Product Reviews

May 2016

Product Reviews:

ELAD FDM-DUO SDR HF and 6 Meter Transceiver

Aerial-51 Model 404-UL Asymmetrical Inverted V Antenna

Emtech ZM-2 Z-Match Low Power Antenna Tuner

SOTABEAMS Band Hopper Dipole

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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.

Reviewed by Steve Ford, WB8IMY
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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.

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.

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

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

Manufacturer's Specifications	Measured in the ARRL Lab
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.

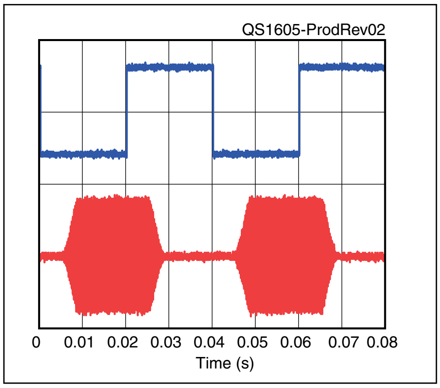


Figure 2 — CW keying waveform for the ELAD FDM-DUO showing the first two dits using external keying. Equivalent keying speed is 60 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions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

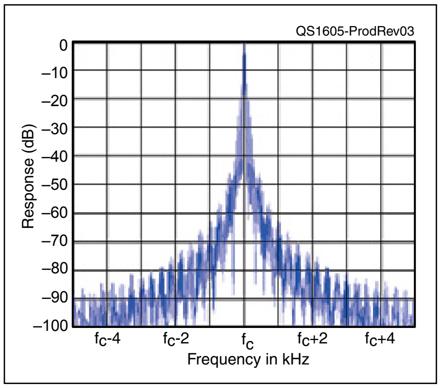


Figure 3 — Spectral display of the ELAD FDM-DUO transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 5 W PEP output on the 14 MHz band,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

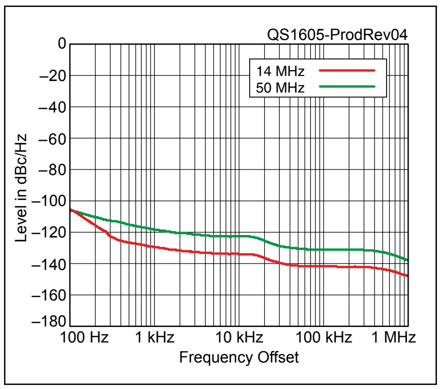


Figure 4 — Spectral display of the ELAD FDM-DUO transmitter output during phase noise testing. Power output is 5 W on the 14 MHz band (red trace) and 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the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

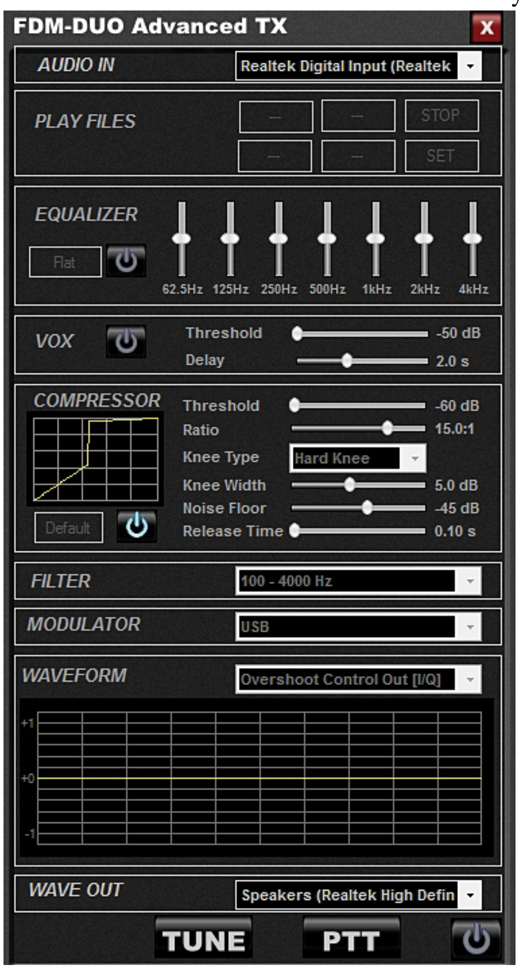


Figure 6 — The "Advanced" window gives you access to functions such as transmit audio equalization, VOX, speech compression, and more.

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.)

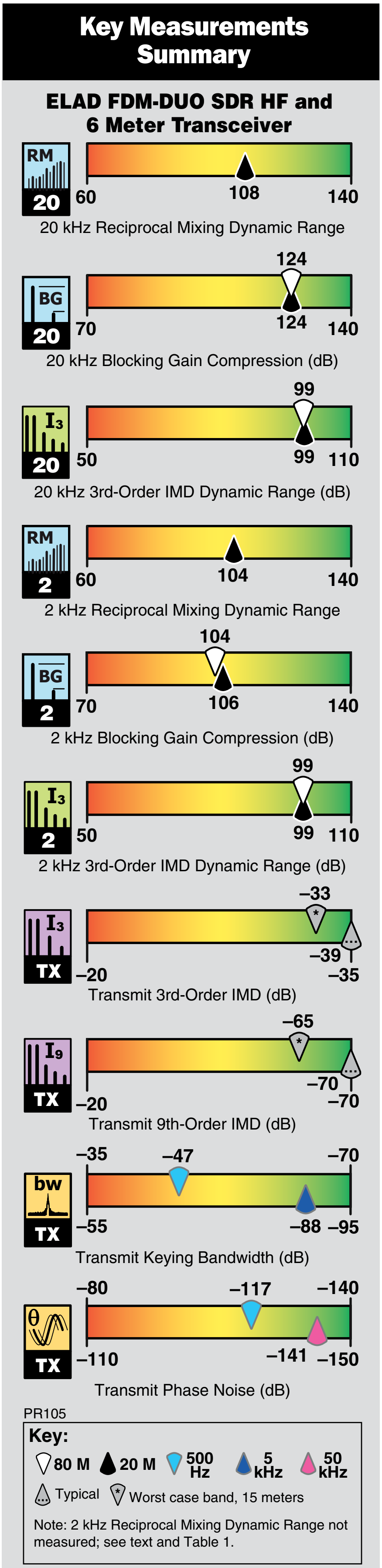
You can adjust a number of display parameters, but I found that I enjoyed the default view with the waterfall display on top of the spectral window as shown in Figure 5. The default mode allows you to activate as many as four separate receivers and each is color-coded to keep confusion to a minimum.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



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.

Aerial-51 Model 404-UL Asymmetrical Inverted V Antenna

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The Aerial-51 Model 404-UL is an asymmetrical, or off-center fed (OCF) multiband dipole designed to operate in an inverted V configuration from 40 through 6 meters. The antenna is constructed of lightweight materials, making it a natural for portable operations.

The antenna is a shortened variation of the classic Windom OCF, popular in the 1930s and originally designed to operate on all the HF bands of the time — 80, 40, 20, and 10 meters.[1] This version has a fundamental resonance on 40 meters and works best on harmonics of the fundamental (20, 15, and 10 meters), but can also work with a tuner on 30, 17, 12, and 6 meters. The idea of an OCF is that, unlike the dramatic shift of center-fed antenna impedance from low at ½ wave to very high on even harmonics, the OCF has a moderate impedance at the fundamental and odd harmonics along with a similar impedance on the even harmonics. Typically it is around 600 Ω, and can be matched to 50 Ω by a 12:1 balun. This antenna is rated at 200 W SSB/CW on all listed bands except 30 meters, which is restricted to 50 W transmitter output.

Bottom Line

The Aerial-51 Model 404-UL is a lightweight, easy-to-deploy antenna that can be operated on 40 through 6 meters, with a low enough SWR to be used without an antenna tuner on most bands. It provides performance comparable to larger and heavier antennas, up to its rated 200 W (50 W on 30 meters), and its lightness make it a good choice for portable operations.

Antenna Configuration

A folded instruction sheet included in the box had sufficient information for someone to install and use the antenna. It also included specifications, dimensions, and a discussion of the theory of operation.

Unlike the original Windom that used a controversial single-wire transmission line, the 67-foot-long 404-UL is fed through a supplied matching unit and about 40 feet of miniature coax. The matching unit is located about ⅓ of the way from one end and is intended to be the apex and support point for the antenna. The total weight of the antenna and coax is about 14 ounces.

The thin insulated antenna wire and coax terminate directly in the matching unit (see

Figure 7 — The 3.3-inch-wide Aerial 51 Model 404-UL matching unit with the cover removed. The antenna wire and coax connect within the sealed unit. The hang-up eye is the way to support the antenna.

Table 2
Comparison of Expected and Measured Standing Wave Ratio

Freq (MHz)	Specified Nominal SWR	Measured SWR at Antenna	Measured SWR at Station
7.05	<2.5:1	1.6:1	1.6:1
7.15	<2.5:1	1.7:1	1.7:1
7.25	<2.5:1	1.8:1	1.8:1
10.12	Abt 8:1	5.8:1	4.3:1
14.02	<2.5:1	2.5:1	1.7:1
14.15	<2.5:1	2.4:1	2.1:1
14.25	<2.5:1	2.4:1	2.1:1
18.1	<4:1	3.2:1	2.6:1
21.2	<2.5:1	2.2:1	1.8:1
24.8	<4:1	3.8:1	3.0:1
28.4	<2.5:1	1.1:1	1.1:1
50.1	<2.5:1	2.1:1	1.8:1

Figure 7), which includes an eye designed for attachment to a mast or halyard. The instructions warn that the wire is not strong enough to support the weight of the matching unit if the antenna were suspended by its ends.

Hanging It Up

The antenna is distributed in the US by SpiderbeamUS, which also provides telescoping fiberglass masts — one of the recommended support methods. We purchased the 12 meter mast with the antenna for our tests, along with a guy belt and a roll of Kevlar guy line. This review is not about the mast, since it is exactly the same as the one I reviewed in 2010, and I suggest looking over that review if you plan to use one of their masts.[2]

I attached the antenna to the second section from the top, as suggested in the instructions, using a loop of light line and a pair of clove-hitch knots secured with tape. The use of the available clamp kit would have made that more secure, but the tape held up through our testing. I also used some electrical tape to secure each telescoped section. I used the antenna wire, extended by light line, as the top guys, along with a single pair of perpendicular light guys at about the 2/3 point attached to the guy belt. If the antenna needed to stay up longer, I would have added a pair of guys parallel to the antenna from the guy belt.

How the Model 404-UL Plays

First I looked at the impedance characteristics right at the bottom of the directly connected length of light coax. As noted in Table 2, in all cases, the SWR I measured

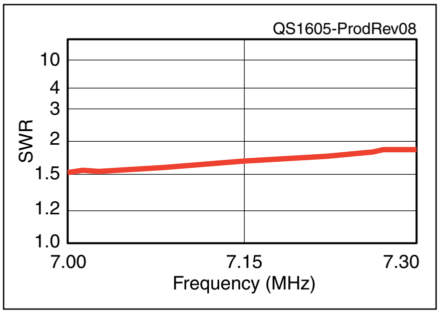

Figure 8 — Measured SWR of the Aerial-51 Model 404-UL in the reviewer's station across 40 meters.

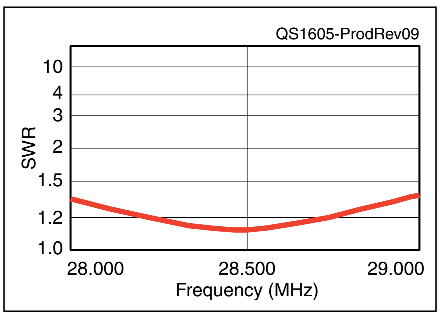

Figure 9 — Measured SWR of the Aerial-51 Model 404-UL in the reviewer's station from 28 to 29 MHz. This was the band with the nicest SWR curve.

was better than the manufacturer's specified maximum SWR. The website indicates that the loss in the thin coax varies from about 1 dB on 40 meters to 2 dB on 10 meters — no doubt contributing to the low SWR. Because the antenna end of the coax (along with the antenna wire) is sealed within the matching unit, we were unable to measure the loss of either the coax or the matching unit. Figures 8 and 9 show SWR curves on 40 and 10 meters.

On-the-air testing indicated good performance. I did a lot of listening tests on all active bands, switching between the OCF and my 80 meter center-fed half-wave dipole that is fed with window line. The orientations were different, and the regular antenna is significantly higher. Nonetheless, there wasn't much difference between them, taking into account their different lobe structure. That was especially noticeable on the higher frequency bands.

Even on 40 meters, some stations were an S unit higher on one antenna, and others an S unit higher on the other. During a 10 meter opening to Europe, I heard a station in Spain who was stronger on the OCF, and then I found a station in the Balearic Islands that was stronger on my 80 meter half wave. I confirmed some of these in the other direction by obtaining A/B signal reports on my transmissions. So, while I'm sure the peak low angle gain of my 80 meter half wave was higher to some narrow azimuths at long ranges, it wasn't terribly evident during many operating sessions.

US Distributor: Spiderbeam-US, Vibroplex, 1001 Broadway, Knoxville, TN 37917; tel 865-309-5073; **www.spiderbeam.us**. Price: Aerial-51 Model 404-UL, $125; Spiderbeam 12 meter pole, $105; Guy belt, $8.50.

Notes

[1]L. Windom, W8GZ/W8ZG, "Notes on Ethereal Adornments," *QST*, Sep 1929, pp 19 – 22, 84.

[2]J. Hallas, W1ZR, "Spiderpole Telescoping Antenna Mast," Product Review, *QST*, Feb 2010, pp 54 – 55.

Emtech ZM-2 Z-Match Low Power Antenna Tuner

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The Z-match concept has been around for decades. Some amateurs date the appearance of the Z-match to the 1950s when the circuit was used in several tube rigs of that era. The Z-match is essentially an L network with one tuning capacitor in series with the inductor and another tuning capacitor in parallel with the inductor, forming a tank circuit.

The Emtech ZM-2 builds upon the classic Z-match with an antenna tuner design that uses a single tapped toroidal inductor and two variable capacitors. In addition, there is a center-off toggle switch that allows the operator to add additional capacitance as needed. The result is an extremely compact (5 × 2.5 × 1.5 inch) antenna tuner that can match a variety of loads from 80 through 10 meters and handle up to 15 W.

The flexible design of the ZM-2 allows it to be used with balanced or unbalanced antenna systems. A BNC connector is available to connect an unbalanced coaxial line, while two terminal posts are provided for balanced lines such as 450-Ω windowed ladder line. Another BNC connector accepts the coaxial line from the transceiver. Figure 10 gives an inside view of the tuner.

Test Driving the ZM-2

Emtech offers the ZM-2 as a completely assembled unit, or as a kit. For this review we decided to purchase a factory assembled unit. Soon after it arrived, ARRL Assistant Laboratory Manager Bob Allison, WB1GCM, subjected the ZM-2 to the Lab's usual testing with a variety of resistive loads. You'll see the results in Table 3. There is significant loss when the load impedance dips below 25 Ω, but this is not unusual. Otherwise, the ZM-2 demonstrated excellent efficiency at higher impedances. Even with impedance loads as high as 800 Ω and an SWR of 16:1, the loss never exceeded 5%.

The ZM-2 is particularly attractive to portable operators thanks to its small size and meager weight (less than 8 ounces). Also, the ZM-2 includes its own SWR indicator in the form of a bright red LED. When you've tuned the ZM-2 to the point where reflected power is at or near zero, the LED stops glowing. It doesn't get much simpler than that.

My first test with the ZM-2 involved an inverted L antenna that happened to present a 4:1 SWR on 40 meters. I toggled the TUNE/OPERATE switch to the TUNE position and applied 5 W of 40 meter RF (the ZM-2 is rated for a maximum of 15 W

Bottom Line

Its small size and easy-to-use tuning indicator make the Emtech ZM-2 a delight for low-power portable operation.

Table 3
Emtech ZM-2

Frequency range: 80 to 10 meters.
Matching range: Not specified.
Power rating: 15 W.
Dimensions (HWD): 2.7 × 5.1 × 2.6 inches (including protrusions). Weight: 8 ounces.
Price: $65 kit, $90 assembled.

ARRL Lab Resistive Load and Loss Testing

SWR	Load (Ω)		80 m	40 m	20 m	10 m	6 m*
4:1	12.5	Power Loss%	9	22	21	34	—
		SWR	1.1	1.9	1.1	1.1	1.7
2:1	25	Power Loss%	5	13	13	27	—
		SWR	1.0	1.6	1.0	1.1	1.4
1:1	50	Power Loss%	1	4	4	14	—
		SWR	1.0	1.2	1.0	1.1	1.2
2:1	100	Power Loss%	5	3	1	3	—
		SWR	1.1	1.3	1.0	1.0	1.1
4:1	200	Power Loss%	3	3	1	1	—
		SWR	1.0	1.0	1.0	1.0	1.0
7.6	400	Power Loss%	7	2	2	1	—
		SWR	1.1	1.1	1.0	1.0	1.9
16:1	800	Power Loss%	3	2	5	5	—
		SWR	1.1	1.1	1.4	1.4	1.1

* Efficiency tests were not performed because the test load is not rated for 50 MHz.

The ZM-2 was able to find a match (SWR less than 2:1) on 80, 40, and 20 meters with an open antenna jack, and on 40 and 20 meters with a shorted antenna jack.

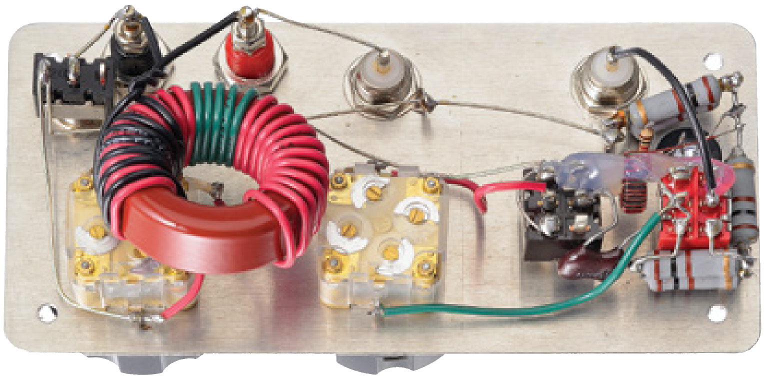

Figure 10 — Inside the ZM-2.

continuous power). I carefully adjusted variable capacitor C1 until I noticed a slight dimming of the LED. Switching to the adjacent C2 knob, I made another adjustment that caused the LED to dim even further. It took a bit of back and forth with the two capacitors, but within less than 45 seconds the LED was extinguished. I flipped the switch to OPERATE and I was good to go!

Great Little Tuner

After using the Emtech ZM-2 on several other antennas, I am impressed. It even managed to load a hank of wire that I had dangled from a fourth-story hotel window. (I used the balanced output and attached a counterpoise wire to the "ground" post.) For portable operations in particular, such as this year's National Parks on the Air event, the ZM-2 is a keeper.

Manufacturer: Emtech, PO Box 296, Traceyton, WA 98393-0296; tel 360-692-7750; **emtech.steadynet.com**.

SOTABEAMS Band Hopper Dipole

Reviewed by Sean Kutzko, KX9X
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If you go to the trouble of operating away from home, your gear needs to be rock solid and easy to deploy. SOTABEAMS has created an entire product line around these concepts. Based in the United Kingdom, SOTABEAMS products are focused on the Summits on the Air (SOTA) community: backpack QRPers who hike with a station to the top of a mountain summit. When you carry your entire station on a hike to a remote location, you need to be confident in your gear. You can't run to the store for a quick part.

I've operated QRP portable for many years. Two critical questions that always come up are: What kind of antenna should I use, and what's the best way to support it? Despite all the antenna designs and permutations out there, for a backpacker, the resonant half-wave dipole is tough to beat on several fronts. It's simple, lightweight, and doesn't require an antenna tuner. But what if you want to transmit on more than one band? You either need to bring multiple antennas, or bring an antenna tuner.

Bottom Line

The SOTABEAMS Band Hopper dipole is designed with portable operation in mind and offers resonant operation on three bands in a lightweight package.

SOTABEAMS Band Hopper Dipole

The SOTABEAMS Band Hopper multiband dipole addresses this problem in a very clever way. By inserting a pair of alligator clips at the proper length on both sides of the dipole, you can electrically lengthen or shorten the antenna to be resonant on one of three bands. Two versions of the Band Hopper dipole are available: one that covers 20, 30, and 40 meters, and another that covers 20, 17, and 15 meters (called the High Hopper). Each model is made from very thin-gauge wire, and comes with a center insulator (see Figure 11) with a current balun and a drilled hole that will slide over the top of SOTABEAMS fiberglass masts, providing a secure installation of the dipole's feed point (more on the mast in a bit). The antenna is rated at 125 W.

When operating portable, you don't want to waste a lot of time with station installation. Thanks to creative hardware design, deployment of the dipole couldn't be easier. Each antenna comes with three plastic winders, as shown in Figure 12. Two winders allow each leg of the dipole to be unwound as you walk away from the center insulator. The third winder spools a tether cord and 30 feet of RG-174 coax, pre-attached to the center insulator. Unwind the two legs of the dipole in opposite directions and the feed line/tether line to shape a T, then raise the antenna into a tree or up a mast, connect the coax to your rig, and you're on the air.

The wire winders are solidly built and come with several holes and a bit of stretch cord. You can use the ends to attach to trees or other supports, or simply use the metal tent pegs included with the dipole to secure the winders to the ground, making an inverted V. Teardown is a breeze; simply wind the dipole legs (or feed line) back on to the spool, taking care to alternate the layers on the winder to allow for easy unspooling during your next activation.

All three winders can be linked together with a hook-and-loop fastener for storage in the dipole's small nylon bag. If storing the antenna in your pack isn't an option, the bag comes with a clip so it can be attached to the exterior of your bag or belt loop.

SOTABEAMS Travel Mast

The SOTABEAMS Travel Mast is one of the better masts I've encountered. Weighing just under 3 pounds, it extends from 26.5 inches long when collapsed to 30 feet when fully extended. The Travel Mast is made completely of fiberglass. Taping a wire vertical to this mast is a breeze, or you can use it with the SOTABEAMS dipole, or almost any other lightweight wire configuration you can imagine.

Putting the mast up is easy: start with the thinnest, or topmost, section mast, pull it up, and twist to friction-lock it in place. The entire thing can be extended in about a minute. The bottom cap of the mast is removable, allowing you to eliminate segments of the mast if you need to make it shorter.

Field Tested

I took the Band Hopper dipole and the 30-foot Travel Mast on two of my recent portable activations for the 2016 ARRL National Parks on the Air event: Vicksburg National Military Park on January 31, and Fort Matanzas National Monument on February 10. Both trips required air travel, and being able to store my mast and antenna in my checked suitcase made life much easier. I used different QRP stations for each activation, with total station weights at 8 pounds for Vicksburg and 4 pounds for Fort Matanzas.

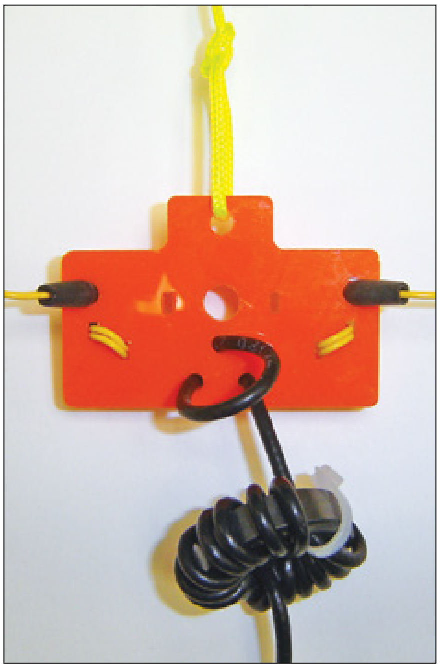

Figure 11 — The Band Hopper center insulator.

Figure 12 — The author activating Fort Matanzas National Monument in Florida for National Parks on the Air. The antenna wire is stored on a convenient winder and alligator clips are used to connect wire segments for use on different bands. [Doug Priest, W3CF, photo]

At Vicksburg, I was directed to set up at Fort Hope, the highest point in the park, overlooking the Mississippi River, as shown in the lead photo. My initial plans were to use the SOTABEAMS standard installation method: using the dipole's two legs, along with a third tether cord provided with the dipole kit, to create the three-legged tripod support for the mast. It's an extremely effective antenna erection method, and there's a video on the SOTABEAMS website demonstrating this technique.

The wind was especially strong that day on the hill, and it made setting up the mast trickier than normal. After two failed attempts to raise the dipole using the traditional method, I decided to tie the base of the mast to a fencepost along the ridge. It wasn't pretty, but it allowed me to get the antenna in the air as an inverted V, with the feed point at about 25 feet. SWR was perfectly flat on all bands.

An important note: SOTABEAMS offers an optional guying kit and numerous guying accessories for their masts. I have no doubt that if I had brought one, I could have installed the mast in the traditional way. If you think you will be operating from remote sites where there are no supports to lash the mast to, a guying kit would be a wise purchase, add very little additional weight to your pack, and provide you with peace of mind.

The bands were quiet and conditions were good. I was able to make about 200 contacts on SSB and CW on 20, 30, and 40 meters using the Travel Mast, Band Hopper dipole, a Yaesu FT-817ND, and a lithium polymer battery pack. Signal reports were very good, with QSOs from 36 states and Puerto Rico. Changing bands only took about 5 minutes, requiring me to loosen the ends of each dipole leg and configure the alligator clip connections for the band I wanted. It was not necessary for me to lower the feed point to do this, but being very tall aided the process. After about 3 hours of operation, I was able to break down the entire station and drive off in less than 15 minutes.

Proper gear is essential for backpack portable operations to be successful. The Band Hopper dipole and the Travel Mast do not disappoint. If you want to be an Activator for National Parks on the Air or Summits on the Air, or just want equipment for portable operating that works with no muss or fuss, look into SOTABEAMS dipoles and masts. They simply work, they are built well, and their customer service is top-shelf.

Manufacturer: SOTABEAMS, 89 Victoria Rd, Macclesfield, Cheshire, SK10 3JA United Kingdom; **www.sotabeams.co.uk**. Price (without tax for US/Canada): Band Hopper dipole, either version, about $60. Travel Mast, about $60. Mast guying kit, about $13.