OPERATORS MANUAL

FOR

MODEL 6520

DIGITAL TERAOHMMETER

OM6520-M-00
30 September 2014

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1. INTRODUCTION

This manual provides complete information on the installation and operation of the Guildline Instruments Model 6520 Digital Teraohmmeter. Also included is a general description of the theory of operation together with instructions for calibration. The Teraohmmeter is based on fundamental work performed by Dr. S. H. Tsao of the National Research Council of Canada, and is manufactured by Guildline Instruments.

1.1. FUNCTION DESCRIPTION

The Guildline Model 6520 Teraohmmeter is a microprocessor based, fully automated, high precision device for measuring high value resistances or very small DC currents. It combines the proven technology of the Guildline Model 9520 Teraohmmeter with the latest in microprocessor technology. For installation instruction, refer to Section 2.

The main features of the model 6520 are:

- Auto ranging from 10^5 to 10^{16} Ohms.
- Auto ranging from 10^{-2} to 10^{-13} Amperes.
- Built in GPIB and RS-232C interfaces.
- Fully controllable through the bus interfaces.
- Internal software routines for measurement error compensation.
- Extensive self-diagnostics.
- User-friendly interface.

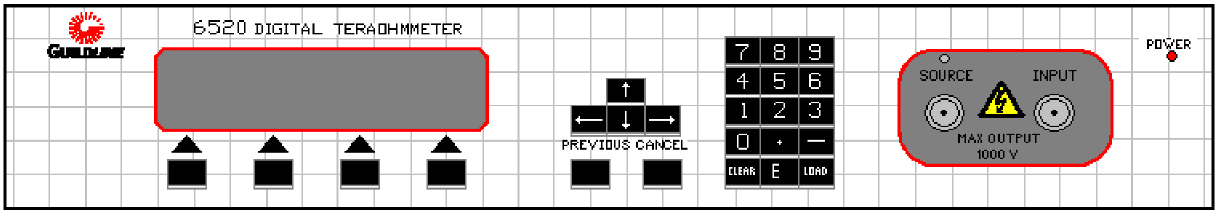


Figure 1-1: 6520 Front Panel

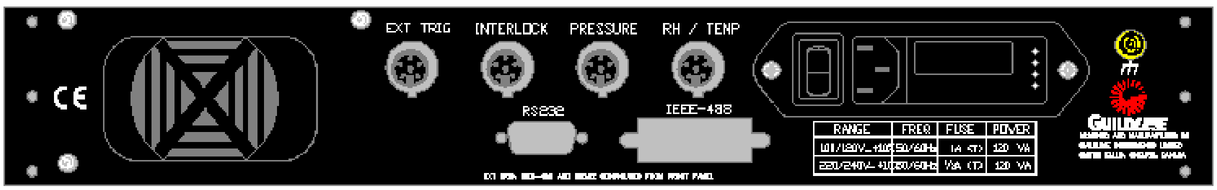


Figure 1-2: 6520 Rear Panel

1.1.1. PHYSICAL DESCRIPTION

The Guildline 6520 Digital Teraohmmeter is housed in a vinyl-clad steel case for reduction of electromagnetic emissions in compliance to CE standards. All indicators and frequently used controls are located on the front panel together with two connectors for connection of the unknown resistor or current. The power connection is made through a detachable 3-conductor power cord, which plugs into the rear panel. Although the instrument is primarily intended for bench top use, front panel flanges are supplied to allow it to be mounted in a standard 19-inch cabinet.

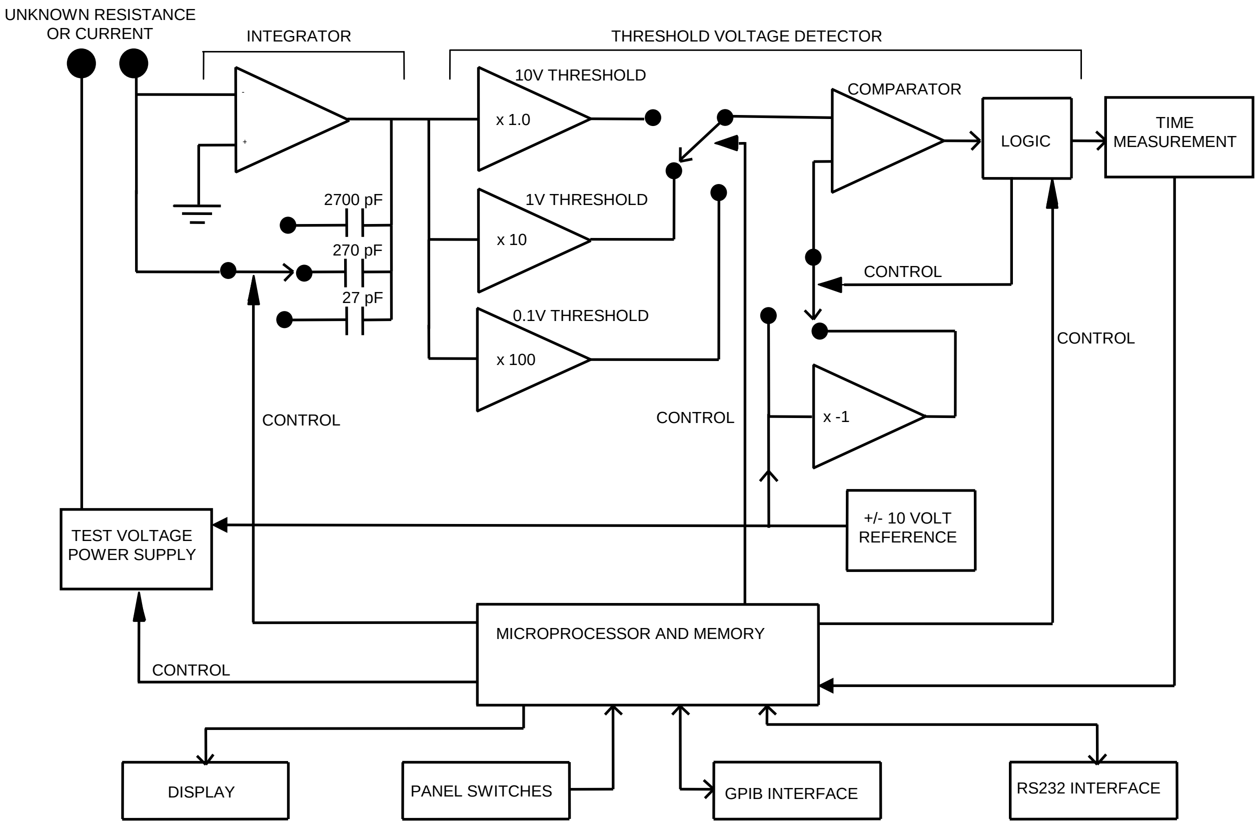


Figure 1-3: 6520 Simplified Block Diagram

1.1.2. PRINCIPLE OF OPERATION

The simplified block diagram of Figure 1-3 details the major components of the Teraohmmeter.

When measuring resistance, a known DC test voltage is supplied by the 6520, which causes a current to flow through the unknown resistor into an integrator. The magnitude of this current is determined by the time required for the integrator output to pass between two different threshold voltage points. Knowing the test voltage and magnitude of the current, the microprocessor can determine the value of the unknown resistor. The test voltage is selectable from 10 standard values in the range ±1 to ±1000 volts. The standard values are 1, 2, 5, 10, 20, 50, 100, 200, 500, and 1000 volts.

Unknown currents can be measured by connecting the unknown current source output directly to the integrator input (the internal test voltage source is not used when measuring currents).

The stability of the Model 6520 depends on the stability of the applied test voltage, the integrator, the timing circuit and the threshold voltage detector at the integrator output. The fixed deviations in the absolute values of these parameters are compensated during calibration by using a software calibration routine in conjunction with a set of external calibration resistors of known value. Guildline manufactures 9336 and 9337 calibration resistors that are ideally suited for this purpose. Guildline also manufactures a 6636 temperature stabilized resistor set that is suited to calibrate the 6520 in environments where the temperature is not regulated to laboratory standards.

The Model 6520 is fully automated with an internal microprocessor to compute the measurements and make the deviation compensations. The microprocessor can be operated from the front panel manual controls or from either one of the two communication control buses. The calculated value of the unknown resistor is displayed on the front panel and is made available to instruments attached to either control bus. The Model 6520 provides increased accuracy through integrated filtering options and taking measurements with test voltage polarity alterations. The computed average is displayed on the front panel and is made available to instruments on the control bus (GPIB or RS-232C).

1.1.3. MODES OF OPERATION

The Model 6520 is fully automated for simplicity and convenience. When specific measurement parameters are required the operator (or instruments on the control bus) can manually configure the 6520.

The instrument can be set to take a continuous series of measurements or to take one measurement for each sample request. A sample request can be made with an external synchronizing signal fed to a rear panel connector or by the operator pressing a front panel function key/push-button.

The number of resistance measurements made per data sample output (averaged), is user selectable. The resistance test voltage polarity is selectable. When measuring current, both polarities can also be accommodated by this selection.

The SOFCAL (software calibration) function permits the operator to calibrate the instrument, and edit the calibration date and the serial number of the instrument.

1.1.4. CIRCUIT DISCUSSION

The Model 6520 Teraohmmeter measures high values of resistance by charging a small capacitor through the resistance to be measured. An operational integrator is shown in Figure 1-4. The equations for this integrator are as follows:

$$\frac{\text{delta } V_{out}(t)}{\text{delta t}} = \frac{V_{in}}{R \times C} \qquad (1)$$

(The equality is not exact but is extremely close when the voltage gain is high)

or:

$$R = \frac{V_{in} \times \text{delta t}}{C \times \text{delta } V_{out}} \qquad (2)$$

Where delta t = a change in time and delta V_{out} = a change in output voltage V_{out} over time delta t.

When current is being measured, V_{in} can be replaced by iR which simplifies (1) to the form:

$$i = \frac{C \times \text{delta } V_{out}}{\text{delta t}} \qquad (3)$$

In the Model 6520:

* V_{in} is the test voltage for resistance measurement.
* C is a stable capacitor selected from the nominal values of 27 pF, 270 pF or 2700 pF.
* delta V_{out} is the potential difference between two threshold voltages placed symmetrically above and below ground (V_{out} = $2V_{thresh}$ where V_{thresh} is selectable from 0.1 volt, 1 volt or 10 volts).

In equations (2) and (3), all terms are constant except R, i and delta t. Therefore delta t is proportional to R or inversely proportional to the current i. During normal operation the 6520 calculates the unknown resistance R or current i by taking measurements of the time delta t.

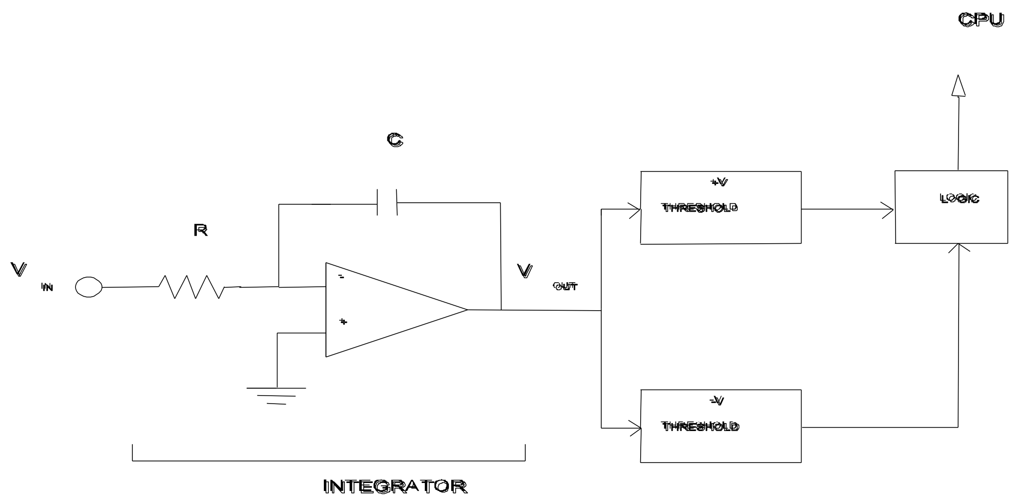


Figure 1-4: 6520 Operational Integrator

2. INSTALLATION

2.1. INSTALLATION

This instrument was thoroughly tested and inspected before shipment and should be free from damage when received. Inspect it carefully, verify that all items on the packing list are present and check the instrument operation as soon as possible. Refer to the warranty card at the front of this manual if any damage or deficiencies are found.

The 6520 Teraohmmeter is an instrument intended to be used in a laboratory environment and is specified to be operated within an environmental temperature range of 23°C ±5°C with humidity levels in the range 40 ±10% RH. Optimum performance is achieved when the environmental temperature range is 23° ±2°C. Higher humidity can degrade the accuracy of the instrument. The 6520 must be mounted with an angle of inclination of no more than 30°. Where the Teraohmmeter is to be used in a rack, attach the mounting brackets provided. To attach the rack mounting flanges (brackets), the original screws holding the handles to the instrument are removed and the flanges attached over the handles with the longer screws supplied. The instrument has to be supported in the rack/cabinet with adjustable support angles or a support bar. In case of interference with other equipment mounted directly below the instrument, the 4 feet must be removed. Install the unit in the rack.

2.2. PRELIMINARIES

The model 6520 has been shipped with the line input voltage set to 240 volts with the fuse removed. The line input selectors must be set to the correct line voltage before power is applied to the instrument. Remove the warning label positioned across the power entry only after setting the proper operating voltage. The line input voltage selection must be set correctly. The settings available are 100 V, 120 V, 220 V, and 240 V. Figure 2-1 details the line input voltage selector.

The instrument is supplied with a North American style line cord, unless otherwise specified at time of order. Ensure that the line cord is plugged into a wall socket or extension cord that has a protective or safety ground. Where 3-contact power supply outputs are not available, a suitable protective ground connection must be made before switching the instrument power on. Any interruption of the protective ground may possibly render the instrument unsafe.

To set the correct line input voltage pry open the power receptacle on the rear panel as shown in Figure 2-1.

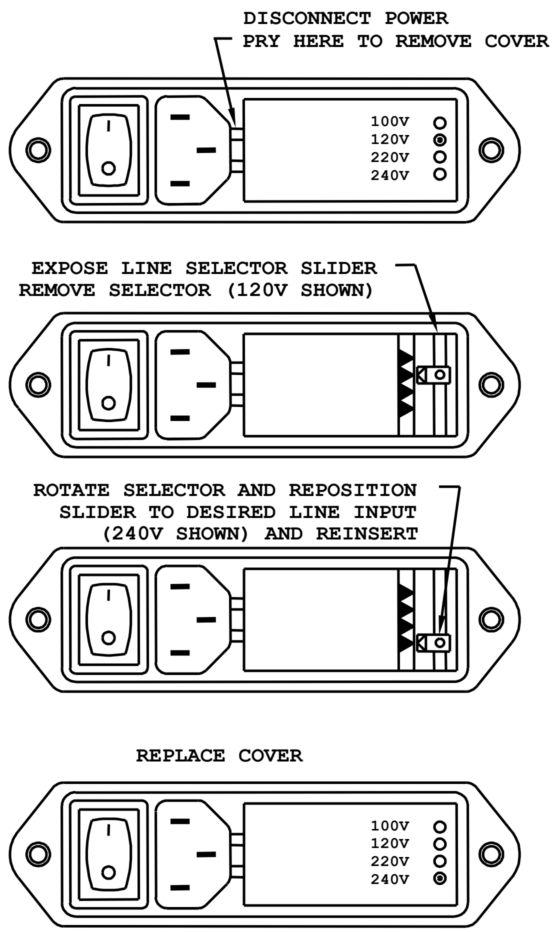


Figure 2-1: Opening the Power Receptacle

Check to see that the fuses inserted in the receptacle correspond to the correct type specified in Table 2-1.

Line Voltage	Fuse Type Required
100 V **120 V**	2 Amp (T) (MDL_2A/250 V)
220 V **240 V**	1 Amp (T) (MDL-1A/250 V)

Table 2-1: POWER FUSE SELECTION

Only fuses of the specified type are to be used. Set the voltage selector drum so that the proper line voltage indication will be visible through the receptacle rear window when the receptacle cover is closed. This is important because the drum selects the proper transformer connection for the required voltage.

The supplied moulded line cord should be plugged into the 3 pin power receptacle on the rear panel of the instrument. Plug the line cord into a receptacle with the required voltage and a protective ground connection. A ferrite sleeve (part no. 060-13229) is provided with the Spare Parts. This sleeve should be installed over the line cord to reduce electromagnetic emissions.

Where the moulded plug on the supplied line cord does not match the power outlet receptacle the plug may be removed and replaced with a 3-pin plug of the correct type.
The plug should be wired as follows:

Brown	-	Line voltage
Blue	-	Neutral
Green/Yellow	-	Ground (Earth)

2.3. PRECAUTIONS

The instrument should be disconnected from the line supply before any attempt is made to remove the cover. Lethal voltages are present at several points within the instrument and under some operating conditions at the source connector. Therefore ONLY QUALIFIED PERSONNEL WHO ARE AWARE OF THE NECESSARY PRECAUTIONS SHOULD BE GIVEN ACCESS TO THIS EQUIPMENT.
Operation of the instrument with the cover removed will result in degraded performance due to the lack of shielding from radiated electrical interference.

2.4. CONTROLS AND INDICATORS

The front panel of the 6520 Teraohmmeter, as shown in Figure 2-2, has a prominent 256 by 64 dot vacuum fluorescent graphic display, which provides a visual readout of data and status. Four momentary action programmable function keys located below the display window combine to provide complete user control and functionality of the 6520. A conventional 3 column by 5 row keypad matrix provides user entry of the digits 0,1,2,3,4,5,6,7,8,9,-, and (.). In addition, a set of keys labelled “CLEAR”, “E”, “LOAD”, with cursor movement keys Up Arrow, Down Arrow, Left Arrow, Right Arrow and menu control keys “PREVIOUS” and “CANCEL”, allow for operator navigation through the set-up and operation of the 6520.

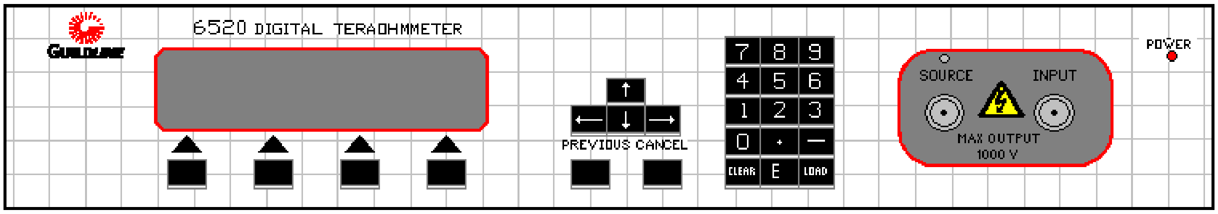


Figure 2-2: 6520 Front Panel

2.4.1. SWITCH FUNCTIONS

2.4.1.1.Rear Panel POWER Entry

The on/off toggle switch is the only function that cannot be controlled by the GPIB and RS-232C bus interfaces.

2.4.1.2.Front Panel KEYPAD

The keypad consists of a 3 key by 5 key momentary switch arrangement that allows entry of a numeric sequence (0, 1, 2, 3, 4, 5, 6, 7, 8, 9). Additional keys in the keypad layout allow for the selection of decimal point ".", minus "-", "CLEAR", exponent "E" and "LOAD" functions.

2.4.1.3. Front Panel Menu Navigation Keys

Two momentary action keys labelled "PREVIOUS" and "CANCEL" allow the operator to move between menu levels of the 6520.

2.4.1.4.Front Panel Programmable Function Keys

This series of four momentary action keys allow for the selection of any one of 4 software-controlled actions. The action available for each function key is displayed in the display directly above the key.

2.4.2. DISPLAY

The main display is a 256 by 64 dot vacuum-fluorescent graphic display that shows the measured data and provides system level information to the operator during the measurement cycle(s), as well as the software calibration and system initialization procedures.

2.4.3. CONNECTORS

Two connectors are mounted to the front panel for attachment of the resistance or current under test (see Figure 2-3 6520 Front Panel Terminals). The connectors are labelled "SOURCE" and "INPUT".

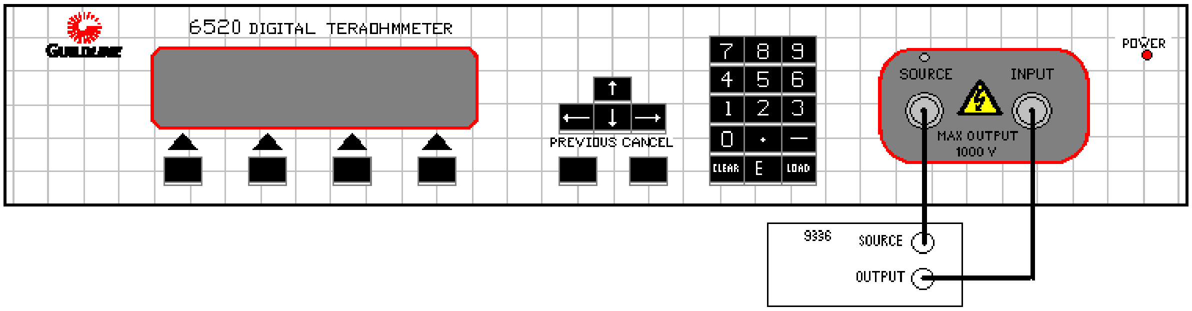


Figure 2-3: 6520 Front Panel Connectors

2.4.3.1.SOURCE CONNECTOR

Lethal voltages of up to 1000 volts may be present at this output and appropriate precautionary measures are necessary. **UNQUALIFIED OR UNINFORMED PERSONNEL SHOULD NOT BE GIVEN ACCESS TO THIS EQUIPMENT.**

The selected voltage is present at the center conductor of the high voltage BNC connector whenever the TEST VOLTS display indicates its numeric value and the LED above the source connector is illuminated. While the source can only generate three or four milliamperes at a steady rate, the output filter capacitors, can produce considerably greater currents for short periods of time. The SOURCE cable provided with the 6520 is HV BNC at the instrument end and Type-N at the U.U.T. end to provide direct connection with Guildline 9336 and 9337 series resistors. Other connector end cables are available as an option.

2.4.3.2.INPUT CONNECTOR

The sensitivity and very high impedances (100k ohm) at this connector require careful handling. Large static discharges to this connector should be avoided. One terminal of the unknown resistance or current is connected to the center conductor of the triax connector. The INPUT cable provided with the 6520 is Triax at the instrument end and Type-N at the U.U.T. end to provide direct connection with out 9336 and 9337 series resistors. Other connector end cables are available as an option.

2.4.4. REAR PANEL CONTROLS

Rear Panel controls are shown in Figure 2-4.

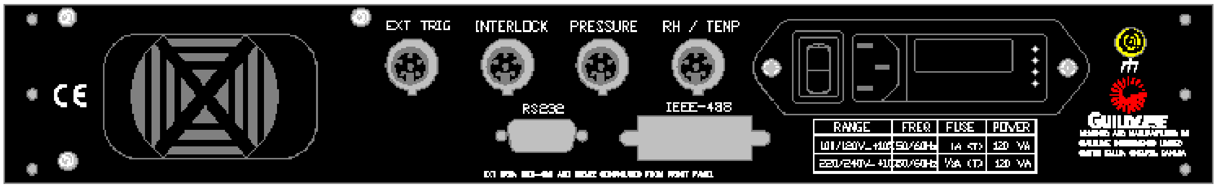


Figure 2-4: 6520 Rear Panel Connectors

2.4.4.1.IEEE-488 INTERFACE

The **IEEE-488** interface consists of the standard **IEEE-488** interface connector. The **IEEE-488** interface provides the means for a computer system to obtain complete control of the 6520. Computer control can be implemented through the use of the included TeraCal software package (part no. 30052-01-33), or through IEEE-488 compliant software that utilizes the 6520 remote command set. A Service Manual (SM6520) is available which details all of the remote commands. A ferrite sleeve (part no. 060-13231) is provided with the Spare Parts. This sleeve should be installed over the IEEE-488 cable to reduce electromagnetic emissions. IEEE interface adaptors and cables can be obtained through Guildline Instruments Limited, See Section 7.9.9 to determine which one is right for you.

2.4.4.2.RS232 INTERFACE

The **RS232** interface consists of the standard **RS232 DB9** interface connector. The **RS232** interface provides the means for a computer system to obtain complete control of the 6520. Computer control can be implemented through a standard **RS232** terminal program or **RS232** based software that utilizes the 6520 remote command set. A Service Manual (SM6520) is available which details all of the remote commands. A ferrite sleeve (part no. 060-13229) is provided with the Spare Parts. This sleeve should be installed over the RS232 cable to reduce electromagnetic emissions.

2.4.4.3.Ground Terminal

The ground terminal consists of a single binding post. The ground terminal is bonded to the chassis of the model 6520 and to power ground of the line input connector.

2.4.4.4.PRESSURE

A 5-pin DIN connector provides the input connection for the Guildline Absolute Pressure Environmental sensor (part no. 65220).

2.4.4.5.RH/TEMP
A 5-pin DIN connector provides the input connection for the Guildline combined %Relative Humidity and Temperature Environmental sensor(part no. 65220).

2.4.4.6.LINE INPUT CONNECTOR
The **Line Input Connector** is a combination of a 3-prong AC standard male connector, an ON/OFF switch and a fused input line voltage selector. The input line's voltage selector consists of a four-position selector and a fuse holder. The selector allows switching between the four possible settings: 100V, 120V, 220V and 240V. A 2 Amp time delay fuse is provided for the 100/120 V operation and a 1 Amp time delay fuse is provided for the 220/240 V operation. The voltage selector and fuse are set for the 240V operation at the factory (see Section 2.2)

2.4.4.7.EXTERNAL TRIGGER CONNECTOR
This rear panel connector shown in Figure 2-4 works when the TRIGGER SOURCE is set to external (See Section 4.4.4) to initiate a measurement each time the EXT TRIG signal pin in the connector is grounded. Internally, the signal pin (pin 1) of the connector is supplied with +5V through an LED and a 330 Ohm resistor. Figure 2-5 shows typical external trigger circuits.

2.4.4.8.INTERLOCK CONNECTOR.
This rear panel connector, shown in Figure 2-4 is a dual function connector containing an interlock control and a Resistivity test fixture Surface/Volume selection indicator signal.
The interlock control and test fixture status interface connections can be wired externally as shown in Figure 2-6 for typical Interlock Circuit Configurations.

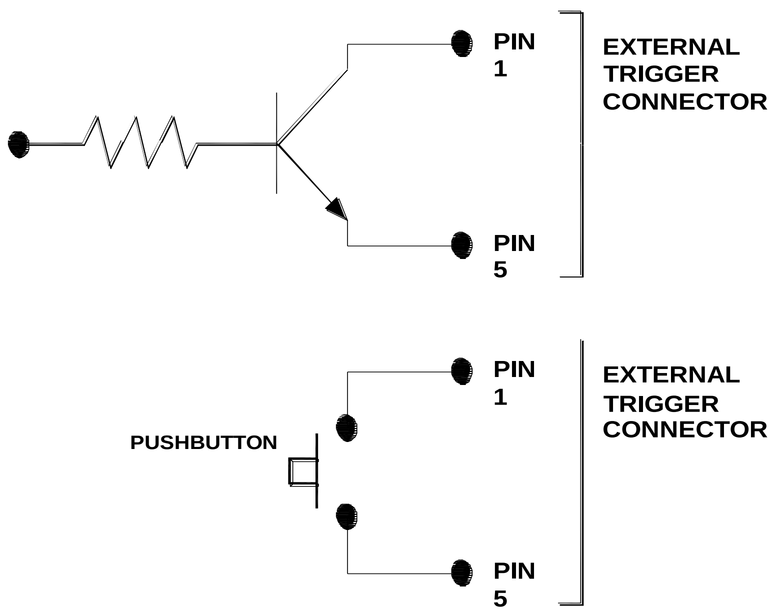


Figure 2-5: Typical External Trigger Circuits

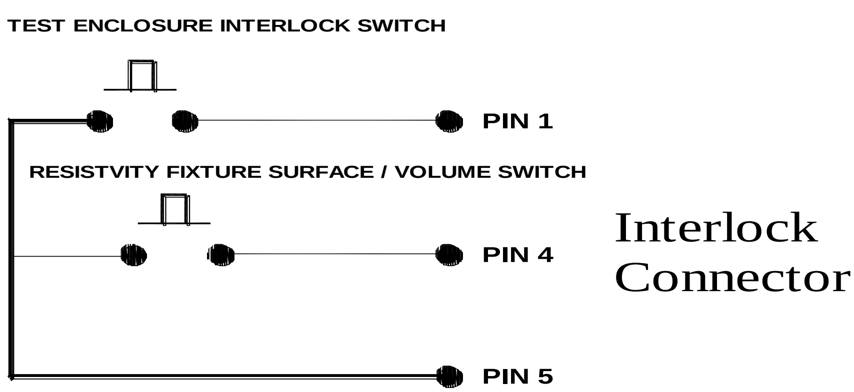


Figure 2-6: Typical Interlock Circuit Configuration

3. QUICK MEASUREMENT GUIDE

The 6520 although having many features and functions allowing in depth control of the measurement process, has been designed for ease of use. The Auto ranging and Auto reverse functions are enabled by default and are the best choice in most applications. This section outlines the basic measurement procedure using this mode of operation. The advanced measurement options and features are all outlined in remaining sections of this manual.

3.1. RESISTANCE MEASUREMENT

Most high and ultra-high value resistors come as a 2 or 3 terminal device. An example of each are the Guildline model 9336 resistor which is a 2-terminal device, and a model 9337 which is a 3-terminal device. The measurement procedure for both the 9336 and 9337 is identical. They both have a "Source" and an "Output" connector. The "Source" (voltage in) connector of the resistor should be connected to the "Source" (voltage out) connector of the 6520. Note that the center pin is the applied voltage with respect to the outer shield (chassis ground).

Note: Lethal voltages of up to 1000 volts may be present at this output and appropriate precautionary measures are necessary.

The "Output" (current out) connector of the resistor should be connected to the "Input" (current in) connector of the 6520. Note that the center pin is the return current with respect to the outer shield (chassis ground). The inner shield (electrometer ground) is shorted to the outer shield to allow for a common reference to the internal voltage supply. Refer to Figures 3-1 and 3-2.

3.1.1. RESISTANCE MEASUREMENT PROCEDURE

To make a resistance measurement, do the following steps.

1. Connect the unknown resistance device.
2. Select the **<Measure>** function key in the **Main Menu**
3. Select the **<Ohms>** function key in the **Measure Option Menu**
4. Select the **<Setup>** function key in the **Measure Ohms Menu**
5. Select the **<Parameters>** function key in the **Ohms Setup Menu**
6. Select the **<Max Volts>** function key in the **Ohms Parameters Menu**
7. Select the "**Previous**" key twice to return to the **Measure Ohms Menu**
8. Select the **<Start>** function key to initiate the measurement cycle.
9. The 6520 will proceed to determine the correct range and take continuous measurements.

3.1.2. 2-TERMINAL RESISTANCE CONNECTION SCHEMATIC

Outlined below is an example of a typical 2-terminal resistance device connected to the 6520. Note that the known voltage is dropped on the U.U.T. resistor element and the resultant current is returned to the electrometer to be measured. The resistance is determined by the measured current and known voltage.

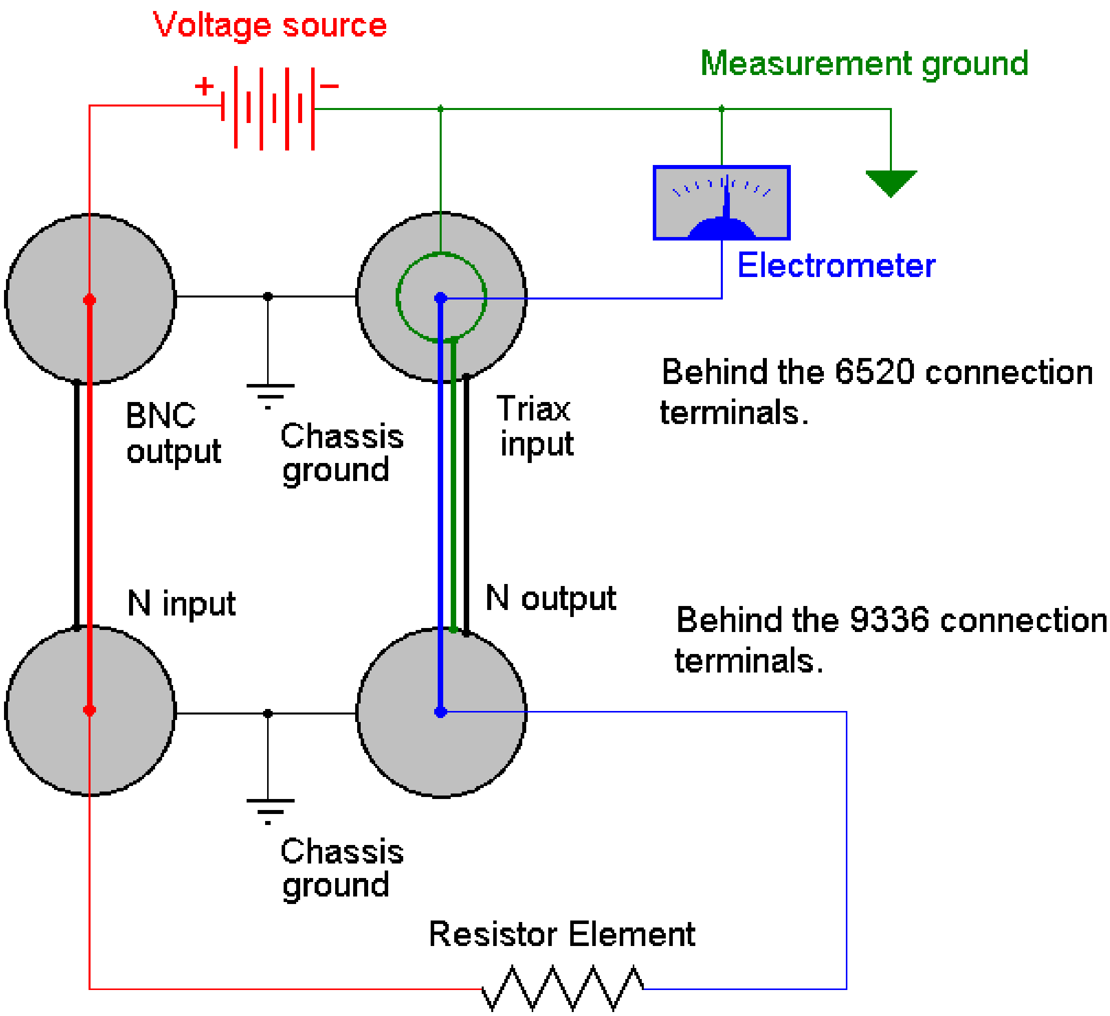


Figure 3-1: 2-Terminal Resistance Measurement Schematic

3.1.3. 3-TERMINAL RESISTANCE CONNECTION SCHEMATIC

Outlined below is an example of a typical 3-terminal resistance device connected to the 6520. Note that the known voltage is dropped on the U.U.T. resistor elements and the resultant current is ratio divided and partially returned to the electrometer to be measured. The effective resistance is determined by the measured return current and known voltage.

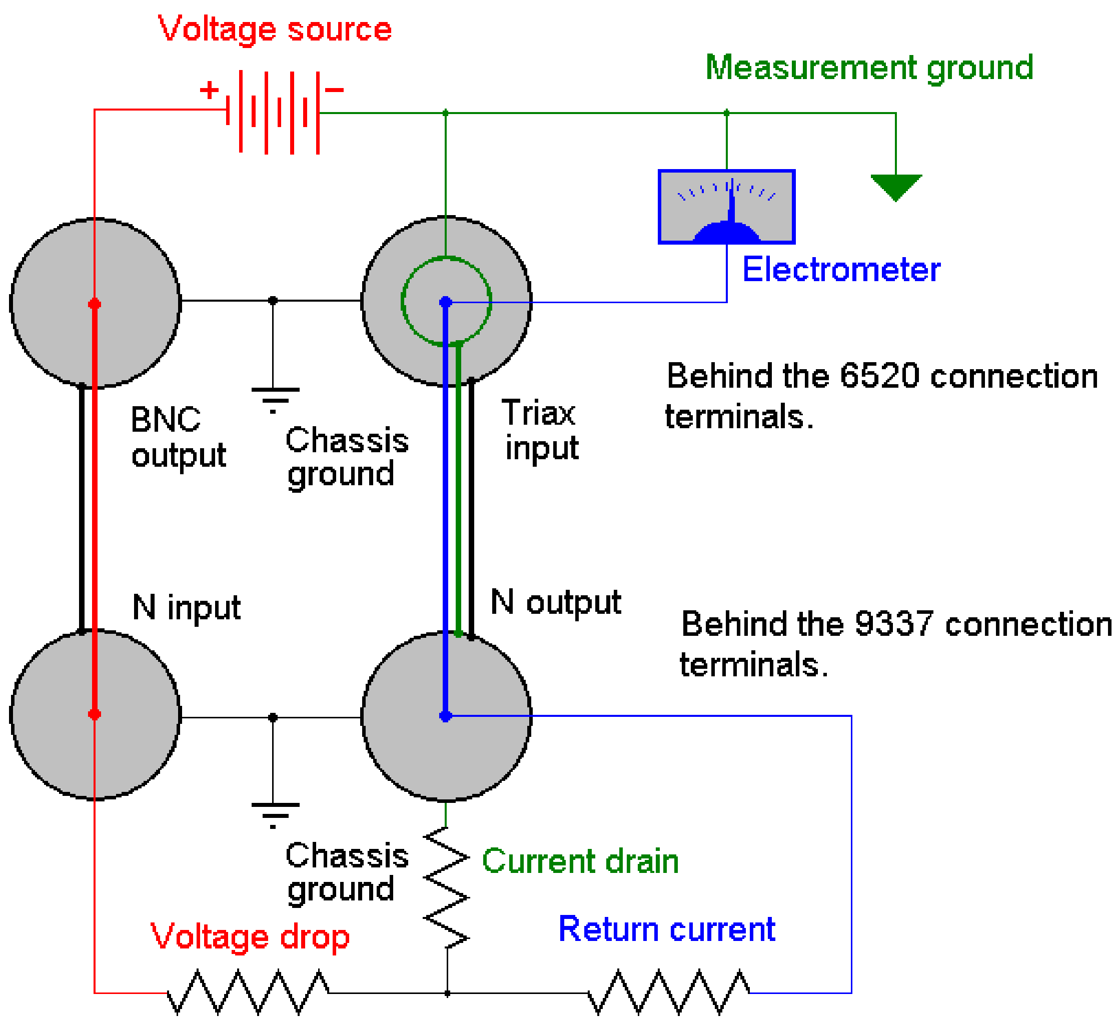


Figure 3-2: 3-Terminal Resistance Measurement Schematic

3.2. CURRENT MEASUREMENT

All current sources come as a 2 terminal device. The “Output” (current out) connector of the current source should be connected to the “Input” (current in) connector of the 6520. Note that the center pin is the current path with respect to the inner shield (electrometer ground). The outer shield is primarily used for noise immunity purposes in current measurements. Refer to Figures 3-3. Many current sources also use the chassis ground as their current output reference which can be fine to short to measurement ground using the standard cable set supplied with your 6520. However, there are also cases where the current output is isolated from chassis ground. The inner shield must be used for measurement ground and **NOT** connected to the outer shield in these cases. Also note that in many cases there are active guard connectors on current sources which should **NEVER** be connected to the 6520 as damage to both devices will likely occur. Using the triax to 3-alligator connection cable found in the 6520 Lead Set Option 65225 will assist in these more complex setups.

3.2.1. CURRENT MEASUREMENT PROCEDURE

To make a current measurement, do the following steps.

1. Connect the unknown current source.
2. Select the **<Measure>** function key in the **Main Menu**
3. Select the **<Current>** function key in the **Measure Option Menu**
4. Select the **<Start>** function key to initiate the measurement cycle.
5. The 6520 will proceed to determine the correct polarity/range and take continuous measurements.

3.2.2. CURRENT SOURCE CONNECTION SCHEMATIC

Outlined below is an example of a typical current source device connected to the 6520. Note that the known voltage source is not required or used and the current is actively driven from the unknown current source to the electrometer to be measured. While many current sources are referenced to chassis ground, some may not be. Use caution and refer to your current source documentation when connecting these devices. Current sources that do not use chassis ground as a reference should only be connected to the inner shield of the 6520 Input connector.

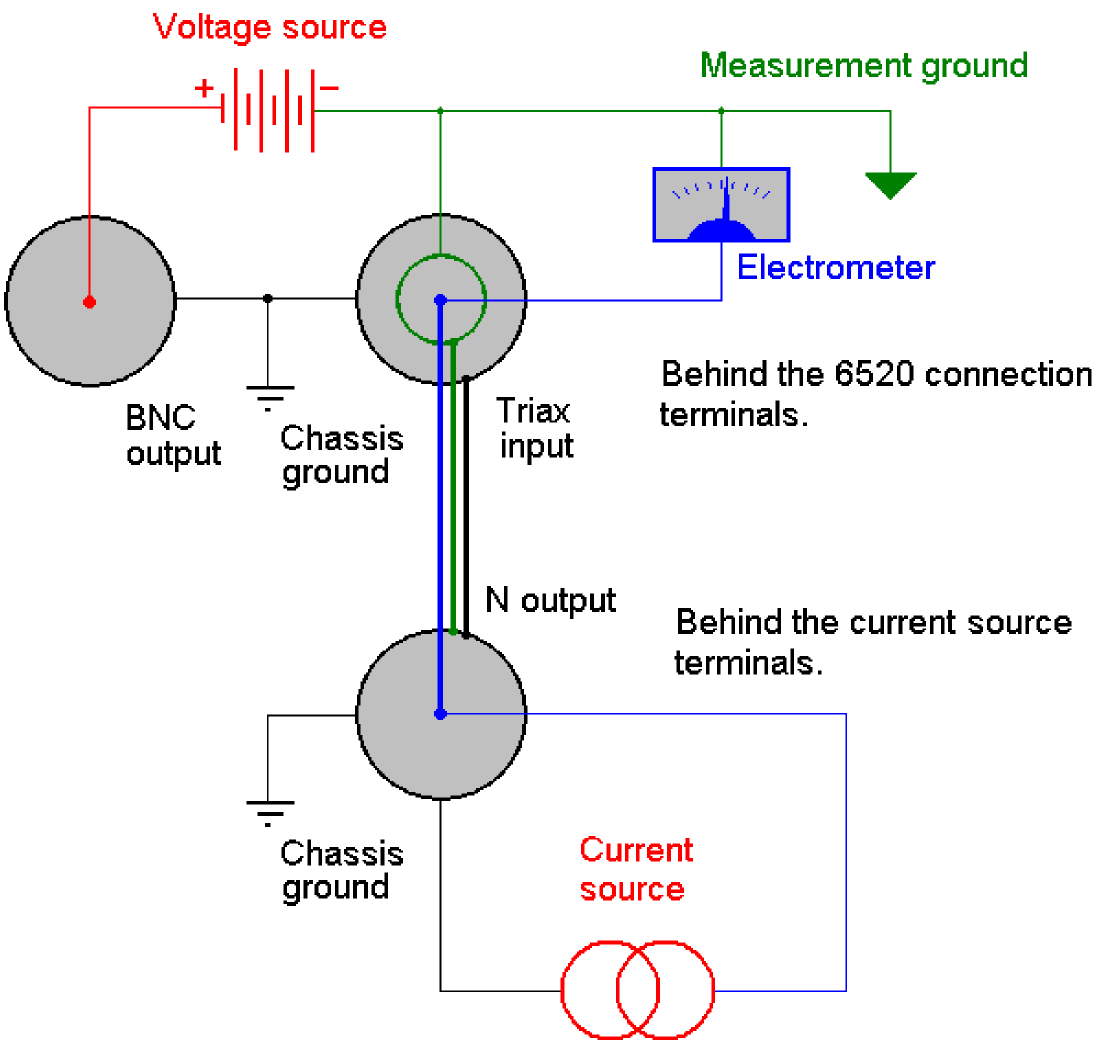


Figure 3-3: Current Source Measurement Schematic

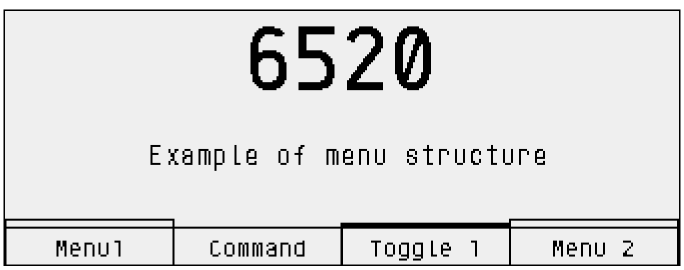
4. INSTRUMENT OPERATION

Instrument operation is controlled from a menu display and command function key approach that uses the front panel graphic display, programmable function keys, cursor movement keys and numeric keypad arrangement. The comprehensive user interface used, prompts the operator for the next required keystroke or it will automatically perform the required function on selection of the displayed operation.

CAUTION
DANGEROUS VOLTAGES CAN BE PRESENT AT THE SOURCE CONNECTOR.
THIS EQUIPMENT MUST NOT BE OPERATED BY UNQUALIFIED PERSONNEL.

4.1. BASIC MENU OPERATION

4.1.1. Menu System



The basic screen structure of the 6520 has allocated the last two (2) lines of the screen to four (4) function keys. The last line contains 10 character descriptions of the function to be performed. The menu system is hierarchical and the box of the function key has three (3) possible states.
“Menu 1” has a double box and indicates that invoking this key will select a sub-menu. “Command” indicates that this is a command key and the specified action will take place when the key is pressed.
“Toggle 1” has a double width line as a box and this indicates that this key will toggle through the defined states. In this mode the function box indicates the current state of the key.

4.1.2. Key functions

Four (4) function keys are software defined within the text on the screen.

The **<cancel>** key cancels any data entered during an edit operation.

The **<previous>** key causes the menu system to return to the previous menu level.

Numeric keys (0-9) are used to enter data during the edit operations.

The <**clear>** key is used to clear the current entry during edit operations.

The **<exponentiation**> key is used for floating point data entry.

The <**minus>** key is used for negative numbers or as a dash in text entry.

The <**period>** key is used for floating point numbers during an edit operation.

The **<load>** key is equivalent of the enter key.

4.1.2.1.Navigation keys (up/down, left/right arrow)

Edit mode.

The left arrow is used to move left to a desired location in an edit field.
The right arrow is used to move right to a desired location in an edit field.
The up arrow is used to enter the existing field and to select the previous field.
The down arrow is used to enter the existing field and to select the next field.

Select mode.

The up arrow selects the previous field.
The down arrow selects the next field.
The left arrow scrolls to the previous column of data if it exists otherwise it will select the first field.
The right arrow scrolls to the next column of data if it exists otherwise it will select the last field.

View mode.

The view portion of the 6520 uses the navigation keys to allow easy movement within the data and graph environments.

1. Summary data.

All navigation keys are not active.

2. Detail data.

The left arrow positions to the beginning of the trace buffer.
The right arrow positions to the end of the trace buffer and also activates an automatic refresh every 3 seconds.
The up arrow will scroll the data up by one entry.

The down arrow will scroll data down by one entry.

3. Summary graph.

All navigation keys are not active.

4. Detail graph.

The left arrow will position the graph at the beginning of the trace buffer.
The right arrow will position the graph at the end of the buffer and activate automatic refresh as more data becomes available.
The up arrow causes the graph to scroll the graph right by the number of entries specified in the view window. (default 20)
The down arrow causes the graph to scroll left by the number of entries specified in the view window. (default 20).

4.1.3. Select Mode

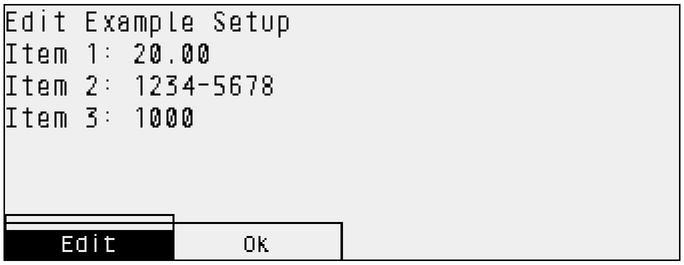
```
      Example of Select Menu
Select item 1          Select item 6
Select item 2          Select item 7
Select item 3          Select item 8
Select item 4          Select item 9
Select item 5          Select item 10

  Select      Ok
```

Select mode allows the selection of a specific item from a list using the navigation keys. The item is selected using the ok function key.

```
   Example of Multi Screen Select Menu
Select item 11         Select item 16
Select item 12         Select item 17
Select item 13         Select item 18
Select item 14         Select item 19
Select item 15

  Select      Ok                 More 2-2
```

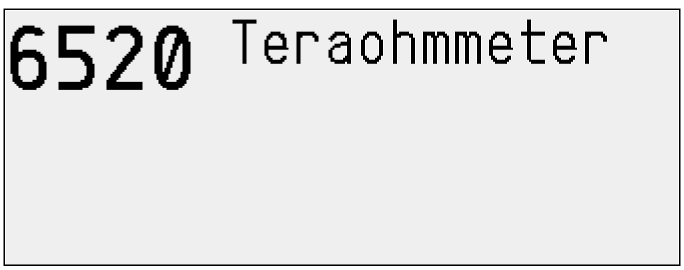
If the selections do not fit on a single screen then the fourth function key is reserved for navigating between the multiple screens.

4.1.4. Edit Mode



Data is entered using the numeric keys. The cancel key will restore all values to their original state. All of the data that has been changed is saved using the ok function. Multiple screens of data are processed using function key 4 (more n-n).

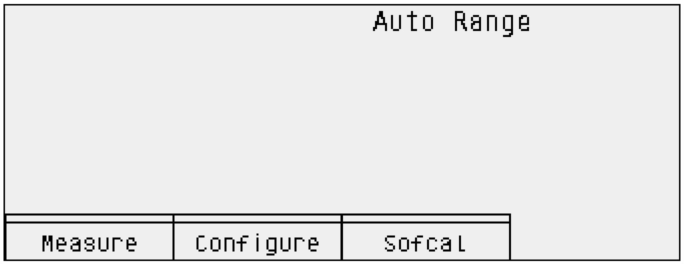
4.2. MAIN MENU



At power ON the model 6520 will start its internal power on self-test programming and display its opening banner:

When the instrument is turned on it performs a series of internal diagnostic checks. The internal diagnostics check the power supplies, reference voltage and system memory.

If the display shows the message Non-Volatile Memory Failure Press any key to continue, it indicates that the calibration data in the instrument memory has been corrupted and the operator should re-enter the proper coefficients (see SOFCAL).



<Measure> is the operations sections of the system.

<Setup> allows the setting up of the operating environment. An example of this would be to setup the display resolution for a measurement.

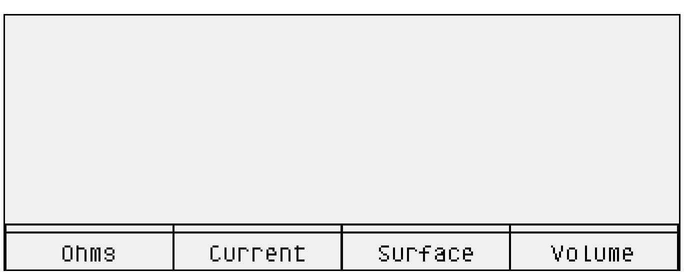
<Sofcal> is the calibration and diagnostics section of the system. Most of this section is under password control.

Pressing any key will remove the opening banner routines.

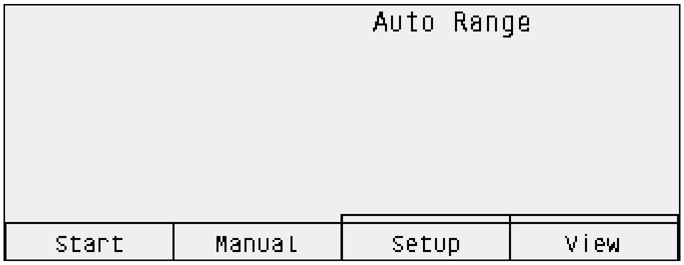
The REMOTE DISPLAY screen will appear only when the model 6520 has been addressed by a remote communication device on the GPIB.

The only active soft function key that will work when in Remote mode is the function key **<Remote>**. The exception is when local lockout has been enabled; in this case none of the keys on the front panel will be enabled.

4.3. Measurement Menu

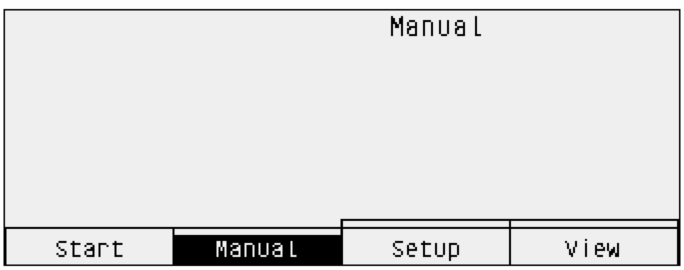


4.4. Ohms Measurement Menu

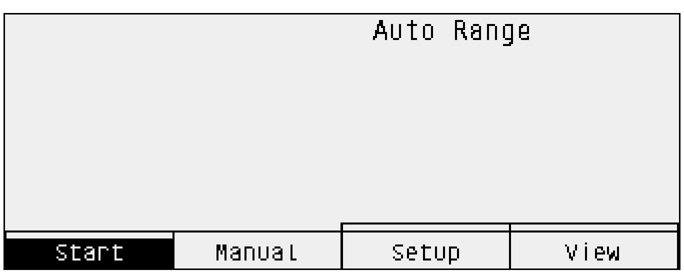


The 6520 operates in both auto range and manual mode. It is recommended that auto range mode be selected whenever possible.

As with all precision measurement instrumentation, the 6520 Teraohmmeter input is very sensitive to external stray electromagnetic and electrostatic fields. The presence of these stray fields can adversely affect the resistance under test as well as the 6520 reading. Proper measurement techniques for handling high impedance circuitry should be used and care should be taken to shield any device that is to be measured. Inadequate shielding will result in unstable readings. The reader should consult Section 7.7 when large value resistances are to be measured.

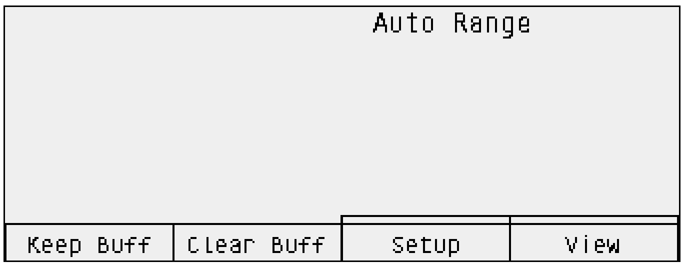


Selection of the Manual command function key puts the system in manual mode. It should be noted at this point that the 6520 will now use the current state of the parameter settings.

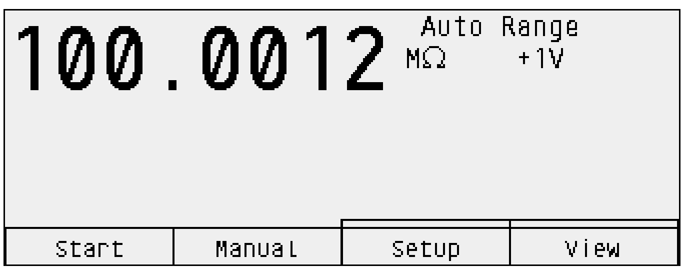


NOTE that **POTENTIALLY LETHAL VOLTAGES CAN BE PRESENT AT THE SOURCE CONNECTOR** when the measurement process is initiated. The yellow LED indicates if the voltage is present. The 6520 default maximum voltage setting is 20 volts if test voltages higher are required the maximum voltage setting must be changed in the setup menu as per section 4.4.2. For the Auto Ranging mode to function properly above 10 Gigaohms the maximum voltage setting should be set to 1000 volts.

If you have configured the 6520 to be in “Prompt” mode (factory default see section 4.9) then you will be greeted with the option to keep or clear the data built up from the previous measurement. If the choice is not made in 30 seconds the 6520 will default to keeping the previous data.

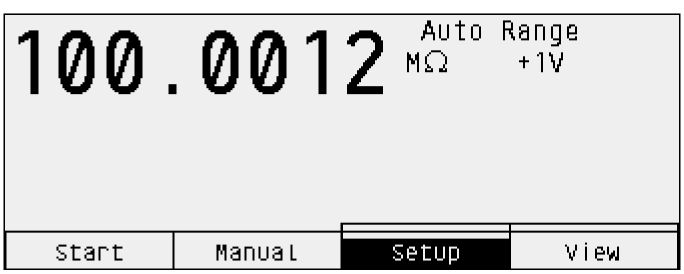


The 6520 will check the value of the resistor and select the optimum parameters for measurement purposes. It will report the approximate setting that it is trying to use as it locates the best settings.

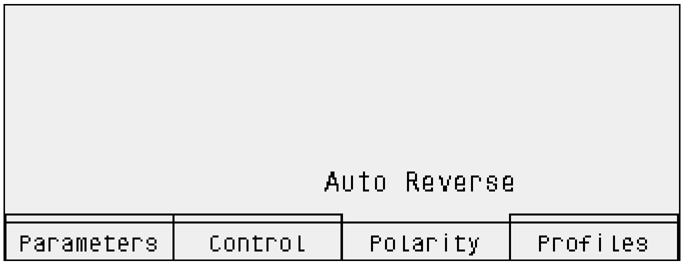


The 6520 will display the measurement values as they become available. It will also display the voltage that is being supplied to the output terminal. This example illustrates +1 volts.

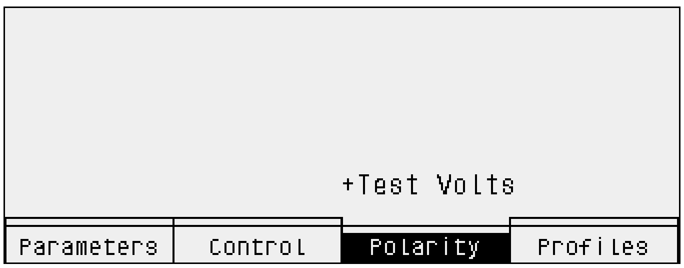
4.4.1. Ohms Setup

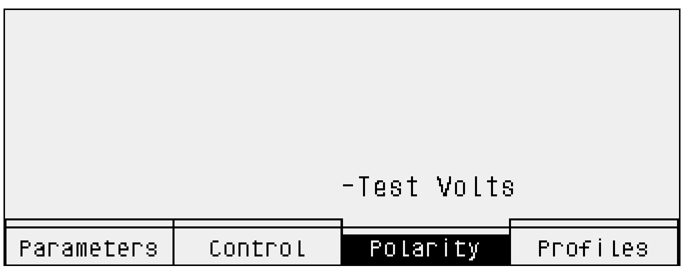


If some of the current settings need to be viewed or changed, selection of the Setup sub-menu is required.



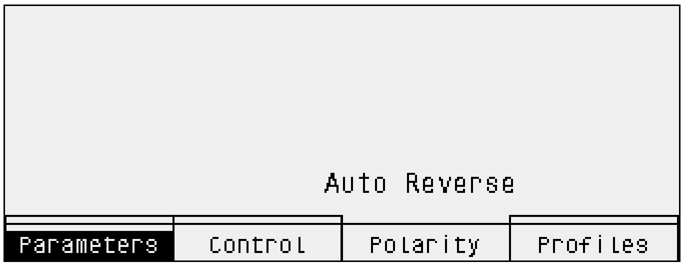
The setup menu allows the user to select the polarity using the polarity command function.

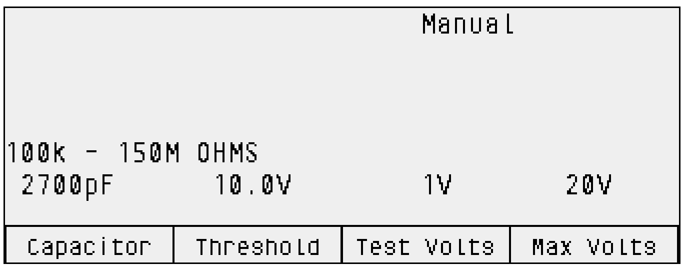




Changing polarity will not stop the measurement. It is recommended that attention is paid to the parameters for auto reverse as this will drastically affect the accuracy of the measurement. Voltage reversals for measurements greater than 10 gigaohms require longer settling time. If the system is configured in 6520 mode and autoranging is used then the system will automatically select appropriate parameters for sample size and sample count based on the resistance. (see section 4.9.2.2.5 System parameter) In manual mode Auto Reverse Sample Count and Stabilize Size (4.4.6.Timers) are used to establish these values.

4.4.2. Ohms Parameters Menu





The parameters menu allows the manual selection of settings.

The Max Volts limits all measurements. Max Volts is set to 20V as power up default. This also applies to auto ranging. This may be important to note as some resistors may be damaged if high voltage is applied. The valid ranges are:

1 V	10 V	100 V	1000V
2 V	20 V	200 V	
5 V	50 V	500 V	

Selection of the Capacitor, Threshold or Test Volts command will automatically set the measurement mode to manual and stop the measurement if it is active.

The Test Volts command selects the voltage to be used during the measurement. The valid ranges are the same as Max Volts however it will not allow the selection to exceed Max Volts. The Max Volts will have to be increased if the desired voltage is greater then Max Volts. This is a deliberate limit to ensure that the voltage is not accidentally changed above the tolerance of the resistor. In Auto Range mode the 6520 will not provide a calibrated measurement if Max Volts is set too low.

The capacitor command selects the integrating capacitor. The valid capacitor values are:

27pf   270pf   2700pf

The 27pf and 270pf selections are only available if the 0.1V threshold is selected.

The Threshold command selects the threshold voltage. The valid voltages are:

0.1 V   1.0 V   10.0 V

The 6520 will display the suggested range of the resistor based on the selected settings. This suggestion can be ignored but it may have a direct effect on the accuracy of the measurement and/or the length of time for a measurement to take place. In Auto Range mode the parameters are automatically selected up to the Max Volts setting.

4.4.3. RESISTANCE, MANUAL RANGING

Manual ranging of the 6520 Teraohmmeter is more complex than using the autoranging function. To fully understand the manual mode, Section 1.1.2 (Principle of Operation) should be reviewed.

The manual mode permits the operator to select the test voltage, the threshold voltage and the integration capacitor. The operator may also select these constants through the GPIB or RS-232C remote communication link. The instrument then measures the integration time and calculates the value of the unknown resistance. If the operator selects inappropriate measurement constants, the full accuracy of the instrument may not be achieved. To make a good selection, an approximate value of the unknown resistor is required. This may be obtained from a prior knowledge or from a repetitive sequence of measurements starting from any assumed value. The instrument works best if the integration time is between 0.54 and 54.0 seconds, however it will work at reduced accuracy with an integration time as short as 5.4 milliseconds or as long as 1000 seconds. The integration capacitor value may be selected from one of 27, 270 or 2700 picofarads. The 2700 pF capacitor is the most stable and should be used if possible.

The threshold may be 0.1, 1 or 10 volts. The test voltage may be selected between the limits of 1 to 1000 volts in steps that are decimal multiples of 1, 2 and 5 of either polarity (±).

The integration time is affected by the selection of the capacitor, threshold and test voltage according to the formula:

$$T = \frac{2 \text{ x } C \text{ x } R \text{ x } V_{threshold}}{V_{source}}$$

Where: T is the integration time in seconds,

R is the unknown resistance in ohms,

C is the integrator capacitance in farads,

$V_{threshold}$ is the threshold voltage in volts,

V_{source} is the test voltage in volts.

The operator may use the timing diagram of Figure 4-1 or Table 7-5 to select the measurement constants without calculation. For example, if the unknown resistor value is approximately 100 megohms (100 M), the operator will find the sloping 100 megohm (100 M) line on the test voltage graph (top of the page). The intersection of the 100 M line with the horizontal 10 V test voltage line gives an input current of 100 nA (vertical line). Following the 100 nA line to the 2700 pF threshold voltage graph (center of page) it can be seen that selecting a 10 V threshold will give an integration time of 540 ms which is within the optimum range of 0.54 to 54.0 seconds. The selection of the 0.1 V threshold should be avoided because it would give an integration time of 5.4 ms.

Another thing that should be considered is the voltage used within the measurement. If the measurement is being performed at low voltages (100 V or less) then the integration time is best to be within 5.4 to 54 seconds. This longer integration time will improve the stability of the inherently lower signal to noise ratio with lower voltages.

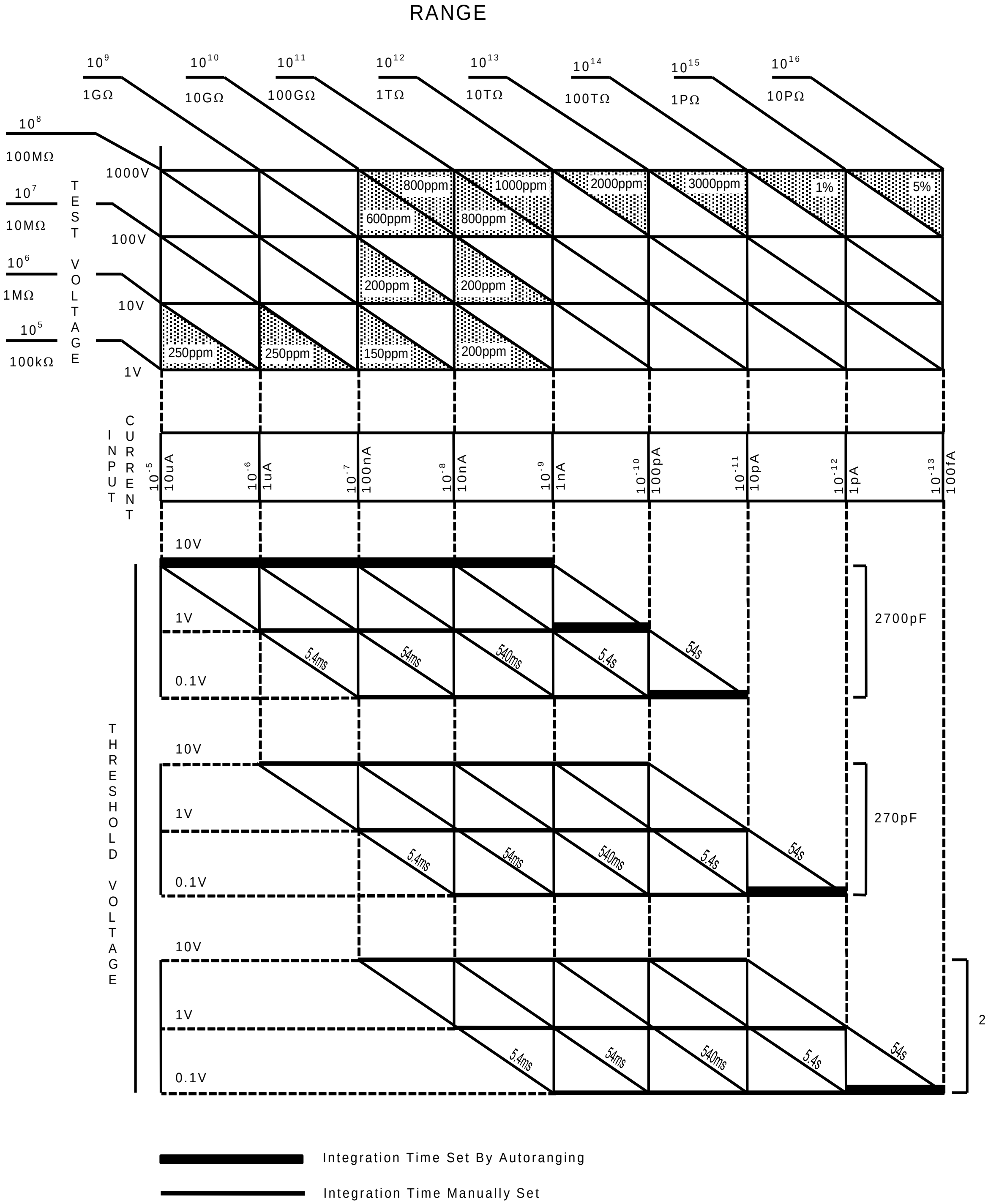
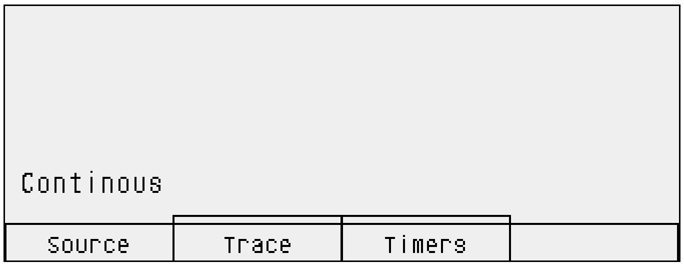


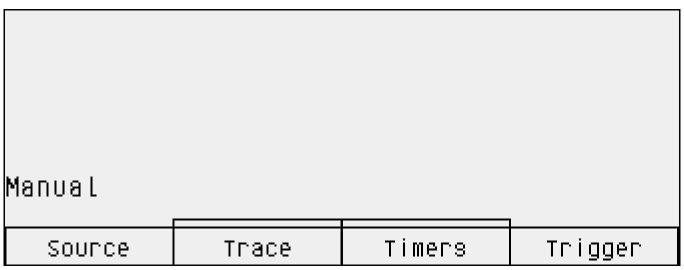
Figure 4-1: Time Diagram

4.4.4. Control Menu



The valid Source selections are:

Manual - requires trigger from **<Trigger>** function key to start a measurement. **<Trigger>** is also available on the Ohms Measurement Menu if this mode is selected

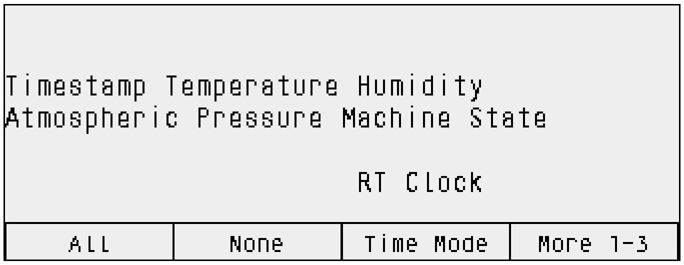


External - external trigger contact closure required on external trigger source on input connector

BUS - measurement initiated by *TRG remote command

Continuous - continuous measurement

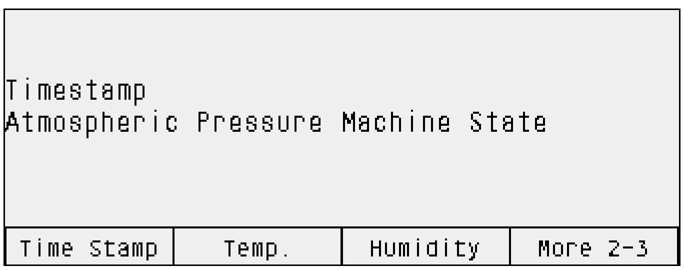
4.4.5. Trace



<All> selects Timestamp, Temperature, Humidity, Atmospheric Pressure, and Machine State.

<None> clears all trace elements.

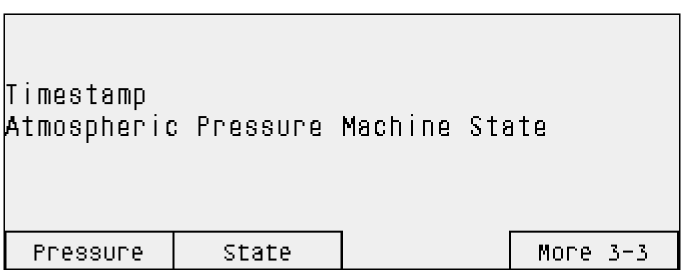
<Time Mode> toggles between Relative Time and the Real Time Clock. This is only traced if Timestamp is selected.



<Time Stamp> selects and removes the Time Stamp in the trace.

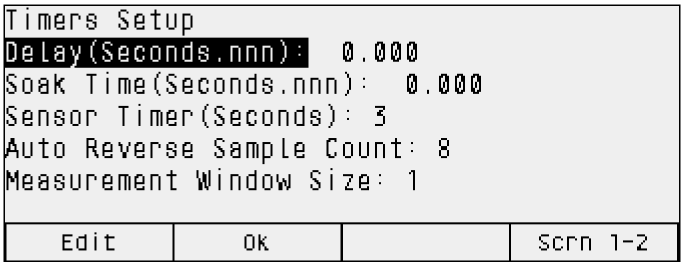
<Temp.> selects and removes the Temperature data in the trace.

<Humidity> selects and removes the Humidity data in the trace.



<Pressure> selects and removes the atmospheric pressure data from the trace.
<State> selects and removes the machine state data from the trace.

4.4.6. Timers



Delay is the time to wait between each sample. It is an internal time based sample trigger.

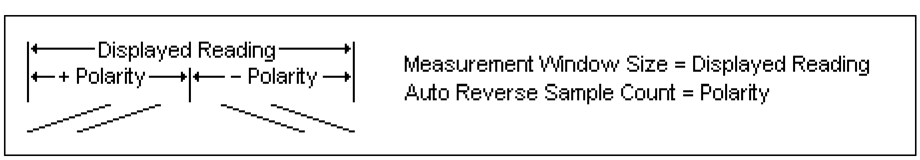
Soak Time is the initial settling wait time after a change in voltage or polarity.

Sensor Time is the wait time between sensor measurements.

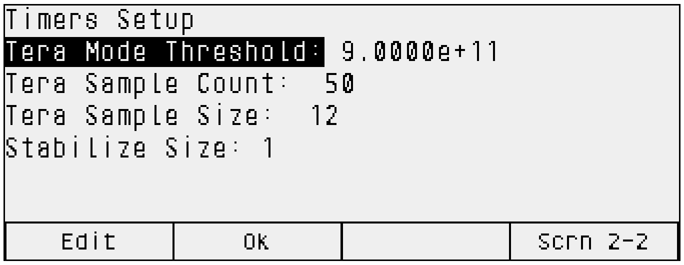
The Auto Reverse Sample Count, Measurement Window Size, Tera Mode Threshold, Tera Sample Count, and Tera Sample Size parameters only affects the 6500 (legacy) mode of operation. For the 6520 (native) mode of operation these parameters are set by a table as outlined in Section 7-5.

Auto Reverse Sample Count is the number of individual samples to take before polarity reversal in Auto Reverse Mode. The smallest and largest value will be removed from the average if the count is greater than 2. This filter is also used for single polarity measurements.

Measurement Window Size is the number of new readings taken before the average is calculated. It is recommended to set the Measurement Window Size to 1. At the start of each measurement the system will accumulate Auto Reverse Sample Count (x 2 for Auto Reverse Mode) before displaying the first reading. If the Measurement Window Size is zero then all measurements will be recorded and no average will be calculated.



This process is used for resistances below the “Tera Mode Threshold” ohms value while in the 6500A (legacy) mode of operation and for current measurements.

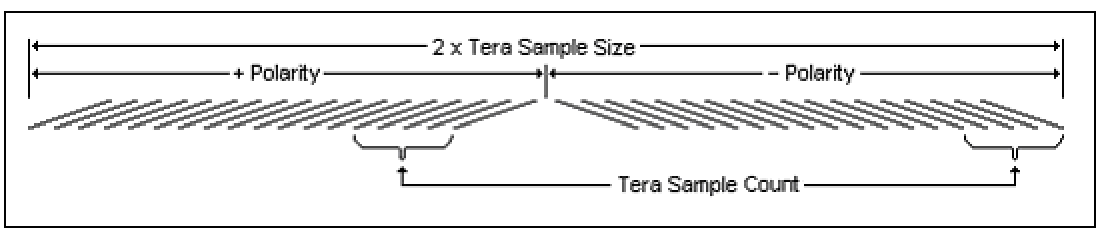


Tera Mode Threshold is the value used to determine at what value (in ohms) that the mode is .switched between "Tera Mode" and the standard auto reverse mode. A measured value which is greater than the specified Tera Mode Threshold value enables the Tera Mode.

Tera Sample Size is the number of individual samples to take before polarity reversal in Auto Reverse Mode when resistance is greater than Tera Mode Threshold.

Tera Sample Count is the number of individual samples to use in calculating the average and standard deviation of each polarity reversal. The last *"x"* number of samples are used, with the minimum and maximum value removed, to calculate the average for each polarity where *"x"* is defined by "Tera Sample Count". The final displayed reading is an average of both polarities in Auto Reverse mode. Measurement Window Size is not used in "Tera Mode".

The standard deviation is calculated on the remaining data and the largest standard deviation (Positive or Negative) is reported.

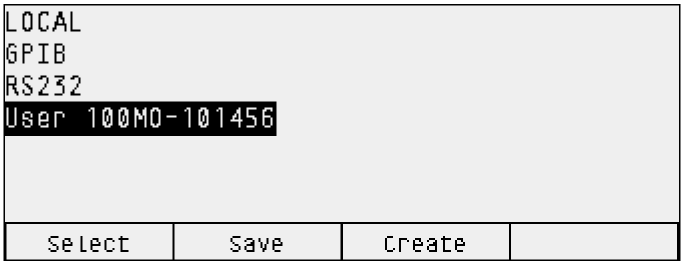


This process is used for resistances above the "Tera Mode Threshold" ohms value while in the 6500A (legacy) mode of operation only.

Stabilize Size is the number of samples to ignore when a polarity change occurs or at the start of a measurement.

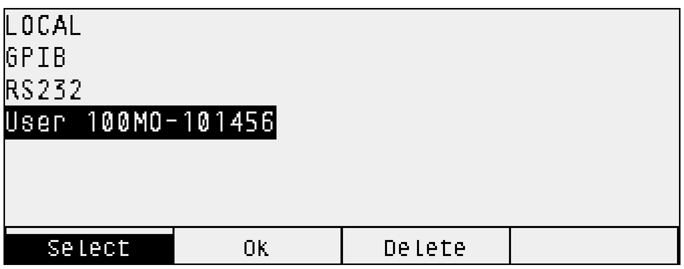
The timer parameter values in the current profile are loaded upon power up of the 6520.

4.4.7. Profiles



Profiles allow the user to select standard default setups or to create individual user profiles. 36 profiles are available in the 6520; 3 are fixed (LOCAL, GPIB, RS232) and 33 are user definable. The remaining 33 profiles are stored in non-volatile memory and will be retain by the 6520 even after powering off.

<Select> allows the selection and deletion of profiles.



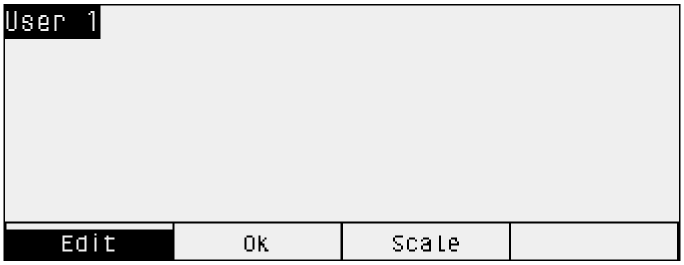
<Ok> selects the highlighted profile.

<Delete> deletes the currently selected profile. This option is only available on user profiles and will not be present when LOCAL, GPIB, or RS232 is highlighted.

<Save> saves the current profile information in the selected profile.

The saved parameters are: Delay Time, Soak Time, Sensor Time, Auto Reverse Count, Measurement Window, Tera Mode Threshold, Tera Mode Sample Size, Tera Mode Sample Count, Stabilize Size, Trigger Source, Display Resolution, Display Brightness, Auto Reverse Mode, Manual Mode, GPIB status, RS232 status, Capacitor, Threshold, Polarity, Shunt, Max Voltage, Output Test Voltage.

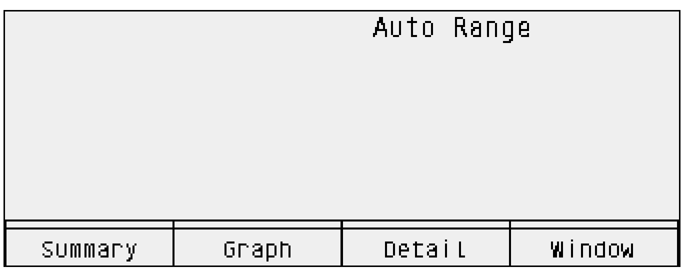
<Create> allows the creation of a new profile using the current profile information.



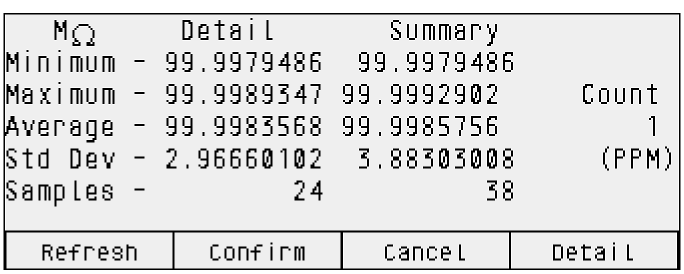
<Ok> creates a new profile with the name as entered in the text. The current profile information will be saved in this profile.
<Scale> allows the insertion of special text for defining the resistor value. It toggles between M Ohms, G Ohms, T Ohms and P Ohms.

4.4.8. View

The **View Menu** allows the user to view the trace data in graphical and text format. The last 1000 entries are kept in memory and the individual entries can be viewed. A summarization of the data is kept from the last **<Clear Sum>** point. A graphical summary is also maintained by averaging all samples within a 180 point array.



4.4.8.1.Summary



The **Count** entry indicates how many actual values have been averaged within the summary graph.

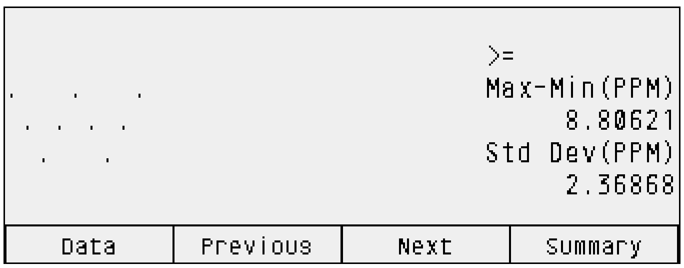
<Refresh> updates the detail and summary values.

<Detail> switches to the Detail display.

<Clear Det> clears the trace buffer. It requires a confirmation to prevent accidental clearing.

<Clear Sum> clears the summary buffer

4.4.8.2.Detail Graph



<Data> switches to the detail display.

<Previous> (if present) scrolls the trace buffer window left.

<Next> (if present) scrolls the trace buffer window right.

<Summary> switches to the summary display.

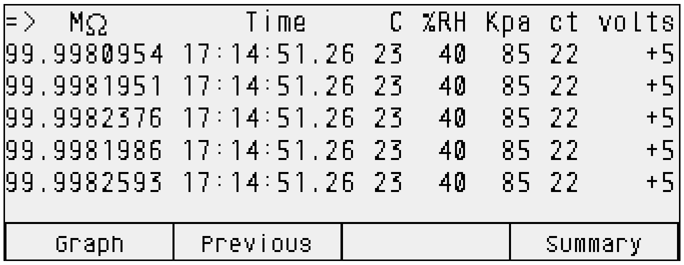
The Up arrow scrolls the trace buffer left by Up/Down Arrow Scroll Size.

The Down arrow scrolls the trace buffer right by Up/Down Arrow Scroll Size.

The Left Arrow scrolls to the beginning of the trace buffer.

The Right Arrow scrolls the end of the buffer and sets the trace in automatic update mode. The >= symbol in the display indicates that the auto update mode is enabled.

4.4.8.3.Detail



<Graph> switches to the graph display.

<Previous> (if present) scrolls back by 5 entries.

<Next> (if present) scrolls forward by 5 entries.

The Up arrow scrolls the trace buffer up by one (1) entry.

The Down arrow scrolls the trace buffer down by one (1) entry.

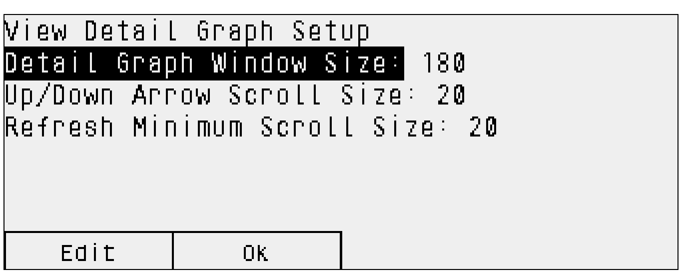
The Left Arrow scrolls to the beginning of the trace buffer.

The Right Arrow scrolls the end of the buffer and sets the trace in automatic update mode.

The ct value is interpreted as follows:

c-t	Capacitor (pf)	Threshold (V)
0	27	0.1
1	270	1
2	2700	10

4.4.8.4.Window

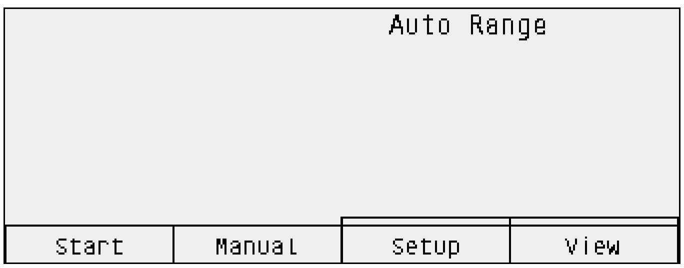


Detail Graph Window Size is the number of trace entries to display on the graph.

Up/Down Arrow Scroll Size is the number of trace entries to scroll by during Up/Down arrow selection in the detail graph.

Refresh Minimum Scroll Size is the number of entries to leave available for update when the detail graph which is currently being viewed reaches the Detail Graph Window Size. This prevents the screen from doing a complete refresh on each new entry once the window size is less than the number of trace entries.

4.5. Current - MEASURING PICOAMPERES



The 6520 Teraohmmeter can be used to measure very low Direct Currents flowing to the center conductor of the input connector. The 6520 input resistance is approximately 100 Kilohms when measuring currents to 10 uA and reduces to approximately 100 ohms (by enabling the internal current shunt) for currents to 10mA and will reduce the expected current flow if the voltage compliance of the current source is not high enough. To connect the unit as a pico ammeter, the current source is fed into the center conductor of the INPUT connector. The INPUT connector inner shield is the current return path to the ground (or low side) of the external circuit. The connector outer shield is connected to the cable shield and safety ground of the 6520.

A coaxial cable to the INPUT connector makes a simple approximation to the ideal circuit configuration when the centre conductor is connected to the current source and the coaxial shield is connected to the ground of the external circuit. Noise pickup may cause a slight degradation of accuracy when using this coaxial cable configuration. Guildline supplies a triaxial cable where the outer and inner shield are joined together at the Type-N connector end.

4.5.1. AUTORANGING - Current

The simplest technique for measuring low currents is to use the autoranging feature of the 6520:

1. Connect the unknown current source.
2. Select the **<Measure>** function key in the **Main Menu**
3. Select the **<Current>** function key in the **Measure Option Menu**
4. Select the **<Start>** function key to initiate the measurement cycle.

5. The 6520 will proceed to determine the correct range and take continuous measurements.
6. The autoranging feature of the 6520 will track slow changes in the magnitude of the unknown current, but if the current changes by a large step value, or if the polarity

   changes, the instrument must be forced to autorange again by pressing the **<Stop>** function key to terminate the measurement and then the **<Start>** function key to initiate the measurement cycle.
7. Select the **<Set Up>** function key in the **Measure Option Menu**
8. Change the polarity of the expected measurement process by selecting the appropriate polarity from the available options **<Polarity +>, <Polarity ->.**
9. Press the front panel menu control key **<PREVIOUS>** to return menu control to the **Measure Option Menu**.
10. Select the **<Start>** function key to initiate the measurement cycle.

4.5.2. MANUAL RANGING - Current

Manual ranging of the 6520 Teraohmmeter is more complex than the autoranging function. Reference to the Time Diagram shown in Figure 4-1 and Table 7-5 are useful when operating the 6520, especially in the manual ranging mode. In order to manual range an approximate value of the current to be measured must be known.

Knowing the current the user must then select an integration capacitor, an integration threshold voltage, and the shunt for the measurement. The integration capacitor value may be selected from one of 27, 270 or 2700 picofarads. The threshold may be 0.1, 1 or 10 volts. The shunt can be on or off.

The selection of the capacitor, the threshold, and the shunt affects the integration time according to the formula:

$$T = \frac{2 \text{ x } C \text{ x } V_{threshold} \text{ x Shunt}}{I}$$

Where: T is the integration time in seconds,

I is the unknown current in amperes,

C is the integration capacitance in farads,

$V_{threshold}$ is the threshold voltage in volts.

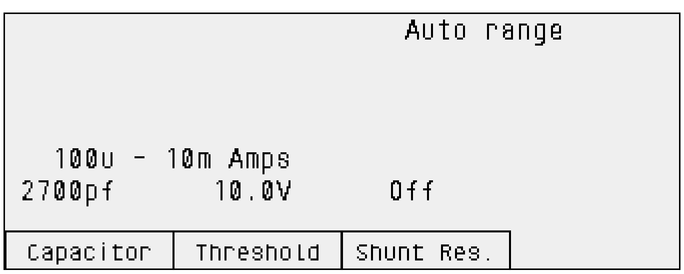
Shunt is 1000 if it has been selected otherwise it is 1. Note: The shunt should be enabled only when trying to measure currents higher than 10 uA.

The instrument works best if the integration time of the electrometer is between 0.5 seconds and 5 seconds however integration times as short as 5.4 milliseconds or as long as 1000 seconds may be used. The 2700 pF capacitor is the most stable and should always be used if possible.

The following steps can be used to measure current in the manual mode:

1. Connect the unknown current source.
2. Select the **<Measure>** function key in the **Main Menu**

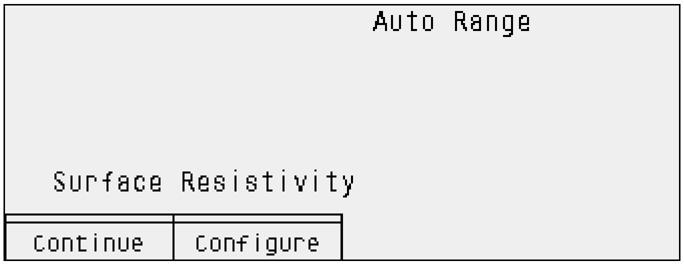
3. Select the **<Current>** function key in the **Measure Option Menu**
4. Select the **<Set Up>** function key in the Measure Option Menu to proceed to the Set Up Menu
5. Select **<Parameters>** in the Set Up Menu to proceed to the Parameters menu
6. Using the suggested timing parameters suggested by entries into the Time Diagram of Figure 4-1 and Table 7-5 to make the appropriate selection of **<Capacitor>**, <**Threshold>** and **<Shunt>.**
7. Press the front panel menu control key **<PREVIOUS>** to return menu control to the Set Up menu.
8. Select the expected test current polarity using the **<Polarity>** function key; (the polarity convention used is such that for a positive polarity, the centre conductor of the INPUT connector is at a positive voltage with respect to the inner shield.)
9. Press the front panel menu control key **<PREVIOUS>** to return menu control to the **Measure Option Menu**.
10. Select the **<Start>** function key to initiate the measurement cycle.

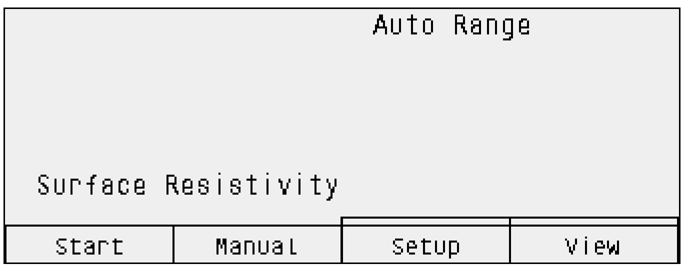


Capacitor	27pf | 270pf | 2700pf
Threshold	0.1V | 1.0V | 10.0V
Shunt	On | Off

4.6. Surface Resistivity

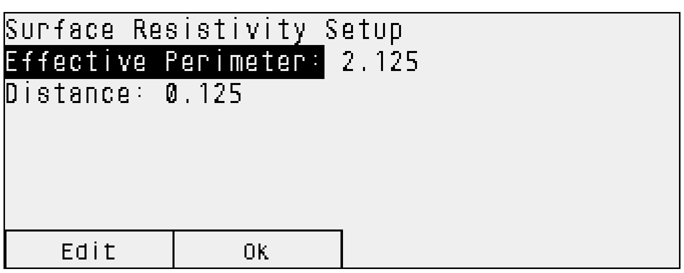
Select **<Measure>** function key in the **Main Menu**
Select **<Surface>** function key in the Measure Option Menu





<Continue> will set the system in Surface Resistivity mode and start the Ohms Menu (4.4).

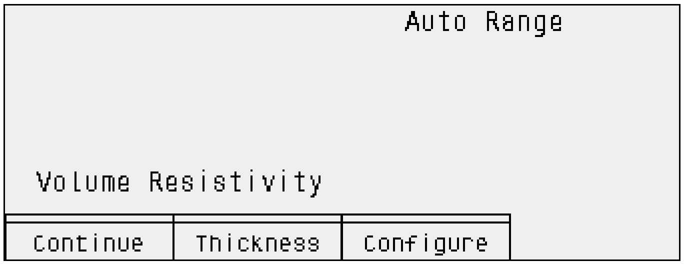
4.6.1. Surface Resistivity Configure

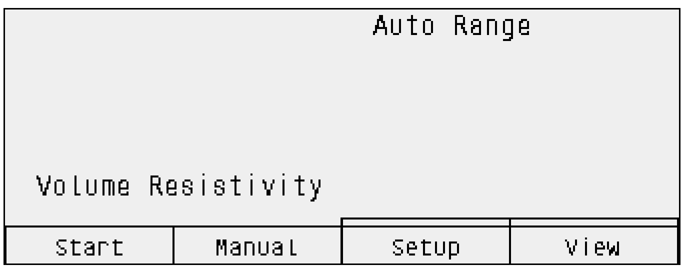


The effective perimeter and distance are fixed parameters for the Model 8009 Resistivity Test Fixture. For a detailed description of these parameters consult the Keithley Model 8009 manual. This is only used for custom fixtures and is not part of the menu selection when the fixture is standard. (see configure).

4.7. Volume Resistivity

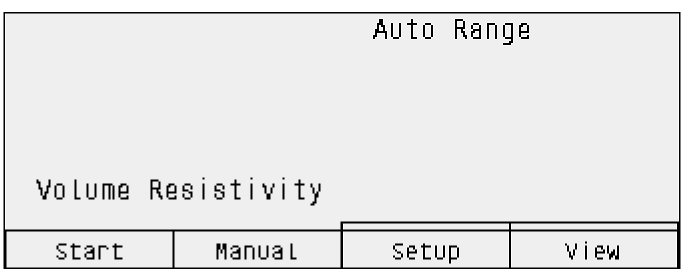
Select **<Measure>** function key in the **Main Menu**
Select **<Volume>** function key in the Measure Option Menu





<Continue> will set the system in Volume Resistivity mode and start the Ohms Menu (4.4)

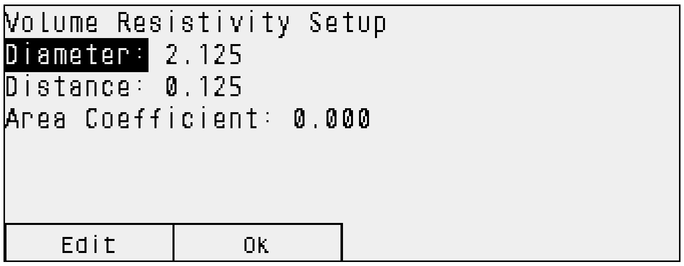
4.7.1. Volume Resistivity Thickness Setup



The thickness of the sample can be changed from the default if necessary. For a detailed description of these parameters consult the Keithley Model 8009 manual.

Units allows the selection of inches or centimetres. The configuration values are automatically converted.

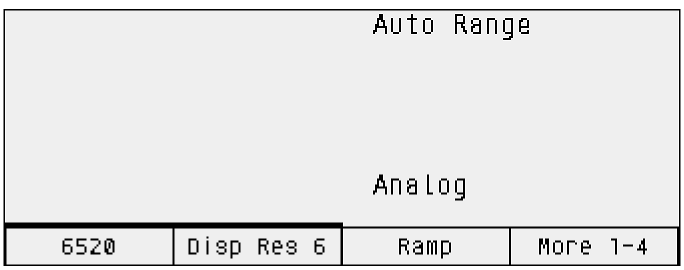
4.7.2. Volume Resistivity Configure



The effective diameter and distance are fixed parameters for the Model 8009 Resistivity Test Fixture. For a detailed description of these parameters consult the Keithley Model 8009 manual. This is only available when a custom fixture is selected from the Configure menu.

4.8. Configure

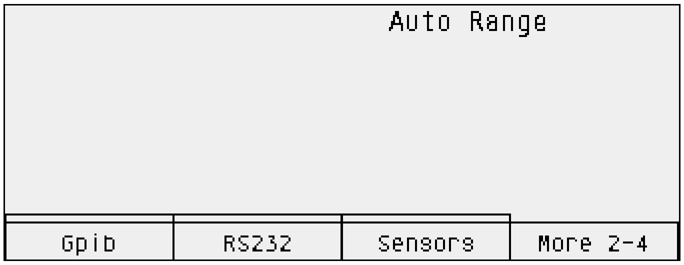
Select **<Configure>** function key in the **Main Menu**

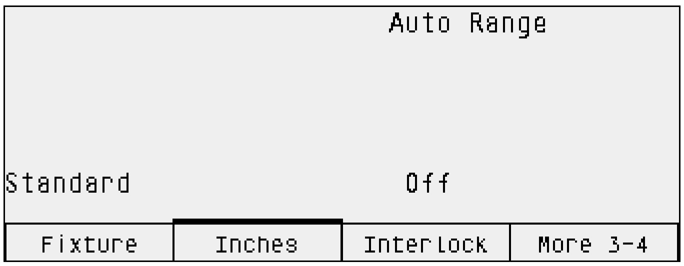


<6520> sets System Mode to 6520 **<Trace 6520>** sets System Mode to trace raw data **<6500A>** sets System Mode to 6500A compatibility mode. This mode does not support the newer filtering and autoranging features but does support Tera Mode. See 4.4.6 Timers for an explanation of Tera Mode.

Resolution for displaying the measurement. 3 | 4 | 5 | 6 | 7 | 8 | Auto Res.

<Ramp> The “Ramp” is the voltage output level of the integrating circuit of the electrometer. It is a good status indicator to show the circuit operation. Setting the “Ramp” to Digital displays ramp volts in digital and Analog displays the ramp graphically.

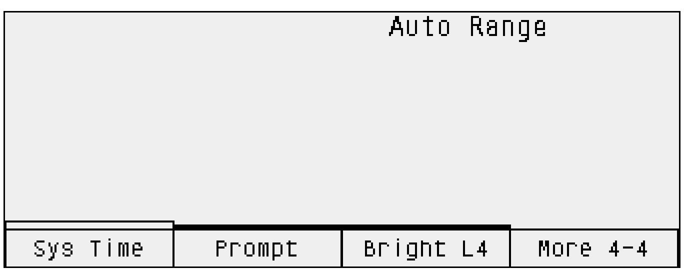




<Fixture> allows the selection of the Standard Guildline Resistivity fixture and also allows the user to define a custom fixture.

<Inches> toggles between inches and centimetres.

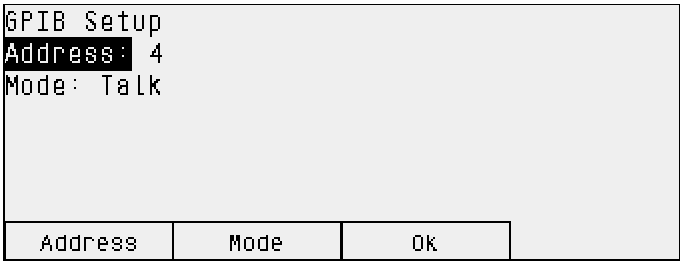
<Interlock> can be off or on. On prevents an Ohms measurement if the external input is not enabled. Resistivity always operates in interlock “on” mode. (This switch is for Manual operation only; see Service Manual SM6520 for Remote operation.)



<Prompt> selects the buffer clear mode. The “Prompt” selection will prompt you before each new measurement to either clear or keep the last measurement in the buffer. The “Keep Data” and “Clear Data” options will always act the labelled manner without prompting.

Bright sets the display brightness. L1 | L2 | L3 | L4.

4.8.1. GPIB

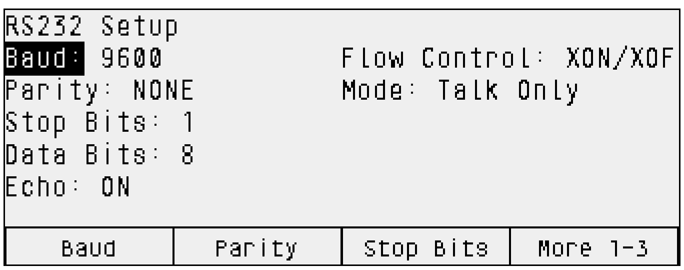


Address is the GPIB device address 0-30. The standard device is 4.

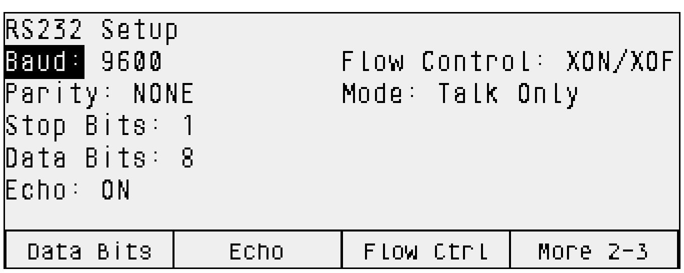
Mode Talk | Talk/Listen | Disabled

Ok is necessary to save the parameters and initialize the device.

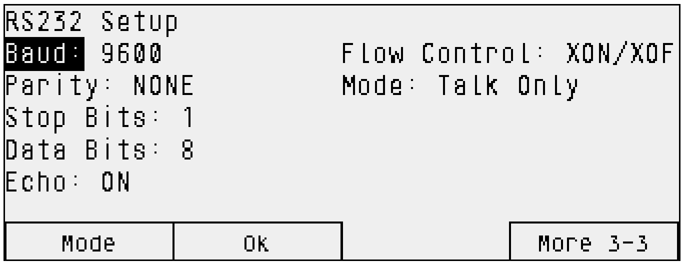
4.8.2. RS232



Baud is the RS232 Baud Rate. 1200 | 4800 | 9600 | 19200 | 38400.
Polarity NONE | EVEN | ODD
Stop Bits 1 | 2



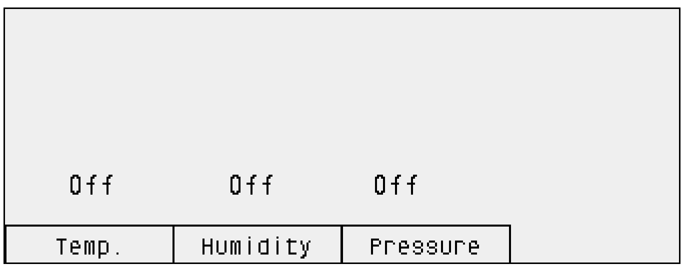
Data Bits 7 | 8
Echo ON | OFF
Flow Control XON/XOFF | RTS/CTS | NONE



Mode Talk Only | Talk Listen | Disable

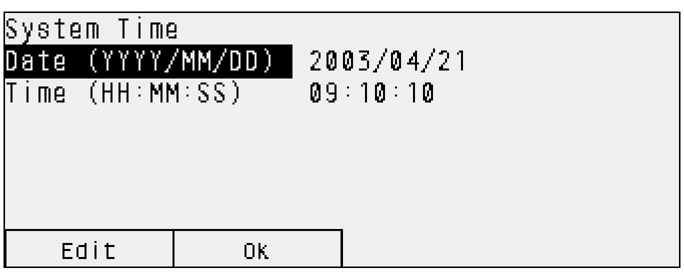
<Ok> is necessary to save the parameters and initialize the device.

4.8.3. Sensors



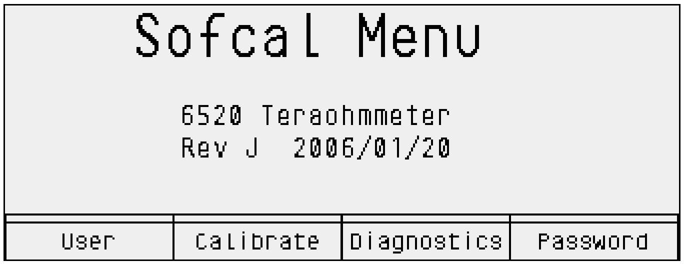
This enables/disables the three (3) sensors. The off state will stop all monitoring of the selected sensor.

4.8.4. Sys Time



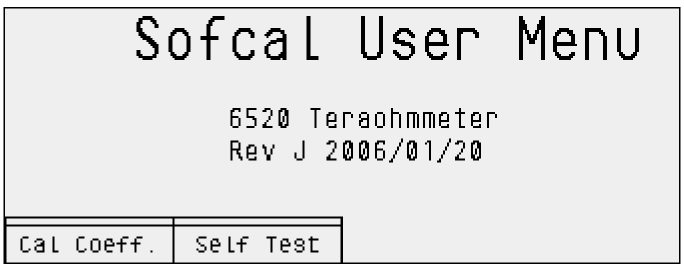
This allows the updating of the system date and time. The time is entered in 24 hour format.

4.9. Sofcal



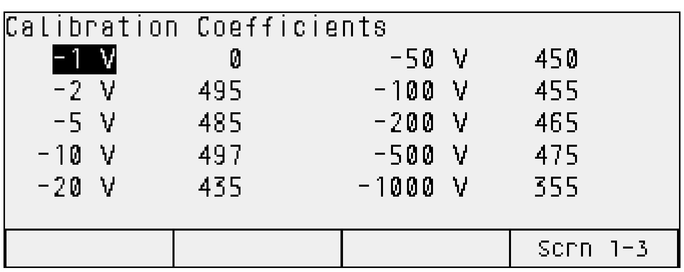
Section 5 provides a detailed explanation of calibration with the Sofcal program.

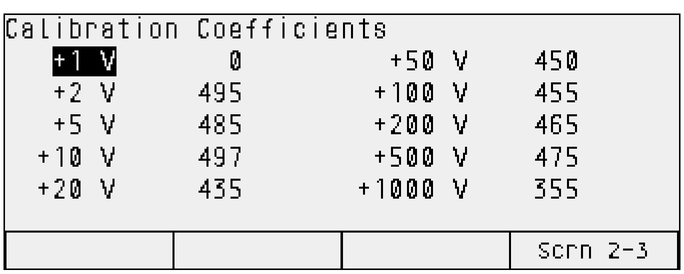
4.9.1. User



4.9.1.1.Calibration Coefficients

This menu displays the Calibration coefficients. It can be updated to re-enter the coefficients from the report given with you 6520 in the event of a non-volatile memory failure. These values are determined during the factory alignment or calibration.





```
Calibration Coefficients
  27pF     500         0.1V    450
 270pF     495         1.0V    455
2700pF     485        10.0V    465
Prot.   100030        Offset  0.00000303450
                      Gain 1.0000000000

                                  Scrn 3-3
```

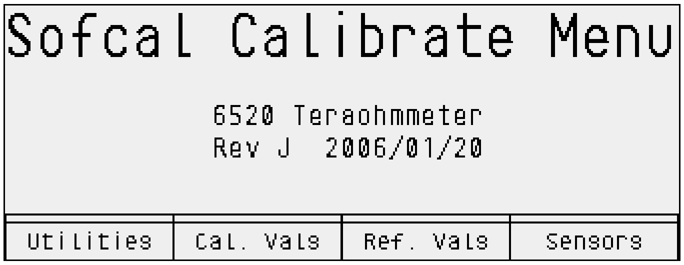
4.9.1.2.Self Test

```
Self Test - (Rev J Date 2006/01/20)

  Error Status : 0 0 0-00000000 0-0000
  ROM Checksum : 24891
  AUX ROM Checksums : -14501,25332
  NVSRAM Checksum : -18246

  OK         Press any key to exit
```

Self Test checks various parameters and displays the results.

Error Status. Bit 0 – Non-Volatile checksum failure
Bit 1 – Rom checksum failure. Could be ROM/Aux ROM.
Bit 2 – Analog failure.
Bit 3 - +5 volts
Bit 4 - -5 volts
Bit 5 - +15 volts
Bit 6 - -15 volts
Bit 7 – Precharge
Bit 8 – High voltage monitor
Bit 9 – 10 volt reference
Bit 10 - Ramp
Bit 11 – Digital failure.
Bit 12 - +5 volts
Bit 13 - -5 volts
Bit 14 - +15 volts
Bit 15 - -15 volts

4.9.2. Calibrate



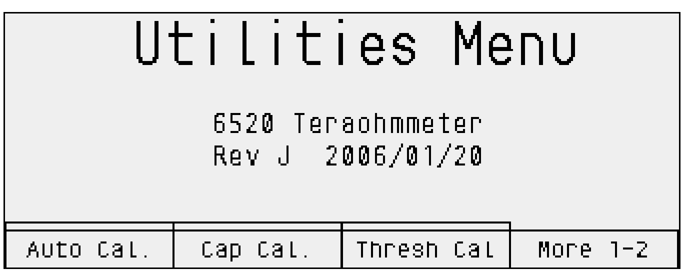
<Utilities> is used to calibrate the capacitors, thresholds, protection resistor and shunt.

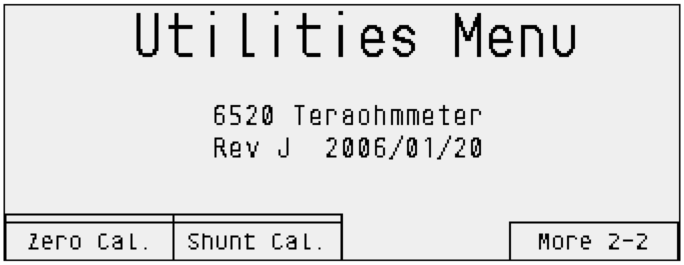
<Cal. Vals> is used to enter or modify the test volts, threshold, protection resistor and shunt correction values.

<Ref. Vals> is used to enter/modify the instrument serial number, calibration date, auto cal parameters, zero parameters and shunt parameters.

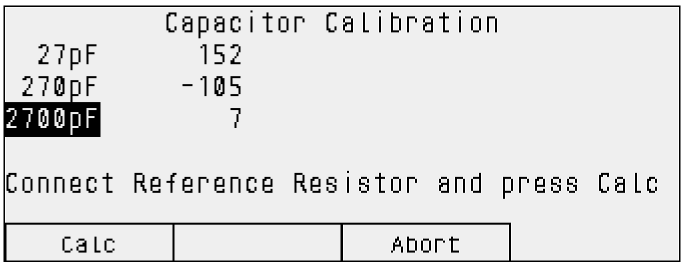
4.9.2.1.Utilities

It should be noted that the instrument may not reach a stable state if it is running in a environment which has climate fluctuations or high levels of electrical or other interference. In some cases it may be necessary to change the variance or the standard deviation from the system default values as displayed in the “Ref-Vals” submenu. If any of the calibration routines is unable to meet the specification then an error message <***** Sample Maximum Exceeded>** will be displayed and the procedure will be aborted.





4.9.2.1.1.Auto Calibration



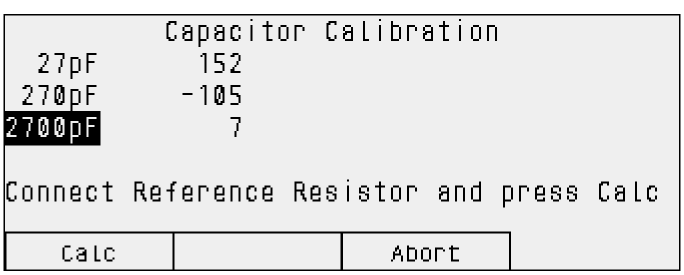
This automates the Capacitor and Threshold calibrations. It utilizes the same procedures as the Capacitor and Threshold calibration but it automatically steps through the three capacitors and the two thresholds. It also automatically sets the calibration date from the system date/time.

<Calc> starts the automated procedure.

<Abort> stops the procedure and restores the values to their original state.

4.9.2.1.2.Cap Calibration

The calibration coefficient is the difference in PPM between the measured value and the actual value of the three integrating capacitors used in the 6520. The three coefficient values are stored in the instruments memory and are used to compensate resistance measurements. If the capacitor values should ever change or if the value in memory should become corrupted, the SOFCAL program is able to measure the true value and store the new Capacitor coefficient value in the 6520 memory in place of the old stored value.



Select the desired capacitor with the Up/Down Arrow and press **<Calc>.**

```
          Capacitor Calibration
 27pF      152                    +1 V
 270pF    -105                       .
2700pF       0     100001360 Ohms
*spec err var 11.54  std dev 5.50
      25   10  var 1.51  std dev 0.57

                      Abort
```

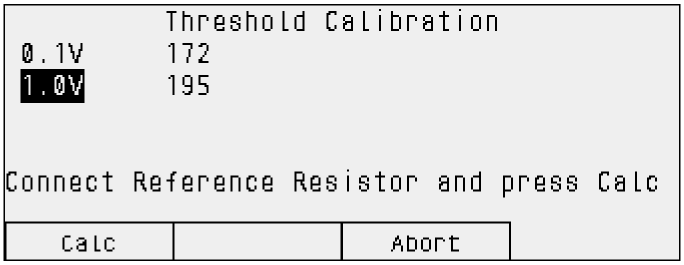
If the specified variance or standard deviation is exceeded then the sample count is reset to zero and the failed spec is displayed on the 5th line of the display. Line 6 of the display consists of the total measurement count, the number of samples which have currently been taken for the valid sample set and the current variance (PPM) and standard deviation (PPM) for the valid sample set.

```
            Capacitor Calibration
 27pF       152
 270pF     -105
2700pF        6
  Variance 1.25  Standard Deviation 0.58
Select Capacitor and press Calc

    Calc        Save       Abort
```

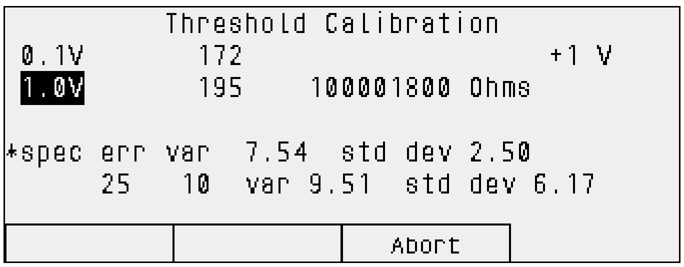
When the number of samples specified has been measured and have not exceeded the specification then the calibration routine has successfully completed and the actual variance (PPM) and standard deviation (PPM) is displayed. If for some reason the routine continues until the maximum retries has been reached, then the last window of samples are used to generate the actual variance (PPM) and standard deviation (PPM) that is displayed. The values are not stored in the 6520 non-volatile memory. When the calibration is complete it will allow the user to **<save>** the values or to select another capacitor and **<Calc>** the calibration coefficient.

4.9.2.1.3.Threshold Calibration

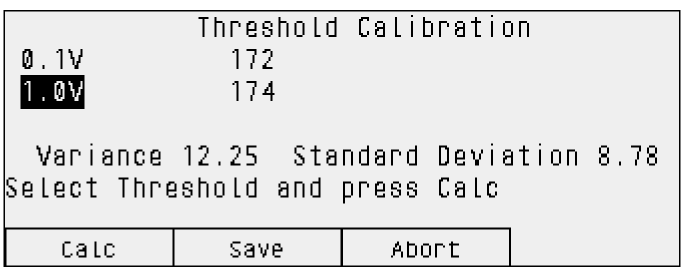
This is the difference in PPM between the measured value and the actual value of the threshold voltages occurring at the integrator output. The threshold coefficient values for the 0.1, 1 and 10 volt thresholds are stored by the 6520 and are used to correct the unknown resistance and current measurements.



Select the desired threshold with the Up/Down Arrow and press **<Calc>.**



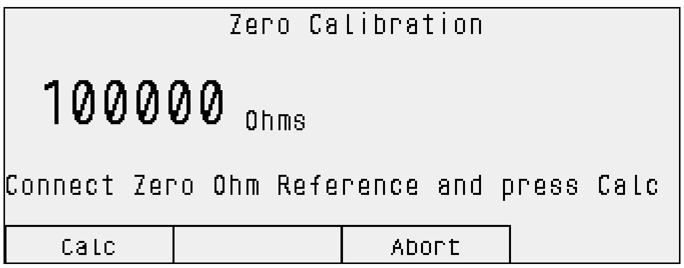
If the specified variance or standard deviation is exceeded then the sample count is reset to zero and the failed spec is displayed on the 5th line of the display. Line 6 of the display consists of the total measurement count, the number of samples which have currently been taken for the valid sample set and the current variance (PPM) and standard deviation (PPM) for the valid sample set.



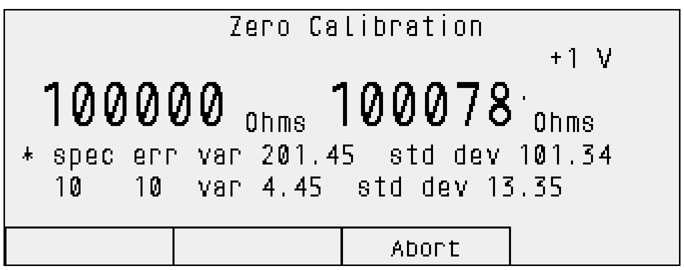
When the number of samples specified has been measured and have not exceeded the specification then the calibration routine has successfully completed and the actual variance (PPM) and standard deviation (PPM) is displayed. If for some reason the routine continues until the maximum retries has been reached, then the last window of samples are used to generate the actual variance (PPM) and standard deviation (PPM) that is displayed. The values are not stored in the 6520 non-volatile memory. When the calibration is complete it will allow the user to **<save>** the values or to select another capacitor and **<Calc>** the calibration coefficient.

4.9.2.1.4.Zero Calibration

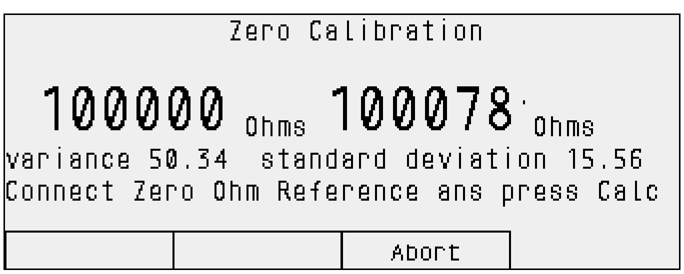
This is the value of the internal resistance presented by the 6520 between the input connector and ground. The 6520 maintains a stored value for this resistance in its memory and subtracts it from all resistance measurements before the final value of the unknown resistance is put on the front panel display or made available at either control bus. If the ZERO CAL resistance should change or if the stored value should become corrupted in the memory, the 6520 is capable of re-measuring the true value and entering the true value into memory.



<Calc> starts the calibration procedure.



If the specified variance or standard deviation is exceeded then the sample count is reset to zero and the failed spec is displayed on the 5th line of the display. Line 6 of the display consists of the total measurement count, the number of samples which have currently been taken for the valid sample set and the current variance (PPM) and standard deviation (PPM) for the valid sample set.



When the number of samples specified has been measured and have not exceeded the specification then the calibration routine has successfully completed and the actual variance (PPM) and standard deviation (PPM) is displayed. If for some reason the routine continues until the maximum retries has been reached, then the last window of samples are used to generate the actual variance (PPM) and standard deviation (PPM) that is displayed. The values are not stored in the 6520 non-volatile memory. When the calibration is complete it will allow the user to **<save>** the values or to select another capacitor and **<Calc>** the calibration coefficient.

4.9.2.1.5.Shunt Calibration

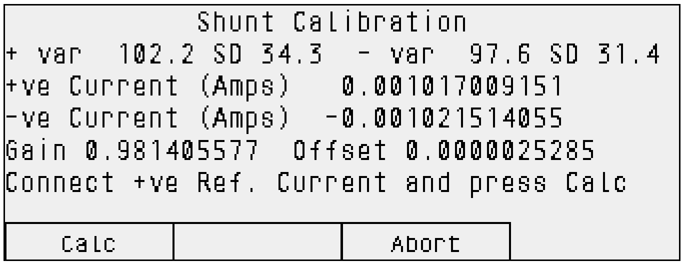
```
            Shunt Calibration

+ve Current (Amps)
-ve Current (Amps)

Connect  +ve Ref. Current and press Calc

   Calc    |          |   Abort
```

```
            Shunt Calibration

+ve Current (Amps)
-ve Current (Amps)

Connect -ve Ref. Current and press Calc

   Calc    |          |   Abort
```

A known reference current source is required which must be approximately 1mA. The polarity must be connected positive first and switched to negative when prompted.

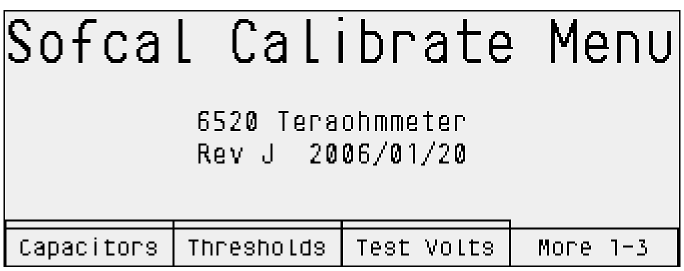
```
            Shunt Calibration
* spec err  var 367.51  std dev 76.23
+ve Current (Amps)   0.001017009151
-ve Current (Amps)

    45   15  var 75.34   std dev 38.46

   Calc    |          |   Abort
```

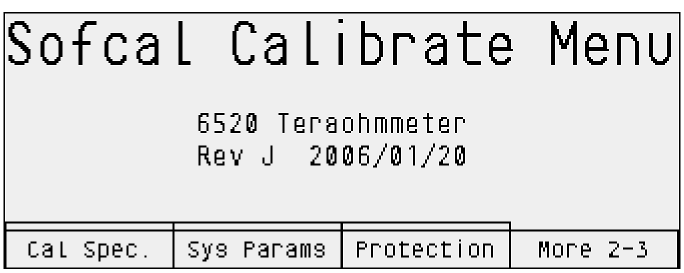
If the specified variance or standard deviation is exceeded then the sample count is reset to zero and the failed spec is displayed on the 2nd line of the display. Line 6 of the display consists of the total measurement count, the number of samples which have currently been taken for the valid sample set and the current variance (PPM) and standard deviation (PPM) for the valid sample set.

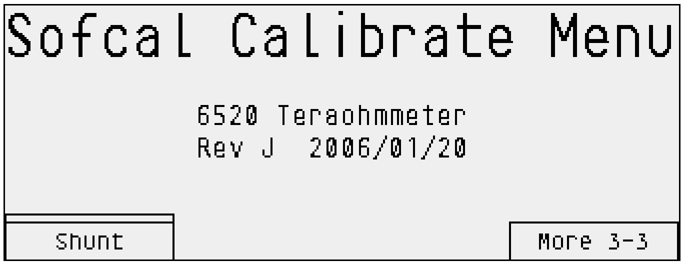


When the number of samples specified has been measured and have not exceeded the specification, for both polarities, then the calibration routine has successfully completed and the actual variance (PPM) and standard deviation (PPM) is displayed. If for some reason the routine continues until the maximum retries has been reached, then the last window of samples are used to generate the actual variance (PPM) and standard deviation (PPM) that is displayed. The values are not stored in the 6520 non-volatile memory. When the calibration is complete it will allow the user to **<save>** the values or to select another capacitor and **<Calc>** the calibration coefficient.

4.9.2.2.Calibration Coefficient Values

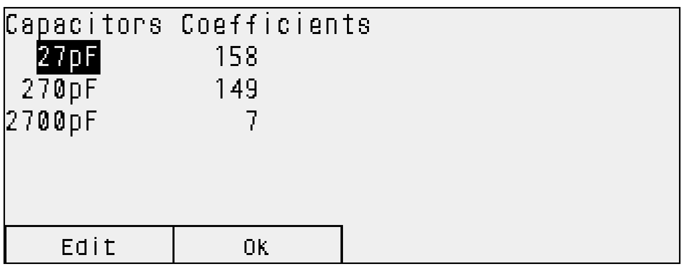






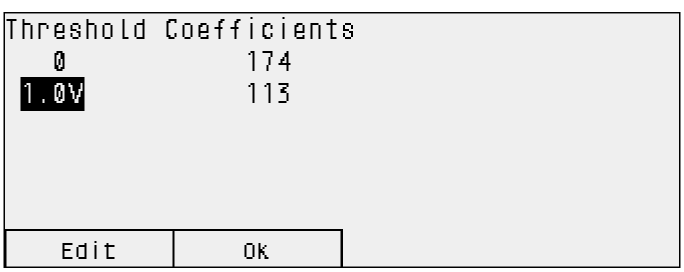
This section allows the editing of the calibration coefficients values.

4.9.2.2.1.Capacitor Coefficients



Pressing the **<Capacitors>** key will display the coefficients stored for each capacitor. By pressing the **<Edit>** key the numbers may be altered by pressing a new sequence of numbers followed by pressing the **<Ok>** key. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu.

4.9.2.2.2.Threshold Coefficients



Pressing the **<Thresholds>** key will display the coefficients stored for each threshold. By pressing the **<Edit>** key the numbers may be altered by pressing a new sequence of numbers followed by pressing the **<Ok>** key. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu.

4.9.2.2.3.Test Volts

Voltage Coefficients			
-1 V	500	-50 V	450
-2 V	495	-100 V	455
-5 V	485	-200 V	465
-10 V	497	-500 V	475
-20 V	435	-1000 V	355
Edit	Ok		Scrn 1-2

Voltage Coefficients			
+1 V	500	+50 V	450
+2 V	495	+100 V	455
+5 V	485	+200 V	465
+10 V	497	+500 V	475
+20 V	435	+1000 V	355
Edit	Ok		Scrn 2-2

Pressing the **<Test Volts>** key will display the test voltages and the coefficients stored for each step. A new value may be entered for each test voltage by pressing the <Edit> key and the numeric keys for the new value, followed by the **<Ok>** key. Press the UP or DN key to select the next test voltage coefficient. The different test voltages are 1, 2, 5, 10, 50, 100, 200, 500, and 1000 in both polarities (±). To determine the output test voltage coefficient a DVM must connected to the Output/Source connector. The following equation is used to calculate the value to enter for each output test voltage range. (see section 5.1.2)

$$\begin{array}{c}\text{Test}\\ \text{Voltage}\\ \text{Coefficient}\end{array} = \begin{array}{c}\text{number to}\\ \text{be keyed}\\ \text{into display}\end{array} = \frac{\text{DVM reading} - |\text{Nominal Voltage}|}{|\text{Nominal Voltage}|} \times 10^6$$

Due to the large number of output test voltage points to be measured during calibration, it is recommended that the numbers are entered using one of the interface busses (GPIB or RS-232C).

4.9.2.2.4.Cal Spec.

	Count	Sample	Variance	Std Dev
27pF	260	100	1.673	0.574
270pF	95	60	6.565	1.749
2700pF	96	30	1.023	0.545
0.1V	173	100	5.645	1.482
1.0V	90	60	1.825	0.632

Press any key to exit

This displays the statistics of the last time that the Utilities were used to establish the Capacitor and Threshold coefficients. It displays the total count of samples required to meet the specification as well as the actual variance and standard deviation for the specified sample size.

4.9.2.2.5.System Parameters

```
System Parameters
Sample Count  90          2700pF 10.0V
Sample Size  100
Window Size    1
Positive Coefficient   -734
Negative Coefficient   -734

   Edit   |   Ok   | 90k-200k |   1V
```

Pressing the **<Sys Params>** key will display the system parameters stored for the 6520. **<Function key 3>** selects the resistance range. **<Function key 4>** selects the available voltage within the resistance range. By pressing the **<Edit>** key the numbers may be altered by pressing a new sequence of numbers followed by pressing the **<Ok>** key. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu.

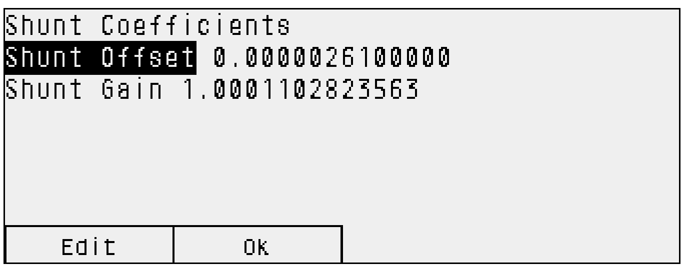
NOTE: Do not alter the system parameters as they will affect the accuracy of the 6520. These are factory set parameters. Access to the parameters is only recommended in the event of a non-volatile memory failure, to confirm and, if required, edit them to return them to the values set by the factory. These values are supplied in hard copy on the instrument report.

4.9.2.2.6.Protection Resistor

Pressing the **<Protection>** key will display the error stored for the internal series protection resistor. By pressing the **<Edit>** key the number may be altered by

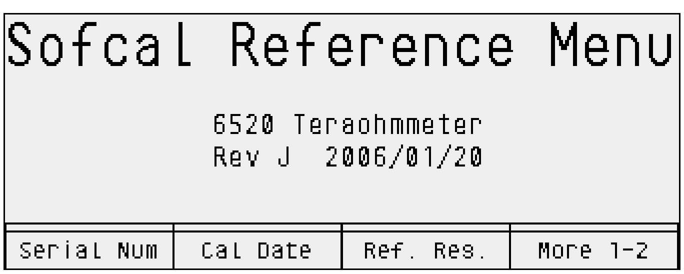
pressing a new sequence of numbers followed by pressing the **<Ok>** key. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu

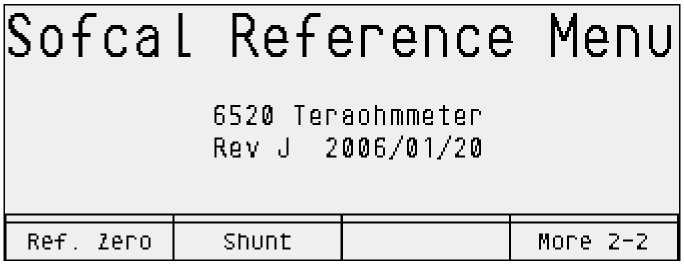
4.9.2.2.7.Shunt Coefficient



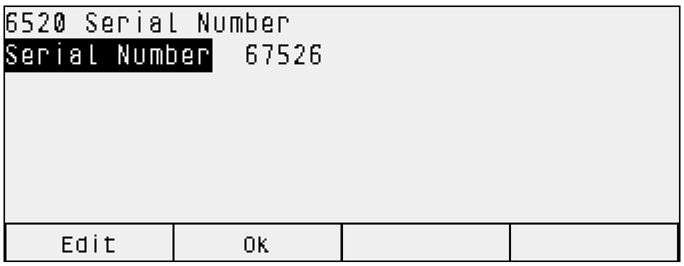
Pressing the **<Shunt>** key will display the gain and offset stored for the internal current resistor. By pressing the **<Edit>** key the numbers may be altered by pressing a new sequence of numbers followed by pressing the **<Ok>** key. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu

4.9.2.3.Reference Values



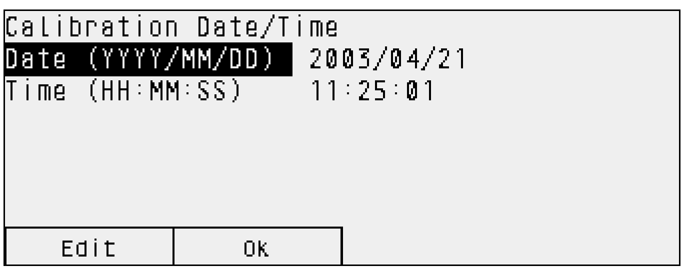


4.9.2.3.1.Serial Number



Used to record serial number from the back plate of 6520.

4.9.2.3.2.Calibration Date



This is the date of last calibration. If a new calibration date is to be entered press the **<Edit>** key. A new date may be keyed in with the numeric keys of the keypad. The calibration date is saved when the **<Ok>** key is pressed. Pressing the **<PREVIOUS>** key exits to the SOFCAL Calibrate Menu.

This is used to record the last date of calibration. It needs to be updated when the 6520 is re-calibrated.

4.9.2.3.3.Reference Resistor

```
Reference Resistor Calibration Values
Reference Resistor        100001200
Serial Number             123456
Variance 2700pF (PPM)         5.00
Standard Dev. 2700pF          2.5
Sample Size 2700pF            30

   Edit   |   Ok    |         | Scrn 1-4
```

```
Reference Resistor Calibration Values
Variance 270pF (PPM)          7.00
Standard Dev. 270pF           3.50
Sample Size 270pF             60
Variance 27pF (PPM)          10.00
Standard Dev. 27pF            5.00

   Edit   |   Ok    |         | Scrn 2-4
```

```
Reference Resistor Calibration Values
Sample Size 27pF              100
Variance 1.0V (PPM)           3.00
Standard Dev. 1.0V            1.25
Sample Size 1.0V              60
Variance 0.1V (PPM)          12.00

   Edit   |   Ok    |         | Scrn 3-4
```

```
Reference Resistor Calibration Values
Standard Dev. 0.1V            3.5
Sample Size 0.1V              100
Maximum Sample Count          3000



   Edit   |   Ok    |         | Scrn 4-4
```

This is used to record the value of the reference resistor used to calibrate the 6520. It is critical that it be entered prior to calibration of the 6520.

A separate value for variance, standard deviation and sample size is used for 2700pF cap, 270pF cap, 27pF cap, 1.0V threshold and 0.1V threshold.

Variance is the difference between the maximum and minimum reading in PPM. This is used to ensure that the reading has stabilized before calculating the calibration coefficient.

Standard deviation (PPM) is used to further ensure that the measurement is stable and within spec.

Sample Size is used to specify the number of measurements to be used for calculating the coefficients.

Maximum Sample Count is set to specify the total number of measurements to be taken before the process is interrupted. Maximum Sample Count is a global setting for all tests in the Auto Cal functions.

It should be noted that the instrument may not reach a stable state if it is running in an environment which has climate fluctuations or high levels of electrical or other types of interference. This will result in the 6520 running until the Maximum Sample Count is reached for each test that cannot satisfy the criteria set in Standard Deviation and Variance. In some cases it may be best to change the variance or the standard deviation from the system default values.

System Default Values:

	Variance	Standard Deviation	Sample Size
2700pF	5.00 (ppm)	2.50 (ppm)	30
270pF	7.00 (ppm)	3.50 (ppm)	60
27pF	10.00 (ppm)	5.00 (ppm)	100
1.0V	3.00 (ppm)	1.25 (ppm)	60
0.1V	12.00 (ppm)	5.00 (ppm)	100

Maximum Sample Count 3000 (global setting for each test)

4.9.2.3.4. Protection Resistor Reference Values

```
Protection Resistor Calibration Values
Variance (PPM)             200.00
Standard Deviation         100.00
Sample Size                25
Maximum Sample Count       1000

   Edit   |   Ok   |        |
```

Variance is the difference between the maximum and minimum reading in PPM. This is used to ensure that the reading has stabilized before calculating the calibration coefficient.

Standard deviation (PPM) is used to further ensure that the measurement is stable and within spec.

Sample Size is used to specify the number of measurements to be used for calculating the coefficients.

Maximum Sample Count is set to specify the total number of measurements to be taken before the process is interrupted.

It should be noted that the instrument may not reach a stable state if it is running in an environment which has climate fluctuations or high levels of electrical or other types of interference. This will result in the 6520 running until the Maximum Sample Count is reached for each test that cannot satisfy the criteria set in Standard Deviation and Variance. In some cases it may be best to change the variance or the standard deviation from the system default values.

System Default Values:

Variance	**Standard Deviation**	**Sample Size**
200.00 (ppm)	100.00 (ppm)	30

Maximum Sample Count 1000

4.9.2.3.5.Shunt Reference Values

Reference Current (Amps)	0.00100000
Variance (PPM)	40.00
Standard Deviation	15.00
Sample Size	60
Maximum Sample Count	1000
Minimum Sample Delay	0

Edit	Ok		

Reference current is used to calibrate the shunt. It is set to 1mA but can have a value from 100 micro amps to 10 milli amps. It is critical that it be entered prior to shunt calibration of the 6520.

Variance is the difference between the maximum and minimum reading in PPM. This is used to ensure that the reading has stabilized before calculating the calibration coefficient.

Standard deviation (PPM) is used to further ensure that the measurement is stable and within spec.

Sample Size is used to specify the number of measurements to be used for calculating the coefficients.

Maximum Sample Count is set to specify the total number of measurements to be taken before the process is interrupted. Maximum Sample Count is a global setting for both polarities in the Current Shunt Cal function.

It should be noted that the instrument may not reach a stable state if it is running in an environment which has climate fluctuations or high levels of electrical or other types of interference. This will result in the 6520 running until the Maximum Sample Count is reached for each test that cannot satisfy the criteria set in Standard Deviation and Variance. In some cases it may be best to change the variance or the standard deviation from the system default values.

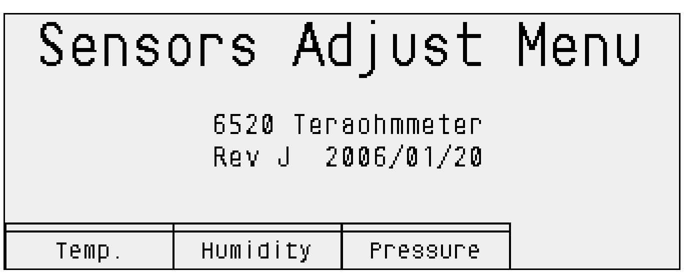
System Default Values:

Variance	**Standard Deviation**	**Sample Size**
40.00 (ppm)	15.00 (ppm)	60

Maximum Sample Count 1000

Minimum Sample Delay 0 second

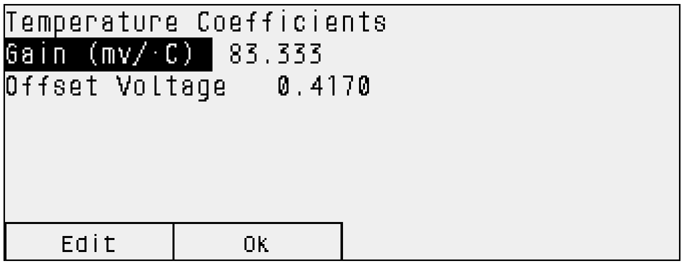
4.9.2.4.Sensors



This section allows setting the gain and Offset Voltage for the sensors. The gain is specified in mV per each unit of measurement.

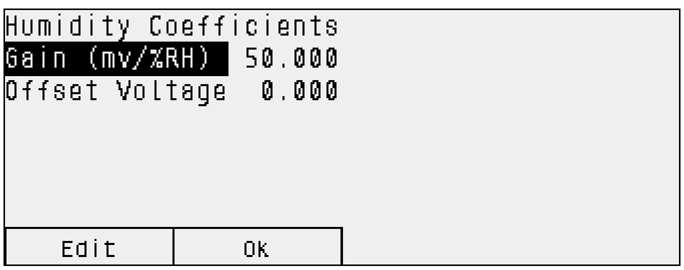
N.B. The default parameters are set for the Guildline environmental sensors option.

4.9.2.4.1.Temperature



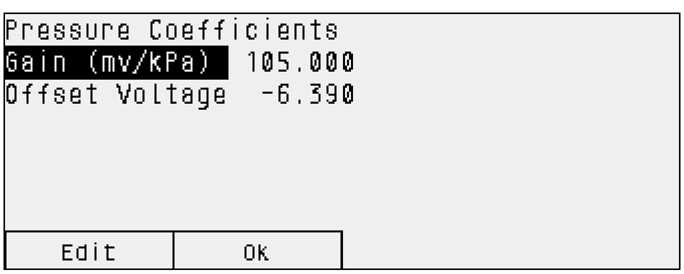
This example supports a sensor that generates 417 millivolts at 0 degrees Celsius and has a sensitivity of 83.333 mv/°C.

4.9.2.4.2.Humidity



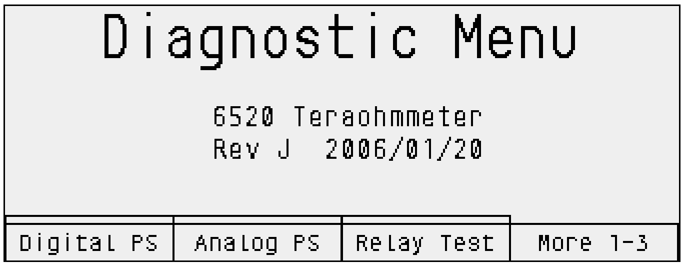
This example supports a sensor that generates 0 volts at 0% relative humidity and has a sensitivity of 50 mv/%RH.

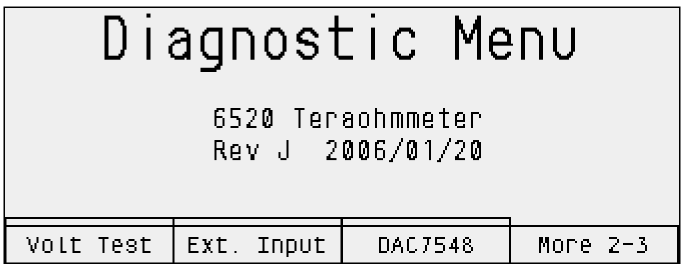
4.9.2.4.3.Pressure

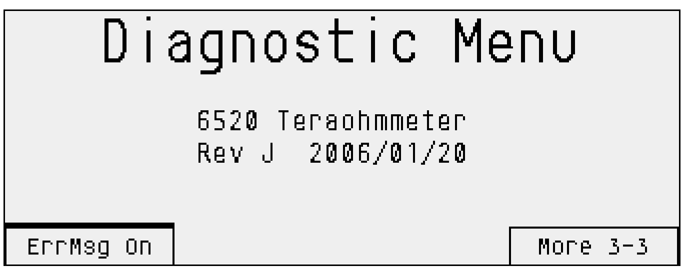


This example supports a sensor that generates –6.390 volts at 0 kPa atmospheric pressure and has a sensitivity of 105 mv/kPa.

4.9.3. Diagnostics



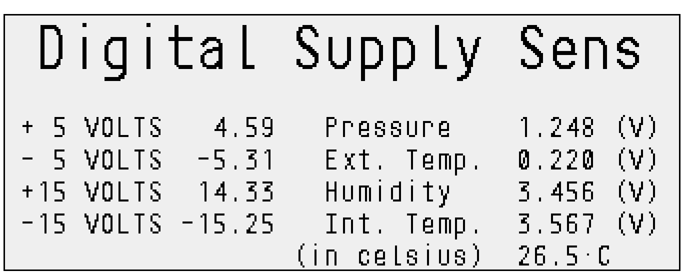




<ErrMsg Off> | <ErrMsg On> Disables/Enables on screen error messages.

The diagnostics section is used by the service technician to monitor voltage and to allow the testing of some of the input and outputs of the system.

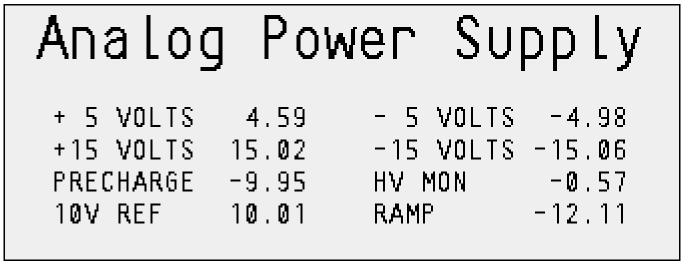
4.9.3.1.Digital PS



The screen updates the values every 5 seconds.

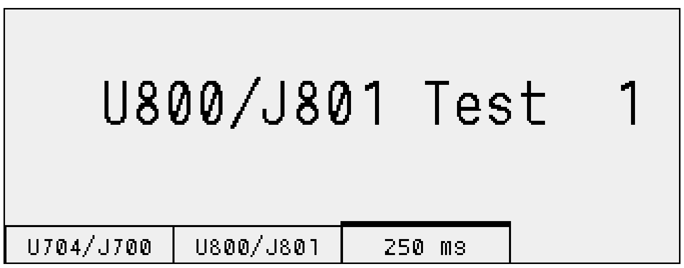
Any key exits to Diagnostics Menu.

4.9.3.2.Analog PS



The screen updates the values every 5 seconds.
Any key exits to Diagnostics Menu.

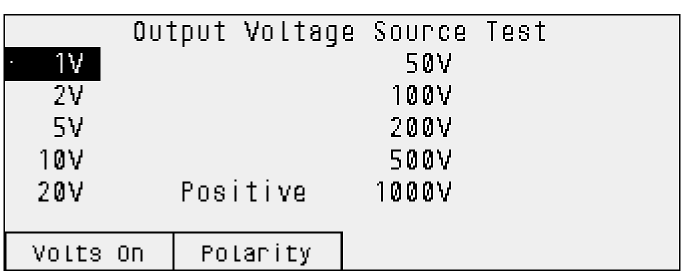
4.9.3.3.Relay Test



This diagnostic tool requires a Guildline test jig and is only used by a qualified Guildline technician. It allows the monitoring of the digital outputs of the CPU board through the LED indicators on the test jig. An example of this is the source voltage relay controls (J801-9 – J801-15).

User selectable time delay between setting relays. 250 ms | 500 ms | 1 second | 2 seconds

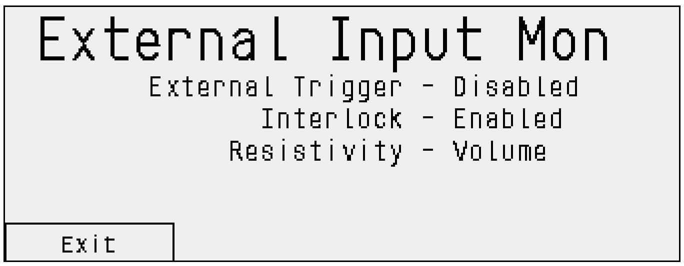
4.9.3.4.Voltage Test



This is procedure requires the use of a DVM.

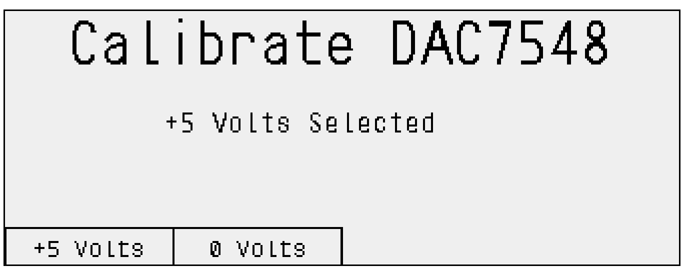
Volts On/Volts Off turns the high voltage on/off.
Polarity Positive | Negative

4.9.3.5.External Input



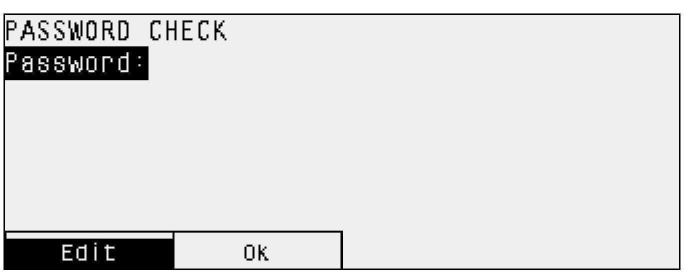
This is used tp check the status of external inputs. It can also be used to test the inputs. Interlock can be disabled from the Configure Menu.

4.9.3.6.DAC7548 Calibrate



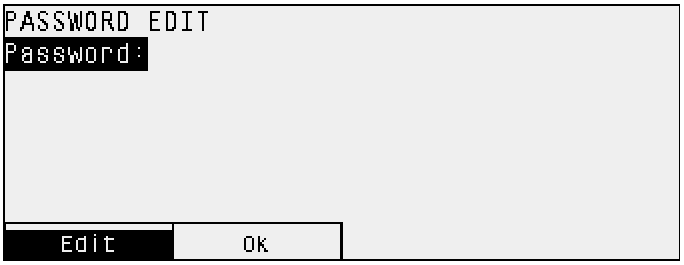
This is a factory calibration procedure for aligning the DAC7548 and is not part of the operational procedures.

4.9.4. Password



This is to allow the updating of the password. The system default password is 6520.

Enter the current password then press **<Ok>.**



If the system is signed on with the correct password then the system will prompt for the new password.
Enter the new password then press **<Ok>.**
<PREVIOUS> will return to the **Sofcal Menu.**

4.10. Menu System Hierarchy Diagrams

The menu system hierarchy used by the 6520 is outlined below. It has a separate section for Ohms, Current, Resistivity, Setup, and Calibrate.

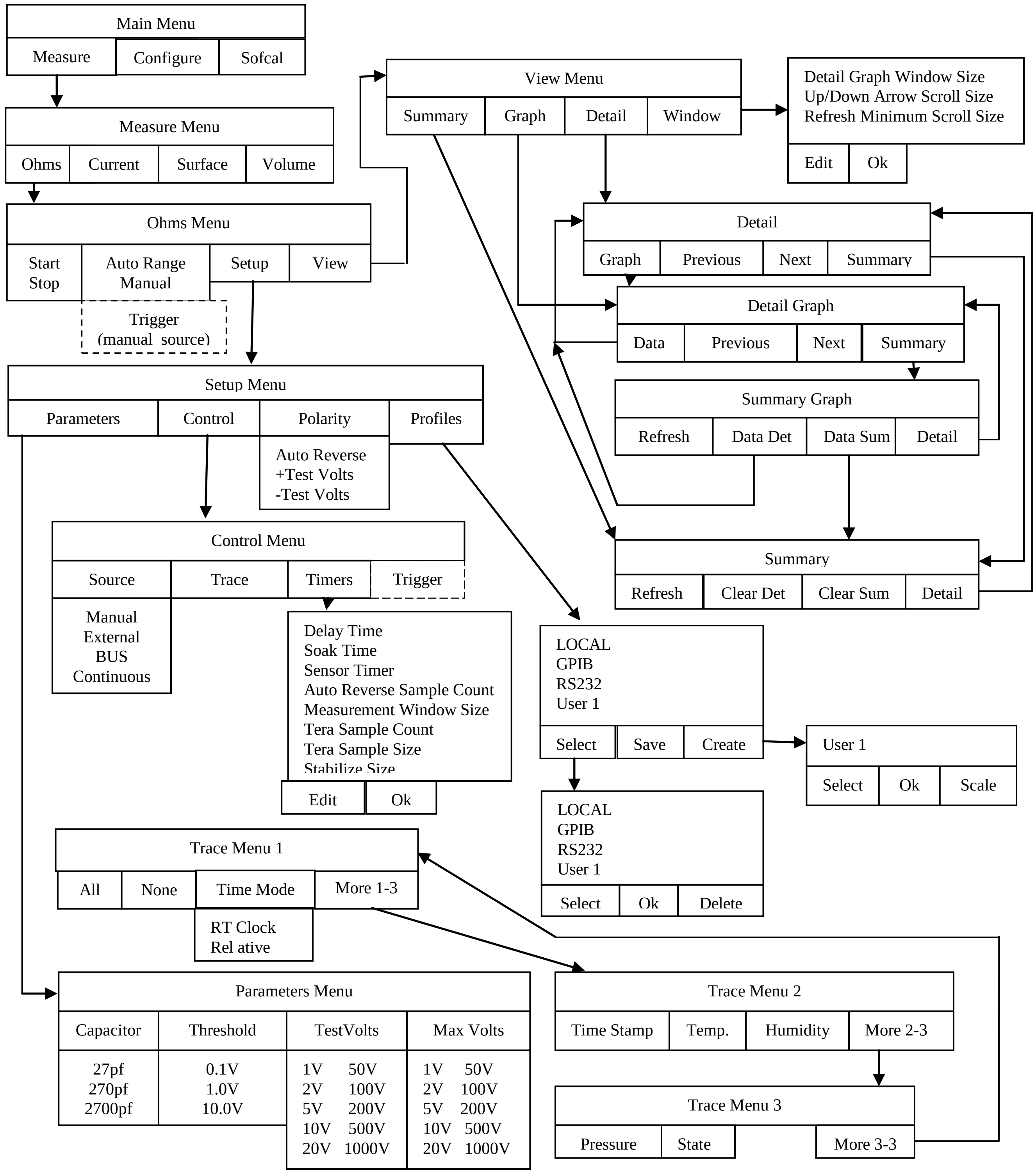


Figure 4-2: Ohms Hierarchy

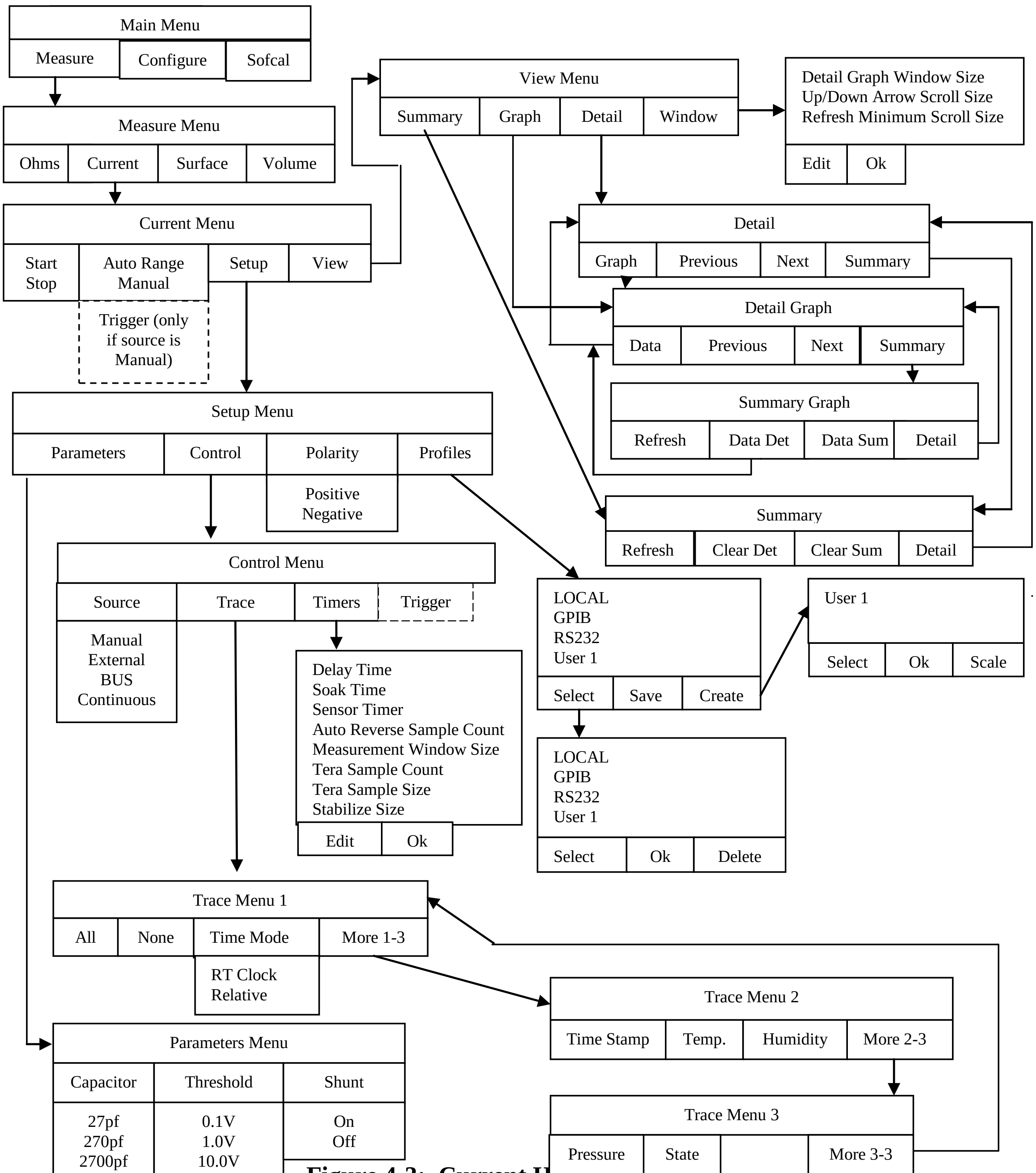


Figure 4-3: Current Hierarchy

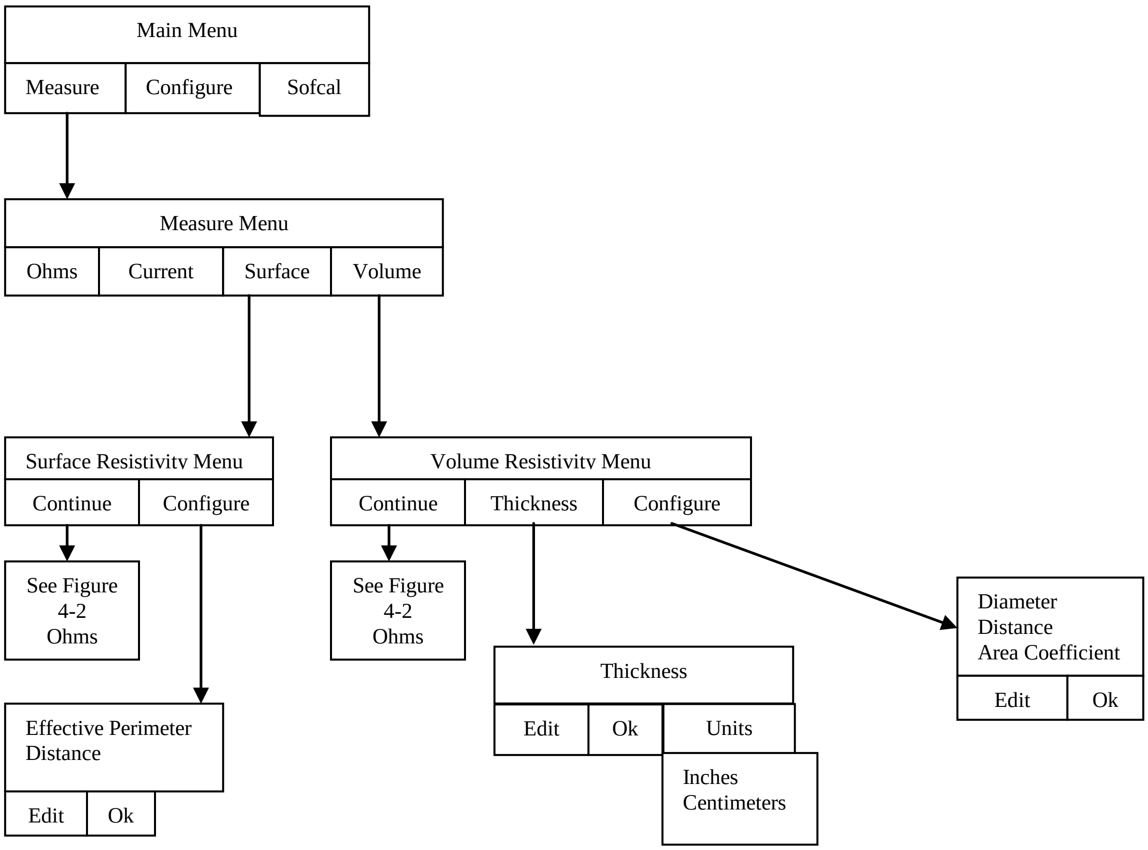


Figure 4-4: Resistivity Hierarchy

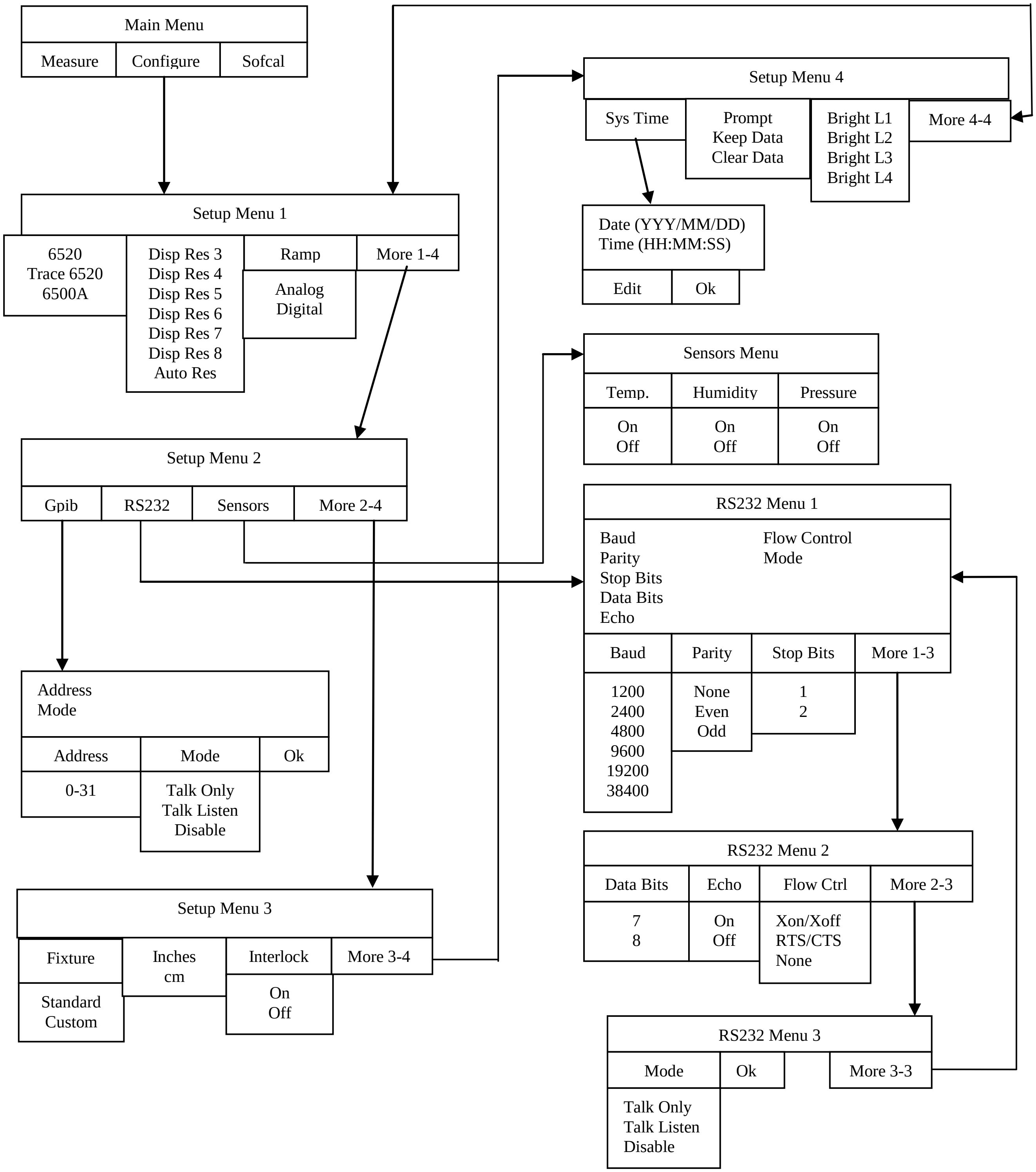


Figure 4-5: Setup Hierarchy

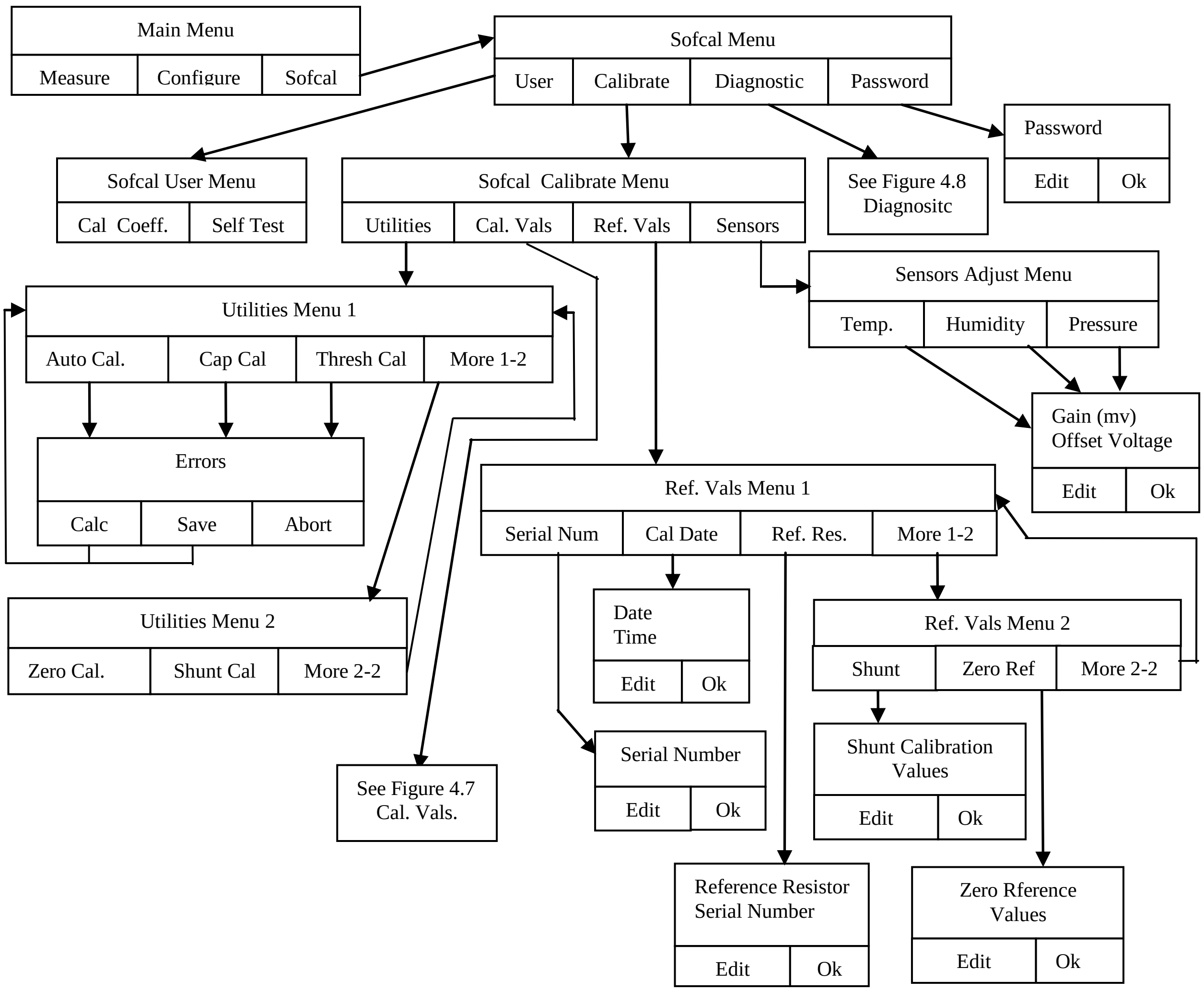


Figure 4-6: Sofcal Hierarchy

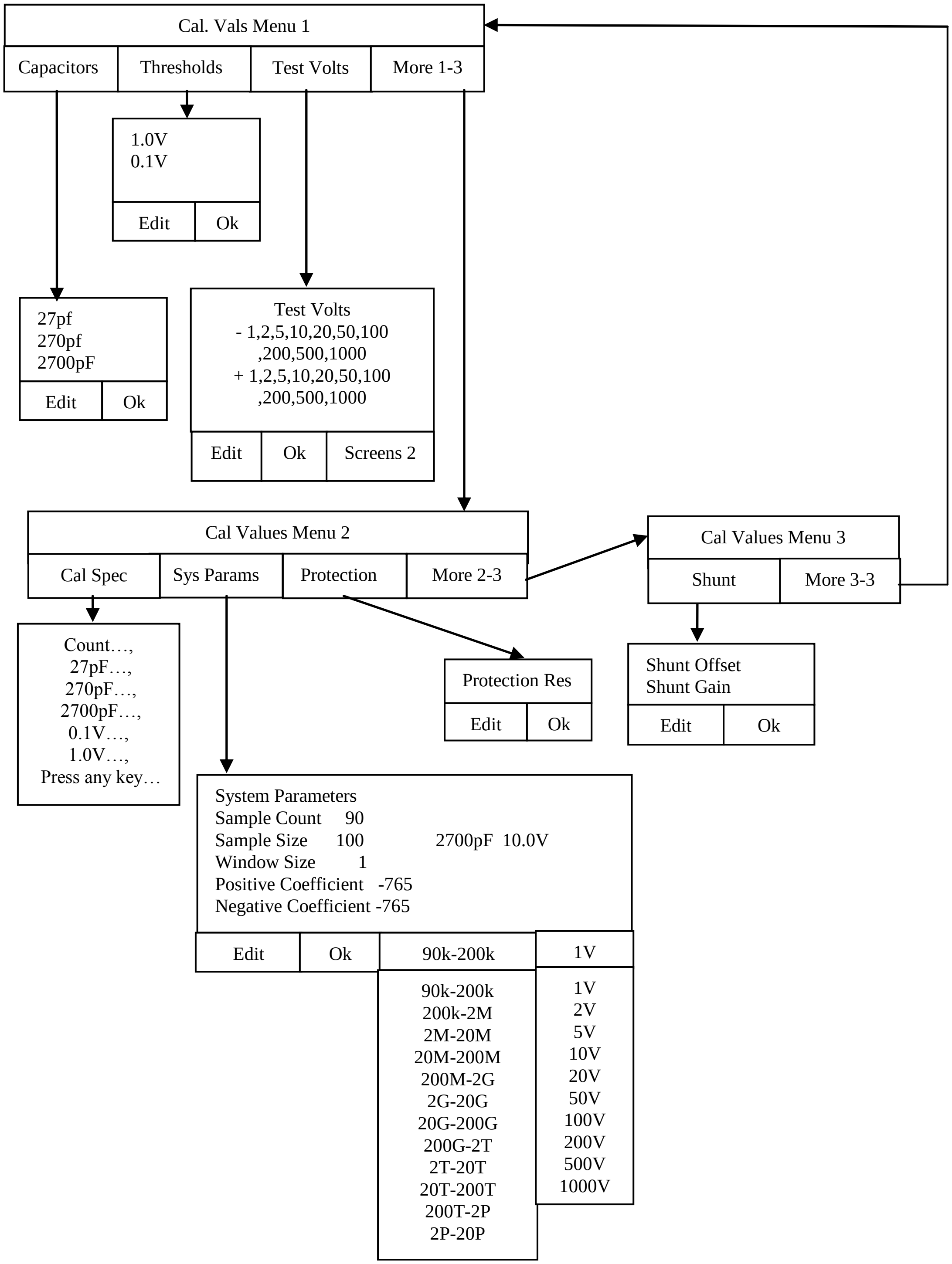


Figure 4-7: Sofcal Cal. Vals. Hierarchy

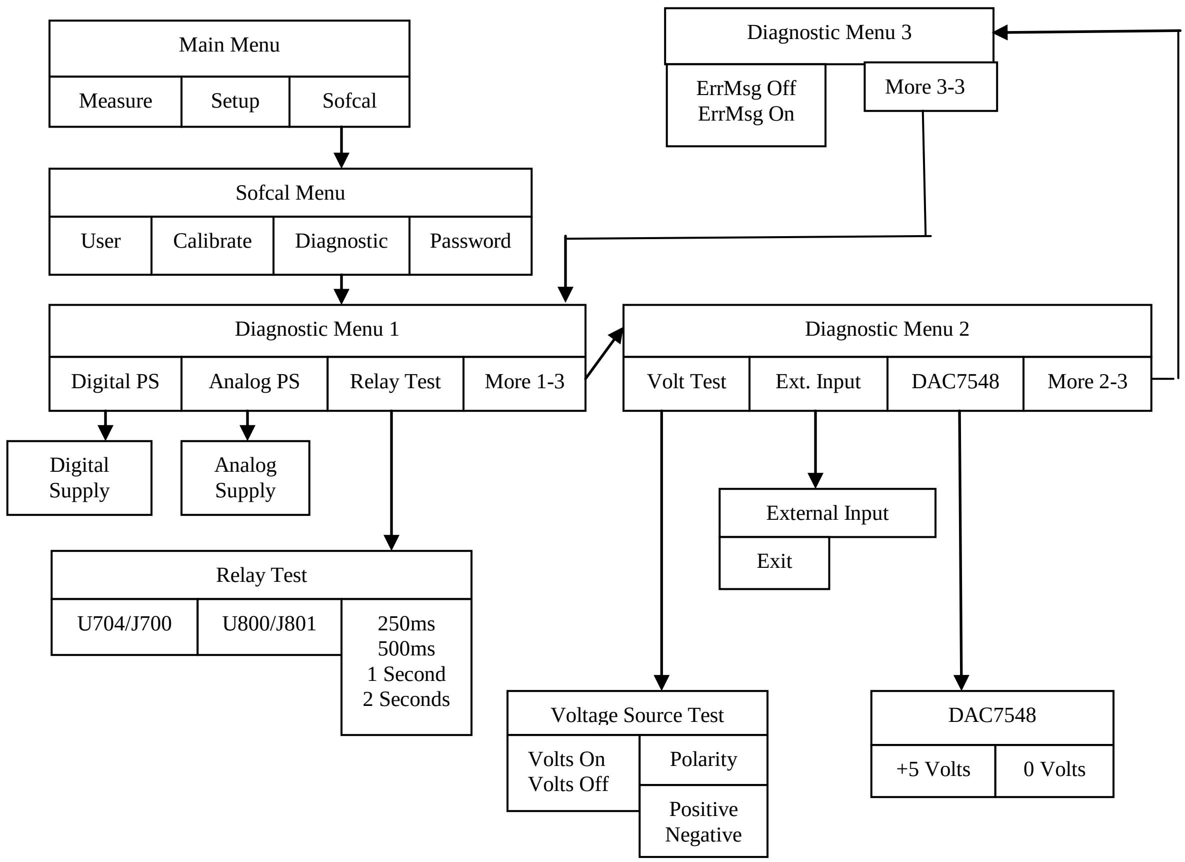


Figure 4-8: Sofcal Diagnostic Hierarchy

5. VERIFICATION AND CALIBRATION

5.1. CALIBRATION DESCRIPTION

The procedure outlined in this section may be used to perform system verification of the 6520 Teraohmmeter for proper operation. This verification procedure may be performed when the instrument is first received to ensure that no damage or maladjustment has occurred during shipment.

5.1.1. ENVIRONMENTAL CONDITIONS

Verification checks should be made only when the instrument is being operated within the operating limits of temperature and humidity specified in Section 7 of this manual.

5.1.2. INITIAL CONDITIONS

A warm-up time of at least one hour must be allowed before beginning the verification process. If the instrument has been subjected to extremes of temperature outside the operating limits, additional time should be allowed for the instrument components to stabilize to their normal operating temperatures. Typically, it takes one additional hour to stabilize a unit that has been exposed to a temperature 10°C outside the specified temperature range.

5.1.3. RECOMMENDED TEST EQUIPMENT

Table 5-1 lists all test equipment required for the verification of the 6520 Teraohmmeter. Alternate equipment may be used as long as the substitute equipment has specifications as good as or better than the equipment listed.

Description	Specification	Manufacturers Model
Digital Voltmeter	±0.003% accuracy 10 megohm input impedance (minimum)	HP/Agilent 3458 or Fluke 8508

Table 5-1: Recommended Verification Test Equipment

5.1.4. CHECK CALIBRATION REPORT

The following paragraph details the procedures to be used to check the stored calibration coefficients against the coefficients listed on the instrument calibration report. If the instrument has been re-calibrated or adjustments made to the instrument after the date printed on the calibration report, the stored coefficients may not match the coefficients listed in the report. The user should verify the instrument against the most recent calibration report.

5.1.4.1. CALIBRATION COEFFICIENTS

- Reference should be made to Section 5.5.2
- Apply power to the instrument
- Verify that the unit passes all self-tests
- Press the **<SOFCAL>** key
- Press the **<Calibrate>** key
- Press the **<Ref Vals>** key
- Press the **<Serial Num>** key
- Verify that the serial number displayed matches the serial number printed on the rear of the instrument and on the instrument calibration report.
- Press the **<PREVIOUS>** key to exit to the Calibrate menu
- Press the **<PREVIOUS>** key to exit to the Sofcal menu
- Press the **<User>** key to enter the User menu
- Press the **<Err Coeff>** key to enter the Error coefficients menu
- Verify the error displayed for each test voltage matches the value listed in the calibration report
- Verify the error displayed for the ZERO COEFFICIENT matches the value listed in the calibration report
- Verify the error displayed for the CAPACITOR COEFFICIENTS matches the values listed in the calibration report
- Verify the error displayed for the THRESHOLD COEFFICIENTS matches the values listed in the calibration report
- Verify the error displayed for the SHUNT COEFFICIENT matches the value listed in the calibration report
- Press the **<PREVIOUS>** key to exit to the User menu
- Press the **<PREVIOUS>** key to exit to the Sofcal menu

5.1.5. TEST VOLTAGE VERIFICATION

Connect the Digital Voltmeter to the SOURCE connector of the 6520 under test.

Put the instrument into the SOFCAL DIAGNOSTIC MENU

Select **<Volt Test>** function key to perform Voltage Test.

Use the Up/Down arrow keys to select the +1 V test voltage.

Press the **<Volts On>** key to turn the SOURCE output on.

Record the reading displayed by the DVM. Press the **<Down Arrow>** key to select the next test voltage. Record each test voltage nominal value (Vnom) and the DVM reading (Vdvm) for each test voltage (+1 V through +1000 V and -1 V through -1000 V). Press the **<Volts Off>** key to turn the SOURCE output OFF. Calculate the test voltage error value from the following expression:

$$\text{Error (ppm)} = \frac{V_{dvm} - V_{nom}}{V_{nom}} \times 10^6$$

Use the absolute value of Vdvm and Vnom. For each test voltage verify that the Error (ppm) does not exceed the +/-50 (ppm) of the listed value in the calibration report (Table 5-3).

5.1.6. OPERATIONAL CHECK

Performing an instrument Power On Reset and observing the response can check the operation of the Teraohmmeter display and indicators. The Teraohmmeter will respond as detailed in Section 4.2. Power "On" the instrument and observe that the instrument responds to the series of internal diagnostic checks as detailed in Section 4.2

5.2. CALIBRATION PROCEDURE

The procedure outlined in this section may be used to perform an Artifact Calibration on the 6520 Teraohmmeter to operate within the limits stated in the specifications (Section 7) of this manual. This calibration procedure should be executed on an annual basis as a minimum to maintain full rated 12 month accuracy. A full confirmation of the 6520 should be performed whenever there is a question of instrument accuracy following an artifact calibration. Full performance confirmation and any subsequent adjustments, though recommended to be performed at the factory, may be performed by a qualified individual as per the procedure outlined in the Service Manual (SM6520). This manual can be obtained from Guildline Instruments Limited. A brief description of the Calibration and Instrument theory can be found in Section 5.4.

5.2.1. ENVIRONMENTAL CONDITIONS

Calibration of the instrument should only be performed while the 6520 is being operated within the operating limits of temperature and humidity specified in Section 7 of this manual.

5.2.2. INITIAL CONDITIONS

A warm-up time of at least one hour must be allowed before beginning the verification process. If the instrument has been subjected to extremes of temperature outside the operating limits, additional time should be allowed for the instrument components to stabilize to their normal operating temperatures. Typically, it takes one additional hour to stabilize a unit that has been exposed to a temperature 10°C outside the specified temperature range.

5.2.3. RECOMMENDED TEST EQUIPMENT

Table 5-2 lists all test equipment required for the Artifact Calibration of the 6520 Teraohmmeter. Alternate equipment may be used as long as the substitute equipment has specifications as good as or better than the equipment listed.

Description	Specification	Manufacturers Model
Digital Voltmeter	±0.003% accuracy 10 megohm input impedance (minimum)	HP/Agilent 3458 or Fluke 8508
Calibration Resistor	100 megohm traceable to NRCC or NIST	Guildline 9336/100M or equivalent
Short Circuit	0 ohm link	Guildline 65224
Multifunction Calibrator (optional)	±0.02% accuracy at 10μA	Fluke 5700A or equivalent

Table 5-2: Recommended Calibration Test Equipment

5.2.4. OUTPUT VOLTAGE CALIBRATION

Connect the Digital Voltmeter to the SOURCE connector of the 6520 under test (use the MHV-M to BANANA PLUG cable P/N 30046-01-21). Attach the TRIAX to type N cable to the INPUT connector.

Put the instrument into the SOFCAL DIAGNOSTIC Menu (reference Section 4.9.3)

Select the +1 V test voltage
Press the **<Volts On/Off>** function key to turn SOURCE output on.

Allow sufficient time for the DVM reading to stabilize. Record the reading displayed by the DVM. Press the <DN> key to select the next test voltage. Record each test voltage nominal value (Vnom) and the DVM reading (Vdvm) for each test voltage (+1 V through +1000 V and -1 V through -1000 V). Press the <Volts On/Off> key to turn the SOURCE output OFF. Calculate the test voltage error value from the following expression:

$$\textbf{Error (ppm)} = \frac{V_{dvm} - V_{nom}}{V_{nom}} \times 10^6$$

Use the absolute value of Vdvm and Vnom. For each test voltage record the Error (ppm) voltage coefficient.

- Press the **<PREVIOUS>** key to exit to the Sofcal Diagnostic Menu.
- Press the **<PREVIOUS>** key to exit to the Sofcal Menu.
- Select the **<Calibrate>** function key

- Reference Section 4.9.2.2
- Verify the unit is in the **<Calibrate>** Menu
- Select the **<Ref. Vals>** function key
- Verify the unit is in the **<Reference>** Menu
- Select the **<Serial Number>** key
- Verify that the Serial Number displayed matches the serial number printed on the rear of the instrument and on the calibration report.
- Press the **<PREVIOUS>** key to exit to the Sofcal Reference Menu.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.
- Select the **<Cal. Vals>** function key
- Verify the unit is in the **<Calibrate>** Menu
- Select the **<Test Volts>** function key
- Verify the display indicates all test voltages and their current error coefficient.
- Select the **<Edit>** function key
- Use the numeric keys to enter the new test voltage coefficients (in ppm) calculated previously.
- Carefully check the entered number then press the **<Ok>** key to accept and store the new coefficients.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.

5.2.5. AUTO CALIBRATION

The Auto Calibration routine is a built in process in the 6520 that will calibrate all three capacitor and both threshold values with a single 100M traceable resistor. This process is an automatic sequencing of the Capacitor and Threshold Calibration routines which can be executed on an individual basis as described in Sections 5.2.6 and 5.2.7. To execute this process follow the steps below.

- Reference Section 4.9.2.1.1.
- Connect the 100 megohm reference resistor between the SOURCE and INPUT terminals of the instrument.
- Select the SOFCAL CALIBRATE MENU by pressing the **<Calibrate>** function key when in the Sofcal Menu
- Press the **<Ref Vals>** function key.
- Press the **<Ref Res>** function key.
- Press the **<Edit>** function key.
- Using the numeric keys enter the new value of the reference resistor and its serial number
- New values for variance, standard deviation and sample size criteria for the 2700pF capacitor may be entered using the numeric keypad ifs required (see Section 4.9.2.3.3)
- Repeat this process for the 270pF and 27pF capacitors, as well as the 1.0V and 0.1V thresholds.

- Press the **<Ok>** key to accept/store the new values.
- Press the **<Cal Date>** function key.
- Press the **<Edit>** function key to edit/re-enter the new calibration date.
- Press the **<Ok>** key to accept the new calibration date.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu (top).
- Press the **<Utilites>** function key.
- Press the **<Auto Cal.>** function key.
- The 6520 will proceed to calibrate all three capacitor and the two thresholds.

Note: Ensure that the 100 megohm reference resistor is connected. Press the <Auto Cal> key to start the automatic capacitor calibration sequence.

Note: When the calibration sequence is complete the instrument will prompt with the new calibration coefficient in the display window.

- The automated calibration sequence will run each measurement until it has satisfied variance and standard deviation requirements for the sample size of each test.
- If the requirements have not been met within the maximum retries the test is automatically stopped.
- If the test completes fully then acceptable results have been achieved. Press the **<Save>** key to save the results. This will update all capacitor coefficients and threshold coefficients.
- If the results are not acceptable then, you will need to return to the **<Reference>** Menu and adjust the test criteria to allow either more retries or a wider standard deviation/variance for the failed test.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.

5.2.6. CAPACITOR CALIBRATION

The Capacitor Calibration is a series of routines that are built in the 6520 to calibrate each of the three capacitors individually with the 100M traceable resistor. To execute this process follow the steps below.

- Reference Section 4.9.2.1.2.
- Connect the 100 megohm reference resistor between the SOURCE and INPUT terminals of the instrument.
- Select the SOFCAL CALIBRATE MENU by pressing the **<Calibrate>** function key when in the Sofcal Menu
- Press the **<Ref Vals>** function key.
- Press the **<Ref Res>** function key.
- Press the **<Edit>** function key.

- Using the numeric keys enter the new value of the reference resistor and its serial number
- New values for variance, standard deviation and sample size criteria for the 2700pF capacitor may be entered using the numeric keypad if required (see Section 4.9.2.3.3)
- Repeat this process for the 270pF and 27pF capacitors.
- Press the **<Ok>** key to accept/store the new values.
- Press the **<Cal Date>** function key.
- Press the **<Edit>** function key to edit/re-enter the new calibration date.
- Press the **<Ok>** key to accept the new calibration date.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu (top).
- Press the **<Utilites>** function key.
- Press the **<Cap Cal.>** function key.

Note: Ensure that the 100 megohm reference resistor is connected. Press the <Calc> key to start the automatic capacitor calibration sequence.

Note: When the calibration sequence is complete the instrument will prompt with the new calibration coefficient in the display window.

- The automated calibration sequence will run each measurement until it has satisfied variance and standard deviation requirements for the sample size of each test.
- If the requirements have not been met within the maximum retries the test is automatically stopped.
- If the test completes fully then acceptable results have been achieved. Press the **<Save>** key to save the results. This will update all capacitor coefficients.
- If the results are not acceptable then, you will need to return to the **<Reference>** Menu and adjust the test criteria to allow either more retries or a wider standard deviation/variance for the failed test.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.

5.2.7. THRESHOLD CALIBRATION

The Threshold Calibration is a series of routines that are built in the 6520 to calibrate each of the three capacitors individually with the 100M traceable resistor. To execute this process follow the steps below.

- Reference Section 4.9.2.1.3.
- Connect the 100 megohm reference resistor between the SOURCE and INPUT terminals of the instrument.
- Select the SOFCAL CALIBRATE MENU by pressing the **<Calibrate>** function key when in the Sofcal Menu

- Press the **<Ref Vals>** function key.
- Press the **<Ref Res>** function key. 2844275
- Press the **<Edit>** function key.
- Using the numeric keys enter the value of the reference resistor and its serial number
- New values for variance, standard deviation and sample size criteria for the 1V and 0.1V thresholds may be entered using the numeric keypad ifs required (see Section 4.9.2.3.3)
- Press the **<Ok>** key to accept/store the new values.
- Press the **<Cal Date>** function key.
- Press the **<Edit>** function key to edit/re-enter the new calibration date.
- Press the **<Ok>** key to accept the new calibration date.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu (top).
- Press the **<Utilites>** function key.
- Press the **<Thresh Cal.>** function key.

Note: Ensure that the 100 megohm reference resistor is connected. Press the <Calc> key to start the automatic capacitor calibration sequence.

Note: When the calibration sequence is complete the instrument will prompt with the new calibration coefficient in the display window.

- The automated calibration sequence will run each measurement until it has satisfied variance and standard deviation requirements for the sample size of each test.
- If the requirements have not been met within the maximum retries the test is automatically stopped.
- If the test completes fully then acceptable results have been achieved. Press the **<Save>** key to save the results. This will update all threshold coefficients.
- If the results are not acceptable then, you will need to return to the **<Reference>** Menu and adjust the test criteria to allow either more retries or a wider standard deviation/variance for the failed test.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.

5.2.8. ZERO COEFFICIENT CALIBRATION

The Zero Coefficient Calibration is a stand alone routine that is built in the 6520 to calibrate the absolute value of the 100k protection resistor with the 100M traceable resistor. To execute this process follow the steps below.

- Reference Section 4.9.2.1.4.
- Remove the 100 megohm reference resistor and replace with a terminal 0 ohm link between SOURCE AND INPUT.

- Select the SOFCAL CALIBRATE MENU by pressing the **<Calibrate>** function key when in the Sofcal Menu
- Press the **<Ref Vals>** function key.
- Press the **<Ref Zero>** function key.
- Press the **<Edit>** function key.
- Using the numeric keys enter the new value of the reference resistor and its serial number.
- New values for variance, standard deviation and sample size criteria for the zero ohm calibration may be entered using the numeric keypad ifs required (see Section 4.9.2.3.4).
- Press the **<Ok>** key to accept/store the new values.
- Press the **<Cal Date>** function key.
- Press the **<Edit>** function key to edit/re-enter the new calibration date.
- Press the **<Ok>** key to accept the new calibration date.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu (top).
- Press the **<Utilites>** function key.
- Press the **<Zero Cal.>** function key.

Note: Ensure that the 0 ohm link is connected. Press the <Calc> key to start the automatic capacitor calibration sequence.

Note: When the calibration sequence is complete the instrument will prompt with the new calibration coefficient in the display window.

- The automated calibration sequence will run each measurement until it has satisfied variance and standard deviation requirements for the sample size of each test.
- If the requirements have not been met within the maximum retries the test is automatically stopped.
- If the test completes fully then acceptable results have been achieved. Press the **<Save>** key to save the results. This will update the protection resistor coefficient.
- If the results are not acceptable then, you will need to return to the **<Reference>** Menu and adjust the test criteria to allow either more retries or a wider standard deviation/variance for the failed test.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.

5.2.9. SHUNT COEFFICIENT CALIBRATION (OPTIONAL)

The Shunt Coefficient Calibration is a stand alone routine that is built in the 6520 to calibrate the offset and gain associated with the current shunt which is only applicable while the shunt is on.

NOTE: The current shunt is used to allow check measurements of larger currents (10uA to 10mA), and is <u>NOT</u> used in resistance measurement at any time. Calibration of this is not mandatory for full 6520 specification performance see Tables 7-2 and 7-3).

This process uses a known reference current in both polarities to calculate the coefficient. To execute this process follow the steps below.

- Reference Section 4.9.2.1.5.
- Press the **<Calibrate>** function key from the Sofcal Menu
- Press the **<Ref Vals>** function key.
- Press the **<Shunt>** function key.
- Press the **<Edit>** function key.
- Using the numeric keys enter 0.001 for the reference current
- New values for variance, standard deviation and sample size criteria for the shunt calibration test may be entered using the numeric keypad ifs required (see Section 4.9.2.3.5).
- Press the **<Ok>** key to accept/store the new values.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Reference Menu.
- Press the **<PREVIOUS>** key to exit back to the Sofcal Calibrate Menu.
- Press the **<Utilities>** function key.
- Press the **<Shunt Cal.>** function key.
- Attach the TRIAX to type N cable to the INPUT connector and connect a type N to dual banana plug adapter to the cable. Plug the banana plugs into the precision multifunction calibrator.
- Set the calibrator to output 0.01 amps.
- Press the <**Calc**> key.
- When prompted, set the calibrator to output -0.01 amps.
- Press the <**Calc**> key.
- The automated calibration sequence will run each measurement until it has satisfied variance and standard deviation requirements for the sample size of each test.
- If the requirements have not been met within the maximum retries the test is automatically stopped.
- If the test completes fully then acceptable results have been achieved. Press the **<Save>** key to save the results. This will update the protection resistor coefficient.
- If the results are not acceptable then, you will need to return to the **<Reference>** Menu and adjust the test criteria to allow either more retries or a wider standard deviation/variance for the failed test.
- Press the **<PREVIOUS>** key to exit to the Sofcal Calibrate Menu.

5.3. CALIBRATION REPORT

Prepare a tabulated results sheet similar to that shown in Table 5-3, using the data reported by the instrument during the calibration procedure of Section 5.2.

MODEL 6520 Teraohmmeter   Serial Number: ________________

Test Voltage (volts)	Coefficient (ppm)	Limits ± (ppm)
1		1000
2		1000
5		1000
10		1000
20		1000
50		1000
100		1000
200		1000
500		1000
1000		1000
-1		1000
-2		1000
-5		1000
-10		1000
-20		1000
-50		1000
-100		1000
-200		1000
-500		1000
-1000		1000

Capacitor PF	Coefficient (ppm)	Limits ± (ppm)
27		200000
270		80000
2700		20000

Threshold (Volts)	Coefficient (ppm)	Limits ± (ppm)
0.1		1000
1.0		1000

Sensor Coefficients	Gain (mV)	Offset (V)
Temperature		
Humidity		
Pressure		

Zero Coefficient: ______________________ ohms (Limits: 90 000 ohms to 11 000 ohms)

Shunt Coefficients :

Shunt Gain ________________

Shunt Offset ________________

Dated:____________________

Calibrated by: ________________________

Table 5-3: Sample Calibration Report Format

5.4. CALIBRATION THEORY

After each resistance reading the integration time is converted to a resistance. The conversion from time to resistance is achieved using the formula:

$$\text{Resistance} = \frac{V_{test} \times T_{integration}}{2 \times C_{integrator} \times T_{integrator}} - R_{protection}$$

Where: Resistance is the value of the unknown resistor

V_{test} is the test voltage from the 6520 source

$T_{integration}$ is the time for the integration

$C_{integrator}$ is the value of the integrator capacitor

$T_{integrator}$ is the threshold of the integrator

$R_{protection}$ is the value of the protection resistor.

The nominal values of each of the components in the equation are known except for the unknown resistance. The variances from the nominal values are determined during the calibration process using Sofcal utilities. The 6520 system software calls up the nominal value of each component and corrects each by use of the respective calibration coefficient before computing the resistance value.

5.4.1. Rprotection COEFFICIENT

The value of the protection resistor is measured by the instrument during calibration using a short circuit connection between the source and input connectors of the 6520 and is stored in the instruments Non-Volatile memory.

5.4.2. Vtest COEFFICIENTS

The variance of the test voltage from its nominal value is determined during calibration by selecting each possible output voltage and measuring its absolute value with a precision voltmeter. The variance of the output voltage from its nominal value is computed in Parts Per Million (ppm) and entered into the instruments Non-Volatile memory either from the front panel or through one of the bus interfaces (RS-232C or GPIB). It should be noted that there are twenty (20) different coefficients computed, and stored in the instrument, one for each voltage of each polarity.

5.4.3. Cintegrator COEFFICIENTS

The exact value of the reference resistor (used during calibration to compute the capacitor and threshold variances) is entered into the instruments Non-Volatile memory either from the front panel (see section 4) or through one of the bus interfaces.

The instrument computes the variance of each integration capacitor. A known Standard Reference resistor (100 megohm) is connected between the instruments source and input terminals. The instrument then takes readings of the Standard Reference resistance until the calibration criteria are met, and computes an average resistance value with corrections for the source voltage and the protection resistor. Using the average resistance value and the reference resistance value a number representing the variance of the capacitor from its nominal value is computed. The capacitor coefficient is automatically stored into the instruments Non-Volatile memory. (see Section 4.9.2.1.2)

5.4.4. Tintegrator COEFFICIENTS

The instrument also computes the variance of the integration thresholds. A known Standard Reference resistor (100 megohm) is connected between the instruments source and input terminals. The instrument then takes readings of the Standard Reference resistance until the calibration criteria are met, and computes an average value with corrections for the source voltage, the integration capacitor and the protection resistor. The average value and the resistance value are used to compute a number representing the variance of the threshold from its nominal value. The threshold variance is automatically stored in the instruments Non-Volatile memory. The Tintegrator Coefficient for the 10 volt threshold is assumed to be 0. (see Section 4.9.2.1.3)

6. TROUBLE SHOOTING AND MAINTENANCE

6.1. PREVENTATIVE MAINTENANCE

Preventative maintenance consists of cleaning and visual inspection of the instrument. Preventative maintenance performed on a regular basis will prevent instrument breakdown and will improve the reliability of this instrument. The severity of the environment to which the 6520 is subjected determines the frequency of maintenance. A convenient time to perform preventative maintenance is preceding recalibration of the instrument. Do not open the instrument for any of the described maintenance activities as removal the protective covering of the 6520 may cause rather than prevent problems.

The 6520 should be cleaned as often as operating conditions require. Accumulation of dirt in the instrument air filter can cause overheating and component breakdown due to improper airflow. These filters should be vacuumed out to keep a clear airflow. The dress skins also provide protection against dust in the interior of the instrument. Operation without these panels in place necessitates more frequent cleaning. However it is recommended that you remove the dress skins to allow better access for vacuuming the air filter

Periodically inspect the instrument for general cleanliness.

CAUTION

Avoid the use of chemical cleaning agents that might damage the plastics used in this instrument. In particular, avoid chemicals that contain benzene toluene, xylene or similar solvents.

Periodically check the diagnostics utility in the 6520 and confirm that there are no error conditions displayed.

Routinely run the artifact calibration procedure to ensure the 6520 is operating to full specifications. See Section 5.

If the instrument is not correctly functioning remove the cover and clean out any accumulated dust with a soft brush, at the same time check for discoloured or damaged wiring. Check all screws and hardware for tightness. This should only occur as a corrective measure.

Note: A grounding wrist strap must be used to prevent electro-static discharge to sensitive components whenever the top cover is removed.

6.2. NON VOLATILE MEMORY CHECKSUM

The model 6520 Teraohmmeter contains a bank of memory into which certain operating data are written and stored. This memory is non-volatile in that data are kept even when power is removed from the instrument.

The integrity of the data in this memory is checked on power up and on an instrument RESET by comparing a stored checksum value with a calculated value. The two checksum values should agree. Occasionally, the stored checksum value may not agree with the newly calculated value (on RESET or Power Up) due to an operator error in entering new data into the non-volatile (NV) RAM or when the non-volatile (NV) RAM battery is low.

When this occurs the 6520 will display the message "NON-VOLATILE MEMORY FAILURE, Press any key to continue". The 6520 will restore factory-set default values and will calculate a new checksum, then reinitialize all non volatile memory.

6.3. TROUBLESHOOTING

Symptom	Possible Cause
No display	Instrument not plugged into source of AC power. Instrument not powered ON. Power Supply fuse open. Cable between CPU PCB and Display PCB loose. Faulty connector on cable between CPU and Display PCB. Faulty Display PCB. Faulty CPU PCB. Faulty Power Supply PCB.
Display on but no Keyboard response	Keyboard switches locked out by remote controller. Cable between CPU and Display PCB loose. Faulty connector on cable between CPU and Display PCB. Faulty Display PCB.
Display on but only partial Keyboard response	Cable between CPU and Display PCB faulty. Faulty Display PCB.
RS-232C no response	Incorrect baud rate set. Talk/Listen mode not selected. RS-232C cable not connected to instrument properly. Cable from rear panel RS-232C connector to CPU PCB faulty. Faulty CPU PCB.

6.4. ERROR MESSAGES

Display Message	Comment
RAM FAILURE XX	RAM Test Failure in bank XX where XX is in the range 01 through 16.
FAST ADC FAILURE	Interrupt from the ADC has not been generated or has not been recognized
ADC NOT RUNNING	ADC converter not running correctly.
ADC OFFSET X.YZ	Ground (zero volts) input to MUX is out of range or MUX output offset magnitude too large. The measured offset is displayed as X.YZ volts.
ADC GAIN XXXX	The 10 V reference channel is measured and determined to be out of range. The measured unacceptable gain is displayed as XXXX.
ADC RATE XXX KHZ	The ADC interrupt rate is out of range as either too slow or too fast. The measured unacceptable rate is displayed as XXX KHZ.
+ 5 Volts X.XX	+ 5 V analogue power supply out of limits; measured X.XX V.
- 5 Volts X.XX	- 5 V analogue power supply out of limits; measured X.XX V.
+ 15 Volts X.XX	+ 15 V analogue power supply out of limits; measured X.XX V.
- 15 Volts X.XX	- 15 V analogue power supply out of limits; measured X > XX V.
PRECHARGE X.XX	Precharge Voltage out of limits; measured X.XX V.
HV MON X.XX	High Voltage monitoring point out of limits; measured X.XX V.
10 V REF X.XX	10 volt Reference point out of limits; measured X.XX V.
RAMP X.XX	Ramp Reference point out of limits; measured X.XX V.
Electrometer OFF	Ramp is not moving or integration time is too long.
Integration < 3ms	Ramp is moving to fast or integration time is too short.

Display Message	Comment
+ 5 Volts X.X	+ 5 V digital power supply out of limits; measured X.X V.
- 5 Volts X.X	- 5 V digital power supply out of limits; measured X.X V.
+ 15 Volts X.X	+ 15 V digital power supply out of limits; measured X.X V.
- 15 Volts X.X	- 15 V digital power supply out of limits; measured X.X V.

7. APPENDICES

7.1. GENERAL SPECIFICATIONS

MODEL 6520 General Specifications		
Operating Temperature	15 to 30	°C °F
Storage Temperature	-30 to 70	°C °F
Operating Humidity (non-condensing)	20 to 50	% RH
Storage Humidity (non-condensing)	15 to 80	% RH
Power Requirements	120	VA
Voltage Requirements	100, 120, 220, 240 +/- 10%	VAC
Line Frequency	50/60Hz ±5%	Hz
Dimensions (Nominal) (1)	D 500, W 17.5, H 89 D 19.7, W 17.5, H 3.5	mm in
Weight	156 33	kg lb

Table 7-1: General Specifications

Note: Add 11mm (0.4 in.) to height for bench top feet.

7.2. RESISTANCE MEASUREMENT SPECIFICATIONS

Note: The uncertainties listed in Table 7-2 are applicable after a one-hour warm-up period when using the autoranging mode of operation and when the current is no less than one picoampere through the unknown resistor.
Many types of high value resistors can be difficult to measure accurately with the 6520 in autoreverse mode because their actual resistance value changes slowly for a period of time after a polarity reversal. They can however be measured to the full 6520 accuracy by allowing sufficient settling time between polarity reversals (soak time). This is done under manual control or through adjusting the 6520 parameters.
The accuracy is traceable to the International System of Units (SI) through NRCC (Canada) or other National Metrology Institutes.

Range (Ohms)	Range (Volts)	Uncertainty (±% of reading over 1 year, 23°C±2°C)	Transfer Uncertainty (±% of reading over 4 hours, 23°C±2°C)*	Temperature Coefficient (±% of reading 15°C to 21°C, 25°C to 30°C)
90k to 200k	1V	0.025	0.006	0.01
200k to 2M	1V	0.025	0.0025	0.0035
2M to 20M	1V	0.025	0.0025	0.0035
20M to 200M	1V to 10V	0.015	0.0025	0.0035
200M to 2G	1V to 100V	0.02	0.0025	0.005
2G to 20G	1V to 1000V	0.06	0.0025	0.007
20G to 200G	10V to 1000V	0.08	0.0025	0.01
200G to 2T	100V to 1000V	0.1	0.008	0.02
2T to 20T	1000V	0.35	0.05	0.03
20T to 200T	1000V	0.6	0.07	0.05
200T to 2P	1000V	2.5	0.2	0.1
2P to 20P	1000V	30	0.5	1

* This is the stability of the measurements of the 6520 over the specified time period.

Table 7-2: Resistance Measurement Uncertainty

Note: The uncertainties listed in Table 7-2 are applicable after a 1-hour warm up period.

7.3. PICOAMMETER MEASUREMENT SPECIFICATIONS

Range (A)	Uncertainty (±% of reading over 1 year, 23°C±2°C)	Temperature Coefficient (±% of reading 15°C to 21°C 25°C to 30°C)
$10^{-3} \leq I \leq 10^{-2}$	*N/A*	*N/A*
$10^{-4} \leq I < 10^{-3}$	*N/A*	*N/A*
$10^{-5} \leq I < 10^{-4}$	*N/A*	*N/A*
$10^{-6} \leq I < 10^{-5}$	0.1	0.005
$10^{-7} \leq I < 10^{-6}$	0.1	0.005
$10^{-8} \leq I < 10^{-7}$	0.2	0.03
$10^{-9} \leq I < 10^{-8}$	0.3	0.03
$10^{-10} \leq I < 10^{-9}$	0.5	0.1
$10^{-11} \leq I < 10^{-10}$	2.0	0.1
$10^{-12} \leq I < 10^{-11}$	5.0	0.2
$10^{-13} \leq I < 10^{-12}$	30.0	1

Table 7-3: Current Measurement Uncertainty

Note: The uncertainties listed in Table 7-3 are applicable after a 1-hour warm up period.

7.4. RESOLUTION

When the Model 6520 is used with short integration time periods, the measurement resolution is limited by the quantization error in the time measuring circuit (plus or minus one clock period). When the quantization error is not significant, the display resolution is truncated at a value commensurate with the short-term measurement stability. The measurement display resolution can be set by the user using the **Set Up Menu** option. The default resolution is fixed at 6 digits. If the **<Auto res>** option is selected then the instrument will set the resolution based on Table 7-4.

Integrating Capacitor	**Display Resolution (Digits) Integration Time**				
pF	**5.4 mSec**	**54 mSec**	**540 mSec**	**5.4 Sec**	**Up To 20000 Sec**
27	5	5	6	6	5
270	5	6	7	7	7
2700	6	7	7	7	7

Table 7-4: Measurement Resolutions (Digits)

Note: The measurements can be performed with reduced accuracy for integration times less than 5.4ms down to 3ms.

7.5. SYSTEM PARAMETER

The table below describes the valid 6520 measurement setups along with the default parameters defined for each resistance/voltage range in auto-reverse mode. These parameters can be accessed and modified in the System parameter section of the 6520. It should be noted that modification of these parameters fro the same in which the 6520 was calibrated invalidates the calibration. The 6520 comes from the factory calibrated to these default parameters.

Note:

0 The dark grey areas are the parameters and range selection that is used by the auto ranging function of the 6520. Theses represent the optimal measurement parameters.

1 The light grey areas are areas in which the 6520 will measure in manual mode to full rated specifications. These alternate settings provide a method for voltage coefficient testing.

2 The white areas in the table are measurements the 6520 can make but are not specified or calibrated. They are primarily useful as check measurements.

Range	Nominal	Test V	Cap.	Thesh.	Ramp	Auto?	Count	Size
90k to 200k	100k	1	2700	10	0.0054	*	90	100
200k to 2M	1M	1	2700	10	0.054	*	45	50
	1M	2	2700	10	0.027		58	65
	1M	5	2700	10	0.0108		72	80
	1M	10	2700	10	0.0054		90	100
2M to 20M	10M	1	2700	10	0.54	*	17	20
	10M	2	2700	10	0.27		17	20
	10M	5	2700	10	0.108		25	30
	10M	10	2700	10	0.054		38	45
	10M	20	2700	10	0.027		58	65
	10M	50	2700	10	0.0108		72	80
	10M	100	2700	10	0.0054		90	100
20M to 200M	*100M*	*1*	*2700*	*10*	*5.4*	*	6	8
	100M	2	2700	10	2.7		6	8
	100M	5	2700	10	1.08		6	8
	100M	10	2700	10	0.54		6	8
	100M	20	2700	10	0.27		17	20
	100M	50	2700	10	0.108		25	30
	100M	100	2700	10	0.054		38	45
	100M	200	2700	10	0.027		58	65
	100M	500	2700	10	0.0108		72	80
	100M	1000	2700	10	0.0054		90	100

200M to 2G	1G	1	2700	1	5.4		8	12
	1G	2	2700	1	2.7		8	12
	1G	5	2700	10	10.8		8	12
	1G	10	2700	10	5.4	*	8	12
	1G	20	2700	10	2.7		8	12
	1G	50	2700	10	1.08		8	12
	1G	100	2700	10	0.54		8	12
	1G	200	2700	10	0.27		17	20
	1G	500	2700	10	0.108		25	30
	1G	1000	2700	10	0.054		38	45
2G to 20G	10G	1	2700	0.1	5.4		8	12
	10G	2	2700	0.1	2.7		8	12
	10G	5	2700	1	10.8		8	12
	10G	10	2700	1	5.4		8	12
	10G	20	2700	1	2.7		8	12
	10G	50	2700	10	10.8		8	12
	10G	100	2700	10	5.4	*	8	12
	10G	200	2700	10	2.7		8	12
	10G	500	2700	10	1.08		8	12
	10G	1000	2700	10	0.54		8	12
20G to 200G	100G	1	270	0.1	5.4		12	20
	100G	2	270	0.1	2.7		12	20
	100G	5	2700	0.1	10.8		12	20
	100G	10	2700	0.1	5.4		12	20
	100G	20	2700	0.1	2.7		12	20
	100G	50	2700	1	10.8		12	20
	100G	100	2700	1	5.4		12	20
	100G	200	2700	1	2.7		12	20
	100G	500	2700	10	10.8		12	20
	100G	1000	2700	10	5.4	*	12	20
200G to 2T	1T	1	27	0.1	5.4		12	20
	1T	2	27	0.1	2.7		12	20
	1T	5	270	0.1	10.8		12	20
	1T	10	270	0.1	5.4		12	20
	1T	20	270	0.1	2.7		12	20
	1T	50	2700	0.1	10.8		12	20
	1T	100	2700	0.1	5.4		12	20
	1T	200	2700	0.1	2.7		12	20
	1T	500	2700	1	10.8		12	20
	1T	1000	2700	1	5.4	*	12	20

2T to 20T	10T	10	27	0.1	5.4		20	50
	10T	20	27	0.1	2.7		20	50
	10T	50	270	0.1	10.8		20	50
	10T	100	270	0.1	5.4		20	50
	10T	200	270	0.1	2.7		20	50
	10T	500	2700	0.1	10.8		20	50
	10T	1000	2700	0.1	5.4	*	20	50
20T to 200T	100T	100	27	0.1	5.4		20	50
	100T	200	27	0.1	2.7		20	50
	100T	500	270	0.1	10.8		20	50
	100T	1000	270	0.1	5.4	*	20	50
200T to 2P	1P	1000	27	0.1	5.4	*	20	50
2P to 20P	10P	1000	27	0.1	54	*	20	50

Table 7-5: Default System parameter

7.6. SAMPLE BUS CONTROL PROGRAM

The following is a brief note on how to configure a National Instruments GPIB-PC controller card when used with the 6520. A program outline is provided that collects data using the National Instruments GPIB-PC interface.

Assuming that National Instrument drivers have been installed with all the default names. The device name for ADDRESS 4 will be "DEV4", and could be used to control the 6520.

The "DEV4" should be configured as follows:

- Default device name: DEV4
- GPIB address (fixed): 4
- Secondary address: none
- Timeout setting: 3 seconds
- Serial poll timeout: 3 seconds
- Terminate read on EOS: YES
- Set EOI with EOS on write: YES
- Type of compare on EOS: 7 bit
- EOS byte: 0A hex
- Send EOI at end of writes: YES
- Enable repeat addressing: YES

- Programming Note 1 : BASIC

Sample Bus Control Program Using Basic And National Instruments GPIB-PC Controller

```
100 REM BASIC Example Program - for Guildline Model 6520 Teraohmmeter
110 REM 6520
120 REM
```

```
130 REM You MUST merge this code with DECL.BAS.
140 REM
150 REM Assign a unique identifier to device and
160 REM store in variable DEV%.
170 REM
180   BDNAME$ = "DEV4"
190   CALL IBFIND (BDNAME$, DEV%)
200 REM
210 REM Check for error on IBFIND call.
220 REM
230   IF DEV% < 0 THEN GOSUB 2000
240 REM
250 REM Clear the device.
260   CALL IBCLR (DEV%)
270 REM
280 REM Check for an error on each GPIB call to be

290 REM safe.
300 REM
320   IF IBSTA% < 0 THEN GOSUB 3000
330 REM
330 REM Tell the 6520 Teraohmmeter to measure resistance
340 REM
350   WRT$ = "MEAS ON"
360   CALL IBWRT (DEV%,WRT$)
370   IF IBSTA% < 0 THEN GOSUB 3000
380 REM
390 REM Loop on reading the status byte until
400 REM the 6520 says that the reading is complete
410 REM Check that the 6520 is still measuring.
420 REM If not measuring then an error has occurred
430   WRT$ = "MEAS?"
440   CALL IBWRT (DEV%,WRT$)
450   IF IBSTA% < 0 THEN GOSUB 3000
460   RD$ = SPACE$(48)
470   CALL IBRD (DEV%,RD$)
480   IF IBSTA% < 0 THEN GOSUB 3000
490   IF RD$ <> "On" THEN GOTO 4000
500 REM Prevent timeout on Voltage Source
510   WRT$ = "CONF:TEST:VOLT CONT"
520   CALL IBWRT (DEV%,WRT$)
530   IF IBSTA% < 0 THEN GOSUB 3000
540 REM
550 REM Now test the status byte (STB).
560 REM If STB has bit 2 set then the 6520 Teraohmmeter
570 REM has finished its reading otherwise
580 REM loop around
590 REM
600   WRT$="*STB?" : CALL IBWRT (DEV%,WRT$)
610   IF IBSTA% < 0 THEN GOSUB 3000
620   RD$ = SPACE$(48) : CALL IBRD (DEV%,RD$)
630   IF IBSTA% < 0 THEN GOSUB 3000
640   IF VAL(RD$) AND &H02 THEN GOTO 700
650   GOTO 430
660 REM
670 REM Ask the 6520 Teraohmmeter to give us the next
680 REM measurement
690 REM
660   WRT$ = "READ:RES?" : CALL IBWRT (DEV%,WRT$)
```

```
700   IF IBSTA% < 0 THEN GOSUB 3000
710   RD$ = SPACE$(48) : CALL IBRD (DEV%,RD$)
720   IF IBSTA% < 0 THEN GOSUB 3000
730 REM
740 REM Print out the reading and loop around to catch
750 REM the next reading
760 REM
770   PRINT RD$
780   GOTO 430
2000 REM A routine at this location would notify
2010 REM you that the IBFIND call failed, and
2020 REM refer you to the handler software
2030 REM configuration procedures.
2040  PRINT "IBFIND ERROR" : RETURN
3000 REM An error checking routine at this
3010 REM location would, among other things,
3020 REM check IBERR to determine the exact
3030 REM cause of the error condition and then
3040 REM take action appropriate to the
3050 REM application. For errors during data
3060 REM transfers, IBCNT may be examined to
3070 REM determine the actual number of bytes
3080 REM transferred.
3090  PRINT "GPIB ERROR" : RETURN
4000 REM An error routine to tell you that the measurement
4010 REM terminated prematurely
4020  PRINT "ERROR, TEST TERMINATED PREMATURELY."
4030 REM
5000  END
```

7.7. MEASUREMENT TECHNIQUE

7.7.1. LARGE VALUE RESISTOR MEASUREMENT TECHNIQUE

The measurement of very large value resistors presents special challenges for the operator. The measurement is often rendered meaningless unless certain precautions are taken.

7.7.2. ENVIRONMENT

The test equipment and the test sample should be located in a clean dry area where the temperature is relatively constant near 23°C. The air humidity should be between 20 and 40% R.H. Ionized air and ionizing radiation should not be present in the test area.

7.7.3. SAMPLE PREPARATION

It is very important to prepare the test sample properly so that unwanted parallel leakage paths are reduced as much as possible. The condition of the insulation surface between the sample terminals is very critical since this usually forms a significant source of electrical leakage. The surface must be dry and free of conductive salts or other deposits.

7.7.4. TEST LEAD ROUTING

Although it is good general practice to use shielded test leads (shielded wires with the shields connected to ground) it is especially important with higher value test resistors. Shielded test leads shunt unwanted leakage current away from the electrometer circuit.

7.7.5. CAPACITIVE TEST SAMPLES

Test samples that store electrical charges and have long time constants can be difficult to measure using the autoreverse feature of the teraohmmeter. You can adjust the autoreverse paramenters or, deactivate autoreverse until a stable resistance reading is displayed with one test voltage polarity and then manually reverse the polarity. The reading from both polarities should be recorded and an average computed.

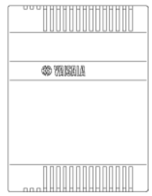
The true resistance of the sample is the numerical average calculated from the two readings taken. This technique allows the sample sufficient time to be measured properly.

7.8. OTHER FEATURES

* Mounting:	Bench top with extra flanges provided separately for 19-inch rack mounting.
* Input Connector:	Front panel with rear panel access optional on request.
* Power Selection Switch:	On rear panel.
* IEEE488.2 Connector:	On rear panel.
*RS232 Connector:	On rear panel

7.9. ACCESSORY EQUIPMENT

7.9.1. Environmental Monitor Model 65220



Temperature/Humidity
Module

Pressure
Module

Temperature/Humidity Sensor Specifications

7.9.1.1.Humidity

Features

* Low power design
* High accuracy
* Fast response time
* Stable, low drift performance
* Chemically resistant

7.9.1.2.RH Sensor Specification

Sensor construction consists of a planar capacitor with a second polymer layer to protect against dirt, dust, oils and other hazards.

RH Accuracy	± 2% RH, 0-100 % RH non-condensing, 25 °C, 5 VDC supply
RH Interchangeability	± 5% RH, 0-60% RH; ± 8% @ 90% RH Typical
RH Linearity	± 0.5% RH Typical
RH Hysteresis	± 1.2% of RH Span Maximum
RH Repeatability	± 0.5% RH
RH response time	15 s in slowly moving air @ 25 °C
RH Stability	± 1% RH Typical at 50% RH in 5 Years
Operating Humidity Range	0 to 100% RH, non-condensing
Operating Temperature Range	-40 °C to 85 °C (-40 °F to 185 °F)
Temperature Compensation	True RH = Sensor RH/(1.0546-0.00216T) T in °C (True RH = Sensor RH/(1.093-0.0012T) T in °F)

Note: The Temperature Compensation is NOT factored in with the humidity displayed on the 6520.

7.9.1.3.Precision Centigrade Temperature Sensor

The temperature sensors are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature. The sensor thus has an advantage over linear temperature sensors calibrated in ° Kelvin, as the user is not required to subtract a large constant voltage from its output to obtain convenient Centigrade scaling. The sensor does not require any external calibration or trimming to provide typical accuracies of ± 1⁄4 °C at room temperature and ± 3⁄4 °C over a full -55 to +150°C temperature range. The low output impedance, linear output, and precise inherent calibration make interfacing to readout or control circuitry especially easy. As it draws only 60 µA from its supply, it has very low self-heating, less than 0.1°C in still air. The sensor is rated to operate over a -55° to +150°C temperature range.

7.9.1.4.Pressure Sensor

The piezoresistive transducer is a state–of–the–art monolithic silicon pressure sensor designed for a wide range of applications, but particularly those employing a microcontroller or microprocessor with A/D inputs. This patented, single element transducer combines advanced micromachining techniques, thin–film metallization, and bipolar processing to provide an accurate, high level analog output signal that is proportional to the applied pressure.

Features
- Patented Silicon Shear Stress Strain Gauge
- Durable Epoxy Unibody Element

7.9.1.5.Integrated Pressure Sensor Specifications

0 to 100 kPa (0 to 14.5 psi): 15 to 115 kPa (2.18 to 16.68 psi)
0.2 to 4.7 Volts Output

Pressure Sensor Device Data

MAXIMUM RATINGS

Parameter	Symbol	Value	Unit
Maximum Pressure	P max	400	kPa
Storage Temperature	T stg	-40˚ to +125˚	˚C
Operating Temperature	T A	-29˚ to +60˚	˚C

NOTE: Exposure beyond the specified limits may cause permanent damage or degradation to the device.

Pressure Offset (as configured - 0 to 60°C)
V S = 5.0 Volts V off 0.088 Vdc

Full Scale Output (as configured - 0 to 60°C)
V S = 5.0 Volts V FSO 4.587 Vdc

Full Scale Span (as configured - 0 to 60°C)
V S = 5.0 Volts V FSS 4.500 Vdc

Accuracy ±2.5 % V FSS

7.9.2. Surface/Volume Resistivity Test Fixture Model 65221

This optional accessory allows the 6520 user to make direct measurement of volume resistivity up to $10^{18}\Omega$–cm (on samples 0.1cm thick) and surface resistivity up to $10^{17}\Omega$/square, in accordance with ASTM procedures. A Keithley model 8009 test fixture is supplied with all the necessary interconnect cables for the 6520. A simple series of keystrokes on the 6520 front panel controls, starts the measurement process.

Resistivity Fixture Device Data
Operating Temperature: –30° to +85°C,
Operating Humidity: 65% R.H. (up to 35°C, derate 3% R.H./°C above 35°C.)
Storage Temperature: –25° to +85°C.
Dimensions: 108mm high × 165mm wide × 140mm deep (41⁄4in × 61⁄2 in × 51⁄2 in).
Weight: 1.45kg (3.19 lbs).

7.9.3. Calibration Resistors

Precision resistors are available (see Table 7-5) for calibrating the 6520. Each is supplied in a shielded enclosure with two male type N connectors spaced to allow connection to the 6520. To meet the accuracy of the specification in Table 7-2 and Table 7-3, a precision 100 megohm resistor is recommended for calibration of error coefficients.

Other Calibration Resistors are available in ascending decades from 100 gigaohm to 100 teraohm as well as special values on request. These precision resistors are typically used as check standards or transfer standards.

Note: The 6520 will accept only a resistor of approximately 100M with an uncertainty better than ±50ppm for setting the capacitor and threshold error coefficients.

Model	Nominal Resistance Value (Ohms)	Nominal Initial Tolerance (±ppm) (Note 1)	Calibration Uncertainty @23˚C±˚C (±ppm) (Note 2)	Stability 12 Months (±ppm)	Temperature Coefficient 18-28˚C (ppm/˚C)	Voltage Coefficient (ppm/volt) (Note 3)
65224/0	0	n/a	n/a	n/a	n/a	n/a
9336/10M	10 M	25	15	10	<5	<0.1
9336/100M	100 M	50	<25	25	<5	<0.5
9336/1G	1 G	100	<80	35	<6	<0.5
9336/10G	10 G	200	<100	100	<25	<1
9336/100G	100 G	500	<500	200	<250	<1
9337/1T	1 T	1000	<1000	500	<300	<2
9337/10T	10 T	3000	<4500	750	<500	<2
9337/100T	100 T	5000	<5500	1000	<800	<2
9337/1P	1 P	20000	<10000	2000	<1000	<2
9337/10P	10 P	100000	<50000	5000	<10000	<2

Table 7-6: Calibration Resistors

Note 1: Nominal Initial Tolerance is the maximum variation of resistance mean value as adjusted initially at point of sale.

Note 2: Calibrated at 23˚C, referred to the unit of resistance as maintained by National Research Council (NRCC) or the National Institute of Standards and Technology (NIST) and expressed as a total uncertainty with a coverage factor of k=2.

Note 3: Maximum Voltage Rating: 1000 volts.

Note 4: The **100M** resistor is **strongly recommended** to maintain a total uncertainty ratio of 4:1 for the 6520.

7.9.4. Small Shielded Enclosure

The model 65223 Small Enclosure provides a stable shielded environment for measuring high resistances and the leakage resistance of capacitors. The sample capacitor should be connected between the "Source" and "C" terminals. This inserts a 10 Mega ohm resistor in series with the Capacitor to limit inrush currents.

CAUTION

Hazardous voltages may be present at the SOURCE terminal. Ensure that the 6520 source is turned off before opening the 65223 cover.

Inside dimensions: 138 × 112 × 60 (mm)
5.375 × 4.375 × 2.375 (ins)

7.9.5. Large Shielded Enclosure

The model 65222 Large Enclosure provides a stable shielded environment for measuring high resistances.

CAUTION

Hazardous voltages may be present at the SOURCE terminal. Ensure that the 6520 source is turned off before opening the 65222 cover. The box of the enclosure should always be connected to the ground lug on the rear panel of the 6520.

Inside dimensions: 342 × 228 × 152 (mm)
13.5 × 9.0 × 6.0 (ins)

7.9.6. Lead Set Model 65225

This kit contains the following items:

- Two 1 metre (39-inch) extension cables fitted with shrouded terminals and optional alligator clips on one end for connection to the unit under test and mating coaxial connector on the other end for connection to the 6520 front panel Source and Input connectors.
- Two 1 metre (39-inch) extension cables fitted with a type N female connector on one end and mating coaxial connectors on the other end for connection to the 6520 front panel Source and Input connectors.
- One 1 metre (39-inch) External Trigger cable with a 5-pin DIN connector for attachment to the 6520 rear panel External Trigger connector with stripped, tinned termination wires for attachment to the external trigger source.
- One 1 metre (39-inch) Interlock cable with a 5-pin DIN connector for attachment to the 6520 rear panel Interlock connector with stripped, tinned termination wire for attachment to the external safety interlock switch.
- Two type N male to BNC female adapters.

7.9.7. Calibration Kit Model 65226

This kit contains the following items:

- Two 1 metre (39-inch) extension cables fitted with a type N female connector on one end and mating coaxial connectors on the other end for connection to the 6520 front panel Source and Input connectors.
- Type N connector to binding post adapter.
- One Zero Ohm link Model 65224
- One Precision resistor Model 9336/100M

7.9.8. Zero Link Model 65224

This option contains a cable with an internal zero Ohm link used in the calibration of the 6520.

7.9.9. IEEE Interface Accessories

This option allows the connection of the 6520 to a Personal Computer or Laptop for software and remote control.

Interface	Supported OS	Description
IEEE PCI	Win 9x/NT4	PCI IEEE-488.2 Interface Card (for PC only)
IEEE USB	Win 98/ME/2K/XP	USB IEEE-488.2 Interface (for Laptop/PC) *** Recommended
IEEE PCMCIA	Win 95 and newer	PCMCIA IEEE-488.2 Interface Card (for Laptop only)
IEEE Cable 1M	N/A	1 Meter, Double Shielded IEEE 488.2 Interface Cable
IEEE Cable 2M	N/A	2 Meter, Double Shielded IEEE 488.2 Interface Cable *** Recommended
IEEE Cable PCMCIA	N/A	1 Meter PCMCIA to IEEE Cable

Table 7-7: IEEE Interfaces

7.9.10. Service Manual SM6520

The Service Manual is a optional reference material for extended maintenance, calibration, as well as remote interface programming information.

7.9.11. 6520/RC Report of Calibration

The 6520 Report of Calibration supplies the extended data for the calibration of your 6520 Teraohmmeter.