Signal Hound USB-SA44B 4.4 GHz Spectrum Analyzer and USB-TG44A Tracking Generator

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The tremendous improvements in digital signal processing (DSP) technology and computing power have resulted in not only some pretty amazing ham transceivers, but also reasonably priced, sophisticated test equipment. This includes standalone test equipment such as oscilloscopes and spectrum analyzers, as well as USB-connected power meters.[1, 2, 3] More recently, simple hardware paired with PC-based sound cards and powerful DSP software make "dongle-based" RF spectrum analysis available at a reasonable price. The Signal Hound USB-SA44B spectrum analyzer and USB-TG44A tracking generator reviewed here, along with their companion *SPIKE* software, turn your computer into a capable 4.4 GHz spectrum analyzer.

Overview

The Signal Hound USB-SA44B is a full-featured spectrum analyzer covering 1 Hz – 4.4 GHz. Consisting of a narrow-band software defined receiver (SDR), it is bigger than the typical "dongle" but is still quite small. Table 3 gives the SA44B features and specifications. (Underscoring the SDR aspect, Signal Hound released an HDSDR driver that allows the SA44B to be used as a receiver. It's available for download from their website.)

Included with the SA44B is a CD-ROM with a matching driver and *SPIKE* software, a PDF *User Manual*, and a 6-foot USB cable. *SPIKE* controls the operation of the hardware and provides the SA44B's computer screen user interface. As with all software-controlled devices, I recommend checking Signal Hound's website for the latest versions of the software and manual.

Bottom Line

The Signal Hound USB-SA44B and USB-TG44A are portable and offer an affordable 4.4 GHz spectrum analyzer/tracking generator package for the more technically inclined ham and serious experimenter.

The SA44B manual states that *SPIKE* will run on any computer running *Windows 7/8*, and Signal Hound says that it also now runs on *Windows 10*. I have two laptops running *Windows 10* (HP 32-bit OS with Intel Celeron 900 processor; Toshiba 64-bit OS with Intel Celeron n2830 processor), and a desktop running *Windows 8.1* (HP 32-bit OS with AMD Athlon 64x2 dual core processor). All computers exceed the hardware requirements stated in the manual, and all computers have the latest firmware and drivers. I could not get *SPIKE* to run on the HP laptop running *Windows 10*, but it did run fine on the other two computers. I suggest downloading *SPIKE* to verify that it runs on your computer before purchasing the SA44B.

After loading *SPIKE*, I found the computer display and controls to be self-explanatory, as most of the controls are similar to those found on standalone spectrum analyzers. All parameters are easily changed on screen, but default values for step size and resolution bandwidth can match a desired span automatically. Setups are saved easily for later recall.

The SA44B front panel (see Figure 5) has an SMA RF input connector adjacent to a BUSY/READY LED. The rear panel (see Figure 6) has a USB/B computer interface, a BNC socket for an external 10 MHz reference for improved frequency accuracy and phase noise measurements, and a BNC socket to interface to the companion Signal Hound TG44A tracking generator discussed later. Internal hardware features include a programmable input attenuator (0, 5, 10, and 15 dB), and a wide-band RF preamplifier for higher sensitivity and lower noise floor when needed.

Using the SA44B

You must supply suitable adapters, cables, and attenuators for your measurements. Prior to using the SA44B, pay close attention to the expected input signal power level. As with most spectrum analyzers, an RF level greater than about +20 dBm (100 mW) can damage or destroy the SA44B. Therefore an external attenuator may be necessary at the SA44B input. Just to provide some safety margin, I select attenuators to limit the input level to no more than 0 dBm (1 mW). I used a 20 dB, 150 W attenuator followed by a 20 dB, 2 W attenuator to reduce the signal level from several low power amateur transceivers under test.

Figure 5 — Signal Hound USB-SA44B spectrum analyzer front panel. Note that the case graphics have changed since we bought the review unit, but the features and performance are the same.

Figure 6 — Signal Hound USB-SA44B rear panel.

Table 3
Signal Hound SA44B Features and Specifications

RF frequency range: 1 Hz – 4.4 GHz.
RF input return loss: Not specified (see discussion under TG44A and Figure 14).
Low noise amplifier available above 500 kHz.
Dynamic range: –151 dBm to +10 dBm.
Resolution bandwidth (RBW): 0.1 Hz – 250 kHz and 5 MHz.
High dynamic range measuring receiver:
0 dBm - –125 dBm, 150 kHz – 1 GHz, ±0.25 dB.
0 dBm - –115 dBm, 1 GHz – 4.4 GHz, ±0.25 dB.
I/Q Data up to a 240 kHz bandwidth.
Frequency sweeps up to 140 MHz per second.
Adjustable digital audio filters.
Digital signal processing provided by connected PC.
Demodulates AM/FM/SSB/CW audio in real-time.
USB powered.
USB 2.0 communications at 480 Mbps.
Size: 7.8 × 3 × 1.2 inches incl connector protrusions.
Weight: 10 ounces.
Price: $919.

Table 5
Signal Hound TG44A Features

Frequency range: 10 Hz – 4.4 GHz.
Frequency accuracy: ±1ppm.
Output level: –30 to –10 dBm in 1 dB steps.
Output level accuracy: ±2 dB.
Harmonic output: Typically better than –10 dBc.
Dynamic range with SA44B: 0 to –90 dB for passive devices, +20 to –70 dB for active devices.
Step size: 19 steps from 10 Hz –10 MHz.
Sweep rate: Up to 700 frequency points per second with the SA44B.
USB powered.
Application Programming Interface compatible with *Windows* OS for writing custom software.
Size: 7.8 × 3 × 1.2 inches incl connector protrusions.
Weight: 10 ounces.
Price: $599.

Table 4
Display Frequency Width versus Minimum Resolution Bandwidth

	---------Minimum RBW ---------		
Sweep Width (MHz)	Signal Hound SA44B	Rigol DSA815	HP 8563E
1000	5 MHz	1 kHz	10 kHz
100	250 kHz	300 Hz	3 kHz
10	100 kHz	100 Hz	1 kHz
1	13 kHz	100 Hz	10 Hz
0.1	1.6 kHz	100 Hz	10 Hz
0.01	123 Hz	100 Hz	10 Hz
0.001	13 Hz	100 Hz	10 Hz

I own a Rigol DSA815-TG spectrum analyzer/tracking generator, so it was convenient to compare performance and operation up to 1.5 GHz. The SA44B and DSA815 were connected in parallel, using Mini-Circuits high isolation 3 dB splitters. I used the ZFSC-2 (1 – 750 MHz), ZAPD-900 0.1 – 0.9 GHz), or ZAPD-11 (0.5 – 2 GHz) based on the frequency band desired.

Before beginning testing, some mention of resolution bandwidth is in order. The narrower the resolution bandwidth, the more spectrum data points available. More expensive spectrum analyzers will have better resolution. Table 4 compares the minimum resolution bandwidth setting available versus the swept frequency range of the Signal Hound SA44B, the Rigol DSA815, and the (very expensive) HP 8563E sometimes used in the ARRL Lab.

A basic spectrum analyzer test is the harmonic and spurious performance of transmitters and amplifiers. Figures 7 and 8 show fundamental signal and harmonic response of my old Yaesu FT-2400 2 meter FM radio. As you can see, the SA44B and DSA815 show the same 2nd harmonic performance of the FT-2400 (about –60 dBc). Overall, both transceivers have excellent harmonic suppression as one normally expects from full-size transceivers — much better than one may see with some inexpensive handheld transceivers.[4] Figure 9 shows the fundamental and harmonic response of my Yaesu FT-1807 440 MHz transceiver. Incidentally, the spectrum spikes that show up in the figure are apparently spurious displays generated by the SA44B (and not generated by the transceiver), as they are visible even when there is no input.

Another common spectrum analyzer test is the two-tone intermodulation distortion (IMD) evaluation of SSB transceivers. Figures 10 and 11 are SA44B and DSA815-TG two-tone displays of my Elecraft KX-3 QRP transceiver (the KX3 has a built-in two-tone generator). Again, both the SA44B and the DSA815 show the same performance.

Signal Hound USB-TG44A Tracking Generator

When used with a spectrum analyzer, a tracking generator adds the capability to measure the gain or loss of two-port devices. Further, return loss measurements are also possible by using an inexpensive directional coupler. See the sidebar, "Measuring Return Loss," for more information on measuring return loss with this system.

The Signal Hound USB-TG44A tracking generator operates with the SA44B under control of the same *SPIKE* software. The TG44A package includes a USB cable, a CD-ROM (with *SPIKE*, the manual, and a small utility for using the TG44A as a standalone signal generator), an SMA male-male adapter, and a 3-foot BNC cable. While not included in the review package, Signal Hound now includes a Mini-Circuits ½ W, 20 dB attenuator. The TG44A looks almost identical to the SA44B. Its front panel (see Figure 12) has an SMA RF output port adjacent to a READY/BUSY light. The rear panel (see Figure 13) has a BNC 10 MHZ REF OUT (reference output) used in legacy software, a USB/B computer interface, and a BNC TG SYNC input that connects to the SA44B SYNC OUT port.

Table 5 gives the TG44A specifications and features. Note: Harmonics up to –10 dBc occur over much of the RF spectrum. These harmonics are normally outside the spectrum analyzer's input bandwidth, and so will have minimal impact on measurements. The high harmonic content should be kept in mind when using the TG44A as a standalone signal generator.

A potential measurement problem can occur when the SA44B/TG44A system is used. While the SA44B *unspecified* input return loss isn't too important for normal spectrum displays, a poor return loss can impact gain and loss measurements when used with a tracking generator. The TG44A manual states that the SA44B has poor input return loss and recommends adding a fixed attenuator to the SA44B input. I measured the SA44B input return loss up to 1200 MHz with an Array Solutions VNAuhf vector network analyzer.[5] As shown in Figure 14, the input return loss is not particularly good below 200 MHz — falling to 9 dB (SWR = 2:1) at 50 MHz and below. A 6 dB input attenuator will improve the return loss by 12 dB, to more than 21 dB (1.2:1 SWR), which should provide for accurate measurements. The attenuator loss is easily subtracted out in the measurement process, but it will decrease the overall dynamic range.

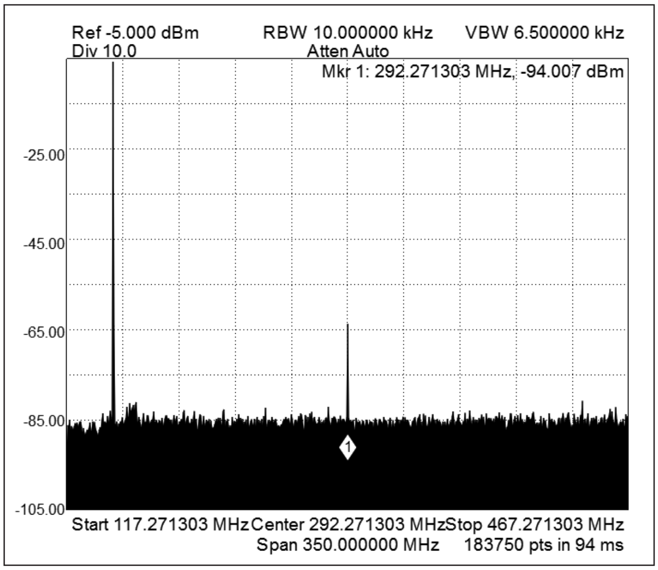

Figure 7 — Spectral display of a Yaesu FT-2400 2 meter transceiver as viewed on the Signal Hound USB-SA44B.

To use the TG44A, connect it to an unused computer USB port. *Windows* will automatically find it. Then *SPIKE* will recognize the TG44A and add the appropriate functions to the display. A sweep is initiated by entering the desired start/stop frequencies and pressing the START button. The SA44B will default to the step size and resolution bandwidth that matches your desired span.

Figure 15 displays the SA44B/TG44A insertion-loss plot of a 6 meter low-pass filter. A 6 dB attenuator at the SA44B input controls the load impedance. The 6 dB attenuator was "zeroed out" using the STORE THRU feature, so insertion loss can be read directly.

Some Other Features Worth Mentioning

While many spectrum analyzers can demodulate AM and FM signals, the SA44B demodulates SSB and CW as well. It can also display phase noise in dBc/Hz vs carrier offset (an external 10 MHz clean reference source is recommended for best results). And finally, the SA44B can measure total channel power. This requires you to input channel bandwidth and channel spacing over the swept range desired. You may wish to download the SA44B/TG44A manuals from the Signal Hound website to look at all the additional capabilities and features available.

Summary

For those amateurs and experimenters who want the next level of testing capability, the 4.4 GHz SA44B/TG44A spectrum analyzer/tracking generator combination for about $1500 is something to consider. With its easy-to-use computer interface, you will be using this system within minutes of unpacking.

Manufacturer: Signal Hound, 35707 NE 86th Ave, La Center, WA 98629 USA; **signalhound.com**.

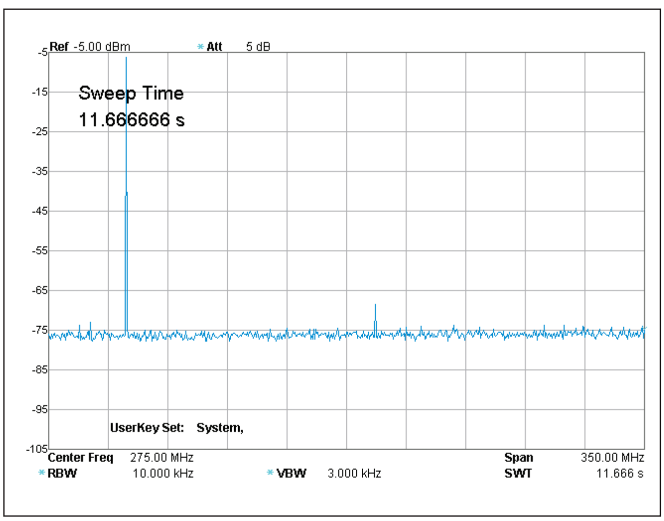

Figure 8 — Spectral display of a Yaesu FT-2400 2 meter transceiver as viewed on the Rigol DSA815-TG.

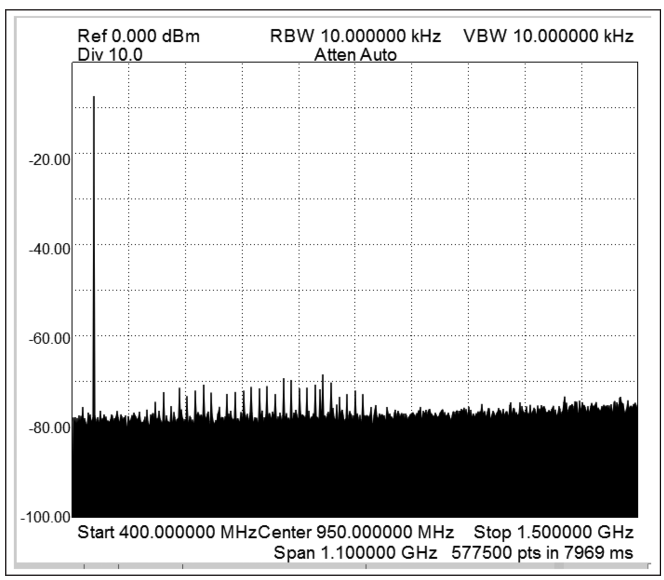

Figure 9 — Spectral display of a Yaesu FT-1807 70 centimeter transceiver as viewed on the Signal Hound USB-SA44B.

Notes

[1]P. Salas, AD5X, "Rigol DS1052E and Tektronix TBS1042 Oscilloscopes," Product Review, *QST*, Oct 2013, pp 49 – 52.
[2]B. Allison, WB1GCM, "Rigol Technologies DSA815-TG Spectrum Analyzer," Product Review, *QST*, Feb 2013, pp 55 – 58.
[3]P. Salas, AD5X, "Mini-Circuits PWR-6GHS+ USB Power Sensor," Product Review, *QST*, Feb 2011, pp 56 – 59.
[4]L. Wolfgang, WR1B, "ARRL Laboratory Handheld Transceiver Testing," Technical Correspondence, *QST*, Nov 2015, pp 74 – 76.
[5]P. Salas, AD5X, "Array Solutions VNAuhf Vector Network Analyzer," Product Review, *QST*, Jul 2013, pp 49 – 50.

Measuring Return Loss

Phil Salas, AD5X

As discussed in the Product Review of the Signal Hound SA44B spectrum analyzer and TG44A tracking generator, return loss can be measured with a spectrum analyzer/tracking generator and a reverse-connected directional coupler is used as shown in Figure A.

A 20 dB coupler gives a good return loss range with most spectrum analyzers/tracking generators. Three

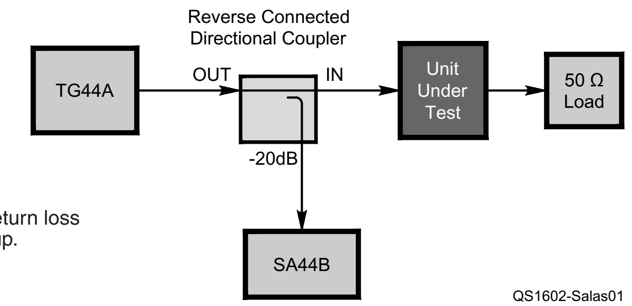

Figure A — Return loss measuring setup.

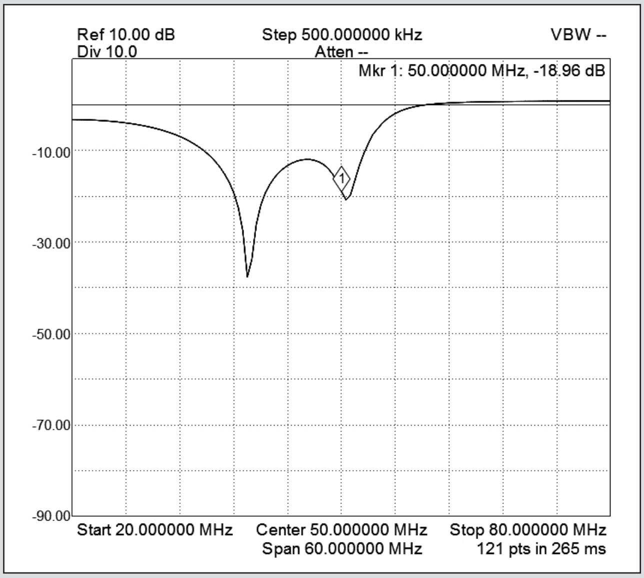

Figure B — Return loss of a 6 meter low-pass filter measured with the SA44B/TG44A.

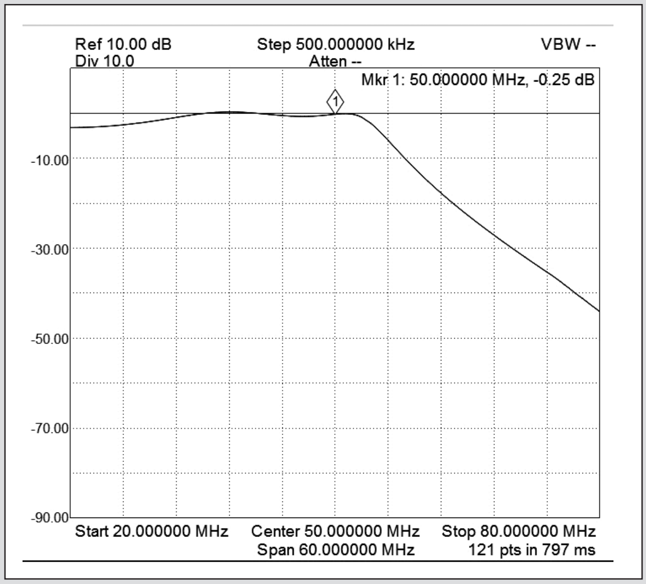

Figure C — Insertion loss of a 6 meter low-pass filter measured with the SA44B/TG44A.

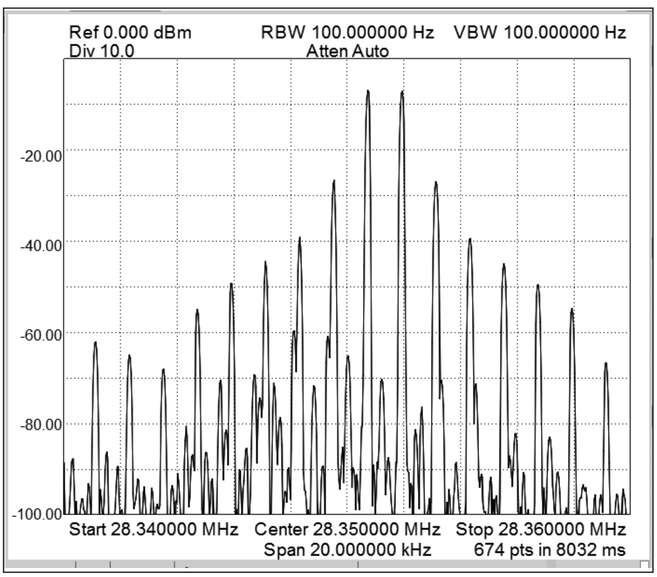

Figure 10 — Two-tone IMD display of the Elecraft KX3 transceiver as viewed on the Signal Hound USB-SA44B.

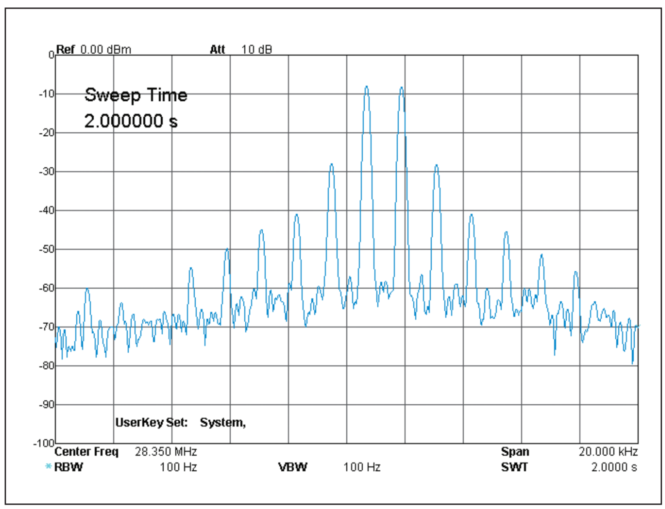

Figure 11 — Two-tone IMD display of the Elecraft KX3 transceiver as viewed on the Rigol DSA-815 TG.

high-directivity directional couplers are available from MiniCircuits. The ZFDC-20-3 ($50) covers 1 – 250 MHz; the ZFDC-20-4 ($70) covers 1 – 1000 MHz; and the ZFDC-20-5 ($90) covers 0.1 – 2000 MHz. I prefer the ZFDC-20-4 as it covers all the amateur bands I use (and more). I also prefer N connectors, as these match up well with my measurement test bench. You can often find these couplers on popular auction sites for much less.

To measure return loss, leave the IN connector of the directional coupler unterminated. All power will be reflected, resulting in a reference 0 dB return loss display on the SA44B. Then connect your unit under test and display the actual return loss of the device as dB below the reference.

Figure B shows a return loss plot of a 6 meter low-pass filter made using the methodology described here. Figure C (also included in the *QST* review) shows the filter's insertion loss. The 0 dB return loss reference includes the "zeroed-out" 20 dB coupling loss with the STORE THRU feature, so return loss can be read directly. Note the similarity of the 50 MHz insertion loss and return loss measurements to measurements made on an Array Solutions VNAuhf vector network analyzer (Figure D).

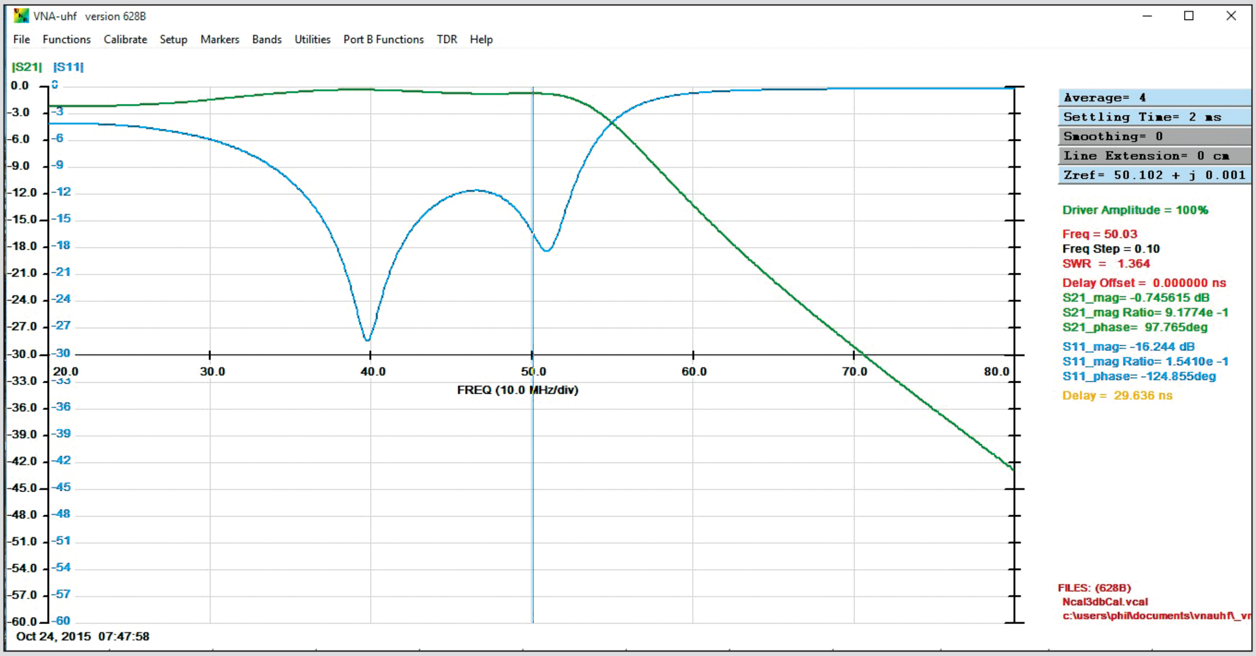

Figure D — Return loss and insertion loss of a 6 meter low-pass filter measured with an Array Solutions VNAuhf vector network analyzer.

Figure 12 — Signal Hound USB-TG44A tracking generator front panel. Note that the case graphics have changed since we bought the review unit, but the features and performance are the same.

Figure 13 — Signal Hound USB-TG44A rear panel.

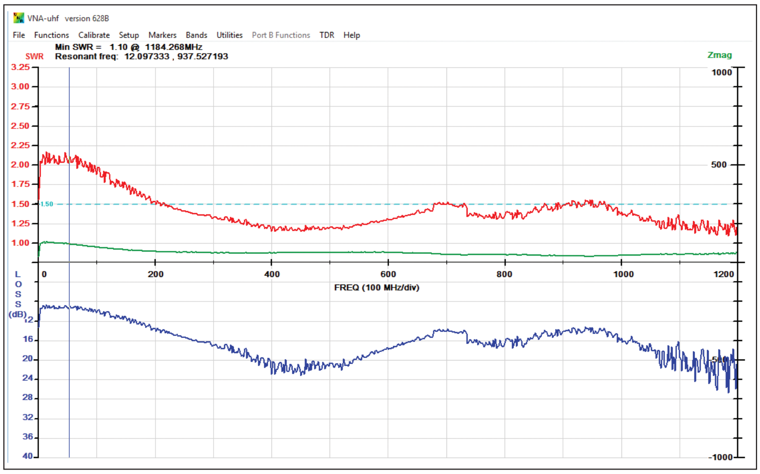

Figure 14 — Signal Hound SA44B input SWR/return loss from 0 – 1200 MHz, measured with an Array Solutions VNAuhf vector network analyzer.

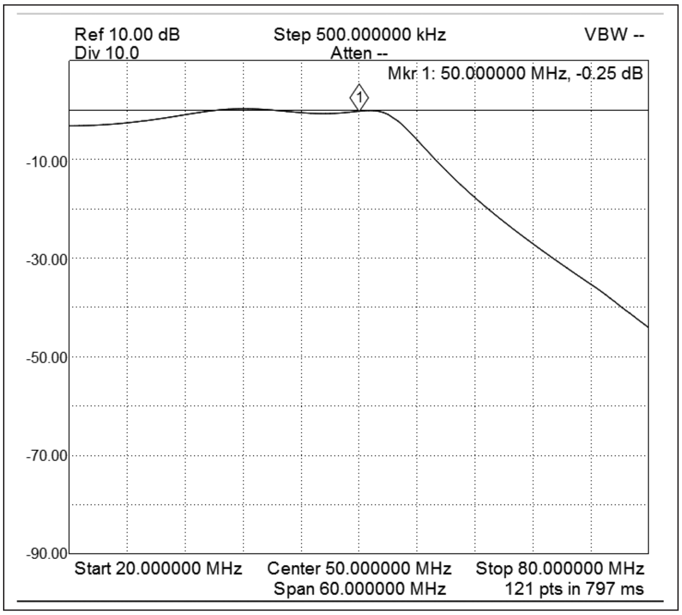

Figure 15 — Insertion loss of a 6 meter low-pass filter as measured with the Signal Hound SA44B and TG44A.