

5560A/5550A/5540A/5530A

Calibrator

Service Manual

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Table of Contents

Title	Page
Introduction.....	1
Contact Fluke Calibration	2
Product-Use Information.....	2
Safety Information	3
Specifications	3
Service Information.....	3
Operation Overview.....	3
Local Operation	3
Remote Operation (GPIB)	3
Remote Operation (RS-232).....	3
Remote Operation (USBTMC).....	4
Remote Operation (Ethernet)	4
Prepare the Product for Operation	4
Theory of Operation.....	4
System Architecture.....	4
Out-guard.....	4
In-guard	5
A14 Output Switching	5
A3 Motherboard	5
A4.....	5
A5 Impedance	6
A6 DDS	6
A7 Current.....	6
A8 High Voltage	6
A12 Supply.....	6
Calibration and Verification of the Product	7
Warmup Procedure for All Verification Tests.....	7
Determine Specification Limits for other Adjustment Intervals	10
Applying Guardbands to Specification Limits	10
Volts DC Calibration and Verification (OUTPUT VZ).....	12
Volts DC Calibration and Verification (AUX Output) (5530A, 5550A, and 5560A)	15
Amps DC Calibration and Verification	17
Resistance Calibration and Verification	26
Volts AC Calibration and Verification (OUTPUT VZ)	33

AC Power. Volts AC Calibration and Verification (OUTPUT VZ) (5530A, 5550A and 5560A)	39
Volts AC Calibration and Verification (AUX Output) (5530A, 5550A, and 5560A)	40
ACV ACV. Volts AC Calibration and Verification (AUX Output) (5530A, 5550A and 5560A)	42
Amps AC Calibration and Verification	42
AC Power. Amps AC Calibration and Verification (5530A, 5550A and 5560A)	54
Capacitance Calibration and Verification	58
Inductance Calibration and Verification (5550A and 5560A)	62
Thermocouple Calibration and Verification	63
Phase Calibration and Verification (5530A, 5550A, and 5560A)	66
Frequency Calibration and Verification	69
Adjustment	70
Start the Adjustment	70
Volts DC Adjustment (OUTPUT VZ)	71
Volts AC Adjustment (OUTPUT VZ)	71
Frequency Adjustment (OUTPUT VZ)	72
Amps DC Adjustment	72
Volts DC (DCV DCV) Adjustment (Secondary Output) (5530A, 5550A, and 5560A)	72
Amps AC Adjustment	73
Volts AC (ACV ACV) Adjustment (Secondary Output) (5530A, 5550A, and 5560A)	73
Resistance Adjustment	74
Capacitance Adjustment	74
Inductance Adjustment	76
TC Source Adjustment	77
TC Measure Adjustment	78
Oscilloscope Calibration Option (600M, 1G, and 2G) Calibration, Verification, and Adjustment	78
Required Equipment for Calibration, Verification, and Adjustment	78
Scope Option Calibration and Verification	79
DC Voltage Calibration and Verification	79
DC Voltage Signal into 1 M Ω Calibration and Verification	80
DC Voltage Signal into 50 Ω Calibration and Verification	82
AC Voltage Amplitude Calibration and Verification	83
AC Voltage Signal into 1 M Ω Calibration and Verification	83
AC Voltage Signal into 50 Ω Calibration and Verification	87
Waveform Generator Calibration and Verification	89
Low Frequency Leveled Sine Flatness Calibration and Verification	96
Leveled Sine Reflection Coefficient Calibration and Verification	111
Edge Rise Time Calibration and Verification	117
Pulse Width Calibration and Verification	119
Time Marker Period Calibration and Verification	119
Measure Resistance Calibration and Verification	120
Measure Capacitance Calibration and Verification	121
Scope Option Adjustment Setup	122
Scope Option Adjustment	122

Before Scope Option Adjustment.....	123
DC Voltage Adjustment.....	125
AC Voltage Adjustment.....	126
Edge Measurement Adjustment.....	130
Leveled Sine Wave Adjustment	131
Resistance Adjustment	136
Maintenance	138
Product Disposal.....	138
Scope Option Maintenance	138
Replaceable Parts	138

Introduction

The 5560A/5550A/5540A/5530A 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 μ A to 30.2 A
- AC waveforms include sine wave and square wave.
- Synthesized Resistance values from a short circuit to 1200 M Ω
- Synthesized Capacitance values from 220 pF to 120 mF
- Synthesized Inductance values from 12 μ H to 120 H (Inductance not available on 5540A or 5530A).
- 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/5530A.
- 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.fluke.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 *5560A/5550A/5540A/5530A Operators Manual* available online at www.fluke.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/5530A Safety Information* document that ships with the Product. It can also be found online at www.fluke.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/5530A Safety Information* manual. Complete specifications are at www.fluke.com. See the *5560A Product Specifications*, *5550A Product Specifications*, or *5540A/5530A Product Specifications*.

Service Information

Contact an authorized Fluke Calibration Service Center if the Product needs calibration and verification 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/5530A Remote Programmers Manual* at www.fluke.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/5530A Remote Programmers Manual* at www.fluke.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 and verification 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/5530A Remote Programmers Manual* at www.fluke.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/5530A Remote Programmers Manual* at www.fluke.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/5530A Remote Programmers Manual* at www.fluke.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/5530A Operators Manual*.

For remote operation, and these topics, see the *5560A/5550A/5540A/5530A Remote Programmers Manual* at www.fluke.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

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 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.

A4

The A4 board provides the oscilloscope adjustment feature. See [*Oscilloscope Calibration Option \(600M, 1G, and 2G\) Calibration, Verification, and Adjustment*](#). Use this functionality to maintain these oscilloscope characteristics:

- Voltage Mode
- Edge Mode
- Leveled Sine Wave Mode
- Time Marker Specifications
- Wave Generator Mode
- Pulse Mode
- Spike Trigger Mode
- Input Impedance Mode (Resistance)
- Input Impedance Mode (Capacitance)
- Overload

For explanations of these functions, see the Operators Manual.

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 μ A 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 and 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 the Product. Calibration and verification should also be done before and after normal periodic adjustment or repair of the Product. Verification also serves to check that internal adjustment 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 5530A 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 www.fluke.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 and 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

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

Equipment Description	Manufacture/Model/PN	Application
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
DBL BANANA N (M) RG58C/U ($\approx$ 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 Adjustment Intervals

The verification procedures in this document tests to the 90-day, 99 % confidence specification limits of the 5560A. For the 5550A, 5540A, and 5530A or for other adjustment 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 5560A at 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:

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

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

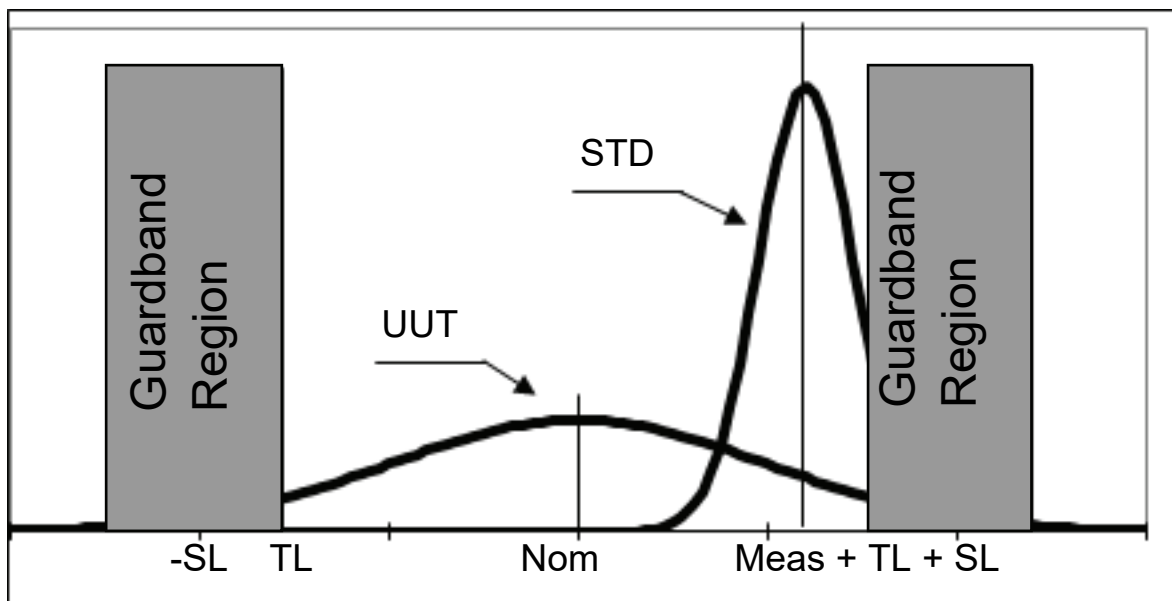
Some quality systems require adherence to particular rules for measurement decision risk when making claims of compliance with a specification.

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 and verification 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 adjustment 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 Adjustment 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 and verification 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. Fluke Calibration and other companies use the RDS method 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 adjustment results.

Volts DC Calibration and Verification (OUTPUT VZ)

Table 2 lists the required equipment.

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

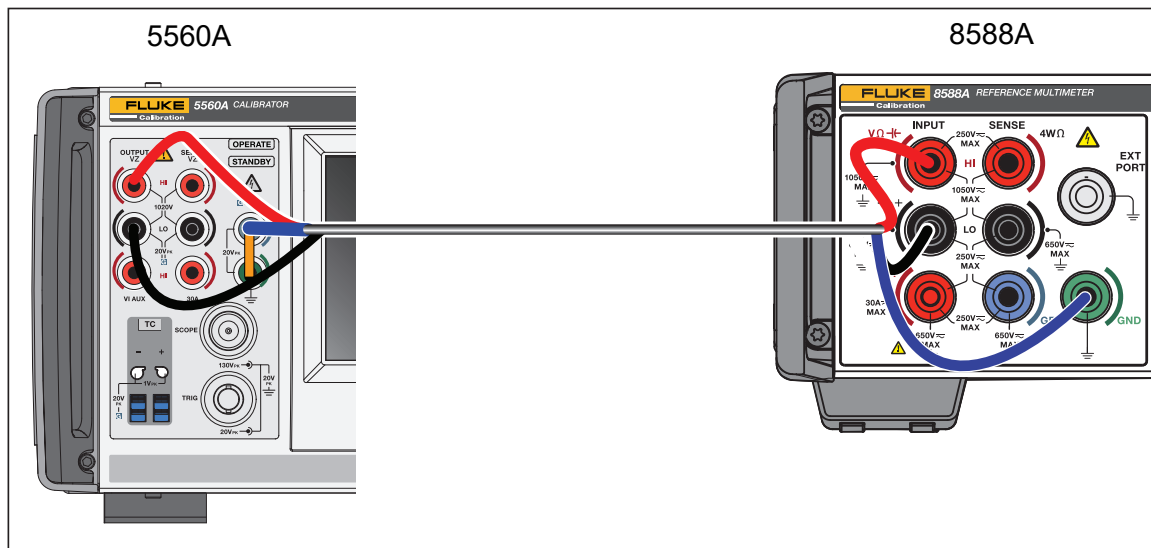
Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
DC Reference Standard	Fluke Calibration 732C	1
Fluke 8508A short	4-wire short (Fluke PN 2540973)	1
Low Thermal Cables	5730A-7003	1

To calibrate the Volts dc function from the main output (see Table 3):

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 STBY.
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 and Verification 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:

$$\text{Calculated Product Output} = V_{std} * \left(\frac{V_{Dmm_product}}{V_{Dmm_732C}} \right)$$

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

Table 3. Calibration and Verification 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

Table 3. Calibration and Verification 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
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
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 and Verification (AUX Output) (5530A, 5550A, and 5560A)

Table 4 lists the required equipment.

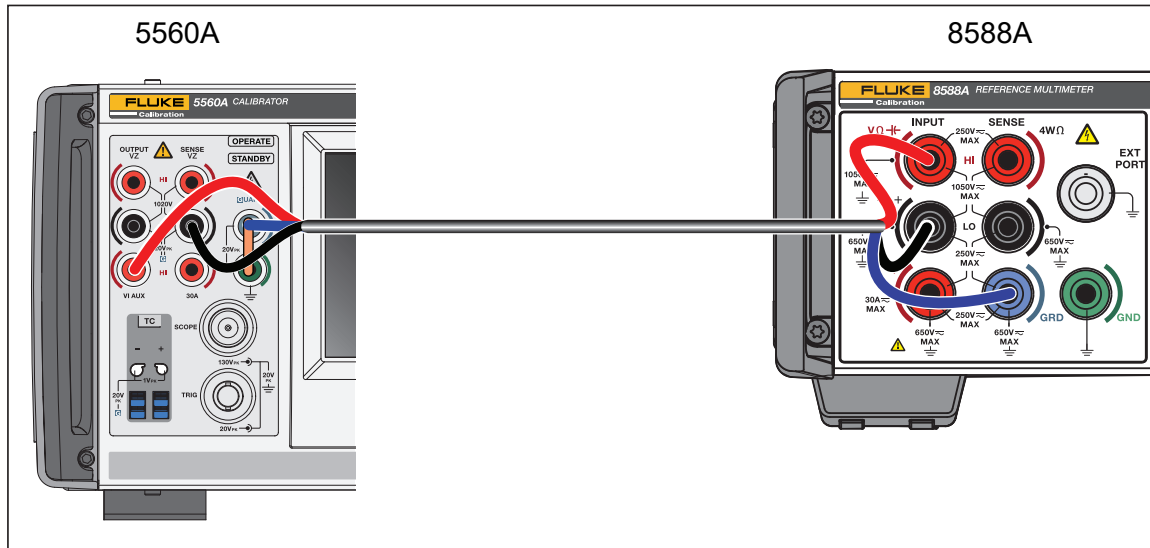
Table 4. Required Equipment for Volts DC (AUX Output)

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 STBY.
5. Complete an internal DC Zero Calibration on the Product.
6. Connect the test equipment as shown in Figure 4.

Figure 4. Volts DC 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. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 5. Calibration and Verification 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 and Verification

Table 6 lists the required equipment.

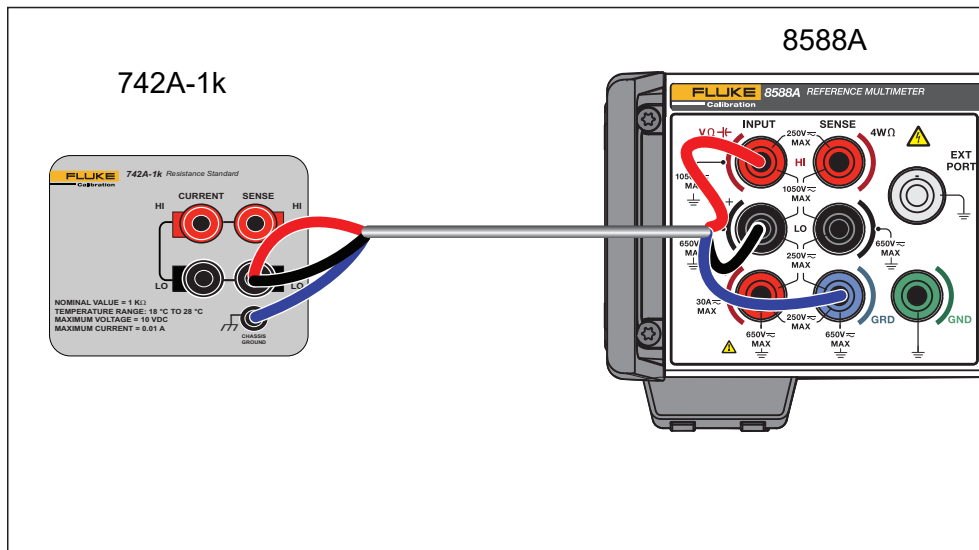
Table 6. Required Equipment for Amps DC

Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
$\pm(0 \mu\text{A to } 100 \mu\text{A})$	Fluke 742A-1k Resistance Standard	1
$\pm(1 \text{ mA to } 1.2 \text{ mA})$	Fluke A40B-1mA Current Shunt	1
$\pm(10 \text{ mA to } 12 \text{ mA})$	Fluke A40B-10mA Current Shunt	1
$\pm(100 \text{ mA to } 120 \text{ mA})$	Fluke A40B-100mA Current Shunt	1
$\pm(1 \text{ A to } 1.2 \text{ A})$	Fluke A40B-1A Current Shunt	1
$\pm 3 \text{ A}$	Fluke A40B-5A Current Shunt	1
$\pm 10 \text{ A}$	Fluke A40B-10A Current Shunt	1
$\pm(12 \text{ A to } 20 \text{ A})$	Fluke A40B-20A Current Shunt	1
$\pm 30 \text{ A}$	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 ($\approx 16 \text{ in}$)	(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 and verification steps, see Table 7):

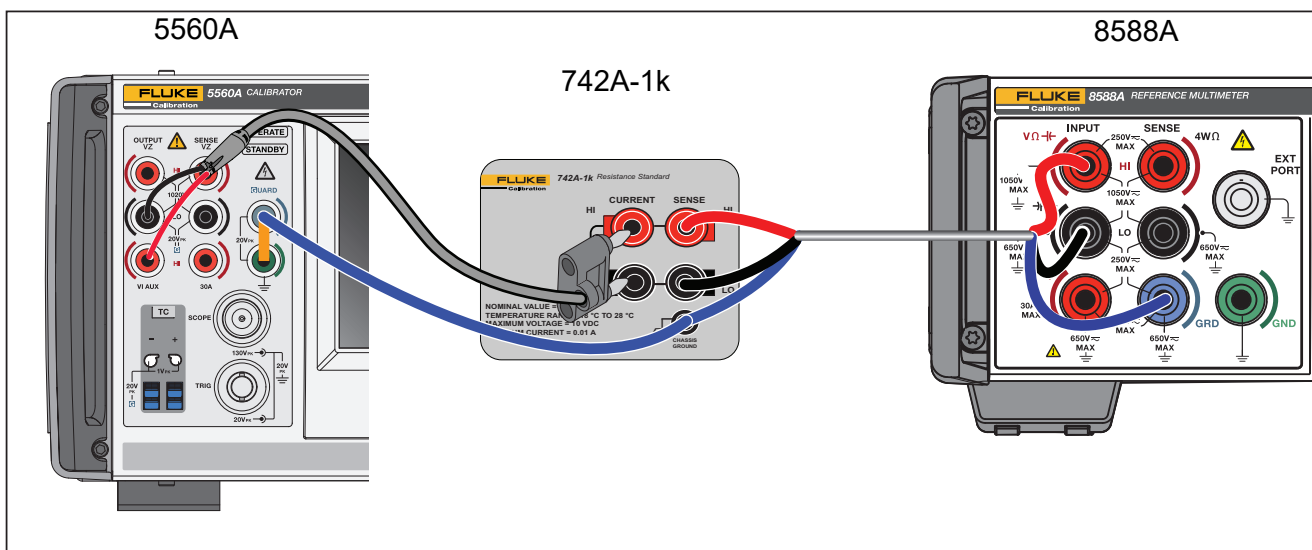
1. Set the 8588A as follows: Volts dc, Range Auto, NPLC 50, Guard ON (external guard).
2. Make sure that the DUT is in STBY.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. Complete an internal DC Zero Calibration on the Product.
5. Calculate the shunt resistance in Ω from the calibration records and/or regression analysis for all shunts listed in Table 7.
6. Record the shunt resistance in the **Shunt_R** Ω column 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



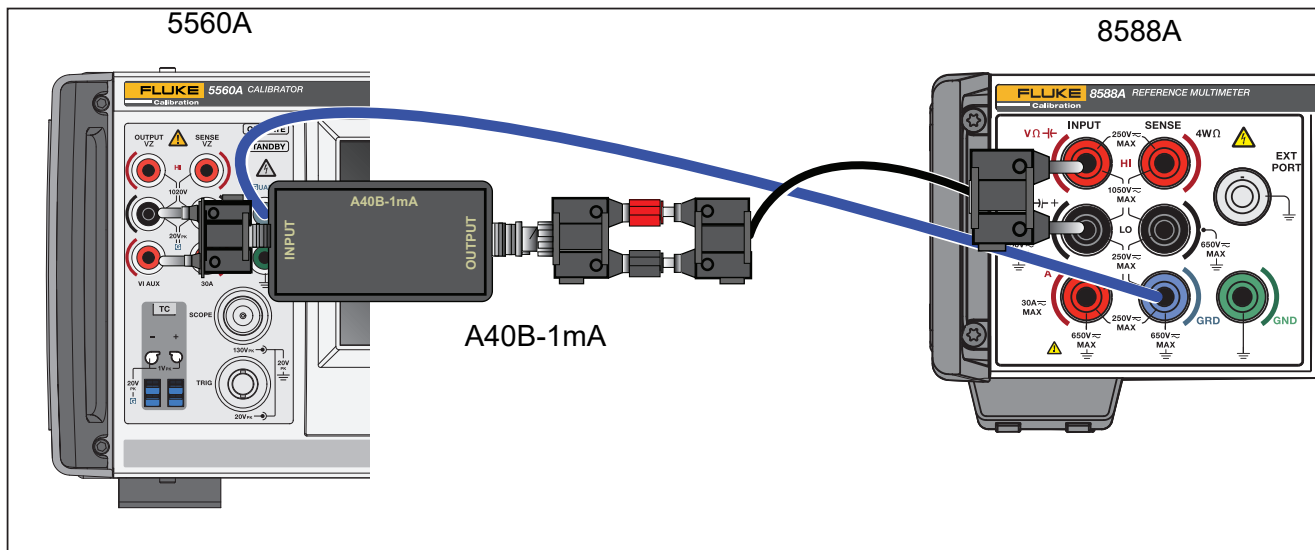
8. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
9. Connect the test equipment as shown in Figure 6.
10. Output from the DUT/Measure with the meter and record the 8588A measured values in the **DMM Reading on Shunt Output [V]** column. Complete all steps for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

Figure 6. Amps DC with 742A-1k



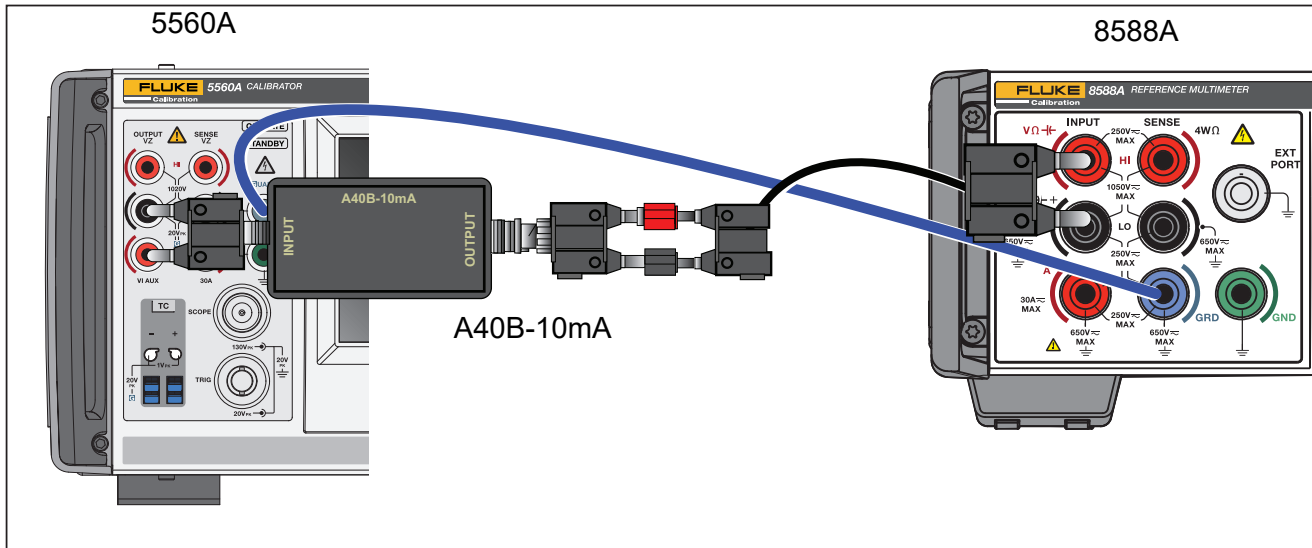
14. Connect the test equipment as shown in Figure 7.
15. Toggle the power switch of the A40B-1mA shunt to ON. Continue only if power light illuminates and the BATT LOW is off.
16. With no current applied from the Product to the Fluke A40B-1mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
17. Start with Table 7, 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 (Table 7, steps 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



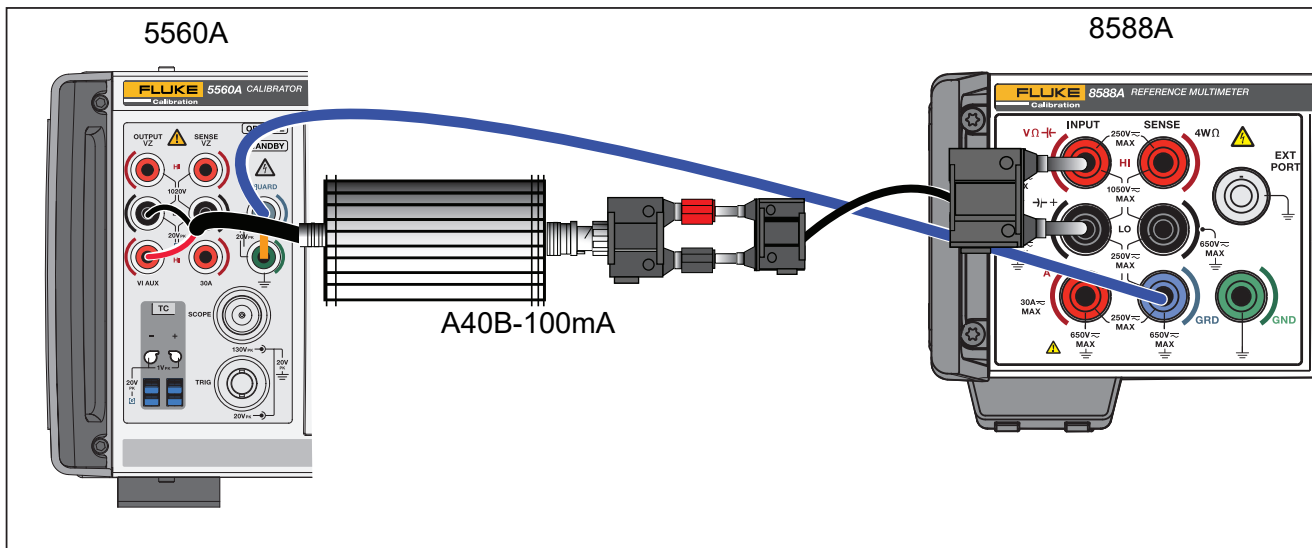
18. Set the Product to STBY. Disconnect the shunt. Toggle the power switch of the A40B-1mA shunt to **OFF**.
19. Connect the test equipment as shown in Figure 8.
20. With no current applied from the Product to the Fluke A40B-10mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
21. Start with Table 7, 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 (Table 7, steps 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



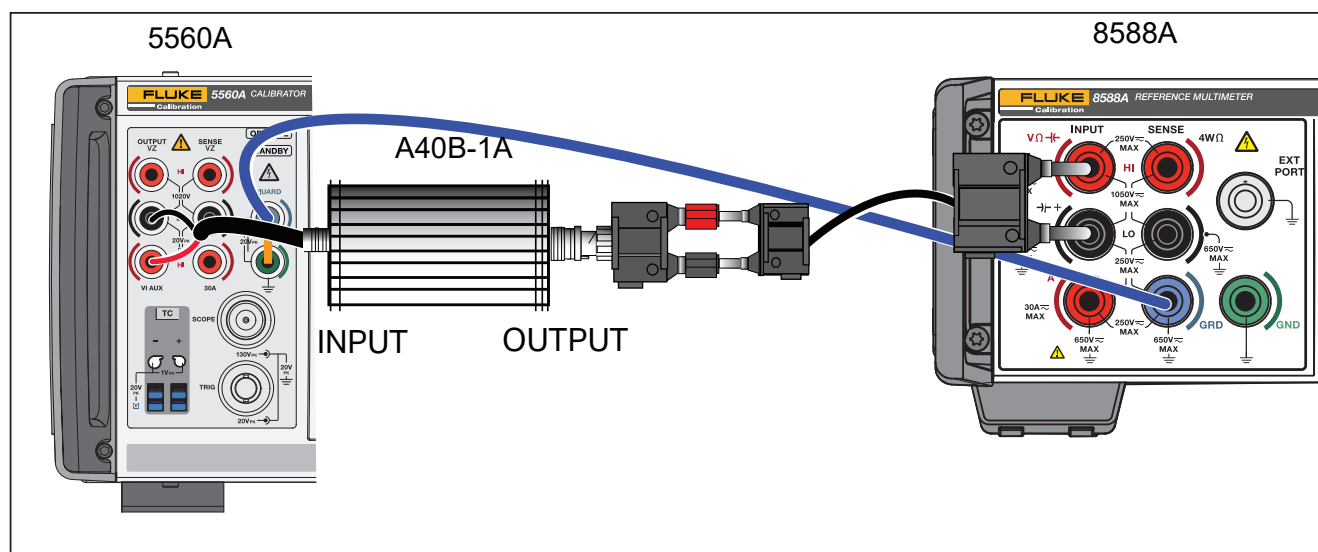
22. Set the Product to STBY. Disconnect the shunt. Connect the test equipment as shown in Figure 9.
23. With no current applied from the Product to the Fluke A40B-100mA shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
24. Start with Table 7, step 31. Set the output from the DUT/Measure with the meter and record the 8588A measured value in the **DDM Reading on Shunt Output [V]** column. Complete all steps for the present connection (Table 7, steps 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



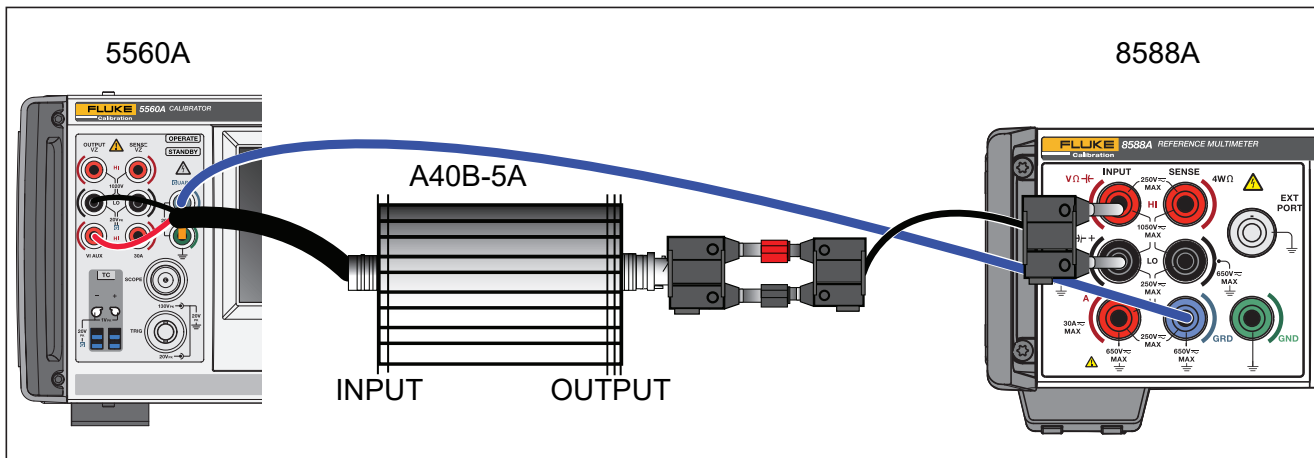
25. Set the Product to STBY. Disconnect the shunt. Connect the test equipment as shown in Figure 10.
26. With no current applied from the Product to the Fluke A40B-1A shunt, proceed with the zero meter function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
27. Start with Table 7, 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 (Table 7, steps 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 STBY.
29. Move the red lead connected to the Product V AUX to the 30 A terminal.
30. Complete the subsequent Table 7, steps 39 and 40 for this connection.

Figure 10. Amps DC with A40B-1A



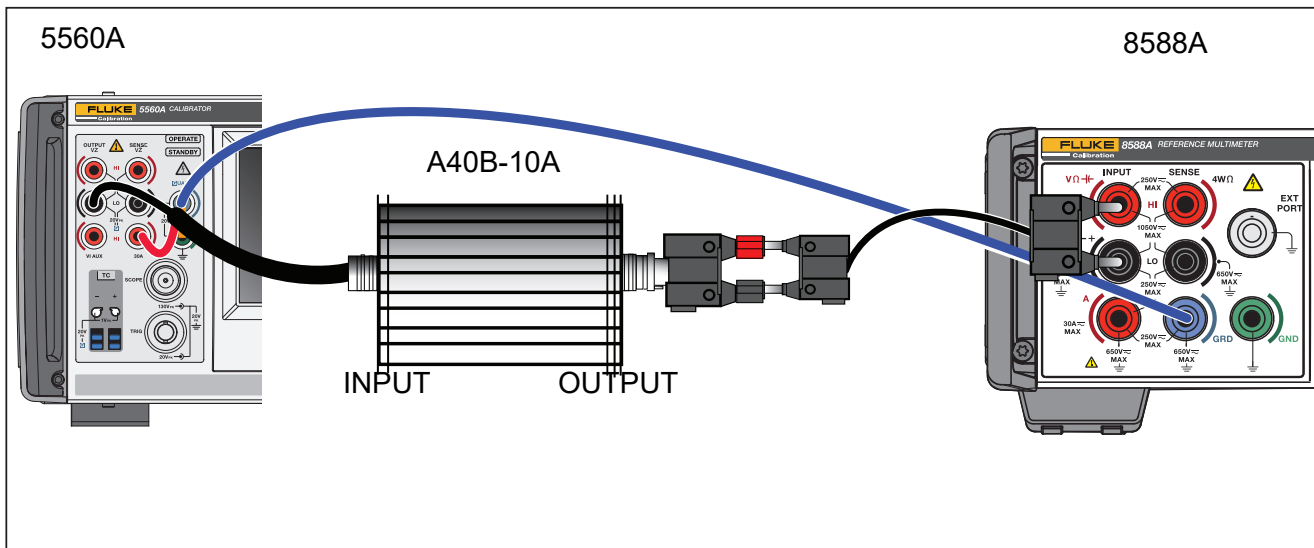
31. Set the Product to STBY. Disconnect the shunt. Connect the test equipment as shown in Figure 11.
32. With no current applied from the Product to the Fluke A40B-5A shunt, proceed with the meter zero function. On the 8588A Push **INPUT**, and then **ZERO FUNC**. Allow the zero function to finish.
33. Start with Table 7, 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 (Table 7, steps 41 and 42).
34. Set the Product to STBY.

Figure 11. Amps DC with A40B-5A



35. Set the Product to STBY. 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 the zero function to finish.
37. Start with Table 7, 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 (Table 7, steps 43 and 44). Refer to the Product manual for how to set/use range lock on bottom of range outputs.

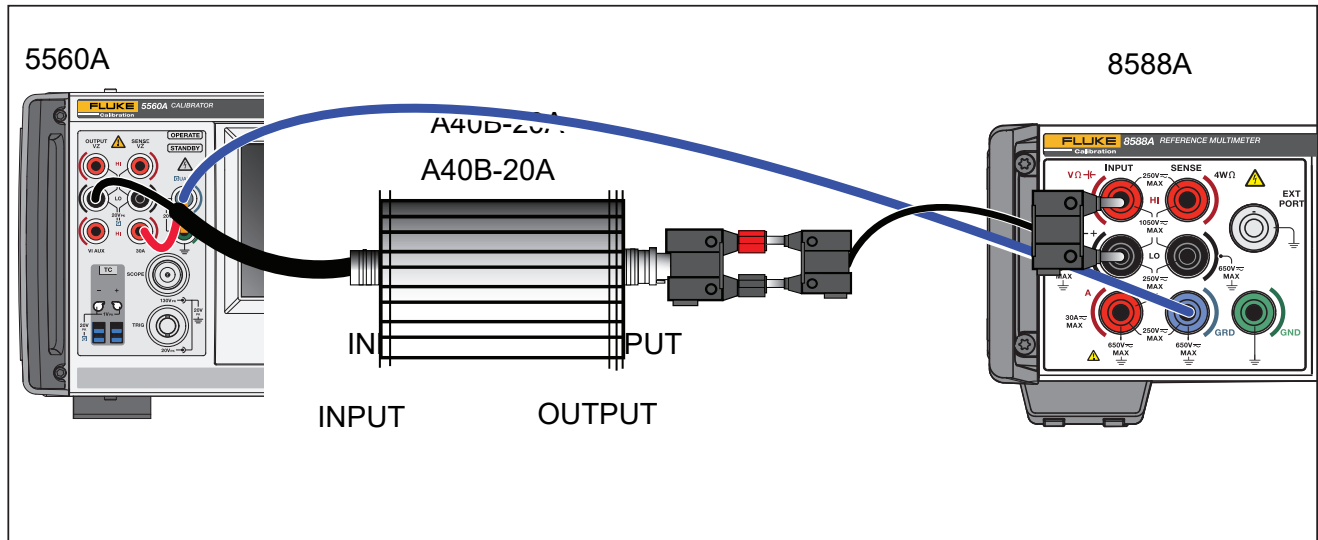
Figure 12. Amps DC with A40B-10A



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

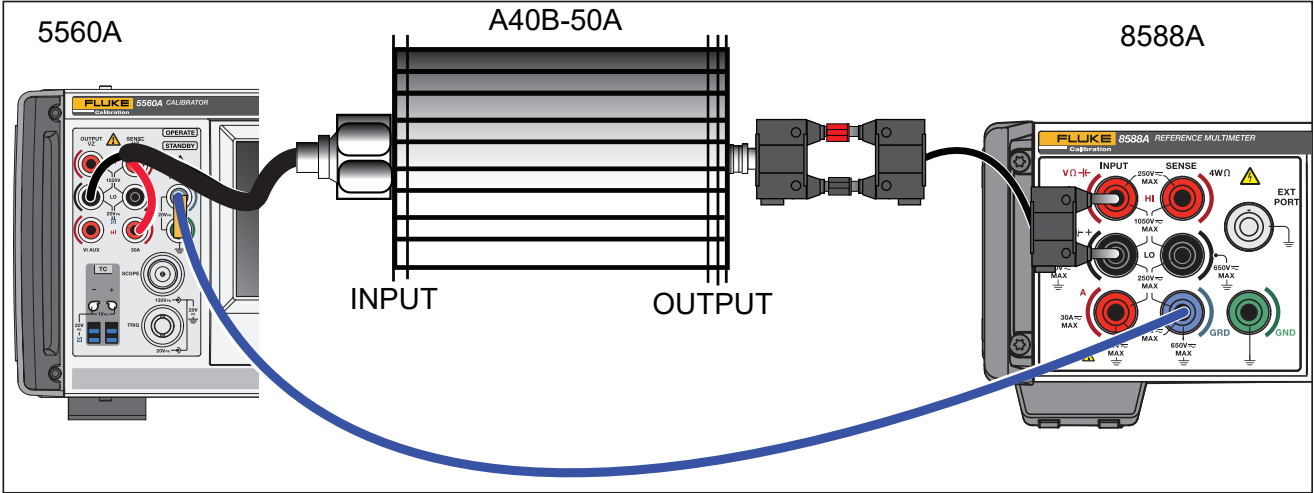
39. With no current applied from the Product to the Fluke A40B-20A shunt, proceed with the meter zero function. On the 8588A, push **ZERO**, and then **ZERO FUNC**. Allow the zero function to finish.
40. Start with Table 7, step 45. Set the output from the DUT and wait 3 minutes for settling. Measure 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 (Table 7, steps 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 STBY. 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 Table 7, 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 (Table 7, steps 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.

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

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

Table 7. Calibration and Verification 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 and Verification 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 and Verification 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 and Verification

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

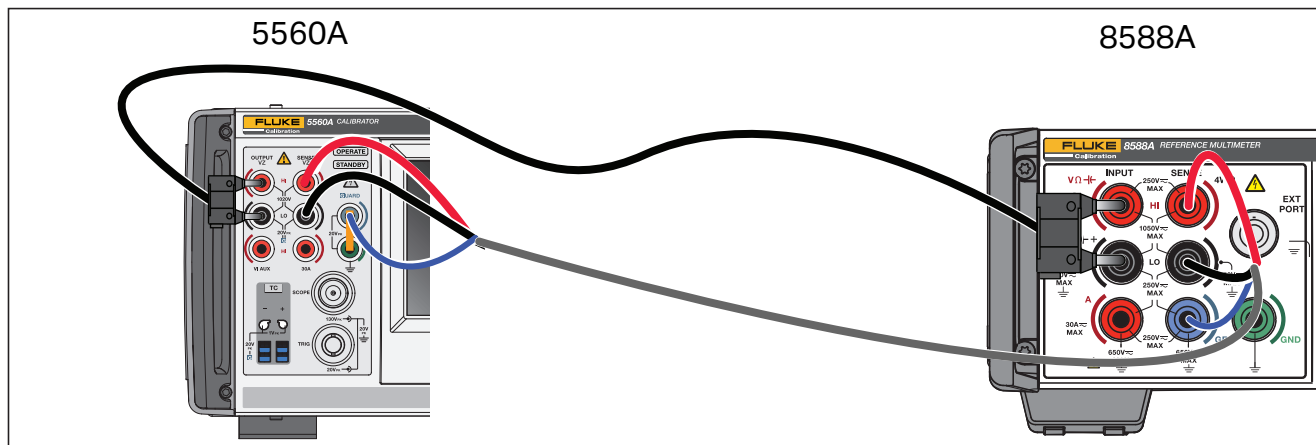
Equipment Description	Manufacture/Model/PN	Quantity
Digital Multimeter	Fluke Calibration 8588A	1
Resistance Standard	Fluke 742A-100k	1
Resistance Standard	Fluke 742A-1M	1
Resistance Standard	Fluke 742A-10M	1
Resistance Standard	MI 9331G/100 M	1
Resistance Standard	MI 9331G/1 G	1
Low Thermal Cables	Fluke 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 STBY.
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 (Table 10, steps 1 to 14).

Figure 15. Resistance 4W with 8588A



6. Set the Product to STBY.
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 k Ω . 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 STBY.
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 k Ω . 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 STBY.
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 M Ω . 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 STBY.
26. Complete Table 10, steps 18 to 22 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 (Table 10, steps 23 to 26) uses characterization and linearization of the 8588A 1 G Ω range at 100 M Ω and 1 G Ω .
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 Table 9, steps 2 to 5.

Meter error at 0.1 GΩ:

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

Meter error at 1 GΩ:

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

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.

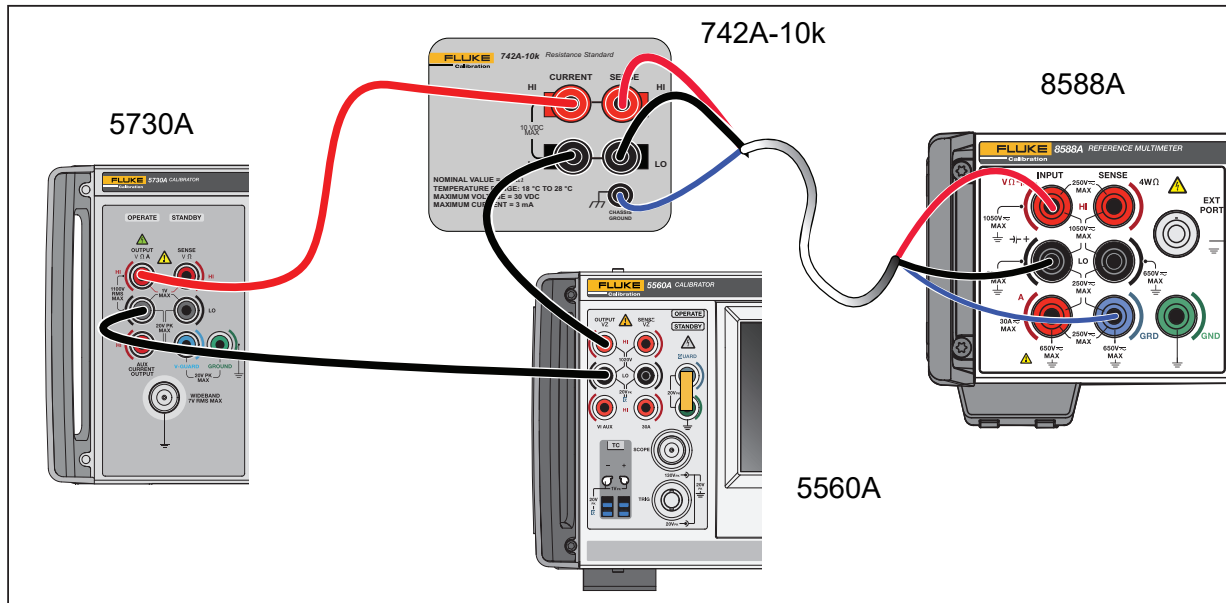
34. Connect the existing setup used for high resistance to the Product for 2-W measurements and complete Table 10, steps 23 to 26.

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 in Table 10, steps 23 and 24 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:	$Product\ Output = DMM_{PROD}$
For steps 15 through 22:	$Product\ Output = DMM_{PROD} - (DMM_{STD} - R_{STD})$
For steps 23 through 26:	$Product\ Output = DMM_{PROD} * (1 - DMM_{Err} * 10^{-6})$

$$Product\ Output = R_{STD} * \left(\frac{DMM_{PROD}}{DMM_{STD}} \right)$$

For steps 27 through 28:

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

Table 10. Calibration and Verification Steps for Resistance

Step	Product Range	Product Output	DMM Mode/ Method	Transfer Resistor	Transfer Value	DMM Measurement on Transfer Resistor	DMM Measurement on Product	Calculated Product Output	Limits
1	12 Ω	0 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	$\pm 1.0\text{ m}\Omega$
2	12 Ω	1 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	$\pm 1.0\text{ m}\Omega$
3	12 Ω	10 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	$\pm 1.2\text{ m}\Omega$
4	120 Ω	12.1 Ω	Normal 10 Ω / Direct	N/A	N/A	N/A	Ω	Ω	$\pm 1.3\text{ m}\Omega$
5	120 Ω	100 Ω	Normal 100 Ω / Direct	N/A	N/A	N/A	Ω	Ω	$\pm 3.2\text{ m}\Omega$
6	1.2 k Ω	0.121 k Ω	Normal 100 Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 4.7\text{ m}\Omega$
7	1.2 k Ω	1 k Ω	Normal 1 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 24.0\text{ m}\Omega$
8	12 k Ω	1.21 k Ω	Normal 1 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 46.6\text{ m}\Omega$
9	12 k Ω	1.9 k Ω	Normal 1 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 61.8\text{ m}\Omega$
10	12 k Ω	3 k Ω	Normal 10 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 86.0\text{ m}\Omega$
11	12 k Ω	5 k Ω	Normal 10 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 130\text{ m}\Omega$
12	12 k Ω	10 k Ω	Normal 10 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 240\text{ m}\Omega$
13	12 k Ω	12 k Ω	Normal 10 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 284\text{ m}\Omega$
14	120 k Ω	12.1 k Ω	Normal 10 k Ω / Direct	N/A	N/A	N/A	k Ω	k Ω	$\pm 466\text{ m}\Omega$
15	120 k Ω	100 k Ω	Normal 100 k Ω / Transfer	Fluke 742A-100k	k Ω	k Ω	k Ω	k Ω	$\pm 2.4\text{ }\Omega$

Table 10. Calibration and Verification Steps for Resistance (cont.)

Step	Product Range	Product Output	DMM Mode/ Method	Transfer Resistor	Transfer Value	DMM Measurement on Transfer Resistor	DMM Measurement on Product	Calculated Product Output	Limits
16	1.2 M Ω	0.121 M Ω	LoI 100 k Ω / Transfer	Fluke 742A-100k	k Ω	k Ω	k Ω	k Ω	$\pm 4.7 \Omega$
17	1.2 M Ω	1 M Ω	Normal 1 M Ω / Transfer	Fluke 742A-1M	M Ω	M Ω	M Ω	M Ω	$\pm 24.0 \Omega$
18	12 M Ω	1.21 M Ω	LoI 1 M Ω / Transfer	Fluke 742A-1M	M Ω	M Ω	M Ω	M Ω	$\pm 63.9 \Omega$
19	12 M Ω	10 M Ω	Normal 10 M Ω / Transfer	Fluke 742A-10M	M Ω	M Ω	M Ω	M Ω	$\pm 310.0 \Omega$
20	120 M Ω	12.1 M Ω	Normal 10 M Ω / Transfer	Fluke 742A-10M	M Ω	M Ω	M Ω	M Ω	$\pm 7.10 \text{ k}\Omega$
21	120 M Ω	100 M Ω	Normal 100 M Ω / Transfer	MI 9331G/100 M	M Ω	M Ω	M Ω	M Ω	$\pm 40.5 \text{ k}\Omega$
22	1.2 G Ω	0.121 G Ω	Normal 100 M Ω / Transfer	MI 9331G/100 M	M Ω	M Ω	M Ω	G Ω	$\pm 0.57 \text{ M}\Omega$
23	1.2 G Ω	0.3 G Ω	Normal 1 G Ω / Transfer	N/A	Table 9, Meter error	$\mu\Omega/\Omega$	G Ω	G Ω	$\pm 1.27 \text{ M}\Omega$
24	1.2 G Ω	0.4 G Ω	Normal 1 G Ω / Transfer	N/A	Table 9, Meter error	$\mu\Omega/\Omega$	G Ω	G Ω	$\pm 1.66 \text{ M}\Omega$
25	1.2 G Ω	0.64 G Ω	Normal 1 G Ω / Transfer	N/A	Table 9, Meter error	$\mu\Omega/\Omega$	G Ω	G Ω	$\pm 2.6 \text{ M}\Omega$
26	1.2 G Ω	1 G Ω	Normal 1 G Ω / Transfer	MI 9331G/1 G	Table 9, Meter error	$\mu\Omega/\Omega$	G Ω	G Ω	$\pm 4.0 \text{ M}\Omega$
27	12 Ω	0 Ω	Ext. current source 100 μA	N/A	N/A	N/A			$\pm 40.0 \text{ m}\Omega$
28	120 Ω	100 Ω	Ext. current source 100 μA	N/A	N/A	N/A			$\pm 42.2 \text{ m}\Omega$

Volts AC Calibration and Verification (OUTPUT VZ)

Table 11 lists the required equipment.

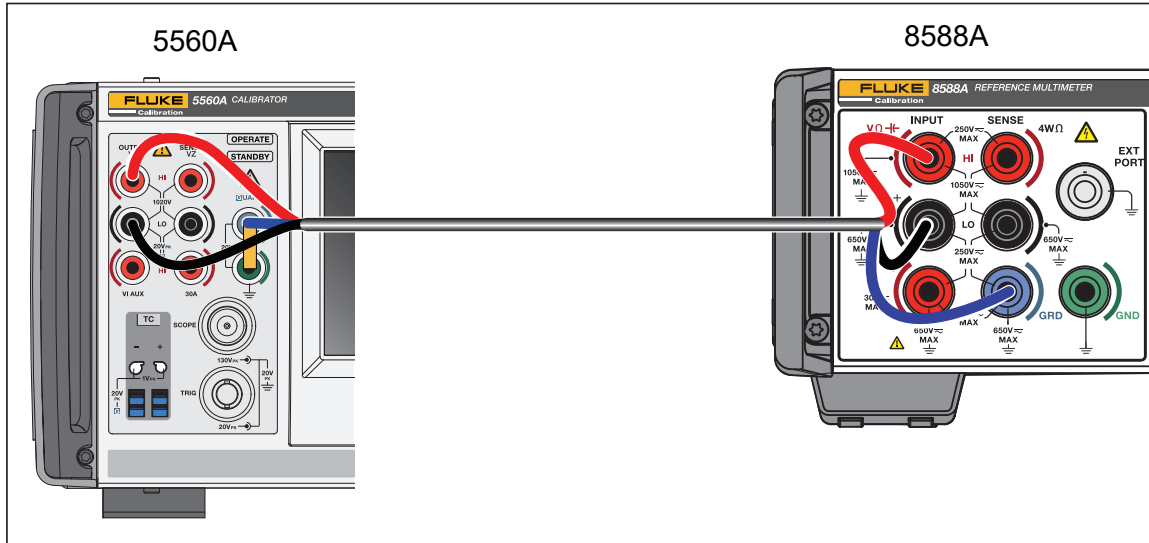
Table 11. Required Equipment Volts AC Main Output

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 $10M\Omega$, Guard ON (external guard).
2. Make sure that the DUT is in STBY.
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.

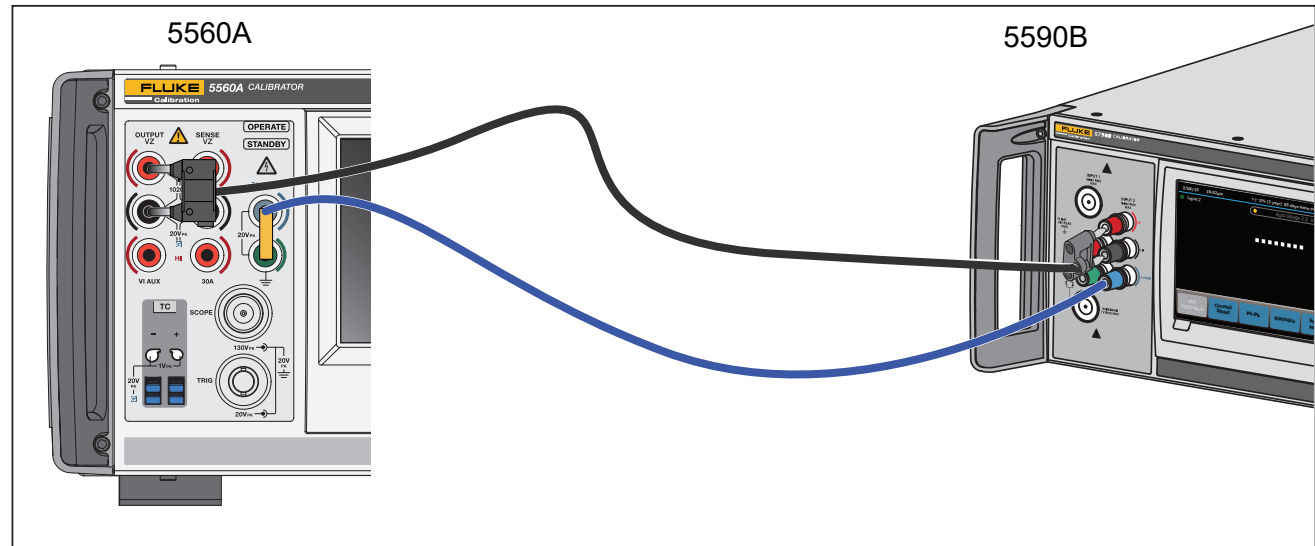
Figure 17. Low frequency Volts AC Calibration



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 (Table 12, 1 to 39).
9. Set the Product to STBY.

- 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 (Table 12, all steps).
- 14. With the entire table populated, evaluate each step for compliance to limits. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 12. Calibration and Verification 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

Table 12. Calibration and Verification steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
4	12 mV	10 mV	3 Hz		±27.0 µV
5	12 mV	10 mV	5 Hz		±14.0 µV
6	12 mV	10 mV	10 Hz		±7.2 µV
46	12 mV	10 mV	1 kHz		±7.2 µV
47	12 mV	10 mV	20 kHz		±7.2 µV
48	12 mV	10 mV	50 kHz		±9.0 µV
49	12 mV	10 mV	100 kHz		±27 µV
50	12 mV	10 mV	300 kHz		±94 µV
51	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
52	120 mV	12.1 mV	1 kHz		±7.4 µV
53	120 mV	12.1 mV	20 kHz		±7.4 µV
54	120 mV	12.1 mV	50 kHz		±11 µV
55	120 mV	12.1 mV	100 kHz		±28 µV
56	120 mV	12.1 mV	300 kHz		±49 µV
57	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
58	120 mV	100 mV	1 kHz		±18 µV
59	120 mV	100 mV	20 kHz		±18 µV
60	120 mV	100 mV	50 kHz		±36 µV
61	120 mV	100 mV	100 kHz		±84 µV
62	120 mV	100 mV	300 kHz		±190 µV
63	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

Table 12. Calibration and Verification steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
15	1.2 V	0.121 V	10 Hz		$\pm 74 \mu\text{V}$
64	1.2 V	0.121 V	1 kHz		$\pm 74 \mu\text{V}$
65	1.2 V	0.121 V	20 kHz		$\pm 74 \mu\text{V}$
66	1.2 V	0.121 V	50 kHz		$\pm 43 \mu\text{V}$
67	1.2 V	0.121 V	100 kHz		$\pm 108 \mu\text{V}$
68	1.2 V	0.121 V	300 kHz		$\pm 264 \mu\text{V}$
69	1.2 V	0.121 V	500 kHz		$\pm 264 \mu\text{V}$
16	1.2 V	1 V	3 Hz		$\pm 2.08 \text{ mV}$
17	1.2 V	1 V	5 Hz		$\pm 0.77 \text{ mV}$
18	1.2 V	1 V	10 Hz		$\pm 0.18 \text{ mV}$
70	1.2 V	1 V	40.01 Hz		$\pm 0.12 \text{ mV}$
71	1.2 V	1 V	1 kHz		$\pm 0.12 \text{ mV}$
72	1.2 V	1 V	20 kHz		$\pm 0.12 \text{ mV}$
73	1.2 V	1 V	50 kHz		$\pm 0.25 \text{ mV}$
74	1.2 V	1 V	100 kHz		$\pm 0.60 \text{ mV}$
75	1.2 V	1 V	300 kHz		$\pm 1.60 \text{ mV}$
76	1.2 V	1 V	500 kHz		$\pm 1.60 \text{ mV}$
19	12 V	1.21 V	3 Hz		$\pm 3.17 \text{ mV}$
20	12 V	1.21 V	5 Hz		$\pm 1.60 \text{ mV}$
21	12 V	1.21 V	10 Hz		$\pm 0.49 \text{ mV}$
77	12 V	1.21 V	1 kHz		$\pm 0.19 \text{ mV}$
78	12 V	1.21 V	20 kHz		$\pm 0.19 \text{ mV}$
79	12 V	1.21 V	50 kHz		$\pm 0.34 \text{ mV}$
80	12 V	1.21 V	100 kHz		$\pm 0.80 \text{ mV}$
81	12 V	1.21 V	300 kHz		$\pm 2.54 \text{ mV}$
82	12 V	1.21 V	500 kHz		$\pm 2.54 \text{ mV}$
22	12 V	10 V	3 Hz		$\pm 20.75 \text{ mV}$
23	12 V	10 V	5 Hz		$\pm 7.75 \text{ mV}$
24	12 V	10 V	10 Hz		$\pm 1.50 \text{ mV}$

Table 12. Calibration and Verification steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
83	12 V	10 V	1 kHz		±1.20 mV
84	12 V	10 V	20 kHz		±1.20 mV
85	12 V	10 V	50 kHz		±2.45 mV
86	12 V	10 V	100 kHz		±5.73 mV
87	12 V	10 V	300 kHz		±16.6 mV
88	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
89	120 V	12.1 V	1 kHz		±1.89 mV
90	120 V	12.1 V	20 kHz		±1.89 mV
91	120 V	12.1 V	50 kHz		±3.40 mV
92	120 V	12.1 V	100 kHz		±8.03 mV
93 ^[1]	120 V	12.1 V	300 kHz		±39.36 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
94	120 V	100 V	40.01 Hz		±12.00 mV
95	120 V	100 V	1 kHz		±12.00 mV
96	120 V	100 V	20 kHz		±12.00 mV
97	120 V	100 V	50 kHz		±25 mV
98	120 V	100 V	100 kHz		±57 mV
99 ^[1]	120 V	70 V	300 kHz		±132 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
100	330 V	121 V	1 kHz		±22 mV

Table 12. Calibration and Verification steps for Volts AC (cont.)

Step	Product Range	Product Output	Product Frequency	Calculated Product Output	Limits
101	330 V	121 V	10 kHz		±22 mV
102	330 V	121 V	10.01 kHz		±22 mV
103	330 V	121 V	20 kHz		±22 mV
104	330 V	121 V	50 kHz		±37 mV
105	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
106	330 V	330 V	1 kHz		±46 mV
107	330 V	330 V	20 kHz		±46 mV
108	330 V	330 V	50 kHz		±87 mV
109	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
110	1020 V	331 V	1 kHz		±118 mV
111	1020 V	331 V	10 kHz		±118 mV
112	1020 V	1000 V	40 Hz		±195 mV
113	1020 V	1000 V	1 kHz		±195 mV
114	1020 V	1020 V	10 kHz		±197 mV
[1] 5560A Only					

AC Power. Volts AC Calibration and Verification (OUTPUT VZ) (5530A, 5550A and 5560A)

This section only applies to devices with **Firmware 4.0** or later.

1. Before you make any connection changes, set the Product to STBY.
2. Connect the Product to 5790B as shown in Figure 19. Note the added copper wire shoring on the terminals of the Product: SENSE VZ LO to SENSE VZ 30 A to OUTPUT VZ VI AUX. Use 16 AWG/ 1.3 mm minimum size.
3. Starting with step 1 in Table 13, the setup of the Product is: Volts AC as fundamental, Current AC set to 3rd harmonic, phase set to 0 degrees.
4. Set the Product to the first step in Table 13 and make the measurement with the 5790B. Record the measurement in the **Product Output** column of the table.
5. Do the rest of the steps in the table for this connection.
6. With the table fully populated, evaluate each step for compliance to limits. To apply Guardbanding, create a table from the example in this manual where the acceptance limits are properly modified by your Guardbanding method.

Figure 19. Connections with Jumpers

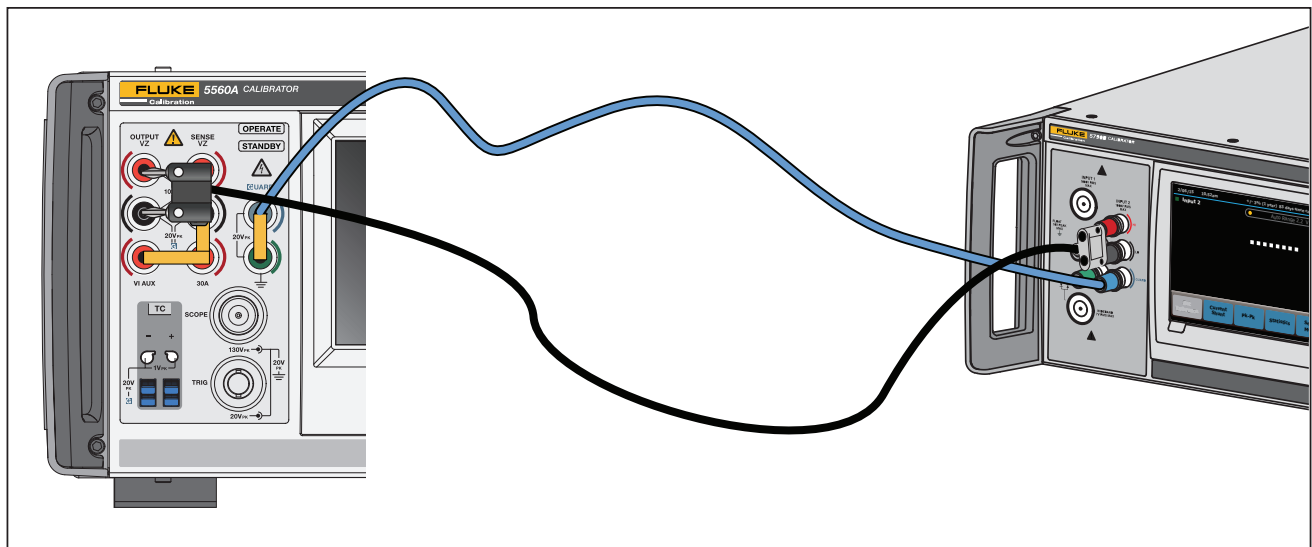


Table 13. Calibration and Verification steps for AC Power - Volts AC

Step	Product Output	Product Frequency	Product Phase	Product Output	90D Specification Limits
1	0.120001 V/3.1 A	333 Hz	0 °		±29.8 µV
2	1.20001 V/12 A	333 Hz	0 °		±238 µV
3	1.20001 V/1.2 A	1666 Hz	0 °		±238 µV
4	1.20001 V/1.2 A	3333 Hz	0 °		±238 µV
5	1.20001 V/0.333 A	10000 Hz	0 °		±238 µV
6	12.0001 V/12 A	333 Hz	0 °		±2.38 mV
7	12.0001 V/1.2 A	1666 Hz	0 °		±2.38 mV
8	12.0001 V/1.2 A	3333 Hz	0 °		±2.38 mV
9	12.0001 V/0.333 A	10000 Hz	0 °		±2.38 mV
10	120.001 V/12 A	333 Hz	0 °		±29.8 mV
11	120.001 V/1.2 A	1666 Hz	0 °		±29.8 mV
12	120.001 V/1.2 A	3333 Hz	0 °		±30 mV
13	330.001 V/12 A	333 Hz	0 °		±198 mV

Volts AC Calibration and Verification (AUX Output) (5530A, 5550A, and 5560A)

Table 14 lists the required equipment.

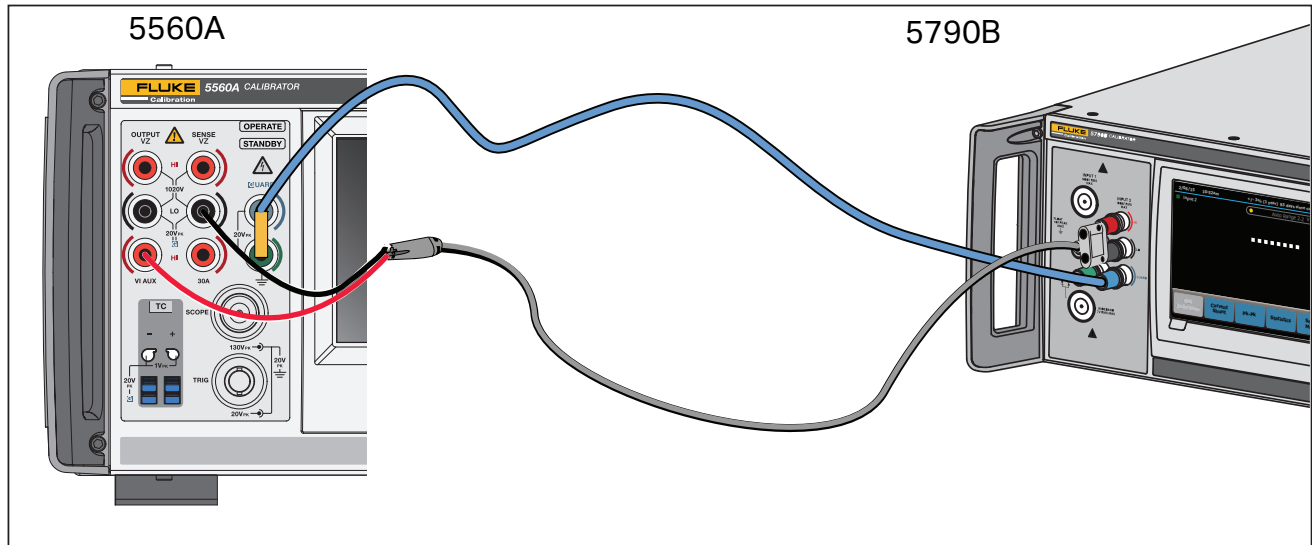
Table 14. Required Equipment Volts AC from the AUX Output

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 20.
2. Connect a strap between the guard and ground terminals of the DUT.

Figure 20. Volts AC Out of the SENSE VZ LO/OUTPUT VI AUX Calibration Adjustment



3. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
4. Start with step 1 in Table 15. Set the DUT to 1 V for the main output and Product output setting V and Hz in Table 15. Make a measurement with the 5790B. Record the measurement in the **Product Output** column of Table 15.
5. Continue with the rest of the steps for this connection (Table 15, steps 41 to 12). 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. To apply Guardbanding, create a table from the example in this manual where the acceptance limits are properly modified by your Guardbanding method.

Table 15. Calibration and Verification steps for Volts AC Out of the AUX Output

Step	Product Output (OUTPUT VZ)	Product Output (SENSE Output)	Product Frequency	Product Output	Limits
1	1 V	120 mV	45 Hz		±0.372 mV
2	1 V	120 mV	65 Hz		±0.372 mV
3	1 V	1.2 V	45 Hz		±1.02 mV
4	1 V	1.2 V	400 Hz		±1.02 mV
5	1 V	1.2 V	1 kHz		±1.02 mV
6	1 V	1.2 V	5 kHz		±1.79 mV
7	1 V	5 V	45 Hz		±3.30 mV
8	1 V	5 V	400 Hz		±3.30 mV
9	1 V	5 V	1 kHz		±3.30 mV
10	1 V	5 V	5 kHz		±6.4 mV
11	1 V	5 V	10 kHz		±12.4 mV
12	1 V	3.3 V	30 kHz		±100 mV

ACV ACV. Volts AC Calibration and Verification (AUX Output) (5530A, 5550A and 5560A)

This section only applies to devices with **Firmware 4.0** or later.

1. Set the Product is set to STBY before you make any connection changes.
2. Connect the Product to Fluke 5790B as shown in Figure 20.
3. The setup of the Product is: AUX Volts as fundamental, AC Voltage out of OUTPUT VZ set to 3rd harmonic, phase set to 0 degrees. Starting at step 1 of Table 16, make a measurement with the 5790B. Record the measurement in the **Product Output** column of the table.
4. Continue with the rest of the steps in the table for this connection.
5. After you have gone through each step of the table, evaluate each step for compliance to limits. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 16. Calibration and Verification steps for ACV ACV - Volts AC (Aux Output)

Step	Product Output	Product Frequency	Product Phase	Product Output	90D Specification Limits
1	1020 V/0.12001 V	166 Hz	0 °		±0.67 mV
2	500 V/0.12001 V	333 Hz	0 °		±0.67 mV
3	250 V/1.2001 V	3333 Hz	0 °		±2.14 mV
4	120 V/1.2001 V	10000 Hz	0 °		±3.58 mV

Amps AC Calibration and Verification

Table 17 lists the required equipment.

Table 17. 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

Table 17. Required Equipment for Amps AC (cont.)

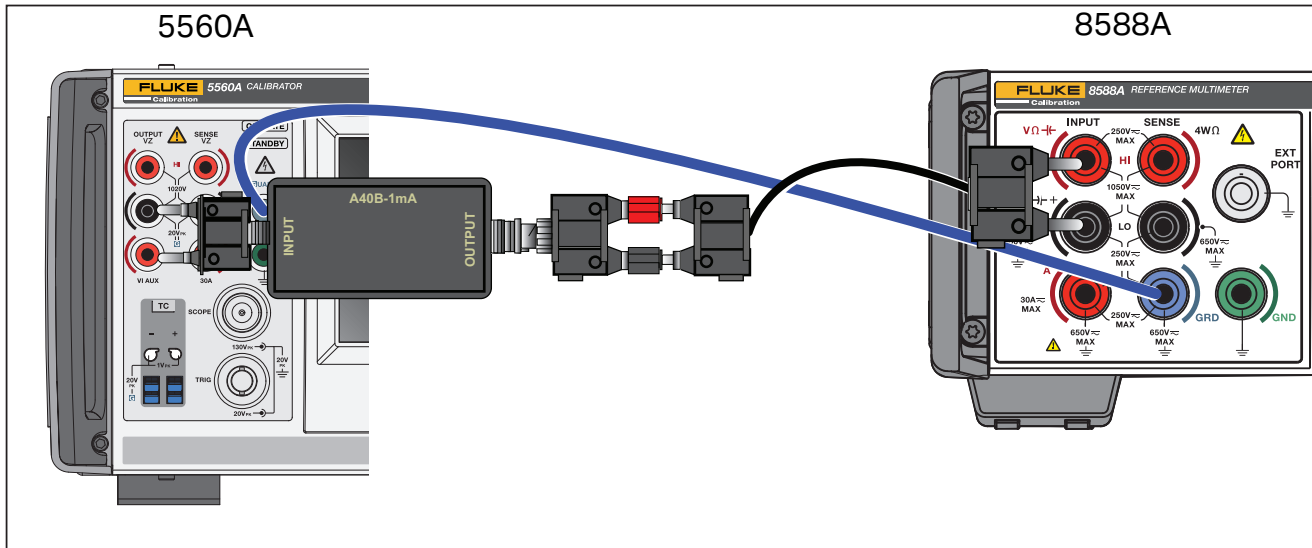
Equipment Description	Manufacture/Model/PN	Quantity
Type N (M) to dual banana (M)	E-Z-Hook PN 9415	1
Type N (F) to Type N (F) adapter	Various	1
LC Male to LC Male adapter	A40B-ADAPT/LC	1
LC Female to N Male inter-series adapter	A40B-ADAPT/LCN	1
N to 4 mm double banana connector	A40B-LEAD/4mm	1
DBL BANANA N (M) RG58C/U (≈ 16 in)	(Fluke PN 900394) 5790-8026	1

The amps ac calibration and verification 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 and verification 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:

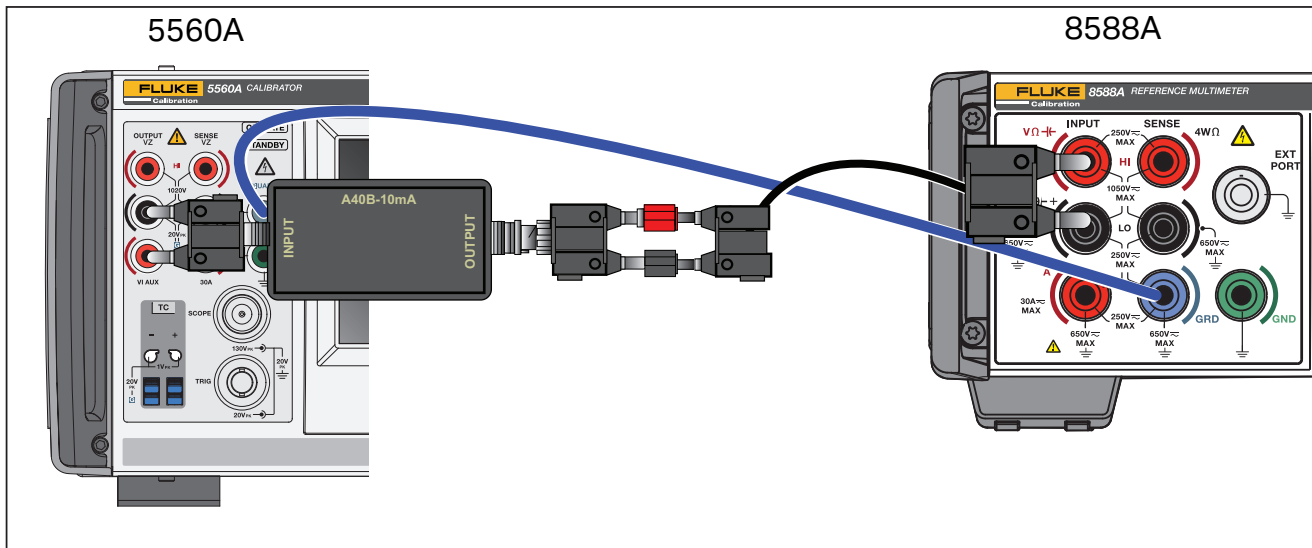
1. Set the 8588A as follows: Volts ac, Range Auto, Wide Bandwidth, Coupling: DC 10 M Ω , Guard ON (external guard).
2. Make sure that the DUT is in STBY.
3. Connect a strap between the Guard and Ground terminals of the DUT.
4. Complete an internal dc zero calibration on the Product.
5. Connect the 8588A to the Product as shown in Figure 21.
6. Make sure that the DUT is in STBY.
7. Calculate the shunt resistance in Ω from calibration records and/or regression analysis for all shunts listed in Table 18. 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 18.
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 18.
11. Continue with step 2, Table 18.
12. Complete Table 18, steps 1 to 5.

Figure 21. Amps AC with A40B-1mA



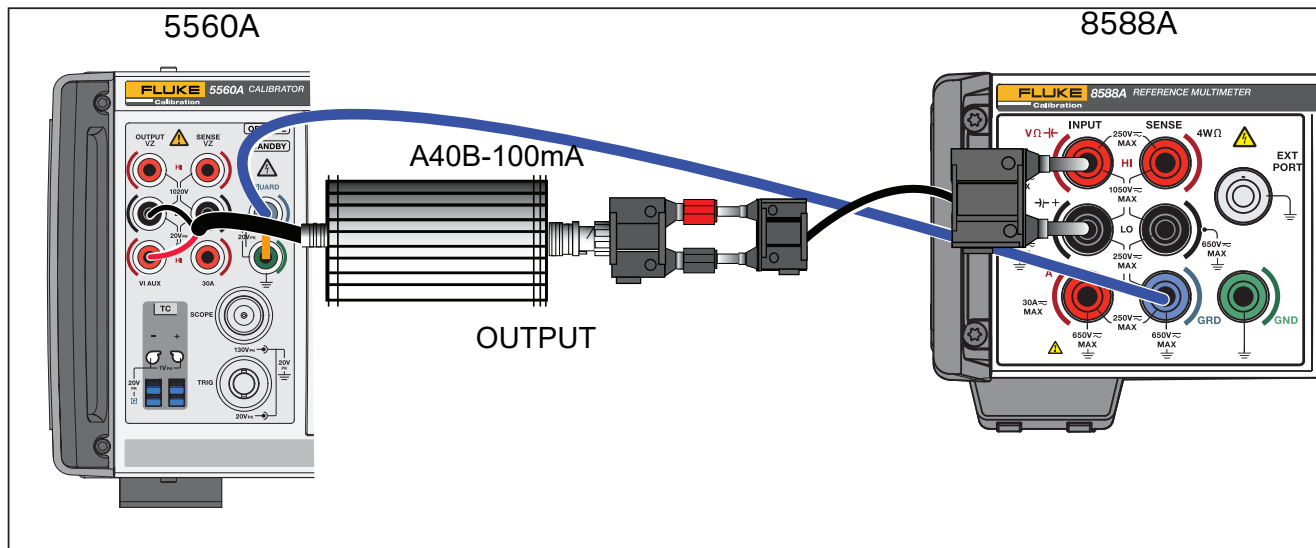
13. Disconnect the shunt output cable from the 8588A and connect it to the 5790B Input 2.
14. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
15. Connect heavy gauge guard cable between the DUT and the 5790B.
16. From step 6, Table 18, set the output from the DUT/Measure with the 5790B and record the 5790B measured in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 6 to 30.
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 22.

Figure 22. Amps AC with A40B-10mA



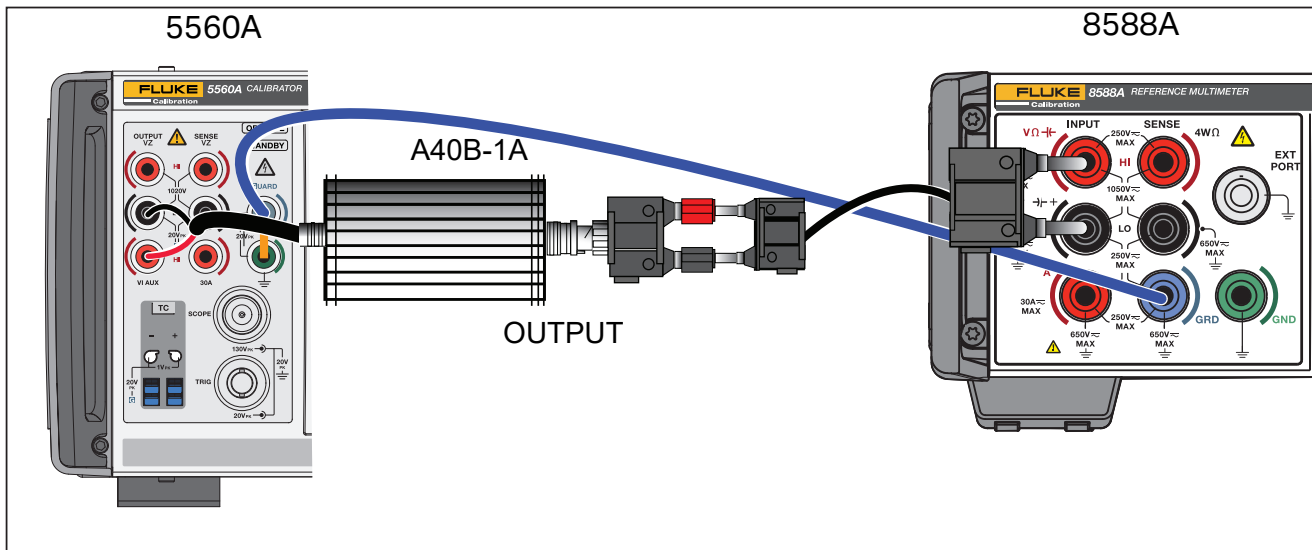
20. From step 31, Table 18, output from the DUT/Measure with the meter and record the 8588A measurement in the **DMM Reading on Shunt Output [V]** column.
21. Complete Table 18, steps 31 and 32.
22. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
23. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
24. Connect a heavy gauge guard cable between the DUT and the 5790B.
25. From Table 18, step 33, output from the DUT/Measure with the 5790B and record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 33 to 42.
26. Set the Product to STBY.
27. Connect the test equipment as shown in Figure 23.

Figure 23. Amps AC with A40B-100mA



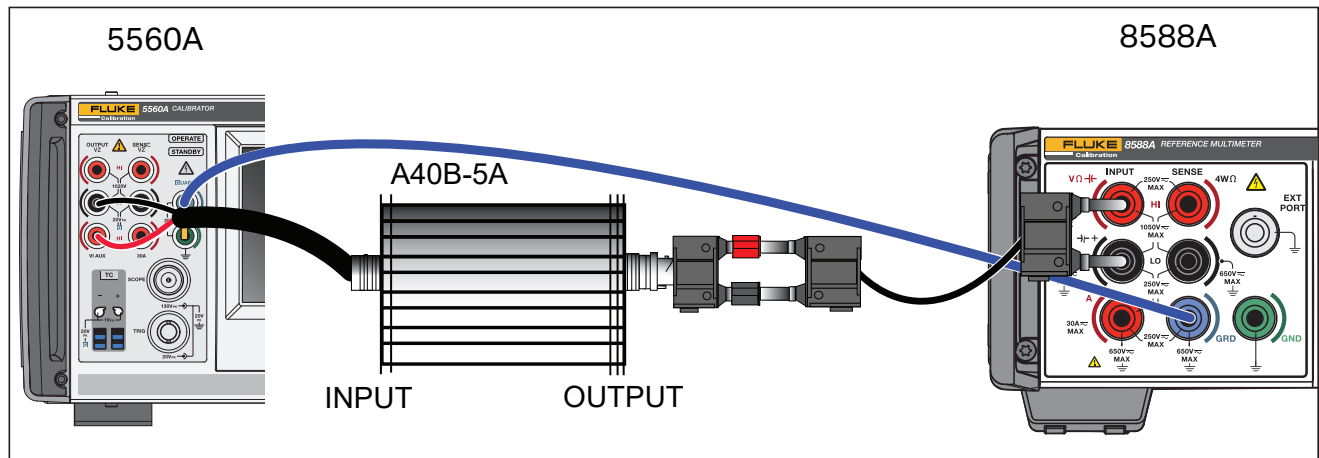
28. From step 43, Table 18, set the output from the DUT/Measure with the meter and record the 8588A measurement in the **DMM Reading on Shunt Output [V]** column.
29. Complete Table 18, steps 43 and 44.
30. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
31. Set the 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 Table 18, step 45, output from the DUT/Measure with the 5790B and record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 45 to 54.
34. Set the Product to STBY.
35. Connect the test equipment as shown in Figure 24.

Figure 24. Amps AC with A40B-1A



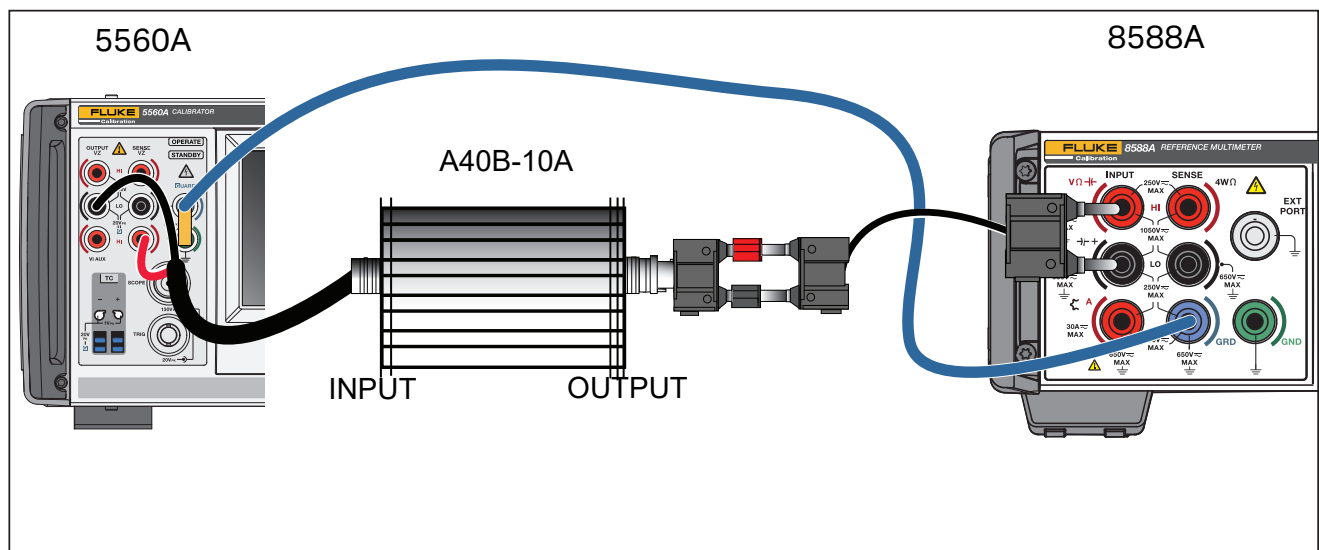
36. From Table 18, step 55, set the output from the DUT and wait 30 seconds for the output to settle. Measure with the meter and record the 8588A measurement in the **DMM Reading on Shunt Output [V]** column.
37. Complete Table 18, step 55 and 56.
38. Disconnect the shunt output cable from the 8588A 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 18, output from the DUT/Measure with the 5790B and record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 57 to 65.
42. Set the Product to STBY.
43. Connect the test equipment as shown in Figure 25.
44. From step 66, Table 18, 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 18, output from the DUT and Measure with the 5790B. Record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 67 to 70.
49. Set the Product to STBY.

Figure 25. Amps AC with A40B-5A



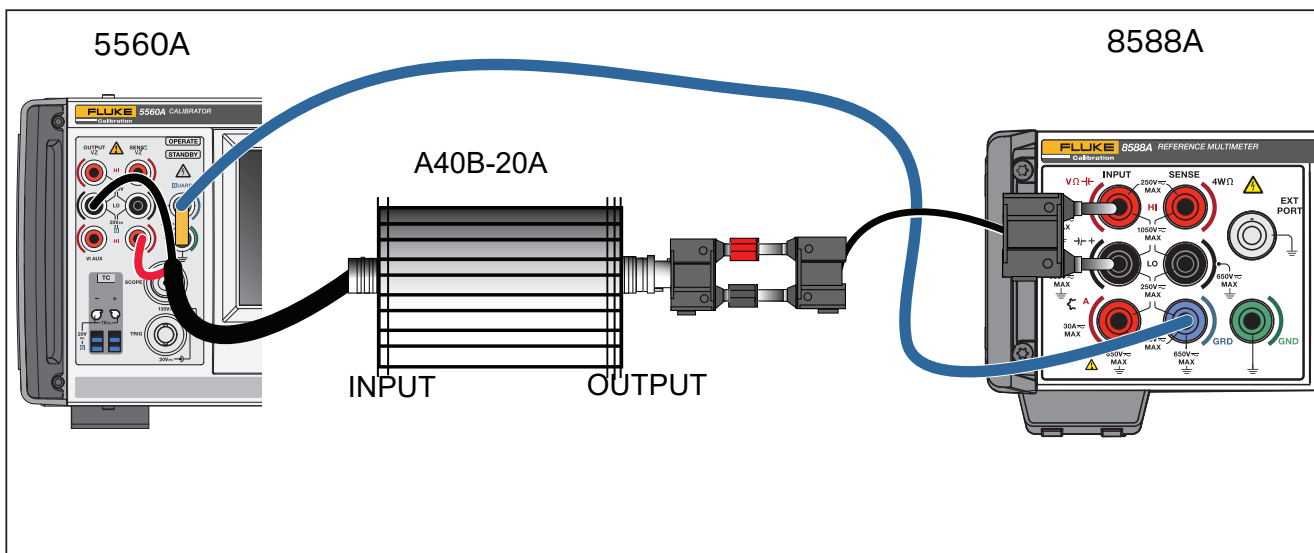
50. Move the red lead connected to the Product VI AUX to the 30 A terminal.
51. Move the connection of the shunt output to the 8588A.
52. From step 71, Table 18, output from the DUT and measure with the meter. Record the 8588A measurement in the **DMM Reading on Shunt Output [V]** column.
53. Disconnect 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 18, output from the DUT and measure with the 5790B and record the measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 72 to 75.
57. Set the Product to STBY.
58. Connect the test equipment as shown in Figure 26.

Figure 26. Amps AC with A40B-10A



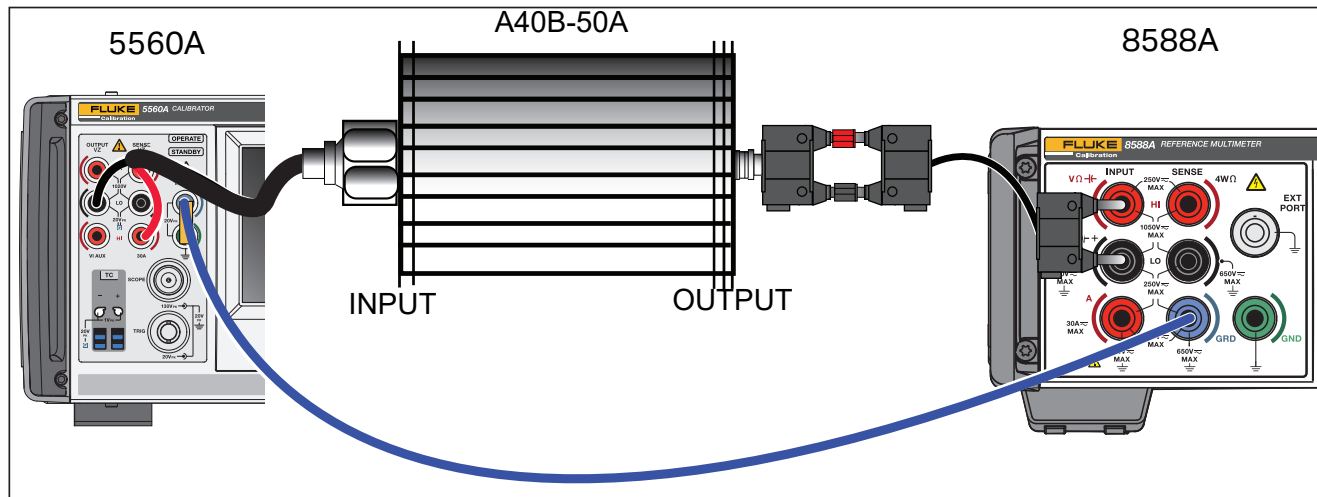
59. From step 76, Table 18, output from the DUT, wait 3 minutes for the output to settle. Measure with the meter and record the 8588A measurement in the **DMM Reading on Shunt Output [V]** column.
60. Disconnect the shunt output cable from the 8588A and connect to the 5790B Input 2.
61. Set the 5790B 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 18, output from the DUT and measure with the 5790B. Record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 77 to 80.
64. Set the Product to STBY.
65. Connect the test equipment as shown in Figure 27.

Figure 27. Amps AC with A40B-20A



66. From step 81, Table 18, 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 18, output from the DUT and measure with the 5790B. Record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, steps 82 to 88.
72. Set the Product to STBY.
73. Connect the test equipment as shown in Figure 28.

Figure 28. Amps AC with A40B-50A



74. From step 89, Table 18, 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 18, output from the DUT and measure with the 5790B. Record the 5790B measurement in the **DMM Reading on Shunt Output [V]** column. Complete Table 18, 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. To apply Guardbanding, create a table from the example in this manual where the acceptance limits are the properly modified by your Guardbanding method.

Table 18. Calibration and Verification 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
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

Table 18. Calibration and Verification 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
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
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

Table 18. Calibration and Verification 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
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
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

Table 18. Calibration and Verification 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
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
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

Table 18. Calibration and Verification Steps for Amps AC (cont.)

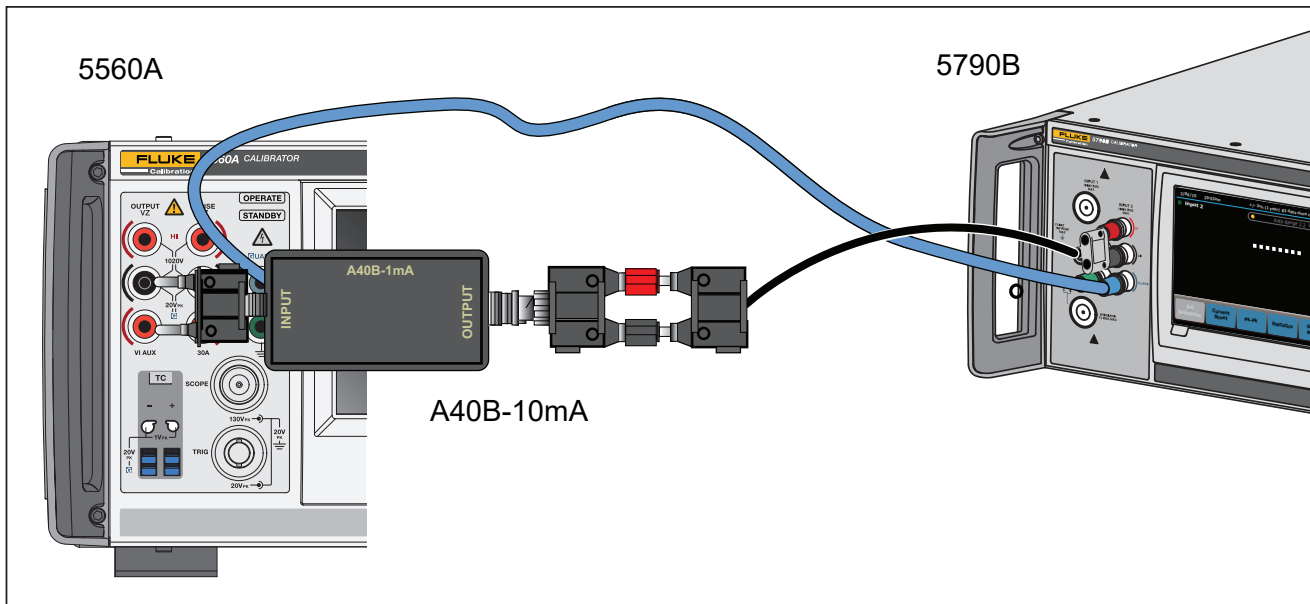
Step	Product Range	Product Output	Product Frequency	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	Limits
88	30.2 A	20 A	5 kHz	Fluke A40B-20A				±88 mA
89	30.2 A	30 A	3 Hz	Fluke A40B-50A				±34 mA
90	30.2 A	30 A	45 Hz	Fluke A40B-50A				±25 mA
91	30.2 A	30 A	1 kHz	Fluke A40B-50A				±25 mA
92	30.2 A	30 A	5 kHz	Fluke A40B-50A				±128 mA

AC Power. Amps AC Calibration and Verification (5530A, 5550A and 5560A)

This section applies to devices with **Firmware 4.0** or later.

1. Set the Product to STBY before you make any connection changes.
2. Connect the test equipment as shown in Figure 29.
3. Calculate the shunt resistance in Ω from calibration records and/or regression analysis for all shunts listed in Table 19. Use the A40B series Users Manual for guidance to calculate shunt ac resistance for every point in the calibration record.
4. Record the shunt resistance for each step in Ω in the **Shunt_R** column in Table 19.

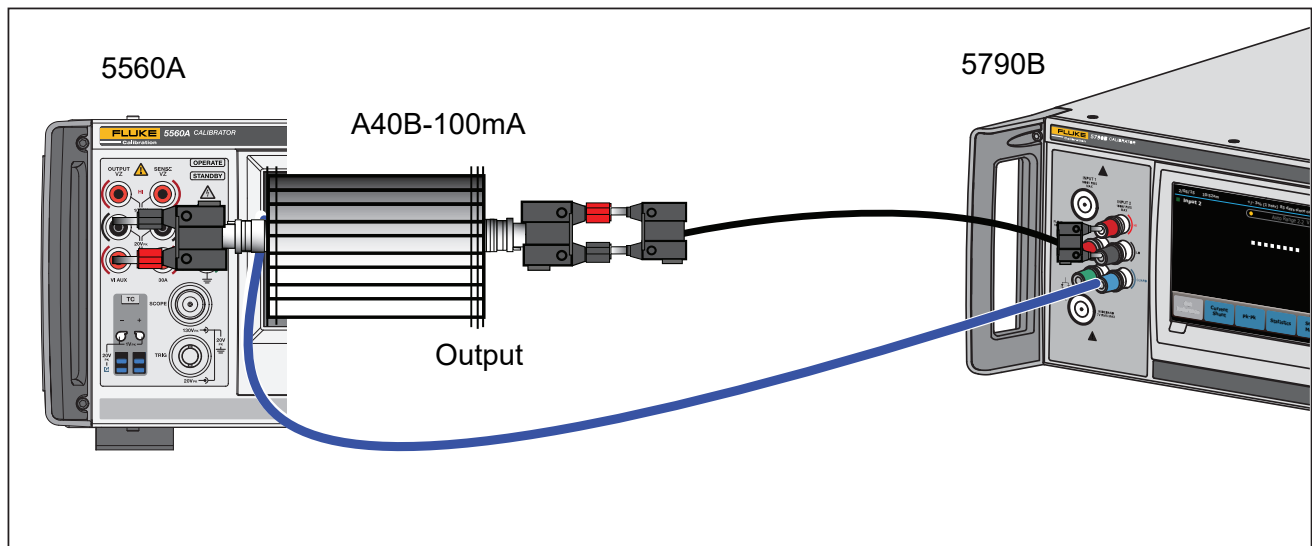
Figure 29. ACP - Amps AC with A40B-10 mA



The setup of the Product is: AC Current as fundamental, AC Voltage set to 3rd harmonic, phase set to 0 degrees.

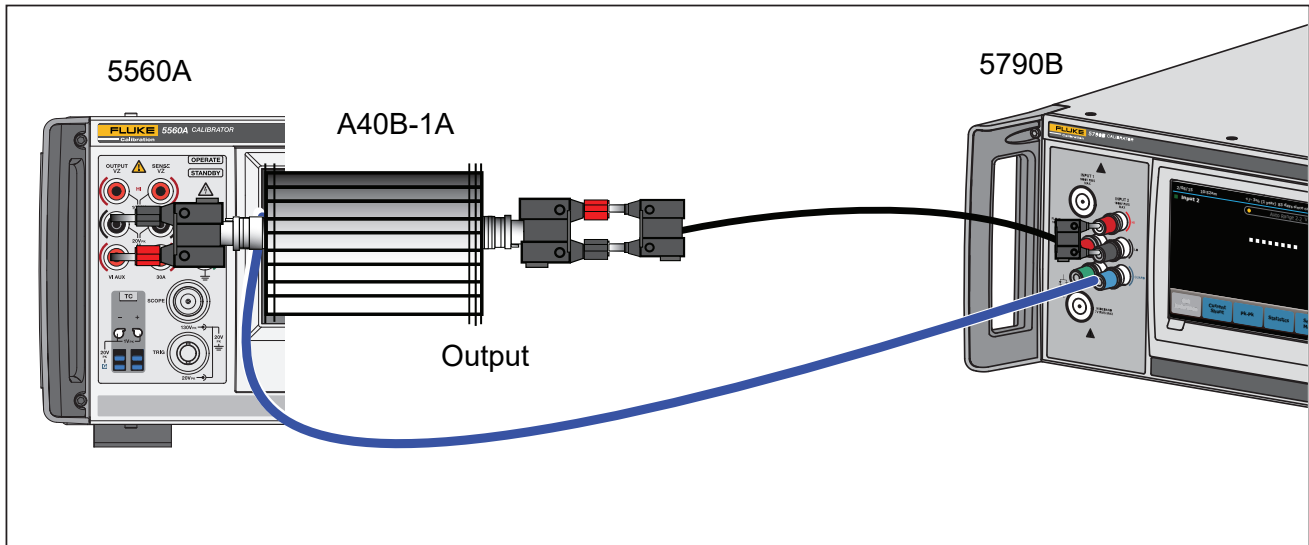
5. Set the 5790B for Input 2, Auto range, High resolution ON, GUARD ON.
6. Connect a heavy gauge guard cable between the DUT and the 5790B.
7. Set the Product to the first step in Table 19, make a measurement with the 5790B. Record the measurement in the **DMM Reading on Shunt Output [V]** column of the table.
8. Complete steps 2 to 4 of the table.
9. Set the Product to STBY.
10. Connect the test equipment as in Figure 30.

Figure 30. ACP - Amps AC with A40B-100mA



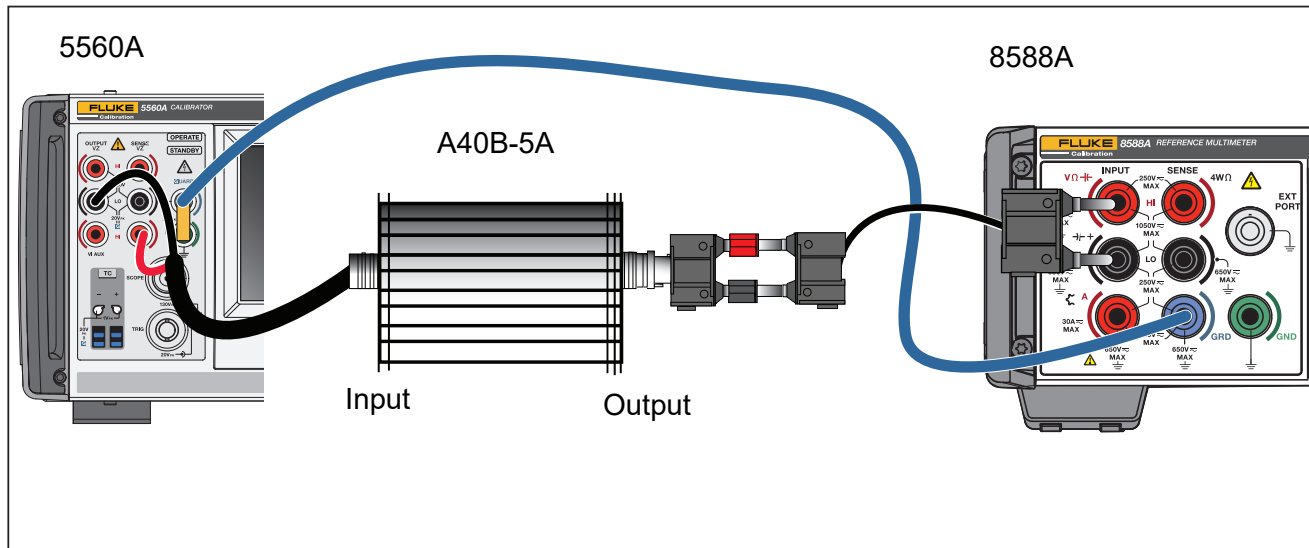
11. Connect a heavy gauge guard cable between the DUT and the 5790B.
12. Set the Product stimulus per step 5 in Table 19, make a measurement with the 5790B. Record the measurement in the **DMM Reading on Shunt Output [V]** column of the table.
13. Complete Table 19, steps 6 to 8.
14. Set the Product to STBY.
15. Connect the test equipment as shown in Figure 31.

Figure 31. ACP - Amps AC with A40B-1A



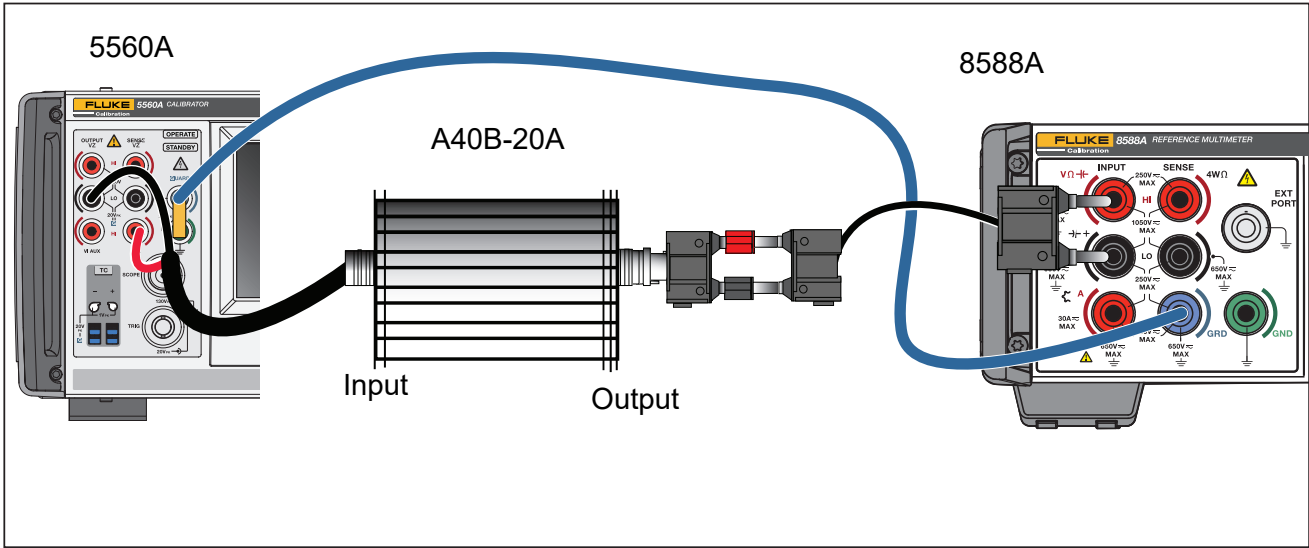
16. Set the Product stimulus per step 9 in Table 19, make a measurement with the 5790B. Record the measurement in the **DMM Reading on Shunt Output [V]** column of Table 19.
17. Set the Product to STBY.
18. Connect the test equipment as shown in Figure 32.

Figure 32. ACP-Amps AC with A40B-5A



19. Set the Product stimulus per step 10 in Table 19 and make a measurement with the 5790B. Record the measurement in the **DMM Reading on Shunt Output [V]** column of the table.
20. Set the Product to STBY.
21. Connect the test equipment as shown in Figure 33.

Figure 33. ACP -Amps AC with A40B-20A



22. Set the Product stimulus per step 11 in Table 19 and make a measurement with the 5790B. Record the measurement in the **DMM Reading on Shunt Output [V]** column of the table.
23. Set the Product to STBY.
24. 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.

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

25. With the entire table populated, evaluate each step for compliance to limits. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.
26. Set the Product to STBY.

Table 19. Calibration and Verification steps for AC Power - Amps AC

Step	Product Output	Product Frequency	Product Phase	Shunt	Shunt_R [\u03a9]	DMM Reading on Shunt Output [V]	Calculated Product Output	90D Specification Limits
1	1020 V/ 0.012001 A	333 Hz	0 \u00b0	Fluke A40B-10mA				\u00b111 \u03bcA
2	500 V/ 0.012001 A	1666 Hz	0 \u00b0	Fluke A40B-10mA				\u00b111 \u03bcA
3	250 V/ 0.012001 A	3333 Hz	0 \u00b0	Fluke A40B-10mA				\u00b118 \u03bcA

Table 19. Calibration and Verification steps for AC Power - Amps AC (cont.)

Step	Product Output	Product Frequency	Product Phase	Shunt	Shunt_R [Ω]	DMM Reading on Shunt Output [V]	Calculated Product Output	90D Specification Limits
4	120 V/ 0.012001 A	10000 Hz	0 °	Fluke A40B-10mA				±34 μA
5	1020 V/ 0.12001 A	333 Hz	0 °	Fluke A40B-100mA				±0.12 mA
6	500 V/ 0.12001 A	1666 Hz	0 °	Fluke A40B-100mA				±0.12 mA
7	250 V/ 0.12001 A	3333 Hz	0 °	Fluke A40B-100mA				±0.18 mA
8	120 V/ 0.12001 A	10000 Hz	0 °	Fluke A40B-100mA				±0.84 mA
9	1020 V/ 1.20001 A	333 Hz	0 °	Fluke A40B-1A				±0.89 mA
10	1020 V/ 3.11 A	333 Hz	0 °	Fluke A40B-5A				±4.75 mA
11	1020 V/ 12.0001 A	333 Hz	0°	Fluke A40B-20A				± 23 mA

Capacitance Calibration and Verification

Table 20 lists the required equipment.

Table 20. Required Equipment for Capacitance

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 21, 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 Cp mode.
7. Output from the Product. Measure with the LCR meter and record in Table 21.

Table 21. Calibration and Verification 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		±4.2 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.

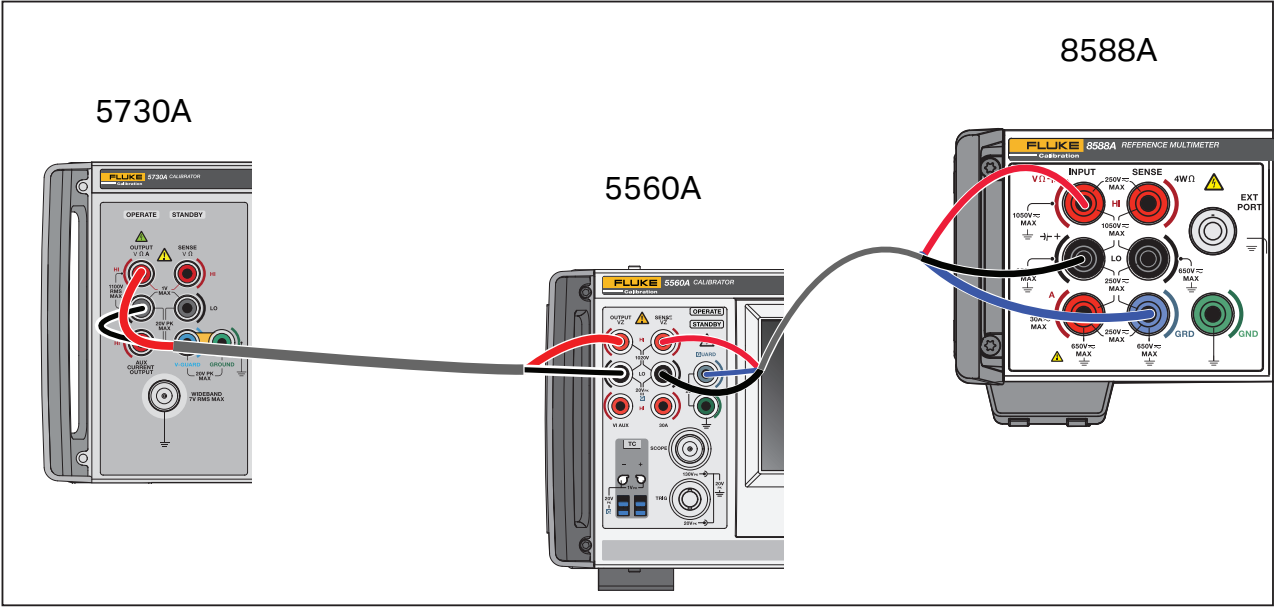
$$C = I * \frac{\Delta_t}{\Delta_v}$$

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 and verification:

9. Connect the precision current source, the sampling DMM (8588A) and the Product as shown in Figure 34.
10. Set the 8588A as follows:
 - Reset meter
 - Set Initiate Layer to Continuous OFF
 - Volts dc
 - Range 1 V (10 V for $C \geq 1.21$ 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 22. 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 22 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 34. Capacitance Charge Connection



The Calculated Product Output is calculated with this formula:

$$\text{Calculated Product Output} = \text{Test_current} * \frac{5}{\Delta_v}$$

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. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 22. Calibration and Verification 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 Calibration and Verification (5550A and 5560A)

Table 23 lists the required equipment.

Table 23. Required Equipment for Inductance

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 24, 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 Ls mode.
7. Output each value from the Product. Measure with the LCR meter and record in Table 24.

Table 24. Calibration and Verification Steps for Inductance with LCR Meter

Step	Product Range	Product Output	Test Frequency	Calculated Product Output	Limits
1	120 μ H	15 μ H	1000 Hz		± 227 nH
2	120 μ H	100 μ H	1000 Hz		± 380 nH
3	1.2 mH	121 μ H	1000 Hz		± 1.13 μ H
4	1.2 mH	1 mH	1000 Hz		± 2.1 μ H
5	12 mH	1.21 mH	110 Hz		± 11.3 μ H
6	12 mH	2 mH	110 Hz		± 12.2 μ H
7	12 mH	3 mH	110 Hz		± 13.3 μ H
8	12 mH	5 mH	110 Hz		± 15.5 μ H
9	12 mH	10 mH	110 Hz		± 21.0 μ H
10	12 mH	12 mH	110 Hz		± 23.2 μ H
11	120 mH	12.1 mH	100 Hz		± 113 μ H
12	120 mH	100 mH	100 Hz		± 210 μ H
13	1.2 H	0.121 H	10 Hz		± 1157 μ H
14	1.2 H	1 H	10 Hz		± 2.3 mH

Table 24. Calibration and Verification Steps for Inductance with LCR Meter (cont.)

Step	Product Range	Product Output	Test Frequency	Calculated Product Output	Limits
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. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Thermocouple Calibration and Verification

Table 25 lists the required equipment.

Table 25. Required Equipment for Thermocouple

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 26.

8. Take a measurement with the Product and record in the **Product Measurement** column of Table 26.
9. Take a measurement with the thermometer system and record in the **Thermometer Measurement** column of Table 26.
10. Calculate the Product input error as follows:

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

Table 26. Type J Thermocouple Calibration and Verification

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 27, 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 27.
9. Calculate the Product input error as follows:

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

Table 27. 10 µV/°C Measure Thermocouple Calibration and Verification

Step	Temp	Amplitude	Function	Step	Temperature Set Point	External Voltage Source Output Equivalent	Product Measurement	Calculated 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 28, 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 27.
10. Continue with the remainder of the steps in Table 28.
11. Calculate the Product input error as follows:

$$Product\ Input\ error = DMM_{meas_^{\circ}C} - Prod_{output\ (V)}$$

Table 28. 10 $\mu\text{V}/^\circ\text{C}$ Source Thermocouple Calibration and Verification

Step	Product Temperature Output setting	Product Output Equivalent	DMM Measurement on Product	Calculated Product Output Error [$^\circ\text{C}$]	Limits
1	0 $^\circ\text{C}$	0 mV			$\pm 1.00 \mu\text{V}$
2	1000 $^\circ\text{C}$	10 mV			$\pm 1.16 \mu\text{V}$
3	-1000 $^\circ\text{C}$	-10 mV			$\pm 1.16 \mu\text{V}$
4	5000 $^\circ\text{C}$	50 mV			$\pm 1.80 \mu\text{V}$
5	-5000 $^\circ\text{C}$	-50 mV			$\pm 1.80 \mu\text{V}$
6	10000 $^\circ\text{C}$	100 mV			$\pm 2.60 \mu\text{V}$
7	-10000 $^\circ\text{C}$	-100 mV			$\pm 2.60 \mu\text{V}$

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

Phase Calibration and Verification (5530A, 5550A, and 5560A)

Table 29 lists the required equipment.

Table 29. Required Equipment for Phase

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 ($\approx 16''$)	(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 30, 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 30.

Table 30. Phase Calibration and Verification 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**.



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 31 with the Shunt Phase Error. Obtain the phase error from the A40B specifications or phase calibration and verification process.
5. Starting with step 8, Table 31, 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 31.
8. Complete Table 31, steps 8 to 19 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 Table 31, steps 20 and 21.
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 31.
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. To apply Guardbanding, create a table from the example in this manual, where the acceptance limits are properly modified by your Guardbanding method.

Table 31. Phase Calibration and Verification 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 °

Table 31. Phase Calibration and Verification Record for V/I (cont.)

Step	Product Output	Product Frequency	Product Phase	Shunt Phase Error	Measured Product Output	Calculated Product Output	Limits
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 and Verification

Table 32 lists the required equipment.

Table 32. Required Equipment for Frequency

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 M Ohm 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 33. 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 33. Frequency Calibration and Verification

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

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 push 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 keypad 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 adjustment steps are available from the front panel interface as well as the remote interface (IEEE-488 or serial). Remote commands for calibration adjustment are described in the 5560A/5550A/5540A/5530A *Remote Programmers Manual* located at www.fluke.com.

Start the 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, 5540A, or 5530A.
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 shows:

**DCV * ACV * Frequency * DCI * DCV DCV¹ * ACI * ACV ACV¹ * Resistance
Capacitance * Inductance¹ * TC_source * TC_meas**

Note

DCV DCV (V dc out of the secondary output) and ACV ACV (V ac out of the secondary output) are not available on the 5540A. Inductance is not available on the 5540A and 5530A.

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

Volts DC 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 shows a connect prompt, connect the 8588A for vdc measurement with a low thermal cable. Table 4 is a list of equipment required. Make the connection and tap **Continue**.
5. When the Product shows 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 subsequent section.

Volts AC Adjustment (OUTPUT VZ)

The Product begins the adjustment with internal steps. The volts ac calibration adjustment 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 M Ω , Guard ON (external guard)
2. Set the 5790B for Input 2, Auto range, High resolution ON, EXT GUARD.
3. When the Product shows a connect prompt, tap **Continue**.
4. At this time, the Product shows 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 subsequent section.

Frequency Adjustment (OUTPUT VZ)

The frequency calibration adjustment requires a frequency counter - see Table 32 for the recommended model/requirements.

1. When the Product shows 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 M Ω Input Impedance, Amplitude 3 V.
3. For each step in this function, set to **OPERATE** when prompted.
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 subsequent section.

Amps DC 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 shows a connect prompt, connect the 8588A for Idc measurement with a heavy gauge low thermal cable. Make the connection and tap **Continue**.
3. When the Product shows 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 subsequent section.

Volts DC (DCV DCV) Adjustment (Secondary Output) (5530A, 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 subsequent section.

Amps AC 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 subsequent section.

Volts AC (ACV ACV) Adjustment (Secondary Output) (5530A, 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 subsequent section.

Resistance 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 k Ω , 1.21 M Ω .
9. When a section is complete, the Product highlights the subsequent section.

Capacitance 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 34 for test frequency setup.

Table 34. Adjustment 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 μ F	100 Hz
12	1 μ F	100 Hz
13	1.21 μ F	80 Hz
14	10 μ F	80 Hz
15	12.1 μ F	20 Hz
16	100 μ F	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 Table 34, steps 6 to 9 until you complete all points in the sequence.
11. Alternatively, Table 34, 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 subsequent section.

Inductance 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 35 for the test frequency setup.

Table 35. Adjustment Steps for Inductance with LCR Meter

Step	Product Output	Test Frequency
1	15 μ H	1000 Hz
2	100 μ H	1000 Hz
3	121 μ H	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 35. Adjustment 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 Table 35, steps 5 to 8 until you complete all points in the sequence.
8. When a section is complete, the Product highlights the subsequent section.

TC Source 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 subsequent section.

TC Measure 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 - t_{cerror} .
10. Take a measurement with the thermometer system - $Thermometer_{meas}$.
11. Calculate the Thermometry System output as:
$$Standard\ temperature = Thermometer_{meas} - t_{cerror}$$
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.

Oscilloscope Calibration Option (600M, 1G, and 2G) Calibration, Verification, and Adjustment

This section documents the calibration, verification, and adjustment procedures of the Oscilloscope Calibration Option (scope option). Scope options are available for the 5560A, 5550A, and 5540A.

When you use the recommended equipment, these procedures supply traceable results for all scope option functions. The necessary equipment and minimum specifications are shown in Table 36.

Fluke recommends that you send your Product to Fluke for calibration, verification, and adjustment. See [Contact Fluke Calibration](#). However, these procedures allow you to adjust the calibration and verify the scope option at your site if necessary. Read through all procedures before you do them to make sure you have the necessary resources.

Hardware adjustments made after repair, at the factory, or designated Fluke service centers, are supplied in this manual.

Required Equipment for Calibration, Verification, and Adjustment

Table 36 summarizes the required equipment used for the calibration adjustment and verification tests of the scope option. Individual lists of required equipment are included at the start of each test. The equipment and methods in this manual are simplified to make it possible to calibrate the Product without advanced metrological techniques and can result in low-test uncertainty ratios.

Table 36. Required Equipment for Scope Option

Equipment Description	Manufacture/Model	Application
AC Measurement Standard - 50 MHz Wideband option	Fluke 5790B/5	Leveled Sine Amplitude, Leveled Sine Flatness Low Frequency
Calibrator	Fluke 5560A/2G	Measure Resistance Leveled Sine Reflection Coefficient
Reference Multimeter	Fluke 8588A	V dc, V ac and Waveform Generator
RF Bridge	Keysight 86205A	Leveled Sine Reflection Coefficient
E-Series Power Sensor	Keysight E9304A	Leveled Sine Flatness Leveled Sine Reflection Coefficient
EPM Series Power Meter	Keysight N1913B	Leveled Sine Flatness Leveled Sine Reflection Coefficient
Arbitrary Function Generator	Tektronix AFG1022	Leveled Sine Reflection Coefficient
Mixed Signal Oscilloscope	Tektronix MSO64B	Edge Rise Time Pulse width Time Marker Period
Type N (M) to Type N (M) adapter	CentricRF – C5552	Leveled Sine Reflection Coefficient
Type N (M) to BNC (F) adapter	CentricRF – C5032	Leveled Sine Flatness Leveled Sine Reflection Coefficient
Type N (F) to BNC (F) adapter	CentricRF – C5003	Leveled Sine Flatness
BNC (F) to dual banana plug adapter	Pomona – 1269	V dc, V ac and Waveform Generator Measure resistance
Shorting Cap for BNC (F)	Pasternack – PE6012	Leveled Sine Reflection Coefficient
BNC (M-F) 50 Ω Feed-Thru termination	CentricRF – CFT508	V dc, V ac and Waveform Generator

Scope Option Calibration and Verification

DC Voltage Calibration and Verification

This procedure uses:

- Fluke 8588A Reference Multimeter
- BNC(f) to Double Banana adapter
- BNC(m-f) Feed-Thru Termination 50 Ω
- Output Scope card cable supplied with the scope option

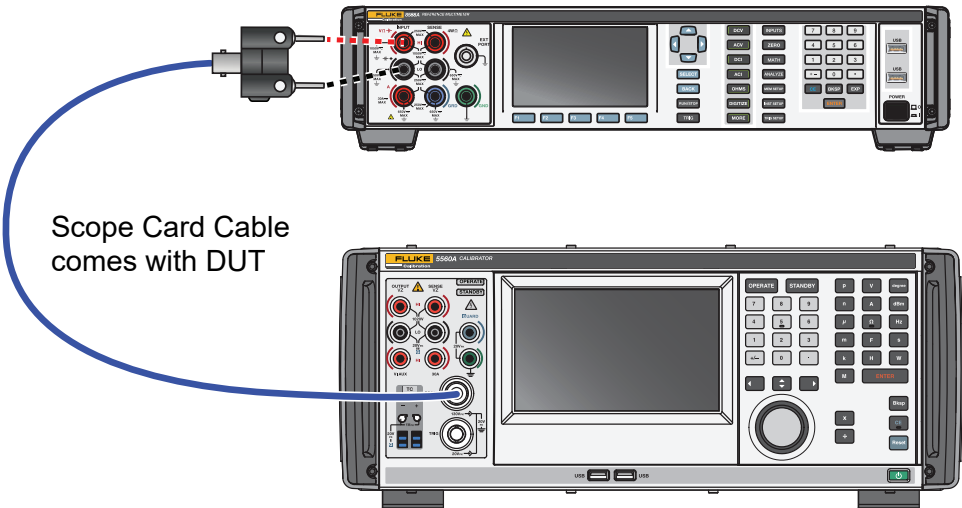
Initial setup:

Set the Product to Scope dc voltage (**Function Menu > Scope > DCV**).

DC Voltage Signal into 1 MΩ Calibration and Verification

1. Make the connections shown in Figure 35.

Figure 35. Equipment Connections for Scope Option DCV, ACV and Edge Adjustment – into 1 M Ohm



2. Make sure the Calibrator is set to 1 MΩ.
3. Set the 8588A to DCV, front input, 60.00 PLC and Zin = 1 MΩ.
4. Set the Calibrator SCOPE output to the voltages in Table 37.
5. Push **OPERATE** on the Calibrator. Let the 8588A measurement become stable.
6. Record the 8588A measurement for each voltage in Table 37.
7. Compare the result to the **Tolerance ±(V dc)** column in Table 37.

Table 37. DC Voltage Calibration and Verification at 1 MΩ

Calibrator Output	8588A Measurement (V dc)	Tolerance ±(V dc)
0 mV		4.000E-05 V
-0.001 mV		4.000E-05 V
5 mV		4.250E-05 V
-5 mV		4.250E-05 V
5.1 mV		4.255E-05 V
-5.1 mV		4.255E-05 V
20 mV		5.000E-05 V
-20 mV		5.000E-05 V
21 mV		5.050E-05 V
-21 mV		5.050E-05 V
50 mV		6.500E-05 V

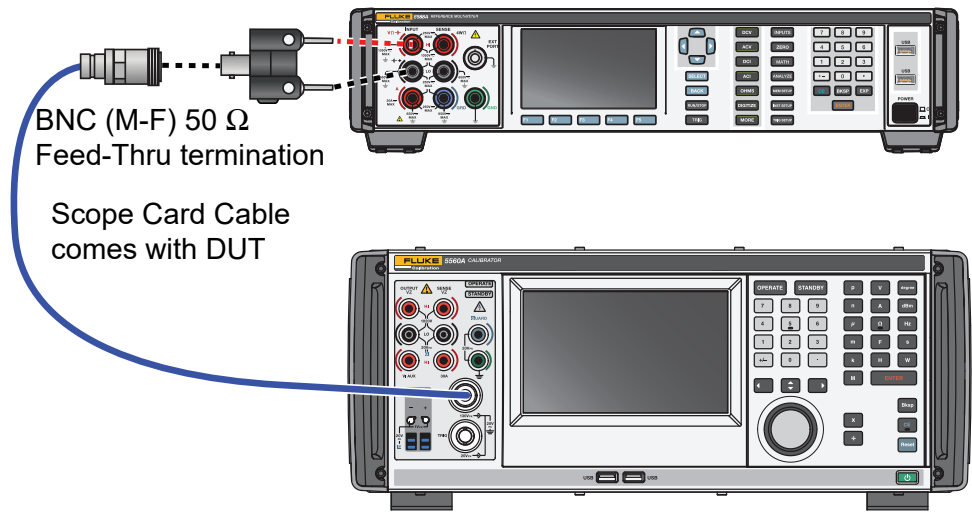
Table 37. DC Voltage Calibration and Verification at 1 M Ω (cont.)

Calibrator Output	8588A Measurement (V dc)	Tolerance $\pm$ (V dc)
-50 mV		6.500E-05 V
51 mV		6.550E-05 V
-51 mV		6.550E-05 V
200 mV		1.400E-04 V
-200 mV		1.400E-04 V
201 mV		1.405E-04 V
-201 mV		1.405E-04 V
500 mV		2.900E-04 V
-500 mV		2.900E-04 V
501 mV		2.905E-04 V
-501 mV		2.905E-04 V
6.6 V		3.340E-03 V
-6.6 V		3.340E-03 V
6.7 V		3.390E-03 V
-6.7 V		3.390E-03 V
9.5 V		4.790E-03 V
-9.5 V		4.790E-03 V
12 V		6.040E-03 V
-12 V		6.040E-03 V
12.1 V		6.090E-03 V
-12.1 V		6.090E-03 V
65 V		3.254E-02 V
-65 V		3.254E-02 V
120 V		6.004E-02 V
-120 V		6.004E-02 V

DC Voltage Signal into 50 Ω Calibration and Verification

1. Make the connections shown in Figure 36.

Figure 36. Equipment Connections Scope Option DCV, ACV and Edge Adjustment – into 50 Ohm



2. Set the Calibrator to 50 Ω.
3. Set the 8588A to DCV, Front input, 60.00 PLC and Zin = 1 MΩ.
4. Set the Calibrator SCOPE output to the voltages in Table 38.
5. Push **OPERATE** on the Calibrator. Let the 8588A measurement become stable.
6. Record the 8588A measurement for each voltage in Table 38.
7. Compare the result to the **Tolerance ±(V dc)** column.

Table 38. 10 DC Voltage Calibration and Verification into 50 Ω

Calibrator Output	Fluke 8588A Measurement (V dc)	Tolerance ±(V dc)
0 mV		4.000E-05 V
-0.001 mV		4.000E-05 V
5 mV		5.250E-05 V
-5 mV		5.250E-05 V
5.1 mV		5.275E-05 V
-5.1 mV		5.275E-05 V
20 mV		9.000E-05 V
-20 mV		9.000E-05 V
21 mV		9.250E-05 V
-21 mV		9.250E-05 V
50 mV		1.650E-04 V

Table 38. 10 DC Voltage Calibration and Verification into 50 Ω (cont.)

Calibrator Output	Fluke 8588A Measurement (V dc)	Tolerance $\pm$ (V dc)
-50 mV		1.650E-04 V
51 mV		1.675E-04 V
-51 mV		1.675E-04 V
200 mV		5.400E-04 V
-200 mV		5.400E-04 V
201 mV		5.425E-04 V
-201 mV		5.425E-04 V
500 mV		1.290E-03 V
-500 mV		1.290E-03 V
501 mV		1.293E-03 V
-501 mV		1.293E-03 V
6.6 V		1.654E-02 V
-6.6 V		1.654E-02 V

AC Voltage Amplitude Calibration and Verification

This procedure uses:

- Fluke 8588A Reference Multimeter
- BNC(f) to Double Banana adapter
- BNC(m-f) Feed-Thru Termination 50 Ω
- Output Scope Card cable supplied with the scope option

Initial Setup:

Set the Product to Scope ac voltage (**Function Menu > Scope > ACV**).

AC Voltage Signal into 1 M Ω Calibration and Verification

1. Make the connections shown in Figure 35.
2. Make sure the Calibrator is set to 1 M Ω .

8588A settings:

- Function: Digitize
- Input > Terminal > Front
- Coupling, Zin: DC, 1 M Ω
- Measure Setup > Low pass filter: 3 MHz
- Measure Setup > Range: base on AC voltage adjust point

- Measure Setup > Aperture: calculated by the this equation:

$$\text{Sample Rate} = 100 * \text{Adjust Frequency}$$

(If Sample Rate > 5000000.0, use 5000000.0)

$$\text{Aperture} = (1 / \text{Sample Rate}) - 0.0000002$$

- Trigger Setup > Triggers/Arm (Count): calculated with this equation:

$$\text{TriggerCount} = 100 * (\text{SampleRate} / \text{Adjust Frequency})$$

- Set the Calibrator SCOPE output to the voltages in Table 39.
- Push **OPERATE** on the Calibrator.
- On the 8588A, push the **TRIG** softkey to collect data from the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.

To process the data, separate the data into two groups:

- Top level: MEDIAN of all readings >90% of reference level
- Base level: MEDIAN of all readings <10% of reference level

The measurement value is calculated as:

$$\text{median of Top line} - \text{median of base line}$$

- Record the 8588A measurement for each voltage in Table 39.
- Compare the results to those in the **Tolerance ±(V dc)** column.

Table 39. AC Voltage Calibration and Verification into 1 MΩ

Calibrator Output	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V ac)	Tolerance ±(V ac)
-1 mV 1 kHz	0.0000098 s	10000		4.100E-05 V
1 mV 1 kHz	0.0000098 s	10000		4.100E-05 V
-2 mV 1 kHz	0.0000098 s	10000		4.200E-05 V
2 mV 1 kHz	0.0000098 s	10000		4.200E-05 V
-2.01 mV 1 kHz	0.0000098 s	10000		4.201E-05 V
2.01 mV 1 kHz	0.0000098 s	10000		4.201E-05 V
-5 mV 1 kHz	0.0000098 s	10000		4.500E-05 V
5 mV 1 kHz	0.0000098 s	10000		4.500E-05 V
-5.1 mV 1 kHz	0.0000098 s	10000		4.510E-05 V
5.1 mV 1 kHz	0.0000098 s	10000		4.510E-05 V
-20 mV 1 kHz	0.0000098 s	10000		6.000E-05 V
20 mV 1 kHz	0.0000098 s	10000		6.000E-05 V
-21 mV 1 kHz	0.0000098 s	10000		6.100E-05 V

Table 39. AC Voltage Calibration and Verification into 1 M Ω (cont.)

Calibrator Output	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V ac)	Tolerance $\pm$ (V ac)
21 mV 1 kHz	0.0000098 s	10000		6.100E-05 V
-50 mV 1 kHz	0.0000098 s	10000		9.000E-05 V
50 mV 1 kHz	0.0000098 s	10000		9.000E-05 V
-51 mV 1 kHz	0.0000098 s	10000		9.100E-05 V
51 mV 1 kHz	0.0000098 s	10000		9.100E-05 V
-200 mV 1 kHz	0.0000098 s	10000		2.400E-04 V
200 mV 1 kHz	0.0000098 s	10000		2.400E-04 V
-201 mV 1 kHz	0.0000098 s	10000		2.410E-04 V
201 mV 1 kHz	0.0000098 s	10000		2.410E-04 V
-500 mV 1 kHz	0.0000098 s	10000		5.400E-04 V
500 mV 1 kHz	0.0000098 s	10000		5.400E-04 V
-501 mV 1 kHz	0.0000098 s	10000		5.410E-04 V
501 mV 1 kHz	0.0000098 s	10000		5.410E-04 V
-2 V 1 kHz	0.0000098 s	10000		2.040E-03 V
2 V 1 kHz	0.0000098 s	10000		2.040E-03 V
-2.01 V 40.01 Hz	0.0002498 s	10000		2.050E-03 V
2.01 V 40.01 Hz	0.0002498 s	10000		2.050E-03 V
-2.01 V 1 kHz	0.0000098 s	10000		2.050E-03 V
2.01 V 1 kHz	0.0000098 s	10000		2.050E-03 V
-2.01 V 10 kHz	0.0000008 s	10000		5.065E-03 V
2.01 V 10 kHz	0.0000008 s	10000		5.065E-03 V
-6.6 V 40.01 Hz	0.0002498 s	10000		6.640E-03 V
6.6 V 40.01 Hz	0.0002498 s	10000		6.640E-03 V
-6.6 V 1 kHz	0.0000098 s	10000		6.640E-03 V
6.6 V 1 kHz	0.0000098 s	10000		6.640E-03 V
-6.6 V 10 kHz	0.0000008 s	10000		1.654E-02 V
6.6 V 10 kHz	0.0000008 s	10000		1.654E-02 V
-6.7 V 40.01 Hz	0.0002498 s	10000		6.740E-03 V

Table 39. AC Voltage Calibration and Verification into 1 M Ω (cont.)

Calibrator Output	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V ac)	Tolerance $\pm$ (V ac)
6.7 V 40.01 Hz	0.0002498 s	10000		6.740E-03 V
-6.7 V 1 kHz	0.0000098 s	10000		6.740E-03 V
6.7 V 1 kHz	0.0000098 s	10000		6.740E-03 V
-6.7 V 10 kHz	0.0000008 s	10000		1.679E-02 V
6.7 V 10 kHz	0.0000008 s	10000		1.679E-02 V
-15 V 40.01 Hz	0.0002498 s	10000		1.504E-02 V
15 V 40.01 Hz	0.0002498 s	10000		1.504E-02 V
-15 V 1 kHz	0.0000098 s	10000		1.504E-02 V
15 V 1 kHz	0.0000098 s	10000		1.504E-02 V
-15 V 10 kHz	0.0000008 s	10000		3.754E-02 V
15 V 10 kHz	0.0000008 s	10000		3.754E-02 V
-15.1 V 40.01 Hz	0.0002498 s	10000		1.514E-02 V
15.1 V 40.01 Hz	0.0002498 s	10000		1.514E-02 V
-15.1 V 1 kHz	0.0000098 s	10000		1.514E-02 V
15.1 V 1 kHz	0.0000098 s	10000		1.514E-02 V
-15.1 V 10 kHz	0.0000008 s	10000		3.779E-02 V
15.1 V 10 kHz	0.0000008 s	10000		3.779E-02 V
-120 V 40.01 Hz	0.0002498 s	10000		1.200E-01 V
120 V 40.01 Hz	0.0002498 s	10000		1.200E-01 V
-120 V 1 kHz	0.0000098 s	10000		1.200E-01 V
120 V 1 kHz	0.0000098 s	10000		1.200E-01 V
-120 V 10 kHz	0.0000008 s	10000		3.000E-01 V
120 V 10 kHz	0.0000008 s	10000		3.000E-01 V

AC Voltage Signal into 50 Ω Calibration and Verification

1. Make the connections shown in Figure 36.
2. Make sure the Product is set to 50 Ω .

8588A settings:

- Function: Digitize
- Input > Terminal > Front
- Coupling, Zin: DC, 1 M Ω
- Measure Setup > Low pass filter: 3 MHz
- Measure Setup > Range: base on ac voltage adjust point
- Measure Setup > Aperture: calculated with this equation:

$$\begin{aligned} \text{Sample Rate} &= 100 * \text{Adjust Frequency} \\ (\text{If Sample Rate} > 5000000.0, \text{ use } 5000000.0) \\ \text{Aperture} &= (1 / \text{Sample Rate}) - 0.0000002 \end{aligned}$$

- Trigger Setup > Triggers/Arm (Count): calculated with this equation:

$$\text{Trigger Count} = 100 * (\text{Sample Rate} / \text{Adjust Frequency})$$

3. Set the Calibrator SCOPE output to the voltages in Table 40.
4. Push **OPERATE** on the Calibrator.
5. On 8588A Reference Multimeter, push **TRIG** softkey to collect data from the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.

To process the data, separate the data into two groups:

- Top level: MEDIAN of all readings >90% of reference level
- Base level: MEDIAN of all readings <10% of reference level

The measurement value is calculated as:

$$\text{median of Top line} - \text{median of Base line}$$

6. Record the 8588A measurement for each voltage in Table 40.
7. Compare the results to those in the **Tolerance $\pm$ (V ac)** column.

Table 40. AC Voltage Calibration and Verification into 50 Ω

Calibrator Output	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V ac)	Tolerance $\pm$ (V ac)
-1 mV 1 kHz	0.0000098 s	10000		4.250E-05 V
1 mV 1 kHz	0.0000098 s	10000		4.250E-05 V
-2 mV 1 kHz	0.0000098 s	10000		4.500E-05 V
2 mV 1 kHz	0.0000098 s	10000		4.500E-05 V
-2.01 mV 1 kHz	0.0000098 s	10000		4.503E-05 V
2.01 mV 1 kHz	0.0000098 s	10000		4.503E-05 V
-5 mV 1 kHz	0.0000098 s	10000		5.250E-05 V
5 mV 1 kHz	0.0000098 s	10000		5.250E-05 V
-5.1 mV 1 kHz	0.0000098 s	10000		5.275E-05 V
5.1 mV 1 kHz	0.0000098 s	10000		5.275E-05 V
-20 mV 1 kHz	0.0000098 s	10000		9.000E-05 V
20 mV 1 kHz	0.0000098 s	10000		9.000E-05 V
-21 mV 1 kHz	0.0000098 s	10000		9.250E-05 V
21 mV 1 kHz	0.0000098 s	10000		9.250E-05 V
-50 mV 1 kHz	0.0000098 s	10000		1.650E-04 V
50 mV 1 kHz	0.0000098 s	10000		1.650E-04 V
-51 mV 1 kHz	0.0000098 s	10000		1.675E-04 V
51 mV 1 kHz	0.0000098 s	10000		1.675E-04 V
-200 mV 1 kHz	0.0000098 s	10000		5.400E-04 V
200 mV 1 kHz	0.0000098 s	10000		5.400E-04 V
-201 mV 1 kHz	0.0000098 s	10000		5.425E-04 V
201 mV 1 kHz	0.0000098 s	10000		5.425E-04 V
-500 mV 1 kHz	0.0000098 s	10000		1.290E-03 V
500 mV 1 kHz	0.0000098 s	10000		1.290E-03 V
-501 mV 1 kHz	0.0000098 s	10000		1.293E-03 V
501 mV 1 kHz	0.0000098 s	10000		1.293E-03 V
-2 V 1 kHz	0.0000098 s	10000		5.040E-03 V
2 V 1 kHz	0.0000098 s	10000		5.040E-03 V
-2.01 V 40.01 Hz	0.0002498 s	10000		5.065E-03 V

Table 40. AC Voltage Calibration and Verification into 50 Ω (cont.)

Calibrator Output	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V ac)	Tolerance $\pm$ (V ac)
2.01 V 40.01 Hz	0.0002498 s	10000		5.065E-03 V
-2.01 V 1 kHz	0.0000098 s	10000		5.065E-03 V
2.01 V 1 kHz	0.0000098 s	10000		5.065E-03 V
-2.01 V 10 kHz	0.0000008 s	10000		5.065E-03 V
2.01 V 10 kHz	0.0000008 s	10000		5.065E-03 V
-6.6 V 40.01 Hz	0.0002498 s	10000		1.654E-02 V
6.6 V 40.01 Hz	0.0002498 s	10000		1.654E-02 V
-6.6 V 1 kHz	0.0000098 s	10000		1.654E-02 V
6.6 V 1 kHz	0.0000098 s	10000		1.654E-02 V
-6.6 V 10 kHz	0.0000008 s	10000		1.654E-02 V
6.6 V 10 kHz	0.0000008 s	10000		1.654E-02 V

Waveform Generator Calibration and Verification

This procedure uses:

- Fluke 8588A Reference Multimeter
- BNC(f) to Double Banana adapter
- BNC(m-f) Feed-Thru Termination 50 Ω
- Output Scope Card cable supplied with the scope option

Initial Setup:

Set the Product to the Scope Waveform Generator function (**Function Menu > Scope > Waveform Generator**).

Calibration and Verification Signal into 1 M Ω

1. Make the connections shown in Figure 35.
2. Make sure the Calibrator is set to 1 M Ω .

8588A settings:

- Function: Digitize
- Input > Terminal > Front
- Coupling, Zin: DC, 1 M Ω
- Measure Setup > Low pass filter: 3 MHz
- Measure Setup > Range: base on ac voltage adjust point
- Measure Setup > Aperture: calculated with this equation:

$$\text{Sample Rate} = 100 * \text{Adjust Frequency}$$

(If Sample Rate > 5000000.0, use 5000000.0)

$$\text{Aperture} = (1 / \text{Sample Rate}) - 0.0000002$$

- Trigger Setup > Triggers/Arm (Count): calculated with this equation:

$$\text{TriggerCount} = 100 * (\text{SampleRate} / \text{Adjust Frequency})$$

- Set the Calibrator SCOPE voltage output and waveform as shown in Table 41.
- Push **OPERATE** on the Calibrator.
- On 8588A Reference Multimeter, push **TRIG** softkey to collect data from the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.

To process the data, separate the data into two groups:

- Top level: MEDIAN of all readings > 90% of reference level
- Base level: MEDIAN of all readings < 10% of reference level

The measurement value is calculated as:

$$\text{median of Top line} - \text{median of Base line}$$

- Record the 8588A measurement for each voltage in Table 41.
- Compare the results to those in the **Tolerance ± V** column.

Table 41. Waveform Generator Calibration and Verification - into 1 MΩ

Calibrator Output	Calibrator Waveform	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V)	Tolerance ± V
1 mV 1 kHz	SQUARE	0.0000098 s	10000		1.300E-04 V
2 mV 1 kHz	SQUARE	0.0000098 s	10000		1.600E-04 V
2.01 mV 1 kHz	SQUARE	0.0000098 s	10000		1.603E-04 V
5 mV 1 kHz	SQUARE	0.0000098 s	10000		2.500E-04 V
5.1 mV 1 kHz	SQUARE	0.0000098 s	10000		2.530E-04 V
20 mV 1 kHz	SQUARE	0.0000098 s	10000		7.000E-04 V
21 mV 1 kHz	SQUARE	0.0000098 s	10000		7.300E-04 V
50 mV 1 kHz	SQUARE	0.0000098 s	10000		1.600E-03 V
51 mV 1 kHz	SQUARE	0.0000098 s	10000		1.630E-03 V
200 mV 1 kHz	SQUARE	0.0000098 s	10000		6.100E-03 V
201 mV 1 kHz	SQUARE	0.0000098 s	10000		6.130E-03 V
500 mV 1 kHz	SQUARE	0.0000098 s	10000		1.510E-02 V
501 mV 1 kHz	SQUARE	0.0000098 s	10000		1.513E-02 V
2 V 1 kHz	SQUARE	0.0000098 s	10000		6.010E-02 V

Table 41. Waveform Generator Calibration and Verification - into 1 M Ω (cont.)

Calibrator Output	Calibrator Waveform	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V)	Tolerance $\pm$ V
2.01 V 1 kHz	SQUARE	0.0000098 s	10000		6.040E-02 V
6.6 V 1 kHz	SQUARE	0.0000098 s	10000		1.981E-01 V
6.7 V 1 kHz	SQUARE	0.0000098 s	10000		2.011E-01 V
15 V 1 kHz	SQUARE	0.0000098 s	10000		4.501E-01 V
15.1 V 1 kHz	SQUARE	0.0000098 s	10000		4.531E-01 V
120 V 1 kHz	SQUARE	0.0000098 s	10000		3.600E+00 V
1 mV 10 kHz	SINE	0.0000008 s	10000		1.300E-04 V
2 mV 10 kHz	SINE	0.0000008 s	10000		1.600E-04 V
2.01 mV 10 kHz	SINE	0.0000008 s	10000		1.603E-04 V
5 mV 10 kHz	SINE	0.0000008 s	10000		2.500E-04 V
5.1 mV 10 kHz	SINE	0.0000008 s	10000		2.530E-04 V
20 mV 10 kHz	SINE	0.0000008 s	10000		7.000E-04 V
21 mV 10 kHz	SINE	0.0000008 s	10000		7.300E-04 V
50 mV 10 kHz	SINE	0.0000008 s	10000		1.600E-03 V
51 mV 10 kHz	SINE	0.0000008 s	10000		1.630E-03 V
200 mV 10 kHz	SINE	0.0000008 s	10000		6.100E-03 V
201 mV 10 kHz	SINE	0.0000008 s	10000		6.130E-03 V
500 mV 10 kHz	SINE	0.0000008 s	10000		1.510E-02 V
501 mV 10 kHz	SINE	0.0000008 s	10000		1.513E-02 V
6.6 V 10 kHz	SINE	0.0000008 s	10000		1.981E-01 V
6.7 V 10 kHz	SINE	0.0000008 s	10000		2.011E-01 V
15 V 10 kHz	SINE	0.0000008 s	10000		4.501E-01 V
15.1 V 10 kHz	SINE	0.0000008 s	10000		4.531E-01 V
120 V 10 kHz	SINE	0.0000008 s	10000		3.600E+00 V

Calibration and Verification Signal into 50 Ω

1. Make the connections shown in Figure 36.
2. Make sure the Calibrator is set to 50 Ω.

8588A settings:

- Function: Digitize
 - Input > Terminal > Front
 - Coupling, Zin: DC, 1 MΩ
 - Measure Setup > Low pass filter: 3 MHz
 - Measure Setup > Range: base on AC voltage adjust point
 - Measure Setup > Aperture: calculated by the following equation
 - Sample Rate = 100 * Adjust Frequency
 - (If Sample Rate > 5000000.0, use 5000000.0)
 - Aperture = (1 / Sample Rate) - 0.0000002
 - Trigger Setup > Triggers/Arm (Count): calculated with the following equation:
 - Trigger Count = 100 * (Sample Rate / Adjust Frequency)
3. Set the Calibrator SCOPE output to the voltage in Table 42.
 4. Push **OPERATE** on the Calibrator.
 5. On 8588A Reference Multimeter, push **TRIG** softkey to collect data from the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.

To process this data, separate the data into two groups:

- Top level: MEDIAN of all readings > 90% of reference level
- Base level: MEDIAN of all readings < 10% of reference level

The measurement value is calculated as:

$$\text{median of Top line} - \text{median of Base line}$$

6. Record the 8588A measurement for each voltage in Table 42.
7. Compare the results to those in the **Tolerance ±(V)** column.

Table 42. Waveform Generator Calibration and Verification - into 50 Ω

Calibrator Output	Calibrator Waveform	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V)	Tolerance ±(V)
1 mV 1 kHz	SQUARE	0.0000098 s	10000		1.300E-04 V
2 mV 1 kHz	SQUARE	0.0000098 s	10000		1.600E-04 V
2.01 mV 1 kHz	SQUARE	0.0000098 s	10000		1.603E-04 V
5 mV 1 kHz	SQUARE	0.0000098 s	10000		2.500E-04 V

Table 42. Waveform Generator Calibration and Verification - into 50 Ω (cont.)

Calibrator Output	Calibrator Waveform	Fluke 8588A Aperture Setup	Fluke 8588A Trigger Setup	Fluke 8588A Measurement (V)	Tolerance $\pm$ (V)
5.1 mV 1 kHz	SQUARE	0.0000098 s	10000		2.530E-04 V
20 mV 1 kHz	SQUARE	0.0000098 s	10000		7.000E-04 V
21 mV 1 kHz	SQUARE	0.0000098 s	10000		7.300E-04 V
50 mV 1 kHz	SQUARE	0.0000098 s	10000		1.600E-03 V
51 mV 1 kHz	SQUARE	0.0000098 s	10000		1.630E-03 V
200 mV 1 kHz	SQUARE	0.0000098 s	10000		6.100E-03 V
201 mV 1 kHz	SQUARE	0.0000098 s	10000		6.130E-03 V
500 mV 1 kHz	SQUARE	0.0000098 s	10000		1.510E-02 V
501 mV 1 kHz	SQUARE	0.0000098 s	10000		1.513E-02 V
2 V 1 kHz	SQUARE	0.0000098 s	10000		6.010E-02 V
2.01 V 1 kHz	SQUARE	0.0000098 s	10000		6.040E-02 V
6.6 V 1 kHz	SQUARE	0.0000098 s	10000		1.981E-01 V
1 mV 10 kHz	SINE	0.0000008 s	10000		1.300E-04 V
2 mV 10 kHz	SINE	0.0000008 s	10000		1.600E-04 V
2.01 mV 10 kHz	SINE	0.0000008 s	10000		1.603E-04 V
5 mV 10 kHz	SINE	0.0000008 s	10000		2.500E-04 V
5.1 mV 10 kHz	SINE	0.0000008 s	10000		2.530E-04 V
20 mV 10 kHz	SINE	0.0000008 s	10000		7.000E-04 V
21 mV 10 kHz	SINE	0.0000008 s	10000		7.300E-04 V
50 mV 10 kHz	SINE	0.0000008 s	10000		1.600E-03 V
51 mV 10 kHz	SINE	0.0000008 s	10000		1.630E-03 V
200 mV 10 kHz	SINE	0.0000008 s	10000		6.100E-03 V
201 mV 10 kHz	SINE	0.0000008 s	10000		6.130E-03 V
500 mV 10 kHz	SINE	0.0000008 s	10000		1.510E-02 V
501 mV 10 kHz	SINE	0.0000008 s	10000		1.513E-02 V
2 V 10 kHz	SINE	0.0000008 s	10000		6.010E-02 V
2.01 V 10 kHz	SINE	0.0000008 s	10000		6.040E-02 V
6.6 V 10 kHz	SINE	0.0000008 s	10000		1.981E-01 V

Leveled Sine Amplitude Calibration and Verification

This procedure uses:

- Fluke 5790B AC Measurement Standard - Wideband
- Output Scope Card cable supplied with the scope option

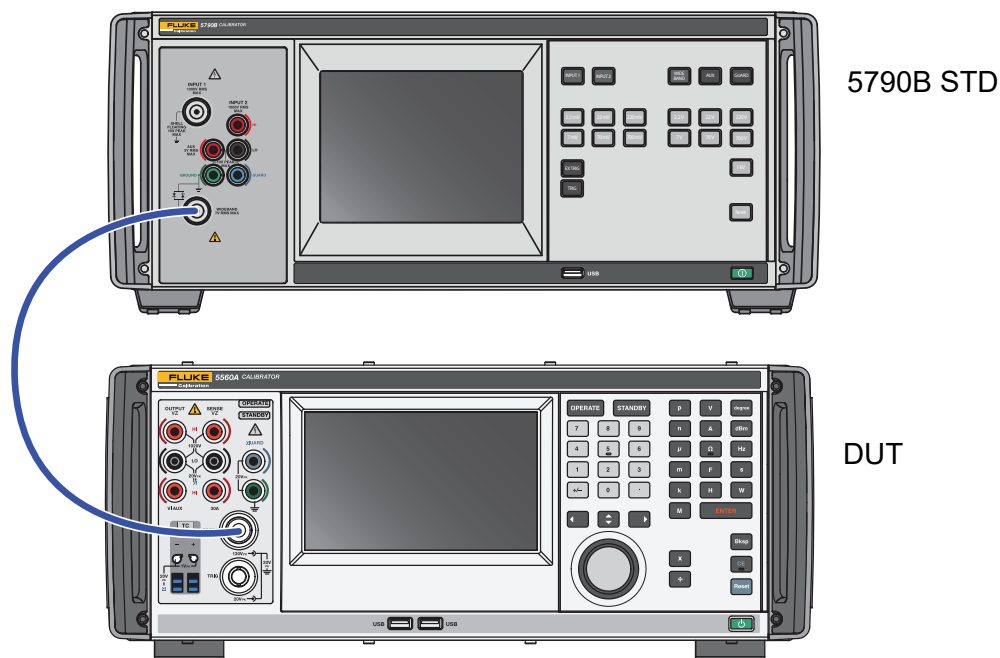
Initial setup

Set the Calibrator to (Function Menu > Scope > Leveled Sine).

Leveled Sign Amplitude Calibration and Verification

1. Connect the Output N-type terminal to a 5790B Wideband configured as shown in Figure 37. Note that this same configuration is used in [Leveled Sine Amplitude Calibration and Verification](#) and [Leveled Sine Wave Adjustment](#).

Figure 37. 5790B to Calibrator Connections



2. Set the Calibrator to 1 MΩ.
3. Set the 5790B to Wideband measurements with the ranges shown in Table 43.
4. Set the Product SCOPE output to the voltages shown in Table 43.
5. Push **OPERATE** on the Product. Let the 5790B measurement become stable.
6. Record the 5790B Wideband measurement for each voltage in Table 43.

Note

Make sure to convert the 5790B Wideband reading in Table 43 from V_{rms} to V_{pp} .

$$V_{pp} = V_{rms} \times 2 \sqrt{2}$$

7. Compare the results to those in the **Tolerance $\pm(V_{pp})$** column of Table 43.

Table 43. Leveled Sine Amplitude Calibration and Verification

Calibrator Output	Fluke 5790B Wideband Range Setup	Fluke 5790B Wideband Measurement (Vpp)	Tolerance $\pm(V_{pp})$
5 mV 50 kHz	2.2 mV		4.000E-04 V
20 mV 50 kHz	7 mV		7.000E-04 V
20.1 mV 50 kHz	7 mV		7.020E-04 V
50 mV 50 kHz	22 mV		1.300E-03 V
50.1 mV 50 kHz	22 mV		1.302E-03 V
200 mV 50 kHz	70 mV		4.300E-03 V
201 mV 50 kHz	70 mV		4.320E-03 V
500 mV 50 kHz	220 mV		1.030E-02 V
501 mV 50 kHz	220 mV		1.032E-02 V
2 V 50 kHz	700 mV		4.030E-02 V
2.01 V 50 kHz	700 mV		4.050E-02 V
5.5 V 50 kHz	2.2 V		1.103E-01 V

Leveled Sine Flatness relative to 50 kHz Calibration and Verification

Leveled Sine Wave Flatness calibration and verification is divided into two frequency bands: 50 kHz to 50 MHz (Low frequency) and >50 MHz to 2 GHz (High frequency). The equipment setups are different for each band. Leveled Sine Wave flatness is measured relative to 50 kHz. This is a direct measurement in the low frequency band. You must do a *transfer* measurement at 50 MHz in the high frequency band to calculate a flatness relative to 50 kHz.

Equipment Setup for Low Frequency Flatness:

- Fluke 5790B AC Measurement Standard with Wideband option
- BNC(f) to Type N(m) adapter
- Output Scope Card cable supplied with the scope option

Initial setup:

1. Use the connections shown in Figure 37.
2. Set the 5790B to Wideband, EXTRIG OFF and HIRES ON.

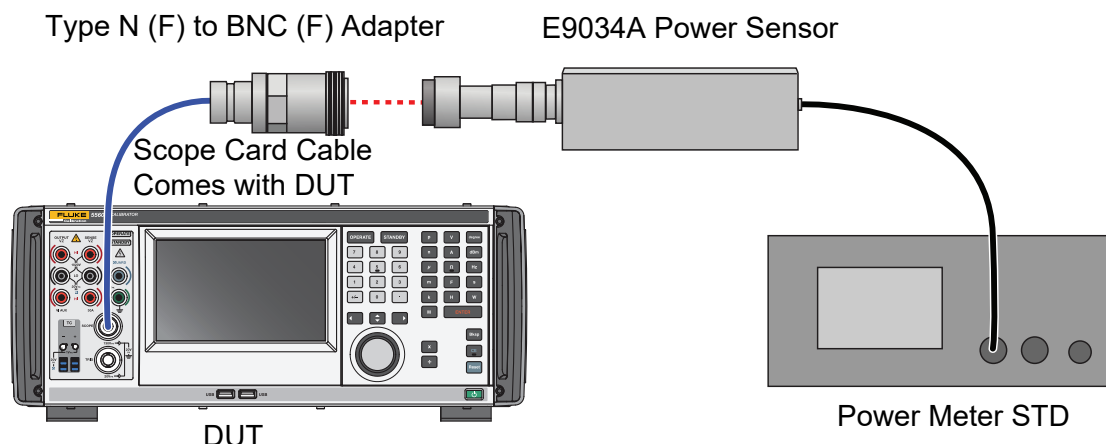
Equipment setup for High Frequency Flatness:

- Fluke 5790B AC Measurement Standard with Wideband option
- BNC(f) to Type N(m) adapter
- Keysight N1913B Power meter
- Keysight E9304A Power sensor
- BNC(f) to Type N(f) adapter
- Output Scope Card cable supplied with the scope option

Initial setup:

1. Connect the Keysight N1913B Power Meter to the Keysight E9304A Power Sensor, see Figure 44. To learn more about how to connect these two instruments, refer to the operator manuals of the instruments.
2. Zero and self-calibrate the power meter with the power sensor. Refer to the Keysight N1913B operator manual to learn more.
3. Connect the power meter and power sensor combination, see Figure 38.

Figure 38. Calibrator and Keysight Power Meter and Power Sensor Connections



The Keysight N1913B Power Meter must be configured with:

- Reference relative to 50 MHz
- AVER:COUN 256
- Turn off Relative for Chan A
- WATTS

Low Frequency Leveled Sine Flatness Calibration and Verification

This procedure gives an example of a low frequency flatness test with a 5 mV Calibrator output. Use the same procedure for other amplitudes. Compare the results with the flatness specification shown in Table 44.

1. Set the Calibrator to output of 5 mV at 50 kHz.
2. Push **OPERATE** on the Product.
3. Allow the 5790B Wideband measurement to become stable. The 5790B shows approximately 1.77 mV rms.
4. Record the 5790B Wideband measurement in column **A** of Table 44 for the test voltages in all rows.
5. Set the Calibrator to the test frequencies listed Table 44. Allow the 5790B Wideband measurement to become stable.
6. Record the 5790B Wideband measurement in column **B** of Table 44.
7. Repeat Table 44, steps 5 and 6 for all the frequencies shown in the table for 5 mV applied. Continue until you complete columns **A** and **B**.

8. After both columns **A** and **B** are filled for all rows of the table, push **STANDBY** on the Calibrator.
9. Use the recorded values in columns **A** and **B** to calculate and record the value in column **C** for all rows with this formula:

$$\text{Column C} = 100 * \left(\frac{\text{Column B} - \text{Column A}}{\text{Column A}} \right)$$

10. Compare column **C** to the specifications shown in the last column.

Table 44. Low Frequency Leveled Sine Flatness Relative to 50 kHz Calibration and Verification

Calibrator Output	A 50 kHz	B	C	Tolerance ±(%)
5 mV Applied				
100 kHz				3.50 %
200 kHz				3.50 %
500 kHz				3.50 %
1 MHz				3.50 %
2 MHz				3.50 %
5 MHz				3.50 %
10 MHz				3.50 %
20 MHz				5.00 %
49.99 MHz				5.00 %
50 MHz				5.00 %
16 mV Applied				
50 MHz				3.63 %
16.1 mV Applied				
50 MHz				3.62 %
Calibrator Output	A 50 kHz	B	C	Tolerance ±(%)
20 mV Applied				
100 kHz				2.00 %
200 kHz				2.00 %
500 kHz				2.00 %
1 MHz				2.00 %
2 MHz				2.00 %
5 MHz				2.00 %

Table 44. Low Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

10 MHz				2.00 %
20 MHz				3.50 %
49.99 MHz				3.50 %
20.1 mV Applied				
100 kHz				2.00 %
200 kHz				2.00 %
500 kHz				2.00 %
1 MHz				2.00 %
2 MHz				2.00 %
5 MHz				2.00 %
10 MHz				2.00 %
20 MHz				3.50 %
49.99 MHz				3.50 %
50 mV Applied				
100 kHz				1.70 %
200 kHz				1.70 %
500 kHz				1.70 %
1 MHz				1.70 %
2 MHz				1.70 %
5 MHz				1.70 %
10 MHz				1.70 %
20 MHz				3.20 %
49.99 MHz				3.20 %
50 MHz				3.20 %
Calibrator Output	A 50 kHz	B	C	Tolerance ±(%)
50.1 mV Applied				
100 kHz				1.70 %
200 kHz				1.70 %
500 kHz				1.70 %
1 MHz				1.70 %
2 MHz				1.70 %
5 MHz				1.70 %

Table 44. Low Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

10 MHz				1.70 %
20 MHz				3.20 %
49.99 MHz				3.20 %
50 MHz				3.20 %
160 mV Applied				
50 MHz				3.06 %
161 mV Applied				
50 MHz				3.06 %
200 mV Applied				
100 kHz				1.55 %
200 kHz				1.55 %
500 kHz				1.55 %
1 MHz				1.55 %
2 MHz				1.55 %
5 MHz				1.55 %
10 MHz				1.55 %
20 MHz				3.05 %
49.99 MHz				3.05 %
201 mV Applied				
100 kHz				1.55 %
200 kHz				1.55 %
500 kHz				1.55 %
1 MHz				1.55 %
2 MHz				1.55 %
Calibrator Output	A 50 kHz	B	C	Tolerance ±(%)
5 MHz				1.55 %
10 MHz				1.55 %
20 MHz				3.05 %
49.99 MHz				3.05 %
500 mV Applied				
100 kHz				1.52 %
200 kHz				1.52 %

Table 44. Low Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

500 kHz				1.52 %
1 MHz				1.52 %
2 MHz				1.52 %
5 MHz				1.52 %
10 MHz				1.52 %
20 MHz				3.02 %
49.99 MHz				3.02 %
50 MHz				3.02 %
501 mV Applied				
100 kHz				1.52 %
200 kHz				1.52 %
500 kHz				1.52 %
1 MHz				1.52 %
2 MHz				1.52 %
5 MHz				1.52 %
10 MHz				1.52 %
20 MHz				3.02 %
49.99 MHz				3.02 %
50 MHz				3.02 %
1.6 V Applied				
50 MHz				3.01 %
1.61 V Applied				
50 MHz				3.01 %
Calibrator Output	A 50 kHz	B	C	Tolerance $\pm$(%)
2 V Applied				
100 kHz				1.51 %
200 kHz				1.51 %
500 kHz				1.51 %
1 MHz				1.51 %
2 MHz				1.51 %
5 MHz				1.51 %
10 MHz				1.51 %

Table 44. Low Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

20 MHz				3.01 %
49.99 MHz				3.01 %
2.01 V Applied				
100 kHz				1.50 %
200 kHz				1.50 %
500 kHz				1.50 %
1 MHz				1.50 %
2 MHz				1.50 %
5 MHz				1.50 %
10 MHz				1.50 %
20 MHz				3.00 %
49.99 MHz				3.00 %
5.5 V Applied				
100 kHz				1.50 %
200 kHz				1.50 %
500 kHz				1.50 %
1 MHz				1.50 %
2 MHz				1.50 %
5 MHz				1.50 %
10 MHz				1.50 %
20 MHz				3.00 %
49.99 MHz				3.00 %
50 MHz				3.00 %

High Frequency Levelled Sine Flatness Calibration and Verification

This procedure is an example of a high frequency flatness test with a 5 mV Calibrator output. Use the same procedure for other amplitudes. Compare the results with the flatness specification shown in Table 45.

To collect Reference values at 50 kHz and 50 MHz with 5790B Wideband:

1. Connect equipment as shown in Figure 37.
2. Set the Calibrator to output of 5 mV at 50 kHz.
3. Push **OPERATE** on the Product and allow the 5790B Wideband measurement become stable. The 5790B displays approximately 1.77 mV rms.
4. Record the 5790B Wideband measurement in column **A** of Table 45 for the test voltage.
5. Set the Calibrator to output of 5 mV at 50 MHz.

6. Push **OPERATE** on the Product. Allow the 5790B Wideband measurement stabilize. The 5790B displays approximately 1.77 mV rms.
7. Record the 5790B Wideband measurement in column **B** of Table 45 for the test voltage.
8. Use the formula below to take the recorded values in columns **A** and **B** to calculate and record the value in column **C** for all rows.

$$\text{Column } C = 100 * \left(\frac{\text{Column } B - \text{Column } A}{\text{Column } A} \right)$$

To collect reference values at 50 MHz with the Power Meter and Power Sensor:

1. Connect equipment as shown in Figure 44.
2. Set the Calibrator to output of 5 mV at 50 MHz.
3. Push **OPERATE** on the Product and allow the power meter measurement to become stable. The power meter measurement is approximately 0.0000627 mW.
4. Record power meter measurement in column **D** of Table 45 for the test voltage (all rows.)

To collect values at test frequency:

1. Set the Calibrator to output of 5 mV at test frequency.
2. Push **OPERATE** on the Product and allow the power meter measurement to become stable.
3. Record power meter measurement in column **E** of Table 45 for the test voltage (all rows).
4. Repeat Table 45, steps 1 and 3 for all the frequencies shown in Table 45 for 5 mV applied. Continue until you have completed column **E**.
5. After all columns **A**, **B**, **C**, **D** and **E** are filled for all rows of the table, push **ENTER** on the Calibrator.
6. Use the formula below to take the recorded values in columns **C**, **D** and **E** to calculate and record the value in column **F** for all rows:

$$\text{Column } F = \left(\frac{\text{Column } E - \text{Column } D}{2} \right) + \text{Column } C$$

7. Compare column **F** to the specifications shown in the last column.

Table 45. High Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification

Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance ±(%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
5 mV Applied							
74.99 MHz							5.00 %
75 MHz							5.00 %
137.49 MHz							5.00 %
137.5 MHz							5.00 %
274.99 MHz							5.00 %
275 MHz							5.00 %
549.99 MHz							5.00 %
550 MHz							5.00 %
600 MHz							5.00 %
600.01 MHz							6.00 %
1 GHz							6.00 %
1.1 GHz							6.00 %
1.10001 GHz							7.00 %
1.49999 GHz							7.00 %
1.5 GHz							7.00 %
2.1 GHz							7.00 %
10 mV Applied							
600.01 MHz							5.00 %
1 GHz							5.00 %
1.1 GHz							5.00 %
1.10001 GHz							6.00 %
1.49999 GHz							6.00 %
1.5 GHz							6.00 %
2.1 GHz							6.00 %
10.1 mV Applied							
600.01 MHz							4.99 %
1 GHz							4.99 %

Table 45. High Frequency Leveled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance $\pm$ (%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
1.1 GHz							4.99 %
1.10001 GHz							5.99 %
1.49999 GHz							5.99 %
1.5 GHz							5.99 %
2.1 GHz							5.99 %
16 mV Applied							
74.99 MHz							3.63 %
75 MHz							3.63 %
137.49 MHz							3.63 %
137.5 MHz							3.63 %
274.99 MHz							3.63 %
275 MHz							3.63 %
549.99 MHz							3.63 %
550 MHz							3.63 %
600 MHz							3.63 %
16.1 mV Applied							
74.99 MHz							3.62 %
75 MHz							3.62 %
137.49 MHz							3.62 %
137.5 MHz							3.62 %
274.99 MHz							3.62 %
275 MHz							3.62 %
549.99 MHz							3.62 %
550 MHz							3.62 %
600 MHz							3.62 %
30 mV Applied							
600.01 MHz							4.33 %
1 GHz							4.33 %
1.1 GHz							4.33 %

Table 45. High Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance $\pm$ (%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
1.10001 GHz							5.33 %
1.49999 GHz							5.33 %
1.5 GHz							5.33 %
2.1 GHz							5.33 %
30.1 mV Applied							
600.01 MHz							4.33 %
1 GHz							4.33 %
1.1 GHz							4.33 %
1.10001 GHz							5.33 %
1.49999 GHz							5.33 %
1.5 GHz							5.33 %
2.1 GHz							5.33 %
50 mV Applied							
74.99 MHz							3.20 %
75 MHz							3.20 %
137.49 MHz							3.20 %
137.5 MHz							3.20 %
274.99 MHz							3.20 %
275 MHz							3.20 %
549.99 MHz							3.20 %
550 MHz							3.20 %
600 MHz							3.20 %
50.1 mV Applied							
74.99 MHz							3.20 %
75 MHz							3.20 %
137.49 MHz							3.20 %
137.5 MHz							3.20 %
274.99 MHz							3.20 %

Table 45. High Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance $\pm$ (%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
275 MHz							3.20 %
549.99 MHz							3.20 %
550 MHz							3.20 %
600 MHz							3.20 %
100 mV Applied							
600.01 MHz							4.10 %
1 GHz							4.10 %
1.1 GHz							4.10 %
1.10001 GHz							5.10 %
1.49999 GHz							5.10 %
1.5 GHz							5.10 %
2.1 GHz							5.10 %
101 mV Applied							
600.01 MHz							4.10 %
1 GHz							4.10 %
1.1 GHz							4.10 %
1.10001 GHz							5.10 %
1.49999 GHz							5.10 %
1.5 GHz							5.10 %
2.1 GHz							5.10 %
160 mV Applied							
74.99 MHz							3.06 %
75 MHz							3.06 %
137.49 MHz							3.06 %
137.5 MHz							3.06 %
274.99 MHz							3.06 %
275 MHz							3.06 %

Table 45. High Frequency Leveled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance $\pm$ (%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
549.99 MHz							3.06 %
550 MHz							3.06 %
600 MHz							3.06 %
161 mV Applied							
74.99 MHz							3.06 %
75 MHz							3.06 %
137.49 MHz							3.06 %
137.5 MHz							3.06 %
274.99 MHz							3.06 %
275 MHz							3.06 %
549.99 MHz							3.06 %
550 MHz							3.06 %
600 MHz							3.06 %
300 mV Applied							
600.01 MHz							4.03 %
1 GHz							4.03 %
1.1 GHz							4.03 %
1.10001 GHz							5.03 %
1.49999 GHz							5.03 %
1.5 GHz							5.03 %
2.1 GHz							5.03 %

Table 45. High Frequency Leveled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

301 mV Applied							
600.01 MHz							4.03 %
1 GHz							4.03 %
1.1 GHz							4.03 %
1.10001 GHz							5.03 %
1.49999 GHz							5.03 %
1.5 GHz							5.03 %
2.1 GHz							5.03 %
Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance ±(%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
500 mV Applied							
74.99 MHz							3.02 %
75 MHz							3.02 %
137.49 MHz							3.02 %
137.5 MHz							3.02 %
274.99 MHz							3.02 %
275 MHz							3.02 %
549.99 MHz							3.02 %
550 MHz							3.02 %
600 MHz							3.02 %
501 mV Applied							
74.99 MHz							3.02 %
75 MHz							3.02 %
137.49 MHz							3.02 %
137.5 MHz							3.02 %
274.99 MHz							3.02 %
275 MHz							3.02 %
549.99 MHz							3.02 %
550 MHz							3.02 %
600 MHz							3.02 %

Table 45. High Frequency Levelled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

1 V Applied							
600.01 MHz							4.01 %
1 GHz							4.01 %
1.1 GHz							4.01 %
1.10001 GHz							5.01 %
1.49999 GHz							5.01 %
1.5 GHz							5.01 %
2.1 GHz							5.01 %
Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance ±(%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
1.01 V Applied							
600.01 MHz							4.01 %
1 GHz							4.01 %
1.1 GHz							4.01 %
1.10001 GHz							5.01 %
1.49999 GHz							5.01 %
1.5 GHz							5.01 %
2.1 GHz							5.01 %
1.6 V Applied							
74.99 MHz							3.01 %
75 MHz							3.01 %
137.49 MHz							3.01 %
137.5 MHz							3.01 %
274.99 MHz							3.01 %
275 MHz							3.01 %
549.99 MHz							3.01 %
550 MHz							3.01 %
600 MHz							3.01 %
1.61 V Applied							
74.99 MHz							3.01 %
75 MHz							3.01 %

Table 45. High Frequency Leveled Sine Flatness Relative to 50 kHz Calibration and Verification (cont.)

137.49 MHz							3.01 %
137.5 MHz							3.01 %
274.99 MHz							3.01 %
275 MHz							3.01 %
549.99 MHz							3.01 %
550 MHz							3.01 %
600 MHz							3.01 %
Calibrator Output ^{[1],[2]}	From 5790B WB			From Power Meter and Power Sensor		F	Tolerance ±(%)
	A 50 kHz (V rms)	B 50 MHz (V rms)	C (%)	D 50 MHz (%)	E (%)		
3.5 V Applied							
600.01 MHz							4.00 %
1 GHz							4.00 %
1.1 GHz							4.00 %
1.10001 GHz							5.00 %
1.49999 GHz							5.00 %
1.5 GHz							5.00 %
2.1 GHz							5.00 %
5.5 V Applied							
74.99 MHz							3.00 %
75 MHz							3.00 %
137.49 MHz							3.00 %
137.5 MHz							3.00 %
274.99 MHz							3.00 %
275 MHz							3.00 %
549.99 MHz							3.00 %
550 MHz							3.00 %
600 MHz							3.00 %
[1] 600 MHz - 1.1 GHz verification points only applicable for the 1G and 2G options. [2] 1.10001 GHz - 2.1 GHz verification points only applicable for the 2G option.							

Leveled Sine Reflection Coefficient Calibration and Verification

This procedure uses:

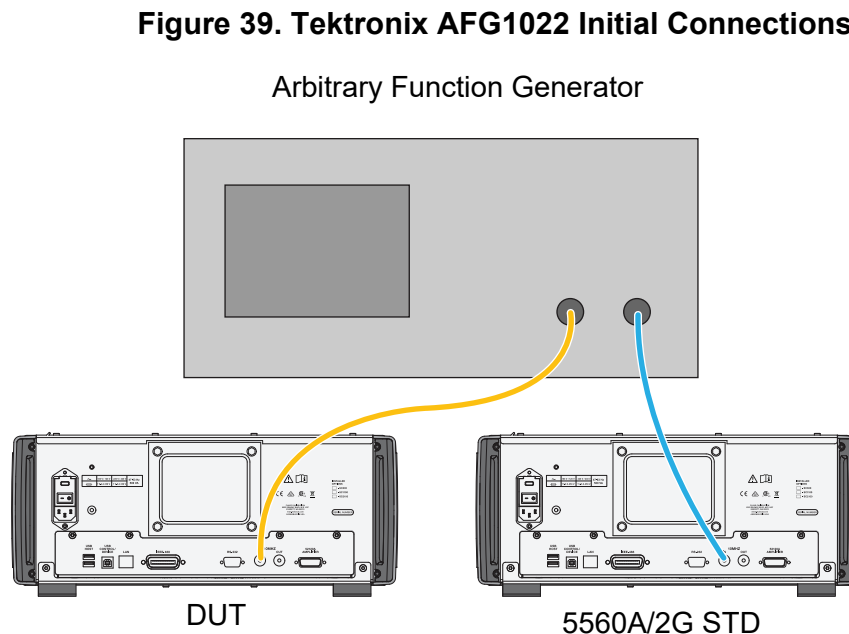
- Fluke 5560A Multi-Product Calibrator (scope option required)
- Tektronix AFG1022 Arbitrary Function Generator
- Keysight 86205A Directional Bridge
- Keysight N1913B Power meter
- Keysight E9304A Power sensor
- BNC(f) to Type N(m) adapter
- Type N(m) to Type N(m) adapter
- Shorting cap for BNC(f)
- Output Scope Card cable supplied with the scope option

Initial setup:

Set the Calibrator (DUT) to Scope, Leveled Sine (**Function Menu > Scope > Leveled Sine**). Ensure both have REFCLOCK Set to **External**.

Tektronix AFG1022 set up:

Connect the 10 MHz IN located in the back of the DUT and the 5560A standard to Out1 and Out2 of the Tektronix AFG1022, see Figure 39.



Tektronix AFG1022 Out1 and Out2 settings:

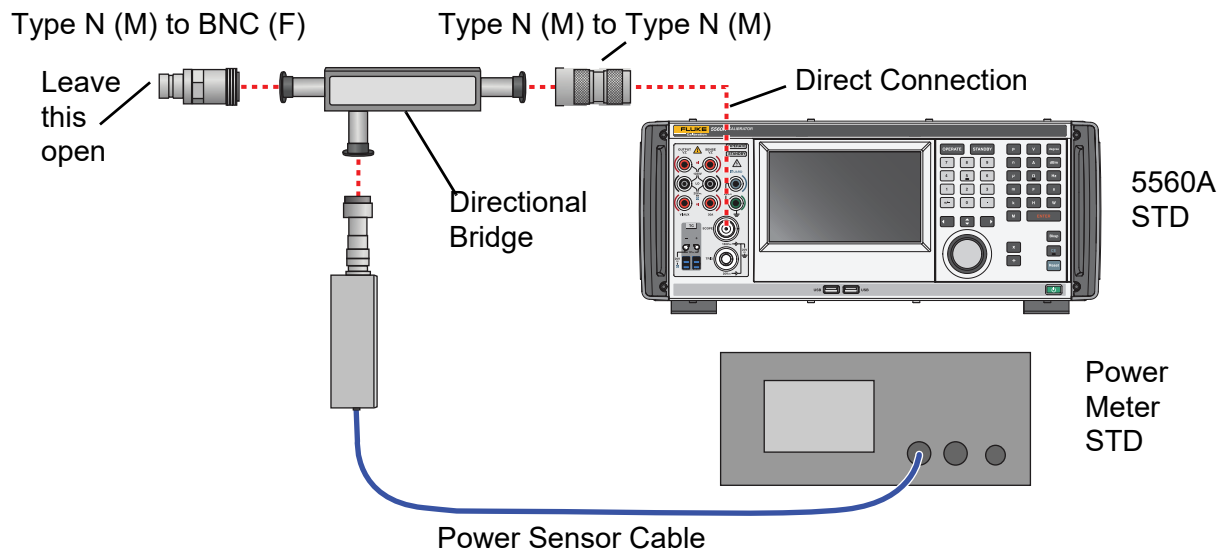
- Waveform: Square
- Frequ: 10 MHz
- Voltage Offset: 2.5
- Voltage amplitude: 5.0

Collect OPEN and SHORT Values

See Figure 40 for connections:

1. Connect the SCOPE connector of the Product to the Directional Bridge with the Type N(m) to Type N(m) adapter.
2. Connect the Power Meter and Power Sensor to the Directional Bridge.
3. Connect Type N(m) to BNC(f) to the third port of Directional Bridge.

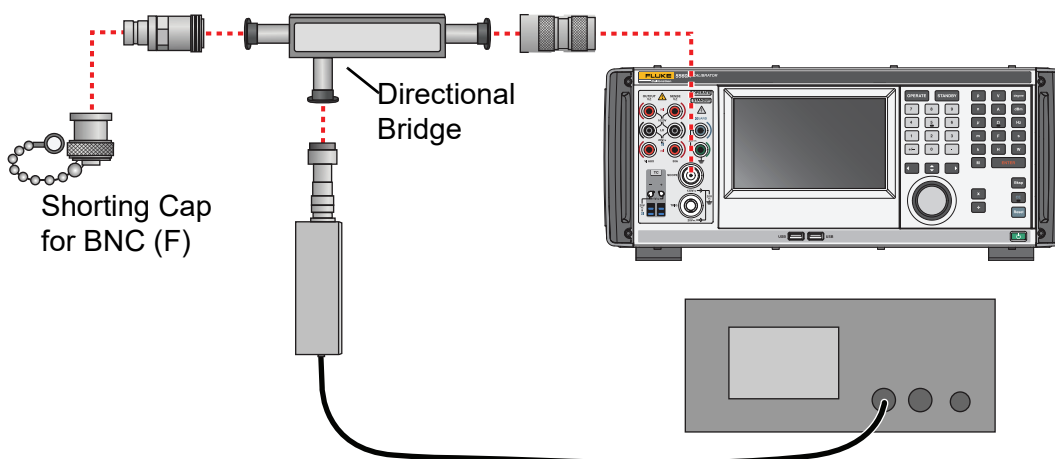
Figure 40. Leveled Sine Reflection Coefficient - OPEN Connections



Power Meter settings:

- Frequency: 5 MHz
 - SENSE1:FREQ 5MHz
 - SENSE1:AVERAGE 0
 - SENSE1:AVERAGE:COUNT:AUTO 0
 - SENSE1:AVERAGE:SDETECT 0
 - SENSE1:MRATE FAST
 - UNIT:POWER DBM
 - INIT:CONT ON
4. Set the Calibrator SCOPE standard output to the voltage shown in column **A** in Table 46.
 5. Set the Power Meter range to the range shown in column **B** in Table 46.
 6. Push **OPERATE** on the Calibrator standard. Let the power meter measurement become stable.
 7. Record the Power meter measurement (converted to Vpp) into column **C** of Table 46.
 8. With the same connections used in Figure 40, add a shorting cap to the connect Type N(m) to BNC(f) connected to the third port of the Directional Bridge. See Figure 41. Let the power meter measurement become stable.
 9. Repeat step 4 through 6 above. Let the power meter measurement become stable.

Figure 41. Levelled Sine Reflection Coefficient - SHORT Connections



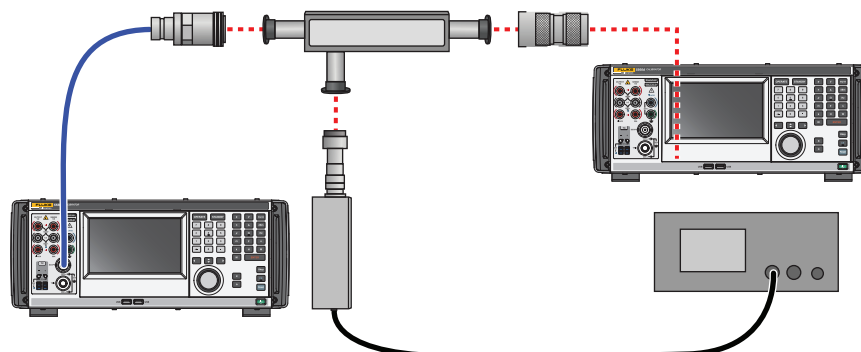
10. Record the Power meter measurement into column **D** of Table 46.
11. After all columns **C** and **D** are filled, push **STANDBY** on the Calibrator Standard.
12. Repeat these steps until columns **C** and **D** are complete.
13. Use the formula below and take the recorded values in column **C** and **D** to calculate and record **Z_Max** in column **E** of Table 46.

$$Column\ E = \left(\frac{Column\ C + Column\ D}{2} \right)$$

Levelled Sine Reflection Coefficient Calibration and Verification Process

1. Remove the shorting cap to the connect Type N(m) to BNC(f) connected to the third port of Directional Bridge.
2. Use the scope card cable to connect to the scope connector of the Calibrator, see Figure 42.

Figure 42. Levelled Sine Reflection Coefficient Calibration and Verification Connections



3. Set the Out1 of Arbitrary Function Generator to SOURCE1:FREQ to the value shown in column **F** of Table 46. Use this formula to calculate the value for a test point:

$$Freq = 10E6 + 10E6 * = \frac{I}{Test\ Frequency}$$

4. Set the Calibrator SCOPE standard output to the voltage shown in column **A** in Table 46.
5. Set the Power Meter range to the range shown in column **B** in Table 46.
6. Set the Calibrator SCOPE output to the voltage shown in Calibrator Output in Table 46.
7. Push **OPERATE** on the Calibrator Standard.
8. Push **OPERATE** on the Calibrator. Let the power meter measurement become stable.
9. Export the Power meter measurement data to the external device and apply 15 reading moving average filter.

Record V_Max (Vpp) of filtered data into column **G** of Table 46.

Record V_Min (Vpp) of filtered data into column **H** of Table 46.

10. After columns **G** and **H** are filled for a row of the table, push **STANDBY** on the Calibrator standard and the Calibrator.
11. Use the recorded values in columns **G** and **H** to calculate and record the value in column **I** with this formula:

$$Column\ I = \frac{Column\ G - Column\ H}{2}$$

12. Use the recorded values in columns **E** and **I** to calculate and record the value in column **J** with this formula:

$$Column\ J = \frac{Column\ I}{Column\ E}$$

13. Compare column **J** to the specifications shown in the last column.
14. Repeat step all steps for all test points listed in Table 46.

Table 46. Leveled Sine Reflection Coefficient Calibration and Verification

Calibrator Output	A	B	C	D	E	F	G	H	I	J	Tolerance ±
	5560A Std Ampl (V)	Power Meter Range	(Open)	(Short)	Z_Max	AFG1022 Out1 Freq (Hz)	V_Max	V_Min	Z_DUT		
2.01 V 5 MHz	3.015 V 5 MHz	RANGE 1				10000002.0000					0.048
2.01 V 10 MHz	3.015 V 10 MHz	RANGE 1				10000001.0000					0.048
2.01 V 20 MHz	3.015 V 20 MHz	RANGE 1				10000000.5000					0.091
2.01 V 49.99 MHz	3.015 V 49.99 MHz	RANGE 1				10000000.2000					0.091

Table 46. Leveled Sine Reflection Coefficient Calibration and Verification (cont.)

Calibrator Output	A	B	C	D	E	F	G	H	I	J	Tolerance $\pm$
	5560A Std Ampl (V)	Power Meter Range	(Open)	(Short)	Z_Max	AFG1022 Out1 Freq (Hz)	V_Max	V_Min	Z_DUT		
1.61 V 50 MHz	2.415 V 50 MHz	RANGE 1				10000000.2000					0.091
1.61 V 74.99 MHz	2.415 V 74.99 MHz	RANGE 1				10000000.1334					0.091
1.61 V 75 MHz	2.415 V 75 MHz	RANGE 1				10000000.1333					0.091
1.61 V 137.49 MHz	2.415 V 137.49 MHz	RANGE 1				10000000.0727					0.091
1.61 V 137.5 MHz	2.415 V 137.5 MHz	RANGE 1				10000000.0727					0.091
1.61 V 274.99 MHz	2.415 V 274.99 MHz	RANGE 1				10000000.0364					0.091
1.61 V 275 MHz	2.415 V 275 MHz	RANGE 1				10000000.0364					0.091
1.61 V 549.99 MHz	2.415 V 549.99 MHz	RANGE 1				10000000.0182					0.091
1.61 V 550 MHz	2.415 V 550 MHz	RANGE 1				10000000.0182					0.091
1.61 V 600 MHz	2.415 V 600 MHz	RANGE 1				10000000.0167					0.107
1.01 V 600.01 MHz	1.515 V 600.01 MHz	RANGE 1				10000000.0167					0.111
1.01 V 1 GHz	1.515 V 1 GHz	RANGE 1				10000000.0100					0.111
1.01 V 1.1 GHz	1.515 V 1.1 GHz	RANGE 1				10000000.0091					0.111
1.01 V 1.10001 GHz	1.515 V 1.10001 GHz	RANGE 1				10000000.0091					0.149

Table 46. Leveled Sine Reflection Coefficient Calibration and Verification (cont.)

Calibrator Output	A	B	C	D	E	F	G	H	I	J	Tolerance $\pm$
	5560A Std Ampl (V)	Power Meter Range	(Open)	(Short)	Z_Max	AFG1022 Out1 Freq (Hz)	V_Max	V_Min	Z_DUT		
1.01 V 1.49999 GHz	1.51 5V 1.49999 GHz	RANGE 1				10000000.0067					0.149
1.01 V 1.5 GHz	1.515V 1.5 GHz	RANGE 1				10000000.0067					0.149
1.01 V 2 GHz	1.515 V 2 GHz	RANGE 1				10000000.0050					0.149
1.01 V 2.1 GHz	1.515 V 2.1 GHz	RANGE 1				10000000.0048					0.167
5 V 5 MHz	0.833V 5 MHz	RANGE 1				10000002.0000					0.048
5 V 10 MHz	0.833 V 10 MHz	RANGE 1				10000001.0000					0.048
5 V 20 MHz	0.833 V 20 MHz	RANGE 1				10000000.5000					0.091
5 V 49.99 MHz	0.833 V 49.99 MHz	RANGE 1				10000000.2000					0.091
5 V 50 MHz	0.833 V 50 MHz	RANGE 1				10000000.2000					0.091
5 V 74.99 MHz	0.833 V 74.99 MHz	RANGE 1				10000000.1334					0.091
5 V 75 MHz	0.833 V 75 MHz	RANGE 1				10000000.1333					0.091
5 V 137.49 MHz	0.833 V 137.49 MHz	RANGE 1				10000000.0727					0.091
5 V 137.5 MHz	0.833 V 137.5 MHz	RANGE 1				10000000.0727					0.091
5 V 274.99 MHz	0.833 V 274.99 MHz	RANGE 1				10000000.0364					0.091
5 V 275 MHz	0.833 V 275 MHz	RANGE 1				10000000.0364					0.091
5 V 549.99 MHz	0.833 V 549.99 MHz	RANGE 1				10000000.0182					0.091
5 V 550 MHz	0.833 V 550 MHz	RANGE 1				10000000.0182					0.091
5 V 600 MHz	0.833 V 600 MHz	RANGE 1				10000000.0167					0.107
3.5 V 600.01 MHz	0.583 V 600.01 MHz	RANGE 1				10000000.0167					0.111

Table 46. Levelled Sine Reflection Coefficient Calibration and Verification (cont.)

Calibrator Output	A	B	C	D	E	F	G	H	I	J	Tolerance $\pm$
	5560A Std Ampl (V)	Power Meter Range	(Open)	(Short)	Z_Max	AFG1022 Out1 Freq (Hz)	V_Max	V_Min	Z_DUT		
3.5 V 1 GHz	0.583 V 1 GHz	RANGE 1				10000000.0100					0.111
3.5 V 1.1 GHz	0.583 V 1.1 GHz	RANGE 1				10000000.0091					0.111
3.5 V 1.10001 GHz	0.583 V 1.10001 GHz	RANGE 1				10000000.0091					0.149
3.5 V 1.49999 GHz	0.583 V 1.49999 GHz	RANGE 1				10000000.0067					0.149
3.5 V 1.5 GHz	0.583 V 1.5 GHz	RANGE 1				10000000.0067					0.149
3.5 V 2 GHz	0.583 V 2 GHz	RANGE 1				10000000.0050					0.149
3.5 V 2.1 GHz	0.583 V 2.1 GHz	RANGE 1				10000000.0048					0.167

Edge Rise Time Calibration and Verification

This verification tests the rise time of the Edge function (**Function Menu > Scope > Edge**).

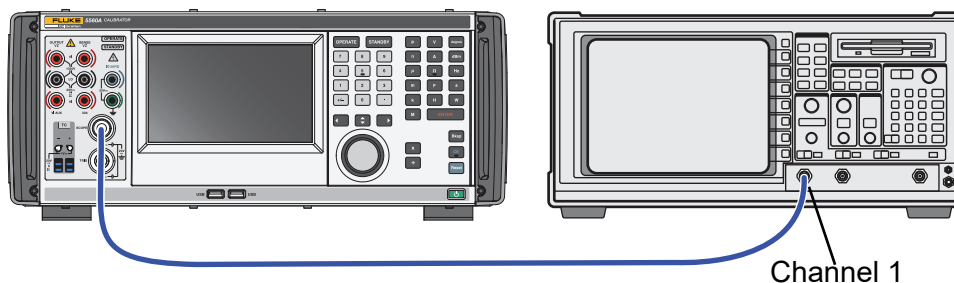
This procedure uses

- Tektronix MSO64B Oscilloscope
- Output Scope Card cable supplied with the scope option

Edge Rise Time Calibration and Verification Process

1. Connect the output cable to the SCOPE connector on the Calibrator.
2. Connect the other end of the output cable to channel 1 of the oscilloscope. See Figure 43.

Figure 43. Time Base Measurement Connection



3. Push the DEFAULT SETUP button to reset to default and then set the oscilloscope to:
 - Acquire mode: Average
 - Number of averages: 500
 - Measure: Risetime
 - Horizontal scale: 500 ps/div
 - Set the Calibrator output to test points list in Table 47.
4. Push **OPERATE** on the Product.
5. Change the scale of the oscilloscope to see full wave.
6. Adjust the main time base position and vertical offset until the edge signal is in the center of the oscilloscope display. Record the rise time measurement for the test point in Table 47. The measured edge rise time must be less than the time shown in last column of Table 47.

Table 47. Edge Rise Time Calibration and Verification

Calibrator Output	Tektronix MSO64B Measurement	Tolerance (ps)
5 mV 100 kHz		≤175
10 mV 100 kHz		≤175
25 mV 100 kHz		≤175
50 mV 100 kHz		≤175
60 mV 100 kHz		≤175
80 mV 100 kHz		≤175
100 mV 100 kHz		≤175
200 mV 100 kHz		≤175
250 mV 100 kHz		≤175
300 mV 100 kHz		≤175
500 mV 100 kHz		≤175
600 mV 100 kHz		≤175
1 V 100 kHz		≤175
2.5 V 100 kHz		≤175

Pulse Width Calibration and Verification

This procedure uses

- Tektronix MSO64B Oscilloscope
- Output Scope Card cable supplied with the scope option

Initial setup:

Set the Calibrator to **Function > Scope > Pulse**.

Pulse Width Calibration and Verification Process

1. Connect the output cable to the SCOPE connector on the Calibrator.
2. Connect the other end of the output cable to channel 1 of the oscilloscope, see Figure 43.
3. Push the DEFAULT SETUP button to reset to default and then set the oscilloscope to:
 - Acquire mode: Average
 - Number of averages: 128
 - Measure: Pulse Width
 - Horizontal scale: 250 ns/div
4. Set the Calibrator output to period shown in Table 48.
5. Set the voltage to 2.5 V.
6. Push **OPERATE** on the Product. Let the oscilloscope measurement become stable.
7. Change the oscilloscope to see full wave.
8. Adjust the main time base position and vertical offset until the pulse signal is in the center of the oscilloscope display.
9. Record the width measurement for the test point in Table 48.
10. Compare the width measurement to the value in the **Tolerance $\pm$ (ns)** column of Table 48.

Table 48. Pulse Width Calibration and Verification

Calibrator Output	Tektronix MSO64B Measurement	Tolerance $\pm$ (ns)
250 ns		2.00

Time Marker Period Calibration and Verification

This procedure uses:

- Tektronix MSO64B Oscilloscope
- Output Scope Card cable supplied with the scope option

Initial setup:

Set the Calibrator to **(Function Menu > Scope > Edge)**.

Time Marker Period Calibration and Verification Process

1. Connect the output cable to the SCOPE connector on the Calibrator. Connect the other end of the output cable to Channel 1 of the oscilloscope. See Figure 43.
2. Push the DEFAULT SETUP button to reset to default and then set the oscilloscope to:
 - Acquire mode: Average
 - Number of averages: 128
 - Measure: Risetime
 - Horizontal scale: 250 ns/div
 - Set the Calibrator output to test points list in Table 49.
3. Push **OPERATE** on the Product.
4. Change the scale of the oscilloscope to see full wave.
5. Adjust the main time base position and vertical offset until the pulse signal is in the center of the oscilloscope display.
6. Record the width measurement for the test point in Table 49.
7. Compare the width measurement to the value in the **Tolerance $\pm(s)$** column of the Table 49.

Table 49. Time Marker Period Calibration and Verification

Calibrator Output	Tektronix MSO64B Measurement	Tolerance $\pm(s)$
20 ns		5.00E-14
2 s		5.00E-06

Measure Resistance Calibration and Verification

This procedure uses

- Fluke 5560A Multi-Product Calibrator
- BNC(f) to Double Banana adapter
- Output Scope Card cable supplied with the scope option

Initial setup:

Set the Calibrator to **Function > Scope > Resistance**.

Measure Resistance Calibration and Verification Process

1. Connect the SCOPE connector of the Calibrator to the 5560A, see Figure 45.
2. Set the 5560A to:
 - Function: Single Output > Resistance
 - Guard: INTERNAL
 - Comp: OFF
3. Set the 5560A to the resistance value shown in Table 50 and Push **OPERATE**. Let the Calibrator measurement become stable.
4. Record the measurement for each test point in Table 50.
5. Compare the result to the **Tolerance $\pm(\Omega)$** column.

Table 50. Measure Resistance Calibration and Verification

Fluke 5560A Output	Calibrator Measurement	Tolerance $\pm(\Omega)$
40 Ω		0.040
50 Ω		0.050
60 Ω		0.060
0.6 M Ω		600
1 M Ω		1000
1.5 M Ω		1500

Measure Capacitance Calibration and Verification

The verification procedure for the Measure Capacitance mode is a capacitance measurement of a known capacitance value and then comparing the capacitance measurement to the value of the capacitance.

This procedure uses:

- Adapter and capacitors to make 5 pF, 29 pF and 49 pF nominal values at the end of a BNC(f) connector.
- Output Scope Card cable supplied with the scope option.

Initial setup:

Set the Calibrator to **Function > Scope > Capacitance**.

Measure Capacitance Calibration and Verification Process

1. Connect one end of the output cable to the SCOPE connector of the Calibrator. Do not connect anything to the other end of this cable.
2. Let the Calibrator measurement become stable and then tap the **Offset ZERO** button on the display to zero the capacitance measurement.
3. Connect the other end of the cable to the capacitance shown in Table 51. Let the Calibrator measurement become stable.
4. Record the measurement for each test point in Table 51.

5. Compare the measured capacitance value to the actual capacitance and the value in the **Tolerance $\pm$ (pF)** column of the Table 51.

Table 51. Measure Capacitance Calibration and Verification

Nominal Capacitance Value	Calibrator Measurement	Actual Capacitance Value	Tolerance $\pm$ (pF)
5 pF			0.75
29 pF			1.95
49 pF			2.95

Scope Option Adjustment Setup

The Calibrator Mainframe must be fully calibrated before you do the scope option calibration adjustment.

You must adjust the calibration of the DCV function first. The ACV function depends on the DCV function.

The Product must complete a warm-up period (a minimum of two times the period the Product was turned off, or a maximum of 30 minutes), and the scope option must be on for a minimum of 5 minutes before you begin calibration adjustment. This lets internal components become thermally stable.

Scope option calibration is adjusted from the front panel.

Note

*Access to the Adjustment mode requires a passcode. The default passcode is set to the serial number of the DUT. Enter the serial number and push **ENTER**. For more passcode information, see the Operators Manual available at www.fluke.com.*

To start Scope Option Adjustment mode, use **Setup > Scope Adjustment** to open the scope adjustment menu.

- All equipment used for calibration adjustment must be calibrated, certified traceable (if traceability is kept), and operated in their specified operation environment.
- For best accuracy, make sure the equipment has sufficient time to warm up before you start adjustment. Refer to the operation manual for each piece of equipment.
- Before you start these procedures, read the complete procedures to make sure you have the resources to do them.
- The Product starts calibration with the dc voltage (DCV) mode. Select **Continue** and follow instructions on the display.

Scope Option Adjustment

The Voltage, Edge, and Wave Generator modes have square wave voltages that must be calibrated or verified. Program the 8588A Reference Multimeter from the front panel or through the remote interface to make these measurements.

Before Scope Option Adjustment

To obtain reference levels for leveled sine at 50 kHz and 50 MHz to use them further in the procedure:

1. Connect the Output N-type terminal to a 5790B Wideband configured to measure ac voltage. See Figure 37.
 5790B settings:
 - External trigger OFF
 - HIRES ON
 - Range: As shown in the **5790B Wideband Range Setup** column of Table 52.
2. Set the Calibrator output to voltages shown in the **Calibrator Output (V)** column of Table 52 at 50 kHz.
3. Push **OPERATE** on the Calibrator. Let the 5790B measurement become stable.
4. Record the 5790B measurement into column **A** of Table 52.
5. Push **STANDBY** on the Calibrator.
6. Set the Calibrator output to voltage shown in the **Calibrator Output** column of Table 52 at 50 MHz.
7. Push **OPERATE** on the Calibrator. Let the 5790B measurement become stable.
8. Record the 5790B measurement for each voltage into column **B** of Table 52.
9. Push **STANDBY** on the Calibrator.
10. Repeat Table 52, steps 2 to 10 and fill each row of the table.

For column **C** in Table 52:

1. Connect the Keysight N1913B Power Meter to the Keysight E9304A Power Sensor, see Figure 44. Refer to their operator manuals for connections.
2. Zero and self-calibrate the power meter with the power sensor. Refer to the Keysight N1913B operator manual.
3. Power Meter settings:
 - a. Turn off relative for channel 1.
 - b. Set channel 1 to measure power, display dBm, auto range, and average 256.
4. For each row of Table 52, connect the Output N-type terminal to a Precision Power Meter configured to measure ac voltage and tap Continue on the display. See Figure 44.
5. Set the Calibrator output to voltages shown in the **Calibrator Output (V)** column of Table 37 at 50 MHz.
6. Push **OPERATE** on the Calibrator. Let the 5790B measurement become stable.
7. Convert the reading from dBm to V RMS and record into column **C** of Table 52.
8. Push **STANDBY** on the Calibrator.
9. Repeat Table 52, steps 5 through 7 and fill each row of the table.

Figure 44. The Keysight N1913B Power Meter and Keysight E9034A Power Sensor Connections

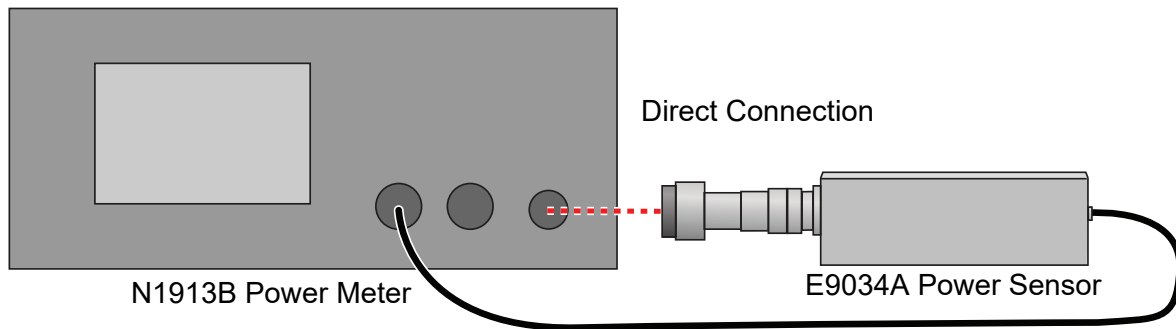


Table 52. Adjustment Points for Levelled Sine Wave - Before

Calibrator Output (V)	5790B Wideband Range Setup	A at 50 kHz	B at 50 MHz	N1913B Setup		C at 50 MHz
				Range	Count	
0.005	2.2 mV			LP	32	
0.01	2.2 mV			LP	32	
0.0101	2.2 mV			LP	16	
0.016	2.2 mV			LP	16	
0.01601	2.2 mV			LP	8	
0.02	22 mV			LP	4	
0.0201	22 mV			LP	4	
0.03	22 mV			LP	4	
0.0301	22 mV			LP	4	
0.05	22 mV			LP	4	
0.0501	22 mV			LP	4	
0.1	70 mV			LP	4	
0.101	70 mV			LP	4	
0.16	70 mV			LP	4	
0.1601	70 mV			LP	4	
0.2	220 mV			LP	4	
0.201	220 mV			HP	32	
0.3	220 mV			HP	32	
0.301	220 mV			HP	32	
0.5	220 mV			HP	32	
0.501	220 mV			HP	16	
1	700 mV			HP	8	

Table 52. Adjustment Points for Leveled Sine Wave - Before (cont.)

Calibrator Output (V)	5790B Wideband Range Setup	A at 50 kHz	B at 50 MHz	N1913B Setup		C at 50 MHz
				Range	Count	
1.01	700 mV			HP	4	
1.6	700 mV			HP	4	
1.601	700 mV			HP	4	
2	2.2 V			HP	4	
2.01	2.2 V			HP	4	
3.5	2.2 V			HP	4	
5.5	2.2 V			HP	4	

DC Voltage Adjustment

This procedure uses:

- Fluke 8588A Reference Multimeter
- BNC(f) to Double Banana adapter
- BNC(m-f) Feed-Thru Termination 50 Ω
- Output Scope Card cable supplied with the scope option

The Product prompts for 1 MOhm and 10 Ohm input impedances. See Figure 35 and Figure 36 for equipment connections.

DCV highlights with the Calibrator in Scope Adjustment mode.

To adjust dc voltage:

1. Make the connections shown in Figure 35.

8588A settings:

- Function: DC Voltage
- Input > Terminal > Front
- Measure Setup > Manual > Edit PLC: 60.00 PLC
- Z in > 1 M Ω

2. Tap **Continue** on the display.

3. Push **OPERATE** on the Calibrator. Let the 8588A voltage measurement become stable. Type in the measurement with the Calibrator keypad and push **ENTER**.

Note

The Calibrator shows a message if the typed value is higher or lower than the limits of the value. If this occurs, examine the connections and carefully re-type the measurement with the correct unit (for example, mV, V). Repair may be necessary if the warning continues.

4. Repeat step 3 until the Calibrator shows the next connection with 50 Ω input impedance and tap **Continue** on the display.

5. Connect the SCOPE connector of the Calibrator to the 8588A input HI and LO as shown in Figure 36.
6. Repeat step 3 until the Calibrator display prompts to adjust ac voltage.

AC Voltage Adjustment

For equipment and setup, see [DC Voltage Adjustment](#).

To adjust ac voltage:

When the Calibrator is in Scope Adjustment mode and **ACV** is highlighted:

1. Make the connections shown in Figure 35.

8588A settings:

- Function: Digitize
- Input > Terminal > Front
- Coupling, Zin: DC, 1 MΩ
- Measure Setup > Low pass filter: 3 MHz
- Measure Setup > Range: base on ac voltage adjust point
- Measure Setup > Aperture: <Aperture value> which is shown in the **8588A Aperture Setup** column of Table 53. This aperture value was calculated based on adjust frequency with this formula:

$$\begin{aligned} \text{Sample Rate} &= 100 * \text{Adjust Frequency} \\ (\text{If Sample Rate} > 5000000.0, \text{ use } 5000000.0) \\ \text{Aperture} &= (1 / \text{Sample Rate}) - 0.0000002 \end{aligned}$$

- Trigger Setup > Triggers/Arm (Count): 10000
2. Tap **Continue** on the display.
 3. Push **OPERATE**.
 4. On the 8588A, push the **TRIG** softkey to collect data from the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.
 5. Process the data.

Separate the data into two groups:

- Top level: MEDIAN of all readings >90% of reference level
- Base level: MEDIAN of all readings <10 % of reference level

The processed value is calculated as:

$$\text{median of Top line} - \text{median of Base line.}$$

6. Type in the processed value from step 5 with the Calibrator keypad and push **ENTER**.

Note

The Calibrator shows a message if the typed value is higher or lower than the limits of the value. If this occurs, examine the setup and carefully re-type in the measurement with the correct unit (for example, mV, V). Repair may be necessary if the warning continues.

7. Repeat step 3 through 6 until the Calibrator shows the next connection with 50 Ω input impedance.
8. Connect the SCOPE connector of the Calibrator to the 8588A input HI and LO as shown in Figure 36.
8588A settings:
Measure Setup > Aperture: <Aperture value> which is shown in the **8588A Aperture Setup** column of Table 54. This aperture value was calculated based on adjust frequency with this formula:
$$\text{Sample Rate} = 100 * \text{Adjust Frequency (If Sample Rate} > 5000000.0, \text{ use } 5000000.0) \text{ Aperture} = (1 / \text{Sample Rate}) - 0.0000002 \cdot \text{Trigger Setup} > \text{Triggers/Arm (Count): } 10000$$
9. Tap **Continue** on the display.
10. Repeat Table 54, steps 3 to 6 until the Calibrator prompts to adjust Edge.

Table 53. Sequential Adjustment Points and 8588A Aperture Setup for AC Voltage - 1 M Ohm

Calibrator Output (V)	ADJ Freq (Hz)	8588A Aperture Setup	8588A Trigger Setup
-0.001	40	0.0002498 s	10000
-0.002	40	0.0002498 s	10000
0.001	40	0.0002498 s	10000
0.002	40	0.0002498 s	10000
-0.002001	40	0.0002498 s	10000
-0.005	40	0.0002498 s	10000
0.002001	40	0.0002498 s	10000
0.005	40	0.0002498 s	10000
-0.005001	40	0.0002498 s	10000
-0.02	40	0.0002498 s	10000
0.005001	40	0.0002498 s	10000
0.02	40	0.0002498 s	10000
-0.020001	40	0.0002498 s	10000
-0.05	40	0.0002498 s	10000
0.020001	40	0.0002498 s	10000
0.05	40	0.0002498 s	10000
-0.05001	40	0.0002498 s	10000
-0.2	40	0.0002498 s	10000
0.05001	40	0.0002498 s	10000
0.2	40	0.0002498 s	10000
-0.20001	40	0.0002498 s	10000

Table 53. Sequential Adjustment Points and 8588A Aperture Setup for AC Voltage - 1 M Ohm

Calibrator Output (V)	ADJ Freq (Hz)	8588A Aperture Setup	8588A Trigger Setup
-0.5	40	0.0002498 s	10000
0.20001	40	0.0002498 s	10000
0.5	40	0.0002498 s	10000
-0.5001	40	0.0002498 s	10000
-2	40	0.0002498 s	10000
0.5001	40	0.0002498 s	10000
2	40	0.0002498 s	10000
-2.0001	40	0.0002498 s	10000
-6.6	40	0.0002498 s	10000
2.0001	40	0.0002498 s	10000
6.6	40	0.0002498 s	10000
-6.601	40	0.0002498 s	10000
-15	40	0.0002498 s	10000
6.601	40	0.0002498 s	10000
15	40	0.0002498 s	10000
-15.01	40	0.0002498 s	10000
-120	40	0.0002498 s	10000
15.01	40	0.0002498 s	10000
120	40	0.0002498 s	10000
6.6	500	0.0000198 s	10000
6.6	5000	0.0000018 s	10000
6.6	10000	0.0000008 s	10000
15	500	0.0000198 s	10000
15	5000	0.0000018 s	10000
15	10000	0.0000008 s	10000
120	500	0.0000198 s	10000
120	5000	0.0000018 s	10000
120	10000	0.0000008 s	10000

Table 54. Sequential Adjustment Points and 8588A Aperture setup for AC Voltage - into 50 Ohm

Calibrator Output (V)	ADJ Freq (Hz)	8588A Aperture Setup	8588A Trigger Setup
-0.001	40	0.0002498 s	10000
-0.002	40	0.0002498 s	10000
0.001	40	0.0002498 s	10000
0.002	40	0.0002498 s	10000
-0.002001	40	0.0002498 s	10000
-0.005	40	0.0002498 s	10000
0.002001	40	0.0002498 s	10000
0.005	40	0.0002498 s	10000
-0.005001	40	0.0002498 s	10000
-0.02	40	0.0002498 s	10000
0.005001	40	0.0002498 s	10000
0.02	40	0.0002498 s	10000
-0.020001	40	0.0002498 s	10000
-0.05	40	0.0002498 s	10000
0.020001	40	0.0002498 s	10000
0.05	40	0.0002498 s	10000
-0.05001	40	0.0002498 s	10000
-0.2	40	0.0002498 s	10000
0.05001	40	0.0002498 s	10000
0.2	40	0.0002498 s	10000
-0.20001	40	0.0002498 s	10000
-0.5	40	0.0002498 s	10000
0.20001	40	0.0002498 s	10000
0.5	40	0.0002498 s	10000
-0.5001	40	0.0002498 s	10000
-2	40	0.0002498 s	10000
0.5001	40	0.0002498 s	10000
2	40	0.0002498 s	10000
-2.0001	40	0.0002498 s	10000
-6.6	40	0.0002498 s	10000
2.0001	40	0.0002498 s	10000
6.6	40	0.0002498 s	10000

Edge Measurement Adjustment

To adjust Edge:

When the Calibrator is in Scope Adjustment mode and **Edge** is highlighted:

1. Connect the SCOPE connector of the Calibrator to the 8588A input HI and LO as shown in Figure 35.

8588A settings:

- Function: Digitize
- Input > Terminal > Front
- Coupling, Zin: DC, 1 MΩ
- Measure Setup > Low pass filter: 3 MHz
- Measure Setup > Range: base on ac voltage adjust point
- Measure Setup > Aperture: <Aperture value> which is shown in the **Fluke 8588A Aperture Setup** column of Table 55. This Aperture value was calculated based on adjust frequency with this formula:

$$\begin{aligned} \text{Sample Rate} &= 100 * \text{Adjust Frequency} \\ (\text{If Sample Rate} > 5000000.0, \text{ use } 5000000.0) \\ \text{Aperture} &= (1 / \text{Sample Rate}) - 0.0000002 \end{aligned}$$

- Trigger Setup > Triggers/Arm (Count): 10000
2. Tap **Continue** on the display.
 3. Push **OPERATE**.
 4. On the 8588A, push the **TRIG** softkey to collect data of the waveform. Export the digitized data to the external device. Reference the *8588A Operators Manual* Digitize Menu function for information to extract the data.
 5. Process the data:
Separate the data into two groups:
 - Top level: MEDIAN of all readings > 90% of reference level
 - Base level: MEDIAN of all readings < 10% of reference level

The processed value is calculated as:

$$\text{median of Top line} - \text{median of Base line.}$$

6. Type in the processed value from step 4 with the Calibrator keypad and push **ENTER**.

Note

The Calibrator shows a message if the typed value is higher or lower than the limits of the value. If this occurs, examine the setup and carefully re-type the measurement with the correct unit (for example, mV, V). Repair may be necessary if the warning continues.

7. Repeat Table 55, steps 3 through 5 until the Calibrator prompts to adjust Leveled Sine.

Table 55. Sequential Adjustment Points and 8588A Aperture Setup for Edge

Calibrator Output (V)	ADJ Freq (Hz)	8588A Aperture Setup	8588A Trigger Setup
0.005	1000	0.0000098 s	10000
0.01	1000	0.0000098 s	10000
0.025	1000	0.0000098 s	10000
0.05	1000	0.0000098 s	10000
0.06	1000	0.0000098 s	10000
0.08	1000	0.0000098 s	10000
0.1	1000	0.0000098 s	10000
0.2	1000	0.0000098 s	10000
0.25	1000	0.0000098 s	10000
0.3	1000	0.0000098 s	10000
0.5	1000	0.0000098 s	10000
0.6	1000	0.0000098 s	10000
1	1000	0.0000098 s	10000
2.5	1000	0.0000098 s	10000

Leveled Sine Wave Adjustment

This procedure uses:

- Fluke 5790B Wideband
- Keysight N1913B Power Meter or equivalent
- Keysight E9304A Power Sensor or equivalent
- Type_N(f) to BNC(f) adapter
- Output Scope Card cable supplied with the scope option

Leveled Sine Wave LOW Frequency Adjustment

When Calibrator is in Scope Adjustment mode and **Leveled Sine** is highlighted:

1. Setup the 5790B Wideband with External trigger OFF and HIRES ON and range as shown in Table 56.
2. Connect the Output N-type terminal to the 5790B Wideband configured to measure ac voltage and push **Continue** on the display. See Figure 37.
3. Push **OPERATE**.
4. Type in the measured output in volts RMS with the Calibrator keypad and push **ENTER**.

Note

The Calibrator shows a message if the typed value is higher or lower than the limits of the value. If this occurs, examine the setup and carefully re-type the measurement with the correct unit (for example, mV, V). Repair may be necessary if the warning continues.

5. Repeat step 3 and 4 until the Calibrator prompts to adjust leveled sine mid frequency.

Table 56. Sequential Adjustment Points for Leveled Sine LO Points Setup

Calibrator Output		5790B Wideband Range Setup
(V)	(Hz)	
0.005	50000	2.2 mV
0.02	50000	22 mV
0.02	20000000	22 mV
0.02	49900000	22 mV
0.0201	50000	22 mV
0.05	50000	22 mV
0.05	20000000	22 mV
0.05	49900000	22 mV
0.0501	50000	22 mV
0.2	50000	220 mV
0.2	20000000	220 mV
0.2	49900000	220 mV
0.201	50000	220 mV
0.5	50000	220 mV
0.5	20000000	220 mV
0.5	49900000	220 mV
0.501	50000	220 mV
2	50000	2.2 V
2	20000000	2.2 V
2	49900000	2.2 V
2.01	50000	2.2 V
5.5	50000	2.2 V
5.5	20000000	2.2 V
5.5	49900000	2.2 V

Leveled Sine Wave MID Frequency and HIGH Frequency Adjustment

To adjust the calibration leveled sine wave MID and HIGH frequencies:

1. Connect the Keysight N1913B Power Meter to the Keysight E9304A Power Sensor, see Figure 44. To learn how to connect these two instruments, refer to their operator manuals.
2. Zero and self-calibrate the power meter with the power sensor. Refer to the Keysight N1913B operator manual.
Power Meter settings:
 - Turn off relative for channel 1
 - Set channel 1 to measure power, display dBm, auto range, and average 256.
3. Connect the Output N-type terminal to a Precision Power Meter configured to measure ac voltage and tap **Continue** on the display. See Figure 44.
4. Push **OPERATE**.
5. Type in the measured output in volts RMS with the Calibrator keypad and push **ENTER**.

Note

For frequency of 50 MHz, type in the measured output collected in column **B** of Table 52.

For frequency >50 MHz, calculate the V_{rms} values with this formula:

Value Enter = Value from Power Meter + column **B** of Table 52 - column **C** of Table 52.

Note

Ensure all values are converted to V_{rms} .

Note

The Calibrator shows a message if the typed value is higher or lower than the limits of the value. If this occurs, examine the setup and carefully re-type the measurement with the correct unit (for example, mV, V). Repair may be necessary if the warning continues.

6. Repeat step 4 and 5 until the Calibrator prompts to adjust Resistance.

Table 57. Sequential Adjustment Points and 5790B or Power Meter Setup for Leveled Sine MID

Calibrator Output		5790B Wideband Range Setup	N1913B Setup	
(V)	(Hz)		Range	Count
0.005	50E+6	2.2 mV		
0.016	50E+6	2.2 mV		
0.016	300E+6		LP	16
0.016	600E+6		LP	16
0.005	75E+6		LP	32
0.005	137E+6		LP	32
0.016	75E+6		LP	16
0.016	137E+6		LP	16
0.01601	50E+6	2.2 mV		

Table 57. Sequential Adjustment Points and 5790B or Power Meter Setup for Leveled Sine MID

Calibrator Output		5790B Wideband Range Setup	N1913B Setup	
(V)	(Hz)		Range	Count
0.05	50E+6	22 mV		
0.05	300E+6		LP	4
0.05	600E+6		LP	4
0.01601	75E+6		LP	8
0.01601	137E+6		LP	8
0.05	75E+6		LP	4
0.05	137E+6		LP	4
0.0501	50E+6	22 mV		
0.16	50E+6	70 mV		
0.16	300E+6		LP	4
0.16	600E+6		LP	4
0.0501	75E+6		LP	4
0.0501	137E+6		LP	4
0.16	75E+6		LP	4
0.16	137E+6		LP	4
0.1601	50E+6	70 mV		
0.5	50E+6	220 mV		
0.5	300E+6		HP	32
0.5	600E+6		HP	32
0.1601	75E+6		LP	4
0.1601	137E+6		LP	4
0.5	75E+6		HP	32
0.5	137E+6		HP	32
0.501	50E+6	220 mV		
1.6	50E+6	700 mV		
1.6	300E+6		HP	4
1.6	600E+6		HP	4
0.501	75E+6		HP	16
0.501	137E+6		HP	16
1.6	75E+6		HP	4

Table 57. Sequential Adjustment Points and 5790B or Power Meter Setup for Levelled Sine MID

Calibrator Output		5790B Wideband Range Setup	N1913B Setup	
(V)	(Hz)		Range	Count
1.6	137E+6		HP	4
1.601	50E+6	700 mV		
5.5	50E+6	2.2 V		
5.5	300E+6		HP	4
5.5	600E+6		HP	4
1.601	75E+6		HP	4
1.601	137E+6		HP	4
5.5	75E+6		HP	4
5.5	137E+6		HP	4

Table 58. Sequential Adjustment Points and Power Meter set up for Levelled Sine HIGH

Calibrator Output		N1913B Setup	
(V)	(Hz) ^{[1], [2]}	Range	Count
0.005	601E+6	LP	32
0.01	601E+6	LP	32
0.01	2E+9	LP	32
0.01	2E+9	LP	32
0.0101	601E+6	LP	16
0.03	601E+6	LP	4
0.03	2E+9	LP	4
0.03	2E+9	LP	4
0.0301	601E+6	LP	4
0.1	601E+6	LP	4
0.1	2E+9	LP	4
0.1	2E+9	LP	4
0.101	601E+6	LP	4

Table 58. Sequential Adjustment Points and Power Meter set up for Leveled Sine HIGH (cont.)

Calibrator Output		N1913B Setup	
(V)	(Hz) ^{[1], [2]}	Range	Count
0.3	601E+6	HP	32
0.3	2E+9	HP	32
0.3	2E+9	HP	32
0.301	601E+6	HP	32
1	601E+6	HP	8
1	2E+9	HP	8
1	2E+9	HP	8
1.01	601E+6	HP	4
3.5	601E+6	HP	4
3.5	2E+9	HP	4
3.5	2E+9	HP	4

[1] 601E+6 adjustment points only applicable for the 1G option.
[2] 2E+9 adjustment points only applicable for the 2G option.

Resistance Adjustment

The Product adjusts the calibration of Measure Resistance mode (**Function > Scope > Resistance**) with resistors of known values. Use the Calibrator keypad to enter the actual resistance values as the Calibrator measures those values.

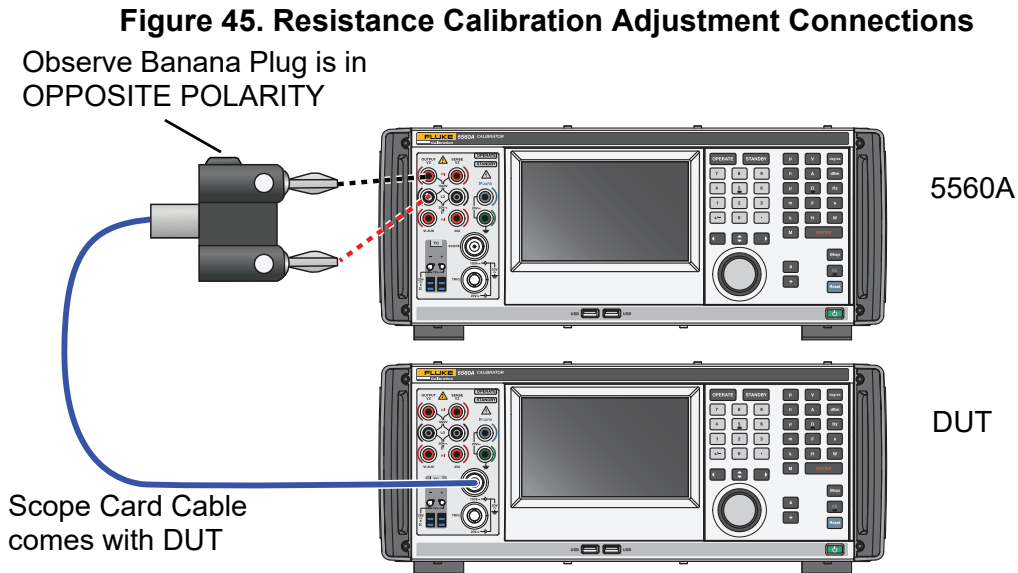
The resistors must make a solid connection to a BNC(f) to make a connection to the end of the output cable supplied with the scope option. You must know the resistance values at this BNC(f) connector.

This procedure uses:

- Resistors of known values and Fluke 5560A Calibrator Main Frame Source Resistance
- Adapter to connect resistors to the BNC(f) connector (Fluke recommends Pomona 1269)

When the Calibrator is in Scope Adjustment mode and **Resistance** is highlighted:

1. Make the connections shown in Figure 45:



5560A Calibrator settings:

- Function setting: **Function > Single Output > Resistance**
- Guard: INTERNAL
- Comp: OFF
- Output: 40 Ω .

2. Push **OPERATE**.
3. Tap the **Continue** button on the display.
4. Tap the **Continue** button on the display again and use the Calibrator keypad to enter the actual Measured value of 40 Ω (40.00 Ω).
5. Push **ENTER**. Wait for the DUT to measure the value and prompt you for the next value.

5560A settings:

- Function setting: **Function > Single Output > Resistance**
- Guard: INTERNAL
- Comp: OFF
- Output: 60 Ω .

6. Push **OPERATE**.
7. Tap the **Continue** button on the display.
8. Tap the **Continue** button on the display again and use the Calibrator keypad to enter the actual Measured value of 60 Ω (60.00 Ω).
9. Push **ENTER**. Wait for the DUT to measure the value and prompt you for the next value.

5560A settings: Observe banana plug is in OPPOSITE polarity.

- Function setting: **Function > Single Output > Resistance**
- Guard: INTERNAL
- Comp: OFF
- Output: 1 M Ω
- Output Scope card cable supplied with the scope option

10. Push **OPERATE**.

11. Tap the **Continue** button on the display.

12. Tap the **Continue** button on the display again and use the Calibrator keypad to enter the actual Measured value of 1 M Ω (1 M Ω).

13. Push **ENTER**. Wait for the DUT to measure the value.

14. Push the **Save** button on the display to store the adjustment results.

Maintenance

Most common maintenance steps for the Product are found in the Operators Manual.

Product Disposal

Dispose of the Product in a professional and environmentally sound manner:

- Delete personal data on the Product before disposal.
- Remove batteries that are not integrated into the electrical system before disposal and dispose of batteries separately.
- If this Product has an integral battery, put the entire Product in the electrical waste.

Scope Option Maintenance

Maintenance procedures of diagnostic remote commands for the scope option are not available to users. If the scope option is not installed or is not connected to internal power, when you tap the **Scope** button, the display indicates that the option is not installed.

If the message shows with an installed scope option, you must send the Calibrator to Fluke for repair. To purchase a scope option, see your Fluke sales representative. See [Contact Fluke Calibration](#).

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 59 to identify some of the parts in Figure 46. Note that not all parts are shown in the figure. Electronic components can be ordered directly from Fluke Calibration and its authorized representatives with the Fluke part number. See [Contact Fluke Calibration](#).

Table 59. 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),BULK HEAD 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
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

Table 59. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
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
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

Table 59. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
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
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

Table 59. Replaceable Parts (cont.)

Item Sequence	Description	Fluke Calibration Part Number	Quantity
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
103	WASHER,SHOULDER,.118 ID,.250 OD,.070 L,NYLON	485417	4
104 (not shown)	CONNECTOR,COAXIAL,BNC(M),DUST CAP,2 GHZ,BULK (5530A)	6075391	1
105 (not shown)	CONNECTOR,COAXIAL,DUST CAP,FEMALE,TYPE N (5530A)	6075475	1

Figure 46. Replacement Parts

