Pascal Villeneuve, VA2PV, va2pv@arrl.org

Product Review

RF-KIT RF2K-S Solid-State Linear Amplifier

Reviewed by Mark Wilson, K1RO
k1ro@arrl.net

The RF2K-S is the latest in a line of high-power solid-state amplifiers made by RF-KIT in Germany. Although earlier versions were offered as kits, the RF2K-S is fully assembled and tested. Sales, service, and support for the US and Canada are handled by Island Amplifier USA in California, and amplifiers are shipped directly from Germany. The shipping cost is included in the price, and the RF2K-S took about 3 months to be delivered, but check with Island Amplifier for the current schedule.

The RF-KIT amplifiers have an active online users' group (**https://b26-pa.groups.io**), which I found helpful when setting up the RF2K-S and exploring its various features. Reinhard Foertsch, DH3NAB, from RF-KIT is active in that group and routinely offers assistance via messages or video calls.

The amplifier has two built-in microcontrollers. One fast internal controller is responsible for all measurements — control as well as storing settings and tuner values. The other is a Raspberry Pi, which is responsible for displaying and external interfaces like LAN, Wi-Fi, and USB. The amplifier features silent PIN diode transmit/receive switching (great for full break-in CW), quiet fans, an internal automatic antenna tuner, extensive transceiver interface options, and remote operation features.

Overview

The RF2K-S covers 160 – 6 meters and delivers 1,500 W output from a pair of LDMOS power transistors. These devices have very high gain, so a built-in attenuator raises the drive level to comply with the 15 dB gain maximum required by the FCC. The reviewed unit typically required about 50 W drive for full output on most bands.

An internal power supply senses the line voltage and automatically adjusts for 90 – 290 V ac input without the need to set jumpers or configure a menu. You'll need a 240 V ac line for full-power operation, but the amplifier is rated for 800 W output with a standard household 120 V line.

A 7-inch color touchscreen (see Figure 1) dominates the front panel and is used for all monitoring and control functions except the ac power **ON/OFF** switch. The power meter at the upper left has bars for forward and

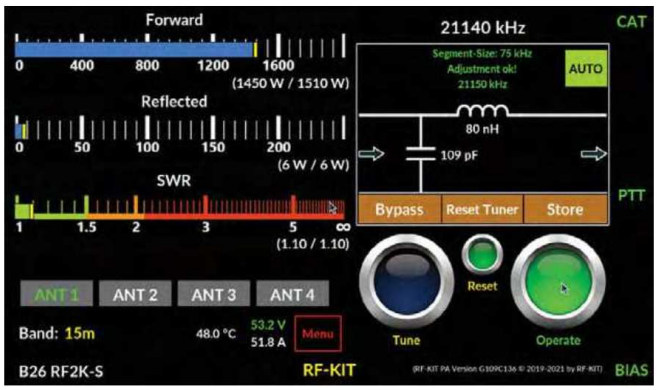

Figure 1 — A 7-inch color touchscreen is used for monitoring and controlling the RF2K-S.

Bottom Line

The RF-KIT RF2K-S offers legal-limit power for 160 – 6 meters in a desktop package. The color touchscreen, quiet fans, silent PIN diode TR switching, built-in antenna tuner, and flexible transceiver and network interfaces are attractive features.

Table 1
RF-KIT RF2K-S, serial number 43/211203

FCC ID number 2AW84RF2K-S. Firmware v. G109C136

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency range: 1.8 – 30 and 50 – 54 MHz.	160-, 80-, 60-, 40-, 30-, 20-, 17-, 15-, 12-, 10-, 6-meter bands, as specified.*
Power output: 1500 W PEP with 230 V ac power; 800 W PEP with 110 V ac.	1500 W as specified with 240 V ac; 900 W typical with 120 V ac.
Driving power required: 50 W.	43 to 67 W, see Figure A.
Spurious and harmonic suppression: Not specified	HF, 57 – 62 dB; 6 meters, 63 – 75 dB; meets FCC requirements.
Third-order intermodulation distortion (IMD): Not specified	3rd/5th/7th/9th-order products (dB below PEP at full output): 14 MHz, –33/–41/–46/–56 dB.
Transmit-receive switching time: <1 ms.	Key to RF output: 2.3 ms CAT/UDP controlled; 3.8 ms UNIVERSAL mode. Unkey to receive: 1.9 ms.
Power requirements: 90 – 290 V ac, 13 A max.	
Size (height, width, depth, including protrusions): 7.4 × 12.2 × 16.7 inches; weight: 35 pounds.	

*In the US, the legal power limit on 30 meters is 200 W PEP output, and on 60 meters it is an ERP of 100 W PEP relative to a half-wave dipole.

reflected power and SWR. If you touch the screen in that area, it changes to a cross-needle display. Four antenna jacks are on the rear panel, and indicators below the wattmeter show which one is in use. The menu has a screen for configuring automatic antenna selection for each band. The current operating band is shown, as well as output stage temperature, voltage, and current.

On the right side of the display, the current operating frequency is shown at the top, along with the transceiver interface in use for switching bands. The center-right portion of the screen displays either the RF-KIT logo or information on the internal automatic antenna tuner. Below that are three touch-sensitive buttons for starting the antenna tuning process, resetting the amplifier after a fault trips the protection circuitry, and switching between standby and operate.

From the **SETTINGS** menu shown in Figure 2, you can add your call sign or other personalized text to the screen. You can also turn off the display if you are controlling the amplifier remotely, or set an adjustable timer to put the amplifier to sleep after a period of inactivity.

Setup

The 34-page, well-illustrated manual is available online in PDF format from the RF-KIT website (**https://rf-kit.de/files/User_Manual_RF2K-S_ENG_V14.pdf**). As of mid-June, there had been a few changes to the amplifier user interface since the manual was last updated. The website also offers an assembly and adjustment manual for the kit version. You won't need this document for the current version, which is fully assembled and tested, but I found it helpful for understanding more about how the amplifier is built and adjusted.

Figure 3 shows the rear panel. The amplifier comes with an ac line cord for 240 V operation, but you may need to change the plug to match the outlet in your station. There are SO-239 connectors for the transceiver and four antennas. The **PTT** phono jack is for transmit/receive (TR) relay control from the transceiver. There is no automatic level control (ALC) connection to the transceiver, as found on some amplifiers, so be careful to not accidentally overdrive the amplifier. The **REM ON/OFF** phono jack is for switching the amplifier power on and off remotely by applying 10 to 15 V dc.

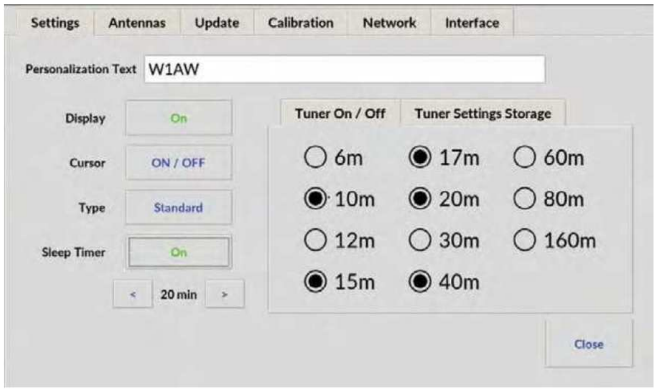

Figure 2 — The six touch-sensitive menu screens are used to configure and customize the RF2K-S for your station.

Figure 3 — The RF2K-S rear panel.

A coupler for predistortion operation with compatible SDR transceivers is built into the RF2K-S. The transmitted signal is attenuated by 55 dB and available at a rear-panel SMA connector labeled **–55dB**. This signal can be used to connect the amplifier to an SDR transceiver with predistortion capability, such as the ANAN radios from Apache Labs, to significantly improve the IMD of the transmitted signal.

The RF2K-S antenna tuner can store tuning data for up to 16 antennas per band, and the **MULTI INTERFACE** DB-15 connector accepts binary coded decimal (BCD) band inputs from an external antenna switching system to tell the tuner which antenna is in use. That connector also provides BCD band data outputs for controlling external devices such as band-pass filters or antenna switches.

Transceiver Interface and Switching Bands

There is no manual band switch. The RF2K-S automatically selects the operating band in one of four ways, set up through the **INTERFACE** menu. The interface in use is shown in the upper right corner of the display.

The Universal interface works with any transceiver. The amplifier measures the frequency of the drive signal and switches to the appropriate band nearly instantaneously when you speak a syllable on voice or send a dit on CW.

In the computer-aided transceiver (CAT) mode, the RF2K-S is capable of interfacing with transceivers from Alinco, ELAD, Elecraft, FlexRadio, Icom, Kenwood, TEN-TEC, and Yaesu via the CAT USB port. In the CAT setup menu, simply select the transceiver make and model and a baud rate (which must match the settings on your transceiver's CAT

Lab Notes: RF-KIT RF2K-S

This was a fun amplifier to test, matching the experiences of the reviewer. A few things stand out to the ARRL Lab staff.

First, as you can see in Figure A, the forward transfer curve of this amplifier is almost a straight line. This means that you get the same gain at lower-power drive as you get at higher power, rather than having the amplifier start to compress and lose gain. An amplifier in heavy gain compression will start to exhibit intermodulation and even harmonic problems. This amplifier doesn't have that issue.

The spectral output is clean. On HF, harmonics are at least 10 dB better than the FCC rules require, and on VHF, the amplifier meets the FCC rules with room to spare.

The transmit intermodulation performance is good. As seen in Figure B, at full rated power, the 20-meter band had third-order IMD performance at about 33 dB below PEP, with fifth-order IMD at about –42 dB PEP. The Lab likes clean signals, so it ran an extra test at 1,000 W PEP. This is a 2 dB reduction in power, or a fraction of an S unit. Figure C shows that a slight reduction in power makes a significant difference in the cleanliness of the transmitted signal, improving the third-order IMD performance to –45 dB PEP.

This amplifier can also make use of predistortion to improve the transmit IMD even further. This can be done with SDR transmitters that have a predistortion feature built in. One example of such a transmitter, the ANAN-8000DLE, is available to the amateur community. Its predistortion capability was discussed in the Product Review Update for the ANAN-8000DLE featured in the November 2018 issue of *QST*. The RF-2K has a predistortion output intended to work with an SDR transceiver with predistortion capability. The Lab didn't have this transceiver to use for testing, but the manufacturer's specification for the predistortion performance is rated to achieve typical 55 dB down from the amplifier's output signal for third-order IMD. — *Ed Hare, W1RFI, ARRL Lab Manager*

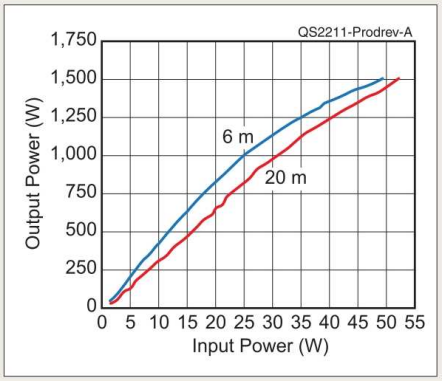

Figure A — RF-KIT RF2K-S, RF input power versus output power.

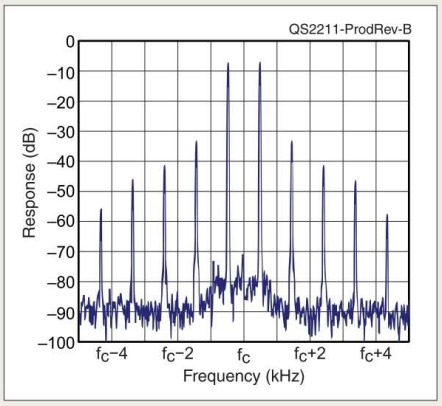

Figure B — RF-KIT RF2K-S, the 20-meter band third- and fifth-order IMD performance at 1,500 W.

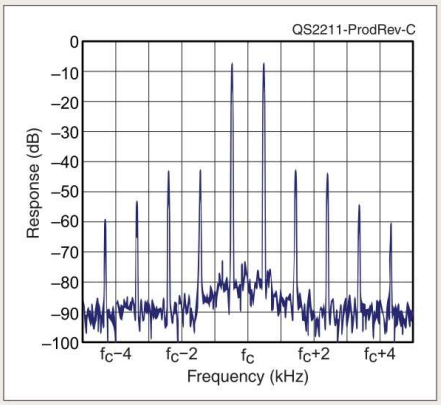

Figure C — RF-KIT RF2K-S, the 20-meter band third- and fifth-order IMD performance at 1,000 W.

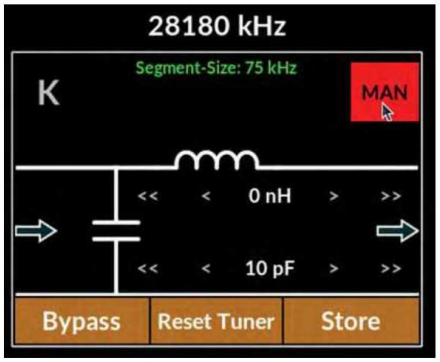

Figure 4 — The **MAN** (manual) setting allows adjustment of inductance and capacitance values if the internal antenna tuner can't find a suitable match automatically. Once values are saved, the amplifier recalls the correct settings when you return to that frequency segment.

setup menu). I used the CAT interface with a serial-to-USB converter between the serial port on my Kenwood TS-590SG transceiver and the USB jack on the amplifier. With my IC-7300, I used a CI-V-to-USB adapter. (In both cases, I was using the transceiver USB port for digital mode software and logging applications.)

The amplifier can also get frequency information using the user datagram protocol (UDP), a method of sharing information among users on a network. Ed Hare, W1RFI, used the UDP interface to control the RF2K-S with an Elecraft K4D transceiver and *N1MM Logger+* software. The final interface is TCI — Transceiver Control Interface — developed by Expert Electronics for their SunSDR transceivers and already adapted by other manufacturers and logging programs.

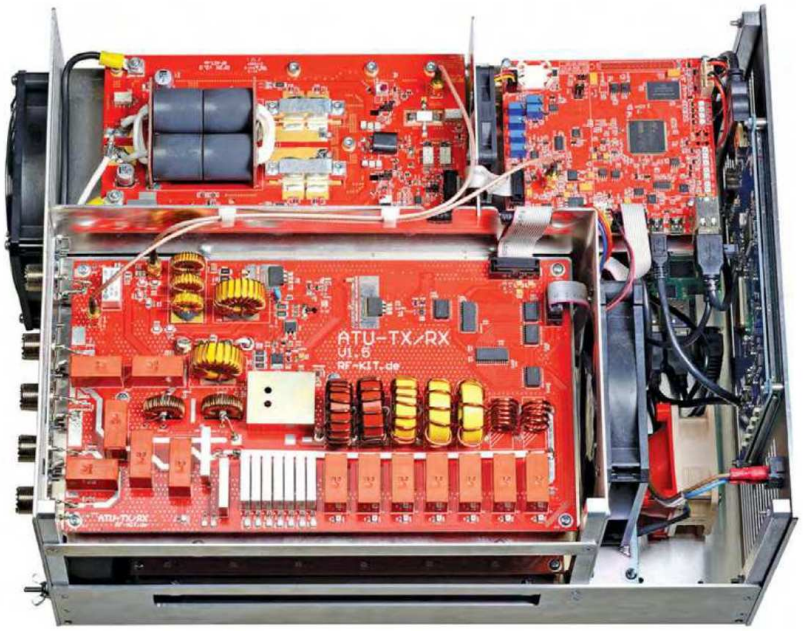

Figure 5 — Inside the RF2K-S. The LDMOS amplifier module is at the top left, with the control board to the right. The automatic antenna tuner and filters are at the bottom. The Raspberry Pi and power supply are not visible.

Antenna Switching and Automatic Antenna Tuner

There are four antenna jacks on the rear panel, with corresponding touch-sensitive indicators on the display. The **ANTENNAS** menu shows a matrix for assigning any or all of antennas 1 – 4 to the various bands. This screen also has checkboxes for enabling an external antenna switch.

The RF2K-S includes an internal automatic antenna tuner (ATU) that is specified to match SWR of up to 3:1. During antenna setup, you can specify whether the ATU is used on each antenna. I used the tuner on 40, 20, 17, 15, and 10 meters.

Each band is divided into segments shown in a chart in the manual. For example, 20 meters is divided into 51 kHz segments, and 10 meters uses 75 kHz segments. Tune the transceiver to the center of the first segment. With the amplifier in standby and the transceiver set to between 4 and 39 W output, press **TUNE** and briefly transmit a steady carrier to start the automatic tuning process. Tune to the next segment and repeat the process.

If the amplifier cannot find a match automatically, you can adjust the inductance and capacitance manually while watching indicators that appear on the display (see Figure 4). In my station, the automatic tuning algorithm only found a tuning solution on 20 meters, but I was able to tune the other bands manually and save the settings. There are three memory banks for saving antenna tuner settings, which would be a big time-saver if you used the amplifier in multiple locations.

Other Features

A common complaint about solid-state high-power amplifiers is fan noise. I have used quite a few solid-state amps over the years, and I have found the RF2K-S to be quieter than other models. The amplifier has a fan on the rear panel and several internal fans visible in Figure 5, but they don't run all of the time. They start when the power amplifier (PA) temperature reaches 42 °C and increase to maximum speed at 55 °C. With the fans running at maximum speed, I could operate without headphones if I wanted to. That's not to say that the amp is *quiet* at maximum fan speed, but I didn't find the level or pitch of the noise bothersome.

For most casual SSB and CW operation, I found that the temperature stayed below 42 °C and the fans stayed off. When oper-

ating RTTY or FT8, it took about 5 minutes to reach maximum fan speed. During prolonged digital mode or CW contest operation, the temperature generally stayed between 55 and 70 °C.

The manual does not discuss a protection system, but I found that the RF2K-S will switch to standby and display an alarm message on the touchscreen if the PA temperature exceeds 72 °C or if the SWR is too high. Touch **RESET** on the screen to restore operation when the fault is cleared. The temperature alarm tripped occasionally when I was running high-duty-cycle digital modes on 10 meters.

The **CALIBRATION** menu includes a screen for calibrating the power meter. The amplifier's forward and reflected power meter readings can be increased or decreased to match an accurate external power meter. Separate settings are available for 160, 80/60, 40/30, 20/17, 15/12/10, and 6 meters.

The RF2K-S was designed for easy internet connectivity, and a number of operators on the **https://b26-pa.groups.io** site use the amplifier in remote stations. You can connect to a local area network (LAN) via the rear-panel Ethernet jack, or via the Raspberry Pi's Wi-Fi feature. From the **NETWORK** screen, I easily connected the RF2K-S to my home Wi-Fi network and was able to check for firmware updates from the **UPDATE** screen. The display clearly shows the graphical user interface (GUI) and controller versions currently installed, along with the latest available version. If you're behind, just touch the **UPDATE** button.

With the Wi-Fi connection running smoothly, I installed the free *VNC Viewer* app from RealVNC on my iPad and was able to monitor and control the amplifier from anywhere in the house. The iPad display is an exact replica of the RF2K-S touchscreen.

Final Thoughts

The RF-KIT RF2K-S has a lot to offer for use in home or remote stations. It delivers legal-limit power from 160 through 6 meters in a compact and quiet package. The color touchscreen and menus are easy to navigate, with flexible transceiver/CAT and LAN interfaces. The internal antenna tuner worked well to match a variety of loads, but the automatic tuning feature could be improved. Once the amplifier is set up, it requires very little involvement from the operator.

Manufacturer: RF-KIT, Gräfenberg, Germany, **https://rf-kit.de**. Distributed in the US and Canada by Island Amplifier USA, 1260 Vina Del Mar Ave., Placentia, CA 92870, **https://islandamplifier.com**. Price: $5,490.

Digital Multimeters (VOMs)

Reviewed by Paul Danzer, N1II
n1ii@arrl.net

For many years I had a volt-ohm-milliammeter (VOM) in the trunk of my car. I needed only a few basic functions: continuity, to see if a fuse was blown; measuring a 12 V line where accuracy was not important (I just needed to see if the 12 V — and years before, 6 V — was at a particular point); and finally, when I forgot about the meter (as I usually did), the battery did not leak and corrode so badly that with a little scraping I could change it. They usually cost between $5 and $10 and were forgotten in the trunk of the car when I sold it.

Needless to say, I had something better in my shack. Typically there was a meter known as the Simpson 260 — or a clone of it. Usually these clones had an analog dial with a mirror strip to reduce the phenomenon known as parallax — a reading that was slightly off due to the fact that you were seeing the needle at an angle. This inexpensive compensation was hardly important, because often the basic accuracy was 10 – 15%, if even known for the clones!

Often lacking was any sort of protection. It was not uncommon to accidentally have the meter on the wrong scale or to connect the leads backwards, resulting in a bent needle; very often a minute puff of smoke would be generated when the meter was set to measure ohms but connected to a voltage.

Today, models and clones of the Simpson 260 meter are still available from both well-established and import sources. Online pricing runs approximately $50 and up, and while the exterior style often resembles the 260, the accuracy of the circuits used is usually unknown.

Bottom Line

A multimeter should be one of the first tools to buy for any new amateur radio operator. Most digital VOMs will do the job, but one of the most useful features for hams is the continuity test with sound (beeps) to check all connections and avoid any shorts.