

**FLUKE®**

# **5500A/EP**

Enhancement Package

## Users Manual

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## Introduction

The 5500A/EP Enhancement Package is used in conjunction with a Fluke 5500A calibrator and a Hewlett Packard 3458A 8½-digit multimeter for performing full calibration on each of these five popular 5½-6½ digit meters:

- Fluke 8840A
- Fluke 8842A
- Hewlett Packard 34401A
- Hewlett Packard 3478A
- Keithley 2000

To use the 5500A/EP, you will need a Fluke 5500A calibrator, a Hewlett Packard 3458A DMM, two IEEE controller cards, and a personal computer running Microsoft Windows and Fluke MET/CAL<sup>®</sup> calibration software, Version 4.3 or higher.

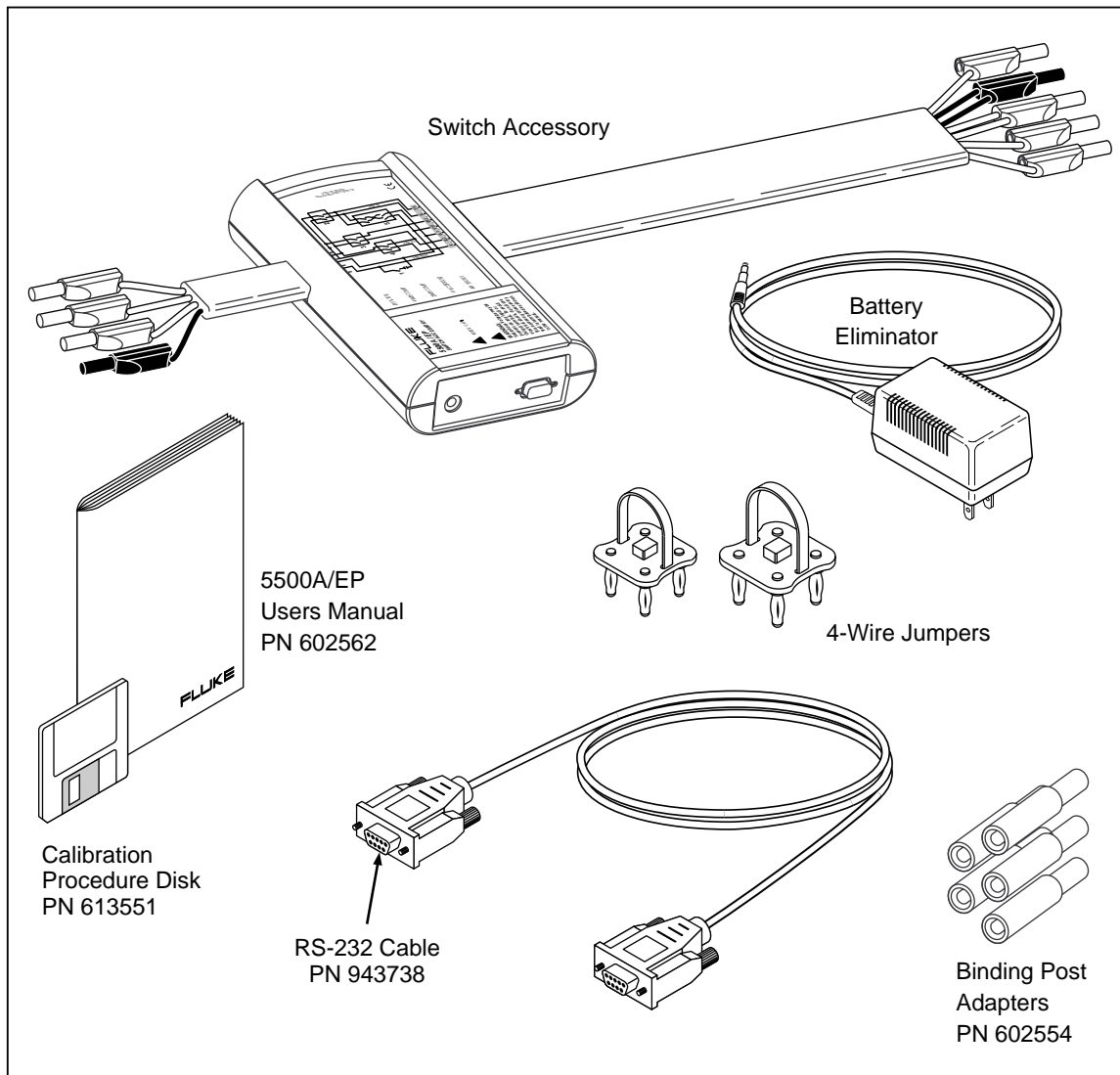


Figure 1. 5500A/EP Enhancement Package Contents

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## Unpacking the 5500A/EP Enhancement Package

The 5500A/EP is packaged in a container designed to prevent damage during shipping. Inspect the enclosed equipment carefully for damage and immediately report any damage to the shipping company.

When you unpack the 5500A/EP, check for all equipment shown in Figure 1. Report any shortage to the place of purchase or to the nearest Fluke Service Center.

## Serial Cable

The serial cable is data terminal equipment as specified in EIA/TIA-574. It consists of a male and female connector in a straight through configuration with these connections:

- pin 1 and pin 6: +12V
- pin 2: receive data
- pin 5: ground

## Verifying the Battery Eliminator Type for Your Country

Make certain the battery eliminator is the correct type for your country, referring to Figure 2. If you do not have the right type, contact your Fluke representative.

### Warning

**The Fluke BE860 battery eliminator provides the necessary voltage isolation for the switch accessory. To avoid the risk of electrical shock, operate the switch accessory only with the BE860 battery eliminator.**

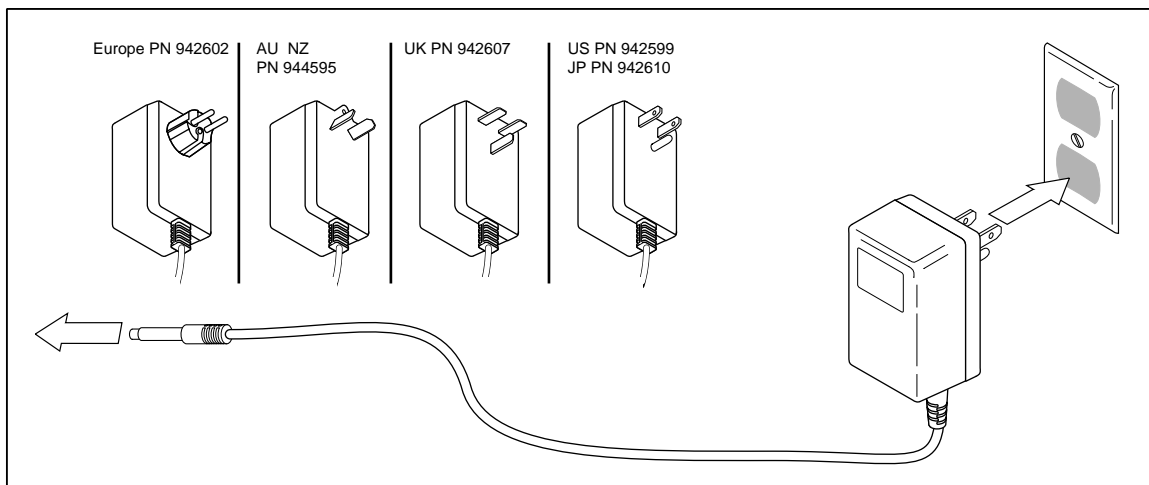


Figure 2. Battery Eliminators for the 5500/EP Switch Accessory

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## 5500A/EP Software

The 5500A/EP procedure disk contains procedures for characterizing the 5500A and for adjusting and verifying the Fluke 8840A, 8842A, Hewlett Packard 34401A, Hewlett Packard 3478A, and Keithley 2000. The calibration programs provide closed-loop procedures that adjust and verify the DMMs listed above to their one-year specifications. All of the procedures have been approved by the manufacturer of the associated DMM.

These procedures require MET/CAL calibration software, version 4.3 or higher installed on your PC, configured with two IEEE interface cards (ports 0 and 1).

## Installing the Software

Installation consists of four parts: modify your MET/CAL, establishing traceability for the 5500A, the 5500A/EP (i.e., the switch accessory), and the Hewlett Packard 3458A, entering the configuration information for each, and then installing the verification and adjustment procedures.

### Note

*The 5500A/EP software utilizes Microsoft DOS calls. In Windows 3.1, be certain the DOS prompt has the property "Close Window on Exit". To set that property, use the PIF Editor (under Program Manager - [Main]) to edit the file DOSPRMPT.PIF. Be certain the box for "Close Window on Exit" is checked. In Windows 95, this same property can be set by opening up the MS-DOS prompt and then clicking the "Properties" icon on the title bar. Under the "Properties" file folder, be certain the box for "Close on exit" is checked.*

## Modify Your MET/CAL

Modify Your MET/CAL as follows:

1. Create a correction file directory.

You must first create a directory for the MET/CAL correction file if it does not already exist. Neither the MET/CAL installation program, nor the Setup program on this disk, creates a correction file directory. For most users this will be "C:\metcal\correct" (see your PC's operating system manual for information about how to create and change directories).

### Note

*The correction file directory should be on the workstation from which the procedure will run even if MET/CAL is run from a network. This is because corrections are specific to the standards used for calibration. A correction file directory must be created on each workstation on which the 5500A/EP procedures will be run.*

2. Edit metcal.ini.

You must edit metcal.ini on each workstation where a correction directory was created so that the value of the "correctdir=" parameter is the directory path from step 1. The metcal.ini file as shipped has "correctdir=none". The file metcal.ini is located in the c:\windows directory. Use an ASCII editor like the Windows Notepad to edit the file.

### Establishing Traceability Information

To establish traceability, you need to enter asset and serial numbers for each instrument, along with additional traceability information.

The instructions for entering traceability information is provided below for two different MET/CAL 4.2 modes: Legacy and Database. Database mode uses new methods than those in earlier versions of MET/CAL. For more information, refer to your Metrology Software manuals.

### Legacy Mode

1. In Legacy mode, log into MET/CAL, and open up the MET/CAL administrator application. In the Administrator, select **File/Open**, then select **Traceability**.
2. To enter traceability information for the Fluke 5500A and the HP 3458A, select **Edit Traceability** to open the Edit Trace Entry Dialog box. Select Fluke 5500A and verify that the fields show the correct information. Edit the fields if necessary and click OK when you are finished. Repeat for the HP 3458A.
3. To enter traceability information for the switch accessory, select **Add** to open the Add New Trace Entry dialog box. Type "Fluke 5500EP" into the top field. Fill in the remainder of the dialog box and click OK when you are finished.

#### Note

*The 5500A/EP does not require periodic calibration, but you must enter a calibration interval. Enter a lengthy period of time in the Interval box that permits infrequent calibration (i.e., 1095 days, or three years).*

### Database Mode

1. In Database Mode, open the MET/CAL Manual Edit Tool. Select **Records/New** to open the Inventory screen.
2. In the Inventory screen, fill in the asset number for one of the three instruments, and fill out the remaining information. Repeat for each instrument: the Fluke 5500A, the HP 3458A, and the Fluke 5500A/EP.

## Configuring the Instruments

Once you have entered the instruments traceability information, you must verify the instruments' configuration, to ensure the calibration system communicates properly.

1. Open the MET/CAL Editor. Select **Tools/Edit Configuration** (or press F12) to open the Edit Configuration dialog box. Fill in the dialog box as follows:
  - Select the Fluke 5500A if it is already configured. If it is not configured, select Add; then select Fluke 5500A in the drop-down list. Type in the same asset number you entered for the traceability information.
  - Choose IEEE-488 as the remote interface, and enter the address, if necessary. The factory default is 4.
  - Under Extended Performance, click the box next to 5500A/EP so it contains an 'x'. Then click OK.
2. Repeat for the HP 3458A. The IEEE-488 address default is 22. If you change these addresses, be sure you use different ones for the Fluke 5500A and the HP 3458A.
3. Repeat for the Fluke 5500A/EP. For this instrument, you will need to type "Fluke 5500EP" in the top field. Then select the following parameters:
  - Choose Serial as the remote interface.
  - Choose COM5500 as the port.
  - Enter the alias as 5500EP.

## Installing the Verification and Adjustment Procedures

Place the 5500A/EP disk into disk drive A or B, and select **File/Run** from the Program Manager. Type "a:setup" or "b:setup" and click OK. Follow the on screen prompts. When the "Select Calibrator Dialog" is displayed, select "All". Install all procedures displayed in the "Procedure Selection Dialog". Procedures are installed in compiled form and are ready to be executed from the Run Time.

## The Switch Accessory

The switch accessory handles all analog outputs that are sourced by the 5500A, operating according to remote commands sent over the 5500A serial bus. It contains shielded test leads, an internal 4-wire ohms short, and a 0.01  $\mu$ F capacitive filter for high-resistive measurements that may require extra noise filtering.

The switch accessory operates as a routing accessory between either of the two sets of instruments listed below:

- The 5500A and the Hewlett Packard 3458A for characterizing the 5500A.
- The 5500A and the DMM you are calibrating.

### **Warning**

**Lethal voltages can appear on any one of the switch accessory's terminals. To avoid electrical shock, never operate the switch accessory unless all leads are connected to an instrument according to the instructions in this manual.**

## Switch Accessory Leads

The switch accessory leads are shown in Figure 3 and their functions are provided in Table 1. The functions refer to the terms provided on the panels for the 5500A, Hewlett Packard 3458A, and the specified DMMs.

**Table 1. Switch Accessory Lead Functions**

<b>Output Leads</b>	<b>Switch Accessory Output</b>	<b>DMM or Hewlett Packard 3458A Input</b>
①	A: 11A max.	Current High Input
②	VL1 & VL2: V, 2W COMP	Voltage Low Input
③	VH1 & VH2: V, 2W COMP	Voltage High Input
④	SL: A, 4W COMP	4-Wire $\Omega$ Low Sense Input
⑤	SH: A, 4W COMP	4-Wire $\Omega$ High Sense Input
<b>Input Leads</b>	<b>Switch Accessory Input</b>	<b>Fluke 5500A Calibrator Output</b>
⑥	NORMAL LO	NORMAL V, $\Omega$ , RTD LO
⑦	NORMAL HI	NORMAL V, $\Omega$ , RTD HI
⑧	AUX LO	AUX A, $\Omega$ -COMP, AUX V LO
⑨	AUX HI	AUX A, $\Omega$ -COMP, AUX V HI

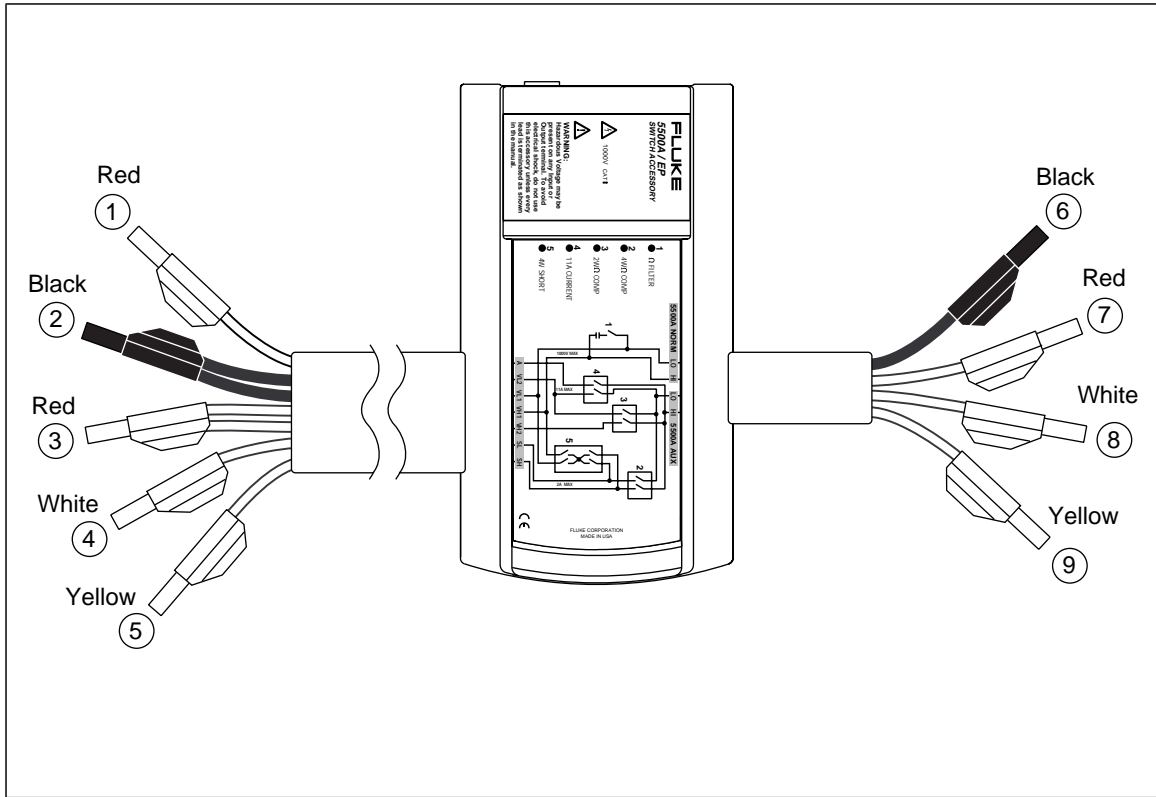


Figure 3. Switch Accessory Leads

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## Calibrating an Instrument

The DMMs specified in this manual can be adjusted and verified to traceable results, by following the procedures in this manual. Essentially, there are two major steps to Calibration, which are:

1. Characterizing the 5500A.

Before you perform any calibration procedure with the 5500A/EP you must characterize the 5500A's outputs. The characterization procedure first performs a zero calibration on the 5500A and an automatic calibration (AUTOCAL) on the Hewlett Packard 3458A. After the calibration procedures are complete, the Hewlett Packard 3458A is used to measure the 5500A's actual output at cardinal points defined by the UUT procedures. This data is stored in a correction file within MET/CAL.

The characterization is valid for 24 hours as long as the temperature remains within  $\pm 2^{\circ}\text{C}$  and the humidity does not change more than  $\pm 10\%$  RH. For convenience, you can run the characterization unattended overnight, and the characterization will be valid for the next workday. Or start the characterization procedure at the beginning of each workday.

2. Adjusting and Verifying the DMM.

Once the characterization is complete, the DMM adjustment and verification procedures can be performed, provided the MET/CAL procedures have been installed and compiled on the PC. The MET/CAL program prompts you through the connection process, allowing for a stabilization period to eliminate thermal emfs in the system. It also automatically performs a zeroing operation on the 5500A.

## Setting up the Equipment

The 5500A/EP is designed to work with the same hardware configuration for both the characterization of the 5500A, and adjustment and verification of the DMM. The only difference between the two setups is the use of a Hewlett Packard 3458A for characterization. Once characterization is complete, you simply disconnect the Hewlett Packard 3458A and replace it with the DMM you are calibrating, using the same connections.

Find a location where you can permanently keep the setup. Your location must provide space for the 5500A calibrator, room to place the switch accessory in front of the 5500A, and ample room on top or preferably to the left of the 5500A to place the DMM or the Hewlett Packard 3458A.

### Note

*When the switch accessory is in operation, high value resistances, which are highly susceptible to noise pickup, are being sourced. The switch accessory's leads contain shielding, and an additional capacitive filter is available to provide additional filtering. To minimize noise pickup, remain at a distance of at least 0.5 meters from the switch accessory during operation.*

### Warning

**Hazardous Voltage may be present on any Input or Output terminal of the 5500A/EP switch accessory. To avoid electrical shock, do not use this accessory unless every lead is terminated as shown in this manual.**

## Connecting the Instruments

This procedure sets up the instruments in their permanent configuration for both the characterization of the 5500A, and adjustment and verification of the DMM. Refer to Figures 4 and 5 during setup.


### Warning

**The binding post adapters have retractable safety shrouds that may expose the metal plug. To avoid electrical shock, connect the binding post adapters to the Hewlett Packard 3458A before you make any other connections, and always make sure the plug is securely inserted into the Hewlett Packard 3458A. The binding post adapters have a manufacturer's rating of 1000V rms and 3A and should not be used beyond these ratings.**

1. Check your hardware configuration. The switch accessory should be placed in front of the 5500A. The Hewlett Packard 3458A or the DMM should be placed either on top of the 5500A or off to the left side.
2. Use the serial cable to connect the serial port on the switch accessory to the Serial 2 to UUT connector on the 5500A. No adapters should be necessary.
3. Use the IEEE-488 bus to connect the IEEE-488 connector on the 5500A to the IEEE Port 0 on the PC running MET/CAL.
4. Connect the battery eliminator cable to the switch accessory. Plug the switch accessory's battery eliminator into a wall outlet.
5. Connect the PC to the Hewlett Packard 3458A or to the DMM according to one of the following instructions.
  - For characterization, connect the IEEE-488 port on the Hewlett Packard 3458A to the IEEE Port 0 on the PC running MET/CAL. You may connect it to the back of the connector running from the 5500A.
  - For verification and adjustment of a DMM, connect the IEEE-488 port on the DMM to the IEEE Port 1 connector on the PC running MET/CAL.
6. The switch accessory's input leads are the shorter ones that are designed to reach the 5500A when the switch accessory is placed directly in front of it. The output leads connect to the Hewlett Packard 3458A or DMM. Connect all leads according to Table 1 under "The Switch Accessory." Refer to Figures 4 and 5.

Before you connect the switch accessory to the Hewlett Packard 3458A, make sure the binding post adapters are connected to its inputs.

### Warning

**Press  on the 5500A before connecting the switch accessory. Resetting the 5500A helps prevent voltages from being present at its connectors, or at the terminals of the switch accessory.**



## Running the Characterization Software

You need to characterize the 5500A every 24 hours to prepare it for calibration during the remainder of that day. Before you run the characterization software, follow the instructions for connecting the hardware, referring to Figure 4.

Follow these steps to run the characterization procedure.

1. Open the MET/CAL program group and select the **Runtime** module.
2. From the procedure list, select the program:  
**Fluke 5500A: (24 hr.) CAL CHAR /3458 /5500A/EP**
3. Follow the prompts to complete the program. The MET/CAL program allows for settling times after any additional connections are made during the procedure.

### *Note*

*During the Characterization process, when prompted for the asset number, enter the asset number of the EP Switch Accessory, and not the 5500A Calibrator.*

## Running the Adjustment and Verification Procedures

To adjust and verify a DMM, make certain the 5500A has been characterized within the past 24 hours according to the instructions in this manual. Before you run the adjustment and verification software, remove the Hewlett Packard 3458A from the calibration system and install the DMM you are calibrating, referring to Figure 5.

Follow these steps to verify and adjust the DMM.

1. Open the MET/CAL program group and select the **Runtime** module.
2. Select the procedure you need to run and follow the prompts to complete the program. You will be instructed to make some connections to the hardware for zeroing during the procedure. The MET/CAL program allows for settling times after any of these connections take place.

The verification and adjustment procedures are listed in Table 2.

Table 2. 5500A/EP MET/CAL Procedures

Name that appears in procedure directory	Function of procedure
Fluke 8840A: CAL ADJ IEEE /5500A/EP	Adjusts the Fluke 8840A
Fluke 8840A: (1 yr.) CAL VER IEEE /5500A/EP	Verifies the Fluke 8840A
Fluke 8842A: CAL ADJ IEEE /5500A/EP	Adjusts the Fluke 8842A
Fluke 8842A: (1 yr.) CAL VER IEEE /5500A/EP	Verifies the Fluke 8842A
HP 34401A: (1 yr.) CAL ADJ IEEE /5500A/EP	Adjusts the Hewlett Packard 34401A
HP 34401A: (1 yr.) CAL VER IEEE /5500A/EP	Verifies the Hewlett Packard 34401A
HP 3478A: CAL ADJ IEEE /5500A/EP	Adjusts the Hewlett Packard 3478A
HP 3478A: (1 yr.) CAL VER IEEE /5500A/EP	Verifies the Hewlett Packard 3478A
Keithley 2000: (1 yr.) CAL ADJ IEEE /5500A/EP	Adjusts the Keithley 2000
Keithley 2000: (1 yr.) CAL VER IEEE /5500A/EP	Verifies the Keithley 2000
Fluke 5500A: (24 hr.) CAL CHAR /3458 /5500A/EP	Characterizes the Fluke 5500A

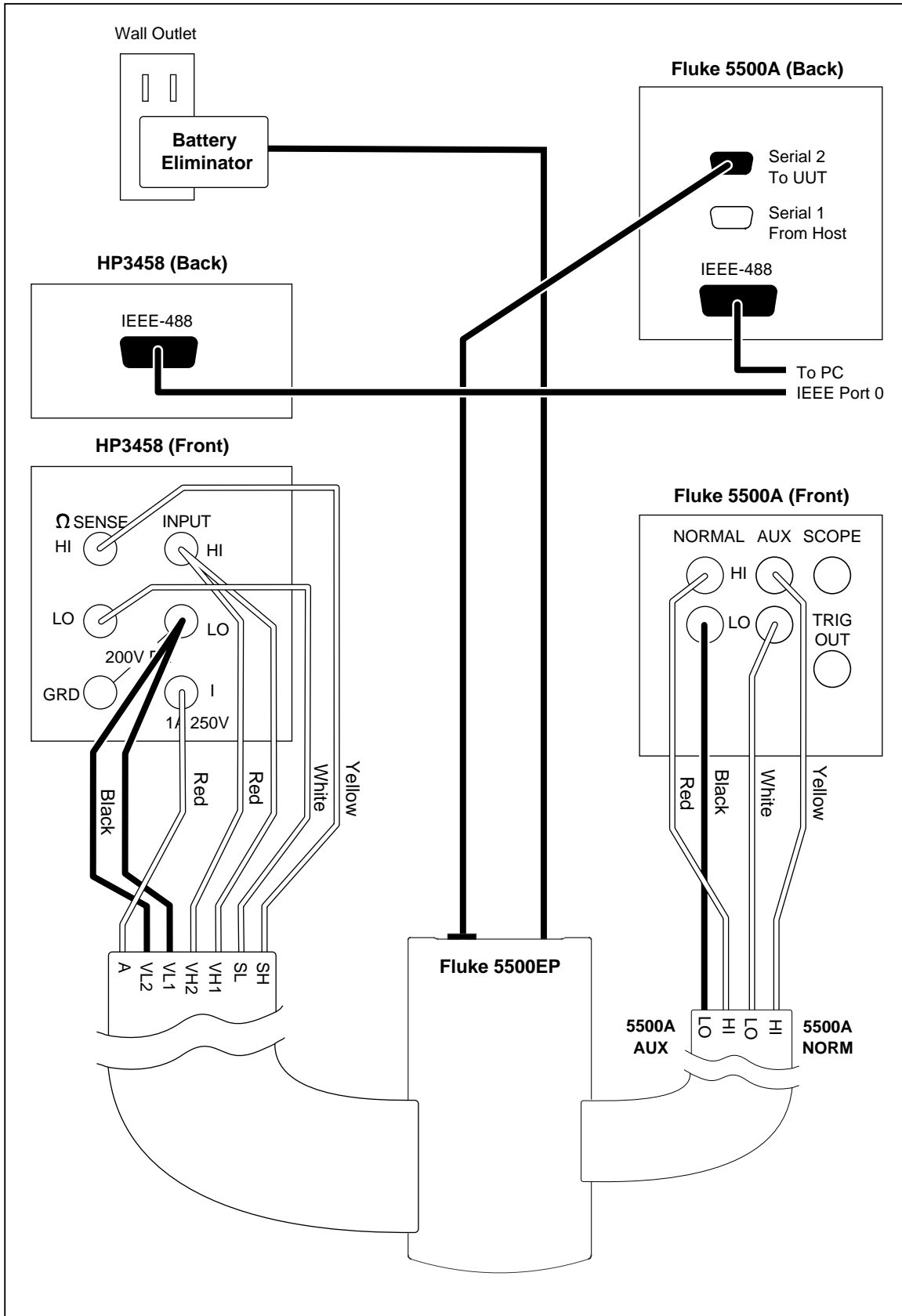


Figure 4. Connections for 5500A Characterization

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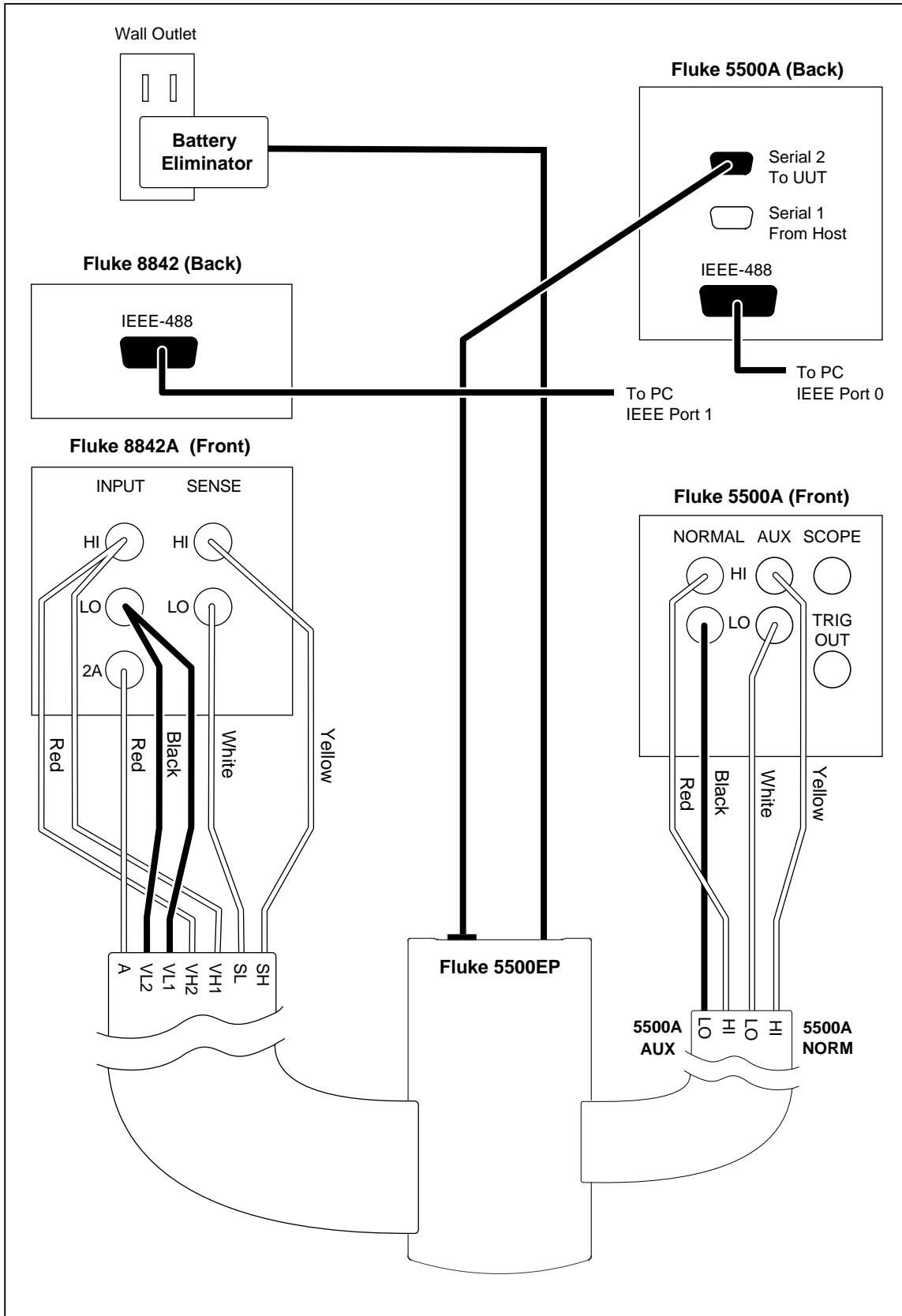


Figure 5. Connections for DMM Calibration

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## Remote Commands for Operating the Switch Accessory

The switch accessory has 11 states, all of which can only be activated when the switch accessory receives a remote command. Remote commands are sent from a PC and transmitted to the 5500A from the IEEE 4888 or Serial 1 port. The 5500A sends the command to the switch accessory from its Serial 2 UUT port or directly using a serial port from the PC.

The communication from the 5500A to the switch accessory is in one direction only, and no feedback from the switch accessory back to the 5500A is provided. To avoid sending the wrong command to the switch accessory, make sure the commands for the 5500A and switch accessory are synchronized when you create the programs.

## 5500A UUT Setup Parameters

When you use MET/CAL, the parameters for addressing the switch accessory through the 5500A's UUT serial port are set automatically so you do not need to program the 5500A. If you address the switch accessory without using MET/CAL, you must program the correct parameters into the UUT Setup menu in the 5500A.

To enter these parameters, follow this procedure.

1. From the 5500A's Setup menu, press the following softkeys to access the REMOTE Setup menu: INSTMT SETUP → REMOTE SETUP.
2. In the Remote Setup menu, verify the HOST option is set to "gpib" and change if necessary.
3. From the Remote Setup menu, press the softkey under UUT SETUP to access the UUT Setup menu. Enter the parameters shown below into the UUT Setup menu.

8 DATA BITS	2 STOP BITS	STALL none	PARITY none	300 BAUD
				

w6f.eps

## Format for Addressing the Switch Accessory

MET/CAL automatically sets up the proper addressing protocol for each command, but if you are addressing the switch accessory without using MET/CAL, you must precede each command with the UUT\_SEND command. For example, to program the switch accessory to provide a 4-Wire short, send the command below, including the quotes:

UUT\_SEND "A>"            Programs the switch accessory to provide a 4-Wire Short circuit.

The states and commands are provided in Table 3.

### Caution

**The internal capacitor should be used for 5500A resistance outputs only. If the capacitor is used, applying voltages in excess of 90V dc or peak-to-peak ac will cause the 5500A to go to standby. The internal 4-Wire Short Circuit mode places a short circuit across the 5500A NORMAL HI and LO terminals. Applying voltages in excess of 330 mV will cause the 5500A to trip into standby.**

Table 3. Switch Accessory Remote Commands

Mode	Remote Command	Description
Voltage, Ohms (no compensation)	@?	Power- on default. All relays are OFF. Used for Voltage and OHMS COMP off.
4-Wire Short Circuit	A>	Relay cluster 5 is ON. Provides a 4-Wire short to the UUT. CAUTION: Shorts the 5500A NORM Hi and LO terminals.
4-Wire Short Circuit with filter	Q.	Same as 4-Wire Short Circuit, but with the Ohms filter applied across the 5500A NORM HI and LO. Used for discharging the Ohms filter capacitor.
2-Wire Comp $\Omega$	B=	Relay cluster 3 is ON. Used when the 5500A OHMS 2-Wire COMP mode is selected.
4-Wire $\Omega$ Low A	D;	Relay cluster 2 is ON. Used when the 5500A OHMS 4-Wire COMP mode is selected. Can also be used when the 5500A is in current mode, to carry up to 2A of current from the 5500A.
4-Wire $\Omega$ Pseudo	F9	Relay clusters 2 and 3 are ON. Provides a 4-Wire connection to the UUT, with the 5500A set to OHMS COMP off.
$\Omega$ no compensation with filter.	P/	Same as Voltage (@?), but with the Ohms filter applied across the 5500A NORM HI and LO. CAUTION: Do not use this mode for Voltage.
$\Omega$ 2-Wire with filter	R-	Same as 2-Wire Comp/Normal $\Omega$ (B=) but with the Ohms filter applied across the 5500A NORM Hi and LO
$\Omega$ 4-Wire with filter	T+	Same as 4-Wire $\Omega$ / Low A (D;), but with the Ohms filter applied across the 5500A NORM Hi and LO
$\Omega$ pseudo 4-Wire with filter	V)	Same as 4-Wire $\Omega$ , Pseudo (F9) but with the Ohms filter applied across the 5500A NORM Hi and LO
Current	H7	Relay cluster 4 is ON. Used for all 5500A current outputs.
Test	_space (Underscore, then space)	Test mode only. Activates all relay clusters and LEDs.

## Operating Guidelines

Follow these guidelines carefully when operating the switch accessory.

### Caution

**Using the 4-Wire Ohms mode for carrying more than 2A can damage the switch accessory. For currents greater than 2A, use Current mode, and the A output lead.**

**Relay clusters 1, 2, and 4 should never carry current above 2A. Currents higher than 2 amps can damage these relays.**

- Thermal emf errors from self heating can occur if high current outputs are followed too closely by low-level V dc (<3V) or by resistance. When sourcing current greater than 2A, wait for a period of twice the amount of time the high current was on before following the output with low level V dc (<3V) or any resistance outputs.

For example, if 11A was sourced for 30 seconds, wait at least one minute before sourcing any V dc that is less than 3V, or before sourcing resistance. This eliminates any self-heating thermal emf errors that may occur.

- The external 4-wire short is used to establish the absolute zero reference of the DMM before the switch accessory is connected.
- The 4-Wire Short Circuit should not be used to provide a low ohms short for 2-Wire Ohms calibration. Use the 5500A 2-Wire COMP mode instead. To provide a reference point for 2-Wire ohms calibration, set the switch accessory to 2-Wire Comp/Normal Ohms mode (UUT\_SEND B=) and set the 5500A to 0.000 Ohms, 2-Wire COMP.

**Hint:** To set the switch accessory back to its default voltage state, place the 5500A into standby mode (press **STBY**). Once the 5500A is in standby, briefly unplug the BE860 battery eliminator from the switch accessory, and then reinsert it.

## Troubleshooting

If you encounter problems during characterization or calibration, check all hardware connections and check that your MET/CAL software is set up properly as outlined below. You may wish to consult your Metrology Software manuals for more assistance.

1. Verify that the MET/CAL directory structure indicates the following:
  - MET/CAL is not in the Runtime Demo mode.
  - ASCII procedure files (\*.PRO) must be located in the directory designated specifically for these files.
  - Picture files (\*.BMP) must be located in a directory designated for picture files.
  - The traceability and configuration information is entered correctly as shown in this manual.
2. Ensure the system is set up according to the instructions in this manual.

## Cleaning the Switch Accessory

Keep the switch accessory's case free of dust or dirt by cleaning when necessary. Use a soft cloth dampened with water or a non-abrasive mild cleaning solution that does not harm plastics.

### Caution

**Do not use aromatic hydrocarbons or chlorinated solvents for cleaning the switch accessory. These chemicals can damage the plastic materials used in the switch accessory.**

## Calibrating the Switch Accessory

Calibration of the switch accessory is not required. The characterization process using the Hewlett Packard 3458A determines the uncertainty of the 5500A and switch accessory. Traceability of the 5500A/EP and the 5500A calibrator is through the Hewlett Packard 3458A DMM.

## Specifications

There are two parts to the specifications for the 5500A/EP, referred to as Parts I and II. Part I specifications provide the 24-hour uncertainty of cardinal points. Part II refers to the repeatability of the 5500A when it is used with the 5500A/EP switch accessory.

Error terms for the 24-hour uncertainty of cardinal points are combined in a root sum square fashion, according to the *Guide to the Expression of Uncertainty in Measurement* (ISBN 92-67-10188-9). All specifications are to the cable ends of the 5500A/EP switch accessory.

### Part I Specifications: Absolute System Uncertainty

These specifications show the cardinal points that are required for adjusting and verifying the following DMMs: the Fluke 8840A, Fluke 8842A, Hewlett Packard 34401A, Hewlett Packard 3478A, and Keithley 2000. These specifications are the complete system uncertainties of the 5500A and 5500A/EP at the specified cardinal points, using the Hewlett Packard 3458A as the standard, and are stored on the procedure disk's accuracy file when a DMM is calibrated. They use the Hewlett Packard 3458A DMM as the standard and include error terms from the 5500A, 5500A/EP switch accessory, and the Hewlett Packard 3458A.

Uncertainties are derived from the 5500A and 5500A/EP repeatability specifications listed in this section, and the Hewlett Packard 3458A one-year specifications indicated by Hewlett Packard. Error sources are combined by using a root sum square method as described in the *Guide to the Expression of Uncertainty in Measurement*.

To determine the absolute uncertainty of outputs not listed below, you should combine the Repeatability error term in Part II with the absolute uncertainty of the Hewlett Packard 3458A. Use the root sum square method, as outlined in the *Guide to the Expression of Uncertainty in Measurement*.



**DC Voltage**

<b>Cardinal Point Output</b>	<b>24 hour Uncertainty, <math>\pm 2^{\circ}\text{C}</math>, <math>\pm 10\%</math> rh <math>\pm</math> (ppm output)</b>
10 mV	175 ppm
19 mV	105 ppm
$\pm 30$ mV	75 ppm
50 mV	52 ppm
$\pm 72.5$ mV	42 ppm
$\pm 100$ mV	35 ppm
$\pm 135$ mV	32 ppm
190 mV	28 ppm
$\pm 260$ mV	25 ppm
300 mV	24 ppm
$\pm 0.51\text{V}$	15 ppm
0.99V to 1.01V, and -1.00V to -1.01V	13 ppm
1.9V	12 ppm
$\pm 3\text{V}$	12 ppm
5V	12 ppm
$\pm 10\text{V}$	13 ppm
19V	18 ppm
30V	17 ppm
$\pm 100\text{V}$	20 ppm
190V	20 ppm
300V	20 ppm
500V	20 ppm
$\pm 1000\text{V}$	20 ppm

**DC Current**

Cardinal Point Output	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
1 mA	60 ppm
10 mA	60 ppm
$\pm 100$ mA	110 ppm
190 mA	97 ppm [1]
0.5A	235 ppm
$\pm 1$ A	190 ppm
2A	200 ppm [2]
2.2A	200 ppm [2]
1. 5500A 90-day specification. 2. Uncertainty is determined by extrapolation.	

**Resistance**

Cardinal Point Output (applies for 2W, 4W, and pseudo 4W COMP modes)	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
10 $\Omega$	125 ppm
19 $\Omega$	130 ppm
100 $\Omega$	36 ppm
190 $\Omega$	26 ppm
1 k $\Omega$	33 ppm
1.9 k $\Omega$	29 ppm
10 k $\Omega$	37 ppm
19 k $\Omega$	31 ppm
100 k $\Omega$	29 ppm
190 k $\Omega$	42 ppm
1 M $\Omega$	34 ppm
1.9 M $\Omega$	139 ppm [1]
10 M $\Omega$	135 ppm
19 M $\Omega$	775 ppm
100 M $\Omega$	950 ppm
1. 5500A 90-day specification.	

**AC Voltage (Sinewave)**

Cardinal Point Output	Frequency	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
1 mV	100 Hz	4700 ppm
10 mV	200 Hz	820 ppm
	1 kHz	820 ppm
	50 kHz	1600 ppm
	100 kHz	5600 ppm
28 mV	20 kHz	480 ppm
100 mV	10 Hz	525 ppm
	20 Hz	525 ppm
	45 Hz	165 ppm
	200 Hz	165 ppm
	1 kHz	165 ppm
	50 kHz	410 ppm
	100 kHz	1000 ppm
190 mV	20 kHz	330 ppm
	50 kHz	475 ppm
	100 kHz	1025 ppm
280 mV	20 kHz	290 ppm
	50 kHz	440 ppm
	100 kHz	975 ppm
300 mV	200 Hz	260 ppm
1V	20 Hz	370 ppm
	200 Hz	140 ppm
	1 kHz	140 ppm
	20 kHz	245 ppm
	50 kHz	385 ppm
	100 kHz	920 ppm
	300 kHz	3250 ppm
1.5V	20 kHz	340 ppm

**AC Voltage (Sinewave), cont.**

Cardinal Point Output	Frequency	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
1.9V	20 Hz	445 ppm
	45 Hz	232 ppm [1]
	200 Hz	232 ppm [1]
2.8V	20 Hz	390 ppm
	50 Hz	221 ppm [1]
	20 kHz	280 ppm
	50 kHz	425 ppm
	100 kHz	950 ppm
3V	1 kHz	175 ppm
3.2V	50 kHz	415 ppm
	100 kHz	930 ppm
	300 kHz	3400 ppm
10V	10 Hz	370 ppm
	1 kHz	150 ppm
	50 kHz	410 ppm
	100 kHz	1075 ppm
15V	100 kHz	1500 ppm
19V	100 kHz	1450 ppm
28V	20 kHz	350 ppm
	50 kHz	500 ppm
	100 kHz	1425 ppm
32V	50 kHz	500 ppm
	100 kHz	1400 ppm
100V	200 Hz	275 ppm
	1 kHz	275 ppm
	20 kHz	330 ppm

**AC Voltage (Sinewave), cont.**

Cardinal Point Output	Frequency	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
280V	20 kHz	654 ppm [1]
320V	20 kHz	647 ppm [1]
500V	1 kHz	490 ppm
700V	1 kHz	470 ppm
	10 kHz	510 ppm

[1] 5500A 90-day specification.

**AC Current (Sinewave)**

Cardinal Point Output	Frequency	24 hour Uncertainty, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output)
10 mA	45 Hz	920 ppm
	1 kHz	525 ppm
	10 kHz	1850 ppm
30 mA	5 kHz	1200 ppm
100 mA	1 kHz	550 ppm
	5 kHz	775 ppm
	10 kHz	1950 ppm
190 mA	1 kHz	858 ppm [1]
	10 kHz	4500 ppm
300 mA	1 kHz	800 ppm [1]
0.5A	1 kHz	1400 ppm [1]
1 A	1 kHz	1100 ppm [1]
	5 kHz	2200 ppm
1.9A	1 kHz	958 ppm [1]
	5 kHz	2000 ppm [2]
2A	1 kHz	950 ppm [1]
	5 kHz	1950 ppm [2]
2.1A	5 kHz	1915 ppm [2]
2.2A	1 kHz	936 ppm [1]

1. 5500A 90-day specification.
2. Uncertainty is determined by extrapolation.

## Part II Specifications: 5500A and 5500A/EP System Repeatability

These specifications refer to the repeatability of the 5500A when used with the 5500A/EP switch accessory. It includes error terms for the 5500A calibrator and switch accessory, These specifications includes error terms for both the 5500A and 5500A/EP, assuming the same loading and application of the environmental conditions that are specified. These do not provide error terms for the Hewlett Packard 3458A. Repeatability applies for the environmental conditions shown.

### DC Voltage

Range	24 hour Repeatability, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output + V)
0 mV to 329.9999 mV	17 + 1.5 $\mu\text{V}$
0V to 3.299999V	7 + 1.5 $\mu\text{V}$
0V to 32.99999V	8 + 15 $\mu\text{V}$
30V to 329.9999V	14 + 150 $\mu\text{V}$
100V to 1000.000V	15 + 475 $\mu\text{V}$

### DC Current

Range	24 hour Repeatability, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output + A)
0 mA to 3.29999 mA	30 + 15 nA
0 mA to 32.9999 mA	30 + 100 nA
0 mA to 329.999 mA	60 + 2.5 $\mu\text{A}$
0A to 2.19999A	75 + 15 $\mu\text{A}$
0A to 11A	100 + 100 $\mu\text{A}$

**Resistance**

Range	24 hour Repeatability, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output + $\Omega$ )
0 $\Omega$ to 10.99 $\Omega$	12 + 1.1 m $\Omega$
11 $\Omega$ to 32.999 $\Omega$	12 + 2 m $\Omega$
33 $\Omega$ to 109.999 $\Omega$	9 + 2 m $\Omega$
110 $\Omega$ to 329.999 $\Omega$	9 + 2 m $\Omega$
330 $\Omega$ to 1.09999 k $\Omega$	16 + 14 m $\Omega$
1.1 k $\Omega$ to 3.29999 k $\Omega$	16 + 14 m $\Omega$
3.3 k $\Omega$ to 10.9999 k $\Omega$	18 + 160 m $\Omega$
11 k $\Omega$ to 32.9999 k $\Omega$	18 + 160 m $\Omega$
33 k $\Omega$ to 109.999 k $\Omega$	18 + 750 m $\Omega$
110 k $\Omega$ to 329.999 k $\Omega$	18 + 750 m $\Omega$
330 k $\Omega$ to 1.09999 M $\Omega$	18 + 8 $\Omega$
1.1 M $\Omega$ to 3.29999 M $\Omega$	18 + 8 $\Omega$
3.3 M $\Omega$ to 10.9999 M $\Omega$	75 + 85 $\Omega$
11 M $\Omega$ to 32.9999 M $\Omega$	140 + 85 $\Omega$
33 M $\Omega$ to 109.999 M $\Omega$	700 + 900 $\Omega$
110 M $\Omega$ to 330 M $\Omega$	950 + 3 k $\Omega$

**AC Voltage (Sinewave)**

Range	Frequency	24 hour Repeatability, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output + V)
1 mV to 32.999 mV	10 Hz to 45 Hz	700 + 3 $\mu\text{V}$
	45 Hz to 10 kHz	300 + 3 $\mu\text{V}$
	10 kHz to 20 kHz	300 + 3 $\mu\text{V}$
	20 kHz to 50 kHz	300 + 3 $\mu\text{V}$
	50 kHz to 100 kHz	400 + 5 $\mu\text{V}$
	100 kHz to 500 kHz	1200 + 10 $\mu\text{V}$
33 mV to 329.999 mV	10 Hz to 45 Hz	400 + 10 $\mu\text{V}$
	45 Hz to 10 kHz	75 + 4 $\mu\text{V}$
	10 kHz to 50 kHz	125 + 8 $\mu\text{V}$
	50 kHz to 100 kHz	200 + 32 $\mu\text{V}$
	100 kHz to 500 kHz	650 + 70 $\mu\text{V}$
0.33V to 3.29999V	10 Hz to 45 Hz	275 + 60 $\mu\text{V}$
	45 Hz to 10 kHz	50 + 25 $\mu\text{V}$
	10 kHz to 50 kHz	100 + 50 $\mu\text{V}$
	50 kHz to 100 kHz	200 + 125 $\mu\text{V}$
	100 kHz to 500 kHz	450 + 250 $\mu\text{V}$
3.3V to 32.9999V	10 Hz to 45 Hz	275 + 650 $\mu\text{V}$
	45 Hz to 10 kHz	75 + 200 $\mu\text{V}$
	10 kHz to 50 kHz	150 + 600 $\mu\text{V}$
	50 kHz to 100 kHz	450 + 1.8 mV
33V to 329.999V	45 kHz to 1 kHz	75 + 2 mV
	1 kHz to 20 kHz	150 + 6 mV
330V to 1000V [1]	45 Hz to 1 kHz	75 + 20 mV
	1 kHz to 10 kHz	50 + 16 mV
1. The standard Hewlett Packard 3458A can measure up to 700V. A high voltage measuring option is available from Hewlett Packard for making measurements up to 1000V.		



**AC Current (Sinewave)**

Range	Frequency	24 hour Repeatability, $\pm 2^{\circ}\text{C}$ , $\pm 10\%$ rh $\pm$ (ppm output + A)
0.029 mA to 0.32999 mA	10 to 20 Hz	650 + 55 nA
	20 Hz to 45 Hz	325 + 55 nA
	45 to 1 kHz	325 + 85 nA
	1 to 5 kHz	1000 + 55 nA
	5 to 10 kHz	3100 + 55 nA
0.33 mA to 3.2999 mA	10 to 20 Hz	500 + 100 nA
	20 Hz to 45 Hz	300 + 100 nA
	45 to 1 kHz	300 + 100 nA
	1 to 5 kHz	500 + 100 nA
	5 to 10 kHz	1600 + 10 nA
3.3 mA to 32.999 mA	10 to 20 Hz	500 + 1000 nA
	20 Hz to 45 Hz	300 + 1000 nA
	45 to 1 kHz	250 + 1000 nA
	1 to 5 kHz	500 + 1000 nA
	5 to 10 kHz	1500 + 1000 nA
33 mA to 329.99 mA	10 to 20 Hz	600 + 12 $\mu\text{A}$
	20 Hz to 45 Hz	325 + 12 $\mu\text{A}$
	45 to 1 kHz	275 + 12 $\mu\text{A}$
	1 to 5 kHz	550 + 12 $\mu\text{A}$
	5 to 10 kHz	1600 + 12 $\mu\text{A}$
0.33A to 2.19999A	10 to 45 Hz	550 + 100 $\mu\text{A}$
	45 to 1 kHz	350 + 100 $\mu\text{A}$
	1 to 5 kHz	1700 + 100 $\mu\text{A}$
2.2A to 11A [1]	45 to 65 Hz	400 + 700 $\mu\text{A}$
	65 to 500 Hz	400 + 700 $\mu\text{A}$
	500 to 1 kHz	1000 + 700 $\mu\text{A}$
1. The Hewlett Packard 3458A has an upper current limit of 1A.		

## Other Specifications

### Switch Accessory Internal Capacitor

Value	Maximum Voltage
0.01 $\mu$ F	50V dc or ac; protected with a 90V protection device.

### General Specifications

<b>Warm-up Time</b>	Four minutes, after connections to the 5500A and DMM have been made.
<b>Standard Interfaces</b>	RS-232
<b>Temperature Performance</b>	Operating: 15 °C to 30 °C Storage: -20 °C to 70 °C [1]
<b>Electromagnetic Compatibility</b>	Designed to operate in standard laboratory environments where the electromagnetic environment is highly controlled. If used in areas with electromagnetic fields >1 V/m, and <3V/m, add 40 $\mu$ V to the V dc uncertainty, and 500 m $\Omega$ to the ohms uncertainty. Performance not specified in fields >3 V/m.
<b>Relative Humidity</b>	Operating: <70% to 30 °C (<60% for 4-wire ohms $\geq$ 10 M $\Omega$ ) Storage: <95%, noncondensing [1]
<b>Altitude</b>	Operating: 3,050m (10,000 ft) maximum Nonoperating: 12,200m (40,000 ft) maximum
<b>Safety</b>	Designed to comply with IEC 1010-1 (1992-1); ANSI/ISA-S82.01-1994; 1000V CATI CAN/CSA-C22.2 No. 1010.1-92
<b>EMI/RFI</b>	Designed to comply with FCC Rules Part 15; VFG 243/1991
<b>Power Consumption</b>	<10W
<b>Dimensions</b>	Switch module: 12.7 cm H x 23.2 cm W x 4.6 cm D (5" x 9.1" x 1.8") Leads: 16.4 cm (6.4") Calibrator 41.3 cm (16.2") UUT
1. If the Switch Accessory is stored at temperature and humidity outside the specified operating range, you must leave it in a environment within the operating range for as long as it was stored outside the operating range.	

