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ELAD FDM-DUO SDR HF and 6 Meter Transceiver

Use it as a standalone QRP transceiver or with the companion SDR software.

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The ELAD FDM-DUO is a software defined radio (SDR), although you wouldn't know it at first glance. Even after switching on the FDM-DUO and trying the various features, you still might not guess that you're using an SDR.

The FDM-DUO seems like most other compact low-power (QRP) transceivers. There is an LCD display on the front manual, along with a sizable VFO knob, a volume control (labeled E1), headphone and auxiliary audio output jacks, and buttons labeled A/B, V-M, M-V, MODE, and MENU. So far, so good — nothing out of the ordinary for a multimode 160 through 6 meter transceiver.

When you flip the FDM-DUO around and look at the rear panel, however, you quickly realize that this radio is far from ordinary, as shown in Figure 1. The rear panel is crowded with a dozen ports, including three USB jacks, an RJ-45 microphone jack, two SO-239 antenna ports, two SMA RF in/out ports, a female DB-9 connector, ⅛-inch PTT and CW key ports and, of course, a coaxial dc power jack. The three USB jacks alone are dead giveaways that this transceiver is designed with computer interfacing in mind.

The ELAD FDM-DUO is a direct-sampling SDR, which means that it digitizes all signals from 10 kHz to 54 MHz, right at the antenna input. Once the RF is converted to data, it can be processed in almost every way imaginable. The result is razor-sharp filtering, good dynamic range, and extraordinary flexibility. The only remaining question is how one goes about using the FDM-DUO: As a traditional standalone radio, or as a device attached to a computer.

The FDM-DUO as a Standalone Transceiver

The SDR aspects notwithstanding, it is important to stress right away that the FDM-DUO *does not require a computer to function*. You can enjoy many of the benefits of this radio without ever connecting it to a PC.

You begin by turning on the rig with the rear-panel slide switch. The display glows immediately, but you have to wait 20 seconds for the radio to fully "boot up."

As you explore its capabilities, you find that the FDM-DUO is rated for a maximum output of 5 W on SSB, CW, FM, and AM from 160 meters through 6 meters. In case you

Bottom Line

The ELAD FDM-DUO is not your typical QRP transceiver. It's a software defined radio (SDR) that can be operated as a standalone transceiver, or connected to a computer running companion software for the full SDR experience.

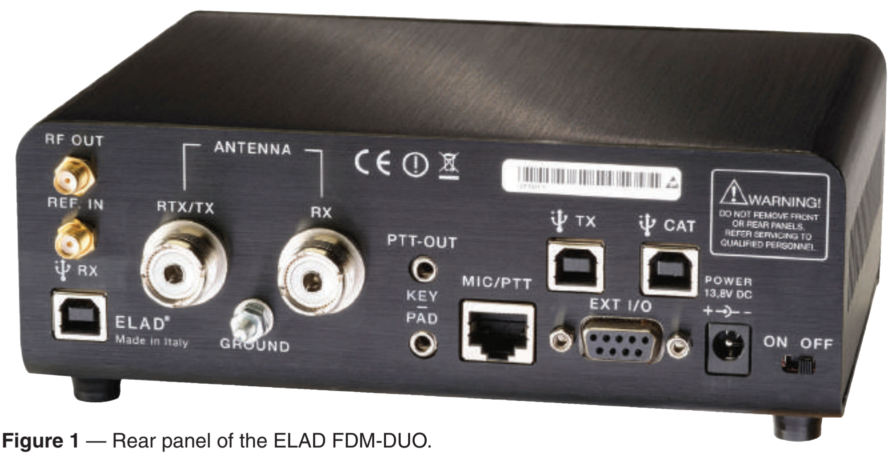


Figure 1 — Rear panel of the ELAD FDM-DUO.

want to use the FDM-DUO with a VHF+ transverter, it includes a convenient SMA jack with just 1 mW output. There are also two SO-239 antenna ports: one for transmit/receive and the other for receive only.

For CW enthusiasts, the FDM-DUO provides a CW keyer function, as well as up to 10 CW message memories and a CW decoder. The decoder feature is clever. When enabled, you see nothing on the LCD display (other than the usual frequency, signal strength, and so on) until you happen to tune across a CW signal. If the signal is sufficiently strong, the FDM-DUO will automatically attempt to decode it, forming a stream of characters moving from right to left across the display. Of course, like all software CW decoders, the FDM-DUO's accuracy depends on the strength of the received signal and the sending ability of the person at the other end of the path. As you'd expect, if the sending operator is using a keyer or keyboard, and the signal is reasonably strong, the FDM-DUO can decode quite well.

Navigating the FDM-DUO's many features takes a bit of practice. Accessing and adjusting various functions requires you to not only twist the knobs, but press them as well. For example, if you want to switch from 20 meters to 6 meters, you need to press the large VFO knob and then use it to change the tuning step to a larger value so that you can change frequencies quickly. There is no "band" button like you are probably accustomed to seeing on other transceivers. Also, when you're not using E1 as a volume control, you can press it repeatedly to toggle between AGC, noise blanker, squelch, noise reduction, and auto-notch functions. Once you see the function you desire, twist the E1 knob to step through the settings. The E2 knob, directly below, works in the same fashion. In its default function, however, a twist of E2 steps through the filter settings (down to 100 Hz when you're in the CW mode).

The FDM-DUO has two VFOs, and switching from one to the other requires only a press of the A/B button. You can also store frequencies and modes in memory and access them with a push of their respective buttons.

Once I became accustomed to the FDM-DUO's knobs and menus, it was a fun little rig to operate on a standalone basis. As you'll see in the accompanying ARRL Laboratory test results, the transmit signal is clean with low phase noise, low transmit IMD, and good keying sidebands. Spectrally, the transmitter is exceptionally clean with very low harmonic levels.

Overall, the FDM-DUO's receive performance was fine. It was interesting to note that its third-order IMD performance actually *improved* when band activity and signal strengths were high.

Finally, if you're using the FDM-DUO as a standalone transceiver, you'll definitely want to invest in a set of headphones or an external speaker. The internal speaker is extremely

Table 1
ELAD FDM-DUO, firmware version 4.48, serial number n/a

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0.01 – 54 MHz; transmit, 160 – 6 meter amateur bands.	Receive, as specified, transmit as specified except 60 meters.
Power requirement: Transmit, <2.2 A; receive, <500 mA at 13.8 V dc ±10%.	At 13.8 V dc: transmit, 2 A (typical); receive, 520 mA.
Modes of operation: SSB, CW, AM, FM.	As specified.
Receiver	**Receiver Dynamic Testing**
Sensitivity: Not specified.	Noise floor (MDS), 500 Hz bandwidth: 0.137 MHz –124 dBm 0.475 MHz –133 dBm 1.0 MHz –133 dBm 3.5 MHz –133 dBm 14 MHz –133 dBm 50 MHz –129 dBm
Noise figure: Not specified.	14 MHz, 14 dB; 50 MHz, 18 dB
Spectral sensitivity: Not specified.	100 kHz screen bandwidth: panadapter, –130 dBm; waterfall, –135 dBm.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1-kHz, 30% modulation, 6 kHz bandwidth: 1.0 MHz 2.06 µV 3.8 MHz 2.14 µV 50.4 MHz 3.46 µV
FM sensitivity: Not specified.	FM (12 dB SINAD): 29 MHz, 1.26 µV 52 MHz, 1.62 µV.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz bandwidth: *20 kHz offset* / *5/2 kHz offset* 3.5 MHz 124 dB 119*/104* dB 14 MHz 124 dB 123*/106* dB 50 MHz 116 dB 116/110* dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 110/107/104 dB

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

Band/Preamp	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR*†
3.5 MHz	20 kHz	–133 dBm –97 dBm	–34 dBm –19 dBm	99 dB
14 MHz	20 kHz	–133 dBm –97 dBm	–34 dBm –18 dBm	99 dB
14 MHz	5 kHz	–133 dBm –97 dBm	–34 dBm –19 dBm	99 dB
14 MHz	2 kHz	–133 dBm –97 dBm	–34 dBm –18 dBm	99 dB
50 MHz	20 kHz	–129 dBm –97 dBm	–34 dBm –24 dBm	95 dB

Second-order intercept point: Not specified.	14 MHz, +67 dBm; 21 MHz, + 67 dBm; 50 MHz, +65 dBm

Manufacturer's Specifications	Measured in the ARRL Lab
DSP noise reduction: Not specified.	11 dB.
FM adjacent channel rejection: Not specified.	29 MHz, 75 dB; 52 MHz, 73 dB.
FM two-tone third order dynamic range: Not specified.	20 kHz spacing: 29 MHz, 75†† dB; 52 MHz, 73†† dB; 10 MHz spacing: 29 MHz, 83 dB; 52 MHz, 79 dB.
Audio output: Not specified.	265 mW at 6.5% THD into 8 Ω. THD @ 1 V_{RMS}, 1.6%.
Squelch sensitivity: Not specified.	29 MHz, 0.4 µV; 52 MHz, 0.63 µV.
S-meter sensitivity: Not specified.	S9 signal: 14 MHz, 53 µV; 50 MHz, 32.7 µV.
IF/audio response: Not specified.	Range at –6 dB points‡: CW (500 Hz): 400-900 Hz (500 Hz); Equivalent Rectangular BW: 499 Hz; USB (2.4 KHz): 185-2450 Hz (2265 Hz); LSB (2.4 kHz): 185-2450 Hz (2265 Hz); AM (10 kHz): 220-5030 Hz (9640 Hz).

Transmitter	Transmitter Dynamic Testing
Power output: 5 W nominal.	0.15 to 8 W typical.
Spurious-signal and harmonic suppression: >60 dB.	HF: >70 dB typical, 67 dB worst case (10.1 MHz); 71 dB (50 MHz). Complies with FCC emission standards.
SSB carrier suppression: >80 dB.	>70 dB.
Undesired sideband suppression: >80 dB.	>70 dB.
Third-order intermodulation distortion (IMD) products: Not specified.	3rd/5th/7th/9th order, 8 W PEP: HF: –39/–55/–62/<–70 dB (typical) –33/–49/–57/–65 dB (worst case, 15 m) 50 MHz: –28/–49/–57/<–60 dB
CW keyer speed range: Not specified.	4.5 to 92 WPM, iambic modes A and B.
CW keying characteristics: Not specified.	See Figures 2 and 3.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S9 signal, AGC fast, 52 ms.
Receive-transmit turn-around time (tx delay): Not specified.	SSB, 18 ms; FM, 42 ms.
Composite transmitted noise: Not specified.	See Figure 4.

Size (height, width, depth, including protrusions): 2.7 × 7.1 × 6.2 inches. Weight: 2.4 lbs.

Price: $1280.

*No blocking occurred up to the point of ADC overload.
†IMD DR values are best case. Third-order two-tone dynamic range depends on band activity and signal strengths. See *QST* February 2010, page 52 for an explanation. Second-order intercept points were determined using S5 reference.
††Measurements were phase noise limited at the value indicated.
‡Default values; bandwidth is adjustable via DSP.

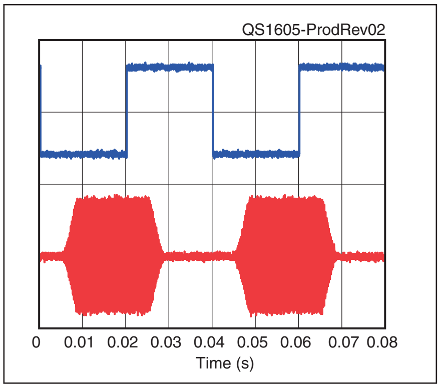


Figure 2 — CW keying waveform for the ELAD FDM-DUO showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 5 W output on the 14 MHz band.

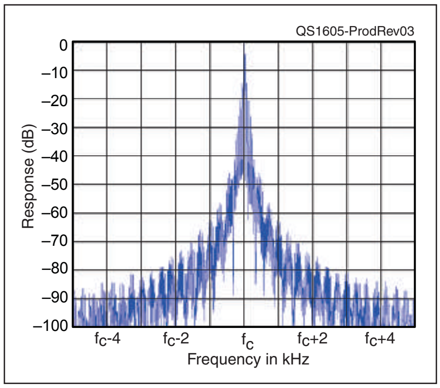


Figure 3 — Spectral display of the ELAD FDM-DUO transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 5 W PEP output on the 14 MHz band, 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.

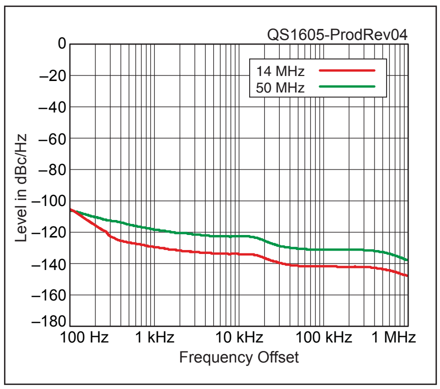


Figure 4 — Spectral display of the ELAD FDM-DUO transmitter output during phase noise testing. Power output is 5 W on the 14 MHz band (red trace) and 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is 0 dBc, and the vertical scale is in dBc/Hz.

small and quite "tinny." It cannot reproduce lower frequency audio, so everything you hear is concentrated at the high end with the thin, hissing sound you'd expect.

Connecting a Computer

Despite the FDM-DUO's excellent standalone functionality, the rig really shines when you connect it to your computer.

"Connect" is the operative word in this instance. As I mentioned earlier, there are three USB ports and the transceiver arrives with three USB cables. You'll need to use at least one of them to interface the FDM-DUO to your computer for receiv-

Figure 5 — The primary *FDM-SW2* software display. Note the color-coded bars in the spectral display. Each one represents a separate receiver.

ing, and possibly all three depending on how much you want to expand your transmit capabilities.

But first, you must load the *FDM-SW2* software, which arrives on a CD-ROM. (The software is also downloadable from ELAD's website.) If your computer doesn't already have Microsoft *NET* installed, or the *VC++* runtime libraries, you may need to install them separately. The instruction manual describes how to do this.

My station computer runs *Windows 10* and I already had the latest version of *NET* installed, as well as the *VC++* libraries. So, all I had to do was run *SETUP* from the CD-ROM and *FDM-SW2* installed smoothly with no hiccups.

My first exercise involved attaching a USB cable to the RX port at the lower left corner of the FDM-DUO's rear panel. As soon as I inserted the plug, my computer searched for the appropriate driver and installed it.

Starting the *FDM-SW2* software, I was presented with an attractive screen filled with buttons and several displays. When I clicked my mouse on the POWER button, everything came to life.

The FDM-DUO handles all signal processing and includes its own sound device, so the load on your computer

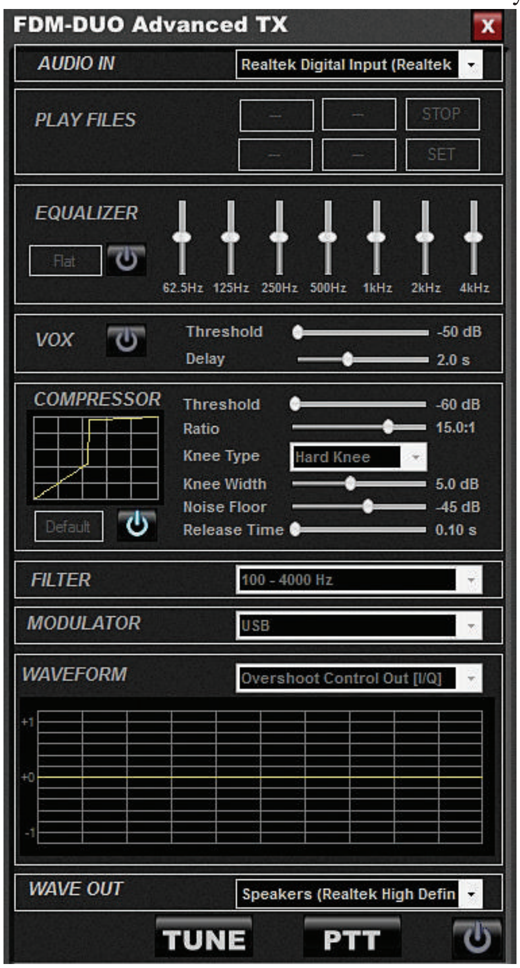


Figure 6 — The "Advanced" window gives you access to functions such as transmit audio equalization, VOX, speech compression, and more.

is very low. My station PC isn't a processing beast, and yet the FDM-DUO required only about 5 to 9% of its CPU resources. This means you will probably see acceptable results even with older *Windows* PCs and laptops. (There is also *Linux* software for the FDM-DUO, but I did not test it for this review.)

You can adjust a number of display parameters, but I found that I enjoyed the default view with the waterfall display on top of the spectral window as shown in Figure 5. The default mode allows you to activate as many as four separate receivers and each is color-coded to keep confusion to a minimum. You can listen to all four receivers simultaneously, if you wish, although the results can be chaotic to say the least.

If you really want to push the reception envelope, you can click the SET button, and then click the ADVANCED tab. In this screen you can select the FDM-DUO "standalone and double channels data acquisition" mode. After you exit (and after the radio resets), you're in dual-channel mode. Click on the CH2 button in the primary display and, after a slight delay, you're presented with a duplicate *FDM-SW2* screen. Between these two "channels" you can configure up to eight separate simultaneous receivers. My monitor and graphics card would only allow me to display seven receivers (and even those only partially). If you own more capable hardware, you'll be able to see all eight receiver displays and both primary channel displays.

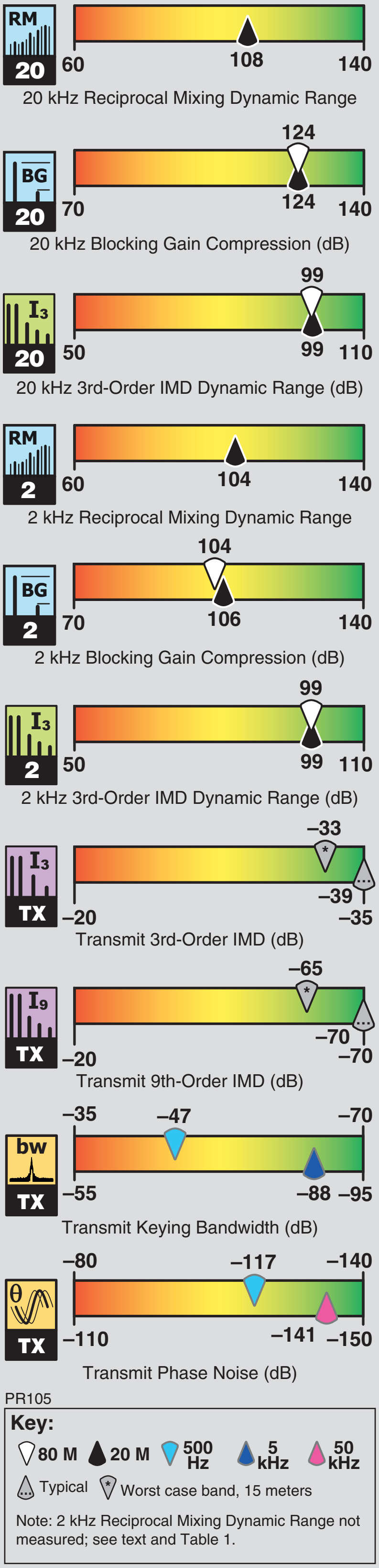
The *FDM-SW2* offers an astonishing number of reception modes including synchronous AM and Digital Radio Mondiale (DRM). The DRM mode includes a separate window you can toggle to see a DRM broadcast schedule and a small INFO window that indicates DRM decoding status.

FDM-SW2 also includes the ability to record everything within the selected passband as an SDR WAV file that you can load and explore later. There is a log function and even an ample set of memories.

Tuning the FDM-DUO within the software is as easy as clicking and dragging the coarse or fine frequency bars below the spectral display window. Alternatively, you can just double-click on the numeric frequency display at

Key Measurements Summary

ELAD FDM-DUO SDR HF and 6 Meter Transceiver



Changes to the Key Measurements Summary

This month, we introduce several changes to the Key Measurements Summary chart for HF transceivers. We have added bars for transmitted CW keying sidebands and transmitted phase noise, which are important parameters of transmission quality, in addition to transmitted intermodulation distortion (IMD) products on SSB. The ranges for these new Key Measurements were determined from data of 30 transceivers tested from 2008 to the present.

Over the past decade, we have seen substantial improvements in receiver technology in terms of dynamic range — the ability to perform well in a band crowded with strong signals. However, the best receiver cannot remove interference created by the poor transmission quality of an adjacent signal. High levels of IMD products caused by poor transmitter design or improper adjustment causes SSB splatter on both sides of the intended transmitted spectrum, interfering with others on nearby frequencies. Strong keying CW sidebands from an adjacent transmitter can cause a thumping sound in the speaker, with or without key clicks. High levels of transmitted phase noise add to the background noise level, masking signals that would normally be audible.

The transmitter Key Measurements give an indication of the overall cleanliness of the transmitter. As with the receiver dynamic range measurements, more detailed information is available in the accompanying table of tests performed in the ARRL Lab. We will also continue to publish the detailed plots showing keying waveform, keying sidebands, and transmitted phase noise.

Note that high keying sideband levels are mainly caused by little or no rise and/or fall time (≤1 millisecond) on the keying waveform. A transmitter with a 1 millisecond of rise and/or fall time will create key clicks and keying sidebands that are 35 dB down and 500 Hz away from the carrier and will likely interfere with neighboring stations. The Lab tests transceivers with default settings, but some radios that are very clean at default settings can be adjusted for rise/fall times that increase the keying sidebands significantly.

You may also notice we are no longer publishing third-order intercept point data for receivers. Technology has changed, and most modern receivers do not have a 3:1 ratio between the IMD signal level and the IMD input level. This ratio can be significantly higher or lower than 3:1. Since the IP3 figure is mathematically based on a 3:1 ratio, publication of this data would be meaningless. Instead, pay attention to the three dynamic ranges — IMD, blocking, and reciprocal mixing. The lowest of these three dynamic ranges represents the limiting dynamic range of the receiver. — *Bob Allison, WB1GCM, ARRL Assistant Laboratory Manager*

the top and a window will appear with a numeric entry pad.

In addition to receive control, the *FDM-SW2* software offers transmit control. You must have the CAT USB line connected to use this feature. Clicking on TX for the chosen receiver displays three buttons that you can use to select your transmit audio source. You can also open an Advanced window (see Figure 6) that features transmit audio equalization controls, adjustable speech processing, VOX control, and a button to toggle the PTT (push-to-talk line). For SSB operating, I used the supplied hand mic rather than software control, but the software functions are ideal for remote-control applications. In fact, *FDM-SW2* includes a remote server for control over the Internet.

If you enjoy digital operating, the FDM-DUO and the *FDM-SW2* will support that as well. As I mentioned before, the FDM-DUO has its own USB Codec sound device that will work with most sound card software. During this review I made several PSK31 contacts with *DigiPan* software. To do this, I had to attach the third USB cable between my computer and the USB port labeled TX on the back of the FDM-DUO. Within *DigiPan*, I had to select the FDM-DUO as the "sound device" for audio input and output, and then choose the PTT port that would key the rig.

Conclusion

Whether you operate it as a standalone rig or with your computer, the ELAD FDM-DUO is a fine little radio with good performance. With just 5 W and a wire antenna, I made CW, SSB, and digital contacts with relative ease. I even tried it during the OK DX RTTY contest, using *MMTTY* software operating in AFSK. The ability to use the *FDM-SW2* software to create ultra-sharp RTTY filters certainly came in handy.

And though it almost goes without saying these days, I should emphasize that like all SDR rigs, the FDM-DUO is upgradeable just by loading new firmware; the *FDM-SW2* software is also constantly undergoing improvement. So, unlike traditional radios, you're potentially investing in a rig that will only get better with time.

Manufacturer: ELAD srl, Via Col de rust, 11, I-33070 Caneva (PN) Friuli-Venezia Giulia, Italy. Distributed in the United States by ELAD USA Inc, 7074 North Ridge Blvd, #3E, Chicago, Il 60645; tel 312-320-8160; **shop.elad-usa.com/**.

See the Digital Edition of *QST* for a video overview of the ELAD FDM-DUO SDR HF and 6 meter transceiver.