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Product Review

Xiegu G90 HF Transceiver

Reviewed by Phil Salas, AD5X
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Xiegu's G90 HF transceiver fills the void between QRP (usually 5 W output) and 100 W radios. Let's take a look at this interesting product, which is distributed and supported by MFJ Enterprises in the US.

Overview

The Xiegu G90 is built on a downconverting software-defined radio (SDR) platform using a 24-bit 48 kb/s sampling analog-to-digital/digital-to-analog converter. A limited bandwidth signal is mixed down directly to baseband, where the signal processing occurs — it is a direct conversion transceiver. (See the *QST* in Depth web page, **www.arrl.org/qst-in-depth**, for more information.) The G90 transmits on the 160- through 10-meter ham bands and has a general-coverage receiver that tunes continuously from 500 kHz to 30 MHz. Transmit power is adjustable from 1 to 20 W, and operating modes include SSB, CW, and AM, as well as digital modes using an external computer.

The G90 includes many features typically found on desktop transceivers, such as split-frequency operation, a built-in SWR bridge, an automatic antenna tuner, a receiver preamp and attenuator, a digital noise blanker, a CW decoder, and variable band-pass audio filters. Additionally, there is a built-in CW keyer and a speech processor for the SSB operator. A 1.8-inch color TFT LCD screen simultaneously displays everything necessary during operation, and it even includes a 48 kHz wide spectrum display and a waterfall display. There is an excellent-sounding top-mounted speaker.

Bottom Line

With 20 W of output power and a wide-range internal auto tuner, the Xiegu G90 is a capable transceiver in a well-thought-out, compact package that will interest the portable operator.

Interfaces and Controls

The G90 looks like a miniature version of my Icom IC-706MKIIG 100 W transceiver. The front panel can even be remotely mounted using the included 1-meter-long DB9 extension cable! And while the G90 is loaded with controls and interface connectors, everything is easily accessible.

Figures 1 and 2 show the various connectors. On the rear, you'll find a standard SO-239 antenna connector, along with 3.5-millimeter stereo jacks for **KEY** (manual, paddle, or external keyer) and **COM** (to update firmware in the main unit). There's also an **I/Q** output for external I/Q channel processing or display (an add-on panadapter had been announced, but was not available when this was written). The eight-pin mini-DIN **ACC** jack is for amplifier interfacing and external audio in/out for digital modes. Finally, there is a mini-Tamiya power connector and a ground connection.

On the left side of the front panel, there are two 3.5-millimeter stereo jacks for headphone and front-panel firmware updates. The microphone plugs into an RJ45 jack on the right side of the front panel. On the top of the radio are up/down buttons for band and mode selection.

The front panel includes 13 pushbuttons, a volume knob, a multifunction knob, and a tuning knob. The knobs have multiple uses, which I'll cover later. All buttons are clearly marked and have a good tactile feel, and most of these buttons provide additional functions depending on whether they are tapped, pushed and held, or accessed after pressing the **FUNC** button. Again — more on this later. There is a yellow LED that flashes in sync with incoming CW when you have the signal properly tuned in, a yellow LED that lights when the **FUNC** button is pressed, and an LED that lights green on receive and red on transmit. The multifunction keypad on the included microphone also permits access to all of the radio's features.

Power Requirements

The G90 requires an external power source of 10.5 to 16.5 V dc. Although the specifications state that the power source must be capable of 8 A maximum current, actual measurements show that less than 5 A are required at maximum power. For portable operation, I prefer lithium polymer (LiPo) batteries due to their low cost and high energy capacity versus size and weight, but a 4S LiPo battery has a fully charged voltage of 16.8 V dc. I asked Xiegu about this, and they stated that the G90 will operate fine up to 17 V dc, and that a 4S LiPo battery is a good choice for portable operation.

Figure 1 — The Xeigu G90 rear panel.


Figure 2 — Connectors on the sides of the G90, near the front panel. See text for details.

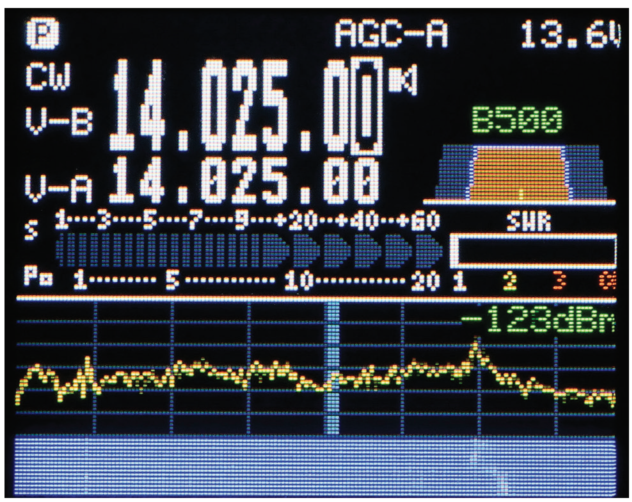

Figure 3 — The G90 display.

A 10 A fused #16 AWG cable with a mini-Tamiya power connector-to-tinned bare wire ends is included with the radio. I added an Anderson PowerPole connector to the wire ends, as that is my standard dc interface. The LiPo batteries for airsoft guns use the same mini-Tamiya connector as the G90, and compatible #14 AWG power cables are readily available from airsoft suppliers. However, be careful if you purchase a prewired airsoft connector, as these cables normally have the red and black power wires reversed from the wires in the G90 power connector.

Firmware Updates and Documentation

A 3.5-millimeter-to-USB cable is provided for firmware updates as well as computer interfacing. You must separately update the main unit and the front-panel firmware. Updating the firmware requires numerous steps, as detailed in the G90 *User Manual*. While this is a somewhat tedious process, it is not difficult.

Xiegu has been very responsive to user inputs with respect to bug fixes and feature updates. Because of these frequent changes, the documentation supplied with G90 transceivers is almost certainly outdated. MFJ maintains the latest G90 firmware and documentation on their website. There is also a very active G90 user group at **groups.io/g/XieguG90** that maintains the latest firmware and documentation in the **FILES** section. The G90 user group is also a great resource for tips and getting answers to your questions.

Some Additional Testing

Table 1 shows the results of testing in the ARRL Lab, with additional comments in the "Lab Notes" sidebar. In addition to the ARRL Lab tests, I did detailed testing on transmit power and current versus the transmit power setting and found that the power setting is reasonably accurate. It is typically within ½ W. At 13.8 V dc input, the required current ranges from about 2 A at 1 W output, to 4 – 4.5 A at full output — much lower than the 8 A maximum current specification. See the *QST* in Depth web page for a table of test results at various power levels on a number of amateur bands.

Next, I tested the internal automatic antenna tuner (ATU). There is no information given on the ATU's capability, so these tests were run to determine its resistive matching range and loss using a precision

Table 1
Xiegu G90, Serial Number X0419350537

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: 0.5 – 30 MHz; transmit, 160 – 10 meter amateur bands.	As specified. On 60 meters, transmit is 5.3305 – 5.405 MHz.
Power requirement: transmit, 8 A maximum; receive, 500 mA maximum, at 10.5 – 16.5 V dc.	At 13.8 V dc: Transmit, 4.4 A typical at maximum RF output, 2.1 A at minimum RF output. Receive, no signal, maximum volume and lights, 558 mA; minimum lights, 540 mA. Power off, 0 mA.
Modes of operation: CW, AM, SSB.	As specified.
Receiver	**Receiver Dynamic Testing**
SSB/CW sensitivity: 1.8 – 2 MHz, 0.35 µV; 2 – 30 MHz, 0.25 µV.	Noise floor (MDS), 500 Hz bandwidth: *Preamp off* / *Preamp on* 1.0 MHz: –128 dBm / –136 dBm 3.5 MHz: –131 dBm / –138 dBm 14 MHz: –132 dBm / –138 dBm 28 MHz: –134 dBm / –139 dBm
Noise figure: Not specified.	Preamp off/on: 14 MHz, 17/8 dB.
AM sensitivity: 0.5 – 2 MHz, 10 µV; 2 – 30 MHz, 2 µV.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz bandwidth: *Preamp off* / *Preamp on* 1.0 MHz: 4.73 µV / 2.04 µV 3.8 MHz: 2.82 µV / 1.49 µV 29 MHz: 2.40 µV / 1.66 µV
ADC overload level: Not specified.	Preamp off/on: –8/–17 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth: *20 kHz offset Preamp off/on* / *5/2 kHz offset Preamp off* 3.5 MHz: 123/121 dB / 123/120 dB 14 MHz: 121/118 dB / 121/108 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset (500 Hz BW): 100/84/84 dB.

ARRL Lab Two-Tone IMD Testing (500 Hz bandwidth)

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*
3.5 MHz/off	20 kHz	–131 dBm	–46 dBm	97 dB
		–97 dBm	–23 dBm	
14 MHz/off	20 kHz	–132 dBm	–37 dBm	95 dB
		–97 dBm	–25 dBm	
14 MHz/on	20 kHz	–138 dBm	–47 dBm	91 dB
		–97 dBm	–14 dBm	
14 MHz/off	5 kHz	–132 dBm	–41 dBm	91 dB
		–97 dBm	–29 dBm	
14 MHz/off	2 kHz	–132 dBm	–42 dBm	90 dB
		–97 dBm	–29 dBm	

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	Preamp off/on, 14 MHz, +39/+47 dBm; 21 MHz, +29/+27 dBm.
IF/audio response: Not specified.	Range at –6 dB points:* CW (500 Hz BW): 495 – 933 Hz; Equivalent Rectangular BW: 442 Hz; USB (2.4 kHz BW): 266 – 2,750 Hz; LSB (2.4 kHz BW): 266 – 2,750 Hz; AM (6 kHz BW): 92 – 3,160 Hz.
Receive processing delay time: Not specified.	8 ms.
Transmitter	**Transmitter Dynamic Testing**
RF power output: 20 W (CW/SSB); 5 W (AM carrier), at 13.8 V dc.	CW/SSB, typically 1.4 – 19 W; AM, 1.4 – 19 W at 13.8 V dc.
RF power output at minimum specified operating voltage: Not specified.	At 10.5 V dc: 1.4 – 15.2 W typical.
Spurious-signal and harmonic suppression: 45 dB.	HF, typically 68 dB; 55 dB (worst case, 160 meters); 50 MHz, 68 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 19 W PEP: –32/–46/–50/–58 dB (HF typical) –29/–43/–44/–48 dB (worst case, 20 m) At 10 W RF output: –34/–39/–45/–56 dB (14 MHz)
CW keyer speed range: Not specified.	5.3 to 57 WPM; iambic mode A and B.
CW keying characteristics: Not specified.	See Figures 4 and 5.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, SSB, 400 ms; CW, 132 ms.
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 60 ms.
Receive processing delay time: Not specified.	8 ms.
Transmit phase noise: Not specified.	See Figure 6.

Size (height, width, depth): 2.0 × 5.5 × 9.8 inches (including protrusions). Weight, 3.6 pounds.

Second-order intercept points were determined using S-5 reference.

*Default values; bandwidth is adjustable.

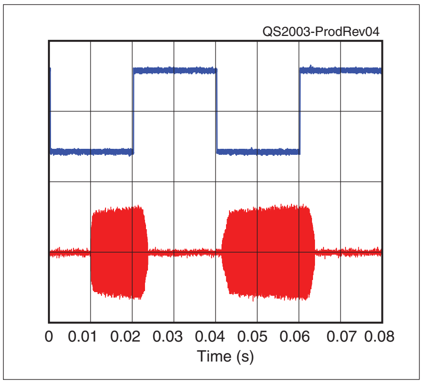

Figure 4 — CW keying waveform for the Xiegu G90 showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 19 W output on the 14 MHz band.

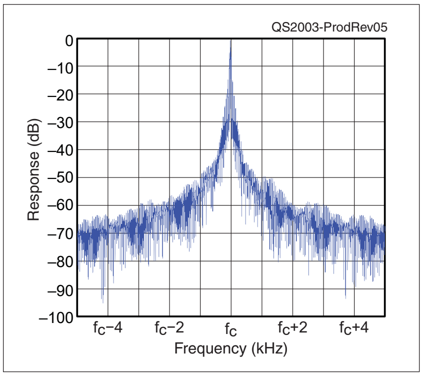

Figure 5 — Spectral display of the Xiegu G90 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 19 W PEP output on the 14 MHz band, and this plot shows the transmitter output ±5 kHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dB.

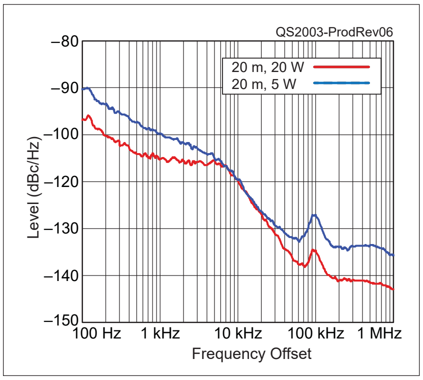

Figure 6 — Spectral display of the Xiegu G90 transmitter output during phase-noise testing. Power output is 19 W on the 14 MHz band (red trace) and 5 W on the 14 MHz band (blue trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier. The reference level is –80 dBc/Hz, and the vertical scale is 10 dB per division.

setup. The full test results are available on the *QST* in Depth web page. From 160 to 40 meters, the loss was negligible (less than 5%) with high-impedance loads up to 400 Ω (8:1 SWR), but was higher with low-impedance loads. On 20 to 10 meters, loss was negligible with most loads from 5 to 200 Ω and just 12 to 14% at 400 Ω.

I also performed open/short circuit testing. I found no instances where the G90 ATU would match an open or short. This implies that the G90 ATU has reasonably low internal losses — obviously a desirable characteristic.

I did find one obscure problem with the G90's antenna tuner operation. On 17 meters, when some reactive loads were tuned to 1:1 with the internal auto tuner, I observed an unstable transmit power variation between about 12 to 20 W. I first found this when using my 43-foot vertical, but then I was able to duplicate it on the bench. Xiegu reported that they had found this issue with some G90 transceivers, and that the problem is resolved in any units shipped after June 2019. MFJ verified the problem, and also verified that recent G90 transceivers no longer have this issue.

Lab Notes: Xiegu G90 HF Transceiver

Bob Allison, ARRL Laboratory Test Engineer

The Xiegu G90 does a fairly good job of handling strong adjacent signals with 108 dB of blocking dynamic range (BDR) at 2 kHz signal spacing. Its two-tone, third-order IMD dynamic range is 90 dB — more than enough for a modest antenna system. Reciprocal mixing dynamic range (RMDR), at 84 dB, is reasonable compared to other portable transceivers we have tested.

The G90 is certainly sensitive when using CW and SSB modes, but it could do a bit better on AM (we like to see 1 μV or better AM sensitivity). The second-order intercept point is lower than average, especially at 21 MHz. This means that it's possible to hear unwanted mixing products when propagation conditions are good and shortwave radio signals are strong. For example, two strong broadcast stations transmitting at 6 and 15 MHz may cause a signal generated inside the G90 to appear at 21 MHz. Audio from both broadcast stations are mixed together into one (false) AM signal.

The G90's transmitter exceeds FCC requirements for harmonic and spurious emission levels. Closer to the intended transmitted signal, CW sidebands are higher than average but will not bother stations on nearby frequencies unless signals are strong. Transmit IMD is higher than we would like to see, but is in line with other low-power transceivers we have tested. Transmit phase noise close to the transmitted signal is also higher than we'd like to see. It is for these reasons that we do not recommend using a power amplifier with this transceiver.

Operating the G90

First, let me state that the display is amazing. As you can see in Figure 3, even though the display is quite small, it is easy to read and provides a tremendous amount of simultaneous information, even showing the signal level in dBm on the spectrum display. I checked the signal level reading against my Elecraft XG3 signal generator, and the G90 displayed levels are quite accurate. The S-meter readings are also quite accurate at reasonable signal levels, dropping 6 dB per S-unit when going from –73 dBm to –107 dBm (S-3 to S-9). The S-meter reads about 20 dB high at a very high –33 dBm signal level (S-9 + 60 dB). Detailed test results are shown in a table on the *QST* in Depth web page.

While the G90 controls and buttons are self-explanatory when used for typical operation, it is worth mentioning some of the controls that have dual or triple functions. The volume control, when tapped, redirects the audio from the internal speaker to the headphone jack and reduces the audio level accordingly. Note that the G90 will not directly drive an external speaker. A powered external speaker will be necessary. An AlexMic G90 is available, which has an amplified speaker built into the mic (see **www.alexloop.com**). This is very similar to the AlexMic for the KX3 and KX2 reviewed in the February 2018 issue of *QST*, but with the correct connectors for the G90.

The multifunction knob, located below the power button, defaults to 100 kHz tuning steps for moving quickly around the bands. A long press on this knob brings up other default functions that can be selected instead — squelch level, power output, keying speed, and FFT scale (band scope display gain). The main tuning knob, when tapped, changes the tuning step from 10 to 100 to 1,000 Hz. The five buttons below the display are clearly marked, and their secondary functions (when the **FUNC** button is tapped) are also clearly marked.

To engage the internal auto tuner, tap the **TUNE** button once. Then press and hold **TUNE** to start the tuning process. When tuning is complete, the radio automatically reverts to receive mode. To disengage the tuner, tap **TUNE** again. Tuning normally takes less than 1 second, and the last tuning solution is remembered for each band.

Tapping the **POW** button once permits you to adjust transmit power with the main tuning knob. Tap the **POW** button a second time and you can set the SWR level that will begin folding back transmit power. A long press of the **POW** button enables an SWR sweep. The default scan width is 150 kHz centered around your receive frequency, but you can also select 300, 450, 600, and 750 kHz sweep ranges. One complete scan takes about 5 seconds, and scanning continues until you press **QUIT**. And finally, if you first tap the **FUNC** button and then tap the **POW** button, you can adjust your microphone gain or select the audio input (microphone or external audio).

Tapping the **LOCK** button sequentially adjusts the display brightness. A long press of the **LOCK** button locks the radio, and another long press will unlock it. Pressing **FUNC** and then tapping **LOCK** permits you to adjust the spectrum display gain (FFT level).

CW Operation

The internal keyer speed range is approximately 5 to 55 WPM. Because I adjust keying speed frequently, I set the multifunction knob default to keying speed. You can select either CW or CWR (reverse) depending on interference conditions. The default CW filter bandwidth is 500 Hz, but you can narrow this all the way down to 50 Hz by pressing the **FUNC F-L** and **FUNC F-H** buttons.

Break-in delay can be set from 0 to 1 second in 100 millisecond increments. However, the delay will never be less than 100 milliseconds because of the SDR signal processing latency, and so the G90 is not capable of full-break-in (QSK) operation. At this time, there are no CW memories. Unlike the X5105 reviewed in the April 2019 issue of *QST*, I found no evidence of key clicks in the G90. The waveform is shaped well enough to avoid this problem.

Clicking from the transmit/receive relay is audible but not objectionable. In the ARRL Lab, Bob Allison, WB1GCM, noted that there are no rubber feet on the bottom of the G90's case, and mechanical coupling between the transceiver and a hard tabletop surface transfers the sound of the relay to the table, making it louder. Adding rubber feet to the bottom cover will reduce this effect.

SSB Operation

SSB operation was almost exhilarating for me. While I can easily make CW contacts at the 5 W QRP level, SSB contacts are much more difficult. However, at the 20 W power level, phone contacts are quite easy to make. The G20 includes a speech compressor which is enabled via a button below the display. And while the compression level is currently not adjustable, the fixed setting works very well.

The default SSB receive filter bandwidth is 2.4 kHz, but you can adjust this using the **FUNC F-L** and **F-H** keys as in the CW mode. I found that the default receive audio passband response was very pleasant to listen to. There is currently no transmit audio equalizer, but the transmit audio is excellent according to reports received during contacts on the air.

Digital Modes

The G90 can be operated with a computer and sound card for FT8, RTTY, PSK, or any of the other popular digital modes. You will need to build or buy an eight-pin mini-DIN radio-to-computer sound card interface cable, or purchase the Xiegu CE-19 Expansion Interface. The interface connections are well documented in the G90 *User Manual*.

Final Thoughts

I found the G90 to be a very enjoyable transceiver to operate. The 20 W transmitter power makes a very big difference when compared to the typical 5 W QRP transceiver, especially for SSB operation. Because of the SDR architecture, we can expect to see more capabilities and features added over time. My only desire would be to have a built-in tilt stand, and maybe an option to give up 160 meters if 6 meters could be included instead. Finally, the Xiegu G90 has a 2-year warranty when purchased through MFJ Enterprises.

Manufacturer: Xiegu Technology Co. Ltd. Distributed and supported in the US by MFJ Enterprises, 300 Industrial Park Rd., Starkville, MS 39759, **www.mfjenterprises.com**. Price: $449.95. CE-19 Expansion Interface, $29.95.

SOTABEAMS Wolfwave Audio Processor

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The Wolfwave Advanced Audio Processor from SOTABEAMS can add selectivity to an existing receiver or transceiver, and it offers a number of other audio processing features as well. It connects to the headphone jack or speaker output and provides processed audio that can be used with headphones or a speaker.

Bottom Line

The Wolfwave Advanced Audio Processor offers a number of ways to add filters, noise reduction, and other features to receivers without those amenities.

Overview

The block diagram for the Wolfwave is simple — audio is fed to an analog-to-digital (A/D) converter, and then it goes to a microprocessor. The processed signal then goes to a digital-to-analog (D/A) converter and then to an audio amplifier connected to the output jacks. The 4 × 3 × 1 inch package is powered by either a USB cable (cable included, without USB power supply) or an external 5.5 to 18 V dc supply. Current draw is approximately 60 mA. We used a 12 V dc wall cube supply.

The Wolfwave is controlled by firmware, which can be updated online using the USB cable. If the USB cable is used to power the unit, the 5 V available in a standard USB connection is fine for headphone use, but it will provide lower speaker output than the 1 W available when using an external power supply of 7 V or more.

The right side panel of the enclosure has a 3.5-millimeter stereo headphone jack and a 3.5-millimeter speaker jack, along with the 2.1-millimeter coaxial dc power receptacle (center pin positive). The left side has the 3.5-millimeter stereo audio input jack and a micro-USB connector. There is also a pushbutton labeled **FIRMWARE** for use during the update process.

One important word of caution — neither side of the speaker can be grounded. The audio amplifier has both output leads floating, and grounding one of them may result in damage to the amplifier. This is important to note if you are using a matching speaker to an older transceiver where one speaker lead is typically grounded to the metal enclosure.

Received audio spectrum and menu commands are shown on a monochrome front-panel display that measures approximately 1⅛ × 11⁄16 inches. A two-color LED is mounted just to the upper left of the display and lights green when a CW signal is detected at the center of the passband. There is no power on/off switch, so you will have to control this function externally.

There are three pushbuttons on the front panel. **MENU** picks the general function you want to select or adjust. **MODE** lets you adjust the selected function and access submenus if available. **HELP** brings up context sensitive information, just as a right click does on many PC applications.

On the bottom of the panel are the audio **VOLUME** control and one labeled **MULTI-USE**. **MULTI-USE** helps select operating mode and menu values (more on this control later).

Using the Controls

I found that there was a bit of a learning curve to be able to rapidly make selections and adjustments using the menus and submenus. The Wolfwave unit has repetitive selection patterns, so with practice, these selections can be made quickly and accurately.

The initial display shows an audio spectrum (100 – 2,700 Hz) with a vertical dotted line in the center representing the filter center frequency. The default is that the band-pass filter is enabled, bandwidth is 2,400 Hz, and the center frequency is 1,500 Hz. To show the general pattern of operation, let's set up a CW filter:

- Rotating **MULTI-USE** (we'll just call it **MULTI**) changes the filter bandwidth in the range of 50 Hz to 5,000 Hz in steps of 10 Hz to 100 Hz depending on bandwidth. You can adjust the width at any time. The display has three ranges, with upper limits of 1,400, 2,700, or 5,000 Hz. It adjusts automatically to the narrowest range that fits the upper edge of the selected passband.
- Press **MULTI** and you will see **CENTRE 1500 Hz** (the default center frequency). Adjust the center frequency by rotating **MULTI** until it matches your preferred CW tone (I like 750 or 800 Hz). Figure 7 shows a 600 Hz filter. You can adjust the filter parameters every time you turn the unit on, store your favorite settings, or select from several preconfigured filters.

To access and adjust other Wolfwave features, the general pattern is:

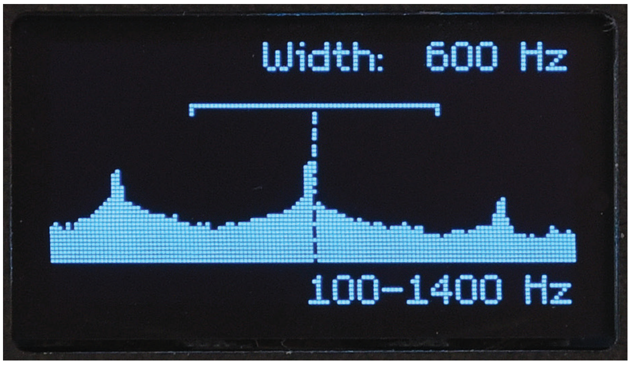

Figure 7 — The Wolfwave set up for a 600 Hz CW filter with a center frequency of 650 Hz.

- Press **MENU** to bring up a list of functions. Scroll through this menu by rotating the **MULTI** control and then press the **MULTI** control to turn a function on and adjust it. As an example, select **NOISE REDUCTION**, and a press of **MULTI** will turn it on and display a sub-menu with several options (including an **ADVANCED** submenu with further options).
- Rotate **MULTI** to highlight the desired parameter, press **MULTI** to select the parameter, and again rotate **MULTI** to adjust the setting.
- Within each submenu, highlight the top line and press **MULTI** to go back to the previous menu.

Within the menu system, pressing **MULTI** and pressing **MODE** usually have the same effect. Pressing **MENU** brings you back to the top-level filter display without having to back out through multiple menu layers.

Testing the Modes and Features

Bypass Function

A long press of the **HELP** button turns off the processing functions. The label **BYP** will appear in the lower left corner. A second press turns processing back on.

Band-Pass Filter

On-the-air testing showed the filter was very sharp and as good as I wanted — as long as the LED on the panel showed green. In addition to experimenting with various SSB bandwidths, I tuned in a strong AM broadcast carrier (S-9 plus) to be just inside the filter passband. Then I slowly turned the transceiver VFO knob to move the carrier out of the filter passband. The carrier quickly dropped to just about S-0. With the tiniest change in transceiver tuning I could manage, the carrier switched between these two values — S-9 and annoying, to S-0 and barely audible.

The Wolfwave offers 14 memories to store band-pass filter settings. Four are preset — wide/narrow for CW and data, and wide/narrow for SSB. The rest are open for your selections, and you can designate a default power-on setting.

A recent firmware addition is **BANDSTOP FILTERING**, which allows the user to set up to 10 notches within the passband. The center frequency and width of each notch is adjustable, and the instructions suggest 100 Hz as the minimum usable width. This might be helpful to reduce unwanted signals within the passband, low-frequency hum, high-frequency hiss, or other irritants. When **BANDSTOP FILTERING** is enabled, any programmed notches are shown in the **BANDSTOP FILTERING** display.

Noise Reduction and Tone Reduction

I tested the **NOISE REDUCTION** function on 75 meters during July, with typical high summer noise levels. Coarse (5% steps) and fine (1% steps) adjustments are available (see Figure 8). I started with the noise reduction level at 50% while listening to my local club net one evening. That level brought minimal improvement. As I increased the setting toward 90%, the noise went down, but the digital artifacts increased (the underwater effect often heard with noise reduction systems). Weaker stations, which I could not really hear in the noise, were reduced to clipped snippets of sound. However, very strong stations became much more readable. At around 75%, the noise was reduced — but not to zero — and the moderately strong stations were easily understandable. For quieter band conditions, settings around 30% reduce the background noise without too many digital effects.

A submode of **NOISE REDUCTION** is **TONE REDUCTION**, where the Wolfwave automatically identifies and notches a steady tone. The **NOISE REDUCTION** mode must be on for **TONE REDUCTION** to work. I tried this function with AM broadcast carriers ranging from S-2 to well over S-9, and the tone was suppressed effectively. Some fuzziness was introduced when the tone was next to the edge of a sideband signal, but that is to be expected.

Hearing Loss Correction

The manufacturer describes this function as applying a gain curve that varies with frequency according to the international standard ISO 7029 (**www.iso.org/standard/42916.html**). From the main menu, select **HEARING LOSS COMP**, and then your gender and age.

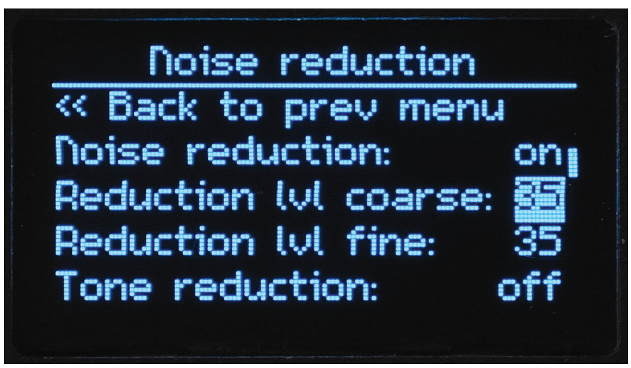

Figure 8 — Setting the Wolfwave noise reduction features.

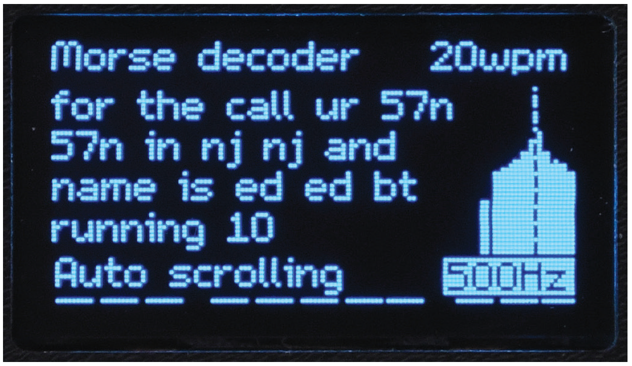

Figure 9 — The Wolfwave Morse decoder screen.

I use hearing aids, so I was very interested in this mode. The instructions also note that if you do use hearing aids, this compensation will not replace the hearing aids. Generally speaking, **HEARING LOSS COMP** adds gain at higher audio frequencies. I removed my hearing aids and set the function for my gender and age. On CW, as expected, I heard no obvious difference because the tone of the CW note was not high (around 800 Hz). Similarly, I didn't hear a noticeable difference while listening on SSB with a filter bandwidth set to 2,300 Hz.

I set the upper limit of the filter bandwidth to 5,000 Hz and tuned in some music on a shortwave broadcast. There was definitely a difference in the high frequencies of the broadcast transmission, but because the bandwidth was limited to 5,000 Hz, I didn't hear a big difference. While this mode appears to work, I didn't find it too useful for typical ham radio modes, which have limited audio bandwidth.

More useful for some operators is the left-right balance control included in a recent firmware update. Accessed from the **OUTPUT SETTINGS** menu, this feature allows increasing the audio level in one ear or the other in ½ dB steps to compensate for differences in hearing.

Morse Code Decoder

Decoded text appears on the display's left side and a audio spectrum scope on the right (see Figure 9). The received signal to be decoded must be centered in the spectrum scope. You can do that by tuning your receiver to the correct pitch, or by turning the **MULTI** knob to match the Wolfwave to the received pitch.

The Wolfwave automatically adjusts to the received CW speed. The default setting allows CW speeds from 5 to 40 WPM, but you can change the limits from 1 to 100 WPM. The detection threshold can be changed as well, which helps with false decodes from noise.

I found the decoder to be very accepting of off-frequency tuning — the pitch just has to be close to the incoming signal. In addition to showing decoded text, dots and dashes are shown at the bottom of the screen and the measured code speed in words per minute on the top left corner. If the band is noisy, try raising the decoder threshold from its factory setting of 3 dB to perhaps 8 or 10 dB.

CW Regen

CW regeneration is a function that I have not seen for a long time. Many years ago, the National Company included a function called *Select-O-Jet* in several of its receivers. The circuit gave positive feedback on a selected frequency, and in the presence of noise or other signals, the selected tones would be boosted by the function.

In the Wolfwave, this experimental function detects the dits and dahs in the received signal and regenerates the CW signal with a clean sine wave and no noise. The CW tone to be regenerated must be in the center of the passband, and the trigger level point can be adjusted from 1 to 30 dB. The output (regenerated) tone can be set to be identical to the input CW tone or offset from it. With a stereo headset, you can listen to the received signal in one ear and the regenerated CW tone in the other.

For the regenerator to work, I had to carefully set the band-pass center frequency to the CW tone I use, and to carefully limit the input signal to the green LED range. The CW regenerator works well, but tuning is critical. Any attempt to change the receiver frequency by a tiny amount almost always resulted in loss of copy, requiring shutting the regenerator off and resetting the receive frequency.

Audio Test Generator

Under **UTILITIES** on the main menu, there is a selection to generate tones. Turning this on brings up an audio generator with the output selections of sine wave, triangle wave, square wave, and two-tone. Each of these can be set to a selected amplitude and frequency.

Support and Firmware Updates

The Wolfwave package does not include a printed manual, but detailed information about setup and operation may be found on the SOTABEAMS website, as well as a website dedicated to this product (**www.wolfwave.co.uk**). In addition to written instructions, there are tutorials and links to helpful videos.

SOTABEAMS offers accessories and replacement cables for the Wolfwave. One that may be useful is an audio ground loop isolator, which can reduce or eliminate hum from ground loops. This isolator plugs in between your transceiver and the filter, breaking the ground loop.

Firmware updates may be downloaded, along with Windows software and drivers needed for the process. The Wolfwave website offers well-illustrated, step-by-step instructions, as well as a video demonstrating the update process. New firmware with added features was released several times during the review period, so it's a good idea to check periodically for updates.

Manufacturer: SOTABEAMS, Macclesfield, United Kingdom; **www.sotabeams.co.uk** or **www.wolfwave.co.uk**. Distributed in the US and Canada by DX Engineering, 1200 Southeast Ave., Tallmadge, OH 44278; **www.dxengineering.com**. Price: $275.99.

Inexpensive Antenna System Tuning Indicators

Reviewed by Paul Danzer, N1II
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We looked at three inexpensive kits intended to simplify the sometimes-tedious process of adjusting an antenna or antenna tuner for a match that the transmitter can handle. The measuring circuit used in all three kits is a modified Wheatstone bridge. More information on the circuits may be found on the *QST* in Depth web page (**www.arrl.org/qst-in-depth**).

Table 2
Feature Comparison

	QRP Guys	HecKits	TennaDipper II
3 – 30 MHz range	Y	Y	Y
Counter function	N	Y	N
Signal generator output	N	Y	Y
Prepared case	N	Y	N
9 V battery needed	N	Y	Y
50 Ω test load supplied	N	Y*	Y*
Filter for signal generator	N/A	Y	Y
10 MHz counter time base	N/A	Y	Y

*The HecKits load is built into a BNC connector. The TennaDipper II includes a 49.9 Ω resistor.

Bottom Line

All three units reviewed here can help you to adjust an antenna or antenna tuner for minimum SWR by adjusting for minimum brightness on an LED. They are small, light, simple to use, and are well suited for portable operation.

QRPGuys LED Tuning Indicator

The LED Tuning Indicator from QRPGuys is the simplest and least expensive kit here. Designed to be used with a QRP transmitter (5 W CW or 10 W PEP maximum), this 1⅝ × 1¼ inch board is placed between the transmitter and antenna tuner or antenna (see Figure 10). The input and output BNC connectors mount directly on the board. Keep transmissions short while using the tuning indicator to find a match, and if possible, reduce power until the antenna or tuner is adjusted to a low SWR.

Construction is straightforward with step-by-step, well-illustrated instructions. The polarity of diode D2 is critical and is shown clearly in the manual. The tuning indicator is designed so that the male BNC connector can mount right on your radio's BNC antenna jack, and the antenna feed line connects to the female BNC jack on the other side. The pin spacing is different for the two connectors, so you cannot interchange them.

A toroidal core is wound as an autotransformer with 25 turns, tapped at 5 turns. An LED shows reflected power — the brighter it lights, the greater the reflected power. The LED and the transformer can be mounted on either side of the board, with the LED facing forward (toward your radio) or on the other side of the board, visible from the back.

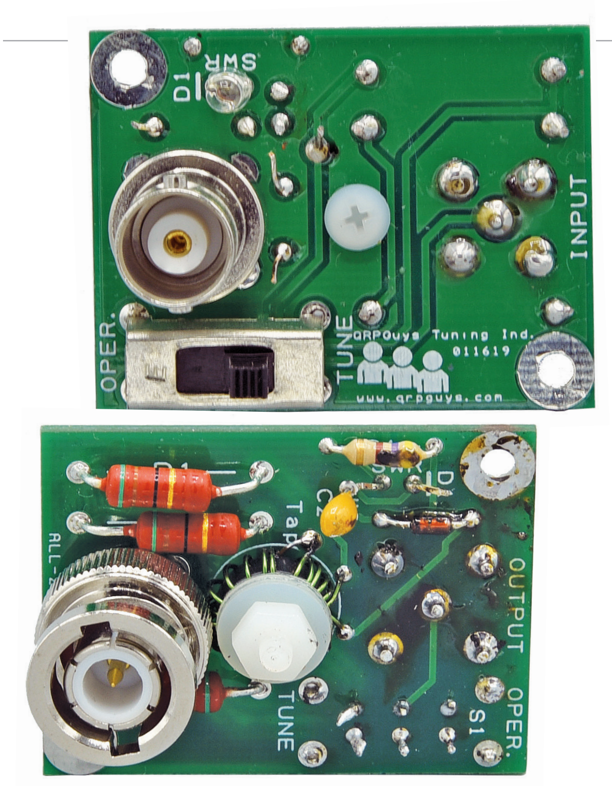

Figure 10 — The QRPGuys LED Tuning Indicator requires no external power source. The input (male) BNC connector is shown here on the component side of the board, with the output BNC connector, indicator LED, and **BYPASS** switch on the other side. The board is intended to mount directly on the antenna jack of the companion QRP transceiver.

The **TUNE**/**OPERATE** slide switch places the tuning indicator in the feed line path, or bypasses it for operation once tuning is finished. The assembly manual notes that with the switch in the **TUNE** position, the transmitter power is reduced by a factor of four at the output jack (for example, 1.25 W output with a 5 W transmitter). At full LED brilliance, the SWR is 4:1 or greater. The LED goes out at 1:1 SWR, and at half brilliance, the SWR is about 2:1. Note that this device offers no guidance on which way to adjust the antenna system for best match. If the SWR is high, some experimentation is required while watching for the LED to dim.

My 5 W QCX QRP transceiver had more than enough power to light the tuning LED, so it was clearly visible in bright daylight. This radio has the antenna BNC connector on the side of the case and is only 1⅝ inch high, so the tuning LED could have been mounted on either side of the board and been very visible.

The QRPGuys LED Tuning Indicator is an inexpensive, lightweight, and compact companion for a portable station without an SWR/power meter built into the transceiver or antenna tuner.

Manufacturer: QRPGuys, **qrpguys.com**. Price: $20 plus shipping.

HecKits 50 Ω Bridge/Frequency Counter

The HecKits bridge (see Figure 11) includes a frequency counter and generates a low-level signal from 3 to 30 MHz, so it can be used to adjust an antenna or antenna tuner without transmitting a signal. It's powered from a 9 V battery and fits in a precut 5½ × 2½ × 1 inch plastic box.

The parts to be assembled mount on a single PC board, which is connected to the pre-assembled display module by two ribbon cables (see Figure 12). The builder does have to solder the ribbon cables to the display board. The boards mount in the case with *very* small nuts, but a tiny nutdriver is supplied.

Assembly is straightforward. Although I found the written instructions in the assembly manual unclear in spots, the illustrations filled in the gaps. The transistors require bending the center lead away from the flat side to fit the mounting holes. Carefully check the LED to find its polarity. You have to wind a toroid core for the transformer. The winding instructions are very good, but you may want to do the five-turn winding before the 30-turn winding.

I widened the three switch holes in the case with a ⁵⁄₁₆-inch drill to provide a bit more clearance for the switches with their caps in place. The on/off slide switch is on the left side. The BNC connector used for the feed line is on the top. The two blue pushbutton switches below the display are used to select the frequency counter or SWR indicator function. Both buttons have to be in the up position for the frequency counter, and both down for the SWR indicator. The LED under the left switch is the SWR indicator.

The black knob on the right side is the shaft of a 30-turn potentiometer to adjust the frequency. According to HecKits, the small knob shown in Figure 11 has been replaced by a larger, easier-to-use knob in kits that are currently shipping. Frequency coverage is in two segments (3 – 12 MHz and 11 – 30 MHz) and is set by the lower blue pushbutton. The frequency readout is a two-line, eight-digit LCD module. A small variable resistor on the circuit board adjusts the brightness.

To find the resonant frequency of an antenna system, connect the feed line to the BNC jack. Set the device to bridge mode and adjust the potentiometer until the LED extinguishes. At that point, the SWR is 1:1 and the frequency is shown on the display. Alternatively, set the HecKits bridge to the desired frequency and adjust the antenna or tuner until the LED goes out. The kit includes a 50 Ω dummy load mounted in a

BNC connector to make testing the bridge and understanding operation easier.

By noting an antenna's resonant frequency on the display, you can try lengthening the antenna if it is resonant higher than the desired frequency, or shorten the antenna if it is resonant below the desired frequency. Adjusting an antenna tuner will require some experimentation.

To use the device as a frequency counter, set both blue pushbuttons to the up position and connect the signal to be measured to the BNC jack. Be careful to keep the applied signal to less than 100 mV.

Figure 11 — The HecKits 50 Ω Bridge/Frequency Counter is mounted in a plastic case with a two-line by eight-character LCD.

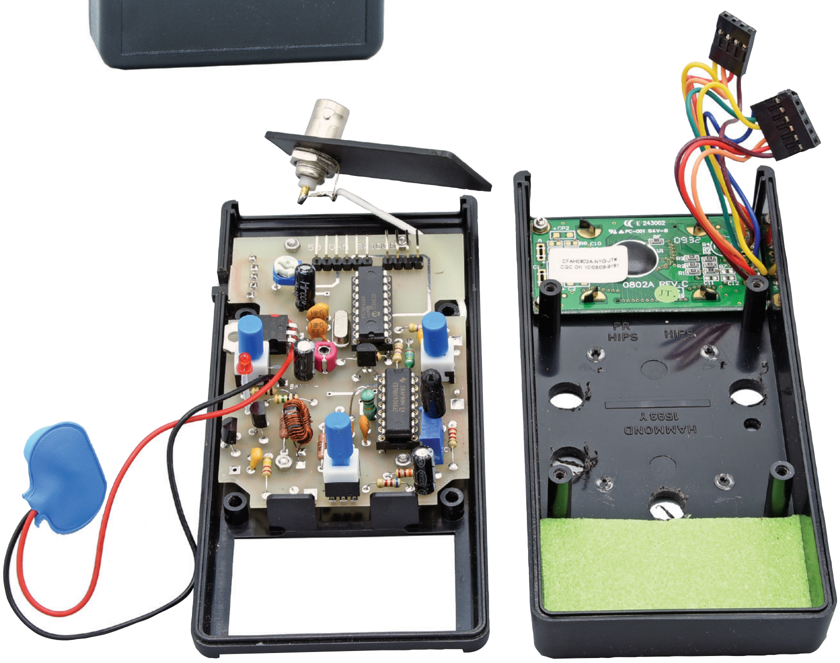

Figure 12 — The builder assembles the main HecKits PC board (on the left) and then connects it to the pre-assembled display board with two ribbon cables.

The test signal generated for the SWR indicator is a square wave that goes through a minimal filter. The output is not a single-frequency signal, but has harmonic components — generally odd harmonics for a square wave. While trying to find the resonant points of a triband Yagi, I found a number of resonances outside the ham bands. Some of these may have been due to the harmonics from the signal generator. Although it's not discussed in the manual, this device can be also used as a simple signal generator to see if a receiver is working.

Manufacturer: HecKits, 1302 Highland Dr., Cedar Park, TX 78613; **heckits.com**. Price: $85, plus $7.90 shipping.

Pacific Antenna TennaDipper II

The TennaDipper II is similar to the HecKits unit, but it uses an LED rather than LCD frequency display (see Figure 13). The case measures approximately 4½ × 2¾ × 1 inches. The four-digit frequency display shows through a window on the front panel, and like the other two units, the **MATCH** LED goes out when the connected load is close to 50 Ω (1:1 SWR).

For construction, you will need a pair of tweezers. A surface-mount IC is used as the voltage regulator. The simple instructions for mounting it are quite clear, but you will want to use something other than your finger to hold it in place while soldering.

All parts mount on a single PC board (see Figure 14). The board is very well made, with an excellent solder mask to prevent solder bridges. The pushbutton switches, **POWER** and **RANGE**, are not square. If a switch does not fit easily, rotate it 90 degrees. As with the HecKits unit, you will need to wind a toroid core for the transformer. I wound the five-turn segment first, leaving the rest of the toroid for the 30 turns. To make sure that the **MATCH** LED can be seen through the hole in the front panel, it must be raised off the board before soldering.

The kit includes a blank plastic enclosure and front-panel decal, but the builder needs to make the holes for the switches, BNC connector, and display. The PDF with the manual devotes six pages to the case preparation, including a page with a 1:1 template for the cutouts.

Figure 13 — The TennaDipper II in its plastic case. The controls are nicely labeled with a decal that covers the whole front panel. The builder needs to carefully cut and drill the case for the display and controls, as described in the text.

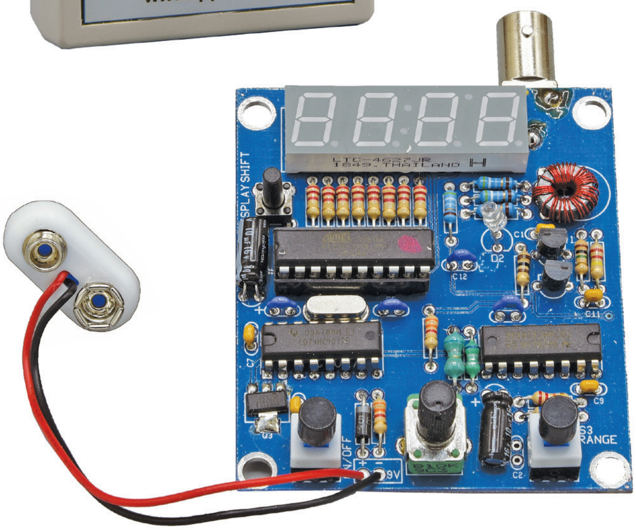

Figure 14 — The completed TennaDipper II board before mounting in the case. All components are mounted on the board, and the controls and display must carefully line up with cutouts in the case.

Before drilling the case, check the printed template carefully to make sure it is the correct size. The manual recommends using a step drill bit, and that worked well. You have to drill it perfectly to use the hole sizes shown on the template. I ended up making the holes one step larger than specified to get the buttons to operate smoothly.

More difficult was getting a good clean cut in the front panel decal, even with a Mazor knife with a fresh blade. The instructions recommend using a hole punch for best results.

Operation is similar to the HecKits unit, except the TennaDipper II does not function as a frequency counter. Connect the antenna or antenna tuner to the BNC connector. Frequency is controlled by the single-turn **TUNE** knob. The **RANGE** switch toggles between 3 – 11 MHz and 10 – 30 MHz. Pressing the **DISPLAY SHIFT** switch changes the display from frequency in MHz with 10 kHz resolution to frequency in kHz with 100 Hz resolution. The **MATCH** LED brightness dips as the SWR goes down, and it is very dim or completely out when the SWR is 1:1.

You can see whether to lengthen or shorten an antenna by noting its resonant frequency on the display. With an antenna tuner, you will need to experiment with different settings to find a good match.

As with the HecKits unit, you can use the TennaDipper II as a simple signal generator. The square wave output is somewhat rounded by two single-stage L filters, but the output does have harmonics.

Excepting for my difficulty preparing the case, I found the instructions and illustrations very clear, and the result is a very nicely designed and packaged instrument.

Manufacturer: Pacific Antenna, P.O. Box 10301, Fayetteville, AR 72703; **www.qrpkits.com**. Price: $45 plus shipping.

New Products

SOTABEAMS 2-Meter Band-Pass Filter

Designed and manufactured by SOTABEAMS, this band-pass filter is intended for use with handheld transceivers in areas with multiple transmitters, such as during hilltop or mountaintop operations. The filter offers SMA female connectors at both ends and is rated for 5 W at a 30% duty cycle and 2 W continuous. The filter bandwidth is 144 to 148 MHz with attenuation of up to 70 dB outside of the passband. $49.95; **www.sotabeams.co.uk**.