SOTABEAMS WSPRlite Antenna and Propagation Tester

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I have two antennas that work on 40 meters — an inverted **V** cut for that band and fed with RG-58 coax, and a 130-foot inverted **V** fed with window line and an antenna tuner that can be used on 80 – 10 meters. The apex of the 40-meter inverted **V** is about 35 feet high, and the apex of the multi-band antenna is about 10 feet higher. Both antennas are oriented in approximately the same direction.

Although I normally use the multiband antenna only for 80 and 30 meters, I sometimes wondered if it would be better than the single-band antenna on 40 meters. It was difficult to draw any meaningful conclusions while using an antenna switch to listen to on-air signals while alternating between the two antennas. After reading an interesting *QEX* article about using simultaneous WSPR measurements to compare antennas, I decided to try the WSPRlite system from SOTABEAMS.[1]

Overview

Originally developed by Joe Taylor, K1JT, WSPR (Weak-Signal Propagation Reporter) implements a digital protocol designed for checking propagation paths using low-power transmissions.[2] Transmissions include the station's call sign, Maidenhead grid locator, and transmitter power in dBm (decibels referenced to 1 milliwatt; 0 dBm = 1 mW). Stations around the world receive and decode the transmissions and report the results on the internet.

The WSPRlite system consists of a multiband, low-power WSPR transmitter (up to 200 mW, see Table 3), companion software, and the DXplorer website (**dxplorer.net**) where reception reports are gathered and displayed in several ways. SOTABEAMS offers two versions of the transmitter, the WSPRlite Classic and the WSPRlite Flexi. We ordered one of each.

The WSPRlite Classic covers 630 – 20 meters. Its transmitter output is rich in harmonics, some of which are only 10 to 20 dB below the fundamental level. Spurious emissions and harmonics must be attenuated by at least 43 dB to meet FCC spectral purity requirements for transmitters below 30 MHz. The Classic includes a low-pass filter for 20 and 30 meters. As measured in the ARRL Lab, harmonics and spurious emissions on 20 meters are attenuated at least 53 dB, but on 30 meters, they are down only 35 dB. According to SOTABEAMS, a single filter is used for both bands, so the attenuation of spurious emissions on 30 meters is less than on 20 meters.

The WSPRlite Flexi covers 630 – 6 meters. It includes no filtering for any band and must be used with an external filter to meet FCC requirements. SOTABEAMS offers several low-pass filter kits that can be used to make the WSPRlite transmitters FCC-compliant on all bands (see the sidebar, "Low-Pass Filters").

Bottom Line

The SOTABEAMS WSPRlite system offers an interesting way to compare antennas or check propagation paths.

Setup and Operation

The WSPRlite transmitters are controlled by software. They have an SMA antenna connector, a micro-

Table 3
WSPRlite Transmitter Power Output (mW)

Measured with HP-437B power meter.

WSPRlite Classic

Band (Meters)	Software Setting (mW) 200	100	50	5
160	190	70	33	2.6
80	195	91	41	3.9
60	203	100	47	3.9
40	177	90	45	3.7
30	163	73	32	2.5
20	176	92	45	3.3

WSPRlite Flexi

Band (Meters)	Software Setting (mW) 200	100	50	5
160	212	109	54	5.8
80	212	107	53	5.8
60	207	103	53	5.8
40	197	102	53	5.8
30	198	102	52	5.8
20	190	101	53	5.6
17	185	98	52	5.7
15	185	97	53	5.6
12	184	98	52	6.2
10	183	96	52	6.2
6	93	92	50	6.6

Low-Pass Filter Kits

As discussed in the text, except for the Classic on 20 meters, the WSPRlite transmitters require external filtering to comply with FCC spectral purity requirements. SOTABEAMS offers several kits to fix this.

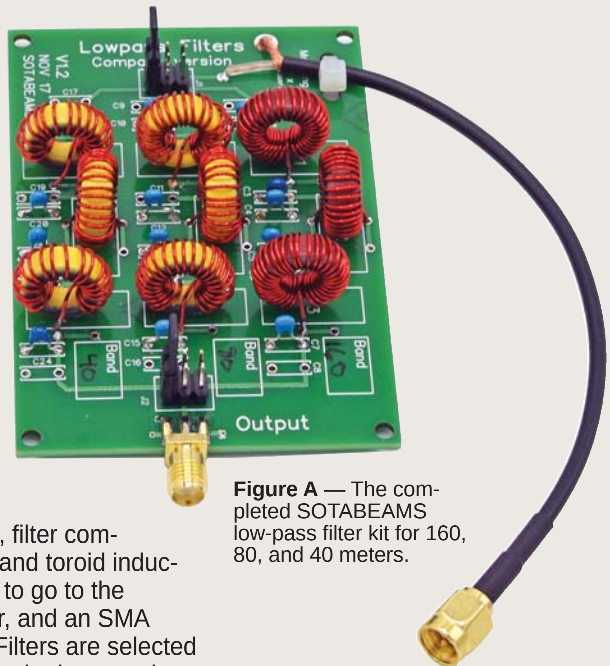

Figure A — The completed SOTABEAMS low-pass filter kit for 160, 80, and 40 meters.

The low-pass filter (LPF) kit for 160, 80, and 40 meters (see Figure A) includes a PC board, filter components (capacitors and toroid inductors), an SMA pigtail to go to the WSPRlite transmitter, and an SMA antenna connector. Filters are selected by moving jumpers at the input and output. The kit is easy to build. You have to wind three toroids for each filter section using the supplied wire and winding instructions. Capacitors are identified in the packaging, but I used a magnifier to double-check the markings. After finishing the build, there's a space on the board to write the band covered by each filter section.

SOTABEAMS also offers a filter PC board kit (the same PC board, connectors, and jumpers), along with individual filter component kits for each band from 160 through 6 meters. I also built one of these with components for 40, 20, and 17 meters.

The ARRL Lab tested the WSPRlite transmitters with and without the filters. In each case, the filters brought the transmitters into FCC compliance without any adjustment (see Figure B).

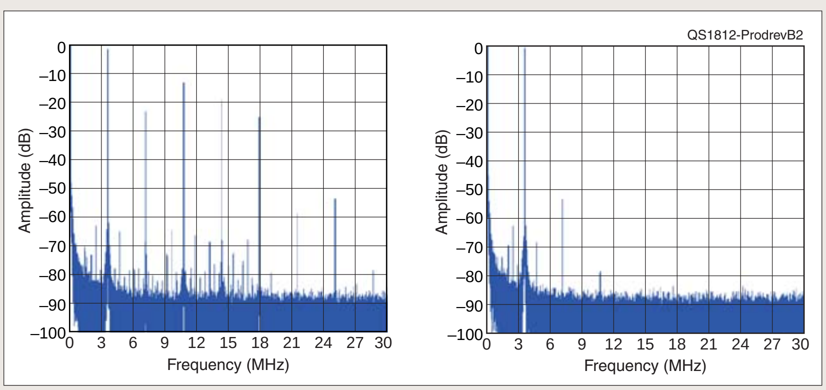

Figure B — Spectral output of the WSPRlite Classic operating on the 80-meter band at 200 mW output. Horizontal divisions are 3 MHz, and vertical divisions are 10 dB. In the plot on the left, without filtering the second through fifth harmonics range from –12 to –25 dBc. With the addition of the SOTABEAMS 80-meter low-pass filter (right), the strongest harmonic is –52 dBc, easily complying with FCC regulations.

USB jack for connection to the host computer (cable not supplied), an LED to indicate status, and a momentary pushbutton switch. Power is supplied via the micro-USB jack as well.

The first step is to visit the DXplorer website and download the configuration software (Windows or Android). Then, if needed, download the appropriate Silicon Labs virtual COM port drivers for your operating system and connect the WSPRlite transmitter. Next, open the WSPRlite application (see Figure 7). Choose the WSPRlite transmitter to set up (if you have more than one) and click **CONNECT**. Other buttons allow you to update firmware and save configuration settings.

Setup is easy. Fill in your WSPR identifier (call sign) and grid locator. Choose a band, and the transmitter will pick a random frequency in the WSPR segment. Select the output power (5, 50, 100, or 200 mW). Select the power level to be reported in your transmission (the same as the WSPRlite output power, unless you are using an external attenuator or amplifier), and indicate if you are using an external filter.

The last two settings control how much you will transmit. A WSPR transmission is 2 minutes long, with 30 time slots per hour. At the default **REPEAT RATE** setting of 20%, you will transmit on six of the 30 available time slots. Maximum repeat rate is 50%. You can also choose how many days (1 – 30) the WSPRlite transmitter will run before shutting off automatically. (You can terminate transmission manually at any time.) After initial setup, the software populates the fields with current settings whenever you **CONNECT** to the WSPRlite transmitter.

The **OPEN IN BROWSER** button at the bottom of the screen is a link to your signal reports on the DXplorer website. I clicked on it and bookmarked the link in my browser.

After you finish configuring the transmitter, the computer connection is no

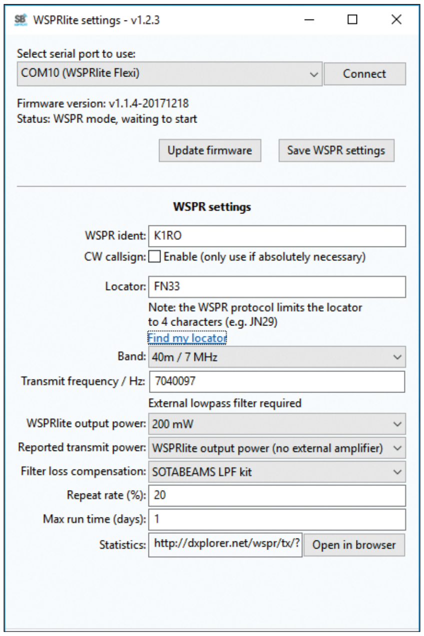

Figure 7 — The WSPRlite configuration screen.

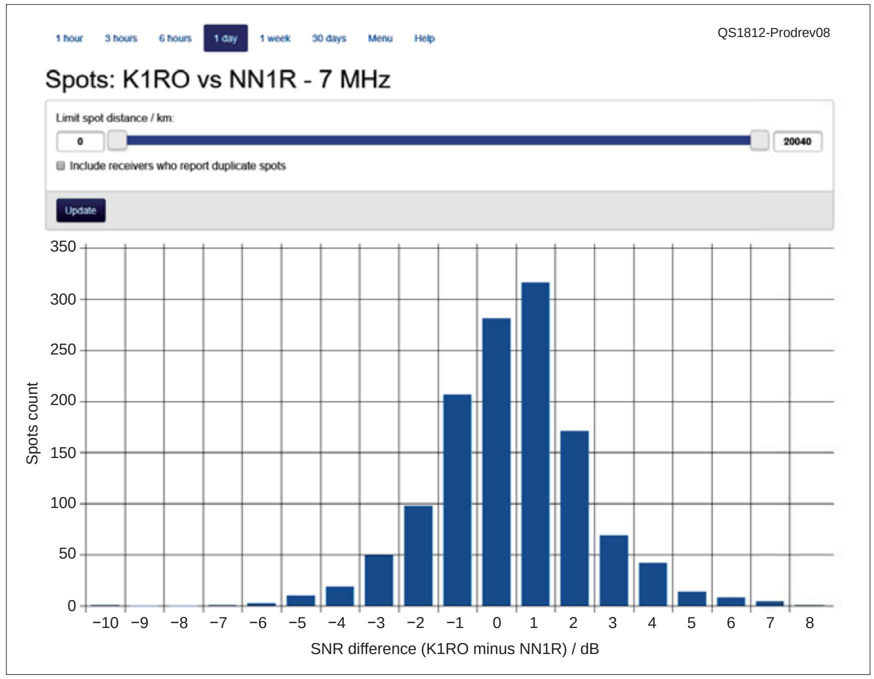

Figure 8 — DXplorer report comparing the strength of the most recent 500 WSPRlite signals received simultaneously from the author's two 40-meter antennas. K1RO used the 40-meter antenna, and NN1R used the multiband dipole tuned to 40 meters. Note that, in this illustration, the axis labels have been enhanced to aid legibility when reproduced at this size.

longer required until you want to change a parameter. However, you will need to keep the transmitter connected to an active USB port or USB power supply during operation.

On the Air

When you connect power to the WSPRlite transmitter via the USB port, the LED blinks red. To start transmitting, press the pushbutton at 2 seconds past the start of an even minute (accurate starting time is important). The LED will glow steady red for about 110 seconds while the transmission is in progress, and then turn off until the next transmit time slot. That's it. You can listen in a nearby receiver to confirm that your WSPRlite is transmitting, or just wait a few minutes and check the DXplorer website for reception reports.

Because I was interested in comparing my two antennas for 40 meters, I set up one of the WSPRlite units to transmit as K1RO with my 40-meter antenna, and the other to transmit with a club call sign, NN1R, with my multiband antenna tuned to 40 meters. I started testing at about 1600Z one afternoon and let the WSPRlites run overnight, until about 1300Z the next day.

Several interesting tools are available on the DXplorer website. (Note that WSPRlite owners have access to Premium features on the website that are not available to other users.) Figure 8 compares received signal strength (SNR — signal-to-noise ratio) for two signals as reported by stations receiving both simultaneously. As you can see, for most of the reports, signals are within 1 dB of each other, with a slight preference to K1RO (the 40-meter antenna). Although I was only interested in comparing my own antennas, you can choose to compare simultaneous reports from a list of other active stations.

Figure 9 is a map showing the locations of stations receiving my WSPR signals during the same timeframe, using the same data as the report in Figure 8. The green dots indicate stations receiving both signals, while blue dots indicate stations receiving only NN1R (the multiband antenna) and red dots are for stations receiving only K1RO (the 40-meter antenna). For the most part, coverage was the same, but the 40-meter antenna gathered some additional reports from Europe. You can click on any of the dots for details. In this example, EI3RCW reported that the 40-meter antenna (K1RO) was 1 dB stronger on this 4,834 kilometer path.

I tried another comparison, this time on 20 meters between my two-element beam at 25 feet pointed west (K1RO) and my multband inverted **V** tuned for 20 meters (NN1R). As shown in the map in Figure 10, quite a few stations in the US heard both signals (green dots). Some heard the beam but not the multiband antenna (blue dots). Off the back of the beam, most of the European reports were for only the multiband antenna (red dots). The simultaneous reception report showed that the beam is almost always stronger, with a mean difference of 5.68 dB according to the report.

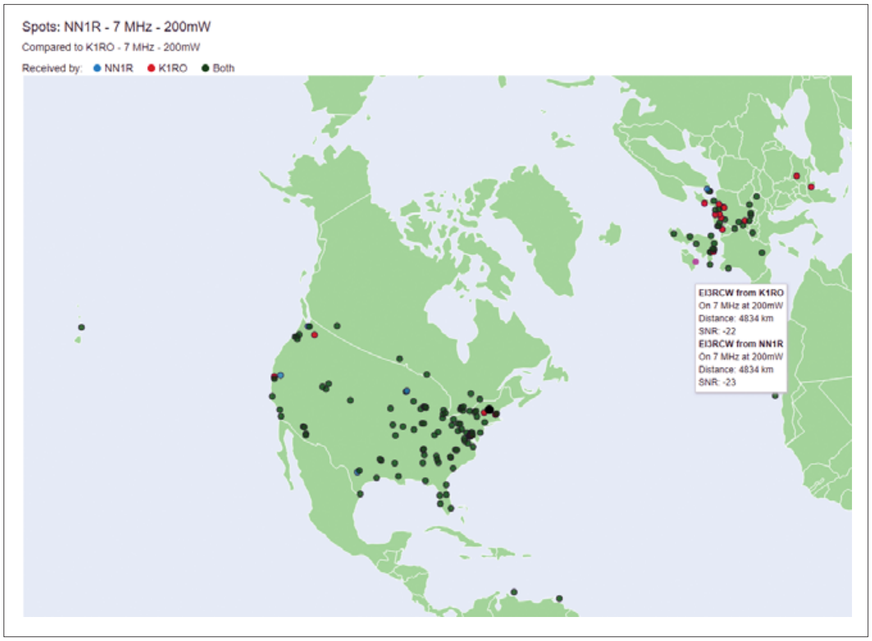

Figure 9 — DXplorer map showing the locations of stations receiving the signals compared in Figure 8. The green dots indicate stations both signals, while blue dots indicate stations receiving only NN1R (the multiband inverted **V**) and red dots are for stations receiving only K1RO (the 40-meter antenna).

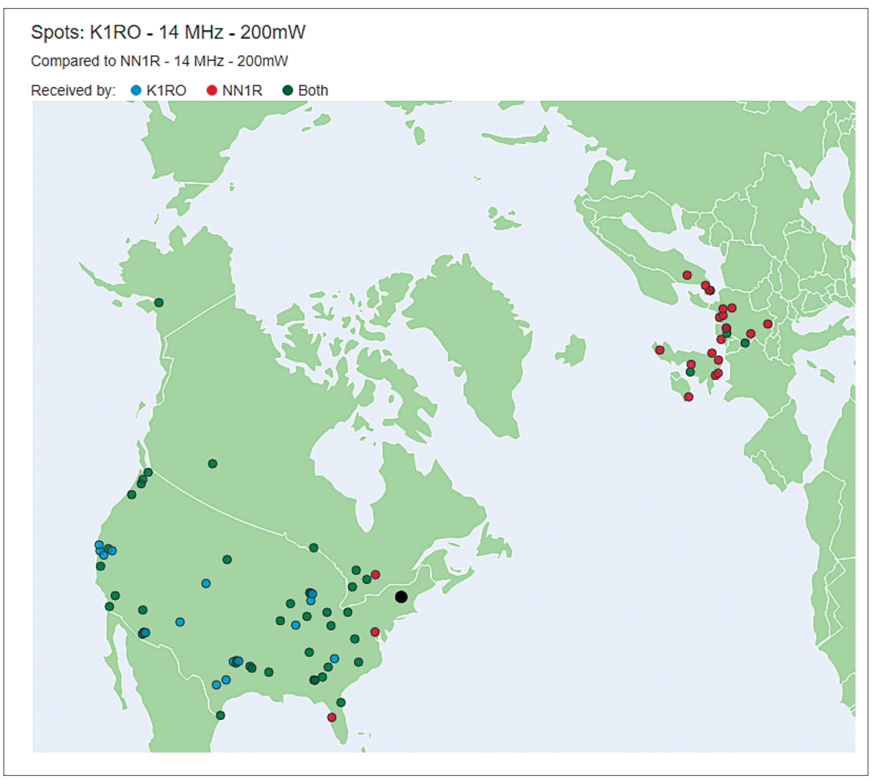

Figure 10 — Another DXplorer map, this time on 20 meters showing WSPRlite signals received from a two-element beam at 25 feet pointed west (K1RO, blue dots) and a mult-band inverted **V** tuned for 20 meters (NN1R, red dots). Quite a few stations in the US heard both signals (green dots).

Other tools on the DXplorer website show the 10 furthest reception reports for a given band and allow downloading a spreadsheet (CSV format) with details of each reception report. The spreadsheet includes date and time, receiving station's call sign and locator, received SNR, distance and azimuth to the receiving station, and other data. During the 40-meter test, K1RO (the 40-meter antenna) received 1,989 individual reports, while NN1R and the multiband antenna received 1,526 reports during the 21-hour period.

Summary

I was happy to learn that my 40-meter antennas compared well — a modern spin on the old "antenna 1, antenna 2" test with other stations watching S-meters for small differences amid fading and band noise. It would be fun to use WSPRlite to compare signals with other stations in the local area as well, and see the differences over various paths. You could also use the system to make your own personal propagation beacon to look for openings on a quiet band.

Manufacturer: SOTABEAMS, Macclesfield, United Kingdom; **www.sotabeams.co.uk**. Available in the US from DX Engineering (**www.dxengineering.com**). Price (DX Engineering): WSPRlite Classic, $77.99; WSPRlite Flexi, $93.99; 160/80/40 meter low-pass filter kit, $36.99; three-band low-pass filter board and connectors, $22.99; filter component kits for three-band LPF board, $13.59 each.

Notes

[1]C. Preston, K7TAA, "Antenna Comparisons Using Simultaneous WSPR Measurements," *QEX*, July/Aug. 2017, pp. 8 – 14.

[2]WSPR is one of the modes included in the popular *WSJT-X* digital communications software package, and an older standalone version, WSPR 2, is still available. For more information, see **physics.princeton.edu/pulsar/k1jt/wspr.html**.