Product Review

Apache Labs ANAN-8000DLE HF and 6-Meter SDR Transceiver

Reviewed by
Dr. Terry G. Glagowski, W1TR
w1tr@yccc.org

Software-defined radio (SDR) is fast becoming a mainstream technology for Amateur Radio. The Apache Labs 8000DLE is a direct-sampling SDR that uses digital downconversion and digital upconversion (DDC/DUC). It is the latest in the evolution of SDR transceivers from Apache Labs and is based on the Orion MKII board.

The 8000DLE operates on 160 through 6 meters, including coverage for Military Auxiliary Radio System (MARS) frequencies outside the ham bands. Modes of operation include SSB, FM, AM, synchronous AM, CW, and digital. Interface to the 8000DLE hardware is via ethernet, using virtual audio cable (VAC) and virtual serial port emulation (VSPE). The transmitter operates at up to 200 W output, so a 13.8 V dc supply at up to 35 A is required.

The 8000DLE requires a companion computer and software to operate, with minimum specified requirements of an Intel i3 processor (2.8 GHz or better), 4 GB RAM, and 1,280 × 1,024 display. A number of open-source software applications can be used with the 8000DLE. The most popular is *PowerSDR/OpenHPSDR mRX PS* (we'll just call it *OpenHPSDR*), which I used for this review. It requires Microsoft *Windows 7* or higher, and the source code and installation package are available for free download. Previous ANAN models use this same software. Other choices include *cuSDR*, *cudaSDR*, *ghpsdr3*, *GnuRadio* (Linux), and *PiHPSDR*.

Bottom Line

The Apache Labs ANAN-8000DLE offers excellent performance in a full-featured SDR 160 – 6 meter transceiver, and it is based on open-source software and firmware. PureSignal pre-distortion for improved transmit IMD is built into the unit, but an external sampler is required for use with an amplifier.

First Impressions

I have been using an Apache Labs ANAN-100D since early 2014, so that is my baseline for comparison. The ANAN-8000DLE is much larger and heavier. The unit feels solid, as do the controls and connectors, and there are handles to help carry it. It makes slightly more noise than my 100D, but the previous owner replaced the fan in my radio, and it may be quieter than stock. The thermal dissipation of the 8000DLE seems better, as it never gets hot to the touch during normal operation.

The front panel includes **POWER**, **RESET**, and **STANDBY** buttons, along with jacks for a microphone, headphones, and a CW key (see above). The four-line LCD (see Figure 1) shows important parameters.

Figure 2 shows the 8000DLE's rear panel. The power connector is a pair of Anderson Powerpoles, but the orientation is reversed from the normal convention. Be careful to *not* plug in a standard cable backward. It would be preferable to have the standard orientation or one rotated 90° to prevent an accident. The rear panel also has an RJ45 ethernet connector, a bootloader enable/disable switch, and a DB-9 jack with seven open collector outputs for control of external equipment. There are phono jacks for push-to-talk (PTT) input and amplifier keying. Other phono jacks handle left/right line-level audio input and output.

Figure 1 — The ANAN-8000DLE LCD shows forward and reflected power, SWR, drain voltage and current, temperature, and status (RX for receive).

There are jacks for the microphone, key, and headphones on both the front (¼ inch) and rear (⅛ inch), so you can hide the wires in the back or conveniently plug them in the front. Software control of the microphone jacks allows assignment of tip or ring connections to either audio or PTT, and PTT can be enabled or disabled. Bias voltage on the audio terminal can be enabled for condenser electret microphones or disabled for dynamic microphones.

There are two ¼-inch stereo phone jacks (left and right) on the back for non-powered speakers, which are wired from tip to ring and not to the grounded sleeve. I found the audio output so plentiful that I modified my speaker with a potentiometer across the 8000DLE output. Alternatively, you can use powered speakers with the headphone jack. The speaker output isn't disconnected with the headphones plugged in, as is the case with most transceivers.

I tried CW with a keyer paddle plugged directly into the 8000DLE and found the internal keyer algorithm very pleasant to use. I then connected my K1EL WinKeyer, which requires setting the 8000DLE for an external straight key.

The 8000DLE has three UHF antenna jacks and BNC jacks for a separate **RX2** antenna input, **XVTR** (transverter) output, and external 10 MHz frequency reference. I am using a splitter on my 100D to monitor two different frequencies with the same antenna on **RX1** and **RX2**. The 8000DLE is missing the **BYPASS**, **EXT1**, **EXT2**, and **XVTR** input jacks of the 100D, so I need a different strategy involving a splitter and an external transmit-receive (TR) switch.

Operational Test Setup

I tested the ANAN-8000DLE at ARRL Field Day 2017 and at my home station. For Field Day, I used an HP Envy

Figure 2 — ANAN-8000DLE rear panel.

Lab Notes: Apache Labs ANAN-8000DLE Transceiver

Bob Allison, WB1GCM, Assistant Laboratory Manager

Two ANAN-8000DLE units passed through the ARRL Lab. The first unit did not comply with FCC emission requirements on the 6-meter band. Its third harmonic measured 51 dB below the fundamental, and the FCC requires at least 60 dB. Apache Labs supplied a second unit, and that is the one we tested, with results shown in Table 1.

The receiver dynamic ranges are typical of some SDRs tested previously at the ARRL Lab. There are no signal-blocking effects from a strong, single, adjacent signal up to the point of analog-to-digital converter (ADC) overload. Reciprocal mixing is also low.

The two-tone, third-order IMD dynamic range (3 IMD DR) is a moving target. Under quiet band conditions, it is in the low 60s. With both the randomizer and dither functions turned on, 3 IMD DR increases to the low 70s. However, with one or more additional strong signals present on the band, simulated in the Lab by adding a signal at S-9 +30 dB, the 3 IMD DR is an excellent 100 dB best case. Those are the test conditions for measurements shown in Table 1. For more information on this SDR receiver behavior, consult page 52 in the February 2010 issue of *QST*.

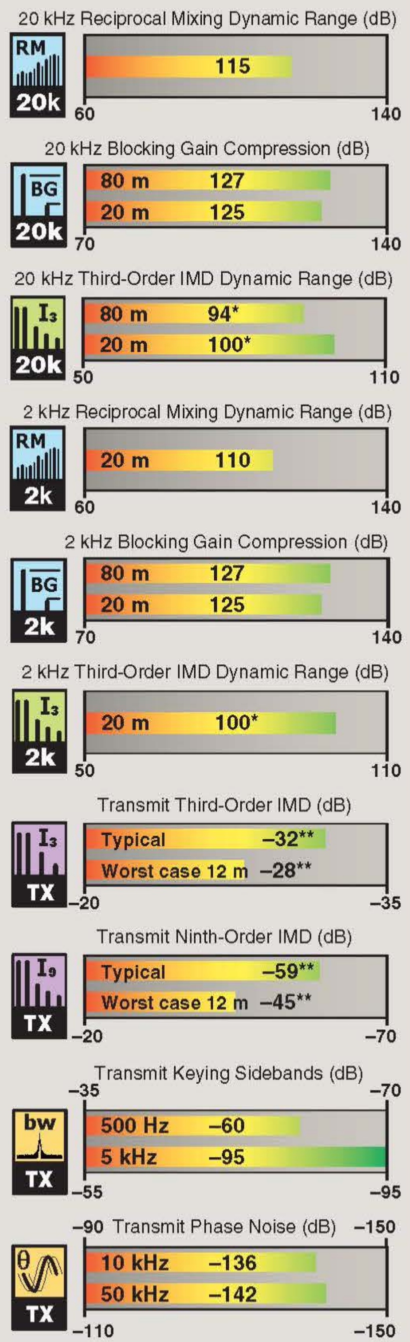
The CW keying waveform and keying sidebands indicate a clean signal, free of key clicks. The *OpenHPSDR* software allows CW keying speed to be adjusted up to 60 WPM with the internal keyer. However, at speeds higher than 48 WPM, the RF output keying waveform cannot keep up with an external keying device. Contesters should keep this in mind when operating above 48 WPM with an external keying source (such as your contest software).

Transmit phase noise is low overall, except for a spur at 180 Hz away from the carrier. Though measurable, this spur is not audible when listening on a test receiver.

Out of the box, the ARRL's ANAN-8000DLE RF power output was only 87 W on 160 meters. On 17 through 10 meters, it measured considerably higher than the specified 200 W (285 W PEP on 15 meters, for example). We adjusted the power output using *OpenHPSDR* as described in the text.

Transmit IMD is best with the PureSignal pre-distortion feature enabled. IMD performance tested better on the lower bands (160 – 40 meters) than on the high bands. Although an external sensor is required to use PureSignal with an external power amplifier, transmit IMD is low with PureSignal off and the 8000DLE's transmitter adjusted for typical amplifier drive levels (100 W or less). There should be no signal quality issues when using a power amplifier with the Apache Labs ANAN-8000DLE.

ANAN-8000DLE
Key Measurements Summary



KEY: QS1804-PR126

*Receiver third order IMD measurements shown are best case and vary with band conditions. See "Lab Notes" sidebar.

**Transmit IMD measurements at 200 W output with PureSignal on.

Table 1
Apache Labs ANAN-8000DLE, s/n 8000DLE0102

Configuration tested: *PowerSDR/OpenHPSDR mRX PS* version 3.4.7; Orion MKII firmware v1.6 Arduino front-panel firmware v1.08

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 0 – 61.44 MHz; transmit, not specified.	Receive, 0.03 – 61.440 MHz.* Transmit, 160 – 6 meter amateur bands, including 5.1 – 5.5 MHz.
Power requirement: Transmit, 35 A; receive, 3 A at 13.8 V dc.	At 13.8 V dc: Transmit, 33 A (typical) at maximum power output; 6.5 A (typical) at minimum power output. Receive, 1.4 A. Off, 2 mA.
Modes of operation: SSB, CW, AM, digital, RTTY, FM.	As specified.
Receiver	**Receiver Dynamic Testing**
Noise floor: Not specified.	Noise floor (MDS), 500 Hz BW:** 0.137 MHz –129 dBm 0.475 MHz –130 dBm 1.0 MHz –132 dBm 3.5 MHz –132 dBm 14 MHz –130 dBm 50 MHz –142 dBm
Noise figure: Not specified.	14 MHz, 17 dB; 50 MHz, 5 dB.
Spectral sensitivity: Not specified.	Panadapter: 14 and 50 MHz, –146 dBm. Waterfall: 14 MHz, –140 dBm, 50 MHz, –152 dBm.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW: 1.0 MHz 2.60 µV 3.88 MHz 2.75 µV 29.0 MHz 3.31 µV 50.4 MHz 0.87 µV
FM sensitivity: Not specified.	29 MHz, 0.85 µV; 52 MHz, 0.23 µV.
ADC overload level: Not specified.	HF, –5 dBm; 50 MHz, –21 dBm.
Blocking gain compression dynamic range: Not specified.	Blocking gain compression dynamic range, 500 Hz BW: *20 kHz offset*** / *5/2 kHz offset*** 3.5 MHz 127 dB 127/127 dB 14 MHz 125 dB 125/125 dB 50 MHz 121 dB 121/121 dB
Reciprocal mixing dynamic range: 116 dB at 2 kHz.	14 MHz, 20/5/2 kHz offset: 115/113/110 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	–132 dBm	–38 dBm	94 dB†
		–97 dBm	–11 dBm	
14 MHz	20 kHz	–130 dBm	–30 dBm	100 dB†
		–97 dBm	–11 dBm	
14 MHz	5 kHz	–130 dBm	–30 dBm	100 dB†
		–97 dBm	–11 dBm	
14 MHz	2 kHz	–130 dBm	–30 dBm	100 dB†
		–97 dBm	–11 dBm	
50 MHz	20 kHz	–142 dBm	–47 dBm	95 dB†
		–97 dBm	–32 dBm	

Second-order intercept point: Not specified.	14 MHz, +73 dBm; 21 MHz, +81 dBm; 50 MHz, +20 dBm.
DSP noise reduction: Not specified.	NR1, 10 dB.
FM adjacent channel rejection: Not specified.	29 MHz, 78 dB; 52 MHz, 79 dB.
Squelch sensitivity: Not specified.	29 MHz, 0.36 µV; 29 MHz, 0.12 µV.
Notch filter depth: Not specified.	Auto-notch, 40 dB; attack time, 3 seconds (single tone).

Manufacturer's Specifications	Measured in the ARRL Lab
FM two-tone third-order dynamic range: Not specified.	20 kHz spacing: 29 MHz, 73 dB; 52 MHz, 79 dB.†† 10 MHz spacing: 29 MHz, 107 dB; 52 MHz, 114 dB.
S-meter sensitivity: Not specified.	S-9 signal: 14 MHz, 50.1 µV; 50 MHz, 50.1 µV (after calibration). Scaling: 6 dB/S-unit.
IF/audio response: Not specified.	Range at –6 dB points:‡ CW (500 Hz BW): 352 – 852 Hz; Equivalent Rectangular BW: 510 Hz; USB (2.4 kHz BW): 156 – 2,562 Hz; LSB (2.4 kHz BW): 156 – 2,562 Hz; AM (6 kHz BW): 97 – 3,000 Hz.
Receive processing delay time: Not specified.	At headphone jack: 44 ms with linear phase filter; 30 ms with low-latency filter.
Audio output: 2 W with 8 Ω load.	Each channel: 1.2 W at 10% THD into 8 Ω. THD at 1 V_{RMS}, 0.1%.
Transmitter	**Transmitter Dynamic Testing**
Power output: 1 – 200 W (SSB, CW, FM, digital); 1 – 50 W AM.	SSB, CW, digital, FM, as specified. AM: 0.2 – 39 W (3.9 MHz), 0.6 – 71 W (29 MHz), 0.3 – 52 W (50.4 MHz).
Spurious-signal and harmonic suppression: >50 dB (HF); >60 dB (50 MHz).	Typically 59 dB (HF) and 62 dB (50 MHz). Worst case, 44 dB (5.330 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): Not specified.	3rd/5th/7th/9th order: –32/–43/–52/–59 dB (HF typical, 200 W PEP, PureSignal on). –30/–38/–47/–54 dB (HF typical, 200 W PEP, PureSignal off) –28/–33/–42/–45 dB (worst case, 200 W PEP, PureSignal on, 12 m); –34/–53/–71/–81 dB (50 MHz, 200 W PEP, PureSignal on). –32/–48/–62/–76 dB (14 MHz, 100 W PEP, PureSignal off).
CW keyer speed range: Not specified.	1 to 48 WPM; iambic mode B.
CW keying characteristics: Not specified.	See Figures 3 and 4.
Transmit-receive turn-around time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast: 110 ms (CW full break-in and SSB).
Receive-transmit turn-around time (tx delay): Not specified.	SSB: 130 ms. FM: 74 ms (29 MHz), 60 ms (52 MHz).
Composite transmitted noise: Not specified.	See Figure 5.
RF output lag time versus amplifier key line open: Not specified.	0 ms (default).

Size (height, width, depth, including protrusions): 5.7 x 19.0 x 15.4 inches.

Weight: 27 pounds.

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

*Reception is possible below 30 kHz, at a noise floor >1 µV.
**Randomizer and Dither features turned on during noise floor and dynamic range measurements.
†Third-order IMD DR measurements are made in a laboratory environment and measurements shown represent the best case. Third-order IMD performance depends on band activity and received signal strengths. See "Lab Notes" sidebar.
††Measurement is phase noise limited at the value indicated.
‡Default values; bandwidth is adjustable via DSP.

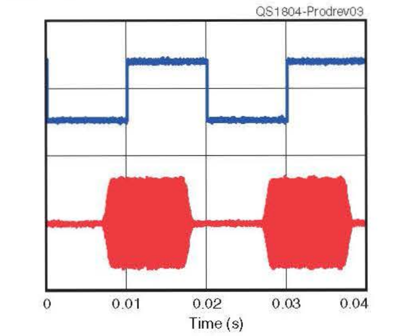


Figure 3 — CW keying waveform for the ANAN-8000DLE showing the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 48 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 milliseconds. The transceiver was being operated at 200 W output on the 14 MHz band. As explained in the "Lab Notes" sidebar, at the normal test speed of 60 WPM, the RF output keying waveform could not keep up with the external keying device.

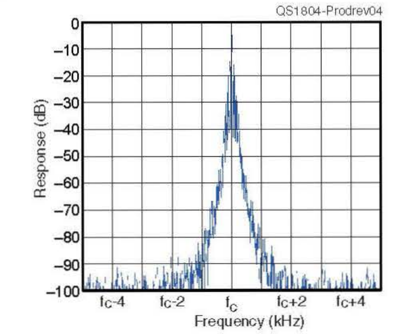


Figure 4 — Spectral display of the ANAN-8000DLE transmitter during keying sideband testing. Equivalent keying speed is 60 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 200 W PEP output on the 14 MHz 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.

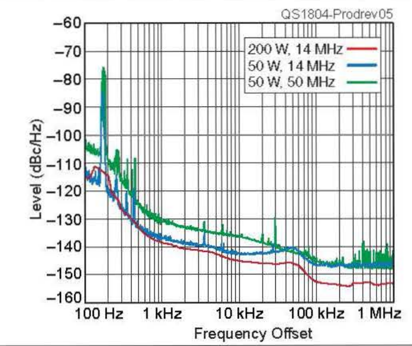


Figure 5 — Spectral display of the ANAN-8000DLE transmitter output during phase-noise testing. Power output is 200 W on the 14 MHz band (red trace), 50 W on the 14 MHz band (blue trace), and 50 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –60 dBc/Hz, and the vertical scale is 10 dB per division.

laptop (i7, 8 GB RAM, 500 GB hard drive) running *Windows 10 Home 64* and an external monitor. Software included *OpenHPSDR* v3.4.1, *N1MM+ Logger*, *fldigi* for digital modes, virtual audio cable (VAC), and virtual serial port emulator (VSPE). I powered the station with an Ameritron 75 A switching supply.

My home station computer is a Dell XPS 8300 (i7, 12 GB RAM, 500 GB solid-state drive, 1.5 TB hard drive) running *Windows 10 Pro 64* and dual monitors. Software is similar to the Field Day setup, except for *OpenHPSDR* v3.4.7 and *MS-DMT* digital messaging software for MARS operation. (I'm active in US Air Force MARS.)

Installation

Clearly marked rear-panel connections make the mechanical setup easy. An RJ45 ethernet connector is available for communication between the firmware on the Orion MKII board in the 8000DLE and a computer. See the expanded version of this review online for details about IP addresses and communication between the 8000DLE and computer.[2]

Several network arrangements can be configured. A *Windows* PC running *OpenHPSDR* can be connected directly to the 8000DLE. A non-*Windows* computer, such as the Apache Labs PiHPSDR Controller running a dialect of *Linux*, can be connected instead.

As shown in my PiHPSDR Controller review, you can connect a local gigabit ethernet switch to your ANAN transceiver, PiHPSDR Controller, and PC running *OpenHPSDR* and other applications.[3] If the PiHPSDR Controller is powered up, only one of the software applications (*OpenHPSDR* or *PiHPSDR*) can be running at a time. Connection from *OpenHPSDR* is established by using the **POWER** button. In the *PiHPSDR* unit, the connection dialog is used to establish the connection.

In a multi-transmitter contest station, connections to several networks might be used, and this is what I did for ARRL Field Day. From the laptop, there was a direct ethernet connection to the 8000DLE and a Wi-Fi connection to the other computers onsite running *N1MM+ Logger* in a networked configuration. I experienced some difficulties, which were resolved by making the connection to the *N1MM+ Logger* Wi-Fi network first, and then connecting to the 8000DLE.

Setup

I was able to import most of the *OpenHPSDR* database settings, memory channels, and equalization settings for my 100D. The only change is to select the 8000DLE hardware. I then configured the microphone and equalizer settings for the mic I wanted to use. Receiving was more or less the same experience as with the 100D.

Setup is well documented in the ANAN-8000DLE *Users Guide*, which describes the 8000DLE hardware and the *OpenHPSDR* software as a combined system. The Apache Labs website has documentation available, which includes some important points:

- Choose the correct radio hardware from the **GENERAL/HARDWARE** form, as well as the correct geographical region to enforce band limitations. Use **EXTENDED** for MARS/CAP coverage. The unit performs well on MARS frequencies from 2 – 30 MHz.
- I disabled keyboard shortcuts in **GENERAL/OPTIONS/KEYBOARD** to prevent accidentally sending the radio into hyperspace by typing something into *OpenHPSDR* that was intended for *N1MM+ Logger* or another application because the wrong window had the current focus.
- For physical controls, you can add a DJ controller (a MIDI control device that DJs use to play and mix music from various sources). After adding the device, you can map the knobs, sliders, and buttons on a DJ controller to radio control commands (such as VFO tuning or RIT). Consult the *User Guide* for detailed instructions.
- Check the power output on each band. If it's not 200 W with drive set to 100%, go to the *OpenHPSDR* Setup panel and set PA Gain for each band. These settings are stored in the *OpenHPSDR* software database, not in the 8000DLE unit itself. Don't expect the drive setting to be proportional to the power output — 50% drive may not give 100 W output when 100% is 200 W. Similarly, the wattmeter readings on the *OpenHPSDR* screen can be adjusted using the **WATT METER** panel. This needs to be done on only one frequency, not for every band.

Operation

The first time *OpenHPSDR* runs, it takes several minutes to initialize the DSP filters. The *OpenHPSDR* software screen will then appear, but it will be inactive until you use the onscreen **POWER** button to connect the computer to the 8000DLE and start receiving.

The 8000DLE's behavior is dominated by the *OpenHPSDR* software screen, shown in Figure 6. **VFO SYNC** causes VFO A and VFO B to track each other for dual-diversity phased reception. **SAVE/RESTORE** offers a quick save/recall of frequency, mode, and filter settings.

The spectrum scope display offers several views. *Panadapter* shows the received signal amplitude versus frequency. *Waterfall* shows the signal amplitude (color) versus frequency over time (vertical). *Panafall* is a combination of panadapter and waterfall. *Scope* and *Scope 2* show the modulation envelope of a received signal. *Panascope* shows a combination of the panadapter and scope displays. With the second receiver (RX2) enabled, panadapter displays will be shown for both receivers, but the combined spectrum scope displays are not available.

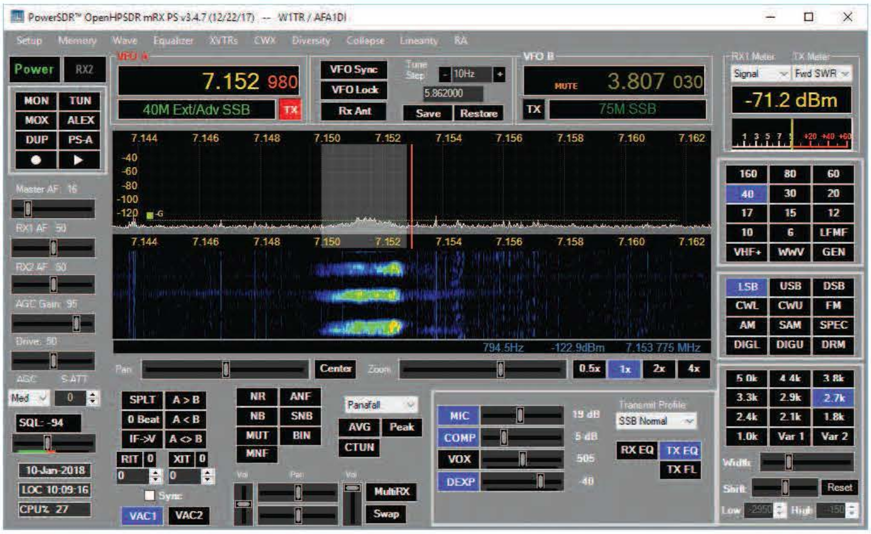


Figure 6 — The *OpenHPSDR* screen is full of controls and information about the SDR.

OpenHPSDR includes a number of advanced receive and transmit DSP functions. Note that these features are associated with the *HPSDR* software and apply to any of the ANAN series radios, not just the 8000DLE.

The software includes a traditional 3- or 10-band receive equalizer that allows the user to control the amplitude versus frequency contour of received signals. Receive DSP processing options can be very helpful under difficult copy conditions, such as weak signals, interference, and noise. The automatic notch filter (ANF) automatically matches the frequency and amplitude of an interfering carrier and nulls it. The multitracking notch filter (MNF) should do the same for multiple carriers, but I have not encountered this situation for a test.

The noise reduction (NR) function is helpful with weak signals and noise. A voice processed with NR sounds like the voice is in a pipe or barrel, but can be intelligible when a non-processed signal is not. NR is especially helpful for CW, and especially on VHF. A voice processed with NR2 sounds like it is warbling and underwater, but can also increase intelligibility for that weak DX contact. The spectral noise blanker (SNB) function can suppress heterodynes from carriers and other steady noise by filtering such items from the desired voice or CW signal.

You must try the various combinations of DSP options in a given situation to determine which ones provide the best reception. Note that these DSP functions impair the reception of MT-63 and Department of Defense digital signals (used for MARS operation), as well as analog and digital SSTV signals that occupy an entire voice channel. Some of these functions may help with PSK, FT8, and other narrowband digital modes.

On the transmit side, the *HPSDR* software includes a traditional 3- or 10-band equalizer, which applies a constant gain versus frequency to adjust the balance between highs, lows, and midrange voice tones. Controlled envelope single sideband (CESSB) processing increases the average power versus peak power ratio of the transmitted signal. Starting in version 3.4.1, continuous frequency compression (CFC) offers a means of varying the compression gain versus frequency similar to an equalizer. Transmit settings for different activities (casual conversation, contesting, and so on) can be saved in **TRANSMIT PROFILES**.

SSB and AM modes allow adjustment of the mic gain, compression level, VOX, audio processing, and transmit filter settings. In FM mode, deviation, CTCSS tones, repeater offset, and memory selections are available.

For CW, there are internal keyer adjustments, sidetone pitch and offset adjustments, full and semi break-in, and an audio peak filter (APF). The panadapter display can show the CW transmit frequency and a virtual carrier.

Digital modes DIGL and DIGU are special cases of LSB and USB. Digital mode settings include **VAC1 RX GAIN** (gain independent of the master AF gain but coupled to the RX1 gain) and **VAC1 TX GAIN** (gain independent of the microphone gain). The DSP functions for both transmit and receive are disabled in the DIGU and DIGL mode to avoid corruption of digital signals.

Operating Experience

With the 8000DLE set up, I checked into the TEN-TEC Net on 1975 kHz. Initial reports indicated that the audio was too bassy (using the dynamic microphone), so I adjusted the equalizer for more highs and fewer lows and got a better report.

The next day, I used the 8000DLE with my linear amplifier to check into the Apache Labs SDR net on 14.340 MHz. The transmit equalizer gave me great-sounding audio with this setup. I tried 6 meters and worked a station in Venezuela. Later, I checked into a USAF MARS net around 4.6 MHz and received and sent traffic using a Department of Defense digital waveform at 600 bps. The 8000DLE performed flawlessly.

Next came ARRL Field Day. I had a totally successful Field Day experience in the face of several nearby stations operating simultaneously — even without using external band-pass filters commonly found in multi-transmitter contest stations. I operated 80-meter CW with a 75-meter SSB station operating only 150 feet away with our antennas broadside to each other. With 20 dB attenuation to keep the 8000DLE's ADC threshold from overload, I was able to copy the weakest CW signals. Only when I moved to within 10 kHz of the other station did I have any difficulties.

After Field Day, I tried the PureSignal pre-distortion function, which can reduce the intermodulation distortion (IMD) products in the transmitter. In the 8000DLE, the feedback loop for pre-distortion is built in and available without an external signal sampler, unless an external linear amplifier is used. The rear panel has SMA jacks for the internal PureSignal sampler output, as well as the PureSignal input, which would be connected to an external sampler if you are using an amplifier.

It was easy to enable the PureSignal feature in **SETUP** and click a couple buttons to perform the automatic two-tone calibration. Calibration is required for each band. Once set, Lab measurements showed that IMD performance with PureSignal is consistent across the band. This is a huge improvement over the manual calibration process with the 100D. See Table 1 and the "Lab Notes" sidebar for more information.

Operating Tips

Spectrum Scope

The panafall display shows frequency (horizontal) and amplitude (vertical). The panadapter portion shows signals that are within a preset frequency range. The waterfall portion shows amplitude by color and moves downward in time, making it easy to detect weak signals. The receive filter is a semi-transparent vertical rectangle showing the passband of the receiver. The virtual carrier frequency is a vertical red line. The AGC gain is the horizontal green line indicating AGC threshold. If both RX1 and RX2 are enabled, a panadapter display will be shown for both receivers. The emission mode of stations on the display can usually be discerned by the shape of the waveform.

Frequency Tuning with Mouse or Keyboard

You can click on the frequency display of interest and use the keyboard to enter the frequency (use the decimal point appropriately). This is useful for tuning to a specific frequency. The individual digits of the frequency display can be adjusted by clicking on a digit and adjusting the mouse thumbwheel for the appropriate setting. This is useful for making large frequency changes.

Frequency Tuning with Mouse and Panadapter

The mouse cursor can be set to adjust the center frequency or edges of the receive filter by dragging the filter or the edges. Or it can be set to tune to the frequency where the mouse is clicked. With the **CTUN** feature enabled, the frequency grid remains stationary while the passband filter moves. With **CTUN** disabled, the panadapter signal display and frequency grid move and the signal selected will stay in the center of the display.

Frequency Tuning with a DJ Controller

Typically, one of the large wheels on a DJ controller is configured to be the VFO knob. Usually there are two such knobs, configured as VFO A and VFO B. Turning this knob is useful for fine frequency adjustment after the mouse or keyboard are used to get the approximate frequency.

Selecting a Signal

To understand where to click, you need to understand the emission mode carrier (or virtual carrier) and the sidebands. For LSB, click on the virtual carrier of the SSB emission at the high side (right) of the signal. For USB, click on the virtual carrier at the low side (left) of the signal. For DSB, AM, or FM, click on the virtual carrier of the emission at the center of the signal. For CW, click on the signal frequency exactly. This will center the passband on the signal with the desired offset. If transmit frequency display is enabled, a vertical yellow line will indicate where to position the cursor to match the received station's frequency.

FSK RTTY is not available in this version of *OpenHPSDR*, so digital mode software should be set up for AFSK. For DIGL (usually used for RTTY) or DIGU (usually used for PSK, FT8, and other "sound card" modes), position the passband to include the signals you want to work with. For PSK or FT8, the software expects a wide passband (SSB bandwidth), while for RTTY it is more appropriate to restrict the passband to include just the signal of interest (250 – 500 Hz).

Visit https://youtu.be/omiDXV5J4TY to see our review of the Apache Labs ANAN-8000DLE HF and 6-Meter SDR Transceiver on YouTube.

Contest Operation

The panafall display provides valuable situational awareness across a band. On a band with few signals, such as 10 or 6 meters and VHF/UHF (with a transverter), the panadapter is valuable for locating activity. On microwave bands where frequency calibration is less accurate, the panadapter can help find a signal that is faint and off frequency. On a busy HF band, the panadapter or panafall display help locate open spots for calling CQ.

An issue with some SDRs is *latency*, the time between a signal arriving at the antenna and sounding in the speaker or headphones. Newer versions of the *OpenHPSDR* software have reduced latency and offer low-latency filter settings. Likewise, there is some latency between speaking into the microphone and the signal going out to the antenna. CW transmit is implemented in the FPGA and has no latency.

Summary

The Apache Labs ANAN-8000DLE is a top-performing SDR transceiver for 160 through 6 meters and MARS frequencies. The 8000DLE can be adapted for use on 630 and 2,200 meters using external filters and antenna-matching networks. A much more detailed version of this review is available online (see Note 2).

Manufacturer: Apache Labs, 20 Eva Ave., Point Cook, VIC, 3030 Australia; e-mail **support@apache-labs.com**; **apache-labs.com**. Available from several US dealers. Price: $3,995.

Notes

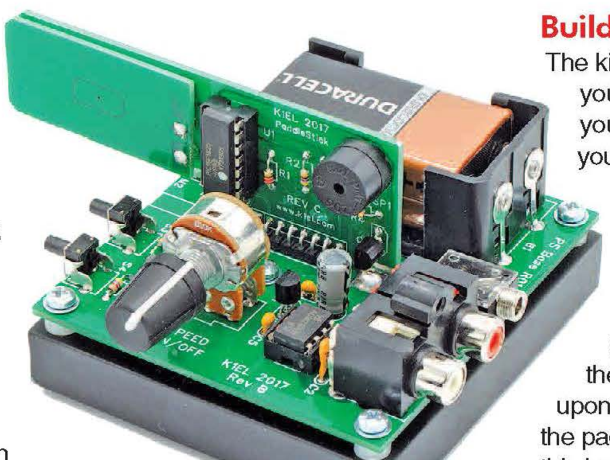
[1]A. Barron, ZL3DW, *An Introduction to HF Software Defined Radio*, Edition 1.1 (Jan. 2017), ISBN-13: 978-1500119935.

[2]A much longer version of this review may be found at **www.arrl.org/qst-in-depth**.

[3]T. Glagowski, W1TR, "Apache Labs PiHPSDR Controller for ANAN SDRs," Product Review, *QST*, Jun. 2017, pp. 58 – 62.

K1EL Systems PaddleStick CW Keyer with Base Kit

Reviewed by Steve Ford, WB8IMY, QST Editor
wb8imy@arrl.org



If there is such a thing as a touch-paddle CW keyer kit that does it all, this may be the one. The K1EL Systems model PS2B PaddleStick keyer is more than just a set of paddles; this is a complete, full-featured CW keyer. At $59, not only is the PS2B economical, especially considering its functionality, it is also a kit that even beginners can tackle. It would be a good candidate for your next club project.

The PS2B includes message memories, a convenient speed-control potentiometer, and a solid-state relay output that is capable of keying both modern and grid-block vacuum tube transmitters. There is even a frequency-adjustable sidetone circuit that drives a tiny speaker. This is great to have when you're using the PS2B with a radio that lacks its own sidetone.

The PS2B keyer operates from 5 to 59 WPM. There is a pool of 236 message characters shared among 12 message and two call sign slots. Slot sizes are not fixed. You can even store two separate user configurations in memory. Although everything is powered by a 9 V battery, the memories are retained when power is removed.

Bottom Line

The K1EL PS2B memory keyer kit with integrated touch paddle goes together quickly. Its heavy steel base keeps the keyer from walking across the table while you're banging out CW.

Building the PS2B

The kit arrives in a small box, but your first surprise will come before you even open it. If you're like me, you'll be astonished at the fact that the nondescript shipping box weighs more than 1½ pounds. (I wasn't expecting the weight and nearly dropped the box when I first picked it up.) This is thanks to the powder-coated steel base upon which the keying circuitry and the paddles rest. When you operate this keyer, you can rest assured that it won't be sliding across your table.

Once you've downloaded the assembly instructions from the K1EL Systems website, everything else is straightforward. The first step is to build the touch paddles and their associated circuitry. The paddles are printed circuit board strips that are used to sense the capacitive effect when your fingers make contact. You essentially make a sandwich of the two boards using a powerful adhesive strip, and then mount a handful of parts, none of which are surface-mount components.