

Siglent Technologies SSA3021X Spectrum Analyzer and TG-SSA3000X Tracking Generator Reviewed by Phil Salas AD5X ad5x@arrl.net

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 at a cost less than that of the average ham transceiver. A recent spectrum analyzer, the SSA3021X (and TG-SSA3000X tracking generator), is offered by SIGLENT Technologies - an international high-tech company that develops, produces and sells test and measurement equipment.



Figure 1: Siglent Technologies SSA3021X Spectrum Analyzer/TG-SSA3000X Tracking Generator

Overview

The Siglent's SSA3021X covers 9 KHz to 2.1 GHz. It is light-weight, compact, and easy to use. Applications include research and development, education, production, and – of course – ham and hobbyist experimentation.

To verify its specifications, this SSA3021X was sent to Essco Calibration Laboratory of Chelmsford, Massachusetts - the lab that annually 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 100KHz to 2.1GHz. Essco measured the worst case variation as -3.42 dB. The tracking generator was listed as "Limited", not "Failed", meaning it is within spec for most of its frequency range. While not mentioned in the certificate, I suspect it rolls off as you approach 2.1 GHz. Table 1 lists the primary specifications of the SSA3021X.

Table 1: 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 (-3dB): 10 Hz~1 MHz
 Reference level: -100 dBm to +30 dBm, 1 dB steps
 Preamplifier: 20 dB (nom.), 9 kHz~3.2 GHz
 Input attenuation: 0~51 dB in 1 dB steps
 Maximum input DC voltage: +/- 50 VDC
 Maximum input RF power: +33 dBm for 3-minutes with input attenuation >20 dB
 Phase noise: -98 dBc/Hz @10 kHz Offset (1 GHz, Typ.)
 Displayed Average Noise Level: -161 dBm/Hz (Typ.)
 Level Display
 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 (>14dB RL) for 10 dB input attenuation
 2nd harmonic distortion: -65 dBc preamp off
 3rd-order intercept, preamp off: +10dBm
 1dB Gain Compression, preamp off: > -5 dBm,nom.
 Display: TFT LCD, 1024×600 (waveform area 751×501), 10.1 inch
 Storage: Internal (Flash) 256 MB, External (USB storage device) 32 GB
 Input voltage range: 100-240VAC, 45 Hz-440 Hz. Power consumption 30W
 Temperature: 0-50 degC operating, -20 to 70 degC storage
 Dimensions WxHxD: 15.5" x 8.2" x 4.6" (393 mm×207 mm×116.5 mm)
 Weight: 10.1 lb (4.60 kg)

I also wanted to continue the resolution bandwidth (RBW) comparison begun by Bob Allison in his review of the Rigol DSA815-TG¹. RBW determines how well close-in frequency components can be displayed, with the optimum RBW depending on the characteristics of the desired signals. Table 2 tabulates the RBW of the Siglent SSA3021X, the Signal Hound SA44B², the Rigol DSA815 and the HP 8563E used in the ARRL Lab (the HP 8563E covers up to 26.5 GHz). As you can see, the SSA3021X minimum RBW stands out among these spectrum analyzers.

Table 2: Display Frequency Width versus 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

Using the SSA3021X

Like much equipment today, a hard copy of the SSA3021X manual is not provided. A pdf copy of the manual is provided on an enclosed CD, or it may be downloaded from the Siglent website. However, operating the SSA3021X was so easy that I only had to refer to the manual to determine how to save screen shots to a memory stick. Tap FREQUENCY to enter center frequency and span, or 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 built-in help which is very effective. Tap the HELP key, followed by the key you are interested in and help information is displayed on the screen.

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

A basic spectrum analyzer test is the harmonic and spurious performance of transmitters and amplifiers. So I began by displaying the fundamental and harmonic response of my Yaesu VX-2 handheld and FT-2400 2-meter radio (Figures 2 and 3), followed by the fundamental and harmonic response of my Yaesu VX-2 handheld and FT-1807 440MHz transceiver (Figures 4 and 5). As expected, the harmonic response of the Yaesu handheld is not as good as a full-size transceiver, but it is still quite good and within the FCC requirements – and certainly better than some inexpensive handhelds on the market³.

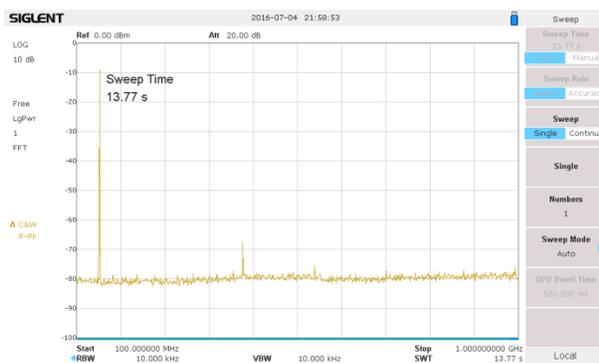


Figure 2: VX-2 2M spectral display

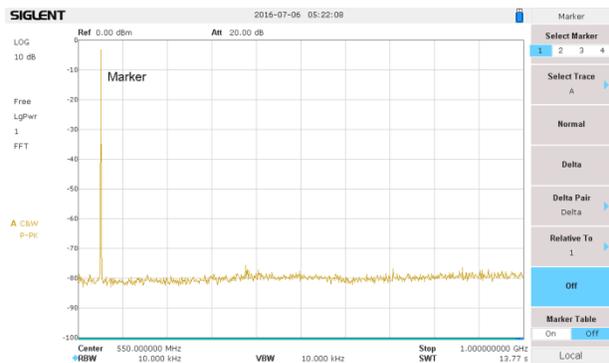


Figure 3: FT-2400 2M spectral display

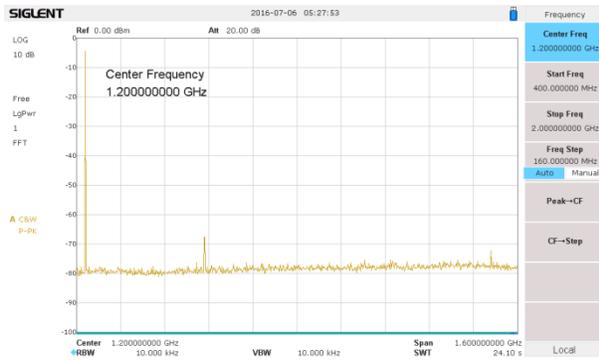


Figure 4: VX-2R 440MHz Spectral Display

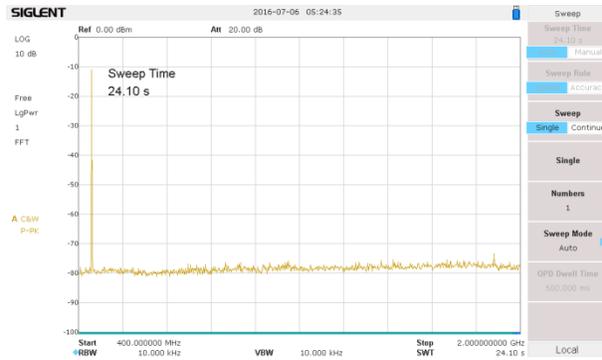


Figure 5: FT-1807 440MHz Spectral Display

Another common spectrum analyzer test is the two-tone evaluation of SSB transceivers and amplifiers. Figures 6- and 7 show the unmodulated- and 2-tone displays of my Elecraft KX-3 QRP transceiver using the KX3's internal 2-tone generator.

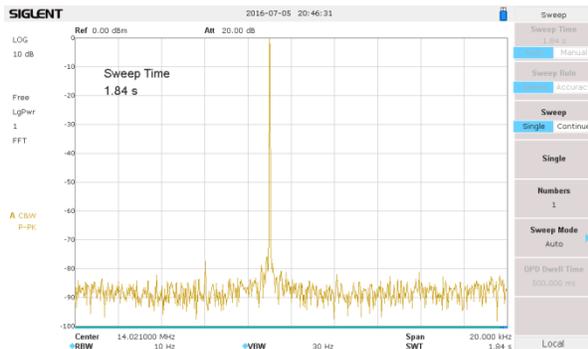


Figure 6: KX3 Unmodulated spectrum

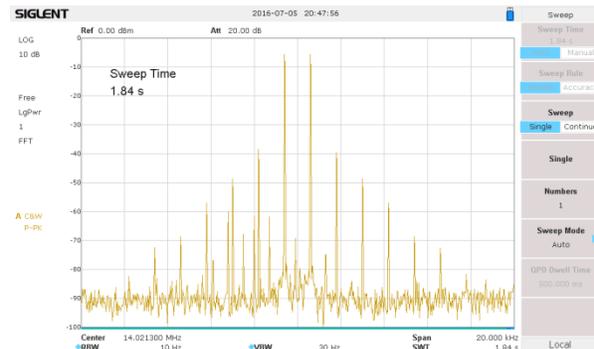


Figure 7: KX3 2-tone display

TG-SSA3000X Tracking Generator

A tracking generator adds the capability to measure the gain or loss of 2-port devices. Further, return loss measurements can be made using the optional Refl-SSA3000X reflection measurement kit, or an inexpensive directional coupler. The TG-SSA3000X tracking generator is just a software update – i.e. the tracking generator hardware is included in the SSA3021X. The specifications and features of the TG-SSA3000X tracking generator are given in Table 3 below.

Table 3: TG-SSA3000X Features

Frequency Range: 100 kHz-2.1 GHz

Output level: -20dBm to 0 dBm

Output level resolution: 1 dB

Output flatness: +/-3 dB

Harmonic output: Typically better than -10dBc.

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

Figures 8 and 9 display the SSA3021X/TG-SSA3000X insertion-loss plot of a 442.8/447.8MHz duplexer I've been working on. Figure 9 is an alternative display that provides a table with more

information. Transmit and receive frequency markers have been set. As you can see, the transmit in-band insertion loss is about 0.9dB, and the receive rejection is about 74dB.

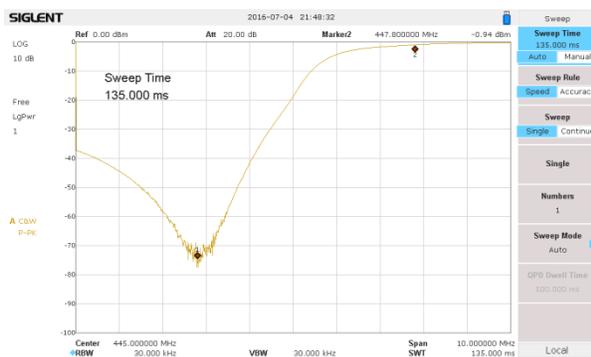


Figure 8: 440MHz Duplexer Insertion loss



Figure 9: Alternative Display with tabular data

Figure 10 shows my set-up for measuring return loss using a reverse-connected MiniCircuits ZFDC-20-5 directional coupler. The ZFDC-20-5 covers 0.1-2000 GHz.

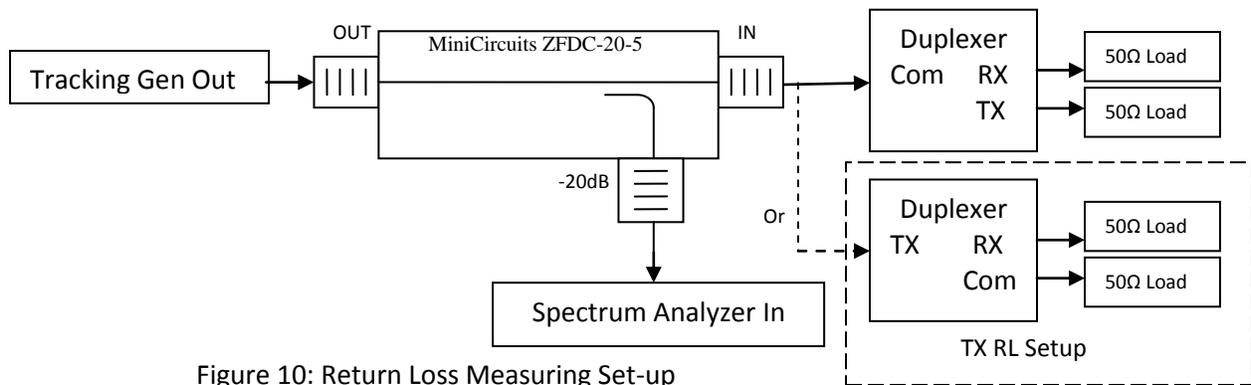


Figure 10: Return Loss Measuring Set-up

To make a return loss measurement, begin by leaving the “IN” connector of the directional coupler un-terminated. All power will be reflected resulting in a 0dB return loss reference display on the SSA3021X (Reference is -20dB 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 11 shows the common port (antenna port) return loss of the duplexer. In this figure, the duplexer common port receive-path return loss is 32dB, and the common port transmit-path return loss is 20dB. To measure the return loss actually presented to the transmitter, reconnect the set-up as shown in the “TX RL Setup” dashed box. More details on measuring return loss can be found in the sidebar in reference¹.

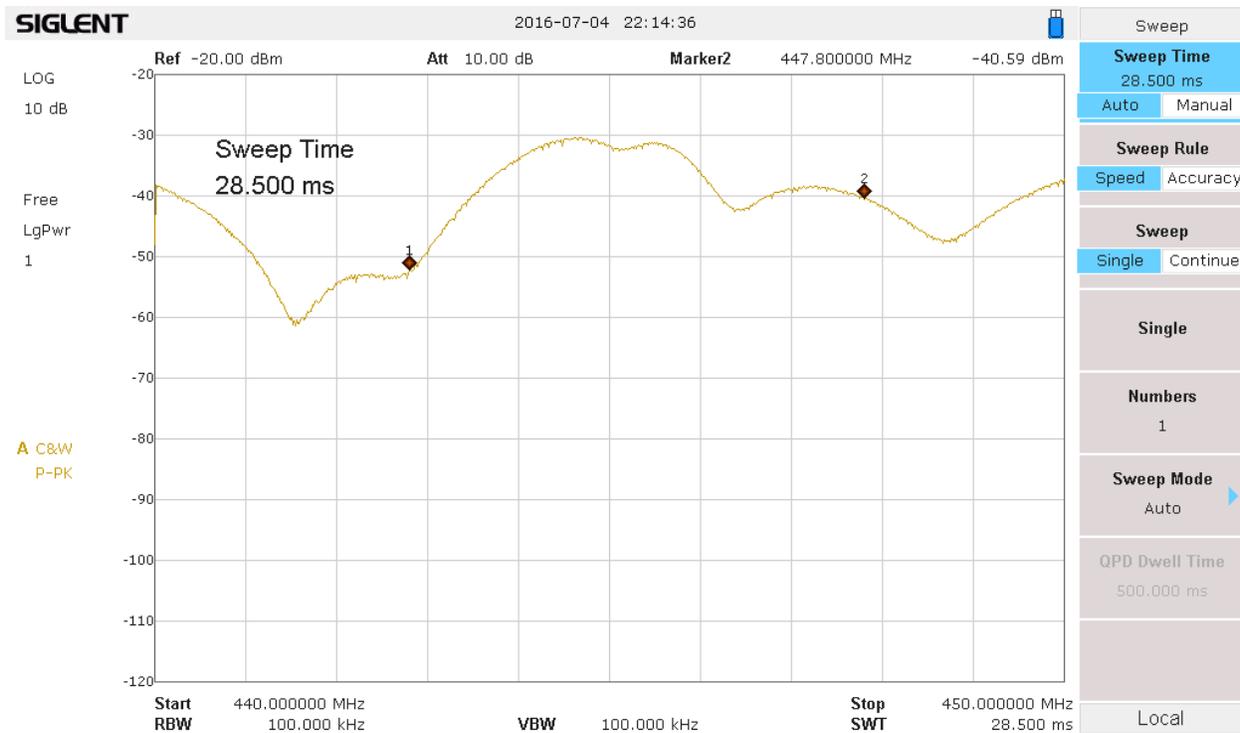


Figure11: SSA3021X/TG44 duplexer return loss

Some Other Features Worth Mentioning

The SSA3021X can demodulate AM and FM signals and output the demodulated audio on the front panel 3.5mm headphone 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, dBuV, volts and watts. I recommend downloading the operating manual from the Siglent website to review all the additional capabilities and features available.

Summary

I thoroughly enjoyed running the SSA3021X/TG-SSA3000 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!

Bottom Line

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

Manufacturer: SIGLENT Technologies America Inc, 6557 Cochran Rd, Solon, Ohio 44139.
Tel: 877-515-5551. <http://siglentamerica.com/index.aspx>; *Price:* SSA3021X Spectrum Analyzer,

\$1595; TG-SSA3000X Tracking Generator, \$169. EMI-SSA3000X EMI Measurement Kit, \$559; Refl-SSA3000X Reflection Measurement Kit (1MHz-2GHz), \$559.

¹Bob Allison WB1GCM, Product Review, “Rigol Technologies DSA815-TG Spectrum Analyzer”, QST February 2013, pp. 55-58.

²Phil Salas AD5X, Product Review, “USB-SA44B 4.4 GHz Spectrum Analyzer and USB-TG44A Tracking Generator”, QST February 2016, pp. 55-60.

³Larry Wolfgang WR1B, “ARRL Laboratory Handheld Transceiver Testing”, QST November 2015, pp. 74-76.