AMPROBE®

BDM40-UA
Bench Digital Multimeter

User Manual

BDM40-UA
Bench Digital Multimeter

User Manual

PN 1675449
March 2007

Limited Warranty and Limitation of Liability

Your Amprobe product will be free from defects in material and workmanship for 1 year from the date of purchase. This warranty does not cover fuses, disposable batteries or damage from accident, neglect, misuse, alteration, contamination, or abnormal conditions of operation or handling. Resellers are not authorized to extend any other warranty on Amprobe's behalf. To obtain service during the warranty period, return the product with proof of purchase to an authorized Amprobe Test Tools Service Center or to an Amprobe dealer or distributor. See Repair Section for details. THIS WARRANTY IS YOUR ONLY REMEDY. ALL OTHER WARRANTIES - WHETHER EXPRESS, IMPLIED OR STAUTORY - INCLUDING IMPLIED WARRANTIES OF FITNESS FOR A PARTICULAR PURPOSE OR MERCHANTABILITY, ARE HEREBY DISCLAIMED. MANUFACTURER SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, ARISING FROM ANY CAUSE OR THEORY. Since some states or countries do not allow the exclusion or limitation of an implied warranty or of incidental or consequential damages, this limitation of liability may not apply to you.

CONTENTS

CERTIFICATIONS AND PRECAUTIONS

This instrument is EN61010-1 certified for Installation Category I -1200V; Pollution Degree II, Class 2. It may only be used to make measurements on energy limited circuits within equipment. All inputs are protected against continuous overload conditions up to the limits of each function's stated input protection (see specifications). Never exceed these limits or the ratings marked on the instrument itself. Always inspect your Multimeter, test leads and accessories for signs of damage or abnormality before every use. If an abnormal condition exists (broken or damaged test leads, cracked case, display not reading, etc.), do not use. Never ground yourself when taking measurements. Do not touch exposed metal pipes, outlets, fixtures, etc., which might be at ground potential. Keep your body isolated from ground and never touch exposed wiring, connections, test probe tips, or any live circuit conductors. Do not operate instrument in an explosive atmosphere (flammable gases, fumes, vapor, dust.) Do not use this or any piece of test equipment without proper training.

SYMBOLS USED IN THIS MANUAL

⚠	Refer to the manual	~	Alternating Current
⚡	Dangerous voltage	⎓	Direct Current
⧈	Double Insulation	CE	Complies with EU directives
⏚	Earth Ground	⯈|	Diode

This meter is shipped with two power cords. The 117/230 volts power switch on the rear panel has been set to 230 volts and the 0.08A fuse installed.
Please verify the switch and fuse for your location before installing the power cord
To change to 117 V operation, install proper fuse at back panel (see manual) and set switch to 117V.

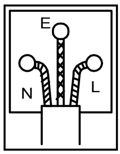
This instrument is shipped configured for 230 volt operation. Operation at 117 VAC requires that the fuse be changed and the proper power cord used.

FOR UNITED KINGDOM ONLY

NOTE: This lead/appliance must only be wired by competent persons

WARNING: THIS APPLIANCE MUST BE EARTHED

IMPORTANT: The wires in this lead are coloured in accordance with the following code:



Green/ Yellow: Earth

Blue: Neutral

Brown: Live (Phase)

As the colours of the wires in main leads may not correspond with the colours marking identified in your plug/appliance, proceed as follows: The wire which is coloured Green & Yellow must be connected to the Earth terminal marked with the letter E or by the earth symbol ⏚ or coloured Green or Green & Yellow. The wire which is coloured Blue must be connected to the terminal which is marked with the letter N or coloured Blue or Black. The wire which is coloured Brown must be connected to the terminal marked with the letter L or P or coloured Brown or Red. If in doubt, consult the instructions provided with the equipment or contact the supplier. This cable/appliance should be protected by a suitably rated and approved HBC mains fuse: refer to the rating information on the equipment and/or user instructions for details. As a guide, cable of 0.75 mm should be protected by a 3A or 5A fuse. Larger conductors would normally require 13A types, depending on the connection method used. Any moulded mains connector that requires removal / replacement must be destroyed by removal of any fuse & fuse carrier and disposed of immediately, as a plug with bared wires is hazardous if engaged in live socket. Any re-wiring must be carried out in accordance with the information detailed on this instruction.

INTRODUCTION

This instrument is a line powered, bench-type digital multimeter with a 4-1/2 digit LED display. The DMM can measure AC/DC volts, AC/DC current, and resistance. Among other features:

- **True RMS Measurements of AC or AC+DC Signals :** True RMS measurement is the only accurate way to directly measure AC or AC+DC signals that are not noise-free pure sine waves. This instrument measures AC voltage frequencies up to 50 kHz.
- **Five measurement functions :**
  - AC and DC VOLTS: Standard linear voltage measurements from 10 μV to 1200 VDC and 10 mV to 1000 VAC or AC+DC true rms.

- AC and DC Current: Standard current measurements from 10 nA to 20 ADC and 10 μA to 20 AAC or AC+DC true rms.
- Resistance: Standard resistance measurements from 10 mΩ to 20 MΩ.
- Each measurement range has: Autopolarity operation. Overrange indication. Effective protection from overloads and transients. Dual slope integration measurement technique to insure fast, accurate, noise-free measurements.
- Diode test: Ranges of the resistance function that will turn on PN junctions allowing testing of diodes and transistors. These ranges are marked with a diode symbol on the front panel of your DMM. The preferred 2kΩ range is marked with the largest diode symbol.

- **Improved test leads:** Finger guards on the probes and shrouded contacts on the input terminals decrease the possibility of accidental contact with circuit voltage.
- **Long-term calibration accuracy:** 1-year.

UNPACKING YOUR INSTRUMENT

The shipping box should contain this manual, your multimeter, test leads (one red and one black), two spare fuses (2A); two spare fuses 0.08A (230V) and 0.125A (117V), and 2 power cords (1 - 115V and 1- 230V). Check the shipment for damage.

⚠ CAUTION

This meter has dual operating voltages. It can be operated from 117VAC or 230VAC source. The unit is shipped in the 230VAC configuration with an 0.08A / 250 V fuse installed. If you plan to use the BDM40-UA on a 117 V source, unplug the power cord, switch to the 0.125A / 250V fuse (supplied with instrument), and set the rear panel switch to 117V.

If the meter maybe damaged if is not setup properly for the source voltage being used.

The label on the top side of your instrument is marked with the line voltage and frequency required for proper operation. Refer to Maintenance section if a change in the input power configuration is desired.

GETTING ACQUAINTED

Your meter is light-weight with a low profile, and requires little space on the work bench. The black case is made of rugged, high-impact plastic. The handle can be rotated to eight positions. The right side of your DMM contains two rows of switches and LED display. The power cord receptacle is located on the rear panel of your DMM. The meter inputs are the 4 inputs on the front panel and are marked for the functions.

USING YOUR METER

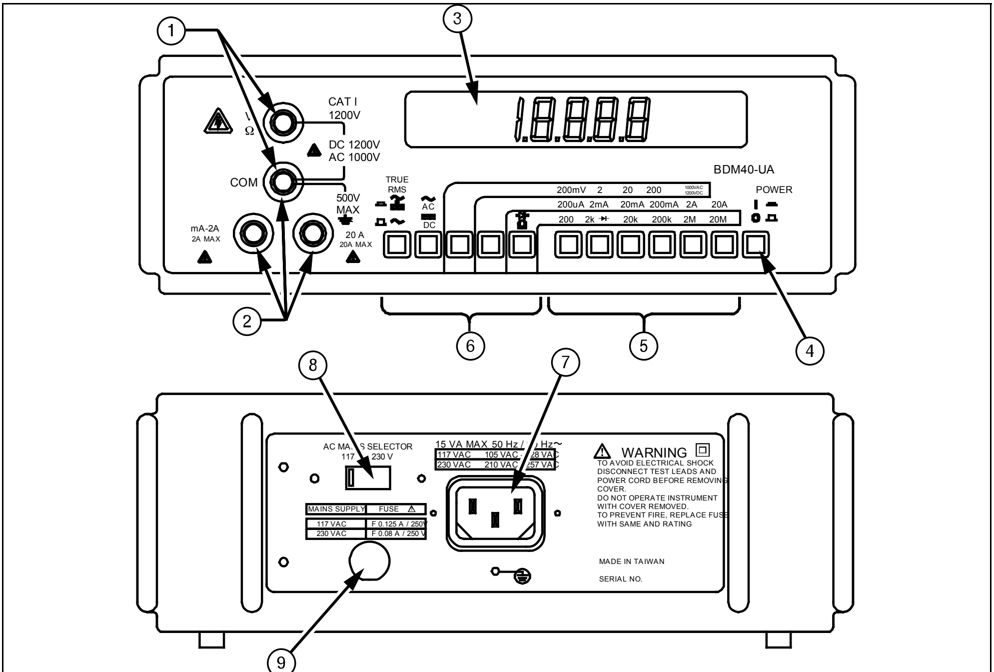
The following paragraphs describe each of the controls on your DMM and how these controls can be used for each instrument function. Exercises are included to help you familiarize yourself with your DMM and to verify that your instrument is functional.

The LED Display

The high-contrast 4-1/2 digit LED display is easily read from across the room. It can register from 0000 to 19999 counts. For ease of discussion, the 19999 will be rounded to 20000 in the remainder of this text. For example, we will refer to the 2V range, not the 1.9999V range. In all linear functions, the decimal point position is determined by the range selected. Polarity of the input signal is indicated by a ‘ – ‘ sign at the center of the left side of the LED. The + sign is disabled in the AC V, AC mA, and kΩ measurement functions. The ‘ – ‘ sign may appear in any measurement function, but is normally not meaningful when making AC V, AC mA, and kΩ measurements. You will only get this indication of an energized circuit if the power in the circuit is negative with respect to the COMMON input terminal. If the power in the circuit is positive with respect to the COMMON input terminal, an erroneous resistance will be displayed. If there is any doubt about whether there is energy remaining in the circuit you are reading, read the resistance, then reverse the test lead positions. If the minus sign is displayed in either case, the remaining energy must be removed from the circuit before correct resistance readings can be made. If you apply an input signal that exceeds the limits of the range selected, the LED display will flash. All decimal point positions appear in the display to indicate certain illegal combinations of front panel switch settings. For example, if you select the DCV function and the 20M range, all four decimal points will appear on the display.

POWER Switch

The green POWER switch is located in the right corner of the DMM front panel. To turn the meter ON, push the POWER button in. To turn the meter OFF, push the POWER button in.



①	Voltage, Ohms, Diode and COM inputs.
②	Current (mA to 2A) and 20A inputs.
③	Reading display 0000 to 19999.
④	Power button (green).
⑤	Range selection switches. The pushbuttons are interlocked with the other ranges.
⑥	Function selection switches. The pushbuttons are interlocked with the other two white function selection switches A and Ω.
⑦	Line Power connector.
⑧	Line Voltage selector switch.
⑨	Line Power Fuse.

Figure 1: BDM40-UA Controls

OPERATING GUIDELINES

To use your multimeter fully, there are some additional factors to be considered, such as measurement techniques, the maximum signal input levels that will not damage your instrument, and common applications.

Operating Notes

The operating notes present the capabilities and limitations of this instrument and routine operator maintenance instructions. Everyone using an DMM should be familiar with the operating notes.

Input Overload Protection

⚠ CAUTION

Exceeding the maximum input overload limits can damage your instrument. The transient overload protection circuit is intended to protect against short duration high energy pulses. The components used limit the protection to approximately five pulses per second for 6kV - 10 microsecond pulses, and about 0.6 watts average for lower amplitude pulses .

Each measurement function is equipped with input overload protection. Table 1 lists the overload limits for each function.

Input Connections to Common

⚠ ⚠ WARNING

TO AVOID ELECTRICAL SHOCK AND/OR INSTRUMENT DAMAGE, DO NOT CONNECT THE COMMON INPUT TERMINAL TO ANY SOURCE OF MORE THAN 500 VOLTS DC OR PEAK AC ABOVE EARTH GROUND

This instrument may be operated with the common input terminal at a potential of up to 500V dc or ac peak with respect to earth ground. If this limit is exceeded, instrument damage or an operator safety hazard may Occur.

Operating Power

This instrument is available in a universal version that uses 117V or 230V AC at 47 to 440Hz

Table 1. Maximum Input Signal Limits

FUNCTION SELECTED		RANGE SELECTED	INPUT TERMINALS	MAXIMUM INPUT OVERLOAD
V	DC	ALL RANGES	V / Ω and COMMON	1200VDC or Peak AC
	AC	20V, 200V, 1000V		1000VDC or Peak AC
		200mV, 2V		1000Vrms for no longer than 15 sec.
2A	DC or AC	ALL RANGES	mA / 20A and COMMON	Fuse protected: F 2A / 250V
20A				Not fused
kΩ		ALL RANGES	V / Ω and COMMON	250VDC or VAC rms

MEASUREMENT TECHNIQUES

The information provided here describes techniques in measurement and interpretation of measurements that may extend the usefulness of your DMM. These techniques, common throughout the electronics industry, have been tailored specifically for this instrument.

AC Measurement Techniques

When making precise measurements of AC signals, there are special parameters that must be considered such as the type of AC converter the meter uses (average, rms, etc.), crest factor, bandwidth, noise, etc.

True RMS

In order to compare dissimilar waveforms, calculate Ohm's law statements or power relationships, you must know the effective value of a signal. If it is a DC signal, the effective value equals the DC level. If the signal is AC, however, we have to use the root mean square or rms value. The rms value of an AC current or AC voltage is defined as being numerically equal to the DC current or voltage that produces the same heating effect in a given resistance that the ac current or voltage produces.

In the past, average responding converters were the type of converter most widely used. Theoretically, the rms value of a pure sine wave is $1 / \sqrt{2}$ of the peak value and the average value is 2 / pi of the peak value. Since the meters converted to the average value, the rms value was $1 / \sqrt{2} \div 2 / pi = pi / (2\sqrt{2}) = 1.11$ of the average value when measuring a sine wave. Most meters used an average responding converter and multiplied by 1.11 to present true rms measurements of sine waves. As the signal being measured deviated from a pure sine wave, the errors in measurement rose sharply. Signals such as square waves, mixed frequencies, white noise, modulated signals, etc., could not be accurately measured. Rough correction factors could be calculated for ideal waveforms if the signal being measured was distortion free, noise-free, and a standard waveform. The true rms converter in your meter provides direct, accurate measurement of these and other signals. Since this DMM is AC and DC coupled, refer to the section on Voltage Measurement Techniques for combined AC and DC signal measurements.

Crest Factor

Crest factor range is one of the parameters used to describe the dynamic range of a voltmeter's amplifiers. The crest factor of a waveform is the ratio of the peak to the rms voltage. In waveforms where the positive and negative half cycles have different peak voltages, the higher voltage is used in computing crest factor. Crest factors start at 1.0 for a square wave (peak voltage equals rms voltage).

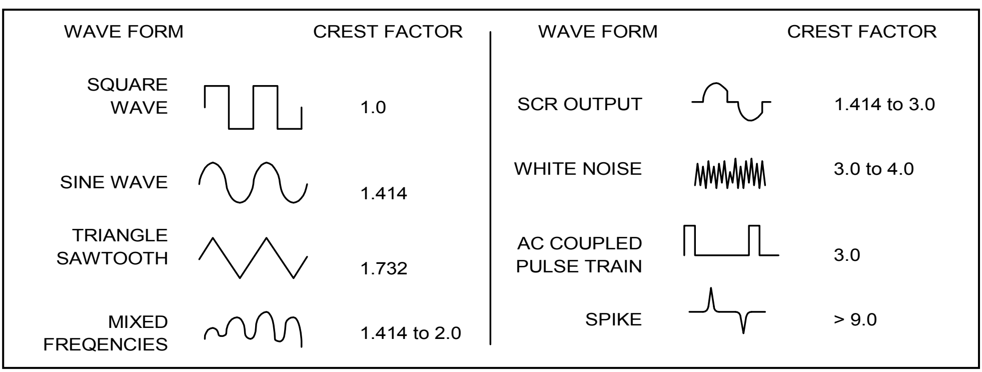


Figure 2 Crest Factors

Your instrument has a crest factor range of 1.0 to 3.0 at full scale. Going down from full-scale, the crest factor capability increases from 3.0 to: Full-Scale x 3 (i.e. 6 at half-scale) RMS Value , If an input signal has a crest factor of 3.0 or less, voltage measurements will not be in error due to dynamic range limitations at full-scale. If the crest factor of a waveform is not known, and you wish to know if it falls within the crest factor of your meter, measure the signal with both your meter and an ac coupled oscilloscope. If the rms reading on your meter is 1/3 of the peak voltage on the waveform or less, then the crest is 3.0. For readings at less than full-scale, use the preceding formula to determine the maximum crest factor. At half-scale the maximum crest factor is: 2 x 3 = 1

The waveforms in Figure 2 show signals with increasing values of crest factor. As you can see from the series of waveforms, a signal with a crest factor above 3.0 is unusual.

For an ac coupled pulse train: Crest Factor = $\sqrt{(1/D)-1}$

Where D = duty cycle or the ratio of pulse width to cycle length. Reversing this formula, we find that your meter can accurately measure pulse trains at full-scale with a duty cycle above 10% without being limited by crest factor.

$$\text{Crest Factor} = 3.0 = \sqrt{(1/D)-1}: \qquad 9.0 = (1/D)-1: \qquad 10.0 = 1/D$$

Bandwidth

Bandwidth defines the range of frequencies where the response of the voltmeter's amplifiers is no more than 3 dB down (half-power levels). Your instrument has a bandwidth of greater than 200kHz.

Slew rate

Slew rate is also called the rate limit or the voltage velocity limit. It defines the maximum rate of change of the output of the amplifiers for a large input signal. Slew rate limitations are not a factor in measuring voltages within specified frequencies and amplitude limits of this DMM.

Rise and fall time effect on accuracy

The rise and fall time of a waveform are the length of time it takes a waveform to change between the points that are 10% and 90% of the peak value. When discussing these periods, we'll only mention rise time. Errors due to rise to fall time can be caused either by bandwidth or slew rate limitations. Slew rate should not affect your measurement with this DMM.

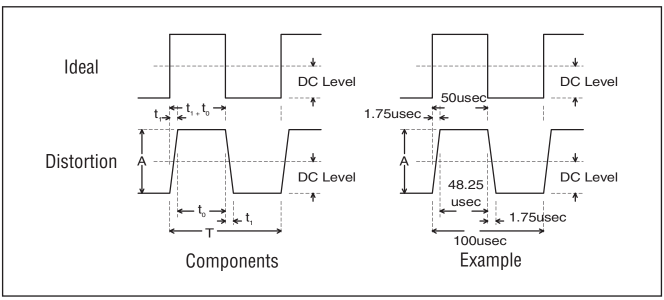


Figure 3 Waveform Distortion

An approximate way of converting bandwidth to rise time limit is to divide 0.35 by the 3 dB down frequency. For your instrument this will be 0.35/200kHz = 1.75 µsec. The following example will help you calculate errors due to this limitation when measuring rectangular pulses. These calculations will be rough because ideal waveforms are used in the analysis.

Ideally, the rectangular pulses would have zero rise and fall time and would be the right angled waveform shown in Figure 3. In practice, every waveform has a rise and fall time and looks more like the waveform in Figure 3. When calculating the error caused by the bandwidth of your Instrument, we will assume that the rise and fall time equals the slew rate of 1.75 μsec. To do this we will calculate the values for the theoretical signal with zero rise and fall time, then calculate the values for a signal with the same period but with total slope periods equal to 1.75 μsec. A comparison of the results will show the measurement error due to the finite bandwidth. Using Figure 3 for a reference, the total rms and DC levels are :

$$\text{V Total rms} = A\sqrt{\frac{3\,t_0 + 2\,t_1}{3\,T}} \qquad \text{VDC} = A\,\frac{t_0 + t_1}{T}$$

Since we can calculate two values, to find what your meter measures, use the formula:

$$\text{VAC rms} = \sqrt{(\text{V total rms})^2 - (\text{V DC})^2}$$

Let's look at the waveform in Figure 3. When using your meter to measure the AC component of the signal, the display will indicate the rms value of the AC signal riding on the DC level. (This DC level is the average value of the waveform relation to the baseline.) The total rms value of the waveform can be calculated using the relationship:

$$\text{V Total rms} = \sqrt{(\text{VAC rms})^2 + (\text{V DC})^2}$$

For our example let's use a 10kHz pulse train of 50 μsec pulses with a peak value of 1 V. Ideally, the pulses would have a zero rise time as shown in Figure 3.

$$\text{V Total rms} = \sqrt{\frac{3(50)+2(0)}{3(100)}} = \sqrt{\frac{150}{300}} = \sqrt{0.5} = 0.707$$

$$\text{V DC} = \frac{50+0}{100} = \frac{50}{100} = 0.5$$

$$\text{V AC rms} = \sqrt{(0.707)^2 - (0.5)^2} = \sqrt{0.50 - 0.25} = \sqrt{0.25} = 0.5$$

When the maximum distortion in rise time of 1.75 μsec is assumed, the signal becomes the isosceles trapezoid waveform shown in Figure 3. In this case:

$$\text{V Total rms} = \sqrt{\frac{3(48.25)+2(1.75)}{3(100)}} = \sqrt{\frac{144.75+3.5}{300}} = \sqrt{\frac{148.25}{300}} = \sqrt{0.494} = 0.703$$

$$\text{V DC} = \frac{48.25+1.75}{100} = \frac{50}{100} = 0.5$$

$$\text{V AC rms} = \sqrt{(0.703)^2 - (0.5)^2} = \sqrt{0.494 - 0.25} = \sqrt{0.244} = 0.494$$

Note that the V DC stayed the same. So, the errors are:

V total rms: = -0.6%: V AC rms: = -1.2%

VOLTAGE MEASUREMENTS

Your DMM can make either linear voltage or AC + DC TRUE RMS voltage measurements. For both types of measurements, plug the black test lead into the COMMON terminal and the red test lead into the V-Ω terminal.

Linear Voltage Measurements

The controls and terminals used for making linear voltage measurements are located on the front panel. Starting at the top left is the ACV/DCV switch. This pushbutton is interlocked with the other two white function selection switches A and Ω. If the DCV function switch is in the IN position (DCV selected), and any other function selection switch is pushed, the DCV pushbutton will be released to the OUT position. Push the DCV switch to the IN position.

The light grey area around the ACV / DCV switch is extended up and to the right to enclose the five range values of the voltage function. Push the range switch immediately above the value to be measured. The range selection switches are interlocked in the same manner as the function switches.

Perform the following procedure:

1. If the test leads are not connected, plug them into your DMM: red test lead to the V-Ω terminal and black to the COMMON terminal.
2. Select the 0.2V range.
3. Push the function switch to the DCV position.
4. With the POWER switch set to the OFF position, connect your DMM to a line power outlet rated at the operating voltage and frequency of your instrument. Keep the probe tips apart, and not connected to a circuit.
5. Push the POWER switch to the ON position. The LED should count down rapidly to a reading of < ± .0020.
6. Select the ACV and 1000V range.

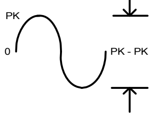
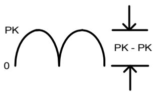
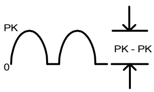
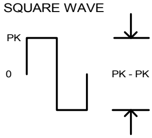
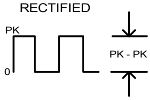
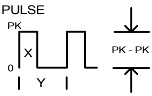
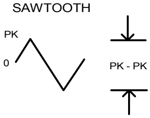
⚠ ⚠ WARNING

LOCAL LINE VOLTAGE IS MEASURED IN THE FOLLOWING STEP. BE CAREFUL NOT TO TOUCH THE PROBE TIPS WITH YOUR FINGERS OR TO ALLOW THE PROBE TIPS TO TOUCH EACH OTHER.

7. Insert the probe tips of the test leads into the slots of a power outlet. The LED should display the true local line voltage.
8. Push the DCV push-button switch. The LED should display near zero volts but there may be some residual dc voltage on the power line due to non-linear loads such as SCR light dimmers.
9. Remove the test leads from the line power outlet.

Converting voltage measurements

Your instrument is one of a family of DMMs that actually measure the true rms value of an AC or AC + DC signal. This is a feature that allows accurate measurement of common waveforms like distorted or mixed frequency sine waves, square waves, sawtooth waves, noise, pulse trains (with a duty cycle of at least 10%), etc. In the past, the methods used for AC measurement have introduced large errors in readings. Unfortunately, we've all grown used to these erroneous voltage readings and depend upon them to indicate whether or not a piece of equipment is working correctly. The data contained in Table 2 should help you convert between measurement methods.

AC COUPLED INPUT WAVEFORM	PEAK VOLTAGES		METERED VOLTAGE			DC AND AC TOTAL RMS
			AC COMPONENT ONLY			
	PK - PK	0 - PK	RMS CAL	AC TRUE RMS	**DC COMPONENT ONLY**	TRUE RMS = $\sqrt{ac^2 + dc^2}$
SINE 	2.828	1.414	1.000	0.000	0.000	1.000
RECTIFIED SINE (FULL WAVE) 	1.414	1.414	0.421	0.435	0.900	1.000
RECTIFIED SINE (HALF WAVE) 	2.000	2.000	0.764	0.771	0.636	1.000
SQUARE WAVE 	2.000	1.000	1.110	1.000	0.000	1.000
SQUARE WAVE RECTIFIED 	1.414	1.414	0.785	0.707	0.707	1.000
RECTANGULAR PULSE  $D = X / Y$ $K = \sqrt{D - D^2}$	2.000	2.000	2.22 K	2 K	2 D	2 $\sqrt{D}$
TRIANGLE SAWTOOTH 	3.464	1.732	.960	1.000	0.000	1.000

* RMS CAL IS DISPLAYED VALUE FOR AVERAGE RESPONDING METERS THAT ARE CALIBRATED TO DISPLAY RMS FOR DINE WAVES
** Your Digital Multimeter

Table 2. Voltage Conversion

Circuit loading error

Connecting most voltmeters to a circuit may change the operating voltage of the circuit if it loads the circuit down. As long as the circuit resistance (source impedance) is small compared to the input impedance of the meter, the error is not significant. For example, when measuring voltage with your meter, as long as the source impedance is 1 kΩ or less, the error will be ≤ .01 %. If circuit loading does present a problem, the percentage of error can be calculated using the appropriate formula in Figure 4.

1. **DC Voltage Measurements**
Loading Error in % = 100 x Rs / (Rs + Rin)
Where: Rs = Source resistance in ohms of the circuit being measured.
Rin = Meter input resistance (1 x 10^7 ohms)

2. **AC Voltage Measurements**
First determine input impedance as follows:

$$Zin = \frac{10^7}{\sqrt{1 + (2\pi FC)^2}}$$

Where: Zin = effective input impedance
Rin = 10^7 ohms
Cin = 100 x 10^{-12} Farads
F= Frequency in Hz

Then determine source loading error as follows:

$$\text{Loading Error in \%} = 100 \times \frac{Zs}{Zs + Zin}$$

Where: Zs = Source impedance
Zin = input impedance
* Vector algebra required

Figure 4. Circuit Loading Error

Combined AC and DC signal measurements

The waveform shown in Figure 5 is a simple example of an AC signal riding on a DC level. To measure waveforms such as these, first measure the rms value of the AC component using the AC function of your meter. Measure the DC component using the DC function of your instrument. The relationship between the total rms value of the waveform and the AC component and the DC component is:

$$\text{RMS Total} = \sqrt{(\text{AC component rms})^2 + (\text{DC component})^2}$$

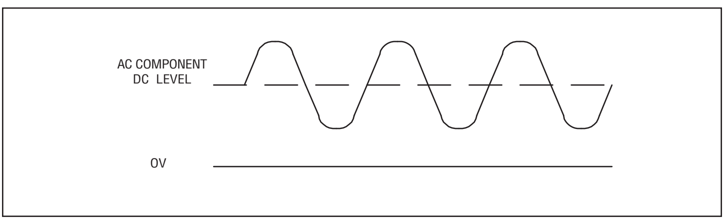


Figure 5. RMS Values

Insignificance of inherent meter offset

If you short the input of your meter while the AC voltage function is selected, you should have a reading of less than 10 digits on the display. This small offset is caused by the action of amplifier noise and offset of the true rms converter. This offset will not significantly affect any readings until you try to measure signals almost at the lower limit of the meter. For example:

Given: An offset of 40 digits
0.40mV in 200 mV range
Input signal = 10mV in 200 mV range

$$\text{Total rms} = \sqrt{10^2 + 0.4^2}$$
$$= \sqrt{100 + 0.16}$$
$$= \sqrt{100.16}$$
$$= 10.01 \text{ mV}$$

The error will be about 0.01mV

Given: An offset of 20 digits
0.20mV in 200 mV range
Input signal = 10mV in 200 mV range

$$\text{Total rms} = \sqrt{10^2 + 0.2^2}$$
$$= \sqrt{100 + 0.04}$$
$$= \sqrt{100.04}$$
$$= 10.00 \text{ mV}$$

the error is not significant

CURRENT MEASUREMENTS

All of the controls and terminals used to make current measurements are located on the front panel. The AC mA and DC mA function switches determine the measurement function. The colored area around the 20A switch extends up and to the right to enclose the six range values for the 20A measurement function. Push the range switch immediately above the value to be measured.

As the colored areas around the terminals indicate, the red test lead should be plugged into the 2A or 20A terminal and the black test lead should be plugged into the COMMON terminal.

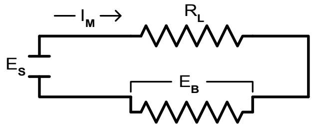
⚠ ⚠ WARNING

INSTRUMENT DAMAGE AND OPERATOR INJURY MAY RESULT IF THE FUSE BLOWS WHILE CURRENT IS BEING MEASURED IN A CIRCUIT WHICH EXHIBITS AN OPEN CIRCUIT VOLTAGE GREATER THAN 600 VOLTS.

Burden voltage error

When a meter is placed in series with a circuit to measure current, you may have to consider an error caused by the voltage drop across the meter (in this case, across the protective fuses and current shunts). This voltage drop is called burden voltage. The maximum full scale burden voltages for your instrument are: 0.3V for the four lowest ranges, and 0.9V for the 2000mA, 20A ranges. These voltage drops can affect the accuracy of a current measurement if the current source is unregulated and the resistance of the shunt and fuse represents a significant part (1/ 1000 or more) of the source resistance. If burden voltage does present a problem, the percentage error can be calculated using the formula below. This error can be minimized by selecting the highest current range that provides the necessary resolution.

Calculating Burden Voltage Error



AMMETER SHUNT

E_s = Source voltage
R_L = Load resistance + Source resistance
I_M = Measured current (display reading in amps)
E_B = Burden voltage (calculated) , i.e.,

Display reading expressed as a % of full scale $\left(100 \text{ x } \frac{\text{Reading}}{\text{Full Scale}}\right)$

times full scale burden voltage for selected range. See table.

RANGE F.S.	BURDEN VOLTAGE
200µA to 200mA	0.3V max.
2000mA	1V max.
20A	2V max.

Maximum current error due to Burden Voltage

$$\text{in } \% = 100 \text{ x } \frac{E_B}{E_S - E_B} \qquad \text{in milli Amps} = 100 \text{ x } \frac{E_B - I_M}{E_S - E_B}$$

Examples: Es = 14V, RL = 9Ω, IM = 1497.mA,

$$E_B = 100 \text{ x } \frac{1497.0}{2000.0} \text{x} 1.0 = 74.9\% \text{ of } 1.0 = 0.749\text{V}$$

$$\text{Maximum error in } \% = 100 \text{ x } \frac{.749}{14 \quad .749} = 100 \text{ x } \frac{.749}{13.251} = 5.06\%$$

Increase displayed current by 5.65% to obtain true current.

$$\frac{\text{Maximum error}}{\text{in milli Amps}} = \frac{.749\text{x}1497}{14 - .749} = \frac{1121.2}{13.251} = 84.6\text{mA}$$

Increase displayed current by 84.6mA to obtain true current.

RESISTANCE MEASUREMENTS

The controls and terminals used to make resistance measurements are located on the front panel. The measurement function is selected by pushing the kΩ switch to the IN position. The colored area enclosing the kΩ function switch extends up and to the right enclosing the six range values for the resistance function. To select a particular resistance range, push the range switch immediately above the value to be measured. Connect the test leads; red to the V-Ω terminal and black to the COMMON terminal.

Use the following procedure to familiarize yourself with the resistance function and to see how the range switches affect decimal point position on the LED.

1. With the test leads held apart, select the 2000 kΩ range. The LED should display an over range indication (all digits are flashing).
2. Make a firm connection between the probe tips of the test leads. The LED should count down to 000.0.
3. Maintain a firm contact between the probe tips and sequentially select all ranges starting with the 200Ω range. The decimal point for each should be as follows:

Range	Display
200Ω	199.99*
2 kΩ	1.9999*
20 kΩ	19.999
200 kΩ	199.99
2000 kΩ	1999.9
20 MΩ	19.999

*Display value will show lead resistance.

Automatic test lead compensation

When measuring low resistances, test lead resistance interferes with low resistance readings and usually has to be subtracted from resistance measurements for accuracy.

DIODE MEASUREMENT

The five resistance ranges bar with a diode symbol beside the range value have a high enough measurement voltage to turn on a silicon junction. These ranges can be used to check silicon diodes and transistors. The 2kΩ range is preferred. It is marked with the largest diode symbol.

CALIBRATION

⚠⚠ WARNING

THESE SERVICING INSTRUCTIONS ARE FOR USE BY QUALIFIED PERSONNEL ONLY. TO AVOID ELECTRICAL SHOCK, DO NOT PERFORM ANY SERVICING OTHER THAN THAT CONTAINED IN THE OPERATING INSTRUCTIONS UNLESS YOU ARE QUALIFIED TO DO SO.

Introduction

This section contains the maintenance information for this Digital Multimeter. This information is divided into service information, general maintenance, a group of performance tests, a calibration adjustment procedure, and troubleshooting. The performance tests are recommended as an acceptance check when the instrument is first received and should be completed as necessary to verify that your DMM is operating within the specification limits listed in SPECIFICATIONS Section. A calibration cycle of 1- year is recommended to maintain the specifications given in SPECIFICATIONS Section of this manual. The test equipment required for both the performance test and the calibration adjustment procedure is listed in Table 3. If the recommended test equipment is not available, instruments having equivalent specifications may be used.

Service Information

This DMM is warranted for a period of 1-year upon delivery to the original purchaser. Conditions of the warranty are given on the first page of this manual and Service instructions are in the Maintenance Section.

Cal Procedures

NOTE

To avoid contaminating the pcb with grease from the fingers, handle the pcb by its edges or wear gloves. If the pcb does become contaminated, refer to the cleaning procedure given later in this section.

Table 3. Recommended Calibration

<table>
<tr><th>INSTRUMENT TYPE</th><th colspan="3">REQUIRED CHARACTERISTICS</th><th>RECOMMENDED MODEL</th></tr>
<tr><td>Calibrator</td><td>DC Volts</td><td>0 to 1000V</td><td>± 0.006 %</td><td rowspan="5">Fluke 5500</td></tr>
<tr><td rowspan="4"></td><td>AC Volts
100Hz
200Hz
1 kHz
10 kHz
20 kHz
50 kHz</td><td>
0 to 750V
0 to 2V
0 to 750V
0 to 100V
0 to 100V
0 to 20V</td><td>
± 0.06 %
± 0.06 %
± 0.06 %
± 0.06 %
± 0.1 %
± 0.5 %</td></tr>
<tr><td>DC Current</td><td>0 to 2000mA</td><td>± 0.05 %</td></tr>
<tr><td>AC Current</td><td>0 to 19mA, 100 Hz</td><td>± 0.1 %</td></tr>
<tr><td>Resistance</td><td>100 Ω, 1 kΩ
10 kΩ, 100 kΩ
1MΩ, 10MΩ</td><td>± 0.01 %
± 0.005 %
± 0.05 %</td></tr>
<tr><td>Calibration Leads</td><td colspan="3">24 “ shielded cable with a double banana plug at both ends</td><td>Pomona 2BC-24</td></tr>
</table>

Calibration Access

Use the following procedure to gain access to the calibration adjustments of this DMM.

1. Set the POWER switch to the OFF position and remove the power cord plug from the receptacle in the rear of the instrument.
2. Remove the Phillips screw from the Bottom of your DMM.
3. Grasp the front panel and slide the instrument out of the case.
4. Turn the instrument upside down as viewed from the front panel.
5. All adjustments necessary to complete the calibration procedure are now accessible.
6. For reassembly, reverse the procedure (be careful to align the grooves in the sides of the front panel with the guides located inside the case and to bend the flexible interconnect inwards and out of the way).

Main PCB Access

Use the following procedure to gain access to all the components and test points ON THE MAIN PCB ASSEMBLY FOR TROUBLESHOOTING AND REPAIRING.

1. Complete the calibration access procedure.
2. Remove the front panel using the following procedure:
    a. The V-Ω input line and the COMMON input line are attached to the front panel by a snap connector. Unplug these lines.
    b. Slide the fuse spring forward to the edge of the slide panel.
    c. Pull the wire up through the slot in the fuse holder barrel.
    d. Pull the spring and the fuse contact up through the hole in the fuse holder barrel.
    e. Reinstall the fuse and fuse holder.
    f. Turn the instrument component-side-down.
    g. Carefully pull the front panel free of the switches.
3. To install the Main PCB, reverse this procedure, being careful to install the PCBs and the shields in their respective guides.

Display Access
Use the following procedure to remove or replace the LED:

1. Carefully lay the display PCB to one side.
2. Both the Main and Display PCBs should now be flat on your workbench, component-side-up.
3. Tilt the Display PCB towards the Main PCB, and remove the shield plate connecting the Display PCB.
4. For reassembly, reverse this procedure.

Performance Tests

The performance tests are used to compare the performance of this instrument to the specifications listed in Section 1 of this manual. If the instrument fails any portion of the performance tests, calibration and/or repair is indicated. Throughout the tests, your DMM will be referred to as the UUT (Unit Under Test).

NOTE

Allow the UUT to warmup a minimum of 5 minutes and conduct the tests at an ambient temperature of 23 ± 5°c (73 ± 9°f).

Display Test
Complete the following procedure to verify proper operation of the display annunciators and each segment of each digit in the display:

1. Select kΩ, 200Ω range with an open circuit input.
2. Verify that for over range indication, the LED will flash in all digit locations.
3. Short the input, select each range listed in Table 4. and verify that the decimal point is positioned as indicated.
4. Select DC V, 200V range.
5. Connect the DMM Calibrator to the UUT: HI to the V-Ω terminal and LO to the COMMON terminal.
6. Apply + 188.88VDC and adjust the calibrator until the UUT displays + 188.88 exactly.

Table 4. Display Test

SELECT RANGE	DISPLAY
200Ω	00.00*
2kΩ	.0000*
20kΩ	0.000
200kΩ	00.00
2000kΩ	000.0
20MΩ	0.000

*The least significant digit(s) may change by several digits from zero, depending on your test lead resistance.

Linear Voltage Test

Use the following procedure to verify the proper operation of both the AC and DC V functions:

1. Select DC V, 200mV range.
2. Connect the calibrator HI volts output to the V-Ω terminal and the calibrator LO volts output to the COM terminal.
3. For each step of Table 5, set the ACV/DCV switch to the indicated position, select the listed range, program the calibrator for the corresponding input to the UUT, and verify that the UUT display value lies within the indicated limits.

Table 5. Linear Voltage Test

STEP	UUT SWITCH POSITIONS		UUT INPUT		DISPLAY READING
	FUNCTION	RANGE	LEVEL	FREQUENCY	
1	DCV	200mV	+190mVDC		+189.90 to +190.10
2			-190mVDC		-189.90 to -190.10
3		2V	+1.9VDC		+18990 to +1.9010
4			-1.9VDC		-1.8990 to -1.9010
5		20V	+19VDC		+18.990 to +19.010
6		200V	+190V DC		+189.90 to +190.10
7		1200V	+1000VDC		+999.3 to +1000.7
8		2V	Short		<.0020
9	AC V	200mV	190mVAC rms	100 Hz	188.90 to 191.10
10				10kHz	188.90 to 191.10
11				50kHz	180.20 to 199.80
12			100mVAC rms	1kHz	99.35 to 100.65
13		2V	1.9VAC rms	100Hz	1.8890 to 1.9110

14				10kHz	1.8890 to 1.9110
15				50kHz	1.8020 to 1.9980
16		20V	19VAC rms	100Hz	18.890 to 19.110
17				10kHz 50kHz	18.890 to 19.110 18.020 to 19.980
18		200V	190VAC rms	100Hz	188.90 to 191.10
19			100VAC rms	10kHz	99.35 to 100.65
20		100V	1000VAC rms	100Hz	993.5 to 1006.5
21				1kHz	993.5 to 1006.5

Current Test

Use the following procedure to verify proper operation of both the AC and DC mA measurement functions:

1. Select DC mA, 200μA range.
2. Connect the calibrator HI amps output to the V-Ω terminal and the calibrator LO amps output to the COM terminal.
3. For each step in Table 6, select the listed range, program the calibrator for the corresponding UUT input, and verify that the UUT display value lies within the indicated limits.
4. Set the FUNCTION switch to the AC mA position and select the 20 mA range.
5. Program the calibrator for a UUT input of 19.000 mA rms at a frequency of 100 Hz.
6. Verify that the UUT display value lies between 18.890 and 19.110.

Table 6. Direct Current Test

STEP	SELECT RANGE	INPUT	DISPLAY READING
1	200μA	190μA	189.61 to 190.39
2	2mA	1.9mA	1.8961 to 1.9039
3	20mA	19mA	18.961 to 19.039
4	200mA	190mA	189.61 to 190.39
5	2000mA	1900mA	1894.1 to 1905.9
6	20A	19A	18.941 to 19.059

Resistance Test

Use the following procedure to verify the accuracy of the kΩ measurement function:

1. Select kΩ, 200Ω range.
2. Connect the calibrator HI ohms output to the V-Ω terminal and the calibrator LO ohms output to the COM terminal.

3. For each step in Table 7, select the listed range, program the calibrator for the corresponding input to the UUT and verify that the UUT display is within the indicated limits.

Table 7. Resistance Test

STEP	SELECT RANGE	INPUT	DISPLAY READING
1	200Ω	Short	00.00 to 00.07
2	200Ω	100Ω	99.86 to 100.14
3	2kΩ	1 kΩ	.9988 to 1.0012
4	20kΩ	10kΩ	9.988 to 10.012
5	200kΩ	100kΩ	99.88 to 10.012
6	2000kΩ	1000kΩ	997.3 to 1002.7
7	20MΩ	10MΩ	9.973 to 10.027

Calibration Adjustments

The calibration adjustment procedure should be used any time your instrument has been repaired or fails to pass the Performance Test. Adjust R306A, R336A if U301, U308 are replaced or if VR302, VR304 do not have enough adjustment range. Replace U501 if VR502 does not have enough adjustment range. The RMS Converter Offset Adjustment should not normally need to be done. Adjust only if VR501 (AC) does not have enough adjustment range or if the display reads .0010 or greater with AC V, 2V range selected and the input shorted.

NOTE Allow the UUT to warm up a minimum of 5 minutes and conduct the calibration at an ambient temperature of 23 ± 5°C (73 ± 9 °F).

DC Voltage Calibration
On the UUT select DC V, 2V range, and connect the calibrator HI volts output to the V-Ω terminal and the calibrator LO volts output to the COM terminal. For each step in Table 8, select the listed range, program the calibrator for the corresponding UUT input, and make the specified adjustment or check.

Table 8. DC Calibration

Step	Range	Input	Adjust	Display Limits
1	200mV	Short	VR303	Less than ± 00.04
2	2V	+ 1.9000V	VR302	+ 1.9000V exactly
3	200mV	+ 190.00mV	VR304	+ 190.00mV exactly
4	200V	+ 190.00V	VR202	+ 190.00V exactly
5	1000V	+ 1000.0V	VR203	+ 1 000.0V exactly

Ohms Calibration

On the UUT select ‘ Ω ‘, 200Ω range, and connect the V-Ω terminal to the calibrator HI ohms output and COM to the calibrator LO ohms output. For each step in Table 9, select the listed range, program the calibrator for the corresponding UUT input, and make the specified adjustment or check.

Table 9. Ohms Calibration

Step	Range	Input	Adjust	Display Limits
1	20 MΩ	10 MΩ	VR402	9.995 to 10.005
2	20 kΩ	10 kΩ	VR401	9.998 to 10.002

DC Current Calibration

On the UUT select DC, 20 A range, and connect the 20A terminal to the calibrator HI amps output and COM to the calibrator LO amps output. For each step in Table 10, select the listed range, program the calibrator for the corresponding UUT input, and make the specified adjustment or check.

Table 10. DC Current Calibration

Step	Range	Input	Adjust	Display Limits
1	20 A	+ 1.9 A	VR206	+ 1.898 to 1.902
2	2 A (2000mA)	+ 1.9 A	VR205	+ 1899.8 to 1900.2
3	200 mA	+ 190.00 mA	VR204	+ 189.98 to 190.02

AC Volts Calibration

On the UUT select AC only, 2 V range, and connect the V-Ω terminal to the calibrator HI volts output and COM to the calibrator LO volts output. For each step in Table 11, select the listed range, program the calibrator for the corresponding UUT input, and make the specified adjustment or check.

Table 11. AC Voltage Calibration

Step	Range	Input	Freq.	Adjust	Display Limits
1	2V	Short		VR501	Less than .0010
2	2V	1.9000V	400Hz	VR502	1.8995 to 1.9005
3				SVC202/203	ADJ to mechanical center
4(a)	200V	100.00V	1 kHz	SVC201	99.90 to 100.10
(b)	20V	19.000V	10 kHz	SVC202	18.990 to 19.010
5(a)	1000v	1000.0v	1 kHz	SVC201	999.5 to 1000.5
(b)	20V	19.000V	10 kHz	SVC203	18.990 to 19.010

MAINTENANCE AND REPAIR

Changing Input Power Configuration

This meter was shipped with power cords and fuses for 117V (USA) and 230V (European) operation. The initial configuration is for 230V.

Fuse Replacement

This DMM has two fuses. The main power fuse is 0.08A or 0.125A, 250V for line protection. The current measurement fuse is 2A / 250V for below 2A current measurements (unscrew the mA – 2A input jack).

117 Line Fuse	T 0.125A / 250V	Bussmann GDB-125mA	Littel Fuse 218.125
230V Line Fuse	T 0.08A / 250V	Bussmann GDB-80mA	Littel Fuse 218.080
2A Current Input Fuse	F 2A / 250V	Bussmann GMA-2A	Littel Fuse 216.002

Maintenance

If there appears to be a malfunction during the operation of the Multimeter, the following steps should be performed in order to isolate the cause of the problem: Review the operating instructions for possible mistakes in operating procedure. Inspect and test the Test Cables for a broken or intermittent connection. Inspect and test the fuse. See Fuse Replacement.

Cleaning

⚠CAUTION

DO NOT USE AROMATIC HYDROCARBONS OR CHLORINATED SOLVENTS FOR CLEANING. THESE SOLUTIONS WILL REACT WITH THE PLASTIC MATERIALS USED IN THE INSTRUMENT.

Clean the front panel and case with a mild solution of detergent and water. Clean dust from the circuit board with clean, dry, low pressure air (20 psi or less). Contaminants can be removed from the PCB using demineralized water and a soft brush (remove the display assembly before washing the Main PCB and avoid getting excess amounts of water on the switches). Dry with clean, dry, low pressure air and then bake at 50 to 60°C (122 to 140°F) for 24 hours.

Repair

All test tools returned for warranty or non-warranty repair or for calibration should be accompanied by the following: your name, company's name, address, telephone number, and proof of purchase. Additionally, please include a brief description of the problem or the service requested and include the test leads with the meter. Non-warranty repair or replacement charges should be remitted in the form of a check, a money order, credit card with expiration date, or a purchase order made payable to Amprobe® Test Tools.

In-Warranty Repairs and Replacement – All Countries

Please read the warranty statement and check your battery before requesting repair. During the warranty period any defective test tool can be returned to your Amprobe® Test Tools distributor for an exchange for the same or like product. Please check the "Where to Buy" section on www.amprobe.com for a list of distributors near you. Additionally, in the United States and Canada In-Warranty repair and replacement units can also be sent to a Amprobe® Test Tools Service Center (see below for address).

Non-Warranty Repairs and Replacement – US and Canada
Non-warranty repairs in the United States and Canada should be sent to a Amprobe® Test Tools Service Center. Call Amprobe® Test Tools or inquire at your point of purchase for current repair and replacement rates.

In USA	In Canada
Amprobe Test Tools	Amprobe Test Tools
Everett, WA 98203	Mississauga, ON L4Z 1X9
Tel: 877-AMPROBE (267-7623)	Tel: 905-890-7600

Non-Warranty Repairs and Replacement – Europe
European non-warranty units can be replaced by your Amprobe® Test Tools distributor for a nominal charge. Please check the "Where to Buy" section on www.amprobe.com for a list of distributors near you.

European Correspondence Address*
Amprobe® Test Tools Europe
P.O. Box 1186
5602 BD Eindhoven
The Netherlands

*(Correspondence only – no repair or replacement available from this address. European customers please contact your distributor.)

SPECIFICATIONS

General

Temperature Coefficient: < 0.1 times the applicable accuracy specification per °C for 0°C to 18°C and 28°C to 50°C (32°F to 64.4°F and 82,4°F to 122°F).

Operating Temperature: 0°C to 50°C (32°F to 122°F).

Storage Temperature: -10°C to +70°C (-14°F to + 158°F).

Relative Humidity: Up to 90%, 0°C to 35°C (32-95°F); up to 70%, 35°C to 50°C (95-122°F), except on 2000kΩ and 20MΩ, ranges: up to 80%, 0°C to 35°C (32-95°F).

Environmental: Intended for Indoor use. Altitude up to 2000m.

Maximum Common Mode Voltage: 500VDC, or peak AC (low terminal potential with respect to power line ground).

Size: 228 (W) x 80 (H) x 329 (D) mm.

Weight: 2.2Kg.

Power requirements:

Line Voltage: 105 to 128Vac @ 47 to 440Hz. or 210 to 257V AC @ 47 to 440Hz specified voltage.
Power Consumption: 15W max.

Safety: meets EN61010-1 Cat I - 1200V Class II, Pollution degree 2.

EMC: Meets EN61326-1

This product complies with requirements of the following European Community Directives: 89/336/EEC (Electromagnetic Compatibility) and 73/23/EEC (Low Voltage) as amended by 93/68/EEC (CE Marking). However, electrical noise or intense electromagnetic fields in the vicinity of the equipment may disturb the measurement circuit. Measuring instruments will also respond to unwanted signals that may be present within the measurement circuit. Users should exercise care and take appropriate precautions to avoid misleading results when making measurements in the presence of electronic interference.

Electrical

The electrical specifications apply for an operating temperature of 18°C to 28°C (64.4°F to 82.4°F), relative humidity up to 90%, and a 1- year calibration cycle.

DC VOLTS:

RANGE	RESOLUTION	ACCURACY for 1 year
± 200 mV	10µV	
± 2V	100µV	
± 20V	1 mV	± (0.03% of reading + 4 digits).
± 200V	10mV	
± 1000V	1000mV	

Input Impedance: 10MΩ in parallel with < 100pF, all ranges.

Normal Mode Rejection Ratio: >60dB at 60Hz or >50dB at 50Hz.

Common Mode Rejection Ratio: >90 dB at dc, 50Hz or 60Hz (1 kΩ unbalanced)

Common Mode Voltage (Maximum): 500V DC or peak AC.

Response Time to Rated Accuracy: 1 second maximum.

Maximum Input: 1200V DC or peak AC continuous (less than 10 seconds duration on both the 200mV and 2V ranges).

AC VOLTS (True RMS Responding, AC or AC + DC):

Voltage Readout Accuracy: ± (% of reading + no. of digits), between 5% of range and full range.

INPUT VOLTAGE	RESOL UTION	Range	20Hz** 45Hz	1kHz	2kHz 10kHz	20kHz	50kHz
10mV-200mV	10 µV	200mV		:			
0.1V-2V	100µV	2V	1 %	0.5%	1%	2%	5%
1V-20V	1mV	20V	+15	+15	+15	+15	+15
10V-200V	10mV	200V		:			
100V-1000V	100mV	1000V			NOT SPECIFIED		

** Typically 3 to 5 digits of rattle will be observed at full scale at 20Hz.

DC CURRENT:

RANGE	RESOLUTION	ACCURACY for 1 Year	VOLTAGE BURDEN
200µA	0.01 µA	(0.2% of reading + 2 digits)	1 mV / 1 µA
2mA	0.1 µA		100 mV / 1 mA
20mA	1 µA		10 mV / 1 mA
200mA	10 µA		1 mV / 1 mA
2000mA	100 µA	(0.3% of reading + 2 digits)	200 mV / 1 A
20A *	1 mA		14 mV / 1 A
* Overload Protection: 5 ranges (200µA, 2mA, 20mA, 200mA, 2000mA), with fuse protection, 20A range, no fuse.			

AC CURRENT (True RMS Responding, AC or AC+DC):

INPUT CURRENT	RESO-LUTION	Range	20Hz**	45Hz	2kHz	10kHz - 20kHz	VOLTAGE BURDEN
10µA -200µA	.01µA	200µA					1 mV / 1 µA
100µA -2mA	0.1 µA	2mA					100mV / 1 mA
1mA-20mA	1 µA	20mA	1%	0.5%	1%	2%	10 mV / 1 mA
10mA-200mA	10 µA	200mA	+15	+15	+15	+15	1mV / 1 mA
100mA-2000mA	100 µA	2000mA					200 mV / 1 A
2000mA-20A	1 mA	20 A			Not Specified		14mV / 1 A
* * Typically 3 to 5 digits of drift will be observed at full scale at 20Hz.							

Crest Factor Range: Waveforms with a Peak / RMS ratio of 1:1 to 3:1 at full scale.

RESISTANCE

RANGE	RESOLUTION	ACCURACY for 1 Year	FULL SCALE VOLTAGE ACROSS UNKNOWN RESISTANCE
00Ω	0.01Ω	± (0.1% reading + 4 digits)	0.2V
2kΩ	0.1Ω	± (0.1% reading + 4 digits)	2V
20kΩ	1ΩΩ		2V
200kΩ	10Ω		0.2V
2000kΩ	100Ω	± (0.25% reading + 4 digits)	2V
20MΩ	1kΩ		2V
Overload Protection: 250V DC/AC rms on all ranges.			

Response Time (To Rated Accuracy): 5 seconds maximum on 20MΩ range; 2 seconds maximum on all other ranges.

Diode Test:

The 200, 2k, and 20kΩ ranges have enough voltage to turn on silicon junctions to check for proper forward to back resistance. The 2kΩ range is preferred and is marked with a large diode symbol on the front panel of the instrument.

Maximum Input Signal Limits

<table>
<tr><th colspan="2">FUNCTION SELECTED</th><th>RANGE SELECTED</th><th>INPUTTERMINALS</th><th>MAXIMUM INPUT OVERLOAD</th></tr>
<tr><td rowspan="3">V</td><td>DC</td><td>ALL RANGES</td><td rowspan="3">V / Ω and COMMON</td><td>1200VDC or Peak AC</td></tr>
<tr><td rowspan="2">AC</td><td>20V, 200V, 1000V</td><td>1000VDC or Peak AC</td></tr>
<tr><td>200mV, 2V</td><td>1000Vrms for no longer than 15 sec.</td></tr>
<tr><td>2A</td><td rowspan="2">DC or AC</td><td rowspan="2">ALL RANGES</td><td rowspan="2">mA / 20A and COMMON</td><td>Fuse protected: F 2A / 250V</td></tr>
<tr><td>20A</td><td>Not fused</td></tr>
<tr><td colspan="2">kΩ</td><td>ALL RANGES</td><td>V / Ω and COMMON</td><td>250VDC or VAC rms</td></tr>
</table>

OPTIONAL ACCESSORIES

DL243D Basic Test Lead Set
DL248D Deluxe Test Lead Set
TL245A Standard Replacement Test Leads
TL36A Test leads with alligator clips
TC 253B Temperature Converter