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Automatic Potentiometer

Model 8000C/8001C

Operator Manual

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AUTOMATIC POTENTIOMETER

MODEL 8000C/8001C

OPERATING MANUAL

8000C.OM Rev. 0 **Approved By:**

2025-12-02 **QA:**

S/N:

Form MI 65, Rev. 1, Dated 09-01-27 (QAP 19, App."M")

The 8000C/8001C is an Electrostatic Sensitive Device (ESD). Failure to observe standard, antistatic practices can result in degradation of performance or improper measurement results, even when an actual failure does not occur. Do not touch the terminals during measurement and avoid any electrostatic discharge, namely when the measurement is running.

To ensure CE power line pulse rejection compliance, the 8000C/8001C must be operated using the power cord supplied by the manufacturer (MIL).

PROLOGUE

The technology of the Model 8000C Binary Voltage Divider potentiometer is based on a switching technique for binary resistive voltage dividers by R.D. Cutkosky (NIST). This concept has been implemented in the 8000C (Range 1 mV to 10 V) by Measurements International and extended to a microprocessor controlled self-balancing Voltage Divider with ranges of 10 V, 30 V, 120 V, 300 V, and 1200 V.

The Model 8001C is used to extend the measurement range of the Model 8000C Automated Potentiometer to 1200 volts. The 8001C connects to channel 20 on the 8000C. The controller first sets the range of the 8001C to 1200 volts and then reads the DMM to find the input voltage out. If the output is low enough then the range will be auto set to the next step lower. This process is repeated until the lowest possible range is selected thereby giving the highest possible voltage out. The remainder of the measurement process is then completed by the 8000C. When the 8000C has completed the measurement the 8001C range and calibration information is then used to calculate the absolute value of the input voltage.

All measurements data, either self calibration or voltage division, is transmitted over the IEEE488 bus. The 8000C and 8001C are fully automatic and can be calibrated without manual intervention. There are no internal adjustments and being a ratio device, “TRUE” self calibration can be performed.

For use as a stand-alone Divider/Measuring device an 8½ digit DVM (either Hewlett Packard 3458A or Keithley 2000), a 10 V Zener (source) and a 10 V zener reference is required.

NOTE

The 8001C has two possibilities of calibration. The Reference calibration uses a 10V Zener to calibrate the ranges. The Bootstrap calibration requires the use of a 5700 series calibrator.

SYSTEM COMPONENTS

The following components comprise the 8000C/8001C 1200 Volt Range Extender system.

- Model 8001C Range Extender
- Model 8000C Automatic Potentiometer
- Detector (Digital Voltmeter, typically 3458A)
- IEEE-488 Cables
- Low Thermal Interconnection Cables
- Compact Disk Software
- Windows compatible PC
- NI IEEE Interface
- To complete the system a 10 V source and a 10 V reference are required.

See figure 4 or 5 for connections between the units and then follow the simple operation:

1: Calibrate 8000C
2: Standardize 8000C
3: Measure Channel 1, and Channel 2
4: Calibrate 8001C
5: Measure using 8001C using Fluke 57xx series of calibrators.

WARNING

SEVERE DAMAGE WILL BE CAUSED IF THE SELECTED VOLTAGE RANGE IS LOWER THAN THE VOLTAGE.

Front panel control is limited to switching INPUT and GUARD voltages on and off as well as selection of the voltage divider RANGE. Self calibration and measurement routines can only be addressed over the interface bus. When under the control of the computer, the front panel keys are inoperative.

REMOTE/LOCAL: The Remote led, when on indicates that the system is in the Remote mode. When in Remote mode all other keys are inoperative. Depressing the Remote key, when the system is not under software control, activates the LOCAL mode. When the next IEEE command is received, the system will return to the REMOTE mode and all front panel keys will be inoperative.

INPUT: This key connects the input voltage to the divider.

BEFORE SELECTING THE INPUT ON, MAKE SURE THAT THE RANGE SELECTION SWITCH IS AT 1200 OR AT THE CORRECT VOLTAGE.

GUARD: This key connects the guard voltage to the guard circuitry. The guard voltage is normally not required.

RANGE: These switches select the correct divider range for the voltage input.

THE RANGE SHOULD BE SET TO 1200 FOR THE FIRST MEASUREMENT THEN LOWERED IF POSSIBLE.

RANGE SETTING WARNINGS

This is for manual ranging. When run by the 8000C software the ranges are selected automatically.

For a RANGE set at 1200 volts, if the output voltage is larger than 2.5 volts do not switch to a lower range.

For a RANGE set at 300 volts, if the output voltage is larger than 4 volts do not switch to a lower range.

For a RANGE set at 120 volts, if the output voltage is larger than 2.5 volts do not switch to a lower range.

For a RANGE set at 30 volts, if the output voltage is larger than 3 volts do not switch to a lower range.

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1 INTRODUCTION

1.1 Scope

This manual contains operating instructions on the Model 8000C Automatic Potentiometer and the Model 8001C 1200 V Range Extender.

1.2 General Description

The technology of the Model 8000C Automatic Potentiometer is based on the switching technique for binary resistive voltage dividers designed by R.D. Cutkosky (NIST). This technology was implemented by Measurements International and has been extended by to a microprocessor controlled self-balancing reference potentiometer.

The Model 8000C Automatic Potentiometer has the capability of:

- self-calibrating in terms of divider linearization
- assigning values to any of its inputs
- standardizing with respect to a known reference on any input channel
- providing 8½ digits of accuracy with 10 nV of resolution

The Model 8000C allows 20 voltage sources to be connected to the input channels on the rear of the unit. This offers flexibility in inter-comparisons of any of the sources connected to the input channels. Source inputs can be selected by front panel selection or via the IEEE488 interface bus and are indicated through front panel LEDs. However, all measurement data, either self-calibration or voltage measurement, is transmitted over the IEEE488 interface bus.

Furthermore, the Model 8000C is fully automatic and is calibrated without manual intervention. There are no internal adjustments and, as the Model 8000C is a ratio device, *"true"* self-calibration can be performed.

Figure 1 displays a functional drawing of the Model 8000C. The right-hand side shows twenty input channels, each with a **HI** and **LO** input terminal.

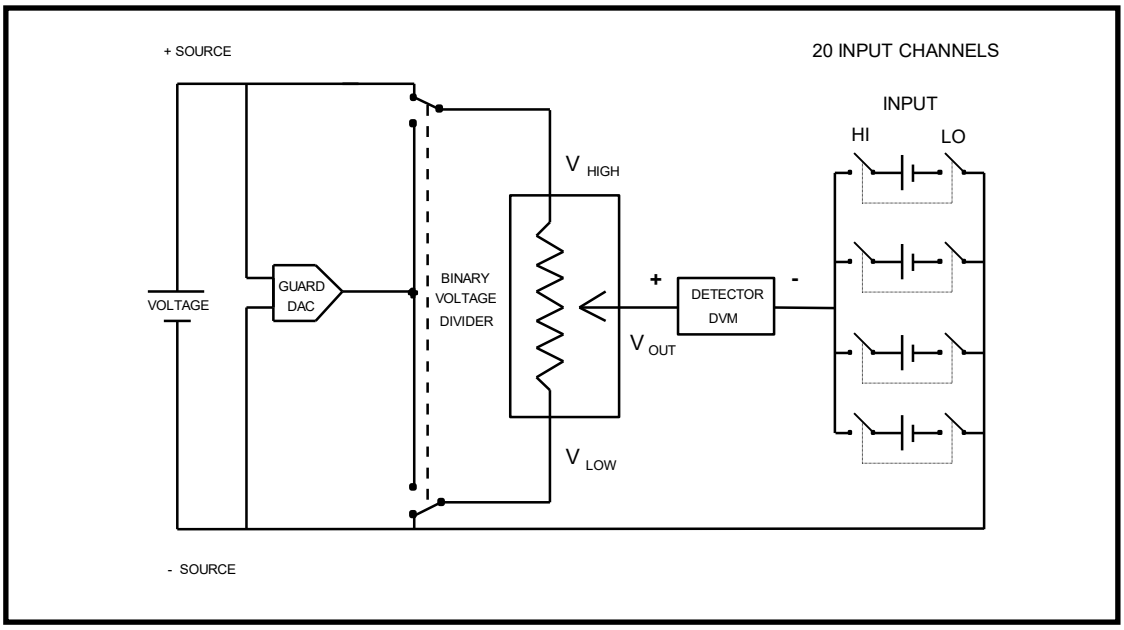

Figure 1 8000C Functional Drawing

2 SETUP & CONNECTIONS

2.1 Setup

2.1.1 Hardware Requirements

The computer, with a minimum of 32M RAM running Windows 7 or later, is recommended for using this software. The hard disk must have at least 4 Mb of free space for the program before installation. The computer must have a National Instruments GPIB-USB-HS card and drivers to operate the 8000 software remotely. GPIB cables are also required to connect the computer to the instruments used in the 8000C system.

For the IEEE interface, a National Instruments GPIB-USB-HS card is required and must have drivers installed on the computer. Although, there are various models of this interface card, we recommend the USB -GPIB card.

2.1.2 IEEE488 Hardware Configuration

Before loading the Model 8000C Software, the GPIB-USB-HS must be connected and have the drivers installed on the hard drive. Ensure the GPIB-USB-HS card is installed and working before installing the 8000C software. Follow the instructions located in the national instruments manual provided in the box with the interface or visit www.NI.com.

2.1.3 8000C Software Installation

NOTE

The Model 8000C Software is provided under an exclusive license and is for use only with the system it was supplied with.

With the IEEE488 Driver loaded successfully, insert the 8000C Software Setup Disk. From the Windows Control Panel install the 8000C Software. The setup procedure will allow the user to install the software to a specific directory or the default directory (**c:\MIL_SW\8000**). Once the software installation is complete, the message *"8000 Software loaded successfully"* will appear and an icon will be created in the Windows Program Manager entitled **"MIL 8000"** Software (Start -> Programs -> Measurements International -> MIL 8000).

NOTE

If an error occurs with loading a specific file, that file may already exist for another application. To correct this problem, rename the existing file and repeat the 8000C Software installation procedure.

2.2 Rear Panel

The rear panel of the Model 8000C is shown in Figure 2. Details on the Power Switch, Input Connections and Address Selection are provided.

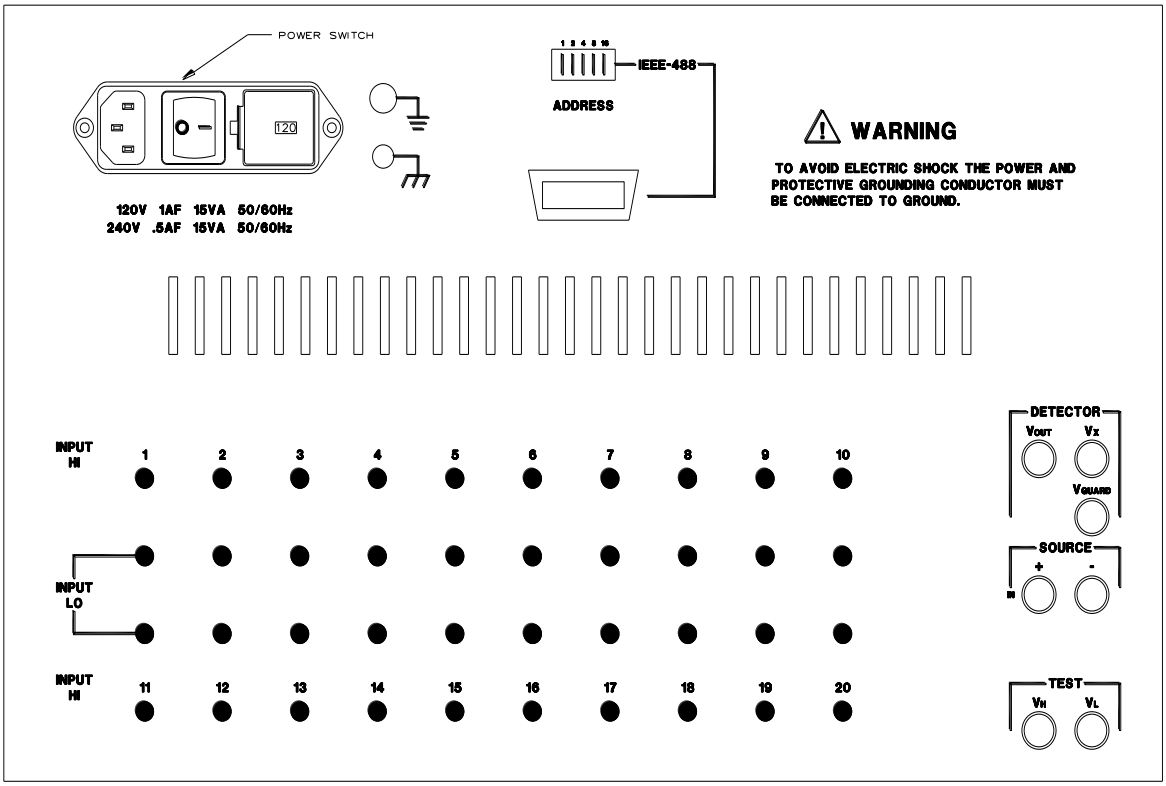

Figure 2 8000C Rear Panel

2.2.1 Power Switch

The power switch is located on the power entry module on the rear of the Model 8000C (refer to Figure 2). When the switch is in the *"ON"* position, the **POWER** LED indicator on the front panel is illuminated.

Before applying power to the Model 8000C, check that the rear panel line voltage selector is set to the nominal line voltage in your area. Refer to the Installation section of the Model 8000C Technical Manual if the voltage is incorrect.

2.2.2 Input Connections

Sources are connected in a two-wire configuration with the leads being connected to the **HI** and **LO** terminals of the input channels. The shields of the low thermal leads are connected to the earth ground (black terminal) on the rear of the Model 8000C.

Other input connections are as follows:

- **DETECTOR:** The Detector (DVM) is connected to the **DETECTOR** terminals designated $\mathbf{V_{OUT}}$ and $\mathbf{V_X}$, where $\mathbf{V_{OUT}}$ connects to DVM positive and $\mathbf{V_X}$ connects to DVM negative.
- **VGUARD:** Vguard is an active driven, low impedance output. This output is used to drive the guard of a guarded detector.

NOTE

When not using a guarded detector, the screen of the detector lead should be tied to the earth ground (black terminal) of the Model 8000C.

- **SOURCE INPUT:** An isolated, low noise voltage source of 10 V is connected to the **SOURCE IN ±** terminals.
- **TEST:** This is used to access the top **(V_H)** and bottom **(V_L)** of the source voltage through the divider for testing purposes.
- **INTERFACE CONNECTIONS:** The Model 8000C is compatible with the IEEE-488 standard. Interface connection is made via the 24-pin connector located on the rear panel of the unit. Commands sent on the interface bus control the relay switching to select the input channel and set the required ratios for calibration and measurement.

2.2.3 Address Selection

The address on the Model 8000C is determined by the setting of the **ADDRESS** select switch located on the rear panel of the unit and is read at power-on.

2.3 Front Panel

Front panel control is limited to the selection of scanner input channels and test programs. Self calibration and measurement routines can only be addressed over the interface bus. The front panel controls include:

- **REMOTE KEY:** When the **REMOTE** LED is illuminated, the system is under control of a computer. Under remote mode, all other front panel keys are inoperative. Depressing the **REMOTE** key under remote mode switches the unit to **LOCAL** or front panel control mode.
- **PROG / ENTER KEY:** This key either selects the Program mode (LED on) or executes channel selection (LED off). Program selection is used for test purposes only and is not normally used during operation.
- **NUMERIC KEYS:** The numeric keys are used to select one of the 20 input channels. This selection must be followed by depressing the **ENTER** key. For example, to select channel 20, depress **2**, then **0**, and finally **ENTER**.
- **LED INDICATORS:** The LED indicators, designated 1 through 20, are used to display the input channel selected.

Before attempting to operate the system over the interface bus, a manual check should be performed to ensure that the input channels are functional. Under front panel control, select various channels and verify that the appropriate LED is illuminated.

2.4 Connection Diagrams

The Connections Diagrams are illustrated in two main sections; each section has sub sections. The two main sections are Calibration and Standardization Diagrams and Measuring Diagrams. Calibration or Standardization Diagrams has three sub sections, they are listed as follows; Calibrate and Standardize 8000C, Calibrate 8001C Input Channel, and 8001C Ranges. These three configurations must be setup and completed before measuring voltages using the 8000C and/or 8001C. They are explained in their respective sections. The second main section is Measuring Diagrams; this section has two subsections; Measuring using an 8000C with the 20-channel scanner, and Measuring using the 8001C Range Extender.

2.4.1 Calibration and Standardization Diagrams

The Calibrate and Standardize diagram for the 8000C is shown below in figure 3. This step must be completed to move onto the Measuring Section. The configuration in which this step is a pre-requisite is for ‘Measuring using an 8000C with a Scanner’.

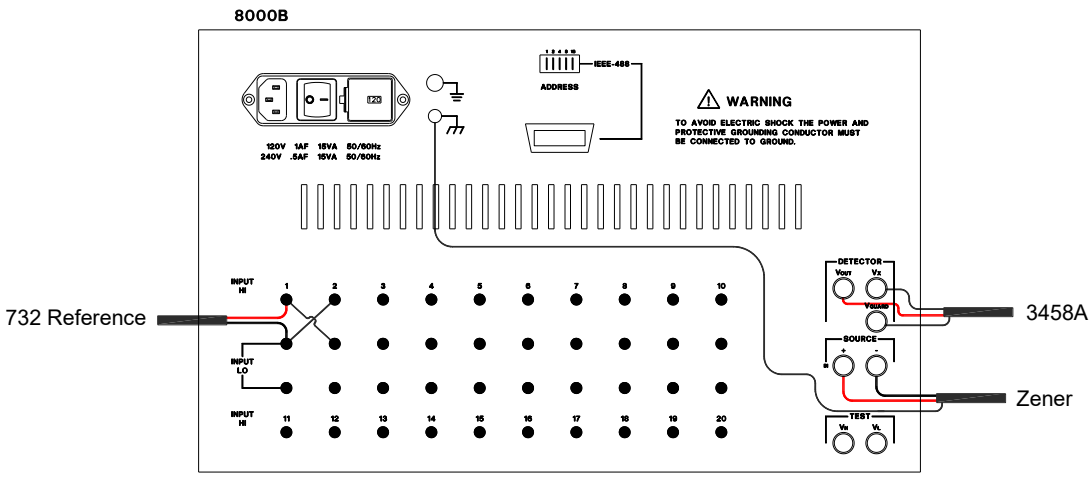

Figure 3 Calibrate and Standardize the 8000

2.4.2 8001C Calibration

This is the third of three sub sections of the Calibrating and Standardizing Diagrams. The 8001C Calibration offers two options called Reference and Bootstrap and gives the user the option of calibrating the 8001C using a 10V reference or a 5700 series of calibrator at 30% of the range voltage.

2.4.2.1 Reference Calibration

The first option is referred to as Reference calibration, and this consists of two stages as follows:

- Calibrating the 8001C Input Channel zero offset voltage by shorting the input terminals (Figure 4).
- Range Calibration of the 10V, 30V, 120V, 300V and 1200V using the same 10 V reference (Figure 5) that the 8000C was standardized against. The number of calibration cycles can also be selected between 1 and 10 where 1 cycle calibrates all the ranges. This completes the calibration procedure for the 8001C Reference calibration.

2.4.2.2 Bootstrap Calibration

The Bootstrap calibration requires the use of a stable 5700 series calibrator. The calibration is completely automatic with the calibrator being controlled over the IEEE bus. A bootstrapping method is used to first measure 10V from the calibrator on the 10V Range and then measuring the same 10V on the 30V Range where the offset is recorded. 30V is then measured on the 30V Range and the same 30V is then measured on the 120V Range.

This is repeated until 300V is measured on the 1200V Range and the offsets recorded. The number of calibration cycles can also be selected along with the stats.

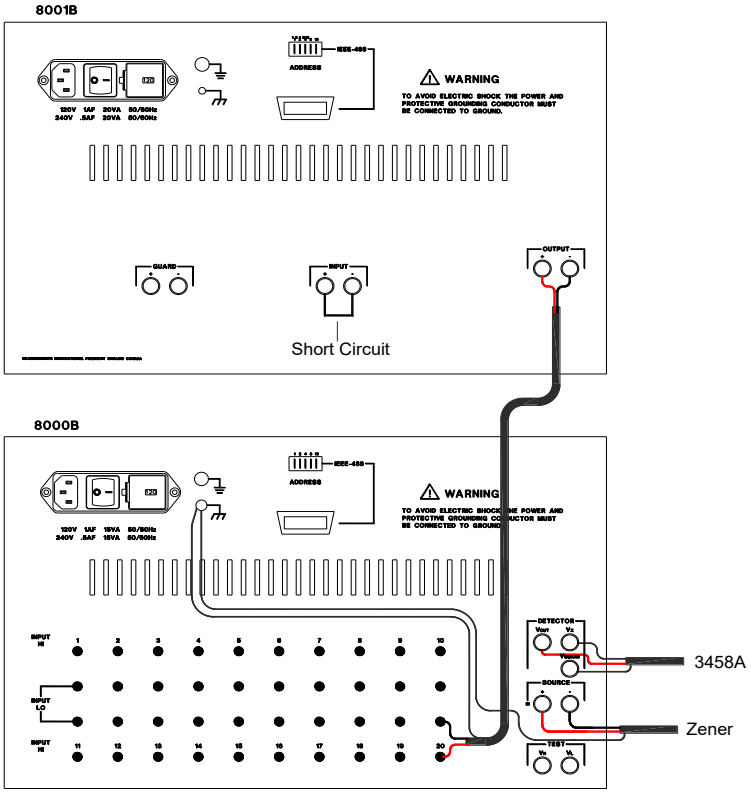

Figure 4 Calibrate 8001C Input zero offset measurement

Upon receiving the instrument both the Reference and Bootstrap calibrations procedures should be performed. This section requires being complete along with section 2.4.1.2, if you want to measure voltages using the ‘Measuring using the 8000C and 8001C.’ (Refer to Figure 7).

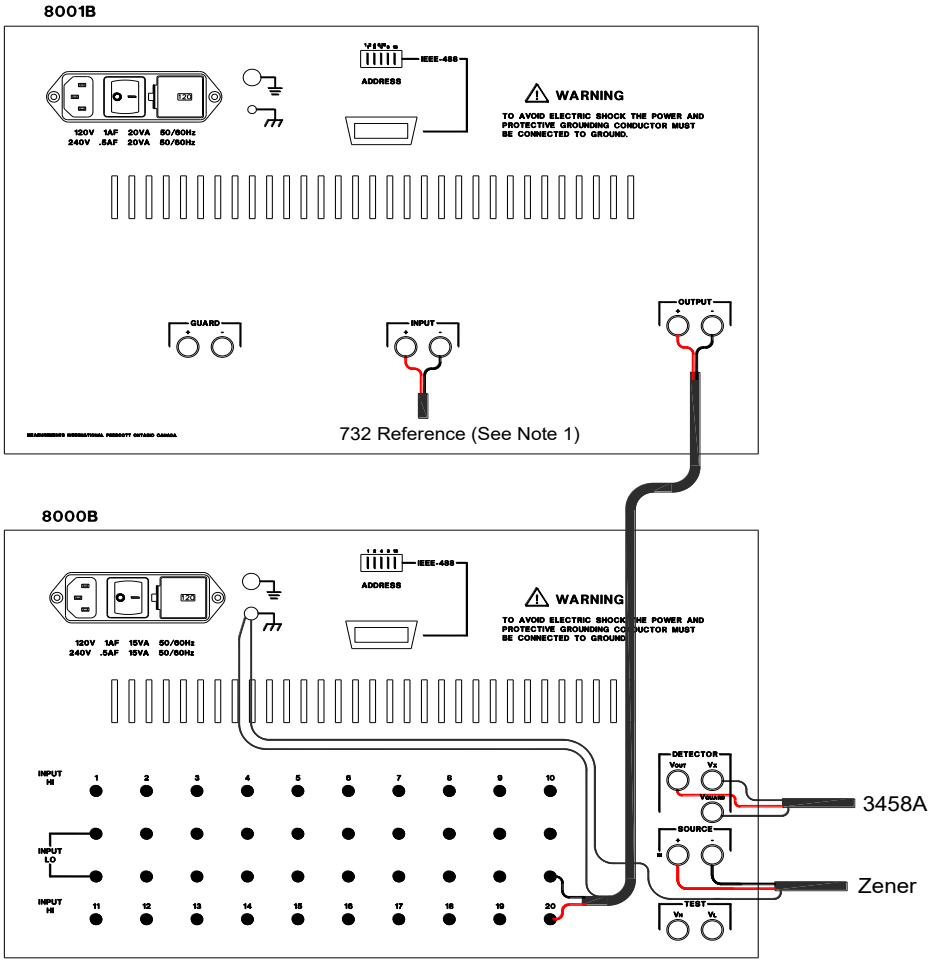

Figure 5 8001C Range Calibration

NOTE

1. **732 Reference can be the same reference as used in section 2.4.1.1 Figure 3.**
2. **For Bootstrap Cal connect a 5700 series calibrator. For 4 wire connections ensure that the Sense button is selected on the 57XX calibrator.**

2.4.3 Measuring Diagrams for the 8000C and 8001C

To start a measurement using the 8000C and the 8001C the user must have completed steps in sections 2.4.1.2 and 2.4.1.3 or 2.4.1.4. After the user has completed the respective sections, the 8000C and 8001C are ready and configured for voltage measurements up to 1200 V. Figure 6 below, illustrates the wiring diagram for using the 8000C and 8001C to measure voltages.

To ensure the best measurement accuracy the voltage source under test should be connected to the 8001C (INPUT) with the same wires that have been used during the 8001C.

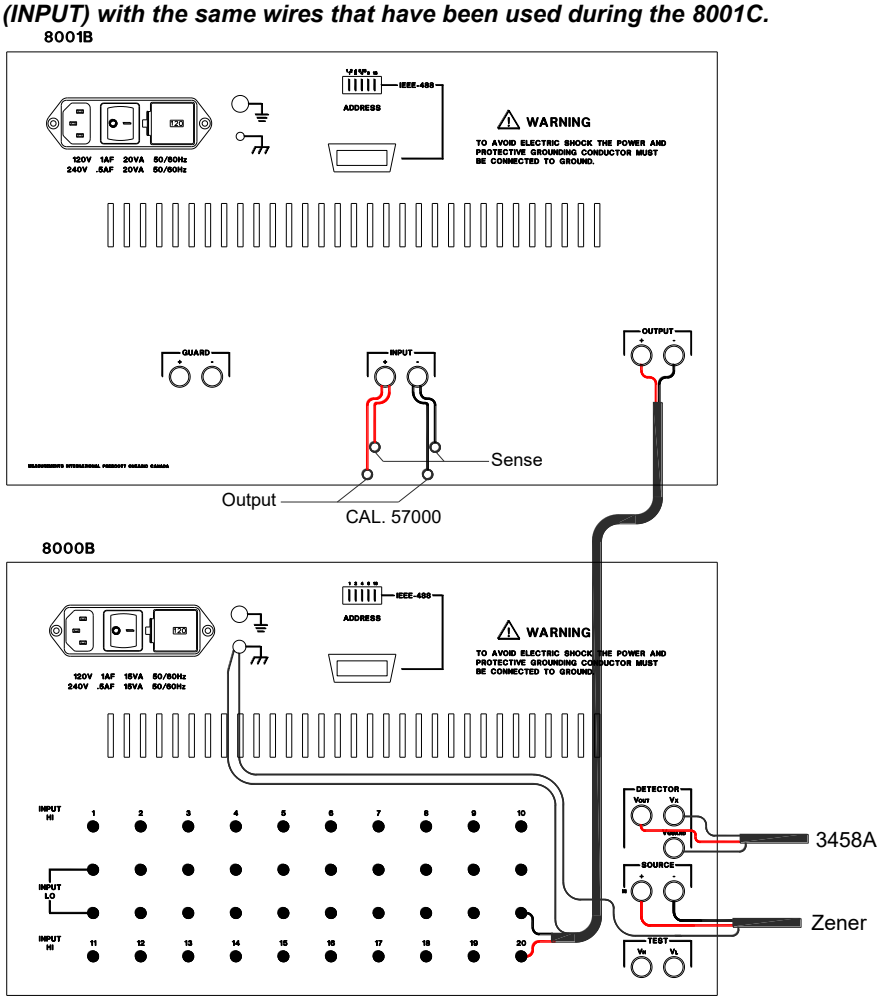

Figure 6 Measuring using the 8001C and 8000C

2.5 Running the 8000C Software

To run the 8000C Software, click the mouse on the **"MIL 8000"** Software icon in Windows Start -> Programs -> Measurements International and the MI 8000 Opening Menu Screen will be displayed as illustrated in Figure 7. Sample files have been included for the Setup, Source, and Program files as a tool to gain familiarity with the software.

NOTE

Please ensure that no other Windows program is running in the background when running the MIL 8000C Software as other programs may conflict with the 8000C Software.

2.5.1 First Time Users - Running the Software in Demo Mode.

Running the software in Demo mode will allow the user to become familiar with the features of the program. At this point the IEEE488 and MI 8000 software have been successfully loaded.

For first time users the software will be run from SET, IDS and PRG sample files. After that the user can create and save additional DEMO files to better understand the screen inputs and operation of the software while reviewing Sections 3 and 4 of the manual. Once the user is familiar with the software, ensure to select the National Instruments 'GPIB Mode' from the System and Rack setting.

1) Click the mouse on the 8000C ICON in Windows Programs. The Main Menu will appear (See Figure 7).

NOTE

An error may occur, e.g. a driver is not loaded. Click the mouse on OK.

2) For the first time users the Setting Files, Source ID Files and Program Files titled Sample will be selected by default. You will develop a list of files based on your test routines. As measurements are made different files can be saved. When doing future measurements selecting the setting, source ID and program files will initialize the settings.

3) Click the mouse on the Continue button. This opens the main menu.

4) Select the System and Rack Settings ICON.
Run the GPIB mode in **'DEMO'**

Load the "Sample.set" Settings file. Predefined Source and Reference fields have been loaded. During actual operation input the Source and Reference field as determined by your equipment.

Select the DVM to be used and enter serial number.

If you have an 8001C select the "In system box" and enter serial number.

Save System and Rack Settings.

Close the System and Rack Screen.

5) Select the Source ID Listings ICON and load the “Sample.ids” Source file provided.

   The upper left corner provides a source designator. This is used to identify the source and to input additional voltage sources. The left column of the table identifies all the Measurand source’s entered. Additional voltage sources are input in the Source ID listing screen by selecting the appropriate Designator and selecting “Create Source.
   When finished inputting all the source information save the file.
   Close the Source ID Listing screen.

6) Select the Program ICON.
   Determined attributes and Wait state attributes are also defined in the “Elements Tab”. Wait states include “Wait For” and “Wait Until”
   Clicking on the “Programs Tab” opens the screen for Measurements, Tasks, and Programs. Double click on the specific Program in the program table, and the Active Program will update to reflect the selected program.

   When finished and ready to run save and close the program screen.

7) The Main Menu Screen will appear.
   The 8000C is now ready to measure the sources connected to any of its inputs based on the selected program.

   Click on the “Start Measurement” Icon Measured results of the ratio and standard deviation are recorded in the lower left table and graphed.

3 SCREEN DESCRIPTIONS

3.1 Opening Menu Screen

The **Opening Menu Screen** is displayed upon entering the 8000C software program; refer to Figure 7. This screen allows the user to load previously saved files for system settings.

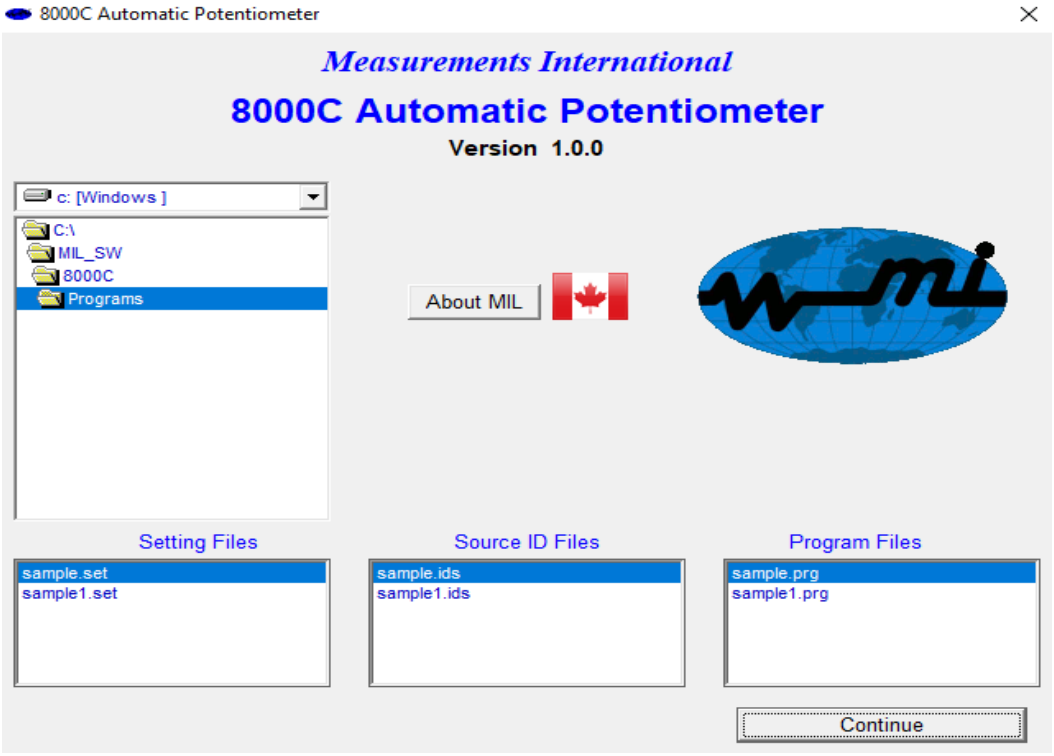

Figure 7 Opening Menu Screen

The lower half of the screen contains lists of all source files (*.ids), setup files (*.set), and program files (*.prg) in the 8000C's 'Programs' directory. It is also possible to change the working drive and/or directory using the appropriate boxes. To select the initial settings, highlight the appropriate files using the mouse as shown in. Some sample files were included with the 8000C.

Software was installed. Sample files for the 'Settings', 'Source IDs', and 'Program Files' are provided to show the information for each file type.

3.1.1 'About MIL'

Selecting the **About MIL** button (see Figure 8) gives the user information on Measurements International and the 8000C software. Any problems or inquiries about the software can be addressed by contacting Measurements International using the phone / fax number or e-mail address (sales@mintl.com).

The software version is also shown here. Please refer to this revision number when contacting Measurements International regarding software problems.

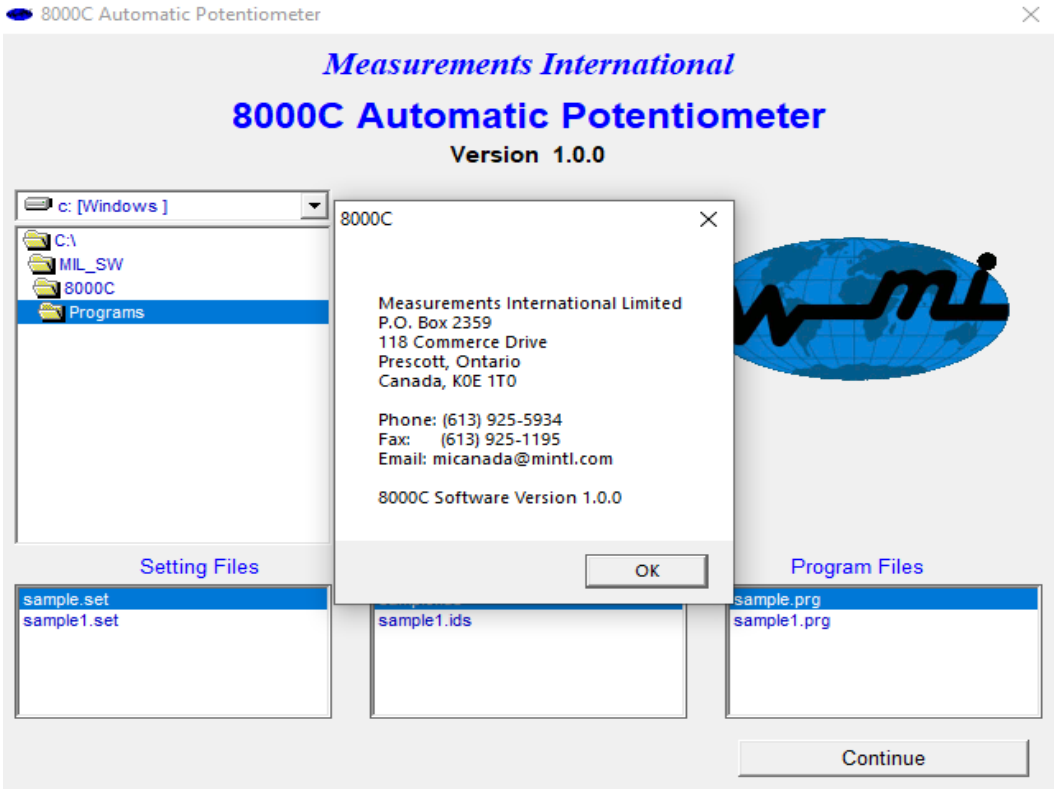

Figure 8 About MIL 8000C Software Information

3.1.2 'Continue'

The **Continue** button loads and opens the highlighted settings, source ID, and program files. Selecting the Continue button opens the Main Menu Screen below, see Figure 9.

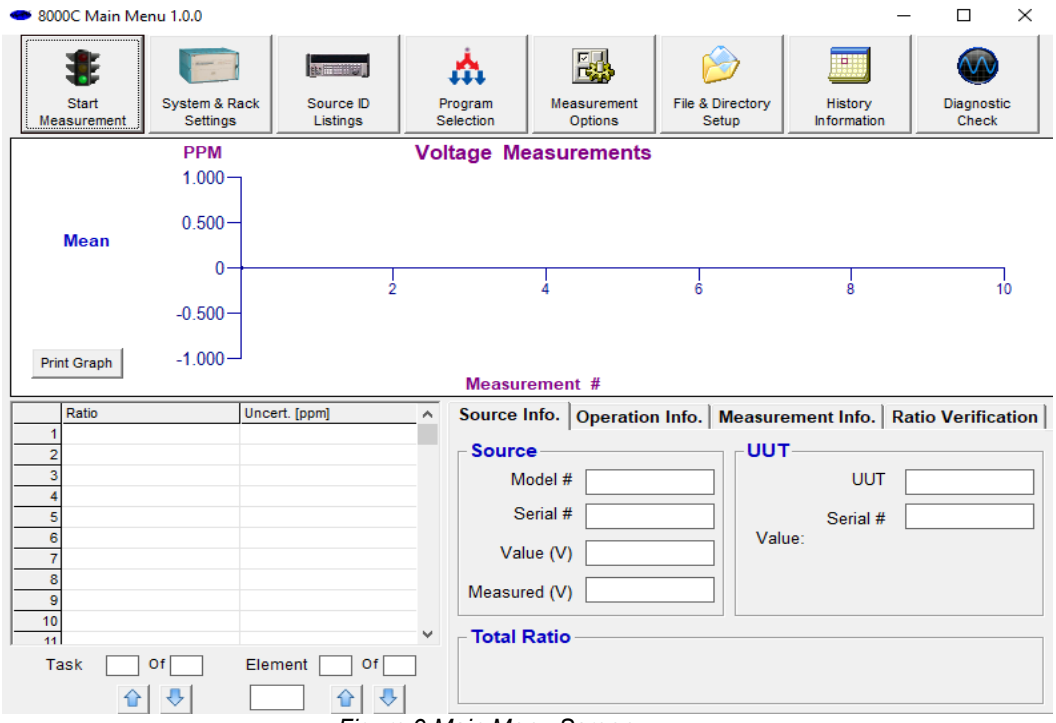

Figure 9 Main Menu Screen

3.1.3 Main Menu

The Main Menu Screen contains a group of menu keys at the top of the screen, which may be selected to perform a complete measurement. These menu keys are selected by clicking the mouse on the desired key.

The following gives a very brief description of the functions of the menu keys in the Main Menu Screen. These keys are described in more detail in later sections.

- **Start / Stop Measurement** - starts or stops a measurement run.
- **System & Rack Settings** - contains hardware configuration.
- **Source ID Listings** - contains source information.
- **Programs Selection** - creates, edits, or selects a measurement program.
- **Measurement Options** - includes various measurement options.
- **File & Directory Setup** – displays present file paths.

- **History Information** – displays summary information on resistors.
- **Diagnostic Check** - calibrates / standardizes the Model 8000C Automatic Potentiometer and the Model 8001C Range Extender.
- **Source Info Tab** – displays information on the source and UUT.
- **Operation Info Tab** – displays graph span, a selection of different graph lines, IEEE commands, software version.
- **Measurement Info** – displays environmental conditions (either entered or active) and measurement parameters as selected in the programs menu for Program information, measurement settings and Active files being used.

Once a Measurement has been performed measurement values are displayed in the Table in the lower left portion of the screen while the values are plotted in a graph in the center of the screen.

The following additional information is found in the lower right of the main menu screen. The **Source Information** tab displays properties as well as the measured uncertainties for Units under test. The **Operation Information** tab allows the operator to access the graphing options and IEEE command display. The **Measurement Information** tab displays the program, task, and measurement settings. The **Ratio Verification** measurement is run from the “Ratio Verification” Tab. Additional information is provided in Section 4.4

Refer to Section 4 – PERFORMING A MEASUREMENT to observe how these functions are used during a measurement run.

3.1.4 System & Rack Settings

This screen is used to enter the information pertaining to the instruments being used in the 8000C system. Enter the 8000C, serial number, GPIB address at the top left of the screen.

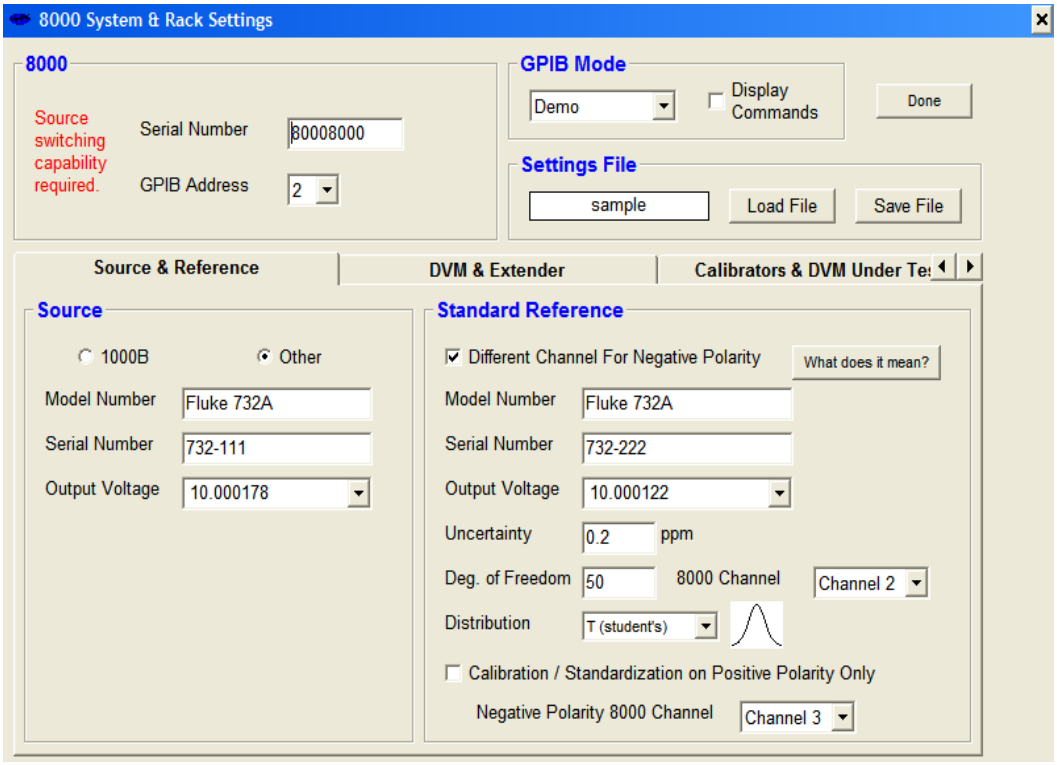

Figure 10 Source & Reference

There are four tabs on the lower half of the screen. The very most left tab is **Source & Reference** (see Figure 10) while the next tab right is for **DVM and Extenders** (see Figure 11). The next two tabs from left to right are **Calibrators & DVM Under Test** (see Figure 12) as well as **Scanners** (see Figure 13). Select the "Source and Reference" tab and enter the source voltage which is the potential applied to the "Source In terminal at the rear of the Model 8000C. Also enter the Model and Serial number, Output voltage, Uncertainty (short term drift), and the channel that the reference is connected to on the rear of the 8000C, see figure 3. By selecting the "DVM & Extenders" tab the 3458A detector serial number and GPIB address can be entered. Additional information on the 3458A for proper usage is already loaded. Checking the 'In System' box can enable the 8001C extenders, enter serial number and GPIB address. Also enter any additional information on

the DVM being used as the detector. We recommend “NPLC60, LFREQ LINE” for the Setup Function for the 3458A. Additional functions can be found in the DVM user manual. This information can now be saved as a system and rack setting file (*.set) and used later.

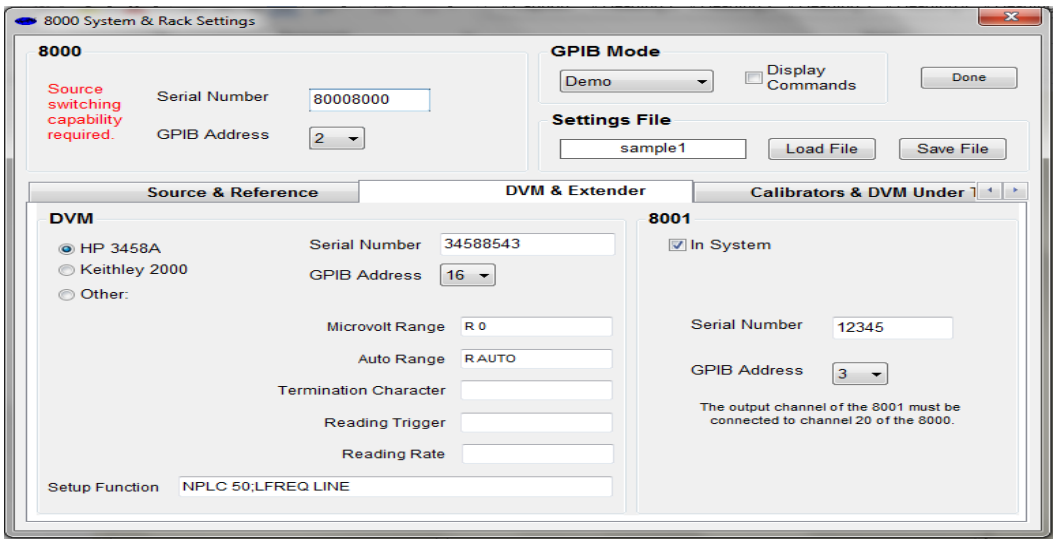

Figure 11 DVM & Extender Set Up Screen

The DVM and Extender menu also allows the Keithley 2000 to be selected as a detector. Other DMMs such as the Fluke 8508A can also be used and is preloaded.

Using the “Calibrators & DVM Under Test” tab (figure 12) you can add a calibrator and an additional DVM for calibration. To add these devices to your system, check the “In System” box and enter the Serial Number as well at GPIB Addresses.

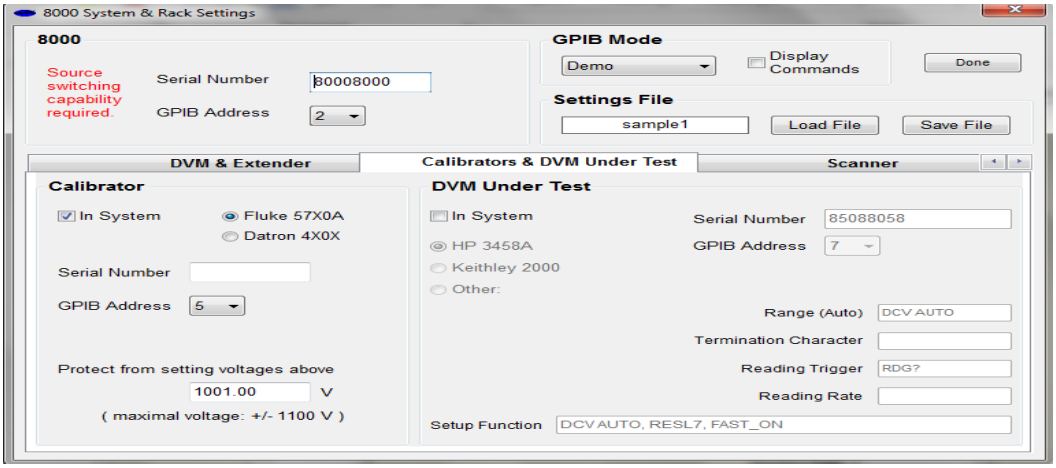

Figure 12 Calibrators & DVM Under Test

The last tab in the 8000C Systems & Rack Settings page is the “Scanner” tab. In the scanner tab the user can select the “In System” tab to use a MI 4040A scanner in this system, also enter the serial number and GPIB addresses of the selected scanner (see Figure 13). The output of the 4040B is connected to channel 19 on the 8000C.

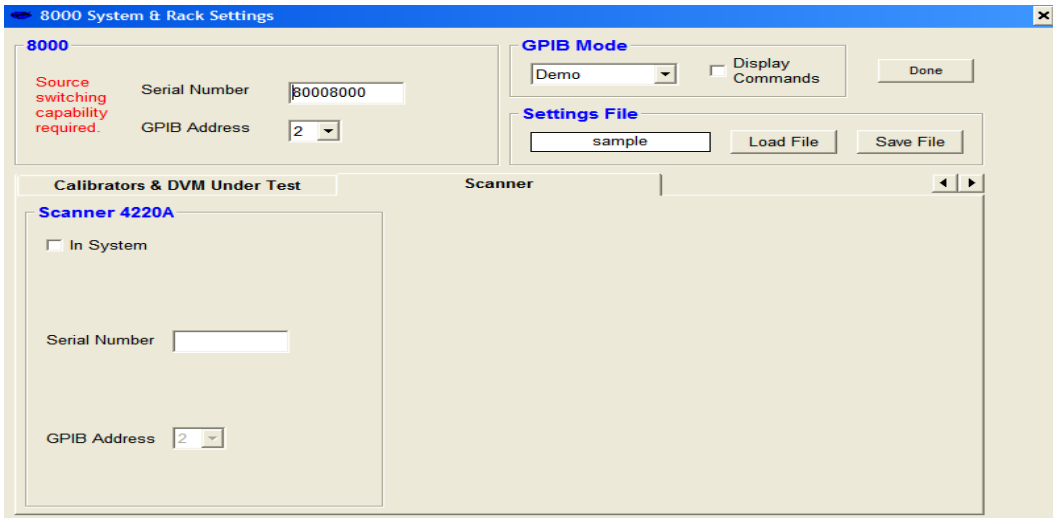

Figure 13 Scanner Tab

NOTE

Many different settings files may be created. It may be advantageous to save the information under the name of the customer and date. In time, when resistors require recalibration, the settings file can be loaded with all the pertinent data.

3.1.5 Source ID Listings

An example of the **Source ID Listing** Menu is displayed in Figure 14. The Source Menu Screen is used to enter or edit source information for voltage measurements. Sources must be identified in the Source table before measurements are performed. Channel 20 is reserved for the 8001C input.

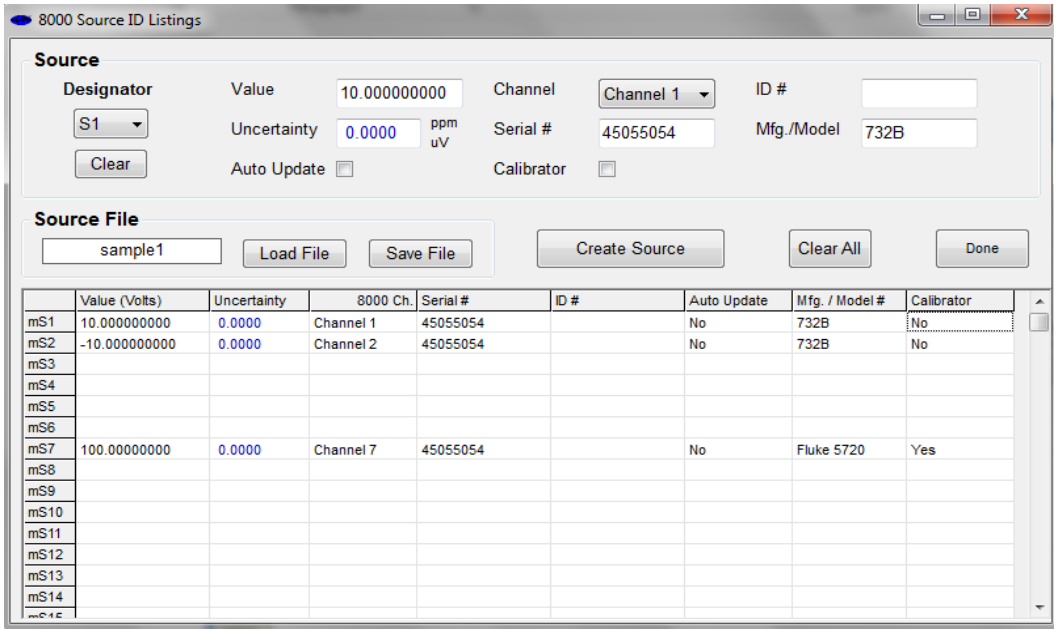

Figure 14 Source ID Listing Menu Screen

To create a source, fill in the information for the Source at the top of the screen (some information may have default values assigned to them). Select the destination row from the grid, and the click on the 'Create Source' button.

NOTE

When the 8001C is enabled in the "System and Rack" Settings channel 20 is made available as the input for the 8001C Extender.

Source's can be selected from the grid by using the 'Designator' combo box in the top left corner, or by clicking on the corresponding row on the grid. A single source or all sources can be cleared using the clear buttons.

To use or edit the information from an existing source, double click on its row on the grid and the data will be copied up to the source creation fields. Make any necessary changes and re-create it in the ID file as above.

NOTE

Many different Source ID Listing files may be created. It may be advantageous to save the information under the name of the customer and date. In time, when sources or references require recalibration, the ID Listing file can be loaded with all the pertinent data. This will also allow the user to track the history on the resistors.

3.1.6 Program Selection

The Programs that run 8000C measurements are set up with the following **Elements** and **Programs** tabs: The base component for a Program is an **Element**. An Element can be one of three types, a Measurement, a Wait State, or a User Function.

A Measurement consists of the source being measured, against the reference value, a settle time, and the number of DVM readings. There are two measurement settings. The number of measurements being taken and the number of readings to use when calculating statistics.

Wait States are used to create a delay between other Elements. They are either wait for a specified amount of time or wait until a specified computer system time.

User Functions are modules that are created in Visual Basic or some other language which run separate user specified routines. These could range from file and data manipulation to controlling other units.

Once Elements have been created, they can then be combined into Tasks. Tasks are a sequence of Elements that run to perform a certain job. These Tasks can in turn be combined to create a Program that can be run from the main screen.

3.1.7 Elements Tab

This section is used to create elements that will be combined to create Tasks.

A Measurement is created using the ‘Measurand Source' grid and entering values into the 'Measurement Attributes' fields. Select a source by dragging the desired source from the 'Source grid to the Measure Source Field in the Attributes. Values for the settle time DVM Readings, number of measurements and statistics must be entered from the pull-down boxes. To finish creating the measurement select the destination row in the

'Measurements' grid and click on the 'Create Measurement' button. Refer to Figure 15.

Create a Wait State by selecting its type ('Wait For' or 'Wait Until'), and then the time desired from the combo box. The times for Wait States are in 24-hour clock format. The 'Wait For' states will delay the Task for the specified amount of time. The 'Wait Until' states will delay until the system clock reaches the selected time. To move the Wait State to the grid, select destination row and then click on the 'Create Wait' button.

Creating a User Function must be done in a programming language and made into a .dll (Dynamically Linked Library) file.

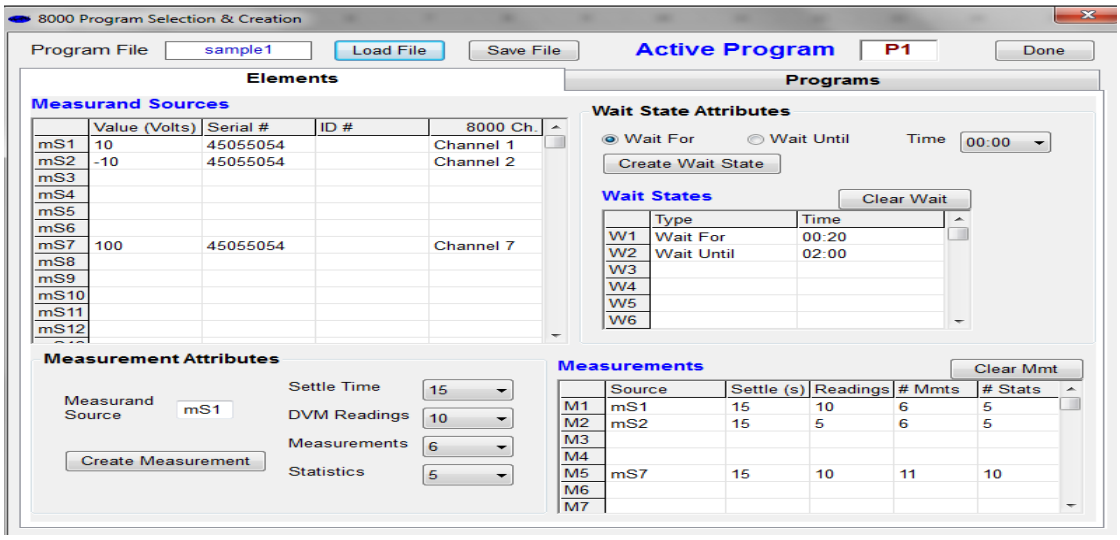

Figure 15 Creating / Editing a Measurement Menu Screen

3.1.8 Programs Tab

The 'Programs' tab allows the operator to create Tasks by combining Measurements, Wait States, and User Functions that were created in the 'Elements' tab.

Elements can be combined into Tasks by “dragging” the desired Measurement, Wait State, or User Function from the appropriate grid and dropping it into one of the rows of the 'Tasks' grid. Elements also include C1 (8000 Calibration), C2 (8000 Standardization), C3 (8001C 2ppm Calibration). To create a Program, “drag” a Task from the 'Tasks' grid to the desired 'Programs' grid row.

NOTE

Elements cannot be dragged directly into the 'Programs' grid. They must be put into a Task first.

To select a Program to be run from the main screen, double click the desired row in the 'Programs' grid and the Program designator will appear in the 'Active Program' window, refer to Figure 16.The file containing the Programs is saved in the 'Program Files' directory specified in the 'Files & Directories Setup' screen.

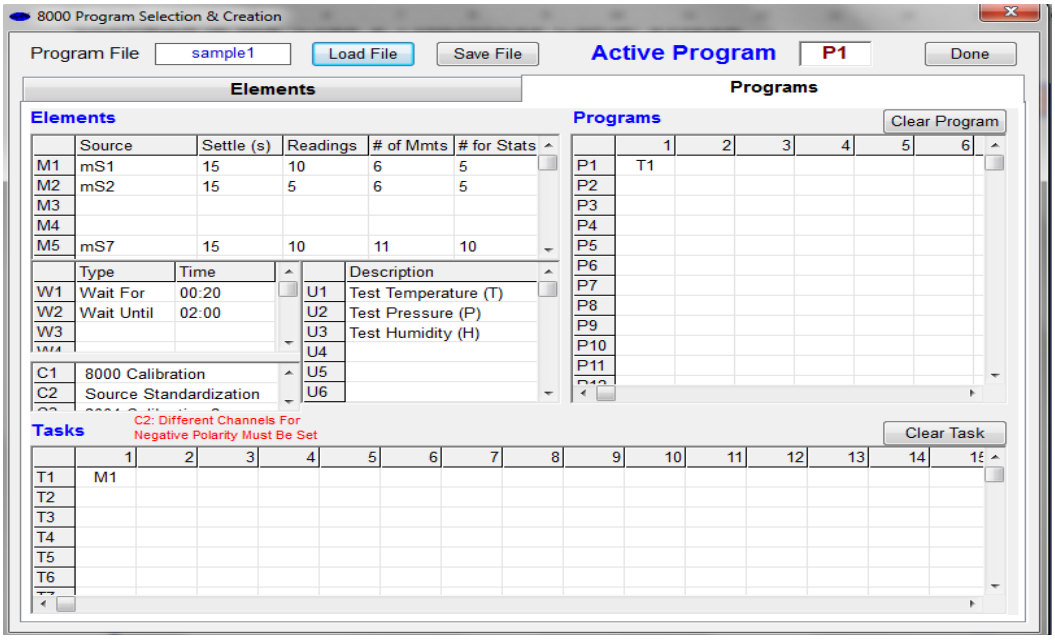

Figure 16 Creating Tasks and Programs Screen

3.1.9 Measurement Options

This screen is used to set conditions for the measurement run. Select the 'Save Measurements' box to save the results to file after a measurement. (see Figure 17). Type in the filename WITHOUT an extension (this is already set to .mea).

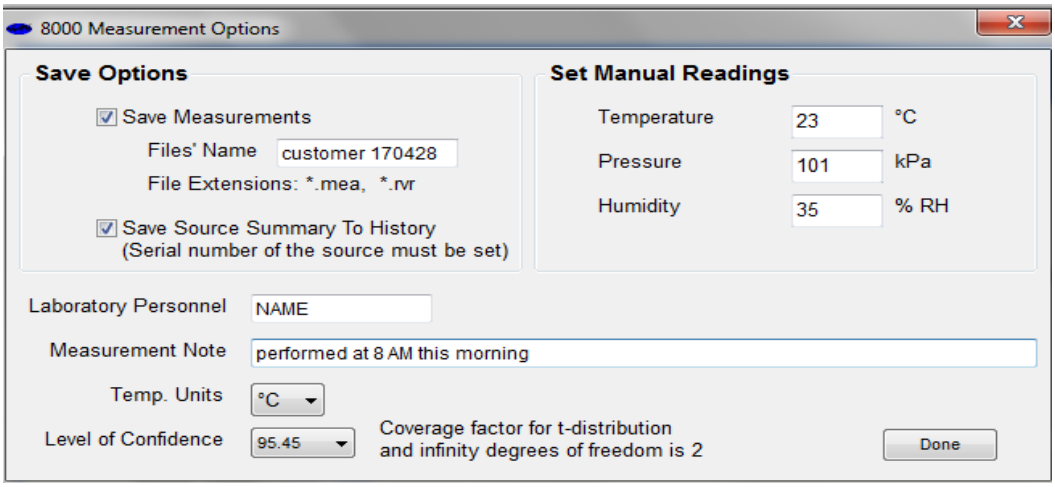

Figure 17 Measurement Options Screen

Select the 'Save Source Summary to the History' box to save a summary of the run to a file that will have the source serial number and extension as its filename ([S/N].his). This file is used by the 'History Information' to display a source history graph.

All these output files are saved in the 'Data Files' directory specified in the 'Files & Directories Setup' screen.

To manually input environmental conditions, enter corresponding values into the fields available in the Temperature, Pressure, and Humidity in the “Set Manual Readings” section.

These values will be displayed on the main screen and written to the saved measurements file from above. Select the temperature units (Temp. Units) to be F or C.

The 8000C allows the user to create USER files for reading these parameters or contact Measurements International directly.

3.2 Files & Directories Setup

There are two ways to change the paths in the 'System Drives & Paths' section. The first is to manually type in the desired path. The second is to locate the file and path using the windows on the right side of the screen. Then drag from the path from the 'Files' box and drop into the appropriate field in the 'System Drives & Paths'. This will copy the currently displayed path. Use this to ensure that the 'System Drives & Paths' section has all the correct 'Program Files', 'Data Files', 'WordPad', and 'Excel' paths (Refer to Figure 18).

The 'Save Present Measurements' section is used to write to file the information displayed on the main screen. Check one or both boxes in this section to indicate what data is to be saved, and then click the 'Save Measurement Information' button. To open a measurement file in WordPad, click on the 'Open Saved Measurement File In WordPad' button to get a listing of files.

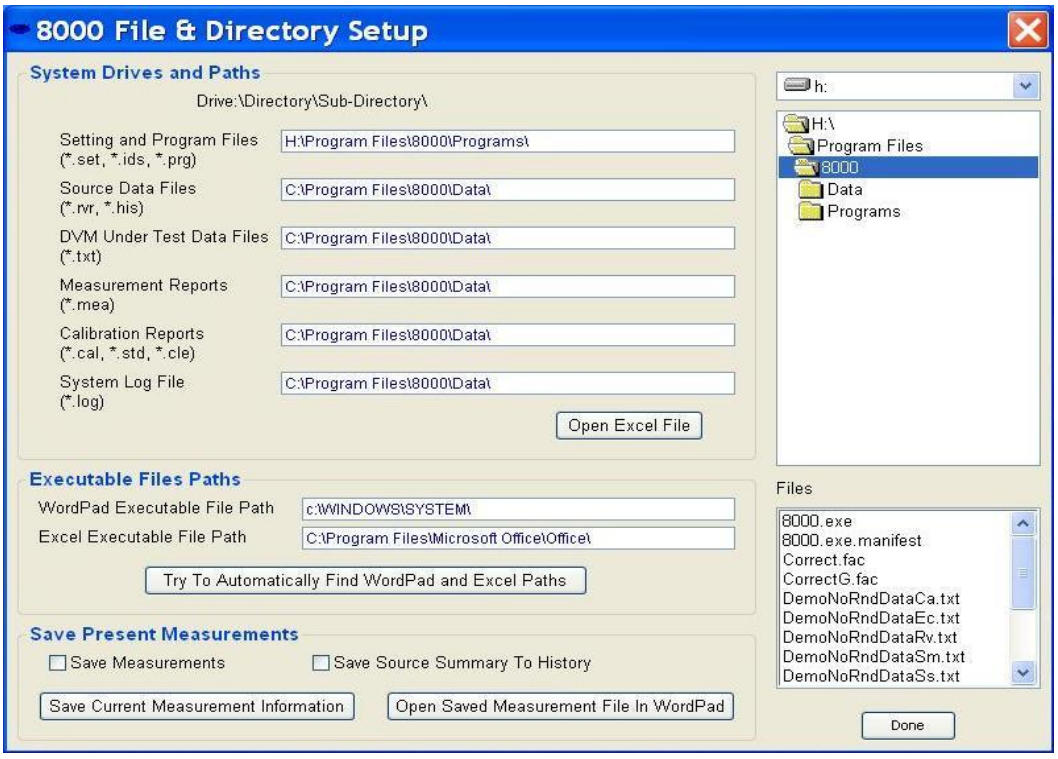

Figure 18 Files & Directory Set Up Screen

3.2.1 History Information

To view a Source saved history data click on the 'Load History File' button, which will bring up a list of files. The software will use regression analysis on the loaded data to project a value for the resistor using the date that the computer is set at. The projected value is displayed using an orange line on the graph. You can print the graph using the button located at the center underneath the graph (see Figure 19).

Open a history file by clicking on the 'Open History File In WordPad' button.

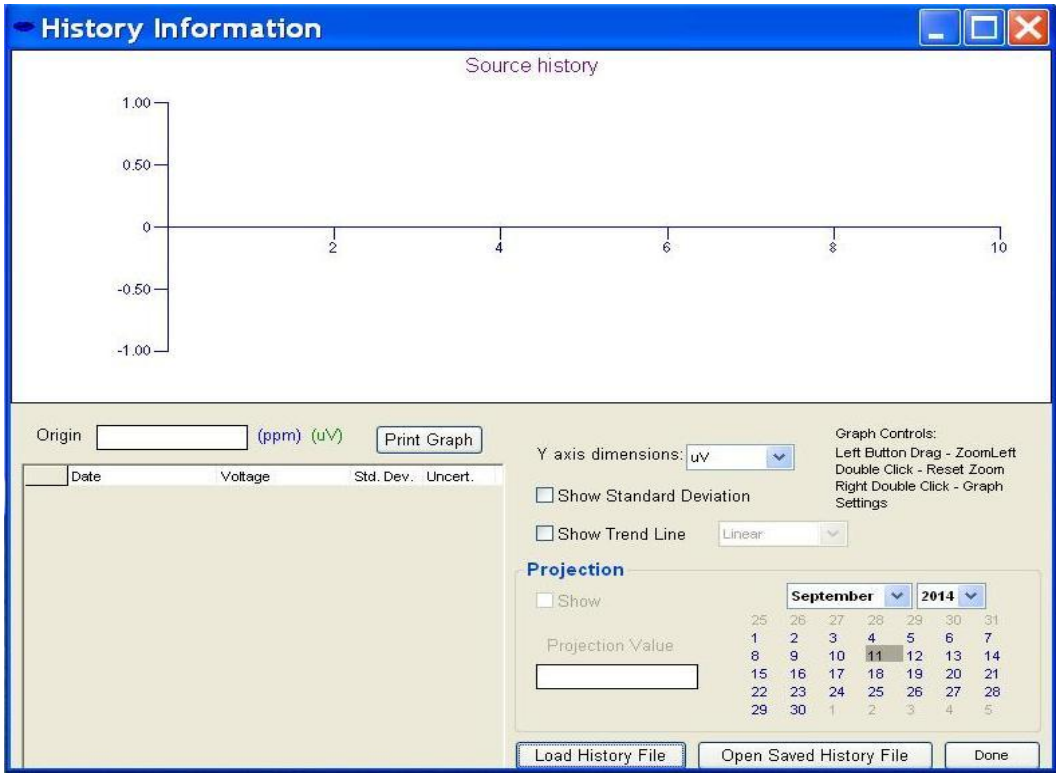

Figure 19 History Screen

3.2.2 Diagnostic Check

From this screen an operator can select and run the remote 8000C Calibration, 8000C Standardization routine, 8000C channel zero offset measurements, the 8001C Reference Calibration routine and the 8001C Bootstrap calibration routine. The **Calibration/Standardization Menu Screen** allows the user to calibrate and/or standardize the Model 8000C. The appropriate option may be selected in the top center of the menu.

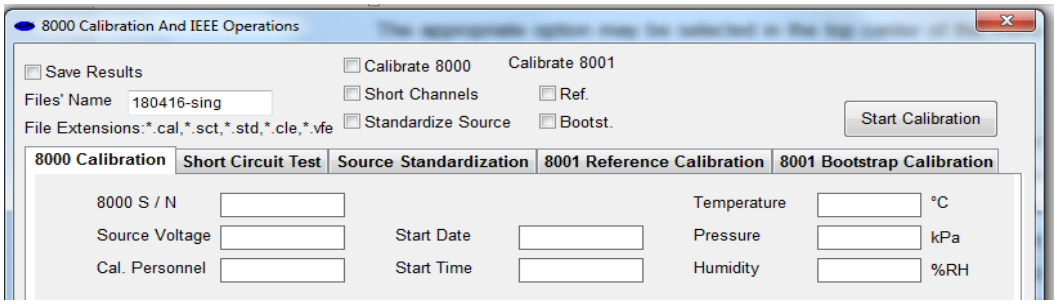

Figure 20 Diagnostic Check Menu Screen

3.2.2.1 8000C Calibration

Calibration information is displayed in the data boxes in top center portion of the Calibration / Standardization Menu Screen. This information includes the **"8000C Serial Number"**, **"Calibration Personnel"**, **"Start Date"**, and **"Stat Time"**. The serial number of the Model 8000C is obtained from the System and Rack Setup Menu Screen, so it must be modified there. However, before a calibration is performed, modify the Calibration Personnel so that the user's name is printed in the *"Report of Calibration"*.

The **Source Voltage** is updated (with the DMM measured value) at the beginning of the calibration or standardization procedure. If user files are used for **Temperature, Humidity or Pressure** of the lab environment this information is displayed in the appropriate data box, or it can be entered manually.

A Calibration Table is displayed in the lower center portion of the Calibration / Standardization Screen. This table displays the *Correction Factors* and *Standard Deviation* of the thirteen individual stages in the Model 8000C. The last column in the table indicates the change in correction factors from the last calibration. If this change is greater than 0.1×10^{-6}, a warning message is displayed at the bottom of the screen and the symbol **"<<"** is placed beside the value in the table (See Figure 20). Repeat the calibration.

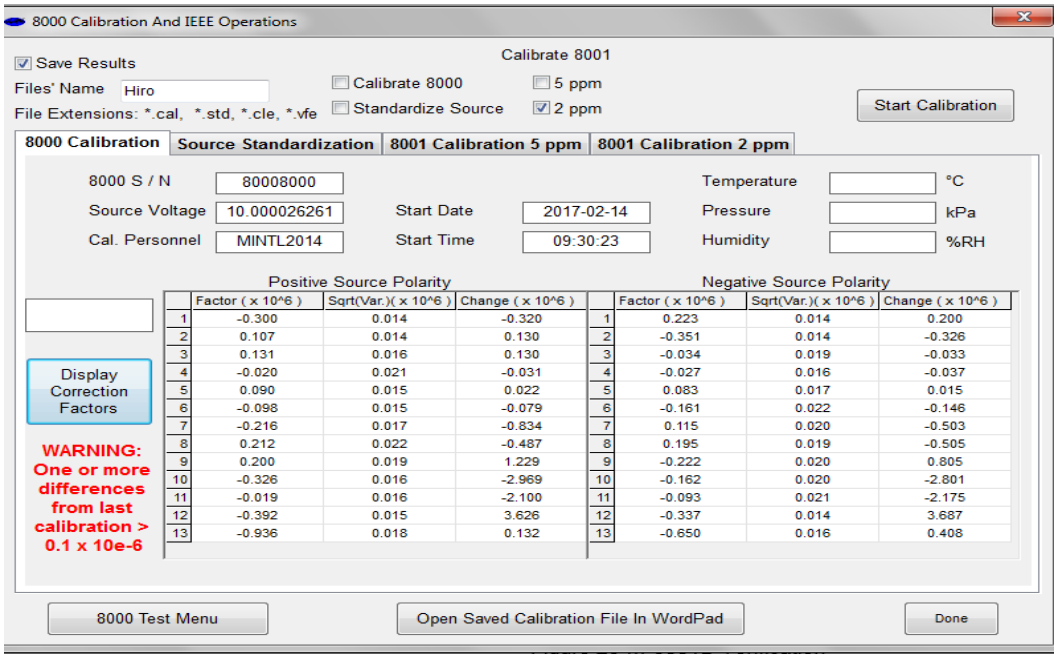

Figure 21 Calibration Warning

NOTE

Before performing measurements for the first time, calibration on the Model 8000C should be performed twice to verify that correction factors are consistent and avoid obtaining the warning message. Ensure that the Model 8000C has reached equilibrium at room temperature, and if a large difference from the last calibration still occurs, consult the factory.

The data will be saved to a file if the 'Save Results' box is checked (refer to Figure 20). The filename should not have an extension (already set to .cal) and the output file is saved in the 'Data Files' directory specified in the 'Files & Directories Setup' screen. To open a calibration file in WordPad, click on the open file button.

NOTE

To gain a history of the calibration stability and uncertainties of the Model 8000C, it is recommended that a calibration be performed daily. Once calibration history has been established, it is recommended that

calibration be performed every 3 to 7 days or as determined from the calibration results.

3.2.2.2 Source Standardization

Standardization of the Model 8000C is performed, by measuring a known reference and comparing the measured ratio with the calibrated value of the reference. This determines the **"Standardization Factor"**, which is applied to each reading taken thereafter. Therefore, standardization is performed to make the Model 8000C direct reading.

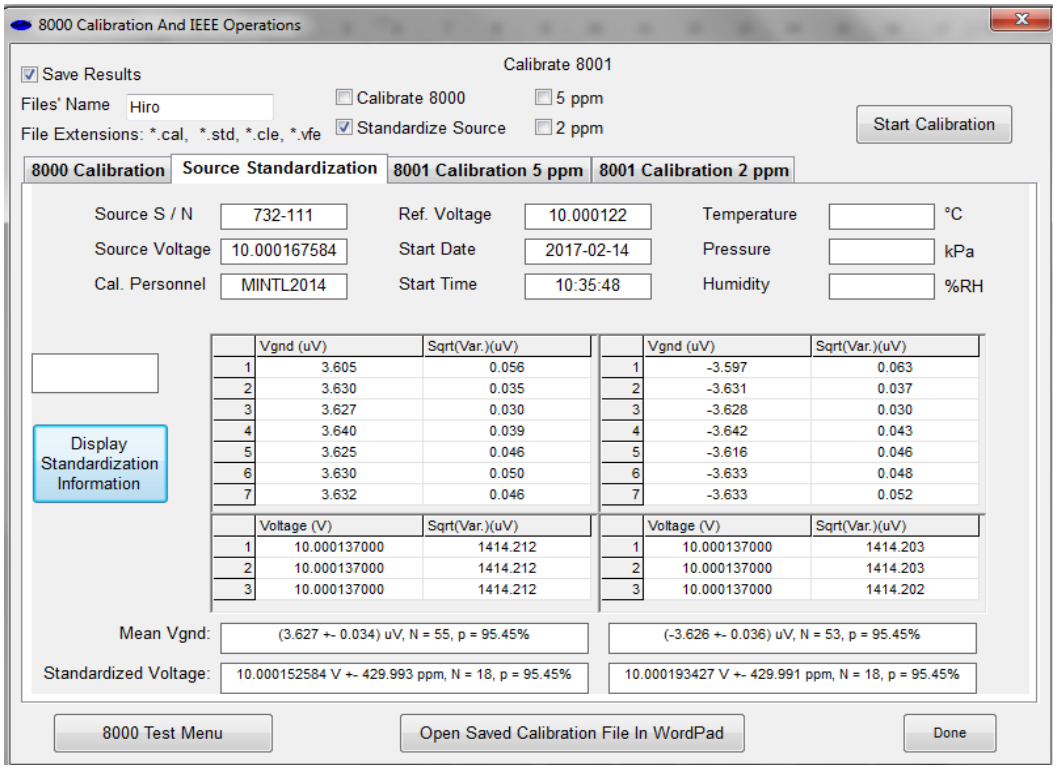

Figure 22 Source Standardization

Standardization information is displayed in the top center portion of the Calibration / Standardization Menu Screen (refer to Figure 22) along with the **"8000C Serial Number"**, **"Source Voltage"**, and **"Calibration Personnel"** data boxes outlined under.

If a standardization program has already been created and selected (refer to Section 3.6.3), then the reference(s) used for standardization will be displayed in the Reference Table at the top of the screen. The information displayed in this table includes the serial number, value, and uncertainty of the reference. The standardization program and number of ratio

measurements within that program will be displayed in the appropriate data boxes to the right of the Reference Table.

NOTE

If a standardization program has not been selected upon entering the Calibration / Standardization Menu Screen, the reference and standardization information will not be displayed. If the user attempts to start standardization at this point, a message reminding the user to select a standardization program will be displayed.

The standardization procedure first measures Vgnd (ie. the system ground) to use in the calculation of the standardization factor. A total of seven measurements are taken and displayed in the Vgnd Table with the **Mean Vgnd** (along with its uncertainty) being calculated and displayed.

Next, the ratio of the 10 V source voltage and each of the 10 V references selected for standardization is measured and displayed in the Ratio Table in the lower right corner of the screen. The number of ratio measurements taken depends on the number of measurements selected in the standardization program (3 to 8) and the number of references used for standardization (1 to 4). From these ratio measurements, a **Standardization Factor** (with uncertainty) is calculated and displayed. This factor is applied to each measurement reading taken thereafter.

NOTE

Before standardization of the 8000C system can be performed, it is necessary to identify the reference and channel in the System and Rack Setting Screen (refer to Section 3.1.4). Next, a standardization program must be created and selected in the Program Menu Screen (refer to Section 3.1.8).

3.2.2.3 8000C Short Circuit Test

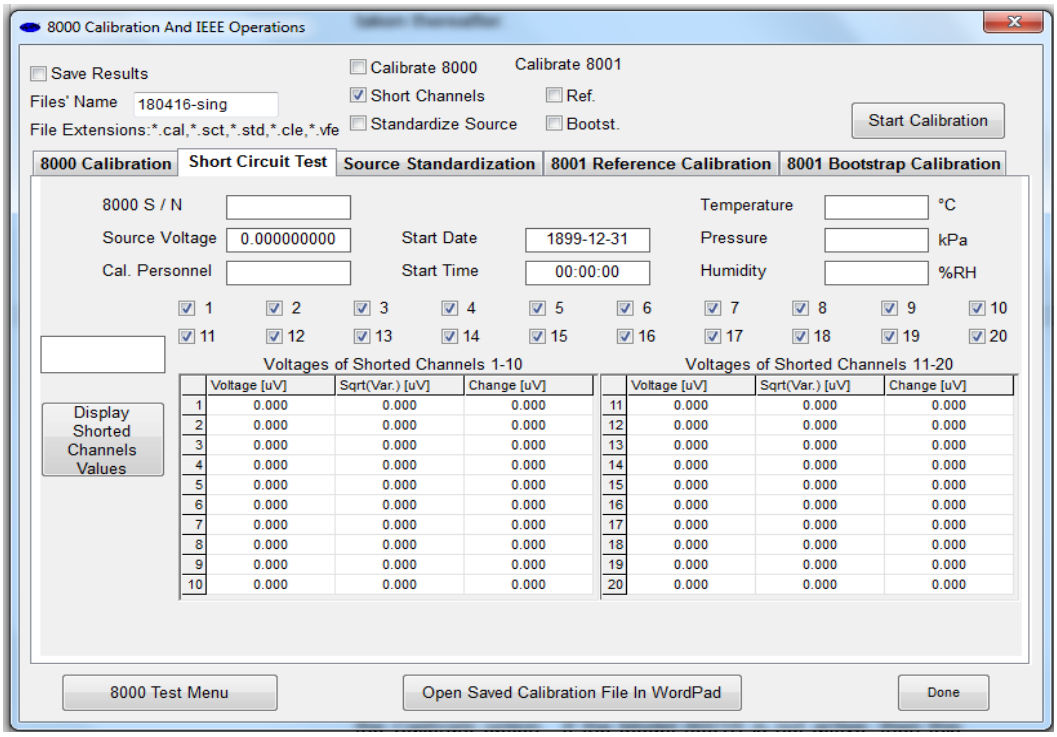

Figure 23 8000C Short Circuit Test

The 8000C Short circuit test is part of the maintenance of the 8000C and should be performed once a year. This test requires short copper wires to be placed between the channels. Note that selected channels can be measured by checking the individual 20 boxes. This test measures the offset voltages of the channels. The standardize routine removes this offset during standardization.

3.2.3 8001C Calibration

If a Model 8001C 1200 V Range Extender is made active in the System and Rack Settings Menu Screen, then the **"Calibrate 8001C"** is displayed in the Diagnostic Menu screen beside the 8000C *Calibrate* option. If the Model 8001C is not active, then this checkbox will be hidden (Refer to Figure 24). Selecting this checkbox allows the user to select either the 8001C Reference Calibration or the 8001C Bootstrap Calibration technique.

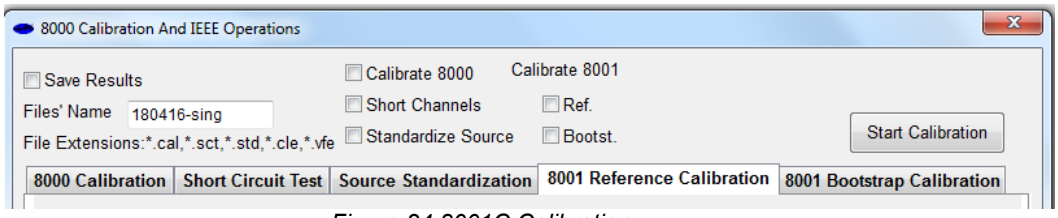

Figure 24 8001C Calibration

3.2.3.1 8001C Reference Calibration

The model 8001C Reference calibration allows the user to calibrate the ratios of the 8001C directly against the same 10 V Zener reference that the 8000C was standardized against. (see section 2.4.2). The 8001C Reference Calibration Screen (refer to Figure 25) is displayed when the "Ref" checkbox is *"checked"* in the Diagnostic Menu Screen. This menu screen allows the user to calibrate the Model 8001C Range Extender to obtain ratios for the various voltage ranges on the extender. First the input offset voltage is measured by selecting the Input Channel box and shorting the 8001C input terminals (Figure 4).

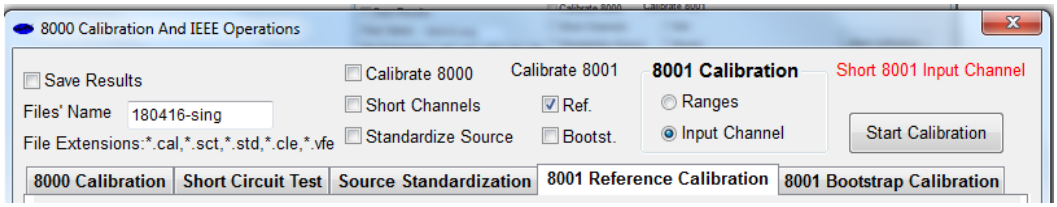

Figure 25 Reference Calibration Input Offset Measurement

3.2.3.2 8001C Reference Calibration Ranges

Reference calibration then requires that the input ranges of the divider be calibrated using the 10 V reference that was used to standardize the 8000C. This is accomplished by connecting the 10 V reference to the 8001C input terminals and pressing Start Calibration (Figure 26).

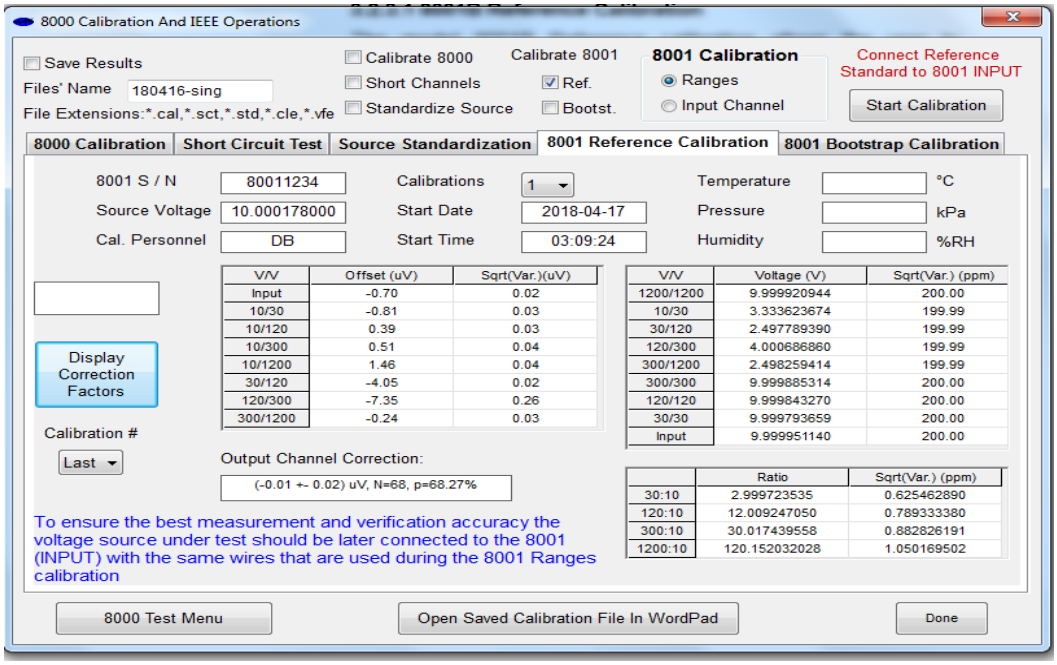

Figure 26 Reference Calibration Ranges

3.2.3.3 8001C Bootstrap Calibration

Selecting this checkbox displays the 8001C Bootstrap Calibration Menu Screen (Figure 27) and allows the user to calibrate the Model 8001C using the Bootstrap technique. This menu screen allows the user to calibrate the Model 8001C Range Extender to obtain ratios for the various voltage ranges on the extender (see section 2.4.2)

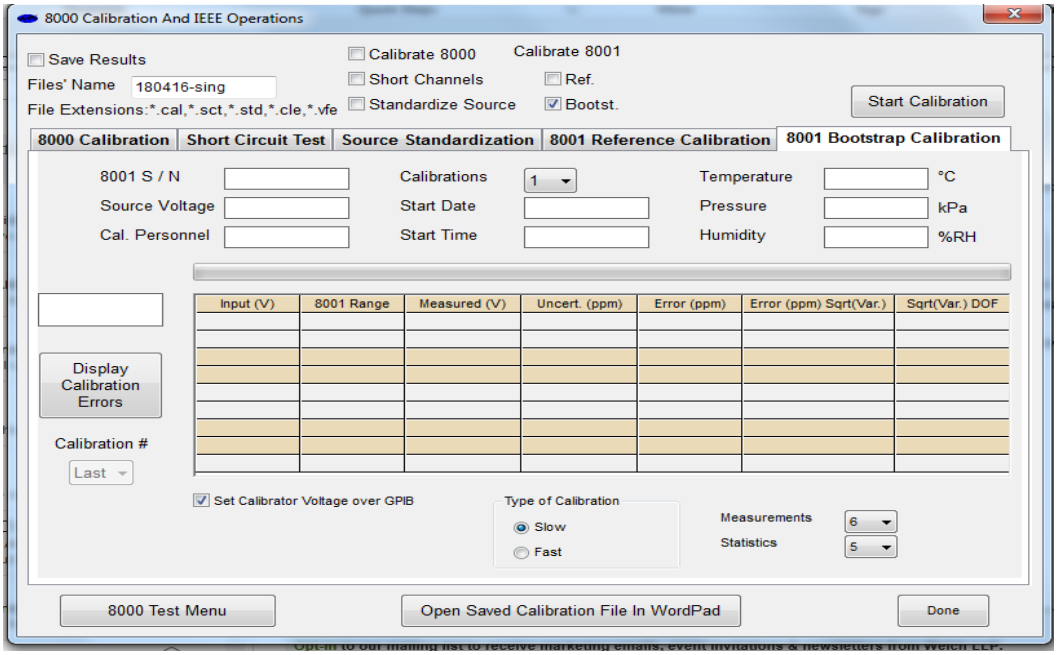

Figure 27 8001C Bootstrap calibration

The calibration of all the voltage ranges from 10V, 30V, 120V, 300V and 1200V requires using a high voltage source (5700 Series calibrator). After connecting the calibrator to the input of the extender the calibrator can be operated either manually or automatically if the calibrator option is selected in the System and Rack settings menu “Calibrators & DVMs Under Test” tab. The manual verification requires each input voltage to be set by the operator. The automatic verification uses a calibrator controlled remotely over the GPIB. To enable the automatic control the box “Set Calibrator Voltage over GPIB” (Figure 24) must be checked. However, to be able to check it, the box “Calibrator” / “In System” in the menu “System & Rack Settings” (Figure 12), must be checked first.

The program automatically sets the ranges and displays the errors and uncertainties.

4 PERFORMING A MEASUREMENT

After selecting the desired System and Rack Set up, ID Listing, and Program files from the Opening Menu Screen, the user is ready to begin a measurement run. Once the sources have been entered in the Source ID Listing and a Measurement, Task, and Program have been created, then a program must be selected. In the '*Programs'* Screen double click on the desired task in the programs table. This program's Designator will be displayed at the top right of the screen in the 'Active Program' box. Return to the main menu and click on the 'Start Measurements' Button, refer to Figure 28.

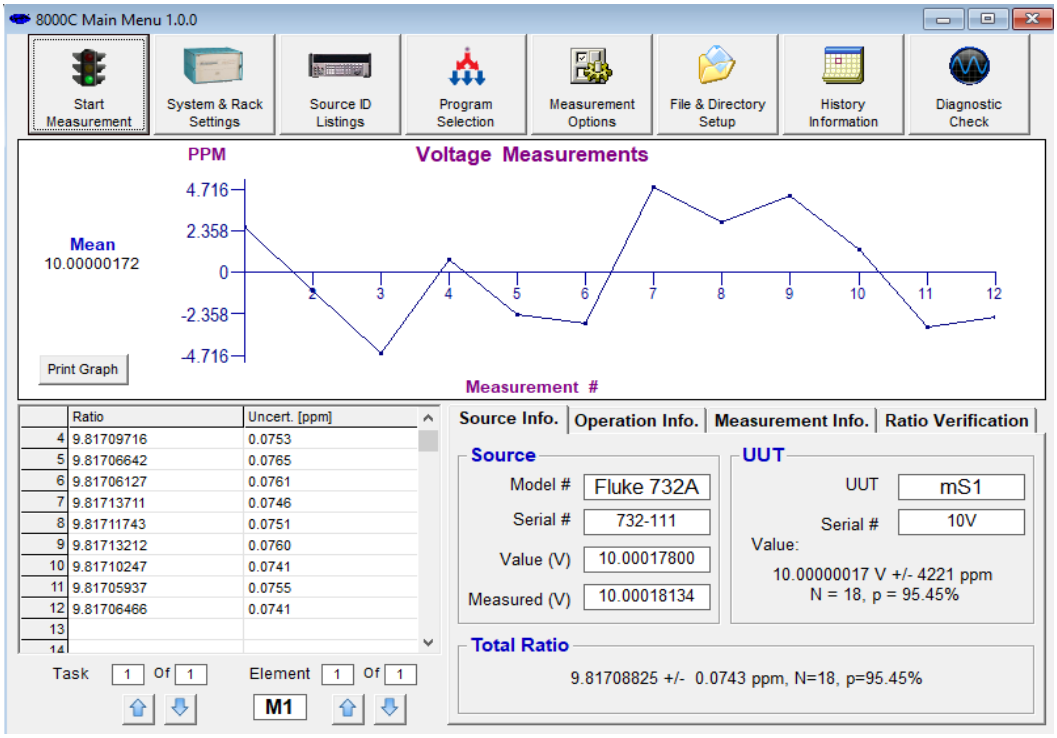

Figure 28 Measurement Run Screen

During the measurement run, measurement information will be displayed and plotted. This is described further in the following sections. To abort at any time during a measurement run, select the *"Stop Measurement"* menu key at the top of the screen. The 8000C software may take a few seconds to shut down completely.

4.1 Measurement Information

The lower right portion of the Main Menu Screen contains tab menus and information boxes that display important information about the measurement being performed. This information is displayed both before and during a measurement run.

The Tab menus can be accessed at any time, even during a measurement run.

The lower left portion of the Main Menu Screen displays a Measurement Table showing the measurement values as they are calculated.

4.1.1 Source Information

The 'Source Information' tab Figure 29 displays the Serial #, Model #, Value, and measured Value for the source. The Serial #, Value, and Uncertainty are shown for the unit under test. The mean and standard deviation, for the measurements are also displayed here.

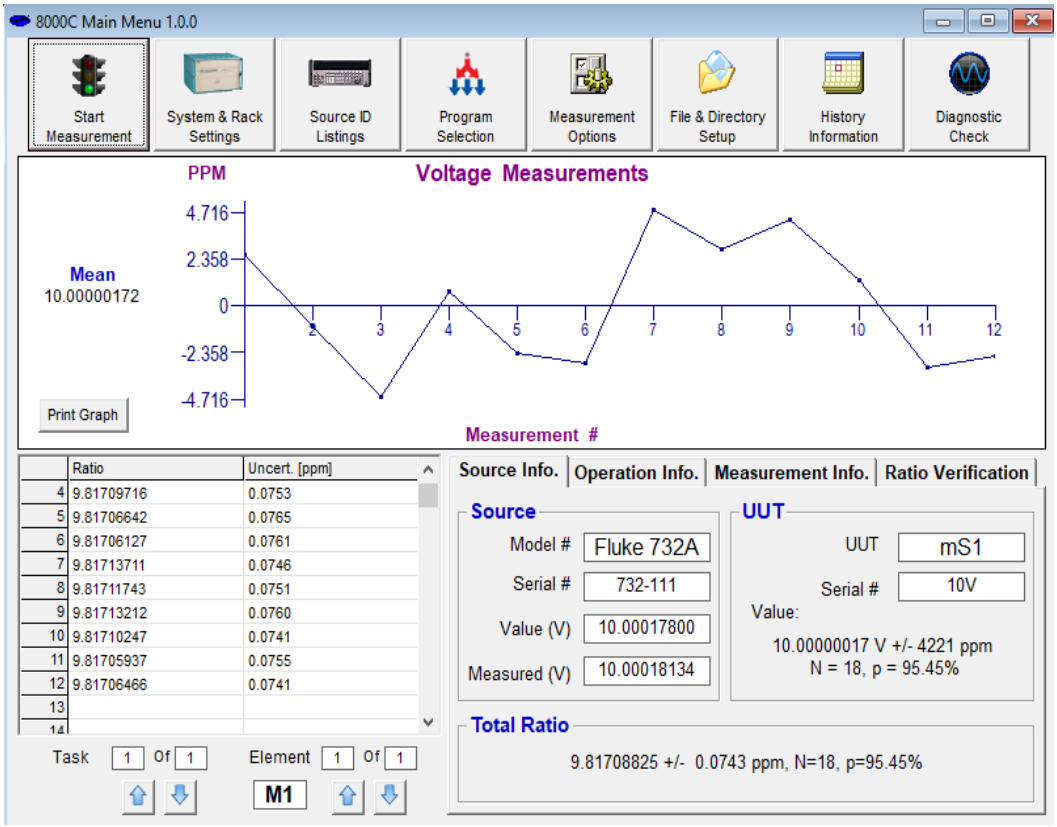

Figure 29 Source Information

4.1.2 Operation Information

The ‘Operation Information’ tab allows the operator access to the graphing options and IEEE command display. The IEEE commands will only be displayed if the ‘Display’ box has been selected in the ‘System and Rack Settings’.

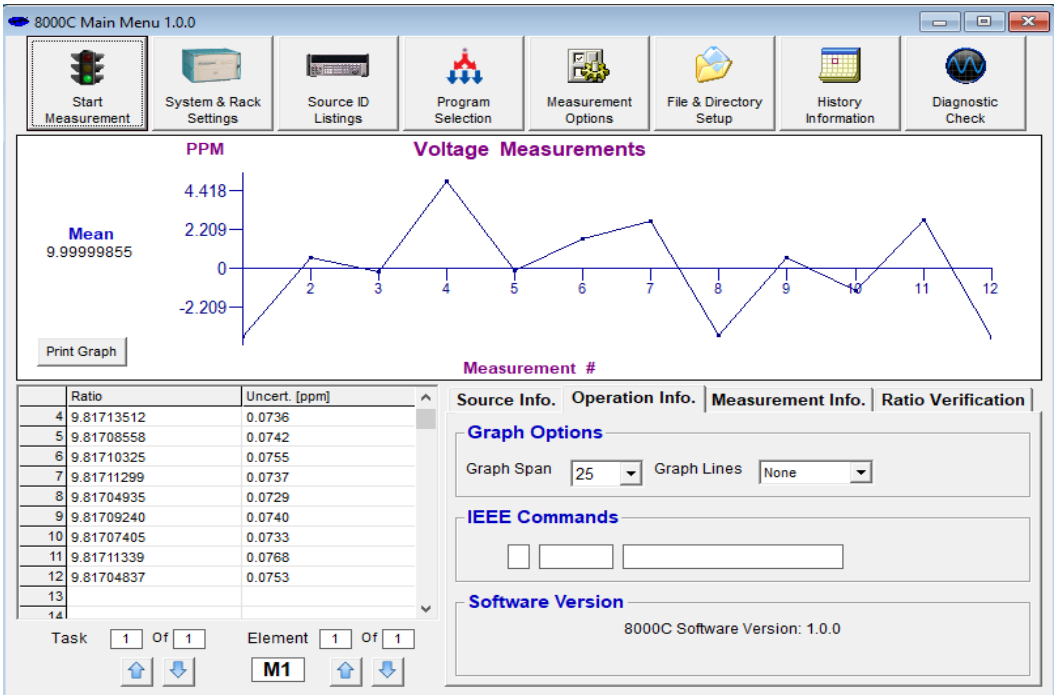

Figure 30 Operation Info

4.1.3 Measurement Information

The ‘Measurement Information’ tab, refer to Figure 31 displays the program information, active tasks, and measurement settings along with the present file status.

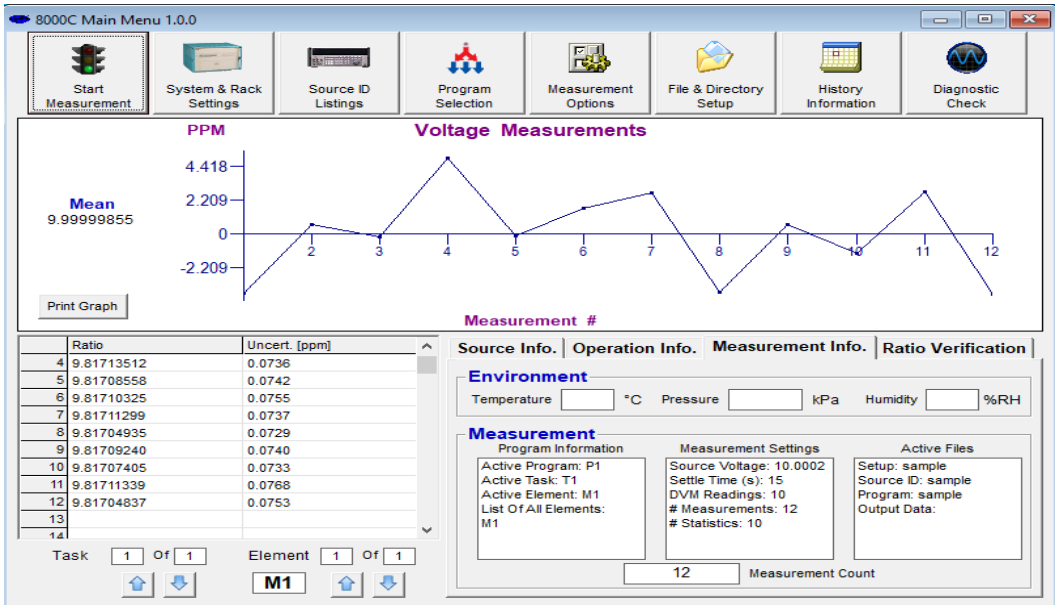

Figure 31 Measurement Information

4.1.4 Ratio Verification

RATIO VERIFICATION: Where external resistors are used to verify the calibrated ratios of the 8000C.

4.1.4.1 Setup

Equipment Required:

- 8000C Ratio Verification Box (RVB) which includes the following:
- A low thermal reversing switch (R).
- Interconnecting cables. (For the Setup refer to Figure 29).

  And
- e.g.: for 1:1 ratio, two 10 K standard resistors. ego: for 10:1 ratio, a 10 KΩ and 100 KΩ standard resistors. (R1, R2 on Figure 29).

NOTE

1. **Terminals at the rear of the 8000C designated V_H and V_L are used as the supply to the resistors.**
2. **The outputs of the resistors are connected to three consecutive scanner channels.**
3. **For purposes of ratio verification, the negative terminals of the channels selected must not be used.**
4. **The resistors inputs have been connected to Channels 1, 2, and 3 as Ratio A, Ratio B, and Ratio C. Refer to Figure 32.**

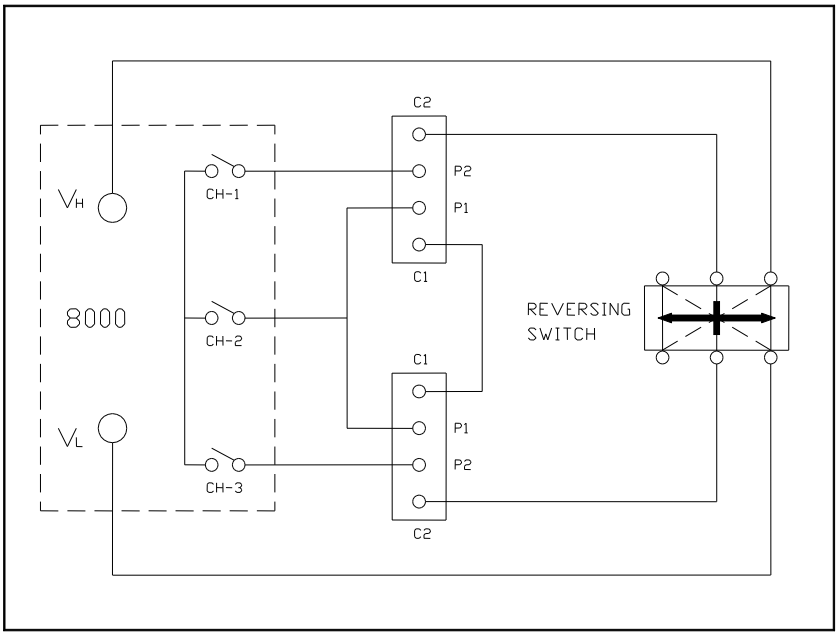

Figure 32 Ratio Verification Setup

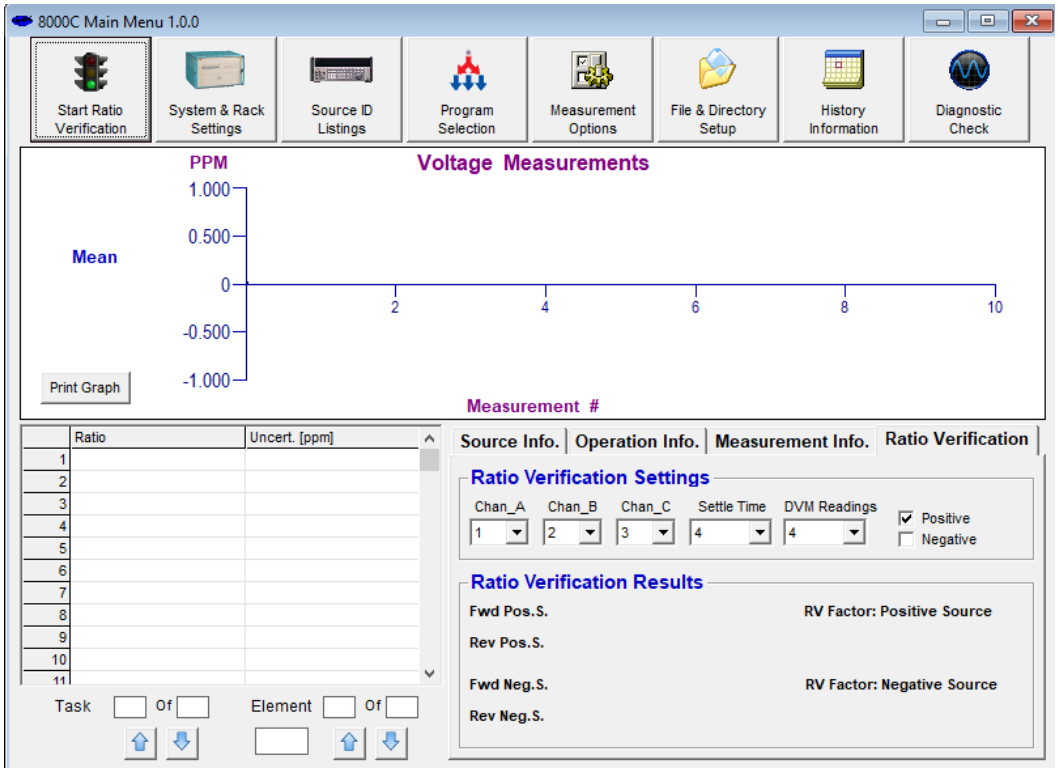

Figure 33 Resistor Input Channels Setup

4.1.4.2 Ratio Verification Measurement

The Ratio Verification is only a semi-automated operation. The normal/reverse switch (R) must be reversed when signaled by the screen message at the proper time in the sequence of measurements.

The quality and accuracy of the ratio verification procedure is a function of the input offset current of the DVM being used and of the magnitude of resistors being used. The verification factor reported is the deviation of the sum from unity (Refer to Figure 34).

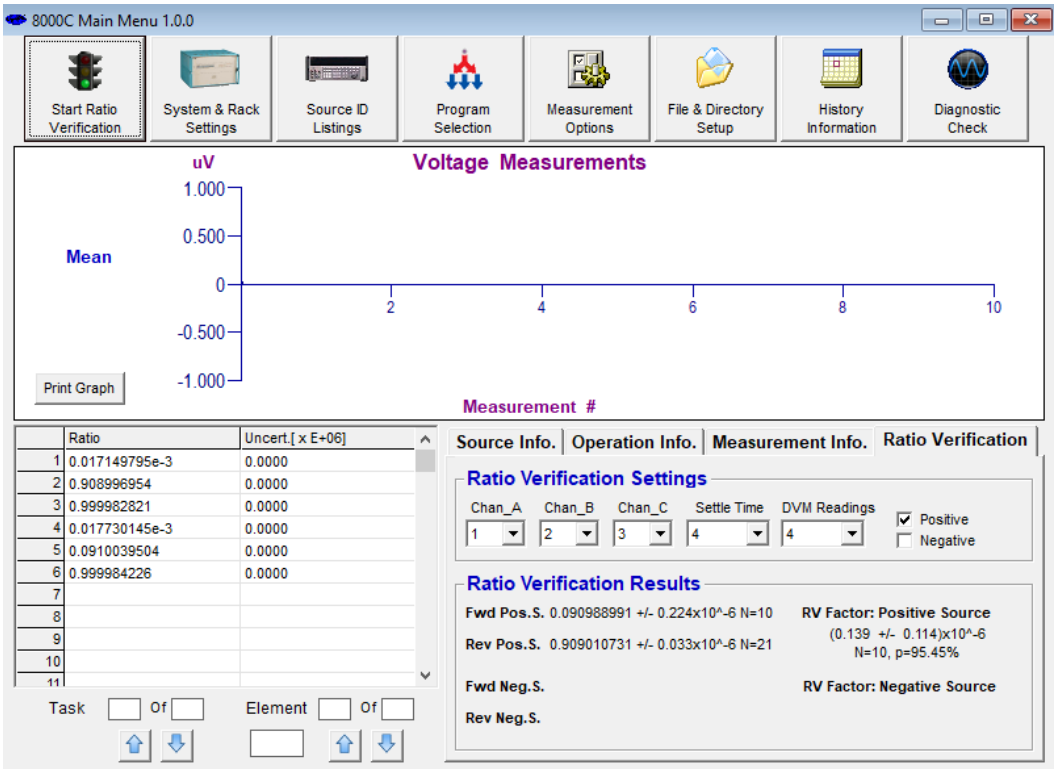

Figure 34 Ratio Verification Measurement

4.2 Measurement Table

The lower left portion of the Main Menu Screen displays a Measurement Table showing the measurement values as they are calculated. For source measurements, the first column of the table displays the ratio values, while the second column displays the standard deviation.

After measurements are completed, the “arrow” keys below the Measurement Table may be used to view previous results. The left set of arrow keys select which task to look at, and right set indicates which measurement is being shown. These arrow keys can only be used once all measurements are completed.

4.3 Plotting the Measurements

During a measurement run, the values obtained are displayed in the Measurement Table and graphed in ppm. As more points are plotted, the axes of the graph are modified to maximize the plotted points to allow the user to focus on the relationship between the points. The mean value of the points is displayed at the left of the graph. The graph may be modified at any time during measurements or after measurements are completed. This is done using the drop-down menus on the Operation Information tab (Refer to Figure 35).

- **Graph Lines** - This option allows the user to observe the best-fit curve, the standard deviation, or both.

- **Graph Span** - This option controls the x-axis of the graph by selecting the number of measurements to view. If statistics are calculated on 20 of 30 measurements, then set the Graph Span to *"Last 20"* to eliminate the first 10 readings. This gives the user an accurate view of the points used in the calculation of the mean and uncertainty.

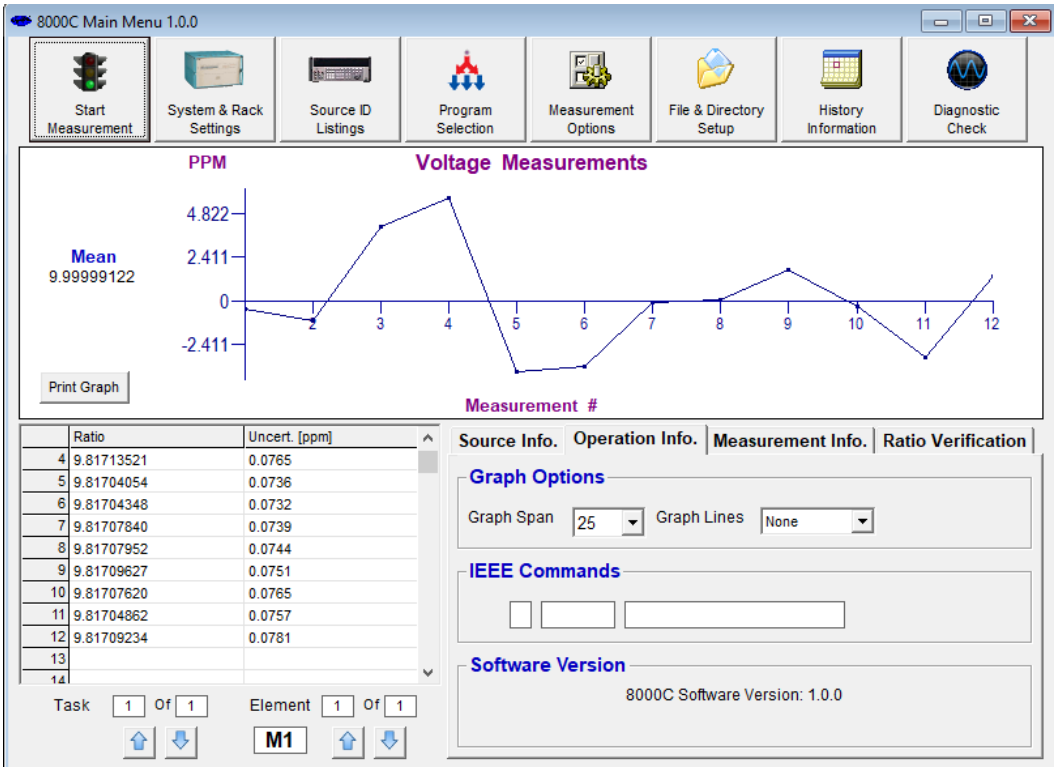

Figure 35 Plotting Measurement Options Screen

5 EXITING THE SOFTWARE

To exit the 8000C software click the close button at the top right of the screen in the Main Menu. Messages will then be displayed reminding the user to save any settings, resistor, or program file changes.

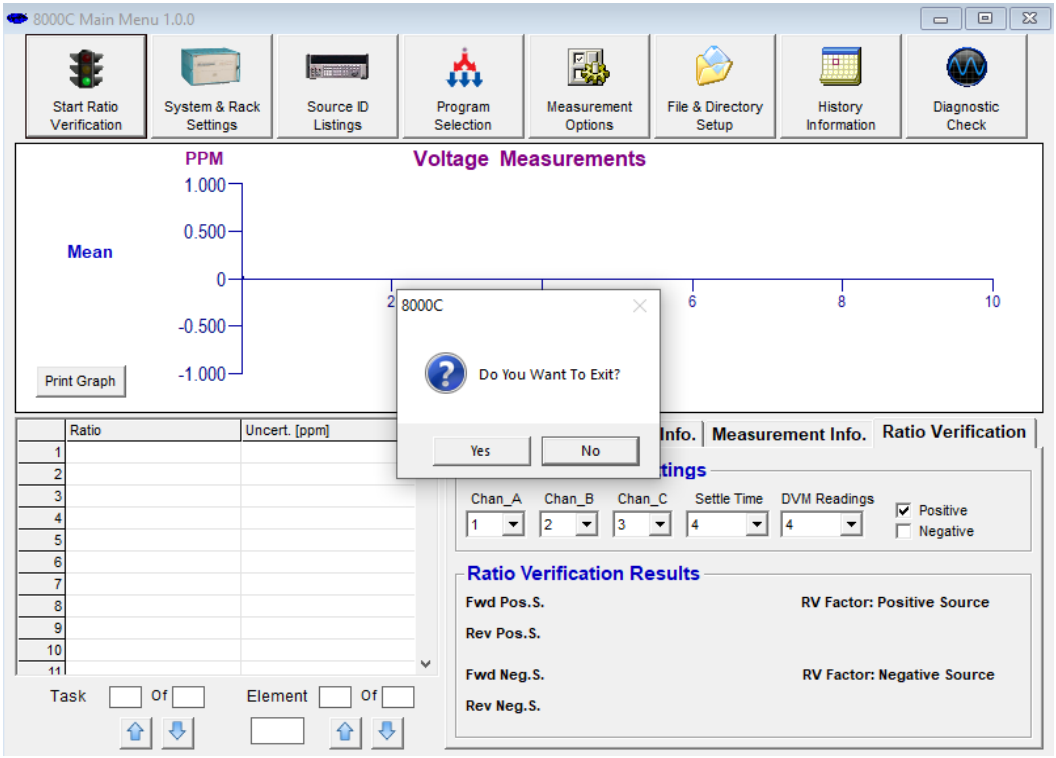

Figure 36 Exiting the Software