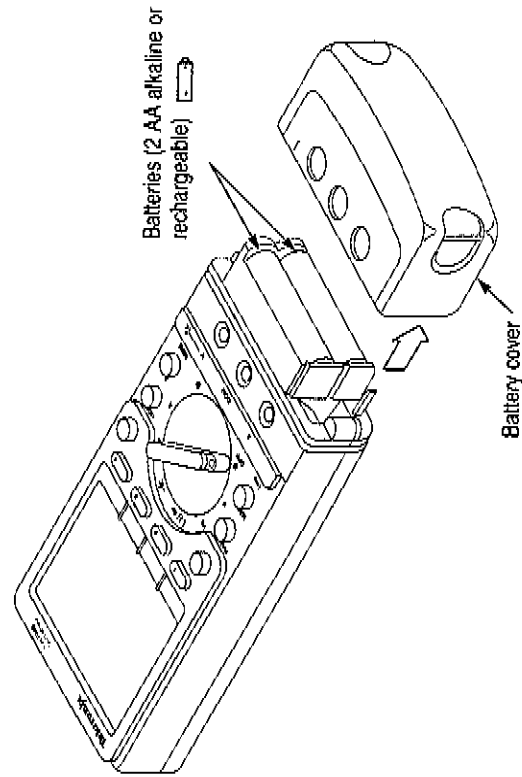
2. Connect the other end of the WSTRM cable to your computer using the 9-pin connector. If you require a 24-pin connection to your PC, you will need to use a 9-pin-to-24-pin adapter.
3. Insert WSTRM CD-ROM into your computer drive and proceed with software installation. Refer to the WSTRM documentation for further instructions on using WSTRM.

You can find further information about WSTRM features on the WSTRM CD-ROM.

Using Protective Boot and Versa-Stand™



Battery Replacement



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

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

See Table 25 on page 43 for the descriptions and part numbers of the replaceable batteries.