Product Reviews

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Yaesu FTM-500DR C4FM/FM 144/430 MHz Transceiver

Portable Power Station - Bluetti EB55

Portable Power Station - EcoFlow RIVER 2 Max

Portable Power Station - Bioenno Power BPP-M500

Product Review

Yaesu FTM-500DR C4FM/FM 144/430 MHz Transceiver

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The Yaesu FTM-500DR is what I call a "kitchen sink" transceiver, and that's intended as a compliment. It is just another way of saying that this radio includes everything except, as the old saying goes, the "kitchen sink."

The FTM-500DR operates either analog FM or C4FM digital on the 2-meter and 70-centimeter bands, but it also receives at all frequencies from 108 to 999.995 MHz (cellular frequencies blocked, of course; see Table 1). The transceiver offers RF output levels of 5, 25, and 50 W with a single SO-239 antenna port.

Like a number of Yaesu transceivers available today, the FTM-500DR is a System Fusion radio — that is, it can sense the modulation scheme of a received signal and adapt accordingly. When you have the Automatic Mode Select (**AMS**) function enabled, you may be called by someone on FM simplex, or through an analog FM repeater, and the FTM-500DR will configure itself for analog FM operation automatically. But if someone calls you using digital C4FM, the radio will instantly jump to C4FM mode without any input from you. While operating in digital mode, you can select between two modes: Voice Wide (**VW**) and Digital Narrow (**DN**). The **DN** mode carries 6.25 kHz of audio data and 6.25 kHz of other information, such as location data — all this simultaneously. If you go into the menu system, you can add the ability to operate in **VW**, which transmits a broader digital signal using the full 12.5 kHz for audio that permits higher fidelity. I found the **DN** mode to be sufficiently clear for my purposes, but the fidelity improvement when I tried **VW** mode was impressive.

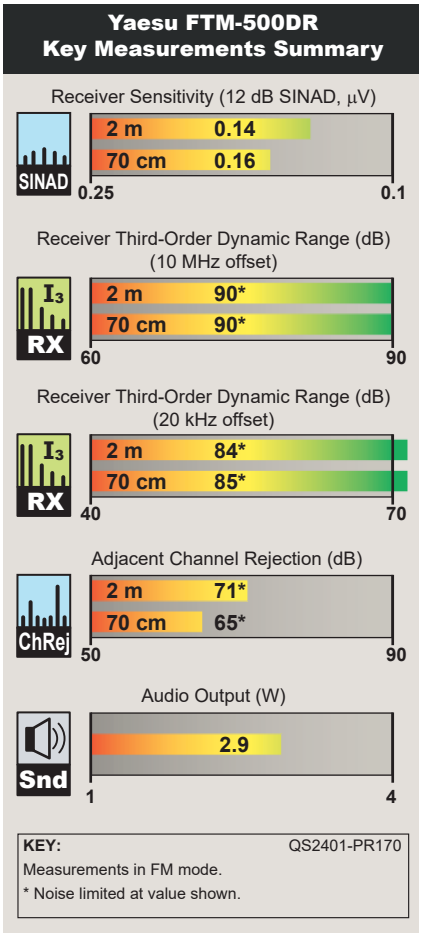
The radio body has a slender profile, at about 5.5 × 1.7 × 5.2 inches. As you can see in the lead photo, the detachable control head is significantly larger, at 6.1 × 2.5 × 2.3 inches. The size disparity is understandable when you realize that the control head includes a 2.4-inch touchscreen that is used to display signals from two bands simultaneously, not to mention an optional band scope. The FTM-500DR also offers a sizable tuning knob, and other knobs and buttons that are sized and positioned for maximum ergonomic efficiency. The main and sub bands each have their own dedicated volume controls on the left-hand side of the head; you can adjust the squelch level with a single press on the desired volume knob.

The control head also includes its own speaker, which appears along the bottom of the unit. Another larger speaker is available on the body as well (we'll discuss the speakers in more detail later).

Of course, you have the option to relocate the body elsewhere in your vehicle, such as under the seats, but you'll need to purchase an optional extension cable to

Bottom Line

The FTM-500DR is a fully featured radio, but Yaesu's simplified approach makes it easy to operate even for beginners. The innovative Acoustic Enhanced Speaker System (AESS) is astonishing, especially for mobile use, and is something you really must hear for yourself.



do this, such as the 10-foot SCU-62 or the 20-foot CT-132. Note that a common Ethernet cable is not recommended, as it will impact the operation. The good news is that the large multifunction microphone can plug directly into the control head. Unlike some transceivers, you won't need to run a separate microphone cable to the body of the unit.

The FTM-500DR is a sharp-looking radio overall, and it is packed with so much functionality; the details can't be contained within a single operating manual (or within the confines of a single *QST* review). That's why the manual included with the radio highlights only the most used

Table 1

Yaesu FTM-500DR, serial number 3E020243
Firmware: Main – 1.02, Sub – 1.02, DSP – 7.20

Manufacturer's Specifications	Measured in the ARRL Lab
Frequency coverage: receive, 108 – 137 MHz (air band), 137 – 174 MHz (144 MHz ham / VHF band), 174 – 400 MHz, 400 – 480 MHz (430 MHz ham / UHF band), 480 – 999.995 MHz (USA cellular blocked); transmit, 144 – 148, 430 – 450 MHz (FM).	As specified.
Modes: FM, digital voice, data.	As specified.
Power requirements: receive, 500 mA; transmit, 10 A on 144 and 430 MHz, 50 W at 13.8 V dc.	Receive, 462 mA (max volume, max lights, no signal, each receiver), 420 mA (max volume, min lights, no signal); transmit, 146 MHz, 9.1/5.8/2.8 A (high/med/low), 440 MHz, 9.9/6.8/3.3 A (high/med/low) at 13.8 V dc.
Receiver	**Receiver Dynamic Testing***
Sensitivity: FM (12 dB SINAD), 0.2 µV (137 – 150 MHz), 0.25 µV (150 – 174 MHz), 0.3 µV (174 – 222 MHz), 0.25 µV (222 – 300, 336 – 420 MHz), 0.2 µV (420 – 520 MHz), 0.4 µV (800 – 900 MHz), 0.8 µV (900 – 999.99 MHz); AM 10 dB S/N, 0.8 µV (108 – 137, 300 – 336 MHz).	FM (12 dB SINAD), 0.14 µV (144 MHz), 0.16 µV (440 MHz), 0.14 µV (WX), 0.48 µV (223 MHz), 0.44 µV (902 MHz); AM (10 dB S+N/N), 0.72 µV.
FM two-tone, third-order IMD dynamic range: Not specified.	20 kHz offset, 146 MHz, 84 dB†, 440 MHz, 85 dB†; 10 MHz offset, 146 MHz, 90 dB†, 440 MHz, 90 dB†.
FM two-tone, second-order IMD dynamic range: Not specified.	146 MHz, 95 dB, 440 MHz, 115 dB.
Adjacent-channel rejection: Not specified.	20 kHz offset, 146 MHz, 71 dB†, 440 MHz, 65 dB†.
Spurious response: Not specified.	If rejection, 146 MHz, 103 dB; 440 MHz, >136 dB; image rejection, 146 MHz, >137 dB, 440 MHz, 73 dB.
Squelch sensitivity: 0.16 µV (144/430 MHz).	At threshold, 146 MHz, 0.09 µV, 0.30 µV (max), 440 MHz, 0.15 µV, 0.36 µV (max).
S-meter sensitivity: Not specified.	S-9, 3.7 µV (144 MHz), 4.8 µV (440 MHz).
Audio output: 3 W at 10% THD into 8Ω.	2.9 W, 10% THD into 8Ω. THD at 1 V_{rms}, 1.6%.
Transmitter	**Transmitter Dynamic Testing**
Power output: 50, 20, 5 W (high, med, low). At 13.8 V dc nominal.	As specified.
Minimum operating voltage: Not specified.	At 12 V dc, 144 MHz, 47/24/5 W output.
Spurious signal and harmonic suppression: >60 dB.	≥60 dB, meets FCC requirements.
Transmit-receive turnaround time (PTT release to 50% of full audio output): Not specified.	Squelch off, S-9 signal, 146 MHz, 356 ms; 440 MHz, 360 ms. With AMS on. 146 MHz, 100 ms; 440 MHz, 102 ms. With AMS off.
Receive-transmit turnaround time ("tx delay"): Not specified.	146 MHz, 74 ms; 440 MHz, 75 ms.
Size (width, height, depth): 6.1 × 2.5 × 2.3 inches (control panel without knobs); 5.5 × 1.7 × 5.2 inches (radio unit).	
Weight: 3.1 pounds (control panel + radio unit + control cable).	

*"Main" and "Sub" receivers measured identically, unless noted.
†Measurement was noise limited at the value indicated.

features. If you want information about more advanced features, such as WIRES-X or the Automatic Packet Reporting System (APRS), you will need to download separate detailed manuals in PDF format from the Yaesu website.

The FTM-500DR Operating System

In a radio as complex as the FTM-500DR, anything that can be done to streamline operation for the user is worthwhile. Yaesu's solution is the Easy to Operate (E2O)-IV operating system. The short summary of E2O-IV is that it consolidates several potentially complicated functions, making the FTM-500DR much easier to learn and operate, even for a beginner.

Consider the **TOUCH & GO** and **SEARCH & GO** functions as examples. With the band scope running in the display, you can use **TOUCH & GO** to jump to a desired frequency with a single touch on a signal bar. With **SEARCH & GO**, a short press on the band scope will start simultaneous reception of that frequency and the main frequency. Another short press will return you to the scope screen.

E2O-IV also streamlines your ability to monitor up to five separate frequencies simultaneously. You "register" your favorites in the Primary Memory Group (**PMG**) with the touch of a button (see Figure 1). You can register up to five. When you press and briefly hold the **PMG** key, the radio begins scanning through the registered channels and displaying activity via vertical bars in the lower half of the display. If you notice that a frequency suddenly appears to be active, a single touch on the bar will take you to that frequency, which replaces the bars in the lower portion of the display.

Another E2O-IV enhancement is the Customized Function List (**CFL**). As with any feature-rich radio, there are some functions you'll use frequently, but others you'll rarely use at all. **CFL** allows you to create a quick-access list of only those functions you use most often. You can add up to eight functions to the list (such as **SCAN**, **APRS ON/OFF**, **TX PWR**, etc.) and then access the list with just a single press of the **FUNC** knob.

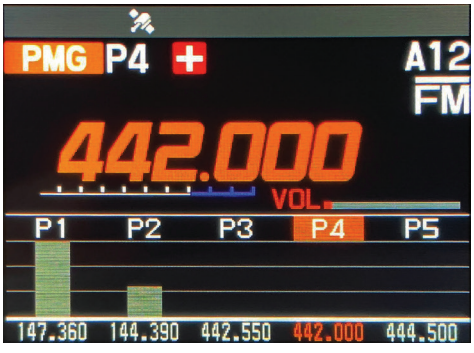


Figure 1 — The Yaesu FTM-500DR PMG feature.

E2O-IV makes it easy to group memories within the same frequency bands for easier scanning and recall. You can even choose to eliminate reception of a given band if it doesn't interest you. Not interested in listening to aeronautical traffic? Use the VFO Band Skip function to temporarily remove it from available bands. When you press the **BAND** button to toggle between bands, the aviation band (108 to 137 MHz) will no longer appear.

AESS

The Acoustic Enhanced Speaker System (**AESS**) is a feature unlike anything I've seen before in an amateur radio transceiver. While it can be described in words, **AESS** is something you really must hear for yourself.

Imagine that you have the FTM-500DR control head mounted beneath the dashboard of your vehicle while the transceiver body is resting beneath a back seat. As I mentioned previously, both units have speakers, and these speakers can be active simultaneously. But if your vehicle is like mine, you know it has its own peculiar acoustic environment. Some sounds you can hear well, but others not so much.

With **AESS**, you can adjust high- and low-frequency emphasis and total volume balance for each speaker independently. You can also adjust the phase balance between the two speakers, effectively introducing a slight delay in either the front or the rear. The effect in my SUV was astonishing. I found myself playing with the **AESS** for quite a while, just listening to the various effects. Your experience will vary depending on your vehicle, but I found **AESS** to be innovative and useful.

Memories and MicroSD

The FTM-500DR has more memories than most of us will ever use. The memory complement includes 1,104 channels with five "home" channels, 50 sets of memories for programmable memory scanning, and 999 "basic" memories.

Yaesu offers free software for managing memories (*ADMS*), but you will need to purchase the SCU-56 cable, which is included in the SCU-58 kit for about $40, in order to connect the radio to your computer. RT Systems (**www.rtsystems.com**) offers a software and cable package for $49.

The FTM-500DR can also accommodate a microSD memory card, and I found that it was possible to write the memory contents to the card, read the card into my computer, and then edit the information there. That's a multi-step process, however, and editing memories with a cable and software is much easier.

That said, I found it relatively straightforward to manipulate the memories via the transceiver's touchscreen. Yes, you have to go through a few steps, but I programmed the FTM-500DR this way initially, and it wasn't overly difficult.

Bluetooth

The wireless Bluetooth feature in the FTM-500DR is well designed. I have a Bluetooth microphone/headset that I use for online conferencing, and I was able to easily pair it with the transceiver. With the FTM-500DR's voice-operated switch (VOX) feature, all I had to do was speak and the radio began transmitting automatically. It pays to be careful if you use a wireless headset with the FTM-500DR in this fashion; you could transmit some utterances best kept to yourself!

Also, if you're considering using a headset as a wireless option while driving, check with your state motor vehicle department first. Some states prohibit headsets completely, while others allow them if they cover only one ear.

APRS

The APRS is a digital communication system for tracking moving objects (such as vehicles), but it also supports other data exchanges such as text messaging, weather information, and more (see Figure 2). In the FTM-500DR, Yaesu has included full-featured APRS functionality. There is a highly sensitive Global Positioning System (GPS) receiver on board that can determine your location within a few meters. The information can then be shared with the built-in terminal node controller (TNC) for transmission to the APRS network.

The APRS modem/TNC defaults to "off" out of the box, so you need to switch it on in the menu system. You will also need to input your APRS call sign and extension. Once you've completed these steps, and set the radio to 144.39 MHz, the FTM-500DR will begin displaying beacon data received from other stations.

I set up the transmit beacon function and drove around the area with the FTM-500DR blasting out my position at regular intervals. I even managed to get a couple of my beacon packets relayed by the digipeater aboard the International Space Station. Not bad for just 25 W to a magnetic mount antenna.

While the FTM-500DR can, of course, send and receive APRS text messages, entering a message for transmission is not easy. A convenient addition to a future transceiver would be the ability to interface a wireless keyboard.

At the rear of the FTM-500DR you'll find a data port to connect to a personal computer (see Figure 3). You can send APRS data to software on your PC, and you can even tap into the GPS data stream for use with another device.

It is also worth noting that the transceiver allows you to record your travel route to a microSD memory card for later viewing on an application such as Google Earth.

Group Monitor

Yaesu has included the Group Monitor feature in the FTM-500DR. While its use is limited to communicating with other Yaesu C4FM transceivers, it has the potential to be quite handy.

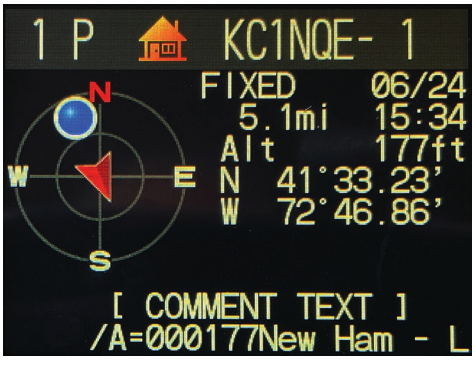


Figure 2 — The Yaesu FTM-500DR APRS screen.

Figure 3 — The Yaesu FTM-500DR rear panel.

Group Monitor essentially creates a kind of ad hoc network between compatible transceivers. Let's say you and several friends all own Yaesu C4FM transceivers with Group Monitor functionality. When the Group Monitor function is enabled (it is just a single button push on the top of the FTM-500DR control head), the radio begins pinging and listening for others who are in Group Monitor mode.

As responses are received, you can see a display of call signs, locations, and distances from your position. You can communicate with individuals in the group and even exchange text messages.

Unfortunately, I didn't have anyone nearby with a compatible transceiver, so I wasn't able to try Group Monitor myself. The Group Monitor feature is sufficiently complex to require its own manual, which is downloadable from the Yaesu website (**www.yaesu.com**).

WIRES-X

Perhaps the most interesting aspect of the FTM-500DR's digital functionality is its ability to interface with the WIRES-X network. The network is composed of nodes that act as portals to the network (see Figure 4). Most WIRES-X nodes are incorporated into System Fusion repeaters, but that doesn't mean that every Fusion repeater is hooked up to WIRES-X. In my immediate vicinity I found six Fusion repeaters, but only two supported WIRES-X. The easiest way to check is to go to the Yaesu WIRES-X Active Node ID List at **www.yaesu.com/jp/en/wires-x/id/active_node.php**. This list includes not only WIRES-X-capable repeaters, but simplex nodes as well.

Through WIRES-X you can enjoy conversations with amateurs all around the world, using the internet as a bridge to pass audio data and other information back and forth. Accessing the WIRES-X network is remarkably easy. I just selected a nearby WIRES-X repeater (I had programmed it into a memory slot) and then pressed the **DX** button on the top of the control head. The transceiver immediately attempted to establish a digital connection. It announced its success on the display, and I used the multifunction microphone to punch in the code for one of my favorite WIRES-X "rooms" (a room is like a reflector, or a group chat). Once I was connected, I soon heard a CQ from a station in the United Kingdom. At the same time, his call sign appeared in the display. I answered and we began carrying on a conversation while I zoomed along the interstate. It was a bit surreal to be doing this with a VHF/UHF transceiver.

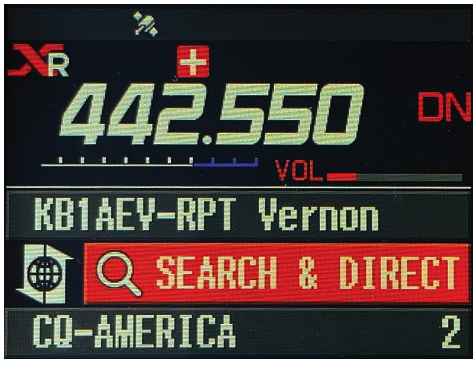


Figure 4 — The Yaesu FTM-500DR connected to the WIRES-X network repeater node.

Please note that with the optional SCU-58 cable you can connect this radio directly to the WIRES-X network using a computer in portable digital node (PDN) mode. The PDN mode allows the FTM-500DR to act as a digital C4FM hotspot or a digital internet radio. If you opt for the optional HRI-200, all the necessary cables are provided. These features are covered in more detail in the Yaesu FTM-200DR review in the September 2023 issue of *QST*.

And That's Not All

The FTM-500DR is so feature rich, I tend to focus on the aspects that are new or novel. Of course, the FTM-500DR offers all the other features you've come to expect in a modern VHF/UHF transceiver. There are multiple frequency scanning modes, weather broadcast reception, a microphone with DTMF buttons and several multifunction programmable buttons, a powerful and quiet cooling fan, two speaker ports on the main body that can be dedicated to main or sub-band audio, and AM reception on the aeronautical band.

But there are also several other items that caught my attention. The first was a new dual CTCSS paging function. It combines two CTCSS tones as a reliable, yet unobtrusive, way of sending and receiving paging signals.

And thanks to its ability to accommodate a microSD card, the FTM-500DR allows you to record any received audio you wish. It will record your own transmissions as well. Install a card with sufficient capacity, and it will record for quite a while. I found the audio quality to be very good, and I can imagine using this feature during public service operations as a means of keeping a record of what transpired.

This may seem trivial, but I liked the fact that I could rotate the control head about 20 degrees to face upward. I haven't seen that feature on other radios lately,

and it can do wonders for display readability in a mobile environment. Yaesu also offers different mounting options for the remote head, like the SJMK-500 (Swing-Head Kit) and the MMB-103 (Dash Mount Bracket).

Finally, there is the "Super DX" function. This feature is a bit of a head scratcher because the manual has little to say about it, other than to note that pressing the **S-DX** button on the top of the control head improves sensitivity. That's it. It seemed to work at the frequencies I tried, but the effect was difficult to quantify in the field. I noticed a definite improvement with weak FM signals, roughly two S-units on 2 meters, for example.

Conclusion

If you are a fan of C4FM and System Fusion, it isn't hyperbole to say that the FTM-500DR is the ultimate transceiver in its class. It offers performance and features that are heads above any other FM/C4FM combo radio.

Manufacturer: Yaesu Musen Co., Ltd., Tokyo, Japan. Available from several US suppliers, **www.yaesu.com**. Price: $649.95.

Portable Power Stations — Jackery Explorer 500, Bluetti EB55, EcoFlow RIVER 2 Max, and Bioenno Power BPP-M500

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Introduction

I enjoy Parks on the Air (POTA) activations and other outdoor amateur radio activities that require portable dc power. I wanted some ac backup power at home to keep critical items running when the power goes out. I also believed that solar power should be a desirable option. I found a potential solution to these requirements with a battery-powered, portable power station that combines all these functions in one device.

A power station, sometimes called a "solar generator," is an integrated system consisting of a lithium-ion battery, a 110 V ac battery charger, a battery management system, a solar controller, a power display, and a 110 V ac inverter all in one case that has a variety of ac and dc inputs and outputs. In this review, we will be testing the devices themselves and not the solar panels.

They are advertised for use when camping and for providing backup power for cell phones, laptops, small appliances, and home medical devices. Some of them are more powerful and expensive, so we've concentrated the reviews on comparable portable units less than $500. They are safe, environmentally friendly, and quiet. The selected ones are easily carried and transported, and you don't need much technical knowledge to connect everything. However, their documentation is sparse, and schematics or diagrams are unavailable. They are not consumer serviceable.

To determine what these devices are capable of, the ARRL Lab and I tested four well-known brands: Jackery, Bluetti, EcoFlow, and Bioenno Power. Power stations are rated in watt hours (Wh) and are available from 250 to 3000 Wh. A watt hour is a unit of energy equal to 1 W expended for 1 hour of time. It is commonly used as a measure of the total amount of energy in a battery or other electrical device. For example, at 100% efficiency, a 500 Wh power station will provide 1 W for 500 hours, or 50 W for 10 hours. We selected 500 Wh power stations for their size, weight, charging options, and outputs (see Table 2). On average, they cost about one dollar per watt hour.

These power stations share many common characteristics. They all weigh 13 to 15 pounds. They are all squarish black and gray hard plastic boxes that are a few inches less than a foot wide and 7 or 8 inches both high and deep.

Table 2
Four Portable Power Stations

Brands and Models	Jackery Explorer 500	Bluetti EB55	EcoFlow RIVER 2 Max	Bioenno BPP-M500
Battery type	Lithium-ion	LiFePO4	LiFePO4	Lithium-ion
Battery pack capacity in watt hours	518 Wh	537 Wh	512 Wh	520 Wh
Recharge cycles with 80%+ capacity	500	2,500	3,000	2,000
Recharge time, 110 V ac	7.5 hours	Approx. 3 hours	1 hour	8 – 10 hours
Recharge time, accessory socket	7.5 hours	6.1 hours@100 W	Not specified	Not specified
Recharge time, solar panel	9.5 hours	1.8 – 2.3 hours	Not specified	Not specified
Light	Yes	Yes	No	No
Car accessory socket charging	Yes	Yes	Yes	Yes
USB charging	Yes	Yes	Yes	Yes
Solar input max	100 W	200 W	220 W	100 W
ac charger supplied	Yes	Yes	Internal	Yes
Number of 110 V ac outlets	1	4	4	2
110 V ac output	500 W	700 W	500 W	520 W
110 V ac output peak	1000 W	1400 W	1000 W	750 W
12 V dc accessory socket max	10 A	10 A	10 A	10 A
dc outlets, other	2	2	2	4
USB outputs	3	5	4	4
Controlled by app	No	No	Yes	Yes
Size in inches (height, width, depth)	9.2 × 11.8 × 7.6	7.8 × 10.9 × 7.9	10.2 × 10.6 × 7.7	6.9 × 12.0 × 7.9
Weight	13.3 lbs	16.5 lbs	13.4 lbs	14.3 lbs
Warranty	2+1 years	2 years	5 years	5 years
See *QST* in Depth (**www.arrl.org/qst-in-depth**) for the full ARRL Laboratory testing results for each unit.				

They all provide "pure sine wave" 110 V ac from their built-in inverters. They all have 110 V ac outlets that provide 500 to 700 W with a kW or more surge capability. All have a single car accessory socket that supplies 12 V dc at 10 A. Additional dc outputs can also be connected using 12 V barrel connectors. And they all have advanced battery management systems that protect the battery from overheating or otherwise shortening the battery's life.

On-the-Air Operations

The Car Accessory Socket Configuration

I configure my radios with Powerpole connectors, but only one of the power stations (Bioenno Power) has Powerpole outputs. For the others I had to use a car accessory socket male-connector-to-Powerpole adapter. I tried three different adapters until I found one that fit the accessory socket tightly. I gave the connectors a hard push to make them connect with the small positive contact inside the socket. As I learned the hard way, some of these adapters have internal fuses, and the 5 A fuse in one of the adapters blew as soon as I tried to transmit with the Icom IC-7300.

It is good practice not to exceed the 10 A limit of the connector or accessory socket, as overheating of the cable or other problems may occur. All of the power stations that I tested turned off by themselves when the current through the accessory socket exceeded 10 A or so.

After obtaining a solid connection with the accessory socket, I connected the power stations to my Icom IC-7300. To stay within the 10 A current limit of the accessory socket, I had to limit the IC-7300's RF output power to about 40 W. The power stations display only their output and input power in watts and the percentage of battery power remaining. So, I connected my in-line Powerwerx Power Analyzer that read volts, amps, and watts to make sure that the voltage and current going into the transceivers were within specifications.

The higher-wattage power stations would provide more operating time, but the 12 V dc output for the accessory socket was still limited to 10 A. At this power, an HF radio would run for about 8 hours on a 500 Wh power station depending on the individual transceiver, the mode, and the duty cycle of the transmission. This power output was fine for running a typical VHF/UHF mobile transceiver, a 100 W HF transceiver at reduced power, or a QRP rig.

The External 13.8 V Power Supply Configuration

Another way to connect a power station to a transceiver is to plug a 110-V-ac-to-13.8-V-dc power supply into a power station's ac outlet. This is the same way that you would connect a transceiver to a gas generator's 110 V ac outlet. This configuration works fine if you want to power your home station when the commercial power is out or if you prefer not to use commercial power.

The 110 V ac outputs on the power stations are rated 500 to 700 W, and that provides plenty of power to run a transceiver at 100 W. My Icom IC-7300 worked fine at 100 W RF output with this type of connection. While not very elegant, and with a slight loss of efficiency, this method is a good solution for backup power at a home station, particularly if the power station is also connected to a solar panel. The disadvantage of this method is that if the power station's battery runs down faster, an additional power supply is needed. I tried this configuration at home with my Samlex SEC-1235M power supply and in the ARRL Lab with a small MFJ switching power supply, and they both worked fine in this mode.

Jackery Explorer 500

I found the Jackery Explorer 500 to be an easy-to-use, compact power station that has a capacity of 518 Wh using a lithium-ion (NMC) battery. It is a handsome unit with its two-tone orange and black color scheme. Orange lines separate the functional areas, and the switches are labeled with white letters that are easy to see in low light.

It's the lightest and smallest of the group, weighing only 13.3 pounds and measuring 11.8 × 7.6 × 9.2 inches. With an integrated handle on the top of its case, it's easy to carry and transport, and it's very rugged.

Jackery specifies that the battery is good for 500 charging cycles to 80% capacity. It is protected for overvoltage and short circuits by a battery management system. The ac charging time is 7.5 hours with either the 110 V ac charger or the car accessory socket adapter.

The user manual is clearly written and nicely illustrated. There is little technical information, but there is a lot more information on the Jackery website (**www.jackery.com**). It was the only unit that came with a cloth zippered bag to store its car charging cable, and the external ac battery charger — a nice touch. Having an external ac charger makes the Jackery lighter in weight, and the charger can be replaced if necessary.

Bottom Line

The Jackery Explorer 500 is a solid option if you need a lightweight, compact, and easy-to-use power station. It is RF quiet using both the dc power and the 110 V ac outlet to a 13.8 V dc power supply.

Display

The front-panel LCD displays black symbols against a gray background, and it packs plenty of information. But it is smaller and not as bright of a display as the other reviewed power stations. The display indicates power level percentage, input and output power in watts, and warnings for low and high temperature, battery overcharging, overloading, and battery draining. There is also a bright flashlight on the side of the Explorer 500 that is controlled by a switch next to the light — a useful feature when the power is out.

Inputs

The Explorer 500's battery can be recharged with the supplied external 90 W ac charger. There is no indication of charging status on the ac adapter. It can also be recharged with a car accessory socket or a solar panel. It has a built-in maximum power point tracking charge controller that maximizes the efficiency of the solar panel. It pairs with the Jackery SolarSaga 100 W solar panel that is sold separately for $299. The SolarSaga can charge two small devices, like a cell phone or tablet, directly without the power station connected. The maximum solar panel input is limited to 200 W.

Output

The front panel has only one switchable, three-prong ac outlet that delivers 110 V ac at 500 W. That's fewer outlets than any of the other power stations. An ac multi-box would have to be added if more ac outlets are needed. There are two dc outputs at 12 V and 10 A, and there are three USB-A outputs labeled **5 V, 2.4 A**.

The car accessory socket that I used to power my radio provides about 13 V. I was disappointed that there was no rubber cover for the car accessory socket. There are also two dc barrel output connectors. All the dc output connectors are controlled with one switch.

I ran my Icom IC-7300 at 40 W for more than an hour on 20 meters FT8 using power from the accessory socket. After an hour, the battery still read 95% available, and it still supplied 13.2 V. It is RF quiet using the dc power or a 110-V-ac-to-13.8-V-dc power supply.

Summary

The Jackery Explorer 500 is a solid option if you need a lightweight, compact, and easy-to-use power station. Its only limitation is its one ac outlet and comparatively long battery-charging time. It has the best documentation and packaging, and its front panel is easy to use and understand. It is backed by an additional 2-year warranty and a 1-year extended warranty and lifetime technical support.

Manufacturer: Jackery Inc., 48531 Warm Springs Blvd., Ste. 408, Fremont, CA 94539, **www.jackery.com**. Price: $499.

Bluetti EB55 Portable Power Station

The Bluetti EB55, which is about the size of a small microwave oven, is a versatile power station with many advanced features. It is the heaviest of the reviewed units, at 16.5 pounds, and its LiFePO4 battery provides a 537 Wh capacity. It can produce 700 W ac power and up to 1400 W ac surge power.

It comes with a hefty external ac charger, a car charging cable, a solar charging cable, and a charging adapter cable. The printed user manual is a scant, folded piece of paper with only the most essential information. Bluetti's website (**www.bluettipower.com**) has more comprehensive information about its technical specifications and features.

It has a solid, steel gray case with light gray lines separating the switchable operating functions. The carrying handle on the top of the case folds down flush into the case when not in use. There is a powerful light with a 7-inch-long white diffuser and a switch on the rear of the case. On the first press of the switch, the light is on low illumination; on the second press, it is on high, and on the third press, the light blinks SOS in CW.

Bottom Line

The Bluetti EB55 with its 700 Wh is the most powerful unit of the four we've reviewed. Plus, in case of an emergency, the integrated light can blink SOS in CW. It's the only unit that has a 15 W wireless charging pad on top of the case.

Display

Its front-panel layout is clearly marked, and it has a bright and easy-to-understand blue and white LED display that indicates input and output in watts and a graphic representation of a battery that displays remaining battery power in percentage. The display also indicates when the unit is in eco-mode (more on that later), and there are alert icons for low voltage, temperature anomaly, overload, and short circuits.

Inputs

The EB55's battery is charged by the supplied external charger. The charger has an LED that is red when the EB55 is charging and green when the battery is full. The 90 W charger can recharge the battery in approximately 3 hours.

For even faster charging, the EB55 has a dual charging system that can use two ac adapters at the same

time or with the ac adapter and solar panel at the same time. With these two fast charging methods, the charging time is significantly reduced. Bluetti claims a full recharge of 1.8 hours with the dual ac chargers. They also note that "the battery's charge/discharge cycle life is 2500 times, so there is no need to worry about the battery's life span due to fast charging."

The EB55 can also be directly charged from a car accessory socket or solar charging. For solar charging, the EB55 can support up to a maximum of 200 W solar power input. The recommended Bluetti PV200 solar panel sells for $499 on Amazon.

Outputs

There are thirteen different outputs on the EB55 that can provide power simultaneously. These include four 120 V ac outlets that provide 700 W. A nice feature is that two of these outlets are two-prong outlets, and two of them are three-prong outlets. There is one USB-C port at 100 W maximum and four USB-A ports at 5 V at 3 A maximum. A feature that is unique to the EB55 is a wireless 15 W charging pad on top of the case. This is a handy feature for charging a smartphone without a cable.

In the dc output section of the front panel, there are two DC5521 barrel connectors that can supply 10 A at 12 V and one car accessory socket that also supplies 10 A at 12 V. There are protective rubber covers over the dc input connectors and the car accessory socket.

The EB55 has an eco-mode setting that improves energy efficiency. When enabled, the ac output automatically turns off the EB55 after an hour when the output is less than 10 W or when there is no load present.

I used the car accessory socket to supply power to my IC-7300 for about an hour on FT8 at 40 W RF output with no problems. However, when I used the Bluetti as a 110 V ac source to power my Samlex power supply, it produced RFI on some of the HF bands and 6 meters. This may be specifically related to my individual setup, as the ARRL Lab tested otherwise for this unit (see *QST* in Depth at **www.arrl.org/qst-in-depth** for the full testing results).

Summary

The EB55 is a good choice if you are looking for a power station with 700 Wh power, many charging options, and other helpful features. It can be used with a 200 W solar panel, and it has the most outputs of any of the power stations. It comes with a 24-month warranty.

Manufacturer: Bluetti Power, 6185 S. Valley View Blvd., Ste. D., Las Vegas, NV 89118, **www.bluettipower.com**. Price: $399.

EcoFlow RIVER 2 Max Portable Power Station

The EcoFlow RIVER 2 Max is a squarish two-tone gray power station that weighs 13.4 pounds. The front panel is dark gray, and although it is well labeled, I found the small, light gray labels hard to read in low light. Its substantial carrying handle is integrated with the top of the case on the rear of the cabinet. While this arrangement is different from the other power stations, I found it easy to carry and transport. However, sometimes it felt like it was going to land on its front panel when I put it down.

The box contains an ac charging cable, a car charging cable, a DC5521 connection cable, and a quick start guide that is well written and illustrated. However, there is limited technical information beyond basic connections and specifications. The EcoFlow website (**www.ecoflow.com**) has expanded technical and operating information. It is also the least expensive reviewed power station.

Bottom Line

The EcoFlow RIVER 2 Max claims that it can go through 3,000+ charge cycles during a period of 10 years before reducing to 80% battery power. This model is the fastest-charging unit of the four we've reviewed; it can fully charge its battery in only 70 minutes.

The RIVER 2 Max uses a 512 Wh LiFePO battery that EcoFlow claims can go through 3,000+ charge cycles for about 10 years before reducing to 80% battery power. It also has a 1000 V "X-Boost" mode if more power is needed. Like all of the power stations, it includes an advanced battery management system.

Display

The front panel has a bright and readable display with large numbers that show charging time, charge time percentage remaining, and input and output power in watts. The display also has warning icons for overload, battery charging temperature, and other critical functions. There are no voltage or amp labels on the front except for the one USB-C connection that is labeled **100 W**. The rear of the case has an ac outlet for charging and a dual pin socket for a solar panel.

Inputs

To charge the EcoFlow's battery, just plug in the supplied ac cord. It has the fastest charging system of any of the power stations that I tested, with the capability of fully charging its battery in only 70 minutes using what EcoFlow calls "X-Stream" fast-charging technology. Along with 110 V ac charging, the EcoFlow can be charged using a car accessory socket, USB-C charging, and solar charging with an EcoFlow 220 W solar panel. I noticed a big increase in RFI on the HF bands and 6 meters when it was being charged. I did not see or hear any RFI when it was not on ac charging.

Outputs

On the front panel, there are three USB-A outputs and one USB-C input or output. There are also two grounded ac outlets and two ac non-grounded outlets. There is a car accessory output with a rubber cover that provides 12 V at 10 A and two dc barrel connectors. Separate switches control each type of power.

Summary

I used the EcoFlow during a POTA activation at Sleeping Giant State Park (K-1717) in Connecticut for more than an hour using the car accessory socket with my Icom IC-7300 at 40 W SSB and FT8. After a little more than an hour's use, the EcoFlow's battery still showed 92% power, and the voltage was still above 13 V after about 20 SSB and 20 FT8 QSOs.

There are two unique features of the EcoFlow RIVER 2 Max. First, it can be controlled by a smart app. There is a QR code on the back of the unit that takes you to the website to download the app, which controls the EcoFlow via Wi-Fi or Bluetooth. According to EcoFlow, you can use their smartphone app to control and monitor charging levels, customize settings, and adjust charging speeds.

Second, the EcoFlow has an automatic switchover system that changes from commercial power to its internal power when commercial power is lost. EcoFlow claims a switchover speed of less than 30 ms. The EcoFlow comes with a 5-year warranty.

Manufacturer: EcoFlow Technology Inc., 1687 114th Ave. SE, Suite 101, Bellevue, WA 98004, **www.ecoflow.com**. Price: $469.

Bioenno Power 500 Wh Renewable Power Pack (BPP-M500)

The Bioenno BPP-M500 is a 520 Wh 750 W peak power station that uses a lithium-ion (NCA) battery. It's about the size of a conventional car battery and weighs 14.3 pounds. It has a black case with bright white letters and markings. The case has a heavy-duty top-mounted pull handle.

In the box there is a 90 W external ac charger. Bioenno states that the battery offers 2,000 charge cycles and takes about 8 to 10 hours for a full charge. Also included in the box are four round male dc barrel connec-

Bottom Line

Although Bioenno Power is well-known by hams, the company doesn't necessarily recommend the BPP-M500 for ham radio applications, but it can do the job. They also offer dc battery products, such as LiFePO batteries, that are more suitable for portable ham radio applications.

tors-to-Powerpole adapters, one dc jack connector to Powerpole, and one car accessory socket-to-Powerpole adapter. There is also a separate dc-to-dc converter included that raises the dc voltage to 13.8 V that Bioenno says can be used for "QRP radio applications."

Display

The display has a visual bar graph of battery output. There are no numerical ratings of power, voltage, or current on the front panel. When ac power is switched on, the letters **AC** appear in the display with a graphic of a sine wave. When dc is switched on, it displays the letters **DC** and a dc connector symbol. Unlike the other power stations, there is no indication of input or output in watts.

Inputs

There are two input connectors on the BPP-M500. A dc barrel connector is provided for the ac charging adapter, and a pair of Powerpole connectors connect to a solar panel. The solar panel output cannot exceed 6 A, and Bioenno sells a 100 W foldable solar panel, BSP-100-LITE, for $209.99.

Outputs

The Bioenno power pack has one 110 V ac outlet that can provide a maximum of 500 W. There are no protective covers over any of the connectors. There are four dc barrel jacks intended for "no more than 6 A" per jack. There are four USB outputs.

Summary

The Bioenno BPP-M500 appears to be more of a commercial or industrial power pack rather than a consumer model. I could not run more than 30 W RF output from the IC-7300 using either the car accessory socket or the supplied dc-to-dc converter. In all fairness, Bioenno does state in the user manual that "this unit is not intended for use with ham radio applications." They suggest that you keep the power below 30 W. It is worth mentioning that Bioenno Power is well-known by amateur radio operators for offering many other dc power products (such as the BLF-series LiFePO batteries) that are more suitable for portable ham radio applications. When I connected my Samlex power supply to the ac outlet on the BPP-M500, the IC-7300 worked fine at 100 W PEP with no discernible RFI.

Manufacturer: Bioenno Power, 3657 W. McFadden Ave., Santa Ana, CA 92704, **www.bioennopower.com**. Price: $499.

Conclusion

In summary, these power stations are lithium-ion battery-powered and are easy to use and connect ac and dc portable power supplies. They are not user serviceable, and their technical documentation does not provide much information.

They can be charged in a variety of ways, including solar power. While they are principally designed to power devices outdoors, these 500 Wh models can supply ac home backup power for low- to medium-power devices in the home or in the field, including amateur radio transceivers. For amateur radio usage, using the (car) accessory socket output, they can supply 12 to 13 V limited to 10 A or 120 W. This limits the RF output of most amateur radio transceivers to 30 to 40 W, which is perfectly acceptable for POTA, VHF/UHF mobile, or QRP transceivers.

Another method of powering an amateur radio transceiver with a power station is to use an external 110-V-ac-to-13.8-V power supply plugged into the power station's ac outlet. This will provide about 500 to 700 W at 110 V, which is enough power to run 100 W RF output.

Another approach to powering an amateur radio station with portable dc power is to buy a battery that is designed for communications applications, a battery charger, a metering device, connectors, and cases. I use a Bioenno 12 A lithium-ion battery in a Powerwerx battery box that provides all of these functions for my POTA activations. If you want to use solar power, you will need to purchase an external solar panel (solar panels are optional for power stations as well) and a solar power controller. This system involves choosing the individual devices and connecting them. An operator can customize this system to suit their needs. However, it would not be as easy to purchase, store, transport, or set up as a power station.

The selection of a particular power station for amateur radio use depends on price, operational ease, size, and weight. Electrically the selection depends on the number and type of inputs and outputs, power output in watts, battery capacity in watt hours, and how many devices you connect and run simultaneously. An operator can run a portable amateur radio station, particularly at 100 W or less RF power levels, for a long time, especially with solar power options.

See *QST* in Depth for More!

Visit www.arrl.org/qst-in-depth for the following supplementary materials and updates:

- ✓ Complete results of the waveform tests, no load and full load tests, and conducted emissions tests, which were performed by the ARRL Lab for all units
- ✓ Portable Power Stations Lab Notes