Calibration

5560A/5550A/5540A
Calibrator

Service Manual

September 2023

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Introduction

The 5560A/5550A/5540A Calibrators (the Product or the Calibrator) addresses a wide calibration workload that includes 6.5 digit bench Digital Multimeters (DMMs), and comes with internal and external features that protect it against damage and make it easier to transport for on-site or mobile calibration. The Product, shown in Figure 1, can also be fully automated with MET/CAL®.

The Product is a fully-programmable precision source for:

- DC voltage from 0 V to ±1020 V
- DC current from 0 A to ±30.2 A
- AC voltage from 1 mV to 1020 V
- AC current from 10 µA to 30.2 A
- AC waveforms include sine wave and square wave.
- Synthesized Resistance values from a short circuit to 1200 MΩ
- Synthesized Capacitance values from 220 pF to 120 mF
- Synthesized Inductance values from 12 µH to 120 H (Inductance not available on 5540A).
- Simulated output for 10 types of Resistance Temperature Detectors (RTDs)
- Simulated output for 17 types of thermocouples
- Simulated power output (not available on 5540A)

Note

All images shown in this manual are the 5560A unless noted otherwise.

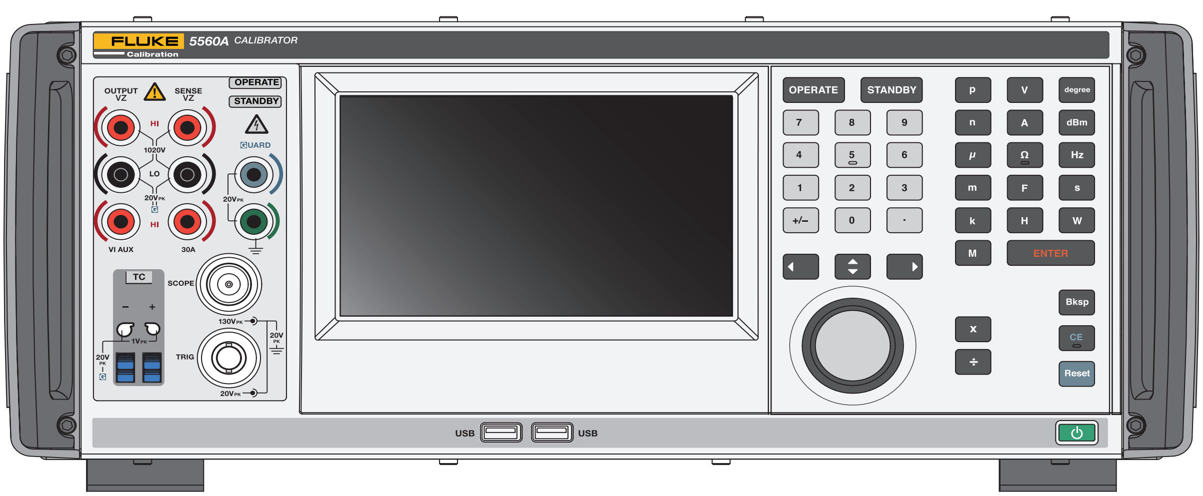

Figure 1. 5560A Calibrator

Product features include:

- Automatic meter error calculation, with user-selectable reference values.
- X (Multiply) and ÷ (Divide) that change the output value by multiples of ten or to pre-determined cardinal values for various functions, including standard oscilloscope timebase and gain steps.
- Programmable entry limits that prevent the operator from entering values that exceed preset output limits.
- Simultaneous output of voltage and current, simulating power up to 30.9 kW (not available on 5540A).
- 10 MHz sync pulse reference input and output. Use this to input a high-accuracy 10 MHz reference to transfer the frequency accuracy to the Calibrator, and/or to synchronize one or more additional Calibrators to a primary 5560A/5550A/5540A.
- Simultaneous output of two voltages.
- Extended bandwidth mode outputs multiple waveforms down to 0.01 Hz, and sine waves to 2 MHz.
- Variable output between 10 MHz reference input and primary OUTPUT, and between voltage and current outputs.
- Standard IEEE-488 (GPIB) interface, complying with ANSI/IEEE Standards 488.1-1987 and 488.2-1987.
- EIA Standard RS-232 serial data interface for Calibrator remote control.
- Universal Serial Bus (USB) 2.0 high-speed interface device port for remote control of the Product using USBTMC.
- Integrated 10/100/1000BASE-T Ethernet port for network connection remote control of the Product.
- USB Host port to save calibration reports to a flash drive and to provide firmware updates.
- Visual Connection Management input terminals illuminate to help show correct cable connection configurations.
- Soft Power - automatic selection of line voltage/frequency.
- WVGA display with touch-screen and keypad control.

Contact Fluke Calibration

Fluke Corporation operates worldwide. For local contact information, go to our website: www.flukecal.com

To register your product, view, print, or download the latest manual or manual supplement, go to our website.

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Product-Use Information

For Product-use information, please see the *5540A/5550A/5560A Operators Manual* available online at www.flukecal.com.

Safety Information

A **Warning** identifies conditions and procedures that are dangerous to the user. A **Caution** identifies conditions and procedures that can cause damage to the Product or the equipment under test.

General Safety Information is located in the printed *5560A/5550A/5540A Safety Information* document that ships with the Product. It can also be found online at www.flukecal.com. More specific safety information is listed in this manual where applicable.

Specifications

Safety Specifications are located in the Safety Specifications section of the *5560A/5550A/5540A Safety Information* manual. Complete specifications are at www.flukecal.com. See the *5560A Product Specifications, 5560A Product Specifications, or 5540A Product Specifications.*

Service Information

Contact an authorized Fluke Calibration Service Center if the Product needs calibration or repair during the warranty period. See *Contact Fluke Calibration*. Please have Product information such as the purchase date and serial number ready when you schedule a repair.

Operation Overview

Operate the Product from the front panel in the local mode, or remotely with the IEEE-488, RS-232, USBTMC, or LAN ports. For remote operations, see the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com. Several software options are available to integrate product operation into a wide variety of calibration requirements.

Local Operation

Typical local operations include front-panel connections to the Device Under Test (DUT), and then manual keystroke and touch-screen entries from the front panel that place the Product in the necessary output mode.

Remote Operation (GPIB)

The Product rear-panel GPIB port is a fully-programmable parallel interface bus meeting the GPIB (IEEE-488.1) standard and supplemental IEEE-488.2 standard. Under the remote control of an instrument controller, the Product operates exclusively as a *talker/listener*. Use the IEEE-488 command set or run MET/CAL software (optional) to write your own programs. See the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com for a discussion of the commands available for IEEE-488 operation.

Remote Operation (RS-232)

The rear panel RS-232 port is dedicated to serial data communications to operate and control the Product during calibration procedures complying with the supplemental IEEE-488.2 standard.

The RS-232 serial data port connects a host terminal or personal computer (PC) to the Product. See the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com for a discussion of the RS-232 commands.

Remote Operation (USBTMC)

The Product rear-panel USB 2.0 type B port is a fully-programmable USBTMC interface that meets the USBTMC-USB488 interface standard and supplemental IEEE-488.2 standard. Use the USBTMC command set. See the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com for a discussion of the commands available for USBTMC operation.

Remote Operation (Ethernet)

The Product rear-panel Integrated 10/100/1000BASE-T Ethernet port is for network connection remote control of the Calibrator and complies with supplemental IEEE-488.2 standard. The Ethernet port connects a host PC to the Product. To send commands to the Product, enter commands from a telnet session running on the host computer. See the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com for a discussion of the Ethernet commands available for Ethernet operation.

Prepare the Product for Operation

This section provides instructions to unpack and install the Calibrator and connect to line power. Instructions for cable connections other than line power can be found here:

- For DUT connections, see Front Panel Operation in the *5560A/5550A/5540A Operators Manual*.

For remote operation, and these topics, see the *5560A/5550A/5540A Remote Programmers Manual* at www.flukecal.com:

- IEEE-488 parallel interface connection
- RS-232C serial interface connection
- LAN Interface Connections
- USB 2.0 Interface Connections

Theory of Operation

System Architecture

The Product architecture consists of two systems:

- An out-guard system that is earth referenced and contains all digital control, user interface (UI), and remote interfaces.
- An in-guard system with all precision analog circuitry enclosed in a guard box that is galvanically isolated.

Out-guard

The out-guard system features:

- Touchscreen display
- Front-panel keypad A2
- A13 interconnect
- A11 out-guard motherboard
- A9 controller.

See the sections below for these individual assemblies.

In-guard

From front to back, the in-guard assemblies are:

- A15 terminal indicators
- A14 output switching
- A10 TC, A3 analog motherboard
- Optional A4 scope option
- A5 impedance
- A6 DDS
- A8 HV amplifiers
- A7 current
- A12 IG power
- Mains transformer secondaries

Each of these assemblies has a detailed theory of operation. See the brief descriptions below.

A14 Output Switching

The A14 contains all the necessary switching for the various functions to the output terminals. The A14 also has some of the protection circuitry that prevents damage from situations such as connecting the Product outputs to line voltage or other high-current power supplies. Firmware control is accomplished with an MSP430 microcontroller via a serial link to the in-guard processor on the A6 DDS. The output terminal binding posts are directly connected to the A14. This connection eliminates cables and improves the reproducibility over a number of units.

A3 Motherboard

The A3 motherboard is a simple analog and digital backplane that consists only of thru-hole connectors, a relay, and a common-mode choke. This assembly was designed to be as simple as possible to improve reliability and reduce the possibility of manufacturing defects. It interconnects all the in-guard assemblies and to the A9 out-guard controller.

A5 Impedance

The A5 provides synthesized equivalents of Resistance, Capacitance, and Inductance. This feature shares some of the circuitry with the Resistance and Capacitance functions.

A6 DDS

The A6 is the heart of the analog system. The A6 provides digital control for all the in-guard assemblies through serial links to MSP430s.

The A6 has:

- The precision, ovenized 7 V reference
- Direct Digital dual channel synthesizer (DDS)
- Precision PWM DACs for both voltage and current
- Averaging ac/dc converter for acv
- Sense dividers and buffers for acv and dcv up to 120 V
- The acv/dcv loop error integrator
- A high-resolution adc for calibration, diagnostics, and monitor functions

A7 Current

The A7 contains most of the circuitry that generates the ACI and DCI functions.

These circuits include:

- A low current (120 µA and 1.2 mA ranges) transconductance amplifier
- A mid-current (12 mA and 120 mA ranges) transconductance amplifier
- A high current linear transconductance amplifier for the 1.2 A and 3.1 A ranges
- A class D 30 A transconductance amplifier for the 12 A and 30 A ranges
- Averaging ac/dc converter
- Precision shunts and shunt amplifier
- The loop error integrator

The A6 DDS provides the precision dc reference and the aci waveforms.

A8 High Voltage

The A8 contains all circuits to generate acv and dcv above 12 V.

The A8 is comprised of:

- A 120 V, 100 kHz dc coupled amplifier
- A 1000 V, 10 kHz dc coupled amplifier

The 120V amplifier is also routed through a step-up autotransformer to generate 120 V to 330 V from 10 kHz to 100 kHz. The A8 also contains the sense dividers and buffers for the 330 V and 1000 V ranges.

A12 Supply

The A12 contains all power supplies for the in-guard circuits.

Calibration Verification of the Product

Verification is the process of measurement data evaluation collected during the process of calibration and evaluating whether the data is within the published specifications for the Product. Verification is recommended annually for 5550A and 5560A, and biannually for 5540A. Calibration verification should also be done before and after normal periodic adjustment or repair of the Product. Verification also serves to check that internal calibration processes are in control.

Notes

Performance limits specified in the test record tables in this section are based on the 90-day specifications for the 5560A at a 99 % level of confidence. For the 5550A, 5540A and/or if limits to other specifications are necessary, the test records must be modified. A description of how to determine a guardband test limit is included in this section. This manual is not updated for changes to specifications. Before you do a verification, download the latest specifications from Flukecal.com.

Equivalent equipment and methods, either manual or automated, may be substituted for the verification tests as long as the same points are tested, and equipment and standards used provide for adequate (determined by process requirements) test uncertainty ratio (TUR). If standards are less accurate than specified, appropriate tolerance limit and/or accuracy reductions must be made to achieve equivalent results.

The verification points are selected based on knowledge about the hardware and the electronic circuits of the product. Although a limited set of the product capabilities, these calibration verification points are adequate to guarantee the performance of the Product for its functions and ranges.

Warmup Procedure for All Verification Tests

Notes

Consider these grounding and guarding suggestions:

- *For capacitance and inductance, disconnect the Guard from the Ground strap.*
- *For all other functions, connect the Guard to ground strap.*
- *When possible, set to external guard to control the guard of measurement instruments that are connected to the Product.*

Before verification:

1. Verify that the Product has warmed up for at least 30 minutes.

   Note

   If the Product has been powered off in an environment outside of operating environment specifications, particularly with humidity above 70 %, allow a minimum of 2 hours for warm-up. Extended storage at high temperatures and humidity can require up to 4 days of power-on stabilization.

2. Ensure that the specified warm-up period for all test equipment has been satisfied per operational requirements.
3. Ensure that the Product is in Standby (**STANDBY** annunciator lit).
4. Zero the Product. Zeroing adjusts internal circuitry, most notably dc offsets in all ranges of operation. To meet the specifications, zeroing is required every 7 days, or when the Product ambient temperature changes by more than 5 °C. There are two Calibrator zero functions: total instrument zero (**ZERO**) and ohms-only zero (**OHMS ZERO**). Before you do the verification tests, do the total Product zero.

To zero the Product:

1. Turn on the Product and allow a warm-up period of at least 30 minutes.
2. Tap the **Setup** softkey to open the Setup Menu.
3. Under Zero Adjustment, tap **Run** to open the calibration activity menu.
4. Push **Continue** as needed to step through the Zero Adjustment process. Push **Abort** to exit this function. When the zero procedure is done (20 minutes), push **Reset** to reset the Product.

An abbreviated summary of required equipment for all the verification tests is given in Table 1. Individual lists of required equipment are included at the beginning of each test. The equipment and methods selected in this manual are simplified to make it possible to calibrate the Product without advance metrological techniques and may result in low test uncertainty ratios. Use of guardbanding techniques is recommended to minimize acceptance risks - see *Applying Guardbands to Specification*

Limits section in this manual.

Table 1. Required Equipment for Main Output

Equipment Description	Manufacture/Model/PN	Application
AC Measurement Standard	Fluke Calibration 5790B	Vac, Iac
Resistance Standards	Fluke 742A Series (100, 1 k, 10 k, 100 k, 1 M, 10 M)	Ohms, Idc
DC Reference Standard	Fluke 732C	Vdc
Frequency Counter	Tektronix FCA3100 (Option MS or HS)	Frequency
Shunts	Fluke A40B Series (1 mA, 10 mA, 100 mA, 1 A, 5 A, 10 A, 20 A, 50 A)	Idc, Iac, Phase
Calibrator (precision source)	Fluke Calibration 5730A	Ohms, Temperature, Cap Charge
Resistance Standard	MI 9331G/100 M	Ohms
Resistance Standard	MI 9331G/1 G	Ohms
Digital Multimeter	Fluke Calibration 8588A	Ohms, Idc, Iac, Vdc, Vac, Cap Charge
LCR Meter	Hioki IM3533	Capacitance, Inductance
Phase meter	Clarke-Hess 6000A	Phase
Thermometer	Fluke 1504	Temperature
Thermistor probe	Fluke 5610-9-B	Temperature
Type J thermocouple	Omega TJ36-ICIN-18U-8-SMPW-M	Temperature
Dewar flask with cap	Various	Temperature
Type B copper mini-plug with copper wire	Various	Temperature
BANANA/DBL BANANA, 2 COND 24 in	Pomona 1368-A-24	Idc, Vac
Low Thermal Cables	5730A-7003,TEST LEAD SET, LOW THERMAL SPADE (Fluke Calibration PN 4376018)	Various
Double banana RG58 cable	Pomona Model 2BC-24 and 2BC-36	Ohms, Idc, Iac, Vdc, Vac

Table 1. Required Equipment for Main Output (cont.)

Equipment Description	Manufacture/Model/PN	Application
DBL BANANA N (M) RG58C/U (≈ 16 in)	(Fluke PN 900394) 5790-8026	Idc, Iac, Phase
BANANA/DBL BANANA, 2 COND 24 in	Pomona 1368-A-24	Idc Zero, Vac AUX
BNC (M) to Binding Posts	Pomona Model 1296	Idc, Iac, Phase
BNC (F) to BNC (M) Y Adapter	Pomona Model 6700	Capacitance, Inductance
BNC (F) To Single Banana Plug	Pomona Model 1894	Capacitance, Inductance
Type N (M) to dual banana (M)	E-Z-Hook PN 9415	Idc, Iac, Phase
Type N (M) On 50 Ohm RG214/U Cable	Pomona Model 1658-T	Idc, Iac
Fluke 8508A short	4-wire short (Fluke PN 2540973)	Vdc
Type N (F) to Type N (F) adapter	Various	Idc, Iac
LC Male to LC Male adapter	A40B-ADAPT/LC	Idc, Iac
LC Female to N Male inter-series adapter	A40B-ADAPT/LCN	Idc, Iac
N to 4 mm double banana cable	A40B-LEAD/4 mm	Idc, Iac, Phase
Single banana to single banana lead	Various	Various
BNC (F) to Type N (M)	Pasternack PN PE9002	Ohms

Determine Specification Limits for other Calibration Intervals

The verification procedures in this document tests to the 90-day, 99 % confidence specification limits of the 5560A. For the 5550A and 5540A or for other calibration intervals, you must calculate limits based upon the specification that was selected. The subsequent examples show how the 1-year specification limits are calculated. These examples illustrate how to calculate the specifications limits for other intervals or levels of confidence.

The first example shows how to calculate a specification limit for a particular test point from the combined specification which is listed as a percentage (or parts per million) of reading plus a floor error in microvolts, millivolts, microamps, or nanoamps. The component of the specification in parts per million is referred to as a range specification. The floor specification has the same base units of measurement as the output value (volts, amps). Do not add a range specification and floor specification together directly, because they are not in the same units of measurement. To add the two quantities, convert one quantity so that they are both in the same unit of measurement.

Example: the 1 year, 99 % confidence specification for the 5560Aat 1 mA, 1 kHz is 0.025 % + 100 nA. Multiply the relative specification by the output value to convert the relative specification to the same measurement unit as the floor specification:

1 mA x 0.025 % = [(1 x 10^{-3}) A x (0.025 x $10^{-2)}$] = 2.5 x 10^{-7} A = 250 nA

This formula makes the combined absolute specification 250 nA + 100 nA = 350 nA

The specification limits at 1 mA would be 0.999650 mA to 1.000350 mA

Applying Guardbands to Specification Limits

The expanded uncertainty of measurement must be determined by each laboratory that calibrates the Product. Even if the procedures for performance verification in this manual are followed completely, there are different sources of uncertainty due to traceability, environment, electrical cabling, electro-magnetic interference, uncertainty of the reference standards used, and operator influences that are unique to each calibration laboratory. These must be accounted for their individual situations, so it is not possible for Fluke Calibration to estimate uncertainty for all user calibrations.

Those doing the calibration of the Product can verify to 99 % confidence limits, 95 % confidence limits, 90-day, 1-year specifications, or 2-year specifications. While the calibration procedure included in this manual is applicable to testing every test point, the uncertainty from the calibration process as compared to the specification limit varies and can require further consideration of measurement decision risk.

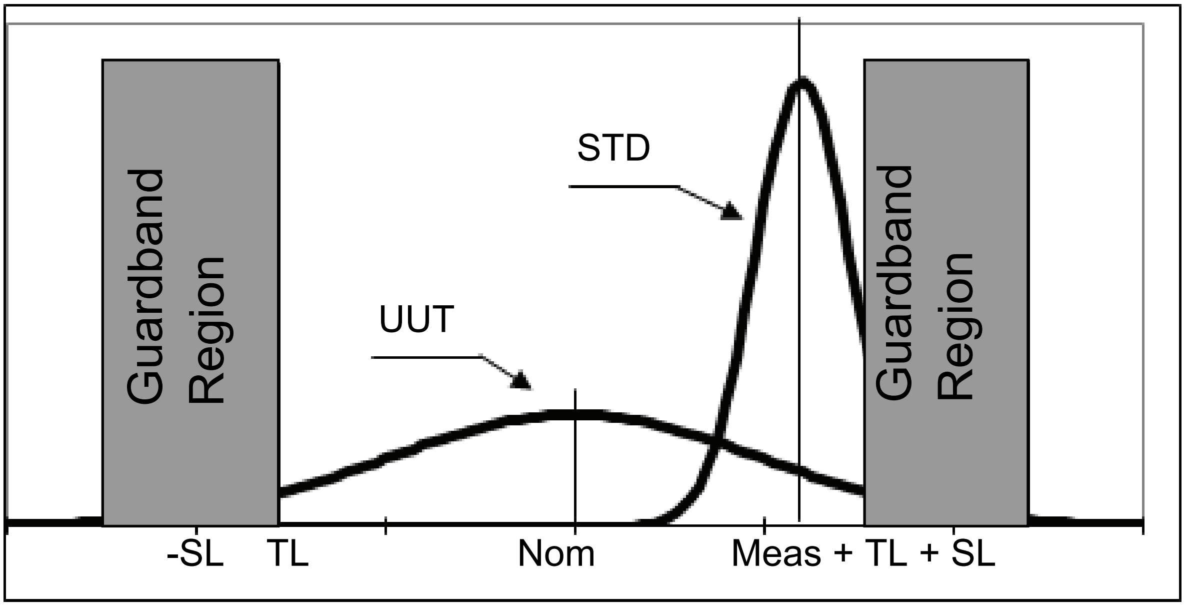
Some quality systems require adherence to particular rules for measurement decision risk when making claims of compliance with a specification.

Examples of decision rules are:

1. The ratio of the specification tested to the expanded uncertainty of measurement (often referred to as the Test Uncertainty Ratio) must be greater than 4:1.
2. The probability of a false accept risk must be less than 2 %.
3. The Product cannot be determined as meeting specifications unless the measurement at the test point is less than the value of the specification minus the expanded uncertainty.

To comply with these decision rules, establish a guardband for each test point. A guardband creates a zone that is less than the specification limits, and if the measured value obtained from the calibration is not in the guardband area, the level of measurement decision risk is sufficient. The inner edge of the guardband is the test limit for the calibration shown in Figure 2.

Figure 2. Test Limits Established by Guardbanding



There are many ways to develop test limits from decision rules. Two of these rules are shown as examples to develop test limits through guardbanding.

ILAC G8 (ISO 14253-1) Decision Rule

In this guardband strategy example, determine the test limit by the subtracting the uncertainty of the measurement from the specification.

Test Limit = Specification Limit - Expanded Uncertainty of Measurement

Obtain the specification limits from the performance verification procedure or compute them with information from *Determine Specification Limits for other Calibration Intervals* as guidance.

Once the calibration laboratory determines the expanded uncertainty for a measurement, compute the test limits for this method as follows:

Using the example test point in the previous section, for the 1-year, 99 % confidence specification for 1 mA at 1 kHz, the specification limits are 350 nA. If for example, the expanded uncertainty of measurement at this test point was 55 nA, the test limit would be:

Test Limit = 350 nA - 55 nA = 295 nA

This creates upper and lower test limits of 0.999705 mA to 1.000295 mA. If the measured value from the calibration were between these limits, by this decision rule the Product would be in tolerance or indicated as Pass.

If the measured value obtained was between 295 nA (the test limit) and 350nA (the specification limit) this is known as an indeterminate measurement by ISO 14253-1. Some organizations elect to call this a conditional pass as it is more likely that the measurement indicates an in tolerance condition than not.

If the measured value is >350 nA, but <405 nA (the sum of the specification limit plus the uncertainty) ISO 14243-1 indicates that this is an indeterminate measurement as well. Some organizations choose to call this a conditional fail because there is still a possibility that the measurement is in tolerance. Most organizations consider this an out of tolerance result because although the value may exist anywhere with the interval of the measured value plus and minus the uncertainty, the best estimate of the value is the measured value.

RDS Method

Another guardbanding method that is the root difference of squares method. The test limit for this method is defined as:

$$\text{Test Limit} = \sqrt{(\text{Specification limit})^2 - (\text{Expanded Uncertainty of Measurement})^2}$$

This method makes a less aggressive guardband while it still provides sufficient confidence in the measurement result for most quality standards. The determination of pass and conditional pass is generally used for this method in the same manner as the ILAC G8 method. The RDS method is used widely at Fluke Calibration and other companies as a reasonable approach to ensure confidence that the verified Product meets its published specifications.

This is not an all-inclusive list of guardbanding strategies. The method selected must meet the quality system requirements of the owner of the Product being calibrated. The best uncertainty attainable at some test points can be relatively large as compared to the specification. Fluke Calibration recommends that when making conformity assessment decisions of in or out of tolerance to published specifications during performance verification, the uncertainties of measurement should be evaluated and appropriate guardbanding rules should be applied to have sufficient confidence in the calibration results.

Volts DC Calibration (OUTPUT VZ)

Table 2 lists the required equipment.

Table 2. Required Equipment for Volts DC (Normal Output)

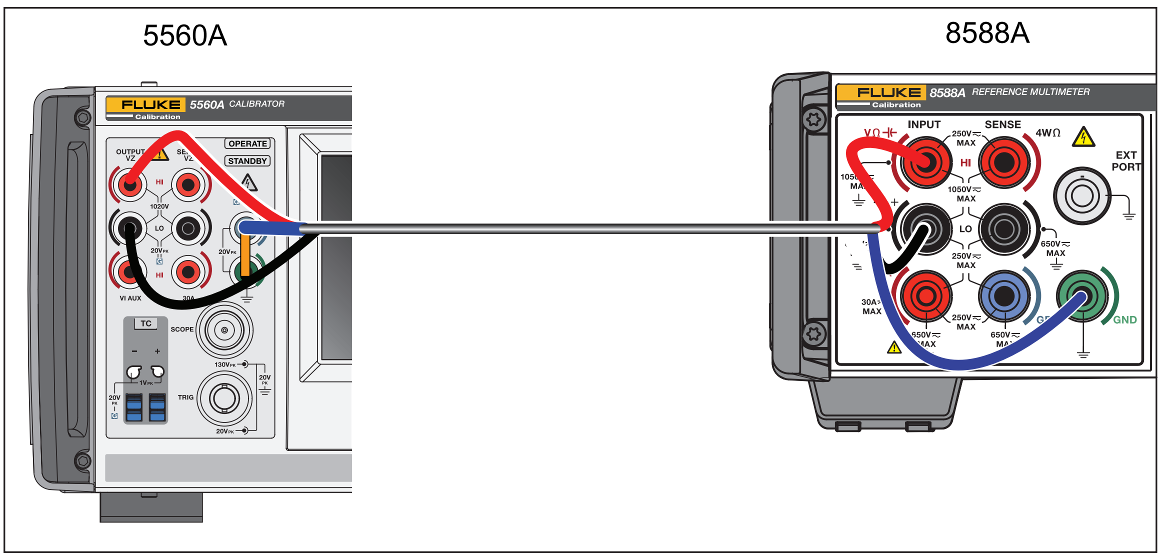
Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
DC Reference Standard	Fluke Calibration 732C	1
Fluke 8508A short	4-wire short (Fluke PN 2540973)	1
Low Thermal Cables	5730A-7003	1

To calibrate the Volts dc function from the main output:

1. On the Fluke Calibration 8588A put a 4-wire short (Fluke PN 2540973) across the HI and LO input and sense terminals.
2. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard)
3. Push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
4. Make sure that the DUT (Device Under Test) is in Standby.
5. Complete an internal DC Zero Calibration on the Product.
6. Record the 732C standard values in the Vstd column.
7. Connect the 8588A for vdc measurement with the low thermal cable to the 732C 100 mV (normal polarity).
8. Record the 8588A measurement in the Vdmm_732C column for applicable steps.
9. Inverse the cable at the 732C 100 mV (negative polarity).
10. Record 8588A measurement in the Vdmm_732C column for applicable steps.

11. Connect the 8588A for vdc measurement with the low thermal cable to the 732C 1 V (normal polarity).
12. Record the 8588A measurement in the Vdmm_732C column for applicable steps.
13. Inverse the cable at the 732C 1 V (negative polarity).
14. Record the 8588A measurement in the Vdmm_732C column for applicable steps.
15. Connect the 8588A for vdc measurement with the low thermal cable to the 732C 10 V (normal polarity).
16. Record the 8588A measurement in the Vdmm_732C column for applicable steps.
17. Inverse the cable at the 732C 10 V (negative polarity).
18. Record the 8588A measurement in the Vdmm_732C column for applicable steps.
19. Connect the test equipment as shown in Figure 3.
20. Connect a strap between the Guard and Ground terminals of the DUT.
21. Output from the DUT/Measure with the meter and record the 8588A measured values when connected to the Product in the Vdmm_prod column. Refer to the product manual for how to set and use range lock on the bottom range outputs.

Figure 3. Volts DC Calibration Direct



22. For steps other than ±100 mV, ±1 V, and ±10 V the output of the Product is the same as the 8588A measurement recorded directly when connected to the product output DMM Reading on Product column. Copy the value to the Calculated Product Output column.
23. For the rest of the steps, calculate the Product output with this formula:

$$\text{Calculated Product Output} = \left(\frac{\text{DMM Reading on Shunt output [V]}}{\text{Shunt\_R } [\Omega]} \right)$$

24. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 3. Calibration Steps for Volts DC (OUTPUT VZ)

Step	Product Range	Product Output	732C Value (Vstd)	DMM Reading on 732C (Vdmm_732C)	DMM Reading on Product (Vdmm_prod)	Calculated Product Output	Limits
1	120 mV	0 mV	N/A	N/A			±0.80 µV
2	120 mV	-0.00001 mV	N/A	N/A			±0.80 µV
3	120 mV	10 mV	N/A	N/A			±0.90 µV
4	120 mV	-10 mV	N/A	N/A			±0.90 µV
25	120 mV	100 mV					±1.8 µV
26	120 mV	-100 mV					±1.8 µV
5	1.2 V	0 V	N/A	N/A			±1.0 µV
6	1.2 V	-0.0000001 V	N/A	N/A			±1.0 µV
27	1.2 V	0.1 V					±1.7 µV
28	1.2 V	-0.1 V					±1.7 µV
29	1.2 V	1 V					±7.6 µV
30	1.2 V	-1 V					±7.6 µV
7	12 V	0 V	N/A	N/A			±10.0 µV
8	12 V	-0.000001 V	N/A	N/A			±10.0 µV
31	12 V	1 V					±17 µV
32	12 V	-1 V					±17 µV
33	12 V	10 V					±75 µV
34	12 V	-10 V					±75 µV
9	120 V	0 V	N/A	N/A			±0.10 mV
10	120 V	-0.00001 V	N/A	N/A			±0.10 mV
35	120 V	10 V					±0.19 mV
36	120 V	-10 V					±0.19 mV
11	120 V	100 V	N/A	N/A			±1.03 mV
12	120 V	-100 V	N/A	N/A			±1.03 mV
13	120 V	120 V	N/A	N/A			±1.22 mV
14	120 V	-120 V	N/A	N/A			±1.22 mV
15	1020 V	0 V	N/A	N/A			±1.00 mV
16	1020 V	-0.0001 V	N/A	N/A			±1.00 mV

Table 3. Calibration Steps for Volts DC (OUTPUT VZ) (cont.)

Step	Product Range	Product Output	732C Value (Vstd)	DMM Reading on 732C (Vdmm_732C)	DMM Reading on Product (Vdmm_prod)	Calculated Product Output	Limits
17	1020 V	100 V	N/A	N/A			±1.9 mV
18	1020 V	-100 V	N/A	N/A			±1.9 mV
19	1020 V	500 V	N/A	N/A			±5.7 mV
20	1020 V	-500 V	N/A	N/A			±5.7 mV
21	1020 V	1000 V	N/A	N/A			±10.3 mV
22	1020 V	-1000 V	N/A	N/A			±10.3 mV
23	1020 V	1020 V	N/A	N/A			±10.5 mV
24	1020 V	-1020 V	N/A	N/A			±10.5 mV

Volts DC Calibration (AUX Output) (5550A and 5560A)

Table 4 lists the required equipment.

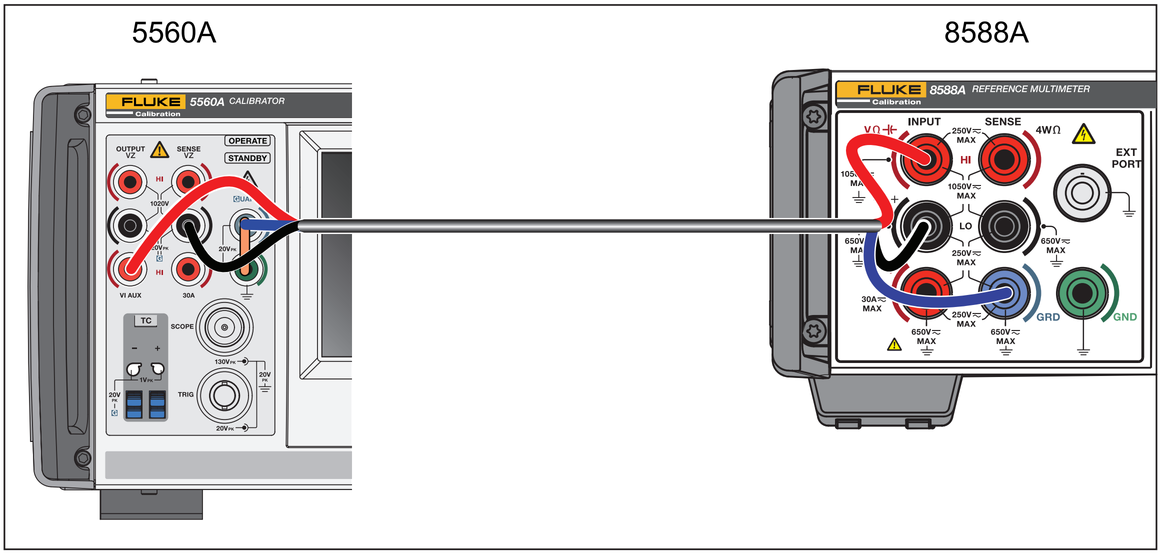
Table 4. Required Equipment for Volts DC Calibration (AUX Output)

Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
Fluke 8508A short	4-wire short (Fluke PN 2540973)	1
Low Thermal Cables	5730A-7003	1

To calibrate the Volts dc function from the secondary output:

1. On the Fluke Calibration 8588A put a 4-wire short (Fluke PN 2540973) across the HI and LO input and sense terminals.
2. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard).
3. Push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
4. Make sure that the DUT is in Standby.
5. Complete an internal DC Zero Calibration on the Product.
6. Connect the test equipment as shown in Figure 4.

Figure 4. Volts DC Calibration SENSE Output



7. Connect a strap between the Guard and Ground terminals of the DUT.
8. Output from the DUT/Measure with the meter and record the 8588A measured values when connected to the Product in the Product Output column, see Table 5.
9. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 5. Calibration Steps for Volts dc (AUX Output)

Step	Product Output (OUTPUT VZ)	Product Range (AUX Output)	Product Output (AUX Output)	Product Output	Limits
1	1 V	120 mV	0 mV		±0.30 mV
2	-1 V	120 mV	120 mV		±0.34 mV
3	1 V	120 mV	-120 mV		±0.34 mV
4	-1 V	1.2 V	0.121 V		±0.34 mV
5	1 V	1.2 V	-0.121 V		±0.34 mV
6	-1 V	1.2 V	1.2 V		±0.66 mV
7	1 V	1.2 V	-1.2 V		±0.66 mV
8	-1 V	7 V	1.21 V		±0.66 mV
9	1 V	7 V	-1.21 V		±0.66 mV
10	-1 V	7 V	7 V		±2.40 mV
11	1 V	7 V	-7 V		±2.40 mV

Amps DC Calibration

Table 6 lists the required equipment.

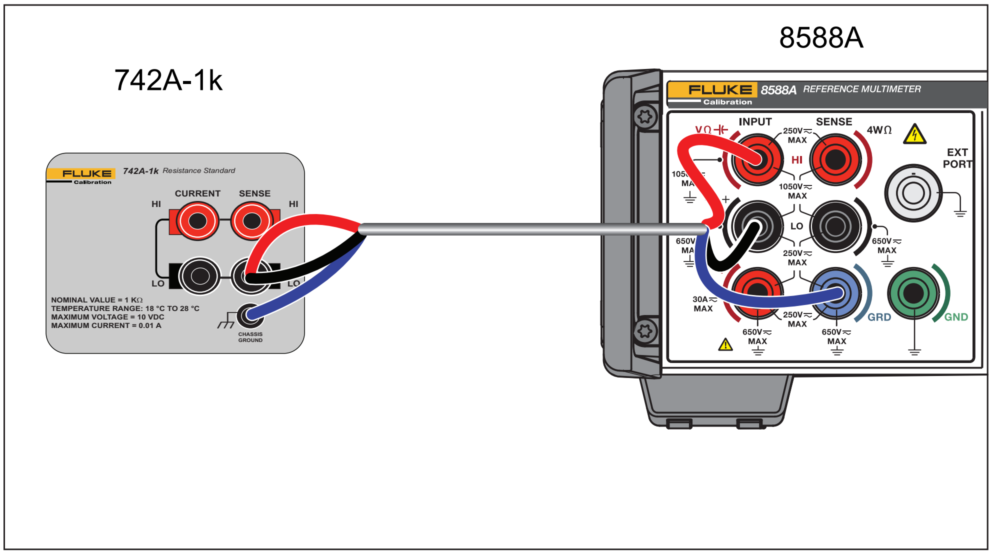
Table 6. Required Equipment for Amps DC

Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
±(0 µA to 100 µA)	Fluke 742A-1k Resistance Standard	1
±(1 mA to 1.2 mA)	Fluke A40B-1mA Current Shunt	1
±(10 mA to 12 mA)	Fluke A40B-10mA Current Shunt	1
±(100 mA to 120 mA)	Fluke A40B-100mA Current Shunt	1
±(1 A to 1.2 A)	Fluke A40B-1A Current Shunt	1
±3 A	Fluke A40B-5A Current Shunt	1
±10 A	Fluke A40B-10A Current Shunt	1
±(12 A to 20 A)	Fluke A40B-20A Current Shunt	1
±30 A	Fluke A40B-50A Current Shunt	1
Type N (M) to dual banana (M)	E-Z-Hook PN 9415	1
Type N (F) to Type N (F) adapter	Various	1
LC Male to LC Male adapter	A40B-ADAPT/LC	1
LC Female to N Male inter-series adapter	A40B-ADAPT/LCN	1
N to 4 mm double banana connector	A40B-LEAD/4mm	1
DBL BANANA N (M) RG58C/U (≈ 16 in)	(Fluke PN 900394) 5790-8026	1
Test Lead Banana to Banana 24 in	Pomona 1368-A-24	1
Low Thermal Cables	Fluke 5730-7003	1

To calibrate the Amps dc function (subsequent amps dc calibration steps refer to Table 7):

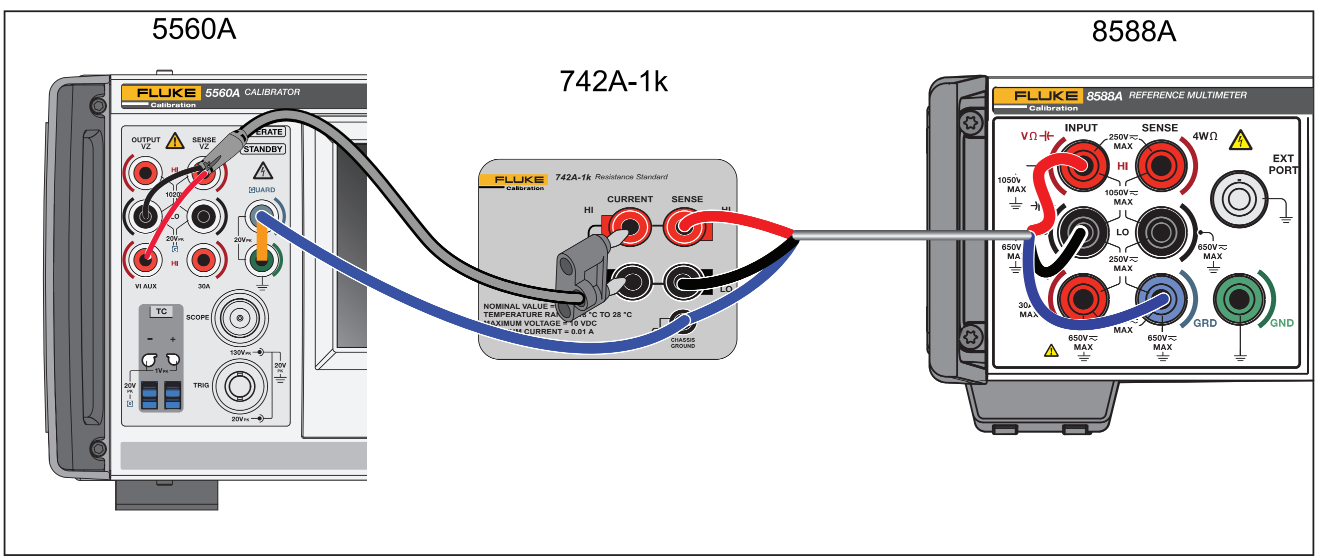
1. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard).
2. Make sure that the DUT is in Standby.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. Complete an internal DC Zero Calibration on the Product.
5. Calculate the shunt resistance in Ω from the calibration records and/or regression analysis for all shunts listed in Table 7.
6. Record the shunt resistance in the Ω column marked as Shunt_R in Table 7.
7. Connect the 8588A for V dc measurement with the low thermal cable to Fluke 742A-1k SENSE See Figure 5.

Figure 5. Amps DC with 742A-1k - Meter Zero



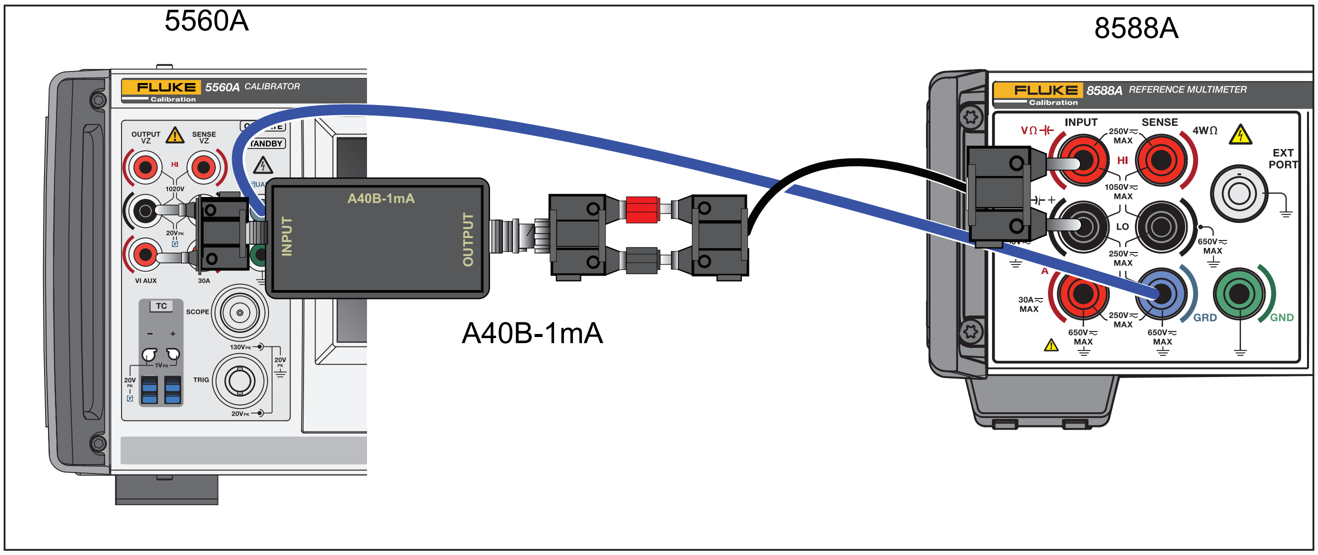
8. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
9. Connect the test equipment as shown in Figure 6.
10. Output from the DUT/Measure with the meter and record the 8588A measured values in the DMM Reading on Shunt Output [V] column. Complete all steps for the present connection (1 to 20). Refer to the Product manual how to set and use range lock on bottom of range outputs.
11. Set the Product to Standby.
12. Move the red lead connected to the Product V AUX to the 30 A terminal.
13. Complete the subsequent steps for this connection (21 and 22, Table 7). See the Product manual for how to set and use range lock on bottom of range outputs.

Figure 6. Amps DC with742A-1k



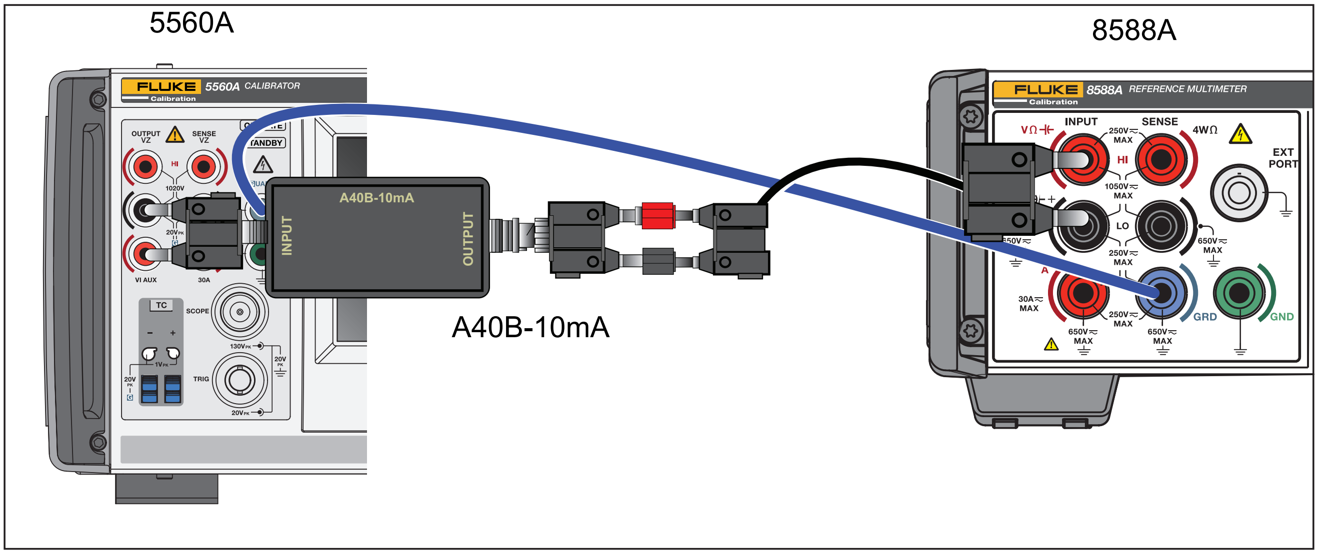
14. Connect the test equipment as shown in Figure 7.
15. Toggle the power switch of the A40B-1mA shunt to ON. Continue only if power light illuminates and the BATT LOW is off.
16. With no current applied from the Product to the Fluke A40B-1mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
17. Start with step 23. Set the output from the DUT/Measure with the meter and record the 8588A measured value in the DMM Reading on Shunt Output [V] column. Complete all steps for the present connection (23 to 26). Refer to the Product manual for how to set/use range lock on bottom of range outputs.

Figure 7. Amps DC with A40B-1mA



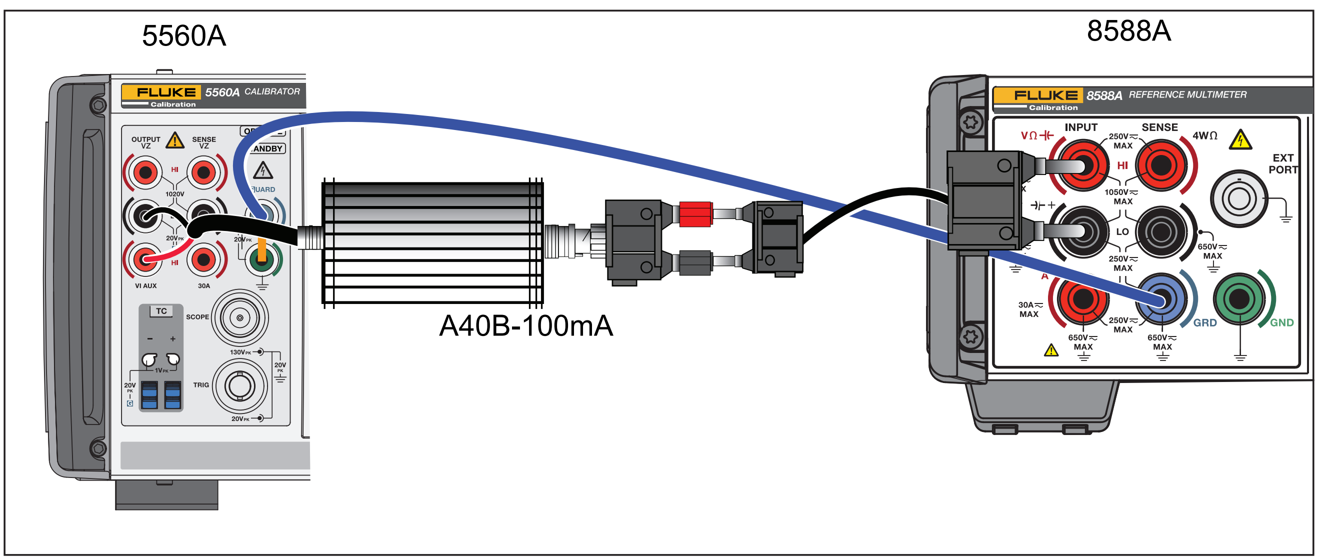
18. Set the product to Standby. Disconnect the shunt. Toggle the power switch of the A40B-1mA shunt to **OFF**.
19. Connect the test equipment as shown in Figure 8.
20. With no current applied from the Product to the Fluke A40B-10mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
21. Start with step 27 and output from the DUT/Measure with the meter and record the 8588A measured value in the DMM Reading on Shunt Output [V] column. Complete all steps for the present connection (27 to 30). Refer to the Product manual for how to set and use range lock on bottom of range outputs.

Figure 8. Amps DC with A40B-10mA



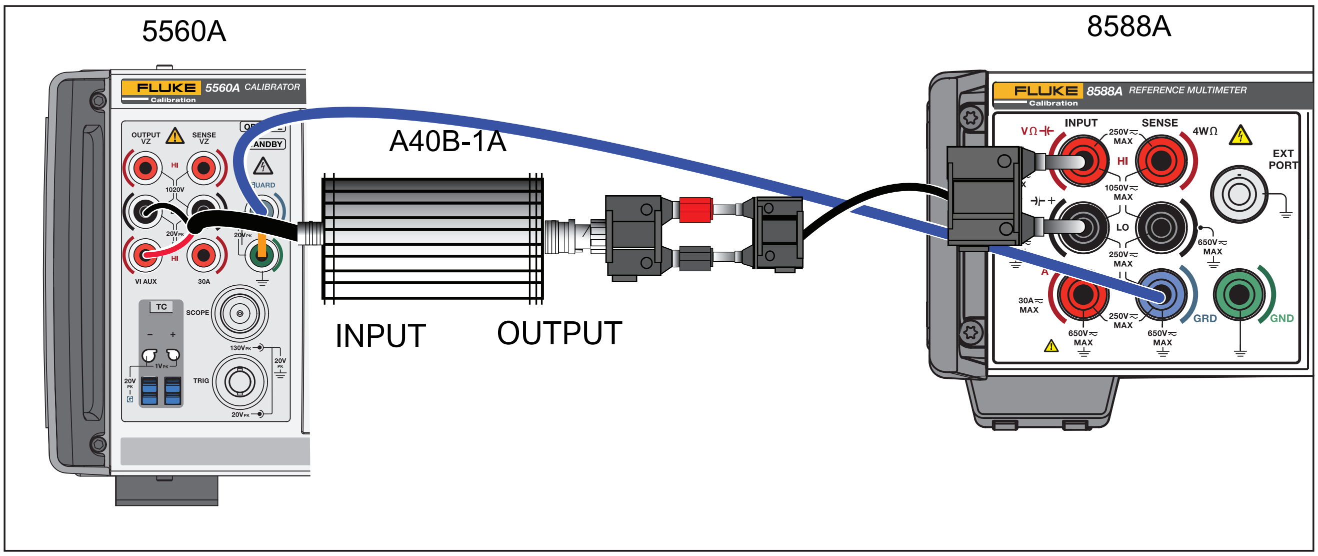
22. Set the Product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 9.
23. With no current applied from the Product to the Fluke A40B-100mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
24. Start with step 31. Set the output from the DUT/Measure with the meter and record the 8588A measured value in the DMM Reading on Shunt Output [V] column. Complete all steps for the present connection (31 to 34). Refer to the Product manual for how to set/use range lock on bottom of range outputs.

Figure 9. Amps DC with A40B-100mA



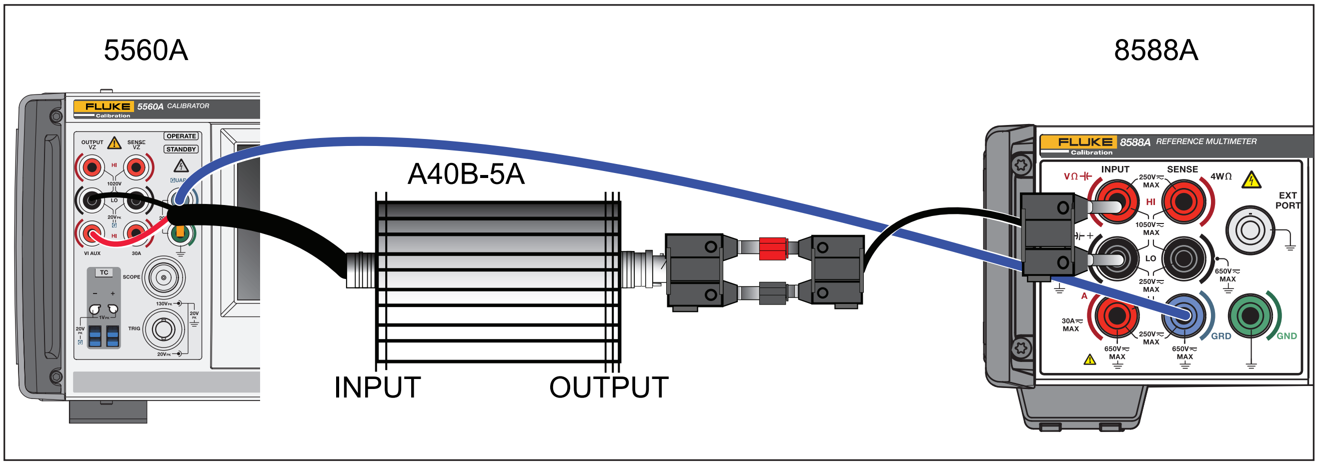
25. Set the Product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 10.
26. With no current applied from the Product to the Fluke A40B-1A shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
27. Start with step 35. Set the output from the DUT and wait 30 seconds for the reading to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column. Complete all steps for the present connection (35 to 38). Refer to the Product manual for how to set and use range lock on the bottom of range outputs.
28. Set the Product to Standby.
29. Move the red lead connected to the Product V AUX to the 30 A terminal.
30. Complete the subsequent steps 39 and 40 for this connection.

Figure 10. Amps DC with A40B-1A



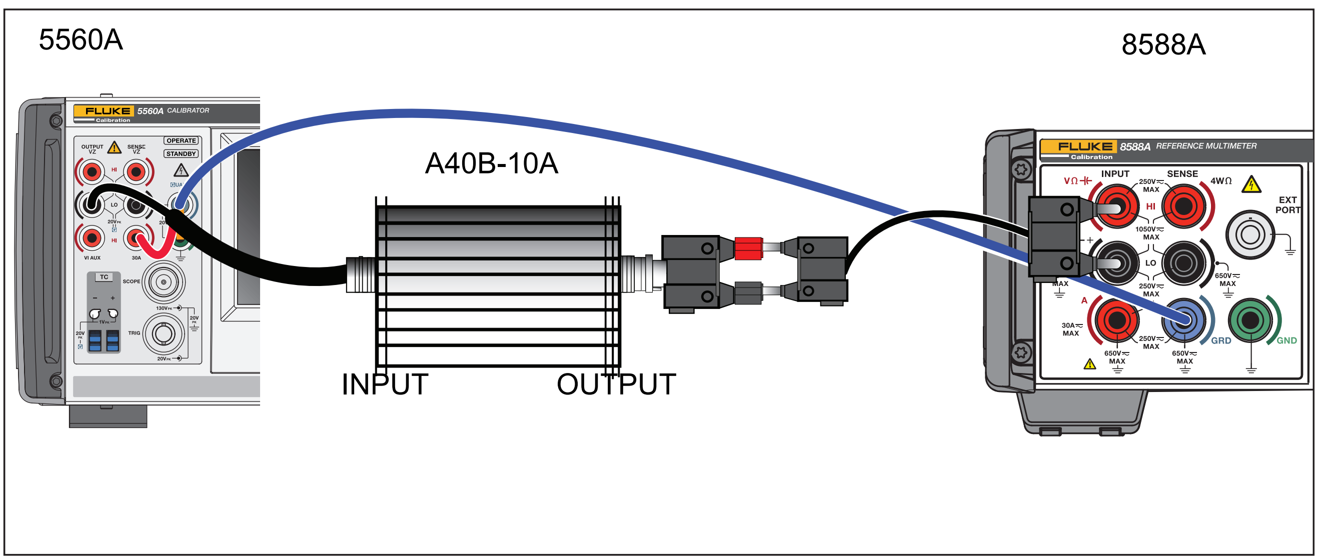
31. Set the product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 11.
32. With no current applied from the Product to the Fluke A40B-5A shunt, proceed with the meter zero function. On the 8588A Push **INPUT**, and then **ZERO FUNC**. Allow the zero function to finish.
33. Start with step 41. Set the output from the DUT and wait 30 seconds the reading to settle. Measure with the meter and record the 8588A measured value in the DMM Reading on Shunt Output [V] column. Complete both steps for the present connection (41 and 42).
34. Set the product to Standby.

Figure 11. Amps DC with A40B-5A



35. Set the product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 12.
36. With no current applied from the Product to the Fluke A40B-10A shunt, proceed with the meter zero function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow th zero function to finish.
37. Start with step 43. Set the output from the DUT, wait 2 minutes for settling and measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column. Complete both steps for the present connection (43 and 44). Refer to the Product manual for how to set/use range lock on bottom of range outputs.

Figure 12. Amps DC with A40B-10A

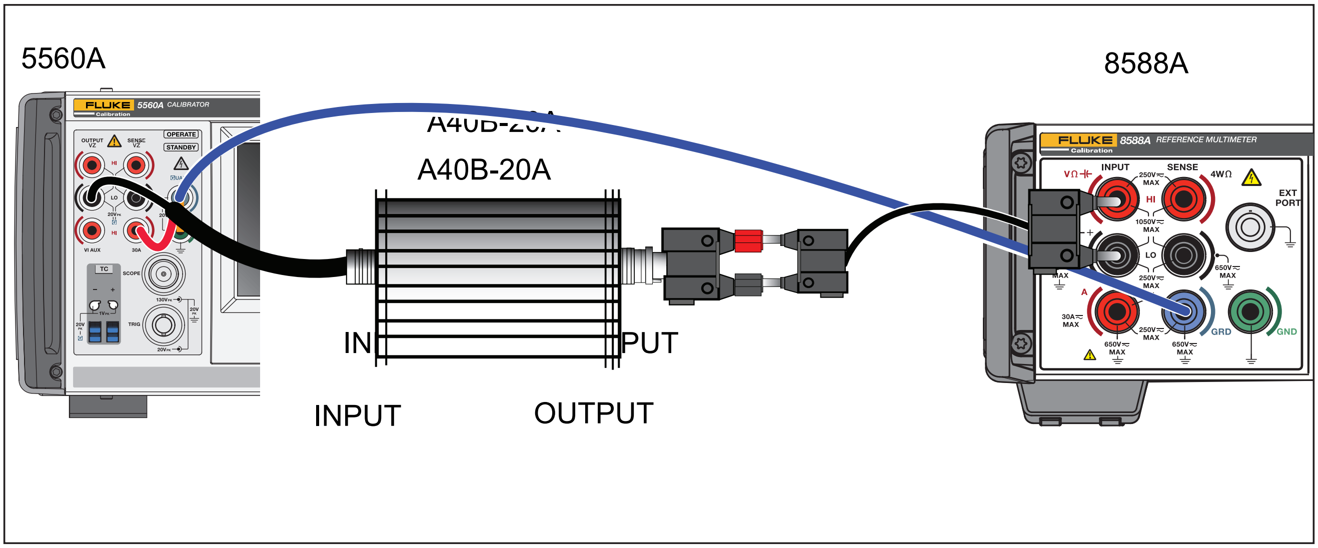


38. Set the Product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 13.

39. With no current applied from the Product to the Fluke A40B-20A shunt, proceed with the meter zero function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.

40. Start with step 45. Set the output from the DUT and wait 3 minutes for settling. Measure with the meter and record the 8588A measured value in the DMM Reading on Shunt Output [V] column. Complete the steps for the present connection (45 to 50). Refer to the Product manual how to set and use range lock on bottom of range outputs.

Figure 13. Amps DC with A40B-20A

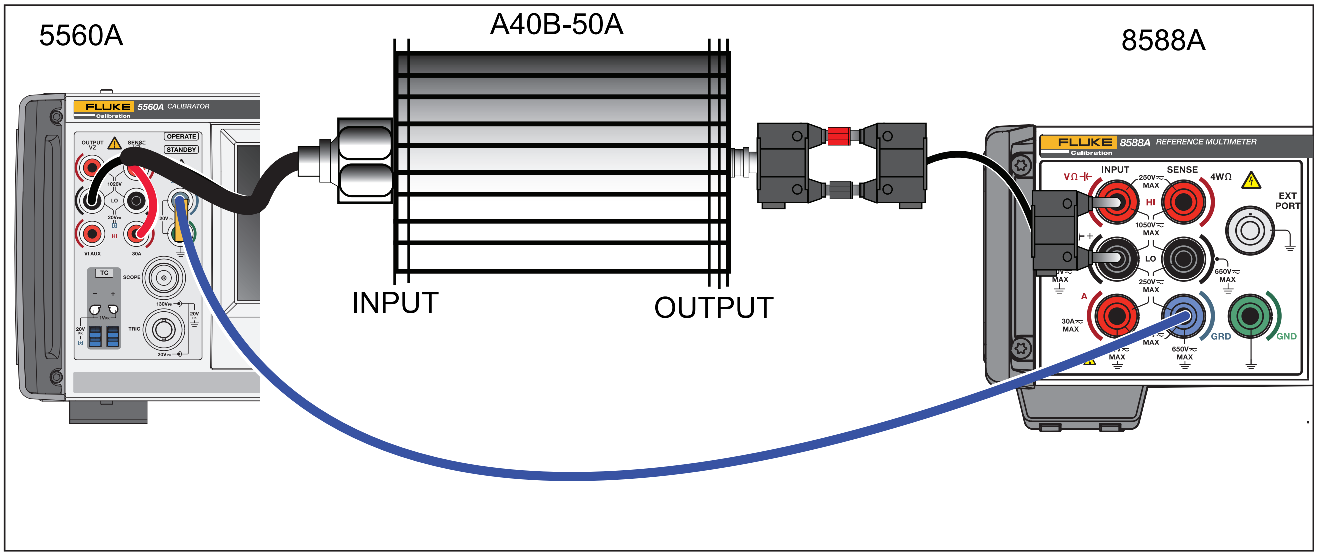


41. Set the Product to Standby. Disconnect the shunt. Connect the test equipment as shown in Figure 14.

42. With no current applied from the Product to the Fluke A40B-50A shunt, proceed with the meter zero function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.

43. Start with step 51. Set the output from the DUT and wait 3 minutes for settling. Measure with the meter and record the 8588A measured in the DMM Reading on Shunt Output [V] column. Complete both steps for the present connection (51 and 52). Refer to the Product manual how to set/use range lock on bottom of range outputs.

Figure 14. Amps DC with A40B-50A



44. For all A dc steps, calculate the output with the formula below. Use the appropriate conversion to convert from base units to units for the specific evaluation step.

$$\text{Calculated Product Output} = \left(\frac{\text{DMM Reading on Shunt output [V]}}{\text{Shunt\_R [}\Omega\text{]}} \right)$$

45. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 7. Calibration Steps for Amps DC

Step	Product Range	Product Output	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
1	120 µA	0 µA	Fluke 742A-1k				±6.0 nA
2	120 µA	-0.0001 µA	Fluke 742A-1k				±6.0 nA
3	120 µA	10 µA	Fluke 742A-1k				±7.0 nA
4	120 µA	-10 µA	Fluke 742A-1k				±7.0 nA
5	120 µA	100 µA	Fluke 742A-1k				±16.0 nA
6	120 µA	-100 µA	Fluke 742A-1k				±16.0 nA
7	1.2 mA	0 mA	Fluke 742A-1k				±15.0 nA
8	1.2 mA	-0.000001 mA	Fluke 742A-1k				±15.0 nA

Table 7. Calibration Steps for Amps DC (cont.)

Step	Product Range	Product Output	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
9	1.2 mA	0.1 mA	Fluke 742A-1k				±23.0 nA
10	1.2 mA	-0.1 mA	Fluke 742A-1k				±23.0 nA
23	1.2 mA	1 mA	Fluke A40B-1mA				±95.0 nA
24	1.2 mA	-1 mA	Fluke A40B-1mA				±95.0 nA
11	12 mA	0 mA	Fluke 742A-1k				±0.08 µA
12	12 mA	-0.00001 mA	Fluke 742A-1k				±0.08 µA
25	12 mA	1 mA	Fluke A40B-1mA				±0.16 µA
26	12 mA	-1 mA	Fluke A40B-1mA				±0.16 µA
27	12 mA	10 mA	Fluke A40B-10mA				±0.88 µA
28	12 mA	-10 mA	Fluke A40B-10mA				±0.88 µA
13	120 mA	0 mA	Fluke 742A-1k				±0.80 µA
14	120 mA	-0.0001 mA	Fluke 742A-1k				±0.80 µA
29	120 mA	10 mA	Fluke A40B-10mA				±2 µA
30	120 mA	-10 mA	Fluke A40B-10mA				±2 µA
31	120 mA	100 mA	Fluke A40B-100mA				±9 µA
32	120 mA	-100 mA	Fluke A40B-100mA				±9 µA
15	1.2 A	0 A	Fluke 742A-1k				±10 µA
16	1.2 A	-0.000001 A	Fluke 742A-1k				±10 µA
33	1.2 A	0.1 A	Fluke A40B-100mA				±23 µA
34	1.2 A	-0.1 A	Fluke A40B-100mA				±23 µA
35	1.2 A	1 A	Fluke A40B-1A				±140 µA
36	1.2 A	-1 A	Fluke A40B-1A				±140 µA
17	3.1 A	0 A	Fluke 742A-1k				±150 µA
18	3.1 A	-0.00001 A	Fluke 742A-1k				±150 µA
37	3.1 A	1 A	Fluke A40B-1A				±390 µA
38	3.1 A	-1 A	Fluke A40B-1A				±390 µA

Table 7. Calibration Steps for Amps DC (cont.)

Step	Product Range	Product Output	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
41	3.1 A	3.1 A	Fluke A40B-5A				±0.894 mA
42	3.1 A	-3.1 A	Fluke A40B-5A				±0.894 mA
19	12 A	0 A	Fluke 742A-1k				±0.250 mA
20	12 A	-0.00001 A	Fluke 742A-1k				±0.250 mA
39	12 A	1 A	Fluke A40B-1A				±490 μA
40	12 A	-1 A	Fluke A40B-1A				±490 μA
43	12 A	10 A	Fluke A40B-10A				±2.650 mA
44	12 A	-10 A	Fluke A40B-10A				± 2.650 mA
45	12 A	12 A	Fluke A40B-20A				± 3.13 mA
46	12 A	-12 A	Fluke A40B-20A				± 3.13 mA
21	30.2 A	0 A	Fluke 742A-1k				± 0.50 mA
22	30.2 A	-0.0001 A	Fluke 742A-1k				± 0.50 mA
47	30.2 A	12.1 A	Fluke A40B-20A				± 10.2 mA
48	30.2 A	-12.1 A	Fluke A40B-20A				±10.2 mA
49	30.2 A	20 A	Fluke A40B-20A				±16.5 mA
50	30.2 A	-20 A	Fluke A40B-20A				±16.5 mA
51	30.2 A	30 A	Fluke A40B-50A				±24.5 mA
52	30.2 A	-30 A	Fluke A40B-50A				±24.5 mA

Resistance Calibration

The verification points for resistance are selected based on knowledge about the hardware and the electronic circuits in the Product. The resistance section uses:

- Different measurement modes. For resistance up to and including 100 kΩ the measurements are performed in four-wire mode (4W). The rest of the measurements are performed in two-wire mode (2W).
- Different measurement methods are used: Direct and Transfer from resistance standards (whenever the TUR is low).
- Different resistance modes. Because of product compliance (Operating Characteristics) certain steps require the Fluke Calibration 8588A to be used in Low Current Mode (LoI) to reduce the current into the product.

For all resistance steps: Toggle the meter to the Volts dc function prior to putting the Product in operate mode. Toggle the meter to the resistance function and range as instructed in the section below after the product is in operate. Failure to follow this sequence results in compliance-limits error on the Product.

Table 8 lists the required equipment.

Table 8. Required Equipment for Resistance

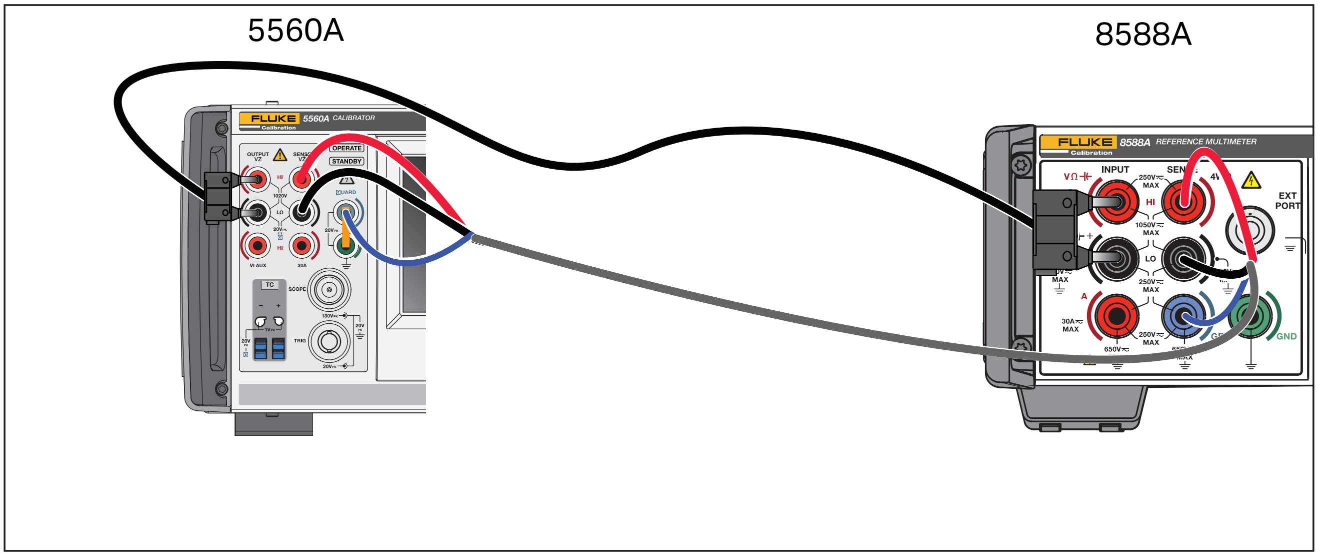
Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
Resistance Standard	Fluke 742A-100k	1
Resistance Standard	Fluke 742A-1M	1
Resistance Standard	Fluke 742A-10M	1
Resistance Standard	MI 9331G/100 M	1
Resistance Standard	MI 9331G/1 G	1
Low Thermal Cables	Fluke Calibration 5730A-7003	1
Double banana RG58 cable	Pomona Model 2BC-24 and 2BC-36	1
BNC (F) to Type N (M)	Pasternack PN PE9002	2
BNC (F) To Single Banana Plug	Pomona Model 1894	1
Resistance Standard.	Fluke 742-10k	1

The instructions in this section and the measurement sequence is structured to use common settings, modes, and methods to simplify the calibration function.

To calibrate the Resistance function:

1. Make sure that the DUT is in Standby.
2. Set the 8588A as follows: Resistance 4Wire, LoI OFF, Range (as per Table 10), NPLC 50, Guard OFF (external guard light ring off). Set the meter to DC Voltage temporarily to prevent compliance limit errors on the Product.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. Connect the test equipment as shown in Figure 15.
5. Start with step 1 in Table 10. Set the output from the DUT 4W Resistance. Measure with the meter and record the 8588A measured value in the DMM Measurement on Product column in Table 10. Change the meter range for each step. Complete all steps for the present connection and meter setup (1 through 14).

Figure 15. Resistance 4W with 8588A



6. Set the Product to Standby.
7. Connect the 8588A to Fluke 742A-100k for 4-Wire measurement.
8. Set the 8588A as follows: Resistance 4Wire, LoI OFF, Range (as per Table 10), NPLC 50, Guard OFF (external guard light ring off).
9. Record the following measurements in step 15 of Table 10.
10. Measure with the meter and record the 8588A measured value in the DMM Measurement on Transfer Resistor column in Table 10.
11. Disconnect the 8588A from the resistor standard and connect the cables to the product for 4W measurement. Set the meter temporarily to the Volts dc Function.
12. Set the Product to output 100 kΩ. Set meter to the Resistance function. Measure with the meter and record the 8588A measured value in the DMM Measurement on Product column in Table 10.
13. Set the product to Standby.
14. Set the 8588A as follows: Resistance 4Wire, LoI ON, Range (as per Table 10.), NPLC 50, Guard OFF (external guard light ring off).
15. Record the following measurements in Table 10, step 16.
16. Measure with the meter and record the 8588A measured value in the DMM Measurement on Transfer Resistor column in Table 10.
17. Connect the 8588A to the Product for 2-Wire measurement. Connect the cable between the meter and DUT guard terminals.
18. Set the 8588A as follows: Resistance 2Wire, LoI ON, Range Auto, NPLC 50, Guard OFF (external guard light ring off). Set temporarily to the Volts dc Function.

19. Set the Product to output 121 kΩ. Set the meter to the Resistance function. Measure with the meter and record the 8588A measured value in the DMM Measurement on Product column in Table 10.
20. Set the product to Standby.
21. Connect the 8588A to Fluke 742A-1M for 2-Wire measurement.
22. Measure with the meter and record the 8588A measured value in the DMM Measurement on Transfer Resistor column in Table 10.
23. Disconnect the 8588A from the resistor standard and connect the cables to the product for 2-W measurement.
24. Set the Product to output 1 MΩ. Measure with the meter and record the 8588A measured value in the DMM Measurement on Product column in Table 10 step 17.
25. Set the Product to Standby.
26. Complete steps 18 to 22 in Table 10 and follow the same sequence for 2W, where the meter measures a resistor following by the Product measurement. For all steps, connect the cable between meter and resistor guard terminals.
27. The subsequent section (steps 23 to 26 in Table 10) uses characterization and linearization of the 8588A 1 GΩ range at 100 MΩ and 1 GΩ.
28. Input the values for both standards in the Transfer Value column in Table 9.
29. Set the 8588A as follows: Resistance 2Wire, LoI OFF, Range 1 G, NPLC 50, Guard OFF (external guard light ring off).
30. Connect the 8588A to 100 MΩ standard for 2-Wire measurement. Use appropriate adapters at the resistor standard to accommodate the connection.
31. Measure with the meter and record the 8588A measured value in the DMM Measurement on Transfer Resistor column in Table 9, step 1.
32. Connect the 8588A to 1 GΩ standard for 2-Wire measurement. Use appropriate adapters at the resistor standard to accommodate the connection.
33. Measure with the meter and record the 8588A measured value in the DMM Measurement on Transfer Resistor column in Table 9 step 5.

    Build the following formulas in Excel to calculate the *Linear error* of the meter at each point for steps 2 to 5 in Table 9.

Meter error at 0.1 GΩ:

$$Y_0 = \frac{(DMM_{meas\text{-}0.1GW} - 0.1G\Omega_{Rvalue})}{0.1G\Omega_{Rvalue}} \quad 10^6 \quad [\mu\Omega/\Omega]$$

Meter error at 1 GΩ:

$$Y_1 = \frac{(DMM_{meas\text{-}1G\Omega} - 1G\Omega_{Rvalue})}{1G\Omega_{Rvalue}} \; 10^6 \; [m\Omega/\Omega]$$

Calculate the Meter error (Linear Interpolation) with this formula:

$$Y = \frac{Y_0(X_1-X)+Y_1(X-X_0)}{X_1-X_0}$$

where X_0=0.1 and X_1=1 and X is the value from the Product Output column in Table 9 for each step.

34. Connect the existing setup used for high resistance to the product for 2-W measurements and complete steps 23 to 26 from Table 10.

Table 9. 8588A 1G W Range Characterization

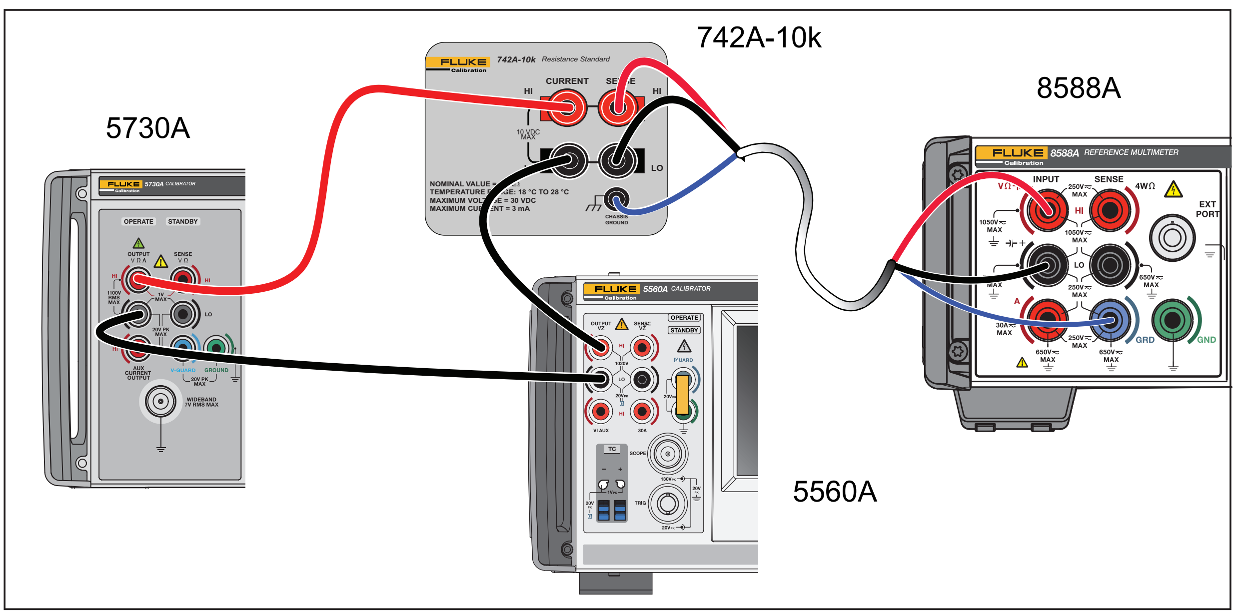
Step	8588A Range	Product Output	Transfer Resistor	Transfer Value	DMM Measurement on Transfer Resistor	Meter Error (Linear Error) DMM_{Err_ppm}
1	1.2 GΩ	0.1 GΩ	MI 9331G/100 M	GΩ	GΩ	N/A
2	1.2 GΩ	0.3 GΩ	N/A	N/A	N/A	μΩ/Ω
3	1.2 GΩ	0.4 GΩ	N/A	N/A	N/A	μΩ/Ω
4	1.2 GΩ	0.64 GΩ	N/A	N/A	N/A	μΩ/Ω
5	1.2 GΩ	1 GΩ	MI 9331G/1 G	GΩ	GΩ	μΩ/Ω

35. Connect the Product, the system 5730A, and the 8588A as shown on Figure 16.

36. Disconnect the V-Guard to Ground strap on the 5730A. The DUT strap should still be connected.

37. Set the 8588A as follows: Resistance 2Wire, LoI OFF, Range (as per Table 10), NPLC 50, Guard OFF (external guard light ring off).

Figure 16. Resistance 4W with Low Current with 5730A as Current Source



38. Input the value of the 742A-10k resistor into the Transfer Resistor column steps 23 and 24 of Table 10 in Ω.
39. Starting with step 23, output the resistance value from the Product.
40. Measure the voltage across the **SENSE** terminals with the 8588A and record in the DMM Measurement on Transfer Resistor column of Table 10 in V.
41. Move the connection to the Product **SENSE** terminals and measure the voltage across the **SENSE** terminals with the 8588A and record in the DMM Measurement on Product column of Table 10 in V.
42. Output the resistance value for step 24 from the Product.
43. Measure the product **SENSE** terminals voltage across the **SENSE** terminals with the 8588A and record in the DMMPROD column of Table 10 in V.
44. Return the connection as in Figure 16.
45. Measure the voltage across the 742A-10k **SENSE** terminals with the 8588A and record in step 24 in the DMMSTD column of Table 10 in V.
46. Calculate the Product Output as follows:

    For steps 1 through 14: $\text{Product Output} = DMM_{PROD}$

    For steps 15 through 22: $\text{Product Output} = DMM_{PROD} - (DMM_{STD} - R_{STD})$

    For steps 23 through 26: $\text{Product Output} = DMM_{PROD} * (1 - DMM_{Err} * 10^{-6})$

    For steps 27 through 28: $$\text{Product Output} = R_{STD} * \left(\frac{DMM_{PROD}}{DMM_{STD}} \right)$$

47. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 10. Calibration Steps for Resistance

Step	Product Range	Product Output	DMM Mode/ Method	Transfer Resistor	Transfer Value	DMM Measure-ment on Transfer Resistor	DMM Measure-ment on Product	Calculated Product Output	Limits
1	12 Ω	0 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	±1.0 mΩ
2	12 Ω	1 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	±1.0 mΩ
3	12 Ω	10 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	±1.2 mΩ
4	120 Ω	12.1 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	±1.3 mΩ
5	120 Ω	100 Ω	Normal 100 Ω / Direct	N/A	N/A	N/A	Ω	Ω	±3.2 mΩ
6	1.2 kΩ	0.121 kΩ	Normal 100 Ω / Direct	N/A	N/A	N/A	kΩ	kΩ	±4.7 mΩ

Table 10. Calibration Steps for Resistance (cont.)

Step	Product Range	Product Output	DMM Mode/ Method	Transfer Resistor	Transfer Value	DMM Measure-ment on Transfer Resistor	DMM Measure-ment on Product	Calculated Product Output	Limits
7	1.2 kΩ	1 kΩ	Normal 1 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±24.0 mΩ
8	12 kΩ	1.21 kΩ	Normal 1 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±46.6 mΩ
9	12 kΩ	1.9 kΩ	Normal 1 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±61.8 mΩ
10	12 kΩ	3 kΩ	Normal 10 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±86.0 mΩ
11	12 kΩ	5 kΩ	Normal 10 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±130 mΩ
12	12 kΩ	10 kΩ	Normal 10 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±240 mΩ
13	12 kΩ	12 kΩ	Normal 10 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±284 mΩ
14	120 kΩ	12.1 kΩ	Normal 10 kΩ / Direct	N/A	N/A	N/A	kΩ	kΩ	±466 mΩ
15	120 kΩ	100 kΩ	Normal 100 kΩ / Transfer	Fluke 742A-100k	kΩ	kΩ	kΩ	kΩ	±2.4 Ω
16	1.2 MΩ	0.121 MΩ	LoI 100 kΩ/ Transfer	Fluke 742A-100k	kΩ	kΩ	kΩ	kΩ	±4.7 Ω
17	1.2 MΩ	1 MΩ	Normal 1 MΩ / Transfer	Fluke 742A-1M	MΩ	MΩ	MΩ	MΩ	±24.0 Ω
18	12 MΩ	1.21 MΩ	LoI 1 MΩ / Transfer	Fluke 742A-1M	MΩ	MΩ	MΩ	MΩ	±63.9 Ω
19	12 MΩ	10 MΩ	Normal 10 MΩ / Transfer	Fluke 742A-10M	MΩ	MΩ	MΩ	MΩ	±310.0 Ω
20	120 MΩ	12.1 MΩ	Normal 10 MΩ / Transfer	Fluke 742A-10M	MΩ	MΩ	MΩ	MΩ	±7.10 kΩ
21	120 MΩ	100 MΩ	Normal 100 MΩ / Transfer	MI 9331G/ 100 M	MΩ	MΩ	MΩ	MΩ	±40.5 kΩ

Table 10. Calibration Steps for Resistance (cont.)

Step	Product Range	Product Output	DMM Mode/ Method	Transfer Resistor	Transfer Value	DMM Measure-ment on Transfer Resistor	DMM Measure-ment on Product	Calculated Product Output	Limits
22	1.2 GΩ	0.121 GΩ	Normal 100 MΩ / Transfer	MI 9331G/ 100 M	MΩ	MΩ	MΩ	GΩ	±0.57 MΩ
23	1.2 GΩ	0.3 GΩ	Normal 1 GΩ / Transfer	N/A	Table 9, Meter error	μΩ/Ω	GΩ	GΩ	±1.27 MΩ
24	1.2 GΩ	0.4 GΩ	Normal 1 GΩ / Transfer	N/A	Table 9, Meter error	μΩ/Ω	GΩ	GΩ	±1.66 MΩ
25	1.2 GΩ	0.64 GΩ	Normal 1 GΩ / Transfer	N/A	Table 9, Meter error	μΩ/Ω	GΩ	GΩ	±2.6 MΩ
26	1.2 GΩ	1 GΩ	Normal 1 GΩ / Transfer	MI 9331G/ 1 G	Table 9, Meter error	μΩ/Ω	GΩ	GΩ	±4.0 MΩ
27	12 Ω	0 Ω	Ext. current source 100 μA	N/A	N/A	N/A			±40.0 mΩ
28	120 Ω	100 Ω	Ext. current source 100 μA	N/A	N/A	N/A			±42.2 mΩ

Volts AC Calibration (OUTPUT VZ)

Table 11 lists the required equipment.

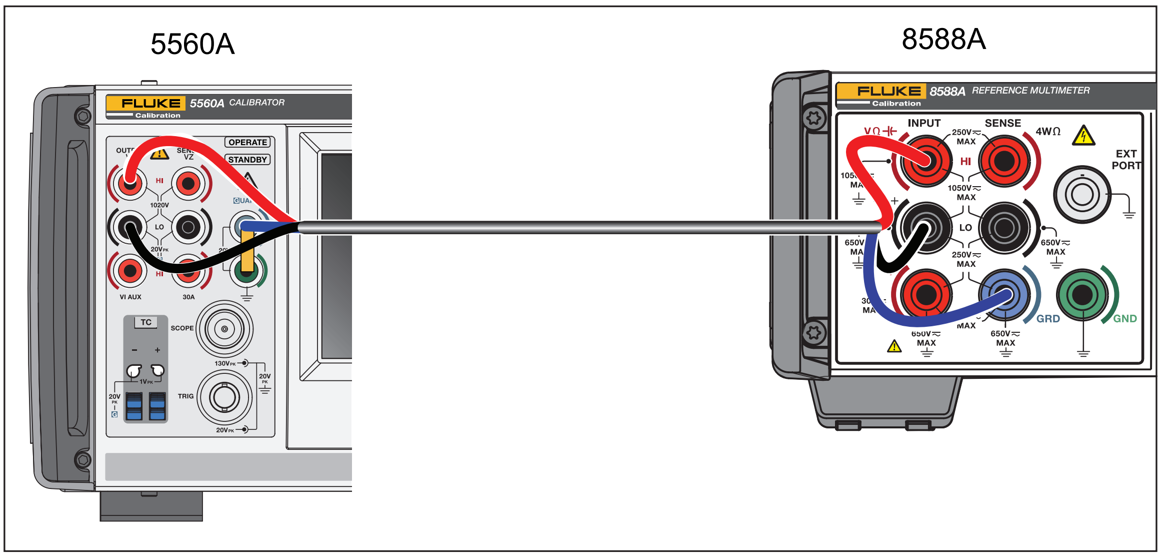
Table 11. Required Equipment Volts AC Main Output

Equipment Description	Manufacture/Model/PN	Quantity
AC Measurement Standard	Fluke 5790B	1
Digital Multimeter	Fluke 8588A	1
Double banana RG58 cable	Pomona Model 2BC-24	1
Single banana to single banana lead	Various	1

The volts ac calibration uses two methods. For frequencies ≤10 Hz low frequency DMM (Fluke 8588A) is used. For frequencies >10 Hz the calibration is accomplished with Fluke 5790B AC Measurement Standard.

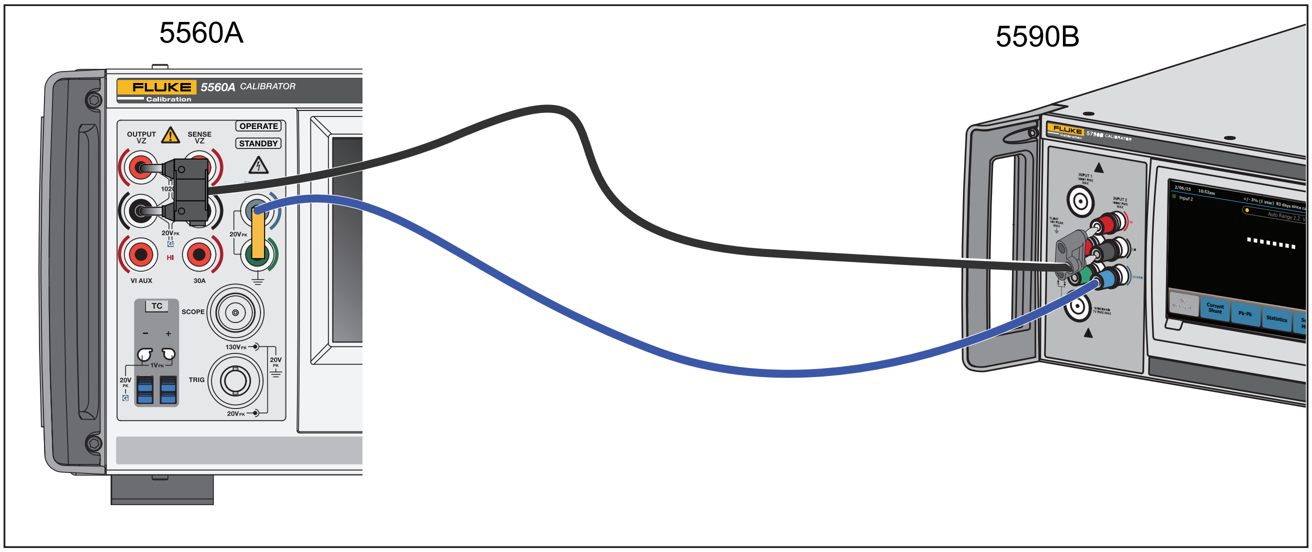
1. Set the 8588A as follows: Volts ac, Range Auto, Band Wideband, Coupling: DC 10MΩ, Guard ON (external guard).
2. Make sure that the DUT is in Standby.
3. Connect a strap between the guard and ground terminals of the DUT.
4. Complete an internal dc zero calibration on the Product.
5. Connect the 8588A to the Product as shown in Figure 17.

Figure 17. Low frequency Volts AC Calibration



6. Start with step 1 in Table 12. Set the Product to Operate. Make a measurement with the meter and record in the Calculated Product Output column.
7. Continue with step 2.
8. Complete all steps for low frequency (1 to 39).
9. Set the product to Standby.
10. Disconnect the present setup.
11. Connect the product to Fluke 5790B as shown in Figure 18.

Figure 18. Volts AC Calibration



12. Starting with step 40, make a measurement with the 5790B. Record the measurement in the Product Output column of Table 12.
13. Continue with the rest of the steps for this connection (steps 40 to 121).
14. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 12. Calibration Steps for Volts AC

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
1	12 mV	1 mV	3 Hz		±9.00 µV
2	12 mV	1 mV	5 Hz		±7.70 µV
3	12 mV	1 mV	10 Hz		±6.12 µV
40	12 mV	1 mV	1 kHz		±6.12 µV
41	12 mV	1 mV	20 kHz		±6.12 µV
42	12 mV	1 mV	50 kHz		±6.30 µV
43	12 mV	1 mV	100 kHz		±16.2 µV
44	12 mV	1 mV	300 kHz		±36.4 µV
45	12 mV	1 mV	500 kHz		±36.4 µV
4	12 mV	10 mV	3 Hz		±27.0 µV
5	12 mV	10 mV	5 Hz		±14.0 µV

Table 12. Calibration Steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
6	12 mV	10 mV	10 Hz		±7.2 µV
47	12 mV	10 mV	1 kHz		±7.2 µV
48	12 mV	10 mV	20 kHz		±7.2 µV
49	12 mV	10 mV	50 kHz		±9.0 µV
50	12 mV	10 mV	100 kHz		±27 µV
51	12 mV	10 mV	300 kHz		±94 µV
52	12 mV	10 mV	500 kHz		±94 µV
7	120 mV	12.1 mV	3 Hz		±31 µV
8	120 mV	12.1 mV	5 Hz		±15 µV
9	120 mV	12.1 mV	10 Hz		±7.4 µV
54	120 mV	12.1 mV	1 kHz		±7.4 µV
55	120 mV	12.1 mV	20 kHz		±7.4 µV
56	120 mV	12.1 mV	50 kHz		±11 µV
57	120 mV	12.1 mV	100 kHz		±28 µV
58	120 mV	12.1 mV	300 kHz		±49 µV
59	120 mV	12.1 mV	500 kHz		±49 µV
10	120 mV	100 mV	3 Hz		±207 µV
11	120 mV	100 mV	5 Hz		±77 µV
12	120 mV	100 mV	10 Hz		±18 µV
61	120 mV	100 mV	1 kHz		±18 µV
62	120 mV	100 mV	20 kHz		±18 µV
63	120 mV	100 mV	50 kHz		±36 µV
64	120 mV	100 mV	100 kHz		±84 µV
65	120 mV	100 mV	300 kHz		±190 µV
66	120 mV	100 mV	500 kHz		±190 µV
13	1.2 V	0.121 V	3 Hz		±317 µV
14	1.2 V	0.121 V	5 Hz		±155 µV
15	1.2 V	0.121 V	10 Hz		±74 µV

Table 12. Calibration Steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
68	1.2 V	0.121 V	1 kHz		±74 μV
69	1.2 V	0.121 V	20 kHz		±74 μV
70	1.2 V	0.121 V	50 kHz		±43 μV
71	1.2 V	0.121 V	100 kHz		±108 μV
72	1.2 V	0.121 V	300 kHz		±264 μV
73	1.2 V	0.121 V	500 kHz		±264 μV
16	1.2 V	1 V	3 Hz		±2.08 mV
17	1.2 V	1 V	5 Hz		±0.77 mV
18	1.2 V	1 V	10 Hz		±0.18 mV
75	1.2 V	1 V	40.01 Hz		±0.12 mV
76	1.2 V	1 V	1 kHz		±0.12 mV
77	1.2 V	1 V	20 kHz		±0.12 mV
78	1.2 V	1 V	50 kHz		±0.25 mV
79	1.2 V	1 V	100 kHz		±0.60 mV
80	1.2 V	1 V	300 kHz		±1.60 mV
81	1.2 V	1 V	500 kHz		±1.60 mV
19	12 V	1.21 V	3 Hz		±3.17 mV
20	12 V	1.21 V	5 Hz		±1.60 mV
21	12 V	1.21 V	10 Hz		±0.49 mV
83	12 V	1.21 V	1 kHz		±0.19 mV
84	12 V	1.21 V	20 kHz		±0.19 mV
85	12 V	1.21 V	50 kHz		±0.34 mV
86	12 V	1.21 V	100 kHz		±0.80 mV
87	12 V	1.21 V	300 kHz		±2.54 mV
88	12 V	1.21 V	500 kHz		±2.54 mV
22	12 V	10 V	3 Hz		±20.75 mV

Table 12. Calibration Steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
23	12 V	10 V	5 Hz		±7.75 mV
24	12 V	10 V	10 Hz		±1.50 mV
90	12 V	10 V	1 kHz		±1.20 mV
91	12 V	10 V	20 kHz		±1.20 mV
92	12 V	10 V	50 kHz		±2.45 mV
93	12 V	10 V	100 kHz		±5.73 mV
94	12 V	10 V	300 kHz		±16.6 mV
95	12 V	10 V	500 kHz		±16.6 mV
25	120 V	12.1 V	3 Hz		±31.7 mV
26	120 V	12.1 V	5 Hz		±16.0 mV
27	120 V	12.1 V	10 Hz		±4.89 mV
97	120 V	12.1 V	1 kHz		±1.89 mV
98	120 V	12.1 V	20 kHz		±1.89 mV
99	120 V	12.1 V	50 kHz		±3.40 mV
100	120 V	12.1 V	100 kHz		±8.03 mV
28	120 V	100 V	3 Hz		±208 mV
29	120 V	100 V	5 Hz		±78 mV
30	120 V	100 V	10 Hz		±15.00 mV
102	120 V	100 V	40.01 Hz		±12.00 mV
103	120 V	100 V	1 kHz		±12.00 mV
104	120 V	100 V	20 kHz		±12.00 mV
105	120 V	100 V	50 kHz		±25 mV
106	120 V	100 V	100 kHz		±57 mV
31	330 V	121 V	3 Hz		±317 mV
32	330 V	121 V	5 Hz		±160 mV
33	330 V	121 V	10 Hz		±22 mV
108	330 V	121 V	1 kHz		±22 mV
109	330 V	121 V	10 kHz		±22 mV
110	330 V	121 V	10.01 kHz		±22 mV
111	330 V	121 V	20 kHz		±22 mV

Table 12. Calibration Steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
112	330 V	121 V	50 kHz		±37 mV
113	330 V	121 V	100 kHz		±158 mV
34	330 V	330 V	3 Hz		±735 mV
35	330 V	330 V	5 Hz		±306 mV
36	330 V	330 V	10 Hz		±46 mV
115	330 V	330 V	1 kHz		±46 mV
116	330 V	330 V	20 kHz		±46 mV
117	330 V	330 V	50 kHz		±87 mV
118	330 V	330 V	100 kHz		±409 mV
37	1020 V	331 V	3 Hz		±737 mV
38	1020 V	331 V	5 Hz		±307 mV
39	1020 V	331 V	10 Hz		±118 mV
120	1020 V	331 V	1 kHz		±118 mV
121	1020 V	331 V	10 kHz		±118 mV
122	1020 V	1000 V	40 Hz		±195 mV
123	1020 V	1000 V	1 kHz		±195 mV
124	1020 V	1020 V	10 kHz		±197 mV

Volts AC Calibration (AUX Output) – 5550A and 5560A

Table 13 lists the required equipment.

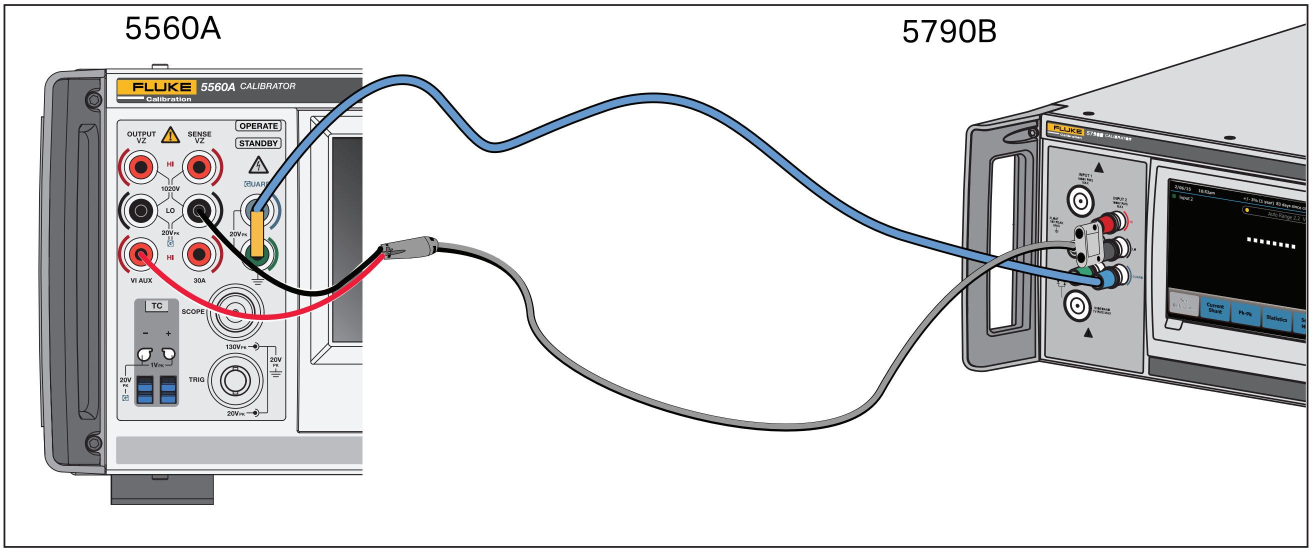
Table 13. Required Equipment Volts AC from the AUX Output

Equipment Description	Manufacture/Model/PN	Quantity
AC Measurement Standard	Fluke 5790B	1
Test Lead Banana to Banana 24 in	Pomona Model 1368-A-24	1
Single banana to single banana lead	Various	1

To proceed with volts ac out of the Sense VZ LO/Output VI AUX proceed as follows:

1. Connect the Product to Fluke 5790B as shown in Figure 19.
2. Connect a strap between the guard and ground terminals of the DUT.

Figure 19. Volts AC Out of the SENSE VZ LO/OUTPUT VI AUX Calibration



3. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
4. Start with step 1 in Table 14. Set the DUT to 1 V for the main output and Product output setting V and Hz in Table 14. Make a measurement with the 5790B. Record the measurement in the Product Output column of Table 14.
5. Continue with the rest of the steps for this connection (steps 40 to 121). The main output to remain set to 1 V for all steps.
6. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual where the acceptance limits are properly modified by your Guardbanding method.

Table 14. Calibration Steps for Volts AC Out of the AUX Output

Step	Product Output (OUTPUT VZ)	Product Output (AUX Output)	Product Frequency	Product Output	Limits
1	1 V	120 mV	45 Hz		±0.390 mV
2	1 V	120 mV	65 Hz		±0.390 mV
3	1 V	1.2 V	45 Hz		±1.20 mV
4	1 V	1.2 V	400 Hz		±1.20 mV
5	1 V	1.2 V	1 kHz		±1.20 mV
6	1 V	1.2 V	5 kHz		±2.15 mV
7	1 V	1.2 V	10 kHz		±3.95 mV
8	1 V	1.2 V	30 kHz		±45.8 mV

Table 14. Calibration Steps for Volts AC Out of the AUX Output (cont.)

Step	Product Output (OUTPUT VZ)	Product Output (AUX Output)	Product Frequency	Product Output	Limits
9	1 V	5 V	45 Hz		±4.05 mV
10	1 V	5 V	400 Hz		±4.05 mV
11	1 V	5 V	1 kHz		±4.05 mV
12	1 V	5 V	5 kHz		±7.9 mV
13	1 V	5 V	10 kHz		±15.4 mV
14	1 V	5 V	30 kHz		±188 mV

Amps AC Calibration

Table 15 lists the required equipment.

Table 15. Required Equipment for Amps AC

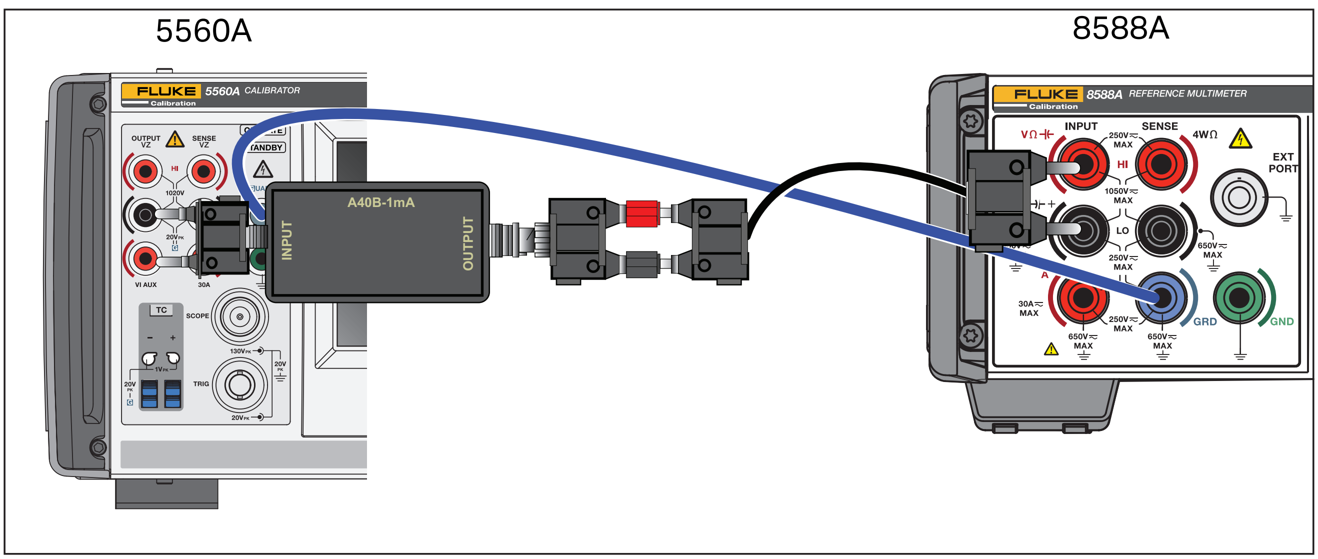
Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke 8588A	1
(1 mA to 1.2 mA)	Fluke A40B-1mA Current Shunt	1
(10 mA to 12 mA)	Fluke A40B-10mA Current Shunt	1
(100 mA to 120 mA)	Fluke A40B-100mA Current Shunt	1
(1 A to 1.2 A)	Fluke A40B-1A Current Shunt	1
3.1 A, 3.11 A	Fluke A40B-5A Current Shunt	1
10 A	Fluke A40B-10A Current Shunt	1
(12.1 A to 20 A)	Fluke A40B-20A Current Shunt	1
30 A	Fluke A40B-50A Current Shunt	1
Type N (M) to dual banana (M)	E-Z-Hook PN 9415	1
Type N (F) to Type N (F) adapter	Various	1
LC Male to LC Male adapter	A40B-ADAPT/LC	1
LC Female to N Male inter-series adapter	A40B-ADAPT/LCN	1
N to 4 mm double banana connector	A40B-LEAD/4mm	1
DBL BANANA N (M) RG58C/U (≈ 16 in)	(Fluke PN 900394) 5790-8026	1

The amps ac calibration uses two methods. For frequencies ≤10 Hz, use a low-frequency Fluke Calibration 8588A meter to monitor the output of Fluke A40B series shunts. For frequencies >10 Hz the calibration is accomplished with the Fluke Calibration 5790B AC Measurement Standard monitoring the output of the Fluke A40B series shunts.

To calibrate the amps ac function:

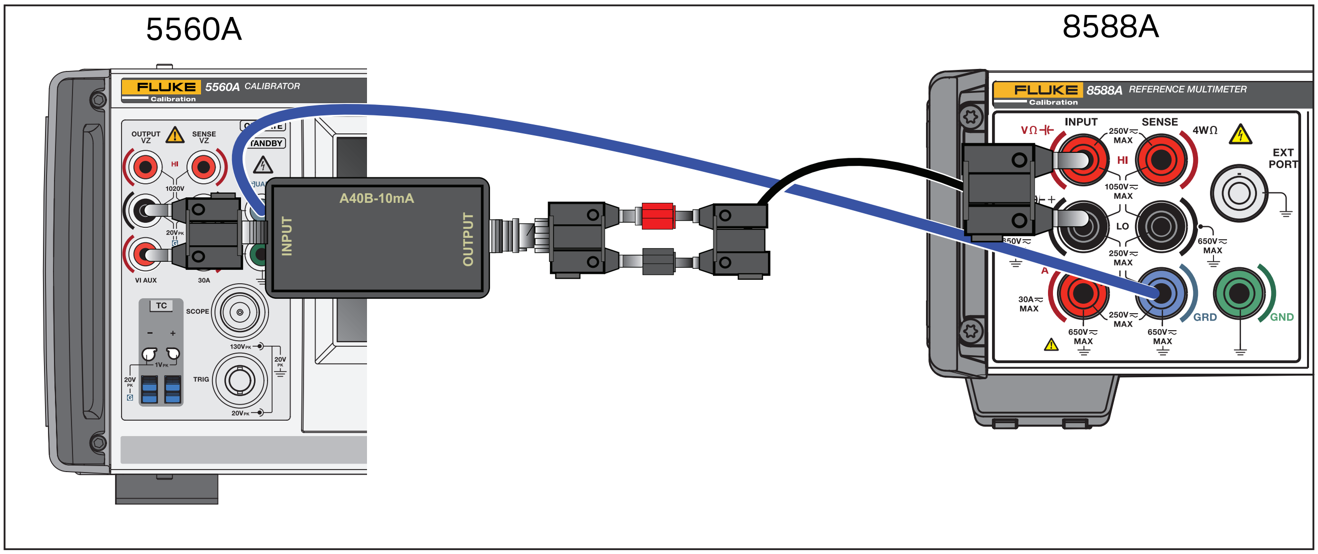
1. Set the 8588A as follows: Volts ac, Range Auto, Wide Bandwidth, Coupling: DC 10 MΩ, Guard ON (external guard).
2. Make sure that the DUT is in Standby.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. Complete an internal dc zero calibration on the Product.
5. Connect the 8588A to the Product as shown in Figure 20.
6. Make sure that the DUT is in Standby.
7. Calculate the shunt resistance in Ω from calibration records and/or regression analysis for all shunts listed in Table 16. Use the A40B series instruction manual for guidance for how to calculate shunt ac resistance for every point in the calibration record.
8. Record the shunt resistance for each step in Ω in the Shunt_R column in Table 16.
9. Toggle the power switch of the A40B-1 mA shunt to ON. Continue only if the power light is illuminated and the BATT LOW is off.
10. Start with step 1. Set the output from the DUT. Measure with the 8588A and record in the DMM Reading on Shunt Output [V] column of Table 16.
11. Continue with step 2, Table 16.
12. Complete steps 1 to 5.

Figure 20. Amps AC with A40B-1mA



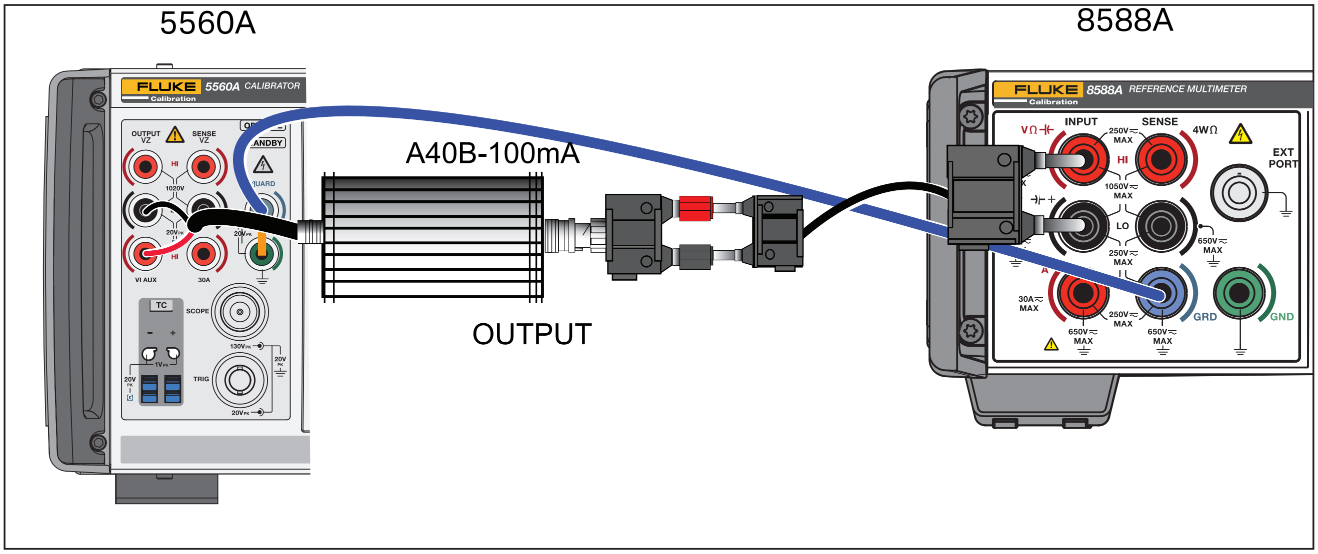
13. Disconnect the shunt output cable from the 8588A and connect it to the 5790B Input 2.
14. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
15. Connect heavy gauge guard cable between the DUT and the 5790B.
16. From step 6, Table 16, set the output from the DUT/Measure with the 5790B and record the 5790B measured in the DMM Reading on Shunt output [V] column. Complete steps 6 to 30,Table 16.
17. Set the Product to STBY.
18. Toggle the power switch of the A40B-1mA shunt to OFF.
19. Connect the test equipment as shown in Figure 21.

Figure 21. Amps AC with A40B-10mA



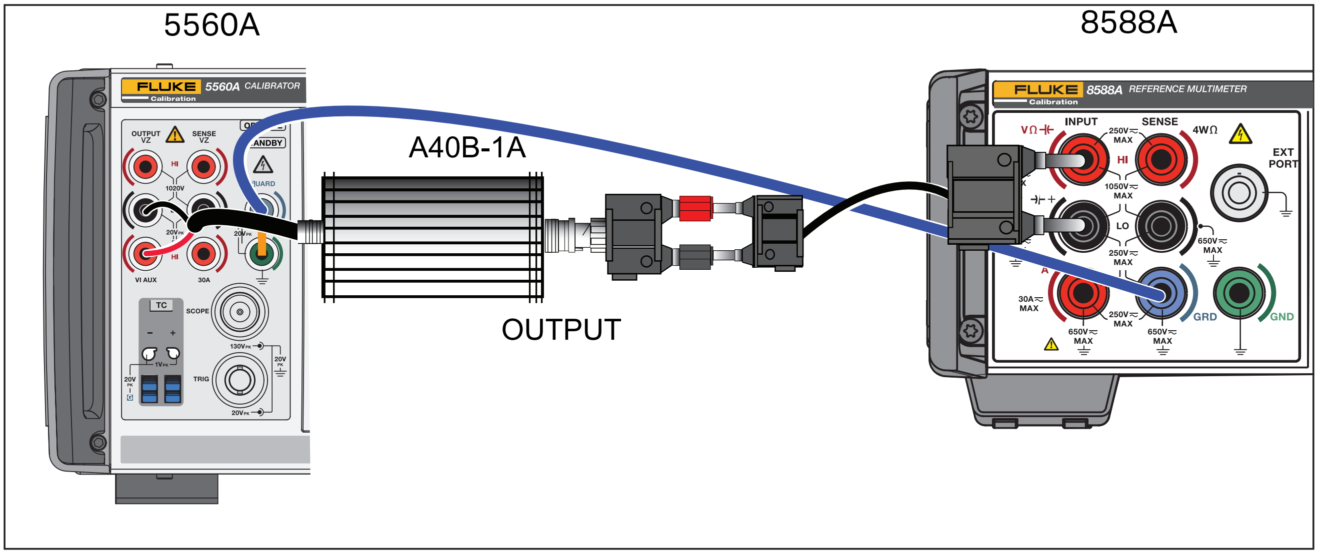
20. From step 31, Table 16, output from the DUT/Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
21. Complete steps 31 and 32.
22. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
23. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
24. Connect a heavy gauge guard cable between the DUT and the 5790B.
25. From step 33, Table 16, output from the DUT/Measure with the 5790B and record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 33 to 42, Table 16.
26. Set the product to STBY.
27. Connect the test equipment as shown in Figure 22.

Figure 22. Amps AC with A40B-100mA



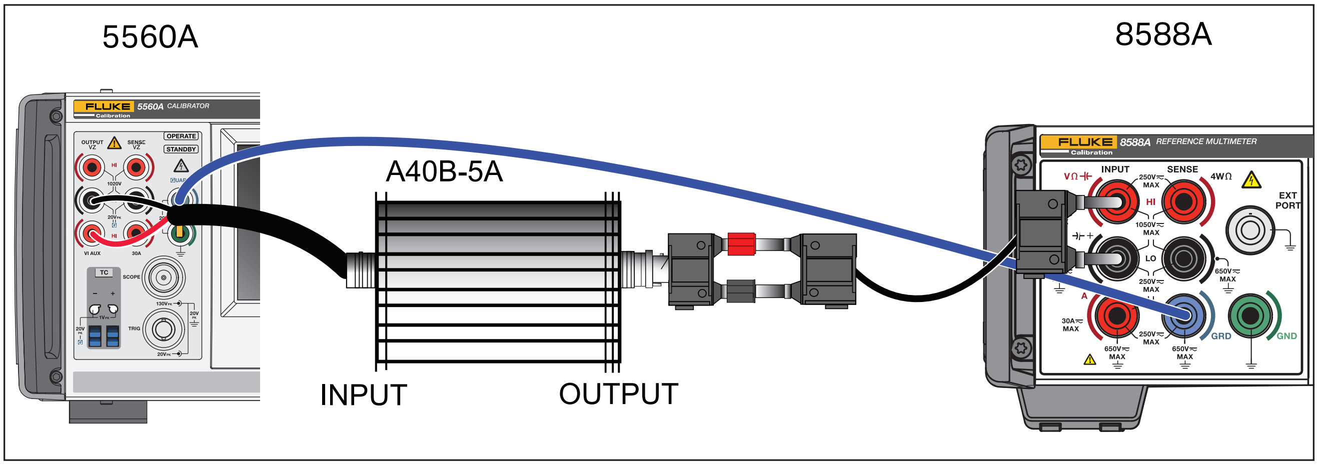
28. From step 43, Table 16, set the output from the DUT/Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
29. Complete steps 43 and 44.
30. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
31. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
32. Connect a heavy gauge guard cable between the DUT and the 5790B.
33. From step 45, Table 16, output from the DUT/Measure with the 5790B and record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 45 to 54.
34. Set the product to STBY.
35. Connect the test equipment as shown in Figure 23.

Figure 23. Amps AC with A40B-1A



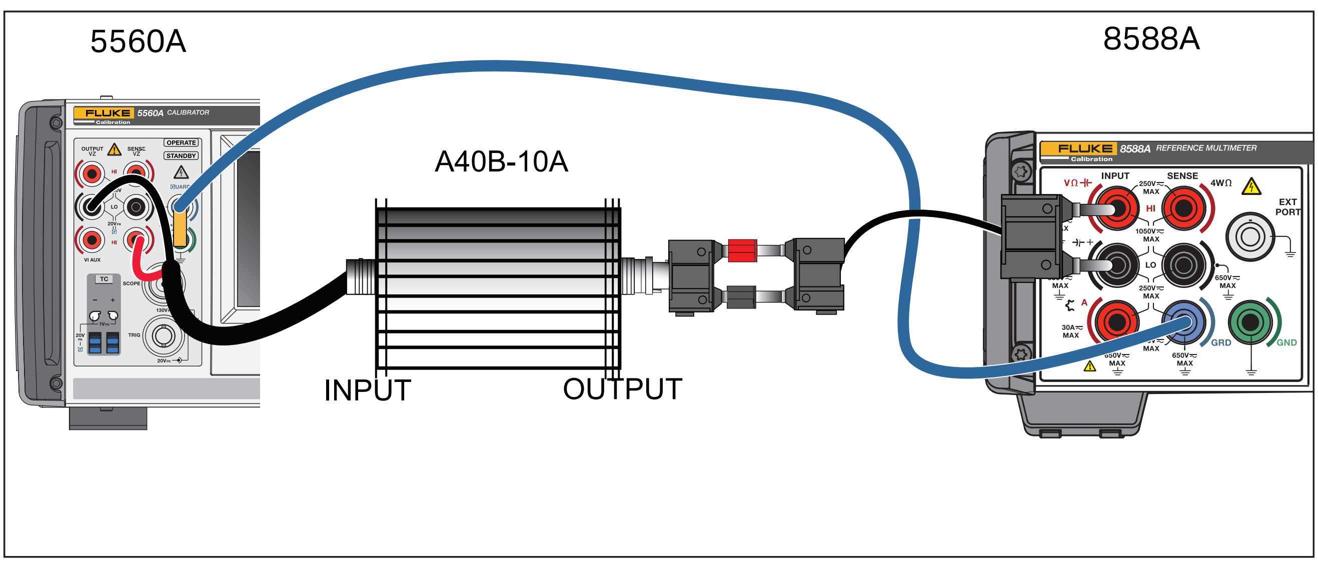
36. From step 55, Table 16, set the output from the DUT and wait 30 seconds for the output to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
37. Complete steps 55 and 56.
38. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
39. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
40. Connect heavy gauge guard cable between the DUT and the 5790B.
41. From step 57, Table 16, output from the DUT/Measure with the 5790B and record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 57 to 65.
42. Set the Product to STBY.
43. Connect the test equipment as shown in Figure 24.
44. From step 66, Table 16, output from the DUT and wait 1 minute for the output to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
45. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
46. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
47. Connect heavy gauge guard cable between the DUT and the 5790B.
48. From step 67, Table 16, output from the DUT and Measure with the 5790B. Record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 67 to 70.
49. Set the product to STBY.

Figure 24. Amps AC with A40B-5A



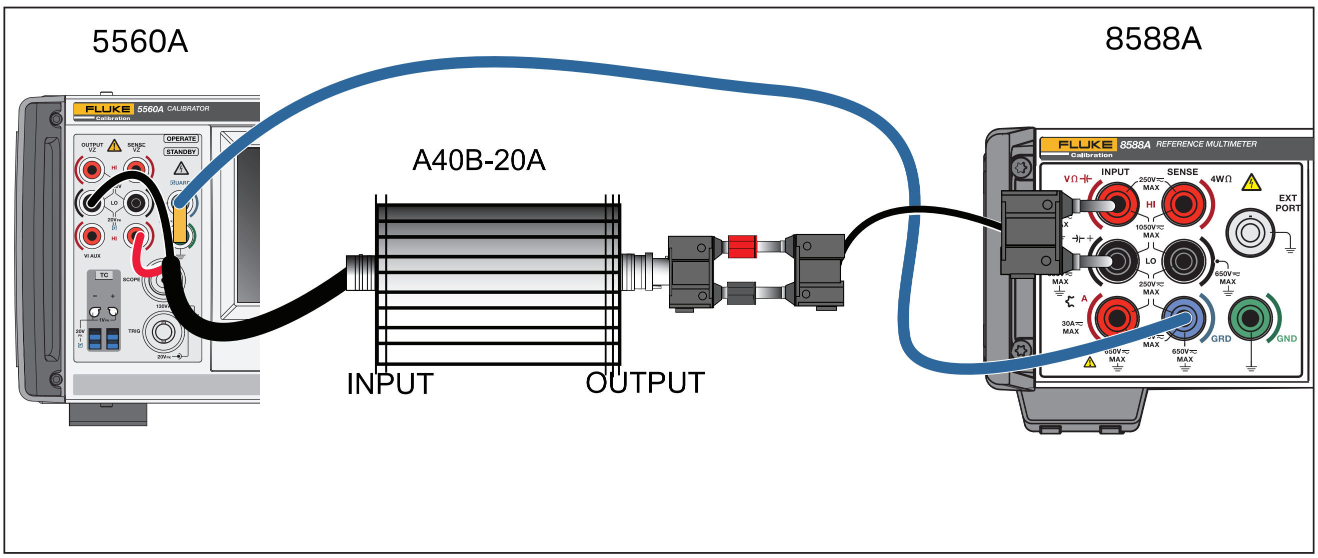
50. Move the red lead connected to the Product VI AUX to the 30 A terminal.
51. Move the connection of the shunt output to the 8588A.
52. From step 71, Table 16, output from the DUT and measure with the meter. Record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
53. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
54. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
55. Connect heavy gauge guard cable between the DUT and the 5790B.
56. From step 72, Table 16, output from the DUT and measure with the 5790B and record the measurement in the DMM Reading on Shunt Output [V] column. Complete steps 72 to 75.
57. Set the product to STBY.
58. Connect the test equipment as shown in Figure 25.

Figure 25. Amps AC with A40B-10A



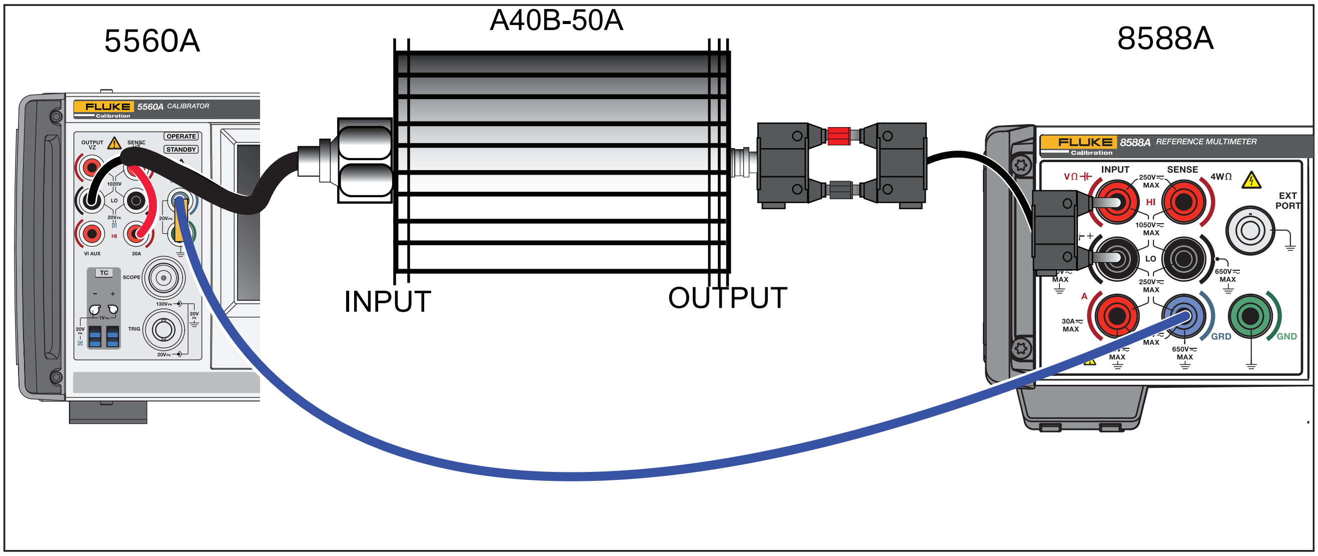
59. From step 76, Table 16, output from the DUT, wait 3 minutes for the output to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
60. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
61. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
62. Connect the heavy gauge guard cable between the DUT and the 5790B.
63. From step 77, Table 16, output from the DUT and measure with the 5790B. Record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 77 to 80.
64. Set the product to STBY.
65. Connect the test equipment as shown in Figure 26.

Figure 26. Amps AC with A40B-20A



66. From step 81, Table 16, output from the DUT and wait 3 minutes for the output to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
67. Continue with and complete step 85.
68. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
69. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
70. Connect heavy gauge guard cable between the DUT and the 5790B.
71. From step 82, Table 16, output from the DUT and measure with the 5790B. Record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 82 to 88.
72. Set the product to STBY.
73. Connect the test equipment as shown in Figure 27.

Figure 27. Amps AC with A40B-50A



74. From step 89, Table 16, output from the DUT and wait 3 minutes for the output to settle. Measure with the meter and record the 8588A measurement in the DMM Reading on Shunt Output [V] column.
75. After step 89 is complete, disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
76. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
77. Connect heavy gauge guard cable between the DUT and the 5790B.
78. From step 90, Table 16, output from the DUT and measure with the 5790B. Record the 5790B measurement in the DMM Reading on Shunt Output [V] column. Complete steps 90 to 92.
79. Set the product to STBY.
80. For all steps, calculate the Product output with the formula below. Use the appropriate conversion to convert from base units to units for the specific evaluation step.

$$\text{Calculated Product Output} = \left(\frac{\text{DMM Reading on Shunt output } [V]}{\text{Shunt\_R } [\Omega]}\right)$$

81. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual where the acceptance limits are the properly modified by your Guardbanding method.

Table 16. Calibration Steps for Amps AC

Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
1	120 µA	10 µA	3 Hz	Fluke A40B-1mA				±12.0 nA
6	120 µA	10 µA	45 Hz	Fluke A40B-1mA				±12.0 nA
7	120 µA	10 µA	1 kHz	Fluke A40B-1mA				±12.0 nA
8	120 µA	10 µA	5 kHz	Fluke A40B-1mA				±12.0 nA
9	120 µA	10 µA	10 kHz	Fluke A40B-1mA				±52.0 nA
10	120 µA	10 µA	30 kHz	Fluke A40B-1mA				±1040.0 nA
2	120 µA	100 µA	3 Hz	Fluke A40B-1mA				±30.0 nA
11	120 µA	100 µA	45 Hz	Fluke A40B-1mA				±30.0 nA
12	120 µA	100 µA	1 kHz	Fluke A40B-1mA				±30.0 nA
13	120 µA	100 µA	5 kHz	Fluke A40B-1mA				±30.0 nA
14	120 µA	100 µA	10 kHz	Fluke A40B-1mA				±160.0 nA
15	120 µA	100 µA	30 kHz	Fluke A40B-1mA				±1400 nA
3	1.2 mA	0.121 mA	3 Hz	Fluke A40B-1mA				±124 nA
16	1.2 mA	0.121 mA	45 Hz	Fluke A40B-1mA				±124 nA
17	1.2 mA	0.121 mA	1 kHz	Fluke A40B-1mA				±124 nA
18	1.2 mA	0.121 mA	5 kHz	Fluke A40B-1mA				±124 nA

Table 16. Calibration Steps for Amps AC (cont.)

Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
19	1.2 mA	0.121 mA	10 kHz	Fluke A40B-1mA				±245 nA
20	1.2 mA	0.121 mA	30 kHz	Fluke A40B-1mA				±5484 nA
4	1.2 mA	1 mA	3 Hz	Fluke A40B-1mA				±300 nA
21	1.2 mA	1 mA	45 Hz	Fluke A40B-1mA				±300 nA
22	1.2 mA	1 mA	1 kHz	Fluke A40B-1mA				±300 nA
23	1.2 mA	1 mA	5 kHz	Fluke A40B-1mA				±300 nA
24	1.2 mA	1 mA	10 kHz	Fluke A40B-1mA				±1300 nA
25	1.2 mA	1 mA	30 kHz	Fluke A40B-1mA				±9.00 µA
5	12 mA	1.21 mA	3 Hz	Fluke A40B-1mA				±1.24 µA
26	12 mA	1.21 mA	45 Hz	Fluke A40B-1mA				±1.24 µA
27	12 mA	1.21 mA	1 kHz	Fluke A40B-1mA				±1.24 µA
28	12 mA	1.21 mA	5 kHz	Fluke A40B-1mA				±1.24 µA
29	12 mA	1.21 mA	10 kHz	Fluke A40B-1mA				±2.45 µA
30	12 mA	1.21 mA	30 kHz	Fluke A40B-1mA				±14.84 µA
31	12 mA	10 mA	3 Hz	Fluke A40B-10mA				±3.00 µA
33	12 mA	10 mA	45 Hz	Fluke A40B-10mA				±3.00 µA

Table 16. Calibration Steps for Amps AC (cont.)

Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
34	12 mA	10 mA	1 kHz	Fluke A40B-10mA				±3.00 μA
35	12 mA	10 mA	5 kHz	Fluke A40B-10mA				±3.00 μA
36	12 mA	10 mA	10 kHz	Fluke A40B-10mA				±13.00 μA
37	12 mA	10 mA	30 kHz	Fluke A40B-10mA				±50 μA
32	120 mA	12.1 mA	3 Hz	Fluke A40B-10mA				±12 μA
38	120 mA	12.1 mA	45 Hz	Fluke A40B-10mA				±6 μA
39	120 mA	12.1 mA	1 kHz	Fluke A40B-10mA				±6 μA
40	120 mA	12.1 mA	5 kHz	Fluke A40B-10mA				±10 μA
41	120 mA	12.1 mA	10 kHz	Fluke A40B-10mA				±25 μA
42	120 mA	12.1 mA	30 kHz	Fluke A40B-10mA				±148 μA
43	120 mA	100 mA	3 Hz	Fluke A40B-100mA				±30 μA
45	120 mA	100 mA	45 Hz	Fluke A40B-100mA				±17 μA
46	120 mA	100 mA	1 kHz	Fluke A40B-100mA				±17 μA
47	120 mA	100 mA	5 kHz	Fluke A40B-100mA				±28 μA
48	120 mA	100 mA	10 kHz	Fluke A40B-100mA				±130 μA
49	120 mA	100 mA	30 kHz	Fluke A40B-100mA				±500 μA

Table 16. Calibration Steps for Amps AC (cont.)

Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
44	1.2 A	0.121 A	3 Hz	Fluke A40B-100mA				±0.12 mA
50	1.2 A	0.121 A	45 Hz	Fluke A40B-100mA				±0.07 mA
51	1.2 A	0.121 A	1 kHz	Fluke A40B-100mA				±0.07 mA
52	1.2 A	0.121 A	5 kHz	Fluke A40B-100mA				±0.10 mA
53	1.2 A	0.121 A	10 kHz	Fluke A40B-100mA				±0.54 mA
54	1.2 A	0.121 A	30 kHz	Fluke A40B-100mA				±0.78 mA
55	1.2 A	1 A	3 Hz	Fluke A40B-1A				±0.30 mA
57	1.2 A	1 A	45 Hz	Fluke A40B-1A				±0.25 mA
58	1.2 A	1 A	1 kHz	Fluke A40B-1A				±0.25 mA
59	1.2 A	1 A	5 kHz	Fluke A40B-1A				±0.28 mA
60	1.2 A	1 A	10 kHz	Fluke A40B-1A				±2.30 mA
61	1.2 A	1 A	30 kHz	Fluke A40B-1A				±4.30 mA
56	3.1 A	1.21 A	3 Hz	Fluke A40B-1A				±0.86 mA
62	3.1 A	1.21 A	45 Hz	Fluke A40B-1A				±0.59 mA
63	3.1 A	1.21 A	1 kHz	Fluke A40B-1A				±0.59 mA
64	3.1 A	1.21 A	5 kHz	Fluke A40B-1A				±0.66 mA
65	3.1 A	1.21 A	10 kHz	Fluke A40B-1A				±2.92 mA
66	3.1 A	3.1 A	3 Hz	Fluke A40B-5A				±1.43 mA
67	3.1 A	3.1 A	45 Hz	Fluke A40B-5A				±1.04 mA
68	3.1 A	3.1 A	1 kHz	Fluke A40B-5A				±1.04 mA
69	3.1 A	3.1 A	5 kHz	Fluke A40B-5A				±1.23 mA
70	3.1 A	3.1 A	10 kHz	Fluke A40B-5A				±6.70 mA
71	12 A	3.11 A	3 Hz	Fluke A40B-5A				±1.93 mA
72	12 A	3.11 A	45 Hz	Fluke A40B-5A				±1.25 mA
73	12 A	3.11 A	1 kHz	Fluke A40B-5A				±1.25 mA
74	12 A	3.11 A	5 kHz	Fluke A40B-5A				±1.73 mA
75	12 A	3.11 A	10 kHz	Fluke A40B-5A				±7.22 mA
76	12 A	10 A	3 Hz	Fluke A40B-10A				±4.00 mA
77	12 A	10 A	45 Hz	Fluke A40B-10A				±2.90 mA

Table 16. Calibration Steps for Amps AC (cont.)

Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
78	12 A	10 A	1 kHz	Fluke A40B-10A				±2.90 mA
79	12 A	10 A	5 kHz	Fluke A40B-10A				±3.80 mA
80	12 A	10 A	10 kHz	Fluke A40B-10A				±21.0 mA
81	30.2 A	12.1 A	3 Hz	Fluke A40B-20A				±20 mA
82	30.2 A	12.1 A	45 Hz	Fluke A40B-20A				±15 mA
83	30.2 A	12.1 A	1 kHz	Fluke A40B-20A				±15 mA
84	30.2 A	12.1 A	5 kHz	Fluke A40B-20A				±56 mA
85	30.2 A	20 A	3 Hz	Fluke A40B-20A				±26 mA
86	30.2 A	20 A	45 Hz	Fluke A40B-20A				±19 mA
87	30.2 A	20 A	1 kHz	Fluke A40B-20A				±19 mA
88	30.2 A	20 A	5 kHz	Fluke A40B-20A				±88 mA
89	30.2 A	30 A	3 Hz	Fluke A40B-50A				±34 mA
90	30.2 A	30 A	45 Hz	Fluke A40B-50A				±25 mA
91	30.2 A	30 A	1 kHz	Fluke A40B-50A				±25 mA
92	30.2 A	30 A	5 kHz	Fluke A40B-50A				±128 mA

Capacitance

Table 17 lists the required equipment.

Table 17. Required Equipment for Capacitance Calibration

Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke 8588A	1
LCR Meter	Hioki IM3533	1
Calibrator (precision current source)	Fluke 5730A	1
BNC (M) to BNC (M) 4W lead set for LCR	Various	1
Low Thermal Cables	5730A-7003	2
BNC (F) to BNC (M) Y Adapter	Pomona Model 6700	2
BNC (F) To Single Banana Plug	Pomona Model 1894	2

To calibrate the Capacitance function for values <1 mF:

1. Remove the Guard Ground strap on the Product.
2. Set the LCR meter for Cp Mode, Level 1V, Freq 1 kHz, Speed Slow.
3. Complete the OPEN/SHORT compensation of the LCR meter and lead set for two-wire measurement that includes the Y adapter and single banana plugs. Do not connect a strap between the Guard and Ground terminals of the DUT for this function.
4. Connect the LCR meter to the Product for two wire capacitance measurements.
5. From step 1, Table 18, set the LCR meter for the recommended frequency (the Product can be verified at frequencies other than specified, but the measured output varies within the specifications as a function of the frequency).
6. Select appropriate mode (Cp or Cs).
7. Output from the Product. Measure with the LCR meter and record in Table 18.

Table 18. Calibration Steps for Capacitance with LCR Meter

Step	Product Range	Product Output	Test Frequency	Calculated Product Output	Limits
1	1.2 nF	0.2 nF	1000 Hz		±2.2 pF
2	1.2 nF	1 nF	1000 Hz		±3.1 pF
3	12 nF	1.21 nF	1000 Hz		±6.3 pF
4	12 nF	10 nF	1000 Hz		±16 pF
5	120 nF	12.1 nF	610 Hz		±45 pF
6	120 nF	20 nF	610 Hz		±54 pF
7	120 nF	30 nF	610 Hz		±66 pF
8	120 nF	50 nF	610 Hz		±90 pF
9	120 nF	100 nF	610 Hz		±150 pF
10	120 nF	120 nF	610 Hz		±174 pF
11	1.2 µF	0.121 µF	100 Hz		±445 pF
12	1.2 µF	1 µF	100 Hz		±1.50 nF
13	12 µF	1.21 µF	80 Hz		±4.45 nF
14	12 µF	10 µF	80 Hz		±15.0 nF
15	120 µF	12.1 µF	20 Hz		±41 nF
16	120 µF	100 µF	20 Hz		±155 nF
17	1.2 mF	0.121 mF	5 Hz		±516 nF

8. When completed, disconnect the current setup.

The Product can source capacitance values larger than what most RCL meters can measure. To do capacitance verification on outputs >120 μF, a dc current from a precision current source and a high-speed sampling digital multimeter is necessary.

Capacitance is the product of an applied current and the ratio of the charge time to the charge voltage.

$$C = I * \frac{\Delta_t}{\Delta_v}$$

A measurement procedure for capacitance is to apply a known current across the capacitor and then measure the voltage change for a known time interval. Fluke Calibration recommended to implement the following in computer-controlled routine for consistency of results and timely sequence execution.

To proceed with this calibration:

9. Connect the precision current source, the sampling DMM (8588A) and the Product as shown in Figure 28.
10. Set the 8588A as follows:
    - Reset meter
    - Set Initiate Layer to Continuous OFF
    - Volts dc
    - Range 1 V (10 V for C ≥1.21 mF)
    - Aperture 1 ms
    - Coupling dc
    - Filter ON 100 kHz
    - Turn Calculate Statistics to ON
    - Select TRIG SETUP and set the Trigger Layer parameters:

      Trigger Event Timer

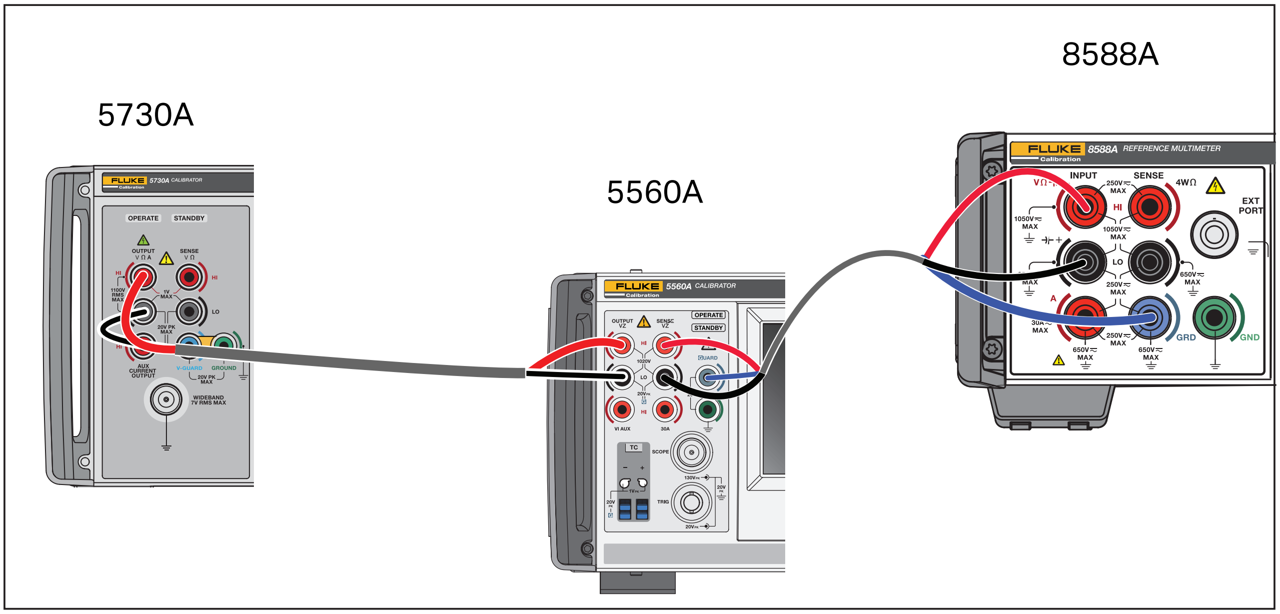
      Trigger Timer 5 s

      Trigger Count 2

      Trigger Delay: 0 s

      Delay 0
11. Set the Product to output the first point of Table 19. Set to Operate.
12. Set the current source calibrate to the DC current value in the table for each step.
13. Set to Operate and as soon as the stable LED for the current source is on, trigger the meter.
14. After the meter acquires the data (in 5 seconds), set the current source to STBY.
15. Retrieve the MIN and MAX readings from the meter acquired statistics system. Calculate (MAX - MIN) and record in Table 19 in the DMM Measurement column.
16. Continue with these steps and use the same routine. The meter setup does not have to be set again except for the statistics system. Clear the statistics between each step.

Figure 28. Capacitance Charge Connection



The Calculated Product Output is calculated with this formula:

$$Calculated\ Product\ Output = Test\_current\ * \frac{5}{\Delta_v}$$

17. Use the appropriate conversion to convert from base units to units for the specific evaluation step.
18. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 19. Calibration Steps for Capacitance Using Charge Method

Step	Product Range	Product Output	Test Current	DMM Measurement [V]	Calculated Product Output	Limits
18	1.2 mF	1 mF	90 μA			±2.5 μF
19	12 mF	1.21 mF	219.9 μA			±5.7 μF
20	12 mF	10 mF	2.199 mA			±25 μF
21	120 mF	12.1 mF	5.5 mA			±84 μF
22	120 mF	100 mF	45 mA			±480 μF

Inductance (5550A and 5560A)

Table 20 lists the required equipment.

Table 20. Required Equipment for Inductance Calibration

Equipment Description	Manufacture/Model/PN	Quantity
LCR Meter	Hioki IM3533	1
BNC (M) to BNC (M) 4W lead set for LCR	Various	1
BNC (F) To Single Banana Plug	Pomona Model 1894	4

To calibrate the Inductance function:

1. Remove the Guard Ground strap on the Product.
2. Set the LCR meter for Ls Mode, Level 1V, Freq 1 kHz, Speed Slow.
3. Complete OPEN/SHORT compensation of the LCR meter and lead set including the banana to bnc plugs. Do not connect a strap between the Guard and Ground terminals of the DUT for this function.
4. Connect the LCR meter to the product for four-wire inductance measurements.
5. Starting at step 1, Table 21, set the LCR meter for the recommended frequency (the Product can be verified at frequencies other than the specified, but the measured output varies within the specifications as a function of the frequency).
6. Select the appropriate mode (Ls or Lp).
7. Output each value from the Product. Measure with the LCR meter and record in Table 21.

Table 21. Calibration Steps for Inductance with LCR Meter

Step	Product Range	Product Output	Test Frequency	Calculated Product Output	Limits
1	120 µH	15 µH	1000 Hz		±227 nH
2	120 µH	100 µH	1000 Hz		±380 nH
3	1.2 mH	121 µH	1000 Hz		±1.13 µH
4	1.2 mH	1 mH	1000 Hz		±2.1 µH
5	12 mH	1.21 mH	110 Hz		±11.3 µH
6	12 mH	2 mH	110 Hz		±12.2 µH
7	12 mH	3 mH	110 Hz		±13.3 µH
8	12 mH	5 mH	110 Hz		±15.5 µH
9	12 mH	10 mH	110 Hz		±21.0 µH
10	12 mH	12 mH	110 Hz		±23.2 µH

Table 21. Calibration Steps for Inductance with LCR Meter (cont.)

Step	Product Range	Product Output	Test Frequency	Calculated Product Output	Limits
11	120 mH	12.1 mH	100 Hz		±113 µH
12	120 mH	100 mH	100 Hz		±210 µH
13	1.2 H	0.121 H	10 Hz		±1157 µH
14	1.2 H	1 H	10 Hz		±2.3 mH
15	12 H	1.21 H	3 Hz		±12.2 mH
16	12 H	10 H	3 Hz		±28.0 mH
17	120 H	12.1 H	2 Hz		±126.6 mH
18	120 H	100 H	2 Hz		±320 mH

8. When completed, disconnect the present setup.
9. Use the appropriate conversion to convert from base units to units for the specific evaluation step.
10. With the entire table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Thermocouple Calibration

Table 22 lists the required equipment.

Table 22. Required Equipment for Thermocouple Calibration

Equipment Description	Manufacture/Model/PN	Quantity
Calibrator (precision voltage source)	Fluke 5730A	1
Digital Multimeter	Fluke 8588A	1
Thermometer	Fluke 1504	1
Thermistor probe	Fluke 5610-9-B	1
Type J thermocouple	Omega TJ36-ICIN-18U-8-SMPW-M	1
Dewar flask with cap	Various	1
Type B copper mini-plug with copper wire	Various	1

The thermocouple function is calibrated for source and measure. The thermocouple function relies on internal sensing to offset the error caused by the temperature at the thermocouple port. Only one measurement of an actual thermocouple is required to verify the performance of the temperature sensing at the thermocouple port. The rest of the measurement verifies the linearity of the thermocouple function.

To calibrate the Thermocouple Measure function including the temperature compensation:

1. Connect a strap between the Guard and Ground terminals of the DUT.
2. Connect a characterized Type J thermocouple to the Product thermocouple port.
3. Set the Product for tc Type J measure.
4. Set the temperature compensation to internal.
5. Immerse the characterized thermocouple in a lag bath together with the thermistor probe monitored by a thermometer system.
6. Both the thermocouple and probe must be immersed to the same depth and be in close proximity.
7. Obtain calibration data for the characterized thermocouple and record its error in the Type J tc Error column of Table 23.
8. Take a measurement with the Product and record in the Product Measurement column of Table 23.
9. Take a measurement with the thermometer system and record in the Thermometer Measurement column of Table 23.
10. Calculate the Product input error as follows:

$$Product\ Input\ error = Prod_{meas} - tc_{error} - Thermometer_{meas}$$

Table 23. Type J Thermocouple Calibration

Step	Product Measurement on Type J tc [°C]	Type J tc Error from Calibration [°C]	Thermometer Measurement of Lag Bath [°C]	Calculated Product Input Error [°C]	Limits
1					±0.09 °C

To calibrate the Thermocouple Measure Function linearity with temperature compensation OFF:

1. Connect a strap between the Guard and Ground terminals of the DUT.
2. Connect a copper thermocouple mini plug with a twisted pair copper wire to the Product thermocouple port.
3. Connect the twisted pair to the Fluke 5730A OUTPT HI/LO. Observe correct polarity.
4. Disconnect the V-Guard to Ground strap on the 5730A.
5. Set the Product for tc 10 µV/°C measure.
6. Set the temperature compensation to external and 0 °C.
7. Starting with step 1,Table 24, source the voltage from the 5730A (external voltage source output equivalent).
8. Wait for the DUT to settle and then record the temperature measurement in the Product Measurement column of Table 24.
9. Calculate the Product input error as follows:

$$Product\ Input\ error\ [V] = Prod_{meas\_°C} * (10 * 10^{-6}) - 5730A_{output}$$

Table 24. 10 µV/°C Measure Thermocouple Calibration

Step	Temp	Amplitude	Func-tion	Step	Temp-erature Set Point	External Voltage Source Output Equivalent	Product Measure-ment	Calc-ulated Product Input Error [V]	Limits
1	0 °C	0 mV	Meas	1	0 °C	0 mV			±1.60 µV
2	1000 °C	10 mV	Meas	2	1000 °C	10 mV			±1.80 µV
3	-1000 °C	-10 mV	Meas	3	-1000 °C	-10 mV			±1.80 µV
4	5000 °C	50 mV	Meas	2	5000 °C	50 mV			±2.60 µV
5	-5000 °C	-50 mV	Meas	3	-5000 °C	-50 mV			±2.60 µV
6	10000 °C	100 mV	Meas	2	10000 °C	100 mV			±3.60 µV
7	-10000 °C	-100 mV	Meas	3	-10000 °C	-100 mV			±3.60 µV
8	30000 °C	300 mV	Meas	4	30000 °C	300 mV			±15.0 µV
9	-30000 °C	-300 mV	Meas	5	-30000 °C	-300 mV			±15.0 µV

To calibrate the Thermocouple Source function linearity with temperature compensation OFF:

1. Connect a strap between the Guard and Ground terminals of the DUT.
2. Connect a copper thermocouple mini plug with twisted pair copper wire to Fluke 8588A INPUT HI/ LO (observe proper polarity). Short the thermocouple mini plug under the VI AUX binding post of the 5560A.
3. Set the 8588A as follows: Volts dc, Range 100 mV, NPLC 50, Guard ON (external guard).
4. Push **ZERO**, and then **ZERO FUNC**. Allow the zero range to finish.
5. Connect the copper mini plug to the product thermocouple port.
6. Set the Product for tc 10 µV/°C source.
7. Set the temperature compensation to external and 0°C.
8. Start with step 1, Table 25, source the temperature from the Product (Product Temperature output setting).
9. Measure with the 8588A and record in the DMM Measurement on Product column of Table 24.
10. Continue with the remainder of the steps in Table 25.
11. Calculate the Product input error as follows:

$$Product\ Input\ error = DMM_{meas\_°C} - Prod_{output\ (V)}$$

Table 25. 10 µV/°C Source Thermocouple Calibration

Step	Product Temperature Output setting	Product Output Equivalent	DMM Measurement on Product	Calculated Product Output Error [°C]	Limits
1	0 °C	0 mV			±1.00 µV
2	1000 °C	10 mV			±1.16 µV
3	-1000 °C	-10 mV			±1.16 µV
4	5000 °C	50 mV			±1.80 µV
5	-5000 °C	-50 mV			±1.80 µV
6	10000 °C	100 mV			±2.60 µV
7	-10000 °C	-100 mV			±2.60 µV

12. With all steps in the table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Phase Calibration (5560A and 5550A)

Table 26 lists the required equipment.

Table 26. Required Equipment for Phase Calibration

Equipment Description	Manufacture/Model/PN	Quantity
Phase meter	Clarke-hess 6000A	1
100 mA	Fluke A40B-100mA Current Shunt	1
3 A	Fluke A40B-5A Current Shunt	1
(10 A, 12 A and 20 A)	Fluke A40B-20A Current Shunt	1
Type N (M) to dual banana (M)	E-Z-Hook PN 9415	1
Type N (F) to Type N (F) adapter	Various	1
N to 4 mm double banana connector	A40B-LEAD/4mm	1
DBL BANANA N (M) RG58C/U (≈ 16")	(Fluke PN 900394) 5790-8026	1
BNC (M) to Binding Posts	Pomona Model 1296	1
Double banana RG58 cable	Pomona Model 2BC-24 and 2BC-36	2

The phase function is calibrated for dual output voltage as well as when voltage/current are sourced out of the Product.

Dual voltage output is straightforward - the Product **OUTPUT VZ** is connected to the phase meter **REFERENCE INPUT** and the product **AUX Output** is connected to the phase meter **SIGNAL INPUT.**

To calibrate dual output V/V:

1. Connect the phase meter **REFERENCE INPUT** to the Product **OUTPUT VZ HI/LO** with the double banana RG58 cable and BNC (M) to the binding post adapter.
2. Connect the phase meter **SIGNAL INPUT** to the Product **SENSE VZ LO/VI AUX** with the double banana RG58 cable and BNC (M) to the binding post adapter. Use the same length cables for both.
3. Start with step 1, Table 27, source the specified phase with specific signal and frequency parameters from the Product.
4. Measure with the phase meter and record in the Measured Product Output column.
5. Continue with the remainder of the steps in Table 27.

Table 27. Phase Calibration Record for V/V

Step	Product Output	Product Frequency	Product Phase	Measured Product Output	Limits
1	10 V/5 V	65 Hz	0°		±0.10 °
2	10 V/5 V	65 Hz	30°		±0.10 °
3	10 V/5 V	65 Hz	45°		±0.10 °
4	10 V/5 V	65 Hz	60°		±0.10 °
5	10 V/5 V	65 Hz	90°		±0.10 °
6	10 V/5 V	65 Hz	180°		±0.10 °
7	10 V/5 V	65 Hz	270°		±0.10 °

Voltage/Current output requires the placement of a current shunt between the Product and the phase meter **SIGNAL INPUT**.

⚠ Caution

Failure to connect a shunt may result in phase meter damage.

To calibrate dual output V/I:

1. Connect phase meter **REFERENCE INPUT** to the Product **OUTPUT VZ HI/LO** with the double banana RG58 cable and the BNC (M) to the binding post adapter.
2. Connect the phase meter **SIGNAL INPUT** to the A40B-100mA shunt output with the appropriate cable and adapters.
3. Connect the shunt input to the Product **SENSE VZ LO/VI AUX** with the A40B-LEAD/4mm. Use the cable with such a length that the total length of shunt and cable is approximately the length of the cables used for the **REFERENCE INPUT**.

4. Populate Table 28 with the Shunt Phase Error. Obtain the phase error from the A40B specifications or phase calibration process.
5. Starting with step 8, Table 28, source the specified phase with the specific signal and frequency parameters from the Product.
6. Measure with the phase meter and record in the Measured Product Output column.
7. Continue with the remainder of the steps in Table 28.
8. Complete steps 8 to 19 in Table 28 for 100 mA.
9. Set the Product to STBY.
10. Replace the 100 mA shunt with the 5 A shunt. For current >3.1 A connect the shunt input to **SENSE VZ LO/30 A**.
11. Complete steps 20 and 21, Table 28.
12. Set the product to STBY.
13. Replace the 5 A shunt with the 20 A shunt.
14. Complete the remainder of the steps in Table 28.
15. Set the Product to STBY when finished.
16. Calculate the Product output as follows:

$$Product\ Product\ Output = PhaseMeter_{meas} - ShuntPhase_{error}$$

17. With all steps in the table populated, evaluate each step for compliance to limits. If Guardbanding is to be applied, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 28. Phase Calibration Record for V/I

Step	Product Output	Product Frequency	Product Phase	Shunt Phase Error	Measured Product Output	Calculated Product Output	Limits
8	10 V/0.1 A	65 Hz	0°				±0.10 °
9	10 V/0.1 A	65 Hz	30°				±0.10 °
10	10 V/0.1 A	65 Hz	45°				±0.10 °
11	10 V/0.1 A	65 Hz	60°				±0.10 °
12	10 V/0.1 A	65 Hz	90°				±0.10 °
13	10 V/0.1 A	65 Hz	180°				±0.10 °
14	10 V/0.1 A	65 Hz	270°				±0.10 °
15	10 V/0.1 A	400 Hz	90°				±0.25 °
16	10 V/0.1 A	1000 Hz	90°				±0.50 °
17	10 V/0.1 A	5000 Hz	90°				±2.5 °
18	10 V/0.1 A	10000 Hz	90°				±5.0 °
19	10 V/0.1 A	30000 Hz	90°				±10 °
20	10 V/3.11 A	65 Hz	0°				±0.10 °
21	10 V/3.11 A	400 Hz	0°				±0.25 °
22	1 V/12.1 A	65 Hz	180°				±0.10 °
23	10 V/12.1 A	65 Hz	30°				±0.10 °
24	1.21 V/20 A	65 Hz	0°				±0.10 °
25	10 V/20 A	400 Hz	90°				±0.25 °
26	250 V/0.1 A	65 Hz	90°				±0.10 °
27	250 V/0.1 A	10000 Hz	0°				±5.00 °
28	250 V/0.1 A	30000 Hz	45°				±10.00 °

Frequency Calibration

Table 29 lists the required equipment.

Table 29. Required Equipment for Frequency Calibration

Equipment Description	Manufacture/Model/PN	Quantity
Frequency Counter	Tektronix FCA3100 (Option MS or HS)	1
BNC (F) To Single Banana Plug	Pomona Model 1894	1
BNC (M) To BNC (M) cable	Various	1

To calibrate the Frequency function:

1. Set the frequency counter as follows: Frequency Input A, Gate time of 1s, Trigger on positive slope, AC Coupled, 1 MOhm Input Impedance, Amplitude 3 V.
2. Connect the frequency counter Input A to the Product **OUTPUT VZ HI/LO** with the BNC cables and adapters.
3. Set the Product to the Frequency/Amplitude in Table 30. Set to operate. Measure with the frequency counter and record the counter measured values in the Product Output Measured by Counter column.
4. Evaluate for compliance to limits. If Guardbanding is to be applied create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 30. Frequency Calibration

Step	Product Frequency	Product Amplitude	Product Output Measured by Counter	Limits
1	1000000 Hz	3 V		±7.5 Hz

Calibration Adjustment

The Product mainframe has no internal hardware adjustments. The Display prompts you through the entire calibration adjustment routine. Calibration adjustment occurs in these major steps:

1. The product sources specific output values and you measure the outputs using traceable measuring instruments of higher accuracy. The product automatically programs the outputs and prompts you to make external connections to appropriate measurement instruments.
2. At each measure and enter step, you can press the OPTIONS, and BACK UP STEP softkeys to redo a step, or SKIP STEP to skip over a step.
3. You enter the measured results either manually through the front panel keyboard or remotely with an external terminal or computer.

Note

There are automatic steps that the Product uses. No operator action is necessary for those steps.

4. The Product computes a software correction factor and stores it in volatile memory.
5. When the calibration adjustment process is complete, you are prompted to either store all the correction factors in nonvolatile memory or discard them and start over. All the routine calibration steps are available from the front panel interface as well as the remote interface (IEEE-488 or serial). Remote commands for calibration are described in the *5560A/5550A/5540A Remote Programmers Manual* located at flukecal.com.

Start the Calibration Adjustment

To begin Product calibration adjustment:

1. Tap **Setup** on the touch screen
2. Tap **Secured** under the **55x0A Adjustment** where, depending on the device being adjusted, the model is 5560A, 5550A, or 5540A.
3. The Product is protected with security passcode.To unprotect the Product, see *Calibration Security Passcode* in the Operators Manual.
4. After the Product is unprotected, the calibration adjustment procedure sequence displays:

   DCV * ACV * Frequency * DCI * DCV DCV[1] * ACI * ACV ACV[1] * Resistance

   Capacitance * Inductance[1] * TC_source * TC_meas

   Note 1: DCV DCV (Vdc out of the secondary output), ACV ACV (Vac out of the secondary output), and Inductance are not available on the 5540A.

To begin a calibration adjustment, tap on **Continue**. The firmware of the device proceeds with the first section of the calibration adjust sequence.

Volts DC Calibration Adjustment (OUTPUT VZ)

The Product begins the adjust with internal steps.Complete a Vdc Zero on the Fluke Calibration 8588A. Put a 4-wire short (Fluke PN 2540973) across the **HI** and **LO** input and sense terminals.

1. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard).
2. Push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. When the Product displays a connect prompt, connect the 8588A for vdc measurement with a low thermal cable. Table 4 is a list of equipment required. Tap **Continue** after the connection is made.
5. When the Product displays an instruction to set the Product to Operate, push **OPERATE**.

6. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units.
7. Continue to follow the on-screen instructions **OPERATE/Measure/Input Value** until all steps in the function are complete.
8. When a section is complete, the Product highlights the following section.

Volts AC Calibration Adjustment (OUTPUT VZ)

The Product begins the adjustment with internal steps. The volts ac calibration uses two methods. For frequencies ≤10 Hz, a low frequency DMM (Fluke Calibration 8588A) is used. For frequencies >10 Hz, use the Fluke Calibration 5790B AC Measurement Standard.

1. Set the 8588A as follows: Volts ac, Range Auto, Bandwidth Wide, Coupling: DC 10 MΩ, Guard ON (external guard)
2. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
3. When the Product displays a connect prompt, tap **Continue**.
4. At this time, the Product displays the amplitude/frequency.
   a. For steps with frequency ≤10 Hz, connect the 8588A for v ac measurement as per Figure 17.
   b. For steps with frequency >10 Hz connect the 5790B for Vac measurement as per Figure 18.
5. Push **OPERATE**.
6. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units.
7. Continue to follow the on-screen instructions (OPERATE/Measure/Input Value) until all steps in the function are complete. Alternate meters based on frequency of the step as for 4 a and b above.
8. When a section is complete, the Product highlights the following section.

Frequency Calibration Adjustment (OUTPUT VZ)

The frequency calibration adjustment requires a frequency counter - see Table 29 for the recommended model/requirements.

1. When the Product displays a connect prompt, connect the frequency counter Input A to the Product **OUTPUT VZ HI/LO** with the BNC cables and adapters
2. Set the frequency counter as follows: Frequency Input A, Gate time of 1s, Trigger on positive slope, AC Coupled, 1 MΩ Input Impedance, Amplitude 3 V.
3. When prompted, set to **OPERATE**.
4. Measure with the frequency counter and input the counter measured value with the touch display interface.
5. Continue with all steps for this function as in step 3 and 4.
6. When a section is complete, the Product highlights the following section.

Amps DC Calibration Adjustment

The Product begins the adjustment with internal steps. Once these internal steps complete, the Product prompts the connection of the VI Aux terminals to a current DMM. This procedure is a simplified method that does not produce the greatest TUR (Test Uncertainty Ratio). Advanced calibration laboratories can use modified methods to improve TUR. Alternatively, you can use the meter with shunts as in the calibration verification section. To proceed with the meter in amps dc mode. To use the high-accuracy mode (shunts with a meter), you must determine and connect the shunt model for each step. Failure to connect the appropriate shunt may result in shunt damage.

1. Set the 8588A as follows: Amps dc, Range Auto, NPLC 50, Guard ON (external guard).
2. When the Product displays a connect prompt, connect the 8588A for Idc measurement with a heavy gauge low thermal cable. Tap **Continue** after the connection is made.
3. When the Product displays an instruction to set the Product to Operate, push **OPERATE**.
4. Measure with the meter and input the value on the touch screen into the Enter Measured Value field. Note that the Product only accepts values in base units.
5. Continue to follow the instructions on screen for OPERATE/Measure/Input Value and/or switching to the high current output via OUTPUT LO/SENSE 30 terminals until all steps in the function are complete.
6. When a section is complete, the Product highlights the following section.

Volts DC (DCV DCV) Calibration Adjustment (Secondary Output) (5550A and 5560A)

The Product begins the adjustment with internal steps. Complete a Vdc Zero on the Fluke Calibration 8588A - put a 4-wire short (Fluke PN 2540973) across the HI and LO input and sense terminals.

1. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard).
2. Push INPUT, and then ZERO FUNC. Allow the zero function to finish.
3. When the Product shows a connect prompt, connect the 8588A for vdc measurement to the Product as instructed on the display with low-thermal cable.
4. When the Product shows an instruction to set the Product in Operate, push **OPERATE**.
5. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units. Example: a measurement output shows as 100.00000 mV, but the Product expects the value to be input in V.
6. Continue to follow the instructions on screen OPERATE/Measure/Input Value until all steps in the function are complete.
7. When a section is complete, the Product highlights the following section.

Amps AC Calibration Adjustment

The Product prompts for the connection of VI Aux terminals to a current DMM. This procedure is a simplified method that does not produce the greatest TUR (Test Uncertainty Ratio). Advanced calibration laboratories can use modified methods to improve TUR. Alternatively, one can use the meter with shunts as in the calibration verification section. To proceed, put the meter into amps ac mode. To use the high-accuracy mode (shunts with a meter), you must determine and connect the shunt model for each step. Failure to connect appropriate shunt may result in shunt damage.

1. Set the 8588A as follows: Amps ac, Range Auto, NPLC 50, Guard ON (external guard).
2. When the Product shows a connect prompt, connect the 8588A for Iac measurement with heavy-gauge low-thermal cable. Tap **Continue** after the connection is made.
3. When the Product shows an instruction to set the Product in Operate, push **OPERATE**.
4. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units. Example: a measurement output is shown as 12.100 mA, but the Product expects the value to be input in A.
5. Continue to follow the on-screen instructions for OPERATE/Measure/Input Value and/or switching to the high-current output via OUTPUT LO/SENSE 30 terminals until all steps in the function are complete.
6. When a section is complete, the Product highlights the following section.

Volts AC (ACV ACV) Calibration Adjustment (Secondary Output) (5550A and 5560A)

Use the Fluke Calibration 5790B AC Measurement Standard to accomplish the volts ac calibration adjustment.

1. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
2. When the Product shows a connect prompt, tap **Continue**.
3. Push **OPERATE** to set the Product to operate.

4. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units. Example: a measurement output is shown as 12.0000 mV, but the Product expects the value to be input in V.
5. Continue to follow the on-screen instructions OPERATE/Measure/Input Value until all steps in the function are complete. Alternate meters based on frequency of the step as for 4 a and b.
6. When a section is complete, the Product highlights the following section.

Resistance Calibration Adjustment

The Product begins the adjustment with internal steps.

Once the internal steps complete, the Product prompts for the connection of a DMM configured for resistance measurements.

1. Connect the meter to the Product for four-wire measurement.
2. Observe the Product calibration adjust value - this drives the required meter range.
3. Set the 8588A as follows: Four Wire Resistance, Range *, NPLC 50, LoI OFF, Guard ON (external guard).
4. Temporarily set the 8588A as follows: Volts dc. These prevents tripping the calibrator to STBY, when the calibrator is set to OPERATE.
5. When the Product shows an instruction to set the Product in Operate, push **OPERATE**.
6. Change the 8588A to the resistance function - all previous setups are preserved.
7. Measure with the meter and input the value on the touch screen in the **Enter Measured Value** field.
8. Continue to follow on-screen instructions for OPERATE/Measure/Input Value until all steps in the function are complete. Note that the subsequent steps require the meter to be in LoI mode (LoI ON): 121 kΩ, 1.21 MΩ.
9. When a section is complete, the Product highlights the following section.

Capacitance Calibration Adjustment

The Product begins the adjustment with a prompt to input the ambient temperature - use the laboratory temperature at the time of the adjustment.

After the ambient temperature entry, the Product requests an LCR meter connection. Do not connect the LCR meter to the DUT at this time.

To proceed:

1. Set the LCR meter for Cp Mode, Level 1V, Freq 1 kHz, Speed Slow.
2. Complete ZERO/SHORT compensation of the LCR meter and the lead set for two-wire measurement when the two-wire setup, including the Y adapter and single banana plugs, is connected.
3. Do not connect a strap (remove strap) between the Guard and Ground terminals of the DUT for this function.
4. Connect the LCR meter to the Product for two-wire capacitance measurements.
5. Tap **Continue** to go to the first adjustment point.
6. For each step, refer to Table 31 for test frequency setup.

Table 31. Calibration Adjust Steps for Capacitance with LCR meter

Step	Product Output	Test Frequency
1	0.2 nF	1000 Hz
2	1 nF	1000 Hz
3	1.21 nF	1000 Hz
4	10 nF	1000 Hz
5	12.1 nF	610 Hz
6	20 nF	610 Hz
7	30 nF	610 Hz
8	50 nF	610 Hz
9	100 nF	610 Hz
10	120 nF	610 Hz
11	0.121 µF	100 Hz
12	1 µF	100 Hz
13	1.21 µF	80 Hz
14	10 µF	80 Hz
15	12.1 µF	20 Hz
16	100 µF	20 Hz
17	0.121 mF	5 Hz
18	1 mF	5 Hz
19	1.21 mF	2 Hz
20	10 mF	2 Hz
21	12.1 mF	1 Hz
22	100 mF	1 Hz

7. Set the LCR meter test frequency.
8. Push **OPERATE** to set the Product to Operate.
9. After the LCR meter measurement settles, input the measurement in the Enter Measurement Value window on the Product.
10. Complete steps 6 to 9 until you complete all points in the sequence.
11. Alternatively, steps 18 to 22 can be measured with the charge method - follow the instructions in the calibration verification section.
12. When a section is complete, the Product highlights the following section.

Inductance Calibration Adjustment

The Product begins with a prompt to connect an LCR meter. Do not connect the LCR meter to the DUT at this time. Proceed as follows.

1. Set the LCR meter for Ls Mode, Level 1 V, Freq 1 kHz, Speed Slow.
2. Complete ZERO/SHORT compensation of the LCR meter and the lead set for four-wire measurement when the single banana plugs are connected. Do not connect a strap (remove strap) between the Guard and Ground terminals of the DUT for this function.
3. Connect the LCR meter to the Product for four-wire inductance measurements.
4. For each step, refer to Table 32 for the test frequency setup.

Table 32. Calibration Steps for Inductance with LCR Meter

Step	Product Output	Test Frequency
1	15 μH	1000 Hz
2	100 μH	1000 Hz
3	121 μH	1000 Hz
4	1 mH	1000 Hz
5	1.21 mH	110 Hz
6	2 mH	110 Hz
7	3 mH	110 Hz
8	5 mH	110 Hz
9	10 mH	110 Hz
10	12 mH	110 Hz
11	12.1 mH	100 Hz
12	100 mH	100 Hz
13	0.121 H	10 Hz

Table 32. Calibration Steps for Inductance with LCR Meter (cont.)

Step	Product Output	Test Frequency
14	1 H	10 Hz
15	1.21 H	3 Hz
16	10 H	3 Hz
17	12.1 H	2 Hz
18	100 H	2 Hz

5. Push OPERATE to set the Product to Operate.
6. After the LCR meter measurement settles, input the measurement in the Enter Measurement Value window on the Product display.
7. Continue with steps 5 to 8 until you complete all points in the sequence.
8. When a section is complete, the Product highlights the following section.

TC Source Calibration Adjustment

The Product begins the adjustment with internal steps. While internal steps are in progress, continue as follows:

1. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard OFF (internal guard).
2. Connect Type B copper mini-plug with copper wire to the meter for vdc measurements. Short the plug at the **VI AUX** terminal of the Product. Allow 3 minutes for thermal dissipation.
3. Push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
4. When the Product shows a connect prompt, connect the 8588A for vdc measurement to the product **TC INPUT/OUTPUT** as instructed on the Display with the mini-plug.
5. When the Product shows an instruction to set the Product in Operate, push **OPERATE**.
6. Measure with the meter and input the value on the touch screen in the Enter Measured Value field. Note that the Product only accepts values in base units. Example: a measurement output shows as 60.00000 mV, but the Product expects the value to be input in V.
7. Follow the on-screen instructions for OPERATE/Measure/Input Value until all steps in the function are complete.
8. When a section is complete, the Product highlights the following section.

TC Measure Calibration Adjustment

The Product begins the adjustment with a prompt to connect to a vdc calibrator.

1. Connect the Type B copper mini-plug with copper wire between a calibrator and the Product TC INPUT/OUTPUT. Allow 3 minutes for thermal dissipation.
2. Tap **Continue**.
3. Follow the on-screen instructions to apply the specific amplitude to the Product.
4. Wait for the calibrator to settle and tap **Continue**.
5. Follow the on-screen instructions until all steps that require calibrator output are complete.
6. When prompted, connect a characterized Type J thermocouple to the Product.
7. The characterized thermocouple should be immersed in a lag bath together with the thermistor probe monitored by a thermometer (thermometer system).
8. Both the thermocouple and the probe have to be immersed to the same depth and be in close proximity.
9. Obtain calibration data for the characterized thermocouple Type J in error from nominal near ambient - tcerror.
10. Take a measurement with the thermometer system - $Thermometer_{meas.}$
11. Calculate the Thermometry System output as:

    $Standard\ temperature = Thermometer_{meas} - tc_{error}$

12. When prompted by the Product, input the calculated standard temperature. The display prompts for Abort or Save. Tap **Save**.

This concludes the calibration adjustment of the Product.

Maintenance

This section explains how to perform the routine maintenance and calibration task required to keep a normally-operating Calibrator in service.

⚠⚠ Warning

To prevent possible electrical shock, fire, or personal injury:

- **Disconnect the mains power cord before you remove the Product covers.**
- **Remove the input signals before you clean the Product.**
- **Use only specified replacement parts.**
- **Use only specified replacement fuses.**
- **Have an approved technician repair the Product.**
- **Do not operate the Product with covers removed or the case open. Hazardous voltage exposure is possible.**

Clean the Product

Clean the case, front-panel keys, and Display with a soft cloth slightly dampened with a mild detergent solution that is not harmful to plastics.

⚠Caution

Do not use aromatic hydrocarbons or chlorinated solvents for cleaning. They can damage the plastic materials used in the Product.

Replace the Mains Power Fuse

Access the fuses from the rear panel. The correct fuse rating for each operating voltage is shown on the label to the right of the fuse compartment.

⚠⚠ Warning

To prevent possible electric shock, fire, or personal injury:

- **Turn the Product off and remove the mains power cord. Stop for two minutes to let the power assemblies discharge before you open the fuse door.**
- **Use only specified replacement fuses, see the back of the Product for the correct replacement fuse.**

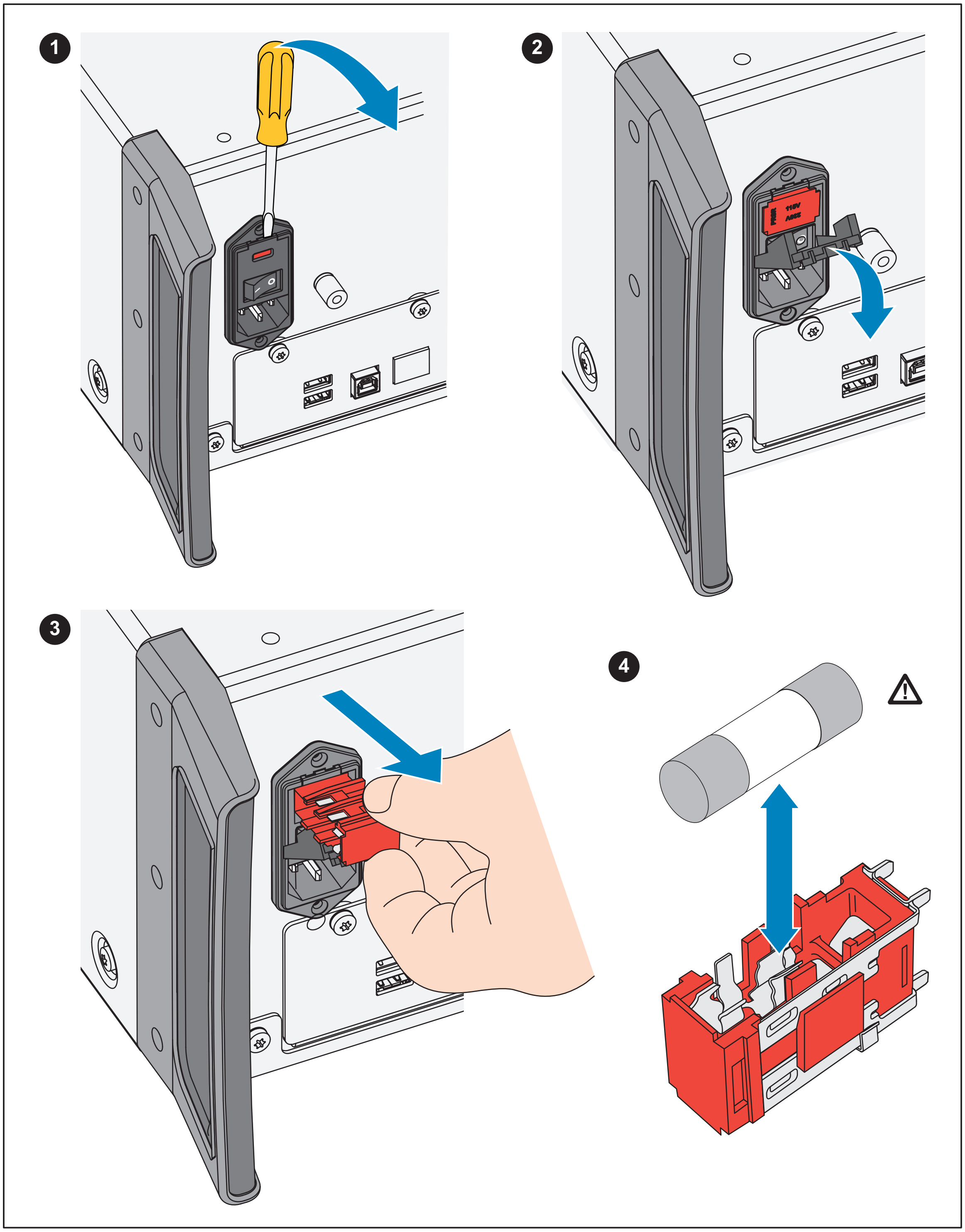
To check or replace the fuse, refer to Table 33 and Figure 29 and proceed as follows:

1. **Disconnect line power**.
2. Open the fuse compartment by inserting a flat screwdriver blade into the tab located at the top of the compartment door and gently pry until it can be removed with the fingers.
3. Remove the fuse from the compartment for replacement or verification.
4. Install the fuse. Make sure the correct fuse is installed.
5. Push the fuse compartment door back into place until the tab locks.

Table 33. Replacement Fuses

Line Voltage Range	Fuse Description	Fluke Calibration Part Number
100 V - 120 V	T 5.0 A 250 V	109215
220 V - 240 V	T 2.5 A 250 V	851931

Figure 29. Access the Fuse



Replaceable Parts

The Product has limited user-replaceable parts available. Due to design, there are hazards associated with repair and replacement of parts internal to the chassis. Service down to a Printed Circuit Assembly (PCA) level should only be performed by a Fluke Calibration Authorized Service Center.

Units found to be unable to adjust within specification or exhibit error codes during diagnostics indicate that the Product will require service and should be returned to a Fluke Calibration Authorized Service Center for troubleshooting and repair.

Use the items in Table 34 to identify some of the parts in Figure 30. Note that not all parts are shown in the figure. Electronic components may be ordered directly from Fluke Calibration and its authorized representatives with the Fluke part number. See *Contact Fluke Calibration*.

Table 34. Replaceable Parts

Item Sequence	Description	Fluke Calibration Part Number	Quantity
14	5080A-8006,HANDLE,4U	3468705	4
15	5560A-2011,TERMINAL BLOCK	4844092	1
16	5560A-2010,FRONT PANEL,PLASTIC	4844089	1
17 (not shown)	5560A-2702,ENCODER MODULE	4937780	1
18	5560A-8003,TERMINAL DECAL	4844160	1
19	5560A-2701-01,BINDING POST- RED	4884440	4
20	5560A-2701-02,BINDING POST- BLACK	4884457	2
21	5560A-2701-04,BINDING POST- GREEN	4884478	1
22	5560A-2701-03,BINDING POST- BLUE	4884469	1
23	CONNECTOR,ADAPTER,C0AXIAL,N(F),SMA(F),BULKHEAD MOUNT,BULK	1279066	1
24	5560A-2012,LIGHT RING COVER	4844108	1
25	5560A-8008,KEYPAD	4937744	1
26	5560A-8009,ENCODER WHEEL	4937842	1
27	5560A-8010,DISPLAY	4937863	1
28	5730A-2012,KNOB,ENCODER	4219600	1
29	5560A-8002,USB/LOWER DECAL	4844151	1
31 (not shown)	FUSE,.25X1.25,5A,250V,SLOW	109215	1
32	POWER ENTRY MODULE,6A,250V,FILTER,FUSE,DPST SWITCH,FLANGE MT,.187TABS,SHIELDED	4355075	1
33	FILTER,LINE,5A/250V,CHASSIS MOUNT,.250 SPADE TERMINALS,64X34MM	5276811	1
34 (not shown)	5440A-8198-01,BINDING POST,STUD,PLATED	102707	1

Table 34. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
35 (not shown)	WASHER LOCK INTRNL STL .267ID	110817	1
36 (not shown)	NUT,HEX,JAM,1/4-28,7/16IN,5/32IN H,BRASS	5569321	1
37 (not shown)	5440A-8197-01,BINDING HEAD,PLATED	102889	1
38 (not shown)	5560A-6501,POWER TRANSFORMER	4944989	1
39 (not shown)	5520A-3013,SHIM,TRANSFORMER	625985	1
40 (not shown)	SCREW,HK M4-0.7X8MM,STEEL,PLAIN,LOW HEAD SOCKET CAP SCREW,W/SELF LOCKING PATCH	3472154	21
43 (not shown)	5560A-8007,NUT, #10, LOW THERMAL	4859582	16
44 (not shown)	WASHER,LOCK,EXT TOOTH,#10 SCREW,.204IN ID,.395IN OD,.018IN THK,PHOS BRONZE	4884555	8
45 (not shown)	WASHER,FLAT,#10 X.5IN OD,.04IN THK,GRADE C-110,COPPER	4884543	8
46 (not shown)	CABLE ASSEMBLY,USB 2.0,USB A(M) TO USB MINI-B(M),SHIELDED,EXTRA-FLEX,12.00 L	3346686	1
48 (not shown)	5730A-4401,INLET HARNESS	4308875	1
49 (not shown)	5730A-4402,INLET WIRE	4308882	1
50 (not shown)	5730A-4403,INLET WIRE	4308894	1
51 (not shown)	5730A-4404,GROUND WIRE	4308907	1
5 (not shown)	5730A-4405,GROUND WIRE	4308918	1
53 (not shown)	CABLE ACCESSORY,CABLE ACCESS,TIE,4.00L,.10W,.75 DIA	172080	3
54 (not shown)	5560A-2003,FAN BRACKET	4844014	1
55	5560A-2002,GUARD BOX COVER	4844006	1
56	5560A-2008,FRONT PANEL	4844061	1
57	5560A-2004,REAR PANEL	4844023	1
58	5560A-2005,TOP COVER	4844038	1
59	5560A-2006,BOTTOM COVER	4844045	1
60	5560A-2009,FRONT COVER, GUARD BOX	4844077	1
61 (not shown)	5560A-2023,FRONT LCD MOUNT	4937726	1
62	5560A-2001,CHASSIS	4843996	1
63 (not shown)	5560A-8016,LCD CUSHION, BACK	4966029	1
64 (not shown)	CONNECTOR ACC,CONN ACC,COAX,BNC,LOCKWASHER	622743	2

Table 34. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
65 (not shown)	CONNECTOR ACC,CONN ACC,COAX,BNC,NUT	622719	2
66 (not shown)	57LFC-4402,TRANSFORMER GROUND CABLE	2095956	1
67 (not shown)	WASHER FLAT.219 ID.506 OD.061 THK STEEL ZINC-CHROMATE	2565513	4
68 (not shown)	SCREW,MODIFIED	660933	4
69	NUT HEX ELASTIC STOP STL 10-32.375	944350	4
70 (not shown)	SCREW,6-32 X 1/4IN,PAN HEAD,PHILLIPS,STEEL,ZINC PL,PATCH LOCK	152140	4
71	SCREW,M4-0.7X6MM,PHILLIPS,PAN HEAD,STEEL,ZINC PLATED,W/SELF LOCKING PATCH	3472262	26
72 (not shown)	SCREW,M3X0.5,8MM,PAN,PHILLIP,STEEL,ZN-CHROMATE,ROHS COMPL.	2803610	19
73 (not shown)	SCREW,4-14,.375,PAN,PHILLIPS,STEEL,ZINC-ROHS CLEAR,THREAD FORM	448456	9
74	CONNECTOR,CONN,COAX,BNC(F),CABLE	412858	1
75 (not shown)	SCREW,M2 X 0.4,3MM,PAN.PHILLIPS,STEEL,ZINC-CHROMATE	2568619	2
76	SCREW,M3-0.5 X 8MM,PHILLIPS FLAT HEAD,DIN 965,STEEL,ZINC PL,W/SELF LOCKING PATCH	3472058	23
77	5560A-2014,TCOUPLE LEVER	4844124	2
78 (not shown)	5560A-2015,TCOUPLE COVER	4844136	1
80	5700A-2043-01,BOTTOM FOOT, MOLDED, GRAY #7	868786	4
81 (not shown)	SPRING,COMPRESSION,0.24IN OD,1.75IN L,0.02IN WIRE,1.5LB/IN,MUSIC WIRE	5272855	2
82 (not shown)	5520A-2026,TRANSFORMER COVER, PAINTED	647138	1
83 (not shown)	5560A-8015,DISPLAY CABLE SHIELD/BRACKET	4962599	1
87	5522A-8002,RETAINER, ANALOG TOPCOVER	3472691	2
89 (not shown)	NUT,HEX,K-LOCK,6-32,.140IN THK,5/16IN AF,EXT TOOTH LOCK WASHER,STEEL	152819	2
90 (not shown)	5560A-2501,FAN ASSEMBLY	4937839	1
91 (not shown)	TAPE,TAPE,FOAM,VINYL,.500,.125	330449	1.666
92 (not shown)	SCREW,M3-0.5 X 10MM L,SOCKET HEAD CAP SCREW,STEEL,ZINC,PATCH LOCK	4603503	4

Table 34. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
93	SCREW,M3X0.5,6MM,PAN HEAD,PHILLIPS,STEEL,ZINC-CHROMATE,S-L NYLON PATCH	3783203	25
94	WT-630564,TILT STAND	2650711	2
95 (not shown)	5560A-8012,LCD CUSHION	4937759	1
97 (not shown)	SPRING,BELLEVILLE,FOR 1/4IN BOLT,.258 ID,.563 OD,.043 THK,.068 H,STEEL,ZINC CLR	5194811	4
98 (not shown)	FOAM PAD,URETHANE,.250 IN X.375 IN X .062 IN THK,ADHESIVE	2567386	6
99	5560A-2027,XFRMR BRACE	5334517	1
100	5560A-2028,BRACE INSULATOR PLATE	5334521	1
101 (not shown)	MAGNETIC MATERIAL,ROUND CABLE EMI SUPPRESSOR,265OHMS@100MHZ,12.7MM CABLE,30X40MM	5383876	1
102 (not shown)	FTCL-8001-01,LABEL,CALIB, CERTIFICATION SEAL,COC REPORT NEED/BATCH	802306	1
103	WASHER,SHOULDER,.118 ID,.250 OD,.070 L,NYLON	485417	4

Figure 30. Replacement Parts