Mark J. Wilson, K1RO, k1ro@arrl.org

Product Review

Xiegu G90 HF Transceiver

Reviewed by Phil Salas, AD5X
ad5x@arrl.net

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.

Reprinted with permission; copyright ARRL.

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.

Reprinted with permission; copyright ARRL.

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 –97 dBm	–46 dBm –23 dBm	97 dB
14 MHz/off	20 kHz	–132 dBm –97 dBm	–37 dBm –25 dBm	95 dB
14 MHz/on	20 kHz	–138 dBm –97 dBm	–47 dBm –14 dBm	91 dB
14 MHz/off	5 kHz	–132 dBm –97 dBm	–41 dBm –29 dBm	91 dB
14 MHz/off	2 kHz	–132 dBm –97 dBm	–42 dBm –29 dBm	90 dB

Reprinted with permission; copyright ARRL.

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.	

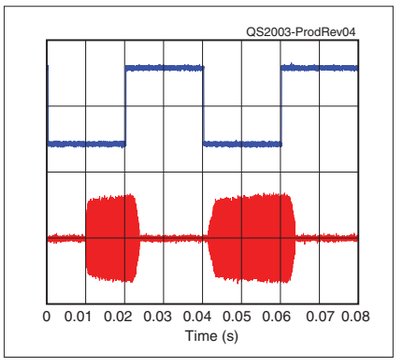

Figure 4 — CW keying waveform for the Xiegu G90 showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions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

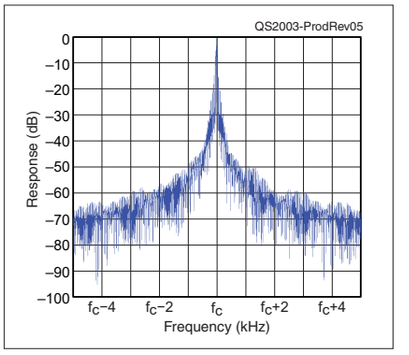

Figure 5 — Spectral display of the Xiegu G90 transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 19 W PEP output on the 14 MHz band, 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.

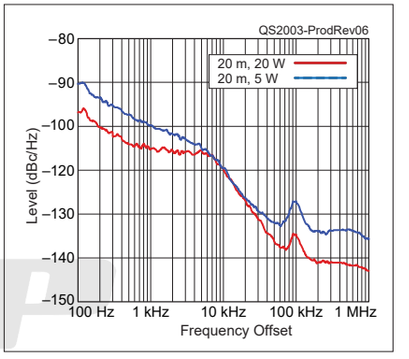

Figure 6 — Spectral display of the Xiegu G90 transmitter output during phase-noise testing. Power output is 19 W on the 14 MHz band (red trace) and 5 W on the 14 MHz band (blue trace). The carrier, off the left edge of the plot, is not shown. This plot shows phase noise 100 Hz to 1 MHz from the carrier.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

Reprinted with permission; copyright ARRL.

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

Reprinted with permission; copyright ARRL.

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.

PILEUP
XIEGU.EU

Reprinted with permission; copyright ARRL.