Siglent Technologies SSA3021X Spectrum Analyzer and TG-SSA3000X Tracking Generator

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The current state-of-the-art in DSP, software, and computing power has resulted in the availability of reasonably priced, sophisticated test equipment. For example, you can now purchase a very capable spectrum analyzer that costs less than an average ham transceiver. This month we'll review the SSA3021X spectrum analyzer and companion TG-SSA3000X tracking generator, offered by Siglent Technologies — an international high-tech company that develops, produces, and sells test and measurement equipment.

Overview

Siglent's SSA3021X covers 9 kHz to 2.1 GHz. It is lightweight, compact, and easy to use. Applications include research and development, education, production, and — of course — ham and hobbyist experimentation.

Table 3 lists the primary specifications of the SSA3021X. To verify its specifications, ARRL sent the review unit to Essco Calibration Laboratory in Chelmsford, Massachusetts — the lab that regularly calibrates ARRL Lab test equipment. Essco checked all specifications and confirmed that they are "as specified" except that the tracking generator was slightly out of spec. The tracking generator flatness is specified as ±3 dB from 100 kHz to 2.1 GHz. Essco measured the worst case variation as –3.42 dB. The tracking generator calibration was listed as "Limited," not "Failed," meaning it is within spec for most of its frequency range. While not mentioned in the calibration certificate, I suspect it rolls off as you approach 2.1 GHz.

I also wanted to continue the resolution bandwidth (RBW) comparison begun by Bob Allison, WB1GCM, in his review of the Rigol DSA815-TG.[5] RBW determines how well close-in frequency components can be displayed, with the optimum RBW depending on the characteristics of the desired signals. Table 4 shows the RBW of the Siglent SSA3021X compared with the Signal Hound SA44B and Rigol DSA815 reviewed previously in *QST* and an HP 8563E (the HP 8563E covers up to 26.5 GHz).[6] As you can see, the SSA3021X minimum RBW stands out among these spectrum analyzers.

Using the SSA3021X

Like much equipment today, a hard copy of the SSA3021X manual is not provided. A PDF format copy of the manual is provided on an enclosed CD, or it may be downloaded from the Siglent website.

Bottom Line

The Siglent Technologies SSA3021X/TG-SSA3000X is a feature-rich, affordable 2.1 GHz spectrum analyzer/tracking generator. It is easy to use, and provides capabilities previously only dreamed of by the home experimenter.

Operating the SSA3021X was so easy that I only had to refer to the manual to determine how to save screenshots to a memory stick. Tap FREQUENCY to enter center frequency and span, or to set start/stop frequencies. Tap BW to set the resolution and video bandwidths. While all parameters are easily changed, default values for step size and resolution bandwidth automatically match a desired span. And when the SSA3021X is turned on, you can elect to have it return to the last setting, return to the default (full span) setting, or return to a user-defined setting. Finally, there is a built-in help menu, which is very effective. Tap the HELP key, followed by the key you are interested in, and related information is displayed on the screen.

Before using the SSA3021X, pay close attention to the expected input signal power level. The SSA3021X is rated to handle +33 dBm (2 W) for 3 minutes if the input attenuator is set to at least 20 dB. To provide a safety margin, I always provide external attenuation to ensure that the maximum power into the spectrum analyzer does not exceed 0 dBm.

A basic spectrum analyzer test is the harmonic and spurious performance of transmitters and amplifiers. I began by displaying the 146 MHz fundamental and harmonic response of my Yaesu VX-2 dual-band handheld and FT-2400 mobile 2 meter radio (see Figures 11 and 12). As expected, the harmonic response of the handheld is not as good as a full-size transceiver, but it is still quite good and well within the FCC requirements — and certainly better than some inexpensive handhelds on the market.[7] I followed that test by checking the 440 MHz fundamental and harmonic response of my Yaesu VX-2 handheld and FT-1807 70 centimeter

Table 3
Siglent Technologies SSA3021X Specifications and Features

Frequency range: 9 kHz – 2.1 GHz.
Frequency resolution: 1 Hz.
Frequency span: Range 0 Hz, 100 Hz to 2.1 GHz.
Internal reference: 10.000000 MHz. Initial calibration accuracy <1 ppm.
Marker frequency counter resolution: 1 Hz.
Resolution bandwidth (–3 dB): 10 Hz ~ 1 MHz.
Reference level: –100 dBm to +30 dBm, 1 dB steps.
Preamplifier: 20 dB (nom), 9 kHz ~ 2.1 GHz.
Input attenuation: 0~51 dB in 1 dB steps.
Maximum input dc voltage: ±50 V dc.
Maximum input RF power: +33 dBm for 3 minutes with input attenuation >20 dB.
Phase noise: –98 dBc/Hz @10 kHz offset (1 GHz, typical).
Displayed average noise level: –161 dBm/Hz (typical).
Display types:
Logarithmic: 10 dB to 100 dB.
Linear: displays dBm, dBmV, dBµV, Volts, Watts.
Number of traces: 4.
Frequency response: ±0.8 dB preamp off, ±0.9 dB preamp on.
RF input VSWR: <1.5:1 nominal (>14 dB RL) for 10 dB input attenuation.
2nd harmonic distortion: –65 dBc preamp off.
3rd order intercept, preamp off: +10 dBm.
1 dB gain compression, preamp off: > –5 dBm, nominal.
Display: 10.1 inch TFT LCD, 1024 × 600 (waveform area 751 × 501).
Storage: Internal (flash) 256 MB; External (USB storage device), 32 GB.
Input voltage range: 100 – 240 V ac, 45 Hz – 440 Hz. Power consumption 30 W.
Temperature: 0 – 50 °C operating, –20 to 70 °C storage.
Dimensions (height, width, depth): 8.2 × 15.5 × 4.6 inches. Weight: 10.1 lb.
Price: SSA3021X spectrum analyzer, $1595; TG-SSA3000X tracking generator option, $169; EMI-SSA3000X EMI measurement kit, $559; RBSSA3X20 Reflection Measurement Kit (1 MHz – 2 GHz, directional coupler and software), $559; Refl-SSA3000X software only, $429.

mobile transceiver with similar results.

Another common spectrum analyzer test is the two-tone evaluation of SSB transceivers and amplifiers. Figure 13 shows a two-tone intermodulation distortion (IMD) test of my Elecraft KX3 QRP transceiver using the KX3's internal two-tone generator.

Table 4
Display Frequency Width vs Minimum Resolution Bandwidth

Sweep Width (MHz)	Minimum RBW SSA3021X	SA44B	DSA815	HP 8563E
1000	1000 Hz	5 MHz	1000 Hz	10,000 Hz
100	300 Hz	250 kHz	300 Hz	3000 Hz
10	10 Hz	100 kHz	100 Hz	1000 Hz
1	10 Hz	13 kHz	100 Hz	10 Hz
0.1	10 Hz	1.6 kHz	100 Hz	10 Hz
0.01	10 Hz	123 Hz	100 Hz	10 Hz
0.001	10 Hz	13 Hz	100 Hz	10 Hz

TG-SSA3000X Tracking Generator

A tracking generator adds the capability to measure the gain or loss of two-port devices such as filters or amplifiers. Further, return loss measurements can be made using the optional RBSSA3X20 reflection measurement kit (directional coupler and software; Refl-SSA3000X is software only), or with an inexpensive third-party directional coupler. The TG-SSA3000X tracking generator is just a software update — the tracking generator hardware is included in the SSA3021X. The specifications and features of the TG-SSA3000X tracking generator are given in Table 5.

Figure 14 displays the SSA3021X/TG-SSA3000X insertion-loss plot of a 442.8/447.8 MHz duplexer I've been working on. This is an alternative display mode that provides a table under the plot with more information. Transmit and receive frequency markers have been set. As you can see, the transmit in-band insertion loss is about 0.9 dB, and the receive rejection is about 74 dB.

Table 5
TG-SSA3000X Tracking Generator Features

Frequency range: 100 kHz – 2.1 GHz.
Output level: –20 dBm to 0 dBm.
Output level resolution: 1 dB.
Output flatness: ±3 dB.
Harmonic output: Typically better than –10 dBc.
Dynamic range: 0 to –90 dB for passive devices, +20 to –70 dB for active devices.
Step size: 19 selectable steps from 10 Hz to 10 MHz.
Sweep rate: Up to 700 frequency points per second.

Figure 15 shows my setup for measuring return loss using a reverse-connected MiniCircuits ZFDC-20-5 directional coupler. The ZFDC-20-5 covers 0.1 – 2000 GHz. To make a return loss measurement, begin by leaving the IN connector of the directional coupler unterminated. All power will be reflected, resulting in a 0 dB return loss reference display on the SSA3021X (the reference is –20 dB, in this case). Then connect your unit under test (the duplexer, in this case) and display the return loss of the device as dB below the reference. Figure 16 shows the common port (antenna port) return loss of the duplexer. In this figure, the duplexer common port receive-path return loss is 32 dB, and the common port transmit-path return loss is 20 dB. To measure the return loss actually presented to the transmitter, reconnect the setup as shown in the TX RL SETUP dashed box. More details on measuring return loss can be found in the sidebar accompanying the Signal Hound review.[6]

Some Other Features Worth Mentioning

The SSA3021X can demodulate AM and FM signals and output the demodulated audio on the front panel 3.5 mm headphone

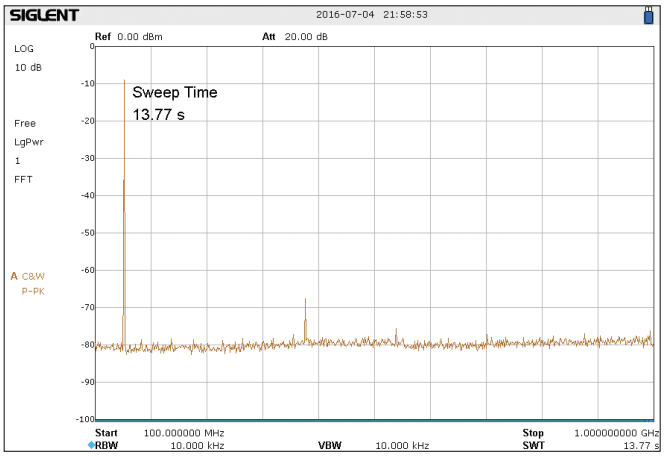

Figure 11 — Spectral display of the VX-2 handheld operating on 2 meters.

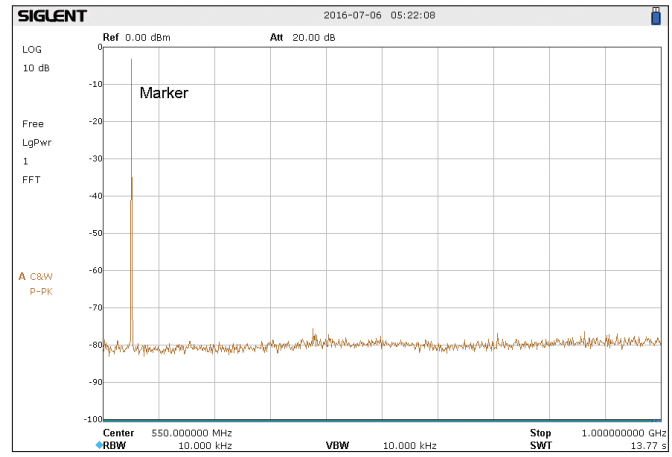

Figure 12 — Spectral display of the FT-2400 mobile transceiver operating on 2 meters.

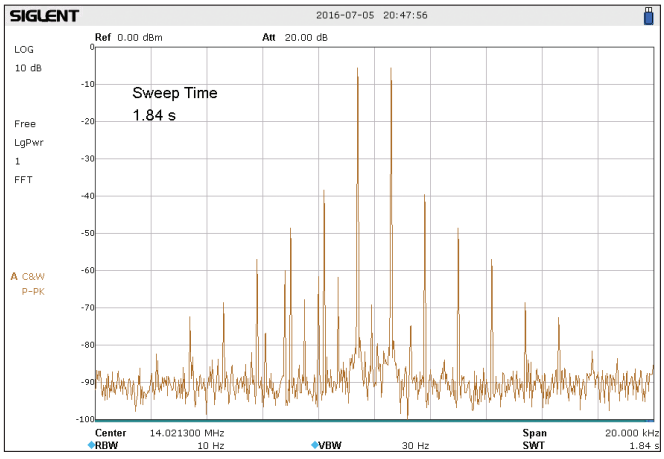

Figure 13 — Two-tone IMD test of the Elecraft KX3 using its internal two-tone generator.

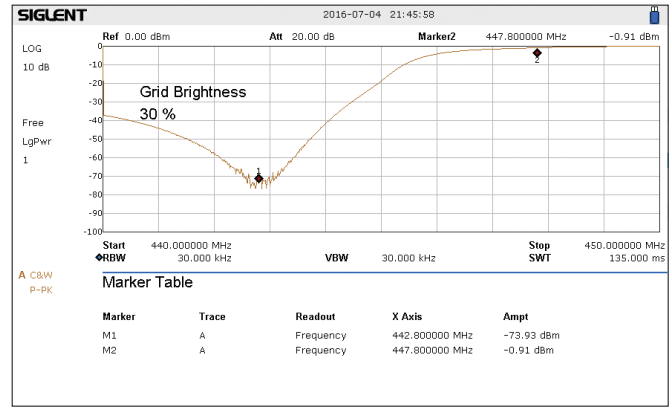

Figure 14 — Insertion loss of a 440 MHz duplexer. This is an alternative display with a plot across the top and a table of values below.

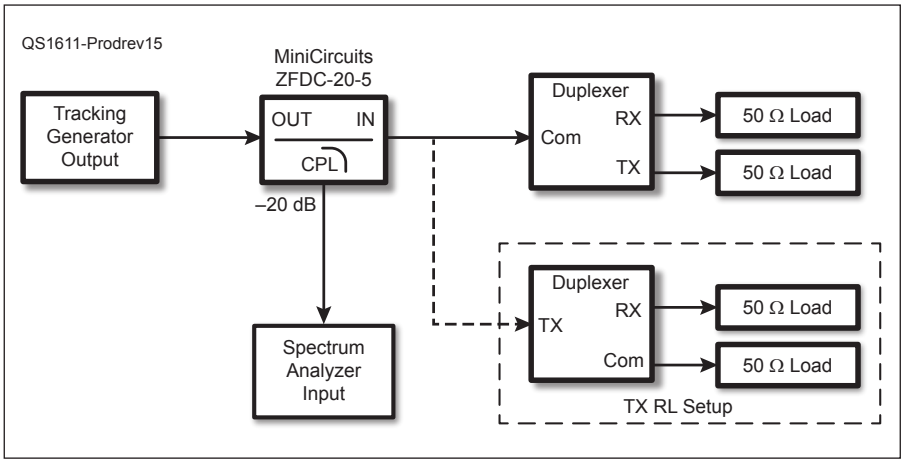

Figure 15 — The author's test setup for measuring return loss of the 440 MHz duplexer.

jack. It can display phase noise in dBc/Hz vs carrier offset. And while a single trace is the default display, the SSA3021X can display up to four traces at the same time (Trace 1 — yellow, Trace 2 — purple, Trace 3 — light blue, and Trace 4 — green). Each trace can have its parameters independently set. The SSA3021X can measure total channel power and channel bandwidth. It can also search for the highest level signal and automatically set this as the displayed center frequency. And the SSA3021X can display information in dBm, dBmV, dBμV, volts, and watts. I recommend downloading the manual from the Siglent website to review all the additional capabilities and features available.

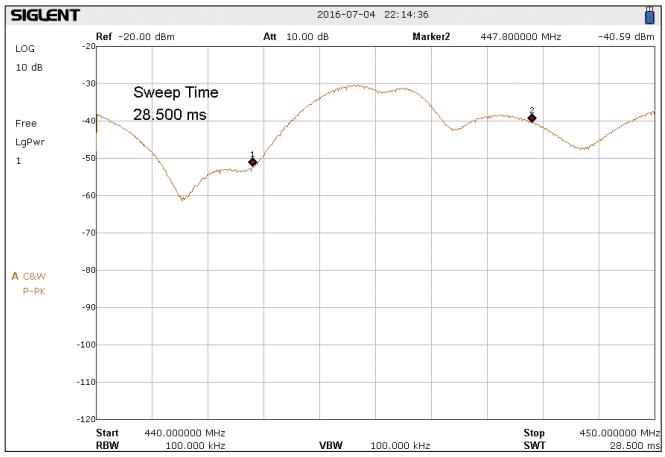

Figure 16 — Return loss of the 440 MHz duplexer as measured with the SSA3021X spectrum analyzer and TG-SSA3000X tracking generator.

Summary

I thoroughly enjoyed putting the SSA3021X/TG-SSA3000X spectrum analyzer/tracking generator through some of its paces for this review. As I often tinker with active and passive RF circuits and perform transmitter and amplifier testing, I can see that this would be a great addition to any experimenter's test bench — mine included!

Manufacturer: Siglent Technologies America Inc**,** 6557 Cochran Rd, Solon, Ohio 44139; tel 877-515-5551; **siglentamerica.com**.

Notes

[5]B. Allison, WB1GCM, "Rigol Technologies DSA815-TG Spectrum Analyzer," Product Review, *QST* Feb 2013, pp 55 – 58.

[6]P. Salas, AD5X, "Signal Hound USB-SA44B 4.4 GHz Spectrum Analyzer and USB-TG44A Tracking Generator," Product Review, *QST,* Feb 2016, pp 55 – 60.

[7]L.Wolfgang, WR1B, "ARRL Laboratory Handheld Transceiver Testing," Technical Correspondence, *QST* Nov 2015, pp 74 – 76.