

TEST EQUIPMENT PLUS

---

Signal Hound USB-TG44A

# User Manual

TEST EQUIPMENT PLUS

# Signal Hound USB-TG44A User Manual

---

© 2010, Test Equipment Plus  
35707 NE 86<sup>th</sup> Ave  
La Center, WA 98604  
Phone (360) 263-5006 • Fax (360) 263-5007

This information is being released into the public domain in accordance with the Export Administration  
Regulations 15 CFR 734

---

**Version 1.00B**

# Table of Contents

<b>1</b>	<b>PREPARING FOR USE.....</b>	<b>1</b>	<b>6</b>	<b>CALIBRATION AND ADJUSTMENT.....</b>	<b>16</b>
1.1	Initial Inspection .....	1	7	SPECIFICATIONS .....	17
1.2	Software Installation.....	2	7.1	Frequency .....	17
1.2.1	System Requirements.....	2	7.2	Amplitude .....	17
1.2.2	Install the Signal Hound Software.....	2	7.3	Spectral Purity .....	17
1.3	Running the software for the first time .....	2	7.4	Inputs and Outputs .....	17
<b>2</b>	<b>GETTING STARTED.....</b>	<b>4</b>	7.5	Environment.....	17
2.1	The Graticule .....	5	7.6	Calibration.....	17
2.2	The Tracking Generator Control Panel .....	5	7.7	Adjustments.....	17
2.2.1	Additional Configuration Options.....	6	<b>8</b>	<b>REVISION HISTORY .....</b>	<b>18</b>
2.3	The Signal Hound Front & Rear Panels .....	7	<b>9</b>	<b>WARRANTY AND DISCLAIMER .....</b>	<b>19</b>
<b>3</b>	<b>TAKING MEASUREMENTS.....</b>	<b>8</b>	9.1.1	Warranty .....	19
3.1	Measuring Insertion Loss or Gain .....	8	9.1.2	Warranty Service.....	19
3.2	Measuring  S21 .....	9	9.1.3	Limitation of Warranty.....	19
3.3	Using Limit Lines.....	10	9.1.4	Exclusive Remedies .....	20
3.4	Improving Accuracy .....	10	9.1.5	Certification .....	20
3.5	Measuring Return Loss .....	11	9.1.6	Credit Notice.....	20
3.5.1	Adjusting an Antenna.....	11			
3.6	Using the Markers.....	11			
3.7	Measuring Low Level Signals .....	12			
3.7.1	Tuning Notch Filters .....	12			
<b>4</b>	<b>THEORY OF OPERATION.....</b>	<b>13</b>			
<b>5</b>	<b>TROUBLESHOOTING .....</b>	<b>14</b>			
5.1.1	General Troubleshooting Procedure.....	14			
5.1.2	General Advice to avoid problems .....	15			

---

## 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-SA44 and USB-SA44B, 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 Signal Hound is operated from a Windows® based PC using our application software. The same software that powers the Signal Hound spectrum analyzer also powers the USB-TG44A tracking generator. Additionally, there is a small standalone utility for using your USB-TG44A in a standalone mode.

### 1.2.1 System Requirements

The Signal Hound software and drivers are compatible with Windows® operating systems. It is recommended that you have at least 500 MB of free disk space, 1 GB of RAM, USB 2.0 and a multi-core processor, and internet access for a one-time calibration data download.

Your computer must have the "Microsoft .net framework" version 3.5 or newer installed. If you have Windows 7 or Windows Vista with automatic updates turned on, you should already have this. If you do not already have a newer version, please install it from the CD.

The software connects to the internet to download a temperature correction file. An internet connection is required the first time you run the software.

### 1.2.2 Install the Signal Hound Software

- Run **setup.msi** from the CD by double-clicking the file. Follow the directions on the screen. **You must have administrator privileges.**
- You should already have the "Visual C++ 2008 redistributable" and "vc\_redist\_x86" installed from your initial Signal Hound software installation. If not, install them now.

### 1.2.3 Firmware Upgrade

- Run the Signal Hound software and check your USB-SA44B firmware version. Version 2.03 or newer is required for proper operation. If your firmware version is lower than 2.03, download the firmware upgrade from [www.signalhound.com](http://www.signalhound.com) downloads page and follow the instructions.

## 1.3 Running the software for the first time

1. Using the included USB cable, connect the USB-TG44A tracking generator (TG) to any available USB 2.0 port. Wait while Windows installs the necessary device drivers. This takes several seconds. Once you see "The hardware is ready to use", continue.
2. Connect your Signal Hound Spectrum analyzer USB cable as well.
3. Connect the SYNC / TRIGGER ports of the two devices using the included BNC cable.
4. Connect the RF output of the tracking generator to the RF input of the spectrum analyzer.

## PREPARING FOR USE

5. Launch the Signal Hound application from the Start Menu or desktop. The first time the software runs, calibration data is transferred from the tracking generator to the computer. This takes about 10 seconds.
6. Observe the new controls below the PRESET button. These are for the tracking generator.
7. **You may begin using the Signal Hound Tracking Generator now.** If you wish to verify basic functionality, proceed with the next steps.
8. With the tracking generator RF out connected to the spectrum analyzer RF in using the provided SMA adapter, and the SYNC/TRIGGER ports connected using the included BNC cable, click START.
9. A dialog box will appear with some additional setup options. Click OK to use default settings.
10. You should see a horizontal line, around -10 dBm, representing the level of the tracking generator output into the spectrum analyzer.
11. Disconnect the tracking generator RF OUT and observe the low signal level. If you do not observe the correct levels, see the **Troubleshooting** section.



*The tracking generator output is **DC-coupled**. Always use a DC block when your device has DC present.*

## 2 Getting Started

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

The Signal Hound Graphical User Interface, or GUI, is used to communicate with the Signal Hound spectrum analyzer and tracking generator, sending commands and receiving data over USB. The user sends commands using the **Control Panel** and **Menu**. The data is returned over USB and displayed in the **Graticule** as a **Trace**. For specific measurements, the **Marker** and **Status Bar** may be used as well. See Figure 1 for the locations of these items.

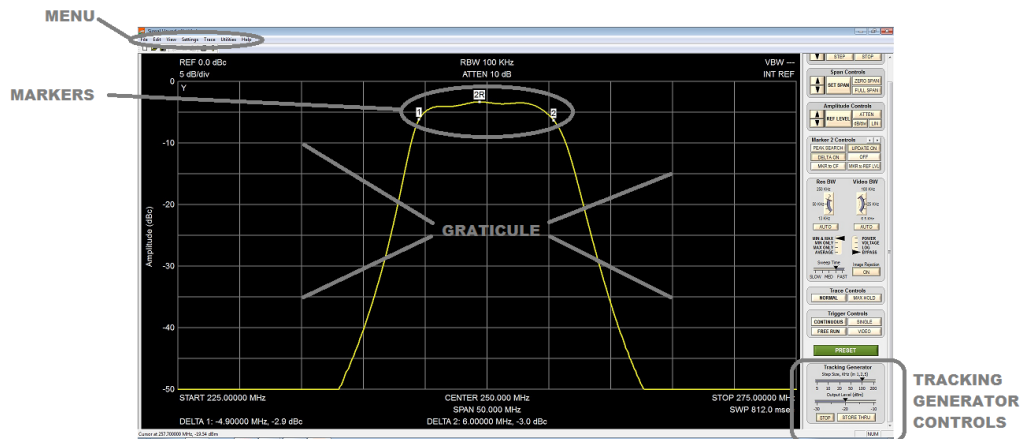


Figure 1 – The Signal Hound Graphical User Interface (GUI)

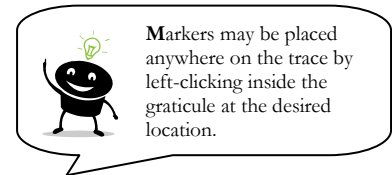
There are two primary sweep modes. The "Fast Sweep" mode is optimized for rapid, general purpose measurements over a 60 dB dynamic range. Approximately 700 discrete readings per second are achievable, allowing for trace updates of less than one second for most sweeps.

The "Slow Sweep" mode is optimized for high dynamic range sweeps, where measurements down to -100 dBc are possible. This is useful when tuning duplexers or notch filters, but is much slower, requiring closer to 1/2 second per data point.

## 2.1 The Graticule

The Graticule contains ten vertical and ten horizontal divisions, just as it did with the Signal Hound Spectrum Analyzer. The primary difference now is that the displayed trace represents hundreds of power readings at various frequencies, as the tracking generator sweeps from the start frequency to the stop frequency.

- ⇒ **REF:** Reference level, top left. The reference level is the signal amplitude for the top Graticule line. This may be in dBm or dBc for relative measurements
- ⇒ **DB/div:** Amplitude scale, near top left, in dB per division of the Display Window. In Linear scale, this will be mV/div.
- ⇒ **ATTEN:** Attenuator setting for USB-SA44(B), top center. The internal electronic attenuator may be set to **0, 5, 10, or 15** dB. In Slow Sweep mode, this will be controlled by the software to achieve maximum dynamic range.
- ⇒ **INT / EXT REF:** Top right. Indicates whether internal or external reference is selected. In slow sweep mode, you must connect the tracking generator's 10 MHz out to the spectrum analyzer's 10 MHz in.
- ⇒ **START, CENTER, STOP:** Bottom left, center and right of Display Window. Start, center, and stop frequencies, representing the frequency of the left, center, and right Graticule lines, respectively.
- ⇒ **SPAN:** Difference between start and stop frequencies.
- ⇒ **SWP:** This is time elapsed during the last sweep.
- ⇒ **MARKER DATA** will appear along the bottom of the graticule.
- ⇒ **Annunciators:** In the top left corner of the graticule, you may see some letters. These will notify you when readings are uncalibrated or a special setting exists. See the HELP menu for additional information.



## 2.2 The Tracking Generator Control Panel

The tracking generator adds additional controls to the control panel, below the PRESET button.

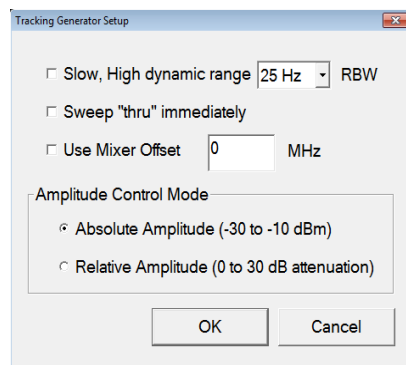
- ⇒ **STEP SIZE** is a slider control which sets the frequency step size of the sweep. This will control how many frequencies the tracking generator hits during its sweep across the selected frequency span.



## GETTING STARTED

- ⇒ **OUTPUT LEVEL** controls the amplitude of the tracking generator signal. This may be in absolute units, dBm, or units relative to the maximum power available, in dBc.
- ⇒ **START** begins the tracking generator sweep. The software switches from spectrum analyzer mode to scalar network analyzer mode, and brings up a popup with some additional configuration options.
- ⇒ **STORE THRU** Stores trace data as the "reference trace" for making relative measurements. Click this button to change from absolute amplitude units (dBm) to relative amplitude units, (dbc). Each subsequent click will re-measure the "thru".

### 2.2.1 Additional Configuration Options



- ⇒ **Slow, High Dynamic Range:** Use when more than 70 dB dynamic range is required, such as when tuning a duplexer.
- ⇒ **Sweep THRU immediately:** Click to make the first sweep the "thru" and subsequent sweeps plotted relative to the thru. If you do not check this, you may store a thru later using the control panel button
- ⇒ **Use Mixer Offset:** Adds an offset frequency to the tracking generator, useful especially when sweeping a mixer or downconverter.
- ⇒ **Amplitude Control Mode:** Depending on your application, you may want a fixed absolute output level (e.g. -15 dBm), or you may want a 30 dB range of control, with maximum and minimum power levels available.

## 2.3 The Signal Hound 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. Connect to the USB-SA44(B) *10 MHz* input for slow sweeps
- 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 fast sweeps.

## 3 Taking Measurements

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

The Signal Hound USB-TG44A Tracking Generator (TG), working in concert with the USB-SA44(B) Spectrum Analyzer, 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 sweeping a mixer's conversion loss, measurements are quick and easy with the USB-TG44A tracking generator. The tracking generator defaults to a rate of 700 points per second (plus 150-200 ms overhead), so a sweep of 50 MHz in 100 KHz steps takes less than 1 second.

### 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 Signal Hound software.
5. Set start / stop / center / span frequencies to desired sweep range
6. Click Tracking Generator "Start" button
7. In the popup dialog box, click "sweep thru immediately", then click OK. This will sweep the barrel connector and set this to 0 dB.

## TAKING MEASUREMENTS

8. Wait for "thru" to sweep. The units displayed will convert to dBc when complete.
9. Insert device to test between the tracking generator output and the spectrum analyzer input.
10. Wait for a complete sweep to finish. Place markers and take measurements as necessary.

### 3.2 Measuring $|S_{21}|$

In two-port linear networks,  $S_{21}$  refers to the forward transmission gain through a network. This may be greater than one in the case of an amplifier, or less than one in the case of an attenuator. With a Vector Network Analyzer (VNA),  $S_{21}$  is measured as a vector, with magnitude and phase. With a Scalar Network Analyzer (SNA), only the magnitude is available.

The Signal Hound USB-TG44A Tracking Generator may be used to measure  $|S_{21}|$ , the magnitude of the forward transmission gain, as follows:

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 Signal Hound software.
5. Set start / stop / center / span frequencies to desired sweep range
6. Under the amplitude controls, click "Linear." This will change the units to mV.
7. Click Tracking Generator "Start" button
8. In the popup dialog box, click "sweep thru immediately", then click OK. This will sweep the barrel connector and set this to  $|S_{21}|$  of 1.0.
9. Wait for "thru" to sweep
10. Insert device to test between the tracking generator output and the spectrum analyzer input.

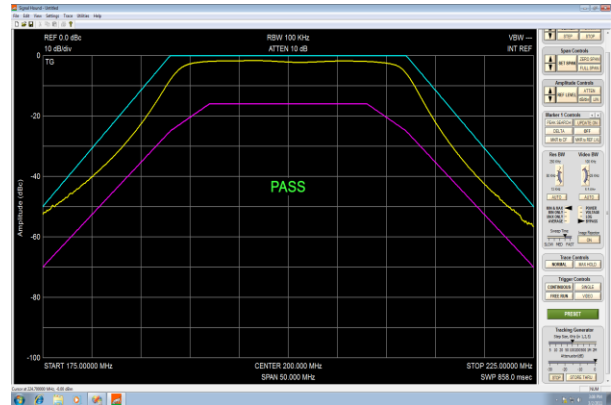
## TAKING MEASUREMENTS

11. Wait for a complete sweep to finish. Place markers and take measurements as necessary.

### 3.3 Using Limit Lines

Limit lines may be used for PASS / FAIL testing. Limit lines are imported from a CSV (comma separated value) file format. This standard file format can be exported from spreadsheet applications, or generated manually in a text editor. Three values per line, separated by commas, correspond to:

1. The frequency (in MHz)
2. The minimum amplitude allowed. This may be in dBm if no "thru" is swept, or dBc after sweeping a "thru". Enter **-200** for "no minimum".
3. The maximum amplitude allowed, in dBm or dBc. Enter **50** for "no maximum".



From the Signal Hound menu, Select **File->Import->Limit Line Table**. This will open a popup where you can navigate to your limit line CSV file. Select your file and click *Open*.

The limit lines will be drawn on the graticule, and a Pass / Fail annunciator will appear. If the entire trace is above the minimum and below the maximum, PASS will be displayed. Otherwise, FAIL will be displayed. Please note that when a setting is changed, there is a one sweep delay before the PASS/FAIL annunciator is valid.

### 3.4 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 6 dB or 10 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, and should enable accurate measurements relative to a 50 ohm system. These may be included when sweeping the "thru," effectively nulling them out.

## 3.5 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 greatly from 6 dB pads on the Signal Hound devices. If noise becomes an issue, you can turn on the RF preamplifier and re-sweep the thru (remember to leave the "IN" port open for sweeping the thru).

This method is not as accurate as using a vector network analyzer, but can be used as a reasonable approximation for many applications.

### 3.5.1 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.

## 3.6 Using the Markers

The Signal Hound has several tools for identifying a signal's frequency and amplitude. The easiest to use is the **Marker**. There are 9 markers available, each with its own reference.

To activate the marker and place it at the peak frequency, locate the Marker **PEAK** button on the Control Panel. The frequency and amplitude readout of the marker is located below the graticule. Please note that **the amplitude accuracy is NOT dependent on the vertical dB/div**, since the I/Q data is linear in voltage and has much higher resolution than is displayed.

To measure a signal that is not the peak, you may simply move the mouse over the desired signal and left-click to place a marker. Use the mouse wheel to fine-tune the marker's placement.

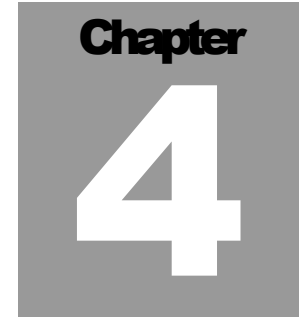
### 3.7 Measuring Low Level Signals

To measure more than 60 dB insertion loss, you will need to employ a few tricks. The first trick available is to use the **Slow, High Dynamic Range** sweep. This is accessible after you click "START". Each sweep will employ a narrow RBW, a slow sweep, and built-in scaling for low level signals. Up to 100 dB of dynamic range is typically possible when you use the maximum available output power. **WARNING:** This will drastically affect sweep time, sweeping 2 points per second instead of 700.

For some setups, the RF input attenuator may be set to 0 dB and / or the RF preamplifier may be turned on to decrease the noise floor. It is recommended that the preamplifier be used only when the input power into the Signal Hound is less than -20 dBm., such as when 6 or 10 dB pads are used on the Signal Hound RF in/out ports.

#### 3.7.1 Tuning Notch Filters

A special case of low-level signal measurement is tuning a band reject or notch filter. While a band pass filter is easily tuned using the standard "fast sweep", a band reject filter often requires 100 dB or more rejection. The easiest way to accomplish this is to set the software to a span of 10 KHz and the Center Frequency to the CW frequency you wish to reject, then turn on the tracking Generator CW mode (under the Utilities menu). Turn the attenuator to 0 dB, preamplifier on, reference level -60 dBm, then adjust until a minimum signal level is achieved.



## 4 Theory of Operation

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

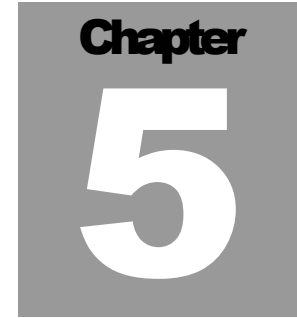
The Signal Hound Tracking Generator is built around a 32-bit programmable modulus DDS. This allows the firmware to set precise 10 Hz steps. The DDS generates frequencies from 10 Hz to 28 MHz directly. To produce higher frequencies this signal is multiplied by an integer from 5 to 200.

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 Test Equipment Plus for repair or replacement.

### 5.1.1 General Troubleshooting Procedure

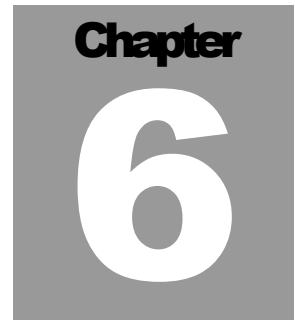
- 1) Unplug the USB cable from your Tracking Generator, count to 10, and plug it back in. If the LED is green, proceed. Otherwise, try a different USB port or cable. Verify the USB-SA44(B) spectrum analyzer is plugged in to USB as well.
- 2) **Launch the application software.** Set your spectrum analyzer 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) Click the Tracking Generator **START** button. Click OK to use the default settings. In 1-2 seconds you should see a trace about -10 dBm across the length of the graticule. If you do not see this and your TG LED is red, verify your SYNC cable. If the cable is damaged, replace it.
- 8) Check function at 10 MHz, 100 MHz, and 1 GHz. If you see a trace of approximately -10 dBm in all cases, the tracking generator is working properly.

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

## TROUBLESHOOTING

### 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.



## **6 Calibration and Adjustment**

Contact Test Equipment Plus for more information regarding calibration software and required equipment.

## 7 Specifications

### 7.1 Frequency

Frequency range: 10 Hz to 4.4 GHz

Frequency Accuracy:  $\pm 1$ ppm

Frequency steps: 19 selectable step sizes from 10 Hz to 10 MHz

### 7.2 Amplitude

Amplitude range: -30 to -10 dBm

Absolute Amplitude accuracy  $\pm 2.0$  dB

Amplitude steps: 1 dB

### 7.3 Spectral Purity

Harmonics Typically  $< -10$ dBc

### 7.4 Inputs and Outputs

- 1) **BNC Timebase Output** (10 MHz output)
- 2) **BNC TG Sync**
- 3) **SMA RF Output**

### 7.5 Environment

20° C to 25° C to achieve published specifications

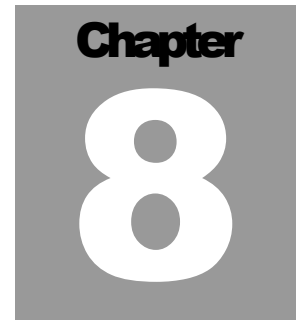
0° C to 70° C safe operating range with derated amplitude specifications

### 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-TG44B will not pass calibration. Temperature correction data is generated only at time of manufacture.



## **8 Revision History**

- Software Version 2.07 – Initial Release of Tracking Generator Software
- Firmware Version 1.00 – Initial Release of USB-TG44A firmware

## 9 Warranty and Disclaimer

©Copyright 2010  
Test Equipment Plus  
All rights reserved

Reproduction, adaptation, or translation without prior written permission is prohibited, except as allowed under the copyright laws.

### 9.1.1 Warranty

The information contained in this manual is subject to change without notice. Test Equipment Plus makes no warranty of any kind with regard to this material, including, but not limited to, the implied warranties or merchantability and fitness for a particular purpose.

Test Equipment Plus shall not be liable for errors contained herein or for incidental or consequential damages in connection with the furnishing, performance, or use of this material. This Test Equipment Plus product has a warranty against defects in material and workmanship for a period of one year from date of shipment. During the warranty period, Test Equipment Plus will, at its option, either repair or replace products that prove to be defective.

### 9.1.2 Warranty Service

For warranty service or repair, this product must be returned to Test Equipment Plus. The Buyer shall pay shipping charges to Test Equipment Plus and Test Equipment Plus shall pay UPS Ground, or equivalent, shipping charges to return the product to the Buyer. However, the Buyer shall pay all shipping charges, duties, and taxes, to and from Test Equipment Plus, for products returned from another country.

### 9.1.3 Limitation of Warranty

The foregoing warranty shall not apply to defects resulting from improper use by the Buyer, Buyer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product. No other warranty is expressed or implied. Test Equipment Plus specifically disclaims the implied warranties or merchantability and fitness for a particular purpose.

**9.1.4 Exclusive Remedies**

The remedies provided herein are the Buyer's sole and exclusive remedies. Test Equipment Plus shall not be liable for any direct, indirect, special, incidental, or consequential damages, whether based on contract, tort, or any other legal theory.

**9.1.5 Certification**

Test Equipment Plus certifies that, at the time of shipment, this product conformed to its published specifications.

**9.1.6 Credit Notice**

*Windows* is a registered trademark of Microsoft Corporation in the United States and other countries.