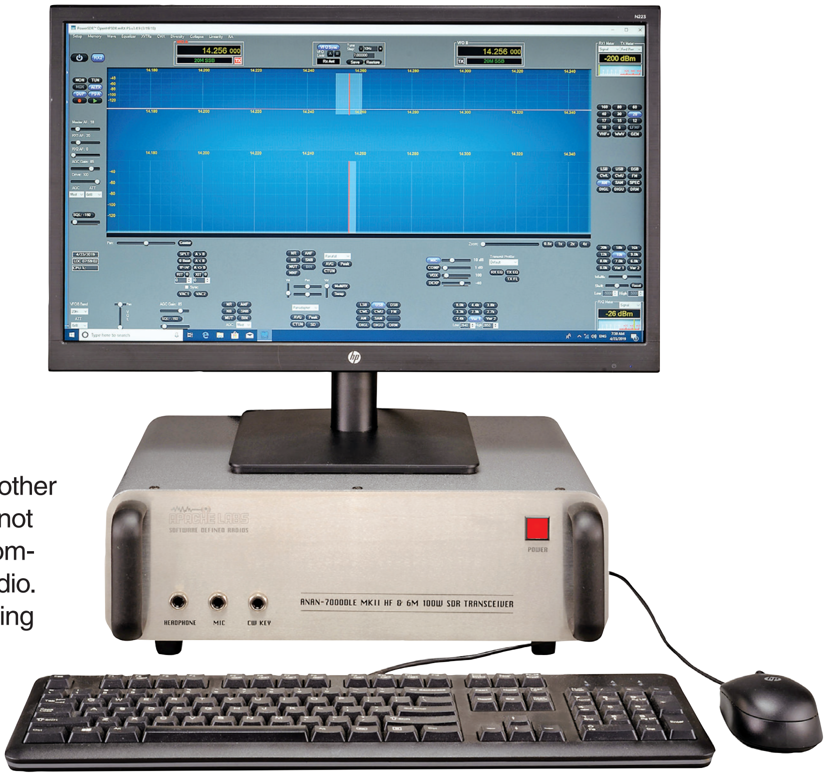
Product Review

Apache Labs ANAN-7000DLE MKII HF and 6-Meter SDR Transceiver with i7 CPU



Reviewed by Terry Glagowski, W1TR
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The ANAN-7000DLE MKII is a newer entry in the family of software-defined radio (SDR) transceiver offerings from Apache Labs. We reviewed the ANAN-100D in the October 2015 issue of *QST*, and the ANAN-8000DLE in the April and November 2018 issues.

Many hams are used to a traditional self-contained transceiver into which you connect power, an antenna, a microphone, a key, and other accessories, and you are on the air. They are not comfortable with using a separate personal computer to run SDR software that controls the radio. Apache Labs addressed that concern by offering versions of the ANAN-7000DLE MKII with a PC module built into the radio chassis. This internal PC eliminates the requirement for a separate computer, but the user supplies a monitor, a keyboard, and a mouse. The internal PC can be networked with other computers on a local area network (LAN), so that data can be exchanged, and the SDR can also be controlled by an external computer if desired.

The Apache ANAN series radios have always used open-source firmware and software. Microsoft Windows has been the dominant operating system, but versions for Linux are also available. We'll discuss the software later in this review.

There are some hardware changes for the ANAN-7000DLE MKII compared to previous ANAN transceivers. The version with the built-in CPU has a cabinet that is 5 × 15 × 13 inches, midway between the size of the '100D and the 8000DLE. The unit without the built-in CPU has a cabinet size similar to the '100D, which is about is 3.5 × 10.5 × 9 inches. The fan is quieter than my '100D, and the fan controller allows for an external fan for better cooling.

System Overview

The review transceiver includes the optional i7 PC module (CPU). It's an Intel NUC8i7BE embedded computer with 8 MB RAM and a 128 GB solid-state drive (SSD) running the 64-bit version of Microsoft Windows 10 Home. This device has Wi-Fi and Bluetooth built in. Apache Labs also offers the 7000DLE MKII with an internal i5 PC module, or no internal PC module.

Bottom Line

The Apache Labs ANAN-7000DLE MKII features improved hardware and software compared to previous models and can be equipped with an internal PC module, which eliminates the need for a separate PC to run the control software. Receiver performance is very good, and the Pure Signal predistortion feature provides an exceptionally clean SSB signal.

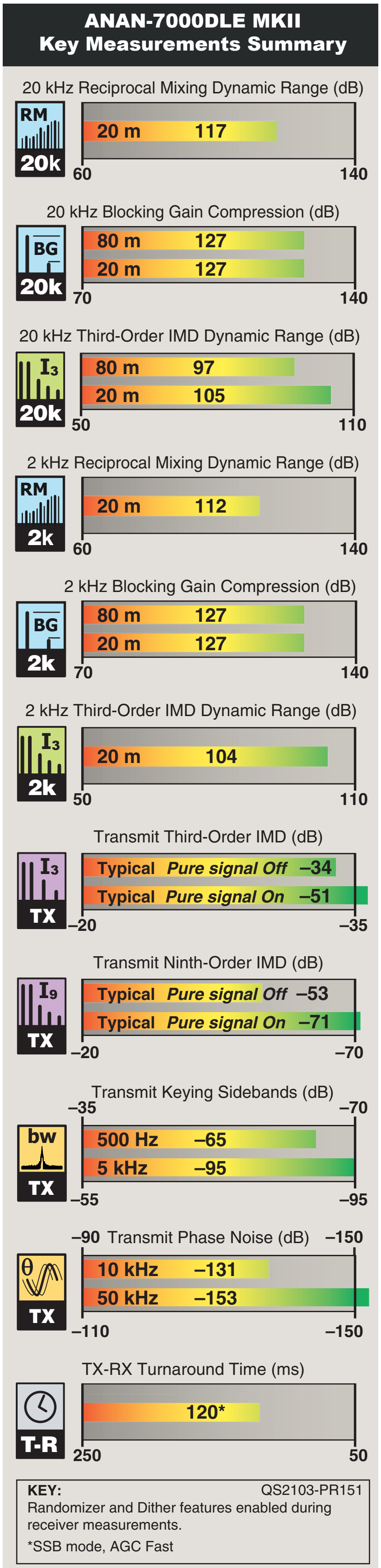

Table 1
Apache Labs ANAN-7000DLE MKII, serial number 7000DLEMKII0006

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: Receive, 9 kHz – 61.44 MHz. Transmit, not specified.	Receive, 0.03 – 61.440 MHz;* 160 – 6 meter amateur bands.
Power requirement: Transmit, 30 A; receive, 3 A at 13.8 V dc.	Transmit, 17 A (typical) at maximum power output; 6.0 A (typical) at minimum power output. Receive, 2.6 A. Power off, <2 mA.
Modes of operation: SSB, CW, AM, FM, digital, RTTY.	As specified.
Receiver	**Receiver Dynamic Testing****
Noise floor: Not specified.	Noise floor (MDS), 500 Hz bandwidth: 0.137 MHz –127 dBm 0.475 MHz –128 dBm 1.0 MHz –130 dBm 3.5 MHz –132 dBm 14 MHz –132 dBm 50 MHz –141 dBm
Noise figure: Not specified.	14 MHz, 15 dB; 50 MHz, 6 dB.
Spectral sensitivity: Not specified.	Panadapter: 14 MHz, –137 dBm, 50 MHz, –143 dBm. Waterfall: 14 MHz, –147 dBm, 50 MHz, –153 dBm.
AM sensitivity: Not specified.	10 dB (S+N)/N, 1 kHz tone, 30% modulation, 6 kHz BW: 1.0 MHz 2.23 µV 3.88 MHz 1.80 µV 29.0 MHz 5.07 µV 50.4 MHz 0.59 µV
FM sensitivity: Not specified.	29 MHz, 0.70 µV; 52 MHz, 0.22 µV.
ADC overload level: Not specified.	HF, –5 dBm; 50 MHz, –19 dBm.
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 127 dB 127/127 dB 14 MHz 127 dB 127/127 dB 50 MHz 119 dB 119/119 dB
Reciprocal mixing dynamic range: Not specified.	14 MHz, 20/5/2 kHz offset: 117/115/112 dB.

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

Band	*Spacing*	*Measured IMD Level*	*Measured Input Level*	*IMD DR****
3.5 MHz	20 kHz	–132 dBm –97 dBm	–35 dBm –10 dBm	97 dB
14 MHz	20 kHz	–132 dBm –97 dBm	–27 dBm –10 dBm	105 dB
14 MHz	5 kHz	–132 dBm –97 dBm	–28 dBm –10 dBm	104 dB
14 MHz	2 kHz	–132 dBm –97 dBm	–28 dBm –10 dBm	104 dB
50 MHz	20 kHz	–141 dBm –97 dBm	–46 dBm –31 dBm	95 dB

Manufacturer's Specifications	Measured in the ARRL Lab
Second-order intercept point: Not specified.	14 MHz, +87 dBm; 21 MHz, + 87 dBm; 50 MHz, +17 dBm.
DSP noise reduction: Not specified.	NR1, 10 dB.
FM adjacent channel rejection: Not specified.	29 MHz, 79 dB; 52 MHz, 72 dB.
FM two-tone, third-order dynamic range: Not specified.	20 kHz spacing, 29 MHz, 51 dB; 52 MHz, 72 dB.† 10 MHz spacing: 29 MHz, 104 dB; 52 MHz, 111 dB.
Squelch sensitivity: Not specified.	29 MHz, 0.28 µV; 52 MHz, 0.09 µV.
Notch filter depth: Not specified.	Auto-notch, >60 dB. Attack time, 1 second (single tone and two tones).
S-meter sensitivity: Not specified.	S-9 signal, 14 MHz, 50.1 µV; 50 MHz, 10 µV (after calibration). Scaling, 6 dB/S-unit.
IF/audio response: Not specified.	Range at –6 dB points:‡ CW (500 Hz BW): 305 – 898 Hz; Equivalent Rectangular BW: 493 Hz; SSB (2.4 kHz BW): 101 – 2594 Hz; AM (6 kHz BW): 11 – 2982 Hz.
Receive processing delay time: Not specified.	57 ms at transceiver rear speaker jacks.
Transmitter	**Transmitter Dynamic Testing**
Power output: 100 W SSB, CW, FM, digital; 1 – 30 W AM.	SSB, CW, FM, AM, digital, as specified for 1.8 – 30 MHz. At 50 MHz, 0 – 100 W SSB, CW, FM, digital; 0 – 32 W AM. At 54 MHz, 56 W maximum output.
Spurious-signal and harmonic suppression: >43 dB (HF); 60 dB (50 MHz).	HF, 71 dB typical; worst case, 66 dB (20 m); 50 MHz, 69 dB. Complies with FCC emission requirements.
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 IMD products 100 W PEP RF output, Pure Signal off: –34/–38/–44/–53 dB (HF typical) –27/–38/–39/–50 dB (worst case, 15 m) 100 W PEP RF output, Pure Signal on –51/–62/–67/–71 dB (HF typical) –31/–55/–52/–58 dB (worst case, 10 m) At 50 W PEP RF output, 14 MHz: –35/–39/–50/–58 dB (Pure Signal off) –57/–64/–70/–73 dB (Pure Signal on) At 50 MHz, 100 W PEP RF output: –30/–37/–42/–53 dB (Pure Signal off) –34/–49/–53/–65 dB (Pure Signal on)
CW keyer speed range: Not specified.	1 to 48 WPM, iambic mode B.
CW keying characteristics: Not specified.	See Figures A and B.
Transmit-receive turnaround time (PTT release to 50% audio output): Not specified.	S-9 signal, AGC fast, SSB: 120 ms; CW, full break-in: 90 ms
Receive-transmit turnaround time (TX delay): Not specified.	SSB, 114 ms; FM, 62 ms (29 MHz), 60 ms (52 MHz).
Transmit phase noise: Not specified.	See Figure C.
RF output lag time versus amplifier key line open: Not specified.	0 ms (default settings).

Size (height, width, depth, with protrusions): 5.1 × 15.3 × 14.4 inches. Weight, 22 lbs.

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 enabled during noise floor and dynamic range measurements.
***Third-order IMD dynamic range measurements in a laboratory environment. Measurements shown represent the best case.
†Measurement is phase noise limited to the value indicated.
‡Default values; bandwidth is adjustable via DSP.

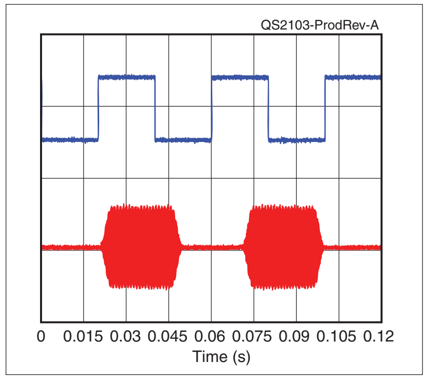

Figure A — CW keying waveform for the ANAN-7000DLE MKII shows the first two dits in full-break-in (QSK) mode using external keying. Equivalent keying speed is 48 WPM. The upper trace is the actual key closure; the lower trace is the RF envelope. (Note that the first key closure starts at the left edge of the figure.) Horizontal divisions are 10 ms. The transceiver was being operated at 100 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.

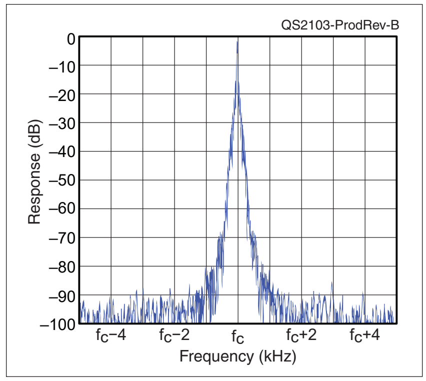

Figure B — The spectral display of the ANAN-7000DLE MKII transmitter is shown during keying sideband testing. Equivalent keying speed is 48 WPM using external keying. Spectrum analyzer resolution bandwidth is 10 Hz, and the sweep time is 30 seconds. The transmitter was being operated at 100 W PEP output 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.

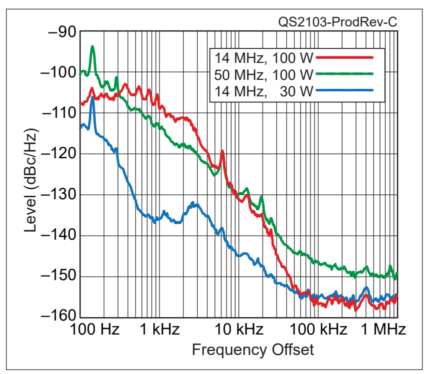

Figure C — The spectral display of the ANAN-7000DLE transmitter output is shown during phase-noise testing. Power output is 100 W on the 14 MHz band (red trace), 30 W on the 14 MHz band (blue trace), and 100 W on the 50 MHz band (green trace). The carrier, off the left edge of the plot, is not shown. This plot shows composite transmitted noise 100 Hz to 1 MHz from the carrier. The reference level is –90 dBc/Hz, and the vertical scale is 10 dB per division.

Lab Notes: Apache Labs ANAN-7000DLE MKII

Bob Allison, WB1GCM

Initial testing of the Apache Labs ANAN-7000DLE MKII showed higher-than-anticipated transmit IMD on the 17- through 10-meter amateur bands, even with the Pure Signal function enabled. We returned the radio to the US service center, where they determined that four inductors in the low-pass filter sections for the affected bands required smaller cores. The replacements were installed in our unit, and all further units employ these new parts.

With the revised inductors, the review radio's transmit IMD improved dramatically. A good benchmark for reasonable third/fifth/seventh/ninth-order IMD products is 30/40/50/60 dB below PEP output. With Pure Signal enabled, the ANAN-7000DLE MKII typically measured 51/62/67/71 dB below PEP. This translates to very low transmitted distortion products and a clean, narrow signal that offers more elbow room for others operating near the transmit frequency.

During initial testing, we also found that the review radio did not comply with FCC spectral purity requirements because of a spurious emission when transmitting on the 6-meter band. This problem was fixed with the release of the Protocol 2 (*Thetis/Metis*) software and firmware.

Other transmit performance parameters are favorable, with reasonably low transmit phase noise and a nicely shaped CW waveform with narrow CW bandwidth. Like the ANAN-8000DLE reviewed previously, the maximum external keying speed of the transmitter is 48 WPM. Any higher speeds will result in character shortening.

The lowest of the three dynamic ranges in the review radio at 2 kHz spacing was two-tone, third-order IMD at 104 dB. This places the ANAN-7000DLE MKII in the top tier of performance. The only parameter that might cause an issue is two-tone, second-order IMD when operating on the 6-meter band. There is a small chance of phantom signals when two strong signals are present at the antenna jack, with the sum of the two frequencies falling somewhere in the 6-meter band.

Turnaround times (receive-to-transmit and transmit-to-receive) are about average for SDR transceivers. Receive processing delay time (the time between when a signal arrives at the antenna jack when it is heard in the speaker) is shorter than expected. At 57 milliseconds, it is faster than some of the other SDRs we have measured.

As the review was wrapping up, the 7000DLE MKII developed a heat-related problem with the video display using the internal i7 PC, although we could still control the radio using an external PC. We sent the radio for repair, and replacement of defective RAM fixed the problem.

A word of caution: prior to testing, I discovered the transmit inhibit function in the setup menu did not inhibit the transmitter. In the Lab, that can result in transmitting at high power into sensitive test equipment.

The unit comes with the software needed to run the SDR already installed, so the unit is ready to use out of the box. As tested here, *Thetis* software version 2.7.0 and *Metis* firmware version 2.0 have been installed. *Thetis/Metis* is also known as Protocol 2 and is the latest generation firmware and software available for the Apache Labs ANAN series SDR transceivers.

I was a little skeptical that 128 GB is sufficient storage, but with two SDR software versions and many third-party ham radio and MARS (Military Affiliate Radio System) applications loaded, my usage is 48 GB. There should be plenty of room for word processing, spreadsheet, and other applications, but anything with a very large database might be a challenge. Because the unit has the capability of Wi-Fi and ethernet LAN connections, external storage is always available.

The Apache Labs ANAN series radios, including the ANAN-7000DLE MKII, have the following major subsystems:

1) The mechanical and electrical chassis, including a heatsink and fans, with provisions for external fans.

2) The RF board containing the analog parts of the receiver and transmitter, the power amplifier, and the filters. The new RF board in the 7000DLE MKII offers better receiver dynamic range and better transmit Pure Signal (pre-distortion) support than previous hardware. (Pure Signal significantly improves the transmitted IMD products, as discussed in the "Lab Notes" sidebar.)

3) The digital board with a field programmable gate array (FPGA) to perform all the direct upconversion/downconversion (DUC/DDC) and digital signal processing (DSP) functions. In the 7000DLE MKII, it is an Orion II board.

4) The SDR firmware for the digital board (*Metis*).

5) The SDR software for the personal computer (*Thetis*).

Apache Labs manufactures the transceiver hardware, but open-source developers create the firmware and software, which is freely available for anyone to use or adapt. The firmware is specific to the digital board used in the transceiver, with versions called Hermes, Angelia, Orion, and so on. The software is common to all the ANAN series transceivers. This article will focus on improvements in the hardware with the ANAN-7000DLE MKII and the Protocol 2 software/firmware.

Hardware Installation

The ANAN-7000DLE MKII requires a user-supplied monitor (HDMI) and USB keyboard and mouse for operation with the internal PC module. I used a wireless keyboard/mouse for testing, but wired units will work fine too. A USB hub may be required if additional USB devices are used. It is too bad that a front-panel USB jack is not available for USB thumb drives, but a USB hub or extension cable will solve that.

The ANAN-7000DLE MKII front panel has stereo ¼-inch jacks for headphones, a CW key, and a microphone. The microphone jack tip and ring are configurable in software for audio or push-to-talk (PTT). Bias for an electret mic is also configurable in software. The microphone, headphone, and key jacks are mirrored on the rear panel with ⅛-inch phone jacks. Bluetooth capability opens the possibility of a wireless headset.

The rear panel (see Figure 1) is quite a bit busier. The radio requires 13.8 V dc at about 20 A, supplied via Anderson Powerpole connectors. (Note that the Powerpole orientation is backward compared to typical usage in the US.) There are BNC connectors for three antennas, a separate receive antenna, and a transverter input. The SMA connectors are for a 10 MHz reference input, a transverter output, and a Wi-Fi antenna (not supplied). There are also two ethernet jacks (SDR LAN and PC LAN), two USB-B and one USB-C ports, an HDMI jack for the monitor, speaker and audio input jacks, and PTT and CW key jacks. The speaker jacks are wired as balanced, tip to ring, with no ground to the sleeve. The embedded PC has a four-conductor headset connector for stereo audio out and monaural microphone in, similar to many laptop computers.

Figure 1 — The ANAN-7000DLE MKII's rear panel.

Controlling External Devices

Seven open-collector outputs available via the rear-panel DB-9 connector are configured using the transverters (XVTRS) and open collector (OC) setup tabs. The transverter local oscillator (LO) frequency offset and error can be programmed in, as well as the drive power required, and control of the transverter output and internal power amplifier. With external transverters connected and configured, your ANAN transceiver can act like a single transceiver from HF through VHF/UHF/microwaves.

The open collector outputs can be used for switching antennas, filters, and other external equipment. With one-hot wiring, seven different options can be selected or deselected. With binary decoding, up to 128 options can be selected. The latest *Thetis* software has separate setup forms for HF, VHF, and SWL bands.

Hardware Knobs, Sliders, and Buttons

The *Thetis* software has a configuration interface to use MIDI devices, such as the Hercules DJ controller series to make knobs, tuning wheels, sliders, and buttons available for those who prefer traditional front-panel controls. As a longtime ANAN SDR owner, I find a hardware controller very helpful for tuning frequency and for setting AF gain, AGC, and drive levels. Over the years, I have become more accustomed to using the on-screen controls for most everything else.

Network Installation

A number of network connection possibilities exist with this system. An air-gapped (standalone) system can be implemented, but wired and Wi-Fi connections to a local area network can be set up as well. The ANAN-7000DLE MKII can also be controlled by an external PC instead of the internal embedded PC, just like the other ANAN transceivers.

An air-gapped system with no connection to the outside world is of interest to Military Auxiliary Radio System (MARS) operators who may need additional security from internet intruders. A USB drive would be needed to install additional software or transfer files.

The 7000DLE internal PC can be connected to a LAN (and the internet) via Wi-Fi, and it can be accessed by other equipment if necessary. The computer would have two IP addresses, Automatic Private IP Addressing (APIPA) for the radio and computer ethernet, and a DHCP or static address for the Wi-Fi router. Use of Wi-Fi requires an external SMA antenna (not supplied, but readily available). If security is a concern, Wi-Fi can be set up temporarily to facilitate software installation and updates, and then disabled to maintain air gap.

Bandwidth may be limited with Wi-Fi, but the 7000DLE can be hardwired to a router via the rear-panel ethernet jack. The radio and/or the computer can be set up with DHCP or static IP addresses as needed. It is possible to control the radio with an external computer instead of the internal CPU in the radio chassis with this arrangement. The external computer would be plugged into the ethernet switch along with the internal CPU and the radio.

The Software

The Apache Labs ANAN-7000DLE MKII comes with operating software and firmware already installed and configured, so further installation is not required. Because updates are made frequently, it's highly recommended that you check for the latest release online at **github.com/TAPR/OpenHPSDR-PowerSDR/releases**. Protocol 1 is the *PowerSDR OpenHPSDR mRX* software. Protocol 2 is for the latest *Thetis* software and *Metis* firmware, which we used for this review.

The display and controls for *Thetis* have not changed much from *PowerSDR OpenHPSDR mRX* software (see Figure 2). There are the usual panadapter/panafall/spectrum display, frequency and mode fields, and buttons and slider controls that drive the behavior of the unit. There are a number of setup tabs to configure less-often-used settings and controls. The main setup screen is shown in Figure 3, and details may be found in the user manual available online.

The signal display shown in Figure 4 is set up as a *panafall*, a combination of panadapter and waterfall, for both receivers. The panadapter shows the current spectrum occupancy, while the waterfall shows the spectrum occupancy over the last few seconds.

The frequency display shows both receivers, along with the transmit frequency when in split mode. It is possible to tune the radio by clicking on the pan-

Figure 2 — The main operating screen for the *Thetis* software.

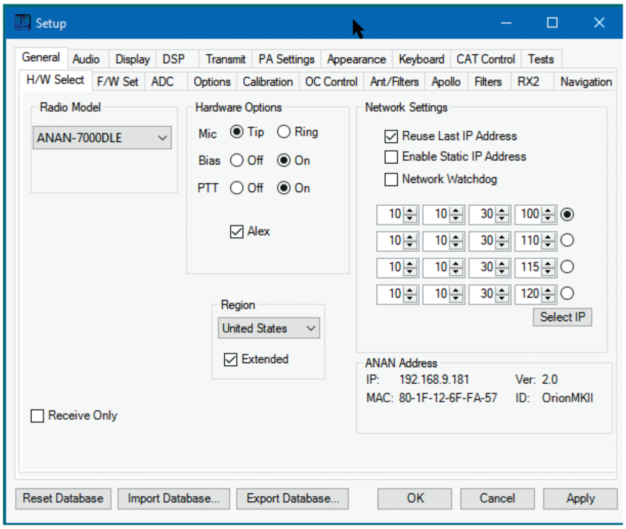

Figure 3 — The main setup screen for configuration of many hardware and software options.

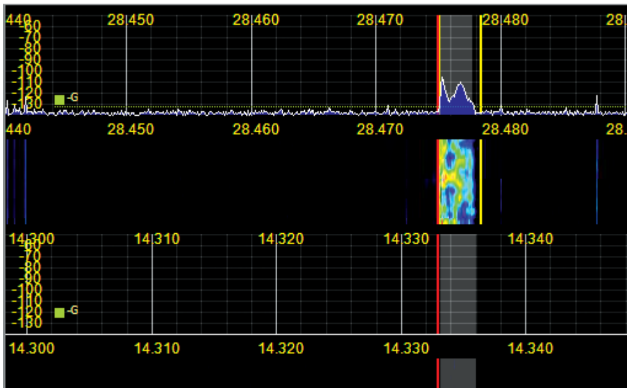

Figure 4 — A portion of the spectrum display in the panafall mode.

adapter, using the mouse thumbwheel, or entering the frequency using the keyboard. You can drag the filter edges to change bandwidth.

The meter displays are very nice. The S-meter shows signal level in dBm as well as S-units (S-9 = –73 dBm, scaling is 6 dB per S-unit). I like the split power/SWR meter that shows forward power in watts and SWR simultaneously.

The Operational Status section of the main screen shows band, mode, DSP functions, levels, and other parameters. There is a mode specific section with controls relevant to the current emission mode. Memory channels can be given group and channel names.

Thetis DSP Features

The *Thetis* software offers a number of standard DSP features. The traditional noise reduction (NR) uses a standard algorithm. The advanced noise reduction algorithm (NR2) is really outstanding. It makes SSB sound like FM, and it plays well with digital modes, including FT8 and MIL-STD-188-M110a waveforms used in MARS.

The spectral noise blanker (SNB) causes signals to pop out of the background noise, while the automatic notch filter (ANF) effectively eliminates annoying heterodynes and carriers. The multi-notch filter (MNF) will attack multiple heterodynes. The CW audio peak filter (APF) offers additional filtering in the audio subsystem.

Audio equalizers are available for receive and transmit. Transmit bandwidth can be set up to 10 kHz for AM aficionados. The advanced continuous frequency compression (CFC) and controlled envelope single sideband (CESSB) processing features allow you to get that AM broadcast quality sound. Audio profiles can store settings for various activities, such as general conversation or contesting.

PowerSDR and *Thetis* have a feature where both VFOs are synchronized to the same frequency and phase locked. If receivers RX1 and RX2 are connected to separate analog-to-digital converters (ADCs) and each ADC is connected to a different antenna, the phase and amplitude of each receiver can be adjusted to enhance desired signals or to cancel unwanted noise and interference.

In *Thetis*, if you right-click on certain controls, you are directly vectored to the tab for settings related to that control. This is very handy for mic gain, VOX, compression, transmit audio profiles, and other frequently used settings.

Thetis offers a lot of flexibility for recording and playing back signals off the air, so you can show others what they sound like rather than having to describe it in words. There is a provision for setting up scheduled recordings as well, for one-time-only or periodic recordings of your favorite shortwave broadcast or ham radio net.

CW QSK Operation

When used with *Thetis* software, the ANAN-7000DLE MKII has full-break-in CW (QSK), which earlier units did not have. The CW QSK is a great step forward for the Apache Labs ANAN series and requires some trial and error setting up the AGC parameters to let the receiver recover from the transmit signal quickly enough. Transmit-receive switching uses relays, and clicking is clearly audible.

I had an issue with QSK operation because the monitor (which tracks the transmit signal) cannot be shut off to hear just the sidetone (which tracks the keyer paddle). As with other SDRs, there is a bit of latency — a slight delay — between the keyer paddle action and the transmitted signal, which is heard in the monitor. The delay is present even with low-latency filter settings. For some reason, you cannot disable the monitor (with latency) and only use the sidetone (no latency). I found it difficult to send without the proper audio feedback while using CW keyer paddles. If sending with keyer memories or a keyboard, this is not as important. I wish there were separate slider controls for monitor level and sidetone level, independent of the master AF gain.

On the Air

I had the luxury of spending quite a while using the ANAN-7000DLE MKII on the air. I used a wide variety of bands and modes, including many digital soundcard modes, such as PSK, RTTY, FT8, and MIL-STD-M110a. I got excellent signal and audio reports across the board.

The unit worked well on MARS frequencies, which are outside the normal ham bands. You need to use the **EXTENDED REGION** in the main setup tab to enable transmission on the MARS frequencies. (Watch the band edges if you operate with this feature enabled.)

The receiver is at least as sensitive as any of my other transceivers, and perhaps more sensitive on 6 meters. It receives better and copies digital transmissions better than any of my other transceivers. The laboratory results show that receiver performance is competitive, and the transmit IMD with Pure Signal enabled is second to none.

Conclusions

The Apache Labs ANAN-7000DLE MKII is the next refinement in a now mature SDR technology available from Apache Labs. I have an Apache Labs ANAN-100D that I acquired in 2014, and I can say the ANAN-7000DLE MKII is a noticeable improvement. This is a great radio. My only issue with it is the behavior of the sidetone and transmit monitor during QSK CW operation, as discussed.

Additional information and screen captures are available from **www.arrl.org/qst-in-depth**.

Manufacturer: Apache Labs Pty Ltd., 3 Pershing Way, Point Cook, VIC 3030, Australia; **www.apache-labs.com**. Available direct or from Ham Radio Outlet. Price: $4,295. With i5 CPU, $3,995. No CPU (Black Edition), $2,795.

tinySA — A Small Spectrum Analyzer

Reviewed by Phil Salas, AD5X
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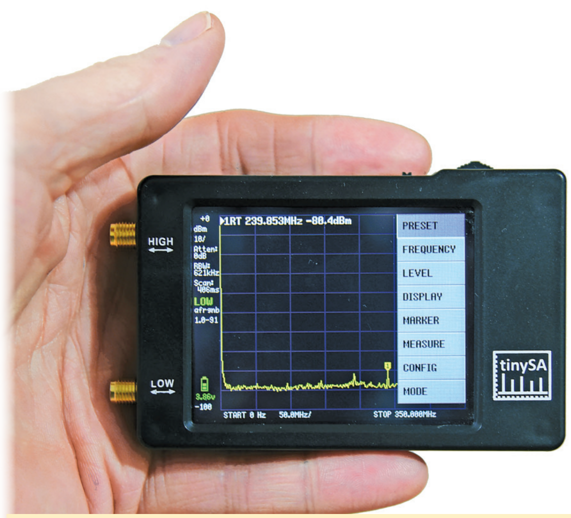
In recent years, a number of inexpensive RF test devices have come on the market. The latest is the tinySA, a small spectrum analyzer with a 2.8-inch, 320 × 240 pixel color touchscreen. This $49 spectrum analyzer was developed by Erik Kaashoek, PDØEK, and is manufactured and distributed by Hugen. The tinySA looks like the nanoVNA I reviewed in the May 2020 issue of *QST*.

Description

The tinySA comes in a nice box and includes a small telescoping antenna, two 8-inch SMA-to-SMA test cables, an SMA-female-to-SMA-female adapter, a USB cable for charging the internal battery and for computer interfacing, and a carrying strap with a guitar-pick stylus (see Figure 5). The spectrum analyzer



Bottom Line

At about $50, the tinySA can put a surprisingly capable spectrum analyzer into the hands of many STEM students and home experimenters.