

## Guardian 2500 AC/DC/IR Hipot Testers

### KEY FEATURES OVERVIEW:

- ❑ Programmable Output Voltage to 5KV AC and 6KV DC
- ❑ Measurement of Real, Imaginary and Total Current
- ❑ Ground Fault Interruption (GFI) for Operator Safety
- ❑ Programmable Ramp, Test and Fall Times
- ❑ Storage of Tests Setups, 25 User (5 predefined), and 9 Multi-Step with 3 steps per measurement
- ❑ Continuous Leakage Current Monitoring down to 0.1µA
- ❑ Ground Continuity Test with Adjustable Limits
- ❑ Password Protected Front Panel Lockout
- ❑ Remote I/O standard; IEEE-488, RS-232 and Enhanced Remote optional
- ❑ Review of Data after Measurement
- ❑ Insulation Resistance Measurements from 10kΩ to 2TΩ

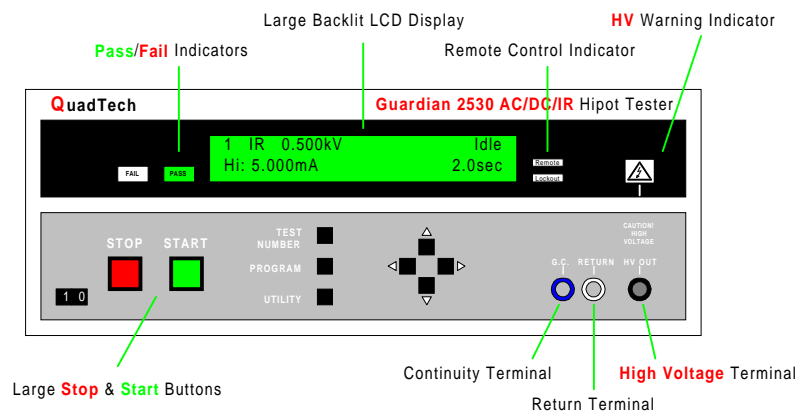


Figure 1: Guardian 2500 Front Panel Key Features

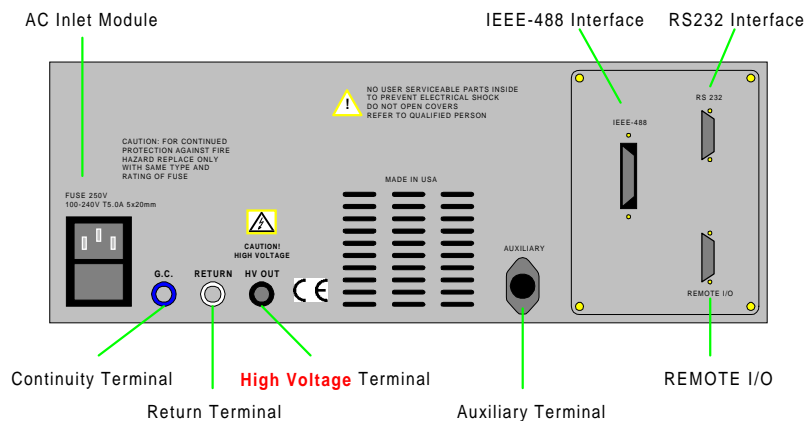


Figure 2: Guardian 2500 Rear Panel Key Features

## Key Features Overview

### Measurement of Real, Imaginary and Total Current

Allows measurement of resistive leakage current on devices that have associated capacitance.

### Ground Fault Interruption (GFI)

Patent pending technique that can protect an operator from shock. This is similar to the GFI used in residential housing.

### Ground Continuity Measurement Mode

The Guardian 2500 Series can perform either a pass/fail check for ground continuity or an actual measurement and display the ground resistance with adjustable pass/fail limits.

### Low Leakage Current Capability

The Guardian 2510 can measure leakage current down to  $1\mu\text{A AC}$ . The Guardian 2520 and 2530 can measure leakage current down to  $0.1\mu\text{A DC}$  and  $1\mu\text{A AC}$ .

### Arc Detection with programmable Level and Time

Adjusting both arc level and arc time can provide a manufacturer with more consistent results and fewer false failures in the production environment.

### Insulation Resistance Measurements

Insulation resistance can be measured over a wide range from  $10\text{k}\Omega$  to  $2\text{T}\Omega$  with an accuracy of as good as 2%. This makes the Guardian 2530 a good stand alone Megohmmeter/IR Tester - not just another hipot with IR capability.

### Enhanced Handler (Optional)

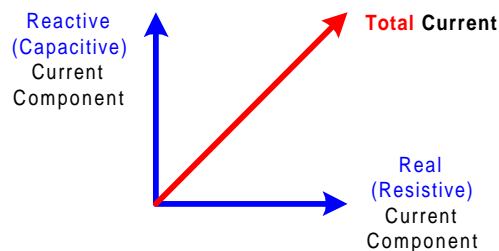
Adds additional features to the standard handler such as recalling setups and determining which failure mode occurred (i.e. did it fail for arc, continuity, high or low limit?).

## Key Features Detail

- **Real, Imaginary and Total Current:**

An AC test must consider the effects of both real and reactive current. When you apply an AC voltage, the current that flows is equal to the voltage divided by the impedance. The impedance, however, is complex since it contains both resistive (real) and capacitive (imaginary) components. Because these two components of AC current are out of phase with each other, they combine in a complex manner to form the total current, as shown in Figure 3. Since the magnitudes of the two components can be significantly different from each other, the (leakage current the “real” component for a product with large amounts of capacitance) can increase significantly without being detected. The method the Guardian 2500 uses to get both the real and imaginary components of the current is simultaneously sampling of both the voltage and current. The sampled signals are then multiplied by the sine and cosine where a correlation method is used to determine the phase angle between the voltage and current. The voltage is then used as a reference and the real and imaginary components of the current are calculated.

**Figure 3: Total Current**



## Key Features Detail (Continued)

- **Ground Fault Interruption (Patent Pending)**

The GFI circuit in the Guardian 2500 Series is designed to protect the operator from injury, resulting from inadvertent contact with high voltage from the tester. The principle of operation is to monitor the current flowing through the secondary of the HV transformer as well as the current in the return. These two currents are then compared and if the difference is found to be greater than 250mA the high voltage source in the unit is shut OFF. Under normal conditions these two currents should be equal if the only path for current flow is through the DUT. **If an operator comes in contact with high voltage from the unit another current path will exist back to ground creating a difference between the current in the HV secondary and return. This triggers a shut off of the high voltage source.** If required for production environments and testing on grounded devices the GFI feature can be turned OFF.

- **Arc Detection**

An electrical arc is characterized by very rapid variations in voltage and current. It also produces an audible crackling or “zapping” sound. Because of these rapid changes, arcing can be detected — as soon as it starts to occur — by sensing for the presence of high frequency energy.

**The Guardian 2500 Series continuously monitors the current flowing through the DUT (which may be either AC or DC) and checks the magnitude and duration of any deviations from user selected values of arc level and arc duration.** Put another way, the arc detection circuit checks to see if any high frequency components of the current exceed the user selected arc level. If the arc level exceeds this limit the circuit then begins timing how long the arc has exceed this level. If this time exceeds the user selected arc duration an arc failure is indicated. The sensitivity of the arc detection can be adjusted from 10 $\mu$ A to the 15mA AC and 8mA DC. The duration of the arc can be adjusted between 5 $\mu$ s and 500 $\mu$ s.

- **Ground Continuity Measurement**

The purpose of a ground continuity test is to verify that all conductive parts of a product that are exposed to user contact are connected to the power line ground (the “green” wire). A 100mA DC current is sourced from the Guardian continuity connector. The voltage is then measured between the return and ground continuity socket. The resistance is then calculated based upon the measured voltage and current. **Normally only found on hipot testers with a ground bond feature, the Guardian Series has the ability to not just indicate a pass or fail for continuity, but to actually make a measurement and display the ground resistance.** The Guardian 2500 Series provides both ground continuity check and a ground continuity measurement mode for added flexibility.

## **Key Features Detail (Continued)**

- **Insulation Resistance Test**

An insulation resistance test measures the total resistance between any two points separated by electrical insulation. Insulation resistance measurements are similar to a DC hipot but rather than displaying leakage current, resistance is calculated and displayed. An insulation resistance test using the Guardian 2530 provides four phases: charge, dwell, measure, and discharge. During the charge phase, the voltage is ramped from zero to the selected voltage, which provides stabilization time and limits the in-rush current to the DUT. Once the voltage reaches the selected value, the voltage can then be allowed to dwell or hold at this voltage before measurements begin. Once the resistance has been measured for the selected time, the DUT is discharged back to 0V during the final phase. **Where most hipots have IR as an option or add-on, the Guardian 2530 has a wide measurement range from 10k $\Omega$  to 2T $\Omega$  and excellent accuracy making it a good stand alone Megohmmeter/IR Tester.**

- **Adjustable Ramp, Dwell, Test and Fall Times**

Both AC and DC test voltage can be ramped up over time from 0.1 to 999 seconds to protect sensitive devices from rapid changes in voltage. Test voltage can be applied to a device over a period of time from 0.1 to 999 seconds. In DC hipot the test voltage can also dwell for a time period from 0.1 to 999 seconds, this allows the voltage to be held on the DUT without checking high and low limits. The test voltage can also continuously be applied in manual mode by setting the test time to “Continuous”. Ramp, dwell and fall times can be set to OFF.

- **DC Hipot Leakage Current down to 0.1 $\mu$ A**

The Guardian 2520 and 2530 instruments have the capability of measuring extremely low levels of leakage current (down to 0.1 $\mu$ A DC).

- **Adjustable minimum and maximum current trip limits**

Minimum and maximum trip currents can be set from 1 $\mu$ A to 15mA AC and 0.1 $\mu$ A to 7.5mA DC. The maximum trip limit is always active. The minimum trip limit can be disabled (turned OFF). This gives the customer flexibility in the Guardian 2500 Series by indicating a pass condition if the current is below the maximum trip and minimum trip is disabled, or indicating a pass only if the current is within the range from the minimum to maximum trip limits.

- **Guardian provides high level of output voltage regulation  $\pm(1\% +5V)$**

Output voltage is regulated for both changes in line voltage and load. This guarantees the user is testing at the correct (programmed) test voltage.

## Key Features Detail (Continued)

- **Remote Control**

Provides remote start, stop and interlock inputs that are active low. Outputs indicating pass, fail and under test are via dry switch contacts that are closed if true. Remote is compatible with Sentry Series 9 pin D series connector.

- **Enhanced Remote (Optional)**

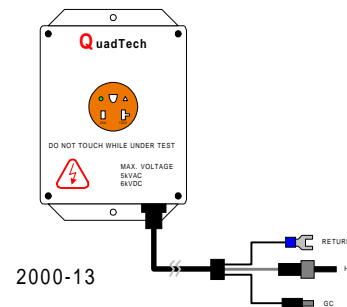
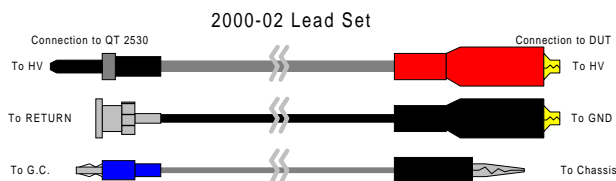
The enhanced handler features additional inputs for selection of memory locations and outputs for High failure, Low failure, Arc failure and Continuity failure.

- **IEEE 488 Interface and RS232 Interface (Optional)**

The Guardian 2500 Series is fully programmable via the IEEE 488 or RS232. Note: Either the IEEE 488 or the RS232 interface can be installed in the Guardian 2500 Series, but not both at the same time.

- **Accessories**

Comes standard with 2000-02 Lead Set. US corded product adapter, international corded product power strip, HV gun probe, high voltage probe, foot switch, power entry cable and longer test leads are available as options.



- **Calibration**

All QuadTech products are delivered with a calibration certificate traceable to NIST.

- **First Annual Calibration**

Sending the Guardian 2500 Series instrument in for 1<sup>ST</sup> Year Calibration extends the warranty one additional year. Additional factory calibrations continue to extend the warranty.

- **45 Day Money Back Guarantee**

No strings attached money back guarantee with NO RESTOCKING FEE.

## Guardian 2500 Series Specifications

**The Guardian 2510 AC Hipot Tester** performs AC dielectric withstand (hipot) tests. The test voltage is programmable in the range from 100VAC to 5KVAC with low and high current detection limits from 1 $\mu$ A to 15mA. The capability of measuring and displaying real, imaginary and total current makes the unit ideal for testing capacitive type devices, such as power supplies, cables and transformers, where the imaginary part of the total current may be significantly higher than the real part.

**The Guardian 2520 AC/DC Hipot Tester** has all the features of the Guardian 2510 with the addition of DC hipot. The test voltage can be programmed in the range from 100VDC to 6KVDC, with low and high current detection limits from 0.1 $\mu$ A to 7.5mA.

**The Guardian 2530 AC/DC/IR Hipot Tester** provides measurement of insulation resistance (IR) in addition to the AC/DC hipot capability of the 2510 and 2520. IR is the resistance in ohms ( $\Omega$ ), between two points separated by an insulating material. The measurement range is from 10k $\Omega$  to 2T $\Omega$  with a programmable voltage range from 50 to 1000VDC in 2V steps.

### Guardian 2510, 2520 and 2530

**AC Output Voltage:** Range: 0.1kV to 5kV AC, in 2V steps  
Frequency: 50/60 Hz selectable  
Frequency Accuracy: 100ppm  
Waveform: Sinusoidal, crest factor 1.4  
Regulation:  $\pm$ (1% of setting + 5V)

**Voltage Display:** Accuracy:  $\pm$ (1% of reading + 5V)  
Resolution: 1V steps

**AC Current Display:** Real, Imaginary or Total Current (user selectable)  
Range: 1 $\mu$ A to 15mA AC, in 1 $\mu$ A steps  
Accuracy:  $\pm$ (0.5% of set high limit + 1 $\mu$ A)

### Guardian 2520 and 2530

**DC Output Voltage:** Range: 0.1kV to 6kV DC, in 2V steps

**Voltage Display:** Accuracy:  $\pm$ (1% of reading + 5V)  
Resolution: 1V steps

**DC Current Display:** Range: 0.1 $\mu$ A to 1.0mA DC, in 0.1 $\mu$ A steps,  
1.0mA to 7.5mA DC, in 1 $\mu$ A steps  
Accuracy:  $\pm$ (0.5% set high limit + 0.1 $\mu$ A or 1 $\mu$ A)

### Guardian 2530

**Insulation Resistance:** Voltage: 50V to 1000V DC, in 1V steps  
Accuracy:  $\pm$ (2% of setting + 5V)  
Range: 10k $\Omega$  - 2T $\Omega$  (voltage dependent)  
Accuracy:  $\pm$ 2% for V/R  $\geq$ 10nA,  $\pm$ 5% for V/R < 10nA

**Charging Current:** 7.5mA maximum

## Specifications (Continued)

### Common Features

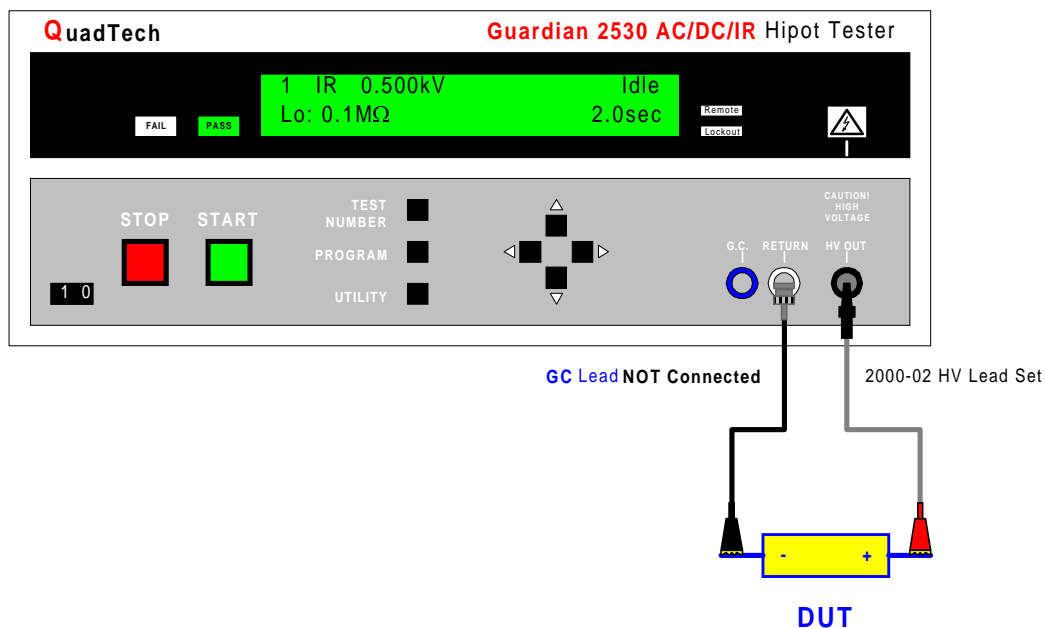
<b>Ground Continuity:</b>	Test Current: 100 mA DC +/- 10% Range: 10m to 10, in 1m steps Accuracy: +/- 5% of reading
<b>Limits:</b>	Programmable Hi/Lo during Test Time (Lo can be set to Off for Hipot & GC, Hi can be set to Off for IR) Programmable Hi/Lo during Ramp Time (AC/DC Hipot only) (Both limits can be set to OFF)
<b>Ground Fault Interrupt:</b>	2ms Shutdown for Current Imbalance > 250 $\mu$ A (AC) > 400 $\mu$ A (DC)
<b>Arc Detection:</b>	Arc Level AC: 0.01mA - 0.5mA for Hi limit set $\leq$ 0.5mA 0.1mA - 15mA for Hi limit set > 0.5mA Arc Level DC: 0.01mA - 0.2mA for Hi limit set $\leq$ 0.2mA 0.1mA - 8mA for Hi limit set > 0.2mA Arc Time: 5 $\mu$ sec to 500 $\mu$ sec, programmable
<b>Indication:</b>	Pass/fail display, lights, audible sound
<b>Buzzer Level:</b>	Low, High, Off
<b>Time:</b>	AC Hipot: Ramp, Test, Fall: 0.1 to 999sec DC Hipot and IR: Ramp, Dwell, Test, Fall: 0.1 to 999sec GC: Test: 0.1 to 999sec (Test can be set to Continuous. Ramp, Dwell, & Fall can be set to Off)
<b>Remote Control:</b>	Inputs: Start, Stop Characteristics: TTL active low, Pulse width > 1ms Outputs: Pass, Fail, Under Test Characteristics: Dry contact relay, Closed if true 120V, 100mA max Connector: 9 pin male D-series (compatible w/Sentry Series)
<b>Test Setups:</b>	25 User Defined (shipped with some factory settings) 9 Multi-step (3 steps)
<b>Connectors:</b>	Front and Rear Connection High Voltage: Locking, Amp Part # 861611-1 Return: BNC female (Selectable for ground or virtual ground) Continuity: Standard Banana Socket
<b>Front Panel Lockout:</b>	6 Digit Password with or without memory recall
<b>Miscellaneous:</b>	Continue Step on Fail Stop Test on Pass Continuous Voltage on Fail Step and Increment
<b>Optional Interfaces:</b>	IEEE488, RS232 Enhanced Remote: Inputs: Test Selection, Start, Stop Outputs: Fail for Hi, Low, Arc and Continuity, Pass, Fail, Under Test Connector: 25 pin male D-series (compatible with Sentry Series via adaptor)
<b>Mechanical:</b>	Bench Mount Dimension: (w x h x d): 17x 5.25x 16in (432x 133x 406mm)
<b>Weight:</b>	29 lbs (13kg) net, 36 lbs (16kg) shipping
<b>Environmental:</b>	Meets MIL-T-28800E, Type 3, Class 5 Operating: 0 to 40 $^{\circ}$ C, Humidity: <75% Storage: - 10 to + 60 $^{\circ}$ C
<b>Power:</b>	· 90 - 130V AC · 50 or 60Hz · 200 - 250V AC · 300W MAX

## Performing an AC Hipot Test

This is one of the most common hipot tests performed. The voltage is applied between the operating circuits and the chassis or ground. Figure 4 illustrates the connection of the DUT to the Guardian 2500 Series instrument for an AC Hipot Test.

In this example we will setup the Guardian 2500 to perform an AC hipot at 1250VAC. The voltage will ramp from 0V to 1250VAC in 1 second, hold the voltage for 1 second then indicate pass. The high current limit will be set to 10mA. If the leakage current exceeds 10mA at any time during the test the Guardian 2500 will indicate a failure. Note that the voltage and current is held in the display until you press the stop button.

In this example, the AC Hipot Test is defined as Test Number [1]. Follow the programming instructions “AC Hipot Test Setup” to input the test conditions defined in the above paragraph.



**Figure 4: Connection to DUT for Hipot Test**



## AC Hipot Test Setup

### Press [Button]

### Display will show:

Press [TEST NUMBER]

1	Idle
No Test Programmed	

Press [ PROGRAM]

1	Program
Mode: No Test Programmed	

Press [ ▼▲ ] to select Mode = AC

1	Program
Mode: AC Total Current	

Press [ ► ] to select Test Voltage

1	Program
Volt:	

Press [ ▼▲ ] to set Voltage = 1.25kV

1	Program
Volt: 1.250 kV	

Press [ ► ] to select High Current Limit

1	Program
High Limit:	

Press [ ▼▲ ] to set High Limit = 10mA

1	Program
High Limit: 10.000 mA	

Press [ ► ] to select Lo Current Limit

1	Program
Lo Limit:	

Press [ ▼▲ ] to set Lo Limit = Off

1	Program
Lo Limit: Off	

Press [ ► ] to select Arc Limit

1	Program
Arc Limit:	

Press [ ▼▲ ] to set Arc Limit = Off

1	Program
Arc Limit: Off	

Press [ ► ] to select Ramp Time

1	Program
Ramp Time:	

Press [ ▼▲ ] to set Ramp Time = 1.0s

1	Program
Ramp Time: 1.0sec	

**AC Hipot Test Setup Continued on Next Page**

## AC Hipot Test Setup

### AC Hipot Test Setup Continued from Previous Page

#### Press [Button]

#### Display will show:

Press [▶] to select HI Lim for Ramp

1 Program  
HI Lim Ramp:

Press [▼▲] to set HI Lim = 10.0 mA

1 Program  
HI Lim Ramp: 10.000 mA

Press [▶] to select Lo Lim Ramp

1 Program  
Lo Lim Ramp:

Press [▼▲] to set Lo Lim Ramp = Off

1 Program  
Lo Lim Ramp: Off

Press [▶] to select Test Time

1 Program  
Test Time:

Press [▼▲] to set Test Time = 1.0s

1 Program  
Test Time: 1.0 sec

Press [▶] to select Fall Time

1 Program  
Fall Time:

Press [▼▲] to set Fall Time = 1.0s

1 Program  
Fall Time: 1.0 sec

Press [▶] to select Test Frequency

1 Program  
Frequency:

Press [▼▲] to set Frequency = 60Hz

1 Program  
Frequency: 60 Hz

Press [▶] to select Ground Continuity

1 Program  
Gnd Continuity:

Press [▼▲] to set Continuity = Off

1 Program  
Gnd Continuity: Off

Press [PROGRAM] to exit Programming Mode

1 AC: 1.250 kV  
Hi: 10.000 mA 1.0sec

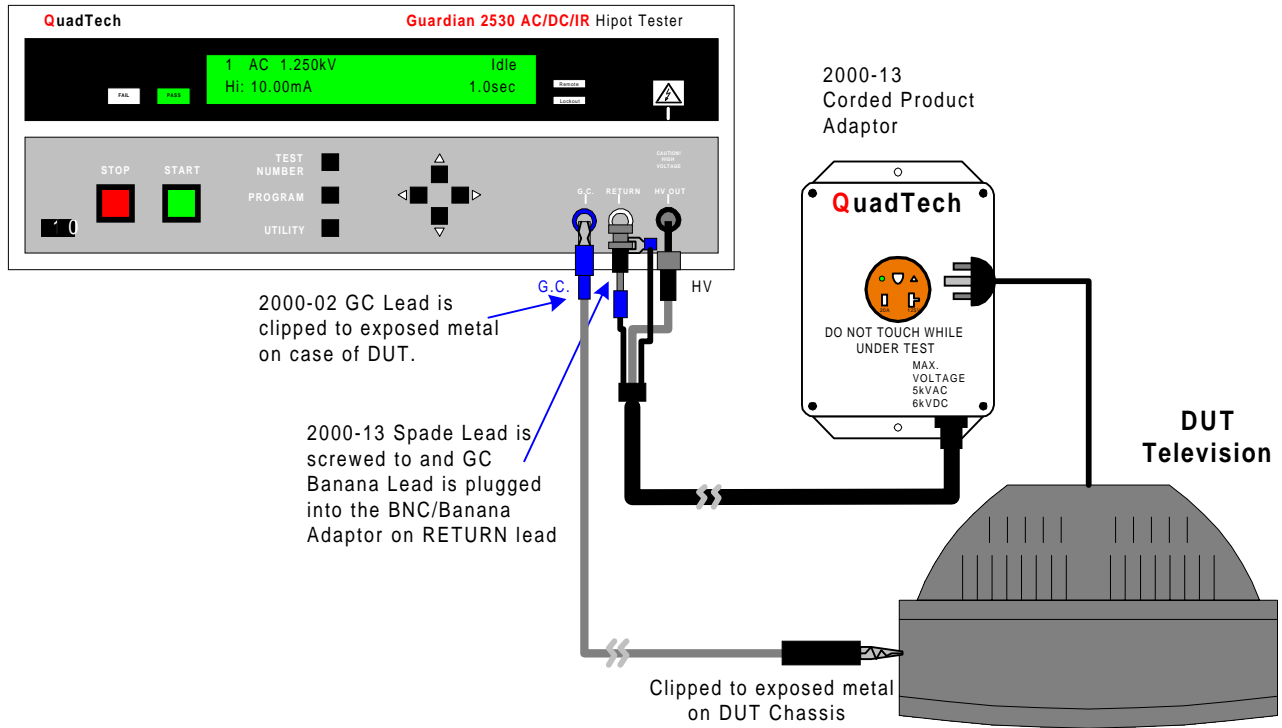
### AC Test Setup is Complete

### Perform Test

Hands away from cables and DUT. Make sure power button on DUT is in ON position. Press [START] button to initiate test.

## AC Hipot Test with Ground Continuity

In this test the Guardian 2500 Series instrument will check that the continuity between the ground blade on the power cord and any exposed metal on the product. The test setup for Ground Continuity is the same as the basic AC Hipot except the ground continuity function is turned ON in the final programming step. Select Test Number 1 that was just programmed in the previous example and set the Ground Continuity check to 0.1Ω.



**Figure 5: AC Hipot & Ground Continuity Test Connection to DUT**

### Press [Button]

Press [TEST NUMBER]

Press [ PROGRAM]

Press [ ► ] to select Ground Continuity

Press [ ▼▲ ] to set Continuity = 0.1Ω

Press [ PROGRAM] to exit programming mode

### Display will show:

1 AC: 1.250 kV	Idle
Hi: 10.00mA	1.0sec

1	Program
Mode: AC Total Current	

1	Program
Gnd Continuity: Off	

1	Program
Gnd Continuity: 0.1Ω	

1 AC: 1.250 kV	Idle
Hi: 10.00mA	1.0sec

**AC Hipot with Ground Continuity Test Setup is Complete**

## AC Hipot & Ground Continuity Test (Continued)

### Perform Test

Hands away from cables and DUT. Make sure power button on DUT is in the ON position. Press [START] button to initiate test. Repeat test with ground continuity cable removed from chassis of DUT.

### Ground Continuity Test

This test differs from the ground continuity check in the previous example because it is a separate measurement in which both the high and low resistance limits and test time are programmed and the actual measured resistance is displayed. In this example we will program the Guardian 2500 Series instrument to detect a high limit of  $0.1\Omega$ . If the resistance measured is greater than  $0.1\Omega$ , the Guardian will indicate a **failure**.

#### Press [Button]

Press [TEST NUMBER]

Press [PROGRAM]

Press [▼▲] to select Ground Continuity

Press [▶] to select High Limit

Press [▼▲] to set High Limit =  $0.10\Omega$

Press [▶] to select Low Limit

Press [▼▲] to set Low Limit = Off

Press [▶] to select Test Time

Press [▼▲] to set Test Time = 1.0sec

Press [PROGRAM] to exit programming mode

#### Display will show:

2	Idle
No Test Programmed	

2	Program
Mode: No Test Programmed	

2	Program
Mode: GC Only	

2	Program
High Limit:	

2	Program
High Limit: $0.10\Omega$	

2	Program
Low Limit:	

2	Program
Low Limit: Off	

2	Program
Test Time:	

2	Program
Test Time: 1.0sec	

2 GC	Idle
Hi: $0.10\Omega$	1.0sec

**Ground Continuity Test Setup is Complete**

## Ground Continuity Test (Continued)

### Perform Test

Hands away from cables and DUT. Make sure power button on DUT is in the ON position. Press **[START]** button to initiate test. Repeat test with ground continuity cable removed from chassis of DUT.

### 2500 Series Instruments & Accessories

Guardian 2510 AC Hipot Tester	\$3295.00
Guardian 2520 AC/DC Hipot Tester	\$3695.00
Guardian 2530 AC/DC/IR Hipot Tester	\$4295.00

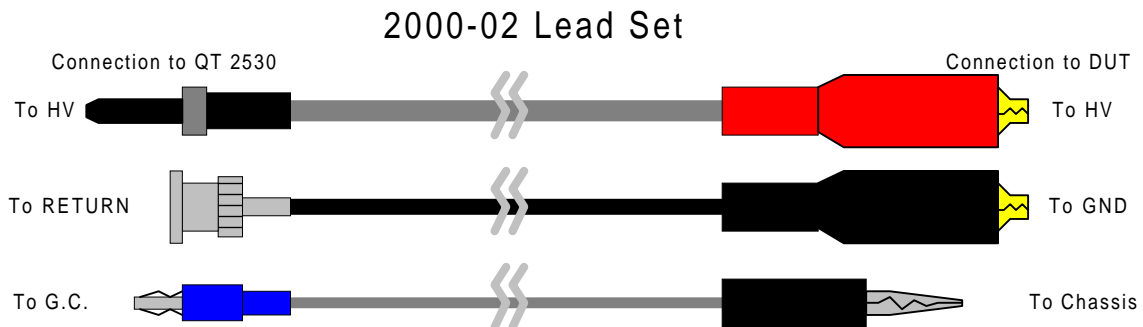
#### Standard Accessories (Included with Purchased Unit):

QT P/N	Description	Price
150319	Instruction Manual	\$0.00
4200-0300-00	AC Power Cable	\$0.00
2000-02	Test Leads (Set of 3)	\$0.00
N/A	Calibration Certificate Traceable to NIST	\$0.00

#### Optional Accessories (Available for Purchase):

QT P/N	Description	Price
2000-02	High Voltage Lead Set (included standard w/unit)	\$115.00
2000-13	Corded Product Adapter (115V)	\$150.00
2000-16	Rack Mount Flanges (require rail support hardware)	\$150.00
2000-25	Corded product Adapter (240V)	\$250.00
2000-40	IEEE-488 Interface (includes Remote I/O Interface)	\$495.00
2000-41	RS-232 Interface (includes Remote I/O Interface)	\$195.00
2000-42	Enhanced Remote I/O & RS-232 Interfaces	\$295.00
N/A	Calibration Data	

Instrument and Accessory prices are subject to change without notice.



## QuadTech Products and Services

### Other Products

QuadTech has a wide variety of hipot testers to fit your different application needs from basic hipot testers to multi-point scanning systems in addition to LCR meters Digibridges. For more information on these products and accessories, please contact the factory at 1-800-253-1230 or visit our website at <http://www.quadtech.com>. If an off the shelf instrument does not meet your testing requirements, call us and perhaps we can custom design a solution for your specific application.

### Applications Assistance

We have Applications Engineers available to answer your test setup, instrument setup and programming questions at our toll-free number (1-800-253-1230) or International number (1-978-461-2100) daily from 8:30am to 5:00pm Eastern Standard Time.

### QuadTech Guarantee

In the United States, all QuadTech products are covered by QuadTech's Lifetime Protection Policy. This plan includes an unconditional 45-day money back guarantee, toll-free hotlines for product and application support, and an extendible product warranty program.

### Repair & Calibration Services

Products manufactured by QuadTech can be sent back to the factory for servicing. All calibration services are traceable to the National Institute of Standards and Technology (NIST). Call our Customer Care Center for more details on our repair and calibration services.

For complete product specifications on the 2500 Series Hipot Testers or any of QuadTech's products, visit us at <http://www.quadtech.com/resources/dataindex.html>. Do you have an application specific testing need? Call us at 1-800-253-1230 or email engineering at [roetzer@quadtech.com](mailto:roetzer@quadtech.com) and we'll work with you on a custom solution. Put QuadTech to the test because we're committed to solving your testing requirements.

The information presented here is subject to change and is intended for general information only

©QuadTech, Incorporated

Telephone: 1- 800-253-1230, Website: <http://www.quadtech.com>

Printed in U.S.A.

P/N 035075

July, 2000