



# USB-TG44A Tracking Generator User Manual

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## **Signal Hound USB-TG44A User Manual**

© 2017, Signal Hound, Inc.  
35707 NE 86th Ave  
La Center, WA 98629 USA  
Phone 360.263.5006 • Fax 360.263.5007

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# 1 Preparing For Use

## *Unpacking your Tracking Generator and Installing Software*

The Signal Hound USB-TG44A is a USB-based 10 Hz to 4.4 GHz economy tracking generator that works with the USB-SA series and BB60C spectrum analyzers, facilitating scalar network analyzer measurements. The Signal Hound USB-TG44A is powered from the USB cable, eliminating the need for a separate power supply. Measuring less than 8 inches long and weighing only ten ounces, the Signal Hound can be used virtually anywhere!



## 1.1 INITIAL INSPECTION

Check your package for shipping damage before opening. Your box should contain a USB cable, a CD-ROM, an SMA M-M adapter, a 3' BNC cable, and a Signal Hound USB-TG44A.

## 1.2 SOFTWARE INSTALLATION

The USB-TG44A uses the same Spike software as your Signal Hound spectrum analyzer. No additional software installation is required. Additionally, there is a small standalone utility for using your USB-TG44A without a USB-SA44B or USB-SA124B.

## 2 Getting Started

*Learn about the basic functions and features of your Signal Hound Tracking Generator*

The primary use for the USB-TG44A tracking generator is to form a **scalar network analyzer** when paired with the USB-SA44B spectrum analyzer and the Spike software. The insertion loss of filters, amplifiers, cables, and attenuators can be measured quickly and accurately from 10 Hz to 4.4 GHz. By adding a directional coupler, return loss can be measured as well.

The Spike software is set up to sweep active devices, such as amplifiers, and passive devices, such as filters and attenuators. By default, high dynamic range is selected, which typically offers 90 dB of dynamic range (0 to -90 dB for passive devices, +20 to -70 dB for active devices, or +40 to -50 dB for active devices with a 20 dB fixed attenuator). High dynamic range sweeps take about ½ second for a 100 point sweep (span > 100 kHz).

For crystals or other very high Q circuits, a second operating mode is available. This narrow-band mode is selected automatically when your span is 100 kHz or less. In this mode, a 100 point sweep takes about 7 seconds, but the sweep updates at each point. See the Spike Software User Manual for more information.

### 2.1 THE USB-TG44A FRONT & REAR PANELS



The **front panel** includes a 50Ω SMA RF input. Do not apply signal or DC to this port. It is a DC-coupled output. Applying DC or signals in excess of +20 dBm will cause damage. A **READY / BUSY** LED flashes orange each time a command from the computer is processed.

The **rear panel** has three connectors:

1. 10 MHz Reference output. Used in the legacy software for some modes requiring 0 ppm frequency error.
2. A USB type B connector. Connect to your PC using the included USB cable.
3. TG Sync. **Connect to the USB-SA44(B) Sync Out port** for all spans of greater than 100 kHz.



# 3 Taking Measurements

*Learn how to take path loss, amplifier gain, and mixer gain/loss measurements*

The Signal Hound USB-TG44A Tracking Generator (TG), combined with the USB-SA44B Spectrum Analyzer (SA) and Spike software, is capable of making a wide range of scalar network analysis measurements. Whether you are tuning an RF filter, sweeping an amplifier to plot gain, or verifying a step attenuator, measurements are quick and easy with the USB-TG44A tracking generator.

## 3.1 MEASURING INSERTION LOSS OR GAIN

The Signal Hound USB-TG44A Tracking Generator may be used to measure insertion loss or gain. To measure insertion loss of a cable or attenuator, the following approach is recommended:

1. Plug the spectrum analyzer and tracking generator devices into the PC using the supplied USB cables.
2. Connect the spectrum analyzer and tracking generator nose-to-nose using the SMA barrel connector provided.
3. Connect the TG Sync to the spectrum analyzer Sync Out.
4. Launch the Spike software.
5. Set start / stop / center / span frequencies to desired sweep range
6. Set your reference level to +10 dBm. This will place the “zero” insertion loss line one division from the top of the graticule.
7. Select **Analysis Mode > Scalar Network Analyzer**
8. Select your ideal sweep size. This will help the software determine step size (the frequency step between measurements).
9. If your device is passive (e.g. attenuator, filter, or cable), select **Passive Device**. For amplifiers with gain of up to 20 dB, select **Active Device** and change your reference level to +20 dBm.
10. If you wish to double the sweep speed and cut the dynamic range in half, un-check **High Range**.
11. With the spectrum analyzer and tracking generator still connected nose-to-nose, wait for a complete sweep to finish. Then click **Store Thru**. This will correct for the amplitude offsets



between the TG and SA, and give you a stable line at 0 dB insertion loss. Note: If you change any settings after Store Thru, repeat this step.

12. (Optional) For maximum accuracy below -45 dB, insert a fixed attenuation of 20 to 30 dB, and then click **Store 20 dB Pad**. The actual attenuation used can be anywhere from 20 to 30 dB, and will be factored out automatically. This corrects for small offsets between the higher range and lower range readings. This is only used for settings of High Range, Passive Device. If you omit this step, accuracy below -40 dB should be treated as +/- 1 dB typical.
13. Insert the device to test and take measurements.

### 3.1.1 Improving Accuracy

One shortcoming of the Signal Hound Spectrum Analyzer and Tracking Generator is poor VSWR / return loss performance. However, this can be easily overcome by adding good 3 dB or 6 dB pads (fixed SMA attenuators) to the output of the tracking generator and / or the input of the spectrum analyzer. A good 6 dB pad will improve return loss by nominally 12 dB to >20 dB, and should enable accurate measurements relative to a 50 ohm system. These may be included when sweeping the "thru," effectively nulling them out. This will decrease your overall dynamic range.

### 3.1.2 Testing High Gain Amplifiers

When measuring an amplifier that will have gain of 20 to 40 dB, the use of a 20 dB pad is required. Simply insert the 20 dB pad before you Store Thru, and leave the pad on either the SA or TG when connecting to the amplifier. For amplifiers with  $P_{sat} > +20$  dBm, the pad should go on the output of the amplifier. If an amplifier cannot safely handle -5 dBm, place the pad on the amplifier's input.

### 3.1.3 Measuring Insertion loss > 80 dB

To measure more than 80-90 dB insertion loss, you will need to use **Utilities > Tracking Generator Control**. Set your frequency to the desired test frequency, and set the amplitude to -10 dBm. Find the CW signal using the USB-SA44B at about a 100 kHz span.

Decrease your span down to about 10 kHz, keeping the signal centered, then reduce your RBW to 10 Hz or 100 Hz, depending on the dynamic range required. With a 10 Hz RBW, your noise floor will generally show about 140 dB of insertion loss. This method is especially good for tuning notch filters where your ultimate rejection at a specified frequency may need to be 100 dB or greater

## 3.2 MEASURING RETURN LOSS

A directional coupler of appropriate frequency range (sold separately) may be used to make approximate return loss measurements. Connect your tracking generator to the "OUT" port, and connect your spectrum analyzer to the "COUPLED" port. Use the "IN" port as your S-parameter test port. Sweep this setup as the "thru" with the test port open (reflecting 100% of power). Then connect your device to test (e.g. antenna) to the "IN" port. Return loss or  $|S_{11}|$  will be displayed.



Once again, measurement accuracy will benefit from 3 to 6 dB pads on the Signal Hound devices. This method is not as accurate as using a precision vector network analyzer with a full two port calibration, but with a good directional coupler, measurements from 0 to -20 dB should be accurate.

### 3.2.1 Adjusting an Antenna

To adjust an antenna for a certain frequency, it is often sufficient to simply maximize return loss at that frequency. This may be done in a swept or CW tracking generator mode. Mount your antenna and ground as you normally would, then connect to the "IN" port as above. Lengthen, shorten, and tweak impedance matching elements until the desired return loss is achieved. Be aware that you will be radiating some RF during this process. It is your responsibility to understand and obey laws regarding transmitting on those frequencies.

## 4 Theory of Operation

Learn about the internal blocks that make up the Signal Hound Tracking Generator

The Signal Hound Tracking Generator is built around a 32-bit programmable modulus direct digital Synthesizer (DDS). This allows the firmware to set precise 10 Hz steps. The DDS generates frequencies from 10 Hz to 28 MHz directly. To produce higher frequencies this signal is multiplied by an integer from 5 to 200.

Below 28 MHz, the output has low harmonic content. However, above 28 MHz, harmonics are generated and not filtered. Typically, harmonics as high as -10 dBc will be observed for much of the RF spectrum. For use as a tracking generator, the presence of harmonics has very little impact on the measurement, since the harmonics will generally be well outside the spectrum analyzer's input bandwidth.

However, when verifying the output power level with an RF power meter, the harmonic content can add up to 0.7 dB to the measured output.

Please note that the phase noise of the USB-TG44A is higher than the USB-SA44. However, this will have minimal impact on readings as out-of-band energy is rejected by the spectrum analyzer.

## 5 Troubleshooting

There is a known intermittent power-on problem with the USB-TG44A. The remedy is to simply unplug the USB, count to 10, then plug it back in. If you repeatedly experience this power on problem, contact Signal Hound for repair or replacement.

## 5.1.1 General Troubleshooting Procedure

1. Unplug the USB cable from your Tracking Generator, count to 10, and plug it back in. If the LED is green, proceed. Otherwise, try a different USB port or cable. Verify the USB-SA44(B) spectrum analyzer is plugged in to USB as well.
2. Launch the application software. Set your spectrum analyzer to SPAN 100 KHz, CENTER FREQ 10 MHz.
3. Connect the TG RF output to the spectrum analyzer RF input.
4. Check for a 10 MHz output from the TG between -20 and -25 dBm. This is the default power on state.
5. If no signal is present, repeat steps 1-4. If there is still no signal, contact technical support at <http://www.signalhound.com>
6. Verify that the TG SYNC is connected to the SYNC out of the spectrum analyzer using a BNC cable. Connect the TG and spectrum analyzer nose-to-nose using the SMA barrel connector.
7. In the Spike Software, sweeping from 10 MHz to 1 GHz, select Analysis Mode  $\square$  Scalar Network Analyzer. In 1-2 seconds you should see a trace near 0 dB +/- 4 dB. If you do not see this and your TG LED is red, verify your SYNC cable. If the cable is damaged, replace it. If sections of the sweep are missing, your TG likely needs repair.

Otherwise, contact technical support at <http://www.signalhound.com>

## 5.1.2 General Advice to avoid problems

- Unplug your USB-TG44A from the USB port when not in use, or before shutting down your computer.
- For maximum stability, a 15 minute warmup is recommended for sensitive measurements.

# 6 Calibration and Adjustment

Contact Signal Hound for more information regarding calibration software and required equipment.

# 7 Specifications

## 7.1 FREQUENCY

**Frequency range** 10 Hz to 4.4 GHz

<b>Frequency Accuracy</b>	±1ppm
<b>Frequency steps</b>	19 selectable step sizes from 10 Hz to 10 MHz

## 7.2 AMPLITUDE

<b>Amplitude range</b>	-30 to -10 dBm
<b>Absolute Amplitude accuracy</b>	±2.0 dB
<b>Amplitude steps</b>	1 dB

## 7.3 SPECTRAL PURITY

<b>Harmonics</b>	Typically < -10dBc
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## 7.4 INPUTS AND OUTPUTS

<b>BNC Timebase Output</b>	(10 MHz output)
<b>BNC TG Sync</b>	
<b>SMA RF Output</b>	

## 7.5 ENVIRONMENT

20° C to 25° C to achieve published specifications

0° C to 70° C safe operating range with derated amplitude specifications

## 7.6 CALIBRATION

Test with factory calibration software to verify that USB-TG44A is operating within tolerance. Recommended calibration interval is 1 year at 20°C to 25°C.

## 7.7 ADJUSTMENTS

Factory adjustment software shall be used to generate new calibration constants when USB-TG44A will not pass calibration.

## 8 Revision History

Version 3.00 – Initial release under the Spike software

## 9 Warranty and Disclaimer

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## 9.1.5 Certification

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## 9.1.6 Credit Notice

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