



Made in the United States of America

Surface Resistance Test Kit Operation and Maintenance



Figure 1. Item [99105](#) Surface Resistance Kit

Description

The Surface Resistance Test Kit is a portable, accurate, and versatile instrument designed to measure point to point resistance (Rp), resistance to ground (Rg), and surface resistivity. It is designed to perform test methods described in EN 61340-5-1 Annex A. Features include:

- Resistance measuring accuracy $\pm 10\%$ (E11 and greater $\pm 20\%$)
- Resistance range $<1.0 \times 10E3$ ohms to $>10E12$ ohms
- Open circuit voltages of 10 and $100 \pm 5\%$
- Electrification period of 15 seconds
- Electrodes 2.27 kilograms $\pm .06$ kg with 50-70 durometer conductive pads

In addition, the Meter measures ambient temperature and relative humidity.

The Surface Resistance Test Kit (or its Meter) is referenced and designed to be used to make measurements in accordance with the test methods in EN 61340-5-1 Annex A Resistance Measurement Test method:

- A. 1 Floor, working surface or storage rack working surface
- A.2 Seating
- A.3 Garments
- A.5.4 Gloves, finger cots and tools (Neither 20 mm plates nor clip connectors provided)

Versatility:

Measures Rp, Rg or Resistivity (requires optional Resistivity Attachment, item [99107](#))

- Quick Checks - Surface resistance exponent number illuminates immediately i.e. 8 = $10E8$ ohms or 100,000,000 ohms

- Periodic Audits of Installed Products - Surface resistance exponent number illuminates immediately and displays Temperature and Relative Humidity during 15 second electrification period making numerous measurements and calculations to the display mantissa i.e LED displays 8 and LCD displaying 7.14 as mantissa = $7.14 \times 10E8$ ohms or 714,000,000 ohms
- Laboratory Test Evaluation of Product - Display same as above Periodic Audit

The Surface Resistance Test Kit is NIST calibrated and is available in two models:

Model	Description	Power
99105	Surface Resistance Test Kit	2 x AA Batteries
99106	Meter and Attachment	2 x AA Batteries
99107	Resistivity Attachment	N/A

A pair of Test Leads (item [99108](#)) can be bought separately. The Charleswater [99109](#) replacement electrodes can be purchased separately also.

Inspection

Remove the meter from the carton and inspect for damage. Each Surface Resistance Test Kit should include the following:

- 1 Protective carrying case
- 1 Meter
- 2 Test leads
- 2 2.27 kilogram electrodes
- 2 AA alkaline batteries
- 1 Certificate of NIST calibration

Properly store the Meter and component assemblies when not in use.

ESD protective products should be tested:

- A. Prior to installation to qualify for listing in user's ESD control plan approved ESD protective materials (see EN 61340-5 paragraph 9.3.2 Qualified protective items)
- B. During initial installation
- C. For periodic audits of installed products as part of EN 61340-5-1 paragraph 9 Quality responsibilities

In addition: Per EN 61340-5-2 paragraph 9.4 "When a new EPA is established, or an existing EPA is reconfigured, it should be thoroughly checked by the ESD co-ordinator and a certificate ... issued."

Electrification Period

The Surface Resistance Test Kit provides the proper electrification period of 15 to 20 seconds per ESD EN 61340-5-1, after numerous readings and calculations are executed, then displays surface resistance mantissa measurement (Note: most analog type meters display measurements instantaneously).

When the Test Button is depressed, the liquid crystal display (LCD) will indicate:

- Temperature in degrees Fahrenheit (tolerance $\pm 5^{\circ}\text{F}$, typical)
- Temperature in degrees Celsius (tolerance $\pm 3^{\circ}\text{C}$, typical)
- Humidity as percentage (from 5% - 95% tolerance, ± 10 percentage points)
- Surface resistance mantissa (with exponent displayed via LED, measurement in ohms)

The surface resistance exponent (or power of number) is immediately illuminated and remains illuminated measuring the range the surface resistance in ohms.

Reference Literature

In addition to those noted above:
ANSI/ESD S20.20 - Development of ESD Control Program
ESD S4.1 Work Surfaces - Resistance Measurements

These documents can be obtained directly from the ESD Association, 7902 Turin Rd., Suite 4, Rome, NY 13440-2069, (315) 339-6937 or www.esda.org.

Other standards are available from the agencies who produce them. MIL-HDBK 263A, EIA-IS-5-A, ASTM-F-150, EN 100015, and EIA-625. If you need help in obtaining these documents, please contact our customer service department.

Features

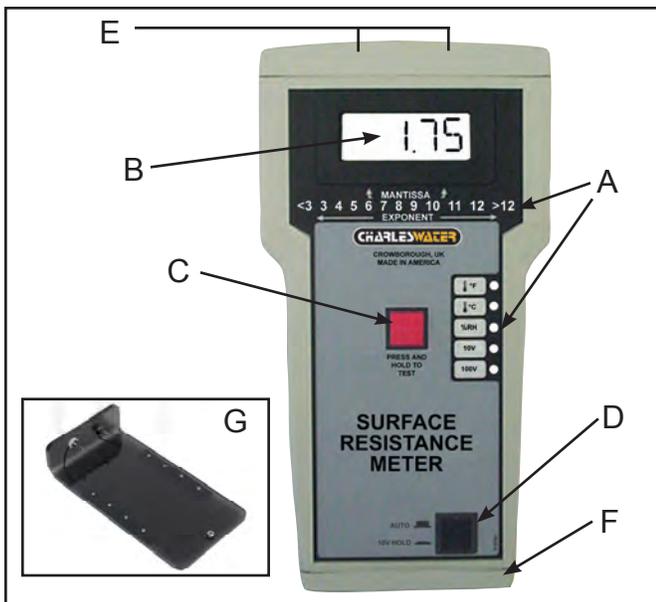


Figure 2. Features of the Surface Resistance Meter

A. LED Displays: Surface resistance exponent is displayed via light emitting diodes illuminating 3.17mm high number. There are 12 LEDs displaying surface resistance exponent measurement. They are color coded for quick checks:

Exponent	Color
<3, 3	Red
4, 5	Green
6, 7, 8	Blue
9, 10, 11	Green
12, >12	Yellow

Five Function LED's identify the measurement being displayed (see B below).

- When battery voltage drops to approximately 2 volts, one of the Function LED's to the right of the red pushbutton switch will begin to flash, indicating the need to replace batteries.

B. Liquid Crystal Display (LCD): Mantissa is displayed via 14.3mm high liquid crystal display and provides easy to read resistance (or resistivity) measurements.

When the Test Button is depressed, the LCD will indicate:

- Temperature in degrees Fahrenheit
- Temperature in degrees Celsius
- Humidity as percentage
- Surface resistance mantissa (with exponent displayed via LED, measurement in ohms)

Surface resistance ohm values are expressed with a mantissa and exponent or power of the number. For example, if "8" is illuminated by its LED and the LCD displays a mantissa of "7.14", the measurement is $7.14 \times 10\text{E}8$ ohms or 714,000,000 ohms

If surface is over $10\text{E}12$ ohms, the following will appear:

- "1 ____" on the LCD display indicate Overrange or that the reading exceeds the display capabilities

C. Test Button: This red button activates electrical power to the Meter. The exponent or power of the number is displayed immediately with LED illuminating number. If "8" is illuminated, the measurement is in the $10\text{E}8$ or $10\text{E}8$ ohm range. To make a measurement, the button is to be depressed for 15-20 seconds for the unit to make numerous readings and calculations. (Testing in accordance with EN 61340-5-1 requires 15 to 20 seconds of electrification; in contrast, most analog type meters display measurements instantaneously.) The LCD will display temperature (F), then temperature (C), then relative humidity, and then the surface resistance mantissa. For example, if the LCD displays a mantissa of "7.14", and "8" is illuminates by its LED, the measurement is $7.14 \times 10\text{E}8$ ohms or 714,000,000 ohms. During the entire period, surface resistance exponent will be displayed by LED illuminating number.

D. Override Test Range Voltage Button: When in the "up" position, during resistance portion of test, Meter will automatically switch to the correct voltage for the resistance range. LED will illuminate noting selected voltage. Conductive material $10\text{E}5$ ohms or less should be measured at 10 volts. Dissipative material $10\text{E}6$ or greater ohms should be tested at 100 volts. The button is a switch, which if depressed, will override automatic voltage selection and test will be performed at 10 volts regardless of resistance level.

E. Jacks: One end of Test Leads has 3.5mm plug (fits Meter left jack). One 3.5mm plug is shielded (identified by insulated tip and barrel black lead) - see Rg test procedure: "The sensing lead of the resistance meter shall be connected to EPA bonding point." One end of Test Lead has standard banana plug (fits 2.27 kg Electrode jack).

F. AA Battery Compartment.

G. Resistivity Parallel Attachment with Electrodes. (optional Item number [99107](#))

Cleaning

Clean the conductive pads of electrodes with a minimum 70% isopropanol-water solution." Make sure they are dry prior to use.

See specific product test standard for laboratory test specimen cleaning instructions. Generally, the test specimens and electrodes should be cleaned twice with a minimum 70% isopropanol-water solution using a clean, low-linting cloth each time." (Note: then conditioned for 72 hours, minimum)

For installed product periodic audits, do not clean surfaces. However, if any measurements lie outside the acceptable range, clean the surface and re-test. (Note: for working surfaces, use Reztore™ Antistatic Surface and Mat Cleaner (item 71021) or other ESD cleaner not containing silicone. Be sure the surfaces dry before testing.

Periodic maintenance - The area surrounding the cable jacks at the top end of the meter should be wiped with a clean cloth moistened with alcohol to remove skin oils that will accumulate and affect the accuracy at high resistances. The frequency of cleaning will depend on usage; once a month would be a good starting point. Other items that should also be cleaned in this fashion are the cable jackets and the resistivity attachment, if included.

Power Requirements

The Meter is powered by two replaceable alkaline AA batteries.

Test Procedure

General Guidelines:

- Use both 2.27 kg Electrodes for Rg
- Use one 2.27 kg Electrode with lead to grounded EPA bonding point for Rp (note: EPA bonding points are usually snaps installed on the material or workstation)
- Use optional Resistivity Attachment (removing leads & Electrodes) for Resistivity measurements
- Ensure that item being measured is electrically isolated (i.e. placed on an insulative surface) or Meter may measure lower resistance path. Lay item on an insulating support (>10E12 ohms) avoiding contact with the table.
- Ensure that test leads are separated or Meter may measure lower resistance path
- When using 2.27 kg Electrodes:
 - Place no closer than 5 cm from edge of surface being measured
 - Place no closer than 7 cm to any EPA bonding point
 - Place 2.3 kg electrodes about 25cm apart for Rp-p
 - Preferred placements include: most commonly used surface portion, most worn, center, furthest from EPA bonding point.
 - For Rg, connect the sensing lead with shielded plug to grounded EPA bonding point
- If surface has sections (like floor tiles or garment panels), for Rp place a 2.27 kilogram electrode on different sections
- Clean surface for Laboratory test, but do not initially clean surface for installed products (if fails, clean and retest)

Laboratory Test Procedure Guideline

For laboratory test of ESD Working surfaces, Floor Materials, Footwear, Garments, or Seating, best advice is to follow test methods of Annex A of EN 63140-5-1.

- The test specimens and electrodes should be cleaned twice with a minimum 70% isopropanol-water solution using a clean, low-linting cloth each time)
- Environmental chamber (Control relative humidity to 12 ±3% RH and 50 ±3% RH and temperature to 23 ±2° C)
- Specimen support surface (greater than 10E12 ohms such as PMMA, PTFE or polycarbonate)
- Specimen Pre-Conditioning (23 ±2 degrees C; 3 specimens at 12 ±3% relative humidity for up to 48 hours minimum, and 3 specimens at 50 ±3% relative humidity for up to 48 hours minimum)
- Measurement of point-to-point resistance shall be performed according to 2.1.2.3 of IEC 61340-4-1 in a minimum of three locations for point-to-point resistance, and a minimum of one location per square metre for large areas for qualification testing, for surface-to-EPA ground resistance. Care shall be taken to include, when applicable, resistance between separate tiles.
- Reporting Test Results
 - Minimum, median and maximum readings for both resistance-to-ground and point-to-point resistance in ohms at low relative humidity
 - Minimum, median and maximum readings for both resistance-to-EPA bonding point and point-to-point resistance in ohms at moderate relative humidity
 - Temperature
 - Relative humidity
 - Actual duration of conditioning
 - Test equipment used

Periodic Audit of Installed Product Test Procedure Guideline

Measure Rg Resistance to Ground

Test Procedure:

- The material shall be tested without cleaning of the surface with liquid cleaning agents. Loose dust may be removed by gentle brushing or by blowing with clean, dry air.
- Remove from the surface only those items that might interfere with the test.
- ESD sensitive devices shall also be removed
- Clip the sensing test lead with shielded plug to grounded EPA bonding point
- Use one 2.27 kg Electrode on other test lead and place Electrode the farthest convenient point on the surface
- Press button and hold Test Button until measurement is displayed
- Perform additional measurements placing Electrode on the most commonly used or most worn area
- Per EN 61340-5-1 paragraph 10.1 "All audit measurements shall be carried out under the normal operating environment, and the temperature and relative humidity shall be recorded"

If measurement is outside acceptable limits, clean surface & retest to determine if cause of failure is insulative dirt layer or the ESD protective product. Note: Use an ESD cleaner containing no insulative silicone (i.e. Reztore™ Antistatic Surface and Mat Cleaner)

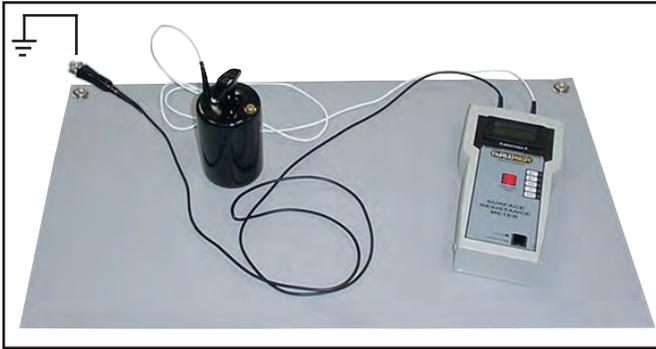


Figure 3. Setting up for Rg testing

Periodic Audit of Installed Product Test Procedure Guideline

Measure Rp Resistance Between Two Points on the Surface

- The material shall be tested without cleaning of the surface with liquid cleaning agents. Loose dust may be removed by gentle brushing or by blowing with clean, dry air.
- Remove from the surface only those items that might interfere with the test.
- ESD sensitive devices shall also be removed
- Use two 2.27 kg Electrodes, place in the most commonly used portion of the surface about 25 cm apart (5 cm from any edge, 7 cm from any EPA bonding point)
- Press button and hold Test Button until measurement is displayed
- If the most used portion is not obvious, use two points near the center of the surface
- Per EN 61340-5-1 paragraph 10.1 "All audit measurements shall be carried out under the normal operating environment, and the temperature and relative humidity shall be recorded"

If measurement is outside acceptable limits, clean surface and retest to determine if cause of failure is insulative dirt layer or the ESD protective product. Note: Use an ESD cleaner containing no insulative silicone (i.e. Reztore™ Antistatic Surface & Mat Cleaner)

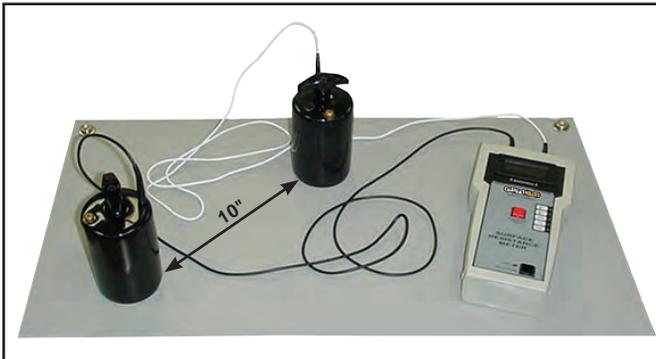


Figure 4. Setting up for Rp testing

Recommended Frequency of Periodic Checks of Installed Products

Note: The frequency of periodic checks is normally specified in corporate operating procedures. The frequency of testing is driven by the amount of risk exposure that can occur between checks. For, example, what is the quantity of product handled between test periods?"

- Working surface - Per EN 61340-5-1 paragraph 10.1 "These audits shall be performed at intervals not exceeding those defined by the ESD co-ordinator." (Users typically perform these quarterly.)
- Non-permanent Footwear - users typically perform a lot sampling at incoming inspection.
- Floor - Per EN 61340-5-1 paragraph 10.1 "These audits shall be performed at intervals not exceeding those defined by the ESD co-ordinator." (Users typically perform these quarterly.)
- Seating - Per EN 61340-5-1 paragraph 10.1 "These audits shall be performed at intervals not exceeding those defined by the ESD co-ordinator." (Users typically perform these quarterly.)
- Non-disposable Garments - Six-monthly check (particularly sleeve-to-sleeve resistance).

Surface Resistivity

Theoretically Resistivity is 10 times greater than Resistance, i.e. a material that measures 10E7 ohms Rp, Surface Resistivity should measure 10E8 ohms/square.*

Ref: ESD S11.11 paragraph 12.0 Conversion to Resistivity states, "When it is appropriate to convert a resistance obtained by this test method to an equivalent resistivity in ohms per square, multiply the resistance measurements obtained by this method by 10. The conversion factor of 10 is derived from the geometry of the electrode assembly."

No conversion is required with the Surface Resistance Test Kit. The Meter incorporates provision to install optional Resistivity Attachment which has parallel electrodes on bottom of the unit to make direct surface resistivity measurements. These parallel electrodes allow for measurement of resistivity or when quick testing without the use of 2.27 kilogram electrodes is desired.

*Note: Per EN 61340-5-2 paragraph 5, "point-to-point resistance has been discussed, rather than the surface and volume resistivity which was found in previous standards and reports. This change has been made to cater for non-homogeneous materials, which are becoming increasingly common in these applications, as well as ease of measurement."

Battery Life: Approximately 1,500 measurements. LED and decimal will blink when battery level falls below 2.00V.

Resistivity Electrodes: Two parallel conductive silicone rubber electrodes (optional item)

External Electrodes: Two 2.27 kilogram weighted electrodes, 6.35 cm in diameter, complies with ESD-S4.1

Display: One 3.5 digit 12.7 mm Liquid Crystal Display (LCD) Display & seventeen Light Emitting Diodes (LED's) illuminated exponent numbers and function being performed.

*Accuracy: Resistance measurements within $\pm 10\%$ (E11 and greater $\pm 20\%$), complies with ESD-S4.1. Open circuit voltages of 10 volts $\pm 5\%$ and 100 volts $\pm 5\%$ exceeds requirements of ESD-S4.1

Meter Weight: 439 grams

Dimensions: 203 mm L x 109 mm W x 41 mm H

Test Switch: Press the red test button for 15-20 second electrification period. Meter will immediately display surface resistance exponent via LED. LCD will display temperature (both Fahrenheit & Celsius), then humidity, and after taking numerous readings and making numerous calculations display surface resistance mantissa.

Note: Reporting test results, you may want to record the resistance, humidity, temperature, and test voltage.

Maintenance

Your Surface Resistance Test Kit will require little maintenance, and there are no user serviceable parts. If your Meter requires service beyond cleaning the Electrodes or replacing the batteries, please contact the factory.

This product utilizes a high frequency switching circuit to step up the 3 volts from the batteries to the 100 volt test level. Some users are able to discern a slight hum or buzzing. This is perfectly normal and should not be considered a flaw or defect.

Calibration*

The Surface Resistance Test Kit is calibrated to NIST traceable standards. Most users require calibration annually.

Please call our Customer Service Department at 00 44 (0) 1892-665313 for details. In-house calibration can be performed by using 1% resistors in each of the meter ranges. Simply attach the resistors to the enclosed cords using grounding clips and recording the meter display. Keep the cords separated. Should adjustment be necessary, it is recommended that the unit be returned to the factory as access to internal adjustments requires special equipment and test cables.

EQUIPMENT:

- Digital Multimeter - accurate to 1.25% @ 10VDC and 100VDC
- Fixed Decade Box value 10E3 - 10E12 - accurate to $\pm 2.5\%$, except at 10E11 and 10E12 ($\pm 5\%$)
- Thermometer - accurate to $\pm 1^\circ\text{F}$
- Humidity meter - accurate to 2%
- Test leads
- 99% Isopropyl alcohol and cleaning wipes

SET UP:

A. Test Area - Area needs to be free of any high voltage transformer or power supply. Not under any type of fluorescent lighting or high power lighting.

B. Worksurface - needs to be covered with conductive mat at 1.0 x 10E3 or less, connected to earth ground.

C. Technician - needs to be grounded with zero ohms resistor to earth ground.

D. Decade Box - needs to be grounded to earth ground.

*Accuracy is measured after normalizing the instrument at 70-80 °F and 30-50% RH for a minimum of 4 hours.

NORMALIZATION OF SURFACE RESISTANCE TESTER

Temperature inside testing area needs to be 75°F @ $\pm 6.6\%$ 40% to 60% RH. Testers need to stay at constant temperature 75°F @ $\pm 6.6\%$ for about 2 hours for proper reading. Testers cannot be inside objects, enclosed boxes, containers or cases unit is supplied with (temperature inside case will differ from outside temperature, cases will act like an insulator to the Testers), Testers will have to be stationary in testing area for about 2 hours with no dramatic temperature changes.

TESTING OF SURFACE RESISTANCE TESTER

- When testing use only the leads supplied with the tester. DO NOT TEST WITH RESISTIVITY ATTACHMENT, Resistivity Attachment will give a much higher reading and is only designed for spot checking.
- With 10V/AUTO switch down, press TEST button - voltage between the two leads should be 10V $\pm 5\%$
- With 10V/AUTO switch up, press TEST button - voltage between the two leads should be 100V $\pm 5\%$
- Using the cleaning wipes and 99% isopropyl, clean around banana jack and mono jack where leads connects to, oil from human fingers can alter accuracy.
- Make sure 10V/AUTO switch is set to AUTO (switch up). Testing each decade starting from 1.0 x 10E12 and down, never start from 1.0 x 10E3.

Temperature
Fahrenheit = 75°F $\pm 6.6\%$ Celsius
= 23.8°C $\pm 10.2\%$

Relativity Humidity ± 10 Digits

A. 1.0 x 10E12

+ 20%	LED = 12 Yellow	Mantissa 1.20
0%	LED = 12 Yellow	Mantissa 1.00
- 20%	LED = 11 Yellow	Mantissa 8.00

B. 1.0 x 10E11

+20%	LED = 11 Yellow	Mantissa 1.20
0%	LED = 11 Yellow	Mantissa 1.00
-20%	LED = 10 Green	Mantissa 8.00

C. 1.0 x 10E10

+10%	LED = 10 Green	Mantissa 1.10
0%	LED = 10 Green	Mantissa 1.00
-10%	LED = 9 Green	Mantissa 9.00

D. 1.0 x 10E9

+10%	LED = 9 Green	Mantissa 1.10
0%	LED = 9 Green	Mantissa 1.00
-10%	LED = 8 Blue	Mantissa 9.00

E. 1.0 x 10E8

+10%	LED = 8 Blue	Mantissa 1.10
0%	LED = 8 Blue	Mantissa 1.00
-10%	LED = 7 Blue	Mantissa 9.00

F. 1.0 x 10E7

+10%	LED = 7 Blue	Mantissa 1.10
0%	LED = 7 Blue	Mantissa 1.00
-10%	LED = 6 Blue	Mantissa 9.00

G. 1.0 x 10E6

+10%	LED = 6 Blue	Mantissa 1.10
0%	LED = 6 Blue	Mantissa 1.00
-10%	LED = 5 Green	Mantissa 9.00

H. 1.0 x 10E5

+10%	LED = 5 Green	Mantissa 1.10
0%	LED = 5 Green	Mantissa 1.00
-10%	LED = 4 Green	Mantissa 9.00

I. 1.0 x 10E4

+10%	LED = 4 Green	Mantissa 1.10
0%	LED = 4 Green	Mantissa 1.00
-10%	LED = 3 Red	Mantissa 9.00

J. 1.0 x 10E3

+10%	LED = 3 Red	Mantissa 1.10
0%	LED = 3 Red	Mantissa 1.00
-10%	LED = <3 Red	Mantissa <0.90

Specifications

Ranges:

1 x 10E3 - 10E12 ohms @ 10 Volts

1 x 10E6 - 1 x 10E12 ohms @ 100 Volts

Power Supply: Two AA alkaline batteries

Limited Warranty

Charleswater expressly warrants that for a period of one (1) year from the date of purchase, Charleswater Ionisation Test Kits will be free of defects in material (parts). Within the warranty period, the material will be tested, repaired or replaced at Charleswater's option, free of charge. Call Customer Service at 00 44 (0) 1892-665313 for a Return Material Authorisation (RMA) and for proper shipping instructions and address. You should include a copy of your original packing slip, invoice, or other proof of purchase date. Any unit under warranty should be shipped prepaid to the Charleswater factory. Warranty replacements will take approximately two weeks.

Warranty Exclusions

THE FOREGOING EXPRESS WARRANTY IS MADE IN LIEU OF ALL OTHER PRODUCT WARRANTIES, EXPRESSED AND IMPLIED, INCLUDING MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE WHICH ARE SPECIFICALLY DISCLAIMED. The express warranty will not apply to defects or damage due to accidents, neglect, misuse, alterations, operator error, or failure to properly maintain, clean or repair products.

Limit of Liability

In no event will Charleswater or any seller be responsible or liable for any injury, loss or damage, direct or consequential, arising out of the use of or the inability to use the product. Before using, users shall determine the suitability of the product for their intended use, and users assume all risk and liability whatsoever in connection therewith.