Guardian 2500 Series
AC/DC/IR Hipot Tester
Instruction Manual

Form 150319/A8

Domestic Sales 800-253-1230

For additional contact information please visit our website
www.quadtech.com

The material in this manual is for informational purposes only and is subject to change, without notice. QuadTech assumes no responsibility for any error or for consequential damages that may result from the misinterpretation of any procedures in this publication.

WARNING

Potentially dangerous voltages may be present on front and rear panel terminals. Follow all warnings in this manual when operating or servicing this instrument. Dangerous levels of energy may be stored in capacitive devices tested by this unit.

Always make sure the high voltage indicator is **not** on when connecting or disconnecting the device under test.


Product will be marked with this symbol (ISO#3684) when it is necessary for the user to refer to the instruction manual in order to prevent injury or equipment damage.


Product marked with this symbol (IEC417) indicates presence of direct current.


Product will be marked with this symbol (ISO#3684) when voltages in excess of 1000V are present.

Contents

Contents (continued)

Contents (continued)

Warranty

QuadTech warrants that Products are free from defects in material and workmanship and, when properly used, will perform in accordance with QuadTech's applicable published specifications. If within one (1) year after original shipment it is found not to meet this standard, it will be repaired, or at the option of QuadTech, replaced at no charge when returned to a QuadTech service facility.

Changes in the Product not approved by QuadTech shall void this warranty.

QuadTech shall not be liable for any indirect, special or consequential damages, even if notice has been given of the possibility of such damages.

This warranty is in lieu of all other warranties, expressed or implied, including, but not limited to any implied warranty or merchantability or fitness for a particular purpose.

SERVICE POLICY

QuadTech policy is to maintain product repair capability for a period of at least five (5) years after original shipment and to make this capability available at the then prevailing schedule of charges.

Specifications

Guardian 2510/2520/2530

AC Output Voltage:	Range:	0.1 to 5KV AC, in 2V steps
	Regulation:	+/-(1% of setting +5V)
	Frequency:	50/60Hz selectable, 100ppm accuracy
	Waveform:	Sinusoidal, crest factor 1.4
Voltage Display:	Accuracy:	+/-(1% of reading +5V)
	Resolution:	1V steps
AC Current Display:	Real, Imaginary or Total current (user selectable)	
	Range:	1µA to 15mA AC, in 1µA steps
	Accuracy:	+/-(0.5% of set high limit + 1µA) *

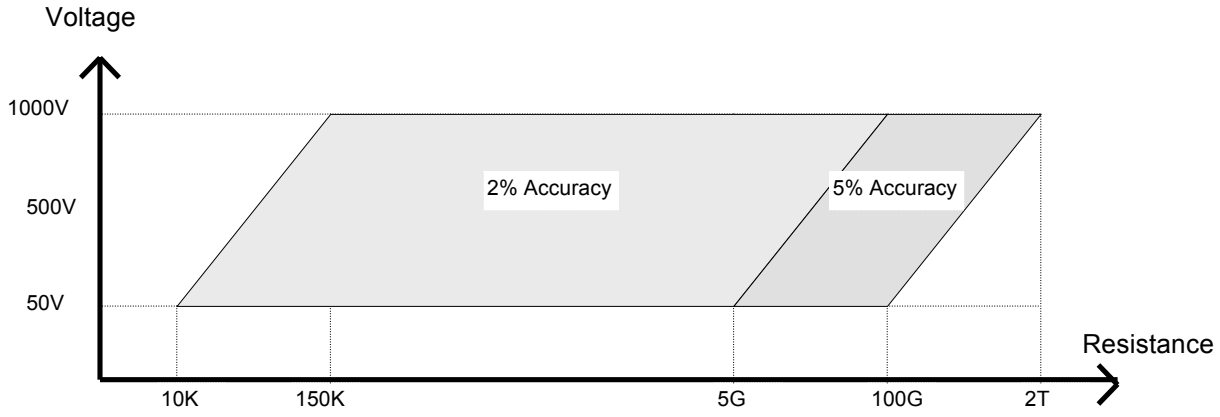
Guardian 2520/2530

DC Output Voltage:	Range:	0.1 to 6KV DC, in 2V steps
Voltage Display:	Accuracy:	+/-(1% of reading +5V)
	Resolution:	1V steps
DC Current Display:	Range:	0.1µA to 1.0mA DC, in 0.1µA steps 1.0mA to 7.5mA DC, in 1µA steps
	Accuracy:	+/-(0.5% of set high limit + 0.1µA or 1µA) *

*Accuracy is degraded by a factor of 2 in DUT Grounded mode

Guardian 2530

Insulation Resistance:	Voltage:	50 - 1000V DC in 1V steps
	Accuracy:	+/-(2% of setting + 5V)
	Range:	10kΩ - 2TΩ, voltage dependent (range limited to V/50µA in DUT Grounded mode)
	Accuracy:	+/-(2% + 1 count) for V/R ≥ 10nA +/-(5% + 1 count) for V/R < 10nA (Accuracy above V/10nA is degraded with Ground Continuity (GC) function in use)
Charging Current:	7.5mA maximum	



Specifications (continued)

Common Features

Ground Continuity:	Test Current:	100 mA DC +/- 10%	
	Range:	10mΩ to 10Ω, in 1mΩ steps	
	Accuracy:	+/- (5% of reading + 20mΩ)	
Limits:	Programmable Hi/Lo during Test Time		
	(Lo can be set to Off : 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)		
Ground Fault	Shutdown within 2msec for current imbalance > 250μA (AC)		
Interrupt:	> 400μA (DC)		
Arc Detection:	Arc Level AC:	0.5mA - 15mA in 0.5mA increments	
	Arc Level DC:	0.5mA - 15mA in 0.5mA increments	
	Arc Time:	1 to 50 μsec programmable	
Indication:	Pass/fail display, lights, audible sound		
Buzzer Level:	Low, High, Off		
Time:	AC Hipot:	Ramp, Test, Fall:	0.1 to 999sec (+/-50ms)
	DC Hipot:	Ramp, Dwell, Test, Fall:	0.1 to 999sec (+/-50ms)
	IR:	Ramp, Dwell, Test, Fall:	0.1 to 999sec (+/-50ms)
	GC:	Test:	0.1 to 999sec (+/-55ms)
	(Test can be set to Continuous. Ramp, Dwell, & Fall can be set to Off)		
Standard Interfaces:	RS-232		
	Remote:		
	Inputs:	Start, Stop	
		Characteristics: TTL active low, Pulse width >1ms	
	Outputs:	Pass, Fail, Under Test	
		Characteristics: Dry contact relay, Closed if true	
		36V, 100mA max	
	Connector: 9 pin male D-series (compatible w/Sentry Series)		
Test Setups:	25 User Defined (shipped with some factory settings)		
	9 Multi-step (3 steps)		
Connectors:	Front and Rear Connection		
	High Voltage:	Locking, Amp Part # 861610-2	
	Return:	BNC female (Selectable for ground or virtual ground)	
	Continuity:	Standard Banana Socket	
Front Panel Lockout:	6 Digit Password with or without setup recall		
Miscellaneous:	Continue Step on Fail		Stop Test on Pass
	Continuous Voltage on Fail		Step and Increment

Specifications (continued)

Optional Interfaces: IEEE-488
Enhanced Remote:
Inputs: Start, Stop, Test Selection
Characteristics: TTL active low, Pulse width >1ms
Outputs: Under Test, Pass, Fail, Fail Hi, Fail Lo, Fail Arc, Fail Cont
Characteristics: Dry contact relay, Closed if true
36V, 100mA max
Connector: 25 pin male D-series (compatible w/Sentry Series via a adaptor)

Mechanical: Bench Mount (optional rack mount flanges available, 2000-16)
Dimensions:(w x h x d): 17x5.25x16in (432x133x406mm)

Weight: 29 lbs (13kg) net, 36 lbs (16kg) shipping

Environmental: Meets MIL-T-28800E, Type 3, Class 5
Operating: 0 to 40°C
Storage: -10 to 60°C
Humidity: Maximum RH of 80% for temperatures up to 31°C
and decreasing linearly to 50% at 40°C
Warm-up Time: 1 minute
Indoor Use: Altitude up to 2000m
Pollution Degree 1, Installation Category II

Power: • 100 - 240V AC +/-10% • 50 – 60 Hz • 300W max

Supplied:
- Instruction Manual
- Power Cable
- Calibration Certificate
- Test Leads (3)

Ordering Information:

Description	Catalog No.
AC Hipot Tester	Guardian 2510
AC/DC Hipot Tester	Guardian 2520
AC/DC/IR Hipot Tester	Guardian 2530

Accessories

Accessories Included

Table 1

Item	Part Number
Instruction Manual	150319
High Voltage Lead Set (consisting of 3 cables)	2000-02
High Voltage Cable (labeled w/QuadTech part # 630113, 10KV rating)	
Ground Continuity Cable (labeled w/QuadTech part # 630114)	
Ground Return Cable (labeled w/QuadTech part # 630115)	
Power Cable	4200-0300
Calibration Certificate Traceable to NIST	

Accessories/Options Available

Table 2

Item	Part Number
High Voltage Lead Set (consisting of 3 cables)	2000-02
High Voltage Cable (labeled w/QuadTech part # 630113, 10KV rating)	
Ground Continuity Cable (labeled w/QuadTech part # 630114)	
Ground Return Cable (labeled w/QuadTech part # 630115)	
High Voltage Lead Set, 2 Meters (consisting of 3 cables)	2000-04
High Voltage Cable (labeled w/QuadTech part # 630133, 10KV rating)	
Ground Continuity Cable (labeled w/QuadTech part # 630134)	
Ground Return Cable (labeled w/QuadTech part # 630135)	
Foot Switch	2000-05
High Voltage Probe	2000-06
Power Entry Adapter Cable	2000-07
Gun Probe	2000-08
High Voltage Lead Set, 2 meters, unterminated	2000-10
Corded Product Adapter (115V)	2000-13
Rack Mount Flanges (require rail support hardware)	2000-16
Corded product Adapter (240V)	2000-25
IEEE-488 Interface (includes Remote I/O Interface)	2000-40
Enhanced Remote I/O Interface	2000-42
2TΩ Enhanced Option (2530 only, factory installed)	2000-43

Accessories (continued)

2000-02 High Voltage Lead Set

2000-02 High Voltage Lead Set

2000-16 Rack Mount Flanges

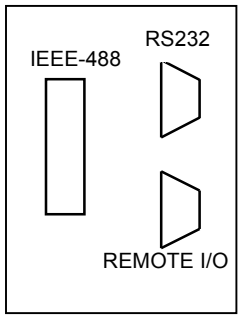
2000-16 Rack Mount Flanges

The 2000-16 Rack Mount Flanges (quantity 2, left and right) are used as dress panels to adapt the 2500 to the standard 19 inch rack width. **THESE FLANGES SHOULD NOT BE USED AS SOLE MOUNTING SUPPORT OF THE 2500** in rack mount applications. Chassis guides or other mechanical support is required to support the instrument. Chassis guides are available from:

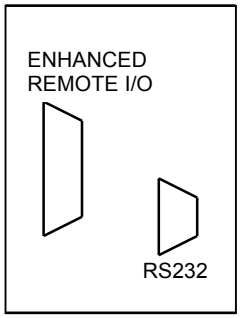
Amco Engineering Company
3801 North Rose Street
Schiller Park, Illinois 60176-2190
Telephone (847) 671-6670

Accessories (continued)

2000-40 and 2000-42 Interfaces



2000-40
IEEE-488 Interface Option
(Rear Panel Configuration)



2000-42
Enhanced Remote Interface
(Rear Panel Configuration)

2000-43 2TΩ Enhanced Option

The 2000-43 is an option for use with the Guardian 2530 only. This option provides enhanced measurement capability of devices with high resistance and substantial parallel capacitance (devices such as wire wound heaters, ac inlet filters, sensors, etc.). When this option is installed additional ramp and dwell time will be required in DC Hipot and fall/discharge time will be increased for DC test voltages greater than 3000 V. AC Hipot functions are not effected by this option. This option generally serves no purpose if insulation resistance measurements are<200 MΩ.

Safety Precautions

The Guardian 2500 Hipot Tester can provide an output voltage as high as 6000VDC (5000VAC) to the external device under test (DUT). Although the Guardian unit is designed with full attention to operator safety, serious hazards could occur if the instrument is used improperly and these safety instructions are not followed.

1. The Guardian 2500 unit is designed to be operated with its chassis connected to earth ground. The instrument is shipped with a three-prong power cord to provide this connection to ground. This power cord should only be plugged into a receptacle which provides earth ground. Serious injury can result if the Guardian 2500 is not connected to earth ground.
2. When connecting test leads to the instrument make sure the RETURN lead is secured tightly with the BNC connector locked in the cw direction, and the HIGH VOLTAGE lead secured tightly with the threaded connector in a cw direction.
3. Never touch the test leads, test fixture or DUT in any manner (this includes insulation on all wires and clips) when the high voltage is applied and the HIGH VOLTAGE light is on.
4. Before turning on the Guardian unit, make sure there is no device (DUT) or fixture connected to the test leads.
5. After each test, press the **STOP** (red) button for safety. This terminates the high voltage being applied to the output terminals.
6. When the **HIGH VOLTAGE** light is flashing (or constantly lit on some later units), NEVER touch the device under test, the lead wires or the output terminals.
7. Before touching the test lead wires or output terminals make sure :
   a) The red **STOP** button has been pressed.
   b) The **HIGH VOLTAGE** light is not flashing (or not lit).
8. Do NOT short the output terminal to the ground line or AC power line. The instrument could then be charged up to a dangerously high voltage.
9. **In the case of an emergency**, turn OFF the POWER switch using the eraser tip of a pencil or "hot stick" and disconnect the AC power cord from the wall. DO NOT TOUCH THE INSTRUMENT.
10. If the **HIGH VOLTAGE light** does not go **off** when the **STOP** button is pressed, immediately stop using the tester and power the instrument down.
11. When the Guardian 2500 instrument is used in remote control mode, be extremely careful. The High Voltage Output is being turned on and off with an external signal.

WARNING

Should the HIGH VOLTAGE light ever malfunction, a changing time display, shown in seconds (lower right corner of front panel LCD display), is also an indication that high voltage is being applied to the output terminals.

CAUTION

When programming the Guardian 2500 for high test voltages it is recommended to program a voltage ramp time (typically > 1 sec). This is intended to prevent any possible high voltage transients across the output resulting from inductive kickback of the instrument's high voltage transformer.

Condensed Operating Instructions

Installation and Power Up

1. Use of this Condensed Operating procedure assumes the operator is somewhat familiar with electrical safety testing and the safety precautions associated with it.
2. The Guardian 2500 should be unpacked from its shipping container. The original carton and packing material should be retained in case it becomes necessary to return the instrument back to the factory for service or calibration at a later date.
3. Install the 2500 in an isolated work area appropriately marked for High Voltage Testing.
4. ⚠ Connect the power cord (female end) to the AC inlet module on the rear panel of the instrument. Connect the other end (male end) to the power receptacle. **The instrument is to be used only with three wire grounded outlets.**
5. Apply power to the Guardian 2500 by pressing the front panel **POWER** switch to **ON** (1 position).
6. The instrument performs a self test and will momentarily display the instrument model number and software version, for example:

QuadTech Guardian 2530 Version 1.00

7. The display will then indicate the power up default test, which is the last test performed before the instrument was powered down. Note the message **"Idle"** in the upper right display, this area always indicates the instrument status.

1 AC:0.500KV	Idle
Hi:15.00mA	7.0sec

Selecting Test Conditions

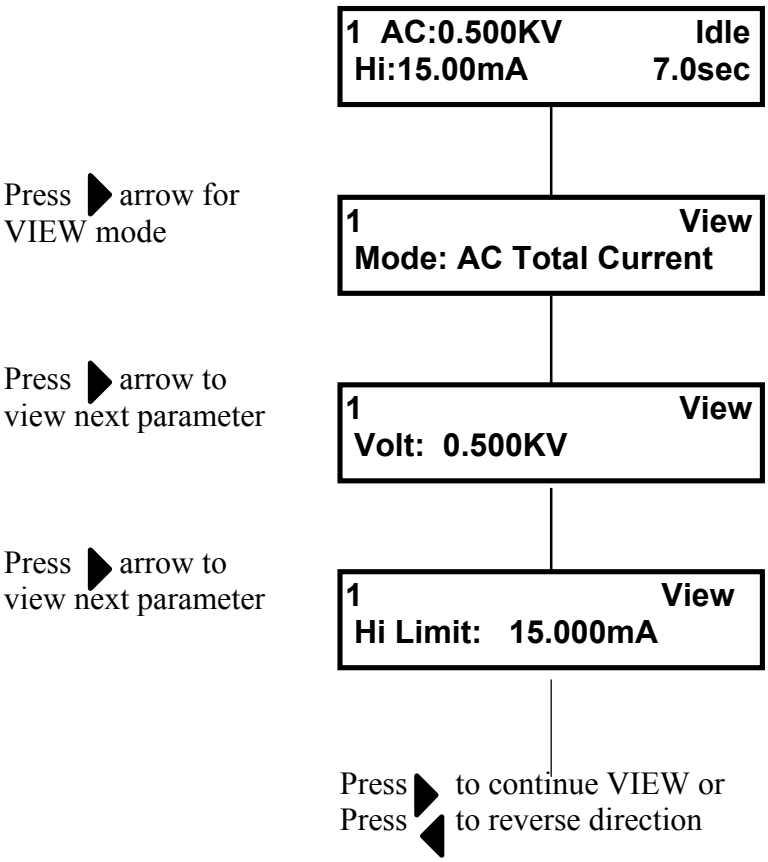
The Guardian 2500 contains memory for storing predefined test conditions. 1 thru 25 are **user defined** setups, (see paragraph 2.5.2 for factory settings) and S1 thru S9 are **sequential test** setups. A sequential test can consist of any combination (up to 3) of user setups. A quick start up is usually performed by recalling or programming modification of setup, see examples in the next paragraphs.

Condensed Operating Instructions (continued)

Recalling Setups/Preprogrammed Test Conditions

1. Press the **TEST NUMBER** key to sequence up through the test setups, those with no program stored will show the message "**No Test Programmed"**. Continue to press the key repeatedly to select any setup desired (user test 1-25, or sequence S1-S9). Typical display below shows setup #1 programmed for AC Hipot at 500 volts, high current limit of 15 mA and test time of 7 seconds. Note the message **"Idle**" in the upper right display, this area always indicates the instrument status. (Pressing the ▲▼ up/down arrow key will also sequence through the test setups, up or down)

2. Once the desired test # has been selected (remains displayed) it is possible to view all test parameters by pressing the ◀ ▶ left/right arrow keys as follows:



Condensed Operating Instructions (continued)

Return the display to **Idle** mode (upper right) and the test # desired (upper left) before proceeding.

Table of Programmable Test Conditions
For the Guardian Models 2510, 2520, 2530

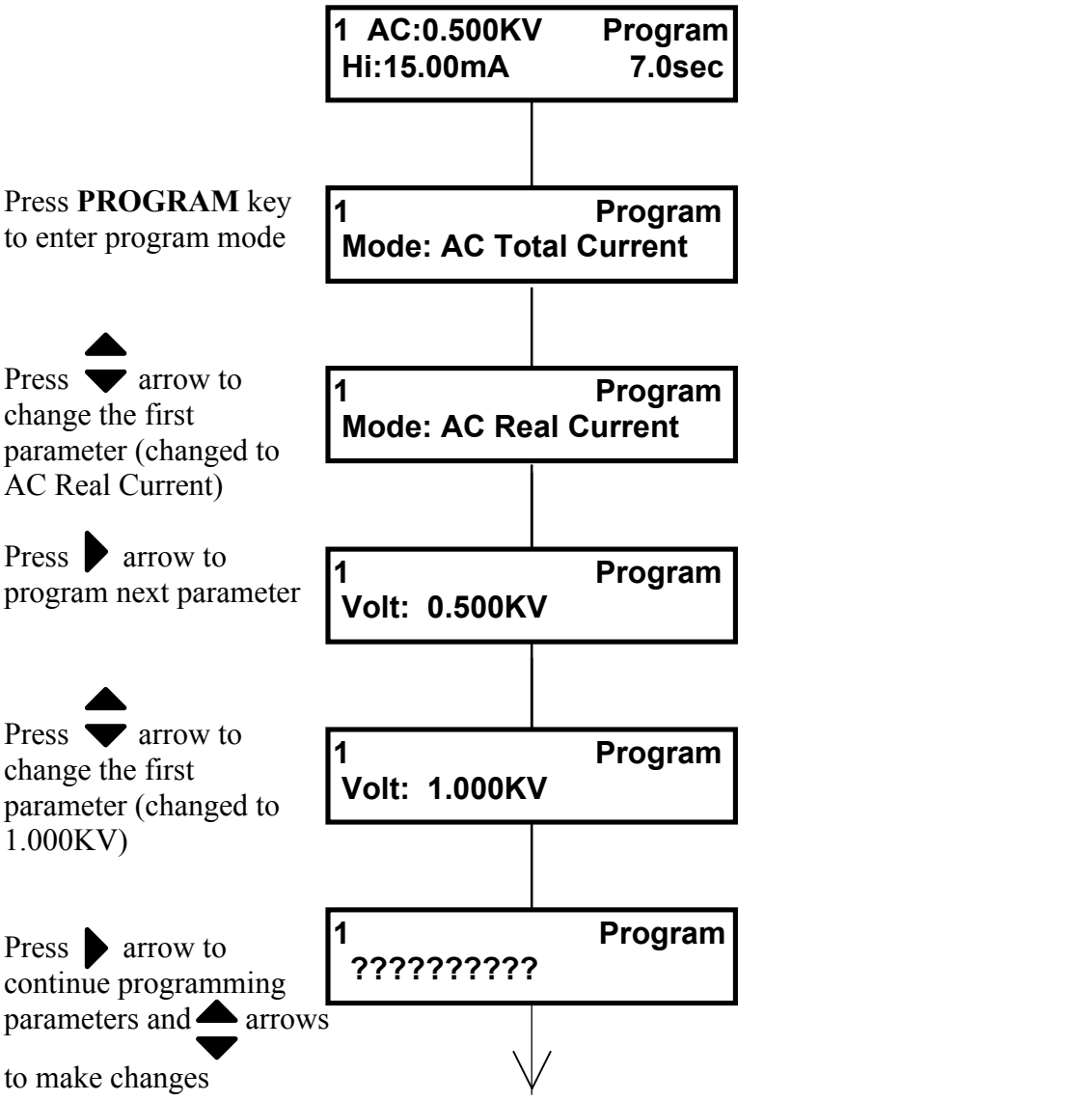
Programmable Parameters	2510 2520 2530 AC	2520 2530 DC	2530 IR
Mode	X	X	X
Voltage	X	X	X
Hi Limit	X	X	X
Lo Limit	X	X	X
Arc Limit	X	X	
Ramp Time	X	X	X
Hi Limit Ramp	X	X	X
Lo Limit Ramp	X	X	X
Dwell Time		X	X
Test Time	X	X	X
Fall Time	X	X	X
Frequency	X		
Gnd Continuity	X	X	X

Modifying/Programming Test Conditions

1. Press the **TEST NUMBER** key to sequence up through the test setups, selecting one for change or one not presently programmed, as noted by the message "**No Test Programmed"**. Continue to press the key repeatedly to select any setup desired (user test 1-25, or sequence S1-S9). Typical display below shows setup #1 programmed for AC Hipot at 500 volts, high current limit of 15 mA and test time of 7 seconds. Note the message **"Idle**" in the upper right display, this area always indicates the instrument status. (Pressing the ▲▼ up/down arrow key will also sequence through the test setups, up or down)

2. Once the desired test # has been selected (remains displayed), to change test conditions proceed as follows:

Condensed Operating Instructions (continued)



Display returns to **Idle** mode after programming the last parameter.

or

Press ◀ arrow to reverse the selection of parameters

or

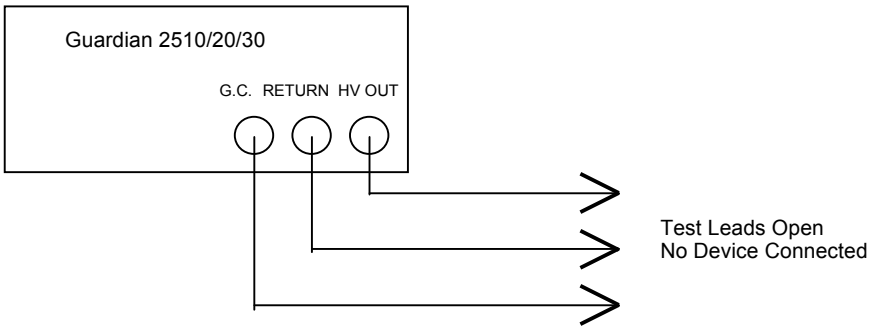
Exit **Program** mode at any time by (with changes made) by pressing **PROGRAM** key

3. Return the display to **Idle** mode (upper right) and the test # desired (upper left) before proceeding.

Implementing Measure Offset

The Guardian provides an automatic zeroing offset function to correct for current leakage effects due to test leads. This correction is stored in instrument memory and applied to ongoing measurements. For optimum measurement accuracy it is recommended that the offset function be performed at the start of daily testing or any time test leads are changed. The instrument should warm-up for at least 10 minutes before zeroing.

1. Connect the 2000-02 lead set (shown below), 2000-13 corded product adapter, or other accessory lead set to the 2500. The test leads must be OPEN (not connected to any test device) and positioned in the approximate location of the expected test. See Note below.



Test Lead Configuration for Measuring Offset

2. Press the **UTILITY** key to select the measure offset function. Press ▲▼ up/down keys to select **Press Start – Get Offset**.

3. Note that the setup number currently selected, 1 - 25 (to which this offset is applied) is indicated in the upper left of the display.

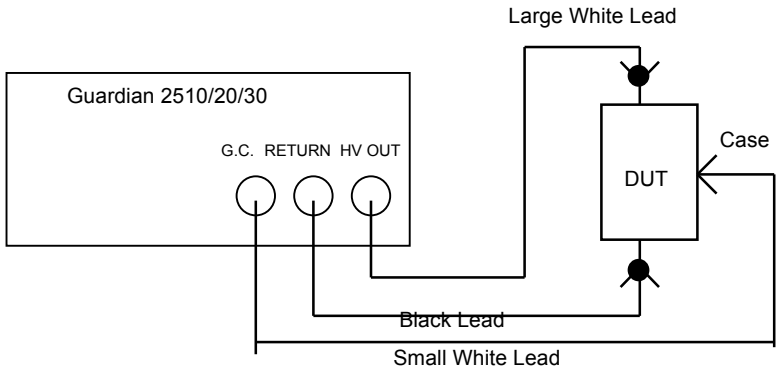
NOTE

When performing the Get Offset function the test leads (HV OUT & RETURN) should be in their normal position with no device connected for AC Hipot, DC Hipot, or IR Mode and test leads (RETURN & G.C.) shorted for GC Only Mode or when Gnd Continuity is turned with an entered limit.

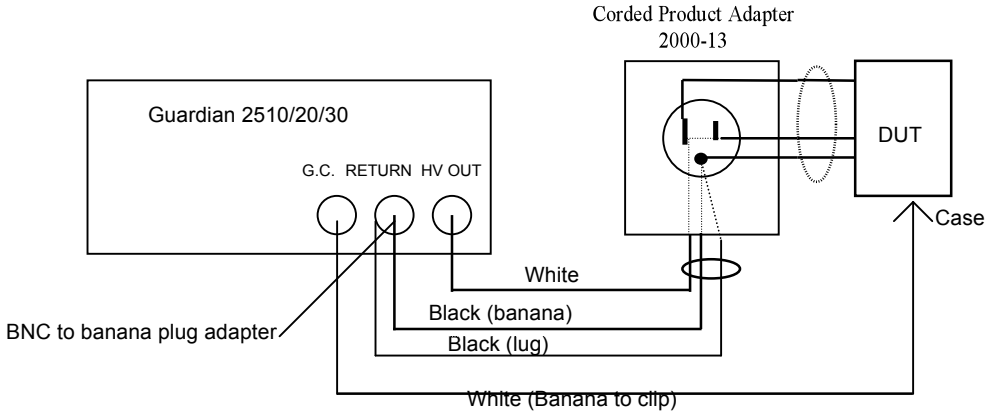
4. Press **START** key to initiate the Offset function, the 2500 stores the connection for the test number shown and returns to the setup display.

Condensed Operating Instructions (continued)

Connection Using Test Leads (Part # 2000-02)



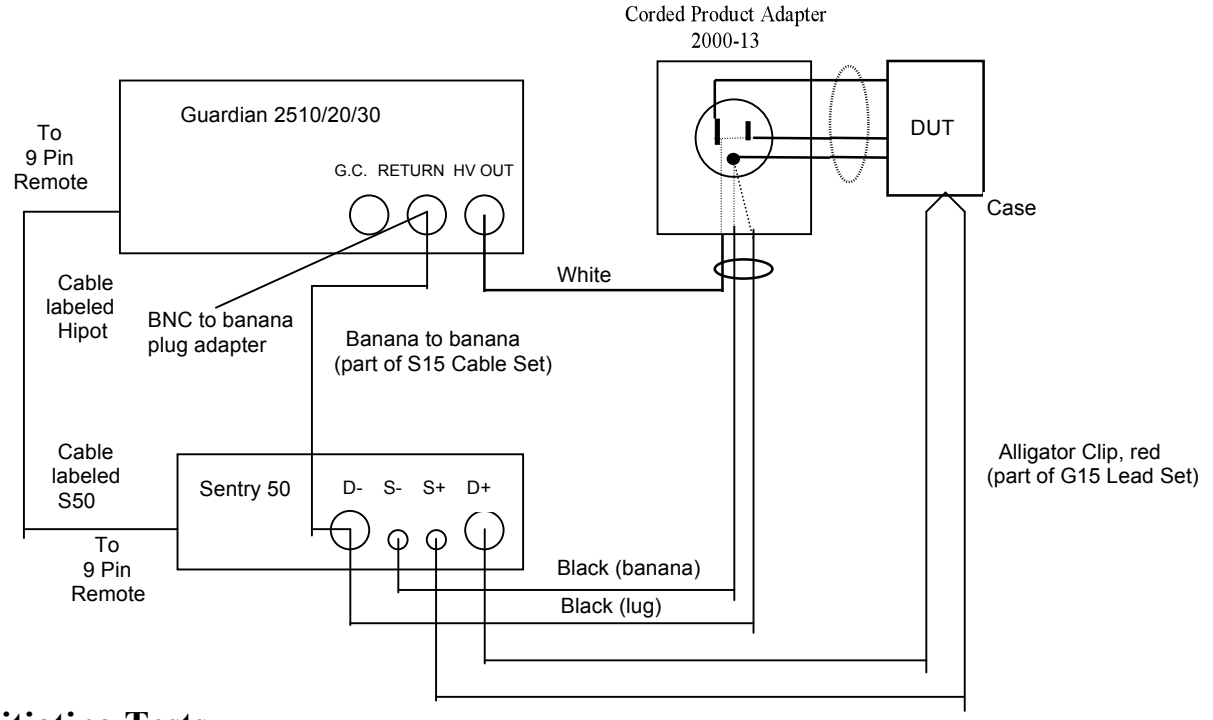
Connection Using Corded Product Adapter (Part # 2000-13)



Condensed Operating Instructions (continued)

Connection to S50 Using Corded Product Adapter (Part # 2000-13)

(Ground Fault Stop on the 2500 must be set for **Off – DUT Grounded**, and START must be initiated from the Sentry 50)

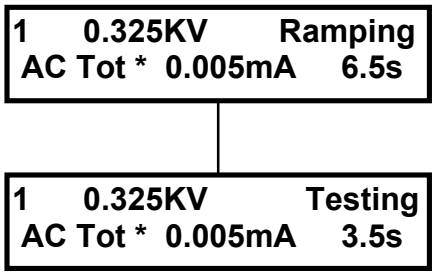


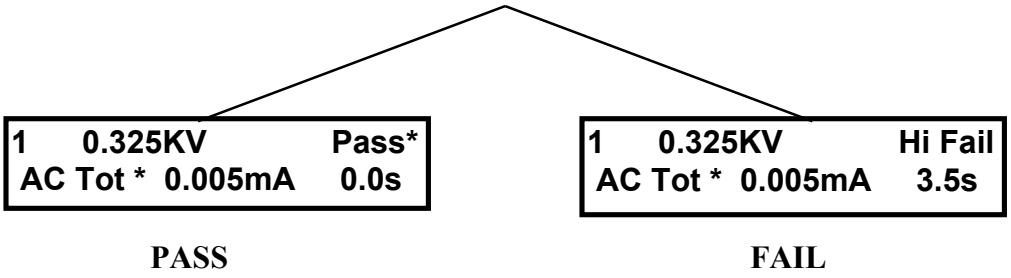
Initiating Tests

1. Before initiating the test the 2500 should be powered up, the desired test # recalled/programmed, measure offset zeroed, and test device connected.

2. ⚠ ⎓ Display should indicate **Idle** mode (upper right) and the test # desired (upper left) before initiating the test. Make sure hands are clear from the device under test and press **START** (green button) to initiate the test. The HIGH VOLTAGE indicator flashing (or constantly lit on some later units) serves as warning to the operator that high voltage is present. **The STOP button may be pressed at any time to abort a test and turn the high voltage off.**

2. The instrument will automatically begin the test cycle, showing the count down through any programmed ramp, dwell and test times.





PASS **FAIL**

3. Test Results Display with Single Test Selected (1 – 25)

If limits are not exceeded during the test the instrument will cycle through the complete test and the Pass indicator (green) will light. The unit is ready for another test.

If limits are exceeded during the test the instrument's high voltage will shut down, the display will indicate the failed limit and an audible alarm will sound (only if buzzer is enabled, see Utility function, paragraph 3.4). Press the **STOP** button two times, one to stop the buzzer (if enabled) and again to reset before another test can be initiated.

One of the following "Display messages" will be shown (upper right of the display)

Display	Test Condition
Pass	Measurement falls within set limits
Lo Ramp	Measurement was below low limit during ramp time
Hi Ramp	Measurement exceeded high limit during ramp time
Lo Fail	Measurement was below low limit during test time
Hi Fail	Measurement exceeded high limit during test time
Arc Fail	Measurement exceeded arc limit
GC Fail	Measurement exceeded ground continuity high limit

NOTE

An asterisk following the parameter as illustrated in the measurement display above (AC Tot *) indicates that the Measure Offset is selected for ON. No asterisk will be shown in the measurement result with Measure Offset to OFF. Refer to Measure Offset, paragraph 2.4.2

An asterisk following a Pass message as illustrated in the measurement display above (Pass*) indicates a conditional pass. A conditional pass can occur when the enhanced feature "Continue Voltage On Fail" is enabled. The asterisk indicates that the device failed at some point during the test but was passing at the end of the test. This would only be seen with "Continue Voltage On Fail" enabled. Refer to Continue Voltage On Fail, paragraph 2.4.9, step 3.

Condensed Operating Instructions (continued)

4. Test Results Summary Display with Sequence Test Selected (S1 – S9)
   Sequence 1 (S1) shown in example below.

S1: Pass 1 2 3 Fail None	S1: Pass 2 3 Fail 1
PASS	**FAIL**
<u>If limits are not exceeded</u> PASS Light ON	<u>If limits are exceeded</u> FAIL Light On
To view test results, press ▲▼ arrow to review test 1 – 3 of the sequence.	To view test results, press STOP button, then ▲▼ arrow to review 1 – 3 tests of the sequence.
Unit is ready for another test to be initiated	Press STOP button second time to reset before another test can be initiated.

NOTE

If "Continue Voltage On Fail" is enabled a "Fail" on the summary display (as shown for Test 1 above) can be a conditional Pass. A conditional pass occurs if, during one of the tests within the sequence, the device failed at some point but was passing at the end of the test.

When reviewing individual test results with up/down arrow as described above an asterisk following the Pass would indicate the conditional Pass. This would only be seen with "Continue Voltage On Fail" enabled. Refer to Continue Voltage On Fail, paragraph 2.4.9, step 3.

1 0.325KV Pass*
AC Tot * 0.005mA 0.0s

Section 1: Introduction

1.1 Unpacking/Inspection

Inspect the shipping carton before opening. If damaged contact the carrier agent immediately. Inspect the Guardian 2500 instrument for any damage. If the instrument appears damaged or fails to meet specifications notify QuadTech (refer to instruction manual front cover) or its local representative. Retain the shipping carton and packing material for future use such as returning for recalibration or service.

1.2 Product Overview

The Guardian 2500 Series of Hipot testers is designed to perform the most common electrical safety tests outlined in UL, CSA, IEC, TUV, EN and other standards. Three models are available, the Guardian 2510, 2520 and 2530.

The Guardian 2510 AC Hipot Tester performs AC dielectric withstand (hipot) tests. The test voltage can be programmed over a range of 100V to 5KVAC with a resolution of 2V. Leakage current detection is programmable over a range of 1μA to 15mA. Total, real or imaginary current can be monitored and displayed.

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 over a range of 100V to 6KVDC with a resolution of 2V. Leakage current detection is programmable over a range of 0.1μA to 7.5mA.

The Guardian 2530 AC/DC/IR Hipot Tester has all the features of the 2510 and 2520 plus measurement of insulation resistance. IR measurements are possible (voltage dependent) over a range from 10kΩ to 2TΩ, at test voltages from 50 to 1000VDC.

All three models of the 2500 include ground continuity test capability. The instrument provides internal storage 25 single step setups and 9 multi-step setups (up to 3 steps each). A remote interface and RS-232 are standard; IEEE-488 or an advance remote interface are available options.

WARNING

The Guardian 2500 Hipot Tester is capable of generating extremely HIGH VOLTAGE, up to 5000VAC or 6000VDC.

Do not touch the Output Test Terminals or Test Leads when the High Voltage light is flashing.

Always make sure the HIGH VOLTAGE light is OFF when connecting or disconnecting the device under test (DUT).

1.3 Front Panel Description

Figure 1-1 shows the controls and indicators on the front panel of the Guardian Series 2500. Table 1-1 identifies them with descriptions and functions.

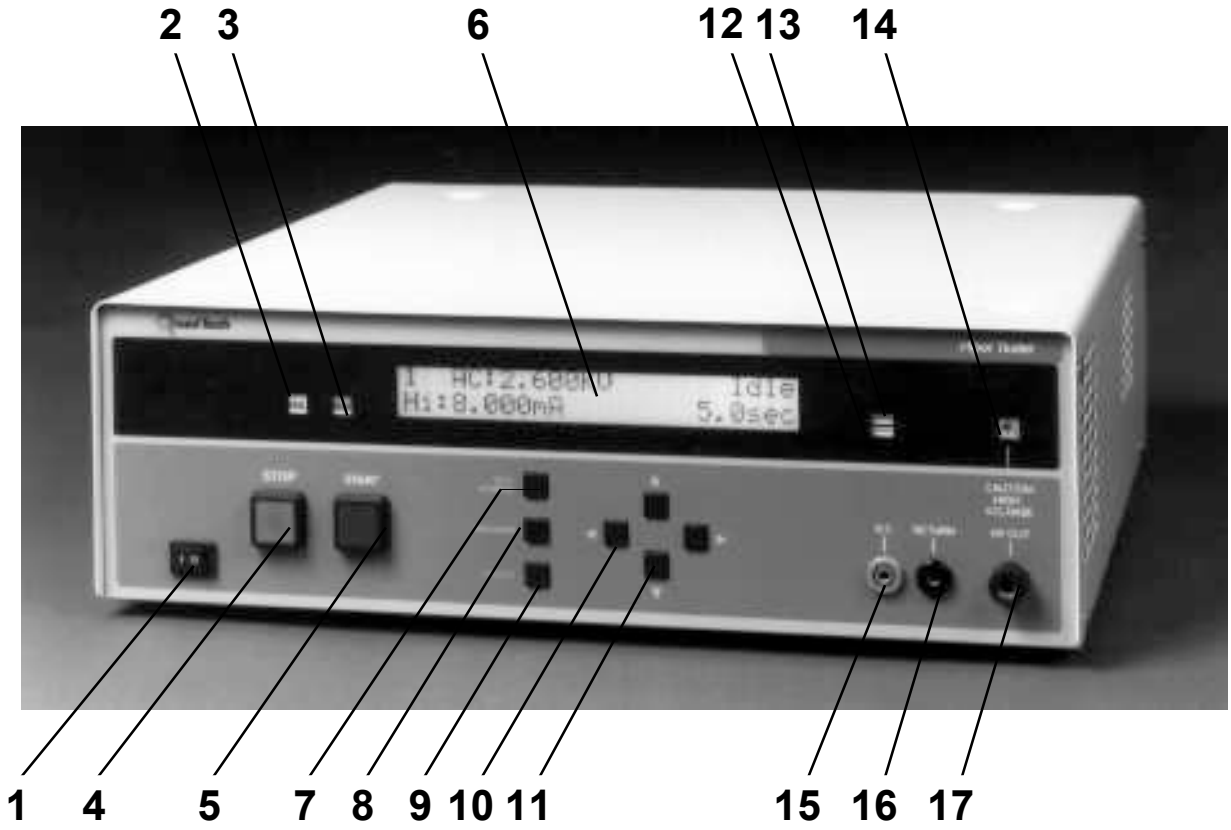


Figure 1-1
Front Panel Controls and Indicators

Table 1-1
Front Panel Controls and Indicators

Fig 1-1 Ref. #	Item	Function
1	Power	Rocker style switch which supplies power to the tester (with OFF (0) and ON (1) markings).
2	**FAIL** Indicator	Measured results indicate a fail condition based on set limits.
3	**PASS** Indicator	Measured results indicate a pass condition based on set limits.
4	**STOP** BUTTON	Pressing this button halts a test or tests in process and shuts down the high voltage.
5	**START** BUTTON	Pressing this button starts a test or tests. All other keys, except STOP, are inactive until the test is complete. START is also used to initiate the Zero Offset function or Calibration.
6	Display	Readout to the operator of programmed tests and test results.
7	**TEST**	Pressing this key will sequentially scroll through test setups (in ascending order) based on how the Utilities Menu is configured (shows all tests or only those enabled). Test number is shown in upper left display as, user defined (1 - 25), or sequence tests (S1 - S9). On sequence tests (S1 - S9) the first test in the sequence will be displayed.
8	**PROGRAM** KEY	Pressing this key will allow the user to program the parameters of the test number presently displayed (**Program** appears in upper right display). In Program mode **UP/DOWN** arrow changes the test parameter conditions. **RIGHT** arrow selects the next parameter and exits program mode (back to **Idle**) after the last parameter is displayed. **LEFT** arrow selects the previous parameter. Pressing **PROGRAM** key at any time exits the programming mode back to Idle. To program another test, from the **Idle** mode, press **TEST** key to select desired test number and press **PROGRAM** key.

Table 1-1 (continued)
Front Panel Controls and Indicators

Fig 1-1 Ref. #	Item	Function
9	**UTILITY** KEY	Pressing this key will allow the user to set functional changes which affect all tests. These functions are listed below and discussed in detail in the Operation Section of this manual. **Measure Offset**- Off, On, Press Start - Get Offset **Keypad Lockout**- Off, Lock Password, Lock Cycle Tests Password **Test Locations**- Show All Tests, Hide Disabled Tests **Buzzer on Fail**- Off, Soft, Loud **Beep on Key Hit**- On, Off **IEEE Address**- 1 thru 16 **Enhanced Features**- On, Off Test Low Limit- Continuous, End of Test Delay Time- Off, 0.1 - 999.9sec Cont Volt On Fail- Off, On Cont Steps On Fail- Off, On Stop Test On Pass- Off, On Step And Increment- Off, On Clear All Tests- No, Yes Test To View- All Tests, Only Sequence Only Single Step, Only Factory Perform Calibration- Cal Date, Start Full, Start GC Only Ground Fault Stop- Off, On, Off - DUT Grounded Arc Pulse Width- 5 - 500µsec Pressing **UTILITY** key at any time exits the utility mode back to Idle.
10	**LEFT/RIGHT** Arrow Keys	In **Idle mode** moves to the next or previous parameter for viewing. In **Program mode** moves to the next or previous parameter for programming. In **Utility mode** moves to the next utility function.
11	**UP/DOWN** Arrow Keys	In **Idle mode** moves to the next or previous test for viewing. In **Program mode** changes the condition of the selected test parameter. In **Utility mode** changes the condition of the selected utility function.
12	**LOCKOUT** Indicator	When illuminated indicates that the front panel keypad lockout has been enabled. (Illuminates green on late model instruments)

Table 1-1 (continued)
Front Panel Controls and Indicators

Fig 1-1 Ref. #	Item	Function
13	**REMOTE** Indicator	When illuminated indicates that the instrument has been enabled for remote operation. (Illuminates green on late model instruments)
	GFI ACTIVE Indicator	When illuminated (green) indicates that the instrument has been enabled for Ground Fault Stop. (Indicator not present on some earlier units)
14	**HIGH VOLTAGE** Indicator	When indicator is flashing (or constantly lit on some later units) serves as a warning to the operator that high voltage is present to the High Voltage Output connector.
15	**GROUND CONTINUITY** Connector	Continuity test connection, measured between this connector and the Return (accepts the small white clip lead cable with banana plug) Standard banana plug.
16	**RETURN** Connector	Ground return for High voltage output (accepts the black clip lead cable with BNC connector). Selectable for ground or virtual ground. BNC female
17	**HIGH** VOLTAGE Connector	⚠ ⎓ High voltage output for AC/DC hipot & insulation resistance measurements, jack recessed for safety purposes (accepts the large white clip lead cable with high voltage connector). Amp Part # 861610-2

1.4 Rear Panel Description

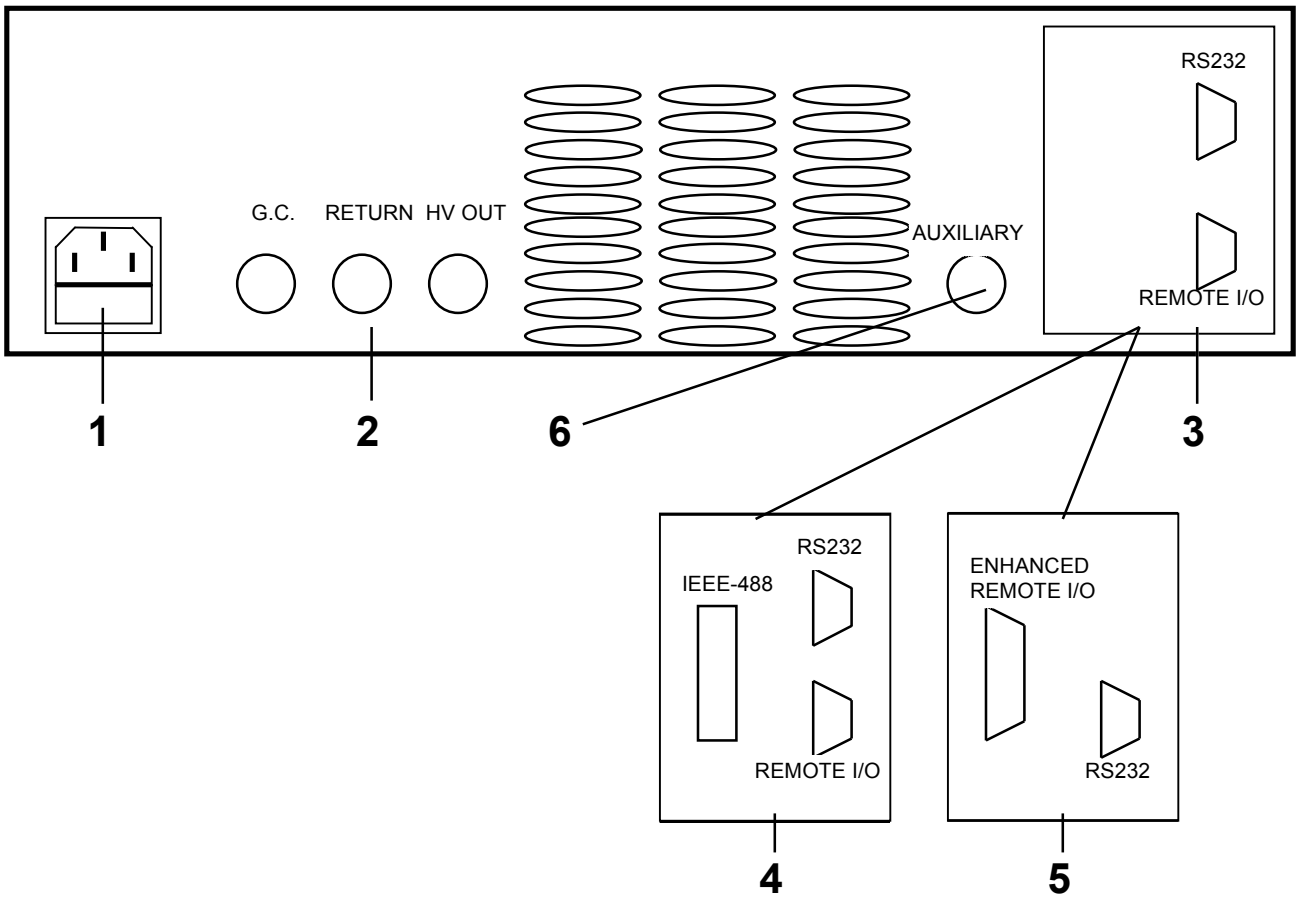


Figure 1-2
Rear Panel View

Table 1-2
Rear Panel Connectors and Controls

Fig 1-2 Ref. #	Item	Function
1	**AC Inlet**	⚠ AC power receptacle in accordance with IEC-320 and CEE-22 Module specifications. Contains fuse T5.0A, 250V, 5x20mm time delay fuse for 90 to 250V operation. Replace only with the same type and rating. (QuadTech PN 520068). Also refer to paragraph 1.5.3. The **Chassis Ground Symbol,** ⏚ shown internal to the instrument and adjacent to the terminal which connects to the green wire from the AC Inlet module, is the instrument's Chassis Ground. **This instrument should be accessed internally only by a qualified service person**.
2	**Rear Panel Connections**	⚠ ⎓ Duplicates front panel connectors, HIGH VOLTAGE, GROUND RETURN and GROUND CONTINUITY
3	**REMOTE & RS232**	Standard Interface on all units except when ENHNACED REMOTE I/O option is ordered. Refer to paragraph 3.2.
4	**IEEE-488**	IEEE-488 Interface Option (2000-40), includes RS232 & Remote I/O Interface). Refer to paragraph 3.5.
5	**ENHANCED REMOTE I/O**	Enhanced Remote Interface Option (2000-42), includes RS232 Interface. Refer to paragraph 3.4.
6	**AUXILIARY**	Factory use only

1.5 Installation

1.5.1 Instrument Positioning

The Guardian 2500 is supplied in a bench configuration, i.e. in a cabinet with resilient feet for placement on a table or bench. The front panel includes a high resolution back lit LCD display for convenient viewing. The optimum angle for viewing is straight onto the display. This means that for bench or rack operation the instrument should be positioned at eye level.

1.5.2 Instrument Cleaning

The Guardian 2500 is designed to operate with minimum maintenance requirements. The instrument is recommended for use in a clean dust free environment and requires positioning to allow for ample circulation of air (at least 3 inches) to the rear and side vents. No internal cleaning is normally required as long as the instrument remains in its original configuration. All external surfaces of the instrument can be cleaned with a soft cloth moistened with "Windex" or other mild general purpose cleaner.

1.5.3 Power Requirements

 The Guardian 2500 can be operated from a power source between 100 and 240Vac at a power line frequency of 50 to 60Hz, no line voltage switching is necessary. Power connection to the rear panel is through an ac inlet module comprised of an ac connector and fuse drawer. Before connecting the 3-wire power cord between the unit and AC power the fuses should be in accordance with the power source, T5.0A, 250V, 5x20mm (QuadTech PN 520068) for 115 or 220V source. Always use an outlet which has a properly connected protection ground. **The instrument is factory shipped with the 5.0A fuse in place. The instrument can be damaged if the wrong fuse is installed.** To change the fuse refer to paragraph 1.5.4.

1.5.4 Safety Inspection

 Before operating the instrument, inspect the power inlet module or the rear panel to ensure that the **properly rated fuse is in place**, otherwise damage to the unit is possible. Refer to paragraph 1.5.2.

The instrument is shipped with a standard U.S. power cord, QuadTech P/N 4200-0300 (with Belden SPH-386 socket or equivalent, and 3-wire plug conforming to IEC 320). Make sure the instrument is only used with these cables (or other approved international cord set) which ensures that the instrument is provided with **connection to protective earth ground.**

The surrounding environment should be **free from excessive dust** to prevent contamination of electronic circuits. The surrounding environment should also be **free from excessive vibration**. The instrument should be positioned with consideration for ample air flow to the rear panel fan ventilation holes, an open space of at least 3 inches (75mm) is recommended behind the rear panel. Do not expose the instrument to direct sunlight, extreme temperature or humidity variations, or corrosive chemicals.

When the 2500 is used in a rack installation (using the QuadTech 2000-16 Rack Mount Flanges) make sure the unit is **secured using rack cabinet mounting rails**, and not secured solely by these front panel flanges.

1.5.5 Fuse Replacement

WARNING

MAKE SURE THE UNIT HAS BEEN DISCONNECTED FROM ITS AC POWER SOURCE FOR AT LEAST FIVE MINUTES BEFORE PROCEEDING.

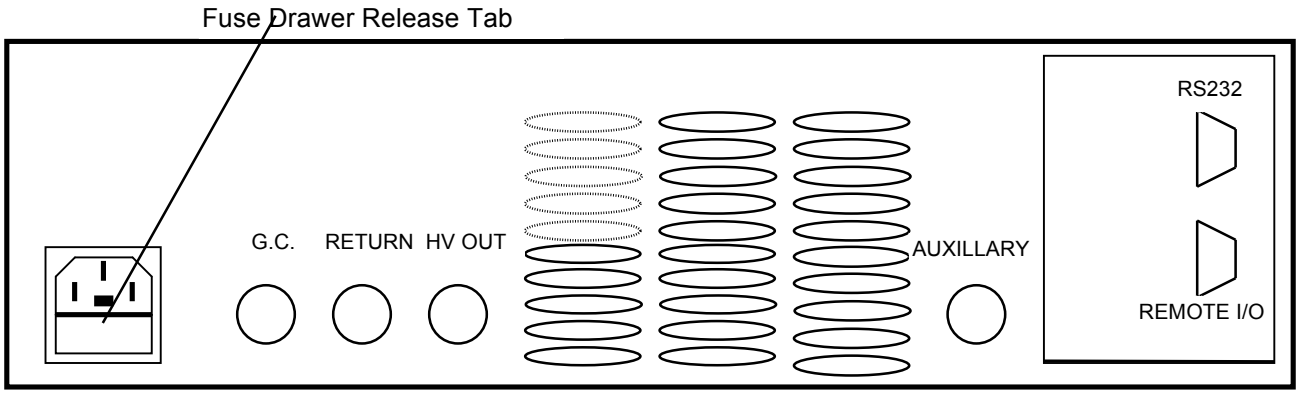


Figure 1-3: Fuse Drawer Release Tab

- Remove the **fuse drawer** by inserting a small flat head screwdriver behind the small tab to force the draw outward. Refer to Figure 1-4.
- Once the fuse drawer has been completely removed from the instrument remove the **clear fuse tray** from the drawer by lifting upward slightly on the long narrow black locking tab. This will allow the fuse tray to be removed from the fuse drawer. This tray contains the active fuse, left side (secured by holder) and spare fuse on the right side (if present). Refer to Figure 1-4.
- Remove the active fuse from the holder by prying upward using a small flat head screwdriver. Insert the replacement fuse into the fuse holder.
- Once the fuse has been installed in the holder and spare fuse (if desired) installed in the right side of the tray insert the tray back into the fuse drawer, push in and lock. The two silver contacts on the fuse tray should be positioned towards the outside.
- Once the fuse tray has been installed in the drawer, reinstall the fuse drawer back into the instrument ac inlet module, push in and lock.

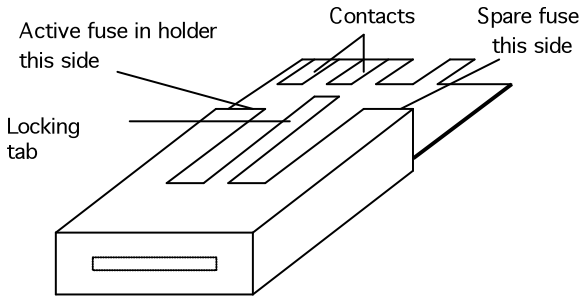


Figure 1-4: Fuse Drawer

Section 2: Operation/Programming

2.1 Power Up

WARNING

NEVER TOUCH THE TEST LEADS IN ANY MANNER (this includes insulation on all wires and clips) WHEN THE HIGH VOLTAGE IS APPLIED AND RED DANGER LIGHT IS ON.

USE ALL PRECAUTIONS NECESSARY TO AVOID TOUCHING THE DEVICE UNDER TEST WHEN THE AMBER HIGH VOLTAGE LIGHT IS ON & FLASHING.

Connect the power cord (female end) to the AC inlet module on the rear panel of the instrument. Connect the other end (male end) to the power receptacle. **The instrument is to be used only with three wire grounded outlets.**

Power is applied to the Guardian 2500 by pressing the front panel **POWER** switch to **ON** (1 position).

WARNING

DO NOT TURN INSTRUMENT POWER ON OR OFF WITH TEST DEVICES CONNECTED.

2.2 Program/Setup Procedure (Test 1-25)

1. Press the **TEST NUMBER** key to select test conditions of setup #1. Continue to press the key repeatedly to select the setup desired for programming (user test 1-25, or sequence S1-S9). A Typical display is shown below, with setup #1 programmed for AC Hipot at 500 volts, high current limit of 15 mA and test time of 7 seconds. Note the message **"Idle"** in the upper right display, this area always indicates the instrument status.

Test Parameter Setup

NOTE

Some of the setups (21 -25, depending on model type) contain factory set test conditions. These can be modified like all other setups (1-20) but can be returned to the original factory set conditions with **Clear All Tests**, refer to paragraph 2.4.9, step 7.

Step	Test Parameter	AC Hipot (2510,2520,2530)	DC Hipot (2520,2530)	IR (2530)	GC (2510,2520,2530)
1		PROGRAM	PROGRAM	PROGRAM	PROGRAM
2	Mode	AC Total Current AC Real Current AC Imag Current	DC Current	IR	GC Only
3	Test Voltage	0.100KV to 5.000KV	0.100KV to 6.000KV	0.050KV to 1.000KV	
4	Hi Limit	0.001mA to 15mA	0.0001mA to 7.5mA	0.01MΩ to 2.000TΩ, Off	0.01 to 10.00Ω
5	Lo Limit	0.001mA to 14.999mA, Off	0.0001mA to 7.4999mA, Off	0.01MΩ to 1.999TΩ	0.01 to 9.99Ω Off
6	Arc Limit	0.5mA to 15mA Off	0.5mA to 15mA Off		
7	Ramp Time	0.1 to 999.9sec Off	0.1 to 999.9sec Off	0.1 to 999.9sec Off	
8	Hi Limit Ramp	0.001mA to 15.000mA, Off	0.0001 to 7.500mA, Off	0.01MΩ to 2.000TΩ, Off	
9	Lo Limit Ramp	0.001mA to 14.999mA, Off	0.0001 to 7.499mA, Off	0.01MΩ to 1.999TΩ, Off	
10	Dwell Time		0.1 to 999.9sec Off	0.1 to 999.9sec Off	
11	Test Time	0.1 to 999.9sec Continuous	0.1 to 999.9sec Continuous	0.1 to 999.9sec Continuous	0.1 to 999.9sec Continuous
12	Fall Time	0.1 to 999.9sec Off	0.1 to 999.9sec Off	0.1 to 999.9sec Off	
13	Frequency	50 or 60Hz			
14	Gnd Continuity	0.01 to 10.00Ω Off	0.01 to 10.00Ω Off	0.01 to 10.00Ω Off	

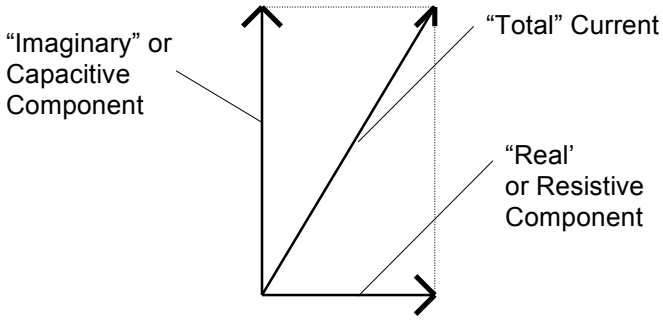
Press **PROGRAM** key, note that the first programmable parameter is displayed and the **"Idle"** message now indicates **"Program".**

1 Program
Mode: AC Total Current

1. **To set the Mode:**

Press ▲▼ up/down arrow keys to scroll through Mode selections.

No Test Programmed
AC Total Current
AC Real Current
AC Imag Current
DC Current (not seen on Model 2510)
IR (Insulation Resistance Measurement) (not seen on Model 2510 or 2520)
GC Only (Ground Continuity Test)



Leave the display set for the selection desired and press ▶ right arrow key to move to the next parameter or **PROGRAM** key to exit program mode.

2. **To set Voltage:**

Press ▲▼ up/down arrow keys to increase or decrease the voltage setting between 0.100KV

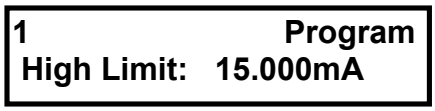
1 Program
Volt: 0.500KV

and 5.000KV (for AC Current) or 0.100KV and 6.000KV (for DC Current) or 0.050KV and 1.000KV (for Insulation Resistance).

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

3. To set Hi Limit:

Press ▲▼ up/down arrow keys to increase or decrease the limit setting between 0.001mA

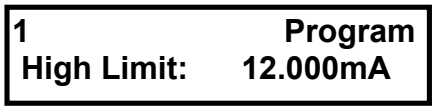


and 15.000mA (for AC Current), 0.0001mA and 7.500mA (for DC Current), 0.01MΩ and 2000000MΩ or Off (for Insulation Resistance) and 0.01Ω and 10.00Ω (for Ground Continuity). **This limit is checked only during the programmed test time. For an AC or DC Hipot test any current above this limit is considered a FAIL and for an Insulation Resistance measurement any value above this is considered a FAIL.**

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

4. To set Lo Limit:

Press ▲▼ up/down arrow keys to increase or decrease the limit setting between Off and 0.001mA to 14.999mA (for AC Current), Off and 0.0001mA to 7.4999mA (for DC Current), 0.01MΩ to 1999000MΩ (for Insulation Resistance), and Off and 0.01Ω and 10.00Ω (for Ground Continuity). **The Lo limit must be set lower than the Hi Limit and is checked only during the programmed test time. For an AC or DC Hipot test any current below this limit is considered a FAIL and for an Insulation Resistance measurement any value below this is considered a FAIL.**



Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

5. To set Arc Limit (AC or DC Current only):

Press ▲▼ up/down arrow keys to increase or decrease the limit setting between Off and 0.5mA to 15.00mA (for AC Current) and between Off and 0.5mA to 15mA (for DC Current). **The arc limit can be limited (see below) to less than that indicated above depending on the Hi Limit setting and is checked only during the programmed ramp and test times.**

Arc Level AC: 0.5mA - 15mA in 0.5mA increments
Arc Level DC: 0.5mA - 15mA in 0.5mA increments

Arc Limit does not apply to GC Only or IR mode (Guardian 2530)

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

6. To set Ramp Time:

Press ▲▼ up/down arrow keys to increase or decrease the ramp time between Off and 0.1 to 999.9sec. The test voltage increases linearly during the programmed ramp time. **The standard Hi/Lo Limits are not checked during this ramp time, for current checking during ramp time refer to Hi Lim Ramp (step 7) and Lo Lim Ramp(step 8).**

```
1                    Program
Ramp Time:    5.0sec
```

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

7. To set Hi Lim Ramp (AC or DC Current only,not available with Ramp Time set Off):

Press ▲▼ up/down arrow keys to increase or decrease the limit setting between Off and 0.001mA and 15.000mA (for AC Current) or 0.0001mA and 7.500mA (for DC Current) or 0.01MΩ and 2000000MΩ (for Insulation Resistance). **This Hi Lim Ramp limit is checked only during the programmed ramp time.**

```
1                    Program
HI Lim Ramp:  10.000mA
```

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

8. To set Lo Lim Ramp (AC or DC Current only, not available with Ramp Time set Off):

Press ▲▼ up/down arrow keys to increase or decrease the limit setting between Off and 0.001mA and 14.999mA (for AC) or 0.0001mA and 7.499mA (for DC) or 0.01MΩ and 1999000MΩ (for Insulation Resistance).. **This Lo Lim Ramp limit is checked only during the programmed ramp time.**

1	Program
Lo Lim Ramp:	10.000mA

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

9. To set Dwell Time (DC Current or Insulation Resistance only)

Press ▲▼ up/down arrow keys to increase or decrease the dwell time between Off and 0.1 to 999.9sec (for DC Current and Insulation Resistance). **No Hi/Lo Limits are checked during the programmed dwell time.**

1	Program
Dwell Time:	5.0sec

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

10. To set Test Time:

Press ▲▼ up/down arrow keys to increase or decrease the test time between Continuous and 0.1 to 999.9sec. **Both Hi and Lo current limits (if programmed) are checked during the test time. When the test time is programmed for Continuous the high voltage remains On until a failure occurs or the STOP button is pressed.**

1	Program
Test Time:	5.0sec

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

11. To set Fall Time:

Press ▲▼ up/down arrow keys to increase or decrease the fall time between Off and 0.1 to 999.9sec. During fall time the programmed voltage decreases linearly to zero. **No Hi/Lo limits are checked during this time.**

1	**Program**
Fall Time:	**5.0sec**

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

Note: Under failed conditions for high limit, low limit or arc limit the 2500 will still execute the fall time (if programmed) during the shutdown process.

12. To set Frequency:

Press ▲▼ up/down arrow keys to toggle the frequency between 50 or 60Hz

1	**Program**
Frequency:	**60Hz**

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

13. To set Gnd Continuity:

Press ▲▼ up/down arrow keys to increase or decrease the resistance limit between Off and 0.01 to 10.00Ω. The ground continuity measurement is made between the G.C. and Return connections. A ground continuity test is performed prior to a Hipot of IR test when the limit is set to a value other than Off. **Any measured value above this limit is considered a FAIL,** no low limit check is performed.

1	**Program**
Gnd Continuity:	**0.10Ω**

Press ▶ right arrow key to move to the next parameter (◀ left arrow for previous parameter) or **PROGRAM** key to exit program mode.

2.3 Programming Sequence (Tests S1 - S9)

A sequence test consists of 1, 2 or 3 tests in sequence. Selected tests can consist of any of the user defined tests (1 - 25), or a calculated test, which can be a calculated value for Total, Real or Imaginary current based on the AC Hipot measurement conditions defined in the first step of the sequence**. A calculated test is not a valid entry for step 1 of a sequence, a calculated test can only be called for in step 2 and/or 3 of the sequence where the test called for in step 1 must be an AC Hipot test.**

Table of Programmable Parameters
For Setting Up Sequence Testing (S1 – S9)

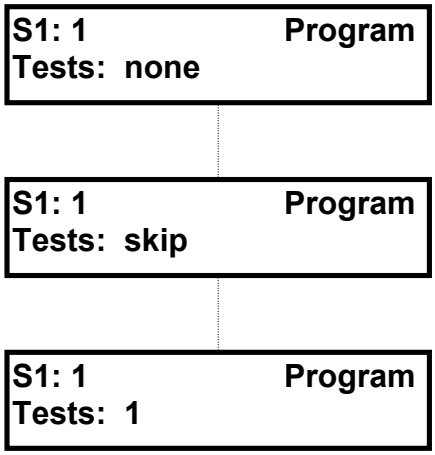
Test #	Programmable Tests for the Sequence
1	none, 1 thru 25, skip
2	none, 1 thru 25, skip, calc
3	none, 1 thru 25, skip, calc

Programmable Parameters for calc	Programmable Hi/lo Limits for Total, Real, or Imag Current	Programmable Range
AC Total Current	Hi Lim	0.000 – 15.000mA
AC Real Current		
AC Imag Current	Lo Lim	0.000 – 15.000mA

1. To Program Sequence Test #1

Press the **TEST NUMBER** key to select test setup for programming (sequence S1 - S9). Continue to press the key repeatedly to select the setup desired, for example: S1 as shown below.

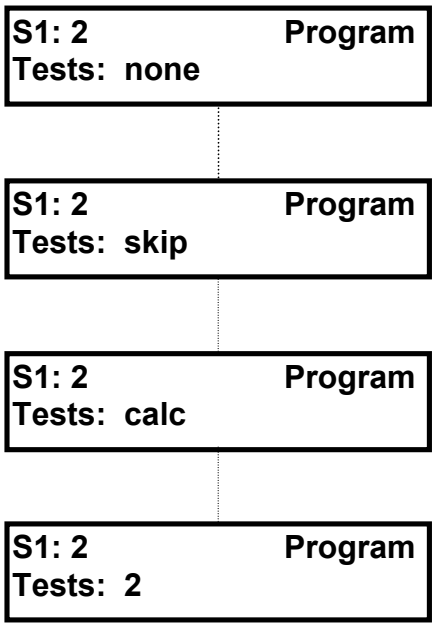
Press **PROGRAM** key, to allow entry of a test number in step number 1. Also note that the **"Idle"** message now indicates **"Program."** Press up/down arrow keys to select the first test in the sequence as none, skip or 1 – 25 (Calculate can not be selected on the first step).



2. To Program Sequence Test #2

Press ▶ right arrow key to program a test number for step 2 of the sequence.

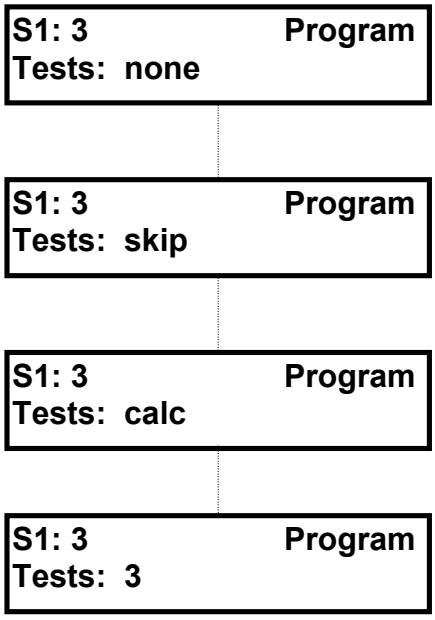
Press ▲▼ up/down arrow keys to select the second test in the sequence as none, skip, 1 – 25 or calc (see discussion of the calculate function, step 4 below).



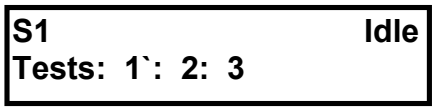
3. To Program Sequence Test #3

Press ▶ right arrow key and to program a test number for step 3 of the sequence.

Press ▲▼ up/down arrow keys to select the third test in the sequence as none, ship, 1 –25 or calc (see discussion of the calculate function, step 4 below).

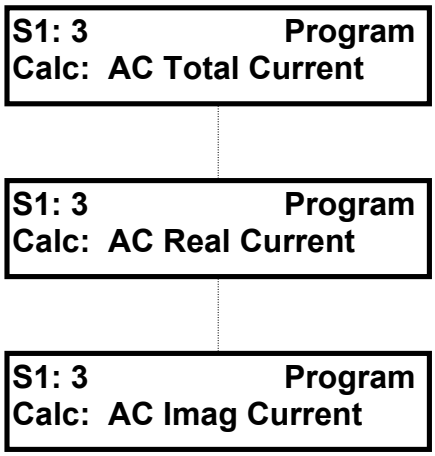


Press ▶ right arrow key to exit the program mode and display the complete sequence for sequence test number 1. **"Program"** message now indicates **"Idle"** and the three tests which were programmed to make up the sequence are now indicated.



4. Programming the Calculate Measurement Function

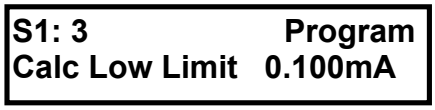
If calc is selected for test #2 or #3, as described above, press ▶ right arrow, then the ▲▼ up/down arrow key to select the current parameter to be calculated, AC Total, AC Real or AC Imaginary.



Press the ▶ right arrow key to select the entry of the calculated High Limit, and then the ▲▼ up/down arrow key to increase or decrease the limit between 0.001mA and 15.000mA.

Press the ▶ right arrow key to select the entry of the calculated Low Limit, and then the ▲▼ up/down arrow key to increase or decrease the limit between 0.001mA and 15.000mA.

The low limit must be set to less than the high limit.



2.4 Utility Functions

2.4.1 General

The Utility functions allow the user to set the Measure Offset function for a currently selected test and set other conditions that affect all tests. When the UTILITY key is pressed the first function, Meas Offset, is displayed and the test number to which this applies is shown in the upper left display. Other functions are accessed by pressing the ▶ right arrow key.

Table of Programmable Parameters For Utility Functions

Programmable Functions	Settings
Measure Offset	On, **Off**, Press Start-Get Offset
Keypad Lockout	Lock Password, **Off** Lock Cycle Tests
Test Locations	Hide Disabled Tests **Show All Tests**
	Soft, Off, Loud
Beep on Key Hit	**On**, Off
RS232 Interface	**9600**, 19200, Disable
IEEE-488 Interface (optional)	1 to 16
Enhanced Features	**On**, Off

This function applies to a single test, other functions apply to all tests

Note: Bold denotes normal default conditions when shipped from factory.

Programmable Functions With (On)	Settings
Test Low Limit	**Continuous,** End of Test
Delay Time	**Off**, 0.1 to 999.9sec
Continue Voltage On Fail	On, **Off**
Continue Steps On Fail	On, **Off**
Stop Test On Pass	On, **Off**
Step And Increment	**Off**, On
Clear All Tests	**No**, Yes
Tests To View	**All Tests** Only Single Step Only Sequence
Perform Calibration	(Follow procedure as indicated on display)
Ground Fault Stop	Off, **On** Off-DUT Grounded
Arc Pulse Width	**1** to 50μsec
Adaptive DC Ramp	**Off**, On
Autoranging	Full, None, **Limited**

applies only to a sequence test (S1-S9) -
applies only to an IR test -
applies only to a sequence test (S1-S9) -
does not apply to the 2510 -

2.4.2 Measure Offset

The Guardian provides an automatic zeroing offset function to correct for current leakage effects due to test leads. This correction is stored in instrument memory and applied to ongoing measurements. For optimum measurement accuracy it is recommended that the offset function be performed at the start of daily testing or any time test leads are changed. The instrument should warm-up for at least 10 minutes before zeroing. **When the offset function is selected for ON, an asterisk following the measurement parameter (for example: AC Tot*) is shown on the setup and results display.**

1. Press the **UTILITY** key to select the measure offset function. Press ▲▼ up/down arrow keys

to select **On , Off** or **Press Start-Get Offset.** Selection to ON applies the currently stored offset value, Off applies no correction and pressing START to get offset obtains a new offset value. Note that the setup number currently selected, 1 - 25 (to which this offset is applied) is indicated in the upper left of the display.

NOTE

When performing the Get Offset function the test leads (HV OUT & RETURN) should be in their normal position with no device connected for AC Hipot, DC Hipot, or IR Mode and test leads (RETURN & G.C.) shorted for GC Only Mode or when Gnd Continuity is turned with an entered limit.

Since the offset is valid for the measured parameter, test voltage, high limit and frequency in effect when measured, changing any of these values will cause the offset to be inaccurate. A new offset should be performed if any of these stated values are changed.

2. Press the **UTILITY** key to exit or Press ▶ right arrow key to move to the next utility function.

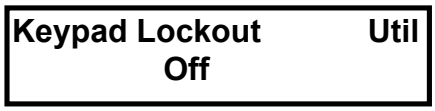
2.4.3 Keypad Lockout

When a password is entered for **Lock Password** only the currently selected test conditions, along with the instrument START and STOP functions are active. This prevents an operator from modifying test conditions. Lockout is enabled or disabled by a six digit password. The ◀▶ left/right arrow key is used to select one of six digits and the ▲▼ up/down arrow key is used to increase or decrease the digit.

When a password is entered for **Lock Cycle Tests** the TEST NUMBER key is active allowing selection of any of the stored setups, however none can be modified.

To Enable Keypad Lockout function

1. Press the **UTILITY** key and ▶ right arrow key to select the Keypad Lockout function.

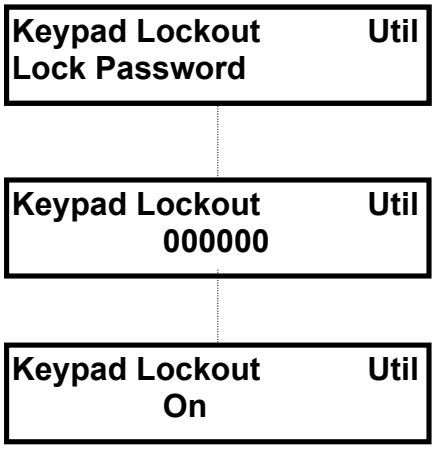


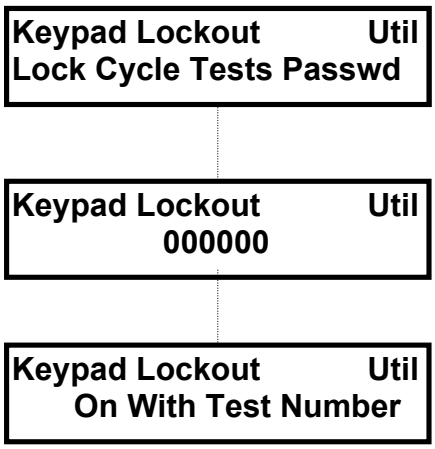
1. Press ▲▼ up/down arrow keys to select **Off**, **Lock Password** or **Lock Cycle Tests Password**.

2. Selection of **Off** allows the operator to modify any stored test conditions and use all functions of the instrument, with no restrictions.

3. To enter a password for **Lock Password** or **Lock Cycle Tests Password** press ▶ right arrow key. Starting with the left digit.

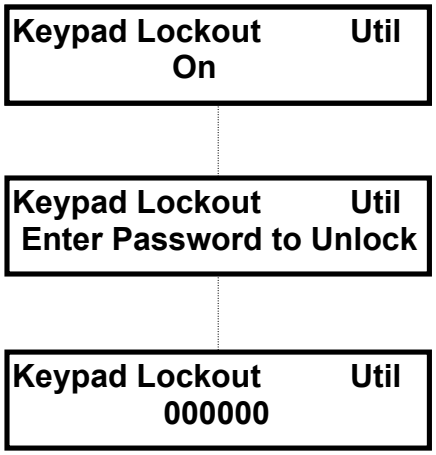
5. Use the ▲▼ up/down arrow key to increase or decrease the digits and the ▶ right arrow key to advance right through all six digits. Note the entered password word (all six digits) before exiting the last digit. The display will now indicate that the Keypad Lockout is On.





6. Press the **UTILITY key to exit** or note that it is still possible to move to the Beep on Key Hit function with the ▶ right arrow key, refer to paragraph 2.4.6 for explanation.

7. **To turn keypad Lockout Off** from the Idle mode Press **UTILITY** key, ▲▼ up/down arrow keys and ▶ right arrow key.



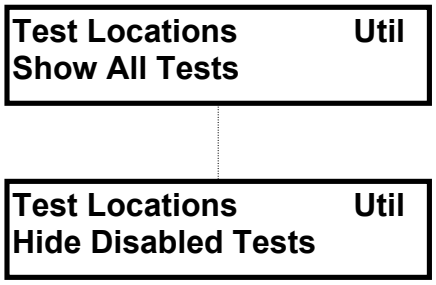
8. Use the up/down arrows key to increase or decrease the digits and the ▶ right arrow key to advance right through all six digits. Enter the password previously stored (all six digits) before exiting the last digit. The display will now indicate that the Keypad Lockout is Off.

9. Press the **UTILITY key to exit** or move to other Utility functions with the ▶ right arrow key.

2.4.4 Test Locations

The Guardian 2500 allows operator selection to show all programmed test locations, 1 - 25 and S1 - S9 (including those with no test programmed) or only those that are enabled.

1. Press the **UTILITY** key and ▶ right arrow key to select the Test Locations function.
2. Press up/down arrow keys to select **Hide Disabled Tests** or **Show All Tests.**

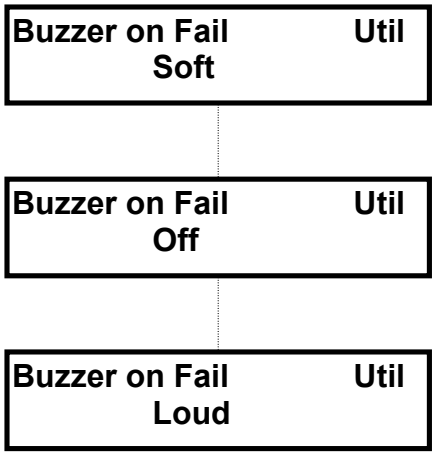


3. Press the **UTILITY key to exit** or move to other Utility functions with th ▶ right arrow key

2.4.5 Buzzer on Fail

The Guardian 2500 allows operator selection of turning the fail buzzer off or on in a soft or loud mode.

1. Press the **UTILITY** key and ▶ right arrow key to select the Buzzer on Fail function.
2. Press ▲▼ up/down arrow keys to select **Soft, Off** or **Loud.** Selection of

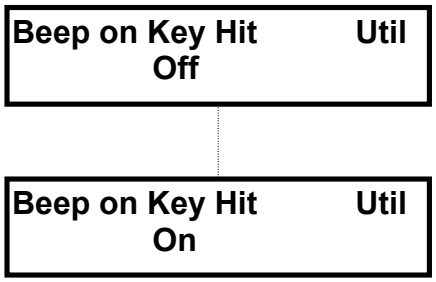


3. Press the **UTILITY key to exit** or move to other Utility functions with the ▶ right arrow key

2.4.6 Beep on Key Hit

The Guardian 2500 allows operator selection of a key beep on or off.

1. Press the **UTILITY** key and ▶ right arrow key to select the Beep on Key Hit function.
2. Press ▲▼ up/down arrow keys to select **On or Off.**

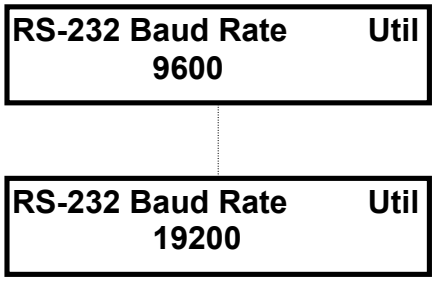


3. Press the **UTILITY key to exit** or move to other Utility functions with the ▶ right arrow key

2.4.7 RS-232 Interface

The Guardian 2500 allows operator selection of the baud rate for the RS-232 (interface standard with unit).

1. Press the **UTILITY** key and ▶ right arrow key to select the RS-232 Interface function.
2. Press ▲▼ up/down arrow keys to select **9600** or **19200 or Disable.**



NOTE

When the RS-232 is set to Disable with no IEEE-488 interface option present the following message will be displayed:

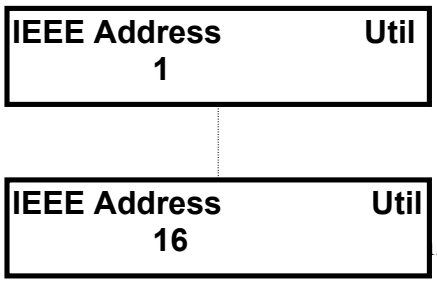
CONFIG REMOTE
HARDWARE NOT DETECTED

When the RS-232 is set to Disable with the IEEE-488 interface option present this port is functional, refer to paragraph 2.4.8 for available IEEE address selections.

2.4.8 IEEE-488 Interface (Optional)

The Guardian 2500 allows operator selection of IEEE-488 address of 1 through 16 (when this option is included).

1. Press the **UTILITY** key and ▶ right arrow key to select IEEE Address.
2. Press ▲▼ up/down arrow keys to select **1** through **16.**



NOTE

The RS232 interface must be set to **Disable** for the IEEE-488 interface

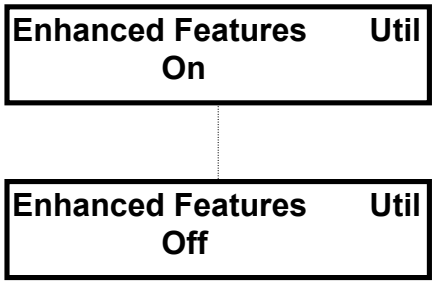
2.4.9 Enhanced Features

The Guardian 2500 allows operator selection of enhanced features. The available enhanced features include:

Test Low Limit	Clear All Tests
Delay Time	Tests To View
Continue Voltage On Fail	Perform Calibration
Continue Steps On Fail	Ground Fault Stop
Stop Test On Pass	Arc Pulse Width
Step And Increment	Adaptive DC Ramp
	Autoranging

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

Press ▲▼ up/down arrow keys to select the display of these features On or Off, as programmed. Selecting Off only prevents the enhanced features from being displayed on the Utility menu. It does not change the operation of any of these enhanced features.



1. Test Low Limit

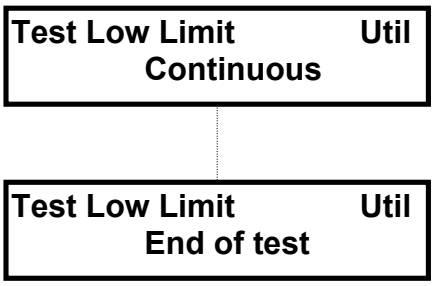
This selection determines when the low limit is checked. If Continuous is selected the low limit is checked **throughout the complete measurement time**, including ramp time. If End of Test is selected the low limit is checked only **at the end** of the measurement time.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features

If Enhanced Features is set for On, press ▶ right arrow key to select Test Low Limit.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Test Low Limit.

Press ▲▼ up/down arrow keys to select Test Low Limit for **Continuous** or **End of Test**.



Press the **UTILITY key to exit** or move to other Enhanced Features with the ▶ right arrow key.

2. Delay Time

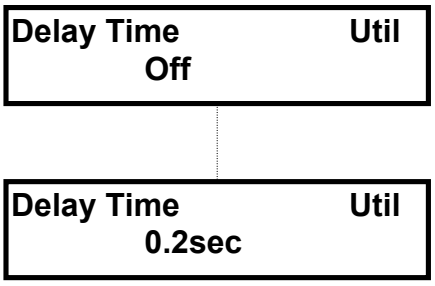
This entry determines the delay time which precedes any programmed ramp time or ground continuity test **(if enabled).**

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Delay Time.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Delay Time.

Press ▲▼ up/down arrow keys to select Test Low Limit for **Off** or from **0.1** to **999.9sec** in 0.1sec steps.



Press the **UTILITY key to exit** or move to other Enhanced Features with the ▶ right arrow key.

3. Continue Voltage On Fail

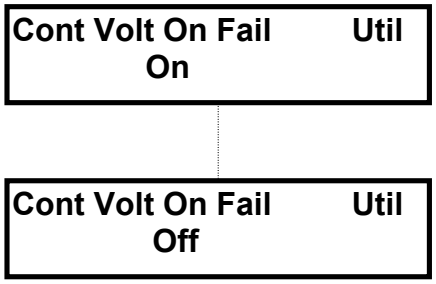
This selection determines whether to continuously **repeat the same test** on fail. When On is selected, if a test fails the voltage remains activated and the same measurement will be repeated again and can be repeated indefinitely. When turned on, this mode is generally used as a continuous probing mode of operation.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Cont Volt On Fail.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Cont Volt On Fail.

Press ▲▼ up/down arrow keys to select Continuous Voltage on Fail, **On** or **Off.**



Press the **UTILITY key to exit** or move to other Enhanced Features with the ▶ right arrow key.

4. Continue Steps On Fail

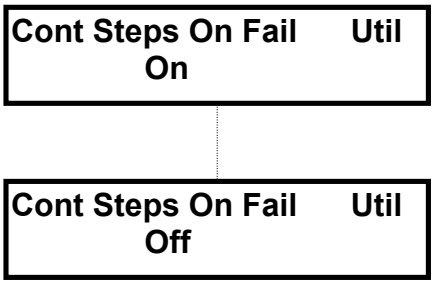
This selection determines if the unit will stop testing or proceed to the next test on fail during a sequence test. When On is selected, if a test fails the instrument proceeds to the next test in the sequence. **This feature only applies to sequence test setups (S1 through S9)**.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Cont Steps On Fail.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Cont Steps On Fail.

Press ▲▼ up/down arrow keys to select Continue Steps on Fail, **On** or **Off.**



Press the **UTILITY key to exit** or move to other Enhanced Features with the ▶ right arrow key.

5. Stop Test On Pass

This selection determines if the unit will stop testing during an insulation resistance (IR) measurement once the value exceeds the low limit, which would meet the requirements for a Pass. **This feature only applicable in IR mode**.

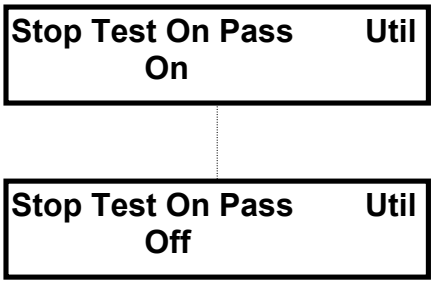
Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Stop Test On Pass.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and

Press ▶ right arrow key to select Stop Test On Pass.

Press ▲▼ up/down arrow keys to select Stop Test On Pass, **On** or **Off**



Press the UTILITY key to exit or move to other Enhanced Features with the ▶ right arrow key.

6. Step And Increment

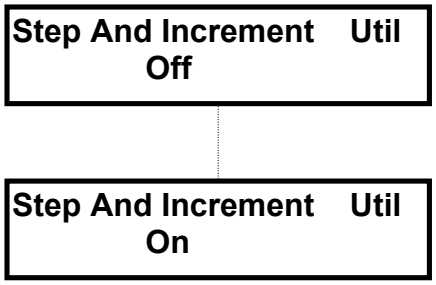
This selection determines how the unit will **step through a sequence test (S1 - S9)**. When On is selected, and a test initiated with the START button, the first step performed is the one currently viewed within a sequence. The next step in a sequence is initiated only when the START button is pressed again, and so on through a maximum of 3 steps. The sequence then starts again with step 1. **This feature only applies to sequence test setups (S1 through S9).**

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Step And Increment.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Step And Increment.

Press up/down arrow keys to select Stop Test On Pass, **On** or **Off**



Press the **UTILITY** key to exit or move to other Enhanced Features with the ▶ right arrow key.

7. Clear All Tests

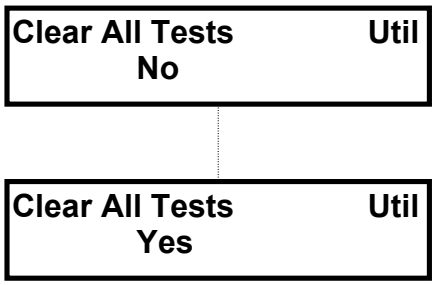
This selection clears all stored test setups. Viewing of test setups after clearing would indicate user defined ones (1 - 20) as No Test Programmed and sequence tests (S1 – S9 as None. User setups 21 thru 25 are returned to factory set conditions, refer to paragraph 2.5.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

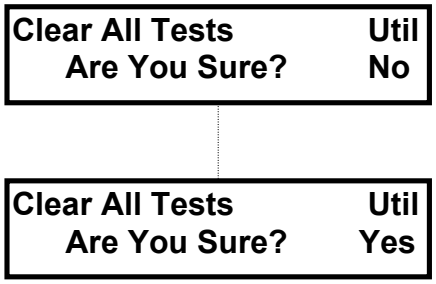
If Enhanced Features is set for On, press ▶ right arrow key to select Clear All Tests.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Clear All Tests.

Press up ▲ down ▼ arrow keys to select Clear All Tests, **No** or **Yes**

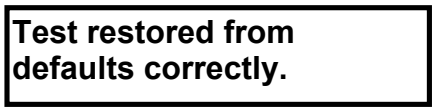


Press **UTILITY** key to exit or ▶ right arrow key to continue with Clear All Tests.



Press ▲▼ down arrow keys to select Clear All Tests**, No** or **Yes**.

Press **UTILITY** key to exit or ▶ right arrow key to continue with Clear All Tests if Yes was selected. All tests would be reset to factory default (most with no programs stored) with the following message displayed momentarily.



Press the **UTILITY** key to exit or move to other Enhanced Features with the ▶ right arrow key.

8. Tests To View

The following selection determines which tests in memory, when selected by test number, are displayed in View mode. Single step are 1 through 25 and sequence are S1 through S9.

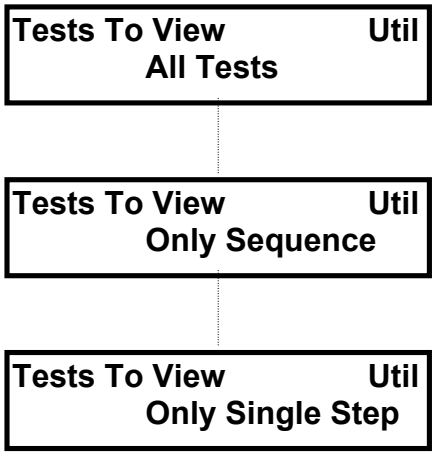
Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Tests to View.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Tests to View

Press ▲▼ up/down arrow keys to select Tests To View, **All Tests** (1-25, and S1 - S9),

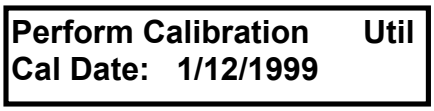
Only Single Step (1 - 25), **Only Sequence** (S1 - S9).



Press the **UTILITY key to exit** or move to other Enhanced Features with the ▶ right arrow key

9. Perform Calibration

This selection indicates the instruments expected calibration date and can be used to enter a calibration routine. This procedure should only be used by qualified calibration personnel and does require proper calibration equipment and password entry. Refer to the Service and Calibration section of this manual for addition information.



10. Ground Fault Stop

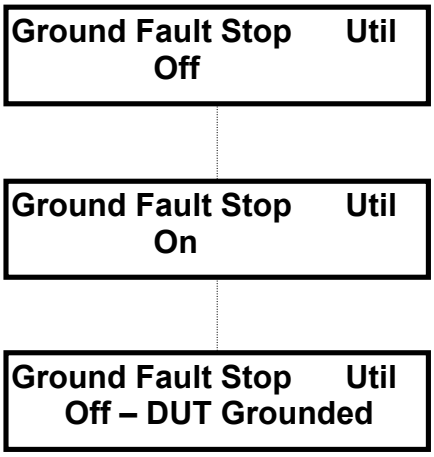
This selection determines the status of ground fault detection. When On is selected the unit monitors the ground return current, and if found to be different from the output current the instrument is shut down. This is a safety feature, intended to make sure that the difference in current is not in a path through the operator. When set to Off fault detection is not monitored. When set to Off – DUT Grounded, the Return input is at chassis ground rather than virtual ground.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Ground Fault Stop.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Ground Fault Stop.

Press ▲▼ up/down arrow keys to select Ground Fault Stop, **Off, On** or **Off – DUT Grounded**.



Press the **UTILITY key to exit,** or move to other Utility functions with the ▶ right arrow key.

11. Arc Pulse Width

The following selection determines the duration of pulse width when arc detection is in effect. An arc failure will occur if any pulses are detected which exceed this duration and the programmed arc level.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Arc Pulse Width.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Arc Pulse Width.

Press ▲▼ up/down arrow keys to select arc pulse width for **1 to 50µsec** in 1µsec steps. This entry determines the minimum width of current pulses which can be detected when arc detection is turned on.

Press the **UTILITY key to exit** or move to other Utility functions with the ▶ right Arrow key.

12. Adaptive DC Ramp

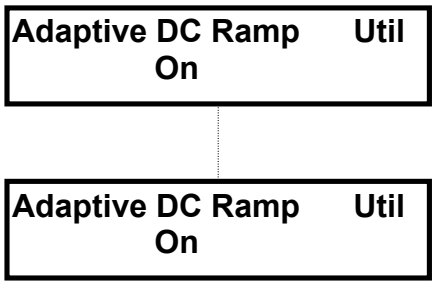
This function (not available on the Guardian 2510) is intended to optimize measurement speed. **Off** should always be selected for DC Hipot and insulation resistance (IR) if the device under test is essentially a pure resistance, or if the resistance is below 200 MΩ. This function should be selected for **On** for insulation resistance measurements on devices >200 MΩ with substantial parallel capacitance. With this function selected, if during ramp time the voltage across the device exceeds the programmed voltage, the output voltage is reduced back within tolerance. To avoid giving an incorrect value, the display will show "??????" in place of the IR value while this voltage adjustment is taking place. In general, **Adaptive DC Ramp** should be turned **On** if the IR test displays "??????" more than briefly during the test phase.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Adaptive DC Ramp.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Adaptive DC Ramp.

Press ▲▼ up/down arrow keys to select Adj. V During Test, **Off, On**.



Press the **UTILITY key to exit,** or move to other Utility functions with the ▶ right arrow key.

13. Autoranging

Selection for autoranging is **Full, None, or Limited**. **The selection Limited is recommended for normal applications.**

Hipot Autoranging

There are two ranges available for Hipot testing, the switchover point from low (more sensitive) to high (least sensitive) is 500 μA for AC Hipot and 200 μA for DC Hipot. For **Full**, the range selected is the more sensitive one if the current is less than this value, independent of the programmed high limit. For **None**, the range selected is always the least sensitive, and for **Limited** the range is determined by the programmed high limit.

IR Autoranging

The Guardian 2530 uses seven ranges of sensitivity for the current input to cover its IR range of 10 kohms to 2000 Gohms. The lowest resistance which can be measured in any range must be high enough to give an input current which will not overload the signal processing circuitry at the programmed test voltage. The highest resistance which can be measured in any range must allow enough current for accurate measurement, which is considered to be about 1% of the full scale current. Both the maximum and minimum resistances are thus proportional to the test voltage.

During the ramp phase of an IR test, the current channel is in the least sensitive range. If autoranging is enabled, the sensitivity of the current channel will be increased step by step as the charging current drops. The highest range which will be reached is determined by the current through the DUT and will be the range at which the DUT IR can be measured with the highest accuracy. This insures that the IR of purely resistive DUTs can be accurately measured up to 2000GΩ.

In some cases, the IR value displayed during a test will be the "greater than" symbol followed by some resistance value, e.g., "> 25.0Mohm". The displayed resistance value is the maximum resistance which can be measured accurately in the IR range being used by the 2530. Unless the displayed value is ">5000.0Gohm", this means that the 2530 is unable to increase the sensitivity for one or more of the following reasons:

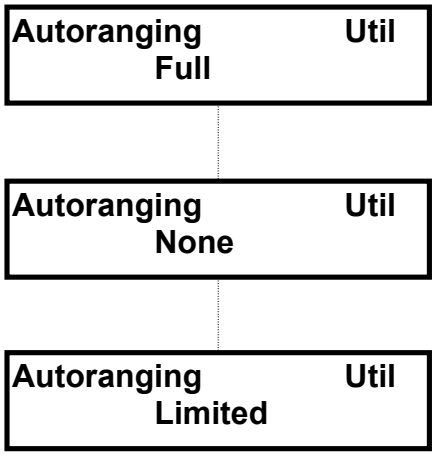
1) The Autoranging utility is set to NONE. This locks the 2530 in the least sensitive IR range.
2) The Autoranging utility is set to LIMITED. This prevents the 2530 from selecting any range more sensitive than the one which would be used if the DUT IR was exactly equal to the programmed LOW LIMIT for the test in progress.
3) Autoranging is being defeated by a non-DC component of the input current. This may result from operation in an electrically noisy environment (near large motors, arc welders etc.), but is most likely the result of a DUT which has a significant parallel capacitance.

Press the **UTILITY** key and ▶ right arrow key to select Enhanced Features.

If Enhanced Features is set for On, press ▶ right arrow key to select Autoranging.

If Enhanced Features is set for Off, press ▲▼ up/down arrow key to select On and press ▶ right arrow key to select Autoranging.

Press ▲▼ up/down arrow keys to select Autoranging, **Full, None** or **Limited**.



Press the **UTILITY key to exit,** or move to other Utility functions with the ▶ right arrow key.

2.5 Default Test Conditions

2.5.1 General

2.5.2 Setups (21 thru 25)

S25 - UL, Appliances
S24 - EN, Appliances (with continuity test)
S23 - EN, Continuity Test (low current)
S22 - EN & UL, Information Technology Equipment
S21 - Insulation Resistance (IR) Demo

Setup (25)

Mode:	AC Total Current
Volt:	1.250KV
Hi Limit:	5.000mA
Low Limit:	Off
Arc Limit:	Off
Ramp Time:	0sec
Hi Limit Ramp:	Off
Low Limit Ramp:	Off
Test Time:	1.0sec
Fall Time:	Off
Frequency:	60Hz
Gnd Continuity:	Off

Setup (24)

Mode:	AC Total Current
Volt:	1.500KV
Hi Limit:	5.000mA
Low Limit:	Off
Arc Limit:	Off
Ramp Time:	0sec
Hi Limit Ramp:	Off
Low Limit Ramp:	Off
Test Time:	1.0sec
Fall Time:	Off
Frequency:	50Hz
Gnd Continuity	1.00Ω

Setup (23)

Mode:	GC Only
Hi Limit:	0.1Ω
Low Limit:	Off
Test Time:	1.0sec

Setup (22), 2520 & 2530 only

Mode:	DC Current
Volt:	2.150KV
Hi Limit:	0.5mA
Low Limit:	Off
Arc Limit:	Off
Ramp Time:	1.0sec
Hi Limit Ramp:	Off
Low Limit Ramp:	Off
Dwell Time:	Off
Test Time:	1.0sec
Fall Time:	1.0sec
Gnd Continuity	Off

Setup (21), 2530 only

Mode:	IR
Volt:	0.500KV
Hi Limit:	Off
Low Limit:	0.10MΩ
Ramp Time:	5.0sec
Hi Limit Ramp:	Off
Low Limit Ramp:	0.01MΩ
Dwell Time:	2.0
Test Time:	5.0sec
Fall Time:	Off
Gnd Continuity	Off

2.6 Error Messages

Operator Help messages

All tests are disabled, program test	
Arc limit must be less, than max gain current	
Arc limit changed to be, less than max current	
Arrow, test, utility, and start keys are valid	
DEVICE UNDER TEST, FAILED TEST	
DUT resistance too low	Programmed voltage cannot be maintained across DUT, it may be necessary to increase RAMP time or DWELL time
ERROR IN CALCULATION, Press STOP to clear	
First step cannot, be a calc test	
GC resistance too high	Ground continuity circuit is too resistive to allow the test current of 100 mA to be passed through it (>> 10 ohms), probably due to a faulty connection.
Ground fault detected, Press STOP to clear	
GROUND CONTINUITY, LIMIT TOO HIGH	
Handler start ignored, Invalid test number	
High limit changed to be, greater than low limit	
High limit can not be, greater than max current	
High limit changed to, correspond to meas param	
High ramp changed to, correspond to meas param	
High changed to be, greater than low ramp	
Interlock Open	Advance handler interlock is enabled and open
INVALID RAMP TIME	
INVALID DWELL TIME	
INVALID DISCHARGE TIME	
NO MEASUREMENT, PARAMETER SPECIFIED	
INVALID RAMP LIMIT	
INVALID HIGH LIMIT	
Limits changed to be, valid for setup	
Low limit must be less, than the high limit	
Low limit changed to be, less than the high limit	
Low ramp changed to be, less than the high ramp	
Low limit changed to, correspond to meas param	
Low ramp changed to, correspond to meas param	
Measured parameter must, be set to program	
MEASUREMENT TIMED OUT, Press STOP to clear	

Operator Help messages (continued)

Only the up and down, arrow keys are valid	
Only the start and stop, keys are valid	
Only up, down, and right, arrow keys are valid	
Only the right and left, arrow keys are valid	
OPEN	GC only, calculated resistance is > 10 ohms
Press right arrow key, to exit programming	
Press the utility, key to exit	
Press the program, key to exit	
Program AC test prior, to a calc test	
Rezero	GC measurements only, indicates that the calculated GC resistance is less than zero, probably because of a change in lead set or using rear input instead of front. Perform Measure Offset
Safety Shutdown	This message may result from a ground fault (GFI) or overload
SHORT	Current exceeded power amp limit of 25 mA
SHORT	Current exceeded limit specified for instrument (20 mAAC, 8 mADC)
SHORT	High voltage relay opened because of current surge. Opening the relay prevents exceeding the specified maximum current.
****SHORT****	A to D converter overrange, usually results from too much capacitance in DUT. Add series resistance to correct
Start ignored, Interlock not asserted	
Start ignored, Stop being asserted	
Sequence offset invalid, select single step test	
Set single step test, currently set to skip	
Set single step test, currently set to calc	
Test is disabled, program measured param	
Test is disabled, program sequence test	
Test restored from, defaults correctly	
Unable to run – Program, single step test	
Unable to set arc detect	Arc detect centering failed, connect HV lead to return lead (to minimize noise) and press STOP twice.

Operator Help messages (continued)

Up, down, utility, and start keys are valid
Voltage changed to, correspond to meas param

>nnn.n	Measurement exceeded the limits of the unit to make an accurate measurement. This may be seen during RAMP time if the DUT is a very low resistance and the programmed voltage cannot be achieved. It is displayed for IR measurements when the DUT has substantial capacitance, preventing the unit from autoranging up to a sensitivity at which the resistance can be measured accurately

Instrument Error Messages

CALIBRATION MEASUREMENT, FAILED
CALIBRATION MEASUREMENT, TIMED OUT
CAN NOT BURN, CALIBRATION DATA
CONFIGURED REMOTE, HARDWARE NOT DETECTED
DAC OVER RANGE
EEPROM CALIBRATION, DEFAULTS BEING SET
EEPROM PERSONALITY, DEFAULT BEING SET
EEPROM PERSONALITY, BEING SET FROM REMOTE
EEPROM REMOTE OPTIONS, DEFAULTS BEING SET
EEPROM TEST/STEP DATA, DEFAULTS BEING SET
EEPROM MISC DATA, DEFAULTS BEING SET
EEPROM LOCKOUT STATE, DEFAULT BEING SET
ERROR IN CALCULATION Error in data processing
ERROR IN, CALIBRATION
ERROR NOT FOUND
FATAL EEPROM PERSONALITY, CANNOT BE INITIALIZED
FATAL UNABLE TO WRITE, EEPROM TEST CHECKSUM
FATAL UNABLE TO WRITE, EEPROM CURRENT TEST/STEP
FATAL UNABLE TO WRITE, EEPROM TEST PARAMETER
FATAL INVALID, GUARDIAN 2500 UNIT
FATAL EEPROM CAL DATA, CANNOT BE INITIALIZED
FATAL EEPROM REM OPTIONS, CANNOT BE INITIALIZED
FATAL EEPROM TEST/STEP, CANNOT BE INITIALIZED
FATAL EEPROM MISC DATA, CANNOT BE INITIALIZED
FATAL NO DATA DURING, MEASUREMENT
FATAL INVALID, HANDLER RETURN
GENERAL INTERNAL ERROR

Instrument Error Messages (continued)

Invalid calibration code
INVALID DAC SLOPE
MEASUREMENT TIMED OUT A/D converter failure
NVRAM FIRST TIME, INIT FAILED
NVRAM INIT FROM FLASH, Press STOP to continue
WATCHDOG TIMEOUT, CONSULT FACTORY

Section 3: Interface

3.1 General

A remote control connector is located on the rear panel of the instrument with input connections for starting and stopping the unit externally and output connections indicating instrument status and a safety interlock connection.

Inputs require a contact closure and outputs provide a contact closure, as shown in the figure below. Pass, Fail and Under Test relays are rated at 36V, 100mA max, 1 billion cycles.

3.2 Remote I/O

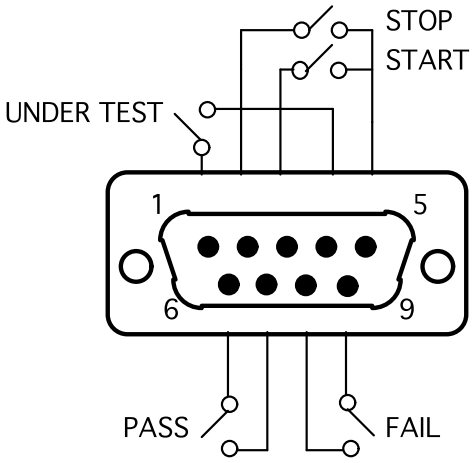
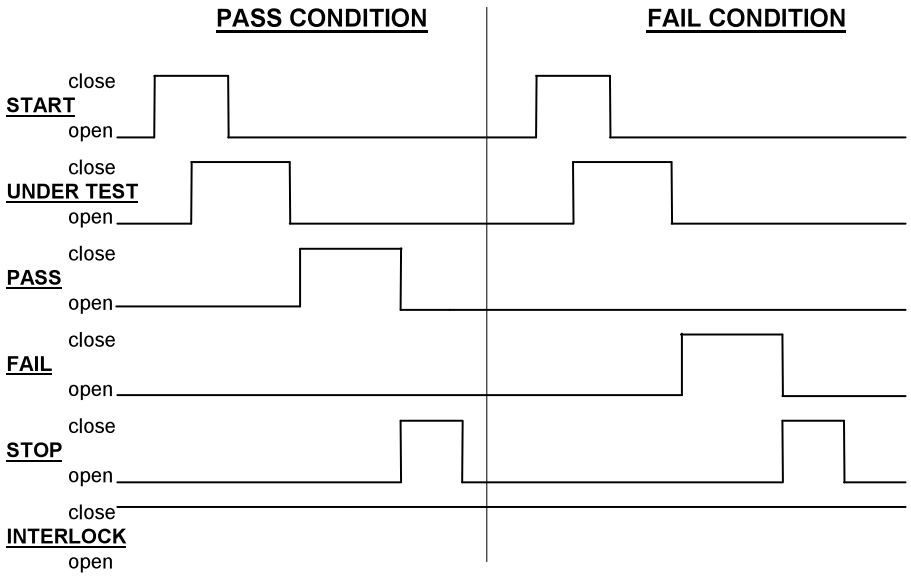


Figure 3-1
Rear Panel Remote Connectors

The Pass and Fail outputs track the front panel PASS and FAIL indicators. After a test is complete, either the Pass or Fail output will be asserted and the PASS or FAIL indicator lit. When the STOP key is depressed and causes the indicators to go out the outputs also return to the reset state. In the mode, **Continue Voltage On Fail**, the Fail output (but not the Pass output) will be asserted or reset in the same manner as the FAIL indicator.



Note:
Time between UNDER TEST and PASS or FAIL can be 1-2 msec

Figure 3-2
Remote I/O Timing

3.3 RS-232 Interface

An RS232 serial port interface is available as an option to the Guardian 2500 Series, through a 9 pin DIN connector on the rear panel of the instrument. The RS232 standard defines electrical specifications for the transmission of bit serial information. The use of the RS232 port requires three lines, receive data, transmit data, and signal ground. With some controllers additional signals maybe required and are listed in Table 3-1. Refer to Figure 3-3 for null modem cable configuration to the standard db9 or db25 connector. Refer to Table 3-4 for the command set which also applies to the RS232 interface. Each command line must be terminated with a carriage return (CR) and line feed (LF) and multiple commands separated by a semicolon. Baud rate for the RS-232 interface is programmed through the UTILITY menu, refer to paragraph 2.4.7. Serial port parameters are comprised of 8 data bits, 1 stop bit, and no parity.

Table 3-1
RS232 Interface Connections

Signal Name	Pin Number	Function
	Inputs:	
DCD	1	Data Carrier Detect
DSR	4	Data Set Ready
RXD	3	Receive Data
CTS	8	Clear to Send
RI	9	Ring Indicator
	Outputs:	
RTS	7	Request to Send
TXD	2	Transmit Data
DTR	6	Data Terminal Ready
GND	5	Signal Ground

2500			Controller	
Pin #	Function		Pin #	Function
3	Receive data	Connect	3	Transmit data
2	Transmit data	to	2	Receive data
6	Data terminal ready		6	Data set ready
5	Signal ground		5	Signal ground
4	Data set ready		4	Data terminal ready

db9 to db9 Cable Configuration

2500			Controller	
Pin #	Function		Pin #	Function
3	Receive data	Connect	2	Transmit data
2	Transmit data	to	3	Receive data
6	Data terminal ready		6	Data set ready
5	Signal ground		7	Signal ground
4	Data set ready		20	Data terminal ready

db9 to db25 Cable Configuration

Figure 3-3
RS-232 Cable Configurations

3.4 Enhanced Remote I/O Interface

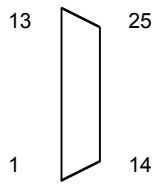
An enhanced remote I/O interface is available as an option to the Guardian 2500 Series, through a 25 pin DIN connector on the rear panel of the instrument. This option also includes the RS-232 interface. Refer to Table 3-2 for signal names, pin numbers as necessary for cable connections.

Table 3-2
Parallel Interface Connections

Signal Name	Pin Number	Function
		Outputs:
Ground	1, 7,25	Signal ground
Pass2	4	Used in conjunction with Pass1, relay closure indicating pass condition. Relay remains closed until next test started.
Fail1	5	Used in conjunction with Fail2, relay closure indicating fail condition. Relay remains closed until STOP button is pressed.
Pass1	6	Relay closure indicating pass condition.
Ut1	8	Used in conjunction with Ut2, relay closure indicating test in process. Relay remains closed until test is completed.
FailHi	14	Fail due to High Limit
FailLo	15	Fail due to Low Limit
FailArc	16	Fail due to Arc Limit
FailGC	17	Fail due to Gnd Continuity Limit
Ut2	20	Relay closure indicating test in process
+5V	21	+5VDC through 100 ohms
Fail2	22	Relay closure indicating fail condition.

Table 3-2 (continued)
Parallel Interface Connections

Signal Name	Pin Number	Function
		Inputs:
Stop	3	Stops a test and remove high voltage. This input or STOP button must be used to resume operation after a test fail, unless remote communication is enabled (in which case the Stop command serves the same function).
Start	2	Starts the test
Data0	9	Binary code 1 (LSB) that determines test number to run (1 thru 15 single user define tests or 1 thru 9 multiple tests). Value is read when Start is initiated. This line must be set 20msec before start and held for 20msec after.
Data1	10	Binary code 2 to determine test number
Data2	11	Binary code 4 to determine test number
Data3	12	Binary code 8 to determine test number
Multi-Step Test	13	When asserted Data0….3 determine multiple test number, when not asserted Data0….3 determine single test number. This line asserted and Data0….3 all off is invalid condition.
Interlock Enable	19	When held low the Interlock function is enabled.
Interlock	24	Used in conjunction with Interlock Enable, and when held low will enable operation of the instrument



Pin Configuration (Viewed from Rear Panel)

3.5 IEEE-488.2 Interface

3.5.1 General

An IEEE-488 interface is available as an option to the Guardian 2500 Series, through a connector (24 pin) on the rear panel. This interface can be used to connect to a system containing a number of instruments and a controller in which each meets IEEE Standard 488.2 (Standard Digital Interface for Programmable Instrumentation) Refer to Table 3-3 below for a full tabulation of connections and Table 3-4 for the command set.

The following functions have been implemented. Refer to the standard for an explanation of the function subsets, represented by the identifications below.

SH1	Source Handshake	PP1	Parallel Poll
AH1	Acceptor Handshake	DC1	Device Clear
T5	Talker	DT1	Device Trigger
L3	Listener	C0	Controller
SR1	Service Request	E2	Electrical Interface
RL1	Remote Local		

3.5.2 IEEE-488 & RS-232 Commands

Table 3-3
IEEE-488 Interface Connections

Signal Name	Pin Number	Function
DAV	6	Low state: "Data is Available" and valid on DI01 through DI08
NRFD	7	Low state: At least one listener on the bus is "Not ready for Data".
NDAC	8	Low state: At least one listener on the bus is "Not Accepting Data".
ATN	11	"Attention" specifies 1 of 2 uses for the DI01 through DI08 lines Low state - Controller command messages High state - Data bytes from the talker device
IFC	9	"Interface Clear" Low state - Returns portions of interface system to a known quiescent state.
SRQ	10	"Service Request" Low state - a talker or listener signals (to the controller) need for attention in the midst of the current sequence of events
REN	17	"Remote Enable" Low state - enables each device to enter remote mode when addressed to listen High state - all devices revert to local control
EOI	5	"End of Identify" if ATN is in high state, then low state of EOI indicates end of a multiple-byte data transfer sequence. If ATN is in low state, then low state of EOI activates a parallel poll.
DI01	1	The 8-line data bus, which conveys interface
DI02	2	messages (ATN low state) or device-dependent
DI03	3	messages (ATN high state), such as remote-
DI04	4	control commands from the controller or from a
DI05	13	talker device
DI06	14	
DI07	15	
DI08	16	

Table 3-4: IEEE & RS-232 Commands

Command	Function		Parameter(s)
TEST:			
TEST	Set the test number		nn
STEP	Set the step number		n
SEQuence	Set the sequence test number		n
CONFigure:			
MODe	Set measurement mode		NONE AC ACRE ACIM DC IR GCOnly
VOLT	Set the voltage in KV		n.nnn
HIGh	Set High limit in	mA for Hipot test mΩ for GC test kΩ for IR test (2530)	nn.nnn
LOW	Set Low limit in	mA mΩ for GC test kΩ for IR test (2530)	nn.nnn OFF
ARC	Set the ARC limit in mA		nn.nnn OFF
TRAmp	Set the Ramp time in seconds		nnn.n OFF
RHIGh	Set Ramp High limit in mA		nn.nnn OFF
RLOW	Set Ramp Low limit in mA		nn.nnn OFF
TDWell	Set the Dwell time in seconds		nnn.n OFF
TMEasure	Set the Test Measurement time in seconds		nnn.n TCONtinuous
TFAll	Set the Fall time in seconds		nnn.n OFF
FREQuency	Set the frequency to either 50 or 60 Hz		50 60
GNDCont	Set Ground Continuity limit in ohms		nn.nn OFF

Valid Parameters for Mode Selected

	AC Total AC Real AC Imag	DC	IR	GC
VOLT	X	X	X	
HIGh	X	X	X	X
LOW	X	X	X	X
ARC	X	X		
TRAmp	X	X	X	
RHIGh	X	X	X	
RLOW	X	X	X	
TDWell		X	X	
TMEasure	X	X	X	X
TFAll	X	X	X	
FREQuency	X		X	
GNDCont	X	X	X	

Table 3-4: IEEE & RS-232 Commands (continued)

Command	Function	Parameter(s)
SEQuence:		
TEST	Set current step to test number	nn NONE SKIP CALC
CALCulate:		
CMODe	Set measurement mode to calculate	AC ACRE ACIM
CHIGh	Set High limit in mA	nn.nnn
CLOW	Set Low limit in mA	nn.nnn
SYSTem:		
	When configuring any of these commands for remote operation it is necessary to send a "STOP" command to implement the changes.	
OFFSet	Measure the Offset	OFF ON GET
SHOW	Show Test Locations	HIDE ALL
BUZZer	Turn on buzzer on failure	LOUD SOFT OFF
BEEP	Beep when a key is pressed	OFF ON
ENHanced	Show enhanced features on display	OFF ON
LOWLimit	Low Limit is tested continuous or EOT	LCONtinuous EOT
TDElay	Set the delay time	nnn.n OFF
CVOF	Continuous voltage on fail	OFF ON
CSOF	Continue on Fail to Next Step	OFF ON
STP	Stop Test on Pass	OFF ON
SAI	Step and Increment	OFF ON
CLR	Clear all tests	YES
VTEsts	Tests to View	VALL VSINgle VSEQuence
GFS	Ground Fault Stop	OFF ON OFFGnd (DUT grounded)
ARCWidth	Arc Pulse Width in μs	nn
VADJust	Adaptive DC Ramp	OFF ON
AUTOrange	Autoranging	0 (None) 1 (Full) 2 (Limited)
LOCKout	Lockout the keypad from the remote	OFF ON

Table 3-4: IEEE & RS-232 Commands (continued)

Command	Function	Parameter(s)

VIEW:

TEST? View the test's programmed parameters

TEST View the single-test's parameters nn

The format of the returned data is as follows:

Mode:<tab><No Test Programmed, AC Total Current, AC Real Current, AC Imag Current, DC Current, IR, or GC Only><CR>
Volt:<tab><n.nnnKV><CR>
Hi Limit:<tab><nn.nnnmA><CR>
Low Limit:<tab><nn.nnnmA or Off><CR>
Arc Limit:<tab><nn.nnnmA or Off><CR>
Ramp Time:<tab><nnn.nsec or Off><CR>
Hi Lim Ramp:<tab><nn.nnnmA or Off><CR>
Low Lim Ramp:<tab><nn.nnnmA or Off><CR>
Dwell Time:<tab><nnn.nsec or Off><CR>
Test Time:<tab><nnn.nsec or Continuous><CR>
Fall Time:<tab><nnn.nsec or Off><CR>
Frequency:<tab><50Hz or 60Hz><CR>
Gnd Continuity:<tab><nn.nnOhms><CR>

Note that only valid parameters are returned for the selected mode (see the previous table).

SEQuence View the sequence n

The format of the returned data is as follows:

S1:1 Test: <nn or skip or none><CR>
S1:2 Test: <nn or skip or none or calc><CR>

Calc: <AC Total Current, AC Real Current, or AC Imag Current><CR>
Calc Hi Lim: <n.nnnmA><CR>
Calc Low Lim: <n.nnnmA><CR>
S1:3 Test: <nn or skip or none or calc><CR>
Calc: <AC Total Current, AC Real Current, or AC Imag Current><CR>
Calc Hi Lim: <n.nnnmA><CR>
Calc Low Lim: <n.nnnmA><CR>

Table 3-4: IEEE & RS-232 Commands (continued)

Command	Function	Parameter(s)

Example: Sequence 1 reply with no calc tests programmed

User sends VIEW:TEST?:SEQ 1 and response is
S1:1 Test: nn (or none)
S1:2 Test: nn (or skip, or none)
S1:3 Test: none

Example: Sequence 2 reply with step 3 programmed for calc

User sends VIEW:TEST?:SEQ 2 and response is
S2:1 Test: 24
S2:2 Test: 25
S2:3 Test: calc
S2:3 Calc: AC Real Current
S2:3 Calc Hi Lim: 1.000mA
S2:3 Calc Low Lim: 0.000mA

UTILity? View the utilities programmed
If enhanced features is set to On the format of the returned data is as follows:
Meas Offset:<tab><Off, On, or Get><CR>
Keypad Lockout:<tab><Off, On, or On With Test Number ><CR>
Test Locations:<tab><Hide Disabled Tests or Show All Tests><CR>
Buzzer on Fail:<tab><Loud, Soft, or Off><CR>
Beep on Key Hit:<tab><Off or On><CR>
RS-232 Baud Rate:<tab><9600 or 19200><CR>
IEEE Address:<tab><nn><CR>
Test Low Limit:<tab><Continuous or End Of Test><CR>
Delay Time:<tab><nnn.nsec or Off><CR>
Cont Voltage On Fail:<tab><Off or On><CR>
Cont Steps On Fail:<tab><Off or On><CR>
Stop Test On Pass:<tab><Off or On><CR>
Step And Increment:<tab><Off or On><CR>
Tests To View:<tab><All Tests, Only Single Step, or Only Sequence><CR>

Table 3-4: IEEE & RS-232 Commands(continued)

Command	Function	Parameter(s)

Cal Due:<tab><nn/nn/nnnn><CR>
Ground Fault Stop:<tab><Off, On, or Off - DUT Grounded<CR>
Arc Pulse Width:<tab><nnmicrosec><CR>

If the enhanced features is set to Off the format of the returned data is as above, ending with the IEEE Address.
Note that if a feature is not available, a <CR> will be returned.

LOCKout? View the Lockout state

CALibrate:

FULL	Perform full calibration	
GCONly	Perform Ground Continuity only calibration	
DATE	Set the date to month, day, year	mm/dd/yyyy

STOP
Stops a measurement

MEASure
Triggers a measurement of single or sequence test.

FETCh?
Fetches the most recent measurement results. The character sequence formats are as follows:

Normal Measurements:
<meas param name>, <test voltage>, <meas param value><units> <pass or Lo ramp, Hi ramp, Lo fail, Hi fail, Arc fail, GC fail, Sys fail>

Note: If a measurement is stopped (by stop button or remote command) the reply will be<meas param name>, <test voltage>, <meas param value><units> STOP FAIL

If a measurement is stopped (by stop button or remote command) the reply will be<meas param name>, <test voltage>, <meas param value><units> STOP FAIL <error type>
where error type is one of the following:
ERROR OVERLOAD, ERROR SAFETY SHUTDOWN or ERROR INTERLOCK OPEN

Table 3-4: IEEE & RS-232 Commands (continued)

Command	Function	Parameter(s)

FETCh?
Sequence-test Measurement:
If sequence is enabled, results will be sent for each test enabled in the format for single tests, with a semicolon between the data for each test.

<meas param name>, <test voltage>, <meas param value>, <pass or fail>; <meas param name>, <test voltage>, <meas param value>, <pass or fail>; <meas param name>, <test voltage>, <meas param value>, <pass or Lo ramp, Hi ramp, Lo fail, Hi fail, Arc fail, GC fail, Sys fail>

F?
Returns all the raw data if a measurement is available, in the string
<Status>,<ACTot>,<ACReal>,<ACImag>,<DC>,<IR>,<reserved>,<GndCnt>

For example in AC Hipot mode the string returned could be:
"0,1.3558e-07,1.1165e-08,1.3512e-07, , , ,"
where the 1st character of the string is required to determine the status of the tester
0 = No status/testing (idle or testing in progress)
1 = Failure (failure due to short, GFI or limit failures)
2 = No measurement available (ramping or does not have a valid measurement)

Note: FETCH? must be sent to the unit, when a status "1" is detected, prior to any additional F? commands being sent. The FETCH? will show the exact failure mode.
During Hipot measurements it is possible for the F? to return 0.0000mA prior to a short or other overload condition.
During IR measurements if the reading is outside of the measurement range F? can return a null field or return –9.9999e+03

***IDN?**
Returns instrument identification "QuadTech, Guardian 25X0,xx...xx, software version".
***ESR?** x denotes serial number up to 10 digits
Returns the read of the event status register.
***STB?**
Returns the read of the status byte register.
***ESE?**
Returns the read of the event status enable register.

***SRE?**
Returns the read of the service request enable register.
***ESE**
Set the event status enable register. value
***SRE**
Set the service request enable register. value
***RST**
Reset the buffer
***CLS**
Clear standard event status register
***OPC**
Operation complete
***OPC?**
Is operation complete
***WAIT**
Wait until operation is complete before executing next command

example: *WAIT;FETCh?
wait until measurement is complete before executing a FETCh? command

3.5.3 Remote Calibration

Calibration can be controlled by remote commands. The procedure and prompts are similar to those used for local calibration. Proceed as follows:

SYSTem LOCKout ON	Place unit in local lockout
*SRE 16	Enable the MAV STB bit (IEEE-488 only)
CAL FULL or GCONly	Select desired cal type
CAL DATE mmddyy or yyyy	Enter the cal date

The calibration will proceed automatically, with the sequence interrupted by requests for user input. When using the RS-232 interface, the prompt is sent without any action by the user, with IEEE-488 the unit sets SRQ to request permission to send the prompt (In multidrop environments, poll SRQ for the configured bus address until the MAV bit is set, then send a query to retrieve the prompt).

FETCh?	When SRQ line asserted (IEEE-488 only)

Read the prompt (returned automatically for RS-232). If the prompt requests a numerical value, the min and max acceptable value will be displayed. Make the requested connections and report the value in the form:

CAL f	Where f is a floating point number

If the prompt requests the user to “Press Start to Continue” the remote start is issued by the command:

CAL MEASure	Loops back for next FETCh command

The STOP command will work at any time to abort calibration. The final prompt will read CAL COMPLETE or CAL FAILED.

3.5.4 Formats

IEEE 488.2 enable remote programming of all instrument functions, measurement conditions and comparator settings etc. Outputs include measurement conditions, open corrections, and measured values.

Data Formats

Data will be transmitted in ASCII NR3 format per IEEE488.2 sec. 8.7.4 and reproduced below.

Multiple results

All response messages will be terminated by the NL character together with the EOI line asserted.

Status Byte Register

Bit	Decimal Value	Use
7	128	Measure completed
6	64	SRQ, SPOL Resets
5	32	Summary of Standard Event Status Register*
4	16	Message Available
3	8	Pass
2	4	None
1	2	None
0	1	None

*The Status Byte Register is readable via the standard *STB? as defined in paragraph. 11.2.2.2 of the IEEE spec. The 2500 will also implement an SRE register to enable each bit of the Status Byte Register per paragraph 11.3.2 of the IEEE spec. This register shall be readable by a SRE? command and writeable by a SRE <#> command.

Standard Event Status Register

Bit	Decimal Value	Use
7	128	Power Up Since Last Query
6	64	None
5	32	Command Error (Syntax)
4	16	Execution Error (Over Range, etc.)
3	8	None
2	4	Query Error
1	2	None
0	1	Operation Complete

This register is read by executing an "*ESR?" command per paragraph 11.5.1.2.2 (except no *). Note that this is a destructive read. Reading the register clears it. Each bit of the Event register must be enabled in order to cause the ESB bit of the Status Register to be set. This enabling is done in the Standard Event Status Enable Register by issuing an ESE command per paragraph 11.5.1.3.

3.5.5 IEEE-488 Sample Program (In Quick Basic)

```
REM $INCLUDE: 'qbdecl.bas'

'declarations
ADAP$ = "GPIB0": G2500$ = "DEV4": V% = 1
W% = 0: C$ = SPACE$(50): d$ = SPACE$(50): C1$ = SPACE$(50): D1$ = SPACE$(50)
STAT$ = SPACE$(50)

'find IEEE card and G2500
CALL IBFIND(ADAP$, GPIB0%)
CALL IBFIND(G2500$, G2500%)

CLS 'clear screen

‘ make sure unit is in stop status
CALL IBWRT(G2500%, "STOP")

'read identification from g2500
CALL IBWRT(G2500%, "*IDN?")
CALL IBRD(G2500%, D1$)
PRINT "Identification =" + D1$

'open a file to store data and status to
20
PRINT "FILE NAME TO STORE RESULT (less than 8 characters)"
INPUT NAME$
IF LEN(NAME$) = 0 THEN NAME$ = "DATA"
IF LEN(NAME$) > 8 THEN GOTO 20
NAME$ = NAME$ + ".TXT"
OPEN NAME$ FOR APPEND AS #1
```

IEEE-488 Sample Program (Continued)

```
'ask user for test location, mode, voltage, current, ramp and test time
40
PRINT "ENTER TEST NUMBER"
INPUT TEST$
IF TEST$ = "" OR TEST$ > "25" THEN GOTO 40 ' check test is in range
50
PRINT "MODE 1 = AC, 2 = AC Real, 3 = AC Imag, 4 = DC"
INPUT MODE$
IF MODE$ = "" OR MODE$ > "4" OR MODE$ < "1" THEN GOTO 50 'check mode is AC/DC hipot
100
PRINT "INPUT VOLTAGE IN kV"
INPUT VOLT$
IF VOLT$ = "" OR VOLT$ > "5" THEN GOTO 100 'check voltage is in range
200
PRINT "HIGH CURRENT LIMIT IN mA"
INPUT CURR$
IF CURR$ = "" OR CURR$ > "15" THEN GOTO 200 'check current is in range
PRINT "RAMP TIME IN seconds"
INPUT RAMP$
300
PRINT "TEST TIME IN seconds"
INPUT TIM$
IF TIM$ = "" OR TIM$ > "999.9" THEN GOTO 300 'check time is in range

'configure g2500
IF MODE$ = "1" THEN MODECH$ = "AC"
IF MODE$ = "2" THEN MODECH$ = "ACRE"
IF MODE$ = "3" THEN MODECH$ = "ACIM"
IF MODE$ = "4" THEN MODECH$ = "DC"

conf$ = "TEST:TEST " + TEST$ + ";CONF:MODE " + MODECH$ + ";CONF:VOLT " + VOLT$ +
";CONF:HIG " + CURR$ + ";CONF:TRA " + RAMP$ + ";CONF:TME " + TIM$

CALL IBWRT(G2500%, conf$)     'send string to Guardian 25XX

FOR I = 1 TO 4000    'wait for unit to configure
NEXT I

'perform a measurement
CALL IBWRT(G2500%, "MEAS") 'start measurement
CALL IBWRT(G2500%, "*WAIT") 'wait for finish of measurement

'Get data from Guardian 2500
CALL IBWRT(G2500%, "FETCH?") 'ask for voltage and current levels
CALL IBRD(G2500%, d$)  'read current,voltage levels and status

PRINT "DATA IS:"; d$   'output data to the screen
PRINT #1, d$ + STAT$ + TIME$ + " " + DATE$  'store data and status to open file
CLOSE #1
CALL IBWRT(G2500%, "STOP")' make sure unit is in stop status

SLEEP
END
```

Section 4: Service & Calibration

4.1 General

Our warranty (at the front of this manual) attests to the quality of materials and workmanship in our products. If malfunction should be suspected or other information be desired, applications engineers are available for technical assistance. Application assistance is available in the U.S. by calling 800-253-1230 and asking for Applications Support. For support outside of the United States, please contact your local QuadTech Distributor.

4.2 Instrument Return

Before returning an instrument to QuadTech for Service please obtain an online Return Materials Authorization Number (RMA#). This number, when placed on the outside of the shipping package, will speed processing at our Service Lab and will serve as a reference number for the time your unit is at QuadTech. Please contact our **Customer Care Center (CCC)** at **800-253-1230** for additional support. The CCC phone line is staffed from 8:00am to 5:00pm (EST).

It will be necessary to include a Purchase Order Number and credit card information to insure expedient processing, although units found to be in warranty will be repaired at no-charge. For any questions on repair costs or shipment instructions please contact our CCC Department at the above number. To safeguard an instrument during storage and shipping please use packaging that is adequate to protect it from damage, i.e., equivalent to the original packaging and mark the box "Delicate Electronic Instrument". Please follow online instructions for shipping materials back to QuadTech.

4.3 Calibration

Calibration of the Guardian 2500 is recommended on an annual basis. If the unit is returned to QuadTech for factory calibration refer to paragraph 4.2 for instructions. The instrument can be calibrated by a qualified service person if traceable calibration equipment and standards are available. The instrument should be powered up for a minimum of 1 hour before calibration to ensure maximum stability.

Calibration procedure for the 2500 is built into the instruments internal software. This procedure should only be performed by qualified calibration personnel, and does require the equipment listed below and the calibration entry code.

Equipment Required

Standard Resistors with known values (rated for 1000V)

- 2 ohms, 0.1%
- 8 ohms, 0.1%
- 40 kohms, 0.1%, rated for 200V
- 1 Mohm, no specified accuracy, rated for 1000V
- 1 Gohm*, 0.1%, rated for 1000V
- 100 Gohm*, 0.1%, rated for 1000V

* tee configuration acceptable, but input divider ratio should not be more than 1000 : 1

Voltmeter – 0.5% or reading to 3000V for DC and 3000 RMS AC. Valhalla 4600 or equivalent suggested.

Calibration Procedure

From the **UTILITY** key select **enhanced features.**

From enhanced features select **Perform Calibration**.

Enter the calibration code 2500225 to enter the calibration routine.

The calibration is performed in sequence according to the instructions indicated on the 2500's display. Connection to the standard resistors is made using the lead set (2000-02) included standard with the unit. The user is prompted to connect or disconnect the meter or standards.