

SIGNAL HOUND

# Field Calibration Software

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## User's Manual

Version 1.12.15

**7/24/2023**

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Regulations 15 CFR 734

Requirements, Installation, Instructions, Usage

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## 1 Introduction

The Signal Hound field calibration software is a PC-based application for running performance verification tests and making adjustments to the Signal Hound BB60A/C/D, SA44B, SA124B, SM200A/B/C and SM435B/C spectrum analyzers, the PNCS-1 phase noise clock standard, the TG44A and TG124A tracking generators, and the VSG25A and VSG60A vector signal generators.

## 2 System Requirements

PC Requirements for BB60A/C/D, SA44B, SA124B, SM200A/B/C, SM435B/C, PNCS-1, TG44A, TG124A, VSG25A, and VSG60A calibrations

- 64-bit Windows 7/8/10
- Intel quad-core i-Series processors
- 4 GB of RAM or more is recommended
- 1x USB 2.0 for USB to GPIB controller
- Spike Software Application installed

PC Requirements for BB60A/C/D, SM200A/B, SM435B, and VSG60A

- Native USB 3.0 support

PC Requirements for SM200A/B, SM435B, and VSG60A

- 1x USB 3.0 port

PC Requirements for BB60A/C/D

- 2x USB 3.0 port (recommended) or 1x USB 3.0 and 1x USB 2.0 port

PC Requirements for SM200C and SM435C

- 10GbE network connectivity through NIC via SFP+ connectors or through Thunderbolt 3 to SFP+ adapter. See SM200C network setup guide for more information.

PC Requirements for SA44B, TG44A, TG124A, and VSG25A

- 1x USB 2.0 for DUT

## PC Requirements for SA124B

- 2x USB 2.0 ports for DUT

## Additional Requirements

- USB to GPIB controller

## 3 Before Installing the Software

Before installing the Signal Hound calibration software, ensure the Signal Hound Spike application is installed and working. Spike is Signal Hound's main spectrum analysis software for all the spectrum analyzer products. Spike can be found on the Signal Hound website ([www.signalhound.com/Spike](http://www.signalhound.com/Spike)). It includes the USB device drivers for the BB60A/C/D, SA44B, SA124B, SM200A/B/C, and SM435B/C spectrum analyzers, the TG44A and TG124A tracking generators, and the VSG25A and VSG60A vector signal generator, which are necessary for the calibration software to communicate with the devices. The BB60C is required to calibrate the VSG25A, and the SM200A/B is required to calibrate the PNCS-1 and the VSG60A.

## 4 Installation Instructions

The Signal Hound calibration software can be downloaded from the Signal Hound website. Unzip the downloaded compressed folder and run the *setup.exe* file. Follow the on-screen instructions to finish the installation. We recommend installing the software to the default installation directory at C:/Program Files/Signal Hound/Field Calibration.

### 4.1 Note for Windows 7

It may be necessary to install the Microsoft Visual C++ 2015 – 2022 redistributable. It can be downloaded here:

<https://docs.microsoft.com/en-us/cpp/windows/latest-supported-vc-redist?view=msvc-170>

Choose either the x64 or x86 download depending on whether you are installing the 64-bit or 32-bit version of the calibration software.

## 5 Uninstalling

On Windows 7/8/10, the Signal Hound calibration software can be uninstalled from the *Programs and Features* menu. The *Program and Features* menu can be found in the *Control Panel*. Find the Signal Hound calibration software, right click the icon, and select uninstall. Once uninstalled, the calibration software can be installed again on the same computer at any time.

## 6 Getting Started

This chapter prepares the user to perform calibrations using the software.

### 6.1 Calibration Cycle

A one-year calibration cycle is recommended for the BB60A/C/D, SA44B, SA124B, SM200A/B/C, SM435B/C, TG44A, TG124A, VSG25A, and VSG60A.

### 6.2 Lab Standards

The calibration software calls for several lab standards. The tests are automated over GPIB. Agilent VISA drivers are used, and a National Instruments or Agilent GPIB adapter is required. To perform all calibrations, all lab standards will need to be present. If any standard is missing, some performance tests will be unavailable. All lab standards need to be within calibration.

#### 6.2.1 BB60A Lab Standards

Below is a list of required equipment to perform a full calibration of the BB60A.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator	10 MHz – 6 GHz, -50 dBm to +10 dBm output, <-55 dBc harmonics, Phase noise (at 1GHz): -75 dBc/Hz @ 100 Hz -81 dBc/Hz @ 1 kHz -88 dBc/Hz @ 10 kHz -98 dBc/Hz @ 100 kHz -122 dBc/Hz @ 1 MHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent ESG Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	2 GHz to 7.5GHz RF input	Agilent 8562E-8565EC
Power Sensor	9 kHz – 6 GHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	9 kHz – 6 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 6 GHz, VSWR < 1.1, ±0.3 dB	Agilent 8493C or equivalent

A DC block is also required for the Amplitude Accuracy (10 MHz – 6 GHz) test.

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generator must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>

## 6.2.2 BB60C Lab Standards

Below is a list of required equipment to perform a full calibration of the BB60C.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator 1	10 MHz – 6 GHz, -50 dBm to +13 dBm output, <-55 dBc harmonics** Phase noise (at 1GHz): -75 dBc/Hz @ 100 Hz -81 dBc/Hz @ 1 kHz -88 dBc/Hz @ 10 kHz -98 dBc/Hz @ 100 kHz -122 dBc/Hz @ 1 MHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent ESG Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Signal Generator 2*	10 MHz – 6 GHz	Agilent MXG Series (N518x) (SCPI) <i>Or</i> Agilent 8340/8341 (HP BASIC), Agilent 8665B (HP-SL)
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	2 GHz to 7.5GHz RF input	Agilent 8562E-8565EC
Power Sensor	9 kHz – 6 GHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	9 kHz – 6 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 6 GHz, VSWR < 1.1, $\pm 0.3$ dB	Agilent 8493C or equivalent

\*Required for Third-Order Intercept test only.

\*\*Only required for optional SFDR Test.

NOTE: To test spurious responses, either the SFDR or the Third-Order Intercept test may be used. When one is run then the other will no longer be available and will not appear in the report. Two generators are required for the Third-Order Intercept test, with less rigorous noise specifications required for the second generator. The SFDR test requires a generator with -55dBC harmonics.

A DC block is also required for the Amplitude Accuracy (10 MHz – 6 GHz) test.

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generator 1 must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>

Signal generator 2 must be compatible with one of the following:

- SCPI
  - o [:SOURce]:FREQuency[:CW] <val><unit>
  - o [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>
- HP BASIC
  - o CW <val><unit>
  - o PL <val><unit>
- HP-SL (Hewlett-Packard System Language)
  - o FREQuency[:CW] <val><unit>
  - o AMPLitude[:OUT][:LEVel] <val><unit>

For calibration of the BB60C 10 MHz time base reference, your signal generator's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the BB60C 10 MHz reference without an accurate external 10 MHz reference is discouraged.

### 6.2.3 BB60D Lab Standards

Below is a list of required equipment to perform a full calibration of the BB60D.



Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator 1	10 MHz – 6 GHz, -50 dBm to +10 dBm output, <-55 dBc harmonics Phase noise (at 1GHz): -75 dBc/Hz @ 100 Hz -81 dBc/Hz @ 1 kHz -88 dBc/Hz @ 10 kHz -98 dBc/Hz @ 100 kHz -122 dBc/Hz @ 1 MHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent ESG Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Signal Generator 2	10 MHz – 6 GHz	Agilent MXG Series (N518x) (SCPI) <i>Or</i> Agilent 8340/8341 (HP BASIC), Agilent 8665B (HP-SL)
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	2 GHz to 7.5GHz RF input	Agilent 8562E-8565EC
Power Sensor	9 kHz – 6 GHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	9 kHz – 6 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 6 GHz, VSWR < 1.1, ±0.3 dB	Agilent 8493C or equivalent
Directional Coupler	25 MHz – 6 GHz	Mini-Circuits ZFDC-10-5-S+
Directional Coupler	6 GHz – 20 GHz	Agilent 87300B

A DC block is required for the Amplitude Accuracy (10 MHz – 6 GHz) test.

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generator 1 must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>

Signal generator 2 must be compatible with one of the following:

- SCPI
  - [:SOURce]:FREQuency[:CW] <val><unit>
  - [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>
- HP BASIC
  - CW <val><unit>
  - PL <val><unit>
- HP-SL (Hewlett-Packard System Language)
  - FREQuency[:CW] <val><unit>

- `AMPLitude[:OUT][:LEVel] <val><unit>`

For calibration of the BB60D 10 MHz time base reference, your signal generator’s internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator’s **10 MHz Input** connector. Adjusting the BB60D 10 MHz reference without an accurate external 10 MHz reference is discouraged.

#### 6.2.4 SA44B Lab Standards

Below is a list of required equipment to perform a full calibration of the SA44B.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator	10 MHz – 4.4 GHz*, -50 dBm to +10 dBm output, Phase noise: -75 dBc/Hz @ 100 Hz -83 dBc/Hz @ 1 kHz -86 dBc/Hz @ 10 kHz -95 dBc/Hz @ 100 kHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent ESG Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Power Sensor	9 kHz – 4.4 GHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	9 kHz – 4.4 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 4.4 GHz, VSWR < 1.1, ±0.3 dB	Agilent 8493C or equivalent

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generator must conform to SCPI, and accept the following commands:

- `[:SOURce]:FREQuency[:CW] <val><unit>`
- `[:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>`

For calibration of the SA44B 10 MHz time base reference, your signal generator’s internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator’s **10 MHz Input** connector. Adjusting the SA44B 10 MHz reference without an accurate external 10 MHz reference is discouraged.

\* A signal generator with a lower maximum frequency may be used to perform a partial, limited calibration up to that frequency.

#### 6.2.5 SA124B Lab Standards

Below is a list of required equipment to perform a full calibration of the SA124B.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator	10 MHz – 12.4 GHz, -50 dBm to +10 dBm output, Phase noise: -75 dBc/Hz @ 100 Hz -83 dBc/Hz @ 1 kHz -86 dBc/Hz @ 10 kHz -95 dBc/Hz @ 100 kHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent ESG Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
Power Meter	Supports E9304A/E9300A sensor	Agilent EPM-series, E4418, E4419
Power Sensor	100 kHz – 12.4 GHz RF input, all E9304A specifications required	Agilent E9304A Option H18
	<i>or</i>	
Power Sensor	100 kHz – 10 MHz RF input, all E9304A specifications required	Agilent E9304A
Power Sensor	10 MHz – 12.4 GHz RF input, all E9300A specifications required	Agilent E9300A
Power Splitter	9 kHz – 6 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 6 GHz, VSWR < 1.1, ±0.3 dB	Agilent 8493C or equivalent

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generator must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWEr[:LEVel][:IMMediate][:AMPLitude] <val><unit>

The Agilent E9304A Option H18 power sensor covers the full frequency range of the SA124B, and can be used for all tests requiring a power sensor. Alternatively, two power sensors may be used to cover this range, the Agilent E9304A for tests below 10 MHz, and the Agilent E9300A for tests above 10 MHz.

For calibration of the SA124B 10 MHz time base reference, your signal generator's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the SA124B 10 MHz reference without an accurate external 10 MHz reference is discouraged.

### 6.2.6 PNCS-1 Lab Standards

Below is a list of required equipment to perform a full calibration of the PNCS-1.

Equipment Type	Key Specifications Used	Required Make / Model
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	1 MHz – 6.1 GHz RF input	Signal Hound SM200A/B
Power Sensor	9 kHz – 2.5 GHz RF input, all E9304A specifications required	Agilent E9304A
Phase Noise Analyzer	10 MHz – 6 GHz	Holzworth HA7402 <i>Or</i> Agilent 5052B

Depending on the test setup, various adapters may be needed and are not listed here.

The PNCS-1 does not connect to the testing computer.

### 6.2.7 SM200A/B/C Lab Standards

Below is a list of required equipment to perform a full calibration of the SM200.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator 1	10 MHz – 20 GHz, -50 dBm to +10 dBm output, <-55 dBc harmonics Phase noise (at 1GHz): -75 dBc/Hz @ 100 Hz -81 dBc/Hz @ 1 kHz -88 dBc/Hz @ 10 kHz -98 dBc/Hz @ 100 kHz -122 dBc/Hz @ 1 MHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Signal Generator 2	10 MHz – 20 GHz	Agilent MXG Series (N518x) <i>Or</i> Agilent 8360 Series, Agilent PSG Series, Equivalent SCPI-compliant generator
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
USB Power Sensor	10 MHz – 20 GHz	Agilent U2002A with Option H26
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	300 MHz to 20 GHz RF input	Agilent 8563E-8565EC
Phase Noise Standard	1 GHz	Signal Hound PNCS-1
Power Sensor	9 kHz – 10 MHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	9 kHz – 20 GHz, VSWR < 1.22, 0.25 dB output tracking	Agilent 11667B or equivalent
Attenuator (10dB)	9 kHz – 20 GHz, VSWR < 1.1, ±0.3 dB	Agilent 8493C or equivalent
Directional Coupler	25 MHz – 6 GHz	Mini-Circuits ZFDC-10-5-S+
Directional Coupler	6 GHz – 20 GHz	Agilent 87300B

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generators 1 and 2 must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWer[:LEVel][:IMMediate][:AMPLitude] <val><unit>

For calibration of the SM200 10 MHz time base reference, your signal generator's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the SM200 10 MHz reference without an accurate external 10 MHz reference is discouraged.

## 6.2.8 SM435B/C Lab Standards

Below is a list of required equipment to perform a full calibration of the SM435.

Equipment Type	Key Specifications Used	Required Make / Model
Signal Generator 1	10 MHz – 50 GHz, -50 dBm to 0 dBm output, <-50 dBc harmonics Phase noise (at 10GHz): <-80 dBc @ 10 kHz	HP 83650B <i>Or</i> Equivalent SCPI-compliant generator
Signal Generator 2	10 MHz – 50 GHz, -50 dBm to 0 dBm output, <-50 dBc harmonics Phase noise (at 10GHz): <-80 dBc @ 10 kHz	HP 83650B <i>Or</i> Equivalent SCPI-compliant generator
Function Generator	9 kHz – 10 MHz, -20 dBm to +13 dBm output	Agilent 33120A or compatible
USB Power Sensor	10 MHz – 50 GHz	Agilent U2055XA
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	300 MHz to 50 GHz RF input	Agilent 8565E
Vector Network Analyzer	45 MHz – 50 GHz	Agilent E8364A
Phase Noise Standard	1 GHz	Signal Hound PNCS-1
Power Sensor	9 kHz – 10 MHz RF input, all E9304A specifications required	Agilent E9304A
Power Splitter	DC – 50 GHz	Agilent 11667C or equivalent
Directional Coupler	1 MHz – 2 GHz	Mini-Circuits ZFDC-10-5-S+
Power Divider	1 GHz – 50 GHz	Mini-Circuits ZC2PD-V154+

Depending on the test setup, various adapters may be needed and are not listed here.

Signal generators 1 and 2 must conform to SCPI, and accept the following commands:

- [:SOURce]:FREQuency[:CW] <val><unit>
- [:SOURce]:POWEr[:LEVel][:IMMediate][:AMPLitude] <val><unit>

For calibration of the SM435 10 MHz time base reference, your signal generator's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the SM435 10 MHz reference without an accurate external 10 MHz reference is discouraged.

### 6.2.9 TG44A Lab Standards

Below is a list of required equipment to perform a full calibration of the TG44A.

Equipment Type	Key Specifications Used	Required Make / Model
Power Meter	Supports E9304A and 8487D sensors	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	9 KHz – 20 GHz RF input	SM200A/B HP 8564E
Power Sensor	9 kHz – 25 MHz RF input, all E9304A specifications required	Agilent E9304A
Power Sensor	100 MHz – 26 GHz RF input	Agilent 8485D/8487D

Depending on the test setup, various adapters may be needed and are not listed here.

For calibration of the TG44A 10 MHz time base reference, your spectrum analyzer's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the TG44A 10 MHz reference without an accurate external 10 MHz reference is discouraged.

#### 6.2.10 TG124A Lab Standards

Below is a list of required equipment to perform a full calibration of the TG124A.

Equipment Type	Key Specifications Used	Required Make / Model
Power Meter	Supports E9304A and 8487D sensors	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	9 KHz – 26 GHz RF input	SM200A/B HP 8564E
Power Sensor	100 kHz – 25 MHz RF input, all E9304A specifications required	Agilent E9304A
Power Sensor	100 MHz – 26 GHz RF input	Agilent 8485D/8487D

Depending on the test setup, various adapters may be needed and are not listed here.

For calibration of the TG124A 10 MHz time base reference, your spectrum analyzer's internal time base must be within 0.2 ppm, or an accurate external 10 MHz reference must be connected to your signal generator's **10 MHz Input** connector. Adjusting the TG124A 10 MHz reference without an accurate external 10 MHz reference is discouraged.

#### 6.2.11 VSG25A Lab Standards

Below is a list of required equipment to perform a full calibration of the VSG25A.

Equipment Type	Key Specifications Used	Required Make / Model
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	100 MHz – 2.5 GHz RF input	Signal Hound BB60C
Power Sensor	9 kHz – 2.5 GHz RF input, all E9304A specifications required	Agilent E9304A

Depending on the test setup, various adapters may be needed and are not listed here.

### 6.2.12 VSG60A Lab Standards

Below is a list of required equipment to perform a full calibration of the VSG60A.

Equipment Type	Key Specifications Used	Required Make / Model
Power Meter	Supports E9304A sensor	Agilent EPM-series, E4418, E4419
Spectrum Analyzer	50 MHz – 20 GHz RF input	Signal Hound SM200A/B
Power Sensor	9 kHz – 6 GHz RF input, all E9304A specifications required	Agilent E9304A

Depending on the test setup, various adapters may be needed and are not listed here.

## 7 Running the Software

This chapter acts as a guide to running the Signal Hound field calibration software.

### 7.1 Before starting the software

At this point all lab standards need to be identified and should be on a GPIB network connected to your PC with a unique GPIB address.

The Signal Hound spectrum analyzer or signal generator under test should be connected to your PC, and should be allowed at minimum 15 minutes of idling time before starting the software. This allows the device to reach a stable operating temperature.

### 7.2 Starting a New Calibration Session

Upon launching the software, the user will be presented with a splash screen and application menu bar. Using the menu bar, select *Start New Test* and choose a device to begin a new calibration test session.



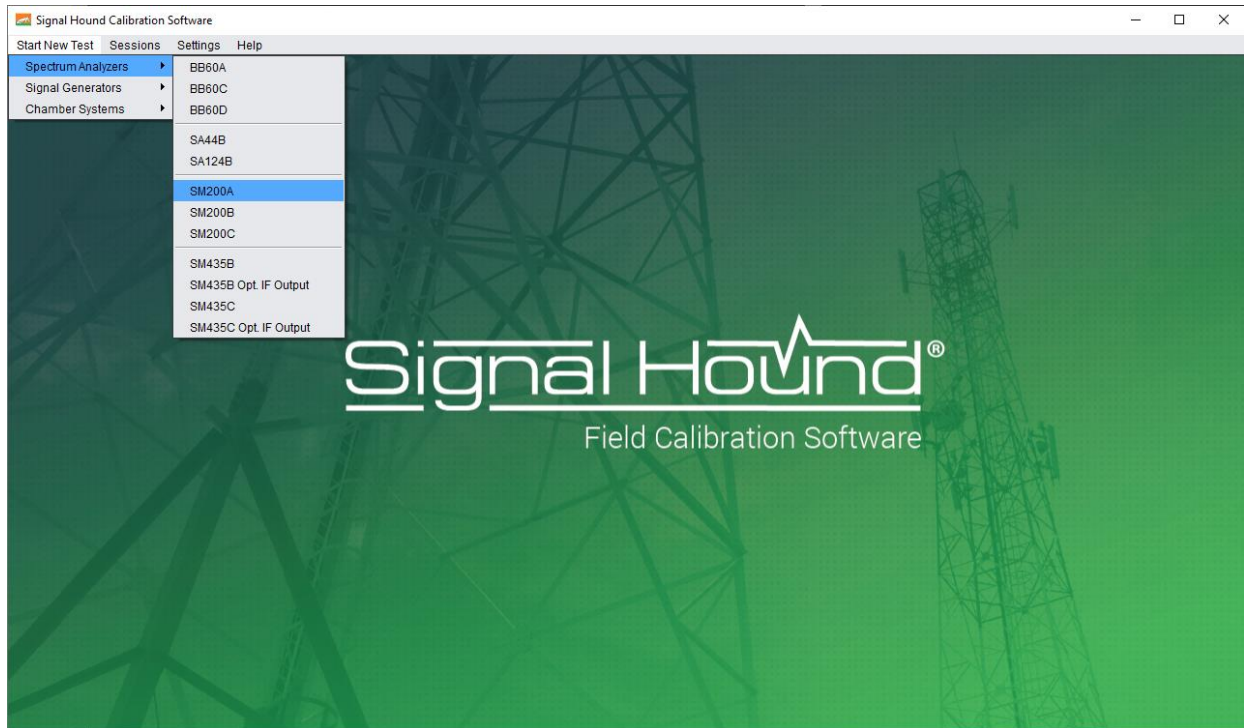


Figure 1: Using the file menu to start a new calibration session

When a new session is begun for an SA or TG series device, all locally cached corrections files for SA and TG devices will be removed. This is to make sure they are pulled from the DUT.

### 7.3 Saving and Loading a Calibration Session

Calibration sessions can be saved and loaded at a later time. This can be useful if you wish to run some tests now and more later, or to experiment with rerunning tests without overwriting the existing one in a saved session.

A session consists of data from test runs, and does not include currently used standards. Only tests that are able to be run can accept session data.

To save a session, select “Save Session” from the Sessions menu, or press Ctrl+S. To load a session, select “Load Session” or press Ctrl+O. You can autosave sessions by checking “Autosave sessions” from the Preferences menu under Settings. This will automatically save the session each time a test is completed.

### 7.4 Application Layout

When a test has been selected the software will immediately change into an interface designed to manage the calibration session.

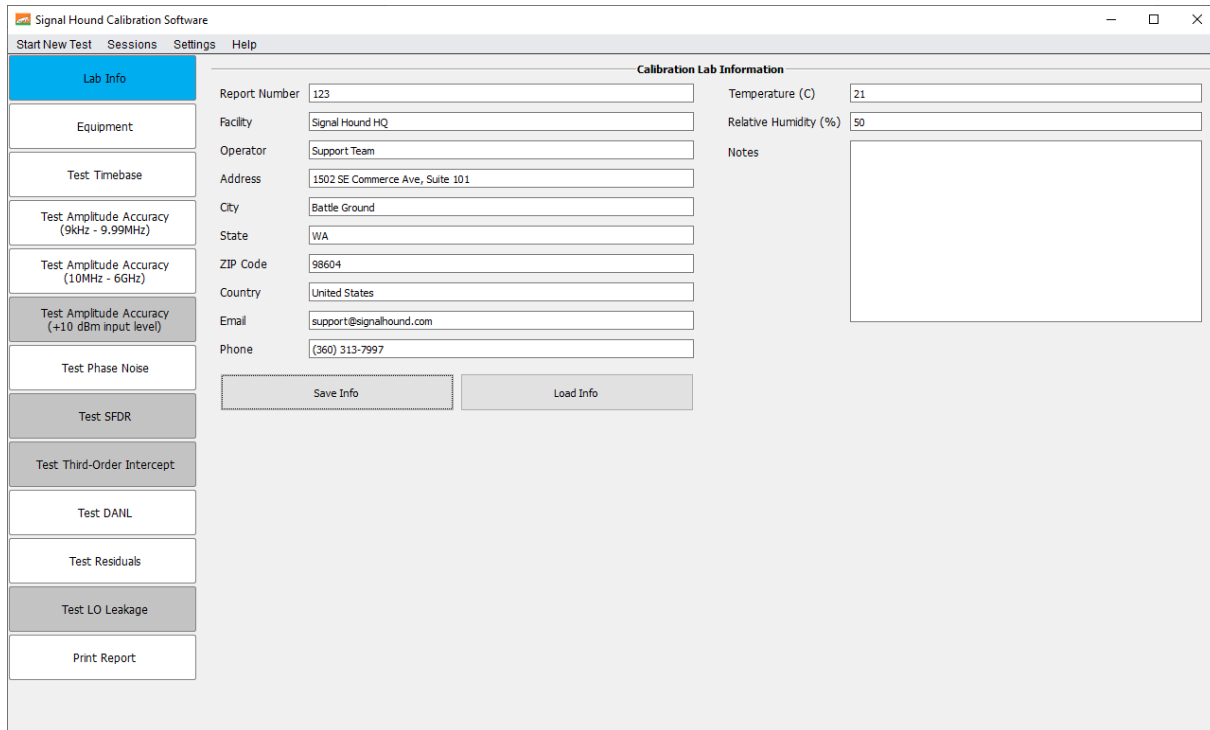


Figure 2: Application Layout for a BB60C Calibration Session

On the left portion of the application you will see various tabs, and on the right is the designated workspace for a given tab. Tabs can be selected with your mouse. Available tabs are colored white, and greyed out tabs indicate tests that are unavailable.

## 7.5 Filling Out Lab Information

Selecting the *Lab Info* tab displays a workspace for entering your calibration lab information as well as test environment information. You can add any notes and a report number for tracking purposes. This information will be printed on the final test report. You can save/load the information on this page to prevent having to re-type it on future tests.

## 7.6 Adding Test Standards

Selecting the *Equipment* tab displays a workspace for entering and connecting your available test standards. From this tab you will connect the device under test, all GPIB instrument, and enter all passive test standards.

It is recommended to add all test standards before beginning the calibration tests.

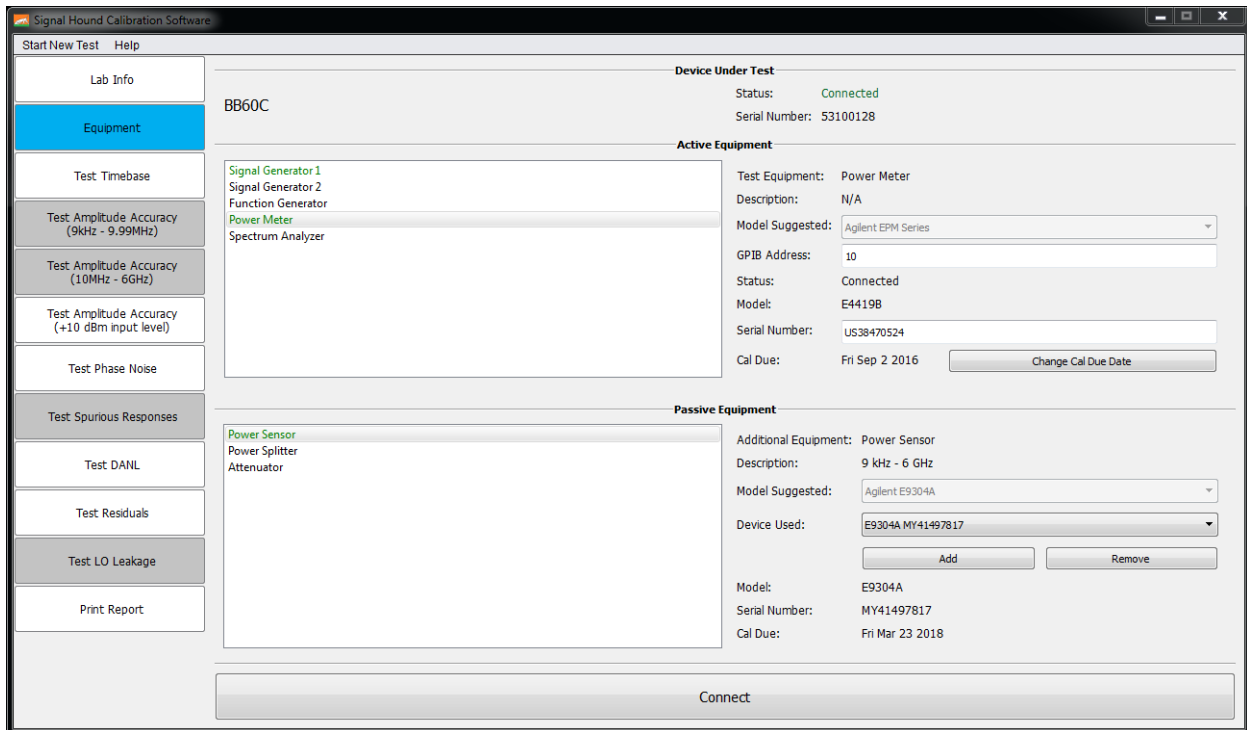


Figure 3: Equipment entry tab for a BB60C calibration session

### 7.6.1 Adding the Device Under Test

The device under test (DUT) can be added simply by having the device connected to your PC and pressing the *Connect* button.\* If it has been properly detected, the *Device Under Test* section under the equipment tab will be updated to show the connection status and serial number.

If at any point during the calibration the DUT becomes disconnected, the software will alert you to this and you will need to return to the *Equipment* tab and re-connect the DUT.

\* The PNCS-1 does not connect to the computer, so after pressing *Connect* you will be prompted to enter the device's serial number. The serial number is found on a sticker on the back of the device.

### 7.6.2 Adding GPIB Instruments

To add a test standard with a GPIB interface, you need to enter a GPIB address for the standard (addresses default to their values from the previous session), and press the *Connect Equipment* button. If the device responds at that address, the session will populate the Model / Serial Number / and Cal Due date for that device. You will need to select the Cal Due date the first time you connect a new test standard.

Once any test standard with a GPIB interface has been added to the software, it cannot be changed until the session or software is restarted.

NOTE: If you are experiencing GPIB connection issues try clearing old connections that may still be in the memory of your IO handler.

### 7.6.3 Adding Passive Test Standards

Passive equipment must be added manually, and is stored in dropdown lists by type. All equipment in this category can be found under the *Passive Equipment* section in the *Equipment* tab. Pressing *Add* next to each piece of equipment allows you to enter the model, serial, and calibration due date of each piece of equipment, and adds it to the corresponding dropdown list. Pressing *Remove* removes the piece of equipment from the dropdown list. Selecting a piece of equipment from the dropdown list designates it for use.

## 7.7 Running the Performance Verification Tests

As you add test standards to the session, test tabs will become available. Each test tab will display a workspace containing a description of the test, and image depicting the test setup, test output, and a start test button.

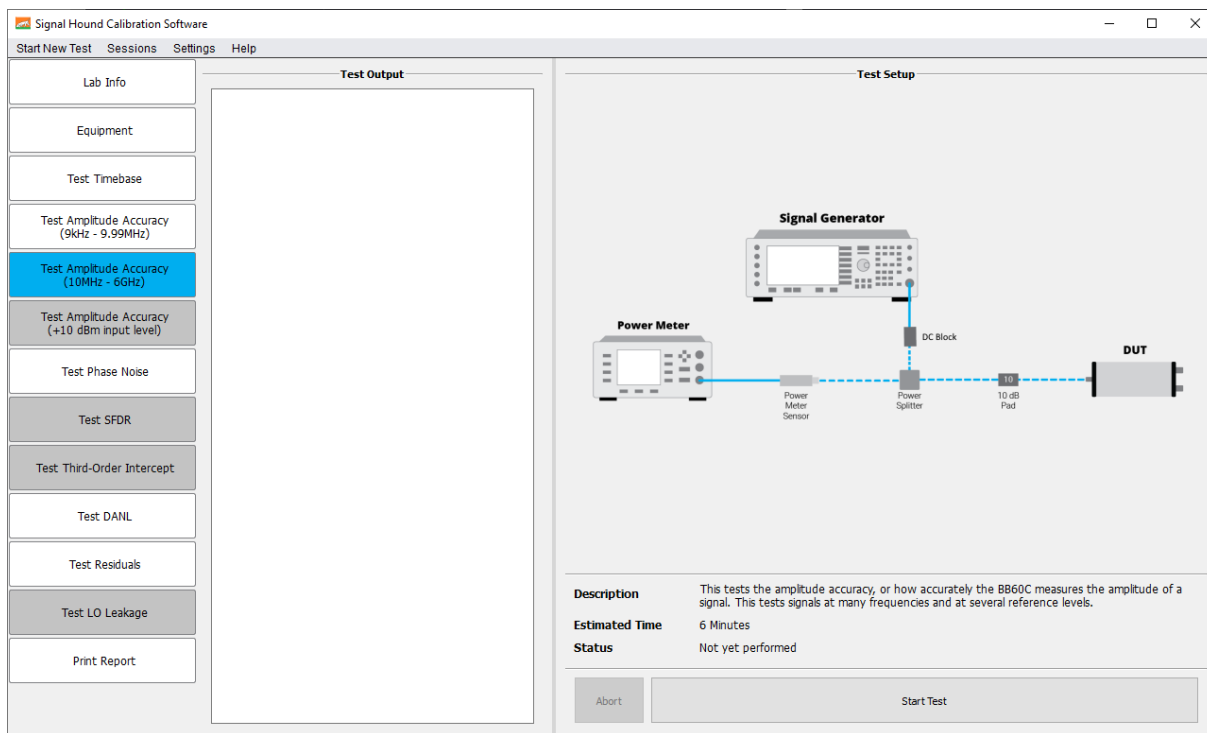


Figure 4: The test workspace for BB60C Amplitude Accuracy

For each test, ensure your test setup matches the one depicted in the image and press *Start Test*.

The test time is shown above the *Start Test* button. The tests will take less than the estimated time on average. Some tests may require you to change the setup part way through the test. The setup changes will be depicted on the setup images for those tests.

Wait for the test status to change to pass/fail before continuing. If the test passes, the test status will be updated to *Test Passed* and the test tab will be colored green. If the test fails, the test status will be updated to *Test Failed* and the test tab will be colored red. In either case, a test may be re-run, and the old results overwritten.

## 7.7.1 PNCS-1

### 7.7.1.1 Phase Noise Test

The Phase Noise Test for the PNCS-1 can be performed with the Holzworth HA7402 Phase Noise Analyzer Engine and its accompanying software (Figure 5), and the resultant data then input into the Field Calibration Software.

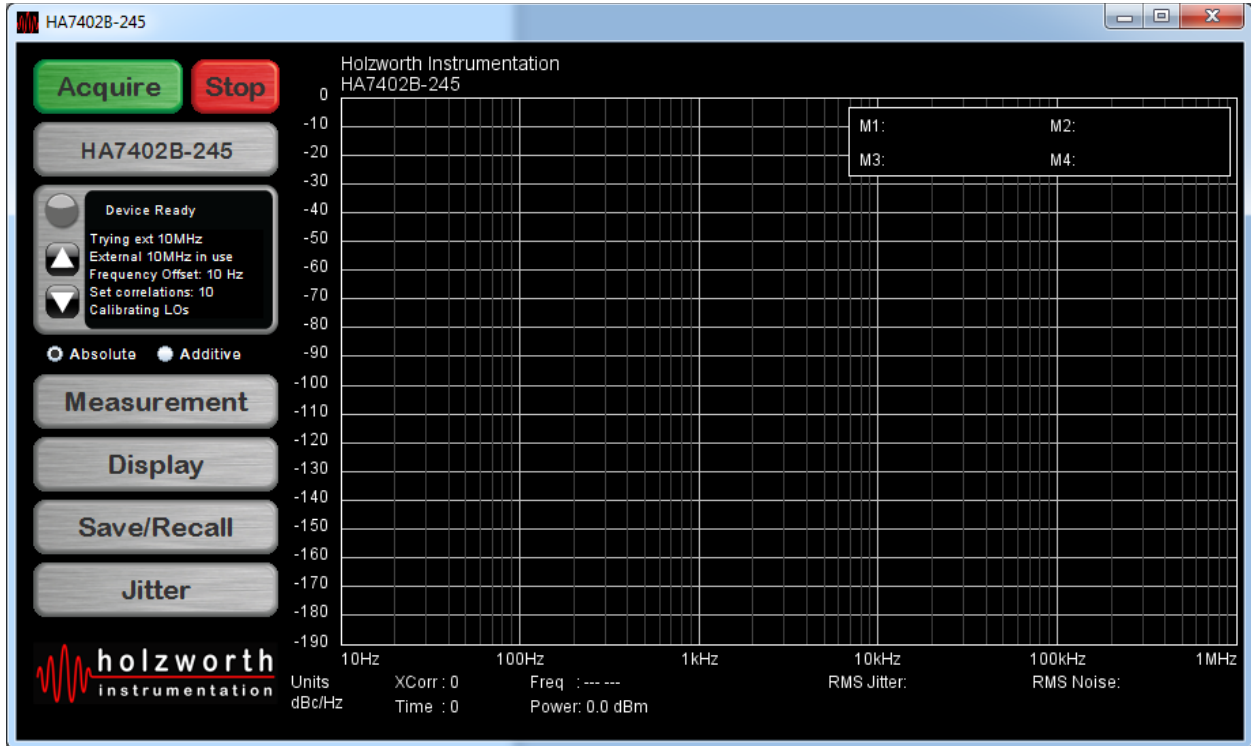


Figure 5: The Holzworth HA7402 software for use in the PNCS-1 Phase Noise Test

Below are screenshots depicting the appropriate measurement and display settings for this test:

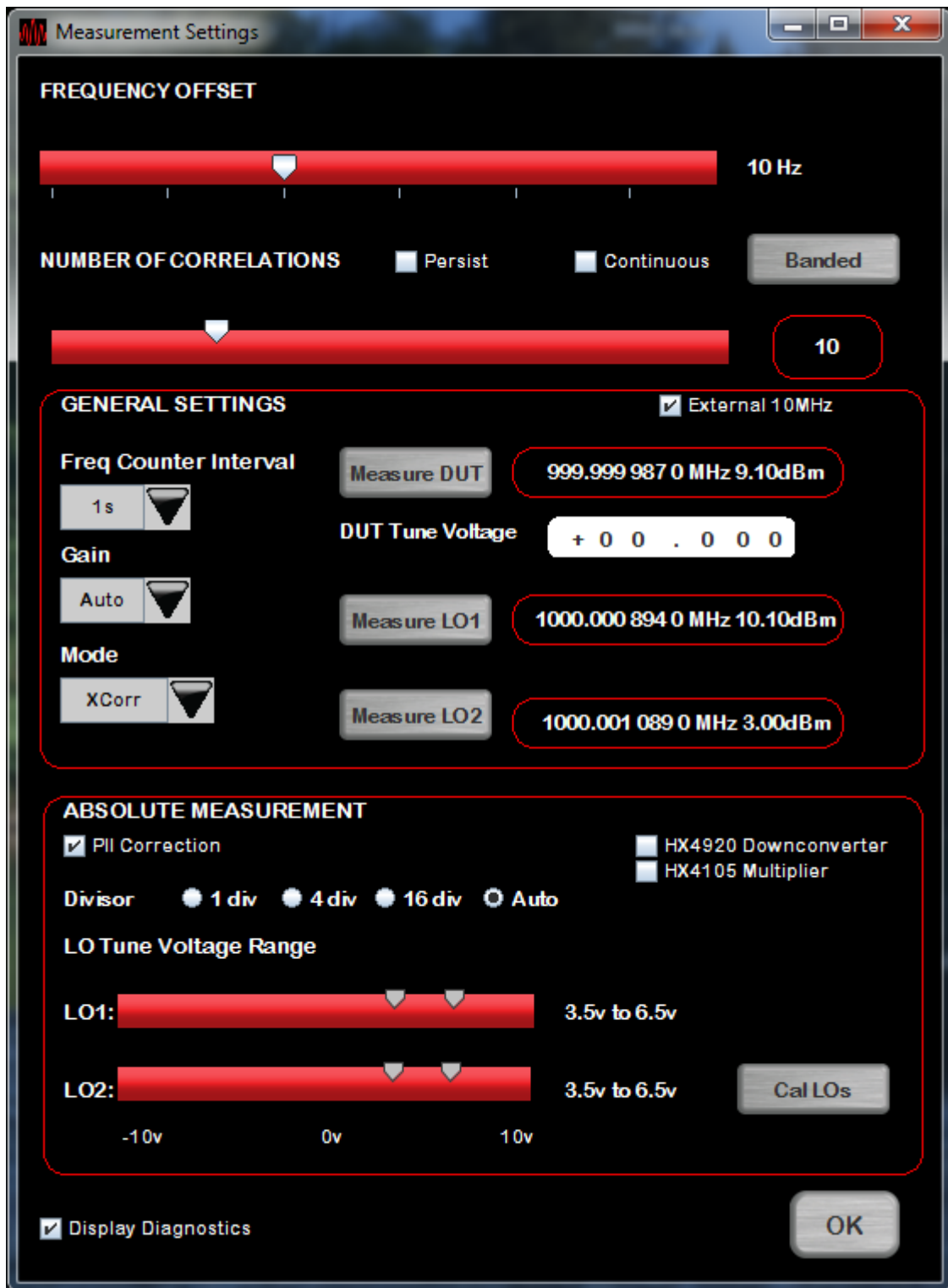


Figure 6: Measurement settings in the Holzworth HA7402 software for the PNCs-1 Phase Noise Test

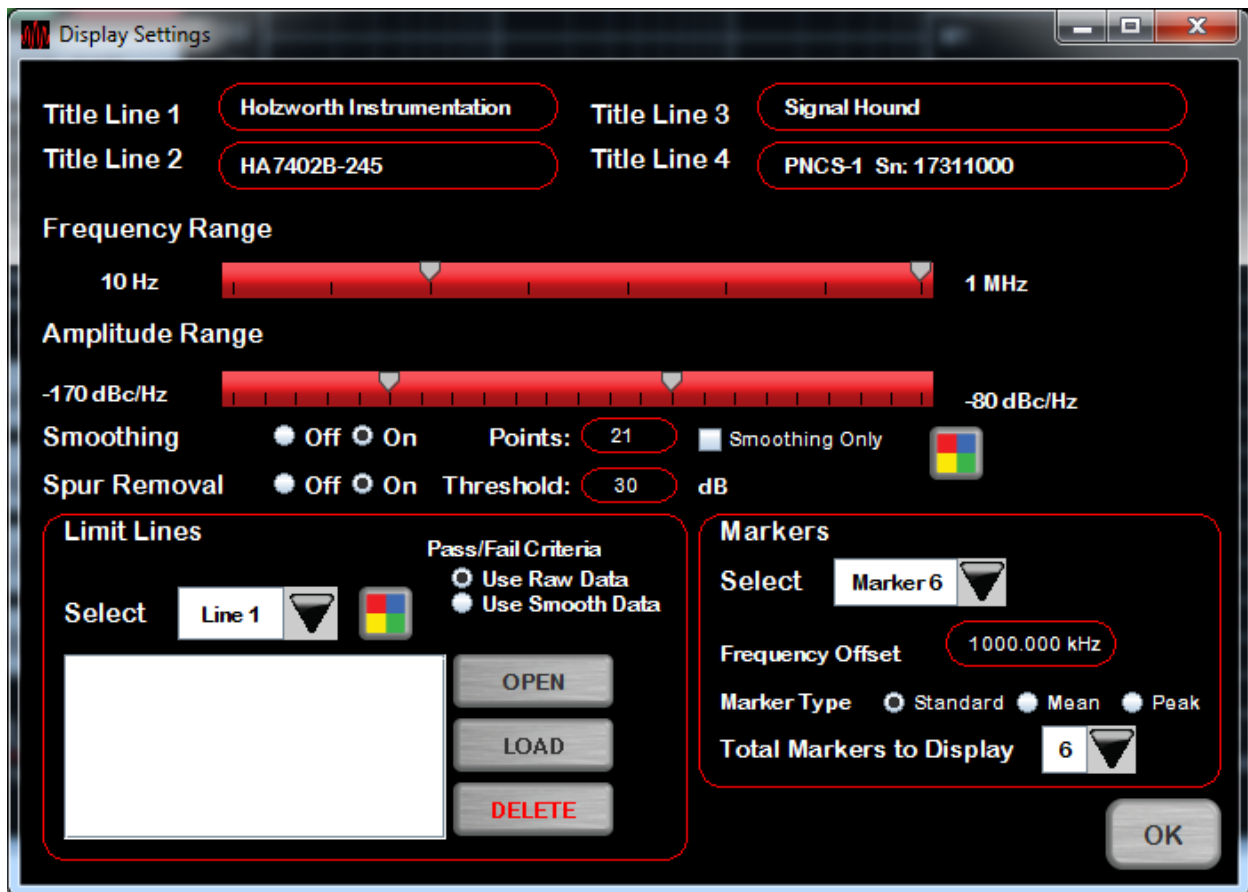


Figure 7: Display settings in the Holzworth HA7402 software for the PNCS-1 Phase Noise Test

In the *Measurement* screen, you must *Measure DUT*, *Measure LO1*, *Measure LO2*, and *Cal LOs*. The frequency returned by *Measure DUT* must be within 4 Hz of the nominal 1 GHz. Manually adjust the “Freq Adj” knob on the PNCS-1 to achieve this.

Adjust *LO Tune* to the EFC of the generator.

WARNING: Even small vibrations can have a huge impact on measurements, as can other equipment plugged in nearby such as fans.

When the measurement is complete (after clicking the *Acquire* button on the main screen), click the *Save/Recall* button and use the dialog to save your data. This will save several CSV files and one PNG image of the plot. The CSV file used by the Field Calibration Software is the one with the “NO\_SPUR” postfix. The plot image will be included in the report.

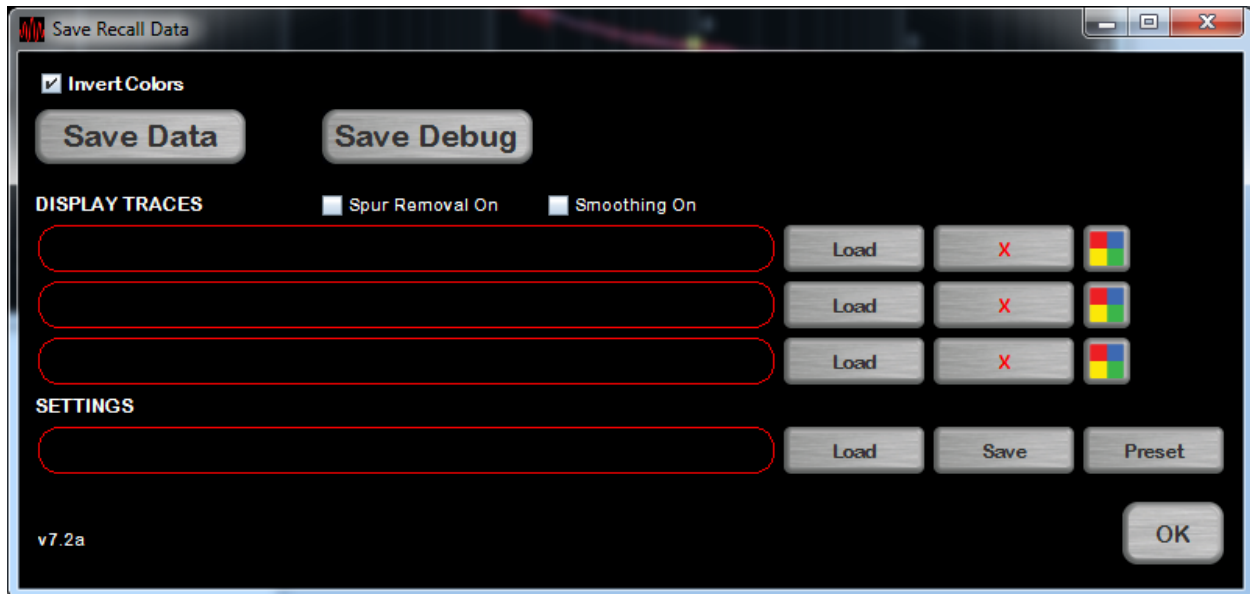


Figure 8: Save/Recall dialog in the Holzworth HA7402 software for the PNCS-1 Phase Noise Test

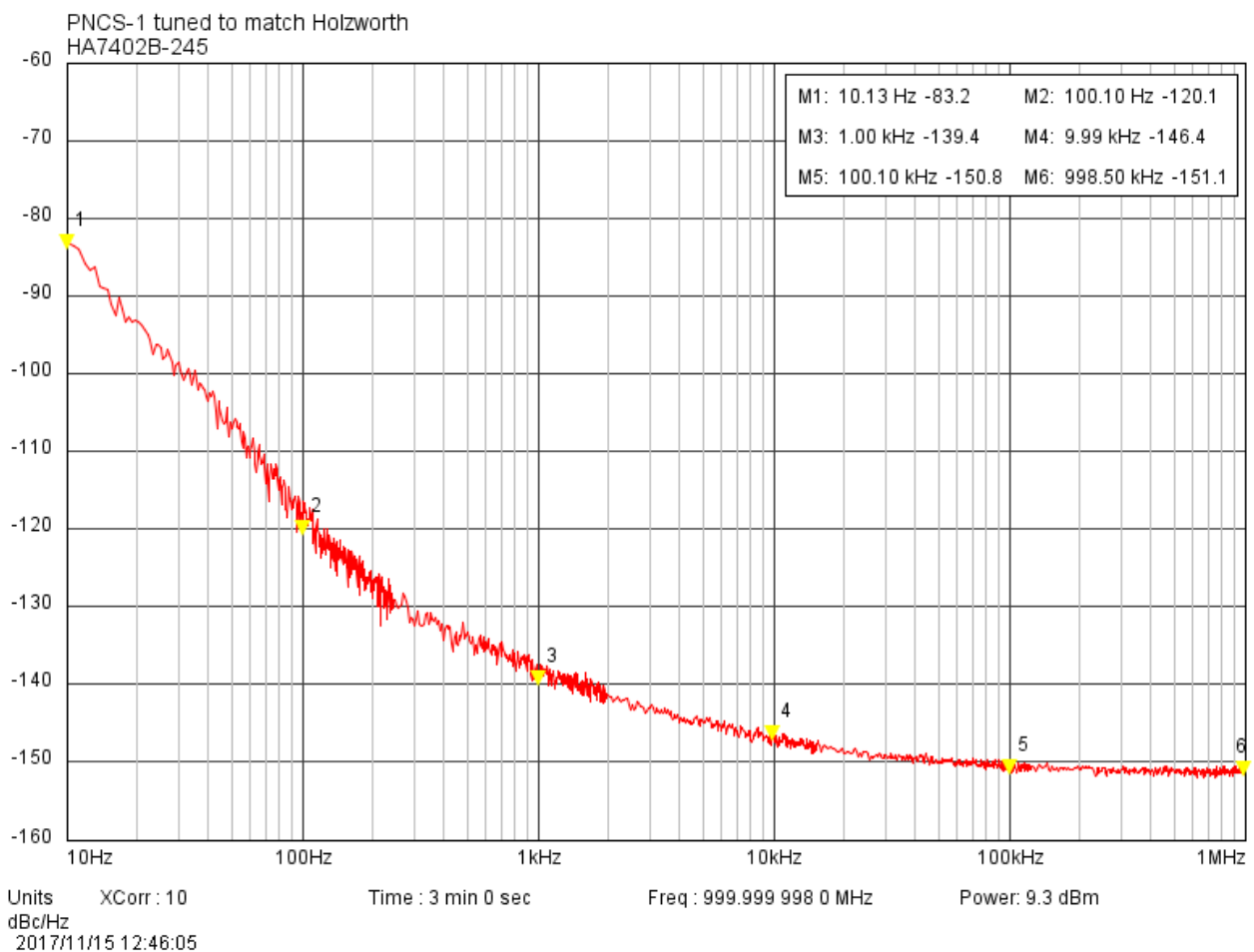


Figure 9: Example plot produced by the Holzworth HA7402 software for the PNCS-1 Phase Noise Test



## 7.8 Adjustments

### 7.8.1 BB60C

#### 7.8.1.1 10 MHz Reference

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. There is a limited amount of FLASH memory dedicated to 10 MHz reference adjustments, so adjustments should not be performed more than once per month. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound. If you choose to make an adjustment the software must be manually restarted, and the calibration session restarted.

### 7.8.2 BB60D

#### 7.8.2.1 10 MHz Reference

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. There is a limited amount of FLASH memory dedicated to 10 MHz reference adjustments, so adjustments should not be performed more than once per month. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound. If you choose to make an adjustment the software must be manually restarted, and the calibration session restarted.

### 7.8.3 SA44B

#### 7.8.3.1 10 MHz Reference

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound.

### 7.8.4 SA124B

#### 7.8.4.1 10 MHz Reference

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound.

### 7.8.5 SM200A/B/C

#### 7.8.5.1 10 MHz Reference

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. There is a limited amount of FLASH memory dedicated to 10 MHz reference adjustments, so adjustments should not be performed more than once per month. It is very important to read the dialog box that appears to give you the

option. All adjustments made are permanent until the device is returned to Signal Hound. If you choose to make an adjustment the software must be manually restarted, and the calibration session restarted.

## **7.8.6 SM435B/C**

### **7.8.6.1 10 MHz Reference**

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. There is a limited amount of FLASH memory dedicated to 10 MHz reference adjustments, so adjustments should not be performed more than once per month. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound. If you choose to make an adjustment the software must be manually restarted, and the calibration session restarted.

## **7.8.7 TG44A**

### **7.8.7.1 10 MHz Reference**

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound.

## **7.8.8 TG124A**

### **7.8.8.1 10 MHz Reference**

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound.

## **7.8.9 VSG25A**

### **7.8.9.1 Internal Time Base**

The 24 MHz internal time base is easily adjusted to within 1 ppm using a 1.8 mm or 1/16" slotted screwdriver, found in many common jeweler's screwdriver kits. To accomplish this, generate a CW signal of known frequency (e.g. 1 GHz), and adjust using a spectrum analyzer, measuring receiver, or counter.

## **7.8.10 VSG60A**

### **7.8.10.1 Internal Time Base**

The 10 MHz reference time base test will allow you to adjust the device upon completion. The software will give you the choice to make the adjustment once the test is complete. It is very important to read the dialog box that appears to give you the option. All adjustments made are permanent until the device is returned to Signal Hound.

## 7.9 Printing the Calibration Report

When you are finished with the device calibration tests, you can print to PDF a report of the calibration session using the *Print Test Report* button under the *Print Report* tab.

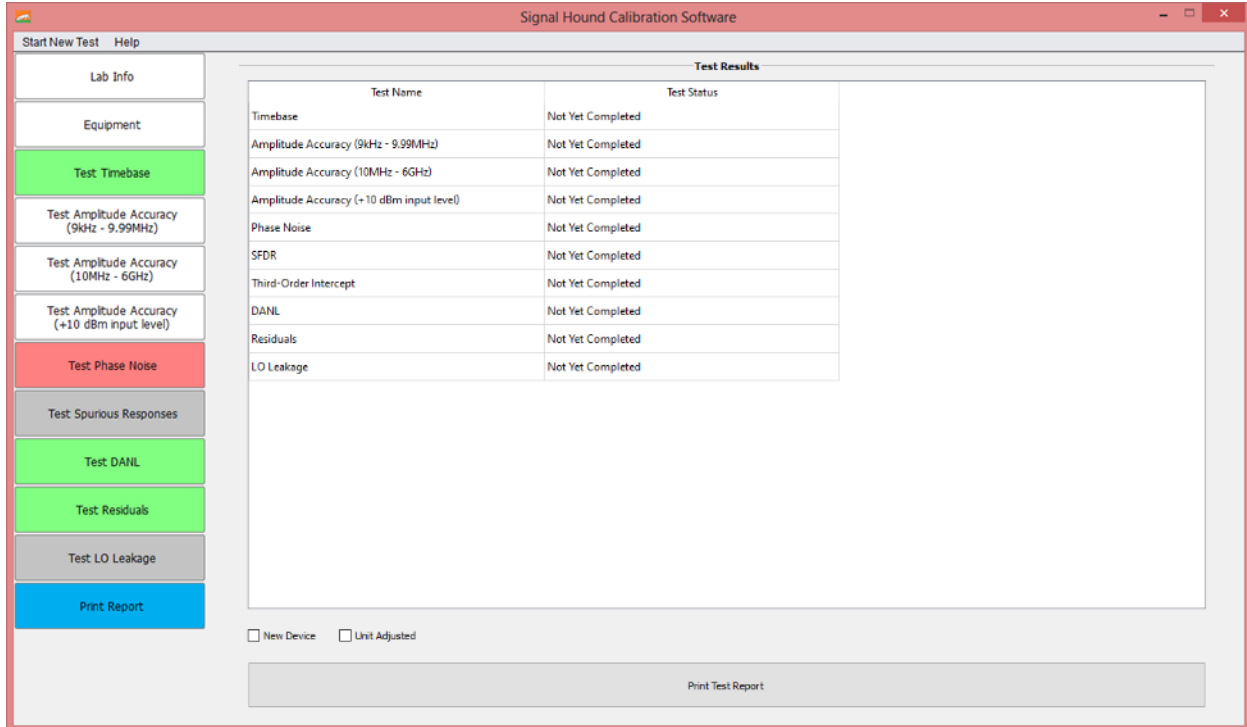


Figure 10: Printing the Calibration Report

You can select the file name and location for the report. You can also print the report at any time during the calibration session. The calibration report includes the facility information, lab standards, and test points and status for each test performed.

## 8 Preferences

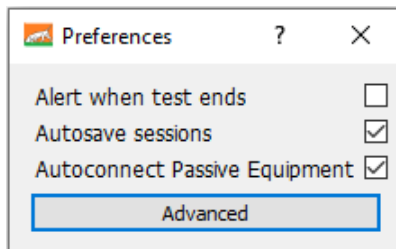


Figure 11: Preferences menu

The preferences menu is found under Settings in the menu bar.

## 8.1 Alert when test ends

Computer will emit beeps to signal that a test has finished.

## 8.2 Autosave sessions

The current session will be automatically saved at the completion of each test.

## 8.3 Autoconnect Passive Equipment

For each passive standard, the first device found that is within cal will be automatically selected during the connect routine.

## 8.4 Advanced

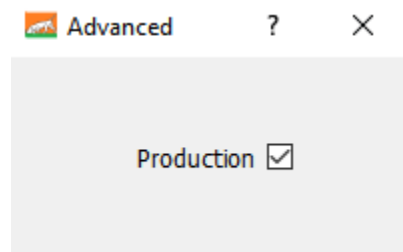


Figure 12: Advanced Preferences menu

### 8.4.1 Production

Tighter limits are used for some tests in production. Checking this box puts the software in production mode, which uses those tighter limits and notes that this is a production calibration in application and report.

## 9 Troubleshooting

If you have any issues contact Signal Hound at [support@signalhound.com](mailto:support@signalhound.com) or by phone 1-800-260-TEST

## 10 Test Uncertainty Ratio and Guard Bands

### 10.1 Managed Risk Approach

Since the BB60A, BB60C, BB60D, PNCS-1, SA44B, SA124B, SM200A, SM200B, SM200C, SM435B, TG44A, TG124A, VSG25A, and VSG60A are relatively new devices, we do not have data on the probability of a device being in tolerance prior to calibration (*a priori* probability). Because of this, in an effort to meet ANSI/NCSLI Z540.3-2006 specifications while minimizing false reject risk, we cannot safely use the simple 4:1 Test Uncertainty Ratio (TUR) to guarantee the required <2% false-accept risk for a calibration. Instead, we use equation 5 of “A Guard-Band Strategy for Managing False-Accept Risk” by Michael Dobbert, Agilent Technologies:

$$A = T - U_{95\%} * (1.04 - e^{(0.38 \ln(\text{TUR}) - 0.54)})$$

where  $U_{95\%}$  is the measurement uncertainty (95% confidence interval),  $A$  is the Acceptance Limit, and  $T$  is the specified tolerance. We can derive from this equation that, for a TUR of 4.6:1 or better, it is acceptable to set the acceptance limit equal to the tolerance limit, even without statistics on what percentage of devices are expected to pass calibration, by simply assuming the worst case.

Where TUR is less than 4.6:1, a guard-band will be subtracted from the tolerance limit to give a tighter acceptance limit. In the case of the BB60C at 0 dB internal attenuator setting (worst case VSWR), the calculated RSS uncertainty of 0.521 dB gives us a TUR of  $(2.0\text{dB} / 0.521\text{ dB}) = 3.84:1$ . Using the above equation, we set our acceptance limit for amplitude accuracy to  $\pm 1.96\text{ dB}$  to keep the false-accept risk below 2% independent of *a priori* probability.

Where TUR is 4.6:1 or better, the acceptance limit is equal to the test limit.

## 10.2 Amplitude Accuracy Test Uncertainty Ratio Calculations

### 10.2.1 BB60A

Parameter	Uncertainty, 0 dB Atten
Power Splitter Output Tracking	0.25 dB
10 dB 8493C Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to splitter (SWR 1.22, 1.19)	0.075 dB
Mismatch gain uncertainty, splitter to 10 dB pad (SWR 1.22, 1.1)	0.04 dB
Mismatch gain uncertainty, 10 dB pad to BB60A	0.205 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty in dB (combined using RSS)	$\pm 0.521\text{ dB}$
Specified Tolerance	$\pm 2.0\text{ dB}$
Test Uncertainty Ratio (TUR)	3.84
Acceptance Limit (Managed Risk Approach)	$\pm 1.96\text{ dB}$

### 10.2.2 BB60C

Parameter	Uncertainty, 0 dB Atten
Power Splitter Output Tracking	0.25 dB
10 dB 8493C Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to splitter (SWR 1.22, 1.19)	0.075 dB
Mismatch gain uncertainty, splitter to 10 dB pad (SWR 1.22, 1.1)	0.04 dB
Mismatch gain uncertainty, 10 dB pad to BB60C	0.205 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%

Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty in dB (combined using RSS)	±0.521 dB
Specified Tolerance	±2.0 dB
Test Uncertainty Ratio (TUR)	3.84
Acceptance Limit (Managed Risk Approach)	±1.96 dB

### 10.2.3 BB60D

Parameter	Uncertainty, 0 dB Atten
Power Splitter Output Tracking	0.25 dB
10 dB 8493C Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to splitter (SWR 1.22, 1.19)	0.075 dB
Mismatch gain uncertainty, splitter to 10 dB pad (SWR 1.22, 1.1)	0.04 dB
Mismatch gain uncertainty, 10 dB pad to BB60C	0.205 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty in dB (combined using RSS)	±0.521 dB
Specified Tolerance	±2.0 dB
Test Uncertainty Ratio (TUR)	3.84
Acceptance Limit (Managed Risk Approach)	±1.96 dB

### 10.2.4 SA44B

Parameter	Uncertainty <i>(assume &lt;3:1 SWR)</i>
Power Splitter Output Tracking	0.25 dB
10 dB 8493C Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to splitter (SWR 1.22, 1.19)	0.075 dB
Mismatch gain uncertainty, splitter to 10 dB pad (SWR 1.22, 1.1)	0.04 dB
Mismatch gain uncertainty, 10 dB pad to SA44B	0.205 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty (uncertainties combined using RSS)	11.3%
System Uncertainty in dB	±0.521 dB
Specified Tolerance	±1.5 dB
Test Uncertainty Ratio (TUR)	2.88
Acceptance Limit (Managed Risk Approach)	±1.41 dB

### 10.2.5 SA124B

	Uncertainty

Parameter	<i>(assume &lt;3:1 SWR)</i>	
Power Splitter Output Tracking	0.25 dB	
10 dB 8493C Attenuator Uncertainty	0.3 dB	
Mismatch gain uncertainty, sensor to splitter (SWR 1.22, 1.19)	0.075 dB	
Mismatch gain uncertainty, splitter to 10 dB pad (SWR 1.22, 1.1)	0.04 dB	
Mismatch gain uncertainty, 10 dB pad to SA124B	0.205 dB	
Power Meter Instrumentation Uncertainty	0.5%	
Sensor Calibration Factor Uncertainty	2.2%	
Uncertainty from Power Sensor Linearity	3%	
Calibrator Output Power Level Uncertainty	0.6%	
Total System Uncertainty (uncertainties combined using RSS)	11.3%	
System Uncertainty in dB	±0.521 dB	
Specified Tolerance	±1.5 dB	±2.5 dB
Test Uncertainty Ratio (TUR)	2.88	4.8
Acceptance Limit (Managed Risk Approach)	±1.41 dB	±2.5 dB

### 10.2.6 SM200A/B/C

Parameter	Uncertainty < 6 GHz <i>(&lt;2.5:1 SWR)</i>	Uncertainty > 6 GHz <i>(&lt;4:1 SWR)</i>
10 dB 8493C Attenuator Uncertainty	0.3 dB	0.5 dB
11667B Output Tracking	0.25 dB	0.4 dB
Mismatch gain uncertainty, U2002A to 10 dB pad (SWR 1.19   1.3, 1.1   1.25)	0.03 dB	0.08 dB
Mismatch gain uncertainty, 10 dB pad to SM200 (SWR 2.5   4.0, 1.1   1.25)	0.18 dB	0.6 dB
Power Meter Normal Mode Accuracy	4%	4%
Sensor Calibration Factor Uncertainty	2.5%	3%
Total System Uncertainty (uncertainties combined using RSS)	11%	22%
System Uncertainty in dB	±0.52 dB	±1.08 dB
Specified Tolerance	±2.0 dB	±3.0 dB
Test Uncertainty Ratio (TUR)	3.85	2.78
Acceptance Limit (Managed Risk Approach)	±1.96 dB	±2.79 dB

### 10.2.7 SM435B/C

Parameter	Uncertainty < 6 GHz	Uncertainty > 6 GHz
11667C Output Tracking	0.30 dB	0.4 dB
Mismatch gain uncertainty U2055XA to 11667C (SWR)	0.20 dB (1.6, 1.22)	0.36 dB (1.65, 1.4)
Mismatch gain uncertainty SM435 to 11667C 0 dB (SWR)	0.44 dB (3.0, 1.22)	1.1 dB (3.0, 1.65)
U2055XA uncertainty	0.25 dB	0.34 dB
System Uncertainty (RSS)	0.62 dB	1.27 dB
Specified Tolerance	2.0 dB	3.0 dB

TUR	3.226	2.362
Acceptance Limit (0 dB SM435 attenuation)	1.92 dB	2.7 dB

### 10.2.8 TG44A

Parameter	Uncertainty <i>(assume &lt;3:1 SWR)</i>
20 dB 8493B Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to 20 dB pad (SWR 1.22, 1.2)	0.079 dB
Mismatch gain uncertainty, 20 dB pad to TG44A (SWR 3.0, 1.2)	0.40 dB
Harmonic power offset uncertainty	0.27 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty (uncertainties combined using RSS)	14.0%
System Uncertainty in dB	±0.57 dB
Specified Tolerance	±2.0 dB
Test Uncertainty Ratio (TUR)	3.51
Acceptance Limit (Managed Risk Approach)	±1.94 dB

### 10.2.9 TG124A

Parameter	Uncertainty <i>(assume &lt;3:1 SWR)</i>
20 dB 8493B Attenuator Uncertainty	0.3 dB
Mismatch gain uncertainty, sensor to 20 dB pad (SWR 1.22, 1.3)	0.113 dB
Mismatch gain uncertainty, 20 dB pad to TG124A (SWR 3.0, 1.3)	0.58 dB
Harmonic power offset uncertainty	0.27 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Total System Uncertainty (uncertainties combined using RSS)	17.6%
System Uncertainty in dB	±0.71 dB
Specified Tolerance	±2.0 dB
Test Uncertainty Ratio (TUR)	2.82
Acceptance Limit (Managed Risk Approach)	±1.87 dB

### 10.2.10 VSG25A

Parameter	Uncertainty, 0 dB Atten
Mismatch gain uncertainty, connector to VSG25A (SWR 1.25, 2.0)	0.228 dB
Mismatch gain uncertainty, connector to sensor (SWR 1.25, 1.22)	0.0611 dB
Power Meter Instrumentation Uncertainty	0.5%



Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
Power Meter Combined uncertainty (dB)	0.169 dB
Total System Uncertainty in dB (RSS)	$\pm 0.29$ dB
Specified Tolerance	$\pm 2.0$ dB

Where TUR is 4.6:1 or better, the acceptance limit is equal to the test limit.

### 10.2.11 VSG60A

Parameter	Uncertainty <i>(assume &lt;4.2:1 SWR)</i>
Mismatch gain uncertainty, sensor to VSG60A (SWR 1.22, 4.2)	0.557 dB
Power Meter Instrumentation Uncertainty	0.5%
Sensor Calibration Factor Uncertainty	2.2%
Uncertainty from Power Sensor Linearity	3%
Calibrator Output Power Level Uncertainty	0.6%
System Uncertainty in dB	$\pm 0.58$ dB
Specified Tolerance	$\pm 2.0$ dB
Test Uncertainty Ratio (TUR)	3.45
Acceptance Limit (Managed Risk Approach)	$\pm 1.94$ dB