QST

Product Reviews

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Product Reviews:

Mark J. Wilson, K1RO, k1ro@arrl.org

MFJ-5008 Ultrasonic Receiver

A useful tool for pinpointing power line noise sources

Reviewed by Mike Gruber, W1MG
ARRL Laboratory
RFI Engineer
w1mg@arrl.org

Without a doubt, power line noise is the single most frequent source of interference reported to the ARRL Lab. Typically it is caused by arcing on power lines and utility-related hardware. The FCC rules regarding power line noise are clear. Power lines and related hardware are classified as *incidental radiators* under Part 15. These are the FCC rules that pertain to unlicensed sources of RF. In a nutshell, these rules prohibit power lines and related hardware from causing harmful interference to licensed radio services, including Amateur Radio. If and when interference occurs from an incidental radiator, and in fact most Part 15 devices, the rules place the burden on the operator of the offending device to correct it. In the case of power line noise, this is most likely your local utility.

For a variety of reasons, power line noise is one of the most difficult interference problems to resolve. In fact, we've seen some cases drag on for more than 10 years without resolution. Further adding to the frustration, many utilities lack the equipment and expertise to address a complaint in a timely fashion. Frequently the noise is intermittent and weather-related. Since locating a noise is only possible when it's active, attempts by utility RFI investigators can often be a hit or miss proposition. This can be especially true if the noise is more likely to be active at odd times, such as nights or weekends. Even under the best of circumstances, power line noise can often test the patience and resolve of almost any ham.

Given the difficulty in resolving many of these cases, it isn't surprising that hams attempt to expedite the process by helping their utility find the sources. This is usually accomplished by using radio direction finding (RDF) techniques to track the noise down to the source pole or poles, typically using VHF or UHF in AM mode once in range of higher frequencies.[1] Since power line noise is typically caused by arcing, and each source has its own unique pattern when viewed in the time domain, so-called fingerprint or signature analysis can be used to conclusively link specific offending noise sources causing the actual problem.

As good as RDFing and signature analysis are for finding structure with the noise, you still haven't located the actual source. Furthermore, the offending hardware on a structure is seldom obvious by eye. Even a relatively simple utility pole can exhibit a multitude of potential and likely sources. Practically speaking, once the source pole or structure has been identified, some means is needed to identify the actual offending hardware on it.

Bottom Line

The MFJ-5008 ultrasonic receiver is an affordable and useful tool for pinpointing faulty or loose hardware on a utility pole once that pole has been located.

The Last Step

Professional RFI investigators typically use one of two methods to locate a noise source on a utility structure. The first requires what is commonly referred to as a "hotstick line sniffer," which is an insulated pole with detectors to find and pinpoint noise sources. Since this device requires a hotstick and is operated from a bucket truck, it can only be used by qualified utility personnel. The other method requires an ultrasonic dish or "parabolic pinpointer." This device can be operated safely from the ground and a hotstick is not required. This is, therefore, the only option suitable for hams and other non-utility personnel. *Caution*: Never bang on poles or related hardware. See the sidebar, "Use Common Sense."

Use Common Sense!

Never strike a utility pole or yank on guy wires to check for loose hardware. These practices can not only create new noises but silence the very one that you are looking for. Even worse, falling hardware or a downed line can cause injury or worse. Keep in mind that the noise is caused by a fault on that pole. The same holds true for climbing a pole or putting a ladder up against it for a closer look: *don't even consider it!* While these situations seem unlikely, they have actually happened. Please use common sense and stay clear! An ultrasonic dish is an excellent tool for troubleshooting poles, and for a closer look, use binoculars.
— Mike Gruber, W1MG

Table 1
MFJ-5008 Ultrasonic Receiver

Current consumption: 34 mA max at 9.3 V dc.
Weight: 2.1 pounds (with battery and headphones).
Size (height, width, depth) including protrusions: 19.8 × 18.8 × 6.9 inches.
Price: $170.

Test Notes:

1) Receiver has reduced sensitivity when the battery voltage reaches 8 V dc. At that point it's time to replace the battery.
2) Picks up arcing noise sources up to 125 feet, provided there are no obstructions between the receiver and the source. The arcing source used for the range test was a Model-T spark coil with a ⅛ inch spark gap. A professional grade RADAR Engineers Ultrasonic Receiver picked up the arcing source 200 feet away.

Professional-grade ultrasonic pinpointers are typically beyond the budget of the average ham. While amateurs have built their own, some parts can be difficult to obtain.[2] We have looked at entry level ultrasonic kits over the years, but many of them seemed to be of marginal use for locating power line noise. Finally, here is a ready-made and useful ultrasonic locator with the typical amateur in mind — the MFJ-5008.

Initial Impressions

Fresh from the box, the MFJ-5008 includes an ultrasonic receiver mounted on the back of a parabolic dish, a headset, and a 9 V battery. No manual was included, but an enclosed paper provides the URL for a PDF download.[3]

As one might expect, the parabolic dish, approximately 18 inches in diameter, is the instrument's most prominent feature. An aluminum tube fastened to a bracket to the rear of the dish serves as a convenient handle. Also mounted on the opposite side of the tube is a plastic case for the receiver electronics (Figure 1). Just slightly larger than a deck of cards, this case includes the receiver's battery compartment. Its bottom surface features the receiver's only control, a knurled thumbwheel, that serves both as an ON/OFF switch and volume control. Also included is a red LED pilot light and the headset jack. A vertical bracket across the entire front of the dish holds the ultrasonic transducer. Fastened to the bottom of the front bracket and dish is a base for support. When used in conjunction with the bottom of the handle, it maintains the entire instrument in a convenient upright position when not in use.

Figure 1 — The MFJ-5008 ultrasonic receiver is mounted to the back of the dish.

I found using and operating the MFJ-5008 to be surprisingly intuitive. The handle grip felt comfortable and well positioned. I could operate the switch and volume control with my thumb while gripping the handle with one hand. Aiming the receiver's dish is accomplished by aligning a pair of peep sights through the front and rear brackets. Once the dish is pointed in the direction of maximum noise, you can see the source by looking through the two holes. While I would have preferred sighting through a clear transparent dish for better visibility, I found the peep sight through an opaque dish adequate for the task. The MFJ-5008 was also light enough that I could maintain a steady aim without undue fatigue or discomfort, even after several minutes of use.

As expected, the eight-page manual provides instructions for basic operation. I was also pleased to see that it includes a general overview on how to locate sources of interference — including a paragraph on finding noisy consumer devices. While the power line noise discussion is both adequate and accurate, it is by no means complete. The manual recommends additional sources for more complete information on the subject, including ARRL and Internet sources.

The manual also includes several paragraphs on the receiver's theory of operation and a complete schematic diagram. Here's how it works: A transducer picks up the ultrasonic sound in the vicinity of 40 kHz with a 3 dB bandwidth of about 2 kHz. It is then amplified and mixed with an oscillator set to about 42 kHz. The range of 38 to 42 kHz is then down converted and heard as 0 to 4 kHz audio.

We Take to the Parking Lot

Our first test was a comparison between the MFJ-5008 and a professional-grade ultrasonic pinpointer. The ARRL Lab's test engineer, Bob Allison, WB1GCM, provided a target source for this test — a vintage Model T spark coil. Unlike modern spark coils, the Model T coil used a magnetically activated vibrating switch that is ideal for generating a continuous high voltage. With a pair of carefully adjusted nails mounted on it for the gap, we began our initial testing in the W1AW parking lot.

Bob and I initially started this test at about 25 feet away from the source. We then swapped the MFJ-5008 and the professional grade instrument between us a few times and noted any differences between them. Next, we continued this process while gradually increasing the distance between us and the source. At about 125 feet, we lost the ability to hear this particular arc with the MFJ-5008. This is in the window of expectation, based on the manual, which indicates a typical range of 100 to 200 feet depending on the level of acoustic noise. We were also able to verify the receiver's accuracy per the manual's claim of being within a foot or so at 30 to 50 feet. While the professional-grade instrument was able to hear the arc at more than 200 feet, and it provided improved accuracy, we both agreed that the MFJ-5008 should get the job done.

I was now eager to try it during an actual power line noise interference investigation. I didn't have to wait long.

Ultrasonic Limitations

An ultrasonic receiver uses a microphone to receive ultrasonic sound waves. Although it is not a radio receiver, it is the amateur's tool of choice when locating an arcing source of RFI on a utility pole *once the pole has been identified.* It is not suitable for locating the pole — only the arcing hardware on the pole once it has been located. This key concept is often misunderstood by hams. Other limitations include:

- Ultrasonic receivers require an unobstructed and direct line of sight between the receiver and the arc in order to hear the noise. This means that you will most likely need to carefully "look" for the arc using a variety of angles and positions from the ground before finding it. The receiver will not work if there is anything between you and the arc. *Helpful Tip:* You can also use this phenomenon to your advantage. While focused on the source, use an object on or around the pole to block your line of sight to the suspected source. If you block the view of the source the noise will be attenuated. As you move back into line of sight of the problem area, you will hear the noise again. Triangulation using this method will improve your accuracy!
- Ultrasonic receivers will hear both arcing and corona discharge. Although it can be difficult to tell them apart just by their ultrasonic sound, corona is rarely a source of power line noise. If you are not careful, this can actually lead to confusing and erroneous false positives. Always try to verify the source pole using an RF receiver, and if the noise is intermittent, do so while simultaneously listening to the source with the ultrasonic receiver. The noise should come and go in unison. If not, you have not located the correct source. I also make a point of searching the entire pole for sources. It's quite possible to misidentify corona as an arcing source if they both occur on the same pole. Do not be fooled by corona!
- Ultrasonic receivers work best on calm days. Wind can create unwanted noise, and if excessive, you'll not be able to use your receiver for its intended purpose. *Helpful Tip:* On windy days, and if it is safe, move to a position that allows the use of your vehicle doors to block wind. — *Mike Gruber, W1MG*

One Morning at the Museum: Bob Allison Investigates

Our ham radio club at the Vintage Radio and Communications Museum of Connecticut was experiencing power line noise, so Mike Gruber, W1MG, and I drove to Windsor, Connecticut, to find it. Though I've watched Mike with his professional-grade ultrasonic receiver many times, I've only tried it once or twice, so I consider myself a novice at locating arcing sources. After we located the troublesome pole (across the street from the museum) using a UHF receiver in AM mode, we both tried finding the defective hardware on the pole. Mike used his professional-grade ultrasonic receiver and I used the MFJ-5008.

Once Mike found the noise source, he smiled but refused to tell me what he found. After circling the pole twice while aiming at various pole components and mindful of passing pedestrians and automobiles, I determined the arcing was coming from the top of a fuse holder for one of the power lines that feeds the museum building. Mike confirmed my conclusion and I had my first power line noise find under my belt. I later contacted the utility company, explained the problem, the faulty hardware, the location, and pole number.

The sound in the headphones that indicated the arcing source was only a slight crackling sound, just above the hissing of the background noise. This was in contrast to the considerably louder headphone response while aimed at the Model-T Ford spark coil spark gap we used in our initial tests. This means the bigger the spark and/or the closer you are to the arcing, the louder the response in the headphones will be. I recommend patience and practice when locating arcing noise sources with the MFJ-5008. — *Bob Allison, WB1GCM, Assistant Laboratory Manager*

Helping a Friend

As luck would have it, a friend contacted me concerning a power line noise problem right in my home town! Based on the noise signature, I concluded that there was only one primary source. Next, the affected ham, Bill, and our mutual friend Rich joined me as we walked in the direction of the noise. We then RDFed the offending pole, which was a little over a half mile away. And since the signature at the pole was a match for the one at Bill's station, there could be no doubt that we had found the right pole.

We were now ready to try the MFJ-5008, which brings me to an important safety tip. I often find traffic to be a significant safety hazard when investigating power line noise, especially when using an ultrasonic receiver. For this reason, I recommend a high visibility vest and a second person to spot traffic during the hunt. This particular pole, however, was located on an unpaved road with virtually no traffic. We were lucky.

Using the MFJ-5008, I was able to quickly identify the source of the noise to be in the area of an insulator at the top of the pole. I used several positions from the ground before confirming my conclusion with a professional-grade ultrasonic receiver. While the MFJ-5008 did the job, I might suggest that some practice is in order, particularly with regard to the gain adjustment. My initial gain setting had been too low, and the arc only produced a subtle increase in what I might describe as background noise. Although increasing the gain improves the ability to hear the arc, I suggest trying it with a known source before taking it in the field. In particular, you'll want to get a good feel for the sound of an arc as well as proper control settings.

Over the years, I've used ultrasonic receivers for pinpointing these problems with great success. For someone with less experience using ultrasonic devices, I once again turned to Bob Allison for help. See the sidebar, "One Morning at the Museum: Bob Allison Investigates," for his comments.

See the Digital Edition of *QST* for a video overview of the MFJ-5008 Ultrasonic Receiver.

Conclusion

The MFJ-5008 is an affordable and useful product for anyone afflicted with a power line noise problem. With some practice, it can be used to pinpoint faulty or loose hardware on a utility pole once that pole has been located. For best results, we recommend additional sources of information on locating power line noise.

While not attempted during this review process, the MFJ-5008 would probably be handy for finding arcs along an electric fence. It might also appeal to nature lovers who might enjoy listening to insects and bats.

The author wishes to acknowledge and thank Mike Martin, K3RFI, of RFI Services (**www.rfiservices.com**) for his assistance with this review.

Manufacturer: MFJ Enterprises, PO Box 494, Mississippi State, MS 39762; tel 800-647-1800; **www.mfjenterprises.com**.

Notes

[1]Power line noise can be heard at progressively higher frequencies as the observer approaches the source. For example, for a noise that affects 80 and 40 meters, the source can be miles away. If the source can be heard at 2 meters and 70 centimeters, it is likely to be within 1500 feet or so. Once in range, good practice dictates the use of VHF or UHF (AM mode) to identify correct pole. Small handheld Yagi or similar antenna is ideal for this purpose. You'll also need a step attenuator or RF gain control to continually minimize the signal as you approach the source. See the 3rd edition of *The ARRL RFI Book* for more information.

[2]See "A Home-made Ultrasonic Power Line Arc Detector" by James T. Hanson, W1TRC, *QST*, Apr 2006, p 41, for complete details on building an ultrasonic pinpointer. Feedback appears on page 99 of the June 2006 issue.

[3]Links to PDF versions of all MFJ manuals, including the MFJ-5008, can be found at **www.mfjenterprises.com**.

LabNation SmartScope Model A14

Reviewed by Martin Ewing, AA6E
aa6e@arrl.org

An oscilloscope should be on every ham's workbench. With a scope, you can measure voltage and current waveforms, view distortion and timing, and do many other checks. Alas, scopes for ham/RF work are generally not inexpensive.

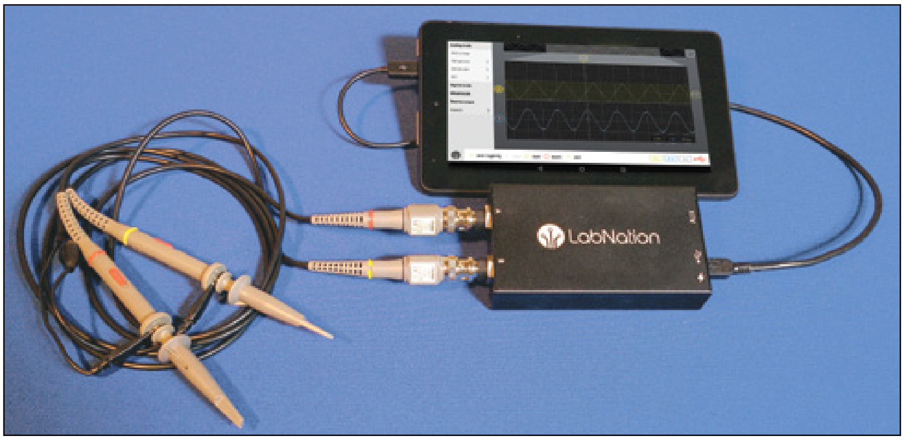


Figure 2 — LabNation SmartScope with probes and Kindle Fire tablet.

The LabNation SmartScope model A14 is a small, cost-effective device that has dual BNC analog inputs and a USB connection to your PC, Macintosh, or Android device, where a SmartScope application program handles oscilloscope control and display. (An Apple *iOS* app is available for some older *iOS* versions. It requires the iOS device to be "jailbroken" to bypass the restrictions Apple puts on the operating system.)

With this setup, you get a dual-channel scope that has millivolt sensitivity and bandwidth to approximately 20 MHz. Supplied scope probes offer ×1 or ×10 at-

Bottom Line

The LabNation SmartScope is a software controlled dual-trace, 20 MHz oscilloscope, logic analyzer, and waveform generator that works with a wide variety of operating systems and devices.

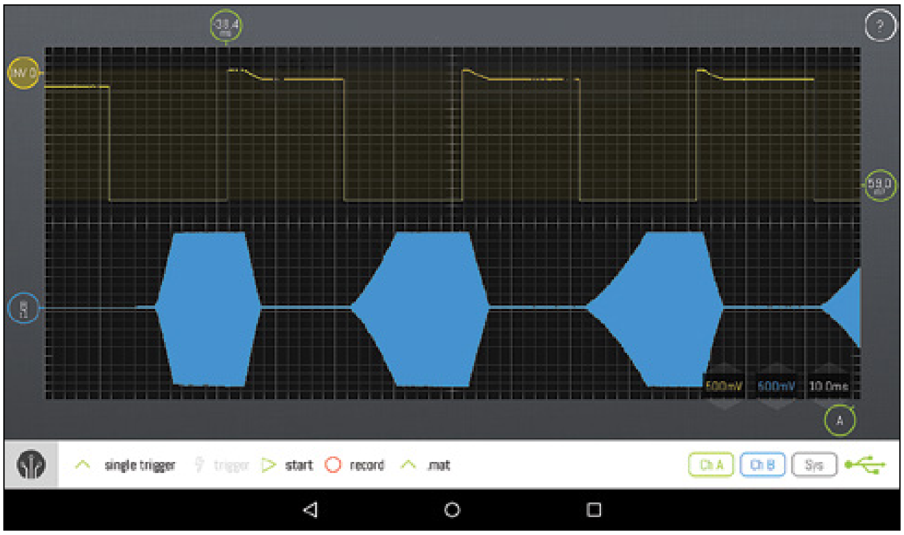


Figure 3 — Screenshot from Kindle Fire connected to LabNation SmartScope showing typical keying delay for an HF transceiver. The top trace is the keying signal (active low) and the bottom trace is the transmitter output, a 14.086 MHz RF envelope.

tenuation with a nominal 5.8 ns rise time. The sweep can be triggered internally from either input channel. (There is a separate external trigger input, but the current software does not support it.) Internal RAM stores up to 4 million samples per channel, allowing for situations where you want to see a signal that may come a long period after a trigger event. You can store data on your desktop or handheld device in .csv (comma separated value) or .mat (MATLAB) formats.

The SmartScope supports several additional operating modes. Instead of the second analog channel, you can connect up to eight independent digital signals with on/off 3.3 V or 5 V levels, 100 megasamples per second (Ms/s). In this mode, you have a digital logic analyzer that you can use to diagnose digital equipment. The SmartScope app supplies a number of handy protocol decoders for I2C, SPI, and UART applications, or you can write your own custom decoder.

Finally, the SmartScope can serve as an arbitrary waveform generator (AWG). In analog mode, you can set the AWG to cycle through up to 2048 data points at up to 50 Ms/s. Output is in the range 0 – 3.3 V. You can use those signals for checking noise reduction in receivers, intermodulation in transmitters, and for many other situations. (A 4-bit digital pattern generator is also provided in hardware, but it is not supported in current software.)

Digital oscilloscopes are subject to several problems that will be new to users of traditional analog scopes. For example, what is the scope's bandwidth? While the input probes and amplifiers are specified to have good response to 30 MHz (–3 dB), the sampling rate is 100 Ms/s. That means that you may see beats and waveform distortion if you work at (say) 20 MHz or above.

Version Tested

SmartScope serial no. 0253403EA16
USB controller v. 0.0.4
Scope controller 641CDEB7
Software v. 0.6.0.1 – 0.7.0.0

There is a similar problem with triggering. With 100 MHz sampling, the scope trigger will only be on steps of 10 ns, leading to jitter in some cases. LabNation provides an "Equivalent Time Sampling" mode that helps interpolate and stabilize triggering when you are viewing periodic signals.

The upshot is that if you want good signal fidelity in an oscilloscope display, you need sampling rates and trigger precision much higher than you might expect for a given signal bandwidth (higher than the Nyquist rate, for example).

Computer Connections

We tested the SmartScope software on a number of computing environments, including *Ubuntu Linux*, *Windows 7*, and Android, but we were unable to test it on *MacOS* or *iOS*. The software is very similar on all the tested platforms. You can control the vertical and horizontal scales, triggering levels, and other parameters by intuitive use of a touchscreen, mouse, or keyboard, depending on what your device supports. A handy on-screen help page prompts you on the basics.

Connecting your tablet or smartphone requires a special USB OTG ("on the go") cable. Many but not all devices support OTG operation. (Check with your vendor or run a free "OTG Checker" app.) We found that all three Android devices at hand did support the SmartScope through OTG: The Nexus 5 phone, the Samsung Galaxy Tab S 8.4 SM-T700 tablet, and the Amazon Kindle Fire (5th gen, 7-inch screen). The Kindle is particularly notable as it is available for less than $50, but you have to "sideload" an apk file to install the software.

The 7-inch format is fairly comfortable for folks with normal vision and finger size. I found the 5-inch Nexus rather too small to view and too hard to manipulate, although it ran the SmartScope nicely. The SmartScope takes only a small amount of power from the USB controller, so it's quite possible to operate this package in a remote location.

This product was originally financed through a KickStarter campaign in 2014. That launched an initial run of 2500 SmartScopes. A prospective buyer needs to consider whether support for the product will continue in the long term — just as with any other low-volume, specialty supplier. On the plus side, the SmartScope schematics, some software, and the API (application program interface) are open source. Users are encouraged to develop their own code for special applications.

The LabNation SmartScope makes a fine addition to your electronics bench. As a good dual-channel scope, it's worth the price. With the logic analyzer and waveform generator, you have a versatile modern electronics lab in a small and economical package.

Manufacturer: LabNation (**www.labnation.com**, **info@labnation.com**). Also available from US distributors TEquipment (**www.tequipment.net**) and Circuit Specialists (**www.circuitspecialists.com**). Price: $229.

MFJ-845 SWR/Wattmeter

Reviewed by Harold Kramer, WJ1B
wj1b@arrl.net

Monitoring your power and SWR independent of the metering on your transceiver is a good operating practice. To accomplish this, most of us have a separate SWR/power meter available for use in the shack or with portable or mobile equipment. The MFJ-845 and MFJ-847 offer some new options for small, lightweight digital SWR/wattmeters. The MFJ-847 has a frequency range of 125 to 525 MHz and it measures power up to 120 W. The MFJ-845's frequency range is 1.6 to 60 MHz (160 meters to 6 meters) and it can measure power up to 200 W. I tested the MFJ-845 for this review.

Overview

The first thing that I noticed about this meter is its small size. It's only about 4 inches wide by 3 inches high and 1 inch deep, and it weighs just half a pound. It fits comfortably in my hand, particularly since the front corners are slightly rounded to make it easy to grip.

The MFJ-845's case is black with clearly labeled white letters. There are two small slide switches on the front, one for POWER and one to turn on the LIGHT (display backlight). SO-239 connectors are mounted on either side of the meter, one for the transmitter connection and one for the antenna. MFJ wisely chose SO-239s for the coax connections, rather than BNCs that would take up less room but would require adapters when used with most HF gear. I also appreciate MFJ putting the transmitter input on the left and antenna connection on the right. Some meters position them differently. Another nice feature is that the unit can stand upright for easier viewing.

The meter's LCD screen is about 2¼ inches wide. The LCD displays digits that are about ½ inch tall for forward (FWD) power and ⅝ inch tall for the reflected (REF) power and SWR digits. The LCD numbers are easy to read and indicate to two decimal points. The LCD background is gray with black letters but the LIGHT switch turns on an amber backlight. To save power, the background light will turn off after 30 seconds if no signal is present and turn on again when a signal is applied. This is a nice feature to conserve batteries, but I found it a little annoying when operating in my shack under low light. The display is easy to read when you are facing it directly, but like most LCD screens, it dims when viewed at an angle. This is also a "barber pole" battery level indicator on the right hand side of the screen.

The meter is reasonably accurate, according to the ARRL Lab tests shown in Table 2. The power meter reads a little optimistically, depending on the band and power level. There is no provision for calibration indicated in the instructions, and neither the Lab staff nor I wanted to open the case and examine the circuit board for such a provision. The MFJ-845 also exhibits very low insertion loss of 0.02 to 0.03 dB.

Using the MFJ-845

The meter is powered by two AAA batteries that fit snugly inside its rear com-

Bottom Line

The MFJ-845 is a compact, easy to use basic wattmeter. Its small size makes it an option for portable or mobile operation.

Table 2
MFJ-845 Digital SWR/Wattmeter, S/N 45025

Specified frequency range: 1.6 to 60 MHz.
Specified power range: 0 to 200 W ±5%.
Measures: Forward/reflected power and SWR.
Power requirements: Two AAA batteries or Micro USB.
Current consumption: 33 mA (backlight off); 97 mA (backlight on).
Size (height, width, depth): 3.0 × 4.0 × 1.2 inches. Weight: 9 oz.
Price: $99.

ARRL Laboratory Measurements

	----------- MFJ-845 Power Display -----------			
Forward Power	**1.8 MHz**	**14 MHz**	**28 MHz**	**50 MHz**
5 W	5.0	6.1	6.2	6.2
50 W	49	56	56	56
100 W	99	115	115	114
Reflected Power				
5 W	4.4	5.5	5.5	5.4
50 W	47	54	53	53
100 W	94	110	106	106
	------------ MFJ-845 SWR Display ------------			
SWR (Resistive Load)	**1.8 MHz**	**14 MHz**	**28 MHz**	**50 MHz**
1:1	1.0	1.0	1.0	1.0
2:1 (25 Ω)	2.42	1.87	1.80	1.72
2:1 (100 Ω)	1.47	1.41	1.46	1.07
3:1	3.10	2.96	3.11	2.57
4:1	6.60	6.01	5.74	3.89
Insertion loss (dB)	0.02	0.02	0.03	0.03

partment. It can also be powered using an enclosed USB-to-Micro USB connector that plugs into any USB charging device, such as a smartphone charger or computer. The USB cable does not charge the batteries! There is no auto-off circuit — the unit must be turned off with the POWER switch or the batteries will drain. The meter only consumes 33 mA of current with the light off, but still you don't want to be confronted with dead batteries when you have not used it for a while.

I used the MFJ-845 at my station with my Icom IC-756PROII and G5RV antenna. The meter performed as expected, reading a little high compared to my ARRL Lab calibrated Daiwa wattmeter. I wish that the meter had a provision for either a peak-hold or an average power function. It reads instantaneous power, so once you stop transmitting, the reading goes to zero.

A single-page instruction sheet is enclosed, but some additional information, particularly about the powering options, would be helpful. Some minimal instructions, in tiny type, are printed on the rear of the meter, but they assume that you know how to use this type of device. It would be nice if an optional case were available, particularly since MFJ notes in its instructions that the '845 is "Not for bad weather — Keep protected from the elements."

Along with indoor use, the MFJ-845 would work well for go-kits, portable, or mobile operation, particularly because it can be powered by AAA batteries or any USB charger. At half a pound, it might be a little too heavy for backpackers. It is accurate enough for most Amateur Radio applications and the 200 W limit is workable for most HF stations.

Manufacturer: MFJ Enterprises, PO Box 494, Mississippi State, MS 39762; tel 800-647-1800; **www.mfjenterprises.com**.

QSK llc TP-1 Touch Paddle

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

As much as I enjoy using mechanical iambic paddles for sending CW, electronic touch paddles have always intrigued me. Touch-sensitive switches have been available for decades, with capacitance switches being the most common type. They rely on the capacitive effect of a human body part — most often a finger — in proximity to a metal surface.

When it comes to CW paddles, the touch switch advantage is the lack of moving parts. The fixed paddles never require cleaning or adjustment, and they are utterly silent. The disadvantage, of course, is that touch paddles require a power source.

The TP-1

QSK llc is a relatively new player in the Amateur Radio market. Even so, their TP-1 touch paddle has already attracted substantial attention from the CW community.

The TP-1 circuitry is housed in a 2 × 1¾ inch black metal enclosure, which is attached to a thin, 9-inch-long padded platform with rubber feet beneath. Between the weight of your hand and the grip of the rubber feet, the entire assembly is stable on any smooth surface.

The actual paddles are each 1⅝ inches in length and 1¼ inches wide. They are extensions of the individual circuit boards with their surface-mount components. The board material is about 1⁄16 inch thick and exhibited little, if any, bending.

At the rear of the TP-1 (Figure 4) there is a coaxial dc power jack and a ⅛-inch three-conductor jack for the keying cable (provided with the TP-1). The keying output is optically isolated.

The TP-1 draws a mere 40 mA at 12 V. It is capable of operating with a supply voltage ranging from 8 to 24 V dc. While you can power the TP-1 from a battery or your station power supply, it arrives with its own ac "wall wart" supply.

Bottom Line

The TP-1 touch paddle is well made and easy to use, offering an alternative to traditional mechanical paddles.

Test Driving the TP-1

When I connected the dc power cable to the TP-1, green LEDs glowed on each paddle to indicate the key was up and running. According to the instructions, it actually takes about 200 milliseconds for the TP-1 to calibrate itself when power is applied. With that in mind, they advise you to avoid touching the paddles when you energize the TP-1 initially.

The TP-1 is shipped for right hand operation, but this can be easily changed by shifting the position of the enclosure. The individual paddles are dedicated to generating "dits" and "dahs," with "dits" on the left paddle and "dahs" on the right. Once again, this can also be easily changed by swapping the positions of the paddles.

Being a right-handed operator, I was completely comfortable with the default configuration. Within just a few minutes after extracting the TP-1 from its shipping box, I was banging out Morse code with my transceiver keyer in practice mode. The instructions caution that sending with a touch paddle may seem odd at first, and may require some practice, but I didn't find this to be the case. The TP-1 felt surprisingly "natural," closer to a mechanical paddle than I would have imagined possible.

It didn't take long before I decided that practice was over and it was time to take to the airwaves. I enjoyed several conversations at various speeds and found the TP-1 to be a pleasure to use. It provided consistently smooth operation with little fatigue.

Conclusion

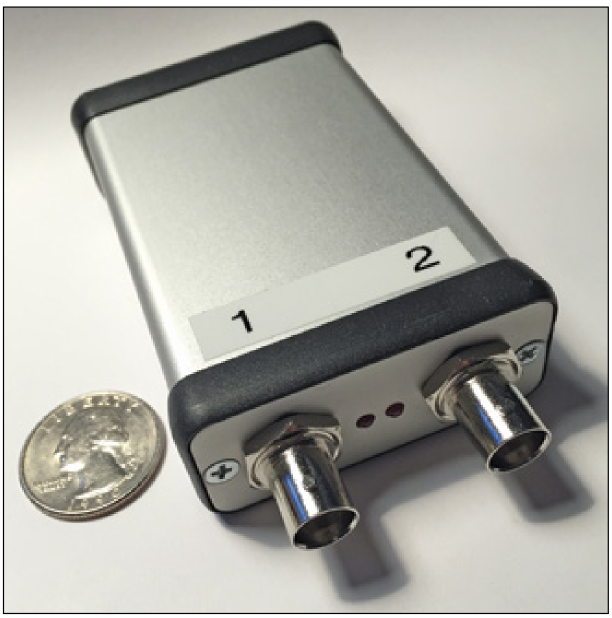
The performance of the TP-1 seems to rival the well-crafted mechanical paddles that I have tried. That's important to keep in mind when you consider the TP-1's price tag. At $159, including shipping, the TP-1 may seem expensive, until you realize that you'd have to pay the same or substantially more to achieve the same performance with a mechanical paddle.

Manufacturer: QSK llc, 14639 South Hawthorne Court North, Homer Glen, IL 60491; **www.qskllc.com**. Price: $159.

Figure 4 — A close-up view of the TP-1 showing the coaxial power jack and ⅛ inch stereo phone jack for the keyer cable.

Leo Bodnar Electronics GPS-Disciplined Oscillator

Reviewed by Pete Smith, N4ZR
n4zr@contesting.com



A favorite way of achieving high frequency accuracy for Amateur Radio purposes is through the use of a GPS-disciplined oscillator (GPSDO), which relies on the frequency and timing information provided by Global Positioning System satellites. Until recently, though, this has required a laboratory standard or a non-trivial amount of home-brewing skill, because reasonably priced existing hardware delivered only a 10 MHz reference signal. Receivers, transverters, and other equipment often require reference signals at other frequencies. For example, the QS1R software-defined receiver used by many participants in the Reverse Beacon Network requires a 125 MHz reference signal. Typically, this frequency conversion is achieved by use of a phase-locked loop which produces a precise 125 MHz signal locked to the 10 MHz reference, but such a unit has not been available in finished form except at very high, laboratory-grade instrument pricing.

Bottom Line

The Leo Bodnar Electronics GPS-disciplined oscillator offers a highly stable and accurate frequency source for amateur applications.

Recently, Force 12 CEO Bill Hein, AA7XT, took on US distribution for the Bodnar GPSDO, being manufactured by Leo Bodnar Electronics in England. Bodnar's business is mainly in the world of race car simulators, but he's also a ham (MØXER), so perhaps it should be no surprise that the device he has developed finds useful application in our hobby as well.

First, Why Bother?

Old-timers like me remember the ARRL Frequency Measurement Tests, BC-221 frequency meters, and crystal calibrators (well, "barely remember" might be more accurate). With those crude tools, measurement accuracies of tens of hertz at 30 MHz were very good. Now, however, it is easy to adjust a transceiver's frequency within a few hertz. A run-of-the-mill transceiver is capable of stability of ±5 PPM, and the best transceiver oscillators achieve ±0.5 PPM. Still, that amounts to 150 and 15 Hz respectively, at 30 MHz, or 720 and 72 Hz at 144 MHz. When you consider that standard WSPR (Weak Signal Propagation

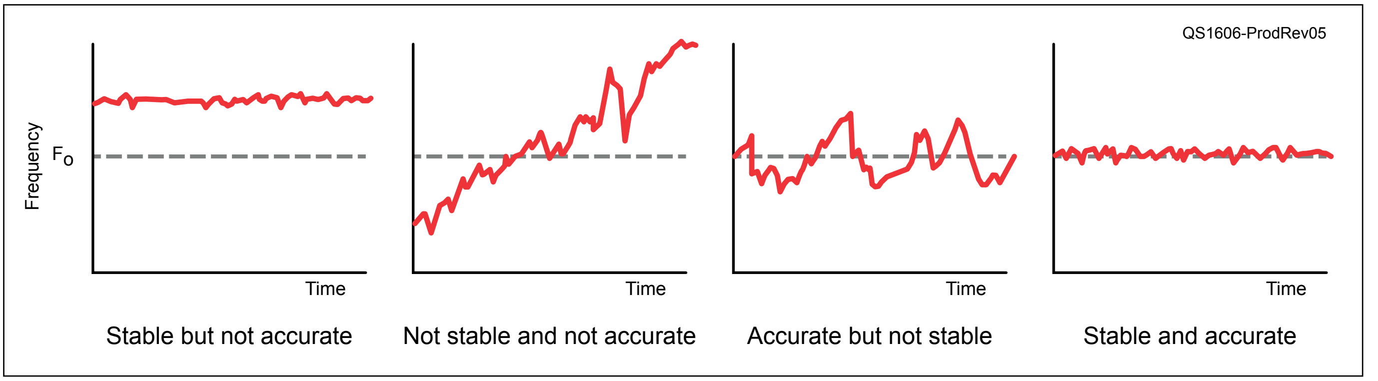


Figure 5 — The relationship between oscillator time and frequency. [Courtesy John Ackermann, N8UR]

Reporter) operation requires 4 Hz stability over a 2-minute transmission in order to decode accurately, and WSPR-15 needs sub-Hz stability over a 15-minute period, something better is needed — particularly in the stability dimension — to enable these very-low-signal modes

John Ackermann, N8UR, has published an excellent website on time and frequency from a ham's perspective (**www.febo.com/pages/stability/** is a good place to start). Figure 5 is drawn from his article, "Frequency and Stability in the Real World," and tells pretty much the whole story.

GPSDOs use the highly accurate time signal from GPS satellites to provide both stable and accurate reference frequency outputs. Both parameters are 1 part in 1 billion at worst, much better than even 2 meter WSPR-15 needs.

Use of highly accurate frequency and time standards also has the potential of offering important benefits for propagation research at VHF and even at HF. Among these are the identification and characterization of exotic VHF modes such as aircraft scatter and even wing-tip vortex scatter. At HF, it might be possible to see vertical movement of the ionosphere as a band is opening and closing, producing Doppler shifts that can be detected in WSPR waterfall displays. It should even be possible to do precise time-of-flight measurements, allowing observers to see how many hops a signal is taking, and at what altitude.

The Hardware

The Bodnar GPSDO is a tiny, nicely-packaged unit which is simplicity itself to operate. Supply 5 – 15 V dc at 130 mA, connect a standard active or passive GPS antenna to the SMA connector, and connect a USB cable to the rear of the unit (Figure 6). Then run the supplied *Windows* configuration software. Within a few minutes' time, you can have the unit delivering clean, precise RF on any frequency from 450 Hz to 850 MHz. The CMOS-compatible 50 Ω output is adjustable from +5 to +13.3 dBm; in my tests it worked with the QS1R "as is," and locked onto GPS satellites in just a few seconds. Once setup is complete, the computer connection is no longer required.

Figure 6 — One end of the enclosure has an SMA connector for a user-supplied GPS antenna, USB jack for connection to a computer for setup, and dc power jack. The two oscillator outputs are on the opposite end of the enclosure.

An enhanced version of the unit is also available through Force 12. It offers phase noise that is even lower than the excellent figure quoted for the standard unit. This could prove to be an advantage in extremely low-signal situations such as EME.

One unique feature of the Bodnar unit is the presence of two reference frequency outputs. They are not completely independent, however. For a given output frequency on Output 1, only certain frequencies can be provided on Output 2, and the options can be quite limited, making this feature less helpful than it might be. The setup software lets you specify a frequency for Output 1, and will then tell you what frequencies are possible on Output 2.

You can always have two identical outputs (10 MHz for example, or 125 MHz, or anything within the full frequency range), and in that case you can adjust their relative phase. This would allow, for example, providing high-quality I and Q local oscillator signals 90 degrees different in phase, to tame an otherwise drifty SDR.

A couple of caveats: there is currently no documentation for the unit other than what Bill Hein has provided on the Force 12 website, and no schematic. Bodnar is working on an improved version of the setup software, and documentation may follow, but I was not able to test the updated software. Still, the unit is simple to use and Bodnar's e-mail support is prompt, so if you need true frequency precision, this is a quick and easy way to start.

Manufacturer: Leo Bodnar (Electronics) LTD, Units 7 & 8 New Rookery Farm, Silverstone, Northamptonshire, NN12 8UP, United Kingdom; **www.leobodnar.com**. *US distributor*: Force 12/InnovAntennas America, 566 West Crete Circle, Unit 1, Grand Junction CO 81505; **www.force12inc.com**. Price: $250.